

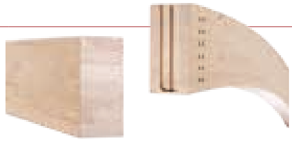

# MM HBE

solid wood building elements

# WHERE IDEAS CAN GROW.

Mayr-Melnhof Holz Holding AG is one of the most prominent companies in the European wood-processing industry. As the market leader in the glued laminated timber (glulam) sector, it is a driving force behind the advancement of cross-laminated timber, the building material of the future. It is only companies with strong roots that are able to grow and surpass themselves, and indeed, Mayr-Melnhof Holz's roots go back as far as 1850. The corporate group draws on over 170 years of experience in processing the raw material, wood, which it sources exclusively from sustainably managed forests. For Mayr-Melnhof Holz, secure sources of supply, consistent traceability of the raw material's origin, transparent quality assurance of products and ongoing optimization of processes lay the foundations for reliability and product quality.

## Mayr-Melnhof Holz products



**MM masterline**
glued laminated timber (glulam)

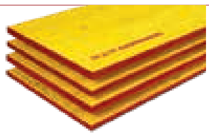
**MM vistaline**
duo and trio beams

**MM profideck**
glulam floor panels

**MM blockdeck**
glulam boards

**MM HBE**
solid wood building elements

**MM crosslam**
cross-laminated timber (CLT)



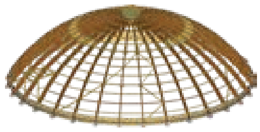
**K1 yellowplan**
shuttering panels

**HT 20plus**
formwork beams

**MM sawn timber**

**MM royalpellets**

## Engineered glulam and engineering services



**MM complete**
timber engineering
and complete systems
by HUTTEMANN

XLAM CONCRETE®
wood-concrete composite elements
by MMK

## CONTENTS




**Mayr-Melnhof Holz Holding AG**
Turmgasse 67 · 8700 Leoben · Austria
**T** +43 3842 300 0
holding@mm-holz.com · www.mm-holz.com

# MM HBE

**solid wood building elements**

With its **MM HBE** system range, Mayr-Melnhof Holz offers an attractive alternative for constructing reliable buildings in solid wood. Similarly to **MM crosslam**, the **MM HBE** system range consists of tried and tested solid timber construction products which are ideally suited to small-scale projects. Customers rely on the **MM HBE** system particularly when what matters most are costs, short delivery times, and a high degree of flexibility when implementing a project.

The **MM HBE** system range is based on a building block principle which consists of a few, easy-to-implement elements, enabling solid wood walls, floors and roofs to be created using a single, standardized construction component. By simply screwing the elements into a frame made up of sill plates and bracing elements, the load is transferred linearly from panel to panel.

## Properties

- Solid, sound construction method
- Excellent strength of shape and dimensional stability
- Pre-fabricated elements
- Easy to assemble with low dust and noise levels
- Short construction times thanks to the dry construction method
- High degree of standardization
- System range, enabling a straightforward application
- Very little cutting waste
- Climate-neutral, natural raw material
- Quick and easy to assemble
- Suitable for creating structurally effective braced frames
- Pleasant indoor living environment

## Areas of application

- Detached houses and multi-family houses
- Adding storeys to existing buildings
- Commercial, office and industrial buildings
- Modular and temporary constructions
- DIY sector
- Hybrid constructions combining natural stone and solid wood

# The MM HBE system range

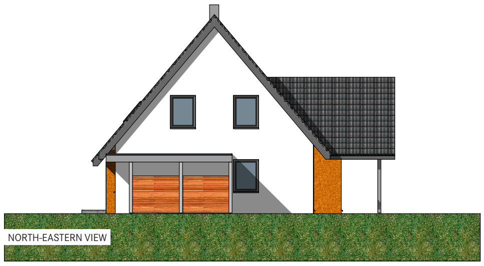
## From the production line to the building site

The **MM HBE** system has been developed by Mayr-Melnhof Holz based on its **MM masterline** product, with the addition of a double tongue and groove joint to create a connecting profile. As an option, a groove can also be milled in the centre of both sides of the panel for later use as a recessed cable duct.

Mayr-Melnhof Holz offers standardized **MM HBE** elements in a standard length or in a “system length” (see below). As well as being kept in stock by Mayr-Melnhof Holz, **MM HBE** elements are also available in stores and from building suppliers around the world.

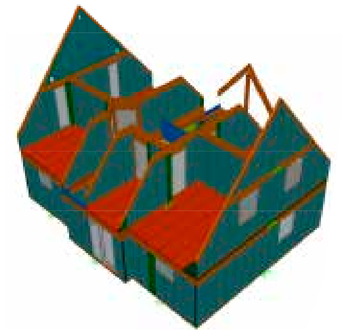
## From the basic design to the building site

The initial plans are put together based on the construction engineering company’s or customer’s drafts, before being transferred to the contractor’s final plan, ready for implementation.

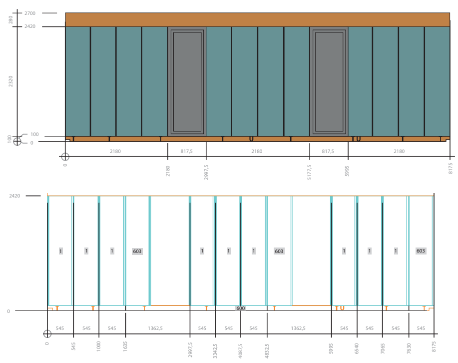



As long as the customer remains flexible and the **MM HBE** design proposal is well thought-out in every detail, taking full advantage of the **MM HBE** system is easy!

In principle, cutting waste can be almost completely eliminated, as windows and doors are included in the plans and cut out at the factory. This avoids unnecessary material costs and on-site processing.



In a final step, the joining and assembly plans are completed which means that rapid assembly can now begin.



certified according to the Construction Products Regulation (CPR)
EN 14080:2013

PEFC
PEFC/06-38-79
Promoting Sustainable Forest Management
www.pefc.org

# Technical data

## Wood species

Spruce (*Picea abies*).

## Surfaces

Visual quality (VI).
Non-visual quality (NVI).

## Product standard

EN 14080:2013

## Strength classes (according to EN 14080:2013)

GL24h

## Bonding

Adhesive based on melamine resin (MUF), type 1 according to EN 301, approved for bonding load-bearing wood components in indoor and outdoor areas.

## Colour of the bonded joint

Light bonded joint (melamine resin adhesive).

## Wood moisture content

Approx. 12% (±2%).

## Bulk density (mean values)

Spruce ........................................................ approx. 430 kg/m³

## Thermal conductivity

$\lambda$ = 0.13 W/(mK) parallel to the bonded joints

## Water vapour resistance factor

$\mu$ = 20 to 40 (with a 12% moisture content)

## Emissions and volatile organic compounds (VOC)

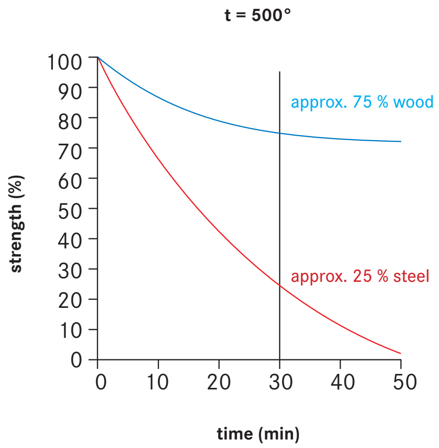
- Formaldehyde class E1.
- Glulam is well within the limit values of emission class E1 (≤ 0.1 ppm HCHO).

## Reaction to fire

Glulam classification:

**Fire classification according to EN 14080 (table 11)**

Minimum mean bulk density .................................. 380 kg/m³
Euroclass .......................................................................... D
Smoke opacity ................................................................... s2
Burning droplets ................................................................ d0




At a temperature of approx. 500 °C, steel looses 75% of its strength after 30 minutes, whereas wood only looses 25% of its strength in the same amount of time.

## Fire resistance

Calculated charring rate: 0.7 mm/min according to EN 1995-1-2 (table 3.1).

## Shrinkage and swelling

Wood is a natural building material which both absorbs and releases moisture. The equilibrium moisture content of the component depends on the climatic conditions of the surroundings. To avoid changes in its dimensions, the building component's wood moisture content must be suitable for its intended place of installation.

At the time of production, glulam has a moisture content of approx. 12% (±2%). This corresponds to an equilibrium moisture content at a room temperature of 20 °C and a relative humidity of 65%.

In height and width, glulam is subject to an average swelling and shrinkage ratio of $\alpha_u$ = 0.24% per 1% change in wood moisture content ($\Delta$u). In most cases, changes in length corresponding to $\alpha_{ull}$ = 0.01% can be ignored.

# Quality

## Visual quality

Glulam is available in two different surface qualities.

**Visual quality (VI):** designed for use in visible areas (e.g. living areas, nursery schools, schools or sports halls).

**Non-visual quality (NVI):** designed for use where there are no requirements for visual appearance (e.g. industrial buildings, compost plants, agricultural buildings such as stables or clad supporting and roof beams).

## Surfaces

Planed on four sides and chamfered (including connecting groove).


**Important information about the quality criteria**

- The quality criteria refer to the surface quality at the time the product is delivered.
- After delivery, the customer must make sure that the glulam products are stored and assembled in a manner that is suitable for the respective materials.
- As wood is a natural raw material and therefore subject to atmospheric conditions, there may be slight differences to the criteria specified above.

## Quality criteria

| Criteria*1 | Non-visual quality (NVI) | Visual quality (VI) |
|---|---|---|
| 1 intergrown knots* 2,3 | permitted | permitted |
| 2 knot holes and loose knots* 2,3 | permitted | Ø ≤ 20 mm permitted* 4<br>Ø ≤ 20 mm to be repaired at the factory* 4 |
| 3 resin pockets* 2,5 | permitted | resin pockets permitted (max. width: 5 mm) |
| 4 flaws, defects and knot holes repaired using wood plugs* 3 | not required | permitted |
| 5 knots and resin pockets repaired using filler* 3 | not required | permitted |
| 6 insect attack* 3 | galleries permitted (max. 2 mm) | bore holes permitted (max. 2 mm) |
| 7 pith | permitted | permitted |
| 8 shrinkage crack width* 3,5,7 | unlimited | up to 4 mm |
| 9 discoloration caused by nail-tough blue stain or red stripe* 5 | unlimited | up to 10% of the visible surface of the entire component |
| 10 mould* 5 | not permitted | not permitted |
| 11 dirt* 5 | permitted | permitted |
| 12 finger joint spacing | unlimited | unlimited |
| 13 surface processing | levelled | planed and chamfered; plane marks permissible up to a depth of 1 mm |

*1 Any differences to the limits defined below in cells 2, 3, 6–9, 12 and 13 are to be tolerated to the following extent: maximum three deviations per m² of visible surface for the visual quality.
*2 Permissible knot size in accordance with DIN 4074.
*3 Unlimited in number.
*4 Measurement of knot diameter same as measurement of the diameters of individual knots on square-sawn timber in accordance with DIN 4074-1:2003-6 (5.1.2.1).
*5 As-delivered condition.
*6 If necessary, filler compounds that can be painted over are to be explicitly requested.
*7 Regardless of the surface quality, on elements which are not intended to be subjected to transverse stress, the crack depth may be up to one sixth (⅙) of the element width, and on elements which are intended to be subjected to transverse stress, the crack depth may be up to one eighth (⅛) of the element width of each side.

# Wall element

## The MM HBE element in a standard length

**MM HBE** elements are produced in lengths of 13.50 m. Depending on the height of the storey, approx. five wall elements can generally be cut out of one standard length on-site. This increases speed, enhances flexibility and minimizes cutting waste.

- GL24h, melamine adhesive, surface in non-visual quality (NVI), moisture content 12% (±2%)
- Profile: double tongue and groove (15 mm)
  with a groove on both sides (20 × 30 mm)
  cable duct (20 × 60 mm; recessed service cavity)
- Thickness: 100 mm
- Width: 360 mm + 560 mm
  (visible width: 345 mm + 545 mm)
- Standard length: 13.50 m

## The MM HBE element, made to measure

Individual wall elements can also be produced according to your specifications. Your Mayr-Melnhof Holz contact person will be delighted to tell you about the various possibilities available in this respect.

## The MM HBE element in a “system length”

Professional users of the **MM HBE** system order and store an **MM HBE** “system length” that best suits their requirements to avoid having to trim down standard length parts. This “system length” also facilitates storage and transport, and means that the components can be easily processed straight out of the package.

- GL24h, melamine adhesive, surface in non-visual quality (NVI), moisture content 12% (±2%)
- Profile: double tongue and groove (15 mm)
  with a groove on both sides (20 × 30 mm)
  cable duct (20 × 60 mm; recessed service cavity)
- Thickness: 100 mm
- Width: 360 mm + 560 mm
  (visible width: 345 mm + 545 mm)
- System length: 2.60 m (example)

## Precision-cut MM HBE element

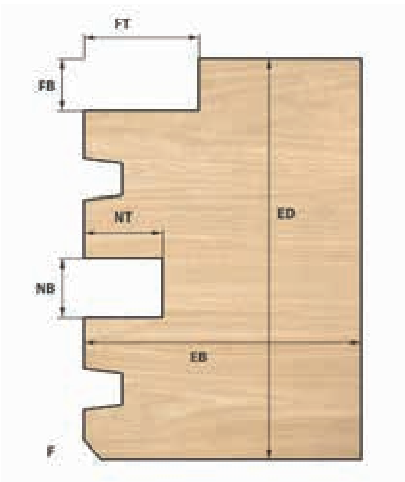
In order to create a complete **MM HBE** construction kit, a professional panel cutting machine is required. Precision CHC machining saves valuable time at the building site, reduces errors and lowers construction costs.

# Wall, floor and roof

**MM HBE** wall, floor and roof elements can be tailored to the customer's wishes so that they are adapted to the building project in question. Below is a list of the various assembly profiles that it is possible to create.

## Terminology and possible dimensions

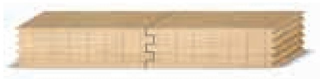
- Rebate depth (FT): 45/60/70 mm
- Rebate width (FB): 1–25 mm (increments: 1 mm)
- Groove depth (NT): 30 mm
- Groove width (NB): 15–30 mm (increments: 1 mm)
- Chamfer (F): 5 mm (other dimensions on request)
- Element thickness (ED): 60–260 mm
  (depending on the profile; increments: 20 mm)
- Element width (EB): 200–960 mm (increments: 40 mm)



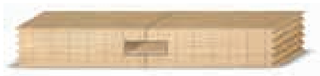

**Double tongue and groove with rebate**
Element thickness (ED): 100 mm to 260 mm.

**Single tongue and groove**
Element thickness (ED): up to 60 mm.

**Double tongue and groove**
Element thickness (ED): 80 mm to 260 mm.



**Groove and groove**
Element thickness (ED): 60 mm to 260 mm.



**Double tongue and groove with groove**
Element thickness (ED): 100 mm to 260 mm.

**Rebate and rebate**
Element thickness (ED): 60 mm to 260 mm.

**Double tongue and groove with groove and rebate**
Element thickness (ED): 140 mm to 260 mm.

**Groove and rebate**
Element thickness (ED): 80 mm to 260 mm.

# Dimensional tolerances and important information

In principle, our **MM HBE** products are manufactured to the exact dimensions ordered. However, production tolerances and the natural shrinkage and swelling behaviour of wood may lead to dimensional deviations in the cross-section.

