RoofKIT

solar decathlon europe 21»22
WUPPERTAL GERMANY

Project Manual

Karlsruhe, 23rd March 2022

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I. Summary of Changes

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III. Rules Checklist

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3.2 Team Officers & Contact Information	Team officer's contact information completely fulfilled in Table 2 (SDE21 WAT).	KIT_CON#6_2022_03_23.xls
4.3 Lot Conditions & attribution	Drawing(s) showing the storage and unloading areas and corresponding load's calculations.	SO-2001
4.3 Lot Conditions	Calculations showing that the structural design remains compliant even if there is a level difference, and drawing(s) showing shimming methods and materials to be used if needed.	ST-1001 ST-1301
4.4 Footings	Drawing(s) showing the locations and depths of all ground penetrations on the Competition site.	ST-1001
4.4 Footings	Drawing(s) showing the location, contact area and soil-bearing pressure of every component resting directly on the ground.	ST-1001
4.7 Construction Equipment	Drawing(s) showing the assembly and disa sembly sequences and the movement of heavy machinery on the Competition site and specifications for heavy machinery.	S0-3001 SO-3007 HS-1001-HS-1007
5.1 Solar Envelope Dimensions	Drawing(s) showing the location of all unit and site components relative to the solar envelope.	AR-4001
6.1 Structural Design Approval	Structural drawings and calculations signed and stamped by a qualified licensed professional.	KIT_DAP#6_2022_03_23.pdf, ST-001 - ST-2002
6.1 Electrical & Photovoltaic Design Approval	Electrical and Photovoltaic drawings and calculations signed and stamped by a qualified licensed professional.	KIT_DAP#6_2022_03_23-pdf
6.1 Codes Design Compliance	List of the country of origin codes complied, properly signed by the faculty advisor.	
6.2 Architectural Footprint	Drawing(s) showing all information needed by the Rules Officials to digitally measure the architectural footprint.	AR-4301
6.2 Architectural Footprint	Drawing(s) showing all the reconfigurable features that may increase the footprint if operated during Contest week.	

Rules Description	Contest Requirements	Drawings/Reports
6.3 Measurable Area	Drawing(s) showing the Measurable Area.	AR-4101
6.4 Entrance & Exit Routes	Drawing(Drawing(s) showing the accessible public tour route, specifying the entrance and exit from the unit to the main street of SDE21 Solar Campus. s) showing the Measurable Area.	PT-0001, PT-1001
7.3 PV Technology Limitations	Specifications and contractor price quote for photovoltaic components.	KIT_PS#6_2022_03_23.xsls
7.4 Batteries	Drawing(s) showing the location(s) and quantity of stand-alone, PV-powered devices and corresponding specifications.	EL-0001
7.6 Thermal Energy Storage	Drawing(s) showing the location of thermal energy storage components and corresponding specifications.	„2.1.2.1 Envelope Thermal Properties", ME-2301
8.1 Containers locations	Drawing(s) showing the location of all the water tanks.	PL-0001, PL-1002, PL-3002
8.2 Water Delivery	Drawing(s) showing the fill location(s), quantity of water requested at each fill location, tank dimensions, diameter of opening(s) and clearance above the tank(s).	PL-0001, PL-1002
8.3 Water Removal	Drawing(s) showing the quantity of water to be removed from each fill location, tank dimensions, diameter of opening(s) and clearance above the tank(s).	PL-0001, PL-3002
8.5 Greywater reuse	Specifications for greywater reuse systems.	„2.1.1.4 Greywater heat recovery", „5.3.3. Climate"
8.6 Rainwater Collection	Drawing(s) showing the layout and operation of rainwater collection systems.	PL-2001
8.8 Thermal Mass	Drawing(s) showing the locations of water-based thermal mass systems and corresponding specifications.	
8.9 Greywater Heat Recovery	Specifications for greywater heat recovery systems.	„2.1.1.4 Greywater heat recovery"

Rules Description	Contest Requirements	Drawings/Reports
9.1 Placement	Drawing(s) showing the location of all vegetation and, if applicable, the movement of vegetation designed as part of an integrated mobile system.	AR-4001 BD-1001
9.2 Watering Restrictions	Drawings showing the layout and operation of greywater irrigation systems.	
10.2 SDE21 Sensors' Location & wire routing	Drawing(s) showing the location of bi-directional meters, metering box, sensors, cables and feed-through to pass the instrumentation wires from the interior to the exterior of the unit.	ID-1001 EL-1001
11.2 Use of the SDE21 Logo	Artwork, and content of all communications materials, including signage (please refer to the SDE21 Graphic Chart & Brand Manual).	KIT_PK#6_2022_03_23.pdf, KIT_PR#6_2022_03_23.pdf „Appendix AA. Flyer" KIT_DES#6_2022_03_23.zip
11.3 Teams' sponsors & Supporting Institutions	Drawing(s) showing the dimensions, materials, artwork, and content of all communications materials, including signage (please refer to the SDE21 Graphic Chart & Brand Manual).	KIT_PK#6_2022_03_23.pdf KIT_PR#6_2022_03_23.pdf „Appendix AA: Flyer" KIT_DES#6_2022_03_23.zip
11.4 Team Uniforms	Drawing(s) showing the artwork, content and design of the Team uniform (please refer to the SDE21 Graphic Chart & Brand Manual).	KIT_VIS#6_2022_03_23.pdf
12.4 Public Tour	Drawing(s) showing the public tour route, indicating the dimensions of any difficult point, complying with the accessibility requirements.	PT-0001, PT-1001, PT-2001 „Appendix AB: Public Tour"
23.0 Contest 5: Drying Method	Drawing(s) showing the clothes drying method and the place where the clothes will be dried.	IN-4001
23.0 Contest 5: House Functioning	Appliances and corresponding technical specifications (Appliances and Home Electronic Equipment specifications and user manuals).	KIT_PS#6_2022_03_23.zip
36.5 Photovoltaic systems design	Contest Specifications of PV generators, inverters, wiring, cables, protections, earthing systems, interface with the electricity distribution ne work turned on. t Requirements	KIT_PS#6_2022_03_23.zip KIT_ELEC#6_2022_03_23.xls EL-2001
36.5 Photovoltaic systems design	Inverters' certificates.	

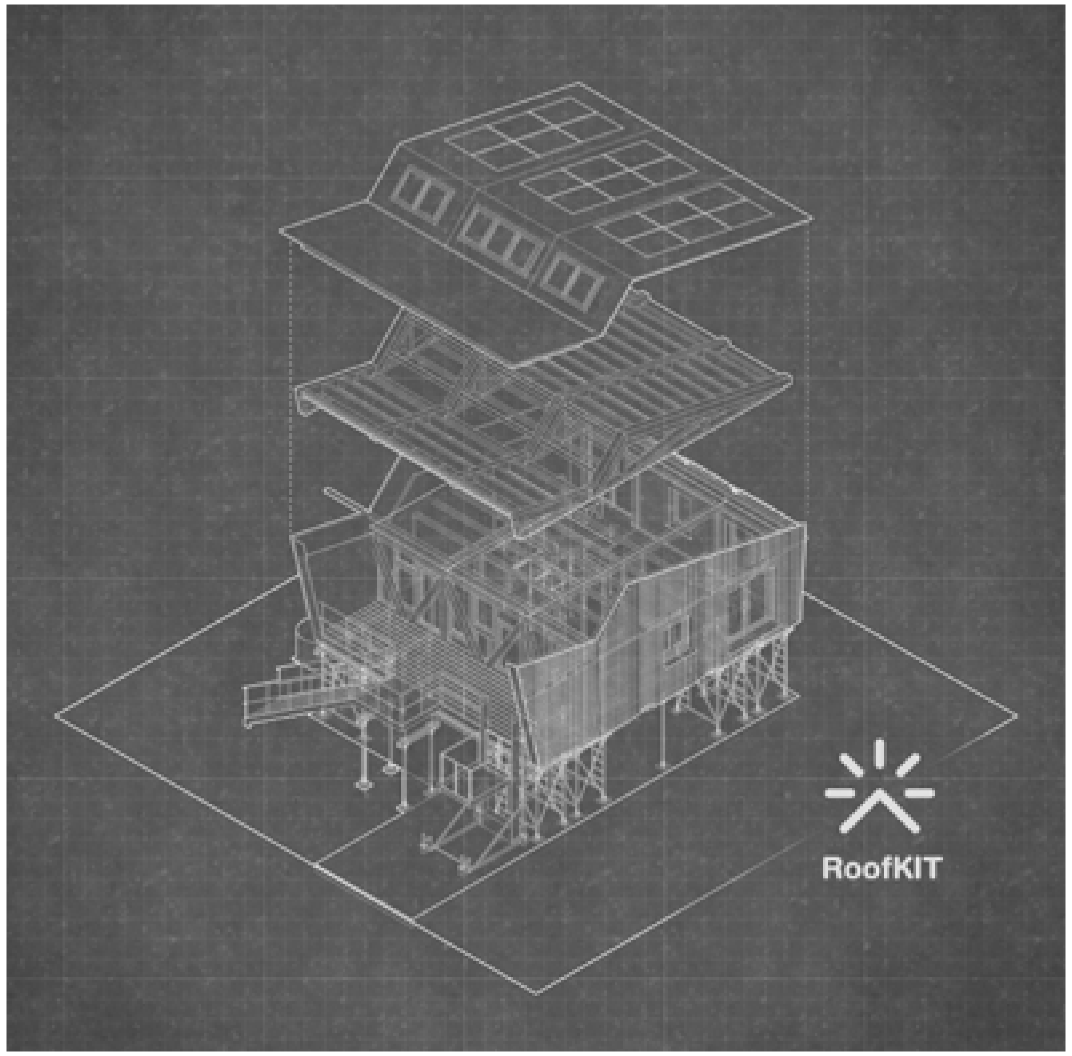
Rules Description	Contest Requirements	Drawings/Reports
36.5 Photovoltaic systems design	Maintenance plan for PV generators, supporting structure, inverters, wiring, cables, protections, circuit breakers in case of fire and earthing system. Fire protection systems for PV DC wiring.	EL-1001, El-2001. EL-3003
36.5 Photovoltaic systems design	The corresponding table 'design summary' must be completed.	
51.3 Fire Safety	Specifications for Fire Reaction of Constructive elements, extinguishers and fire resistance of the unit's structure.	KIT_FP#6_2022_03_23.xlsx
51.3 Fire Safety	Drawings showing compliance with the evacuation of occupants' requirements and fire extinguishers location.	FP-0001
51.4 Safety against falls	Specifications of compliance with the slipperiness degree classes of floors included in House Tour.	
51.4 Safety against falls	Drawing(s) showing compliance with conditions for uneven flooring, floors with different level, Restricted Areas stairs, Public Areas Staircases, Restricted Areas Ramps and Public Areas Ramps.	AR-2301
51.4 Safety for impact risk & avoiding trapping	Drawing(s) showing compliance with conditions for avoiding impact risk and trapping.	
51.4 Safety against the risk of inadequate lighting	Specifications for level of illumination of House Tour areas light fittings.	
51.5 Accessibility for People with Disabilities and Special Needs	Interior and exterior plans showing the entire accessible tour route.	PT-0001, PT-1001
51.6 Structural Safety	Specifications for the use of dead loads, live loads, safety factors and load combinations in the structural calculations.	XIII. Structural Calculations
51.7 Electrical and PV Systems	Complete the 'Electrical System Design PV Chart and Checklist'.	KIT_ELEC#6_2022_03_23.docx

Rules Description	Contest Requirements	Drawings/Reports
51.7 Electrical and PV Systems	Specifications of the wiring, channels, panels and protections of the electrical installation.	KIT_PS#6_2022_03_23.xlsx
51.7 Electrical and PV Systems	One-line electrical diagram and drawings showing the grounding, execution and paths.	EL-5001 PV-4001 PV-3001 PV-2001 PV-1001 EL-6001

IV. Contest Support Documents

1. Architecture Design Report

1.1. Architectural Concept RoofKIT



Sustainable Architecture must be extremely beautiful, otherwise it will not be loved, maintained or taken care off and becomes irrelevant.

Architecture, next to its traditional understanding of beauty, solidity and utility introduced by Vitruvius, has in addition also a responsibility towards society at large and its immediate and greater environment. We see our contribution RoofKIT for SDE21/22 as a light house project combining the traditional and contemporary view towards our discipline in times of climate change, social distancing and resource scarcity. If we as architects, engineers, scientists, designers and planners want to take on the responsibility for our planet and future generations to live on it, we are convinced that we need to design in consistency with our natural circular systems and understand the act of building as an integral social approach. This requires a paradigm shift in how we understand and construct our built environment: away from a linear understanding of temporary solutions towards an endless circular approach of beauty, durability and design for disassembly. We need to give up our unconscious production of waste and reach a level of responsibility, whereby

buildings become the producers of renewable forms of energy and material banks of the future, without giving up the traditional preconditions of beauty, solidity and utility: in contrast, we finally would take those seriously.

This section describes our architecture and construction approach within three increasing levels of detail from site integration (neighborhood), building design (community) and the demonstration housing unit (personal level). Our strategic concepts of social space creation, circular economy, and renewable energy production are cross-cutting themes integrated in our vision for an affordable inner-city living approach resulting in a new generation of sustainable housing typologies. We thereby understand the process as a very clear and conscious approach towards the development of a “proto-typology”, rather than a “prototype”. The modernist notion of prototype is imbued with the belief that there is one ideal model configuration, which could therefore be applied in a serial way in whatever condition. The “proto-typology” however, defines a flexible and heterogeneous form of organization, which can be changed and readjusted instantly and serve different contextual conditions, up to the level of material. It is a process rather than a product. We therefore hope that all ideas and inventions our competition contribution demonstrates can find their way in many different designs for any inner-city situation. The methodologies and approaches necessary to do so are described in the following pages.

1.1.1. Site Integration / Neighborhood Design Approach

Fig. IV.1. 1. .The RoofKIT top-up project within the Mirke neighborhood

Urbanization rates in Europe reached approximately 75%, tendency growing[1]. This enormous success of urban life in the European city has of course advantages and disadvantages at the same time. While density, exchange, social contact, security, integration and short distances could be seen as positive outcomes, our cities face also several urgent challenges, reaching from social density questions towards affordable living space, an increasing elderly population, urban heat island effects, missing or outdated infrastructure, an existing building stock which is not fit for a climate-neutral use, or linear and even toxic building materials. We need to address these issues to be a relevant societal player in the future and to comply with the European Green Deal targets. The most critical challenges aligned with the scope of our project are:

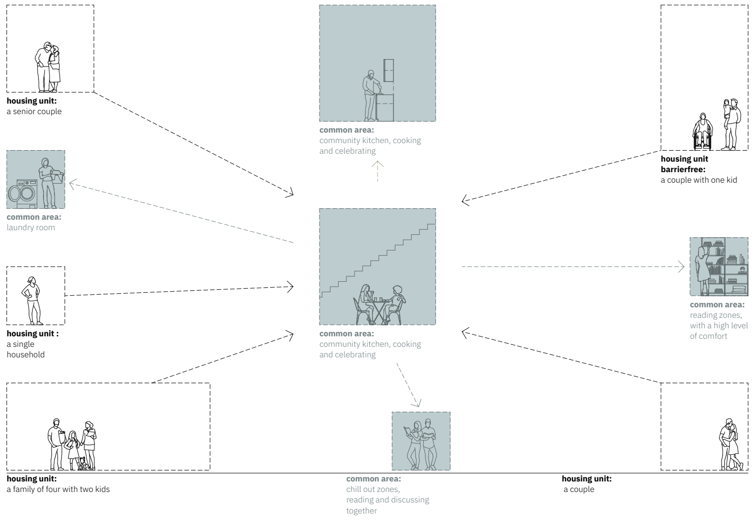


Fig. IV.1. 2. Social mix as a robust neighborhood model

Affordable living and healthy social space is getting rare within the existing boundaries of our cities due to the increasing rate of migration from people into cities and the constant growth of the consumption of square meter per person[2]. If no further open and productive soil should be destroyed by an ongoing, sometimes uncontrolled growth, left (and often overseen) spaces within our cities must be systematically searched and intelligently used to meet the demand. Emphasis should be put on affordable housing, social integration and new demands for home-office work which result hopefully in a decrease of individual mobility necessities and at the same time in a growing demand of a productive inner-city greenery as an important psychological and environmental regenerative spatial configuration. Here, the identification with the neighborhood as a provider of health and affordable and social space plays an important role.

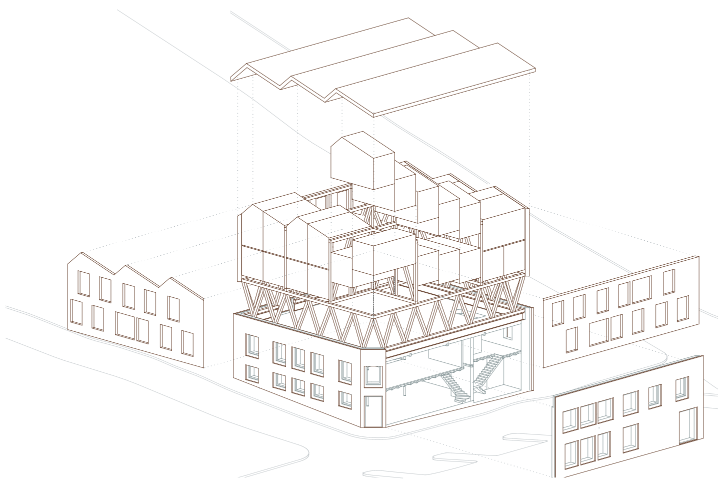


Fig. IV.1. 3. Affordable housing also requires an intelligent construction and planning

To achieve such an **affordable housing** market, **new typologies** for a more flexible approach towards different living phases of families and individuals should be offered. Especially in Germany, the single-family house still stands in for an idealistic view that puts the limited period of a single-family life under one roof in the center of our doing. But after this rather short period of children being brought up, they leave the nest shortly after. The remaining family members very often live from this point on alone in way too big structures, in many cases disconnected from an inner-city vibrant life with all necessary services and social connections. The "concrete loneliness" (betonierte Einsamkeit – referring to the building material) is by now a very well-known result of such a wrong idealistic view. In contrast, the inner-city neighborhood could indeed offer new typologies also for older people, a sharing economy of spaces, services and social interactions. Living conditions in those new typologies designed for such a golden age generation could be a very successful model in order to free again single-family homes for a new generation of partners raising their youngsters. Also here, the neighborhood plays an important role as providing spaces and services for all different generations of people, who seek affordable living, social exchange, connectivity to services and institutions and an easy-to-use public mobility concept. Building in the existing city does not require a new infrastructural system, therefore the cost for housing, especially in a new sharing space model, could be significantly lower.

Fig. IV.1. 4. . Consistency as part of the sustainable concept can and should play also on the urban and building scale

Environmental quality in cities is strongly affected by pollution, mainly caused by combustion (traffic, heating), as well as light-, noise- and other emissions. On top, increasing temperatures caused by urban heat island effects[3] threaten our well-being. Thus, to enhance the health and well-being of the urban population, appropriate urban design concepts concentrating on natural circular systems leaving space for the regeneration of our natural environments are necessary. The urban natural landscape must be understood as a health pump for all citizens. The productive potential of healthy greenery, clean water and clean air for humans, flora and fauna has to be understood and planned as an integrative circular system and not as a decorative element. Greenery provides oxygen and cooling by shading and evaporation effects. To guarantee those mechanisms, we need to harvest rainwater and source it back into our urban soils in efficient amounts. We need to reopen our sealed grounds, allowing also for neighborhood gardening as a social event.

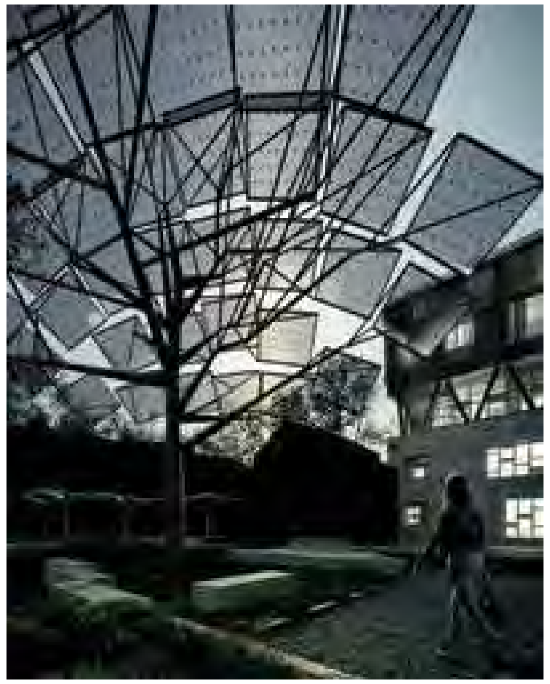


Fig. IV.1. 5. The RoofKIT project understands itself as an energy harvesting entity and battery system for the neighborhood

Buildings should be seen as future energy providers. We need to guarantee the production of regenerative energy as it is part of a consistent design approach, using the only open supply system we have on our planet: sunlight. It needs to be harvested, transformed in either heat (and therefore also cooling) or electrical power to fuel future circular systems from buildings to neighborhoods and their mobility systems.

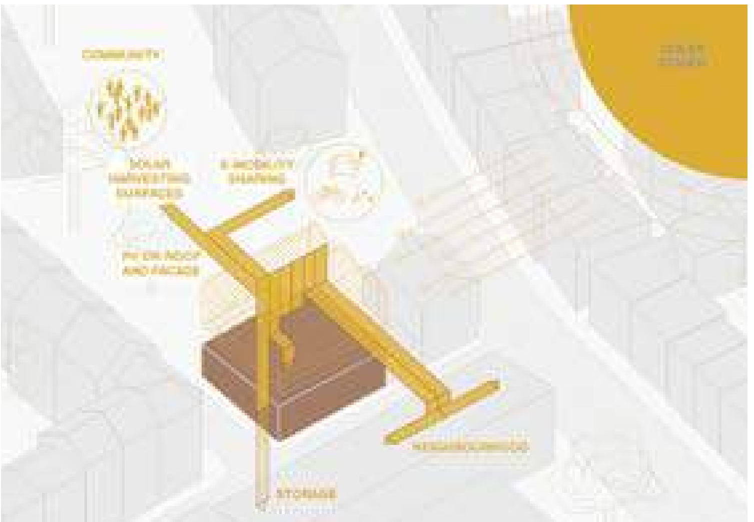


Fig. IV.1. 6. Mobility is part of the immobile building concept

Urban mobility needs to be addressed as a social necessity, not an individual right. Understanding mobile systems as an integral part of immobile buildings, as they are powered by them in form of a city-wide net of public transport or as the energy provider of smaller units such as shared e-bikes or e-rollers, they become a shared entity as well for a larger neighborhood community. This sharing ideology frees us from a technical building law discussion of providing parking lots or garages on our valuable and productive urban land. Streets should be connecting elements between people, not between parking lots and garages. See also the Urban Mobility Report.

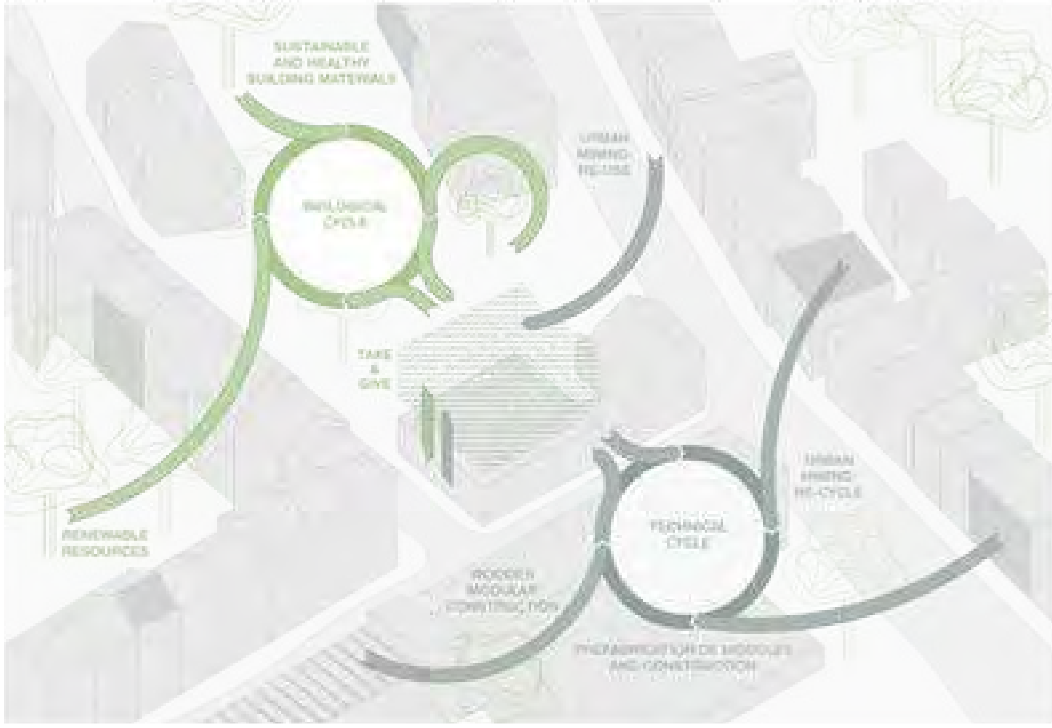


Fig. IV.1. 7. The RoofKIT project understands itself as a circular model on social, ecological and economical levels

Buildings should be seen as material banks and CO_2 sinks. The building sector is responsible for 50% of the primary material consumption in the EU, 50% of the primary energy consumption, 40% of CO_2 and other greenhouse gas emissions and 36% of all solid waste production. The reason is a wrong design approach, whereby we as planners, architects, engineers and designers pay no attention to the end-of-life scenario of our products and buildings. We need to design in such a way, that all materials and building elements can be taken out of buildings after use on the same quality level as we put them in. This requires using no composite materials (as they are almost impossible to recycle) and also a new approach towards construction, as we should not use connection systems, that make it impossible to retrieve the materials and elements. We need to give up glues, foams, impregnations and other forms of irreversible connection systems and replace them with a new generation of innovative details that allow for a true circular economy. This leads to an extreme reuse and reconfiguration of secondary building materials (making us independent form large imports) and protecting our natural resources without creating waste. Or as Mitchell Joachim expressed: "The future city makes no distinction between waste and supply."[6]

In addition, our buildings should become a huge CO_2 sink, as we could mainly use biological building materials. Capturing CO_2 during their growth, such natural building materials are seen as allies in our fight against climate change.

As Hans-Joachim Schellnhuber, former head of the Potsdam Insitute for Climate Impact Research puts it: Wood needs to become the main resource for the building sector.

The RoofKIT project wants to take on the described challenges as a holistic design approach. The team decided to use the existing Café Ada and its unused potential of its roof scape as the building site for our competition entry.[7] Although the construction of roof top-ups increases the structural loads on the existing structure - which needs to be carefully considered in the design process - it offers incredible advantage of an existing supply infrastructure within an established neighborhood acting as a highly known identification point within the city fabric. Our project wants to take advantage of both: the psychological familiarity and the technical and infrastructural base situation.

In addition, the project wants to add even a higher level of communal space, bringing a new typological thinking of shared spatial configurations into the site, which we hope will even more intensify the exchange between people of different generations in the Mirke quarter. This will be achieved by providing special features such as a beautiful public event space, called the "Urban Gap", open and healthy outside areas for all, diverse typologies for affordable living, hotel rooms for inviting guests and friends to stay, a building design providing renewable energy and acting as a material bank and last but not least: increase the visibility of the existing Café Ada as a communal point of social gathering and an international hot spot of tango dancing. Site integrations needs to happen on several levels:

1. Quality outside space

Fig. IV.1. 8. The site concept of the RoofKIT top-up project asks for a holistic integration of technical, biological and social aspects

Café Ada is situated in the northeastern part of the district Mirke in the corner between the Froweinstraße and the Wiesenstraße. The outdoor space north of Café Ada is currently a mixed-use urban left-over and does not follow an overarching concept. In its current state, the site mainly offers an outdoor

space for the Café Ada, a forum made of concrete elements and a carsharing station. Atmosphere has so far, if at all, only been created by the Café Ada itself, as well as some trees and the forgotten character of the site. It is bordered to the west by a wall on Froweinstraße and to the north by the bare firewalls of the neighboring buildings. Understanding the free lot north of Café Ada as a productive landscape for the neighborhood, we set focus on the introduction of a field of possibilities.

The site needs to be accessible for everyone and should make no distinction between residents, neighbors or visitors. In this way a space is created for public use, collaborations, exhibitions, events, workshops, music interpretation, appropriation, and freedom. Therefore, in accordance with the concept of urban mining, we want to preserve the existing tribune and evolve it into a multi-usable stage.

It provides greenery to produce oxygen, shade and a modest micro-climate using natural evaporation. The idea is to create a permaculture garden, which does not need a constant maintenance. In contrast it holds several different types of plants, all growing in different heights and periods, making the garden a spectacle in all seasons. In addition, urban gardening elements are offered to the neighborhood, fostering social group events and forms of maintenance as a social common project.

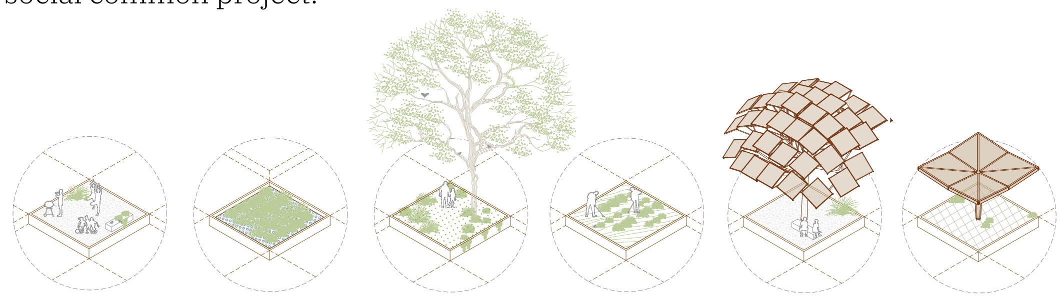


Fig. IV.1. 9. The spatial layout strategy tries to provide a field of possibilities

A multidirectional grid is chosen as a underlaying design organization, avoiding hierarchies.

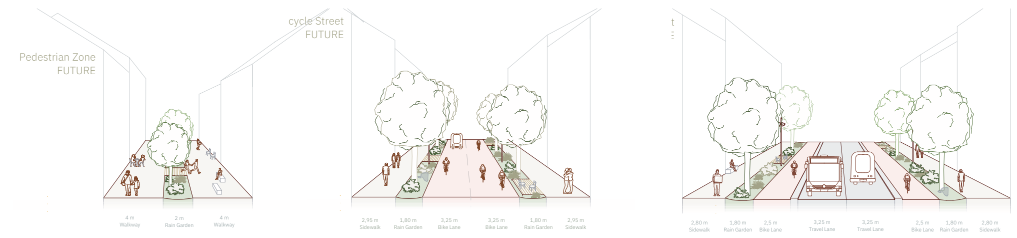


Fig. IV.1. 10. The urban mobility concept favors a communal approach over an individual one

In the east, a Mobility Hub is introduced to the site. This highly functional wooden umbrella structure does not only offer a bus stop connecting the site to the public transport system, it functions also as a charging point for electric bikes. It features spaces as well for storing garden tools, a compost, a bike-

service, a community bookshelf, drinking fountains and tanks in which the rainwater is collected and can be used for garden irrigation. The Mobility Hub is therefore not only a technical infrastructure, but also a social one.
ure by closing all surrounding streets for individual car traffic.

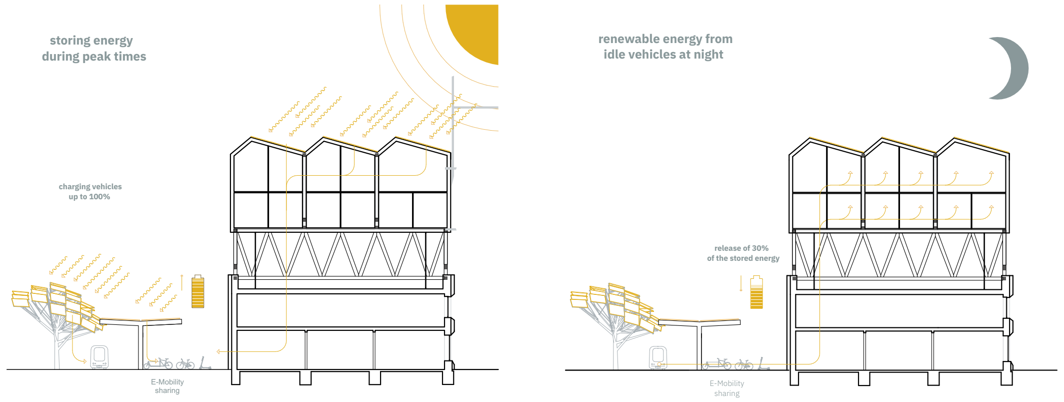


Fig. IV.1. 11. Mobility entities and the building are understood as two engaged entities helping each other

The outdoor field behind the Café Ada is also part of the energy harvesting system. We designed to so-called “solar trees”. They produce shadow and electrical power at the same time, feeding not only the building itself, but providing energy for the whole neighborhood together with all other PV and PVT elements on our roofs.

The lighting concept of the outdoor areas responds to the design of the outdoor space and creates an atmospheric evening situation in an interplay of punctual islands of light and linear elements, which, bathed in warm light, invites people to linger and get to know each other. In this way, the lighting also creates an appealing setting and sets the stage for the solar trees, which are also staged as highlights of this facility during the hours of darkness. The lighting also refrains from unnecessary light upwards to avoid light pollution and, with its glare-free light sources, reduced light output and some dark zones, also considers the diversity of flora and fauna.

2. Quality communal space within the building

It is important to keep the Café Ada intact as a local identification point of the neighborhood but at the same time as an international hotspot for tango dance. To do so, the restaurant area is kept on the ground floor, renovated, and re-organized mostly to re-organize and upgrade the circulation system within in building to react to the new added functions.

Fig. IV.1. 12. Spatial flexibility for different needs

In the first upper floor (Level 2), the former dance area is replaced by hotel rooms, maintained, and organized by Café Ada as a new income source and to provide space for the international tango guests. But also, the neighborhood and the inhabitants of RoofKIT take advantage of this possibility, having the opportunity to book rooms for family members, friends or other visitors.

The new third level houses the new neighborhood event space. It replaces the old dance floor and introduced a state of the art ballroom for tango and other dance performances. But in between, it can also be used for family celebrations, film nights, get-togethers, theater performances, weddings or as an activity and sport space for the neighborhood. Being placed between the old building and the new addition and recessed from the steel construction system, it forms the so-called “Urban Gap performance space”.

Level 4 and 5 provide new affordable living space as a communal and shared entity across both floors connected by a central stair. Focus is given on large social areas within each floor, to guarantee exchange and communication between all inhabitants. While the individual spaces are kept minimal and flexible, this communal space is supported by larger kitchen and dining areas, lounge areas, reading rooms, storage facilities, and laundry rooms. Nevertheless, each individual unit still provides a smaller kitchen, as the inhabitants can decide if they would like to take part of a communal act or prefer to keep their privacy. This very compact design offers the described new typology being able to be inhabited by several generations and family models beyond our common concepts.

3. Quality communal space within the apartment

A characteristic design element of RoofKIT is to be seen in the central core of infrastructure (kitchen, bathroom, technical supply) in each apartment. The layout of each apartment is organized around this core element making it also a focal point of daily life. Here, the users can decide on their own level of privacy and retreat versa a more communal approach in the shared spaces

1.1.2. Whole Building Design Approach

RoofKIT wants to demonstrate that roof top-up strategies do not only have the potential to create new communal and private living space within the existing inner city, but also to upgrade the existing building itself by ecological, economic, social, aesthetic and energetic terms. Following this awareness and based on the deep analysis of the existing structure, layout and functions of Café Ada and its neighborhood, strategies have been developed to arrive at a meaningful architectural and structural concept.

Fig. IV.1. 13. The overall design of RoofKIT as a top-up strategy for Café Ada

The existing building

The cafe: The existing two-story building embracing Café Ada needs to be kept in its majority of structures, materials, elements and functions. We do know by now, that 60-70% of all grey energy is bound in the structure of buildings alone. Therefor we propose to keep all structural elements (outer walls and ceilings) of Café Ada intact. The first floor will be reorganized to give Café ADA the space it deserves: The secondary rooms are moved to the closed eastern fire wall, in order to orient the restaurant towards the urban street scape and the urban garden in the back. Clogged windows on the western wall are reopened and their original size is restored. Infrastructure elements placed on the existed facades are updated and removed. The main entrance is relocated to the prominent position of the beveled corner in the southwest, to give the Café Ada a new appearance and demonstrate a new era we want to start with the project.

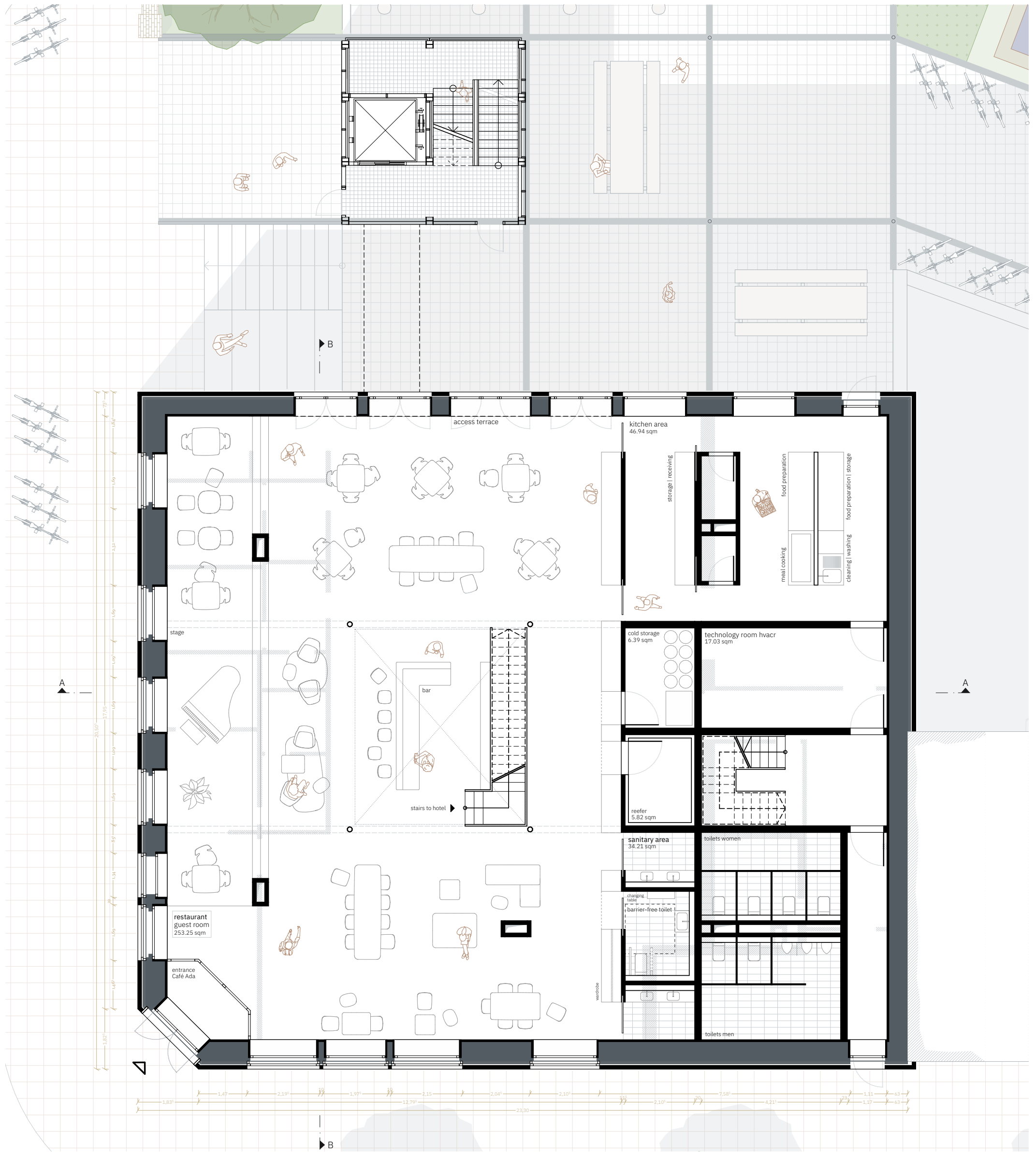


Fig. IV.1. 14. The new ground floor layout of Café Ada

Flexible elements such as a bar in the center of the restaurant, a staircase to the hotel floor behind the bar, and a removable stage structure divide the restaurant area. Between the secondary rooms and the freely organized catering area, a serving layer for storage and preparation is added to an existing wall towards the east. In addition, a new central emergency stairwell was added to the building in the east with an escaoe exit to the south. This emergency stairwell only is used also as an overall bracing structural element. The main circulation space for the whole building is placed in the north, as a new additional element coming from the Urban Mine and marking a new address for all tenants and inhabitants.

Fig. IV.1. 15. The integration of the different functions as a layered concept within the Mirke quater

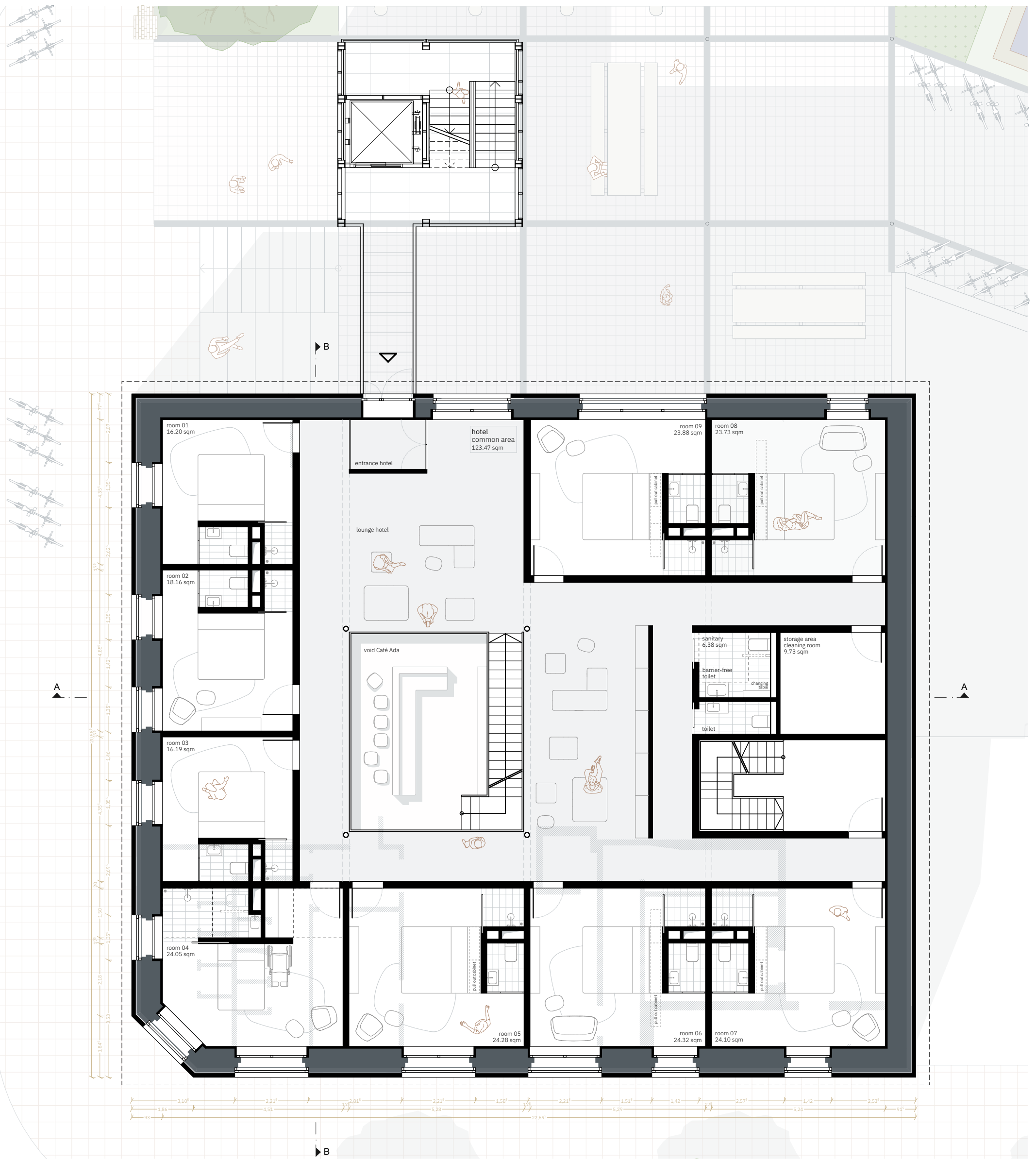


Fig. IV.1. 16. The spatial layout of the new hotel program

The hotel: The second floor of the existing building holds momentarily the ballroom for dance performances and practice. Here, we want to change the function completely and propose the establishment of a small hotel arrangement, that is managed by Café Ada. Not only does this provide an additional income opportunity for the café, it also creates the possibility to host international guests and create a family atmosphere, as sleeping, eating and dancing can be hosted under one roof. Also, it pays attention the whole neighborhood, as friends and guest have finally the opportunity to stay within the quarter for visits. The guest rooms are arranged along the southern, western and northern façade. Sanitary rooms are located along the east façade next to the continuous emergency stairwell. The central communal area is used for gatherings and as a flexible co-working and meeting space. This space is connected to the café below by an open staircase in the vaulted ceiling to demonstrate the connection between the two elements of Café Ada. All internal structures are done in a light-weight wooden framework technique, avoiding any glues, foams, synthetic paints which prevent a circular building system. We see the construction of the hotel floor like the House Demonstration Unit, as it is described below. After removing the old roof for further use as a resource of urban mining, a new ceiling is installed instead using the upgraded interior load bearing structure of the existing building. This ceiling forms the new layer between the old building and all new functions and structures added on top.

Fig. IV.1. 17. The layering concept introducing the Urban Gap performance space

The building envelope: The existing Café Ada building stands exemplary for many buildings in the existing building stock in Europe erected before the 1990ies: their thermal envelopes to not meet current standards. As a result, the energy (heating) demand, in the colder seasons is homogenous. Also here, we want to demonstrate how the building could be retrofitted without destroying the existing building, its history, identification and function. Therefor we decided to add a new thermal layer on the outer skin: First, an insulation layer will be added, using a fully organic insulation material. Here, reed or seagras (Neptutherm) could be used, both are free of any synthetic stabilizers or fire protection chemicals. Using STONECYCLING bricks, a new outer layer is constructed, respecting all former details of the façade and even re-introducing them to keep the original character as much as possible intact. STONECYCLING bricks are made from construction rubble, adding only 10-15 % new clay to the mix. Different colors and patterns can be chosen, according to which mineral waste material was used. Alternatively, reused fired clay bricks coming from the urban mine as a re-use strategy could be installed. In both scenarios, the façade keeps the familiar appearance of a building with patina. In addition, either new windows following the idea of a 100% circular construction (no wet sealants, no glues, no paint)or adding simply a second layer of secondary used windows from the urban mine in front of the existing ones will be installed. The new glazing area is larger than the old one and thereby shows parts of the existing brick wall. Inside, a second insulation layer is planned to reduce the thickness of the exterior one, to avoid conflicts with the sidewalks in the urban space. This inner insulation consists of calcium silicate and together with a loam rendering it regulates moisture threshold. Overall, the U-value of the existing walls can be reduced by about 75% (see also the Engineering and Construction report).

The top-up

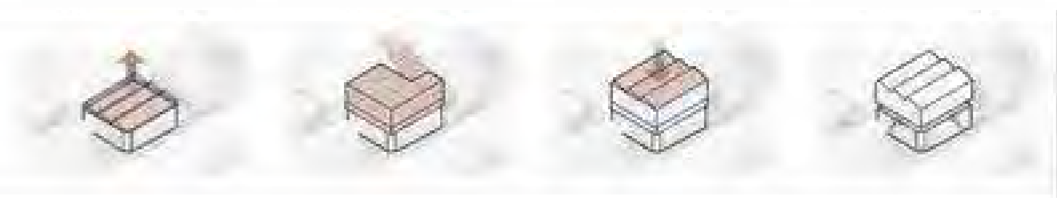


Fig. IV.1. 18. The top-up strategy of the RoofKIT project

Architecture, Construction and Materiality of the URBAN-GAP performance space: The most visible and prominent space of the design is found between the old café-building and the new top-up living structure: a recessed public, fully glazed performance and communal space of double height: the so-called Urban-Gap. It is meant to be a social incubator between the people of the Mirke quarter and an international dance community. Here, family celebrations and performances and practice can happen all year around. The attractive space is recessed from the outer perimeter walls of the two volumes above and below to allow for a very transparent and democratic appearance and an outside space circling all around the four facades. Weddings, social gatherings, sport events, theatre, concerts, rehearsals, company celebrations, cinema, congresses, citizens' meetings (currently at Mirker Bahnhof), workshops and exhibitions – all would and should be possible.

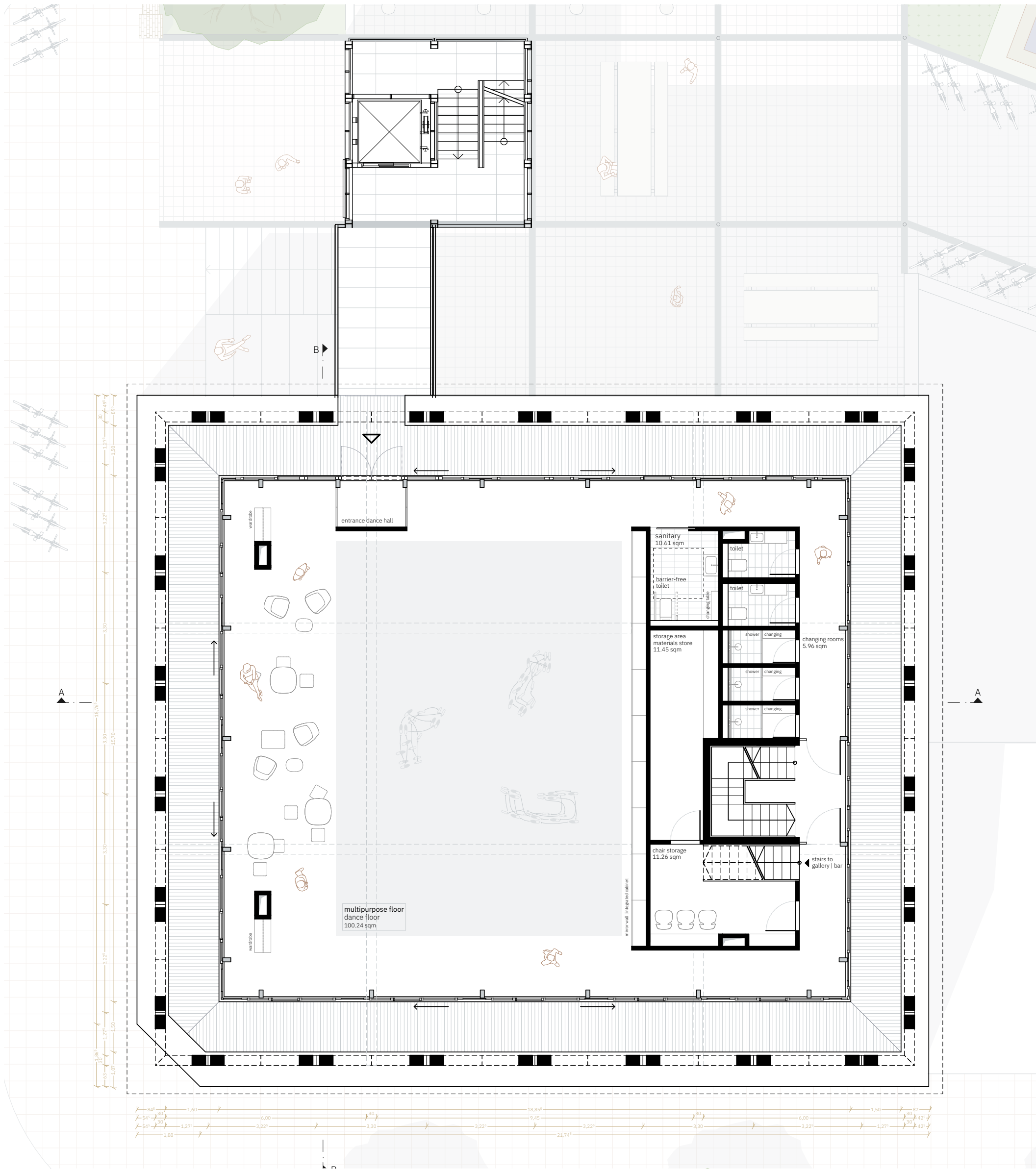


Fig. IV.1. 19. Floor plan of the Urban Gap performance space

The floor marking the dividing layer between the old building and new top-up is constructed adhering to highest acoustic issues. Decoupling layers and floor impact protection ensure a high level of sound insulation for the sensitive use of the accommodation underneath. The functional core includes dressing rooms, toilets, technical facilities, structural elements, the staircase and storage space. This guarantees, that the space can be used multifunctionally. In addition, the functional core has a grandstand on top equipped with a bar. This way, you can watch the dancers performing or simply have a seated bar area, where social gatherings can take place with a breathtaking view over the Mirke quatre. The entire functional core is fully mirrored, which adheres to the functional needs of dancing but also reflects the idea of invisibility within the bigger urban context above the roofs of Wuppertal.

Fig. IV.1. 20. The Urban Gap performance space in its neighboring context

Architecture, Construction and Materiality of the new housing top-up: In Germany the average number of persons per household is constantly dropping because of the dissolution of multi-generational households, a lower birth rate at increasing divorce and decreasing marriage rates. As a consequence, the average space consumption per person is constantly increasing, which inevitably leads to a higher waste of resources and a blockage of existing single-family houses for young families, resulting in a constant unsustainable hunger for new single homes quarters. To counteract this effect, RoofKIT works with the concept of shared spaces, that help to reduce the individual provided space while still maintaining a high communal and social comfort.

On top of the Urban-Gap performance space resting on its surrounding steel framework structure, a two-story wooden framework structure is placed. In and around this structure, a wooden modular system of living units is proposed. We choose this construction method consciously also as a part of a social sustainability strategy: producing the modules in a protective environment of a construction hall, we are convinced that the health of the workers is placed in the center of the construction process and on top, the rate of mistakes is far less, as research shows. Here, we can add to the overall lifetime cost analysis by avoiding bad performance, repair or even exchange during the usage period. In addition, construction time and therefore noise and traffic can be reduced to a minimum, adhering to a friendly relationship to the neighbors.

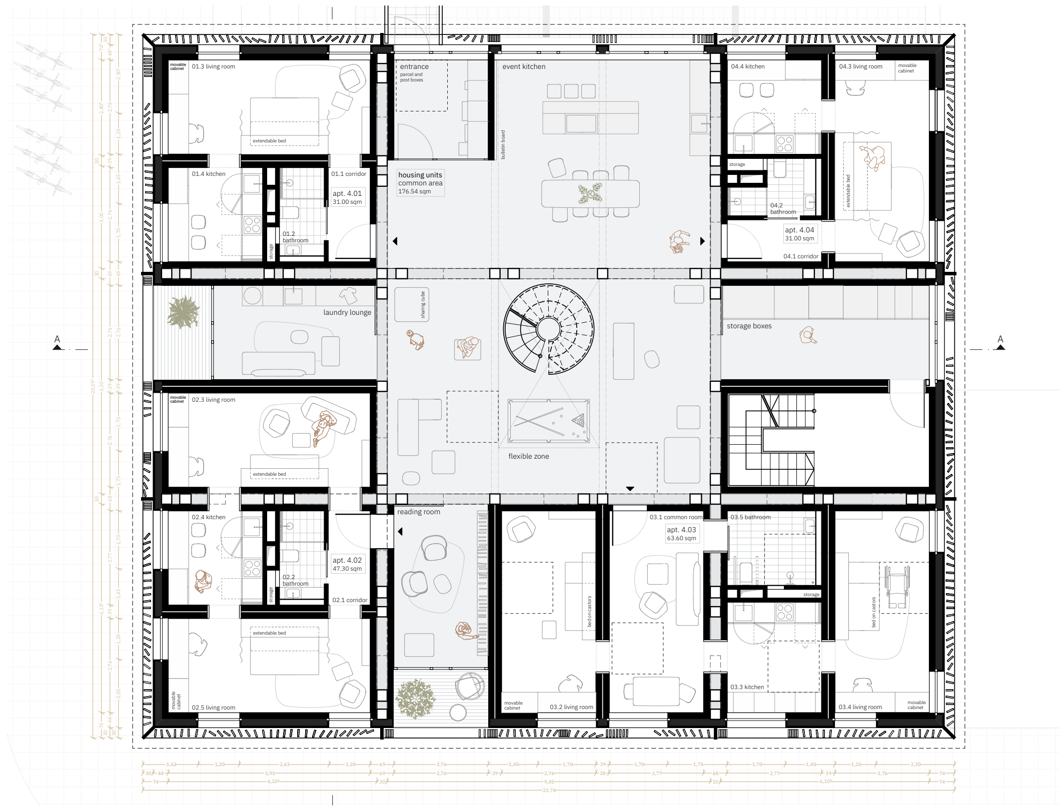


Fig. IV.1. 21. The floor plan of the housing level 1

The exterior and interior walls as well as the ceilings and the roof are also constructed in wood. We want to build on the one hand side a CO_2 sink by using this natural material, on the other we need to be careful not to use any wooden materials connected to any kind of synthetic glue (as in so many wooden OSB or particle boards or glue-lams) as this prohibits the material to be reintroduces in a biological circle (consistency). Cascade usage as it is mostly done with composite materials, should only be the last possible choice and needs to be avoided whenever possible. In addition, we must be careful with our local wood production. The material is only sustainable, as it is forested in a sustainable matter as well. Here, society needs to be informed and educated in order to be critical and aware. In RoofKIT, focus is given especially on the concept of using as many secondary “pure” (meaning not in form of composites) material streams a possible, but also to construct in such a way, that future generations can disassemble the structure without destroying any element or component. Therefore, all glues, foams or other non-reversable construction methods are forbidden, the structure is layered in accordance to each single constructive requirement asked from it, starting from aesthetics, health requirements, thermal comfort, weathering, fire or noise protection. Each of those layers can be dismantled without any problems, allowing the building to go fully back to a circular system, without any quality loss. The roof, holding the biggest possible PVT collection system, is covered in 100% recycled copper, as it is scientifically proofen, that copper once mined, is the best recycling metal with the highest value chain we know momentarily. In addition, the design of RoofKIT also proposes to use colored PV-Elements along the East, South, and West façade, not only harvesting energy, but giving the building a unique and recognizable look. The windows should come as much as possible from the urban mine, as we discovered, that an unbelievable high number of 3-layered glass windows are often not even installed out of production or measurement problems. We need to tap this resource. All floor deep openings are designed to supply each apartment with a large amount of daylight. Loggias are placed around the façade provide in addition outside sitting areas, allowing daylight as well entering the structure. The roof is designed in such a way, that it takes up the original shed-form, allowing window-openings towards the north, guaranteeing a soft northlight entering the upper communal living spaces as well as providing views towards the skies.

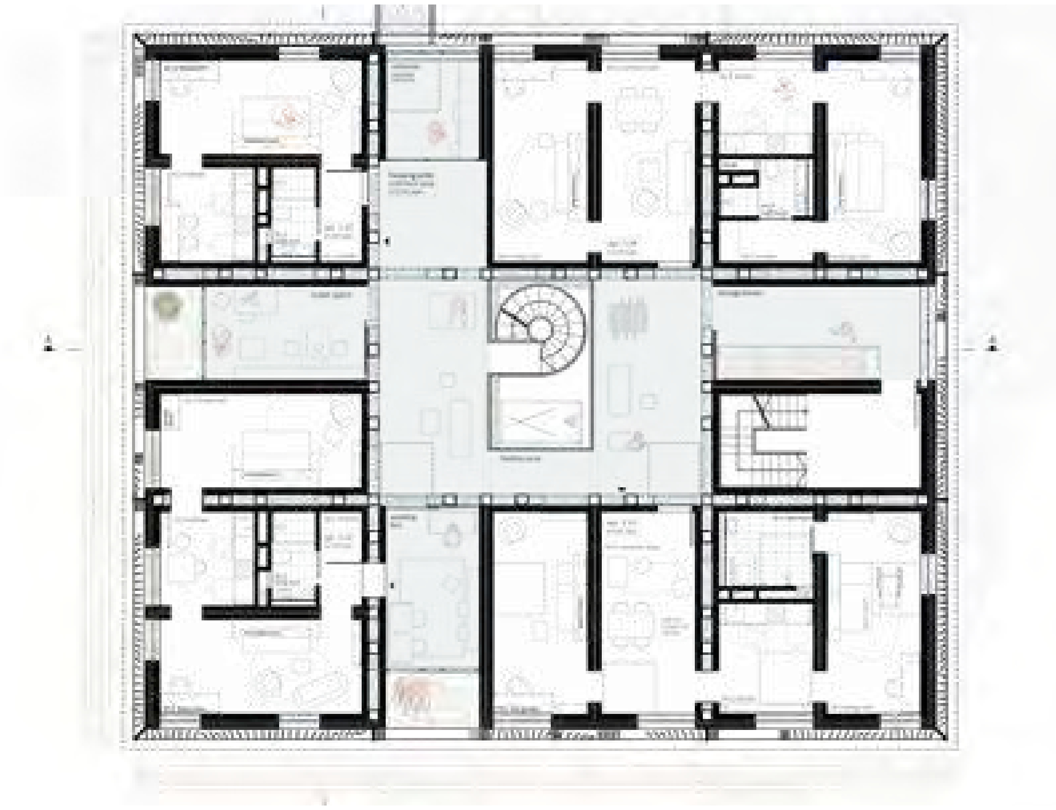


Fig. IV.1. 22. The floor plan of the housing level 2

Architecture, Construction and Materialiity of individual and communal spaces: The layout of the single modules is chosen in accordance to the idea of the shared space ideology: The individual, modular wooden living units constructed in a frame methodology using only glue-free elements, are arranged around a public atrium. In between the apartment modules there are commonly used rooms for special purposes such as reading spaces, sewing spots, hobby tables, playrooms, etc., that can be separated from the atrium if required and connect the central area to the façades. Specifically, laundry cafés, a library and a billiard lounge are offered as well as co-working spaces. The billiard lounge serves as a flexible zone, which can also be used for small parties, meetings among friends and neighbors by simply covering the table and use it as a buffet or similar.

Each individual space is arranged around a central core element, that houses kitchen, bathroom, technical infrastructure and storage. Next to the very effective use of infrastructural layout, this idea provides a private small kitchen for every apartment. This is important, as not everyone might join in the big communal kitchen based in the base floor of the living cube. Here, the idea is

a meeting and focal social point of cooking, eating and talking. In this way the different needs of the residents - that consists of a variety of target groups - can be addressed. The various audiences include people from all phases of life, e.g. pensioners who gave up their single family house and maybe could find a mission in cooking for and with others. In return others, maybe younger generations will help them with physical work, shopping or technical issues. Working parents will easily find someone to look after their children, they all need and have a point of contact, safety and protection. Because of that age-spread concept all communal spaces as well as some of the residential units are designed barrier-free. The social mixing creates a house community that can offer symbiotic relationships which bring the residents closer to the social nature of human beings. Thus, RoofKIT counteracts the increasing tendency of distancing and separating ourselves from society.

Fig. IV.1. 23. Building construction of the overall design proposal

Overall circulation systems: Two main stairways guarantee the circulation and escape routes for all floors: first the already mentioned staircase in the east with an escape exit to the south, acting as the escape circulation space and also as a structural bracing element for the whole building. Secondly, we added an outside steel staircase, coming from an old coal mine structure in Nordrhein-Westfalen, which is being reconfigured as well as structurally adjusted to our needs. Also here, we believe, that the urban mining concept could provide a very harmonious coexisting with the old building and re-configured façade of Café Ada as well as to the URBAN-GAP performance space with its steel structural framework and the living top-up with its wooden construction and solar façade. In both cases, elevator systems allow for a barrier free access of all floors. The two stair cases together with the new entry to Café Ada provide the access from ground floor to all functions of the building.

They will create the new addresses for RoofKIT.

In addition, several interior staircases allow for access to functionally connected spaces: from the café to the hotel rooms, from the performance floor to the bar area and from the first to the second floor of the living top-up. In addition, the two main staircases allow the same access via elevators.

Overall light concept: The artificial lighting concept puts emphasis on the URBAN-GAP performance space. It should appear as a glowing space between the existing building and the upper living floors. While the restaurant will work with light islands to create a warm and friendly environment, the hotel and living apartments will be steered individually, creating an interesting and playful arrangement as an active and vibrant part of the urban neighborhood. The overall idea is not to play with colorful effects, but to create an elegant and modest setting that puts volume and materiality in the focus.

Overall structural design concept: please refer to "1.2 Structural Design" below

Overall energy concept: please refer to the "Engineering and Construction" report

1.1.3. House and Demo Unit Design Approach

Fig. IV.1. 24. The Housing Demonstration Unit of the RoofKIT project

In order to transfer our concept from the overall building to the house demonstration unit, we have chosen the southwest corner of our building as a representative "cutout" element and therefore acts as our demonstration unit for the competition. It shows and combines two main components of our design: the residential unit sitting on top of a communal space. This elevated position seems extremely important for us, as it represents a main architectural performance idea: the individual resting on the communal, allowing for a constant social exchange within the neighborhood.

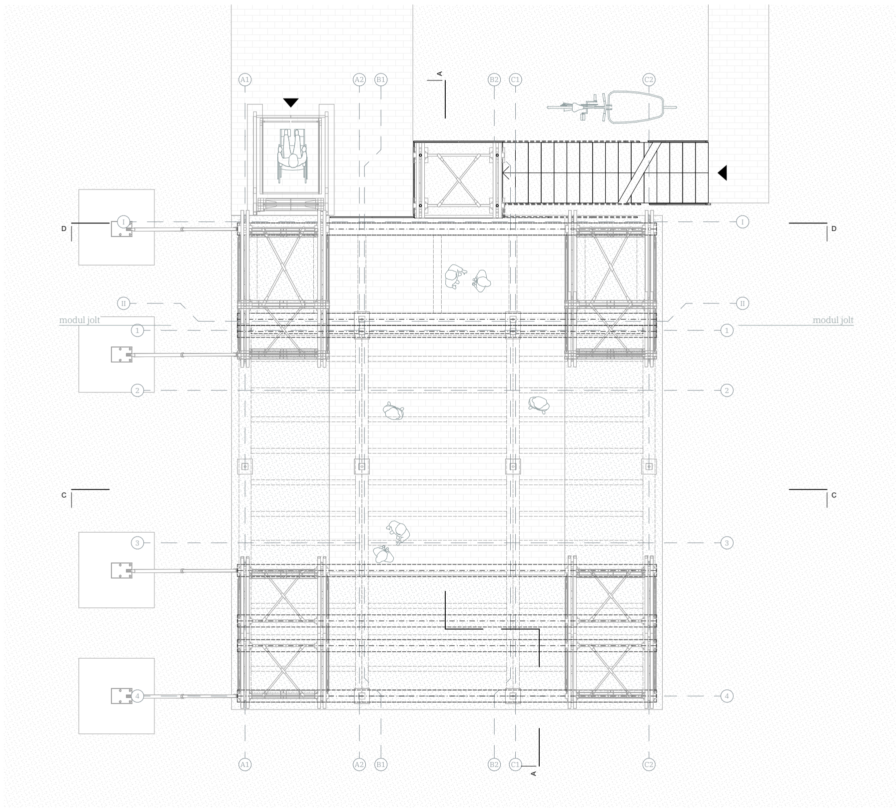


Fig. IV.1. 25. Rented scaffolding underneath the HDU

Fig. IV.1. 26. The structural design of the HDU

Modularity: To emphasize the fact that the prototype is representing a fragment taken out of a larger structure, the HDU is prefabricated and brought to site as for modules. We do believe that this construction has several advantages: being manufactured in a protected environment, the workers take advantage of a safe, healthy, warm and social active environment, adhering to the idea of social sustainability. In addition, it is proven, that the quality of work improves accordingly, avoiding costly mistakes by fixing, repairing or even exchanging in the finished building. This has to do with the fact as well, that several craft disciplines are in one space, offering help and advice to each other. Also, construction time and therefore noise and traffic is reduced to a minimum on site, which is especially important for an inner city construction site as ours in Wuppertal.

An intelligent planning is necessary to avoid complex connection systems between the modules, as those connections could be possible weak points in the future. Therefore, the RoofKIT HDU concentrates all technical infrastructure almost entirely at the central inner module. From here, the whole infrastructural and technical management is steered, it is the “brain” of the HDU. Only the heating and thermal collector system as well as smaller electrical plugs need to be connected after the placing on site.

Modular after-use: The modular system also allows for an easy dismantling after the competition, as the project will find its new home at the campus of KIT university in Karlsruhe, being a demonstrator for future circular and energy optimized building technologies but also a research unit for projects already in the pipeline on user comfort. The unit will be rented out for KIT students and researchers with the condition, to support the research and allow for public tours.

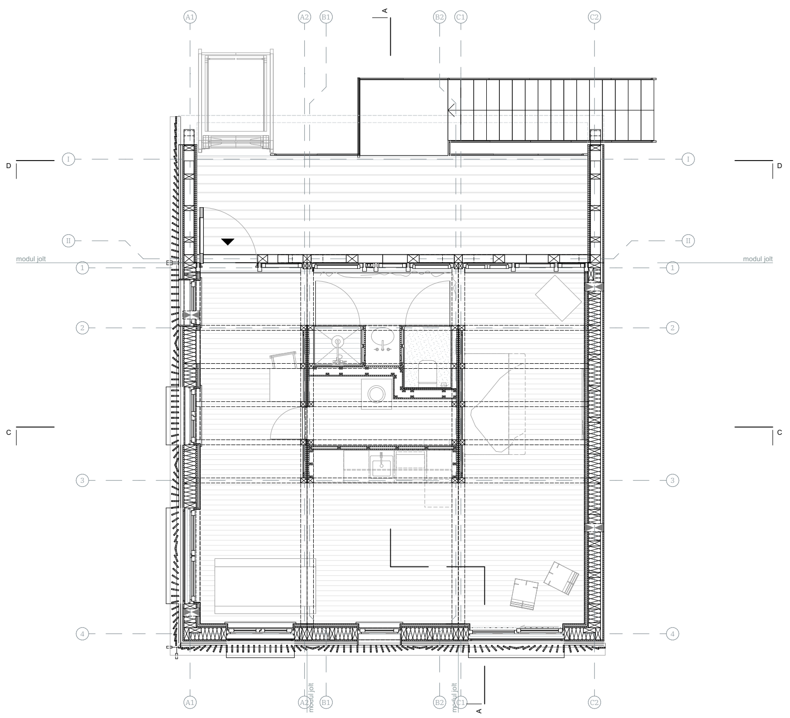


Fig. IV.1. 27. The floor plan of the HDU

Architectural layout: The overall idea is to create an open floating space around a central core holding the functions of the kitchen, the bathroom elements as well as a walkable technical and storage space. With this arrangement, we avoid unnecessary circulation space within the apartment, also looking at the economic performance of architecture and the effective use of space. While the “brain” holds all the technical components as well as functional infrastructures as kitchen and bathroom, the two (also a little bit smaller) modules to the left and right act as the two wing components, holding less specialized spatial zones such as the entry zone, a small working desk, the eating table, a small living zone and the sleeping area. The “red line” of the architectural experience is therefore to be seen as a constant increase of privacy, as one is moving through the space: the entry provides space for hanging one’s coat, changing shoes, welcoming guests and friends.

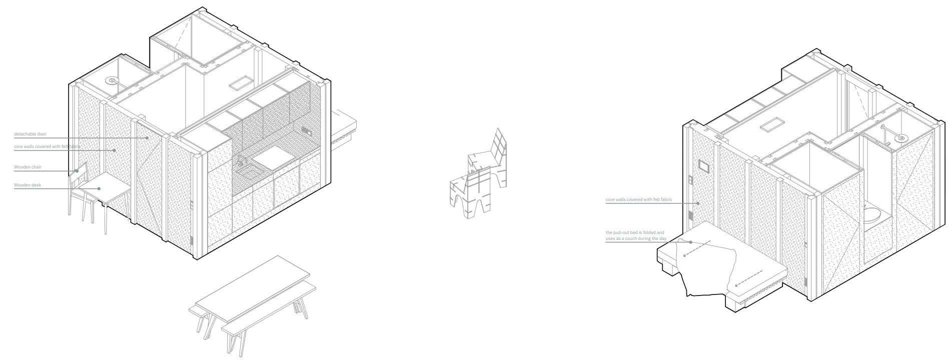


Fig. IV.1. 28. The core element of the HDU

The small work desk made from old door panels from a primary school building near Freiburg, creates a first little separation, while the big flexible wooden eating table offers a space to rest, sit, talk and discuss. Adjacent, now already part of the central module which is also demonstrated by a change of floor material from fresh to used wood, the kitchen is located as part of the central core element. Here, space is given for preparing food, cooking, cleaning and storage. Special features are pull out working desks and a special kitchen-top material, made from old yoghurt cups.

Now entering the next side module, a small lounge or resting area, again floored with fresh wood, is following, showing furniture elements made from re-configured materials as tetra packs or re-used materials as an old metal barrel acting as a table. Moving more and more to private zones, the sleeping area is reached, where a bed is located, that can be arranged in different width configurations. It can act as a single or double bed during night, and also allow for a couch during the day.

Fig. IV.1. 29. The interior space of the HDU

Turning 90 degrees and entering again the central module, the flooring changes ones again, reaching the most private space, the bathroom area. Here, the user can decide on her own on the level of privacy. A big curtain is allowing to separate the area in front of the shower, toilet and sink completely from the rest of the apartment. Shower and toilet are the only two spaces in the whole apartment having a door. Inside, they show glass ceramics made from recycled glass and stainless-steel floors and ceilings allowing for a glue and wet sealant construction. Illuminated by LES corner strips, the create a special space, given their minimum spatial arrangement. The area around the sink and even the mirror are made out of stainless steel, the mirror being highly polished avoiding silver metal steaming technologies as usually used in regular mirror elements. The sink itself is a found re-used object coming from a private household, such is the toilet and the water basin behind. All armatures (also in the kitchen) come from a re-used fair demonstration elements.

After the bathroom area, the visitor reaches again the entrance and the circle is closed. One space is left: the inner core technical room, which is reachable to a magical opening and not being recognized as a door. Here, all technical features are stored, up to the washing machine. The core itself is cladded in a pure natural felt, also adhering to acoustical reasons, spanning on boards made out of food scraps, while the rest of the walls are plastered with clay, guaranteeing a humidity regulation and thermal mass.

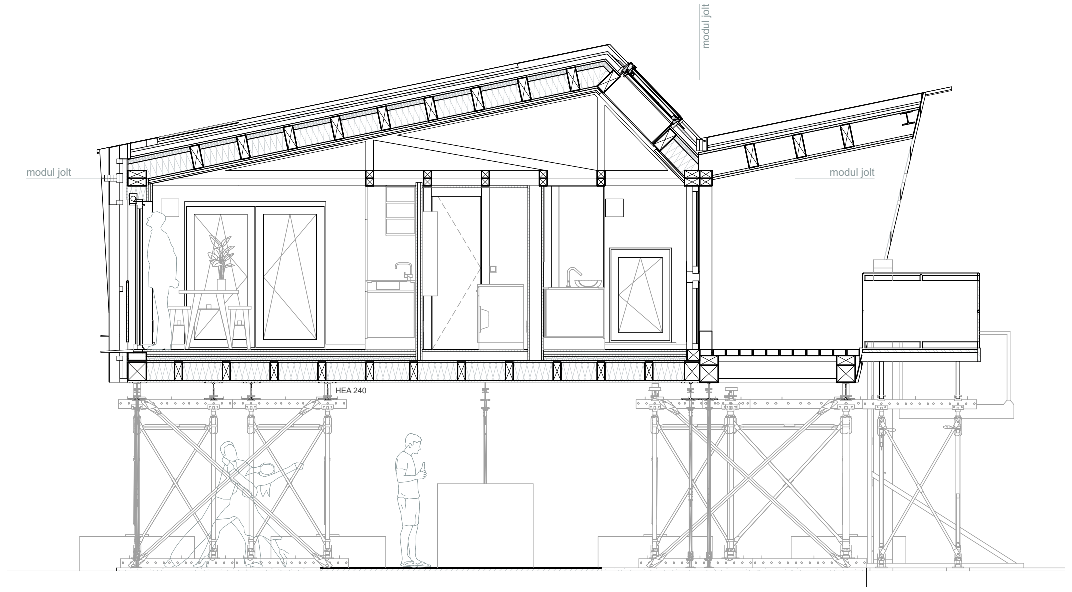


Fig. IV.1. 30. The section of the HDU showing the scaffolding, living space, core and roof structure with the PVT panels

The height of the space varies quite strongly: while the ceiling is low at the entrance point, it reaches is maximum height at the central line of the unit. Like this, also northern light could be allowed to illuminate the apartment from top. The openings adhere in general to the position of the unit within the overall design concept: the south and west apartment show in total 6 windows to the outside, while the east wall represents a connecting wall to the rest of the structure, is kept without windows. This is also demonstrated with a material change in the outer façade. Same is true for the northern façade: here, the wooden framework, a mayor element in the overall design as it carries the loads of all wooden modules, is shown contracted in used wooden beams. In front, being part of the apartment, the northern façade is constructed only out od used, found windows, forming a special almost artistic element and demonstrating the possibility of architectural design to incorporate those found objects in an intelligent way.

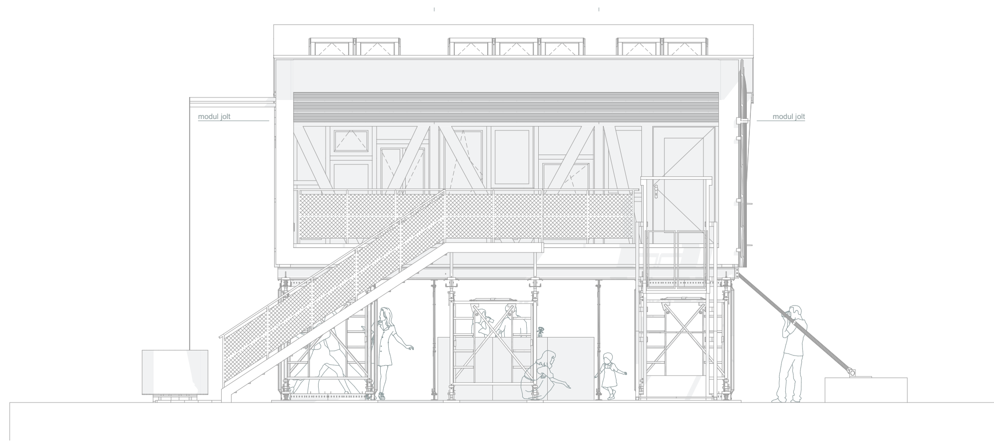


Fig. IV.1. 31. The elevation of the HDU seen from the main entrance route

Circulation: The fourth module, sitting turned by 90 degrees to the other ones, forms the entrance element to the unit, but also represents the communal space in the overall design concept. The module is reached either by a used staircase coming from the urban mine or by an elevator, just rented for the time of the exhibition. In Wuppertal, the entry module acts as a gathering point before the tours, but also as a hang-out space for visitors and guests. It provides an elevated view and stage at the same time. Due to the planning of the apartment, other specific circulation spaces or elements are not necessary and reduced to a minimum.

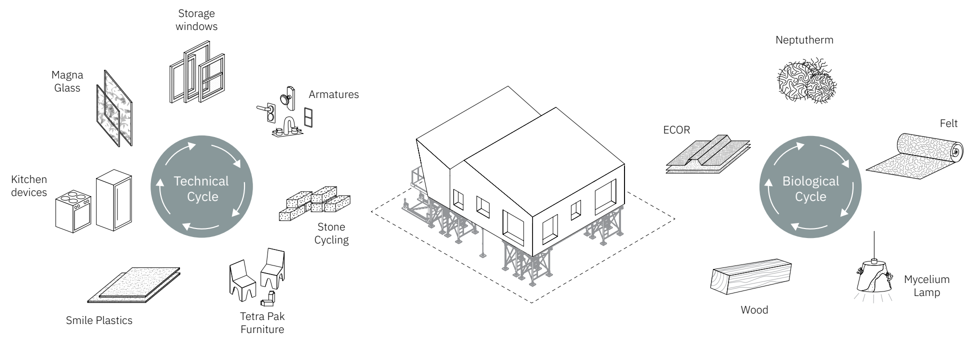


Fig. IV.1. 32. Circular material conceots

Circularity – from a linear to a circular construction method: With the introduction of an industrialized building market, the mentality of take-make-throw became the dominant way of how we understand our natural environment: we take out resources, make products out of them and after use, we simply throw them away. This thinking led to a perverse situation, whereby the material itself is no longer of any value to us as soon as it reaches its end of use scenario. And with this in mind, we constructed for the longest time our building accordingly: we did not plan for a dismantling phase in order to bring the materials back to the point, where we can use them again in an endless manner. Buildings are still seen as consumers of resources and not as intelligent storage facilities. Only lately, the discussion is focusing on another direction: The EU with the Green Deal not only wants to provide Europe with a climate neutral energy supply, it is also pushing us into a fully circular industry, whereby waste is no longer accepted as an outcome of our doing. But additionally, also geopolitical and environmental issues are changing the market rapidly: the war in Ukraine will booster the wish to leave fossil energy carrier behind and move even faster in renewables. The state secretary of finances of the Federal Republic of Germany calls those energy supplies a question of freedom, given this transformation an immense political power. But the same is true for resources and materials: we need to start immediately to see them as renewables as well: either in form of building up a gigantic easy to handle and composite-free material depot or as an incredible innovation laboratory introducing a new class of building materials coming from the biological realm. This is underlined by an immense cost increase for almost every material in the past two years, due to a global pandemic but also by the very simple equation, that our resources on this planet are finite and we are reaching a point where this can be felt quite strongly. In Germany alone, the cost in the building industry climbed up 14% in 2021.

The growing understanding that we need to change something, and the growing scarcity of resources calls for a paradigm shift from linear material consumption

to circular economy model - especially in the construction industry. RoofKIT implements this claim: The unit is constructed from separable, mono-material resources that are completely reusable, recyclable or compostable. The concept of cycles therefore plays a central role: Used materials are not consumed and then disposed of; instead, they are borrowed from their technical or biological cycle for a certain period and later returned to these material cycles. RoofKIT is both – a temporary material depot and a material laboratory – proofing the academic, technical and constructive possibility for a fully circular system in the building industry.

RoofKIT adheres to the two main conditions for circularity: (1) Utilizing solely recyclable and already recycled material resources or reused components, including newly grown biological products. (2) Designed for disassembly at the end of its service time, RoofKIT also represents a material depot for future projects: instead of connecting elements and components irreversibly such as chemical glues, foams or other synthetic elements, RoofKIT uses reversable screw connections, clamps or fully interlocking systems in order to recover all used substances cleanly and sorted in order to return them to their specific material cycles at the highest quality and quantity.

Developed and planned in close cooperation with industry and craftsmen, the unit now offers the opportunity to investigate methods and materials for the circular economy. It is more than a demonstrator, but rather a laboratory, a lived-in apartment in the future sitting at the campus of KIT in Karlsruhe, that will provide verifiable feedback to a consortium of researchers for the next years to come. And due to its construction as a material depot with easy and reversible connections, RoofKIT will also be adapted and developed further within this period on the continued quest for closed material cycles and new construction technologies. As such, we see RoofKIT as a research platform promoting and creating the path towards a circular economy in the built environment. (for further information see „5. Sustainability Report“)

Building Construction: Adhering to the concept of circularity (see sustainability report), all components, elements and systems of RoofKIT were designed in a very careful manner. The scaffolding, lifting the structure, was already explained. It follows the thinking perfectly: the elements will be given back in an existing fully established circular system.

The modules are structurally composed of a wooden framework, which is cladded in case of the walls, floor and ceiling with solid wooden boards arranges diagonally over the frames in order to stabilize them statically. (usually, here OSB or other composit wood boards are used, resembling a composit material which is to be avoided.) In between those two solid wooden layers, we work with a 100% natural insulation material, seagras, provided by the company NETUTHERM (located in Karlsruhe).

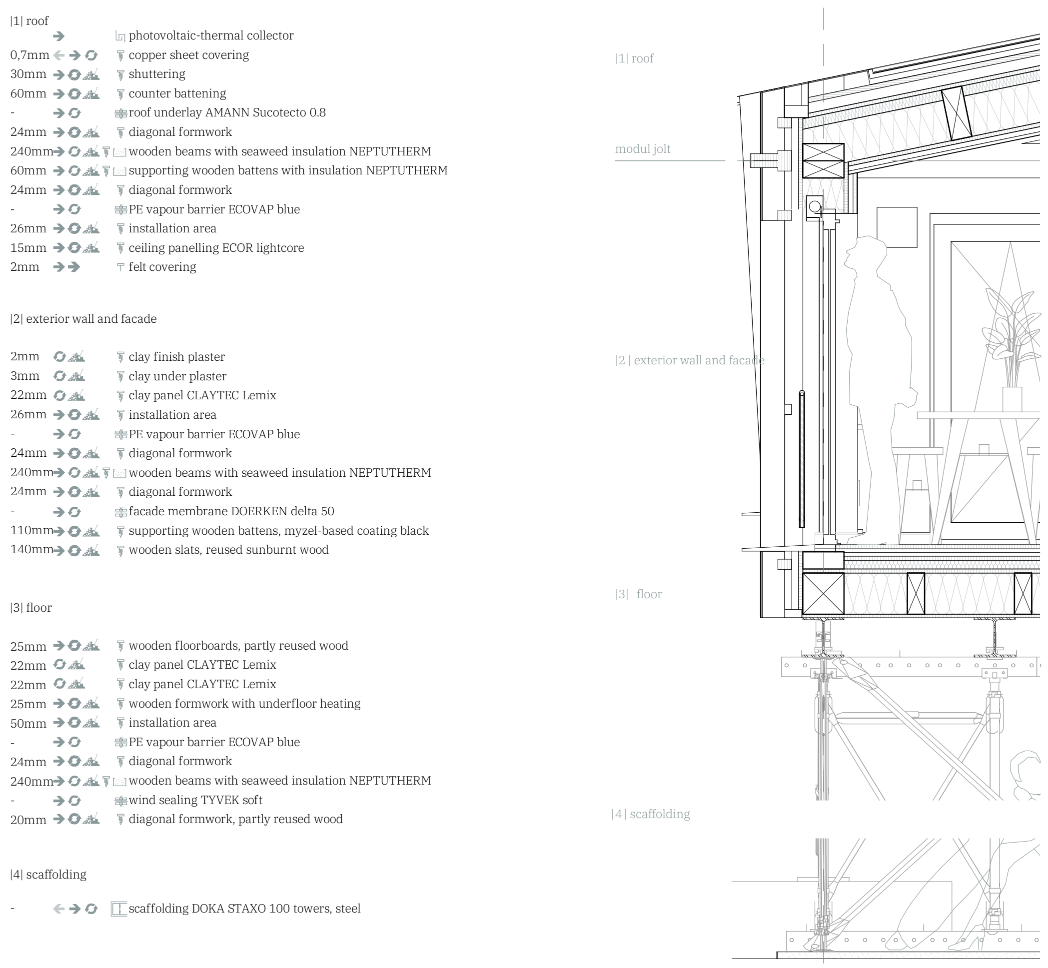


Fig. IV.1. 33. The façade section showing the circular material layering and circular connection details

The outer wall structure: the most inner layer forms a white clay plaster, in two layers applied over a heavy clay board. Both products come from the company CLAYTEC . The clay will regulate the humidity in the unit and at the same time, together with the heavy boards, it increases the thermal mass, which is important for a wooden light weight structure as RoofKIT to adress thermal comfort (see engineering report). Between the clay board and the solid wood layer, a wooden substructure, functioning as a installation layer and vapor barrier in form of a PE-foil is placed, which is overlapped by 30 cm and only clamped with the wooden substructure in order to avoid the usual adhesice tape, as it the reason why those otherwise mono-material vapor papers end as waste. On the outer side of the main wood/insulation layer, a wind- and water blocking UV-resistant barrier is placed in the same clamping technique, followed by a wooden substructure, holding a used wooden façade, which various in its degree of opening, allowing for a skin that is constantly aired and therefore can dry up easily, protecting the wood for a long-term use. On the eastern and northern façade, old truck tarpaulin from the company FREITAG are used to demonstrate the temporary character, as those facades would mark the connection to the rest of the overall building design. The material is scrapped over wooden frames and can 100% retrieved after use. The facades are also used to show the construction to the visitors as a drawing being placed on it.

The floor structure: the same principles are used in the floor. Starting again from the most inner surface, a wooden floor without any chemical or other

treatment is offered. Here, we work with new as well as used wooden planks differentiated between the different modules. It sits on a wooden substructure, which is emerged in two layers of the heavy clay boards already known from the wall structure and mainly function as a thermal mass supplier. Those sit on a special structure of the floor heating system: as we could not find a composite-free existing sublayer, we decided to mill the paths for the copper pipes in a solid wooden layer, holding the pipes and the conductive metal plates. This system is fully dismantling without any adhesive components. Separated again by a PE vapor barrier, the main structural element follows as described above, including a wind paper between the main structure and the final diagonally placed board structure. The last solid wooden layer in its diagonal arrangement is visible from below without any additional layer.

Variation: a smaller part of the floor heating system is constructed with an air-dried clay system of the company Rhomberg located in Dornbirn, Austria. Here, clay tiles, which are still moist while being placed on the vapor barrier, are used to receive the floor heating pipes. Afterwards, when the clay is air dried, remaining gaps will be filled with natural gravel (thermal mass) and layered with the clay board as in the other areas as well. This work requires a very careful handling, as the only air-dried tiles should to be loaded by workers walking on them. We see this attempt as a possible research area to understand advantages and disadvantages of the two different systems.

The roof structure: Starting from the most inner layer again, we will use a 100% natural white sheep wool felt as the visible and light reflective ceiling surface coming from the company M&K Filze. It is chosen also to control noise emission. The felt is strapped over a board from the company ECOR, produced 100% from food scraps holding high contents of fibers (potatoes, carrots, etc.). Those panels are hold by a wooden substructure, sitting on the PE vapor barrier, followed by the main structural framework holding the insulation as described above. On top, a wind and water resitant foil is placed, followed by a wooden lathing and counter-laything and another solid wood layer placed diagonally. On top, a standing steam copper cladding follows coming from the company TECU, using only 100% certified recycled materials. All edgings (around the roof windows, etc.) are also done in copper. The rain gutters are constructed in stainless steel, just inserted as a single element across all modules after placement on site. The standing seam system allows for a very easy placement of the final layer of the PV substructure and panels.

The inner wall structure: inner walls exist only around the inner core. Here, either the bathroom elements with special materials such as glass ceramics coming from the company MAGNA GLASKERAMIK or the reconfigured yoghurt cups from the company SMILE PlASTICS are in use. All other wall elements are again covered in felt (colored gray around the core) with the decribed advantages. Inside the core, the rough wooden bords are shown and kept in their original state.

Connection systems: All connective elements in the unit are 100% reversible.

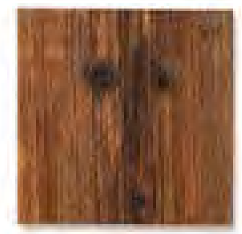
Most evident becomes this idea celebrating the connection systems holding the single units together. Very visible, it is shown, how and where those are placed. The same is true for connective electrical an heating systems as they need to be disconnected again before moving the unit to Karlsruhe after the competition in Wuppertal.

Openings: All windows used are coming from the urban mine. Five windows in the south and west façade are mined in Bael, Switzerland with help of the company InSitu Baubüro and the Schweizer Bauteilbörse. Being only installed for 3 years in an office building for a Swiss bank, they were taken out of the structure just recently. Now, the triple-glassed wooden frame windows found their new place in the RoofKIT project. Most of the windows of the north-façade are all bought at ebay Kleinanzeigen, using the private market. The two florr-deep windows in the west and south façade as well as two windows in the north-façade are coming from the company WERU, which installed a fully recovery service on a company level for full windows as well as window frames and the glass itself. The primary selection criterion is adequate thermal insulation. All windows are triple-glazed with a U-value of 0,6 W/m²K. The glazing with a solar transmission of 0,59 still allows for solar gains in winter but requires a very effective solar protection system for summer conditions. Therefore, exterior textile screens fabricated of reused material are used, which offer a very good shading coefficient (Fc = 0,16). Using automated control through the energy management system, shading is optimized in terms of allowing solar heat gains in winter and preventing overheating during summer.
The door to the unit is a unique feature, as it was made from an old found door coming from the black forest of Peter Rieger Historishe Baustoffe, which was then reworked and combined with an up-to date thermal and security approach. While the old door appears from the outside, the newer updated layer is visible from within.

Fig. IV.1. 34. The RoofKIT HDU material collection

Materiality: Here, a small selection of the circular materials used in the RoofKIT unit are listed and described:

ALBA, Smile Plastics: The material is made from the humble kitchen cast-off, yoghurt pot. It is 100% recycled and 100% recyclable and shows no VOC off-gassing. With its white, marble-like surface and hints of gold and silver, Alba is used in the project for the kitchen area and bathroom doors.



Used Wood: all used wood in the unit comes from sources supplied by RESTADO, the biggest used construction material platform in Germany. The wood coming from old barns and sheds is cleaned and brushed and wherever needed re-cut and shaped to its new use in the project.

MAGNA GLASCERAMICS: the material is produced out of broken glass pieces coming either directly from the production line or glass containers. It can be ordered in different colors as well as surface characteristics. RoofKIT uses it as a cladding wall element in the toilet space and shower.

TECU copper roofing material: TECU products are solely made from scrap metal and production scrap – with all the economic and ecological advantages. Copper can be endlessly reused without any loss of quality. Copper refining at KME enables the complete removal of any impurities. This is an advantage over aluminum, for example, whose alloy, composite and coating components are rather difficult to remove. The complete roof is cladded with TECU products

CLAYTECH: All claytech materials are 100% natural and therefore endlessly recyclable in the biological realm. RoofKIT uses clay plasters as well as clay boards for its outer envelope construction to enhance the air quality (humidity exchange, removal of possible air impurities) and increase the thermal mass in the building.

ECOR: the product is born out of the waste conversion process. Using only recycled water, heat and pressure, ECOR is a 100% natural product. Locally sourced raw biological materials are pulped into usable fibers, dispersed in water, dewatered to create a slurry, then passed between two metal plates in a hot press. A rough fiber mat is created that ultimately becomes a finished ECOR panel. RoofKIT uses the panels as a substructure for all felt surfaces.

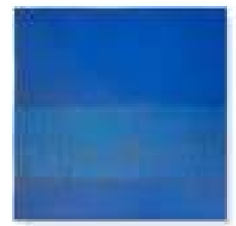
NEPTUTHERM: RoofKIt uses a 100% biological insulation material, which consist out of seagrass only, rolled by the wind into small balls. It needs no agricultural land, no watering, no fertilization and no other treatment. No chemical or synthetic additions are used to provide this natural insulation material. RoofKIT uses it in its complete outer envelope.

MYCELIUM: Coming from our own research, mycelium bound panels are shown in the unit to demonstrate that already today synthetic glues can be overcome focusing more on nature´s own techniques combining biological materials only. The material is 100% compostable.

XYHLO BIOFINISH: The product is a fully biological and consistent wood protection application. Introducing an organic, protective and self-healing membrane to the wood through a base coating consisting of natural oils and a second layer of a living biological fungal material, it allows wood to experience a long lasting protection without the application of synthetic or toxic materials.

STONECYCLING: Stonecycling products are made by more than 90% out of construction rubble. With small amounts of added clay, they are re-burned on much lower temperatures as a new fired brick and according to color and texture, different variations exist in the market. They are 100% recyclable or reusable, as we lay them in a sand bed only without any cementous materials. RoofKIT uses Stonecycling bricks for the outside pavements in front and below the unit.

M&K FILZE: RoofKIT is using a 100% biological wool felt from M&K Filze for all ceiling and outer core surfaces. No synthetic additives are given into the production, making it a 100% compostable material.



FREITAG: used truck canvas: FREITAG is a well-known company based in Zürich, producing every day products out of used truck canvas. FREITG provides RoofKIT with such canvas to clad the eastern and northern façade of the unit, scrapped over wooden frames.

HANSGROHE armatures: All armatures in the roofKIT projects are returns of the the HansGrohe company coming from fair exhibitions in the last months. Usually, those products are sorted out and destroyed. Here, they find a second life application.

Energy and technical components: please refer to the Engineering and Construction report.

Infrastructural supply systems: As the unit is a representative of a larger design proposal for the top-up of Café Ada, we decided to place infrastructural supply systems such as fresh water, sewage water, the electrical inverter, the battery pack and the source-side buffer storage for the heat pump outside, more specific underneath the actual unit. This allows us a very flexible and cost effective arrangement, The water tanks are just rented for the time of the competition and will go back after the event. The other elements are temporarily installed, following the idea of a outside supply chain, demonstrated with flexible hoses and cable systems, almost as an organism extending its body to tap into those vital supply systems.

Lighting concept: The lighting project also implements circular economy values combining state of the art LED-lighting technologies and innovative user-oriented lighting design. A basic general lighting system, mounted around the core of the interior space, provides an indirect melanopic lighting solution with biodynamic controls and is manufactured by a small Swiss company MEXTAR using second hand parts. Furthermore, a variety of portable luminaires with rechargeable batteries is provided for the occupants to decide for individually lit spaces at various intensities. These are free standing reading luminaires and decorative wall sconces from the German manufacturer NIMBUS. To underline the holistic circular philosophy of the project, a unique decorative luminaire cluster hanging over the dining table is designed by the RoofKIT team. The center piece luminaire, from a Swiss manufacturer RIBAG, providing good task lighting with glare free technology, is customized with shades from natural grown fungal bacteria and natural reflective minerals, like shell limestone.

Outdoor lighting meets the SDE requirements for security and visibility during dark hours around the entrance, stairs and lift. It is designed with specially selected products, second hand from an Italian producer iGUZZINI, that minimize glare and light pollution to the environment. As a special feature, the lighting under the unit will provide a soft wash of the ceiling to be perceived well from the distance and adjustable light spots for flexible outdoor event situations.

The lighting management is realized via a wireless solution which enables easy access and control from different locations and devices, avoiding a fully automated system and giving the steering as much as possible in the hands of the users.

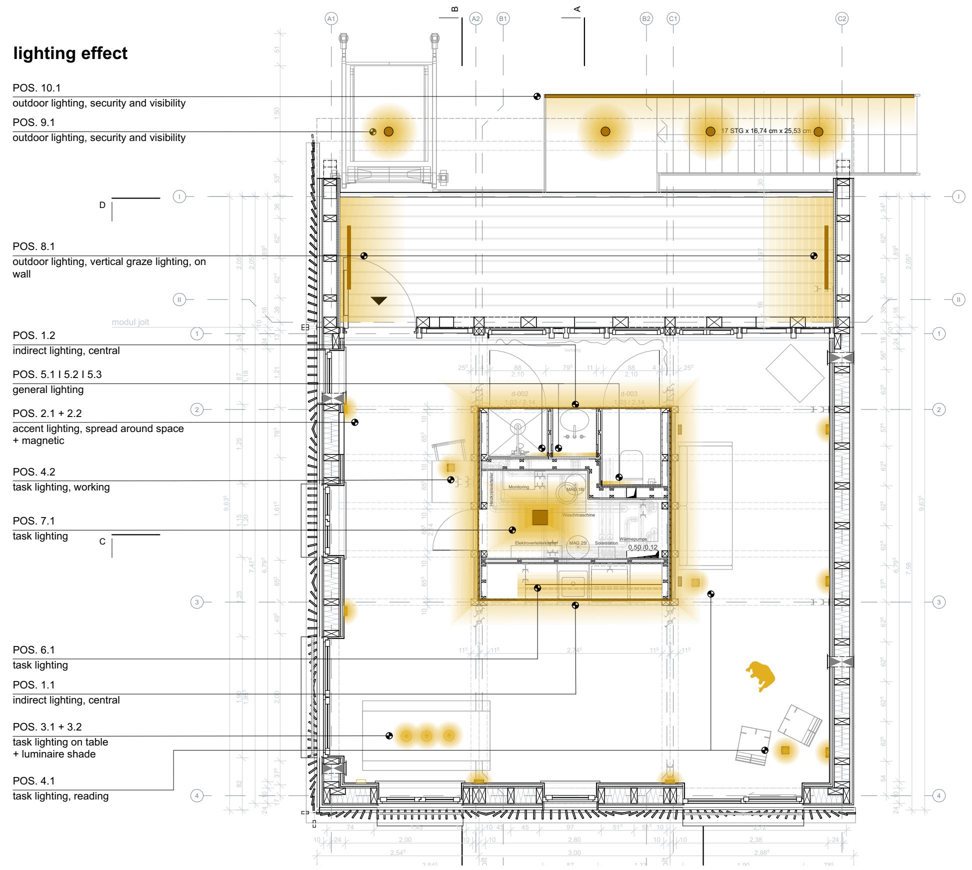


Fig. IV.1. 35. Lighting concept of the HDU

1.2. Structural Design

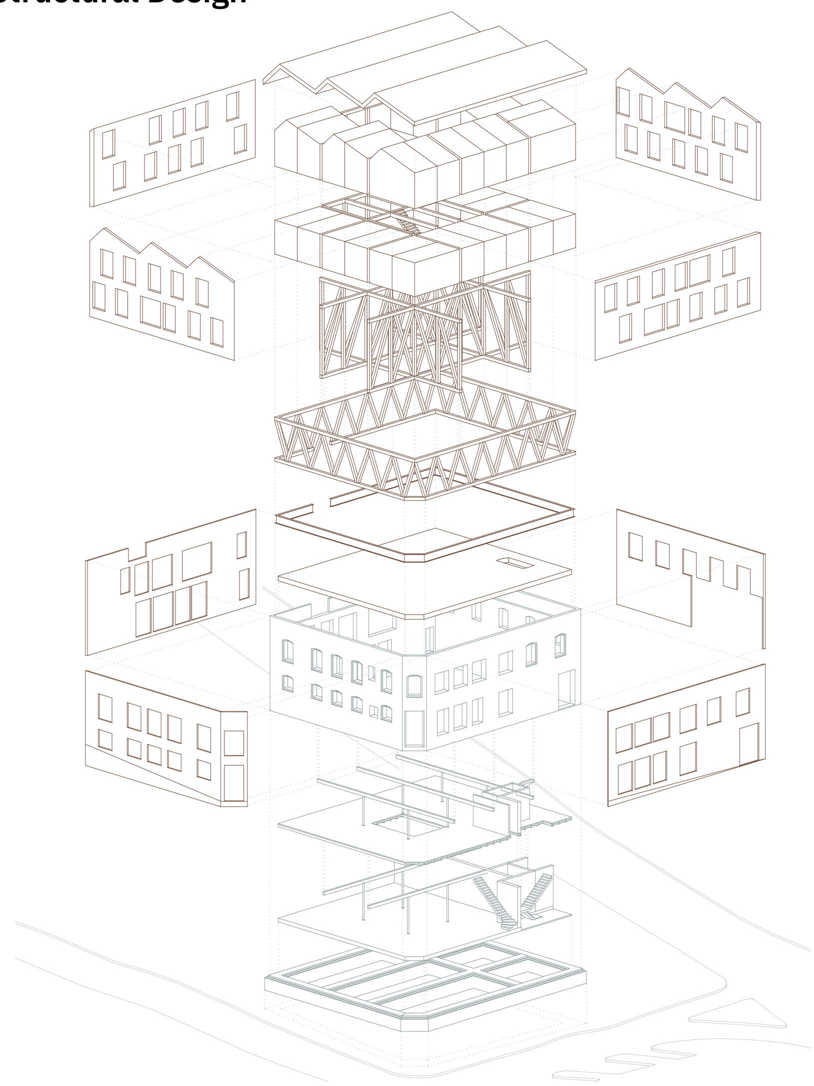


Fig. IV.1. 36. Structural design concept of the overall design

The existing building structure

The challenge for our rooftop extension RoofKIT is to base on an already existing building (Fig.1.36), whose bearing structure has almost reached its load limits. The structural design of the project keeps the established building almost free from additional loads. Only the thick external brick walls bear the load of the addition. The existing roof of the café must be reinforced to bear the increased live loads of the urban gap performance space. It is also crucial to examine whether the foundation and the construction ground can withstand the increased vertical and horizontal loads from the roof top extension.

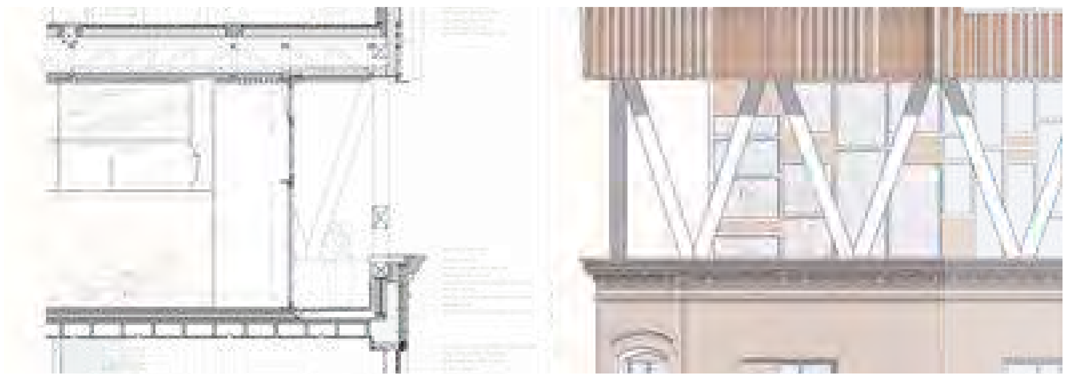


Fig. IV.1. 37. Connection existing/top-up structure

The circumferential steel beam

On top of the walls of the existing Café Ada, we are installing a circumferential steel beam to equally distribute the loads from the top up. Furthermore, the steel beam is needed to direct the loads to not perforated wall pillars away from the fenestration of the brickwork (Fig. 1.37.).

The urban gap wooden truss

Above the circumferential steel beam, we place a system of V-shaped diagonal columns – with the visual appearance of a truss girder - outside of the façade of the urban gap performance space (Fig. 1.37). The connections to the steel beam must also support shear loads since the urban gap truss plays a major role for the bracing of the entire rooftop extension in both axes. The height of this floor is about 4.50m, thus the columns need to have large cross-sections to avoid buckling. Moreover, constructive measures to preserve the timber must be considered, since these supporting members are located outside of the thermal shell of the building.

The wooden frame structure of the extension

To keep the additional dead loads for the top-up to a minimum, a lightweight wooden frame construction was chosen. The skeleton of the structure consists of four crossed wooden trusses, that span across the entire length of the building and rest on the top girder of the urban gap wooden truss (Fig.1.37). Two of them span in North-South direction, the other two in East-West. Thus, the bracing of the extension in both directions is ensured. We chose the static height of the trusses to be twice the height of a story in the top-up to maximize the section modulus. This benefit in its geometric resistance allows us to save material to reach the required resistance.

The wooden modules

The individual modules come with their own timber-frame construction. Following the same principles as the wooden modules in the HDU, each is statically safe for itself and braced through the diagonal cladding within the walls. In the building, the modules are connected to each other and supported by the wooden truss system described above.

HDU Strucural Design Concept

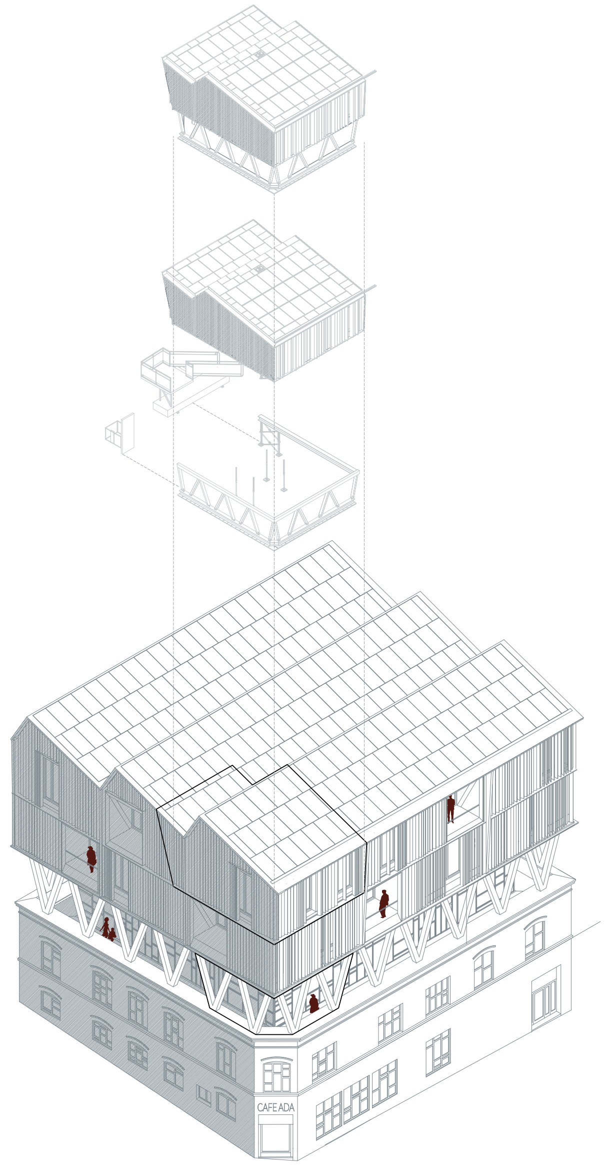


Fig. IV.1. 38. The RoofKIT HDU in its context of the overall design

For the demonstration unit, we cut out a part of the structure from the building design (Fig.1.38). As a replacement for the urban gap truss beam, we chose to base it on a temporary scaffolding for the competition in Wuppertal (Fig. 1.39.). Firstly, this construction serves the purpose of maintaining the image of the HDU as a rooftop extension, where the space below still can be used as dance floor. Secondly, the flexible scaffolding is a sustainable and affordable solution for the short competition phase in comparison to the rest of the HDU's life cycle, where it will be placed directly on top of an existing building. It consists of two members, simple columns below the technical core to support its increased dead loads due to heavy machines and scaffolding towers, that are stiffened within and thus could carry horizontal and vertical loads.

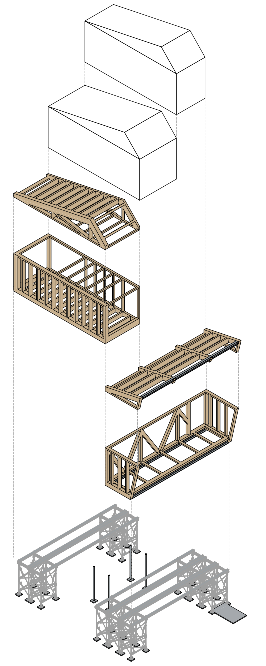


Fig. IV.1. 39. Structural design HDU – Scaffolding

Fig. IV.1. 40. Structural design HDU - concept

The demonstration unit itself is divided into four modules. Three of them work as the living space and the fourth adds the patio to the building (Fig.1.40.). Structural components that are not included in the building design but are crucial for the temporary structure of the demonstration unit are clarified by the use of steel extracted from the urban mine. In that manner we have included a steel beam in the roof of the patio module to facilitate the large span to create as much open space as possible. All other elements are made of wood according to the overall structural design. Furthermore, we pay attention that the modules work not only as a combined system but also as individuals for the transport. The building is separated into roof and living modules. The roof modules are designed as truss beams to combine a sufficient static height with efficient use of material. For the living modules we employed a classic timber-frame structure.

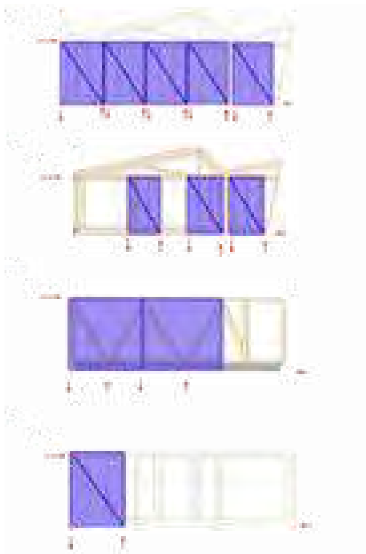


Fig. IV.1. 41. Bracing structure of the HDU

Fig. IV.1. 42. Structural design HDU - concept

We paid special attention to the horizontal bracing of the modules themselves as well as of the entire HDU (Fig.1.42.). In the axis North-South, the bracing of each module is ensured by a purpose-built 24 mm layer of wooden diagonal cladding within the walls and the floor. Thus, the walls work as plain stress structures, passing the horizontal loads onto the diagonal cladding within the floor of the HDU. In the East-West axis the bracing functions the same way in

the Southern exterior wall. For the Northern window façade we added an extra wooden truss-like beam whose web members support the horizontal loads functioning together as triangular shear panels.

Below the living space of the HDU, the floor cladding works as plain stress structure as well, distributing the loads via stiff shear connections onto steel beams that are rigidly connected to each scaffolding tower. Within the strong axis of the towers (North-South) two towers each are connected by a diagonal steel bracing slab to improve their horizontal bearing capacity. These tensional wind braces support the load into two u-sectional beams, that work as the footings of the towers. The static friction of these beams can pass the horizontal loads into the ground (Fig. 1.42.).

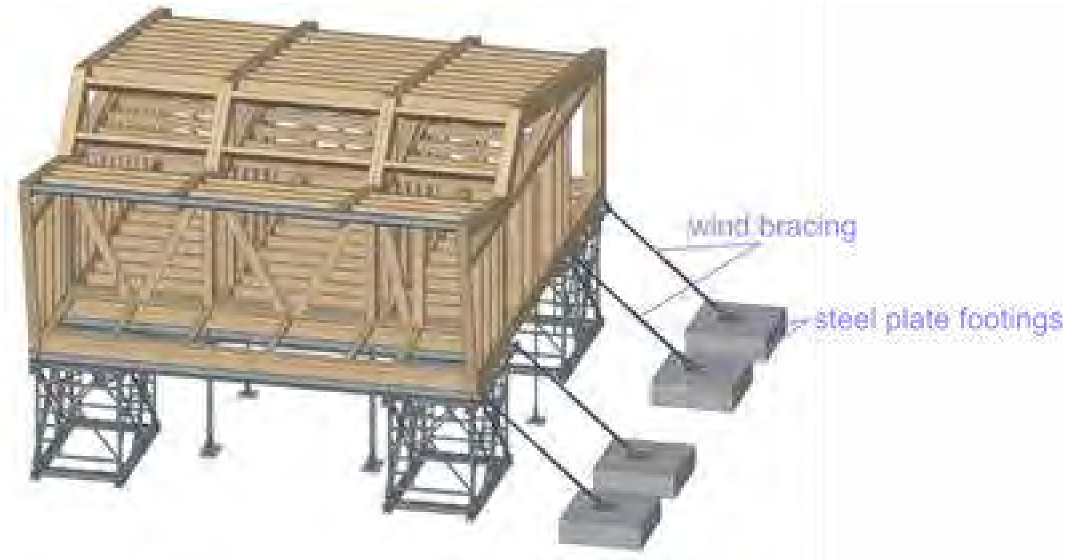


Fig. IV.1. 43. Structural design HDU – horizontal bracing (ballasting)

For the East-West axis, the horizontal bearing capacity of the towers themselves would be exceeded supporting the horizontal loads in this direction. Thus, we had to install additional wind braces connected to 15 mm thick steel plate footings with additional ballasting loads (natural stone filled gabions), whose dead loads entail extra static friction to the supporting structure (Fig. 1.43).

The modules are connected to each other by reversible connections, that allow a simple dismantling after the competition in Wuppertal in order to reassemble the demonstration unit on a roof in Karlsruhe. Therefore, we take care to not stress the wood several times, for instance at the connections between timber and steel joists (Fig. 1.44.: Reversible Joint).

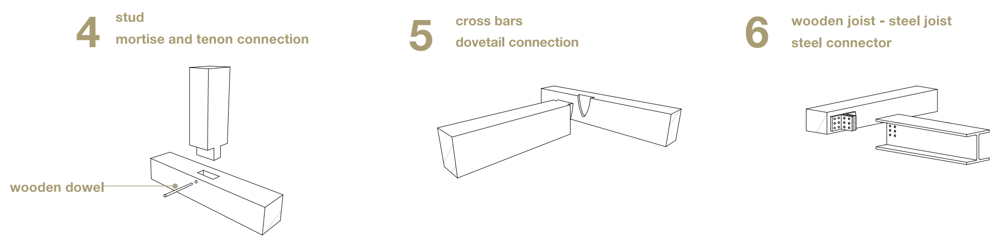


Fig. IV.1. 44. Structural design HDU - joints

For the connection of the structural elements within the modules, we want to reuse and promote traditional carpenters' connection techniques, for instance the dovetail connection.

A lot of them are mono-material connections to provide the possibility of an easy reuse or composting at the end of its life cycle. For the predesign of the cross-sections we divided the structure into several static systems and calculated the relevant loads on the structure. We based our calculation on the Eurocodes 0,1,2 and 5 to obtain the dimensions for our structural elements. Our detailed load assumptions as well as the calculations of the internal forces and the checks according to the Eurocodes can be found in the 'Structural calculations' document.

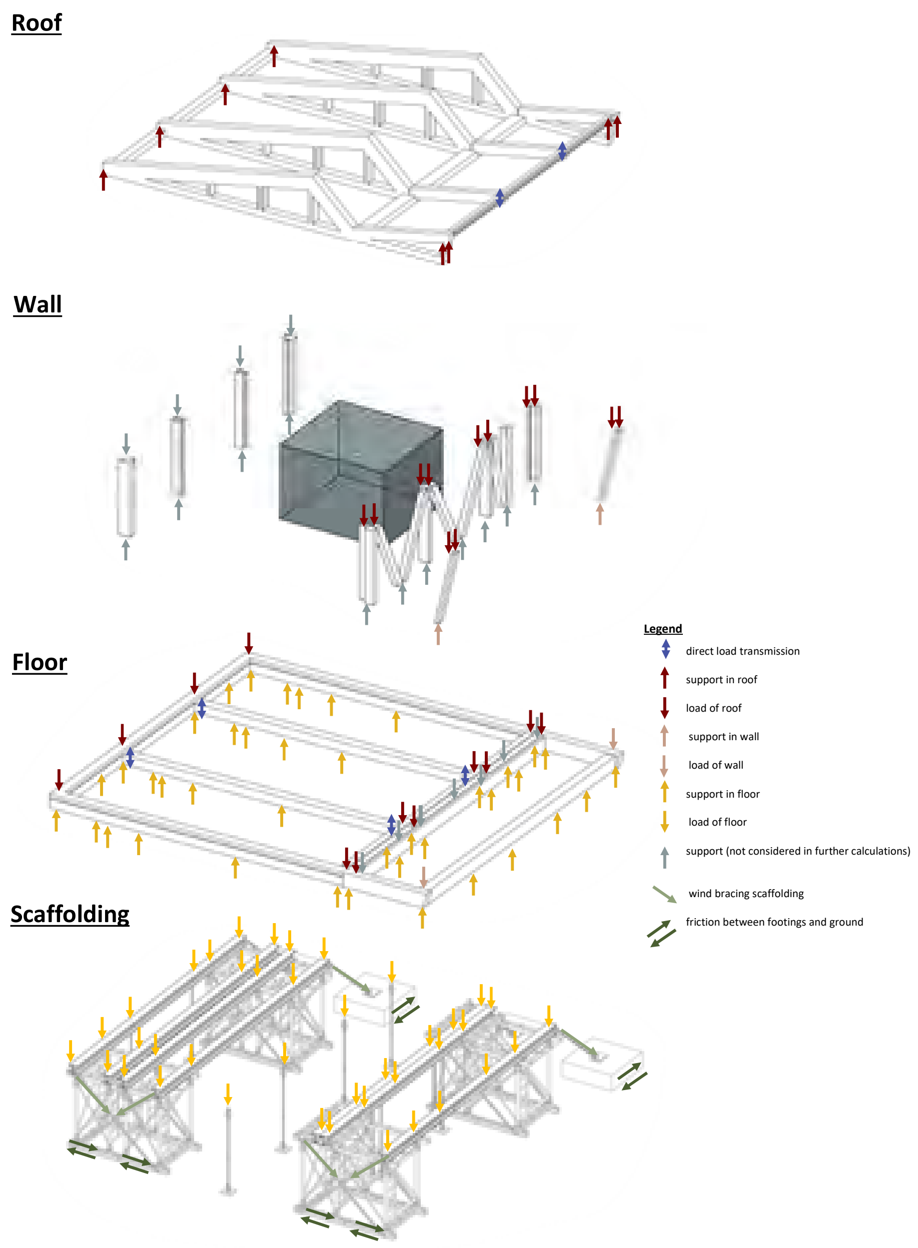


Fig. IV.1. 45. Structural design HDU – force diagram vertical loads

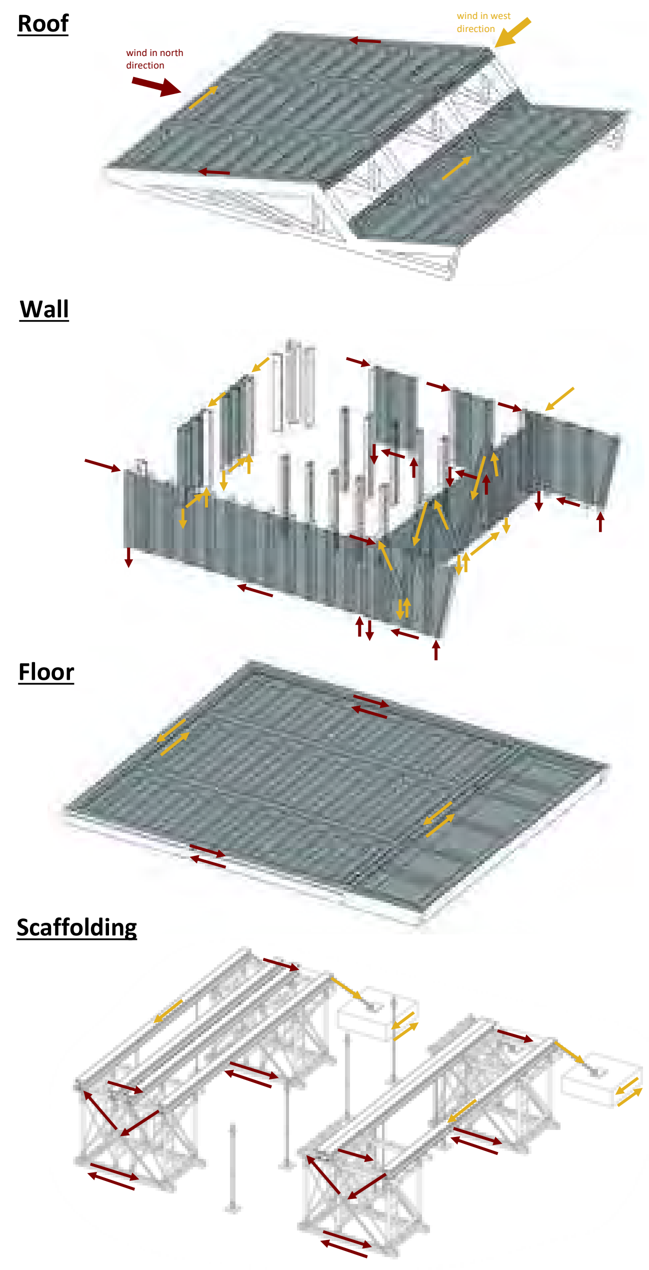


Fig. IV.1. 46. Structural design HDU – force diagram horizontal loads

1.3. Solar System Integration

Fig. IV.1. 47. RoofKIT HDU model

As the RoofKIT top-up is a new construction with a high energy efficiency standard, the total energy demand (including appliances and e-mobility) will be covered by solar systems on the building envelope. Energy self- sufficiency has been demonstrated by previous projects, e.g. Solar Decathlon units in former competitions. The new challenge here is the coverage of the overall energy demand for both, the new living unit and the existing building, as the ratio between the available area for solar panels on the building envelope and the net floor area (determining the energy demand) decreases with the number of floors. The project aims to maximize the area for PV panels on the roof (and also the roof of the stair tower), building surfaces (e.g. façade modules, shading systems) and the available site for solar harvesting (e.g. the solar trees and the roof of the Mobility Hub). In order to achieve the established energy goals, the existing infrastructure (natural gas, electricity from the municipal grid) will be replaced to get as close as possible to carbon neutrality. As part of the goal, the sizing of the RoofKIT's PV and battery system will focus on a high self-coverage of the energy demand as well as on stabilizing effects of the grid. In other words, the feed-in of surplus electric energy during solar peaks and heavy charging of grid energy during peak load times will be avoided by a smart building energy management including the building and mobility solutions. A balanced energy threshold over the year (consumption and generation) as a function of available solar radiation, actual energy demand and grid requirements will be achieved by load shifting or any other sort of demand-side management. RoofKIT does not regard the use of solar systems as a mere necessity but as a possibility to design the building on an architectural level. The full design potential of currently available solar modules was therefore exploited.

The sawtooth roof with its three south oriented parts contains 207 standard-sized photovoltaic modules in total. The roof of the stair tower contains 15 of those modules. The modules will be colored copper-brown to match the roofing in order to create a convincing overall architectural appearance and to integrate into the roof. Therefore, we use an innovative technique with low losses in efficiency. After that, an additional heat exchanger will be mounted on the rear side of the PV modules, to enhance them to photovoltaic-thermal hybrid modules. Therefore, the roof area can be double-used for power generation and solar water heating. As RoofKIT aims to install a building integrated system, a collector design with insulated fluid pipes is applied.

However, since in dense urban situations it is often not sufficient to use only the roof surface to supply the entire existing situation, additional façade elements are activated for energy generation. The PV modules on the façade will be colored as well and form a uniform overall image in combination with materials from the urban mine. While the slats containing PV cells will be mounted on the eastern, southern and western façade of the building, the elements on the northern façade will be made out of colored glass. On this way, the facades are aligned while only using the favorably orientated parts for solar energy use. Between the two glass panes of the slats thin film PV-cells will be integrated. Through a matrix with small distances, they function comparable to textile sunscreens. The orientation of the vertical slats is optimized for the use of solar energy, shading purposes and views towards the outside and makes the façade appear like a living shell. Further steps in the design process will also focus on the integration, constructive solution, impact on CO_2 footprint, maintenance and economy of the installation.

1.4. References

[1] Almost three quarters of the European population lived in urban areas in 2015 and it could rise to just over 80 % by 2050. Urbanization Report-European Urbanization Trends, BBVA Research, Ciudad Madrid, https://www.bbvaresearch.com/wp-content/uploads/2016/12/European-urbanization-trends_.pdf, accessed on 21.10.2019, 11:30 am

[2] The living space per person increased in Germany between 2011-17 from 46.1 square meters (m) to 46.5 m. Data UBA

[3] The average temperature in some cities could rise by more than four degrees by 2100, and the seasonal maximum temperatures could rise even more. A greater number of hot days could further aggravate the effects of urban heat islands and thus increase heat-related health problems and air pollution. Rian van Staden, https://www.klimafakten.de/sites/default/files/images/reports/printversion/klimawandelundstaedte.pdf , accessed 21.10.2019, 11:55 am

[4] Buildings are responsible for approximately 40% of energy consumption and 36% of CO2 emissions in the EU. Currently, about 35% of the EU's buildings are over 50 years old and almost 75% of the build. stock is energy inefficient. EU, https://ec.europa. eu/info/news/new-rules-greener-and-smarter-buildings-will-increase-qualitylife-all-europeans-2019-apr-15_en , accessed 21.10.2019, 12:20 pm

[5] According to Eurostat Construction is the economic activity with the most waste generation in the EU, Approx. 36%.Source Eurostat Statistical Books, Energy, Transport and Environmental Statistics, 2019 Edition, p. 130

[6] Hebel, Dirk E., Marta H. Wisniewska and Felix Heisel (eds.) (2014). Building from Waste, Recovered Materials in Architecture and Construction. Berlin, Germany and Basel, Switzerland: Birkh user.

[7] Overall, a potential of around 1.1 million additional apartments with 84.2 million m2 of additional living space through the addition of storeys is calculated. study

[8] Filip Dujardin, https://www.dezeen.com/2017/10/27/peoples-pavilion-dutch-design-week-low-ecological- footprint-bureau-sla-overtreders-w/, accessed on 28.06.2021, 3:30 pm

2.Engineering & Construction Report

2.1. Engineering & Construction Concept

Seeking for innovative strategies for the densification of the existing European city, the RoofKIT team has chosen the extension of the Café ADA in Wuppertal. RoofKIT not only creates new living space, but takes the historic building and its use as an international meeting place for tango dancers as the initial point for an integrated solar-based design concept.

The exterior of the existing building remains largely unchanged to remain as a point of identification in the neighborhood, with an energetic upgrade of the building envelope. The newly designed ballroom will be moved up one floor. Through its form and materiality, it spatially forms a transition between the existing building and the new structure. The space thus gained by the former dance hall will be converted into accommodations for international artists and other temporary residents.

The additional residential units on top of the new ballroom will be manufactured as prefabricated wooden modules. This allows for quick, simplified assembly on the construction site. The elevation presents a concept of shared spaces to renegotiate the available individual as well as commonly used space. Thus, RoofKIT aims to address the needs of residents in different living situations, among them students, families and seniors, and shall help to create a social togetherness.

2.1.1. Whole building approach

RoofKIT follows a holistic approach in which the energy concept is an integral and visible part of the architectural design from the very beginning: a synthesis of passive measures (e.g. use of solar energy and daylight, natural ventilation, passive cooling) for high indoor environmental quality and innovative solutions for energy supply, yielding carbon neutrality over the year. Key design factors seek into comfort and well-being as of utmost importance for living spaces. The implemented measures extend to the improvement of the urban microclimate and outdoor comfort around the building by known approaches (e.g. unsealed green surfaces plants, shading). Fig. 2.1 shows the concept of the RoofKIT whole building approach with its main innovative features and figure 2.2 gives an more detailed overview of the different technical systems.

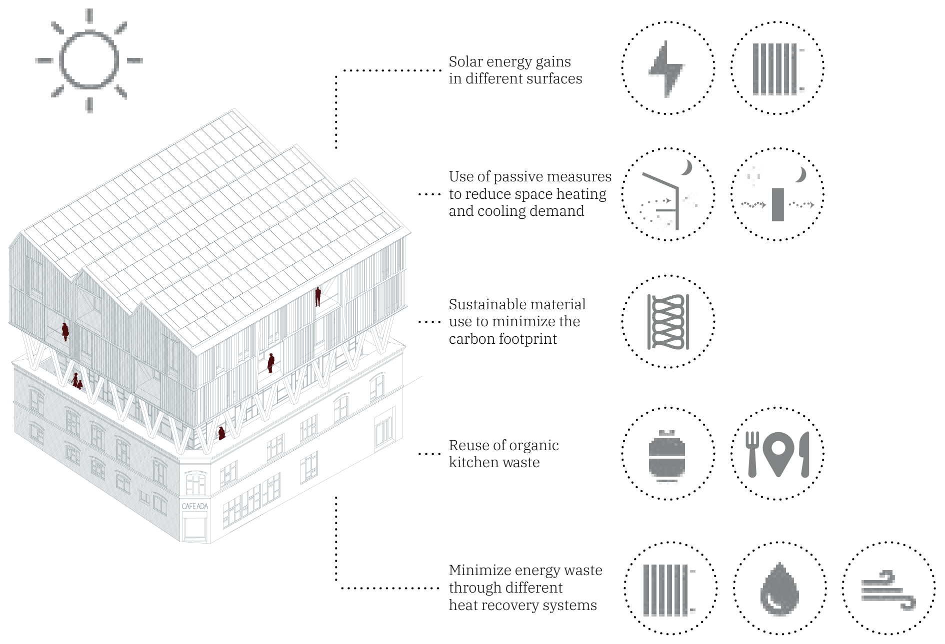


Fig. IV.2. 1. Concept of the RoofKIT whole building approach with its main innovations

A strong focus of the design strategy is reproducibility in various urban contexts. Therefore, RoofKIT waives systems and strategies which would be implementable in the given situation of Café ADA in Wuppertal, but not in common urban contexts. For example, earth probes were excluded as a heat source for the heat pump as most buildings in cities do not possess enough plot area to place them.

As facades are only partly usable for solar harvesting in dense urban environments due to shading, roofs are the main source for solar energy supply. However, topping up a building impairs the ratio between available roof area and net floor area to be conditioned. Therefore, the energy consumption of the whole building has to be minimized for a maximum of solar coverage in an annual balance. Further, emphasis has to be put on solar technologies to be applied which guarantee a most efficient solar harvesting.

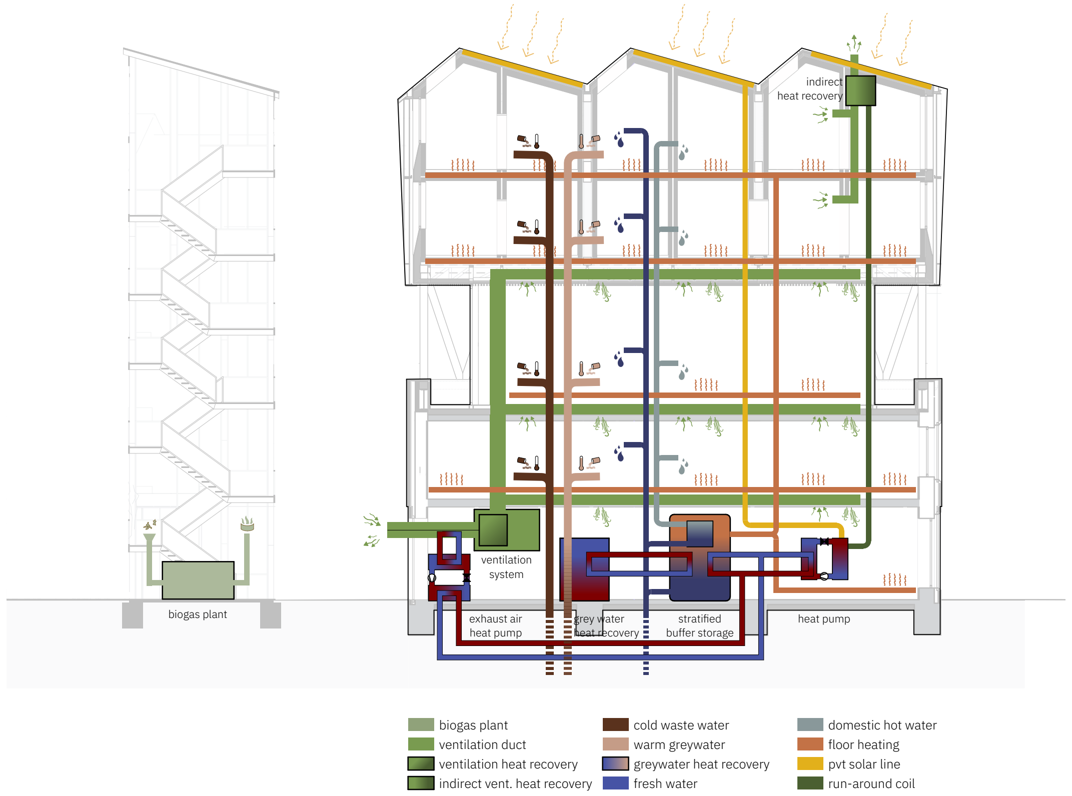


Fig. IV.2. 2. Technical systems of RoofKIT

2.1.1.1 Designing for high energy efficiency and comfort

Building envelope

An important prerequisite for reducing heat losses is the quality of the thermal envelope. While the new extension can easily be constructed close to passive house standard (more details about the construction can be found in section 2.1.2.1), specific solutions have to be elaborated for the existing building from the beginning of the twentieth century with its non-insulated walls and floor. The currently existing spaces between the wooden floor construction and the ground are filled up with insulating material. Thus, a U-value of 0.20 W/(m²K) can be achieved. For the exterior walls a solution is proposed which is transferable to other situations where the old and rough character of existing structures shall be preserved, and energy performance improvement is sought at the same time. This is reached by the addition of exterior insulation behind a shell constructed of StoneCycling bricks made from waste, which mirrors the character of the old brick façade. Additional windows from the urban mine are mounted in front of the existing ones, to improve the thermal properties. The new glazing area is larger than the old one and thereby shows parts of the existing brick wall. Inside, a second insulation layer is planned to reduce the thickness of the exterior one, to avoid conflicts with the sidewalks in the urban space. This inner insulation consists of calcium silicate and together with a loam rendering it regulates moisture threshold. Overall, the U-value of the existing walls can be reduced by about 75% to 0.23 W/(m²K).
The whole building envelope is further optimized with regard to solar input and daylight availability. Parametric studies for the summer period helped to achieve a façade design with optimal window-to-wall ratio, appropriate optical properties for the glazing and adequate shading which minimizes overheating

and still guarantees daylight and a view to the outside. In addition, the combination of shading and solar harvesting is considered resulting in a façade system which allows electricity generation and shading at the same time.

Ventilation

As a first step towards high indoor air quality, low-emitting materials are selected for the interior of the whole building. This also reduces the required rate of fresh air resulting in less energy consumption for ventilation. According to the multiple usages in the building, the overall volume is split up in two ventilation zones: The first one includes the refurbished part with restaurant and boarding house as well as the new ball room, where a central ventilation system with direct heat recovery is applied. The exhaust air serves as an additional heat source for a heat pump, assuring a more constant temperature over time compared to ambient air. The apartment storeys of the extension, with a significantly lower demand of fresh air, have decentral exhaust systems to vent the internal bathrooms – each of them for two private units connected by a vertical installation duct – and the kitchens in the commonly used area. Supply air is provided through narrow openings in the window frames serving fresh air from the outside directly to living areas, and exhaust air is drawn from areas with high contaminant concentration. Special care is taken to avoid draft from cold air by proper placement of the openings. As a direct heat recovery is not possible in this system, heat from the exhaust air is extracted by a heat exchanger before the air outlet through the roof and delivered to the buffer storage in the HVAC room on the ground floor. Thus, the required space for installations can be reduced to a minimum and no air ducts compromising interior architectural design and air quality have to be installed in the residential storeys. Fig. 2.3. shows the two different ventilation systems.

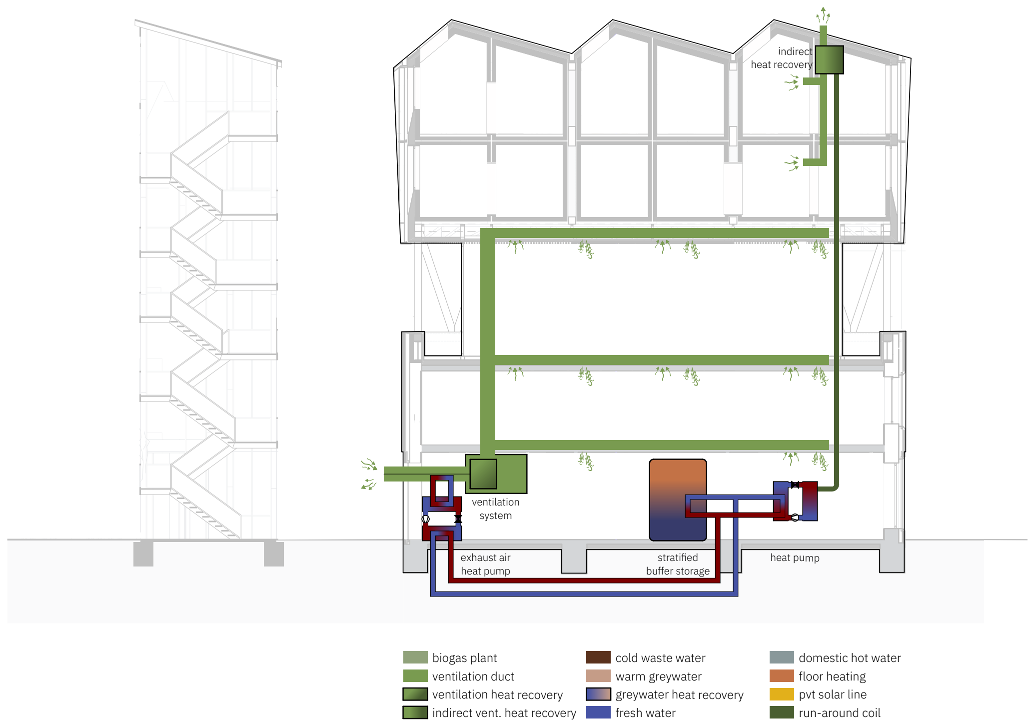


Fig. IV.2. 3. Ventilation systems of RoofKIT

Thermal mass and night ventilation

Although proper insulation of the envelope and effective shading minimizes heating and cooling loads, special care has to be given to overheating during summer since the extension on top of the ball room is a lightweight structure. Therefore, clay boards in walls and floors are used as thermal mass to control the indoor temperature dynamics. The thermal mass in both parts of the building is discharged by natural ventilation during nights. In the residential part of the building, the atrium improves the night ventilation by the buoyancy effect. Further, furniture with spelt filling as a lightweight material but high thermal capacity, and personal comfort systems can support passive cooling by individually providing comfort when needed. To handle peak loads – e.g. during heat waves or exceptional use patterns – radiative cooling against the sky during nights can be facilitated with the solar collectors. For this purpose, heat is extracted from the spaces through the floor heating system.

2.1.1.2 Energy concept – solar energy use and heat recovery

The building‘s energy supply is based on PVT collectors that simultaneously provide solar electricity and heat for a heat pump. Energy management maximizes the self-consumption of solar energy and the building‘s grid serviceability by optimizing solar yield, electricity demand, and charging / discharging of batteries (building and e-vehicle) and buffer storage. Heat recovery from a central wastewater heat exchanger further contributes to the building‘s high energy efficiency. The conversion of biowaste into biogas for cooking is also taken into account with a view to extending the idea of the circular economy to technical processes in the building. Together with the design features for energy efficiency, it is possible to cover the annual energy demand with solar energy and heat recovery. Fig. 2.4 gives an overview of the different systems and their interconnection.

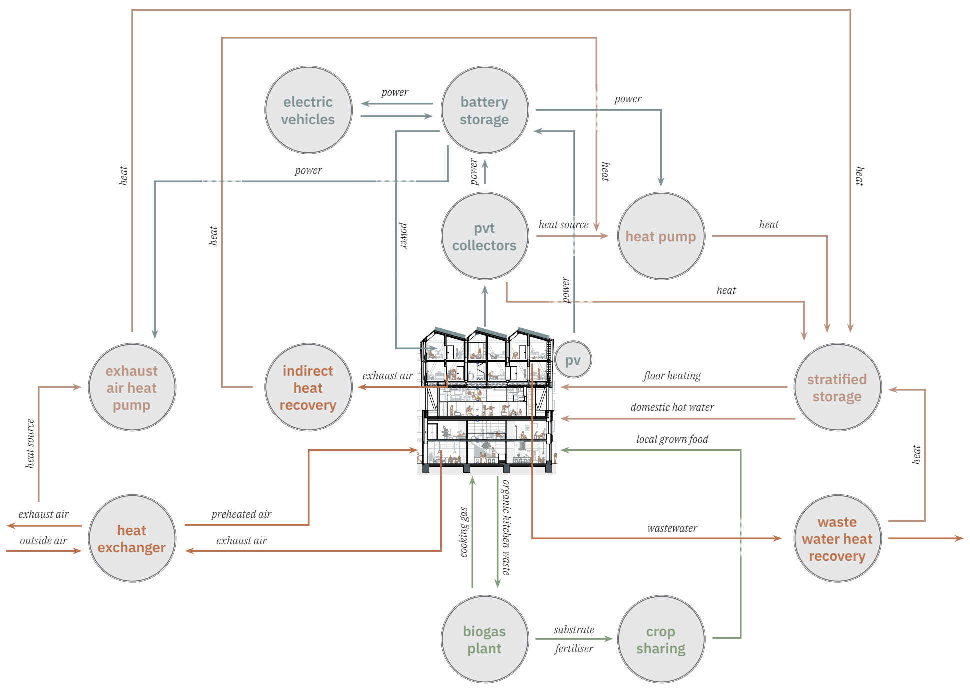


Fig. IV.2. 4. Overview of the different technical systems and their interconnection

Solar harvesting

The building‘s sawtooth roof with its three south oriented parts is covered with 207 standard-sized photovoltaic modules (as parts of PVT collectors) in total. The intention is to use existing or refurbished modules, both collected from the urban mine. In order to adapt to the building‘s architectural concept, colored modules are used, applying an innovative coating technique with low losses in efficiency. By using PVT technology, the roof area can efficiently be double-used for power and heat generation. Aiming at an esthetically well integrated system, a liquid-cooled uncovered collector design with fluid pipes directly connected to the rear of the PV modules is applied. The generated heat is used as the main heat source for a brine-water heat pump. During summertime, direct heat use is considered due to the higher temperature level of the fluid in the collector.
Moveable glass lamellae which cover the façades of the extension homogeneously (see fig. 2.5), also generate electricity and control solar input through the windows at the same time, preventing the building surface from heating up. Small thin film PV-cells are integrated between two glass panes and through a matrix with small distances, the lamellae can be operated comparable to textile sunscreens. The orientation of the vertical slats in front of windows is controlled by the energy management system which balances solar yield, indoor thermal comfort and daylighting. Slats in front of opaque walls are either fixed or jointly operated with a push rod.

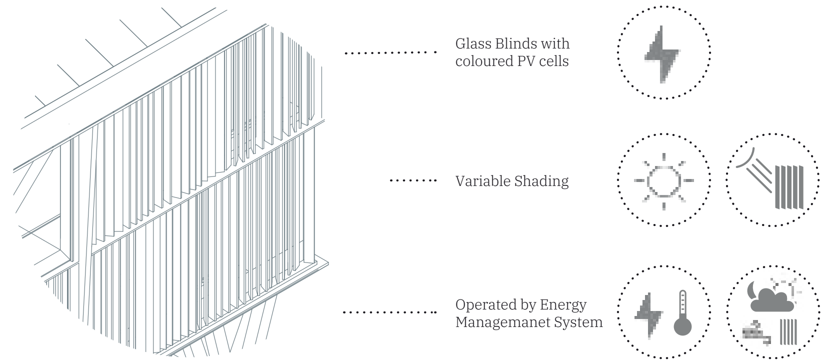


Fig. IV.2. 5. PV systems work as shading systems on the facade of the RoofKIT extension

To enlarge the total area for photovoltaic, RoofKIT also uses the stair tower (see fig. 2.1) as well as areas on the property. The site concept integrates special elements representing the importance of renewable energies in an urban context. Photovoltaic modules on the roof of the mobility hub provide energy which is immediately used for charging e-bikes. Solar Trees built with materials from the urban mine with photovoltaic ‘leaves’ generate electricity for the building and serve as a public charging station for smartphones via USB-hubs. Furthermore, they improve – together with real trees – the microclimate by shading the lot from the sun.
To increase the self-consumption fraction on a daily level, a short-term battery storage is used. Additionally, grid-connected electric bikes and minibuses are part of a power management system on the building and district level and serve as an expansion of stationary mounted batteries. Their charging status is allowed to drop to a level which is still sufficient regarding the needed range for the upcoming hours (For further explanation see Urban Mobility Report 6.2.3).

The photovoltaic systems installed on the roof, façades and on the property lead to a significant electricity surplus in the summer months. However, the superior objective remains carbon neutrality in an annual energy balance.

Greywater heat recovery

Following the philosophy of circular economy, RoofKIT is also seeking to reuse waste energy from the building wherever possible. One of these sources is energy from wastewater. Already being recovered from communal sewage tunnels in some cities, decentralized systems (for greywater) are also available in buildings, e.g. in shower tubs. In order to benefit from all sources available in RoofKIT (restaurant, boarding house, residential storeys), an unpressurized overflown greywater heat exchanger is used as a central recovery system (see fig. 2.6). The main advantage compared to tank-based systems is a simpler maintenance without interruption of operation. To increase the heat transfer, separate duct systems for hot greywater and cold wastewater are installed. Rough estimations show that approx. 20% of the energy demand for domestic hot water can be replaced by the recovery system. Hence, greywater heat recovery (together with heat recovery from ventilation) is a further contribution to reach the aim of carbon neutrality within an urban situation and to take advantage of a more continuous energy flow in addition to the fluctuating solar contribution.

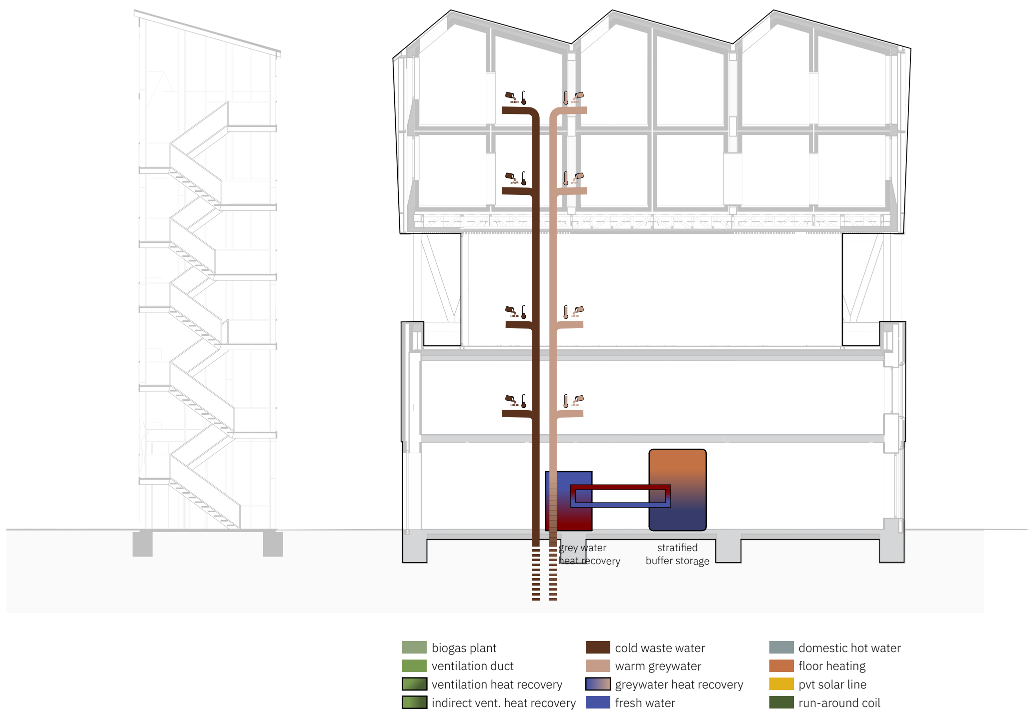


Fig. IV.2. 6. Greywater Heat recovery in RoofKIT

Circular biogas system

Another mostly unused energy source in buildings is organic kitchen waste, which is indeed partly collected on city level, but why should waste be transported if it is possible to use the embodied energy directly on site? Small decentral biogas plants are scaling down the cycles and reduce transportation emissions. In addition, the awareness of a circular economy is much higher if the inhabitants are able to use the produced biogas immediately for cooking.

The utilization mix with café and apartments create a quite steady source for a biogas plant. As the expectable amount of gas would only cover a very small fraction of the annual heating demand, the use of biogas is limited to the direct use for cooking. Thus, problematic large storage tanks for the produced biogas can be avoided. The unit is placed underneath the external stairs. This plant produces about 4.300 kWh/a out of 5.250 kg organic waste from the restaurant and the inhabitants.

2.1.2. Demonstration unit (HDU)

For the competition in Wuppertal, a residential unit from the elevation will be simplified and „cut out“ as a demonstrator. Despite being a part of the whole building, the HDU has specific requirements but also offers opportunities, e.g. it does not build up on an existing building and it has a better ratio between available solar envelope and conditioned volume. As a construction, it consists of four prefabricated modules with a central core that bundles all technical installations as well as the kitchen and bathroom. This leaves almost the entire net floor area of the unit free for living, working and sleeping. To demonstrate the elevation, the building unit is placed on scaffolding, and the area underneath the building is additionally used during the competition for visitor access, in allusion to the dance hall, but also for technical equipment that would otherwise be found in technical rooms in the existing building. Fig. 2.7 shows a sketch of the HDU with its main innovations.

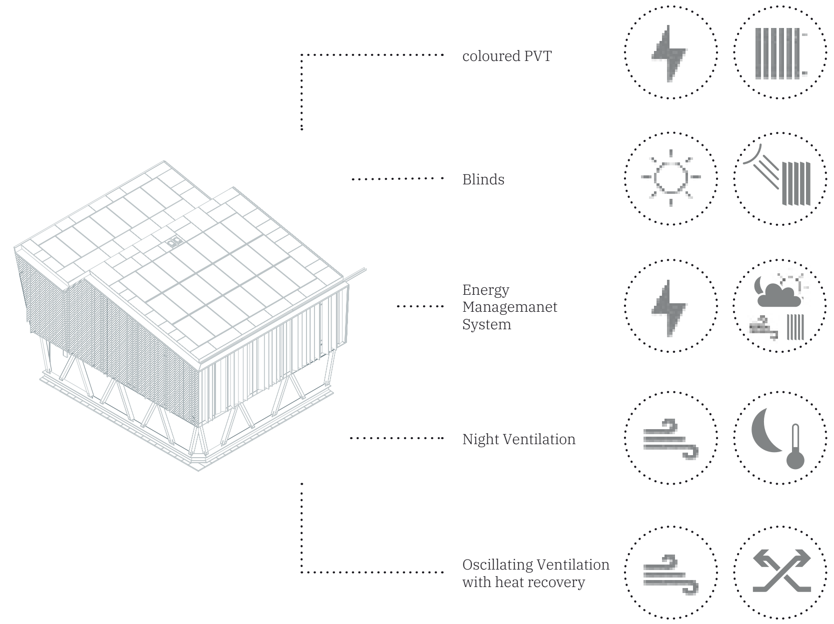


Fig. IV.2. 7. Concept of the HDU with its main innovations

2.1.2.1 Designing for high energy efficiency and comfort

The implementation of the aforementioned design strategies is a main aspect in the development of the unit, to provide maximum indoor comfort conditions and minimum energy consumption. No active cooling is considered in the building unit. The design process is accompanied by in-depth dynamic simulations to evaluate design decisions with regard to energy performance and indoor climate.

Building envelope

Wood from various recycled stages is used for the load-bearing structure of the HDU as well as for sheathing to further reduce the global warming potential of the building also through stored CO_2. In addition, the reuse of all materials and components is ensured through mono-fraction construction without non-detachable connections as far as possible. The thermal insulation of the entire building envelope is realized with a natural product based on dead water plants, which is processed into insulating material without additives and offers a comparatively good Lambda-value as a natural mono-fraction insulation material. To avoid condensation in the construction, the building envelope is supplied with a moisture barrier on the interior surface of the timber frame, that on both sides is revetted with airtight diagonal wooden form boards. On the exterior side a permeable windproof paper is applied to increase the airtightness (see figure 2.8).

Since the HDU is elevated and thus connects to outside air on all six sides, the floor area must also meet the high requirements for thermal insulation - unlike in the case of an extension. The composition and thickness of the building envelope‘s different components result in different U-values. The walls show the highest value (U_{wal}l = 0,2 W/m²K), whereas roof and floor have a slightly better value (U_{roof} = 0,14 W/m²K; Ufloor = 0,18 W/ m²K).

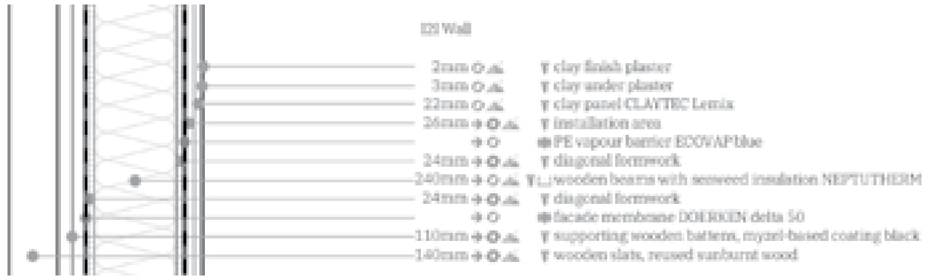


Fig. IV.2. 8. Wall construction of the RoofKIT extension

Another special feature of the HDU are the windows – here so-called stock windows, i.e. windows from or for other construction projects, are used for the HDU. The primary selection criterion is adequate thermal insulation; different window sizes are used as a design feature. All windows are triple-glazed with a U-value of 0,6 W/m²K. The glazing with a solar transmission of 0,59 still allows for solar gains in winter but requires a very effective solar protection system for summer conditions. Therefore, exterior textile screens fabricated of reused material are used, which offer a very good shading coefficient (Fc = 0,16). Using automated control through the energy management system, shading is optimized in terms of allowing solar heat gains in winter and preventing overheating during summer.

Ventilation

In deviation from the system of the whole building an alternative approach for ventilation is realized in order to save space and avoid extensive ducting for the small building unit which is also not divided into separate rooms. Oscillating decentralized ventilation systems (or “push-pull” devices) with internal heat recovery are integrated into the façade. These devices from the company LUNOS provide supply and exhaust air, changing their flow direction every 60 seconds with a theoretical average heat recovery efficiency of 83%. Figure 2.9 shows the planned distribution of the decentralized ventilation units in the HDU to obtain an optimized ventilation effectivity. Besides, exhaust air systems are situated in the bathroom and shower to remove excessive moisture and prevent odors from diffusing into the living area. To guarantee moisture protection, the exhaust fan in the shower operates automatically with a humidity sensor. In the bathroom, a conventional on-off strategy with a 15-minute time delay is considered. The exhaust fan in the technical core aims at extracting heat from technical components, therefore a temperature-based controller is installed.

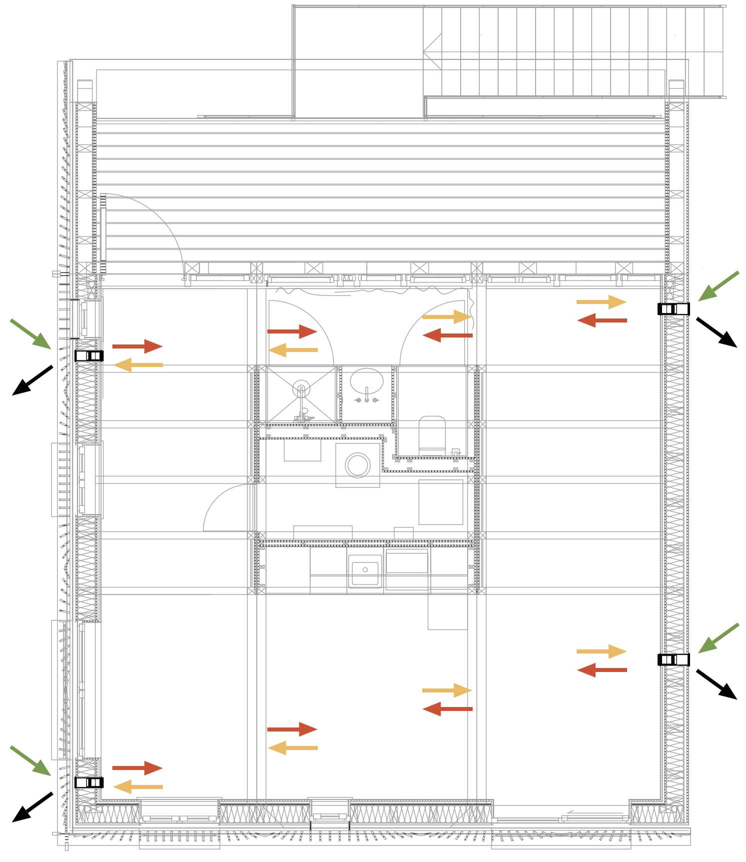


Fig. IV.2. 9. Decentralized ventilation systems in the HDU

All systems are designed according to the German standard DIN 1946-6 which regulates the required ventilation rates in residential buildings. As a result, the decentralized units have to be installed pairwise (illustrated in figure 2.9) to provide a ventilation rate of at least 10 m³/h for moisture protection, 35 m³/h for nominal ventilation and 60 m³/h for intense ventilation. Special care is taken to avoid draft from cold air by proper placement of the ventilation units in the exterior walls.

Outside the heating season the oscillating ventilation systems can be turned off in favor of manual ventilation through windows by the occupants. An openable skylight and fully openable windows can be used to maximize air change rates if necessary.

Thermal mass and night ventilation

As explained for the whole building approach, additional thermal mass has to be implemented into the lightweight construction to guarantee successful passive cooling. In line with the mono-fraction and detachability strategy, clay boards are integrated into the inner wall surfaces (together loam rendering) as well as in two layers in the floor (above and in good contact with the floor heating pipes). Besides their outstanding performance regarding heat buffering, clay is an excellent moisture buffer as well. These measures ensure a thermal inertia of 46,5 h of the HDU. Further scenarios with additional thermal mass through phase change materials (PCM) have been investigated but show only little improvement regarding thermal performance. Alternatively, personal comfort systems are suggested for individual improvement of thermal comfort (see Section 2.1.2.3). For effectively discharging the thermal mass by night ventilation, reasonable ventilation rates have to be achieved. The decentralized ventilation units can achieve around 0,8 ACH at nominal speed, whereas natural ventilation can be designed to provide air exchange rates between 4 and 6 ACH. Therefore, a night ventilation concept with the windows and a skylight in the bathroom area is implemented (see figure 2.10). Thus, the buoyancy effect can be utilized, guaranteeing higher air change rates with air entering through the windows and exhausting through the skylight. Simulations with SimRoom[1] show that the proposed solution achieves indoor temperatures that are within the desired range of the adaptive comfort model according to DIN EN 16798 (categories 1 and 2) for 90% of the time, and only 0.4% of points in unacceptable conditions (category 4) (see also section 2.2.1).

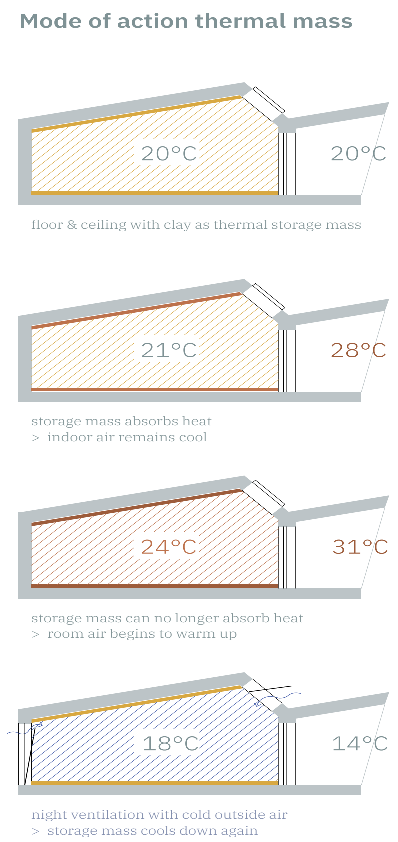


Fig. IV.2. 10. Night ventilation strategy in the HDU

2.1.2.2 Energy concept – solar energy use and heat recovery

The solar energy supply concept of the whole building, including energy management, is basically adopted for the HDU, but scaled down and partly adapted to the requirements of the small building unit. As described above, some technical components (inverter, battery and source-side buffer storage for the heat pump) are installed externally as they would have been located in the technical rooms of the existing building (see figure 2.11).

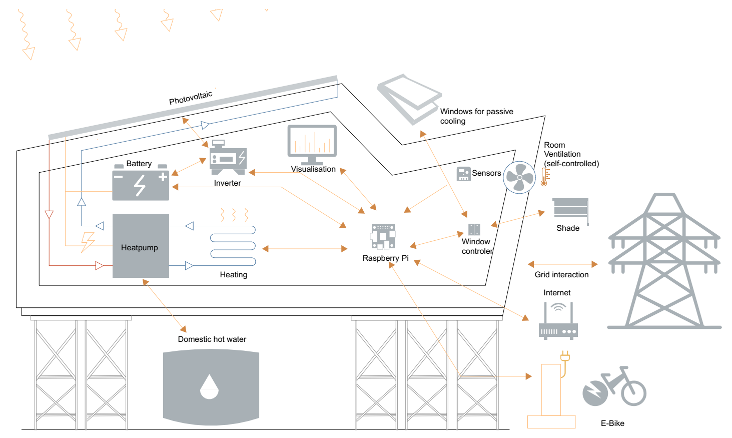


Fig. IV.2. 11. Energy concept of the HDU

Solar harvesting

Despite the fact that the HDU‘s south oriented sloped roof would offer enough space for separate thermal and photovoltaic collectors, the idea of efficient double use of this space with PVT collectors is adopted from the whole building approach to demonstrate a general solution for extensions in urban situations. The HDU‘s roof (without the roof of the patio) will be covered with 18 solar modules in total. Simulations showed that 12 PVT collectors are enough to serve as a heat source for the heat pump. The modules are connected in parallel on the thermal side to reach the required mass flow through the collector field. A buffer storage of 1.000 l separates the brine-filled collector circuit and the heat pump‘s evaporator circuit and helps to adapt the operation of the collectors to periods with sunshine and ambient temperatures above 0°C to avoid icing around their fluid pipes. The selected buffer tank (Buderus SU1000.5-B) has an insulation thickness of 11 cm, which minimizes the heat energy losses of the tank. This system design is a consequence of the architectural decision to apply flat PVT-collectors without lamellae at the fluid pipes on the back of the PV modules in order to have an esthetically well integrated system on the roof (see figure 2.12). The piping system goes through the technical core below the HDU. The circuit has a total length of 18,5 m, and uses copper as pipe material (Wieland Sanco). Different accessories regarding security system (expansion vessel, relief valve, etc.) are included in the system – they can be seen in the plan ME-4101 in the Project Drawings. The roof can be accessed from the side of the HDU for maintenance purposes.

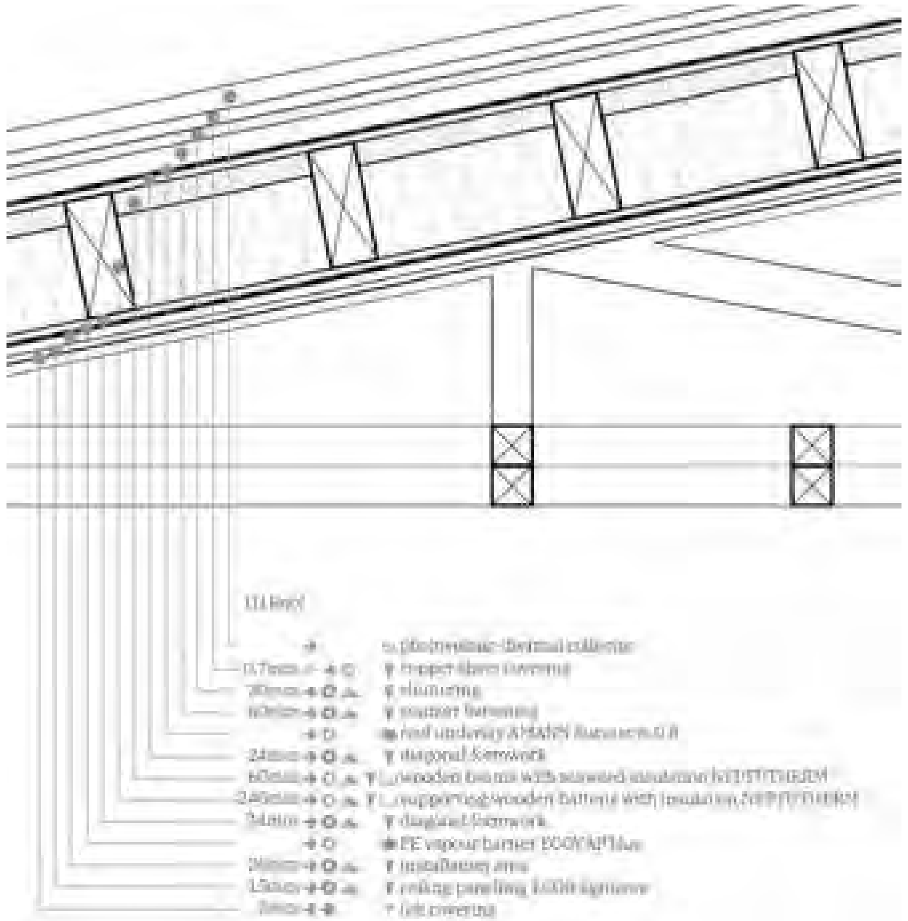


Fig. IV.2. 12. Integration of PVT collectors into the roof of the HDU

In addition to the 12 PVT-collectors, 6 more PV modules are installed to reach a homogeneous roof cover and to provide enough electricity for the later operation of the HDU as a guest house at KIT in Karlsruhe (heat pump, household electricity, mobility) on an annual basis. The PV modules from AxSun Solar GmbH have a rusty brown color which is identical to the roof color – again a measure to understand the solar roof as an integral part of the architectural design of the building. Applying an innovative coating technique, the PV modules show a comparably high efficiency (18% reported by the company). Generally, PVT technology helps to increase PV output as the solar cells are cooled by the brine circuit.

The AX M-60 PV modules are assembled by Solator GmbH with retrofitted thermal collectors. The module used is “Solator + Therm Aufdach” with the product code PVTHERMAU300. For the SDE competition in Wuppertal, only 10 PV modules will be connected to the electrical system to not exceed the limit for PV output of 3kWp, given by the SDE rules. Considering the temperature coefficient, they have an input voltage range from 193.6V to 509.2V. The connection to the inverter (Fronius Symo Gen 24 Plus 5.0) which will be placed beneath the HDU together with the battery (BYD HVS 5.1 kWh), will be installed along the outside of the building. The required circuit breaker will be placed and marked in accordance with the SDE rules and requirements set by the local fire brigade, below the HDU and close to the inverter. The inverter serves for connecting to the AC SDE campus grid and the distribution network of the city, as well as to the battery (DC) and the low voltage AC network of the HDU at the

same time. Therefore, no second inverter is necessary and the overall efficiency of the system is improved. The battery has a capacity of 5 kWh which is not in accordance with the SDE rules. Reason for this is the absence of battery packs with a capacity of 2.5 kWh on the German market. Furthermore, the product has been chosen for its synergies with the inverter (the two companies have a long lasting working relationship and cooperation) and will be set to a maximum capacity of 2.5 kWh by the software of the product in the building management system.

Team RoofKIT developed the necessary safety measures for the whole PV system, including battery and inverter. The safety devices (circuit breaker, overvoltage protection and residual current device) were dimensioned according to the requirements of the standard IEC 60364-7-712 and following the recommendation of the different products. For additional safety, an emergency switch to safely disconnect the PV system is installed next to the inverter. All DC wiring is outside the HDU, contributing to additional fire safety. The battery and the inverter are placed in a water-proof case. More details about the safety standards of the installation can be found on section XI – Electrical & PV design systems information.

Heating and DHW system

A heat pump (Bosch Compress 7800i LW M(F) with a maximum heating capacity 6 kW) which situated in the core of the unit, provides domestic hot water and heating energy for the HDU. The heat pump has an integrated storage for DHW (185 l) with an electric heater as a backup. Due to the proximity of the kitchen, shower and bathroom, piping for hot water supply can be kept simple which also avoids heat losses and material use. The piping system for the source side of the heat pump and the sink side up to the heating circuit distributor has a total length of 23 m and is made of copper (Wieland Sanco). The piping system for DHW is 28 m long, also made of copper and has diameters from 15 to 25 mm. Different accessories regarding security system (expansion vessel, relief valve, filters, etc.) are included in the system – they can be seen in the plan ME-4101 in the Project Drawings. Insulation of the pipes will be done with cork as a natural material.

A floor heating system provides thermal comfort in winter. A central circuit distributor feeds warm water from the heat pump into six circuits. The piping with al total length of 415 m is realized with copper tubes (Wieland Cuprotherm CTX 14x2 mm) which connect to the clay boards above with heat conducting plates, and which are installed in wooden panels with prefabricated milled recesses, thus allowing complete detachability. Again, the design of the HDU allows for a compact installation around the centered technical core. The floor heating has a nominal heating power of 39,6 W/m² (nominal water volume flow is 390 l/h with a supply temperature 40°C). The selected heat pump comes with an integrated modulating control strategy, that allows a direct integration of the heat pump into the floor heating circuit, therefore disregarding a buffer tank on the sink side of the system. The six different circuits are controlled together through a heating circuit distributor. The flow velocity in the pipes is between 0.8 and 1.5 m/s, which should not cause noise disturbances.

Energy management system

The energy consumption of the HDU is optimized by an energy management system, with a particular focus on energy efficiency and self-consumption. The following components are used as actively controllable components in the HDU: The battery, the heat pump, the decentralized ventilation systems, the skylights, the shading systems of the windows and a controllable socket to which an e-bike can be connected for charging. Besides, a weather station is planned on the roof to capture all necessary weather data locally, and also two indoor environmental sensors (room temperature, relative humidity and CO_2 concentration) are installed on both sides of the HDU. The position of the sensors and its wiring is depicted in EL-3007 in the Project Drawings. All components are connected to the energy management system by Modbus or KNX via the central hardware abstraction software BEMCom. Both KNX and Modbus are state-of-the-art communication protocols used in building management systems to apply advanced control strategies. User preferences, especially setpoints for room temperature, are recorded via a web-based dashboard (Energy Management Panel) on a touch screen. This also enables further information on the current status of various parameters in the HDU, such as the battery charge level. Based on the user preferences, schedules for the active components are calculated by means of a model-based optimization algorithm and then executed by them. The wiring of the complete building management system, including the KNX and Modbus connections, is shown in the BMS-1001 to BMS-1008 wiring plans of the Project Drawings.

The lighting management is realized via a wireless solution which enables easy access and control from different locations and devices. The light switches are also integrated to the KNX system, which allows a remote controlling.

Electrical System Design

As with all other installations, also electricity is distributed to the different appliances most effectively, taking advantage of the central core of the unit which keeps the installation as compact as possible. Most of the sockets and lighting outlets are placed in or very close to the core. Few exceptions are made for the electrically driven sunscreens in front of the windows, the façade-integrated ventilation devices and some strategically placed sockets as well as exterior lighting to fulfill the requirements of at least 20 lux in exterior areas set by the SDE rules. In addition, wireless switches will be used all over inside the building unit to reduce raw materials.

Table 2.1 shows a list of the installed devices and appliances in the HDU. The total installed power supply is 30,6 kW. This power is well balanced over the three phases. For every circuit, overcurrent protections (MCB) were selected following the standard IEC 60364-5-52. In every case, the maximum admissible current was calculated to determine the size of the protection in amperes. Besides, for the lighting and socket circuits, residual current devices (RCD) with a sensitivity of 30 mA must be included. In those circuits, instead of installing two protections per line, a single residual current breaker with overcurrent (RCBO) protection is installed, that combines the capabilities of both devices into a single one. This approach leads to a higher material saving in the fuse box.

Product / Device	Devices	Power [W]	Total power [W]	Phase line	Current [A]
Heat pump	1	3700	3700	L1/L2/L3	23
Push-pull ventilation + Exhaust fans	4 + 3	3,3 / 6,2	31,8	L3	1
Solar pump	1	2	2	L3	< 1
KNX	1	12	12	L3	< 1
Refrigerator + Freezer	1	100	100	L3	3
Cooking field (Stove)	1	7200	7200	L1	28
Oven	1	3400	3400	L2	15
Dishwasher	1	2100	2100	L3	8
Washing mashine	1	2400	2400	L3	10
Blinds (shutters)	6	240	1440	L2	7
Skylight	4	200	800	L2	3
E-Bike Socket	2	125	250	L3	1
Sockets kitchen and bath	1	2500	2500	L3	11
Sockets other rooms	1	2500	2500	L2	11
Lighting	1	454	454	L1	1
Lift (off-meter)	1	3000	3000	L3	10
Water pump (off-meter)	1	750	750	L1	7.5
Total			**30.6 kW**		

Fig. IV.2. 13. List of appliances and devices connected in the HDU. The phase line is included to show a correct load balancing (9,6 kW in L1, 9,3 kW in L2 and 11,6 kW in L3).

All electrical circuits are connected to the central fuse box in the core. Fifteen circuits will cover all the needs and requirements set by the SDE, like fixed connections and separate fuses for high power output devices over 2 kW. Three additional circuits are considered for the off-meter devices. Two main current distribution cables will be run down from the central fuse box to the house connection beneath the building as well as to the inverter and battery for the PV system. Besides, the necessary cables for lighting and socket power run also below the HDU. A central house connection box is located below the HDU, were the grid is connected. The house connection is planned to be in accordance with the TN-C-S system, where the grounding and neutral line are together. After the grid connection, a surge protection device (SPD) is installed to protect electrical equipment from damage caused by power surges or transient overvoltages. The SPD provides a direct connection to the equipotential bonding rail, and therefore is the main device that provides the grounding to the HDU. Due to the separation of the neutral and the protection conductor, this configuration provides a clean PE. All components will be installed or placed in enclosed casings to ensure the safety of the public and the safety of the components. Fire safety is also considered for electrical lines in wooden components. The cable to the house connection from the distribution network will be placed in a steel pipe to ensure safety in case of a malfunction. Lightning protection is not required by SDE rules but is still being considered and discussed due to the further use of the unit after the contest in Wuppertal. More details about circuits, protection devices and wiring can be found in section XI Electrical & PV design systems information and the electrical project drawings (EL-5001, EL-6001 to EL-6005, PV-1001 to PV-1004).

Lighting concept

The lighting concept also implements circular economy values combining state of the art LED-lighting technologies and innovative user-oriented lighting design. A basic general lighting system, mounted around the core of the interior space, provides an indirect melanopic lighting solution with biodynamic controls and is manufactured by the Swiss company Mextar using second hand parts.

Furthermore, a variety of portable luminaires with rechargeable batteries is provided for the occupants to decide for individually lit spaces at various intensities. These are free standing reading luminaires and decorative wall sconces from the German manufacturer Nimbus.

To underline the holistic circular philosophy of the project, a unique decorative luminaire cluster hanging over the dining table is designed by the RoofKIT team. The center piece luminaire, from the Swiss manufacturer Ribag, providing good task lighting with glare free technology, is customized with shades from natural grown fungal bacteria and natural reflective minerals, like shell limestone.

Outdoor lighting meets the SDE requirements for security and visibility during dark hours around the entrance, stairs and lift. It is designed with specially selected products, second hand from an Italian producer, that minimize glare and light pollution to the environment. As a special feature, the lighting under the unit will provide a soft wash of the ceiling to be perceived well from the distance and adjustable light spots for flexible outdoor event situations. Figure 2.14 shows the lighting concept of the HDU.

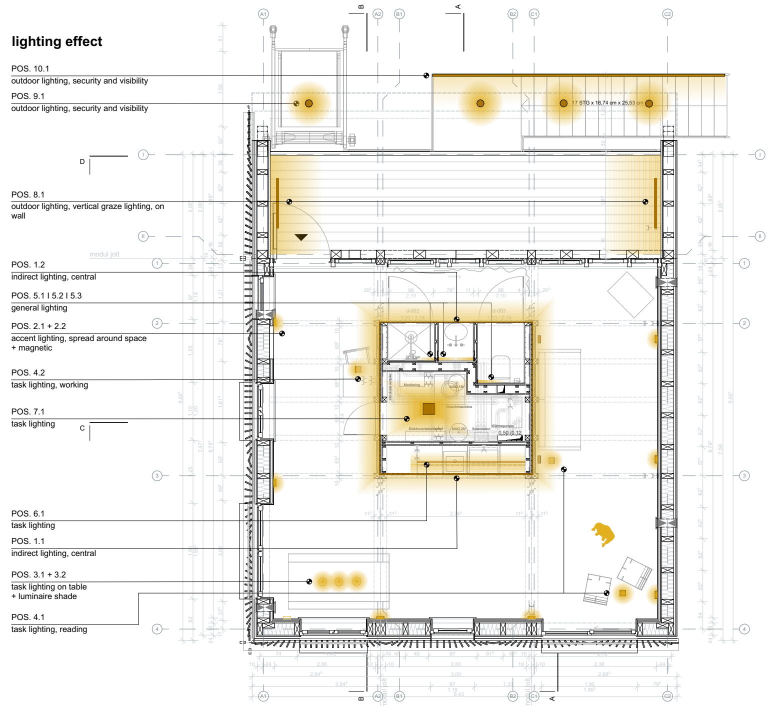


Fig. IV.2. 14. Lighting concept of the HDU

2.1.2.3 Indoor climate and comfort

Comfort and well-being was among the priorities throughout the design process which results in a variety of different measures to ensure high indoor environmental quality, including indoor air quality. Thermal comfort in winter is achieved by high-level insulation of the building envelope, ventilation heat recovery and a radiant heating system. This provides a comfortable temperature level by radiant heat transfer and avoids temperature asymmetries. The decentralized ventilation systems were placed in a way that draft does not affect the occupants. Thermal mass provided by the clay boards helps to homogenize temperature fluctuations by solar and internal gains. In summer, passive cooling guarantees a comfortable indoor environment as already described in detail in section 2.1.2.1. Again, the implementation of thermal mass into the lightweight construction has a crucial role as it stores heat over the day which is then discharged during the night via natural ventilation through the buoyancy effect. Figure 2.15 shows the simulated indoor room temperature.

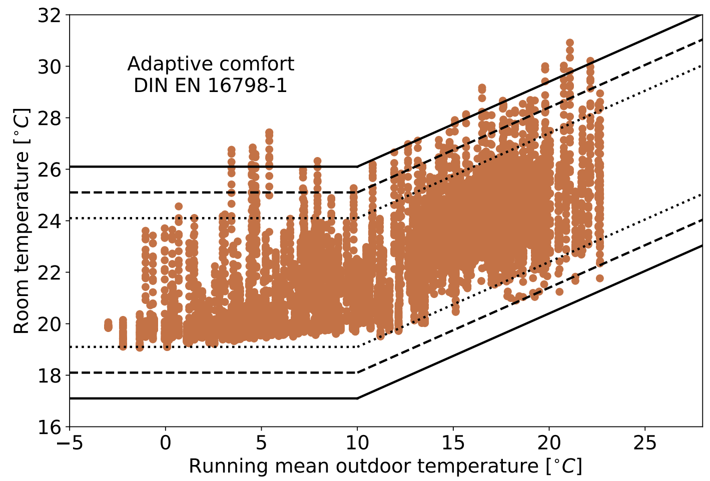


Fig. IV.2. 15. :Operative temperatures as a function of the running mean of the outdoor temperature, together with the comfort band of the adaptive comfort model according to DIN EN 16798.

Visual comfort is addressed by providing sufficient daylight through windows and even more the skylights. Glare and direct sunlight can be controlled by using the shading systems which are manually operable. The basic artificial lighting of the HDU around the core delivers light with a luminous color adapted to the time of the day. Individual preferences of lighting level at any place in the HDU can be satisfied by portable luminaires which are powered by rechargeable batteries.

With regard to air quality, the first step was to select non-/low-emitting materials for the interior which reduces the concentration of substances in the air to mainly human-based pollutants. These are continuously discharged by the mechanical ventilation and/or by manual window opening (only outside the heating season). A monitoring system visualizes the CO2 concentration for this purpose and reminds the user to open a window. In the bathroom and shower, excessive moisture and odors are removed by exhaust ventilation systems operating automatically during and after occupancy. Additionally, clay surfaces regulate and buffer humidity peaks in the main living areas.

These general approaches affecting the whole building unit are accompanied by personal comfort systems (PCS) to provide individual possibilities for increasing thermal comfort. Besides „normal“ adaptive opportunities like changing of clothes, drinking, moving to a shaded place, desk fans etc., two additional appliances are offered for the occupants of the RoofKIT:

Firstly, blankets and pillows filled with a layer of phase change material (PCM) are provided which help to regulate sweat production during the night in warm and hot summer periods. According to the manufacturer, skin surface temperature can be lowered by approx. 1 Kelvin, thus reducing the sweat rate and enabling a more restful sleep. Secondly, a chair at the work place is provided which can either directly heat or cool the body through the seat and backrest. This is achieved by a resistance heater (heating mode) and two small fans (cooling mode) which can be manually controlled on two levels. Both appliances show that PCS are far more energy efficient as they directly condition the human body and not the whole space.

2.2. Building Performance Analysis

The design process for the whole building approach as well as for the HDU was accompanied by building and system simulation from the very beginning to develop, test and justify the concepts based on performance analysis. As an integrated building design concept is a synthesis of optimized physical building properties and adapted building services systems, a thoughtful approach with adequate tools is necessary to fully understand the interdependencies between the different design parameters on the building and the technical systems side. Preliminary design of the whole building was accompanied with EnerCalC [2], which calculates total primary energy consumption of a building on monthly balances. In a more advanced design stage, dynamic building simulation with the software TRNSYS17 [3] was used to investigate and optimize the heating energy demand and summer comfort. Similarly, for the HDU a simplified, dynamic one-zone model (SimRoom) was firstly used to approach the indoor conditions during summer and to roughly size the thermal mass needed, which was then followed by a deeper analysis of the temperature dynamics with the software DesignBuilder [4] to optimize air change rates during night ventilation with a simplified air-flow model and to check draft risks with CFD. Finally, the solar-based heating system of the HDU was modeled with the software OpenModelica (hourly simulations)[5] in order to find an optimal system design, to size the system components and to optimize the control strategy for the system.

2.2.1 Dynamic Building Simulation

Whole building approach

The whole building was modeled with six zones and the shading effect caused by surrounding buildings and the overhang of the ball room was considered. As required, the EnergyPlus weather file [6] DEU_Dusseldorf.104000_IWEC.epw. was used and an isotropic sky model was chosen to calculate the radiation components on tilted surfaces. The simulation with hourly time steps resulted in a heating energy demand of approx. 23 kWh/(m² a) for the whole building which is remarkably low considering the fact that the first two floors of the building are refurbished and the ventilation system for the apartment part of the building was not modelled with a heat recovery system in the simulation.
The proposed design has a total electrical energy consumption of 77 kWh/m²a, with a high self-consumption index (75%). Even through carbon neutrality is not achieved, the proposed design generates around 90% of the consumed energy, which is considerably high, especially since the consuption of the kitchen in the restaurent is relatively much higher than the rest of the building.

HDU

For the HDU, hourly simulations were carried out using the software SimRoom. The selected modelling approach was the 5R1C model from the DIN EN ISO 13790. This approach creates a thermal model of the HDU as a single air temperature node (with a certain heat capacity) and divides the heat flux into five categories: transmission losses (windows and walls), ventilation heat losses, internal loads, solar gains, and the resulting space heating load, depending on the selected temperature set point. Team RoofKIT followed this modelling approach to optimize the resulting U-values and thermal mass C-values for the House Demonstration Unit. As a result, figure 2.16 shows the monthly values of the energy balance in the HDU. To perform this simulation, assumptions about the internal loads (2-person household, 150 DHW consumption per day, 1200 kWh electricity per person) and ventilation losses (n50 = 0.5 h-1) were defined. As shown in fig. 2.16, the HDU has a very low heating energy demand of 24 kWh/(m² a) and heating is only required during 4 months in the winter.

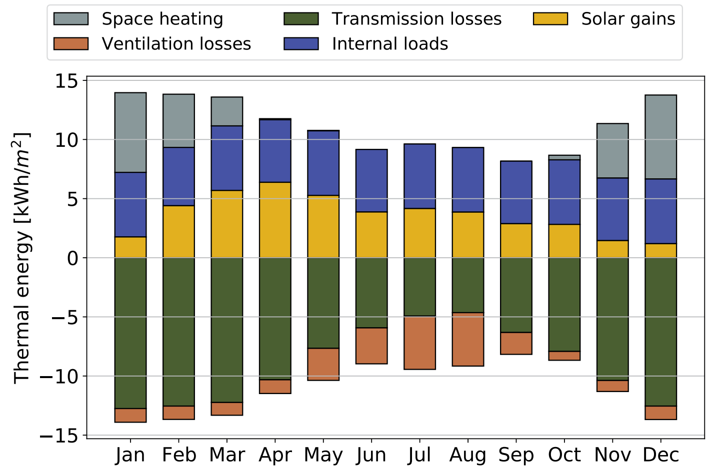


Fig. IV.2. 16. Monthly energy balance of the HDU

Furthermore, for validation and optimization of the night ventilation concept, a detailed simulation study was performed for the HDU using DesignBuilder, varying different opening configurations of the façade windows and the skylight. The focus was on air change rate and indoor temperatures during the hottest period of the considered site close to Wuppertal (International Weather for Energy Calculation, Düsseldorf). The results show that the complementary opening of the south façade windows with the skylight reaches lower indoor temperatures inside the HDU compared to the solely use of the skylight. The additional opening of the west façade windows leads to further but marginal improvements. Interesting enough, using only roof windows for night ventilation achieves peak air exchange rates around 5 which is due to the inflow of air through the decentralized ventilation units. In that sense, Team RoofKIT decided to open the available skylights in the HDU automatically through the building management system, but to leave the façade windows to be manually operated. Hence occupants can influence the effectiveness of night ventilation by opening the façade windows at night. Figure 2.17 shows simulations results for different window opening scenarios.

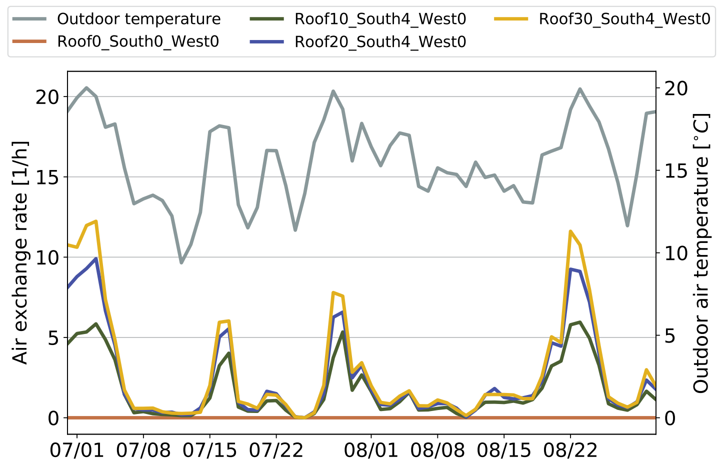


Fig. IV.2. 17. Air change rates for night ventilation, considering different window opening scenarios

Further examination focused on the air flow within the HDU to assure that a sleeping person is not disturbed. Figure 2.18 shows a section of the CFD simulation results for a point in time with a high air change rate. Even with open south façade windows and resulting cross ventilation along the bed, the air velocity is always lower than 0.1 m/s. Similar results can also be observed on the other side of the HDU, where low air speeds appear when the skylights are opened.

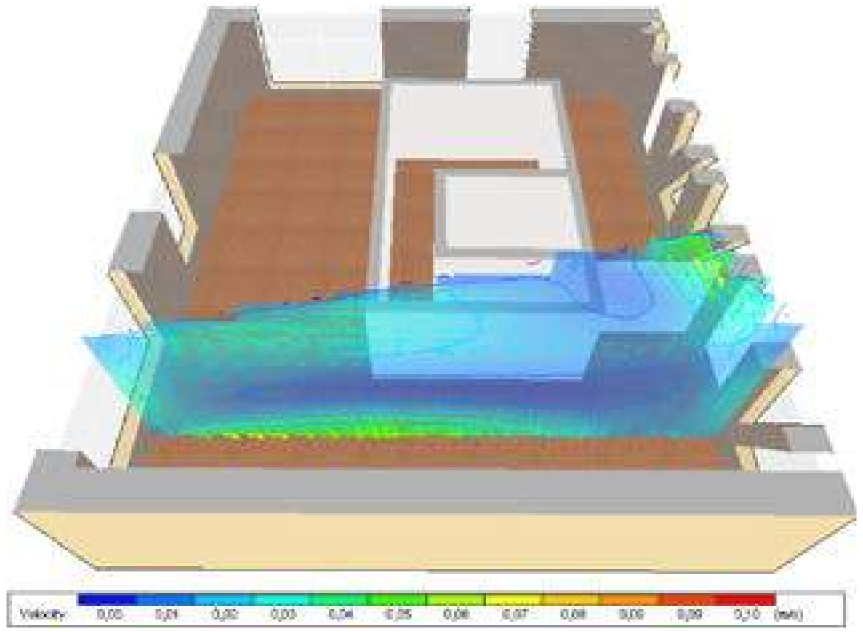


Fig. IV.2. 18. Air velocities in the HDU from CFD simulations for a point in time with a high air change rate

2.2.2 System Simulation

Extensive system simulations have been performed to find the best possible design solution for the solar-based heating system. Many combinations with components (PVT collectors, buffer and DHW storages, heat pump) and their hydraulic connections have been investigated, including a sensitivity analysis regarding the number of PVT collectors, to maximize the use of solar energy

over the year and to minimize CO_2 emissions from operating the system with electricity from the grid. The simulation results are scalable to the whole building concept.

The system simulation was carried out in OpenModelica with hourly time steps. The model for the whole system was developed from the system design and parameterized according to the components‘ specifics (e.g. datasheets). Again, the weather file of Düsseldorf has been applied for the simulations. The same 5R1C building model from the SimRoom simulation is applied. Figure 2.19 illustrates a schematic drawing of the simulated system (for a detailed installation plan see Project Drawings – ME-4101).

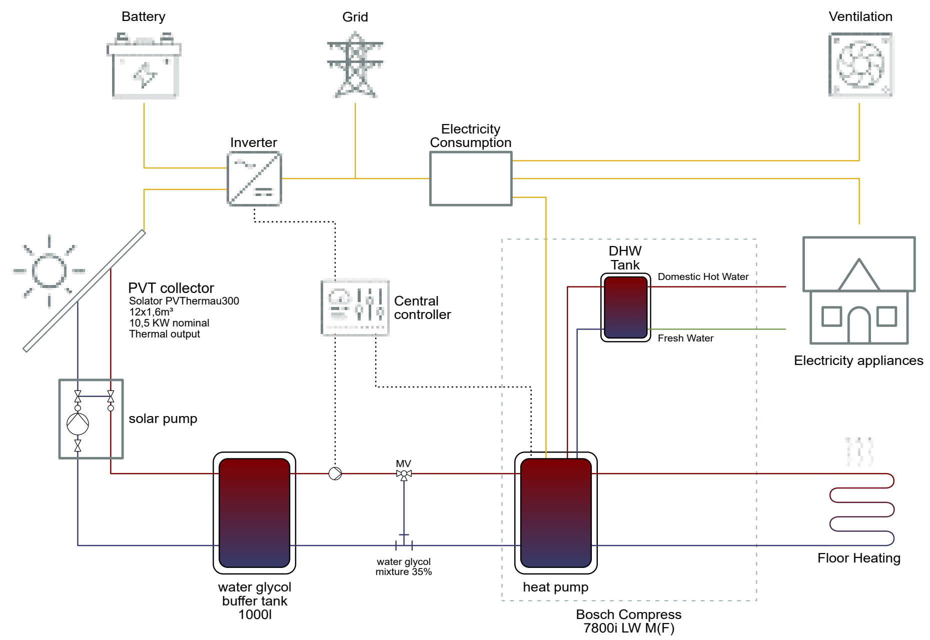


Fig. IV.2. 19. Schematic drawing of the simulated system

The brine-water heat pump model was parameterized using a characteristic curve based on the inlet and outlet heat pump temperature and mass flow rates. The thermal circuit of the PVT-collectors was parameterized according to the standard ISO 9806. Domestic hot water and buffer storage tank were modeled with five layers to account for the stratification. For the floor heating all relevant physical parameters for the different layers were implemented into the model. The floor heating is controlled using a heat curve from the heat pumps data sheet. Additionally, a hysteresis cycle for the heating temperature set point is included to avoid unstable system behavior.

According to the implemented control strategy, the PVT-collector loads the buffer tank. Hot water is then prepared with the heat pump, that operates at its highest possible efficiency in summer (COP = 5,85). The heat pump is capable of providing heat to the hot water tank and the floor heating at the same time.

The daily domestic hot water usage is assumed 150 l at 43 °C (4 kWh per day) and the necessary maximum heating capacity for the HDU is 2 kW. Results show that 12 PVT collectors in parallel are an acceptable trade-off between the winter and summer optimum (28 collectors for a maximum COP of the heat pump versus 6 collectors for sufficient DHW supply). The total heat delivered by the heat pump for floor heating and DHW amounts to 2.571 kWh per year which means a specific annual energy supply of 48 kWh/(m² a). With an overall electrical consumption of 1.027 kWh per year, the heat pump has a seasonal COP of 2,51. Using the PVT collectors as single heat source for the heat pump results in a high heat pump performance when the sun shines. In winter, where the solar radiation is lower, the collectors must be shut down to avoid icing on the back side, which can lead to structural damages. The recommendation of the manufacturer is to not operate the collectors when the brine temperature goes below 2°C, and that was implemented in the simulation model as well. In those cases, the heat comes solely from the electrical back up system. This leads to a decreased overall system efficiency and lower COP values when the outdoor temperature is below 0°C.

Regarding only DHW, the system has a seasonal COP of 4,34 throughout the whole year. The heat delivered by the solar PVT collectors can be stored successfully with the 1.000 l buffer tank. The heat pump can handle inlet temperatures up to 30°C. The temperature difference that the heat pump has to handle in summer is then around 15°C, leading to higher COP values in this season. The total thermal energy demand per month and the contribution of the solar PVT system is illustrated in Figure 2.20. The total heating energy demand is 1.399 kWh, with a heating peak load of around 1,5 kW. The heat demand for DHW is 1.172 kWh (45% of the total heating energy demand). The solar collectors contribute to 40% of the energy demand in winter and around 85% in summer.

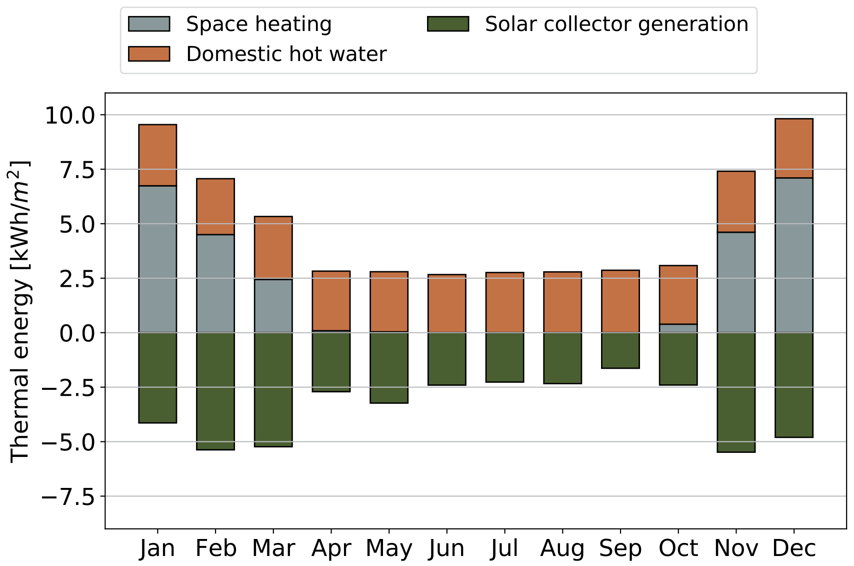


Fig. IV.2. 20. Monthly thermal energy demand and the contribution of the solar PVT system

Regarding the electrical energy consumption, the household consumption was modelled based on the total consumption for a 2-person household (2.380 kWh/a) and the daily profiles from the German Association of Energy and Water Industries (BDEW). The heat pump‘s electrical energy consumption is calculated using the delivered thermal energy and the COP. For the ventilation systems, a constant fan speed of 33% was assumed during the whole year. The mobility electricity was calculated assuming a single E-bike that runs 8 km per day (the battery must be fully charged every ten days). The total electricity demand per month and the contribution of the solar PV system is illustrated in Figure 2.21. The solar PV panels were modelled with the reported efficiency of the installed system (18%).

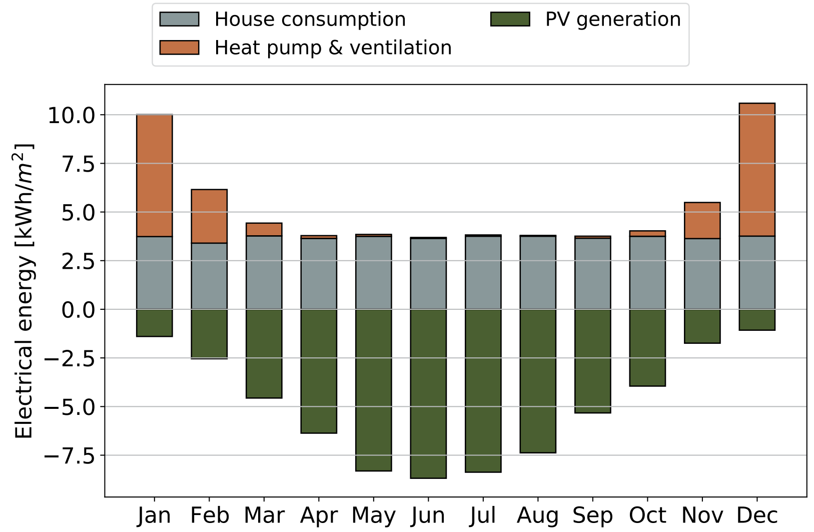


Fig. IV.2. 21. Monthly electricity demand and the contribution of the solar PV system

The total yearly electricity demand is 3.424 kWh, and the energy generated by the PV system is 3.224 kWh. The contribution of the solar thermal energy from the PVT collectors can be seen in the high COP values that minimize the heat pump energy consumption in summer. The HDU generates 95% of the electricity that it consumes on an annual basis, which means that carbon neutrality is almost reached. The average self-consumption is 83%, meaning that this amount of the generated energy is consumed, and the rest must be taken from the grid. This confirms the ability of the energy management system to optimize the battery charging behavior in order to minimize the grid energy consumption.

2.3. Minimizing the carbon footprint of the HDU

2.3.1 Approach

One of the major objectives of RoofKIT is to minimize its carbon footprint by emissions and other environmental impact throughout the whole lifecycle. RoofKIT shows that an urban mining approach which means reusing materials and (building) components – most likely from the site’s region to minimize emissions related to transport – as well as integrating recyclable natural and cultivated materials can reduce the carbon footprint drastically. Furthermore, RoofKIT‘s concept of prefabricated modules is a big step towards transforming urban mining into an industrialized building process that helps to minimize the number of used materials not only during the planning process but also during fabrication. In summary, the approach is to use natural, mono-fraction, detachable materials that neither cause major emissions during the manufacturing phase of the building modules and erection of the building itself as well as at the end of their life cycle. Further, there should be no need for major replacements within a life cycle of 50 years.

Natural and mono-fraction materials

RoofKIT uses a large amount of wood-based materials from different reuse and recycling stages that have a positive effect on the Global Warming Potential due to the carbon bond of wood during growth. Furthermore, thermal utilization of wooden materials at the end of their life cycle will be avoided (even if a high efficiency is assumed according to EU standards). Instead, RoofKIT focuses on reuse, recycling and down-cycling as long as possible, as it helps preserving our forests and gives them time to recover. Further materials, likewise taken from the natural cycle, are NeptuTherm and cork insulation, both causing only low emissions as they are extracted from nature and hardly processed. For the ceiling, fiberboards made of biological waste materials from ECOR hold a covering of pure sheep felt (no synthetic additives).

RoofKIT also focuses on keeping materials in the most natural way possible in order to fulfill the claim to only use mono-fraction materials. Again, NeptuTherm serves as a good example as it is purely based on dead water plants shredded by the movement of the sea and only mechanically processed for the use as insulation material. The same is figuratively true for the sheep felt. Cork for the insulation of pipes is peeled from the cork oak, then ground into granules and treated with superheated steam which leads to a natural expansion of the granules. Furthermore, the cohesion between the granules is accomplished by the cork's own resin, which makes it possible to produce different forms for insulation.

Recycled materials

A variety of materials from secondary streams are applied in RoofKIT to avoid the waste of resources. Examples are products from waste glass (Magna Glaskeramik), old yogurt cups (Smile Plastics) or waste wood (Restado/Rieger). The roof sealing is made of recycled copper material.

Detachable constructions

An important prerequisite for re-use of building materials and components is its detachability. In RoofKIT a pure solid timber construction without the use of adhesives (no glue laminated beams, OSB or chipboard) is realized with static wall stiffeners in massive diagonal formwork technology. All wooden connections are executed with CNC technology and without the use of screws or nails. Dry seals are used instead of wet seals with the help of clamped profiles and no synthetic-mineral floor coverings are applied, thus avoiding adhesives, fillers and joints. A floating floor construction was chosen without otherwise common adhesives or bonding techniques which is also true for vapor and moisture barriers which are loosely overlapped or clamped. The clay boards to increase thermal mass were bolted in the walls and floor. (For further information see Sustainability Report 5.3.4 durability).

Urban mining

Strong emphasis is laid on using materials from the urban mine and to understand this as a design principle. For example, stock windows, i.e. windows from or for other(s) building projects, are used – so there is no need to custom make new windows for the building unit at all. Consequently, the architectural design of the facades has been based on the given re-used products. The same applies to the complete fittings of the WC and shower, which originate from exhibition returns of the Grohe company and returns (WC, cistern) from Freiburg im Breisgau.

The company Altbaustoffe Rieger from Etzwihl in the Black Forest provides a used entrance door, the primary wood beams for the truss construction, and a used industrial staircase including railings, letter being taken back after the competition. The same is true for the scaffolding from the company DOCA. The necessary lift for barrier-free access is bought second hand from a German distributor. By doing so, RoofKIT acknowledges the value of second-hand items and the economic efficiency of urban mining materials.

Transportation

Beyond that RoofKIT tries to reduce carbon dioxide emissions caused by transportation by using as many local and regional materials as possible. The entire demonstration unit is prefabricated in a factory in Vorarlberg, Austria (Kaufmann Zimmerei und Tischlerei). There, only wood (silver fir) from certified, sustainable forestry in the surrounding area is used, so that transportation routes remain at a minimum level. The clay boards and the PVT-collectors are delivered by companies located in Austria (Claytec, Solator). Thus, almost all the used building materials and fixtures originate from Germany or neighboring countries.

2.3.2 Evaluation

Life cycle Analysis

The life cycle assessment according to EN 15978 was carried out for the House Demonstration Unit (HDU). The Global Warming Potential values for the structural elements were taken from the UMI tool (Urban Mining Index tool) and the values for the technical components from the eLCA tool on the basis of a mass calculation and component list.

System boundary: The carbon footprint was calculated over a standardized life cycle of 50 years for the House Demonstration Unit with a reference net floor area of 54 m^2. The balancing includes the production of the building materials and the technical equipment, the usage phase including the operation and maintenance of the building, as well as the disposal. The life cycle phases A1-3, B4, B6, C3-4 and, as an addition, phase D were calculated. Devices and furniture were not included.

Documents used:

- Durability – Building Materials and Construction according to German industry standard DIN 276
- Durability – Technical installation according to German industry standard VDI 2067
- Technical System Dataset according to VDI 2067

Tools used:

-Urban Mining Index Tool: calculation of the global warming potential of the construction using data from the German database "Ökobaudat" Version: 2021-II from 25.06.2021

-SIM-Room: operational energy use and correlated carbon emissions of the HDU

-eLCA Version 0.9.7

All materials in the House Demonstration Unit are attached to each other in such a way that they can be dismantled in pure fractions of mono-materials, for example by means of screw connections, overlaps or clamps, see Fig. 2.8 and 2.12. This means that, unlike with conventional composite components, the service life of the individual materials does not depend on the weakest component. In this way, RoofKIT strives to ensure the durability of the materials used. Mechanical stresses, e.g. on the wooden floor, can easily be repaired by simple woodwork.

Manufacturing Phase A1-A3:

During the manufacturing phase, emissions are mostly caused by services systems, like the heating system with the PVT collectors, battery storage, decentralized ventilation systems, plumbing and general installation, with 40,7 kg CO2e, see figure 2.22.

Indikator	Einheit	Gesamt / $m^2_{NGF}a$	%
GWP	kg CO2-Äqv.	40.6964235874	43,0

Fig. IV.2. 22. Global Warming Potential of technical services, manufacturing phase A1-A3

Sustainable building construction with a high fraction of natural materials like wood or seaweed insulation as well as a lot of secondary raw materials like glass ceramics, storage windows or rented materials like the scaffold towers in contrast to the service systems, reduces the global warming potential in this phase by-30.000 kg CO_2e, see figures 2.24 or 2.25.

Usage Phase B4, B6:

Regarding a life cycle of 50 years, nearly all the construction materials implemented in the Urban Mining Index endure the supposed time span or even longer. Only the vapour barriers (lifespan 40 years) and the 100% cotton felt (lifespan 25 years) at the interior walls and the ceiling soffit need to be replaced once. The possible materials for the necessary membranes were critically analysed with regard to their pollutant content. The decision was made in favour of the materials that were most likely to be single-origin. The global warming potential value for the Replacement Phase is close to zero, see figures 2.25 or 2.26.

The service life of technical components is shorter than that of building elements. Except for the ventilators and the exhaust air pipes, all components must be replaced 1-2 times within 50 years. Almost all technical components are bundled in the technical core. The pipes are left visible wherever possible. The easy accessibility to the elements in the technical core enables quick and easy repair and replacement of necessary individual components. The technical components cause 42,47 kg CO_2e, see figures 2.23.

Indikator	Einheit	Gesamt / $m^2_{NGF}a$	%
GWP	kg CO2-Äqv.	42,4698033868	44,9

Fig. IV.2. 23. Global Warming Potential of technical services, replacement phase B4

RoofKIT primarily uses electricity directly produced by the PVT collectors or electricity stored in the batteries during surplus generation periods. Additional needs have to be covered by the grid. The energy concept with PV generation

and a battery system on site together with an energy management system optimizing the self-consumption fraction leads to only 1.009 kWh of electric energy needed from the grid per year. Weighted with an emission factor of 200 g CO_2e/kWh this results in approx. 10.090,8 kg CO_2e over 50 years.

On the other hand, RoofKIT generates an electricity surplus of 5.040,8 kWh/a. Considering the same emission factor as for grid electricity, as this replaces general grid electricity by electricity from a renewable source, 1.008,16 kg CO_2e can be subtracted over the 50-year emission balance during the usage phase. In total, the energy balance shows a value of 5.050 kgCO_2e (see also Fact Sheet).

Waste processing and disposal C3, C4:

For some elements, the end-of-life scenario Reuse or Recycling was selected, such as for the copper roof. For most renewable resources, thermal recycling as a standard scenario was assumed and greyed out in the UMI-Tool.

According to EN 15978, the carbon balance for e.g. wood must be balanced over the entire life cycle. Thermal utilisation in phase C is automatically taken into consideration. In this case, this would mean that all CO_2 sink potentials in phase C are cancelled out and 54,000 t CO_2e are emitted, see figure 2.25.

Since RoofKIT does not envisage thermal recycling, but wants to continue to use all materials as long as possible and keep them in the cycle, phase C was manually set to zero for all renewable raw materials, like wood, seaweed insulation, cellulose plates, and the 100% cotton felt, see figure 2.26. This takes into account, for example, as with the used old wood for the lamellas on the facade, that the materials will be re-used and only composted at some point in a longer life cycle, but not burnt. The nutrients end up in the soil and the cycle starts all over again.

For the technical components, no end-of-life scenario could be selected in the eLCA tool. Here, too, the actual value is lower than 1,7 kg CO_2e, see figures 2.24.

Indikator	Einheit	Gesamt / $m^2_{NGF}a$	%
GWP	kg CO2-Äqv.	0,0839611532	0,1

Indikator	Einheit	Gesamt / $m^2_{NGF}a$	%
GWP	kg CO2-Äqv.	1,6399004301	1,7

Fig. IV.2. 24. Global Warming Potential of technical services, Removal phase C3, C4

In total, the life cycle analysis adds up to emissions of approx. -15.865,13kg CO_2e during manufacturing, usage phase and demolition (see Fact Sheet). Especially the wooden construction serves as carbon sink and reduces the carbon footprint significantly.

Phase D:

The potential for recycling and reuse outside the system boundaries is -19.000 kg CO_2e for the structural building elements and -5.088 kg CO_2e for the technical elements in material terms.

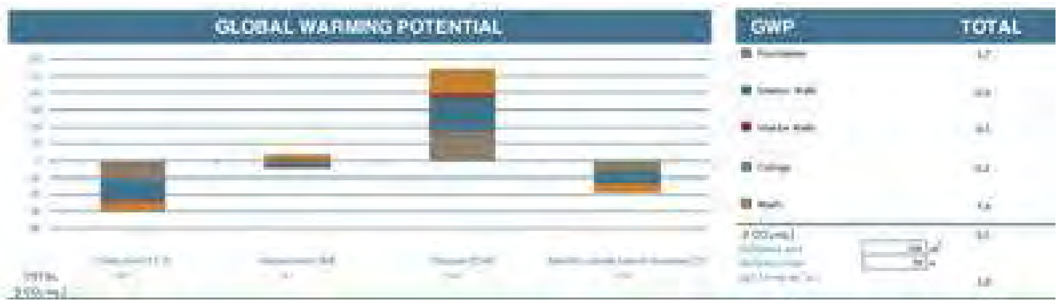


Fig. IV.2. 25. Global Warming Potential building structure, UMI

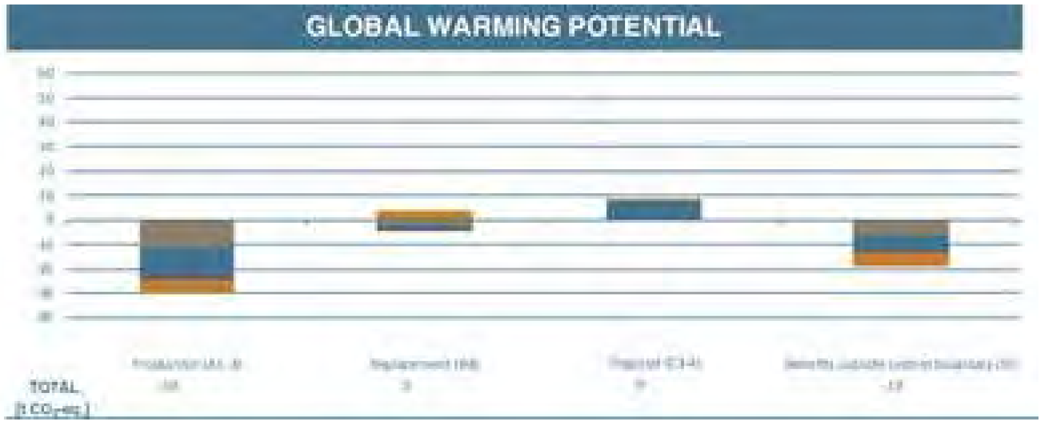


Fig. IV.2. 26. Global Warming Potential building structure, UMI

Urban Mining Index

The above data for the global warming potential within a life cycle of the HDU regarding the structural elements were taken from the Urban Mining Index Tool. The tool evaluates the circularity potential of the main construction elements, taking into account the dismantling possibility and the (closed) loop potential, as well as the return of all materials into the technical or biological cycle. RoofKIT achieves a recycling potential of 101.7 % for the HDU. For detailed information see Appendix A,B and refer to Sustainability Report.

Material data base

Another important objective is to not only balance the requested categories by using the Urban Mining Index, but to also combine different tools for a holistic evaluation of the HDU. For this purpose, the project is aligned with the ongoing KIT research on LCA and urban mining materials which aims at creating a digital material data base for used materials at Madaster©. Consequently, material passports will be prepared and implemented in the KIT Material Library (see Appendix AS: Example Material Passport). This supports the visibility of the emerging market for trading with materials from the urban mine and gives value to used resources. The RoofKIT team is convinced that there will be sales markets available for the materials implemented in the Urban Mining Index at the end of the assumed life cycle of 50 years.

Appendices A-I can be found at the end of the document and provide further information on Chapter IV.2 Engineering and Construction.

2.4. References

[1] Dr. Markus Lichtmeß (2022) SimRoom [online]. Ayl: Institut für Gebäude-Energieforschung. https://www.ingefo.de/Werkzeuge/SimRoom/ [accessed on March 11th at 3 pm]

[2] Dr. Markus Lichtmeß (2022) EnerCalC [online]. Ayl: Institut für Gebäude-Energieforschung. https://www.ingefo.de/Werkzeuge/EnerCalC/ [accessed on March 11th at 3 pm]

[3] Transsolar SoftwareEngineering (2022) TRNSYS [online]. Stuttgart: Transsolar SoftwareEngineering. https://www.trnsys.de/ [accessed on March 11th at 3:05 pm]

[4] DesignBuilder Software Ltd (2022) DesignBuilder [online]. Gloucestershire, United Kingdom: DesignBuilder Software Ltd. https://designbuilder.co.uk/software/product-overview [accessed on March 11th at 3:05 pm]

[5] Open Source Modelica Consortium (2022) OpenModelica [online]. Open Source Modelica Consortium. https://www.openmodelica.org/ [accessed on March 11th at 3:10 pm]

[6] EnergyPlus (2022) EnergyPlus [online]. USA: Department of Energy/National Renewable Energy Laboratory. https://energyplus.net/ [accessed on March 11th at 3:10 pm]

3. Affordability and Viability Report

The following report analyses and describes the existing urban context in the selected city of Wuppertal in Germany, the socio-economic conditions and developments as well as urban problems in the city and the Mirke district. Possibilities and strategies are identified to find an answer to the question of affordability and viability of the proposed project. Based on a comprehensive analysis at different scales, concepts are developed on how the design for the renovation and extension of Café Ada can be integrated into the strengths of the city, enhance them further and at the same time address solutions to urban issues in order to create added value for the building, the neighbourhood and the city, as well as different target groups. From the specific strategy, it will be explored how transferability the concepts and ideas are to a larger scale.

3.1 Analysis

To continue building in an existing urban context and in order to preserve the already built environment as cultural heritage and urban identification it is necessary to read and understand the existing conditions and structures.[1] In addition to the scale level of the city, the existing building and its use as well as its connection with the neighbourhood, the city or the region are also considered on a smaller scale. In the context of the building task, the renovation and addition of storey to the Café Ada in Wuppertal, a SWOT analysis documents the internal strengths, opportunities, weaknesses and threats on the different scale levels. The analysis also includes own conducted interviews with residents of the city of Wuppertal to get a personal view of the conditions, wishes and needs.

3.1.1. Wuppertal

Wuppertal is located in western Germany, north of the Ruhr area and is the seventh largest city in North Rhine-Westphalia with about 355,000 inhabitants (s. Fig. 3.1). It is the largest industrial, economic, educational and cultural centre of the region "Bergisches Land".
The city is located in an arc of the river Wupper within a strong topography and is composed of ten urban districts, which are further divided into 69 city quarters. In the urban district Elberfeld, the city quarter Elberfelder Nordstadt is located. Nordstadt itself is formed with Ölberg and Mirke, where the project is located (s. Fig.3. 2, 3.4).

Wuppertal offers a high quality of urban living due to its extensive Wilhelminian style housing stock, villa districts and special views provided by the topography (s. Fig. 3.3). Its urban history is mainly characterized by industrial architecture and the remains of its former textile industry.

The range between renovated old building properties, such as in the Briller Quarter, Toelleturm or the Zoo-Quarter, and simpler, unrenovated flats is very high. This causes different rent levels and different residents in each district,

as well as possibility of segregation. However, a high densification of building stock in the valley locations of the ribbon town around the river Wupper is taking place. In general, the vacancy rate in the city has been falling since 2013 due to the increasing number of inhabitants.

Due to the comparatively low rental levels, next to commuters (moving there because of proximity to more expensive cities such as Düsseldorf and Cologne), a heterogeneous mix of people of different ages, financial situations, backgrounds, religions, origins, family constellations and genders can be found in Wuppertal, that have been distributed among the districts without mixing within one area. The main migrant groups represented origin from Turkey, Italy, Syria, Greece, Poland, Romania, Morocco, Serbia, Macedonia and Iraq and make up about 19,3% of the population (2017).

In general, there is a high level of public, civic engagement and connectivity between the inhabitants that celebrate their differences and strive to improve urban living quality in Wuppertal despite their lack of funds.
Although the debt level of the city now is relatively stable, there is still a lack of funds, which prevents larger investments. Another problem is the increasing popularity of the city for commuters and the resulting risk of gentrification.

Fig. IV.3. 1. map of Wuppertal

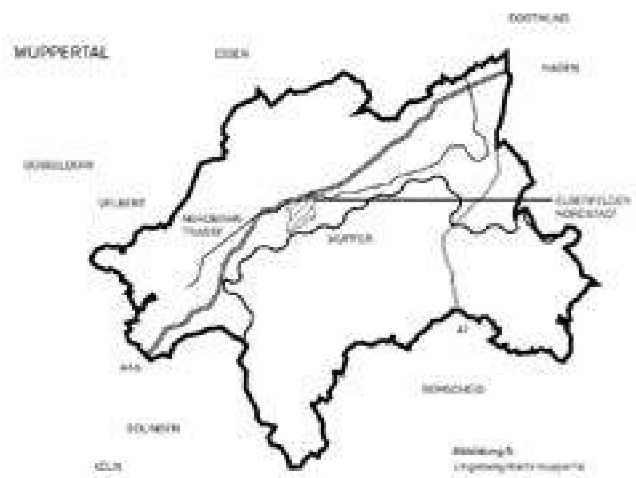


Fig. IV.3. 2. map of the Wuppertal region

Fig. IV.3. 3. streets in Wuppertal

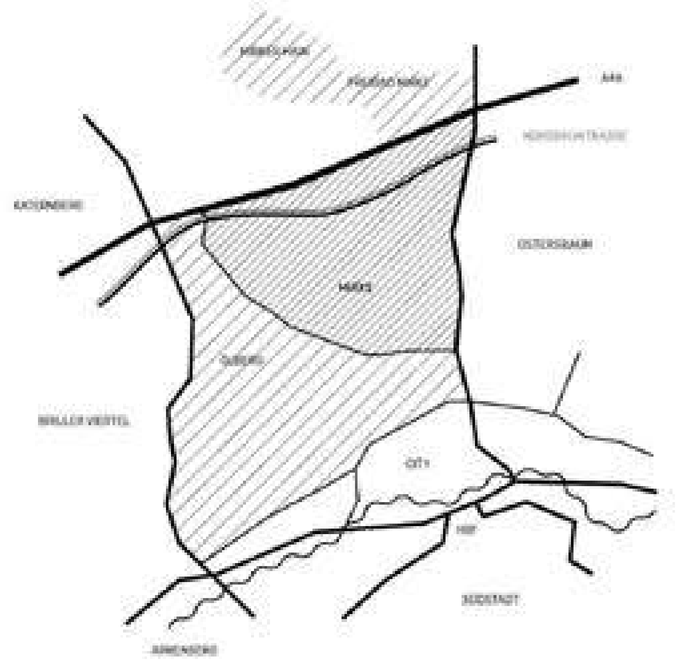


Fig. IV.3. 4. Mirke quarter, part of the district Nordstadt

3.1.2. Mirke District

The Mirke district (s. Fig. 3.4, 3.6) originally formed in the late 19th century as a workers' quarter and urban expansion of the textile industry that settled around the river Wupper. Since then, it has transformed greatly into the lively district it is known to be today.

The neighbourhood experienced an enormous economic decline and structural change after the Second World War and especially in the 1970s. Additionally the poor quality of homes concerning their floorplans and facilities and equipment, made many families move away into single-family homes in the suburbs. Left behind were the ones who could not afford to move: the unemployed, migrant guest workers and workers in the low wage sector. Since then, Mirke has been considered a problem area for a long time. Until the 1970s, the city of Wuppertal

even considered demolishing and replacing huge parts of the neighbourhood, which ultimately failed due to a lack of financing.

Fig. IV.3. 5. SWOT Analysis Wuppertal

With its high proportion of buildings from the Wilhelminian period with well-preserved and intact facades, the old factories and the converted Mirke railway station, the neighborhood is also representative of the industrial history of Wuppertal: Around 48% of their buildings are built before 1919 and more of half of the buildings are protected as historical monuments. Nevertheless, one of the biggest weaknesses in the district is the often unrenovated building stock, which has a correspondingly poor energy standard.

Moreover, the ownership structure in the Mirke district consists of a high number of rented properties and a correspondingly low number of owner-occupiers. Similar to other German neighborhoods, residential buildings are largely owned by private landlords. Due to this fragmented ownership structure, the state of individual buildings varies immensely. Furthermore, this complicates investments for the improvement of building energy performance and refinancing.

In short: Mirke district features many attributes that make urban transformation difficult
and is therefore representative of many urban neighborhoods in Germany and Europe.

Accordingly, the decision-making process is very lengthy and complex and the attractiveness to larger commercially oriented investors is rather unlikely.

In recent years, thanks to the work of the citizens' initiatives, social- and non-profit organizations and the general openness of their community, the image has been shifted towards a hip, cultural district. The residents' identification with the community is very strong, and today the former problem neighborhood is very divers, manifold, popular and lively.
Since 2009, more and more important players for the cultural and art scene in Wuppertal have settled in the Mirke district. Essential parts of this scene include Café Ada, Utopiastadt in the former Mirke central station, the Museum Bandweber in the old Goldzack Factory, the Talton Theatre and Café Bahnhof Blo, and the Alte Feuerwache as a children and youth facility, which have contributed to the revitalization of the neighborhood.

The low rents in the neighborhood, on the other hand, ensure a steady influx of young people and artists, who also contribute to the neighbourhoods' liveliness and influence the social structures. Along with the institutions mentioned above, they are the driving force behind the art and culture scene of Wuppertal. This is also reflected in the low average age, ranging around 30% with the age under 25 and only 11,5% over the age of 65.

The increasing popularity of the district also increases the risk of gentrification, as the proportion of financially strong groups of people with higher levels of education is also growing. Furthermore, renovations cause rents to increase and consequently displace lower-income residents.

Fig. IV.3. 6. Mirke quarter

Fig. IV.3. 7. SWOT Analysis Mirke District

3.1.3. Café Ada

The structural substance of the existing two-storey building is problematic, however, as too little information is available about the load-bearing capacity of the masonry. Additionally, although the building had been renovated in 2006, its heating demand stayed on a very high level. Using the component structure of a few existing building plans, we have made an approximation to the U-value, the heat transfer coefficient. Please refer to chapter 2 Engineering & Construction. Poorly insulated walls and an uninsulated floor (s. Fig. 8) result in correspondingly high operational costs. The roof offers the possibility to create additional living space in the city by means of inward densification and to add value to the existing context.

On the other hand, the entire site of the café - including a future extension - has a high solar potential and could become a representative of energetic refurbishment in Wuppertal. The public space in the backyard of Café Ada is almost unused. It has no urban quality and is almost completely sealed, which favours so-called heat islands effects and prevents rain seepage. It has big potential to create ecological, economic and social added value for Café Ada itself, but also for the whole neighbourhood in the Mirker Quarter. Please refer to Chapter 3.3 Concepts.

It should be noted that most of the residents of the neighborhood have very little financial power. According to the structure of the Sinus milieus, there are mainly people here who can be classified in the lower third of the milieus (see „3.3.2. Concept for Social Viability “).
The building stock, with which the present work is concerned, is the Café Ada. A two-story, industrial building, built around 1905 with a floor area of about 456m2 and a remarkable shed roof. While a dense building stock from around 1918 lines up to the east, the southern and northern neighborhoods are formed by newer residential buildings from around 1980. A 2500m² open space borders directly to the north, next to the Café Ada (see Appendix M design challenge object fact sheet).
Culturewise, the Café Ada (s. Fig. 6,9) plays a central role for life in the Mirke district, celebrating diverse cultural life and history for over 30 years. There is a café on the first floor and a popular dance hall on the upper floor. In the roof area there are only small dark accommodations for internationally arriving guests. Café Ada is a centre of attraction for the international tango scene. Through many concerts, performances and cultural events, it has an appeal that extends beyond the country‘s borders. The association INSEL e.V. plays an essential role for organizing and hosting all cultural activities in the Café Ada. However, their short opening hours from 17:00-00:00 don´t reflect the importance of this centrepiece of Mirke. Low occupancy raises the question of how existing space can be better utilized or how it needs to be designed to prevent vacancy.

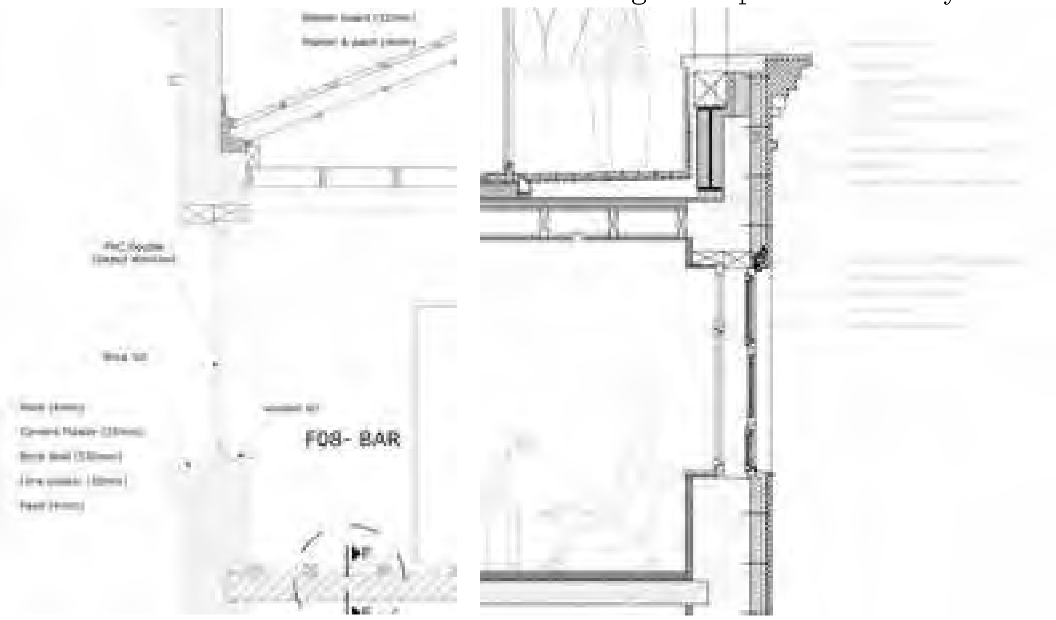


Fig. IV.3. 8. system details, existing building, before and after

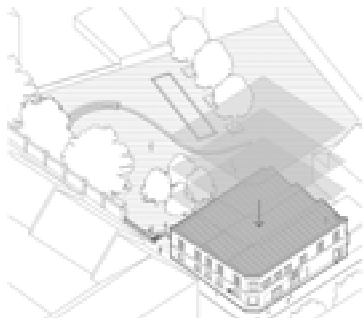


Fig. IV.3. 9. Café Ada

Fig. IV.3. 10. SWOT Analysis Café Ada

3.2 Definitions

3.2.1. Local Housing Market

Land and property value of the residential areas in Mirke district are classified according to the GARS (Gutachterausschuss für Grundstückswerte) in the category „medium“(i.e. better than simple, worse than good or exclusive). Along the street Gathe in the east and south and the Mirke railway station and the A46 in the north the flats are rather simple. However, as the ownership structure of most buildings is very complex and since hardly any of them are owned by a single person, the decision-making process for redevelopment is lengthy and difficult. Most of the apartments in the Mirker quarter have 3 to 4 rooms, some have less than 3 rooms; very few have 5 to 6 rooms. Accordingly, the apartment sizes are mostly between 60 and 89 m², a few between 90 and 119 m² and some are less than 45 m². In addition, Mirke District is characterized by a high vacancy rate in retail and a lower vacancy rate for apartments (8%). Although the vacancy rate has been declining since 2011, old buildings in the Mirke district are often found to be disproportionately affected (the newer the building, the lower the vacancy rate)[2].

