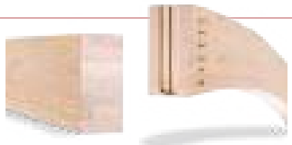
MM HBE

Solid timber construction element

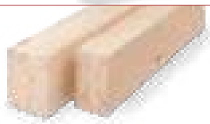
WHERE IDEAS CAN GROW.

Wood is naturally CO_2-neutral and energy-efficient in all respects. This building material contributes significantly to the protection of our environment through its positive properties in the area of summer heat protection and cold winter protection as well as the storage of CO_2. Building with wood is a valuable contribution to climate and environmental protection. Each second, one new cubic metre of wood is growing in Austria. In one cubic meter of wood, carbon from one tonne of CO_2 is stored in the atmosphere, relieving the strain on our environment. As a PEFC certified company, Mayr-Melnhof Holz mainly processes spruce, as well as fir, larch and pine. The majority of the wood originates from local forests around the individual company locations.

Products of Mayr-Melnhof Holz



MM masterline
Glulam beams



MM vistaline
Duo-/Trio beams

MM profideck
Laminated ceiling elements

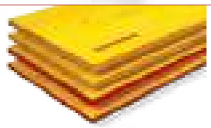
MM blockdeck
Floor and wall beams

MM HBE
Solid timber construction element (HBE)

MM crosslam
Cross-laminated timber

XLAM CONCRETE®
Timber concrete compound element

K1 multiplan
3-ply structural panels

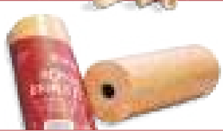


K1 yellowplan
Formwork panels

HT 20plus
Formwork beams

MM sawn timber

MM royalpellets



MM royalbriquettes

CONTENT

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MM HBE

Solid timber construction element

With this **MM HBE** system, Mayr-Melnhof offers an attractive alternative for tried-and-tested solid timber house construction. Similar to **MM crosslam** cross-laminated timber, a proven construction product made from solid timber, the system shows its strengths in smaller projects. Especially when short delivery times, flexibility of project development and costs are the main points of concern, customers rely on our **MM HBE** system.
The **MM HBE** system is based on the Lego principle and works with few and simple details. Solid walls, ceilings or roofs made of wood are created with just one standardised building block. By simply bolting together the elements in a frame of beams and stiffening frames, loads are linearly derived via slabs.
MM HBE stock items are available always and everywhere, and you can start your small or larger project tomorrow.

Properties

- Solid, long-term valuable construction
- Excellent form stability and dimensional accuracy
- Prefabricated elements
- Simple assembly with only minor dust and noise emissions
- Short construction time due to dry construction method
- High degree of standardisation
- System-based, simple application
- Little amount of waste material
- Natural resource, positive climate balance
- Easy and quick assembly
- Suitable for structurally effective slab formation
- Pleasant room and living climate

Areas of application

- Single and multiple family houses
- Added storeys
- Commercial, office and industrial buildings
- Modular and temporary buildings
- DYI area
- Hybrid constructions in combination with massive stone and timber framework construction

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The system

From production to construction site

The **MM HBE** system is produced by Mayr-Melnhof Holz and **MM master**line then processed with a double groove and spring as a connection profile. Optionally, a groove mounted on both sides can also be milled in the middle, which can later be used as an internal cable duct.

The standardised element **MM HBE** is stored as a storage rod or in a system length at Mayr-Melnhof Holz. In addition to the MMH stock program, **MM HBE** stock rods are also kept available by retailers and system users worldwide.

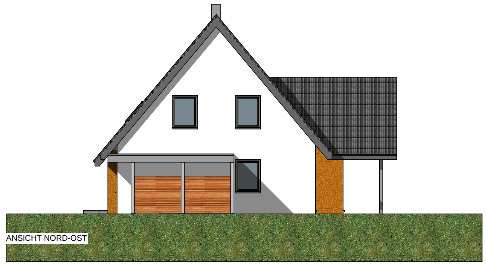
Thus, **MM HBE** is available always and everywhere and you can start your new project at any time.

Certificate according to the Building Products Regulation
Wismar 769 - CPR - 6162
Eppingen-Richen 0797 - CPR - 0802
Gaishorn 1359 - CPR - 0637

Chain of Custody
PEFC/06-38-79

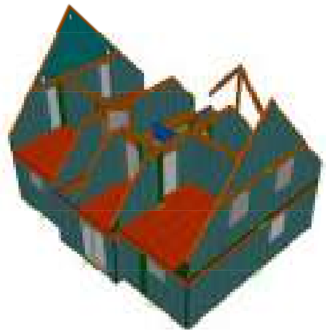
From draft to construction site

On the basis of the planner / builder, the first plans and designs of the planner are created, which are presented in a foreman concept or execution plan prior to execution.

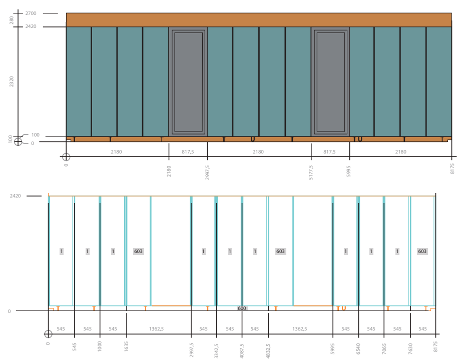


The more flexible the **MM HBE** client and the more elaborate the design plan is, the better the advantages of the **MM HBE** system can be played out.

As a rule, cuttings can be avoided almost completely, because windows and doors are integrated in a grid-type plan and their openings will be recessed. Thus, joinery and unnecessary material costs are avoided.



In the final step, the joinery and assembly plans are completed and the rapid assembly enabled by the system components can begin.



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Technical Data

Types of wood

Nordic spruce

Surfaces

Visible quality (SI) Industrial quality (NSI)

Product standard

EN 14080:2013

Strength classes (according to EN 14080:2013)

GL 24h

Bonding

Glue on melamine resin basis, (MUF) according to EN 301 type 1 for bonding load-bearing timber components indoors and outdoors.

Colour of glued joint

Bright glued joint (melamine resin bonding)

Wood moisture

approx. 12% ± 2%

Raw density (mean values)

Spruce approx. 450 kg/m³

Heat conductivity

λ = 0,13 W/(mK) parallel to the glued joints

Diffusion resistance

μ= 20 – 40 (at 12% wood moisture)

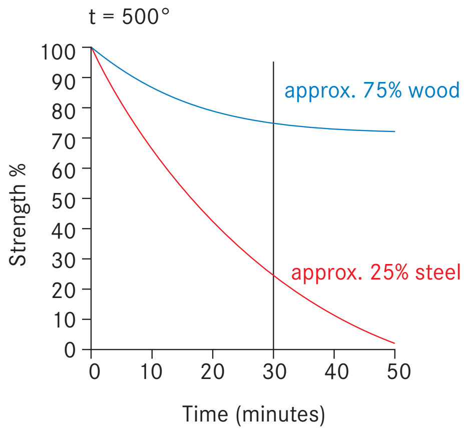
Emissions & VOC

Formaldehyde class E1
The limit values of emission class E1 (≤ 0,1 ppm HCHO) are clearly undercut by glued-laminated timber.

Fire resistance behaviour

Classification of glued-laminated timber:
Fire behaviour class according to EN 14080, table 11
mean minimum raw density 380 kg/m³

European class	D
Smoke class (smoke)	s2
Dropping class (drop)	d0



At a temperature of approx. 500 ° C, steel loses 75% of its strength after 30 minutes, whereas at that time wood only loses 25% of its strength.

Fire resistance

Calculated burning rate 0,7 mm/min. according to EN 1995-1-2, table 3.1.

Shrinkage and swelling behaviour

Wood is a natural building material. It can both absorb and release moisture. The equilibrium moisture content of the component depends on the climatic conditions of the environment. In order to avoid changes in the component dimensions, the wood moisture should be adapted to the later installation location.

Glued-laminated timber is produced with a wood moisture content of approx. 12% ± 2%. This corresponds to the equilibrium moisture content at a room temperature of 20 ° C and a relative humidity of 65%.

Glulam has a medium swelling and shrinkage in height and width of α_u = 0,24% per 1% change in wood moisture (Δu). Changes in length with α_{ull} = 0,01% can usually be ignored.

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Quality

Visual quality

Glued-laminated timber is produced in two different surface qualities:

Visual quality (SI): For visible applications e.g. In residential areas, kindergartens, schools, sports facilities etc.

Industrial quality (NSI): For use without any visual demands such as e.g. industrial halls, composting plants, stables, clad roof and ceiling girder surfaces

Surfaces

Planed and chamfered on 4 sides incl. connecting notch

Visual quality

Industrial quality

Important notes

- The criteria refer to the surface quality at the time of delivery.
- Appropriate storage for the material and assembly of the glued-laminated timber after delivery must be ensured by the customer.
- Depending on the surrounding climate, material-related deviations of the natural material wood from the above criteria may occur.

Quality criteria

Criteria*1	Industrial quality	Visual quality
1 firmly ingrown knots*2,3	admissible	admissible
2 knots fallen out or loose*2,3	admissible	Ø < 20 mm are admissible*4 Ø > 20 mm must be replaced at the factory*4
3 pitch pockets*3,5	admissible	up to 5 mm wide pitch pockets are
4 knots and defects repaired by knothole stoppers or "boats"*3	not required	admissible
5 knots and pitch pockets repaired with filling mass*3	not required	admissible
6 insect infestation*3	Galleries up to 2 mm are admissible	Insect holes up to 2 mm are admissible
7 pith	admissible	admissible
8 width of shrinkage cracks*3,5,7	no limits apply	up to 4 mm
9 colouring due to blueness as well as red and blue nail-tight strips*5	no limits apply	up to 10% of the visible surface of the entire construction component
10 mould infestation*5	not admissible	not admissible
11 contaminations*5	admissible	not admissible
12 finger joint distance	no limits apply	no limits apply
13 processing of the surface	levelled	planed and chamfered; plane marks admissible to a depth of 1 mm

*1 Deviations from the limit values defined below in cells 2, 3, 6-9, 12 and 13 can be tolerated to the following extent: Maximum three deviations / m2 visible surface for visual quality.
*2 Admissible knot size according to DIN 4074
*3 No limits regarding the number
*4 Measurement of the knot diameter in analogy to the measurement of the diameter of single knots in square timber according to 4074-1: 2003-6, 5.1.2.1.
*5 State of delivery
*6 If necessary, paintable filling masses must be requested explicitly.
*7 Irrespective of the surface quality, the crack depth may be up to 1/6 of the component width for components without a planned transverse tensile stress and up to 1/8 of the component width of each side for components with a planned transverse tensile stress.