The dimensional tolerances for **MM HBE** elements are regulated in EN 14080:2013. The reference moisture measurement is 12%.

| | | | |
|---|---|---|---|
| Width | 60 mm ≤ b ≤ 300 mm | | |
| Width tolerance | ±2 mm | | |
| Height | 100 mm ≤ h ≤ 400 mm | 400 mm < h ≤ 2,500 mm | |
| Height tolerance | +4 mm/−2 mm | −2 mm | |
| Length | < 2 m | 2 m to < 20 m | > 20 m |
| Length tolerance | ±2 mm | ±0.1% | ±20 mm |

## Crack formation

Depending on the ambient conditions to which the wood is exposed, shrinkage cracks can occur as a result of the material's natural shrinkage and swelling behaviour. The external areas of the component can absorb moisture, particularly during the construction phase. To prevent the formation of shrinkage cracks, this building moisture must be gradually eliminated and the equilibrium moisture content restored through adequate ventilation and careful heating of the building.

Shrinkage cracks can occur on the surfaces and along the bonded joints of **MM HBE** elements. On components not subjected to transverse stress related to the structure, these shrinkage cracks can be tolerated up to a depth of one sixth (⅙) of the component width (on each side).

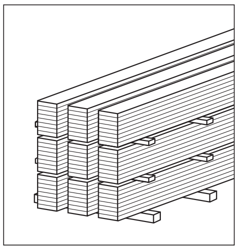
If the component is directly exposed to the weather or extremely fluctuating climatic conditions, the risk of shrinkage cracks increases.

## Packaging and storage

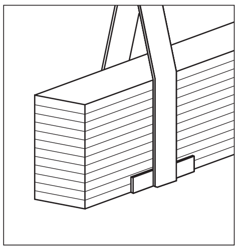
The following guidelines for storing timber must be observed:

- Place wooden skids under the components.
- If the components are stacked horizontally, spacer timbers must be placed between each layer.
- Prevent the components from tipping over.
- Remove the protective film to prevent condensation from forming.
- Protect the components by storing them at a sufficient distance from the ground, and cover them with tarpaulins to protect them from rain, spray water and rising damp.
- In the event of longer storage periods, additional flooring sleepers should be put in place to prevent creep deformation.

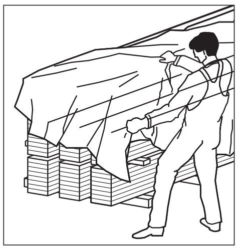
**Stacking**
Use spacer timbers and stacking slats. Prevent the components from tipping over.



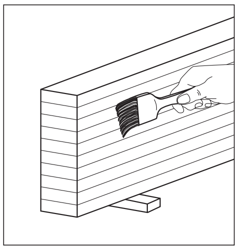
**Damage**
Use wide straps when transporting the components and place edge protectors underneath and, if necessary, at the top to avoid damaging the components.



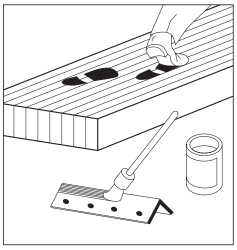
**Humidity**
After delivery, cover the components with tarpaulins to protect them from humidity. Remove the packaging film immediately, otherwise condensation may form.



**Protection from the weather**
Observe the preservation measures for structural timber. In addition, apply a moisture protection coating as a temporary protection from the weather during the construction period.



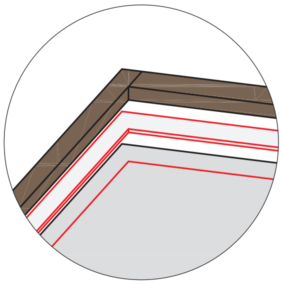
**Soiling**
Cover the components or apply a protective coating to prevent soiling. Avoid stains, impregnating salts and rusty metal parts particularly caused by welding or grinding work.



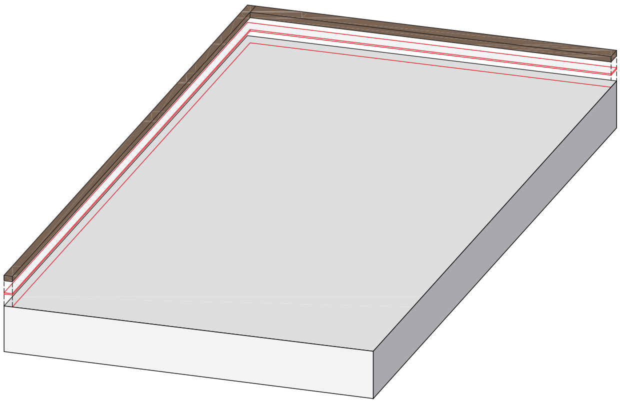
Source: Studiengemeinschaft Holzleimbau e.V.

# Assembly of wall and floor elements

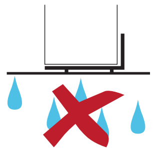
## Mounting the sill plate

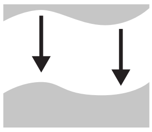
**Note:**
We recommend installing a damp-proof course above the concrete slab to prevent moisture from travelling up to the wood.



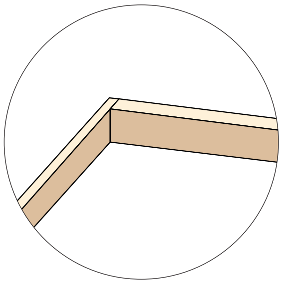
**Double protection**
Prevents humidity from being absorbed into the wood by capillary action and ensures excellent airtightness.



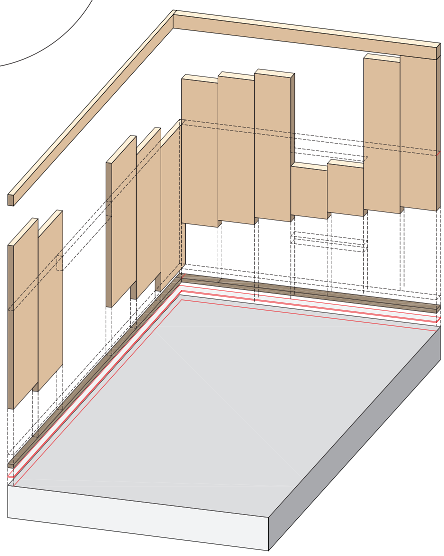
**Adaptability**
Adhesive PU foam profiles can be used to level out any irregularities on the base.



## Connecting the sill plate, assembling the wall elements on the ground floor and assembling the upper joist



**Note:**
The upper joist should be installed in the opposite direction to the sill plate.

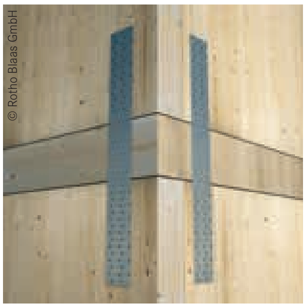


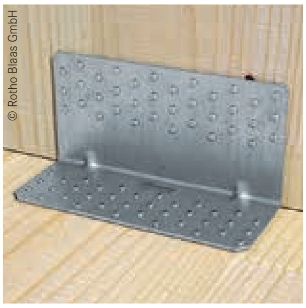


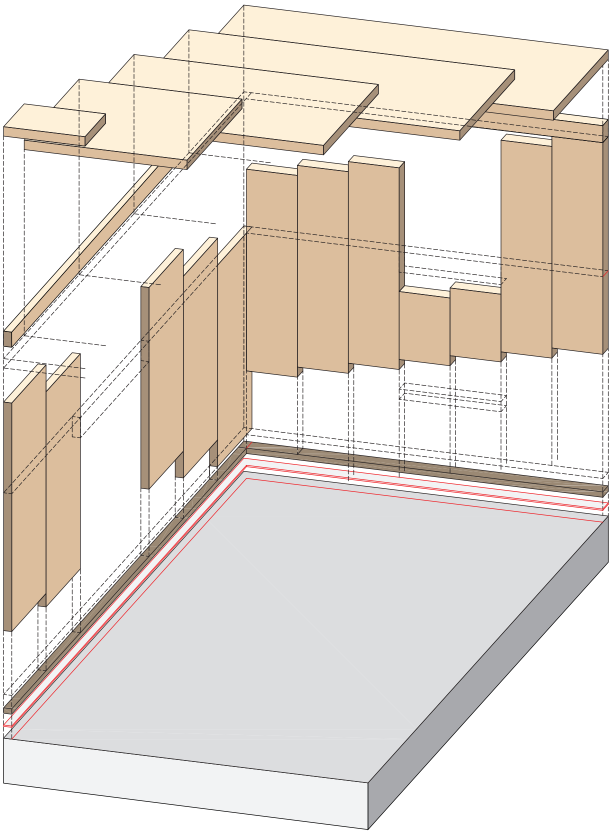

# Assembly of wall and floor elements

## Assembling an MM HBE wall element in the top storey

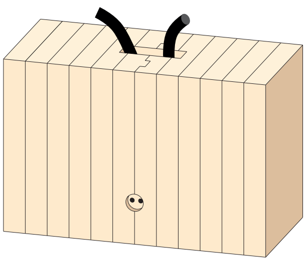




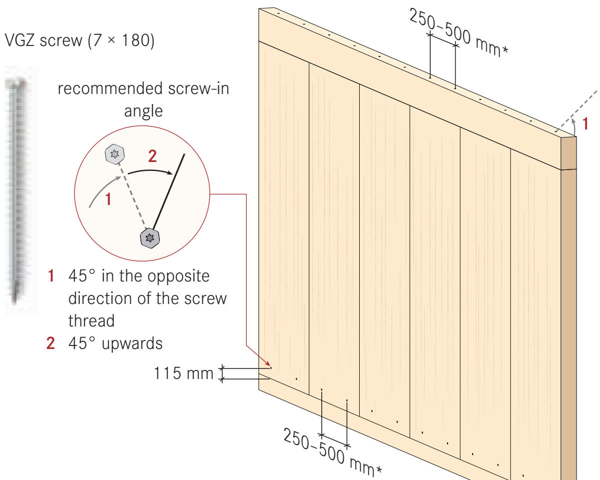



## Cable routing (cable duct) possible between each MM HBE wall element



## Diagram (showing position of screw holes)




* according to static requirements

# Accessories

## Transporting MM HBE elements

The hoist anchor is designed for transporting prefabricated parts and cross-glued panels. Made from galvanized cast steel, it is extremely hard-wearing. The integrated lugs clasp the head of the screw which is firmly screwed into the component. The hoist anchor can be used for lifting axle loads and transverse loads.


## Assembly support (assembly braces)

The "Giraffe" assembly support is made entirely of galvanized steel. The practical handle enables fine adjustments to be carried out quickly and easily. The assembly support can be extended by up to 3.00 m and yet only weighs 9.80 kg. The support is equipped with large plates at the top and bottom. The top plate is wide enough to support the weight of two panels at the same time, while the bottom plate can be easily screwed to the floor through the holes provided for the purpose.


## Panel puller

This panel puller can be used for precisely assembling solid wood walls, dowel-laminated timber floors, roof elements and so much more.

Thanks to its plates that can be rotated 360°, it can also be used in areas that are difficult to access such as on sloping roofs or when the components form tight angles.


## Assembly gauge

The steel assembly gauge facilitates the installation of wood screws at an angle of 45°.

# Preliminary design table

## External wall | fire from one side: required element thickness

**Reference standards for determining the required cross-section**

- ÖN EN 14080
- ÖN EN 1995-1-1:2019, ÖN B 1995-1-1:2019
- ÖN EN 1995-1-2:2011, ÖN B 1995-1-2:2019

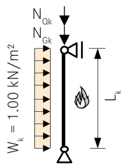
**Assumptions for the calculation**

- $\rho_{mean}$ = 500 kg/m³
- Service class 1
- Partial safety factor: $\gamma_M$ = 1.25
- Modification factor: $k_{mod}$ = 0.80 or 0.90
  (wind, snow for locations above 1,000 m above sea level)
- System factor: $k_{sys}$ = 1.00

**Material parameters**

- Material: GL24h
- Deformation factor: $k_{def}$ = 0.60 (floors)
  $k_{def}$ = 0.80 (roofs)

**Static system**




**Fire safety design**

- Exposed to fire from one side

**Fire resistance**

| R0 | R30 | R60 | R90 | R120 |
|---|---|---|---|---|

| Permanent load | Imposed load | Wall height [m] (corresponds to the assumed buckling length $L_k$) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $N_{Gk}$ [kN/m] | $N_{Qk}$ [kN/m] | 2.50 | | | | 3.00 | | | | 3.20 | | | | 3.50 | | | |
| | | R0 | R30 | R60 | R90 | R0 | R30 | R60 | R90 | R0 | R30 | R60 | R90 | R0 | R30 | R60 | R90 |
| 10 | 10 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 |
| | 20 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 |
| | 40 | 60 | 60 | 80 | 100 | 60 | 80 | 100 | 120 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 60 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 80 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| 20 | 10 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 |
| | 20 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 | 60 | 80 | 100 | 100 | 60 | 80 | 100 | 120 |
| | 40 | 60 | 60 | 80 | 100 | 60 | 80 | 100 | 120 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 60 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 80 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| 40 | 10 | 60 | 60 | 80 | 100 | 60 | 80 | 100 | 120 | 60 | 80 | 100 | 120 | 60 | 80 | 100 | 120 |
| | 20 | 60 | 60 | 80 | 100 | 60 | 80 | 100 | 120 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 40 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 60 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 80 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| 60 | 10 | 60 | 80 | 100 | 120 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 20 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 40 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 60 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 80 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 100 | 100 | 120 | 140 |
| 80 | 10 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 20 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 40 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 60 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 100 | 100 | 120 | 140 |
| | 80 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 100 | 100 | 120 | 120 | 100 | 100 | 120 | 140 |

- These tables are provided for preliminary design purposes only and are not intended to substitute a structural analysis.
- The self-weight of the CLT elements is already taken into account in the table at $\rho$ = 500 kg/m³.