Most of the apartments in the district are rental apartments. Since it is a very lively and affordable neighborhood, it is interesting for students and newcomers to the city, among others[3]. For buildings built since 2014, Fig. 3.11 shows the rents that are charged in Wuppertal. But the housing market in Wuppertal is also saturating. Especially smaller apartments for senior citizens and large family apartments are in demand. The number of social housing units dropped, but the number of "investor properties" is increasing due to the liberalization of the housing market. The demand for single-family homes in the countryside is also increasing and accordingly for many the search for housing shifted to the suburbs[4].

building age range 2014 to 2019

	living space	average arithm. average in €/m²	span lower or upper limit in €/m²
A	17,5 m² to 50 m²		
B	over 50 m² to 90 m²	7,68	6,92
C	over 90 m² to 150 m²	7,7	8,35

Fig. IV.3. 11. local rents 2014-2019

3.2.2. Urban Issues

German Society is undergoing a profound process of demographic, social and socio-economic change, which consequences can be observed most clearly in the cities. The analysis shows that Wuppertal is dealing with various urban issues that can also be found in other German and European cities.

Population growth, demand for living space, land sealing
Increasing population (see Fig. 3.12 for Wuppertal) requires additional living space. At the same time, against the background of the question about resources, it is necessary to prevent the additional consumption of land with the resulting sealing of land.

Building in an existing context, renovation, segregation, gentrification
In order to create additional living space in a historically grown, densely built city with existing residents and uses, considerations must be made about how to continue building. User losses due to long construction periods lead to high costs, both in existing uses and a lack of rental income from the new added living spaces.

Wuppertal itself has a large stock of buildings from the Wilhelminian period in need of renovation, whose socio-cultural value, cultural heritage and urban identity through evolved urban history should be preserved. The gap between unrenovated building stock and renovated housing is large. As a result, there are big differences in rents, which leads to different resident groups and fosters segregation problems.

A major issue is gentrification because of increased rents due to necessary modernization of the building stock. Lower-income societies are being pushed out of centres or modernized neighbourhoods.

Diverse population, individual needs, urban (human) living space
In terms of urban space, Wuppertal's evolved social structure calls for places for interaction. There is a need for social spaces where people of different ages, interests, backgrounds, educational levels and incomes can exchange, live together and are able to become an active part of urban development. The unused public space behind the Café Ada building in particular misses out on the potential to create an appropriate recreational space for the residents and visitors of Wuppertal and to help shape urban life in the city.

In the context of the sealed and green-poor urban space behind the Café Ada, ecological problems become relevant, which have an impact on the healthy urban life of humans and animals. Sealed surfaces, little greenery and missing water surfaces, as found in many cities, promote heat island effects and increased temperatures in urban spaces, especially during summer. At the same time, sealed surfaces promote the risk of flooding due to a lack of insurance options, which can become life-threatening under certain circumstances, as experienced in the summer of 2021 in western Germany.

Lack of resources, extraction of finite raw material, climate change, local actions and global impacts
Furthermore, construction of buildings and necessary infrastructure requires increasing material input. The global extraction of non-renewable raw materials for the construction industry has increased by 376% since 1970 to 2017[5]. A lot of existing built structures do not achieve long-lasting value. Their durability is becoming shorter and shorter due to their operational nature, so the structures are being demolished.
Furthermore the building structure is mostly made of unhealthy composite materials that can never be separated from each other again and grow as expensive hazardous waste in landfills and harms the environment.
At the same time, our finite resources are becoming increasingly rare. Through the extraction of raw materials as well as the use of limited raw materials, humans are currently interfering with the natural balance to such an extent that nature cannot recover.
In 2021, the global Overshoot Day was dated on July 29, in single Germany on May 5, 2021. In global terms, this means that within only 7 months, more carbon was put into circulation than the forests and oceans can absorb in one year. According to the Global Footprint Network (GFN), 1.7 Earths would be necessary for nature to regenerate.
It should be noted that CO_2-emissions are not exclusively about ecological factors and effects, but also economic and social, such as the question of raw material distribution and clean drinking water. Everything that happens locally has a global impact.

With the energy-intensive extraction, processing and use of raw materials, emissions are released into the environment along the entire value chain. They are taken from the natural cycles, consumed and disposed of without aiming for a continuously sustainable value. Closely related to this is a constant consumption of land with accompanying land sealing. No other economy releases such immense material flows as the building sector (see Fig. 3.13).

Individual living space, use of existing (limited) space
Further, the analysis raises the question of how adequate living space for such a diverse population in Wuppertal can be created. The gross area of Café Ada is limited and fixed. Different residents and changing users have different needs and wishes. How can individual, private living space be designed and created while encouraging community and interaction? How can individual living space be reduced? How can existing space be used efficiently and thus reduce operating cost?

lack of financial resources of the city
Strained financial situations of public budgets and a lack of financial resources of the city requires new financing concepts for the extensive tasks of maintenance, renovation and conversion of residential quarters.

Fig. IV.3. 12. population statistics Wuppertal[6]

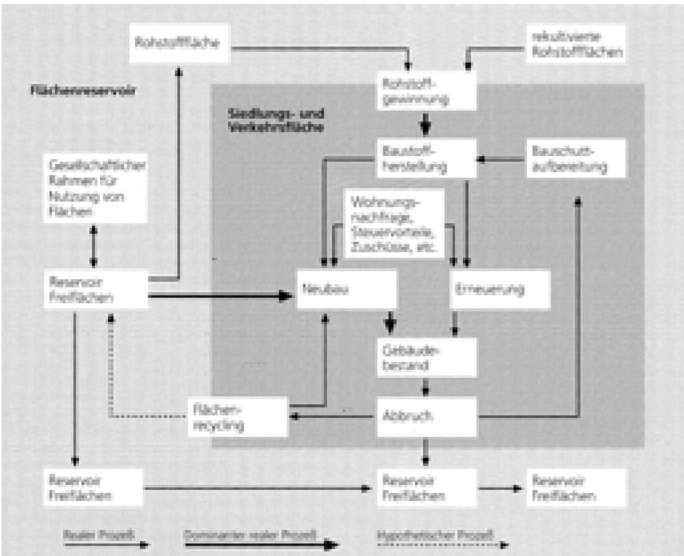


Fig. IV.3. 13. interactions between land use and material flows

3.2.3. Social Scenario

RoofKIT wants to invite the diverse population structure of the Mirke district, the surrounding area but also travellers into our building. The diversity of the people is one of the main strengths of the district. RoofKIT does not only focus on the resident of the new designed flats. The addition is conceived in relation to the existing Café Ada and in the context of the quarter, the city and urban life. Therefore, not only house residents but also city inhabitants and stakeholders are analysed (s. Fig. 3.14).

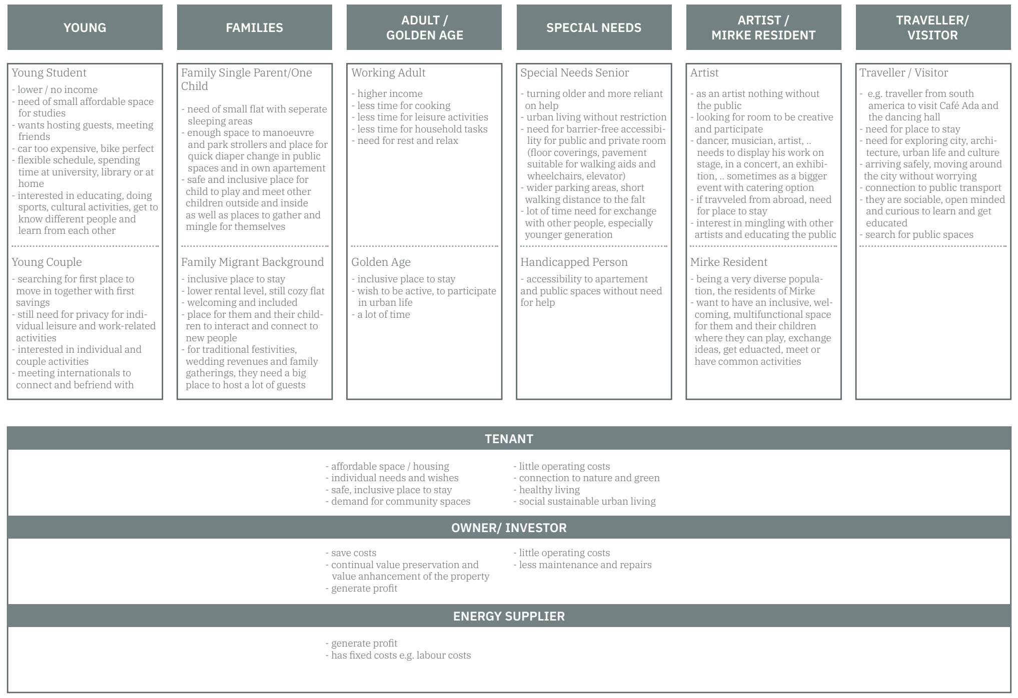


Fig. IV.3. 14. social scenario

3.2.4 Strategic Objectives

Together with the initial analysis of the situation, the overall design will focus on the most pressing questions of the current time: How can adequate socio-economically fair living space be created without destroying natural resources? How can ecologically sensitive building structures be built, acknowledging the finite state of natural material resources and how can any state of "waste" be avoided by understanding the existing building stock as an urban material bank for the future? How can alternative energy supply systems be implemented as part of an urban mining ideology and propose paradigm-shifting innovation as a first-of- its-kind worldwide? How can urban mobility systems be applied as an integrative part of the immobile building sector? What financing and business models are possible to ensure affordability and economic viability?
In this sense, the design for the „New Café Ada" strives to become an incubator for the urban development of the neighbourhood in all these aspects and inspire others to do the same.

Densification inwards, conversion and continuation instead of demolishing and building new

RoofKIT wants to tackle the urban issues of a growing population and the difficulty of densification with an addition of storey on top of the Café Ada, since it occupies no more land mass and uses existing (infra)structure, such as water supply and road connection.

Prefabrication, modular construction, shortened construction site time, avoidance of user loss, reduction of construction costs

Modular prefabrication in a weather-protected workshop offers weather-independent, faster work processes. It reduces the overall construction time, the on-site construction times, reduces user absences in an existing, lived-in context and thus reduces costs. At the same time, earlier rental income is possible due to faster project finalisation. Attention is paid to appropriate working conditions in terms of social sustainability.

Energetic modernization and careful renovation of the existing building stock

By carefully renovating the existing building stock and an architecturally integrated energy concept based on renewable energy sources, energy consumption, operating costs and the ecological footprint are significantly reduced. s. Engineering and Construction Report. The extension offers added value not only for the existing building, but also for the surrounding neighbourhood buildings, as solar surpluses can be directed into the neighbourhood electricity grid. Furthermore, the sealed area in the backyard will be broken up and more green space will be added in order to counteract urban heat island effects, fine dust as well as seepage problems and thus create a healthy living space for people and animals.

Urban Mining, secondary raw materials, innovative joining techniques, circular economy, city as a future material depot

Considering how many raw materials and materials are already built into the built environment, it becomes apparent that this is where the potential of the city lies as a supplier of raw materials, instead of continuing to extract raw materials from nature. Currently, Europe is building up an economic, anthropogenic stock of 10 tons per person and year, which is added to the already existing 400 tons per person (see Fig. 3.15).

This stock can become a raw material supplier and should become a future urban material bank, from which the materials at the end of the use/life cycle do not lose value or are thrown away, but can be transferred into a further use cycle, considering climate neutrality. This approach of urban mining is an intermediate step on the way to a circular economy as a model for the future, in which a continuously sustainable value is aimed for.

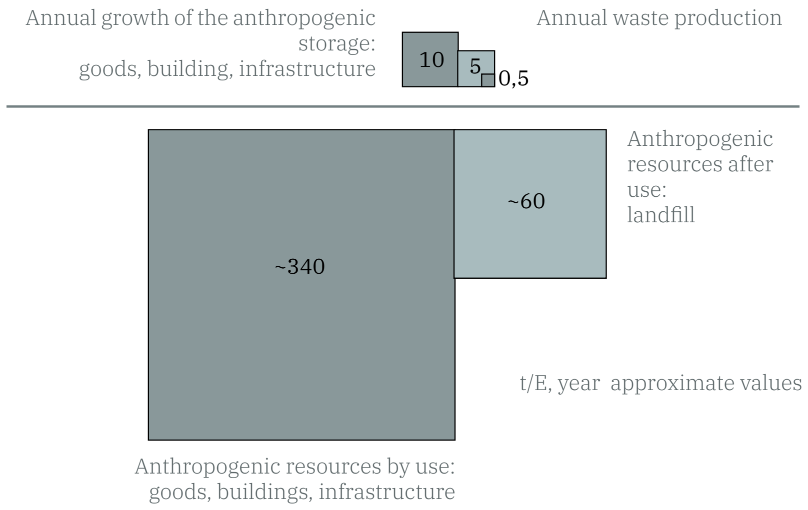


Fig. IV.3. 15. anthropogenic storage and annual growth, Europe, 2016[7]

Preserving and promoting urban diversity and variety, preventing segregation

The question is how to promote diversity and mixing of the city‘s society through appropriate financing-, space- and use-models to prevent segregation and gentrification and to give people space to actively shape the development of the city.

The internationally known cultural attraction of Café Ada with its culturally identity-creating tango scene receives an (urban) spatial upgrade by shifting the use of the dance hall to the generated urban gap and thus creating a radiant effect in the neighbourhood. The transparency and public accessibility of the urban gap invites the diverse residents to a multifunctional platform for exchange and creativity.

In addition, the public space behind Café Ada will provide further interaction space for the residents and visitors of Café Ada, the neighbourhood and the city to live together and benefit from each other.

The room concept and the floor plans offer barrier free and inclusive space in a modular system for different groups of residents to come together in the community spaces.

With the help of the concept of cross subsidising the renovation through the addition of more storeys on top of the Café Ada, RoofKIT counteracts gentrification and becomes a symbol for urban diversity.

Durability of the built environment, sharing concepts, flexibility, adaptability

Reuse of the existing structure enables a new use cycle. Flexible wooden room modules react to changing residents demands and needs, shared areas reduce individual living space and enable more efficient use of existing space resources. Single-origin construction methods and maintenance-friendly joining techniques enable material savings. Flexible, adaptable and repair-friendly interiors extend the useful life of these elements and raise awareness of society‘s throwaway mentality.

Innovative financing concept, counteracting gentrification, value preservation strategy

The cross-subsidisation of the renovation through the increase counteracts possible gentrification. More expensive flats in the extension help finance the renovation of the existing structures without displacing the resident lower-income residents. In the case of Café Ada, this additionally keeps the rent for the dance hall and café lower.

Flexibility and adaptability ensure the durability of the property. Innovative construction methods allow the materials to be recycled into the technical or biological cycle, thus ensuring a continuous value. RoofKIT becomes a material storage and therefore investment for the future.

3.3 Concepts

The goal of the project is to plan a rooftop addition to an existing building in Wuppertal, the Café Ada, that follows the principles of urban mining and the use of renewable energies within a neighbourhood system (s. Fig. 3.16 "Design Challenge RoofKIT").

The overall concept is to close cycles in an ecologic, economic and social way.

For ecology the goal is a closed loop system. With the choice of material, innovative joining techniques and single-origin construction, a healthy living environment for the residents and an affordable dismantling of the building at the end of its life is ensured.

For economy, a closed loop management of materials in the design is established. This includes the concept of "product as service", in which products used to build the design are only rented and returned at the end of use. The building can be seen as a material storage and therefore investment for the future. Innovative financing concepts are elaborated to finance this higher quality of living while still catering to individuals with lower income.

For Social, the classification in the social scenario by target groups allows a closer look at the needs of each individual. RoofKIT does not only focus on the resident of the extension of the Café Ada. The extension is developed in the context of the existing building. And further, the overall design in the context of the city and the urban life within it.

Fig. IV.3. 16. Design Challenge RoofKIT

3.3.1. Concept for Affordability & Economic Viability

3.3.1.1. Focus on residents

3.3.1.1.1. Effects on operational costs

In the long term, the entire building will have lower operating costs than a comparable building of conventional design thanks to the use of the latest technology, the principles of circular economy and the optimisation of energy demand. For the tenants of the residential units, this means lower operating costs and a reliable supply.

A facing shell made of recycled building rubble (Stone Cycling) attached to the exterior of the existing building, as well as a storage window area, s. Fig. 3.17, allows for a better insulated building envelope. The extension is developed together with the existing building and receives a passive house standard. This means that less heating energy is required overall and a comparatively small heating system can be installed, which just needs to run on fewer days a year. This reduces the number of operating hours and the clocking (switching on and off) and thus the repair and maintenance work and costs and allows for a longer service life. In addition, heating costs are minimised through heat recovery in the wastewater and exhaust air. Water consumption is reduced through grey water and rainwater utilisation and recycling systems, thus lowering wastewater charges.

The optimised use of daylight and the reduction of the need for artificial lighting lowers the electricity demand for lighting. The solar gains from PVT collectors on the roof, PV modules on the façade and on landscaped areas in the backyard, such as the Solartree, can be used not only for the building's own electricity needs but also by surrounding buildings, thus reducing the load on the electricity grid. For the energy concept, see the chapter Engineering & Construction Report.

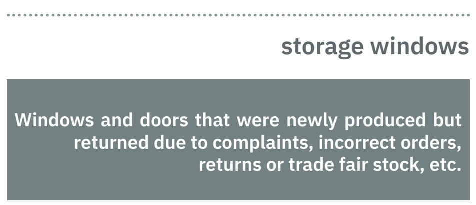


Fig. IV.3. 17. definition of storage windows

In Germany, a kilowatt hour (kWh) of electricity from the grid currently (as of January 2022) costs about 36 ct/kWh (depending on the size of the system). The electricity production costs of a PV system are around 11-13 ct/kWh, which means the user only pays around 12 ct/kWh per solar electricity used.

If the self-consumption of solar electricity for a house is 20%, 80% would still be drawn from the grid.

The feed-in tariff is currently about 4.96 ct/kWh. If the solar electricity is not consumed by the owner, it is sold below value, because then we do not receive 36 ct/kWh (24 ct/kWh profit) for the kilowatt hours of solar electricity we produce for 12 ct/kWh, but only the feed-in tariff of 4.96 ct/kWh (thus 7.04 ct/kWh loss). The higher the self-consumption, the higher the profits from the PV system (see Fig. 3.18). We achieve the increased self-consumption in the project through

an intelligent power grid „smart grid“ and by supplying the surrounding direct neighbours with our solar profits.
The energy savings and use of renewable energy sources also contribute to the saving of resources. Together with the use of secondary raw materials and materials from the urban mine, CO2 emissions can be reduced in this way, see Life Cycle Assessment Engineering & Construction Report.
Shared spaces reduce individual living space consumption, which means that more residents can be accommodated in the extension in total. This increases occupancy, which means that property tax and liability and property insurance can be passed on to more tenants. Furthermore, caretaker activities and gardening in the backyard can be carried out by the building community, so that caretaker costs are saved. At the same time, this strengthens the sense of community.

energy demand in total: 104.322 kWh/year

	user costs of solar electricity 12 ct/kwh (electricity production costs for PV)		user costs grid connection at 36 ct/kwh		total costs	profit/loss
scenario 1	0%	-	0%	37.555,92 €	37.555,92 €	-
scenario 2	20%	2.503,73 €	80%	30.044,64 €	32.548,37 €	+13,33 %
scenario 3	60%	7.511,18 €	40%	15.022,37 €	25.533,55 €	+32,01 %
scenario RoofKIT	116%	14.628,24 €	0%	-	14.628,24 €	+61,05 %

Fig. IV.3. 18. electricity supply, electricity costs

3.3.1.1.2. Affordability for the residents

With the above actions, the operating costs in the building can be strongly reduced. In addition, through the sharing concept in the common room, we provide many residents with uses and space that they would otherwise not have or not be affordable. One example is the washing machine in the laundry. Appointments are booked by the residents, who then only pay for the use during this period. In addition, the principle of „product as a service“ is strived for. Shared space leads to more efficient use of space. Shared and borrowed equipment and objects reduce conventional consumption thinking.
This system creates more flexibility, as the borrowed objects can be exchanged at any time. It is possible to stay up to date with the latest technology without spending a lot of money and producing waste, because the company takes back the old product and recycles it. In this way, resources are better used. Finally, the flexibility of the design helps to ensure that the space and the furnishings are individually adaptable when wishes and needs change due to, for example, changed living conditions or living constellations.
In the case of renovations and publicly used spaces, such as the dance hall or Café Ada in our case, the question of financing them arises in order to avoid gentrification at the same time. A constant rent, with significantly reduced operating costs, makes it possible to cross-subsidise the necessary renovation in the urban building stock. Please refer to chapter 3.3.1.2.4. Operating and Business models and 3.3.2.2.1. Solving urban issues.
The design proposal of RoofKIT supports the common economy, environmental awareness, social integration and counteracts gentrification in order to maintain

the diversity of the population.

3.3.1.1.3 Stakeholder Energy Supplier

An energetic renovation measure in the existing building initially leads to a lower energy demand. This means lower income for the energy supplier, while fixed costs, e.g. wage costs, remain the same. With the extension of Café Ada, additional living space is generated, which in turn requires energy, thus ensuring additional income. Moreover, the rainwater retention through unsealing and the planting of vegetation in the backyard relieve the pressure on the sewer network.

3.3.1.2. Focus on property owner / investor

3.3.1.2.1. Construction Costs

For detailed calculation see „Appendix N. Calculation of Total Construction Cost (german: Gesamtbaukosten/GBK)“.
An initial cost estimate showed total construction costs of €4,959,489 (+/- 15%) for the addition and the existing building. Two calculation methods were used, the results of them were averaged. The first calculation was based on the gross volume of the existing building and the extension, which was offset against the assumed standard cost values (1,900€/ m² for the new building and 850€/m² for the conversion of the existing building). To check the plausibility, a second calculation was carried out using the gross room volume and the corresponding standard cost values (620€/m³ and 310€/m³).

3.3.1.2.2. Financing plan for the implementation

To be able to realize the proposed project, new innovative paths for financing are foreseen.
To set up a basic financing plan for the project, the rental prices in Wuppertal were analysed and base the calculation on Wuppertal’s rental price index. The realistic market prices for rental apartments 1-8 can be found in the Excel file: „Appendix O“.
Additionally, a short amortization analysis was carried out to present the attractiveness to investors. The total cost of construction come from the construction cost calculation from chapter „3.3.1.2.1. Estimated real-live construction costs“.
The existing building, featuring cultural offerings for the entire district, is to be financed by the high rental income from the high-quality rental apartments through cross-subsidisation. Building in existing stock enables connection to existing infrastructure, such as water supply and road access. Furthermore, in case of addition of storeys on the top of Café Ada, no land costs are to be paid.

With prefabricated modular construction methods RoofKIT guarantees schedule reliability, reduces time on construction site and thus user absences, and ensures earlier rental income for the new flats. Within the past seven years the rents in Germany have been rising 30 percent (see Fig. 3.19)[8]. Over the same period, average net income has increased by only ten percent. The demand for affordable housing is rising. To address this situation, we would like to establish a concept inspired by the „Miethäuser Syndikat“ (Rental house syndicate). This

concept is based on the idea of common ownership. In the „Miethäuser Syndikat“, house projects throughout Germany are organized in a loose association. Each project-group of inhabitants is formally organized as an independent limited company and manages itself. There are two shareholders in each case: the association consisting of the house community and the „Miethäuser Syndikat“. The whole thing is financed by direct loans from investors and bank loans (see Fig. 20)9 which are basically paid back by the particular housing- GmbH through the rents. The residents pay about 80 percent of the basic rent for the financing - i.e. the repayment plus interest. In addition, a solidarity contribution is paid for the syndicate. This starts at a minimum of 0.10 euros per square meter per month and increases each year by at least 0.5 percent of the previous year-old rent.[6] Many who can afford it charge only low interest or dispense completely. The repayment is made not only by the income from the rent, but usually likewise by accepting new direct loans. This type of debt rescheduling can keep repayment costs low and thus also the rent. If a housing project is debt-free, rents tend to become more affordable. However, they do not fall on operating costs. The financing of the projects is designed for a long period of time. One big advantage of that kind of organization of financing the building is that the inhabitants have more impact on what is built and who is participating. So, a high level of identification will be reached.
With the conclusion of the Paris Climate Agreement of 2019, it was determined that from 2021 every ton CO2 emission must be paid. The CO2 emissions of the design proposal based on electricity demand was calculated. Comparing the demand per square meter of floor space with the yield of solar panels on the roof, facade and grounds, the difference is -15.865,13 kg CO2e over 50 years. s. 2.3.2 Life Cycle Analysis. Based on the prices set by the federal government, this results in a total saving of € 872,3 – 1031,1 from 2025 onwards. Comparing the demand per square meter of floor space with the yield of solar panels on the roof, facade and grounds, the difference is -15.865,13 kg CO2e. s. 2.3.2 Life Cycle Analysis. Based on the prices set by the federal government, this results in a saving of €1512.5 per year. The net rental yield was calculated by dividing the annual net income by the total construction costs. The annual net income is composed of the annual net cold rent minus the owner costs and results in a return of 1.46% for our proposal.

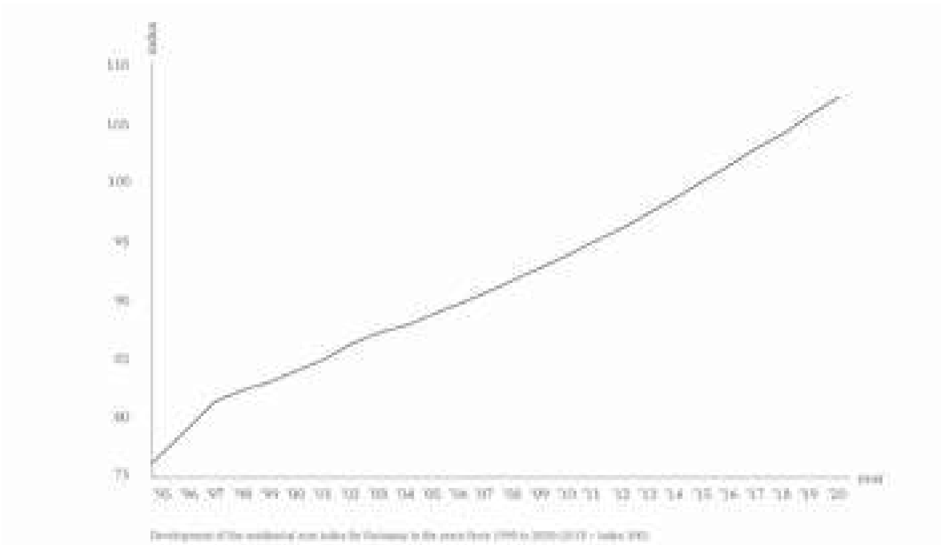
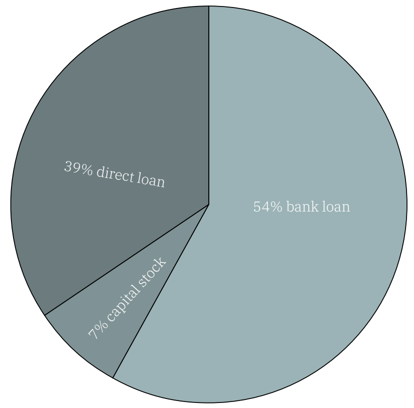


Fig. IV.3. 19. rising rents: Development of the residential rent index for Germany in the years from 1995 to 2020 (2015 = index 100[8]



Funding distribution
*total amount of money tied up in the syndicate is 170 million euros. Status 11/2020

Fig. IV.3. 20. funding distribution[9]

„The total amount of money tied up in the syndicate is 170 million euros. “ Status 11/2020

3.3.1.2.3. Effects on the unit value

The renovation of the existing building initially increases the value of the existing property. The extension in the Whole Design as well as in the House Demonstration Unit ensure the durability of the building by using low-maintenance technologies and repair-friendly construction methods. Furthermore, flexible floor plans and room constellations (see Fig. 3.23) as well as flexible furniture allow for individual adaptability to the user. The building and its elements are designed with a life-cycle approach for possible deconstruction and considered as a material storage for the future building sector. This avoids waste and the property follows a continuous value preservation strategy. Material passports register which material was used where and with which joining technique, ensuring rapid deconstruction and return of materials to closed cycles. Building as Material Bank. Single-origin construction methods and innovative joining techniques as „design for disassembly“. Particular importance is attached to the use of secondary raw materials from the urban mine, see room programme and interior design.
The good indoor climate by means of passive cooling in summer as well as breathable clay walls and the environmentally friendly building materials increase the attractiveness of the building. Finally, the operating costs of our building are very low (see „3.3.1.1 Impact on operating costs“), which increases the value of the unit. As the project is planned to be CO2-neutral, there will be no charges for CO2 emissions introduced in Germany in 2021.

3.3.1.2.4. Operating and business models

n the context of the city, the renovation of the existing buildings and the low rent of the café in the ground floor, dance hall and hotel are cross-subsidised by the higher-priced flats in the extension. The different uses in the building as a whole can benefit from and support each other. For example, the dance hall can be rented out for an external event that brings in earnings and for which Cafe Ada then takes over the catering. In addition, visitors to the event can stay

overnight in the guest rooms of the building and leave relaxed the next day. In this way, the uses in the building are connected and coordinated with each other.
In that way, the existing mix of different resident groups in the neighbourhood is maintained and further promoted by public and / or community-used areas, such as the urban gap.
The Housing Improvement District Model, an association of property owners to jointly develop housing and quality of life improvements, supports this idea.
In the extension itself, the modular construction and concentration of supply chains allows for a flexible use of the available space. Depending on user needs, different room constellations can be created with little effort. In addition, flexible furniture offers individual design in existing rooms. This changeability ensures a high occupancy rate and prevents the building from being vacant, thus enabling an extended user period.
The „product as a service" concept reduces individual consumption and as a result resources and costs. The company ensures that the product can be returned to closed cycles by committing to take it back. Due to the single-origin construction method, the overall building is more expensive in terms of investment costs, but it offers significant profitability in operation and above all in dismantling, i.e., a longer life cycle.

3.3.2. Concept for Social Viability

3.3.2.1. Focus on Urban Context

3.3.2.1.1. Solving urban issues

The design from RoofKIT aims to create a positive impact for the urban area and its urban life together with the local economy and environment: It is not only about urban integration, but also about improvement in the sense of positive neighbourhood development.
The addition of RoofKIT to Café Ada in the Mirke district as an inward densification strategy responds to the growing demand for housing from the growing population. The additional living space does not seal any further land area and saves resources.
The careful renovation and energetic modernisation of the existing, historically grown building stock, the Café Ada, through partial interventions in the existing structures and an appropriate, detailed developed building envelope made of building waste bricks reflects the character of the former industrial building and lowers the energy transmittance (U-value). RoofKIT thinks the existing building together with the addition and develops an overall energy concept, see chapter Engineering & Construction.

Prefabricated, lightweight timber modules respond to the limited load reserves of the existing building. Prefabricated to a large extent in a weather-protected factory, construction site times are reduced and schedule and cost reliability are guaranteed. Lower occupant losses enable earlier rental income in the affordable, flexible flats.

The additional structure is planned as a symbiosis for the existing building as an energy supply, social networking space and enrichment of the neighbourhood. The transparent Urban Gap, the „public storey" on the 2nd floor, radiating into the neighbourhood, is intended to invite the diverse neighbourhood of the Mirke quarter, the residents of the additional storey as well as long-distance travellers, and provide them with space to exchange and get creative (see „3.3.2.1.2. Neighbourhood support"). At the same time, the transparent facade of the urban gap symbolically carries the ideas of RoofKIT into the city. Together with the newly established Café ADA, the temporary flats on the 1st floor and the public facilities in the courtyard, the Urban Gap forms a comprehensive package for diverse actions and can fulfil its function as an incubator and catalyst for cultural and civic life in Mirke. This reinforces the diversity of the neighbourhood and counteracts segregation.

By means of cross-subsidisation, existing buildings can be co-financed with the help of the more expensive flats of the extension, so that lower-income households are not displaced and a mix is maintained.

Furthermore, RoofKIT supports the promotion of sustainable public transport and the reduction of motorised individual transport and thus the reduction of stationary traffic, such as parking spaces, through the introduction of e-mobility, powered by solar energy from the building, and a direct cable car connection from Mirke station to the main station in a mobility hub.
Together with an innovative and energy-efficient mobility concept, in line with the „compact city" concept for the whole neighbourhood, RoofKIT improves the connectivity of the area and its quality of life with a resilient, diverse programme that includes social engagement, participation and cooperation for a more sustainable positive and resilient behaviour.

The garden side will be unsealed and vegetated as much as possible, and water bodies will be added. This reduces heat island effects and binds dust. Flora and fauna can spread here and increase the quality of life. The green space also acts as a carbon sink and contributes to a healthy urban quality of life by providing oxygen through photosynthesis. A seasonal design of the outdoor space ensures a constantly high quality to stay. Rainfall can be filtered in the infiltration trough and collected rainwater from roof surfaces serves as irrigation for urban gardening, (s. Fig. 3.21).
The innovative architectural integration of PV panels on the roof and façade, together with the planting concept in the backyard, aims to improve the microclimate in the neighbourhood.
Urban gardening and spending time in quality public spaces strengthen cohesion in cities and communities and promote communication between people and non-commercial urban togetherness. It also raises awareness of sustainability, closeness to nature and healthy eating across all generations.

In addition, RoofKIT will be a pilot project in the use of limited resources. Urban mining, the use of high-quality secondary raw materials, reuse, recycling and innovative construction methods that can be separated single-origin and the establishment of a necessary circular economy are the focus of RoofKIT's work. S. Sustainability Report. Building as Material Bank (BAMB). The city as a raw material store for the building of tomorrow.

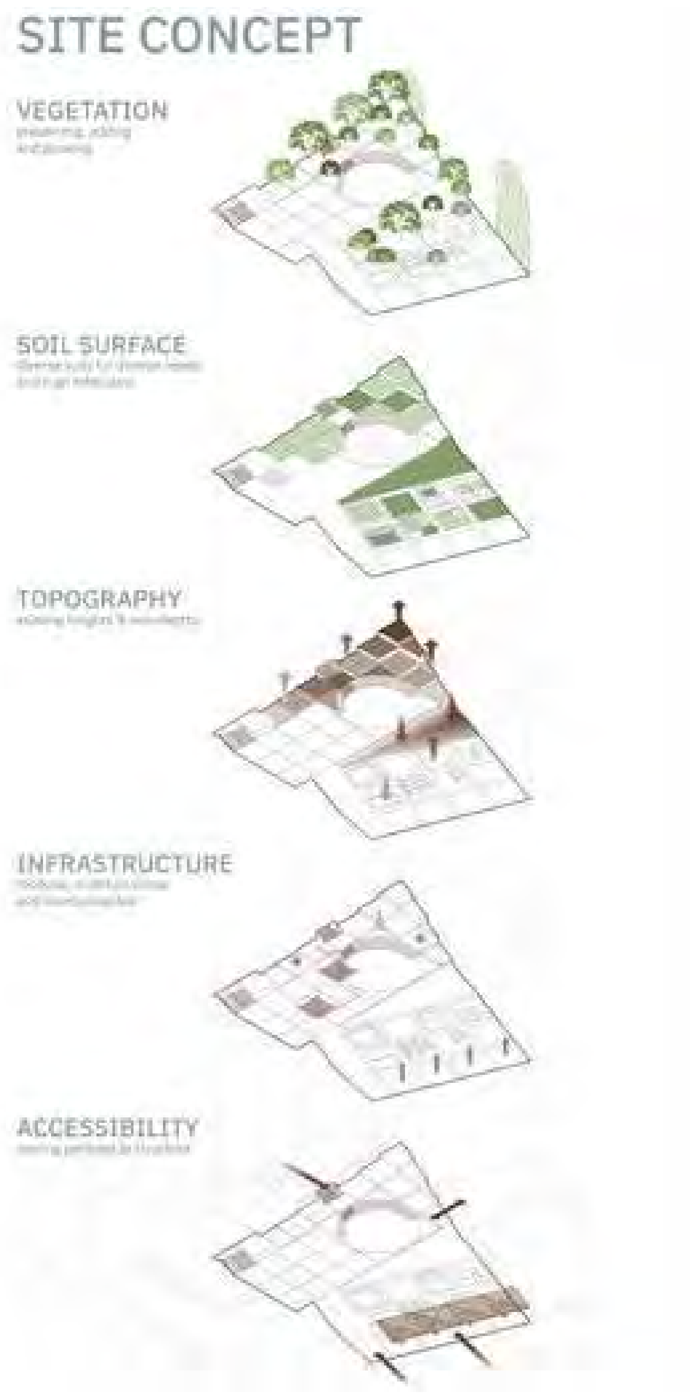


Fig. IV.3. 21. site concept

3.3.2.1.2. Neighborhood support

Our program seeks to incorporate different public functions together with our program of living in the top of the addition by creating attractive meeting points indoors and outdoors that welcome the diverse neighbourhood of Mirke and beyond.

Above all, the higher quality of stay in and around Café Ada, through its renovation. It is now all barrier-free and wheelchair accessible. To contribute to the sustainability thought of the overall addition and counteract to the short opening hours, it can become a place for preparation and education for

sustainable food management by offering midday meals made from scraps from the neighbourhood and crops grown in their own garden and a location for food sharing.

The outdoor area of Café Ada, on the other hand, experiences a redesign accessible with a non-slip pavement suitable for the use of wheelchairs and walking aids. Outside its expansion offers a barrier-free public square and a barrier-free urban garden both with barrier-free access from the city, creating opportunities for encounters in everyday life, in cross-generational leisure activities, in joint gardening, at events and workshops suitable for all generations and cultural backgrounds. It offers plenty of space to gather and celebrate specific festivities such as the sugar festival and Ramadan together as a community and educate and enrich each other with their own set of cultures. In the shape of a structured urban park, it also creates a quality of stay for the residents of the surrounding area, who usually do not have their own garden. The creative heterogeneity, which is created using objects from the urban mine, also reflect the social mix in the Mirke district. The site is structured by shafts in a squared grid of the square design, which serve as a multifunctional modular technical infrastructure. They offer possibilities for lighting, sound, evaporative cooling, mounting of various devices such as sun sails, canvas walls, movie screens, playground equipment, art installations, other technical devices such as beamers, Wi-Fi, 5G, diverse sensors, etc.

On the west side, an amphitheatre is located that offers plenty of space to linger, move and play as well as catering for various public events with an audience. The area of the amphitheatre is connected to the grid of the public square and the areas can be used and played simultaneously, separately or together. Closely there is a solar tree which provides shading and creates energy for the addition. Over time a place is created where the coexistence of people, animals and plants is combined in such a way that the systems function indefinitely and support each other. As the garden grows, the people of the neighbourhood will also grow together through joint actions and workshops in the context of the garden.

Together with a reorganisation of the street space in the district without any cars and with wide barrier-free pedestrian paths, it enables children to play safely outside in a multifunctional playground. In this way, our site sets an example of giving more space for kids and taking children´s opinion for urban development since they will be the future adults to make the city of tomorrow a better place to live.

The new boarding house on the first floor of the existing building further enhances the attractiveness of Café Ada. It offers a place for the night for travellers that visit Wuppertal or artists, teachers and congressmen that propose cultural exchange in the Urban Gap. If vacant, it can be used temporarily by the municipality and social welfare agencies as additional rooms or contact point for e.g. the care for addicted clients and as temporary homes for the homeless or refugees. It can be catered as well by the Café on the ground floor. In this way, the extension and the existing building benefit equally from each other.

On top, the new urban presence of the ballroom increases the cultural value added to the building. It offers a space that is barrier-free and wheelchair accessible through the public staircase and can cater multiple needs. These can be either of cultural nature, such as sport lessons, balls, exhibitions and concerts, of formal nature, such as wedding venues, workshops, seminars or coachings, or of informal nature, such as big family gatherings, parent-child-meetings, association gatherings, playdates for children or open kitchens, and so on. It´s multifunctionality is emphasized by offering a big open space together with various types of service rooms as core, such as storage space for tables, chairs and other tools, changing rooms, a cloakroom, a mobile stage, a mobile bar, a tribune and a wheelchair accessible bathroom. In its function it can create symbiotic co-dependencies with the Café and the Boarding House downstairs through catering, hosting and accommodation of guests. Through its full glazing, its reputation as an attractive, welcoming space can shine into the city and contribute to its livelihood, education and culture.

3.3.2.2. Focus on Residents / target group

3.3.2.2.1. Quality of living improvement

In general, the quality of life is improved by the increase of offers that can serve all people by making them barrier-free and inviting to serve the neighbourhood and the new residents (see „3.3.2.1.2. Neighbourhood support"). With the design for living on top, alternative and innovative solutions for new inclusive housing concepts are offered.

The new flats are located on the top floors and consist of lightweight, prefabricated modules with a flexible floor plan. This means that room constellations can be individually adapted to changing living conditions. Additionally so-called Joker-Rooms can be rented in addition, e.g. for guests.
Instead of standard rooms for one use, multifunctional rooms allow optimised use of limited space. While individual space is kept to a minimum in the residential modules to ensure cheaper rent, space is kept generous in the partially interconnected communal modules. Housing models improve the quality of life for residents by offering both: the comfort of affordable, private retreats and shared leisure, work and meeting opportunities with the community.

All flats have access to large communal spaces, such as a large communal kitchen overlooking the garden, and small communal spaces along the east, south and west facades, such as a library, laundry room, workshop, laundry café, sound lounge and billiards lounge. In addition, loggias on the east, south and west facades offer a magnificent view over Wuppertal. The sharing concepts can save energy, resources as well as costs for the residents.
By interweaving community and privacy, sharing concepts and the promotion of active neighbourly help, a new sense of community between the different groups is created.

3.3.2.2.2. Room program and interior design

The apartments consist of two to four interconnected modules. Up to 24 persons can live in the extension, which, with a net area of 778m², results in a space

requirement of 32m² per person. In comparison to 2019, the space per capita in our proposal is 15m² below average[10].
The flats are so flexible and individually adaptable that residents can „grow old" here. They start in a 2-room flat as a single or couple (31 sqm), start raising a family in the 3- or 4-room flat (47.3-63.6 sqm) and retire to a barrier-free flat (63.6 sqm), (s. Fig. 3.22).

Fig. IV.3. 22. flat types + concept floor plans

All common areas and some of the flats are designed barrier-free (see Fig. 3.23). On average, twelve people will live on each floor. Fig. 3.24 "Daily routine of the target groups" shows an example of how communal life can function and how the common areas can be occupied. The individual flats with 2 to 4 rooms are equipped with everything necessary. Supply cores bundle the pipes and wet rooms. The surrounding space thus remains flexible.

The use of flexible and multifunctional furnishing will allow an individual design of the floor plans, especially in the common area of the extension, in order to meet the specific needs of the residents and to increase the appropriation potential of the rooms. In the flats themselves, the furniture is very reduced. Most of it is integrated into the functional walls and the installation core. Bed that transforms into a sofa for daytime use, shelves on wheels, an extendable kitchen and movable desks integrated into cabinets make the flats flexible and space-saving. Induction switches reduce cables. Flexible, cable-free luminaires can be used where they are needed in line with the sufficiency concept.

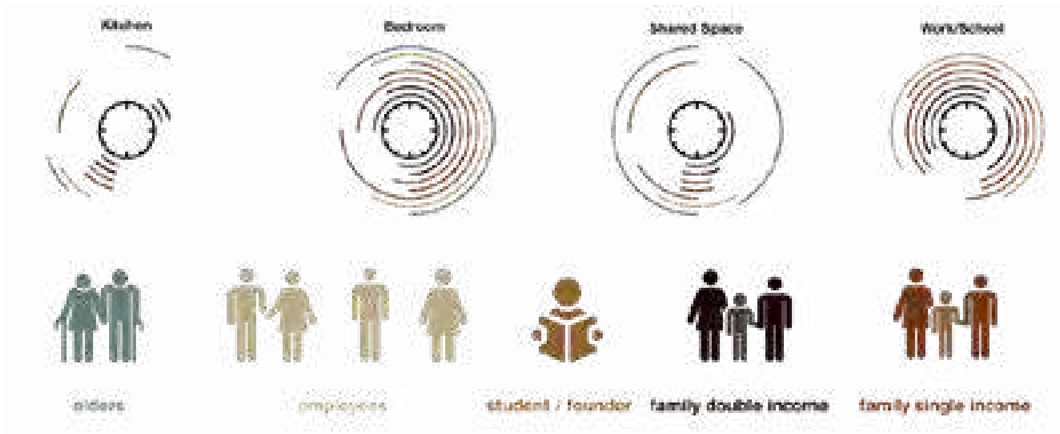


Fig. IV.3. 23. Daily routine of the target groups

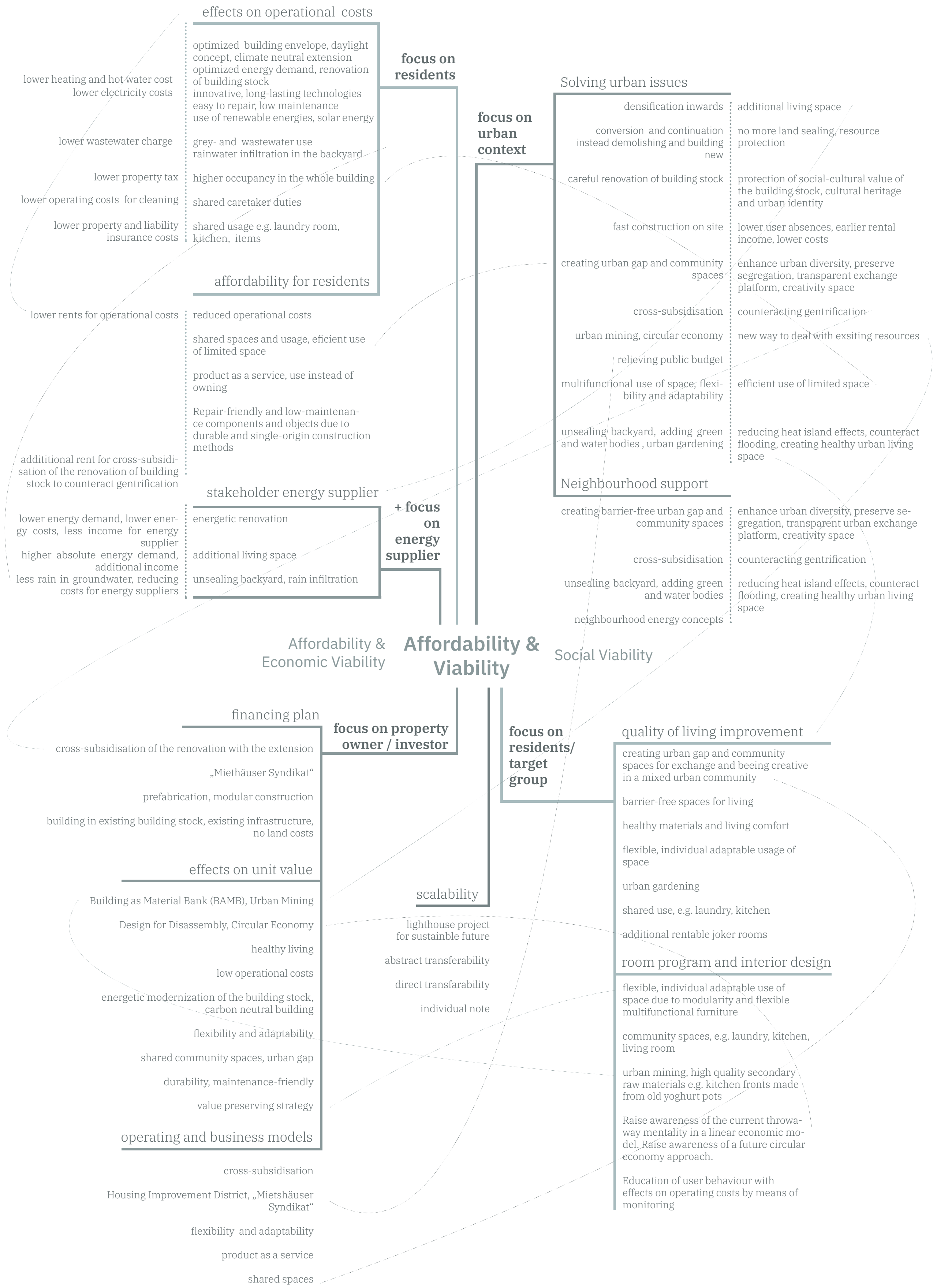
For families with strollers and seniors, barrier free flats will be provided. Following the principle of the inverted Broken Windows theory, which states originally that the more a place is already polluted, the quicker and easier it falls into disrepair, RoofKIT will generate appreciation for the environment, the people and the building, which will multiply itself. Or in short: „we only preserve what we love". Accordingly, RoofKIT ensures that the proposed building design is preserved by making it beautiful. Without a beautiful design that people relate to and care for, the building is more likely to be left to itself and not be taken care of. But only then, it is truly sustainable. As a result, recycled and reused materials of the Urban Mine are integrated that already carry a history and therefore emotion with it, such as old wooden boards as parquet flooring. In the kitchen on the other hand, we use Smile Plastics, which are waste materials (yoghurt pots) transformed into unique decorative panels.

3.3.2.2.3. Scalability

RoofKIT is an example building that aims to be a lighthouse project for sustainable future oriented design processes, that can be easily transferred to similar situations in other cities, such as vacant buildings that would profit from an extension made of lightweight wooden modules, that are equally easy to transport and erect, and an energetic renovation.
Scalability of our project can be reached by an abstract transferability, a direct transferability and an individual note to each site.

The abstract transferability consists of the application of our core principle of closing cycles in economy, ecology and society (see „3.3. Concepts" in the Sustainability Report), such as the usage of Urban Mining and the creation of small Co-dependencies within the building, to result in a socially, economically and ecologically valid and sustainable design.
With the aspect of energetic refurbishment of old building stock and our multifunctional modules in modular timber construction and lightweight construction, our project becomes directly transferable due to its lax and flexible characteristics following the principles of adaptive scalability. Doing that, it leaves behind standardisation, which was seen as a panacea for urban issues, without becoming uneconomical.

As an individual note, a multi-layered examination of the location and of the spatial, structural and social situation, anchoring the project into one specific place and ensuring its acceptance by future residents, is needed to be able to propose a fitting design for an individual site.



3.4. References

[1] S. Müller, Kerstin in: Walter Sobek u.a., Urban Mining und kreislaufgerechtes Bauen: Die Stadt als Rohstofflager, hg. Von Felix Heisel und Dirk Hebel (Stuttgart: Fraunhofer IRB Verlag, 2021), p. 66.

[2] Wohnungsleerstandsanalyse 2015, Wuppertal, Ressort Stadtentwicklung und Städtebau; Abteilung Statistik und Wahlen, 2015

[3] Lorijn, "SDE21-The-Mirke-District_V1.0_18_02_20"

[4] The number of dwellings has only increased by 8% between 2010 and 2017, while the population has increased by 3.8% in the same period. The statistics assume that the population will continue to increase. Westdeutsche Zeitung, "Wuppertal: Der Bedarf an Wohnungen Wächst," Westdeutsche Zeitung, April 16, 2019, accessed November 23, 2020, 2.28pm, URL: https://www.wz.de/nrw/wuppertal/wuppertal-der-bedarf- an-wohnungen-waechst_aid-38135683.

[5] Vgl. Vienna University of Economics and Business (WU Vienna), „Global Trends of Material Use" (Institute for Ecological Economics, 2018), http://www.materialflows.net/global-trends-of-material-use/.

[6] Quelle: https://www.wuppertal.de/ber_2019.pdf

[7] Scharff, Christoph, Anthropogenes Lager und jährlicher Zuwachs (schematisch) abgebildet in: Recycling und Rohstoffe, herausgegeben von Karl J. Thomé-Kozmiensky und Daniel Goldmann, Bd. 9. Berlin: TK Verlag, 2016.

URL: https://issuu.com/tkverlag/docs/recycling_und_rohstoffe_band_9/1 (Status: 29th September 2021).

[8] Statista.de

[9] https://www.syndikat.org/de/

[10] In 2019 the average per capita living space in Germany was 47 square metres. Statista, "Wohnfläche Je Einwohner in Wohnungen in Deutschland Bis 2019 | Statista," accessed November 27, 2020, 11.02 am, URL: https://de.statista.com/statistik/daten/studie/36495/umfrage/wohnflaeche-je-einwohner-in-deutsch- land-von-1989-bis-2004/

4. Communication, Education & Social Awareness Report

We see the contest as part of our overall project strategy. We want to inform about the most important topics of sustainability and show our implementation of the contest as an example and “Reallabor” (field test). Fundamental to this is our understanding of our project. RoofKIT sees the city as a social factory, urban mine and regenerative energy producer. In the form of our “Reallabor”, we present an architectural solution that needs to be communicated - taking into account the four pillars of sustainability: economy, ecology, social and aesthetics.

Fig. IV.4. 1. pilars of sustainability

4.1. Communication Sub-Report
4.1.1. Analysis

Due to the challenging and new situation of the pandemic, we faced new challenges in our team. The very strict Covid19 measures of the state of Baden-Württemberg and the KIT resulted in a new configuration in the team. Since we at the Faculty of Architecture have a culture of always working directly with each other in our work spaces (studios), it was a change of learned behavior for the majority of the participants in the team. This makes us all the more positive about the current team collaboration, which has been able to take place in person again since October 2021.

To go into more detail on how we deal with this in our team, you can find our SWOT analysis in Appendix P.

chances

risks

internal

Strenghts

Establishment of a clear focus on objectives and strategies.
Communication within the team, due to the COVID-19 pandemic, we are finally allowed to meet in smaller groups of three.
Meeting up in different key groups for a close exchange, including a weekly jour fix for everyone.
Specialist for all kinds of communication channels and bringing together the different topics on our website.
Through site analysis and good understandings of the Mirke District.
Quite a lot of correlating courses can be chosen at the university, so the project is an overall theme.

Weaknesses

Online team meetings are less flexible than in person; the KIT is holding up the COVID-19 prevention measures, so the university is held online until winter semester 21/22.
Most Students have to do a lot of balancing between their academic studies and competition.
Some students cannot stay in the team for more than one semester as they have to pursue further their academic goals, so the team constantly needs to spread the basic knowledge.

external

Opportunities

Broadcasting innovative visions for a better neighborhood and, on a larger scale, city for the future.
Reaching a large audience because the community is shifted towards online. Promoting these new forms of communities and, on a larger scale, societies.
Addressing relevant environmental issues and sustainable construction strategies.
Distances become more and more irrelevant, so it is easier to contact a wider field of people.
Referring to our local community, supporting our local associations.

Threats

Participatory projects are threatened or at least much more complicated due to the COVID-19 pandemic.
It is still uncertain when or whether a second field trip to Wuppertal will be possible in the near future.
It is uncertain when we can meet as a team back at the university due to the strict COVID-19 measures.

Fig. IV.4. 2. SWOT Communication

To look beyond our team, we would also like to take a look at our communication partners. The pandemic made it much more difficult to draw attention to our work for SDE21/22 within our university as presentations and events were very much regulated.

4.1.2. Strategic Planning

4.1.2.1. Strategic Communication Objectives

In order to be able to explain our mission, which is why we are participating in the competition, we have to take a step back and „start at the beginning“ in the context of the current global development. In the construction industry, we face a variety of problems today. Affordable housing is becoming dramatically rare as demand increases and buildings still generate about 40% of global CO_2 and other greenhouse gas emissions annually. Other statistical figures that make the problematic issues more tangible are that the building sector has about 50% of the primary energy consumption and uses 50% of the primary raw materials. It is also responsible for 36% of the solid waste - which are the same figures RoofKIT uses in its Audio-visual #1 (link: https://www.youtube.com/watch?v=j-VCXwpEK3cU).

Fig. IV.4. 3. Audio-visual #1. https://www.youtube.com/watch?v=j-VCXwpEK3cU

In addition, the way of constructing and the way the building sector handles natural resources mainly is a truly unsustainable linear process: We take, build and throw away. Our generation needs to stop this waste of our natural resources and stop emitting climate-changing gases. The objective is to build up attention and establish real-life references to describe today's situation to a broad public of listeners and viewers. This is intended to stimulate discussions and create an openness to suggestions for solutions, which is goes along with the motto of the students in team RoofKIT: „We want to change the world! To put it roughly.". For us, it is particularly important that we can convey that the goal of a circular economy can only be achieved if we promote a proper circular economy through the transitional phase of urban mining.

Fig. IV.4. 4. The RoofKIT project understands itself as a circular model on social, ecological and economical levels

Above all, the objective is to communicate how the team's project develops over time within the SDE21's framework and to promote it from start to finish at a local as well as national and international level. To create a good basis, the audience should also be informed about all important data throughout the competition. This includes information about the key concepts, the background for the project (concerning the global challenges especially for the building industry and the SDE tasks and goals for the project development), the team

progress, news, the team members, and the possibility to get in contact.
In addition, and to facilitate a broader discussion, contacts with creatives and partners from industry, universities, research institutes, and decision-makers are to be established and strengthened. Together, students and professionals create a platform to gather knowledge during the competition and after.

Team RoofKIT wants:
A change towards a truly circular construction, 100% renewable energies, social justice, and equality, and lastly, truly aesthetic design, based on more knowledge and attention about sustainable thinking and acting in the building sector. These main parameters are also shown in our audio-visual #2 (link: https://www.youtube.com/watch?v=8NRLyZhGQME).

Fig. IV.4. 5. Audio-visual #2 https://www.youtube.com/watch?v=8NRLyZhGQME).

Circular construction requires the efficiency and reuse of materials and elements in the construction sector. We need to construct in such a way, that the re-assembly of buildings becomes an easy act. We need to re-envision all construction details, making them fit and ready for a truly circular system. This forbids using current glues, adhesive protection layers, or other composite strategies and material mixtures, which destroy the possibility of a functioning circular system. Once we achieved this, buildings become material storage and man-made depot for the future.

In the project we are envisioning the use of **100% renewable energies**. On the one hand, we harvest solar energy on all possible and adequate surfaces, as well as additional solar installations in the backyard. On the other hand, we close energy cycles by using the building's residues, such as organic waste and sewage, as fuel for energy and heat generation.

Social justice and equality
It is vital to include rather than accidentally exclude groups of people, which

could happen for instance when planners do not design barrier-free spaces or cultural exchange is missing due to wrong design decisions. We need to include everybody and treat everyone the same!

Aesthetics

Without beauty in the design, no one will love the building and take care of it, so that all our sustainable goals in developing would not be expedient. Only with an aesthetic point of view, it is truly sustainable networking.

Additionally, we find that without networking and joining forces, not much can be achieved in the long term. We can share experiences and knowledge, success, by working and developing together! To ensure our successful processing throughout the contest, it is necessary that we respect an open communication in our team with each other, as well, as an open communication with all those who are interested in our project. By differentiating the various target groups, we want to inspire people to rethink architecture and see how our interdisciplinary work will enhance todays worldwide challenges.

4.1.2.2. Target Groups

The KIT Team‘s communication aims to reach as many different target groups as possible in various ways and via a broad range of channels. In the process, communication should not exclude anyone. In addition to subject-specific informative content, care should be taken to ensure that younger and non-specialist groups of people are also aware of the team’s project process and key statements on an adequate informative level.

The RoofKIT Team identifies the following target groups, listed in no particular order:

(a) Interested amateurs (out of the general public, future building owners or developers)

To make a change in the everyday construction business, it is our intention to address the future home owners, as well, as the general public to ensure a more sensitive approach with the building sector. We want to play a part in ensuring that an early paradigm shift via content-related sensitization leads to a sustainable building turnaround. Whether this is detailed talking about or project, or engaging in a discourse on the challenges of modern architecture in general and contemporary sustainable architecture in particular.

Our narrative is: „How do we build in the future?“. By asking such a general question that affects everyone, we aim to keep the topics discussed as comprehensive as possible.

(b) Citizens of Wuppertal and the inhabitants of the Mirke District and representatives of the civil society (of all ages, statuses and backgrounds), the management of Café ADA

The competition offers the best opportunity to investigate and develop an important contribution to urban consolidation. It will be able to highlight the inevitable transformation process that European cities are facing. We therefore want to address our proposal directly to the inhabitants of Wuppertal and address our objectives in a direct way (i.e. face-to-face contact). It is an

important chance to get in contact with the neighborhood residents in the real setting, making it a special opportunity to drive university practice to the top. As experts in their neighborhood they can best assess the social impact of the proposals. Our approach here is as direct as possible (i.e. interviewing different associations, that help building a local neighborhood).

Our narrative for engaging with this population group is: „How can we build faster and cheaper in the future without everything looking the same?“ A question for residents who are reluctant to accept change in their own neighbourhoods. Through our project, we show how a fast, inexpensive and simple construction method can offer diversity.

(c) Education referenced persons (i.e. schools and universities, faculties and students or academic professionals/researcher)

In the academic environment, information is discussed, incorporated into the curriculum, and further developed. We aim to build up and strengthen networks with students and professionals, like engineers and urban designers. For this, it helps to tie in with the curriculum and find a comprehensible language that will at the same time engage students and teachers. It is possible to combine courses between school and university.

Our narrative: „What contribution can buildings make to the energy transition?“. This target group and interdisciplinary exchange presupposes a fundamental knowledge of current issues that society needs to transform and focuses the discussion on the added value of the competition and the outcome of our project.

(d) Politicians

Policymakers, from local authorities/communities up to international levels (e.g. EU), are setting tomorrow‘s political context for the building sector. That means that a profound knowledge base of sustainable construction and planning methods is crucial for assuring the future potential application of sustainable building practices. Decision-makers are often experts themselves - However, we want to ensure that the language we use here is understandable so that our findings and messages can be grasped and shared easily. Besides the policymakers we want to spread our knowledge and discussion into the operating planning offices. The authorized architects, specialist planners and engineers are operating in the given legal context and are in the fortunate position to promote change from within the industry.

Our narrative: „How can we build without new raw materials?“. The political landscape needs to understand that it takes more than greenwashing of building projects to offer long-term proposals for our housing. Building projects, besides financial support, need to be promoted in terms of creating awareness of finite resources.

(e) Professionals from the construction industry (i.e. firms, manufacturer/producer, as well as craftsman and teaching company)

As professionals, they can give new impulses and share them in networks. They are the ones with the capacity and power to implement the principles of sustainable building as the upcoming industry standard. We can address this group here with more complex language and facts. We want to communicate our new vision of building in the apprentice generation and the working craft, to prove the assembling progress. It is also important to highlight results as much as possible and present them in a way that can be grasped quickly.

Our narrative: „How can building materials be used over and over again? Due to the professional background of the people we contact in this field, we ask ourselves concrete questions, such as the construction and realization of our project. The expertise of our discussion partners means that we have a more detailed topic for discussion much more quickly.

As can be seen from the formulated narratives and their linkage to the target groups, the narratives are aligned with the goals. The main message following the objectives will be adapted to the target group's knowledge background and age. However, the messages will always also include the following information: In the urban consolidation setting on the rooftop of Café ADA in Wuppertal, RoofKIT aims to represent a shift towards affordable and healthy living by using circular and modular construction methods together with renewable energies in an innovative way.
Keywords
Urban Mining, Solar Energy, Renewable Energies, Material Reuse, Circular Construction, Modular Construction, Circular Economy, Co-Living, Urban Gap, Material Bank, Material Passports, Urban Transformation.

4.1.2.3 Online Strategy

Due to the new participants in our team, that extended the teams on about 80 people, and the related new organizing structure we are constantly working on refining and improving our online appearance.

For many interested users, the RoofKIT-website is the first stopping point. In addition to the website, we identified four other Distributors: Facebook, Instagram, YouTube, and a podcast format (via Spotify, in cooperation with Campusradio Karlsruhe).
The main information gathering representative of RoofKIT is the team's website. The website is intended to inform widely about our project and our mindsets philosophy, as well about the SDE21 in general.

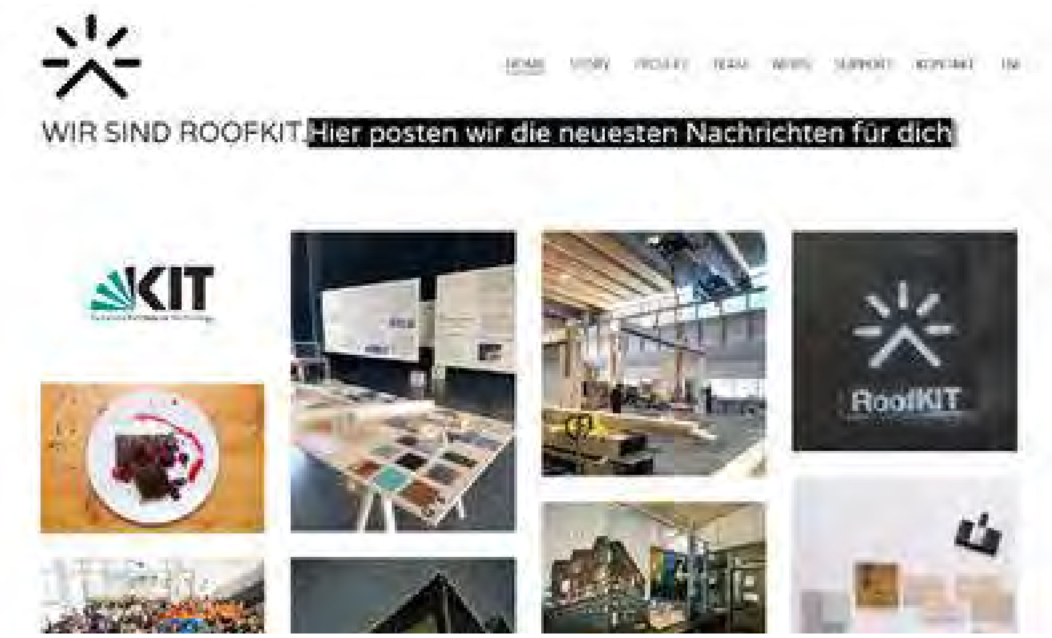


Fig. IV.4. 6. RoofKIT online appearance

We want to aim at different target groups through the differentiation of the content and hierarchizing of the related information, to arouse curiosity and inspire the visitor in as many different ways as possible. Our collage-like home page shows what is currently going on and what we are working on/what keeps us busy. This serves as a general appetizer, so as not to overwhelm all visitors with the hard facts. Behind the Story tab, you can learn more about the history of the SDE and the resulting design requirements, and about our project and what makes it unique under „project". The team and our structure can be found under the Team tab and the News Blog is used to disseminate updates.

The teams YouTube Channel is the basis of sharing or embedding our audio-visual content on other platforms, such as the website.

Other opportunities for getting in touch with the team, learning about the team's work progress, or various topics around the paradigm change we encourage, is provided by social media. The team's existing Instagram account is constantly updated. In our new strategy we change the focus of each platform. Our Facebook is currently stopped, due to our minimal reach. We started to spread milestones but saw that we could not gain the appropriate attention there. This was the point, when we decided to bundle up our sources and focus on the platform with the best reach.

The Instagram account is aiming for the same personal connection, but is next to a feed, that will show our work in a more portfolio styled way, the instrument of regular confrontation for our follower. With a new content strategy, we are posting here regularly and interactive stories to ensure a multiple social awareness for all target groups (the different theme days are shown in Appendix Q, R).

Fig. IV.4. 7. RoofKIT Instagram page

Next to these platforms we are operating with our podcast „Fighting 40%" on Spotify, in collaboration with the campusradio Karlsruhe. Thus, we can reach a young target group that is also looking for information and education in their everyday life on this platform. This is also confirmed by our statistics.

This is our way of communicating directly with extern partners and professionals about general topics of "how we build in the future". Each episode focuses on a topic represented by the interviewed person. Due to the recalibration of the team structure, we have discontinued the podcast for the time being.

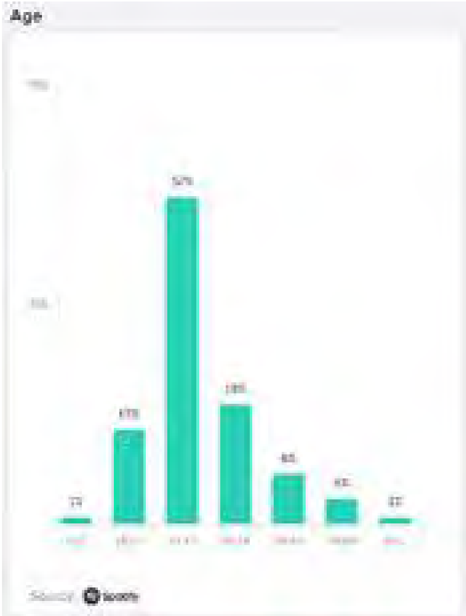


Fig. IV.4. 8. roofkit- statistics 01

Fig. IV.4. 9. roofkit- statistics 02

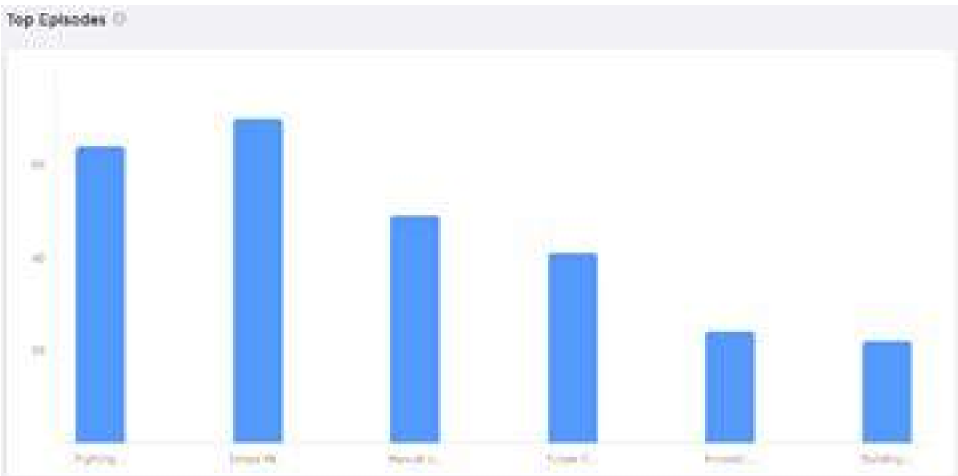


Fig. IV.4. 10. roofkit -statistics 03

Therefore, we would like to point out the recorded episodes here once again.

- **"fighting 40%", short introduction by the Podcast Team**
- **„urban mining", Prof. Dirk Hebel**
- **„manual of recycling", Prof. Dipl.Ing. Petra Rieger-Floors**
- **"future cities", Angelika Hinterbrandner**
- **"innovative materials", Rasa Weber**
- **"building in existing contexts", Sophia Schmitt**

We are planning to get back in the "spotify game" on-site! Depending on our team strength on the event campus, we will try to record new episodes and short episodes in and from our HDU, which will then deal with specific questions about our project and also with the interactions of the visitors. We see those discussions and the ongoing discourse as a great way to present our project and especially the mindset behind it.

Fig. IV.4. 11. roofkit -spotify overview

4.1.2.4. Offline Strategy

The objective here is to reach a variety of offline publishers and publication opportunities in combination to online publishing. These include professional journals and magazines, magazines addressed to students and young academics, leaflets and diverse offline methods like lectures or guest contributions. To achieve this goal, the team is preparing and reaching out to local (both: Wuppertal and Karlsruhe) as well as national press. A sub-item of this task is the distribution of flyers and posters locally. In addition, the team would like to do participatory activities with the inhabitants of the Mirke District, with Utopiastadt, and with the management of Café ADA. These include interviews and surveys, collective gatherings, and think tanks.
Due to the safety measures in response to the covid-19 pandemic, however, these activities will most likely have to be channeled through other communication strategies.

4.1.3. Operative Planning

For communication and public relations, a team of 5 students is permanently involved in keeping the online channels up to date and the offline actions

scheduled and organized.
Actions are discussed and feedbacked by the greater team and if they are bigger, such as exhibitions, elaborated in curriculum events.

RoofKIT's branding identity is characterized by its light, recognizable and memorizable design. The concept proposes both color and black and white designs to support printability.
The specifications for colors, fonts, and layout can be looked up in our RoofKIT's Visual Identity Manual. The logo combines two basic symbols in a pictographic way that everyone can understand: the sun (rays) and the (gabled) roof, which together symbolize the solar energy supply for buildings and refers to the kit we are developing for roofs as a solution for the European City, challenging the current topics in the building sector.

To prepare for upcoming events, the team is planning a further field trip to Wuppertal. Looking forward to the competition, in addition to the publication of the project status, exhibitions and happenings are planned, some of which will take place in Wuppertal, such as the showing of the project development process and various surveys with smaller community actions. This continues to be accompanied by both online and offline reporting, such as talks and blog posts, which will keep the audience up to date even if they are not participating in person.

In Karlsruhe, the team has access to rooms for their work outside the university buildings and other spaces such as the "Architekturschaufenster" (https://www.architekturschaufenster.de/) for exhibitions and lectures.

At KIT, a high number of students are engaged in extracurricular groups such as Architects for Future or KIT Engineers Without Borders and are well connected with the RoofKIT Team. Together, the Team is developing informative materials and happenings. Towards the end of the competition, a retrospective and explanatory exhibition of the entire project is planned to happen both in Wuppertal and Karlsruhe. A list of actions can be found in Appendix AC and the implementation lists.

4.1.4 Implementation, Assessment/Controlling

Our partly new, upcoming communication strategy is evaluated by the response of guests we ask to rate the different appearances before our relaunch. When launched the new structure is, on the one hand, evaluated by the statistics and, on the other hand, regularly re-thought to improve the quality and keep it updated. With the website (including a blog) as a good publishing tool, we can combine the different contents in a new way and check out which correlations work best and attract our audience. By updating the different platforms in different time rhythms, we can engage our audience in variant time slots.

Given that feedback information and the use of statistical information of the providers, we steer the actions due to the biggest range we can get. By doing so, we are able to focus on the channels and actions with the biggest impact.

4.2. Education Sub-Report

The report details the strategic and operative integration of activities, seminars, design studios, among others followed to integrate the Solar Decathlon Europe competition into university teaching, research and practice.

To have a focused view on how and who to target with our education strategy the SWOT Analysis is attached in „Appendix S: SWOT Analysis Education".

chances

risks

internal

Strenghts

- Excellent infrastructure of big technical university
- Excellent university with a varity of expertises
- Experience in realization of prototypolies as educational approach
- KIT offers a lot of experts to cooperate with for educational projects
- Broad network for having a lot of input and options for students to gain knowledge and skills
- By closely involving industry partners and associations valuable knowledge from practitioners will be gained through the whole design and construction process
- Weekly consultations in smaller groups enables the team to react on urgent topics or adjust the strategy if needed (agility workflow)
- Existing experiences of iterative exchange of research and teaching
- Iterative approach

Weaknesses

- Rigide Bachelor Master curricula are not properly compatible with SDE regulations and timetable
- Most Students have to do a lot of balancing between their academic studies and competition.
- Some students cannot stay in the team for more than one semester as they have to pursue further their academic goals, so the team constantly needs to spread the basic knowledge.
- Teamspirit is hard to achieve due to Pandemic Situation

external

Opportunities

- Raising awareness for the holistic approach of sustainable architecture at larger student groups in different formats
- New alliances for educational approach: Collaborations with other schools and colleges; Partners offer real situations to get involved with in educational classes.
- Realistic learning approach: Students gain experiences in real-life-topics and feedbacks
- Provide Know-How to Students on a "Real World" Realism level
- Enable students to take a stance on the most relevant issues of our time
- nterdisciplinary working as a real world experience
- Team spirit

Threats

- Educational classes and events are threatened or at least much more complicated due to the COVID-19 pandemic.
- Most time during the planning phase it was almost not possible to meet in person with groups, that made the planning less agile
- It is uncertain if we can meet as a team at the university all the rest of the time due to COVID-19 measures.
- Due to the prolongation of the SDE period it is even tougher to keep the team together, as many students reach their masters degree before SDE is realized.
- Strict curricula make it harder to realize an interdisciplinary approach.

Fig. IV.4. 12. SWOT Education

4.2.1. Strategic Planning

Teaching in times of climate change becomes not only a societal but also a political mandate for KIT to provide the new generation of engineers, architects, and planners with the required tools and knowledge to shift the paradigms in our professions.

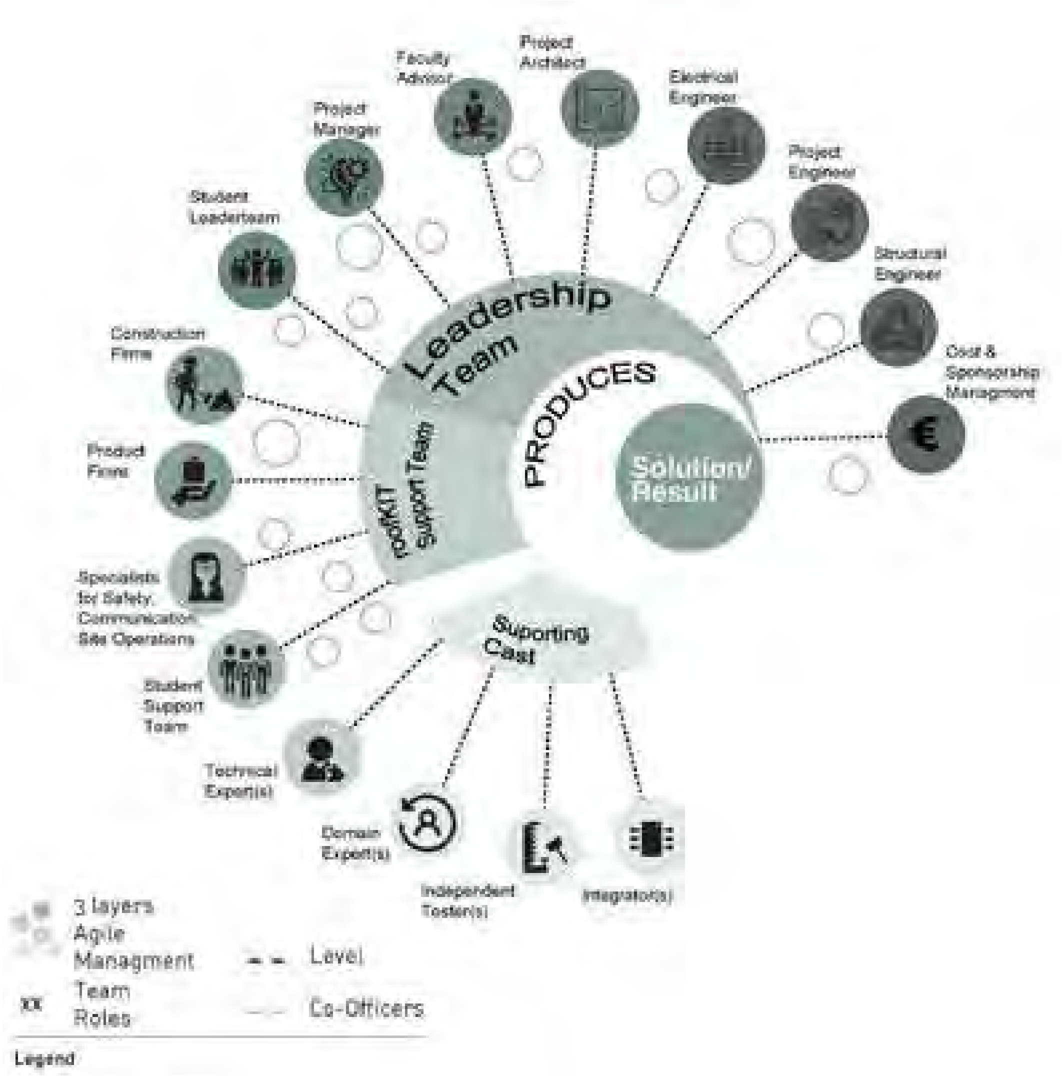


Fig. IV.4. 13. profession diagram

The strategic planning approach foreseen by the KIT Team is based on a continuous interrelation of key elements such as (a) strategic integration of SDE21 across the curricula, (b) constant knowledge exchange, (c) agile planning workflow, and (d) strategic partners.

The holistic approach of SDE21 fits perfectly with the broader University strategy of KIT. In its Overarching KIT 2025 Strategy KIT states: “The Karlsruhe Institute of Technology (KIT) consistently continues its role of pioneer in the German science system. As “The Research University in the Helmholtz Association,” the KIT will make full use of its synergy potential. In the years to come, the duties of a national research institution and a state university will be merged further step by step. Henceforth, the KIT will concentrate even more strongly on the topics of Energy, Mobility, and Information. In this way, the KIT aligns its major research areas to the long-term challenges facing society to develop sustainable solutions to urgent problems of the future. Energy, mobility, and information have traditionally been strong research areas at the KIT; their perfect merger in fundamental research and their application are essential, for instance, to the success of the “energy turnaround.” Promoting young scientists is just as important an objective of the KIT as the education of students. (...). In its research strategy, the KIT intends to merge even more closely natural sciences, engineering, economics, humanities, and social sciences.” [1]

4.2.1.1. Integration of SDE21 at KIT curricula

The strategic combination of SDE21 concepts across the teaching curricula includes the involvement of bachelor as well as master students in the design challenge of SDE21 at KIT. The knowledge transfer has not only happened in seminars and lectures but in 4 consecutive design studios, the first on bachelor level, the following ones on master level, establishing the core student team of RoofKIT. This teaching started already in winter term 2019 and will continue to happen at KIT together with several other departments as well as in summer and winter schools leading towards the physical manifestation of the design. Besides the different seminars and projects planned within the Architecture Department of KIT, further alliances have been established during the competition process. Initial collaborations included work with students from other departments f.e. of the KIT-Department of Mechanical Engineering, the KIT-Department of Electrical Engineering and Information Technology, and with students of the University of Applied Science in Offenburg for simulations and energy-systems as well as students of the Heinrich Meidinger School Karlsruhe for plumbing and technical systems. Knowledge in the design of rooftop living units has already been gained in the winter term of 2018/19 when a studio project with 50 students focused on this topic in collaboration with Volkswohnung Karlsruhe, the local Karlsruhe housing association.
Besides the crucial tasks of design and technical planning, the curriculum activities also included topics focusing on related research (like seminars committed to the analysis of circular construction methods) and communication (f.e. exhibition design and development of a communication strategy).

The Solar Decathlon with its declared goal of being a complex design build project fits perfectly to the self-perception of the educational idea of integrating “hand, mind and gut feeling”, as it provides the possibility for the students to gain experience in a dedicated design process (gut feeling plus mind), a detailed technical planning process (mind) and not at least the actual implementation as a built structure, constructed by their own hands (hand). Being not only a regular architectural planning but also a source for implementation of cutting edge research topics in a “Reallabor” (field test) it is what we would call a “proto-typology”: A prototype building where students can apply current research under supervision and learn from the experience gained. In this sense, we consider the SDE curricula as a major chance for really practicing an integrated educational idea that is interdisciplinary, team orientated and research driven.

4.2.1.2. Iterative Knowledge Exchange

The RoofKIT project will implement platforms for the constant exchange of knowledge from research, teaching, and practice. The teaching components will be the continuous factor running from October 2019 until the end of construction and monitoring of the physical “proto-typology”. The research will be inspired by the teaching questions, results, and feedback to incorporate the new outcomes back into the teaching pool. Besides, investigations of innovative products from the technological world will be performed and results will be introduced to a broad audience of people and experts. Furthermore, by closely involving industry partners and associations, valuable knowledge from practitioners will be gained through the whole design and construction process. The three main topics for the design challenges were addressed in a bachelor design studio attended by approximately 60 students. The results from the first design studio have been the basis for a master design studio in Summer 2020 (with 13 students) which pushed forward the development of the framework for the final design. Besides the central design studio, additional courses and seminars held by the Departments of Architecture, Mechanical Engineering, and Economics provided technical and economic support. The seminars included but were not limited to energy design concepts, integrated building simulations, circular construction methods, and budget planning. The recruitment of a permanent team of about 20 to 30 students allowed consecutive work through the different phases of the SDE21 as far as not disturbed by the pandemic situation. The group has been and still is supervised by the teams of the leading units of “Sustainable Construction” and “Building Physics and Technical Building Services” as in an architectural firm. The student team coordinated all necessary external consultants and specialists during the planning phase and will continue to do so in the upcoming construction phase. The pre-construction phase of the final HDU would involve the facilities of a key partner, Kaufmann Zimmerei. The design studios have been supervised continuously by 2-3 teachers in weekly consultations and supported by inputs by experts. The additional weekly seminars and courses are led by teachers with specialized expertise on the focused topics.

4.2.1.3. Agile Planning Workflow

Fig. IV.4. 14. planning workflow diagram

An Agile Planning Workflow (APW) approach is the base structure for the development of planning and construction of the RoofKIT team. The APW

structure established the leadership team comprised of the core Student Team (Leaders), the Faculty Advisors and other KIT team members as well as the leading engineers (Appendix T). The core team will be supported in the work process by the student support team that consists of a more extensive student network, specialists, and experts of the supporting firms. Furthermore, particular tasks like testing, infrastructure supplies among others will be organized by requirement out of a pool of supporters and the supporting cast. Besides the definition of leadership, the APW approach defines critical handoffs and interdependencies such as agility strategy, standing meeting daily activity cycle, agility review meeting, go/no-go decisions, and impact assessment (Appendix J). Agility Planning Meetings aim to steer the decisions concerning strategic objectives, schedules, deliverables, dependencies, risk management, financial management, recruitment of new team members, and frequency of meetings. Project changes will be an inherent part of the process and will first be discussed here. Brief daily stand-up meetings will bring on the creative outcome. They also help to keep the big picture in mind and set the course for the rest of the day. The project board of all stakeholders is integrated by the leadership team as well as the core student team, the KIT professors involved in the project, and other participating professors. The agility planning meetings will start after the final recruitment of the student team. The sessions will be installed weekly in the first phase to deliverable 1 and 2, later twice weekly if necessary. Consultants of KIT and partners will join those meetings. Each session will begin with a meeting for a daily update on the project status and set the daily and weekly goals. Besides, agility review meetings will be the central platform for the assessment of the progress against milestones and critical handoffs within the design process. Whenever it is necessary, additional meetings will be scheduled. The supporting team and the most relevant partners for the milestones to discuss, such as Kai Fischer, Katharina Helleckes, Karsten Schlesier, and Sandra Böhm will periodically join those meetings. External partners such as specialists on technical and legal issues are continuously involved in the planning process to support the student team. The outcome will be structured through protocols and controlled through dynamic working tools such as Open Gantt Charts. The elaborated results of those meetings will finally go on to a Go/No-Go Decision Evaluation. The decision-making is an iterative process; thus, the non-pass activity will return to the previous phase to be adjusted and then through the evaluation at the agility meeting. After having passed the release readiness stage, the last step in the line will be an impact assessment, where all feedback from students and other stakeholders will be input for starting the next stage again with another agility meeting. The scientific research and teaching team will make the decisions regarding the project board back into the teaching and design groups. Whenever possible, courses to endow the students with the necessary specialist skills will be integrated into the curriculum.

4.2.1.4. Strategic Partners

As already described in point 4.2.1.1, the educational network consists of various players within KIT. The leading professorships of Sustainable Building and FBTA within the Faculty of Architecture are supported by the professorships of Architectural Communication, Urbanism, Structural Design and, in the field of

LCA, by the Center for Real Estate. In the larger network within KIT, students from the Department of Mechanical Engineering and Civil Engineering are partially involved. In addition, there are cooperations with educational institutions with a more specific profile, e.g. with students from the Offenburg University of Applied Sciences and students from the Heinrich Meidinger School, who are undergoing vocational training in the field of heating, ventilation and sanitation. Other partners also support our team with technical questions, e.g. with subject-specific inputs or by making knowledge available to students.
The strategic network established for knowledge sources and partnerships is presented in (Appendix T).

Fig. IV.4. 15. Partner and Knowledge Source

4.2.2. Operative Planning

The following activities have been organized in the last five semesters (October 2019 - February 2022) and for the upcoming semester (April 2022 - July 2022).

Winter 2019:
• Design studio Bachelor: “In between, on top and aside”, resulting in about 40 design projects examining the different SDE21 sites in Wuppertal
• Excursion to Wuppertal with about 60 students, visiting the sites, meeting SDE-Organising Team and representatives of the local initiative “Utopiastadt“
• Seminar “Solar Energy Concepts for Heating and Cooling”

Summer 2020:
• Design Studio Master “Renewable up to 3”, resulting in 13 projects focusing on topping up Café ADA in Wuppertal with a special focus on renewable energy systems, renewable construction (in the sense of circularity), and “renewable” social life
•Seminar “solar-based Energy Concepts for Zero-Energy Buildings”, accompanying and complementary to the Design Studio
• Seminar “Building Performance Simulation for Assessing Solar Design Solutions”, accompanying and complementary to the Design Studio
• Stegreif (impromptu) Brief Design Happening of the Student Team as “Bottleneck”- decision, leading to one building design project out of the gained experiences of the Design studio results.

Winter 2020:
• Design Studio Master “RoofKIT” with the Student Design Team elaborating the building design and as a “ThinkTank” developing the forthcoming steps of the competition
• Seminar “Energy Supply for RoofKIT”
• Seminar “Performance Analysis for Buildings”
• Seminar “Circular Construction Methods” (in Cooperation with Fachgebiet Baukonstruktion, Prof. Ludwig Wappner)
• Seminar with self-selected in-depth topics especially for SDE21 Student Team members
• Symposium “grow build repeat” focusing on “Consideration of the breeding, cultivation, sowing, and harvesting of biological building materials and their system cycles”, open access to all students and other team members, several guest lectures by the specialist for material and construction research as well as lectures on best practice projects

Summer 2021:
• Design Studio Master “Architekturlabor” with the Student Design Team elaborating the advanced design and construction of the “House Demonstration Unit” in all details
• Student “ThinkTank” developing the forthcoming steps of the competition, supported by the teaching and researching staff
• Self-selected in-depth topics in the design studio and seminars, especially for SDE21student team members
• Seminar “Detail planning and energy concept”, focusing on RoofKIT HDU
• Seminar “Planning and building with light”, focusing on RoofKIT HDU
• Seminar “Circular Construction Methods II – Connections and Joints” – Joining techniques of circular-economy construction
• Seminar week with „How To”-Manuals for project planning, not only for SDE21 student team members
• Exhibition of state submitted for D#4 at KIT/ Department of Architecture, Main Hall

Winter 2021:
• Design Studio Master “RoofKIT” with the Student Design Team further elaborating the advanced design and construction and organizing and preparing the building process
• Seminar „Detailled Energy Conception“
• Seminar „Lighting Conception“
• Seminar „Architekturlabor Solar Decathlon - Detailplanung des Nachhaltigen Bauens“
• Seminar „Myco Fabrication - Design and Build with Mycelium“
• Seminar “Nachhaltigkeit Kommunizieren” (Communicating Sustainability), Cooperation with Professorship Architectural Communication, Prof. Rambow, leading to the exhibition “RoofKIT – how do we build in the future” that was first presented in Architekturschaufenster Karlsruhe in January 2022 and will be shown at different other locations during 2022.
• Stegreif „Model of Wall Construction”
• Collaboration with local vocational college for technical planning
• Field Trip to supporting company Kaufmann Zimmerei by RoofKIT team members
•Public Exhibition „RoofKIT – Wie bauen wir die Zukunft?“ at Architekturschaufenster Karlsruhe, January 2022

Ongoing - in the upcoming semester, Summer 2022:
• Stegreif - PR and Educational actions around SDE21 (planned)
• Field Trip(s) to supporting companies of the construction industry, as far as the COVID situation allows to.
• Symposium “Sustain. Build. Repeat.” focusing on “Building Stock as the Material Resource of the 21st century”, open access to all students and other team members, several guest lectures by the specialist for building stock research as well as lectures on best practice projects
• Seminar week with excursion to different built projects with the focus on circular construction and urban mining in Switzerland, Belgium and the Netherland, not only for SDE21 student team members. The excursion is planned to end in Wuppertal with the group to join the opening ceremony of SDE21/22.
• Building and constructing the HDU

4.2.2.1. Educational Concepts and Actions for Students and the General Public

Educational concepts and actions for students as well as the general public do and include Social Media actions such as the “Talking Tuesday” or the “Social Saturday”, a regular story theme on Instagram that focuses on topics concerning i.e. material in terms of sustainability to inform about issues and challenges in that field (for the story themes, see Appendix R).

Fig. IV.4. 16. Communication strategy

In addition to that, we constantly display selected results of our planning process and its accompanying thematic fields on our websites roofkit.com, nb.ieb.kit.edu, our social media accounts (Facebook, Instagram) as well as on specific platforms on sustainable construction such as “changelab.exchange”, a KIT/Wacker platform focusing on material development and cycle-compatible construction. Doing so is letting a broader public participate at the raising awareness of our students and spreads the ideas for implementing new architectural thinking as a major part of the socio-economic transition that climate change requires. We also publish the results of the different Design Studios as Brochures especially for the next generation of students to learn. That project is still ongoing.

In summer 2020 we exhibited the state of our team’s submission publicly in the faculty, so that other students and teachers could get involved with our approaches. Furthermore, despite the complicated situation concerning Covid19, in January and February 2022 we have presented an exhibition at Architekturschaufenster Karlsruhe, a public forum and architecture gallery committed to the communication of architecture and urbanism-related topics to a professional public as well as an interested civil society public. The Exhibition, entitled „RoofKIT – Wie bauen wir die Zukunft?“, is curated by a group of students related to team RoofKIT and supervised by Katharina Blümke and Daniel Lenz of the professorship of sustainable construction in cooperation with Prof. Dr. Riklef Rambow of a*komm, professorship of architectural communication at KIT. It focuses on six topics considered to be the most important parameters for future building, such as circularity, urban mining, prefabrication, densification, social issues of urbanization and renewable energy supply. All the topics are illustrated using the RoofKIT project as an example and prepared with the focus of comprehensibility in order to reach a broader public.
It was open to anyone interested and displayed the topics in a nutshell to the pedestrian zone passengers walking by in the inner city of Karlsruhe in

January and February 2022. The exhibition gained attention of other interested organisations, so it will move to different places in Karlsruhe and Wuppertal during 2022, such as the city council, the Zukunftraum Karlruhe and the SDE event.

Fig. IV.4. 17. Exhibition "RoofKIT- How do we build in the future" at Architekturschaufenster Karlsruhe, ©Riklef Rambow)

In November 2022, a reflection on "architectural education for the age of circular building" was published in Magazine "Lust Auf Gut –Republic of Culture special 34" ."[2] by Katharina Blümke and Daniel Lenz, also mentioning the RoofKIT project. That issue is targeted to a broad public and features many local businesses and initiatives.

4.2.3. Implementation, Assessment, and Control

The individual steps in the implementation of the project and the corresponding task areas are shown in Appendix V. The different tasks are assigned to the relevant responsible persons and evaluated at regular meetings to guarantee a trouble-free process. At the end of each planning phase, a report that includes the design, technical and economic status of the project will be prepared with increasing depth and accuracy of elaboration. The cost comparison with the financial income through fundraising, the schedule, and the distribution of tasks is kept permanently up to date. The main tasks will be handled by the core team consisting of the lead and the student team. The task development will be supported by an agile development of further students (e.g. from courses specially designed for certain subtasks) and supporting partners such as technical planners and experts. In each development phase from the project definition to the as-built documentation, there will be Go/No-Go decisions. Each key design decision to be made will be a result of a team brainstorming and iterative workflow, as shown in Appendix U.

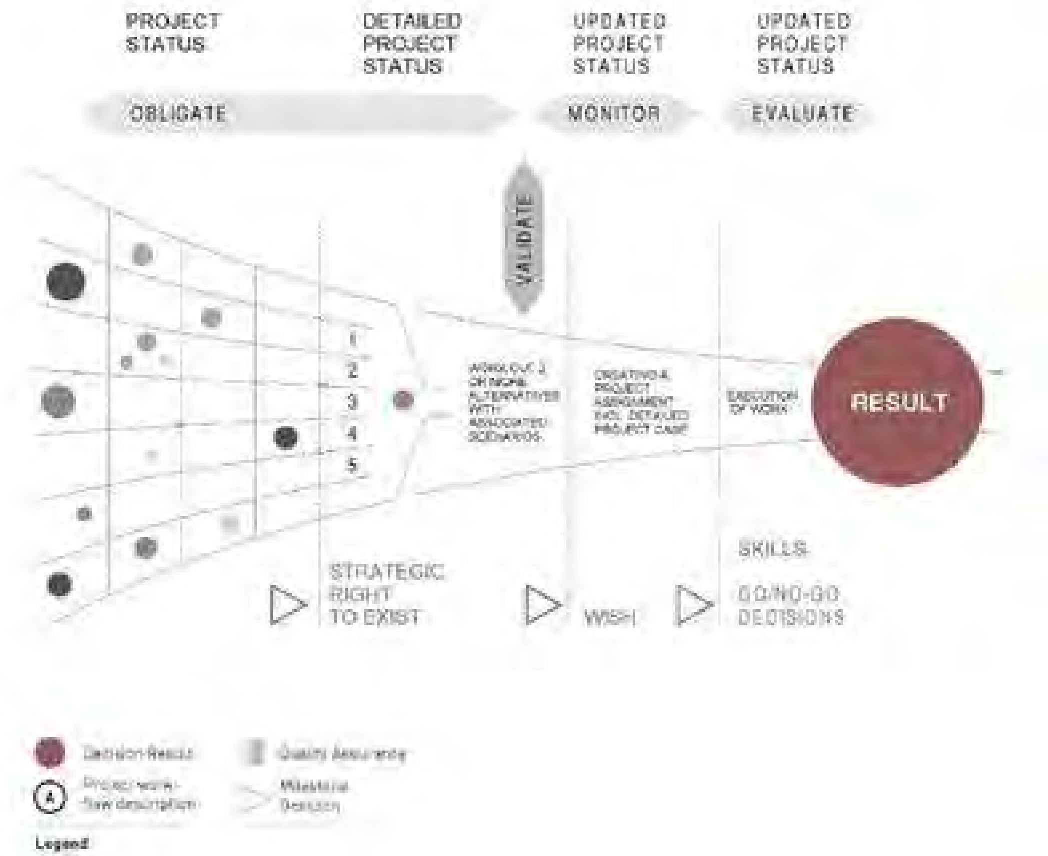


Fig. IV.4. 18. project development

Brainstorming will provide a wide range of ideas in the beginning. Those ideas will go through the first selection process in which all relevant team members discuss their strategic right to exist. The remaining designs will be further elaborated and extended by small groups or teams of specialists resulting in a minimum of two alternative scenarios. Then, those designs are compared and assessed through the regular process to find the consistent and most adequate result for each step. Above all, the cost situation is subject to permanent evaluation, which represents a go/no-go decision in every phase. The successful conversion into the HDU and the further construction success is based on the consensual implementation of Go/No-Go decisions taken across all the stages by team members, partners and supporters, and contractors (if required). The team task continues once the project is completed after the successful re-built of the HDU on KIT Campus. To achieve the project goals, long-term monitoring is carried out as quality assurance and to optimize future planning. Furthermore, it is also planned to explore the adaptability of the proto-typology to other real situations in collaboration with partners and supporters such as Volkswohnung Karlsruhe. These further activities would ideally lead to the construction of projects that allow to test and validate the concepts in a different urban scenario. Organized tasks and deliverables subdivided throughout the entire competition period are shown in the project schedule in Appendix U. The diagram shows the parallel and sequential activities planned to optimize the project workflow and time management. The milestones describe the chronological sequence of the Go/No Go decision criteria. The project would be managed on a digital platform that would allow not only data management but also dynamic task distribution and a real-time validations process.

4.3. Social Awareness Sub-Report

This sub-report details the way of how we want to use our communication strategy for spreading social awareness.

4.3.1. Analysis

First of all it is important to stress that the SDE21 is a joined movement for us which Today, we still have far too little knowledge and action in the building industry towards truly sustainable construction and the measures we already have in our hands ready to taken care of. Even if the situation is slowly changing, it is still far from happening in the same way or sufficiently throughout the industry.
Through the SDE we have the chance to enhance the new building economy under a shed of a professional „strong back“. The contest gives our education strategy more volume - thus this would normally not be the case with such an important topic. As we are able to create content and elaborate communication strategies by integrating it into the curriculum, we can use that power and our range to inform our audience about our philosophy for the future sustainable European city. The various communication sources and networks we maintain (social media, exhibitions, direct actions, talks etc.) offer the opportunity of sharing our goals with a broad audience as well as addressing specific audience.

Through the two-storey demonstration unit on-site, we have the chance to bring more characteristics of our overall design and the urban situation to the solar

campus. The connecting issue of how we will live in the future will be once more demonstrated in the inside. We show that the housing quality is improved by the circular economy background and which advantages our paradigm shift has towards the inhabitants.
In 4.1.1 analysis, concise figures describing these circumstances are presented - and this is how Team RoofKIT sees it: Our generation needs to stop the waste of our natural resources and to stop emitting climate-changing gasses. To achieve this, it is possible, for example, to start where contact with some principles of sustainable action is already established. For example, children already learn in primary school about cycles (recycling, water cycles, etc.) or energy-conscious behavior. Another example is that students or professionals in the construction industry, who want to specifically deepen their knowledge. However, there are also people in the general public and professionals who do not yet have much or hardly any knowledge about urban sustainability topics. For such an audience, a language must be found to reach and interest them.

4.3.2. Strategic Planning

We consider a broad reach and networks as one of the important goals. For social awareness Team RoofKIT identifies and shortly describes the following target groups, listed in no particular order:

(a) Interested amateurs (out of the general public, future building owners or developers)

To achieve a change towards truly sustainable living, it is important that everyone works together. It should become a given to act sustainably and it starts with every single person. That this is not too abstract we include the „Motivation Monday“ in our Instagram story themes. So we can show enthusiast followers how new opportunities in the building sector can provoke a change.

(b) Citizens of Wuppertal and the inhabitants of the Mirke District (of all ages, statuses and backgrounds), the management of Café ADA

The inhabitants of Wuppertal can discover the results of sustainable building and living on site and experience them in their city. This gives them first-hand knowledge. Similar the residents of the Mirke District experience the changes in their neighborhood first hand. They are also experts in their neighborhood and can best assess the social impact of the proposals. For us it is very important to deepen the contact with local, social associations.

(c) Education referenced persons (i.e. schools and universities, faculties and students or academic professionals/researcher)

Schools and Universities teach simple basic principles of sustainable living and action. We aim to build up and strengthen networks with other specialists, architects, and urban designers to tie on the existing base and establish a thorough knowledge.

(d) Politicians

Policymakers from local up to international levels (e.g. EU) are setting tomorrow‘s political context for the building sector, which means that profound knowledge of sustainable construction and planning methods is crucial for assuring the future potential application of sustainable building practices.

(e) Professionals from the construction industry (i.e. firms, manufacturer/ producer, as well as craftsman and teaching company)

„How can we build in future?“ This is one question among many, about which we need to talk and educate in schools. Topics such as resource scarcity, sustainable resources and reusable building materials are rarely taught in schools. Nevertheless, in our opinion this topic is incredibly important because today`s schoolchildren are going to play a decisive role in shaping the future, creating new life spaces and living in them. For more information see communication plan School Visit.

AUDIENCE	COMMUNICATION GOAL	COMMUNICATION TOOL
elementary school	resource focus & structure and components of building Which materials is the building made of? Do we have infinite building materials? What can be finite and renewable resources? How and where do these materials grow?	-Explanation in the form of a comic and a memory game -Bring material samples and explain them in a playful way
middle school	focus on resources and energy Which form of housing do you know? How did you grow up? Where would you like to live later? Where does your electricity come from at home? Do we have infinite building materials? How can we prevent that building materials turn into waste? How can we build without new natural resources?	-Introductory presentation/ short film -Bring material samples -Group work in which the different questions are discussed -Competition among students (estimation questions/ task to separate component joints) -card game „sustainability“
high school	holistic view of construction in the future How can we build in the future? How do we want to live together? Where does our energy come from? How can we prevent that building materials turn into waste? How can we build without new resources? How to reuse old building materials?	-Introductory presentation/ short film -Bring material samples -Group work in which the different questions are discussed -Competition among students (estimation questions/ task to separate component joints) -card game „sustainability“

Fig. IV.4. 19. “school visit”

It is vital to establish and maintain professional networks. Professionals are the ones who have the capacity and power to implement the principles of sustainable building as the upcoming industry standard. The students of the KIT Department of Architecture already benefit from a strong exchange between teaching, research, and practice with guest contributions and cooperations on the topic of urban sustainability. Lectures and results are also accessible to the public and are currently being made available digitally due to the COVID-19 pandemic. There are also physical spaces such as exhibition and demonstration rooms (architecture showcase, material library, etc.), which can be converted into digital spaces (compare symposium “grow build repeat”, winter 2020) and/ or brought outdoors for the public (material library).

To reach as many different audiences as possible, different ways need to be explored and a wide range of offers needs to be made available. For this purpose, following the structure of the communication sub-report, both online and offline strategies will be pursued. With our communication tools, we want to specifically raise awareness of urban sustainability topics. We want to raise awareness of true circular construction, 100% renewable energies, social justice, and equality, and, lastly, truly aesthetic design! In doing so, we want to form networks, expand them further and act face to face to make the relevance clear and strengthen the desire to act responsibly as an interesting, sustainable way of life. This applies both in Karlsruhe and in Wuppertal.
This is also what we currently focus on in our public tour and the exhibition set up as shown in 4.2.2.1. (Educational Concepts and Actions for Students and the General Public).

In summer 2022 the House Demonstration Unit itself will give a statement to the interested audience in Wuppertal at the Solar Campus. It will be not only the Shell for an exhibition but an exhibition itself. All relevant topics and proposals can and will be discussed and presented directly in scale 1:1 as we aim to proof, that f.e. circular construction planning and building is already possible. As is planned to bring the Unit back to Karlsruhe after the SDE event phase, the discussion will be brought from University Karlsruhe to Wuppertal public audience to Karlsruhe public audience.

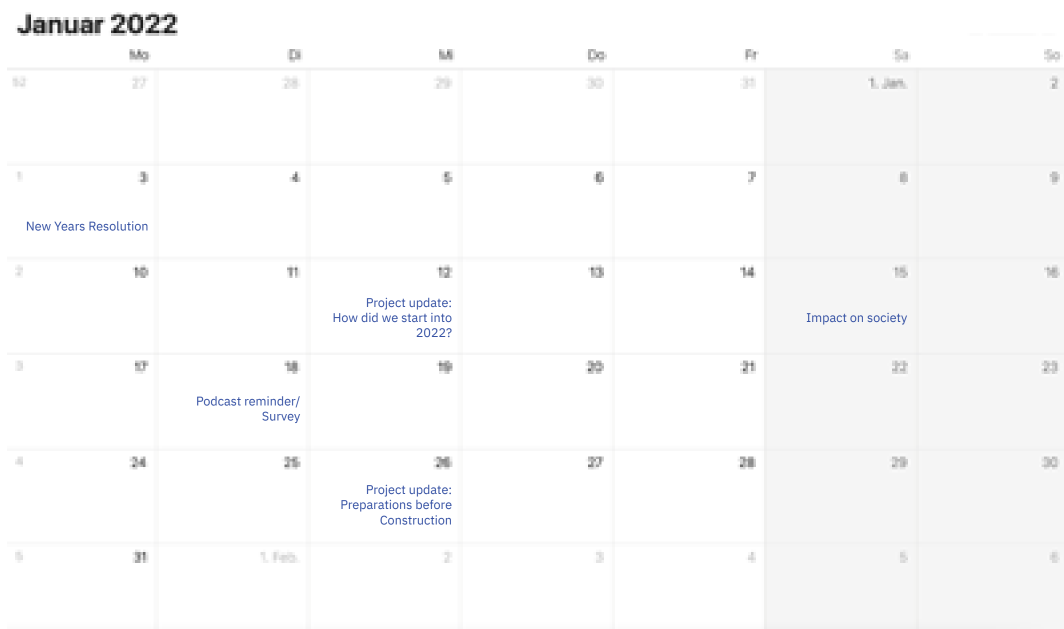


Fig. IV.4. 20. calendar plan

4.3.3 Operative Planning

RoofKIT builds its understanding on four pillars of sustainability: ecology, economy, society and aesthetics. Issues and problems we face in the construction industry today are related to these four main pillars. The team is committed to a future in which sustainable thinking and acting become a matter of course. All presented facts and statements are always communicated in the context of this basic theory. All facets must be treated consistently and equally alongside each other. In terms of the communication possibilities, statements are communicated to the audience in a variety of ways with the help of and always in the context of such basic theories through:

- Lectures at the KIT-Department of Architecture
- The RoofKIT Website and Blog
- Partnering Associations
- RoofKIT Instagram account
- Audio-visuals
- RoofKIT Podcast format

The distributors mentioned above and their functions (see 4.2.4. and appendix Q) also apply to our toolbox for social awareness.

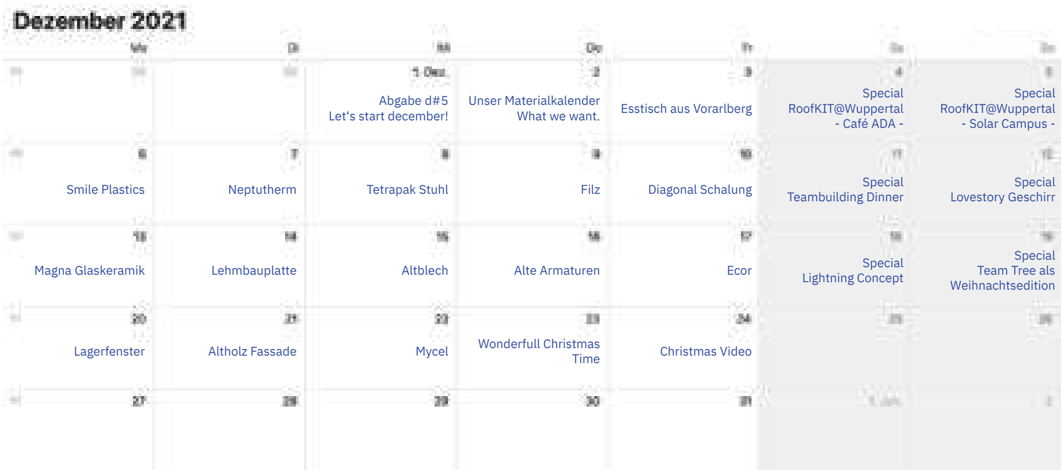


Fig. IV.4. 21. December has been the „Adventskalender“-month

4.3.4 Implementation, Assessment/Controlling

The following actions have been implemented or are in an advanced planning stage:

(a) targeting Interested amateurs

A variety of smaller actions, such as “guerilla-style” spray chalk claims on the streets in Karlsruhe or interactive “Adventskalender”-posts on Instagram on sustainable-construction-related topics enhance the communication with our audience on Instagram or sets topics on everyday situations.
The aim of the “Adventskalender” is spreading a wider knowledge about sustainable building and materials by presenting material based informations each day. It is our goal to communicate products that have something to do with our HDU and inform our followers about it.

In general, all social media channels, such as the website, Instagram, youtube and facebook channels, have been successfully implemented and presented all sorts of media in order to give an idea of our goals and our project.

An exhibition set up especially designed to be comprehensive for a broad range of people was implemented. As described in 4.2.2.1 it was already shown to the public at a public gallery. We received a lot of good feedback which also lead to

at least two more places and dates for the exhibition to be shown.

(b) targeting Citizens of Wuppertal and the inhabitants of the Mirke District

Due to the pandemic situation we unfortunately have not been able to install our activities in Wuppertal itself. But as the HDU will be the key exhibit to bring all our claims and ideas to life, we are optimistic to get into contact with the people of Mirke at least during the event weeks. We plan to also have some actions around the neighborhood of Mirke at that time.

(c) targeting Education referenced persons, students and teachers

We set up different networks with different schools and Faculties of KIT, such as a cooperation with Heinrich Meidinger School, where students for plumbing were integrated into the planning process or Hochschule Offenburg, which offered interested students the option to sneak into our team’s activities.
Faculty parties and exhibitions communicated the goals and the related topics to the faculty members to get in touch and discuss the future of construction.

We plan to implement the actions for smaller children and school students of different ages as shown in the communication plan “School visit”. The plan defines particular goals and tools with how to reach them for elementary pupils, middle school students and high school students. Materials such as memory games, presentations and short films (f.e. our audio visuals in German language) combined with showing strategies, solutions and materials to face the problems such as resource and energy scarcity and how to build in the most sustainable way.
Unfortunately, it was not possible yet to implement those ideas with a real school audience, due to the strict pandemic situation. But we plan to get in contact to teachers and officials to do so in the upcoming semester.

(d) targeting Politicians and Administrations

The podcast series “fighting 40%” connects the interested audience to specialists working in the different fields of sustainable construction and planning by making comprehensive interviews and asking easy to follow up questions.

At the same time our team tried to set up different networking actions and alliances in order to spread the social awareness issues. So the project was presented to architects for the future and the initiative “Quartier Zukunft”, which is ruling an exhibition space called “Zukunftsraum” self dedicated as “an interface between science and citizenship. It is an offer for people and ideas to come together”[3]
Exhibitions there and in the Regierungspräsidium Karlsruhe are going to bring the topic right to the political and administrative people in charge.

(e) targeting Professionals from the construction industry, professional planners
Last but not least we aim to spread our strategies and findings in different media

channels such as professional journals (to reach an audience of architects and planners or professional investors). F.e.in March our RoofKIT project is shown in the urbanistic magazine “POLIS” and will be featured in an online article of the same magazine. As example for addressing a general audience related to design topics, we published an article mentioning the RoofKIT project in the lifestyle magazine “Lust Auf Gut”, which has a wide recognition of different local business people.

As we had to deal a lot with sponsorships and different firms of the construction industry, we had a lot of face to face discussions on sustainability, future planning, threats and opportunities.

Another implemented way of raising awareness for the topics are the symposiums with talks and panel discussions, addressing professionals as well as students.

4.4. Mandatory Attachments

4.4.1. Team Visual Identity Manual

A team visual manual can be found in the appendix W.

4.4.2. Sponsorship Manual

The Team uses all kinds of channels, from personal interviews to official letters to the various companies, to establish contact and win sponsors. To specify the contribution options and to provide decision guidance, a gradation was implemented, which is described in the official letter. The team differentiates between silver, gold, and platinum sponsorship and precisely explains the benefits of each category. A list of sponsors and the sponsoring letter can be found in appendices Y and Z.

4.4.3. Public Tour Description

A document describing the public tour can be found in appendix AB.

4.4.4. Implementation List

Educational (University curriculum) for more detailed list see Education Sub-Report: Operative planning (4.2.2)

• Design Studio Bachelor, duration 1 Semester, from October 2019, 60 students
• Design Studio Master, duration 1 Semester from April 2020, 13 students
• Design Studio Master, duration 1 Semester from November 2020, up to 8 students
• Design Studio Master, duration 1 Semester from April 2021, up to 16 students
• Several Seminars in support focusing on technical and constructive topics, duration 1 Semester each, 10-20 students each
• Impromptu: duration 2-3 weeks, 8 students
• Field trip to Wuppertal, Fall 2019, duration 2 days, 60 students

• Various guest lectures and inputs by consulting professors on the topics of Structural Design, Economics, Building Technology, Building Industry, Urban Planning/Mobility, Design Sponsorship/Partners

See list of Sponsors Appendix X and description (4.4.2).

Communication and Social Awareness. See list of actions/activities, KIT_ CESA#6_2022_03_23

4.5. References

[1] https://www.kit.edu/kit/english/23339.php, 17/03/21. 10:30

[2] https://www.lust-auf-gut.de/magazine-previews/blaettern/lust-auf-gut-magazin-special-rund-ums-bau-en-und-wohnen-288/, 13/03/22. 17:15

[3] https://www.quartierzukunft.de/vor-ort/zukunftsraum-fuer-nachhaltigkeit-und-wissenschaft/, 13/03/22. 22:15

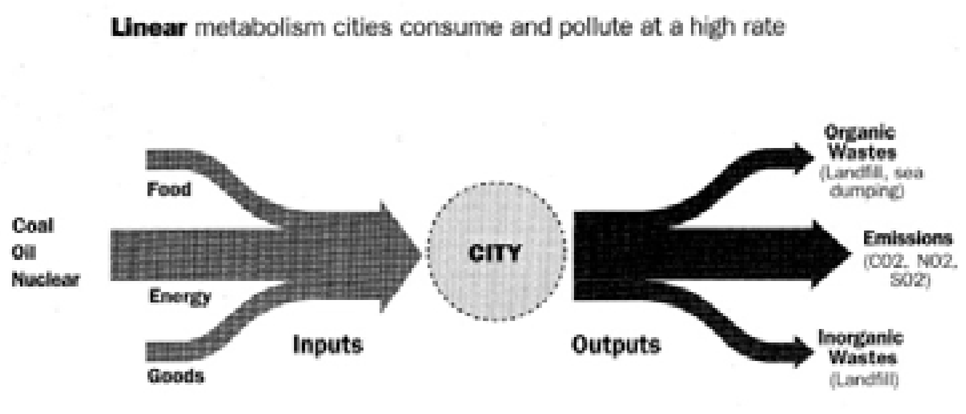
5. Sustainability Report

5.1. General Sustainability Concept

The most sustainable building is the one already built.

In September 2020, as part of her State of the Union address, the President of the European Commission Ursula von der Leyen reiterated the goal to establish a fully circular economy in the EU, as outlined in the Circular Economy Action Plan (CEAP) published in March of that year. She singled out the construction sector as bearing particular responsibility as, according to the Commission, it was responsible for 50% of primary raw material consumption within the EU in 2019 and for 36% of solid waste production. The reason for this lies in our current linear model of thinking and economics: raw materials are extracted from natural cycles, are made into goods and products for public consumption which are then disposed of after use. This still dominant linear approach has profound consequences for the planet and is seriously disrupting existing ecosystems. Materials such as sand, copper, zinc or helium will soon no longer be technically, ecologically and economically viable to extract from natural sources. As an alternative to the prevailing destructive pattern of linear raw material consumption, Ursula von der Leyen calls for the adoption of closed material cycles that are intelligently planned and designed with foresight.

At the same time, the building industry is also responsible for 50% of all energy consumption and 40% of all CO2 and other greenhouse gas emissions within the European Union. The bulk of this energy is used for heating a gigantic built environment, designed, and built in vast majority before 1980 with no or very poor insulation qualities and powered by fossil energy carriers. It is obvious, that we have to lower the demand by updating our old structures following the principles of a circular economy, but it is obvious as well, that this circular approach needs to be **turned by renewable energy only.**



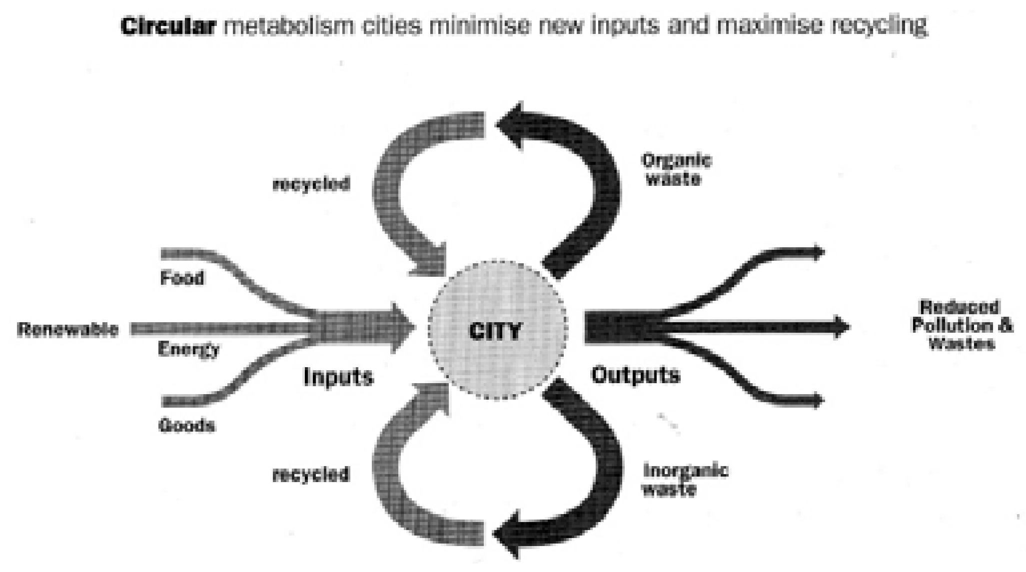


Fig. IV.5. 1. Richard Rogers, Cities for a small planet, 1996

RoofKIT therefore addresses those two most urgent and pressing questions of our time: energy and resources. While technology is widely available to harvest the only existing open system on our planet - sunlight radiation to power all natural and technical circular systems – we still need to establish closed- loop scenarios and necessary technologies for a truly circular operating building sector on the resource level. **The RoofKIT concept therefore understands itself as a respond to respect and keep the existing building structure, adding a concept of a future material depot onto it and designing a big energy harvesting machine acting also as a battery for the existing building as well as the whole neighborhood in the Mirke quarter.**

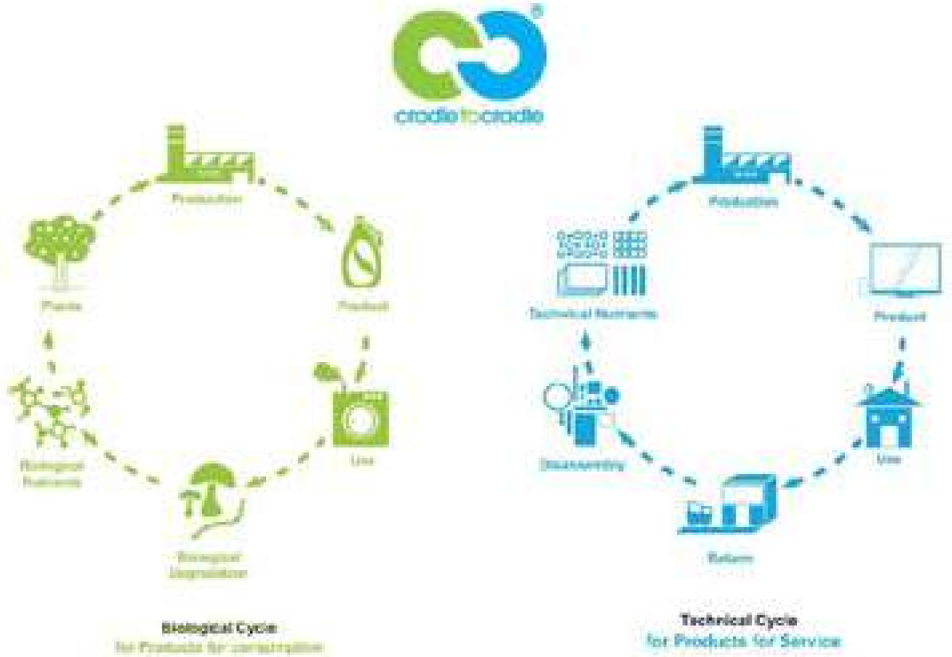


Fig. IV.5. 2. The biological and technical cycling after Cradle to Cradle and the circular approach auf Ellen Mc Arthur Foundation

5.2. Circularity – from a linear to a circular construction method:

With the introduction of an industrialized building market, the mentality of take-make-throw became the dominant way of how we understand our natural environment: we take out resources, make products out of them and after use, we simply throw them away. This thinking led to a perverse situation, whereby the material itself is no longer of any value to us as soon as it reaches its end of use scenario. And with this in mind, we constructed for the longest time our building accordingly: we did not plan for a dismantling phase in order to bring the materials back to the point, where we can use them again in an endless manner. Buildings are still seen as consumers of resources and not as intelligent storage facilities. Only lately, the discussion is focusing on another direction: The EU with the Green Deal not only wants to provide Europe with a climate neutral energy supply, it is also pushing us into a fully circular industry, whereby waste is no longer accepted as an outcome of our doing. But additionally, also geopolitical and environmental issues are changing the market rapidly: the war in Ukraine will booster the wish to leave fossil energy carrier behind and move even faster in renewables. The state secretary of finances of the Federal Republic of Germany calls those energy supplies a question of freedom, given this transformation an immense political power. But the same is true for resources and materials: we need to start immediately to see them as renewables as well: either in form of building up a gigantic easy to handle and composite-free material depot or as an incredible innovation laboratory introducing a new class of building materials coming from the biological realm. This is underlined by an immense cost increase for almost every material in the past two years, due to a global pandemic but also by the very simple equation, that our resources on this planet are finite and we are reaching a point where this can be felt quite

strongly. In Germany alone, the cost in the building industry climbed up 14% in 2021.

The growing understanding that we need to change the system, and the growing scarcity of resources calls for a paradigm shift from linear material consumption to circular economy model - especially in the construction industry. RoofKIT implements this claim: The unit is constructed from separable, mono-material resources that are completely reusable, recyclable or compostable. The concept of cycles therefore plays a central role: Used materials are not consumed and then disposed of; instead, they are borrowed from their technical or biological cycle for a certain period and later returned to these material cycles. RoofKIT is both – a temporary material depot and a material laboratory – proofing the academic, technical and constructive possibility for a fully circular system in the building industry.

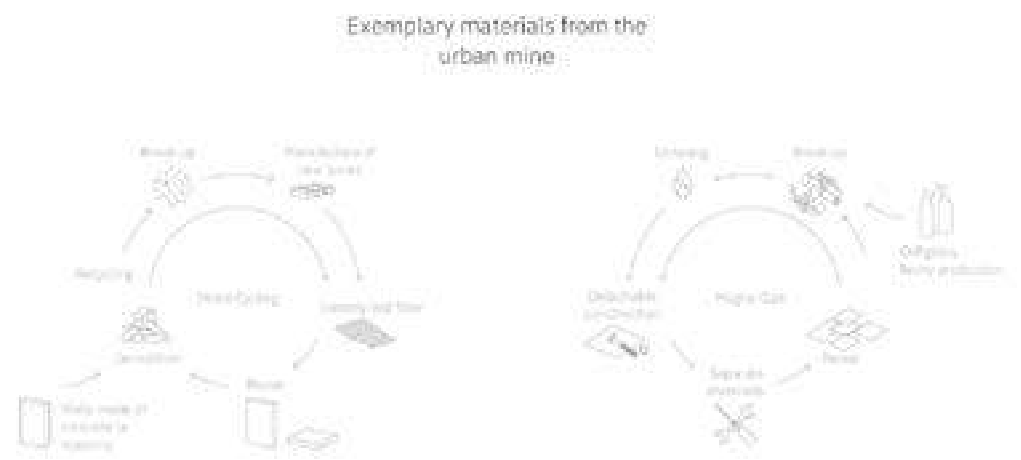


Fig. IV.5. 3. Two products designed to circle in the technical realm: StoneCycling and Magna glass ceramics

RoofKIT adheres to the following main conditions for circularity:

(1) Materials - Mono-Materials over composites: All materials we bring into the built environment need to be in a mono-material state. In this respect, they are in their original basic configuration. They are not mixed, alloyed, coated, or otherwise combined with another material with different material properties. These materials can have a biotic (from living beings) origin (wood, straw) or an abiotic (not from living beings) (plastics, metals, minerals, salts, coal, petroleum). The two groups have different recycling cycles, on the one hand, the biological, on the other hand, the technical, as is adequately described in the cradle-to-cradle principle by Braungart and McDonough. Both cycles are based on the ideology of reuse or recycling without loss of quality and negative effects on other systems or cycles. In our demonstration unit, we use only biological insulation materials such as seagrass and expanded cork. These materials can be reused or composted and thus returned to the biological cycle whenever necessary. Products from the technical realm such as StoneCycling made from construction rubble or Alba made from discarded yoghurt pots or Magna glass ceramics are designed to turn endlessly in a specific, technical circle: the precondition is a mono-material status in all cases.

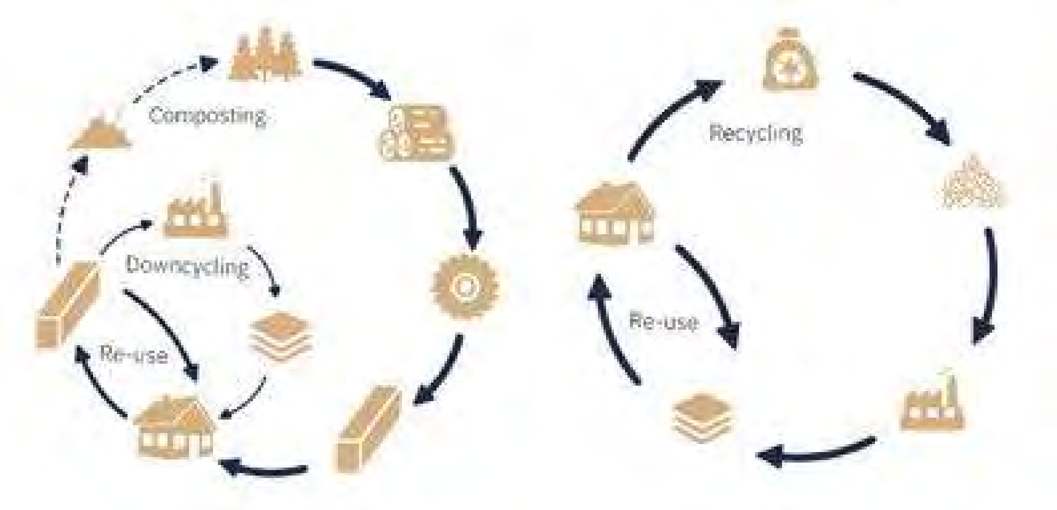


Fig. IV.5. 4. Possible scenarios in the biological circle (here: wood)

Wooden timber beams, using wood from sustainable forests and untreated, can also be reused. An alternative would be to shred them into fibers and press them into wood fiber insulation boards (downcycling). This is possible in the so-called wet process without adhesives. We use both materials in our demonstration unit. In addition, we avoid the usual OSB boards for bracing and rely on so-called GFM (Glue Free Massiv) boards and diagonal boards. These are solid wood planks that are connected with tongue and groove and lie on top of each other in several layers that are twisted against each other, thus providing bracing and at the same time serving as a natural vapor barrier. They can also be composted, reused, or made into wood fiber insulation boards („Fig. 5.4. material loop wood"). Even the vapor barrier in the roof and floor, which is rainproof but open to diffusion, is monomaterial, consists exclusively of polypropylene, and can be reused or recycled.

We are closing previously open technical loops wherever possible by using mainly secondary raw material: the surfaces of the kitchen are covered with panels made of recycled HDPE of old yoghurt cups, the product is named "Alba", see section "Materials". The waste is collected, sorted, and pressed into new structural panels, allowing a use with all regular fittings, screws and other connection systems established. An example for a one-time down-cycling process is shown with the lounge chairs. They are made from tetrapacks. The material was shredded and then hot-pressed into thicker panels. The technology was developed in India, where no recycling possibilities are given for tetrapacks. Using the material there as a replacement of metal roof sheeting, it has the beautiful effect of mirroring radiation back into the cosmos, as the contained aluminum acts as a mirror. The panels shown here come from an old project in the US, the NO-WASTE-PAVILLION. The company produced them as an alternative for gypsum board panels. Left-over panels were connected only with PE strips. Here, a dismantling strategy is at hand allowing the material to enter the recycling process again and again.

Fig. IV.5. 5. Reconfigured tetrapack material in the NO-WASTE-WALL NY, 2016, Hebel, Heisel, Block

The Urban Mine is considered as a regional source for mostly technical building materials that could be used as ready-made building parts (Re-Use). The more construction material we can acquire out of the Urban Mine the lesser new material has to be consumed and produced. That also means less destruction of natural resources and less emission of CO_2. For the entrance stairs, we will use a former industrial piece The lift is rented and will be provided with for the period of the exhibition. After that, the manufacturer will get it back and can use it again. We reuse bathroom fittings and door handles. Instead of new glass for our illuminated glass wall between toilette and wash basin and between washbasin and shower, we use 100% recycled glass ceramic. The façade on the east side is covered with a reused truck tarpaulin onto which the component structure is printed so that it can also be seen from the outside.

Following list provides the materials used at RoofKIT and their potential for future possibilities of re-use, recycling, down-cycling, and reconfiguration.

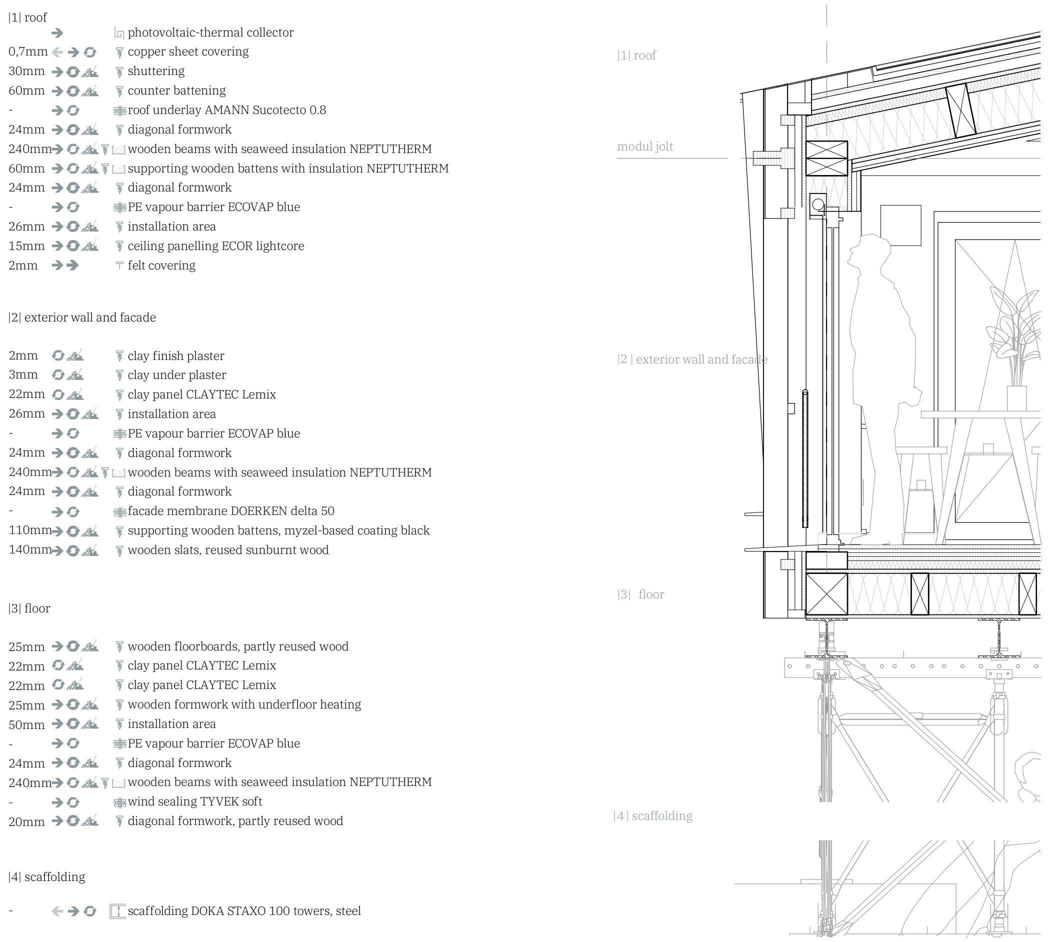


Fig. IV.5. 6. RoofKIT material application, Façade section HDU, 2022

Outer Envelope:

Roof cladding: the roof is cladded with a 100% recycled material coming from the company TECU.
Existing recycling content: 100%
Toxicity: Possible toxic substances are comparable to the primary material. Copper is essential for good health. However, exposure to higher doses can be harmful. Longterm exposure to copper dust can irritate your nose, mouth, and eyes, and cause headaches, dizziness, nausea, and diarrhea. As used in RoofKIT, we do not foresee any harmful exposures as no dust is emitted.
Recyclability/Future possibilities: As copper shows the highest value chains in re-use and recycling of all metals, it will be 100% reused or fully recycled, as we can guarantee also a 100% dismantling.

Outer vapor barrier roof: the roof is protected by a vapor barrier from the company Amman, Sucotecto
Existing recycling content: 0-100% (the exact recycling content is not known)
Toxicity: No toxicity is specified in the product, containing only polypropylen
Recyclability/Future possibilities: The construction method of avoiding gluing the foil, allows for a 100% reuse and 100% recycling as it is a mono-material.

Facade: the outer facade layer is constructed with a 100% recycled wood material (spruce) coming from the company RESTADO.
Existing recycling content: 100%

Toxicity: Possible toxic substances could be found in used wood by old chemical protection application. This needs to be checked before re-used again. In the case of RoofKIT this was done.
Recyclability/Future possibilities: The construction method of RoofKIT allows for a 100% reuse. But also, a not desired cascade-use (downcycling) is possible due to the mono-material character. This downcycling should be avoided as long as possible to keep the wood as a CO2 sink for future generations.

Outer vapor barrier wall: the outer facade layer is protected against weathering by a vapor barrier from the company Doerken (Delta 50).
Existing recycling content: 0% (no information given)
Toxicity: No toxicity is specified in the product, containing polyester and acryl
Recyclability/Future possibilities: The construction method of avoiding gluing the foil, allows for a 100% reuse. The company gives also the possibility of a 100% recycling possibility within their company.

Inner structural layer:

Frame structure and diagonal boarding: the outer facade layer is constructed with a 100% glue-free wood material (spruce) coming from the Bregenzer Wald.
Existing recycling content: 0%
Toxicity: none
Recyclability/Future possibilities: The construction method of RoofKIT allows for a 100% reuse. But also, a not desired cascade-use (downcycling) is possible due to the mono-material character avoiding glues and chemical treatments. This downcycling should be avoided as long as possible to keep the wood as a CO2 sink for future generations.

Timber framing north facade: the north facade timber framing is constructed with a 100% recycled wood material (oak) coming from the company Rieger in the black forest.
Existing recycling content: 100%
Toxicity: Possible toxic substances could be found in used wood by old chemical protection application. This needs to be checked before re-used again. In the case of RoofKIT this was done.
Recyclability/Future possibilities: The construction method of RoofKIT allows for a 100% reuse. But also, a not desired cascade-use (downcycling) is possible due to the mono-material character without adding any chemicals or glues. This downcycling should be avoided as long as possible to keep the wood as a CO2 sink for future generations.

Insulation: the insulation layer is a 100% biological material: seagrass coming from the company Neptutherm.
Existing recycling content: 100%
Toxicity: none
Recyclability/Future possibilities: The construction method of RoofKIT allows for a 100% reuse. But also, a not desired cascade-use (downcycling) is possible due to the mono-material character without adding any chemicals or glues.

This downcycling should be avoided as long as possible to keep the seagrass as a CO2 sink for future generations.

Windows: all windows are coming from the urban mine as a re-use concept.
Existing recycling content: 100%
Toxicity: none
Recyclability/Future possibilities: The construction method of RoofKIT allows for a 100% reuse.

Entry door: the entry door is an old door coming from the company Rieger in the Black Forest. It is combined (visible from the outside) with a state of the art wooden construction allowing for safety measures as required.
Existing recycling content: at least 50%
Toxicity: none
Recyclability/Future possibilities: The construction method of RoofKIT allows for a 100% reuse and 100% recycling of all components (wood and metal).

Inner envelope:

Outer walls: all inner layers of the outer walls are cladded with loam boards and a loam plaster coming from the company Claytech.
Existing recycling content: 0-100%
Toxicity: none
Recyclability/Future possibilities: The construction method of RoofKIT allows for a 100% recycling of all components (clay, organic additives and reinforcement).

Inner walls and roof 1: all inner walls are cladded with a 100% mono-material felt from sheep wool coming from the company M&K Filze with no chemical additives.
Existing recycling content: 0-100%
Toxicity: none
Recyclability/Future possibilities: The construction method of RoofKIT allows for a 100% reuse and 100% organic recycling.

Inner walls and roof 2: all inner wall felt panels are cladded over an 100& biological produced board panel from fibre scraps from the company Ecor.
Existing recycling content: 0-100%
Toxicity: none
Recyclability/Future possibilities: The construction method of RoofKIT allows for a 100% reuse and 100% organic recycling.

Inner vapor barrier: the inner construction is protected by a 100& Polyethylene mono-material vapor barrier from the company Amann, Ecovap (blue)
Existing recycling content: 0-100% (the exact recycling content is not known)
Toxicity: No toxicity is specified in the product, containing only Polyethylene
Recyclability/Future possibilities: The construction method of avoiding gluing the foil, allows for a 100% reuse and 100% recycling as it is a mono-material.
Floor 1: 2/3 of the floor is constructed with a 100% glue-free wood material (European ash) coming from the Bregenzer Wald.
Existing recycling content: 0%
Toxicity: none
Recyclability/Future possibilities: The construction method of RoofKIT allows for a 100% reuse. But also, a not desired cascade-use (downcycling) is possible due to the mono-material character avoiding glues and chemical treatments. This downcycling should be avoided as long as possible to keep the wood as a CO2 sink for future generations.

Floor 2: 1/3 of the floor is constructed with a 100% glue-free used wood material (spruce) coming from the Black Forest.
Existing recycling content: 100%
Toxicity: Possible toxic substances could be found in used wood by old chemical protection application. This needs to be checked before re-used again. In the case of RoofKIT this was done.
Recyclability/Future possibilities: The construction method of RoofKIT allows for a 100% reuse. But also, a not desired cascade-use (downcycling) is possible due to the mono-material character. This downcycling should be avoided as long as possible to keep the wood as a CO2 sink for future generations.

Floor installation 1: 2/3 of the floor installation layer is constructed with a milled glue-free wooden substructure (spruce) and two clay boards from the company Claytech.
Existing recycling content: 0-100%
Toxicity: none
Recyclability/Future possibilities: The construction method of RoofKIT allows for a 100% reuse and 100% recycling (clay). But also, a not desired cascade-use (downcycling) is possible due to the mono-material character. This downcycling should be avoided as long as possible to keep the wood as a CO2 sink for future generations.

Floor installation 2: 1/3 of the floor installation layer is constructed with an air-dried clay brick and one clay boards from the company Claytech.
Existing recycling content: 0-100%
Toxicity: none
Recyclability/Future possibilities: The construction method of RoofKIT allows for a 100% reuse and 100% recycling (clay).

Floor installation 3: all pipings within the HDU are done in copper.
Existing recycling content: 0-100%
Toxicity: Possible toxic substances are comparable to the primary material. Copper is essential for good health. However, exposure to higher doses can be harmful. Longterm exposure to copper dust can irritate your nose, mouth, and eyes, and cause headaches, dizziness, nausea, and diarrhea. As used in RoofKIT, we do not foresee any harmful exposures as no dust is emitted.
Recyclability/Future possibilities: As copper shows the highest value chains in re-use and recycling of all metals, it will be 100% reused or fully recycled, as we can guarantee also a 100% dismantling.

Fig. IV.5. 7. The People`s Pavilion, Eindhoven Design week, 2019, bureau SLA + Overtreders W: all components can be dismantled

(2) Construction - Design for disassembly: At the end of its service time, RoofKIT also represents a material depot for future projects: instead of connecting elements and components irreversibly such as chemical glues, foams or other synthetic elements, RoofKIT uses reversable screw connections, clamps or fully interlocking systems in order to recover all used substances cleanly and sorted in order to return them to their specific material cycles at the highest quality and quantity. Many material fractions, which are classified as mono-materials due to their material properties, cannot be recovered due to contamination from unjust joining techniques in the sense of a truly circular economy. This is largely due to the way these materials and products are connected in construction. Bonding, wet sealing, or grouting can cause such contamination of the material fractions and prevent recycling processes on the same quality level. A switch to a truly circular construction industry, therefore, harbors the great opportunity to develop and market new, adapted construction methods and joining techniques for materials and components. RoofKIT will demonstrate these construction methods. The main structural elements are done in wood-wood connections and only screwed together. We will also use purely mechanical means to connect all modules. The exposed beams inside are managed with metal threads, so that the modules as a whole can be easily detached from each other. The above-mentioned insulation is therefore not glued, but stuffed, inserted between the wooden studs or beams.

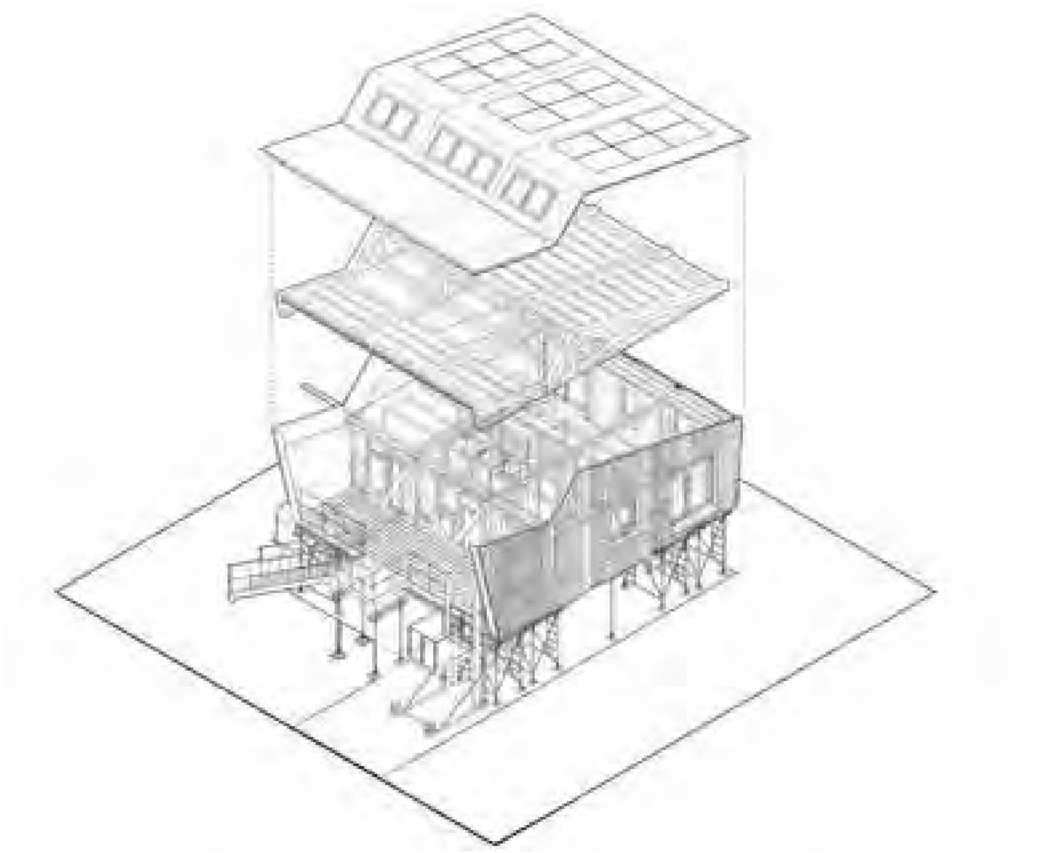


Fig. IV.5. 8. all materials and building elements are easily retrievable, the building acts as a material depot

Clay panels are reversibly screwed exclusively to the substructure. We have even found a solution for the floor heating: Copper pipes are inserted into grooved wooden elements and air-dried clay bricks (push-fit) and the aluminum baffles are just placed into those. We avoid the usual composite material connections as they are state of the art momentarily. The wooden planks above the heating are joined together with tongue and groove and placed on bearing timbers between the heating coils. The sealing membrane in the roof and floor is stapled overlapping and is also used in the bathroom as a vapor barrier. There, the glass ceramic elements are also screwed together and can be removed easily again. There are also no silicone joints or similar. Instead, we work with dry pressed-on seals and other transitions.

Developed and planned in close cooperation with industry and craftsmen, the unit now offers the opportunity to investigate methods and materials for the circular economy. It is more than a demonstrator, but rather a laboratory, a lived-in apartment in the future sitting at the campus of KIT in Karlsruhe, that will provide verifiable feedback to a consortium of researchers for the next years to come. And due to its construction as a material depot with easy and reversible connections, RoofKIT will also be adapted and developed further within this period on the continued quest for closed material cycles and new construction technologies. As such, we see RoofKIT as a research platform promoting and creating the path towards a circular economy in the built environment.

1| roof	
	photovoltaic-thermal collector
0,7mm	copper sheet covering
30mm	shuttering
60mm	counter battening
-	roof underlay AMANN Sucotecto 0.8
24mm	diagonal formwork
240mm	wooden beams with seaweed insulation NEPTUTHERM
60mm	supporting wooden battens with insulation NEPTUTHERM
24mm	diagonal formwork
-	PE vapour barrier ECOVAP blue
26mm	installation area
15mm	ceiling panelling ECOR lightcore
2mm	felt covering

2| exterior wall and facade	
2mm	clay finish plaster
3mm	clay under plaster
22mm	clay panel CLAYTEC Lemix
26mm	installation area
-	PE vapour barrier ECOVAP blue
24mm	diagonal formwork
240mm	wooden beams with seaweed insulation NEPTUTHERM
24mm	diagonal formwork
-	facade membrane DOERKEN delta 50
110mm	supporting wooden battens, myzel-based coating black
140mm	wooden slats, reused sunburnt wood

Fig. IV.5. 9. RoofKIT translates all loop strategies in a circular construction methodology

To make this thinking transparent and traceable, all materials and components used in RoofKIT will have a material passport to inform future generations on their existence in quality and quantity. But as we know for fact, that current recycling quotes for metals and minerals in Europe are not matching the demands in the construction sector, we are convinced that we need to close this resource gap with cultivated biological and therefore renewable building materials. As such, the project will explore the use of biological building materials such as wood, mycelium, seagrass, cork and sheep wool. The intention is to incorporate new products from KIT and research partners into the design to proof the technical possibilities. („Fig. 5. 1. technical and biological loop").

As this thinking addresses in a very direct way the ecological issues of sustainability, we will also show what economic impacts this thinking will have. New concepts such as "product as service" will be introduced within the project as well as new technologies such as developments exploring the idea of using construction rubble for the development of new materials and products. But also the demonstration unit itself will be a hint to alternative construction methods based in safe and protected environments, minimizing the threat of accidents and dangerous situations during construction itself. We believe that a circular building industry needs to address such cultural issues as well. As such, the project will also explore the possibility to understand the existing infrastructure as a new field of technological as well as architectural exploration.

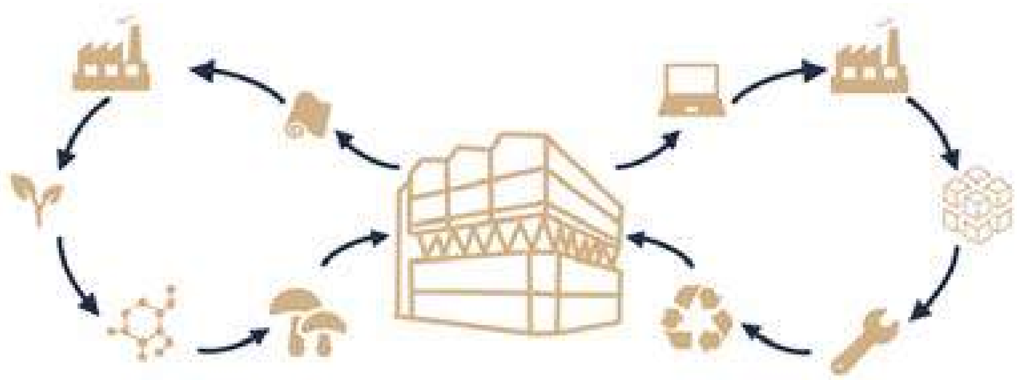


Fig. IV.5. 10. RoofKIT as part of a consistency strategy in biological as well as technical loops

(3) Maintenance, repair and durability: The Solar Panels on the roof must be cleaned annually. For the associated electrical systems (battery and inverter), maintenance is recommended every four years, which we can guarantee through easy access to the technical core. „Fig. 5.6. durability of technical

building services" shows the estimated durability of our technical installations.) All installations are openly visible and reachable within the core element, nothing is hidden or incorporated in building elements.

Since our demonstration unit was designed according to the principles of mono-material construction and on the premise of deconstructability, all connections are easily detachable, and the individual materials and elements can thus be maintained and repaired. Especially in the case of the floorboards, we assume that they will need to be reworked once within the assumed life cycle of 50 years. This is easily possible as they are full wooden boards and can easily be sanded. But even replacing some (if necessary to a heavy damage or reaching the floor heating system underneath) is easy, due to the tongue- and-groove connection of the boards to each other and their application without any glues. Materials that cannot be easily replaced or maintained, such as the seagrass insulation materials, have natural protection against
rot and moth infestation, what makes them really attractive to us, as we do not need to add any synthetic chemicals. One reason to clad the façade with used wood, is to activate the patina the boards already have. We see this patina as a natural protection layer, similar to old barns or other wooden structures in the Alp region, sitting there sometimes for more than 200 years, as they are correctly constructed allowing the material to breath and dry out after it was wettened by rain. This knowledge was used to construct the façade of the RoofKIT as a vertical fan structure, allowing to dry out as much as possible. Giving the competition outline, the HDU cannot demonstrate an overhanging roof on all 4 sides as it is planned, but constructive protection is key to this thinking.

RoofKIT also introduces a completely new form of weathering protection as a living, self-healing organism: the product is used to protect the horizontal sub-structure of the façade. The product is a fully biological and consistent wood protection application. Introducing an organic, protective and self-healing membrane to the wood through a base coating consisting of natural oils and a second layer of a living biological fungal material, it allows wood to experience a long lasting protection without the application of synthetic or toxic materials.

This simpler approach to building entails considering the composition and assembly of building materials and construction components so that individual materials can be reclaimed separated with circularity in mind. For this one must think intelligently about the individual layers of buildings. For example, the parts of a building that most frequently need maintenance, servicing, renovation or replacement are the inner and outer surfaces of the building envelope. By contrast, the loadbearing structure of a building is almost always enclosed by or encased in shielding layers and need only be accessed in exceptional cases.

Simple, intelligent design means detailing the building to ensure easy access to the external façade and inner faces of the building envelope at any time over the building's service life so that these can be serviced, and in extreme cases, dismantled and separated by type of material. Similarly, the clearer and more separate the design and installation of the technical systems, the easier it is to replace parts of them. By abstaining from using technically enhanced special solutions and integral components, a building becomes more repair-friendly and more robust in comparison to many of today's composite building systems that are harder to repair, less long-lasting, less robust and therefore less sustainable.

The clay surfaces applied through the whole design are as well a perfect example of a friendly repair, maintenance and finally circular concept: Clay can easily repaired by simply wetting the damaged area and re-plaster it. And in its final stage, it simply can be mixed with water and is ready for any other application. All inner ceilings and cores within the design are cladded with 100% natural wool felt. In case of a local damage, it is very easy to replace single panels, the felt can be reused in smaller parts or fully composted.

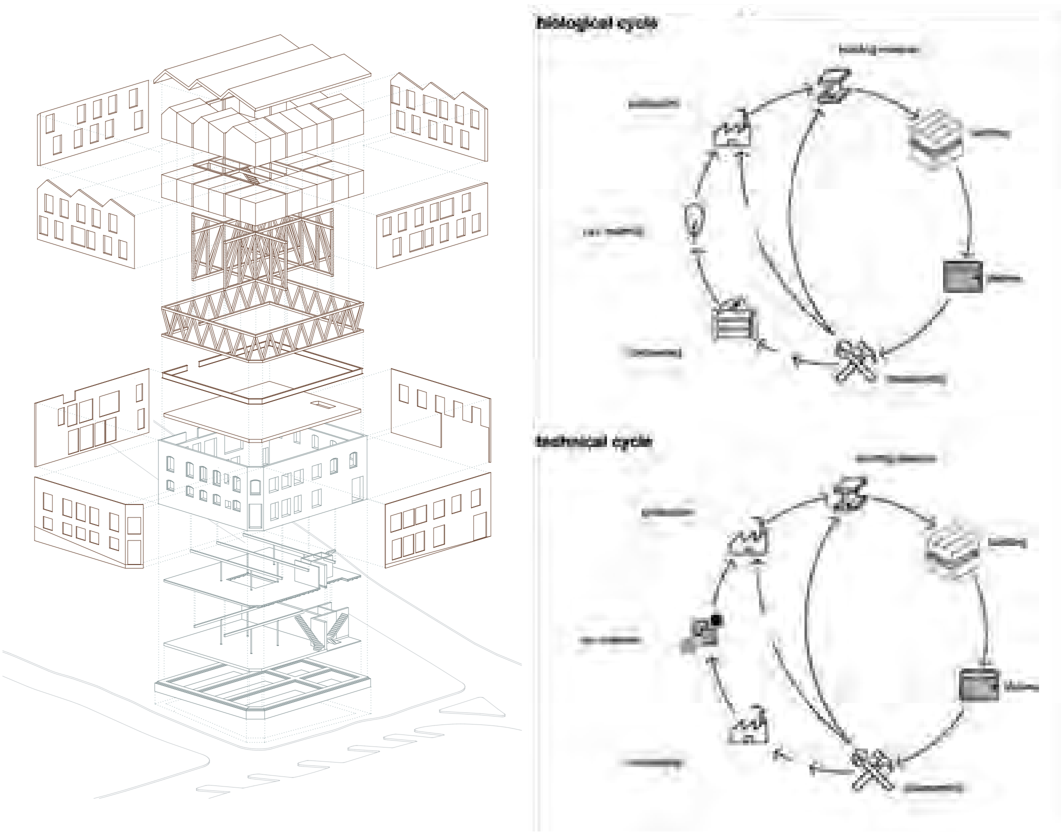


Fig. IV.5. 11. RoofKIT keeps the existing structure intact and adds a material depot on top

(4) Circularity Concept - Keep the existing and keep it in the loop: The re-use of materials, products, and buildings as such is a clear demonstrator for circular and sustainable thinking. 60-70% of the grey energy bound in a building is to be found in the structural elements as such (foundations, load bearing walls or beams, ceilings). Generally, Café Ada will be preserved as far as possible. The foundations, floor slab, ceilings, and existing beams and columns will be retained, and with them the grey energy stored in them. A second layer of reused bricks and windows will improve the insulation quality of the existing building from the last century. For this, we use the bricks from the wall on the west side of the property. Inside, loam plasters will be applied to contribute to air and humidity quality within the building. The roof extension will use as many

reused metals as stairs and façade cladding as possible. This material carries history and identification and will therefore also serve as a social identification point within the city structure.

The best level of maintenance will be reached if the building will be accepted and loved by its users and inhabitants. In that way, the architectural design itself must provide inspiration and identification as "aesthetic sustainability". We will do that by using high-quality materials in their purest form as well as materials from the Urban Mine visible for everyone to see from the outside and inside and build a material depot for the future. Circularity will serve as an identity bearer for their home by telling a story with its specific haptic and patina. The mounted facade as well as the entire construction will be joint only with completely detachable solutions without the use of glue and other binders. In this way, the materials can be separated single-origin and re-used or recycled. This guarantees avoidance of trash in the future deconstruction of the building.

Technical Building Services	**years**
Heating/Transfer: Hot water underfloor heating	30-40
Heating/Distribution: Circulation pumps	10-15
Heating/Distribution: Insulation of pipes	20-30
Heating/Pipelines: Hot water heating	40-50
Heat Pumps: Electricity	20-30
Solar Energy: Absorbers	20-30
Solar Energy: Flat plate collectors	20-30
Solar Energy: Batteries	20-30
Solar Energy: Converter	30-40
Electrical Installations	30-50

Architectural building components	years
Roof cladding copper	>100
Outer wooden façade	30-50
Outer vapor barrier	25-50
Inner wooden structure	>100
Insulation	>100
Inner vapor barrier	>100
Inner clay cladding	30-50
Inner felt cladding	30-50
Inner wooden floor	25-30
Kitchen excluding appliances	30-50
Kitchen appliances	15-20
Bathroom excluding appliances	50-70
Bathroom appliances	15-20
Lamps	30-50
Light fixtures	5-10
Batteries	10-15

Fig. IV.5. 12. Durability of technical services and architectural components within RoofKIT

(5) Carbon Footprint of the construction

Life cycle Analysis

The life cycle assessment according to EN 15978 was carried out for the House Demonstration Unit (HDU). The Global Warming Potential values for the structural elements were taken from the UMI tool (Urban Mining Index tool) and the values for the technical components from the eLCA tool on the basis of a mass calculation and component list.

System boundary: The carbon footprint was calculated over a standardized life cycle of 50 years for the House Demonstration Unit with a reference net floor area of 54 m2. The balancing includes the production of the building materials and the technical equipment, the usage phase including the operation and maintenance of the building, as well as the disposal. The life cycle phases A1-3, B4, B6, C3-4 and, as an addition, phase D were calculated. Devices and furniture were not included.

The focus here is on the carbon footprint of the constructive components based on the UMI tool.
For the entire life cycle assessment taking into account the technical components, see chapter evaluation, Engineering & Construction Report.

All materials in the House Demonstration Unit are attached to each other in such a way that they can be dismantled in pure fractions of mono-materials, for example by means of screw connections, overlaps or clamps, see V.6 and V.9. This means that, unlike with conventional composite components, the service life of the individual materials does not depend on the weakest component. In this way, RoofKIT strives to ensure the durability of the materials used. Mechanical stresses, e.g. on the wooden floor, can easily be repaired by simple woodwork.

Manufacturing Phase A1-A3:
Sustainable building construction with a high fraction of natural materials like wood or seaweed insulation as well as a lot of secondary raw materials like glass ceramics, storage windows or rented materials like the scaffold reduces the global warming potential in this phase by -30.000 kg CO2e, see figures 14. Positive GWPs result mostly from the necessary foils. We have tested various films for the respective area of application for purity and toxic substances and decided on the materials that are most likely to be pure and healthy. Additionally the stainless steel surfaces cause positive GWPs. Because of the concept of dismantability in pure fractions of mono-materials and innovative construction methods, the metal can be 100% reused or recycled. The impact on the global warming potential of secondary raw materials is particularly visible for the window components. With the exception of the roof windows, we have only used storage windows. In the case of the new roof windows, it can be seen that the new glazing has the highest GWP value of all the materials in the HDU. Storage windows, together with all other secondary raw materials, enable the equalisation with zero.

Usage Phase B4, B6:
Regarding a life cycle of 50 years, nearly all the construction materials implemented in the Urban Mining Index endure the supposed time span or even longer. Only the vapour barriersand other foils (lifespan 40 years) and the 100% cotton felt (lifespan 25 years) at the interior walls and the ceiling soffit need to be replaced once. The global warming potential value for the Replacement Phase is close to zero, see figures 14.
The service life of technical components is shorter than that of building elements.

Except for the ventilators and the exhaust air pipes, all components must be replaced 1-2 times within 50 years, s. Fig. 5.13. Almost all technical components are bundled in the technical core. The pipes are left visible wherever possible. The easy accessibility to the elements in the technical core enables quick and easy repair and replacement of necessary individual components.

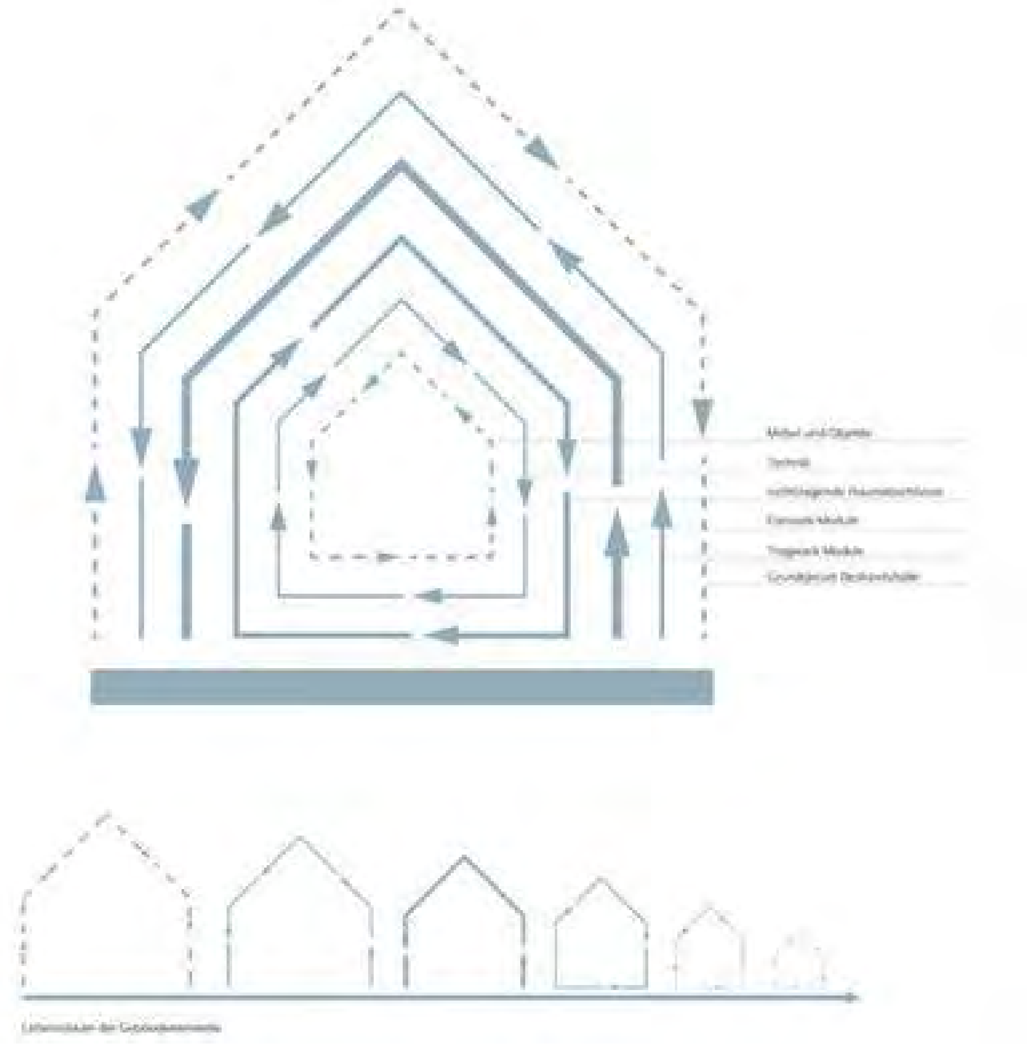


Fig. IV.5. 13. life span of building components

Waste processing and disposal C3, C4:
For some elements, the end-of-life scenario Reuse or Recycling was selected, such as for the TECU copper roof. For most renewable resources, thermal recycling as a standard scenario was assumed and greyed out in the UMI-Tool.
According to EN 15978, the carbon balance for e.g. wood must be balanced over the entire life cycle. Thermal utilization in phase C is automatically taken into consideration. In this case, this would mean that all CO2 sink potentials in phase C are cancelled out and 54,000 t CO2e are emitted, see figure 5.14.
Since RoofKIT does not envisage thermal recycling, but wants to continue to use all materials as long as possible and keep them in the cycle, phase C was manually set to zero for all renewable raw materials, like wood, seaweed insulation, cellulose plates, and the 100% cotton felt, see figure 5.15. This takes into account, for example, as with the used old wood for the lamellas on the facade, that the materials will be re-used and only composted at some point in a longer life cycle, but not burnt. The nutrients end up in the soil and the cycle starts all over again.

Phase D:
The potential for recycling and reuse outside the system boundaries is -19.000 kg CO2e for the constructive components.

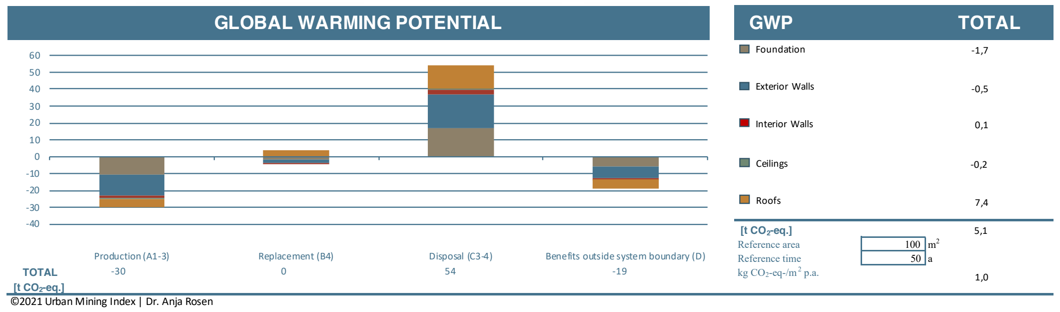


Fig. IV.5. 14. Global Warming Potential building structure, UMI

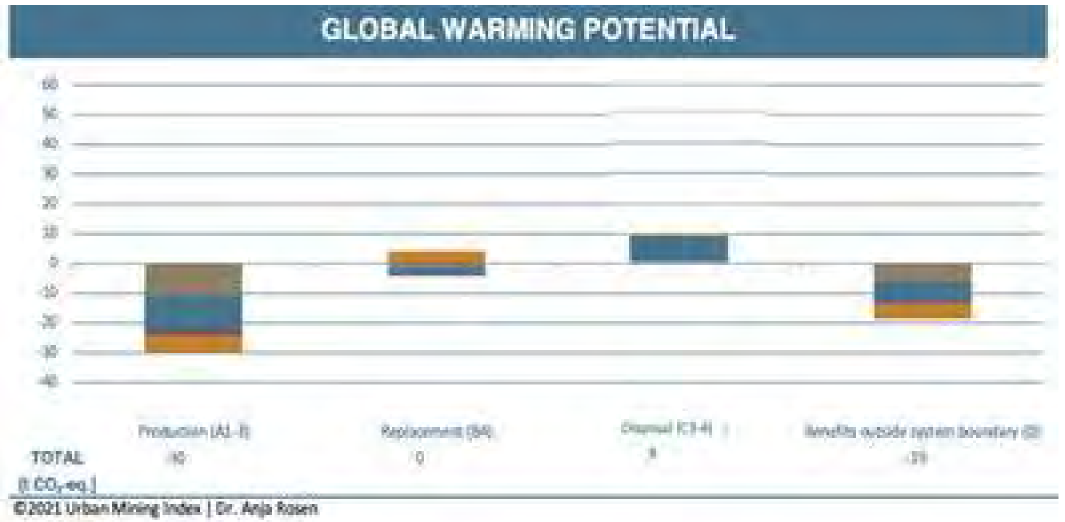


Fig. IV.5. 15. Global Warming Potential building structure, UMI

Urban Mining Index
The above data for the global warming potential within a life cycle of the HDU regarding the structural elements were taken from the Urban Mining Index Tool. The tool evaluates the circularity potential of the main construction elements, taking into account the dismantling possibility and the (closed) loop potential, as well as the return of all materials into the technical or biological cycle. RoofKIT achieves a recycling potential of 101.7 % for the HDU. We have entered the materials for each building component in the UMI tool based on the German database Ökobaudat. For detailed information about the single materials see Appendix AG.
Notes and errors are listed and can be read in Appendix AH.

5.3. Sufficiency, Flexibility & Environmental Performance

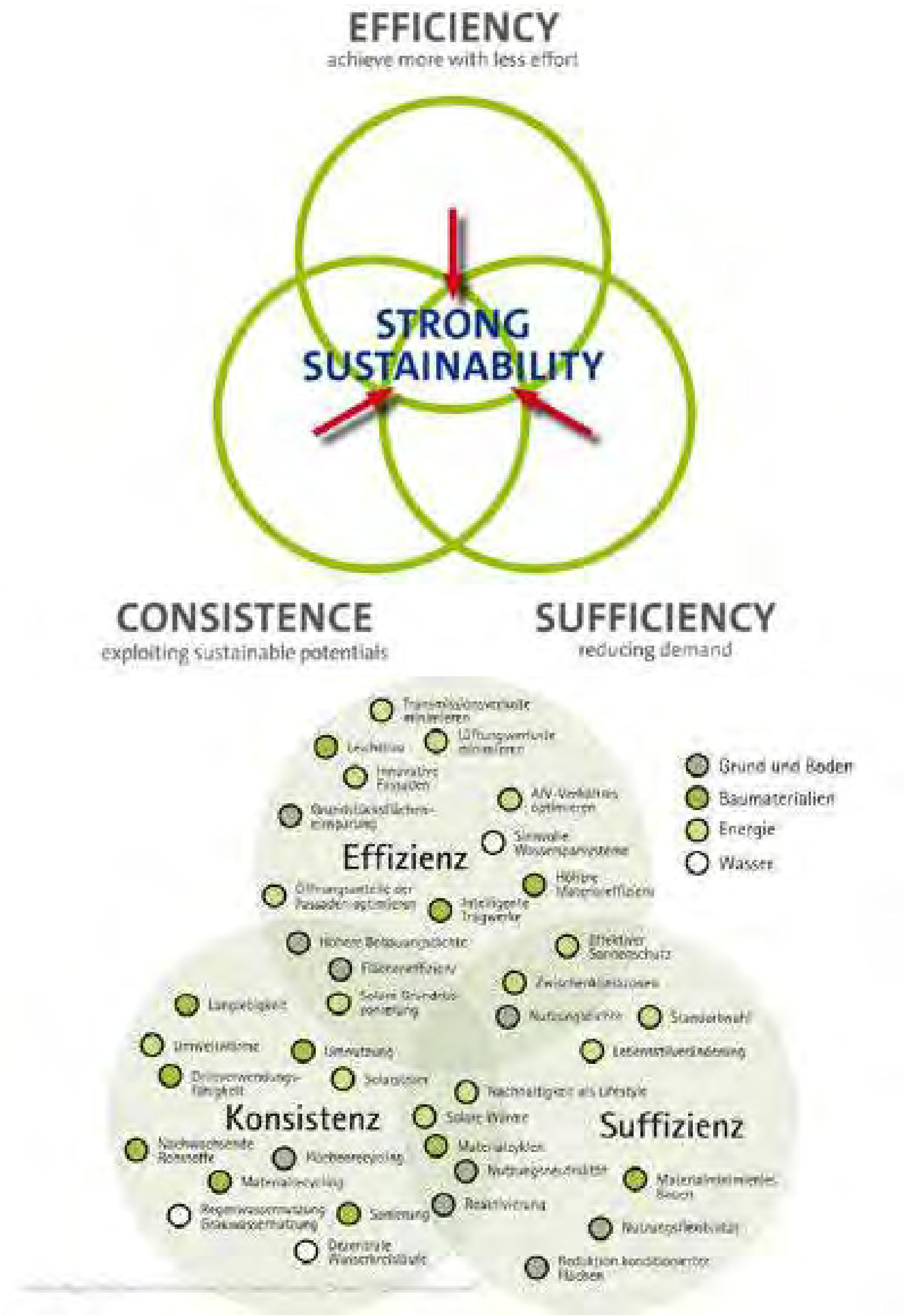


Fig. IV.5. 16. The concept of sufficiency, consistency and efficiency

General introduction: Sufficiency as innovation

In recent decades, the process of building has become increasingly regulated by technical rules and ordinances. The multitude of standards that apply to the building industry are complex and sometimes even contradictory. As a result, construction itself has become harder to manage, which can also lead to mistakes and frustration among all involved. Alongside the strategies of efficiency – making the existing system better – and consistency – changing our actions to bring them in harmony with natural cycles and processes – there

is the strategy of sufficiency, which could also be described as “less”. What at first sounds like imposed austerity and practicing restraint actually means, on the one hand, a return to easily understandable construction processes and specifications (without compromising health and safety), and on the other, employing technical innovation to intelligently leverage existing knowledge to reduce the consumption of resources, i.e. products and materials, and in turn the ecological footprint.

A further aspect is technical simplicity using innovative and intelligent control systems. There are now many examples of this, starting with systems at the scale of the building that employ waste heat from kitchen appliances, work equipment and people. Or intelligent systems that respond pro-actively to changes in the outdoor climate so that heating or cooling systems can adapt slowly in anticipation of changing weather conditions instead of requiring ad-hoc activation with high energy input. Further technological means for sufficiency strategies exist at the component level. For example, light switches that do not need cabling: using a principle similar to a bicycle dynamo, they convert the kinetic energy produced by pressing a switch into an electrical impulse that signals a light to switch on or off. Mobile lighting systems that can be mounted at magnetic docking points make it possible to flexibly meet changing lighting needs without pre-installing all possible lighting points and associated wiring in every room. A similar principle exists for heat pads which once heated centrally can be taken by the user to wherever they happen to be without needing to heat the entire room or section of a building. Wall plaster systems with so-called phase-changing materials can delay heat transfer and thus balance out indoor temperature fluctuations. All these are examples of technological sufficiency strategies.

Alongside technical approaches, one can also put nature’s own inherent sufficiency strategies to intelligent use. Earthen building materials, for example, can be used to regulate indoor humidity levels at thicknesses of 30 mm or more, obviating the need for corresponding technical installations. Some insulation materials are naturally fire retardant and comply with fire regulations without the need for additional chemical impregnations. The reverse is also true: an organic insulation material that must be treated with a carcinogenic substance to meet building regulations is neither intelligent nor sufficient nor sustainable.

Guiding all these construction-related and material-specific considerations should be an intelligent and sustainable design concept that takes account of basic principles such as orientation with respect to the sun for passive solar gain, construction details with suitable overhangs and projections to protect the windows and structure, or structural and construction solutions that distribute the load intelligently so that wall and ceiling thicknesses and reinforcement methods can be kept to a minimum to reduce material consumption. Sustainability through sufficient design is largely the responsibility of the architect and designer, who should examine the available design options before turning to technological problem solvers. This chapter identifies and describes some of these approaches.

5.3.1. Biodiversity

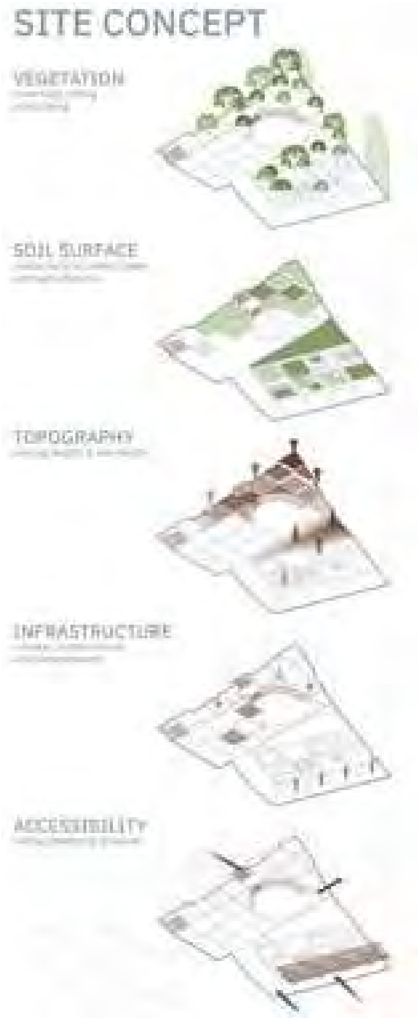


Fig. IV.5. 17. The site concept of RoofKIT

We will re-activate natural loop systems again, by unsealing the garden site, allowing air and water to exchange again with the soil system of the site, including the re-appearance of a diverse flora and fauna. We are restructuring the entire site behind the building by preserving, adding, and growing a variety of elements and vegetation on the site. The existing trees will be retained and supplemented with new plantings. The fire walls on the north side will also be re-vegetated and the walls facing the north site will be made permeable. The existing wall towards Froweinstr. will be partly opened up and complemented by the Mobility-Hub on the east side to frame the site. The Mobility-Hub architecturally frames the site towards the city and is at the same time a prelude, entrance gate, info-point and infrastructure. It offers a range of mobility services that are compatible with the city and forms one of the most important interfaces between the district and the city (For further information see „6. Urban Mobility Report“). On the garden side, there is a compost and storage space for gardening utensils, and the roof with its intensive greening serves as a water filter and water collector, which is then stored in containers directly under the roof and thus provides sufficient pressure for garden irrigation („Fig. 5.17. site concept“).

By choosing a rooftop extension as a construction site, the negative impact on land consumption, terrain adjustment, and surface sealing will be minimized by definition. The new structural elements in the garden, such as the Mobility-Hub, the solar-trees and the new stair tower, touch the ground only selectively and thus minimise the intervention. The excavation resulting from the adjustment of the topography is also minimal, as we orientate ourselves on the original shape of the terrain and abstract it into tiles, which we delimit from each other with Corten steel plates out of the urban mine which also stabilizes the slope and provides visual interest. We encourage diversity of flora

and fauna by creating very different conditions on the site. The upper north of the site towards Froweinstraße will consist of tiles containing wildflowers and allowing free growth of plants. This area will primarily serve as an untouched place and retreat for the free development of flora and fauna. In this way we avoid monocultures, which take nutrients from the soil in a very one-sided way and thus harm it and instead promote a diversity of grasses and plants that otherwise could not develop in the middle of the city and give the diverse fauna existing in our cities a retreat.

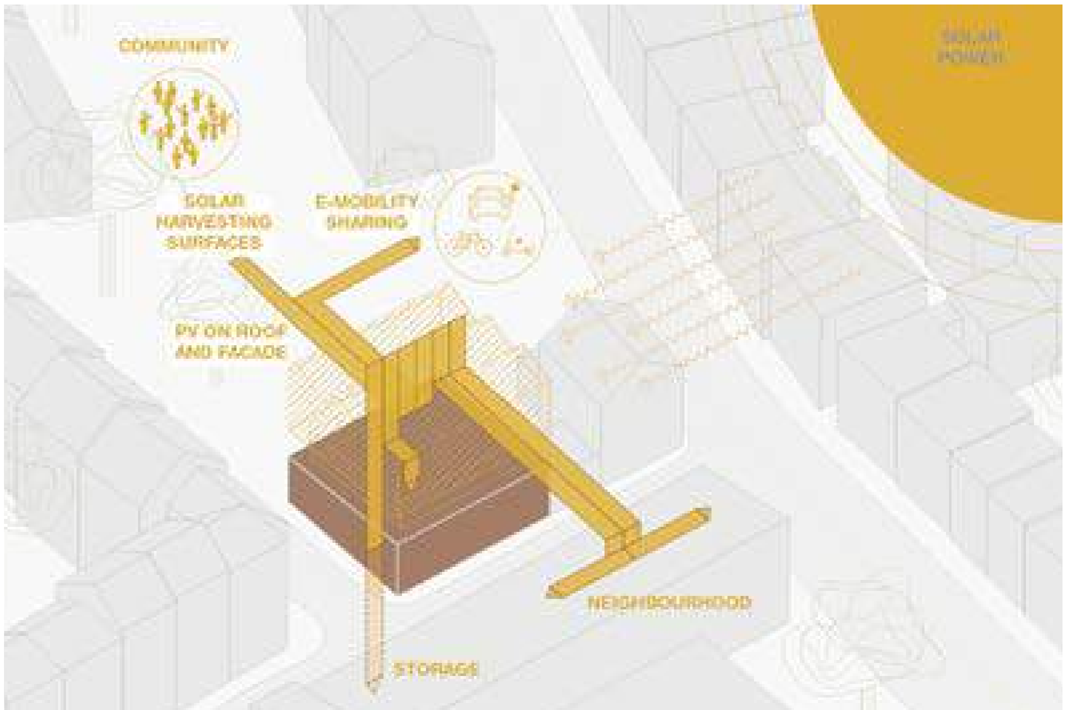


Fig. IV.5. 18. The urban battery concept of RoofKIT

The area under the stairs is suitable for plants that prefer shadier areas, and the firewall to the north, which is to be greened, provides new habitat for insects and birds. Basically, we prefer hardy plants that occur naturally in our latitudes. We also offer a community kitchen garden for the district that follows the principles of permaculture. It is a nascent garden that grows in an ongoing process through the application of fresh humus to the area formerly used as a car park. The humus is made from composted organic waste from Café Ada and the district, and over time a place is created where the coexistence of people, animals and plants is

combined in such a way that the systems function and support each other in permanence. As the garden grows, the people of the neighborhood will also grow together through joint actions and workshops in the context of the garden. By installing nesting boxes for birds and insects on the trees and the green wall in the north we encourage the creation of a small scale ecosystem on site. Shading is provided by the existing trees that have been preserved, the solar tree, which does not bind CO2 like naturally grown trees but can be used for energy production, and the cantilevering roof of the Mobility-Hub. The roof with its intensive greening serves as a water filter and water collector, which is then stored in containers directly under the roof and thus provides sufficient pressure for garden irrigation. („Fig. 5. 19. site concept: water”).

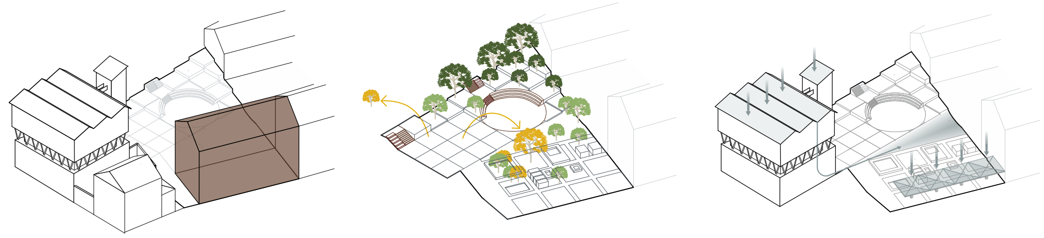


Fig. IV.5. 19. Trees, water and future potential analysis

The lighting varies across the site. So, there is none to very little in places to provide a natural retreat for the animals, like towards Froweinstr. At the upper northern edge of the property. In this way, we reduce the areas in the city that are unsuitable as habitats for animals due to high light pollution. At the Mobility-Hub and especially at the outdoor space of Café Ada and the amphitheater, lighting is of course important and available accordingly as part of stelae in the grid of the square design, which serve as a multifunctional modular technical and interconnected infrastructure. They offer possibilities for lighting, sound, evaporative cooling, mounting of various devices such as sun sails, canvas walls, movie screens, playground equipment, art installations and technical devices such as beamers, wifi, 5G, diverse sensors, etc. These stelae are also to be installed in the district and will replace the former streetlights. The lighting concept for the exterior of the HDU corresponds to these principles. We only illuminate the necessary traffic routes, the access to the lift and the stairs with the terrace. The HDU is not illuminated from the outside to avoid light emissions. Instead, the framework is backlit so that the light contrast emphasises the architecture. In addition, there are seating stools in the outdoor space that illuminate the ground directly below them. This keeps the light close to the ground so that the surroundings are not unnecessarily illuminated and insects are not disturbed.

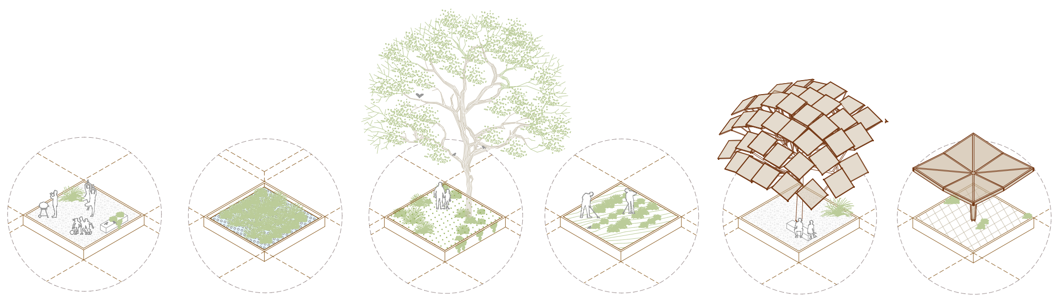


Fig. IV.5. 20. Urban environmental interaction elements

A swale infiltration is planned on site as the lowest point of the topography between the square of Cafe Ada with the Amphitheater and the garden which will be vegetized with grasses as natural filter to purify water before it seeps into the ground. It catches the excess rainwater runoff from the site and the building roof and filters it through layers of soil and recycled concrete.

In addition to preserving the existing trees and planting new ones on the site, the neighborhood streets are also to be made greener and more spaces in the neighborhood are to be unsealed („Fig. 5. 21. analysis of possible new public

green“). Among other things, parking spaces, which are generally reduced and often interrupt the perimeter development in the neighborhood, can be used for this purpose and new trees can provide extra shade on these lots (for further information see „6. Urban Mobility Report“).

Fig. IV.5. 21. Analysis of potential new public green

5.3.2. Society

Sufficiency: The housing typology is developed according to the principles of sufficiency. On the one hand, a basic construction that is as neutral as possible will allow for maximum flexibility in the conversion or further use of the new part of the building. The central shaft in the residential modules, in which the installations are bundled, allows the flexible redesign of the common areas. For our project, we want to invite the huge diversity of the existing population structure in the Mirke neighborhood into our building, since we see it as one of the great strengths of the district. We want to bring together this mix of old and young, single people and families, and different social classes and cultural groups. „Fig. 5. 22. target groups and schedules“ shows how the people described meet and how their different life rhythms and schedules work in our design. As a result, we classified the target groups to take a closer look at their needs to be met in our addition. (for further information see „3. Affordability and Viability Report“). With our addition we want to reduce the individual living space consumption in an innovative living concept to be able to accommodate more people of diverse needs, while interacting with the lively, culturally diverse neighborhood. This we want to achieve by designing barrier free and inclusive spaces with both private flats and common spaces for the inhabitants, as well as public spaces that invite the public from Wuppertal and beyond to counteract social isolation and evoke a feeling of belonging.

Construction wise, our design will respond to the lack of funds and the poor quality of housing with Urban Mining, modular construction and an innovative funding plan and react upon the problem of gentrification.

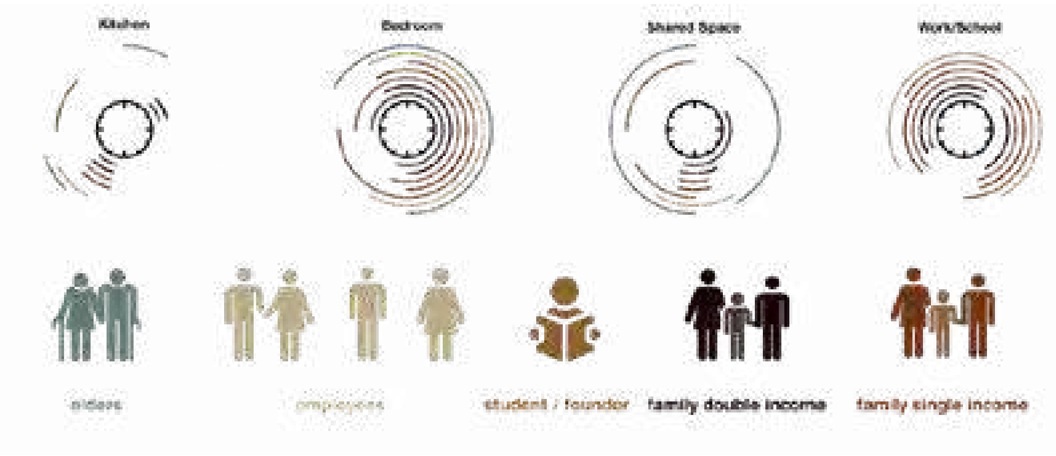


Fig. IV.5. 22. target groups and occupation schedule

Community: Our over-all project as a roof top-up of Café Ada encourages the residents to support each other and at the same time represents our society as a whole. Each tenant or family has a small private apartment in the size of 1 to 3 rooms equipped with all basic needs and access to big shared communal spaces, such as a big community kitchen in the north with garden view and small communal spaces alongside the east, south and west facades, such as a library, a workshop, a laundry café, a sound lounge and a billiard lounge. The two storeys are interconnected by a big atrium, which offers a multifunctional room in the middle for communal events. All the communal areas and some of the apartments are barrier-free. Through the sharing concept in the common area, we make uses accessible to many residents that they would otherwise not have or not at this price. At the same time, resources are used more efficiently. An example is the washing machine: appointments are booked by the residents, who then only pay for the use during this period. This is much more efficient and resource-saving than several small households each buying their own machine.

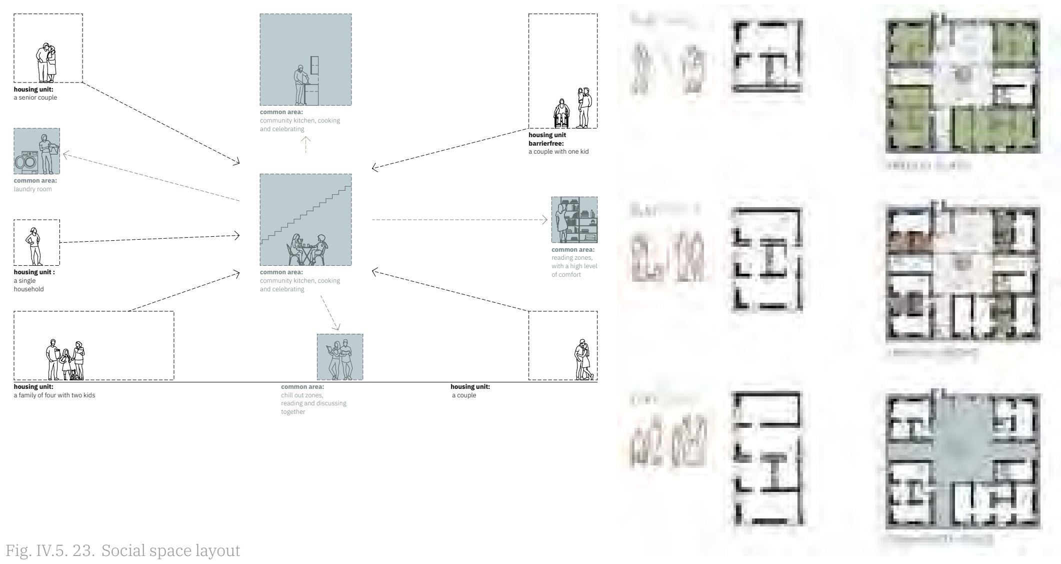


Fig. IV.5. 23. Social space layout

Flexibility: The flexibility of the project helps to stay comfortable in our project even if living conditions and needs change. Our floor plan is designed in the way, that the inhabitants could grow old in our building: They would start off in a 1-room-apartment as a single, move with a partner in the 2-room-apartment,

found a family in the 3 or 4-room-apartment and retire in a barrier free apartment. This results in mixed generations community, which can profit in many ways from itself, by for example the possibility to take care of children and elders. Flexible, multifunctional, and more tailored furniture will be explored more in the process to maximize the space saving potential of both, the private modules, as well as in the communal spaces. This principle of a cluster apartment offers the inhabitants both, an independent apartment to retreat and access to big rooms. In this way, the residents can take part and host bigger communal events, while still having privacy. The modules also have great advantages for sound insulation due to possibility to dampen noise by placing rubber plates between the individual modules.

Fig. IV.5. 24. Sound insulation mycelium boards

The new wooden trusses rest on decoupling bearings as well and acoustic panels out of the regrowing mycelium are also installed in the dance hall („Fig. 5. 24. sound insulation mycelium“), so that the rooms of the entire extension are soundproofed, and the residential modules can function as quiet retreats. For the demonstration unit we follow the same concept of a complete flexible floor plan. Instead of given determined layout by a room structure, we introduce a flexible space around a core element, that can be arranged and changed as wished for. The bed is a flexible entity as well and can be adjusted to persons and needs. During the day, it serves as a sofa, while at night, when it is pulled out, it becomes the desired resting location. The kitchen is also planned flexibly. When extended, it creates a pleasant cooking area, while the living space expands when the kitchen is closed. In this way, the living space can adapt to the respective use and no space is wasted.

On the site, we have established a similar flexible system of stelae in the grid of the square design, which serve as a multifunctional modular technical and interconnected infrastructure reflecting the diversity of usage scenarios. The community kitchen garden as it grows will also adapt and reflect the needs and desires of the community. Our program seeks to incorporate different public functions together with our program of living in the top of the addition by creating attractive meeting points indoors and outdoors that welcome the diverse neighborhood of Mirke and beyond.

Design for all: Above all, the higher quality of stay in and around Café Ada is reached through its refurbishment. It is now all barrier-free and wheelchair accessible. For visually impaired persons, there are indications for the floor on the handrailing of the staircase in braille and high contrast signs for orientation distributed throughout the addition, as well as a place for diaper changing in the public bathrooms. To contribute to the sustainability thought of the overall addition and counteract to the short opening hours, it can become a place for preparation and education for sustainable food management by offering midday meals made from scraps from the neighborhood and crops grown in their own garden and a location for food sharing.

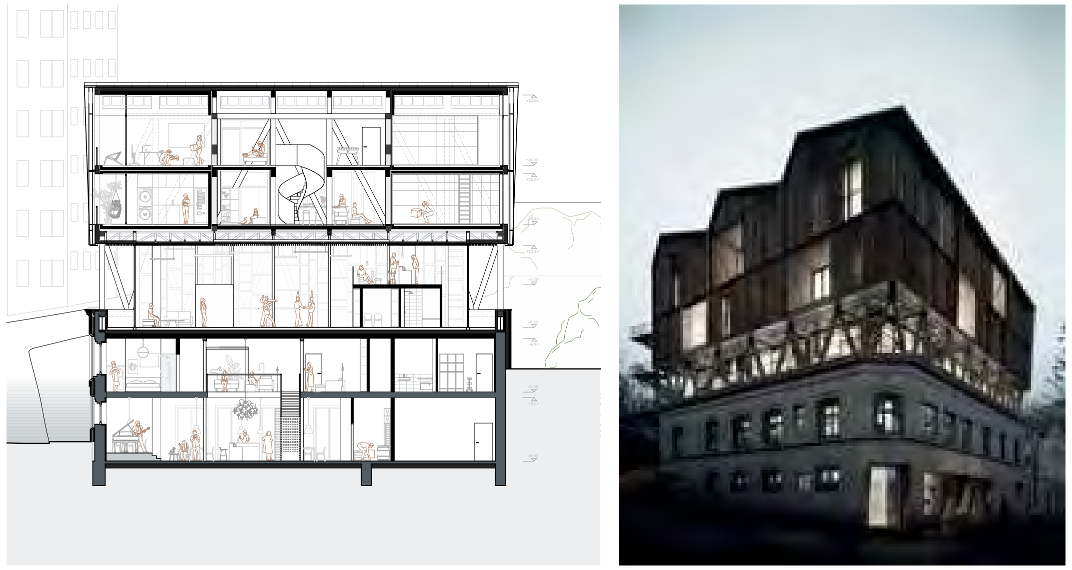


Fig. IV.5. 25. RoofKIT – a space for all

5.3.3. Climate

Fig. IV.5. 26. Ceramic tile chipping

Avoiding heat islands: Increasing challenges to equip buildings for the consequences of climate change are primarily met with a strategy of influencing the micro-climate on the site as positively as possible. Paths are made of recycled ceramic chippings, reflecting most of the radiation back to space („Fig. 5. 26. ceramic chippings“).

Water absorption: According to the Sponge City principle, water should be able to percolate where it occurs. On site, the garden area in the north will be de-sealed to allow rain water to enter the upper and lower soils again. We use different types of paving that allow for this. In this way, we reduce the risk of a falling groundwater table while allowing evaporation of the soils cooling the micro system of the neighborhood. Shading is provided by additional greens, trees and solar structures. Additionally, by swale infiltration, off-running rainwater from the roofs and the square is collected and given back to the soils or together with the buildings grey water is used to water the plants.

Water recycling: The usage of rainwater and grey water will allow us to save drinking water by using it for flushing of the toilets and the usage in washing machines. Potable water will also get saved by the implementation of separation toilets. These separate yellow water from black water. In this way, valuable nutrients can get collected and used for agriculture and gardening, instead of being flushed away and less energy will be needed on the side of the purification plant. Future plans also include the treatment of greywater by plants with phyto purification, which consists of a basin filled with gravel of different sizes and reeds. By the nature of the roots and the reeds, this system contains bacteria that are capable of clearing water of decomposing organic matter and mineralizing phosporus and nitrogens.

Shade and oxygen: Part of the site is shaded by the Mobility-Hub, the Solar structures and different trees, as well as the building itself. This creates shaded retreats for the residents of the neighborhood during the summer months. In addition, the trees and vegetation put in place by the design produces oxygen and helps to increase the air quality for all inhabitants of the Mirke quarter.

Thermal mass: To ensure that the temperature inside the building does not correspond to the often short-term fluctuations of the temperature outside, we need thermal mass. In the existing building, we achieve this by installing a new brick formwork in front of the old one and a new insulation. In the extension, we install phase change material in the dance hall of the urban gap performance space, among other places. There we put PCM panels on the acoustic panels, which, when they have thawed, i.e., absorbed heat, can simply be replaced, or removed and cooled. Alternatively, we cool them via night ventilation. In addition, at the transition between the existing and the new building, i.e., in the ceiling between the first floor of the existing building and the urban gap, a double layered plasterboard is installed below the trusses. With these plasterboards, we increase the thermal mass here as well. All these measures are meant to avoid any air conditioners and other technical means to make our future buildings simply intelligent by choice of design and materials and not by even more complicated technology.

5.3.4. Durability

Maximization of the building’s lifespan is one of the goals. As referred also in the other sub-issues that will be a result of the combination of low-maintenance structures, neutral, flexible ground-floor designs, easy-to-repair construction methods, and durable materials. The flexible floor plans of the residential modules in the building design, which can be adapted to the needs of the residents (see „5.3.2. Society“), enables better use of the building over its entire lifetime, as the living area can always be adapted to the new needs of the residents. By using the Urban Gap performance space concept, we also avoid vacancies here and use the space efficiently. Workshops, exhibitions, and co-working can take place here in the mornings. In the evening, there is space for dance events. In particular, the simple replacement of individual modules can optimize the lifetime because the changing needs of future societies can be addressed. In our project, we therefore enable simple renovation and conversion.

For the Demonstration Unit, we adapt these concepts. The floor plan represents a solution for a flat for one to two people in the competition but can easily be converted into an office. The modular construction of the living spaces enables cheaper production through multiple fabrications of a module. In addition, the construction and dismantling are very simple, so that at the end of the life cycle the building can be easily deconstructed. The slats that form the façade in the over-all design also benefit from the detachable construction. They are made of glass, partly covered with solar modules and partly colored. They can be easily replaced if they have to. Alternatively, they can be removed individually, repaired, and reinserted.

This reduces maintenance costs in our over-all building design. The sheet metal façade behind the slats provides an extremely durable and maintenance free weather protection for the construction underneath and can be reused without any complex modification. Maintenance of technical installations is also important for the durability of a building. For this reason, the pipes in the technical core in the middle of the demonstration unit are open so that they are easily accessible. Other equipment for energy supply, such as the heat pump or the buffer tank, are also easily accessible and can therefore be replaced in parts or completely (for further information see„5.2. Circularity“).

Basically, we assume that the surfaces in the interior have the shortest life span. That is why we have chosen materials that are particularly durable and easy to repair or replace. The surfaces of the walls are covered with clay plaster. This can be easily refreshed by moistening. If a different color should be desired over the years, the top plaster can be removed and applied in a new shade. The old clay can be used elsewhere with the same quality. The wooden planks on the floor can easily be sanded down if that is desired. However, we do not recommend varnishing to future users, as this would destroy the idea of an intact circular system as explained above. All materials taken out of the technical cycle, such as the kitchen panels produced from former yoghurt cups, are chosen in the light of durability and the absents from any toxic pollutants. The yoghurt panels are easy to recycle and particularly easy to process (similar to wood). These concepts apply to the HDU as well as to the overall building design. All materials are described in detail in the “Architectural Report”.

For the supporting structure, care is taken to ensure that the connections between the modules are reversible, so that the House Demonstration Unit can be disassembled after the assembly period on the Solar Campus and reassembled in Karlsruhe for further use. See “5.2. Circularity”.

From an **economic perspective**, circular principles are opening up new business models that are beginning to disrupt prevailing linear material flows. For example, companies are beginning to switch from selling their products to charging only for their use. After their service life, the materials (which are designed to be easily retrieved) are returned to the companies’ own production cycles. Through far-sighted design and assembly, the product becomes a future source of raw materials. By leveraging circular economy principles, these companies develop new know-how and new technologies and market these innovations. In this change of thinking lies an enormous opportunity to revolutionise the construction sector as well as to open up and develop completely new business areas. The development of new construction principles therefore represents the technological basis for enabling the circular extraction of raw materials.

Converting the building sector to operate according to circular construction principles requires a radical rethinking of the way resources are managed in the construction industry and the built environment. Similar to warehousing, buildings, cities and regions will have to keep track and anticipate the stocks and flows of materials. The goal must be an inventory that documents and communicates (at the right moment) which materials in what quantities and qualities become available for re-use or recycling where and at what time in the future. This has major implications for the design and construction process, for supply and value chains within the construction industry, and for data capture and management, and these are currently the focus of various global research initiatives.

To understand material flows and enable their incorporation into closed cycles, circular construction requires detailed datasets, and it is from this that the concept of material passports has emerged. Broadly speaking, a materials passport is a digital record of all materials, components and products used in a building, including detailed information on quantities, qualities, dimensions and positions of all materials. In addition to such thorough documentation at the level of the individual building, a further prerequisite for circular resource management at a regional level lies in the standardisation and registration of such passports on a central platform or in official cadastral plans.

5.3.5. Building Materials

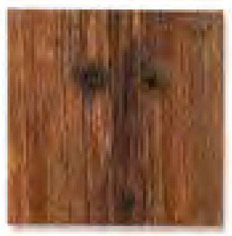
Beyond that RoofKIT holds the carbon dioxide emission caused by transportation low using local materials. The entire demonstration unit will be prefabricated in a factory in Vorarlberg, Austria (Kaufmann Zimmerei und Tischlerei). There only wood (European ash, spruce) from certified, sustainable forestry from the surrounding area will be used, so that the transportation routes for the wood material remain at a minimum level. The clay boards and plasters come from a company located in Austria (Claytec) as well as the PVT cells from Dornbirn, Austria. Thus, almost all the used building materials and fixtures originate from Southern Germany or neighboring alpine countries, where the final destination of the HDU will also be located - Karlsruhe.

Here, a small selection of the special circular materials used in the RoofKIT unit are listed and described:

Spruce: The used spruce wood in the HDU is 100% certified grown and free of any glues, protectives, or other chemical components.
Origin of the product: Bregenzer Wald, Austria
Toxicity: none
Mono Materiality: yes – fully biological

European Ash: The used ash wood in the HDU is 100% certified grown and free of any glues, protectives, or other chemical components.
Origin of the product: Bregenzer Wald, Austria
Toxicity: none
Mono Materiality: yes – fully biological

ALBA, Smile Plastics: The material is made from the humble kitchen cast-off, yoghurt pot. It is 100% recycled and 100% recyclable and shows no VOC off-gassing. With its white, marble-like surface and hints of gold and silver, Alba is used in the project for the kitchen area and bathroom doors.
Origin of the product: London, UK (in absence of a local provider)
Toxicity: none
Mono Materiality: yes



Used Wood: all used wood in the unit comes from sources supplied by RESTADO, the biggest used construction material platform in Germany. The wood coming from old barns and sheds is cleaned and brushed and wherever needed re-cut and shaped to its new use in the project.
Origin of the product: Southern Germany, provided through RESTADO
Toxicity: none
Mono Materiality: yes – fully biological

MAGNA GLASCERAMICS: the material is produced out of broken glass pieces coming either directly from the production line or glass containers. It can be ordered in different colors as well as surface characteristics. RoofKIT uses it as a cladding wall element in the toilet space and shower.
Origin of the product: Teutschenthal, Germany
Toxicity: none
Mono Materiality: yes

TECU copper roofing material: TECU products are solely made from scrap metal and production scrap – with all the economic and ecological advantages. Copper can be endlessly reused without any loss of quality. Copper refining at KME enables the complete removal of any impurities. This is an advantage over aluminum, for example, whose alloy, composite and coating components are rather difficult to remove. The complete roof is cladded with TECU products.
Origin of the product: Osnabrück, Germany
Toxicity: none
Mono Materiality: yes

CLAYTECH: All claytech materials are 100% natural and therefore endlessly recyclable in the biological realm. RoofKIT uses clay plasters as well as clay boards for its outer envelope construction to enhance the air quality (humidity exchange, removal of possible air impurities) and increase the thermal mass in the building.
Origin of the product: Mörtschach, Österreich
Toxicity: none
Mono Materiality: yes – fully biological

ECOR: the product is born out of the waste conversion process. Using only recycled water, heat and pressure, ECOR is a 100% natural product. Locally sourced raw biological materials are pulped into usable fibers, dispersed in water, dewatered to create a slurry, then passed between two metal plates in a hot press. A rough fiber mat is created that ultimately becomes a finished ECOR panel. RoofKIT uses the panels as a substructure

for all felt surfaces.
Origin of the product: Venlo, The Netherlands (in absence of a local provider)
Toxicity: none
Mono Materiality: yes – fully biological

NEPTUTHERM: RoofKIt uses a 100% biological insulation material, which consist out of seagrass only, rolled by the wind into small balls. It needs no agricultural land, no watering, no fertilization and no other treatment. No chemical or synthetic additions are used to provide this natural insulation material. RoofKIT uses it in its complete outer envelope.
Origin of the product: Karlsruhe, Germany
Toxicity: none
Mono Materiality: yes – fully biological

MYCELIUM: Coming from our own research, mycelium bound panels are shown in the unit to demonstrate that already today synthetic glues can be overcome focusing more on nature´s own techniques combining biological materials only. The material is 100% compostable.
Origin of the product: Karlsruhe, Germany
Toxicity: none
Mono Materiality: yes – fully biological

XYHLO BIOFINISH: The product is a fully biological and consistent wood protection application. Introducing an organic, protective and self-healing membrane to the wood through a base coating consisting of natural oils and a second layer of a living biological fungal material, it allows wood to experience a long lasting protection without the application of synthetic or toxic materials.
Origin of the product: Devender, Niederlande
Toxicity: none
Mono Materiality: yes – fully biological

STONECYCLING: Stonecycling products are made by more than 90% out of construction rubble. With small amounts of added clay, they are re-burned on much lower temperatures as a new fired brick and according to color and texture, different variations exist in the market. They are 100% recyclable or reusable, as we lay them in a sand bed only without any cementous materials. RoofKIT uses Stonecycling bricks for the outside pavements in front and below the unit.
Origin of the product: Amsterdam, Niederlande (in absence of a local provider)
Toxicity: none
Mono Materiality: yes

M&K FILZE: RoofKIT is using a 100% biological wool felt from M&K Filze for all ceiling and outer core surfaces. No synthetic additives are given into the production, making it a 100% compostable material.
Origin of the product: Spalt, Germany
Toxicity: none
Mono Materiality: yes – fully biological

FREITAG: used truck canvas: FREITAG is a well-known company based in Zürich, producing every day products out of used truck canvas. FREITG provides RoofKIT with such canvas to clad the eastern and northern façade of the unit, scrapped over wooden frames.
Origin of the product: Zürich, Switzerland
Toxicity: could contain traces of VOC (only placed a s an outside temporary façade)
Mono Materiality: yes

6. Urban Mobility Report

6.1 City Level

6.1.1. Analysis

The city of Wuppertal extends along the river Wupper. Wuppertal's hilly topographical urban area is widely sustained according to the flowing structure and the river valley. The city's present form exists since 1929, when the cities Barmen and Elberfeld with some other settlements united to Wuppertal. Divided into 10 main urban districts which are further composed of smaller quarters and areas the city of Wuppertal is a real patchwork of different urban and social structures. Due to the limiting topography that shapes the urban area of the city of Wuppertal, traffic management is based on simplicity. Three main motorways are crossing the city: the A46, the A1 and the A535. The motorways are accompanied by a system of federal and inner-city roads connecting the districts and leading to the individual quarters. Furthermore, the different districts of Wuppertal are interconnected by public transport offers such as several bus and tram lines as well the famous "Schwebebahn" which are connected to the Wuppertal main station and the main railway traffic of the Federal Republic of Germany. The "Schwebebahn" itself was built directly above the river Wupper and connects the different parts of Wuppertal from Oberbarmen in the east to Vohwinkel in the far west of the city.

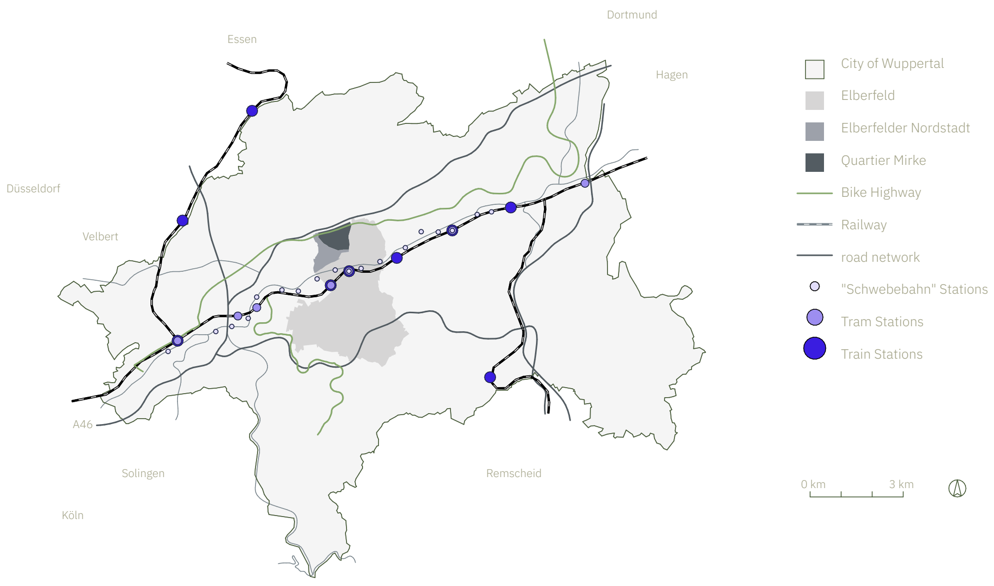


Fig. IV.6. 1. Today's Traffic Wuppertal

While the "Schwebebahn" covers the inner City following the river Wupper, the public transport system is complemented by the tram with its three lines (S7, S8 and S9). The tram is lead apart from the streets and has its own stops at smaller tram stations. Given the rail-based transport serving mainly the east-west connections, the north-south connections are run by buses.
Compared to the national average motorization rate of 450 cars per 1000

inhabitants, the average for the city of Wuppertal is lower, with about 420 cars per 1000 inhabitants. Regarding the Federal Environment Agency's target for more sustainable mobility of 150 cars per 1000 inhabitants, this development will represent a great challenge for the city of Wuppertal within the following years. The increasing number of residents in the neighborhood also increases the number of motor vehicles, creating conflicts with pedestrians and cyclists.
No changes

6.1.2. Vision

Like many cities, Wuppertal, rebuilt after 2nd World War as a car friendly city, faces different challenges, and must transform itself to remain a place worth living in future. Our main objective for the future is the transformation from a mainly individual transportation based on owned cars, to a mainly collective system with an easy and broad accessibility, that benefits everyone. That will lead to some significant changes in the field of mobility. We plan to implement a cable car connection between the residential district Uellendahl in the north and the main station in the city center. The line can optionally be extended to the university campus in the south creating a high performance north-south connection and avoiding street traffic in hilly and steep situations. By enhancing the public transport and lessen the attractiveness of motorized individual transport, cars will no longer dominate the city. Instead, public transport will be the main mean of transport and available on high frequencies. Due to the implementation of the cable car line some of the buses connecting the north with the south can be reduced in their frequency. The biggest advantage of cable cars, tram and buses is the proportion of large number of passengers compared to the required energetic resources. The 3S cable car model of Dopplemayr is able to transport up to 5.500 passengers per hour and direction[1].
The connection of important points, such as tram and bus stops with mobility hubs will establish a network of different types of transport. Long-distance transportation, like public busses, shared cars, and cable cars, will be linked to a network of bikes, scooters, and autonomous minibuses for the short distances. This allows an optimal change between the different means of transport. A transformation of the streets will prioritize pedestrians and bikers. At the moment streets are divided in a strip of sidewalk for pedestrians, a lane for parking, and a two-lane system of active traffic. The pavements are often not lowered and blocked by parked vehicles and rubbish bins. Due to marginal individual car traffic, most parking lots will become redundant, and it will be possible to reduce the pavement of the streets. The space gained will be used for pedestrian sidewalks and bike lanes.
Most of the individual parking lots along the streets will be repurposed to community spaces. By slowing down traffic to 30 km/h all over the inner city and adding vegetation and outdoor furniture the amenity values of the streets raise. Different materials characterize the space for pedestrians and bikes and emphasize the prioritization. Clearly marked paths improve the safety for cyclists and other road users. We reclaim the street as a place for appropriation and for personal and collective use.

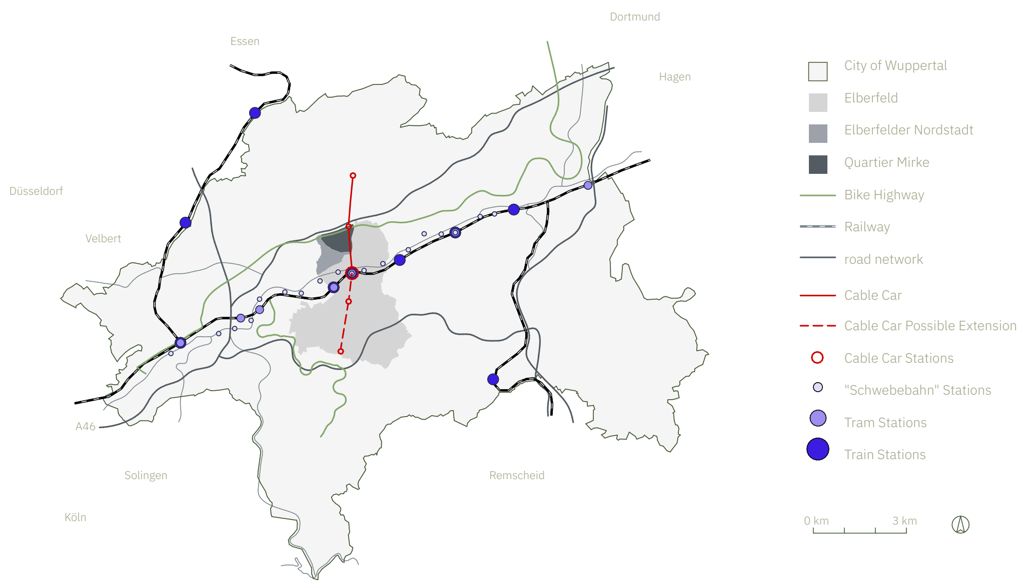


Fig. IV.6. 2. Vision Traffic Wuppertal

Fig. IV.6. 3. Topography cable car way; source: google earth, P.Zeile

6.1.2.1. Ecology

The rate of green and open spaces in Wuppertal is low and soil sealing is very high at 50-80% [2]. By unsealing parking lots, rain water can be absorbed and stored locally according to the principle of the sponge city. This enhances the stormwater management in the city, prevents flooding and improves the urban climate by promoting the health of urban trees. That topic will be of increasing urgency, as the devastating flood events in North Rhine-Westphalia in summer 2021 has shown. The city of Wuppertal was also directly and widely affected by the heavy rains. [3]

Green spots contribute simultaneously to the cooling of the city in hot summer months (For further information see 5. Sustainability). To establish a green network, we are connecting the shared green community spaces within the district and the surrounding districts via footpaths or shared spaces. Different gardens, parks and squares link not only on a spatial but also on a social level.

Analogue to our site concept a system of different designed and used tiles can be implemented. Depending on adjoining neighborhood and requirement, areas for sports, urban farming or recreation enhance the Mirke quarter. The community gardens make an important contribution to social interaction. They allow to live in a sustainable way and in a natural environment. We imagine a place of sharing and interaction where the inhabitants of this housing block can meet and exchange their know-how on building things, gardening, planting, and cultivating. (For further information see 1. Architecture Design Report).

Fig. IV.6. 4. Analysis of possible New Public Green - BD-00.4.16 6.15

6.1.2.2. Social

The behavior in public spaces is changing, due to the way we use vehicles. Streets are a public space used for socialization, trade, and education. The progressing towards such a space can be accomplished by reorganizing and reorienting the streets towards the pedestrians and soft mobility. Nonetheless, certain situations, such as deliveries, still require the use of cars. Various programs, such as car and bike sharing are promoting social interaction and raise environmental awareness. According to the ADEME (Agency for Environment and Urbanism) one shared vehicle can replace 10 personal ones, thus liberating 9 parking spots. Mutualization, which means a shared resource management of equipment, know how etc. promotes a collective way of living. The grouping of resources strengthens social inclusion and brings advantages in various other fields. We achieve a reduction of carbon dioxide and raise the awareness for energy due to the involvement and engagement of the residents

6.1.2.3. Energy

Today, electrical vehicles are one solution to fight air and noise pollution produced by regular fueled-motorized vehicles. Our electric driven public transport as well as the shared car fleet need to be charged. Charging points for e-mobility form the basis for a network we want to establish in the city. We are expanding the existing range to achieve comprehensive, area-wide parking and recharging facilities (decentralized energy generation). Power generators and consumers form an interplay on different scales. A smart grid bundles them for a more efficient energy supply. In addition to solar systems on roofs and facades, solar paths can also contribute to power generation. The vehicle fleet serves as a mobile energy storage and through intelligent control of energy distribution, residents are given the opportunity to adjust their usage behavior according to current prices and demand. Demand Side Management (possibly real-time pricing) improves load distribution and eliminates the need for peak load power plants.

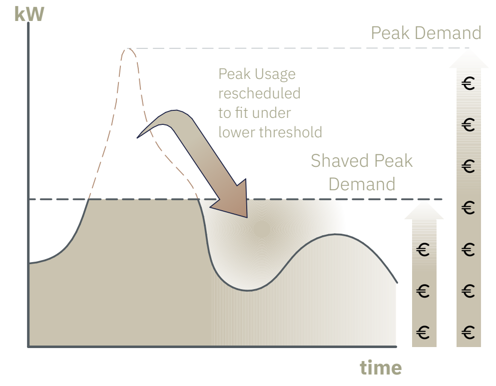


Fig. IV.6. 5. Demand-Side-Management

Wuppertal is already using hydrogen-powered buses as part of its innovative local transport system. This future-oriented driving force contributes to a reduction of the carbon footprint.

6.2. District Level

6.2.1. Analysis

The Mirke quarter, surrounding our site location, is situated in the north-eastern part of the Nordstadt, a district in the middle of the city of Wuppertal near the northern shoreline of the river. The Nordstadt district is formed by the Mirke quarter and the adjacent Ölberg quarter. In recent years each of the quarters established its social structure, neighborhood, and urban environment. The Mirke district is bounded by the motorway A46 in the North, street Gathe in the East and the Karlstraße and Hochstraße in the South and the West. This geographical situation combined with the high traffic flow results in certain isolation and inward-looking situations for the people inhabiting the quarter. Besides that, the Mirke quarter consists of extremely dense urban areas. Because of high proportions of traffic routes, industrial and commercial spaces, the level of soil sealing is very high and the search of open spaces, green or forested areas inside the quarter is mostly unsuccessful. Furthermore, this high traffic and the big streets are framing and confining the quarter, which impede the extension of new public green spaces. The accessibility of existing green spaces becomes more difficult by A46, Gathe and Karlstraße. The topography within the Mirke quarter is characterized by the constantly sloping hill towards the Wupper shore leading to road gradients of up to 10%. The narrow spaces between the buildings which are often organized as one-way-roads show a

deficit of car parking spaces. The street network in the neighborhood consists mainly of hanging streets.[4] Those enable a high permeability.

6.2.1.1 Social

Many people in the Mirke quarter are already actively driving the movement of the turn to a new mobility culture. The participation of more and more people inhabiting the quarter is inevitable for the successful development of the movement. The Mirke inhabitants will gradually become enthusiastic supporters and users of a future-oriented mobility concept. Thus, the Mirke quarter aims to persuade sustainers of their idea on the political level with their initiative “Utopiastadt”.[5]

Long before these progressive actions driven by the inhabitants themselves the Mirke quarter has been a district of textile workers who were working for the big textile companies of Elberfeld. A network of factories supplying these companies was developing on this conveniently situated area around the Mirke railway station. Close by there is also the former gas station “Hebebühne”, which hosts art and culture events on a regular basis. The Southeastern part of the Mirke quarter is characterized by a high density of buildings with predominantly four or five storeys. Some of the buildings are renovated but the quality of inhabiting them is to a large extent decreasing or already on a low level. The Northeastern part offers the most attractive living area in the northern Nordstadt district. The buildings date back to the so called “Gründerzeit” and are mostly renovated and of high substantial quality. Several facades in the calm neighborhood are sophisticatedly and artistically designed because of the short distance to the former meaningful Mirke railway station in the Western part of the Mirke district, a mixture of simple quality buildings from late 19th century and bigger blocks from a later period are noticeable. As the streets are designed without any trees or other plants in that area, some green paths and playgrounds are hiding in the backyards of the buildings.[6] Additionally, the old factory building “Gold-Zack-Werke AG” can be found here. It is an industrial monument of the Wuppertal textile industry, which now houses the bouldering hall and café “Bahnhof Blo” and a passementerie museum (a pre-industrial trade from the 17th to 19th century). Besides the green backyards in the northern and western parts of the Mirke quarter, the graveyard in the west provides some green area. In general, a real lack of usable green spaces can be observed. Additionally, the high traffic flow on some of the main streets crossing through the quarter such as the Karlstraße or the Hochstraße creates a physical and mental barrier out of urban squares of high potential like the Karlsplatz. Though the Hochstraße has an important function for the Mirke quarter. It is characterized by small retail trade businesses and simple gastronomy services to provide and secure the local supply for the inhabitants of the quarter. Other small trade companies are spread throughout the quarter, particularly on the Friedrichstraße and the Wiesenstraße, as well as in some of the appealing green backyards. The population of the Mirke district can be described as a melting pot of different cultures, generations, and educational status. The district´s ever rising migrant population has a strong influence on the neighborhood. In general, the level of education is below average and most part of the population is very reliant on unemployment benefits. Mirke offers a lot of charitable services, such as comprehensive services for the youth, integration, and violence reduction, offered by both, state, church and self-organized migrant groups. Accordingly, Mirke is a quite attractive first point of arrival for migrants. However, there is a huge influx of young people and artists with high educational qualifications and high average income, which results in rising rents.[7] While transforming the district of Mirke it should be the interest of the city of Wuppertal to provide sustainable and affordable living space for all, those who already live there and those who will move to Mirke. That could be done by laws regulating the housing market and the rents in the district.

6.2.1.2. Mobility Situation Today Mirke

The public transport offer in the Mirke quarter provides a connection between the quarter and the city center as well as the main station. There are 17 bus stops in a total spread in the quarter and five bus lines running periodically as well as additional vehicles ensuring the offer at night. During the rush hour, they arrive and leave in a frequency of 20 minutes (3/h) from and to the main railway station, which is accessible by an about 11 minutes bus ride or 6 minutes by bike. Mirke is a neighborhood easily accessible by bus. Three bus stops are in the immediate surrounding of Café Ada (Line 620 - Wiesenstrasse, Different day and Night Lines - Schleswiger Strasse and Ludwigstrasse). The next Schwebebahn station is at Wuppertal main station. From Café ADA the center of Elberfeld is reachable within 11 minutes, the center of Barmen in 25-30 minutes and Campus Haspel in about 25 minutes via public transportation. The WSW mobil GmbH, which is part of the Stadtwerke Wuppertal, established a public transport service for on-demand transport. The pickup service works via an app, that finds a driver nearby. The WSW cabs drive many virtual stopping points and thus enable an individual and flexible scheduling[8].

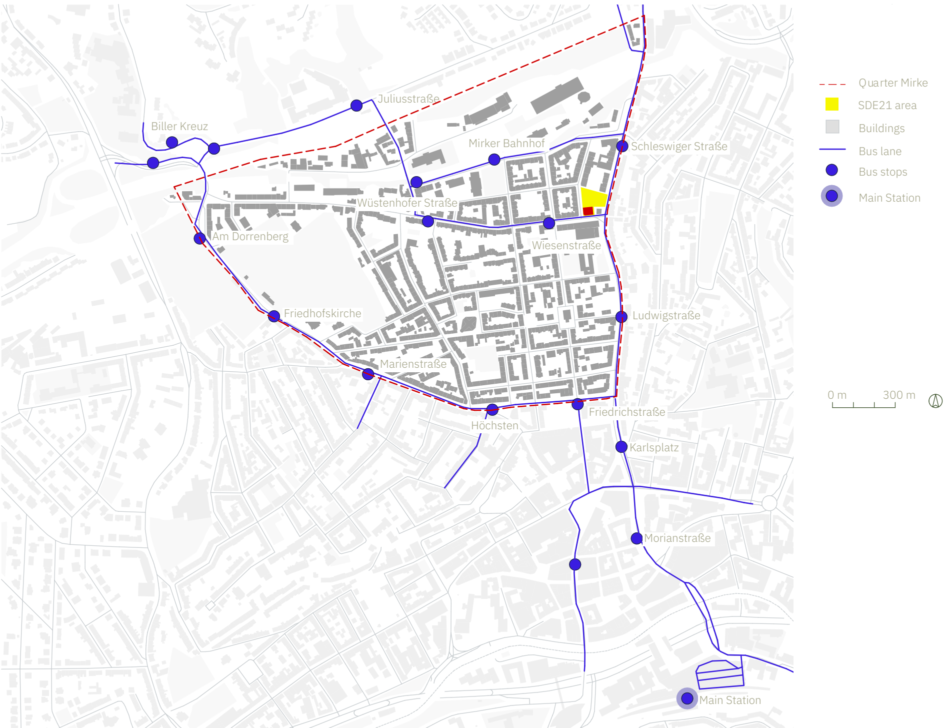


Fig. IV.6. 6. Today's Public Traffic Mirke

The city of Wuppertal is one of the German cities rethinking its traffic planning management from the car perspective towards the guiding principle "Wuppertal as a bicycle city". There are currently 12 rental stations in the Nordstadt, four of them in Mirke. Six pedelecs, and six cargo bikes are for free rental. In 2014 the former railway line "Nordbahntrasse" was reactivated as a cycling and walking path. Parallel to the motorway A46 it connects the eastern and the western parts of Wuppertal. About one kilometer of the 23-kilometer "Nordbahntrasse" leads through the northern part of the Mirke quarter and link it to the neighboring districts and the whole city. The above- mentioned bicycle fast track is a part of the currently longest bicycle expressway in Germany and marks the beginning of society's shift in thinking towards bicycle-friendly cities. People have access to the "Nordbahntrasse" at Dorrenberg and Mirke railway station

Fig. IV.6. 7. Today's Individual Traffic Mirke

6.2.2. Vision

By banning private cars from entering the district and reorganizing the urban mobility, the shape of Mirke will be transformed. District internal mobility will be done by foot, bike, and autonomous minibuses, while transportation over longer distances will be accomplished by using public buses and cable cars. Following the climate protection project of Wuppertal "Short Ways for Climate Protection", Mirke will become more and more bike and pedestrian friendly.
Mobility hubs will establish a network of important points to change the type of transport throughout the whole city. In Mirke they can be differentiated into two types: The mobility hubs inside the district bundle the small mobility supplies like scooters and bikes using existing public places. The other types of hubs are located at the edge of the district with a direct link to the Autobahn and connect shared cars with public busses. At "Mirke Bahnhof" the hub also integrates the new cable car station. Following the principle of the car-free city, the remaining public bus transport will use the district border roads only. Therefore, the inner district itself will be free from noise and pollution emissions. Inside the district electric driven autonomous minibuses will be established for district internal and district connecting transportation using virtual stops, as a further development

of the on-demand WSW cabs. Multiple individual trips can be bundled using one optimized route helping to reduce the number of vehicles driving around. Due to the optimization of trips and the use of virtual stops, a fixed timetable for stationary stops is not needed anymore. The time passing from calling to boarding the autonomous minibus will be around 5 minutes but maximum 10 minutes. This time period is needed by the individual to get to the virtual stop given by the system but also by the autonomous minibus to continue its trip and arrive there. The autonomous minibuses can not only manage the traffic on the road. An innovative system named upBUS and developed by RWTH Aachen allows them to click in the system of the cable car and continue their ride in the air.[9]

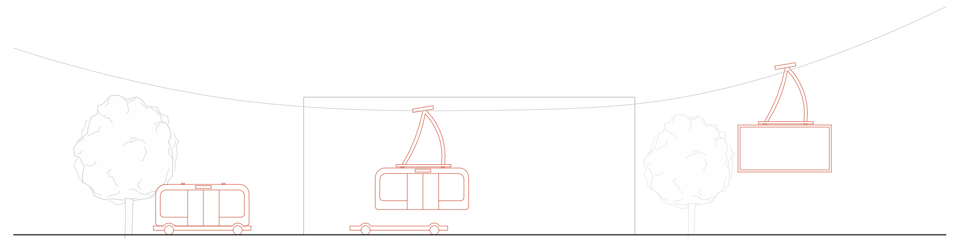


Fig. IV.6. 8. Combination of Autonomous Minibuses and Cable Car

The other way around, all gondolas acting as cable cars can be put on the chassis and transform into autonomous minibuses. It connects both benefits of driving on the road and flying high above the city, avoiding traffic and moving fast and straight. As it is possible to use the chassis for public transportation, it is also possible to put a container with goods of all kinds on top. The minibuses and the cable cars work together as a system combining local and long-distance traffic and public and delivery traffic.