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The wall element

The MM HBE element at stored length

Warehouse lengths are produced at 13.5 m. Depending on the height of the storeys, usually about 5 wall elements from one warehouse length can be cut to size on site. This makes the whole process quicker, increases flexibility and minimises waste.

- GL 24h, melamine glue, surface in industrial quality (NSi), wood moisture 12 +/- 2%
- Profile: 15 mm double groove - double tongue with double-sided groove
  20 x 30 mm
  20 x 60 mm cable duct (integrated installation level)
- Strength: 100 mm
- Widths: 360 + 560 mm (covering widths 345 + 545 mm)
- Warehouse length: 13.5 m

The MM HBE wall element from manufacturing

Individual wall elements can also be manufactured according to their material list. Your Mayr-Melnhof contact person will be pleased to inform you about the numerous available options!

The MM HBE element at system length

Specialised users of the **MM HBE** system order and store the best-fitting **MM HBE** system length and thus save on caps from the warehouse bar. The system length is also advantageous for storage and transport. Therefore it is possible to simply work right off the package!

- GL 24h, melamine glue, surface in industrial quality (NSi), wood moisture 12 +/- 2%
- Profile: 15 mm double groove - double tongue with double-sided groove
  20 x 30 mm
  20 x 60 mm cable duct (integrated installation level)
- Strength: 100 mm
- Widths: 360 + 560 mm (covering widths 345 + 545 mm)
- Warehouse length: e.g. 2.6 m

The MM HBE pre-cut wall element

For a complete **MM HBE** kit, however, a professional joinery system should be used. Precise CNC machining reduces valuable working time on the construction site, avoids errors and cuts construction costs!

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Wall, ceiling and roof

MM HBE wall, ceiling and roof elements can be produced according to individual customer requirements and for your construction project according to the below special forms.

Term definitions and available dimensions

- FT = rebate depth: 45 / 60 / 70 mm
- FB = rebate width: 1 - 25 mm (1 mm steps)
- NT = groove depth: 30 mm
- NB = groove width: 15 - 30 mm (1 mm steps)
- F = chamfer: 5 mm (other dimensions available on request)
- ED = element thickness: depending on the profiling:
  60 - 260 mm (20 mm steps)
- EB = element width 200 – 960 mm (40 mm steps)

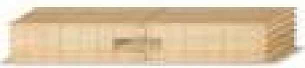
Double groove - double tongue with rebate
From an element strength (ED) of 100 mm to 260 mm

Single groove - single tongue
Up to an element strength (ED) of 60 mm

Double groove - double tongue
From an element strength (ED) of 80 mm to 260 mm

Groove - groove
From an element strength (ED) of 60 mm to 260 mm

Double groove - double tongue with groove
From an element strength (ED) of 100 mm to 260 mm



Rebate - rebate
From an element strength (ED) of 60 mm to 260 mm

Double groove - double tongue with groove and rebate
From an element strength (ED) of 140 mm to 260 mm

Groove - rebate
From an element strength (ED) of 80 mm to 260 mm

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Measuring tolerances and important notes

Our **MM HBE** products are always manufactured to the exact size ordered. However, manufacturing tolerances and the natural shrinkage and swelling behaviour of the wood can lead to dimensional deviations of the cross section.

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

<table>
<tr><td>Width</td><td colspan="4">60 mm ≤ b ≤ 300 mm</td></tr>
<tr><td>Width tolerance</td><td colspan="4">± 2 mm</td></tr>
<tr><td>Height</td><td colspan="2">100 mm ≤ h ≤ 400 mm</td><td colspan="2">400 mm < h ≤ 2,500 mm</td></tr>
<tr><td>Height tolerance</td><td colspan="2">+ 4 mm/- 2 mm</td><td colspan="2">+ 1%/- 0,5%</td></tr>
<tr><td>Length</td><td>< 2,0 m</td><td colspan="2">2,0 m bis < 20 m</td><td>> 20 m</td></tr>
<tr><td>Length tolerance</td><td>± 2 mm</td><td colspan="2">± 0,1%</td><td>± 20 mm</td></tr>
</table>

Crack formation

As a result of the natural shrinkage and swelling behaviour, shrinkage cracks can occur depending on the ambient conditions. Especially during the construction phase, the outer areas of the component can absorb moisture. In order to prevent shrinkage cracks, this building moisture must be gradually returned to equilibrium moisture content by sufficient ventilation and careful heating of the building.

Shrinkage cracks, even along the glue joint, can occur on the surfaces of the **MM HBE** elements. For components without system-related transverse tensile stress, such shrinkage cracks are tolerated up to a depth of ⅙ of the component width (on each side).

With direct weathering and strongly changing climatic stresses, the tendency to crack formation increases.

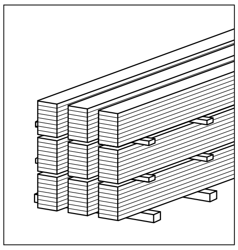
Packaging and storage

For the storage of elements, the principles that apply to the storage of wood must be observed:

- Use sleepers
- In case of horizontal stacking of building parts, laminated wood and intermediate timber must be placed on top of each other.
- Protect from tipping
- Remove protective film to prevent condensation
- Building parts must be protected from rain, splash water and rising ground moisture by way of ensuring sufficient clearance to the ground and using tarpaulins.
- In case of long-term storage, additional sleepers must be used to prevent creep deformation.

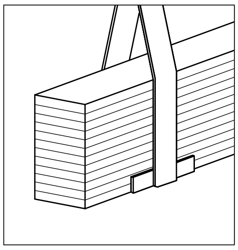
Stacking

Use sleepers and stacking bars
Protect components from tipping.



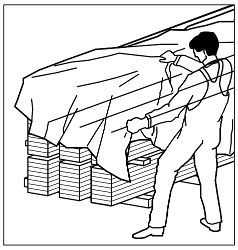
Damage

Use wide straps and edge protectors at the bottom and if necessary at the top. Avoid any damage.



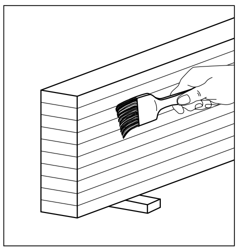
Moisture

Protect against moisture with tarpaulins after delivery. Remove packing immediately, otherwise there is a risk of condensation.



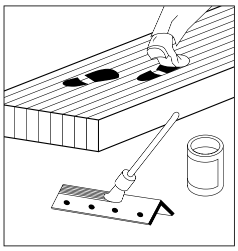
Weather protection

Ensure constructional wood protection. In addition: Moisture protection coat for short-term weathering as temporary protection during the construction period.



Contamination

Prevent contamination by painting, covering or similar. Avoid stains, impregnation salts and rusting steel parts (also due to splashes caused by welding or flexing).



Source: Studiengemeinschaft Holzleimbau e.V.

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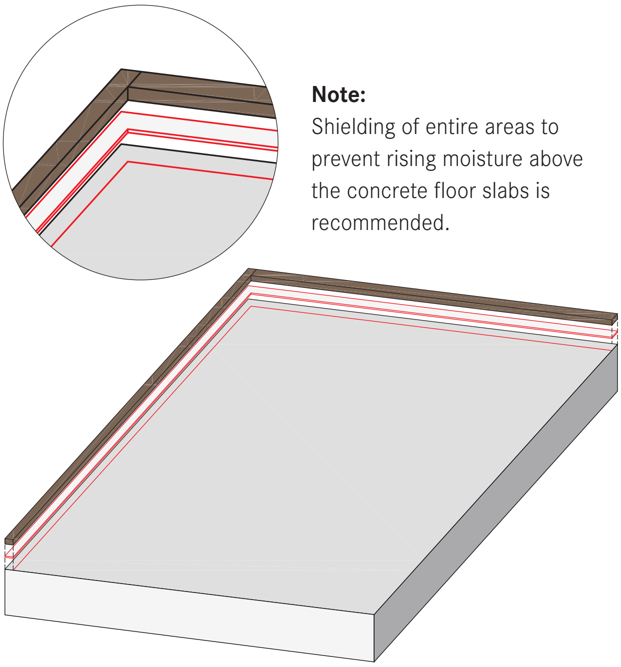
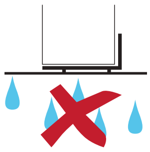
Mounting of wall and ceiling elements

Fixing the equalization threshold

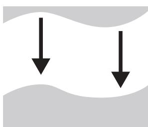


Note:
Shielding of entire areas to prevent rising moisture above the concrete floor slabs is recommended.

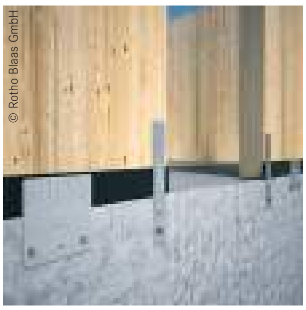
Double protection:
Prevents capillary rising of moisture into the wood and ensures excellent airtightness.