# Preliminary design table

## Internal wall | fire from one side: required element thickness

### Reference standards for determining the required cross-section

- ÖN EN 14080
- ÖN EN 1995-1-1:2019, ÖN B 1995-1-1:2019
- ÖN EN 1995-1-2:2011, ÖN B 1995-1-2:2019

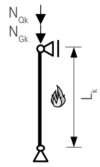
### Assumptions for the calculation

- $\rho_{mean}$ = 500 kg/m³
- Service class 1
- Partial safety factor: $\gamma_M$ = 1.25
- Modification factor: $k_{mod}$ = 0.80 or 0.90
  (wind, snow for locations above 1,000 m above sea level)
- System factor: $k_{sys}$ = 1.00

### Material parameters

- Material: GL24h
- Deformation factor: $k_{def}$ = 0.60 (floors)
  $k_{def}$ = 0.80 (roofs)

### Static system




### Fire safety design

- Exposed to fire from one side

### Fire resistance

| R0 | R30 | R60 | R90 | R120 |
|---|---|---|---|---|

| Permanent load | Imposed load | Wall height [m] (corresponds to the assumed buckling length $L_k$) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $N_{Gk}$ [kN/m] | $N_{Qk}$ [kN/m] | 2.50 | | | | 3.00 | | | | 3.20 | | | | 3.50 | | | |
| | | R0 | R30 | R60 | R90 | R0 | R30 | R60 | R90 | R0 | R30 | R60 | R90 | R0 | R30 | R60 | R90 |
| 10 | 10 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 |
| | 20 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 |
| | 40 | 60 | 60 | 80 | 100 | 60 | 80 | 100 | 120 | 60 | 80 | 100 | 120 | 60 | 80 | 100 | 120 |
| | 60 | 60 | 80 | 100 | 120 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 80 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| 20 | 10 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 |
| | 20 | 60 | 60 | 80 | 100 | 60 | 60 | 80 | 100 | 60 | 80 | 100 | 100 | 60 | 80 | 100 | 120 |
| | 40 | 60 | 60 | 80 | 100 | 60 | 80 | 100 | 120 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 60 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 80 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| 40 | 10 | 60 | 60 | 80 | 100 | 60 | 80 | 100 | 120 | 60 | 80 | 100 | 120 | 60 | 80 | 100 | 120 |
| | 20 | 60 | 60 | 80 | 100 | 60 | 80 | 100 | 120 | 60 | 80 | 100 | 120 | 60 | 80 | 100 | 120 |
| | 40 | 60 | 80 | 100 | 120 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 60 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 80 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| 60 | 10 | 60 | 80 | 100 | 120 | 60 | 80 | 100 | 120 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 20 | 60 | 80 | 100 | 120 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 40 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 60 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 80 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 100 | 100 | 120 | 140 |
| 80 | 10 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 20 | 60 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 40 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 |
| | 60 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 100 | 120 | 140 |
| | 80 | 80 | 80 | 100 | 120 | 80 | 80 | 100 | 120 | 80 | 100 | 120 | 120 | 100 | 100 | 120 | 140 |

- These tables are provided for preliminary design purposes only and are not intended to substitute a structural analysis.
- The self-weight of the CLT elements is already taken into account in the table at ρ = 500 kg/m³.

# Preliminary design table

## Internal wall | fire from both sides: required element thickness

**Reference standards for determining the required cross-section**

- ÖN EN 14080
- ÖN EN 1995-1-1:2019, ÖN B 1995-1-1:2019
- ÖN EN 1995-1-2:2011, ÖN B 1995-1-2:2019

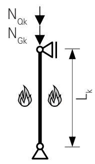
**Assumptions for the calculation**

- $\rho_{mean}$ = 500 kg/m³
- Service class 1
- Partial safety factor: $\gamma_M$ = 1.25
- Modification factor: $k_{mod}$ = 0.80 or 0.90 (wind, snow for locations above 1,000 m above sea level)
- System factor: $k_{sys}$ = 1.00

**Material parameters**

- Material: GL24h
- Deformation factor: $k_{def}$ = 0.60 (floors)
  $k_{def}$ = 0.80 (roofs)

**Static system**




**Fire safety design**

- Exposed to fire from two sides

**Fire resistance**

| R0 | R30 | R60 | R90 | R120 |
|---|---|---|---|---|

| Permanent load | Imposed load | Wall height [m] (corresponds to the assumed buckling length $L_k$) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $N_{Gk}$ [kN/m] | $N_{Qk}$ [kN/m] | 2.50 | | | | 3.00 | | | | 3.20 | | | | 3.50 | | | |
| | | R0 | R30 | R60 | R90 | R0 | R30 | R60 | R90 | R0 | R30 | R60 | R90 | R0 | R30 | R60 | R90 |
| 10 | 10 | 60 | 80 | 120 | 160 | 60 | 80 | 120 | 160 | 60 | 100 | 120 | 160 | 60 | 100 | 140 | 180 |
| | 20 | 60 | 80 | 120 | 160 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 |
| | 40 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 |
| | 60 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 | 80 | 100 | 140 | 180 | 80 | 100 | 140 | 180 |
| | 80 | 60 | 100 | 140 | 180 | 80 | 100 | 140 | 180 | 80 | 100 | 140 | 180 | 80 | 120 | 160 | 180 |
| 20 | 10 | 60 | 80 | 120 | 160 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 |
| | 20 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 |
| | 40 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 | 80 | 100 | 140 | 180 |
| | 60 | 60 | 100 | 140 | 180 | 80 | 100 | 140 | 180 | 80 | 100 | 140 | 180 | 80 | 100 | 140 | 180 |
| | 80 | 60 | 100 | 140 | 180 | 80 | 100 | 140 | 180 | 80 | 100 | 140 | 180 | 80 | 120 | 160 | 200 |
| 40 | 10 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 |
| | 20 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 |
| | 40 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 | 80 | 100 | 140 | 180 | 80 | 100 | 140 | 180 |
| | 60 | 60 | 100 | 140 | 180 | 80 | 100 | 140 | 180 | 80 | 100 | 140 | 180 | 80 | 120 | 160 | 200 |
| | 80 | 80 | 100 | 140 | 180 | 80 | 120 | 140 | 180 | 80 | 120 | 160 | 200 | 80 | 120 | 160 | 200 |
| 60 | 10 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 | 80 | 100 | 140 | 180 |
| | 20 | 60 | 100 | 140 | 180 | 60 | 100 | 140 | 180 | 80 | 100 | 140 | 180 | 80 | 100 | 140 | 180 |
| | 40 | 60 | 100 | 140 | 180 | 80 | 100 | 140 | 180 | 80 | 100 | 140 | 180 | 80 | 120 | 160 | 200 |
| | 60 | 80 | 100 | 140 | 180 | 80 | 120 | 140 | 180 | 80 | 120 | 160 | 200 | 80 | 120 | 160 | 200 |
| | 80 | 80 | 100 | 140 | 180 | 80 | 120 | 160 | 200 | 80 | 120 | 160 | 200 | 100 | 120 | 160 | 200 |
| 80 | 10 | 60 | 100 | 140 | 180 | 80 | 100 | 140 | 180 | 80 | 100 | 140 | 180 | 80 | 120 | 140 | 180 |
| | 20 | 60 | 100 | 140 | 180 | 80 | 100 | 140 | 180 | 80 | 100 | 140 | 180 | 80 | 120 | 160 | 200 |
| | 40 | 80 | 100 | 140 | 180 | 80 | 120 | 140 | 180 | 80 | 120 | 160 | 200 | 80 | 120 | 160 | 200 |
| | 60 | 80 | 100 | 140 | 180 | 80 | 120 | 160 | 200 | 80 | 120 | 160 | 200 | 80 | 120 | 160 | 200 |
| | 80 | 80 | 100 | 140 | 180 | 80 | 120 | 160 | 200 | 80 | 120 | 160 | 200 | 100 | 120 | 160 | 200 |

- These tables are provided for preliminary design purposes only and are not intended to substitute a structural analysis.
- The self-weight of the CLT elements is already taken into account in the table at $\rho$ = 500 kg/m³.

# Preliminary design table

## Floor | single-span beam: required element thickness

### Reference standards for determining the required cross-section

- ÖN EN 14080
- ÖN EN 1995-1-1:2019, ÖN B 1995-1-1:2019
- ÖN EN 1995-1-2:2011, ÖN B 1995-1-2:2019

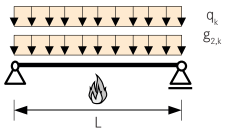
### Assumptions for the calculation

- $\rho_{mean}$ = 500 kg/m³
- Service class 1
- Partial safety factor: $\gamma_M$ = 1.25
- Modification factor: $k_{mod}$ = 0.80 or 0.90
  (wind, snow for locations above 1,000 m above sea level)
- System factor: $k_{sys}$ = 1.00

### Material parameters

- Material: GL24h
- Deformation factor: $k_{def}$ = 0.60 (floors)
  $k_{def}$ = 0.80 (roofs)

### Static system




### Fire safety design

- Exposed to fire from two sides

### Fire resistance

| R0 | R30 | R60 | R90 | R120 |
|---|---|---|---|---|

| Permanent load | Category | Imposed load | Span L [m] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 3.00 | | | 3.50 | | | 4.00 | | | 4.50 | | | 5.00 | | | 6.00 | | | 7.00 | | |
| $g_{2,k}$ [kN/m²] | | $q_k$ [kN/m²] | floor class (I, II, III) | | | | | | | | | | | | | | | | | | | | |
| | | | I | II | III | I | II | III | I | II | III | I | II | III | I | II | III | I | II | III | I | II | III |
| 1.00 | A/B | 1.50 | 140 | 120 | 80 | 160 | 140 | 80 | 180 | 160 | 100 | 200 | 160 | 100 | 240 | 180 | 120 | – | 220 | 140 | – | – | 160 |
| | | 2.00 | 140 | 120 | 80 | 160 | 140 | 80 | 180 | 160 | 100 | 200 | 160 | 120 | 240 | 180 | 120 | – | 220 | 140 | – | – | 180 |
| | | 3.00 | 140 | 120 | 80 | 160 | 140 | 100 | 180 | 160 | 120 | 200 | 160 | 120 | 240 | 180 | 140 | – | 220 | 160 | – | – | 200 |
| | C/D | 3.00 | 140 | 120 | 80 | 160 | 140 | 100 | 180 | 160 | 120 | 200 | 160 | 120 | 240 | 180 | 140 | – | 220 | 180 | – | – | 200 |
| | | 4.00 | 140 | 120 | 100 | 160 | 140 | 100 | 180 | 160 | 120 | 200 | 160 | 140 | 240 | 180 | 160 | – | 220 | 180 | – | – | 220 |
| | | 5.00 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 120 | 200 | 160 | 140 | 240 | 180 | 160 | – | 220 | 200 | – | – | 220 |
| 2.00 | A/B | 1.50 | 140 | 120 | 80 | 160 | 140 | 80 | 180 | 160 | 100 | 200 | 160 | 100 | 240 | 180 | 120 | – | 220 | 140 | – | – | 160 |
| | | 2.00 | 140 | 120 | 80 | 160 | 140 | 100 | 180 | 160 | 100 | 200 | 160 | 120 | 240 | 180 | 120 | – | 220 | 160 | – | – | 180 |
| | | 3.00 | 140 | 120 | 80 | 160 | 140 | 100 | 180 | 160 | 120 | 200 | 160 | 120 | 240 | 180 | 140 | – | 220 | 160 | – | – | 200 |
| | C/D | 3.00 | 140 | 120 | 100 | 160 | 140 | 100 | 180 | 160 | 120 | 200 | 160 | 140 | 240 | 180 | 160 | – | 220 | 180 | – | – | 220 |
| | | 4.00 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 140 | 200 | 160 | 140 | 240 | 180 | 160 | – | 220 | 200 | – | – | 220 |
| | | 5.00 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 140 | 200 | 160 | 160 | 240 | 180 | 160 | – | 220 | 200 | – | – | 240 |
| 2.50 | A/B | 1.50 | 140 | 120 | 80 | 160 | 140 | 80 | 180 | 160 | 100 | 200 | 160 | 100 | 240 | 180 | 120 | – | 220 | 140 | – | – | 180 |
| | | 2.00 | 140 | 120 | 80 | 160 | 140 | 100 | 180 | 160 | 100 | 200 | 160 | 120 | 240 | 180 | 120 | – | 220 | 160 | – | – | 180 |
| | | 3.00 | 140 | 120 | 80 | 160 | 140 | 100 | 180 | 160 | 120 | 200 | 160 | 120 | 240 | 180 | 140 | – | 220 | 160 | – | – | 200 |
| | C/D | 3.00 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 120 | 200 | 160 | 140 | 240 | 180 | 160 | – | 220 | 200 | – | – | 220 |
| | | 4.00 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 140 | 200 | 160 | 160 | 240 | 180 | 160 | – | 220 | 200 | – | – | 240 |
| | | 5.00 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 140 | 200 | 160 | 160 | 240 | 180 | 180 | – | 220 | 200 | – | – | 240 |
| 3.00 | A/B | 1.50 | 140 | 120 | 80 | 160 | 140 | 80 | 180 | 160 | 100 | 200 | 160 | 120 | 240 | 180 | 120 | – | 220 | 140 | – | – | 180 |
| | | 2.00 | 140 | 120 | 80 | 160 | 140 | 100 | 180 | 160 | 100 | 200 | 160 | 120 | 240 | 180 | 120 | – | 220 | 160 | – | – | 180 |
| | | 3.00 | 140 | 120 | 80 | 160 | 140 | 100 | 180 | 160 | 120 | 200 | 160 | 120 | 240 | 180 | 140 | – | 220 | 160 | – | – | 200 |
| | C/D | 3.00 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 140 | 200 | 160 | 140 | 240 | 180 | 160 | – | 220 | 200 | – | – | 240 |
| | | 4.00 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 140 | 200 | 160 | 160 | 240 | 180 | 180 | – | 220 | 200 | – | – | 240 |
| | | 5.00 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 140 | 200 | 160 | 160 | 240 | 180 | 180 | – | 220 | 220 | – | – | 240 |
| 3.50 | A/B | 1.50 | 140 | 120 | 80 | 160 | 140 | 80 | 180 | 160 | 100 | 200 | 160 | 120 | 240 | 180 | 120 | – | 220 | 140 | – | – | 180 |
| | | 2.00 | 140 | 120 | 80 | 160 | 140 | 100 | 180 | 160 | 100 | 200 | 160 | 120 | 240 | 180 | 140 | – | 220 | 160 | – | – | 180 |
| | | 3.00 | 140 | 120 | 80 | 160 | 140 | 100 | 180 | 160 | 120 | 200 | 160 | 120 | 240 | 180 | 140 | – | 220 | 180 | – | – | 200 |
| | C/D | 3.00 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 140 | 200 | 160 | 160 | 240 | 180 | 180 | – | 220 | 200 | – | – | 240 |
| | | 4.00 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 140 | 200 | 160 | 160 | 240 | 180 | 180 | – | 220 | 220 | – | – | 240 |
| | | 5.00 | 140 | 120 | 120 | 160 | 140 | 120 | 180 | 160 | 140 | 200 | 160 | 160 | 240 | 180 | 180 | – | 220 | 220 | – | – | – |

- These tables are provided for preliminary design purposes only and are not intended to substitute a structural analysis.
- The self-weight of the CLT elements is already taken into account in the table at ρ = 500 kg/m³.