Fig. IV.6. 9. Vision Public Traffic Mirke

A main goal of the city of Wuppertal in terms of bicycle friendliness is to connect

the Main station via cycle lanes with “Mirke Bahnhof”. Neue Friedrichstraße will be converted into a bicycle lane, which means parking spaces will be removed, traffic islands will be added, and signs will be erected. It directly joins the “Nordbahntrasse” at its northern end and provides a connection of the quarter with the city network, especially the main station in the south. Furthermore, street Gathe, which runs parallel to Alte Friedrichstraße and marks the eastern border of the quarter, as well as Hochstraße in the west, will be opened for cycling by adding protected bike lanes. The cycling grid is being completed by cycling streets on Höchsten, Ludwigstraße and Wiesenstraße. Thus, there will be two direct links to the Nordbahntrasse connecting the Bicycle expressway with Mirke. Cycle services have a great potential of development as they don’t take up much space and don’t require excessive public or collective investments. Due to the topography with its slope of up to 10%, we especially want to expand the range of electric bikes. Supplementary there shall be an offer of self-service bike stations. By making biking even easier, we seek to encourage diverse generations and users to move sustainably. All the bike related functions can be found at the mobility hubs inside the quarter.

Fig. IV.6. 10. Vision Bicycle Traffic Mirke

Deliveries can be made by cargo bikes by oneself but also can be conducted by a delivery service using their cargo bikes and the autonomous minibuses as delivery vehicles outside of the public transport.
All over the district sidewalks are enhanced in width and accessibility aiming to be able to walk through the district more easily. Public green and playgrounds will be connected with each other, creating green corridors for socializing and ecological balance throughout the district and above. By reducing the traffic on the district boarder roads, the selection in different districts is being diminished. Additional crosswalks and pedestrian friendliness create a new permeability between the districts. The existing businesses in the south of Mirke will benefit from the pedestrian zone right in front of their stores. This area marks the transition towards the city center, becoming denser and more business orientated

Fig. IV.6. 11. Vision Pedestrian Traffic and Public Green

We aim to separate those traffic participants, who compete with each other. Wherever it is possible every participant, like pedestrians, cyclists, and buses, gets its own lane. Nevertheless, there are streets where the uses overlap. Buses require a width of 3,50 meters, safe bikes lanes need 2,50 meters, and a comfortable pedestrian path should be 2,70 meters.[10] Generally, the streets can be classified into three types: pedestrian zones, bicycle streets and bus streets.

Given the existing situation in Mirke like narrow and steep roads a demand-orientated distribution will not always be possible. Thus, a mix of priorities and compromises are being used for the new street designs. This can be realized by meandering road guidance enlarging alternately the pedestrian pathways and the street space bringing together both the traffic performance for bikes and buses and the space needed for a comfortable walk and lingering.
By creating more space for small local businesses like cafés, bookstores, and grocery stores for daily needs in the first floors of the buildings the functions of the city get mixed up and Mirke develops into a vivid district. The pedestrian zones and green oases throughout Mirke pull the people out of their houses, stimulate an active and connected neighborhood and bring the life back to public spaces.

Fig. IV.6. 12. Pedestrian Zones, Bicycle Street and Bus Streets

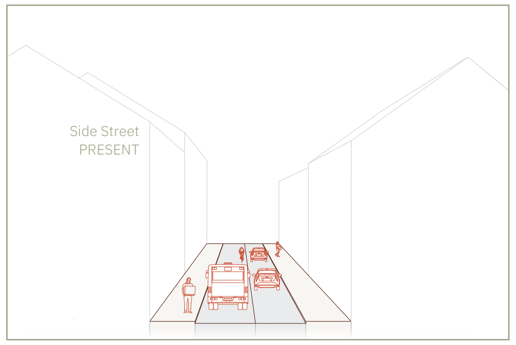


Fig. 1. side street present

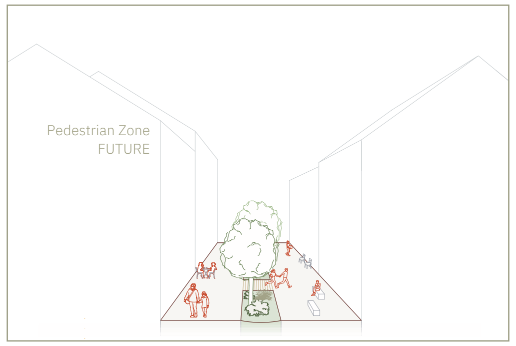


Fig. 2. pedestrian zone future

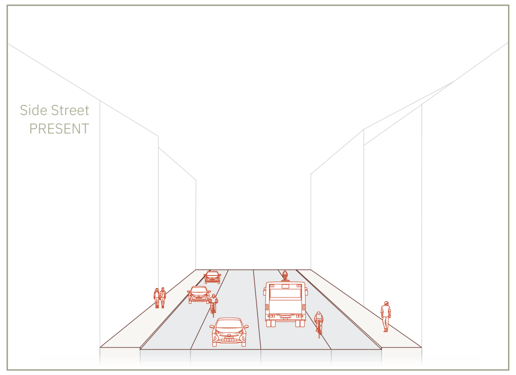


Fig. 3. side street present

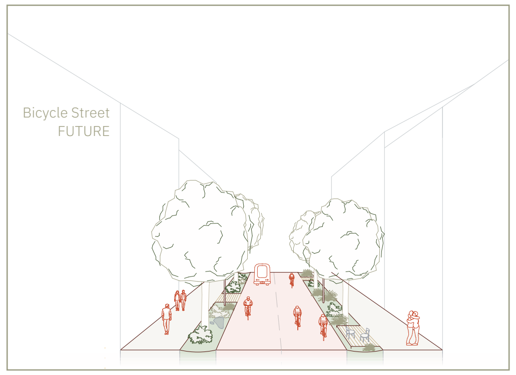


Fig. 4. bicycle street future

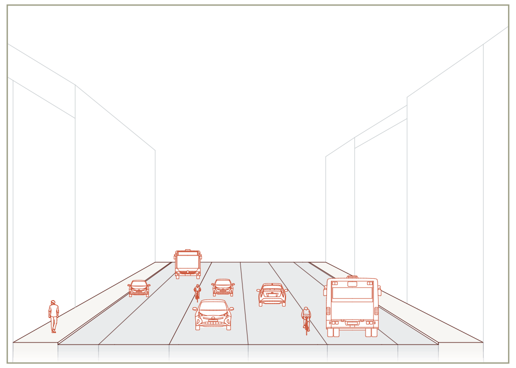


Fig. 5. main street present

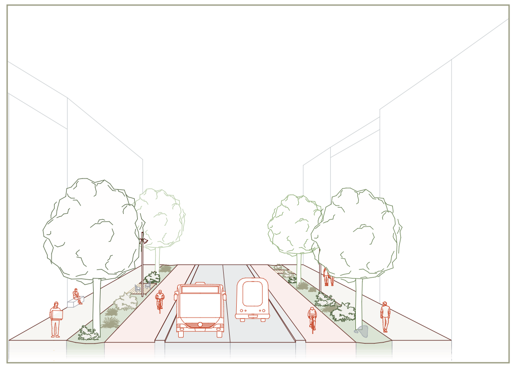


Fig. 6. bus street future

6.3. Building Level

6.3.1. Analysis

Thinking about the best result in terms of supporting urban mobility in the Mirke quarter, our team decided to work on the addition of storey on the Café ADA. It is situated in the northeastern part of the district in the corner between the Froweinstraße and the Wiesenstraße. For more than 30 years Café ADA has been a cultural centre for the inhabitants of the Mirke quarter. The internationally known Tango scene in Wuppertal originated here and still is an attractive meeting point for artists, musicians, and other guests from different nations.
The appurtenant property is being used as a parking space in the east and is covered mainly by trees and bushes in the west. A brick wall along Froweinstraße separates a small place used as an outdoor café from the street. To the north, a circular staircase in the form of an amphitheatre creates opportunities for relaxing, coming together and playing music or theatre. These possibilities are not fully exploited yet, and the amphitheatre remains mostly unused.
Besides the parking facilities at the property, there is much street space used for car parking. While on Wiesenstraße designated diagonal parking lots are built, on Froweinstraße cars can be parked on both sides of the street. Hence a big part of public space is used for car parking.

6.3.2. Vision

Our design of the mobility integration on site serves as an example for future implementation on other properties within Mirke and Wuppertal. The concept of our applied mobility concept on building level is based on the three principles of sustainability: consistency, sufficiency, and efficiency. Consistency is being fulfilled by switching from fossil fuels to 100% shared and electric driven public transport making individual motorized transport redundant. Efficiency is reached by multiple people using one vehicle and bundling their routes by using the autonomous minibuses. Last but not least, Sufficiency is implemented by creating a city of short ways, where everything for the daily needs is reachable in a 5 minute walk by foot.

For our addition of stories on top of Café Ada, instead of providing parking spaces for each resident and focusing on individual car use, autonomous minibuses are being used to get around for shorter distances. In addition to the space savings and environmental benefits, a wider range of vehicles will be made available, and at the same time residents will no longer incur costs for insurance. The Café ADA lot is located on the edge of district Mirke having the potential of being an entrance to the whole district. Given the amphitheatre and the social aspects of Café ADA the lot has the perfect requirements to become a point for people to come together and the neighbors spending time with each other.

The streets around the Café ADA property are rearranged following the principles mentioned above (6.2.2 Vision). The main traffic with public buses and autonomous minibuses is processed on Uellendahler Strasse, while Wiesenstrasse and Froweinstrasse are bike streets open for the autonomous minibuses. The junction of Uellendahler Strasse and Wiesenstrasse is designed as a big pedestrian crossing connecting the Osterbaum district via Hollsteiner Treppe with district Mirke and Café ADA underlining the pedestrian friendliness.

Fig. IV.6. 13. Site Plan and Urban Mobility Concept

Following our vision, reachability of important infrastructure, such as the main station, will be improved. The ban of private cars and the implementation of autonomous minibuses imply a reduction of road traffic in general. Thus,

traffic lights and junctions can be adapted to the new circumstances, making it easier for pedestrians and cyclists to cross the streets. By having their own track of the road and not sharing their space with pedestrians or cars anymore, cyclists are able to go more direct and more rapid. All in all, a better traffic flow and traffic execution is expected, which allows all traffic participants to get smoother, safer and faster to their destinations. Taking the cable car, the main station is reachable within a few minutes. So is the University, which is a big enhancement compared to the current situation. By using the flexibility of the cable car-autonomous minibus-system, smaller destinations can be reached quicker, too. These improvements, except the cable car connections, are being partly weakened by the maximum speed limit of 30 km/h on the inner-city road network.

The lot of Café ADA itself is structured by a grid system and divided in two sections, each following the building edges on both sides, creating a drainage swale for rainwater in the overlap of both sections. The pavement differs and is orientated on the grid. Multifunctional piles strengthen the appearance of the grid while implemented on its intersections. They contain lighting, sound and water vaporizers for cooling. The amphitheatre is being maintained and integrated in the overall concept. It is developed as a more attractive place for activities like theatre, dancing and coming together. Most parts of the western part, brick wall, trees and greens remain and are integrated into the grid structure while an urban garden for herbs and vegetables is created in the eastern part. By breaking the brick wall at two points and paving a path to the northern neighbors as well as the entrance and the mobility hub the lot is connected to its surroundings, is permeable for pedestrians and integrating itself into the district (for further information see 1. Architecture Design Report). The roof of the café and the solar trees, linked together, provide a surface for photovoltaic panels, which produced electric power will be used directly to charge the shared vehicles or supply Café Ada or the local grid (for further information see 2. Engineering & Construction).

The mobility hub in the east of the property at Uellendahler Strasse is assembled as a modular structure forming a roof over parking lots for bike-sharing with charging infrastructure. The structure is mainly constructed by using Urban Mining elements taken from deconstructed industrial buildings. It offers a range of mobility services that are compatible with the city and forms one of the most important interfaces between the district and the city. Here you will find a bus stop, which was moved here from some meters north, with a barrier-free digital info point with all relevant information on mobility and a sharing book shelf, shared e-cargo bikes and e-bikes. A bike service station with various tools and an air pump is located directly next to the bike lane at the street side of the mobility hub. The mobility hub architecturally frames the exterior of Café ADA towards the city and is at the same time a prelude, entrance gate, info point and infrastructure. On the garden side, there is space for compost and storage space for gardening utensils, and the roof with its intensive greening serves as a water filter and water collector, which is then stored in containers directly under the roof and thus provides sufficient pressure for garden irrigation.

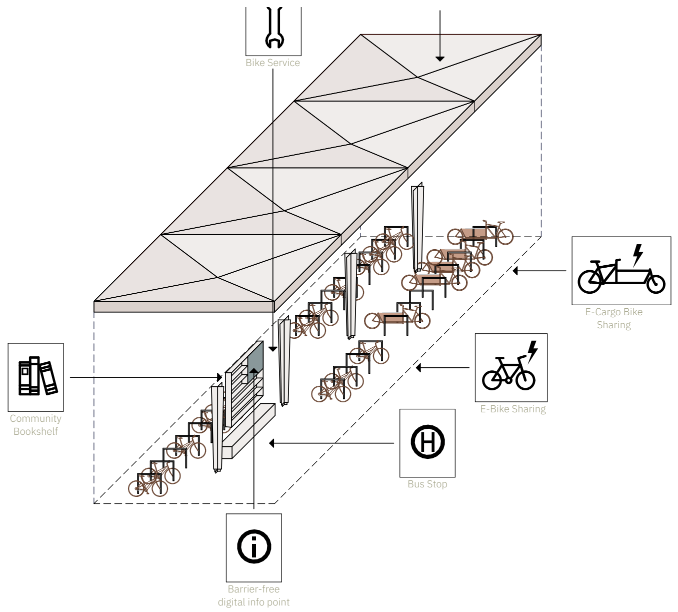
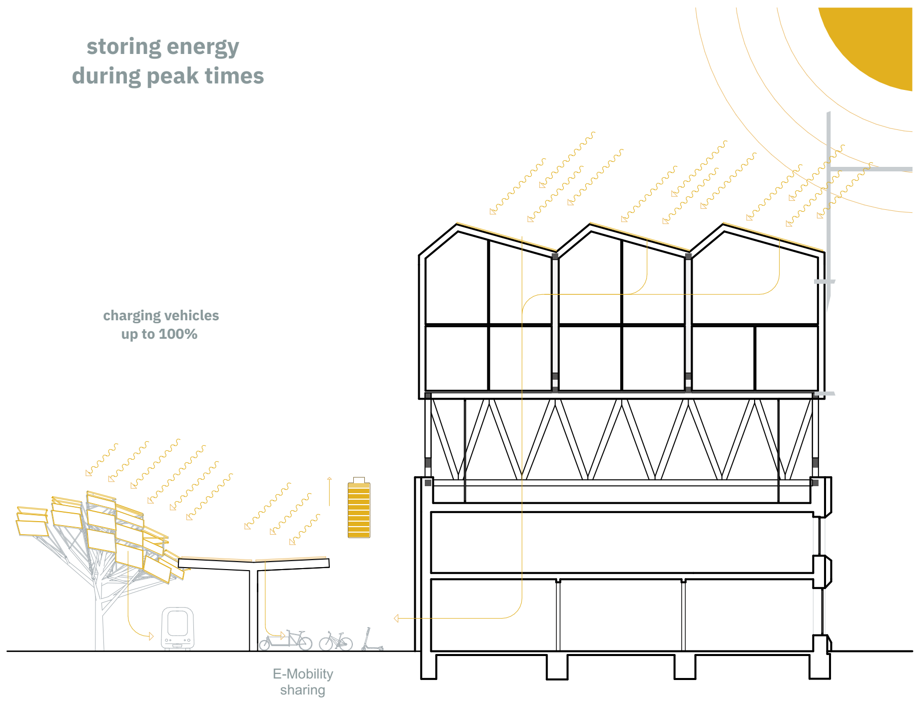


Fig. IV.6. 14. Mobility Hub Café ADA

When not in use, the e-bikes and minibuses will work as batteries storing energy for the floor addition and giving it back to the building when at night or on cloudy days no solar energy is generated. Thereby we reduce the mismatch between supply and demand of energy. The on-site renewable energy supply coming from the sun can thus optimally cover the demand occurring in the building and compensate for fluctuations. A better balance between consumption and production of energy will be established, while promoting a smart and efficient mobility system. Quarter-based opportunities to supply renewable energy locally are implemented: for storage, for our project, for the neighborhood and the establishment of further e-mobility offers



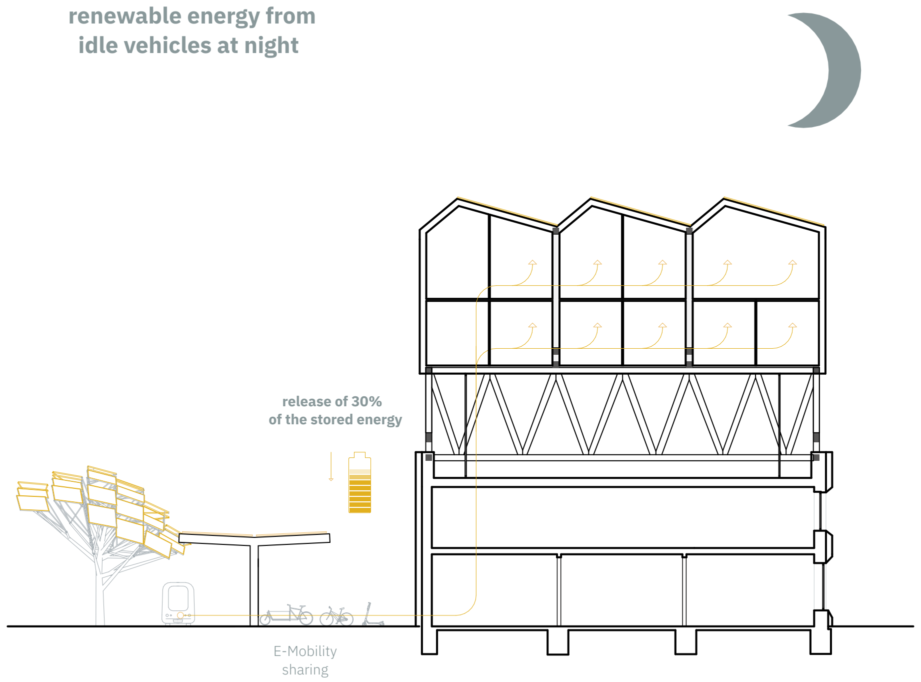


Fig. IV.6. 15. Energy Day and Energy Night

6.4. House Demonstration Unit

For our House Demonstration Unit, we will have an electric cargo bike, charged by the photovoltaic system of our House Demonstration Unit. (For further information see 1. Architecture Design) It will serve as a small excerpt from our Master Plan for the Urban Mobility. The cargo bike will not only be there for transport throughout the contest but will be used for other purposes and events. One goal is to balance electricity generation and demand locally and to make energy experienceable. Additionally, it can be used to distribute flyers, advertise and bring the Solar Decathlon event to the people in Wuppertal.

The charging facilities for the electric cargo bike is being integrated at the base level of the technic core of the HDU. They are located next to the water tanks, where a dry tank space provides enough space for all the electrical facilities needed to be operated from the outside. This appendix of the technic core also provides a socket for charging one battery of the electric cargo bike while another one can be actively used in the bike. As the battery can be removed from the bike, we will have two batteries for the bike, so it is possible to always have one battery charged. Thus, battery and cargo bike can be separated during the charging process. That also means there is no need to park the vehicle next to the charging station. The bicycle is free to be parked at various places around the HDU, flexible to the needs of any event. We consider two planned options for that. One of those is a place next to the stairs, between the northern planting pot and and the scaffolding in the northern edge of the building. The bike can easily be brought to that place as it is close to the entrance and stairs. It is easy to reach when needed and it is not blocking any way through under

or around the building. The cargo bike can also be parked under the HDU when there is a need to protect it from wheather events such as rain. The dedicated parking area under the HDU is in the southern part of the base floor and can easily be reached from the northern entrance between the lift and the stairs and has enough space to turn the bike around. The whole way there is also paved with brick paving, so it will be possible to navigate the cargo bike precisely by pushing it. Both considered parking spots have enough light to ensure a safe handling of the bike.
The outdoor parking lot is a flexible and multi-functional space, which is not strictly separated from its surroundings. The underground is partly paved with recycled bricks. The rest of the surface area is covered with recycled broken mineral material used similar to gravel. Due to the bicycle stand no additional bicycle parking facility is required.

We particularly represent the bike-friendly part of our mobility concept, by using a borrowed cargo bike, which is supported by an electric engine. The model of that bike will be “Bullit”, which is a so called “Long John” type of Cargo bike with two wheels and the carrier between the handlebar and the front wheel, that is especially agile and handy and has a very good performance in terms of reach and power usage. That type of bike fits perfectly for the steeper parts of Mirke, such as the possibility of transporting middle sized goods. The cargo bike will be sponsored by a cargo-bike-sharing association for the period of the Solar Decathlon event phase. As mentioned above it will be used for all transportation purposes around the event period to demonstrate that this is an adequate alternative for most situations of car usage and one important building block of the traffic turnaround.
Following the concept of sharing instead of owning vehicles like electric cars or cargo bikes, we see the cargo bike spot under our HDU not as a private garage but as a small scale decentralized version of the mobility hubs mentioned above. The mentioned cargo-bike-sharing association in reality operates with the exact same strategy of spreading such mini-hubs all over densely populated neighborhoods, where the bikes can be charged on the one hand and on the other hand can be localized and booked via an App system and be used by a whole community. In this sense, our spot represents a mini-hub with the possibility of charging and providing one of the bikes of a potential sharing community in Wuppertal. For that purpose, we consider the way of parking as not as important as: Firstly, the bike can stand safely by itself and secondly, the accessibility will be secured at any time due to the good accessibility of the ground and the base level space of the HDU.

By using appropriate materials as the mentioned paving with recycled bricks we provide a regular and safe surface where passing of pedestrians or a filigran handling of the bike is needed. We also provide adequate widths for the paths going towards and beneath our HDU, with several options of spots wide enough for wheelchair users to turn around. As the surfaces are safe and of good visibility (contrasting the unpaved areas) and with a lighting concept considering the safety of passengers, all needs for pedestrians will be fulfilled.
As shown in our vision on District Level, barrier free access will also be a

guiding principle for the HDU. Despite building our HDU in a hight of 2+ meters, wheelchair accessibility will be implemented by having a lift that is big enough to fulfil the rules.

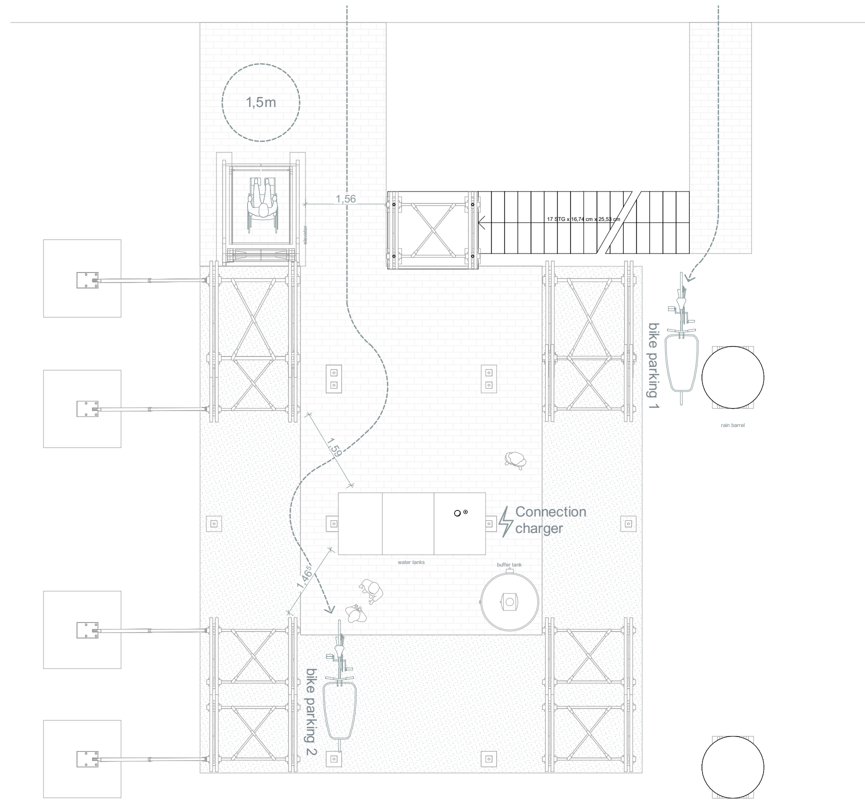


Fig. IV.6. 16. Floor plan HDU with parking space and passenger ways

6.5. References

[1] https://www.doppelmayr.com/de/systeme/3s-bahnen/

[2] SDE21 Document "SDE21 – The-Mirke-District_V1.0", p.6

[3] https://www.wz.de/nrw/wuppertal/hochwasser-in-wuppertal-so-sieht-es-in-den-stadtteilen-aus_aid-61357317

[4] "net elements, which are connected to other streets at both ends of meshed nets", source: SDE21 Document "urban situations defined", p.25

[5] https://quartier-mirke.de/stadtentwicklungssalon-mobilitaetswende/, assessed 15.04.2021, 10.00 am

[6] https://quartier-mirke.de/mirke/, assessed 15.04.2021, 10.00 am

[7] SDE21 Document "THE MIRKE DISTRICT. overview, background & history", p.17

[8] https://www.holmich-app.de/, assessed 15.04.2021, 10:00 am

[9] https://www.upbus.rwth-aachen.de/

[10] FUSS e.V.

V. Dinner Party Menu

RoofKIT Dinnernight
less waste - more taste

As sustainability is the main aspect of the RoofKIT design, we also aimed to make this dinner as sustainable as possible, by making it seasonal, regional, vegan, and reducing waste.
Seasonal food that can be grown locally is our main source to create this dinner menu. By consuming locally CO^{2}-emissions can be reduced, local stores are supported, and the products are definitely more tasteful.
The meat and dairy industry are largely responsible for climate change. Among other factors this industry needs more than 83 per cent of the land used for agriculture in general and hereby contributes for example to deforestation, reduced biodiversity, and waste of resources. Therefore, we chose to use only vegan products, focusing on a variety of vegetables, greens, and fruit in each course.
A first step to reduce the waste produced due to the dinner, we chose the local market as our main source. For products that can't be found at the market we will shop at the unpackaged store or the organic supermarket.
The dinner is generally aiming to be a simple but tasty meal that one would share with friends and family in their homes as well.

local market unpackaged store organic supermarket

Fig. V. 1. dinner table

First| fresh dark bread with more than one choice

We will start the evening with a variety of appetizers called "Vesper".
"Vesper" is a southern German tradition, that includes different kinds of salty quick foods that are served as snack between meals or in our case just before dinner. Bread is the number one ingredient for a good "Vesper", toping it off with various bread spreads and toppings. As the "Vesper" is a simple individual snack this course will be served in separated bowls so everyone can prepare it for their likings. Through this we want to create the opportunity for everyone to interact, get to know each other and feel the coziness of a dinner among friends.

Second | fruity green salad with a little crunch

Following the "Vesper" we will be serving a light salat. Made from seasonal lettuces and herbs combined with fresh fruits and berries toped of with some crunchy extras. Different combinations of these simple but delicious ingredients will create a rich and harmonic salat for each dinner evening.

Third | good old potato with the splash of color

The main course of the menu puts the potato in the center of attention. The potato is a frequently used product for all kinds of different German and southern German recipes. On each dinner evening we will present the potato in a different from, combining it with other seasonal colorful vegetables.

Forth | mingled red fruit with extra sweetness

We will be ending the dinner menu with something sweet and comforting. Compote is a common way to preserve the seasonal fruits and vegetables, to enjoy them even during cold winter days. Even though summer is not over yet we want to include this tasteful component to our deserts. Combining fresh fruit compote with other flavors such as chocolate and vanilla in various forms, will create a sweet end for each menu.

Dinnermenu
Vesper


Fig. V. 2. vesper | bread

bread

500 g	spelt flour
450 ml	water
1 cube	yeast
2 tbsp.	apple vinegar
2 tsp.	salt
60 g	flax seed
60 g	sunflower seeds
1 tbsp.	sunflower oil

tomato butter

250 g	vegan butter
100 g	dryed tomatos
80 g	tomato paste
2	garlic clove
pinch	salt, pepper

pea dip

160 g	peas
2	garlic clove
50 g	sunflower seeds
50 g	mint
1 tsp.	lemon juice
pinch	salt, pepper

preperation

1
For the bread dough, mix flour, crumbled yeast and lukewarm water in a large bowl, then knead into a smooth dough.

2
Add the apple vinegar and salt and continue kneading. Then add the flax seeds and sunflower seeds.

3
Grease the loaf tin and pour the dough in. Then place in the oven at 200 °C for approx. 50-60 min. Turn off the heat and leave the bread without the loaf tin in the oven for another 10 minutes.

4
For the tomato butter, bring the butter to room temperature, then cut the dried tomatoes into small pieces and press the garlic cloves. Then mix everything together.

5
For the pea dip, put the peas, garlic, sunflower seeds and lemon juice in a mixer and blend until smooth. Add the chopped mint and season with salt and pepper.

evaluation

ingredients	amount	cost	energy	water	waste
bread	8 serv.	3,90 €	2,0 kWh	4,5l	Small plastic bag for yeast and glass bottle for vinegar. A plastic bag for vegan butter and glass bottles for dryed tomatos, tomato paste and lemon juice.
tomato butter	8 serv.	4,45 €	-	-	
pea dip	8 serv.	2,60 €	0,25 kWh	-	

nutrition data in g

ingredients	amount	calories	protein	carbs	sugars	fat	fibre	salt
bread	1 serv.	325 kcal	11,95	47,19	0,56	9,38	5,30	0,00
tomato butter	1 serv.	204 kcal	2,44	9,19	5,75	18,91	1,90	1,29
pea dip	1 serv.	56 kcal	2,8	3,83	0,92	3,49	1,30	0,02

Fig. V. 3. evaluation and nutrition table

Dinnermenu I

starter | salad with strawberries

Fig. V. 4. dinner I starter dish

As the test cooking took place in winter, the ingredients for the dish were adapted.

salad

600 g	lettuce
500 g	strawberries
200 g	stale bread
pinch	salt, pepper
10 ml	sunflower oil

dressing

1 tbsp.	mustard
2 tbsp.	agave syrup
1 tbsp.	apple vinegar
5 tbsp.	sunflower oil
pinch	salt, pepper

preperation

1
Wash all vegetables and fruits for the entire dinner. To use less water, start with the cleanest and reuse the water.

2
Next, cut the stale bread into small cubes. Then put them in a pan with rape oil and fry until golden brown.

3
Drain the croutons a little and then flavor with salt and pepper.

4
For the dressing mix together the mustard, vinegar, agave syrup and oil and then season with salt and pepper.

5
Place the lettuce, the strawberries und the homemade croutons in a large salad bowl and pour the dressing over just before serving.

evaluation

ingredients	amount	cost	energy	water	waste
salad	8 serv.	10,26 €	0,25 kWh	5l	Small plastic bag for agave syrup and glass bottles for vinegar and mustard, used in every menu.
dressing	8 serv.	1,90 €	-	-	

nutrition data in g

ingredients	amount	calories	protein	carbs	sugars	fat	fibre	salt
salad	1 serv.	108 kcal	3,35	19,54	4,57	2,37	2,80	0,04
dressing	1 serv.	66 kcal	0,06	2,72	2,54	6,30	0,00	0,04

Fig. V. 5. evaluation and nutrition table

Dinnermenu I

main course | hash browns with vegtables

Fig. V. 6. dinner I main course

As the test cooking took place in winter, the ingredients for the dish were adapted.

hash browns

2 kg	potatoes
4 medium	onions
120 g	spelt flour
pinch	salt, pepper
pinch	nutmeg
350 ml	sunflower oil

sides

1 kg	broccoli
1 kg	carrots
pinch	salt, pepper
to taste	herbs
80 ml	sunflower oil

chutney

4 big	apples
2 medium	onions
20 g	ginger
100 g	brown sugar
140 ml	apple vinegar
pinch	salt, pepper, chili

preperation

1
If not yet done - wash all vegetables and fruits for the entire dinner. To use less water, start with the cleanest and reuse the water.

2
Peel the potatoes and flavor the potato peel with oil, salt and pepper. Put these aside.

3
For the chutney cut the apples and the oninos into small cubes and grate the ginger. Cook these three ingredients on low heat, add the brown sugar, pour in the vinegar and cook until soft. Stir and flavor the chutney with chilli, pepper.

4
Cut broccoli, onions and carrots into strips. Flavor the carrots with oil, salt, pepper and herbs. Place the carrots and the potato peelings each on a tray in the oven at 200 °C for about 30 min.

5
Grate the potatoes. Then place the grated potato in a clean dish towel and squeeze out as much liquid as possible. Mix the potatoes with the onions, flour and flavor with salt, pepper and nutmeg. Shape the mixture into small balls and place in the pan. Flatten them while frying until golden brown.

6
Bring 2,5l of water with some salt to a boil and then blanch the broccoli for about 5 min. Flavor the cooked broccoli with salt, pepper and herbs.

7
Briefly place the broccoli in the oven with the other vegetables. If needed warm up the hash browns for a few minutes in the oven.

evaluation

ingredients	amount	cost	energy	water	waste
hash browns	16 pieces	5,89 €	1,5 kWh	-	Small plastic bags for seasoning and a glass bottle for vinegar, used in every menu.
sides	8 serv.	5,52 €	2,0 kWh	2,5l	
chutney	8 serv.	3,95 €	0,5 kWh	-	

nutrition data in g

ingredients	amount	calories	protein	carbs	sugars	fat	fibre	salt
hash browns	2 pieces	663 kcal	7,84	59,31	5,13	45,59	6,40	0,04
sides	1 serv.	161 kcal	5,12	9,92	10,12	10,9	5,80	0,08
chutney	1 serv.	191 kcal	0,992	44,50	39,50	0,12	4,66	0,08

Fig. V. 7. evaluation and nutrition table

Dinnermenu I

dessert | rhubarb crumble

Fig. V. 8. dinner I dessert

As the test cooking took place in winter, the ingredients for the dish were adapted.

rhubarb

600 g	rhubarb
100 g	brown sugar
1 tbsp.	starch

crumble

100 g	spelt flour
50 g	oat flakes
70 g	brown sugar
60 g	vegan butter
pinch	salt

preperation

1
If not yet done - wash the rhubarb. Then add corn starch and sugar and cook on low heat for about 15 min.

2
For the cumbles mix all ingredients in a bowl. Make sure the butter is not too soft to get nice crumbles and not a smooth dough.

3
Transfer rhubarb compot into a casserole and layer crumble on top.

4
Place in oven and bake at 180°C for about 20 min.

5
Add some vegan ice cream if wanted and serve.

evaluation

ingredients	amount	cost	energy	water	waste
rhubarb	8 serv.	2,80 €	0,25 kWh	-	Small plastic bag for starch, used in every menu. A plastic bag for vegan butter.
crumble	8 serv.	1,75 €	1,0 kWh	-	

nutrition data in g

ingredients	amount	calories	protein	carbs	sugars	fat	fibre	salt
rhubarb	1 serv.	67 kcal	0,68	16,60	12,85	0,15	1,40	0,00
crumble	1 serv.	138 kcal	2,35	20,85	8,78	5,01	1,20	0,16

Fig. V. 9. evaluation and nutrition table

Dinnermenu II

starter | salad with raspberries

Fig. V. 10. dinner II starter dish

As the test cooking took place in winter, the ingredients for the dish were adapted.

salad

600 g	field lettuce
500 g	raspberries
200 g	sunflower seeds
pinch	salt, pepper

dressing

100 g	raspberries
1 tbsp.	agave syrup
3 tbsp.	vinegar
7 tbsp.	sunflower oil
pinch	salt, pepper

preperation

1
Wash all vegetables and fruits for the entire dinner. To use less water, start with the cleanest and reuse the water.

2
For the dressing blend the raspberries, then add the agave syrup, the vinegar and oil and mix. Flavor with salt and pepper.

3
Place the lettuce, the raspberries and sunnflower seeds in large salad bowl and mix gently.

4
Pour the dressing over just before serving.

evaluation

ingredients	amount	cost	energy	water	waste
salad	8 serv.	8,45 €	-	5l	Small plastic bag for agave syrup and a glass bottle for vinegar, used in every menu.
dressing	8 serv.	1,90 €	0,25 kWh	-	

nutrition data in g

ingredients	amount	calories	protein	carbs	sugars	fat	fibre	salt
salad	1 serv.	199 kcal	8,27	11,07	3,94	14,02	5,10	0,06
dressing	1 serv.	89 kcal	0,16	2,79	1,79	8,84	0,80	0,00

Fig. V. 11. evaluation and nutrition table

Dinnermenu II

main course | baked potatoes with vegtables

Fig. V. 12. dinner II main course

As the test cooking took place in winter, the ingredients for the dish were adapted.

baked potatoes

2 kg	potatoes
2 tbsp.	starch
pinch	salt, pepper
pinch	seasonal herbs
25 ml	sunflower oil

sides

1 kg	green asparagus
1,2 kg	cherry tomato
pinch	salt, pepper
to taste	herbs
80 ml	sunflower oil

dip

250 ml	soy yoghurt
1/2	cucumber
1	garlic clove
pinch	salt, pepper
20 ml	lemon juice

preperation

1
If not yet done, wash the vegetables. To use less water, start with the cleanest and reuse the water.

2
Cut the potatoes into small cubes and mix with starch, oil, salt, pepper and the herbs.

3
Spread out the potatos on a baking tray and place in the oven at 180°C for about 30 min. until golden brown.

4
For the dip cut cucumber into very small cubes and grate the garlic.
Mix everything together and season with salt, pepper and extra lemon juice if needed.

5
Cut the tomatos into half and crop of the dry bottom edges of the asparagus.

6
Fry the asparagus in a pan for about 10 min. then add the tomatos for another 5 min. Season with salt, pepper and seasonal herbs.

7
Place baked potatoes and the vegetables on a plate, decorate with the dip and serve.

evaluation

ingredients	amount	cost	energy	water	waste
baked potatoes	8 serv.	3,75 €	1,0 kWh	-	Small plastic bag for starch, used in every menu. A plastic bag for soy yoghurt.
sides	8 serv.	15,50 €	0,25 kWh	-	
dip	8 serv.	3,50 €	-	-	

nutrition data in g

ingredients	amount	calories	protein	carbs	sugars	fat	fibre	salt
baked potatoes	1 serv.	222 kcal	4,51	45,9	4,25	3,38	5,00	0,08
sides	1 serv.	151 kcal	4,18	9,10	5,10	10,87	1,90	0,02
dip	1 serv.	23 kcal	1,84	1,93	0,06	0,94	0,00	0,00

Fig. V. 13. evaluation and nutrition table

Dinnermenu II

dessert | vanilla pudding with rhubarb

Fig. V. 14. dinner II dessert

As the test cooking took place in winter, the ingredients for the dish were adapted.

rhubarb

600 g		rhubarb
100 g		sugar
1 tbsp.		starch

vanilla pudding

1 l		vegetable milk
80 g		starch
6 tbsp.		sugar
1 tsp.		vanilla
pinch		salt

preperation

1
If not yet done, wash the rhubarb and cut into pieces. Then add corn starch and sugar and cook on low heat until the consitency of compot is achieved.

2
For the pudding heat up 850 ml of the milk.

3
Mix starch, sugar, vanilla and salt together and combine with the rest of the milk until smooth.

4
Once the milk is boiling remove it from the heat and add the starch mixture.

5
Put back on heat and bring to a boil once more until the pudding starts to thicken.

6
Fill the pudding into small glasses and leave to cool.

7
Before serving it, add the rhubarb compot on top.

evaluation

ingredients	amount	cost	energy	water	waste
rhubarb	8 serv.	2,80 €	0,25 kWh	-	Small plastic bag for starch, used in every menu. A plastic bag for vegetable milk.
vanilla pudding	8 serv.	3,55 €	0,5 kWh	-	

nutrition data in g

ingredients	amount	calories	protein	carbs	sugars	fat	fibre	salt
rhubarb	1 serv.	67 kcal	0,68	16,60	12,85	0,15	1,40	0,02
vanilla pudding	1 serv.	117 kcal	1,54	23,49	11,45	1,92	0,80	0,00

Fig. V. 15. evaluation and nutrition table

Dinnermenu III
starter | salad with red currants

Fig. V. 16. dinner III starter dish

As the test cooking took place in winter, the ingredients for the dish were adapted.

salad

600 g	lettuce
500 g	red currants
200 g	walnuts
pinch	salt, pepper

dressing

100 g	berries
1 tbsp.	agave syrup
3 tbsp.	vinegar
7 tbsp.	sunflower oil
pinch	salt, pepper

preperation

1
Wash all vegetables and fruits for the entire dinner. To use less water, start with the cleanest and reuse the water.

2
For the dressing blend the berries, then add the agave syrup, the vinegar and oil and mix. Flavor with salt and pepper.

3
Chop the walnuts into pieces and then roast in a small pan without oil until golden brown.

4
Place the lettuce, the red currants and the walnuts in large salad bowl and mix gently.

5
Pour the dressing over just before serving.

evaluation

ingredients	amount	cost	energy	water	waste
salad	8 serv.	10,00 €	0,25 kWh	5l	Small plastic bag for agave syrup and a glass bottles for vinegar, used in every menu.
dressing	8 serv.	1,90 €	0,25 kWh	-	

nutrition data in g

ingredients	amount	calories	protein	carbs	sugars	fat	fibre	salt
salad	1 serv.	207 kcal	5,58	12,98	3,99	16,82	6,80	0,06
dressing	1 serv.	87 kcal	0,09	2,3	1,85	8,8	0,30	0,00

Fig. V. 17. evaluation and nutrition table

Dinnermenu III

main course | mashed potatoes with vegtables

Fig. V. 18. dinner III main course

As the test cooking took place in winter, the ingredients for the dish were adapted.

mashed potatoes

2 kg		potatoes
250 g		vegan butter
250 ml		vegetable milk
to taste		nutmeg
pinch		salt, pepper

sides

800 g		beetroot
800 g		green beans
2 medium		onion
pinch		salt, pepper
to taste		herbs
80 ml		sunflower oil

sauce

500 ml		red wine
2 tbsp.		starch

preperation

1
If not yet done - wash all vegetables. To use less water, start with the cleanest and reuse the water.

2
Peel the potatoes and flavor the potato peels with oil, salt and pepper. Spread the peels out on a tray and bake at 200 °C for about 30 min.

3
Cut the potatoes into cubes and cook unitl soft. Remove the water, then mash the potatos while adding butter and milk. Once the mashed potatoes is smooth season with salt, pepper and nutmeg.

4
Cut the beetroot and onion into strips and place in a casserole. Bake in the oven while adding red wine every now and then. Mix some of the wine with the starch and set aside.

5
Cut of the edges of the green beans and cook for about 10 min.

6
Once the beetroot is soft, add the starch mixure and if needed more wine to get a nice sauce.

7
Place mashed potatoes and the vegetables on a plate, decorate with the sauce and serve.

evaluation

ingredients	amount	cost	energy	water	waste
mashed potatoes	8 serv.	6,35 €	1,5 kWh	5l	Small plastic bag for starch, used in every menu. A plastic bags for vegan butter and vegetable milk and a glass bottle for red wine.
sides	8 serv.	8,45 €	2,5 kWh	1l	
sauce	8 serv.	3,65 €	-	-	

nutrition data in g

ingredients	amount	calories	protein	carbs	sugars	fat	fibre	salt
mashed potat	1 serv.	353 kcal	4,64	41,46	3,78	19,18	6,20	0,65
sides	1 serv.	208 kcal	4,44	27,81	12,87	10,38	7,70	0,23
sauce	1 serv.	56 kcal	0,04	2,59	0,39	0,00	0,00	0,00

Fig. V. 19. evaluation and nutrition table

Dinnermenu III
dessert | brownie with rhubarb

Fig. V. 20. dinner III dessert

As the test cooking took place in winter, the ingredients for the dish were adapted.

rhubarb

600 g	rhubarb
100 g	sugar
1 tbsp.	starch

brownie

200 g	spelt flour
200 g	sugar
50 g	cacao powder
200 g	dark chocolate
100 ml	sunflower oil
200 ml	vegetable milk

preperation

1
If not yet done, wash the rhubarb and cut into pieces. Then add corn starch and sugar and cook on low heat until consitency of compot is achieved.

2
For the brownie chop up the chocolate into chunks.

3
Mix all the dry ingredients, then add the liquids.

4
Mix everything until the batter is smooth, then add the chocolate chunks.

5
Grease the casserole and then pour in the batter. Bake at 180 °C for about 20 min.

6
Let the brownie cool for a while, then cut into pieces and serve with some rhubarb compot.

evaluation

ingredients	amount	cost	energy	water	waste
rhubarb	8 serv.	2,80 €	0,25 kWh	-	Small plastic bag for starch, used in every menu. A plastic bag for vegetable milk.
brownie	8 serv.	7,10 €	1,0 kWh	-	

nutrition data in g

ingredients	amount	calories	protein	carbs	sugars	fat	fibre	salt
rhubarb	1 serv.	67 kcal	0,68	16,60	12,85	0,15	1,40	0,02
brownie	1 serv.	570 kcal	4,71	61,38	42,47	33,77	1,50	0,00

Fig. V. 21. evaluation and nutrition table

VI. Contest Week Tasks Planning

SOLAR DECATHLON EUROPE 21/22 - Contest week tasks' planning

Deliverable No.	D#6
Team ID	KIT
University/ City	Karlsruhe

Note: For the activities highlighted in pink, not every Team is scheduled to do the activity on that day. The exact details of which Team is responsible for which task/activity at which time will be announced at a later date. However, a responsible person should be appointed.

Activities/Roles	Responsibles Name of the Team Member 1	Name of the Team Member 2	Name of the Team Member 3	Name of the Team Member 4
11.06.2022	Saturday			
on site registration	All Team Members			
welcome ceremony	All Team Members			
health and safety training	All Team Members			
20.05. - 27.05.2022	Assembly Phase 1			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Michael Hosch	Possible
assembly	All Team Members			
Faculty Advisor	Dirk Hebel	Katharina Blümke		
Project Manager	Regina Gebauer	Nicolás Carbonare	Katharina Blümke	Possible
Health and Safety Team Coordinator	Regina Gebauer	Michael Hosch		
Teams Safety Officers	Michael Hosch	Stefanie Christl	Martin Kautzsch	Possible
Electrical Engineer				
Structural Engineer	Johannes Hasselmann	Jonas Ernst		
Site Operations Coordinators	Stefanie Christl	Sven Teichmann	Michael Hosch	Possible
contact water delivery + removal	Nicolás Carbonare	Martin Kautzsch	Benjamin Weber	Possible
notify appropriate inspector	Regina Gebauer	Nicolás Carbonare		
contact instrumentation	Nicolás Carbonare	Martin Kautzsch		
27.05. - 03.06.2022	Assembly Phase 2			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Michael Hosch	Possible
assembly	All Team Members			
Faculty Advisor	Dirk Hebel			
Project Manager	Regina Gebauer	Nicolás Carbonare		
Health and Safety Team Coordinator	Regina Gebauer	Michael Hosch		
Teams Safety Officers	Michael Hosch	Nicolas Salbach	Martin Kautzsch	Possible
Electrical Engineer				
Structural Engineer	not on site			
Site Operations Coordinators	Sven Teichmann	Michael Hosch		
contact water delivery + removal	Nicolás Carbonare	Martin Kautzsch	Katharina Blümke	Possible
notify appropriate inspector	Regina Gebauer	Nicolás Carbonare		
contact instrumentation	Nicolás Carbonare	Martin Kautzsch		
04. - 06.06.2022	Saturday-Monday			
contact for blower door test	Nicolás Carbonare	Martin Kautzsch		
07. - 09.06.2022	Tuesday-Thursday			
performance gap evaluation	Nicolás Carbonare	Martin Kautzsch		

Fig. VI. 1. KIT_TASK#6_2022_03_22

10.06.2022	Friday			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Michael Hosch	Possible
opening ceremony	All Team Members			
Teams Safety Officers	Regina Gebauer	Michael Hosch	Martin Kautzsch	Possible
VIP public tours	Regina Gebauer	Martin Kautzsch	Michael Hosch	Certain
jury visits CESA	Nadine Georgi	Saskia Nehr	Regina Gebauer	Remote
speed peer review	Michael Hosch	Benjamin Weber	Saskia Nehr	Certain
11.06.2022	Saturday			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Michael Hosch	Possible
Teams Safety Officers	Regina Gebauer	Michael Hosch	Martin Kautzsch	Possible
puplic tours	Benjamin Weber	Katharina Knoop	Saskia Nehr	Certain
jury visits CESA	Nadine Georgi	Saskia Nehr	Regina Gebauer	Remote
12.06.2022	Sunday			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Benjamin Weber	Possible
Teams Safety Officers	Regina Gebauer	Michael Hosch	Martin Kautzsch	Possible
puplic tours	Martin Kautzsch	Julian Schmidgruber	Benjamin Weber	Certain
jury visits CESA	Nadine Georgi	Saskia Nehr	Regina Gebauer	Remote
award ceremony (CESA)	All Team Members			
OOC award ceremony (Mirke Choice)	All Team Members			
13.06.2022	Monday			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Benjamin Weber	Possible
Teams Safety Officers	Regina Gebauer	Michael Hosch	Martin Kautzsch	Possible
privileged feed-in	Nicolás Carbonare	Martin Kautzsch		
contact for sound insulation test	Nicolás Carbonare	Martin Kautzsch		
washing	Saskia Nehr	Katharina Knoop	Julian Schmidgruber	Possible
drying	Saskia Nehr	Katharina Knoop	Julian Schmidgruber	Possible
dish washing	Saskia Nehr	Katharina Knoop	Julian Schmidgruber	Possible
oven	Saskia Nehr	Katharina Knoop	Julian Schmidgruber	Possible
cooking	Saskia Nehr	Katharina Knoop	Julian Schmidgruber	Possible
home electronics	Benjamin Weber	Michael Hosch	Martin Kautzsch	Possible
hot water draws	Nicolás Carbonare	Martin Kautzsch	Michael Hosch	Possible
beverages delivery	Benjamin Weber	Michael Hosch	Martin Kautzsch	Possible
food retrieval	Saskia Nehr	Katharina Knoop	Julian Schmidgruber	Possible
control interior & exterior lighting	Martin Kautzsch	Nicolás Carbonare	Michael Hosch	Possible

Fig. VI. 2. KIT_TASK#6_2022_03_22

14.06.2022	Tuesday			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Michael Hosch	Possible
Teams Safety Officers	Regina Gebauer	Michael Hosch	Martin Kautzsch	Possible
demand side management	Martin Kautzsch	Nicolás Carbonare		
jury visits Affordability & Viability	Regina Gebauer	Julian Schmidgruber		
contact for sound insulation test	Martin Kautzsch	Nicolás Carbonare		
washing	Saskia Nehr	Katharina Knoop	Regina Gebauer	Possible
drying	Saskia Nehr	Katharina Knoop	Regina Gebauer	Possible
dish washing	Saskia Nehr	Katharina Knoop	Regina Gebauer	Possible
oven	Saskia Nehr	Katharina Knoop	Regina Gebauer	Possible
cooking	Saskia Nehr	Katharina Knoop	Regina Gebauer	Possible
home electronics	Benjamin Weber	Michael Hosch	Martin Kautzsch	Possible
hot water draws	Nicolás Carbonare	Martin Kautzsch	Benjamin Weber	Possible
beverages delivery	Benjamin Weber	Michael Hosch		
dinner hosts	Saskia Nehr	Katharina Knoop		
dinner visitors	Michael Hosch	Benjamin Weber		
user friedliness	Michael Hosch	Benjamin Weber		
beverages delivery	Benjamin Weber	Michael Hosch	Martin Kautzsch	Possible
dinner shopping	Saskia Nehr	Katharina Knoop		
food retrieval	Saskia Nehr	Katharina Knoop		
control interior & exterior lighting	Martin Kautzsch	Nicolás Carbonare	Benjamin Weber	Possible
15.06.2022	**Wednesday**			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Michael Hosch	Possible
Teams Safety Officers	Regina Gebauer	Michael Hosch	Martin Kautzsch	Possible
jury visits Engineering & Construction	Martin Kautzsch	Nicolás Carbonare		
jury visits Affordability & Viability	Regina Gebauer	Julian Schmidgruber		
contact for sound insulation test	Nicolás Carbonare	Martin Kautzsch		
washing	Benjamin Weber	Michael Hosch		
drying	Benjamin Weber	Michael Hosch		
dish washing	Benjamin Weber	Michael Hosch		
oven	Benjamin Weber	Michael Hosch		
cooking	Benjamin Weber	Michael Hosch		
home electronics	Benjamin Weber	Michael Hosch		
hot water draws	Nicolás Carbonare	Martin Kautzsch	Benjamin Weber	Possible
dinner hosts	Saskia Nehr	Katharina Knoop		
dinner visitors	Julian Schmidgruber	Martin Kautzsch		
user friedliness	Julian Schmidgruber	Martin Kautzsch		
beverages delivery	Saskia Nehr	Katharina Knoop		
dinner shopping	Saskia Nehr	Katharina Knoop		
food retrieval	Saskia Nehr	Katharina Knoop		
control interior & exterior lighting	Martin Kautzsch	Nicolás Carbonare	Benjamin Weber	Possible

Fig. VI. 3. KIT_TASK#6_2022_03_22

16.06.2022	Thursday			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Benjamin Weber	Possible
Teams Safety Officers	Regina Gebauer	Michael Hosch	Martin Kautzsch	Remote
puplic tours	Saskia Nehr	Katharina Knoop	Benjamin Weber	Certain
jury visits Engineering & Construction	Martin Kautzsch	Nicolás Carbonare		Remote
jury visits Sustainability	Regina Gebauer	Katharina Blümke	Michael Hosch	Possible
washing	Katharina Knoop	Julian Schmidgruber		
drying	Katharina Knoop	Julian Schmidgruber		
dish washing	Katharina Knoop	Julian Schmidgruber		
oven	Katharina Knoop	Julian Schmidgruber		
cooking	Katharina Knoop	Julian Schmidgruber		
home electronics	Benjamin Weber	Michael Hosch		
hot water draws	Nicolás Carbonare	Martin Kautzsch	Michael Hosch	Possible
award ceremony (Affordability & Viability)	All Team Members			
control interior & exterior lighting	Martin Kautzsch	Nicolás Carbonare	Michael Hosch	Possible
17.06.2022	**Friday**			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Benjamin Weber	Possible
Teams Safety Officers	Regina Gebauer	Michael Hosch	Martin Kautzsch	Remote
puplic tours	Michael Hosch	Saskia Nehr	Katharina Knoop	Certain
contact water delivery + removal	Nicolás Carbonare	Martin Kautzsch	Katharina Blümke	Possible
jury visits Sustainability	Regina Gebauer	Katharina Blümke	Michael Hosch	Remote
dish washing	Martin Kautzsch	Benjamin Weber		
oven	Martin Kautzsch	Benjamin Weber		
home electronics	Martin Kautzsch	Benjamin Weber		
hot water draws	Nicolás Carbonare	Martin Kautzsch	Michael Hosch	Possible
food retrieval	Martin Kautzsch	Benjamin Weber		
award ceremony (Engineering & Construction)	Saskia Nehr	Katharina Knoop		
OOC award ceremony (Indoor Air Quality)	All Team Members			
OOC award ceremony (Solar)	All Team Members			
control interior & exterior lighting	Martin Kautzsch	Nicolás Carbonare	Michael Hosch	Possible
18.06.2022	**Saturday**			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Michael Hosch	Possible
Teams Safety Officers	Regina Gebauer	Michael Hosch	Martin Kautzsch	Remote
puplic tours	Benjamin Weber	Katharina Blümke	Regina Gebauer	Certain
dish washing	Katharina Knoop	Saskia Nehr		
oven	Katharina Knoop	Saskia Nehr		
home electronics	Katharina Knoop	Saskia Nehr		
hot water draws	Nicolás Carbonare	Martin Kautzsch	Benjamin Weber	Possible
award ceremony (Sustainability)	All Team Members			
OOC award ceremony (Craft)	All Team Members			
control interior & exterior lighting	Martin Kautzsch	Nicolás Carbonare	Benjamin Weber	Possible

Fig. VI. 4. KIT_TASK#6_2022_03_22

19.06.2022	Sunday			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Michael Hosch	Possible
Teams Safety Officers	Regina Gebauer	Michael Hosch	Nicolas Salbach	Possible
puplic tours	Saskia Nehr	Katharina Knoop	Michelle Montnacher	Certain
dish washing	Johannes Hasselmann	Nicolas Salbach		
oven	Johannes Hasselmann	Nicolas Salbach		
home electronics	Johannes Hasselmann	Nicolas Salbach		
hot water draws	Nicolás Carbonare	Martin Kautzsch	Benjamin Weber	Possible
OOC award ceremony (Timber Construction)	All Team Members			
control interior & exterior lighting	Martin Kautzsch	Nicolás Carbonare	Benjamin Weber	Possible

20.06.2022	Monday			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Benjamin Weber	Possible
Teams Safety Officers	Regina Gebauer	Michael Hosch	Nicolas Salbach	Possible
privileged feed-in	Nicolás Carbonare	Martin Kautzsch		
contact for sound insulation test	Nicolás Carbonare	Martin Kautzsch		
washing	Katharina Knoop	Michelle Montnacher		
drying	Katharina Knoop	Michelle Montnacher		
dish washing	Johannes Hasselmann	Nicolas Salbach		
oven	Johannes Hasselmann	Nicolas Salbach		
cooking	Johannes Hasselmann	Nicolas Salbach		
home electronics	Benjamin Weber	Dominic Faltien		
hot water draws	Martin Kautzsch	Michael Hosch	Michael Hosch	Possible
beverages delivery	Nicolas Salbach	Johannes Hasselmann		
food retrieval	Katharina Knoop	Saskia Nehr		
control interior & exterior lighting	Martin Kautzsch	Nicolás Carbonare	Michael Hosch	Possible

21.06.2022	Tuesday			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Benjamin Weber	Possible
Teams Safety Officers	Regina Gebauer	Michael Hosch	Nicolas Salbach	Possible
demand side management	Nicolás Carbonare	Martin Kautzsch		
contact for sound insulation test	Nicolás Carbonare	Martin Kautzsch		
washing	Stefanie Chrisl	Michelle Montnacher		
drying	Stefanie Chrisl	Michelle Montnacher		
dish washing	Sven Teichmann	Julian Raupp		
oven	Sven Teichmann	Julian Raupp		
cooking	Sven Teichmann	Julian Raupp		
home electronics	Jonas Ernst	Michelle Montnacher		
hot water draws	Jonas Ernst	Michelle Montnacher	Michael Hosch	Possible
dinner hosts	Dominic Faltien	Johannes Hasselmann		
dinner visitors	Saskia Nehr	Katharina Knoop		
user friedliness	Saskia Nehr	Katharina Knoop		
jury visits Urban Mobility	Nicolas Salbach	Johannes Hasselmann		
beverages delivery	Benjamin Weber	Michael Hosch		
dinner shopping	Dominic Faltien	Johannes Hasselmann		
food retrieval	Dominic Faltien	Johannes Hasselmann		
control interior & exterior lighting	Martin Kautzsch	Benjamin Weber	Michael Hosch	Possible

Fig. VI. 5. KIT_TASK#6_2022_03_22

22.06.2022	Wednesday			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Michael Hosch	Possible
Teams Safety Officers	Regina Gebauer	Michael Hosch	Nicolas Salbach	Possible
puplic tours	Michelle Montnacher	Julian Raupp	Stefanie Christl	Certain
jury visits Architecture	Regina Gebauer	Michael Hosch	Katharina Blümke	Possible
washing	Dominic Faltien	Benjamin Weber		
drying	Dominic Faltien	Benjamin Weber		
dish washing	Sven Teichmann	Saskia Nehr		
oven	Sven Teichmann	Saskia Nehr		
cooking	Sven Teichmann	Saskia Nehr		
home electronics	Julian Raupp	Martin Kautzsch		
hot water draws	Julian Raupp	Martin Kautzsch	Benjamin Weber	Possible
jury visits Urban Mobility	Nicolas Salbach	Johannes Hasselmann		
award ceremony (Energy | Comfort | Functioning)	All Team Members			
OOC award ceremony (BIM)	All Team Members			

23.06.2022	Thursday			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Michael Hosch	Possible
Teams Safety Officers	Regina Gebauer	Michael Hosch	Nicolas Salbach	Possible
puplic tours	Johannes Hasselmann	Jonas Ernst	Benjamin Weber	Certain
jury visits Architecture	Regina Gebauer	Michael Hosch	Katharina Blümke	Possible
award ceremony (Urban Mobility)	All Team Members			
OOC award ceremony (Applied Mobility Sciences)	All Team Members			
OOC award ceremony (German Sustainable Housing)	All Team Members			

24.06.2022	Friday			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Benjamin Weber	Possible
Teams Safety Officers	Regina Gebauer	Michael Hosch	Nicolas Salbach	Possible
puplic tours	Katharina Knoop	Dominic Faltien	Sven Teichmann	Certain
award ceremony (Architecture | Innovation | Final)	All Team Members			

25.06.2022	Saturday			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Benjamin Weber	Possible
Teams Safety Officers	Regina Gebauer	Michael Hosch	Nicolas Salbach	Possible
puplic tours	Saskia Nehr	Martin Kautzsch	Nicolas Salbach	Certain
OOC award ceremony (Human Centered Interior Arch.)	All Team Members			
OOC award ceremony (Sustainable Arch. Lighting)	All Team Members			

26.06.2022	Sunday			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Michael Hosch	Possible
Teams Safety Officers	Regina Gebauer	Michael Hosch	Nicolas Salbach	Possible
puplic tours	Johannes Hasselmann	Nicolas Salbach	Katharina Knoop	Certain
OOC award ceremony (People's Choice)	All Team Members			

Fig. VI. 6. KIT_TASK#6_2022_03_22

28.06. - 03.07.2022	Disassembly Phase			
team/organiser meeting	Regina Gebauer	Nicolás Carbonare	Michael Hosch	Possible
disassembly	All Team Members			
Faculty Advisor	Dirk Hebel			
Project Manager	Regina Gebauer	Nicolás Carbonare	Katharina Blümke	Possible
Health and Safety Team Coordinator	Regina Gebauer	Michael Hosch		
Teams Safety Officers	Michael Hosch	Martin Kautzsch	Stefanie Christl	Possible
Electrical Engineer				
Structural Engineer	not on site			
Site Operations Coordinators	Sven Teichmann	Stefanie Christl	Regina Gebauer	Remote
contact water delivery + removal	Nicolás Carbonare	Martin Kautzsch		
notify appropriate inspector	Regina Gebauer	Nicolás Carbonare		
contact instrumentation	Nicolás Carbonare	Martin Kautzsch		

Fig. VI. 7. KIT_TASK#6_2022_03_22

VII. Cost Estimate and Project Financial Summary Cost

1. Business & Fund-Raising Plan

To be able to realize our project, we are dependent on many supporters. We need sponsors and partners who support us both financially and materially and help us to implement the House Demonstration Unit in Wuppertal.
The organizers (Energy Endeavour Foundation from the USA), the Federal Government in the form of the Federal Ministry for Economic Affairs and Energy, the State of Baden-Württemberg with its timber construction initiative, the Karlsruhe Institute of Technology (KIT) in the form of personnel costs, and the Faculty of Architecture with its financial support possibilities are already helping us from the public side. For sustainability reasons, we also decided, together with the President of KIT, to bring the structure back to Karlsruhe (Germany) to the KIT after the jury's assessment and to present it to an interested public and make it accessible. In addition to the building process, the transport,installation and dismantling at the Solar Decathlon Site and the return transport and reconstruction in Karlsruhe require a large amount of resources, which we can only raise through a large number of supporters.
In order to attract as many sponsors as possible and reach our fundraising goal, we have created a plan in which we define our main target groups and how we want to reach them.

1.1 Attraction of Sponsors

In order to raise attention of possible sponsors, we have chosen various methods:

- We contact possible sponsors via their website or by mail with a request and exact information about our project plan. Through this direct way of contacting, we can send precisely customized requests and leave a more personal impression.
- By being present at public events and specially organized events, we want to address the broad masses and make our project accessible especially to people who have no direct connection to the industry. We want to achieve this, for example, through bake sales and also presentations in schools.
- With the help of posters and spray chalk actions we would like to arouse interest, which will attract sponsors to our website.
- In the following months, we will launch a crowdfunding section on our website to enable donations from individuals and friends.
- We are planning a cooperation with an artist, in which we will design T-shirts together with her and thus generate attention for our project.

1.2 Key Sponsors

We want to reach sponsors who can identify with our sustainable approach and are interested in implementing challenging solutions that are not yet common in the industry.

- Public organisations and foundations
- Building and consulting partners
- Financing partners

1.3 Sponsorship

We rely both on monetary sponsorship and on donations of materials and expertise. In order to give something back to the sponsors for their performance, we have come up with three comprehensive categories depending on the donation amount and coinciding with the rules of passive sponsoring.

RoofKIT Silver: The contribution will be between 400 and 8.000 EUR

- You and your logo will be listed on the homepage and social media feeds (without linking to the sponsor's homepage/social media channels (so-called tagging)) in the Silver category.
- You and your logo will be presented on a construction sign (without special highlighting) during the construction in Wuppertal.
- You and your logo will be listed on a joint sign under the silver category at the entrance area of the publicly accessible unit after the structure has been returned to Karlsruhe.

RoofKIT Gold: The contribution will be between 8.000 and 15.000 EUR

- You and your logo will be listed on the homepage and social media feeds (without linking to the sponsor's homepage/social media channels (so-called tagging)) in the Gold category.
- You and your logo will be presented on a construction sign (without special highlighting) during the construction in Wuppertal.
- You will be invited to events, receive press releases and photos of the project for your information.
- You and your logo will be listed on a joint sign under the category Gold at the entrance of the publicly accessible unit after the return of the construction to Karlsruhe.

RoofKIT Platinum: The contribution will be over 15.000 EUR

- You and your logo will be listed on the homepage and social media feeds (without linking to the sponsor's homepage/social media channels (so-called tagging)) in the Platinum category.
- You and your logo will be presented on a construction sign (without special highlighting) during the construction in Wuppertal.

- You will be invited to events, receive press releases and photos of the project for your information.
- You and your logo will appear on all work clothing (T-shirts, jackets, caps).
- You and your logo will be listed on a joint sign under the Platinum category at the entrance of the publicly accessible unit after the building has been returned to Karlsruhe.
- VIP tours with the RoofKIT team can be booked in Wuppertal and Karlsruhe.

For the HDU, we mainly ask for donations in kind in order to use the materials directly and to comply with our overall theme, urban mining. This is the perfect way we can use stock goods from companies and return them or sell them on.

2. Cost Estimate & Project Summary Budget

Based on the current planning status, we made a cost estimate and also outlined our current income details. For more details see KIT_COST#6_2022_03_23.xslx

2.1 Cost form

table1_COST FORM						
			SDE 21/22 COMPETITION			
			Lead applicant's abbreviation			
			KIT			
			RoofKIT			
Nº	Name		Description	Cost		% Total
				excluding VAT	including VAT*	on ex VATA
Full Cost Calculation						
3.	DIRECT MATERIALS			158.185,48 €	195.290,71 €	15,19%
4.	DIRECT LABOUR			304.427,48 €	375.836,39 €	29,23%
5.	LABOUR OVERHEAD			308.149,92 €	380.432,00 €	29,59%
6.	CONSULTANTS			90.161,06 €	111.309,95 €	8,66%
7.	OTHER DIRECT COSTS			19.683,00 €	24.300,00 €	1,89%
8.	TRAVEL AND OTHER COST FOR FINAL PHASE			69.915,54 €	86.315,48 €	6,71%
9.	ASSEMBLY, TRANSPORT AND DISASSEMBLY PROCECCES			87.332,18 €	107.817,51 €	8,39%
10.	INSURANCE POLICIES			3.645,00 €	4.500,00 €	0,35%
			Personnel	**1.041.499,65 €**	**1.285.802,04 €**	**100,00%**

*Local expenses are calculated with local VAT rate. Expenses in Germany are calculated with German VAT rate. If you are in the position to be input tax deductible, please copy the whole column one step to the left.

Fig. VII. 1. Sheet 01 Cost Form KIT_COST#6_2022_03_23

2.2 Income Details

table2_INCOME DETAILS			
Company Name	**Collaboration Details**	**Amount of support**	**% Total**
Institutional Support			
Solar Decathlon Europe 21/22	donation	100.000,00 €	7,33%
Timber construction initiative	donation	80.000,00 €	5,87%
Karlsruhe Institute of Technology	donation	350.000,00 €	25,67%
Faculty of Architecture	donation	20.000,00 €	1,47%
Volkswohnung Karlsruhe GmbH	donation	10.000,00 €	0,73%
Hilti	donation	10.000,00 €	0,73%
Ratisbona	donation	19.997,00 €	1,47%
Toto Lotto	donation	15.001,00 €	1,10%
Wolff Müller	donation	3.000,00 €	0,22%
Sparkasse Umweltstiftung	donation	2.500,00 €	0,18%
Bosch	donation	15.000,00 €	1,10%
Ingenieurgruppe Bauen	donation	8.001,00 €	0,59%
Becken	donation	25.000,00 €	1,83%
Fischer	donation	?	
BMWK	donation	538.000,00 €	39,46%
		1.196.499,00 €	87,76%
Industrial Partners & Sponsors			
2HS	hours	15.000,00 €	1,10%
LUNOS	material	6.424,38 €	0,47%
Rotor DC	material	2.500,00 €	0,18%
Bosch	material	11.021,00 €	0,81%
Hans Grohe	material	2.892,40 €	0,21%
Fischer	material	?	
Tecu Kupfer	material	9.000,00 €	0,66%
Weru	material	14.500,00 €	1,06%
Roma	material	10.000,00 €	0,73%
Magna Glaskeramik	material	10.188,16 €	0,75%
Wieland	material	5.140,90 €	0,38%
Nimbus	material	3.420,00 €	0,25%
Neptutherm	material	9.000,00 €	0,66%
FREITAG	material	1.000,00 €	0,07%
Open Project	material	3.753,00 €	0,28%
Jung	material	5.000,00 €	0,37%
BYD	material	3.500,00 €	0,26%
VZug	material	1.851,15 €	0,14%
ECOR	material	2.288,00 €	0,17%
DOKA	material	5.000,00 €	0,37%
Fronius	material	1.889,00 €	0,14%
Rewall	material	300,00 €	0,02%
Implenia	material	8.000,00 €	0,59%
Lastenvelo Freiburg	material	6.000,00 €	0,44%
AxSun	material	6.875,82 €	0,50%
Doerken	material	800,00 €	0,06%
Ölfass Äthiopien	material	100,00 €	0,01%
Solator	material	4.084,80 €	0,30%
Claytech	material	4.084,80 €	0,30%
M&K Filze	material	6.173,72 €	0,45%
Velux	material	5.000,00 €	0,37%
Dörken	material	1.071,60 €	0,08%
AMANN	material	1.061,70 €	0,08%
		166.920,43 €	12,24%
Other Income Details			
			0,00%
		0,00 €	0,00%
Total		**1.363.419,43 €**	**100,00%**

Fig. VII. 2. Sheet 02 Income Details KIT_COST#6_2022_03_23

2.3 Direct Material

Fig. VII. 3. Sheet 03 direct materialsKIT_COST#6_2022_03_23

table3_DIRECT MATERIALS						
No.	description	UNIT of MEAS.	QUANTITY	PRICE €	TOTAL	%
1.	CONSTRUCTION					35%
1	Claytec wall construction					
2	Claytec finishing plaster	m2	65		4084,80	
3	Claytec concealed plaster	m2	65			
4	Claytech clay building board heavy	m2	175		3149,00	
5	PE film ecovap blue	Stck.	2		1061,70	
6	Diagonal formwork old wood 20 mm visible	m3	50		2675,00	
7	Diagonal formwork 20 mm					
8	seagrass insulation	m2	300			
9	Facade film underlay open joints	m2	70			
10	Roof underlay sucotecto	m2				
11	Underlay facade closed Tyvek Soft		50m2			
12						
13	Reclaimed wood sunburned (facade) 14-16mm	m2	90		4815,00	
14	felt blanket (white)	m2	90		2326,69	
15	felt walls (grey)					
16	ECOR panels cover and core	m2	80		2288,00	
17	tin roof	m2	75		9000,00	
18	Floor covering 1 (wooden floorboards old)	m2	30		78,75	
19	Flooring 2 (wooden floorboards new)					68989,94
20	Wooden floorboards with milling for FBH					
21	Reclaimed wood structure north facade	m3	1		1600,00	
22	Processing waste wood (Rieger)				650,00	
23	Façade covering on the east and north sides	Stck.	20x 2,4x2,4m		1000,00	
24	Façade covering processing				3000,00	
25	Façade covering pressure				2000,00	
26	Window facade in situ	Stck.	4		2154,00	
27	Window facade 4x weru west, south, north	Stck.	4		14500,00	
28	Window storage window at FG	Stck.	10		500,00	
29	skylight	Stck.			5000,00	
30	entrance	Stck.	1		300,00	
31	Sun protection punched window	Stck.	6			
32	Fronts wet area (kitchen, bathroom)	m2	20		3807,00	
33	magna glass	Stck.	8		5000,00	
34	Stainless steel ceiling/floor					
35	Gap elements warehouse window facade					
36	Fall protection window, terrace module					
37	Device stairs (safety)					
38	Rain gutters including drip steel cable?					
2.	TGA: HEAT SUPPLY					21%
39	Colored PVT modules	Stck.	8		6875,82	
40	PVT retrofit	Stck.	12		3176,00	
41	Substructure PVT	Stck.	18			
42	solar pump group	Stck.	1			
43	monitoring item					
44	Heat pump with DHW tank 185L	Stck.	1		26000,00	40921,82
45	buffer storage	Stck.	1			
46	heatsinks	Stck.	280		1280,00	
47	Heating pipes copper 14mm	lfm	400		3200,00	
48	connectors	Stck.	1		200,00	
49	Heating circuit distributor + MAGs (3x)	Stck.	1		190,00	
3.	TGA: VENTILATION					2%
50	Pendulum fan	Stck.	4		2400,00	
51	Exhaust fans toilet and shower	Stck.	2		400,00	4800,00
52	KNX fan control + Extra Silvento	Stck.	1		2000,00	
53	Link	Stck.	2			
4.	TGA: WATER					3%
54	Pipe insulation cork				2800,00	
55	water pump	Stck.	1		412,00	5012,00
56	Pipeline (fresh cold water - copper pipes)	m2	60		1800,00	
57	Pipeline (waste water - stainless steel)					
5.	TGA: ELECTRIC					7%
58	battery storage	Stck.	1		3500,00	
59	PV inverter	Stck.	1		1889,00	
60	Sun protection control for punched windows	Stck.	6			
61	Skylight window opening control	Stck.	2			
62	Skylight darkening control	Stck.	1			
63	Sun protection switch					
64	KNX actuators and gateways					
65	grounding HDU				500,00	13363,95
66	Switch + sockets				5000,00	
67	monitor				1500,00	
68	Raspberry Pi	Stck.	1		174,95	
69	Distribution box + MP + house connection box	Stck.	1		300,00	
70	fuses and cable routing	Stck.	1		300,00	
71	TV					
72	FRITZBOX 6850 LTE				200,00	
7.	STRUCTURE FIRST FLOOR					10%
73	Foundation plates lift, stairs, Eurex supports	Stck.				
74	Scaffolding DOKA				5000,00	
75	Erection/dismantling of scaffolding DOKA				800,00	
76	Load distribution primary beam steel				1000,00	
77	scaffold lift	Miete			8800,00	
78	stairway		1		960,00	20004,00
79	Gratings for platform				240,00	
80	Old steel tubes for railings				204,00	
81	Conversion/construction of stairs				3000,00	
82	ballasts					
83	dowel ballasting					
8.	LIGHTING					6%
84	light switch					
85	LED strip wet cells	lfm	6		668,00	
86	LED strip cube	lfm	11		1293,00	
87	LED strip kitchen	lfm	50		500,00	
88	Pendant lamp above table (mushroom)	Stck.	3			
89	Winglets NIMBUS 3x set of 3 = 9 pcs.	Stck.	3		1680,00	
90	Roxanne Nimbus 3 pcs.	Stck.	3		1740,00	12081,00
91	Ceiling light technical room				300,00	
92	Wallwasher entrance area 2x				1000,00	
93	LED strip stair/elevator	lfm	70		700,00	
94	Spotlights on the lower edge of the terrace module	Stck.	3		600,00	
95	Ceiling wash under unit 2x	Stck.	2		1600,00	
96	small spotlights on scaffolding towers (possibly colored)				2000,00	
9.	FURNISHING					8%
97	built-in oven	Miete	1		1950,00	
98	built-in cooker	Miete	1		1790,00	
99	suction	Miete	1		1549,00	
100	Sink	Stck.	1			
101	Built-in fridge/freezer	Miete	1		100,00	
102	Washing machine	Miete	1		500,00	
103	Sink/shower fittings, washbasin	Stck.			500,00	
104	toilet (hanging toilet)	Stck.	1		120,00	
105	sink bathroom	Stck.	1			
106	Dishwasher 45 cm	Stck.	1		299,00	
107	mirror (in front of sink)		1		200,00	
108	Cistern (toilet) including substructure	Stck.	1		300,00	
109	toilet accessories	Stck.	1		50,00	
110	curtain	m2				
111	curtain track	lfm				
112	lounge chairs	Stck.	2		300,00	
113	lounge table	Stck.	1		100,00	
114	bed	Stck.	1		598,00	
115	mattress	Stck.	1		549,00	14768,00
116	Dining table + benches Mohr	Stck.	1		2640,00	
117	Desk made from old doors	Stck.	1		1000,00	
118	Roller cabinet businessman	Stck.	1			
119	Stainless steel fronts and surfaces					
120	Wall structure layer model				500,00	
121	Cooking pot for the House Functioning Contest					
122	Tableware sets 8x				300,00	
123	Cutlery 8x					
124	Shower hose for House Functioning Contest				100,00	
125	smoke detector	Stck.			100,00	
126	fire extinguisher	Stck.	1		100,00	
127	Clothes rack 2x		2		348,00	
128	bedding?				100,00	
129	First aid kit				60,00	
130	Take the escape plan position point sticker with you					
131	Coat hooks 6x		6		90,00	
132	felt overcoat		25		525,00	
133	Cleaning agent environmentally friendly					
134	Padlock Container Wuppertal					
10.	EXTERIOR					3%
135	Fresh and waste water tanks 2x	Stck.	2	250	500,00	
136	rain barrels 2x	Stck.	2		500,00	
137	Earthworks/Flooring	m2	20		1000,00	
138	ballasting scaffolding (gabions)				3000,00	6500,00
139	stone cycling				1200,00	
140	crushed sand				300,00	
141	cargo bike					
11.	BUILDING SITE EQUIPMENT					1%
142	Rent Steiger assembly roof and facade				800,00	
143	Rent a truck crane				1600,00	
144						2400,00
145						
146						
12.	TRANSPORT COSTS					3%
147	rotor DC materials				500,00	
148	Foil covering material transport				300,00	
149	Claytec Transport				500,00	
150	transportation thermal insulation				500,00	
151	transportation devices				500,00	
152	Roof covering / PV transport				1000,00	
153	Rieger waste wood etc.				1000,00	6450,00
154	Smile Plastics					
155	magna				500,00	
156	ECOR				800.87	
157	Restado				650,00	
158	Staircase from KA to Reuthe				500,00	
159	StoneCycling				500,00	
					TOTAL €	195.290,71

2.4 Direct Labour

Fig. VII. 4. Sheet 04 direct labour KIT_COST#6_2022_03_23

table4_DIRECT LABOUR						
No.	description	UNIT of MEAS.	QUANTITY	PRICE €	No. OF LABOURS	TOTAL €
1.	**LABOURERS**					
1.1	Kaufmann Zimmerei und Tischlerei					
	Modul planning					26.733
	Construction					346.103
1.2	Solator GmbH					
	Assembly	day	3	1000	1	3000
1.3						
						0
1.4						
						0
1.5						
						0
					TOTAL	**375.836**

2.5 Labour Overhead

Fig. VII. 5. Sheet 05 direct overhead KIT_COST#6_2022_03_23

table5_LABOUR OVERHEAD						
No.	description	UNIT of MEAS.	QUANTITY	PRICE €	No. OF LABOURS	TOTAL €
1.	**PROFESSORS AND RESEARCHERS**					
1.1	KIT					
	professors					36.400
	researchers					324.000
2.	**GRANTED STUDENTS**					
2.1	KIT					
	students	hours	1600	12,52		20.032
						0
3.	**ADMINISTRATIVES**					
3.1						
						0
						0
					TOTAL	**380.432**

2.6 Consultants

Fig. VII. 6. Sheet 06 Consultants KIT_COST#6_2022_03_23

table6_CONSULTANTS						
No.	description	UNIT of MEAS.	QUANTITY	PRICE €	No. OF LABOURS	TOTAL €
1.	**Consultants**					
1.1	Kaufmann Zimmerei und Tischlerei					
	timbPlanning of module construction and technical services					26.733,35
1.2	ip5 Ingenieurpartnerschaft					
	building performance simulation					9.960,00
1.3	K+P GmbH Ingenieurbüro für Elektrotechnik					
	planning of electrical systems					5.878,60
1.4	FZI					
	planning of energy management system					59.738,00
1.5	Inspecting structural engineer					
	inspection	hours				4.000,00
	statics					5.000,00
					TOTAL	**111.310**

2.7 Other direct costs

Fig. VII. 7. Sheet 07 other direct costs KIT_COST#6_2022_03_23

table7_OTHER DIRECT COSTS					
No.	description	UNIT of MEAS.	QUANTITY	PRICE €	TOTAL €
1.	**GENERAL & ADMINISTRATIVE EXPENSES**				
1.1	INDIRECT EXPENSES				
	buffer future costs				8.536,42
1.2	SECURITY				
	KIT				0
1.3	MODEL				
	material		1	957,58	957,58
	transport		1	476	476,00
1.4	COMMUNICATION ACTIVITIES				
	flyer	1	post	30	30,00
	communication materials	1	post	300	300,00
	film documentation	1	post	9000	9.000,00
	photography documentation	1	post	5000	5.000,00
				TOTAL	**24.300**

2.8 Travel and other costs

Fig. VII. 8. Sheet 08 other costs KIT_COST#6_2022_03_23

table8_TRAVEL AND OTHER COST FOR FINAL PHASE					
No.	description	UNIT of MEAS.	QUANTITY	PRICE €	TOTAL €
1.	**Travel expenses**				
	traveling (bus)	post	1	2800	2.800
	Reuthe travel expenses	post	1	12600	12.600
	lodging	persons			15.475
	travel expenses Kaufmann	post	1	48241	48.241
	local expenses	post	1	5200	5.200
	miscellaneous expenses	post	1	1000	1.000
2.	**Other cost**				
	Country & Culture Day				1.000
				TOTAL	**86.315**

2.9 Assembly, Transport and Disassembly

Fig. VII. 9. Sheet 09 Assembly, transport and disassembly KIT_COST#6_2022_03_23

table9_ASSEMBLY, TRANSPORT AND DISASSEMBLY PROCECCES					
No.	description	UNIT of MEAS.	QUANTITY	PRICE €	TOTAL €
1.	**DISASSEMBLY IN ORIGIN**				
	storage	post	1	5000	5.000
2.	**TRANSPORT**				
	transport to builder	post	1	5000	5.000
	delivery Kaufmann	post			20.664
	from Wuppertal	post	10	2300	23.000
3.	**ASSEMBLY IN DESTINATION**				
	crane	post	1	6400	6.400
	scaffolding	post	1	5000	5.000
	electrician	hours	16	68	1.088
	plumber	hours	16	58	928
	assembly Kaufmann	post			28.853
	woodworkers	hours	64	44	2.816
	roofer	hours	16	52,5	840
4.	**DISASSEMBLY IN DESTINATION**				
	crane	post	1	6400	6.400
	woodworkers	hours	32	44	1.408
	roofer	hours	8	52,5	420
				TOTAL	**107.818**

2.10 Insurance Policies

Fig. VII. 10. Sheet 10 Insurance policies KIT_COST#6_2022_03_23

table10_INSURANCE POLICIES					
No.	description	UNIT of MEAS.	QUANTITY	PRICE €	TOTAL €
1.	**Insurance**				
	Insurance	post	1	4500	4.500
				TOTAL	**4.500**

VIII. Site Operations Plans

1. General Data

The House Demonstration Unit (HDU) of Team RoofKIT for the SDE21 competition is a 2-floor, corner cut-out of the Whole Design Building. As urban situation the renovation of the established Café Ada in Wuppertal was chosen, where the existing building should be extended by three further stories on top. By using the first additional story as a ballroom to host several events and activities it acts as an urban gap. The two other additional floors are used to create a space for individual and shared communal living. To reduce the weight of the structure, a lightweight wooden construction was chosen. A two-part timber frame spans the entire length of the building. An exoskeleton is placed around the ball room, as well as a truss system above, into which the modules are suspended. For further information and details see „1.1. Architectural Concept“ and „1.2. Structural Design“. The construction has an advantage by prefabricating the modules and therefore is time efficient when being assembled on the construction site. This combined with reduced restrictions on ongoing operations in the existing building, will be transferred on the (dis-) assembly of the HDU on the SDE21 Solar Campus in Wuppertal.
The first assembly period of the HDU will take place in Reuthe in Austria, where the carpenter Kaufmann will prefabricate the three living space modules, the terrace module and the four roof modules including façade, components of the energy system and the interior design. The production processes are basing on our detailed factory planning and circular constructions methods. During this process, the RoofKIT team will constantly control the prefabrication and the product requirements. The team members will have the opportunity to participate during prefabrication and thus learn more about the demonstrator unit and how the transfer from a digital to a genuine construction works.
After the prefabrication phase, the modules and further parts of the HDU will be transported to the competition site in Wuppertal according to the transport rules of the SDE21, where the unit will be assembled.

2. Site Operations Coordinators

Sven Teichmann will be responsible to organize and manage the Site Operations. Furthermore, he will be responsible for the coordination of the assembly. He will be supported by other team members and work in close consultation with the Project Architect and Project Engineer.
The site operations coordinator will be able to manage the site operations and ensure that the schedule can be maintained on the SDE21 Solar Campus. Special attention must be paid to avoiding risks and protecting all stakeholders during assembly and disassembly phases. Therefore, the Site Operations Coordinator will work in close interaction with the health and safety protection coordinator and the safety officers.

Contact information and details:

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3. Logistics outside the SDE21 Campus

As mentioned in section 1 of this chapter, mostly prefabricated elements of the HDU will be transported just-in-time from Reuthe to Wuppertal on trucks. Special attention will also be paid to additional materials that are needed for the transport e.g., bracing elements, weather protection and other materials and equipment. To ensure the cradle-to-cradle principle we will communicate with the logistic specialists that only reusable materials will be used for the transport. On the competition site, the construction methods will enable an optimal assembly of the unit before and a fast disassembly of the unit after the event phase. After the disassembly in Wuppertal, the components and parts will be transported to our hometown, Karlsruhe, where we will use the unit for a second utilization phase.

3.1. Trucks Route

The trucks that contain the prefabricated elements will leave the factory in Reuthe in Austria and arrive in Wuppertal, Germany, according to the site operations schedule. (Appendix AN) The first truck will arrive on 21 May 2022, the first day of the assembly period, after passing the road distance of about 645km, over the motorways A96, A7, A8 near Stuttgart, A5 near Karlsruhe and A3 to Wuppertal. We will use the roadhouse Höfgen at A3/A46 motorway intersection as buffer area for delivery coordination to reduce site traffic to a minimum and make just-in-time transport possible. From this roadhouse we will order the trucks to gate A of the construction site when needed.

Fig. VIII. 1. route: Austria-Wuppertal

3.2. Trucks Specifications and Shipment

As a preliminary estimation, a total of five semi-trailer trucks will be necessary to transport all the building elements from Reuthe to Wuppertal. Because of the part dimensions, all five trucks will be special transport but without the need of an police escort. We will use two-axle trucks with a length of 16.50m, a width of 2.55m, an overall height of 2,7 m and a two-axle trailer according to the EU directive 96/53/EG. Eight more trucks will be used to transport the needed equipment to Wuppertal.
Each truck will be loaded according to the construction schedule. Where the load of the carriage is not known yet an estimation is used in the following specification. The aim is to maximize the production speed and reduce the need for storing on site. On the other hand, we will use the storage containers when we transport material and equipment from Karlsruhe to Wuppertal that would not arrive just-in-time. The reason is that we aim to avoid the use of additional trucks to reduce CO2-emissions and transport costs.

The preliminary specifications of the trailers from Reuthe are following:
Truck A dimensions: 16.50 m x 2.55 m x 4 m
Turning radius: 12.5 m
Truck B dimensions: 7.00 x 2.55 x 2.70 m
Turning radius: 8 m

Machinery used for unloading: 35t crane / 100t crane for living modules
Preliminary estimated weight of the load per truck: 12 tons
The order of entry corresponds to the truck numbers.

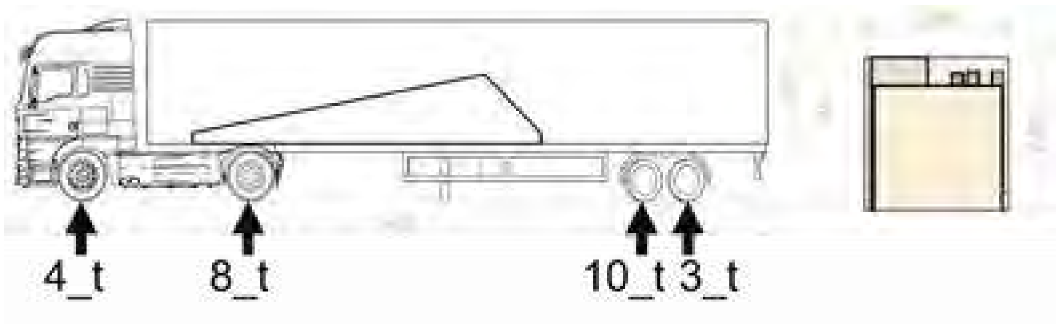
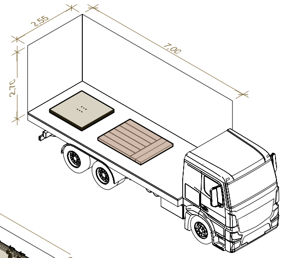
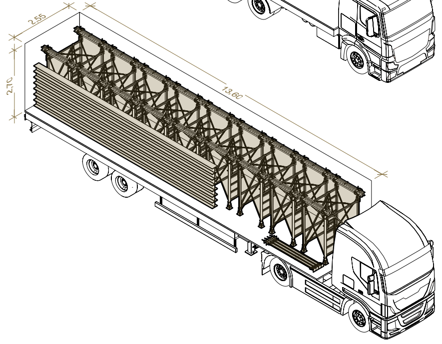


Fig. VIII. 2. route: Austria-Wuppertal

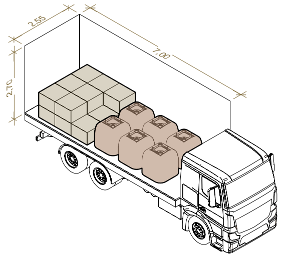
Truck 1: Steel Plates and Strip Footings
Truck dimensions: 7.00 x 2.55 x 2.70 m
Load weight: 5 t



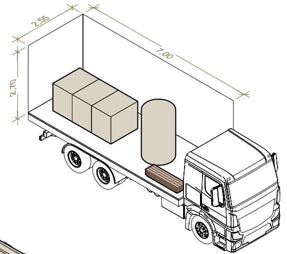
Truck 2: DOKA scaffold
Truck dimensions: 13.60 x 2.55 x 2.70 m
Load weight: 6 t



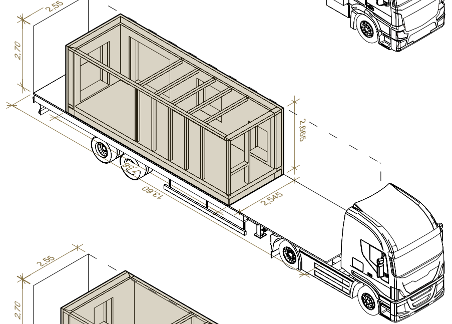
Truck 3: Gabions and Stones
Truck dimensions: 7.00 x 2.55 x 2.70 m
Load weight: 5 t



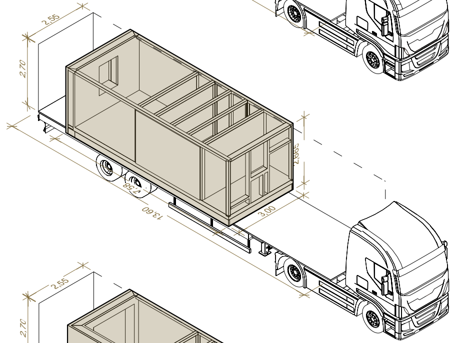
Truck 4: Buffer Storage and Tanks
and Seating Boards
Truck dimensions: 7.00 x 2.55 x 2.70 m
Load weight: 3 t



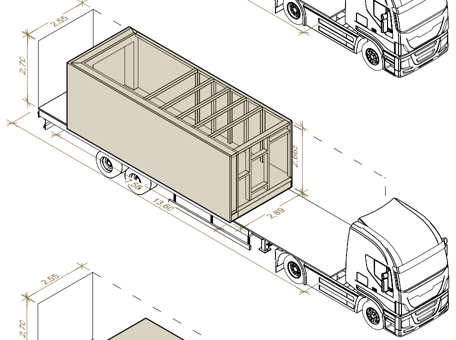
Truck 5: prefabricated living
module number 1
Truck dimensions: 13.60 x 2.55 x 2.70 m
Load weight: 9 t



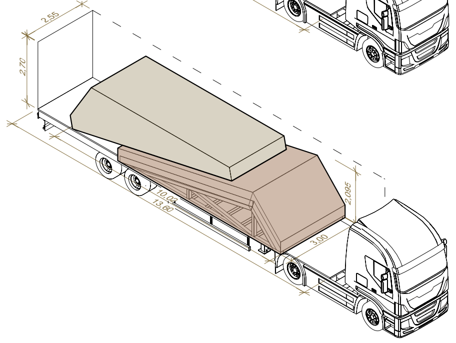
Truck 6: prefabricated living
module number 2
Truck dimensions: 13.60 x 2.55 x 2.70 m
Load weight: 9 t



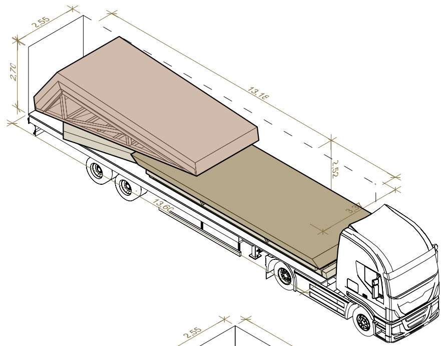
Truck 7: prefabricated living
module number 3
Truck dimensions: 13.60 x 2.55 x 2.70 m
Load weight: 9 t



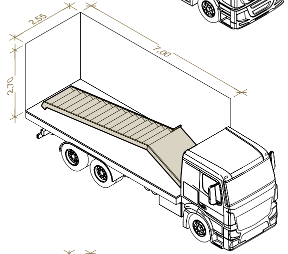
Truck 8: prefabricated roof modules
number 1 and 2
Truck dimensions: 13.60 x 2.55 x 2.70 m
Load weight: 9 t



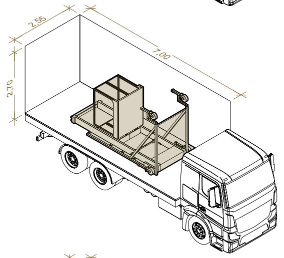
Truck 9: prefabricated roof
module number 3,
roof terrace module, terrace module
Truck dimensions: 13.60 x 2.55 x 2.70 m
Load weight: 9 t



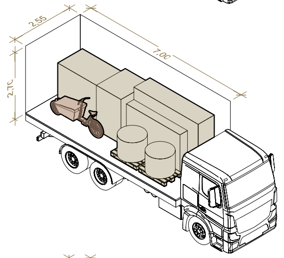
Truck 10: Stairs
Truck dimensions: 7.00 x 2.55 x 2.70 m
Load weight: 2 t



Truck 11: Elevator
Truck dimensions: 7.00 x 2.55 x 2.70 m
Load weight: 2 t



Truck 12: Furniture, Cargo bike
Truck dimensions: 7.00 x 2.55 x 2.70 m
Load weight: 1 t



Truck 13: Paving Stones
Truck dimensions: 7.00 x 2.55 x 2.70 m
Load weight: 5 t

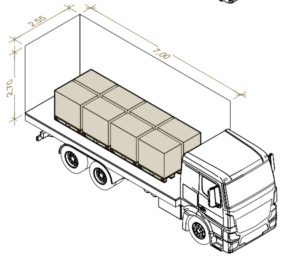


Fig. VIII. 3. Turcks with Load

4. Logistics on the SDE21 Solar Campus

4.1 Infrastructures

All materials required for the construction will be transported to the Solar Campus by ten trucks, as already described in „3.2 Trucks Specifications and Shipment".
We have chosen the location for the truck as shown in the transport logistics manual to ensure sufficient space for the crane and its slewing capability. By using the given loading zone, the truck traffic will not affect other teams by minimizing the parking effort and therefore avoiding blocking the street.
On the operation area between the crane and the parking area, we placed an unloading area that acts as a temporary buffer and enables us to work on the modules before their assembly. It is furthermore used to minimize the parking time of the truck so that it can leave the construction site quickly since the cargo can be directly put onto the unloading area. Furthermore, an equipment area is set up next to the unloading area to provide the necessary tools for the montage.
The crane itself is positioned next to the House Demonstration Unit in the operation area. This ensures optimal loading and assembly of the individual beams and modules. The crane is positioned to easily access the truck, the unloading area and the demonstration unit without slewing over leisure and public areas.
At the southern side of our operation area, we placed the health and safety area containing the emergency and rescue equipment and next to the health and safety area the energy distribution box.
The storage area, which is located on the west side of the lot, serves us as an intermediate storage area. Here, individual pieces of furniture that were included in the in the truck with modules are temporarily stored to facilitate the assembly of the individual modules.

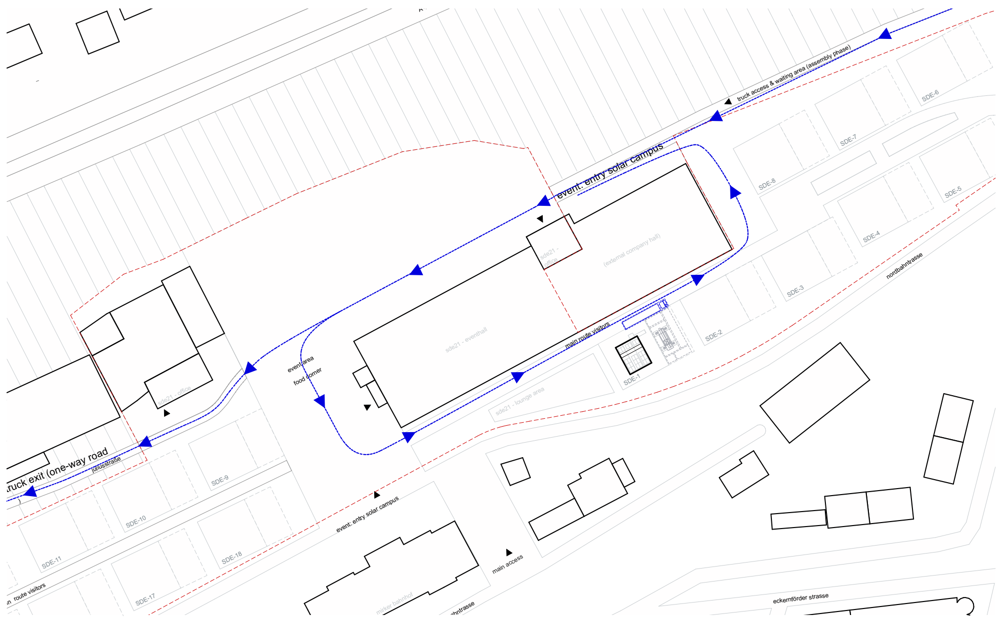


Fig. VIII. 4.   truck route on the SDE campus

4.2 Construction working Teams

In addition to the executing company Kaufmann, the students Stefanie Christl and Sven Teichmann will take over the construction management on site. Since studying civil engineering with a focus on construction management, they already have much knowledge about the site and construction management. Mr. Teichmann thus acts as a contact person for the students and coordinates the work to be carried out correctly between all parties involved.
Most of the work regarding the assembly of the modules and setting up the technical building equipment will be carried out by professionals from Kaufmann. The students of the team RoofKIT will support the workers in all assembly phases. Furthermore, the students will set up the monitoring hardware and adjust the software to the given conditions. The students, mainly the team officers, will do job-site inspections. Other Students will assemble the interior and design the exterior.

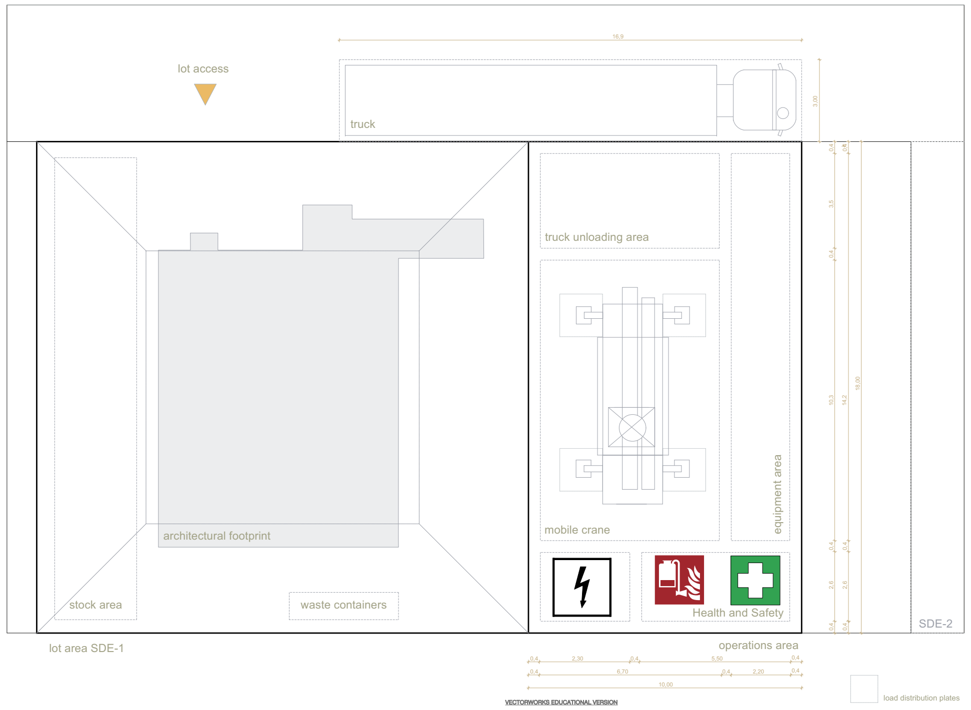


Fig. VIII. 5.   lot plan

4.3 Phases description

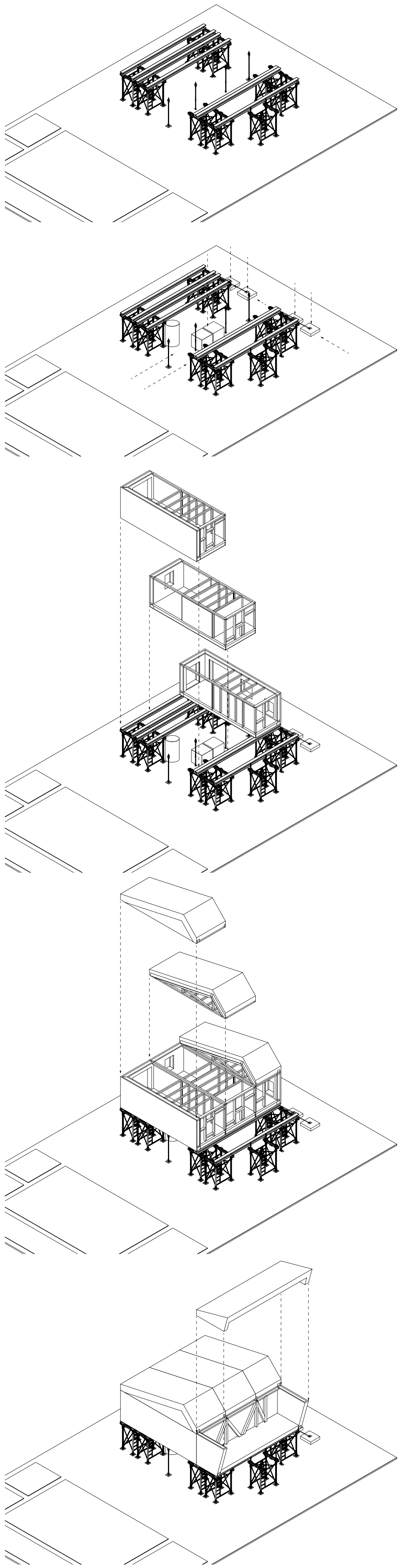
In the first phase, the students will prepare the construction lot and the basic construction. The precast steel panels will be placed in the lot area. Next the scaffold will be arranged and levelled on top of the panels. Furthermore, the gabions will be placed and filled with the stones by three Students. In this phase, the mobile crane will be used for placing the scaffold and the gabions. Workers from the scaffold company Doka will be at the construction site as well as the RoofKIT coordinators and a group of students for preparing the lot. This phase will also be used to position the buffer tank and the water tanks under the scaffolding and will last two days.
The next phase is used for the assembly of the HDU. The three living modules are put on the scaffold by crane and connected to the terrace module. Later,

the roofs for the individual modules are attached to the already assembled modules and the gutters are connected. Afterwards the terrace module will be connected to the living modules. In this phase, the 100-t mobile crane will be used to carry the 9-t modules. Next, the stairs are connected to the terrace and the surface joints sealed including the connection of all sanitary and electrical systems between the modules. At the end of this phase the HDU will be accepted by the responsible team officers of RoofKIT. This phase will last 3 days. In this time, workers from Kaufmann will be at the construction site as well as the RoofKIT team officers.
In the third phase, the electrical systems of the HDU will be installed and the exterior as well as the interior will be prepared. As a part of the electrical system, the lighting will be installed, the power cable for the lift laid and the pipes and wires inside the HDU covered. After the outdoor area is paved, the flower pots and rain barrels are installed in the outdoor area. In this phase the technical building equipment will be checked. Furthermore, the interior will be assembled and installed to finalize the demonstration unit. Students will set up the monitoring hardware and software. Also they will assemble the interior and design the exterior, while the RoofKIT team officers will lead the processes. This phase will last 7 days.

(See „Appendix AO: Assembly Chart“, „Appendix AP: Disassembly Chart“, „Appendix AQ: Equipment Requirement Chart“).

4.4 Waste management

Our team’s goal is including all used materials in a cycle and thus tries to minimize the waste.
In principle, all materials should be embedded in a cycle. After the House Demonstration Unit has been used, all



products are to be transferred back to the Urban Mine and used in other areas of application or taken up into the natural cycle. For this reason, we use only recyclable wood already when securing the transport of the individual modules. Reusable shells are used as weather protection for the modules during construction.
Thus, minimal waste is generated during on-site assembly thanks to the modular design. For the disassembly and transport of the unit to Karlsruhe, the same securing materials are ultimately used as for the transport to Wuppertal.
The waste that is generated during dis-/assembly will be collected in a fractionated and sorted manner. Following fractions will be collected: Paper and cardboard packaging, plastic packaging, treated wood, mixed metals, biological waste.

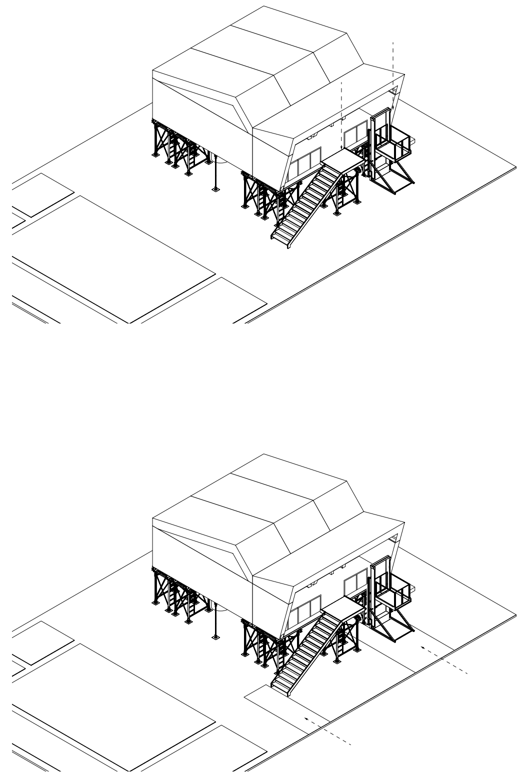


Fig. VIII. 6. building phases

5. Assembly / Disassembly Schedules

Due to our modular and single-variety planning, simplified and accelerated construction can be made possible.
Two working days are currently estimated for the mere set-up of the pavilion. For this process, a crane is needed in our assembly phase.
The remaining work on site is related to the assembly of the furniture, the preparation of the technical building equipment of the House Demonstration Unit and the design of the outdoor space. For the assembly as well as for the rest of the work, the Kaufmann company will provide the tools. Hand tools, cordless screwdrivers and a circular saw will be used for this purpose („Appendix AQ: Equipment Requirement Chart“).
The disassembly is expected to take five working days. In the first two days, the furniture will first be dismantled and the water and power lines disconnected. On the following day, the individual modules will be loaded onto trucks and transported to Karlsruhe. The next days will be used to disassemble the gabions, unpave the lot, remove the lift and the stairs and disassemble the scaffold. All elements will be loaded on the scheduled trucks according to the disassembly schedule.
Detailed information can be found in „Appendix AO: Assembly Chart“ and „Appendix AP: Disassembly Chart“.

IX. Health & Safety Report and Documentation

1. Health & Safety Checklist

LEGAL CONTENTS	LOCATION IN THE REPORT OR IN DRAWINGS
Name and Adress of SDE21/22, HS Coordinator, Prevention authorities, Team	Has not been announced yet by SDE21/22
Number of workers	5.9 / 6.3
Contact information of the Site Operations Coordinator	13.1
Description of works	VIII.4.3
First aid procedure	13.1
Name and number of first aid certificated workers	17
Description of the Teams first aid kit	13 / 13.2
Description of hygiene conditions (toilet, changing room, restroom)	The location is not known on the part of SDE
Detailed description of operating modes	5.1 / 5.2 / 5.8
Risk assessment - risks generated by other	14.1
Risk assessment - risks generated by environment	14.2
Risk assessment - risks generated on other	14.3
Risk assessment - self-generated risks	14.4
Procedures to adapt collective protection	Appendix AU

2. General Data of the Project

The House Demonstration Unit of our project roofKit consists of eight open modules which are mounted on scaffolding towers, accessible with stairs and a lift. The scaffolding, which will serve as a substructure, is erected and aligned by a professional scaffolding company with educated workers.
The construction of the modules is mainly located at kaufmann zimmerei und tischlerei gmbh in Reuthe, Austria, where the elements are prefabricated, including water, heating, and electrical installations. In that way, a professional workspace is guaranteed, with educated workers used to the environment and fabrication process, reducing the risk of accidents.
Additionally, the construction process at the solar campus is relatively short and simple. On the other hand, the prefabricated modules are very large, heavy objects, that demand special caution.
During build-up and disassembly, the responsible person for any health and safety issues are HS Coordinator Regina Gebauer, HS Officer Michael Hosch and HS Officer Nicolas Salbach. Regina has a master's degree in project management and architecture, while Michael and Nicolas are close to get their master's degrees. All three have been working for the project since the beginning or more than one year, getting a clear overview and maintaining a strong communication with all project teams.

3. Health & Safety Plan Objectives

The Health and Safety Plan aims to identify possible risks (injuries, accidents, ...) in advance and to find measures to avoid those risks. A description of all activities and involved people on the construction site should be included, as well as possible scenarios of accidents, and in the likelihood that an accident occurs, instructions on how to act. The process of construction is analyzed a long time before it even starts, to install measures to minimize the probability of risks. The goal is to develop a system for securing the safety of all workers, team members, and visitors during the whole competition phase, including the time the Solar Campus is open for the public.
The Health and Safety plan is also a way to brief every team member about precautions and how to act on a construction site and to raise awareness about dangers. Therefore, it should be read by everyone involved, and be available at all times.

4. Instruction Concept Including Contents

Our HS Team Coordinator is going to instruct every team member about risks and hazards during the prefabrication phase, during the transport phase, during the assembly phase and during the disassebly phase.
Each morning the HS Team Coordinator will explain the tasks for the day and what the risks are for each step. (See Health & Safety: Risk Analysis).
Before the start of construction, the HS Team Coordinator will show and explain the H&S plan and answer the team's questions.

5. Conditions of the site

5.1. Constructive process

The construction period on the Solar Campus consists of different phases, roughly parted into preparation, unloading, assembly, maintenance, disassembly, and cleaning. Before every shift change and especially before every new phase, a few minutes are reserved for a briefing session and answering questions of the workers and team members, so the Site Operations team and the Health and Safety team should be available and prepared.
The constructive process starts with preparing the construction site: at first, an instruction of the team members about health and safety regulations (about for example wearing appropriate workwear at all times) will be held by the Health and Safety team. Next, we will place the security fences around the construction site, install a storage and waste area and place the first aid kits and fire extinguishers.

The arrival of the trucks is according to the different steps of assembly, so the crane unloads the modules directly to where they belong on the construction site. People will have to direct the movements of the trucks, and everyone should pay attention at all times during the arrival and movement of a truck. When the first truck arrives with the scaffolging for the first floor, stairs, and lift, the assembly can begin. Two experienced scaffolders will guide the assembly of the scaffold. When the scaffold of the ballroom floor is placed, the next eight trucks arrive with wooden modules for the second floor and the work with the crane can begin. Everyone must pay special attention on the swivel range of the crane.
The modules are placed on top of the scaffolding with the crane.
At last, the four roof modules are placed on top. Now the different modules must be connected with boards or steel plates to fill the gaps. The professional workers will make the connections by means of a riser. During this phase, they are permanently attached to the riser or the roof with a certified rope. The process of assembly is the construction step with the highest danger of severe injuries, because of the crane works and heavy, large-scale modules, making it especially important to stick to the Health and Safety Plan and not risking any person being close to the lifted modules.
Then the interior fittings are placed.
Before the competition phase, it is very important to clean up and check all objects for safety on the construction site, in order for the HDU to be prepared for the public.
The disassembly works the same way as the assembly in reversed order.

5.2. Type and characteristics of the materials and elements

The HDU consists mainly of elements made from wood, which is a natural, raw material. Therefore, it is very likely to find wood splitters or other unevennesses to pay extra attention to. To work wood, highly dangerous machines like saws or sanding machines are used. To prevent any injuries, it is important to ensure that only educated, professional workers use these machines, and if they‘re not used, they should be unplugged from electricity and stored safely.
There are also large glass elements built in the HDU. Glass is a very fragile material being very dangerous when it’s broken into pieces. To work with glass, special caution is required.
To guarantee a safe workspace, there are some measures to take into action to avoid any injuries when working with different materials and elements:

- check before lifting an object if there are any bumps or sharp edges
- all materials that are meant to walk on or hold onto should be topped with anti-slippery material
- check the fire regulations of all the materials
- if an object breaks, remove the object immediately, especially broken glass can be highly dangerous when left on the construction site

- always check if the weight of an object is appropriate, or if you need help to carry it

5.3 Site description

The HDU of our team roofKIT is located on Lot no. 1 on Solar Campus. Like the other lots, it measures 18x18m, with an operations area right next to it with 10x18m. The whole area has hardly any difference in altitude, which minimizes the risk of falling or tripping. On the other hand, there are hardly any trees or other objects leading to shade (summer weather can cause nausea, sunstroke, during SDE and construction phase).

5.4 Climate description

Western Germany is characterized by mild, marine weather, because of the relative closeness to the Atlantic Sea. The average precipitation in Germany is between 750 and 800mm, so Wuppertal with over 1100mm is located in a region with a lot of precipitation compared to other parts of Germany. About 200 days of the year are rainy, meaning precipitation above 0,1 mm.
An explanation for the high amount of rainy days is the location in a region with a high probability of orographic precipitation: westerly winds coming from the Atlantic are forced to rise at the edge of the low mountain range in the Ruhr area, cool down, and condense, which leads to the high probability of rain compared to other German regions.

Fig. IX. 1. climate diagram

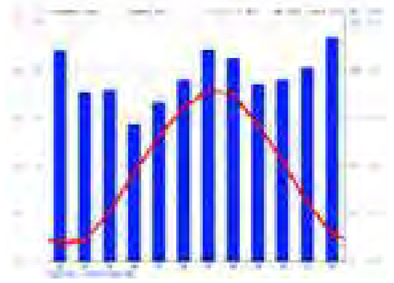


Fig. IX. 2. climate diagram

5.5 Accesses and paths for vehicles

Access for vehicles is possible from the north via Uellendahler Straße and Hamburger Straße. For the truck route, see the Site Operations Drawing of the Solar Campus. If an accident occurs and paramedics are needed, the ambulance can access the building lot just like the trucks from the north. As an alternative exit route, when turning the vehicle around and exiting the site as it arrived is not possible or too dangerous, the ambulance can exit in the eastern direction.

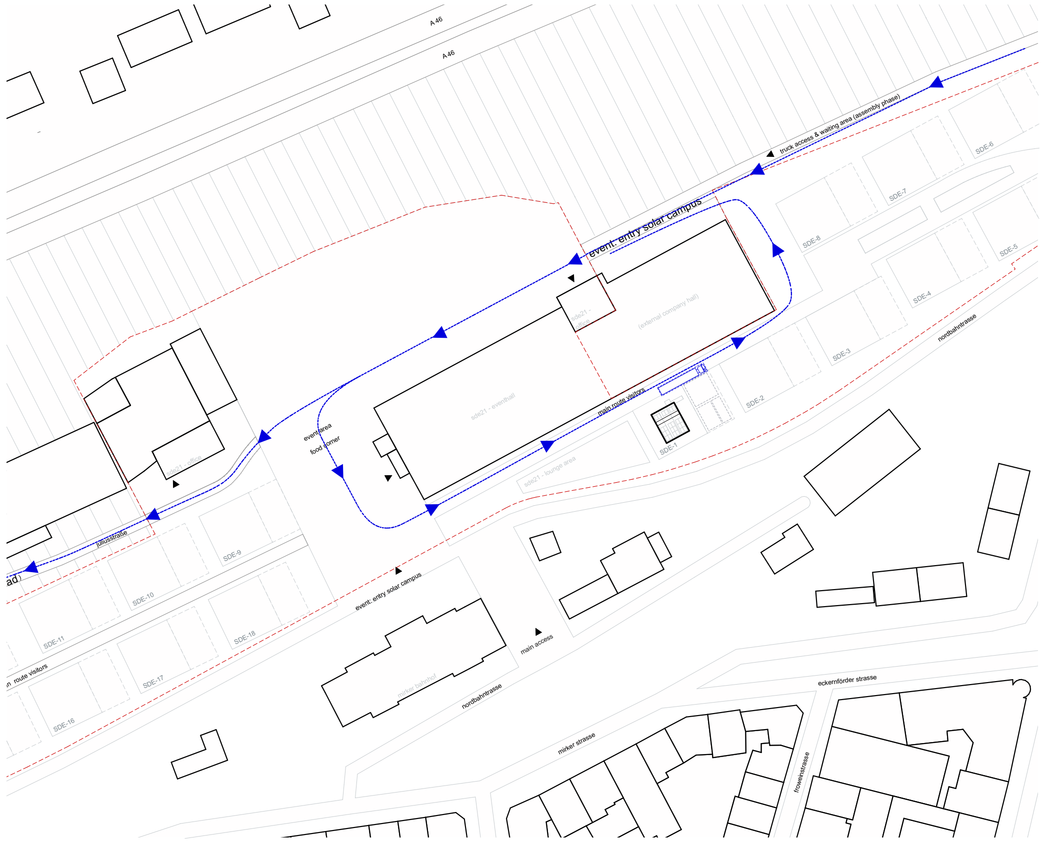


Fig. IX. 3. ambulance route

5.6. Determining factors for the house placing

The most important factor in determining the House placement in the middle of the building lot is a matter of design. We want the open side and the stairs and lift to access the upper floors of the house to face the main route of visitors. This placement is also compatible with the orientation of the PV panels to the south. Also, the solar envelope is a significant factor to place the roofKIT HDU in the middle of the lot, because it is a two-story building with a height of about 6m. Additionally, the placement of the house secures distance to the truck parking spots.

5.7. Overlaps with the affected services and other activities

During Construction Phase, the Solar Campus will be filled with team members, workers, machines, vehicles and cranes, easily causing safety hazards. It is important to avoid getting distracted and inattentive to your

surroundings, and instead, pay special attention when crossing the paths of vehicles or stepping on a different building lot. To prevent injuries, good communication is required between the teams with lots next to each other.
Moreover, the Solar Campus is a place of community, and all teams should behave respectfully and carefully considering the close surroundings, as well as the environment in a broader sense. Because we are not the only Team to build our HDU on the Solar Campus, we must ensure we don't only care about the Health and Safety of our own team members and workers, but also about the wellbeing of the other teams. Therefore, it is mandatory to restrict the storage and working area to our own lot and not interfere with the construction of our neighboring teams. Furthermore, responsible handling of waste is required. Where we can help other teams to avoid risks of injuries, we should not hesitate. For example, it is significant to alarm the other teams and the HS Officials if there are unauthorized persons on the Solar Campus before opening or if there is any damage to the construction.

5.8. Planned activities

Please refer to Site Operation Chart Appendix AT

- prefabrication of the modules in Reuthe, Austria
- transport
- delivery of the modules
- placing the protective fences, restrooms, storage area, first aid kit, fire extinguisher
- assembly of the scaffolging of the first floor with the crane
- assembly of the second-floor modules
- assembly of the roof modules
- connection of the modules with boards or steel plates
- addition of the stairs and lift
- connection of the water and electricity supply
- placement of the interior fittings
- cleaning the construction site
- Produce flooring on the ground floor
- checking the construction site for any safety hazards
- Competition Period (Guided House Tour, Dinner, ...)
- disconnecting the modules
- assembly of the scaffolding
- disassembly of the roof modules
- disassembly of the second-floor modules
- disassembly of the timber framework of the first floor
- transport

5.9. Trades affected by the risk's prevention

About 7 professional workers are planned to help the team members during the construction process: one electrician, one plumber, one roofer, and 3 to 4 woodworkers.
The different trades are affected in different ways by the risk preventive measures. In general, all the workers have to behave in a safe, responsible way, which also applies to the team members (see „10. Safe working").
For working with electrical installations, the most dangerous injury is electrical shock, therefore it is important to check for electrical current before working on electrical installations.
The highest danger in the trade of roofing is falling. To ensure that this does not happen, the workers must be secured with ropes. When connecting the modules, the workers are working with lifts. the workers are attached to these lifts so that they cannot fall down.
The plumber and all team members working with plumbing must pay special attention to being exposed to harmful substances, needing to always wear protective gloves and workwear.

5.10. Auxiliary resources planned for the construction

- lighting
- mobile crane
- trucks
- lifts
- electricity supply
- water supply
- ladder

5.11. Machinery planned for the construction

- mobile crane
- trucks
- portable machines: cordless screwdriver, hand-held circular saw, carpenter's plane, sanding machine
- telesopic work platform

5.12. Construction site installations

- electricity supply
- water supply
- restrooms

5.13. Characteristics Table for the stocks

The stocks should be placed orderly in the storage area and removed right away when misplaced in the working area. It should be available:
- safety helmets

- safety glasses with side shields
- safety boots with ankle protection, steel toe can and pierce protection
- drinking water, food
- working equipment
- Hearing protection

6. Activities for Risks Prevention

All the measures to prevent certain risks on the construction site can be found in the Health and Safety Risk Analysis.
See Appendix: AT KIT_HS#6_2022_02_22.xlsx.

6.1 Construction plan: Determination of work effective timing

See „Appendix AV: Lot Plan" and „Appendix AO: Assembly Chart", „Appendix AP: Disassembly Chart" for detailed information.

6.2. Overlaps and incompatibilities in the construction

There are no overlaps or incompatibilities in the construction.

6.3. Number of Construction Team members

There are about 10 team members taking part in the construction, getting help from 7 additional workers from kaufmann zimmerei und tischlerei gmbh.

6.4. Contracting planned

There is no additional contracting planned for the construction in Wuppertal. The kaufmann zimmerei und tischlerei gmbh in Reuthe, Austria, that prefabricates the modules, provides 7 professional workers and equipment for the assembly of the modules.

7. Critical work phases for Risks Prevention

The most critical work phase is the assembly of the modules, which is the main part of the construction, because of the work with the crane. The modules are very heavy, large objects and could easily knock a person over if they would be in the wrong place during assembly. Other critical work phases are the ones involving trucks, due to the severity of injuries caused by accidents involving large vehicles. Therefore, the speed limit for trucks on the Solar Campus is walking speed and the trucks need to be guided when parking. Also, the transport of the modules can be a risk to the health of workers and team members. The modules will be secured by professional workers, who are used to this work and have big experience. The drivers are also professionals who are used to drive trucks with big cargo. Choosing an adapted speed will lower the risk of a traffic accident.

8. Risks identification and efficacy evaluation of the adopted protecitions

8.1 Location and identification of the areas where the works involving special risks will be developped

The turning circle of the crane is an especially dangerous area and should be marked with signs. Also, the parking area of the trucks involves special risk prevention measures, for example, the need to guide the movement of the trucks to avoid anyone getting hit while parking.

8.2 Risks identification and efficacy evaluation of the adopted protections

Protective workwear is also a very easy, successful way to prevent injuries of individuals. Wearing a helmet can protect you from head injuries, when for example an object falls on your head from an upper level, or you fall because of slippery floors or an uneven surface.
Loading errors and injuries from falling objects can be prohibited by working with educated, professional workers who are used to the tasks and the environment and only using certified slings.
Getting hit by a parking vehicle or a moving crane can be very dangerous. It can be prevented by supervision of the banksman and escorting the moving and parking vehicles. No one is allowed to be under modules moved by the crane. In addition, the team members are being briefed about this danger. This briefing also contains the explanation of the emergency exit plan.
Getting hit by parts of scaffolding during assembly is being prevented by keeping other team members away and the supervision of one HS Officer.
Fire and explosions can be prevented by the prohibition of smoking and open fires. These safety instructions will be visualized by the common signs.
Errors while installing electricity can be prevented when the work is done by a professional with special protective workwear.

A possible risk is the injury from operation machines and tools. The proper use of those machines and tools will be part of the safety training. Important rules will be visualized by attachments.
Hearing damage by noise is prevented using certified noise protection headphones.

9. Collective protections to use

The Health and Safety Plan is the most important collective protection on the construction site, should be read beforehand, and available at all times.
Drinking water and food should be always available, to prevent weakness and sickness of the workers and team members, especially during high temperatures. In case of emergency, fire extinguishers and first aid kids are mandatory collective protection to instate. During construction, a mobile scaffolding or a telescopic work platform with rails are essential to secure safe working on higher levels. Below two meters a ladder can be used, while one person is securing it.
All team members, crew and volunteers will be trained on the proper use, inspection, and limitations by a Health and Safety Professional before the start of the event. Furthermore, listening to the instructions of the HS Officials is mandatory.
Flammable substances like fuel and oil are stored in a lockable storage, which has a drip tray for liquids.

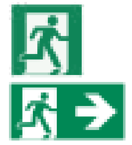
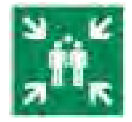
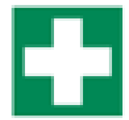
10. Individual protection resources to use

10.1 Signposting of the risks according to DIN EN ISO 7010

There will be sufficient PPE for every team member, who is involved in assembly or disassembly or in maintenance. The PPE is sponsored by Implenia and reaches the standards of the European Legislation, for example the “CE” branding. The PPE consist of protective helmets, a shirt with sleeves and long trousers, safety boots with ankle protection, steel toe can and pierce protection, as well as reflective jackets and gloves and ear protection. The instructions of each protective and safety equipment can be found in Appendix AU.(selection)
By conducting a safety training before the event starts, every team member will be aware about the proper use, inspection, and limitations of the PPE.

One team member will oversee the safety for others while working with the crane. For this task the team member will wear a reflective jacket with the term “BANKSMAN” on its back.

sign	name	decreases risks of...
	no access for unauthorized personnel	manipulation from unauthorized persons; injury of uneducated persons; injury of persons not wearing the appropriate workwear, behaving the appropriate way
	do not use the lift in case of fire	getting stuck in the lift in case of fire
	do not smoke	fire
	do not use open fire	fire
	foot protection needed	foot injury after stepping on sharp objects; foot injury after an object or tool fell on your feet
	head protection needed	head injury, e.g. caused by getting hit/ knocked out by falling objects or tools
	safety clothes needed	getting cut
	safety eyewear needed	eye injury
	Wash your hands	being exposed to harmful substances; spreading illnesses
	Safety Vest Needed	getting hit by a truck; getting hit by the crane during movement; getting hit by the module during assembly

	Working gloves needed	getting your hand cut; being exposed to electric connections; being exposed to harmful substances
	Warning of danger of slipping	falling
	Warning of the risk of falling	falling from an upper level
	Warning of suspended load	getting hit by the module during assembly
	Emergency exit on your right	not knowing the way out in case of emergency
	Assembly station	someone getting lost or forgotten in case of emergency
	First Aid kit	not knowing where to get a First Aid Kit; injuries getting worse because immediate help is not available
	Fire extinguisher	not knowing where to find a fire extinguisher in case of fire

11. Safe working procedures of every Team member

To guarantee a mode of operation that complies with the developed Health and Safety measures, the team members have to agree to the Health and Safety terms written down in the Health and Safety Plan. To do so, the Health and Safety Plan must be explained to all the team members and be always available on the construction site. If there are any questions of the team members, they have to be answered before the construction begins. Then, they must all commit to certain ways to act on the construction site.
First, it is important, that the working team members are in good health and shape. Every team member is checked by the company doctor before the start of construction. If a team member is sick or unwell, the risk increases that he or she gets easily distracted and risks the injury of other team members or gets hurt themself. If a team member is not feeling

well, he or she can't work on the construction site.
There is no alcohol or drug use permitted on the construction site, leading to inattentive and irresponsible behavior.
Smoking is prohibited on the building lot, for increasing the risk of fire.
Appropriate workwear must be worn while being on the construction site: at least a helmet, safety glasses with side shields, safety boots with ankle protection, long pants, and a long shirt.
The team members have to listen to the instructions of the professional workers and the Health and Safety Coordinator at all times. If there is a matter of discussion the Solar Decathlon organizers and HS officials have the final power to decide.
The construction site is to be kept clean at all times, meaning no objects, tools, or waste lying around.
The teams have to stick to appropriate work hours and stopping the works no later than sundown, so proper lighting is guaranteed.

12. Machinery and auxiliary resources

Various auxiliary tools can help and should be used to work safely and responsibly on the construction site: for example proper lighting.
For protection purposes, certified workwear such as helmets, safety glasses with side shields, and safety boots with ankle protection should be available to the workers and team members.
To meet the needs of the workers and team members, restrooms are installed on the solar campus.
When machinery is used, it is essential to ensure that only educated, professional workers use these machines, and if they're not used, they should be unplugged from electricity and stored safely.

13. Planned Measures in case of an accident

13.1. First aids

If the taken measures to prevent an accident didn't succeed and someone got hurt, the following steps are a common guideline to decide how to act:
Note, that if you call an ambulance in Germany (where the SDE 21 will take place) the emergency number is 112, responsible for fire and first aid. During the call, try to describe the situation as clear as possible and try to answer 4 important questions:
Where are you? How many people are hurt? What happened? What injuries do they have?

1. First, you have to check the scene and get an overview of what happened. Pay attention to how many people got hurt, how severe their conditions are and how many people are available to help, especially if a first aid certified worker is nearby.
2. Take the injured person away from the danger that caused the injury if that's possible without risking an injury yourself.
3. Start with the person whose injuries seem most severe to you and check if he/ she is awake, if so, introduce yourself to them and ask for permission to help. Call an ambulance according to the situation. If the injured person isn't responding, try shouting, tapping their shoulder, etc.
4. If the injured person still isn't responding, check if he/ she is still breathing e.g. by paying attention to the movement of the thorax.
5. If the person still breathes, bring him or her into a recovery position and call an ambulance.
6. If the injured person doesn't breathe, call an ambulance. Then, make sure that the person is face-up on a firm, flat surface and begin CPR (if you are trained to) until the person shows signs of breathing or the ambulance with medical staff arrives.

Contact of the First aid certified worker and HS Team Coordinator
Regina Gebauer (regina.gebauer@kit.edu)
Contact of the Site Operations Coordinator
Sven Teichmann (sven.teichmann@student.kit.edu)

13.2. First aids bag

The requirements of first aid kits on construction sites in Germany are laid down in DIN 13157, concerning the small first aid kit, and DIN 13169, concerning the big first aid kit. Which one is required depends on the number of workers. With over 11 workers on the construction site, it is mandatory to have one big first aid kit available. So according to DIN 13169, the following materials should be inside the first aid kit at our construction site:
2 rolls of adhesive 2,5x5cm, 16 bandages 10x6cm, 8 fingertip Band-Aids 4x7cm, 16 wound dressings 12x2cm, 8 waterproof plaster strips 2,5x7,2cm, 8 waterproof plaster strips 1,9x7,2cm, 6 sterile gauze wound dressings medium, 2 sterile gauze wound dressings big, 2 sterile gauze wound dressings small, 2 sterile gauze wound dressings 60x80cm, 12 compresses 10x10cm, 4 sterile eye dressings 5,6x7cm, 2 instant cold compresses, 2 emergency blankets 210x160cm, 4 elastic bandages 6cm, 4 elastic bandages 8cm, 4 triangular bandages, 1 pair of scissors, 4 foil bags, 10 nonwoven swabs 20x30cm and 8 pairs of vinyl disposable gloves.

13.3 Preventive medicine

Antiallergic medicine (e.g. Cetirizine) or cream can be useful.

13.4. Accident victim evacuation

The victim evacuation works according to the easiest way for an ambulance to reach and exit the construction site (see. 4.5 Accesses and paths for vehicles).
The closest hospital is Bethesda Krankenhaus about 1,3 km west of the Solar Campus, with a car ride of about 5 minutes. The next closest hospital is St. Josef Hospital, which is about 1,4 km south of the Solar Campus, with a car ride of about 7 minutes. For not so urgent injuries, the nearest general practice of Barbara Kring-Nühlen is only 500 m by foot, opened Monday to Friday from 8.00h until noon.

14. Risks identification

14.1 Risk assessment – risks generated by other

Unauthorized people can pose a risk to the health and safety of the Solar decathletes and are strictly prohibited on Solar Campus before opening to the public. They could manipulate the building or start a fire, which is very unlikely but very dangerous. Even if they mean well, they could endanger themselves and the other team members due to distracting the workers or being inattentive, because of not having the appropriate Health and Safety education and not knowing the rules how to act, which is much more likely and just as dangerous.

14.2 Risk assessment – risks generated by the environment

In the broader sense of environment, it will likely rain during the construction period (see „4.4 Climate description“), so injury because of wet, slippery floors is very probable. Fortunately, the risk of injury becomes relatively trivial if all materials that are meant to walk on or hold onto are topped with anti-slippery material.
In the narrow sense of the term environment, considering the surroundings, the following risks occur: getting hit by parking (very dangerous, but low probability), getting hit by unlocking the load (can be very dangerous, possible), getting hit by the crane during movement (very dangerous, possible), getting knocked down by unloading or assembling the module (can be very dangerous, possible), tripping due to materials lying in the working area (slight injury, possible) or getting knocked out by objects or tools (slight to moderate injury, possible).
Therefore, all involved parties need to pay attention to their surroundings and team members, keeping the construction site clean, wearing clothes that attract attention, and wearing protective workwear.

14.3 Risk assessment – risks generated on other

Just as the construction process poses a risk to us team members, other parties are also endangered. The neighboring teams are especially exposed to the same risks as the working team members: getting hit by parking (very dangerous, but low probability), getting hit by unlocking the load (can be very dangerous, possible), getting hit by the crane during movement inside the swing area (very dangerous, possible), getting knocked down by unloading or assembling the module (can be very dangerous, possible), tripping due to materials lying in the working area (slight injury, possible) or getting knocked out by objects or tools (slight to moderate injury, possible). Neighboring teams need to communicate frequently and consult with each other when risk prevention measures are required.
Another party that should be considered preventing risks is the visitors. The following risks should be kept in mind: getting hit by loose objects (slight to moderate injury, possible), stepping on objects (slight to moderate injury, possible), fall of persons at a different level (moderate to severe injury, possible), fall of persons at the same level (e.g. because of collision with still objects, other people, ... (slight to moderate injury, possible)), not knowing the way out in case of emergency (moderate to severe injury, possible), visitors ignoring dangers of the project site (slight to moderate injury, possible) or fall of objects because of manipulation (moderate risk, remote).
To prevent any risks generated on the visitors, checking the HDU before Opening Day of the Solar Campus and the approval by the members of the Site Operations/ HS team is mandatory. During the public tour, the tour guide is responsible to supervise the visitors and a protective railing is installed to prevent falling or tripping. As another effective measure to avoid accidents, signs are placed to raise awareness about dangerous areas or to help find the emergency exits, fire extinguishers or first aid kits in case of emergency.

14.4 Risk assessment – self-generated risks

Self-generated risks could be injuries due to inattentive work (possible, moderate risk), injuries due to wrong, careless handling of machines (unlikely, important risk), injury because of carrying too much weight (very likely, important risk), or bad hygiene leading to the spread of illnesses (possible, moderate risk).
When it comes to self-generated risks, they can be relatively easily avoided, when the team members and workers stick to the tasks, they’re responsible for and are well informed about. For the team members not used to working on a construction site, safety briefings are necessary, to prevent an unsafe workspace.

15. Useful plans and information for works

15.1 how to lift heavy objects

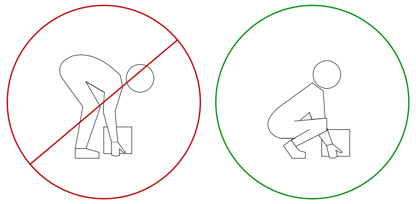


Fig. IX. 4. how to lift heavy objects

15.2 how to execute First Aid

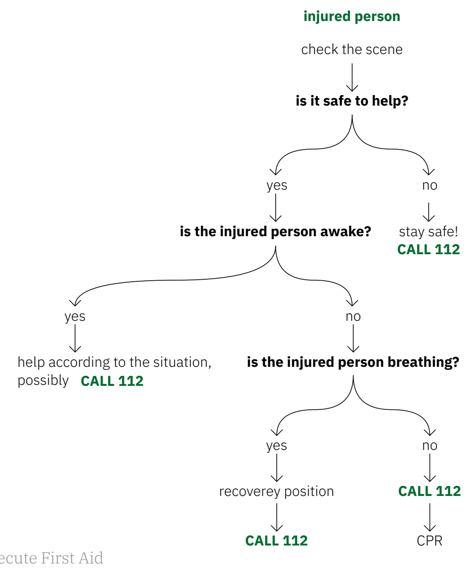


Fig. IX. 5. how to execute First Aid

16. Adopted system for the level of health and safety control during works

Just as important as it is to lay down rules on how to work safely on a construction site, it is to check, that these rules are followed. The Health and Safety Team Coordinator is responsible to do so. Inspection walkways in between the shift are important to have regular control and mistakes are avoided. The Health and Safety briefings between each shift are meant to discuss any inconsistencies regarding the work according to the Health and Safety Plan.

17. Formation and information

In several workshops, team members are taught about risks and hazards in construction by our KIT internal safety-health coordinator. These workshops are divided as follows:
- Safety and health risks
- Planning the construction site
-Construction site safety

Everyone involved in construction will attend a first aid course before starting the construction process. The H&S team coordinator will give each team member a Health & Safety briefing before entering the site.

Each team member will complete these lists prior to the construction phase:
- Training Statement
- Health & Safety Statement
- Medical Statement

18. Emergency evacuation plan during the assembly and disassembly plan

In case of an emergency that requires evacuation (fire, terrorist attacks, accidents, ...) the health and safety coordinator is responsible for alarming the other team members and try to avoid any panic or turmoil.
When it comes to evacuation routes, it is essential to define a simple, short way to get to the assembly station with wide enough passageways to avoid injuries caused by tripping or colliding with other people. The building lot of our team roofKIT is located at the most optimal position, due to the closeness to the main entrance, which offers a big, prominent way to escape in case of emergency. The parking lot in front of the Mirker Bahnhof works as the assembly station, where all teams have to check for any lost team members, and the number of team members present must be verified by the Health and Safety coordinator.
For further notice please see Project Drawings HS-2001 and HS-2002. (Appendix AV, Fig. IX.7+8)

Fig. IX. 6. evacuation routes

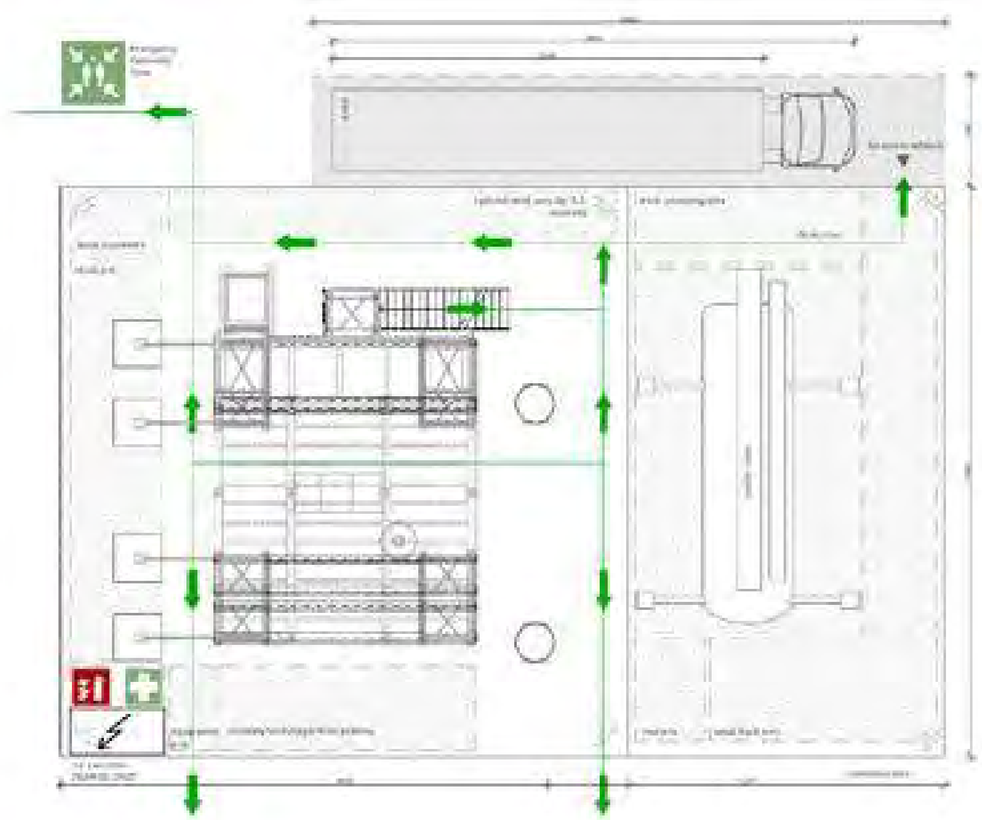


Fig. IX. 7. evacuation route ground floor

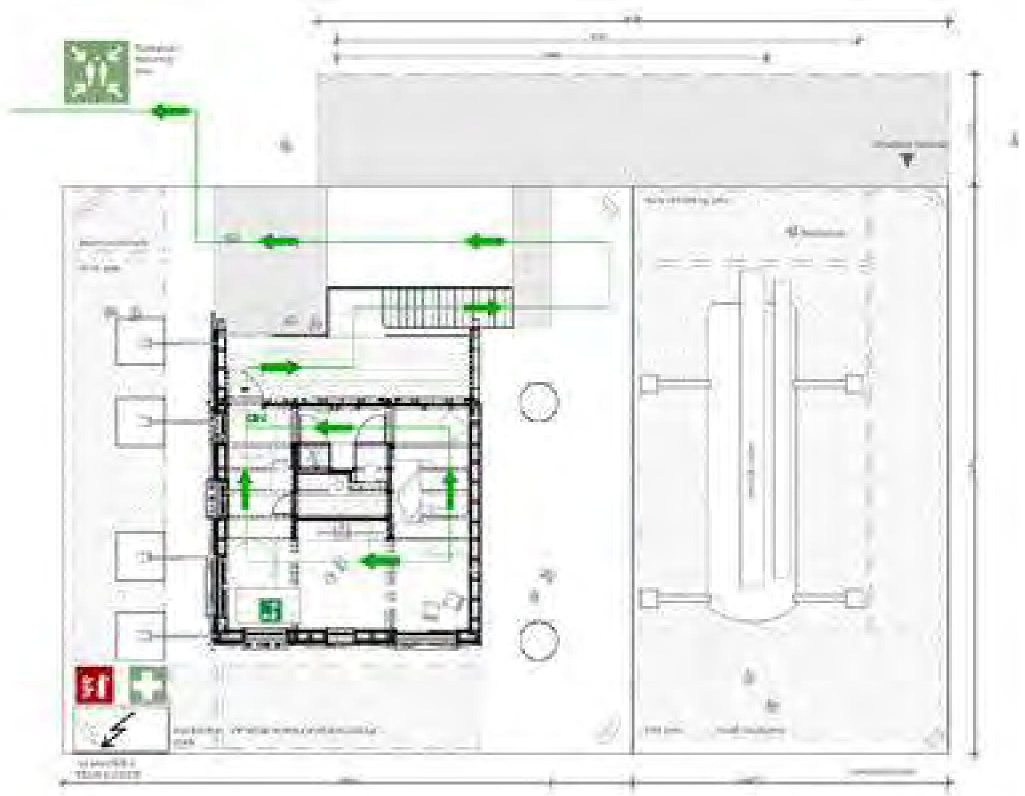


Fig. IX. 8. evacuation route first floor

X. Detailed Water Budget

X. Detailed Water Budget

This chapter provides information about the water requirements during the competition period for the RoofKIT House and the selected container dimensions. The calculation is based on the rules of SDE and the event calendar. (Water Budget Appendix AR)

Fresh and waste water system

To make a whole house functional, water management plays an important role in the process. The system is designed to meet water needs during all events. Tanks are located outside under the HDU, while most of the equipment is located in the mechanical room. The heating and cooling circuits are also located in the HDU in the mechanical room. The water supply system is integrated into both the interior and exterior of the HDU. The supply and disposal principle of water consumption must be kept as low as possible. Details about the fresh and waste water system can be found in the Engineering and Construction report, and the Plumbing drawings. A schematic diagram of the system is depicted in Figure X.1. Figure 2 provides a technical detail regarding the connection of the fresh water tank below the HDU.

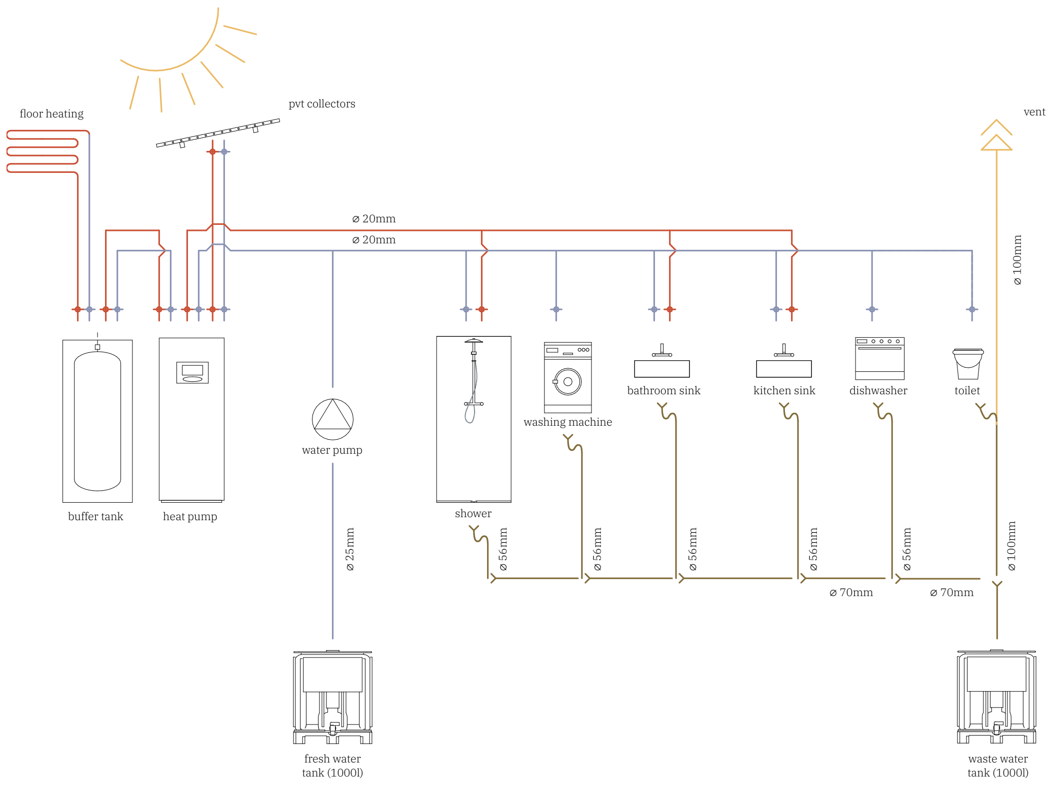


Fig. X. 1. Plumbing schematic diagram – Also illustrated in the Project Drawings (PL-4001).

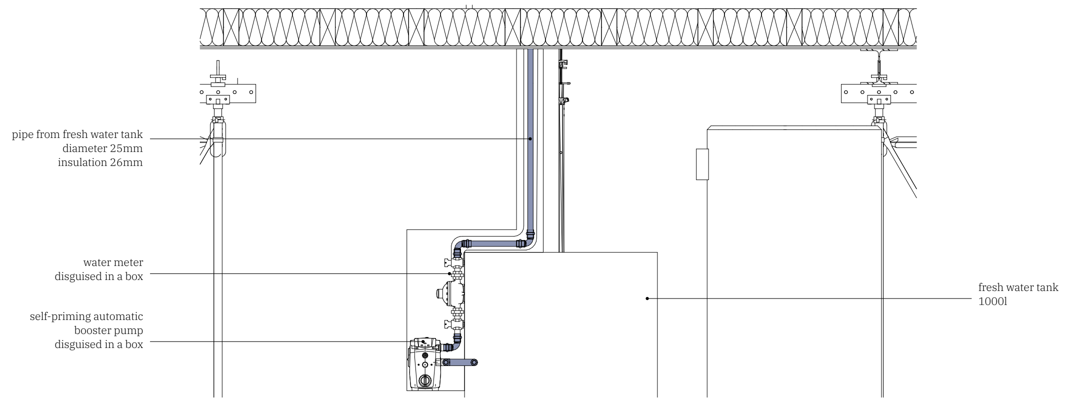


Fig. X. 2. Detail of the installed water pump in the fresh water tank and the corresponding water meter – Also illustrated in the Project Drawings (PL-1004).

Calculation of water consumption in the assembly phase

The main water consumption sources in a construction site, without considering hydration (delivered water is non-potable) are the following, for a dry construction using prefabricated modules (as Team RoofKIT proposes):

- Cleaning tools and small equipment during construction
- Workers general cleaning
- HDU cleaning after construction
- Site and tools cleaning after construction

Given the experience of our specialist team, the amount of water estimated for our construction is of 400 m³. Besides, to avoid legionella in our water tanks, regular flushing must be planned. Around 50 liters flushing every three days before competition is planned. Therefore, around 200 m³ of water before competition must be considered.

Calculation of water consumption during competition

The Competition Week calendar of events (10 Jun 2022 till 26 Jun 2022) is used as the basis for calculating water consumption. The tasks and tests will take place on the days between June 13 and June 22 (SDE 21/22 – Tasks + Tests Calendar – V 5.0). In the competition phase, the hot water connections are tested. This test runs through a hose in the shower. Besides, the washbasin at the kitchen and bathroom must be fully functional. These faucets consume both hot and cold water. Appliances, such as the washing machine and the dishwasher, consume only cold water.

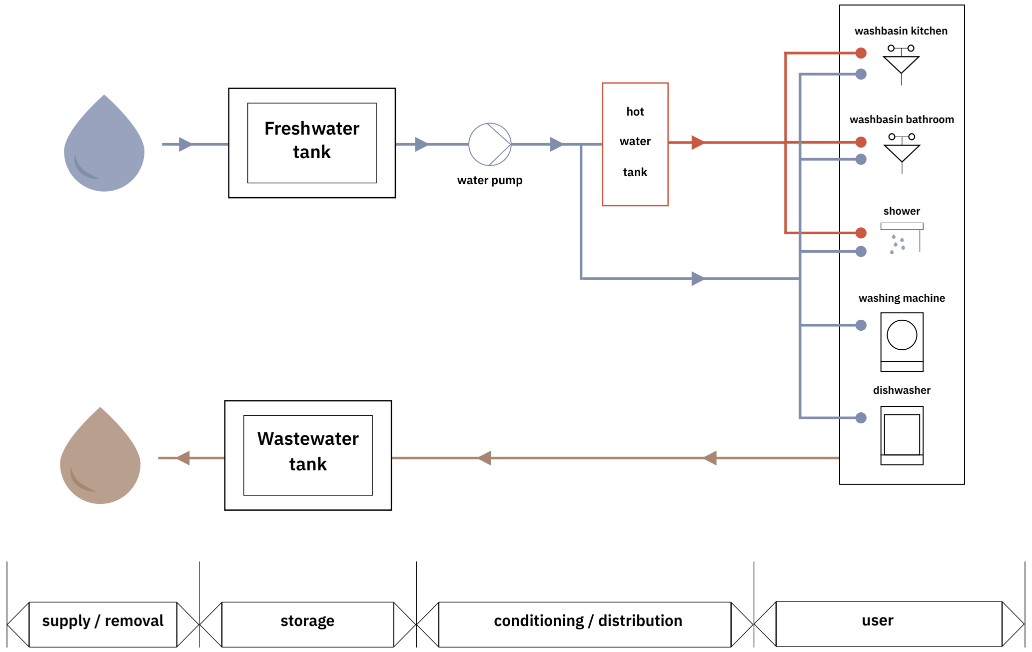


Fig. X. 3. Water consumption and removal during SDE competition tasks.

In the competition phase, the hot water connections are tested. This test runs through a hose in the shower. Hot water draws will occur during the times specified in the Competition Calendar. For each draw, at least 50 liters of hot water shall be delivered in 10 minutes. At least 50 liters. It may happen that three hot water taps are used in a row in one day. According to the manufacturer ́s instructions our selected fittings have a flow rates by a pressure of 1 to 2 bar. Other sub-competitions are laundry, dishwasher, cooking and dinner. The washing machine (Miele WWH860) consumes 47 liters per wash cycle for 8 kg of mixed laundry at a water temperature of 40°C. In addition, the dishwasher (AEG F78450VI0P) consumes 8,5 liters per cycle. Both product datasheets are available in the project specifications (KIT_APPL_Dishwasher_AEG and KIT_APPL_WashingMachine_Miele). For the estimation of the water consumption, a 10% extra water is considered for unexpected higher consumptions.

The dinner takes place on 3 days (14 June, 15 June, and 21 June). Since the water quality delivered is non-potable, the water for cooking and hydration will be brought by RoofKIT.

Date	13.06	14.06	15.06	16.06	17.06	18.06	19.06	20.06	21.06	22.06
Weekday	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed
Washing machine	47	47	47	47	0	0	0	47	47	47
Dishwasher	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Hot water draws	150	150	150	100	50	50	50	150	150	100
Subtotal	205,5	205,5	205,5	155,5	58,5	58,5	58,5	205,5	205,5	155,5
10 % extra	20	20	20	15	6	6	6	20	20	15
Total daily consumption	225	225	225	170	65	65	65	225	225	170

Table 1 – Water consumption in liters plan during the contests from 13th to 22nd June

Fig. X. 4. Table 1 – Water consumption in liters plan during the contests from 13th to 22nd June

The total consumption without considering extra unexpected consumptions is illustrated in Figure X. 5.

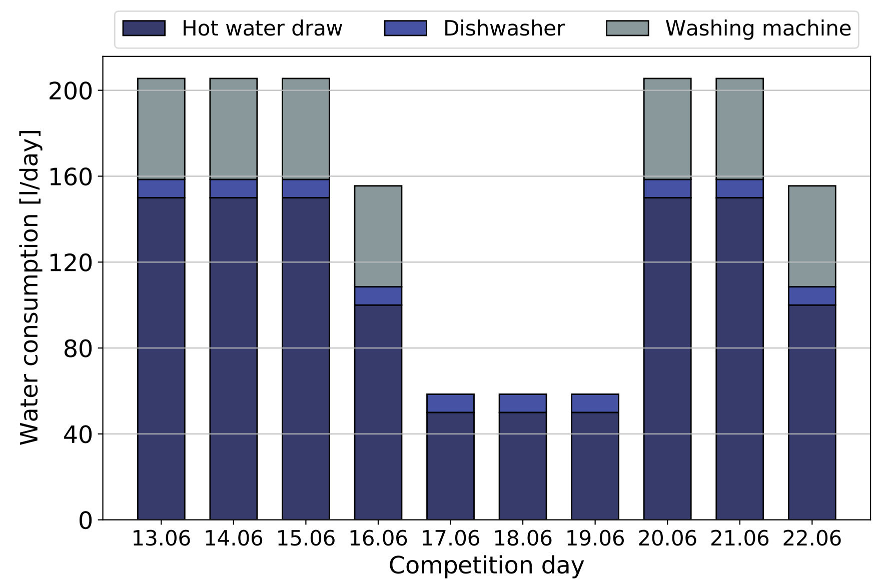


Fig. X. 5. Total water consumption during competition

Besides, once a week the HDU must be cleaned. For that purpose, a consumption of 25 liters per cleaning is assumed. For the first competition week (13-17.06), a total of 935 liters of consumption is assumed, and for the second week a total of 775 liters.

Water delivery calendar

The water delivery and removal will take place on the respective specified dates by the water delivery related document.

Wednesday, 25th May 2022	Water Delivery I
Friday, 03rd June 2022	Water Delivery II + Water removal I
Friday, 17th June 2022	Water Delivery III + Water removal II
Monday, 27th June 2022	Water removal III

Fig. X. 6. Table 2 - Water delivery and removal calendar

According to the previous estimations, the following delivery calendar is proposed by Team RoofKIT. This considers both the estimations during assembly and competition phase. Finally, to avoid running out of water in the HDU, a back up of 100 liters is considered since the first water delivery. For example, between the first and second delivery, Team RoofKIT estimates a consumption of 500 liters, then the first water delivery is planned to be of 600 liters.
Figure X.7. illustrates the total water balance along the six weeks, considering the assembly phase and the two competition weeks.

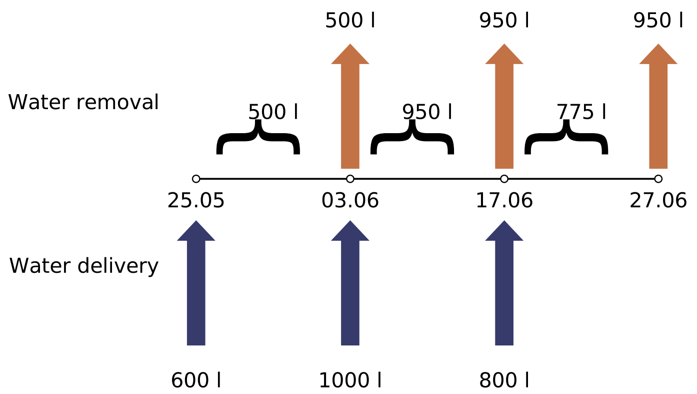


Fig. X. 7. Water balance during the whole competition

Water tanks

Two main water tanks are placed below the HDU – a fresh water tank and a waste water tank. Both have a total volume of 1000 liters. The tanks are provided by the company Highlight Cubes. The model is the IBC Container, which recycles old tanks from the food industry. These tanks are rented for a short time, as after the competition the HDU will be transported to Karlsruhe and a water supply connection will be there available. A GEKA Plus Quick Coupling connection will be available for the water delivery and removal. Besides, the heat pump has a 185 liters domestic hot water tank, where additional hot water can be stored for immediate use. All tanks are optimized for HDU operation during competition.
Figure X.8. shows a picture of the IBC Container, that will be used as fresh and waste water tank.

Fig. X. 8. IBC Container – Fresh and waste water tank.

In addition, Team RoofKIT will place two rainwater containers of 900 liters each, to collect and reuse rainwater, for cleaning purposes. However, the amount of water for cleaning must also be considered in the total water budget in case there is no rain over these days.

Water-saving technologies

Water-saving technologies such as high-efficiency household appliances and the use of low-flow faucets reduce the consumption of all water.

Due to the special consumption during the competitions, the daily fresh water demand will be slightly lower than in a standard routine. The water consumption during the competition does not reflect reality because the available water is non-potable, and the water usage will depend on the rules. Thus, cooking will be performed with a limited amount of water and a variety of applications will not be used in a daily routine. All selected faucets of HDU ensure economical water consumption due to their efficient design. The faucets allow everyday process and personal hygiene. Figure X.9. summarizes the effect of the proposed water-saving technologies in the total water consumption of the HDU against conventional buildings in Germany.

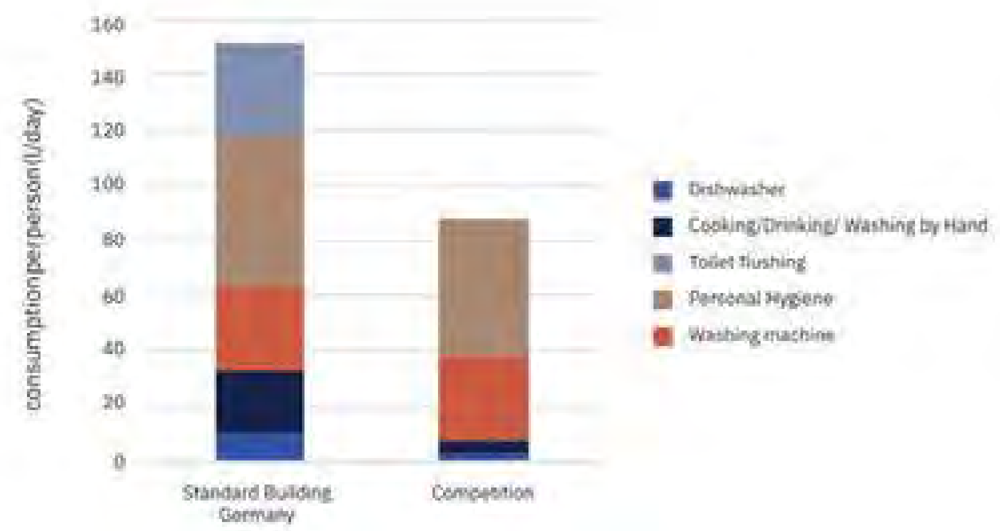


Fig. X. 9. Water consumption of a standard building in Germany and the HDU during competition.

XI. Electrical & PV Design Systems Information

Other than described in the rules, the information about the technical components is requested in the SDE21_FACT_Project-Facts.

Accordingly, only the templates 'Electrical System Design Checklist', 'Photovoltaic Checklist' and 'Electrical Storage System Checklist' are provided here. The template 'Electrical and Photovoltaic Chart' is omitted.

These checklists are used to verify the requirements described in the Rules and in particular the Building Code.

To check the requirements, please describe the current status of implementation in the Comments column. In the Location column, please indicate in which documents and in which chapter the implementation is described technically. For drawings, please specify the file name of the drawing. And for certificates or attestations, please also indicate the respective file names.

contents

Electric System Design Checklist

Team ID	Team Name	Country
KIT	RoofKIT	Germany
	University	**Date**
	Karlsruhe Institute of Technology	09.03.2022

Subject	Element	Required specification or information	Comment	Location PD sheet, PM Page or other documents
General Requirement	Electricity System	Technical products that are used in the House Demonstration Unit (HDU) must provide a safety level equivalent to European standard.	All products which are currently set	Project specifications
		The electrical installations of the HDU must be planned properly by an installation designer and needs to be approved by a professional electrical engineer.	The electrical installation was planned by our student team and approved by a professional electrical engineer.	Electrical confirmation sheet
Electrical Grid	Low Voltage Distribution Network	Nominal voltage and frequency in the German Low Voltage distribution networks are: Voltage:400 V/230 V (phase-neutral). Frequency: 50 Hz.>Voltage band: 207 -253 V (normal operating range); >Frequency band: 49.5 -50.5 Hz (normal operating range).	All HDU loads are three-phase (400 V) or single-phase (230 V).	Project specifications
		Overvoltage: equal or over 230 + 10% = 253 V; Undervoltage: equal or under 230 –10% = 207 V	All selected products operate between 220-240 V	Project specifications
		Overfrequency: equal or over 50 + 0.5 = 50.5 Hz; Underfrequency: equal or under 50 –0,5 = 49.5 Hz	All selected products operate at 50 Hz	Project specifications
	TN-C-S System	The cable connection of the HDU must be made according to the TN-C-S system, which is used in the German Low-Voltage Grid.	Considered in drawings	EL-6001
		The TN system (French: terre neutre) is a certain type of implementation of a low-voltage grid in the electrical energy supply. The most important feature is the type of earth connection of this power supply system to the power source.	Considered in drawings	EL-6001

		Colour Code according to the international standard IEC 60446:	Following colour code from the IEC 60446 Standard will be used in the installation: - L1 / L: Brown - L2: Black - L3: Grey - N: Blue - PE: green/yellow - PEN: light blue with green/yellow markings	
	Utility Compatibility	The HDU needs to connect to the German Grid. If the Teams home country provides a different voltage, they have to announce this to the SDE21 Organisers.	The HDU is planned at a voltage of 400V/230V, same as the German grid.	
		Teams are responsible for the installation of an appropriate transformer, in case their HDU is built for a different voltage. The chosen fabricationneeds to be listed in the equipment listings.	The HDU is planned at a voltage of 400V/230V, same as the German grid, therefore no transformer is needed	
		Devices in the house do not necessarily be compatible with the German Grid for the competition phase.	All Devices are compatible with the german grid	Project specifications
Safety Requirements	Short circuit protection	An automatic Residual Current Device (RCD) for personnel protection against indirect contact is needed.	Team RoofKIT proposes the use of RCBO protection devices instead of traditional RCD devices. This contributes to reducing the safefy material by combining MCB (miniature circuit breaker) and RCD into an RCBO (Residual Current Breaker with Over-Current) device.	EL-5001, EL-6001, EL-6002, EL-6003, EL-6004 and EL-6005
		RCD prevents injuries caused by short circuits.	Team RoofKIT considers that the safety of the installation and the occupants is of utmost importance, and thus RCD (RCBO) protection devices are foreseen in the electric design of the system.	
		A protection against contact of 30 milliamperes must be ensured.	All RCD (RCBO) devices connected to sockets or house appliances (where necessary) have a protection against contact of 30mA. These are only considered where the risk of residual current appears (sockets, or appliances	EL-5001, EL-6001, EL-6002, EL-6003, EL-6004 and EL-6005 E&C Report, Table 1

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			without direct connection to the fuse box). All other protections were dimensioned following the consumptions listed in every circuit (Table 1, E&C Report).	
		The RCD is mandatory in the fuse box of the HDU.	The RCBO protection devices will be properly placed in the fuse box and named accordingly to avoid mistakes in the connection phase.	
	Earthing	An earthing-system is needed according to IEC 60364-5-54:2011.	The earthing system was dimensioned following the conventions according to the IEC 60364-5 and following the requirements according to the data sheet of the devices.	
		Teams must provide equipotential bonding for each washing basin and bathtub and for all household appliances;	Every socket and device installed in the HDU will have a connection to the equipotential bonding at the distribution box.	EL-6002, EL-6004, EL-6005
		All conductors must be connected on a main equipotential bonding rail;	Team RoofKIT considered this from the beginning, as one of the main requirements of IEC 60364-5. There will be a bonding rail in the use box (technical core) which collects the earthing for all devices. There will be another bonding rail in the house connection box (under the HDU) which will connect the earthing of the HDU loads together with the DC system.	EL-6003
		Connection to rod/ strip earth electrodes on the Teams lot which will be prepared by the SDE21 Organisers.	The grid connection available in Wuppertal is a TN-C-S connection, where PE and N come together as PEN. Team RoofKIT proposes the earthing to go through a main surge protection device (SPD), grounded to the main equipotential rail.	EL-6001
	Receptacles	All receptacles must have a building inspectorate approval. For that a CE marking is required.	Team RoofKIT ensures that all receptacles/sockets have a CE Marking.	Project specifications, Certificate of compliance JUNG
		Any receptacles used must be protected with ground a residual current device (RCD). Enclosures provided must be suitable for damp locations (minimum IP44 protection level).	Team RoofKIT proposes the use of RCBO protection devices instead of traditional RCD devices. Every available socket in the HDU will be protected againt residual	EL-6002, EL-6004, EL-6005 Project specifications, KIT_EL_Sockets_Jung

			current. The receptacles/sockets (SCHUKO Socket from Jung) provide an IP44 protection level.	
		Receptacles must be three-poled and have to be equipped with a child safety lock.	All receptacles are three-poled (SCHUKO Socket from Jung).	EL-6002, EL-6004, EL-6005 Project specifications, KIT_EL_Sockets_Jung
		If a power connection is provided in the kitchen, it must be fused separately.	All sockets available in the kitchen are fused together (and separated from other loads or known kitchen appliances) with a RCBO protection of 30mA / B16 A and a wire diameter of 2.5 mm². This enables a connected total power up to 3.5 kW.	EL-5001, EL-6005
		For the heating test, a three-phase current socket (equipped for 5 kW) must be available in the house.	A three-phase current socket is installed in the technical core with an RCBO protection of 30mA / B32 A, and a wiring of 1.5 mm². This allows a connected total power up to 7.5 kW.	EL-5001, EL-6005
	High Current Power Connection	If there is a high current power connection (fixed connection) for the oven in the kitchen, it must be fused separately.	In the kitchen, the oven and the stove receive separate currect circuits: -Stove: 7.4 kW / MCB N32 A, 6mm² wiring. -Oven: 3.4 kW / RCBO 30mA-B20 A / 4 mm² wiring.	EL-5001, EL-6005
		Any other device with an output greater than 3.5 kW must also have a fixed connection.	All the other kitchen appliances are under 3 kW (apart rfom Stove and Oven). Special attention is paid to the dishwasher (2,1 kW). For safety reasons, the dishwasher is also connected separately (RCBO 30mA – B16 A), 2.5 mm² wiring.	EL-5001, EL-6005
	Exterior and Interior Lighting	In house tour areas, light fittings must provide a minimum illumination level of 20 lux for exterior path and traffic areas, and a minimum of 100 lux in average for interior areas. A minimum of 1 lux for all areas is required.	Team RoofKIT created a lighting design concept focusing on the individual needs of the user and specific tasks in the areas in use. This fit-for-purpose strategy offers a flexible use of light, integrating visual comfort with adecuate light levels inside	EL-4003-4008

			and outside and reducing the waste of energy.	
		Colour temperature of luminaires should be warm white (2700K-3000K) with a colour rendition Ra >80. Coloured lighting is prohibited in outdoor areas.	To enhance wellbeing and support the user's circadian rhythm throughout the whole day, the general light solution provides biodynamic tunable white lighting that changes its color temperature following the outside daylight situation and creates a natural atmosphere inside the living unit. All other lighting fixtures are specified in warm white with a high colour rendition to meet today's quality lighting standards.	EL-4003-4008
		The exterior and interior lighting design should minimize light pollution ("dark sky").	The architecture provides a possibility to cover/shield the window openings at night time to avoid any interior lighting emitting to the outdoor environment. The outdoor lighting considers the dark sky recommendations with precise light distribution directed downwards, without glare or spill light, to avoid disturbing effects and light pollution.	EL-4003-4008
		Houses which have no or only inadequate external lighting on their lot, will be closed during evening hours.	The lighting concept of Team RoofKIT acknowledges this and ensures that adequate lighting is provided in the exterior for the evening hours.	EL-4006, EL-4007, EL-4008
Technical Requirements	Electricity Meter	Teams must provide an installation space for standardized electricity meters in the HDU. Four metering devices with separate wiring are expected to be installed in the HDU (sub-distribution, battery, PV and consumer meters). Dimensions and exact specifications will be provided on the SDE21 WAT.	According to the monitoring procedures, the energy meters are placed within the monitoring panel of SDE. The cabling from the monitoring panel to the central fuse box is considered by team RoofKIT and shown in the wiring plan of the project drawings.	EL-6001, ID-3001 (Energy meters topology) EL-3004, EL-3007 (wiring plan)
		Installation height: distance of meter niches from the surface of the finished floor (DIN 18013) > Upper edge max. 210 cm; > Lower edge min. 40 cm.	The monitoring panel has some space reserved in the HDU according to the monitoring procedures.	EL-3001
		The cables are inserted vertically into the electricity meter from above or below.	This indication will be considered during the assembly phase.	
	Equipment Listings	All electrical equipment must be certified for the European market by	All the electrical equipment is certified for the European market. Besides, all the	Project specifications

		complying with European standards and must bear a CE mark.	equipment is ready for a CE marking process.	
		All DC to AC utility-interactive inverters must be fully listed to European Standard.	Considered in all products which are currently set	Project specifications
	House Connection	Teams must provide an empty conduit with an outside diameter of 25 mm for the house connection of the HDU.	The empty conduit with an outside diameter of 25 mm will be provided according to this rule.	EL-3001, EL3002

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Photovoltaic Checklist

Team ID	Team Name	Country
KIT	RoofKIT	Germany
	University	**Date**
	Karlsruhe Institute of Technology	09.03.2022

Subject	Element	Required specification or information	Comment	Location PD sheet, PM Page or other documents
General Requirement	Photovoltaic System Design	Particular attention should be paid to photovoltaic system design, storage batteries, generators, grounding, conductors for general wiring, flexible cords and cables, and over-current protection devices, respectively.	Team RoofKIT has decided to install innovative PVT collectors on the roof of the HDU. The design of the DC system is tackled in the Engineering & Construction Report.	E&C Report section 2.1.2.2, PV-Drawings
		photovoltaic system design	10 PV Panels will be connected in series on the roof of the HDU. The novelty is that the panels are in copper red, which allows a higher aesthetic integration of solar energy systems in an urban context. In the HDU, only 10 of the total 18 available PV panels are connected, due to the limit of 3 kWp for the total nominal power output.	PV-Drawings
		storage batteries	To store the electrical energy generated by the sun and use it at night, batterie are foreseen. As mentioned before, RoofKIT aims at maximizing the efficiency of the installed systems, and therefore decided to work with BYD Batteries (Li-Ion). In the market, only batteries from 5 kWh are available, and to comply with the Rule 7.4, the charging of the battery will be artificially limited to 2.5 kWh by the building management system.	PV-Drawings

		generators	No other generators, besides the PV panels, are installed in the HDU.	PV-Drawings
		grounding	An appropriate grounding system is installed at the complete DC system. PV panels, protections, battery and inverter are connected to the earthing system.	PV-4001
		conductors for general wiring	All general wiring conductors have been appropriately dimensioned, following the requirements from every component regarding cable diameter, nominal current and protections.	PV-Drawings
		flexible cords and cables	Cables are flexible enough to allow a clear disposition around the HDU.	PV-Drawings
		over-current protection devices	For the DC system, the protection devices were carefully selected and dimensioned.	PV-1001
	Regulation Compliance	In order to verify the regulation compliance, Teams must complete and submit these “Photovoltaic Checklist”.	I am currently doing this 🙂. Attached to this document is the signature of our certified electrical engineer.	
Safety Requirements	Emergency Switch The photovoltaic system shall include the following protection devices at the utility interface:	A general emergency switch for DC current must be set up close to photovoltaic system, and remote controlled from electric box of the house, near to the house general circuit breaking system.	A general emergency switch for the photovoltaic system is considered before entering the inverter. This box is placed near the main house grid connection, below the HDU.	EL-2001, PV-1001, PV-2001
		The general emergency switch must provide the isolation level required by the German Regulation.	A general emergency switch complies with the German regulation.	
		This switch will be accessible to the electricity distribution company in order to be able to perform a safe manual disconnection of the photovoltaic system.	The placement of the box will allow the electricity distribution company to perform the manual disconnection of the PV system.	
	Earthing	Earthing of the photovoltaic system equipment shall be done without disturbing the earthing of the utility distribution system, ensuring that no defects are transferred to the distribution network. See Rule 50.5 for Ground Penetration limits.	The earthing is done through an equipotential bonding rail, next to the house grid connection. The ground penetration limits are considered.	EL-2001, PV-1001, PV-4001
		The photovoltaic system shall guarantee galvanic separation	The selected inverter (Fronius Symo GEN24 Plus 5.0) provides galvanic	Project specifications

		between the Low Voltage distribution network and the photovoltaic system, by means of an isolation transformer (included in or external to the inverters) or by any other means fulfilling the same function, based on state-of-the-art technological development.	separation between AC and DC network.	
		In this sense, inverters with high-frequency transformers or transformer less inverters are permitted, provided that the inverter(s) manufacturer(s) provides a certificate guaranteeing that the maximum DC current to be fed into the grid is smaller or equal than 0.5% of the nominal output current of the device(s).	The selected inverter is transformerless. The characteristics are mentioned in the data sheet.	Product sheet of inverter in Project specifications
		Teams must include in the project documents certificates of the inverters manufacturers that demonstrate compliance with the galvanic separation requirement as well as with other requirements of the German Regulations mentioned in Rule 50.2 (for example, protections against over/under voltage and frequency).	A certificatation according to German regulations of the selected inverter is attached to the datasheet of the inverter	Certificatation according to German regulations of inverter in Project Specifications
	Equipment Listings	Unlisted PV modules may be used in a system with a DC bus voltage of no greater than 60 volts (open circuit) at 0 °C if, and only if, such equipment has been evaluated and approved by the Solar Decathlon Europe 2021 Building Official and Solar Decathlon Europe 2021 electrical inspectors. PV cell and module mounting means are subject to increased scrutiny in custom made, unlisted, building-integrated PV applications.	Our PV modules are produced by the German company AxSun Solar. All connected modules are listed. The PV systemis certified with the safety standard IEC 61730-2.	Project specifications
		The use of unlisted PV modules and the installation of listed PV modules in an unapproved manner in a system with a DC bus voltage of greater than 60 volts (open-circuit) at 0 °C are prohibited. Listings shall be to European Standards and shall be granted by an approved, accredited testing laboratory (e.g. German TÜV).	Our PV modules are produced by the German company AxSun Solar. All connected modules are listed. The PV systemis certified with the safety standard IEC 61730-2.	Project specifications
		The attachment of PV modules to any material where the PV module is not listed for such an application is	Our PV modules are produced by the German company AxSun Solar. All connected modules are	Project specifications

		prohibited, regardless of the bus voltage.	listed. The PV systemis certified with the safety standard IEC 61730-2.	
Technical Requirements	Grid Interconnection	The Photovoltaic system will be connected to the electricity distribution network following a single-phase configuration (connection to the phase and neutral) or a three-phase configuration for huge systems.	Team RoofKIT is aware that a 3 kWp PV system can be connected with a single-phase configuration to the grid. Given that the system total power will increase to 5.4 kWp after the competition, the grid connection is designed as a three-phase configuration. The selected inverter (Fronius Symo Gen24 Plus 5.0) can handle the required voltage and power and is connected according to the drawings.	PV-1001, PV-2001, PV-3001. Project specifications
		The interface between the Photovoltaic system and the electricity distribution network shall comply with the international standard IEC 61727 – Photovoltaic (PV) systems – Characteristics of the utility interface.	The interface between the PV system and the electricity distribution network is provided by the inverter. The selected inverter is certified to comply with the international standard IEC 61727, attached to the project specifications.	Project specifications
		IEC 61727 regulates the grid interconnection of low-power electricity generation installations Photovoltaic systems up to 100 kW to Low Voltage electricity distribution networks.	The interface between the PV system and the electricity distribution network is provided by the inverter. The selected inverter is certified to comply with the international standard IEC 61727, attached to the project specifications.	Project specifications
	Inverters	PV DC cables remain at exterior of the house as most as possible, and then enter directly in mechanical room. In the best case, inverters are positioned at exterior, on house roof. In other cases, PV DC cables remain only in mechanical room, in a protected path. This path must resist during 30 minutes to the fire.	The inverter is located on the under the HDU in the exterior, although in a protected place. No DC systems are inside the HDU.	EL-2001, EL-3008
		A circuit breaking system is installed to switch off simultaneously all inverters. This inverters emergency circuit breaking system will be visible, near to house general circuit breaking	A circuit breaking system is installed on the AC side to switch off the inverter from the grid. The circuit breaker is located inside the fuse box,	EL-2001, PV-1001, PV-3001

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		system, and these two general switches must be identified by quoting: «Warning: presence of tension sources: 1-Distribution grid 2-Photovoltaic panels», in black letter with yellow background. Furthermore, a pictogram representing photovoltaic risk must be indicated at exterior of the house, on mechanical room door.	in the technical core. The selected inverter comes with a WSD module (wired shut down) integrated, to safely disconnect the inverter from the grid inmediately. The safety signs are considered.	
	Over / under Voltage and Frequency	The photovoltaic system shall disconnect from the utility system (grid) whenever voltage or frequency are outside the specified ranges. To this aim, an automatic switch will be used to guarantee protection against over/under voltage and frequency. This switch can be integrated in the inverter, in which case it shall comply with the German Low Voltage Electric-Technical Regulation.	The inverter works with an output voltage of 400V/230V (three-phase system). An automatic switch for over/under voltage is included in the inverter.	Project specifications inverter

Photovoltaic system drawings

• Teams must complete the drawings according to the specifications given below.
• Drawings reference numbers shown below indicate the minimum drawings required for approval. Additional drawings can be included, provided that they respect the corresponding section, for example: for particular details of the complete PV system, new drawings with reference numbers PV-11 to PV-19 can be added. The same applies for details of the DC circuits (new drawings: PV-21 to PV-29), AC circuits (PV-21 to PV-29) and Grounding system (PV-41 to PV-49)

PV-10	**Photovoltaic system: General** This drawing shall be electrical and include the interfaces with the electrical installation of the house and the electricity distribution network	Team SDE	**RoofKIT**
PV-20	**Photovoltaic system: DC circuits** This drawing shall be electrical and include information about wiring (section, type), protections (current characteristics) and wiring methods of DC circuits	Team SDE	**RoofKIT**
PV-30	**Photovoltaic system: AC circuits** This drawing shall be electrical include information about wiring (section, type), protections (current characteristics) and wiring methods of AC circuits	Team SDE	**RoofKIT**
PV-40	**Photovoltaic system: Grounding system** This drawing shall include information about wiring (section, type) and wiring methods of the grounding system, including DC and AC circuits	Team SDE	**RoofKIT**

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Electrical Storage System Checklist

Team ID	Team Name	Country
KIT	RoofKIT	Germany
	University	**Date**
	Karlsruhe Institute of Technology	09.03.2022

Subject	Element	Required specification or information	Comment	Location PD sheet, PM Page or other documents
General Requirement s	Inverter	The inverter to be used together with the battery bank must be designed for operation in a grid type TN-C-S	The inverter is properly connected to the TN-C-S grid, according to the drawings of the grid connection and integration of DC system.	Project specifications, EL-6001, PV-1001, PV-2001
		This characteristic will be properly justified in the corresponding technical document.	See product sheets in the project specifications.	Project specifications
	Batteries	With respect to the conditions during the competition weeks and the measured Contest the maximal usable storage capacity of the battery bank is 2,5kWh	There is no viable Product on the German market. A battery with higher capacity (5 kWh) is being installed and locked to 2,5 kWh by the building management system. A certificate of the inverter company (Fronius) is included, where the statement regarding the capacity limit is described.	Project specifications, Engineering & Construction Report – Section 2.1.2.2

XII. Project Specifications

1.Architectural Elements

Fig. 7. KIT_PS#6_2022_03_22.xlsx

SDE 21_Project Specifications: Architectural Elements

Deliverable No.	D#6
Team ID	KIT
University/ City	Karlsruhe

Architectural Elements

Category	Document Name	GuID (BIM)
Category definitions (see Categorization Guideline)	*Team ID_Abbreviation_Product or Material_maufacturer.pdf when used more than once: Team ID_Abbreviation_Product or Material_maufacturer_01.pdf*	*Element ID according to your BIM Model*
01_Construction materials		
	KIT_CONS_ConstructionWood_Kaufmann.pdf	*Since the number of Elements and attached GuIDs is very high (381) and we wand to ensure the readability and usability of this document, we attached the GuIDs as an appendix to the particular data sheet.*
	KIT_CONS_Stairs_Rieger.pdf	0hcw6lT5nBEwQ3SkuF$0y6
	KIT_CONS_SteelBeams_Kaufmann.pdf	16cqmPhIT9nA9ewFDzOUHw
CONS *(Construction materials)*	KIT_CONS_ScaffoldingStaxo40_Doka.pdf	2vOqNJSQf919nnNQIm25l_ 3c4M46L0j87eU9mnDoX10p 2HPRADJn591eTWRvvXRz9l 16oJ2sisr2hutF2fcVAmW6 2F1IcJLL53TvYnplfCDfww 1cyee_PvD0ZvluWTYtZLRz 1ZckwuqLj0xgWuHny6Fmku 0UmHODH6L5Ov4Qa6$3h8Cl 0tFTfCt8L3Lvmz3iPSCnDD 0D0WTuj693ivRfRBqgbvIQ 3Q2JFEHSn8Hfgr9QRSJ2Ap 13H8bvbHPBfA7cuwGhcNJg 30Zz2_m056dgHPgRrmRhX1 2ttiDHh41EHvJEmHT2gqu$ 3ZwkcqCH91kQe6u8fHzu_o 33sDOsej13wAXnlIhqGBWh 1ZsgYmUiv6LvTJJ9gjAQFa 2Cn6BidlL9phsGNU7CVg1M 20SNu9qVzDEQHArh9YlkuS 3tnLQcDy52AQIX_BnyVK0j 37tG3iKjPBORqKgWUmls5h 0vA5jPd71AK9hr7bOkOY5M 0ZBpXnv3XE6f8ByBks_WYm 1chJD5Av94WRATPDqp0ejL 1syY4avxz6FemHvGWLJl3K 3p1JVBT7DBbwYxyGA51uzZ 2aIk$TCjXBKvRDO2B5gW$4 3NLFaMHfz6qfImDLIlYD7U 1J140IP6LD6BLqA4jaIDC5 1YUDMz1oT3F8JRECBkFMGh 3jg$luFAXDIeL05HlBpR0N 3ftOB4uYv1oA1Eczx1h0Vc 2gKEA4sDT4tRCC7NdiRcBu 1c1_R_mvzAaPEwvAYa9nUi 2_dOMlGvD44vhIQzJuePc4 3l7YoGSaTA1B1g$tzVGY$a 3TvZHv4Sb5YhYB0cFD2ciC 0Kgv7jZunBzBe8fn1$12MR 0Dli5apLjC9BdSWvxDu$dW 0kUnjYZEf4hAITdVxi1_Fs 0$RFlc7VX2Q9WhXNfinfa9 0KZ_JqivTFsxloqrheqyhN 0YvteBxqD8UQ7wEZWNTB$d 1GF0JsnwrDY93cp9$mFizh 2CkL0tWnH0XuAaENsaFX2r 2MdN6$YDbDIvwDRxOgKeI$ 37yQhGfAb5Hgk8sh6aPi9U 1wsOCiaqz1ygtETHSLDPfs 2Ud_Izouv2_eJwdmU9WALN 1kF7FxM512tPOvJ7MmHJeT 1nTCcKmUL6ix_w7HBTcl

		1F3D$XOwv77wBgHdfmxtV6 31snu4Ryf56RCNF6DTdy0F 2vPlEhGsTFURzyHsOr4Ra1 0aKAxw5gH1tfA6utH6_iZj 0qZDEaTMvBruAMT06Yq_Rs 1dGeuu7Cz9Fec7MqTMbMCM 0WjLwptUD9zhnfReV3UtoI 1xa$8sz6zFzPJps6tf_SEg 0o3c1VeiX9OB3ISg97GY4q 0RoxgVZ7948Bds2LXz9xpT 1RtF$kkbHAxAyfD59i1uAq 2mxjK27j13kuNcmr7VCrZ0 2AsrtjFnbBCwcL91sKpXXA 17AKJs2RzChOTjEAPkkwS1 0mChio8RXFp9nhzmamnimE 0D0mJRUhT8_gBc7JPssZON 07QNB0Bjf8lRxUcWUufOdv
02_Cladding material		
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	KIT_CLAD_ClayPlaster_Yosima_Claytec.pdf	2gphc290Jl9FTMj$9EXERn 2cZS_vtPsPeF0TsKoHZ5JO 3vJT$TRGeYI6AnUh0X_U06
	KIT_CLAD_Designfilz_MKFilze.pdf	0f7eiR0PeCmYrZnlBvJgRw 2C4thcodI19wp5QNxKt$6R 2M$r2V5q2cU9xwC51CLAZH 1AFFDW6pwNNYiBeF5YSszD 3jVDewKtBbE5yBZE6hM4U_ 1rQiaX53ECWMJL4PUVwVys 1L0hje0o1BVQc4BZlIRPUi 1H53GirnaFHRv00KUns8_a
	KIT_CLAD_board_smile_plastics.pdf	0H4n2rpC9Ejuv8AVS6QdTF 1J1HXWN7jAj9AzV73P2vb$
CLAD *(Cladding material)*	KIT_CLAD_CopperSheets_KME.pdf	0gN7bTvagliwYCO05HnBVV 3D3bnKDf9LfuO7mQJp$HXP 2CP0Vr3fsXaGCX9vQ0dze6 1mrZC7tvfPrCP6eF0WyFH_ 1R2xXPH2$VO_KnIOS0nmBR 1zUiMET6fiAsnPR33LjaOk 0t_tnpfnZrZQnXz8ItxQeF 0qP7i1pMymT$7WdEqej8PE 3EbW_K0uMUqywYNpvR$v_J 3DuQ0GYDFKSoU7xYkbdRXb 0cOS$S0EcTZ_XBXw0EEcib 3HLnE4KIlUgBn_4RXayzak 0O8hdMrDvAetWfOjJdPp6v 3YNFj5Ju0j_oS6Hu_4U4y$
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	KIT_CLAD_Glaskeramik_MAGNA.pdf	3Ou3c2m1f7dBbPaX8ml3DY 1U29M$dzP2RRosSDsoOqxY 2M9UD9CVv57h9dU8RszW21 3eHNVJQMrCiPcl6wmF_r3p 1ZJ66gk8X4CxORZY5WBA1n 1M3g_v7Sv0Xv6ccgHYBXhR 1pB1FAclj1g8w233IT1Dof 1U0d8bGcPDZAIzsMzCI33D
03_Construction boards		
	KIT_BRD_Woodenboard_GFM_MassivholzJunker.pdf	1UAqPF127fU32HGl5SAGBJ 233udDKTkepIxpMT89tqo1 08TuYuNyklJShTu9cZJQ1E 2r7yhKxCHcrV6oPQP00KB4 08ZiF0E2GOI743rfQd4zui 3M4XC1uwqaf37X7o7L8dO1 1VZFepQOd4FkI_54fITkQr 32nUU66C47oPQ8H09t8HmT 0AG9RRevOiJkhnKVfFW5A2 2tnLo$0OUvzuLCp4bwEWdQ 3_koxBFU0y13slt4Z9wjNC 3OjUXH$NYW2evZ8QcTsM0C 1Hkm9ia8LGtGFB1Iqa0BkH 3fAq6IZjXaNk1cd3BErk8z 3QFZPPuEsbPh5l$jZTbwHz 0Dorpe4FMX6Jv_kgcgrip9 3_LWmYS_pfBaPoT4lw33U4 04$g3dh4BLJ2teeuvKDeRX 3vnUUotpUKa1m6dCtzC729 1r8a_XGtgVKJuOq4P00$sz 2zlSKWzGHJlYq4_tMhMTF9 1Z1kqAL5wyLRXzF98FkyAv 1Nm5vtfaZpR2Si5c1nH2V1 0tO_qzcj3$BD9gZGhXfzO2 1c3zlwhs3dBj9vlCossGHZ

BRD *(Construction boards)*		1fNDWFSTAO4FuHjlMVtdG2 2TVfDDRxSQLaUS67yN9n9e 2qt8t1zXQlp83Wcxlf3$uM 24hyPLoQ1Ug4ertlc7ypDT 1jmxhVASgkLB19PTPjdVPZ 1qKJeIvFauj2joVSOgv0Kh 3gENwTeS_bAH1geLN262xf 2xvCPy2eL7SOjkR_hh16IM 3NQOaZJgzZmTzqSIBXRtHy 35jmO0MRqHet$GgsllHQFG 2g7Ij853zZlgWKBtoYlEiX 3l_VE$iQhTEQqLm5RvHzzy 1h8zI5xOoifTnUxAYtoQrM 33XJy2YJnlkMTBPB6LpWlq
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	KIT_BRD_Clayboard_Claytec.pdf	0XH7vP$pCwwklh_AuNMayk 1xScaGFFF7gk2TyDrPNzhm 0XMzLJTdHC0KzvtsQ3AbDo 1pkJzB8hGYbvhBNByBilDl 3BgBCxNQ$JfODezPIUvR3h 2V07f4Lddm_QEbM5fvk4wG 3ChOFf84zwqKF5qjvIJINr 0Eo$uS6$5_CzxfIZTffH6H 0niw6Bo9V71B8xtuPGHzNH
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04_Thermal Insulation		
THI *(Thermal Insulation)*	KIT_THI_Neptutherm_NeptuGmbH.pdf	1X473aRWnv$vjbeee8a1bP 3wt7gS4ID_KEwiN7DqVhPG 2bZVkXRRG$zwx8YtPhwlad 3NIDdsDA88QnhwCOmKaslS 1KMN5$5II6CG3TePUivYYT 0FV1SBIt2$fAl0EccWZA0q 1AS1QmmIfNaTZoX6kqHKSj 18D5w5hh7FqgJCDkiQdklJ 1cvGl8tRVMDzkebTswa_2H 0iKyCKtNs4H_elk4_JBy2V 2YT2Q9SYFfhczDTbqtYFG$ 3hnOri2pxallUf_buIvs5p 2RuT0PKDCpqLsrKPfSHebC 3UWETSkpdfO6nwCJGpv77h 2wbQJ5d76jzGnaeHcWLQuR 08ewHkjUGYDpBCc96IlMWP
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	KIT_WPR_EcovapBlue_Amann.pdf	2O7vFFwSXzV5lNuA6xMwpb 2gphc290Jl9FTMj$9EXERn 1cvGl8tRVMDzkebTswa_2H 1wygQo6LMzTqxW7C0FZPxg 3UgyjUziGXCL0eZXKqBXRf 2cZS_vtPsPeF0TsKoHZ5JO 0Dorpe4FMX6Jv_kgcgrip9 1k6uDABl2qwHLZz3Ff7VNJ 3GIeBRazOPdvY8IhjPwit7 0hdURWr8$cidorT0tXxSsI 0eVK_UI0iS8C4ELNvBKjXw 3nVLIzqfVYepBQDi7LIg_e 24ajSnt75JTlWWtvPyFUZy 2eKwwWVgX6nwFwFksx94Qv 3IBzg9wPnvktXp8gUtc8_n 3nz8G$alZayi6c9Q6WvK_c 0yFwMzmoNRjTttQ1mtU7HH 0ijDJyQJkfcUZGQymC3D20 1hZh7a9ASh99DP4HM$L1kM
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	KIT_FCD_Wood_Kaufmann.pdf	*Since the number of Elements and attached GuIDs is very high (378) and we wand to ensure the readability and usability of this document, we attached the GuIDs as an appendix to the particular data sheet.*
07_Openings		
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09_Furnishing		
FUR	KIT_FUR_board_smile_plastics.pdf	1PETI10iz5y90mFTvak9hk 0LsGbC621EDP_mTV0p6Be1 1p8si9OMz0WeIrtQnGf6OC 1goRP2stL18vbRdPPy4cyj 3SwJkgN19FpATpXhXayvbJ 0sbhu8gfP1aABSGLpGtOKt 3oj_EIHCDArfNRU41ooeZP 3lkw9YJeTESxEdwL0UgHcH 07OLAtAsX7uPT_EEhiGlPz 297brQEFn6dewcxxmpERjy 0lDBv1c1rAN9HzAvwh_RoQ 3wNGuXTeD3hAeugEOakbd7
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	KIT_FUR_DiningSet_Mohr.pdf	0ew3NBdKr2jwkfn2KQ2lW_ 12bFPzoHvB6Qsr24mNIJBm 0JUb8loiX6sfeRJfEoZFpn
	KIT_FUR_Matress_Manufactum.pdf	1IdW$VkjL5ae8dJm8UOgSs
	KIT_FUR_Mycelium_KIT.pdf	2twXVCH6P8AuSa$4emBXnH
	KIT_FUR_NakedBoard_ReWall.pdf	1RHDjEUtD1IvpLQfyAcDie 0QYRfHQObB9xqJytbn6Mwe

FUR *(Furnishing)*		0QYRfHQObB9xqJytbn6Mwe
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	KIT_FUR_StainlessSteel_Kaufmann.pdf	2LBwq6u9XEZ8klWRdz1G2O 0A37EnQub1CfxtpkpFfcEg 3qcuvnaoWhBBUp219eXqlG 2bR7tOUbVmiApLdmqCGzax 19iW1TVlRcVC4Mg4IsVKta 2wrwCT5uEksZn4hogjCj5c 3oblIw_k2Xb1gPVkmK7Nv0 3RmMqBYt4h2qwDjWF4hxTH 2PLb1IJhubW_BTaOziwAfh 1kZPhaLYq67R4YQ8dvXkzS 1qu8Io18PkkAf14tdy3Brz 0f26Xizyb0Xx_Ggf$RZcBl 1hpaM_uadFesZwYxWp7psK 1EmuiqURjA9XruPtKTLA3D 3nywasqwhxPKXGzJULZKJW 2jooHv2hVV7BAShdQDLjW1 375qsqy39vr7Yy25NnY7tS 1i51mX3VVraAj0IypR9r9k 0FM$QTqpVJ2RIJGLrg1_Ra 0LKo9iCXL57R$5Tatv2Rwm 1$JUYlJUH3YvOp7lWOnFoG 2cx8YqiMoKjDeA_T$jFw6h

2. Technical Building Services

Fig. 8. KIT_PS#6_2022_03_22.xlsx

SDE 21_Project

Deliverable No.	D#6
Team ID	KIT
University/ City	Karlsruhe

Technical Building Services		
Category	**Document Name**	**GuID (BIM)**
Category definitions *(see Categorization Guideline)*	*Team ID_Abbreviation_Product or Material_maufacturer.pdf* *when used more than once:* *Team ID_Abbreviation_Product or Material_maufacturer_01.pdf*	*Element ID* *according to your BIM Model*
01_Elevator		
ELV *(Elevator)*	KIT_ELV_Lift_Reco.pdf	3EPX7JWvD0SfHg$pjkHn4s
02_Plumbing		
PL *(Plumbing)*	KIT_PL_Drain_hansgrohe.pdf	2TcDgXhKv6pONka7cUWZhz
	KIT_PL_CopperPipes_Wieland.pdf	*Since the number of Elements and attached GuIDs is very high (212) and we wand to ensure the readability and usability of this document, we won't list the GuIDs for this Elements.*
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03_Electrical		
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	KIT_EL_BlindsActuator_Jung.pdf	*Not modelled.*
	KIT_EL_CentralController_RaspberryPi.pdf	*Not modelled.*
	KIT_EL_CoverSwitch1_Jung.pdf	3bTgRhX4b4Jg_VYKMXfA4B 3S78rGXpNLHhdCi3GBnEf4 0CHYOuIBksHPF_2EiMskb4 36VshPMpy8Hg9LOKMGR4ql 2pUpPAesztJBPuNWwiAv9w 3D3OLB_tVyHgjQ757cKFNA 0e7gQ6EyrVHeAkoAqxLwW6
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	KIT_EL_CoverSwitch3_Jung.pdf	3bTgRhX4b4Jg_VYKMXfA4B 3S78rGXpNLHhdCi3GBnEf4 0CHYOuIBksHPF_2EiMskb4 36VshPMpy8Hg9LOKMGR4ql 2pUpPAesztJBPuNWwiAv9w 3D3OLB_tVyHgjQ757cKFNA 0e7gQ6EyrVHeAkoAqxLwW6
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	KIT_EL_LampiPlan_iGuzzini.pdf	*Not modelled.*
	KIT_EL_LampKivo_Ribag.pdf	*Not modelled.*
	KIT_EL_LampLinealuce_iGuzzini.pdf	*Not modelled.*
	KIT_EL_LampPalco_iGuzzini_01.pdf	*Not modelled.*
	KIT_EL_LampPalco_iGuzzini_02.pdf	*Not modelled.*
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	KIT_EL_LampRoxxaneLeggera101_Nimbus.pdf	*Not modelled.*
	KIT_EL_LampSlim30_Mextar.pdf	*Not modelled.*
	KIT_EL_LampTrick_iGuzzini.pdf	*Not modelled.*
	KIT_EL_LampUnderscore_iGuzzini.pdf	*Not modelled.*
	KIT_EL_LampVario40_Mextar.pdf	*Not modelled.*
	KIT_EL_LampWinglet_Nimbus.pdf	*Not modelled.*
	KIT_EL_LTEBox_AVM.pdf	*Not modelled.*

EL *(Electrical)*	KIT_EL_LTEBox_AVM.pdf	*Not modelled.*
	KIT_EL_Multistation_Jung.pdf	*Not modelled.*
	KIT_EL_PowerSourceandIPGateway_Jung.pdf	*Not modelled.*
	KIT_EL_SmokeDetector_Jung.pdf	*Not modelled.*
	KIT_EL_Sockets_Jung.pdf	10vzarFwT_IfHAXysYqreT 1C_o8P4QAHIR7B6WuN0dK5 36pGqV_c1ClwzGfr27wpYW 29lTc4NA_WGgwdd0UTGs9b 2CVqx$j605GwMhj4mjV7df 2kuuUHI_spJfaFHNBr8dWI 1xi2jAr$zYHPkdKst2uUw6 1dNzwJs27NGQqOYGaib1An 27cG4UcPNtGeTOsB6OtDEa 3H0iu8wrv_HRVmpTdz0Sz4 2N0LVynt6QGueKlSDcUbLM 1AFJ81dQVtJuXsZ_lNp8hB 1MFbA$4dn6GR_rhQ3dJ79l 2$1b9wAQy8JO1Yk0_CX09H 2F1$dAWlSRIOPxfN2HvbVE 1jbhY6psL2HADxgQm3RDob 3D3OLB_tVyHgjQ757cKFNA 0e7gQ6EyrVHeAkoAqxLwW6
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	KIT_EL_SwitchActuator_Jung.pdf	*Not modelled.*
	KIT_EL_WeatherStation_Jung.pdf	*Not modelled.*
	KIT_EL_WirelessReceiver_Jung.pdf	*Not modelled.*
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	KIT_EL_WirelessSwitch4_Jung.pdf	3bTgRhX4b4Jg_VYKMXfA4B 3S78rGXpNLHhdCi3GBnEf4 0CHYOuIBksHPF_2EiMskb4 36VshPMpy8Hg9LOKMGR4ql 2pUpPAesztJBPuNWwiAv9w 3D3OLB_tVyHgjQ757cKFNA 0e7gQ6EyrVHeAkoAqxLwW6
04_HVAC		
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	KIT_HVAC_CorkInsulation_DIB.pdf	*Not modelled.*
	KIT_HVAC_FloorHeating_Wieland.pdf	*Since the number of Elements and attached GuIDs is very high (575) and we wand to ensure the readability and usability of this document, we won't list the GuIDs for this Elements.*
	KIT_HVAC_HeatPump_Bosch.pdf	1$KIIzOfBJJABv8M12t0e6
	KIT_HVAC_RoomSensor_Jung.pdf	*Not modelled.*
	KIT_HVAC_Ventilation_Lunos_01.pdf	3itdSyxtL2DgagdAnGfnj6

HVAC *(HVAC)*	KIT_HVAC_Ventilation_Lunos_01.pdf KIT_HVAC_Ventilation_Lunos_02.pdf	3itdSyxtL2DgagdAnGfnj6 2jcSr7TDD0_wTM_WuB4viY 28pNCHtMDDpwgEmTYtcyQf 2oKdht589BTxYFs_zRxO8p 1ZlfhLqh56Ih8QovgNer9L 0TcWuzwoT6xwEf3zPEpSNh 0ET03AlTT0QxqqPKHi$mbS 2WkgvYvdTEcebKFaI9hDQ5 1EQ7kCAH1Bq8U15j$kE9D8 02MY08TmrAUh2Yb0JFkQcE 2ZhggwifD00wt2nbMeZZhT 0zwJYem5jEHhk12FEBy$Mu
06_Solar systems and PV		
SWPV *(Solar systems and PV)*	KIT_SWPV_Inverter_Fronius_01.pdf KIT_SWPV_Inverter_Fronius_02.pdf KIT_SWPV_Inverter_Fronius_03.pdf KIT_SWPV_Inverter_Fronius_04.pdf	2XVvryhsrF2Rvjq_5i_UKa
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	KIT_SWPV_PVTModuleCoating_Axsun.pdf	1fuCGxhST8IxcOzhv5cei6 2hH4VGuczB8ewZNWMeZ$4t 3Kvd1LJVHEdxTa$VlMfT9Y
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	KIT_SWPV_SolarPump_Solator.pdf	2gVHoVquvqHP66Mt9024Xa
	KIT_SWPV_Controller_Lovato.pdf	*Not modelled.*
07_Appliances		
APPL *(Appliances)*	KIT_APPL_Connector_hansgrohe.pdf	3ams8ZdDf3t9_IaiE7bX2l
	KIT_APPL_CookerHood_V-ZUG_01.pdf KIT_APPL_CookerHood_V-ZUG_02.pdf	16CEMmkOv0ue9bHXv$6Vr1
	KIT_APPL_Dishwasher_AEG.pdf	0sbhu8gfP1aABSGLpGtOKt
	KIT_APPL_InductionHob_V-ZUG_01.pdf KIT_APPL_InductionHob_V-ZUG_02.pdf	340F9nYWL3hO_QE_iVHAeB
	KIT_APPL_Oven_V-ZUG_01.pdf KIT_APPL_Oven_V-ZUG_02.pdf	0UhN2Y4Db9mRMD8O0KYcYq
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	KIT_APPL_TapMetris_hansgrohe.pdf	1o3rfw_Oj41wTCC_r3DYGE
	KIT_APPL_Thermostat_hansgrohe.pdf	3ams8ZdDf3t9_IaiE7bX2l
	KIT_APPL_WashingMachine_Miele.pdf	3f9aS2cjJNIvSxvhxNpk1I
08_Vehicles		
VEH *(Vehicles)*	KIT_VEH_cargobike_shimano_01.pdf KIT_VEH_cargobike_shimano_02.pdf	*Not modelled.*
	KIT_VEH_EBike_Socket.pdf	*Not modelled.*
	KIT_VEH_steps_ebullitt_shimano_01.pdf KIT_VEH_steps_ebullitt_shimano_02.pdf	*Not modelled.*

XIII. Structural Calculations

XIII. Structural Calculations

The next chapter lists the structural calculations of all parts of the HDU.

1. Structural Analysis Part 1 - Timber Construction
Part one covers the primary load-bearing structure made of wood. Calculations of all individual modules of the HDU.

2. Structural Analysis Part 2 - DOKA Scaffolding Support Structure
Part two shows the specific calculations of the framework under the HDU. Our HDU is placed on a scaffold to create a flexible usable space underneath that underlines the architectural idea of our design. The scaffolding is from DOKA.

3. Structural Analysis Part 3 - Stairs, Railing and Foundations
Part three ensures that the stairway to our HDU and the railing on our terrace are stable and safe. Furthermore, here are exact calculations for the foundation and the stability.

Structural Analysis

Project SDE21 – House Demonstration Unit RoofKIT

Client RoofKIT
Chair of Sustainable Construction
KIT Karlsruhe
Englerstr. 11
76131 Karlsruhe
Germany

Project Engineer Dipl.-Ing. Karsten Schlesier

Date and signature 18 March 2022

This document contains 210 pages + 15 pages appendix

2hs Architekten und Ingenieur
PartGmbB Hebel Heisel Schlesier
Prof. Dirk E. Hebel . Felix Heisel . Karsten Schlesier

Wenzingerstraße 5
79285 Ebringen

TABLE OF CONTENTS

General Information

Applied standards and documents

DIN EN 1990	Eurocode 0:	Basis of Structural Design;
	NA to EN 1990:	National Annex Germany to EC0, 2010-12
DIN EN 1991	Eurocode 1:	Actions on Structures;
	Part 1-1 (10.10):	General actions – Densities, self-weight, imposed loads for buildings
	Part 1-3 (12.10):	General actions – Snow loads
	Part 1-4 (12.10):	General actions – Wind actions
	NA to EN 1991:	National Annex Germany to EC1, 2009-09
DIN EN 1993	Eurocode 3:	Design of Steel Structures;
	Part 1-1:	General rules and rules for buildings
	NA to EN 1993:	National Annex Germany to EC3, 2018-12
DIN EN 1995	Eurocode 5:	Design of Timber Structures;
	Part 1-1:	General common rules and rules for buildings
	NA to EN 1995:	National Annex Germany to EC5, 2013-08
ETA -15/0187	11/08/2017	Pitzl HVP Verbinder (Connectors)

Applied Software

RSTAB	Framework program, version 8.26
EXCEL	Spreadsheet program
FIXperience 2.92	Fischer Connectors calculation software

Used Materials

Solid timber:	C24 (spruce/fir) according to EN 14081-1
Structural steel:	S235 according to EN 10025, EN 10210-1, EN 10210-2, EN 10219-1 and EN 10219-2

Description of the Project

This structural analysis is conducted for the House Demonstration Unit (HDU) of *Team RoofKIT* from Karlsruhe, Germany within their participation in the Solar Decathlon Europe 2021 (SDE21) in Wuppertal. As part of this competition every team needs to embody their concepts and ideas in a temporary building that will be installed in Wuppertal, Germany for the competition phase in May/June 2022. The HDU of *Team RoofKIT*, however, will be deconstructed after the competition and shall be re-installed in another location in future. Thus, conditions for a permanent building are assumed for the design of the structure.

The building itself is elevated ~ 2.20m above ground level through a scaffolding system and consists of four modules. Three of the modules are the interior living space, the fourth is installed perpendicular to the others and will be further on referred to as the terrace module. The roof of each module is manufactured separately and mounted on site.

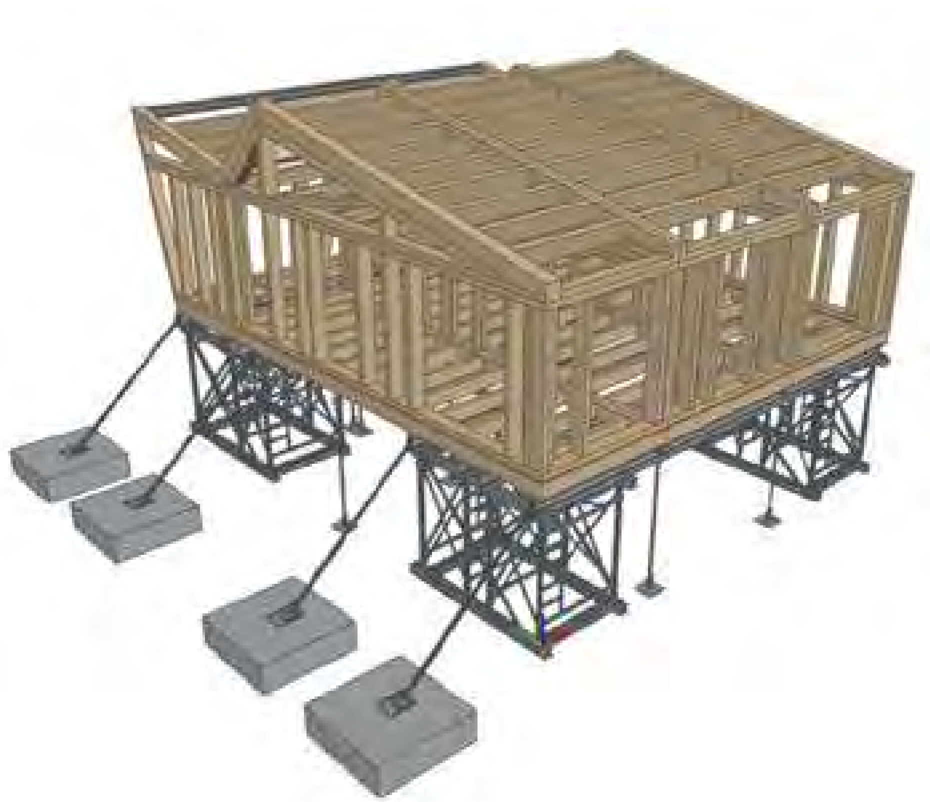
These modules are constructed almost entirely as a timber framework structure, only one steel girder is included in the roof of the terrace module. The wooden modules themselves work as individuals for the transport as well as a combined system.

The main vertical loads are carried by the frame structure in each exterior wall, that support the load to the scaffolding. The connections within the structure are assumed to be hinged, as usual in timber construction.

The horizontal bracing of the living space modules in their principal direction is ensured through a handcrafted 24mm layer of wooden diagonal cladding within the walls, that work as shear areas. Additionally, a truss like system in the terrace module is designed to transmit the horizontal loads in the perpendicular direction onto the scaffolding system.

Rendering

View from North-East



View from South-West

Limitations and Conditions of this Structural Analysis

This structural analysis covers the main support structure of the elevated timber building. The structural analysis of the ground floor steel support structure (below the lower edge of the building) including the load transfer at joints between the two systems as well as the steel structures of stairs and railings are not part of this document.

Information from external documents on connections between the support structure and the timber structure must be observed. Connections between the wooden structure and the steel substructure must be appropriately secured by additional mechanical shear connections.

Connections between cross-sections that are considered as load-bearing components in this calculation must be constructed to be shear-resistant. Direct force transmission between beams and columns must be ensured.

Details of the main load-bearing structure that are not part of this calculation are to be verified by the executing company. Details and fasteners can be replaced by alternatives that have at least the same capabilities in terms of load-bearing and stiffness.

Load-bearing elements of the main supporting structure of the walls and floor must be encapsulated with boards or wooden planks at least 22 mm thick for fire protection reasons.

Rebuilding the building in a new location requires structural approval.

TABLE 30. MINIMUM REQUIREMENTS FOR THE BUILDING STRUCTURE OF THE HDU.

COMPONENT	PART	REQUIREMENTS
Primary Structure	loadbearing walls columns and bracing	R 30
Roof	loadbearing structure of the roof	no requirements
Staircases	Loadbearing structure on escape routes	no requirements
Wall & Floor Coverings	interior and ceiling slabs	no requirements
	raised floors in escape route	no requirements
All applied Building materials	all parts	E-d2, EL-d2, Efl according to DIN EN 13501-1 2010-01 or Eca according to DIN EN 50575:2017-02
Rooms for lithium-ion-storage with a storage capacity over 2,5 kWh	perimeter walls	E 30 according to DIN EN 13501-2 2016-12
	door	SaC5 according to DIN EN 16034 2014-12 incl. DIN EN 16034 Ber 1 2018-02
	openable window	preferably available for ventilation in case of fire

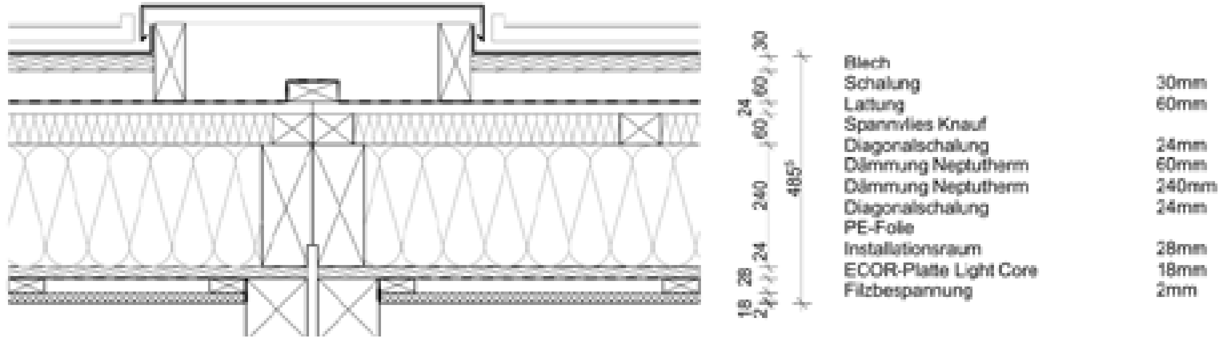
SDE21 Rules for structural fire safety (Rule 50.4, Table 30)

Load Assumptions

Dead loads

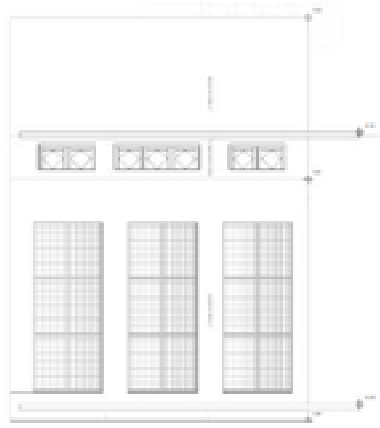
The dead loads of the members of the in RSTAB calculated systems are considered by the program itself. All other components, such as roof, wall and floor construction are listed below.