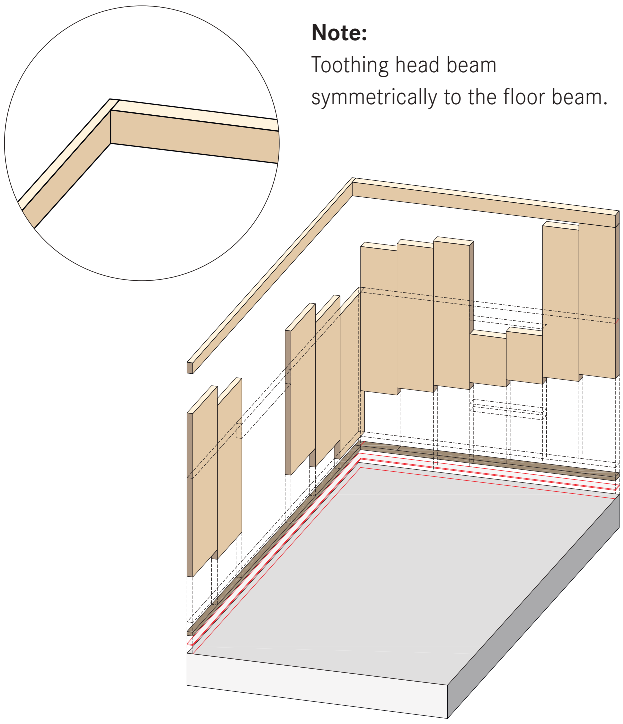


Adjustable:
The adhesive PU foam profiles make it possible to compensate for any irregularities in the substrate.



Connection of the equalization beam and installation of the wall elements on the ground floor as well as the floor beam





Note:
Toothing head beam symmetrically to the floor beam.

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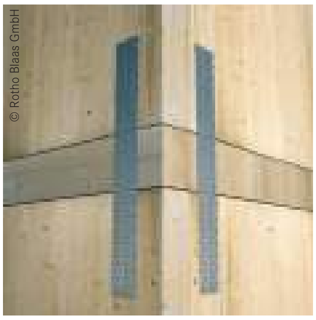
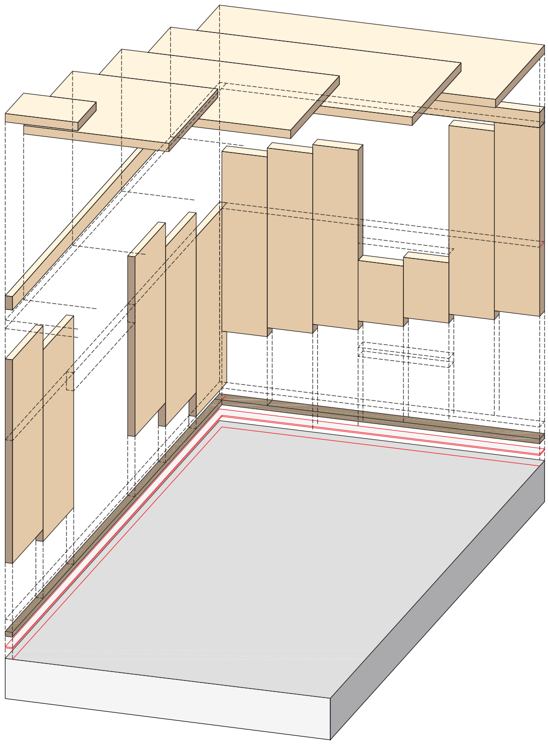
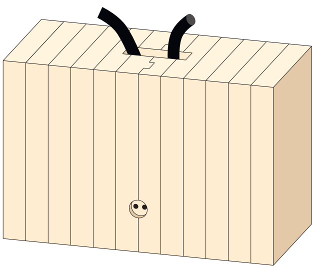
Mounting MM HBE wall elements on the upper floor

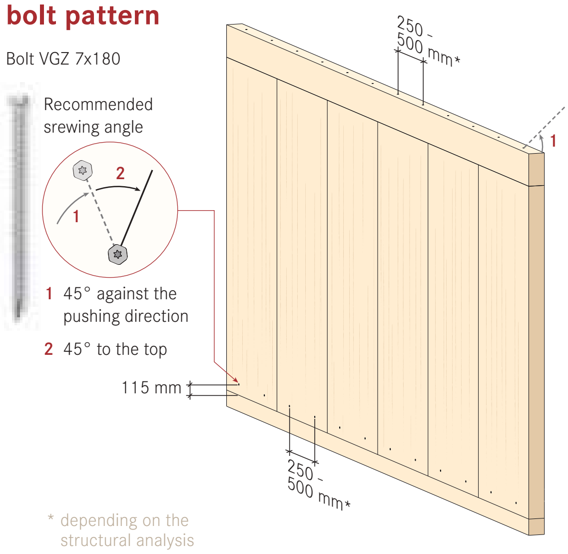




Cable routing Cable duct between each MM HBE wall element is possible



Schematic depiction - bolt pattern



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Accessories

Transport of MM HBE elements

Anchor for the transport of prefabricated parts / cross-laminated panels. The anchor for the transport of prefabricated components is made of galvanised cast steel and therefore very resistant. The integrated tabs serve to retain the head of the screw that is threaded into the component. The anchor can be used for axial loads and for transverse loads.

Mounting supports

The "Giraffe" mounting support is made entirely made of galvanised steel. The exact fine adjustment makes a simple and accurate use possible. It can be extended to 3m and weighs only 9,8 kg. The mounting post also has a handy revolver handle for quick adjustment. Another advantage is the large plates at the top and at the bottom of the support. The upper plate allows a wide stop, even on two walls at the same time. The lower plate, on the other hand, can be easily fixed through the holes on both sides of the floor.

Panel tightener

This panel tightener is suitable for the jointing of solid wood walls, board pile ceilings, roof elements, and much more.
Due to the 360° rotatable plates, this panel tightener can also be used in places that are difficult to access, such as sloping ceilings, obtuse or acute angles.

Assembling jig

Facilitated installation of the wood screws at 45° by using the steel assembly jig.

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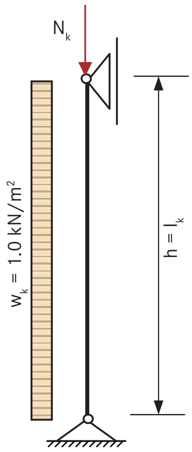
Pre-dimensioning tables

Exterior walls (incl. Wind / fire on one side): required cross-sectional dimensions

Assumptions

- Single span girder and double span girder with same span width
- $\int_{mean}$ = 500 kg/m³
- Component safety factor γ_M = 1.25
- Modification coefficient k_{mod} = 0.80 or 0.90 (Wind, snow < 1,000 m)
- System coefficient k_{sys} = 1.0
- Material: GL 24h
- E-module $E_{0,mean}$ = 11,500 N/mm²
- Bending strength $f_{m,k}$ = 24.0 N/mm²
- Shear strength $f_{v,k}$ = 2.5 N/mm² (k_{cr} = 1.0)
- Compressive strength $f_{c,\theta,k}$ = 24.0 N/mm²
- k_{def} = 0.60 for ceiling
- k_{def} = 0.80 for roof



Exterior wall ▼		Wall height [m] (corresponds to the assumed buckling length l_k)															
g_{2k} [kN/m]	q_k [kN/m]	2.5				3.0				3.2				3.5			
		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

g_{2k}: permanent load (floor structure); q_k: Service load

☐ R30; ☐ R60; ☐ R90

Categories: A: Residential area; B: Office area; C: Areas with groups of persons; D: Sales areas

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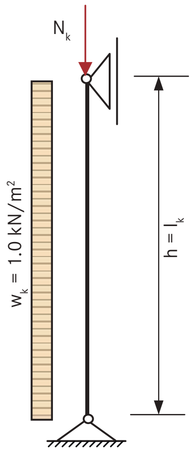
Interior walls | fire on one side: required cross-sectional dimensions

Assumptions

- Single span girder and double span girder with same span width
- $\int_{mean}$ = 500 kg/m³
- Component safety factor γ_M = 1.25
- Modification coefficient k_{mod} = 0.80 or 0.90 (Wind, snow < 1,000 m)
- System coefficient k_{sys} = 1.0
- Material: GL 24h
- E-module $E_{0,mean}$ = 11,500 N/mm²
- Bending strength $f_{m,k}$ = 24.0 N/mm²
- Shear strength $f_{v,k}$ = 2.5 N/mm² (k_{cr} = 1.0)
- Compressive strength $f_{c,0,k}$ = 24.0 N/mm²
- k_{def} = 0.60 for ceiling
- k_{def} = 0.80 for roof



Inside walls fire on one side ▼		Wall height [m] (corresponds to the assumed buckling length l_k)															
g_{2k} [kN/m]	q_k [kN/m]	2.5				3.0				3.2				3.5			
		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

g_{2k}: permanent load (floor structure); q_k: Service load

Categories: A: Residential area; B: Office area; C: Areas with groups of persons; D: Sales areas

☐ R30; ☐ R60; ☐ R90

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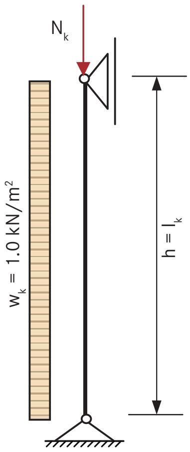
Interior walls | fire on both sides: required cross-sectional dimensions

Assumptions

- Single span girder and double span girder with same span width
- $\int_{mean}$ = 500 kg/m^3
- Component safety factor γ_M = 1.25
- Modification coefficient k_{mod} = 0.80 or 0.90 (Wind, snow < 1,000 m)
- System coefficient k_{sys} = 1.0

- Material: GL 24h
- E-module $E_{0,mean}$ = 11,500 N/mm^2
- Bending strength $f_{m,k}$ = 24.0 N/mm^2
- Shear strength $f_{v,k}$ = 2.5 N/mm^2 (k_{cr} = 1.0)
- Compressive strength $f_{c,0,k}$ = 24.0 N/mm^2
- k_{def} = 0.60 for ceiling
- k_{def} = 0.80 for roof