# Preliminary design table

## Floor | two-span beam: required element thickness

**Reference standards for determining the required cross-section**

- ÖN EN 14080
- ÖN EN 1995-1-1:2019, ÖN B 1995-1-1:2019
- ÖN EN 1995-1-2:2011, ÖN B 1995-1-2:2019

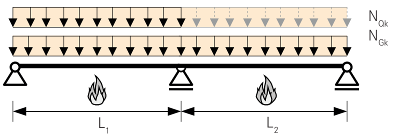
**Assumptions for the calculation**

- $\rho_{mean}$ = 500 kg/m³
- Service class 1
- Partial safety factor: $\gamma_M$ = 1.25
- Modification factor: $k_{mod}$ = 0.80 or 0.90
  (wind, snow for locations above 1,000 m above sea level)
- System factor: $k_{sys}$ = 1.00

**Material parameters**

- Material: GL24h
- Deformation factor: $k_{def}$ = 0.60 (floors)
  $k_{def}$ = 0.80 (roofs)

**Static system**




**Fire safety design**

- Exposed to fire from one side

**Fire resistance**

| R0 | R30 | R60 | R90 | R120 |
|---|---|---|---|---|

| Permanent load | Category | Imposed load | Span L [m] 3.00 | | | 3.50 | | | 4.00 | | | 4.50 | | | 5.00 | | | 6.00 | | | 7.00 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $G_{2,k}$ [kN/m²] | | $Q_k$ [kN/m²] | Floor class (I, II, III) | | | | | | | | | | | | | | | | | | | | |
| | | | I | II | III | I | II | III | I | II | III | I | II | III | I | II | III | I | II | III | I | II | III |
| 1.00 | A/B | 1.50 | 120 | 100 | 60 | 140 | 120 | 80 | 160 | 140 | 80 | 180 | 160 | 80 | 200 | 160 | 100 | 240 | 200 | 120 | – | 220 | 140 |
| | | 2.00 | 120 | 100 | 60 | 140 | 120 | 80 | 160 | 140 | 80 | 180 | 160 | 100 | 200 | 160 | 100 | 240 | 200 | 120 | – | 220 | 140 |
| | | 3.00 | 120 | 100 | 80 | 140 | 120 | 80 | 160 | 140 | 100 | 180 | 160 | 100 | 200 | 160 | 120 | 240 | 200 | 140 | – | 220 | 160 |
| | C/D | 3.00 | 120 | 100 | 80 | 140 | 120 | 80 | 160 | 140 | 100 | 180 | 160 | 120 | 200 | 160 | 120 | 240 | 200 | 140 | – | 220 | 160 |
| | | 4.00 | 120 | 100 | 80 | 140 | 120 | 100 | 160 | 140 | 100 | 180 | 160 | 120 | 200 | 160 | 140 | 240 | 200 | 160 | – | 220 | 180 |
| | | 5.00 | 120 | 100 | 80 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 120 | 200 | 160 | 140 | 240 | 200 | 160 | – | 220 | 200 |
| 2.00 | A/B | 1.50 | 120 | 100 | 60 | 140 | 120 | 80 | 160 | 140 | 80 | 180 | 160 | 100 | 200 | 160 | 100 | 240 | 200 | 120 | – | 220 | 140 |
| | | 2.00 | 120 | 100 | 60 | 140 | 120 | 80 | 160 | 140 | 80 | 180 | 160 | 100 | 200 | 160 | 100 | 240 | 200 | 120 | – | 220 | 140 |
| | | 3.00 | 120 | 100 | 80 | 140 | 120 | 80 | 160 | 140 | 100 | 180 | 160 | 100 | 200 | 160 | 120 | 240 | 200 | 140 | – | 220 | 160 |
| | C/D | 3.00 | 120 | 100 | 80 | 140 | 120 | 100 | 160 | 140 | 100 | 180 | 160 | 120 | 200 | 160 | 120 | 240 | 200 | 160 | – | 240 | 180 |
| | | 4.00 | 120 | 100 | 80 | 140 | 120 | 100 | 160 | 140 | 100 | 180 | 160 | 120 | 200 | 160 | 140 | 240 | 200 | 160 | – | 240 | 180 |
| | | 5.00 | 120 | 100 | 80 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 120 | 200 | 160 | 140 | 240 | 200 | 160 | – | 240 | 200 |
| 2.50 | A/B | 1.50 | 120 | 100 | 60 | 140 | 120 | 80 | 160 | 140 | 80 | 180 | 160 | 100 | 200 | 160 | 100 | 240 | 200 | 120 | – | 220 | 140 |
| | | 2.00 | 120 | 100 | 60 | 140 | 120 | 80 | 160 | 140 | 80 | 180 | 160 | 100 | 200 | 160 | 100 | 240 | 200 | 120 | – | 220 | 140 |
| | | 3.00 | 120 | 100 | 80 | 140 | 120 | 80 | 160 | 140 | 100 | 180 | 160 | 100 | 200 | 160 | 120 | 240 | 200 | 140 | – | 220 | 160 |
| | C/D | 3.00 | 120 | 100 | 80 | 140 | 120 | 100 | 160 | 140 | 100 | 180 | 160 | 120 | 200 | 160 | 120 | 240 | 200 | 160 | – | 240 | 180 |
| | | 4.00 | 120 | 100 | 80 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 120 | 200 | 160 | 140 | 240 | 200 | 160 | – | 240 | 180 |
| | | 5.00 | 120 | 100 | 100 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 140 | 200 | 160 | 140 | 240 | 200 | 180 | – | 240 | 200 |
| 3.00 | A/B | 1.50 | 120 | 100 | 60 | 140 | 120 | 80 | 160 | 140 | 80 | 180 | 160 | 100 | 200 | 160 | 100 | 240 | 200 | 120 | – | 220 | 140 |
| | | 2.00 | 120 | 100 | 60 | 140 | 120 | 80 | 160 | 140 | 80 | 180 | 160 | 100 | 200 | 160 | 100 | 240 | 200 | 120 | – | 220 | 160 |
| | | 3.00 | 120 | 100 | 80 | 140 | 120 | 80 | 160 | 140 | 100 | 180 | 160 | 100 | 200 | 160 | 120 | 240 | 200 | 140 | – | 220 | 160 |
| | C/D | 3.00 | 120 | 100 | 80 | 140 | 120 | 100 | 160 | 140 | 100 | 180 | 160 | 120 | 200 | 160 | 140 | – | 220 | 160 | – | – | 180 |
| | | 4.00 | 120 | 100 | 80 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 120 | 200 | 160 | 140 | – | 220 | 160 | – | – | 200 |
| | | 5.00 | 120 | 100 | 100 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 140 | 200 | 160 | 140 | – | 220 | 180 | – | – | 200 |
| 3.50 | A/B | 1.50 | 120 | 100 | 60 | 140 | 120 | 80 | 160 | 140 | 80 | 180 | 160 | 100 | 200 | 160 | 100 | 240 | 200 | 120 | – | 220 | 140 |
| | | 2.00 | 120 | 100 | 60 | 140 | 120 | 80 | 160 | 140 | 80 | 180 | 160 | 100 | 200 | 160 | 100 | 240 | 200 | 140 | – | 220 | 160 |
| | | 3.00 | 120 | 100 | 80 | 140 | 120 | 80 | 160 | 140 | 100 | 180 | 160 | 100 | 200 | 160 | 120 | 240 | 200 | 140 | – | 220 | 160 |
| | C/D | 3.00 | 120 | 100 | 80 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 120 | 200 | 180 | 140 | – | 220 | 160 | – | – | 180 |
| | | 4.00 | 120 | 100 | 80 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 120 | 200 | 180 | 140 | – | 220 | 160 | – | – | 200 |
| | | 5.00 | 120 | 100 | 100 | 140 | 120 | 100 | 160 | 140 | 120 | 180 | 160 | 140 | 200 | 180 | 140 | – | 220 | 180 | – | – | 200 |

- These tables are provided for preliminary design purposes only and are not intended to substitute a structural analysis.
- The self-weight of the CLT elements is already taken into account in the table at ρ = 500 kg/m³.

# Preliminary design table

## Roof | single-span beam | roof pitch α = 0° to 5°: required element thickness

### Reference standards for determining the required cross-section

- ÖN EN 14080
- ÖN EN 1995-1-1:2019, ÖN B 1995-1-1:2019
- ÖN EN 1995-1-2:2011, ÖN B 1995-1-2:2019

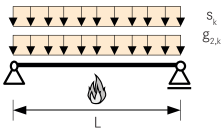
### Assumptions for the calculation

- $\rho_{mean}$ = 500 kg/m³
- Service class 1
- Partial safety factor: $\gamma_M$ = 1.25
- Modification factor: $k_{mod}$ = 0.80 or 0.90 (wind, snow for locations above 1,000 m above sea level)
- System factor: $k_{sys}$ = 1.00

### Material parameters

- Material: GL24h
- Deformation factor: $k_{def}$ = 0.60 (floors)
  $k_{def}$ = 0.80 (roofs)

### Static system




### Fire safety design

- Exposed to fire from one side

### Fire resistance

| R0 | R30 | R60 | R90 | R120 |
|---|---|---|---|---|

| Permanent load | Snow load | Span L [m] | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 3.00 | | 3.50 | | 4.00 | | 4.50 | | 5.00 | | 6.00 | | 7.00 | |
| $g_{2,k}$ [kN/m²] | $s_k$ [kN/m²] | snow loads (locations above 1,000 m above sea level or locations below 1,000 m above sea level) | | | | | | | | | | | | | |
| | | <1,000 m | >1,000 m | <1,000 m | >1,000 m | <1,000 m | >1,000 m | <1,000 m | >1,000 m | <1,000 m | >1,000 m | <1,000 m | >1,000 m | <1,000 m | >1,000 m |
| 1.00 | 0.50 | 60 | 60 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 120 | 120 | 140 | 140 |
| | 1.00 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 140 | 140 | 160 | 160 |
| | 1.50 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 |
| | 2.00 | 80 | 80 | 80 | 80 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 180 | 180 |
| | 3.00 | 80 | 80 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 200 | 200 |
| | 4.00 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 180 | 180 | 200 | 200 |
| | 5.00 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 |
| | 6.00 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 160 | 160 | 200 | 200 | 220 | 220 |
| | 7.00 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 240 | 240 |
| 1.50 | 0.50 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 |
| | 1.00 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 |
| | 1.50 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 |
| | 2.00 | 80 | 80 | 80 | 80 | 100 | 100 | 120 | 120 | 120 | 120 | 160 | 160 | 180 | 180 |
| | 3.00 | 80 | 80 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 200 | 200 |
| | 4.00 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 180 | 180 | 200 | 200 |
| | 5.00 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 |
| | 6.00 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 160 | 160 | 200 | 200 | 240 | 240 |
| | 7.00 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 240 | 240 |
| 2.00 | 0.50 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 160 |
| | 1.00 | 60 | 60 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 |
| | 1.50 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 |
| | 2.00 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 120 | 120 | 160 | 160 | 180 | 180 |
| | 3.00 | 80 | 80 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 200 | 200 |
| | 4.00 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 180 | 180 | 200 | 200 |
| | 5.00 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 |
| | 6.00 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 160 | 160 | 200 | 200 | 240 | 240 |
| | 7.00 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 240 | 240 |

- These tables are provided for preliminary design purposes only and are not intended to substitute a structural analysis.
- The self-weight of the CLT elements is already taken into account in the table at ρ = 500 kg/m³.

# Preliminary design table

## Roof | single-span beam | roof pitch $\alpha$ = 30°: required element thickness

**Reference standards for determining the required cross-section**

- ÖN EN 14080
- ÖN EN 1995-1-1:2019, ÖN B 1995-1-1:2019
- ÖN EN 1995-1-2:2011, ÖN B 1995-1-2:2019

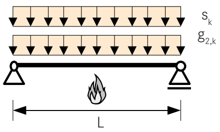
**Assumptions for the calculation**

- $\rho_{mean}$ = 500 kg/m³
- Service class 1
- Partial safety factor: $\gamma_M$ = 1.25
- Modification factor: $k_{mod}$ = 0.80 or 0.90
  (wind, snow for locations above 1,000 m above sea level)
- System factor: $k_{sys}$ = 1.00

**Material parameters**

- Material: GL24h
- Deformation factor: $k_{def}$ = 0.60 (floors)
  $k_{def}$ = 0.80 (roofs)

**Static system**




**Fire safety design**

- Exposed to fire from one side

**Fire resistance**

| R0 | R30 | R60 | R90 | R120 |
|---|---|---|---|---|

| Permanent load | Snow load | Span L [m] | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 3.00 | | 3.50 | | 4.00 | | 4.50 | | 5.00 | | 6.00 | | 7.00 | |
| $g_{2,k}$ [kN/m²] | $s_k$ [kN/m²] | snow loads (locations above 1,000 m above sea level or locations below 1,000 m above sea level) | | | | | | | | | | | | | |
| | | <1,000 m | >1,000 m | <1,000 m | >1,000 m | <1,000 m | >1,000 m | <1,000 m | >1,000 m | <1,000 m | >1,000 m | <1,000 m | >1,000 m | <1,000 m | >1,000 m |
| 1.00 | 0.50 | 80 | 80 | 100 | 100 | 100 | 120 | 120 | 120 | 140 | 140 | 180 | 180 | 220 | 220 |
| | 1.00 | 80 | 80 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 180 | 180 | 220 | 220 |
| | 1.50 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 |
| | 2.00 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 160 | 160 | 200 | 200 | 240 | 240 |
| | 3.00 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 | – | – |
| | 4.00 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 240 | 240 | – | – |
| | 5.00 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 240 | 240 | – | – |
| | 6.00 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 | – | – | – | – |
| | 7.00 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 220 | 220 | – | – | – | – |
| 1.50 | 0.50 | 80 | 80 | 100 | 100 | 120 | 120 | 120 | 140 | 140 | 140 | 180 | 180 | 220 | 220 |
| | 1.00 | 80 | 80 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 160 | 180 | 180 | 220 | 220 |
| | 1.50 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 200 | 220 | 220 |
| | 2.00 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 160 | 160 | 200 | 200 | 240 | 240 |
| | 3.00 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 | – | – |
| | 4.00 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 240 | 240 | – | – |
| | 5.00 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 240 | 240 | – | – |
| | 6.00 | 120 | 120 | 140 | 140 | 160 | 160 | 200 | 200 | 220 | 220 | – | – | – | – |
| | 7.00 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 220 | 220 | – | – | – | – |
| 2.00 | 0.50 | 80 | 80 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 |
| | 1.00 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 200 | 200 | 220 | 240 |
| | 1.50 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 200 | 200 | 240 | 240 |
| | 2.00 | 10 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 160 | 160 | 200 | 200 | 240 | 240 |
| | 3.00 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 | – | – |
| | 4.00 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 240 | 240 | – | – |
| | 5.00 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 240 | 240 | – | – |
| | 6.00 | 120 | 120 | 140 | 140 | 180 | 180 | 200 | 200 | 220 | 220 | – | – | – | – |
| | 7.00 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 220 | 220 | – | – | – | – |

- These tables are provided for preliminary design purposes only and are not intended to substitute a structural analysis.
- The self-weight of the CLT elements is already taken into account in the table at ρ = 500 kg/m³.