Roof Living Modules



Layers	density kg/m³	specific weight kN/m³	height m	width m	load introduction width m	surface load kN/m²
PV modules						0,10
reused sheet metal		78,5	0,002			0,157
cladding		5	0,03			0,150
battens		5	0,06	0,024	0,5	0,014
underlay spunbond						
diagonal cladding		5	0,024			0,120
insulation *Neptutherm*	70	0,69	0,300	0,505	0,625	0,166
construction wood		5,00	0,300	0,12	0,625	0,288
diagonal cladding		5,00	0,024			0,120
PE foil		0,07	0,05			0,070
panel *ECOR light core*		4,00	0,018			0,072
felt covering						
Total load						**1,253**

Calculation PV Modules		
roof area living modules	70,55	m²
number modules	18	
weight per module	38	kg
total weight	684	kg
weight/m²	9,70	kg/m²
Surface load	**0,10**	**kN/m²**

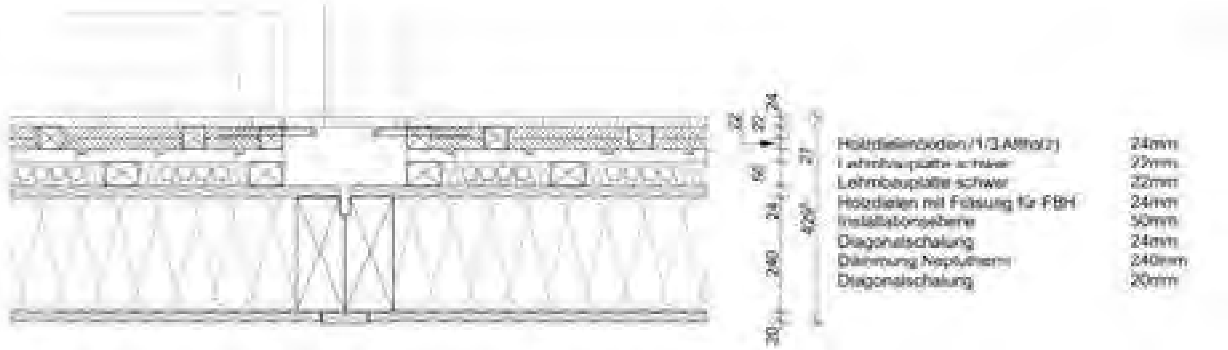


Roof Terrace Module

Layers	density [kg/m³]	specific weight [kN/m³]	height [m]	width [m]	load intro. width [m]	surface load [kN/m²]
PV modules						0,10
reused sheet metal		78,50	0,002			0,157
cladding		5,00	0,030			0,150
battens		5,00	0,060	0,024	0,50	0,014
underlay spunbond						
diagonal cladding		5,00	0,024			0,120
construction wood		5,00	0,240	0,12	0,625	0,230
battens		5,00	0,060	0,024	0,50	0,014
reused timber		5,00	0,020			0,100
Total load						**0,886**

calculated with:	**1,089**

Floor Living Modules

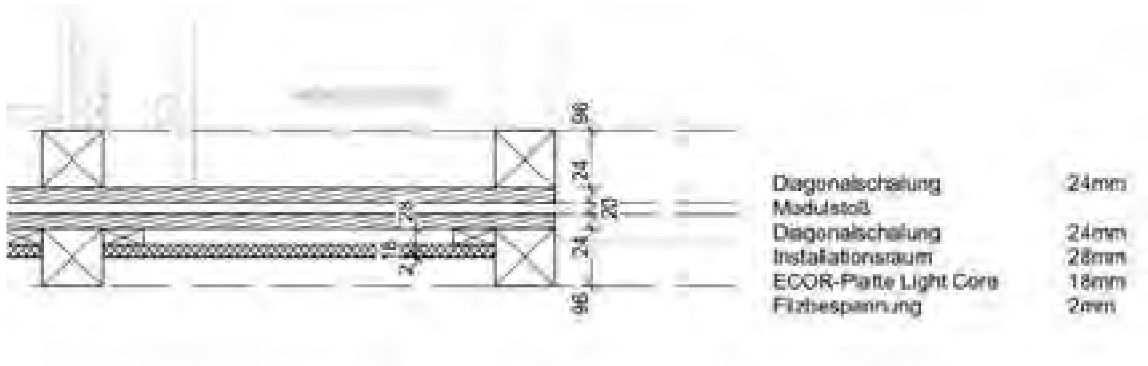


Layers	density kg/m³	specific weight kN/m³	height m	width m	oad introduction widtl m	surface load kN/m²
wooden flooring (1/3 reused)		5	0,024			0,120
clay construction panel	1800	17,66	0,044			0,777
milled wooden boards		5,00	0,024			0,120
insulation *Neptutherm*	70	0,69	0,050	0,135	0,205	0,023
construction wood		5	0,050	0,07	0,205	0,085
diagonal cladding		5	0,024			0,120
insulation *Neptutherm*	70	0,69	0,240	0,525	0,625	0,138
construction wood		5	0,240	0,1	0,625	0,192
diagonal cladding		5	0,024			0,120
Total load						**1,695**

Floor Boards Terrace Modules

Layers	density kg/m³	specific weight kN/m³	height m	width m	load introduction width m	surface load kN/m²
wooden terrace boards		5	0,080			0,400
Total load						**0,400**

Wall Technical Core



Wall 1 (core side)

Layers	spec. Weight kN/m³	height m	thickness m	width m	load introduction width m	unif. distr. load kN/m
wooden posts	5,00	2,38	0,100	0,100	0,755	0,158
diagonal cladding	5,00	2,38	0,024			0,286
Total load						**0,443**

Wall 2 (living room)

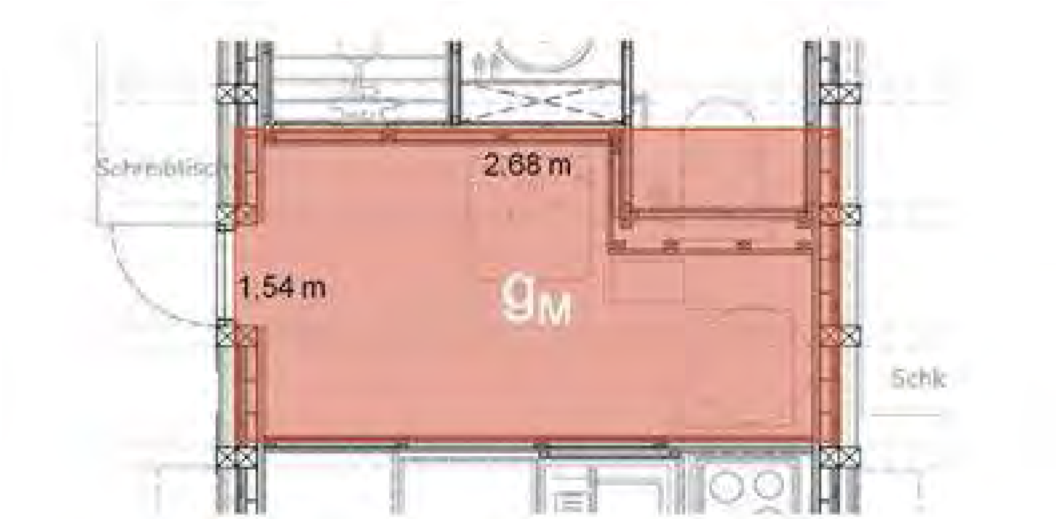
Layers	spec. Weight kN/m³	height m	thickness m	width m	load introduction width m	unif. distr. load kN/m
acoustic decoupling layer						
diagonal cladding	5,00	2,38	0,024			0,286
panel *ECOR light core*	4,00	2,38	0,018	0,042	0,655	0,011
felt covering						
wooden posts	5,00	2,38	0,100	0,100	0,755	0,158
Total load						**0,454**

Machines Technical Core

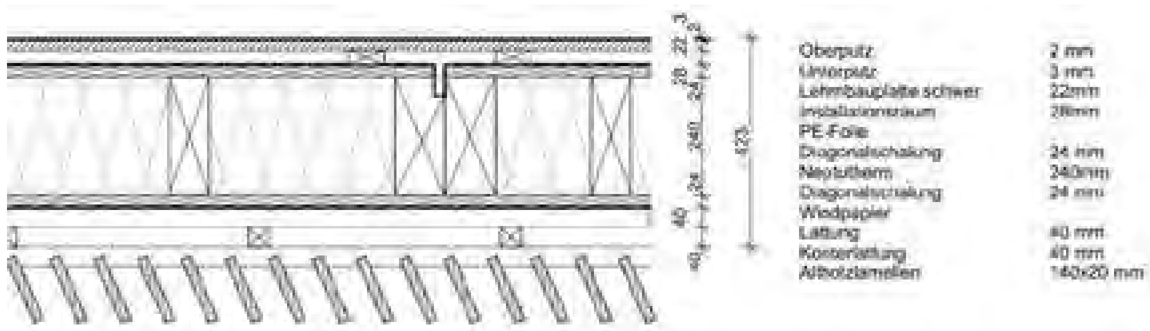
Object	Brand/Producer	Width [mm]	Thickness [mm]	Height [mm]	Weight [kg]	
heat pump	Bosch CS7800iLW 6 M	600,00	600,000	1780,000	236,000	
buffer storage 125	Bosch	600		980	178	
buffer storage 300	Bosch				367	
buffer storage 500	Bosch				590	
heating manifold	Kermi					
pump						
power inverter	Fronius				25	
battery	BYD B-Box 2.5				114	
ventilator	Lunos e260					
ventilator	Lunos Silvento					
washing machine	Siemens				75	
monitoring box SDE						
fuse box						
water pump						
PVT					360	
					1945	kg

Netto area technical core (simplified as rectangle) 4,127 m²

smeared load as uniformally distributed load g_M **4,62 kN/m²**



Exterior Wall



Layers	density [kg/m³]	spec. weight [kN/m³]	thickness [m]	width [m]	load intro. width [m]	surface load [kN/m²]
clay plaster finish	2050	20,11	0,002			0,040
plaster	2050	20,11	0,003			0,060
clay slab	1600	15,70	0,022			0,345
counter battens		5,00	0,028	0,070	0,625	0,016
PE foil		0,07				0,070
diagonal cladding		5,00	0,024			0,120
insulation *Neptutherm*	70	0,69	0,240	0,525		0,087
wooden posts		5,00	0,240	0,100	0,625	0,192
diagonal cladding		5,00	0,024			0,120
wind paper						
battens		5,00	0,040	0,040	0,625	0,013
counter battens		5,00	0,040	0,040	0,625	0,013
reused timber		5,00	0,020	0,140	0,100	0,140
Total load						**1,216**

Wall 1st floor

height wall 2,38 m

Total load **2,893 kN/m**

Uniformally distributed load wall roof area A (smudged)

area A 6,65 m²

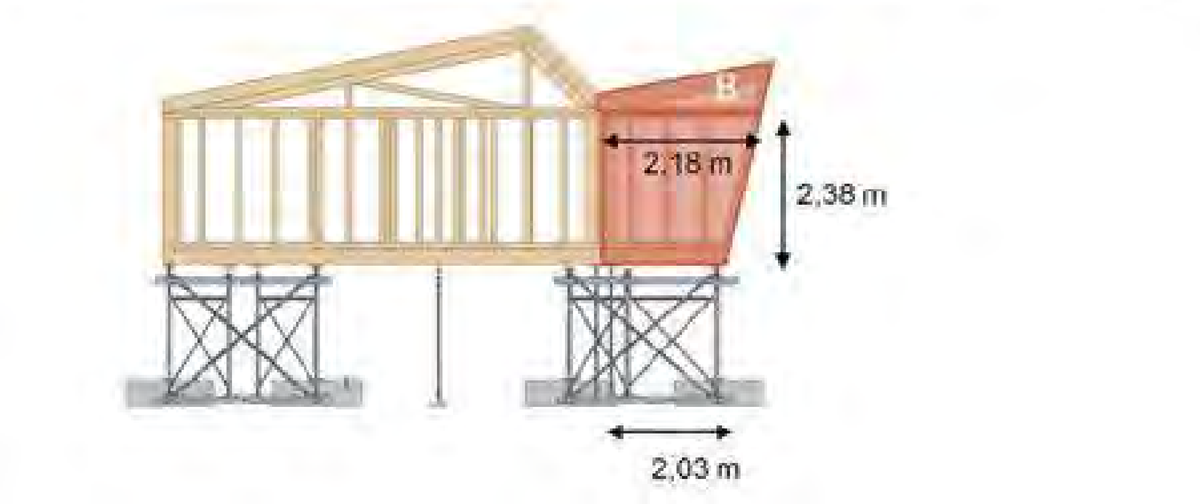
length 7,47 m

medium height 0,89 m

Total load **1,082 kN/m**

Wall Terrace Module

Layers	density [kg/m³]	spec. weight [kN/m³]	thickness [m]	width [m]	load intro. width [m]	surface load [kN/m²]
reused timber		5,00	0,020			0,100
diagonal cladding		5,00	0,024			0,120
wooden posts		5,00	0,200	0,100	0,625	0,160
diagonal cladding		5,00	0,024			0,120
wind paper						
battens		5,00	0,040	0,040	0,625	0,013
counter battens		5,00	0,040	0,040	0,625	0,013
reused timber		5,00	0,020	0,140	0,100	0,140
Total load						**0,666**



Wall 1st floor

height wall 2,38 m

1,584 kN/m

calculated with **2,021 kN/m**

Uniformally distributed load wall roof area B (smudged)

area B 1,62 m²
length top 2,18 m
length bottom 2,03 m
medium height 0,74 m

Total load top **0,495 kN/m**
calculated with **0,560 kN/m**

Total load bottom **0,531 kN/m**
calculated with **0,600 kN/m**

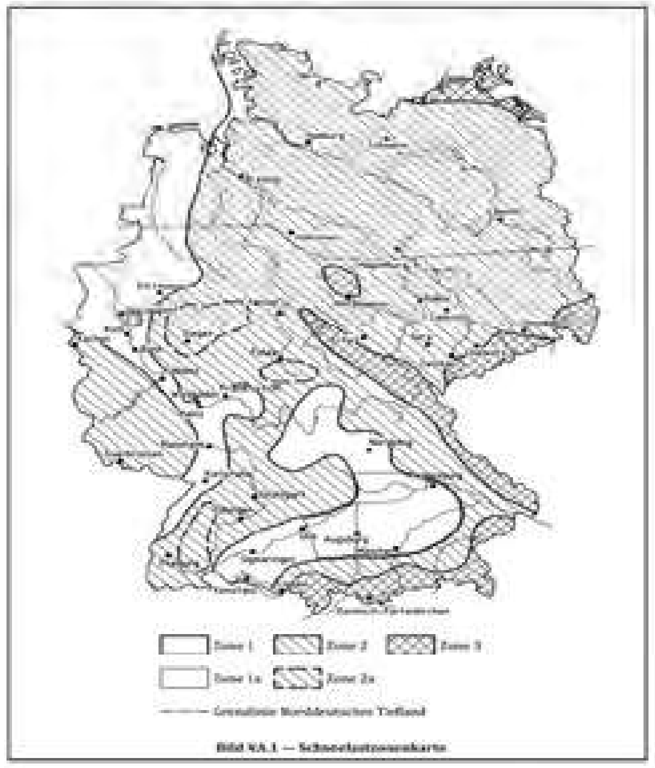
Window Façade at Module Split

Layers	density [kg/m³]	spec. weight [kN/m³]	height [m]	thickness [m]	width [m]	unif. distr. load [kN/m]
windows		25,00	2,14	0,018		0,963
Total load						**0,963**

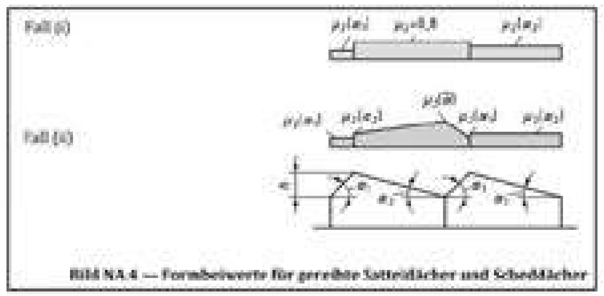
Live loads

Roof	according to the load assumptions of the SDE	1,0 kN/m²
Living Modules	according to the load assumptions of the SDE	2,5 kN/m²
Terrace Module	according to DIN EN 1991-1-1/NA	4,0 kN/m²

Snow loads



Level above above sea level	A =	160 m
Zone		1
ground load (up to 400m)	s_k =	0,65 kN/m²
	α_1 =	11,65 °
	α_2 =	46,01 °
	α =	28,83 °



	μ_2 =	0,8
	μ_3 =	1,57
	s_2 =	0,52 kN/m²
	s_3 =	1,02 kN/m²

<u>Wind actions</u>

Windzone	v_{b0}	q_{b0}
WZ 1	22,5 m/s	0,32 kN/m²
WZ 2	25,0 m/s	0,39 kN/m²
WZ 3	27,5 m/s	0,47 kN/m²
WZ 4	30,0 m/s	0,56 kN/m²

Bild NA.A.1 — Windzonenkarte für das Gebiet der Bundesrepublik Deutschland

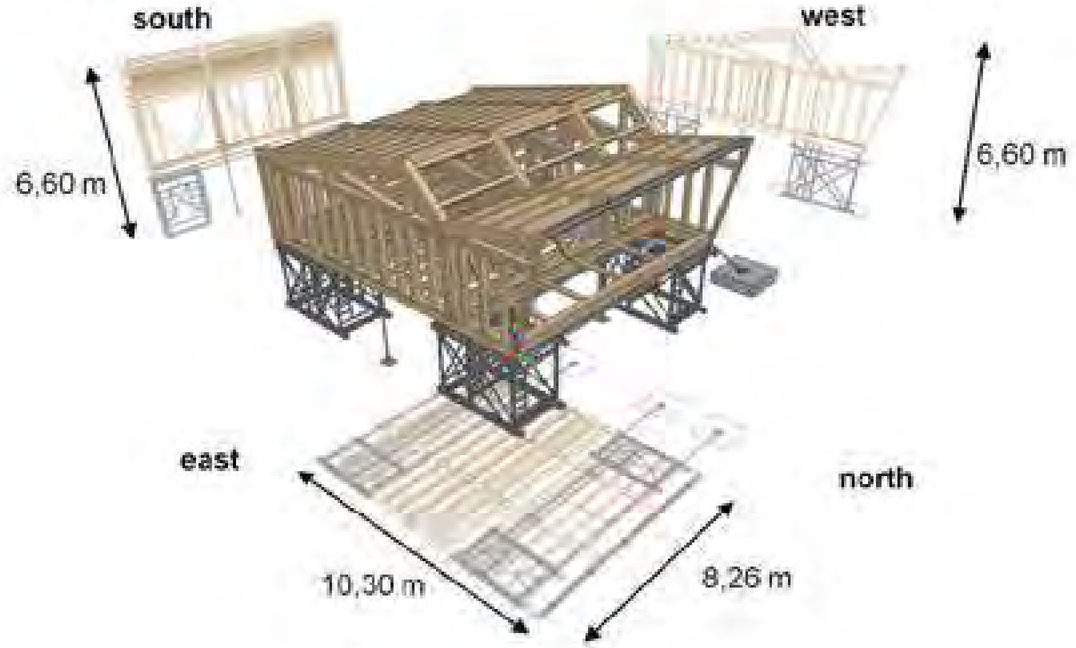
Windzone 1

Tabelle NA.B.3 — Vereinfachte Geschwindigkeitsdrücke für Bauwerke bis 25 m Höhe

Windzone		Geschwindigkeitsdruck q_p in kN/m² bei einer Gebäudehöhe h in den Grenzen von		
		$h \leq 10$ m	10 m < $h \leq$ 18 m	18 m < $h \leq$ 25 m
1	Binnenland	0,50	0,65	0,75
2	Binnenland	0,65	0,80	0,90
	Küste und Inseln der Ostsee	0,85	1,00	1,10
3	Binnenland	0,80	0,95	1,10
	Küste und Inseln der Ostsee	1,05	1,20	1,30
4	Binnenland	0,95	1,15	1,30
	Küste der Nord- und Ostsee und Inseln der Ostsee	1,25	1,40	1,55
	Inseln der Nordsee	1,40	—	—

Peak velocity pressure q_p= 0,50 kN/m²

Dimensions



h =	6,60 m
l_{north} =	8,26 m
l_{east} =	10,30 m
$l_{roof\ area\ 1}$ =	6,235 m
$l_{roof\ area\ 2}$ =	1,24 m
$l_{roof\ area\ 3}$ =	2,85 m

<u>Wind pressure on the roof</u>

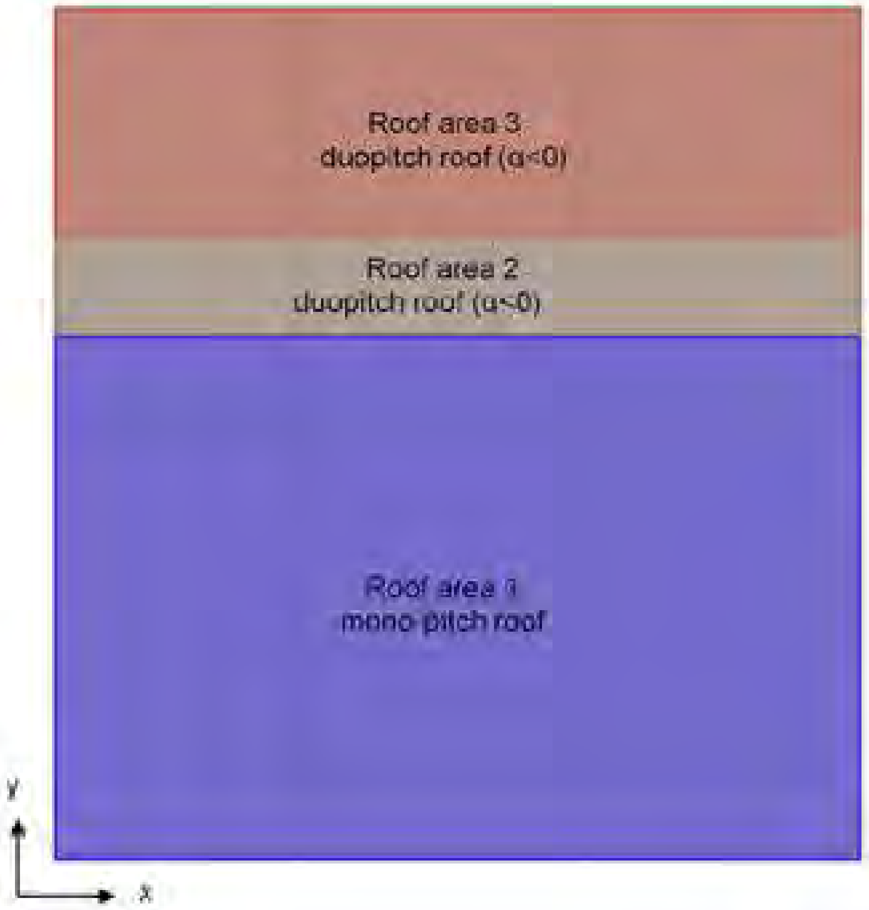
Suction on the roof caused by wind loads will be negliged for the internal forces of the individual members. It will only be considered in the checks for the connection details (D#6)

α	11,65 °
β	46,01 °
γ	11,65 °

According to DIN EN 1991-1-4 7.2.7 the wind loads on multispan roofs can be calculated with a combination of monopitch and duopitch roofs (α<0).

Factors for the pressures are reduced as shown in Figure 7.10.

The zones F/G/J used should be considered only for the upwind face. The zones H and I should be considered for each span of the multispan roof.



1. External pressure coefficients for wind from the south

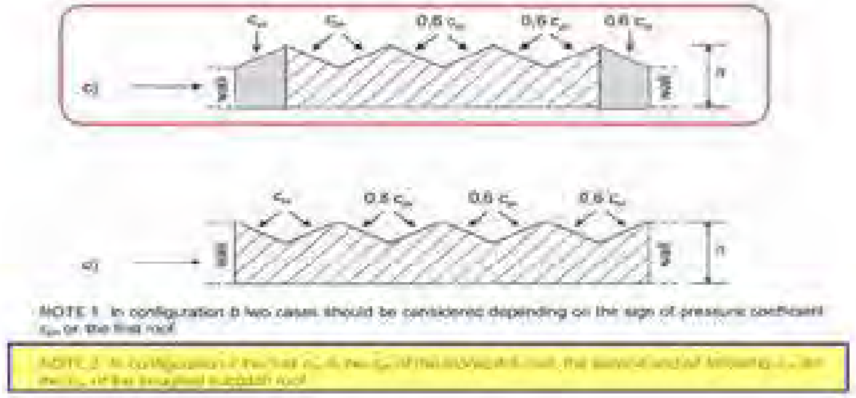
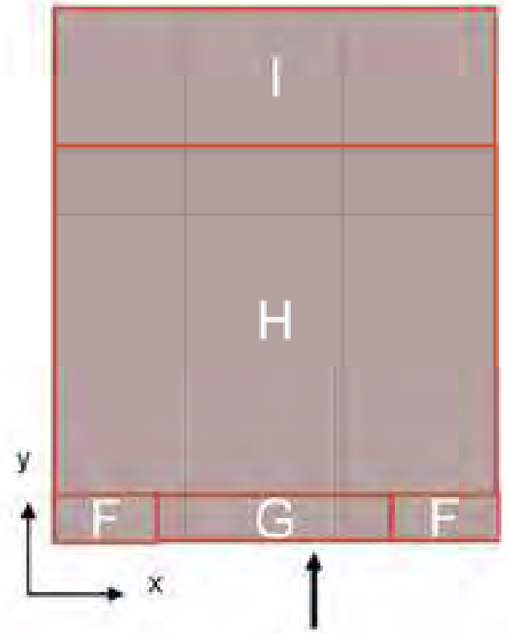


Figure 7.10 — Key to multispan roofs



Roof area 1 (monopitch roof 15°)

	$c_{pe,10}$	w,k [kN/m²]	suction [kN/m²]
F	0,2	0,10	-0,9
G	0,2	0,10	-0,8
H	0,2	0,10	-0,3

	e =	8,26 m		
	x-direction		y-direction	
F:	e/4 =	2,07 m	e/10 =	0,83 m
G:	e/2 =	4,13 m	e/10 =	0,83 m
H:	b =	8,26 m	l_1-(e/10) =	5,41 m

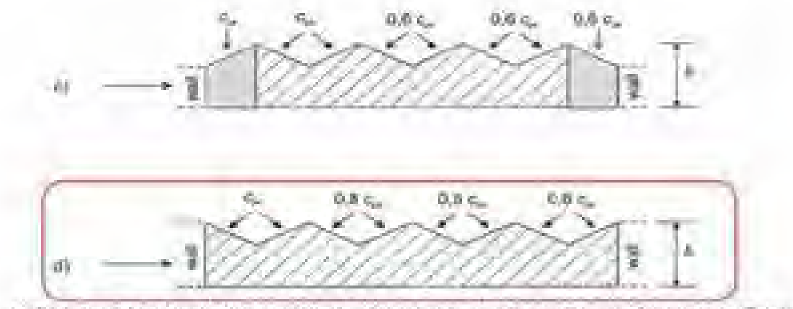
Roof area 2 (duopitch roof -45°)

	$c_{pe,10}$	w,k [kN/m²]
H	-0,8	-0,40

Roof area 3 (duopitch roof -15°)

	$c_{pe,10}$	w,k [kN/m²]
I	-0,5	-0,25

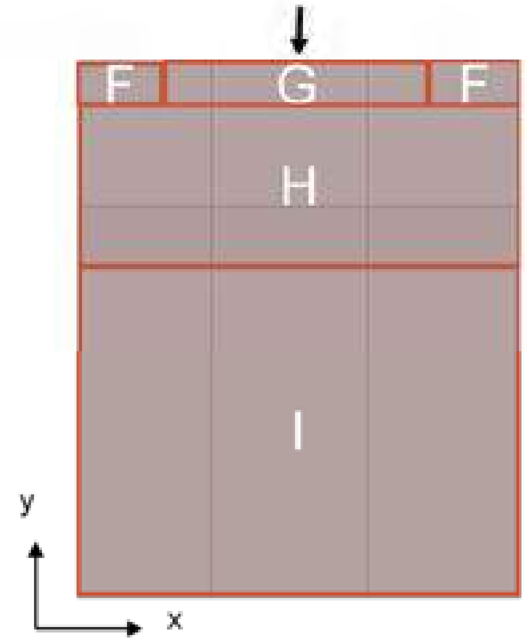
2. External pressure coefficients for wind from the north



NOTE 1 In configuration b two cases should be considered depending on the sign of pressure coefficient c_{pe} on the first roof.

NOTE 2 In configuration c the first c_{pe} is the c_{pe} of the monopitch roof, the second and all following c_{pe} are the c_{pe} of the troughed duopitch roof.

Figure 7.10 — Key to multispan roofs



Roof area 1 (duopitch roof -15°)

	$c_{pe,10}$ * 0,8	w,k [kN/m²]
H	-0,72	-0,36

Roof area 2 (duopitch roof -45°)

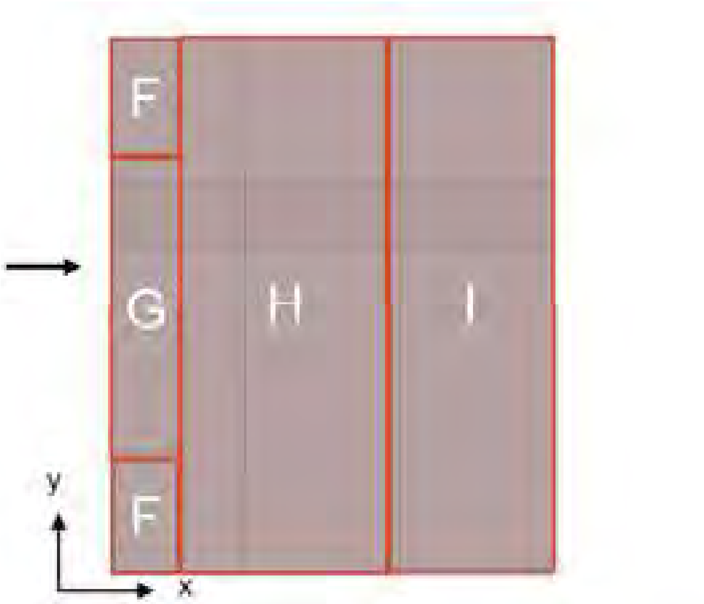
	$c_{pe,10}$	w,k [kN/m²]
I	-0,7	-0,35

Roof area 3 (duopitch roof -15°)

	$c_{pe,10}$	w,k [kN/m²]
F	-2,5	-1,25
G	-1,3	-0,65
H	-0,9	-0,45

	e =	8,26 m		
	x-direction		y-direction	
F:	e/4 =	2,07 m	e/10 =	0,83 m
G:	e/2 =	4,13 m	e/10 =	0,83 m
H:	b =	8,26 m	l_3-(e/10) =	2,02 m

3. External pressure coefficients for wind from the east/west



Roof area 1 (-15°)

	$c_{pe,10}$	w,k [kN/m²]
F	-1,9	-0,95
G	-1,2	-0,60
H	-0,8	-0,40
I	-0,8	-0,40

	e =	10,3 m		
	x-direction		y-direction	
F:	e/10 =	1,03 m	e/4 =	2,58 m
G:	e/10 =	1,03 m	l1-(e/4) =	3,66 m
H:	e/2-e/10 =	4,12 m	l1	6,24 m
I:	b-e/2	3,11 m	l1	6,24 m

Roof area 2 (-45°)

	$c_{pe,10}$	w,k [kN/m²]
F	-1,4	-0,70
G	-1,2	-0,60
H	-1	-0,50
I	-0,9	-0,45

	e =	10,30 m		
	x-direction		y-direction	
G:	e/10 =	1,03 m	l2	1,24 m
H:	e/2-e/10 =	4,12 m	l2	1,24 m
I:	b-e/2	3,11 m	l2	1,24 m

Roof area 3 (-15°)

	$c_{pe,10}$	w,k [kN/m²]
F	-1,9	-0,95
G	-1,2	-0,60
H	-0,8	-0,40
I	-0,8	-0,40

	e =	10,3 m		
	x-direction		y-direction	
F:	e/10 =	1,03 m	e/4 =	2,58 m
G:	e/10 =	1,03 m	l1-(e/4) =	0,28 m
H:	e/2-e/10 =	4,12 m	l1	2,85 m
I:	b-e/2	3,11 m	l1	2,85 m

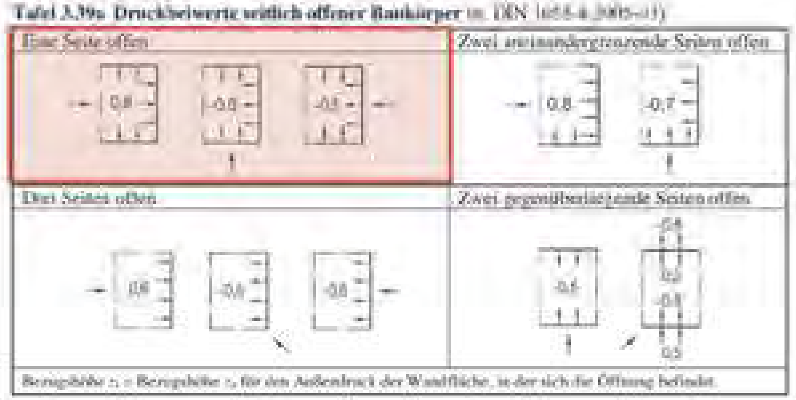
Consideration of the internal wind pressure in the terrace module

In the currently valid Eurocode, the calculation of wind loads for structures open on one side is not regulated. The state of the art corresponds to the procedure from DIN 1055-4. The procedure is shown in the following section.

7.2.11 Seitlich offene Baukörper

Hinweise zu seitlich offenen Baukörpern sind in DIN EN 1991-1-4 nicht enthalten. Aus diesem Grund wird empfohlen, die nachfolgend angegebenen Regelungen nach DIN 1055-4 (Ausg. 2005) zu verwenden. Wände, bei denen mehr als 30 % der Fläche offen sind, gelten als offen. Fenster, Türen und Tore sind als geschlossen anzusehen, wenn sie nicht betriebsbedingt bei Sturm geöffnet werden müssen (z. B. Ausfahrtore von Gebäuden für Rettungsdienste). Druckbeiwerte für die innenliegenden Flächen seitlich offener Baukörper sind in Tafel 3.39a angegeben. Für die außenliegenden Flächen gelten die Druckbeiwerte geschlossener Baukörper (Abschnitte 7.2.2 bis 7.2.6), sofern in Tafel 3.39a nichts anderes angegeben ist.

Tafel 3.39a Druckbeiwerte seitlich offener Baukörper (n. DIN 1055-4:2005-03)



The wind load applies on all internal surfaces (walls, roof, floor).

Wind from the north

c_{pe} =	0,8	w,k =	0,4 kN/m²

Wind from the east/west

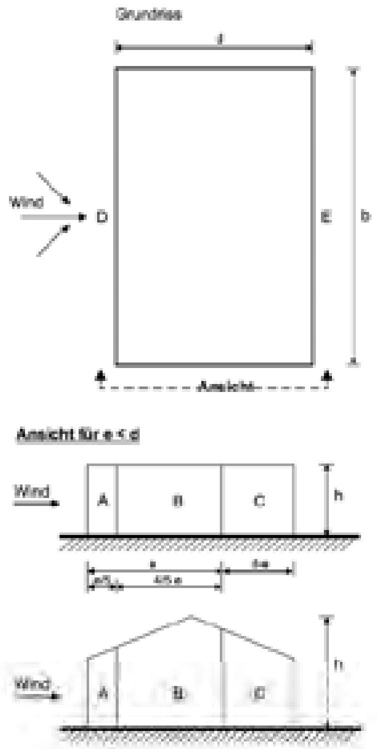
c_{pe} =	-0,6	w,k =	-0,3 kN/m²

Wind from the south

c_{pe} =	-0,5	w,k =	-0,25 kN/m²

Wind actions on the walls

Wind from the north/south



$b = l_{north}$ = 8,26 m

$d = l_{east}$ = 10,30 m

e = min b = 8,26 = 8,26 m
2h = 13,2

e/5 = 1,65 m

4/5 e = 6,61 m

d-e = 2,04 m

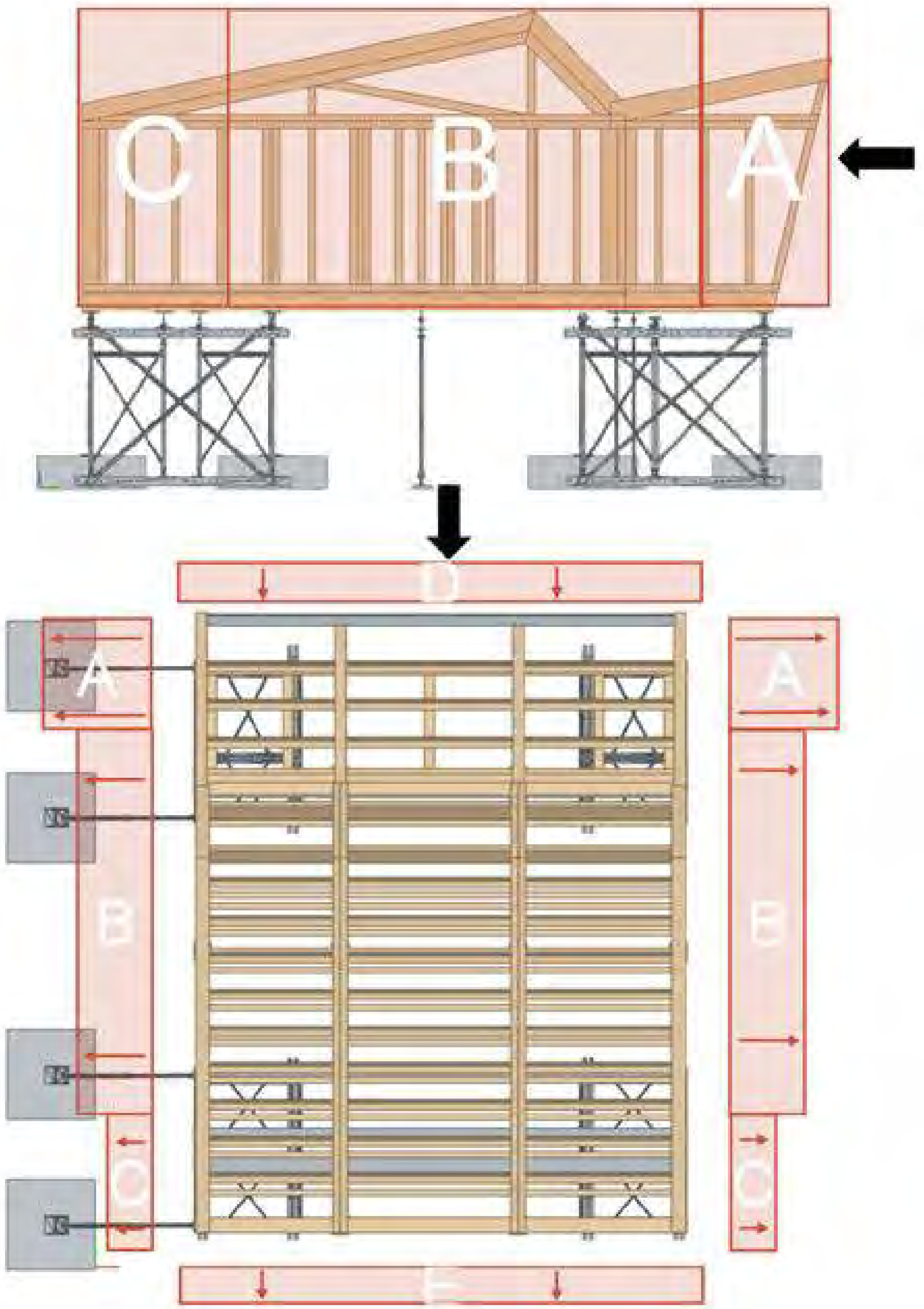
h/d = 0,64 ≈ 1

Tabelle 7.1 — Empfohlene Außendruckbeiwerte für vertikale Wände rechteckiger Gebäude

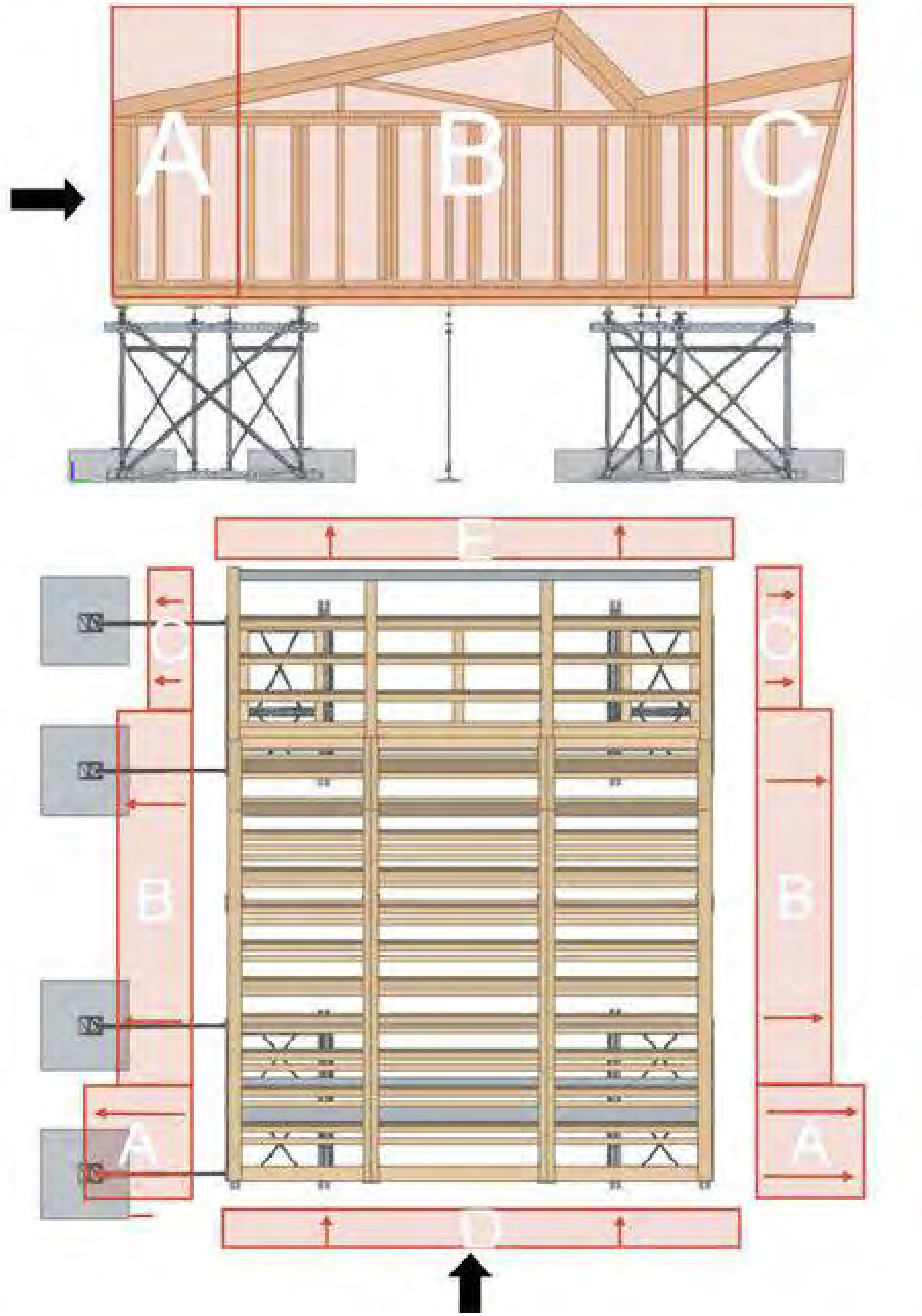
Bereich	A		B		C		D		E	
h/d	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$
5	-1,2	-1,4	-0,8	-1,1	-0,5		+0,8	+1,0	-0,7	
1	-1,2	-1,4	-0,8	-1,1	-0,5		+0,8	+1,0	-0,5	
≤ 0,25	-1,2	-1,4	-0,8	-1,1	-0,5		+0,7	+1,0	-0,3	

w_A =	0,50	*	-1,2	=	-0,6 kN/m²
w_B =	0,50	*	-0,8	=	-0,4 kN/m²
w_C =	0,50	*	-0,5	=	-0,25 kN/m²
w_D =	0,50	*	0,8	=	0,4 kN/m²
w_E =	0,50	*	-0,5	=	-0,25 kN/m²

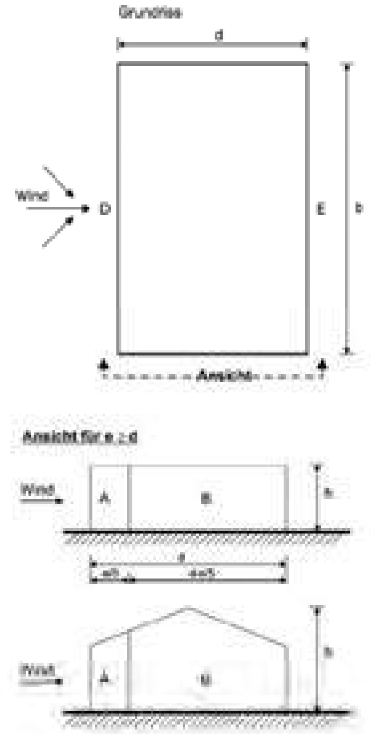
Wind from the north



Wind from the south



Wind from the east/west



$b = l_{east} =$ 10,30 m

$d = l_{north} =$ 8,26 m

e = min b = 10,30 ; 2h = 13,20 = 10,30 m

e/5 = 2,06 m

d-e/5 = 6,20 m

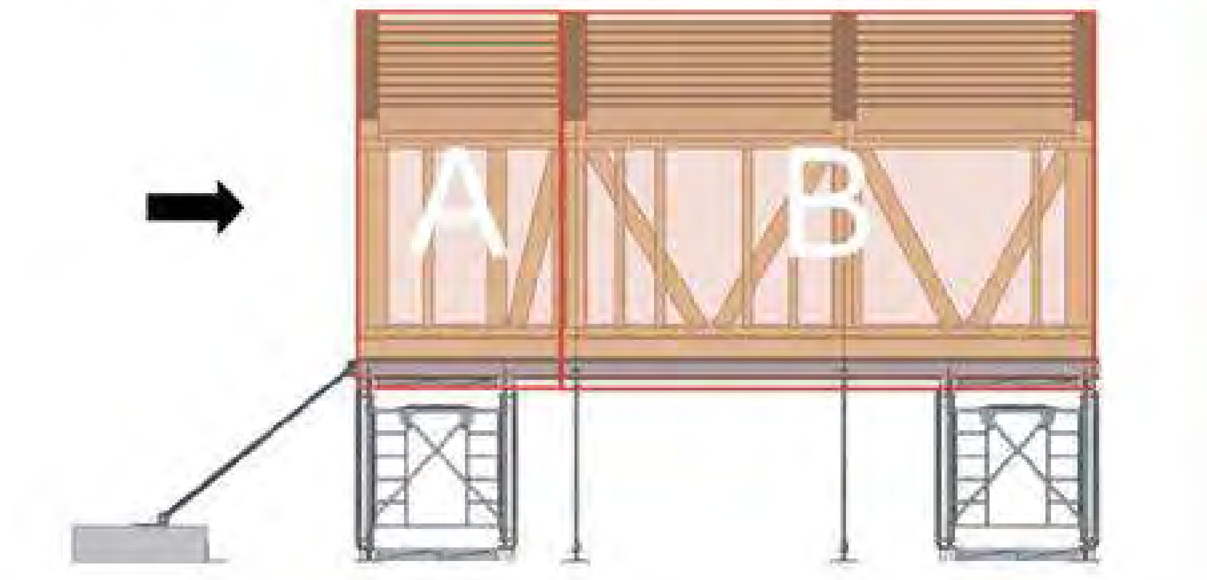
h/d = 0,80 ≈ 1

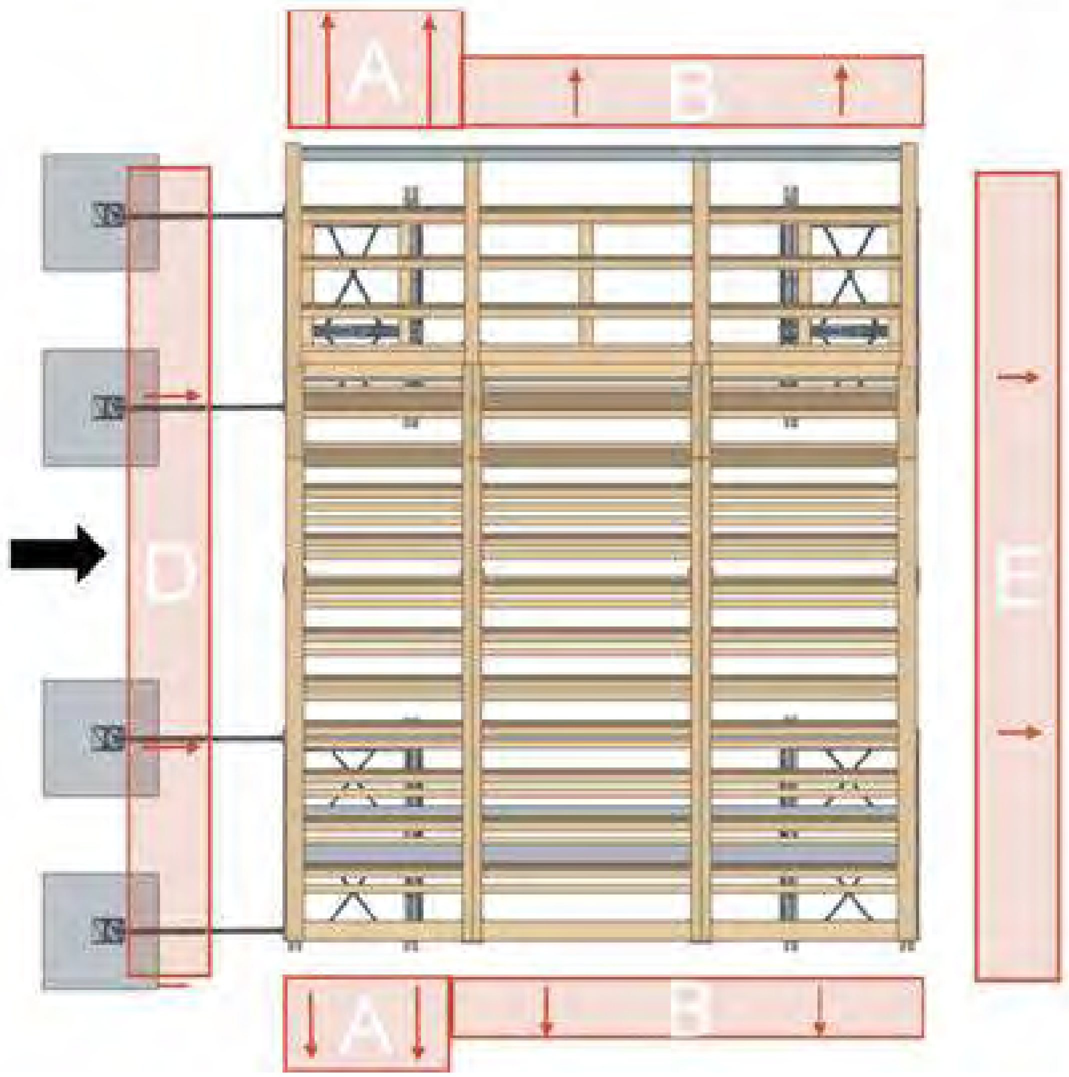
Tabelle 7.1 — Empfohlene Außendruckbeiwerte für vertikale Wände rechteckiger Gebäude

Bereich	A		B		C		D		E	
h/d	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$
5	-1,2	-1,4	-0,8	-1,1	-0,5		+0,8	+1,0	-0,7	
1	-1,2	-1,4	-0,8	-1,1	-0,5		+0,8	+1,0	-0,5	
≤ 0,25	-1,2	-1,4	-0,8	-1,1	-0,5		+0,7	+1,0	-0,3	

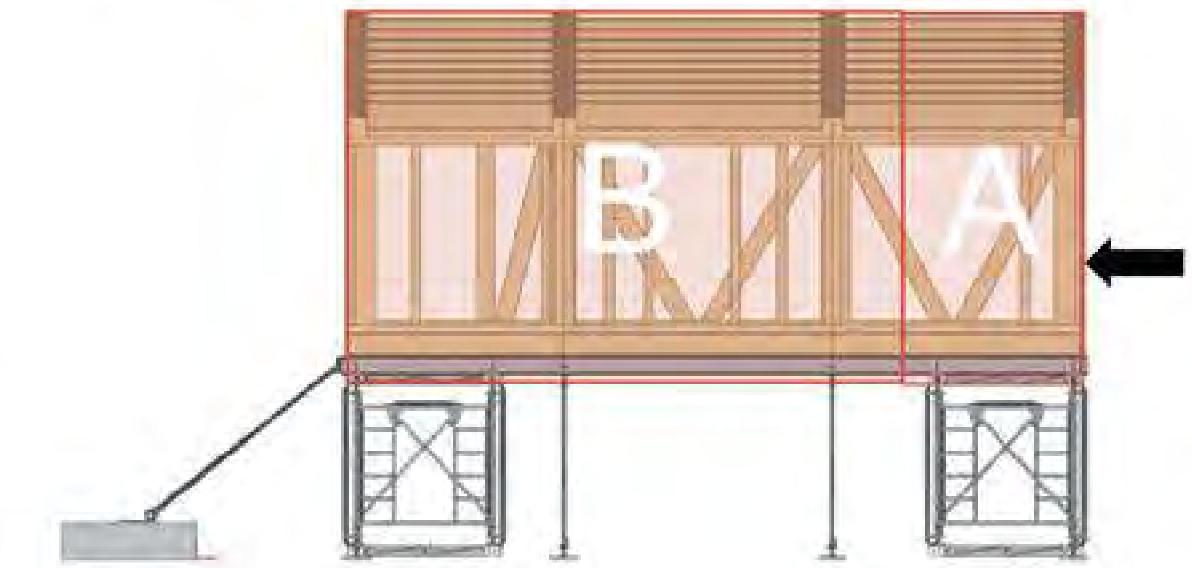
w_A=	0,50	*	-1,2	=	-0,6	kN/m²
w_B=	0,50	*	-0,8	=	-0,4	kN/m²
w_C=	0,50	*	-0,5	=	-0,25	kN/m²
w_D=	0,50	*	0,8	=	0,4	kN/m²
w_E=	0,50	*	-0,5	=	-0,25	kN/m²

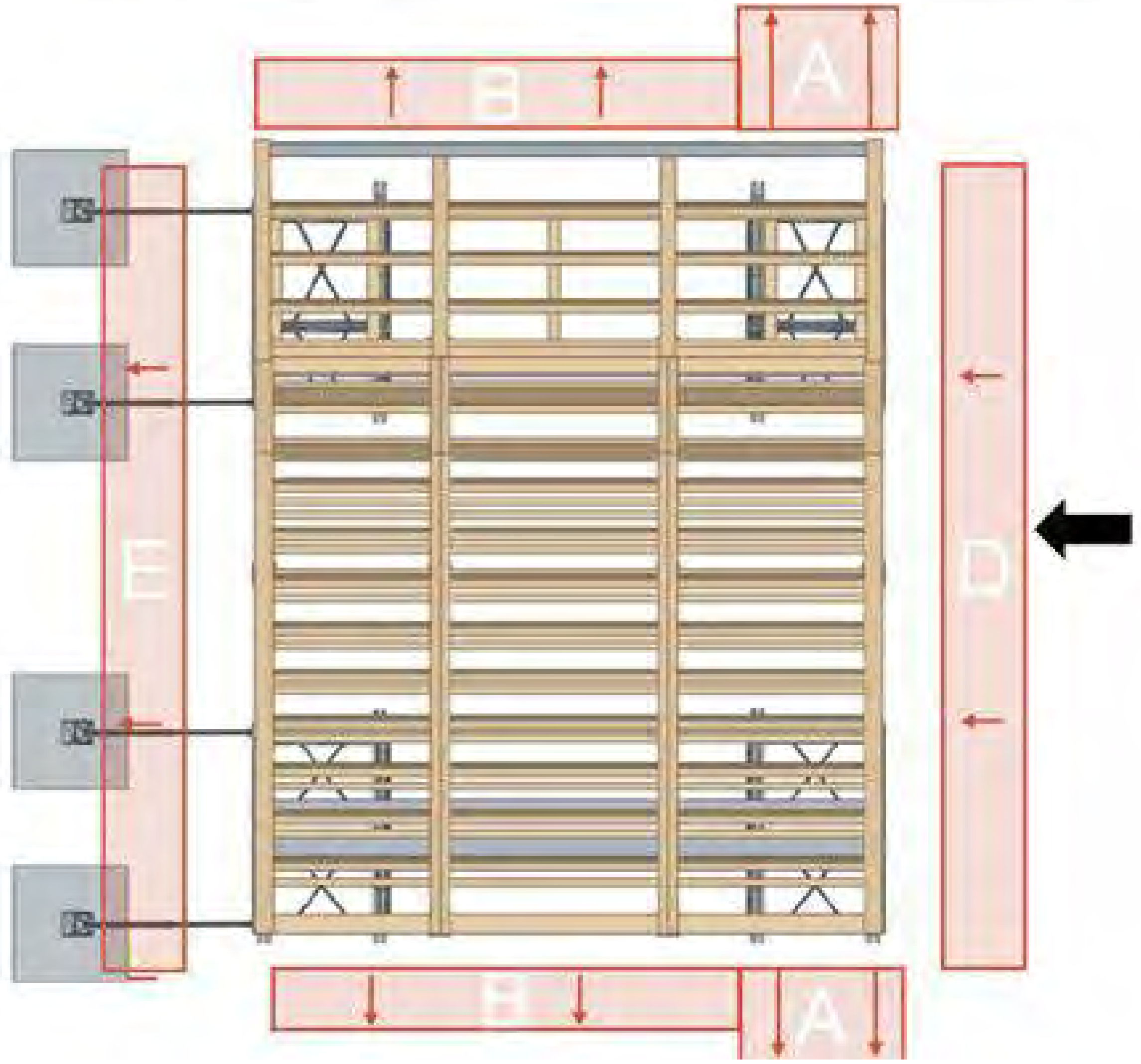
Wind from the east





Wind from the west





Load Cases and Load Case Combinations

In general, the global load cases **dead load**, **live loads** (*Category A: domestic, residential areas* and *Category H: roofs)*, **snow load** and **wind from three directions** (North, South, East/West) were considered. The wind loads affect the respective members in different ways, e.g. wind pressure/suction on the roof + horizontal loads through pressure/suction on the wall + vertical loads resulting from the bracing walls, that function as shear areas *(see "Horizontal Load Transfer (Bracing)")*.

However, not every member is imposed to each load case. Thus, the load cases are given for each system in the section "*Applied Loads and Checks according to Eurocode".*

The load case combinations were generated automatically in the RSTAB calculation according to Eurocode 0.

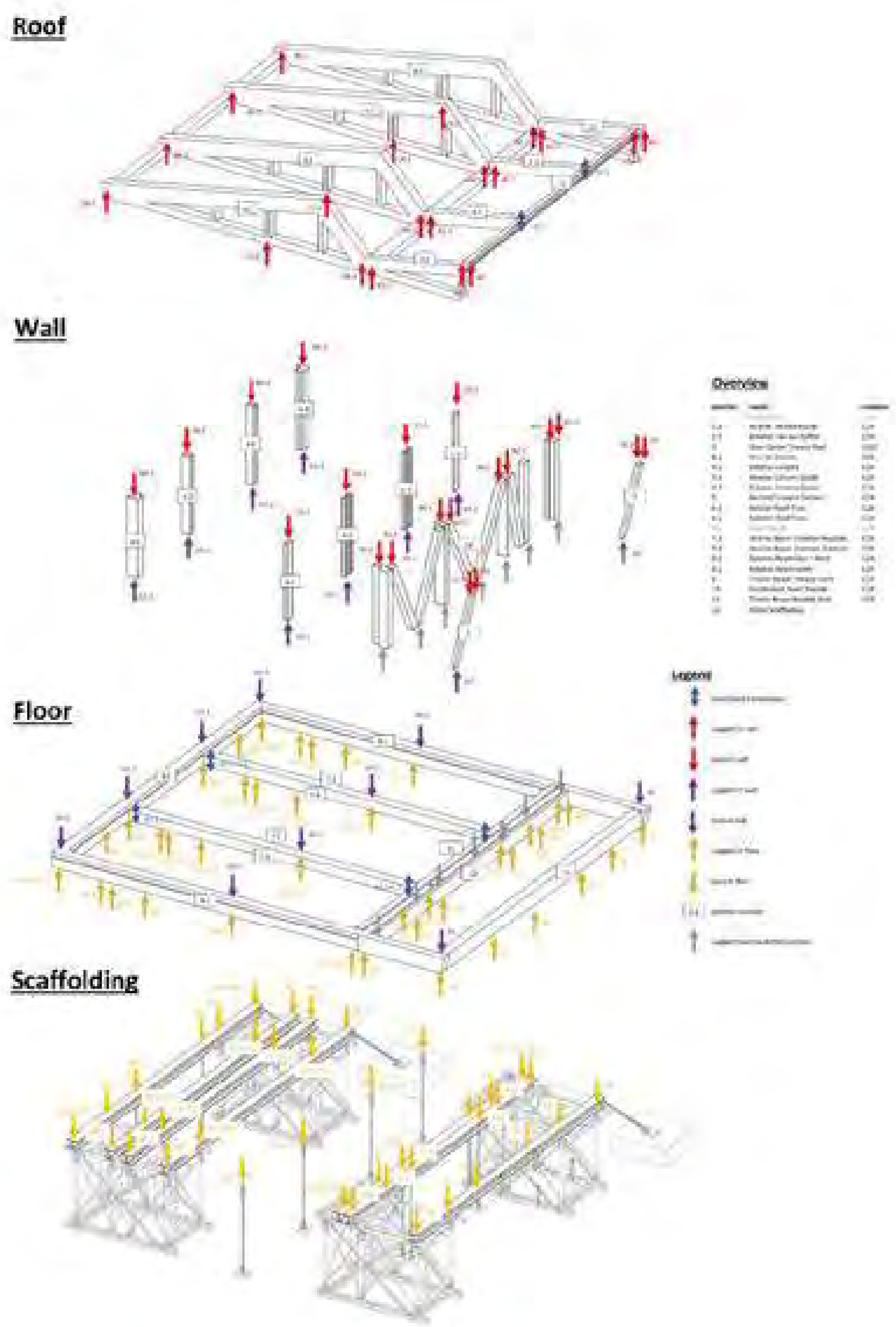
For the Ultimate Limit State (ULS), we used the combination of actions for the Fundamental (persistent and transient) design situations:

$$\sum F_d = \sum_i \gamma_{G,i} G_{k,i} + \gamma_{Q,1} Q_{k,1} + \sum_{j>1} \gamma_{Q,j} \psi_{0,j} Q_{k,j} + (\gamma_P P_k) \qquad (8.12)$$

For the Servieability State (SLS), we used the quasi-permanent combination of actions to calculate the deflections:

$$\sum F_d = \sum_i G_{k,i} + \sum_j \psi_{2,j} Q_{k,j} + (P_k) \qquad (8.31)$$

Vertical Load Transfer



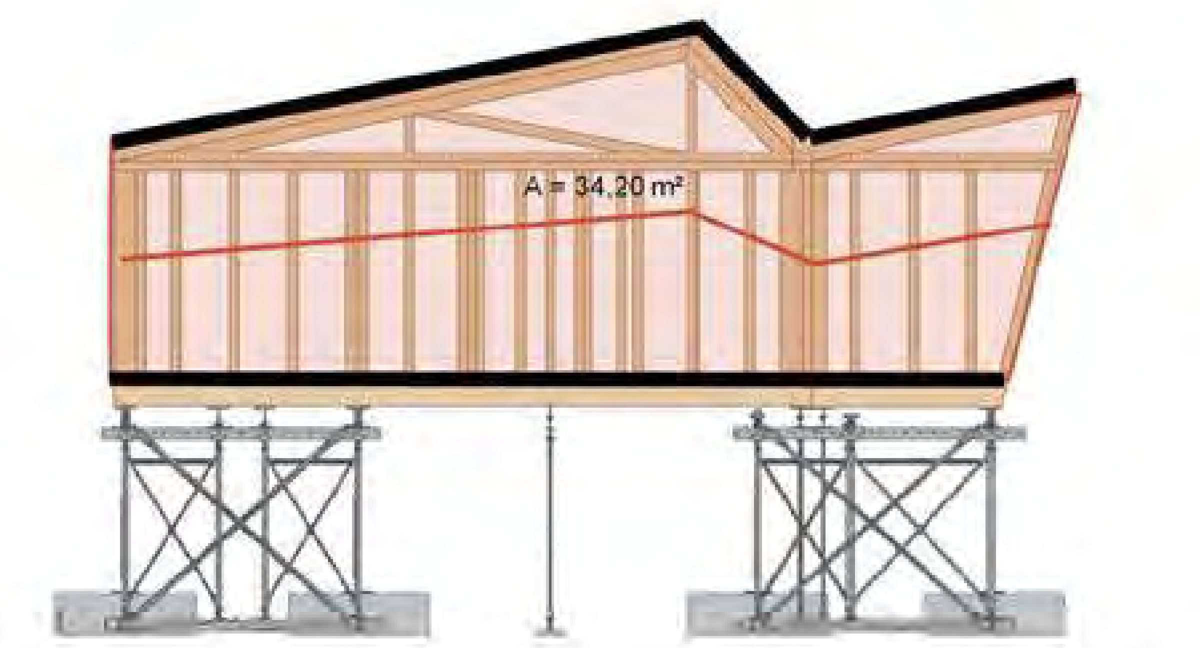
The vertical load transfer in the HDU works as given in the sketch above. The positions of the specific members will be referred to in the calculations of the support reactions, internal forces and checks according to Eurocode.

Horizontal Load Transfer (Bracing)

Relevant wind load

For the calculation of the bracing the wind direction parallel to the bracing direction is relevant. In this case, the wind pressure and wind suction of the two opposite wall directions add up. In the case of the wind direction orthogonal to the bracing direction, the wind suction on the two walls cancel each other out.

Load application area of the horizontal bracing plates (Wind from East/West)

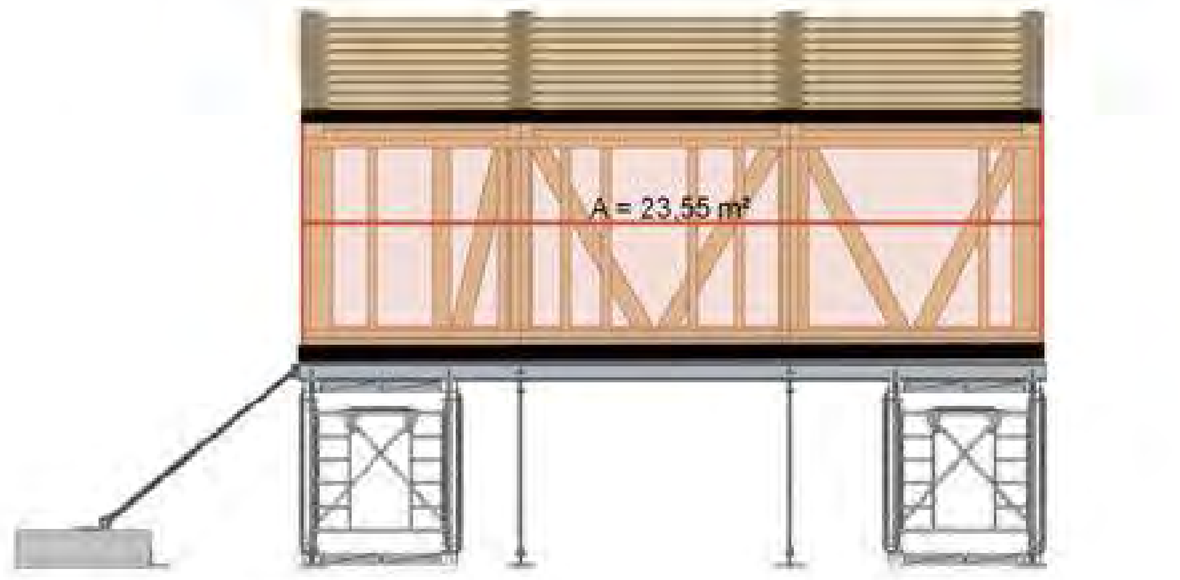


A = 34,20 m²

Total wind load on the bracing plate in the roof
$Wx = (w_D+(-w_E))*A/2$ = 11,12 kN

Total wind load on the bracing plate in the floor
$Wx = (w_D+(-w_E))*A$ = 22,23 kN

Load application area of the horizontal bracing plates (Wind from North/South)



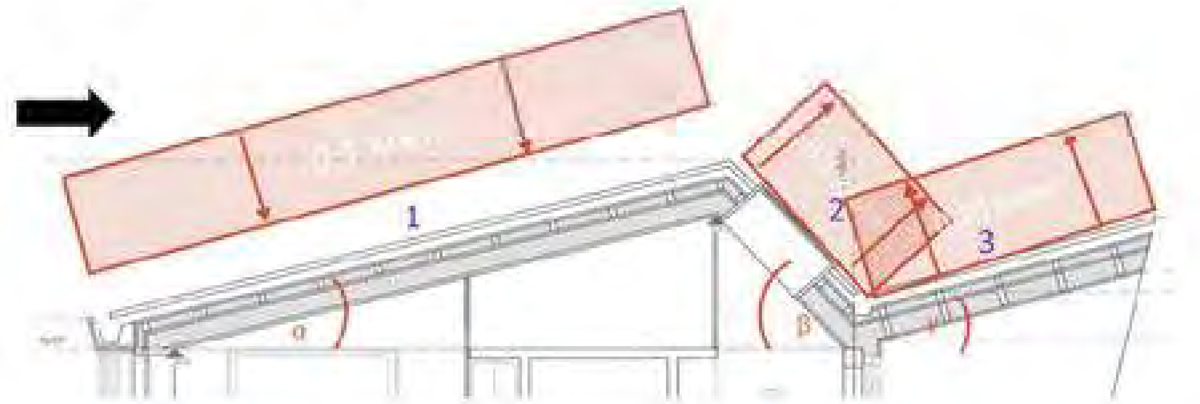
A = 23,55 m²

Total wind load on the bracing plate in the roof
$Wy = (w_D+(-w_E))*A/2 + W_h$ = 11,76 kN
due to prior calculation: 16,05 kN

Total wind load on the bracing plate in the floor
$Wy = (w_D+(-w_E))*A + W_h$ = 19,41 kN
due to prior calculation: 23,70 kN

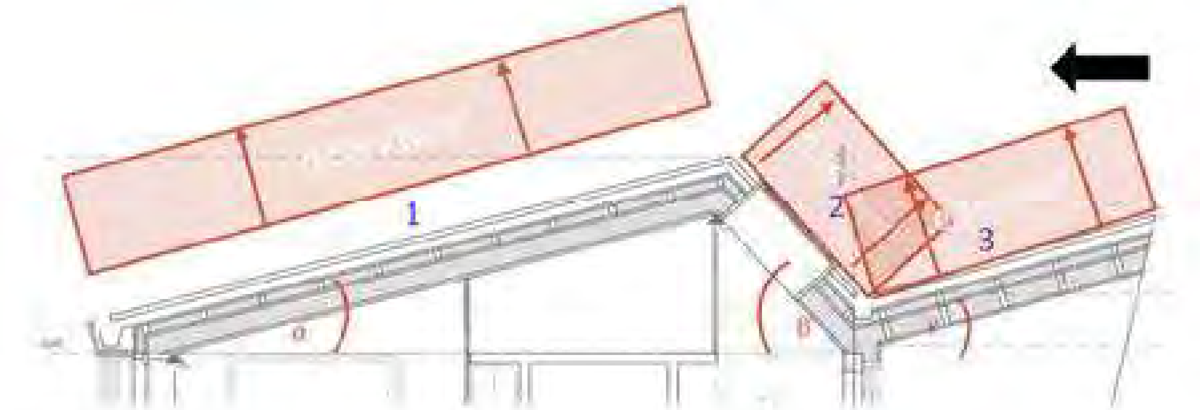
Horizontal wind load acting on the roof (Wind from North/South)

Angle:			Area:		
	α =	11,65 °		A_1 =	52,74 m²
	β =	46,01 °		A_2 =	14,78 m²
	γ =	11,65 °		A_3 =	24,09 m²



Resulting horizontal load

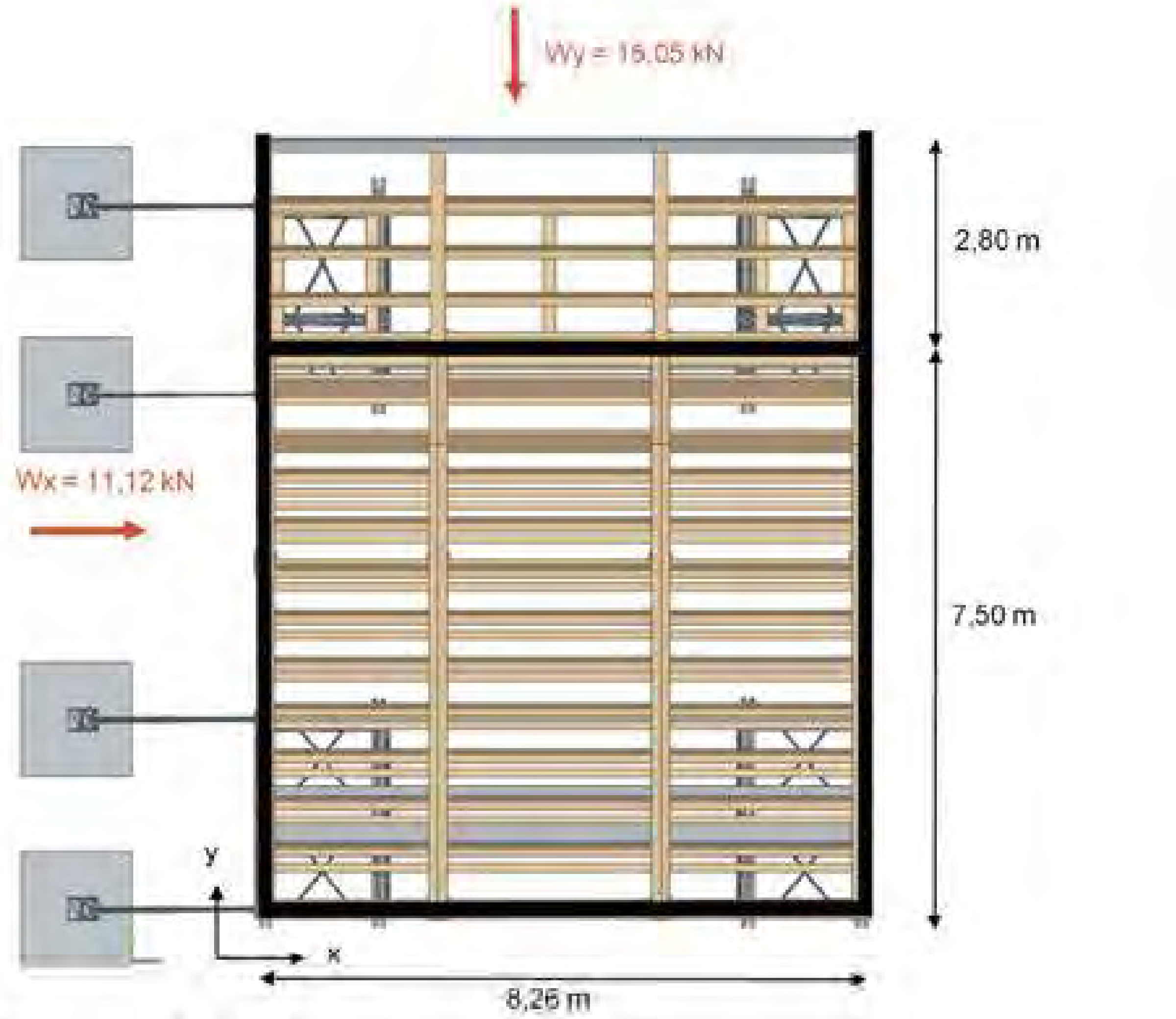
$W_h = 0{,}1 \cdot A_1 \cdot \sin(\alpha) + 0{,}4 \cdot A_2 \cdot \sin(\beta) - 0{,}25 \cdot A_3 \cdot \sin(\gamma) =$ 4,10 kN



Resulting horizontal load

$W_h = 0{,}36 \cdot A_1 \cdot \sin(\alpha) - 0{,}35 \cdot A_2 \cdot \sin(\beta) + 0{,}45 \cdot A_3 \cdot \sin(\gamma) =$ 2,30 kN

Bracing walls



Distribution of the loads

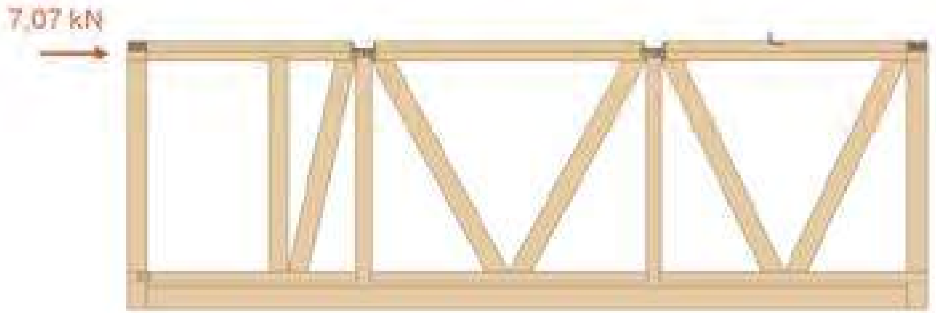
A = B =	Wy/2 =	8,03 kN
C =	Wx/10,3*(2,80+7,50/2) =	7,07 kN
D =	Wx/10,3*7,50/2 =	4,05 kN

Transmission of the force through the wall plate

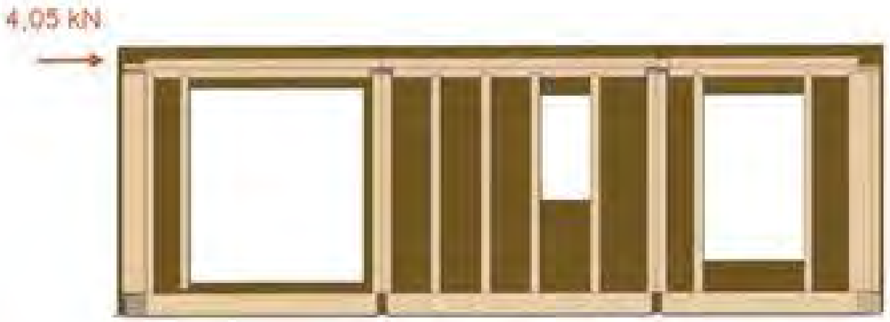
Wall A

Wall B

Wall C

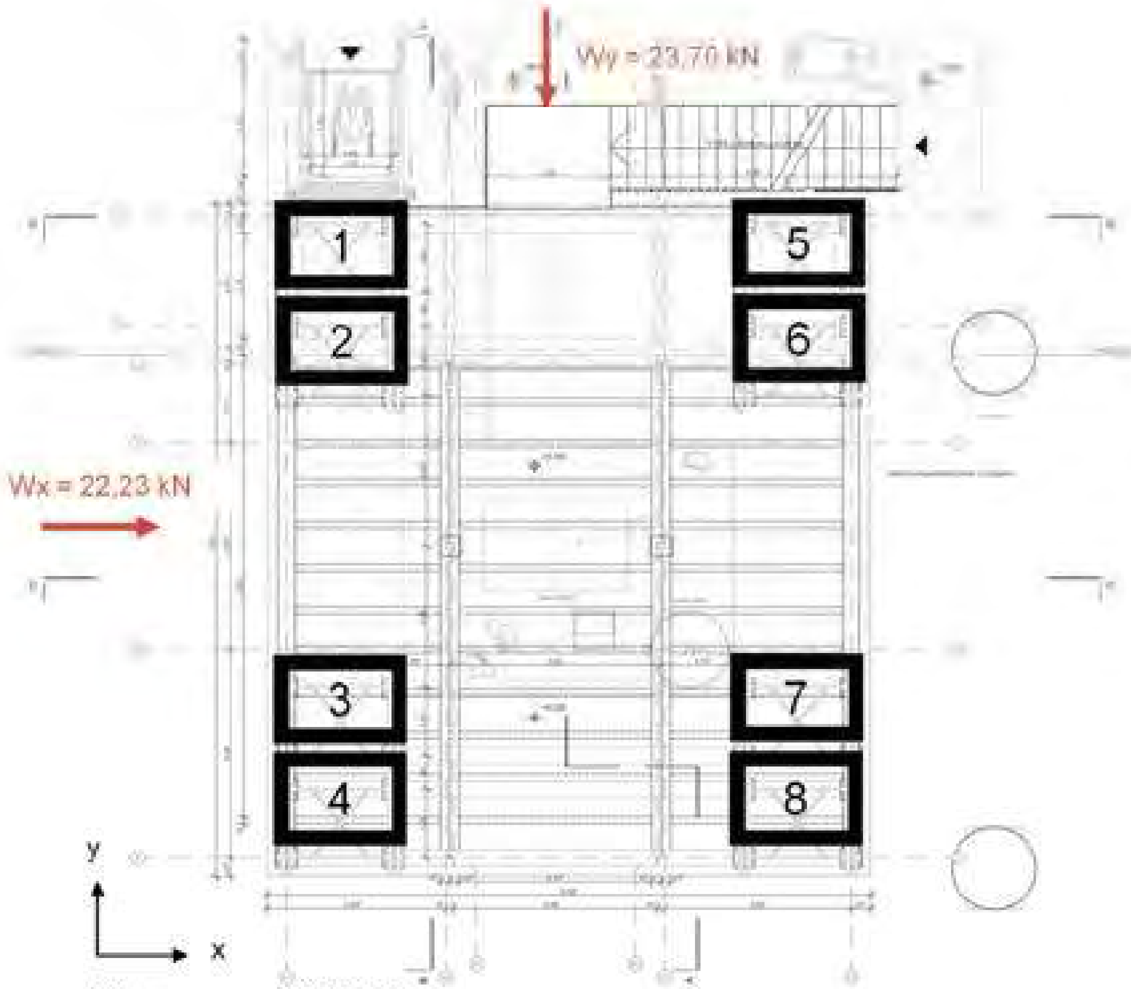


Wall D



Bracing scaffolding towers

Due to the symmetry in both axes, the distribution of wind loads can be simplified.



Wx =	22,23 kN
Wy =	23,70 kN

Horizontal wind load per scaffolding tower

Wx,i =	2,78 kN
Wy,i =	2,96 kN

Since the wind loads of the two axes result from different wind directions, they do not have to be superimposed.

Applied Loads and analysis according to Eurocode

As explained before the load of each system comprises the gathered dead loads, the support reactions of each load case of the system above as well as the resulting vertical loads from the wind loads in the shear wall. The loads on each system are presented below. Usually every cross-section and loaded area are calculated for the final state (the three living modules connected to each other), only pos. 7.1a and 7.2a are an exception here. The loaded area is depicted for each system as well as its support reactions (without partial factors/characteristic).

The load case combinations were generated by RSTAB according to Eurocode 1.

The relevant checks (stress, stability) according to Eurocode 3 (steel structures) and Eurocode 5 (timber construction) are conducted with the internal forces calculated by RSTAB for the impact combination of the ULS and the quasi-permanent impact combination of the SLS (if relevant for the particular member).

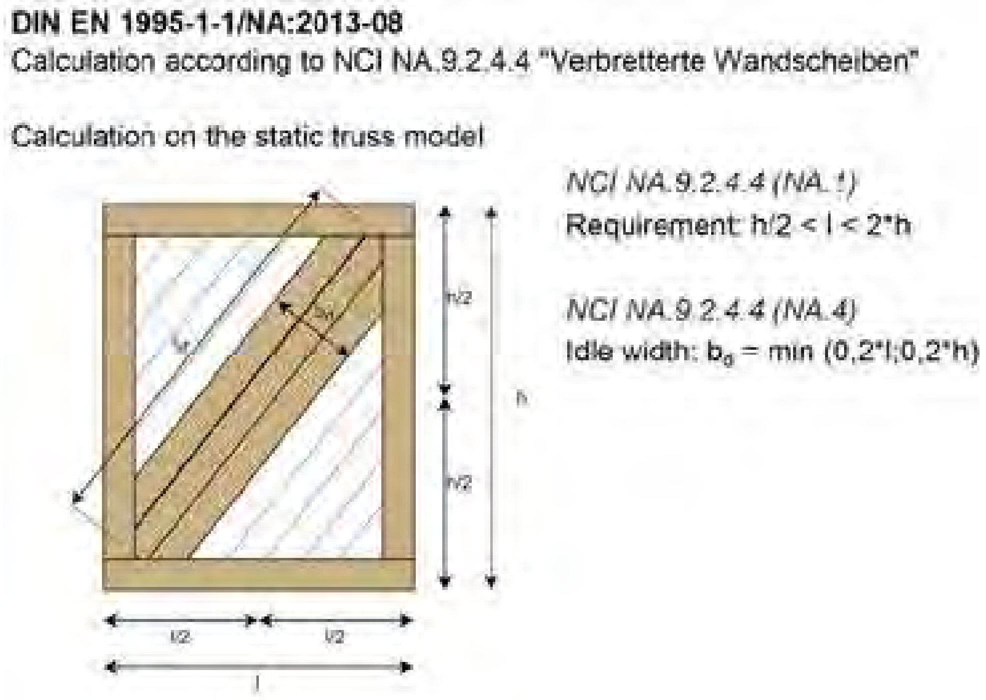
For timber members it is crucial to differentiate between different load-duration classes and moisture influences, that produce varying material strengths. For each of the load-duration classes the load case combination with the maximum internal forces is examined and checked. Within this distinction of cases of different load-duration classes the significant internal force (NEd, VEd and MEd) is also distinguished. This means that the examined internal force specified the place within the slab, where the other internal forces are received from.

For structurally identical members (materials, cross sections and geometry) such as Pos. 7.1a and Pos. 7.2a only the position exposed to higher loads, and thus with higher internal forces, was checked. This also applies for cases, where the cross-sections of the member are larger, but the internal forces are smaller, for instance for positions 6.1 and 6.2.

Only the structural fire safety of the uncladded members were checked. It is assumed that all other loadbearing members meet the requirement of R30.

Pos. 0 – Bracing Walls

The horizontal loads on the wall plates were calculated in the chapter "Horizontal Load Transfer". In the following, the bracing of the wall plates made of timber frame construction with diagonal cladding is verified. The check is carried out in accordance with the procedure for the calculation of "Verbretterte Wandscheiben" contained in the National Annex.



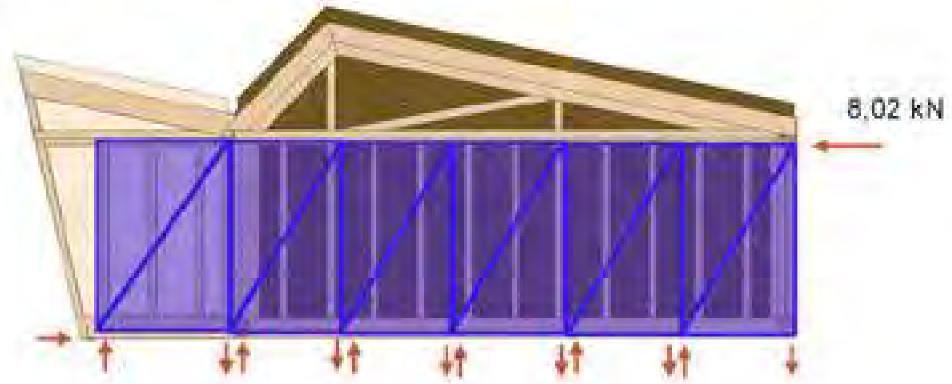
Summary

The 24mm thick diagonal cladding with must be screwed at a maximum distance of 15 cm. Therefore Fischer FSPII 5.0x70 or similar screws must be used. The screws are to be screwed into all studs.

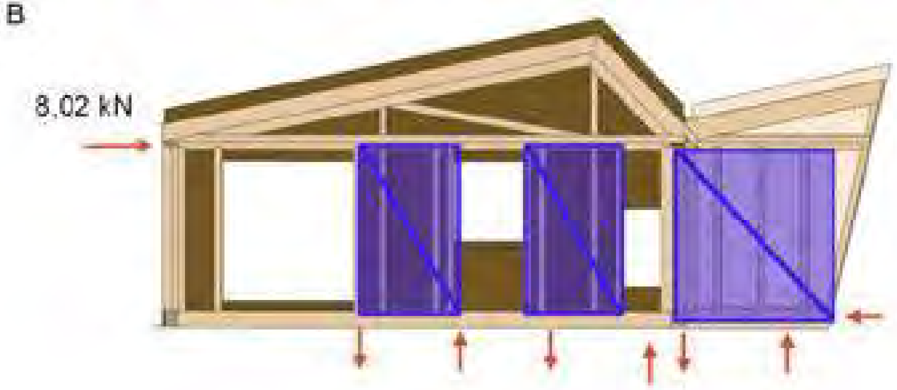
Loads

Force displayed in one direction as an example

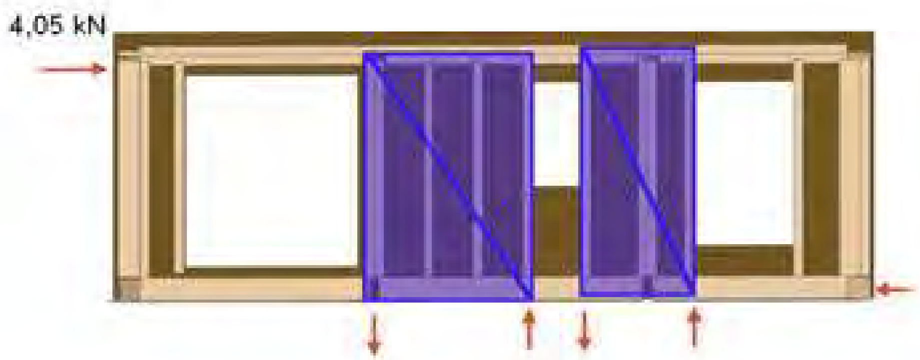
Wall A



Wall B



Wall D



Check of the fasteners

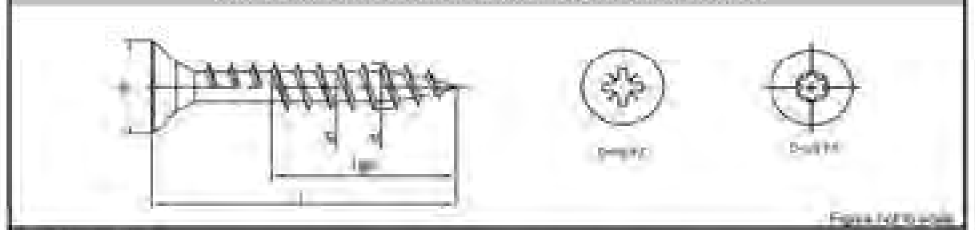
Wall plate divided into panels with 2 fields width

h =	2,46	m	(mid of bottom plate to mid of top plate)
l =	1,25	m	(mid of stud to mid of stud)
d =	0,024	m	thickness of the diagonal cladding
α =	63,1	°	
l_{ef} =	2,76	m	
b_d =	0,25	m	

Fasteners

Fischer FSPII 5,0x70 partial thread or similar

ClassicFast II - Countersunk head with full- or partial thread
FSP II - Countersunk head with full- or partial thread



* Carbon steel
** Possible surface treatments: yellow zinc-plated, blue zinc-plated

Nominal diameter		3,0	3,5	4,0	4,5	5,0	6,0
d	Outer thread diameter	3,00	3,50	4,00	4,50	5,00	6,00
di	Inner thread diameter	1,80	2,20	2,50	2,90	3,15	3,70
dk	Head diameter	5,80	6,80	7,80	8,60	9,80	11,70
	Drive TX	10	10	20	20	25	30
	Drive PZ	1	2	2	2	2	3

d1 =	3,15	mm	inner thread diameter
$F_{v,Rk}$ =	623	N	load capacity calculated like nail connections
$F_{v,Rd}$ =	566	N	
b_0 =	1,23	m	
ci =	1	for $b_0<b_i$	
s =	0,15	m	distance between fasteners
$F_{i,v,Rd}$ =	4,64	kN	

Wall A

Resistance			Actions		
$n_{Wall\ plates}$ =	6		$F_{v,Ek}$ =	8,02	kN
$F_{v,Rd}$ =	27,87	kN	$F_{v,Ed}$ =	12,03	kN

Check: 0,43

Actions on a single diagonal for following checks

$F_{i,v,Ed}$ = 2,01 kN

$F_{i,1}$ = 4,43 kN

Wall B (relevant)

Resistance			Actions		
$n_{Wall\ plates}$ =	3		$F_{v,Ek}$ =	8,02	kN
$F_{v,Rd}$ =	13,93	kN	$F_{v,Ed}$ =	12,03	kN

Check: 0,86

Actions on a single diagonal for following checks

$F_{i,v,Ed}$ = 4,01 kN

$F_{i,1}$ = 8,85 kN

Wall D

Resistance			Actions		
$n_{Wall\ plates}$ =	2		$F_{v,Ek}$ =	4,05	kN
$F_{v,Rd}$ =	9,29	kN	$F_{v,Ed}$ =	6,08	kN

Check: 0,65

Actions on a single diagonal for following checks

$F_{i,v,Ed}$ = 3,04 kN

$F_{i,1}$ = 6,71 kN

Check of the diagonal

 # Cross-section

Parameter	Symbol	Value	Unit
Height	h	24	mm
Width	b	250	mm
Area	A	6000	mm²
Area moment of inertia	I		mm^4
Modulus of section	W		mm³
Radius of inertia	i_y	6,94	mm
Radius of inertia	i_z	72,25	mm

 # Material: C24

Parameter	Symbol	Value	Unit
Characteristic tensile strength	$f_{t,0,k}$	14	N/mm²
Characteristic compressive strength	$f_{c,0,k}$	21	N/mm²
Characteristic bending strength	$f_{m,0,k}$	24	N/mm²
Characteristic shear strength	$f_{v,k}$	4	N/mm²
Modulus of elasticity (Fifth percentile)	$E_{0.05}$	7400	N/mm²

Ultimate Limit State
Stability of members - Columns subjected to compression

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of compressive force	$N_{Ed,c}$	8,85	kN
Design value of bending moment	$M_{y,Ed}$	0,00	kNm
Design value of shear force	V_{Ed}	0,00	kN

--> *Flexural Moment and Shear Force negligible*

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	2	-
Load duration class	KLED	Short/Very Short	
Modification factor	k_{mod}	1,0	-

 # Buckling Euler-Case II

Parameter	Symbol	Value	Unit
	β	1	-
Effective length	l_{ef}	1280	mm
Slenderness ratio	λ_y	184,499	-
Relative slenderness ratio	$\lambda_{rel,c}$	3,129	-
Straightness factor	β_c	0,200	-
	k	5,677	-
Instability factor	k_c	0,096	-

 # Check

Parameter	Symbol	Value	Unit
Design compressive stress along the grain	$\sigma_{c,0,d}$	1,48	N/mm²
Design compressive strength along the grain	$f_{c,0,d}$	16,15	N/mm²

 # Stability (*DIN EN 1995-1-1 6.3.2*)

$$\eta_{stability} = \frac{\sigma_{c,0,d}}{k_c * f_{c,0,d}} \leq 1$$

Stress ratio $\eta_{Stability}$ **95%**

Support reactions

The support reactions are characteristic loads that are transmitted to the subsequent components. The tensile forces must be transmitted by fasteners if they are not overloaded by other loads.

$F_{i,c,Ed} = F_{i,t,Ed} = F_{i,v,Ed} * h/b_i$

Wall A

Fi,c,Ed = Fi,t,Ed = 2,63 kN

Wall B

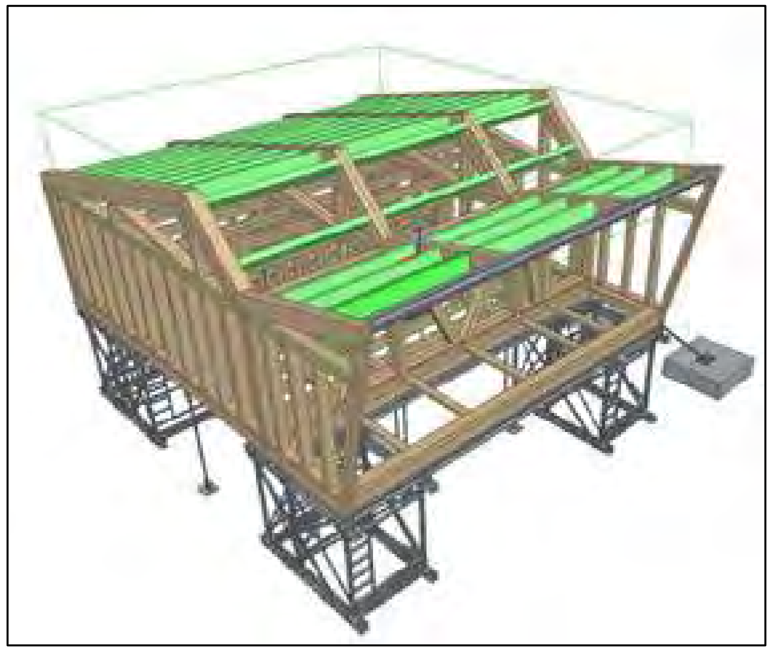
Fi,c,Ed = Fi,t,Ed = 5,26 kN

Wall D

Fi,c,Ed = Fi,t,Ed = 3,99 kN

Pos. 1 – Roof Beam

Overview



Loads

Dead loads

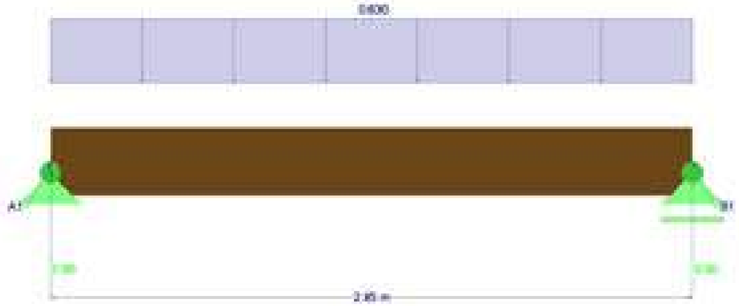
		surface loads [kN/m²]	load intro. width [m]	unif. distr. Load [kN/m]
dead load roof living modules	g_{RL}	1,25	0,63	0,78

Load case 1 (LF1):

Live loads

		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
live load roof	p_R	1,00	0,63	0,63

Load case 2 (LF2):



Snow loads

		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
snow load roof	s_R	1,02	0,63	0,64

Load case 3 (LF3):

Wind actions

		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
wind action roof	w_R	0,10	0,63	0,063

Load case 4 (LF4):

Load case combinations

LK1	1.35*LF1
LK2	1.35*LF1 + 1.5*LF2
LK3	1.35*LF1 + 1.5*LF2 + 0.75*LF3
LK4	1.35*LF1 + 1.5*LF2 + 0.75*LF3 + 0.9*LF4
LK5	1.35*LF1 + 1.5*LF2 + 0.9*LF4
LK6	1.35*LF1 + 1.5*LF3
LK7	1.35*LF1 + 1.5*LF3 + 0.9*LF4
LK8	1.35*LF1 + 1.5*LF4
LK9	1.35*LF1 + 0.75*LF3 + 1.5*LF4

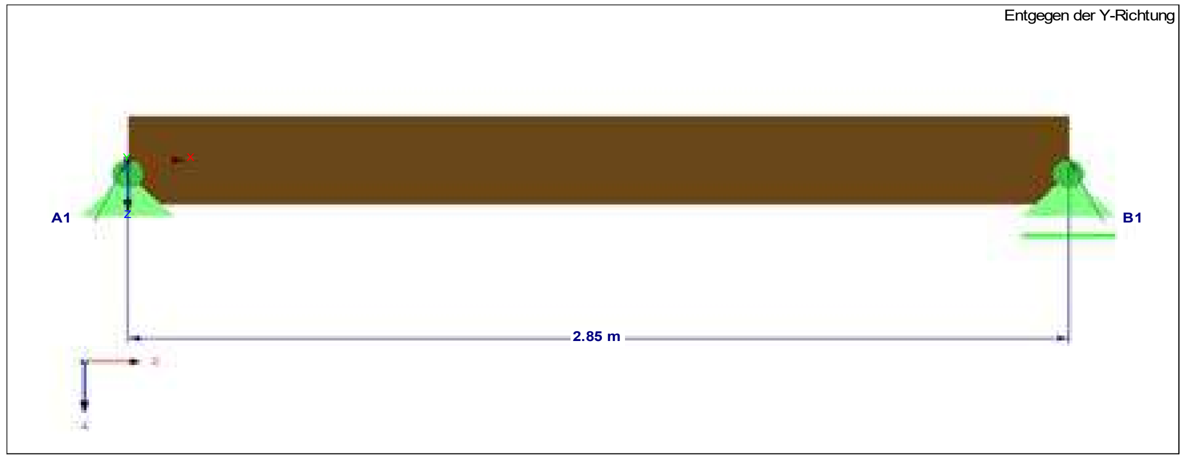
Support reactions

$A1_g$	1,33 kN
$B1_g$	1,33 kN
$A1_p$	0,90 kN
$B1_p$	0,90 kN
$A1_s$	0,91 kN
$B1_s$	0,91 kN
$A1_w$	0,09 kN
$B1_w$	0,09 kN

Check

Since the members of position 1 are arranged in a close grid, their load application width is relatively small and thus is exposed to low stress. Therefore, a check of the serviceability state is not required. The checks of the ultimate limit state according to Eurocode 5 are presented below.

System



Cross-section: 12x30 cm²

Parameter	Symbol	Value	Unit
Height	h	300	mm
Width	b	120	mm
Area	A	36000	mm²
Area moment of inertia	I	270000000	mm^4
Modulus of section	W	1800000	mm³
Radius of inertia	i_y	86,7	mm
Radius of inertia	i_z	34,68	mm

Material: C24

Parameter	Symbol	Value	Unit
Characteristic tensile strength	$f_{t,0,k}$	14	N/mm²
Characteristic compressive strength	$f_{c,0,k}$	21	N/mm²
Characteristic bending strength	$f_{m,0,k}$	24	N/mm²
Characteristic shear strength	$f_{v,k}$	4	N/mm²
Modulus of elasticity (Fifth percentile)	$E_{0.05}$	7400	N/mm²
Crack coefficient	k_{cr}	0,5	-
Effective area	A_{eff}	18000	mm²

Ultimate Limit State **LK 4**

Design of cross-sections subjected to stress in one principal direction

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	0,01	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	2,78	kNm
Design value of shear force	V_{Ed}	3,90	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Short-term	
Modification factor	k_{mod}	0,9	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,00	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	1,54	N/mm²
Design shear stress	τ_d	0,33	N/mm²
Design tensile strength	$f_{t,0,d}$	9,69	N/mm²
Design compressive strength	$f_{c,0,d}$	14,54	N/mm²
Design bending strength	$f_{m,0,d}$	16,62	N/mm²
Design shear strength	$f_{v,d}$	2,77	N/mm²

 # Flexural stress with tension (*DIN EN 1995-1-1 6.2.3*)

$$\eta_{flexural} = \frac{\sigma_{t,0,d}}{f_{t,0,d}} + \frac{\sigma_{m,0,d}}{f_{m,0,d}} \leq 1$$

Stress ratio $\eta_{flexural}$ **9%**

 # Flexural stress with compression (*DIN EN 1995-1-1 6.2.4*)

$$\eta_{compression} = \left(\frac{\sigma_{c,0,d}}{f_{c,0,d}}\right)^2 + \frac{\sigma_{m,0,d}}{f_{m,0,d}} \leq 1$$

Stress ratio $\eta_{compression}$ **9%**

 # Shear stress (*DIN EN 1995-1-1 6.1.7*)

$$\eta_{shear} = \frac{\tau_d}{f_{v,d}} \leq 1$$

Stress ratio η_{shear} **12%**

Ultimate Limit State **LK 1**

Design of cross-sections subjected to stress in one principal direction

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	0,00	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	1,28	kNm
Design value of shear force	V_{Ed}	1,79	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Permanent	
Modification factor	k_{mod}	0,6	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,00	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	0,71	N/mm²
Design shear stress	τ_d	0,15	N/mm²
Design tensile strength	$f_{t,0,d}$	6,46	N/mm²
Design compressive strength	$f_{c,0,d}$	9,69	N/mm²
Design bending strength	$f_{m,0,d}$	11,08	N/mm²
Design shear strength	$f_{v,d}$	1,85	N/mm²

 # Flexural stress with tension (*DIN EN 1995-1-1 6.2.3*)

$$\eta_{flexural} = \frac{\sigma_{t,0,d}}{f_{t,0,d}} + \frac{\sigma_{m,0,d}}{f_{m,0,d}} \leq 1$$

Stress ratio $\eta_{flexural}$ **6%**

 # Flexural stress with compression (*DIN EN 1995-1-1 6.2.4*)

$$\eta_{compression} = \left(\frac{\sigma_{c,0,d}}{f_{c,0,d}}\right)^2 + \frac{\sigma_{m,0,d}}{f_{m,0,d}} \leq 1$$

Stress ratio $\eta_{flexural}$ **6%**

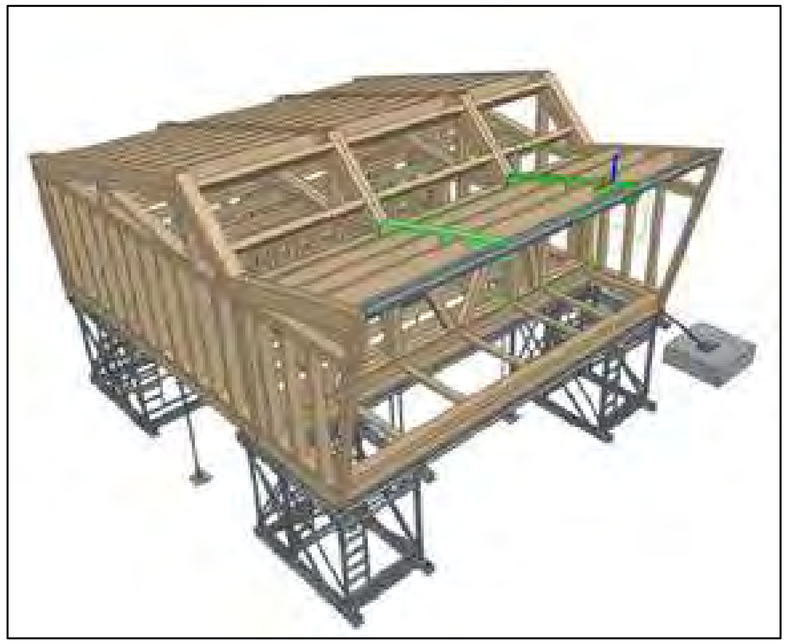
 # Shear stress (*DIN EN 1995-1-1 6.1.7*)

$$\eta_{shear} = \frac{\tau_d}{f_{v,d}} \leq 1$$

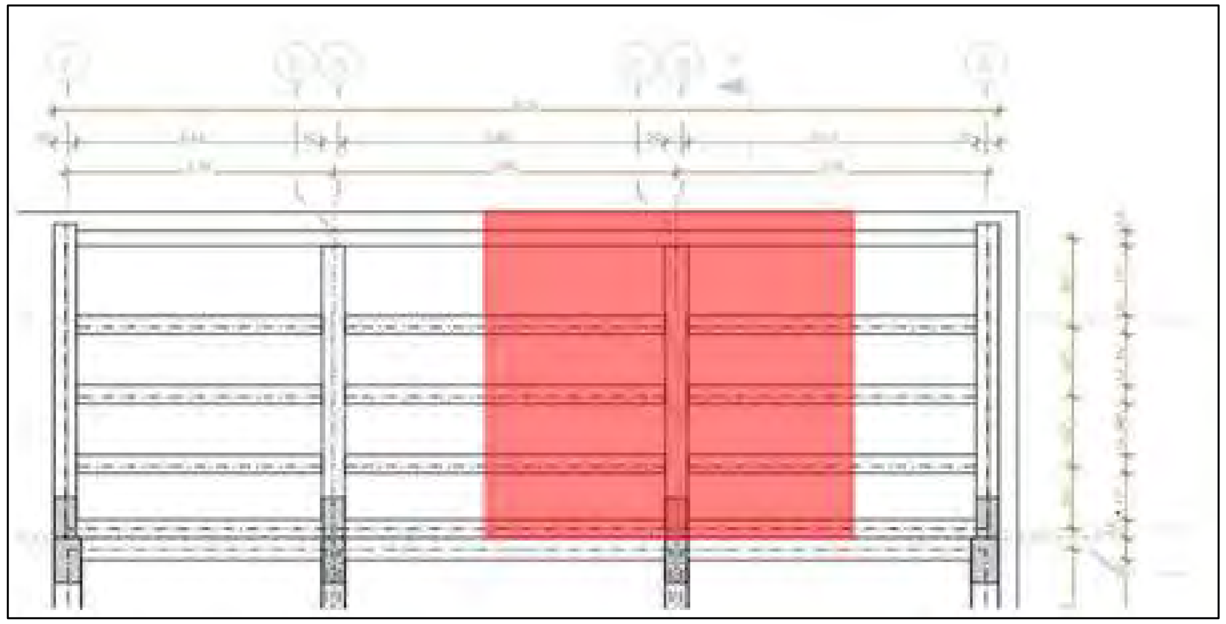
Stress ratio η_{shear} **8%**

Pos. 2.1 – Interior Terrace Rafter

Overview



Load application area

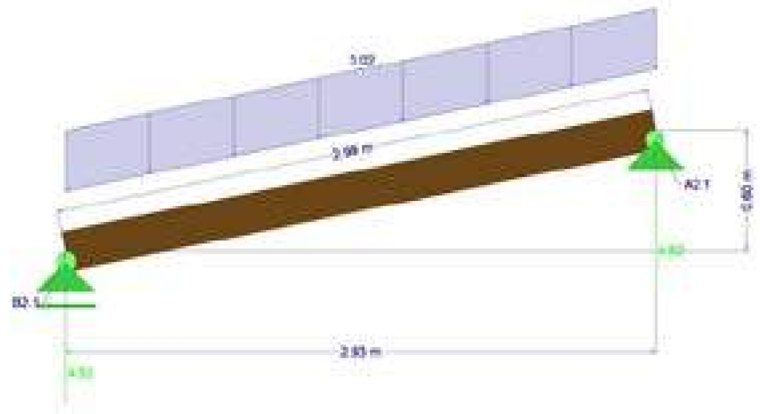


Loads

Dead loads

		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
dead load roof terrace module	g_{RT}	1,06	2,85	3,02

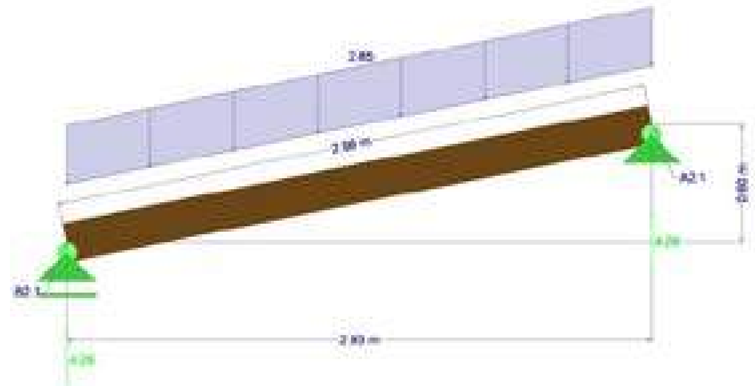
Load case 1 (LF1):



Live loads

		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
live load roof	p_R	1	2,85	2,85

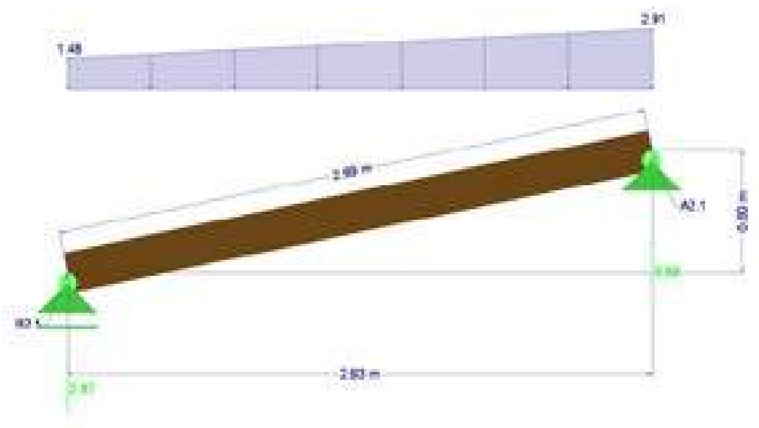
Load case 2 (LF2):



Snow loads

		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
snow load roof min	s_{Rmin}	0,52	2,85	1,48
snow load roof max	s_{Rmax}	1,02	2,85	2,91

Load case 3 (LF3):



Load case combinations

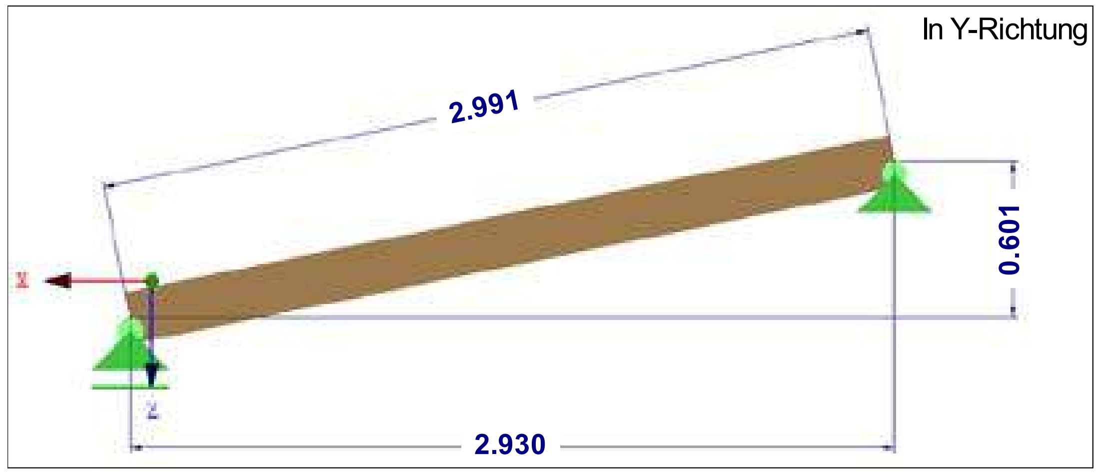
LK1	1.35*LF1
LK2	1.35*LF1 + 1.5*LF2
LK3	1.35*LF1 + 1.5*LF3
LK4	1.35*LF1 + 0.75*LF2 + 1.5*LF3

Support reactions

A2.1$_g$	4,52 kN	RSTAB
B2.1$_g$	4,52 kN	RSTAB
A2.1$_p$	4,26 kN	RSTAB
B2.1$_p$	4,26 kN	RSTAB
A2.1$_s$	2,87 kN	RSTAB
B2.1$_s$	3,56 kN	RSTAB

Check

 # System



 # Cross-section: 20x20 cm²

Parameter	Symbol	Value	Unit
Height	h	200	mm
Width	b	200	mm
Area	A	40000	mm²
Area moment of inertia	I	133333333	mm^4
Modulus of section	W	1333333,33	mm³
Radius of inertia	i_y	57,8	mm
Radius of inertia	i_z	57,8	mm

 # Material: C24

Parameter	Symbol	Value	Unit
Characteristic tensile strength	$f_{t,0,k}$	14	N/mm²
Characteristic compressive strength	$f_{c,0,k}$	21	N/mm²
Characteristic bending strength	$f_{m,0,k}$	24	N/mm²
Characteristic shear strength	$f_{v,k}$	4	N/mm²
Modulus of elasticity (Fifth percentile)	$E_{0.05}$	7400	N/mm²
Crack coefficient	k_{cr}	0,5	-
Effective area	A_{eff}	20000	mm²

Ultimate Limit State LK 4

Design of cross-sections subjected to stress in one principal direction

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	3,20	kN
Design value of compressive force	$N_{Ed,c}$	-2,79	kN
Design value of bending moment	$M_{y,Ed}$	10,92	kNm
Design value of shear force	V_{Ed}	14,82	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Short-term	
Modification factor	k_{mod}	0,9	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,08	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,07	N/mm²
Design bending stress	$\sigma_{m,0,d}$	8,19	N/mm²
Design shear stress	τ_d	1,11	N/mm²
Design tensile strength	$f_{t,0,d}$	9,69	N/mm²
Design compressive strength	$f_{c,0,d}$	14,54	N/mm²
Design bending strength	$f_{m,0,d}$	16,62	N/mm²
Design shear strength	$f_{v,d}$	2,77	N/mm²

 # Flexural stress with tension (*DIN EN 1995-1-1 6.2.3)*

$$\eta_{flexural} = \frac{\sigma_{t,0,d}}{f_{t,0,d}} + \frac{\sigma_{m,0,d}}{f_{m,0,d}} \leq 1$$

Stress ratio $\eta_{flexural}$ **50%**

 # Flexural stress with compression (*DIN EN 1995-1-1 6.2.4)*

$$\eta_{compression} = \left(\frac{\sigma_{c,0,d}}{f_{c,0,d}}\right)^2 + \frac{\sigma_{m,0,d}}{f_{m,0,d}} \leq 1$$

Stress ratio $\eta_{compression}$ **49%**

 # Shear stress (*DIN EN 1995-1-1 6.1.7)*

$$\eta_{shear} = \frac{\tau_d}{f_{v,d}} \leq 1$$

Stress ratio η_{shear} **40%**

Ultimate Limit State LK 1

Design of cross-sections subjected to stress in one principal direction

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	1,23	kN
Design value of compressive force	$N_{Ed,c}$	-1,23	kN
Design value of bending moment	$M_{y,Ed}$	4,47	kNm
Design value of shear force	V_{Ed}	5,97	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Permanent	
Modification factor	k_{mod}	0,6	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,03	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,03	N/mm²
Design bending stress	$\sigma_{m,0,d}$	3,35	N/mm²
Design shear stress	τ_d	0,45	N/mm²
Design tensile strength	$f_{t,0,d}$	6,46	N/mm²
Design compressive strength	$f_{c,0,d}$	9,69	N/mm²
Design bending strength	$f_{m,0,d}$	11,08	N/mm²
Design shear strength	$f_{v,d}$	1,85	N/mm²

 # Flexural stress with tension (*DIN EN 1995-1-1 6.2.3)*

$$\eta_{flexural} = \frac{\sigma_{t,0,d}}{f_{t,0,d}} + \frac{\sigma_{m,0,d}}{f_{m,0,d}} \leq 1$$

Stress ratio $\eta_{flexural}$ **31%**

 # Flexural stress with compression (*DIN EN 1995-1-1 6.2.4)*

$$\eta_{compression} = \left(\frac{\sigma_{c,0,d}}{f_{c,0,d}}\right)^2 + \frac{\sigma_{m,0,d}}{f_{m,0,d}} \leq 1$$

Stress ratio $\eta_{flexural}$ **30%**

 # Shear stress (*DIN EN 1995-1-1 6.1.7)*

$$\eta_{shear} = \frac{\tau_d}{f_{v,d}} \leq 1$$

Stress ratio η_{shear} **24%**

Serviceability State
Limiting values for deflections of beams

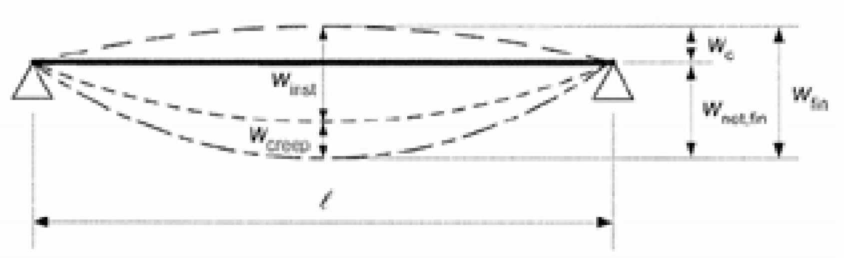


Figure 7.1 – Components of deflection

 # Deflections

Parameter	Symbol	Value	Unit
Precamber	w_c	0,0	mm
Instantaneous deflection (self-weight)	$w_{inst,G}$	2,2	mm
Instantaneous deflection (snow)	$w_{inst,S}$	not relevant (ψ_0=0,0)	
Instantaneous deflection (imposed load)	$w_{inst,Q}$	not relevant (ψ_0=0,0)	
Deformation factor	k_{def}	0,6	
Net final deflection	$w_{net,fin}$	3,5	mm

 # Check

Parameter	Symbol	Value	Unit
Length	l	2991	mm
Limiting value of deflection	l/250	12,0	mm

 # Deflection *(DIN EN 1995-1-1 7.2)*

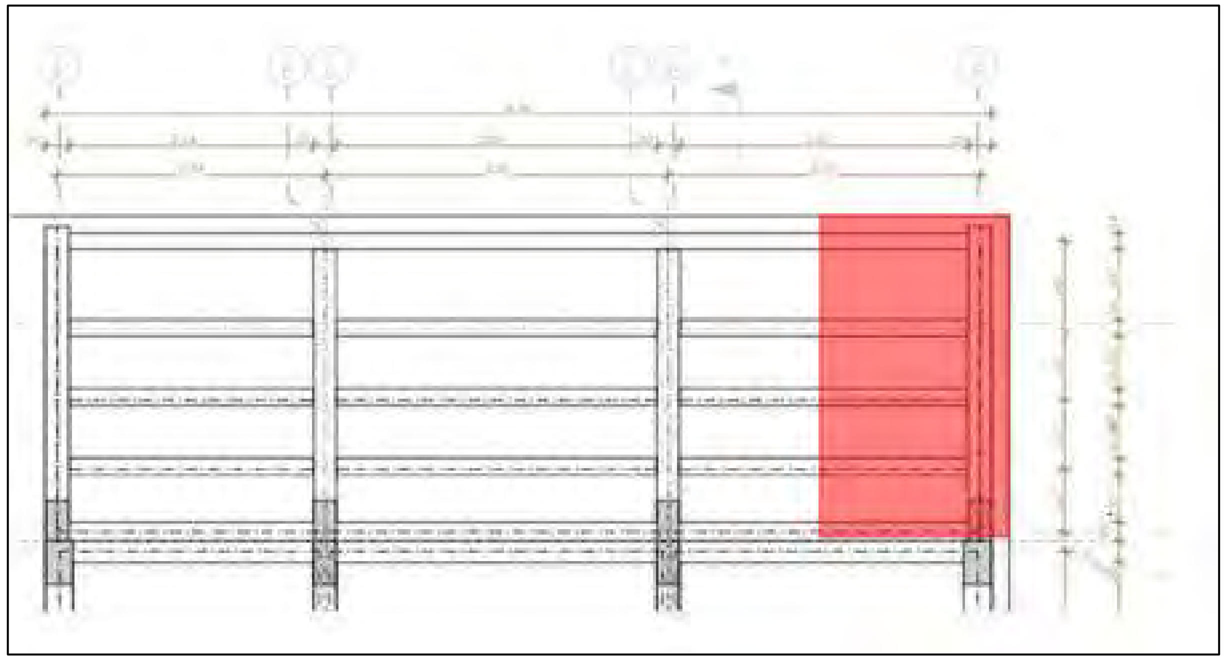
$$\eta_{deflection} = \frac{w_{net,fin}}{l/250} \leq 1$$

Deflection ratio $\eta_{deflection}$ **29%**

Pos. 2.2 – Exterior Terrace Rafter

Overview

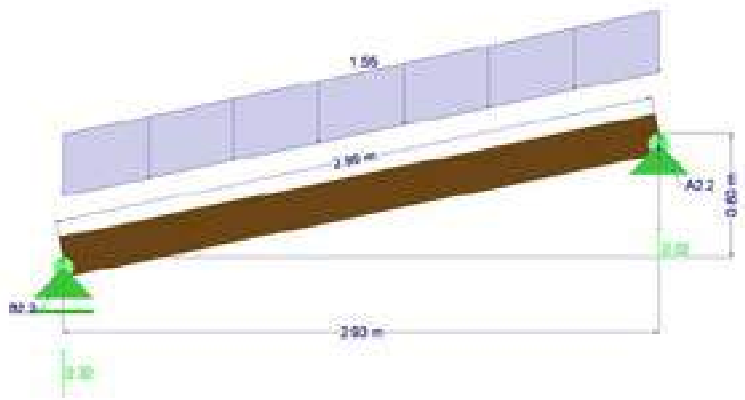
Load application area



Loads

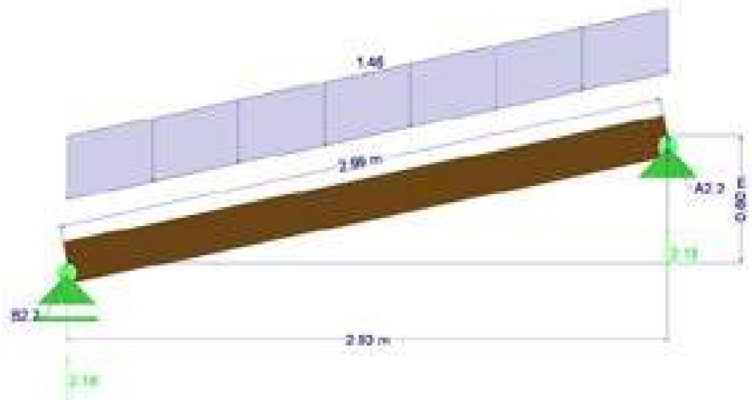
Dead loads		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
dead load roof terrace module	g_{RT}	1,06	1,46	1,55

Load case 1 (LF1):



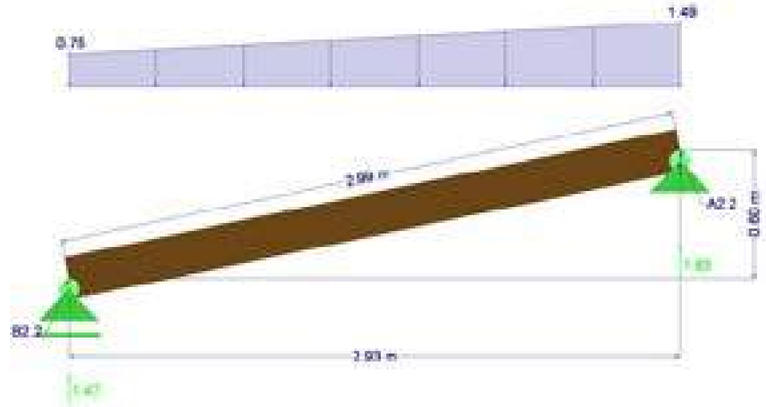
Live loads		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
dead load roof	p_R	1,00	1,46	1,46

Load case 2 (LF2):



Snow loads		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
snow load roof min	s_{Rmin}	0,52	1,46	0,76
snow load roof max	s_{Rmax}	1,02	1,46	1,49

Load case 3 (LF3):



Load case combinations

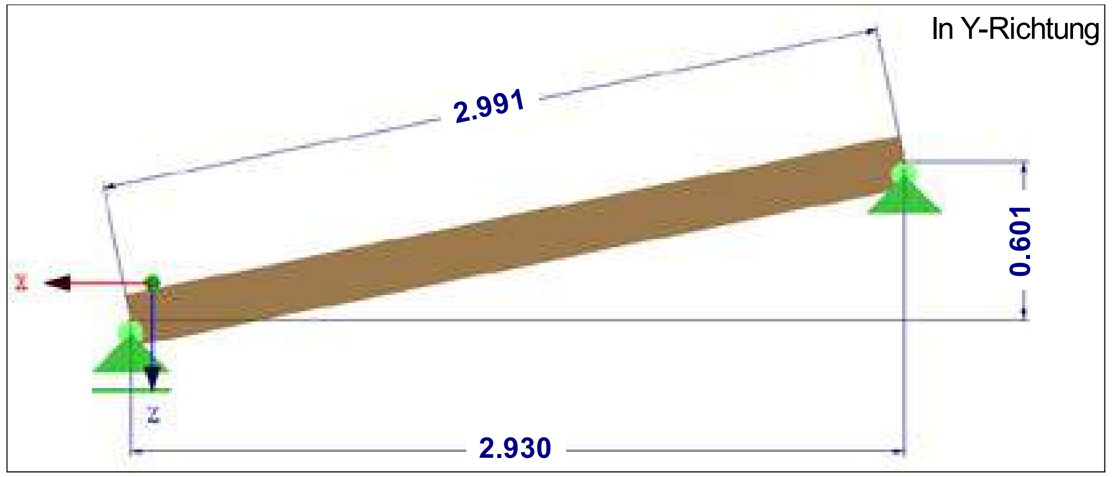
LK1	1.35*LF1
LK2	1.35*LF1 + 1.5*LF2
LK3	1.35*LF1 + 1.5*LF3
LK4	1.35*LF1 + 0.75*LF2 + 1.5*LF3

Support reactions

$A2.2_g$	2,32 kN
$B2.2_g$	2,32 kN
$A2.2_p$	2,18 kN
$B2.2_p$	2,18 kN
$A2.2_s$	1,47 kN
$B2.2_s$	1,83 kN

Check

 # System



 # Cross-section: 20x20 cm²

Parameter	Symbol	Value	Unit
Height	h	200	mm
Width	b	200	mm
Area	A	40000	mm²
Area moment of inertia	I	133333333	mm^4
Modulus of section	W	1333333,33	mm³
Radius of inertia	i_y	57,8	mm
Radius of inertia	i_z	57,8	mm

 # Material: C24

Parameter	Symbol	Value	Unit
Characteristic tensile strength	$f_{t,0,k}$	14	N/mm²
Characteristic compressive strength	$f_{c,0,k}$	21	N/mm²
Characteristic bending strength	$f_{m,0,k}$	24	N/mm²
Characteristic shear strength	$f_{v,k}$	4	N/mm²
Modulus of elasticity (Fifth percentile)	$E_{0.05}$	7400	N/mm²
Crack coefficient	k_{cr}	0,5	-
Effective area	A_{eff}	20000	mm²

Ultimate Limit State LK 4

Design of cross-sections subjected to stress in one principal direction

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	1,60	kN
Design value of compressive force	$N_{Ed,c}$	-1,47	kN
Design value of bending moment	$M_{y,Ed}$	5,60	kNm
Design value of shear force	V_{Ed}	7,61	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Short-term	
Modification factor	k_{mod}	0,9	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,04	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,04	N/mm²
Design bending stress	$\sigma_{m,0,d}$	4,20	N/mm²
Design shear stress	τ_d	0,57	N/mm²
Design tensile strength	$f_{t,0,d}$	9,69	N/mm²
Design compressive strength	$f_{c,0,d}$	14,54	N/mm²
Design bending strength	$f_{m,0,d}$	16,62	N/mm²
Design shear strength	$f_{v,d}$	2,77	N/mm²

 # Flexural stress with tension (*DIN EN 1995-1-1 6.2.3*)

$$\eta_{flexural} = \frac{\sigma_{t,0,d}}{f_{t,0,d}} + \frac{\sigma_{m,0,d}}{f_{m,0,d}} \leq 1$$

Stress ratio $\eta_{flexural}$ **26%**

 # Flexural stress with compression (*DIN EN 1995-1-1 6.2.4*)

$$\eta_{compression} = \left(\frac{\sigma_{c,0,d}}{f_{c,0,d}}\right)^2 + \frac{\sigma_{m,0,d}}{f_{m,0,d}} \leq 1$$

Stress ratio $\eta_{compression}$ **25%**

 # Shear stress (*DIN EN 1995-1-1 6.1.7*)

$$\eta_{shear} = \frac{\tau_d}{f_{v,d}} \leq 1$$

Stress ratio η_{shear} **21%**

Ultimate Limit State **LK 1**

Design of cross-sections subjected to stress in one principal direction

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	0,64	kN
Design value of compressive force	$N_{Ed,c}$	-0,62	kN
Design value of bending moment	$M_{y,Ed}$	2,29	kNm
Design value of shear force	V_{Ed}	3,07	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Permanent	
Modification factor	k_{mod}	0,6	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,02	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,02	N/mm²
Design bending stress	$\sigma_{m,0,d}$	1,72	N/mm²
Design shear stress	τ_d	0,23	N/mm²
Design tensile strength	$f_{t,0,d}$	6,46	N/mm²
Design compressive strength	$f_{c,0,d}$	9,69	N/mm²
Design bending strength	$f_{m,0,d}$	11,08	N/mm²
Design shear strength	$f_{v,d}$	1,85	N/mm²

 # Flexural stress with tension (*DIN EN 1995-1-1 6.2.3*)

$$\eta_{flexural} = \frac{\sigma_{t,0,d}}{f_{t,0,d}} + \frac{\sigma_{m,0,d}}{f_{m,0,d}} \leq 1$$

Stress ratio $\eta_{flexural}$ **16%**

 # Flexural stress with compression (*DIN EN 1995-1-1 6.2.4*)

$$\eta_{compression} = \left(\frac{\sigma_{c,0,d}}{f_{c,0,d}}\right)^2 + \frac{\sigma_{m,0,d}}{f_{m,0,d}} \leq 1$$

Stress ratio $\eta_{compression}$ **16%**

 # Shear stress (*DIN EN 1995-1-1 6.1.7*)

$$\eta_{shear} = \frac{\tau_d}{f_{v,d}} \leq 1$$

Stress ratio η_{shear} **12%**

Serviceability State

Limiting values for deflections of beams

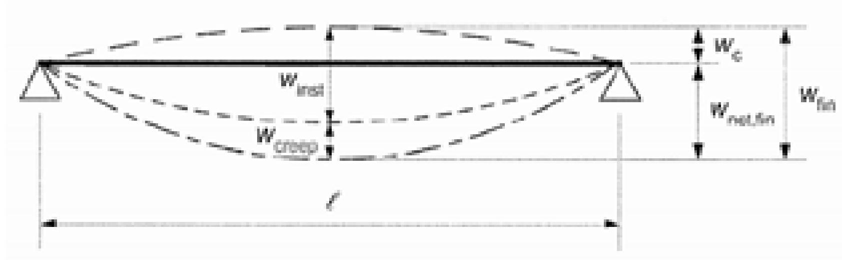


Figure 7.1 – Components of deflection

 # Deflections

Parameter	Symbol	Value	Unit
Precamber	w_c	0,0	mm
Instantaneous deflection (self-weight)	$w_{inst,G}$	1,2	mm
Instantaneous deflection (snow)	$w_{inst,S}$	not relevant (ψ_0=0,0)	
Instantaneous deflection (imposed load)	$w_{inst,Q}$	not relevant (ψ_0=0,0)	
Deformation factor	k_{def}	0,6	
Net final deflection	$w_{net,fin}$	1,9	mm

 # Check

Parameter	Symbol	Value	Unit
Length	l	2991	mm
Limiting value of deflection	l/250	12,0	mm

 # Deflection (*DIN EN 1995-1-1 7.2)*

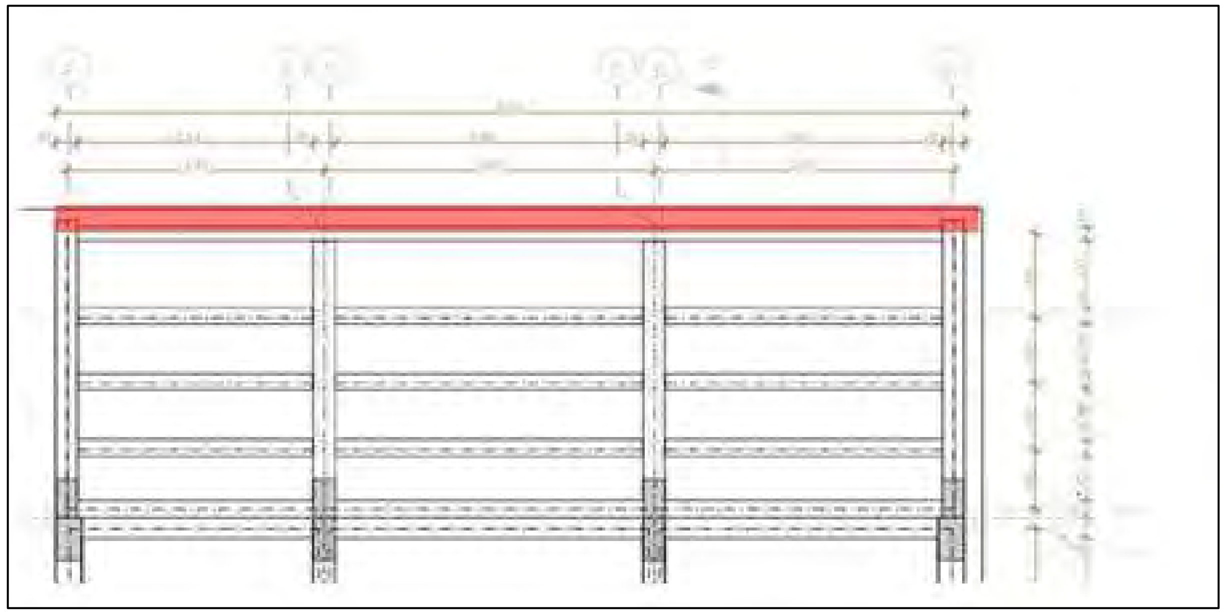
$$\eta_{deflection} = \frac{w_{net,fin}}{l/250} \leq 1$$

Deflection ratio $\eta_{deflection}$ **16%**

Pos. 3 – Steel Girder Terrace Roof

Overview

Load application area



Loads

Dead loads			
			point load [kN]
support reaction 2.1 Interior Terrace Rafter A2.1$_g$			4,52

Load case 1 (LF1):

Live loads			
			point load [kN]
support reaction 2.1 Interior Terrace Rafter A2.1$_p$			4,26

Load case 2 (LF2):

Snow loads			
			point load [kN]
support reaction 2.1 Interior Terrace Rafter A2.1$_s$			2,87

Load case 3 (LF3):

Load case combinations

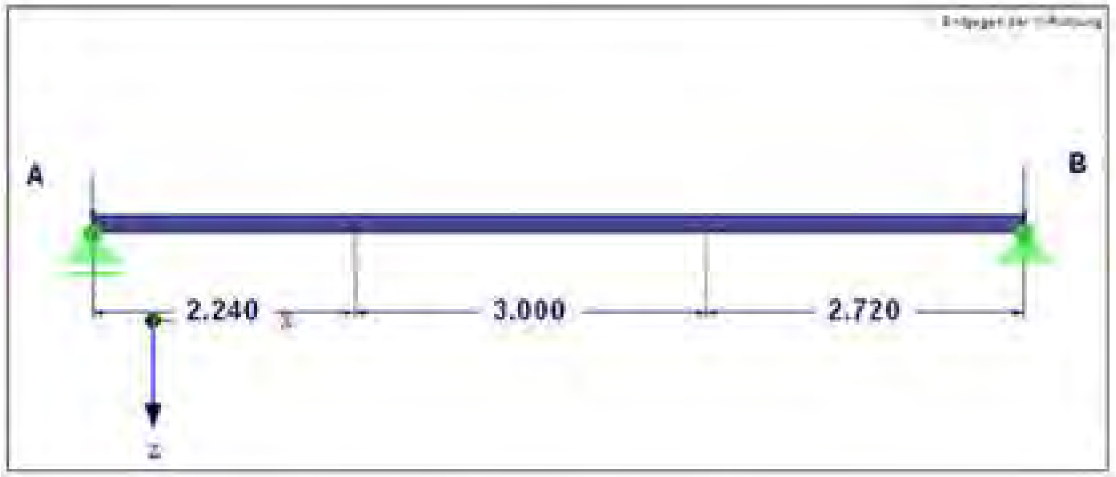
LK1	1.35*LF1
LK2	1.35*LF1 + 1.5*LF2
LK3	1.35*LF1 + 1.5*LF3
LK4	1.35*LF1 + 0.75*LF2 + 1.5*LF3

Support reactions

$A3_g$	6,45 kN
$B3_g$	6,02 kN
$A3_p$	4,46 kN
$B3_p$	4,06 kN
$A3_s$	3,01 kN
$B3_s$	2,73 kN

Check

 # System



 # Cross-section: HEB160

Parameter	Symbol	Value	Unit
Height	h	160	mm
Width	b	160	mm
Web thickness	t_w	8	mm
Flange thickness	t_f	13	mm
Area	A	5425	mm^2
Area moment of inertia	I_y	24920000	mm^4
Area moment of inertia	I_z	8892300	mm^4
First moment of area	S_y	176980	mm^3

 # Material: S235

Parameter	Symbol	Value	Unit
Yield strength	f_y	235	N/mm^2
Ultimate strength	f_u	360	N/mm^2

Ultimate Limit State
Design of cross-sections subjected to stress in one principal direction

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of the compression axial force	N_{Ed}	0,39	kN
Design value of the bending moment about y-y axis	$M_{y,Ed}$	42,13	kNm
Design value of the bending moment about z-z axis	$M_{z,Ed}$	0,00	kNm
Design value of the shear force	V_{Ed}	17,65	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor for resistance of cross-sections	γ_{M0}	1,0	-
Classification of cross-section	QK	1	

 # Check

Parameter	Symbol	Value	Unit
Design value of the longitudinal stress	$\sigma_{x,Ed}$	135,32	N/mm²
Design value of the shear stress	τ_{Ed}	15,67	N/mm²
	$\sigma_{v,Ed}$	138,02	N/mm²
	$\sigma_{x,Rd}$	235,00	N/mm²
	τ_{Rd}	135,68	N/mm²

 # Flexural stress (*DIN EN 1993-1-1)*

$$\eta_{flexural} = \frac{\sigma_{x,Ed}}{\sigma_{x,Rd}} \leq 1$$

Stress ratio **$\eta_{flexural}$** **58%**

 # Shear stress (*DIN EN 1993-1-1)*

$$\eta_{shear} = \frac{\tau_{Ed}}{\tau_{Rd}} \leq 1$$

Stress ratio **η_{shear}** **12%**

Serviceability State
Limiting values for deflections of beams

 # Deflections

Parameter	Symbol	Value	Unit
Deflection in EK3 - Quasi-permanent	w	31,6	mm

 # Check

Parameter	Symbol	Value	Unit
Length	l	7960	mm
Limiting value of deflection	l/200	39,8	mm

 # Deflection (*DIN EN)*

$$\eta_{deflection} = \frac{w}{l/200} \leq 1$$

Deflection ratio **$\eta_{deflection}$** **79%**

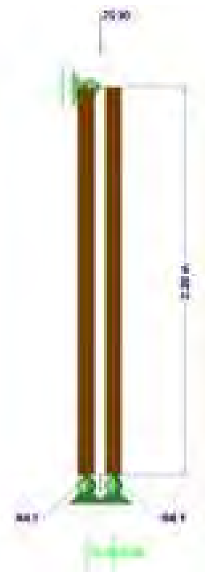
Pos. 4.1 – Interior Column

Loads

Dead loads

			point load [kN]
support reaction 6.1 Interior Roof Truss $C6.1_g$			20,90

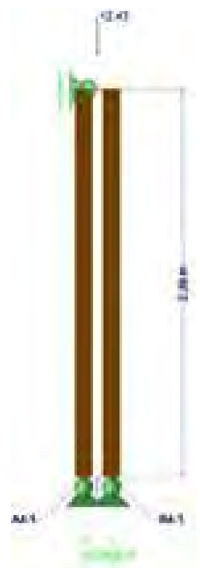
Load case 1 (LF1):



Live loads

			point load [kN]
support reaction 6.1 Interior Roof Truss $C6.1_p$			12,47

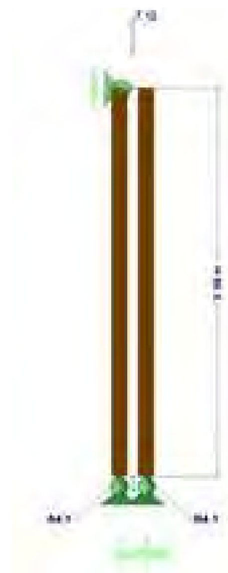
Load case 3 (LF3):



Snow loads

			point load [kN]
support reaction 6.1 Interior Roof Truss $C6.1_s$			7,13

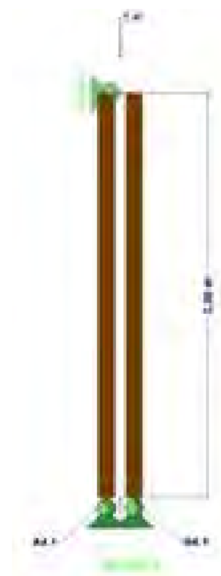
Load case 2 (LF2):



Wind actions

			point load [kN]
support reaction 6.1 Interior Roof Truss $C6.1_w$			1,41

Load case 6 (LF6):



Load case combinations

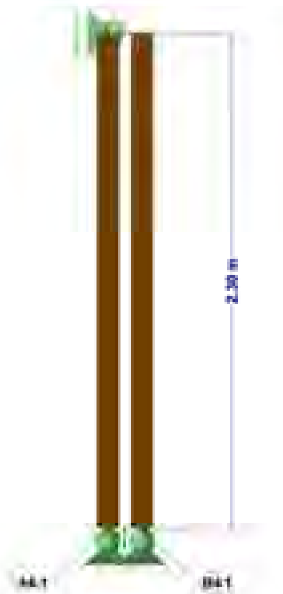
LK1	1.35*LF1
LK2	1.35*LF1 + 1.5*LF2
LK3	1.35*LF1 + 1.5*LF2 + 0.9*LF6
LK4	1.35*LF1 + 1.5*LF3
LK5	1.35*LF1 + 0.75*LF2 + 1.5*LF3
LK6	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 0.9*LF6
LK7	1.35*LF1 + 1.5*LF3 + 0.9*LF6
LK8	1.35*LF1 + 1.5*LF6
LK9	1.35*LF1 + 0.75*LF2 + 1.5*LF6

Support reactions

$A4.1_g/B4.1_g$	10,55 kN
$A4.1_p/B4.1_p$	6,24 kN
$A4.1_s/B4.1_s$	3,57 kN
$A4.1_w/B4.1_w$	0,71 kN

Check

System



l 230 cm

Cross-section: 10x10 cm²

Parameter	Symbol	Value	Unit
Height	h	100	mm
Width	b	100	mm
Area	A	10000	mm^2
Area moment of inertia	I		mm^4
Modulus of section	W		mm^3
Radius of inertia	i_y	28,9	mm
Radius of inertia	i_z	28,9	mm

Material: C24

Parameter	Symbol	Value	Unit
Characteristic tensile strength	$f_{t,0,k}$	14	N/mm^2
Characteristic compressive strength	$f_{c,0,k}$	21	N/mm^2
Characteristic bending strength	$f_{m,0,k}$	24	N/mm^2
Characteristic shear strength	$f_{v,k}$	4	N/mm^2
Modulus of elasticity (Fifth percentile)	$E_{0,05}$	7400	N/mm^2

Ultimate Limit State LK 6

Stability of members - Columns subjected to compression

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of compressive force	$N_{Ed,c}$	-26,90	kN
Design value of bending moment	$M_{y,Ed}$	0,00	kNm
Design value of shear force	V_{Ed}	0,00	kN

--> Flexural Moment and Shear Force negligible

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Short-term	
Modification factor	k_{mod}	0,9	-

 # Buckling Euler-Case II

Parameter	Symbol	Value	Unit
	β	1	-
Effective length	l_{ef}	2300	mm
Slenderness ratio	λ_z	79,585	-
Relative slenderness ratio	$\lambda_{rel,c}$	1,350	-
Straightness factor	β_c	0,200	-
	k	1,516	-
Instability factor	k_c	0,453	-

 # Check

Parameter	Symbol	Value	Unit
Design compressive stress along the grain	$\sigma_{c,0,d}$	2,69	N/mm²
Design compressive strength along the grain	$f_{c,0,d}$	14,54	N/mm²

 # Stability (*DIN EN 1995-1-1 6.3.2*)

$$\eta_{stability} = \frac{\sigma_{c,0,d}}{k_c * f_{c,0,d}} \leq 1$$

Stress ratio $\eta_{Stability}$ **41%**

Ultimate Limit State LK 1

Stability of members - Columns subjected to compression

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of compressive force	$N_{Ed,c}$	-14,24	kN
Design value of bending moment	$M_{y,Ed}$	0,00	kNm
Design value of shear force	V_{Ed}	0,00	kN

--> Flexural Moment and Shear Force negligible

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Permanent	
Modification factor	k_{mod}	0,6	-

 # Buckling Euler-Case II

Parameter	Symbol	Value	Unit
	β	1	-
Effective length	l_{ef}	2300	mm
Slenderness ratio	λ_z	79,585	-
Relative slenderness ratio	$\lambda_{rel,c}$	1,350	-
Straightness factor	β_c	0,200	-
	k	1,516	-
Instability factor	k_c	0,453	-

 # Check

Parameter	Symbol	Value	Unit
Design compressive stress along the grain	$\sigma_{c,0,d}$	1,42	N/mm²
Design compressive strength along the grain	$f_{c,0,d}$	9,69	N/mm²

 # Stability (*DIN EN 1995-1-1 6.3.2*)

$$\eta_{stability} = \frac{\sigma_{c,0,d}}{k_c * f_{c,0,d}} \leq 1$$

Stress ratio $\eta_{Stability}$ **32%**

Fire Safety

The fire safety for this member is checked, since it is the only uncladded member. All other members within the HDU must be cladded.

Datum: 17.03.2022 Projekt: Modell: 04.1 Interior Column Seite: 1/2 Blatt: 1

HOLZ Pro
FA2
Brandschutz

1.1.1 BASISANGABEN

Zu bemessende Stäbe: Alle

Bemessung nach Norm: DIN EN 1995-1-1/NA:2013-08

Brandschutznachweise
Zu bemessende Ergebniskombinationen: EK5 GZT (STR/GEO) - Außergewöhnlich - psi-1,1 - Gl. 6.11c

1.1.2 DETAILEINSTELLUNGEN

Stabilitätsanalyse: Stabilitätsnachweis nach Ersatzstabverfahren

Angaben für Brandschutz nach EN 1995-1-2
Feuerwiderstandsklasse: R 30
Teilsicherheitsbeiwert $\gamma_{M,fi}$: 1.00

Weitere Bemessung zulassen, falls der Hauptachsenwinkel den Grenzwert nicht überschreitet: $|\alpha| \leq 5.00°$

1.1.3 NORMDATEN

Teilsicherheitsbeiwerte für Materialeigenschaften

Vollholz - Grundsituation	γ_M:	1.300
Anschlüsse	γ_M:	1.300
Stahlausstellungen (EN 1993)	γ_{M2}:	1.250
Außergewöhnliche Situation	γ_M:	1.000
Für Holz im Brandfall	$\gamma_{M,fi}$:	1.000

Modifikationsbeiwert k_{mod}

Vollholz

KLED	1	2	3
Ständig	0.600	0.600	0.500
Lang	0.700	0.700	0.550
Mittel	0.800	0.800	0.650
Kurz	0.900	0.900	0.700
Kurz / Sehr kurz	1.000	1.000	0.800
Sehr kurz	1.100	1.100	0.900

Parameter für Nadelholz

Abbrandrate β_n:	0.80	mm/min
Erhöhter Abbrand d_0:	7.00	mm
Beiwert k_0:	1.25	

1.4 LASTEINWIRKUNGSDAUER UND NUTZUNGSKLASSE

LF/LK/ EK	Lastfall- bzw. LK-/EK-Bezeichnung	Lastfalltyp	Klasse der Lasteinwirkungsdauer KLED
LF1	Eigengewicht	Ständig	Ständig
LF2	Schnee	Schnee (H ≤ 1000 m über NN)	Kurz
LF6	Wind in -X	Wind	Kurz / Sehr kurz
LK29	LF1	-	Ständig
LK30	LF1 + 0.2*LF2	-	Kurz
LK31	LF1 + 0.2*LF6	-	Kurz / Sehr kurz

Nutzungsklasse NKL
Nutzungsklasse 1: Identisch für alle Stäbe/Stabsätze

1.5 KNICKLÄNGEN - STÄBE

Stab Nr.	Knicken möglich	Knicken um Achse y: möglich	$k_{cr,y}$	$L_{cr,y}$ [m]	Knicken um Achse z: möglich	$k_{cr,z}$	$L_{cr,z}$ [m]	Biegedrillknicken: möglich	L_{cr} definieren / M_{cr}	L_{cr} [m] / M_{cr} [kNm]
1	☒	☒	1.000	2.300	☒	1.000	2.300	☒	Als Stablänge	2.300
2	☒	☒	1.000	2.300	☒	1.000	2.300	☒	Als Stablänge	2.300

1.10 BRANDSCHUTZ - STÄBE

Nr.	Stäbe Nr.	Brandbeanspruch vierseitig	Brandbeanspruch: Oben	Unten	Links	Rechts
1	1	☐	☐	☐	☒	☐
2	2	☐	☐	☐	☐	☒

2.2 NACHWEISE QUERSCHNITTSWEISE

Quer. Nr.	Stab Nr.	Stelle x [m]	LF/LK/ EK	Nachweis		Bemessung Nr.	Bezeichnung
1	H-Rechteck 100/100 - Untergurt						
	1	2.300	LK30	0.36	≤ 1	602)	Brandschutznachweis - Querschnittstragfähigkeit - Druckspannung in Faserrichtung nach 6.1.4
	1	2.300	LK30	0.27	≤ 1	603)	Brandschutz - Druckstab mit Normaldruck nach 6.3.2 - Knicken um beiden Achsen

RSTAB 8.27.01 - Räumliche Stabwerke www.dlubal.com

Datum: 17.03.2022 Projekt: Modell: 04.1 Interior Column Seite: 2/2 Blatt: 1

3.1 MASSGEBENDE SCHNITTGRÖSSEN STABWEISE

Stab Nr.	Stelle x [m]	Last- fall	Kräfte [kN]: N	V_y	V_z	Momente [kNm]: M_T	M_y	M_z	Bemessung Nr.
1	Querschnitt Nr. 1 - H-Rechteck 100/100								
	2.300	LK30	-11.26	0.00	0.00	0.00	0.00	0.00	602)
	Brandschutznachweis - Querschnittstragfähigkeit - Druckspannung in Faserrichtung nach 6.1.4								
	2.300	LK30	-11.26	0.00	0.00	0.00	0.00	0.00	603)
	Brandschutz - Druckstab mit Normaldruck nach 6.3.2 - Knicken um beiden Achsen								
2	Querschnitt Nr. 1 - H-Rechteck 100/100								
	2.300	LK30	-11.26	0.00	0.00	0.00	0.00	0.00	602)
	Brandschutznachweis - Querschnittstragfähigkeit - Druckspannung in Faserrichtung nach 6.1.4								
	2.300	LK30	-11.26	0.00	0.00	0.00	0.00	0.00	603)
	Brandschutz - Druckstab mit Normaldruck nach 6.3.2 - Knicken um beiden Achsen								

RSTAB 8.27.01 - Räumliche Stabwerke www.dlubal.com

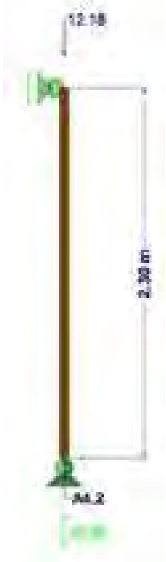
Pos. 4.2 – Interior Column South

Loads

Dead loads

				point load [kN]
support reaction 6.2 Exterior Roof Truss	$C6.2_g$			12,18

Load case 1 (LF1):



Live loads

				point load [kN]
support reaction 6.2 Exterior Roof Truss	$C6.2_p$			7,82

Load case 3 (LF3):

Snow loads

				point load [kN]
support reaction 6.2 Exterior Roof Truss	$C6.2_s$			3,93

Load case 2 (LF2):

Wind actions

				point load [kN]
support reaction 6.2 Exterior Roof Truss	$C6.2_w$			0,80

Load case 6 (LF6):

Load case combinations

LK1	1.35*LF1
LK2	1.35*LF1 + 1.5*LF2
LK3	1.35*LF1 + 1.5*LF2 + 0.9*LF6
LK4	1.35*LF1 + 1.5*LF3
LK5	1.35*LF1 + 0.75*LF2 + 1.5*LF3
LK6	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 0.9*LF6
LK7	1.35*LF1 + 1.5*LF3 + 0.9*LF6
LK8	1.35*LF1 + 1.5*LF6
LK9	1.35*LF1 + 0.75*LF2 + 1.5*LF6

Support reactions

$A4.2_g$	12,32 kN
$A4.2_p$	7,82 kN
$A4.2_s$	3,93 kN
$A4.2_w$	0,80 kN

Check

No additional check is required, since position 4.2 is less loaded than position 4.1.

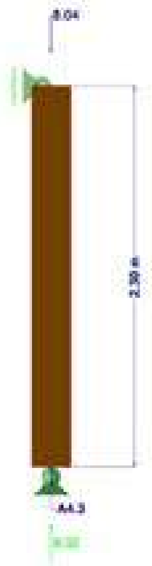
Pos. 4.3 – Exterior Column

Loads

Dead loads

				point load [kN]
support reaction 6.1 Interior Roof Truss	$A6.1_g$			8,04

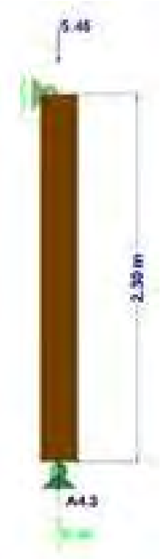
Load case 1 (LF1):



Live loads

				point load [kN]
support reaction 6.1 Interior Roof Truss	$B6.1_p$			5,46

Load case 3 (LF3):



Snow loads				point load [kN]
support reaction 6.1 Interior Roof Truss	$B6.1_s$			2,74

Load case 2 (LF2):

Wind actions				point load [kN]
support reaction 6.1 Interior Roof Truss	$B6.1_w$			0,43

Load case 6 (LF6):

Load case combinations

LK1	1.35*LF1
LK2	1.35*LF1 + 1.5*LF2
LK3	1.35*LF1 + 1.5*LF2 + 0.9*LF6
LK4	1.35*LF1 + 1.5*LF3
LK5	1.35*LF1 + 0.75*LF2 + 1.5*LF3
LK6	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 0.9*LF6
LK7	1.35*LF1 + 1.5*LF3 + 0.9*LF6
LK8	1.35*LF1 + 1.5*LF6
LK9	1.35*LF1 + 0.75*LF2 + 1.5*LF6

Support reactions

$A4.3_g$	8,32 kN
$A4.3_p$	5,46 kN
$A4.3_s$	2,74 kN
$A4.3_w$	0,43 kN

Check

No additional check is required, since position 4.3 is less loaded than position 4.1.

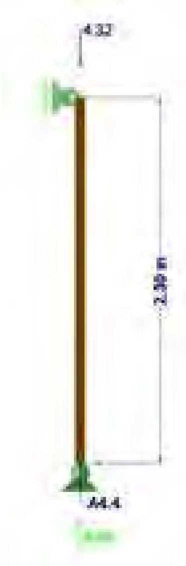
Pos. 4.4 – Exterior Column South

Loads

Dead loads

				point load [kN]
support reaction 6.2 Exterior Roof Truss	B6.2$_g$			4,32

Load case 1 (LF1):



Live loads

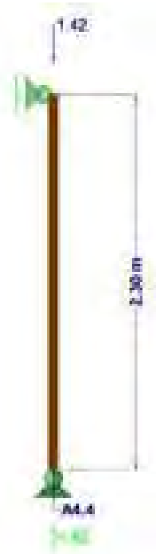
				point load [kN]
support reaction 6.2 Exterior Roof Truss	B6.2$_p$			2,82

Load case 3 (LF3):

Snow loads

				point load [kN]
support reaction 6.2 Exterior Roof Truss	B6.2$_s$			1,42

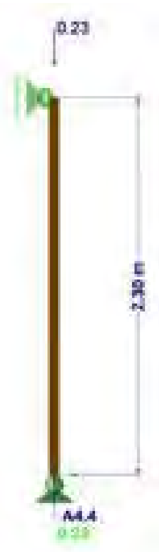
Load case 2 (LF2):



Wind actions

				point load [kN]
support reaction 6.2 Exterior Roof Truss	B6.2$_w$			0,23

Load case 6 (LF6):



Load case combinations

LK1	1.35*LF1
LK2	1.35*LF1 + 1.5*LF2
LK3	1.35*LF1 + 1.5*LF2 + 0.9*LF6
LK4	1.35*LF1 + 1.5*LF3
LK5	1.35*LF1 + 0.75*LF2 + 1.5*LF3
LK6	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 0.9*LF6
LK7	1.35*LF1 + 1.5*LF3 + 0.9*LF6
LK8	1.35*LF1 + 1.5*LF6
LK9	1.35*LF1 + 0.75*LF2 + 1.5*LF6

Support reactions

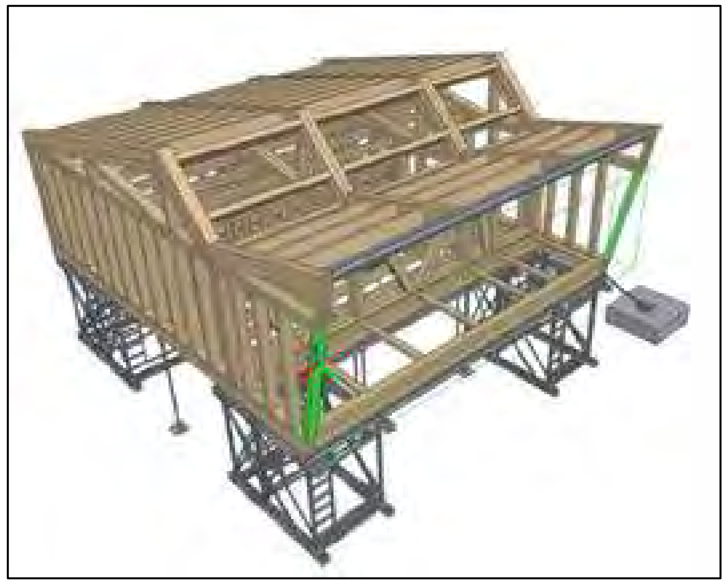
$A4.4_g$	4,46 kN
$A4.4_p$	2,82 kN
$A4.4_s$	1,42 kN
$A4.4_w$	0,23 kN

Check

No additional check is required, since position 4.4 is less loaded than position 4.1.

Pos. 5 – Inclined Column Terrace

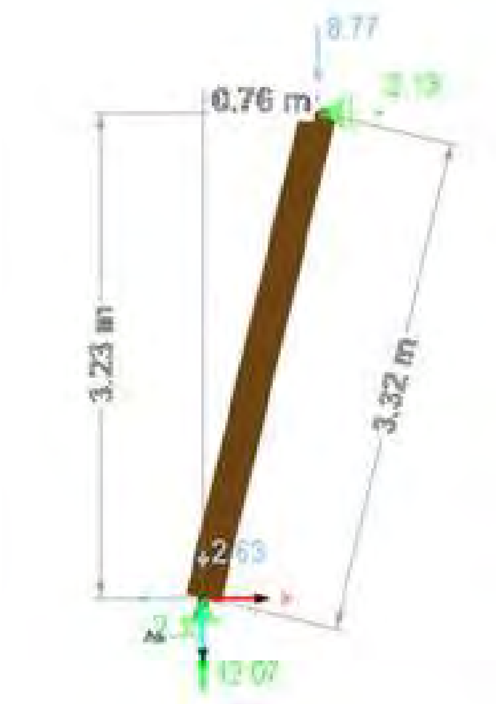
Overview



Loads

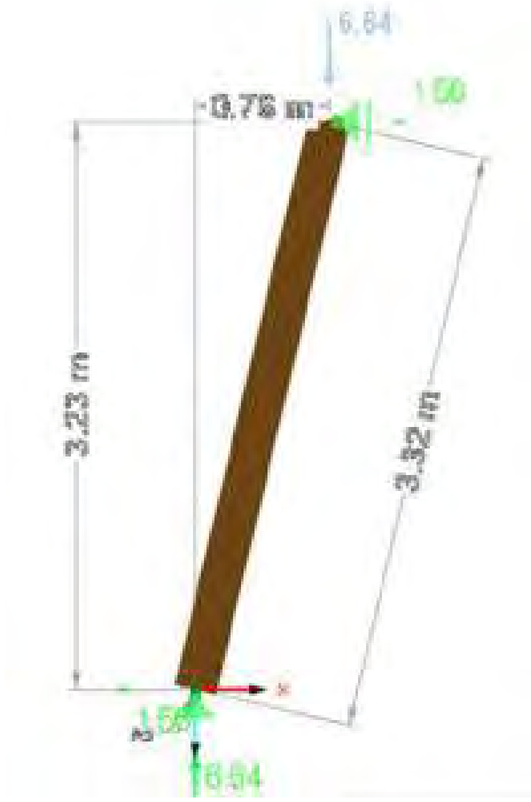
Dead loads		unif. distr. load [kN/m]	load appl. width [m]	point load [kN]
support reaction 2.2 Exterior Terrace Rafter	$A2.2_g$		-	2,32
support reaction 3 steel Girder Terrace Roof	$A3_g$		-	6,45
Total load	$\mathbf{T_g}$			**8,77**
dead load wall terrace roof area	G_{WTR}	0,56	1,09	0,61
dead load wall terrace module	G_{WT}	2,02	1,00	2,02
Total load	$\mathbf{T_{Wg}}$			**2,63**

Load case 1 (LF1):



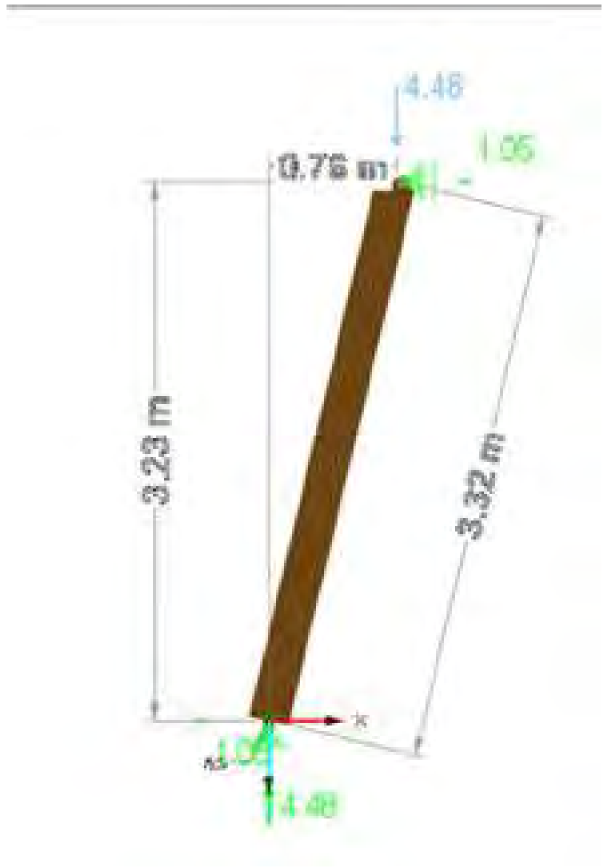
Live loads		unif. distr. load [kN/m]	load appl. width [m]	point load [kN]
support reaction 2.2 Exterior Terrace Rafter	$A2.2_p$			2,18
support reaction 3 steel Girder Terrace Roof	$A3_p$			4,46
Total load	$\mathbf{T_p}$			**6,64**

Load case 2 (LF2):



Snow loads		unif. distr. load [kN/m]	load appl. width [m]	point load [kN]
support reaction 2.2 Exterior Terrace Rafter	$A2.2_s$			1,47
support reaction 3 steel Girder Terrace Roof	$A3_s$			3,01
Total load	$\mathbf{T_s}$			**4,48**

Load case 3 (LF3):



Load case combinations

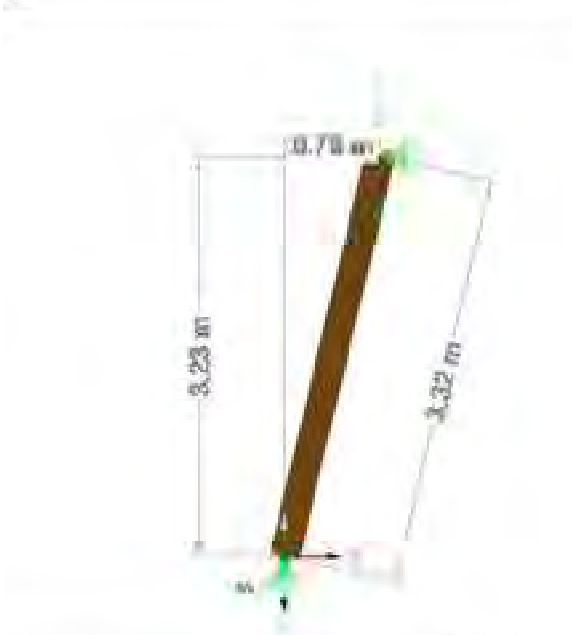
LK1	1.35*LF1
LK2	1.35*LF1 + 1.5*LF2
LK3	1.35*LF1 + 1.5*LF3
LK4	1.35*LF1 + 0.75*LF2 + 1.5*LF3

Support reactions

$A5_{g,z}$	12,07	kN
$A5_{g,x}$	2,13	kN
$A5_{p,z}$	6,64	kN
$A5_{p,x}$	1,56	kN
$A5_{s,z}$	4,48	kN
$A5_{s,x}$	1,05	kN

Check

System



lx	76 cm
ly	323 cm
α	77,2 °
l	332 cm

Cross-section: 20x24 cm²

Parameter	Symbol	Value	Unit
Height	h	240	mm
Width	b	200	mm
Area	A	48000	mm²
Area moment of inertia	I		mm⁴
Modulus of section	W		mm³
Radius of inertia	i_y	69,36	mm
Radius of inertia	i_z	57,8	mm

Material: C24

Parameter	Symbol	Value	Unit
Characteristic tensile strength	$f_{t,0,k}$	14	N/mm²
Characteristic compressive strength	$f_{c,0,k}$	21	N/mm²
Characteristic bending strength	$f_{m,0,k}$	24	N/mm²
Characteristic shear strength	$f_{v,k}$	4	N/mm²
Modulus of elasticity (Fifth percentile)	$E_{0.05}$	7400	N/mm²

Ultimate Limit State LK 4

Stability of members - Columns subjected to compression

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of compressive force	$N_{Ed,c}$	-26,74	kN
Design value of bending moment	$M_{y,Ed}$	0,09	kNm
Design value of shear force	V_{Ed}	0,10	kN

--> Flexural Moment and Shear Force negligible

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	3	-
Load duration class	KLED	Short-term	
Modification factor	k_{mod}	0,7	-

 # Buckling Euler-Case II

Parameter	Symbol	Value	Unit
	β	1	-
Effective length	l_{ef}	3318	mm
Slenderness ratio	λ_z	57,408	-
Relative slenderness ratio	$\lambda_{rel,c}$	0,973	-
Straightness factor	β_c	0,200	-
	k	1,041	-
Instability factor	k_c	0,709	-

 # Check

Parameter	Symbol	Value	Unit
Design compressive stress along the grain	$\sigma_{c,0,d}$	0,56	N/mm²
Design compressive strength along the grain	$f_{c,0,d}$	11,31	N/mm²

 # Stability (*DIN EN 1995-1-1 6.3.2*)

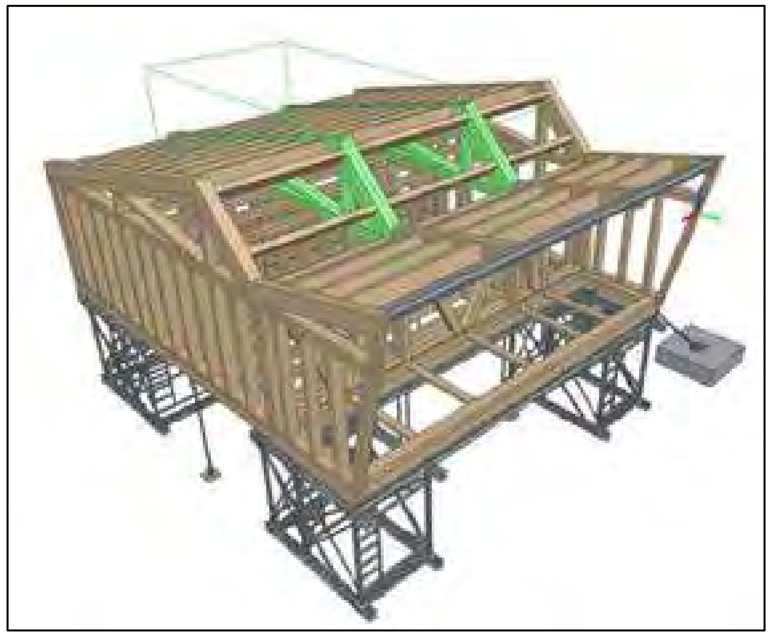
$$\eta_{stability} = \frac{\sigma_{c,0,d}}{k_c * f_{c,0,d}} \leq 1$$

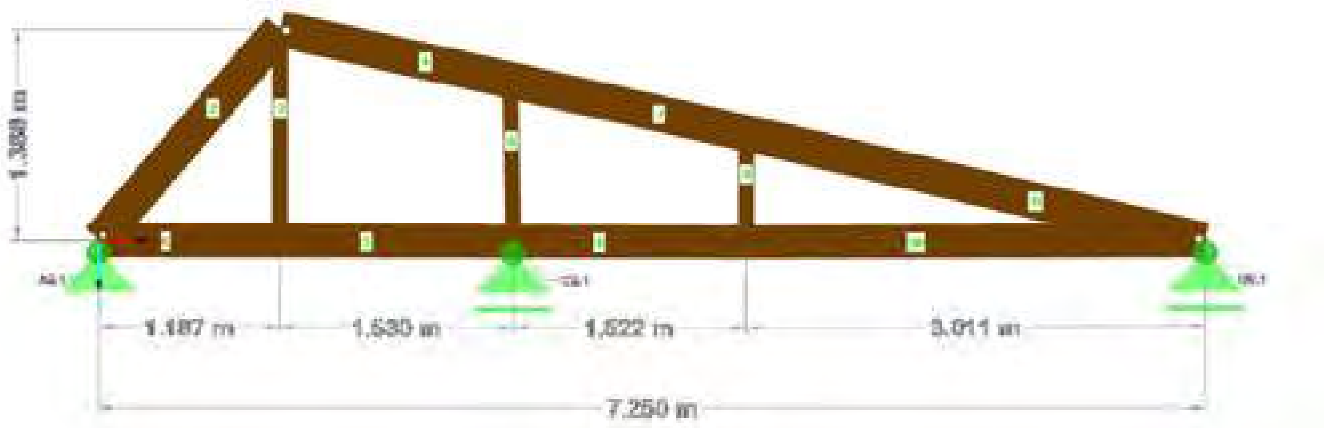
Stress ratio	$\eta_{Stability}$	**7%**

Pos. 6.1 – Interior Roof Truss

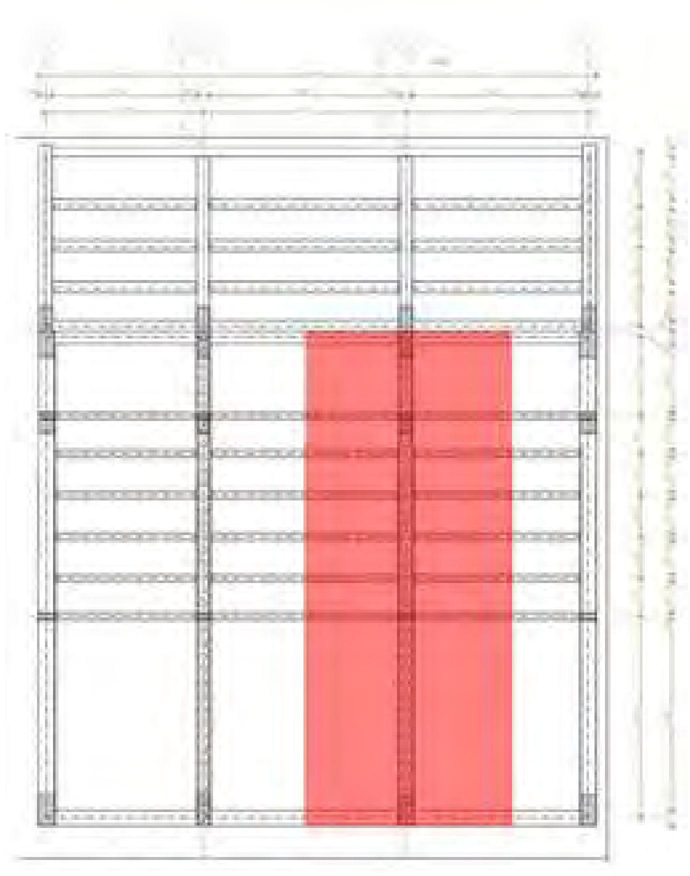
The system consists of continuous beams in the form of a gable roof. The roof beams are coupled with the horizontal beam layer via vertical struts. Due to the support, which is provided underneath the building with a column in vertical alignment under the middle connecting strut, a vertical support is applied at the appropriate point.

Overview





Load application area



Loads

Dead loads		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
dead loads roof living modules	g_{RL}	1,25	2,85	3,57
dead load 16cm beam increase	g_l			0,16
				3,73

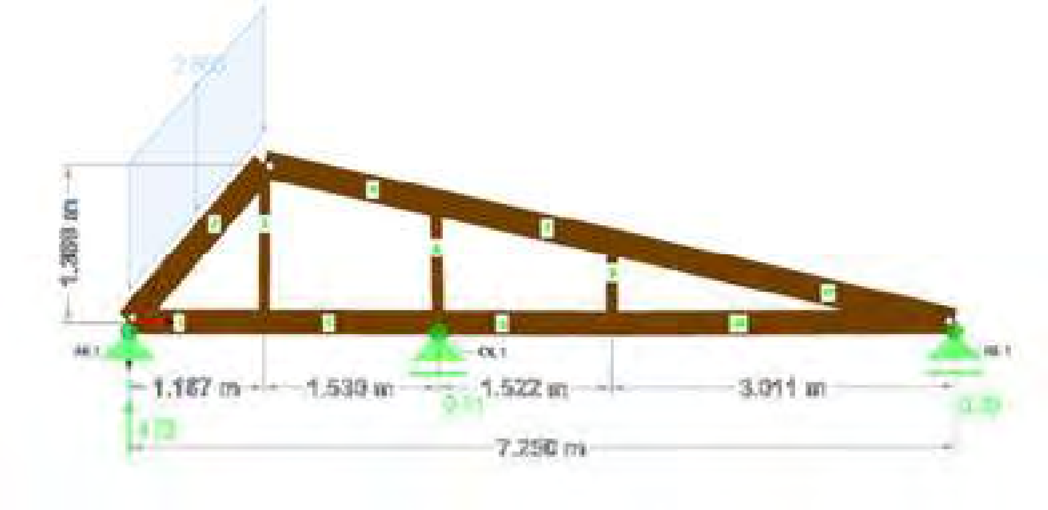
Load case 1 (LF1):

Snow loads		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
snow load roof MIN	s_{Rmin}	0,52	2,85	1,48
snow load roof MAX	s_{Rmax}	1,02	2,85	2,91

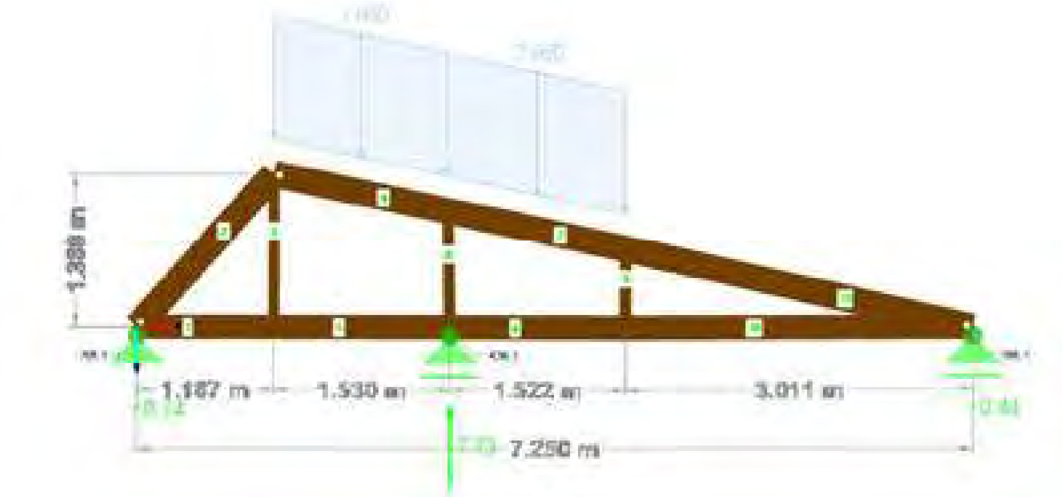
Load case 2 (LF2):

Live loads		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
live load roof	p_R	1	2,85	**2,85**

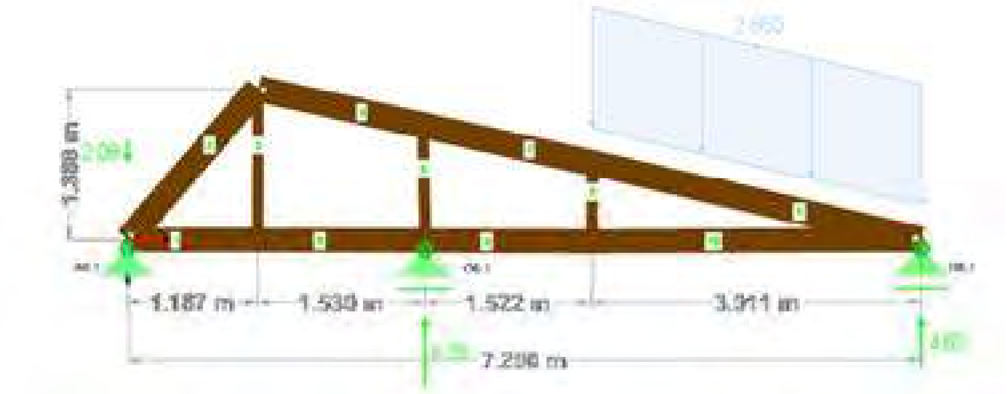
Load case 3 (LF3):



Load case 4 (LF4):

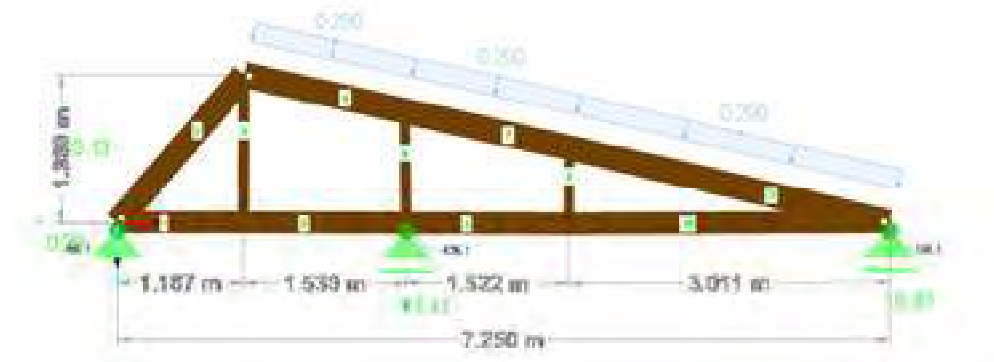


Load case 5 (LF5):



Wind actions				
		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
wind action roof	w_R	0,1	2,85	0,29

Load case 6 (LF6):



Load case combinations

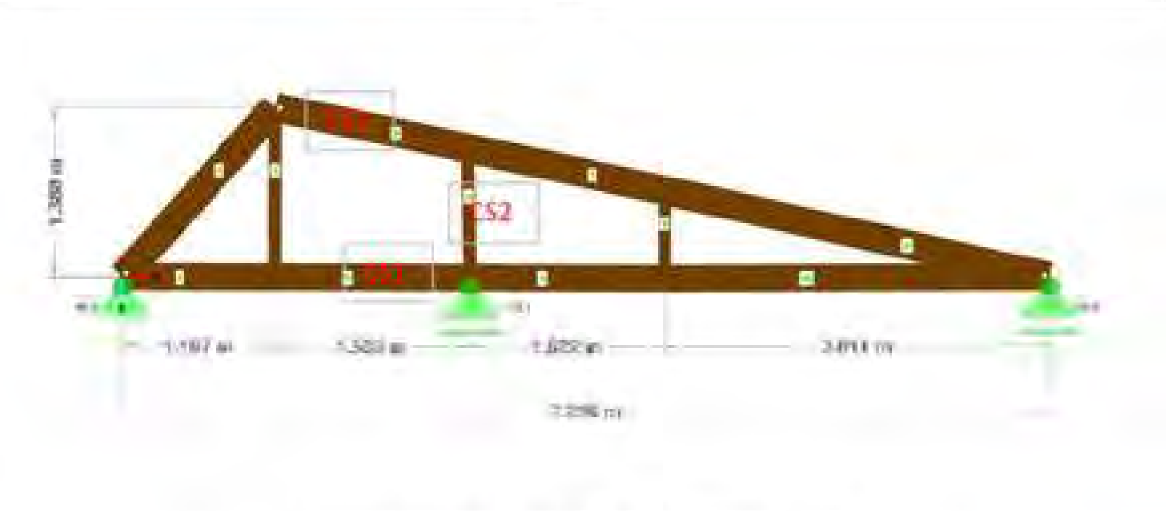
LK1	1.35*LF1	LK51	LF1 + 0.5*LF2 + LF3 + 0.6*LF6
LK2	1.35*LF1 + 1.5*LF2	LK52	LF1 + 0.5*LF2 + LF3 + LF4 + 0.6*LF6
LK3	1.35*LF1 + 1.5*LF2 + 0.9*LF6	LK53	LF1 + 0.5*LF2 + LF3 + LF4 + LF5 + 0.6*LF6
LK4	1.35*LF1 + 1.5*LF3	LK54	LF1 + 0.5*LF2 + LF3 + LF5 + 0.6*LF6
LK5	1.35*LF1 + 1.5*LF3 + 1.5*LF4	LK55	LF1 + 0.5*LF2 + LF4 + 0.6*LF6
LK6	1.35*LF1 + 1.5*LF3 + 1.5*LF4 + 1.5*LF5	LK56	LF1 + 0.5*LF2 + LF4 + LF5 + 0.6*LF6
LK7	1.35*LF1 + 1.5*LF3 + 1.5*LF5	LK57	LF1 + 0.5*LF2 + LF5 + 0.6*LF6
LK8	1.35*LF1 + 1.5*LF4	LK58	LF1 + LF3 + 0.6*LF6
LK9	1.35*LF1 + 1.5*LF4 + 1.5*LF5	LK59	LF1 + LF3 + LF4 + 0.6*LF6
LK10	1.35*LF1 + 1.5*LF5	LK60	LF1 + LF3 + LF4 + LF5 + 0.6*LF6
LK11	1.35*LF1 + 0.75*LF2 + 1.5*LF3	LK61	LF1 + LF3 + LF5 + 0.6*LF6
LK12	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 1.5*LF4	LK62	LF1 + LF4 + 0.6*LF6
LK13	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 1.5*LF4 + 1.5*LF5	LK63	LF1 + LF4 + LF5 + 0.6*LF6
LK14	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 1.5*LF5	LK64	LF1 + LF5 + 0.6*LF6
LK15	1.35*LF1 + 0.75*LF2 + 1.5*LF4	LK65	LF1 + LF6
LK16	1.35*LF1 + 0.75*LF2 + 1.5*LF4 + 1.5*LF5	LK66	LF1 + 0.5*LF2 + LF6
LK17	1.35*LF1 + 0.75*LF2 + 1.5*LF5	LK67	1.8*LF1
LK18	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 0.9*LF6	LK68	1.8*LF1
LK19	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 1.5*LF4 + 0.9*LF6	LK69	1.8*LF1 + LF2
LK20	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 1.5*LF4 + 1.5*LF5 + 0.9*LF6	LK70	1.8*LF1 + LF2 + 0.6*LF6
LK21	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 1.5*LF5 + 0.9*LF6	LK71	1.8*LF1 + LF3
LK22	1.35*LF1 + 0.75*LF2 + 1.5*LF4 + 0.9*LF6	LK72	1.8*LF1 + LF3 + LF4
LK23	1.35*LF1 + 0.75*LF2 + 1.5*LF4 + 1.5*LF5 + 0.9*LF6	LK73	1.8*LF1 + LF3 + LF4 + LF5
LK24	1.35*LF1 + 0.75*LF2 + 1.5*LF5 + 0.9*LF6	LK74	1.8*LF1 + LF3 + LF5
LK25	1.35*LF1 + 1.5*LF3 + 0.9*LF6	LK75	1.8*LF1 + LF4
LK26	1.35*LF1 + 1.5*LF3 + 1.5*LF4 + 0.9*LF6	LK76	1.8*LF1 + LF4 + LF5
LK27	1.35*LF1 + 1.5*LF3 + 1.5*LF4 + 1.5*LF5 + 0.9*LF6	LK77	1.8*LF1 + LF5
LK28	1.35*LF1 + 1.5*LF3 + 1.5*LF5 + 0.9*LF6	LK78	1.8*LF1 + 0.5*LF2 + LF3
LK29	1.35*LF1 + 1.5*LF4 + 0.9*LF6	LK79	1.8*LF1 + 0.5*LF2 + LF3 + LF4
LK30	1.35*LF1 + 1.5*LF4 + 1.5*LF5 + 0.9*LF6	LK80	1.8*LF1 + 0.5*LF2 + LF3 + LF4 + LF5
LK31	1.35*LF1 + 1.5*LF5 + 0.9*LF6	LK81	1.8*LF1 + 0.5*LF2 + LF3 + LF5
LK32	1.35*LF1 + 1.5*LF6	LK82	1.8*LF1 + 0.5*LF2 + LF4
LK33	1.35*LF1 + 0.75*LF2 + 1.5*LF6	LK83	1.8*LF1 + 0.5*LF2 + LF4 + LF5
LK34	LF1	LK84	1.8*LF1 + 0.5*LF2 + LF5
LK35	LF1 + LF2	LK85	1.8*LF1 + 0.5*LF2 + LF3 + 0.6*LF6
LK36	LF1 + LF2 + 0.6*LF6	LK86	1.8*LF1 + 0.5*LF2 + LF3 + LF4 + 0.6*LF6
LK37	LF1 + LF3	LK87	1.8*LF1 + 0.5*LF2 + LF3 + LF4 + LF5 + 0.6*LF6
LK38	LF1 + LF3 + LF4	LK88	1.8*LF1 + 0.5*LF2 + LF3 + LF5 + 0.6*LF6
LK39	LF1 + LF3 + LF4 + LF5	LK89	1.8*LF1 + 0.5*LF2 + LF4 + 0.6*LF6
LK40	LF1 + LF3 + LF5	LK90	1.8*LF1 + 0.5*LF2 + LF4 + LF5 + 0.6*LF6
LK41	LF1 + LF4	LK91	1.8*LF1 + 0.5*LF2 + LF5 + 0.6*LF6
LK42	LF1 + LF4 + LF5	LK92	1.8*LF1 + LF3 + 0.6*LF6
LK43	LF1 + LF5	LK93	1.8*LF1 + LF3 + LF4 + 0.6*LF6
LK44	LF1 + 0.5*LF2 + LF3	LK94	1.8*LF1 + LF3 + LF4 + LF5 + 0.6*LF6
LK45	LF1 + 0.5*LF2 + LF3 + LF4	LK95	1.8*LF1 + LF3 + LF5 + 0.6*LF6
LK46	LF1 + 0.5*LF2 + LF3 + LF4 + LF5	LK96	1.8*LF1 + LF4 + 0.6*LF6
LK47	LF1 + 0.5*LF2 + LF3 + LF5	LK97	1.8*LF1 + LF4 + LF5 + 0.6*LF6
LK48	LF1 + 0.5*LF2 + LF4	LK98	1.8*LF1 + LF5 + 0.6*LF6
LK49	LF1 + 0.5*LF2 + LF4 + LF5	LK99	1.8*LF1 + LF6
LK50	LF1 + 0.5*LF2 + LF5	LK100	1.8*LF1 + 0.5*LF2 + LF6

Support reactions

A6.1$_g$	4,90 kN	
B6.1$_g$	8,04 kN	
C6.1$_g$	20,90 kN	
A6.1$_p$	5,44 kN	(uplifting 2,08 kN not considered)
B6.1$_p$	5,46 kN	
C6.1$_p$	12,47 kN	
A6.1$_s$	1,71 kN	
B6.1$_s$	2,74 kN	
C6.1$_s$	7,13 kN	
A6.1$_w$	-0,13 kN	
B6.1$_w$	0,43 kN	
C6.1$_w$	1,41 kN	

Check

System



 # Cross-section 1: 24x22 cm² (bottom chord)

Parameter	Symbol	Value	Unit
Height	h	220	mm
Width	b	240	mm
Area	A	52800	mm²
Area moment of inertia	I	212960000	mm^4
Modulus of section	W	1936000	mm³
Radius of inertia	i_y	63,58	mm
Radius of inertia	i_z	69,36	mm

 # Cross-section 2: 24x10 cm² (web members)

Parameter	Symbol	Value	Unit
Height	h	100	mm
Width	b	240	mm
Area	A	24000	mm²
Area moment of inertia	I	20000000	mm^4
Modulus of section	W	400000	mm³
Radius of inertia	i_y	28,9	mm
Radius of inertia	i_z	69,36	mm

 # Cross-section 3: 24x24 cm² (top cord)

Parameter	Symbol	Value	Unit
Height	h	240	mm
Width	b	240	mm
Area	A	57600	mm²
Area moment of inertia	I	276480000	mm^4
Modulus of section	W	2304000	mm³
Radius of inertia	i_y	69,36	mm
Radius of inertia	i_z	69,36	mm

 # Material: C24

Parameter	Symbol	Value	Unit
Characteristic tensile strength	$f_{t,0,k}$	14	N/mm²
Characteristic compressive strength	$f_{c,0,k}$	21	N/mm²
Characteristic compressive strength perpendicular	$f_{c,90,k}$	2,5	N/mm²
Characteristic bending strength	$f_{m,0,k}$	24	N/mm²
Characteristic shear strength	$f_{v,k}$	4	N/mm²
Modulus of elasticity (Fifth percentile)	$E_{0.05}$	7400	N/mm²
Crack coefficient	k_{cr}	0,5	-
Effective area 1	$A_{eff,1}$	26400	mm²
Effective area 2	$A_{eff,2}$	12000	mm²
Effective area 3	$A_{eff,3}$	28800	mm²

Cross-section 1

Ultimate Limit State - Load cases with load duration class short-term

Design of cross-sections subjected to stress in one principal direction - **max abs M**

Load case combination	**LK 20**
Slab No.	**8**
x [m]	**0**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	0,35	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	-9,75	kNm
Design value of shear force	V_{Ed}	12,76	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Short-term	
Modification factor	k_{mod}	0,9	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,01	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	5,04	N/mm²
Design shear stress	τ_d	0,73	N/mm²
Design tensile strength	$f_{t,0,d}$	9,69	N/mm²
Design compressive strength	$f_{c,0,d}$	14,54	N/mm²
Design bending strength	$f_{m,0,d}$	16,62	N/mm²
Design shear strength	$f_{v,d}$	2,77	N/mm²

Checks according to DIN EN 1995-1-1 Eqns. (6.13),(6.17) and (6.19):

Flexural stress ratio with tension	$\eta_{flexural}$	**30%**
Flexural stress ratio with compression	$\eta_{flexural}$	**30%**
Shear stress ratio	η_{shear}	**26%**

Ultimate Limit State - Load cases with load duration class short-term

Design of cross-sections subjected to stress in one principal direction - **max N** (tension)

Load case combination	**LK 12**
Slab No.	**1**
x [m]	**0,000**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	4,23	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	0,00	kNm
Design value of shear force	V_{Ed}	1,27	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Short-term	
Modification factor	k_{mod}	0,9	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,08	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	0,00	N/mm²
Design shear stress	τ_d	0,07	N/mm²
Design tensile strength	$f_{t,0,d}$	9,69	N/mm²
Design compressive strength	$f_{c,0,d}$	14,54	N/mm²
Design bending strength	$f_{m,0,d}$	16,62	N/mm²
Design shear strength	$f_{v,d}$	2,77	N/mm²

Checks according to DIN EN 1995-1-1 Eqns. (6.13),(6.17) and (6.19):

Flexural stress ratio with tension	$\eta_{flexural}$	**1%**
Flexural stress ratio with compression	$\eta_{flexural}$	**0%**
Shear stress ratio	η_{shear}	**3%**

Ultimate Limit State - Load cases with load duration class short-term

Design of cross-sections subjected to stress in one principal direction - **max abs V**

Load case combination	**LK 20**
Slab No.	**8**
x [m]	**0,000**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	0,35	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	-9,75	kNm
Design value of shear force	V_{Ed}	12,76	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Short-term	
Modification factor	k_{mod}	0,9	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,01	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	5,04	N/mm²
Design shear stress	τ_d	0,73	N/mm²
Design tensile strength	$f_{t,0,d}$	9,69	N/mm²
Design compressive strength	$f_{c,0,d}$	14,54	N/mm²
Design bending strength	$f_{m,0,d}$	16,62	N/mm²
Design shear strength	$f_{v,d}$	2,77	N/mm²

Checks according to DIN EN 1995-1-1 Eqns. (6.13),(6.17) and (6.19):

Flexural stress ratio with tension	$\eta_{flexural}$	**30%**
Flexural stress ratio with compression	$\eta_{flexural}$	**30%**
Shear stress ratio	η_{shear}	**26%**

Ultimate Limit State - Load cases with load duration class permanent

Design of cross-sections subjected to stress in one principal direction - **max abs M**

Load case combination	**LK1**
Slab No.	**8**
x [m]	**0,000**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	0,49	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	-4,92	kNm
Design value of shear force	V_{Ed}	6,46	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Permanent	
Modification factor	k_{mod}	0,6	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,01	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	2,54	N/mm²
Design shear stress	τ_d	0,37	N/mm²
Design tensile strength	$f_{t,0,d}$	6,46	N/mm²
Design compressive strength	$f_{c,0,d}$	9,69	N/mm²
Design bending strength	$f_{m,0,d}$	11,08	N/mm²
Design shear strength	$f_{v,d}$	1,85	N/mm²

Checks according to DIN EN 1995-1-1 Eqns. (6.13),(6.17) and (6.19):

Flexural stress ratio with tension	$\eta_{flexural}$	**23%**
Flexural stress ratio with compression	$\eta_{flexural}$	**23%**
Shear stress ratio	η_{shear}	**20%**

Ultimate Limit State - Load cases with load duration class permanent

Design of cross-sections subjected to stress in one principal direction - **max N**

Load case combination	**LK1**
Slab No.	**1**
x [m]	**0,000**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	0,78	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	0,00	kNm
Design value of shear force	V_{Ed}	0,82	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Permanent	
Modification factor	k_{mod}	0,6	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,01	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	0,00	N/mm²
Design shear stress	τ_d	0,05	N/mm²
Design tensile strength	$f_{t,0,d}$	6,46	N/mm²
Design compressive strength	$f_{c,0,d}$	9,69	N/mm²
Design bending strength	$f_{m,0,d}$	11,08	N/mm²
Design shear strength	$f_{v,d}$	1,85	N/mm²

Checks according to DIN EN 1995-1-1 Eqns. (6.13),(6.17) and (6.19):

Flexural stress ratio with tension	$\eta_{flexural}$	**0%**
Flexural stress ratio with compression	$\eta_{flexural}$	**0%**
Shear stress ratio	η_{shear}	**3%**

Ultimate Limit State - Load cases with load duration class permanent

Design of cross-sections subjected to stress in one principal direction - **max abs V**

Load case combination	**LK1**
Slab No.	**8**
x [m]	**0,000**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	0,00	kN
Design value of compressive force	$N_{Ed,c}$	0,49	kN
Design value of bending moment	$M_{y,Ed}$	-4,92	kNm
Design value of shear force	V_{Ed}	6,46	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Permanent	
Modification factor	k_{mod}	0,6	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,00	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,01	N/mm²
Design bending stress	$\sigma_{m,0,d}$	2,54	N/mm²
Design shear stress	τ_d	0,37	N/mm²
Design tensile strength	$f_{t,0,d}$	6,46	N/mm²
Design compressive strength	$f_{c,0,d}$	9,69	N/mm²
Design bending strength	$f_{m,0,d}$	11,08	N/mm²
Design shear strength	$f_{v,d}$	1,85	N/mm²

Checks according to DIN EN 1995-1-1 Eqns. (6.13),(6.17) and (6.19):

Flexural stress ratio with tension	$\eta_{flexural}$	**23%**
Flexural stress ratio with compression	$\eta_{flexural}$	**23%**
Shear stress ratio	η_{shear}	**20%**

Cross-section 2

Ultimate Limit State - Load cases with load duration class short-term

Stability of members - Columns subjected to compression

Design of cross-sections subjected to stress perpendicular to the grain

Load case combination	**LK 23**
Slab No.	**6**
x [m]	**1,056**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of compressive force	$N_{Ed,c}$	-35,70	kN
Design value of bending moment	$M_{y,Ed}$	0,00	kNm
Design value of shear force	V_{Ed}	0,00	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Short-term	
Modification factor	k_{mod}	0,9	-
Factor for compression perpendicular	$k_{c,90}$	1,0	-

 # Buckling Euler-Case I

Parameter	Symbol	Value	Unit
	β	1	-
	l_{ef}	1056	mm
	λ_y	36,540	-
	$\lambda_{rel,c}$	0,620	-
	β_c	0,200	-
	k	0,724	-
	k_c	0,911	-

 # Check

Parameter	Symbol	Value	Unit
Design compressive stress parallel to the grain	$\sigma_{c,0,d}$	1,49	N/mm²
Design compressive strength parallel to the grain	$f_{c,0,d}$	14,54	N/mm²
Design compressive stress perp. to the grain	$\sigma_{c,90,d}$	1,49	N/mm²
Design compressive strength perp. to the grain	$f_{c,90,d}$	1,73	N/mm²
Parallel stress ratio	$\eta_{Stability}$	**11%**	
Perpendicular stress ratio	$\eta_{c,90}$	**86%**	

Ultimate Limit State - Load cases with load duration class permanent

Stability of members - Columns subjected to compression

Load case combination	**LK1**
Slab No.	**6**
x [m]	**1,056**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of compressive force	$N_{Ed,c}$	-17,82	kN
Design value of bending moment	$M_{y,Ed}$	0,00	kNm
Design value of shear force	V_{Ed}	0,00	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Permanent	
Modification factor	k_{mod}	0,6	-
Factor for compression perpendicular	$k_{c,90}$	1,0	

 # Buckling Euler-Case I

Parameter	Symbol	Value	Unit
	β	1	-
	l_{ef}	1056	mm
	λ_y	36,540	-
	$\lambda_{rel,c}$	0,620	-
	β_c	0,200	-
	k	0,724	-
	k_c	0,911	-

 # Check

Parameter	Symbol	Value	Unit
Design compressive stress parallel to the grain	$\sigma_{c,0,d}$	0,74	N/mm²
Design compressive strength parallel to the grain	$f_{c,0,d}$	9,69	N/mm²
Design compressive stress perp. to the grain	$\sigma_{c,90,d}$	0,74	N/mm²
Design compressive strength perp. to the grain	$f_{c,90,d}$	1,15	N/mm²
Stress ratio	$\eta_{Stability}$	**8%**	
Perpendicular stress ratio	$\eta_{c,90}$	**64%**	

Cross-section 3

Ultimate Limit State - Load cases with load duration class short-term

Design of cross-sections subjected to stress in one principal direction - **max abs M**

Load case combination	**LK 23**
Slab No.	**11**
x [m]	**1,544**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	2,05	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	14,13	kNm
Design value of shear force	V_{Ed}	0,90	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Short-term	
Modification factor	k_{mod}	0,9	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,04	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	6,13	N/mm²
Design shear stress	τ_d	0,05	N/mm²
Design tensile strength	$f_{t,0,d}$	9,69	N/mm²
Design compressive strength	$f_{c,0,d}$	14,54	N/mm²
Design bending strength	$f_{m,0,d}$	16,62	N/mm²
Design shear strength	$f_{v,d}$	2,77	N/mm²

Checks according to DIN EN 1995-1-1 Eqns. (6.13),(6.17) and (6.19):

Flexural stress ratio with tension	$\eta_{flexural}$	**37%**
Flexural stress ratio with compression	$\eta_{flexural}$	**37%**
Shear stress ratio	η_{shear}	**2%**

Ultimate Limit State - Load cases with load duration class short-term

Design of cross-sections subjected to stress in one principal direction - **max N** (tension)

Load case combination	**LK 24**
Slab No.	**2**
x [m]	**0,000**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	7,61	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	0,00	kNm
Design value of shear force	V_{Ed}	3,76	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Short-term	
Modification factor	k_{mod}	0,9	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,13	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	0,00	N/mm²
Design shear stress	τ_d	0,20	N/mm²
Design tensile strength	$f_{t,0,d}$	9,69	N/mm²
Design compressive strength	$f_{c,0,d}$	14,54	N/mm²
Design bending strength	$f_{m,0,d}$	16,62	N/mm²
Design shear strength	$f_{v,d}$	2,77	N/mm²

Checks according to DIN EN 1995-1-1 Eqns. (6.13),(6.17) and (6.19):

Flexural stress ratio with tension	$\eta_{flexural}$	**1%**
Flexural stress ratio with compression	$\eta_{flexural}$	**0%**
Shear stress ratio	η_{shear}	**7%**

Ultimate Limit State - Load cases with load duration class short-term

Design of cross-sections subjected to stress in one principal direction - **max abs V**

Load case combination	**LK 23**
Slab No.	**7**
x [m]	**1,584**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	6,23	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	-12,51	kNm
Design value of shear force	V_{Ed}	-18,15	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Short-term	
Modification factor	k_{mod}	0,9	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,11	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	5,43	N/mm²
Design shear stress	τ_d	0,95	N/mm²
Design tensile strength	$f_{t,0,d}$	9,69	N/mm²
Design compressive strength	$f_{c,0,d}$	14,54	N/mm²
Design bending strength	$f_{m,0,d}$	16,62	N/mm²
Design shear strength	$f_{v,d}$	2,77	N/mm²

Checks according to DIN EN 1995-1-1 Eqns. (6.13),(6.17) and (6.19):

Flexural stress ratio with tension	$\eta_{flexural}$	**34%**
Flexural stress ratio with compression	$\eta_{flexural}$	**33%**
Shear stress ratio	η_{shear}	**34%**

Ultimate Limit State - Load cases with load duration class permanent

Design of cross-sections subjected to stress in one principal direction - **max abs M**

Load case combination	**LK1**
Slab No.	**11**
x [m]	**1,544**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	-0,61	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	6,97	kNm
Design value of shear force	V_{Ed}	0,48	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Permanent	
Modification factor	k_{mod}	0,6	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,01	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	3,03	N/mm²
Design shear stress	τ_d	0,03	N/mm²
Design tensile strength	$f_{t,0,d}$	6,46	N/mm²
Design compressive strength	$f_{c,0,d}$	9,69	N/mm²
Design bending strength	$f_{m,0,d}$	11,08	N/mm²
Design shear strength	$f_{v,d}$	1,85	N/mm²

Checks according to DIN EN 1995-1-1 Eqns. (6.13),(6.17) and (6.19):

Flexural stress ratio with tension	$\eta_{flexural}$	**27%**
Flexural stress ratio with compression	$\eta_{flexural}$	**27%**
Shear stress ratio	η_{shear}	**1%**

Ultimate Limit State - Load cases with load duration class permanent

Design of cross-sections subjected to stress in one principal direction - **min N**

Load case combination	**LK1**
Slab No.	**2**
x [m]	**0,000**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	0,00	kN
Design value of compressive force	$N_{Ed,c}$	-4,90	kN
Design value of bending moment	$M_{y,Ed}$	0,00	kNm
Design value of shear force	V_{Ed}	-3,19	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Permanent	
Modification factor	k_{mod}	0,6	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,00	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,09	N/mm²
Design bending stress	$\sigma_{m,0,d}$	0,00	N/mm²
Design shear stress	τ_d	0,17	N/mm²
Design tensile strength	$f_{t,0,d}$	6,46	N/mm²
Design compressive strength	$f_{c,0,d}$	9,69	N/mm²
Design bending strength	$f_{m,0,d}$	11,08	N/mm²
Design shear strength	$f_{v,d}$	1,85	N/mm²

Checks according to DIN EN 1995-1-1 Eqns. (6.13),(6.17) and (6.19):

Flexural stress ratio with tension	$\eta_{flexural}$	**0%**
Flexural stress ratio with compression	$\eta_{flexural}$	**0%**
Shear stress ratio	η_{shear}	**9%**

Ultimate Limit State - Load cases with load duration class permanent

Design of cross-sections subjected to stress in one principal direction - **max abs V**

Load case combination	**LK1**
Slab No.	**7**
x [m]	**1,584**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	1,58	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	-6,29	kNm
Design value of shear force	V_{Ed}	-9,06	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Permanent	
Modification factor	k_{mod}	0,6	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,03	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	2,73	N/mm²
Design shear stress	τ_d	0,47	N/mm²
Design tensile strength	$f_{t,0,d}$	6,46	N/mm²
Design compressive strength	$f_{c,0,d}$	9,69	N/mm²
Design bending strength	$f_{m,0,d}$	11,08	N/mm²
Design shear strength	$f_{v,d}$	1,85	N/mm²

Checks according to DIN EN 1995-1-1 Eqns. (6.13),(6.17) and (6.19):

Flexural stress ratio with tension	$\eta_{flexural}$	**25%**
Flexural stress ratio with compression	$\eta_{flexural}$	**25%**
Shear stress ratio	η_{shear}	**26%**

Serviceability State

Limiting values for deflections of beams

note: only cross-section 3 covered, since other elements do not show critical deflections

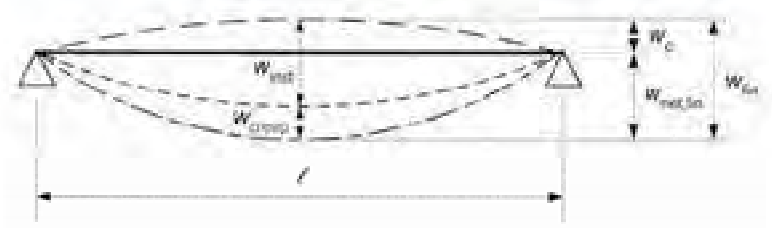


Figure 7.1 – Components of deflection

 # Deflections

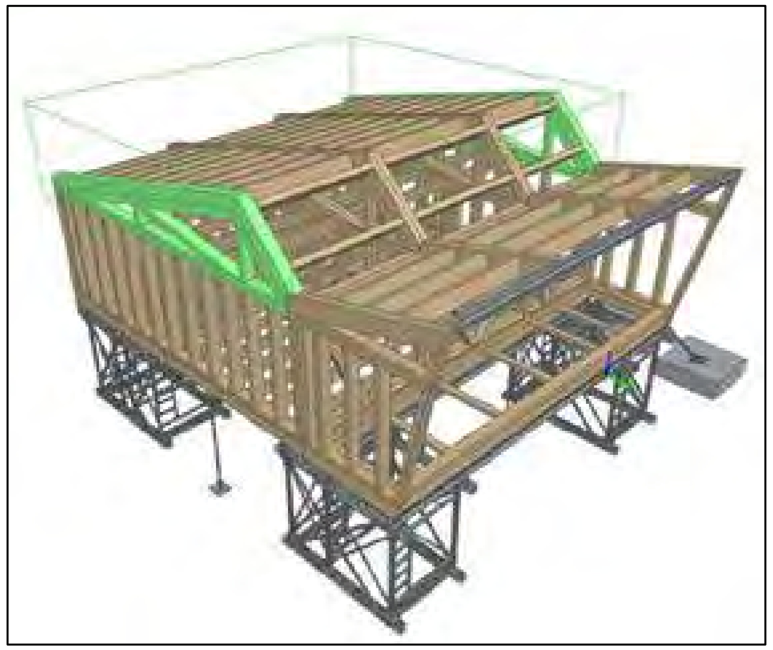
Parameter	Symbol	Value	Unit
Precamber	w_c	0,0	mm
Instantaneous deflection (self-weight)	$w_{inst,G}$	3,1	mm
Slab No.		11	
x		2,1620	m
Instantaneous deflection (snow)	$w_{inst,S}$	*not relevant (ψ_2 =0,0)*	
Instantaneous deflection (imposed load)	$w_{inst,Q}$	*not relevant (ψ_2 =0,0)*	
Deformation factor (NKL 1)	k_{def}	0,6	
ψ_2 (snow)	$\psi_{2,s}$	0	
ψ_2 (imposed loads, Kat. H: roofs)	$\psi_{2,Q}$	0	
Net final deflection	$w_{net,fin}$	5,0	mm

 # Check

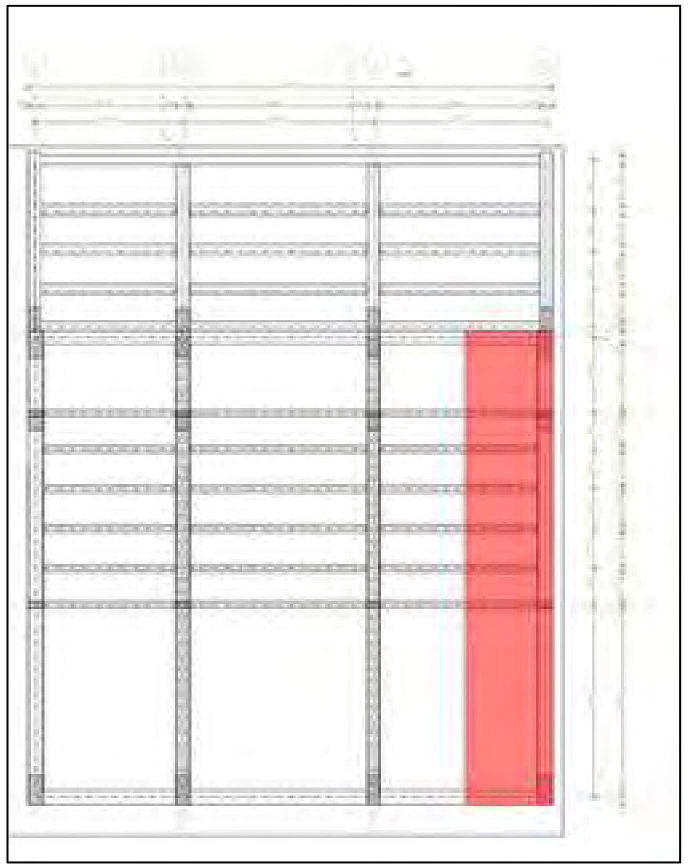
Parameter	Symbol	Value	Unit
Length	l	3088	mm
Limiting value of deflection	l/350	8,8	mm
Deflection ratio	$\eta_{deflection}$	**56%**	

Pos 6.2 – Exterior Roof Truss

Overview



Load application area

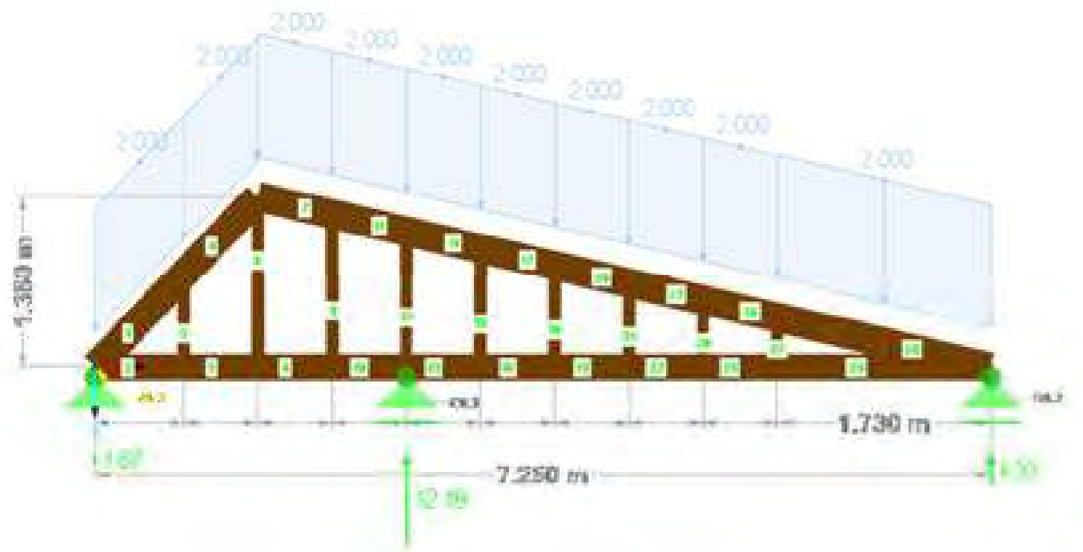


Loads

Dead loads

		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
dead loads roof living modules	g_{RL}	1,25	1,47	1,84
dead load 16cm beam increase	g_{l}			0,16
				2,00

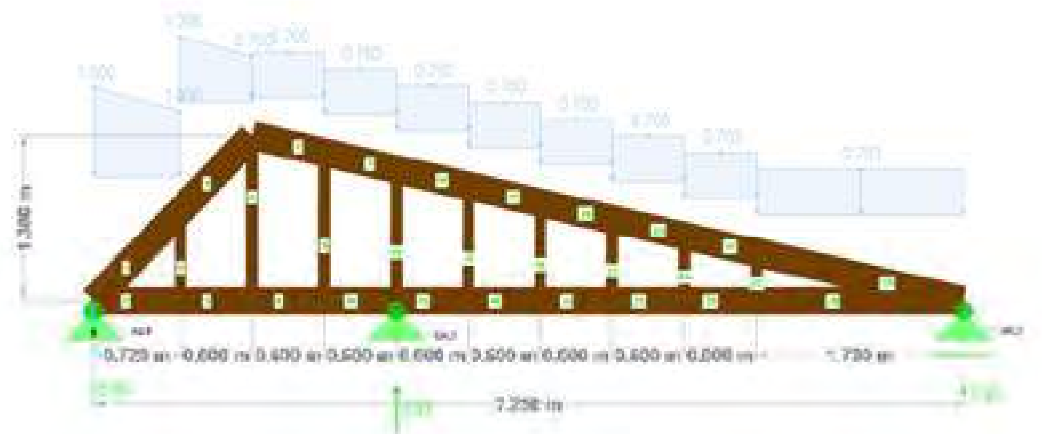
Load case 1 (LF1):



Snow loads

		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
snow load roof MIN	s_{Rmin}	0,52	1,47	0,76
snow load roof MAX	s_{Rmax}	1,02	1,47	1,50

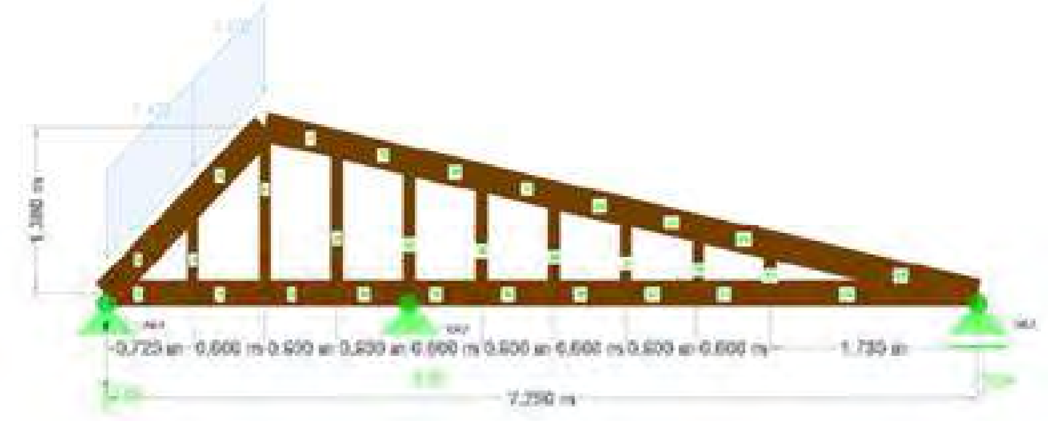
Load case 2 (LF2):



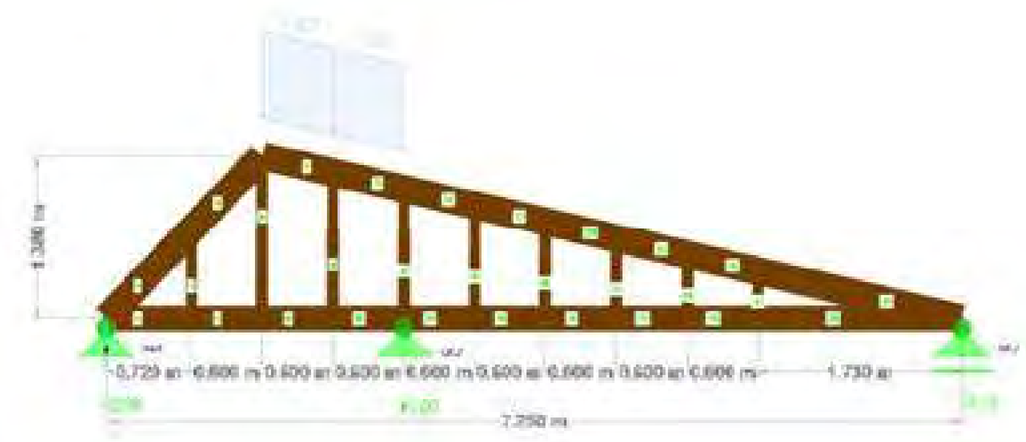
Live loads

		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
live load roof	p_R	1	1,47	1,47

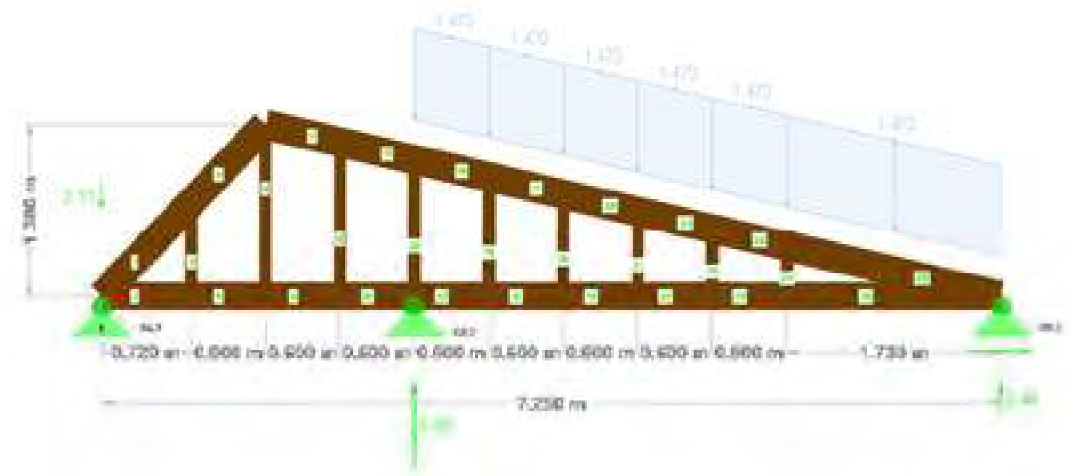
Load case 3 (LF3):



Load case 4 (LF4):

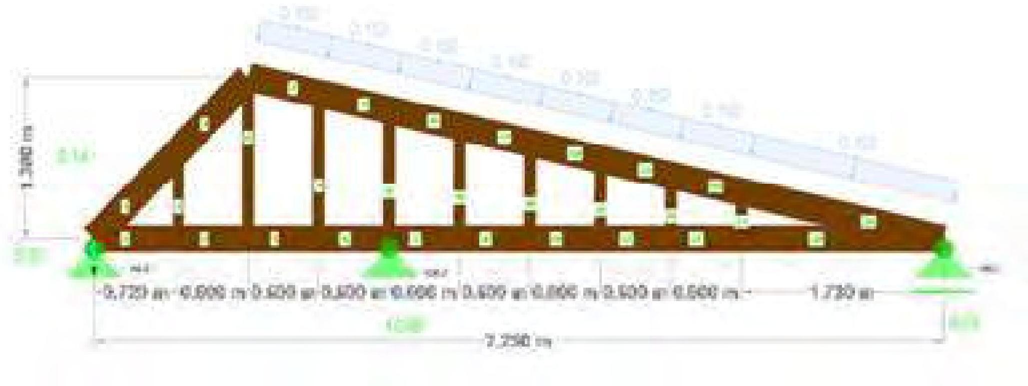


Load case 5 (LF5):



Wind actions		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
wind actions	w_R	0,1	1,47	0,15

Load case 6 (LF6):



Support reactions

A6.2$_g$	1,67 kN	
B6.2$_g$	4,32 kN	
C6.2$_g$	12,18 kN	
A6.2$_p$	3,21 kN	(uplifting 2,11 kN not considered)
B6.2$_p$	2,82 kN	
C6.2$_p$	7,82 kN	
A6.2$_s$	0,65 kN	
B6.2$_s$	1,42 kN	
C6.2$_s$	3,93 kN	
A6.2$_w$	-0,14 kN	
B6.2$_w$	0,23 kN	
C6.2$_w$	0,80 kN	

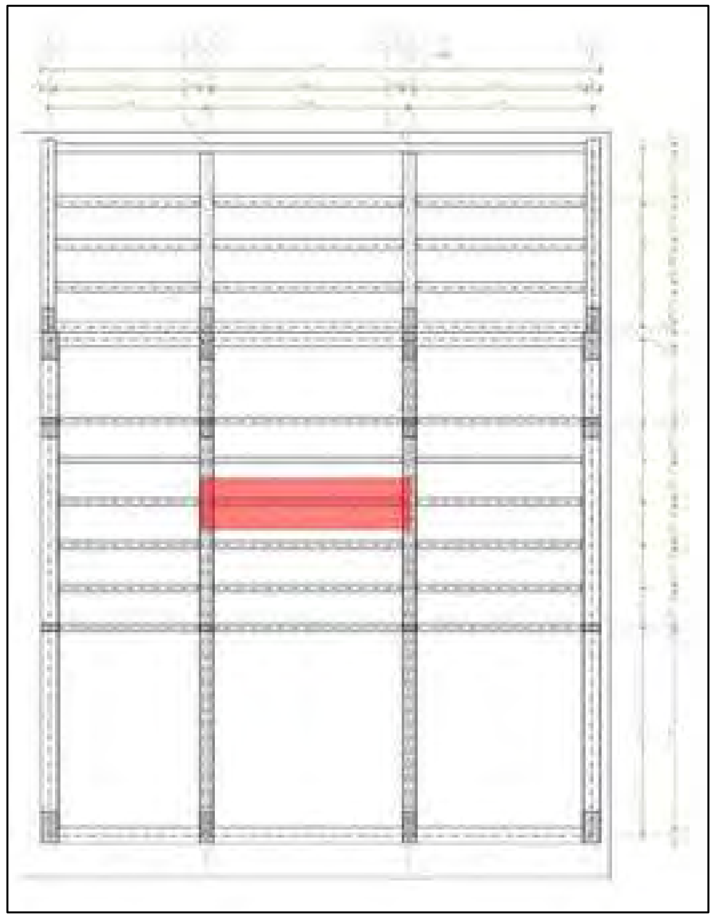
Check

Pos 6.2 has a smaller load application width as Pos. 6.1 and has also more web members for stabilisation, thus no additional check for Pos. 6.2 is conducted.

Pos 7.0 – Floor Beams

Overview

Load application area

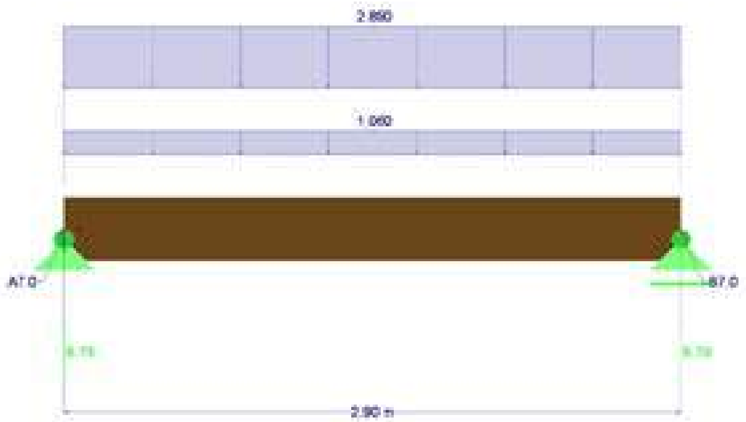


Loads

Dead loads		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
dead floor living modules	g_{FL}	1,70	0,625	1,06
dead load machines technical core	g_M	4,62	0,625	2,89

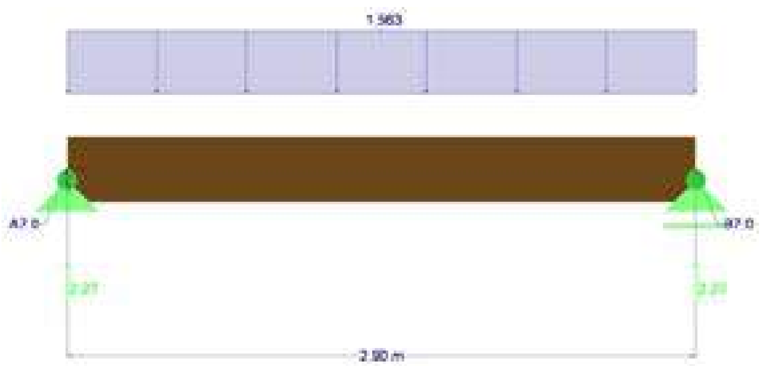
dead load of the member disabled in RSTAB, since already considered in floor construction

Load case 1 (LF1):



Live loads		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
live load living module	p_L	2,5	0,625	1,563

Load case 2 (LF2):

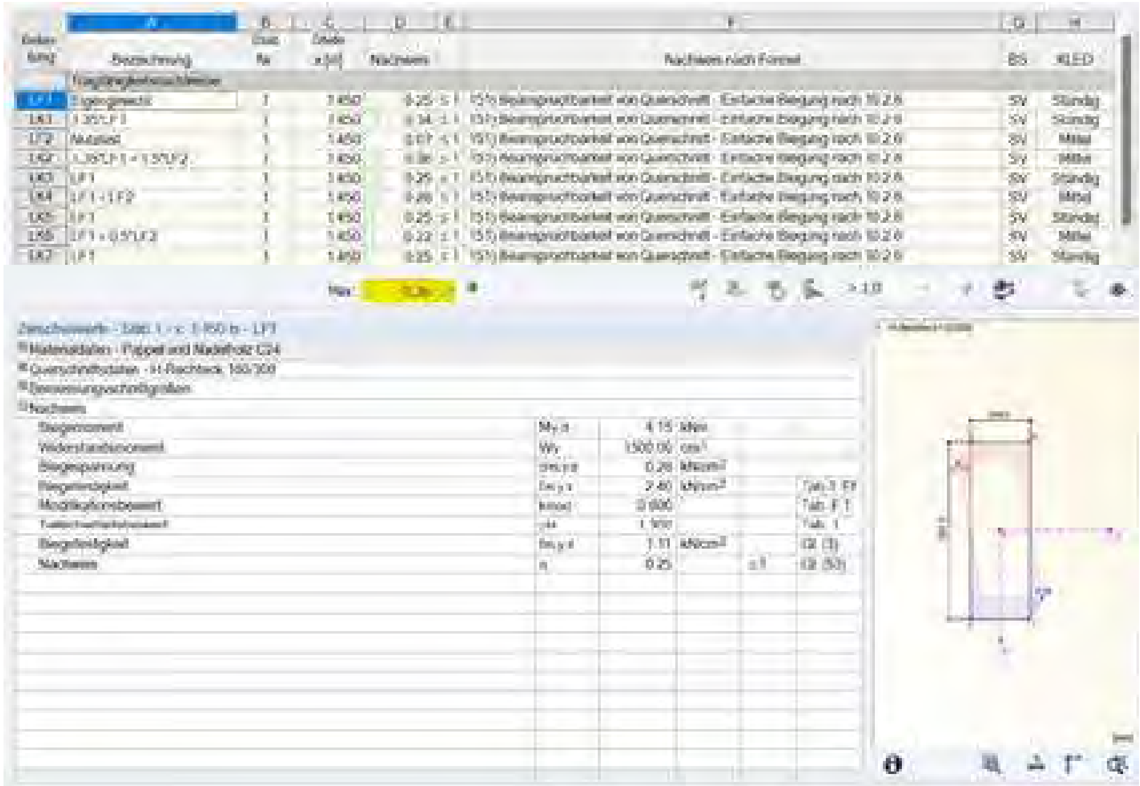


Support reactions

A7.0$_g$	5,73 kN
B7.0$_g$	5,73 kN
A7.0$_p$	2,27 kN
B7.0$_p$	2,27 kN

Check

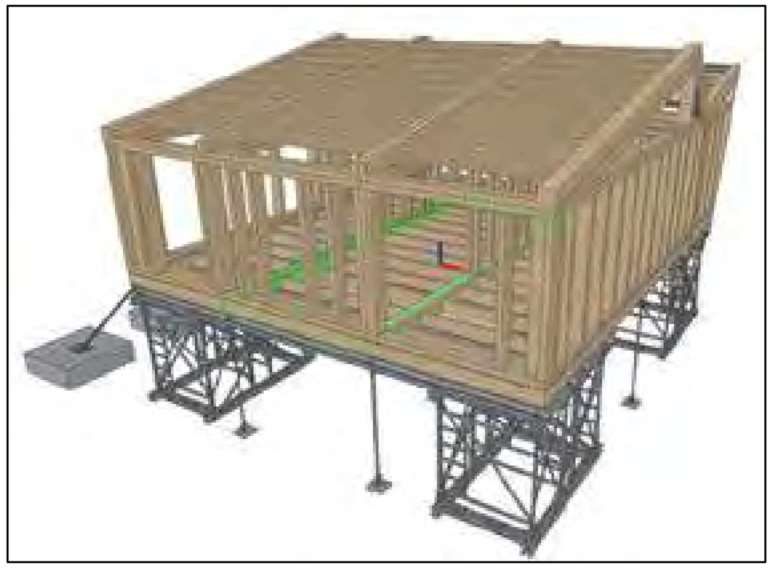
Since the members of position 7.0 are arranged in a close grid, their load application width is relatively small and thus is exposed to low stress. Therefore, a detailed check is not required. The checks according to Eurocode 5 are conducted in RSTAB and are presented below.



Pos 7.1 – Interior Beam (Interior Module)

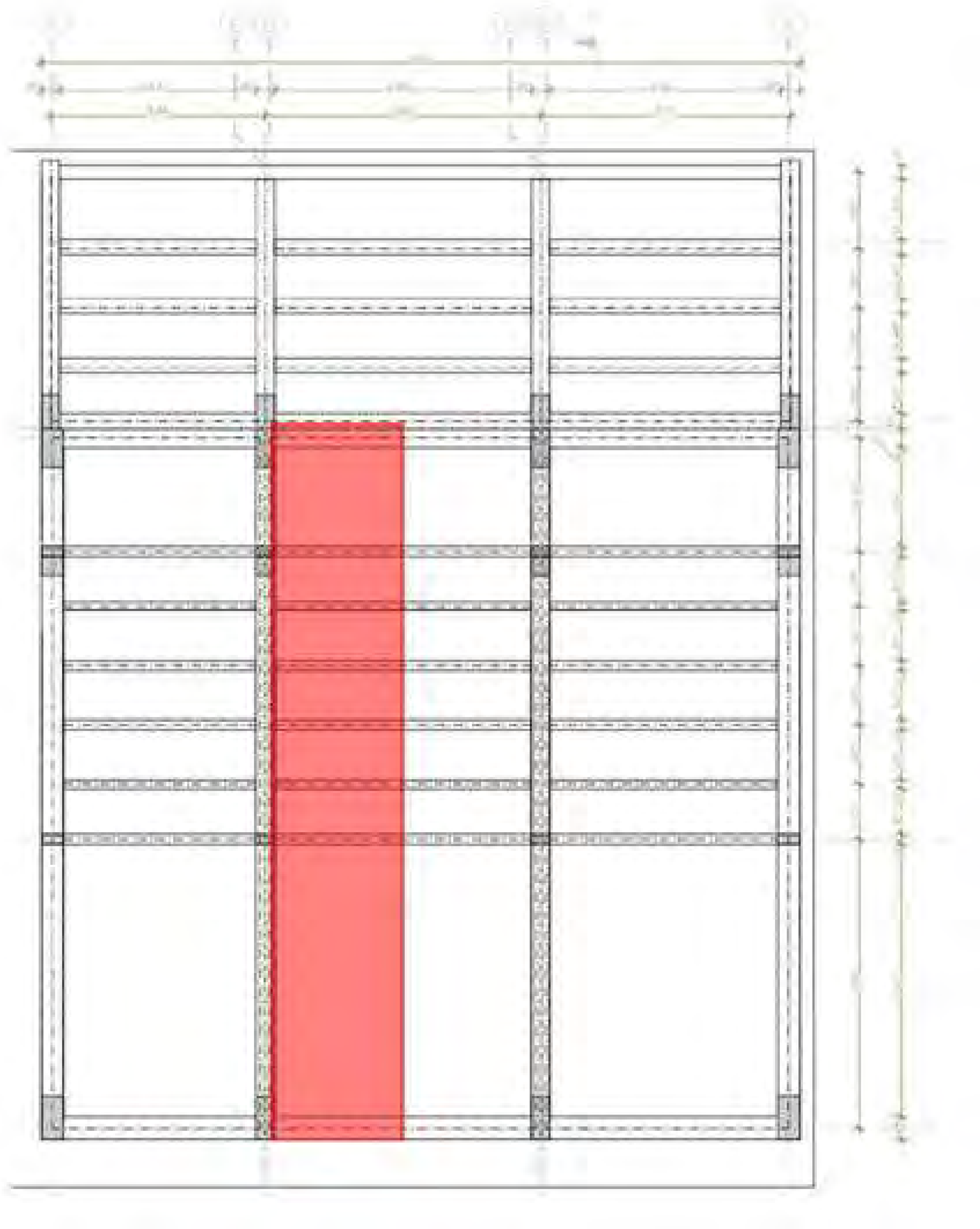
It must be paid attention, that pos 7.1 and pos 7.2 are separated, although they are connected to each other to form a unified beam after the final assembly of the HDU. However pos 7.1 must carry the unusually high dead loads of the machines in the technical core. Thus, it also needs to function as an individual member (cross-section w/h =10x24 cm²).

Overview



The loads of position 4.1 are passed through the beam. They have no influence on the internal forces of the beam and become relevant only for the support reactions. For this reason, the load cases live load (roof), snow load and wind actions are mentioned, but not part of the load case combinations. These forces are important for the check of compression perpendicular to the grain.