Inside walls fire on both sides ▼		Wall height [m] (corresponds to the assumed buckling length l_k)															
g_{2k} [kN/m]	q_k [kN/m]	2,5				3,0				3,2				3,5			
		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

g_{2k}: permanent load (floor structure); q_k: Service load

☐ R30; ☐ R60; ☐ R90

Categories: A: Residential area; B: Office area; C: Areas with groups of persons; D: Sales areas

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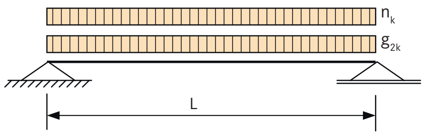
Ceilings - single span girder: Required cross-sectional measurements

Assumptions

- Single span girder and double span girder with same span width
- $\int_{mean}$ = 500 kg/m³
- Component safety factor γ_M = 1.25
- Modification coefficient k_{mod} = 0.80 or 0.90 (wind, snow < 1,000 m)
- System coefficient k_{sys} = 1.0
- Material: GL 24h
- E-module $E_{0,mean}$ = 11,500 N/mm²
- Bending strength $f_{m,k}$ = 24.0 N/mm²
- Shear strength $f_{v,k}$ = 2.5 N/mm² (k_{cr} = 1.0)
- Compressive strength $f_{c,e,k}$ = 24.0 N/mm²
- k_{def} = 0.60 for ceiling
- k_{def} = 0.80 for roof



Ceilings single span girders ▼			Span width (m)																				
			3.0			3.5			4.0			4.5			5.0			6.0			7.0		
			Ceiling class (I, II, III)																				
g_{2k} [kN/m²]	Kat.	q_k [kN/m²]	DK I	DK II	DK III	DK I	DK II	DK III	DK I	DK II	DK III	DK I	DK II	DK III	DK I	DK II	DK III	DK I	DK II	DK III	DK I	DK II	DK III
1.0	A/B	1.5	140	120	80	160	140	80	180	160	100	200	160	100	240	180	120	-	220	140	-	-	160
		2.0	140	120	80	160	140	80	180	160	100	200	160	120	240	180	120	-	220	140	-	-	180
		3.0	140	120	80	160	140	100	180	160	120	200	160	120	240	180	140	-	220	160	-	-	200
	C/D	3.0	140	120	80	160	140	100	180	160	120	200	160	120	240	180	140	-	220	180	-	-	200
		4.0	140	120	100	160	140	100	180	160	120	200	160	140	240	180	160	-	220	180	-	-	220
		5.0	140	120	100	160	140	120	180	160	120	200	160	140	240	180	160	-	220	200	-	-	220
2.0	A/B	1.5	140	120	80	160	140	80	180	160	100	200	160	100	240	180	120	-	220	140	-	-	160
		2.0	140	120	80	160	140	100	180	160	100	200	160	120	240	180	120	-	220	160	-	-	180
		3.0	140	120	80	160	140	100	180	160	120	200	160	120	240	180	140	-	220	160	-	-	200
	C/D	3.0	140	120	100	160	140	100	180	160	120	200	160	140	240	180	160	-	220	180	-	-	220
		4.0	140	120	100	160	140	120	180	160	140	200	160	140	240	180	160	-	220	200	-	-	220
		5.0	140	120	100	160	140	120	180	160	140	200	160	160	240	180	160	-	220	200	-	-	240
2.5	A/B	1.5	140	120	80	160	140	80	180	160	100	200	160	100	240	180	120	-	220	140	-	-	180
		2.0	140	120	80	160	140	100	180	160	100	200	160	120	240	180	120	-	220	160	-	-	180
		3.0	140	120	80	160	140	100	180	160	120	200	160	120	240	180	140	-	220	160	-	-	200
	C/D	3.0	140	120	100	160	140	120	180	160	120	200	160	140	240	180	160	-	220	200	-	-	220
		4.0	140	120	100	160	140	120	180	160	140	200	160	160	240	180	160	-	220	200	-	-	240
		5.0	140	120	100	160	140	120	180	160	140	200	160	160	240	180	180	-	220	200	-	-	240
3.0	A/B	1.5	140	120	80	160	140	80	180	160	100	200	160	120	240	180	120	-	220	140	-	-	180
		2.0	140	120	80	160	140	100	180	160	100	200	160	120	240	180	120	-	220	160	-	-	180
		3.0	140	120	80	160	140	100	180	160	120	200	160	120	240	180	140	-	220	160	-	-	200
	C/D	3.0	140	120	100	160	140	120	180	160	140	200	160	140	240	180	160	-	220	200	-	-	240
		4.0	140	120	100	160	140	120	180	160	140	200	160	160	240	180	180	-	220	200	-	-	240
		5.0	140	120	100	160	140	120	180	160	140	200	160	160	240	180	180	-	220	220	-	-	240
3.5	A/B	1.5	140	120	80	160	140	80	180	160	100	200	160	120	240	180	120	-	220	140	-	-	180
		2.0	140	120	80	160	140	100	180	160	100	200	160	120	240	180	140	-	220	160	-	-	180
		3.0	140	120	80	160	140	100	180	160	120	200	160	120	240	180	140	-	220	180	-	-	200
	C/D	3.0	140	120	100	160	140	120	180	160	140	200	160	160	240	180	180	-	220	200	-	-	240
		4.0	140	120	100	160	140	120	180	160	140	200	160	160	240	180	180	-	220	220	-	-	240
		5.0	140	120	120	160	140	120	180	160	140	200	160	160	240	180	180	-	220	220	-	-	-

g_{2k}: permanent load (floor structure); q_k: Load capacity
DK: Ceiling class according to ÖNORM B 1995-1-1:2015

R60; R90

Categories: A: Residential area; B: Office area; C: Areas with groups of persons; D: Sales areas

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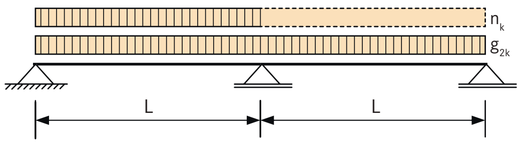
MAYR MELNHOF HOLZ

Ceilings - double span girder with same span width: Required cross-sectional measurements

Assumptions

- Single span girder and double span girder with same span width
- $\int_{mean}$ = 500 kg/m³
- Component safety factor γ_M = 1.25
- Modification coefficient k_{mod} = 0.80 or 0.90 (wind, snow < 1,000 m)
- System coefficient k_{sys} = 1.0
- Material: GL 24h
- E-module $E_{0,mean}$ = 11,500 N/mm²
- Bending strength $f_{m,k}$ = 24.0 N/mm²
- Shear strength $f_{v,k}$ = 2.5 N/mm² (k_{cr} = 1.0)
- Compressive strength $f_{c,\varphi,k}$ = 24.0 N/mm²
- k_{def} = 0.60 for ceiling
- k_{def} = 0.80 for roof



Ceilings double span girders ▼			Span width (m)																				
			3.0			3.5			4.0			4.5			5.0			6.0			7.0		
			Ceiling class (I. II. III)																				
g_{2k} [kN/m²]	Kat.	q_k [kN/m²]	DK I	DK II	DK III	DK I	DK II	DK III	DK I	DK II	DK III	DK I	DK II	DK III	DK I	DK II	DK III	DK I	DK II	DK III	DK I	DK II	DK III
1.0	A/B	1.5	120	100	60	140	120	80	160	140	80	180	160	80	200	160	100	240	200	120	-	220	140
		2.0	120	100	60	140	120	80	160	140	80	180	160	100	200	160	100	240	200	120	-	220	140
		3.0	120	100	80	140	120	80	160	140	100	180	160	100	200	160	120	240	200	140	-	220	160
	C/D	3.0	120	100	80	140	120	80	160	140	100	180	160	120	200	160	120	240	200	140	-	220	160
		4.0	120	100	80	140	120	100	160	140	100	180	160	120	200	160	140	240	200	160	-	220	180
		5.0	120	100	80	140	120	100	160	140	120	180	160	120	200	160	140	240	200	160	-	220	200
2.0	A/B	1.5	120	100	60	140	120	80	160	140	80	180	160	100	200	160	100	240	200	120	-	220	140
		2.0	120	100	60	140	120	80	160	140	80	180	160	100	200	160	100	240	200	120	-	220	140
		3.0	120	100	80	140	120	80	160	140	100	180	160	100	200	160	120	240	200	140	-	220	160
	C/D	3.0	120	100	80	140	120	100	160	140	100	180	160	120	200	160	120	240	200	160	-	240	180
		4.0	120	100	80	140	120	100	160	140	100	180	160	120	200	160	140	240	200	160	-	240	180
		5.0	120	100	80	140	120	100	160	140	120	180	160	120	200	160	140	240	200	160	-	240	200
2.5	A/B	1.5	120	100	60	140	120	80	160	140	80	180	160	100	200	160	100	240	200	120	-	220	140
		2.0	120	100	60	140	120	80	160	140	80	180	160	100	200	160	100	240	200	120	-	220	140
		3.0	120	100	80	140	120	80	160	140	100	180	160	100	200	160	120	240	200	140	-	220	160
	C/D	3.0	120	100	80	140	120	100	160	140	100	180	160	120	200	160	120	240	200	160	-	240	180
		4.0	120	100	80	140	120	100	160	140	120	180	160	120	200	160	140	240	200	160	-	240	180
		5.0	120	100	100	140	120	100	160	140	120	180	160	140	200	160	140	240	200	180	-	240	200
3.0	A/B	1.5	120	100	60	140	120	80	160	140	80	180	160	100	200	160	100	240	200	120	-	220	140
		2.0	120	100	60	140	120	80	160	140	80	180	160	100	200	160	100	240	200	120	-	220	160
		3.0	120	100	80	140	120	80	160	140	100	180	160	100	200	160	120	240	200	140	-	220	160
	C/D	3.0	120	100	80	140	120	100	160	140	100	180	160	120	200	160	140	-	220	160	-	-	180
		4.0	120	100	80	140	120	100	160	140	120	180	160	120	200	160	140	-	220	160	-	-	200
		5.0	120	100	100	140	120	100	160	140	120	180	160	140	200	160	140	-	220	180	-	-	200
3.5	A/B	1.5	120	100	60	140	120	80	160	140	80	180	160	100	200	160	100	240	200	120	-	220	140
		2.0	120	100	60	140	120	80	160	140	80	180	160	100	200	160	100	240	200	140	-	220	160
		3.0	120	100	80	140	120	80	160	140	100	180	160	100	200	160	120	240	200	140	-	220	160
	C/D	3.0	120	100	80	140	120	100	160	140	120	180	160	120	200	180	140	-	220	160	-	-	180
		4.0	120	100	80	140	120	100	160	140	120	180	160	120	200	180	140	-	220	160	-	-	200
		5.0	120	100	100	140	120	100	160	140	120	180	160	140	200	180	140	-	220	180	-	-	200

g_{2k}: permanent load (floor structure); q_k: Load capacity
DK: Ceiling class according to ÖNORM B 1995-1-1:2015