# Preliminary design table

## Roof | single-span beam | roof pitch α = 45°: required element thickness

### Reference standards for determining the required cross-section

- ÖN EN 14080
- ÖN EN 1995-1-1:2019, ÖN B 1995-1-1:2019
- ÖN EN 1995-1-2:2011, ÖN B 1995-1-2:2019

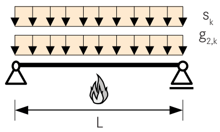
### Assumptions for the calculation

- $\rho_{mean}$ = 500 kg/m³
- Service class 1
- Partial safety factor: $\gamma_M$ = 1.25
- Modification factor: $k_{mod}$ = 0.80 or 0.90 (wind, snow for locations above 1,000 m above sea level)
- System factor: $k_{sys}$ = 1.00

### Material parameters

- Material: GL24h
- Deformation factor: $k_{def}$ = 0.60 (floors)
  $k_{def}$ = 0.80 (roofs)

### Static system




### Fire safety design

- Exposed to fire from one side

### Fire resistance

| R0 | R30 | R60 | R90 | R120 |
|---|---|---|---|---|

| Permanent load | Snow load | Span L [m] | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 3.00 | | 3.50 | | 4.00 | | 4.50 | | 5.00 | | 6.00 | | 7.00 | |
| $g_{2,k}$ [kN/m²] | $s_k$ [kN/m²] | snow loads (locations above 1,000 m above sea level or locations below 1,000 m above sea level) | | | | | | | | | | | | | |
| | | < 1,000 m | > 1,000 m | < 1,000 m | > 1,000 m | < 1,000 m | > 1,000 m | < 1,000 m | > 1,000 m | < 1,000 m | > 1,000 m | < 1,000 m | > 1,000 m | < 1,000 m | > 1,000 m |
| 1.00 | 0.50 | 80 | 80 | 100 | 100 | 100 | 120 | 120 | 120 | 140 | 140 | 180 | 180 | 220 | 220 |
| | 1.00 | 80 | 80 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 180 | 180 | 220 | 220 |
| | 1.50 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 |
| | 2.00 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 160 | 160 | 200 | 200 | 240 | 240 |
| | 3.00 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 | – | – |
| | 4.00 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 240 | 240 | – | – |
| | 5.00 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 240 | 240 | – | – |
| | 6.00 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 | – | – | – | – |
| | 7.00 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 220 | 220 | – | – | – | – |
| 1.50 | 0.50 | 80 | 80 | 100 | 100 | 120 | 120 | 120 | 140 | 140 | 140 | 180 | 180 | 220 | 220 |
| | 1.00 | 80 | 80 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 160 | 180 | 180 | 220 | 220 |
| | 1.50 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 200 | 200 | 220 | 220 |
| | 2.00 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 160 | 160 | 200 | 200 | 240 | 240 |
| | 3.00 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 | – | – |
| | 4.00 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 240 | 240 | – | – |
| | 5.00 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 240 | 240 | – | – |
| | 6.00 | 120 | 120 | 140 | 140 | 160 | 160 | 200 | 200 | 220 | 220 | – | – | – | – |
| | 7.00 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 220 | 220 | – | – | – | – |
| 2.00 | 0.50 | 80 | 80 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 |
| | 1.00 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 200 | 220 | 240 |
| | 1.50 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 200 | 200 | 240 | 240 |
| | 2.00 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 160 | 160 | 200 | 200 | 240 | 240 |
| | 3.00 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 | – | – |
| | 4.00 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 240 | 240 | – | – |
| | 5.00 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 240 | 240 | – | – |
| | 6.00 | 120 | 120 | 140 | 140 | 180 | 180 | 200 | 200 | 220 | 220 | – | – | – | – |
| | 7.00 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 220 | 220 | – | – | – | – |

- These tables are provided for preliminary design purposes only and are not intended to substitute a structural analysis.
- The self-weight of the CLT elements is already taken into account in the table at ρ = 500 kg/m³.

# Preliminary design table

## Roof | two-span beam | roof pitch $\alpha$ = 0° to 5°: required element thickness

**Reference standards for determining the required cross-section**

- ÖN EN 14080
- ÖN EN 1995-1-1:2019, ÖN B 1995-1-1:2019
- ÖN EN 1995-1-2:2011, ÖN B 1995-1-2:2019

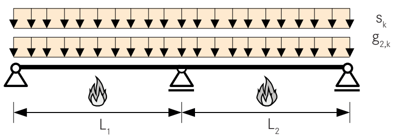
**Assumptions for the calculation**

- $\rho_{mean}$ = 500 kg/m³
- Service class 1
- Partial safety factor: $\gamma_M$ = 1.25
- Modification factor: $k_{mod}$ = 0.80 or 0.90 (wind, snow for locations above 1,000 m above sea level)
- System factor: $k_{sys}$ = 1.00

**Material parameters**

- Material: GL24h
- Deformation factor: $k_{def}$ = 0.60 (floors)
  $k_{def}$ = 0.80 (roofs)

**Static system**




**Fire safety design**

- Exposed to fire from one side

**Fire resistance**

| R0 | R30 | R60 | R90 | R120 |
|---|---|---|---|---|

| Permanent load | Snow load | Span L [m] | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 3.00 | | 3.50 | | 4.00 | | 4.50 | | 5.00 | | 6.00 | | 7.00 | |
| $g_{2,k}$ [kN/m²] | $s_k$ [kN/m²] | snow loads (locations above 1,000 m above sea level or locations below 1,000 m above sea level) | | | | | | | | | | | | | |
| | | <1,000 m | >1,000 m | <1,000 m | >1,000 m | <1,000 m | >1,000 m | <1,000 m | >1,000 m | <1,000 m | >1,000 m | <1,000 m | >1,000 m | <1,000 m | >1,000 m |
| 1.00 | 0.50 | 60 | 60 | 60 | 60 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 |
| | 1.00 | 60 | 60 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 |
| | 1.50 | 60 | 60 | 80 | 80 | 80 | 80 | 80 | 80 | 100 | 100 | 120 | 120 | 140 | 140 |
| | 2.00 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 |
| | 3.00 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 |
| | 4.00 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 120 | 120 | 160 | 160 | 180 | 180 |
| | 5.00 | 80 | 80 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 |
| | 6.00 | 80 | 80 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 180 | 180 | 200 | 200 |
| | 7.00 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 180 | 180 | 200 | 200 |
| 1.50 | 0.50 | 60 | 60 | 60 | 60 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 120 | 120 |
| | 1.00 | 60 | 60 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 |
| | 1.50 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 |
| | 2.00 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 |
| | 3.00 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 |
| | 4.00 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 120 | 120 | 160 | 160 | 180 | 180 |
| | 5.00 | 80 | 80 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 |
| | 6.00 | 80 | 80 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 180 | 180 | 200 | 200 |
| | 7.00 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 |
| 2.00 | 0.50 | 60 | 60 | 60 | 60 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 120 | 120 |
| | 1.00 | 60 | 60 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 120 | 120 | 120 | 120 |
| | 1.50 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 |
| | 2.00 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 |
| | 3.00 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 |
| | 4.00 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 120 | 120 | 160 | 160 | 180 | 180 |
| | 5.00 | 80 | 80 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 |
| | 6.00 | 80 | 80 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 180 | 180 | 200 | 200 |
| | 7.00 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 |

- These tables are provided for preliminary design purposes only and are not intended to substitute a structural analysis.
- The self-weight of the CLT elements is already taken into account in the table at $\rho$ = 500 kg/m³.

# Preliminary design table

## Roof | two-span beam | roof pitch $\alpha$ = 30°: required element thickness

### Reference standards for determining the required cross-section

- ÖN EN 14080
- ÖN EN 1995-1-1:2019, ÖN B 1995-1-1:2019
- ÖN EN 1995-1-2:2011, ÖN B 1995-1-2:2019

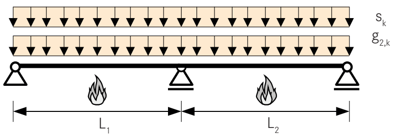
### Assumptions for the calculation

- $\rho_{mean}$ = 500 kg/m³
- Service class 1
- Partial safety factor: $\gamma_M$ = 1.25
- Modification factor: $k_{mod}$ = 0.80 or 0.90
  (wind, snow for locations above 1,000 m above sea level)
- System factor: $k_{sys}$ = 1.00

### Material parameters

- Material: GL24h
- Deformation factor: $k_{def}$ = 0.60 (floors)
  $k_{def}$ = 0.80 (roofs)

### Static system




### Fire safety design

- Exposed to fire from one side

### Fire resistance

| R0 | R30 | R60 | R90 | R120 |
|---|---|---|---|---|

| Permanent load | Snow load | Span L [m] | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 3.00 | | 3.50 | | 4.00 | | 4.50 | | 5.00 | | 6.00 | | 7.00 | |
| $g_{2,k}$ [kN/m²] | $s_k$ [kN/m²] | snow loads (locations above 1,000 m above sea level or locations below 1,000 m above sea level) | | | | | | | | | | | | | |
| | | < 1,000 m | > 1,000 m | < 1,000 m | > 1,000 m | < 1,000 m | > 1,000 m | < 1,000 m | > 1,000 m | < 1,000 m | > 1,000 m | < 1,000 m | > 1,000 m | < 1,000 m | > 1,000 m |
| 1.00 | 0.50 | 60 | 60 | 60 | 60 | 80 | 80 | 80 | 80 | 80 | 80 | 100 | 100 | 120 | 120 |
| | 1.00 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 |
| | 1.50 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 140 | 140 | 160 | 160 |
| | 2.00 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 |
| | 3.00 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 |
| | 4.00 | 80 | 80 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 200 | 200 |
| | 5.00 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 180 | 180 | 200 | 200 |
| | 6.00 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 |
| | 7.00 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 160 | 160 | 200 | 200 | 220 | 220 |
| 1.50 | 0.50 | 60 | 60 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 |
| | 1.00 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 |
| | 1.50 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 |
| | 2.00 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 |
| | 3.00 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 |
| | 4.00 | 80 | 80 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 200 | 200 |
| | 5.00 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 180 | 180 | 200 | 200 |
| | 6.00 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 |
| | 7.00 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 160 | 160 | 200 | 200 | 220 | 220 |
| 2.00 | 0.50 | 60 | 60 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 120 | 120 | 120 | 140 |
| | 1.00 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 |
| | 1.50 | 60 | 60 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 |
| | 2.00 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 |
| | 3.00 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 |
| | 4.00 | 80 | 80 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 200 | 200 |
| | 5.00 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 |
| | 6.00 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 |
| | 7.00 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 160 | 160 | 200 | 200 | 220 | 220 |

- These tables are provided for preliminary design purposes only and are not intended to substitute a structural analysis.
- The self-weight of the CLT elements is already taken into account in the table at $\rho$ = 500 kg/m³.

# Preliminary design table

## Roof | two-span beam | roof pitch $\alpha$ = 45°: required element thickness

### Reference standards for determining the required cross-section

- ÖN EN 14080
- ÖN EN 1995-1-1:2019, ÖN B 1995-1-1:2019
- ÖN EN 1995-1-2:2011, ÖN B 1995-1-2:2019

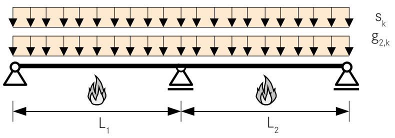
### Assumptions for the calculation

- $\rho_{mean}$ = 500 kg/m³
- Service class 1
- Partial safety factor: $\gamma_M$ = 1.25
- Modification factor: $k_{mod}$ = 0.80 or 0.90
  (wind, snow for locations above 1,000 m above sea level)
- System factor: $k_{sys}$ = 1.00

### Material parameters

- Material: GL24h
- Deformation factor: $k_{def}$ = 0.60 (floors)
  $k_{def}$ = 0.80 (roofs)

### Static system




### Fire safety design

- Exposed to fire from one side

### Fire resistance

| R0 | R30 | R60 | R90 | R120 |
|---|---|---|---|---|

| Permanent load | Snow load | Span L [m] | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 3.00 | | 3.50 | | 4.00 | | 4.50 | | 5.00 | | 6.00 | | 7.00 | |
| $g_{2,k}$ [kN/m²] | $s_k$ [kN/m²] | snow loads (locations above 1,000 m above sea level or locations below 1,000 m above sea level) | | | | | | | | | | | | | |
| | | < 1,000 m | > 1,000 m | < 1,000 m | > 1,000 m | < 1,000 m | > 1,000 m | < 1,000 m | > 1,000 m | < 1,000 m | > 1,000 m | < 1,000 m | > 1,000 m | < 1,000 m | > 1,000 m |
| 1.00 | 0.50 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 160 |
| | 1.00 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 |
| | 1.50 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 120 | 120 | 160 | 160 | 180 | 180 |
| | 2.00 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 200 | 200 |
| | 3.00 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 |
| | 4.00 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 160 | 160 | 200 | 200 | 220 | 220 |
| | 5.00 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 240 | 240 |
| | 6.00 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 | – | – |
| | 7.00 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 180 | 180 | 220 | 220 | – | – |
| 1.50 | 0.50 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 140 | 160 | 160 |
| | 1.00 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 |
| | 1.50 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 120 | 120 | 160 | 160 | 180 | 180 |
| | 2.00 | 80 | 80 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 200 | 200 |
| | 3.00 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 |
| | 4.00 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 160 | 160 | 200 | 200 | 220 | 220 |
| | 5.00 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 240 | 240 |
| | 6.00 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 | – | – |
| | 7.00 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 180 | 180 | 220 | 220 | – | – |
| 2.00 | 0.50 | 60 | 60 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 120 | 140 | 140 | 160 | 160 |
| | 1.00 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 180 | 180 |
| | 1.50 | 80 | 80 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 |
| | 2.00 | 80 | 80 | 100 | 100 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 200 | 200 |
| | 3.00 | 100 | 100 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 |
| | 4.00 | 100 | 100 | 120 | 120 | 140 | 140 | 140 | 140 | 160 | 160 | 200 | 200 | 220 | 220 |
| | 5.00 | 100 | 100 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 200 | 200 | 240 | 240 |
| | 6.00 | 120 | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 220 | 220 | – | – |
| | 7.00 | 120 | 120 | 140 | 140 | 160 | 160 | 180 | 180 | 180 | 180 | 220 | 220 | – | – |

- These tables are provided for preliminary design purposes only and are not intended to substitute a structural analysis.
- The self-weight of the CLT elements is already taken into account in the table at $\rho$ = 500 kg/m³.

# Preliminary design example

## General information

Based on the example of a three-storey building, the verifications that are required for individual components are explained below. For greater clarity, we have simplified the verifications as well as the method for determining the internal forces, therefore the example should by no means be considered exhaustive. The calculations are carried out based on a "typical storey" in accordance with EN 1995-1-1 and on the regulations specified in the National Annex applicable in Austria.

The boundary conditions and exceptions that have been taken into account are explained below.

**MM HBE** solid wood construction elements were treated as cross-laminated timber (glulam) boards in strength class GL24h according to EN 14080. The partial safety factor for glulam is $\gamma_M$ = 1.25.

It was assumed that all the components used belong to service class 1 in accordance with ÖN EN 1995-1-1. A "medium term" load-duration class was used for the verification of the floor elements, whereas "short-term/very short-term" (wind) was used for the verification of the wall elements. Accordingly, the modification factor $k_{mod}$ is $k_{mod}$ = 0.80 for the floor elements and $k_{mod}$ = 1.05 for the wall elements.

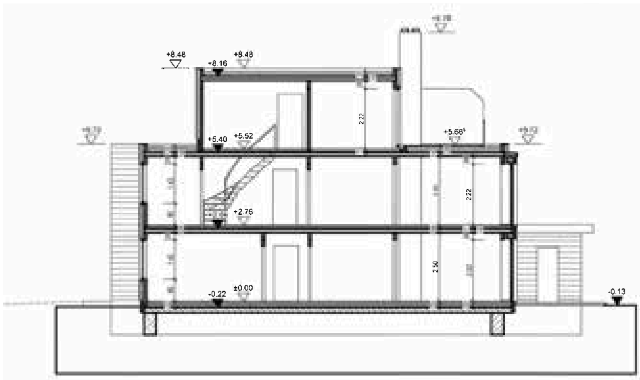
The partial safety factor on the side subject to actions is $\gamma_G$ = 1.35 | 0.90 (unfavourable | favourable) for constant actions, and $\gamma_G$ = 1.50 | 0 for variable actions.