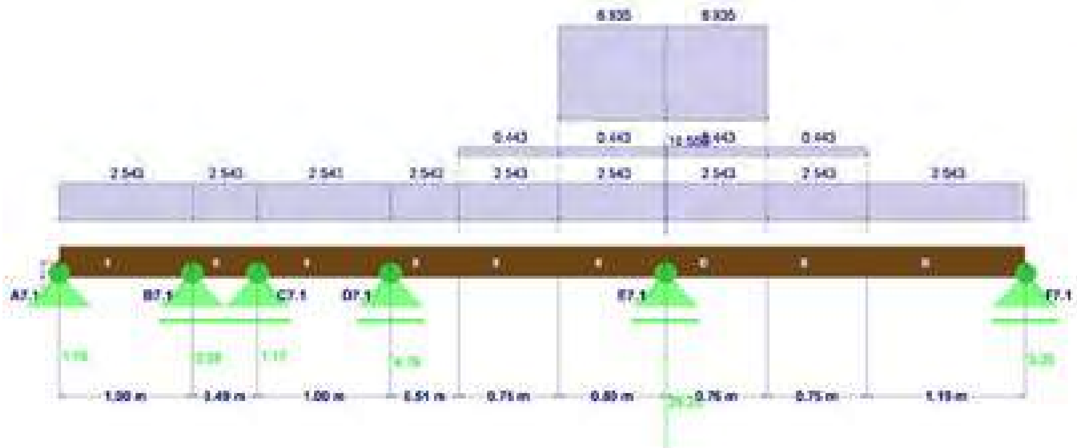
Load application area



Loads

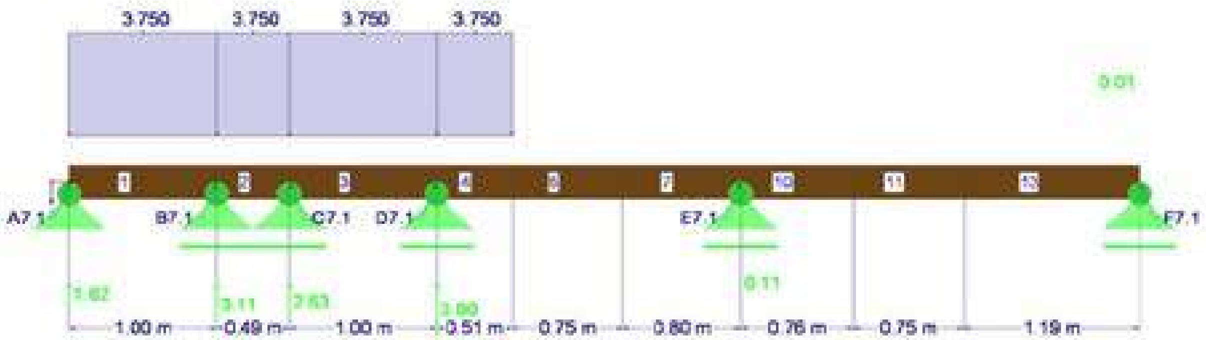
Dead loads		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
dead load floor living module	g_{FL}	1,70	1,5	2,54
dead load wall 1(technical core)	g_{WT}			0,44
dead load 6cm beam increase	g_{I}			0,03
dead load machines technical core	g_{M}	4,62	1,5	6,93
support reaction 4.1 Interior Column	$A4.1_g$			10,55

Load case 1 (LF1):

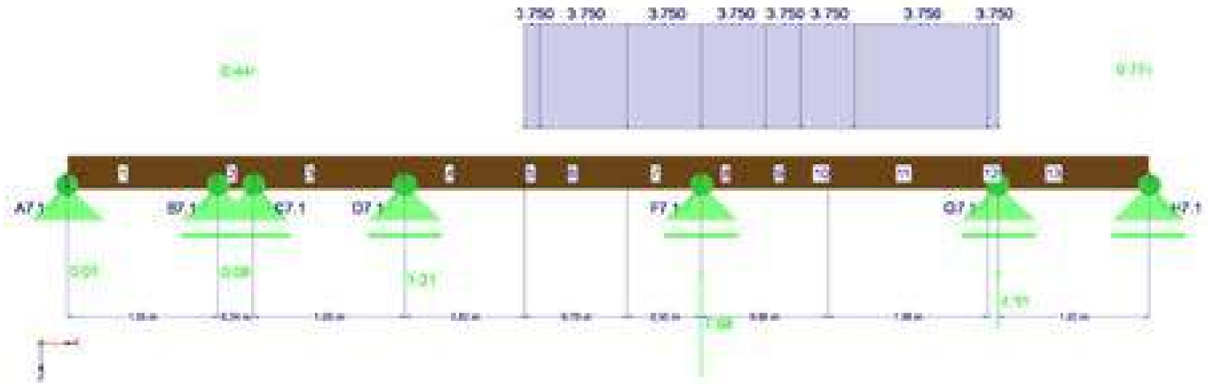


Live loads		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
live load living module	p_L	2,5	1,5	3,75
support reaction 4.1 Interior Column	$A4.1_p$			6,24

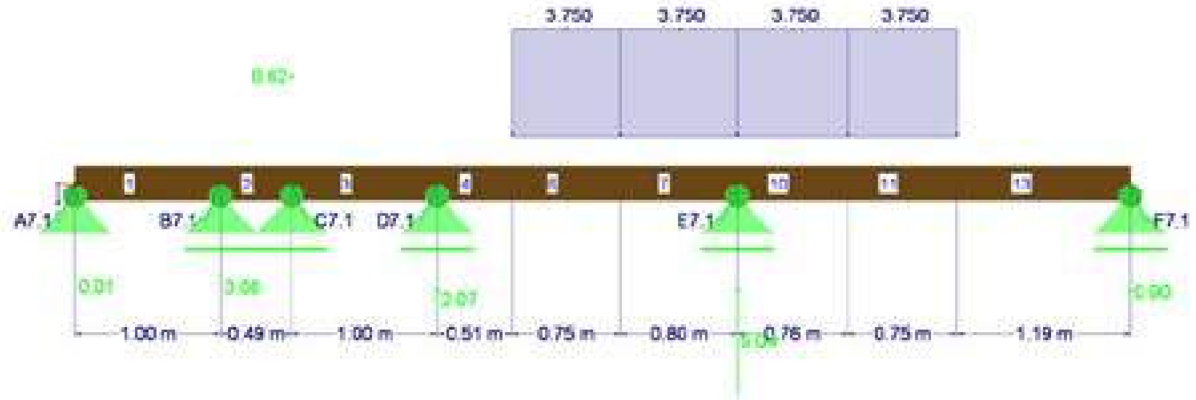
Load case 3 (LF3):



Load case 4 (LF4):



Load case 5 (LF5):



Snow loads				point load [kN]
support reaction 4.1 Interior Column	$A4.1_s$			3,57

Wind actions				point load [kN]
support reaction 4.1 Interior Column	$A4.1_w$			0,71

Load case combinations

LK1	1.35*LF1
LK2	1.35*LF1 + 1.5*LF2
LK3	1.35*LF1 + 1.5*LF2 + 1.5*LF3
LK4	1.35*LF1 + 1.5*LF2 + 1.5*LF3 + 1.5*LF4
LK5	1.35*LF1 + 1.5*LF2 + 1.5*LF4
LK6	1.35*LF1 + 1.5*LF3
LK7	1.35*LF1 + 1.5*LF3 + 1.5*LF4
LK8	1.35*LF1 + 1.5*LF4

Support reactions

$A7.1_g$	1,15 kN	
$B7.1_g$	2,28 kN	
$C7.1_g$	1,17 kN	
$D7.1_g$	4,79 kN	
$E7.1_g$	29,25 kN	
$F7.1_g$	3,25 kN	
		uplifting:
$A7.1_p$	1,63 kN	
$B7.1_p$	3,19 kN	-0,03 kN
$C7.1_p$	2,85 kN	-0,62 kN
$D7.1_p$	5,87 kN	-0,61 kN
$E7.1_p$	10,8 kN	
$F7.1_p$	4,13 kN	-0,01 kN
$E7.1_p$ (roof)	6,24 kN	
$E7.1_s$	3,57 kN	
$E7.1_w$	0,71 kN	

Check

System

Cross-section: 10x24 cm²

Parameter	Symbol	Value	Unit
Height	h	240	mm
Width	b	100	mm
Area	A	24000	mm^2
Area moment of inertia	I	115200000	mm^4
Modulus of section	W	960000	mm^3
Radius of inertia	i_y	69,36	mm
Radius of inertia	i_z	28,9	mm

Material: C24

Parameter	Symbol	Value	Unit
Characteristic tensile strength	$f_{t,0,k}$	14	N/mm^2
Characteristic compressive strength	$f_{c,0,k}$	21	N/mm^2
Characteristic bending strength	$f_{m,0,k}$	24	N/mm^2
Characteristic shear strength	$f_{v,k}$	4	N/mm^2
Modulus of elasticity (Fifth percentile)	$E_{0,05}$	7400	N/mm^2
Crack coefficient	k_{cr}	0,5	-
Effective area	A_{eff}	12000	mm^2

Ultimate Limit State - Load cases with load duration class medium-term
Design of cross-sections subjected to stress in one principal direction - **max abs M**

Load case combination	**LK 4**
Slab No.	**10**
x [m]	**0,00**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	0,09	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	-8,37	kNm
Design value of shear force	V_{Ed}	22,27	kN
Design value of reduced shear force	$V_{ed, red}$	17,68	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Medium-term	
Modification factor	k_{mod}	0,8	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,00	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	8,72	N/mm²
Design shear stress	τ_d	2,21	N/mm²
Design tensile strength	$f_{t,0,d}$	8,62	N/mm²
Design compressive strength	$f_{c,0,d}$	12,92	N/mm²
Design bending strength	$f_{m,0,d}$	14,77	N/mm²
Design shear strength	$f_{v,d}$	2,46	N/mm²

Flexural stress ratio with tension	$\eta_{flexural}$	**59%**
Flexural stress ratio with compression	$\eta_{flexural}$	**59%**
Shear stress ratio	η_{shear}	**90%**

Ultimate Limit State - Load cases with load duration class medium-term
Design of cross-sections subjected to stress in one principal direction - **max abs V**

Load case combination	**LK 4**
Slab No.	**10**
x [m]	**0,00**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	0,09	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	-8,37	kNm
Design value of shear force	V_{Ed}	22,27	kN
Design value of reduced shear force	$V_{ed, red}$	17,68	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Medium-term	
Modification factor	k_{mod}	0,8	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,00	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	8,72	N/mm²
Design shear stress	$\tau_{d, red}$	2,21	N/mm²
Design tensile strength	$f_{t,0,d}$	8,62	N/mm²
Design compressive strength	$f_{c,0,d}$	12,92	N/mm²
Design bending strength	$f_{m,0,d}$	14,77	N/mm²
Design shear strength	$f_{v,d}$	2,46	N/mm²

Flexural stress ratio with tension	$\eta_{flexural}$	**59%**
Flexural stress ratio with compression	$\eta_{flexural}$	**59%**
Shear stress ratio	η_{shear}	**90%**

Ultimate Limit State - Load cases with load duration class permanent
Design of cross-sections subjected to stress in one principal direction - **max abs M**

Load case combination	**LK1**
Slab No.	**10**
x [m]	**0,00**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	0,00	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	-4,54	kNm
Design value of shear force	V_{Ed}	13,26	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Permanent	
Modification factor	k_{mod}	0,6	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,00	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	4,73	N/mm²
Design shear stress	τ_d	1,66	N/mm²
Design tensile strength	$f_{t,0,d}$	6,46	N/mm²
Design compressive strength	$f_{c,0,d}$	9,69	N/mm²
Design bending strength	$f_{m,0,d}$	14,77	N/mm²
Design shear strength	$f_{v,d}$	1,85	N/mm²
Flexural stress ratio with tension	$\eta_{flexural}$	**32%**	
Flexural stress ratio with compression	$\eta_{flexural}$	**32%**	
Shear stress ratio	η_{shear}	**90%**	

Ultimate Limit State - Load cases with load duration class permanent
Design of cross-sections subjected to stress in one principal direction - **max abs V**

Load case combination	**LK1**
Slab No.	**10**
x [m]	**0,00**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	0,03	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	-4,54	kNm
Design value of shear force	V_{Ed}	13,26	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Permanent	
Modification factor	k_{mod}	0,6	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,00	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	4,73	N/mm²
Design shear stress	τ_d	1,66	N/mm²
Design tensile strength	$f_{t,0,d}$	6,46	N/mm²
Design compressive strength	$f_{c,0,d}$	9,69	N/mm²
Design bending strength	$f_{m,0,d}$	14,77	N/mm²
Design shear strength	$f_{v,d}$	1,85	N/mm²
Flexural stress ratio with tension	$\eta_{flexural}$	**32%**	
Flexural stress ratio with compression	$\eta_{flexural}$	**32%**	
Shear stress ratio	η_{shear}	**90%**	

--> max. shear stress already checked, reduced V not even necessary

Serviceability State

Limiting values for deflections of beams Slabs 10,11,13

only third span covered since it is the largest span

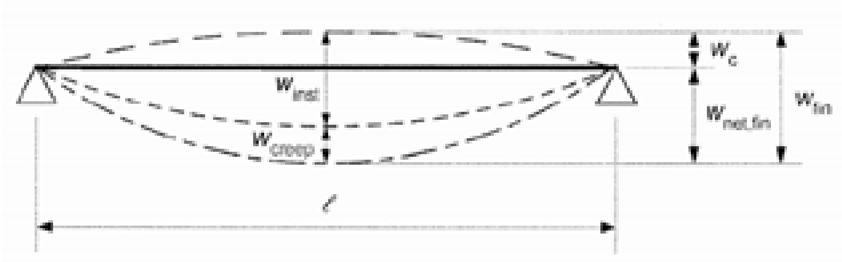


Figure 7.1 – Components of deflection

 # Deflections

Parameter	Symbol	Value	Unit
Slab No.		10	
length	l	760,00	mm
Precamber	w_c	0,0	mm
Instantaneous deflection (self-weight)	$w_{inst,G}$	1,0	mm
Instantaneous deflection (imposed load)	$w_{inst,Q}$	0,4	mm
Slab No.		11	
length	l	750,00	mm
Precamber	w_c	0,0	mm
Instantaneous deflection (self-weight)	$w_{inst,G}$	1,3	mm
Instantaneous deflection (imposed load)	$w_{inst,Q}$	0,7	mm
Slab No.		13	
length	l	1190,00	mm
Precamber	w_c	0,0	mm
Instantaneous deflection (self-weight)	$w_{inst,G}$	1,3	mm
Instantaneous deflection (imposed load)	$w_{inst,Q}$	0,7	mm

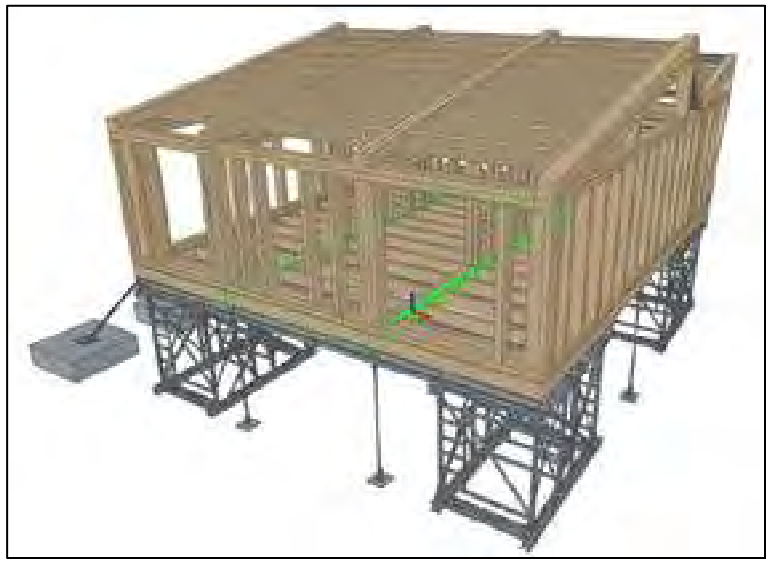
	total w_c	**0,0**	mm
	total $w_{inst,G}$	**1,3**	mm
	total $w_{inst,Q}$	**0,7**	mm
Deformation factor (service class: 1)	k_{def}	0,6	
ψ_2 (imposed loads, Kat. A: living spaces)	$\psi_{2,Q}$	0,3	
Net final deflection	$w_{net,fin}$	2,4	mm

 # Check

Parameter	Symbol	Value	Unit
Length	l	2700,00	mm
Limiting value of deflection	l/350	7,7	mm
Deflection ratio	$\eta_{deflection}$	**31%**	

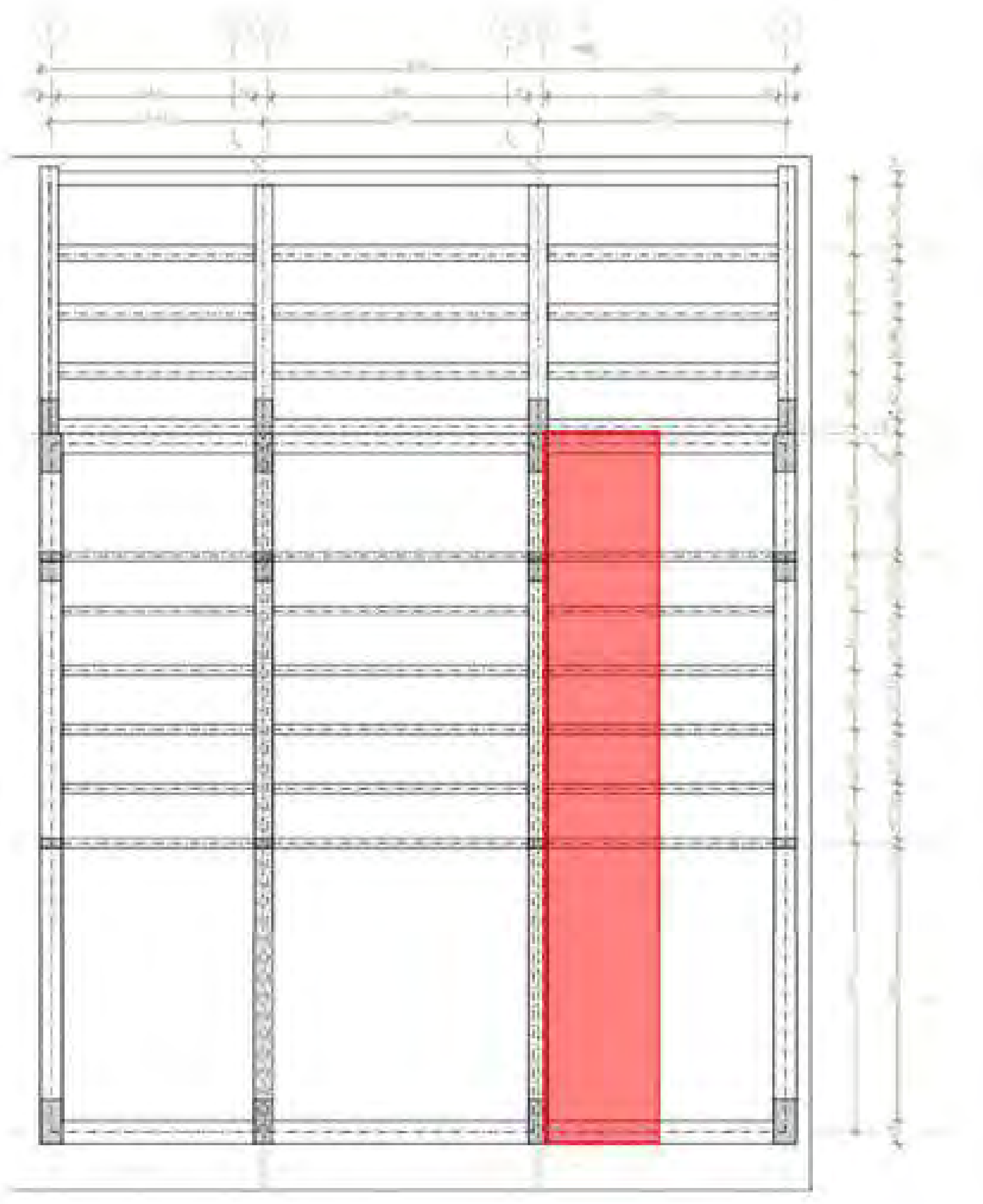
Pos 7.2 – Interior Beam (Exterior Module)

Overview



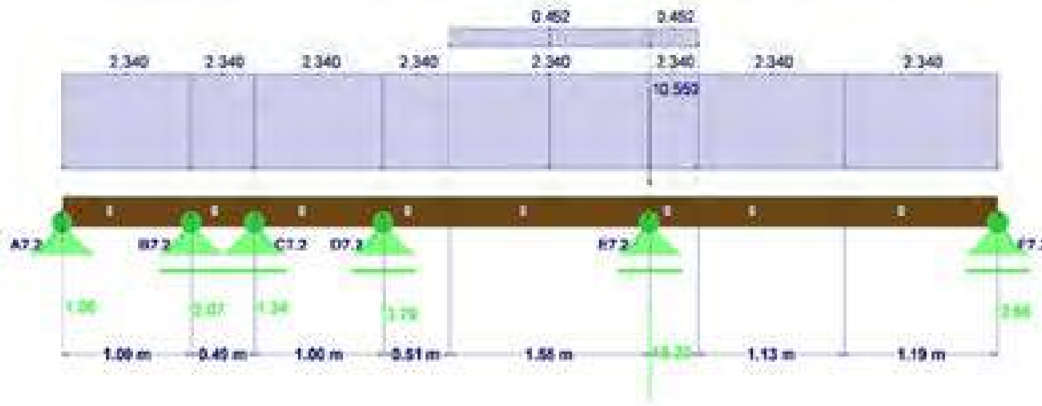
As already mentioned for position 7.1, the loads of position 4.1 are passed through the beam. They have no influence on the internal forces of the beam and become relevant only for the support reactions. For this reason, the load cases live load (roof), snow load and wind actions are mentioned, but not part of the load case combinations. These forces are important for the check of compression perpendicular to the grain.

Load application area

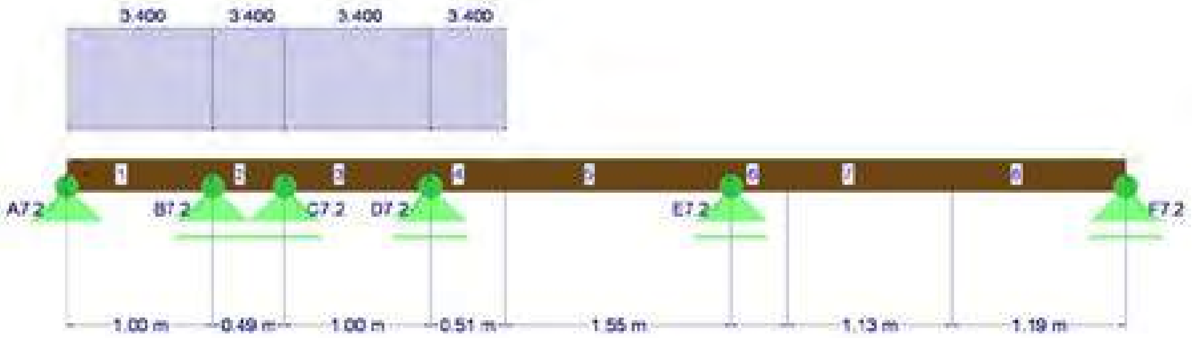


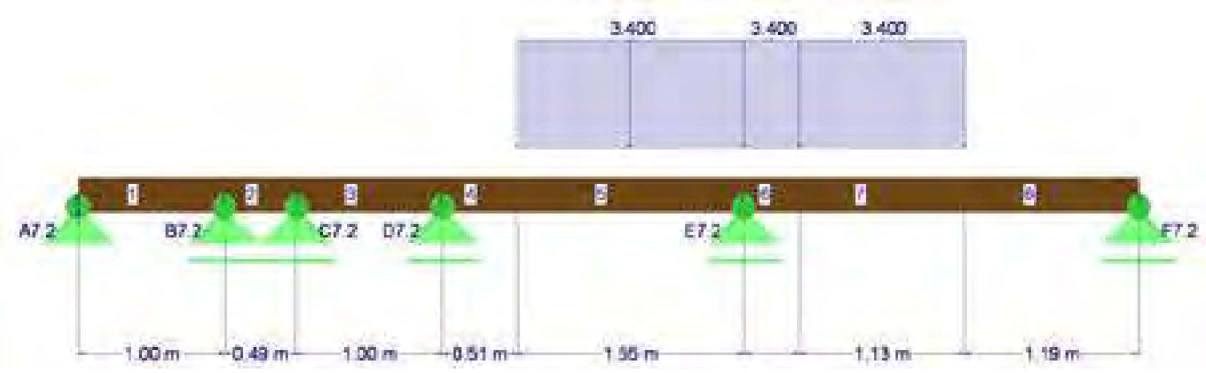
Loads

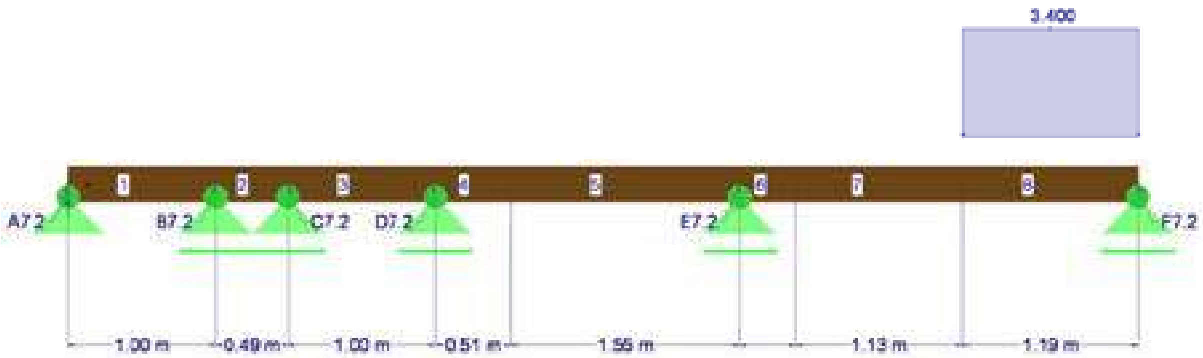
Dead loads		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
dead load floor living module	g_{FL}	1,70	1,36	2,31
dead load wall 2(living room)	g_{WL}			0,45
dead load 6cm beam increase	g_{I}			0,03
support reaction 4.1 Interior Column	$A4.1_g$			10,55



Live loads		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
live load living module	p_{L}	2,5	1,36	3,40
support reaction 4.1 Interior Column	$A4.1_p$			6,24







Snow loads				
				point load [kN]
support reaction 4.1 Interior Column	$A4.1_s$			3,57

Wind actions				
				point load [kN]
support reaction 4.1 Interior Column	$A4.1_w$			0,71

Support reactions

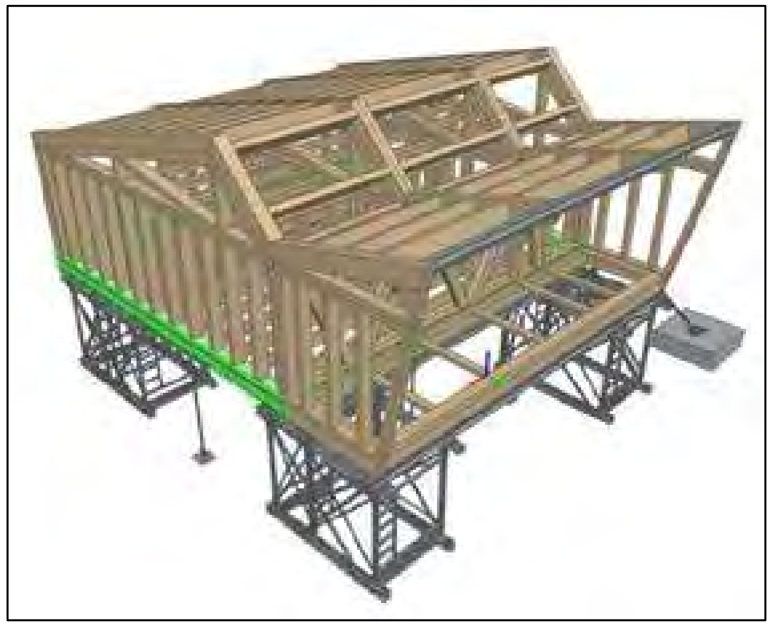
$A7.2_g$	1,06 kN	
$B7.2_g$	2,07 kN	
$C7.2_g$	1,34 kN	
$D7.2_g$	3,79 kN	
$E7.2_g$	18,20 kN	
$F7.2_g$	2,66 kN	
		uplifting:
$A7.2_p$	1,48 kN	
$B7.2_p$	2,89 kN	-0,03 kN
C7.2p	2,59 kN	-0,56 kN
$D7.2_p$	5,32 kN	-0,55 kN
$E7.2_p$	9,79 kN	
$F7.2_p$	3,75 kN	-0,01 kN
$E7.2_p$ (roof)	6,24 kN	
$E7.2_s$	3,57 kN	
$E7.2_w$	0,71 kN	

Check

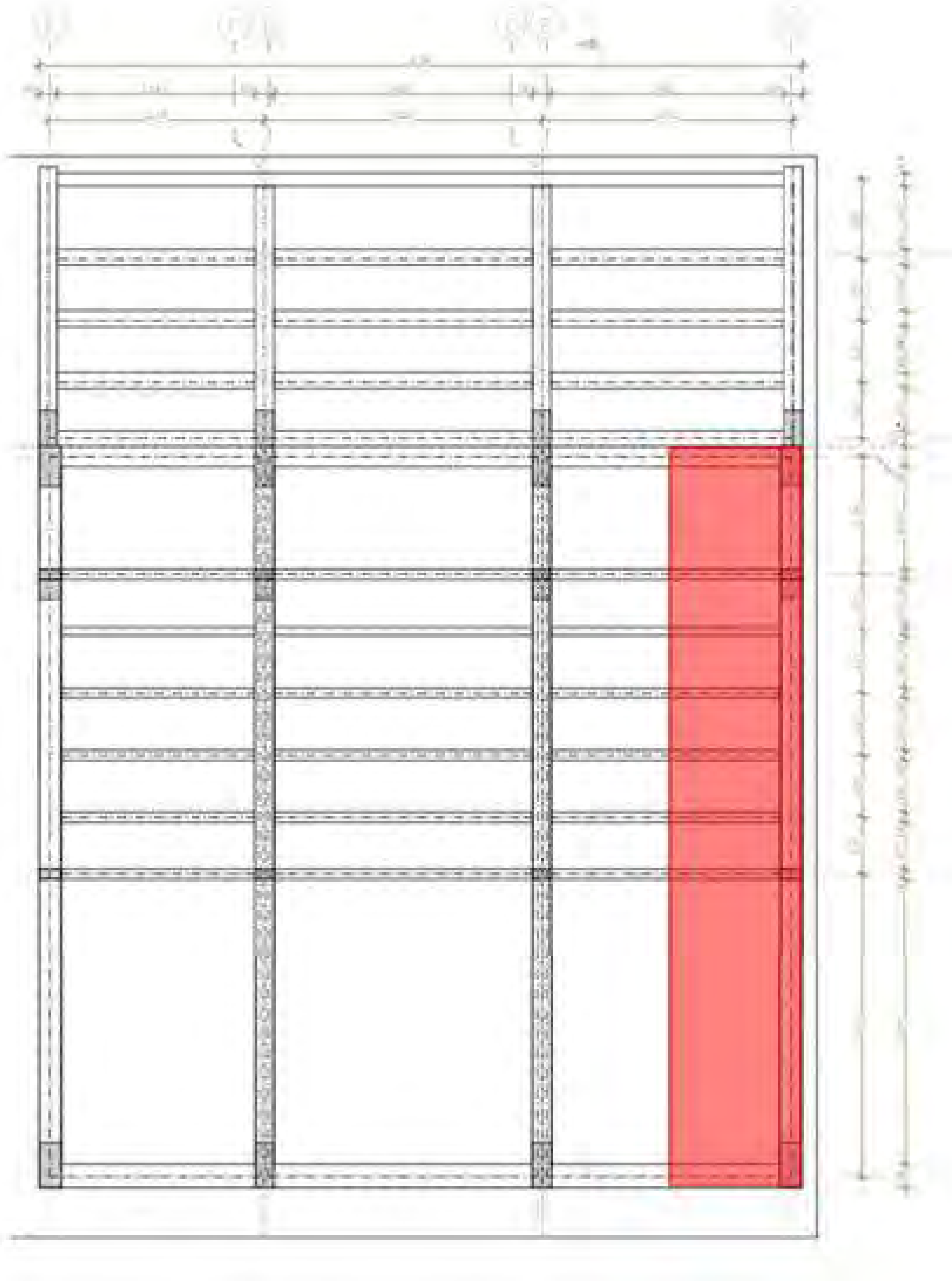
Pos. 7.1a is the same static system and has the same dimensions as pos. 7.2a. Since the loads on pos. 7.2a are lower than those on pos. 7.1a, no additional check is required

Pos. 8.1 – Exterior Beam East + West

Overview



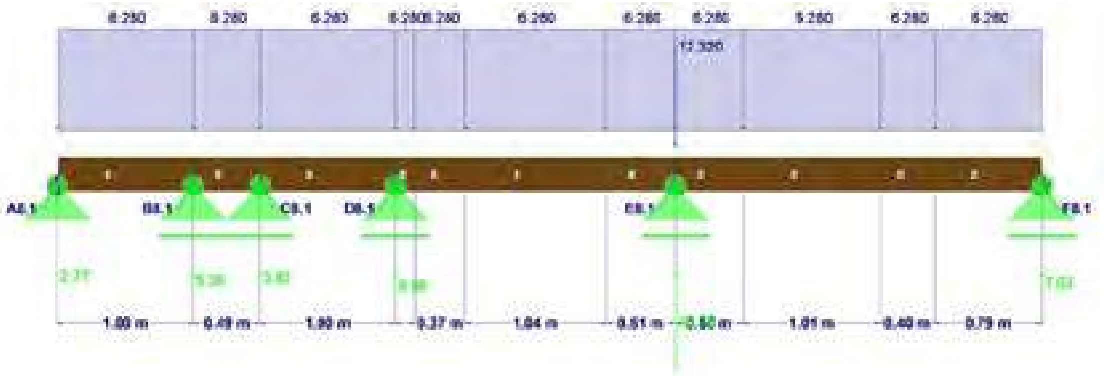
Load application area



Loads

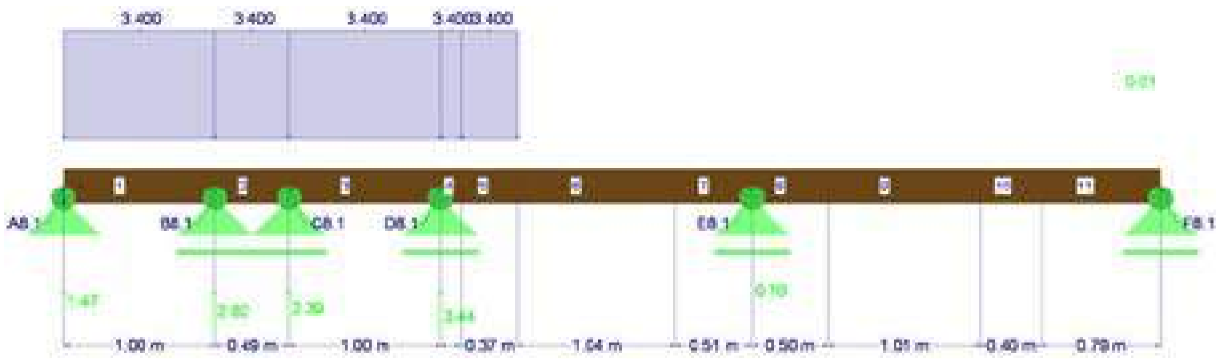
Dead loads		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
dead load floor living module	g_{FL}	1,70	1,36	2,31
dead load exterior wall (1st floor + roof)	g_W			3,98
dead load 6cm beam increase	g_I			0,03
support reaction 4.2 Exterior Column	$A4.2_g$			12,32

Load case 1 (LF1):

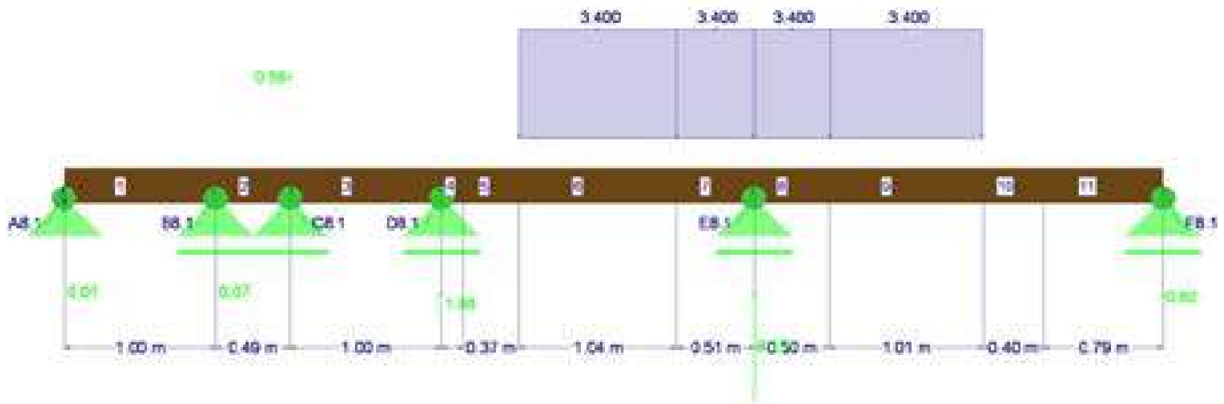


Live loads		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]
live load living module	p_L	2,5	1,36	3,40
support reaction 4.2 Exterior Column	$A4.2_p$			7,82

Load case 2 (LF2):



Load case 3 (LF3):

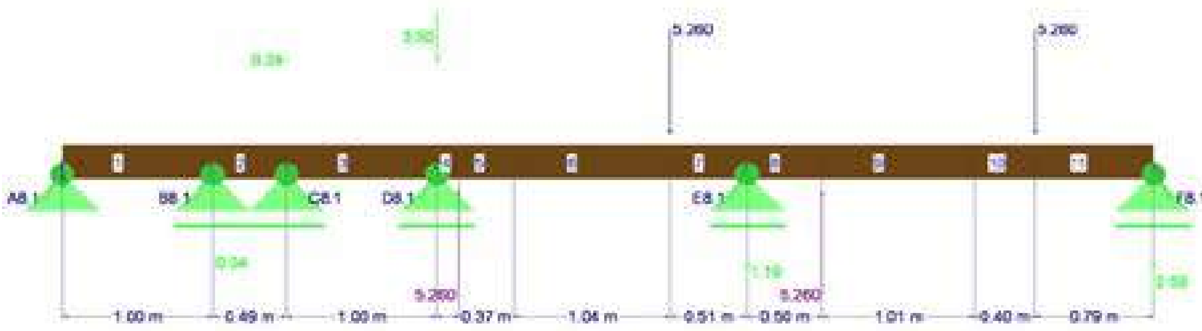


Load case 4 (LF4):

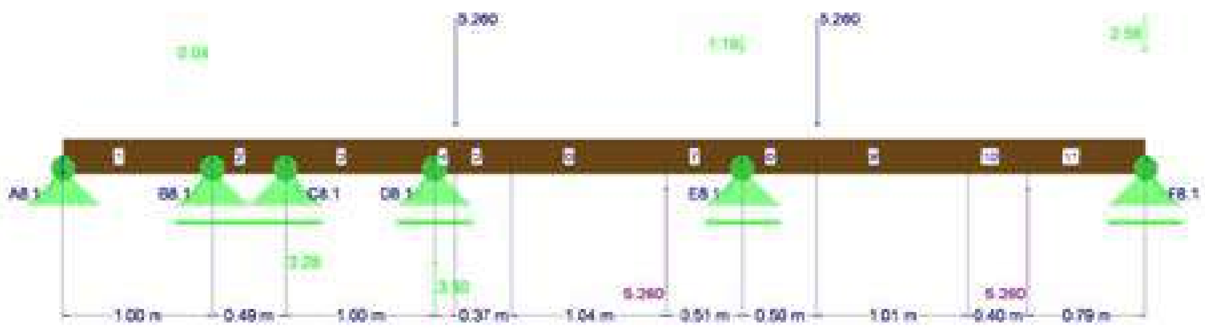
Snow loads				point load [kN]
support reaction 4.2 Exterior Column	$A4.2_s$			3,93

Wind actions		surface loads [kN/m²]	point load [kN]	
wind actions bracing wall B compression	W_B		5,26	
wind actions bracing wall B tension	W_B		-5,26	
support reaction 4.2 Exterior Column	$A4.2_w$		0,80	

Load case 5 (LF5)



Load case 6 (LF6):



Load case combinations

LK1	1.35*LF1
LK2	1.35*LF1 + 1.5*LF2
LK3	1.35*LF1 + 1.5*LF2 + 1.5*LF3
LK4	1.35*LF1 + 1.5*LF2 + 1.5*LF3 + 1.5*LF4
LK5	1.35*LF1 + 1.5*LF2 + 1.5*LF4
LK6	1.35*LF1 + 1.5*LF3
LK7	1.35*LF1 + 1.5*LF3 + 1.5*LF4
LK8	1.35*LF1 + 1.5*LF4
LK9	1.35*LF1 + 1.5*LF2 + 0.9*LF5
LK10	1.35*LF1 + 1.5*LF2 + 0.9*LF6
LK11	1.35*LF1 + 1.5*LF2 + 1.5*LF3 + 0.9*LF5
LK12	1.35*LF1 + 1.5*LF2 + 1.5*LF3 + 0.9*LF6
LK13	1.35*LF1 + 1.5*LF2 + 1.5*LF3 + 1.5*LF4 + 0.9*LF5
LK14	1.35*LF1 + 1.5*LF2 + 1.5*LF3 + 1.5*LF4 + 0.9*LF6
LK15	1.35*LF1 + 1.5*LF2 + 1.5*LF4 + 0.9*LF5
LK16	1.35*LF1 + 1.5*LF2 + 1.5*LF4 + 0.9*LF6
LK17	1.35*LF1 + 1.5*LF3 + 0.9*LF5
LK18	1.35*LF1 + 1.5*LF3 + 0.9*LF6
LK19	1.35*LF1 + 1.5*LF3 + 1.5*LF4 + 0.9*LF5
LK20	1.35*LF1 + 1.5*LF3 + 1.5*LF4 + 0.9*LF6
LK21	1.35*LF1 + 1.5*LF4 + 0.9*LF5
LK22	1.35*LF1 + 1.5*LF4 + 0.9*LF6
LK23	1.35*LF1 + 1.5*LF5
LK24	1.35*LF1 + 1.5*LF6
LK25	1.35*LF1 + 1.05*LF2 + 1.5*LF5
LK26	1.35*LF1 + 1.05*LF2 + 1.5*LF6
LK27	1.35*LF1 + 1.05*LF2 + 1.05*LF3 + 1.5*LF5
LK28	1.35*LF1 + 1.05*LF2 + 1.05*LF3 + 1.5*LF6
LK29	1.35*LF1 + 1.05*LF2 + 1.05*LF3 + 1.05*LF4 + 1.5*LF5
LK30	1.35*LF1 + 1.05*LF2 + 1.05*LF3 + 1.05*LF4 + 1.5*LF6
LK31	1.35*LF1 + 1.05*LF2 + 1.05*LF4 + 1.5*LF5
LK32	1.35*LF1 + 1.05*LF2 + 1.05*LF4 + 1.5*LF6

Support reactions

A8.1$_g$	2,77 kN	
B8.1$_g$	5,39 kN	
C8.1$_g$	3,82 kN	
D8.1$_g$	8,98 kN	
E8.1$_g$	30,75 kN	
F8.1$_g$	7,03 kN	
		uplifting:
A8.1$_p$	1,48 kN	
B8.1$_p$	2,89 kN	-0,03 kN
C8.1$_p$	2,59 kN	-0,56 kN
D8.1$_p$	5,32 kN	-0,55 kN
E8.1$_p$	9,79 kN	
F8.1$_p$	3,75 kN	-0,01 kN
E8.1$_p$ (roof)	7,82 kN	
E8.1$_s$	3,93 kN	
	wind in +y (North)	
E8.1$_w$	0,80 kN	
	wind in +x (East)	wind in -x (West)
A8.1$_w$	0,00 kN	0,00 kN
B8.1$_w$	0,04 kN	-0,04 kN
C8.1$_w$	-0,28 kN	0,28 kN
D8.1$_w$	-3,50 kN	3,50 kN
E8.1$_w$	1,19 kN	-1,19 kN
F8.1$_w$	2,56 kN	-2,56 kN

Check

 # System

 # Cross-section: 12x24 cm²

Parameter	Symbol	Value	Unit
Height	h	240	mm
Width	b	120	mm
Area	A	28800	mm²
Area moment of inertia	I	138240000	mm⁴
Modulus of section	W	1152000	mm³
Radius of inertia	i_y	69,36	mm
Radius of inertia	i_z	34,68	mm

 # Material: C24

Parameter	Symbol	Value	Unit
Characteristic tensile strength	$f_{t,0,k}$	14	N/mm²
Characteristic compressive strength	$f_{c,0,k}$	21	N/mm²
Characteristic bending strength	$f_{m,0,k}$	24	N/mm²
Characteristic shear strength	$f_{v,k}$	4	N/mm²
Modulus of elasticity (Fifth percentile)	$E_{0.05}$	7400	N/mm²
Crack coefficient	k_{cr}	0,5	-
Effective area	A_{eff}	14400	mm²

Ultimate Limit State - Load cases with load duration class very short

Design of cross-sections subjected to stress in one principal direction - **max abs M**

Load case combination	**LK 36**
Slab No.	**10**
x [m]	**0,4**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	0,00	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	9,82	kNm
Design value of shear force	V_{Ed}	0,28	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	2	-
Load duration class	KLED	Very Short	
Modification factor	k_{mod}	1,0	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,00	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	8,52	N/mm²
Design shear stress	τ_d	0,03	N/mm²
Design tensile strength	$f_{t,0,d}$	10,77	N/mm²
Design compressive strength	$f_{c,0,d}$	16,15	N/mm²
Design bending strength	$f_{m,0,d}$	18,46	N/mm²
Design shear strength	$f_{v,d}$	3,08	N/mm²

Flexural stress ratio with tension	$\eta_{flexural}$	**46%**
Flexural stress ratio with compression	$\eta_{flexural}$	**46%**
Shear stress ratio	η_{shear}	**1%**

Ultimate Limit State - Load cases with load duration class very short

Design of cross-sections subjected to stress in one principal direction - **max abs V**

Load case combination	**LK 14**
Slab No.	**8**
x [m]	**0,000**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	0,11	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	-8,89	kNm
Design value of shear force	V_{Ed}	24,31	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	2	-
Load duration class	KLED	Very Short	
Modification factor	k_{mod}	1,0	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,00	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	7,72	N/mm²
Design shear stress	$\tau_{d, red}$	2,53	N/mm²
Design tensile strength	$f_{t,0,d}$	10,77	N/mm²
Design compressive strength	$f_{c,0,d}$	16,15	N/mm²
Design bending strength	$f_{m,0,d}$	18,46	N/mm²
Design shear strength	$f_{v,d}$	3,08	N/mm²

Flexural stress ratio with tension	$\eta_{flexural}$	**42%**
Flexural stress ratio with compression	$\eta_{flexural}$	**42%**
Shear stress ratio (even without $V_{ed, red}$)	η_{shear}	**82%**

Ultimate Limit State - Load cases with load duration class medium-term

Design of cross-sections subjected to stress in one principal direction - **max abs M**

Load case combination	**LK4**
Slab No.	**7**
x [m]	**0,51**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	0,00	kN
Design value of compressive force	$N_{Ed,c}$	-0,01	kN
Design value of bending moment	$M_{y,Ed}$	-9,35	kNm
Design value of shear force	V_{Ed}	-17,55	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	2	-
Load duration class	KLED	Medium-term	
Modification factor	k_{mod}	0,8	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,00	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	8,12	N/mm²
Design shear stress	τ_d	1,83	N/mm²
Design tensile strength	$f_{t,0,d}$	8,62	N/mm²
Design compressive strength	$f_{c,0,d}$	12,92	N/mm²
Design bending strength	$f_{m,0,d}$	14,77	N/mm²
Design shear strength	$f_{v,d}$	2,46	N/mm²

Flexural stress ratio with tension	$\eta_{flexural}$	**55%**
Flexural stress ratio with compression	$\eta_{flexural}$	**55%**
Shear stress ratio (even without $V_{ed, red}$)	η_{shear}	**74%**

Ultimate Limit State - Load cases with load duration class medium-term

Design of cross-sections subjected to stress in one principal direction - **max abs V**

Load case combination	**LK4**
Slab No.	**8**
x [m]	**0,00**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	0,09	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	-9,35	kNm
Design value of shear force	V_{Ed}	22,01	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	2	-
Load duration class	KLED	Medium-term	
Modification factor	k_{mod}	0,8	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,00	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	8,12	N/mm²
Design shear stress	$\tau_{d, red}$	2,29	N/mm²
Design tensile strength	$f_{t,0,d}$	8,62	N/mm²
Design compressive strength	$f_{c,0,d}$	12,92	N/mm²
Design bending strength	$f_{m,0,d}$	14,77	N/mm²
Design shear strength	$f_{v,d}$	2,46	N/mm²

Flexural stress ratio with tension	$\eta_{flexural}$	**55%**
Flexural stress ratio with compression	$\eta_{flexural}$	**55%**
Shear stress ratio (even without $V_{ed, red}$)	η_{shear}	**93%**

Ultimate Limit State - Load cases with load duration class permanent

Design of cross-sections subjected to stress in one principal direction - **max abs M**

Load case combination	**LK1**
Slab No.	**7**
x [m]	**0,51**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	0,00	kN
Design value of compressive force	$N_{Ed,c}$	-0,01	kN
Design value of bending moment	$M_{y,Ed}$	-5,88	kNm
Design value of shear force	V_{Ed}	-11,03	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	2	-
Load duration class	KLED	Permanent	
Modification factor	k_{mod}	0,6	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,00	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	5,10	N/mm²
Design shear stress	τ_d	1,15	N/mm²
Design tensile strength	$f_{t,0,d}$	6,46	N/mm²
Design compressive strength	$f_{c,0,d}$	9,69	N/mm²
Design bending strength	$f_{m,0,d}$	11,08	N/mm²
Design shear strength	$f_{v,d}$	1,85	N/mm²

Flexural stress ratio with tension	$\eta_{flexural}$	**46%**
Flexural stress ratio with compression	$\eta_{flexural}$	**46%**
Shear stress ratio (even without $V_{ed, red}$)	η_{shear}	**62%**

Ultimate Limit State - Load cases with load duration class permanent

Design of cross-sections subjected to stress in one principal direction - **max abs V**

Load case combination	**LK1**
Slab No.	**8**
x [m]	**0,00**

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of tensile force	$N_{Ed,t}$	0,03	kN
Design value of compressive force	$N_{Ed,c}$	0,00	kN
Design value of bending moment	$M_{y,Ed}$	-5,88	kNm
Design value of shear force	V_{Ed}	13,84	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	2	-
Load duration class	KLED	Permanent	
Modification factor	k_{mod}	0,6	-

 # Check

Parameter	Symbol	Value	Unit
Design tensile stress	$\sigma_{t,0,d}$	0,00	N/mm²
Design compressive stress	$\sigma_{c,0,d}$	0,00	N/mm²
Design bending stress	$\sigma_{m,0,d}$	5,10	N/mm²
Design shear stress	τ_d	1,44	N/mm²
Design tensile strength	$f_{t,0,d}$	6,46	N/mm²
Design compressive strength	$f_{c,0,d}$	9,69	N/mm²
Design bending strength	$f_{m,0,d}$	11,08	N/mm²
Design shear strength	$f_{v,d}$	1,85	N/mm²

Flexural stress ratio with tension	$\eta_{flexural}$	**46%**
Flexural stress ratio with compression	$\eta_{flexural}$	**46%**
Shear stress ratio (even without $V_{ed, red}$)	η_{shear}	**78%**

Serviceability State

Limiting values for deflections of beams Slabs 8,9,10,11

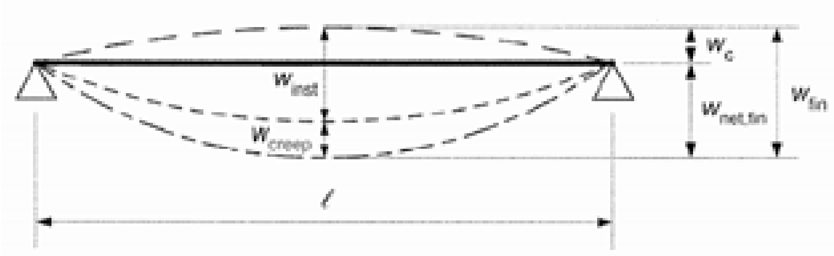


Figure 7.1 – Components of deflection

 # Deflections

Parameter	Symbol	Value	Unit
Slab No.		8	
length	l	500,00	mm
Precamber	w_c	0,0	mm
Instantaneous deflection (self-weight)	$w_{inst,G}$	0,9	mm
Instantaneous deflection (imposed load)	$w_{inst,Q}$	0,1	mm
Slab No.		9	
length	l	1010,00	mm
Precamber	w_c	0,0	mm
Instantaneous deflection (self-weight)	$w_{inst,G}$	2,0	mm
Instantaneous deflection (imposed load)	$w_{inst,Q}$	0,3	mm
Slab No.		10	
length	l	400,00	mm
Precamber	w_c	0,0	mm
Instantaneous deflection (self-weight)	$w_{inst,G}$	2,0	mm
Instantaneous deflection (imposed load)	$w_{inst,Q}$	0,3	mm
Slab No.		11	
length	l	790,00	mm
Precamber	w_c	0,0	mm
Instantaneous deflection (self-weight)	$w_{inst,G}$	1,7	mm
Instantaneous deflection (imposed load)	$w_{inst,Q}$	0,2	mm

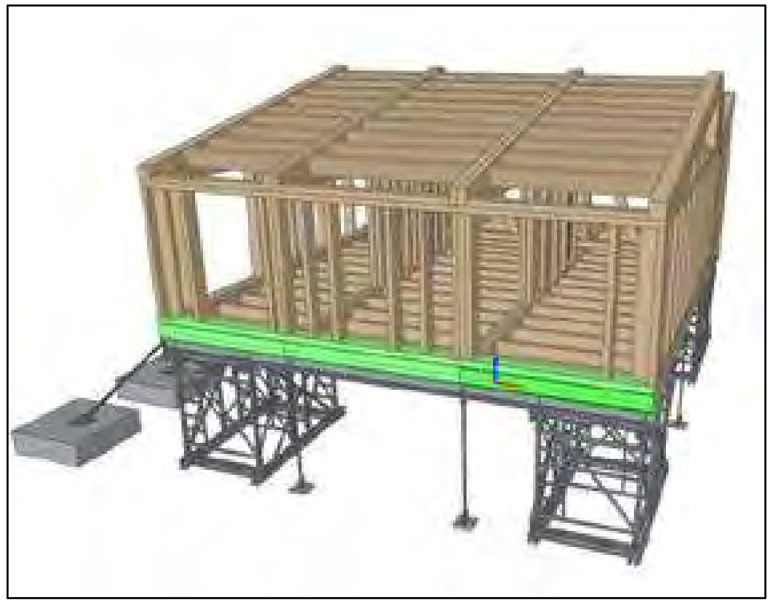
total precamber	$\mathbf{w_c}$	**0,0**	**mm**
max. deflection (self-weight)	$\mathbf{w_{inst,G}}$	**2,0**	**mm**
max. deflection (imposed load)	$\mathbf{w_{inst,Q}}$	**0,3**	**mm**
Deformation factor (service class: 1)	k_{def}	0,6	
ψ_2 (imposed loads, Kat. A: living spaces)	$\psi_{2,Q}$	0,3	
Net final deflection	$w_{net,fin}$	3,3	mm

 # Check

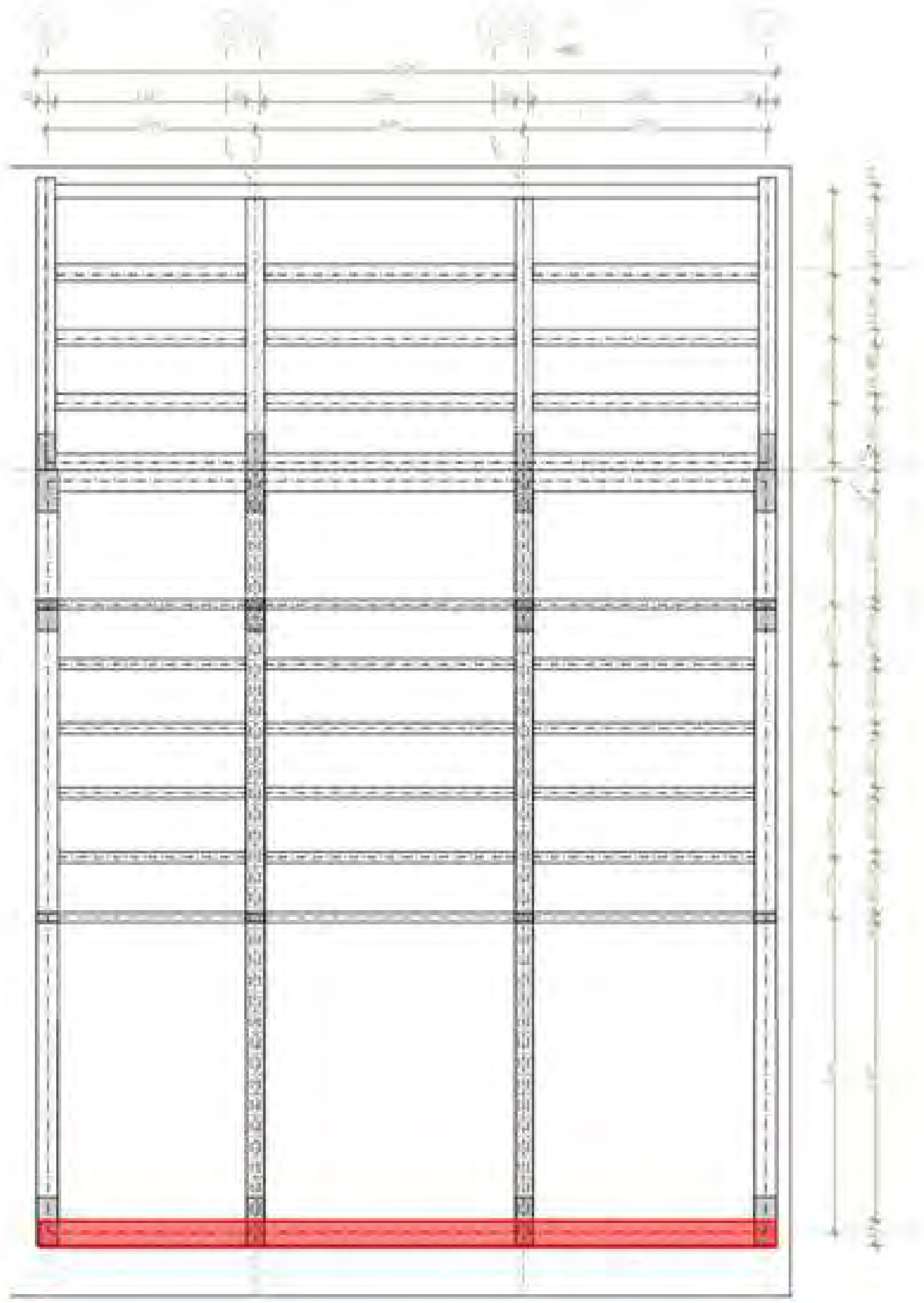
Parameter	Symbol	Value	Unit
Length	l	2700,00	mm
Limiting value of deflection	l/350	7,7	mm
Deflection ratio	$\mathbf{\eta_{deflection}}$	**43%**	

Pos. 8.2 – Exterior Beam South

Overview



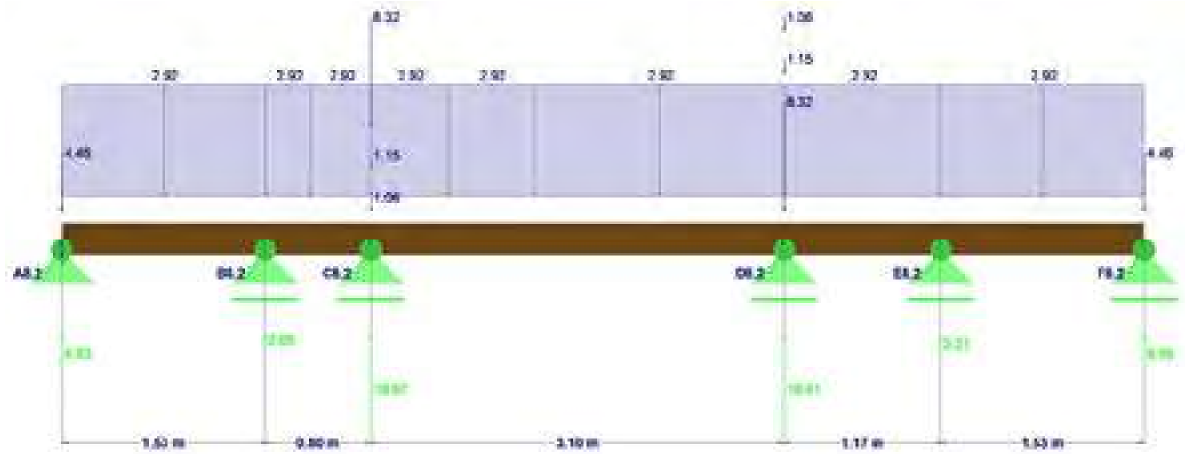
Load application area



Loads

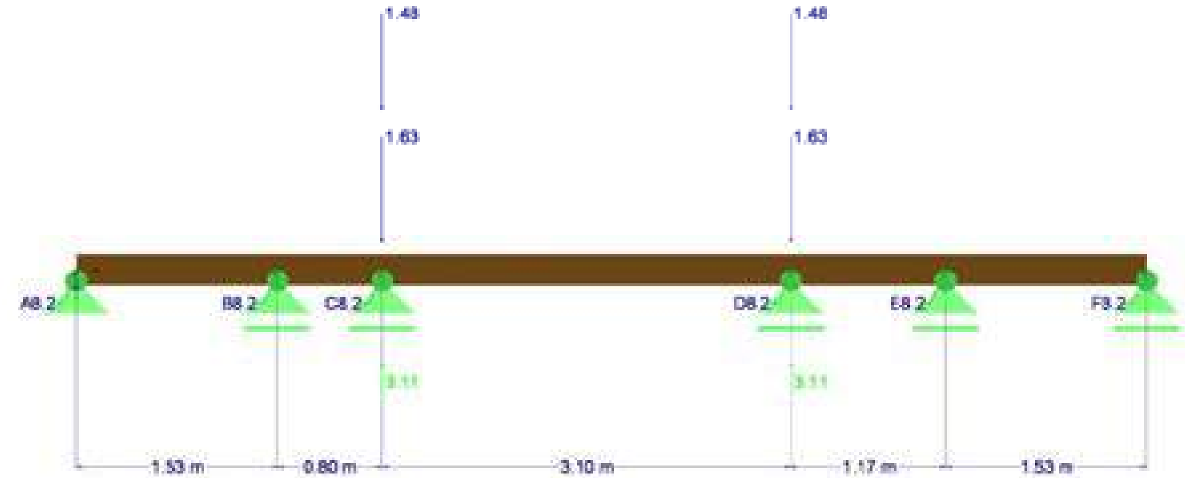
Dead loads

		load appl. width [m]	unif. distr. Load [kN/m]	point load [kN]
dead load exterior wall (1st floor)	g_W		2,89	
dead load 6cm beam increase	g_l		0,03	
			2,92	
support reaction 4.3 Interior Column South	$A4.3_g$			8,32
support reaction 4.4 Exterior Column South	$A4.4_g$			4,46
support reaction 7.1 Interior Beam (interior module)	$A7.1_g$			1,15
support reaction 7.2 Interior Beam (exterior module)	$A7.2_g$			1,06



Live loads

		load appl. width [m]	unif. distr. Load [kN/m]	point load [kN]
support reaction 4.3 Interior Column South	$A4.3_p$			5,46
support reaction 4.4 Exterior Column South	$A4.4_p$			2,82
support reaction 7.1 Interior Beam (interior module)	$A7.1_p$			1,63
support reaction 7.2 Interior Beam (exterior module)	$A7.2_p$			1,48

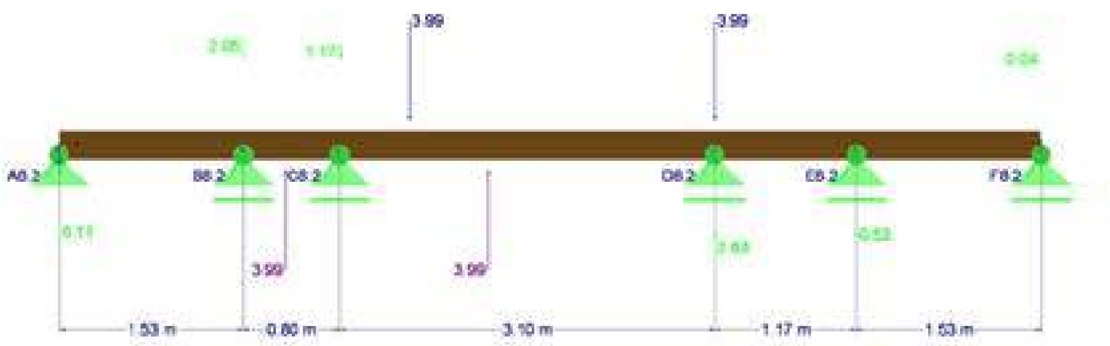


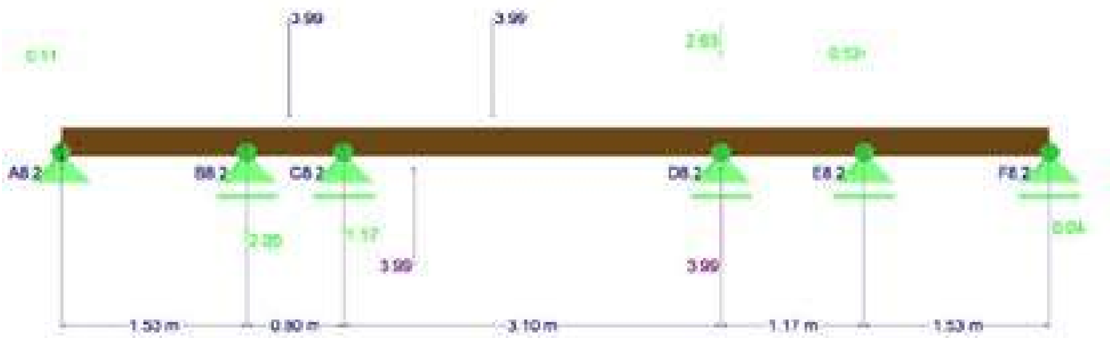
Snow loads

		load appl. width [m]	unif. distr. Load [kN/m]	point load [kN]
support reaction 4.3 Interior Column South	$A4.3_s$			2,74
support reaction 4.4 Exterior Column South	$A4.4_s$			1,42

Wind actions

		load appl. width [m]	unif. distr. Load [kN/m]	point load [kN]
wind actions bracing wall D compression	W_B			3,99
wind actions bracing wall D tension	W_B			-3,99
support reaction 4.3 Interior Column South	$A4.3_w$			0,43
support reaction 4.4 Exterior Column South	$A4.4_w$			0,23





Support reactions

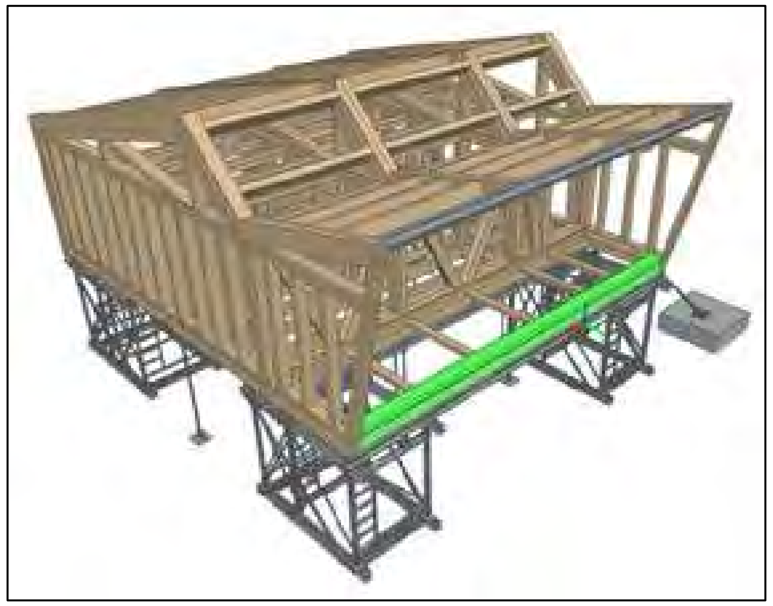
$A8.2_g$	6,53 kN	
$B8.2_g$	2,05 kN	
$C8.2_g$	18,67 kN	
$D8.2_g$	18,61 kN	
$E8.2_g$	3,21 kN	
$F8.2_g$	6,59 kN	
$A8.2_p$ (roof)	2,82 kN	
$A8.2_p$ (living space)	0,00 kN	
$B8.2_p$ (roof)	0,00 kN	
$B8.2_p$ (living floor)	0,00 kN	
$C8.2_p$ (roof)	5,46 kN	
$C8.2_p$ (living space)	3,11 kN	
$D8.2_p$ (roof)	5,46 kN	
$D8.2_p$ (living space)	3,11 kN	
$E8.2_p$ (roof)	0,00 kN	
$E8.2_p$ (living space)	0,00 kN	
$F8.2_p$ (roof)	2,82 kN	
$F8.2_p$ (living space)	0,00 kN	
$A8.2_s$	1,42 kN	
$B8.2_s$	0,00 kN	
$C8.2_s$	2,74 kN	
$D8.2_s$	2,74 kN	
$E8.2_s$	0,00 kN	
$F8.2_s$	1,42 kN	
	Wind in +x (East)	**Wind in -x (West)**
$A8.2_w$	0,11 kN	-0,11 kN
$B8.2_w$	-2,05 kN	2,05 kN
$C8.2_w$	-1,17 kN	1,17 kN
$D8.2_w$	2,63 kN	-2,63 kN
$E8.2_w$	0,53 kN	-0,53 kN
$F8.2_w$	-0,04 kN	0,04 kN
	Wind in +y (North)	
$A8.2_w$	0,23 kN	
$B8.2_w$	0,00 kN	
$C8.2_w$	0,43 kN	
$D8.2_w$	0,43 kN	
$E8.2_w$	0,00 kN	
$F8.2_w$	0,23 kN	

Check

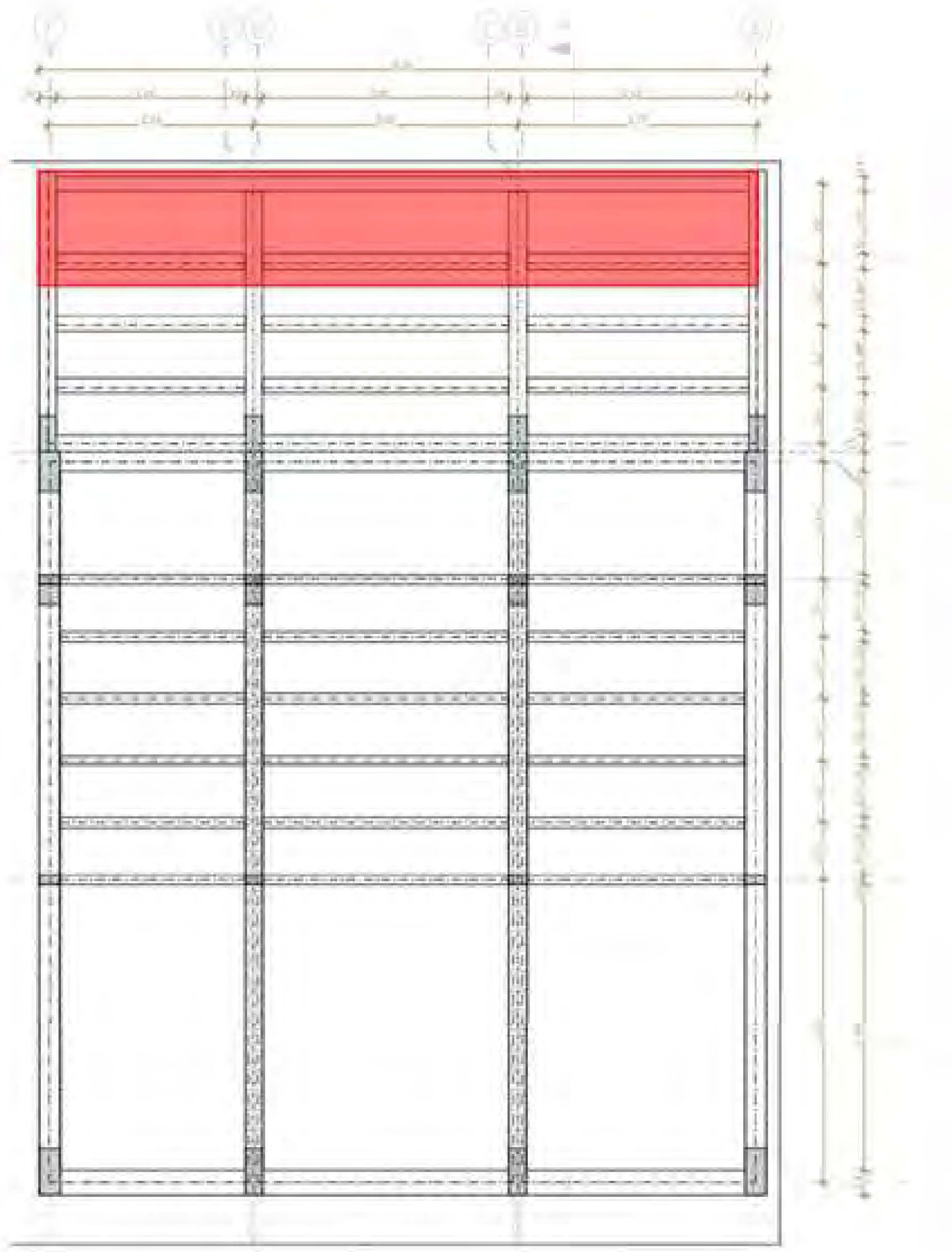
No checks conducted. This member is not working as a structurally required beam, since it is directly supported by the flexural steel girder below. For the structural analysis of the steel girder see “Standsicherheitsnachweis DOKA”.

Pos. 9 – Timber Beam Terrace North

Overview



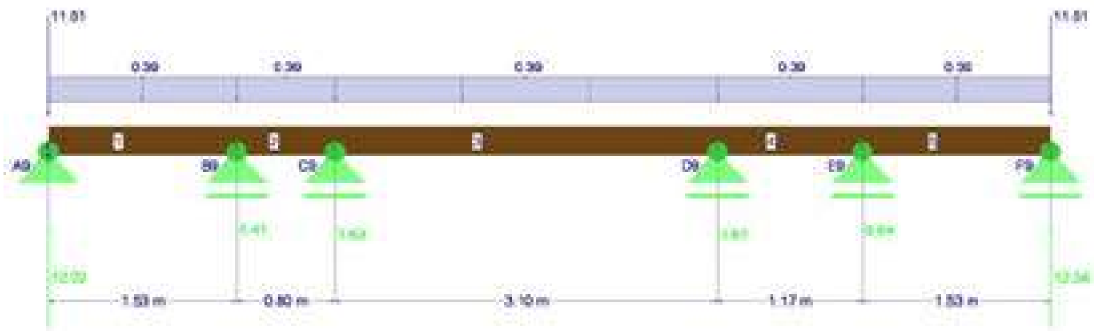
Load application area



Loads

Dead loads		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]	point load [kN]
support reaction 5 Inclined Column Terrace	$B5_g$				11,61
dead load floor terrace module	g_{FT}	0,40	0,98	0,39	

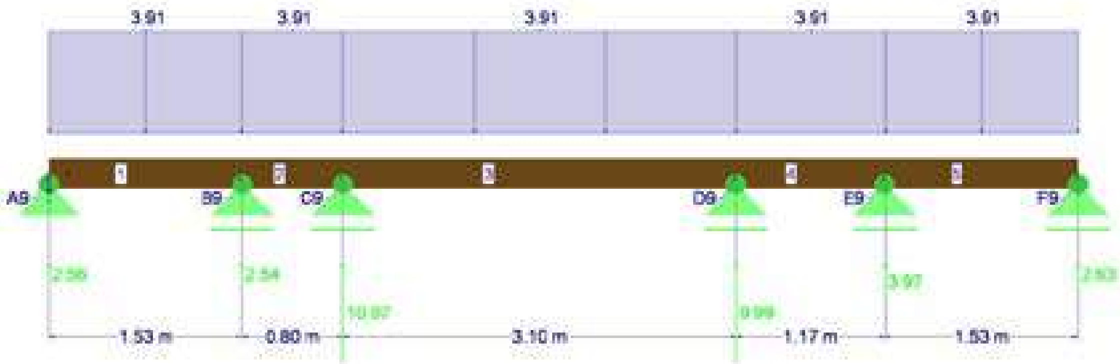
Load case 1 (LF1):



Live loads		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]	point load [kN]
support reaction 5 Inclined Column Terrace	$B5_p$				6,64
live load terrace	p_T	4,00	0,98	3,91	

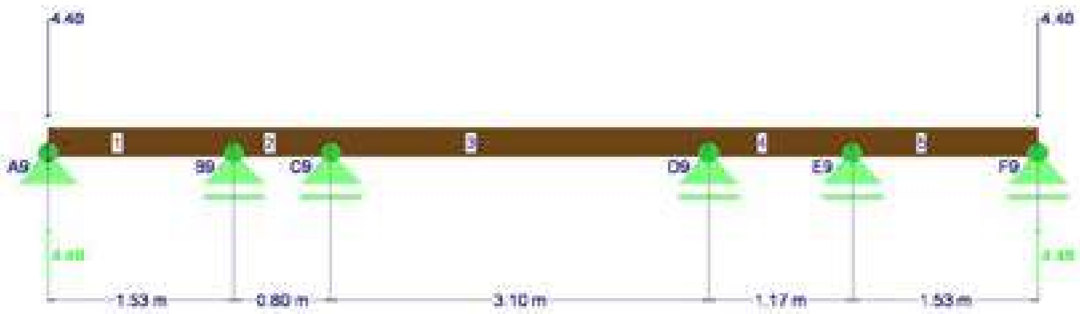
Load case 2 (LF2):

Load case 3 (LF3):



Snow loads		surface load [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]	point load [kN]
support reaction 5 Inclined Column Terrace	$B5_s$				4,48

Load case 4 (LF4):



Load case combinations

LK1	1.35*LF1
LK2	1.35*LF1 + 1.5*LF3
LK3	1.35*LF1 + 0.75*LF2 + 1.5*LF3
LK4	1.35*LF1 + 1.5*LF4
LK5	1.35*LF1 + 1.05*LF3 + 1.5*LF4
LK6	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF4
LK7	1.35*LF1 + 0.75*LF2 + 1.5*LF4
LK8	1.35*LF1 + 1.5*LF2
LK9	1.35*LF1 + 1.5*LF2 + 1.05*LF3
LK10	LF1
LK11	LF1 + LF3
LK12	LF1 + 0.5*LF2 + LF3
LK13	LF1 + LF4
LK14	LF1 + 0.7*LF3 + LF4
LK15	LF1 + 0.5*LF2 + 0.7*LF3 + LF4
LK16	LF1 + 0.5*LF2 + LF4
LK17	LF1 + LF2
LK18	LF1 + LF2 + 0.7*LF3
LK19	1.8*LF1
LK20	1.8*LF1 + 1.24*LF3
LK21	1.8*LF1 + 0.5*LF2 + 1.24*LF3
LK22	1.8*LF1 + LF4
LK23	1.8*LF1 + 0.94*LF3 + LF4
LK24	1.8*LF1 + 0.5*LF2 + 0.94*LF3 + LF4
LK25	1.8*LF1 + 0.5*LF2 + LF4
LK26	1.8*LF1 + LF2
LK27	1.8*LF1 + LF2 + 0.94*LF3

Support reactions

$A9_g$	**12,02**	kN
$B9_g$	**0,41**	kN
$C9_g$	**1,63**	kN
$D9_g$	**1,61**	kN
$E9_g$	**0,64**	kN
$F9_g$	**12,04**	kN

$A9_p$ (roof)	**6,64**	kN
$A9_p$ (living space)	**2,56**	kN
$B9_p$ (roof)	**0,00**	kN
$B9_p$ (living floor)	**2,54**	kN
$C9_p$ (roof)	**0,00**	kN
$C9_p$ (living space)	**10,07**	kN
$D9_p$ (roof)	**0,00**	kN
$D9_p$ (living space)	**9,99**	kN
$E9_p$ (roof)	**0,00**	kN
$E9_p$ (living space)	**3,97**	kN
$F9_p$ (roof)	**6,64**	kN
$F9_p$ (living space)	**2,63**	kN

$A9_s$	**4,48**	kN
$B9_s$	**0,00**	kN
$C9_s$	**0,00**	kN
$D9_s$	**0,00**	kN
$E9_s$	**0,00**	kN
$F9_s$	**4,48**	kN

Check

No checks conducted. This member is not working as a structurally required beam, since it is directly supported by the flexural steel girder below. For the structural analysis of the steel girder see “Standsicherheitsnachweis DOKA”.

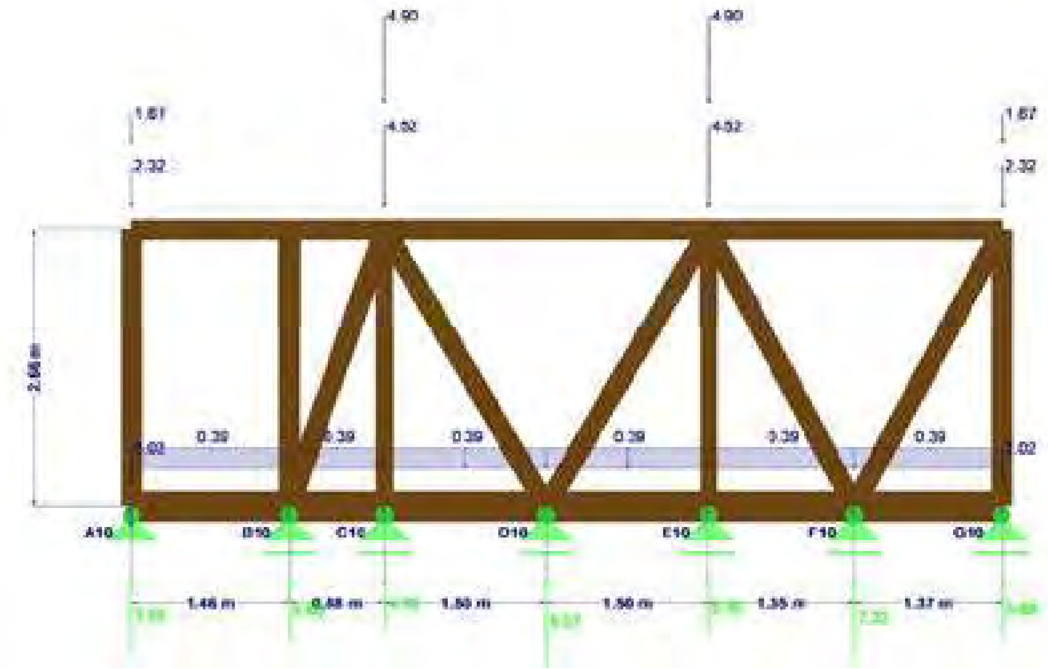
Pos. 10 – Framework North Facade

Overview

Loads

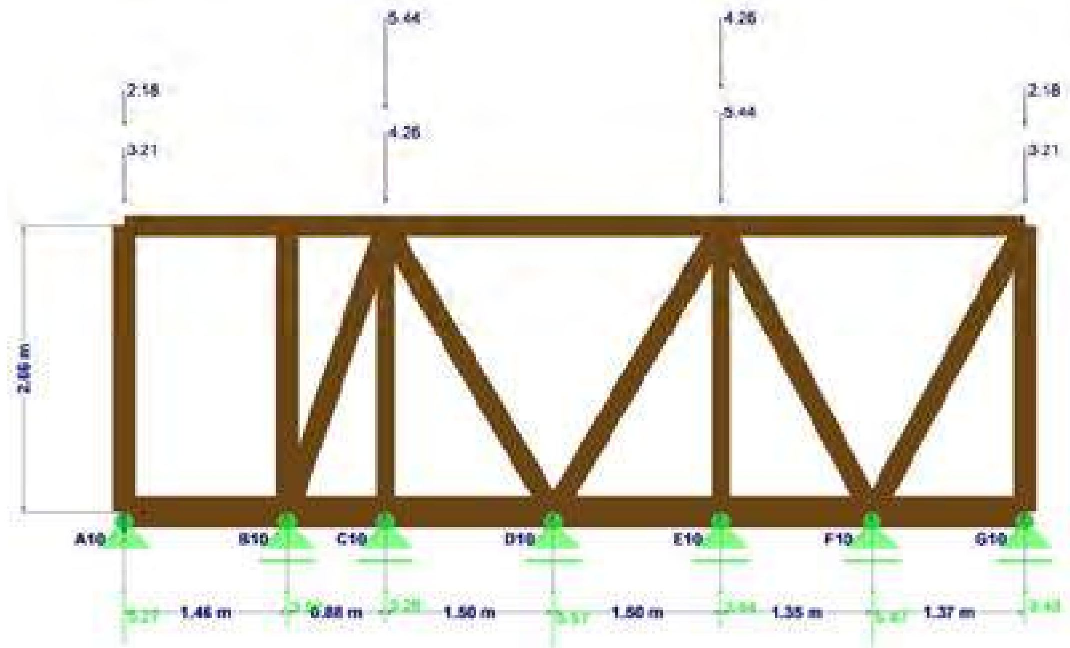
Dead loads		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]	point load [kN]
support reaction 2.1 Interior Terrace Rafter	$B2.1_g$				4,52
support reaction 2.2 Exterior Terrace Rafter	$B2.2_g$				2,32
support reaction 6.1 Interior Roof Truss	$A6.1_g$				4,90
support reaction 6.2 Exterior Roof Truss	$A6.2_g$				1,67
dead load floor terrace module	g_{FT}	0,40	0,978	0,39	
dead load wall terrace modul	g_{WT}		1,00	2,02	2,02

Load case 1 (LF1):

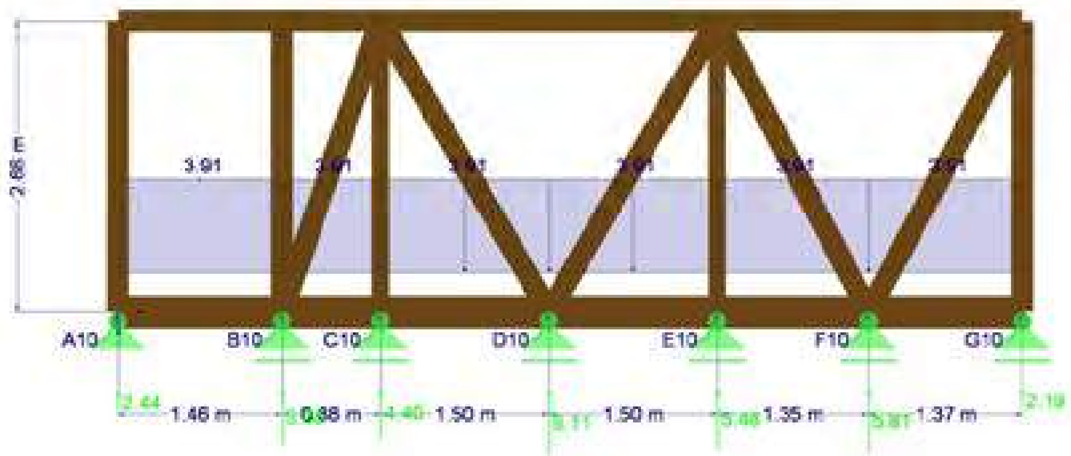


Live loads		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]	point load [kN]
support reaction 2.1 Interior Terrace Rafter	$B2.1_p$				4,26
support reaction 2.2 Exterior Terrace Rafter	$B2.2_p$				2,18
support reaction 6.1 Interior Roof Truss	$A6.1_p$				5,44
support reaction 6.2 Exterior Roof Truss	$A6.2_p$				3,21
live load terrace	p_T	4,00	0,98	3,91	

Load case 2 (LF2):

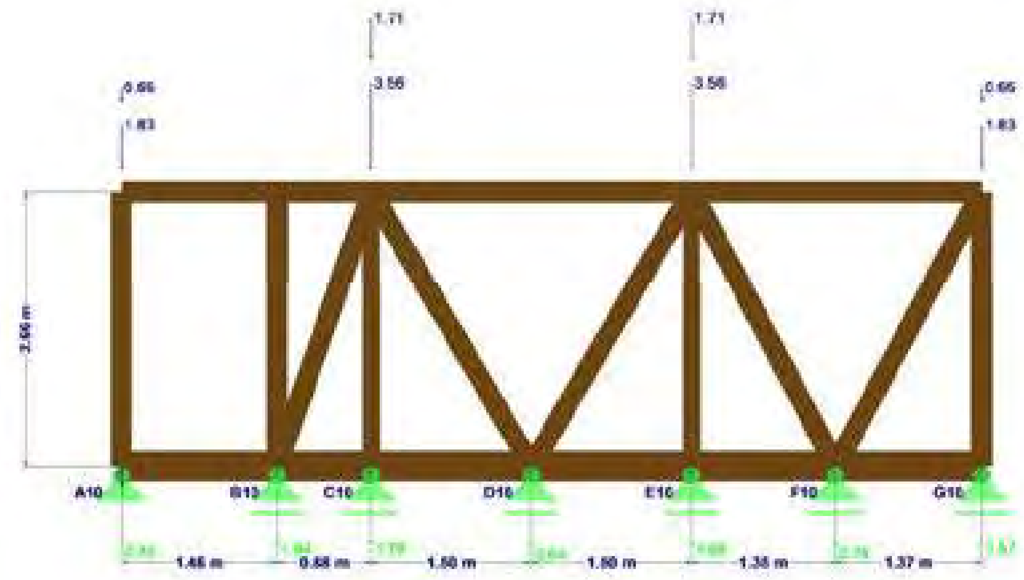


Load case 3 (LF3):



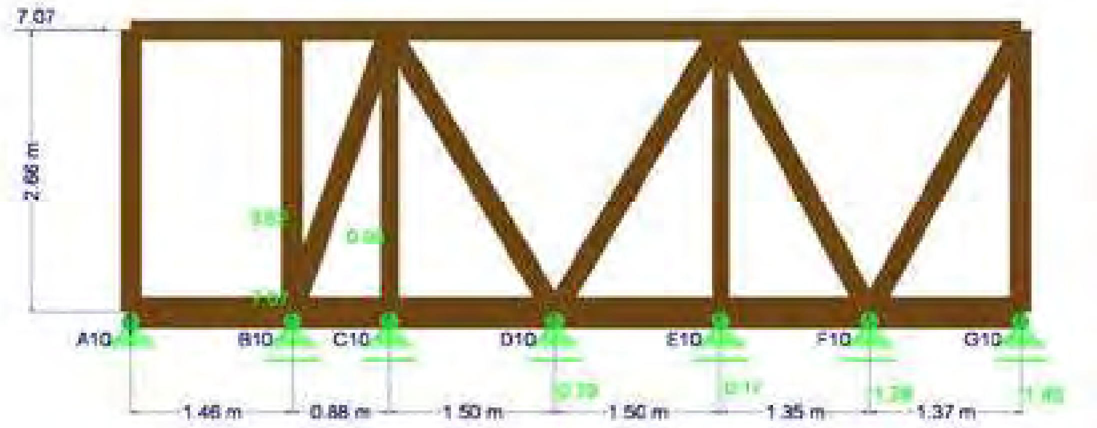
Snow loads		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]	point load [kN]
support reaction 2.1 Interior Terrace Rafter	$B2.1_s$				3,56
support reaction 2.2 Exterior Terrace Rafter	$B2.2_s$				1,83
support reaction 6.1 Interior Roof Truss	$A6.1_s$				1,71
support reaction 6.2 Exterior Roof Truss	$A6.2_s$				0,65

Load case 4 (LF4):

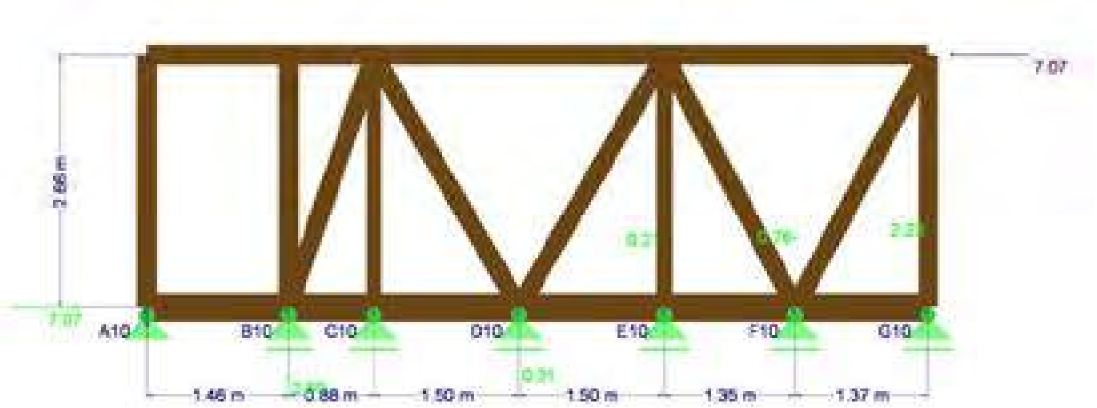


Wind actions		surface loads [kN/m²]	load appl. width [m]	unif. distr. Load [kN/m]	point load [kN]
support reaction 6.1 Interior Roof Truss	$A6.1_w$				-0,13
support reaction 6.2 Exterior Roof Truss	$A6.2_w$				-0,14
horizontal wind load (brac	W_B				7,07

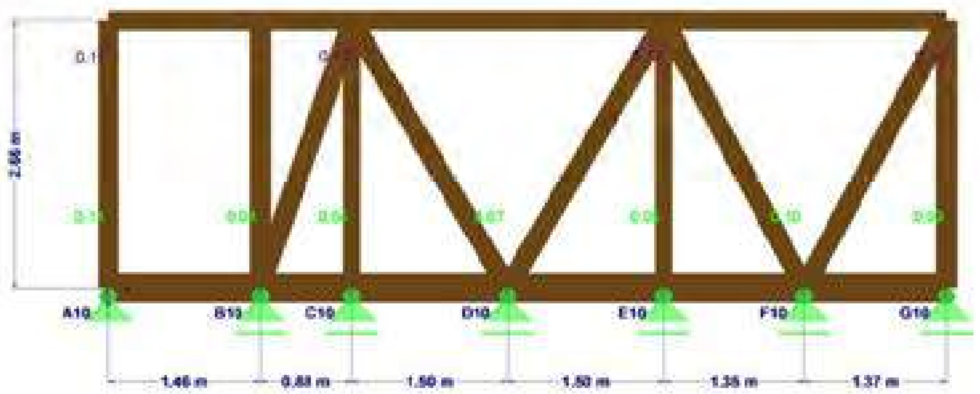
Load case 5 (LF5):



Load case 6 (LF6):



Load case 7 (LF7):



Load case combinations

LK1	1.35*LF1
LK2	1.35*LF1 + 1.5*LF3
LK3	1.35*LF1 + 0.75*LF2 + 1.5*LF3
LK4	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 0.9*LF5
LK5	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 0.9*LF6
LK6	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 0.9*LF7
LK7	1.35*LF1 + 1.5*LF3 + 0.9*LF5
LK8	1.35*LF1 + 1.5*LF3 + 0.9*LF6
LK9	1.35*LF1 + 1.5*LF3 + 0.9*LF7
LK10	1.35*LF1 + 1.5*LF4
LK11	1.35*LF1 + 1.05*LF3 + 1.5*LF4
LK12	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF4
LK13	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF4 + 0.9*LF5
LK14	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF4 + 0.9*LF6
LK15	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF4 + 0.9*LF7
LK16	1.35*LF1 + 1.05*LF3 + 1.5*LF4 + 0.9*LF5
LK17	1.35*LF1 + 1.05*LF3 + 1.5*LF4 + 0.9*LF6
LK18	1.35*LF1 + 1.05*LF3 + 1.5*LF4 + 0.9*LF7
LK19	1.35*LF1 + 0.75*LF2 + 1.5*LF4
LK20	1.35*LF1 + 0.75*LF2 + 1.5*LF4 + 0.9*LF5
LK21	1.35*LF1 + 0.75*LF2 + 1.5*LF4 + 0.9*LF6
LK22	1.35*LF1 + 0.75*LF2 + 1.5*LF4 + 0.9*LF7
LK23	1.35*LF1 + 1.5*LF4 + 0.9*LF5
LK24	1.35*LF1 + 1.5*LF4 + 0.9*LF6
LK25	1.35*LF1 + 1.5*LF4 + 0.9*LF7
LK26	1.35*LF1 + 1.5*LF2
LK27	1.35*LF1 + 1.5*LF2 + 1.05*LF3
LK28	1.35*LF1 + 1.5*LF2 + 1.05*LF3 + 0.9*LF5
LK29	1.35*LF1 + 1.5*LF2 + 1.05*LF3 + 0.9*LF6
LK30	1.35*LF1 + 1.5*LF2 + 1.05*LF3 + 0.9*LF7
LK31	1.35*LF1 + 1.5*LF2 + 0.9*LF5
LK32	1.35*LF1 + 1.5*LF2 + 0.9*LF6
LK33	1.35*LF1 + 1.5*LF2 + 0.9*LF7
LK34	1.35*LF1 + 1.5*LF5
LK35	1.35*LF1 + 1.5*LF6
LK36	1.35*LF1 + 1.5*LF7
LK37	1.35*LF1 + 1.05*LF3 + 1.5*LF5
LK38	1.35*LF1 + 1.05*LF3 + 1.5*LF6
LK39	1.35*LF1 + 1.05*LF3 + 1.5*LF7
LK40	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF5
LK41	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF6
LK42	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF7
LK43	1.35*LF1 + 0.75*LF2 + 1.5*LF5
LK44	1.35*LF1 + 0.75*LF2 + 1.5*LF6
LK45	1.35*LF1 + 0.75*LF2 + 1.5*LF7
LK46	LF1
LK47	LF1 + LF3
LK48	LF1 + 0.5*LF2 + LF3
LK49	LF1 + 0.5*LF2 + LF3 + 0.6*LF5
LK50	LF1 + 0.5*LF2 + LF3 + 0.6*LF6
LK51	LF1 + 0.5*LF2 + LF3 + 0.6*LF7
LK52	LF1 + LF3 + 0.6*LF5

LK53	LF1 + LF3 + 0.6*LF6
LK54	LF1 + LF3 + 0.6*LF7
LK55	LF1 + LF4
LK56	LF1 + 0.7*LF3 + LF4
LK57	LF1 + 0.5*LF2 + 0.7*LF3 + LF4
LK58	LF1 + 0.5*LF2 + 0.7*LF3 + LF4 + 0.6*LF5
LK59	LF1 + 0.5*LF2 + 0.7*LF3 + LF4 + 0.6*LF6
LK60	LF1 + 0.5*LF2 + 0.7*LF3 + LF4 + 0.6*LF7
LK61	LF1 + 0.7*LF3 + LF4 + 0.6*LF5
LK62	LF1 + 0.7*LF3 + LF4 + 0.6*LF6
LK63	LF1 + 0.7*LF3 + LF4 + 0.6*LF7
LK64	LF1 + 0.5*LF2 + LF4
LK65	LF1 + 0.5*LF2 + LF4 + 0.6*LF5
LK66	LF1 + 0.5*LF2 + LF4 + 0.6*LF6
LK67	LF1 + 0.5*LF2 + LF4 + 0.6*LF7
LK68	LF1 + LF4 + 0.6*LF5
LK69	LF1 + LF4 + 0.6*LF6
LK70	LF1 + LF4 + 0.6*LF7
LK71	LF1 + LF2
LK72	LF1 + LF2 + 0.7*LF3
LK73	LF1 + LF2 + 0.7*LF3 + 0.6*LF5
LK74	LF1 + LF2 + 0.7*LF3 + 0.6*LF6
LK75	LF1 + LF2 + 0.7*LF3 + 0.6*LF7
LK76	LF1 + LF2 + 0.6*LF5
LK77	LF1 + LF2 + 0.6*LF6
LK78	LF1 + LF2 + 0.6*LF7
LK79	LF1 + LF5
LK80	LF1 + LF6
LK81	LF1 + LF7
LK82	LF1 + 0.7*LF3 + LF5
LK83	LF1 + 0.7*LF3 + LF6
LK84	LF1 + 0.7*LF3 + LF7
LK85	LF1 + 0.5*LF2 + 0.7*LF3 + LF5
LK86	LF1 + 0.5*LF2 + 0.7*LF3 + LF6
LK87	LF1 + 0.5*LF2 + 0.7*LF3 + LF7
LK88	LF1 + 0.5*LF2 + LF5
LK89	LF1 + 0.5*LF2 + LF6
LK90	LF1 + 0.5*LF2 + LF7
LK91	LF1
LK92	LF1 + 0.5*LF3
LK93	LF1 + 0.3*LF3 + 0*LF4
LK94	LF1 + 0.2*LF2
LK95	LF1 + 0.2*LF2 + 0.3*LF3
LK96	LF1 + 0.2*LF5
LK97	LF1 + 0.2*LF6
LK98	LF1 + 0.2*LF7
LK99	LF1 + 0.3*LF3 + 0.2*LF5
LK100	LF1 + 0.3*LF3 + 0.2*LF6
LK101	LF1 + 0.3*LF3 + 0.2*LF7
LK102	LF1
LK103	LF1 + 0.3*LF3

Support reactions

$A10_g$	7,03 kN	
$B10_g$	5,88 kN	
$C10_g$	4,70 kN	
$D10_g$	8,07 kN	
$E10_g$	5,45 kN	
$F10_g$	7,32 kN	
$G10_g$	5,68 kN	
$A10_p$ (Dach)	5,27 kN	
$A10_p$ (Wohnraum)	2,44 kN	
$B10_p$ (Dach)	3,52 kN	
$B10_p$ (Wohnraum)	5,08 kN	
$C10_p$ (Dach)	3,26 kN	
$C10_p$ (Wohnraum)	4,40 kN	
$D10_p$ (Dach)	5,57 kN	
$D10_p$ (Wohnraum)	6,11 kN	
$E10_p$ (Dach)	3,64 kN	
$E10_p$ (Wohnraum)	5,48 kN	
$F10_p$ (Dach)	5,47 kN	
$F10_p$ (Wohnraum)	5,81 kN	
$G10_p$ (Dach)	3,43 kN	
$G10_p$ (Wohnraum)	2,19 kN	
$A10_s$	2,42 kN	
$B10_s$	1,94 kN	
$C10_s$	1,78 kN	
$D10_s$	3,04 kN	
$E10_s$	1,98 kN	
$F10_s$	2,78 kN	
$G10_s$	1,57 kN	
		Uplifting:
$A10_w$	0,00 kN	0,00 kN
$B10_w$	-3,62 kN	2,89 kN
$C10_w$	-0,08 kN	0,00 kN
$D10_w$	0,79 kN	0,31 kN
$E10_w$	0,17 kN	-0,21 kN
$F10_w$	1,28 kN	-0,76 kN
$G10_w$	1,45 kN	-2,23 kN
$A10_w$	-0,14 kN	
$B10_w$	-0,04 kN	
$C10_w$	-0,04 kN	
$D10_w$	-0,07 kN	
$E10_w$	-0,05 kN	
$F10_w$	-0,10 kN	
$G10_w$	-0,09 kN	

Check

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STRUCTURAL ANALYSIS

PROJECT

CLIENT

CREATED BY

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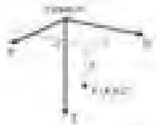
MODEL - GENERAL DATA

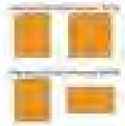
General	Model name	10 - Fachwerk Nordfassade
	Type of model	2D-XZ (uX/uZ/φY)
	Positive direction of global axis Z	Downward
	Classification of load cases and combinations	According to Standard: EN 1990 National Annex: DIN - Deutschland
	☐Automatically create combinations	☐Load Combinations
Options	☐ Use CQC Rule	
	☐ Enable CAD/BIM model	
	Standard Gravity g	10.00 m/s²

1.1 NODES



Node No.	Reference Node	Coordinate System	Node Coordinates X [m]	Z [m]	Comment
1	-	Cartesian	0.000	0.000	
2	-	Cartesian	0.000	-2.656	
3	-	Cartesian	1.461	0.000	
4	-	Cartesian	1.461	-2.600	
5	-	Cartesian	2.340	0.000	
6	-	Cartesian	2.340	-2.656	
7	-	Cartesian	3.840	0.000	
8	-	Cartesian	2.340	0.000	
9	-	Cartesian	5.340	0.000	
10	-	Cartesian	5.340	-2.656	
11	-	Cartesian	6.593	0.000	
12	-	Cartesian	7.840	0.000	
13	-	Cartesian	6.358	0.000	
14	-	Cartesian	8.099	-2.656	
15	-	Cartesian	5.340	0.000	
16	-	Cartesian	4.889	0.000	
17	-	Cartesian	6.889	0.000	

1.3 CROSS-SECTIONS

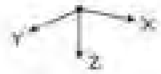


Section No.	Matl. No.	J [cm⁴] / A [cm²]	I_y [cm⁴] / A_y [cm²]	I_z [cm⁴] / A_z [cm²]	Principal Axes α [°]	Rotation α' [°]	Overall Dimensions [mm] Width b	Height h
1	H-Rechteck 240/300							
	1	720.00	54000.00	486.00	0.00	0.00	240.0	300.0
	Bodenträger							
2	H-Rechteck 160/160							
	1	256.00	3461.33	213.33	0.00	0.00	160.0	160.0
	Pfosten							
3	H-Rechteck 160/200							
	1	320.00	10666.67	266.67	0.00	0.00	160.0	200.0
	Diagonalen/Außengurtstäbe + vertikal Träger							
4	H-Rechteck 360/200							
	1	720.00	24000.00	600.00	0.00	0.00	360.0	200.0
	Laufträger							

1.7 MEMBERS

Mbr. No.	Member	Node Start	Node End	Rotation Type	β [°]	Cross-Section Start	Cross-Section End	Hinge No. Start	Hinge No. End	Ecc. No.	Div. No.	Length L [m]	
1	Beam	1	3	Angle	0.00	1	1	-	-	-	-	1.461	X
2	Beam	3	5	Angle	0.00	1	1	-	-	-	-	0.879	X
3	Beam	5	7	Angle	0.00	1	1	-	-	-	-	1.500	X
4	Beam	7	9	Angle	0.00	1	1	-	-	-	-	1.500	X
5	Beam	9	11	Angle	0.00	1	1	-	-	-	-	1.545	X
6	Beam	11	13	Angle	0.00	1	1	-	-	-	-	1.068	X
7	Beam	2	4	Angle	0.00	4	4	-	-	-	-	1.461	X
8	Beam	4	6	Angle	0.00	4	4	-	-	-	-	0.879	X
10	Beam	6	10	Angle	0.00	4	4	-	-	-	-	3.000	X
11	Beam	10	14	Angle	0.00	4	4	-	-	-	-	2.758	X
13	Truss	1	2	Angle	0.00	3	3	-	-	-	-	2.656	Z
14	Truss	3	4	Angle	0.00	3	3	-	-	-	-	2.656	Z
15	Truss	13	14	Angle	0.00	3	3	-	-	-	-	2.656	Z
16	Truss	3	6	Angle	0.00	3	3	-	-	-	-	2.798	XZ
17	Truss	6	7	Angle	0.00	3	3	-	-	-	-	3.050	XZ
18	Truss	7	10	Angle	0.00	3	3	-	-	-	-	3.050	XZ
19	Truss	10	11	Angle	0.00	3	3	-	-	-	-	2.970	XZ
20	Truss	11	14	Angle	0.00	3	3	-	-	-	-	2.868	XZ
21	Truss	4	5	Angle	0.00	3	3	-	-	-	-	2.656	Z
22	Truss	10	9	Angle	0.00	3	3	-	-	-	-	2.656	Z

1.8 NODAL SUPPORTS



Support No.	Nodes No.	Rotation [°] about Y	Support or Spring [kN/m] [kNm/rad] u_X	u_Z	$φ_Y$	Comment
1	1	0.00	☒	☒	☐	
2	3,5,7,9,11,13	0.00	☐	☒	☐	

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4.3 CROSS-SECTIONS - INTERNAL FORCES

Member No.	LC/CO	Node No.	Location x [m]		Forces [kN] N	V_z	Moments M_y [kNm]
	Section No. 1: H-Rechteck 240/300 (Bodenträger)						
3	CO40	MAX N	0.000		10.86	3.62	-0.69
1	CO44	MIN N	0.730		-10.61	-0.11	0.19
6	CO8	MAX V_z	0.000		0.00	5.56	-1.17
1	CO8	MIN V_z	1.461		-6.36	-5.75	-1.06
1	CO5	MAX M_y	0.584		-6.36	0.28	1.34
3	CO8	MIN M_y	1.500		-3.89	-5.45	-1.36
	Section No. 2: H-Rechteck 160/100 (Pfosten)						
22	LC5	MAX N	0.000		0.21	0.00	0.00
22	CO13	MIN N	2.656		-13.06	0.00	0.00
21	CO40	MAX V_z	2.656		-6.41	0.00	0.00
21	CO40	MIN V_z	0.000		-5.95	0.00	0.00
21	LC1	MAX M_y	0.000		-3.52	0.00	0.00
21	LC1	MIN M_y	0.000		-3.52	0.00	0.00
	Section No. 3: H-Rechteck 160/200 (Diagonalen/Außenpfosten + neben Tür)						
16	LC5	MAX N	0.000		3.50	0.00	0.00
19	CO13	MIN N	2.979		-16.52	-0.15	0.00
17	CO13	MAX V_z	0.000		-15.23	0.16	0.00
17	CO13	MIN V_z	3.050		-15.80	-0.16	0.00
17	CO13	MAX M_y	1.525		-15.51	0.00	0.13
13	LC1	MIN M_y	0.000		-4.54	0.00	0.00
	Section No. 4: H-Rechteck 240/200 (Dachträger)						
12	CO12	MAX N	2.718		3.10	-0.49	0.00
8	CO40	MIN N	0.879		-10.61	0.01	-0.14
8	CO12	MAX V_z	0.000		0.00	0.86	-0.60
10	CO13	MIN V_z	3.000		-1.25	-0.87	-0.46
10	CO14	MAX M_y	1.200		-0.18	0.01	0.33
7	CO14	MIN M_y	1.461		0.00	-0.75	-0.60

4.3 CROSS-SECTIONS - INTERNAL FORCES

Result Combinations

Member No.	RC	Node No.	Location x [m]		Forces [kN] N	V_z	Moments M_y [kNm]	Corresponding Load Cases
	Section No. 1: H-Rechteck 240/300 (Bodenträger)							
3	RC1		0.000	MAX N	10.86	3.62	-0.69	CO 40
1	RC1		0.730	MIN N	-10.61	-0.11	0.19	CO 44
6	RC1		0.000	MAX V_z	0.00	5.56	-1.17	CO 8
1	RC1		1.461	MIN V_z	-6.36	-5.75	-1.06	CO 8
1	RC1		0.584	MAX M_y	-6.36	0.28	1.34	CO 5
3	RC1		1.500	MIN M_y	-3.89	-5.45	-1.36	CO 8
	Section No. 2: H-Rechteck 160/100 (Pfosten)							
21	RC2		0.000	MAX N	-3.43	0.00	0.00	CO 79
22	RC1		2.656	MIN N	-13.06	0.00	0.00	CO 13
21	RC1		2.656	MAX V_z	-6.41	0.00	0.00	CO 40
21	RC1		0.000	MIN V_z	-5.95	0.00	0.00	CO 40
21	RC1		0.000	MAX M_y	-4.75	0.00	0.00	CO 1
21	RC1		0.000	MIN M_y	-4.75	0.00	0.00	CO 1
	Section No. 3: H-Rechteck 160/200 (Diagonalen/Außenpfosten + neben Tür)							
16	RC1		2.798	MAX N	0.86	-0.09	0.00	CO 34
19	RC1		2.979	MIN N	-16.52	-0.15	0.00	CO 13
17	RC1		0.000	MAX V_z	-15.23	0.16	0.00	CO 13
17	RC1		3.050	MIN V_z	-15.80	-0.16	0.00	CO 13
17	RC1		1.525	MAX M_y	-15.51	0.00	0.13	CO 13
13	RC1		0.000	MIN M_y	-6.13	0.00	0.00	CO 1
	Section No. 4: H-Rechteck 240/200 (Dachträger)							
12	RC1		2.718	MAX N	3.10	-0.49	0.00	CO 12
8	RC1		0.879	MIN N	-10.61	0.01	-0.14	CO 40
8	RC1		0.000	MAX V_z	0.00	0.86	-0.60	CO 12
10	RC1		3.000	MIN V_z	-1.25	-0.87	-0.46	CO 13
10	RC1		1.200	MAX M_y	-0.18	0.01	0.33	CO 14
7	RC1		1.461	MIN M_y	0.00	-0.76	-0.60	CO 14

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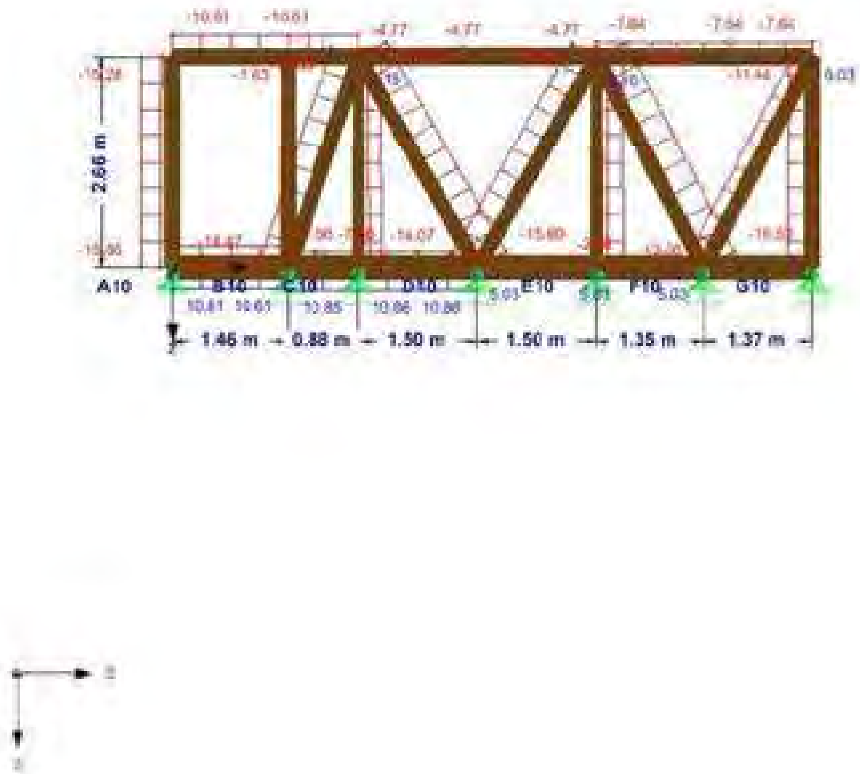
INTERNAL FORCES N

RC1 - GZT (STR/GEO) - Ständig / vorübergehend - Gl. 6.10 Against Y-direction
Schnittgrößen N
Ergebniskombinationen: Max- und Min-Werte



Max N: 10.86, Min N: -16.52 [kN]

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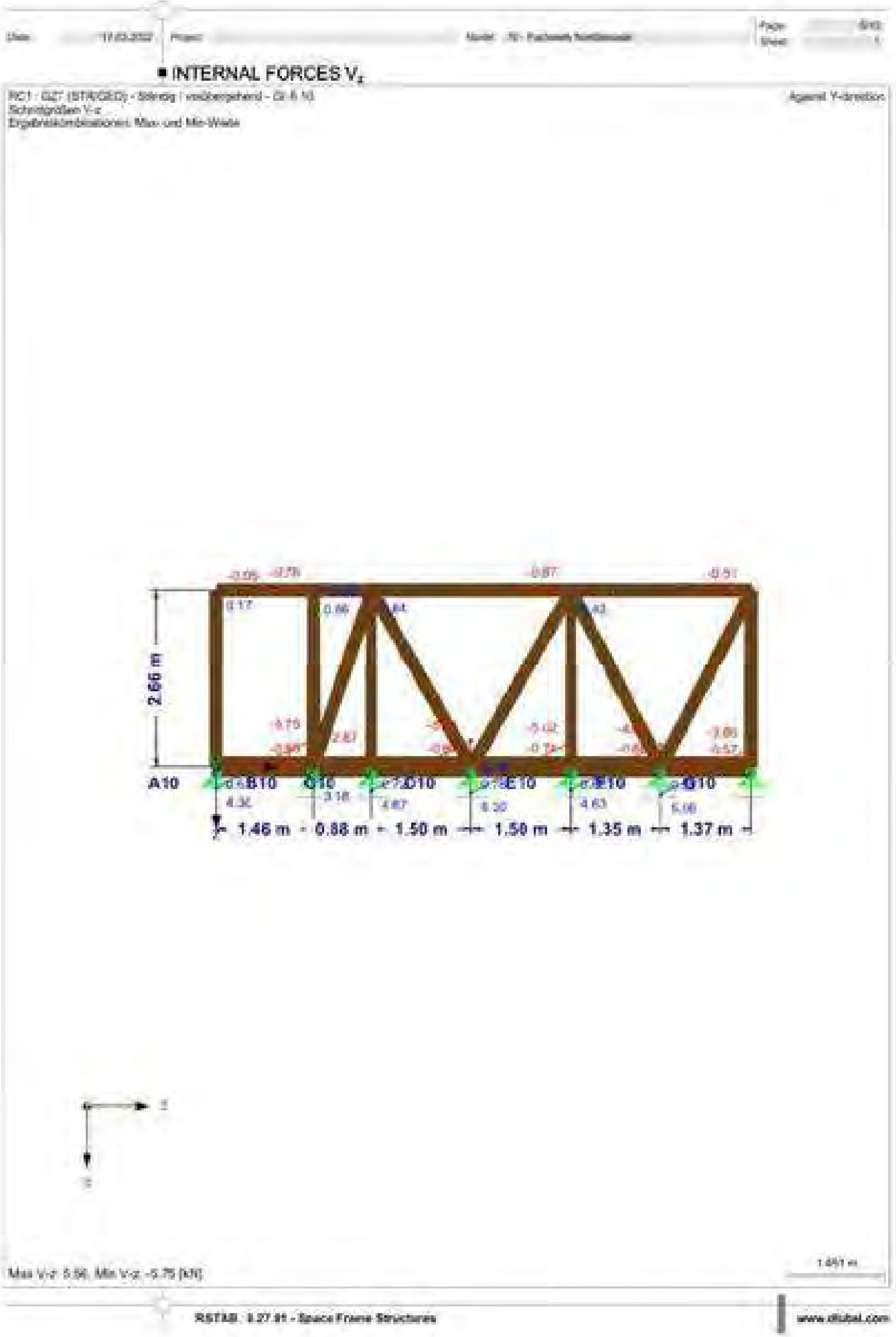
INTERNAL FORCES V_z
2.66 m
A10
B10
C10
D10
E10
F10
G10
1.46 m
0.88 m
1.50 m
1.50 m
1.35 m
1.37 m
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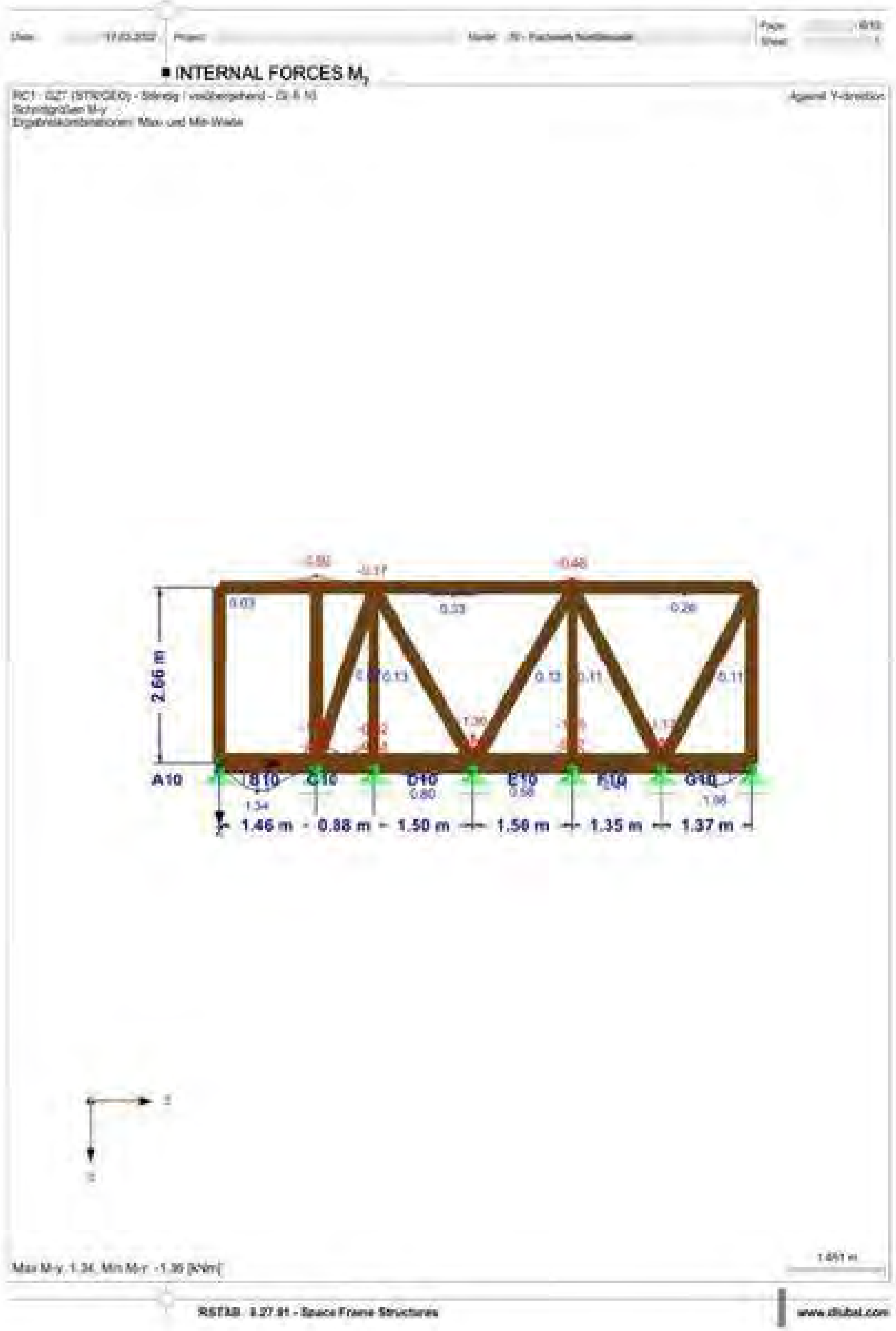
INTERNAL FORCES M_y
2.66 m
A10
B10
C10
D10
E10
F10
G10
1.46 m
0.88 m
1.50 m
1.50 m
1.35 m
1.37 m
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CA1							

1.1.1 GENERAL DATA

Members to design:		All
Design according to Standard:		DIN 1052:2008-12
Ultimate Limit State Design		
Load cases to design:	LC1	Eigengewicht
	LC2	Schnee
	LC3	Nutzlast
	LC4	Nutzlast
	LC5	Wind in +X
	LC6	Wind in -X
	LC7	Wind in +Y
Load combinations to design:	CO1	1.35*LF1
	CO2	1.35*LF1 + 1.5*LF3
	CO3	1.35*LF1 + 0.75*LF2 + 1.5*LF3
	CO4	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 0.9*LF5
	CO5	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 0.9*LF6
	CO6	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 0.9*LF7
	CO7	1.35*LF1 + 1.5*LF3 + 0.9*LF5
	CO8	1.35*LF1 + 1.5*LF3 + 0.9*LF6
	CO9	1.35*LF1 + 1.5*LF3 + 0.9*LF7
	CO10	1.35*LF1 + 1.5*LF4
	CO11	1.35*LF1 + 1.05*LF3 + 1.5*LF4
	CO12	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF4
	CO13	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF4 + 0.9*LF5
	CO14	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF4 + 0.9*LF6
	CO15	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF4 + 0.9*LF7
	CO16	1.35*LF1 + 1.05*LF3 + 1.5*LF4 + 0.9*LF5
	CO17	1.35*LF1 + 1.05*LF3 + 1.5*LF4 + 0.9*LF6
	CO18	1.35*LF1 + 1.05*LF3 + 1.5*LF4 + 0.9*LF7
	CO19	1.35*LF1 + 0.75*LF2 + 1.5*LF4
	CO20	1.35*LF1 + 0.75*LF2 + 1.5*LF4 + 0.9*LF5
	CO21	1.35*LF1 + 0.75*LF2 + 1.5*LF4 + 0.9*LF6
	CO22	1.35*LF1 + 0.75*LF2 + 1.5*LF4 + 0.9*LF7
	CO23	1.35*LF1 + 1.5*LF4 + 0.9*LF5
	CO24	1.35*LF1 + 1.5*LF4 + 0.9*LF6
	CO25	1.35*LF1 + 1.5*LF4 + 0.9*LF7
	CO26	1.35*LF1 + 1.5*LF2
	CO27	1.35*LF1 + 1.5*LF2 + 1.05*LF3
	CO28	1.35*LF1 + 1.5*LF2 + 1.05*LF3 + 0.9*LF5
	CO29	1.35*LF1 + 1.5*LF2 + 1.05*LF3 + 0.9*LF6
	CO30	1.35*LF1 + 1.5*LF2 + 1.05*LF3 + 0.9*LF7
	CO31	1.35*LF1 + 1.5*LF2 + 0.9*LF5
	CO32	1.35*LF1 + 1.5*LF2 + 0.9*LF6
	CO33	1.35*LF1 + 1.5*LF2 + 0.9*LF7
	CO34	1.35*LF1 + 1.5*LF5
	CO35	1.35*LF1 + 1.5*LF6
	CO36	1.35*LF1 + 1.5*LF7
	CO37	1.35*LF1 + 1.05*LF3 + 1.5*LF5
	CO38	1.35*LF1 + 1.05*LF3 + 1.5*LF6
	CO39	1.35*LF1 + 1.05*LF3 + 1.5*LF7
	CO40	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF5
	CO41	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF6
	CO42	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF7
	CO43	1.35*LF1 + 0.75*LF2 + 1.5*LF5
	CO44	1.35*LF1 + 0.75*LF2 + 1.5*LF6
	CO45	1.35*LF1 + 0.75*LF2 + 1.5*LF7
	CO46	LF1
	CO47	LF1 + LF3
	CO48	LF1 + 0.5*LF2 + LF3
	CO49	LF1 + 0.5*LF2 + LF3 + 0.6*LF5
	CO50	LF1 + 0.5*LF2 + LF3 + 0.6*LF6
	CO51	LF1 + 0.5*LF2 + LF3 + 0.6*LF7
	CO52	LF1 + LF3 + 0.6*LF5
	CO53	LF1 + LF3 + 0.6*LF6
	CO54	LF1 + LF3 + 0.6*LF7
	CO55	LF1 + LF4
	CO56	LF1 + 0.7*LF3 + LF4
	CO57	LF1 + 0.5*LF2 + 0.7*LF3 + LF4
	CO58	LF1 + 0.5*LF2 + 0.7*LF3 + LF4 + 0.6*LF5
	CO59	LF1 + 0.5*LF2 + 0.7*LF3 + LF4 + 0.6*LF6
	CO60	LF1 + 0.5*LF2 + 0.7*LF3 + LF4 + 0.6*LF7
	CO61	LF1 + 0.7*LF3 + LF4 + 0.6*LF5
	CO62	LF1 + 0.7*LF3 + LF4 + 0.6*LF6
	CO63	LF1 + 0.7*LF3 + LF4 + 0.6*LF7
	CO64	LF1 + 0.5*LF2 + LF4
	CO65	LF1 + 0.5*LF2 + LF4 + 0.6*LF5
	CO66	LF1 + 0.5*LF2 + LF4 + 0.6*LF6
	CO67	LF1 + 0.5*LF2 + LF4 + 0.6*LF7
	CO68	LF1 + LF4 + 0.6*LF5
	CO69	LF1 + LF4 + 0.6*LF6
	CO70	LF1 + LF4 + 0.6*LF7
	CO71	LF1 + LF2
	CO72	LF1 + LF2 + 0.7*LF3
	CO73	LF1 + LF2 + 0.7*LF3 + 0.6*LF5
	CO74	LF1 + LF2 + 0.7*LF3 + 0.6*LF6
	CO75	LF1 + LF2 + 0.7*LF3 + 0.6*LF7
	CO76	LF1 + LF2 + 0.6*LF5
	CO77	LF1 + LF2 + 0.6*LF6
	CO78	LF1 + LF2 + 0.6*LF7
	CO79	LF1 + LF5
	CO80	LF1 + LF6
	CO81	LF1 + LF7
	CO82	LF1 + 0.7*LF3 + LF5
	CO83	LF1 + 0.7*LF3 + LF6
	CO84	LF1 + 0.7*LF3 + LF7
	CO85	LF1 + 0.5*LF2 + 0.7*LF3 + LF5
	CO86	LF1 + 0.5*LF2 + 0.7*LF3 + LF6
	CO87	LF1 + 0.5*LF2 + 0.7*LF3 + LF7
	CO88	LF1 + 0.5*LF2 + LF5
	CO89	LF1 + 0.5*LF2 + LF6
	CO90	LF1 + 0.5*LF2 + LF7

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1.1.1 GENERAL DATA

	CO91	LF1
	CO92	LF1 + 0.5*LF3
	CO93	LF1 + 0.5*LF3 + 1*LF4
	CO94	LF1 + 0.2*LF2
	CO95	LF1 + 0.2*LF2 + 0.3*LF3
	CO96	LF1 + 0.2*LF5
	CO97	LF1 + 0.2*LF6
	CO98	LF1 + 0.2*LF7
	CO99	LF1 + 0.3*LF3 + 0.2*LF5
	CO100	LF1 + 0.3*LF3 + 0.2*LF6
	CO101	LF1 + 0.3*LF3 + 0.2*LF7
	CO102	LF1
	CO103	LF1 + 0.3*LF3
Result combinations to design:	RC1	GZT (STR/GEO) - ständig / vorübergehend - Gl. 6.10
	RC2	GZG - Charakteristisch
	RC3	GZG - häufig
	RC4	GZG - Quasi-ständig

1.2 MATERIALS

Matl. No.	Description	Factor Category	Comment
1	Nadelholz C24 | DIN 1052 - 08	Solid Timber	

1.3.1 CROSS-SECTIONS

Sect. No.	Matl. No.	Cross-section Description [mm]	Max Design Ratio	Comment
1	1	H-Rechteck 240/320	0.10	Knotenlager
2	1	H-Rechteck 160/160	0.05	Pfosten
3	1	H-Rechteck 160/200	0.46	Diagonalen/Aufdoppelungen - vorher Tie
4	1	H-Rechteck 300/200	0.12	Dachträger

1.4 LOAD DURATION AND SERVICE CLASS

LC/CO/RC	LC, CO or RC Description	Load Case Type	Classification of Load Duration
LF1	Eigengewicht	Permanent	Permanent
LF2	Schnee	Snow (H ≤ 1000 m a.s.l.)	Short-term
LF3	Nutzlast	Imposed - Category A: domestic, residential areas	Medium-term
LF4	Nutzlast	Imposed - Category H: roofs	Short-term
LF5	Wind in +X	Wind	Short-term
LF6	Wind in -X	Wind	Short-term
LF7	Wind in +Y	Wind	Short-term
LK1	1.35*LF1	-	Permanent
LK2	1.35*LF1 + 1.5*LF3	-	Medium-term
LK3	1.35*LF1 + 0.75*LF2 + 1.5*LF3	-	Short-term
LK4	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 0.9*LF5	-	Short-term
LK5	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 0.9*LF6	-	Short-term
LK6	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 0.9*LF7	-	Short-term
LK7	1.35*LF1 + 1.5*LF3 + 0.9*LF5	-	Short-term
LK8	1.35*LF1 + 1.5*LF3 + 0.9*LF6	-	Short-term
LK9	1.35*LF1 + 1.5*LF3 + 0.9*LF7	-	Short-term
LK10	1.35*LF1 + 1.5*LF4	-	Short-term
LK11	1.35*LF1 + 1.05*LF3 + 1.5*LF4	-	Short-term
LK12	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF4	-	Short-term
LK13	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF4 + 0.9*LF5	-	Short-term
LK14	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF4 + 0.9*LF6	-	Short-term
LK15	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF4 + 0.9*LF7	-	Short-term
LK16	1.35*LF1 + 1.05*LF3 + 1.5*LF4 + 0.9*LF5	-	Short-term
LK17	1.35*LF1 + 1.05*LF3 + 1.5*LF4 + 0.9*LF6	-	Short-term
LK18	1.35*LF1 + 1.05*LF3 + 1.5*LF4 + 0.9*LF7	-	Short-term
LK19	1.35*LF1 + 0.75*LF2 + 1.5*LF4	-	Short-term
LK20	1.35*LF1 + 0.75*LF2 + 1.5*LF4 + 0.9*LF5	-	Short-term
LK21	1.35*LF1 + 0.75*LF2 + 1.5*LF4 + 0.9*LF6	-	Short-term
LK22	1.35*LF1 + 0.75*LF2 + 1.5*LF4 + 0.9*LF7	-	Short-term
LK23	1.35*LF1 + 1.5*LF4 + 0.9*LF5	-	Short-term
LK24	1.35*LF1 + 1.5*LF4 + 0.9*LF6	-	Short-term
LK25	1.35*LF1 + 1.5*LF4 + 0.9*LF7	-	Short-term
LK26	1.35*LF1 + 1.5*LF2	-	Short-term
LK27	1.35*LF1 + 1.5*LF2 + 1.05*LF3	-	Short-term
LK28	1.35*LF1 + 1.5*LF2 + 1.05*LF3 + 0.9*LF5	-	Short-term
LK29	1.35*LF1 + 1.5*LF2 + 1.05*LF3 + 0.9*LF6	-	Short-term
LK30	1.35*LF1 + 1.5*LF2 + 1.05*LF3 + 0.9*LF7	-	Short-term

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■ 1.4 LOAD DURATION AND SERVICE CLASS

LC/CO/ RC	LC, CO or RC Description	Load Case Type	Classification of Load Duration
LK31	1.35*LF1 + 1.5*LF2 + 0.9*LF5	-	Short-term
LK32	1.35*LF1 + 1.5*LF2 + 0.9*LF6	-	Short-term
LK33	1.35*LF1 + 1.5*LF2 + 0.9*LF7	-	Short-term
LK34	1.35*LF1 + 1.5*LF5	-	Short-term
LK35	1.35*LF1 + 1.5*LF6	-	Short-term
LK36	1.35*LF1 + 1.5*LF7	-	Short-term
LK37	1.35*LF1 + 1.05*LF3 + 1.5*LF5	-	Short-term
LK38	1.35*LF1 + 1.05*LF3 + 1.5*LF6	-	Short-term
LK39	1.35*LF1 + 1.05*LF3 + 1.5*LF7	-	Short-term
LK40	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF5	-	Short-term
LK41	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF6	-	Short-term
LK42	1.35*LF1 + 0.75*LF2 + 1.05*LF3 + 1.5*LF7	-	Short-term
LK43	1.35*LF1 + 0.75*LF2 + 1.5*LF5	-	Short-term
LK44	1.35*LF1 + 0.75*LF2 + 1.5*LF6	-	Short-term
LK45	1.35*LF1 + 0.75*LF2 + 1.5*LF7	-	Short-term
LK46	LF1	-	Permanent
LK47	LF1 + LF3	-	Medium-term
LK48	LF1 + 0.5*LF2 + LF3	-	Short-term
LK49	LF1 + 0.5*LF2 + LF3 + 0.6*LF5	-	Short-term
LK50	LF1 + 0.5*LF2 + LF3 + 0.6*LF6	-	Short-term
LK51	LF1 + 0.5*LF2 + LF3 + 0.6*LF7	-	Short-term
LK52	LF1 + LF3 + 0.6*LF5	-	Short-term
LK53	LF1 + LF3 + 0.6*LF6	-	Short-term
LK54	LF1 + LF3 + 0.6*LF7	-	Short-term
LK55	LF1 + LF4	-	Short-term
LK56	LF1 + 0.7*LF3 + LF4	-	Short-term
LK57	LF1 + 0.5*LF2 + 0.7*LF3 + LF4	-	Short-term
LK58	LF1 + 0.5*LF2 + 0.7*LF3 + LF4 + 0.6*LF5	-	Short-term
LK59	LF1 + 0.5*LF2 + 0.7*LF3 + LF4 + 0.6*LF6	-	Short-term
LK60	LF1 + 0.5*LF2 + 0.7*LF3 + LF4 + 0.6*LF7	-	Short-term
LK61	LF1 + 0.7*LF3 + LF4 + 0.6*LF5	-	Short-term
LK62	LF1 + 0.7*LF3 + LF4 + 0.6*LF6	-	Short-term
LK63	LF1 + 0.7*LF3 + LF4 + 0.6*LF7	-	Short-term
LK64	LF1 + 0.5*LF2 + LF4	-	Short-term
LK65	LF1 + 0.5*LF2 + LF4 + 0.6*LF5	-	Short-term
LK66	LF1 + 0.5*LF2 + LF4 + 0.6*LF6	-	Short-term
LK67	LF1 + 0.5*LF2 + LF4 + 0.6*LF7	-	Short-term
LK68	LF1 + LF4 + 0.6*LF5	-	Short-term
LK69	LF1 + LF4 + 0.6*LF6	-	Short-term
LK70	LF1 + LF4 + 0.6*LF7	-	Short-term
LK71	LF1 + LF2	-	Short-term
LK72	LF1 + LF2 + 0.7*LF3	-	Short-term
LK73	LF1 + LF2 + 0.7*LF3 + 0.6*LF5	-	Short-term
LK74	LF1 + LF2 + 0.7*LF3 + 0.6*LF6	-	Short-term
LK75	LF1 + LF2 + 0.7*LF3 + 0.6*LF7	-	Short-term
LK76	LF1 + LF2 + 0.6*LF5	-	Short-term
LK77	LF1 + LF2 + 0.6*LF6	-	Short-term
LK78	LF1 + LF2 + 0.6*LF7	-	Short-term
LK79	LF1 + LF5	-	Short-term
LK80	LF1 + LF6	-	Short-term
LK81	LF1 + LF7	-	Short-term
LK82	LF1 + 0.7*LF3 + LF5	-	Short-term
LK83	LF1 + 0.7*LF3 + LF6	-	Short-term
LK84	LF1 + 0.7*LF3 + LF7	-	Short-term
LK85	LF1 + 0.5*LF2 + 0.7*LF3 + LF5	-	Short-term
LK86	LF1 + 0.5*LF2 + 0.7*LF3 + LF6	-	Short-term
LK87	LF1 + 0.5*LF2 + 0.7*LF3 + LF7	-	Short-term
LK88	LF1 + 0.5*LF2 + LF5	-	Short-term
LK89	LF1 + 0.5*LF2 + LF6	-	Short-term
LK90	LF1 + 0.5*LF2 + LF7	-	Short-term
LK91	LF1	-	Permanent
LK92	LF1 + 0.5*LF3	-	Medium-term
LK93	LF1 + 0.3*LF3 + 0*LF4	-	Short-term
LK94	LF1 + 0.2*LF2	-	Short-term
LK95	LF1 + 0.2*LF2 + 0.3*LF3	-	Short-term
LK96	LF1 + 0.2*LF5	-	Short-term
LK97	LF1 + 0.2*LF6	-	Short-term
LK98	LF1 + 0.2*LF7	-	Short-term
LK99	LF1 + 0.3*LF3 + 0.2*LF5	-	Short-term
LK100	LF1 + 0.3*LF3 + 0.2*LF6	-	Short-term
LK101	LF1 + 0.3*LF3 + 0.2*LF7	-	Short-term
LK102	LF1	-	Permanent
LK103	LF1 + 0.3*LF3	-	Medium-term

Service Class SECL
Service Class 2: Identical for All Members/Sets of Members

■ 2.2 DESIGN BY CROSS-SECTION

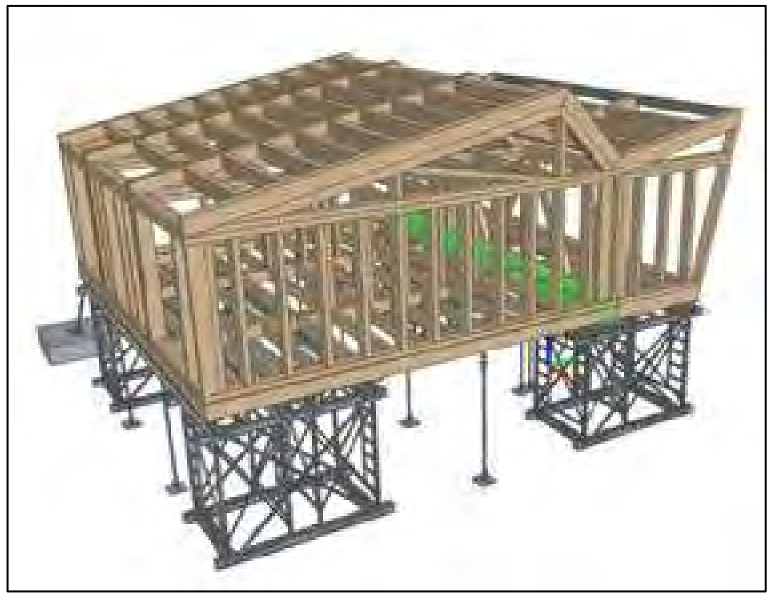
Sect. No.	Member No.	Location x [m]	LC/CO/ RC	Design		Design No.	Description
1	H-Rechteck 240/300 - Bodenträger						
	6	0.821	LK88	0.00	≤ 1	100)	Cross-section resistance - Negligible internal forces
	3	0.000	LK40	0.02	≤ 1	101)	Cross-section resistance - Tension along the grain acc. to 10.2.1
	1	0.730	LK44	0.01	≤ 1	102)	Cross-section resistance - Compression along the grain acc. to 10.2.3
	1	1.461	LK2	0.10	≤ 1	111)	Cross-section resistance - Shear due to shear force Vz/Vy acc. to 10.2.9
	1	0.584	LK2	0.03	≤ 1	151)	Cross-section resistance - Uniaxial bending acc. to 10.2.6

■ 2.2 DESIGN BY CROSS-SECTION

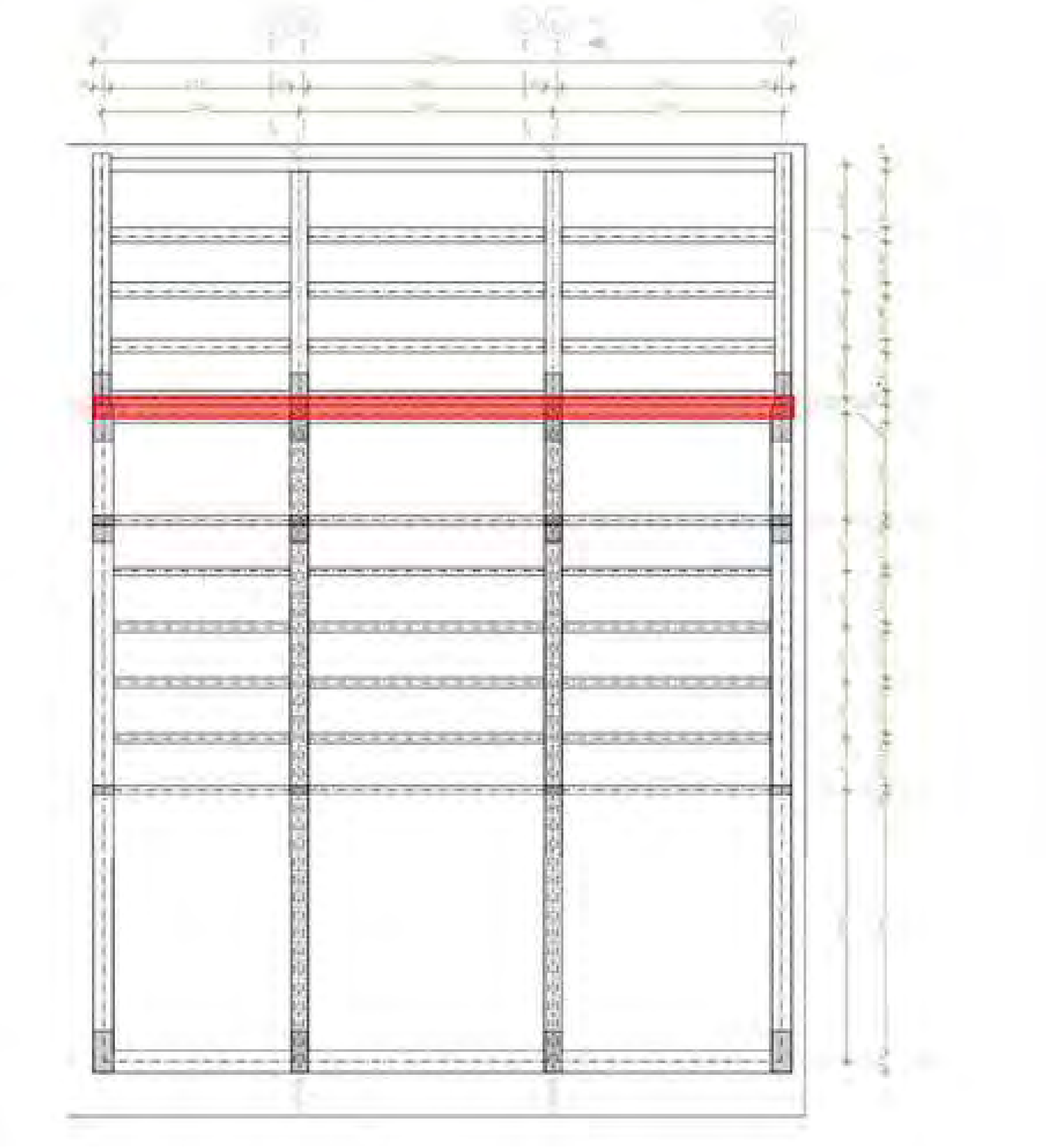
Sect. No.	Member No.	Location x [m]	LC/CO/ RC	Design		Design No.	Description
	3	1.500	LK4	0.03	≤ 1	161)	Cross-section resistance - Uniaxial bending and tension acc. to 10.2.7
	3	1.500	LK3	0.02	≤ 1	171)	Cross-section resistance - Uniaxial bending and compression acc. to 10.2.8
	1	1.006	LK44	0.01	≤ 1	300)	Stability - Axial compression acc. to 10.3.1 - Buckling about both axes
	1	0.584	LK2	0.03	≤ 1	311)	Stability - Uniaxial bending without compression acc. to 10.3.2
	1	0.584	LK3	0.03	≤ 1	322)	Stability - Uniaxial bending and compression acc. to 10.3.3
	4	0.000	LK2	0.02	≤ 1	351)	Stability - Uniaxial bending and tension acc. to 10.3.4
2	H-Rechteck 100/100 - Pfosten						
	22	0.000	LF5	0.00	≤ 1	100)	Cross-section resistance - Negligible internal forces
	22	2.656	LK13	0.04	≤ 1	102)	Cross-section resistance - Compression along the grain acc. to 10.2.3
	22	2.656	LK13	0.05	≤ 1	300)	Stability - Axial compression acc. to 10.3.1 - Buckling about both axes
3	H-Rechteck 100/200 - Diagonalen/Außenpfosten + neben Tür						
	14	0.986	LK93	0.00	≤ 1	100)	Cross-section resistance - Negligible internal forces
	16	0.000	LF5	0.01	≤ 1	101)	Cross-section resistance - Tension along the grain acc. to 10.2.1
	19	2.979	LK13	0.04	≤ 1	102)	Cross-section resistance - Compression along the grain acc. to 10.2.3
	17	3.050	LK1	0.01	≤ 1	111)	Cross-section resistance - Shear due to shear force Vz/Vy acc. to 10.2.9
	17	1.525	LK35	0.01	≤ 1	151)	Cross-section resistance - Uniaxial bending acc. to 10.2.6
	16	1.865	LK34	0.01	≤ 1	161)	Cross-section resistance - Uniaxial bending and tension acc. to 10.2.7
	17	1.525	LK1	0.01	≤ 1	171)	Cross-section resistance - Uniaxial bending and compression acc. to 10.2.8
	19	2.979	LK13	0.06	≤ 1	300)	Stability - Axial compression acc. to 10.3.1 - Buckling about both axes
	17	1.525	LK35	0.01	≤ 1	311)	Stability - Uniaxial bending without compression acc. to 10.3.2
	19	1.655	LK13	0.06	≤ 1	322)	Stability - Uniaxial bending and compression acc. to 10.3.3
	16	1.865	LK34	0.00	≤ 1	351)	Stability - Uniaxial bending and tension acc. to 10.3.4
4	H-Rechteck 200/200 - Dachträger						
	7	0.232	LK93	0.00	≤ 1	100)	Cross-section resistance - Negligible internal forces
	12	2.718	LK12	0.00	≤ 1	101)	Cross-section resistance - Tension along the grain acc. to 10.2.1
	8	0.879	LK40	0.01	≤ 1	102)	Cross-section resistance - Compression along the grain acc. to 10.2.3
	12	0.000	LK1	0.02	≤ 1	111)	Cross-section resistance - Shear due to shear force Vz/Vy acc. to 10.2.9
	10	3.000	LK1	0.02	≤ 1	151)	Cross-section resistance - Uniaxial bending acc. to 10.2.6
	12	0.000	LK1	0.02	≤ 1	161)	Cross-section resistance - Uniaxial bending and tension acc. to 10.2.7
	8	0.000	LK13	0.01	≤ 1	171)	Cross-section resistance - Uniaxial bending and compression acc. to 10.2.8
	7	0.000	LK40	0.01	≤ 1	300)	Stability - Axial compression acc. to 10.3.1 - Buckling about both axes
	7	1.461	LK13	0.02	≤ 1	322)	Stability - Uniaxial bending and compression acc. to 10.3.3

Pos. 11 – Timber Beam Module Joint

Overview



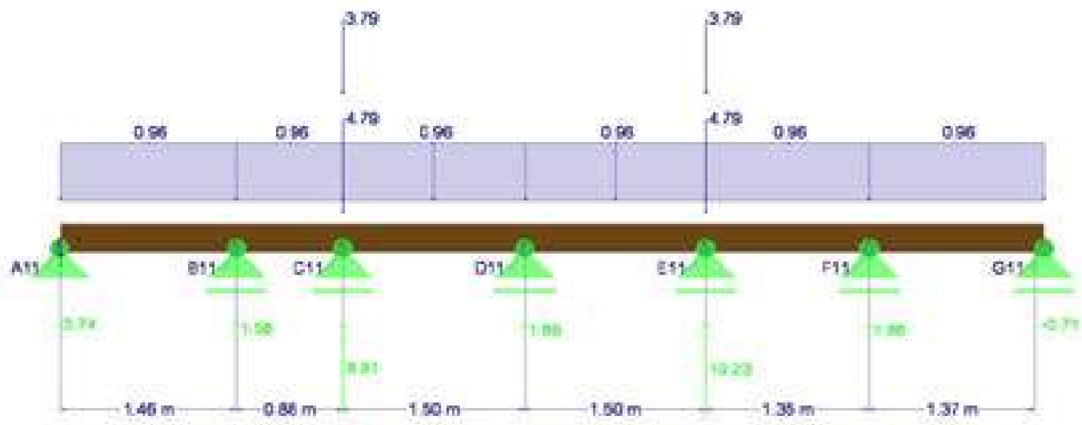
Load application area



Loads

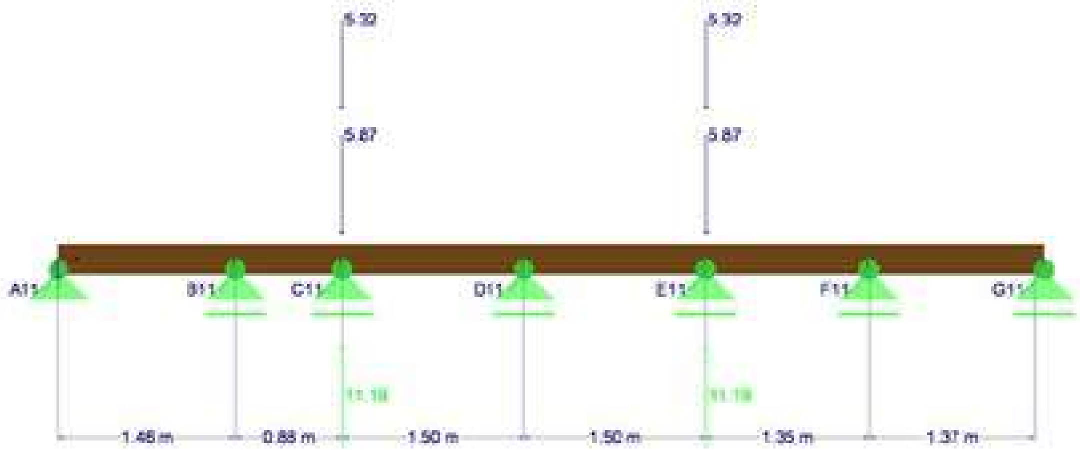
Dead loads		surface loads [kN/m²]	unif. distr. Load [kN/m]	point load [kN]
support reaction 7.1a Interior Beam (interior module)	D7.1a			4,79
support reaction 7.2a Interior Beam (exterior module)	D7.2a			3,79
dead load Window Façade at Module Split	g_{WF}		0,96	

Load case 1 (LF1):



Live loads		surface loads [kN/m²]	unif. distr. Load [kN/m]	point load [kN]
support reaction 7.1a Interior Beam (interior module)	D7.1a			5,87
support reaction 7.2a Interior Beam (exterior module)	D7.2a			5,32

Load case 2 (LF2):



Load case combinations

LK1	1.35*LF1
LK2	1.35*LF1 + 1.5*LF2
LK3	1.35*LF1 + 1.5*LF2 + 1.05*LF4
LK4	1.35*LF1 + 1.5*LF2 + 1.05*LF4 + 0.9*LF5
LK5	1.35*LF1 + 1.5*LF2 + 0.9*LF5
LK6	1.35*LF1 + 1.5*LF3
LK7	1.35*LF1 + 0.75*LF2 + 1.5*LF3
LK8	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 1.05*LF4
LK9	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 1.05*LF4 + 0.9*LF5
LK10	1.35*LF1 + 0.75*LF2 + 1.5*LF3 + 0.9*LF5
LK11	1.35*LF1 + 1.5*LF3 + 1.05*LF4
LK12	1.35*LF1 + 1.5*LF3 + 1.05*LF4 + 0.9*LF5
LK13	1.35*LF1 + 1.5*LF3 + 0.9*LF5
LK14	1.35*LF1 + 1.5*LF4
LK15	1.35*LF1 + 0.75*LF2 + 1.5*LF4
LK16	1.35*LF1 + 0.75*LF2 + 1.5*LF4 + 0.9*LF5
LK17	1.35*LF1 + 1.5*LF4 + 0.9*LF5
LK18	1.35*LF1 + 1.5*LF5
LK19	1.35*LF1 + 0.75*LF2 + 1.5*LF5
LK20	1.35*LF1 + 0.75*LF2 + 1.05*LF4 + 1.5*LF5
LK21	1.35*LF1 + 1.05*LF4 + 1.5*LF5

Support reactions

$A10_g$	**0,74**	kN
$B10_g$	**1,58**	kN
$C10_g$	**9,91**	kN
$D10_g$	**1,89**	kN
$E10_g$	**10,23**	kN
$F10_g$	**1,86**	kN
$G10_g$	**0,71**	kN

$A10_p$ (roof)	**0,00**	kN
$B10_p$ (roof)	**0,00**	kN
C10p (roof)	**11,19**	kN
D10p (roof)	**0,00**	kN
E10p (roof)	**11,19**	kN
F10p (roof)	**0,00**	kN
G10p (roof)	**0,00**	kN

Check

No checks conducted. This member is not working as a structurally required beam, since it is directly supported by the flexural steel girder below. For the structural analysis of the steel girder see "Standsicherheitsnachweis DOKA".

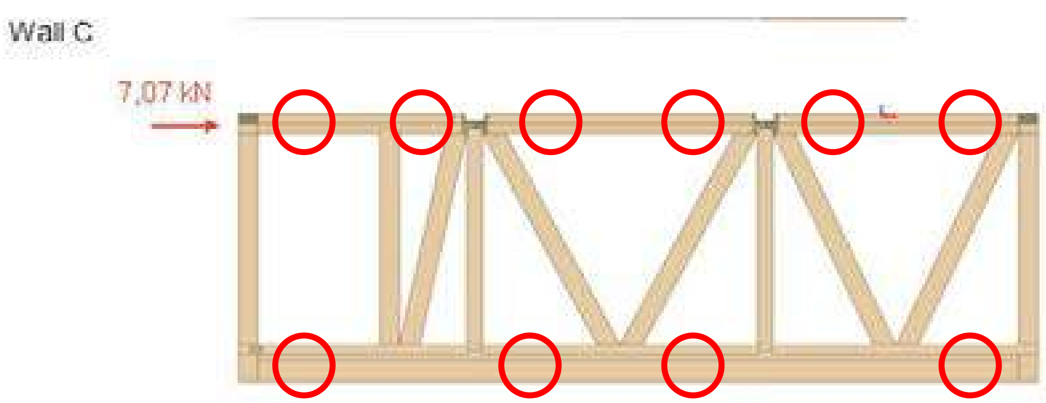
Details

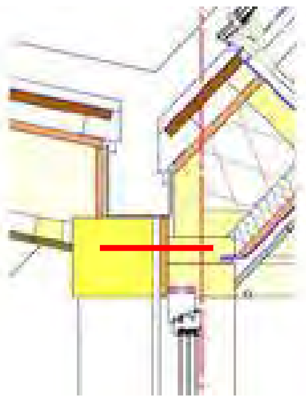
Connections between cross-sections that are considered as load-bearing components in this calculation must be constructed to be shear-resistant. Direct force transmission between beams and columns must be ensured.

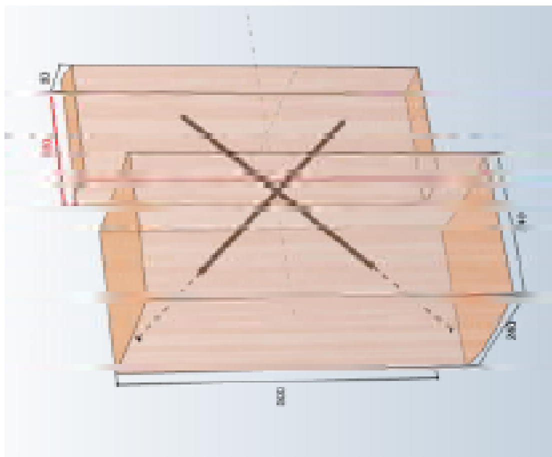
Details of the main load-bearing structure that are not part of this calculation are to be verified by the executing company. Details and fasteners can be replaced by alternatives that have at least the same capabilities in terms of load-bearing and stiffness.

Pos. D01 – Detail connection truss wall to main structure

Horizontal load transfer from the main structure to the truss wall due to wind:







Gaps in the construction are to be filled rigidly.

Assumption: force distribution along two connections of crossed screws.

Screw: Fischer FPF-ZT ZPF ø8,0 mm x 375 mm or equal

Detail design analysis see appendix.

Pos. D02 – Detail walls post to substructure

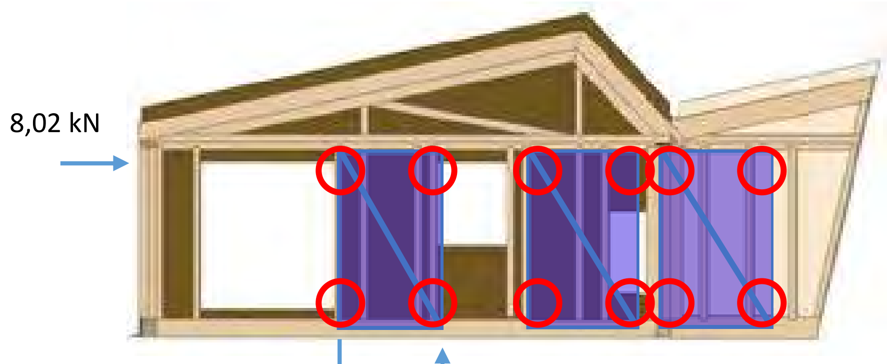
Load from wind – decisive situation:

Dimensions of wall panel – h = 2,46 m l = 1,25 m

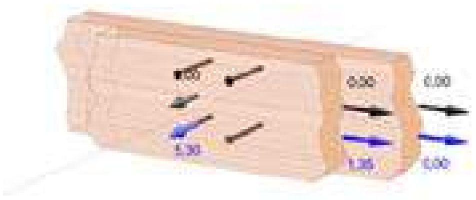
Conservative assumption: no dead loads taken into account.

Uplifting load: F_v = 8,02 / 3 * 2,46 / 1,25 = 5,3 kN

Shear force: F_h = 8,02 / 3 / 2 = 1,35 kN



Chosen screw: FPF-ST ZPP ø10,0 mm x 140 mm or equal



Detail design analysis see appendix.

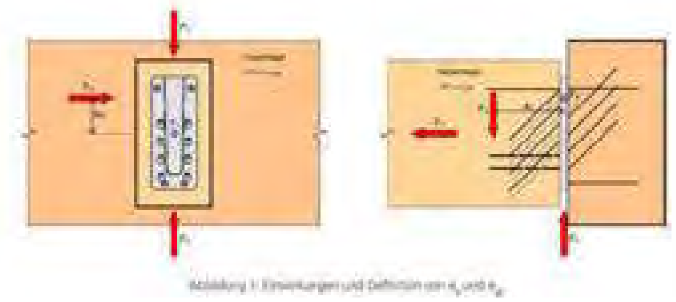
Pos. D03 – Joist to main beam roof

Support reactions from Pos. 1

$A1_g$	1,33 kN
$B1_g$	1,33 kN
$A1_p$	0,90 kN
$B1_p$	0,90 kN
$A1_s$	0,91 kN
$B1_s$	0,91 kN
$A1_w$	0,09 kN
$B1_w$	0,09 kN

Max vertical load: $F_{2,d}$ = 1,35 x 1,33 + 1,5 x (0,9+0,91+0,09) = 4,64 kN (conservative)

Analysis according to ETA-15/0187



Der **charakteristische Wert ($F_{2,Rk}$)** ist gemäß ETA-15/0187 berechnet.

Der **Bemessungswert der Tragfähigkeit ("Design-Wert": $F_{2,Rd}$)** ist nach EN 1995-1-1 (Eurocode 5) gegeben.

$F_{2,Rd} = k_{mod} \cdot \frac{F_{2,Rk}}{\gamma_M}$; γ_M = 1,3 für Verbindungen nach EN 1995-1-1 bzw. entsprechend NAD

Dabei ist
$F_{2,Rk}$ der charakteristische Wert der Tragfähigkeit in Einschubrichtung;
γ_M der Teilsicherheitsbeiwert für das Verbindungsmittel;
k_{mod} der Modifikationsbeiwert zur Berücksichtigung der Lasteinwirkungsdauer und dem Feuchtegehalt

HVP-Verbinder mit Schrauben Ø 4,5

HVP-Verbinder			Tragfähigkeit in Einschubrichtung bei C24 in [kN]		
Serie	Art-Nr.	Abmessungen (B x H x D)	$F_{2,Rk}$ mit Schrauben Ø 4,5 mm [1]		
			50 mm	60 mm	80 mm
880	88004.1000	25 x 40 x 12	2,26	2,67	3,54
	88006.1000	25 x 60 x 12	4,52	5,33	7,08
	88008.1000	25 x 80 x 12	6,79	8,00	10,62
	88010.1000	25 x 100 x 12	9,05	10,66	14,16
881	88107.1000	40 x 70 x 12	6,79	8,00	10,62
	88109.1000	40 x 90 x 12	9,05	10,66	14,16
	88111.1000	40 x 110 x 12	11,31	13,33	17,70
	88113.1000	40 x 130 x 12	13,57	15,99	21,24
	88115.1000	40 x 150 x 12	18,10	21,33	28,32

[1] f_d = l - 6 mm

K_{mod} = 0,7 (conservative)

γ_M = 1,3

Chosen: Pitzl HVP Verbinder Connector 88111.1000 + screws d = 4,5 mm, L = 80mm

Wood C24

$F_{2,Rd} = 0{,}7\frac{14{,}16kN}{1{,}3} = 7{,}62\ kN$ > 4,64 kN = $F_{2,d}$ ⇒ OK

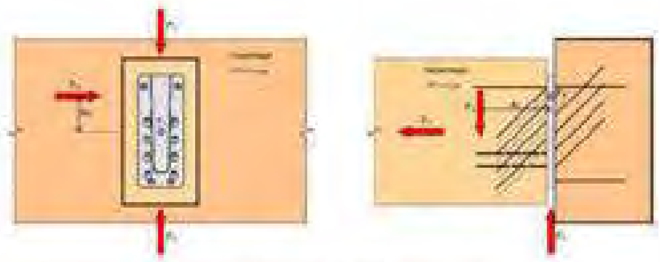
Pos. D04 – Joist to main beam floor

Support reactions from Pos. 7

$A7.0_g$	5,73 kN
$B7.0_g$	5,73 kN
$A7.0_p$	2,27 kN
$B7.0_p$	2,27 kN

Max vertical load: $F_{2,d}$ = 1,35 x 5,73 + 1,5 x 2,27 = 11,14 kN

Analysis according to ETA-15/0187



Der **charakteristische Wert ($F_{2,Rk}$)** ist gemäß ETA-15/0187 berechnet.

Der **Bemessungswert der Tragfähigkeit ("Design-Wert": $F_{2,Rd}$)** ist nach EN 1995-1-1 (Eurocode 5) gegeben:

$F_{2,Rd} = k_{mod} \cdot \frac{F_{2,Rk}}{\gamma_M}$; γ_M = 1,3 für Verbindungen nach EN 1995-1-1 bzw. entsprechend NAD

Dabei ist
$F_{2,Rk}$ der charakteristische Wert der Tragfähigkeit in Einschubrichtung;
γ_M der Teilsicherheitsbeiwert für das Verbindungsmittel;
k_{mod} der Modifikationsbeiwert zur Berücksichtigung der Lasteinwirkungsdauer und dem Feuchtegehalt

HVP-Verbinder mit Schrauben Ø 4,5

HVP-Verbinder			Tragfähigkeit in Einschubrichtung bei C24 in [kN]		
Serie	Art-Nr.	Abmessungen (B x H x D)	$F_{2,Rk}$ mit Schrauben Ø 4,5 mm [1]		
			50 mm	60 mm	80 mm
880	88004.1000	25 x 40 x 12	2,26	2,67	3,54
	88006.1000	25 x 60 x 12	4,52	5,33	7,08
	88008.1000	25 x 80 x 12	6,79	8,00	10,62
	88010.1000	25 x 100 x 12	9,05	10,66	14,16
881	88107.1000	40 x 70 x 12	6,79	8,00	10,62
	88109.1000	40 x 90 x 12	9,05	10,66	14,16
	88111.1000	40 x 110 x 12	11,31	13,33	17,70
	88113.1000	40 x 130 x 12	13,57	15,99	21,24
	88115.1000	40 x 150 x 12	18,10	21,33	28,32

[1] f_d = l - 6 mm

K_{mod} = 0,7

γ_M = 1,3

Chosen: Pitzl HVP Verbinder Connector 88115.1000 + screws d = 4,5 mm, L = 80mm

Wood C24

$F_{2,Rd} = 0{,}7 \frac{28{,}32 kN}{1{,}3} = 15{,}25\ kN$ > 11,14 kN = $F_{2,d}$ ⇒ OK

Pos. D04 – Column on beam

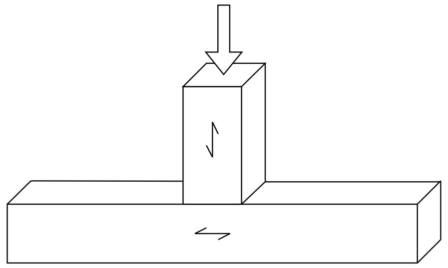
The loads of the columns in the wall are transferred via pressure to the beams in the floor. The same applies to the top of the column.

The detail at the column with the largest loads and the smallest cross-section is decisive. Therefore, the check is performed at position 4.1.

In the following, the check for compression perpendicular to the grain is performed.

Since the verification is not fulfilled, the required support area is calculated. The executing company must distribute the loads sufficiently either by increasing the cross-section of the column or by using a hardwood plate.

 # System



 # Cross-section: 10x10 cm²

Parameter	Symbol	Value	Unit
Height	h	100	mm
Width	b	100	mm
Area	A	10000	mm²

 # Material: C24

Parameter	Symbol	Value	Unit
Characteristic compressive strength perpendicular to the gr	$f_{c,90,k}$	2,5	N/mm²

Ultimate Limit State

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of compressive force	$N_{Ed,c}$	26,90	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Short-term	
Modification factor	k_{mod}	0,9	-
Factor for compression perpendicular	$k_{c,90}$	1,0	-

 # Check

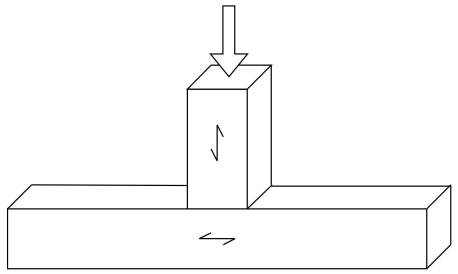
Parameter	Symbol	Value	Unit
Design compressive stress perpendicularto the grain	$\sigma_{c,90,d}$	2,69	N/mm²
Design compressive strength perpendicular to the grain	$f_{c,90,d}$	1,73	N/mm²

 # Compression perpendicular to the grain (*DIN EN 1995-1-1 6.1.5*)

$$\eta = \frac{\sigma_{c,90,d}}{k_{c,90} * f_{c,90,d}} \leq 1$$

Stress ratio $\eta_{Stability}$ **155%**

 # System



 # Cross-section: 10x10 cm²

Parameter	Symbol	Value	Unit
Height	h	100	mm
Width	b	100	mm
Area	A	10000	mm²

 # Material: C24

Parameter	Symbol	Value	Unit
Characteristic compressive strength perpendicular to the	$f_{c,90,k}$	2,5	N/mm²

Ultimate Limit State

 # Internal Forces

Parameter	Symbol	Value	Unit
Design value of compressive force	$N_{Ed,c}$	14,24	kN

 # Factors

Parameter	Symbol	Value	Unit
Partial factor	γ_M	1,3	-
Service class	NKL	1	-
Load duration class	KLED	Permanent	
Modification factor	k_{mod}	0,6	-
Factor for compression perpendicular	$k_{c,90}$	1,0	-

 # Check

Parameter	Symbol	Value	Unit
Design compressive stress perpendicularto the grain	$\sigma_{c,90,d}$	1,42	N/mm²
Design compressive strength perpendicular to the grain	$f_{c,90,d}$	1,15	N/mm²

 # Compression perpendicular to the grain (*DIN EN 1995-1-1 6.1.5*)

$$\eta = \frac{\sigma_{c,90,d}}{k_{c,90} * f_{c,90,d}} \leq 1$$

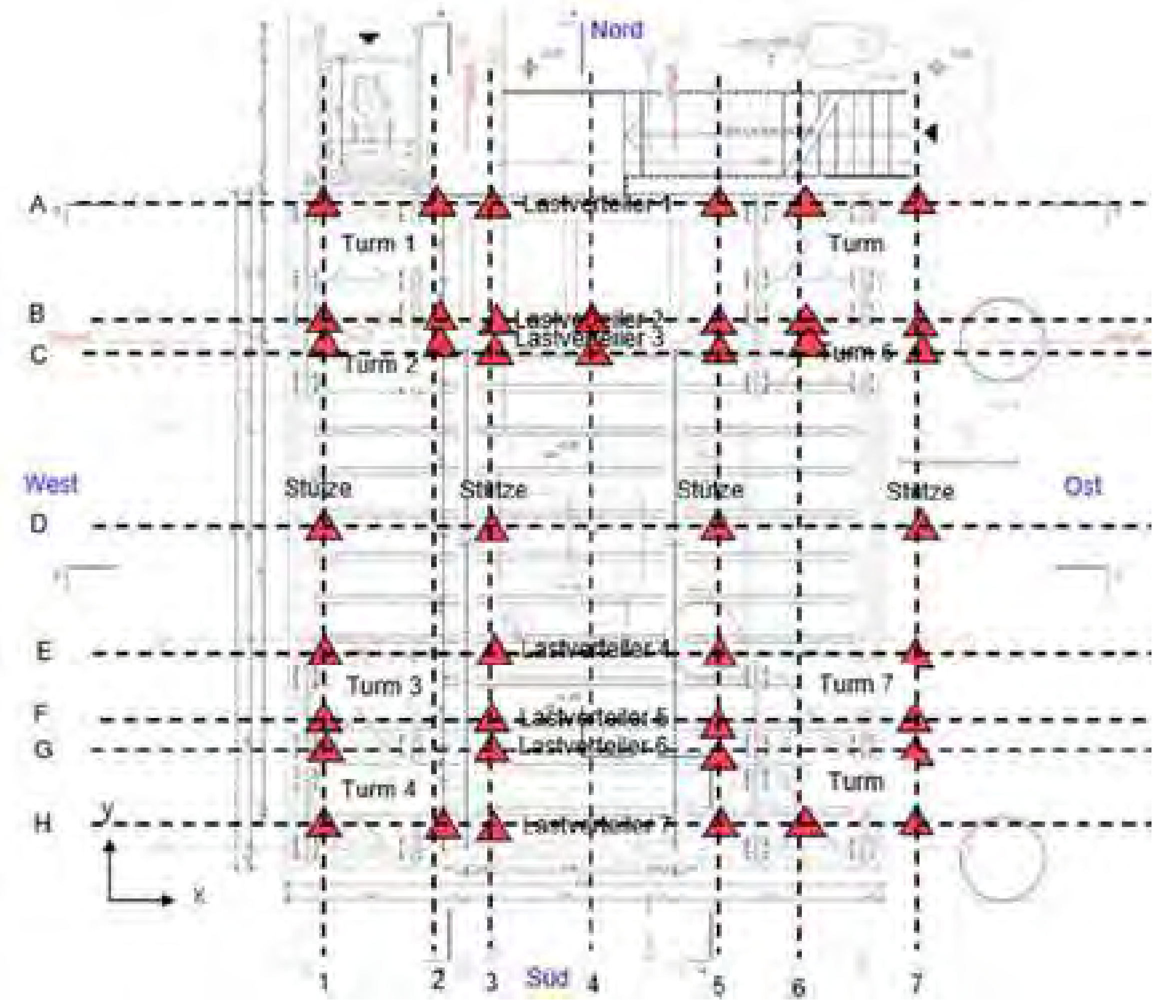
Stress ratio $\eta_{Stability}$ **123%**

 # Required support area

Parameter	Symbol	Value	Unit
Design compressive strength perpendicular to the grain	$f_{c,90,d}$	1,73	N/mm²
Design value of compressive force	$N_{Ed,c}$	26,90	kN
Factor for compression perpendicular	$k_{c,90}$	1,0	-
Required support area	A_{req}	15542	mm²
Recommended cross section		10x16	cm²

Transfer Support Reactions to Supporting Steel Scaffolding Structure (DOKA)

For the interface between the wooden construction and the scaffolding system below, several supports for the HDU were defined and are depicted below.



In an order to have a safe interface for the structural analysis of DOKA, we decided to increase the loads by a safety factor of γ = 1,1. Hence, the following point loads were handed over to DOKA (i*n German upon request of the firm)*:

Vertikale Lasten *(positives Vorzeichen: Last in Richtung der Gravitation. negatives Vorzeichen: abhebende Last*

	Lastangriffspunkt	*Achse*	Eigengewicht	Nutzlast Wohnraum >0	Nutzlast Wohnraum <0	Nutzlast Dach >0	Nutzlast Dach <0	Schneelast	Windlast in +y	Windlast in +x	Windlast in -y	Windlast in -x
Lastverteiler 1	**0,00 m**	**A1**	13,22	2,82		7,30		4,93				
	1,53 m	**A2**	0,45	2,79		0,00		0,00				
	2,33 m	**A3**	1,79	11,08		0,00		0,00				
	5,43 m	**A5**	1,77	10,99		0,00		0,00				
	6,60 m	**A6**	0,70	4,37		0,00		0,00				
	8,13 m	**A7**	13,24	2,89		7,30		4,93				
Lastverteiler 2	**0,00 m**	**B1**	7,73	2,68		5,80		2,66	-0,15	0,00		0,00
	1,46 m	**B2**	6,47	5,59		3,87		2,13	-0,04	-3,98		3,18
	2,34 m	**B3**	5,17	4,84		3,59		1,96	-0,04	-0,09		0,00
	3,84 m	**B4**	8,88	6,72		6,13		3,34	-0,08	0,87		0,34
	5,34 m	**B5**	6,00	6,03		4,00		2,18	-0,06	0,19		-0,23
	6,69 m	**B6**	8,05	6,39		6,02		3,06	-0,11	1,41		-0,84
	8,13 m	**B7**	6,25	3,77		6,39		1,73	-0,10	1,60		-2,45
Lastverteiler 3	**0,00 m**	**C1**	8,55	4,13	-0,01					2,82		-2,82
	1,46 m	**C2**	1,74	0,00								
	2,34 m	**C3**	10,90	12,31								
	3,84 m	**C4**	2,08	0,00								
	5,34 m	**C5**	11,25	12,31								
	6,69 m	**C6**	2,05	0,00								
	8,13 m	**C7**	0,78	4,13	-0,01					2,82		-2,82
Stütze 1		**D1**	33,83	10,77		8,60		4,32	0,88	1,31		-1,31
Stütze 2		**D3**	52,20	22,65		13,73		7,85	1,56			
Stütze 3		**D5**	52,20	22,65		13,73		7,85	1,56			
Stütze 4		**D7**	33,83	10,77		8,60		4,32	0,88	1,31		-1,31
Lastverteiler 4	**0,00 m**	**E1**	9,88	5,85	-0,61					-3,85		3,85
	2,33 m	**E3**	9,44	12,31	-1,28							
	5,43 m	**E5**	9,44	12,31	-1,28							
	8,13 m	**E7**	9,88	5,85	-0,605					-3,85		3,85
Lastverteiler 5	**0,00 m**	**F1**	4,20	2,85	-0,62					-0,31		0,31
	2,33 m	**F3**	2,76	5,98	-1,30							
	5,43 m	**F5**	2,76	5,98	-1,30							
	8,13 m	**F7**	4,20	2,85	-0,616					-0,31		0,31
Lastverteiler 6	**0,00 m**	**G1**	5,93	3,18	-0,03					0,04		-0,04
	2,33 m	**G3**	4,79	6,69	-0,07							
	5,43 m	**G5**	4,79	6,69	-0,07							
	8,13 m	**G7**	5,93	3,18	-0,033					0,04		-0,04
Lastverteiler 7	**0,00 m**	**H1**	10,23	1,63		3,10		1,56	0,25	0,12		-0,12
	1,53 m	**H2**	2,26	0,00		0,00		0,00	0,00	-2,26		2,26
	2,33 m	**H3**	20,54	3,42		6,01		3,01	0,47	-1,29		1,29
	5,43 m	**H5**	20,47	3,42		6,01		3,01	0,47	2,89		-2,89
	6,60 m	**H6**	3,53	0,00		0,00		0,00	0,00	0,58		-0,58
	8,13 m	**H7**	10,30	1,63		3,10		1,56	0,25	-0,04		0,04

Horizontale Lasten

	Lastangriffspunkt	*char. Last* F_k [kN]	Eigengewicht	Nutzlast Wohnraum >0	Nutzlast Wohnraum <0	Nutzlast Dach >0	Nutzlast Dach <0	Schneelast	Windlast in +y	Windlast in +x	Windlast in -y	Windlast in -x
Turm 1-8									3,26	3,06	3,26	3,06

Dated: 18-03-2022

APPENDIX

Analysis of screw connections

Produktinfo

FPF-ZT ZPF ø8,0 mm x 295 mm

Power-Full | *Zylinderkopf* | *Torx* | *Vollgewinde* | *Stahl*

Anzahl (Gesamt)	2 Stück
Artikelnummer 659307	50 Stück / VE

Eingaben - Holzbau - Zugscherverbindung

Träger

Höhe	200 mm
Breite	80 mm

Nadelholz / C24 / Fichte, Tanne oder Kiefer

Seitenlaschen

Anordnung	Links
Höhe	240 mm
Breite	240 mm
Überlappung	500 mm

Nadelholz / C24 / Fichte, Tanne oder Kiefer

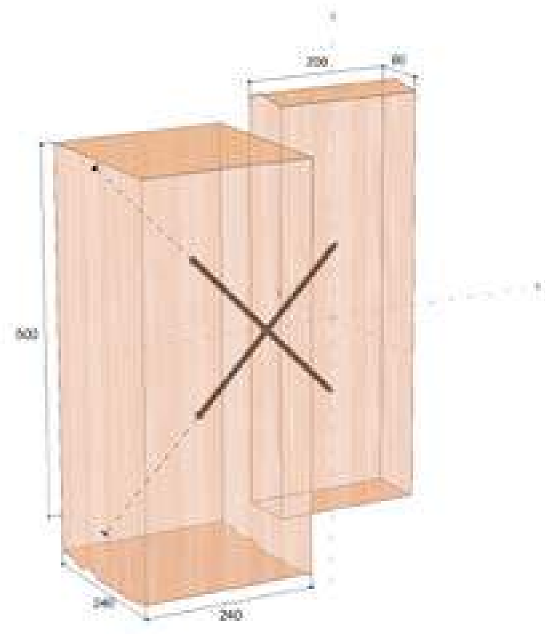
Belastung

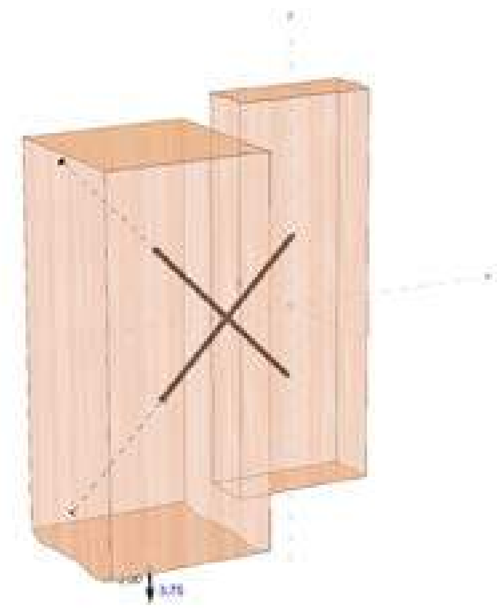
Nutzungsklasse	2
ständige Last in z-Richtung	0,00 kN
veränderliche Last in z-Richtung	3,75 kN
Lasteinwirkungsdauer	kurz
Teilsicherheitsbeiwert Ständige Last	1,35
Teilsicherheitsbeiwert Veränderliche Last	1,50

Schrauben

Anordnung	gekreuzt
Einschraubwinkel	45 °
Einschraubung	mittig Gewinde

nicht vorgebohrt

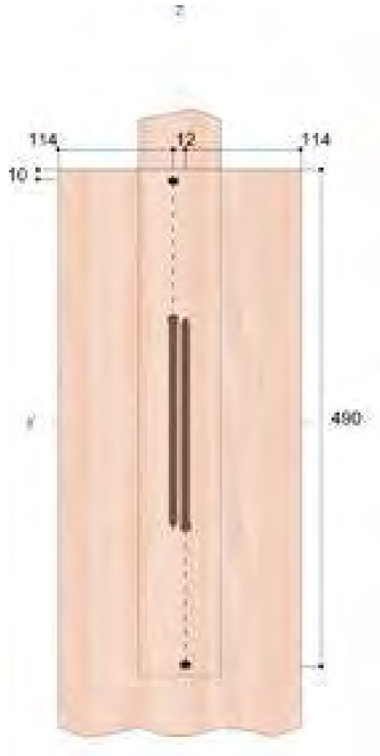




Abstände [mm]

Seitenlaschen	
min. $a_{2,c}$ / $a_{2,c}$	24 / 114 (ETA)
min. a_{CS} / a_{CS}	12 / 12 (ETA)
min. $a_{1,c}$ / $a_{1,c}$	40 / 198 (ETA)
v (Versenkmaß)	192
m_1 (Montagemaß)	10
m_2 (Montagemaß)	490

Träger	
min. $a_{2,c}$ / $a_{2,c}$	24 / 34 (ETA)
min. a_{CS} / a_{CS}	12 / 12 (ETA)
min. $a_{1,c}$ / $a_{1,c}$	40 / 198 (ETA)



Bemessung

Lastfallkombinationen

LFK1	Ständige Last
LFK2	Ständige Last und veränderliche Last

Bemessungslasten

$\alpha = 45\,°$

$V_{d,S} = \frac{0{,}5 \cdot F_{v,d}}{cos(\alpha)}$

$V_{d,S,1} = 0{,}00\,kN \;|\; V_{d,S,2} = 3{,}98\,kN$

Herausziehen des Schraubengewindes aus den Seitenlaschen

$V_{d,S,1} = 0{,}00\,kN \;|\; V_{d,S,2} = 3{,}98\,kN$

$k_{mod,1} = 0{,}60 \;|\; k_{mod,2} = 0{,}90$ EN 1995-1-1 3.1.3 (1)

$n = 1$

$n_{ef} = n^{0.9} = 1{,}00$ EN 1995-1-1 8.7.2 (8) (8.41)

$f_{ax,k} = 9{,}00\,\frac{N}{mm^2}$ ETA-12/0073 (02-2012 - 03-2016)

$d = 8{,}0\,mm$ ETA-12/0073 (02-2012 - 03-2016)

$l_{ef} = 140\,mm$

$\alpha = 45\,°$ EN 1995-1-1 8.7.2 (4)

$\rho_k = 350\,\frac{kg}{m^3}$ EN 338 5 EN 14080 5.1.4.3 (4)(5)

$F_{ax,\alpha,Rk} = \frac{n_{ef}\, f_{ax,k} \cdot d \cdot l_{ef}}{1{,}2 \cdot \cos^2\alpha + \sin^2\alpha} \cdot \left(\frac{\rho_{k,ETA}}{\rho_a}\right)^{0{,}8} = 9{,}16\,kN$ ETA-12/0073 (02-2012 - 03-2016)

$\gamma_M = 1{,}30$ DIN EN 1995-1-1/NA NDP 2.4.1(1)P

$F_{ax,\alpha,Rd} = k_{mod} \cdot \frac{F_{ax,\alpha,Rk}}{\gamma_M}$ EN 1995-1-1 2.4.3 (1)P (2.17)

$F_{ax,\alpha,Rd,1} = 4{,}23\,kN \;|\; F_{ax,\alpha,Rd,2} = 6{,}34\,kN$

$\eta = \left(\frac{V_{d,S}}{F_{ax,\alpha,Rd}}\right) \cdot 100\,\%$

$\eta_1 = 0{,}00\,\% \;|\; \eta_2 = 62{,}70\,\%$

Herausziehen des Schraubengewindes aus dem Träger

$V_{d,S,1} = 0{,}00\,kN \;|\; V_{d,S,2} = 3{,}98\,kN$

$k_{mod,1} = 0{,}60 \;|\; k_{mod,2} = 0{,}90$ EN 1995-1-1 3.1.3 (1)

$n = 1$

$n_{ef} = n^{0.9} = 1{,}00$ EN 1995-1-1 8.7.2 (8) (8.41)

$f_{ax,k} = 9{,}00\,\frac{N}{mm^2}$ ETA-12/0073 (02-2012 - 03-2016)

$d = 8{,}0\,mm$ ETA-12/0073 (02-2012 - 03-2016)

$l_{ef} = 140\,mm$

$\alpha = 45\,°$ EN 1995-1-1 8.7.2 (4)

$\rho_k = 350\,\frac{kg}{m^3}$ EN 338 5 EN 14080 5.1.4.3 (4)(5)

$F_{ax,\alpha,Rk} = \frac{n_{ef}\, f_{ax,k} \cdot d \cdot l_{ef}}{1{,}2 \cdot \cos^2\alpha + \sin^2\alpha} \cdot \left(\frac{\rho_{k,ETA}}{\rho_a}\right)^{0{,}8} = 9{,}16\,kN$ ETA-12/0073 (02-2012 - 03-2016)

$\gamma_M = 1{,}30$ DIN EN 1995-1-1/NA NDP 2.4.1(1)P

$F_{ax,\alpha,Rd} = k_{mod} \cdot \frac{F_{ax,\alpha,Rk}}{\gamma_M}$ EN 1995-1-1 2.4.3 (1)P (2.17)

$F_{ax,\alpha,Rd,1} = 4{,}23\,kN \;|\; F_{ax,\alpha,Rd,2} = 6{,}34\,kN$

$\eta = \left(\frac{V_{d,S}}{F_{ax,\alpha,Rd}}\right) \cdot 100\%$

$\eta_1 = 0{,}00\% \;|\; \eta_2 = 62{,}70\%$

Zugfestigkeit der Schrauben

$V_{d,S,1} = 0{,}00\,kN \;|\; V_{d,S,2} = 3{,}98\,kN$

$n = 1$

$n_{ef} = n^{0.9} = 1{,}00$ — EN 1995-1-1 8.7.2 (8) (8.41)

$f_{tens,k} = 25{,}00\,kN$ — ETA-12/0073 (02-2012 - 03-2016)

$F_{t,Rk} = n_{ef} \cdot f_{tens,k} = 25{,}00\,kN$ — EN 1995-1-1 8.7.2 (7) (8.40c)

$\gamma_M = 1{,}30$ — DIN EN 1995-1-1/NA NDP 2.4.1(1)P

$F_{t,Rd} = \frac{F_{t,Rk}}{\gamma_M} = 19{,}23\,kN$

$\eta = \left(\frac{V_{d,S}}{F_{t,Rd}}\right) \cdot 100\%$

$\eta_1 = 0{,}00\% \;|\; \eta_2 = 20{,}68\%$

Ausknicken der Schrauben in den Seitenlaschen

$V_{d,S,1} = 0{,}00\,kN \;|\; V_{d,S,2} = 3{,}98\,kN$

$d_1 = 5{,}20\,mm$ — ETA-12/0073 (02-2012 - 03-2016)

$f_{y,k} = 1.000\,\frac{N}{mm^2}$ — ETA-12/0073 (02-2012 - 03-2016)

$N_{pl,k} = \pi \cdot \frac{d_1^2}{4} \cdot f_{y,k} = 21{,}24\,kN$ — ETA-12/0073 (02-2012 - 03-2016)

$d = 8{,}0\,mm$ — ETA-12/0073 (02-2012 - 03-2016)

$\rho_k = 350\,\frac{kg}{m^3}$ — EN 338 5, EN 14080 5.1.4.3 (4)(5)

$\alpha = 45°$

$c_h = (0{,}19 + 0{,}012 \cdot d) \cdot \rho_k \cdot \left(\frac{90° + \alpha}{180°}\right) = 75{,}08\,\frac{N}{mm^2}$ — ETA-12/0073 (02-2012 - 03-2016)

$E_S = 205.000\,\frac{N}{mm^2}$ — ETA-12/0073 (02-2012 - 03-2016)

$I_S = \frac{\pi \cdot d_1^4}{64} = 35{,}89\,mm^4$ — ETA-12/0073 (02-2012 - 03-2016)

$N_{ki,k} = \sqrt{c_h \cdot E_S \cdot I_S} = 23{,}50\,kN$ — ETA-12/0073 (02-2012 - 03-2016)

$\lambda_k = \sqrt{\frac{N_{pl,k}}{N_{ki,k}}} = 0{,}95$ — ETA-12/0073 (02-2012 - 03-2016)

$k = 0{,}5 \cdot \left[1 + 0{,}49 \cdot (\lambda_k - 0{,}2) + \lambda_k^2\right] = 1{,}14$ — ETA-12/0073 (02-2012 - 03-2016)

$\kappa_c = \frac{1}{k + \sqrt{k^2 - \lambda_k^2}} = 0{,}57$ — ETA-12/0073 (02-2012 - 03-2016)

$F_{ki,Rk} = n_{ef} \cdot \kappa_c \cdot N_{pl,k} = 12{,}09\,kN$ — ETA-12/0073 (02-2012 - 03-2016)

$\gamma_{M1} = 1{,}10$ — DIN EN 1993-1-1/NA NDP 6.1(1) 2B

ETA-12/0073 (02-2012 - 03-2016)

$F_{ki,Rd} = \frac{F_{ki,Rk}}{\gamma_{M1}} = 10{,}99\,kN$

$\eta = \left(\frac{V_{d,S}}{F_{ki,Rd}}\right) \cdot 100\%$

$\eta_1 = 0{,}00\% \;|\; \eta_2 = 36{,}20\%$

Ausknicken Träger

$V_{d,S,1} = 0{,}00\,kN \;|\; V_{d,S,2} = 3{,}98\,kN$

$d_1 = 5{,}20\,mm$ — ETA-12/0073 (02-2012 - 03-2016)

$f_{y,k} = 1.000\,\frac{N}{mm^2}$ — ETA-12/0073 (02-2012 - 03-2016)

$N_{pl,k} = \pi \cdot \frac{d_1^2}{4} \cdot f_{y,k} = 21{,}24\,kN$ — ETA-12/0073 (02-2012 - 03-2016)

$d = 8{,}0\,mm$ — ETA-12/0073 (02-2012 - 03-2016)

$\rho_k = 350\,\frac{kg}{m^3}$ — EN 338 5, EN 14080 5.1.4.3 (4)(5)

$\alpha = 45°$

$c_h = (0{,}19 + 0{,}012 \cdot d) \cdot \rho_k \cdot \left(\frac{90° + \alpha}{180°}\right) = 75{,}08\,\frac{N}{mm^2}$ — ETA-12/0073 (02-2012 - 03-2016)

$E_S = 205.000\,\frac{N}{mm^2}$ — ETA-12/0073 (02-2012 - 03-2016)

$I_S = \frac{\pi \cdot d_1^4}{64} = 35{,}89\,mm^4$ — ETA-12/0073 (02-2012 - 03-2016)

$N_{ki,k} = \sqrt{c_h \cdot E_S \cdot I_S} = 23{,}50\,kN$ — ETA-12/0073 (02-2012 - 03-2016)

$\lambda_k = \sqrt{\frac{N_{pl,k}}{N_{ki,k}}} = 0{,}95$ — ETA-12/0073 (02-2012 - 03-2016)

$k = 0{,}5 \cdot \left[1 + 0{,}49 \cdot (\lambda_k - 0{,}2) + \lambda_k^2\right] = 1{,}14$ — ETA-12/0073 (02-2012 - 03-2016)

$\kappa_c = \frac{1}{k + \sqrt{k^2 - \lambda_k^2}} = 0{,}57$ — ETA-12/0073 (02-2012 - 03-2016)

$F_{ki,Rk} = n_{ef} \cdot \kappa_c \cdot N_{pl,k} = 12{,}09\,kN$ — ETA-12/0073 (02-2012 - 03-2016)

$\gamma_{M1} = 1{,}10$ — DIN EN 1993-1-1/NA NDP 6.1(1) 2B

$F_{ki,Rd} = \frac{F_{ki,Rk}}{\gamma_{M1}} = 10{,}99\,kN$ — ETA-12/0073 (02-2012 - 03-2016)

$\eta = \left(\frac{V_{d,S}}{F_{ki,Rd}}\right) \cdot 100\%$

$\eta_1 = 0{,}00\% \;|\; \eta_2 = 36{,}20\%$

Zug Träger

$F_{d,1} = 0{,}00\,kN \;|\; F_{d,2} = 5{,}63\,kN$

$b = 80\,mm$

$n = 2$

$d_0 = 5\,mm$ — ETA-12/0073 (02-2012 - 03-2016)

$b_{netto} = b - n \cdot d_0 = 70\,mm$ — EN 1995-1-1 52

$h = 200\,mm$

$A = b_{netto} \cdot h = 13.920\,mm^2$

$\sigma_{t,0,d} = \frac{F_d}{A}$

$\sigma_{t,0,d,1} = 0{,}00\,\frac{N}{mm^2}$ | $\sigma_{t,0,d,2} = 0{,}40\,\frac{N}{mm^2}$

$k_{mod,1} = 0{,}60$ | $k_{mod,2} = 0{,}90$ — EN 1995-1-1 3.1.3 (1)

$k_h = 1{,}00$ — EN 1995-1-1 3.2 (3) (3.1)

$f_{t,0,k} = 9{,}7\,\frac{N}{mm^2}$ — EN 338 5, EN 14080 5.1.4.3 (4)(5)

$f_{t,0,k} = k_h \cdot f_{t,0,k} = 9{,}67\,\frac{N}{mm^2}$ — EN 1995-1-1 3.2 (3) (3.1)

$\gamma_M = 1{,}30$ — DIN EN 1995-1-1/NA NDP 2.4.1(1)P

$f_{t,0,d} = k_{mod} \cdot \frac{f_{t,0,k}}{\gamma_M}$ — EN 1995-1-1 2.4.1 (1)P (2.14)

$f_{t,0,d,1} = 4{,}46\,\frac{N}{mm^2}$ | $f_{t,0,d,2} = 6{,}69\,\frac{N}{mm^2}$

$\eta = \left(\frac{\sigma_{t,0,d}}{f_{t,0,d}}\right) \cdot 100\,\%\%$ — EN 1995-1-1 6.1.2 (1)P (6.1)

$\eta_1 = 0{,}00\,\%$ | $\eta_2 = 6{,}04\,\%$

Zug Seitenlaschen

$F_{d,1} = 0{,}00\,kN$ | $F_{d,2} = 5{,}63\,kN$

$b = 240\,mm$

$n = 2$

$d_0 = 5\,mm$ — ETA-12/0073 (02-2012 - 03-2016)

$b_{netto} = b - n \cdot d_0 = 230\,mm$ — EN 1995-1-1 5.2

$h = 240\,mm$

$A = b_{netto} \cdot h = 55.104\,mm^2$

$\sigma_{t,0,d} = \frac{F_d}{A}$

$\sigma_{t,0,d,1} = 0{,}00\,\frac{N}{mm^2}$ | $\sigma_{t,0,d,2} = 0{,}10\,\frac{N}{mm^2}$

$k_{mod,1} = 0{,}60$ | $k_{mod,2} = 0{,}90$ — EN 1995-1-1 3.1.3 (1)

$k_h = 1{,}00$ — EN 1995-1-1 3.2 (3) (3.1)

$f_{t,0,k} = 9{,}7\,\frac{N}{mm^2}$ — EN 338 5, EN 14080 5.1.4.3 (4)(5)

$f_{t,0,k} = k_h \cdot f_{t,0,k} = 9{,}67\,\frac{N}{mm^2}$ — EN 1995-1-1 3.2 (3) (3.1)

$\gamma_M = 1{,}30$ — DIN EN 1995-1-1/NA NDP 2.4.1(1)P

$f_{t,0,d} = k_{mod} \cdot \frac{f_{t,0,k}}{\gamma_M}$ — EN 1995-1-1 2.4.1 (1)P (2.14)

$f_{t,0,d,1} = 4{,}46\,\frac{N}{mm^2}$ | $f_{t,0,d,2} = 6{,}69\,\frac{N}{mm^2}$

$\eta = \left(\frac{\sigma_{t,0,d}}{f_{t,0,d}}\right) \cdot 100\,\%\%$ — EN 1995-1-1 6.1.2 (1)P (6.1)

$\eta_1 = 0{,}00\,\%$ | $\eta_2 = 1{,}53\,\%$

Nachweis erfolgreich

Technische Hinweise

Die Bemessung erfolgt nach:
ETA-12/0073 (02-2012 - 03-2016)
EN 338 (2010-12), EN 14080 (2013-09)
EN 1990 (2010-12), DIN EN 1990/NA (2010-12), DIN EN 1990/NA/A1 (2012-08)
EN 1995-1-1 (2010-12), EN 1995-1-1/A2 (2014-07), DIN EN 1995-1-1/NA (2013-08)
Die Schrauben dürfen nur für vorwiegend ruhende Belastungen verwendet werden.
Die Holzfeuchte beim Einbau darf höchstens 20% betragen.
Es sind Schrauben des gleichen Durchmessers und der gleichen Länge zu verwenden.
Der Nachweis des Blockscherversagens ist, sofern erforderlich, separat nachzuweisen.

Aufgrund aktueller, aber nicht abgeschlossener Forschung und daraus gewonnenen Erkenntnissen, wird die Querkraft- Tragfähigkeit u.a. von auf Abscheren beanspruchten Schrauben in Stahlblech- Holzverbindungen bei Laubholz- oder Laubholzprodukten (z.B. Pollmeier BauBuche) bislang um bis zu 43% überschätzt. Deshalb ist es bis auf Weiteres ratsam, die Ausnutzung solcher auf Abscheren beanspruchten Stahlblech- Hartholz- Verbindungen zu begrenzen. Bei den Laubhölzern der Festigkeitsklassen D30 - D40 sollte der Ausnutzungsgrad auf ca. 80% begrenzt werden. Beim Furnierschichtholz „Pollmeier BauBuche“ auf ca. 70%.

Allgemeine Hinweise

Sämtliche in den Programmen enthaltenen Informationen und Daten beziehen sich ausschließlich auf die Verwendung von fischer-Produkten und basieren auf den Grundsätzen, Formeln und Sicherheitsbestimmungen gem. den technischen Anweisungen und Bedienungs-, Setz- und Montageanleitungen usw. von fischer, die vom Anwender genau eingehalten werden müssen. Sämtliche enthaltenen Werte sind Durchschnittswerte; daher sind vor Anwendung des jeweiligen fischer-Produkts stets einsatzspezifische Tests durchzuführen. Die Ergebnisse der mittels der Software durchgeführten Berechnungen beruhen maßgeblich auf den von Ihnen einzugebenden Daten. Sie tragen daher die alleinige Verantwortung für die Fehlerfreiheit, Vollständigkeit und Relevanz der von Ihnen einzugebenden Daten. Sie sind weiterhin alleine dafür verantwortlich, die erhaltenen Ergebnisse der Berechnung vor der Verwendung für Ihre spezifische(n) Anlage(n) durch einen Fachmann überprüfen und freigeben zu lassen, insbesondere hinsichtlich der Konformität mit geltenden Normen und Zulassungen. Das Bemessungsprogramm dient lediglich als Hilfsmittel zur Auslegung von Normen und Zulassungen ohne jegliche Gewährleistung auf Fehlerfreiheit, Richtigkeit und Relevanz der Ergebnisse oder Eignung für eine bestimmte Anwendung.
Sie haben alle erforderlichen und zumutbaren Maßnahmen zu ergreifen, um Schäden durch das Bemessungsprogramm zu verhindern oder zu begrenzen. Insbesondere müssen Sie für die regelmäßige Sicherung von Programmen und Daten sorgen sowie regelmäßig ggf. von fischer angebotene Updates des Bemessungsprogramms durchführen. Sofern Sie nicht die automatische Update-Funktion der Software nutzen, müssen Sie durch manuelle Updates über die fischer Internetseite sicherstellen, dass Sie jeweils die aktuelle und somit gültige Version des Bemessungsprogramms verwenden. Soweit Sie diese Verpflichtung schuldhaft verletzen, haftet fischer nicht für daraus entstehende Folgen, insbesondere nicht für die Wiederbeschaffung verlorener oder beschädigter Daten oder Programme.

Produktinfo

FPF-ST ZPP ø10,0 mm x 140 mm

Power-Fast | Senkkopf | Torx | Teilgewinde | Stahl

Anzahl (Gesamt)	4 Stück
Artikelnummer 696775	50 Stück / VE

Eingaben - Holzbau - Allgemeine Verbindung

Träger

Höhe	80 mm
Breite	240 mm
Nadelholz / C24 / Fichte, Tanne oder Kiefer	

Seitenlaschen

Höhe	80 mm
Breite	240 mm
Winkelabweichung zur Horizontalen	0 °
Nadelholz / C24 / Fichte, Tanne oder Kiefer	

Schrauben

Anordnung	gerade
Einschraubwinkel	90 °
Einschraubung	bündig Träger
nicht vorgebohrt	

Belastung

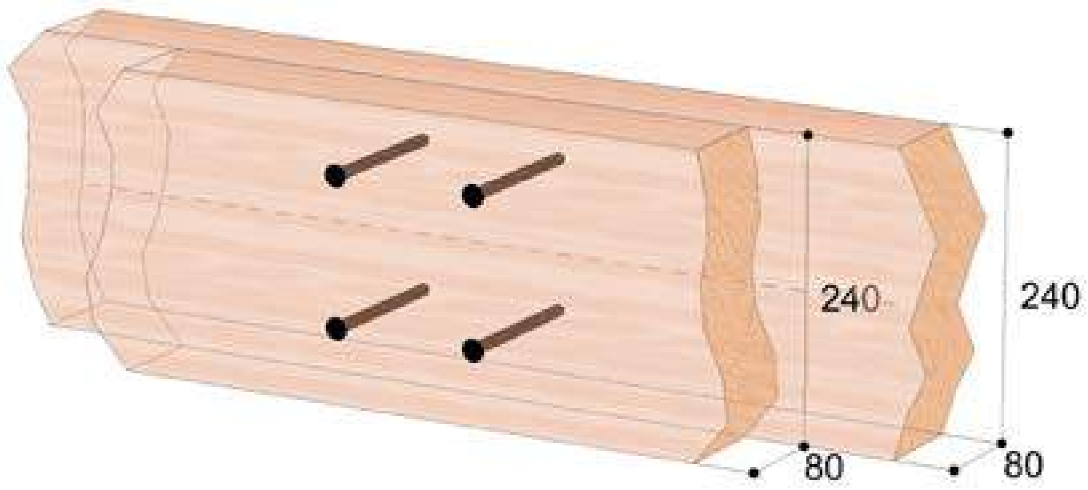
Nutzungsklasse	1

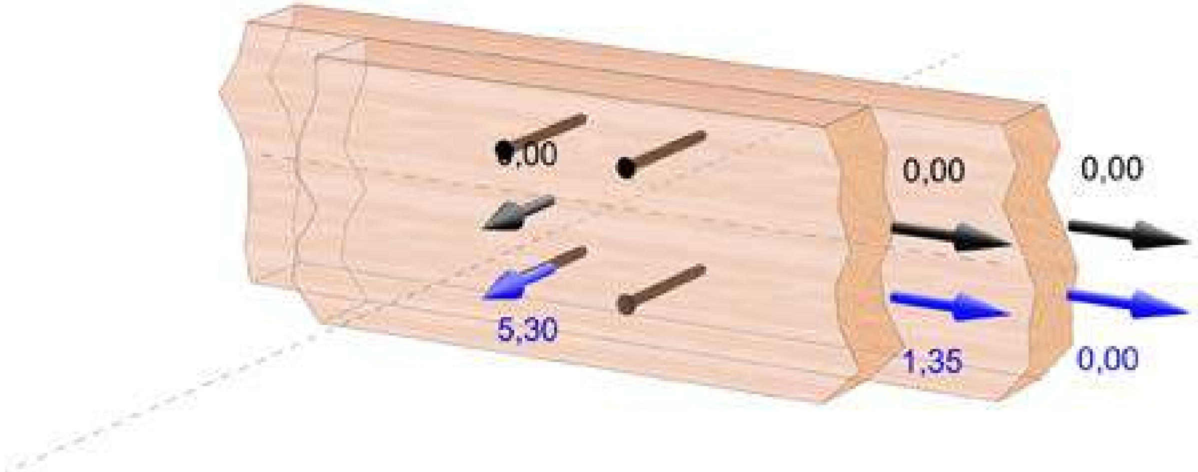
Ständige Last

Zuglast	0,00 kN
Querlast Träger	0,00 kN
Querlast Seitenlaschen	0,00 kN
Teilsicherheitsbeiwert	1,35

Veränderliche Last

Zuglast	5,30 kN
Querlast Träger	0,00 kN
Querlast Seitenlaschen	1,35 kN
Teilsicherheitsbeiwert	1,50
Lasteinwirkungsdauer	kurz





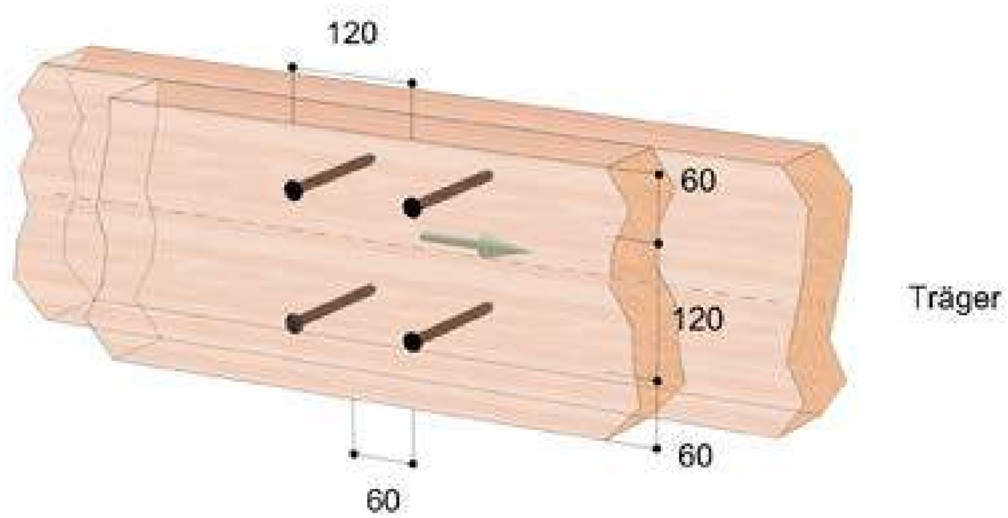
Die Eingabewerte und die Bemessungsergebnisse sowie die Montage sind zu kontrollieren und anhand gültiger Normen und Zulassungen auf Plausibilität zu prüfen. Bitte beachten Sie den Haftungsausschluss in den Lizenzbedingungen der Software.

Abstände [mm]

Träger	
min. $a_{4,c}$ / $a_{4,c}$	50 / 60 (unbeanspruchter Rand)

Seitenlaschen	
min. a_0 / a_0	120 / 120
a_m	60
min. a_{90} / a_{90}	120 / 120
min. $a_{4,c}$ / $a_{4,c}$	50 / 60 (unbeanspruchter Rand)

Die resultierende Querkraft wird in der Grafik als Pfeil und die beanspruchten Ränder rot bzw. fett dargestellt.



Bemessung

Lastfallkombinationen

LFK1	Ständige Last
LFK2	Ständige Last und veränderliche Last

Modifikationsbeiwert

	k_{mod}
LFK1	0,60
LFK2	0,90

Abscheren

$V_{d,1} = 0{,}00\,kN \mid V_{d,2} = 2{,}02\,kN$

$k_{mod,1,1} = 0{,}60 \mid k_{mod,1,2} = 0{,}90$ — EN 1995-1-1 3.1.3 (1)

$k_{mod,2,1} = 0{,}60 \mid k_{mod,2,2} = 0{,}90$ — EN 1995-1-1 3.1.3 (1)

$k_{mod} = \sqrt{k_{mod,1} k_{mod,2}}$ — EN 1995-1-1 2.2.3.1 (2) (2.6)

$k_{mod,1} = 0{,}60 \mid k_{mod,2} = 0{,}90$

$n_{0,1} = 2$

$n_{ef,0,1,1} = 2{,}00 \mid n_{ef,0,1,2} = 1{,}90$ — EN 1995-1-1 8.3.1.1 (8) (8.17)

$n_{90,1} = 2$

$n_{0,2} = 2$

$n_{ef,0,2,1} = 2{,}00 \mid n_{ef,0,2,2} = 1{,}90$ — EN 1995-1-1 8.3.1.1 (8) (8.17)

$n_{90,2} = 2$

$n = min(n_{ef,0,1} \cdot n_{90,1}; n_{ef,0,2} \cdot n_{90,2})$

$n_1 = 4{,}00 \mid n_2 = 3{,}80$

$\rho_{k,1} = 350 \frac{kg}{m^3}$ — EN 338 5, EN 14080 5.1.4.3 (4)(5)

$\rho_{k,2} = 350 \frac{kg}{m^3}$ — EN 338 5, EN 14080 5.1.4.3 (4)(5)

$f_{h,1,k,1} = 14{,}38 \frac{N}{mm^2} \mid f_{h,1,k,2} = 14{,}38 \frac{N}{mm^2}$ — ETA-11/0027

$f_{h,2,k,1} = 14{,}38 \frac{N}{mm^2} \mid f_{h,2,k,2} = 14{,}38 \frac{N}{mm^2}$ — ETA-11/0027

$t_1 = 80\,mm$ — EN 1995-1-1 8.2.2 (1)

$t_2 = 60\,mm$ — EN 1995-1-1 8.2.2 (1)

$\beta = \frac{f_{h,2,k}}{f_{h,1,k}}$ — EN 1995-1-1 8.2.2 (1) (8.8)

$\beta_1 = 1{,}00 \mid \beta_2 = 1{,}00$

$M_{y,k} = 35{,}8\,Nm$ — ETA-11/0027

$F_{ax,Rk} = 0{,}00\,kN$ — EN 1995-1-1 8.2.2 (2)

$(a)\ f_{h,1,k} t_1 d$ — EN 1995-1-1 8.2.2 (1) (8.6)

$(a,1) = 11{,}51\,kN \mid (a,2) = 11{,}51\,kN$

$(b)\ f_{h,2,k} t_2 d$ — EN 1995-1-1 8.2.2 (1) (8.6)

$(b,1) = 8{,}63\,kN \mid (b,2) = 8{,}63\,kN$

$(c)\ \frac{f_{h,1,k} t_1 d}{1+\beta}\left[\sqrt{\beta + 2\beta^2\left[1+\frac{t_2}{t_1}+\left(\frac{t_2}{t_1}\right)^2\right]+\beta^3\left(\frac{t_2}{t_1}\right)^2} - \beta\left(1+\frac{t_2}{t_1}\right)\right] + \frac{F_{ax,Rk}}{4}$ — EN 1995-1-1 8.2.2 (1) (8.6)

$(c,1) = 4{,}24\,kN \mid (c,2) = 4{,}24\,kN$

$(d)\ 1{,}05 \frac{f_{h,1,k} t_1 d}{2+\beta}\left[\sqrt{2\beta(1+\beta) + \frac{4\beta(2+\beta)M_{y,k}}{f_{h,1,k} d t_1^2}} - \beta\right] + \frac{F_{ax,Rk}}{4}$ — EN 1995-1-1 8.2.2 (1) (8.6)

$(d,1) = 4{,}48\,kN \mid (d,2) = 4{,}48\,kN$

$(e)\ 1{,}05 \frac{f_{h,1,k} t_2 d}{1+2\beta}\left[\sqrt{2\beta^2(1+\beta) + \frac{4\beta(1+2\beta)M_{y,k}}{f_{h,1,k} d t_2^2}} - \beta\right] + \frac{F_{ax,Rk}}{4}$ — EN 1995-1-1 8.2.2 (1) (8.6)

$(e,1) = 3{,}62\,kN \mid (e,2) = 3{,}62\,kN$

$(f)\ 1{,}15\sqrt{\frac{2\beta}{1+\beta}}\sqrt{2 M_{y,k} f_{h,1,k} d} + \frac{F_{ax,Rk}}{4}$ — EN 1995-1-1 8.2.2 (1) (8.6)

$(f,1) = 3{,}69\,kN \mid (f,2) = 3{,}69\,kN$

$F_{v,Rk} = min(F_{v,Rk}(a); F_{v,Rk}(b); F_{v,Rk}(c); F_{v,Rk}(d); F_{v,Rk}(e); F_{v,Rk}(f))$ — EN 1995-1-1 8.2.2 (1) (8.6)

$F_{v,Rk,1} = 3{,}62\,kN \mid F_{v,Rk,2} = 3{,}62\,kN$

$\gamma_M = 1{,}30$ — DIN EN 1995-1-1/NA NDP 2.4.1(1)P

$F_{v,Rd} = k_{mod} \cdot \frac{F_{v,Rk}}{\gamma_M}$ — EN 1995-1-1 2.4.3 (1)P (2.17)

$F_{v,Rd,1} = 1{,}67\,kN \mid F_{v,Rd,2} = 2{,}50\,kN$

$\eta = \left(\frac{V_d}{n \cdot F_{v,Rd}}\right) \cdot 100\,\%$

Die Eingabewerte und die Bemessungsergebnisse sowie die Montage sind zu kontrollieren und anhand gültiger Normen und Zulassungen auf Plausibilität zu prüfen. Bitte beachten Sie den Haftungsausschluss in den Lizenzbedingungen der Software.

$\eta_1 = 0{,}00\,\% \mid \eta_2 = 21{,}29\,\%$

Herausziehen

	$f_{ax,k}$ [N/mm²]	$f_{head,k}$	
	10,00	12,00	

	$V_{d,Z}$ [kN]	$F_{ax,\alpha,Rd}$ [kN]	[%]
LFK1	0,00	6,53	0,00
LFK2	7,95	9,79	81,17

Zugfestigkeit (Zugkraft)

	$f_{tens,k}$
	29,80

	$V_{d,Z}$ [kN]	$F_{t,Rd}$ [kN]	[%]
LFK1	0,00	79,82	0,00
LFK2	7,95	79,82	9,96

Interaktion

	$V_{d,Z}$ [kN]	$F_{ax,\alpha,Rd}$ [kN]	$F_{t,Rd}$ [kN]
LFK1	0,00	6,53	79,82
LFK2	7,95	9,79	79,82

	$V_{d,Q}$ [kN]	$F_{v,Rd}$ [kN]
LFK1	0,00	4,00 * 1,67
LFK2	2,02	3,80 * 2,50

	[%]
LFK1	0,00
LFK2	70,42

Zug in Faserrichtung

Seitenlaschen	$\sigma_{t,0,d}$ N/mm²	$f_{t,0,d}$ N/mm²	[%]
LFK1	0,00	7,59	0,00
LFK2	0,11	11,38	0,93

Auslastung [%]	
	81,17

Nachweis erfolgreich

Technische Hinweise

Als Bemessungsgrundlage dient die ETA-11/0027 für "fischer Power-Fast Schrauben".

Die Bemessung erfolgt nach:

EN 338 (2010-12), EN 14080 (2013-09)

EN 1990 (2010-12), DIN EN 1990/NA (2010-12), DIN EN 1990/NA/A1 (2012-08)

EN 1995-1-1 (2010-12), EN 1995-1-1/A2 (2014-07), DIN EN 1995-1-1/NA (2013-08)

Die Schrauben dürfen nur für vorwiegend ruhende Belastungen verwendet werden.

Die Holzfeuchte beim Einbau darf höchstens 20% betragen.

Es sind Schrauben des gleichen Durchmessers und der gleichen Länge zu verwenden.

Die Abstände zum Hirnholz der Träger werden nicht betrachtet.

Bei Schraubenverbindungen, welche durch einwirkende Querkräfte wegen der unterschiedlich großen Randabstände exzentrisch zu den Systemlinien der Bauteile angeordnet sind, ist bauseits sicherzustellen,dass die durch den exzentrischen Anschluss hervorgerufenen Kipp- und Torsionsmomente durch konstruktive Maßnahmen in den Bauteilen abgeleitet werden oder für den Anschluss zumindest rechnerisch vernachlässigt werden können.Andernfalls sind diese durch erhöhte Einwirkungen bei den Zug- und Querkräften in der Eingabe des Programms zu berücksichtigen.

Allgemeine Hinweise

Sämtliche in den Programmen enthaltenen Informationen und Daten beziehen sich ausschließlich auf die Verwendung von fischer-Produkten und basieren auf den Grundsätzen, Formeln und Sicherheitsbestimmungen gem. den technischen Anweisungen und Bedienungs-, Setz- und Montageanleitungen usw. von fischer, die vom Anwender genau eingehalten werden müssen. Sämtliche enthaltenen Werte sind Durchschnittswerte; daher sind vor Anwendung des jeweiligen fischer-Produkts stets einsatzspezifische Tests durchzuführen. Die Ergebnisse der mittels der Software durchgeführten Berechnungen beruhen maßgeblich auf den von Ihnen einzugebenden Daten. Sie tragen daher die alleinige Verantwortung für die Fehlerfreiheit, Vollständigkeit und Relevanz der von Ihnen einzugebenden Daten. Sie sind weiterhin alleine dafür verantwortlich, die erhaltenen Ergebnisse der Berechnung vor der Verwendung für Ihre spezifische(n) Anlage(n) durch einen Fachmann überprüfen und freigeben zu lassen, insbesondere hinsichtlich der Konformität mit geltenden Normen und Zulassungen. Das Bemessungsprogramm dient lediglich als Hilfsmittel zur Auslegung von Normen und Zulassungen ohne jegliche Gewährleistung auf Fehlerfreiheit, Richtigkeit und Relevanz der Ergebnisse oder Eignung für eine bestimmte Anwendung.
Sie haben alle erforderlichen und zumutbaren Maßnahmen zu ergreifen, um Schäden durch das Bemessungsprogramm zu verhindern oder zu begrenzen. Insbesondere müssen Sie für die regelmäßige Sicherung von Programmen und Daten sorgen sowie regelmäßig ggf. von fischer angebotene Updates des Bemessungsprogramms durchführen. Sofern Sie nicht die automatische Update-Funktion der Software nutzen, müssen Sie durch manuelle Updates über die fischer Internetseite sicherstellen, dass Sie jeweils die aktuelle und somit gültige Version des Bemessungsprogramms verwenden. Soweit Sie diese Verpflichtung schuldhaft verletzen, haftet fischer nicht für daraus entstehende Folgen, insbesondere nicht für die Wiederbeschaffung verlorener oder beschädigter Daten oder Programme.

ERSTELLER: DEUTSCHE DOKA Schalungstechnik GmbH Frauenstraße 35, D82216 Maisach		doka
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BAUWERK: UNI KARLSRUHE ROOFKIT		DATUM: 07.03.2022

Lfd. Nr.	Dokument Nr.	Bezeichnung	Datum	Seiten
1	224-016371-1001S-101	STANDSICHERHEITSNACHWEIS	07.03.2022	1-34

BAUTEIL:	SEITE: I	ARCHIV-NR
KAPITEL: ÄNDERUNGSVERZEICHNIS		

STANDSICHERHEITSNACHWEIS

Bauvorhaben:	Uni Karlsruhe RoofKIT
Projektnummer:	224-016371-1001S-101
Bauteil:	
Schalungssystem:	Traggerüst Staxo 100 Traggerüst SL-1 Deckenstütze Eurex 100 plus
Ausführende Firma:	Karlsruher Institut für Technologie Baubetrieb Campus Süd Gotthard-Franz-Straße 3 76131 Karlsruhe
Aufsteller:	Deutsche Doka Schalungstechnik GmbH Frauenstr. 35 D-82216 Maisach
Sachbearbeiterin:	Alexandra Sell Statik Deutschland T+ 49 8141 394 6210 Mail: alexandra.sell@doka.com

Berechnungsumfang: **Seite 1 - 34** (+**5 Anhänge)**

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BAUWERK: UNI KARLSRUHE ROOFKIT | PROJEKT-NUMMER: 224-016371-1001S-101 | DATUM: 07.03.2022

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1 Quellen

1.1 Regelwerke

- DIN EN 1991: Einwirkungen auf Tragwerke
- DIN EN 1993: Bemessung und Konstruktion von Stahlbauten
- DIN EN 12811: Temporäre Konstruktionen für Bauwerke
- DIN EN 12812: Traggerüste
- DIN 20000-2: Anwendung von Bauprodukten in Bauwerken
- TRBS 2121: Technische Regeln für Betriebssicherheit

1.2 Zulassungen / Prüfbescheinigungen

- Typenprüfung „DOKA-Traggerüst Staxo 100“, geprüft vom Deutschen Institut für Bautechnik Berlin in der aktuell gültigen Fassung
- Typenprüfung „Alu-Spindelstütze Titan“, geprüft vom Prüfamt für Standsicherheit Nürnberg in der aktuell gültigen Fassung

1.3 Anwenderinformationen

- Anwenderinformation „Traggerüst Staxo 100“ der Fa. Doka in der aktuellen Ausgabe
- Anwenderinformation „Traggerüst SL-1“ der Fa. Doka in der aktuellen Ausgabe

1.4 Pläne

Pläne der Deutschen Doka:

Plannummer		Beschreibung
224-016371	1001	Einsatzplan

1.6 Weitere Unterlagen

Lastvorgaben der Uni Karlsruhe

- Punktlasten aus dem Holzbau zur Bemessung des Traggerüstes aus Excel Tabelle „22-01-28_RoofKIT HDU-Lasten Doka Gerüst.xls“ aus Mail vom 01.02.2022 von Regina Gebauer:

Vertikale Lasten (positives Vorzeichen: Last in Richtung der Gravitation, negatives Vorzeichen: abhebende Last — Stand: 28.01.2022

	Lastangriffspunkt	Achse	Eigengewicht	Nutzlast Wohnraum	Nutzlast Wohnraum	Nutzlast Dach >0	Nutzlast Dach <0	Schneelast	Windlast in +y	Windlast in +x	Windlast in -y	Windlast in -x
Lastverteiler 1	0,00 m	A1	11,06	2,32		7,50		4,93				
	1,53 m	A2	0,45	2,79		0,00		0,00				
	2,53 m	A3	1,79	11,08		0,00		0,00				
	5,43 m	A5	1,77	10,99		0,00		0,00				
	6,89 m	A6	0,70	4,57		0,00		0,00				
	8,13 m	A7	11,02	2,89		7,50		4,88				
Lastverteiler 2	0,00 m	B1	17,40	2,06		9,00		5,38	0,41	0,00		0,00
	1,46 m	B2	11,50	5,58		6,59		3,91	0,31	[illegible]		3,18
	2,54 m	B3	9,38	4,84		6,07		3,60	0,29	-0,09		0,00
	3,84 m	B4	16,91	6,72		10,40		6,26	0,48	0,87		0,54
	5,54 m	B5	11,50	6,03		6,79		4,03	0,32	0,19		-0,23
	6,69 m	B6	10,88	6,58		9,87		5,85	0,40	1,41		-0,84
	8,13 m	B7	12,60	5,00		6,50		3,50	0,28	1,60		-2,45
Lastverteiler 3	0,00 m	C1	10,95	4,15	-0,01					2,82		-2,82
	1,46 m	C2	1,74	0,00								
	2,54 m	C3	10,60	12,51								
	3,84 m	C4	7,08	0,00								
	5,54 m	C5	11,76	12,85								
	6,69 m	C6	2,05	0,00								
	8,13 m	C7	0,78	4,15	-0,01					2,82		-2,82
Stütze 1		D1	26,54	10,77						1,31		1,31
Stütze 2		D3	38,34	22,65								
Stütze 3		D5	[illegible]	22,85								
Stütze 4		D7	26,54	10,77						1,31		1,31
Lastverteiler 4	0,00 m	E1	12,93	5,85	-0,61					[illegible]		3,85
	2,57 m	E3	9,44	12,51	-1,28							
	5,43 m	E5	9,44	12,51	-1,28							
	8,13 m	E7	12,93	5,85	-0,605					[illegible]		3,85
Lastverteiler 5	0,00 m	F1	5,50	2,85	-0,62					0,31		0,31
	2,30 m	F3	7,76	5,98	-1,30							
	5,43 m	F5	7,76	5,98	-1,30							
	8,13 m	F7	5,50	2,85	-0,616					-0,31		0,31
Lastverteiler 6	0,00 m	G1	7,77	3,18	-0,05					0,04		-0,04
	4,17 m	G3	4,79	6,08	-0,07							
	5,43 m	G5	4,79	5,80	-0,07							
	8,13 m	G7	7,77	3,18	-0,033					0,04		-0,04
Lastverteiler 7	0,00 m	H1	17,50	1,83		8,11		3,07	0,56	0,12		-0,12
	1,53 m	H2	2,82	0,00		0,00		0,00	0,00	-1,26		2,26
	2,53 m	H3	[illegible]	3,47		11,85		5,95	1,06	-1,29		1,79
	5,43 m	H5	[illegible]	3,42		11,88		5,98	1,06	2,80		[illegible]
	6,89 m	H6	4,93	0,00		0,00		0,00	0,00	0,58		-0,58
	8,13 m	H7	17,50	1,03		8,11		3,07	0,56	-0,04		0,04

Horizontale Lasten

	Lastangriffspunkt	charakterist. Fk [kN]	Eigengewicht	Nutzlast Wohnraum	Nutzlast Wohnraum	Nutzlast Dach >0	Nutzlast Dach <0	Schneelast	Windlast in +y	Windlast in +x	Windlast in -y	Windlast in -x
Turm 1-8									3,26	3,06	3,26	3,06

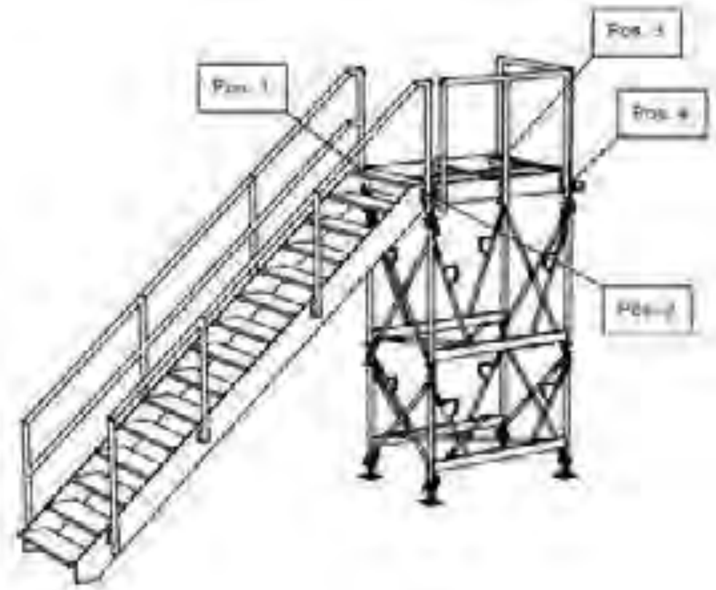
Auszug Excel Tabelle

- Lasten aus Aufzug siehe Mail vom 18.02.2022 von Regina Gebauer:

"Der Aufzug wird auf etagenhöhe mit Standard Gerüstrohrkupplungen am Bodem oder am Gerüst o.a. befestigt. Maximale Lasten (worst case) Rx= 0,5 kN /Ry=0,9 kN "

Auszug aus Mail

- Lasten aus Treppe „22022-treppe_HDU-Stützelasten-dos.pdf“ siehe Mail vom 22.02.2022 von Andersson Largueche:



	Gk			Qk			Sk			Wk			Ed Bemessungswert		
	Rx [kN]	Ry [kN]	Rz [kN]	Rx [kN]	Ry [kN]	Rz [kN]	Rx [kN]	Ry [kN]	Rz [kN]	Rx [kN]	Ry [kN]	Rz [kN]	Rx [kN]	Ry [kN]	Rz [kN]
Pos. 1	0.12	–	1.75	0.47	±0.15	7.38	0.03	–	0.96	±0.22	±0.47	±0.30	1.2	±0.7	13.9
Pos. 2	0.08	–	1.67	0.22	±0.15	8.81	0.06	–	0.89	±0.22	±0.47	±0.87	0.7	±0.7	13.5
Pos. 3	–	–	0.35	–	–	2.61	–	–	0.34	–	–	0	–	–	4.7
Pos. 4	–	–	0.25	–	–	1.93	–	–	0.25	–	–	0	–	–	3.5

Auszug aus pdf

2 Allgemeines

Im Zuge des Bauvorhabens „Uni Karlsruhe RoofKIT“ kommen zur Unterstellung eines Holzgebäudes Traggerüste des Typs Staxo 100, Deckenstützen Eurex 100 plus und Komponenten des Traggerüstes SL-1 zum Einsatz.

Der nachfolgende Standsicherheitsnachweis wird für das Traggerüst erstellt. Das Traggerüst wird im Wesentlichen mit DOKA - Produkten hergestellt und hat nachfolgenden Aufbau:

<u>Traggerüst:</u>

Zentrierplatten: kundenseitig mit einem Mindestreibwert μ = 0,31

Lastverteilerträger SL-1 Träger (HEM 220, S235)

Jochträger: Mehrzweckriegel WS10

Unterstellung: Staxo 100

Deckenstützen: Eurex 100 plus

Lasten aus dem Holzbau wie z.B. aus Eigengewicht, Verkehr und Wind werden über die schubfeste Bodenscheibe des Holzbaus mittels Reibung (μ_{min} = 0,31) in das Traggerüst Staxo 100 eingeleitet.