R30; R60; R90

Categories: A: Residential area; B: Office area; C: Areas with groups of persons; D: Sales areas

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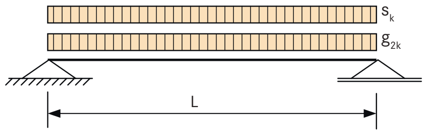
Roofs - single span girder - roof inclination α = 0° to 5°: Required cross-sectional measurements

Assumptions

- Single span girder and double span girder with same span width
- ρ_{mean} = 500 kg/m³
- Component safety factor γ_M = 1.25
- Modification coefficient k_{mod} = 0.80 or 0.90 (wind, snow < 1,000 m)
- System coefficient k_{sys} = 1.0
- Material: GL 24h
- E-module $E_{0,mean}$ = 11,500 N/mm²

- Bending strength $f_{m,k}$ = 24.0 N/mm²
- Shear strength $f_{v,k}$ = 2.5 N/mm² (k_{cr} = 1.0)
- Compressive strength $f_{c,e,k}$ = 24.0 N/mm²
- k_{def} = 0.60 for ceiling
- k_{def} = 0.80 for roof



Roof single span girder ▼		Span width (m)													
		3.0		3.5		4.0		4.5		5.0		6.0		7.0	
		Snow loads (locations above 1,000 m above sea level) NN or locations below 1,000 m above sea level NN)													
g_{2k} [kN/m²]	s [kN/m²]	< 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
1.0	0.5	60	60	60	60	80	80	80	80	100	100	120	120	140	140
	1.0	60	60	80	80	80	80	100	100	100	100	140	140	160	160
	1.5	80	80	80	80	100	100	100	100	120	120	140	140	160	160
	2.0	80	80	80	80	100	100	120	120	120	120	140	140	180	180
	3.0	80	80	100	100	120	120	120	120	140	140	160	160	200	200
	4.0	100	100	100	100	120	120	140	140	140	140	180	180	200	200
	5.0	100	100	120	120	120	120	140	140	160	160	180	180	220	220
	6.0	100	100	120	120	140	140	140	140	160	160	200	200	220	220
	7.0	100	100	120	120	140	140	160	160	180	180	200	200	240	240
1.5	0.5	60	60	80	80	80	80	100	100	100	100	120	120	140	140
	1.0	60	60	80	80	80	80	100	100	120	120	140	140	160	160
	1.5	80	80	80	80	100	100	100	100	120	120	140	140	160	160
	2.0	80	80	80	80	100	100	120	120	120	120	160	160	180	180
	3.0	80	80	100	100	120	120	120	120	140	140	160	160	200	200
	4.0	100	100	100	100	120	120	140	140	140	140	180	180	200	200
	5.0	100	100	120	120	120	120	140	140	160	160	180	180	220	220
	6.0	100	100	120	120	140	140	140	140	160	160	200	200	240	240
	7.0	100	100	120	120	140	140	160	160	180	180	200	200	240	240
2.0	0.5	60	60	80	80	80	80	100	100	100	100	120	120	140	160
	1.0	60	60	80	80	100	100	100	100	120	120	140	140	160	160
	1.5	80	80	80	80	100	100	100	100	120	120	140	140	160	160
	2.0	80	80	100	100	100	100	120	120	120	120	160	160	180	180
	3.0	80	80	100	100	120	120	120	120	140	140	160	160	200	200
	4.0	100	100	100	100	120	120	140	140	140	140	180	180	200	200
	5.0	100	100	120	120	120	120	140	140	160	160	180	180	220	220
	6.0	100	100	120	120	140	140	140	140	160	160	200	200	240	240
	7.0	100	100	120	120	140	140	160	160	180	180	200	200	240	240

g_{2k}: permanent load (floor structure); q_k: Service load

Categories: A: Residential area; B: Office area; C: Areas with groups of persons; D: Sales areas

☐ R30; ☐ R60; ☐ R90

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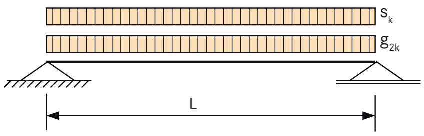
V 03/19

Roofs - single span girder - roof inclination α = 30°: Required cross-sectional measurements

Assumptions

- Single span girder and double span girder with same span width
- ρ_{mean} = 500 kg/m³
- Component safety factor γ_M = 1.25
- Modification coefficient k_{mod} = 0.80 or 0.90 (wind, snow < 1,000 m)
- System coefficient k_{sys} = 1.0
- Material: GL 24h
- E-module $E_{0,mean}$ = 11,500 N/mm²
- Bending strength $f_{m,k}$ = 24.0 N/mm²
- Shear strength $f_{v,k}$ = 2.5 N/mm² (k_{cr} = 1.0)
- Compressive strength $f_{c,\alpha,k}$ = 24.0 N/mm²
- k_{def} = 0.60 for ceiling
- k_{def} = 0.80 for roof



Roof single span girder ▼		Span width (m)													
		3.0		3.5		4.0		4.5		5.0		6.0		7.0	
		Snow loads (locations above 1,000 m above sea level) NN or locations below 1,000 m above sea level NN)													
g_{2k} [kN/m²]	s [kN/m²]	< 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
1.0	0.5	60	60	80	80	80	100	100	100	120	120	140	140	160	160
	1.0	80	80	80	80	100	100	120	120	120	120	140	140	180	180
	1.5	80	80	100	100	100	100	120	120	140	140	160	160	180	180
	2.0	80	80	100	100	120	120	120	120	140	140	160	160	200	200
	3.0	100	100	100	100	120	120	140	140	160	160	180	180	220	220
	4.0	100	100	120	120	140	140	140	140	160	160	200	200	220	220
	5.0	100	100	120	120	140	140	160	160	180	180	200	200	240	240
	6.0	120	120	120	120	140	140	160	160	180	180	220	220	-	-
	7.0	120	120	140	140	160	160	180	180	180	180	220	220	-	-
1.5	0.5	60	80	80	80	100	100	100	100	120	120	140	140	180	180
	1.0	80	80	80	80	100	100	120	120	120	120	160	160	180	180
	1.5	80	80	100	100	100	100	120	120	140	140	160	160	180	180
	2.0	80	80	100	100	120	120	120	120	140	140	160	160	200	200
	3.0	100	100	100	100	120	120	140	140	160	160	180	180	220	220
	4.0	100	100	120	120	140	140	140	140	160	160	200	200	240	240
	5.0	100	100	120	120	140	140	160	160	180	180	200	200	240	240
	6.0	120	120	120	120	140	140	160	160	180	180	220	220	-	-
	7.0	120	120	140	140	160	160	180	180	200	200	220	220	-	-
2.0	0.5	80	80	80	80	100	100	100	100	120	120	140	160	180	180
	1.0	80	80	80	80	100	100	120	120	120	120	160	160	180	180
	1.5	80	80	100	100	100	100	120	120	140	140	160	160	200	200
	2.0	80	80	100	100	120	120	120	120	140	140	180	180	200	200
	3.0	100	100	100	100	120	120	140	140	160	160	180	180	220	220
	4.0	100	100	120	120	140	140	140	140	160	160	200	200	240	240
	5.0	100	100	120	120	140	140	160	160	180	180	200	200	240	240
	6.0	120	120	120	120	140	140	160	160	180	180	220	220	-	-
	7.0	120	120	140	140	160	160	180	180	200	200	220	220	-	-

g_{2k}: permanent load (floor structure); q_k: Service load

Categories: A: Residential area; B: Office area; C: Areas with groups of persons; D: Sales areas

R30; R60; R90

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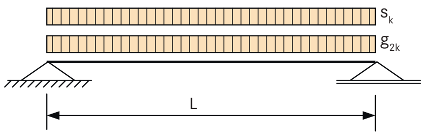
Roofs - single span girder - roof inclination α = 45°: Required cross-sectional measurements

Assumptions

- Single span girder and double span girder with same span width
- $\int_{mean}$ = 500 kg/m³
- Component safety factor γ_M = 1.25
- Modification coefficient k_{mod} = 0.80 or 0.90 (wind, snow < 1,000 m)
- System coefficient k_{sys} = 1.0
- Material: GL 24h
- E-module $E_{0,mean}$ = 11,500 N/mm²
- Bending strength $f_{m,k}$ = 24.0 N/mm²
- Shear strength $f_{v,k}$ = 2.5 N/mm² (k_{cr} = 1.0)
- Compressive strength $f_{c,ϴ,k}$ = 24.0 N/mm²
- k_{def} = 0.60 for ceiling
- k_{def} = 0.80 for roof