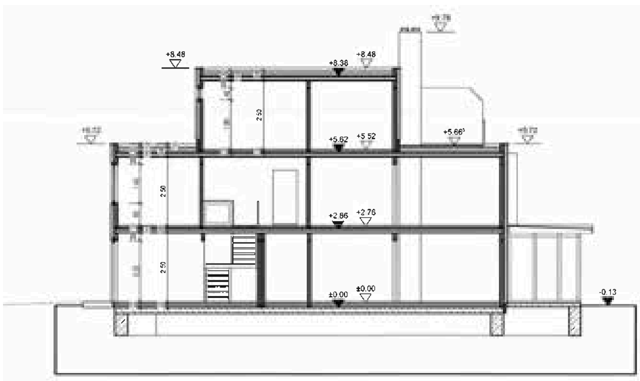
The building is braced using gypsum fibreboard panels (in accordance with approval ETA-03/0050) generally attached on one side, placed end-to-end, and offset in relation to the **MM HBE** solid wood elements by half an element. The panel is attached to the solid wood elements with cleats.

Wherever different values are used, this is pointed out explicitly.

## Example

In this three-storey building, which has a total living area of 400 m² and is shared by four families, the external and internal walls as well as the floor and roof are made of **MM HBE** elements.

## Actions

The actions on the structures are determined according to the rules in the EN 1991 series of standards.

### Constant actions

**External wall with thermal insulation system**

| Layer no. | Name | Thickness [mm] | Unit weight (specific weight) [kN/m³] | Surface weight [kN/m²] |
|---|---|---|---|---|
| 1 | plaster system | 7 | 20.00 | 0.140 |
| 2 | mineral wool insulation | 120 | 0.70 | 0.084 |
| 3 | MM HBE solid wood construction element | 100 | 5.00 | 0.500 |
| 4 | plasterboard | 15 | 10.00 | 0.150 |
| **Total** | | **242** | | **0.870 ≈ 0.90** |

**Internal wall**

| Layer no. | Name | Thickness [mm] | Unit weight (specific weight) [kN/m³] | Surface weight [kN/m²] |
|---|---|---|---|---|
| 1 | plasterboard | 15 | 10.00 | 0.150 |
| 2 | MM HBE solid wood construction element | 100 | 5.00 | 0.500 |
| 3 | plasterboard | 15 | 10.00 | 0.150 |
| **Total** | | **130** | | **0.800** |

**Floor with wet screed**

| Layer no. | Name | Thickness [mm] | Unit weight (specific weight) [kN/m³] | Surface weight [kN/m²] |
|---|---|---|---|---|
| 1 | flooring (parquet) | 15 | 8.00 | 0.120 |
| 2 | separation layer | 1 | 14.00 | 0.014 |
| 3 | cement screed | 60 | 22.00 | 1.320 |
| 4 | separation layer (plastic film) | 1 | 14.00 | 0.014 |
| 5 | impact sound insulation (35/30 mm) | 30 | 0.70 | 0.021 |
| 6 | backfill (loose) | 60 | 17.00 | 1.020 |
| 7 | membrane (protection against trickling and moisture) | 1 | 14.00 | 0.014 |
| 8 | MM HBE solid wood construction element | 140 | 5.00 | 0.700 |
| 9 | plasterboard | 15 | 10.00 | 0.150 |
| **Total** | | **323** | | **3.370 ≈ 3.40** |

**Roof with sealing sheet**

| Layer no. | Name | Thickness [mm] | Unit weight (specific weight) [kN/m³] | Surface weight [kN/m²] |
|---|---|---|---|---|
| 1 | sealing sheet (EPDM) | 2 | 14.00 | 0.028 |
| 2 | insulation panels | 200 | 0.35 | 0.070 |
| 3 | sealing sheet | 5 | 14.00 | 0.070 |
| 4 | MM HBE solid wood construction element | 140 | 5.00 | 0.700 |
| 5 | plasterboard | 15 | 10.00 | 0.150 |
| **Total** | | **362** | | **1.018 ≈ 1.00** |

### Variable actions

Snow according to EN 1991-1-3.

Assumptions:

characteristic value $s_k$: $s'_k = 2.50$ kN/m²

shape factor $\mu$: $\mu = 0.80$

snow on the ground: $s_k = \mu \cdot s'_k = 0.80 \cdot 2.50$ = **2.00 kN/m²**

### Wind pressure

Wind according to EN 1991-1-4.

Assumptions:

| | |
|---|---|
| basic wind velocity | $v_{b,0} = 27.00$ m/s (highest basic wind speed in Austria) |
| basic velocity pressure | $q_{b,0} = 0.456$ kN/m² |
| terrain category: | III |
| minimum height $z_{min}$: | 10.00 m |
| Height of the roof parapet upper edge: | 11.00 m |

peak velocity pressure

$$q_p = q_{b,0}\ 1{,}75 \cdot \left(\frac{z}{10}\right)^{0{,}29} = 0{,}45 \left(\frac{11{,}0}{10}\right)^{0{,}29} = 0{,}463 \text{ kn/m}^2$$

### Wind pressure coefficients (outside)

- Transverse wind flow (in the y direction)

b = 15.94 m
d = 13.32 m
h = 10.50 m

h ÷ d = 10.50 ÷ 13.32 = 0.79
Zone A: $c_{pe,10} = -1.20$
Zone B: $c_{pe,10} = -0.80$
Zone C: $c_{pe,10} = -0.50$
Zone D: $c_{pe,10} = +0.71$
Zone E: $c_{pe,10} = -0.32$

- Longitudinal wind flow (in the x direction)

b = 13.32 m
d = 15.94 m
h = 10.50 m

h ÷ d = 10.50 ÷ 15.94 = 0.66
Zone A: $c_{pe,10} = -1.20$
Zone B: $c_{pe,10} = -0.80$
Zone C: $c_{pe,10} = -0.50$
Zone D: $c_{pe,10} = +0.76$
Zone E: $c_{pe,10} = -0.41$

### Wind pressure coefficients (inside)

Simplified (least favourable value): $c_{pi} = +0.20/-0.30$.

### Resulting wind pressure

Rather than dividing the surface area of the walls arranged parallel to the wind into zones as stipulated by standard ÖN EN 1991-1-4, the value applied to zone B is considered to be the decisive value. It is also assumed that the wind actions are transferred via the bracing system of the typical storey as shown below. The top storey has been simplified by considering it to be a typical storey.

The wind pressure for the respective zones is determined from the following equations:

$w = q_p \cdot (c_{pe} - w_{pi})$

- For a transverse wind flow (in the y direction)

Zone D: $w_{D,k} = 0.462 \cdot (+0.71\ +0.20) = +0.420$ kN/m² ≈ +0.45 kN/m²
Zone B: $w_{B,k} = 0.462 \cdot (-0.80\ -0.30) = -0.508$ kN/m² ≈ −0.50 kN/m²
Zone E: $w_{E,k} = 0.462 \cdot (-0.32\ -0.30) = -0.286$ kN/m² ≈ −0.30 kN/m²

- For a transverse wind flow (in the x direction)

Zone D: $w_{D,k} = 0.462 \cdot (+0.76\ +0.20) = +0.444$ kN/m² ≈ +0.45 kN/m²
Zone B: $w_{B,k} = 0.462 \cdot (-0.80\ -0.30) = -0.508$ kN/m² ≈ −0.50 kN/m²
Zone E: $w_{E,k} = 0.462 \cdot (-0.41\ -0.30) = -0.328$ kN/m² ≈ −0.35 kN/m²

### Resulting wind forces

- To simplify the calculation, the wind pressure is taken into account below with $w_k = \pm 0.50$ kN/m².

The design values of the resulting wind pressures are determined as follows:

- In the x direction:
  $w_d = \gamma_Q \cdot w_k \cdot h_1 \cdot b = 1.50 \cdot \pm 0.50 \cdot (2.50 \cdot 3.15 + 1.00) \cdot (13.32 + 1.03) = 95.50$ kN
- In the y direction:
  $w_d = \gamma_Q \cdot w_D \cdot h_1 \cdot b = 1.50 \cdot \pm 0.50 \cdot (2.50 \cdot 3.15 + 1.00) \cdot (15.94 \div 2) = 53.10$ kN

- Imposed load according to EN 1991-1-1

Assumptions:

| | |
|---|---|
| habitable surfaces in category A1: | $q_k = 2.00$ kN/m² |
| addition of a partition wall: | $q_{ZW,k} = 1.00$ kN/m² |
| total of the imposed load: | $q_k = 3.00$ kN/m² |

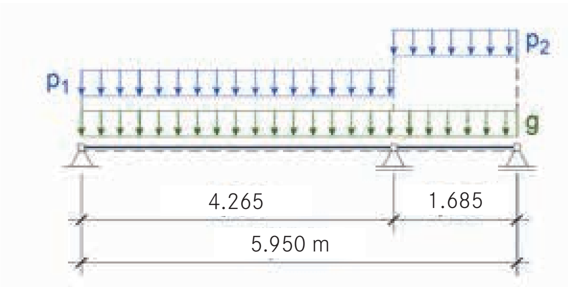
## Internal forces

The internal forces are determined for a floor or wall section of 1 metre in width (b = 1 m). The pre-exponential factors for the verification of the two-span floor strip were based on those specified in a building tables book (Bautabellenbuch).

**Floor**

$l_1$ = 4.265 m; $l_2$ = 1.685 m

(α = 4.265 ÷ 1.685 = 2.53)




$B_{\text{“1.00”}}$ = “1.00” · (|−1.109| + 1.506) · 1.685 = 4.406 kN/m

$M_{B\text{“1.00”}}$ = “1.00” · (− 0.609) · 1.6852 = −1.73 kNm/m

**Design internal forces**

**min $M_d$** = (−1.73) · [1.35 · 3.40 + 1.50 · 3.00] **≈ −15.70 kN/m**

(max $M_d$ ist not decisive!)

$V_{B,re;\text{“1.00”}}$ = (1.35 · 1.506 · 3.40 + 1.50 · 1.491 · 3.00) · 1.685 = 23.00 kN/m

**Wall**

Note: the verification for the **MM HBE** load-bearing solid wood wall is carried out in the lowest storey with wooden components.

**Design internal forces**

**max $B_d$** = 1.35 · (4.406 · (1.00 + 2 · 3.40) + 3 · 3.00 · 0.80) + 1.50 · 4.406 · (2.00 + 2 · 3.00) = **109 kN/m**

**min $B_d$** = 0.90 · (4.406 · (1.00 + 2 · 3.40) + 3 · 3.00 · 0.80) **= 37.40 kN/m**

## Verifications

Verifications for the roof.

- **In the load-bearing capacity limit state**

**Bending verification:**

$$\sigma_{m,d} = \frac{M_d}{W} = \frac{15.7 \cdot 10^6}{\left(\frac{1{,}000 \cdot 140^2}{6}\right)} = 4.81 \text{ N/mm}^2$$

$$f_{m,d} = \frac{f_{c,0,k}}{\gamma_M} = k_{mod}\,\frac{24.0}{1.25} = 0.80 = 15.4 \text{ N/mm}^2$$

Verification:

$$\frac{\sigma_{m,d}}{f_{m,d}} = \frac{4.81}{15.4} = 0.31 = 1.0$$

**Shear verification:**

$$\tau_d = 1{,}5\,\frac{V_d}{A} = 1{,}5\,\frac{23.0 \cdot 10^3}{1{,}000 \cdot 140} = 0.246 \text{ N/mm}^2$$

$$f_{v,d} = \frac{f_{v,k}}{\gamma_M} \cdot k_{mod} = \frac{2.50}{1.25} \cdot 0.80 = 1.60 \text{ N/mm}^2$$

Verification:

$$\frac{\sigma_{v,d}}{f_{v,d}} = \frac{0.246}{1.60} = 0.15 < 1.0$$

- **In the serviceability limit state**

**Deflection**

Deflection in floor panel 2 (in the centre of the panel).

$$w_g = \frac{5}{384} \cdot \frac{3.40 \cdot 4{,}265^4}{11{,}600 \cdot \left(\frac{1{,}000 \cdot 140^3}{12}\right)} = 5.52 \text{ mm}$$

(preliminary design as a single-span beam)

$$w_p = \frac{5}{384} \cdot \frac{3.00 \cdot 4{,}265^4}{11{,}600 \cdot \left(\frac{1{,}000 \cdot 140^3}{12}\right)} = 4.87 \text{ mm}$$

Verification of characteristic (infrequent) load combination.

$$w = w_g + w_p = 5.52 + 4.87 = 10.4 \text{ mm} < \frac{l}{300} = \frac{4{,}265}{300} = 14.2 \text{ mm}$$

Verification of the quasi-permanent load combination.

$$w = \left(w_g + \psi_2 \cdot w_p\right) \cdot (1 + k_{def}) - w_c =$$

$$= (5.52 + 0.3 \cdot 4.87) \cdot (1 + 0.6) - 0 = 11.2 \text{ mm} < \frac{l}{250}$$

## Verification for the wall

Buckling verification.

| | |
|---|---|
| buckling length $L_k$: | $l_k = 3.00$ m |
| geometrical slenderness: | $\lambda = l_k \div i = 3{,}000 \div (0.289 \cdot 100) = 104$ |
| buckling coefficient $k_c$: | for GL24h: $k_c = 0.340$ |


$$\sigma_{c,0,d} = \frac{N_d}{b \cdot h} = \frac{109 \cdot 10^3}{1{,}000 \cdot 100} = 1.09 \text{ N/mm}^2$$

$$f_{c,0,d} = \frac{f_{c,0,k}}{\gamma_M} k_{mod} = \frac{21.0}{1.25} 0.80 = 13.4 \text{ N/mm}^2$$

Verification:

$$\frac{\sigma_{c,0,d}}{k_c \cdot f_{c,0,d}} = \frac{1.09}{0.340 \cdot 13.4} = 0.24 < 1.0$$

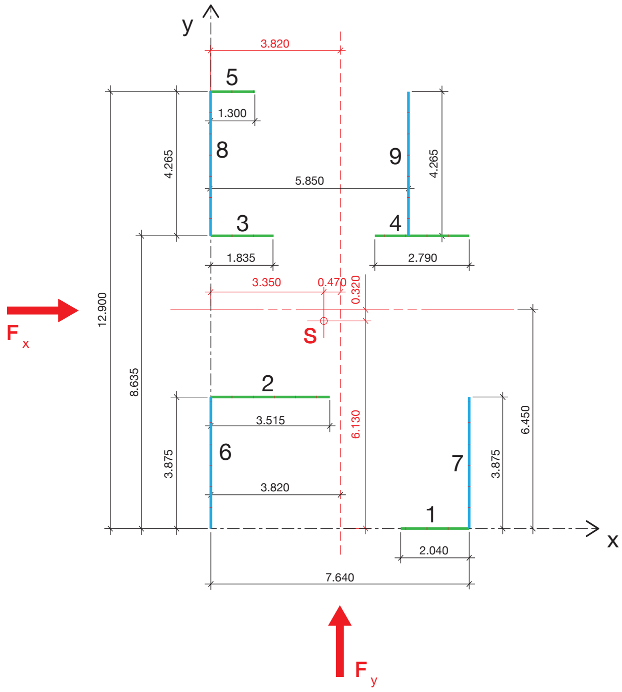
**Verification of the load-bearing capacity of braced walls for MM HBE solid wood elements – determination of the bracing capacity of each wall.**