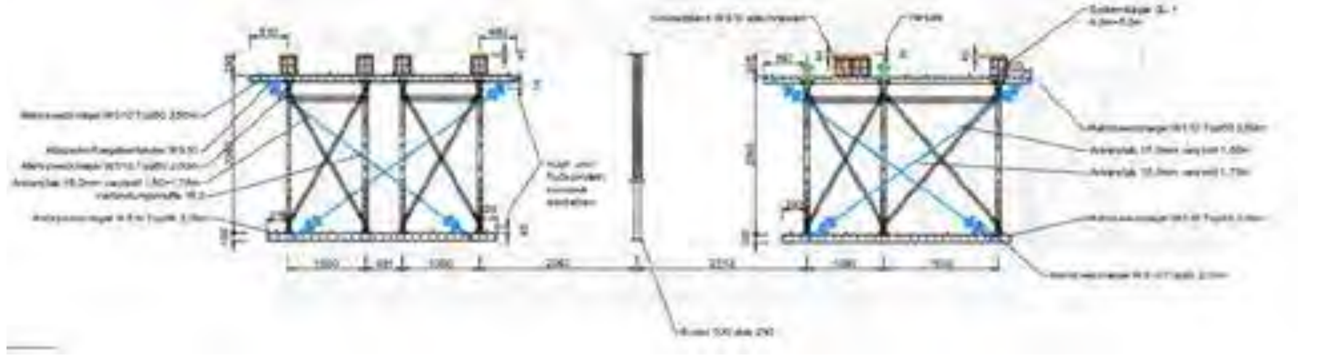
Neben den Lastvorgaben der Uni Karlsruhe (siehe Kapitel 3) leitet das Traggerüst noch folgende Lasten ab:

- Wind auf das Traggerüst
- Horizontale Ersatzlast (V/100) nach DIN EN 12812
- Imperfektion (V/100) nach DIN EN 12812

Eine zusätzliche Belastung der Schalkonstruktion durch Schnee und Eis ist nicht nachgewiesen.

Für die Unterstellung des Gebäudes kommen DOKA Lasttürme Staxo 100 zum Einsatz. Die Türme werden aus geschweißten Rahmen (nachfolgend Rahmenebene genannt) und montierten Diagonalstreben (nachfolgend Strebenebene genannt) aufgebaut.

Das Traggerüst wird in Rahmenebene und Strebenebene am Kopf gehalten nachgewiesen.



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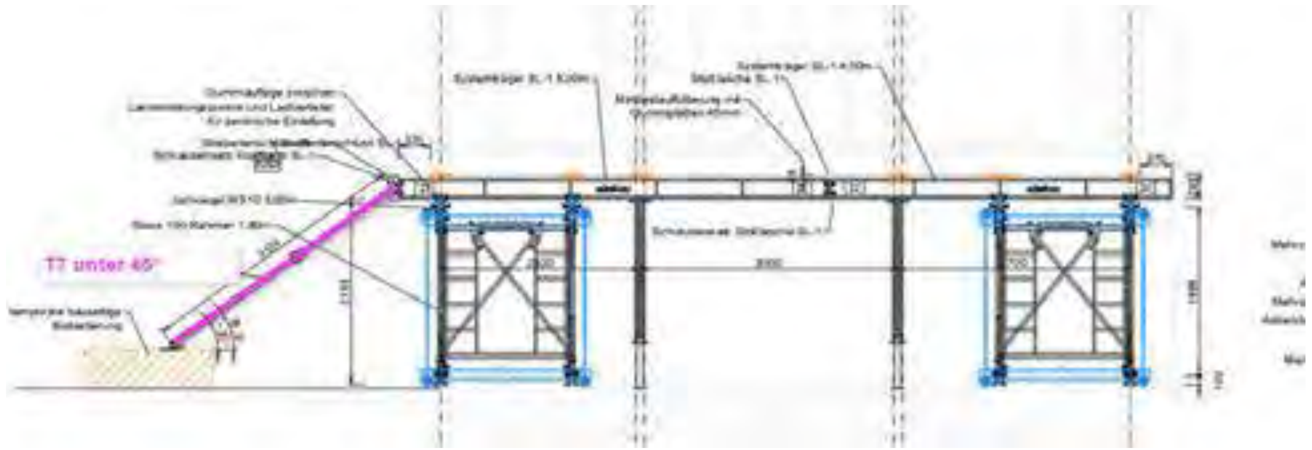
Skizze

In Strebenebene erfolgt die Kopfhalterung des Traggerüst über eine kreuzweise Verspannung der Jochträger mit dem Bodenriegel WS10. Der Bodenriegel WS10 leitet die Last mittels Reibung Stahl/Kies (μ = 0,45 > $\mu_{erforderlich}$ = 0,31) in den Baugrund.

In Rahmenebene wird das Traggerüst über die zug-/druckfeste Anbindung der Oberkonstruktion mittels Spindelstreben T7 am Kopf gehalten. Die Spindelstreben sind unter 45° einzubauen und am Fußpunkt auf einem kundenseitigen Fundament zu fixieren. Sowohl die Wahl des Verbindungsmittels als auch die globalen und lokalen Nachweise des kundenseitigen Fundaments werden von der Uni-Karlsruhe geführt.



Skizze

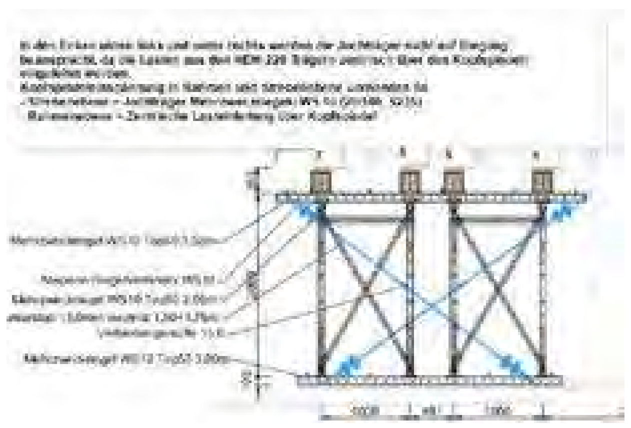
Die Kopfspindeln sind wie folgt eingespannt (siehe nachfolgender Skizze):

Im Bereich der Lastverteiler 1-3 sind die Kopfspindeln in beide Richtungen eingespannt.

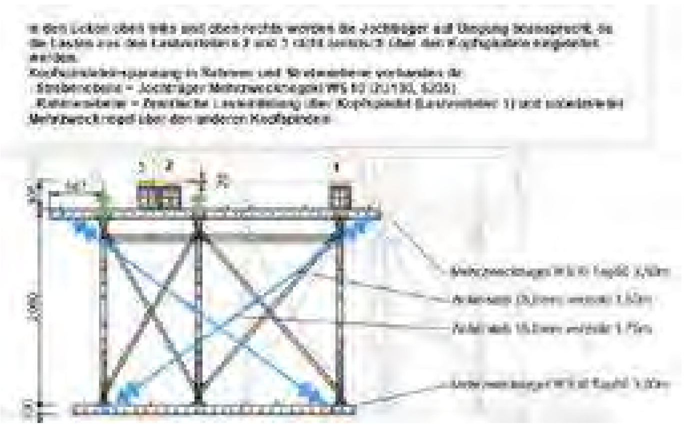
- Kopfspindeleinspannung mittels Stahljoch WS 10
- Kopfspindeleinspannung mittels zentrischer Lasteinleitung in Kopfspindelachse
- Kopfspindeleinspannung mittels unbelasteten Querträger

Im Bereich der Lastverteiler 4-7 sind die Kopfspindeln in beide Richtungen eingespannt.

- Kopfspindeleinspannung mittels Stahljoch WS 10
- Kopfspindeleinspannung mittels zentrischer Lasteinleitung in Kopfspindelachse



Skizze

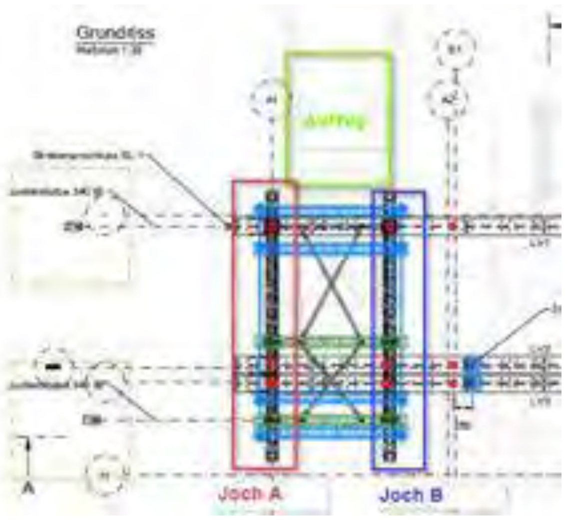


Skizze

Von der Uni-Karlsruhe wurden Einzellasten ermittelt, die punktuell auf die 7 Lastverteiler aufgegeben werden. Im Bereich dieser Lasteinleitungspunkte sind Elastomerplatten zwischenzulegen, die einen Mindest-Reibbeiwert von μ =0,31 nicht unterschreiten. Die gleichen Platten sind zwischen die Lastverteiler-Träger (HEM 220, S235) und Jochträger (Mehrzweckriegel WS10 – 2U100, S235) zu legen.

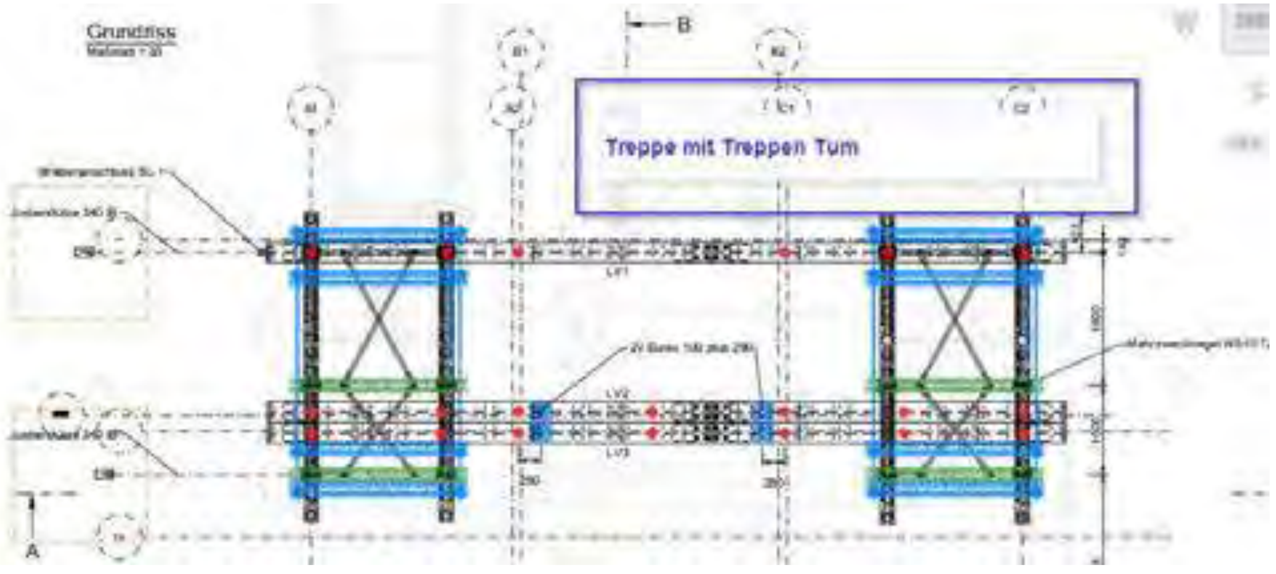
Eine ungleiche Setzung der Traggerüststiele ist zu vermeiden. Für die einzelnen Stiele und die Deckenstützen ist eine geeignete Lagerung kundenseitig vorzusehen. Die maßgebenden Stiellasten und Stützenlasten sind der nachfolgenden Bemessung zu entnehmen.

Zwischen Achse A1 und Achse A2 soll ein Aufzug positioniert werden. Dieser ist mittels einer Gerüstrohranbindung an die Joche A und B anzubinden. Eine Anbindung innerhalb des Gerüstturms ist nicht zulässig.



Skizze

Zwischen Achse B1 und C2 soll eine kundenseitige Treppe erstellt werden. Hierfür ist das kundenseitige Podest an den Holzbau anzuschließen. Dieser Anschluss dient auch der Kopfhalterung des Traggerüst und muss kundenseitig für dieses dimensioniert und ausgeführt werden. Sämtliche H-Lasten aus der Treppe werden über den Anschluss des Podests in den Holzbau eingeleitet. Der Holzbau als schubfeste Bodenscheibe leitet die H-Lasten dann in die Kopfhalterung des Traggerüst.



Skizze

Der Traggerüstturm unterhalb des Treppenpodest leitet lediglich die Vertikallasten ab und wird durch den Anschluss des Podests an den Holzbau am Kopf gehalten. In Richtung Achse 1 ist der Traggerüstturm mittels einer Abspannung für Traggerüste unter 45° abgespannt. So kann bei einseitiger Belastung ein Kippen ausgeschlossen und eine Mindestauflast von 5kN je Stiel gewährleitet werden. Der Nachweis wird für ein am Kopf gehaltenes Traggerüst - mit einer Kopfspindeleinspannung in nur einer Richtung – geführt.

Für jegliche Verankerungen ist eine geeignete Lagerung kundenseitig vorzusehen. Die maßgebenden Verankerungskräfte sind der nachfolgenden Bemessung zu entnehmen.

Der Lastfall 1 gemäß DIN EN 12812 (Eigengewicht + Sturmwind) ist für den Nachweis des Traggerüstes nicht bemessungsmaßgebend. Das vorhandene Eigengewicht der Konstruktion reicht aus, um die H-Lasten in diesem Zustand über Reibung ($\mu_{erforderlich}$ = 0,31) in den Baugrund zu leiten.

Als bemessungsmaßgebend für das Traggerüst ist der Zustand Volllast inklusive Nutzlast und Sturmwind. Hier erfolgt der Nachweis der H- Lastableitung ebenfalls über Reibung ($\mu_{erforderlich}$ = 0,31) in den Baugrund.

Weitere Hinweise und Anmerkungen sind den gültigen Anwenderinformationen zu entnehmen.

Um Gefahren für Leben und Gesundheit der Anwender oder dritter Personen zu vermeiden, sind ergänzend zu den Planinformationen die entsprechenden Anwenderinformationen bzw. Betriebs- und Einbauanleitungen verpflichtend zu beachten.

Sämtliche Bühnenbeläge, Geländer, Absturzsicherungen und Aufstiege sind entsprechend der DIN EN 12811-1 Arbeitsgerüste und der DIN 4420-1 Schutzgerüste sowie der TRBS 2121 Gefährdung von Personen durch Absturz bauseits auszuführen.

Kundenseitige Ausführungen und solche Leistungen, die nicht explizit als Leistung der Firma DOKA gekennzeichnet sind, sind nicht Gegenstand dieses Nachweises und erfolgen seitens der bauausführenden Firma.

Der Standsicherheitsnachweis wird unter Verwendung der Statiksoftware RSTAB aus dem Hause Dlubal geführt.

3 Lastannahmen

Für den statischen Nachweis wird die Bemessungsklasse B1 gemäß DIN EN 12812 gewählt. Eine Unterscheidung der Teilsicherheitsbeiwerte γ_F für ständige und weitere Einwirkungen gemäß DIN EN 12812, Kap.9.2.2.1 b erfolgt nicht. Im Berechnungsprogramm ist auf der sicheren Seite liegend ein globaler Sicherheitsbeiwert von γ_F=1,50 für die Einwirkungen als Abminderung auf der Widerstandsseite berücksichtigt.

Die charakteristischen Einwirkungen N_{EK} werden mit den zulässigen Widerständen N_{zul} abgeglichen:

$$N_{EK} \leq N_{zul}$$

$$N_{zul} = \frac{N_{Rk}}{\gamma_M * \gamma_F}$$

3.1 Vertikallasten aus Holzbau gemäß Excel Tabelle

Bei den angegebenen Punktlasten handelt es sich um charakteristische Lasten γ_f = 1,0.

Vertikale Lasten (positives Vorzeichen: Last in Richtung der Gravitation, negatives Vorzeichen: abhebende Last) Stand: 28.01.2022

	Lasteingriffspunkt	Achse	Eigengewicht	Nutzlast Wohnraum	Nutzlast Wohnraum	Nutzlast Dach >0	Nutzlast Dach <0	Schneelast	Windlast in +y	Windlast in +y	Windlast in -y	Windlast in -x
Lastverteiler 1	0,00 m	A1	11,00	2,82		7,30		4,93				
	1,53 m	A2	0,46	2,75		0,00		0,00				
	[illegible]	A3	1,79	13,08		0,00		0,00				
	5,48 m	A5	1,77	10,99		0,00		0,00				
	[illegible]	A6	0,70	4,37		0,00		0,00				
	8,13 m	A7	11,02	2,89		7,30		4,98				
Lastverteiler 2	0,00 m	B1	17,40	3,68		9,08		5,38	0,43	0,00		0,00
	1,46 m	B2	11,50	5,59		6,59		3,91	0,31	[illegible]		3,38
	2,34 m	B3	9,80	4,84		6,07		3,60	0,29	-0,09		0,00
	3,84 m	B4	16,93	6,72		10,40		6,36	0,40	0,87		0,34
	5,34 m	B5	11,30	6,03		6,79		4,05	0,32	0,19		-0,23
	6,69 m	B6	16,89	6,35		9,87		5,88	0,46	1,41		-2,84
	8,13 m	B7	12,60	5,90		6,78		3,90	0,28	1,60		[illegible]
Lastverteiler 3	0,00 m	C1	10,97	4,13	-0,01					2,82		[illegible]
	1,46 m	C2	1,74	0,00								
	2,34 m	C3	10,90	12,31								
	3,84 m	C4	2,06	0,00								
	5,34 m	C5	11,25	12,21								
	6,69 m	C6	2,06	0,00								
	8,13 m	C7	0,78	4,13	-0,01					2,82		-2,40
Stütze 1		D1	38,54	10,77						1,31		-1,31
Stütze 2		D3	36,99	22,65								
Stütze 3		D5	36,99	22,65								
Stütze 4		D7	38,54	10,77						1,31		-1,31
Lastverteiler 4	0,00 m	E1	12,93	5,05	-0,61					[illegible]		3,65
	[illegible]	E3	9,44	12,31	-1,28							
	5,43 m	E5	9,44	12,31	-1,28							
	8,13 m	E7	12,93	5,05	-0,605					[illegible]		3,65
Lastverteiler 5	0,00 m	F1	5,50	2,85	-0,62					-0,31		0,31
	[illegible]	F3	2,76	5,90	-1,20							
	5,43 m	F5	2,76	5,90	-1,20							
	8,13 m	F7	5,50	2,85	-0,616					-0,31		0,31
Lastverteiler 6	0,00 m	G1	7,77	3,16	-0,03					0,04		-0,04
	[illegible]	G3	4,79	6,65	-0,07							
	5,43 m	G5	4,79	6,65	-0,07							
	8,13 m	G7	7,77	3,16	-0,033					0,04		-0,04
Lastverteiler 7	0,00 m	H1	17,50	1,63		6,11		3,07	0,56	0,12		-0,12
	1,53 m	H2	2,62	0,00		0,00		0,00	0,00	[illegible]		2,26
	[illegible]	H3	[illegible]	3,43		11,88		5,95	1,06	-1,29		1,29
	5,48 m	H5	[illegible]	3,43		11,88		5,95	1,06	3,89		[illegible]
	[illegible]	H6	4,95	0,00		0,00		0,00	0,00	0,58		-0,58
	8,13 m	H7	17,60	1,63		6,11		3,07	0,56	-0,04		0,04

Änderung der Vertikallasten vom 01.03.2022 bezogen auf den Lastverteiler 1 in Achse A1 und A7 in gelb:

Es haben sich zwei Werte des Eigengewichts bei Lastverteiler 1 geändert. (siehe Screenshot)

	Lastangriffspunkt	Achse	Eigengewicht
Lastverteiler 1	0,00 m	A1	13,22
	1,53 m	A2	0,45
	3,33 m	A3	1,79
	5,43 m	A5	1,77
	6,60 m	A6	0,70
	8,13 m	A7	13,24

3.2 Ständige Einwirkungen Traggerüst „Q1“

EIGENLAST

- Mehrzweckriegel WS10 [2x U100; S235] ....0,22 kN/lfm
- Systemträger SL-1 [HEM 220; S235] ....1,51 kN/lfm
- Nadelholz / Spanplatten inkl. Zuschläge für Verbindungsmittel und Hartholzteile .... 6,0 kN/m³

3.3 Veränderliche andauernde horizontale Einwirkungen „Q3“

HORIZONTALE ERSATZLAST

- Entspricht 1% der Vertikallast gemäß DIN EN 12812 .... V/100

3.4 Wind „Q5“

3.4.1 Wind auf Traggerüst

Die Ermittlung der Windlast erfolgt gemäß DIN EN 1991-1-4/NA:2010-12 und DIN EN 12812:

Aerodynamische Beiwerte	
Traggerrüst Staxo 100	1,85

Maximaler Wind (Sturmwind)	
Windzone:	1
Bezugsgeschwindigkeitsdruck qb,0:	0,32 kN/m²
Geländekategorie:	II
Höhe OK Schalung über Geländeoberkante z:	8,00 m
Standzeit:	≤ 12 Monate
Abminderungsfaktor unter Berücksichtigung der Standzeit	0,6
Böengeschwindigkeitsdruck qp,red	0,38 kN/m²
Böengeschwindigkeit vp	88,8 km/h

3.4.2 Wind auf Holzbau

Die Lasten infolge Wind auf den Holzbau werden von der Uni-Karlsruhe vorgegeben und sind der Excel-Tabelle wie folgt zu entnehmen:

Horizontale Lasten

	Lastangriffspunkt	charakteristisch Fk [kN]	Eigengewicht	Nutzlast Wohnraum	Nutzlast Wohnraum	Nutzlast Dach >0	Nutzlast Dach <0	Schneelast	Windlast in +y	Windlast in +x	Windlast in -y	Windlast in -x
Turm 1-8									3,26	3,06	3,26	3,06

Es handelt sich hierbei um charakteristische Lasten γ_f = 1,0, welche ohne Berücksichtigung des Standzeitfaktors ermittelt wurden. In Absprache mit der Uni-Karlsruhe werden für die Bemessung der Kopfhalterung des Traggerüst die in der Tabelle angegebenen Lasten noch mit dem Standzeitfaktor für Einsatzdauern ≤ 12 Monate multipliziert.

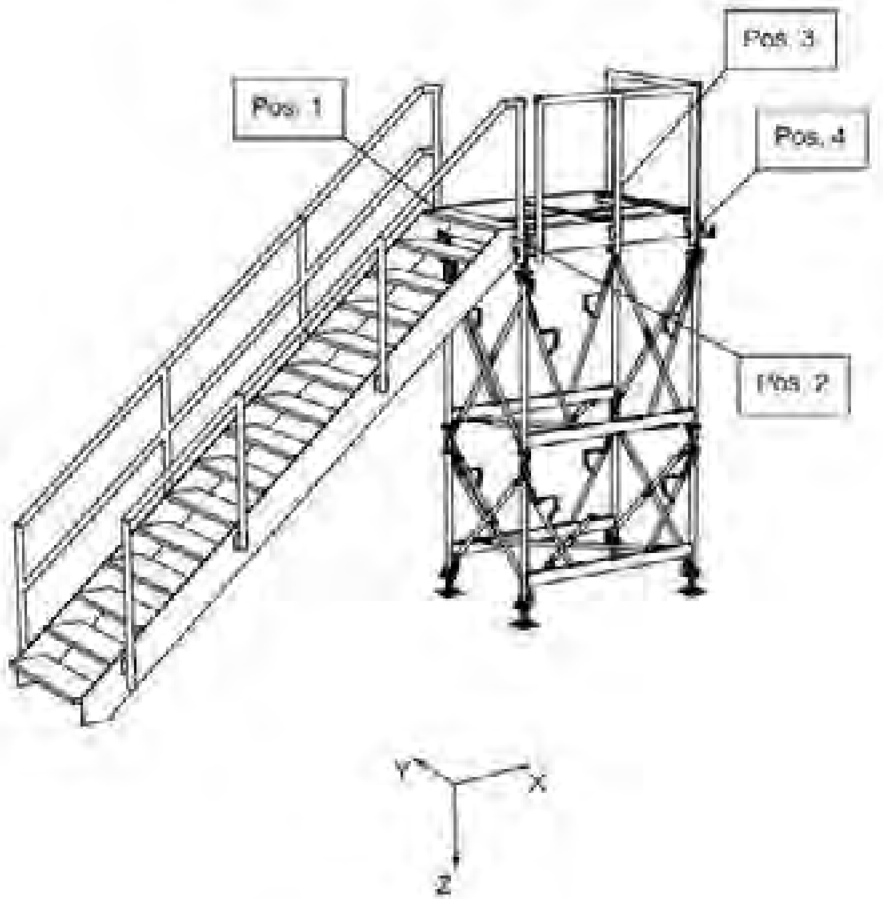
Somit reduziert sich die Windlast je Turm auf H_{Turm} = 0,6 x 3,26kN = 1,96kN

3.5 H-Lasten aus Aufzug

Vorgabe Uni-Karlsruhe:

"Der Aufzug wird auf Etagenhöhe mit Standard-Gerüstrohrkupplungen am Boden oder am Gerüst o.ä. befestigt. Maximale Lasten (worst case): Rx= 0,5 kN / Ry=0,9 kN“ Die angegebenen Lasten werden auf sicherer Seite liegend als charakteristisch angesetzt.

3.7 Lasten aus Treppenpodest Stand 01.03.2022



	Gk (Eigengewicht)			Qk (Nutzlast 5kN/m²)			Sk (Schneelast 0,65kN/m²)			Wk Windlast (0.22kN/m²)			Ed Bemessungswert		
	R_X [kN]	R_Y [kN]	R_Z [kN]	R_X [kN]	R_Y [kN]	R_Z [kN]	R_X [kN]	R_Y [kN]	R_Z [kN]	R_X [kN]	R_Y [kN]	R_Z [kN]	R_X [kN]	R_Y [kN]	R_Z [kN]
Pos. 1	0.12	-	1.75	0.47	±0.15	7.38	0.03	-	0.96	±0.22	±0.47	±0.35	**1.2**	**±0.7**	**13.9**
Pos. 2	0.06	-	1.67	0.22	±0.15	6.81	0.06	-	0.89	±0.22	±0.47	±0.35	**0.7**	**±0.7**	**13.5**
Pos. 3	-	-	0.35	-	-	2.61	-	-	0.34	-	-	0	**-**	**-**	**4.7**
Pos. 4	-	-	0.25	-	-	1.03	-	-	0.25	-	-	0	**-**	**-**	**3.5**

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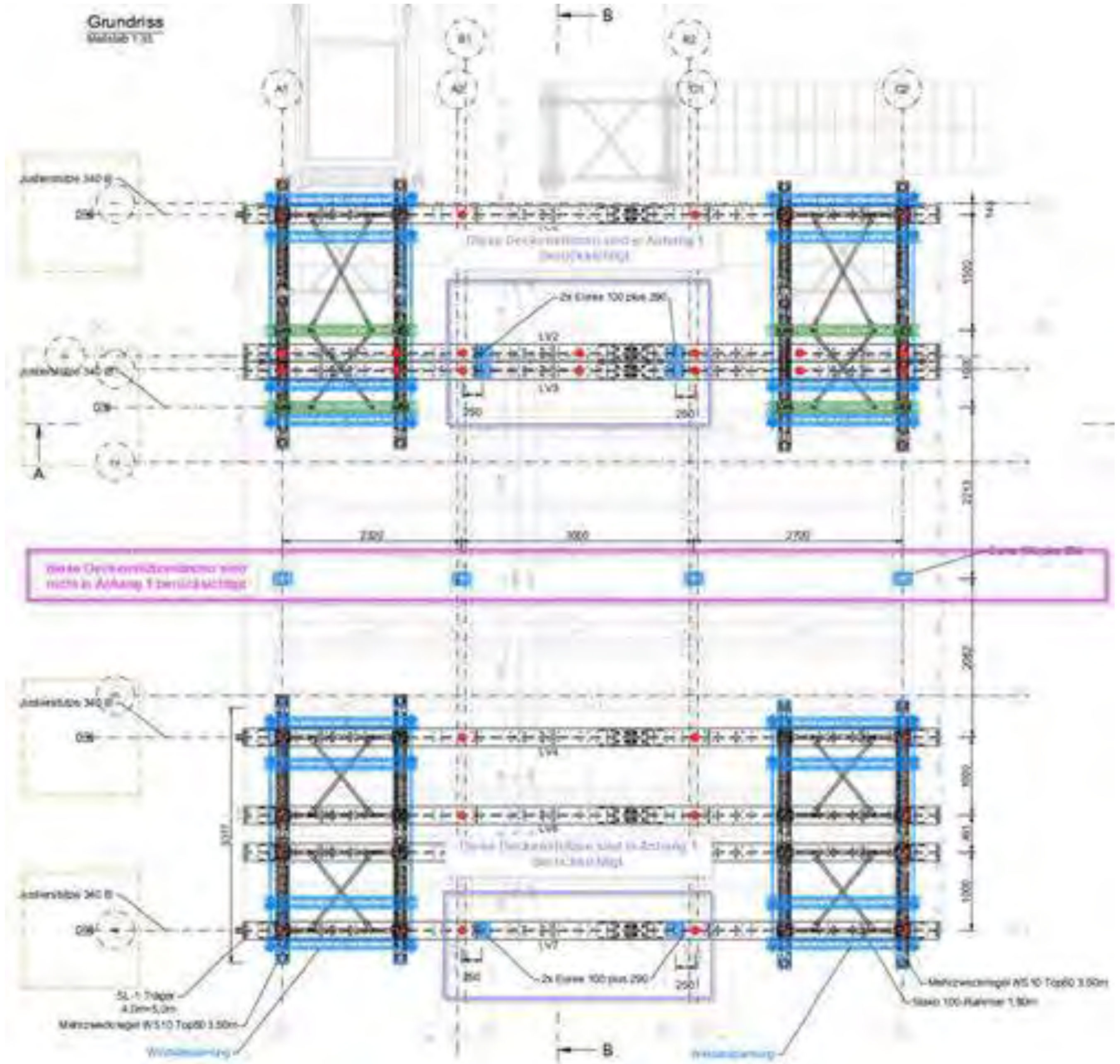
4 Lastverteiler HEM 220 Träger

Als Jochträger kommen SL-1Träger (HEM 220, S235) der Länge 5,0m und 4,0m zum Einsatz, die untereinander mittels Stirnplattenstoß biegesteif verbunden werden. Als Belastung der Jochträger werden die Vertikallasten aus der Excel Tabelle aufgegeben.



In den Lastfällen LF 4 (Nutzlast <0) und LF 6 (Schneelast) wurde ein LF –Faktor von 0,001 berücksichtigt, da LF 4 die vorhandene Vertikallast verringern würde und zu geringeren H-Lasten führen würde und Jahreszeitenbedingt wird die temporäre Konstruktion nicht für Schnee und Eislasten nachgewiesen.

Der Nachweis wird im Anhang 1 geführt.

Lastsummenkontrolle

LF 2 Eigengewicht

Soll = 471,74kN davon 111,06kN in den Deckenstützen, die nicht im Anhang 1 abgebildet sind.

Last in Deckenstützen F = 26,54kN+28,99kN+28,99kN+26,54kN = 111,06kN

Soll Rstab = 471,74kN – 111,06kN = 360,68kN

IST Rstab = 360,66kN

Lastfall 3: Nutzlast Wohnraum >0

Soll = 256,61kN davon 66,84kN in den Deckenstützen, die nicht im Anhang 1 abgebildet sind.

Last in Deckenstützen F = 10,77kN+22,65kN+22,65kN+10,77kN = 66,84kN

Soll Rstab = 256,61kN – 66,84kN = 189,77kN

IST Rstab = 189,79kN

Lastfall 5: Nutzlast Dach >0

Soll Rstab = 105,69kN

IST Rstab = 105,71kN

Die maximale Spannungsausnutzung beträgt $\sigma_{max.\ vorhanden} = 0{,}12 < \sigma_{zulässig} = 100\%/1{,}5 = 0{,}667$

⇨ **Nachweis erfüllt!**

4.2 Stirnplattenstoß SL-1

Die maximale Spannungsausnutzung im Stoß beträgt $\sigma_{max.\ vorhanden} = 0{,}06$ im Lastverteiler 2

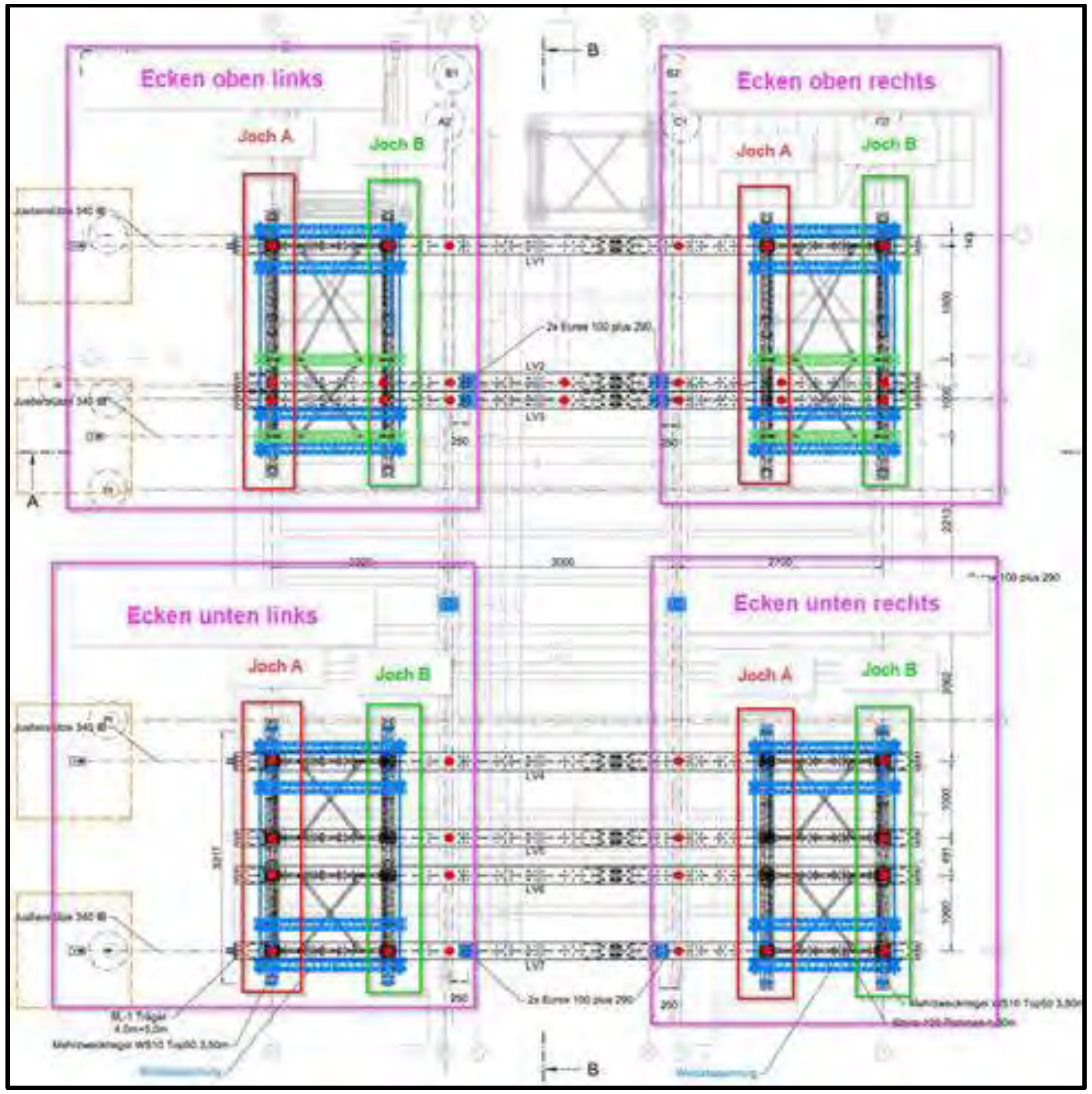
$N_k = 0kN \rightarrow$ Kurve A

$V_{z,k} = -21{,}67kN$

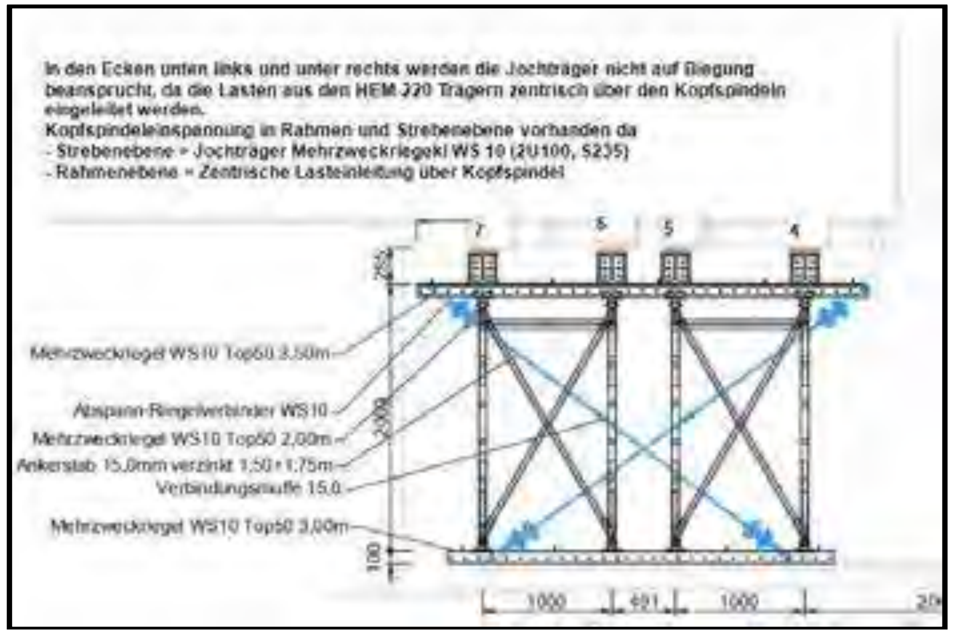
$\rightarrow M_{zulässig} = 32kNm \geq M_{y,k} = 1{,}99kNm$

⇨ **Nachweis erfüllt!**

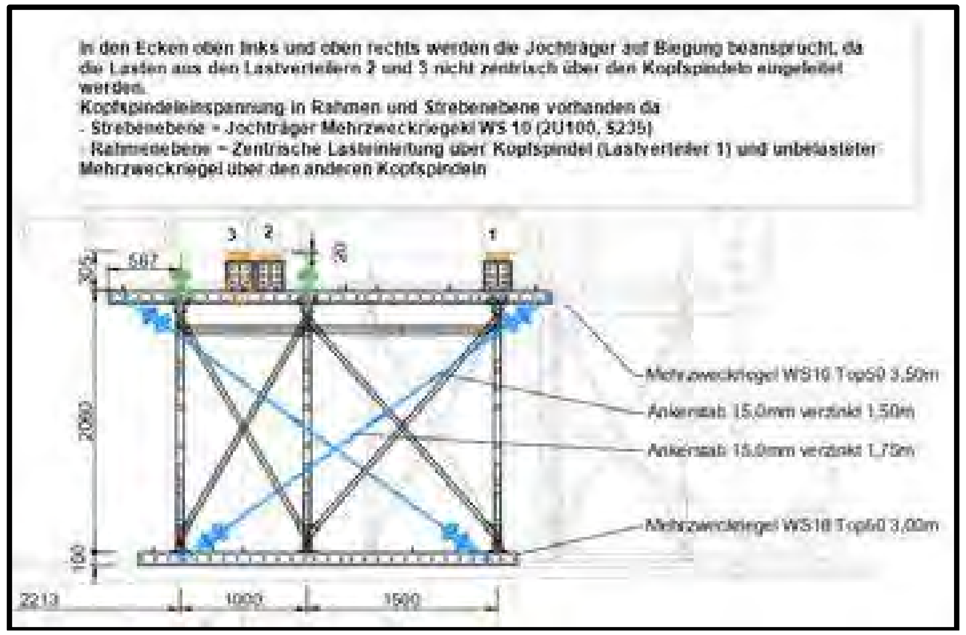
5 Jochträger



Skizze zur Erläuterung



Skizze: Situation Ecke unten links und unten rechts



Skizze Situation Ecke oben links und oben rechts

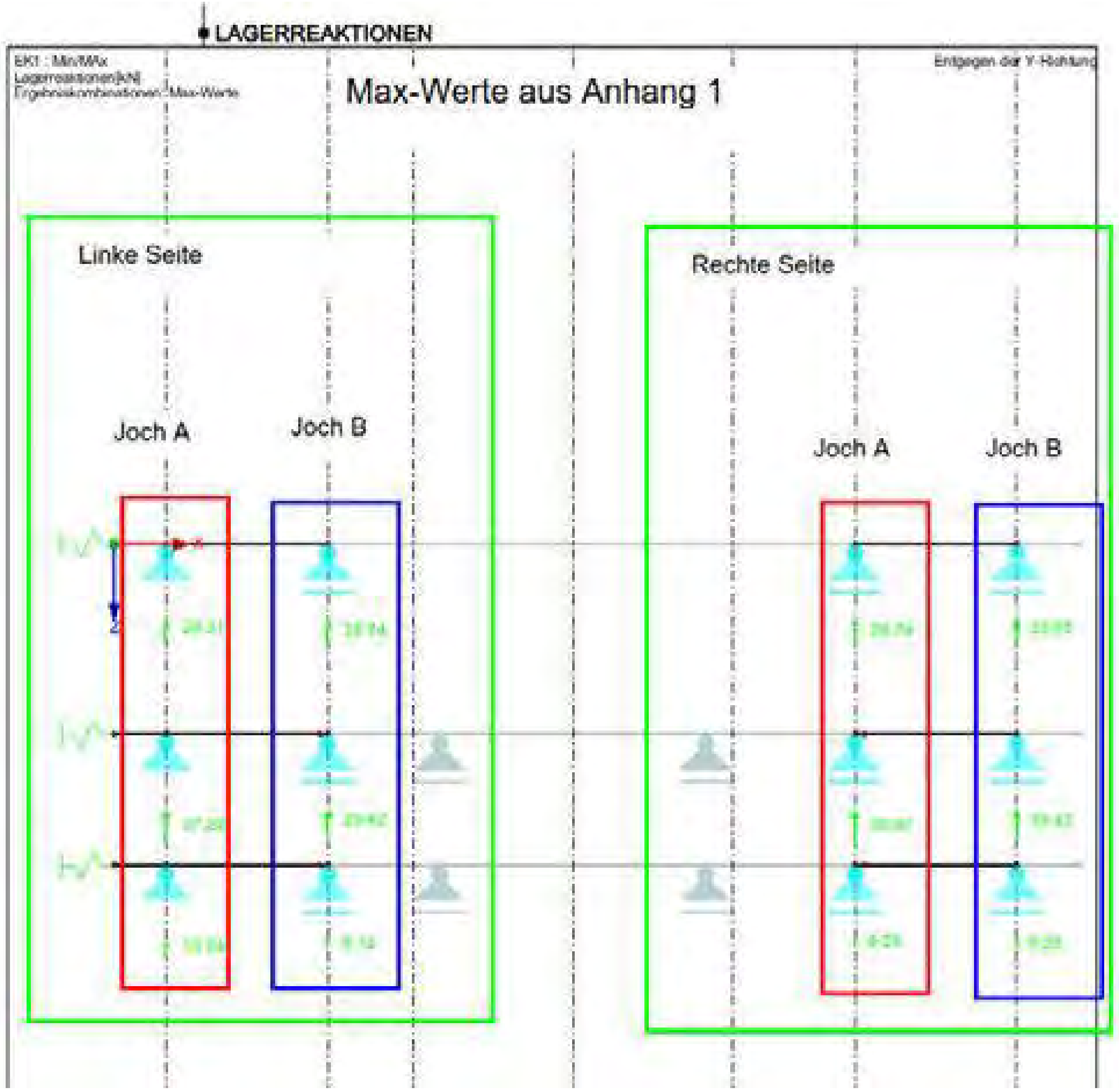
Als Jochträger kommen Mehrzweckriegel WS 10 der Länge 3,50m zum Einsatz.

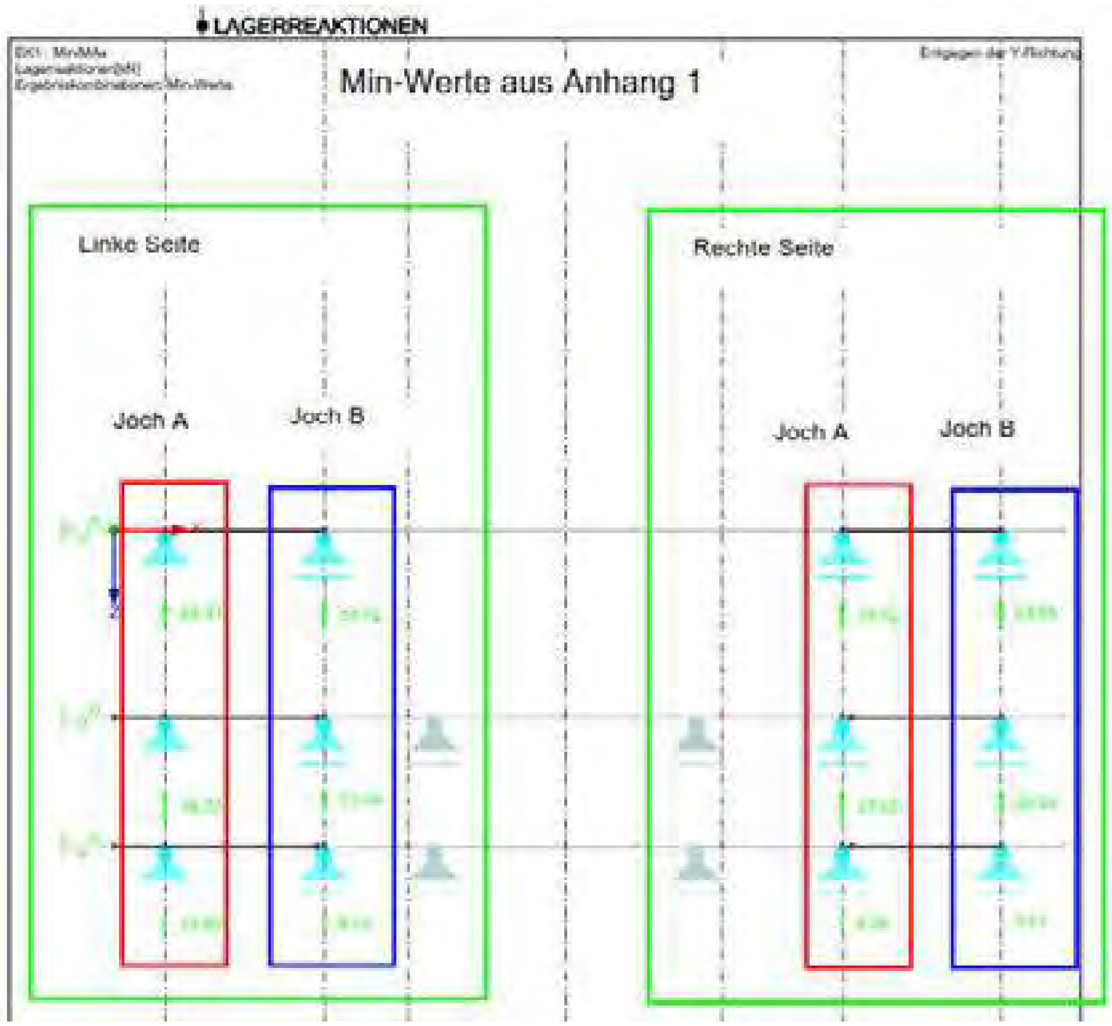
Es werden die auf Biegung beanspruchten Joche in den beiden oberen Ecken – im Bereich der Lastverteiler 1, 2 und 3 - nachgewiesen.

Lastfälle

LF 1: Eigengewicht Mehrzweckriegel WS 10

LF 2-5: Maximal Werte bzw. Minimal Werte aus Anhang 1





LF 6: max. H-Last je Abspannungseinheit aus Anhang 4

Der Nachweis wird im Anhang 2 geführt.

Die maximale Spannungsausnutzung beträgt $\sigma_{max.\ vorhanden} = 0{,}40 < \sigma_{zulässig} = 100\%/1{,}5 = 0{,}667$

6 Horizontallasten

6.1 Nur Eigenlasten und Windlasten

• Wind auf Oberkonstruktion (Vorgabe UNI):		
$H_{pro\ Trum}$= 1,96 kN/Turm n = 8 Türme		
$H_{Oberkonstruktion}$=	=	15,65 kN
• Wind auf einen Traggerüstturm (Abschattung unberücksichtigt):		
H_W= w[kN/m²] x cp x h[m] x Aref[m²/m] / 2 x n Türme		
H_W= 0,50 x 1,85 x **2,00** x **0,48** / 2 x **8**	=	3,55 kN
• Horizontale Ersatzlast Traggerüst (V/100):		
H_E=max.F_v[kN] / 100		
H_E= **327,21** / 100	=	3,27 kN
• Imperfektion Traggerüst (V/100):		
H_I= max.F_v[kN] / 100		
H_I= **327,21** / 100	=	3,27 kN
• Imperfektion aus Deckenstützen (V/100):		
H_I= max.F_v[kN] / 100		
H_I= **240,92** / 100	=	2,41 kN
• Horizontale Lasten aus aus Deckenstützen (V/100):		
H= max.F_v[kN] / 100		
H= **240,92** / **100**	=	2,41 kN
Summe der Horizontallast für den Nachweis der Kopfhalterung	**=**	**30,56 kN**

Der Wind auf den Traggerüstturm wird auf sicherer Seite mit Aref= 0,48m²/m angesetzt.

Horizontale Ersatzlast und Imperfektion Traggerüst

Es wird die LK 4 zu Grunde gelegt. Dies beinhaltet das reine Eigengewicht und keine Vertikallasten aus Wind, da dieser nicht unbedingt vorhanden sein muss

Diese ergibt sich aus der LK 4 abzüglich der Lasten in den Deckenstützen unter den Lastverteilern 3, 4 und 7:

F_v = Summe P_z aus LK 4 – ohne Lasten in Deckenstützen aus Anhang 1

F_v = 457,07kN-(22,50kN+12,66kN+13,99kN+23,57kN+27,10kN+30,04kN)

F_v = 457,07kN-129,86kN = 327,21kN

für Horizontale Ersatzlast und Imperfektion Deckenstützen:

F_v = Summe Stütze1-4 aus Excel Tabelle + Lasten in Deckenstützen aus Anhang 1

F_v = 22,50kN+12,66kN+13,99kN+23,57kN+27,10kN+30,04kN + 111,06kN=240,92kN

F_v = 111,06kN+129,86kN = 240,92kN

Kontrolle

SOLL: 96,41kN (Gewicht SL-1 Träger) + 471,74kN (Summe V Excel Tabelle) = 568,15kN

IST: Summe V Traggerüst + Summe V Deckenstützen =327,21kN+240,92kN = 568,13kN

→ in Ordnung

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VERFASSER: ALEXANDRA SELL

BAUWERK: UNI KARLSRUHE ROOFKIT | PROJEKT-NUMMER: 224-016371-1001S-101 | DATUM: 07.03.2022

6.2 Eigenlasten und Nutzlasten:

• Wind auf Oberkonstruktion (Vorgabe UNI):		
$H_{pro\ Trum}$= 1,96 kN/Turm n = 8 Türme		
$H_{Oberkonstruktion}$=	=	15,65 kN
• Wind auf einen Traggerüstturm (Abschattung unberücksichtigt):		
H_W= w[kN/m²] x cp x h[m] x Aref[m²/m] / 2 x n Türme		
H_W= 0,50 x 1,85 x **2,00** x **0,48** / 2 x **8**	=	3,55 kN
• Horizontale Ersatzlast Traggerüst(V/100):		
H_E=max.F_v[kN] / 100		
H_E= **576,55** / 100	=	5,77 kN
• Imperfektion Traggerüst (V/100):		
H_I= max.F_v[kN] / 100		
H_I= **576,55** / 100	=	5,77 kN
• Imperfektion aus Deckenstützen (V/100):		
H_I= max.F_v[kN] / 100		
H_I= **422,66** / 100	=	4,23 kN
• Horizontale Lasten aus aus Deckenstützen (V/100):		
H= max.F_v[kN] / 100		
H= **422,66** / **100**	=	4,23 kN
Summe der Horizontallast für den Nachweis der Kopfhalterung	**=**	**39,18 kN**

Es wird die LK 1 aus Anhang 1 zu Grunde gelegt, da hier die maximale Vertikallastsumme hervor geht.

für Horizontale Ersatzlast und Imperfektion Traggerüst:

F_v = Summe P_z aus LK 1 – Last aus Deckenstützen in Anhang 1

F_v = 818,70kN–(21,85kN+50,47kN+24,27kN+53,20kN+43,73kN+48,63kN)

F_v = 818,70kN-242,15kN=576,55kN

für Horizontale Ersatzlast und Imperfektion Deckenstützen:

F_v = Summe Stütze1-4 aus Excel Tabelle + Last aus Deckenstützen in Anhang 1

F_v = 180,51kN + (21,85kN+50,47kN+24,27kN+53,20kN+43,73kN+48,63kN)=

F_v = 180,51kN + 242,15kN = 422,66kN

Kontrolle

SOLL: 96,41kN (Gewicht SL-1 Träger) + 839,83 kN (Summe V Excel Tabelle) = 936,24kN

Summe V Excel Tabelle = Eigengewicht + Nutzlast Wohnraum >0, Nutzlast Dach >0

IST: Summe V Traggerüst + Summe V Deckenstützen = 576,55kN+422,66kN= 999,21kN

→ in Ordnung

6.3 Lokales Gleiten „nur Eigenlasten und Windlasten" über Reibung

Überprüfung, ob das Eigengewicht ausreicht, um die H-Last über Reibung in das Traggerüst zu leiten.

Hierfür wird die gesamte H-Last für den Zustand „nur Eigenlasten und Wind" gleichmäßig auf die 4 Ecken aufgeteilt.

Wichtig:

Zwischen Holzbau und HEM 220 Träger sind Elastomerplatten mit einem Reibbeiwert von mindestens

$\mu_{erforderlich}$ *=0,31 einzulegen.*

Die gleichen Elastomerplatten sind zwischen WS 10 und HEM 220 Träger zu legen.

	LK 4: Ecke oben links	LK 4: Ecke oben rechts
Joch A	12,80 kN	9,52 kN
	19,46 kN	17,71 kN
	12,59 kN	5,81 kN
Summe	**44,85 kN**	**33,04 kN**
JochB	9,58 kN	13,04 kN
	11,79 kN	15,26 kN
	5,80 kN	2,65 kN
Summe	**27,17 kN**	**30,95 kN**

	LK 4 Ecke unten links	LK 4 Ecke unten rechts
Joch A	9,37 kN	19,17 kN
	4,68 kN	10,15 kN
	5,05 kN	12,89 kN
	18,58 kN	13,33 kN
Summe	**37,68 kN**	**55,54 kN**
Joch B	20,46 kN	9,52 kN
	10,58 kN	4,88 kN
	13,58 kN	6,30 kN
	12,91 kN	18,77 kN
Summe	**57,53 kN**	**39,47 kN**

Übersicht Auflagerlasten in den Lastverteilern LK4 aus Anhang1

→ minimal vorhandene Auflast in einem Joch beträgt 27,17kN (Ecke oben links Joch B)

Der Nachweis des Lokalen Gleitens wird im Anhang 3 geführt.

6.4 Lokales Gleiten „Eigenlasten und Nutzlasten" über Reibung

Zu der H-Last aus Kapitel 6.2 werden noch die H-Lasten aus dem Aufzug und der Treppe auf einen Turm hinzugerechnet.

Wichtig:

Zwischen Holzbau und HEM 220 Träger sind Elastomerplatten mit einem Reibbeiwert von mindestens

$\mu_{erforderlich}$ *=0,31 einzulegen.*

Die gleichen Elastomerplatten sind zwischen WS 10 und HEM 220 Träger zu legen.

	LK1 Ecke unten links	LK 1 Ecke unten rechts
Joch A	10,16 kN	35,78 kN
	5,07 kN	18,22 kN
	6,48 kN	21,92 kN
	29,39 kN	17,83 kN
Summe	**51,10 kN**	**93,75 kN**
Joch B	38,67 kN	10,23 kN
	19,42 kN	5,23 kN
	23,48 kN	6,69 kN
	18,93 kN	29,51 kN
Summe	**100,50 kN**	**51,66 kN**

	LK1: Ecke oben links	LK 1: Ecke oben rechts
Joch A	23,31 kN	28,74 kN
	37,28 kN	39,02 kN
	16,42 kN	8,29 kN
Summe	**77,01 kN**	**76,05 kN**
JochB	28,74 kN	23,55 kN
	26,58 kN	32,06 kN
	9,12 kN	6,43 kN
Summe	**64,44 kN**	**62,04 kN**

	LK 2 Ecke unten links	LK 2 Ecke unten rechts
Joch A	6,31 kN	35,78 kN
	4,76 kN	18,22 kN
	6,52 kN	21,92 kN
	29,01 kN	18,74 kN
Summe	**46,60 kN**	**94,66 kN**
Joch B	37,96 kN	6,38 kN
	19,42 kN	4,92 kN
	23,48 kN	6,73 kN
	16,10 kN	28,86 kN
Summe	**96,96 kN**	**46,89 kN**

	LK2: Ecke oben links	LK 2: Ecke oben rechts
Joch A	23,31 kN	28,74 kN
	36,75 kN	39,87 kN
	19,24 kN	8,29 kN
Summe	**79,30 kN**	**76,90 kN**
JochB	28,74 kN	23,55 kN
	22,08 kN	33,42 kN
	9,12 kN	9,25 kN
Summe	**59,94 kN**	**66,22 kN**

	LK 3 Ecke unten links	LK 3 Ecke unten rechts
Joch A	14,01 kN	35,78 kN
	5,38 kN	18,22 kN
	6,44 kN	21,92 kN
	28,71 kN	16,50 kN
Summe	**54,54 kN**	**92,42 kN**
Joch B	38,67 kN	14,08 kN
	19,42 kN	5,54 kN
	23,48 kN	6,65 kN
	21,18 kN	29,09 kN
Summe	**102,75 kN**	**55,36 kN**

	LK3: Ecke oben links	LK 3: Ecke oben rechts
Joch A	23,31 kN	28,74 kN
	36,93 kN	37,65 kN
	13,60 kN	8,29 kN
Summe	**73,84 kN**	**74,68 kN**
JochB	28,74 kN	23,55 kN
	29,42 kN	29,30 kN
	9,12 kN	3,61 kN
Summe	**67,28 kN**	**56,46 kN**

Übersicht Auflagerlasten in den Lastverteilern aus Anhang1 →LK2 ergibt geringste V-Last

Der Nachweis des Lokalen Gleitens wird im Anhang 4 geführt.

Maßgebend für den Nachweis des lokalen Gleitens ist der Zustand „nur Eigenlasten und Windlasten" (Anhang 3). Hier ergibt sich ein erforderlicher Reibbeiwert von μ =0,31.

In der Fuge zwischen Bodenriegel WS 10 und dem Kiesbett muss ebenfalls ein Reibbeiwert von μ ≥0,31 vorhanden sein.

1.8 Reibungsbeiwerte

1. Grenzwerte für den Gleitsicherheitsnachweis bei Traggerüsten[2)]

Holz/Holz (Reibfläche parallel oder quer zur Faser) 0,4–1,0	Holz/Stahl 0,5–1,2
	Holz/Beton (Mörtelbett) 0,8–1,0
	Stahl/Stahl 0,2–0,8
Holz/Holz (mindestens eine Reibfläche zur Faser [Hirnholz]) 0,6–1,0	Beton/Beton 0,5–1,0
	Beton/Stahl 0,2–0,4

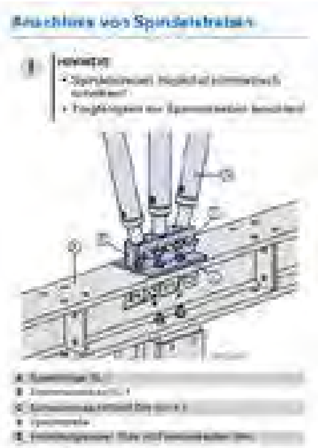
2. Näherungswerte *(Zusammenstellung aus älterer Literatur)*

Beton auf Sand und Kies 0,60–0,35	Hirnholz auf Langholz,
Beton auf Lehm und Ton 0,35–0,25	in Faserrichtung des Langholzes 0,43
Beton auf Stahl 0,45–0,30	Stahl auf Stein und Kies 0,45
Mauerwerk (rau) auf Sand/Kies 0,60	Stahl auf Sand 0,48
Mauerwerk (glatt) auf Sand/Kies 0,30	Stahl auf Stahl, wenig fettig 0,13
Mauerwerk (rau) auf nassem Ton 0,30	Stahl auf Stahl, trocken 0,15
Mauerwerk (glatt) auf nassem Ton............0,20	Stahl auf Gusseisen 0,33
Mauerwerk auf Beton 0,76	Gummi auf Stahl, trocken/nass 0,35/0,15
Holz auf Metall 0,60	Faserpressstoff auf Stahl, trocken 0,25–0,35
Holz auf Stein 0,60	PVC auf Stahl, trocken/nass 0,40/0,25
Holz auf Holz 0,50	Polyurethan auf Stahl, trocken/nass 0,45/0,35
	Keramik auf Stahl, trocken/nass 0,45/0,35

[2)] Ergebnisse eines Forschungsauftrags, durchgeführt vom Lehrstuhl für Ingenieurholzbau und Baukonstruktion der Universität Karlsruhe, abgeschlossen 1977.

Auszug aus Schneider Bautabellen Auflage20

6.5 Ableitung der H-Lasten über zug-/druckfeste Anbindung mit T7 Spindel



Die Ableitung der H-Last (maßgebender Zustand „Eigenlasten und Nutzlasten) erfolgt je Anbindung über eine Spindelstrebe T7.

Der Berechnung wird ein Aufstellwinkel von 45°zu Grunde gelegt.

Vorhandene H-Last aus Anhang 4 je Ecke H_k = 12,56kN ~ 13kN

H-Last für 2 Ecken H_k =2x13kN = 26kN

Die H-Last von 2 Ecken wird von zwei Spindeln abgeleitet, somit ergibt sich eine H-Last je Spindel von

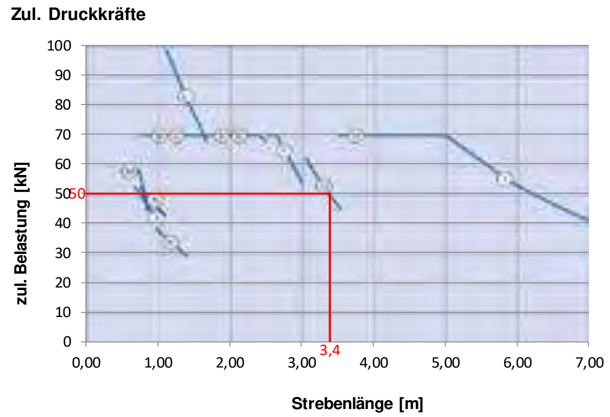
$H_{k,Spindel}$ =26kN/2 = 13kN

6.5.1 Nachweis Spindelstrebe T7

Die Horizontallastaufnahme in Rahmenebene
erfolgt lotrecht zur Abschalfläche mittels Elementabstützungen unter einem
Winkel von α = **45,0°**

Abzutragende Last in Abstützrichtung:								
N_A=	H[kN/m]	x	e[m]	/	cos	α[°]		
N_A=	**13,0**	x	**1,00**	/	cos	45,0°	=	**18,38 kN**
Erforderliche Anzahl an Elementabstützungen pro Joch:								
erf.n≥	N_A[kN]	/	zul.N[kN]					
erf.n≥	18,38	/	**50,0**				=	**0,4** ⇨gewählt n = **1**
Last in Abstützrichtung:								
vorh.N=	N_A[kN]	/	n					
vorh.N=	18,38	/	1				=	**18,38 kN**
Vertikale Lastkomponente resultierend aus Elementabstützungen:								
F_V=	vorh.N[kN]	x	sin	α[°]				
F_V=	18,38	x	sin	45,0°			=	**13,00 kN**

Länge der Spindelstrebe 3,40m oder kleiner



zul. Belastung	**50,0 kN**
Strebenlänge	**3,40 m**

Legende und zul. Zugkräfte

Pos.	Bezeichnung	zul. Zugkraft [kN]
A	Spindelstrebe T6 73/110cm	57
B	Spindelstrebe T7 75/110cm	70
C	Spindelstrebe T7 100/150cm	70
D	Spindelstrebe T7 150/200cm	70
E	Spindelstrebe T7 200/250cm	70
F	Spindelstrebe T7 250/300cm	70
G	Spindelstrebe T7 305/355cm	70
H	Spindelstrebe T10 350/400cm	70
I	Spindelstrebe T10 ....mm (min. Strebenlänge anführen)	70
J	Spindelstrebe GS T5 65/101cm	42
K	Spindelstrebe GS T6 95/140cm	38
L	Spindelstrebe GS T7 109/166cm	105
M	Spindelstrebe 40/80cm	58

vorh. N = 18,40kN ≤ 50 kN = zul. N

⇨ Nachweis erfüllt!

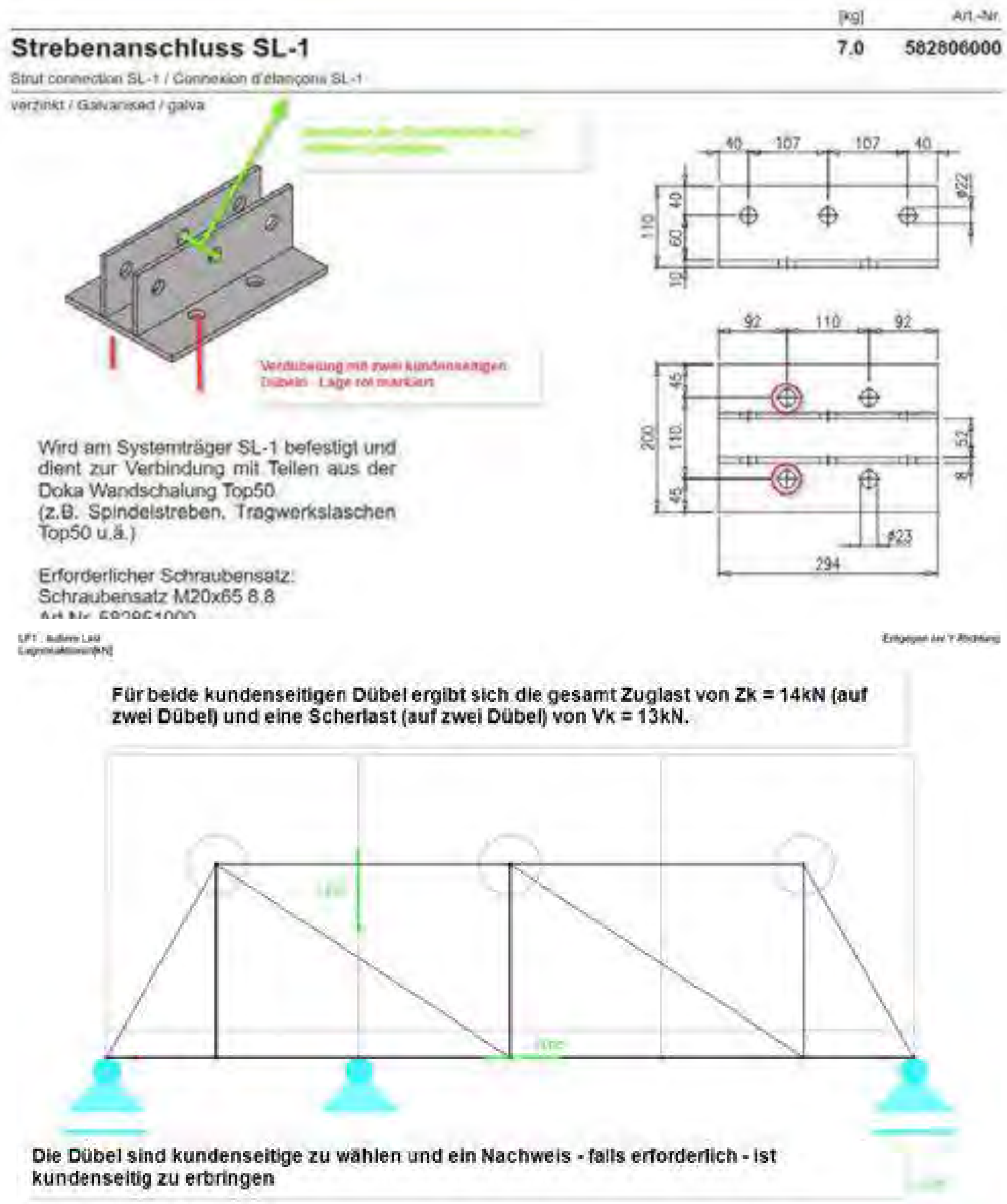
6.5.2 Verdübelung am Fußpunkt der Spindelstrebe mittels Strebenschuh SL-1

Die Lagesicherung in Rahmenebene für der Traggerüst erfolgt über die zug-/druckfeste Anbindung der Spindelstrebe T7 an ein temporäres Fundament.

Dieses temporäre Fundament kann zum Beispiel ein Betonklotz sein, der neben Kippen und Abheben die H-Last über Reibung in den Baugrund leitet.

Alle lokalen und globalen Nachweise für dieses temporäre Fundament sind seitens der Uni-Karlsruhe zu erbringen.

Angabe der Dübellasten für Strebenschuh SL-1



Die Berechnung wird im Anhang 5 geführt.

7 Deckenstützen

Max. Last in der Deckenstütze ergibt sich aus der Excel Tabelle zu:

F_v = 28,99kN + 22,65kN = 51,64kN

Max. Last in der Deckenstütze aus Anhang 1

F_v = 53,33kN

Die Bemessung erfolgt gemäß Typenprüfung **Alu-Spindelstütze „TITAN“ (Eurex 100 plus)**

AUSZUG TYPENPRÜFUNG: Alu-Spindelstütze „TITAN“

Zul. Stützenlasten - eingespannte Deckenstütze [kN]

Stützenlänge [m]	Eurex 100 plus eingespannt		
	290	410	550
2,5	110,8		
2,4	115,7		

vorh. F_V = 53,33kN (B1) ≤ 110,8kN = zul. F_V

⇨ **Nachweis erfüllt!**

8 Traggerüst Staxo 100

Standsicherheitsnachweis wird nach Typenblatt für den Staxo 100- Lastturm geführt. Der Nachweis des Traggerüstes erfolgt unter Berücksichtigung der folgenden Randbedingungen:

• max. Traggerüsthöhe:	2,0	m
• max. Fuß- und Kopfspindelauszüge ≤	30	cm
• Rahmengröße 1,80m:	Ja	
• Rahmenabstand:	1,0/1,5	m
• Rahmenanzahl ≥	2	
• Kopfspindel in Rahmenebene eingespannt:	Ja	
• Kopfspindel in Strebenebene eingespannt:	Ja	
• Traggerüst in Rahmenebene:	am Kopf gehalten	
• Traggerüst in Strebenebene:	am Kopf gehalten	

	Einsetzbare Rahmentypen	1,80 m (1,20m, 0,90m)*		1,20 m 0,90 m			1,20 m (0,90 m zwingend im obersten und untersten Schuss)			1,80 m (1,20m, 0,90 m)*		1,20 m (0,90 m zwingend im obersten und untersten Schuss)		
	Rahmenabstand a [m]	1,5 - 3,0	1,0	1,5 - 3,0	1,0	0,6	1,5 - 3,0	1,0	0,6	1,5 - 3,0	1,0	1,5 - 3,0	1,0	0,6
	Traggerüsthöhe h [m]	20,4												
Ziffer	Regelausführung mit Spindelausbildung (A)	7.1	7.2	7.5	7.6	7.7	7.8	7.9	7.10	7.11	7.12	7.13	7.14	7.15
	Regelausführung mit Spindelausbildung (B)	7.3	7.4	- - -			- - -			- - -				
	Alternative Ausführung nach Ziffer oder	4.3.3.1 Geneigtes Traggerüst								4.3.7 Einzelstiele bei unregelmäßiger Grundrissform				
	Alternative Ausführung nach Ziffer oder	4.3.5.1 Angependelte Rahmenscheiben								- - -				
	Alternative Ausführung nach und	4.4 Montageebenen												
	Alternative Ausführung nach	4.3.6 Traggerüste mit Zwischenhalterungen												

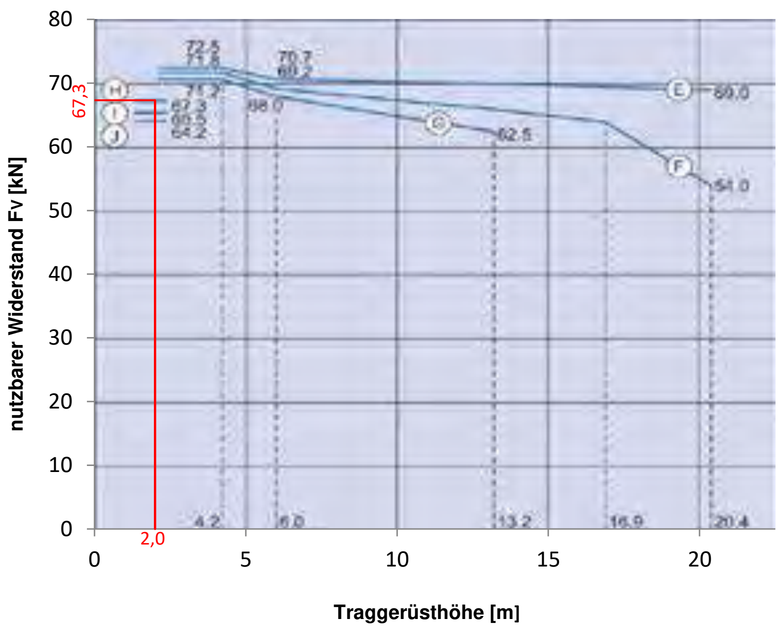
*) Es sind maximal zwei kleinere Rahmen je Scheibe zur Höhenanpassung ohne Anpassung der Windlast zulässig.

8.1 Staxo 100 am Kopf gehalten - Rahmen- und Strebenebene

Die Bemessung erfolgt gemäß Typenprüfung „DOKA-Traggerüst Staxo 100".

AUSZUG TYPENPRÜFUNG „STAXO 100 TRAGGERÜST"

Diagramm 3



Traggerüsthöhe	2,00 m
nutzbarer Widerstand Fv	67,3 kN

vorh. F_V = 40,18 kN aus Anhang 2 ≤ 67,3kN = zul. F_V (Kurve H)

bzw.

vorh. F_V = 29,51 kN (Anhang 1 -Lastverteiler 7 Achse 7) + 13kN (Last aus T7 Spindel)

= 42,518kN ~ 43kN

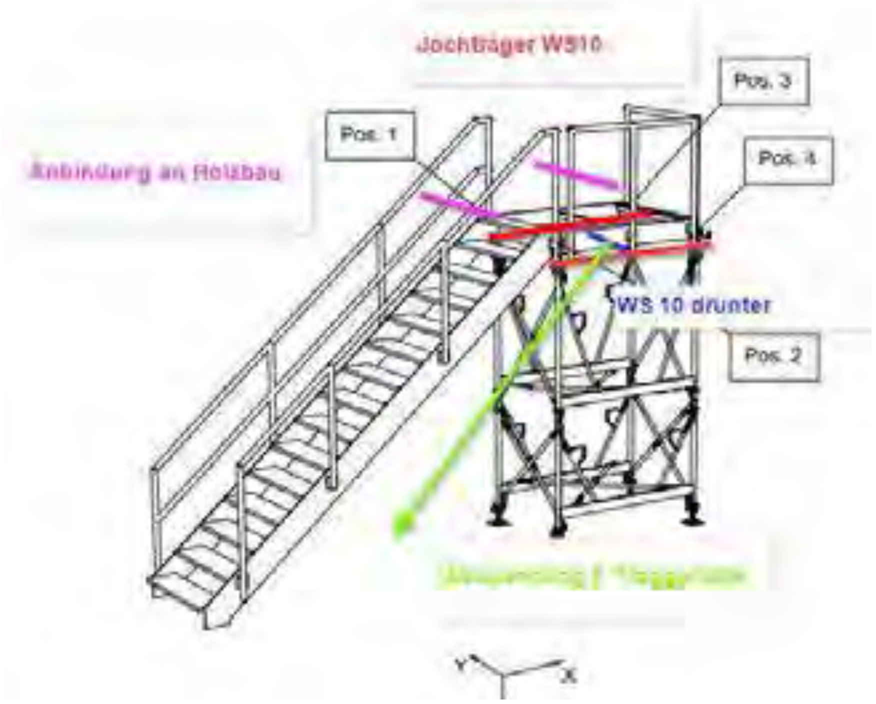
vorh. F_V = 38,367kN (Anhang 1 -Lastverteiler 4 Achse 2) nicht maßgebend

vorh. F_V = 43 kN ≤ 67,3kN = zul. F_V (Kurve H)

⇨ **Nachweis erfüllt**

9 Traggerüst Staxo 100 unter Treppenpodest

	Gk (Eigengewicht)			Qk (Nutzlast 5kN/m²)			Sk (Schneelast 0.85kN/m²)			Wk Windlast (0,32kN/m²)			Ed Bemessungswert		
	R_x [kN]	R_y [kN]	R_z [kN]	R_x [kN]	R_y [kN]	R_z [kN]	R_x [kN]	R_y [kN]	R_z [kN]	R_x [kN]	R_y [kN]	R_z [kN]	R_x [kN]	R_y [kN]	R_z [kN]
Pos. 1	0.12	-	1.75	0.47	±0.15	7.38	0.03	-	0.96	±0.22	±0.47	±0.35	**1.2**	**±0.7**	**13.9**
Pos. 2	0.08	-	1.67	0.22	±0.15	6.81	0.06	-	0.89	±0.22	±0.47	±0.35	**0.7**	**±0.7**	**13.5**
Pos. 3	-	-	0.35	-	-	2.61	-	-	0.34	-	-	0	-	-	**4.7**
Pos. 4	-	-	0.25	-	-	1.93	-	-	0.25	-	-	0	-	-	**3.5**



Prinzip Skizze

Das Treppenpodest liegt auf den Jochträgern (Mehrzweckriegel WS 10) auf und ist in Pos. 1 und 3 an den Holzbau anzubinden. Diese Anbindung stellt die Kopfhalterung des Traggerüst dar. Die Anschlüsse müssen entsprechend ausgeführt und nachgewiesen werden.

Mittig im Turm wird ein weiterer Mehrzweckriegel W10 vorgesehen, in dem die Abspannung für Traggerüste angreift.

Die Abspannung erfolgt unter 45° und ist auf eine Normalkraft von N_k = 2x 5kN x√2 = 14,14kN zu dimensionieren.

9.1 Nachweis Abspannung für Traggerüste

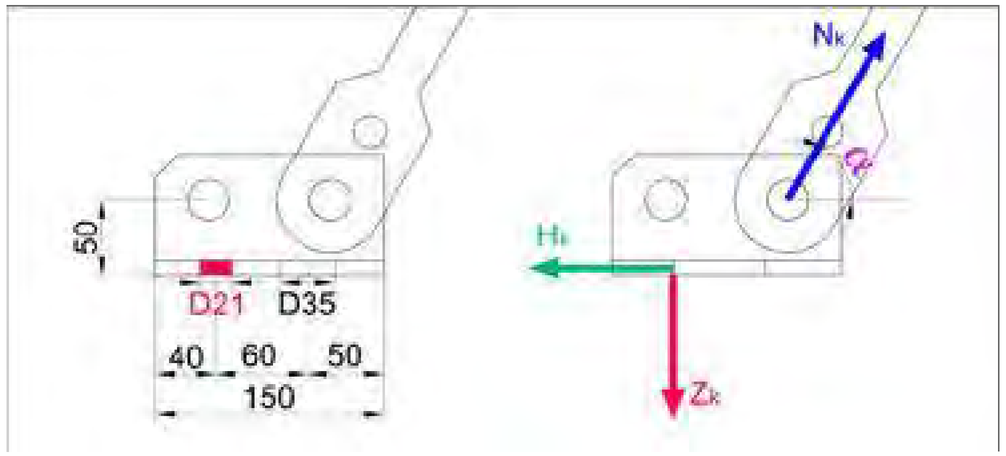
Die Horizontallastaufnahme in Rahmenebene
erfolgt lotrecht zur Abschalfläche mittels Traggerüstabspannungen unter einem Winkel von α = **45,0°**

Abzutragende Last in Abspannrichtung:								
N_A=	H[kN/m]	x	e[m]	/ cos	α[°]			
N_A=	**10,0**	x	**1,00**	/ cos	45,0°	=	**14,14 kN**	
Erforderliche Anzahl an Traggerüstabspannungen pro Joch:								
erf.n≥	N_A[kN]	/	zul.N[kN]					
erf.n≥	14,14	/	**50,0**			=	**0,3**	⇨gewählt n = **1**
Last in Traggerüstabspannung:								
vorh.N=	N_A[kN]	/	n					
vorh.N=	14,14	/	1			=	**14,14 kN**	
Vertikale Lastkomponente resultierend aus Traggerüstabspannung:								
F_V=	vorh.N[kN]	x	sin	α[°]				
F_V=	14,14	x	sin	45,0°		=	**10,00 kN**	

⇨ **Nachweis erfüllt!**

9.1.1 Angabe der Dübellasten

N_k=	14,14 kN
Winkel von α=	45,00 °
Gewähltes System:	Abspannung_für_Traggerüste_d21
H_k=	**10,00 kN**
Z_k=	**16,25 kN**



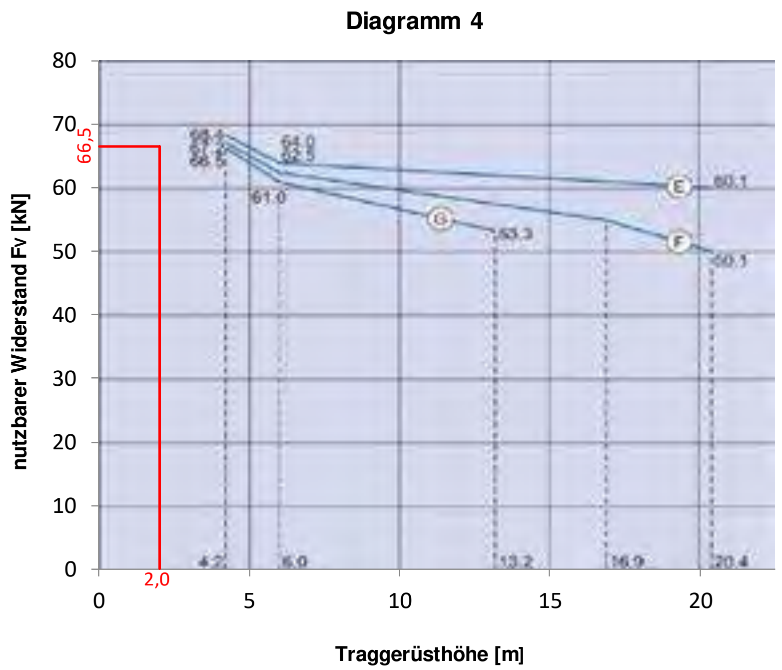
Die Wahl des geeigneten Dübels erfolgt kundenseitig.

9.2 Staxo 100 am Kopf gehalten - Rahmen- und Strebenebene

• max. Traggerüsthöhe:	2,0	m
• max. Fuß- und Kopfspindelauszüge ≤	30	cm
• Rahmengröße 1,80m:	Nein	
• Rahmenabstand:	1,0	m
• Rahmenanzahl ≥	2	
• Kopfspindel in Rahmenebene eingespannt:	Nein	
• Kopfspindel in Strebenebene eingespannt:	Ja	
• Traggerüst in Rahmenebene:	am Kopf gehalten	
• Traggerüst in Strebenebene:	am Kopf gehalten	

Die Bemessung erfolgt gemäß Typenprüfung „DOKA-Traggerüst Staxo 100“.

AUSZUG TYPENPRÜFUNG „STAXO 100 TRAGGERÜST“



Traggerüsthöhe	**2,00 m**
nutzbarer Widerstand Fv	**66,5 kN**

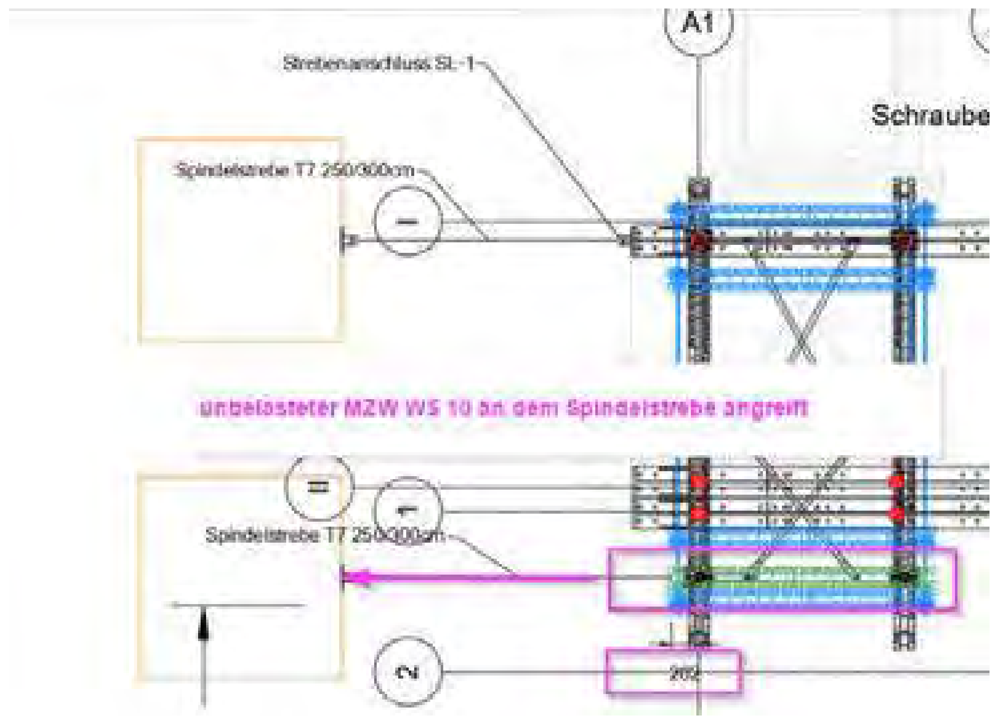
Fv = 13,9kN / 1,4 (Stiellast) + 10kN/2 (halbe Last aus Abspannung) = 14,93kN

vorh. F_V = 14,93 kN ≤ 66,5kN = zul. F_V

⇨ **Nachweis erfüllt**

ERSTELLER:	DEUTSCHE DOKA Schalungstechnik GmbH Frauenstraße 35, D82216 Maisach	doka
VERFASSER: ALEXANDRA SELL		
BAUWERK: UNI KARLSRUHE ROOFKIT	PROJEKT-NUMMER: 224-016371-1001S-101	DATUM: 07.03.2022

10 Unbelasteter MZR WS 10 – Angiffspunkt T7 Spindel

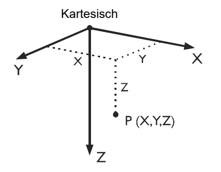


Max. M = F_v x 0,202m = 13kN x 0,202m = 2,62kNm < zul.M = 12,30kNm (2x U 100, S235)

BAUTEIL:	SEITE: 34	ARCHIV-NR
KAPITEL: UNBELASTETER MZR WS 10 – ANGIFFSPUNKT T7 SPINDEL		

■ MODELL-BASISANGABEN

Allgemein	Modellname	:	224-016371-1001S-501
	Modelltyp	:	2D-XZ (ux/uz/φy)
	Positive Richtung der globalen Z-Achse	:	Nach unten
	Klassifizierung der Lastfälle und Kombinationen	:	Nach Norm: EN 1990 Nationaler Anhang: CEN - EU
Optionen	■ CQC-Regel anwenden		
	■ CAD/BIM-Modell ermöglichen		
	Erdbeschleunigung		
	g	:	10.00 m/s²



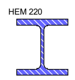
■ 1.1 KNOTEN

Knoten Nr.	Bezugs-Knoten	Koordinaten-System	Knotenkoordinaten X [mm]	Z [mm]	Kommentar
3	-	Kartesisch	0.0	0.0	Gelagert
4	-	Kartesisch	489.8	0.0	
5	-	Kartesisch	2013.8	-0.2	
6	-	Kartesisch	5000.0	-0.2	
7	-	Kartesisch	6985.8	-0.2	
8	-	Kartesisch	8509.3	-0.2	
9	-	Kartesisch	9103.5	0.0	
13	-	Kartesisch	2819.8	-0.2	
15	-	Kartesisch	5829.8	-0.2	
20	-	Kartesisch	0.0	6775.3	Gelagert
21	-	Kartesisch	489.8	6775.3	
22	-	Kartesisch	2013.8	6775.1	
23	-	Kartesisch	5000.0	6775.1	
24	-	Kartesisch	6985.8	6775.1	
25	-	Kartesisch	8509.3	6775.1	
26	-	Kartesisch	9103.5	6775.3	
29	-	Kartesisch	5829.8	6775.1	
32	-	Kartesisch	0.0	7775.3	Gelagert
33	-	Kartesisch	489.8	7775.3	
34	-	Kartesisch	2013.8	7775.1	
35	-	Kartesisch	5000.0	7775.1	
36	-	Kartesisch	6985.8	7775.1	
37	-	Kartesisch	8509.3	7775.1	
38	-	Kartesisch	9103.5	7775.3	
39	-	Kartesisch	2819.8	7775.1	
41	-	Kartesisch	5829.8	7775.1	
44	-	Kartesisch	0.0	8265.8	Gelagert
45	-	Kartesisch	489.8	8265.8	
46	-	Kartesisch	2013.8	8265.7	
47	-	Kartesisch	5000.0	8265.7	
48	-	Kartesisch	6985.8	8265.7	
49	-	Kartesisch	8509.3	8265.7	
50	-	Kartesisch	9103.5	8265.8	
53	-	Kartesisch	2819.8	8265.7	
55	-	Kartesisch	5829.8	8265.7	
58	-	Kartesisch	0.0	9265.8	Gelagert
59	-	Kartesisch	489.8	9265.8	
60	-	Kartesisch	2013.8	9265.7	
61	-	Kartesisch	5000.0	9265.7	
62	-	Kartesisch	6985.8	9265.7	
63	-	Kartesisch	8509.3	9265.7	
64	-	Kartesisch	9103.5	9265.8	
67	-	Kartesisch	2819.8	9265.7	
69	-	Kartesisch	5829.8	9265.7	
75	-	Kartesisch	0.0	1790.8	Gelagert
76	-	Kartesisch	489.8	1790.7	
77	-	Kartesisch	1943.8	1790.6	
78	-	Kartesisch	5000.0	1790.6	
80	-	Kartesisch	8509.3	1790.6	
81	-	Kartesisch	9103.5	1790.8	
82	-	Kartesisch	2819.8	1790.6	
84	-	Kartesisch	5829.8	1790.6	
89	-	Kartesisch	0.0	2024.0	Gelagert
90	-	Kartesisch	489.8	2023.8	
91	-	Kartesisch	1943.8	2023.8	
92	-	Kartesisch	5000.0	2023.8	
94	-	Kartesisch	8509.3	2023.8	
95	-	Kartesisch	9103.5	2024.0	
98	-	Kartesisch	2819.8	2023.8	
100	-	Kartesisch	5829.8	2023.8	
105	-	Kartesisch	4329.8	2023.8	
107	-	Kartesisch	4329.8	1790.6	
108	-	Kartesisch	2819.8	6775.1	
110	-	Kartesisch	3069.8	9265.7	
111	-	Kartesisch	5579.8	9265.7	
112	-	Kartesisch	3069.8	1790.6	
113	-	Kartesisch	3069.8	2023.8	
116	-	Kartesisch	5579.8	1790.6	
117	-	Kartesisch	5579.8	2023.8	
118	-	Kartesisch	7075.6	1790.6	
119	-	Kartesisch	7075.6	2023.8	
120	-	Kartesisch	2013.8	1790.6	
121	-	Kartesisch	2013.8	2023.8	
122	-	Kartesisch	6985.5	1790.6	
123	-	Kartesisch	6985.5	2023.8	

1.2 MATERIALIEN

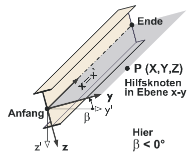
Mat. Nr.	Modul E [kN/cm²]	Modul G [kN/cm²]	Spez. Gewicht γ [kN/m³]	Wärmedehnz. α [1/°C]	Teilsich.-Beiwert γ_M [-]	Material-Modell
1	S235 - EN12812 | EN 10025-2:2019-10					
	21000.00	8076.92	78.50	1.20E-05	1.10	Isotrop linear elastisch
	Benutzerdefiniertes Material					
2	Beton C30/37 | DIN 1045-1:2008-08					
	2830.00	1179.17	25.00	1.00E-05	1.00	Isotrop linear elastisch
	Beton C30/37					
3	Baustahl S 235 | DIN EN 1993-1-1:2010-12					
	21000.00	8076.92	78.50	1.20E-05	1.00	Isotrop linear elastisch
	Baustahl S 235					
4	S235 - EN12812 | EN 10025-2:2019-10					
	21000.00	8076.92	78.50	1.20E-05	1.10	Isotrop linear elastisch
	Benutzerdefiniertes Material					

1.3 QUERSCHNITTE



Quers. Nr.	Mater. Nr.	I_T [cm⁴] / A [cm²]	I_y [cm⁴] / A_y [cm²]	I_z [cm⁴] / A_z [cm²]	Hauptachsen α [°]	Drehung α' [°]	Gesamtabmessungen [mm] Breite b	Höhe h
1	0-Statik							
	3		1.00		0.00	0.00	0.0	0.0
		1.00		1.00				
	0-Statik							
2	DUENQ DOKA_WU14_(2U140_S235)							
	1		1209.31		0.00	0.00	173.0	140.0
		40.73		16.51				
3	HEM 220							
	1		14600.00		0.00	0.00	226.0	240.0
		149.40		30.64				

1.7 STÄBE

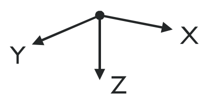


Stab Nr.	Stabtyp	Knoten Anfang	Knoten Ende	Drehung Typ	β [°]	Querschnitt Anfang	Querschnitt Ende	Gelenk Nr. Anfang	Gelenk Nr. Ende	Exz. Nr.	Teilung Nr.	Länge L [mm]	
1	Balkenstab	82	112	Winkel	0.00	3	3	-	-	-	-	250.0	X
2	Balkenstab	3	4	Winkel	0.00	3	3	-	-	-	-	489.8	X
3	Balkenstab	4	5	Winkel	0.00	3	3	-	-	-	-	1524.0	X
4	Balkenstab	5	13	Winkel	0.00	3	3	-	-	-	-	806.0	X
5	Balkenstab	6	15	Winkel	0.00	3	3	-	-	-	-	829.8	X
6	Balkenstab	7	8	Winkel	0.00	3	3	-	-	-	-	1523.5	X
7	Balkenstab	8	9	Winkel	0.00	3	3	-	-	-	-	594.3	X
8	Balkenstab	13	6	Winkel	0.00	3	3	-	-	-	-	2180.3	X
9	Balkenstab	15	7	Winkel	0.00	3	3	-	-	-	-	1156.0	X
10	Balkenstab	108	23	Winkel	0.00	3	3	-	-	-	-	2180.3	X
11	Balkenstab	29	24	Winkel	0.00	3	3	-	-	-	-	1156.0	X
12	Balkenstab	39	35	Winkel	0.00	3	3	-	-	-	-	2180.3	X
13	Balkenstab	41	36	Winkel	0.00	3	3	-	-	-	-	1156.0	X
14	Balkenstab	20	21	Winkel	0.00	3	3	-	-	-	-	489.8	X
15	Balkenstab	21	22	Winkel	0.00	3	3	-	-	-	-	1524.0	X
16	Balkenstab	22	108	Winkel	0.00	3	3	-	-	-	-	806.0	X
17	Balkenstab	23	29	Winkel	0.00	3	3	-	-	-	-	829.8	X
18	Balkenstab	24	25	Winkel	0.00	3	3	-	-	-	-	1523.5	X
19	Balkenstab	25	26	Winkel	0.00	3	3	-	-	-	-	594.3	X
20	Balkenstab	53	47	Winkel	0.00	3	3	-	-	-	-	2180.3	X
21	Balkenstab	55	48	Winkel	0.00	3	3	-	-	-	-	1156.0	X
22	Balkenstab	67	110	Winkel	0.00	3	3	-	-	-	-	250.0	X
23	Balkenstab	32	33	Winkel	0.00	3	3	-	-	-	-	489.8	X
24	Balkenstab	33	34	Winkel	0.00	3	3	-	-	-	-	1524.0	X
25	Balkenstab	34	39	Winkel	0.00	3	3	-	-	-	-	806.0	X
26	Balkenstab	35	41	Winkel	0.00	3	3	-	-	-	-	829.8	X
27	Balkenstab	36	37	Winkel	0.00	3	3	-	-	-	-	1523.5	X
28	Balkenstab	37	38	Winkel	0.00	3	3	-	-	-	-	594.3	X
29	Balkenstab	69	62	Winkel	0.00	3	3	-	-	-	-	1156.0	X
32	Balkenstab	44	45	Winkel	0.00	3	3	-	-	-	-	489.8	X
33	Balkenstab	45	46	Winkel	0.00	3	3	-	-	-	-	1524.0	X
34	Balkenstab	46	53	Winkel	0.00	3	3	-	-	-	-	806.0	X
35	Balkenstab	47	55	Winkel	0.00	3	3	-	-	-	-	829.8	X
36	Balkenstab	48	49	Winkel	0.00	3	3	-	-	-	-	1523.5	X
37	Balkenstab	49	50	Winkel	0.00	3	3	-	-	-	-	594.3	X
42	Balkenstab	58	59	Winkel	0.00	3	3	-	-	-	-	489.8	X
43	Balkenstab	59	60	Winkel	0.00	3	3	-	-	-	-	1524.0	X
44	Balkenstab	60	67	Winkel	0.00	3	3	-	-	-	-	806.0	X
45	Balkenstab	61	111	Winkel	0.00	3	3	-	-	-	-	579.8	X
46	Balkenstab	62	63	Winkel	0.00	3	3	-	-	-	-	1523.5	X
47	Balkenstab	63	64	Winkel	0.00	3	3	-	-	-	-	594.3	X
54	Balkenstab	75	76	Winkel	0.00	3	3	-	-	-	-	489.8	X
55	Balkenstab	76	77	Winkel	0.00	3	3	-	-	-	-	1454.0	X
56	Balkenstab	77	120	Winkel	0.00	3	3	-	-	-	-	70.0	X
57	Balkenstab	78	116	Winkel	0.00	3	3	-	-	-	-	579.8	X
58	Balkenstab	122	118	Winkel	0.00	3	3	-	-	-	-	90.0	X
59	Balkenstab	80	81	Winkel	0.00	3	3	-	-	-	-	594.3	X
64	Balkenstab	89	90	Winkel	0.00	3	3	-	-	-	-	489.8	X
65	Balkenstab	90	91	Winkel	0.00	3	3	-	-	-	-	1454.0	X
66	Balkenstab	91	121	Winkel	0.00	3	3	-	-	-	-	70.0	X
67	Balkenstab	92	117	Winkel	0.00	3	3	-	-	-	-	579.8	X
68	Balkenstab	123	119	Winkel	0.00	3	3	-	-	-	-	90.0	X
69	Balkenstab	94	95	Winkel	0.00	3	3	-	-	-	-	594.3	X
76	Balkenstab	107	78	Winkel	0.00	3	3	-	-	-	-	670.2	X

1.7 STÄBE

Stab Nr.	Stabtyp	Knoten Anfang	Knoten Ende	Drehung Typ	β [°]	Querschnitt Anfang	Querschnitt Ende	Gelenk Nr. Anfang	Gelenk Nr. Ende	Exz. Nr.	Teilung Nr.	Länge L [mm]	
78	Balkenstab	98	113	Winkel	0.00	3	3	-	-	-	-	250.0	X
79	Balkenstab	105	92	Winkel	0.00	3	3	-	-	-	-	670.2	X
82	Balkenstab	110	61	Winkel	0.00	3	3	-	-	-	-	1930.2	X
83	Balkenstab	111	69	Winkel	0.00	3	3	-	-	-	-	250.0	X
84	Balkenstab	112	107	Winkel	0.00	3	3	-	-	-	-	1260.0	X
85	Balkenstab	113	105	Winkel	0.00	3	3	-	-	-	-	1260.0	X
86	Balkenstab	84	122	Winkel	0.00	3	3	-	-	-	-	1155.8	X
87	Balkenstab	100	123	Winkel	0.00	3	3	-	-	-	-	1155.8	X
88	Balkenstab	116	84	Winkel	0.00	3	3	-	-	-	-	250.0	X
89	Balkenstab	117	100	Winkel	0.00	3	3	-	-	-	-	250.0	X
90	Balkenstab	118	80	Winkel	0.00	3	3	-	-	-	-	1433.7	X
91	Balkenstab	119	94	Winkel	0.00	3	3	-	-	-	-	1433.7	X
92	Balkenstab	120	82	Winkel	0.00	3	3	-	-	-	-	806.0	X
93	Balkenstab	121	98	Winkel	0.00	3	3	-	-	-	-	806.0	X

1.8 KNOTENLAGER



Lager Nr.	Knoten Nr.	Lagerdrehung [um Y	Lagerung bzw. Feder [kN/m] [kNm/rad] $u_{X'}$	$u_{Z'}$	$\varphi_{Y'}$	Kommentar
1	4,21,33,45,59,76,90	0.00	■	Ausfall	■	
2	in nächster Reihe:	0.00	■	Ausfall	■	
	5,7,8,22,24,25,34,36,37,46,48,49,60,62,63,80,94,110-113,116,117,120-123					
4	3,20,32,44,58,75,89	0.00	Feder	■	■	

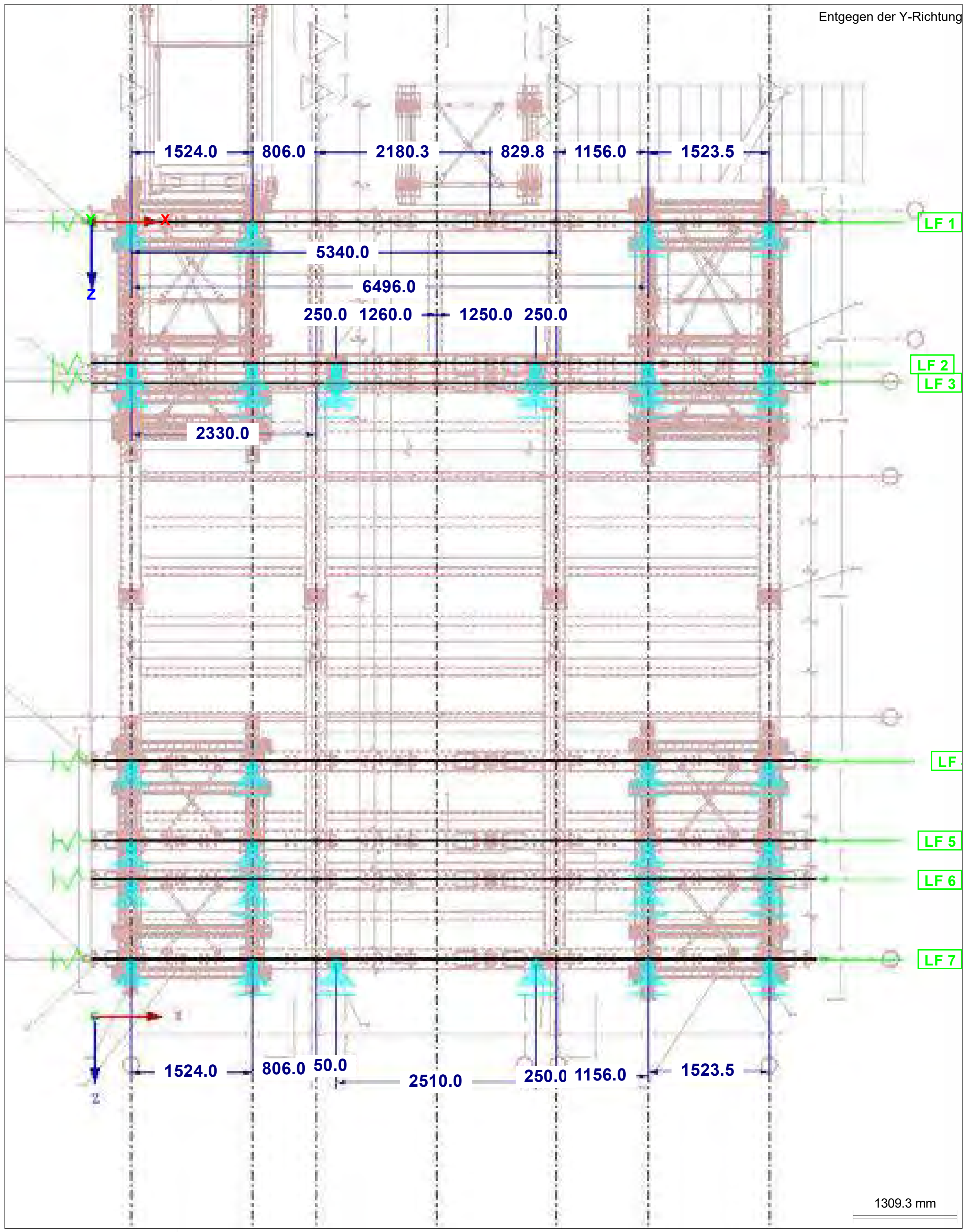
1.8.2 KNOTENLAGER - FEDERN

Lager Nr.	Knoten Nr.	Weg- bzw. Drehfeder [kN/m] [kNm/rad] $C_{u,X'}$	$C_{u,Z'}$	$C_{\varphi,Y'}$	Kommentar
4	3,20,32,44,58,75,89	10.000	-	-	

1.8.3 KNOTENLAGER - AUSFÄLLE

Lager Nr.	Knoten Nr.	Ausfall des Lagers bei $P_{X'}$	$P_{Z'}$	$M_{Y'}$	Kommentar
1	4,21,33,45,59,76,90	-		Ausfall alle, falls -P	
2	5,7,8,22,24,25,34,36, 37,46,48,49,60,62,63, 80,94,110-113,116,117, 120-123	-		Ausfall alle, falls -P	

MODELL



2.1 LASTFÄLLE

Last-fall	LF-Bezeichnung	EN 1990 | CEN Einwirkungskategorie	Eigengewicht - Faktor in Richtung Aktiv	X	Y	Z
LF1	Eigengewicht Einfluss unabh.	Ständig	■	0.000		1.290
	Erhöhungsfaktor zur Berücksichtigung der Querschotte beim Eigengewicht.					
LF2	Eigengewicht	Ständig/Nutzlast	■			
LF3	Nutzlast Wgh > 0	Nutzlasten - Kategorie A: Wohn/Aufenthaltsräume	■			
LF4	Nutzlast Wgh < 0	Nutzlasten - Kategorie A: Wohn/Aufenthaltsräume	■			
LF5	Nutzlast Dach >0	Nutzlasten - Kategorie A: Wohn/Aufenthaltsräume	■			
LF6	Schneelast	Schnee (H ≤ 1000 m über NN)	■			
LF7	Wind + Y	Wind	■			
LF8	Wind +X	Wind	■			
LF9	Wind -X	Wind	■			

2.1.1 LASTFÄLLE - BERECHNUNGSPARAMETER

Last-fall	LF-Bezeichnung	Berechnungsparameter	
LF1	Eigengewicht Einfluss unabh.	Berechnungstheorie	: ■ Theorie I. Ordnung (linear)
		Steifigkeitsbeiwerte aktivieren für:	: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LF2	Eigengewicht	Berechnungstheorie	: ■ Theorie I. Ordnung (linear)
		Steifigkeitsbeiwerte aktivieren für:	: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LF3	Nutzlast Wgh > 0	Berechnungstheorie	: ■ Theorie I. Ordnung (linear)
		Steifigkeitsbeiwerte aktivieren für:	: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LF4	Nutzlast Wgh < 0	Berechnungstheorie	: ■ Theorie I. Ordnung (linear)
		Optionen	: ■ Belastung mit Faktor bearbeiten: 0.001
		Steifigkeitsbeiwerte aktivieren für:	: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LF5	Nutzlast Dach >0	Berechnungstheorie	: ■ Theorie I. Ordnung (linear)
		Steifigkeitsbeiwerte aktivieren für:	: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LF6	Schneelast	Berechnungstheorie	: ■ Theorie I. Ordnung (linear)
		Steifigkeitsbeiwerte aktivieren für:	: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LF7	Wind + Y	Berechnungstheorie	: ■ Theorie I. Ordnung (linear)
		Steifigkeitsbeiwerte aktivieren für:	: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LF8	Wind +X	Berechnungstheorie	: ■ Theorie I. Ordnung (linear)
		Steifigkeitsbeiwerte aktivieren für:	: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LF9	Wind -X	Berechnungstheorie	: ■ Theorie I. Ordnung (linear)
		Optionen	: ■ Belastung mit Faktor bearbeiten: -1.000
		Steifigkeitsbeiwerte aktivieren für:	: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)

2.5 LASTKOMBINATIONEN

Last-kombin.	Lastkombination BS	Bezeichnung	Nr.	Faktor	Lastfall	
LK1		Wind + Y	1	1.00	LF1	Eigengewicht Einfluss unabh.
			2	1.00	LF2	Eigengewicht
			3	1.00	LF3	Nutzlast Wgh > 0
			4	1.00	LF4	Nutzlast Wgh < 0
			5	1.00	LF5	Nutzlast Dach >0
			6	1.00	LF6	Schneelast
			7	1.00	LF7	Wind + Y
LK2		Wind +x	1	1.00	LF1	Eigengewicht Einfluss unabh.
			2	1.00	LF2	Eigengewicht
			3	1.00	LF3	Nutzlast Wgh > 0
			4	1.00	LF4	Nutzlast Wgh < 0
			5	1.00	LF5	Nutzlast Dach >0
			6	1.00	LF6	Schneelast
			7	1.00	LF8	Wind +X
LK3		Wind -x	1	1.00	LF1	Eigengewicht Einfluss unabh.
			2	1.00	LF2	Eigengewicht
			3	1.00	LF3	Nutzlast Wgh > 0
			4	1.00	LF4	Nutzlast Wgh < 0
			5	1.00	LF5	Nutzlast Dach >0
			6	1.00	LF6	Schneelast
			7	1.00	LF9	Wind -X
LK4		nur Eigengewicht	1	1.00	LF1	Eigengewicht Einfluss unabh.
			2	1.00	LF2	Eigengewicht

2.5.2 LASTKOMBINATIONEN - BERECHNUNGSPARAMETER

Last-kombin.	Bezeichnung	Berechnungsparameter	
LK1	Wind + Y	Berechnungstheorie	: ■ II. Ordnung (P-Delta)
		Optionen	: ■ Entlastende Wirkung von Zugkräften berücksichtigen
			: ■ Belastung mit Faktor bearbeiten: 1.500
			■ Ergebnisse durch Lastfaktor zurückdividieren

■ 2.5.2 LASTKOMBINATIONEN - BERECHNUNGSPARAMETER

Last-kombin.	Bezeichnung	Berechnungsparameter	
			: ■ Schnittgrößen auf das verformte System beziehen für:
			■ Normalkräfte N
			■ Querkräfte V_y und V_z
			■ Momente M_y, M_z und M_T
		Steifigkeitsbeiwerte aktivieren für:	: ■ Materialien (TeilsicherheitsbeiwertγM)
			: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LK2	Wind +x	Berechnungstheorie	: ■ II. Ordnung (P-Delta)
		Optionen	: ■ Entlastende Wirkung von Zugkräften berücksichtigen
			: ■ Belastung mit Faktor bearbeiten: 1.500
			■ Ergebnisse durch Lastfaktor zurückdividieren
			: ■ Schnittgrößen auf das verformte System beziehen für:
			■ Normalkräfte N
			■ Querkräfte V_y und V_z
			■ Momente M_y, M_z und M_T
		Steifigkeitsbeiwerte aktivieren für:	: ■ Materialien (TeilsicherheitsbeiwertγM)
			: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LK3	Wind -x	Berechnungstheorie	: ■ II. Ordnung (P-Delta)
		Optionen	: ■ Entlastende Wirkung von Zugkräften berücksichtigen
			: ■ Belastung mit Faktor bearbeiten: 1.500
			■ Ergebnisse durch Lastfaktor zurückdividieren
			: ■ Schnittgrößen auf das verformte System beziehen für:
			■ Normalkräfte N
			■ Querkräfte V_y und V_z
			■ Momente M_y, M_z und M_T
		Steifigkeitsbeiwerte aktivieren für:	: ■ Materialien (TeilsicherheitsbeiwertγM)
			: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LK4	nur Eigengewicht	Berechnungstheorie	: ■ II. Ordnung (P-Delta)
		Optionen	: ■ Entlastende Wirkung von Zugkräften berücksichtigen
			: ■ Belastung mit Faktor bearbeiten: 1.500
			■ Ergebnisse durch Lastfaktor zurückdividieren
			: ■ Schnittgrößen auf das verformte System beziehen für:
			■ Normalkräfte N
			■ Querkräfte V_y und V_z
			■ Momente M_y, M_z und M_T
		Steifigkeitsbeiwerte aktivieren für:	: ■ Materialien (TeilsicherheitsbeiwertγM)
			: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)

■ 2.6 ERGEBNISKOMBINATIONEN

Ergebn.-kombin.	Bezeichnung	Belastung
EK1	Min/MAx	LK1/s oder bis LK3

LF2
Eigengewicht

■ 3.1 KNOTENLASTEN - KOMPONENTENWEISE - KOORDINATENSYSTEM

LF2: Eigengewicht

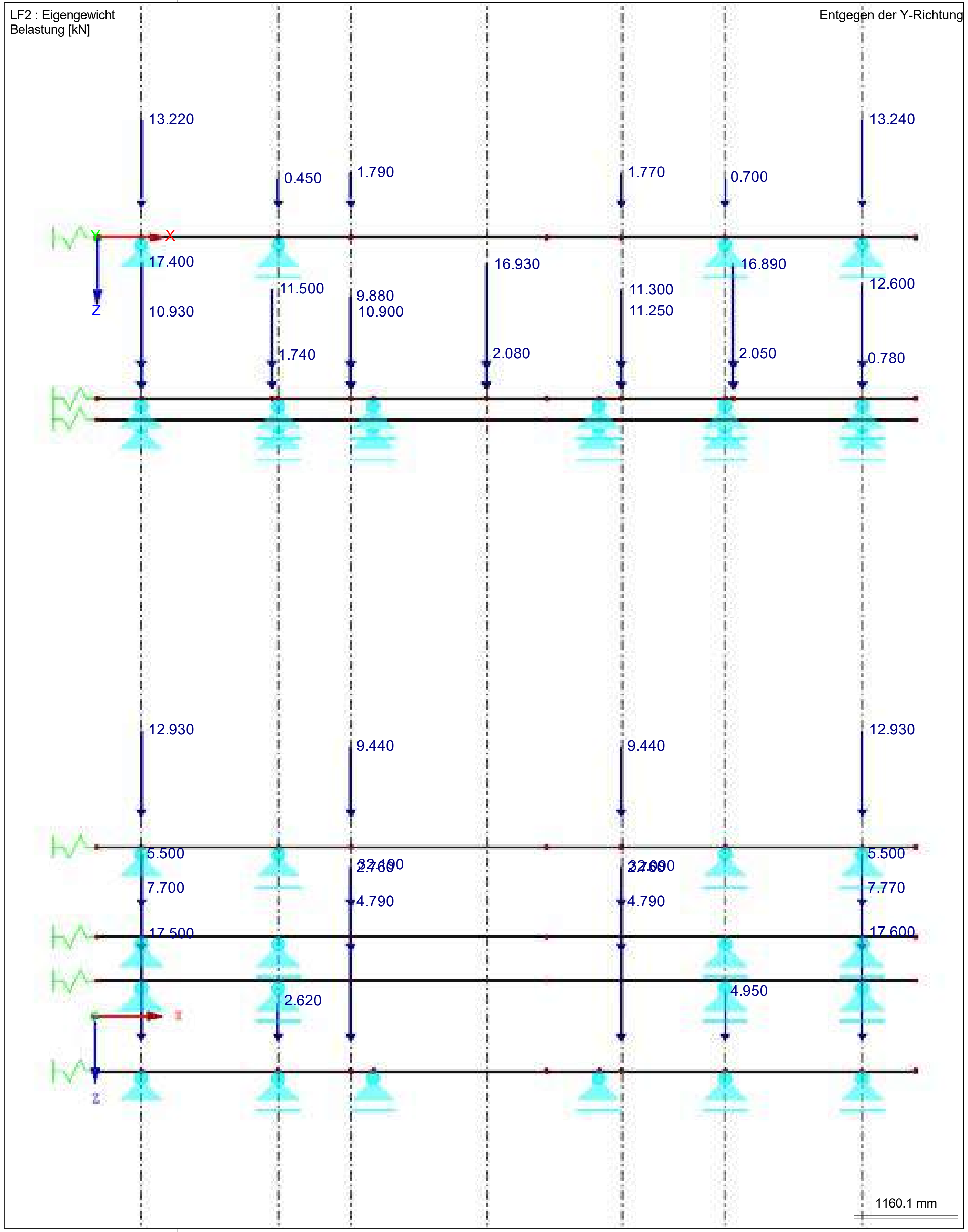
Nr.	An Knoten Nr.	Koordinaten-system	Kraft [kN] P_X / P_U	P_Z / P_W	Moment M_Y / M_V [kNm]
1	4	0 | Globales XYZ	0.000	13.220	0.000
2	5	0 | Globales XYZ	0.000	0.450	0.000
3	13	0 | Globales XYZ	0.000	1.790	0.000
4	15	0 | Globales XYZ	0.000	1.770	0.000
5	7	0 | Globales XYZ	0.000	0.700	0.000
6	8	0 | Globales XYZ	0.000	13.240	0.000
7	76	0 | Globales XYZ	0.000	17.400	0.000
8	77	0 | Globales XYZ	0.000	11.500	0.000
9	82	0 | Globales XYZ	0.000	9.880	0.000
10	107	0 | Globales XYZ	0.000	16.930	0.000
11	84	0 | Globales XYZ	0.000	11.300	0.000
12	118	0 | Globales XYZ	0.000	16.890	0.000
13	80	0 | Globales XYZ	0.000	12.600	0.000
14	90	0 | Globales XYZ	0.000	10.930	0.000
16	98	0 | Globales XYZ	0.000	10.900	0.000
17	105	0 | Globales XYZ	0.000	2.080	0.000
18	100	0 | Globales XYZ	0.000	11.250	0.000
19	119	0 | Globales XYZ	0.000	2.050	0.000
20	94	0 | Globales XYZ	0.000	0.780	0.000
21	21,25	0 | Globales XYZ	0.000	12.930	0.000
22	33,37	0 | Globales XYZ	0.000	5.500	0.000
23	45	0 | Globales XYZ	0.000	7.700	0.000
24	59	0 | Globales XYZ	0.000	17.500	0.000
25	29,108	0 | Globales XYZ	0.000	9.440	0.000
26	39,41	0 | Globales XYZ	0.000	2.760	0.000
27	53,55	0 | Globales XYZ	0.000	4.790	0.000

■ 3.1 KNOTENLASTEN - KOMPONENTENWEISE - KOORDINATENSYSTEM

LF2: Eigengewicht

Nr.	An Knoten Nr.	Koordinaten-system	Kraft [kN] P_X / P_U	P_Z / P_W	Moment M_Y / M_V [kNm]
29	60	0 | Globales XYZ	0.000	2.620	0.000
30	67	0 | Globales XYZ	0.000	32.190	0.000
31	69	0 | Globales XYZ	0.000	32.090	0.000
32	62	0 | Globales XYZ	0.000	4.950	0.000
33	63	0 | Globales XYZ	0.000	17.600	0.000
39	49	0 | Globales XYZ	0.000	7.770	0.000
40	91	0 | Globales XYZ	0.000	1.740	0.000

LF2: EIGENGEWICHT



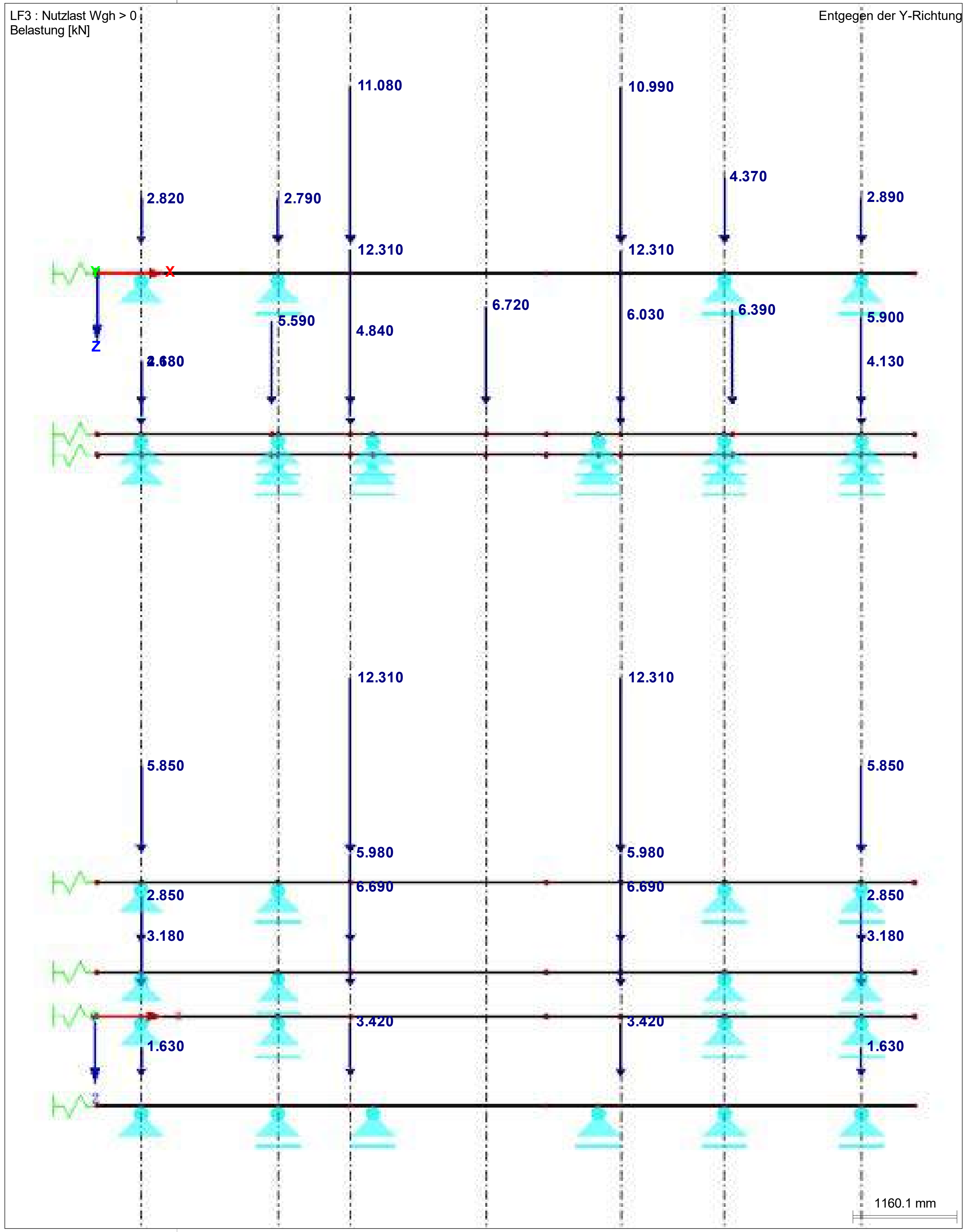
LF3
Nutzlast Wgh > 0

3.1 KNOTENLASTEN - KOMPONENTENWEISE - KOORDINATENSYSTEM

LF3: Nutzlast Wgh > 0

Nr.	An Knoten Nr.	Koordinaten-system	Kraft [kN] P_X / P_U	P_Z / P_W	Moment M_Y / M_V [kNm]
1	4	0 | Globales XYZ	0.000	2.820	0.000
2	5	0 | Globales XYZ	0.000	2.790	0.000
3	13	0 | Globales XYZ	0.000	11.080	0.000
4	15	0 | Globales XYZ	0.000	10.990	0.000
5	7	0 | Globales XYZ	0.000	4.370	0.000
6	8	0 | Globales XYZ	0.000	2.890	0.000
7	76	0 | Globales XYZ	0.000	2.680	0.000
8	77	0 | Globales XYZ	0.000	5.590	0.000
9	82	0 | Globales XYZ	0.000	4.840	0.000
10	107	0 | Globales XYZ	0.000	6.720	0.000
11	84	0 | Globales XYZ	0.000	6.030	0.000
12	118	0 | Globales XYZ	0.000	6.390	0.000
13	80	0 | Globales XYZ	0.000	5.900	0.000
14	90,94	0 | Globales XYZ	0.000	4.130	0.000
15	98,100	0 | Globales XYZ	0.000	12.310	0.000
18	21,25	0 | Globales XYZ	0.000	5.850	0.000
20	108	0 | Globales XYZ	0.000	12.310	0.000
21	29	0 | Globales XYZ	0.000	12.310	0.000
22	39,41	0 | Globales XYZ	0.000	5.980	0.000
23	37	0 | Globales XYZ	0.000	2.850	0.000
24	45,49	0 | Globales XYZ	0.000	3.180	0.000
25	53,55	0 | Globales XYZ	0.000	6.690	0.000
26	59,63	0 | Globales XYZ	0.000	1.630	0.000
28	33	0 | Globales XYZ	0.000	2.850	0.000
29	67,69	0 | Globales XYZ	0.000	3.420	0.000

LF3: NUTZLAST WGH > 0



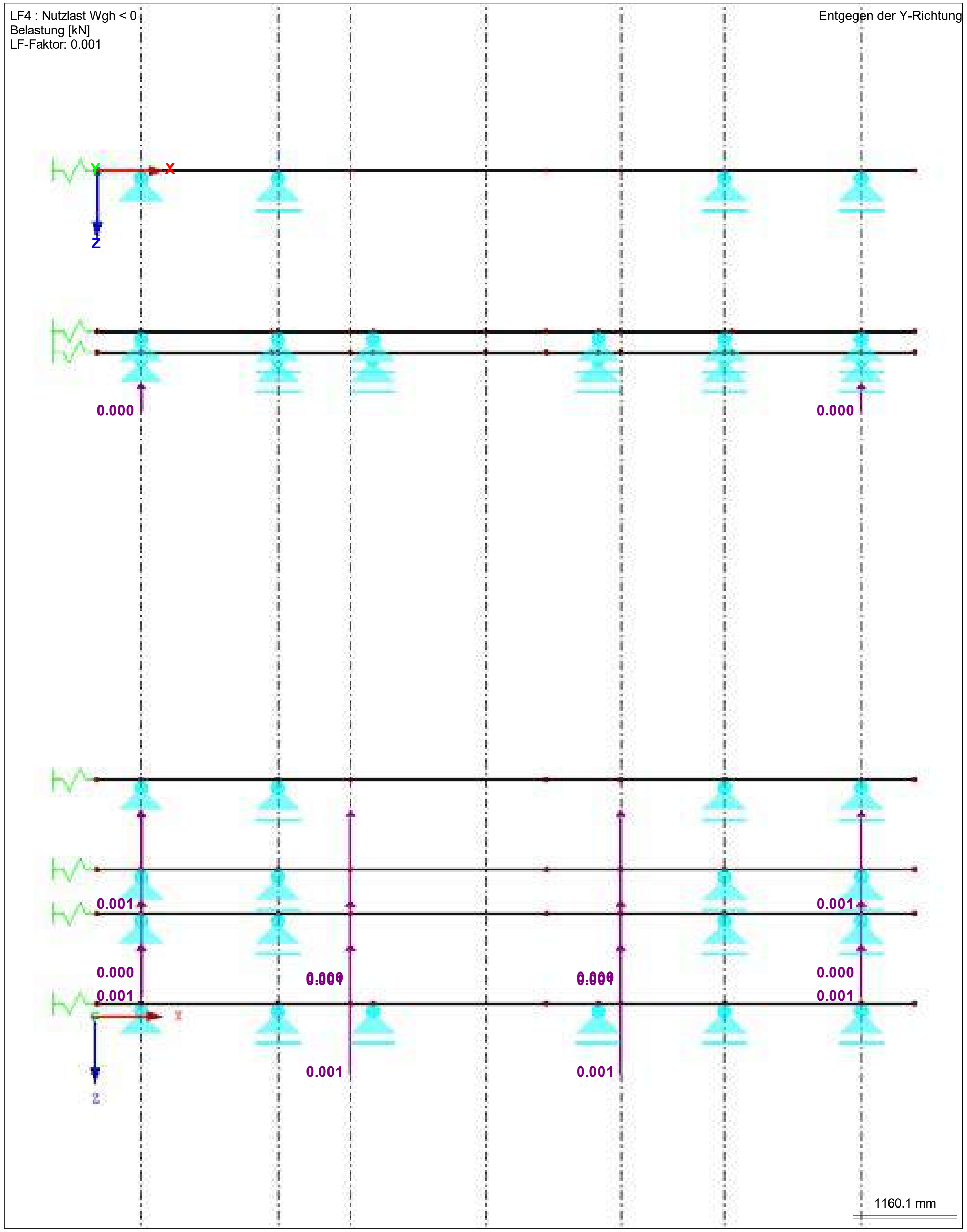
LF4
Nutzlast Wgh < 0

3.1 KNOTENLASTEN - KOMPONENTENWEISE - KOORDINATENSYSTEM

LF4: Nutzlast Wgh < 0

Nr.	An Knoten Nr.	Koordinaten-system	Kraft [kN] P_X / P_U	P_Z / P_W	Moment M_Y / M_V [kNm]
1	90,94	0 | Globales XYZ	0.000	-0.010	0.000
2	21	0 | Globales XYZ	0.000	-0.610	0.000
3	29,108	0 | Globales XYZ	0.000	-1.280	0.000
4	33,37	0 | Globales XYZ	0.000	-0.620	0.000
5	39,41	0 | Globales XYZ	0.000	-1.300	0.000
6	45	0 | Globales XYZ	0.000	-0.030	0.000
7	53,55	0 | Globales XYZ	0.000	-0.070	0.000
8	25	0 | Globales XYZ	0.000	-0.605	0.000
9	49	0 | Globales XYZ	0.000	-0.033	0.000

■ LF4: NUTZLAST WGH < 0



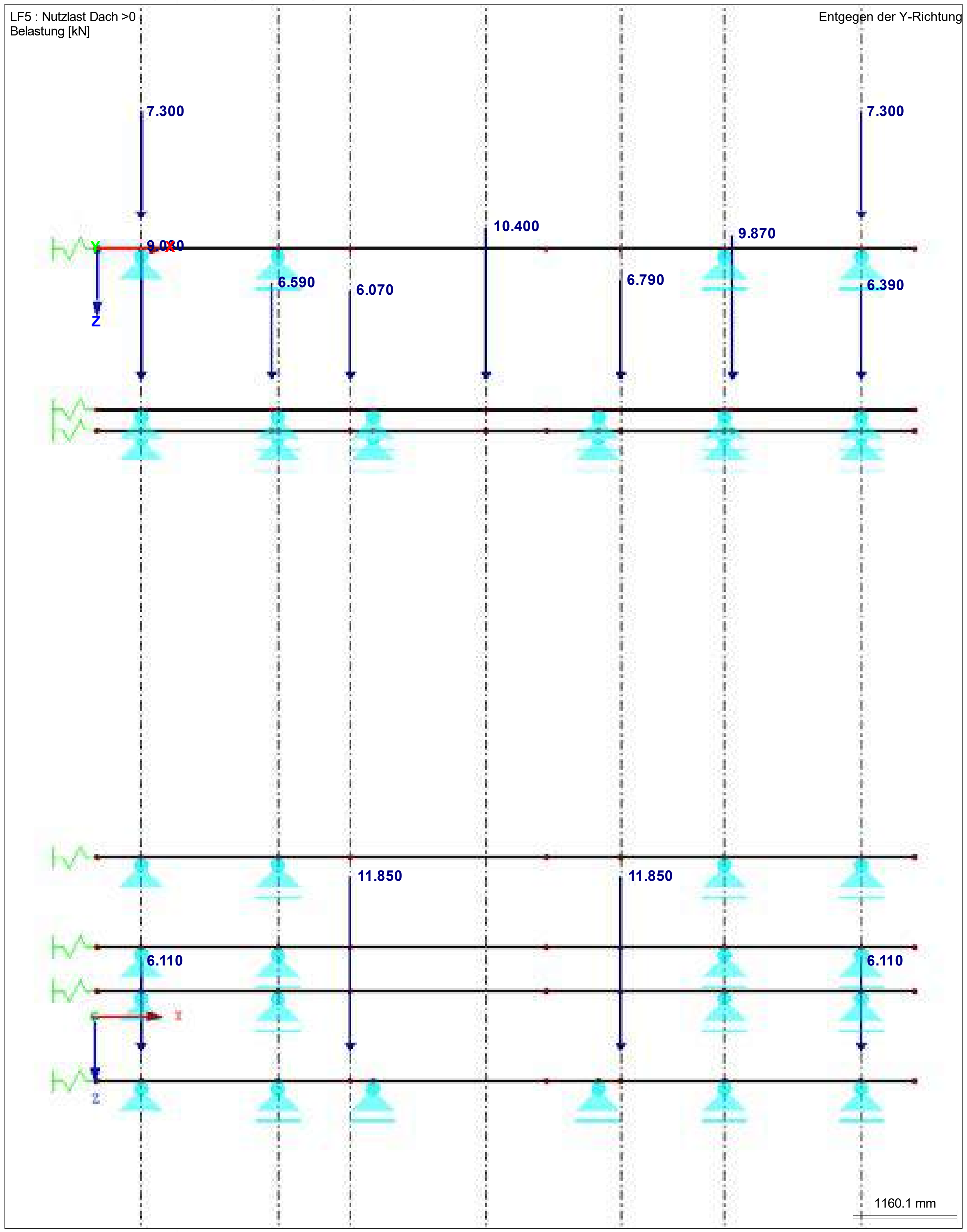
LF5
Nutzlast Dach >0

■ 3.1 KNOTENLASTEN - KOMPONENTENWEISE - KOORDINATENSYSTEM

LF5: Nutzlast Dach >0

	An Knoten	Koordinaten-	Kraft [kN]		Moment
Nr.	Nr.	system	P_X / P_U	P_Z / P_W	M_Y / M_V [kNm]
1	4,8	0 | Globales XYZ	0.000	7.300	0.000
2	76	0 | Globales XYZ	0.000	9.080	0.000
3	77	0 | Globales XYZ	0.000	6.590	0.000
4	82	0 | Globales XYZ	0.000	6.070	0.000
5	107	0 | Globales XYZ	0.000	10.400	0.000
6	84	0 | Globales XYZ	0.000	6.790	0.000
7	118	0 | Globales XYZ	0.000	9.870	0.000
8	80	0 | Globales XYZ	0.000	6.390	0.000
9	59,63	0 | Globales XYZ	0.000	6.110	0.000
10	67,69	0 | Globales XYZ	0.000	11.850	0.000

■ LF5: NUTZLAST DACH >0



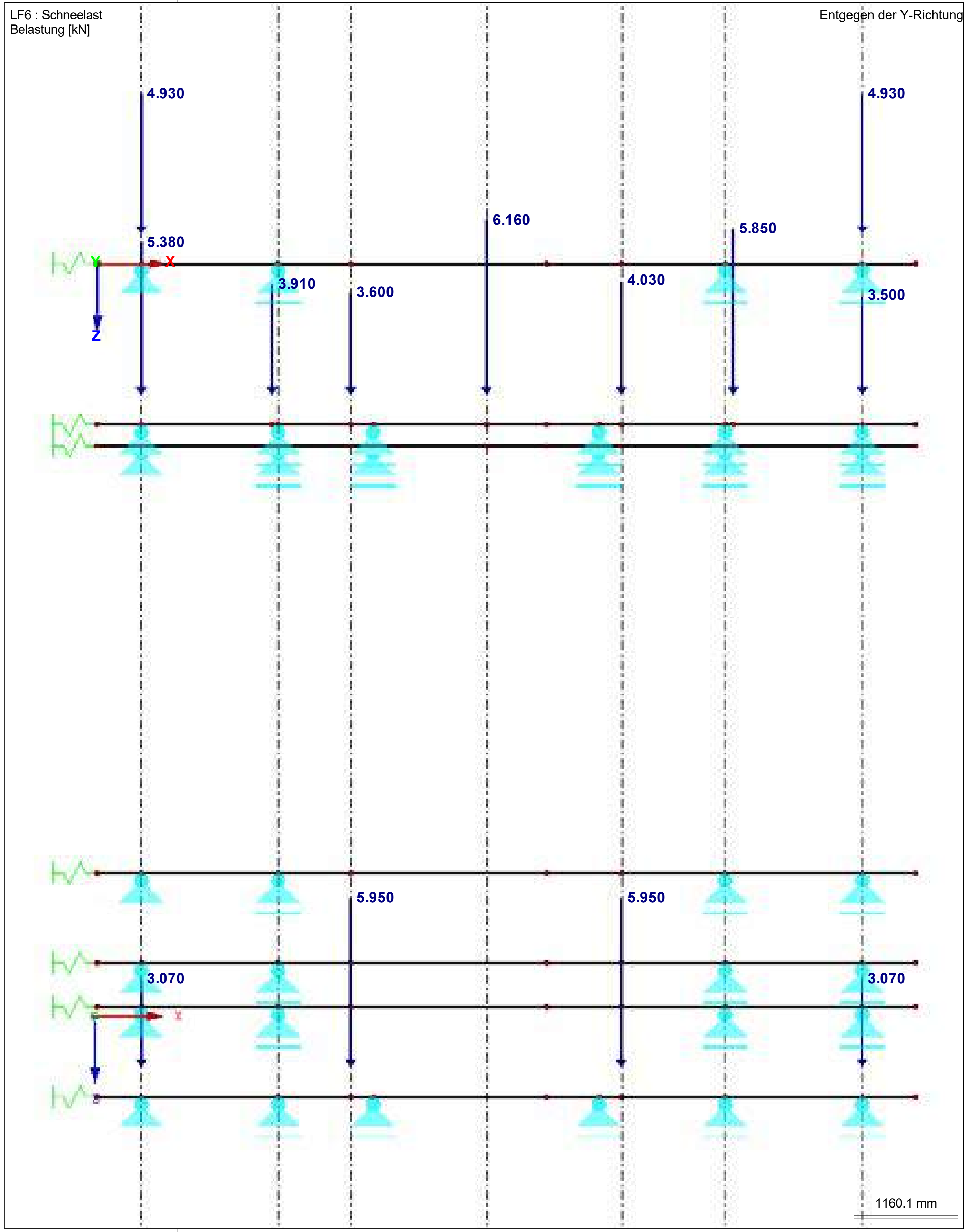
■ 3.1 KNOTENLASTEN - KOMPONENTENWEISE - KOORDINATENSYSTEM

LF6
Schneelast

LF6: Schneelast

Nr.	An Knoten Nr.	Koordinaten-system	Kraft [kN] P_X / P_U	P_Z / P_W	Moment M_Y / M_V [kNm]
1	4,8	0 | Globales XYZ	0.000	4.930	0.000
2	59,63	0 | Globales XYZ	0.000	3.070	0.000
3	67,69	0 | Globales XYZ	0.000	5.950	0.000
4	76	0 | Globales XYZ	0.000	5.380	0.000
5	77	0 | Globales XYZ	0.000	3.910	0.000
6	82	0 | Globales XYZ	0.000	3.600	0.000
7	107	0 | Globales XYZ	0.000	6.160	0.000
8	84	0 | Globales XYZ	0.000	4.030	0.000
9	118	0 | Globales XYZ	0.000	5.850	0.000
10	80	0 | Globales XYZ	0.000	3.500	0.000

LF6: SCHNEELAST



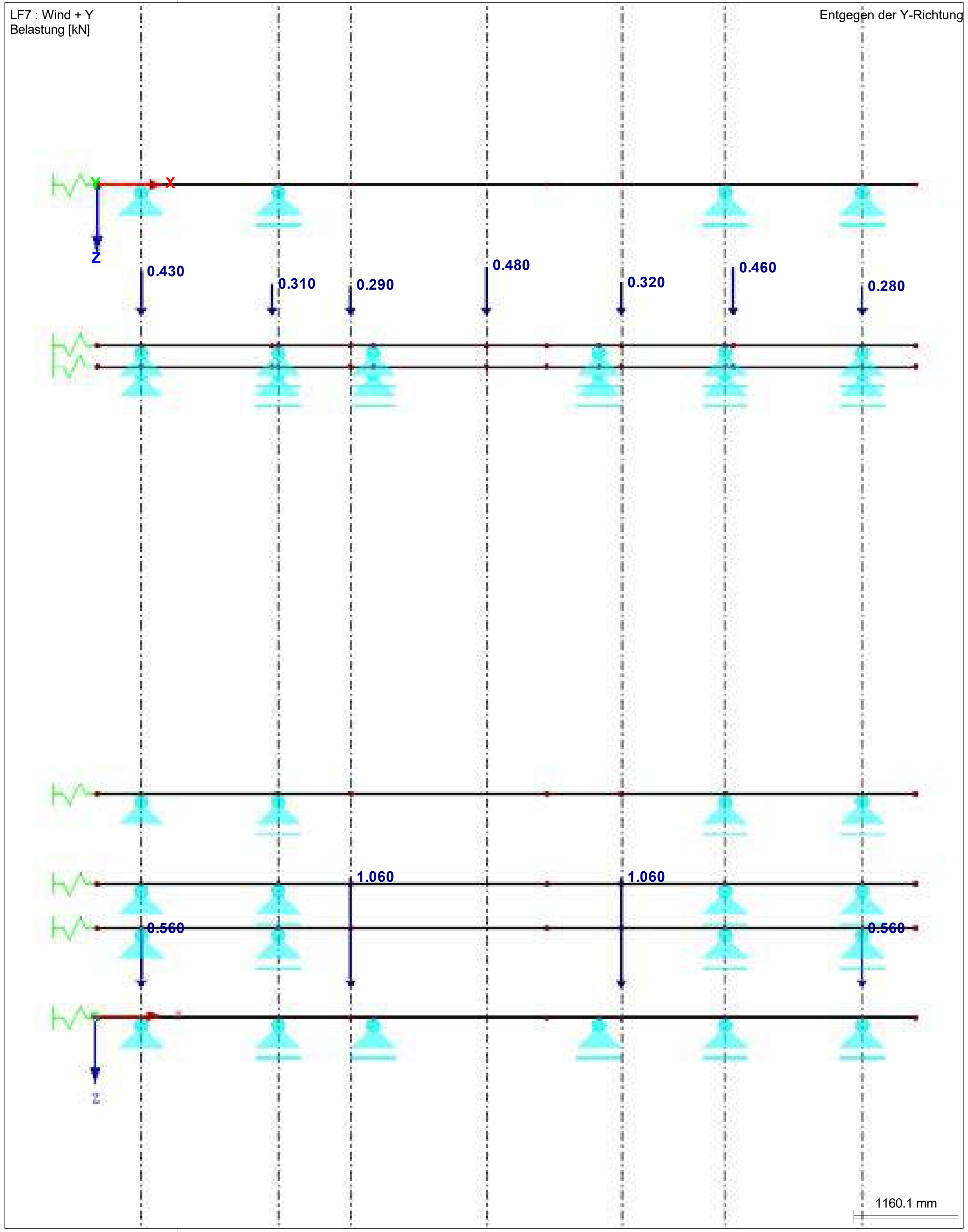
LF7
Wind + Y

3.1 KNOTENLASTEN - KOMPONENTENWEISE - KOORDINATENSYSTEM

LF7: Wind + Y

Nr.	An Knoten Nr.	Koordinaten-system	Kraft [kN] P_X / P_U	P_Z / P_W	Moment M_Y / M_V [kNm]
1	76	0 | Globales XYZ	0.000	0.430	0.000
31	77	0 | Globales XYZ	0.000	0.310	0.000
32	82	0 | Globales XYZ	0.000	0.290	0.000
33	107	0 | Globales XYZ	0.000	0.480	0.000
34	84	0 | Globales XYZ	0.000	0.320	0.000
35	118	0 | Globales XYZ	0.000	0.460	0.000
36	80	0 | Globales XYZ	0.000	0.280	0.000
37	59,63	0 | Globales XYZ	0.000	0.560	0.000
38	67,69	0 | Globales XYZ	0.000	1.060	0.000

LF7: WIND + Y



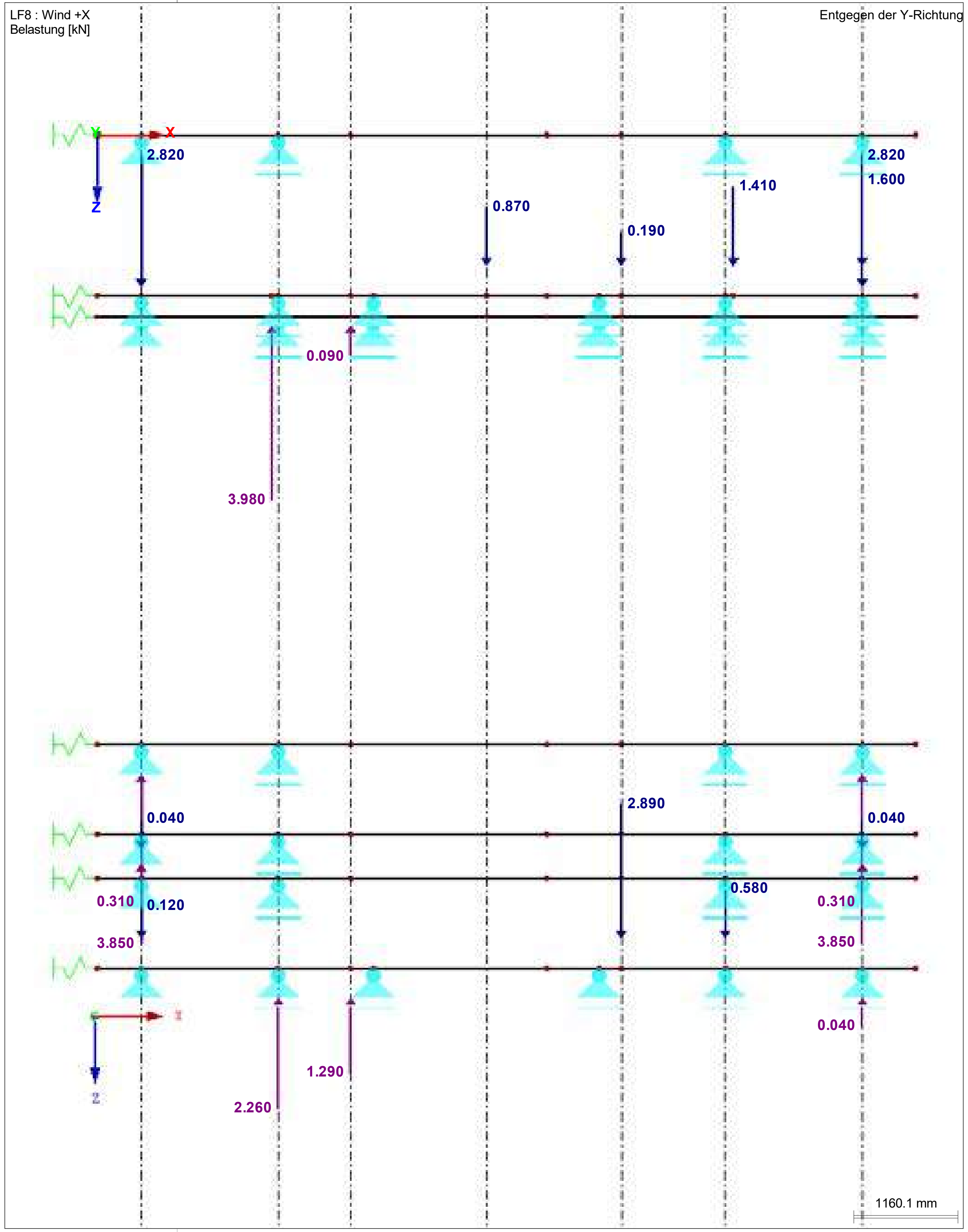
LF8
Wind +X

3.1 KNOTENLASTEN - KOMPONENTENWEISE - KOORDINATENSYSTEM

LF8: Wind +X

Nr.	An Knoten Nr.	Koordinaten-system	Kraft [kN] P_X / P_U	P_Z / P_W	Moment M_Y / M_V [kNm]
1	77	0 | Globales XYZ	0.000	-3.980	0.000
2	82	0 | Globales XYZ	0.000	-0.090	0.000
3	107	0 | Globales XYZ	0.000	0.870	0.000
4	84	0 | Globales XYZ	0.000	0.190	0.000
5	118	0 | Globales XYZ	0.000	1.410	0.000
6	80	0 | Globales XYZ	0.000	1.600	0.000
7	90,94	0 | Globales XYZ	0.000	2.820	0.000
8	21,25	0 | Globales XYZ	0.000	-3.850	0.000
9	33,37	0 | Globales XYZ	0.000	-0.310	0.000
10	45,49	0 | Globales XYZ	0.000	0.040	0.000
11	59	0 | Globales XYZ	0.000	0.120	0.000
12	60	0 | Globales XYZ	0.000	-2.260	0.000
13	67	0 | Globales XYZ	0.000	-1.290	0.000
14	69	0 | Globales XYZ	0.000	2.890	0.000
15	62	0 | Globales XYZ	0.000	0.580	0.000
16	63	0 | Globales XYZ	0.000	-0.040	0.000

LF8: WIND +X



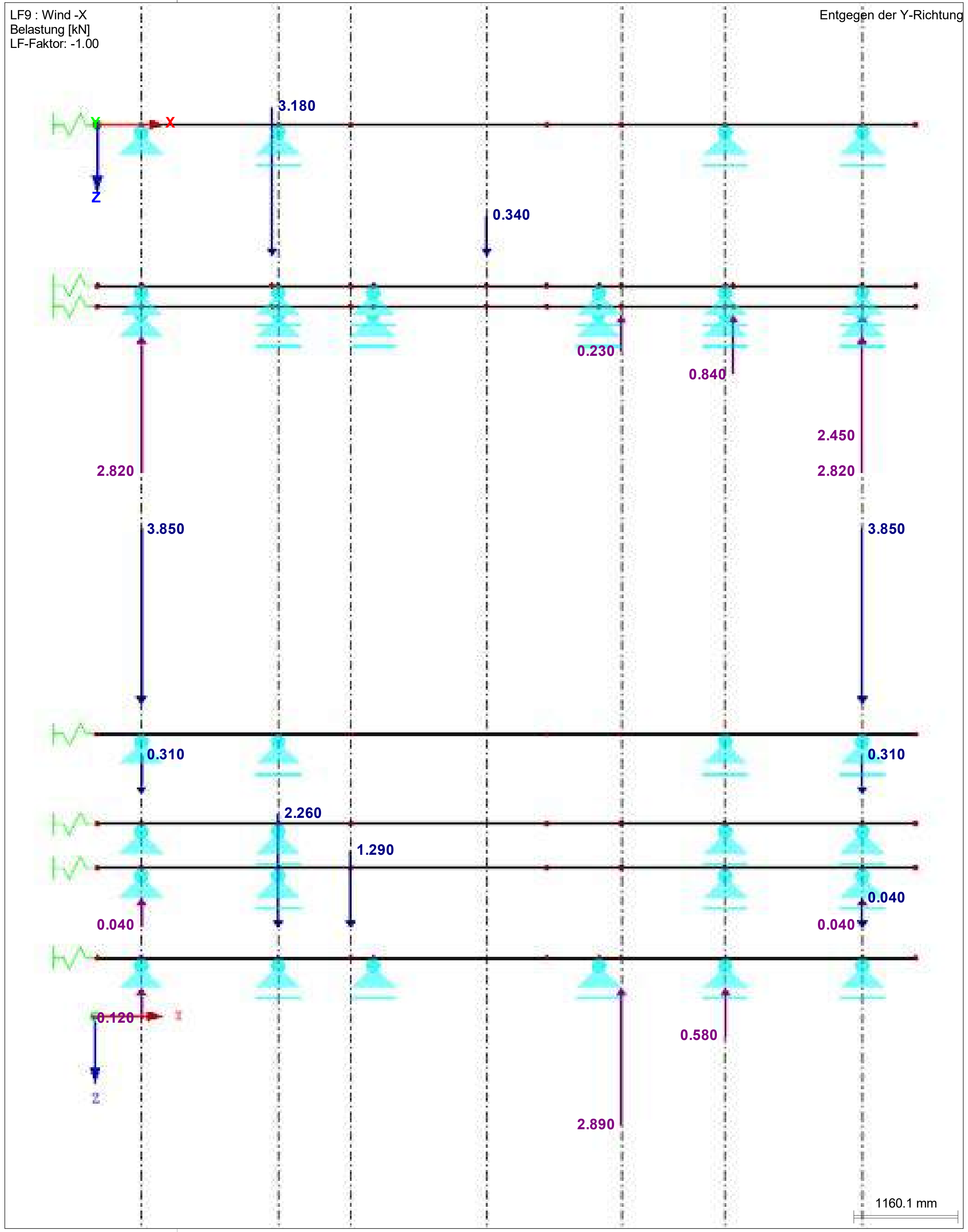
3.1 KNOTENLASTEN - KOMPONENTENWEISE - KOORDINATENSYSTEM

LF9
Wind -X

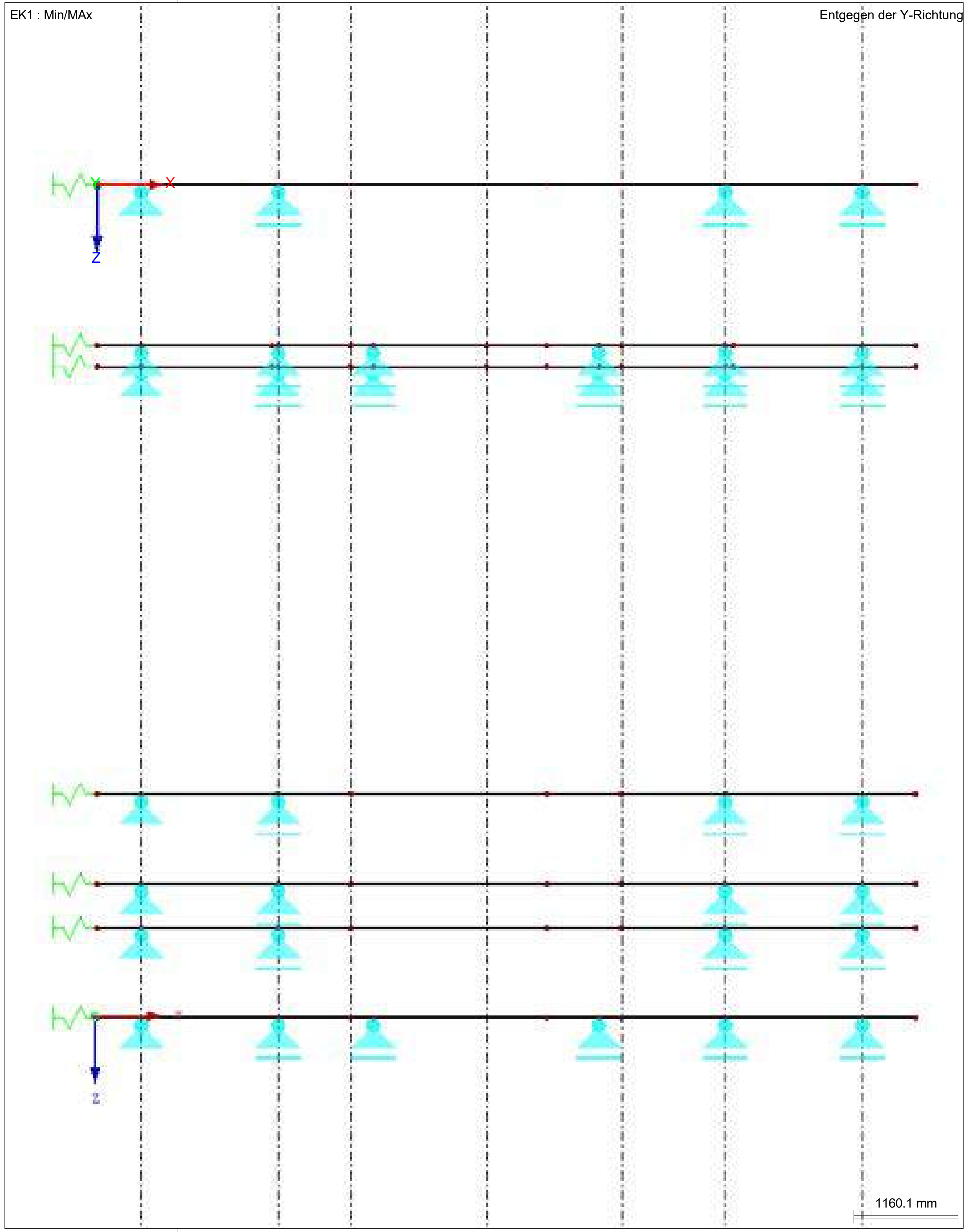
LF9: Wind -X

	An Knoten	Koordinaten-	Kraft [kN]		Moment
Nr.	Nr.	system	P_X / P_U	P_Z / P_W	M_Y / M_V [kNm]
1	77	0 | Globales XYZ	0.000	-3.180	0.000
3	107	0 | Globales XYZ	0.000	-0.340	0.000
4	84	0 | Globales XYZ	0.000	0.230	0.000
5	118	0 | Globales XYZ	0.000	0.840	0.000
6	80	0 | Globales XYZ	0.000	2.450	0.000
7	90,94	0 | Globales XYZ	0.000	2.820	0.000
8	25	0 | Globales XYZ	0.000	-3.850	0.000
9	33,37	0 | Globales XYZ	0.000	-0.310	0.000
10	45,49	0 | Globales XYZ	0.000	0.040	0.000
11	59	0 | Globales XYZ	0.000	0.120	0.000
12	60	0 | Globales XYZ	0.000	-2.260	0.000
13	67	0 | Globales XYZ	0.000	-1.290	0.000
14	69	0 | Globales XYZ	0.000	2.890	0.000
15	62	0 | Globales XYZ	0.000	0.580	0.000
16	63	0 | Globales XYZ	0.000	-0.040	0.000
17	21	0 | Globales XYZ	0.000	-3.850	0.000

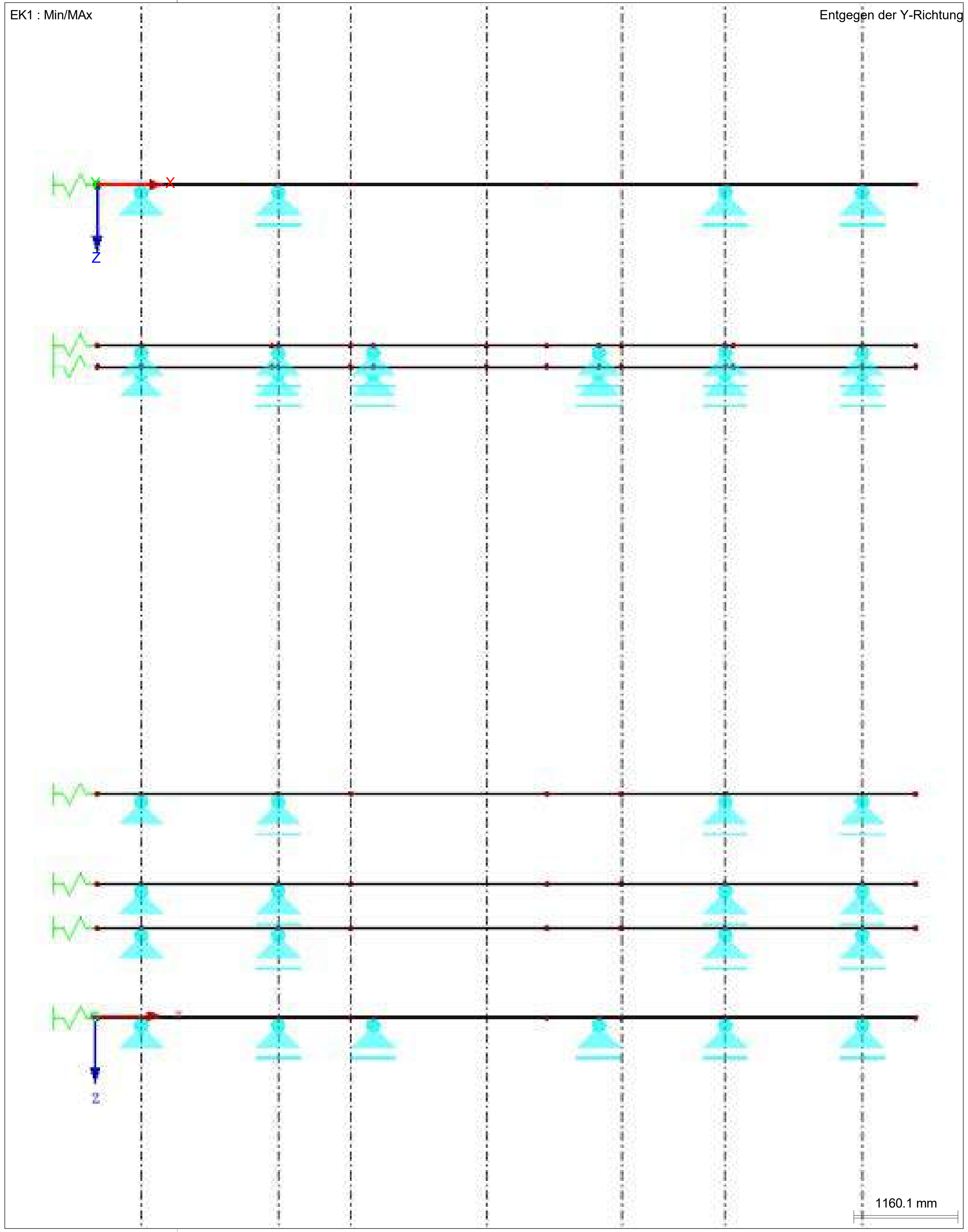
■ LF9: WIND -X



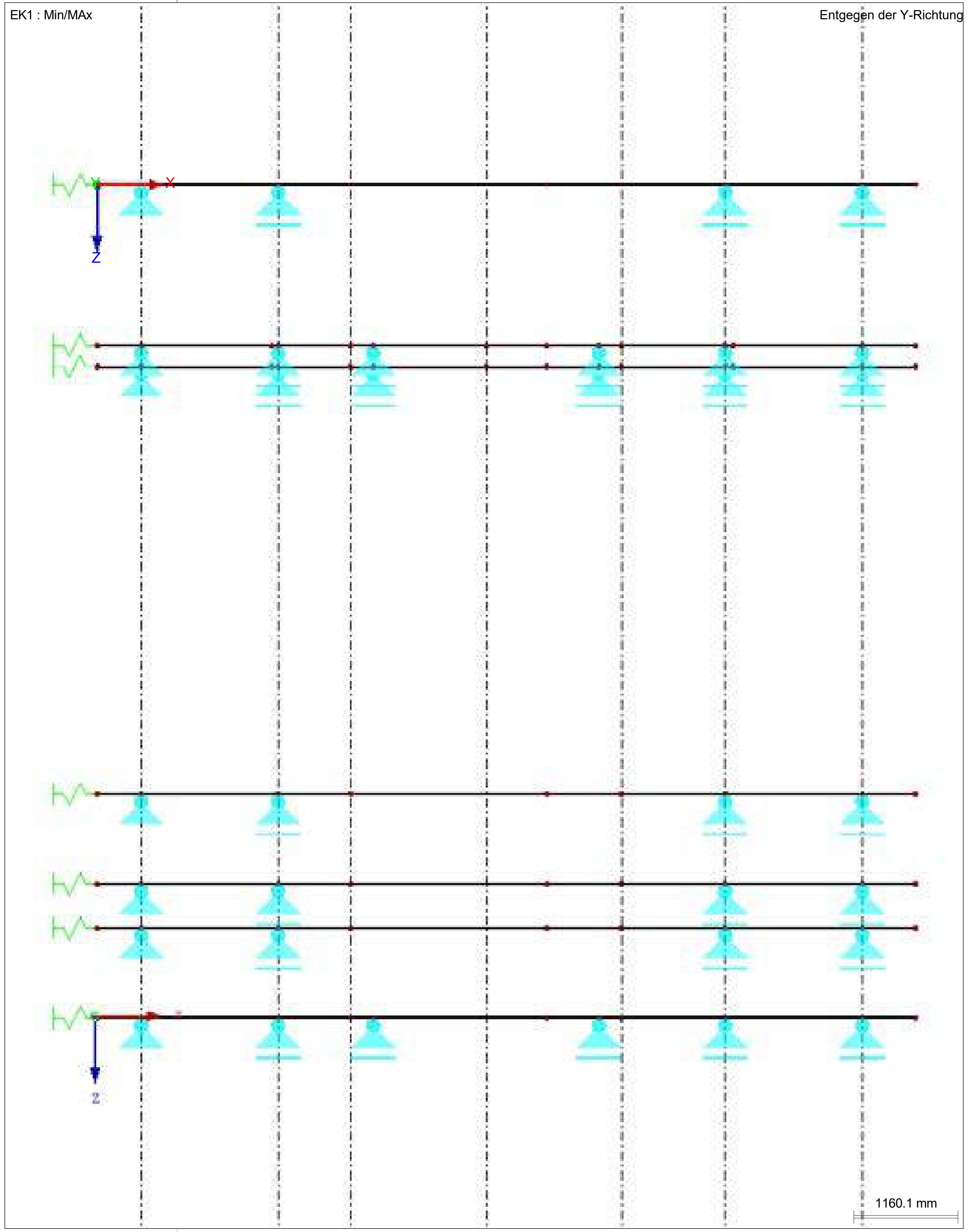
■ EK1: MIN/MAX



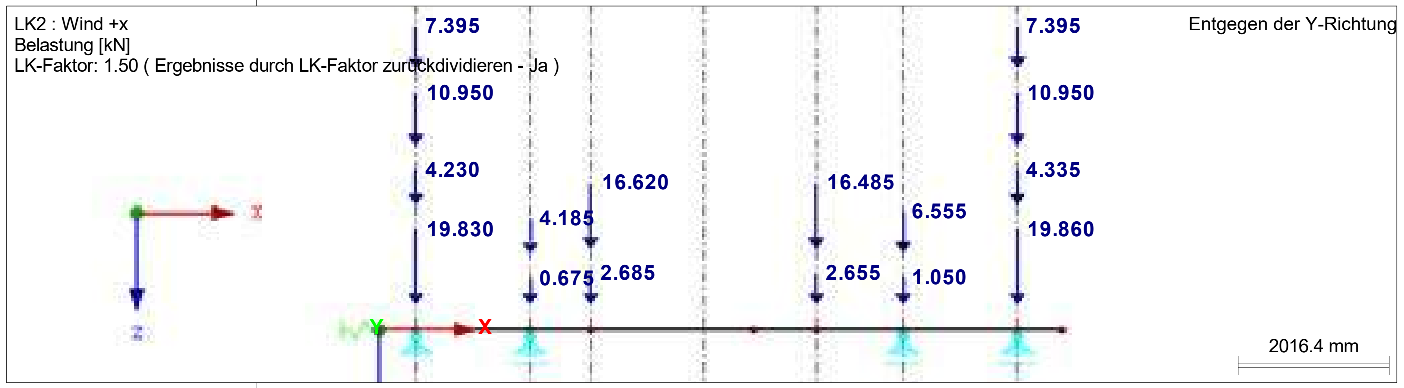
■ EK1: MIN/MAX



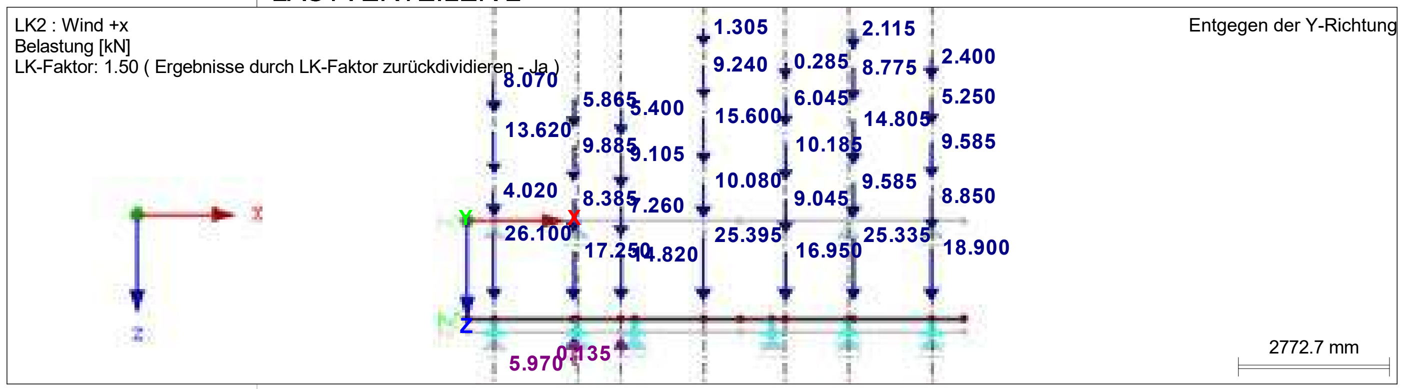
■ EK1: MIN/MAX



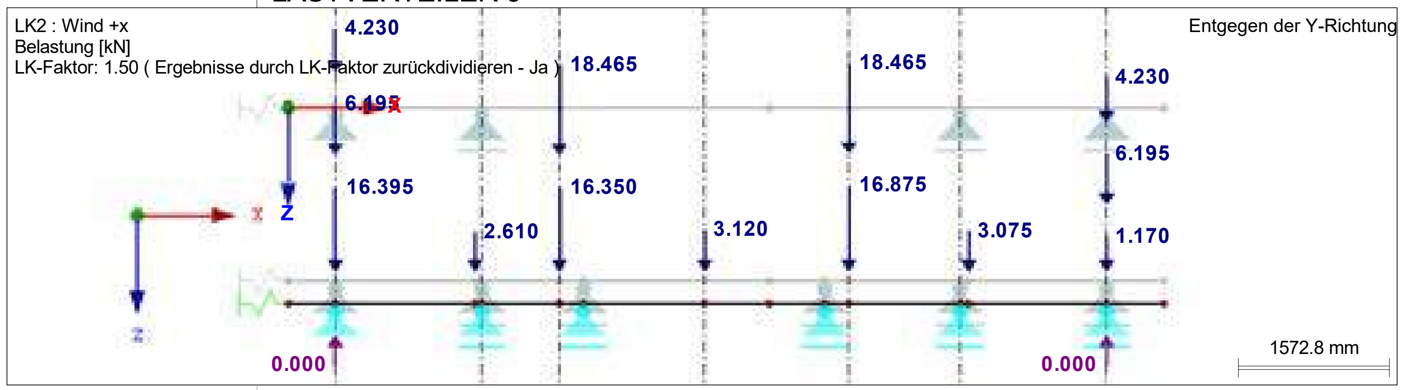
LASTVERTEILER 1



LASTVERTEILER 2



LASTVERTEILER 3



4.0 ERGEBNISSE - ZUSAMMENFASSUNG

	Bezeichnung	Wert	Einheit	Kommentar
	LK1 - Wind + Y			
	Summe Belastung in Richtung X	0.00	kN	
	Summe Lagerkräfte in X	0.00	kN	
	Summe Belastung in Richtung Z	818.70	kN	
	Summe Lagerkräfte in Z	818.70	kN	Abweichung 0.00%
	Max. Verschiebung in X	-0.0	mm	
	Max. Verschiebung in Z	1.0	mm	Stab Nr. 10, x: 1744.2 mm
	Max. Verschiebung vektoriell	1.0	mm	Stab Nr. 10, x: 1744.2 mm
	Max. Verdrehung um Y	0.5	mrad	Stab Nr. 11, x: 462.4 mm
	Berechnungstheorie	II. Ordnung		Theorie II. Ordnung (nichtlinear, Timoshenko)
	Schnittgrößen bezogen auf verformtes System für...	■		N, V_y, V_z, M_y, M_z, M_T
	Steifigkeitsreduktion multipliziert mit Faktor	■		
	Entlastende Wirkung der Zugkräfte berücksichtigen	■		
	Ergebnisse durch LK-Faktor zurückdividieren	■		
	Anzahl der Laststufen	1		
	Anzahl der Iterationen	2		
	Verzweigungslastfaktor ermitteln	■		
	LK2 - Wind +x			
	Summe Belastung in Richtung X	0.00	kN	
	Summe Lagerkräfte in X	0.00	kN	
	Summe Belastung in Richtung Z	810.29	kN	
	Summe Lagerkräfte in Z	810.29	kN	Abweichung 0.00%
	Max. Verschiebung in X	-0.0	mm	
	Max. Verschiebung in Z	1.0	mm	Stab Nr. 10, x: 1744.2 mm
	Max. Verschiebung vektoriell	1.0	mm	Stab Nr. 10, x: 1744.2 mm
	Max. Verdrehung um Y	0.5	mrad	Stab Nr. 11, x: 462.4 mm
	Berechnungstheorie	II. Ordnung		Theorie II. Ordnung (nichtlinear, Timoshenko)
	Schnittgrößen bezogen auf verformtes System für...	■		N, V_y, V_z, M_y, M_z, M_T
	Steifigkeitsreduktion multipliziert mit Faktor	■		
	Entlastende Wirkung der Zugkräfte berücksichtigen	■		
	Ergebnisse durch LK-Faktor zurückdividieren	■		
	Anzahl der Laststufen	1		
	Anzahl der Iterationen	2		
	Verzweigungslastfaktor ermitteln	■		
	LK3 - Wind -x			
	Summe Belastung in Richtung X	0.00	kN	
	Summe Lagerkräfte in X	0.00	kN	
	Summe Belastung in Richtung Z	815.49	kN	
	Summe Lagerkräfte in Z	815.49	kN	Abweichung 0.00%
	Max. Verschiebung in X	-0.0	mm	
	Max. Verschiebung in Z	1.0	mm	Stab Nr. 10, x: 1744.2 mm
	Max. Verschiebung vektoriell	1.0	mm	Stab Nr. 10, x: 1744.2 mm
	Max. Verdrehung um Y	0.5	mrad	Stab Nr. 11, x: 462.4 mm
	Berechnungstheorie	II. Ordnung		Theorie II. Ordnung (nichtlinear, Timoshenko)
	Schnittgrößen bezogen auf verformtes System für...	■		N, V_y, V_z, M_y, M_z, M_T
	Steifigkeitsreduktion multipliziert mit Faktor	■		
	Entlastende Wirkung der Zugkräfte berücksichtigen	■		
	Ergebnisse durch LK-Faktor zurückdividieren	■		
	Anzahl der Laststufen	1		
	Anzahl der Iterationen	2		
	Verzweigungslastfaktor ermitteln	■		
	LK4 - nur Eigengewicht			
	Summe Belastung in Richtung X	0.00	kN	
	Summe Lagerkräfte in X	0.00	kN	
	Summe Belastung in Richtung Z	457.07	kN	
	Summe Lagerkräfte in Z	457.07	kN	Abweichung 0.00%
	Max. Verschiebung in X	-0.0	mm	
	Max. Verschiebung in Z	0.5	mm	Stab Nr. 10, x: 1744.2 mm
	Max. Verschiebung vektoriell	0.5	mm	Stab Nr. 10, x: 1744.2 mm
	Max. Verdrehung um Y	0.3	mrad	Stab Nr. 11, x: 462.4 mm
	Berechnungstheorie	II. Ordnung		Theorie II. Ordnung (nichtlinear, Timoshenko)
	Schnittgrößen bezogen auf verformtes System für...	■		N, V_y, V_z, M_y, M_z, M_T
	Steifigkeitsreduktion multipliziert mit Faktor	■		
	Entlastende Wirkung der Zugkräfte berücksichtigen	■		
	Ergebnisse durch LK-Faktor zurückdividieren	■		
	Anzahl der Laststufen	1		
	Anzahl der Iterationen	2		
	Verzweigungslastfaktor ermitteln	■		
	Gesamt			
	Max. Verschiebung in X	-0.0	mm	LK1,
	Max. Verschiebung in Z	1.0	mm	LK1, Stab Nr. 10, x: 1744.2 mm
	Max. Verschiebung vektoriell	1.0	mm	LK1, Stab Nr. 10, x: 1744.2 mm
	Max. Verdrehung um Y	0.5	mrad	LK1, Stab Nr. 11, x: 462.4 mm
	Anzahl 1D-Finite-Elemente (Stabelemente)	68		
	Anzahl der FE-Knoten	75		
	Anzahl der Gleichungen	225		
	Maximale Anzahl Iterationen	100		
	Stabteilungen für Ergebnisse der Stäbe	10		
	Stabteilungen der Seil-, Bettungs- und Voutenstäbe	10		
	Stab-Schubsteifigkeiten (A-y, A-z) berücksichtigen	■		
	Lagernichtlinearitäten berücksichtigen	■		

Sonstige Einstellungen	Maximale Anzahl Iterationen	:	100
	Anzahl der Stabteilungen für Ergebnisverläufe	:	10
	Stabteilungen Seilstäbe, Bettungs- und Voutenstäbe	:	10
	Anzahl der Stabteilungen für das Suchen der Maximalwerte	:	10

■ 4.0 ERGEBNISSE - ZUSAMMENFASSUNG

Optionen	■ Schubsteifigkeit (Ay, Az) der Stäbe aktivieren ■ Steifigkeitsänderungen berücksichtigen (Materialien,Querschnitte, Stäbe, Lastfälle und Kombinationen) ■ Temperatur-/Verformungslasten ohne Steifigkeitsänderungen anwenden
Genauigkeit und Toleranz	■ Standardeinstellung ändern
Nichtlineare Effekte - Aktivieren	■ Lager und elastische Bettungen ■ Ausfallende Stäbe infolge des Stabtyps ■ Stabendgelenke ■ Elastische Stabbettungen ■ Stabnichtlinearitäten

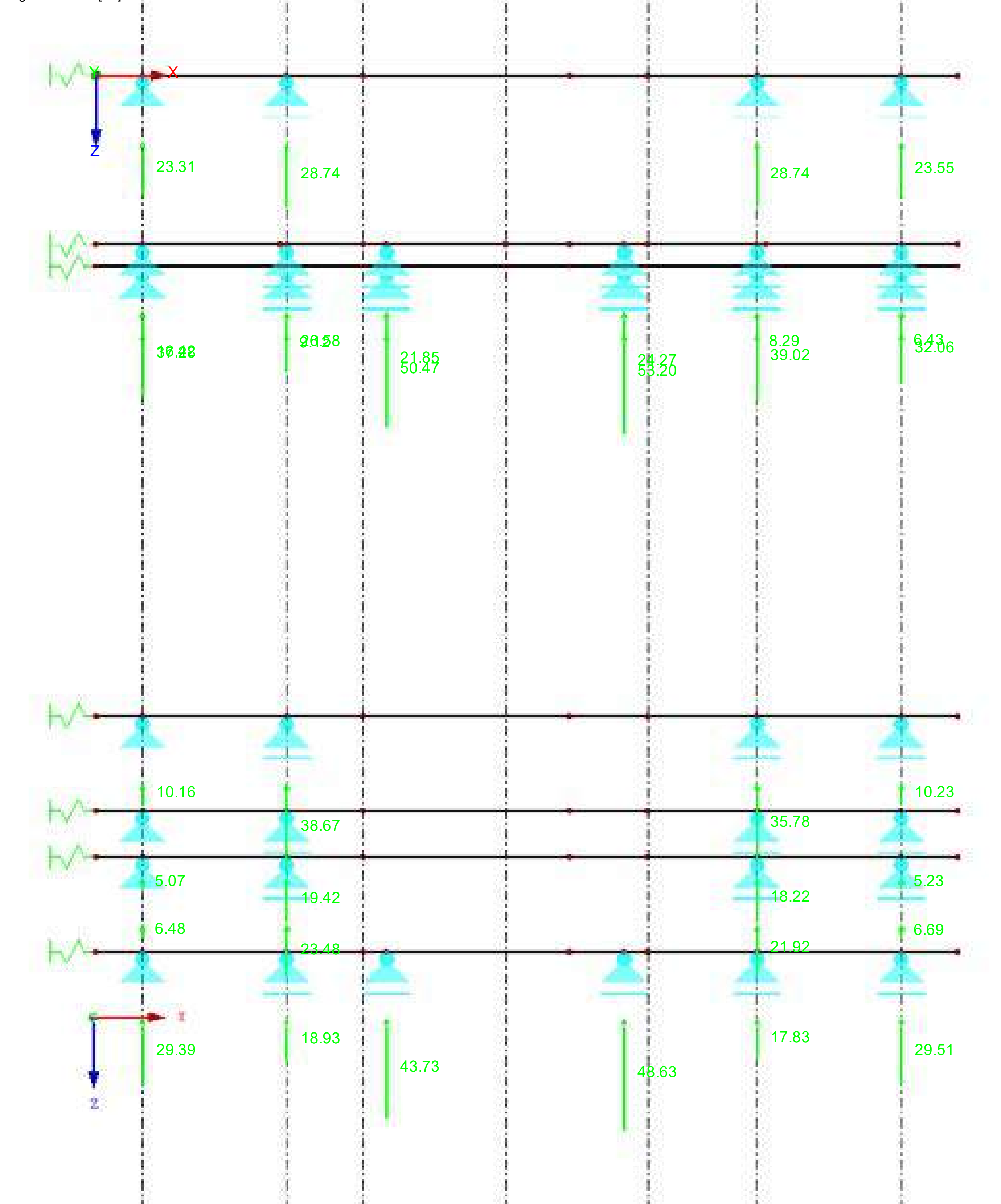
■ 4.3 QUERSCHNITTE - SCHNITTGRÖSSEN

Stab Nr.	LF/LK	Knoten Nr.	Stelle x [mm]	Kräfte [kN] N	Kräfte [kN] V_z	Momente M_y [kNm]
	Querschnitt-Nr. 3: HEM 220					
16	LK1	MAX N	564.2	⊳ 0.02	26.14	-1.22
18	LK1	MIN N	0.0	⊳ -0.01	11.76	-16.42
83	LK2	MAX V_z	0.0	0.02	⊳ 47.83	-3.44
22	LK3	MIN V_z	250.0	0.02	⊳ -42.53	-2.25
76	LK2	MAX M_y	0.0	0.00	-20.65	⊳ 16.17
11	LK1	MIN M_y	1156.0	0.02	-24.02	⊳ -16.42

■ LAGERREAKTIONEN

LK1 : Wind + Y
LK-Faktor: 1.50 (Ergebnisse durch LK-Faktor zurückdividieren - Ja)
Lagerreaktionen[kN]

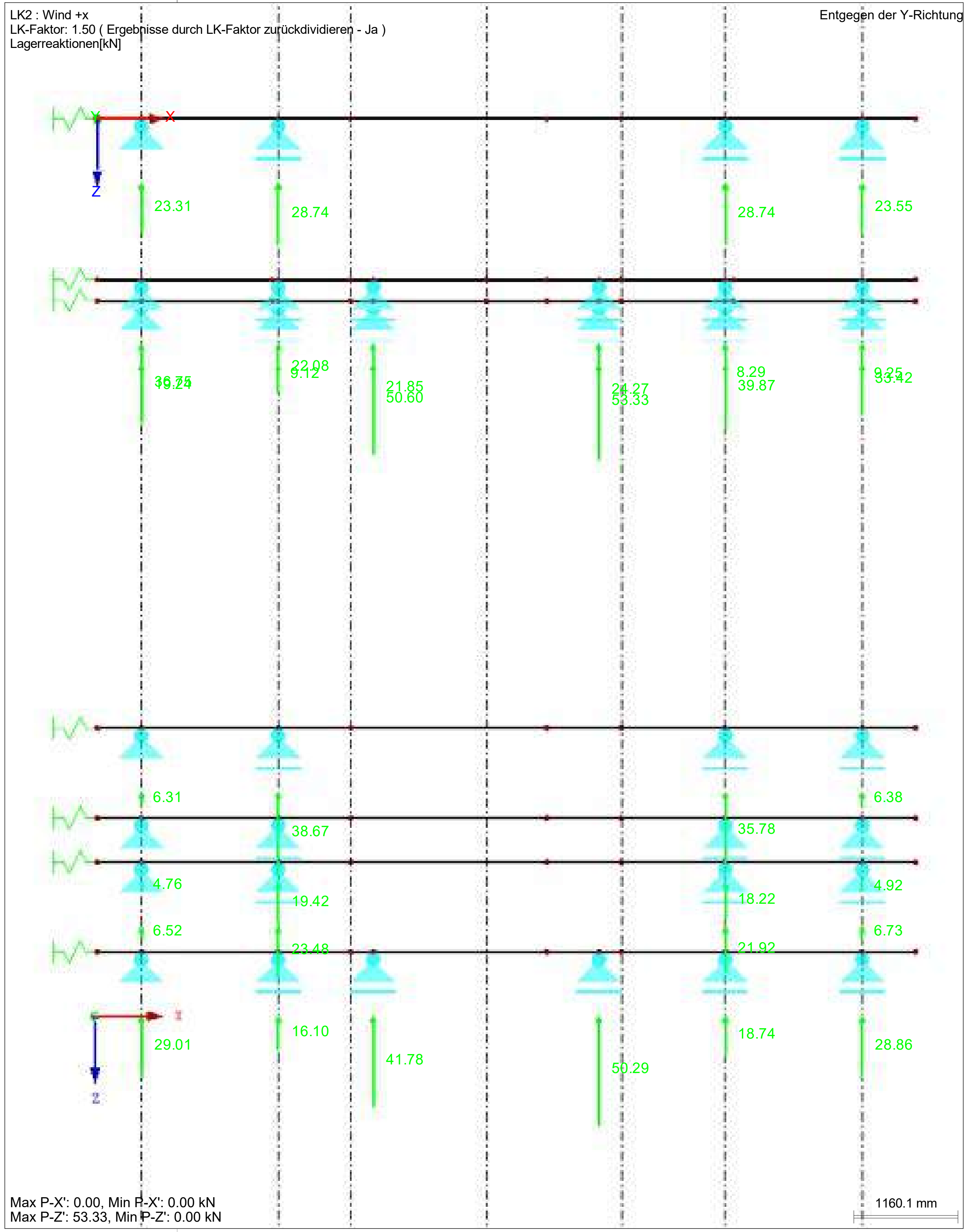
Entgegen der Y-Richtung



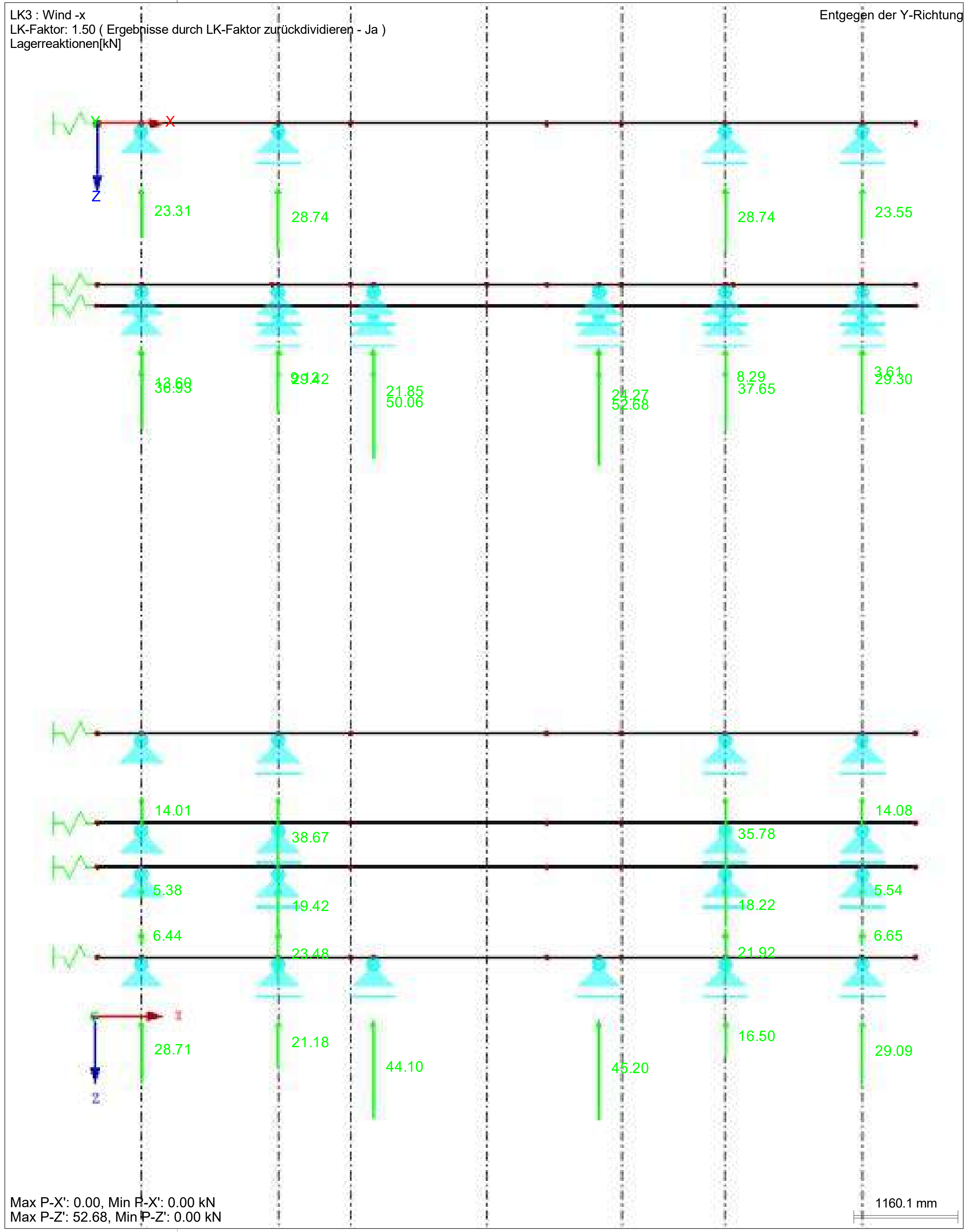
Max P-X': 0.00, Min P-X': 0.00 kN
Max P-Z': 53.20, Min P-Z': 0.00 kN

1160.1 mm

LAGERREAKTIONEN



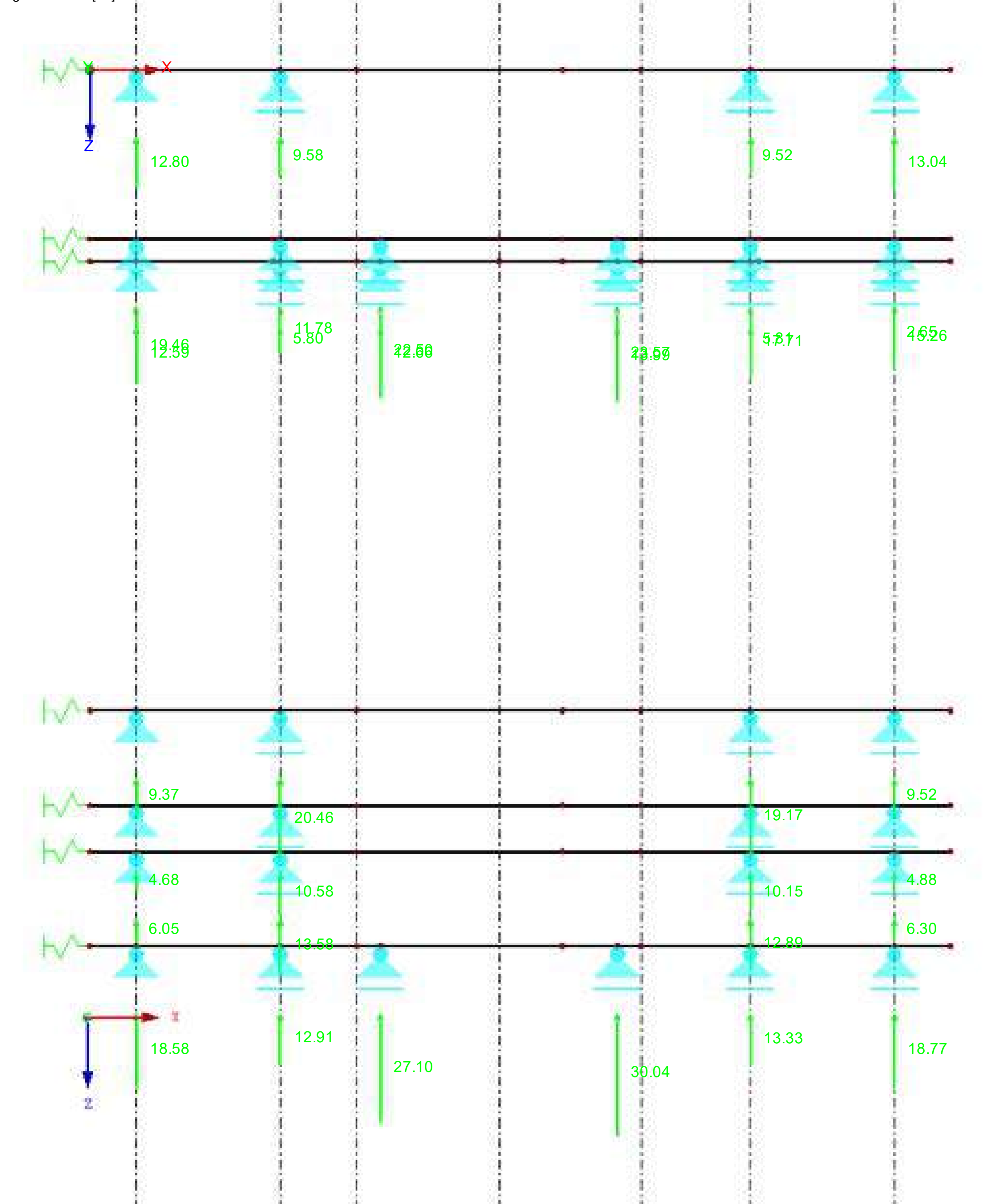
LAGERREAKTIONEN



■ LAGERREAKTIONEN

LK4 : nur Eigengewicht
LK-Faktor: 1.50 (Ergebnisse durch LK-Faktor zurückdividieren - Ja)
Lagerreaktionen[kN]

Entgegen der Y-Richtung



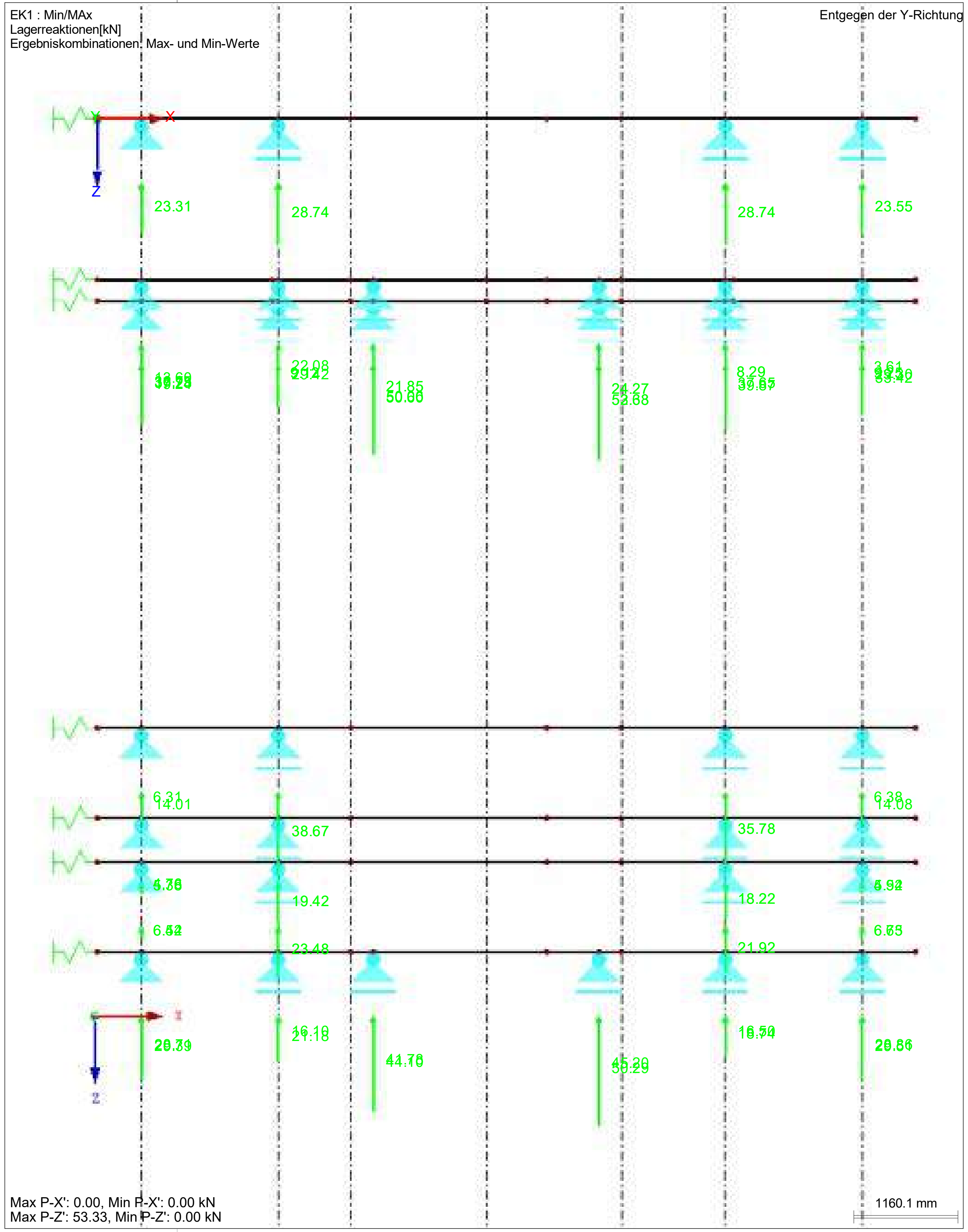
Max P-X': 0.00, Min P-X': 0.00 kN
Max P-Z': 30.04, Min P-Z': 0.00 kN

■ 4.3 QUERSCHNITTE - SCHNITTGRÖSSEN

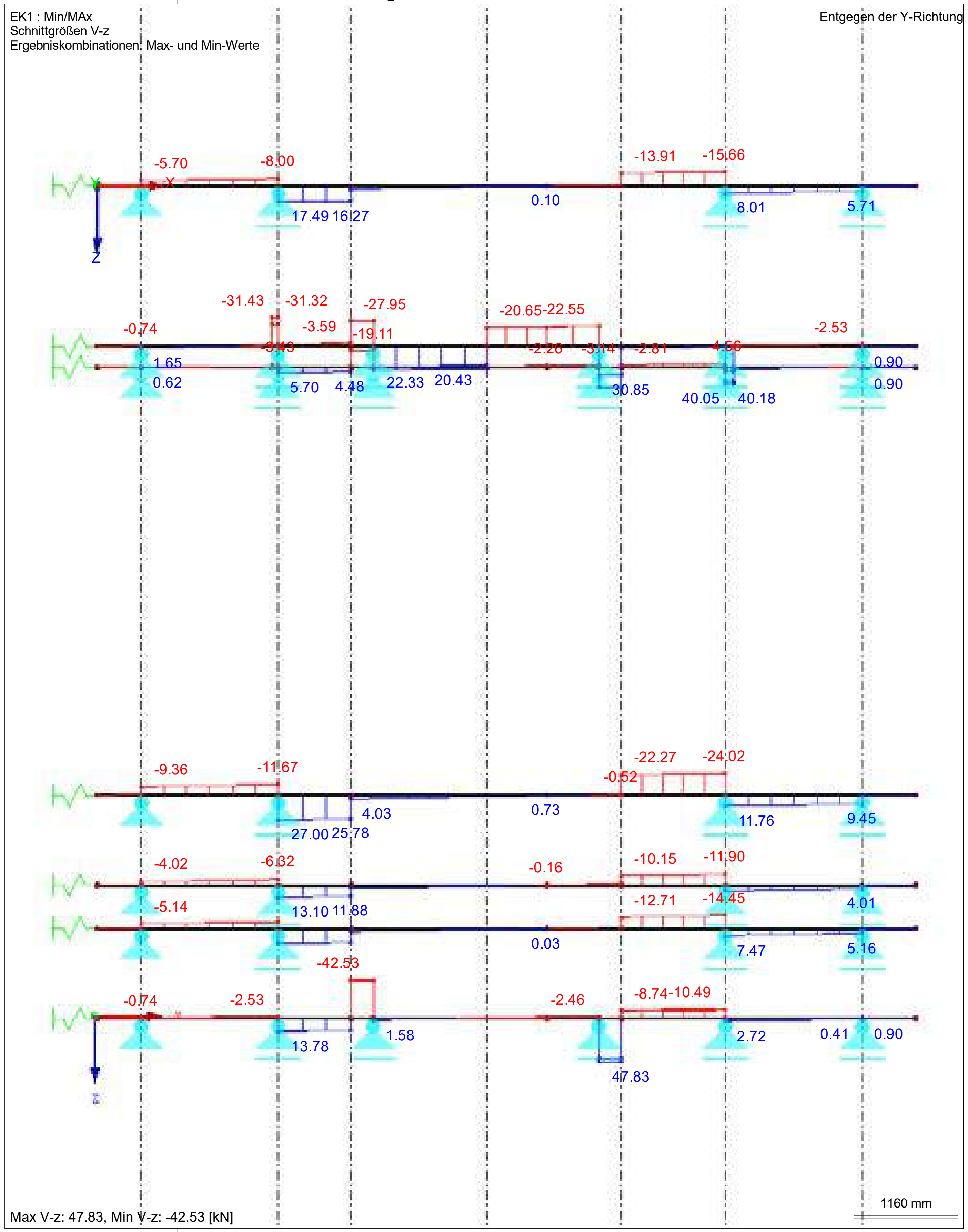
Ergebniskombinationen

Stab Nr.	EK	Knoten Nr.	Stelle x [mm]		Kräfte [kN] N	Kräfte [kN] V_z	Momente M_y [kNm]	Zugehörige Lastfälle
	Querschnitt-Nr. 3: HEM 220							
16	EK1		564.2	MAX N	▹ 0.02	26.14	-1.22	LK 1
18	EK1		0.0	MIN N	▹ -0.01	11.76	-16.42	LK 1
83	EK1		0.0	MAX V_z	0.02	▹ 47.83	-3.44	LK 2
22	EK1		250.0	MIN V_z	0.02	▹ -42.53	-2.25	LK 3
76	EK1		0.0	MAX M_y	0.00	-20.65	▹ 16.17	LK 2
11	EK1		1156.0	MIN M_y	0.02	-24.02	▹ -16.42	LK 1

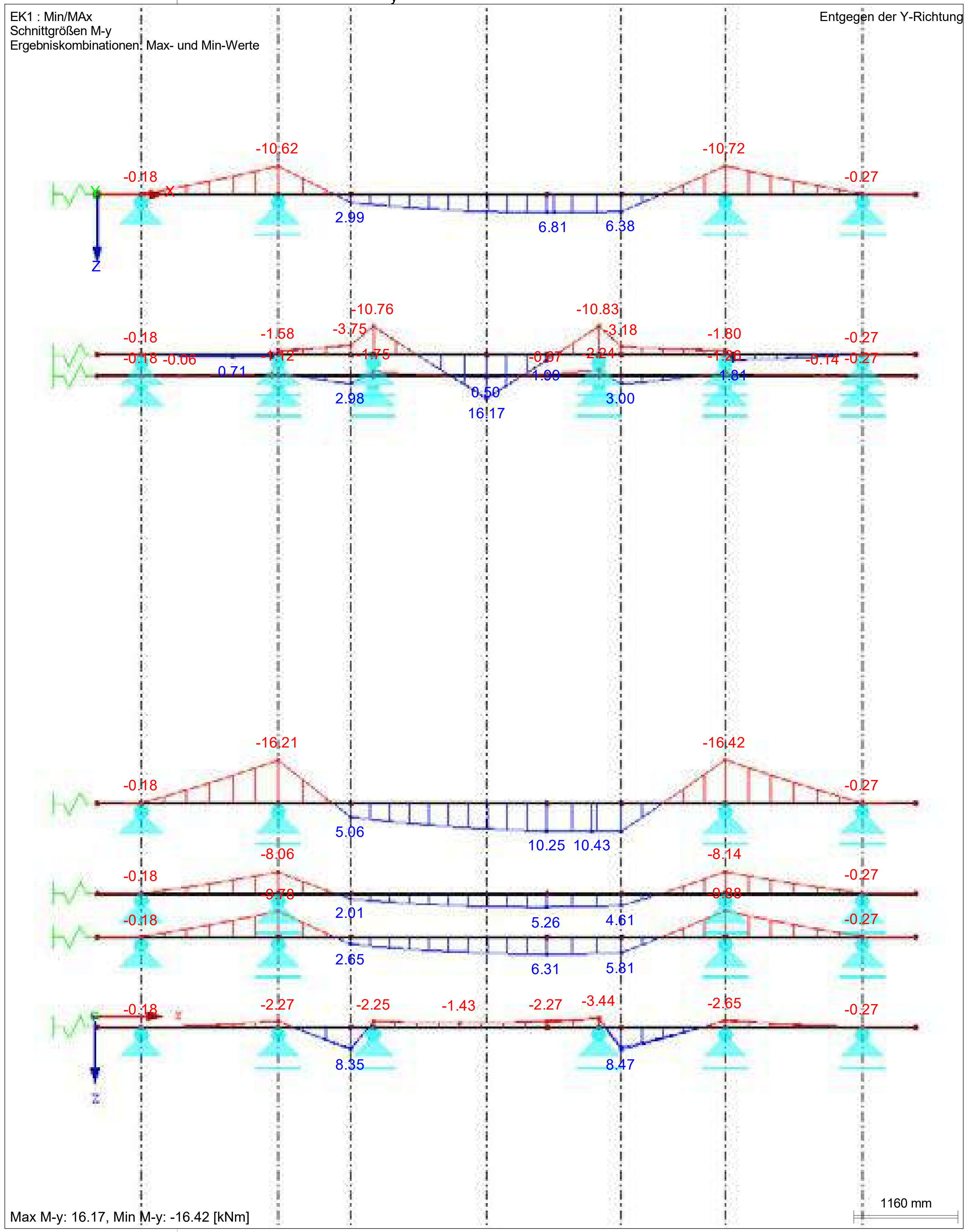
LAGERREAKTIONEN



SCHNITTGRÖSSEN V_z



■ SCHNITTGRÖSSEN M_y



STAHL
FA1
Allgemeine
Spannungsanalyse von
Stäben

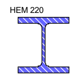
■ 1.1.1 BASISANGABEN

Zu bemessende Stäbe:		Alle
Zu bemessende Lastkombinationen:	LK1	Wind + Y
	LK2	Wind +x
	LK3	Wind -x

■ 1.2 MATERIALIEN

Matl. Nr.	Material-Bezeichnung	Teilsich.-Faktor γ_M [-]	Streckgrenze f_{yk} [kN/cm²]	Grenzspannungen [kN/cm²] Manuell	grenz σ_x	grenz τ	grenz σ_v
1	S235 - EN12812	1.10	23.50	■	21.36	12.33	21.36

■ 1.3.1 QUERSCHNITTE

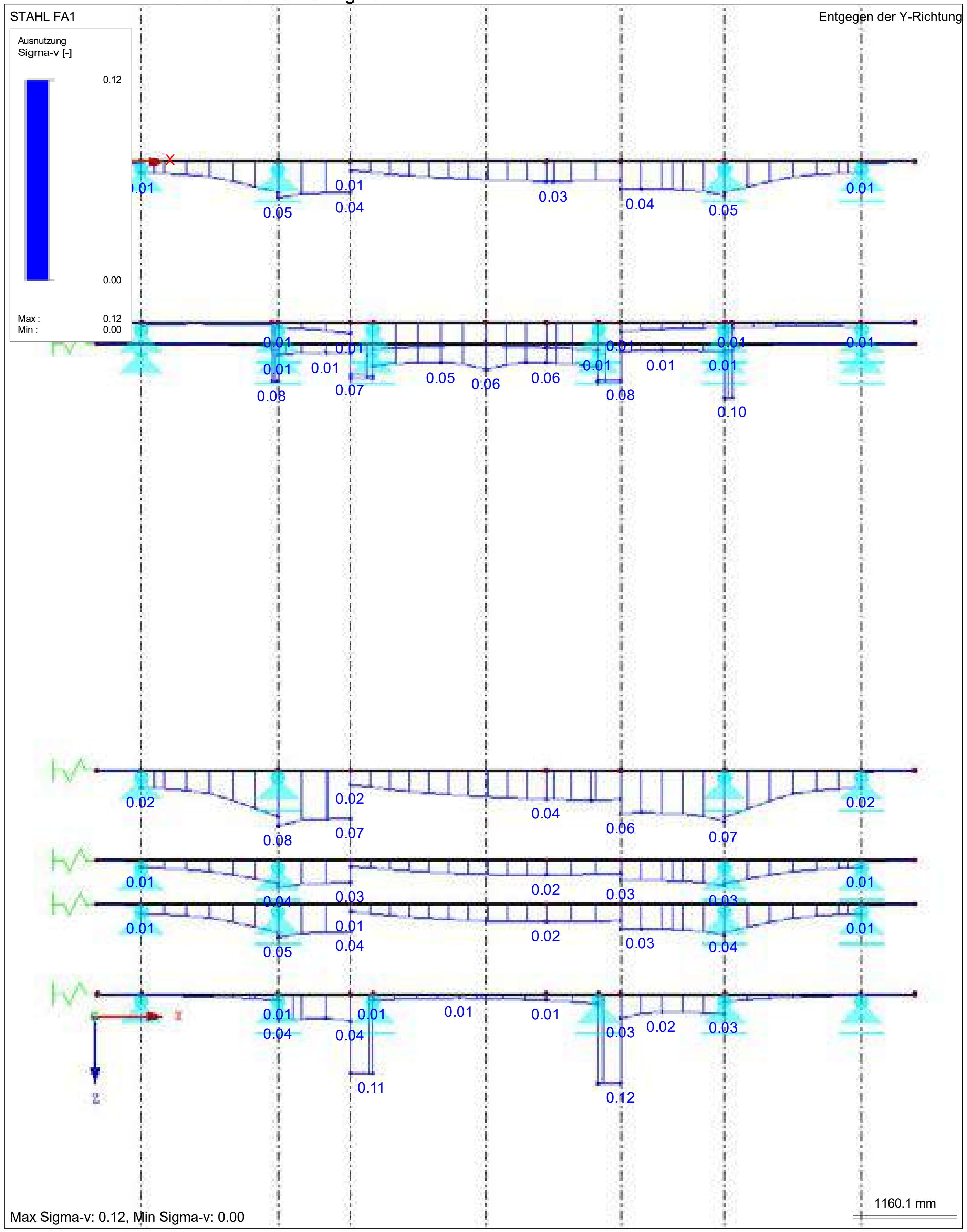


Quer. Nr.	Matl. Nr.	Querschnitt Bezeichnung	I_t [cm⁴] / A [cm²]	I_y [cm⁴] / $\alpha_{pl,y}$	I_z [cm⁴] / $\alpha_{pl,z}$	Kommentar
3	1	HEM 220	315.30	14600.00	5012.00	
			149.40	1.17	1.53	

■ 2.1 SPANNUNGEN QUERSCHNITTSWEISE

Quer. Nr.	Stab Nr.	Stelle x [mm]	S-Punkt Nr.	Last-fall	Spannungsart	Spannung [kN/cm²] Vorhanden	Limit	Aus-nutzung
3	**HEM 220**							
	11	1156.0	1	LK1	Sigma gesamt	1.35	21.36	0.06
	83	0.0	13	LK2	Tau gesamt	1.50	12.33	0.12
	83	0.0	13	LK2	Sigma-v	2.60	21.36	0.12

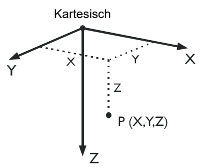
AUSNUTZUNG Sigma-v



MODELL-BASISANGABEN

Allgemein	Modellname	:	224-016371-1001S-504
	Modelltyp	:	2D-XZ (ux/uz/φy)
	Positive Richtung der globalen Z-Achse	:	Nach unten
	Klassifizierung der Lastfälle und Kombinationen	:	Nach Norm: EN 1990 Nationaler Anhang: CEN - EU
Optionen	■ CQC-Regel anwenden		
	■ CAD/BIM-Modell ermöglichen		
	Erdbeschleunigung		
	g	:	10.00 m/s²

1.1 KNOTEN

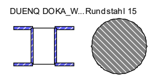


Knoten Nr.	Bezugs-Knoten	Koordinaten-System	Knotenkoordinaten X [mm]	Z [mm]	Kommentar
1	-	Kartesisch	0.0	0.0	
2	-	Kartesisch	137.0	0.0	
3	-	Kartesisch	569.2	0.0	
4	-	Kartesisch	1569.2	0.0	
5	-	Kartesisch	3067.0	0.0	
6	-	Kartesisch	3460.0	0.0	
7	-	Kartesisch	587.3	2060.0	
8	-	Kartesisch	2982.3	2060.0	
9	-	Kartesisch	1036.1	0.0	
10	-	Kartesisch	1036.1	0.0	
11	-	Kartesisch	5000.0	0.0	
12	-	Kartesisch	1276.1	0.0	
13	-	Kartesisch	5137.0	0.0	
14	-	Kartesisch	5569.2	0.0	
15	-	Kartesisch	6569.2	0.0	
16	-	Kartesisch	8067.0	0.0	
17	-	Kartesisch	8460.0	0.0	
18	-	Kartesisch	5587.3	2060.0	
19	-	Kartesisch	7982.3	2060.0	
20	-	Kartesisch	6036.1	0.0	
22	-	Kartesisch	6276.1	0.0	

1.2 MATERIALIEN

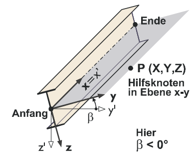
Mat. Nr.	Modul E [kN/cm²]	Modul G [kN/cm²]	Spez. Gewicht γ [kN/m³]	Wärmedehnz. α [1/°C]	Teilsich.-Beiwert γ_M [-]	Material-Modell
1	S235 - EN12812 | EN 10025-2:2019-10					
	21000.00	8076.92	78.50	1.20E-05	1.10	Isotrop linear elastisch
	Benutzerdefiniertes Material					
2	ST900/1100 - DIN 18216 | EN 1993-1-1:2005-05					
	19500.00	8100.00	78.50	1.20E-05	1.10	Isotrop linear elastisch
	Benutzerdefiniertes Material					

1.3 QUERSCHNITTE



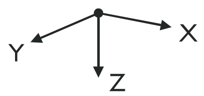
Quers. Nr.	Mater. Nr.	I_T [cm⁴] / A [cm²]	I_y [cm⁴] / A_y [cm²]	I_z [cm⁴] / A_z [cm²]	Hauptachsen α [°]	Drehung α' [°]	Gesamtabmessungen [mm] Breite b	Höhe h
1	DUENQ DOKA_WS10_(2U100_S235)							
	1	26.90	410.60	9.74	0.00	0.00	153.0	100.0
2	Rundstahl 15							
	2	1.77	0.25	1.48	0.00	0.00	15.0	15.0

1.7 STÄBE



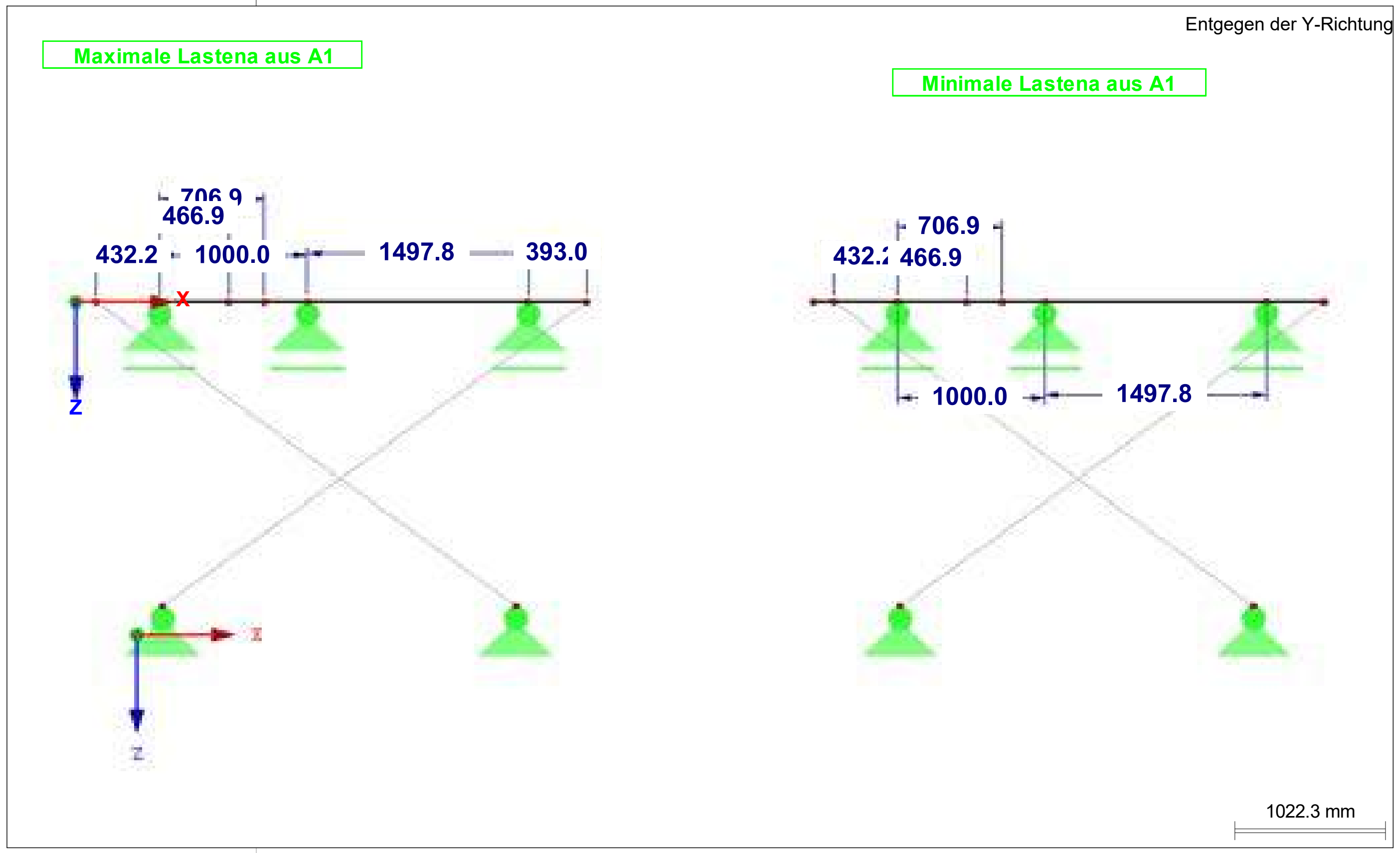
Stab Nr.	Stabtyp	Knoten Anfang	Knoten Ende	Drehung Typ	β [°]	Querschnitt Anfang	Querschnitt Ende	Gelenk Nr. Anfang	Gelenk Nr. Ende	Exz. Nr.	Teilung Nr.	Länge L [mm]	
1	Balkenstab	1	2	Winkel	0.00	1	1	-	-	-	-	137.0	X
2	Balkenstab	2	3	Winkel	0.00	1	1	-	-	-	-	432.2	X
3	Balkenstab	3	10	Winkel	0.00	1	1	-	-	-	-	466.9	X
4	Balkenstab	4	5	Winkel	0.00	1	1	-	-	-	-	1497.8	X
5	Balkenstab	5	6	Winkel	0.00	1	1	-	-	-	-	393.0	X
6	Zugstab	6	7	Winkel	0.00	2	2	-	-	-	-	3534.9	XZ
7	Zugstab	2	8	Winkel	0.00	2	2	-	-	-	-	3512.8	XZ
8	Balkenstab	11	13	Winkel	0.00	1	1	-	-	-	-	137.0	X
9	Balkenstab	13	14	Winkel	0.00	1	1	-	-	-	-	432.2	X
10	Balkenstab	10	12	Winkel	0.00	1	1	-	-	-	-	240.0	X
11	Balkenstab	12	4	Winkel	0.00	1	1	-	-	-	-	293.1	X
12	Balkenstab	14	20	Winkel	0.00	1	1	-	-	-	-	466.9	X
13	Balkenstab	15	16	Winkel	0.00	1	1	-	-	-	-	1497.8	X
14	Balkenstab	16	17	Winkel	0.00	1	1	-	-	-	-	393.0	X
15	Zugstab	17	18	Winkel	0.00	2	2	-	-	-	-	3534.9	XZ
16	Zugstab	13	19	Winkel	0.00	2	2	-	-	-	-	3512.8	XZ
17	Balkenstab	20	22	Winkel	0.00	1	1	-	-	-	-	240.0	X
18	Balkenstab	22	15	Winkel	0.00	1	1	-	-	-	-	293.1	X

1.8 KNOTENLAGER



Lager Nr.	Knoten Nr.	Lagerdrehung [um Y	Lagerung bzw. Feder [kN/m] [kNm/rad] u_X	u_Z	φ_Y	Kommentar
1	3-5,14-16	0.00	■	■	■	
2	7,8,18,19	0.00	■	■	■	

MODELL



2.1 LASTFÄLLE

Last-fall	LF-Bezeichnung	EN 1990 | CEN Einwirkungskategorie	Aktiv	Eigengewicht - Faktor in Richtung X	Y	Z
LF1	Eigengewicht	Ständig	■	0.000		1.000
LF2	Joch A Links	Ständig/Nutzlast	■			
LF3	Joch B Links	Ständig/Nutzlast	■			
LF4	Joch A Rechts	Ständig/Nutzlast	■			
LF5	Joch B Rechts	Ständig/Nutzlast	■			
LF6	H-Last + X	Ständig/Nutzlast	■			

2.1.1 LASTFÄLLE - BERECHNUNGSPARAMETER

Last-fall	LF-Bezeichnung	Berechnungsparameter	
LF1	Eigengewicht	Berechnungstheorie	: ■ Theorie I. Ordnung (linear)
		Steifigkeitsbeiwerte aktivieren für:	: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LF2	Joch A Links	Berechnungstheorie	: ■ Theorie I. Ordnung (linear)
		Steifigkeitsbeiwerte aktivieren für:	: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LF3	Joch B Links	Berechnungstheorie	: ■ Theorie I. Ordnung (linear)
		Steifigkeitsbeiwerte aktivieren für:	: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LF4	Joch A Rechts	Berechnungstheorie	: ■ Theorie I. Ordnung (linear)
		Steifigkeitsbeiwerte aktivieren für:	: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LF5	Joch B Rechts	Berechnungstheorie	: ■ Theorie I. Ordnung (linear)
		Steifigkeitsbeiwerte aktivieren für:	: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LF6	H-Last + X	Berechnungstheorie	: ■ Theorie I. Ordnung (linear)
		Steifigkeitsbeiwerte aktivieren für:	: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)

2.1.1 LASTFÄLLE - BERECHNUNGSPARAMETER

Last-fall	LF-Bezeichnung	Berechnungsparameter
		: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)

2.5 LASTKOMBINATIONEN

Last-kombin.	BS	Lastkombination Bezeichnung	Nr.	Faktor	Lastfall	
LK1		LF1 + LF2 + LF6	1	1.00	LF1	Eigengewicht
			2	1.00	LF2	Joch A Links
			3	1.00	LF6	H-Last + X
LK2		LF1 + LF3 + LF6	1	1.00	LF1	Eigengewicht
			2	1.00	LF3	Joch B Links
			3	1.00	LF6	H-Last + X
LK3		LF1 + LF4 + LF6	1	1.00	LF1	Eigengewicht
			2	1.00	LF4	Joch A Rechts
			3	1.00	LF6	H-Last + X
LK4		LF1 + LF5 + LF6	1	1.00	LF1	Eigengewicht
			2	1.00	LF5	Joch B Rechts
			3	1.00	LF6	H-Last + X
LK5		LF1 + LF2 - LF6	1	1.00	LF1	Eigengewicht
			2	1.00	LF2	Joch A Links
			3	-1.00	LF6	H-Last + X
LK6		LF1 + LF3 - LF6	1	1.00	LF1	Eigengewicht
			2	1.00	LF3	Joch B Links
			3	-1.00	LF6	H-Last + X
LK7		LF1 + LF4 - LF6	1	1.00	LF1	Eigengewicht
			2	1.00	LF4	Joch A Rechts
			3	-1.00	LF6	H-Last + X
LK8		LF1 + LF5 - LF6	1	1.00	LF1	Eigengewicht
			2	1.00	LF5	Joch B Rechts
			3	-1.00	LF6	H-Last + X

2.5.2 LASTKOMBINATIONEN - BERECHNUNGSPARAMETER

Last-kombin.	Bezeichnung	Berechnungsparameter	
LK1	LF1 + LF2 + LF6	Berechnungstheorie	: ■ II. Ordnung (P-Delta)
		Optionen	: ■ Entlastende Wirkung von Zugkräften berücksichtigen
			: ■ Belastung mit Faktor bearbeiten: 1.500
			■ Ergebnisse durch Lastfaktor zurückdividieren
			: ■ Schnittgrößen auf das verformte System beziehen für:
			■ Normalkräfte N
			■ Querkräfte V_y und V_z
			■ Momente M_y, M_z und M_T
		Steifigkeitsbeiwerte aktivieren für:	: ■ Materialien (Teilsicherheitsbeiwert γM)
			: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LK2	LF1 + LF3 + LF6	Berechnungstheorie	: ■ II. Ordnung (P-Delta)
		Optionen	: ■ Entlastende Wirkung von Zugkräften berücksichtigen
			: ■ Belastung mit Faktor bearbeiten: 1.500
			■ Ergebnisse durch Lastfaktor zurückdividieren
			: ■ Schnittgrößen auf das verformte System beziehen für:
			■ Normalkräfte N
			■ Querkräfte V_y und V_z
			■ Momente M_y, M_z und M_T
		Steifigkeitsbeiwerte aktivieren für:	: ■ Materialien (Teilsicherheitsbeiwert γM)
			: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LK3	LF1 + LF4 + LF6	Berechnungstheorie	: ■ II. Ordnung (P-Delta)
		Optionen	: ■ Entlastende Wirkung von Zugkräften berücksichtigen
			: ■ Belastung mit Faktor bearbeiten: 1.500
			■ Ergebnisse durch Lastfaktor zurückdividieren
			: ■ Schnittgrößen auf das verformte System beziehen für:
			■ Normalkräfte N
			■ Querkräfte V_y und V_z
			■ Momente M_y, M_z und M_T
		Steifigkeitsbeiwerte aktivieren für:	: ■ Materialien (Teilsicherheitsbeiwert γM)
			: ■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			: ■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LK4	LF1 + LF5 + LF6	Berechnungstheorie	: ■ II. Ordnung (P-Delta)
		Optionen	: ■ Entlastende Wirkung von Zugkräften berücksichtigen
			: ■ Belastung mit Faktor bearbeiten: 1.500
			■ Ergebnisse durch Lastfaktor zurückdividieren
			: ■ Schnittgrößen auf das verformte System beziehen für:
			■ Normalkräfte N
			■ Querkräfte V_y und V_z
			■ Momente M_y, M_z und M_T
		Steifigkeitsbeiwerte aktivieren für:	: ■ Materialien (Teilsicherheitsbeiwert γM)

2.5.2 LASTKOMBINATIONEN - BERECHNUNGSPARAMETER

Last-kombin.	Bezeichnung	Berechnungsparameter	
			■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LK5	LF1 + LF2 - LF6	Berechnungstheorie	■ II. Ordnung (P-Delta)
		Optionen	■ Entlastende Wirkung von Zugkräften berücksichtigen
			■ Belastung mit Faktor bearbeiten: 1.500
			■ Ergebnisse durch Lastfaktor zurückdividieren
			■ Schnittgrößen auf das verformte System beziehen für:
			■ Normalkräfte N
			■ Querkräfte V_y und V_z
			■ Momente M_y, M_z und M_T
		Steifigkeitsbeiwerte aktivieren für:	■ Materialien (Teilsicherheitsbeiwert γM)
			■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LK6	LF1 + LF3 - LF6	Berechnungstheorie	■ II. Ordnung (P-Delta)
		Optionen	■ Entlastende Wirkung von Zugkräften berücksichtigen
			■ Belastung mit Faktor bearbeiten: 1.500
			■ Ergebnisse durch Lastfaktor zurückdividieren
			■ Schnittgrößen auf das verformte System beziehen für:
			■ Normalkräfte N
			■ Querkräfte V_y und V_z
			■ Momente M_y, M_z und M_T
		Steifigkeitsbeiwerte aktivieren für:	■ Materialien (Teilsicherheitsbeiwert γM)
			■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LK7	LF1 + LF4 - LF6	Berechnungstheorie	■ II. Ordnung (P-Delta)
		Optionen	■ Entlastende Wirkung von Zugkräften berücksichtigen
			■ Belastung mit Faktor bearbeiten: 1.500
			■ Ergebnisse durch Lastfaktor zurückdividieren
			■ Schnittgrößen auf das verformte System beziehen für:
			■ Normalkräfte N
			■ Querkräfte V_y und V_z
			■ Momente M_y, M_z und M_T
		Steifigkeitsbeiwerte aktivieren für:	■ Materialien (Teilsicherheitsbeiwert γM)
			■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)
LK8	LF1 + LF5 - LF6	Berechnungstheorie	■ II. Ordnung (P-Delta)
		Optionen	■ Entlastende Wirkung von Zugkräften berücksichtigen
			■ Belastung mit Faktor bearbeiten: 1.500
			■ Ergebnisse durch Lastfaktor zurückdividieren
			■ Schnittgrößen auf das verformte System beziehen für:
			■ Normalkräfte N
			■ Querkräfte V_y und V_z
			■ Momente M_y, M_z und M_T
		Steifigkeitsbeiwerte aktivieren für:	■ Materialien (Teilsicherheitsbeiwert γM)
			■ Querschnitte (Faktor für J, I_y, I_z, A, A_y, A_z)
			■ Stäbe (Faktor für GJ, EI_y, EI_z, EA, GA_y, GA_z)