Roof single span girder ▼		Span width (m)													
		3.0		3.5		4.0		4.5		5.0		6.0		7.0	
		Snow loads (locations above 1,000 m above sea level) NN or locations below 1,000 m above sea level NN)													
g_{2k} [kN/m²]	s [kN/m²]	< 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
1.0	0.5	80	80	100	100	100	120	120	120	140	140	180	180	220	220
	1.0	80	80	100	100	120	120	140	140	140	140	180	180	220	220
	1.5	100	100	100	100	120	120	140	140	160	160	180	180	220	220
	2.0	100	100	120	120	140	140	140	140	160	160	200	200	240	240
	3.0	100	100	120	120	140	140	160	160	180	180	220	220	-	-
	4.0	120	120	140	140	160	160	180	180	200	200	240	240	-	-
	5.0	120	120	140	140	160	160	180	180	200	200	240	240	-	-
	6.0	120	120	140	140	160	160	180	180	220	220	-	-	-	-
	7.0	140	140	160	160	180	180	200	200	220	220	-	-	-	-
1.5	0.5	80	80	100	100	120	120	120	140	140	140	180	180	220	220
	1.0	80	80	100	100	120	120	140	140	140	160	180	180	220	220
	1.5	100	100	120	120	120	120	140	140	160	160	200	200	220	220
	2.0	100	100	120	120	140	140	140	140	160	160	200	200	240	240
	3.0	100	100	120	120	140	140	160	160	180	180	220	220	-	-
	4.0	120	120	140	140	160	160	180	180	200	200	240	240	-	-
	5.0	120	120	140	140	160	160	180	180	200	200	240	240	-	-
	6.0	120	120	140	140	160	160	200	200	220	220	-	-	-	-
	7.0	140	140	160	160	180	180	200	200	220	220	-	-	-	-
2.0	0.5	80	80	100	100	120	120	140	140	160	160	180	180	220	220
	1.0	100	100	100	100	120	120	140	140	160	160	180	200	220	240
	1.5	100	100	120	120	120	120	140	140	160	160	200	200	240	240
	2.0	100	100	120	120	140	140	160	160	160	160	200	200	240	240
	3.0	100	100	120	120	140	140	160	160	180	180	220	220	-	-
	4.0	120	120	140	140	160	160	180	180	200	200	240	240	-	-
	5.0	120	120	140	140	160	160	180	180	200	200	240	240	-	-
	6.0	120	120	140	140	180	180	200	200	220	220	-	-	-	-
	7.0	140	140	160	160	180	180	200	200	220	220	-	-	-	-

g_{2k}: permanent load (floor structure); q_k: Service load

R30; R60; R90

Categories: A: Residential area; B: Office area; C: Areas with groups of persons; D: Sales areas

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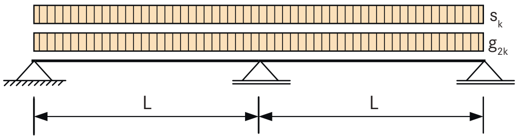
Roofs - double span girder with same span width - roof inclination α = 0° to 5°: Required cross-sectional measurements

Assumptions

- Single span girder and double span girder with same span width
- ρ_{mean} = 500 kg/m³
- Component safety factor γ_M = 1.25
- Modification coefficient k_{mod} = 0.80 or 0.90 (wind, snow < 1,000 m)
- System coefficient k_{sys} = 1.0
- Material: GL 24h
- E-module $E_{0,mean}$ = 11,500 N/mm²
- Bending strength $f_{m,k}$ = 24.0 N/mm²
- Shear strength $f_{v,k}$ = 2.5 N/mm² (k_{cr} = 1.0)
- Compressive strength $f_{c,\alpha,k}$ = 24.0 N/mm²
- k_{def} = 0.60 for ceiling
- k_{def} = 0.80 for roof



Roof double span girder ▼		Span width (m)													
		3.0		3.5		4.0		4.5		5.0		6.0		7.0	
		Snow loads (locations above 1,000 m above sea level) NN or locations below 1,000 m above sea level NN)													
g_{2k} [kN/m²]	s [kN/m²]	< 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
1.0	0.5	60	60	60	60	60	60	80	80	80	80	100	100	100	100
	1.0	60	60	60	60	80	80	80	80	100	100	100	100	120	120
	1.5	60	60	80	80	80	80	80	80	100	100	120	120	140	140
	2.0	60	60	80	80	80	80	100	100	100	100	120	120	140	140
	3.0	80	80	80	80	100	100	100	100	120	120	140	140	160	160
	4.0	80	80	100	100	100	100	120	120	120	120	160	160	180	180
	5.0	80	80	100	100	120	120	120	120	140	140	160	160	180	180
	6.0	80	80	100	100	120	120	120	120	140	140	180	180	200	200
	7.0	100	100	100	100	120	120	140	140	140	140	180	180	200	200
1.5	0.5	60	60	60	60	60	60	80	80	80	80	100	100	120	120
	1.0	60	60	60	60	80	80	80	80	100	100	100	100	120	120
	1.5	60	60	80	80	80	80	100	100	100	100	120	120	140	140
	2.0	60	60	80	80	80	80	100	100	100	100	120	120	140	140
	3.0	80	80	80	80	100	100	100	100	120	120	140	140	160	160
	4.0	80	80	100	100	100	100	120	120	120	120	160	160	180	180
	5.0	80	80	100	100	120	120	120	120	140	140	160	160	180	180
	6.0	80	80	100	100	120	120	140	140	140	140	180	180	200	200
	7.0	100	100	100	100	120	120	140	140	160	160	180	180	200	200
2.0	0.5	60	60	60	60	60	60	80	80	80	80	100	100	120	120
	1.0	60	60	60	60	80	80	80	80	100	100	120	120	120	120
	1.5	60	60	80	80	80	80	100	100	100	100	120	120	140	140
	2.0	60	60	80	80	80	80	100	100	100	100	120	120	140	140
	3.0	80	80	80	80	100	100	100	100	120	120	140	140	160	160
	4.0	80	80	100	100	100	100	120	120	120	120	160	160	180	180
	5.0	80	80	100	100	120	120	120	120	140	140	160	160	180	180
	6.0	80	80	100	100	120	120	140	140	140	140	180	180	200	200
	7.0	100	100	100	100	120	120	140	140	160	160	180	180	200	200

g_{2k}: permanent load (floor structure); q_k: Service load

☐ R30; ☐ R60; ☐ R90

Categories: A: Residential area; B: Office area; C: Areas with groups of persons; D: Sales areas

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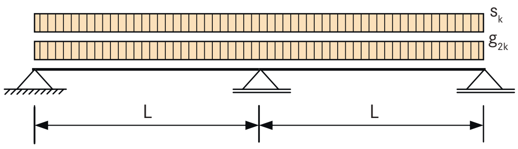
Roofs - double span girder with same span width - roof inclination α = 30°: Required cross-sectional measurements

Assumptions

- Single span girder and double span girder with same span width
- ρ_{mean} = 500 kg/m³
- Component safety factor γ_M = 1.25
- Modification coefficient k_{mod} = 0.80 or 0.90 (wind, snow < 1,000 m)
- System coefficient k_{sys} = 1.0
- Material: GL 24h
- E-module $E_{0,mean}$ = 11,500 N/mm²
- Bending strength $f_{m,k}$ = 24.0 N/mm²
- Shear strength $f_{v,k}$ = 2.5 N/mm² (k_{cr} = 1.0)
- Compressive strength $f_{c,0,k}$ = 24.0 N/mm²
- k_{def} = 0.60 for ceiling
- k_{def} = 0.80 for roof



Roof double span girder ▼		Span width (m)													
		3.0		3.5		4.0		4.5		5.0		6.0		7.0	
		Snow loads (locations above 1,000 m above sea level) NN or locations below 1,000 m above sea level NN)													
g_{2k} [kN/m²]	s [kN/m²]	< 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
1.0	0.5	60	60	60	60	80	80	80	80	80	80	100	100	120	120
	1.0	60	60	80	80	80	80	100	100	100	100	120	120	140	140
	1.5	60	60	80	80	80	80	100	100	100	100	140	140	160	160
	2.0	80	80	80	80	100	100	100	100	120	120	140	140	160	160
	3.0	80	80	100	100	100	100	120	120	140	140	160	160	180	180
	4.0	80	80	100	100	120	120	120	120	140	140	160	160	200	200
	5.0	100	100	100	100	120	120	140	140	140	140	180	180	200	200
	6.0	100	100	120	120	120	120	140	140	160	160	180	180	220	220
	7.0	100	100	120	120	140	140	140	140	160	160	200	200	220	220
1.5	0.5	60	60	60	60	80	80	80	80	100	100	100	100	120	120
	1.0	60	60	80	80	80	80	100	100	100	100	120	120	140	140
	1.5	60	60	80	80	80	80	100	100	120	120	140	140	160	160
	2.0	80	80	80	80	100	100	100	100	120	120	140	140	160	160
	3.0	80	80	100	100	100	100	120	120	140	140	160	160	180	180
	4.0	80	80	100	100	120	120	120	120	140	140	160	160	200	200
	5.0	100	100	100	100	120	120	140	140	140	140	180	180	200	200
	6.0	100	100	120	120	120	120	140	140	160	160	180	180	220	220
	7.0	100	100	120	120	140	140	140	140	160	160	200	200	220	220
2.0	0.5	60	60	60	60	80	80	80	80	100	100	120	120	120	140
	1.0	60	60	80	80	80	80	100	100	100	100	120	120	140	140
	1.5	60	60	80	80	100	100	100	100	120	120	140	140	160	160
	2.0	80	80	80	80	100	100	100	100	120	120	140	140	160	160
	3.0	80	80	100	100	100	100	120	120	140	140	160	160	180	180
	4.0	80	80	100	100	120	120	120	120	140	140	160	160	200	200
	5.0	100	100	100	100	120	120	140	140	160	160	180	180	200	200
	6.0	100	100	120	120	120	120	140	140	160	160	180	180	220	220
	7.0	100	100	120	120	140	140	140	140	160	160	200	200	220	220

g_{2k}: permanent load (floor structure); q_k: Service load

Categories: A: Residential area; B: Office area; C: Areas with groups of persons; D: Sales areas

R30; R60; R90

WHERE IDEAS CAN GROW.