## Coordinates of centres of mass

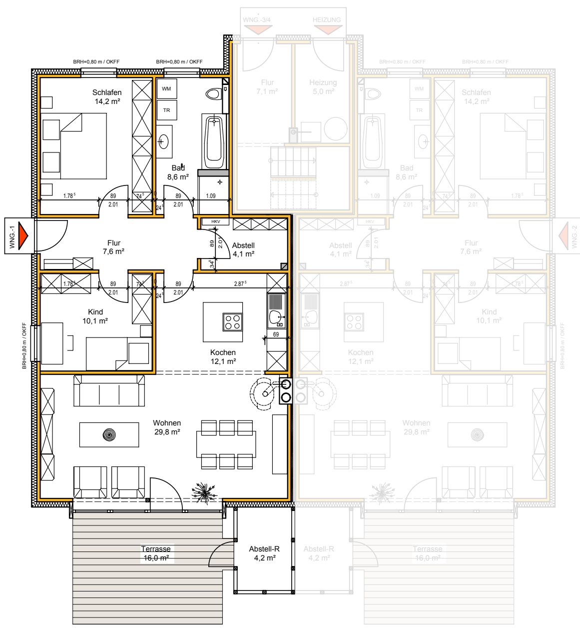
| Wall no. | x | y | $l_x$ | $l_y$ | $x \cdot l_x$ | $y \cdot l_y$ |
|---|---|---|---|---|---|---|
| | [m] | [m] | [m] | [m] | [m] | [m] |
| 1 | – | 0 | – | 2.040 | – | 0 |
| 2 | – | 3.875 | – | 3.515 | – | 13.62 |
| 3 | – | 8.635 | – | 1.835 | – | 15.85 |
| 4 | – | 8.635 | – | 2.790 | – | 24.09 |
| 5 | – | 12.90 | – | 1.300 | – | 16.77 |
| 6 | 0 | – | 3.875 | – | 0 | – |
| 7 | 7.64 | – | 3.875 | – | 29.61 | – |
| 8 | 0 | – | 4.265 | – | 0 | – |
| 9 | 5.85 | – | 4.265 | – | 24.95 | – |
| **Total** | | | 11.480 | 16.280 | 54.560 | 70.33 |

$$x_M = \frac{\sum_{i=1}^{n} x \cdot l_x}{\sum_{i=1}^{n} l_x} = \frac{54.560}{16.280} = 3.35 \text{ m}$$

$$y_M = \frac{\sum_{i=1}^{n} y \cdot l_y}{\sum_{i=1}^{n} l_y} = \frac{70.330}{11.480} = 6.13 \text{ m}$$




Bracing system with position and length of the braced walls.



## Determining the shear forces per wall and verification according to EN 1995-1-1

| Determining the shear forces per wall | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wall no. | $F_{x,N,i}$ | $F_{y,N,i}$ | $I_x \cdot (x - x_M)^2$ | $I_y \cdot (y - y_M)^2$ | $F_{x,m,i}$ | $F_{y,m,i}$ | $F_{x,i}$ | $F_{y,i}$ |
| | [kN] | [kN] | [m³] | [m³] | [kN] | [kN] | [kN] | [kN] |
| 1 | 17.00 | – | – | 76.60 | – | -1.86 | – | 15.10 |
| 2 | 29.20 | – | – | 17.80 | – | -1.18 | – | 28.10 |
| 3 | 15.30 | – | – | 11.60 | – | 0.686 | – | 16.00 |
| 4 | 23.20 | – | – | 17.60 | – | 1.04 | – | 24.30 |
| 5 | 10.80 | – | – | 59.70 | – | 1.31 | – | 12.10 |
| 6 | – | 12.60 | 43.50 | – | -1.94 | – | 10.70 | – |
| 7 | – | 12.60 | 71.30 | – | 2.48 | – | 15.10 | – |
| 8 | – | 13.90 | 47.90 | – | -2.13 | – | 11.80 | – |
| 9 | – | 13.90 | 26.60 | – | 1.59 | – | 15.50 | – |
| **Total** | 95.50 | 53.00 | 189 | 183 | | | | |

### Verification according to EN 1995-1-1

The verification of the load-bearing capacity limit state is carried out for the horizontal wind action only.

The verification of braced wall section 3 (wall length: $l_x$ = 1.835 m) is provided here as an example:

- The horizontal wind actions are transferred by a gypsum fibreboard panel attached to one side (t = 15 mm).
  The design value of the shear stress in the panel is:

  $$f_{v,d} = k_{mod} \cdot \frac{f_{v,k}}{\gamma_M} = 0.95 \cdot \frac{3.50}{1.30} = 2.56 \text{ N/mn}$$

  (exceptions: service class 1; load-duration class [KLED]: wind "short-term/very short-term"; $k_{mod}$ = 0.95; partial safety factor: $\gamma_M$ = 1.30)
- Design value of the horizontal action: $F_{V,3,Ed}$ = 16.00 kN
- Shear stress in the panel:

  $$f_{v,0,d} = \frac{F_{v,i,E,d}}{l_i \cdot t} = \frac{16.0 \cdot 10^3}{1{,}835 \cdot 15} = 0.581 \text{ N/mm}^2$$

Verification:

$$\frac{\tau_{v,0,d}}{f_{v,0,d}} = \frac{0.581}{2.56} = 0.23 < 1.0$$

### Verification of the fastener

Fastener used: cleats (Ø 2 mm; l = 60 mm)

- Embedding strength:

$$f_{h,k} = 7 \cdot d^{-0.7} \cdot t^{0.9} = 7 \cdot 2.0^{-0.7} \cdot 15^{0.9} = 49.3 \text{ N/mm}^2$$

- Yield moment:

$$M_{y,k} = 0.3 \cdot f_{u,k} \cdot d^{2.6} = 0.3 \cdot 850 \cdot 2.0^{2.6} = 1{,}546 \text{ Nmm}$$

- Load-bearing capacity (bearing strength) of the fasteners:

$$F_{v,Rk} = 0.7 \cdot \sqrt{2 \cdot M_{yk} \cdot f_{h,k} \cdot d} = 2 \cdot 0.7 \cdot \sqrt{2 \cdot 1.546 \cdot 49.3 \cdot 2.0} = 773 \text{ N}$$

$$R_{d,Na} = k_{mod} \cdot \frac{F_{v,Rk}}{\gamma_M} \cdot \eta = 1.00 \cdot \frac{773}{1.10} = 703 \text{ N}$$

$$s = \frac{R_{d,na}}{F_{v,I,d}} \cdot l = \frac{703}{16.0 \cdot 10^3} \cdot 1{,}835 = 80.6 \text{ mm} \approx 75 \text{ mm}$$

### Verification of wall 3

$F_{v,3,d}$ = 16.00 kN | $N_d$ = 37.40 kN

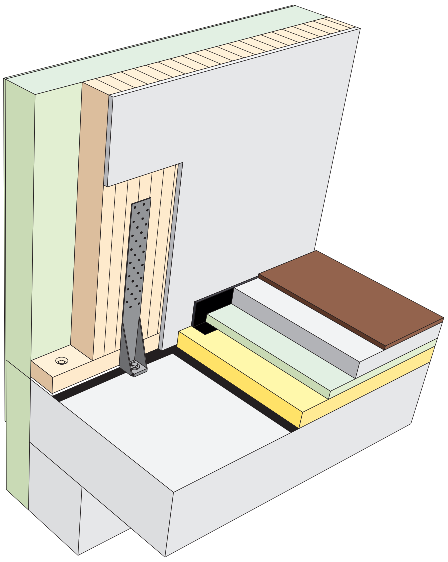
$$A_{v,d} = \frac{1}{1.835} \cdot \left(16.0 \cdot 3.0 - 37.4 \cdot \frac{1.835}{2}\right) = 7.46 \text{ kN}$$

- Lifting of wall – traction anchor required.

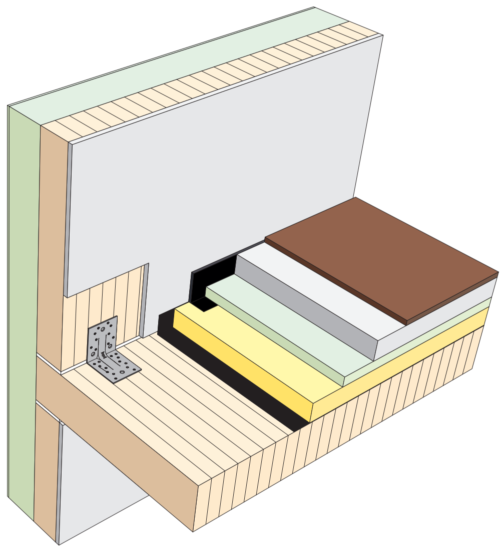
# Diagrams of connection details

The four illustrations below provide examples of how **MM HBE** wall, floor and roof elements can be connected.

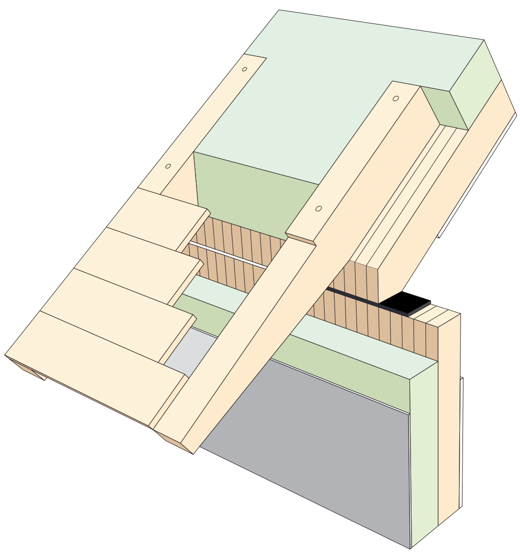
## Base element



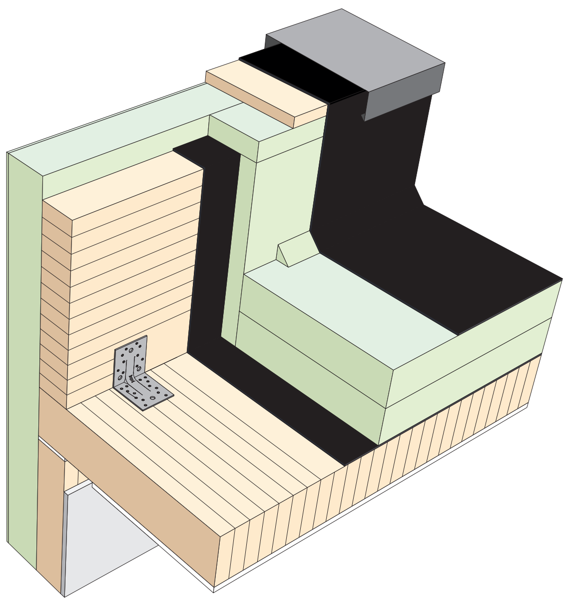
## Floor connection



## Roof connection



## Parapet connection



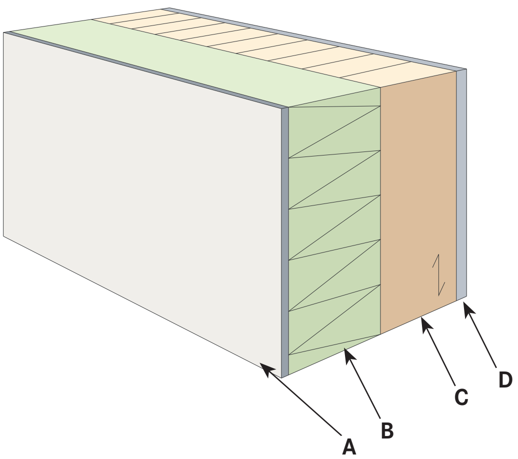
# Building physics

The structural components listed below are simply provided as suggestions. The building physics parameters specified are provided for information only and may vary depending on the construction product used.

## External wall with thermal insulation system

| Element structure | |
|---|---|
| **A** plaster system | 7 mm |
| **B** mineral wool | 120 mm |
| **C** **MM HBE** solid wood construction element (in accordance with structural analysis) | 100 mm |
| **D** plasterboard | 15 mm |
| **Total thickness of the element** | **242 mm** |

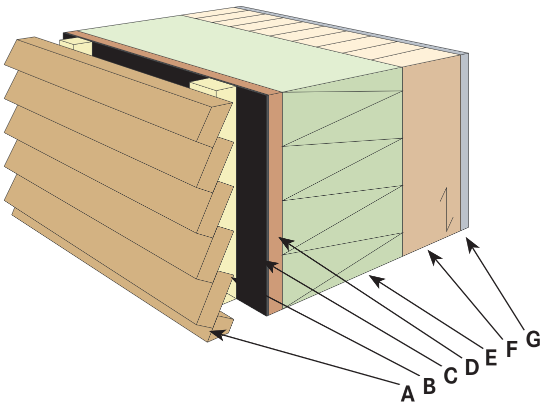
| Structural characteristics | |
|---|---|
| **Thermal insulation**<br>U value | **0.25 W/(m²K)** |
| **Permeability** | adequate |
| **Sound insulation**<br>$R_w(C; C_{tr})$ | 39 (−1; −6) dB |
| **Fire protection**<br>REI from inside<br>REI from outside | 90 min<br>60 min |




## External wall with ventilated wood façade

| Element structure | |
|---|---|
| **A** external wall cladding | 20 mm |
| **B** battens (30/50 mm) | 30 mm |
| **C** vapour-permeable membrane | – |
| **D** plasterboard | 15 mm |
| **E** wood fibre insulation boards | 200 mm |
| **F** **MM HBE** solid wood construction element (in accordance with structural analysis) | 100 mm |
| **G** plasterboard | 15 mm |
| **Total thickness of the element** | **380 mm** |

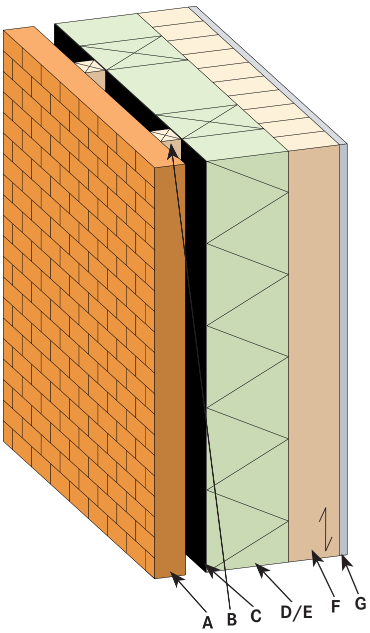
| Structural characteristics | |
|---|---|
| **Thermal insulation**<br>U value | **0.17 W/(m²K)** |
| **Permeability** | adequate |
| **Sound insulation**<br>$R_w(C; C_{tr})$ | 43 dB |
| **Fire protection**<br>REI from inside<br>REI from outside | 60 min<br>30 min |



## Red brick façade

| Element structure | |
|---|---|
| **A** red bricks | 60 mm |
| **B** ventilation gap | 40 mm |
| **C** vapour-permeable membrane | – |
| **D** structural timber | 160 mm |
| **E** mineral wool | 160 mm |
| **F** **MM HBE** solid wood construction element (in accordance with structural analysis) | 100 mm |
| **G** fire protection plasterboard | 15 mm |
| **Total thickness of the element** | **535 mm** |