2.6 ERGEBNISKOMBINATIONEN

Ergebn.-kombin.	Bezeichnung	Belastung
EK1	Min/Max	LK1/s oder bis LK8

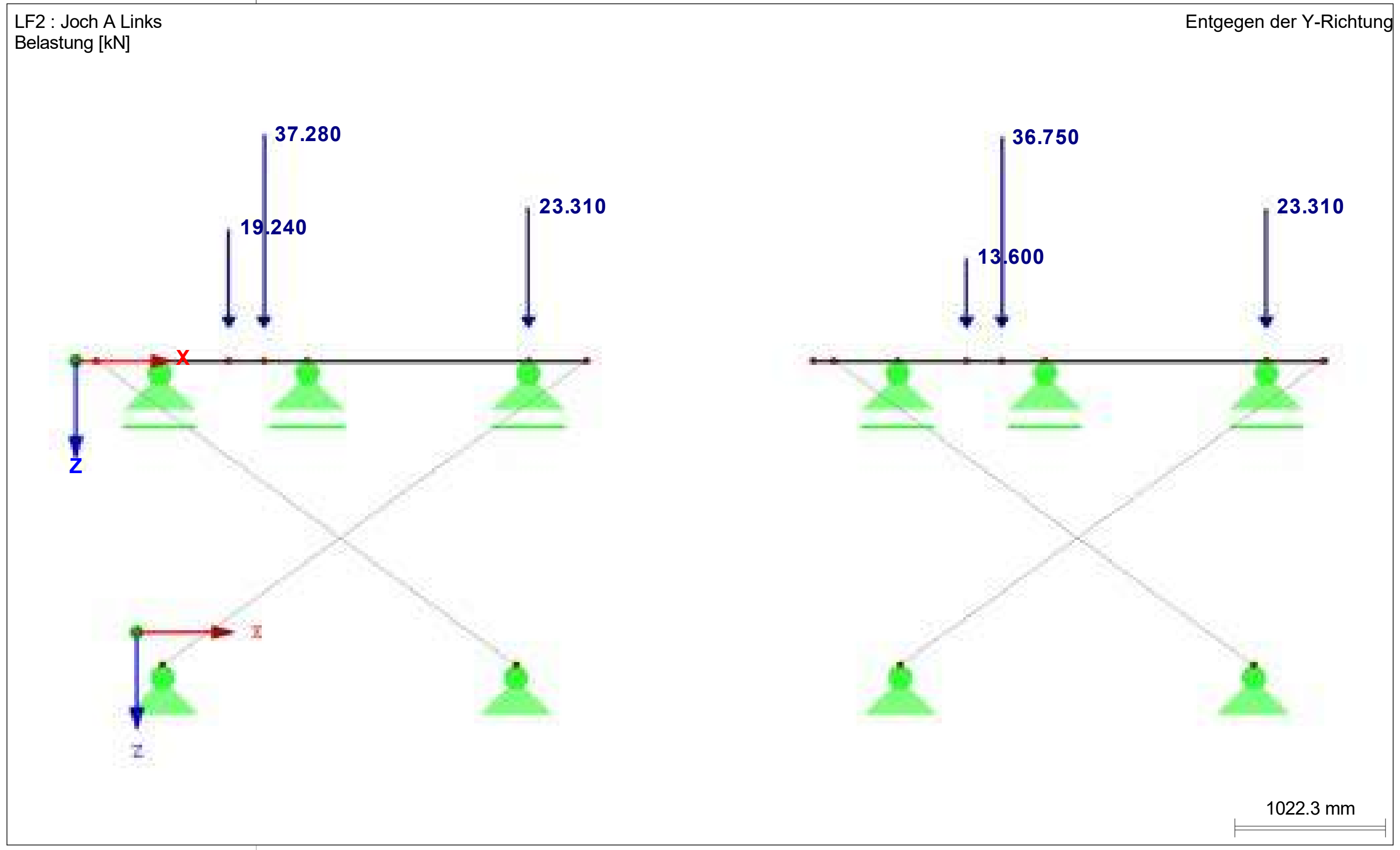
3.1 KNOTENLASTEN - KOMPONENTENWEISE - KOORDINATENSYSTEM

LF2: Joch A Links

LF2
Joch A Links

Nr.	An Knoten Nr.	Koordinaten-system	Kraft [kN] P_X / P_U	Kraft [kN] P_Z / P_W	Moment M_Y / M_V [kNm]
1	16	0 | Globales XYZ	0.000	23.310	0.000
2	22	0 | Globales XYZ	0.000	36.750	0.000
3	20	0 | Globales XYZ	0.000	13.600	0.000
4	10	0 | Globales XYZ	0.000	19.240	0.000
5	12	0 | Globales XYZ	0.000	37.280	0.000
6	5	0 | Globales XYZ	0.000	23.310	0.000

LF2: JOCH A LINKS



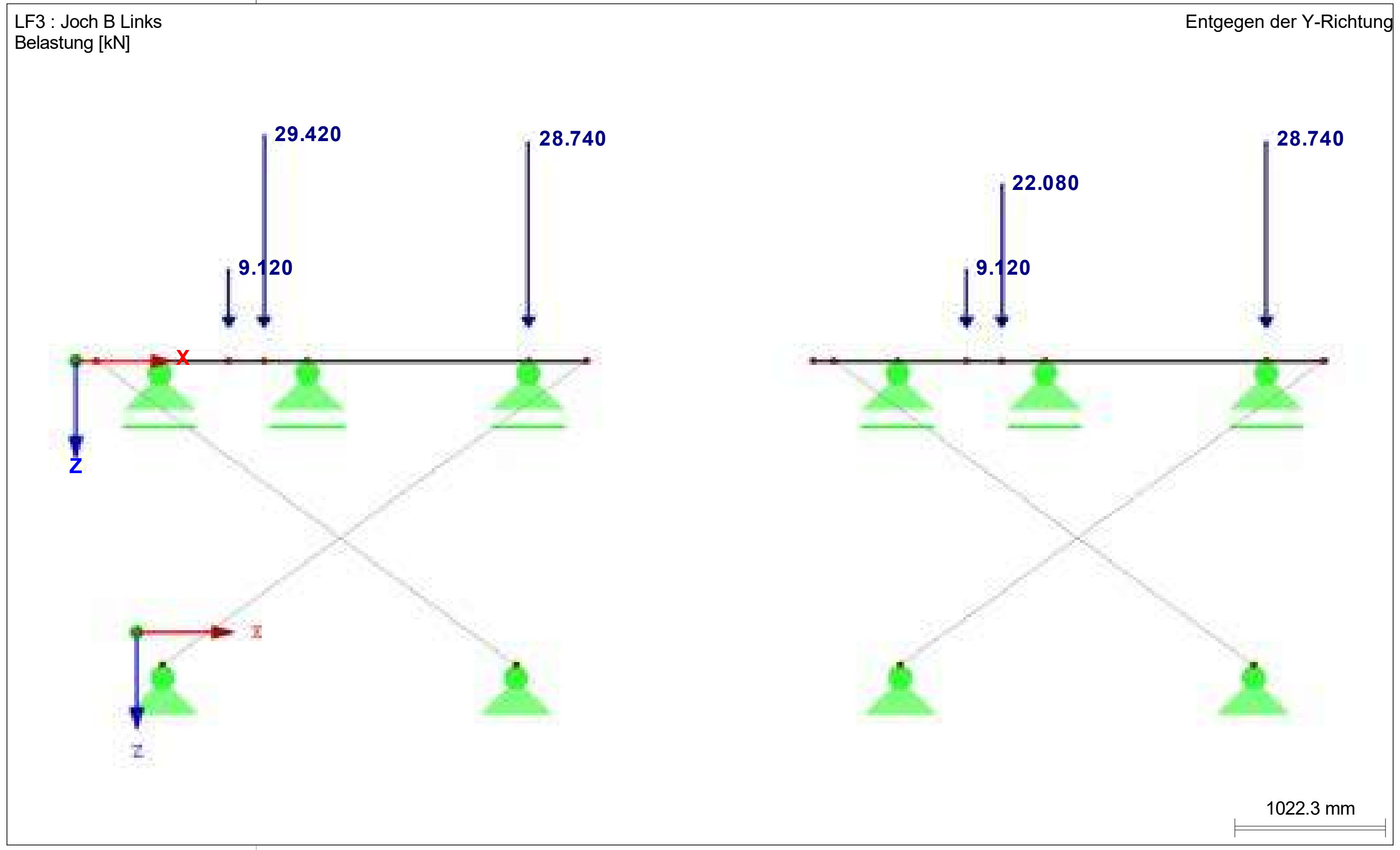
3.1 KNOTENLASTEN - KOMPONENTENWEISE - KOORDINATENSYSTEM

LF3: Joch B Links

LF3
Joch B Links

Nr.	An Knoten Nr.	Koordinaten-system	Kraft [kN] P_X / P_U	Kraft [kN] P_Z / P_W	Moment M_Y / M_V [kNm]
1	16	0 | Globales XYZ	0.000	28.740	0.000
2	22	0 | Globales XYZ	0.000	22.080	0.000
3	20	0 | Globales XYZ	0.000	9.120	0.000
4	5	0 | Globales XYZ	0.000	28.740	0.000
5	12	0 | Globales XYZ	0.000	29.420	0.000
6	10	0 | Globales XYZ	0.000	9.120	0.000

LF3: JOCH B LINKS



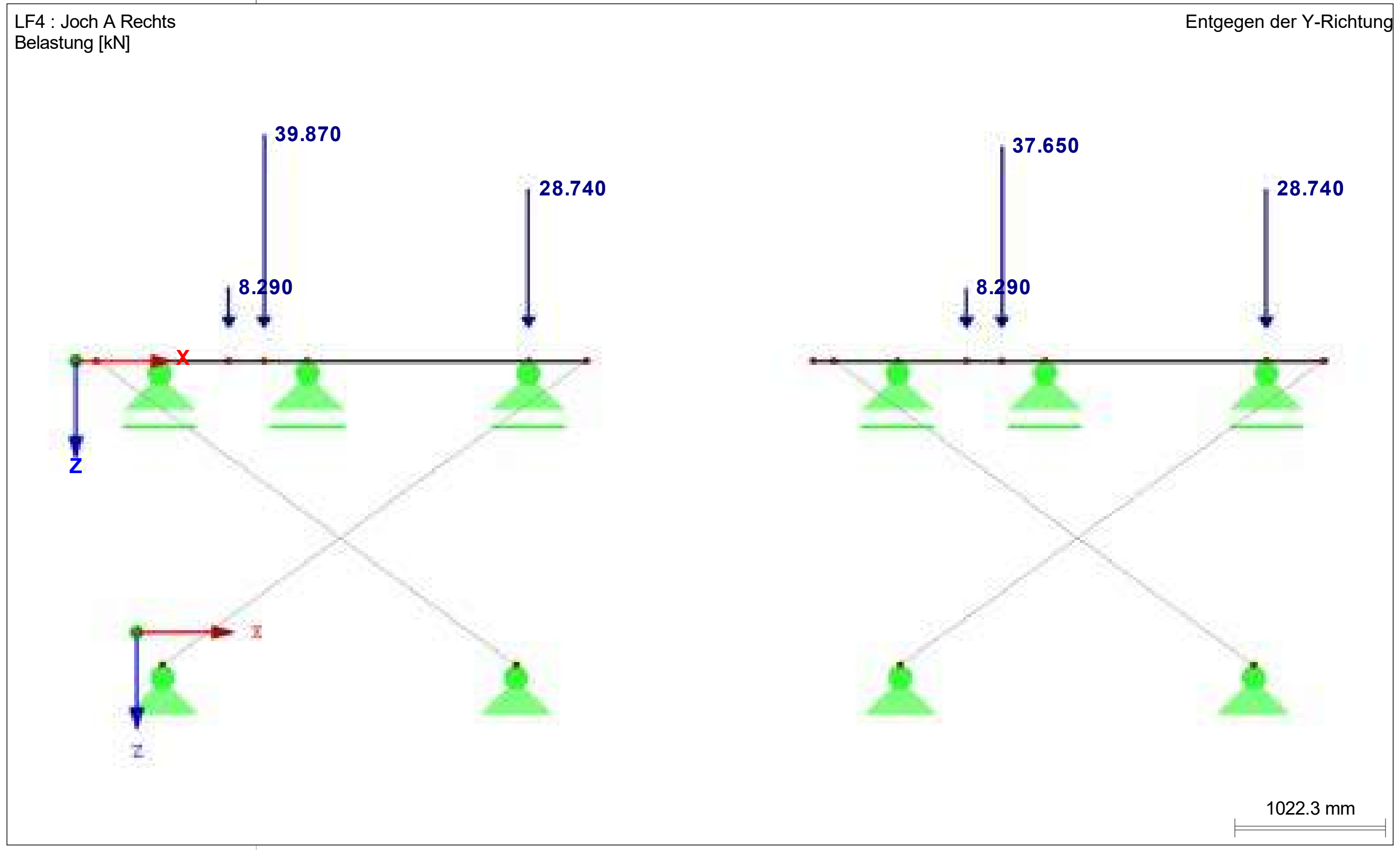
3.1 KNOTENLASTEN - KOMPONENTENWEISE - KOORDINATENSYSTEM

LF4: Joch A Rechts

LF4
Joch A Rechts

Nr.	An Knoten Nr.	Koordinaten-system	Kraft [kN] P_X / P_U	P_Z / P_W	Moment M_Y / M_V [kNm]
1	16	0 | Globales XYZ	0.000	28.740	0.000
2	22	0 | Globales XYZ	0.000	37.650	0.000
3	20	0 | Globales XYZ	0.000	8.290	0.000
4	5	0 | Globales XYZ	0.000	28.740	0.000
5	12	0 | Globales XYZ	0.000	39.870	0.000
6	10	0 | Globales XYZ	0.000	8.290	0.000

LF4: JOCH A RECHTS



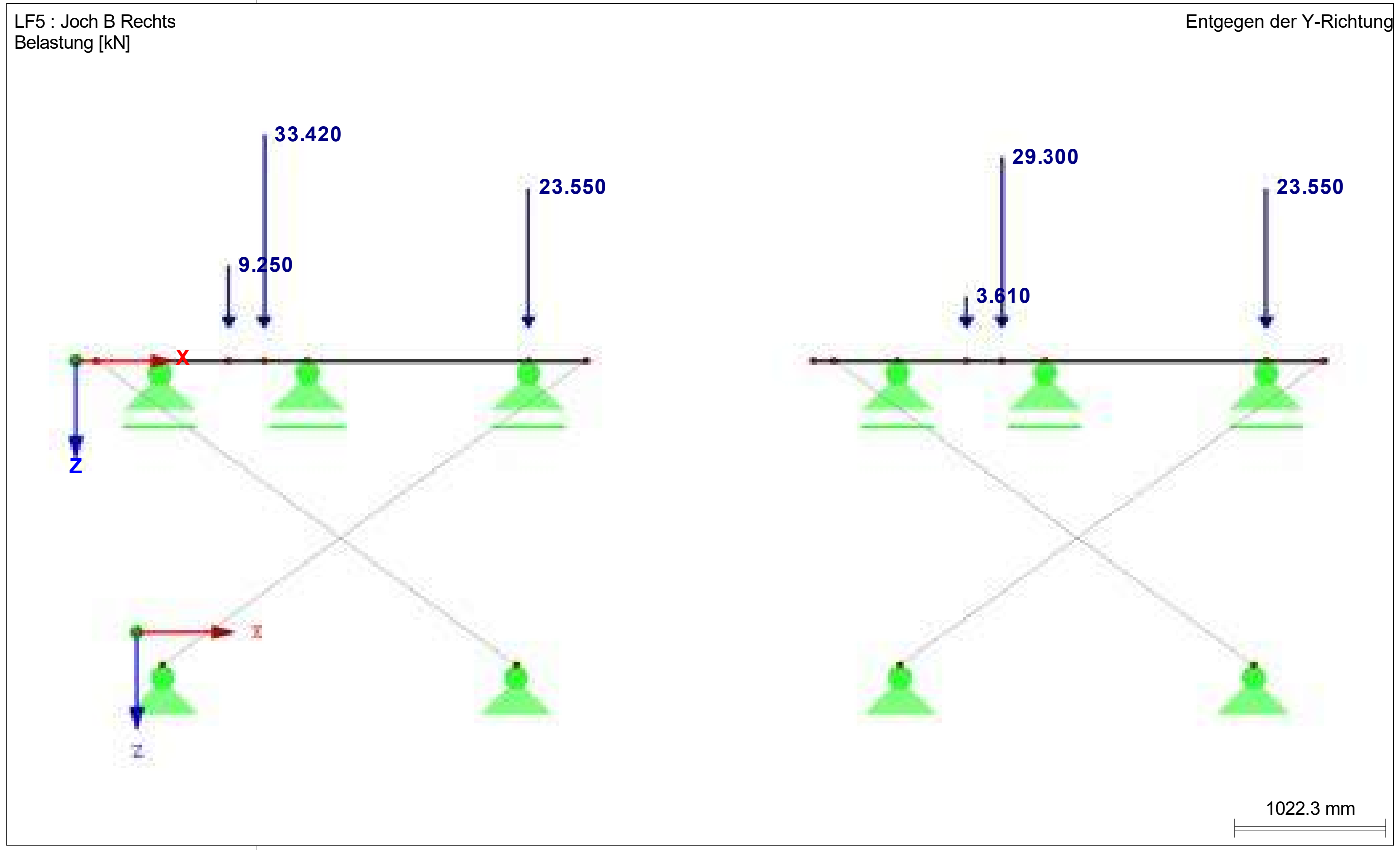
3.1 KNOTENLASTEN - KOMPONENTENWEISE - KOORDINATENSYSTEM

LF5: Joch B Rechts

LF5
Joch B Rechts

Nr.	An Knoten Nr.	Koordinaten-system	Kraft [kN] P_X / P_U	P_Z / P_W	Moment M_Y / M_V [kNm]
1	16	0 | Globales XYZ	0.000	23.550	0.000
2	22	0 | Globales XYZ	0.000	29.300	0.000
3	20	0 | Globales XYZ	0.000	3.610	0.000
4	5	0 | Globales XYZ	0.000	23.550	0.000
5	12	0 | Globales XYZ	0.000	33.420	0.000
6	10	0 | Globales XYZ	0.000	9.250	0.000

LF5: JOCH B RECHTS



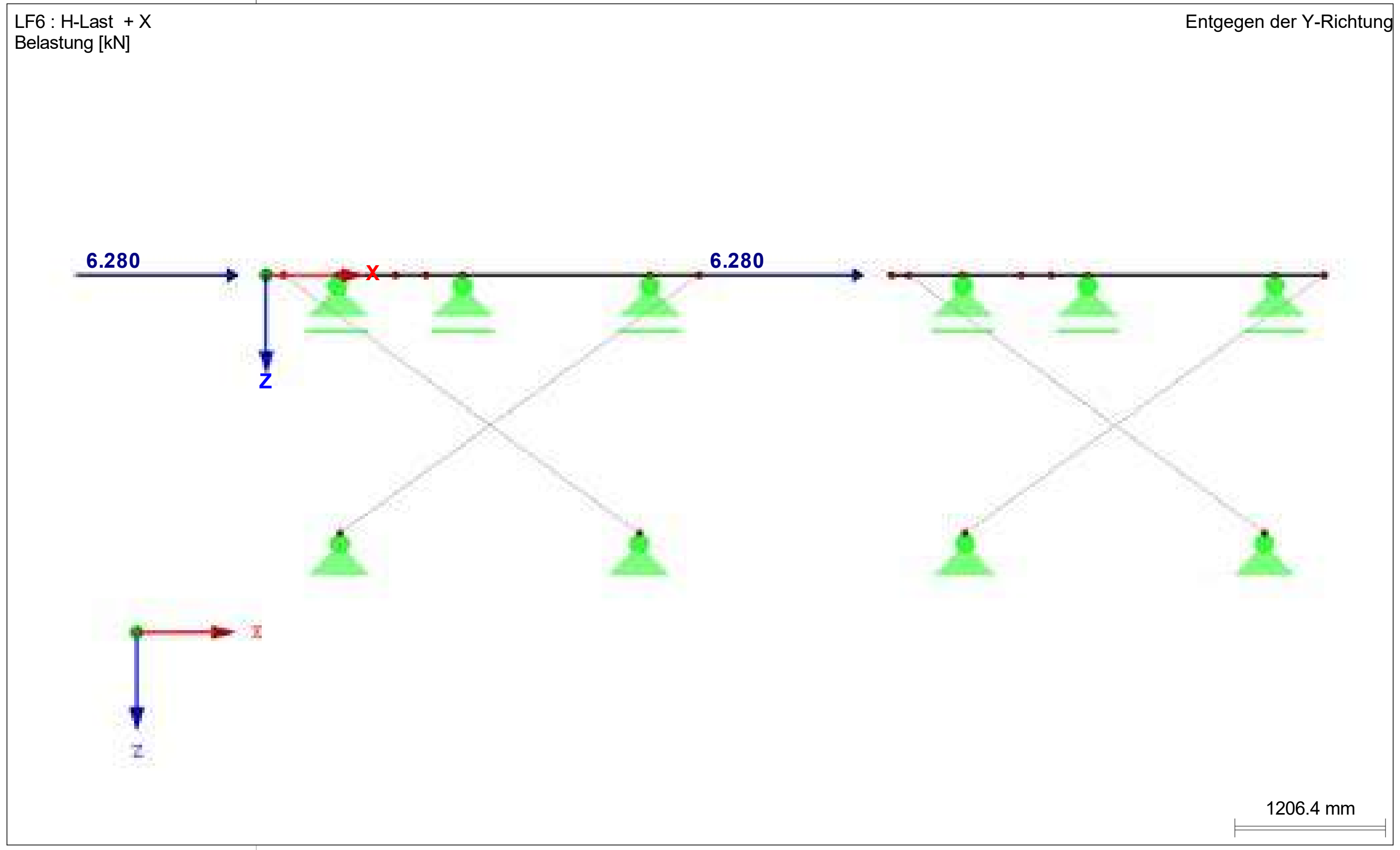
3.1 KNOTENLASTEN - KOMPONENTENWEISE - KOORDINATENSYSTEM

LF6: H-Last + X

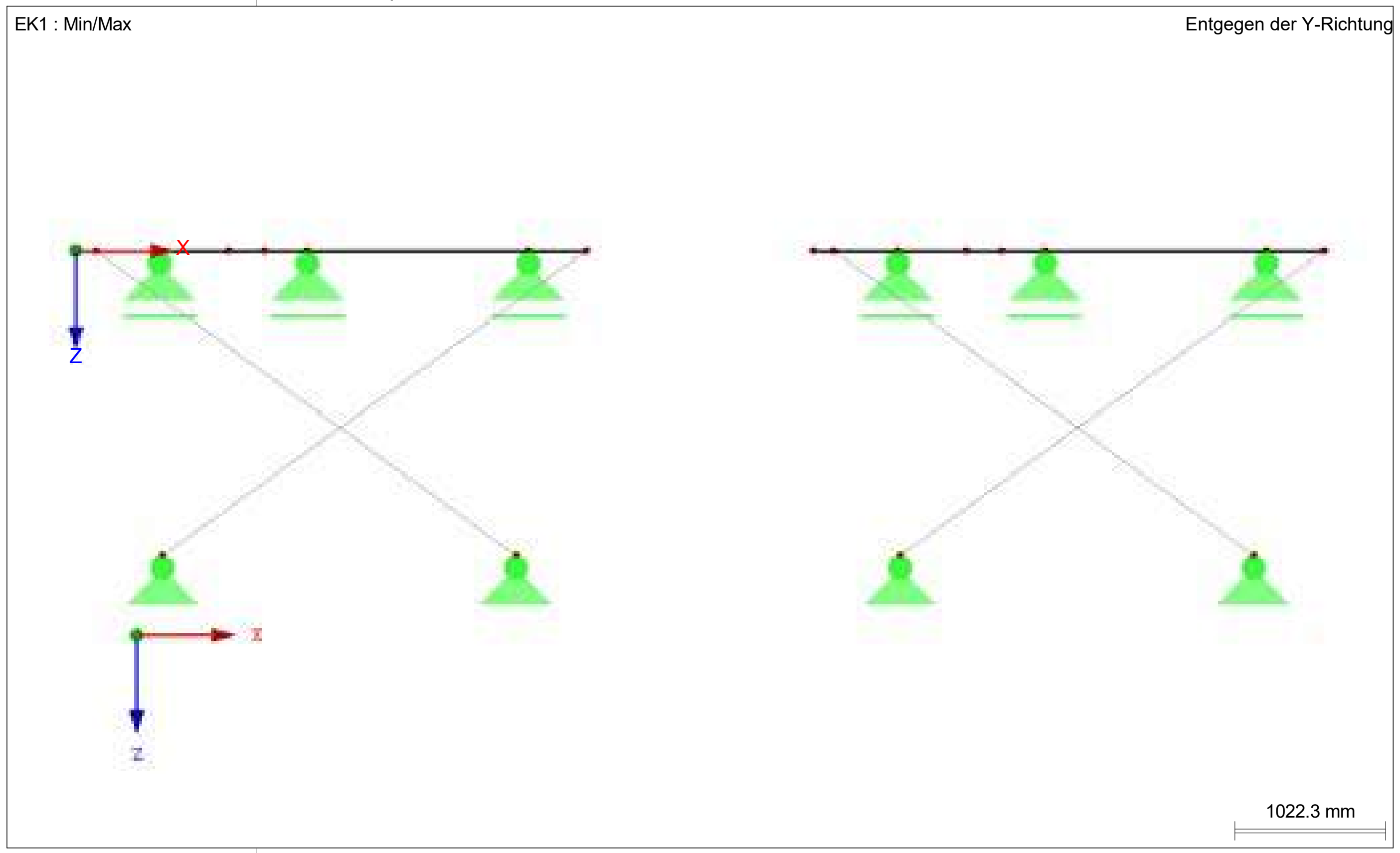
LF6
H-Last + X

Nr.	An Knoten Nr.	Koordinaten-system	Kraft [kN] P_X / P_U	P_Z / P_W	Moment M_Y / M_V [kNm]
1	1,11	0 | Globales XYZ	6.280	0.000	0.000
	aus Anhang A4				

LF6: H-LAST + X

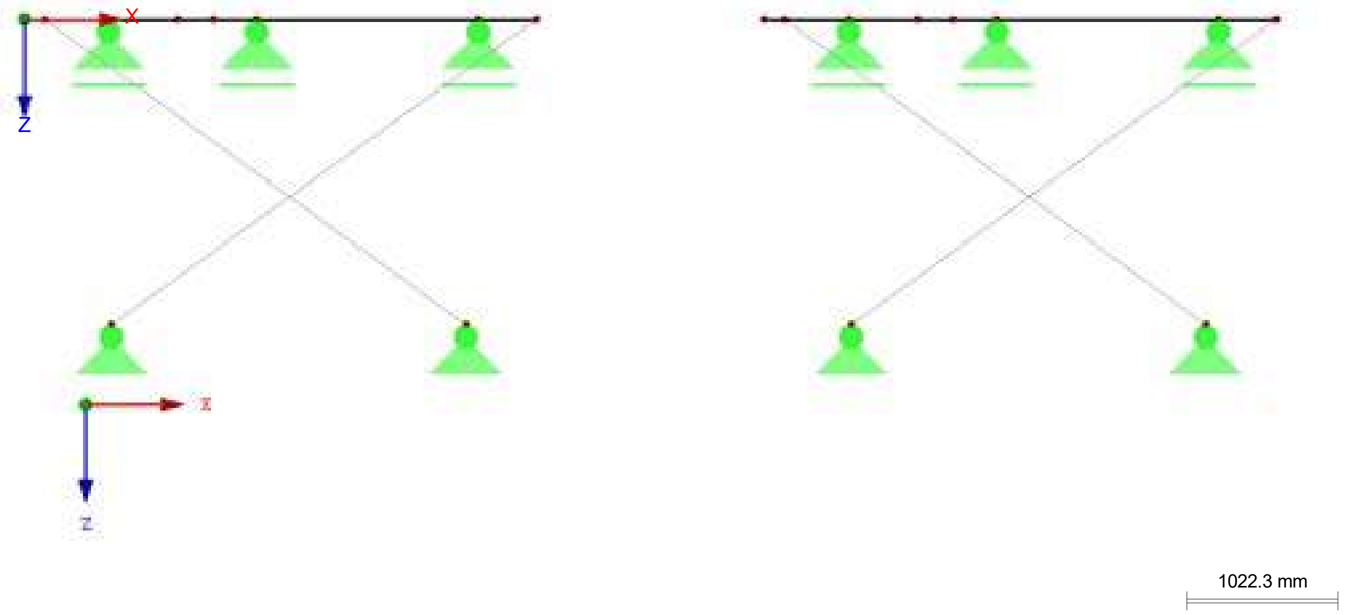


EK1: MIN/MAX



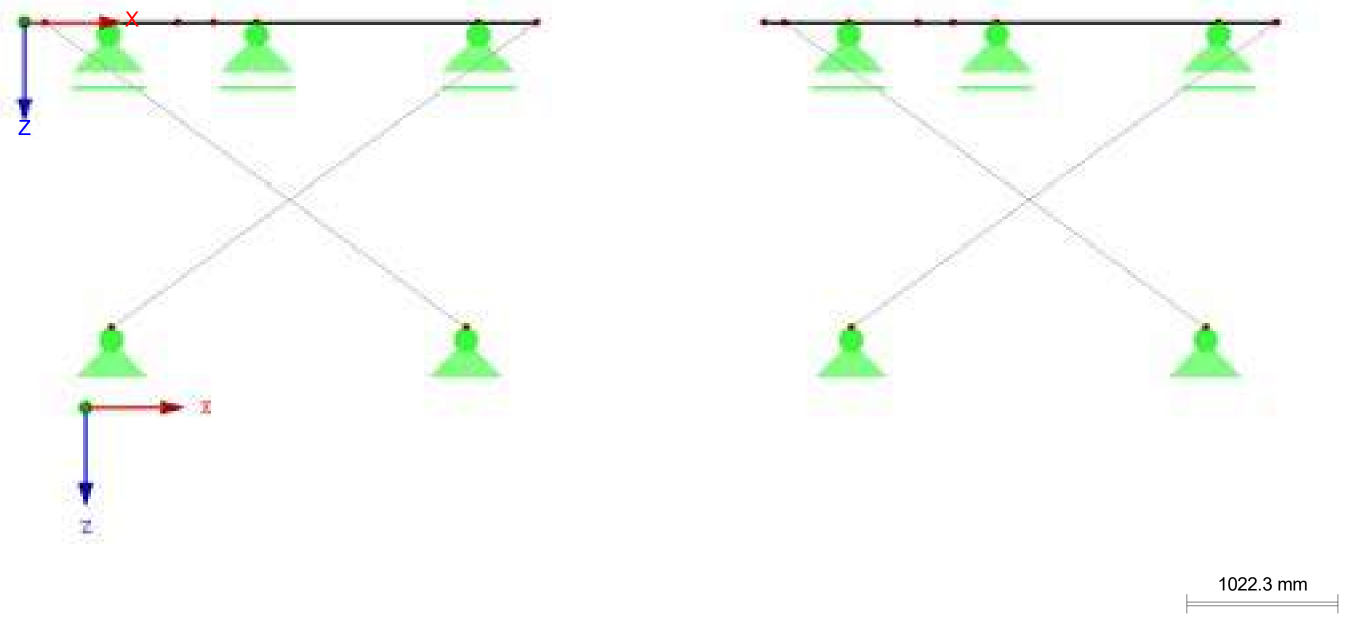
EK1: MIN/MAX

EK1 : Min/Max Entgegen der Y-Richtung



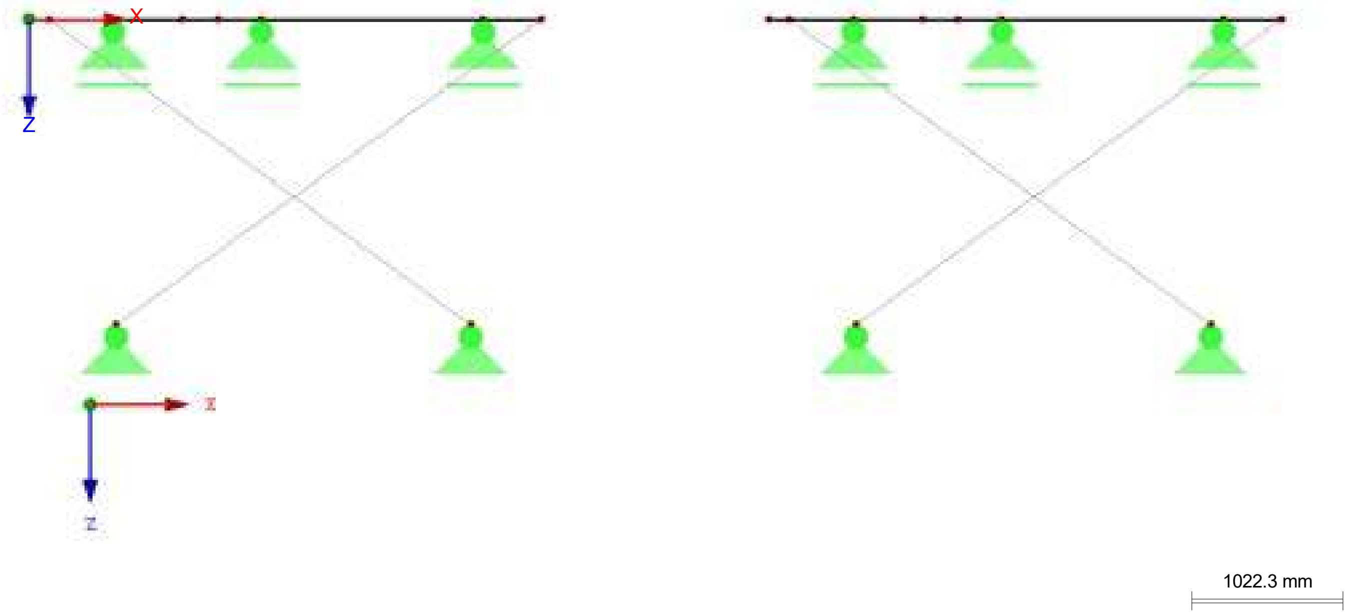
EK1: MIN/MAX

EK1 : Min/Max Entgegen der Y-Richtung



EK1: MIN/MAX

EK1 : Min/Max Entgegen der Y-Richtung



■ 4.0 ERGEBNISSE - ZUSAMMENFASSUNG

Bezeichnung	Wert	Einheit	Kommentar
LF1 - Eigengewicht			
Summe Belastung in Richtung X	0.00	kN	
Summe Lagerkräfte in X	0.00	kN	
Summe Belastung in Richtung Z	1.66	kN	
Summe Lagerkräfte in Z	1.66	kN	Abweichung 0.00%
Resultierende der Reaktionen um X	0.00	kNm	Im Schwerpunkt des Modells (X:4237.36, Y:0.00, Z:121.55 mm)
Resultierende der Reaktionen um Y	0.00	kNm	Im Schwerpunkt des Modells
Resultierende der Reaktionen um Z	0.00	kNm	Im Schwerpunkt des Modells
Max. Verschiebung in X	-0.0	mm	Stab Nr. 3, x: 420.2 mm
Max. Verschiebung in Z	0.0	mm	Stab Nr. 1, x: 0.0 mm
Max. Verschiebung vektoriell	0.0	mm	Stab Nr. 1, x: 0.0 mm
Max. Verdrehung um Y	0.0	mrad	Stab Nr. 1, x: 0.0 mm
Berechnungstheorie	I. Ordnung		Theorie I. Ordnung (linear)
Steifigkeitsreduktion multipliziert mit Faktor	■		
Anzahl der Laststufen	1		
Anzahl der Iterationen	3		
LF2 - Joch A Links			
Summe Belastung in Richtung X	0.00	kN	
Summe Lagerkräfte in X	0.00	kN	
Summe Belastung in Richtung Z	153.49	kN	
Summe Lagerkräfte in Z	153.49	kN	Abweichung 0.00%
Resultierende der Reaktionen um X	0.00	kNm	Im Schwerpunkt des Modells (X:4237.36, Y:0.00, Z:121.55 mm)
Resultierende der Reaktionen um Y	10.61	kNm	Im Schwerpunkt des Modells
Resultierende der Reaktionen um Z	0.00	kNm	Im Schwerpunkt des Modells
Max. Verschiebung in X	0.6	mm	Stab Nr. 1, x: 0.0 mm
Max. Verschiebung in Z	-1.4	mm	Stab Nr. 1, x: 0.0 mm
Max. Verschiebung vektoriell	1.5	mm	Stab Nr. 1, x: 0.0 mm
Max. Verdrehung um Y	2.5	mrad	Stab Nr. 11, x: 205.2 mm
Berechnungstheorie	I. Ordnung		Theorie I. Ordnung (linear)
Steifigkeitsreduktion multipliziert mit Faktor	■		
Anzahl der Laststufen	1		
Anzahl der Iterationen	1		
LF3 - Joch B Links			
Summe Belastung in Richtung X	0.00	kN	
Summe Lagerkräfte in X	0.00	kN	
Summe Belastung in Richtung Z	127.22	kN	
Summe Lagerkräfte in Z	127.22	kN	Abweichung 0.00%
Resultierende der Reaktionen um X	0.00	kNm	Im Schwerpunkt des Modells (X:4237.36, Y:0.00, Z:121.55 mm)
Resultierende der Reaktionen um Y	-21.53	kNm	Im Schwerpunkt des Modells
Resultierende der Reaktionen um Z	0.00	kNm	Im Schwerpunkt des Modells
Max. Verschiebung in X	0.4	mm	Stab Nr. 1, x: 0.0 mm
Max. Verschiebung in Z	-0.9	mm	Stab Nr. 1, x: 0.0 mm
Max. Verschiebung vektoriell	1.0	mm	Stab Nr. 1, x: 0.0 mm
Max. Verdrehung um Y	1.7	mrad	Stab Nr. 11, x: 205.2 mm
Berechnungstheorie	I. Ordnung		Theorie I. Ordnung (linear)
Steifigkeitsreduktion multipliziert mit Faktor	■		
Anzahl der Laststufen	1		
Anzahl der Iterationen	1		
LF4 - Joch A Rechts			
Summe Belastung in Richtung X	0.00	kN	
Summe Lagerkräfte in X	0.00	kN	
Summe Belastung in Richtung Z	151.58	kN	
Summe Lagerkräfte in Z	151.58	kN	Abweichung -0.00%
Resultierende der Reaktionen um X	0.00	kNm	Im Schwerpunkt des Modells (X:4237.36, Y:0.00, Z:121.55 mm)
Resultierende der Reaktionen um Y	-23.49	kNm	Im Schwerpunkt des Modells
Resultierende der Reaktionen um Z	0.00	kNm	Im Schwerpunkt des Modells
Max. Verschiebung in X	0.5	mm	Stab Nr. 1, x: 0.0 mm
Max. Verschiebung in Z	-1.1	mm	Stab Nr. 1, x: 0.0 mm
Max. Verschiebung vektoriell	1.2	mm	Stab Nr. 1, x: 0.0 mm
Max. Verdrehung um Y	2.1	mrad	Stab Nr. 11, x: 205.2 mm
Berechnungstheorie	I. Ordnung		Theorie I. Ordnung (linear)
Steifigkeitsreduktion multipliziert mit Faktor	■		
Anzahl der Laststufen	1		
Anzahl der Iterationen	1		
LF5 - Joch B Rechts			
Summe Belastung in Richtung X	0.00	kN	
Summe Lagerkräfte in X	0.00	kN	
Summe Belastung in Richtung Z	122.68	kN	
Summe Lagerkräfte in Z	122.68	kN	Abweichung 0.00%
Resultierende der Reaktionen um X	0.00	kNm	Im Schwerpunkt des Modells (X:4237.36, Y:0.00, Z:121.55 mm)
Resultierende der Reaktionen um Y	-0.28	kNm	Im Schwerpunkt des Modells
Resultierende der Reaktionen um Z	0.00	kNm	Im Schwerpunkt des Modells
Max. Verschiebung in X	0.4	mm	Stab Nr. 1, x: 0.0 mm
Max. Verschiebung in Z	-1.0	mm	Stab Nr. 1, x: 0.0 mm
Max. Verschiebung vektoriell	1.1	mm	Stab Nr. 1, x: 0.0 mm
Max. Verdrehung um Y	1.9	mrad	Stab Nr. 11, x: 205.2 mm
Berechnungstheorie	I. Ordnung		Theorie I. Ordnung (linear)
Steifigkeitsreduktion multipliziert mit Faktor	■		
Anzahl der Laststufen	1		
Anzahl der Iterationen	1		
LF6 - H-Last + X			
Summe Belastung in Richtung X	12.56	kN	
Summe Lagerkräfte in X	12.56	kN	Abweichung 0.00%
Summe Belastung in Richtung Z	0.00	kN	
Summe Lagerkräfte in Z	0.00	kN	
Resultierende der Reaktionen um X	0.00	kNm	Im Schwerpunkt des Modells (X:4237.36, Y:0.00, Z:121.55 mm)
Resultierende der Reaktionen um Y	-1.53	kNm	Im Schwerpunkt des Modells
Resultierende der Reaktionen um Z	0.00	kNm	Im Schwerpunkt des Modells
Max. Verschiebung in X	1.4	mm	Stab Nr. 1, x: 0.0 mm
Max. Verschiebung in Z	0.5	mm	
Max. Verschiebung vektoriell	1.4	mm	Stab Nr. 5, x: 393.0 mm
Max. Verdrehung um Y	-1.3	mrad	Stab Nr. 5, x: 393.0 mm
Berechnungstheorie	I. Ordnung		Theorie I. Ordnung (linear)
Steifigkeitsreduktion multipliziert mit Faktor	■		
Anzahl der Laststufen	1		

■ 4.0 ERGEBNISSE - ZUSAMMENFASSUNG

Bezeichnung	Wert	Einheit	Kommentar
Anzahl der Iterationen	2		
LK1 - LF1 + LF2 + LF6			
Summe Belastung in Richtung X	12.56	kN	
Summe Lagerkräfte in X	12.56	kN	Abweichung 0.00%
Summe Belastung in Richtung Z	155.15	kN	
Summe Lagerkräfte in Z	155.15	kN	Abweichung -0.00%
Max. Verschiebung in X	1.8	mm	Stab Nr. 1, x: 0.0 mm
Max. Verschiebung in Z	-1.7	mm	Stab Nr. 1, x: 0.0 mm
Max. Verschiebung vektoriell	2.5	mm	Stab Nr. 1, x: 0.0 mm
Max. Verdrehung um Y	-3.0	mrad	Stab Nr. 2, x: 432.2 mm
Berechnungstheorie	II. Ordnung		Theorie II. Ordnung (nichtlinear, Timoshenko)
Schnittgrößen bezogen auf verformtes System für...	■		N, V_y, V_z, M_y, M_z, M_T
Steifigkeitsreduktion multipliziert mit Faktor	■		
Entlastende Wirkung der Zugkräfte berücksichtigen	■		
Ergebnisse durch LK-Faktor zurückdividieren	■		
Anzahl der Laststufen	1		
Anzahl der Iterationen	4		
Verzweigungslastfaktor ermitteln	■		
LK2 - LF1 + LF3 + LF6			
Summe Belastung in Richtung X	12.56	kN	
Summe Lagerkräfte in X	12.56	kN	Abweichung 0.00%
Summe Belastung in Richtung Z	128.88	kN	
Summe Lagerkräfte in Z	128.88	kN	Abweichung -0.00%
Max. Verschiebung in X	1.7	mm	Stab Nr. 1, x: 0.0 mm
Max. Verschiebung in Z	-1.1	mm	Stab Nr. 1, x: 0.0 mm
Max. Verschiebung vektoriell	2.1	mm	Stab Nr. 1, x: 0.0 mm
Max. Verdrehung um Y	-2.3	mrad	Stab Nr. 5, x: 393.0 mm
Berechnungstheorie	II. Ordnung		Theorie II. Ordnung (nichtlinear, Timoshenko)
Schnittgrößen bezogen auf verformtes System für...	■		N, V_y, V_z, M_y, M_z, M_T
Steifigkeitsreduktion multipliziert mit Faktor	■		
Entlastende Wirkung der Zugkräfte berücksichtigen	■		
Ergebnisse durch LK-Faktor zurückdividieren	■		
Anzahl der Laststufen	1		
Anzahl der Iterationen	4		
Verzweigungslastfaktor ermitteln	■		
LK3 - LF1 + LF4 + LF6			
Summe Belastung in Richtung X	12.56	kN	
Summe Lagerkräfte in X	12.56	kN	Abweichung 0.00%
Summe Belastung in Richtung Z	153.24	kN	
Summe Lagerkräfte in Z	153.24	kN	Abweichung 0.00%
Max. Verschiebung in X	1.8	mm	Stab Nr. 1, x: 0.0 mm
Max. Verschiebung in Z	-1.3	mm	Stab Nr. 1, x: 0.0 mm
Max. Verschiebung vektoriell	2.2	mm	Stab Nr. 1, x: 0.0 mm
Max. Verdrehung um Y	2.5	mrad	Stab Nr. 11, x: 205.2 mm
Berechnungstheorie	II. Ordnung		Theorie II. Ordnung (nichtlinear, Timoshenko)
Schnittgrößen bezogen auf verformtes System für...	■		N, V_y, V_z, M_y, M_z, M_T
Steifigkeitsreduktion multipliziert mit Faktor	■		
Entlastende Wirkung der Zugkräfte berücksichtigen	■		
Ergebnisse durch LK-Faktor zurückdividieren	■		
Anzahl der Laststufen	1		
Anzahl der Iterationen	4		
Verzweigungslastfaktor ermitteln	■		
LK4 - LF1 + LF5 + LF6			
Summe Belastung in Richtung X	12.56	kN	
Summe Lagerkräfte in X	12.56	kN	Abweichung 0.00%
Summe Belastung in Richtung Z	124.34	kN	
Summe Lagerkräfte in Z	124.34	kN	Abweichung -0.00%
Max. Verschiebung in X	1.8	mm	Stab Nr. 1, x: 0.0 mm
Max. Verschiebung in Z	-1.2	mm	Stab Nr. 1, x: 0.0 mm
Max. Verschiebung vektoriell	2.1	mm	Stab Nr. 1, x: 0.0 mm
Max. Verdrehung um Y	-2.4	mrad	Stab Nr. 5, x: 393.0 mm
Berechnungstheorie	II. Ordnung		Theorie II. Ordnung (nichtlinear, Timoshenko)
Schnittgrößen bezogen auf verformtes System für...	■		N, V_y, V_z, M_y, M_z, M_T
Steifigkeitsreduktion multipliziert mit Faktor	■		
Entlastende Wirkung der Zugkräfte berücksichtigen	■		
Ergebnisse durch LK-Faktor zurückdividieren	■		
Anzahl der Laststufen	1		
Anzahl der Iterationen	4		
Verzweigungslastfaktor ermitteln	■		
LK5 - LF1 + LF2 - LF6			
Summe Belastung in Richtung X	-12.56	kN	
Summe Lagerkräfte in X	-12.56	kN	Abweichung 0.00%
Summe Belastung in Richtung Z	155.15	kN	
Summe Lagerkräfte in Z	155.15	kN	Abweichung 0.00%
Max. Verschiebung in X	-0.7	mm	Stab Nr. 8, x: 0.0 mm
Max. Verschiebung in Z	1.0	mm	Stab Nr. 10, x: 72.0 mm
Max. Verschiebung vektoriell	1.1	mm	Stab Nr. 10, x: 72.0 mm
Max. Verdrehung um Y	2.5	mrad	Stab Nr. 11, x: 205.2 mm
Berechnungstheorie	II. Ordnung		Theorie II. Ordnung (nichtlinear, Timoshenko)
Schnittgrößen bezogen auf verformtes System für...	■		N, V_y, V_z, M_y, M_z, M_T
Steifigkeitsreduktion multipliziert mit Faktor	■		
Entlastende Wirkung der Zugkräfte berücksichtigen	■		
Ergebnisse durch LK-Faktor zurückdividieren	■		
Anzahl der Laststufen	1		

4.0 ERGEBNISSE - ZUSAMMENFASSUNG

Bezeichnung	Wert	Einheit	Kommentar
Anzahl der Iterationen	4		
Verzweigungslastfaktor ermitteln	■		
LK6 - LF1 + LF3 - LF6			
Summe Belastung in Richtung X	-12.56	kN	
Summe Lagerkräfte in X	-12.56	kN	Abweichung 0.00%
Summe Belastung in Richtung Z	128.88	kN	
Summe Lagerkräfte in Z	128.88	kN	Abweichung 0.00%
Max. Verschiebung in X	-1.0	mm	Stab Nr. 8, x: 0.0 mm
Max. Verschiebung in Z	0.6	mm	Stab Nr. 10, x: 96.0 mm
Max. Verschiebung vektoriell	1.1	mm	Stab Nr. 17, x: 96.0 mm
Max. Verdrehung um Y	1.6	mrad	Stab Nr. 11, x: 205.2 mm
Berechnungstheorie	II. Ordnung		Theorie II. Ordnung (nichtlinear, Timoshenko)
Schnittgrößen bezogen auf verformtes System für...	■		N, V_y, V_z, M_y, M_z, M_T
Steifigkeitsreduktion multipliziert mit Faktor	■		
Entlastende Wirkung der Zugkräfte berücksichtigen	■		
Ergebnisse durch LK-Faktor zurückdividieren	■		
Anzahl der Laststufen	1		
Anzahl der Iterationen	4		
Verzweigungslastfaktor ermitteln	■		
LK7 - LF1 + LF4 - LF6			
Summe Belastung in Richtung X	-12.56	kN	
Summe Lagerkräfte in X	-12.56	kN	Abweichung 0.00%
Summe Belastung in Richtung Z	153.24	kN	
Summe Lagerkräfte in Z	153.24	kN	Abweichung 0.00%
Max. Verschiebung in X	-0.8	mm	Stab Nr. 8, x: 0.0 mm
Max. Verschiebung in Z	0.8	mm	Stab Nr. 10, x: 96.0 mm
Max. Verschiebung vektoriell	1.1	mm	Stab Nr. 10, x: 96.0 mm
Max. Verdrehung um Y	2.1	mrad	Stab Nr. 11, x: 205.2 mm
Berechnungstheorie	II. Ordnung		Theorie II. Ordnung (nichtlinear, Timoshenko)
Schnittgrößen bezogen auf verformtes System für...	■		N, V_y, V_z, M_y, M_z, M_T
Steifigkeitsreduktion multipliziert mit Faktor	■		
Entlastende Wirkung der Zugkräfte berücksichtigen	■		
Ergebnisse durch LK-Faktor zurückdividieren	■		
Anzahl der Laststufen	1		
Anzahl der Iterationen	4		
Verzweigungslastfaktor ermitteln	■		
LK8 - LF1 + LF5 - LF6			
Summe Belastung in Richtung X	-12.56	kN	
Summe Lagerkräfte in X	-12.56	kN	Abweichung 0.00%
Summe Belastung in Richtung Z	124.34	kN	
Summe Lagerkräfte in Z	124.34	kN	Abweichung 0.00%
Max. Verschiebung in X	-1.0	mm	Stab Nr. 8, x: 0.0 mm
Max. Verschiebung in Z	0.7	mm	Stab Nr. 10, x: 96.0 mm
Max. Verschiebung vektoriell	1.1	mm	Stab Nr. 17, x: 120.0 mm
Max. Verdrehung um Y	1.8	mrad	Stab Nr. 11, x: 205.2 mm
Berechnungstheorie	II. Ordnung		Theorie II. Ordnung (nichtlinear, Timoshenko)
Schnittgrößen bezogen auf verformtes System für...	■		N, V_y, V_z, M_y, M_z, M_T
Steifigkeitsreduktion multipliziert mit Faktor	■		
Entlastende Wirkung der Zugkräfte berücksichtigen	■		
Ergebnisse durch LK-Faktor zurückdividieren	■		
Anzahl der Laststufen	1		
Anzahl der Iterationen	4		
Verzweigungslastfaktor ermitteln	■		
Gesamt			
Max. Verschiebung in X	1.8	mm	LK1, Stab Nr. 1, x: 0.0 mm
Max. Verschiebung in Z	-1.7	mm	LK1, Stab Nr. 1, x: 0.0 mm
Max. Verschiebung vektoriell	2.5	mm	LK1, Stab Nr. 1, x: 0.0 mm
Max. Verdrehung um Y	-3.0	mrad	LK1, Stab Nr. 2, x: 432.2 mm
Anzahl 1D-Finite-Elemente (Stabelemente)	18		
Anzahl der FE-Knoten	21		
Anzahl der Gleichungen	63		
Maximale Anzahl Iterationen	100		
Stabteilungen für Ergebnisse der Stäbe	10		
Stabteilungen der Seil-, Bettungs- und Voutenstäbe	10		
Stab-Schubsteifigkeiten (A-y, A-z) berücksichtigen	■		
Ausfallende Stäbe berücksichtigen	■		

Einstellung	Wert
Sonstige Einstellungen	Maximale Anzahl Iterationen : 100 Anzahl der Stabteilungen für Ergebnisverläufe : 10 Stabteilungen Seilstäbe, Bettungs- und Voutenstäbe : 10 Anzahl der Stabteilungen für das Suchen der Maximalwerte : 10
Optionen	■ Schubsteifigkeit (Ay, Az) der Stäbe aktivieren ■ Steifigkeitsänderungen berücksichtigen (Materialien,Querschnitte, Stäbe, Lastfälle und Kombinationen) ■ Temperatur-/Verformungslasten ohne Steifigkeitsänderungen anwenden
Genauigkeit und Toleranz	■ Standardeinstellung ändern
Nichtlineare Effekte - Aktivieren	■ Lager und elastische Bettungen ■ Ausfallende Stäbe infolge des Stabtyps ■ Stabendgelenke ■ Elastische Stabbettungen ■ Stabnichtlinearitäten
Reaktivierung der ausgefallenen Stäbe	■ Verformung der ausfallenden Stäbe überprüfen und ggf. diese reaktivieren Maximale Anzahl der Reaktivierungen : 3

4.3 QUERSCHNITTE - SCHNITTGRÖSSEN

Stab Nr.	LF/LK	Knoten Nr.	Stelle x [mm]	Kräfte [kN] N	Kräfte [kN] V_z	Momente M_y [kNm]
	Querschnitt-Nr. 1: DUENQ DOKA_WS10_(2U100_S235)					
8	LK6	MAX N	0.0	▹ 6.28	0.00	0.00
10	LK3	MIN N	240.0	▹ -6.29	4.91	7.38
3	LK5	MAX V_z	0.0	0.07	▹ 19.67	-2.01
11	LK1	MIN V_z	293.1	-6.09	▹ -38.93	-3.48
3	LK1	MAX M_y	466.9	-6.26	17.74	▹ 8.29
4	LF2	MIN M_y	0.0	-1.22	2.30	▹ -3.79
	Querschnitt-Nr. 2: Rundstahl 15					
7	LK5	MAX N	0.0	▹ 7.77	0.00	0.00
6	LF1	MIN N	3534.9	▹ -0.01	0.00	0.00
6	LF1	MAX V_z	0.0	0.01	▹ 0.00	0.00
6	LF1	MIN V_z	0.0	0.01	▹ 0.00	0.00
6	LF1	MAX M_y	0.0	0.01	0.00	▹ 0.00
6	LF1	MIN M_y	0.0	0.01	0.00	▹ 0.00

4.3 QUERSCHNITTE - SCHNITTGRÖSSEN

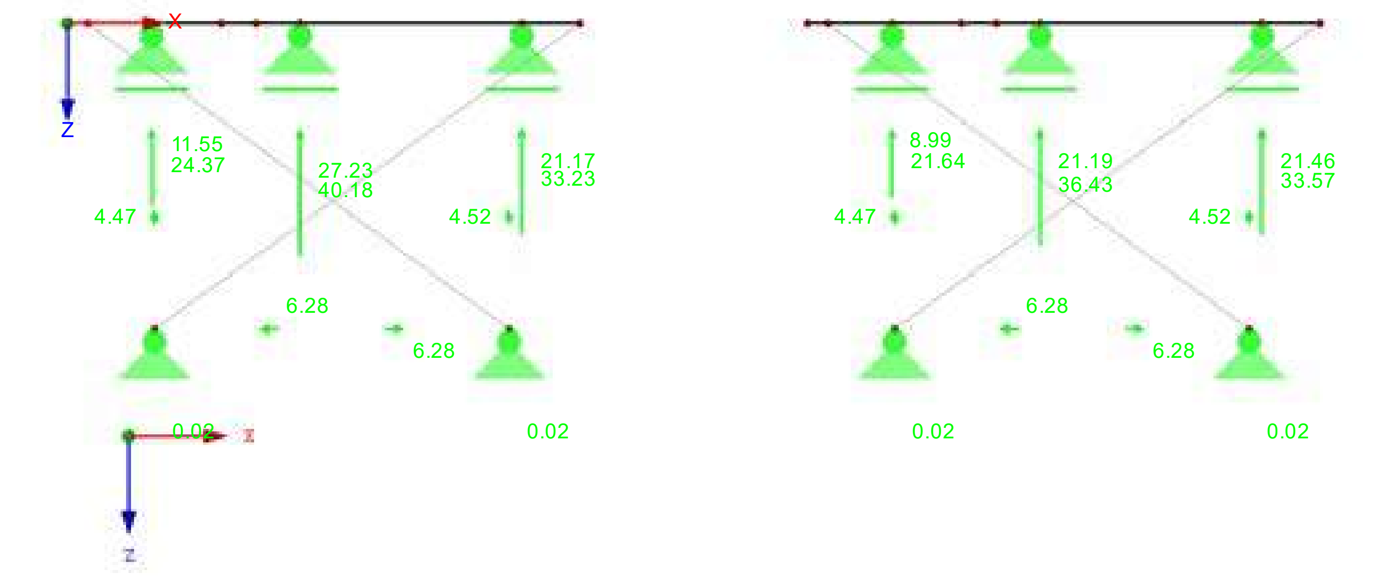
Ergebniskombinationen

Stab Nr.	EK	Knoten Nr.	Stelle x [mm]		Kräfte [kN] N	Kräfte [kN] V_z	Momente M_y [kNm]	Zugehörige Lastfälle
	Querschnitt-Nr. 1: DUENQ DOKA_WS10_(2U100_S235)							
8	EK1		0.0	MAX N	▹ 6.28	0.00	0.00	LK 6
10	EK1		240.0	MIN N	▹ -6.29	4.91	7.38	LK 3
3	EK1		0.0	MAX V_z	0.07	▹ 19.67	-2.01	LK 5
11	EK1		293.1	MIN V_z	-6.09	▹ -38.93	-3.48	LK 1
3	EK1		466.9	MAX M_y	-6.26	17.74	▹ 8.29	LK 1
4	EK1		0.0	MIN M_y	-0.01	2.56	▹ -3.63	LK 5
	Querschnitt-Nr. 2: Rundstahl 15							
7	EK1		0.0	MAX N	▹ 7.77	0.00	0.00	LK 5
7	EK1		0.0	MIN N	▹ 0.00	0.00	0.00	LK 1
6	EK1		0.0	MAX V_z	7.74	▹ 0.00	0.00	LK 1
6	EK1		0.0	MIN V_z	7.74	▹ 0.00	0.00	LK 1
6	EK1		0.0	MAX M_y	7.74	0.00	▹ 0.00	LK 1
6	EK1		0.0	MIN M_y	7.74	0.00	▹ 0.00	LK 1

LAGERREAKTIONEN

EK1 : Min/Max
Lagerreaktionen[kN]
Ergebniskombinationen: Max- und Min-Werte

Entgegen der Y-Richtung



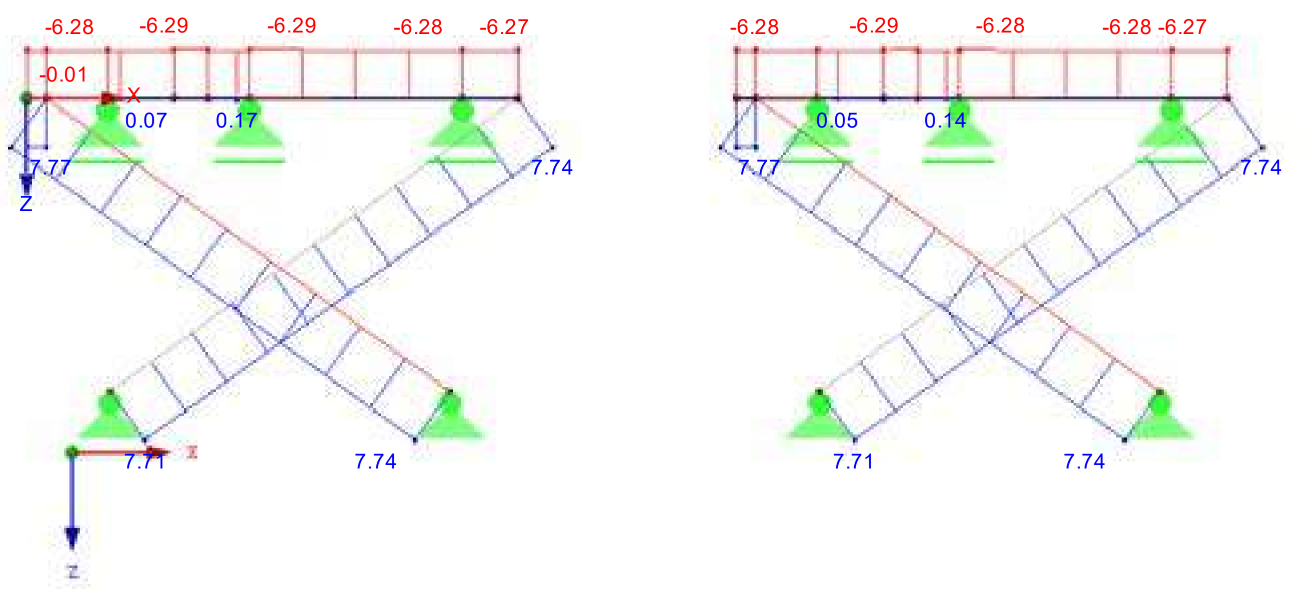
Max P-X': 6.28, Min P-X': -6.28 kN
Max P-Z': 40.18, Min P-Z': -4.52 kN

1022.3 mm

SCHNITTGRÖSSEN N

EK1 : Min/Max
Schnittgrößen N
Ergebniskombinationen: Max- und Min-Werte

Entgegen der Y-Richtung



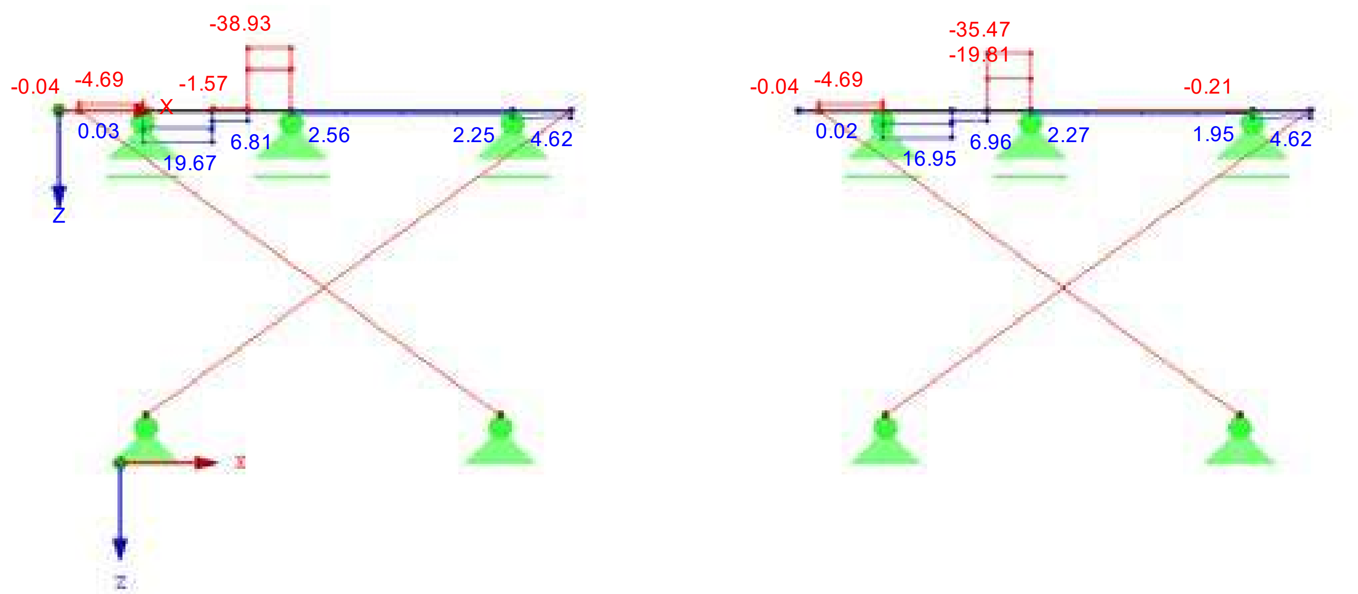
1065.4 mm

Max N: 7.77, Min N: -6.29 [kN]

SCHNITTGRÖSSEN V_z

EK1 : Min/Max
Schnittgrößen V-z
Ergebniskombinationen: Max- und Min-Werte

Entgegen der Y-Richtung



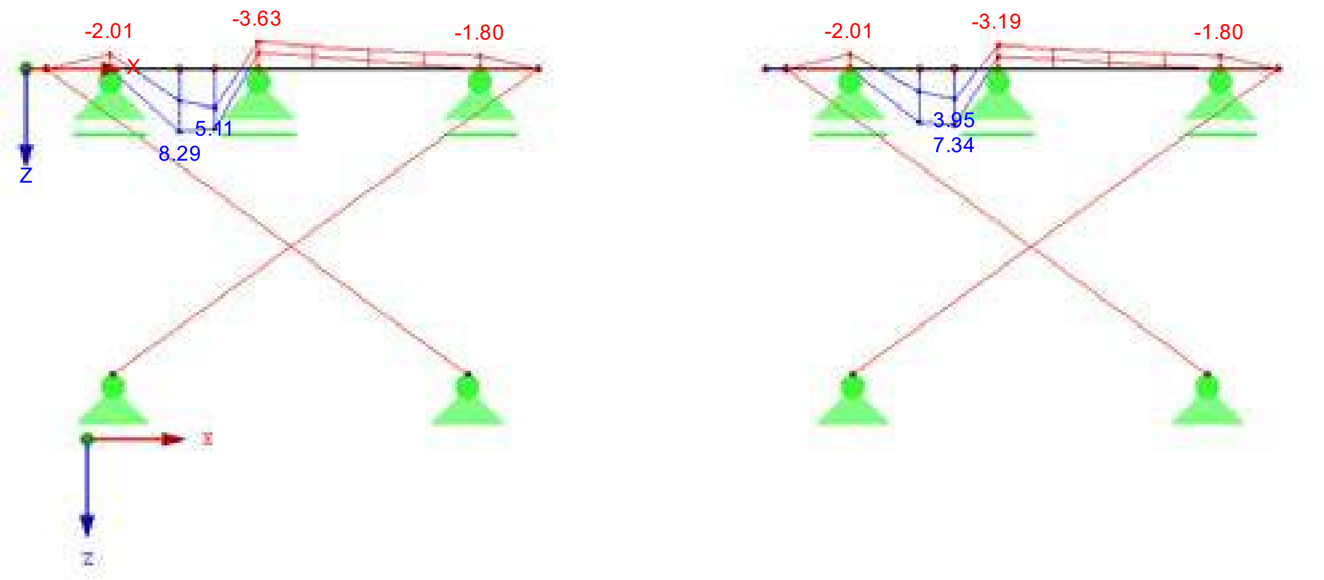
1022.3 mm

Max V-z: 19.67, Min V-z: -38.93 [kN]

SCHNITTGRÖSSEN M_y

EK1 : Min/Max
Schnittgrößen M-y
Ergebniskombinationen: Max- und Min-Werte

Entgegen der Y-Richtung



1022.3 mm

Max M-y: 8.29, Min M-y: -3.63 [kNm]

Anhang 2

Deutsche Doka Schalungstechnik GmbH

Frauenstraße 35 - 82216 Maisach

Seite: 18/18
Blatt: 1

STAHL

Projekt: | Modell: 224-016371-1001S-504 | Datum: 07.03.2022

STAHL
FA1
Allgemeine Spannungsanalyse von Stäben

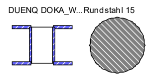
1.1.1 BASISANGABEN

Zu bemessende Stäbe:		Alle
Zu bemessende Lastkombinationen:	LK1	LF1 + LF2 + LF6
	LK2	LF1 + LF3 + LF6
	LK3	LF1 + LF4 + LF6
	LK4	LF1 + LF5 + LF6
	LK5	LF1 + LF2 - LF6
	LK6	LF1 + LF3 - LF6
	LK7	LF1 + LF4 - LF6
	LK8	LF1 + LF5 - LF6

1.2 MATERIALIEN

Matl.	Material-	Teilsich.-Faktor	Streckgrenze	Grenzspannungen [kN/cm²]			
Nr.	Bezeichnung	γ_M [-]	f_{yk} [kN/cm²]	Manuell	grenz σ_x	grenz τ	grenz σ_v
1	S235 - EN12812	1.10	23.50	■	21.36	12.33	21.36
2	ST900/1100 - DIN 18216	1.10	84.00	■	76.36	44.09	76.36

1.3.1 QUERSCHNITTE



Quer. Nr.	Matl. Nr.	Querschnitt Bezeichnung	I_t [cm⁴] / A [cm²]	I_y [cm⁴] / $\alpha_{pl,y}$	I_z [cm⁴] / $\alpha_{pl,z}$	Kommentar
1	1	DUENQ DOKA_WS10_(2U100_S235)	83.45	410.60	532.93	
			26.90	1.00	1.00	
2	2	Rundstahl 15	0.50	0.25	0.25	
			1.77	1.70	1.70	

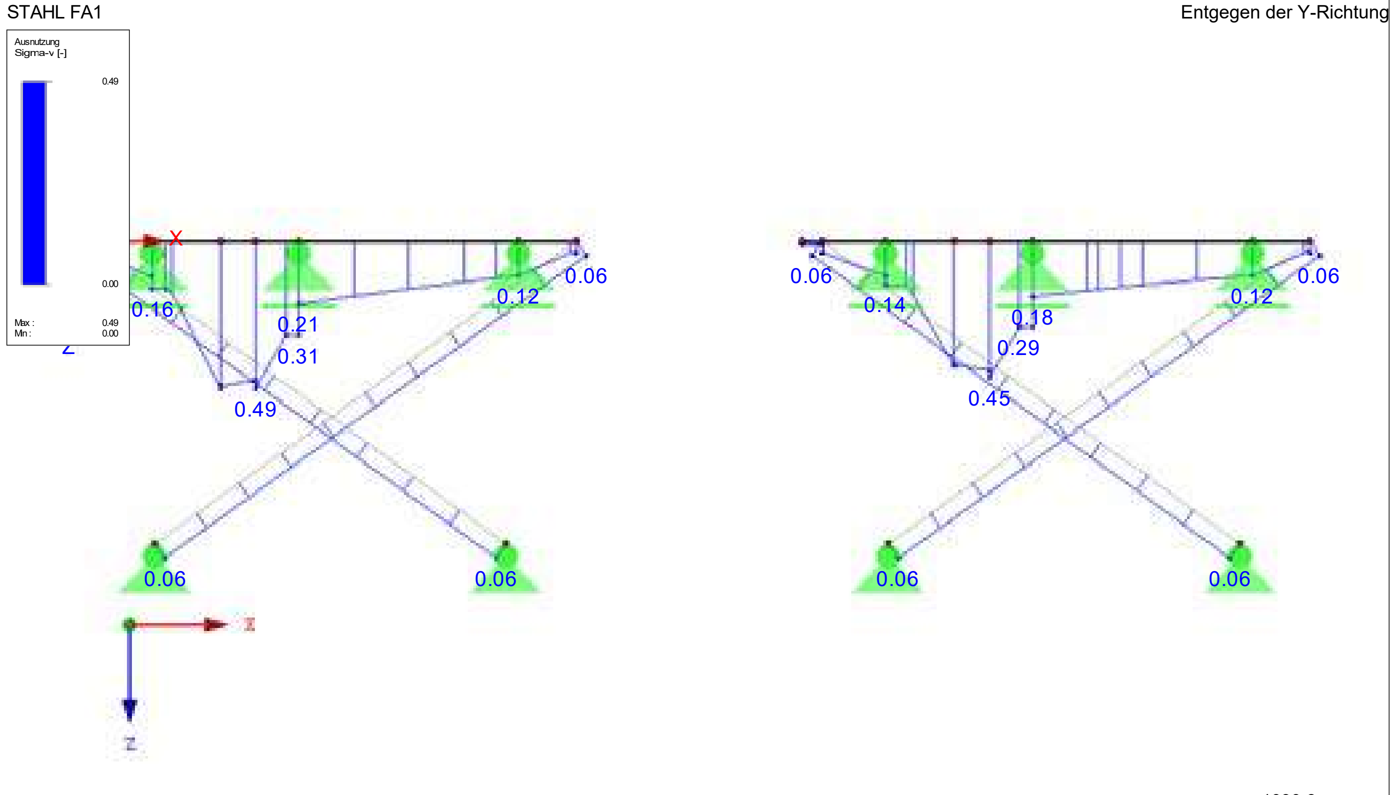
2.1 SPANNUNGEN QUERSCHNITTSWEISE

Quer. Nr.	Stab Nr.	Stelle x [mm]	S-Punkt Nr.	Last-fall	Spannungsart	Spannung [kN/cm²] Vorhanden	Limit	Aus-nutzung
1	**DUENQ DOKA_WS10_(2U100_S235)**							
	10	0.0	1	LK1	Sigma gesamt	-10.32	21.36	0.48
	11	293.1	15	LK1	Tau gesamt	3.87	12.33	0.31
	11	0.0	5	LK1	Sigma-v	10.45	21.36	0.49
2	**Rundstahl 15**							
	7	0.0	1	LK5	Sigma gesamt	4.40	76.36	0.06
	6	0.0	1	LK1	Tau gesamt	0.00	44.09	0.00
	7	0.0	1	LK5	Sigma-v	4.40	76.36	0.06

AUSNUTZUNG Sigma-v

STAHL FA1

Entgegen der Y-Richtung



Max Sigma-v: 0.49, Min Sigma-v: 0.00

Anhang 3

Deutsche DOKA Schalungstechnik GmbH
Frauenstraße 35
D - 82216 Maisach

Projekt: 224-016371 RoofKit

Gesamt H-Last $A_H := 30.56\ kN$

Anzahl Ecken $n := 4$

Belastung je Ecke $A_{Ecke} := \frac{A_H}{n} = 7.64\ kN$

Belastung Abspannung $H_k := \frac{A_{Ecke}}{2} = 3.82\ kN$

$V_k := 27.17\ kN$

erforderlicher Reibbeiwert $\mu := 0.31$

Lokales Gleiten nach EN 12812 9.2.2.3.4

$F_d := 1.5 \cdot H_k = 5.73\ kN$ $\gamma_\mu := 1.3$

$R_{f.d} := \frac{\mu}{\gamma_\mu} \cdot 0.9 \cdot V_k = 5.83\ kN$

$Nachweis\left(\frac{F_d}{R_{f.d}} \le 1\right) = \text{“Nachweis erfüllt”}$ $\frac{F_d}{R_{f.d}} = 0.98$

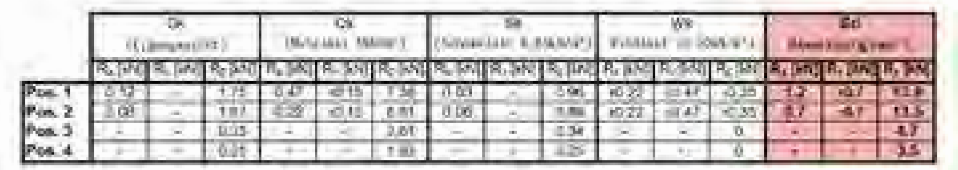
Projekt: 224-016371 RoofKit

Gesamt H-Last: $A_H := 39.18\ kN = 39.18\ kN$ aus Kapitel 6.2

Anzahl Ecken: $n := 4$

Belastung je Ecke: $A_{Ecke} := \frac{A_H}{n} = 9.8\ kN$

Last aus Treppe:
Um vom angegeben Bemessungswert auf den charakteristischen Wert zu kommen wird durch ein γ_f=1.4 (gemittelter Wert) geteilt



	Gk [illegible]			Qk [illegible]			Sk [illegible]			Wk [illegible]			Ed [illegible]		
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pos. 1	[illegible]	-	1.75	0.47	±0.15	[illegible]	[illegible]	-	[illegible]	±0.22	±0.47	[illegible]	1.2	±0.7	13.9
Pos. 2	[illegible]	-	1.87	[illegible]	±0.15	[illegible]	0.06	-	[illegible]	±0.22	±0.47	[illegible]	[illegible]	[illegible]	13.5
Pos. 3	-	-	[illegible]	-	-	[illegible]	-	-	[illegible]	-	-	0	-	-	4.7
Pos. 4	-	-	[illegible]	-	-	[illegible]	-	-	[illegible]	-	-	0	-	-	3.5

$$H_{Treppe} := \frac{(1.2\ kN + 0.7\ kN)}{1.4} = 1.36\ kN$$

$$H_{2V100Treppe} := \frac{2}{100} \cdot \frac{(13.9\ kN + 13.5\ kN + 4.7\ kN + 3.5\ kN)}{1.4} = 0.51\ kN$$

$$A_{Treppe} := (H_{Treppe} + H_{2V100Treppe}) = 1.87\ kN$$

Last aus Aufzug: $A_{Aufzug} := 0.9\ kN$

Geamtlast je Ecke: $A := A_{Ecke} + A_{Treppe} + A_{Aufzug} = 12.56\ kN$

Belastung Abspannung: $H_k := \frac{A}{2} = 6.28\ kN$

$V_k := 46.60\ kN$

erforderlicher Reibbeiwert: $\mu := 0.31$

Lokales Gleiten nach EN 12812 9.2.2.3.4

$F_d := 1.5 \cdot H_k = 9.42\ kN$ $\gamma_\mu := 1.3$

$$R_{f.d} := \frac{\mu}{\gamma_\mu} \cdot 0.9 \cdot V_k = 10\ kN$$

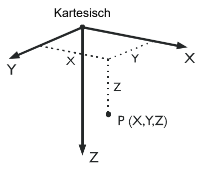
$$Nachweis\left(\frac{F_d}{R_{f.d}} \le 1\right) = \text{“Nachweis erfüllt”} \qquad \frac{F_d}{R_{f.d}} = 0.94$$

Projekt: Modell: 224-016371-1001S-503
Stützenschuh, Justierstützenfuß, Strebenschuh
Datum: 07.03.2022

■ MODELL-BASISANGABEN

Allgemein	Modellname	:	224-016371-1001S-503
	Modelbezeichnung	:	Stützenschuh, Justierstützenfuß, Strebenschuh
	Modelltyp	:	2D-XZ (ux/uz/φy)
	Positive Richtung der globalen Z-Achse	:	Nach unten
	Klassifizierung der Lastfälle und Kombinationen	:	Nach Norm: Ohne Nationaler Anhang: Kein
Optionen	■ CQC-Regel anwenden		
	■ CAD/BIM-Modell ermöglichen		
	Erdbeschleunigung		
	g	:	10.00 m/s²

■ 1.1 KNOTEN



Knoten Nr.	Bezugs-Knoten	Koordinaten-System	Knotenkoordinaten X [mm]	Z [mm]	Kommentar
78	-	Kartesisch	0.0	0.0	
84	-	Kartesisch	147.0	-70.0	
85	-	Kartesisch	254.0	-70.0	
88	-	Kartesisch	40.0	0.0	
89	-	Kartesisch	294.0	0.0	
90	-	Kartesisch	40.0	-70.0	
91	-	Kartesisch	147.0	0.0	
92	-	Kartesisch	254.0	0.0	
95	-	Kartesisch	202.0	0.0	
98	-	Kartesisch	284.0	0.0	
99	-	Kartesisch	92.0	0.0	
100	-	Kartesisch	10.0	0.0	

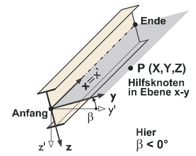
■ 1.2 MATERIALIEN

Mat. Nr.	Modul E [kN/cm²]	Modul G [kN/cm²]	Spez. Gewicht γ [kN/m³]	Wärmedehnz. α [1/K]	Teilsich.-Beiwert γ_M [-]	Material-Modell
1	Baustahl S 235 | EN 10025-2:2004-11 21000.00	8100.00	78.50	1.20E-05	1.00	Isotrop linear elastisch

■ 1.3 QUERSCHNITTE

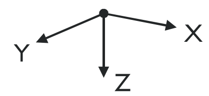
Quers. Nr.	Mater. Nr.	I_T [cm⁴] / A [cm²]	I_y [cm⁴] / A_y [cm²]	I_z [cm⁴] / A_z [cm²]	Hauptachsen α [°]	Drehung α' [°]	Gesamtabmessungen [mm] Breite b	Höhe h
1	Flachstahl 100/10 1	10.00	0.83	8.33	0.00	0.00	100.0	10.0

■ 1.7 STÄBE



Stab Nr.	Stabtyp	Knoten Anfang	Ende	Drehung Typ	β [°]	Querschnitt Anfang	Ende	Gelenk Nr. Anfang	Ende	Exz. Nr.	Teilung Nr.	Länge L [mm]	
83	Balkenstab	91	84	Winkel	0.00	1	1	-	-	-	-	70.0	Z
84	Balkenstab	92	85	Winkel	0.00	1	1	-	-	-	-	70.0	Z
86	Balkenstab	88	90	Winkel	0.00	1	1	-	-	-	-	70.0	Z
97	Balkenstab	78	100	Winkel	0.00	1	1	-	-	-	-	10.0	X
98	Balkenstab	88	99	Winkel	0.00	1	1	-	-	-	-	52.0	X
99	Balkenstab	91	95	Winkel	0.00	1	1	-	-	-	-	55.0	X
100	Fachwerkstab	90	84	Winkel	0.00	1	1	-	-	-	-	107.0	X
101	Fachwerkstab	90	91	Winkel	0.00	1	1	-	-	-	-	127.9	XZ
102	Fachwerkstab	78	90	Winkel	0.00	1	1	-	-	-	-	80.6	XZ
103	Fachwerkstab	85	89	Winkel	0.00	1	1	-	-	-	-	80.6	XZ
104	Balkenstab	92	98	Winkel	0.00	1	1	-	-	-	-	30.0	X
112	Fachwerkstab	84	92	Winkel	0.00	1	1	-	-	-	-	127.9	XZ
113	Fachwerkstab	84	85	Winkel	0.00	1	1	-	-	-	-	107.0	X
114	Balkenstab	95	92	Winkel	0.00	1	1	-	-	-	-	52.0	X
115	Balkenstab	98	89	Winkel	0.00	1	1	-	-	-	-	10.0	X
116	Balkenstab	99	91	Winkel	0.00	1	1	-	-	-	-	55.0	X
117	Balkenstab	100	88	Winkel	0.00	1	1	-	-	-	-	30.0	X

■ 1.8 KNOTENLAGER



Lager Nr.	Knoten Nr.	Lagerdrehung [um Y	Lagerung bzw. Feder [kN/m] [kNm/rad] $u_{X'}$	$u_{Z'}$	$\varphi_{Y'}$	Kommentar
2	78,89	0.00	■	Ausfall	■	
8	99	0.00	■	Ausfall	■	

1.8.3 KNOTENLAGER - AUSFÄLLE

Lager Nr.	Knoten Nr.	Ausfall des Lagers bei $P_{X'}$	$P_{Z'}$	$M_{Y'}$	Kommentar
2	78,89	-		Ausfall falls -P	
8	99	-		Ausfall falls +P	

2.1 LASTFÄLLE

Last-fall	LF-Bezeichnung	Keine Norm Einwirkungskategorie	Aktiv	Eigengewicht - Faktor in Richtung X	Y	Z
LF1	äußere Last	Nutzlasten	■			

2.1.1 LASTFÄLLE - BERECHNUNGSPARAMETER

Last-fall	LF-Bezeichnung	Berechnungsparameter	
LF1	äußere Last	Berechnungstheorie	: ■ Theorie I. Ordnung (linear)

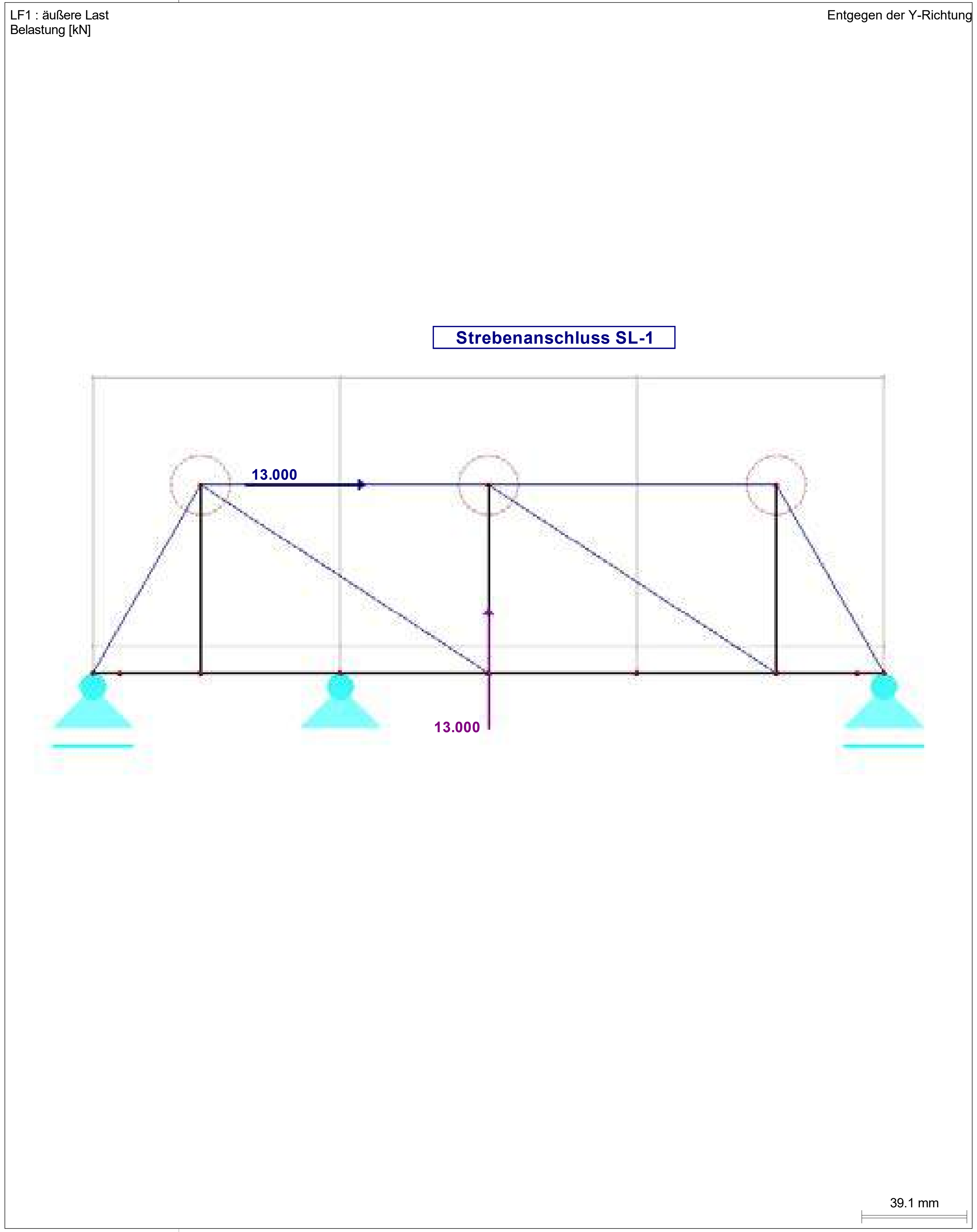
3.1 KNOTENLASTEN - KOMPONENTENWEISE - KOORDINATENSYSTEM

LF1: äußere Last

LF1
äußere Last

Nr.	An Knoten Nr.	Koordinaten-system	Kraft [kN] P_X / P_U	P_Z / P_W	Moment M_Y / M_V [kNm]
11	84	0 | Globales XYZ	13.000	-13.000	0.000

LF1: ÄUSSERE LAST



■ 4.0 ERGEBNISSE - ZUSAMMENFASSUNG

Bezeichnung	Wert	Einheit	Kommentar
LF1 - äußere Last			
Summe Belastung in Richtung X	13.00	kN	
Summe Lagerkräfte in X	13.00	kN	Abweichung 0.00%
Summe Belastung in Richtung Z	-13.00	kN	
Summe Lagerkräfte in Z	-13.00	kN	Abweichung 0.00%
Resultierende der Reaktionen um X	0.00	kNm	Im Schwerpunkt des Modells (X:147.00, Y:0.00, Z:-32.53 mm)
Resultierende der Reaktionen um Y	-0.49	kNm	Im Schwerpunkt des Modells
Resultierende der Reaktionen um Z	0.00	kNm	Im Schwerpunkt des Modells
Max. Verschiebung in X	0.0	mm	Stab Nr. 83, x: 70.0 mm
Max. Verschiebung in Z	-0.1	mm	Stab Nr. 97, x: 0.0 mm
Max. Verschiebung vektoriell	0.1	mm	Stab Nr. 97, x: 0.0 mm
Max. Verdrehung um Y	-2.3	mrad	Stab Nr. 98, x: 20.8 mm
Berechnungstheorie	I. Ordnung		Theorie I. Ordnung (linear)
Steifigkeitsreduktion multipliziert mit Faktor	■		
Anzahl der Laststufen	1		
Anzahl der Iterationen	3		
Gesamt			
Anzahl 1D-Finite-Elemente (Stabelemente)	17		
Anzahl der FE-Knoten	12		
Anzahl der Gleichungen	36		
Maximale Anzahl Iterationen	100		
Stabteilungen für Ergebnisse der Stäbe	10		
Stabteilungen der Seil-, Bettungs- und Voutenstäbe	10		
Stab-Schubsteifigkeiten (A-y, A-z) berücksichtigen	■		
Lagernichtlinearitäten berücksichtigen	■		

Sonstige Einstellungen	Maximale Anzahl Iterationen	:	100
	Anzahl der Stabteilungen für Ergebnisverläufe	:	10
	Stabteilungen Seilstäbe, Bettungs- und Voutenstäbe	:	10
	Anzahl der Stabteilungen für das Suchen der Maximalwerte	:	20
Optionen	■Schubsteifigkeit (Ay, Az) der Stäbe aktivieren		
	■Steifigkeitsänderungen berücksichtigen (Materialien,Querschnitte, Stäbe, Lastfälle und Kombinationen)		
	■Temperatur-/Verformungslasten ohne Steifigkeitsänderungen anwenden		
Genauigkeit und Toleranz	■Standardeinstellung ändern		
Nichtlineare Effekte - Aktivieren	■Lager und elastische Bettungen		
	■Ausfallende Stäbe infolge des Stabtyps		
	■Stabendgelenke		
	■Elastische Stabbettungen		
	■Stabnichtlinearitäten		

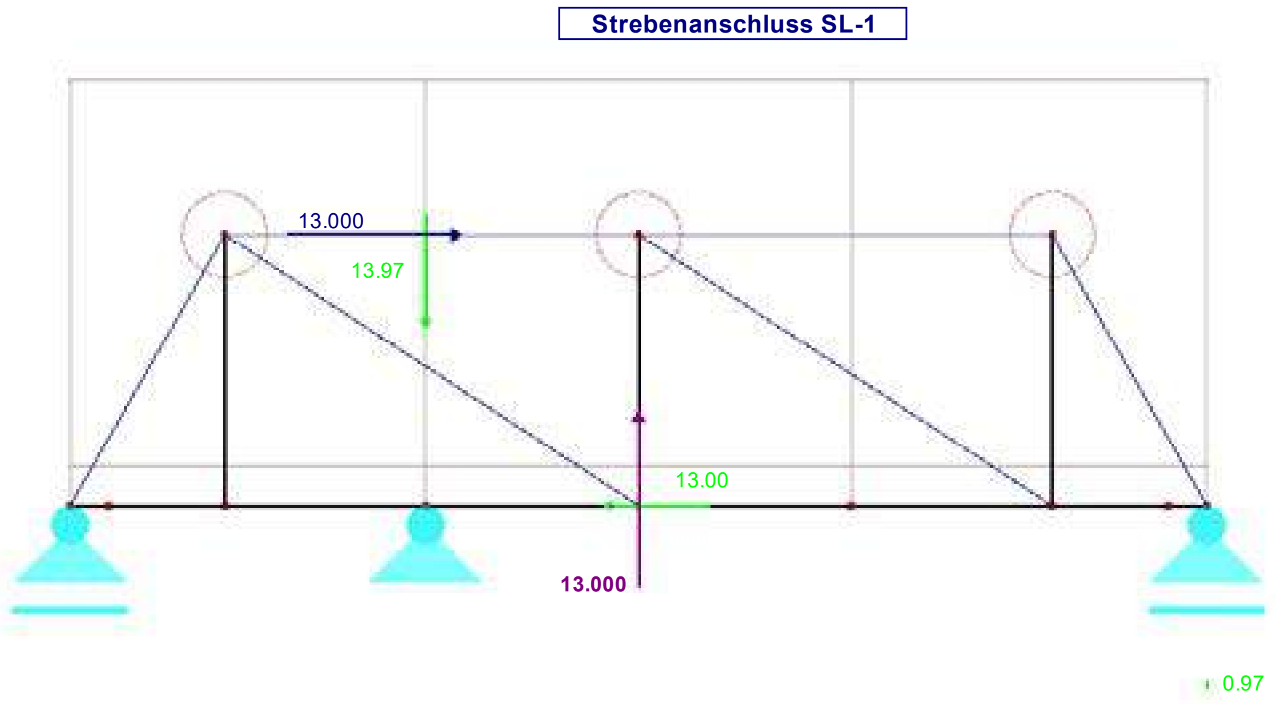
■ 4.3 QUERSCHNITTE - SCHNITTGRÖSSEN

Stab Nr.	LF/LK	Knoten Nr.	Stelle x [mm]	Kräfte [kN] N	Kräfte [kN] V_z	Momente M_y [kNm]
	Querschnitt-Nr. 1: Flachstahl 100/10					
116	LF1	MAX N	0.0	▷ 15.20	-6.78	0.22
101	LF1	MIN N	0.0	▷ -13.13	0.00	0.00
98	LF1	MAX V_z	0.0	2.20	▷ 7.19	-0.15
116	LF1	MIN V_z	0.0	15.20	▷ -6.78	0.22
98	LF1	MAX M_y	52.0	2.20	7.19	▷ 0.22
98	LF1	MIN M_y	0.0	2.20	7.19	▷ -0.15

■ LAGERREAKTIONEN

LF1 : äußere Last
Belastung [kN]
Lagerreaktionen[kN]

Entgegen der Y-Richtung



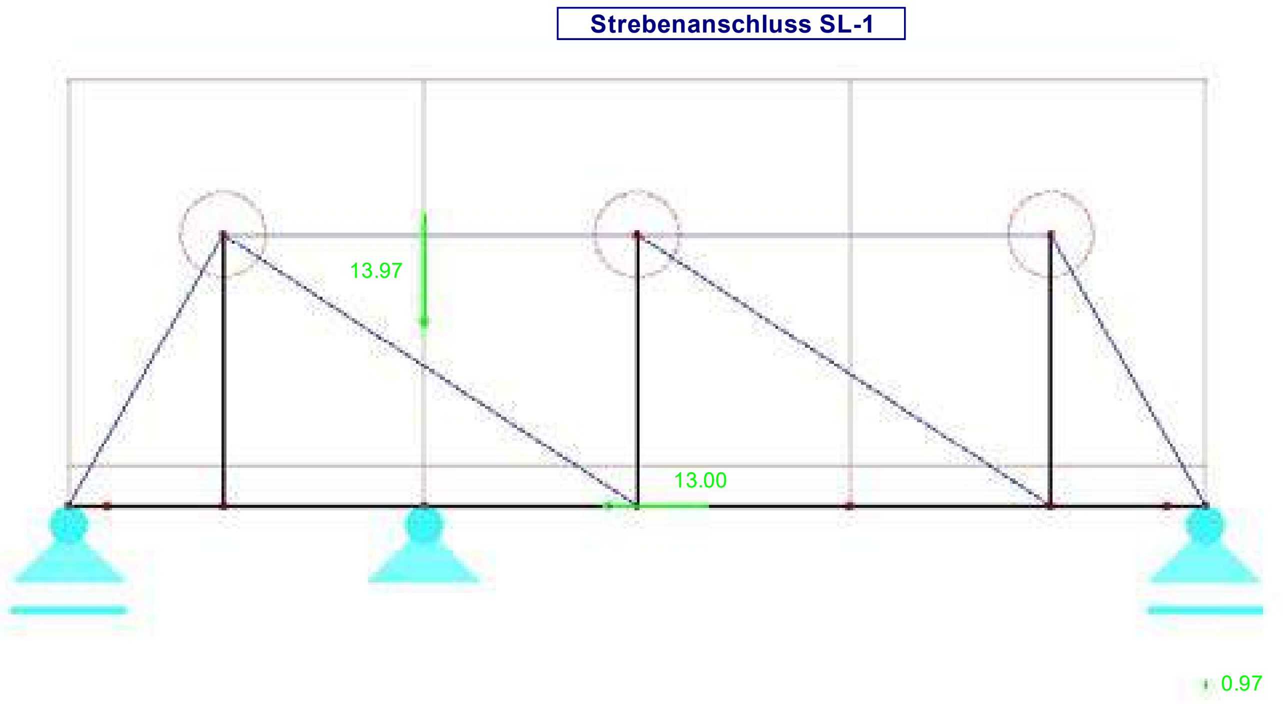
Max P-X': 13.00, Min P-X': 0.00 kN
Max P-Z': 0.97, Min P-Z': -13.97 kN

39.1 mm

■ LAGERREAKTIONEN

LF1 : äußere Last
Lagerreaktionen[kN]

Entgegen der Y-Richtung



Max P-X': 13.00, Min P-X': 0.00 kN
Max P-Z': 0.97, Min P-Z': -13.97 kN

39.1 mm

dos
design of structures
Englerstraße 7, D-76131
Karlsruhe

11.03.2022

ROOFKIT – TREPPE UND ABSTURZSICHERUNG

GENEHMIGUNGSPLANUNG

Version 00

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INHALTSVERZEICHNIS

1 ALLGEMEIN

Für die Ausstellung solar decathlon europe 21/22 in Wuppertal wird ein temporäres Bauwerk errichtet. Das Bauwerk steht auf ca. 3m hohe Stahltürme. Da das Bauwerk ein temporäres Bauwerk ist, dürfen keine Verankerungen in den Boden vorgenommen werden. Die Gründung muss daher oberirdisch ausgeführt werden.
Dieser Bericht stellt die statische Nachweise der Treppe, der Geländer, den Absturzsicherungen und der Gründung vor. Die Berechnungen sind mit dem FE-Programm Karamba3D 2.2.0 durchgeführt.

1.1 NORMEN UND REGELUNGEN

Der Bericht ist laut folgende Normen und Regelungen ausgeführt.

- DIN EN 1990-Eurocode 0-Grundlagen der Tragwerksplanung
- DIN EN 1991-Eurocode 1-Einwirkungen auf Tragwerke
- DIN EN 1993-Eurocode 3-Bemessung und Konstruktion von Stahlbauten

1.2 ANGABEN UND GRUNDLAGEN

Der Bericht wurde mit den Folgenden Dokumenten als Grundlage durchgeführt.

Das Bodengutachten ist von der Bergische Universität in Wuppertal an dem 07.06.2021 erstellt.

- *SDE21_Solar-Campus-Specifications_V1.0_07_06_21*

Pläne und Bericht von Deutsche Doka Schalungstechnik GmbH mit dem Planstand 07.03.2022

- *224-016371-1001.pdf*
- *224-016371-1001S-001.pdf*

1.3 LASTFÄLLE UND LASTKOMBINATIONEN

LF1	Eigengewicht
LF21	Nutzlast Stufen
LF22	Nutzlast Gelände lokale Y-Richtung
LF23	Nutzlast Gelände globale Y-Richtung
LF31	Windlast +/- Y
LF41	Schneelast

LK101	1,0*LF1 + 1,0*LF21 + 0,6*LF31 + 0,5*LF41
LK102	1,0*LF1 + 1,0*LF21 + 1,0*LF22 + 0,6*LF31 + 0,5*LF41
LK103	1,0*LF1 + 1,0*LF21 + 1,0*LF23 + 0,6*LF31 + 0,5*LF41
LK1001	1,35*LF1 + 1,5*LF21 + 1,5*0,6*LF31 + 1,5*0,5*LF41
LK1002	1,35*LF1 + 1,5*LF21 + 1,5*LF22 + 1,5*0,6*LF31 + 1,5*0,5*LF41
LK1003	1,35*LF1 + 1,5*LF21 + 1,5*LF23 + 1,5*0,6*LF31 + 1,5*0,5*LF41

1.4 MATERIALIEN

STAHL S235

Elastizitätsmodul	E = 210 000	N/mm^2
Dichte	ρ = 7850	kg/m^3
Temperaturausdehnungskoeffizient	α_T = 0,000012	K^{-1}
Charakteristische Fließgrenze Festigkeit	f_y = 235	N/mm^2
Charakteristische Festigkeit	f_y = 360	N/mm^2

2 LASTANNAHMEN

2.1 EIGENLASTEN

Die Eigenlast ist in der Software mit den angegebenen Materialdichten automatisch generiert.

2.2 NUTZLASTEN

DIN EN 1991-1-1/NA:2010-12

Tabelle 6.1DE (fortgesetzt)

Spalte	1		2	3	4	5
Zeile	Kategorie		Nutzung	Beispiele	q_k kN/m²	Q_k[e] kN
13	D	D1	Verkaufsräume	Flächen von Verkaufsräumen bis 50 m² Grundfläche in Wohn-, Büro- und vergleichbaren Gebäuden	2,0	2,0
14		D2		Flächen in Einzelhandelsgeschäften und Warenhäusern	5,0	4,0
15		D3		Flächen wie D2, jedoch mit erhöhten Einzellasten infolge hoher Lagerregale	5,0	7,0
16	E	E1.1	Lager, Fabriken und Werkstätten, Ställe, Lagerräume und Zugänge	Flächen in Fabriken[a] und Werkstätten[a] mit leichtem Betrieb und Flächen in Großviehställen	5,0	4,0
17		E1.2		Allgemeine Lagerflächen, einschließlich Bibliotheken	6,0[b]	7,0
18		E2.1		Flächen in Fabriken[a] und Werkstätten[a] mit mittlerem oder schwerem Betrieb	7,5[b]	10,0
19	T[c]	T1	Treppen und Treppenpodeste	Treppen und Treppenpodeste in Wohngebäuden, Bürogebäuden und von Arztpraxen ohne schweres Gerät	3,0	2,0
20		T2		Alle Treppen und Treppenpodeste, die nicht in T1 oder T3 eingeordnet werden können	5,0	2,0
21		T3		Zugänge und Treppen von Tribünen ohne feste Sitzplätze, die als Fluchtwege dienen	7,5	3,0
22	Z[d]		Zugänge, Balkone und ähnliches	Dachterrassen, Laubengänge, Loggien usw., Balkone, Ausstiegspodeste	4,0	2,0

[a] Nutzlasten in Fabriken und Werkstätten gelten als vorwiegend ruhend. Im Einzelfall sind sich häufig wiederholende Lasten je nach Gegebenheit als nicht vorwiegend ruhende Lasten einzuordnen.

[b] Bei diesen Werten handelt es sich um Mindestwerte. In Fällen, in denen höhere Lasten vorherrschen, sind die höheren Lasten anzusetzen.

[c] Für die Weiterleitung der Lasten in Räumen mit Decken ohne ausreichende Querverteilung auf stützende Bauteile darf der angegebene Wert um 0,5 kN/m² abgemindert werden.

[d] Hinsichtlich der Einwirkungskombinationen sind die Einwirkungen der Nutzungskategorie des jeweiligen Gebäudes oder Gebäudeteils zuzuordnen.

[e] Falls der Nachweis der örtlichen Mindesttragfähigkeit erforderlich ist (z. B. bei Bauteilen ohne ausreichende Querverteilung der Lasten), so ist er mit den charakteristischen Werten für die Einzellast Q_k ohne Überlagerung mit der Flächenlast q_k zu führen. Die Aufstandsfläche für Q_k umfasst ein Quadrat mit einer Seitenlänge von 50 mm.

Tabelle 6.12DE — Horizontale Lasten auf Zwischenwände und Absturzsicherungen

Spalte	1	2
Zeile	Belastete Fläche nach Kategorie	Horizontale Nutzlast q_k kN/m
1	A, B1, H, F1[b] bis F4[b], T1, Z[a]	0,5
2	B2, B3, C1 bis C4, D, E1.1[c], E1.2[c], E2.1[c] bis E2.5[c], FL1[b] bis FL6[b], HC, T2, Z[a]	1,0
3	C5, C6, T3	2,0

[a] Für Kategorie Z ist die Zuordnung in Zeile 1 bzw. Zeile 2 entsprechend der zugehörigen maßgebenden Nutzungskategorie nach Tabelle 6.1DE vorzunehmen.

[b] Anprall wird durch konstruktive Maßnahmen ausgeschlossen.

[c] Bei Flächen der Kategorie E1.1, E1.2, E2.1 bis E2.5, die nur zu Kontroll- und Wartungszwecken begangen werden, sind die Lasten in Abstimmung mit dem Bauherrn festzulegen, jedoch mindestens 0,5 kN/m.

2.3 WINDLASTEN

Windzone	$v_{b,0}$	$q_{b,0}$
WZ 1	22,5 m/s	0,32 kN/m²
WZ 2	25,0 m/s	0,39 kN/m²
WZ 3	27,5 m/s	0,47 kN/m²
WZ 4	30,0 m/s	0,56 kN/m²

Bild NA.A.1 — Windzonenkarte für das Gebiet der Bundesrepublik Deutschland

Windzone	1	
Basiswindgeschwindigkeit	$v_{b,0}$ = 22,5	m/s
Basisgeschwindigkeitsdruck	q_b = 0,32	kN/m²

2.4 SCHNEELASTEN

Schneelastzone	1	
Höhe über NN	149	m
Schneelast (charakteristisch)	s_k = 0,65	kN/m²

2.5 ERDBEBENLAST

Erdbebeneinwirkungen müssen laut dem Bodengutachten nicht berücksichtigt werden.

3 NACHWEIS – TREPPE

3.1 SYSTEM

Die Stufen und das Geländer sind mit Balkenelemente- und die Wangen mit Plattenelemente modelliert. Die Stahlgüte S235 ist in den Berechnungen für die gesamte Treppe verwendet.

Das Geländer ist mit dem Rohrprofil 48,3x5 modelliert. Der Nachweis der hier geführt ist, ist auch für andere Geländer mit denselben oder kleineren Pfostenabstand und Geländerhöhe gültig.

Der Anschluss zwischen der Treppe und dem Turm, ist in dem Berechnungsmodell mit zwei gelenkigen Auflagerpunkte an der Oberkante der Treppe modelliert. Da Verankerungen in dem Boden nicht erlaubt sind, wird die Treppe zu eine 15mm dicke Stahlplatte angeschlossen, die auf einer Neoprenmatte liegt. Zusätzlich wird Ballast auf die Platte hingelegt, um das Gleiten zu vermeiden. Diese Auflagersituation ist in dem Berechnungsmodell mit zwei Federn modelliert (siehe Abbildung 2).

Das Gesamtgewicht der Platte beträgt

$$1{,}5m \cdot 1{,}5m \cdot 0{,}015m \cdot 78{,}5kN/m^3 = 2{,}65kN$$

Der Reibungskoeffizient zwischen der Neoprenmatte und der Erde ist zu 0,7 angenommen. Um eine Federsteifigkeit von 5kN/m zu erreichen ist ein zusätzliches Gewicht von 4,5kN erforderlich.

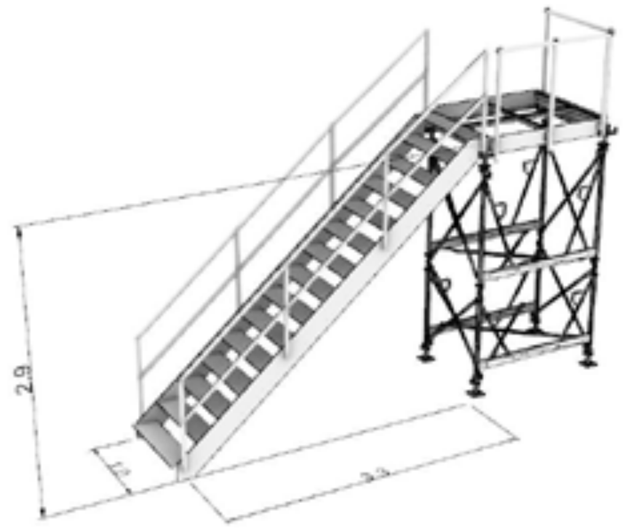


Abbildung 1 Abmessungen der Treppe [m].

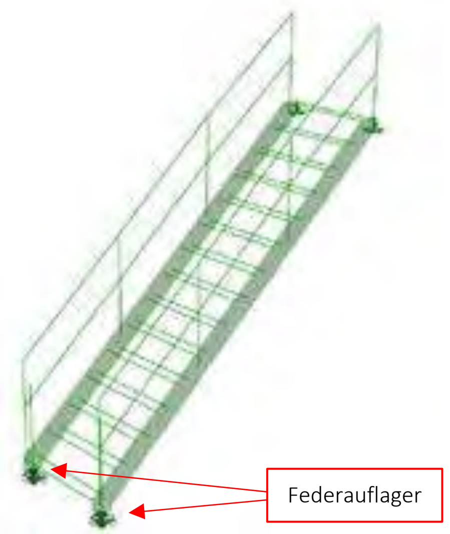


Abbildung 2 Statisches System der Treppe.

3.2 AUSNUTZUNGSGRAD

Die Treppen und das Geländer sind im Grenzzustand der Tragfähigkeit bis zu 82% der elastischen Materialgrenze ausgenutzt.

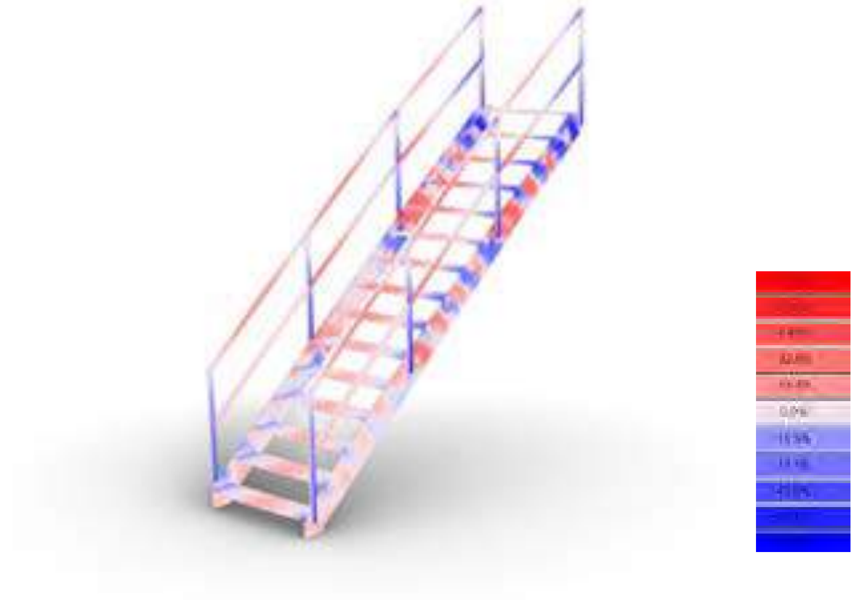


Abbildung 3 Ausnutzungsgrad der Treppe

3.3 VERFORMUNGEN

Die maximale vertikale Verformung im Grenzzustand der Gebrauchstauglichkeit beträgt 0,2cm, oder L/825.

Abbildung 4 Vertikale Verformung der Treppe [cm].

3.4 AUFLAGERKRÄFTE

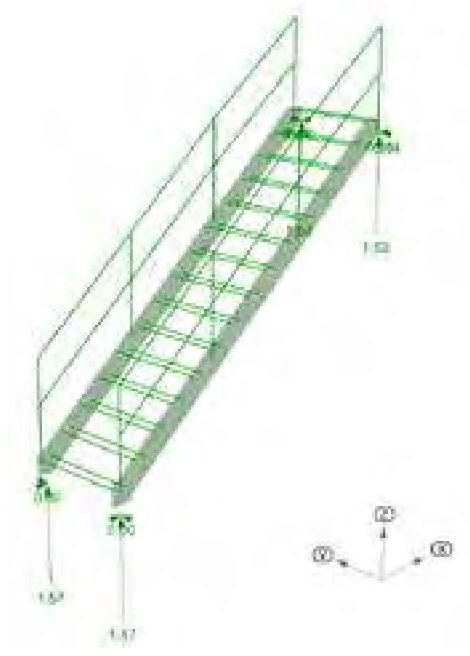


Abbildung 5 Auflagerkräfte LF1 – Eigengewicht [kN]

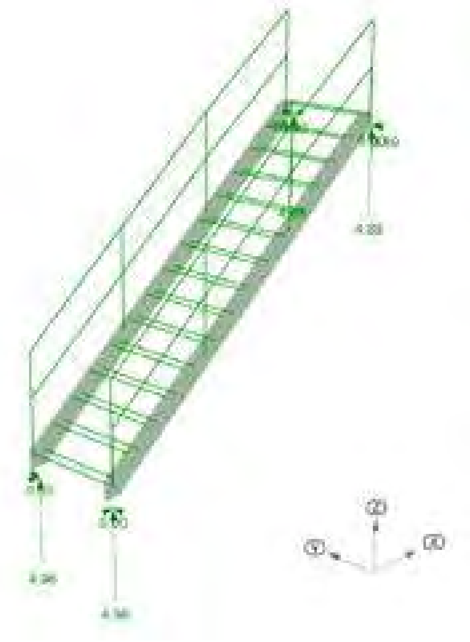


Abbildung 6 Auflagerkräfte LF21 - Nutzlast [kN]

Abbildung 7 Auflagerkräfte LF31 - Windlast +Y [kN]

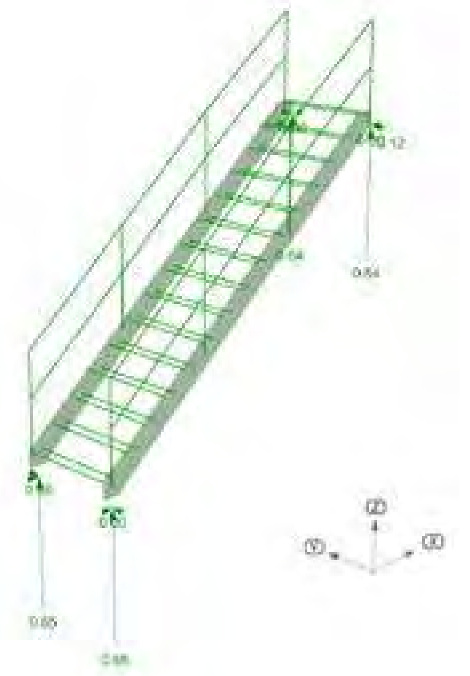


Abbildung 8 Auflagerkräfte LF41 - Schneelast [kN]

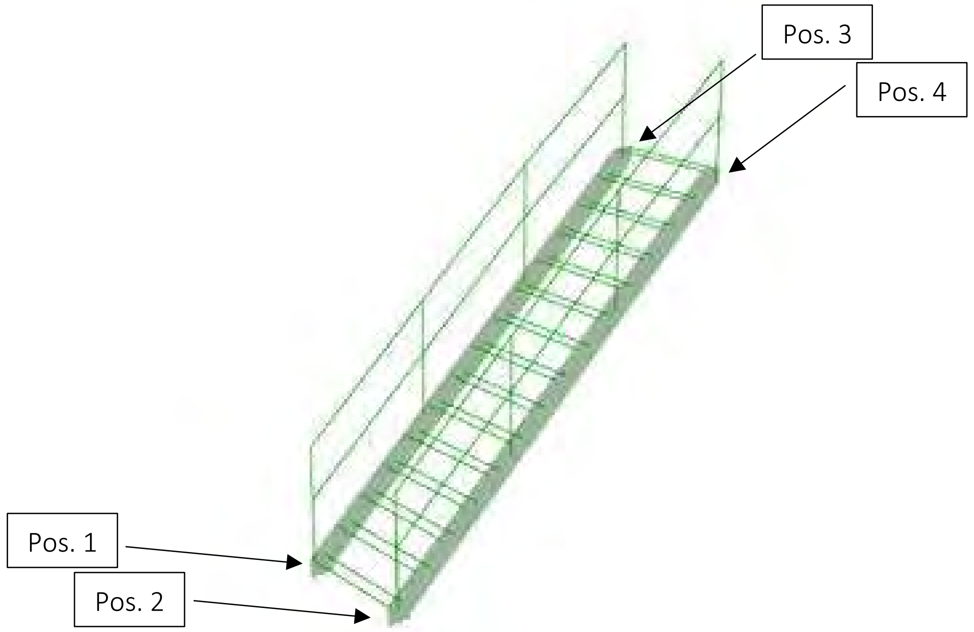


Abbildung 9 Erläuterung der Auflagerpositionen.

	LF1 - Eigengewicht			LF21 - Nutzlast			LF31 - Windlast			LF41 - Schneelast			Bemessungswert Ed		
	F_x	F_y	F_z	F_x	F_y	F_z	F_x	F_y	F_z	F_x	F_y	F_z	F_x	F_y	F_z
Pos. 1	0.00	0.00	1.57	0.00	0.00	4.96	0.00	±0.09	±0.06	0.00	0.00	0.65	0.00	0.12	10.10
Pos. 2	0.00	0.00	1.57	0.00	0.00	4.96	0.00	±0.08	±0.06	0.00	0.00	0.65	0.00	0.12	10.10
Pos. 3	0.00	-0.14	1.53	0.00	-0.89	4.88	±1.12	±0.45	±0.69	0.00	-0.12	0.64	1.01	-2.02	10.49
Pos. 4	0.00	0.14	1.53	0.00	0.89	4.88	±1.12	±0.45	±0.69	0.00	0.12	0.64	1.01	2.02	10.49

3.5 LEITDETAILS

Die Leitdetails der Treppe und des Podests werden unten beschrieben.

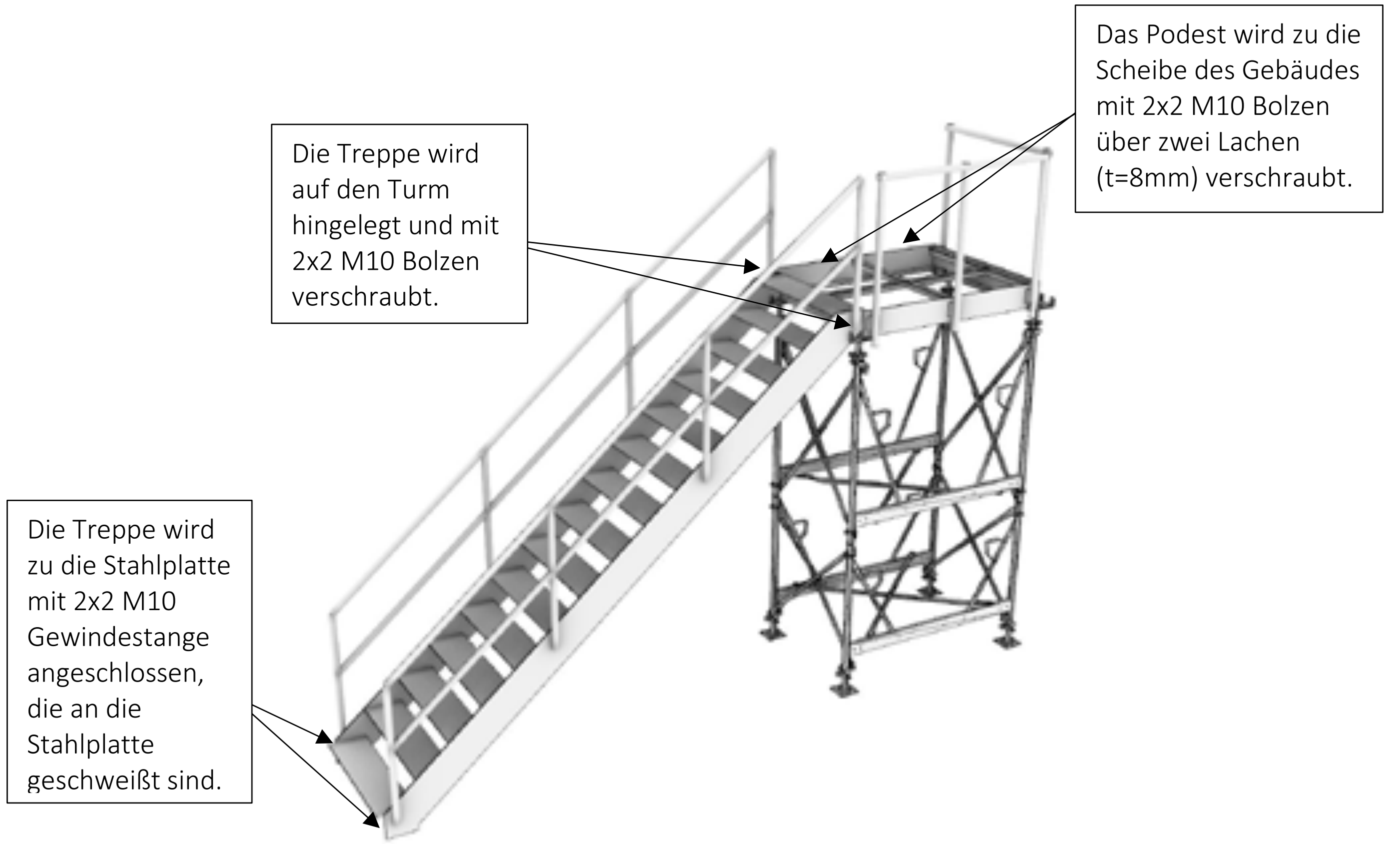


Abbildung 10 Beschreibung der Leitdetails.

Schraubennachweise		nach DIN EN 1993-1-8 3.6.1					
Querschnittswerte							
Schraubengröße	M 10						
Festigkeitsklasse	8.8						
	$d=$	10 [mm]	$f_{yb}=$	640 [N/mm²]	$e_1=$	20 [mm]	
Lochspiel	$\Delta d=$	1 [mm]	$f_{ub}=$	800 [N/mm²]	$e_2=$	20 [mm]	
Lochdurchmesser	$d_0=$	11 [mm]			$p_1=$	30 [mm]	
	$A=$	79 [mm²]	$f_y=$	S 235 [N/mm²]	$p_2=$	30 [mm]	
	$A_s=$	58 [mm²]	$f_u=$	360 [N/mm²]			
Bauteildicke	$t=$	8 [mm]					
Einwirkungen							
Abscherkraft	$F_{v,Ed}=$	15 [kN]					
Zugkraft	$F_{t,Ed}=$	15 [kN]					

Nachweise						
Abscheren	Scherfuge im Gewinde	$\alpha_v=$	0.6			
	Grenzabscherkraft	$F_{v,Rd}=$	22.27 [kN]			
	Nachweis	$\frac{F_{v,Ed}}{F_{v,Rd}}=$	0.67	≤ 1,0	Nachweis erbracht	
Zug	Grenzzugkraft	$F_{t,Rd}=$	33.408 [kN]	mit	$k_2=$ 0.9	
	Nachweis	$\frac{F_{t,Ed}}{F_{t,Rd}}=$	0.45	≤ 1,0	Nachweis erbracht	
Zug und Abscheren	Nachweis	$\frac{F_{v,Ed}}{F_{v,Rd}}+\frac{F_{t,Ed}}{1.4\cdot F_{t,Rd}}=$	0.99	≤ 1,0	Nachweis erbracht	
Lochleibung	Randschraube in Kraftrichtung	$\alpha_b=$	0.61			
		$k_1=$	2.12			
	Grenzlochleibungskraft	$F_{b,Rd}=$	29.60 [kN]			
	Nachweis	$\frac{F_{b,Ed}}{F_{b,Rd}}=$	0.50	≤ 1,0	Nachweis erbracht	

Der Schraubennachweis zeigt, dass die erforderlich Kapazität in den Anschlüsse vorhanden ist.

4 NACHWEIS – ABSTURZSICHERUNG

4.1 SYSTEM

Die Absturzsicherungen sind hinsichtlich der Abmessungen in zwei Typen unterteilt, wo Typ 1 eine Breite bis zu 1,2m und Typ 2 eine Breite zwischen 1,2 und 1,8m hat. Aufgrund der größeren Spannweite, hat Typ 2 eine zusätzliche Pfosten in der Mitte.

Die zwei Typen sind mit Balkenelementen mit einer Querschnitt von 40x20mm modelliert und die sind an vier Punkte gelenkig gelagert (siehe folgende Abbildungen). Die Stahlgüte S235 ist in den Berechnungen für beide Typen verwendet.

4.1.1 Typ 1

Abbildung 11 Abmessungen der Absturzsicherung Typ 1 [m].

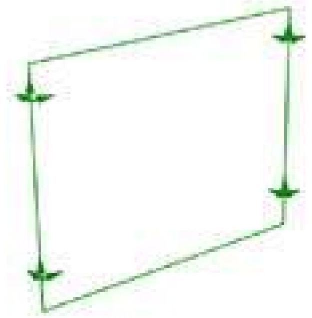


Abbildung 12 Statisches System der Absturzsicherung Typ 1.

4.1.2 Typ 2

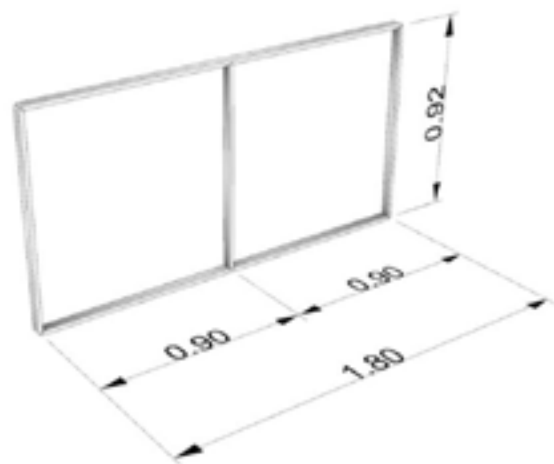


Abbildung 13 Abmessungen der Absturzsicherung Typ 2 [m].

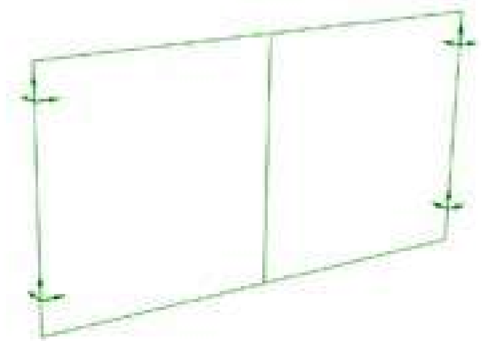


Abbildung 14 Statisches System der Absturzsicherung Typ 2.

4.2 AUSNUTZUNGSGRAD

4.2.1 Typ 1

Die Absturzsicherung Typ 1 ist im Grenzzustand der Tragfähigkeit bis zu 73% der elastischen Materialgrenze ausgenutzt.

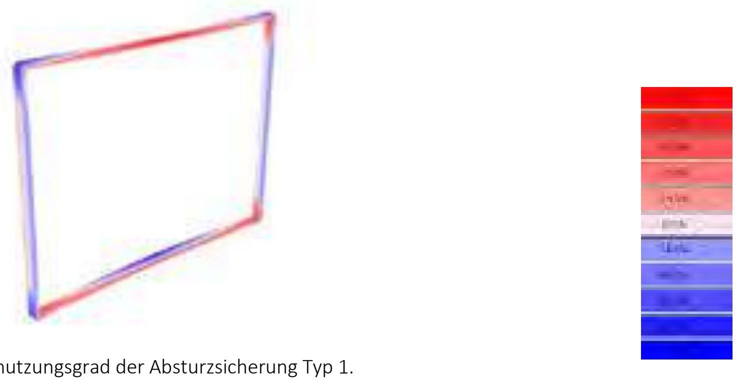


Abbildung 15 Ausnutzungsgrad der Absturzsicherung Typ 1.

4.2.2 Typ 2

Die Absturzsicherung Typ 2 ist im Grenzzustand der Tragfähigkeit bis zu 65% der elastischen Materialgrenze ausgenutzt.

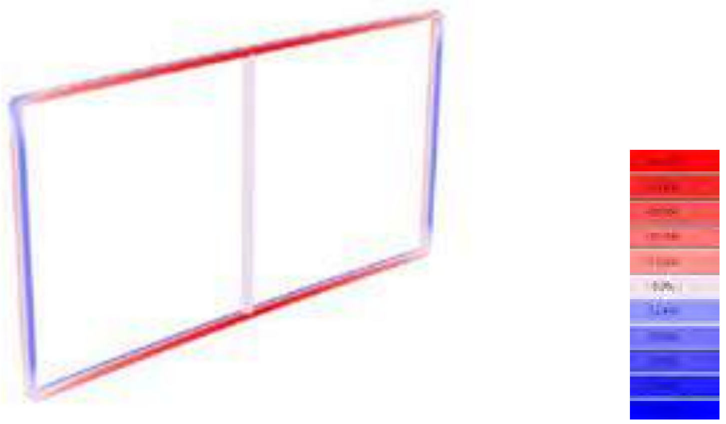


Abbildung 16 Ausnutzungsgrad der Absturzsicherung Typ 2.

4.3 VERFORMUNGEN

4.3.1 Typ 1

Die Verformung der Absturzsicherung Typ 1 unter Personenlast im Grenzzustand der Gebrauchstauglichkeit beträgt 0,3cm (L/400) und erfüllt damit die Sicherheitsanforderungen.

Abbildung 17 Verformung der Absturzsicherung Typ 1 [cm].

4.3.2 Typ 2

Die Verformung der Absturzsicherung Typ 2 unter Personenlast im Grenzzustand der Gebrauchstauglichkeit beträgt 0,8cm (L/225) und erfüllt damit die Sicherheitsanforderungen.

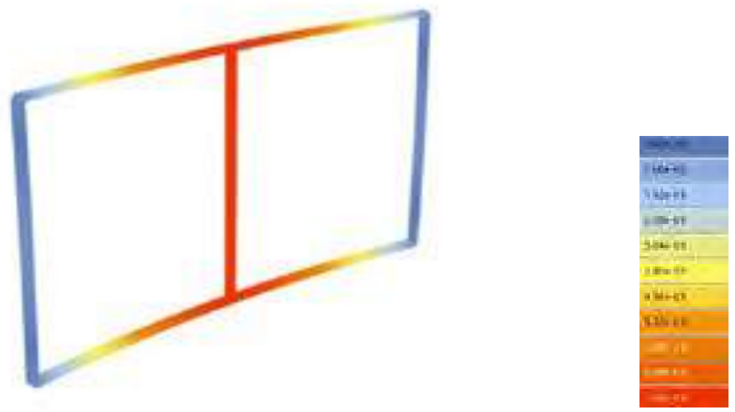


Abbildung 18 Verformung der Absturzsicherung Typ 2 [cm].

4.4 AUFLAGERKRÄFTE

4.4.1 Typ 1

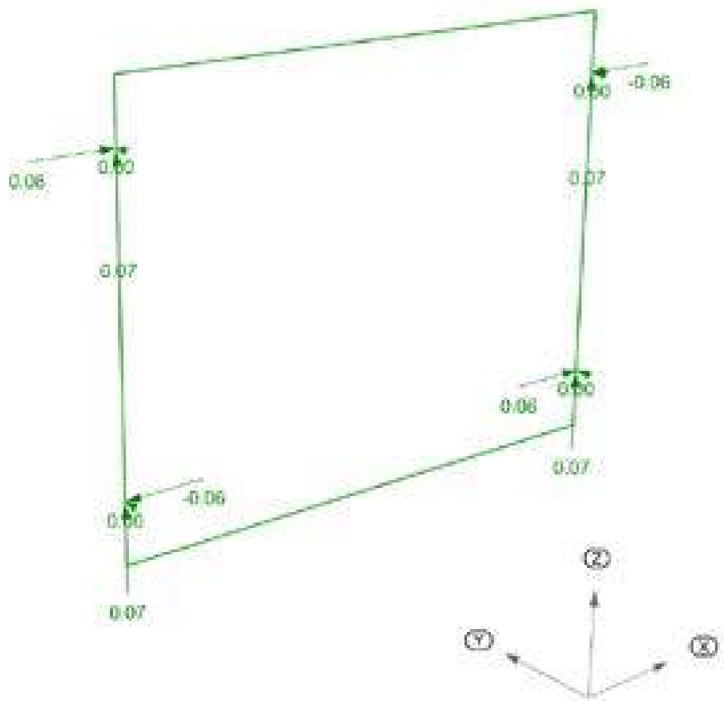


Abbildung 19 Auflagerkräfte LF1 - Eigengewicht [kN].

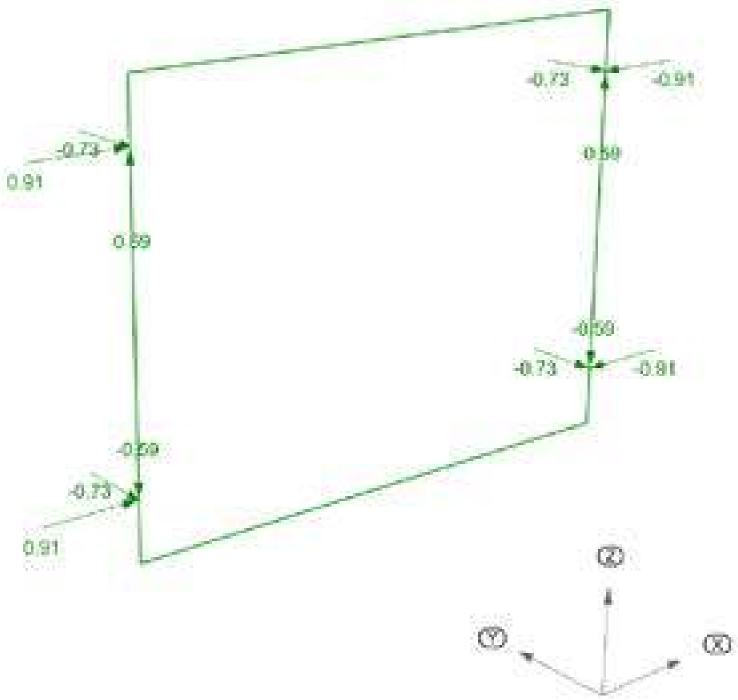


Abbildung 20 Auflagerkräfte LF21 - Nutzlast [kN].

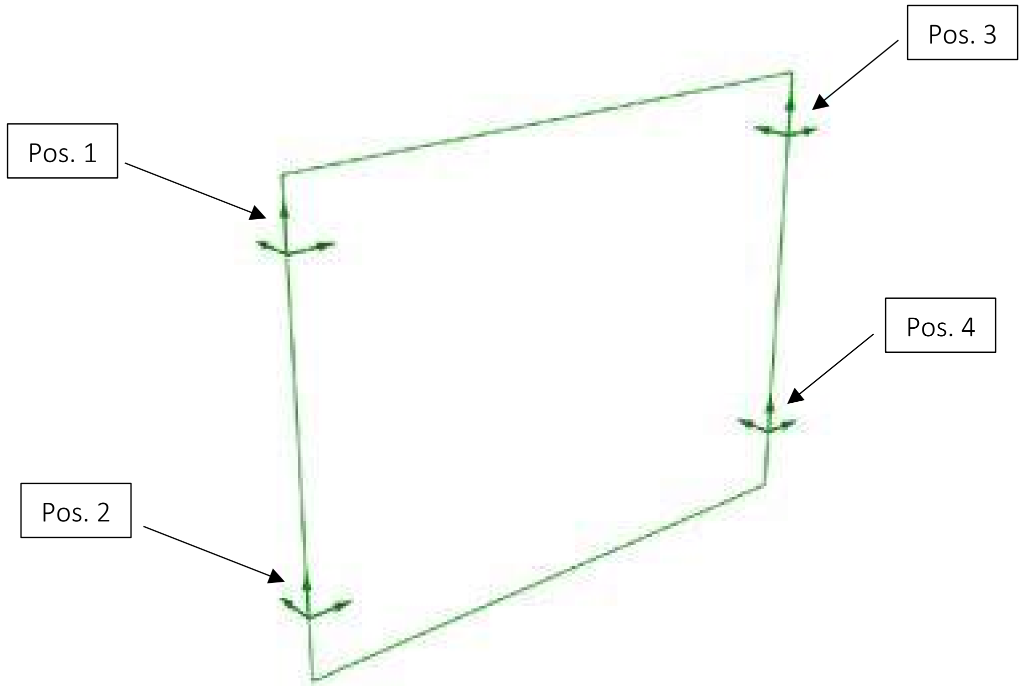


Abbildung 21 Erläuterung der Auflagerpositionen.

	LF1 - Eigengewicht			LF21 - Nutzlast			Bemessungswert Ed		
	F_x	F_y	F_z	F_x	F_y	F_z	F_x	F_y	F_z
Pos. 1	0.06	0.00	0.07	0.91	-0.73	0.59	1.45	-1.10	0.98
Pos. 2	-0.06	0.00	0.07	0.91	-0.73	-0.59	1.28	-1.10	-0.79
Pos. 3	-0.06	0.00	0.07	-0.91	-0.73	0.59	-1.45	-1.10	0.98
Pos. 4	0.06	0.00	0.07	-0.91	-0.73	-0.59	-1.28	-1.10	-0.79

4.4.2 Typ 2

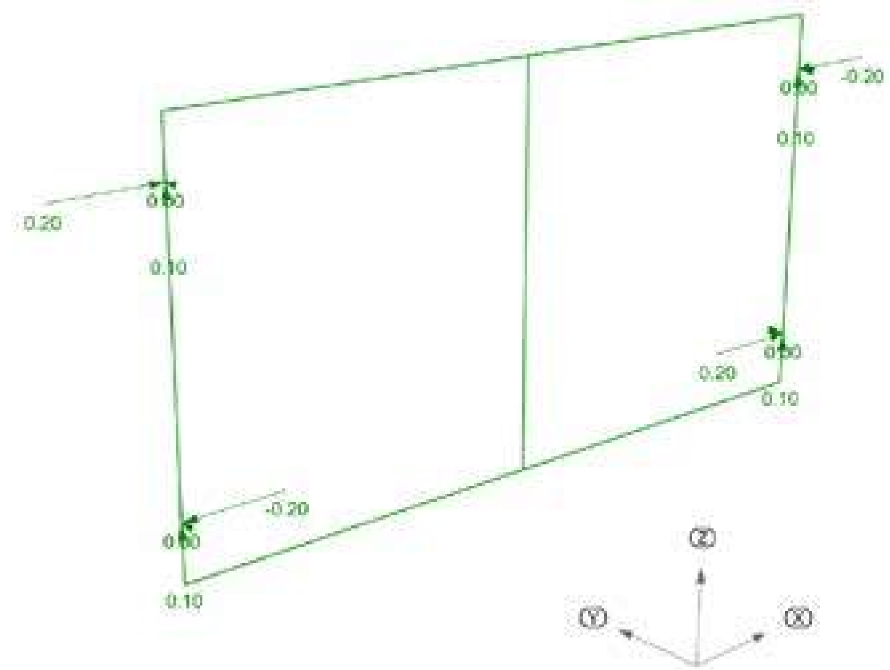


Abbildung 22 Auflagerkräfte LF1 - Eigengewicht [kN].

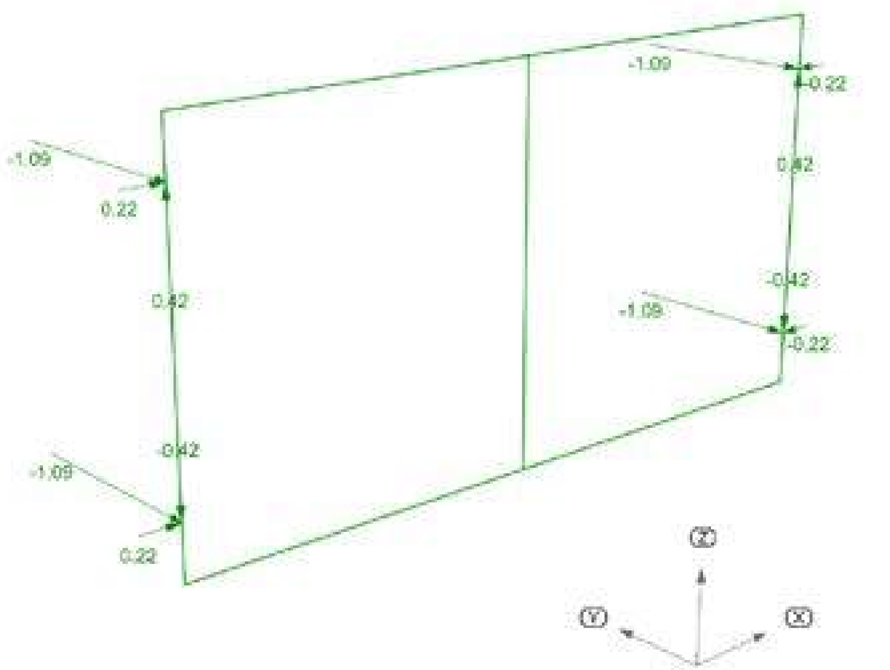


Abbildung 23 Auflagerkräfte LF21 - Nutzlast [kN].

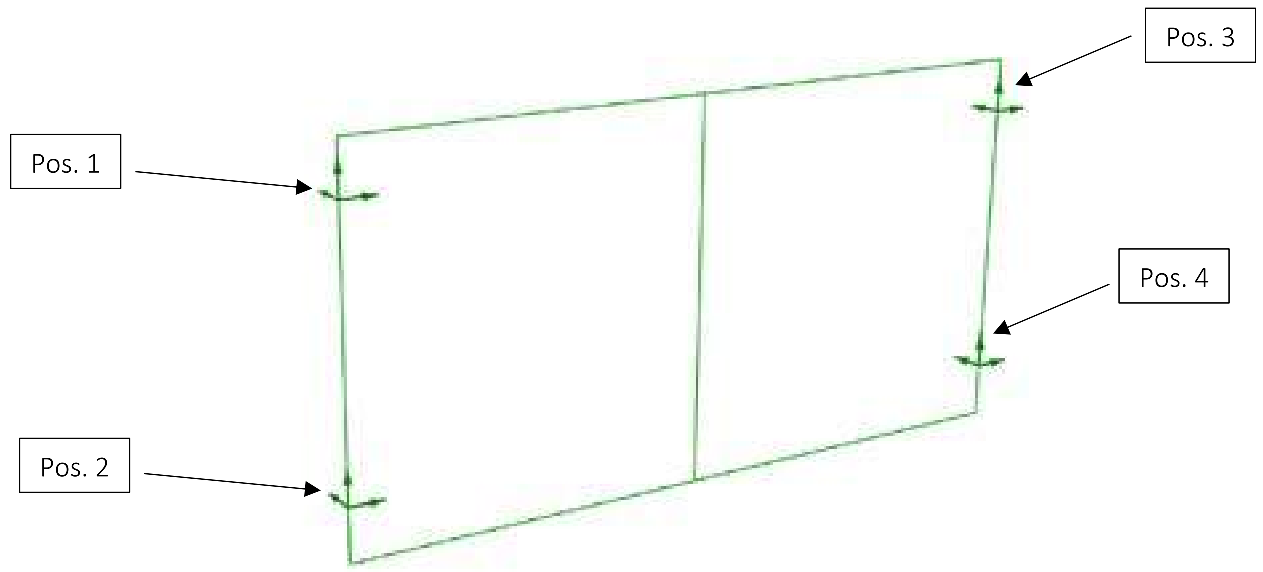


Abbildung 24 Erläuterung der Auflagerpositionen.

	LF1 - Eigengewicht			LF21 - Nutzlast			Bemessungswert Ed		
	F_x	F_y	F_z	F_x	F_y	F_z	F_x	F_y	F_z
Pos. 1	0.20	0.00	0.10	0.22	-1.09	-0.42	0.60	-1.64	-0.50
Pos. 2	-0.20	0.00	0.10	0.22	-1.09	0.42	0.06	-1.64	0.77
Pos. 3	-0.20	0.00	0.10	-0.22	-1.09	-0.42	-0.60	-1.64	-0.50
Pos. 4	0.20	0.00	0.10	-0.22	-1.09	0.42	-0.06	-1.64	0.77

5 GRÜNDUNG

5.1 SYSTEM

Die Horizontallasten auf dem gesamten Bauwerk werden in eine Richtung über Zug- und Druckstreben in eine außenliegende Gründung abgeleitet (siehe Abbildung 25).

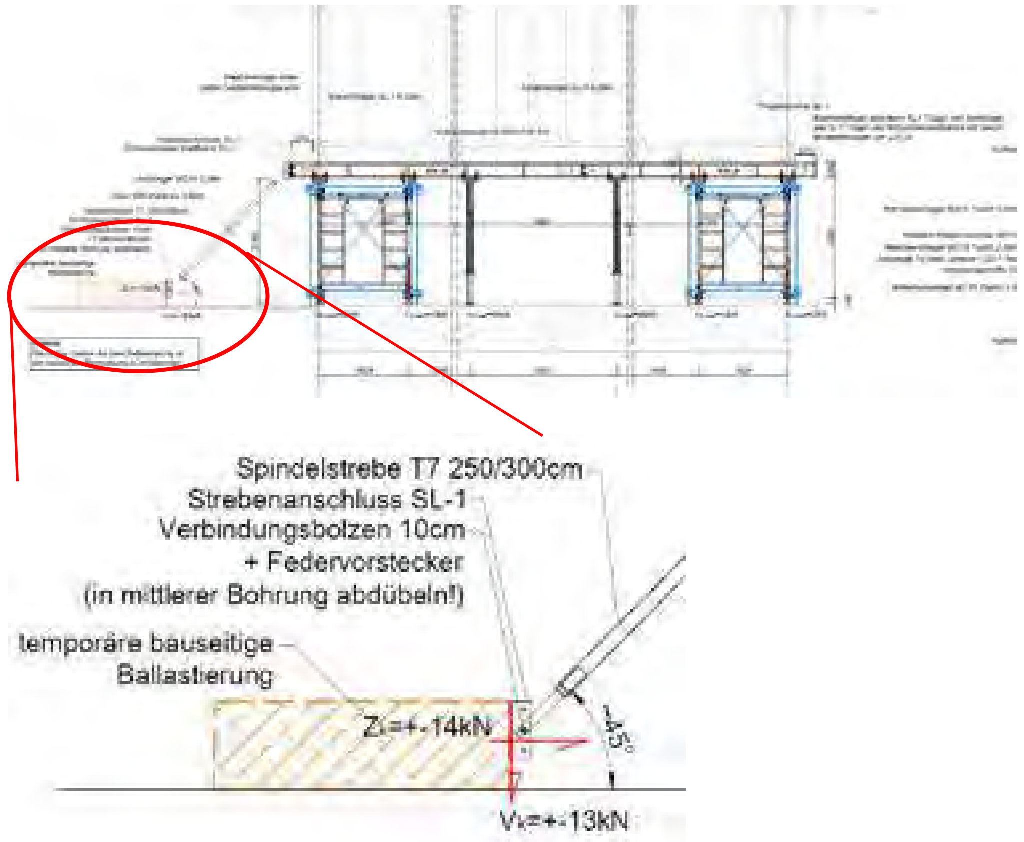
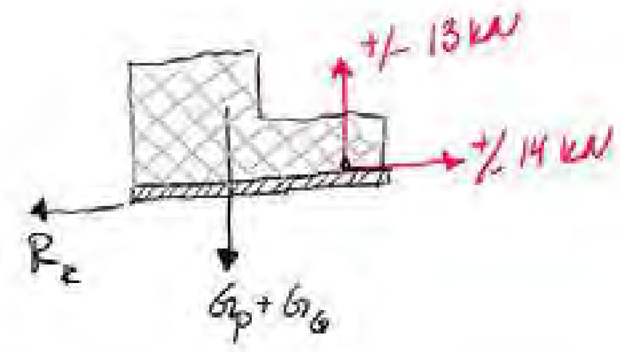


Abbildung 25 Screenshot aus dem Plan 224-016371-1001.pdf

Das Fundament wird von einer 15mm starke Stahlplatte gebildet, die auf einer Neoprenmatte liegt. Da Verankerungen in dem Boden nicht gestattet sind, trägt die Gründung die Horizontalkräfte durch Reibung ab. Um sicher zu stellen dass das Fundament nicht gleitet, muss eine ausreichende Normalkraft vorhanden sein, daher wird die Stahlplatte mit Gabionen ballastiert (siehe Abbildung 26).

Abbildung 26 Skizze des Fundaments

5.2 STANDSICHERHEITSNACHWEIS



Dichte Gabione	$\rho_G = 17$	kN/m³
Reibungskoeffizient	$\gamma = 0{,}7$	
Sohldruckwiderstand	$\sigma_{Rd} = 120$	kN/m²

5.2.1 Kippen

Das Kippen des Fundaments muss nicht berücksichtigt werden, da die Horizontallast in der Ebene der Platte angreift.

5.2.2 Hochheben

Um das Hochheben des Fundaments zu vermeiden muss jederzeit ein Mindestgewicht von

1,5*13kN = 19,5 kN

gewährleistet sein.

5.2.3 Gleiten

Um das Gleiten des Fundaments zu vermeiden muss jederzeit ein Mindestgewicht von

1,5*14kN / 0,7 = 30 kN

gewährleistet sein.

5.2.4 Sohldruck

Um den Sohldruckwiderstand nicht zu überschreiten muss das Fundament ein Mindestfläche von

30kN / 120kN/m² = 0,25m²

haben.

5.3 DIMENSIONIERUNG

Die angenommenen Dimensionen der Stahlplatte sind 1,5m x 1,5m x 0,015m. Das führt zu einem Mindestvolumen der Gabionen von 1,6m³.

Unten folgt ein Vorschlag zu der Ausbildung der Gabionen.

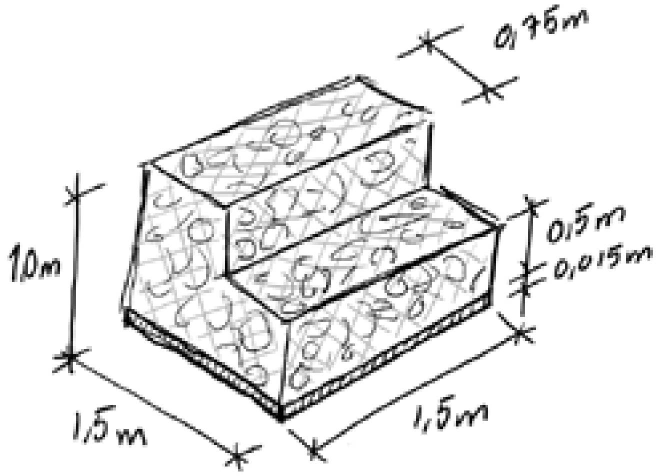
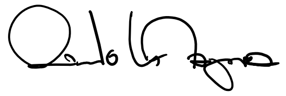


Abbildung 27 Vorschlag zu der Ausformung der Gabionen.

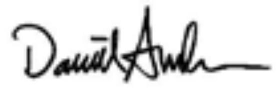
AUSFÜHRUNG

Den Bericht ist an dem 11. März 2022 von

Prof. Dr.-Ing. La Magna, Riccardo



M.Sc. Andersson Largueche, David



fertiggestellt.

XIV. Appendix

House Demonstration Unit • Life cycle analysis

Note: This sheet refers to the design of the **House Demonstration Unit**. Devices and furniture that do not belong to the building (e.g. household appliances such as washing machines and refrigerators) and lighting are not part of the building life cycle assessment.
kg CO_2e = kg CO2-equivalents [Global Warming Potential (**GWP**)]

Calculation methods

Calculation period	a	50

Calculation tools applied	Calculation tool	Tool website
Tool 1	Sim Room	https://www.enec.de/page/SimRoom/index.html
Tool 2	urban mining index	
Tool 3		

▼ Energy consumption during use (calculation)

Note: The pre-filled emission factors for the natural gas and power grid correspond to the data of Table 4 in Rule 7.

Energy purchase

Note: When entering the data, it is important to note that only the additional energy purchased for the building must be considered for the carbon footprint! Also, mobility and appliances are not included in the simplified analysis. This value can be determined by SimRoom, for example.
Grid electricity = [Final energy demand (electricity)] - [Self consumption (electricity)] - [Mobility (electricity)] - [Appliances (electricity)]

	Final energy demand kWh/a	kWh over 50a	**Emisssion factor** g CO_2e/kWh	**Emissions, 50a** kg CO_2e
Grid electricity	1009	50454	200	10090,8
Natural gas	0	0	241	0
Others*				
		0		0
		0		0
			Sum:	10090,8

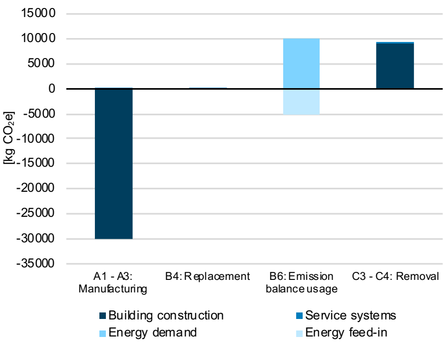
*In the case of other energy carriers, the applied carbon factors must be **communicated to the SDE21 Organisers** for general consistency (see Rule 7).

Feed-in electricity (generated and not self-consumed)

	Feed-in electricity kWh/a	kWh per 50a	**Emisssion factor** g CO_2e/kWh	**Emission credits, 50a** kg CO_2e
AC power grid	504,08	25204	200	-5040,8
Emission balance usage phase, 50a			**Total:**	**5050**

Life cycle analysis

		Building construction	Service systems	Total
A: Manufacturing phase				
A1 - A3:	kg CO_2e	-30.000	40,7	-29959,3
A1: Sourcing of raw materials				
A2: Transportation				
A3: Production				
B: Usage phase (50a)				
B4: Replacement	kg CO_2e	0	42,47	42,47
B6: Emission balance usage	kg CO_2e			5050
C: Removal phase				
C3 - C4:	kg CO_2e	9.000	1,7	9001,7
C3: Waste processing				
C4: Disposal				
Total	kg CO_2e	-21000	84,87	-15865,13
per gross floor area	/m^2_{gfa}	-250	1,010357143	-188,8705952
per net floor area	/m^2_{nfa}	-405,2489386	1,637784639	-306,158433
per net conditioned floor area	/m^2_{cfa}	-417,2959224	1,686471664	-315,259717



RESULTS

COMPONENTS

PROJECT INFORMATION

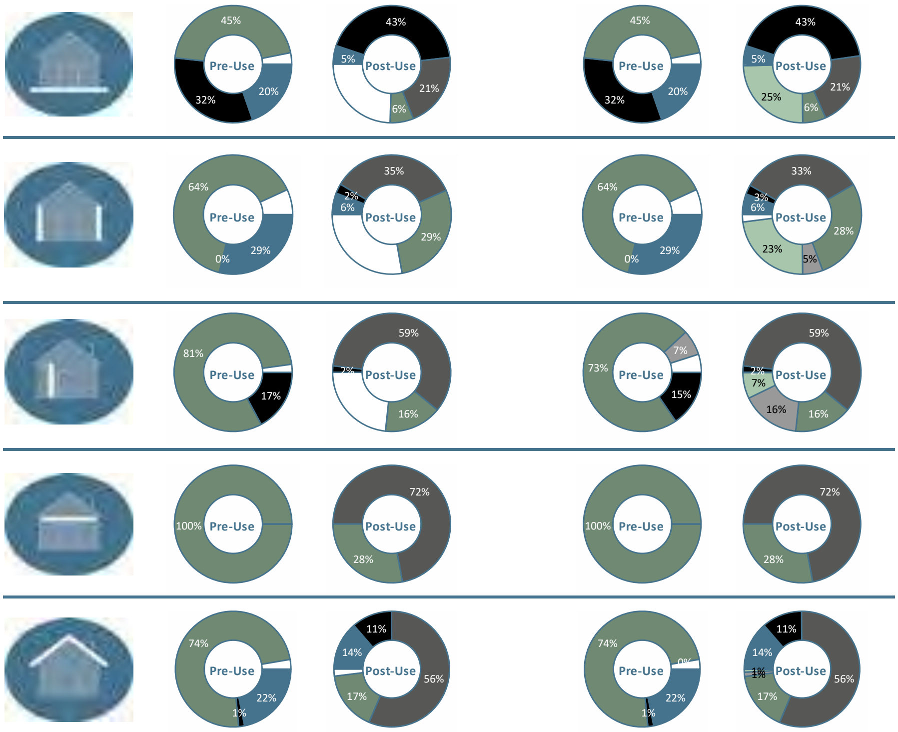
TEAM ID
KIT

TEAM NAME
RoofKIT

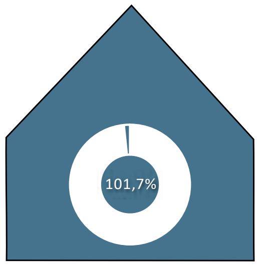
UNIVERSITY
Karlsruhe Institute of Technology (KIT)

PROJECT NAME
RoofKIT_SDE

CLOSED-LOOP POTENTIAL — LOOP POTENTIAL



URBAN MINING INDICATOR



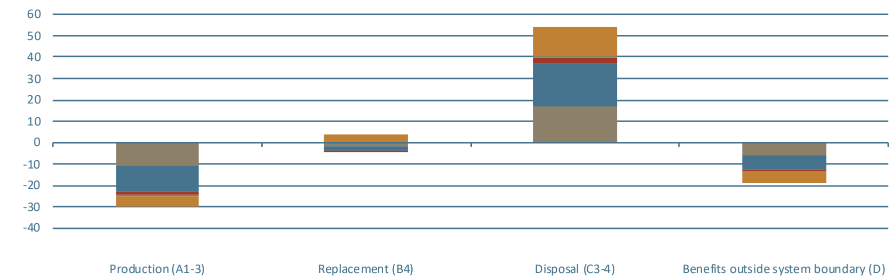
PRE-USE

- Reused materials (RU)
- Recycled materials (RC)
- Renewable materials (RN)
- Downcycled materials (DC)
- Primary raw materials, non-renewable (PR)

POST-USE

- reusable (ru)
- recyclable (rc)
- downcyclable, certified renewable (dccr)
- energetically recyclable, certified renewable (encr)
- downcyclable (dc)
- energetically recyclable, renewable (enr)
- energetically recyclable, fossile (enf) or Disposal (w)

GLOBAL WARMING POTENTIAL



	Production (A1-3)	Replacement (B4)	Disposal (C3-4)	Benefits outside system boundary (D)
TOTAL [t CO_2-eq.]	-30	0	54	-19

GWP	TOTAL
Foundation	-1,7
Exterior Walls	-0,5
Interior Walls	0,1
Ceilings	-0,2
Roofs	7,4
[t CO_2-eq.]	5,1
Reference area 100 m^2	
Reference time 50 a	
kg CO_2-eq-/m^2 p.a.	1,0

RESULTS

COMPONENTS

PROJECT INFORMATION

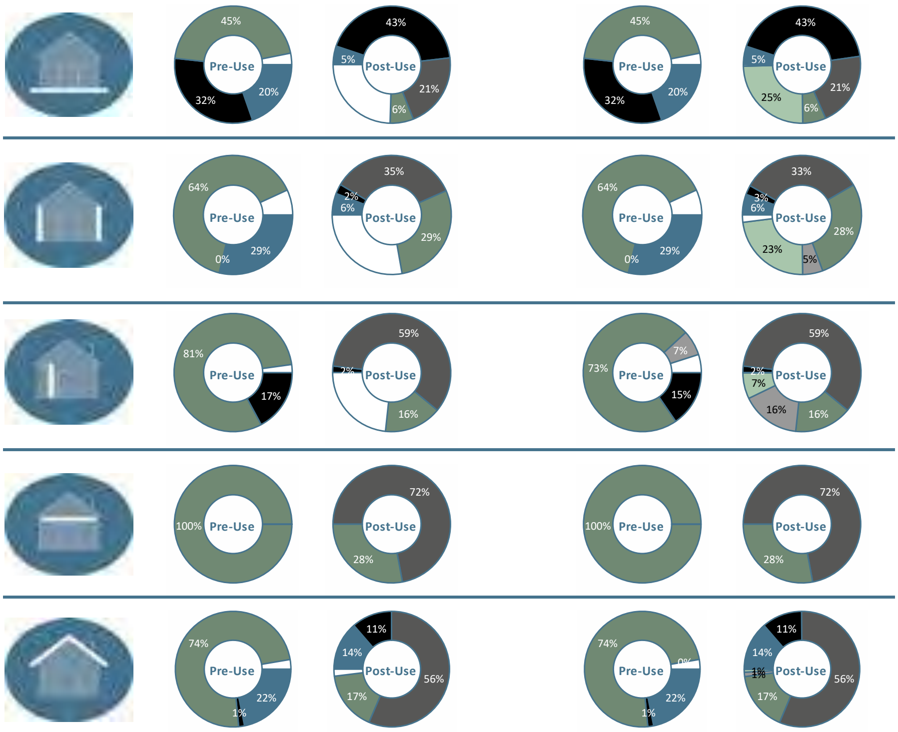
TEAM ID
KIT

TEAM NAME
RoofKIT

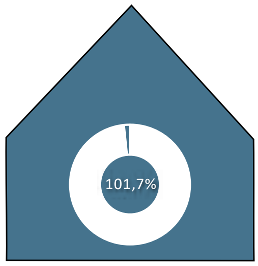
UNIVERSITY
Karlsruhe Institute of Technology (KIT)

PROJECT NAME
RoofKIT_SDE

CLOSED-LOOP POTENTIAL | LOOP POTENTIAL



URBAN MINING INDICATOR



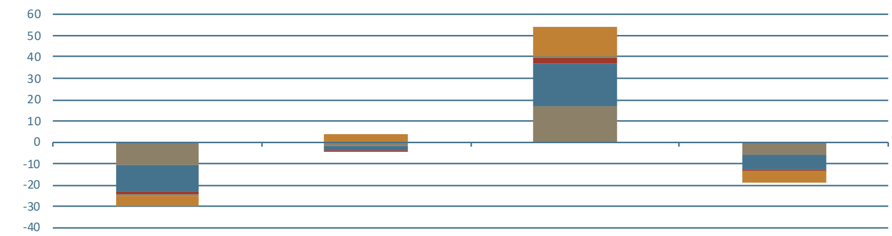
PRE-USE

- Reused materials (RU)
- Recycled materials (RC)
- Renewable materials (RN)
- Downcycled materials (DC)
- Primary raw materials, non-renewable (PR)

POST-USE

- reusable (ru)
- recyclable (rc)
- downcyclable, certified renewable (dccr)
- energetically recyclable, certified renewable (encr)
- downcyclable (dc)
- energetically recyclable, renewable (enr)
- energetically recyclable, fossile (enf) or Disposal (w)

GLOBAL WARMING POTENTIAL



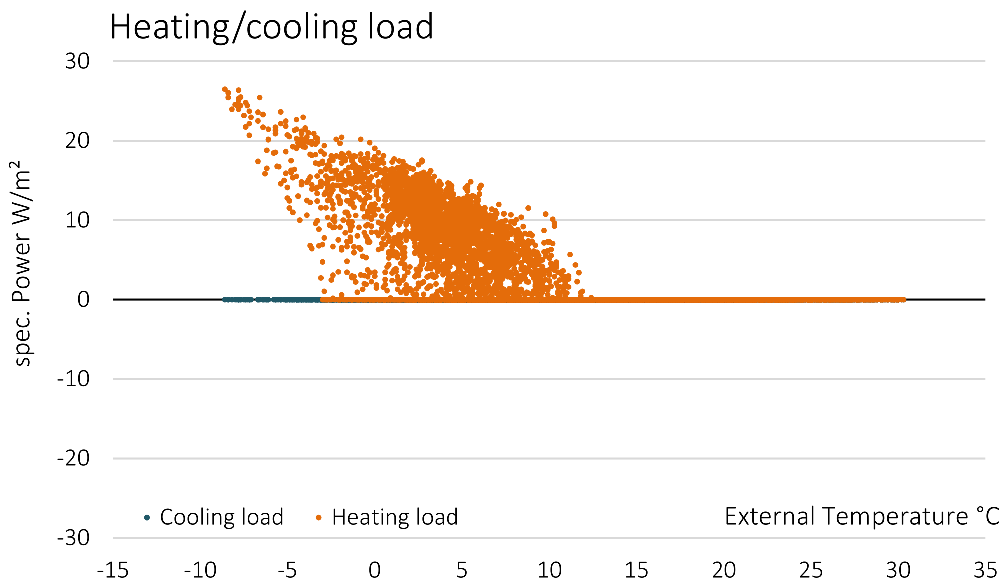
	Production (A1-3)	Replacement (B4)	Disposal (C3-4)	Benefits outside system boundary (D)
TOTAL [t CO_2-eq.]	-30	0	54	-19

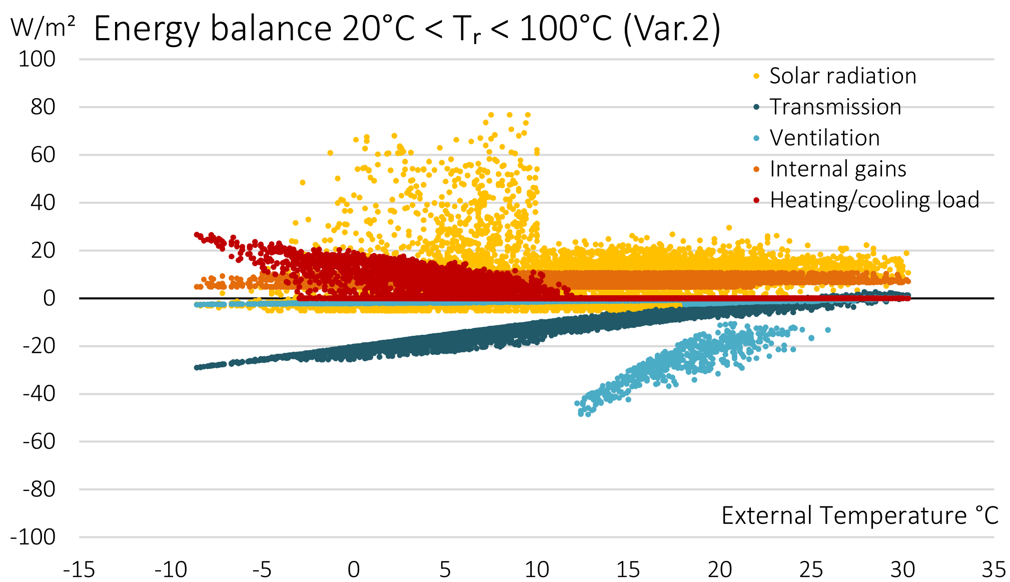
GWP TOTAL

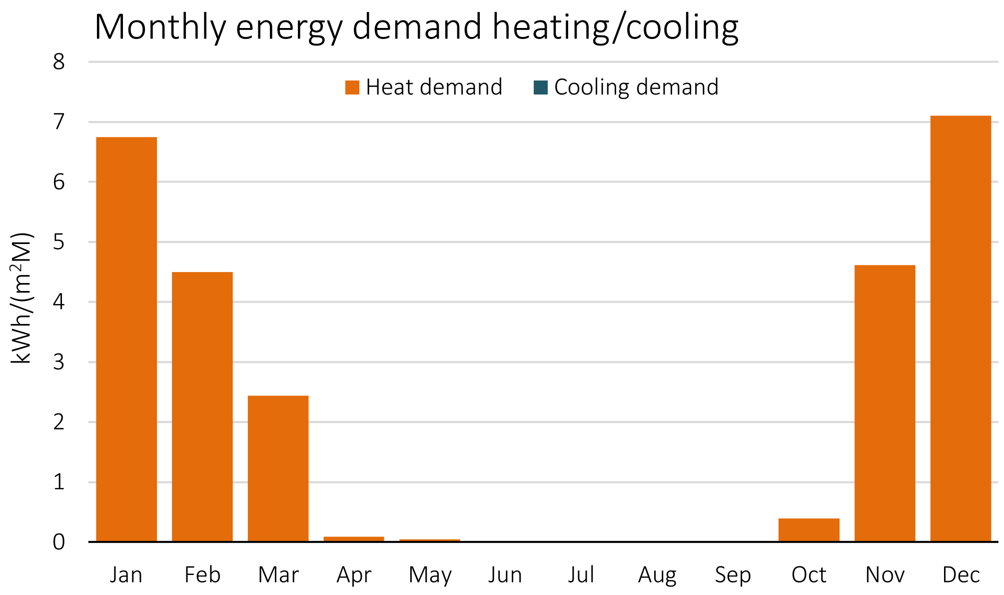
GWP	TOTAL
Foundation	-1,7
Exterior Walls	-0,5
Interior Walls	0,1
Ceilings	-0,2
Roofs	7,4
[t CO_2-eq.]	5,1
Reference area 100 m^2	
Reference time 50 a	
kg CO_2-eq-/m^2 p.a.	1,0

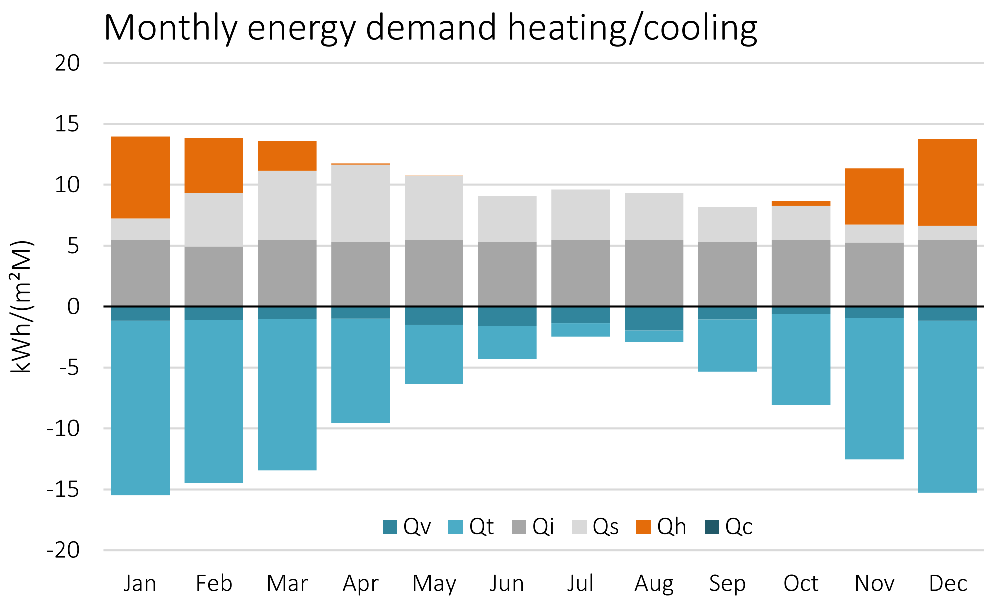
Simulation Results – Sim Room

Heating load and energy balance

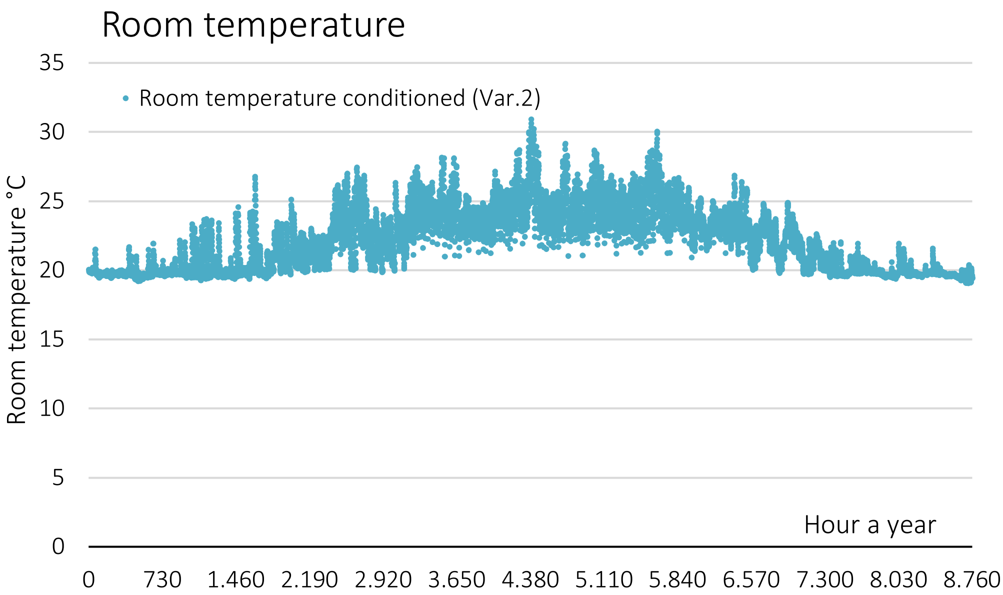


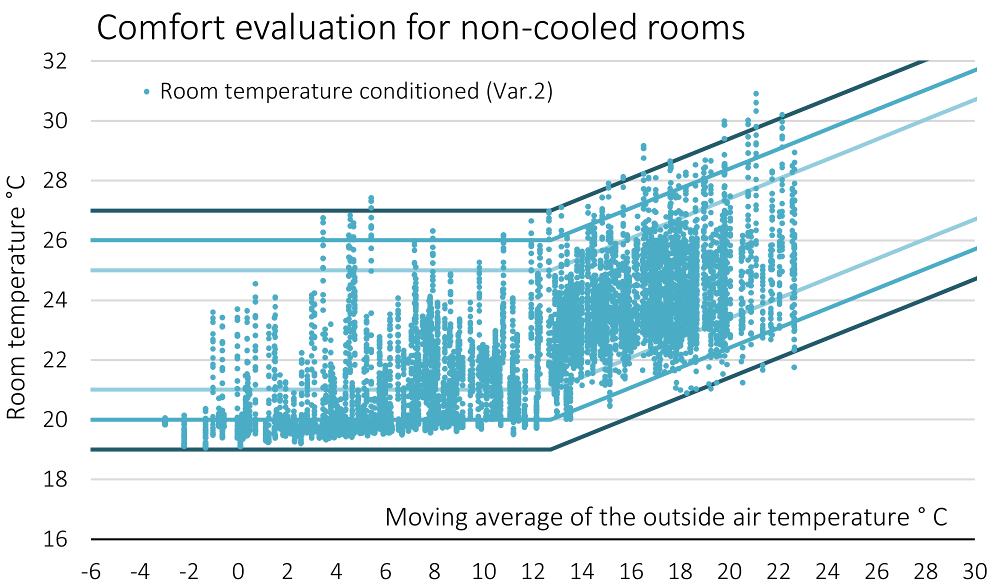



Monthly energy demand heating/cooling
Heat demand
Cooling demand
kWh/(m²M)
0
1
2
3
4
5
6
7
8
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

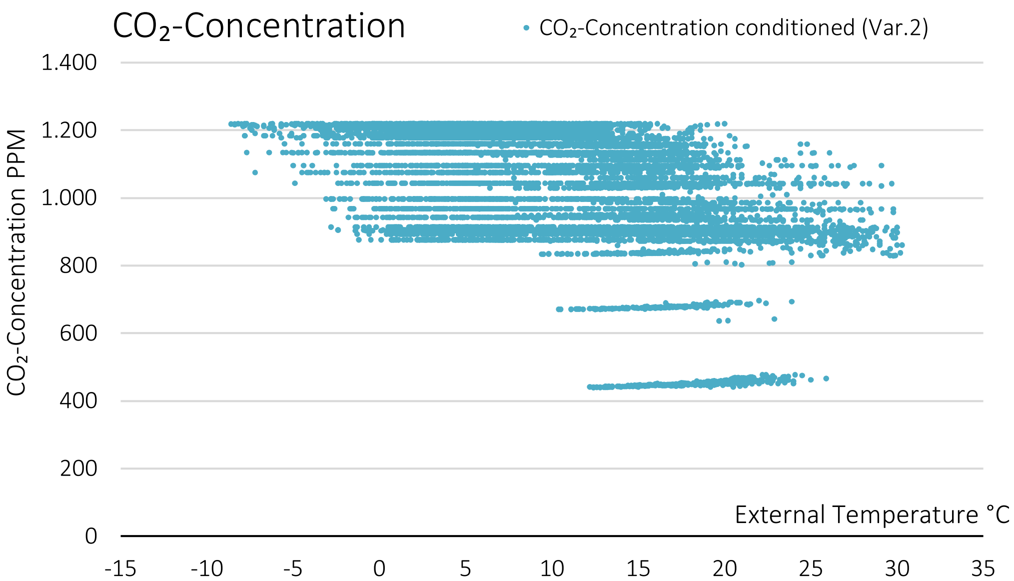

Monthly energy demand heating/cooling
kWh/(m²M)
20
15
10
5
0
-5
-10
-15
-20
Qv
Qt
Qi
Qs
Qh
Qc
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

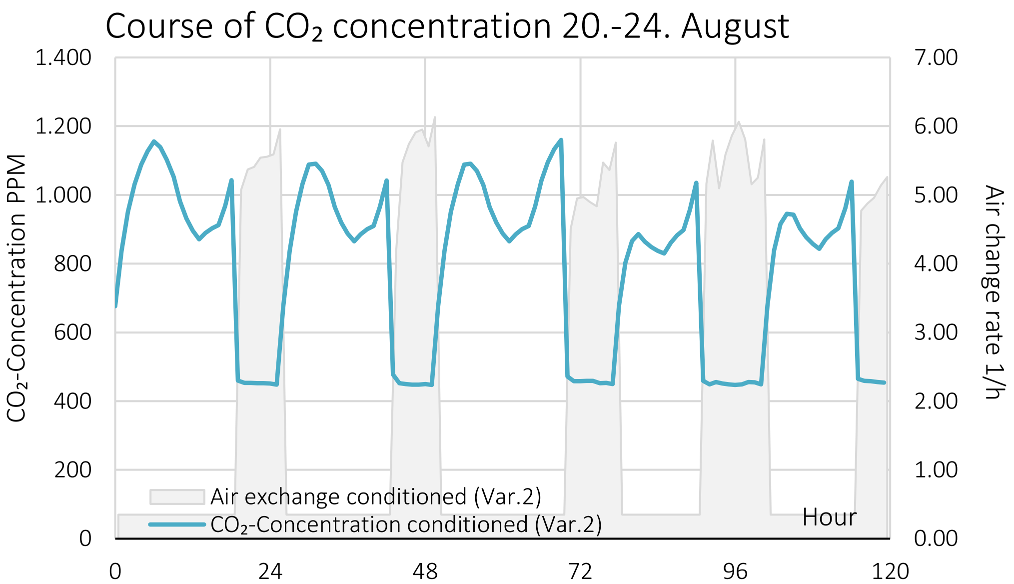
Room temperature





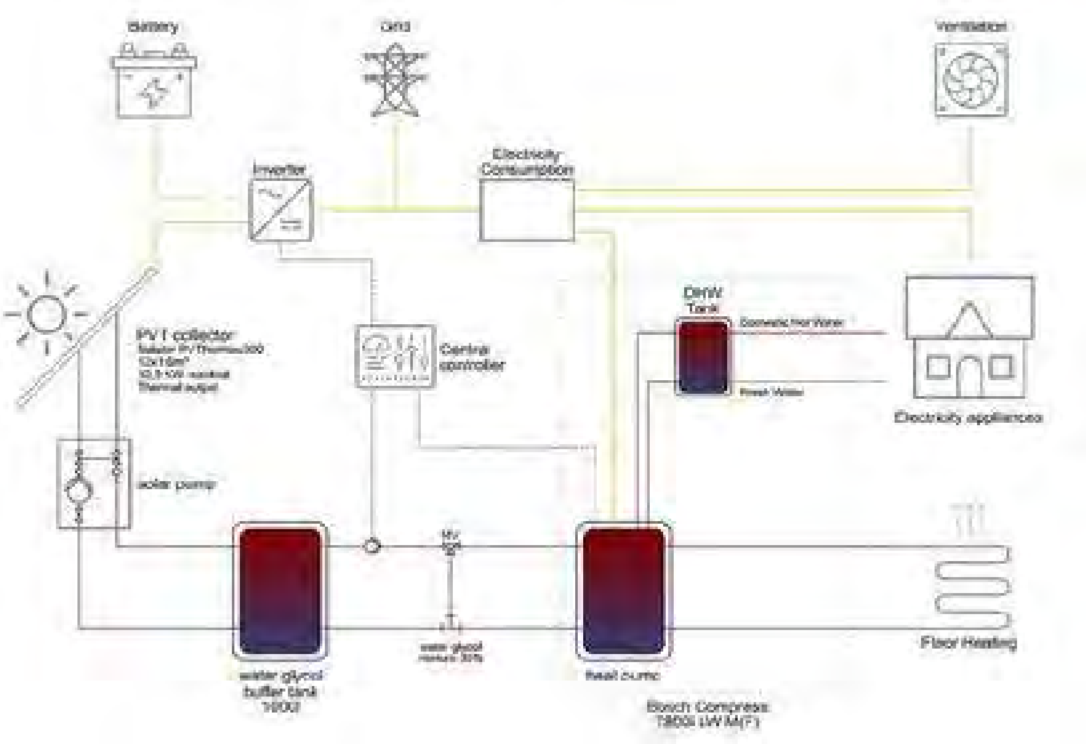
Room air quality

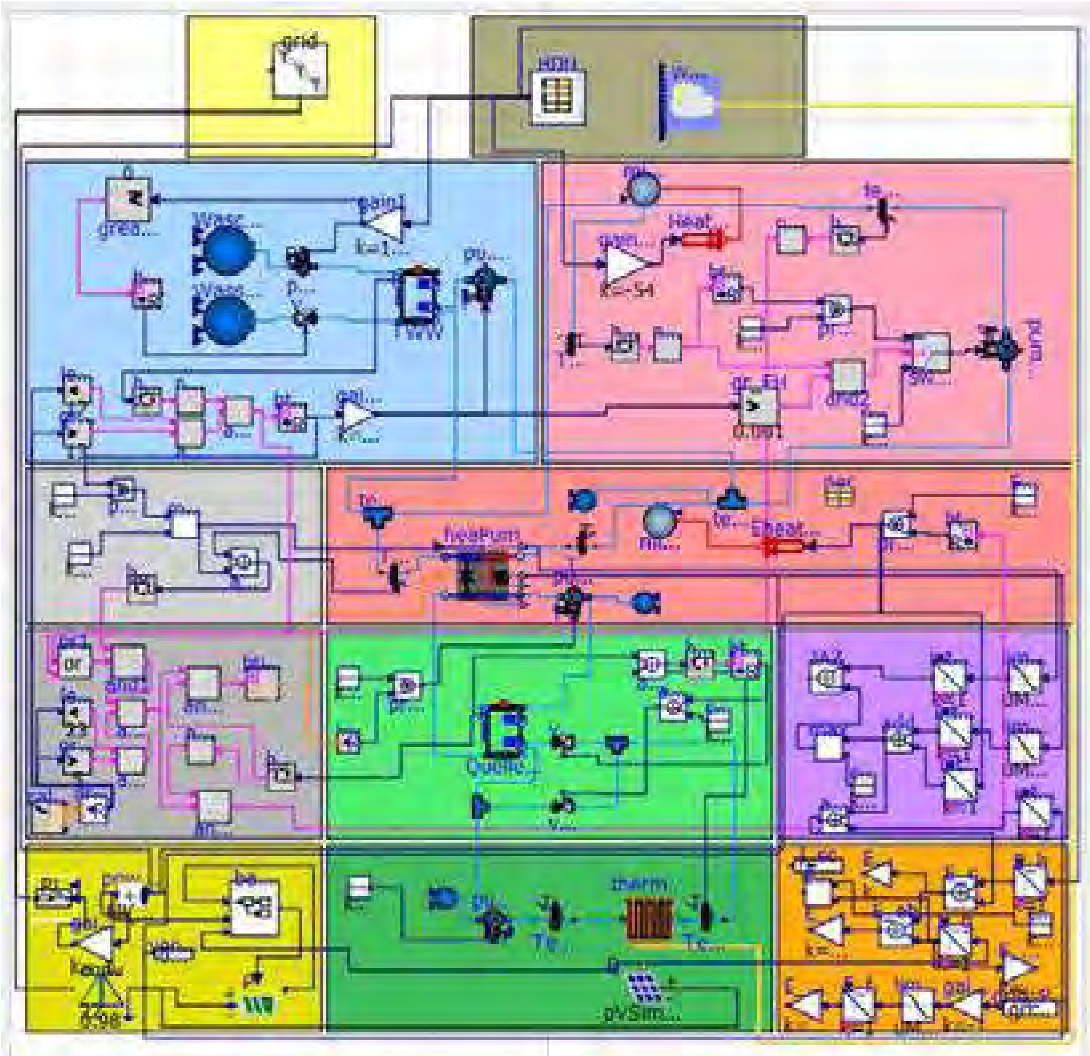




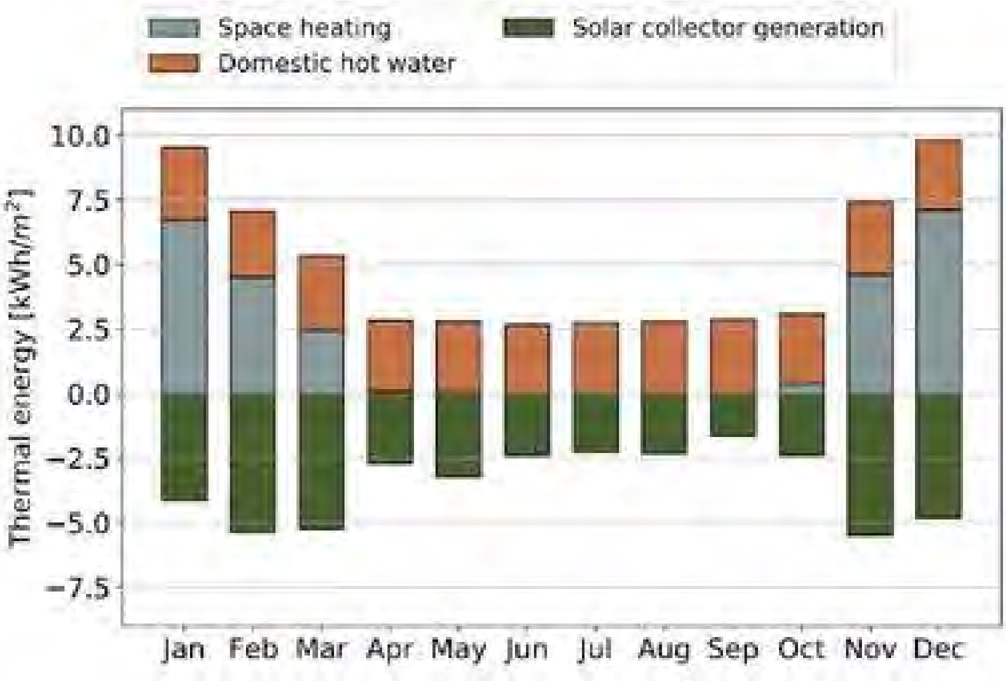
Simulation Results – Modelica – HDU

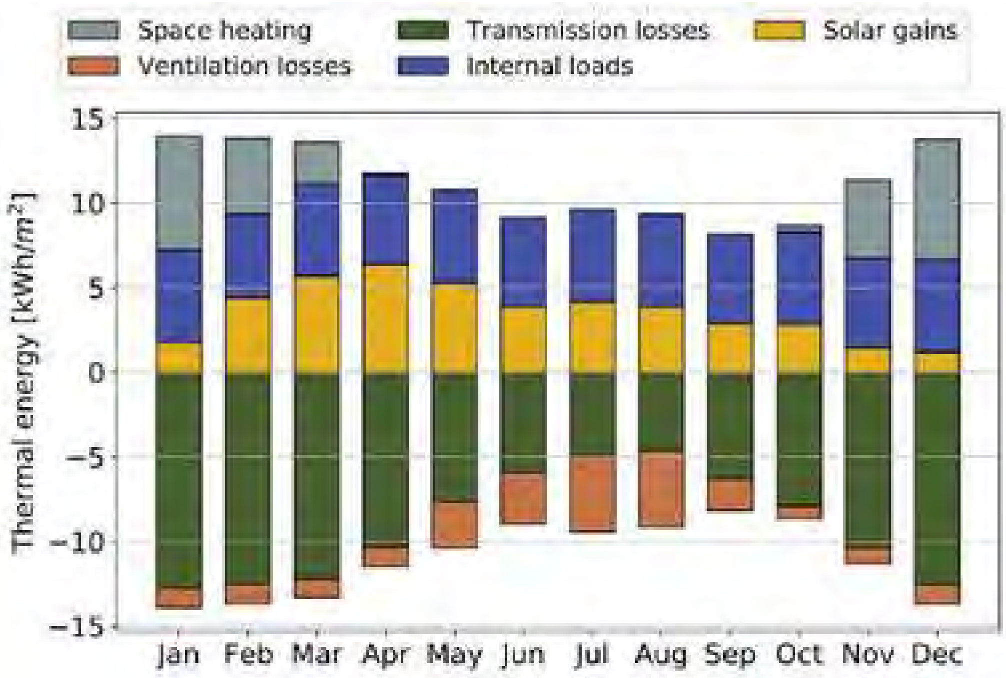
Developed model schematic / Modelica model

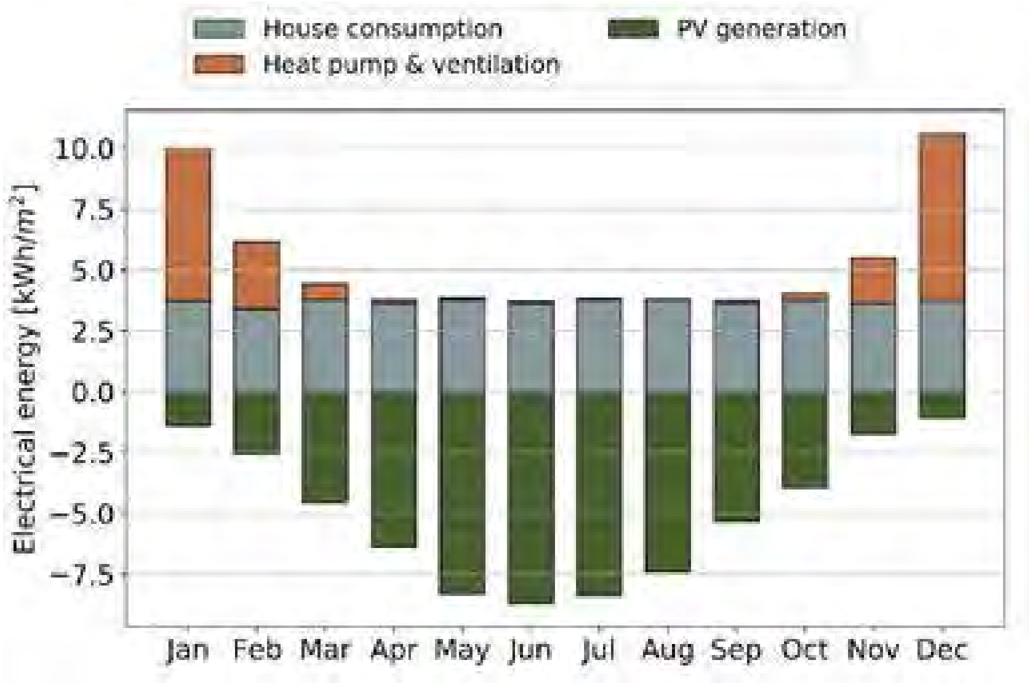


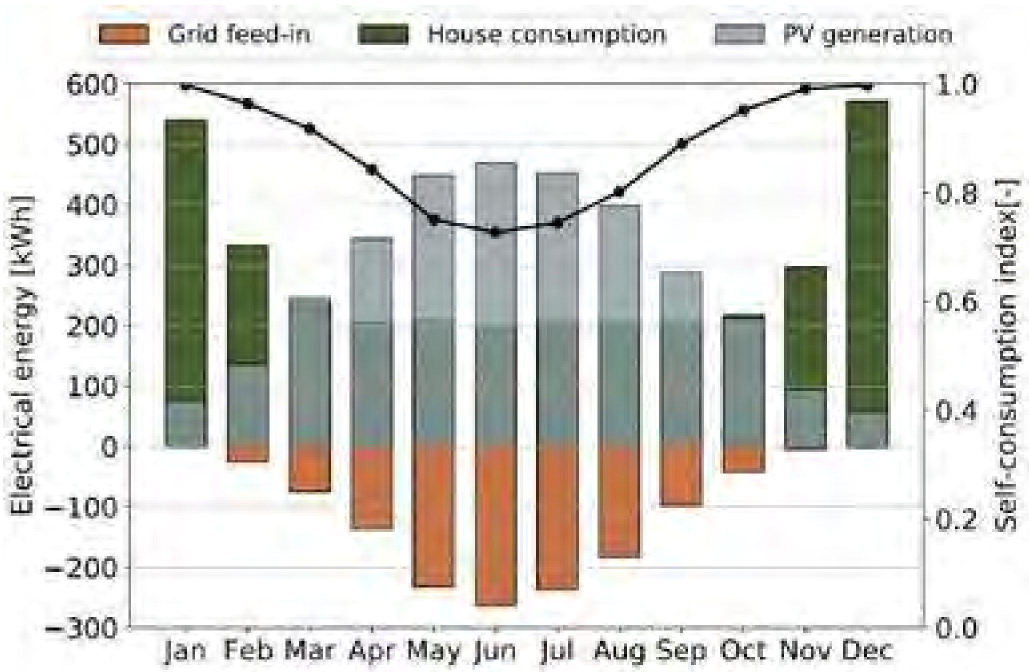

grid
gain1
k=-54
0.001
0.98

Results


Space heating
Domestic hot water
Solar collector generation
Thermal energy [kWh/m²]
10.0
7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

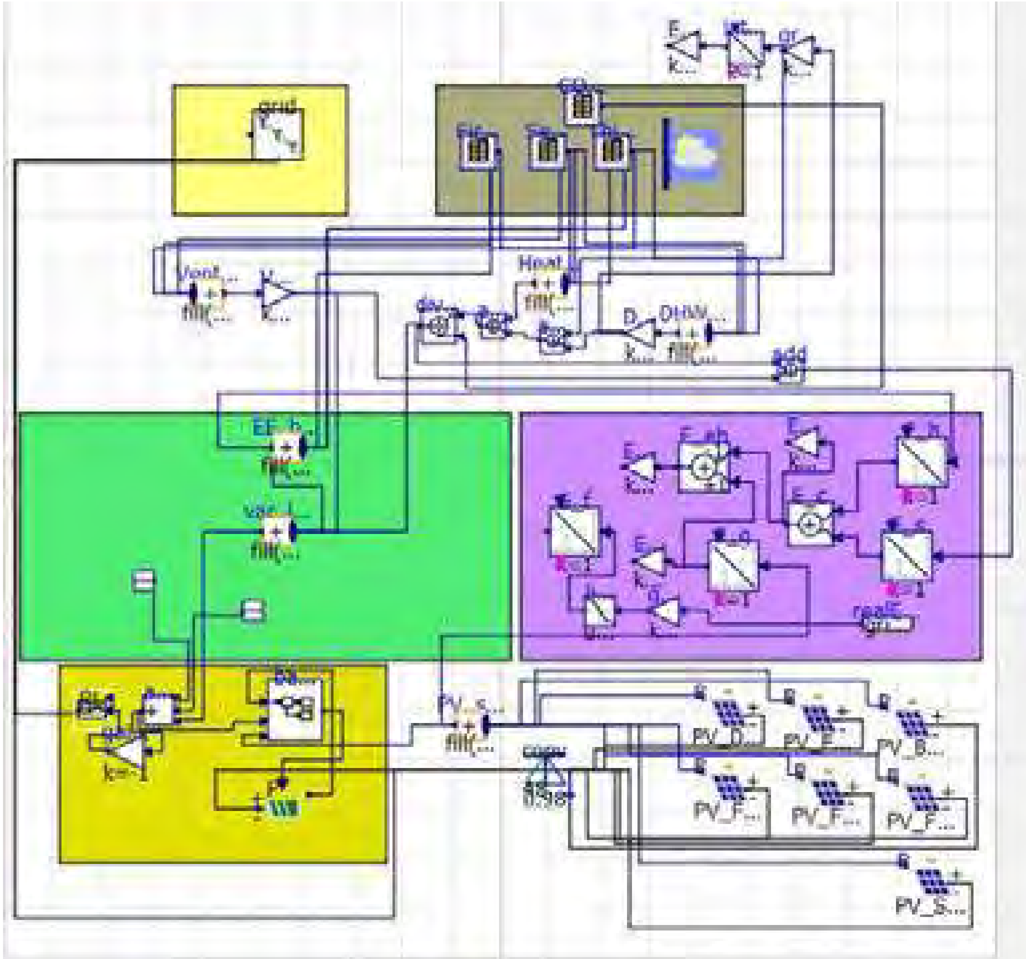

Space heating
Ventilation losses
Transmission losses
Internal loads
Solar gains
Thermal energy [kWh/m²]
15
10
5
0
−5
−10
−15
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


House consumption
PV generation
Heat pump & ventilation
Electrical energy [kWh/m²]
10.0
7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

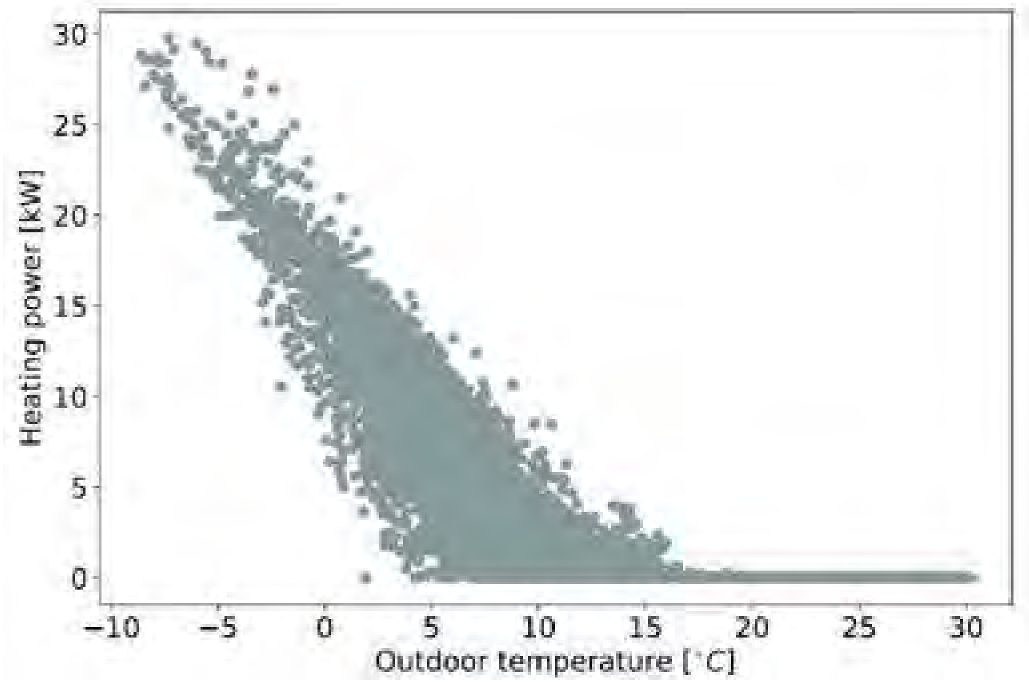

Grid feed-in
House consumption
PV generation
Electrical energy [kWh]
600
500
400
300
200
100
0
−100
−200
−300
Self-consumption index[-]
1.0
0.8
0.6
0.4
0.2
0.0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Dynamic simulation results – Design challenge

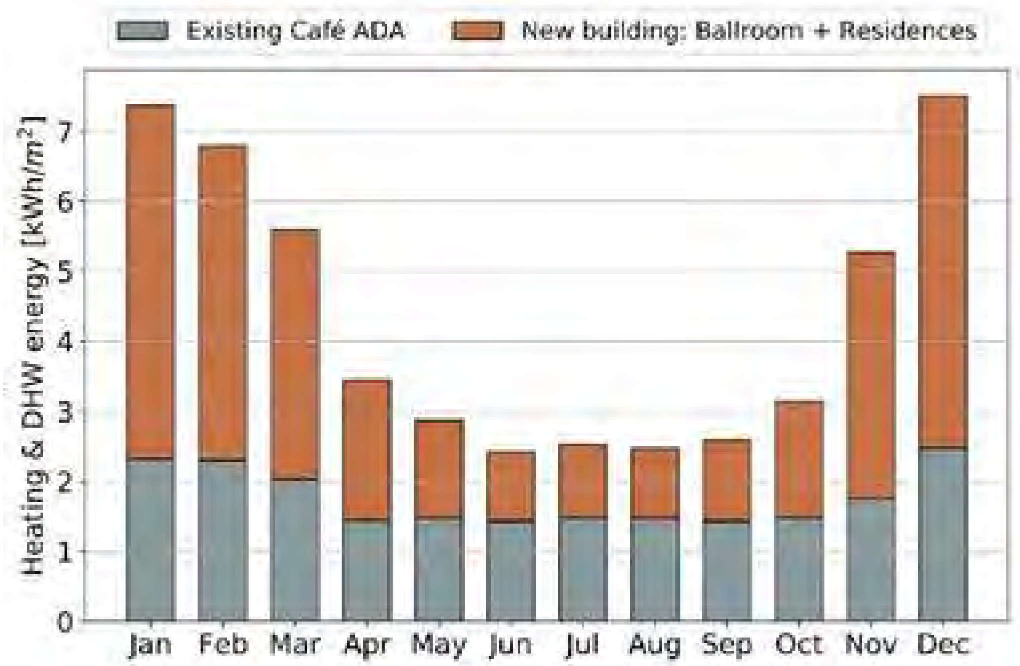
Modelica simplified model



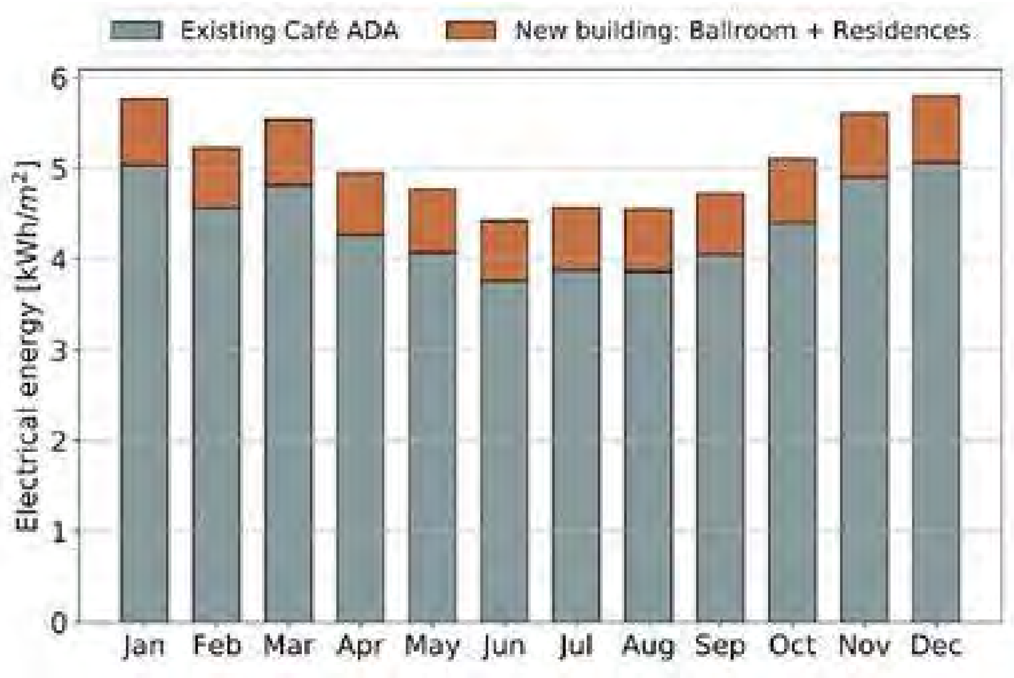
Heating power



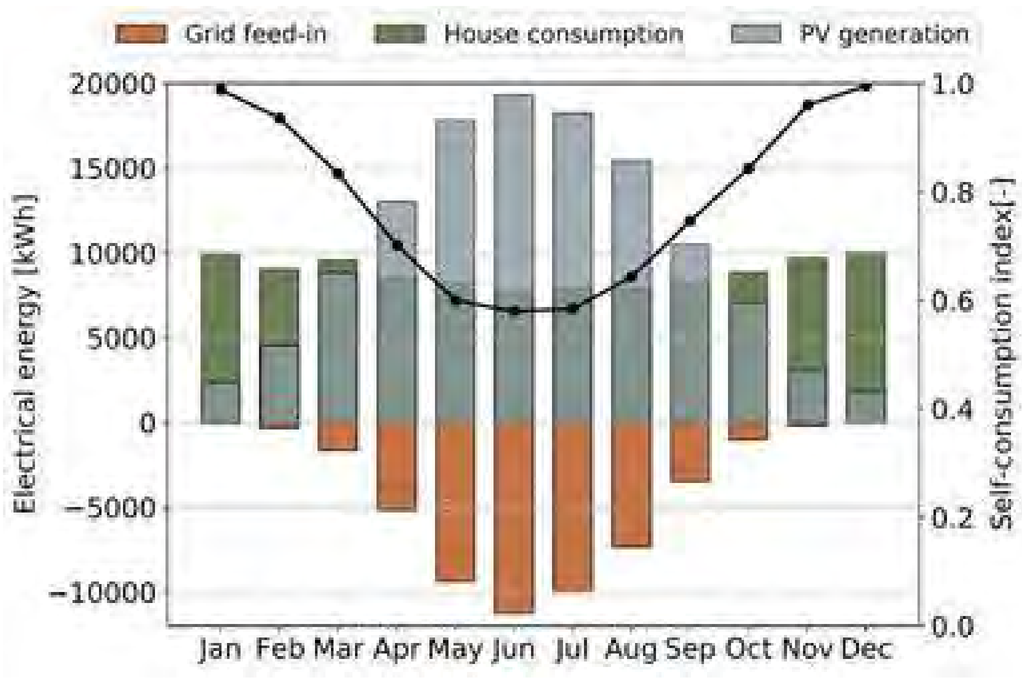
Thermal energy consumption



Electrical energy consumption



PV Generation and self-consumption index



Appendix F: Electronic

Group	Component type	Circuit	Circuit number/Device	Location	Quantity
MCB Protections	B 3x50 A	Total loads	Main circuit breaker	House connection box	1
	K 3x16 A	HVAC loads	1	Electrical distribution box	1
	B 10 A	HVAC loads	2, 6, 10	Electrical distribution box	3
	B 32 A	HDU loads	4	Electrical distribution box	1
	B 3 A	HDU loads	13	Electrical distribution box	1
	B 16 A	HDU loads	14	Electrical distribution box	1
	B 3x16 A	PV circuit	Inverter	Electrical distribution box	1
	B 20 A	PV circuit	PV panels	PV distribution box	1
	B 25 A	PV circuit	Battery	PV distribution box	1
	B 10 A	Off-meter	17	House connection box	1
RCBO Protections	30 mA + B 20 A	HDU loads	3	Electrical distribution box	1
	30 mA + B 16 A	HDU loads	5, 7, 9, 11, 15	Electrical distribution box	5
	30 mA + B 10 A	HDU loads	8, 12	Electrical distribution box	2
	30 mA + B 16 A	Off-meter	16, 18	House connection box	2
RCD Protections	300 mA	PV circuit	Inverter	Electrical distribution box	1
SPD Protection	Type 1 100 kA	Total loads	Main circuit earthing	House connection box	1
	Type 1 + 2 1000 VDC	PV circuit	Inverter	Inverter	1

Appendix G: EMS

Group	Name	Usage	Manufacturer	Identifier	Quantity
General BMS	Voltage/IP gateway	Voltage supply for KNX and IP-gateway	Jung	20320 1S IPS R	1
	4G Internet Router	Internet connection, switch, wifi	AVM	Fritzbox 6850 LTE	1
	Central computer	Optimization, "heart of the BMS"	Raspberry Pi	Raspberry Pi 4	1
	DALI Gateway	Control of the lights	Jung	2099 REGHE	1
User interface	Touch Monitor	User interface for most BMS functions	iiyama	PL T2234MSC-B7X	1
	Wireless user switches 1-gang + cover + frame	User control over lights, shutters and skylights	Jung	4071 RF TSM	2
	Wireless user switches 2-gang + cover + frame	User control over lights, shutters and skylights	Jung	4072 RF TSM	1
	Wireless user switches 3-gang + cover + frame	User control over lights, shutters and skylights	Jung	4073 RF TSM	4
	Wireless user switches 4-gang + cover + frame	User control over lights, shutters and skylights	Jung	4074 RF TSM	1
	Radio receiver KNX	Wireless radio receiver for switches	Jung	MK 100 RF	1
Sockets	Controllable power socket	Loading of e-bikes	Jung	820 GN NAWSLEB	2
	Sockets indoor	SCHUKO Sockets snow white	Jung	LS 1521 WWM	35
	Sockets outdoor	SCHUKO Sockets snow white with lock	Jung	LS 1520 NAKLSL WW	3
Sensors	Room sensors	Monitoring of room comfort	Jung	CO2 LS 2178 WWM	2
	Weather station	Monitoring of outside wind, temperature, humidity, rain...	Jung	2225 WS U	1
	Power supply weather station	Supply of needed power	Jung	WSSV 10	1
	Smoke detector	Fire protection	Jung	RWM 200 SW	2
Heating	Heat pump connection box	Gateway to KNX/Raspberry Pi	Bosch	MB Lan 2	1
	Solar pump controller	Controller of the PVT thermal collectors	Lovato	Lovasol MTDC	1
Ventilation	Facade ventilation control	Control of the 4 wall ventilators	Lunos	KNX Control 4	1
	Core ventilation control	Ventilation control depending on room temperature and humitidy	Lunos	5/EC-KE	1
	Shower ventilation control	Ventilation control depending on humitidy	Lunos	5/EC-FK	1
	WC ventilation control	Ventilation control depending on light switch	Lunos	5/EC-ZI	1
PV Management	Inverter	Information about battery status and PV production	Fronius	SYMO GEN24 PLUS 5.0	1
	Smart Meter	Sensor for inverter control unit	Fronius	63A-3	1

Appendix H: Lighting

Floor	Room	Position nr.	Light solution	Light type	Manufacturer	Product	Power (W)	Switch position (circuit number)
First floor, interior	Core, all	1.1	Indirect lighting, central	Linear light profile	Mextar	Vario40	106,50	1,2,3 (I)
	Core, all	1.2	Indirect lighting, central	Linear light profile	Mextar	Vario40	41,25	1,2,3 (II)
First floor, interior	All	2.1	Accent lighting, spread around space	Wall luminaire	Nimbus	Winglet CL 3er-Set	0,00	Battery
		2.2		Mounting accessory	Nimbus	Winglet CL Magnets		
First floor, interior	Dining	3.1	Task lighting on table	Pendant luminaire	Ribag	KIVO	36,00	1,2 (III)
		3.2		Luminaire shade	KIT-RoofKIT	Decorative luminaire cluster		
First floor, interior	Living	4.1	Task lighting, reading	Free standing luminaire	Nimbus	Roxxane Leggera	0,00	Battery
First floor, interior	Working	4.2	Task lighting, working	Table luminaire	Nimbus	Roxxane Leggera	0,00	Battery
First floor, interior	Shower	5.1	General lighting	Linear light profile	Mextar	Slim30	11,20	4 (IV)
First floor, interior	Wash basin	5.2	General lighting	Linear light profile	Mextar	Slim30	12,40	4 (V)
First floor, interior	WC	5.3	General lighting	Linear light profile	Mextar	Slim30	11,20	4 (VI)
First floor, interior	Kitchen	6.1	Task lighting	Linear light profile	iGuzzini	Underscore, LED strip	5,40	5 (VII)
First floor, interior	Technical core	7.1	Task lighting	Flat ceiling luminaire	iGuzzini	iPlan Access	30,00	6 (VIII)
First floor, interior	Balcony / Entrance	8.1	Outdoor lighting, vertical graze lighting, on wall	Linear wallgrazer	iGuzzini	Linealuce	26,00	1 (IX)
First floor, exterior	Entrance / Stairs + Lift	9.1	Outdoor lighting, security and visibility	Adjustable spot	iGuzzini	Palco inOut / iPro	32,00	Automatic time clock
Ground floor, exterior	Stairs	10.1	Outdoor lighting, security and visibility	Linear light profile	iGuzzini	Underscore InOut, LED strip	16,00	Automatic time clock
Ground floor, exterior	Staying area	11.1	Outdoor lighting, visibility, accentuation roof	Ceiling washer	iGuzzini	Trick, wallwasher	8,00	Automatic time clock
Ground floor, exterior	Staying area	12.1	Outdoor lighting, event	Adjustable spot	iGuzzini	Palco inOut / iPro	30,00	Automatic time clock

Group	Product / Pipe / Fitting	Material	Length (m)	Diameter (mm)	Quantity
Ventilation	Facade-integrated ventilation - Lunos e²60				4
	Exhaust ventilation - Lunos Silvento ec				3
	Vent system waste water	Steel	4.75	90	
	Piping exhaust ventilation	Steel	4	70	
Plumbing	Pipe from fresh water tank until main shut-off device	Copper	5	25	
	Domestic cold water pipe + cork insulation 26 mm	Copper	8	20	
	Domestic hot water pipe + cork insulation 26 mm	Copper	10.5	20	
	Domestic cold water pipe + cork insulation 26 mm	Copper	3	15	
	Domestic hot water pipe + cork insulation 26 mm	Copper	1.5	15	
	Waste water pipe WC	Steel	1.5	100	
	Waste water pipe rest	Steel	7.5	56	
	Shut-off valve				4
	Backflow preventer (check valve)				2
	Main shut-off device				1
	Water meter				1
	System separator valve				1
Solar circuit	PVT Module - Solator PVT INDACH + AxSun PV Emsemble M-60				12+18
	Solar pump - Solator PUDN25				1
	Transition connections	Copper			6
	Expansion vessel 25 l + Valve				1
	Exhaust line				1
	Pipes + cork insulation 38 mm	Copper	18.5	25	
	Cu-Bend 90°	Copper		25	20
Buffer-HP circuit	Buffer tank - Buderus SU1000 5-B (1000 l)				1
	3-way mixing valve				1
	Transition connections	Copper			5
	Enclosure			25	2
	Expansion vessel 50 l + Valve				1
	Exhaust line				1
	Vent				1
	Drainage				1
	Pipes + cork insulation 38 mm	Copper	12	25	
	Cu-Bend 90°	Copper		25	12
	Cu-Bend 45°	Copper		25	1
	Tees	Copper		25	2
Floor heating circuit	Heat pump - Bosch Compress 7800i LW M(F)				1
	Floor heating piping - Wieland Cuprotherm CTX 14x2 mm	Copper	415	14	
	Heat conducting plates for floor heating	Steel	415	15	
	Transition connections	Copper			16
	Security group (manometer, safety valve, vent)				1
	Exhaust line				1
	Enclosure			15	4
	Vent				2
	System separation valve				1
	Magnetic filter				1
	Backflow preventer (check valve)				1
	Heating distribution circuit				1
	Expansion vessel 12 l + Valve				1
	Pipes + cork insulation 26 mm	Copper	11	15	
	Cu-Bend 90°	Copper		15	9
	Cu-Bend 45°	Copper		15	2
	Tees	Copper		15	3

RoofKIT - Ceiling HDU

RoofKIT_Dach_Neptutherm

Roof construction
created on 22.3.2022

Thermal protection

U = 0,14 W/(m²K)

GEG 2020 Bestand*: U<0,24 W/(m²K)

excellent insufficient

Moisture proofing

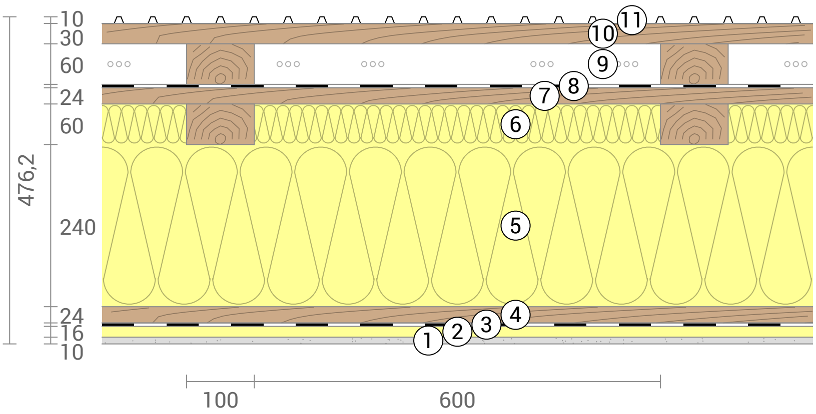
Drying reserve: 1085 g/m²a
No condensate

excellent insufficient

Heat protection

Temperature amplitude damping: >100
phase shift: non relevant
Thermal capacity inside: 61 kJ/m²K

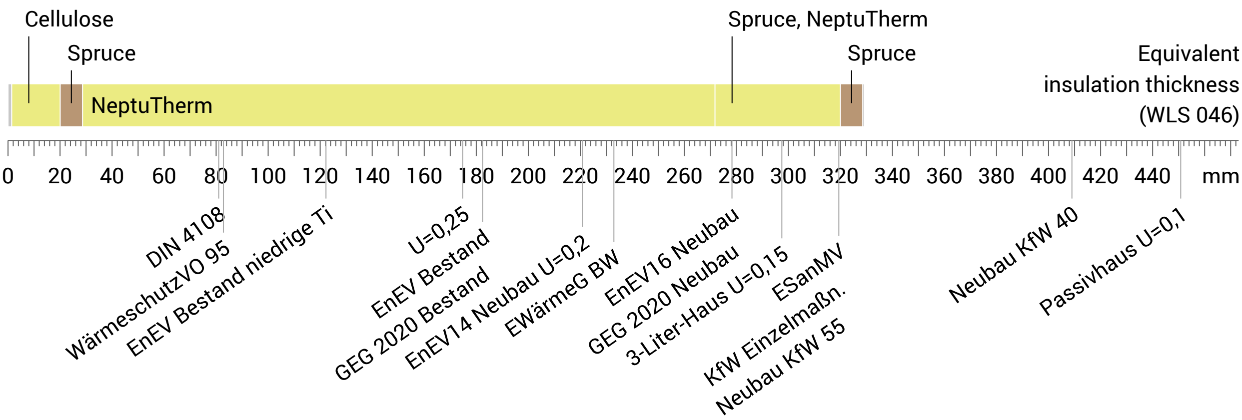
excellent insufficient



1. HASIT 150 Filzputz (10 mm)
2. Cellulose (16 mm)
3. Dampfsperre
4. Spruce (24 mm)
5. NeptuTherm (240 mm)
6. NeptuTherm (60 mm)
7. Spruce (24 mm)
8. Knauf Insulation LDS 0.04
9. Rear ventilated level (60 mm)
10. Holzschalung mit Fugen (30 mm)
11. trapezoidal sheet (10 mm)

Impact of each layer and comparison to reference values

For the following figure, the thermal resistances of the individual layers were converted in millimeters insulation. The scale refers to an insulation of thermal conductivity 0,046 W/mK.



Inside air :	20,0°C / 50%			Thickness:	47,6 cm
Outside air:	-5,0°C / 80%	sd-value:	2002,4 m	Weight:	92 kg/m²
Surface temperature.:	19,2°C / -4,9°C	Drying reserve:	1085 g/m²a	Heat capacity:	114 kJ/m²K

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*Comparison of the U-value with den Höchstwerten aus GEG 2020 Anlage 7 (GEG 2020 Bestand); den techn. Mindestanforderungen für BEG Einzelmaßnahmen; 80% des U-Werts der Referenzausführung aus GEG 2020 Anlage 1 (GEG20 Neubau); den R-Werten aus DIN 4108-2 Tabelle 3

RoofKIT_Dach_Neptutherm, U=0,14 W/(m²K)

U-Value calculation according to DIN EN ISO 6946

#	Material	Dicke [cm]	λ [W/mK]	R [m²K/W]
	Thermal contact resistance inside (Rsi)			0,100
1	HASIT 150 Filzputz	1,00	0,330	0,030
2	Cellulose	1,60	0,040	0,400
3	Dampfsperre	0,20	160,000	0,000
4	Spruce	2,40	0,130	0,185
5	NeptuTherm	24,00	0,046	5,217
6	NeptuTherm	6,00	0,046	1,304
	Spruce (14%)	6,00	0,130	0,462
7	Spruce	2,40	0,130	0,185
8	Knauf Insulation LDS 0.04	0,02	0,270	0,001
	Thermal contact resistance outside (Rse)			0,100

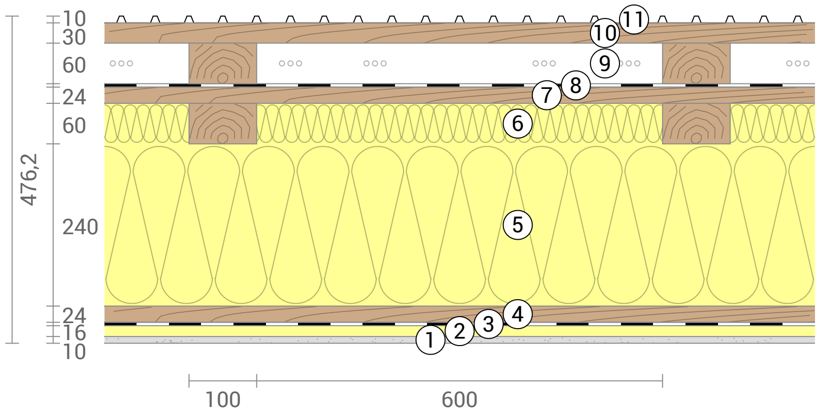
Thermal contact resistances have been taken from DIN 6946 Table 7.
Rsi: heat flow direction upwards
Rse: heat flow direction upwards, outside: Ventilation level

Upper limit of thermal resistance $R_{tot;upper}$ = 7,389 m²K/W.
Lower limit of thermal resistance $R_{tot;lower}$ = 7,252 m²K/W.
Check applicability: $R_{tot;upper}$ / $R_{tot;lower}$ = 1,019 (maximum allowed: 1,5)

The procedure may be used.

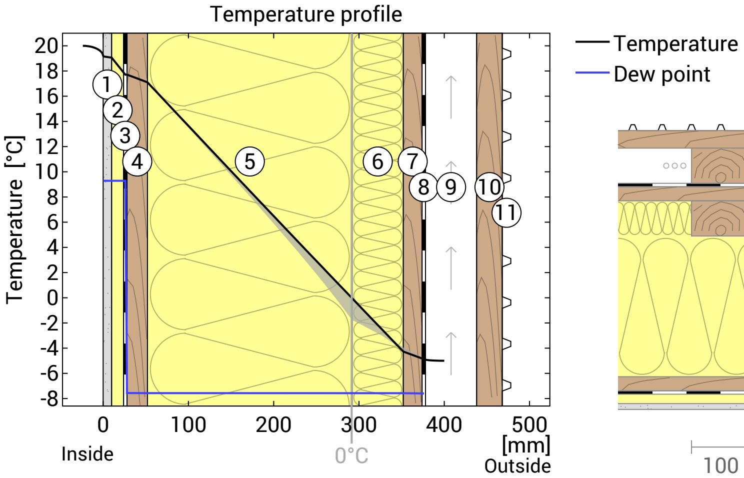
Thermal resistance $R_{tot} = (R_{tot;upper} + R_{tot;lower})/2$ = 7,320 m²K/W
Estimated maximum relative uncertainty according to section 6.7.2.5: 0,93%

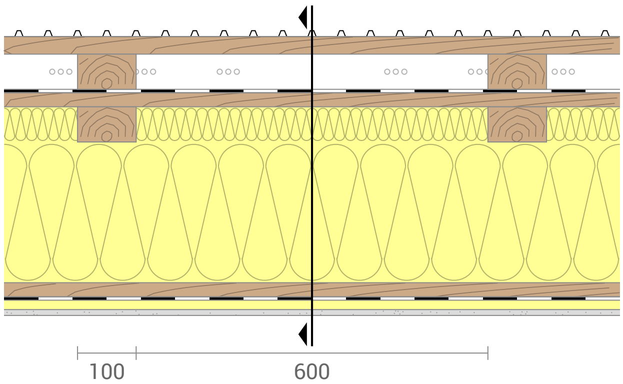
Heat transfer coefficient U = $1/R_{tot}$ = **0,14 W/(m²K)**



RoofKIT_Dach_Neptutherm, U=0,14 W/(m²K)

Temperature profile





① HASIT 150 Filzputz (10 mm)
② Cellulose (16 mm)
③ Dampfsperre
④ Spruce (24 mm)
⑤ NeptuTherm (240 mm)
⑥ NeptuTherm (60 mm)
⑦ Spruce (24 mm)
⑧ Knauf Insulation LDS 0.04
⑨ Rear ventilated level (60 mm)
⑩ Holzschalung mit Fugen (30 mm)
⑪ trapezoidal sheet (10 mm)

Left: Temperature and dew-point temperature at the place marked in the right figure. The dew-point indicates the temperature, at which water vapour condensates. As long as the temperature of the component is everywhere above the dew point, no condensation occurs. If the curves have contact, condensation occurs at the corresponding position.
Right: The component, drawn to scale.

Layers (from inside to outside)

#		Material	λ [W/mK]	R [m²K/W]	Temperatur [°C] min	max	Weight [kg/m²]
		Thermal contact resistance*		0,250	19,2	20,0	
1	1 cm	HASIT 150 Filzputz	0,330	0,030	19,1	19,2	12,0
2	1,6 cm	Cellulose	0,040	0,400	17,7	19,1	0,8
3	0,2 cm	Dampfsperre	160,000	0,000	17,7	17,7	5,4
4	2,4 cm	Spruce	0,130	0,185	17,1	17,7	10,8
5	24 cm	NeptuTherm	0,046	5,217	-1,8	17,1	18,0
6	6 cm	NeptuTherm	0,046	1,304	-4,3	0,0	3,9
	6 cm	Spruce (14%)	0,130	0,462	-4,0	-1,4	3,9
7	2,4 cm	Spruce	0,130	0,185	-4,9	-3,9	10,8
8	0,02 cm	Knauf Insulation LDS 0.04	0,270	0,001	-4,9	-4,8	0,1
		Thermal contact resistance*		0,040	-5,0	-4,8	
9	6 cm	Rear ventilated level (outside air)			-5,0	-5,0	0,0
10	3 cm	Holzschalung (Decke) mit Fugen			-5,0	-5,0	21,0
11	1 cm	trapezoidal sheet			-5,0	-5,0	1,0
	47,62 cm	Whole component		7,344			91,5

*Thermal contact resistances according to DIN 4108-3 for moisture protection and temperature profile. The values for the U-value calculation can be found on the page 'U-value calculation'.

Surface temperature inside (min / average / max):	19,2°C	19,2°C	19,2°C
Surface temperature outside (min / average / max):	-4,9°C	-4,9°C	-4,8°C

RoofKIT_Dach_Neptutherm, U=0,14 W/(m²K)

Moisture proofing

For the calculation of the amount of condensation water, the component was exposed to the following constant climate for 90 days: inside: 20°C und 50% Humidity; outside: -5°C und 80% Humidity. This climate complies with DIN 4108-3.

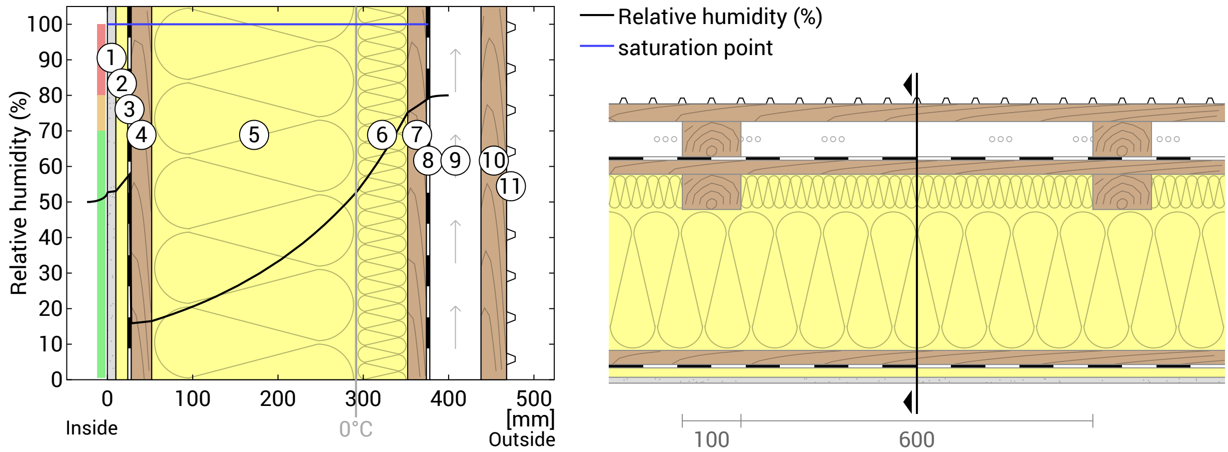
This component is free of condensate under the given climate conditions.

Drying reserve according to DIN 4108-3:2018: 1085 g/(m²a)
At least required by DIN 68800-2: 250 g/(m²a)

#		Material	sd-value [m]	Condensate [kg/m²]	[Gew.-%]	Weight [kg/m²]
1	1 cm	HASIT 150 Filzputz	0,05	-		12,0
2	1,6 cm	Cellulose	0,02	-		0,8
3	0,2 cm	Dampfsperre	2000	-		5,4
4	2,4 cm	Spruce	0,48	-	-	10,8
5	24 cm	NeptuTherm	0,24	-		18,0
6	6 cm	NeptuTherm	0,06	-		3,9
	6 cm	Spruce (14%)	3,00	-	-	3,9
7	2,4 cm	Spruce	1,20	-	-	10,8
8	0,02 cm	Knauf Insulation LDS 0.04	0,04	-		0,1
	47,62 cm	Whole component	2.002,40			91,5

Humidity

The temperature of the inside surface is 19,2 °C leading to a relative humidity on the surface of 53%.Mould formation is not expected under these conditions.
The following figure shows the relative humidity inside the component.



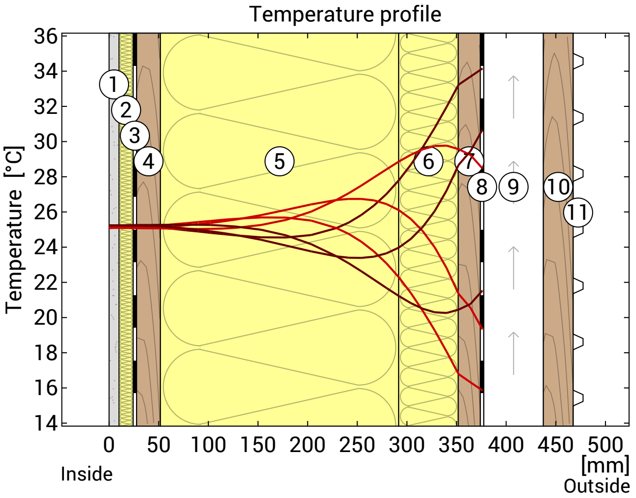
① HASIT 150 Filzputz (10 mm)
② Cellulose (16 mm)
③ Dampfsperre
④ Spruce (24 mm)
⑤ NeptuTherm (240 mm)
⑥ NeptuTherm (60 mm)
⑦ Spruce (24 mm)
⑧ Knauf Insulation LDS 0.04
⑨ Rear ventilated level (60 mm)
⑩ Holzschalung mit Fugen (30 mm)
⑪ trapezoidal sheet (10 mm)

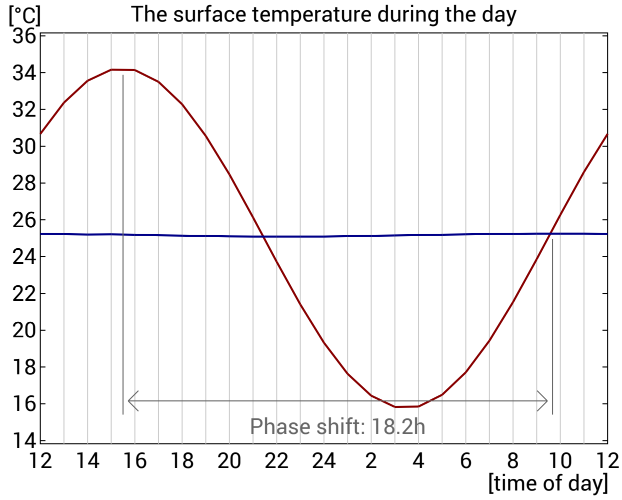
Notes: Calculation using the Ubakus 2D-FE method. Convection and the capillarity of the building materials were not considered. The drying time may take longer under unfavorable conditions (shading, damp / cool summers) than calculated here.