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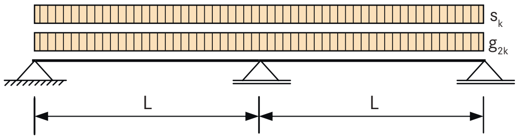
Roofs - double span girder with same span width - roof inclination α = 45°: Required cross-sectional measurements

Assumptions

- Single span girder and double span girder with same span width
- $\int_{mean}$ = 500 kg/m^3
- Component safety factor γ_M = 1.25
- Modification coefficient k_{mod} = 0.80 or 0.90 (wind, snow < 1,000 m)
- System coefficient k_{sys} = 1.0
- Material: GL 24h
- E-module $E_{0,mean}$ = 11,500 N/mm^2
- Bending strength $f_{m,k}$ = 24.0 N/mm^2
- Shear strength $f_{v,k}$ = 2.5 N/mm^2 (k_{cr} = 1.0)
- Compressive strength $f_{c,\theta,k}$ = 24.0 N/mm^2
- k_{def} = 0.60 for ceiling
- k_{def} = 0.80 for roof



Roof double span girder ▼		Span width (m)													
		3.0		3.5		4.0		4.5		5.0		6.0		7.0	
		Snow loads (locations above 1,000 m above sea level) NN or locations below 1,000 m above sea level NN)													
g_{2k} [kN/m²]	s [kN/m²]	< 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
1.0	0.5	60	60	80	80	80	80	100	100	100	100	120	120	140	160
	1.0	80	80	80	80	100	100	100	100	120	120	140	140	160	160
	1.5	80	80	100	100	100	100	120	120	120	120	160	160	180	180
	2.0	80	80	100	100	100	100	120	120	140	140	160	160	200	200
	3.0	100	100	100	100	120	120	140	140	160	160	180	180	220	220
	4.0	100	100	120	120	140	140	140	140	160	160	200	200	220	220
	5.0	100	100	120	120	140	140	160	160	180	180	200	200	240	240
	6.0	120	120	120	120	140	140	160	160	180	180	220	220	-	-
	7.0	120	120	140	140	160	160	180	180	180	180	220	220	-	-
1.5	0.5	60	60	80	80	80	80	100	100	100	100	120	140	160	160
	1.0	80	80	80	80	100	100	100	100	120	120	140	140	160	160
	1.5	80	80	100	100	100	100	120	120	120	120	160	160	180	180
	2.0	80	80	100	100	120	120	120	120	140	140	160	160	200	200
	3.0	100	100	100	100	120	120	140	140	160	160	180	180	220	220
	4.0	100	100	120	120	140	140	140	140	160	160	200	200	220	220
	5.0	100	100	120	120	140	140	160	160	180	180	200	200	240	240
	6.0	120	120	120	120	140	140	160	160	180	180	220	220	-	-
	7.0	120	120	140	140	160	160	180	180	180	180	220	220	-	-
2.0	0.5	60	60	80	80	80	80	100	100	100	120	140	140	160	160
	1.0	80	80	80	80	100	100	100	100	120	120	140	140	180	180
	1.5	80	80	100	100	100	100	120	120	140	140	160	160	180	180
	2.0	80	80	100	100	120	120	120	120	140	140	160	160	200	200
	3.0	100	100	100	100	120	120	140	140	160	160	180	180	220	220
	4.0	100	100	120	120	140	140	140	140	160	160	200	200	220	220
	5.0	100	100	120	120	140	140	160	160	180	180	200	200	240	240
	6.0	120	120	120	120	140	140	160	160	180	180	220	220	-	-
	7.0	120	120	140	140	160	160	180	180	180	180	220	220	-	-

g_{2k}: permanent load (floor structure); q_k: Service load

Categories: A: Residential area; B: Office area; C: Areas with groups of persons; D: Sales areas

R30; R60; R90

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Pre-dimensioning example

General data

For the illustrated 3-storey building, the required proofs for individual components are listed below as examples. For reasons of clarity, details for the determination of the rated internal forces as well as the verification were simplified. The example therefore does not claim to be complete. The calculations are based on the illustrated "standard floor" according to EN 1995-1-1 and the regulations in the national annex valid for Austria.

The following framework conditions or assumptions were taken into account:

MM HBE Solid timber construction elements were considered as glued-laminated timber (BSH) of strength class GL 24h according to EN 14080. The component safety factor on the material side for BSH is γ_M = 1,25.

It was assumed that all components of use class 1 can be assigned to ÖNORM EN 1995-1-1. For the verification of the ceiling elements, a class of the load impact duration "medium" was assumed and invoiced for the verification of the wall elements "short/very short" (wind). This results in a modification factor k_{mod} for the ceiling elements k_{mod} = 0,8 and for the wall elements k_{mod} = 1,05.

The component safety factor on the exposure side for permanent impacts is γ_G = 1,35 | 0,90 (unfavourable | favourable) and for changing impacts γ_G = 1,50 | 0.

The building bracing is done with usually one-sided planking of gypsum fibreboards (in accordance with ETA-03/0050 approval), which are arranged along half of the width of the element with the butted edge facing the **MM HBE** solid timber elements. The planking is fixed to the solid timber elements by means of brackets.

When different values are used, this is explicitly stated at the relevant place.

Disclaimer

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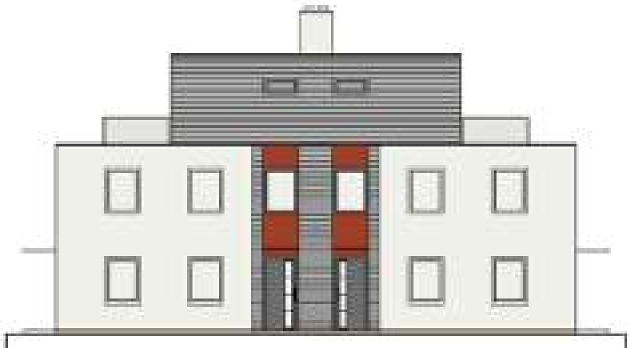
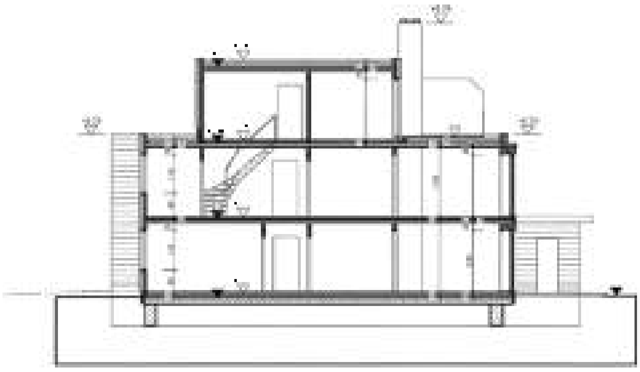
Example

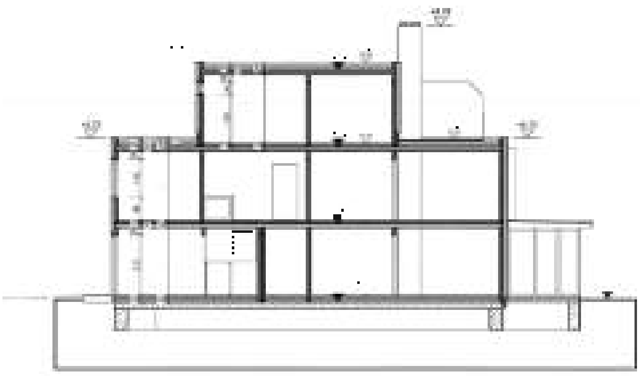
In this 3-storey building with 400 m² living space for a total of four families, the outer and inner walls as well as the ceilings and the roof consist of **MM HBE** elements.



North elevation



South elevation



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Impacts

The occurring influences are determined according to the regulations of the EN 1991 series of standards.

Permanent impact

Exterior wall with heat insulation compound system				
Level No.	**Designation**	**Thickness** [mm]	**Specific weight** [kN/m³]	**Specific surface weight** [kN/m²]
1	Rendering system	7	20.0	0.140
2	Rock wool insulation	120	0.7	0.084
3	**MM HBE** Solid timber element	100	5.0	0.500
4	Gypsum fibreboard	15	10.0	0.150
Total		**242**		**0.870 ≈ 0.90**

Interior wall				
Level No.	**Designation**	**Thickness** [mm]	**Specific weight** [kN/m³]	**Specific surface weight** [kN/m²]
1	Gypsum fibreboard	15	10.0	0.150
2	**MM HBE** Solid timber element	100	5.0	0.500
3	Gypsum fibreboard	15	10.0	0.150
Total		**130**		**0.800**

Ceiling with wet floor screed				
Level No.	**Designation**	**Thickness** [mm]	**Specific weight** [kN/m³]	**Specific surface weight** [kN/m²]
1	Flooring (parquet floor)	15	8.0	0.120
2	Separating layer	1.0	14.0	0.014
3	Cement screed	60	22.0	1.320
4	Separating layer plastic film	1.0	14.0	0.014
5	Footfall insulation 35/30 mm	30	0.7	0.021
6	Loose grit filling	60	17.0	1.020
7	Film (moisture and trickling protection)	1.0	14.0	0.014
8	**MM HBE** Solid timber element	140	5.0	0.700
9	Gypsum fibreboard	15	10.0	0.150
Total		**283**		**3.370 ≈ 3.40**

Roof with sealing film				
Level No.	**Designation**	**Thickness** [mm]	**Specific weight** [kN/m³]	**Specific surface weight** [kN/m²]
1	Roof sealing sheet (EPDM)	2	14.0	0.028
2	Insulation boards	200	0.35	0.070
3	Sealing sheet	5	14.0	0.070
4	**MM HBE** Solid timber element	140	5.0	0.700
5	Gypsum fibreboard	15	10.0	0.150
Total		**362**		**1.018 ≈ 1.00**

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Changing impacts

• Snow according to EN 1991-1-3

Assumptions:

characteristic value s_k	s'_k = 2.50 kN/m²
form coefficient μ	μ = 0.8
Snow on the floor	$s_k = \mu \cdot s'_k$ = 0.8 · 2,50 = **2.00 kN/m²**