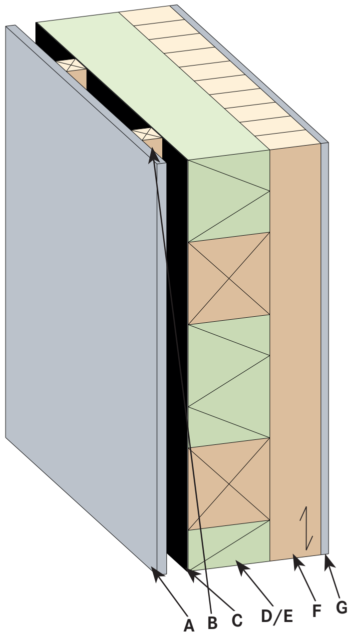
| Structural characteristics | |
|---|---|
| **Thermal insulation** U value | **0.21 W/(m²K)** |
| **Permeability** | adequate |
| **Sound insulation** $R_w(C; C_{tr})$ | 45 dB |
| **Fire protection** REI | 60 min |




## Timber material façade

| Element structure | |
|---|---|
| **A** external wall cladding | 19 mm |
| **B** battens (40/60 mm) | 40 mm |
| **C** vapour-permeable membrane | – |
| **D** structural timber | 160 mm |
| **E** mineral wool | 160 mm |
| **F** **MM HBE** solid wood construction element (in accordance with structural analysis) | 100 mm |
| **G** fire protection plasterboard | 15 mm |
| **Total thickness of the element** | **494 mm** |

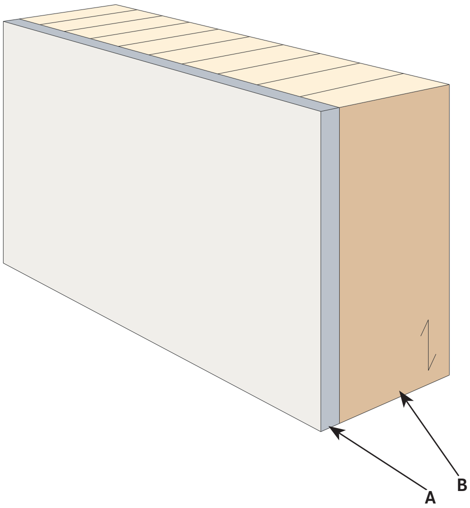
| Structural characteristics | |
|---|---|
| **Thermal insulation** U value | **0.21 W/(m²K)** |
| **Permeability** | adequate |
| **Sound insulation** $R_w(C; C_{tr})$ | 45 dB |
| **Fire protection** REI | 60 min |



## Internal wall in visual quality

| Element structure | |
|---|---|
| **A** plasterboard | 15 mm |
| **B** **MM HBE** solid wood construction element (in accordance with structural analysis) | 100 mm |
| **Total thickness of the element** | **115 mm** |

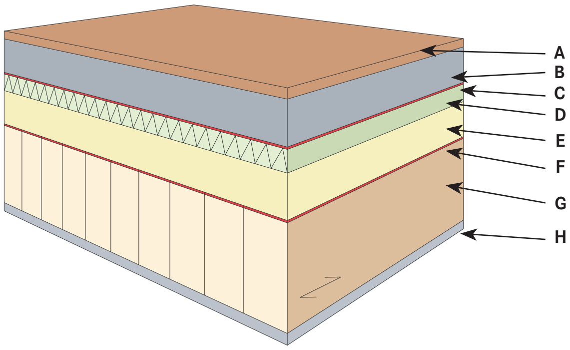
| Structural characteristics | |
|---|---|
| **Thermal insulation** U value | **not specified** |
| **Permeability** | adequate |
| **Sound insulation** $R_w(C; C_{tr})$ | not specified |
| **Fire protection** REI | 30 min |




## Floor with wet screed

| Element structure | |
|---|---|
| **A** flooring | 15 mm |
| **B** cement screed | 60 mm |
| **C** plastic separation layer | – |
| **D** impact sound insulation (35/30 mm) | 30 mm |
| **E** backfill (bound) | 60 mm |
| **F** plastic membrane | – |
| **G** **MM HBE** solid wood construction element (in accordance with structural analysis) | 140 mm |
| **H** plasterboard | 15 mm |
| **Total thickness of the element** | **320 mm** |

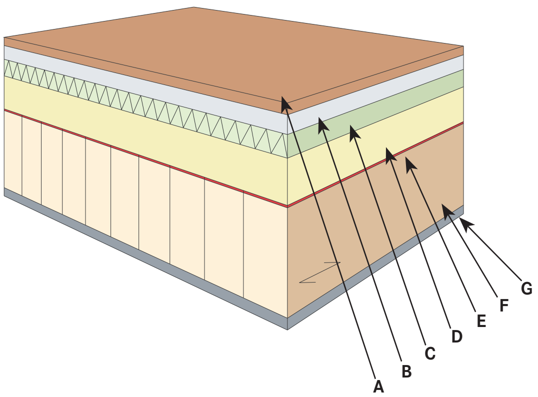
| Structural characteristics | |
|---|---|
| **Thermal insulation** U value | **0.43 W/(m²K)** |
| **Permeability** | adequate |
| **Sound insulation** $R_w(C; C_{tr})$ $L_{n,w}$ $(C_I)$ | 62 dB 52 dB |
| **Fire protection** REI | 60 min |



## Floor with dry screed

| Element structure | |
|---|---|
| **A** flooring | 15 mm |
| **B** dry screed | 25 mm |
| **C** impact sound insulation (35/30 mm) | 30 mm |
| **D** fill (elastically bound) | 60 mm |
| **E** plastic membrane | – |
| **F** **MM HBE** solid wood construction element (in accordance with structural analysis) | 140 mm |
| **G** plasterboard | 15 mm |
| **Total thickness of the element** | **285 mm** |

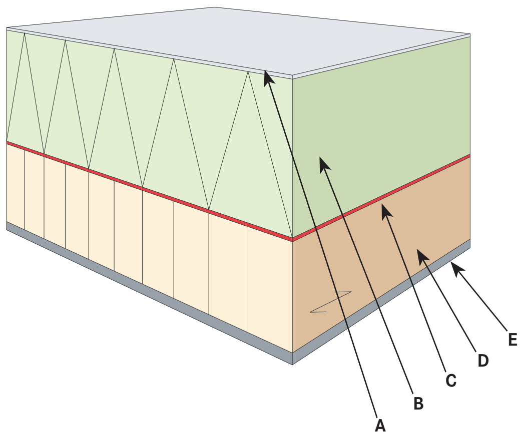
| Structural characteristics | |
|---|---|
| **Thermal insulation**<br>U value | **not specified** |
| **Permeability** | adequate |
| **Sound insulation**<br>$R_w(C; C_{tr})$<br>$L_{n,w}$ $(C_I)$ | 62 (−5; −13) dB<br>50 (−1) dB |
| **Fire protection**<br>REI | 60 min |




## Flat roof with sealing membrane

| Element structure | |
|---|---|
| **A** sealing sheet (for roof) | 7 mm |
| **B** wood fibre insulation board | 120 mm |
| **C** sealing sheet | – |
| **D** **MM HBE** solid wood construction element (in accordance with structural analysis) | 100 mm |
| **E** plasterboard | 15 mm |
| **Total thickness of the element** | **242 mm** |

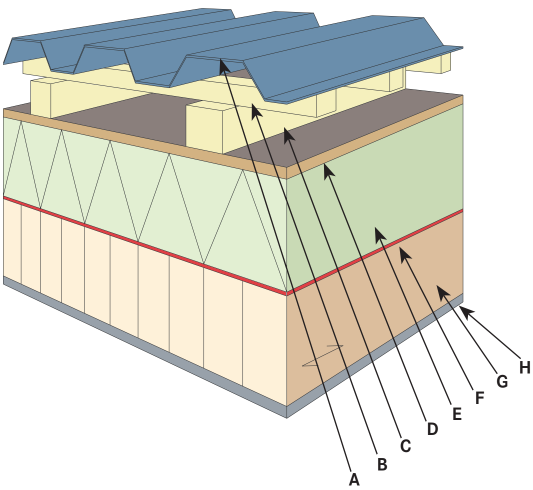
| Structural characteristics | |
|---|---|
| **Thermal insulation**<br>U value | **0.21 W/(m²K)** |
| **Permeability** | adequate |
| **Sound insulation**<br>$R_w(C; C_{tr})$ | 43 (−2; −7) dB |
| **Fire protection**<br>REI | 30 min |



## Flat, tin roof

| Element structure | |
|---|---|
| **A** profiled sheeting | – |
| **B** roof battens (50/30 mm) | 30 mm |
| **C** counter battens (80/50 mm) | 50 mm |
| **D** roof underlay | – |
| **E** above-rafter insulation | 180 mm |
| **F** sealing sheet | – |
| **G** **MM HBE** solid wood construction element (in accordance with structural analysis) | 100 mm |
| **H** plasterboard | 15 mm |
| **Total thickness of the element** | **375 mm** |

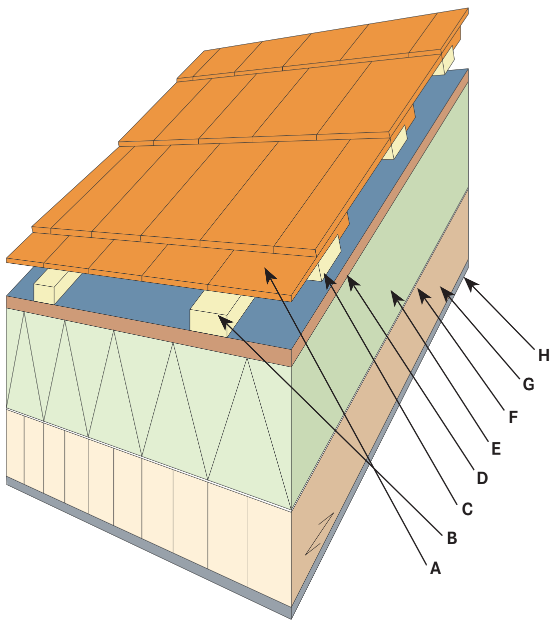
| Structural characteristics | |
|---|---|
| **Thermal insulation** U value | **0.16 W/(m²K)** |
| **Permeability** | adequate |
| **Sound insulation** $R_w(C; C_{tr})$ | 45 dB |
| **Fire protection** REI | 30 min |




## Pitched, tiled roof

| Element structure | |
|---|---|
| **A** roof tile | – |
| **B** roof battens (50/30 mm) | 30 mm |
| **C** counter battens (80/50 mm) | 50 mm |
| **D** roof underlay panel | 22 mm |
| **E** wood fibre insulation boards | 180 mm |
| **F** sealing sheet | – |
| **G** **MM HBE** solid wood construction element (in accordance with structural analysis) | 120 mm |
| **H** plasterboard | 15 mm |
| **Total thickness of the element** | **417 mm** |

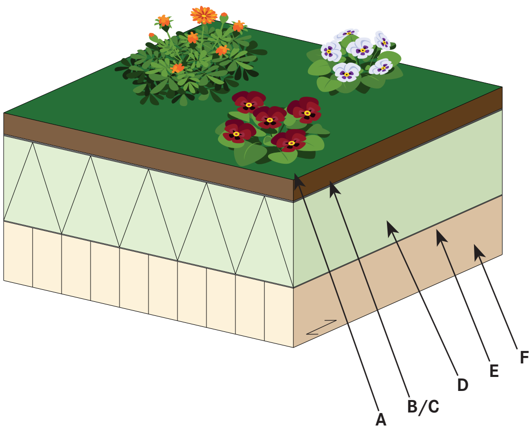
| Structural characteristics | |
|---|---|
| **Thermal insulation** U value | **0.16 W/(m²K)** |
| **Permeability** | adequate |
| **Sound insulation** $R_w(C; C_{tr})$ | 45 (−1; −7) dB |
| **Fire protection** REI | 30 min |



## Green roof with visible surface inside

| Element structure | |
|---|---|
| **A** fill | 50 mm |
| **B** geotextile filter layer | – |
| **C** sealing sheet (for roof) | – |
| **D** wood fibre insulation board | 200 mm |
| **E** sealing sheet | – |
| **F** **MM HBE** solid wood construction element (in accordance with structural analysis) | 140 mm |
| **Total thickness of the element** | **390 mm** |

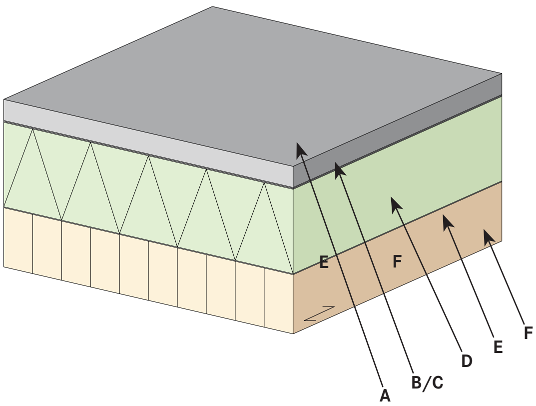
| Structural characteristics | |
|---|---|
| **Thermal insulation**<br>U value | **0.21 W/(m²K)** |
| **Permeability** | adequate |
| **Sound insulation**<br>$R_w(C; C_{tr})$ | 50 dB |
| **Fire protection**<br>REI | 30 min |




## Roof with visible surface inside

| Element structure | |
|---|---|
| **A** fill | 50 mm |
| **B** geotextile filter layer | – |
| **C** sealing sheet (for roof) | – |
| **D** wood fibre insulation board | 200 mm |
| **E** sealing sheet | – |
| **F** **MM HBE** solid wood construction element (in accordance with structural analysis) | 140 mm |
| **Total thickness of the element** | **390 mm** |

| Structural characteristics | |
|---|---|
| **Thermal insulation**<br>U value | **0.21 W/(m²K)** |
| **Permeability** | adequate |
| **Sound insulation**<br>$R_w(C; C_{tr})$ | 50 dB |
| **Fire protection**<br>REI | 30 min |









# Our sites




**Contact details of our second transformation sites:**

MAYR MELNHOF HOLZ


**Mayr-Melnhof Holz Gaishorn GmbH**
Nr. 182 · 8783 Gaishorn am See · Austria
**T** +43 3617 2151 0 · gaishorn@mm-holz.com

**Mayr-Melnhof Holz Reuthe GmbH**
Vorderreuthe 57 · 6870 Reuthe · Austria
**T** +43 5574 804 0 · reuthe@mm-holz.com

**Mayr-Melnhof Holz Wismar GmbH**
Am Torney 14 · 23970 Wismar · Germany
**T** +49 3841 221 0 · wismar@mm-holz.com

**Mayr-Melnhof Holz Olsberg GmbH**
Industriestraße · 59939 Olsberg · Germany
**T** +49 2962 806 0 · olsberg@mm-holz.com

**www.mm-holz.com**



Version 2024/01
Photos: Armin Wenzel, Abbundzentrum Wismar, Bergkvist Siljan, Dan Skanska, Dosthaler & Waldhauser, Gerhard Kreuzbichler, Carolin Hirschfeld, Walter Luttenberger, MMH Archiv, Architekt Günter Mohr, Klaus Morgenstern, Paul Ott, rothoblaas, Albrecht Imanuel Schnabel