RoofKIT_Dach_Neptutherm, U=0,14 W/(m²K)

Heat protection

The following results are properties of the tested component alone and do not make any statement about the heat protection of the entire room:





Top: Temperature profile within the component at different times. From top to bottom, brown lines: at 3 pm, 11 am and 7 am and red lines at 7 pm , 11 pm and 3 am.
Bottom: Temperature on the outer (red) and inner (blue) surface in the course of a day. The arrows indicate the location of the temperature maximum values . The maximum of the inner surface temperature should preferably occur during the second half of the night.

Phase shift*	non relevant	Heat storage capacity (whole component):	114 kJ/m²K
Amplitude attenuation **	>100	Thermal capacity of inner layers:	61 kJ/m²K
TAV ***	0,009		

* The phase shift is the time in hours after which the temperature peak of the afternoon reaches the component interior.
** The amplitude attenuation describes the attenuation of the temperature wave when passing through the component. A value of 10 means that the temperature on the outside varies 10x stronger than on the inside, e.g. outside 15-35 °C, inside 24-26 °C.
*** The temperature amplitude ratio TAV is the reciprocal of the attenuation: TAV = 1 / amplitude attenuation

Note: The heat protection of a room is influenced by several factors, but essentially by the direct solar radiation through windows and the total amount of heat storage capacity (including floor, interior walls and furniture). A single component usually has only a very small influence on the heat protection of the room.

The calculations presented above have been created for a 1-dimensional cross-section of the component.

RoofKIT - Exterior wall HDU

RoofKIT_Außenwand_240_Neptutherm

Exterior wall
created on 22.3.2022

Thermal protection

U = 0,20 W/(m²K)

GEG 2020 Bestand*: U<0,24 W/(m²K)

excellent insufficient

Moisture proofing

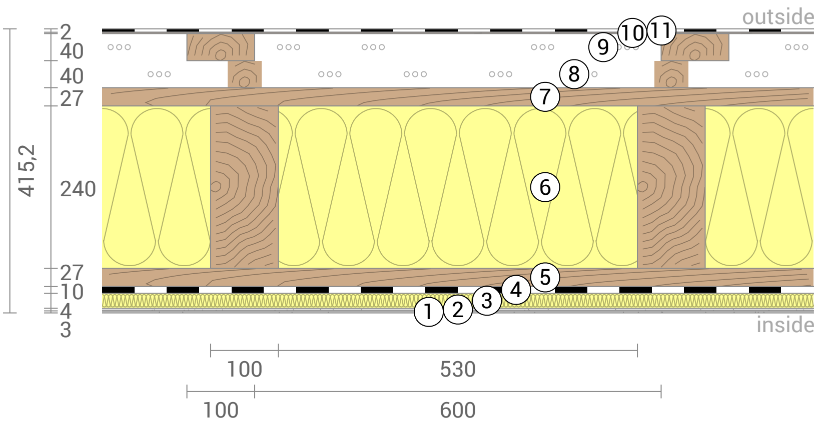
Drying reserve: 711 g/m²a
No condensate

excellent insufficient

Heat protection

Temperature amplitude damping: >100
phase shift: non relevant
Thermal capacity inside: 117 kJ/m²K

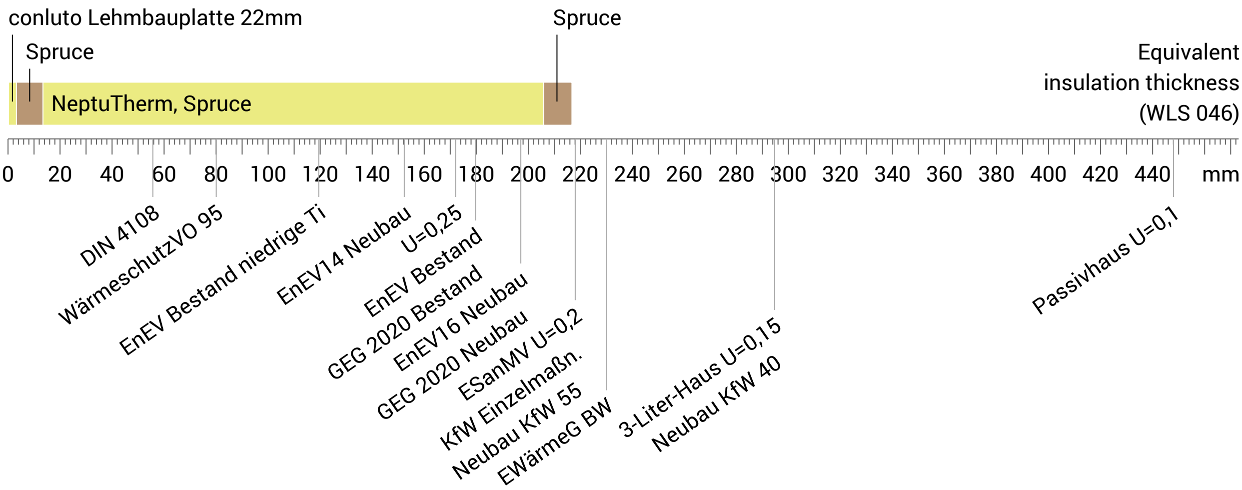
excellent insufficient



1. Lehm-Oberputz (3 mm)
2. Lehm-Unterputz (4 mm)
3. conluto Lehmbauplatte 22mm (22 mm)
4. Dampfsperre
5. Spruce (27 mm)
6. NeptuTherm (240 mm)
7. Spruce (27 mm)
8. Air layer (40 mm)
9. Rear ventilated level (40 mm)
10. Spruce (2 mm)
11. Knauf Insulation LDS 0.04

Impact of each layer and comparison to reference values

For the following figure, the thermal resistances of the individual layers were converted in millimeters insulation. The scale refers to an insulation of thermal conductivity 0,046 W/mK.



Inside air :	20,0°C / 50%			Thickness:	41,5 cm
Outside air:	-5,0°C / 80%	sd-value:	10003,1 m	Weight:	133 kg/m²
Surface temperature.:	18,7°C / -4,8°C	Drying reserve:	711 g/m²a	Heat capacity:	172 kJ/m²K

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*Comparison of the U-value with den Höchstwerten aus GEG 2020 Anlage 7 (GEG 2020 Bestand); den techn. Mindestanforderungen für BEG Einzelmaßnahmen; 80% des U-Werts der Referenzausführung aus GEG 2020 Anlage 1 (GEG20 Neubau); den R-Werten aus DIN 4108-2 Tabelle 3

Page 1

RoofKIT_Außenwand_240_Neptutherm, U=0,20 W/(m²K)

U-Value calculation according to DIN EN ISO 6946

#	Material	Dicke [cm]	λ [W/mK]	R [m²K/W]
	Thermal contact resistance inside (Rsi)			0,130
1	Lehm-Oberputz	0,30	0,910	0,003
2	Lehm-Unterputz	0,40	0,910	0,004
3	conluto Lehmbauplatte 22mm	2,20	0,353	0,062
4	Dampfsperre	1,00	160,000	0,000
5	Spruce	2,70	0,130	0,208
6	NeptuTherm	24,00	0,046	5,217
	Spruce (16%)	24,00	0,130	1,846
7	Spruce	2,70	0,130	0,208
	Thermal contact resistance outside (Rse)			0,130

Thermal contact resistances have been taken from DIN 6946 Table 7.
Rsi: heat flow direction horizontally
Rse: heat flow direction horizontally, outside: Ventilation level

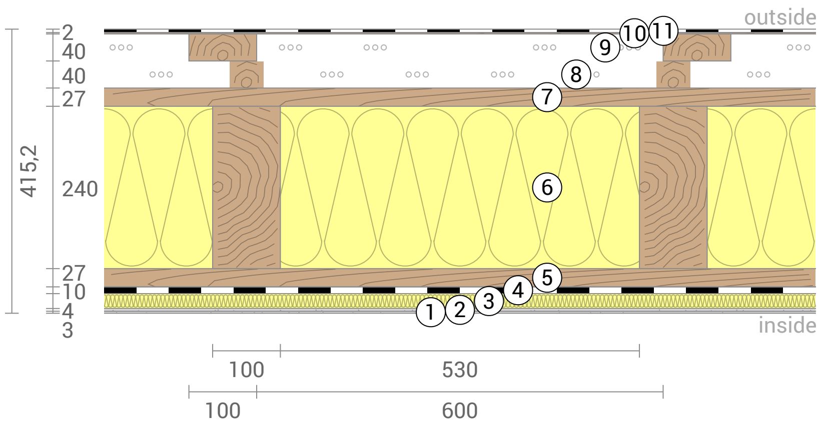
Upper limit of thermal resistance $R_{tot;upper}$ = 5,028 m²K/W.
Lower limit of thermal resistance $R_{tot;lower}$ = 4,883 m²K/W.
Check applicability: $R_{tot;upper}$ / $R_{tot;lower}$ = 1,030 (maximum allowed: 1,5)

The procedure may be used.

Thermal resistance R_{tot} = ($R_{tot;upper}$ + $R_{tot;lower}$)/2 = 4,956 m²K/W
Estimated maximum relative uncertainty according to section 6.7.2.5: 1,5%

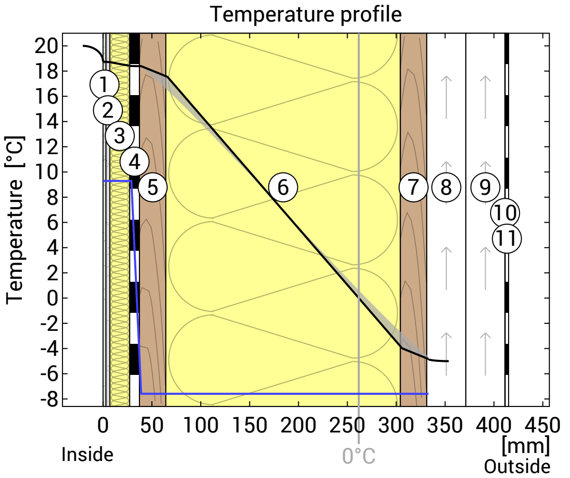
Heat transfer coefficient U = 1/R_{tot} = **0,20 W/(m²K)**

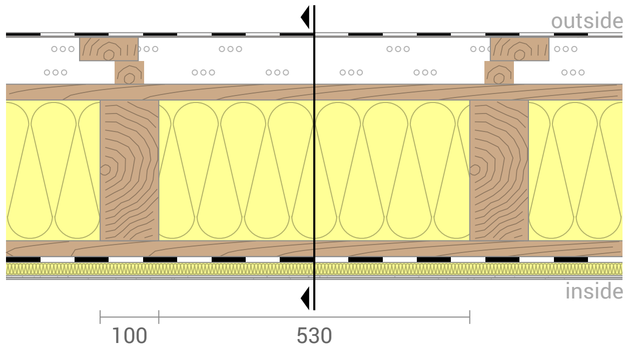
This component includes several inhomogeneous layers of different overall width. For all the calculations it was assumed that the layer arrangement is repeated in width all 70 cm. This, however, is not true for at least layer 6 with a total width of 63 cm and can cause increased inaccuracy of the U-value.



RoofKIT_Außenwand_240_Neptutherm, U=0,20 W/(m²K)

Temperature profile





① Lehm-Oberputz (3 mm)
② Lehm-Unterputz (4 mm)
③ conluto Lehmbauplatte 22mm (22 mm)
④ Dampfsperre
⑤ Spruce (27 mm)
⑥ NeptuTherm (240 mm)
⑦ Spruce (27 mm)
⑧ Air layer (40 mm)
⑨ Rear ventilated level (40 mm)
⑩ Spruce (2 mm)
⑪ Knauf Insulation LDS 0.04

Left: Temperature and dew-point temperature at the place marked in the right figure. The dew-point indicates the temperature, at which water vapour condensates. As long as the temperature of the component is everywhere above the dew point, no condensation occurs. If the curves have contact, condensation occurs at the corresponding position.
Right: The component, drawn to scale.

Layers (from inside to outside)

#		Material	λ [W/mK]	R [m²K/W]	Temperatur [°C] min	max	Weight [kg/m²]
		Thermal contact resistance*		0,250	18,7	20,0	
1	0,3 cm	Lehm-Oberputz	0,910	0,003	18,7	18,8	4,5
2	0,4 cm	Lehm-Unterputz	0,910	0,004	18,7	18,7	6,4
3	2,2 cm	conluto Lehmbauplatte 22mm	0,353	0,062	18,4	18,7	31,9
4	1 cm	Dampfsperre	160,000	0,000	18,4	18,4	27,0
5	2,7 cm	Spruce	0,130	0,208	16,5	18,4	12,2
6	24 cm	NeptuTherm	0,046	5,217	-4,0	17,5	14,7
	24 cm	Spruce (16%)	0,130	1,846	-3,2	16,8	19,6
7	2,7 cm	Spruce	0,130	0,208	-4,8	-2,8	12,2
		Thermal contact resistance*		0,040	-5,0	-4,7	
8	4 cm	Air layer (ventilated)			-5,0	-5,0	0,0
9	4 cm	Rear ventilated level (outside air)			-5,0	-5,0	0,0
10	0,2 cm	Spruce			-5,0	-5,0	0,9
11	0,02 cm	Knauf Insulation LDS 0.04			-5,0	-5,0	0,2
	41,52 cm	Whole component		4,959			132,8

*Thermal contact resistances according to DIN 4108-3 for moisture protection and temperature profile. The values for the U-value calculation can be found on the page 'U-value calculation'.

Surface temperature inside (min / average / max):	18,7°C	18,7°C	18,8°C
Surface temperature outside (min / average / max):	-4,8°C	-4,8°C	-4,7°C

RoofKIT_Außenwand_240_Neptutherm, U=0,20 W/(m²K)

Moisture proofing

For the calculation of the amount of condensation water, the component was exposed to the following constant climate for 90 days: inside: 20°C und 50% Humidity; outside: -5°C und 80% Humidity. This climate complies with DIN 4108-3.

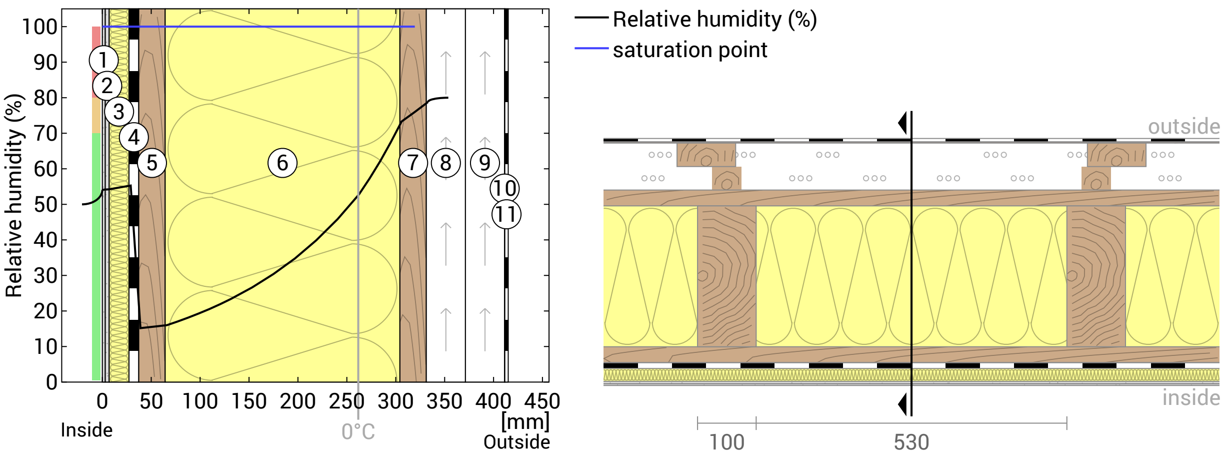
This component is free of condensate under the given climate conditions.

Drying reserve according to DIN 4108-3:2018: 711 g/(m²a)
At least required by DIN 68800-2: 100 g/(m²a)

#		Material	sd-value [m]	Condensate [kg/m²]	[Gew.-%]	Weight [kg/m²]
1	0,3 cm	Lehm-Oberputz	0,02	-		4,5
2	0,4 cm	Lehm-Unterputz	0,02	-		6,4
3	2,2 cm	conluto Lehmbauplatte 22mm	0,11	-		31,9
4	1 cm	Dampfsperre	10000	-		27,0
5	2,7 cm	Spruce	0,54	-	-	12,2
6	24 cm	NeptuTherm	0,24	-		14,7
	24 cm	Spruce (16%)	12,00	-	-	19,6
7	2,7 cm	Spruce	1,35	-	-	12,2
	41,52 cm	Whole component	10.003,14			132,8

Humidity

The temperature of the inside surface is 18,7 °C leading to a relative humidity on the surface of 54%.Mould formation is not expected under these conditions.
The following figure shows the relative humidity inside the component.



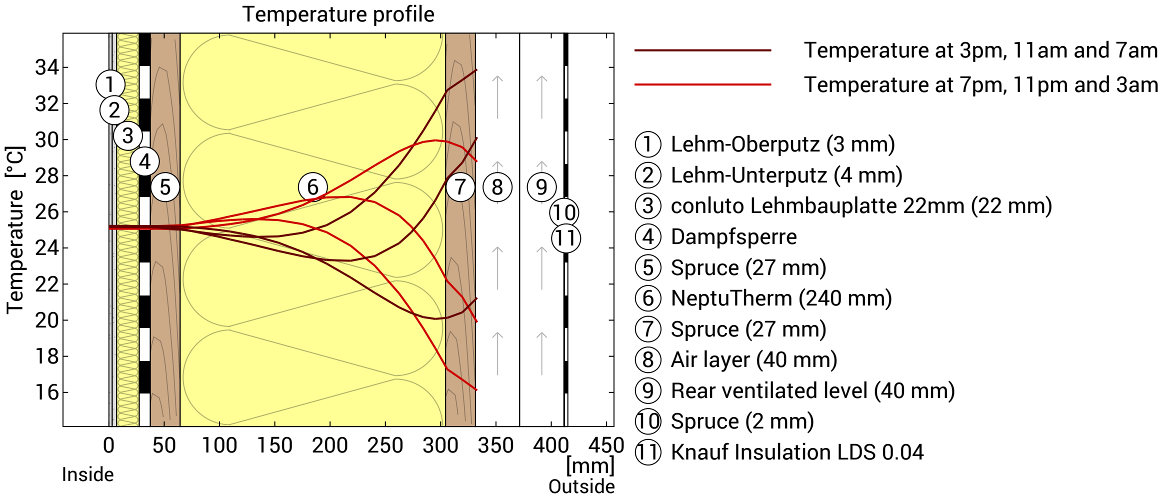
1. Lehm-Oberputz (3 mm)
2. Lehm-Unterputz (4 mm)
3. conluto Lehmbauplatte 22mm (22 mm
4. Dampfsperre
5. Spruce (27 mm)
6. NeptuTherm (240 mm)
7. Spruce (27 mm)
8. Air layer (40 mm)
9. Rear ventilated level (40 mm)
10. Spruce (2 mm)
11. Knauf Insulation LDS 0.04

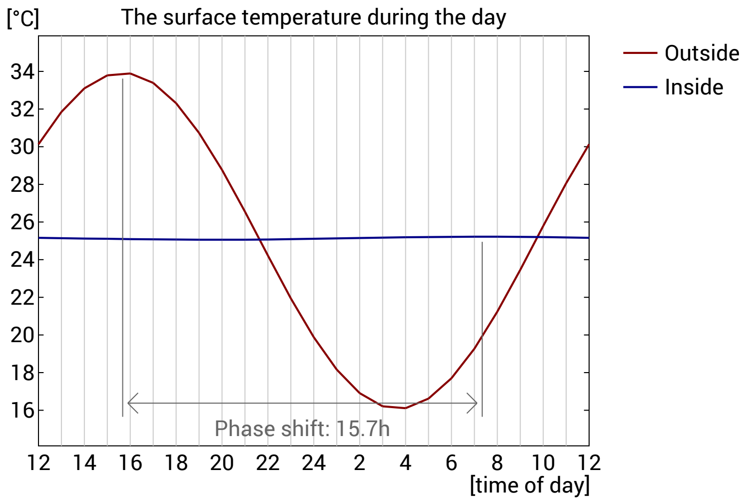
Notes: Calculation using the Ubakus 2D-FE method. Convection and the capillarity of the building materials were not considered. The drying time may take longer under unfavorable conditions (shading, damp / cool summers) than calculated here.

RoofKIT_Außenwand_240_Neptutherm, U=0,20 W/(m²K)

Heat protection

The following results are properties of the tested component alone and do not make any statement about the heat protection of the entire room:





Top: Temperature profile within the component at different times. From top to bottom, brown lines: at 3 pm, 11 am and 7 am and red lines at 7 pm , 11 pm and 3 am.
Bottom: Temperature on the outer (red) and inner (blue) surface in the course of a day. The arrows indicate the location of the temperature maximum values . The maximum of the inner surface temperature should preferably occur during the second half of the night.

Phase shift*	non relevant	Heat storage capacity (whole component):	172 kJ/m²K
Amplitude attenuation **	>100	Thermal capacity of inner layers:	117 kJ/m²K
TAV ***	0,009		

* The phase shift is the time in hours after which the temperature peak of the afternoon reaches the component interior.
** The amplitude attenuation describes the attenuation of the temperature wave when passing through the component. A value of 10 means that the temperature on the outside varies 10x stronger than on the inside, e.g. outside 15-35 °C, inside 24-26 °C.
*** The temperature amplitude ratio TAV is the reciprocal of the attenuation: TAV = 1 / amplitude attenuation

Note: The heat protection of a room is influenced by several factors, but essentially by the direct solar radiation through windows and the total amount of heat storage capacity (including floor, interior walls and furniture). A single component usually has only a very small influence on the heat protection of the room.

The calculations presented above have been created for a 1-dimensional cross-section of the component.

RoofKIT - Floor HDU

RoofKIT_Boden_Neptutherm

Floor
created on 22.3.2022

Thermal protection

U = 0,16 W/(m²K)

GEG 2020 Bestand*: U<0,3 W/(m²K)

excellent insufficient

Moisture proofing

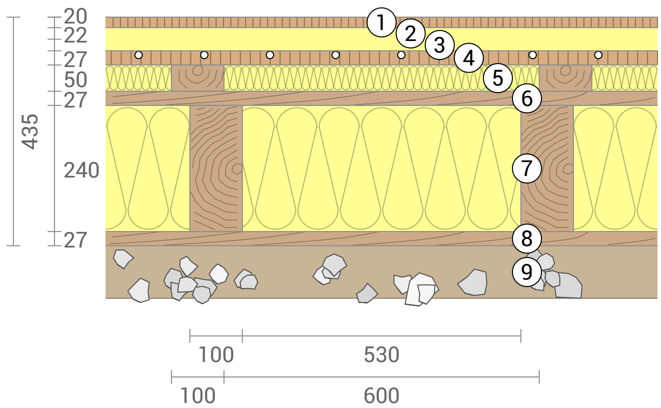
Drying reserve: 991 g/m²a
No condensate

excellent insufficient

Heat protection

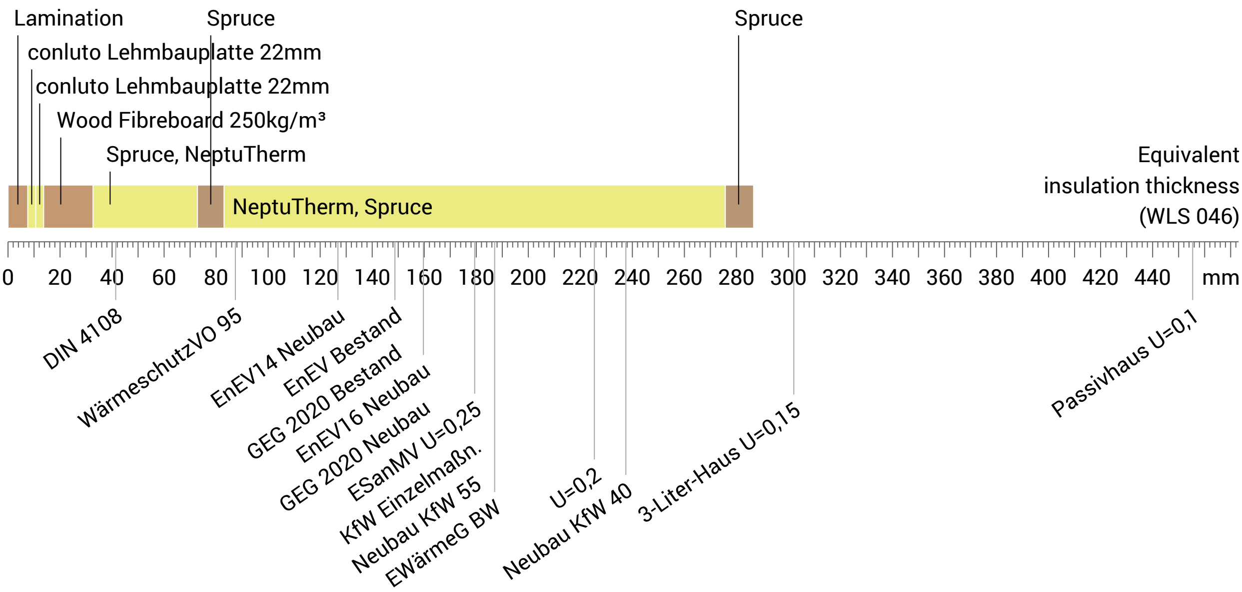
Component is adjacent to earth:
TAV and phase non relevant
Thermal capacity inside: 328 kJ/m²K

excellent insufficient



1. Lamination (20 mm)
2. conluto Lehmbauplatte 22mm (22 mm)
3. conluto Lehmbauplatte 22mm (22 mm)
4. Wood Fibreboard 250kg/m³ (27 mm)
5. NeptuTherm (50 mm)
6. Spruce (27 mm)
7. NeptuTherm (240 mm)
8. Spruce (27 mm)
9. Soil

Impact of each layer and comparison to reference values



Inside air :	20,0°C / 50%			Thickness:	43,5 cm
Ground:	8,0°C / 100%	sd-value:	3,4 m	Weight:	146 kg/m²
Surface temperature.:	26,4°C / 8,2°C			Heat capacity:	213 kJ/m²K

☑ GEG 2020 Bestand ☑ BEG Einzelmaßn. ☑ GEG 2020 Neubau ☑ DIN 4108

*Comparison of the U-value with den Höchstwerten aus GEG 2020 Anlage 7 (GEG 2020 Bestand); den techn. Mindestanforderungen für BEG Einzelmaßnahmen; 80% des U-Werts der Referenzausführung aus GEG 2020 Anlage 1 (GEG20 Neubau); den R-Werten aus DIN 4108-2 Tabelle 3

Page 1

RoofKIT_Boden_Neptutherm, U=0,16 W/(m²K)

U-value calculation

#	Material	Dicke [cm]	λ [W/mK]	R [m²K/W]
	Thermal contact resistance inside (Rsi)			0,100
1	Lamination	2,00	0,130	0,154
2	conluto Lehmbauplatte 22mm	2,20	0,353	0,062
3	conluto Lehmbauplatte 22mm	2,20	0,353	0,062
4	Wood Fibreboard 250kg/m³	2,70	0,070	0,386
5	NeptuTherm	5,00	0,046	1,087
	Spruce (14%)	5,00	0,130	0,385
6	Spruce	2,70	0,130	0,208
7	NeptuTherm	24,00	0,046	5,217
	Spruce (16%)	24,00	0,130	1,846
8	Spruce	2,70	0,130	0,208
	Thermal contact resistance outside (Rse)			0,000

Thermal contact resistances have been taken from DIN 6946 Table 7.
Rsi: heat flow direction upwards
Rse: heat flow direction downward, outside: Ground

Upper limit of thermal resistance $R_{tot;upper}$ = 6,469 m²K/W.
Lower limit of thermal resistance $R_{tot;lower}$ = 6,181 m²K/W.
Check applicability: $R_{tot;upper}$ / $R_{tot;lower}$ = 1,047 (maximum allowed: 1,5)

The procedure may be used.

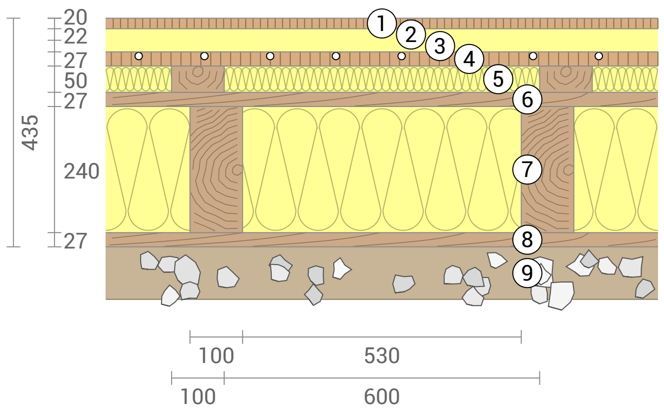
Thermal resistance R_{tot} = ($R_{tot;upper}$ + $R_{tot;lower}$)/2 = 6,325 m²K/W
Estimated maximum relative uncertainty according to section 6.7.2.5: 2,3%

DIN 6946 may not be used for earth-contacting components. However, for the alternative method from DIN V 4108-6 Annex E, the required data on the size and position of this component are missing.

Heat transfer coefficient U = 1/R_{tot} = **0,16 W/(m²K)**

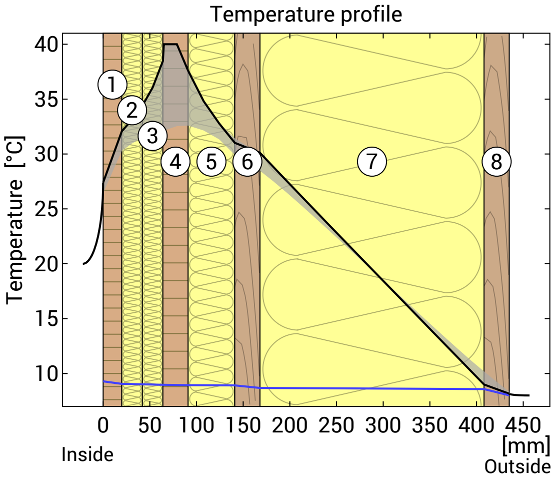
The constructive U-value was calculated. Heat losses across the ground or basement were not considered because the necessary data are missing.

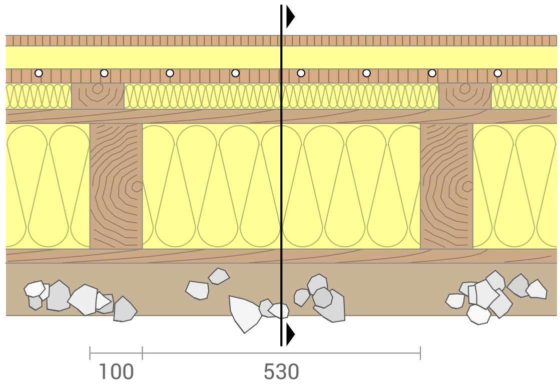
This component includes several inhomogeneous layers of different overall width. For all the calculations it was assumed that the layer arrangement is repeated in width all 70 cm. This, however, is not true for at least layer 7 with a total width of 63 cm and can cause increased inaccuracy of the U-value.



RoofKIT_Boden_Neptutherm, U=0,16 W/(m²K)

Temperature profile





① Lamination (20 mm)
② conluto Lehmbauplatte 22mm (22 mm)
③ conluto Lehmbauplatte 22mm (22 mm)
④ Wood Fibreboard 250kg/m³ (27 mm)
⑤ NeptuTherm (50 mm)
⑥ Spruce (27 mm)
⑦ NeptuTherm (240 mm)
⑧ Spruce (27 mm)

Left: Temperature and dew-point temperature at the place marked in the right figure. The dew-point indicates the temperature, at which water vapour condensates. As long as the temperature of the component is everywhere above the dew point, no condensation occurs. If the curves have contact, condensation occurs at the corresponding position.
Right: The component, drawn to scale.

Layers (from inside to outside)

#		Material	λ [W/mK]	R [m²K/W]	Temperatur [°C] min	max	Weight [kg/m²]
		Thermal contact resistance*		0,250	20,0	27,4	
1	2 cm	Lamination	0,130	0,154	26,4	32,2	10,0
2	2,2 cm	conluto Lehmbauplatte 22mm	0,353	0,062	30,3	34,6	31,9
3	2,2 cm	conluto Lehmbauplatte 22mm	0,353	0,062	31,5	38,6	31,9
4	2,7 cm	Wood Fibreboard 250kg/m³	0,070	0,386	32,1	40,0	6,8
5	5 cm	NeptuTherm	0,046	1,087	29,9	37,6	3,1
	5 cm	Spruce (14%)	0,130	0,385	30,3	36,3	4,1
6	2,7 cm	Spruce	0,130	0,208	28,5	31,4	12,2
7	24 cm	NeptuTherm	0,046	5,217	9,0	30,2	14,7
	24 cm	Spruce (16%)	0,130	1,846	9,8	29,4	19,6
8	2,7 cm	Spruce	0,130	0,208	8,2	10,2	12,2
		Thermal contact resistance*		0,040	8,0	8,3	
9		Soil			8,0	8,0	74,0
	43,5 cm	Whole component		6,316			146,4

*Thermal contact resistances according to DIN 4108-3 for moisture protection and temperature profile. The values for the U-value calculation can be found on the page 'U-value calculation'.

Surface temperature inside (min / average / max):	26,4°C	27,1°C	27,4°C
Surface temperature outside (min / average / max):	8,2°C	8,2°C	8,3°C

RoofKIT_Boden_Neptutherm, U=0,16 W/(m²K)

Moisture proofing

For the calculation of the amount of condensation water, the component was exposed to the following constant climate for 90 days: inside: 20°C und 50% Humidity; outside: 8°C und 100% Humidity (Climate according to user input).

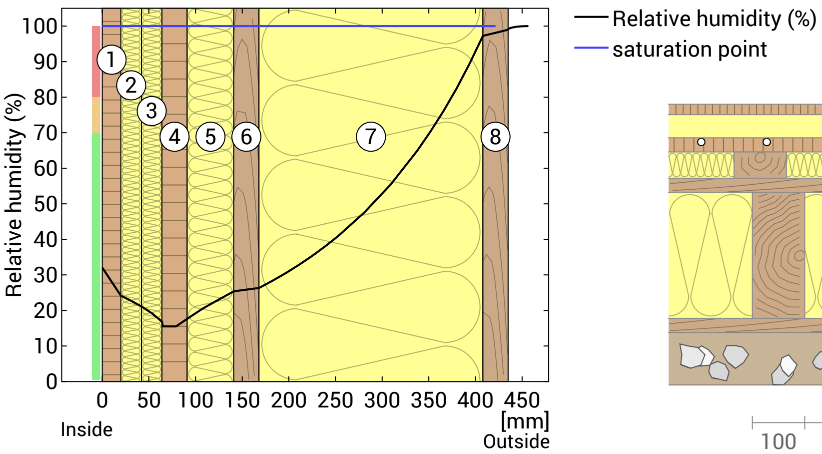
This component is free of condensate under the given climate conditions.

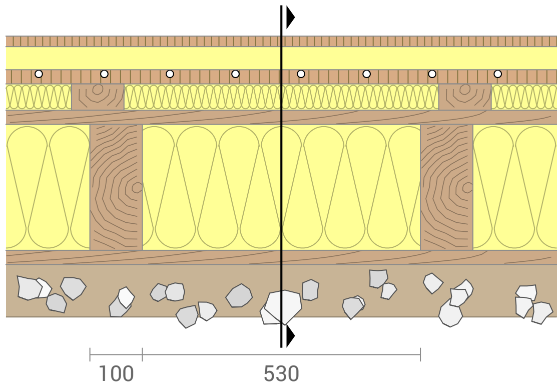
Drying reserve according to Ubakus 2D-FE method: 991 g/(m²a)
At least required by DIN 68800-2: 100 g/(m²a)

#		Material	sd-value [m]	Condensate [kg/m²]	Condensate [Gew.-%]	Weight [kg/m²]
1	2 cm	Lamination	0,60	-	-	10,0
2	2,2 cm	conluto Lehmbauplatte 22mm	0,11	-		31,9
3	2,2 cm	conluto Lehmbauplatte 22mm	0,11	-		31,9
4	2,7 cm	Wood Fibreboard 250kg/m³	0,00	-	-	6,8
5	5 cm	NeptuTherm	0,05	-		3,1
	5 cm	Spruce (14%)	1,00	-	-	4,1
6	2,7 cm	Spruce	0,54	-	-	12,2
7	24 cm	NeptuTherm	0,24	-		14,7
	24 cm	Spruce (16%)	4,80	-	-	19,6
8	2,7 cm	Spruce	1,35	-	-	12,2
	43,5 cm	Whole component	3,40			146,4

Humidity

The temperature of the inside surface is 20,0 °C leading to a relative humidity on the surface of 34%.Mould formation is not expected under these conditions.
The following figure shows the relative humidity inside the component.





① Lamination (20 mm)
② conluto Lehmbauplatte 22mm (22 mm)
③ conluto Lehmbauplatte 22mm (22 mm)
④ Wood Fibreboard 250kg/m³ (27 mm)
⑤ NeptuTherm (50 mm)
⑥ Spruce (27 mm)
⑦ NeptuTherm (240 mm)
⑧ Spruce (27 mm)

Notes: Calculation using the Ubakus 2D-FE method. Convection and the capillarity of the building materials were not considered. The drying time may take longer under unfavorable conditions (shading, damp / cool summers) than calculated here.

RoofKIT_Boden_Neptutherm, U=0,16 W/(m²K)

heating level

Heat output into the interior (heating output): approx. 28 W/m².

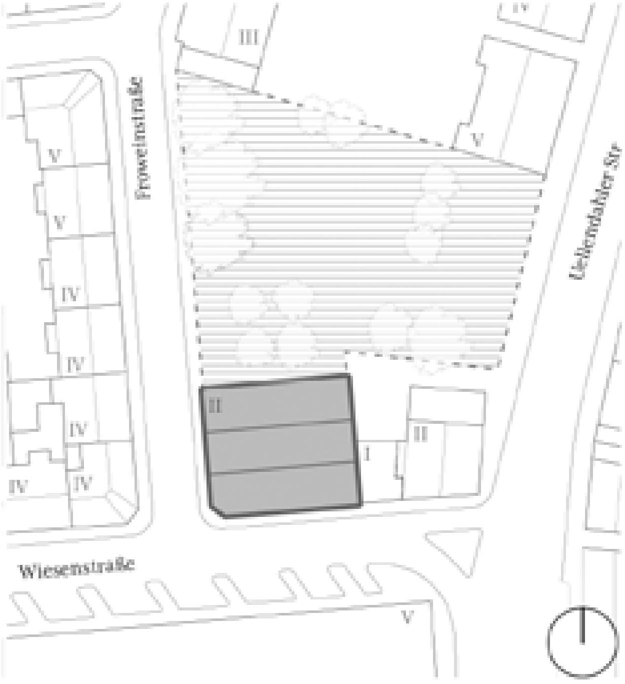
The heating plane leads to increased heat losses to the outside and can be taken into account with an effective U-value (Ueff):

Effective u-value:	0,41 W/m²K	(Energy loss of the heated component)
U-value:	0,158 W/m²K	(Energy loss of the un-heated component)
Thermal transmission to the outside:	4,87 W/m²	(At an outside temperature of 8°C)

At the assumed temperatures of room air, outside air and heating plane, the heat loss to the outside corresponds to an identical but unheated component with an U-value of Ueff =0,41 W/m²K.

Temperature of the inside surface (min/average/max): 26,4 / 27,1 / 27,4 °C

These values are based on an average water temperature in the heating plane of 40 °C, a room temperature of 20 °C and an outside temperature of 8 °C.



Construction area: 456 sqm
Site concept area: 2500 sqm
Footprint: 456 sqm
Type of building: Solitaire with industrial character

ORIGINAL BUILDING:
Use: floor,upstairs event location for e.g. dance courses
Year of construction: around 1905
Floors: 2 floors
Roof shape: sawtooth roof
Floor height: 3,5 m first floor
3 m second floor
Construction method: column grid
Type of facade: punctuated façade
Year and type of last renovation: completely renovated in 2006
Energy supply: natural gas and power grid

Calculation of Total construction costs (Gesamtbaukosten/ GBK):

a) Calculation via gross floor area:

Cost guide value 1*	€/sqm gross floor area	1900
Cost guide value 2 (existing building)	€/sqm GFA	850
Gross floor area 1	sqm GFA	2379
Gross floor area 2 (existing building)	sqm GFA	964

Calculation of total construction costs:

New construction: 1900€/sqm x 2379 sqm = 4.520.100 €

Existing building: 850€/sqm x 964 sqm = 819.400 €

5.339.500 €

b) Calculation via gross volume for plausibility check

Cost guide value 1*	€/cbm BRI	620
Cost guide value 2 (existing building)	€/cbm BRI	310
Gross volume 1	cbm BRI	5641
Gross volume 2 (existing building)	cbm BRI	3492

Calculation total construction cost:

New construction: 620€/cbm x 5641cbm = 3.497.420 €

Existing building: 310€/cbm x 3492 cbm = 1.082.778 €

4.580.198 €

The total construction cost (GBK) is estimated at 4,959,849 euros (+/-15% range).

Characteristic	Lower limit in €/m²	Higher limit in €/m²	Comment
Living space	7,40 €	9,26 €	17,5 m² to 50 m² (Group VII building age range 2014 to 2019)
Separate shower	0,06 €	0,06 €	Bathroom with bath and separate shower
High quality flooring	0,41 €	0,41 €	Real wood parquet
Underfloor heating	0,30 €	0,30 €	
Balcony	0,23 €	0,23 €	Loggia with at least 5 m² actual area or at least 1,50 m depth
Garden	0,33 €	0,33 €	Community garden
Great accessibility	0,37 €	0,37 €	Barrier-free creation of the apartment
Elevator	0,15 €	0,15 €	
Equipped kitchen	0,25 €	0,25 €	Superior quality
Trapped spaces			
Good area	0,50 €	0,50 €	Mirke
Price per €/m²	10,00 €	11,86 €	
Space W1 in m²	32,15	32,15	
Community living space in m²	174,65	174,65	
Community cost share	310,72 €	368,30 €	Proportionate to the common living area (395,63 m²) for each apartment area
Total rent net	**632,35 €**	**749,52 €**	per month

Characteristic	Lower limit in €/m²	Higher limit in €/m²	Comment
Living space	7,40 €	9,26 €	17,5 m² to 50 m² (Group VII building age range 2014 to 2019)
Separate shower	0,06 €	0,06 €	Bathroom with bath and separate shower
High quality flooring	0,41 €	0,41 €	Real wood parquet
Underfloor heating	0,30 €	0,30 €	
Balcony	0,23 €	0,23 €	Loggia with at least 5 m² actual area or at least 1,50 m depth
Garden	0,33 €	0,33 €	Community garden
Great accessibility	0,37 €	0,37 €	Barrier-free creation of the apartment
Elevator	0,15 €	0,15 €	
Equipped kitchen	0,25 €	0,25 €	Superior quality
Trapped spaces			
Good area	0,50 €	0,50 €	Mirke
Price per €/m²	10,00 €	11,86 €	
Space W2 in m²	32,3	32,3	
Community living space in m²	174,65	174,65	
Community cost share	312,17 €	370,01 €	Proportionate to the common living area (395,63 m²) for each apartment area
Total rent net	**635,30 €**	**753,02 €**	per month

Characteristic	Lower limit in €/m²	Higher limit in €/m²	Comment
Wohnfläche	7,40 €	9,26 €	17,5 m² to 50 m² (Group VII building age range 2014 to 2019)
Separate Dusche	0,06 €	0,06 €	Bathroom with bath and separate shower
Hochwertiger Bodenbelag	0,41 €	0,41 €	Real wood parquet
Fußbodenheizung	0,30 €	0,30 €	
Balkon	0,23 €	0,23 €	Loggia with at least 5 m² actual area or at least 1,50 m depth
Garten	0,33 €	0,33 €	Community garden
Große Barrierefreiheit	0,37 €	0,37 €	Barrier-free creation of the apartment
Aufzug	0,15 €	0,15 €	
Einbauküche	0,25 €	0,25 €	Superior quality
„gefangene" Räume			
Gute Wohnlage	0,50 €	0,50 €	Mirke
Price per €/m²	10,00 €	11,86 €	
Space W3 in m²	49,87	49,87	
Community living space in m²	174,65	174,65	
Community cost share	481,98 €	571,29 €	Proportionate to the common living area (395,63 m²) for each apartment area
Total rent net	**980,88 €**	**1.162,63 €**	per month

Characteristic	Lower limit in €/m²	Higher limit in €/m²	Comment
Living space	6,92 €	8,35 €	50 m² to 90 m² (Group VII building age range 2014 to 2019)
Separate shower	0,06 €	0,06 €	Bathroom with bath and separate shower
High quality flooring	0,41 €	0,41 €	Real wood parquet
Underfloor heating	0,30 €	0,30 €	
Balcony	0,23 €	0,23 €	Loggia with at least 5 m² actual area or at least 1,50 m depth
Garden	0,33 €	0,33 €	Community garden
Great accessibility	0,37 €	0,37 €	Barrier-free creation of the apartment
Elevator	0,15 €	0,15 €	
Equipped kitchen	0,25 €	0,25 €	Superior quality
Trapped spaces	- 0,08 €	- 0,08 €	
Good area	0,50 €	0,50 €	Mirke
Price per €/m²	9,44 €	10,87 €	
Space W4 in m²	66,46	66,46	
Community living space in m²	174,65	174,65	
Community cost share	606,11 €	697,92 €	Proportionate to the common living area (395,63 m²) for each apartment area
Total rent net	**1.233,49 €**	**1.420,34 €**	per month

Characteristic	Lower limit in €/m²	Higher limit in €/m²	Comment
Living space	7,40 €	9,26 €	17,5 m² to 50 m² (Group VII building age range 2014 to 2019)
Separate shower	0,06 €	0,06 €	Bathroom with bath and separate shower
High quality flooring	0,41 €	0,41 €	Real wood parquet
Underfloor heating	0,30 €	0,30 €	
Balcony	0,23 €	0,23 €	Loggia with at least 5 m² actual area or at least 1,50 m depth
Garden	0,33 €	0,33 €	Community garden
Great accessibility	0,37 €	0,37 €	Barrier-free creation of the apartment
Elevator	0,15 €	0,15 €	
Equipped kitchen	0,25 €	0,25 €	Superior quality
Trapped spaces			
Good area	0,50 €	0,50 €	Mirke
Price per €/m²	10,00 €	11,86 €	
Space W5 in m²	32,15	32,15	
Community living space in m²	134,18	134,18	
Community cost share	200,87 €	238,08 €	Proportionate to the common living area (395,63 m²) for each apartment area
Total rent net	**522,49 €**	**619,31 €**	per month

Characteristic	Lower limit in €/m²	Higher limit in €/m²	Comment
Living space	6,92 €	8,35 €	50 m² to 90 m² (Group VII building age range 2014 to 2019)
Separate shower	0,06 €	0,06 €	Bathroom with bath and separate shower
High quality flooring	0,41 €	0,41 €	Real wood parquet
Underfloor heating	0,30 €	0,30 €	
Balcony	0,23 €	0,23 €	Loggia with at least 5 m² actual area or at least 1,50 m depth
Garden	0,33 €	0,33 €	Community garden
Great accessibility	0,37 €	0,37 €	Barrier-free creation of the apartment
Elevator	0,15 €	0,15 €	
Equipped kitchen	0,25 €	0,25 €	Superior quality
Trapped spaces	- 0,08 €	- 0,08 €	
Good area	0,50 €	0,50 €	Mirke
Price per €/m²	9,44 €	10,87 €	
Space W6 in m²	66,37	66,37	
Community living space in m²	134,18	134,18	
Community cost share	391,29 €	450,56 €	Proportionate to the common living area (395,63 m²) for each apartment area
Total rent net	**1.017,82 €**	**1.172,00 €**	per month

Characteristic	Lower limit in €/m²	Higher limit in €/m²	Comment
Living space	7,40 €	9,26 €	17,5 m² to 50 m² (Group VII building age range 2014 to 2019)
Separate shower	0,06 €	0,06 €	Bathroom with bath and separate shower
High quality flooring	0,41 €	0,41 €	Real wood parquet
Underfloor heating	0,30 €	0,30 €	
Balcony	0,23 €	0,23 €	Loggia with at least 5 m² actual area or at least 1,50 m depth
Garden	0,33 €	0,33 €	Community garden
Great accessibility	0,37 €	0,37 €	Barrier-free creation of the apartment
Elevator	0,15 €	0,15 €	
Equipped kitchen	0,25 €	0,25 €	Superior quality
Trapped spaces	- 0,08 €	- 0,08 €	
Good area	0,50 €	0,50 €	Mirke
Price per €/m²	9,92 €	11,78 €	
Space W7 in m²	49,87	49,87	
Community living space in m²	134,18	134,18	
Community cost share	309,09 €	366,82 €	Proportionate to the common living area (395,63 m²) for each apartment area
Total rent net	**804,00 €**	**954,17 €**	per month

Characteristic	Lower limit in €/m²	Higher limit in €/m²	Comment
Living space	6,92 €	8,35 €	50 m² to 90 m² (Group VII building age range 2014 to 2019)
Separate shower	0,06 €	0,06 €	Bathroom with bath and separate shower
High quality flooring	0,41 €	0,41 €	Real wood parquet
Underfloor heating	0,30 €	0,30 €	
Balcony	0,23 €	0,23 €	Loggia with at least 5 m² actual area or at least 1,50 m depth
Garden	0,33 €	0,33 €	Community garden
Great accessibility	0,37 €	0,37 €	Barrier-free creation of the apartment
Elevator	0,15 €	0,15 €	
Equipped kitchen	0,25 €	0,25 €	Superior quality
Trapped spaces	- 0,08 €	- 0,08 €	
Good area	0,50 €	0,50 €	Mirke
Price per €/m²	9,44 €	10,87 €	
Space W8 in m²	66,46	66,46	
Community living space in m²	134,18	134,18	
Community cost share	391,82 €	451,17 €	Proportionate to the common living area (395,63 m²) for each apartment area
Total rent net	**1.019,20 €**	**1.173,59 €**	per month

apartment	Rental income per month	
W1	749,52 €	
W2	753,02 €	
W3	1.162,63 €	
W4	1.420,34 €	
W5	619,31 €	
W6	1.172,00 €	
W7	954,17 €	
W8	1.173,59 €	
Cafe	2.000,00 €	Estimation based on market offerings
Total	**10.004,58 €**	
Annual earnings	120.054,92 €	

Amortization calculation			
Annual earnings	120.054,92 €		
Total cost	-15%		+ 15%
	4.215.565,65 €	4.959.489,00 €	5.703.412,35 €
Amortization period in years	**35,11**	**41,31**	**47,51**

chances | risks

internal

Strenghts

Establishment of a clear focus on objectives and strategies.
Communication within the team, due to the COVID-19 pandemic, we are finally allowed to meet in smaller groups of three.
Meeting up in different key groups for a close exchange, including a weekly jour fix for everyone.
Specialist for all kinds of communication channels and bringing together the different topics on our website.
Through site analysis and good understandings of the Mirke District.
Quite a lot of correlating courses can be chosen at the university, so the project is an overall theme.

Weaknesses

Online team meetings are less flexible than in person; the KIT is holding up the COVID-19 prevention measures, so the university is held online until winter semester 21/22.
Most Students have to do a lot of balancing between their academic studies and competition.
Some students cannot stay in the team for more than one semester as they have to pursue further their academic goals, so the team constantly needs to spread the basic knowledge.

external

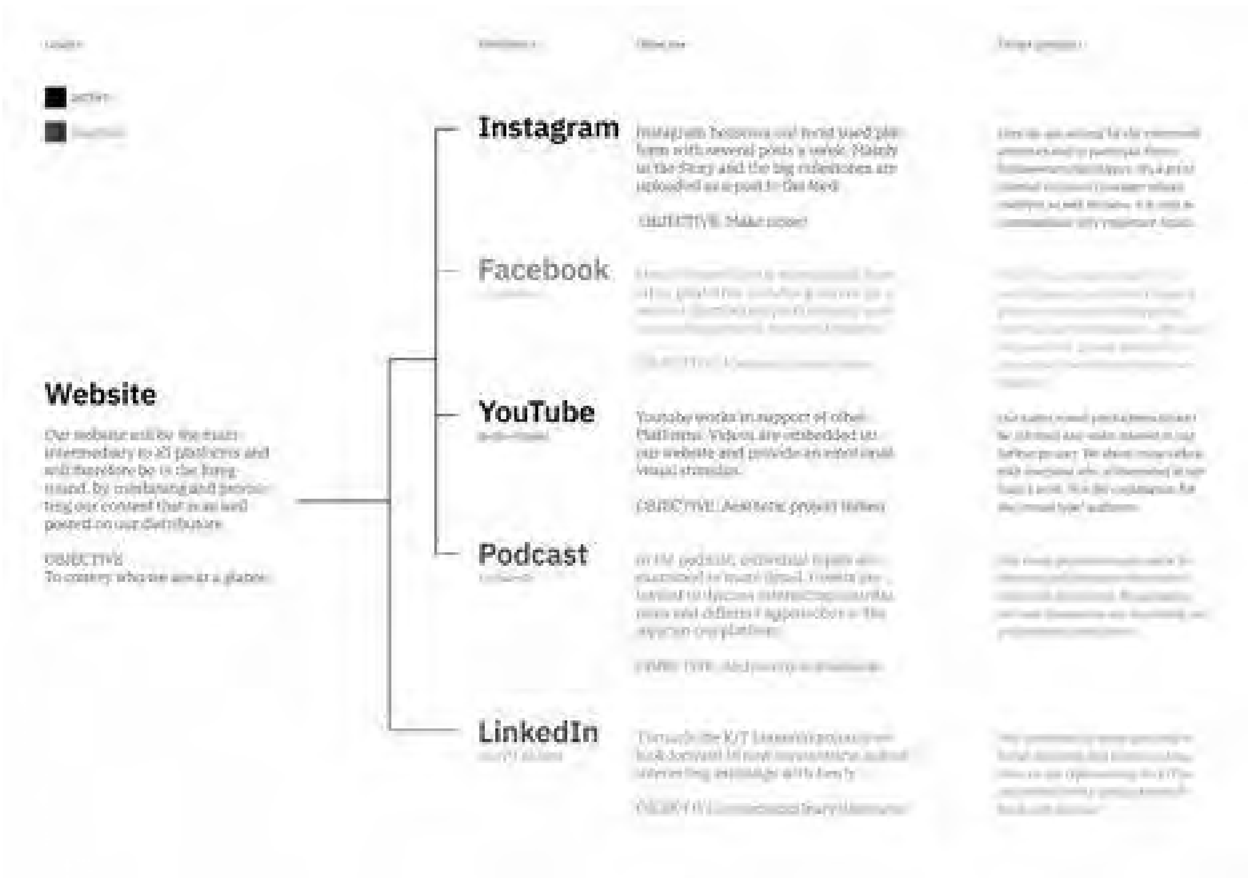
Opportunities

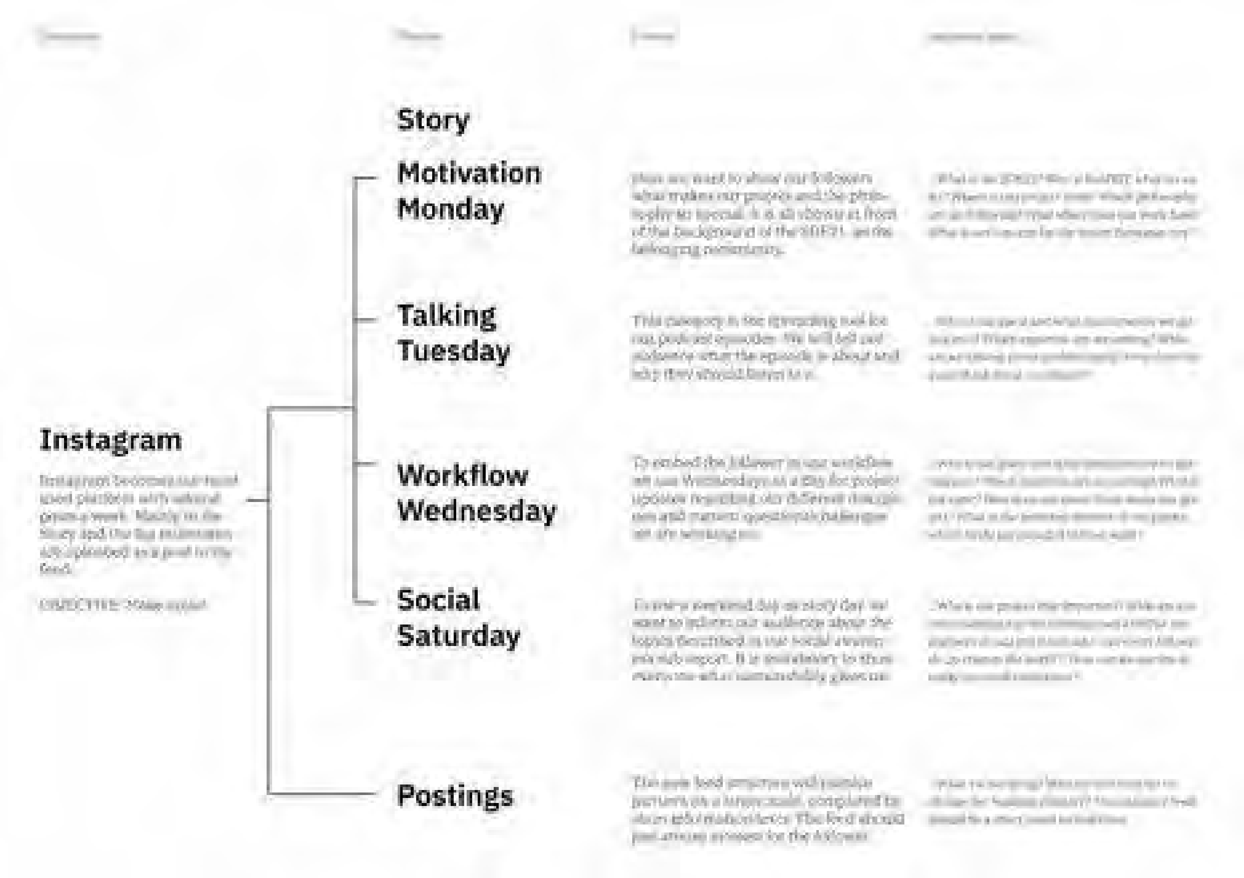
Broadcasting innovative visions for a better neighborhood and, on a larger scale, city for the future.
Reaching a large audience because the community is shifted towards online. Promoting these new forms of communities and, on a larger scale, societies.
Addressing relevant environmental issues and sustainable construction strategies.
Distances become more and more irrelevant, so it is easier to contact a wider field of people.
Referring to our local community, supporting our local associations.

Threats

Participatory projects are threatened or at least much more complicated due to the COVID-19 pandemic.
It is still uncertain when or whether a second field trip to Wuppertal will be possible in the near future.
It is uncertain when we can meet as a team back at the university due to the strict COVID-19 measures.

Appendix Q: RoofKIT Communication strategy 01





Appendix S: SWOT Education

chances

risks

internal

Strenghts

Excellent infrastructure of big technical university
Excellent university with a varity of expertises
Experience in realization of prototypolies as educational approach
KIT offers a lot of experts to cooperate with for educational projects
Broad network for having a lot of input and options for students to gain knowledge and skills
By closely involving industry partners and associations valuable knowledge from practitioners will be gained through the whole design and construction process
Weekly consultations in smaller groups enables the team to react on urgent topics or adjust the strategy if needed (agility workflow)
Existing experiences of iterative exchange of research and teaching
Iterative approach

Weaknesses

Rigide Bachelor Master curricula are not properly compatible with SDE regulations and timetable
Most Students have to do a lot of balancing between their academic studies and competition.
Some students cannot stay in the team for more than one semester as they have to pursue further their academic goals, so the team constantly needs to spread the basic knowledge.
Teamspirit is hard to achieve due to Pandemic Situation

external

Opportunities

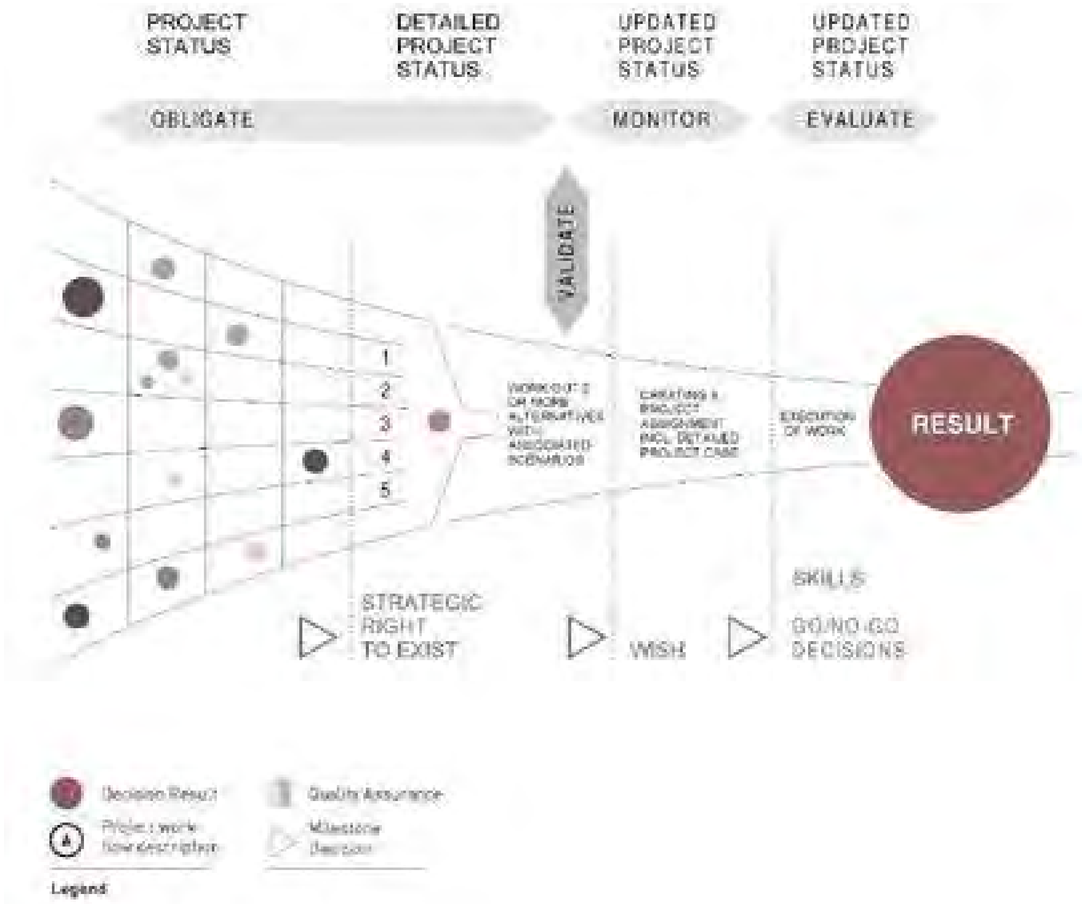
Raising awareness for the holistic approach of sustainable architecture at larger student groups in different formats
New alliances for educational approach: Collaborations with other schools and colleges; Partners offer real situations to get involved with in educational classes.
Realistic learning approach: Students gain experiences in real-life-topics and feedbacks
Provide Know-How to Students on a “Real World” Realism level
Enable students to take a stance on the most relevant issues of our time
- nterdisciplinary working as a real world experience
Team spirit

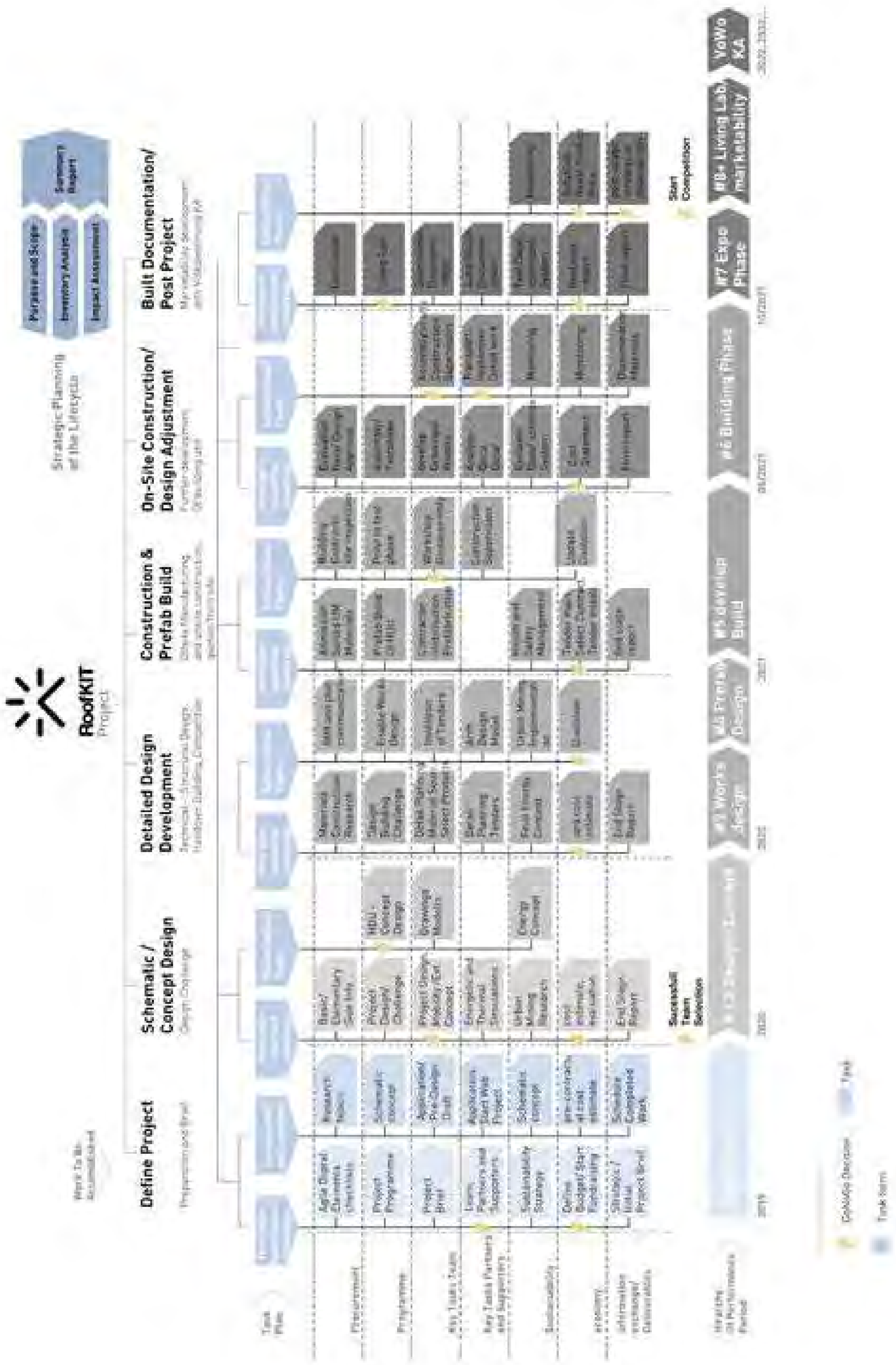
Threats

Educational classes and events are threatened or at least much more complicated due to the COVID-19 pandemic.
Most time during the planning phase it was almost not possible to meet in person with groups, that made the planning less agile
It is uncertain if we can meet as a team at the university all the rest of the time due to COVID-19 measures.
Due to the prolongation of the SDE period it is even tougher to keep the team together, as many students reach their masters degree before SDE is realized.
Strict curricula make it harder to realize an interdisciplinary approach.

Appendix T: Partner and Knowledge

Appendix U: Project Development




RoofKIT
Project
Define Project
Schematic / Concept Design
Detailed Design Development
Construction & Prefab Build
On-Site Construction/ Design Adjustment
Built Documentation/ Post Project
VoWo KA

Team Visual Identity Manual

Karlsruhe, 09th February 2022

page 1/7

RoofKIT – Logo, isolated

Logo on white Background

Logo on black Background

Logo + subline

Logo + subline

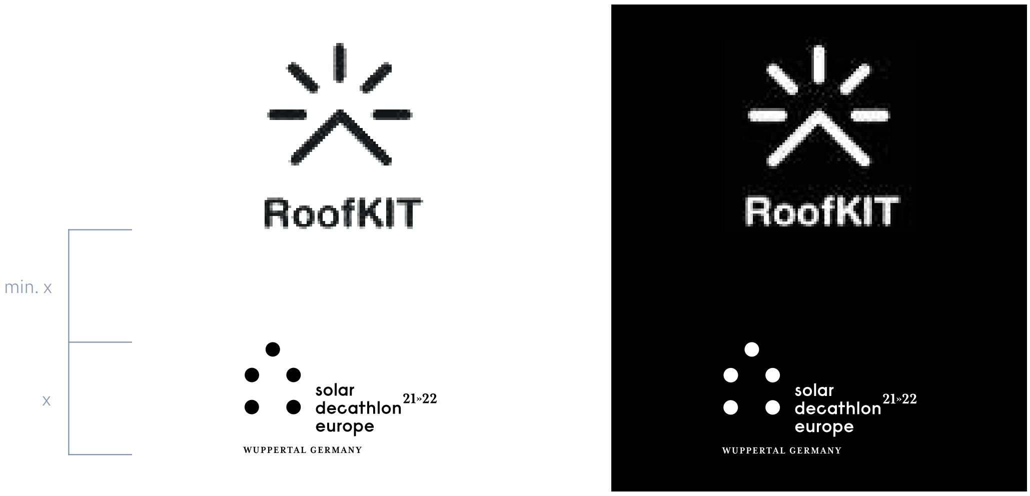
Logo placement and combination + Examples

The RoofKIT Logo is always placed in the upper left corner of printed media. The logo placement can alter in digital use. The logo consists of the figurative mark and the word mark. These must not be seperated in printed media. Only the figurative mark can be used only in digital use.

RoofKIT logo is always placed in the upper left corner either in black or white

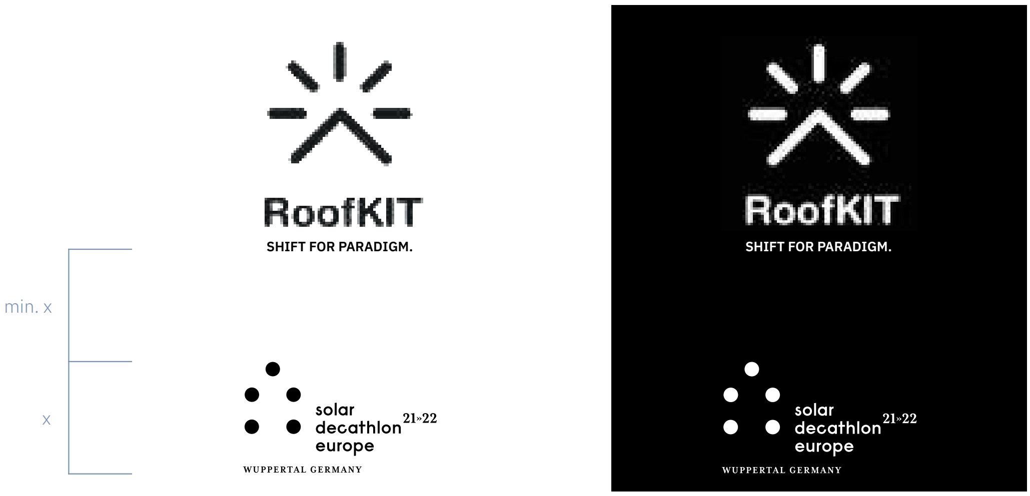
RoofKIT logo + subline is always placed in the upper left corner either in black or white

RoofKIT – Logo, combined with SDE21/22‘s Logo



combined Logo on white Background

combined Logo on black Background



combined Logo + subline on white Background

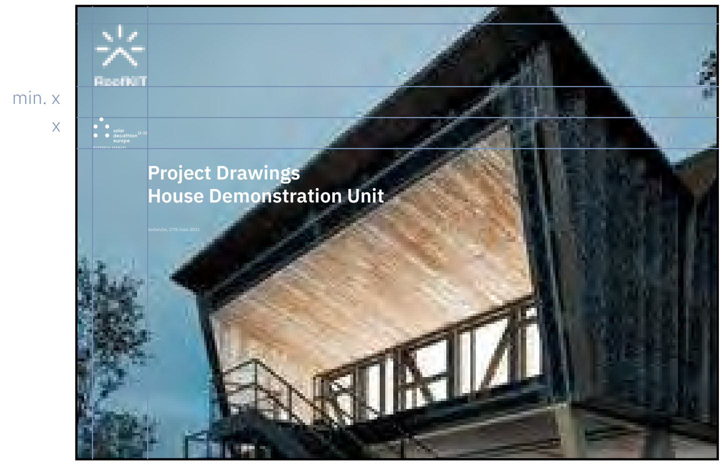
combined Logo + subline on black Background

Logo placement and combination

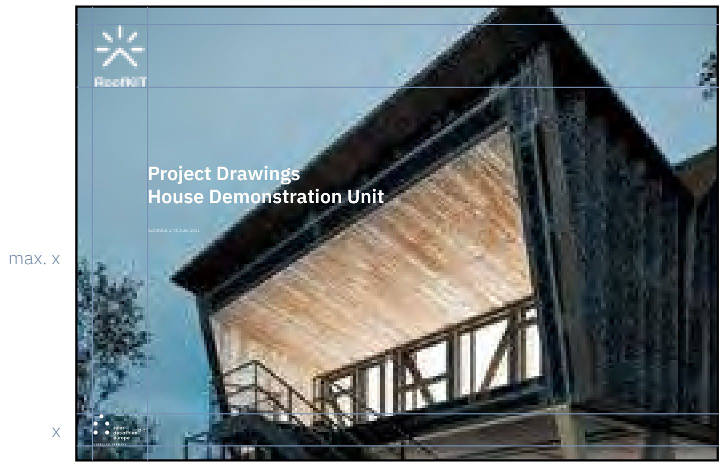
The SDE21/22 logo is always placed below the RoofKIT logo in the upper left corner. The distance between Roofkit and SDE21/22 logos is minimum one time the height of the SDE21/22 logo with the same width as the RoofKIT logo. It is possible to increase the distance. It is therefore also allowed to place the RoofKIT logo on the upper left corner of a printed document and the SDE21/22 logo on the bottom left corner of the document. The Logos have to be in one axis with the same width.

RoofKIT – Logo, combined with SDE21/22‘s Logo

Logo placement and combination Examples



SDE 21/22 logo is always placed under the RoofKIT logo. The spacing between is at least one time the height of the SDE21/22 logo



The spacing between the two logos can be incresed so that the SDE21/22 logo can be in the bottom left corner right below the RoofKIT logo

RoofKIT – Logo, combined with supporting institutions + sponsors

supporters + sponsors

Logo on white Background with all supporting institutions and sponsors

Logo placement and combination + Example

The RoofKIT Logo is always placed in the upper left corner. The logos of supporting institutions and sponsors are placed at the bottom of the document in a certain arrrangement that is prepared as a single block. The two left columns of this block are the supporting institutions, all of the other logos are sponsors. These logos do not interact with the RoofKIT logo in any way for they are to be read as an autark strip of information.

RoofKIT – KIT team participates at European Solar Decathlon competition

Karlsruhe, 01.12.2021

"The future city makes no distinction between waste and supply"
- *Joachim Mitchell, New York*

In the light of a world-wide climate crisis, we need to shift our architectural way to think, act and build! – So, how can we create social-economic fair living spaces without destroying our natural resources? Furthermore, how can we create ecologically sensitive building structures, acknowledging the finite state of natural material supplies? What has to be done to avoid "waste", when understanding the existing building stock as an urban material bank for the future?
Our team RoofKIT of the Karlsruhe Institute of Technology (KIT) will address those questions in our upcoming building design with exploring a gigantic new surface resource of cities: rooftops.
In the same way cities give us the material resources we need to build new buildings. If old buildings are demolished, the materials can be used to insert them into new buildings: The city becomes a new mine. In applying this concept of „urban mining" on new possible building sites to solve the material and energy question, the project will show that it is possible to integrate the building sector in a functioning circular economy system. – And that without making a distinction between "waste" and "supply" anymore. We need to re-invent all constructive details to prepare our future buildings for such a shift. Constructions have to be easier detachable in the future, so that we can reuse materials more effectively. It needs a new generational contract for both – the society and young architects. RoofKIT will demonstrate, how this is possible today: We will showcase new construction systems and materials emerging from research and how newly developed solar energy harvesting systems will follow our belief:

"Sustainable architecture must be breath-taking beautiful!"
Werner Sobek, Stuttgart

The logos of the supporting institutions and sponsors are always placed on the bottom in a single block

Sponsoring – Logos

The sponsoring logos should be placed in a double row at the bottom center of the media. Make sure to leave enough space between the sponsoring logos to guarantee that the indivudual protection area is not disturbed.

Color scheme

primary colors

89989A

A8BBBE

748183

conductive colors

A8BBBE	89989A	748183	5F696B	5A321D	694532	C59C87	4A5F31	617D40	90A27A

secondary colors

A8BBBE	89989A	4653A5	363B6B	7E0000	C37246	C59C87	4A5F31	799B50	E2B01F

Besides black and white, blue is the main color to use in digital and printed media. The secondary colors are used in CAD-drawings and may only be used in consultation with the graphic design team for special cases in digital and printed media.

Typography

We use the IBM Plex font family. It is an open type font family with many weights. For headlines and bold text on posters we use *IBM Plex Sans Semibold*. For standard text and side notes we use *IBM Plex Serif Light*.

Make sure that the font sizes of the different weights differ sufficiently from each other to create a clear hierarchy of information.

I am a strong Headline!

I am the main text. I use serifs for better legibility and i have a really nice grey value.

I am a little side note. Don't overlook me, i've got important information for you.

Team uniform

The team uniform is a dark blue shirt with a white chestprint of the RoofKIT - Logo.

The uniforms are supposed to create a feeling of team spirit and to give the team a recognizable identity.
With nothing but the RoofKit - logo on the front and the unique color there will definitely be a feeling of togetherness.

SPONSORSHIP LIST

Deliverable No.	D#6
Team ID	KIT
University/ City	Karlsruhe

Sponsor	Category	Type of Sponsorship	Contact Person	E-Mail
Volkswohnung Karlsruhe GmbH	Gold	Monetary	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
HILTI	Gold	Monetary	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
Ratisbona	Platinum	Monetary	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
Toto Lotto	Platinum	Monetary	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
Wolff & Müller	Silver	Monetary	Prof. Andreas Wagner	wagner@kit.edu
Umweltstiftung Sparkasse Karlsruh	Silver	Monetary	Prof. Andreas Wagner	wagner@kit.edu
Ingenieurgruppe Bauen	Gold	Monetary	Prof. Andreas Wagner	wagner@kit.edu
BOSCH	Platinum	Monetary and Materials	Prof. Andreas Wagner	wagner@kit.edu
Kaufmann Zimmerei	Platinum	Materials, Workmanship	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
Lunos	Silver	Materials	Prof. Andreas Wagner	wagner@kit.edu
Neptutherm	Gold	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
Doka	Gold	Materials, Workmanship	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
AxSun	Gold	Materials	Prof. Andreas Wagner	wagner@kit.edu
Solator	Silver	Materials, Workmanship	Prof. Andreas Wagner	wagner@kit.edu
JUNG	Silver	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
ROMA	Gold	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
Claytec	Silver	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
Velux	Silver	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
Rotor DC	Silver	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
OpenProject	Silver	Software	Prof. Andreas Wagner	wagner@kit.edu
Hilzinger	Silver	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
Becken	Platinum	Monetary	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
Fischer	not defined yet	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
TECU	Gold	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
Weru	Gold	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
Roma	Silver	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
MAGNA	Platinum	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
Wieland	Silver	Materials	Prof. Andreas Wagner	wagner@kit.edu
Nimbus	not defined yet	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
FREITAG	Silver	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
BYD	Silver	Materials	Prof. Andreas Wagner	wagner@kit.edu
Vzug	Silver	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
Hans Grohe	Silver	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
ECOR	Silver	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
Fronius	Silver	Materials	Prof. Andreas Wagner	wagner@kit.edu
Implenia	not defined yet	Materials, Workmanship	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
Lastenvelo Freiburg	Silver	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
M&K Filze	Silver	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
Dörken	Silver	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
AMANN	Silver	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
Carlstahl	not defined yet	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu
Ribag	not defined yet	Materials	Prof. Andreas Wagner	wagner@kit.edu
Miele	not defined yet	Materials	Prof. Dirk E. Hebel	dirk.hebel@kit.edu

RoofKIT

Prof. Dipl.-Arch. Dirk E. Hebel
Dean of faculty

Institute for Sustainable Design
Department of Architecture

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Web: nb.ieb.kit.edu

Prof. Dipl.-Ing. Andreas Wagner
Vice Dean Research

Institute for Building Science
Department of Architecture

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Fax: +49 721 608 46092
E-Mail: wagner@kit.edu
Web: fbta.ieb.kit.edu

Categories sponsorship
Karlsruhe, June 16, 2021

Category - RoofKIT Silver

- You and your logo will be listed on the homepage and social media feeds (without linking to the sponsor's homepage/social media channels (so-called tagging)) in the Silver category.
- You and your logo will be presented on a construction sign (without special highlighting) during the construction in Wuppertal.
- You and your logo will be listed on a joint sign under the silver category at the entrance area of the publicly accessible unit after the structure has been returned to Karlsruhe.
- Your contribution will be between 400 and 8,000 EUR.

Category - RoofKIT Gold

- You and your logo will be listed on the homepage and social media feeds (without linking to the sponsor's homepage/social media channels (so-called tagging)) in the Gold category.
- You and your logo will be presented on a construction sign (without special highlighting) during the construction in Wuppertal.
- You will be invited to events, receive press releases and photos of the project for your information.
- You and your logo will be listed on a joint sign under the category Gold at the entrance of the publicly accessible unit after the return of the construction to Karlsruhe.
- Your contribution will be between 8.000 and 15.000 EUR.

Category - RoofKIT Platinum

- You and your logo will be listed on the homepage and social media feeds (without linking to the sponsor's homepage/social media channels (so-called tagging)) in the Platinum category.
- You and your logo will be presented on a construction sign (without special highlighting) during the construction in Wuppertal.
- You will be invited to events, receive press releases and photos of the project for your information.
- You and your logo will appear on all work clothing (T-shirts, jackets, caps).
- You and your logo will be listed on a joint sign under the Platinum category at the entrance of the publicly accessible unit after the building has been returned to Karlsruhe.
- VIP tours with the RoofKIT team can be booked in Wuppertal and Karlsruhe.
- Your contribution will be over 15,000 EUR.

RoofKIT

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Sponsorship Categories
Karlsruhe, 24th June 2021

Ladies and Gentlemen,

team RoofKIT, a group of students, architects, and engineers from the Karlsruhe Institute of Technology (KIT), under the leadership of Prof. Dirk E. Hebel and Prof. Andreas Wagner, has been selected to participate in the renowned Solar Decathlon Europe 21/22 (SDE21/22). The competition focuses on the future of sustainable building and renewable energy.
Our two supporting professorships fulfill exactly the requirement profile of the competition. On the one hand, the question of building energy concepts based on renewable energy sources and their implementation in a building to be realized as part of the competition (it does not remain with the paper tiger). On the other hand, the topic of the circular economy-related to all building materials and products, including their way of construction.

Solar Decathlon 21/22

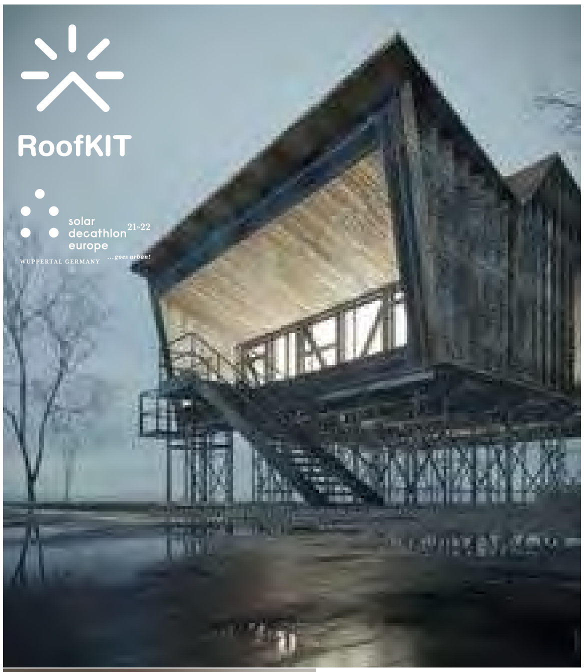
The SDE21/22 is a public decathlon for sustainable building and living. The project will be judged in Wuppertal in 2022 in all of the ten different disciplines. The motto to „design-build-operate“ means that, unlike in other architectural competitions, the participating teams will build a 1:1 house demonstration unit of their designs.

The first Solar Decathlon was held in 2002 by the United States Department of Energy on the National Mall in Washington D.C., followed by the first European version in Madrid in 2010. With the SDE21/22, the 21st edition of the competition worldwide is coming to Germany for the first time. With a new urban profile the contest asks questions of how we should deal with the materials of the urban mine in the future and return them to our buildings in a cycle-friendly way.

SDE 21/22 „...goes urban“

In 2022, eighteen university teams from eleven countries will construct a fully usable demonstration building of approx. 80 square meters on the Solar Campus in Wuppertal on the Utopiastadt e.V. site.
The teams will compete with their buildings in ten disciplines, such as energy balance, eco-balance, environmental justice, design, choice of materials, social relevance, or innovation. The evaluation points on all categories are added up and the team that shows the best working ideas for sustainable, energy-efficient, and social housing and living in the city will win the competition.

Until now, the Solar Decathlon competitions have mainly been about showing ways of using renewable energy in new buildings. However, the European city is largely built. The most pressing questions of energy transition and climate protection in architecture and urban development lie within the established, urban neighborhoods.
For this reason, SDE21 is addressing the urban reality of inhabited properties for the first time. The teams deal with existing building structures of a city district, its infras-

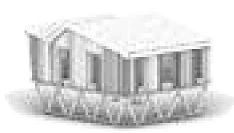


PROJECT

"The future city makes no distinction between waste and supply", Joachim Mitchell, New York How can we create socio-economically fair living space without destroying our natural resources? And how can we create ecologically sensitive buildings, acknowledging the fact that natural material supplies are finite, and avoi-ding any state of "waste"? And thereby understand the existing building substance as an urban material bank for the future? How can we create alternative solar harves-ting systems as part of an urban mining ideology and propose paradigm-shifting innovations as first-of-their-kind worldwide? And how can we apply urban mobility systems as an integrative part of the immobile building sector? The team RoofKIT of the Karlsruhe Institute of Technology (KIT) will address those urgent questions in the European Solar Decathlon competition by exploring the rooftops within our cities as a resource with great potential.

NEW CONSTRUCTION PRICIPLES

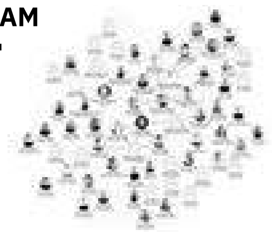
At the same time, RoofKIT will develop new design princi-ples in order to make a technologically of reuse possible. The goal is the state of a circular construction industry, on the basis of which so-called material passports are crea-ted. These will be connected to a digital cadastral system for future generations to know where, in which quantities and when materials are available. RoofKIT will also deve-lop those passports and data ports and make them avai-lable for everyone. In order to be able to meet 100% of the demand for building materials from the urban mine and the associated urban depot, we must increasingly shift to regenerative cultivation, breeding and cultivation of in-novative building materials with a future-proof transition instead of continuing to rely on finite fossil, mineral and metallic resources.



HOUSE DEMONSTRATION UNIT

The "House Demonstration Unit" (short HDU) is an essential part of the pro-ject. Besides the development of the overall design, this is a representative section, which will be built on the Solar Campus of the SDE21 in Wuppertal. The HDU characterises the most important de-sign parameters and summarises them for the visitors to experience. After the SDE21, the HDU will be moved to Karlsruhe, where it will be open to the public.

TEAM



CONTACT

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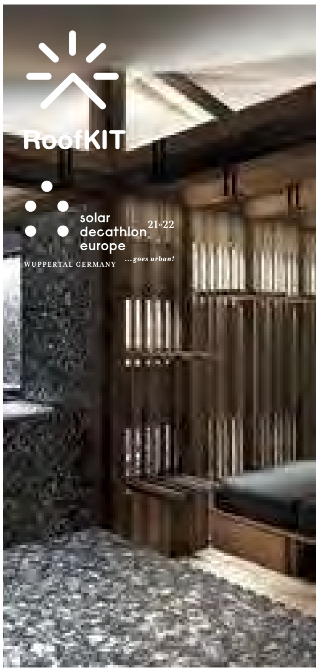
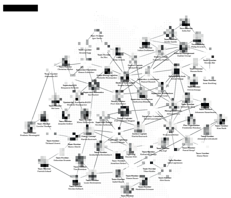
Web: www.roofkit.de
PressKit downloadable.

Website YouTube Instagram

Are there any unanswered questions? We are always hap-py to receive an email, new contacts and an interesting exchange.



TEAM



PROJECT

"The future city makes no distinction between waste and supply", Joachim Mitchell, New York
How can we create social-economic fair living space without destroying our natural resources? And how can we create ecologically sensitive building struc-tures, acknowledging the finite state of natural ma-terial supplies, and avoid any state of "waste", but unders- tand the existing building stock as an urban material bank for the future? How can we create alternative solar harvesting systems as part of an urban mining ideology and propose paradigm-shif-ting innovations as first-of-their-kind worldwide? And how can we apply urban mobility systems as an integrative part of the immobile building sector? The RoofKIT team of the Karlsruhe Institute of Tech-nology (KIT) will address those urgent questions in the European Solar Decathlon competition by exploring a gi- gantic surface resource within our cities: rooftops.

NEW CONSTRUCTION PRICIPLES

At the same time, RoofKIT will develop new design principles in order to make the reu- se technologically possible. Once this state of a real cycle-based cons-truction industry has been reached, it is necessary to create so-called material passports and connect them with a digital cadastral system so that future genera-tions know where, in what quantities and when and where available materials will be available. RoofKIT will also develop those passports and data ports and make them available for everyone. However, we will not be able to meet the demand for resources from the urban mine alone due to the non-existent techno-logies for 100% transformation of the materials. We increasingly have to close this gap with a shift towards regenerative cultivation, breeding and cultivation of future building materials, instead of continuing to rely on finite fossil, mineral and metallic deposits.

CONTACT

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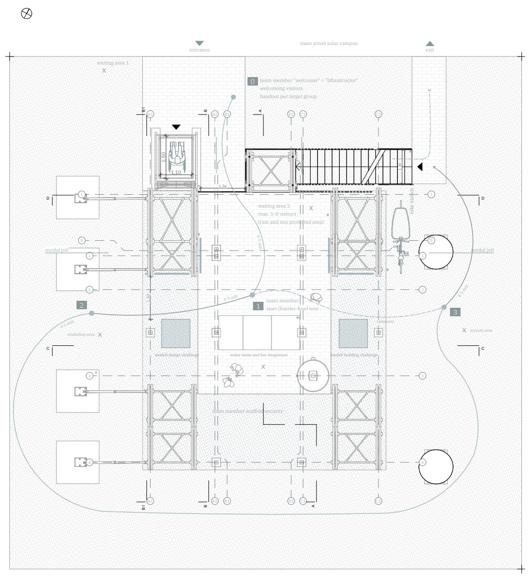
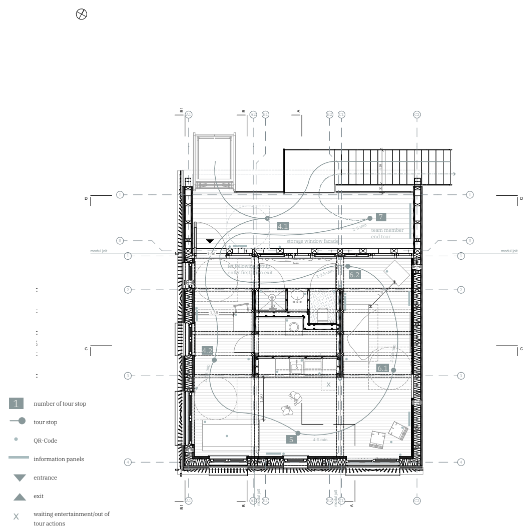
PressKit downloadable.



Public Tour - Level 0



Public Tour - Level 1

HOUSE TOUR GENERAL INFORMATION

Visitors to the HDU come to the Lot at position 0. This is where waiting area 1 is located if the waiting line is quite long. The team member „welcomer" welcomes the guests, distributes the handout per target group and leads the first group of 5-8 people to waiting area 2. Protected from rain, wind and sun, the visitors have the opportunity to look at the brochure and get a first impression from the info panels before the tour starts.
At point 1, the first tour with team member guide 1 starts with a group of maximum 5-8 people. The target group as well as the language will be checked first. The tour is then given in english or german. Team member guide 1 accompanies the group from start to finish. As soon as team member guide 1 reaches position 2, Tour 2 starts with team member guide 2 according to a rotating system. Time management is done via a timer.

The long tour lasts 24-30 min, the short tour in case of a long waiting line is reduced to 12-18 min. Which tour takes place is managed by team member "welcomer", depending on the checked waiting line.

Visitors gain access to the housing unit via an Urban Mining staircase as well as barrier-free access via a rented lift.

	p0	p1	p2	p3	p4	p5	p6	p7
ts0	w1							
ts1	w1	t1						
ts2	w1	t2	t1					
ts3	w1	t3	t2	t1				
ts4	w1	t4	t3	t2	t1			
ts5	w1	t5	t4	t3	t2	t1		
ts6	w1	t6	t5	t4	t3	t2	t1	
ts7	w1	t7	t6	t5	t4	t3	t2	t1
ts8	w1	t1	t7	t6	t5	t4	t3	t2
ts9	w1	..	t1	t7	t6	t5	t4	t3
ts10	w1	..	..	t1	t7	t6	t5	t4
ts11	w1	..	..	..	t1	t7	t6	t5
ts12	w1	..	..		..	t1	t7	t6
ts13	w1	..	..	..	..	..	t1	t7
ts14	w1	..	..	..	..	..	..	t1

(shaded) = public tour
ts = timeslot
p = position
t = team member guide
w = welcomer, liftinstructor

public tour rotation concept

X waiting line entertainment, further actions out of public tour:

- kids tour/game: playful acquisition of the topics, downscaled information
- VR, AR
- darts match floor level 0
- daily lectures on the east facade, lecture area
- workshops, workshop area
- late night tour
- urban mining and circular economy tour (focus materials and detachability)
- energy tour (focus energy concept)
- open house
- interior change tour
- get together bar area

0 **teammember "welcomer"="liftinstructor"**
welcoming visitors, guiding every 4-5 min visitorgroup of maximum 5-8 persons to waiting area;
handout per target group

1 **team member guide 1**
presenting the project, Design Challenge and cut out HDU (general concept) to group 1

2 **team member guide 1** presenting idea of the ground floor (scaffold towers, stone cycling, gabions, lift and staircase, west and south facade, ..);
team member guide 2 starting at position 1

3 **team member guide 1**
presenting more detailed concept of the HDU at the east facade (truck plane, water tanks, energy supply);
checking whether previous group has finished the tour, walking upstairs, liftinstructor helping people with need

4.1 **team member guide 1**
and whole group meeting at the terrace; presenting cut out situation of the whole design concept;
presenting idea of the storage window facade, idea of the door, taking a look to the private area

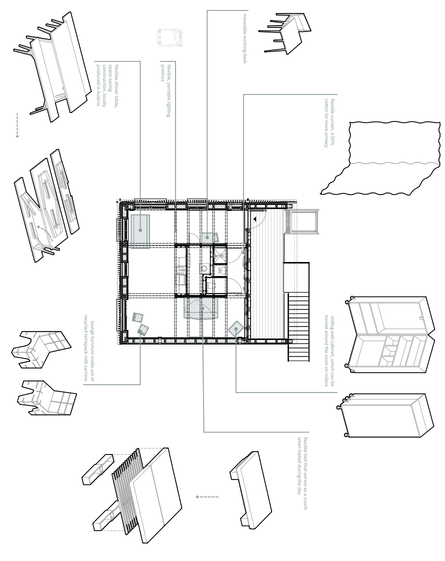
4.2 **team member guide 1**
presenting idea of the core and the flexible usage of space around, giving insight to the core, working area, claywalls, ..

5 **team member guide 1**
more private area through walking the round,
living room, lounge area and kitchen, offer to take a seat while showing kitchen idea and portable lighting idea with possibility to try, showing flexible table (dining table and kitchen), ..

6.1 **team member guide 1**
flexible bed, suitcase cabinet, private space, ..

6.2 **team member guide 1**
wet cells, how to design wet cells without wet seals , ..

7 **team member guide 1**
Thank you, questions, feedback, invitation to further actions on the lot



Flexible Furniture

floor	position	duration	Long Public Tour (24-30 min) 5-8 visitors per group	parallel activities	duration	Short Public Tour (12-18 min) 5-8 visitors per group	additional material
floor - level 0	0	4-5 min*	**team member "welcomer"="liftinstructor"** welcoming visitors, guiding every 4-5 min visitorgroup of maximum 5-8 persons to waiting area; handout per target group		2-3 min*	see long tour, shortened	handout, information panels floorplan level 0
	START TOUR						
	1	4-5 min	**team member guide 1** presenting the project, Design Challenge and cut out HDU (general concept) to group 1		2-3 min	see long tour, shortened	models, ipad, information panels floorplan level 0
				"welcomer" Pos.0 welcoming next group and guiding to waiting area			
	2	4-5 min	**team member guide 1** presenting idea of the ground floor (scaffold towers, stone cycling, gabions, lift and staircase, west and south facade, ..)		2-3 min	see long tour, shortened	samples, ipad
				"welcomer" Pos.0 welcoming next group and guiding to waiting area			
				team member guide 2 starting at Pos. 1			
	3	4-5 min	**team member guide 1** presenting more detailed concept of the HDU at the east facade (truck plane, water tanks, energy supply); checking whether previous group has finished the tour, walking upstairs, liftinstructor helping people with need		2-3 min	see long tour, shortened	samples, ipad, east facade print
				"welcomer" Pos.0 welcoming next group and guiding to waiting area			
				team member guide 2 starting at Pos. 2			
				team member guide 3 starting at Pos. 1			

floor	position	duration	Long Public Tour (24-30 min) 5-8 visitors per group	parallel activities	duration	Short Public Tour (12-18 min) 5-8 visitors per group	additional material
floor - level 1	4.1+4.2	2-2,5 min + 2-2,5 min	**team member guide 1** and whole group meeting at the terrace; presenting cut out situation of the whole design concept; presenting idea of the storage window facade, idea of the door, taking a look to the private area; team member guide 1 presenting idea of the core and the flexible usage of space around, giving insight to the core, working area, claywalls, ..		2-3 min	see long tour, shortened	samples, ipad, information panels floorplan level 1
				"welcomer" Pos.0 welcoming next group and guiding to waiting area			
				team member guide 2 starting at Pos. 3			
				team member guide 3 starting at Pos. 2			
				team member guide 4 starting at Pos. 1			
	5	4-5 min	**team member guide 1** more private area through walking the round, living room, lounge area and kitchen, offer to take a seat while showing kitchen idea and portable lighting idea with possibility to try, showing flexible table (dining table and kitchen), ..		2-3 min	see long tour, shortened	samples, ipad, information panels floorplan level 1
				"welcomer" Pos.0 welcoming next group and guiding to waiting area			
				team member guide 2 starting at Pos. 4.1+4.2			
				team member guide 3 starting at Pos. 3			
				team member guide 4 starting at Pos. 2			
				team member guide 5 starting at Pos. 1			

floor	position	duration	Long Public Tour (24-30 min) 5-8 visitors per group	parallel activities	duration	Short Public Tour (12-18 min) 5-8 visitors per group	additional material
floor - level 1	6.1+6.2	4-5 min	**team member guide 1** flexible bed, suitcase cabinet, private space, wet cells, how to design wet cells without wet seals , ..		2-3 min	see long tour, shortened	samples, ipad, information panels floorplan level 1
				"welcomer" Pos.0 welcoming next group and guiding to waiting area			
				team member guide 2 starting at Pos. 5			
				team member guide 3 starting at Pos. 4.1+4.2			
				team member guide 4 starting at Pos. 3			
				team member guide 5 starting at Pos. 2			
				team member guide 6 starting at Pos. 1			
	END TOUR						
	7	4-5 min	**team member guide 1** Thank you, questions, feedback, invitation to further actions on the lot		2-3 min	see long tour, shortened	-
				"welcomer" Pos.0 welcoming next group and guiding to waiting area			
				team member guide 2 starting at Pos. 6.1+6.2			
				team member guide 3 starting at Pos. 5			
				team member guide 4 starting at Pos. 4.1+4.2			
				team member guide 5 starting at Pos. 3			
				team member guide 6 starting at Pos. 2			
				team member guide 7 starting at Pos. 1			

* timeline manager for each team member

CESA IMPLEMENTATION LIST

Deliverable No.	D#6
Team ID	KIT
University/ City	Karlsruhe

Communication (overview since d#4, not all)

Type	Name	Online / Offline	Date (Duration)	Place	Target Group	Short Description	No. of Participants/ Visitors/ Engag	Link
Webpost	RoofKIT - faculty team participates at SDE 21/22	Online	02.01.2021	Website faculty for architecture KIT arch.kit.edu	all visitors of the website: especially faculty members, registered students, interested future architecture students	Webpost about RoofKIT: Team, Project, What is the Solar Decathlon Europe 2021/2022?, How to be part and participate, Invitation to share ideas and motivation, Link to Website, Instagram and Facebook as well as the SDE21/22 Website for further informations		https://www.arch.kit.edu/english/aktuelles/4731.php
Webpost	RoofKIT - How will we build in the future? Exhibition at Architekturschaufenster Karlsruhe, 11 January 2022 - 04 February 2022	Online	11.01.2021	Website a*komm https://akomm.ekut.kit.edu/RoofKIT.php	all visitors of the website	Announcement and Invitation to the exhibition abour RoofKIT in the "Architekturschaufenster Karlsruhe" public platform for architecture communication to visit		
Announcement	RoofKIT - KIT team participates at SDE21/22	Online	17.02.2021	Website nb.ieb.kit.edu	all visitors of the website	Webpost on website of Professorship Sustainable Concstruction, Announcement RoofKIT participates at the SDE 21/22.	We have no information on this (is not in our hands)	https://nb.ieb.kit.edu/
Publication	LookKIT	Offline	01.03.2021	Magazine	Research Magazine	The issue focused on the future of sustainable construction and various approaches to solving it. Our project as an exemplary work for the future | published in third edition 2021	We have no information on this (is not in our hands)	
Webpost	Infosession RoofKIT - join the team	Online	06.04.2021	Website nb.ieb.kit.edu	all visitors of the website	Invitation for Infosession RoofKIT - join the team		https://nb.ieb.kit.edu/
Webpost	RoofKIT - update project	Online	07.04.2021	Website nb.ieb.kit.edu	all visitors of the website	Update Project: On what the team is adresssing, what the goals are and how RoofKIT intends to achieve them		https://nb.ieb.kit.edu/
Podcast	RoofKIT Podcast on Spotify and Campus Radio: Epi 1	Online/Offline	13.04.2021	Spotify and Campus Radio	Architects, Engineers, Building and Sustainbility interests, students, young generation, .. parties involved in the construction	Episode 1: Fighting 40% > Definition of the problem in the building environment and building industry, Presentation RoofKIT		https://www.campusradio-karlsruhe.de/2021/04/13/new-podcast-fighting-40/
Infosession	Semesteropening - Course Presentation	Online	14.04.2021	Zoom	faculty members, registered students	Presentation of RoofKIT, Invitation to Infosession in the afternoon for further Project Informations		
Infosession	Infosession RoofKIT - join the team	Online	14.04.2021	Zoom	registered students	Presentation of RoofKIT, Invitation to participate and possibility to get credits		
Speaker	Architects for Future KA	Online	20.04.2021	Zoom	Participants Architects for future	Presentation of RoofKIT, Invitation to follow the further project and invitation to Wuppertal.	20 people	
Podcast	RoofKIT Podcast on Spotify and Campus Radio: Epi 2	Online/Offline	10.05.2021	Spotify and Campus Radio	Architects, Engineers, Building and Sustainbility interests, students, young generation, .. parties involved in the construction	Episode 2: Urban Mining, Solution for the Future - Guest: Prof. Dirk Hebel		https://www.campusradio-karlsruhe.de/2021/05/10/urban-mining/
Webpost	Urban Mining . New episode of the podcast	Online/Offline	18.05.2021	Website nb.ieb.kit.edu	all visitors of the website	Announcement podcast episode published on Spotify, Campusradio Karlsruhe.		https://nb.ieb.kit.edu/
Presentation Faculty Meeting	Faculty Meeting, Presentation of current Projects	Offline	23.05.2021	Faculty for Architecture Karlsruhe	Faculty members, different professors, deanery	Projectpresentation RoofKIT to the faculty members	15	
Podcast	RoofKIT Podcast on Spotify and Campus Radio: Epi 3	Online/Offline	08.06.2021	Spotify and Campus Radio	Architects, Engineers, Building and Sustainbility interests, students, young generation, .. parties involved in the construction	Episode 3: Manual of Recycling - Guest: Petra Riegler-Floors		https://www.campusradio-karlsruhe.de/2021/06/08/manual-of-recycling/
Podcast	RoofKIT Podcast on Spotify and Campus Radio: Epi 4	Online/Offline	12.07.2021	Spotify and Campus Radio	Architects, Engineers, Building and Sustainbility interests, students, young generation, .. parties involved in the construction	Episode 4: The Future City - Guest Angelika Hinterbrandner		https://www.campusradio-karlsruhe.de/2021/07/12/the-future-city/
Publikation	Sortenrein Bauen - Methodik I Material I Konstruktion	Offline	15.07.2021	DETAIL Verlag	Architects, Engineers, Public, professionals, professors, Teaching Assistants and Researcher, craft apprentices, architecture/engineering students, municipal representatives, mayors, craftsmen, building and sustainbility interests, ..			
Website	RoofKIT @linktree	Online	01.08.2021	website linktree	General Public, all visitors of the website	launchpad to our latest videos, website posts, social meida post - everywhere we are online		@RoofKIT | Linktree
social media channel	roofkit_@Instagram	Online	01.08.2021	instagram	General Public, social media user	open general social media channel - postings about concept, design, materials, (team) activities, etc.	more then 400 people	Team RoofKIT (@roofkit_) • Instagram-Fotos und -Videos
Podcast	RoofKIT Podcast on Spotify and Campus Radio: Epi 5	Online/Offline	10.08.2021	Spotify and Campus Radio	Architects, Engineers, Building and Sustainbility interests, students, young generation, .. parties involved in the construction	Episode 5: Innovative Materials - Guest: Rasa Weber		https://www.campusradio-karlsruhe.de/2021/08/10/innovative-materials/
Publication	CliKIT	Online	19.08.2021	Website	Students Magazine	General publication about the goal of the team and the competition	We have no information on this (is not in our hands)	https://www.clickit-magazin.de/die-stadt-der-zukunft-als-rohstofflager/
Podcast	RoofKIT Podcast on Spotify and Campus Radio: Epi 6	Online/Offline	11.10.2021	Spotify and Campus Radio	Architects, Engineers, Building and Sustainbility interests, students, young generation, .. parties involved in the construction	Episode 6: About existing material - Guest: Sophia Schmidt		https://www.campusradio-karlsruhe.de/2021/10/11/about-existing-material/
Party	Semester Opening Party	Offline	13.10.2021	KIT	Team Members and new Students	Party about the current status of the plans and a bit of recruiting feeling	40 people	
Publication	Lust auf Gut	Online / Offline	29.10.2021	Website/Magazine	Interested public	Special issue of the magazine in which the cultural focus in particular makes it clear how different sustainable four walls can look like.	We have no information on this (is not in our hands)	https://www.lust-auf-gut.de/magazine-previews/blaettern/lust-auf-gut-magazin-special-rund-ums-bauen-und-wohnen-34/
Webpost	Publication RoofKIT in LooKIT magazine	Online	04.11.2021	Website nb.ieb.kit.edu	all visitors of the website	Announcement that a post about RoofKIT has been published in LooKIT magazine.		
Webpost	"Welttag der Städte" - RoofKIT models on travveling exhibition in Wuppertal	Online	09.11.2021	Website nb.ieb.kit.edu	all visitors of the website	Announcement that RoofKIT is on tour (travelling exhibition in NRW)		
social media channel	RoofKIT@youtube	Online	01.12.2021	youtube	General Public, social media user	open general social media channel - videos about concept, design, materials, etc.	more then 600 views	RoofKIT - YouTube
Semesterprogramme	Seminar/Design Course/Research Seminar Announcement	Online/Offline	06.12.2021	Website faculty for architecture KIT arch.kit.edu	registered students	Invitation to participate and possibility to get credits		
Webpost	Solar Decathlon in Wuppertal: RoofKITs vision for Café Ada	Online	09.12.2021	Website nb.ieb.kit.edu	all visitors of the website	Announcement that a post about RoofKIT has been published in LooKIT magazine.		
Webpost	ASF - Exhibition RoofKIT - How do we built in the future?	Online	02.01.2022	Website architekturschaufenster.de/	all visitors of the website: architecture interested, students, public	Announcement and Invitation to the exhibition abour RoofKIT in the "Architekturschaufenster Karlsruhe" public platform for architecture communication to visit		
Exhibition	RoofKIT - How do we build in the future?	Offline	11.01 – 04.02.2022	Architekturschaufenster Karlsruhe	General Public, Students, Architects	Exhibition focussing on the most relevant topics for future buildings in terms of sustainability. The topics are explained on the basis of the RoofKIT project.		
Webpost	How do we build in the future? RoofKIT exhibition Architekturschaufenster	Offline	12.01.2022	Website nb.ieb.kit.edu	all visitors of the website	Announcement and Invitation to the exhibition abour RoofKIT in the "Architekturschaufenster Karlsruhe" public platform for architecture communication to visit		
Webpost	RoofKIT - How do we built in the future?	Online	15.01.2022	Website of the city of Karlsruhe: kalender.karlsruhe.de	all visitors of the website	Announcement and Invitation to the exhibition abour RoofKIT in the "Architekturschaufenster Karlsruhe" General event Calendar of the City of Karlsruhe		https://kalender.karlsruhe.de/db/termine/kultur/ausstellungen/roofkit
Webpost	RoofKIT - How do we built in the future?	Online	15.01.2022	Website polis-magazin.com	all visitors of the website	Announcement and Invitation to the exhibition abour RoofKIT in the "Architekturschaufenster Karlsruhe" public platform for architecture communication to visit		https://polis-magazin.com/events/event/roofkit-wie-bauen-wir-in-zukunft/
Semesterprogramme	Announcement Seminar Architecture Comunication	Online	19.01.2022	Website faculty for architekture KIT arch.kit.edu	registered students	Invitation to participate and possibility to get credits, How does Architecture can be communicated to the public. Project: RoofKIT		https://www.arch.kit.edu/aktuelles/veranstaltungskalender.php/event/45578
Workshop Vernissage	Werkraumhäuschen, Werkraum Bregenzerwald, Austria	Offline	25.02.2022	Andelsbuch, Austria	Architects, craft apprentices, elektricals, plumbers, carpenters, roofers, upholsterer, .. building and sustainbility interests, ..	RoofKIT Participation at the Workshop and Vernissage "Werkraumhäuschen", in the Werkraum Bregenzerwald (architect: Peter Zumthor), togehter with Wolfgang Schwarzmann, Prof. for Architecture in Liechtenstein (AT), and some caft apprentices who developted ideas how single-origin and innovative joining techniques can be realised 1:1. Additionally RoofKIT brought some urban mining material samples and presented them to the young apprentices and further participants of the Workshop.	30	
Finnisage	Constructive Alps	Offline	25.02.2022	Andelsbuch, Austria	Architects, craft apprentices, elektricals, plumbers, carpenters, roofers, upholsterer, .. architecture students from liechtenstein, municipal representatives, mayors, craftsmen, building and sustainbility interests, ..	Get in contact with different target groups, presentation of the project RoofKIT, Invitation to the Event in Wuppertal, discussing at dinner table	60	
Publication	Bauphysik	Online / Offline	15.03.2022	Website/Magazine	Expert audience	Project presentation with fous on construction (materials) and passive cooling	We have no information on this (is not in our hands)	
Publication	Solarenergie	Online / Offline	15.03.2022	Website/Magazine	Expert audience	General project presentation	We have no information on this	
Exhibition	MobiLab	Offline	21.03-11.04.2022	Karlsruhe	gerneral public, visitors of the "Frühlingstage der Nachhaltigkeit"	We have the chance to present our project and the topic in the MobiLab, which is a participatory Tinyhouse.		
game	card game: sustainability facts on the go	Offline	01.04.2022 onwards	Karlsruhe	general public	Everywhere that we are presenting the project (exhibitions, projects, speeches, etc.) we want to distribute the card game - for the guests to take home and play		
Symposium	Presenting RoofKIT at the Symposium "sustain.build.repeat."	Offline /Online	19.04.2022	ZKM Karlsruhe (centre for art and media karlsruhe)	Architects, Engineers, Public, professionals, professors, Teaching Assistants and Researcher, craft apprentices, architecture/engineering students, municipal representatives, mayors, craftsmen, building and sustainbility interests, ..	Presentation of RoofKIT at the Symposium sustain.build.repeat an the ZKM (centre for art and media Karlsruhe)		
Publication	TAB	Online / Offline	22.04.2022	Website/Magazine	Expert audience	Project presentation with focus on technical services systems	We have no information on this	
Publication	COBEE 2022 Conference	Offline	25. - 29.07.2022	Conference proceedings	Scientists	Project presentation with focus on passive cooling and solar system performance	normally >> 100 conference participants	
Publication	sbe22 Conference	Offline	20. - 23.09.2022	Conference proceedings	Scientists	Project presentation with focus on passive cooling and carbon footprint	normally >> 100 conference participants	
Speaker	Learning Tour Ratisbona	Offline	30.09.2022	Regensburg	Expert audience	Ratisbona is developing most of the supermarkets in Germany. They advocate new strategies and concepts, such as a supermarket that can be dissembled trough single-origin detachable and innovative joining techniques, on the way to a circular economy. We have been asked to talk about the issues related to the RoofKIT.	not known yet	
Publication	Haus & Grund	Online / Offline	coming soon	Magazine	Generel interested Public	Presentation of project work with a focus on representing the interests of home, apartment and land owners at the federal level vis-à-vis politicians	We have no information on this (is not in our hands)	
Publication	Detail	Online	coming soon	Website	Focused on architects but open for all	Presentation of all German teams in series	We have no information on this (is not in our hands)	
Cooperation	EWB	Online / Offline	coming soon	To be determined		EWB (Engeneers without bourders)		
Cooperation	A4F	Online / Offline	coming soon	To be determined		A4F (Architects for future)		
Publication	Polis	Offline	coming soon	Magazine	Architects and Urban Planners	Short Project presentation in News		
Publication	Polis	Online	coming soon	Magazine	Architects and Urban Planners	Online Article about the project by Dirk Hebel and Daniel Lenz		
Exhibition	RoofKIT - How do we build in the future?	Offline	coming soon		Activists, Students, Academics	Exhibition focussing on the most relevant topics for future buildings in terms of sustainability. The topics are explained on the basis of the RoofKIT project.		
Exhibition	RoofKIT - How do we build in the future?	Offline	coming soon	Regierungspräsidium Karlsruhe	General Public, Administration	Exhibition focussing on the most relevant topics for future buildings in terms of sustainability. The topics are explained on the basis of the RoofKIT project.		

CESA IMPLEMENTATION LIST

Deliverable No.	D#6
Team ID	KIT
University/ City	Karlsruhe

Education (overview since d#4, not all)

Type	Name	Online / Offline	Date (Duration)	Place	Target Group	Short Description	No. of Participants/ Visitors/ Engagement	Link
Design Course 1	Design studio Bachelor: "In between, on top and aside" (Drüber, Drauf und Dran)	Offline	WS 19/20	Faculty of Architecture, KIT	registered architecture students (bachelor)	Each student developed one architectural design concept, uncluding cost estimate, energy concept, .. over three months. Analysis of all three possible building tasks in Wuppertal for the SDE competition - resulting in about 40 design projects examining the different SDE21 sites in Wuppertal	60	
Excursion	Excursion to Wuppertal	Offline	WS 19/20	Wuppertal, Solar Campus, Mirker Bahnhof, different Places	registered architecture students (bachelor)	Excursion with visiting the sites, meeting SDE-Organising Team and representatives of the local initiative "Utopiastadt", visiting sustainable housing Projects	60	
Seminar	"Solar Energy Concepts for Heating and Cooling"	Offline	WS 19/20	Faculty of Architecture, KIT	registered architecture students (bachelor)			
Design Course 2	Design Studio Master: "Renewable up to 3" (Erneuerbar Hoch 3) - Solar Decathlon Europe 2021 - Design for Café Ada	Online / Offline	SS 20	Faculty of Architecture, KIT	registered architecture students (master)	Each student developed one architectural design concept, uncluding cost estimate, energy concept, .. over three months, focus Café Ada - The studio was resulting in projects focussing on topping up Café ADA in Wuppertal with a special focus on renewable energy systems, renewable construction (in the sense of circularity), and "renewable" social life	20	
Seminar	"solar-based Energy Concepts for Zero-Energy Buildings"	Online / Offline	SS 20	Faculty of Architecture, KIT	registered architecture students (master)	Seminar accompanying and complementary to the Design Studio		
Seminar	"Building Performance Simulation for Assessing Solar Design Solutions"	Online / Offline	SS 20	Faculty of Architecture, KIT	registered architecture students (master)	Seminar accompanying and complementary to the Design Studio		
Stegreif	Bottleneck 1	Online / Offline	SS 20	Faculty of Architecture, KIT	Architecture Students	Brief Design Happening of the Student Team as "Bottleneck"- decision, leading to one building design project out of the gained experiences of the Design studio results		
Seminar week	"Architecture toolbox"	online	SS 20	Faculty of Architecture, KIT	Architecture Students	Seminar week with „How To"-Manuals for project planning, not only for SDE21 student team members		
Design Course 3	Design Studio Master: "RoofKIT" Café Ada - Housing Demonstration Unit	Online / Offline	WS 20/21	Faculty of Architecture, KIT	registered architecture students (master)	The student team has further developed the design for the café ada extension and created a design for the housing demonstration unit. The Student Design Team elaborating the building design and as a "ThinkTank" developing the forthcoming steps of the competition		
Seminar	"Energy Supply for RoofKIT"	Online / Offline	WS 20/21	Faculty of Architecture, KIT	registered architecture students (master)	Seminar focussing on RoofKIT		
Seminar	"Performance Analysis for Buildings"	Online / Offline	WS 20/21	Faculty of Architecture, KIT	registered architecture students (master)	Seminar focussing on RoofKIT		
Seminar	"Circular Construction Methods"	Online / Offline	WS 20/21	Faculty of Architecture, KIT	registered architecture students (master)	Seminar of Sustainable Construction in Cooperation with Fachgebiet Baukonstruktion, Prof. Ludwig Wappner; focussing on circular construction methods.		
Seminar	Joker Seminar	Online / Offline	WS 20/21	Faculty of Architecture, KIT	registered architecture students (master)	Seminar with self-selected in-depth topics especially for SDE21 Student Team members		
Symposium	"grow build repeat"	Online	WS 20/21	ZKM Karlsruhe	faculty members, registered students, architects and professionals	Symposium "grow build repeat" focusing on "Consideration of the breeding, cultivation, sowing, and harvesting of biological building materials and their system cycles", open access to all students and other team members, several guest lectures by the specialist for material and construction research as well as lectures on best practice projects		
Publication	LookKIT	Offline	15.03.2021	Magazine	Research Magazine	The issue focused on the future of sustainable construction and various approaches to solving it. Our project as an exemplary work for the future	We have no information on this (is not in our hands)	
Design Course 4	Design Studio Master: Architecture Laboratory Solar Decathlon (Architekturlabor) - Detail planning within substinable construction methods	Online	SS 21	Faculty of Architecture, KIT	registered architecture students (master)	This semester, a team of 15 students, together with teachers and partners, started the implementation planning up to a scale of 1:1. they developed single-variety constructions and cycle-friendly details, researched materials from the urban mine and entered into exchange with manufacturers and experts.		
Seminar	Joker Seminar	Online / Offline	SS 21	Faculty of Architecture, KIT	registered architecture students (master)	Seminar with self-selected in-depth topics especially for SDE21 Student Team members		
Seminar	"Detail planning and energy concept"	Online / Offline	SS 21	Faculty of Architecture, KIT	registered architecture students (master)	with a special focus on the RoofKIT HDU		
Seminar	"Planning and building with light"	Online / Offline	SS 21	Faculty of Architecture, KIT	registered architecture students (master)	with a special focus on the RoofKIT HDU		
Seminar	"Circular Construction Methods II – Connections and Joints"	Online / Offline	SS 21	Faculty of Architecture, KIT	registered architecture students (master)	Joining techniques of circular-economy construction		
Think Tank	Student "ThinkTank" developing the forthcoming steps of the competition, supported by the teaching and researching staff	Online / Offline	SS 21	Faculty of Architecture, KIT	registered architecture students			
Exhibition	Exhibition of state submitted for D#4 at KIT/ Department of Architecture, Main Hall	Offline	SS 21	Faculty of Architecture, KIT	Team Members and new Students, faculty	presenting the project in the faculty		
Podcast	RoofKIT Podcast on Spotify and Campus Radio: Epi 1	Online/Offline	13.04.2021	Spotify and Campus Radio	Architects, Engineers, Building and Sustainbility interests, students, young generation, .. parties involved in the construction	Episode 1: Fighting 40% > Definition of the problem in the building environment and building industry, Presentation RoofKIT		https://www.campusradio-karlsruhe.de/2021/04/13/new-podcast-fighting-40/
Infosession	Semesteropening - Course Presentation	Online	14.04.2021	Zoom	faculty members, registered students	Presentation of RoofKIT, Invitation to Infosession in the afternoon for further Project Informations		
Infosession	Infosession RoofKIT - join the team	Online	14.04.2021	Zoom	registered students	Presentation of RoofKIT, Invitation to participate and possibility to get credits		
Podcast	RoofKIT Podcast on Spotify and Campus Radio: Epi 2	Online/Offline	10.05.2021	Spotify and Campus Radio	Architects, Engineers, Building and Sustainbility interests, students, young generation, .. parties involved in the construction	Episode 2: Urban Mining, Solution for the Future - Guest: Prof. Dirk Hebel		https://www.campusradio-karlsruhe.de/2021/05/10/urban-mining/
Podcast	Urban Mining . New episode of the podcast	Online/Offline	18.05.2021	Website professorship sustainable construction nb.ieb.kit.edu	all visitors of the website	Announcement podcast episode published on Spotify, Campusradio Karlsruhe.		
Presentation Faculty Meeting	Faculty Meeting, Presentation of current Projects	Offline	23.05.2021	Faculty of Architecture, KIT	Faculty members, different professors, deanery	Projectpresentation RoofKIT to the faculty members	15	
Podcast	RoofKIT Podcast on Spotify and Campus Radio: Epi 3	Online/Offline	08.06.2021	Spotify and Campus Radio	Architects, Engineers, Building and Sustainbility interests, students, young generation, .. parties involved in the construction	Episode 3: Manual of Recycling - Guest: Petra Riegler-Floors		https://www.campusradio-karlsruhe.de/2021/06/08/manual-of-recycling/
Podcast	RoofKIT Podcast on Spotify and Campus Radio: Epi 4	Online/Offline	12.07.2021	Spotify and Campus Radio	Architects, Engineers, Building and Sustainbility interests, students, young generation, .. parties involved in the construction	Episode 4: The Future City - Guest Angelika Hinterbrandner		https://www.campusradio-karlsruhe.de/2021/07/12/the-future-city/
Podcast	RoofKIT Podcast on Spotify and Campus Radio: Epi 5	Online/Offline	10.08.2021	Spotify and Campus Radio	Architects, Engineers, Building and Sustainbility interests, students, young generation, .. parties involved in the construction	Episode 5: Innovative Materials - Guest: Rasa Weber		https://www.campusradio-karlsruhe.de/2021/08/10/innovative-materials/
Publication	CliKIT	Online	19.08.2021	Website	Students Magazine	General publication about the goal of the team and the competition	We have no information on this (is not in our hands)	https://www.clickit-magazin.de/die-stadt-der-zukunft-als-rohstofflager/
Design Course 5	Design Studio Master: "RoofKIT"	Offline	WS 21/22	Faculty of Architecture, KIT	registered architecture students (master)	the Student Design Team further elaborating the advanced design and construction and organizing and preparing the building process		
Seminar	„Architekturlabor Solar Decathlon - Detailplanung des Nachhaltigen Bauens"	Offline	WS 21/22	Faculty of Architecture, KIT	registered architecture students (master)	New formate for being part of the team	10	
Seminar	"Nachhaltigkeit Kommunizieren" (Communicating Sustainability)	Offline	WS 21/22	Faculty of Architecture, KIT	Architecture Students	Cooperation with Professorship Architectural Communication, Prof. Rambow. Preparation of the exhibtion "RoofKIT - How do we build in the future" at Architekturschaufenster Karlsruhe	15	
Seminar	"Detailled Energy Conception"	Offline	WS 21/22	Faculty of Architecture, KIT	Architecture Students	Detailing the energy concept	15	
Seminar	"Myco-Fabricate - Design and Build with Mycelium"	Offline	WS 21/22	Faculty of Architecture, KIT	Architecture Students	Developing some furniture or accecoires for the HDU	15	
Seminar	"Lighting Conception"	Offline	WS 21/22	Faculty of Architecture, KIT	Architecture Students	Finalising the lighting, documentation on studies	15	
Stegreif	Model of Wall Construction	offline	WS 21/22	Faculty of Architecture, KIT	Architecture Students	Students build a 1:1 Model of a Wall section of the HDU out of real Materials - for demontrative and educational usage in our exhibitions and at the solar decathlon event site		
Cooperation	Heinrich-Maidinger-School	Offline	01.10.2021 - to the end of competition	Faculty of Architecture, KIT	Interdisciplinary Students	Further developing of the HLS concepts.	15	
Podcast	RoofKIT Podcast on Spotify and Campus Radio: Epi 6	Online/Offline	11.10.2021	Spotify and Campus Radio	Architects, Engineers, Building and Sustainbility interests, students, young generation, .. parties involved in the construction	Episode 6: About existing material - Guest: Sophia Schmidt		https://www.campusradio-karlsruhe.de/2021/10/11/about-existing-material/
Party	Semester Opening Party	Offline	13.10.2021	KIT	Team Members and new Students	Party about the current status of the plans and a bit of recruiting feeling	40 people	
Semesterprogramme	Seminar/Design Course/Research Seminar Announcement	Online/Offline	06.12.2021	Website faculty of architecure KIT arch.kit.edu	registered students	Invitation to participate and possibility to get credits		
Exhibition	RoofKIT - How do we build in the future?	Offline	11.01 – 04.02.2022	Architekturschaufenster Karlsruhe	General Public, Students, Architects	Exhibition focussing on the most relevant topics for future buildings in terms of sustainability. The topics are explained on the basis of the RoofKIT project.		
Semesterprogramme	Announcement Semianr Architecture Comunication	Online	19.01.2022	Website faculty of architecure KIT arch.kit.edu	registered students	Invitation to participate and possibility to get credits, How does Architecture can be communicated to the public. Project: RoofKIT		https://www.arch.kit.edu/aktuelles/veranstaltungskalender.php/event/45578
Workshop Vernissage	Werkraumhäuschen, Werkraum Bregenzerwald, Austria	Offline	25.02.2022	Andelsbuch, Austria	Architects, craft apprentices, elektricals, plumbers, carpenters, roofers, upholsterer, .. building and sustainbility interests, ..	RoofKIT Participation at the Workshop and Vernissage "Werkraumhäuschen", in the Werkraum Bregenzerwald (architect: Peter Zumthor), togehter with Wolfgang Schwarzmann, Prof. for Architecture in Liechtenstein (AT), and some caft apprentices who developted ideas how single-origin and innovative joining techniques can be realised 1:1. Additionally RoofKIT brought some urban mining material samples and presented them to the young apprentices and further participants of the Workshop.	30	
Finnisage	Constructive Alps	Offline	25.02.2022	Andelsbuch, Austria	Architects, craft apprentices, elektricals, plumbers, carpenters, roofers, upholsterer, .. architecture students from liechtenstein, municipal representatives, mayors, craftsmen, building and sustainbility interests, ..	Get in contact with different target groups, presentation of the project RoofKIT, Invitation to the Event in Wuppertal, discussing at dinner table	60	
1:1	Construction Site Reuthe, Austria	Offline	15.03 - 15.05.2022	Reuthe, Austria	Architect, craft, project manager, apprentices	RoofKIT builds in Austria with a carpentry company that deals with the future issues of sustainable building. Above all, apprentices are involved in the building process. Students of architecture or civil engineering have the opportunity to see how details and building processes can be solved in reality through active participation. Furthermore, professional carpenters and project developers have the opportunity to face the challenge of rethinking and rethinking construction.	40	https://www.kaufmannzimmerei.at/
Presentation	"Workroom" Vorarlberg	Online / Offline	21.03. - 13.05.2022	Vorarlberg, Austria	Apprentices	Presentation of the project, which is integrated in the world of study. Focus of the apprentices and trainees to perform educational work in the direction of architects. Their job offers the possibility of enforcing the feasibility of the project.	Unknown	
Workshop	Spring Days of Sustainability KIT	Online / Offline	28. – 31.03. 2022	KIT	Students of all Faculties	Project days on general sustainability topics	Unknown, still negating	https://www.zak.kit.edu/fruehlingstage/index.php
game	card game: sustainability facts on the go	Offline	01.04.2022 onwards	Karlsruhe	general public	Everywhere that we are presenting the project (exhibitions, projects, speeches, etc.) we want to distribute the card game - for the guests to take home and play		
material library	Adding materials to the faculty library used in the HDU	Online/Offline	01.04.2022 onwards	Faculty of Architecture, KIT	architecture students, faculty members	RoofKIT added some new materials to the upcoming material library at faculty of architecture, KIT, where ystudents can get inspired, learn about single-origin materials, new materials and integrated them in further design courses and projects.	unknown	
Presentation	Speed peer review and diskussion	Offline	end of April	Faculty of Architecture, KIT	architecture students, faculty members	to present our project again within the faculty and discuss the topic with members of the faculty and students		
Symposium	"sustain build repeat"	offline	SS 22	ZKM Karlsruhe	faculty members, registered students, architects and professionals	Symposium "Sustain. Build. Repeat." focusing on "Building Stock as the Material Resource of the 21st century", open access to all students and other team members, several guest lectures by the specialist for building stock research as well as lectures on best practice projects		

CESA IMPLEMENTATION LIST

Deliverable No.	D#6
Team ID	KIT
University/ City	Karlsruhe

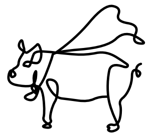
Social Awareness (overview since d#4, not all)

Type	Name	Online / Offline	Date (Duration)	Place	Target Group	Short Description	No. of Participants/ Visitors/ Engagement	Link
Podcast	RoofKIT Podcast on Spotify and Campus Radio: Epi 1	Online/Offline	13.04.2021	Spotify and Campus Radio	Architects, Engineers, Building and Sustainbility interests, students, young generation, .. parties involved in the construction	Episode 1: Fighting 40% > Definition of the problem in the building environment and building industry, Presentation RoofKIT		https://www.campusradio-karlsruhe.de/2021/04/13/new-podcast-fighting-40/
Speaker	Architects for Future KA	Online	20.04.2021	Zoom	Participants Architects for future	Presentation of RoofKIT, Invitation to follow the further project and invitation to Wuppertal.	20 people	
Podcast	RoofKIT Podcast on Spotify and Campus Radio: Epi 2	Online/Offline	10.05.2021	Spotify and Campus Radio	Architects, Engineers, Building and Sustainbility interests, students, young generation, .. parties involved in the construction	Episode 2: Urban Mining, Solution for the Future - Guest: Prof. Dirk Hebel		https://www.campusradio-karlsruhe.de/2021/05/10/urban-mining/
Podcast	RoofKIT Podcast on Spotify and Campus Radio: Epi 3	Online/Offline	08.06.2021	Spotify and Campus Radio	Architects, Engineers, Building and Sustainbility interests, students, young generation, .. parties involved in the construction	Episode 3: Manual of Recycling - Guest: Petra Riegler-Floors		https://www.campusradio-karlsruhe.de/2021/06/08/manual-of-recycling/
Podcast	RoofKIT Podcast on Spotify and Campus Radio: Epi 4	Online/Offline	12.07.2021	Spotify and Campus Radio	Architects, Engineers, Building and Sustainbility interests, students, young generation, .. parties involved in the construction	Episode 4: The Future City - Guest Angelika Hinterbrandner		https://www.campusradio-karlsruhe.de/2021/07/12/the-future-city/
Publikation	Sortenrein Bauen - Methodik I Material I Konstruktion	Offline	15.07.2021	DETAIL Verlag	Architects, Engineers, Public, professionals, professors, Teaching Assistants and Researcher, craft apprentices, architecture/engineering students, municipal representatives, mayors, craftsmen, building and sustainbility interests, ..			
Website	RoofKIT @linktree	Online	01.08.2021	website linktree	General Public, all visitors of the website	launchpad to our latest videos, website posts, social meida post - everywhere we are online		@RoofKIT | Linktree
social media channel	roofkit_@Instagram	Online	01.08.2021	instagram	General Public, social media user	open general social media channel - postings about concept, design, materials, (team) activities, etc.	more then 400 people	Team RoofKIT (@roofkit_) • Instagram-Fotos und -Videos
Podcast	RoofKIT Podcast on Spotify and Campus Radio: Epi 5	Online/Offline	10.08.2021	Spotify and Campus Radio	Architects, Engineers, Building and Sustainbility interests, students, young generation, .. parties involved in the construction	Episode 5: Innovative Materials - Guest: Rasa Weber		https://www.campusradio-karlsruhe.de/2021/08/10/innovative-materials/
Publication	CliKIT	Online	19.08.2021	Website	Students Magazine	General publication about the goal of the team and the competition	We have no information on this (is not in our hands)	https://www.clickit-magazin.de/die-stadt-der-zukunft-als-rohstofflager/
Podcast	RoofKIT Podcast on Spotify and Campus Radio: Epi 6	Online/Offline	11.10.2021	Spotify and Campus Radio	Architects, Engineers, Building and Sustainbility interests, students, young generation, .. parties involved in the construction	Episode 6: About existing material - Guest: Sophia Schmidt		https://www.campusradio-karlsruhe.de/2021/10/11/about-existing-material/
Publication	Lust auf Gut	Online / Offline	29.10.2021	Website/Magazine	Interested public	Special issue of the magazine in which the cultural focus in particular makes it clear how different sustainable four walls can look like.	We have no information on this (is not in our hands)	https://www.lust-auf-gut.de/magazine-previews/blaettern/lust-auf-gut-magazin-special-rund-ums-bauen-und-wohnen-34/
social media channel	RoofKIT@youtube	Online	01.12.2021	youtube	General Public, social media user	open general social media channel - videos about concept, design, materials, etc.	more then 600 views	RoofKIT - YouTube
Interacitve Knowledge	Adventskalender	Online	01.12.2021	Instagram	instagram followers	The advent calender explains each day another topic of our project. For example the materials, energie concept, team, design and more.	more then 400 people	
Exhibition	RoofKIT - How do we build in the future?	Offline	11.01 – 04.02.2022	Architekturschaufenster Karlsruhe	General Public, Students, Architects	Exhibition focussing on the most relevant topics for future buildings in terms of sustainability. The topics are explained on the basis of the RoofKIT project.		
Exhibition	Art Installation	Offline	01.02. - 26.06.2022	Karlsruhe		Starting Feb. In public spaces in Karlsruhe, ongoing under our HDU in June		
publicity action	spray chalk	Offline	13.02.2022	Karlsruhe	general public on shopping street	spraying question "How do we build in the future?" and our Logo on the public shopping street in Karlsruhe to get attention for the project and the topic	a couple hundred people walk on that street every day - the chalk stayed for 3 days	
Workshop Vernissage	Werkraumhäuschen, Werkraum Bregenzerwald, Austria	Offline	25.02.2022	Andelsbuch, Austria	Architects, craft apprentices, elektricals, plumbers, carpenters, roofers, upholsterer, .. building and sustainbility interests, ..	RoofKIT Participation at the Workshop and Vernissage "Werkraumhäuschen", in the Werkraum Bregenzerwald (architect: Peter Zumthor), togehter with Wolfgang Schwarzmann, Prof. for Architecture in Liechtenstein (AT), and some caft apprentices who developted ideas how single-origin and innovative joining techniques can be realised 1:1. Additionally RoofKIT brought some urban mining material samples and presented them to the young apprentices and further participants of the Workshop.	30	
Finnisage	Constructive Alps	Offline	25.02.2022	Andelsbuch, Austria	Architects, craft apprentices, elektricals, plumbers, carpenters, roofers, upholsterer, .. architecture students from liechtenstein, municipal representatives, mayors, craftsmen, building and sustainbility interests, ..	Get in contact with different target groups, presentation of the project RoofKIT, Invitation to the Event in Wuppertal, discussing at dinner table	60	
Exhibition	MobiLab	Offline	21.03-11.04.2022	Karlsruhe	gerneral public, visitors of the "Frühlingstage der Nachhaltigkeit"	We have the chance to present our project and the topic in the MobiLab, which is a participatory Tinyhouse.		
Interactive Knowledge	"Energietouren durch die Oststadt"	Offline	30. - 31.03.2022	Karlsruhe, Frühlingstage der Nachhaltigekeit	general public, interessted guests	We are part of these tours that target interested people for the topic of engerie use and sustainibility		
Exhibition	RoofKIT - How do we build in the future?	Offline	30. - 31.03.2022	Karlsruhe,Frühlingstage der Nachhaltigekeit	students and members of the KIT	The university event "Frühlingstage der Nachhaltigkeit" is a chance for students and members to take workshops, hear speeches and more all with the topic of sustainibility. We are taking part on those days with to online exhibitions		Frühlingstage der Nachhaltigkeit am KITFtdN Startseite
game	card game: sustainability facts on the go	Offline	01.04.2022 onwards	Karlsruhe	general public	Everywhere that we are presenting the project (exhibitions, projects, speeches, etc.) we want to distribute the card game - for the guests to take home and play		
Exhibition	RoofKIT - How do we build in the future?	Offline	15.04. - 31.05.2022	Zukunftsraum Karlsruhe	General Public, Students, Architects	Exhibition focussing on the most relevant topics for future buildings in terms of sustainability. The topics are explained on the basis of the RoofKIT project.		
Symposium	Presenting RoofKIT at the Symposium "sustain.build.repeat."	Offline /Online	19.04.2022	ZKM Karlsruhe (centre for art and media karlsruhe)	Architects, Engineers, Public, professionals, professors, Teaching Assistants and Researcher, craft apprentices, architecture/engineering students, municipal representatives, mayors, craftsmen, building and sustainbility interests, ..	Presentation of RoofKIT at the Symposium sustain.build.repeat an the ZKM (centre for art and media Karlsruhe)		
Knowledge Sharing	Postcard	Offline	22.04.2022	Karlsruhe	gerneral public	laying out postcards for people to take with information about the project and sustainibility in gerneral		
Exhibition	RoofKIT - How do we build in the future?	Offline	15.07.2022	Regierungspräsidium Karlsruhe	General Public, Students, Architects	Exhibition focussing on the most relevant topics for future buildings in terms of sustainability. The topics are explained on the basis of the RoofKIT project.		
Publication	Haus & Grund	Online / Offline	coming soon	Magazine	Generel interested Public	Presentation of project work with a focus on representing the interests of home, apartment and land owners at the federal level vis-à-vis politicians	We have no information on this (is not in our hands)	
Publication	Detail	Online	coming soon	Website	Focused on architects but open for all	Presentation of all German teams in series	We have no information on this (is not in our hands)	

-UTOPÜSCHEL-
Mit 32 Karten in eine nachhaltigere Zukunft

Das Kartenspiel „Utopüschel" bietet Fakten und Hilfsmittel, um den eigenen Alltag ein Stück nachhaltiger zu gestalten.

Ziel ist es, neue Impulse zum Thema Nachhaltigkeit zu setzen, einen belebenden Austausch und eine spannende Diskussion unter den Spieler*innen zu schaffen. Spieler*innen werden sensibilisiert, um achtsamer mit unserer Umwelt umzugehen und ihren Alltag ein wenig nachhaltiger zu gestalten.



Das Spiel fokussiert sich auf vier verschiedene Themen:
Kleidung, Ernährung, Energie/ Mobilität und soziales Bewusstsein -
Die Grundbedürfnisse eines Jeden.
Zu jeder der Kategorien, die im Zusammenhang mit der Nachhaltigkeit im Alltag stehen, gibt es acht Karten. Diese sind in Actions-, Fragen- und Faktenkarten gegliedert.

Regeln:
I Alle Antworten werden respektiert
II Das Gespräch hat Vorrang

Quellen:

- -Rentenversicherung Bund: Rentenversicherung in Zeitreihen 2018, S. 111 & D Rentenversicherung: Positionspapier zur Bedeutung psychischer Erkrankungen, 2014
- -https://www.willy-hellpach-schule.de/index.php/schulleben/97-schulfach-glueck
- -https://fogsmagazin.com/waesche-waschen/
- -https://mode-macht-menschen.com/ressourcenverbrauch-quiz.html
- -Was ist wirklich nachhaltig? - In über 140 Tipps zu mehr Klimafreundlichkeit im Alltag; Georgina Wilson-Powell; Dorling Kindersley Verlag; 2021 I S.40
- -Zerowaste - Alles rund um ein Leben fast ohne Müll; Elise Timm, mit Illustrationen von Isabelle Vandeplassche; frechverlag; 1. Auflage 2019 I S.15 I S.21
- -https://utopia.de/ratgeber/regrowing-gemuese-einfach-auf-der-fensterbank-nachwachsen-lassen/
- -https://www.smarticular.net/radieschenblaetter-weiter-verwerten-rezepte-pesto-suppe-chips-gesund/
- -https://praxistipps.chip.de/ladekabel-in-steckdose-lassen-ist-das-gefaehrlich_97856
- -https://www.co2online.de/energie-sparen/heizenergie-sparen/heizkosten-sparen/richtig-heizen-die-10-besten-tipps/l/
- -https://info.kaufsignal.ch/13-tipps-zum-strom-sparen-beim-kuhlschrank/
- -https://www.nuernberg.de/imperia/md/esp/dokumente/konsumtipps_duschen.pdf
- -https://www.focus.de/gesundheit/gesundleben/fitness/treppensteigen-so-viele-kalorien-verbrennst-du-wenn-du-die-treppe-nimmst_id_10258969.html

Warum eigentlich „Utopüschel"?

Das Kartenspiel ist aus einem Seminar „Expedition Utopüschel" am Fachgebiet Bildende Kunst am KIT (Karlsruher Insitut für Technologien) entstanden. Die Seminarleitung Sanne Pawelzyk und neun Studierenden haben sich mit der Frage:
„Können wir mit einem kleinen Ableger der großen Zukunftsutopie – mit einem kleinen Utopüschel - beginnen?" beschäftigt.

Annika Enders, Julian Fehrenbacher, Karolin Unger, Katharina Knoop, Paula Seifert, Nisa Turkic, Nils Bachert, Tamara Kwasnik, Tamara Schütte

Die Entwicklung und Vervielfältigung des Kartenspieles wurde von RoofKIT unterstützt. Das Team RoofKIT nimmt am Solar Decathlon Europe, einem Studentenwettbewerb, teil. Der im Rahmen einer europäischen Vision von Nachhaltigkeit, Energieeffizienz und verantwortungsbewusstem Ressourcenmanagement durchgeführt wird.

RoofKIT

RESULTS

COMPONENTS

PROJECT INFORMATION

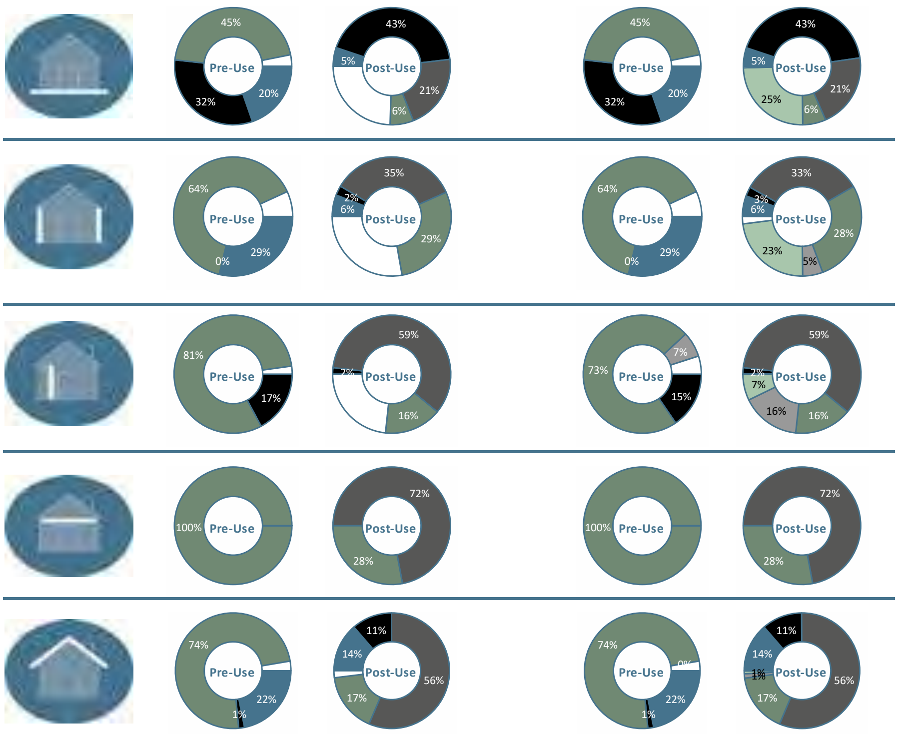
TEAM ID
KIT

TEAM NAME
RoofKIT

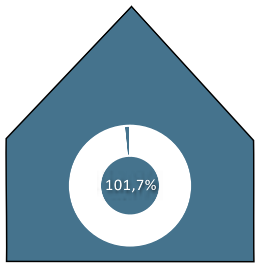
UNIVERSITY
Karlsruhe Institute of Technology (KIT)

PROJECT NAME
RoofKIT_SDE

CLOSED-LOOP POTENTIAL | LOOP POTENTIAL



URBAN MINING INDICATOR



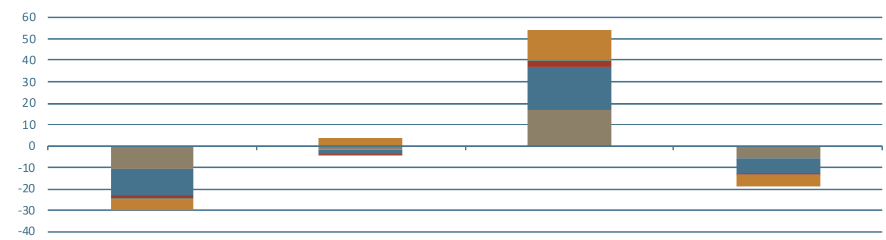
PRE-USE

- Reused materials (RU)
- Recycled materials (RC)
- Renewable materials (RN)
- Downcycled materials (DC)
- Primary raw materials, non-renewable (PR)

POST-USE

- reusable (ru)
- recyclable (rc)
- downcyclable, certified renewable (dccr)
- energetically recyclable, certified renewable (encr)
- downcyclable (dc)
- energetically recyclable, renewable (enr)
- energetically recyclable, fossile (enf) or Disposal (w)

GLOBAL WARMING POTENTIAL



	Production (A1-3)	Replacement (B4)	Disposal (C3-4)	Benefits outside system boundary (D)
TOTAL [t CO_2-eq.]	-30	0	54	-19

GWP	TOTAL
Foundation	-1,7
Exterior Walls	-0,5
Interior Walls	0,1
Ceilings	-0,2
Roofs	7,4
[t CO_2-eq.]	5,1
Reference area: 100 m^2	
Reference time: 50 a	
kg CO_2-eq-/m^2 p.a.	1,0

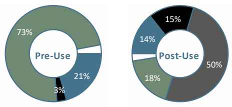
UMI-Tool and Components, Notes

component	including	component layer	note
general		biological materials	for all biological materials (wood, seaweed insulation, cellulose boards, felt, ...), thermal recycling is automatically selected as the end-of-life scenario, although RoofKIT does not aim for this, option cannot be changed in the tool
320_Foundation	insulated floor	old wood parket, stainless steel sheet and new wooden parket	the different surfaces of the floor were added partially in the component layer, error in tool: translation german-english
		clay	the Claytec product could not be selected in the Ökobaudat database; manufacturer-independent clay products were accepted; Claytec is currently developing an EPD-Datasheet
		seagrasswool	error in tool: translation german-english, manuell change not possible; the used product Neptutherm could not be selected in the Ökobaudat/EPD database; manufacturer-independent seagrasswool product was accepted
		PE vapour barrier	the used product ecovap blue could not be selected in the Ökobaudat/EPD database; (most possible mono-material and healthy material for this usage was selected); manufacturer-independent vapour barrier products were accepted
		Windpapier	error in tool: translation german-english, manuell change not possible; the used product Tyvek Soft AMANN could not be selected in the Ökobaudat/EDP database; (most possible mono-material and healthy material for this usage was selected) manufacturer-independent windpaper products were accepted
320_2_Foundation	uninsulated terrace		
320_3_Foundation	all steel elements in the floor level 0	scaffold towers	all steel elements from DOKA (rented for event-phase) were calculated by mass
330_2_Exterior_Walls	uninsulated exterior walls (terrace)	Windpapier	error in tool: translation german-english, manuell change not possible; the used product Tyvek Soft AMANN could not be selected in the Ökobaudat/EDP database; (most possible mono-material and healthy material for this usage was selected); manufacturer-independent clay product was accepted
330_3_Exterior_Walls	storage window facade and reused truck plane in the north		
330_4_Exterior_Walls	exterior walls south, east, west	clay	the Claytec product could not be selected in the Ökobaudat database. Manufacturer-independent clay products were accepted; Claytec is currently developing an EPD-Datasheet
		PE vapour barrier	the used product ecovap_blue could not be selected in the Ökobaudat/EPD database; (most possible mono-material and healthy material for this usage was selected); manufacturer-independent vapour barrier product was accepted

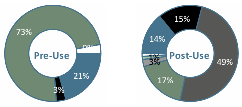
component	including	component layer	note
		Windpapier	error in tool: translation german-english, manuell change not possible; the used product Tyvek Soft AMANN could not be selected in the Ökobaudat/EDP database; (most possible mono-material and healthy material for this usage was selected); manufacturer-independent windpaper product was accepted
340_Interior_Walls	corewalls, modul jolt, east and west	„Inner support“	diagonal formwork solid wood sustainable forestry is used, no glued laminated timber like mentioned in UMI; error in tool: changes could not be made, neither through editing, nor with deleting and adding a new material
340_2_Interior_Walls	partition wall shower, WC, washbasin area	Glas ceramics	the used product Glasceramics could not be selected in the Ökobaudat/EPD database; melting takes place at lower temperatures than classical glass melting, this means that less energy is required; GWP values in manufacturing phase may vary; manufacturer-independent glas ceramics product was accepted
340_3_Interior_Walls	partition technical core, bathroom		
340_4_Interior_Walls	partition technical core, kitchen		
350_Ceilings	ceiling above technical core		
360_Roof	roof insulated, roof windows, windows west and south exterior wall	copper sheet	the used product TECU could not be selected in the Ökobaudat/EPD database; TECU uses only recycled copper, GWP was set to zero because of reuse; manufacturer-independent copper from Ökobaudat product was accepted
		roof covering Polypropylen	the used product Sucotecto could not be selected in the Ökobaudat/EPD database; (most possible mono-material and healthy material for this usage was selected); manufacturer-independent vapour barrier product was accepted
		Vapor retarder	the used product ecovap_blue could not be selected in the Ökobaudat/EPD database; (most possible mono-material and healthy material for this usage was selected); manufacturer-independent vapour barrier product was accepted
		windows	roof windows were added as „new“ windows; windows (frame and glazing) from exterior walls (south and west and north) were added here because of tool error in the component list of the exterior walls: no additional materials could be added; as the windows are reused storage windows, the GWP was set to zero
360_2_Roof	uninsulated roof (terrace)	copper sheet	the used product TECU could not be selected in the Ökobaudat/EPD database; manufacturer-independent copper from Ökobaudat product was accepted

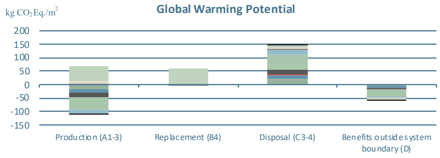
ROOF

CLOSED-LOOP POTENTIAL 200,67%



LOOP POTENTIAL 204,16%





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COMPONENT AREA 69,74 m²

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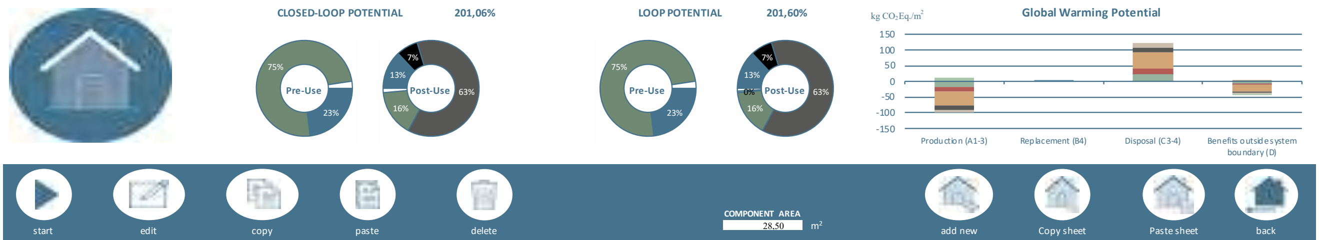
TYPE OF COST Source: DIN 276	COMPONENT Source: Nutzungsdauern (operating life)	DISMANTLING WORK Source: Bauteilkatalog (components catalogue)	MATERIAL	WASTE GROUP	LIFE CYCLE MASS [kg/m²]	VIABILITY FACTOR	CLP [%]	LP [%]	GWP [kg CO₂/m²]
Roof coverings	Coverings: Zinc, copper sheet, aluminum, stainless steel	very low	Copper sheet	170401_Copper	6,23	0	200,00%	200,00%	0
Roof cladding	Wood cladding: Wood, wood-based material and multilayer lightweight panels	very low	coniferous wood boards / battens sustainable forestry	170201_Wood A1	12,549	0,8	200,00%	200,00%	-1,51
Roof construction	Supporting structure: pitched roof	Collar beam/rafter/batten	Solid structural timber, sustainable forestry	170201_Wood A1	6,768	0,8	200,00%	200,00%	-3,79
Roof construction	Supporting structure: pitched roof	Collar beam/rafter/batten	Solid structural timber, sustainable forestry	170201_Wood A1	1,41	0,8	200,00%	200,00%	-0,79
Roof coverings	Waterproofing membranes above insulation with light protective layer	very low	Abdichtung, Polypropylen	Reuse, others	0,24564	1	90,00%	90,00%	1,73
Roof cladding	Wood cladding: Wood, wood-based material and multilayer lightweight panels	very low	coniferous wood boards / battens sustainable forestry	170201_Wood A1	10,0392	0,8	200,00%	200,00%	-1,21
Roof coverings	Insulation seaweed	very low	seaweed	Biological fibres, compostable	16,17	0,7	224,60%	231,98%	2,14
Roof construction	Supporting structure: pitched roof	Collar beam/rafter/batten	Solid structural timber, sustainable forestry	170201_Wood A1	31,584	0,8	200,00%	200,00%	-17,70
Roof cladding	Wood cladding: Wood, wood-based material and multilayer lightweight panels	very low	coniferous wood boards / battens sustainable forestry	170201_Wood A1	8,7984	0,8	200,00%	200,00%	-1,06
Roof coverings	Waterproofing membranes underneath the insulation	very low	Vapor retarder (PE-LD) *	Reuse, others	0,1404	1	90,00%	90,00%	1,31
Roof cladding	cladding	very low	ECOR, plates of waste cellulose material	Biological fibres, compostable	0,01498068	0	300,00%	500,00%	0,00
Roof cladding	Wallpapers: Plastic, textile, woven fabric, paper, not paintable/ paintable	very low	felt	Biological fibres, compostable	0,8736	0	200,00%	200,00%	2,02
Roof windows, roof openings, roofing	Roof windows (frames): aluminium, plastic, aluminium-wood composite	PVC window profiles (without secondary raw material content)	Polyvinyl chloride (PVC)	Manufacturer or association return	4,968	0	200,00%	200,00%	8,94
Roof windows, roof openings, roofing	Glazing: safety insulating glass, 3-pane thermal insulation glass, 2-pane thermal insulation glass, fire protection insulating glass, sound insulation glass, attack resistant	Insulating glazing, clamped	Float glass for insulating glazing without secondary raw material	170202_Glass	0,5	0	100,00%	200,00%	119,79
Roof windows, roof openings, roofing	Glazing: safety insulating glass, 3-pane thermal insulation glass, 2-pane thermal insulation glass, fire protection insulating glass, sound insulation glass, attack resistant	Insulating glazing, clamped	Float glass for insulating glazing without secondary raw material	170202_Glass	1,3	0	100,00%	200,00%	0,00
Roof windows, roof openings, roofing	Roof windows (frames): aluminium, plastic, aluminium-wood composite	PVC window profiles (without secondary raw material content)	Polyvinyl chloride (PVC)	Manufacturer or association return	7,452	0	200,00%	200,00%	0,00
Roof windows, roof openings, roofing	Glazing: safety insulating glass, 3-pane thermal insulation glass, 2-pane thermal insulation glass, fire protection insulating glass, sound insulation glass, attack resistant	Insulating glazing, clamped	Float glass for insulating glazing without secondary raw material	170202_Glass	1	0	100,00%	200,00%	0,00
Roof windows, roof openings, roofing	Roof windows (frames): aluminium, plastic, aluminium-wood composite	PVC window profiles (without secondary raw material content)	Polyvinyl chloride (PVC)	Manufacturer or association return	3,726	0	200,00%	200,00%	0,00
Roof cladding	Wood cladding: Wood, wood-based material and multilayer lightweight panels	very low	coniferous wood boards / battens sustainable forestry	170201_Wood A1	1,316	0,8	200,00%	200,00%	-0,16

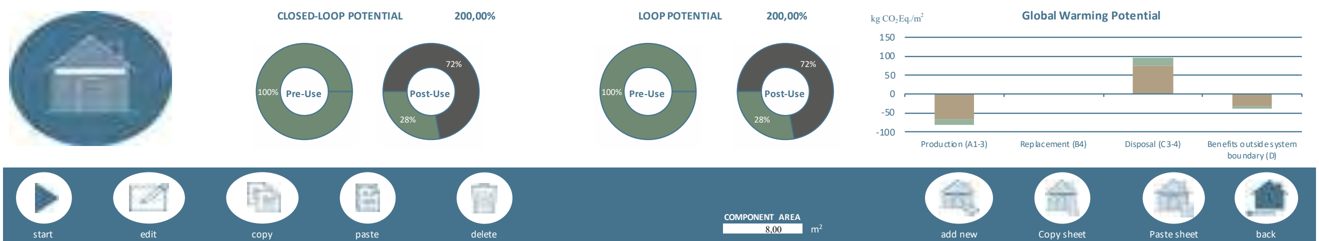
ROOF_2



TYPE OF COST Source: DIN 276	COMPONENT Source: Nutzungsdauern (operating life)	DISMANTLING WORK Source: Bauteilkatalog (components catalogue)	MATERIAL	WASTE GROUP	LIFE CYCLE MASS [kg/m²]	VIABILITY FACTOR	CLP [%]	LP [%]	GWP [kg CO_2/m²]
Roof coverings	Coverings: Zinc, copper sheet, aluminum, stainless steel	very low	Copper sheet	170401_Copper	6,23	0	200,00%	200,00%	0,994704
Roof cladding	Wood cladding: Wood, wood-based material and multilayer lightweight panels	very low	coniferous wood boards / battens sustainable forestry	170201_Wood A1	12,126	0,8	200,00%	200,00%	-1,46
Roof coverings	Waterproofing membranes above insulation with light protective layer	very low	Abdichtung, Polypropylen	Reuse, others	0,15824	0	90,00%	90,00%	1,73
Roof cladding	Wood cladding: Wood, wood-based material and multilayer lightweight panels	very low	coniferous wood boards / battens sustainable forestry	170201_Wood A1	9,7008	0,8	200,00%	200,00%	-1,17
Roof construction	Supporting structure: pitched roof	Collar beam/rafter/batten	Solid structural timber, sustainable forestry	170201_Wood A1	29,61	0,8	200,00%	200,00%	-16,59
Roof cladding	Wood cladding: Wood, wood-based material and multilayer lightweight panels	very low	coniferous wood boards / battens sustainable forestry	170201_Wood A1	8,2344	0,8	200,00%	200,00%	-0,99
Roof cladding	Wood cladding: Wood, wood-based material and multilayer lightweight panels	very low	coniferous wood boards / battens sustainable forestry	170201_Wood A1	6,862	0,8	233,30%	239,96%	-0,83
Roof construction	Supporting structure: pitched roof	very low	Steel beam	Reuse, others	12,1	1	190,00%	190,00%	9,33

Appendix AJ: building component -Ceiling

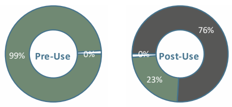
CEILINGS



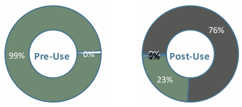
TYPE OF COST Source: DIN 276	COMPONENT Source: Nutzungsdauern (operating life)	DISMANTLING WORK Source: Bauteilkatalog (components catalogue)	MATERIAL	WASTE GROUP	LIFE CYCLE MASS [kg/m²]	VIABILITY FACTOR	CLP [%]	LP [%]	GWP [kg CO_2/m²]
Ceiling construction	Wooden ceilings: Solid wood ceiling, wooden beam ceiling, prefabricated wooden elements, wood-concrete composite ceiling.	Wood beam ceiling, incl. Planking	Solid structural timber, sustainable forestry	170201_Wood A2	43,24	0,7	200,00%	200,00%	-24,233444
Ceiling claddings	Wood cladding: Wood, wood-based material and multilayer lightweight panels	very low	coniferous wood boards / battens sustainable forestry	170201_Wood A1	11,28	0,8	200,00%	200,00%	-1,36

INTERIOR WALLS

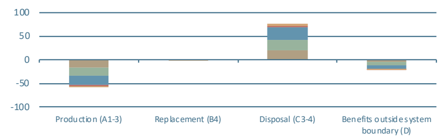
CLOSED-LOOP POTENTIAL 197,78%



LOOP POTENTIAL 198,69%



Global Warming Potential



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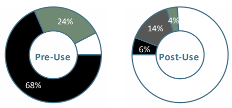
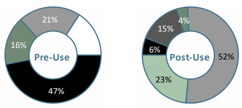
TYPE OF COST Source: DIN 276	COMPONENT Source: Nutzungsdauern (operating life)	DISMANTLING WORK Source: Bauteilkatalog (components catalogue)	MATERIAL	WASTE GROUP	LIFE CYCLE MASS [kg/m²]	VIABILITY FACTOR	CLP [%]	LP [%]	GWP [kg CO_2/m²]
Interior wall cladding	Cladding: Wood, wood-based material and multi-layer lightweight panels, aluminum, steel, copper, zinc, natural stone, artificial stone, ceramic tiles and	very low	coniferous wood boards / battens sustainable forestry	170201_Wood A1	11,28	0,8	200,00%	200,00%	-1,357128
Interior wall cladding	Cladding: Wood, wood-based material and multi-layer lightweight panels, aluminum, steel, copper, zinc, natural stone, artificial stone, ceramic tiles and	very low	coniferous wood boards / battens sustainable forestry	170201_Wood A1	11,28	0,8	200,00%	200,00%	-1,36
Inner supports	Wooden support	very low	Glued laminated timber, sustainable forestry	170201_Wood A1	14,57	0,8	194,00%	196,40%	-1,75
Interior wall cladding	cladding	very low	ECOR, plates of waste cellulose material	Biological fibres, compostable	0,0144045	0,7	300,00%	330,00%	1,17
Interior wall cladding	Wallpapers: Plastic, textile, woven fabric, paper not paintable	very low	felt	Biological fibres, compostable	1,512	0	200,00%	200,00%	2,33

INTERIOR WALLS_2

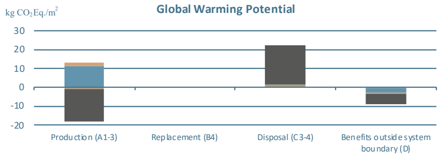
CLOSED-LOOP POTENTIAL 123,82%



LOOP POTENTIAL 253,75%



Global Warming Potential



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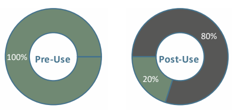
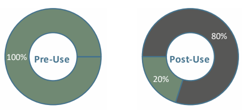
TYPE OF COST Source: DIN 276	COMPONENT Source: Nutzungsdauern (operating life)	DISMANTLING WORK Source: Bauteilkatalog (components catalogue)	MATERIAL	WASTE GROUP	LIFE CYCLE MASS [kg/m²]	VIABILITY FACTOR	CLP [%]	LP [%]	GWP [kg CO_2/m²]
Interior non-bearing walls	Stud wall systems	very low	Solid structural timber, sustainable forestry	170201_Wood A1	0,846	0,8	200,00%	200,00%	-0,4741326
Interior wall cladding	Ceramic tiles and slabs: Fine stoneware, stoneware, stoneware, split tiles, glass mosaic	very low	Glas ceramics	170202_Glass	15,624	0	100,00%	400,00%	0,00
Interior wall cladding	Cladding: Wood, wood-based material and multi-layer lightweight panels, aluminum, steel, copper, zinc, natural stone, artificial stone, ceramic tiles and	very low	Stainless steel sheet	170405_Stainless steel	3,1995	1	100,00%	100,00%	8,84
Interior wall cladding	Ceramic tiles and slabs: Fine stoneware, stoneware, stoneware, split tiles, glass mosaic	very low	Glas ceramics	170202_Glass	19,2696	0	100,00%	200,00%	0,00
Interior wall cladding	Cladding: Wood, wood-based material and multi-layer lightweight panels, aluminum, steel, copper, zinc, natural stone, artificial stone, ceramic tiles and	very low	Stainless steel sheet	170405_Stainless steel	0,6873	1	100,00%	100,00%	1,90
	Cladding: Wood, wood-based								

INTERIOR WALLS_3

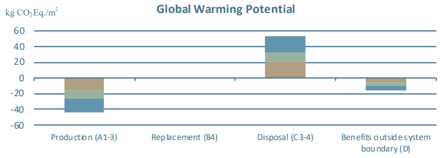
CLOSED-LOOP POTENTIAL 200,00%



LOOP POTENTIAL 200,00%



Global Warming Potential



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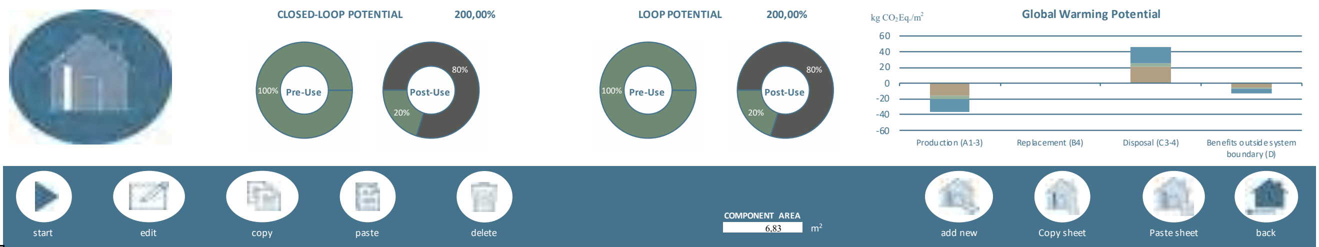
TYPE OF COST Source: DIN 276	COMPONENT Source: Nutzungsdauern (operating life)	DISMANTLING WORK Source: Bauteilkatalog (components catalogue)	MATERIAL	WASTE GROUP	LIFE CYCLE MASS [kg/m²]	VIABILITY FACTOR	CLP [%]	LP [%]	GWP [kg CO_2/m²]
Interior wall cladding	Cladding: Wood, wood-based material and multi-layer lightweight panels, aluminum, steel, copper, zinc, natural stone, artificial stone, ceramic tiles and	very low	coniferous wood boards / battens sustainable forestry	170201_Wood A1	11,28	0,8	200,00%	200,00%	-1,357128
Interior non-bearing walls	Stud wall systems	very low	Solid structural timber, sustainable forestry	170201_Wood A1	6,58	0,8	200,00%	200,00%	-3,69
Interior wall cladding	Cladding: Wood, wood-based material and multi-layer lightweight panels, aluminum, steel, copper, zinc, natural stone, artificial stone, ceramic tiles and	very low	coniferous wood boards / battens sustainable forestry	170201_Wood A1	11,28	0,8	200,00%	200,00%	-1,36

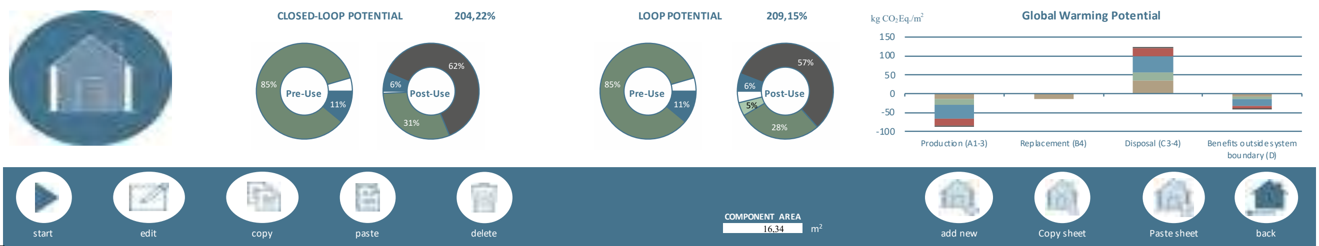
INTERIOR WALLS_4



TYPE OF COST Source: DIN 276	COMPONENT Source: Nutzungsdauern (operating life)	DISMANTLING WORK Source: Bauteilkatalog (components catalogue)	MATERIAL	WASTE GROUP	LIFE CYCLE MASS [kg/m²]	VIABILITY FACTOR	CLP [%]	LP [%]	GWP [kg CO₂/m²]
Interior wall cladding	Cladding: Wood, wood-based material and multi-layer lightweight panels, aluminum, steel, copper, zinc, natural stone, artificial stone, ceramic tiles and	very low	coniferous wood boards / battens sustainable forestry	170201_Wood A1	11,28	0,8	200,00%	200,00%	-1,357128
Interior non-bearing walls	Stud wall systems	very low	Solid structural timber, sustainable forestry	170201_Wood A1	2,256	0,8	200,00%	200,00%	-1,26
Interior wall cladding	Cladding: Wood, wood-based material and multi-layer lightweight panels, aluminum, steel, copper, zinc, natural stone, artificial stone, ceramic tiles and	very low	coniferous wood boards / battens sustainable forestry	170201_Wood A1	11,28	0,8	200,00%	200,00%	-1,36

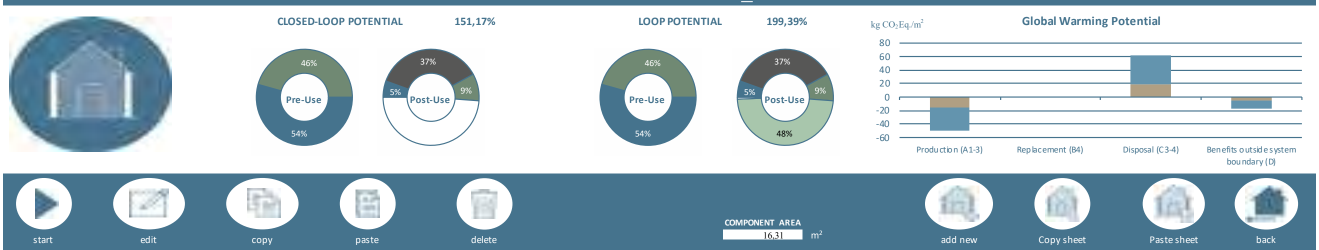
Appendix AL: building component- Exterior Wall

EXTERIOR WALLS_2



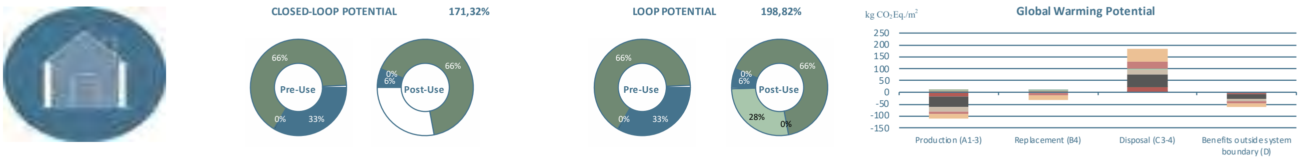
TYPE OF COST Source: DIN 276	COMPONENT Source: Nutzungsdauern (operating life)	DISMANTLING WORK Source: Bauteilkatalog (components catalogue)	MATERIAL	WASTE GROUP	LIFE CYCLE MASS [kg/m²]	VIABILITY FACTOR	CLP [%]	LP [%]	GWP [kg CO₂/m²]
Wall cladding, exteriors	Wood cladding: Coniferous wood untreated	very low	Old wood lathing	170201_Wood A1	9,4	0	233,00%	266,00%	-2,26188
Wall cladding, interior	Cladding: Wood, wood-based material and multi-layer lightweight panels, aluminum, steel, copper, zinc, natural stone, artificial stone, ceramic tiles and	very low	coniferous wood boards / battens sustainable forestry	170201_Wood A1	11,28	0,8	200,00%	200,00%	-1,36
Exterior bearing walls	Wooden wall	very low	Solid structural timber, sustainable forestry	170201_Wood A1	24,44	0,8	200,00%	200,00%	-13,70
Wall cladding, interior	Cladding: Wood, wood-based material and multi-layer lightweight panels, aluminum, steel, copper, zinc, natural stone, artificial stone, ceramic tiles and	very low	coniferous wood boards / battens sustainable forestry	170201_Wood A1	11,28	0,8	200,00%	200,00%	-1,36
Wall cladding, exteriors	Windproofing membrane on ventilated facade	very low	Windpapier	Reuse, others	0,000012	1	90,00%	90,00%	0,00
	Cladding: Wood, wood-based								

EXTERIOR WALLS_3



TYPE OF COST Source: DIN 276	COMPONENT Source: Nutzungsdauern (operating life)	DISMANTLING WORK Source: Bauteilkatalog (components catalogue)	MATERIAL	WASTE GROUP	LIFE CYCLE MASS [kg/m²]	VIABILITY FACTOR	CLP [%]	LP [%]	GWP [kg CO₂/m²]
External supports	Wooden support	very low	Solid structural timber, sustainable forestry	170201_Wood A1	10,387	0,8	200,00%	200,00%	-1,2496887
External supports	Wooden support	very low	Solid structural timber, conventional forestry	170201_Wood A1	35,44	0,8	100,00%	200,00%	0,00
Wall cladding, interior	Cladding: Wood, wood-based material and multi-layer lightweight panels, aluminum, steel, copper, zinc, natural stone, artificial stone, ceramic tiles and	very low	coniferous wood boards / battens sustainable forestry	170201_Wood A1	23,171	0,8	200,00%	200,00%	-2,79
Wall cladding, exteriors	Cladding	very low	Reused PVC tarp	Reuse, others	4,5	0	190,00%	190,00%	0,00

EXTERIOR WALLS_4



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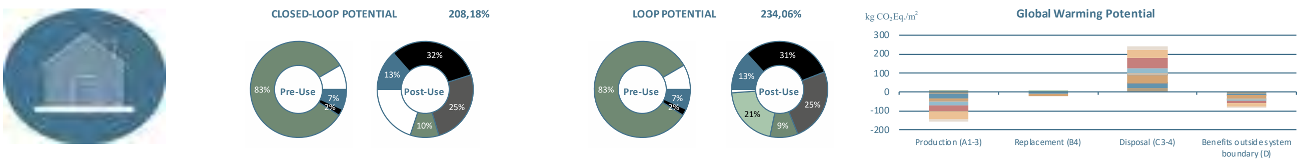
TYPE OF COST Source: DIN 276	COMPONENT Source: Nutzungsdauern (operating life)	DISMANTLING WORK Source: Bauteilkatalog (components catalogue)	MATERIAL	WASTE GROUP	LIFE CYCLE MASS [kg/m²]	VIABILITY FACTOR	CLP [%]	LP [%]	GWP [kg CO_2/m²]
Wall cladding, interior	Standard interior plasters: gypsum plaster, anhydrite plaster, lime plaster, lime-gypsum plaster, lime-cement plaster, synthetic resin plaster, clay plaster	very low	Clay Plaster	170504_Soil/Pure Clay Materials	0,00085	0	200,00%	200,00%	9,206246
Wall cladding, interior	Cladding (systems): plasterboard, plasterboard composite panels, clay building panels	Clay building boards 20mm, with fine clay plaster	Clay building board *	170504_Soil/Pure Clay Materials	0,0000319	0	3,00%	103,00%	0,08
Wall cladding, interior	Sealing foil	very low	PE Vapour barrier	Reuse, others	0,18	0	0,00%	0,00%	1,36
Wall cladding, interior	Cladding: Wood, wood-based material and multi-layer lightweight panels, aluminum, steel, copper, zinc, natural stone, artificial stone, ceramic tiles and	very low	coniferous wood boards / battens sustainable forestry	170201_Wood A1	11,28	0	200,00%	200,00%	-1,36
Wall cladding, exteriors	Insulation Wooden panel / stud construction	very low	Seegras wool *	Biological fibres, compostable	1,5792	0	224,60%	249,20%	0,21

Appendix AM: building component- Foundation

FOUNDATION



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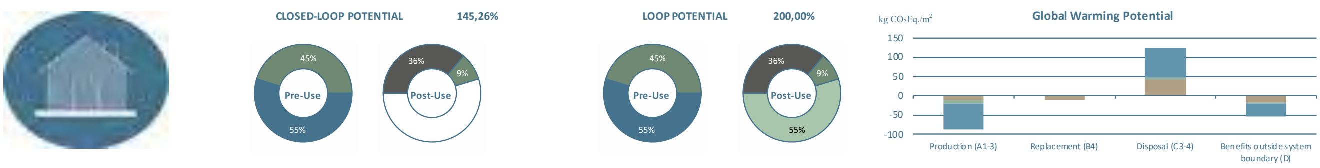
TYPE OF COST Source: DIN 276	COMPONENT Source: Nutzungsdauern (operating life)	DISMANTLING WORK Source: Bauteilkatalog (components catalogue)	MATERIAL	WASTE GROUP	LIFE CYCLE MASS [kg/m²]	VIABILITY FACTOR	CLP [%]	LP [%]	GWP [kg CO_2/m²]
Foundation coverings	Solid wood parquet, wooden floorboards, wooden planks	wooden floorboards, screwed	Solid wood, sustainable forestry, uncoated or coated with natural wood oil/wax	Reuse, others	14,1888	0	223,30%	356,60%	-1,63
Foundation coverings	Others	very low	Edelstahlblech	170405_Stainless steel	0,96	1	150,00%	150,00%	2,65
Foundation coverings	Solid wood parquet, wooden floorboards, wooden planks	wooden floorboards, screwed	Solid wood, sustainable forestry, uncoated or coated with natural wood oil/wax	Reuse, others	0,2956	0	223,30%	356,60%	-14,96
Foundation coverings	Clay board	very low	clay	170504_Soil/Pure Clay Materials	54,208	0,9	200,00%	200,00%	0,08
Foundation coverings	Solid wood parquet, wooden floorboards, wooden planks	wooden floorboards, screwed	Solid wood, sustainable forestry, uncoated or coated with natural wood oil/wax	Reuse, others	13,47936	0	223,30%	356,60%	-3,27



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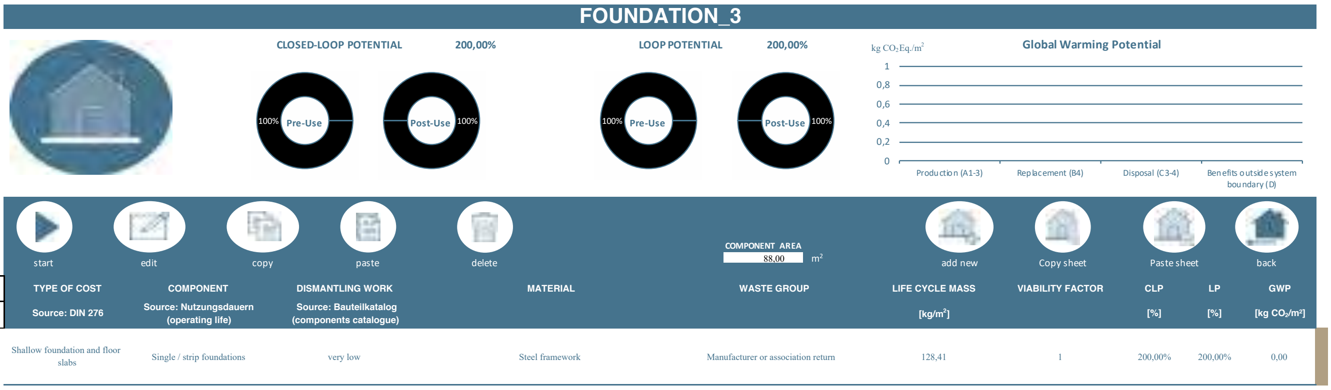
TYPE OF COST Source: DIN 276	COMPONENT Source: Nutzungsdauern (operating life)	DISMANTLING WORK Source: Bauteilkatalog (components catalogue)	MATERIAL	WASTE GROUP	LIFE CYCLE MASS [kg/m²]	VIABILITY FACTOR	CLP [%]	LP [%]	GWP [kg CO_2/m²]
Foundation coverings	Solid wood parquet, wooden floorboards, wooden planks	wooden floorboards, screwed	Solid wood sustainable forestry, untreated or treated with natural wood oil/wax	170201_Wood A1	59,12	0	100,00%	200,00%	-3,27
Shallow foundation and floor slabs	Wooden Floor slab, elevated	Wooden beams with bracing panels	Solid structural timber beams, sustainable forestry	170201_Wood A1	4,888	0,8	200,00%	200,00%	-2,74
Shallow foundation and floor slabs	Wooden Floor slab, elevated	Wooden beams with bracing panels	Solid structural timber beams, sustainable forestry	170201_Wood A1	43,992	0,8	200,00%	200,00%	-24,65



Appendix AN: Site Operations

SOLAR DECATHLON EUROPE 2021/22 - SITE OPERATIONS CHART

Deliverable No. D#6

Team ID KIT

University/ City Karlsruhe

Assembly period

team ID	Pos.	Description	Start Date	End Date	Duration (in days)	Day 0 19/05/2022	Day 1 20/05/2022	Day 2 21/05/2022	Day 3 22/05/2022	Day 4 23/05/2022	Day 5 24/05/2022	Day 6 25/05/2022	Day 7 26/05/2022	Day 8 27/05/2022	Day 9 28/05/2022	Day 10 29/05/2022	Day 11 30/05/2022	Day 12 31/05/2022	Day 13 01/06/2022	Day 14 02/06/2022	Day 15 03/06/2022
KIT	1	Assembly start	20/05/2022	20/05/2022	1		■														
	2	preparations, measuring	20/05/2022	20/05/2022	1		■														
	3	delivery foundations	20/05/2022	20/05/2022	1		■														
	4	placing foundations	20/05/2022	20/05/2022	1		■														
	5	delivery scaffolding towers	20/05/2022	20/05/2022	1		■														
	6	assemble and level towers, load distribution beams	20/05/2022	20/05/2022	1		■														
	7	delivery gabions	20/05/2022	20/05/2022	1		■														
	8	delivery buffer, water tanks, battery, bikes,...	21/05/2022	21/05/2022	1			■													
	9	placing and filling gabions, placing watertanks and buffer	21/05/2022	21/05/2022	1			■													
	10	delivery and assemly of prefabricated HDU-modules	24/05/2022	27/05/2022	4						■	■	■	■							
	11	delivery and installation stairs	25/05/2022	25/05/2022	1							■									
	12	technical fittings	25/05/2022	26/05/2022	2							■									
	13	delivery interior	28/05/2022	28/05/2022	1										■						
	14	cleaning HDU	28/05/2022	28/05/2022	1										■						
	15	furnish HDU	28/05/2022	28/05/2022	2										■						
	16	delivery pavement stones	30/05/2022	30/05/2022	1												■				
	17	pave the paths	31/05/2022	31/05/2022	1													■			
	18	delivery and installation lift	31/05/2022	31/05/2022	1													■			

Disassembly period*

* For the Living Lab Teams there is no need to fill in the Disassembly period.

team ID	Pos.	Description	Start Date	End Date	Duration (in days)	Day 38 26/06/2022	Day 39 27/06/2022	Day 40 28/06/2022	Day 41 29/06/2022	Day 42 30/06/2022	Day 43 01/07/2022	Day 44 02/07/2022	Day 45 03/07/2022	Day 46 04/07/2022
KIT	1	Disassembly start	27/06/2022	27/06/2022	1									
	2	take out interior	27/06/2022	27/06/2022	1		■							
	3	pick up lift	27/06/2022	27/06/2022	1		■							
	4	pick up stairs	28/06/2022	28/06/2022	1			■						
	5	disassembly HDU-modules	27/06/2022	29/06/2022	3		■	■	■					
	6	pick up water tank, buffer,...	29/06/2022	29/06/2022	1				■					
	7	dismantle gabions	29/06/2022	29/06/2022	1				■					
	8	remove pavement stones	29/06/2022	29/06/2022	1				■					
	9	pick up gabions	30/06/2022	30/06/2022	1					■				
	10	pick up pavement stones	30/06/2022	30/06/2022	1					■				
	11	disassemble load distribution beams and	30/06/2022	30/06/2022	1					■				
	12	pick up scaffolding	30/06/2022	30/06/2022	1					■				
	13	pick up foundations	30/06/2022	30/06/2022	1					■				
	14	clean lot	30/06/2022	30/06/2022	1					■				

SOLAR DECATHLON EUROPE 2021/22 - ASSEMBLY CHART

Deliverable No.	D#6
Team ID	KIT
University/ City	Karlsruhe

T1	Trucks (truck deliveries; fill in T1, T2, T3, …)	**Number of Trucks (in total)**	27.0
C	Crane (40t)	**Crane hours 40t (in total)**	3.5
C	Crane (100t)	**Crane hours 100t (in total)**	10.5
H	Telehandler	**Telehandler hours (in total)**	0.0
F	Forklift	**Forklift hours (in total)**	5.5
P	Telescopic work platform	**Telescopic work platform hours (in total)**	37.5
W	Hydraulic Winch	**Hydraulic Winch hours (in total)**	0.0

Opening Hours in assembly period: 7:00 - 23:00 h

team ID	*Day*	*Date*	*Equipment*	06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30	18:00	18:30	19:00	19:30	20:00	20:30	21:00	21:30	22:00	22:30	23:00
KIT	Day 1	20/05/2022	Trucks												T1	T2	T2				T3																
			Crane (40t)												C	C	C				C																
			Crane (100t)																																		
			Telehandler																																		
			Forklift												F																						
			Telescopic work platform																																		
			Hydraulic Winch																																		
	Day 2	21/05/2022	Trucks				T4	T4																													
			Crane (40t)				C	C																													
			Crane (100t)																																		
			Telehandler																																		
			Forklift																		F	F	F	F													
			Telescopic work platform																																		
			Hydraulic Winch																																		
	Day 3	22/05/2022	Trucks																																		
			Crane (40t)																																		
			Crane (100t)																																		
			Telehandler																																		
			Forklift																																		
			Telescopic work platform																																		
			Hydraulic Winch																																		
	Day 4	23/05/2022	Trucks																																		
			Crane (40t)																																		
			Crane (100t)																																		
			Telehandler																																		
			Forklift																																		
			Telescopic work platform																																		
			Hydraulic Winch																																		
	Day 5	24/05/2022	Trucks		T5		T6		T7		T8	T8	T8	T8		T9	T9	T9	T9	T9	T9	T9	T9														
			Crane (40t)																																		
			Crane (100t)		C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C												
			Telehandler																																		
			Forklift																																		
			Telescopic work platform		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P												
			Hydraulic Winch																																		
	Day 6	25/05/2022	Trucks				T10																														
			Crane (40t)				C																														
			Crane (100t)																																		
			Telehandler																																		
			Forklift																																		
			Telescopic work platform		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P											
			Hydraulic Winch																																		
	Day 7	26/05/2022	Trucks																																		
			Crane (40t)																																		
			Crane (100t)																																		
			Telehandler																																		
			Forklift																																		
			Telescopic work platform		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P											
			Hydraulic Winch																																		
	Day 8	27/05/2022	Trucks																																		
			Crane (40t)																																		

		Crane (100t)										
		Telehandler										
		Forklift										
		Telescopic work platform	P	P	P	P	P	P	P	P	P	P
		Hydraulic Winch										
Day 9	28/05/2022	Trucks							T11	T11		
		Crane (40t)										
		Crane (100t)										
		Telehandler										
		Forklift							F	F	F	F
		Telescopic work platform										
		Hydraulic Winch										
Day 10	29/05/2022	Trucks										
		Crane (40t)										
		Crane (100t)										
		Telehandler										
		Forklift										
		Telescopic work platform										
		Hydraulic Winch										
Day 11	30/05/2022	Trucks							T12	T12		
		Crane (40t)										
		Crane (100t)										
		Telehandler										
		Forklift							F	F		
		Telescopic work platform										
		Hydraulic Winch										
Day 12	31/05/2022	Trucks							T13			
		Crane (40t)										
		Crane (100t)										
		Telehandler										
		Forklift										
		Telescopic work platform										
		Hydraulic Winch										
Day 13	01/06/2022	Trucks										
		Crane (40t)										
		Crane (100t)										
		Telehandler										
		Forklift										
		Telescopic work platform										
		Hydraulic Winch										
Day 14	02/06/2022	Trucks										
		Crane (40t)										
		Crane (100t)										
		Telehandler										
		Forklift										
		Telescopic work platform										
		Hydraulic Winch										
Day 15	03/06/2022	Trucks										
		Crane (40t)										
		Crane (100t)										
		Telehandler										
		Forklift										
		Telescopic work platform										
		Hydraulic Winch										

SOLAR DECATHLON EUROPE 2021/22 - DISASSEMBLY CHART

Deliverable No.	D#6
Team ID	KIT
University/ City	Karlsruhe

T1	Trucks (truck deliveries; fill in T1, T2, T3, …)
C	Crane (40t)
C	Crane (100t)
H	Telehandler
F	Forklift
P	Telescopic work platform
W	Hydraulic Winch

Number of Trucks (in total)	29.0
Crane hours 40t (in total)	4.5
Crane hours 100t (in total)	8.0
Telehandler hours (in total)	0.0
Forklift hours (in total)	0.0
Telescopic work platform hours (in total)	26.5
Hydraulic Winch hours (in total)	0.0

Opening Hours in disassembly period: 7:00 - 22:00 h

team ID	*Day*	*Date*	*Equipment*	06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30	18:00	18:30	19:00	19:30	20:00	20:30	21:00	21:30	22:00	22:30	23:00
KIT	Day 39	27/06/2022	Trucks										T1	T1					T2	T2																	
			Crane (40t)																																		
			Crane (100t)																																		
			Telehandler																																		
			Forklift																																		
			Telescopic work platf		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P												
			Hydraulic Winch																																		
	Day 40	28/06/2022	Trucks		T3		T4	T4	T4	T4	T4	T4	T4					T5	T5					T6	T6												
			Crane (40t)																																		
			Crane (100t)		C		C	C	C	C	C	C	C					C	C					C	C												
			Telehandler																																		
			Forklift																																		
			Telescopic work platf		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P												
			Hydraulic Winch																																		
	Day 41	29/06/2022	Trucks					T7	T7					T8	T8				T9	T9																	
			Crane (40t)																C	C																	
			Crane (100t)					C	C					C	C																						
			Telehandler																																		
			Forklift																																		
			Telescopic work platf		P	P	P	P	P	P	P	P	P	P	P																						
			Hydraulic Winch																																		
	Day 42	30/06/2022	Trucks		T10	T10		T11	T11												T12	T12		T13													
			Crane (40t)		C	C		C	C												C	C		C													
			Crane (100t)																																		
			Telehandler																																		
			Forklift																																		
			Telescopic work platform																																		
			Hydraulic Winch																																		
	Day 43	01/07/2022	Trucks																																		
			Crane (40t)																																		
			Crane (100t)																																		
			Telehandler																																		
			Forklift																																		
			Telescopic work platform																																		
			Hydraulic Winch																																		
	Day 44	02/07/2022	Trucks																																		
			Crane (40t)																																		
			Crane (100t)																																		
			Telehandler																																		
			Forklift																																		
			Telescopic work platform																																		
			Hydraulic Winch																																		
	Day 45	03/07/2022	Trucks																																		
			Crane (40t)																																		
			Crane (100t)																																		
			Telehandler																																		
			Forklift																																		
			Telescopic work platform																																		
			Hydraulic Winch																																		

SOLAR DECATHLON EUROPE 2021/22 - EQUIPMENT REQUIREMENT CHART

Deliverable No.	D#6
Team ID	KIT
University/ City	Karlsruhe

Pos	*Description*	*Price / Unit*	*Unit*	*Quantity*	*TOTAL**
1	Mobile crane (40t)	171.86 €	hour	3.5	601.51 €
2	Electric forklift	178.15 €	day	5.5	979.83 €
3	Telehandler	478.33 €	day		- €
4	Hydraulic winch	214.20 €	day		- €
5	Scissor lift	133.78 €	day		- €
6	Transport wagon	28.29 €	day		- €
7	Pallet truck	34.21 €	day		- €
8	Cold light lamp	8.21 €	day	14	114.94 €
9	LED illuminated balloon	86.22 €	day		- €
10	Stepladder	20.53 €	day	2	41.06 €
11	Single ladder	19.34 €	day	1	19.34 €
12	Mobile scaffold (3m)	24.26 €	day	1	24.26 €
13	Ladder-lift	142.28 €	day		- €
14	Winch	86.56 €	day		- €
15	Waste containers	11.42 €	day		- €
16	Hand truck / Barrow	20.17 €	day		- €
17	Work trestles	5.71 €	day		- €
18	Pavillion	42.84 €	day		- €
19	Construction disk saw	69.19 €	day		- €
20	Table saw / Chop saw	69.19 €	day		- €
21	Hand-held circular saw	35.25 €	day		- €
22	Electric ripsaw	58.75 €	day		- €
23	Reciprocating saw	31.53 €	day		- €
24	Jigsaw	16.66 €	day		- €
25	Drill hammer	23.81 €	day		- €
26	Cordless screwdriver	48.08 €	day		- €
27	Agitator / Mixer	25.07 €	day		- €
28	Grinding machine	43.11 €	day		- €
29	Vacuum cleaner	61.58 €	day	1	61.58 €
30	Angle grinder (max. tool size Ø 125 mm)	16.42 €	day		- €
31	Angle grinder (max. tool size Ø 230 mm)	32.75 €	day		- €
32	Impact wrench	48.08 €	day		- €
33	Cable drum	15.99 €	day		- €
34	Extension cable (25 m lenght)	5.10 €	day	7	35.70 €
35	Extension cable (20 m lenght)	4.95 €	day		- €
36	Extension cable (15 m lenght)	4.80 €	day		- €

37	Extension cable (10 m lenght)	4.65 €	day		- €
38	Automatic level laser	61.58 €	day		- €
39	Compressor	56.67 €	day		- €
40	Compressed-air tube	13.55 €	day		- €
41	Nail gun pneumatic	58.55 €	day		- €
42	Spirit level				- €
	Length 600 mm	0.95 €	day		- €
	Length 1000 mm	1.25 €	day		- €
	Length 2000 mm	1.75 €	day		- €
43	Stop angle	1.37 €	day		- €
44	Flat angle	1.71 €	day		- €
45	Screw clamp (Span 250 mm)	0.93 €	day		- €
46	Screw clamp (Span 800 mm)	0.93 €	day		- €
47	Sledgehammer	2.57 €	day		- €
48	Radios	19.99 €	2 pcs.		- €
49	Fire extinguisher	54.74 €	pcs.	1	54.74 €
50	Fire blanket	147.99 €	pcs.	1	147.99 €
51	First aid kit	61.58 €	pcs.	1	61.58 €
52	Road plates	20.62 €	day		- €
53	Extension ladder	45.50 €	day		- €
54	Mobile scaffold (10m)	97.56 €	day		- €
55	Ramp for Forklifts	35.00 €	day		- €
56	Mobile crane (100t)	265.00 €	hour	10	2,650.00 €

Items listed above are described in detail the 'Equipment Catalogue'. **TOTAL** **2,142.53 €**

*all prices are net prices

Other required Equipment				
telescopic work platform	/	hours	37,5	/
rubber hammer (2pcs)	/	day	1	/
lashing straps (4pcs)	/	day	1	/
	/			/

Add further items, if something is missing. We will coordinate with our logistics & equipment rental partner, if this is possible.

SOLAR DECATHLON EUROPE 21/22 - Detailed Water Budget

Deliverable No.	D#5
Team ID	KIT
University/ City	Karlsruhe

Tank overview

Type of tank	*Quantity [#]*	*Volume per tank [litre]*	*Volume total [litre]*
Fresh water tank	1	1000	1000
Waste water tank	1	1000	1000
Rainwater tank (optional)	2	900	1800
Grey water tank (optional)	0		0
Other water usage (fill in below)			
			0
			0
			0
Total	4	2900	3800

Tank openings

Is there a central opening (no. = 1) or is it decentralised per tank (no. ≥ 2)?

	No. of openings [#]
Water Delivery	1
Water Removal	1

Water Delivery / Water Removal

	Water Delivery I	*Water Delivery II*	*Water Delivery III*	
		Water Removal I	*Water Removal II*	*Water Removal III*
	25. May 2022	***03. June 2022***	***17. June 2022***	***27. June 2022***
Fresh water delivery [litre]	1000	1000	1000	/
Waste water removal [litre]	/	1000	1000	1000

Material Passport

RoofKIT

Wooden Fibre Board

Raw Density: 130 kg/m³

Thermal conductivity: 0,041 W/mK

Manufacturer: GUTEX

Production: Wet Process

Material Loop Status: downcycled wood

End-of-Life Scenario: energetic Disposal, Re-use

Global Warming Potential: 64,28 kg CO2

Material Loop Wood

SDE 21_Health & Safety: Risk Analysis

Deliverable No.	D#5
Team ID	KIT
University/ City	Karlsruhe

L	Slight Injury	CP	Collective Protection
G	Serious Injury	IP	Individual Protection
Mo	Fatal Injury	S	Signs

NOTE: In this evaluation we consider "avoided risks" all qualified as "trivial" or "tolerable"; the rest of the qualifications are considered "not avoided risks" and need to be solved with further measures.

A Work-Units		B Tasks		C Agents	D Risks							E Measures					
Break down to WORK-UNITS		Identify TASKS in each work unit		Identify the AGENTS	Identify the RISKS							Develop MEASURES					
Work Unit Number	Name of Work Unit	Task Number	Name of the task	Name of the agents	Risk Number	Brief description/ listing of the risks	Probability of the risk	Consequence of the risk			Risk qualification without measures	Solution Number	Brief description/ listing of the solution	Determined precaution			Risk qualification with measures
								L	G	Mo				CP	IP	S	
Previous Works at university phase																	
Work Unit 1	Model Building	Task 1	Cutting elements for the Model	team members	Risk 1a	slight injury due to inattentive work	Possible	x			Moderate risk	Solution 1a	always providing a first aid kit near by, team members will work focused and take breaks whenever needed		x		Tolerable risk
General protective measures																	
General protective measures will be performed at all times. this includes wearing the PPE including helmet, safety boots reflective clothing and when needed gloves and noice protection. The team members and contracted staff will undergo a special health&safety training and will always be aware of risks and working with high focus on their tasks and the surroundings. Everyone																	
Prefabrication in Reuthe (AT) phase																	
Work Unit 2	Module Building	Task 2	handling dangerous machines (like saws)	workers	Risk 2a	injuries due to wrong, careless handling	Possible		x		Moderate risk	Solution 1a	educated, professional workers used to the tasks and the environment; wearing certified protective workwear		x		Tolerable risk
		Task 3	loading up the modules	workers	Risk 3a	getting knocked down while loading up the module	Possible			x	Intolerable risk	Solution 2a	educated, professional workers used to the tasks and the environment	x		x	Tolerable risk
					Risk 3b	overloading the loading ramp	Possible			x	Intolerable risk	Solution 2b	educated, professional workers used to the tasks and the environment	x		x	Tolerable risk
					Risk 3c	overloading the slings	Possible			x	Intolerable risk	Solution 2c	educated, professional workers used to the tasks and the environment	x		x	Tolerable risk
					Risk 3d	using unapproved slings	Possible			x	Intolerable risk	Solution 2d	Use only certified slings visually checked before every use. Only educated, professional workers used to the tasks and the environment	x		x	Tolerable risk
Decathletes Training phase																	
	H&S education	Task 4	safety training	team members		General Health&Safety training from a certified safety engineer							strenghten awareness for general safety hazards on a construction site and especially for our tasks from a professional	x	x		Trivial risk
		Task 5	risk presentation	team members workers		Presentation from our H&S team for the whole team, presenting our risk analysis so everyone is aware of all the hazards								x	x		Trivial risk
		Task 6	First aid training	team members										x	x		Trivial risk
		Task 7	daily briefings	team members workers		the H&S team will provide a daily briefing to team members and contracted workers, going through the tasks of the day and the safety hazards connected to those								x	x		Trivial risk
Transport Phase																	
Work Unit 3	Transport from Production Facility	Task 8	transport of scaffolding for the first floor, stairs, lift, eight open modules with trucks	truck truck driver	Risk 8	road accidents due to the load getting loose because of insufficient locking	Remote			x	Important risk	Solution 1a	locking the load with certified equipment from all 4 sides	x			Trivial risk
		Task 9	driving on Solar Campus where the road is not only used by vehicles but also by decathlets and other SDE participants	truck truck driver pedestrians	Risk 9	Possible accidents caused by speeding (driving faster than walking speed)	Possible			x	Important risk		Truck is leaded and followed by two team members to prevent driver from speeding	x			Trivial risk
		Task 10	parking	truck truck driver	Risk 10	getting hit by parking (very dangerous, but low probability)	Remote			x	Intolerable risk	Solution 2a	qualified drivers and workers, marking the work area; supervision by one member of the site operations/ h&s team (banksman) ; guiding the truck while parking	x	x	x	Trivial risk
Assembly Phase																	
Work Unit 4	Unloading	Task 11	unloading foundations, stones, scaffolding, modules, lift, stairs and other materials	truck, workers, team members, fork lift	Risk 11a	Risk of getting hit while unlocking the load	Possible			x	Important risk	Solution 1a	qualified workers/briefing of the team members; checking the load before unlocking; supervision by one member of the site operations/ h&s team	x	x		Tolerable risk
					Risk 11b	Risk of injury caused by the fork while unloading with the fork lift	Possible		x		Important risk		Only specially trained drivers are allowed to operate the fork lift; supervision by one member of the site operations/ h&s	x	x		Tolerable risk
					Risk 11c	getting hit by the crane during movement (very dangerous, possible)	Possible			x	Intolerable risk	Solution 1b	briefing of the team members; marking the movement range of the crane; supervision by one member of the site operations/	x	x	x	Tolerable risk
					Risk 11d	getting knocked down while unloading heavy objects	Possible		x		Important risk	Solution 1c	briefing of the team members; marking the slewing range of the crane; controlling the load with ropes; keeping other workers/team members away from the module; supervision by one member of the site operations/ h&s team*	x	x	x	Tolerable risk
					Risk 11e	risk of injury while placing objects (e.g. foundation plates, gabion stones) on the ground	Possible		x		Moderate risk		Every team member wears their safety shoes at all times on site. Both the workers and the person who places the objects have to wauch out for the other and keep a safe distance dusing the placement	x	x		Tolerable risk
					Risk 11f	disablement of the work due to materials lying in the working area (Slight Injury, possible)	Possible	x			Moderate risk	Solution 1d	preparation of the site and approval by the site operations manager	x	x		Trivial risk
Work Unit 5	Assembly	Task 12	assembling of the scaffolding as the primary supporting structure for the HDU	workers team members	Risk 12a	disablement of the work due to materials lying in the working area (Slight Injury, possible)	Possible	x			Moderate risk	Solution 2a	preparation of the site and approval by the site operations manager	x	x		Tolerable risk
					Risk 12b	getting hit by scaffolding elements assembly (can be very dangerous, possible)	Possible			x	Intolerable risk	Solution 2b	briefing of the team members (handling long objects); keeping other workers/team members away; supervision by one member of the site operations/ h&s team; marking the slewing range of the crane, wearing a certified helmet	x	x	x	Tolerable risk
					Risk 12c	Cuts due to sharp edges on steel	Possible	x			Moderate risk		all people working with the scaffolding pipes have to wear protective gloves	x	x		Trivial risk
		Task 13	levelling of the load distribution beams, working from mobile scaffolding	workers team members	Risk 13	danger of the scaffolding tipping over or workers stumbling due to movements.	Possible		x		Important risk		Use of certified mobile scaffold that can be secured against movements and moving to another work area only when no one is standing on it				Tolerable risk
		Task 14	Filling the gabions with stones	workers team members	Risk 14a	Scratches or cuts due to sharp edges of stones	Possible	x			Moderate risk		Wear protective gloves				Trivial risk
					Risk 14b	risk of injury caused by falling stones	Possible	x			Tolerable risk		Safe placement of stones, not dropping it from a height and waering safety boots.		x		Trivial risk
		Task 15	assembling the modules on top of the ground floor structure	workers team members	Risk 15a	disablement of the work due to materials lying in the working area (Slight Injury, possible)	Possible	x			Moderate risk	Solution 3a	preparation of the site and approval by the site operations manager	x	x		Trivial risk
					Risk 15b	getting hit by the module during assembly (can be very dangerous, possible)	Possible			x	Intolerable risk	Solution 3b	briefing of the team members; keeping other workers/team members away; supervision by one member of the site operations/ h&s team; marking the slewing range of the crane, wearing a certified helmet	x	x	x	Tolerable risk
					Risk 15c	risk of getting hit by falling objects during assembly of the modules	Possible		x				no one is allowed under the modules during the task		x	x	Tolerable risk
					Risk 15d	getting trapped during assembly with the existing building elements/objects (can be very dangerous, possible)	Possible			x	Intolerable risk	Solution 3c	briefing of the team members; keeping other workers/team members away; supervision by one member of the site operations/ h&s team	x	x		Tolerable risk
				workers	Risk 15e	Working in heights, risk of falling	Possible			x	Intolerable risk	Solution4a	work executed on a telescopic work platform with standardised railing; wearing a certified helmet; qualified workers used to working on the assembly of roofs; supervision by one member of the site operations/ h&s team	x	x	x	Tolerable risk

				workers	Risk 15f	working on a telescopic work platform	Possible		x		Moderate risk		the vehicle is only to be moved by a qualified driver when no one is standing on the platform	x	x		Tolerable risk
		Task 16	Installation of the lift	workers	Risk 16	risk of tilting back during installation	Possible			x	Moderate risk		no one is allowed to be in the moving area until it is secured; special workers used to working with this lift, supervision by H&S coordinator/officers	x	x		Tolerable risk
		Task 17	securing the well-being of the workers and team members	workers team members	Risk 17	workers and team members being unwell, sick, weak, stressed; overexertion	Possible	x			Moderate risk	Solution 5a	Securing availability of a comfortable place of retreat, food and drinks; not extending work hours	x	x		Trivial risk
		Task 18	laying the paving stones	team members	Risk 18a	risk of injury caused by falling stones	Remote	x			Moderate risk		safe placing, no dropping from a height		x		Trivial risk
					Risk 18b	risk of injuring hands while paving work (includes use of a hammer)	Possible	x			Moderate risk		protective gloves, working focused		x		Trivial risk
		Task 19	connecting electricity for the HDU	workers	Risk 19	exposure to electric connections	Possible		x		Moderate risk	Solution 6b	qualified workers, wearing the appropriate workwear	x		x	Tolerable risk
		Task 20	general assembly	workers team members	Risk 20	getting knocked out by objects or tools	Possible			x	Intolerable risk	Solution 6d	wearing the appropriate workwear, e.g. a certified helmet	x	x	x	Tolerable risk
Work Unit 6	**interior fittings**	Task 21	assembling the interior of the HDU	workers team members	Risk 21a	Injury because of carrying too much weight	Possible		x		Important risk	Solution 7a	organizing safety briefing with showing the appropriate way to carry; supervision by one member of the site operations/ h&s team	x	x	x	Tolerable risk
					Risk 21b	Risk of tripping due to cables or other equipment	Possible				Important risk	Solution 7b	keeping the working area clean and tidy at all times. Controls are carried out by the H&S coordinators/officers	x	x	x	Tolerable risk
Work Unit 7	**preparation for Competition Phase**	Task 22	cleaning the construction site of all equipment, waste, tools, etc.	workers team members	Risk 22	fall after tripping over objects lying around on the construction site	Possible	x			Moderate risk	Solution 8a	wearing the appropriate workwear, cleaning the construction site carefully; approval by the site operations manager and the health and satay coordinator	x	x	x	Trivial risk
Maintenance during Competition Phase*																	
Work Unit 8	**Competition Phase**	Task 23	Public House Tour	visitors team members	Risk 23a	Getting hit by loose objects	Possible		x		Moderate risk	Solution 1a	approval by the site operations manager/ h&s team; checking the HDU for loose objects before Opening Day of the Solar Campus	x	x		Tolerable risk
					Risk 23b	Stepping on objects	Possible	x			Moderate risk	Solution 1b	checking the HDU before Opening Day of the Solar Campus, approval by one member of the site operations/ h&s team	x	x		Trivial risk
					Risk 23c	Fall of persons at a different level	Possible			x	Intolerable risk	Solution 1c	installation of a railing; supervision of the visitors by the Public Tour Guide	x	x	x	Tolerable risk
					Risk 23d	Fall of persons at the same level (e.g. because of collision with still objects, other people, ...)	Possible		x		Moderate risk	Solution 1d	installation of a railing; supervision of the visitors by the Public Tour Guide; planning the Public House Tour with wide enough passageways through the building, e.g. no interior in	x	x	x	Trivial risk
					Risk 23e	Not knowing the way out in case of emergency	Possible			x	Intolerable risk	Solution 1e	Health and Safety briefing for all team members, clear signs, always one person on the construcion side which knows what to do in case of emergency	x	x	x	Tolerable risk
					Risk 23f	Visitors ignore dangers of the project site	Possible			x	Intolerable risk	Solution 1f	relevant signs with informations about specific danger areas (no entry), only walking on predetermined ways	x	x	x	Trivial risk
Disassembly Phase																	
Work Unit 9	**Disassembly, Unloading**	See Unlaoding, Assembly, in reversed order															
General risks during the whole Competition on the Solar Campus																	
Work Unit 10	**work on the construction site, competition period**	Task 24	work on the construction site, competition period	workers team members visitors	Risk 24a	Fire	Remote			x	Intolerable risk		prohibition of smoking and open fire (indicated by signs)	x	x	x	Tolerable risk
					Risk 24b	Explosion	Remote			x	Intolerable risk		prohibition of smoking and open fire (indicated by signs)	x	x	x	Tolerable risk
					Risk 24c	injury because of wet, slippery floors	Possible		x		Moderate risk		all materials that are meant to walk on or hold onto should be topped with anti-slippery material; wearing appropriate shoes; posting signs after rain	x	x	x	Tolerable risk
					Risk 24d	exposure to electric connections	Possible			x	Intolerable risk		electricians being professional workers wearing protective workwear; no team members working on electrical connections; proper electrical isolation	x	x		Tolerable risk
					Risk 24e	bad hygiene leading to the spread of illnesses	Possible		x		Moderate risk		Wiping frequently touched surfaces e.g. door handles with desinfection regularly	x	x		Tolerable risk
					Risk 24f	Risk of injury from operating machines and tools	Possible			x	Intolerable risk		Creating and visible attachment of important rules of conduct for the individual machines and tools. For example, ladders, hammers, saws… Before the equipment is used, the HS Team Coordinator will provide a briefing.	x	x		Tolerable risk
General risks from enviroment																	
Work Unit 11	**work on the construction site, competition period**	Task 25	work on the construction site, competition period	workers team members visitors	Risk 25a	Noise	Remote			x	Intolerable risk		Provide proofed noise protection headphones	x	x	x	Tolerable risk
					Risk 25b	Weather	Possible		x		Moderate risk		Provide workers with rain jackets. Stop work if weather conditions are too difficult. Team members must wear safety shoes throughout the construction process. These also serve to prevent slipping. Anything that could be potentially dangerous if it gets wet must be secured (e.g.: building electricity).	x	x	x	Tolerable risk
					Risk 25c	Wind	Possible		x		Moderate risk		Temporary barriers so that no foils or materials can fly around Leave nothing lying arond, secure things position protections	x	x	x	Tolerable risk
					Risk 25d	Visibility	Possible		x		Moderate risk		Adequately equip the construction site with light	x	x	x	Tolerable risk

*** examples of further work-units can be used by the teams; the list is not complete and may be extended

**** examples for further risks descriptions can be used by the teams, but does not need to; the list is not complete and may be extended; nevertheless teams are encouraged to describe risks in their own words

EU-Konformitätserklärung
EN ISO 20345:2011

Die **ATLAS® - Schuhfabrik GmbH & Co. KG, Frische Luft 159, DE - 44319 Dortmund** erklärt hiermit, dass der
XP 505 Art.-Nr.: #349
ein **Sicherheitsschuh in S3 mit Outdoor Sohlentechnologie,**
die mit den Bestimmungen der Verordnung 2016/425 EU und der einzelstaatlichen Norm EN ISO 20345:2011 übereinstimmt, harmonisiert im Amtsblatt der EU und identisch ist mit der PSA, die Gegenstand der vom **TÜV Rheinland Product Safety GmbH, Köln Notified Body Nr. 0197, PFI Prüf- und Forschungsinstitut Pirmasens e.V., Pirmasens Notified Body Nr. 0193** ausgestellten EU- Baumusterprüfbescheinigung (Modul 2) Nr. **2105139-01-86 /** ist.

EU declaration of Conformity
EN ISO 20345:2011

ATLAS® - Schuhfabrik GmbH & Co. KG Frische Luft 159, DE - 44319 Dortmund hereby declares that
XP 505 Art.-No.: #349,
a **safety shoe in S3 with Outdoor Sohlentechnologie,**
conforms to the terms of Regulation (EU) No. 2016/425 and the national standard EN ISO 20345:2011, harmonised in the Official Journal of the European Union, and is identical with the PPE subject of the EU Type Examination Certificate (Modul 2) No. **2105139-01-86/** issued by **TÜV Rheinland Product Safety GmbH, Cologne, Notified Body No. 0197, and PFI Prüf- und Forschungsinstitut Pirmasens e.V.**(Test and Research Institute)**, Pirmasens, Notified Body No. 0193**.

EU-conformiteitsverklaring
EN ISO 20345:2011

ATLAS® - Schuhfabrik GmbH & Co. KG, Frische Luft 159, DE - 44319 Dortmund verklaart bij dezen dat de
XP 505 art.nr.: #349,
een **veiligheidsschoen in S3 met Outdoor Sohlentechnologie** is,
die overeenkomt met de bepalingen van de Verordening 2016/425 EU en de nationale norm EN ISO 20345:2011, geharmoniseerd in het Publicatieblad van de EU, en identiek is met het PBM, dat voorwerp is van het door **TÜV Rheinland Product Safety GmbH, Köln Notified Body Nr. 0197, PFI Prüf- und Forschungsinstitut Pirmasens e.V., Pirmasens Notified Body Nr. 0193** opgemaakte certificaat van EG-typeonderzoek (Modul 2) nr. **2105139-01-86 /** .

EU-overensstemmelseserklæring
EN ISO 20345:2011

ATLAS® - Schuhfabrik GmbH & Co. KG, Frische Luft 159, DE - 44319 Dortmund erklærer hermed, at
XP 505 art.-nr.: #349,
en **sikkerhedssko i S3 med Outdoor Sohlentechnologie,**
stemmer overens med bestemmelserne i forordning 2016/425 EU og den nationale standard EN ISO 20345:2011, harmoniseret i EU-Tidende og identisk med PSU (personligt sikkerheds udstyr), der er genstand for den af **TÜV Rheinland Product Safety GmbH, Köln Notified Body nr. 0197, PFI Prüf- og Forschungsinstitut Pirmasens e.V., Pirmasens Notified Body nr. 0193** udstedte EU-typeafprøvningsattest (Modul 2) nr. **2105139-01-86 /** .

Declaração de conformidade da UE
EN ISO 20345:2011

A **ATLAS® - Schuhfabrik GmbH & Co. KG, Frische Luft 159, DE - 44319 Dortmund** declara que o
XP 505 Nº de art.: #349,
é um **calçado de segurança em S3 com Outdoor Sohlentechnologie,**
que cumpre as disposições do Regulamento 2016/425 UE e a norma nacional EN ISO 20345:2011, harmonizada no Jornal Oficial da UE e é idêntico ao EPI que é objeto do certificado de exame UE de tipo (Modul 2) Nº **2105139-01-86 /** emitido pela **TÜV Rheinland Product Safety GmbH, Colônia Notified Body Nº 0197, Instituto de Pesquisa e Testes PFI Pirmasens e.V., Pirmasens Notified Body Nº 0193**.

EU - Försäkran om överensstämmelse
EN ISO 20345:2011

ATLAS® - Schuhfabrik GmbH & Co. KG, Frische Luft 159, DE - 44319 Dortmund förklarar härmed att
XP 505 art.nr: #349,
en **säkerhetssko i S3 med Outdoor Sohlentechnologie,**
uppfyller kraven i förordningen 2016/425 EU och den nationella standarden EN ISO 20345:2011, harmoniserat i EU:s officiella tidning och identisk med den personliga skyddsutrustningen som är föremål för det av **TÜV Rheinland Product Safety GmbH, Köln Notified Body nr. 0197, PFI Prüf- und Forschungsinstitut Pirmasens e.V., Pirmasens Notified Body Nr. 0193** utställda EU-typundersökningsintyget (Modul 2) nr. **2105139-01-86 / .**

EU declaration of conformity
EN ISO 20345:2011

Par la présente, la manufacture de chaussures **ATLAS® - Schuhfabrik GmbH & Co. KG, Frische Luft 159, DE - 44319 Dortmund**, déclare que la chaussure
XP 505, n° d'art. : #349,
une **chaussure de sécurité en S3 avec Outdoor Sohlentechnologie,**
est conforme aux dispositions du Règlement (CE) 2016/425 et à la norme nationale EN ISO 20345:2011, harmonisée dans le Journal Officiel de la CE, et elle est identique à l'équipement de protection personnelle faisant l'objet de l'attestation d'examen CE de type (Modul 2) n° **2105139-01-86 /** établie par le **TÜV Rheinland Product Safety GmbH** (Contrôle Technique de Rhénanie)**, Cologne, Notified Body n° 0197,** et le **PFI Prüf- und Forschungsinstitut Pirmasens e.V.** (Institut d'essais et de Recherche Pirmasens), **Pirmasens, Notified Body n° 0193**.

Deklaracja zgodności UE
EN ISO 20345:2011

ATLAS® - Schuhfabrik GmbH & Co. KG, Frische Luft 159, DE - 44319 Dortmund oświadcza niniejszym, że wyrób
XP 505 nr wyrobu: #349,
obuwie bezpieczne kategorii S3 z podeszwą wykonaną w Outdoor Sohlentechnologie,
który jest zgodny z postanowieniami Rozporządzenia 2016/425 UE i krajowej normy wdrażającej zharmonizowaną w Dzienniku Urzędowym UE normę EN ISO 20345:2011 i jest identyczny z ŚOI, dla którego **jednostka notyfikowana (Notified Body) TÜV Rheinland Product Safety GmbH, Kolonia , numer jednostki notyfikowanej 0197 oraz jednostka notyfikowana (Notified Body) PFI Prüf- und Forschungsinstitut Pirmasens e.V., numer jednostki notyfikowanej 0193** wydała certyfikat badania typu UE (według Modul 2) nr **2105139-01-86 /** .

EU-megfelelőségi nyilatkozat az EN ISO 20345:2011 szabvány szerint

Az **ATLAS® – Schuhfabrik GmbH & Co. KG, Frische Luft 159, DE – 44319 Dortmund** ezennel kijelenti, hogy a
XP 505 cikkszám: #349,
egy **S3 kivitelű biztonsági lábbeli Outdoor Sohlentechnologie,**
amely megfelel a EU 2016/425 sz. rendeletének és az EU Európai Unió Hivatalos Lapjában harmonizált EN ISO 20345:2011 sz. nemzeti szabványnak, és megegyezik azzal az egyéni védőeszközzel, amely a **TÜV Rheinland Product Safety GmbH, Köln, 0197 sz. bejelentett szervezet** és a **PFI Prüf- und Forschungsinstitut Pirmasens e.V., Pirmasens, 0193 sz. bejelentett szervezet** által kiállított **2105139-01-86 /** sz. EU típusvizsgálati tanúsítvány (Modul 2) tárgya.

ЕС декларация за съответствие
EN ISO 20345:2011

ATLAS® - Schuhfabrik GmbH & Co. KG, Frische Luft 159, DE – 44319 Dortmund Дортмунд декларира с настоящото,
XP 505 Артикул № #349
предпазна обувка в **S3 mit Outdoor Sohlentechnologie,**
който е в съответствие с разпоредбите на Регламент 2016/425 ЕС и националния стандарт EN ISO 20345: 2011, хармонизиран в Официален вестник на ЕС и е идентичен с ЛПС, което е предмет на дат. **TÜV Rheinland Product Safety GmbH, Köln Notified Body Nr. 0197, PFI Prüf- und Forschungsinstitut Pirmasens e.V., Pirmasens Notified Body Nr. 0193** издаден сертификат за ЕС изследване на типа (Modul 2) Nr. **2105139-01-86 /** .

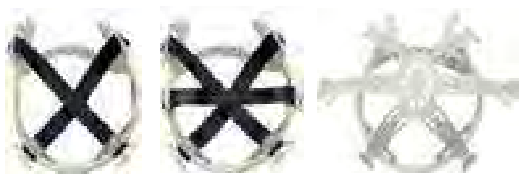
Thomas Lanzki
ATLAS® Qualitätsmanagement

Datum: 18.02.2020

ATLAS® Schuhfabrik GmbH & Co. KG
Frische Luft 159
44319 Dortmund

E-Mail: info@atlasschuhe.de
Website: **www.atlasschuhe.de**

VOSS INFO



EU - KONFORMITÄTSERKLÄRUNG

Nr.: 1125-1140-1155

PSA:	Schutzhelm für Bau und Industrie
Produktnummern:	1125, 1140, 1155
Hersteller:	**VOSS-HELME GmbH & Co. KG** **Kokenhorststraße 24** **30938 Burgwedel/Germany**
Gegenstand der Erklärung:	**INAP-Master** INAP-Master-4 (1125) INAP-Master-6 (1140) INAP-Master-K-90/6 (1155)

Hiermit erklären wir auf unsere alleinige Verantwortung, dass vorstehend beschriebener Schutzhelm den einschlägigen Harmonisierungsrechtsvorschriften der EU-Verordnung 2016/425 der Europäischen Union über persönliche Schutzausrüstung entspricht.

Angewandte harmonisierte Norm:	EN 397 (2013)
Die notifizierte Stelle	**Kenn-Nummer: 0121** IFA – Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung Alte Heerstraße 111 53757 Sankt Augustin

hat die EU-Baumusterprüfung durchgeführt und die EU-Baumusterprüfbescheinigung **IFA 1501009** ausgestellt.

Unterzeichnet für und im Namen von

VOSS-HELME GmbH & Co. KG
Kokenhorststraße 24
30938 Burgwedel/Germany

ppa. [signature]

Burgwedel, den 02. Januar 2020 Cordula Freiberg – Organisation & Vertrieb

LEIPOLD + DÖHLE GMBH

Thüringer Str. 22 A
D-37269 Eschwege - Germany - Allemagne

EU-Konformitätserklärung

Declaration of conformity - Déclaration de conformité

- Wir erklären hiermit, dass das/die nachstehend beschriebene/n Sicherheitsmittel den Vorschriften der PSA-Verordnung (EU) 2016/425 sowie den Spezifikationen der harmonisierten technischen Normen **EN 420:2003+A1:2009, EN 388:2016** entspricht/entsprechen und identisch ist mit den Sicherheitsmitteln gemäß Bestätigung des nachstehenden akkreditierten Prüfinstituts:

- *Herewith we declare, that the following model of personal protective equipment is in accordance with the directions of the European regulation (EU) 2016/425, as well as the specifications of the harmonized technical standards* **EN 420:2003+ A1:2009, EN 388:2016** *and is in conformity with the personal protective equipment as tested at following accredited testing institute:*

- *Le produit est conforme à la Réglementation Européenne (UE) 2016/425 relative aux Equipements de Protection Individuelle (EPI) et les normes européennes* **EN 420:2003+A1:2009, EN 388:2016.** *Attestation d'Examen CE de type (AET):*

Institut/Institute/Institut: CTC, 69367 Lyon Cedex 07 France
Zertifikat/Certificate/Certificat No.: 0075/1437/162/01/19/0082 v. 09.01.2019
Kenn-Nr./Notified body/Organisme notifié No.: 0075

Artikel *Style* *Produit*	**Beschreibung** *Description* *Description*
1158	**NONE STICKY FOAM** Feinstrickhandschuh aus grauem Nylon, schwarz-geschäumte Nitrilbeschichtung, EN 420 :2003+A1 :2009, EN 388 :2016, Cat. II.

Eschwege, 06.01.2022

Marion Gimbel
Geschäftsleitung / Management / Direction

E-A-RSoft™ Yellow Neon™ & Yellow Neon Blasts™ vorzuformende Gehörschutzstöpsel

Produkt Beschreibung

Die E-A-RSoft™ Yellow Neon™ und Yellow Neon Blasts™ sind vorzuformende Gehörschutzstöpsel, die den Gehörgang optimal abschliessen, um gefährlichen Lärm und laute Geräusche zu verringern. Diese Produkte sind mit und ohne Kordel erhältlich.

Die Ausführung ohne Kordel ist auch im One Touch™ Spender erhältlich.

Eigenschaften

- Polyurethan Schaum mit langsamer Rückstellung.
- Extrem weiches Material mit geringem Ausdehnungsdruck im Ohrkanal und somit erhöhtem Tragekomfort.
- Kegelform, die sich an die meisten Gehörgänge anpasst und zuverlässige Abdichtung und Tragekomfort bietet.
- Ausgezeichnetes Dämmverhalten - SNR 36 dB
- Besonders geeignet für tieffrequenten Lärm.
- Auffallende Farbgegbung - E-A-RSoft Yellow Neon Blasts mit Flammen
- Lieferung in einer wieder verschließbaren Verpackung für einfache Handhabung.
- Erhältlich mit und ohne Kordel.

Anwendungen

Die E-A-RSoft™ Yellow Neon™ und Yellow Neon Blasts™ sind ideal bei hohen Lärmpegeln und sind besonders geeignet für alle Frequenzbereiche beim Einsatz im Arbeitsumfeld und in der Freizeit. Beispiele für typische Anwendungen sind:

- Automobilindustrie
- Chemisch-Pharmazeutische Industrie
- Bauindustrie
- Schwerindustrie
- Metallverarbeitung
- Textilindustrie
- Holzverarbeitung

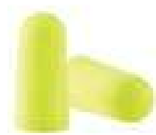
Standard & Zulassung

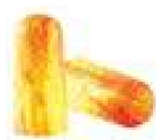
Der E-A-RSoft™ Yellow Neon™ und Yellow Neon Blasts™ sind CE geprüft und entsprechen der Europäischen Norm EN352-2:1993. Diese Produkte erfüllen die Mindestsicherheitsanforderungen nach Anhang II der Richtlinie der Europäischen Gemeinschaft 89/686/ EEC und wurden in der Entwicklungsphase von INSPEC International Limited, 56 Leslie Hough Way, Salford, Greater Manchester M6 6AJ, Großbritanien geprüft. (Nummer der Prüfstelle: 0194).

Materialien

Die folgenden Materialien wurden zur Herstellung dieses Produktes verwendet.

Bestandteil	**Material**
Gehörstöpsel	Polyurethanschaum
Kordel	PVC





Dämmwerte

Frequenz (Hz)	63	125	250	500	1000	2000	4000	8000
Mf (dB)	23,7	30,8	36,1	39,2	39,5	35,8	42,1	46,1
sf (dB)	6,7	6,5	6,7	4,7	3,9	4,9	3,1	3,3
APVf (dB)	17,0	24,3	29,4	34,5	35,6	30,9	39,0	42,8

SNR = 36dB H = 34dB M = 34dB L = 31dB

APVf (dB) = Mf – sf (dB)

Mf = Mittlerer Dämmwert

sf = Standardabweichung

APVf = Angenommener Dämmwert

H = Hoch-Frequenz Dämmwert (erwartete Dämmung für Geräusche mit L(C) – L(A) = -2dB)

M = Mittel-Frequenz Dämmwert (erwartete Dämmung für Geräusche mitL(C) – L(A) = +2dB)

L = Nieder-Frequenz Dämmwert (erwartete Dämmung für Geräusche mit L(C) – L(A) = +10dB)

SNR = Single Number Rating (Durchschnittswert, der vom gemessenen C-bewerteten Schallpegel L(C) abgezogen wird um den effektiven A-bewerteten Schallpegel im Ohr abzuschätzen.

3M

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