Wind pressure

• Wind according to EN 1991-1-4

Assumptions:

Basic wind speed:	$v_{b,0}$ = 27.0 m/s (highest basic resulting wind speed in AT)
Basic speed pressure:	$q_{b,0}$ = 0.456 kN/m²
type of terrain:	III
Minimum height z_{min}:	10.0 m
Height of upper edge of the attic:	11.0 m

top wind speed pressure:

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

Wind pressure coefficient - outside

• Transverse wind flow (in y-direction)

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

h/d = 10.5 / 13.32 = 0.79
Zone A: $c_{pe,10}$ = - 1.2
Zone B: $c_{pe,10}$ = - 0.8
Zone C: $c_{pe,10}$ = - 0.5
Zone D: $c_{pe,10}$ = + 0.71
Zone E: $c_{pe,10}$ = - 0.32

• Oncoming wind (in x- direction)

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

h/d = 10.5 / 15.94 = 0.66
Zone A: $c_{pe,10}$ = - 1.2
Zone B: $c_{pe,10}$ = - 0.8
Zone C: $c_{pe,10}$ = - 0.5
Zone D: $c_{pe,10}$ = + 0.76
Zone E: $c_{pe,10}$ = - 0.41

Interior wind pressure coefficients

simplified (more unfavourable value): c_{pi} = +0.2 / -0.3

Resulting wind pressure

A partition according to ÖNORM EN 1991-1-4 of the walls arranged parallel to the wind impact direction is omitted and the value for zone B is regarded as decisive. It is further assumed that the deflection of the wind impact effects takes place via the subsequently described reinforcement system of the standard storey. The top floor was considered as a standard storey for reasons of simplification.

The wind pressure for the respective zones results from:
$$\mathbf{w = q_p \cdot (c_{pe} - w_{pi})}$$

• at a transverse wind flow (in y-direction)

Zone D: $w_{D,k}$ = 0.462 · (+0.71+0.2) = +0.420 kN/m²
≈ +0.45 kN/m²
Zone B: $w_{B,k}$ = 0.462 · (-0.8–0.3) = -0.508 kN/m²
≈ -0.50 kN/m²
Zone E: $w_{E,k}$ = 0.462 · (-0.32–0.3) = -0.286 kN/m²
≈ -0.30 kN/m²

• with transverse oncoming wind (in x-direction)

Zone D: $w_{D,k}$ = 0.462 · (+0.76+0.2) = +0.444 kN/m²
≈ +0.45 kN/m²
Zone B: $w_{B,k}$ = 0.462 · (-0.8–0.3) = -0.508 kN/m²
≈ -0.50 kN/m²
Zone E: $w_{E,k}$ = 0.462 · (-0.41–0.3) = -0.328 kN/m²
≈ -0.35 kN/m²

Resulting wind forces

• In a simplified formula, wind pressure is taken into account as w_k = ± 0.50 kN/m².

The dimensioning values of the resulting wind pressures are as follows:

• in x-direction:
$w_d = \gamma_Q \cdot w_k \cdot h_1 \cdot b$ = 1.50 · ± 0.50 · (2.5 · 3.15 + 1.0) · (13.32 + 1.03) = 95.5 kN

• in x-direction:
$w_d = \gamma_Q \cdot w_D \cdot h_1 \cdot b$ = 1.50 · ± 0.50 · (2.5 · 3.15 + 1.0) · (15.94 /2) = 53.1 kN

• Load capacity according to EN 1991-1-1

Assumptions:

Residential areas in category A1	q_k	= 2.00 kN/m²
partition wall surcharge	$q_{ZW,k}$	= 1.00 kN/m²
total load capacity	q_k	= 3.00 kN/m²

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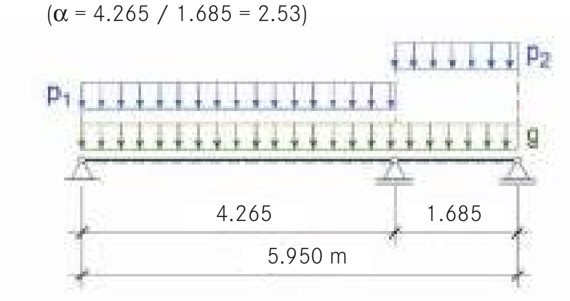
Static forces

The determination of the static forces is made for a ceiling or wall section with a with of b = 1 m. The preliminary factors for the verification of the double-layered ceiling strip were taken from a construction book.

Ceiling

l_1 = 4.265 m; l_2 = 1.685 m
(α = 4.265 / 1.685 = 2.53)



$B_{\text{“}1,0\text{“}}$ = „1.0“ · (|−1.109| + 1.506) · 1.685 = 4.406 kN/m
$M_{B\text{“}1,0\text{“}}$ = „1.0“ · (− 0.609) · 1.685² = −1.73 kNm/m

Dimensioning stress resultants:
min M_d = (−1.73) · [1.35 · 3.40 + 1.50 · 3.00] **≈ − 15.7 kN/m**
(max M_d not decisive!)

$V_{B,re;\text{“}1,0\text{“}}$ = (1.35 · 1.506 · 3.40 + 1.50 · 1.491 · 3.00) · 1.685
= 23.0 kN/m

Wall

Note: Proof of the load-bearing **MM HBE** solid timber wall is provided on the lowest floor with components made of wood.

Dimensioning stress resultants:
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)
= 37.4 kN/m

Proof

Proof - ceiling

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

Bending proof:

$$\sigma_{m,d} = \frac{M_d}{W} = \frac{15{,}7 \cdot 10^6}{\left(\frac{1.000 \cdot 140^2}{6}\right)} = 4{,}81\ N/mm^2$$

$$f_{m,d} = \frac{f_{c,0,k}}{\gamma_M} \cdot k_{mod} = \frac{24{,}0}{1{,}25} \cdot 0{,}80 = 15{,}4\ N/mm^2$$

Proof:

$$\frac{\sigma_{m,d}}{f_{m,d}} = \frac{4{,}81}{15{,}4} = 0{,}31 < 1{,}0$$

Shear proof:

$$\tau_d = 1{,}5 \cdot \frac{V_d}{A} = 1{,}5 \cdot \frac{23{,}0 \cdot 10^3}{1.000 \cdot 140} = 0{,}246\ N/mm^2$$

$$f_{v,d} = \frac{f_{v,k}}{\gamma_M} \cdot k_{mod} = \frac{2{,}50}{1{,}25} \cdot 0{,}80 = 1{,}60\ N/mm^2$$

Proof:

$$\frac{\sigma_{v,d}}{f_{v,d}} = \frac{0{,}246}{1{,}60} = 0{,}15 < 1{,}0$$

- **In the limit state of fitness for purpose**

Bending:
Bending in ceiling span 2 (in mid-span)

$$w_g = \frac{5}{384} \cdot \frac{3{,}40 \cdot 4.265^4}{11.600 \cdot \left(\frac{1.000 \cdot 140^3}{12}\right)} = 5{,}52\ mm$$

(by approximation, as a single-span girder)

$$w_p = \frac{5}{384} \cdot \frac{3{,}00 \cdot 4.265^4}{11.600 \cdot \left(\frac{1.000 \cdot 140^3}{12}\right)} = 4{,}87\ mm$$

Proof of characteristic (rare) load case combination

$$w = w_g + w_p = 5{,}52 + 4{,}87 = 10{,}4\ mm < \frac{l}{300} = \frac{4.265}{300} = 14{,}2\ mm$$

Proof of quasi-permanent load case combination

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

$$= (5{,}52 + 0{,}3 \cdot 4{,}87) \cdot (1 + 0{,}6) - 0 = 11{,}2\ mm < \frac{l}{250}$$

$$= \frac{4.265}{250} = 17{,}1\ mm$$

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Proof - wall

Buckling proof

Buckling length l_k	l_k = 3.00 m
Geometric slimness	$\lambda = l_k / i = 3{,}000 / (0.289 \cdot 100)$ = 104
Buckling coefficient k_c	for GL 24h: k_c = 0.340

$$\sigma_{c,0,d} = \frac{N_d}{b \cdot h} = \frac{109 \cdot 10^3}{1.000 \cdot 100} = 1{,}09\,N/mm^2$$

$$f_{c,0,d} = \frac{f_{c,0,k}}{\gamma_M} \cdot k_{mod} = \frac{21{,}0}{1{,}25} \cdot 0{,}80 = 13{,}4\,N/mm^2$$

Proof

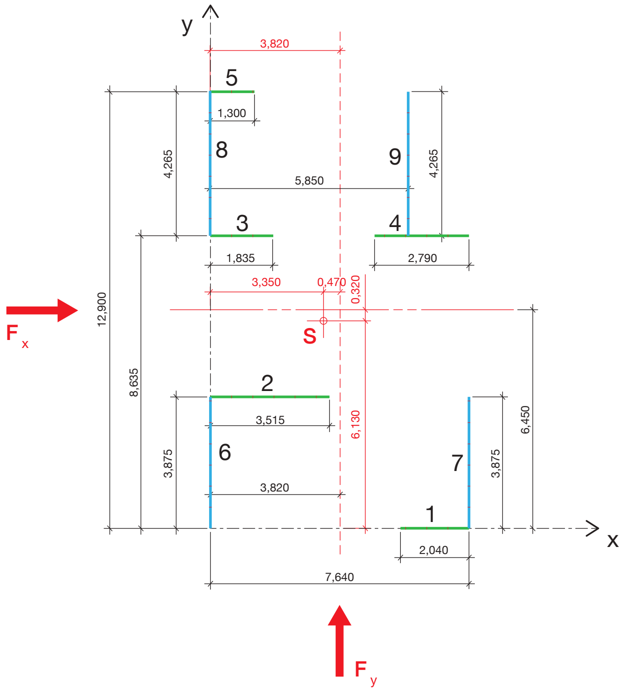
$$\frac{\sigma_{c,0,d}}{k_c \cdot f_{c,0,d}} = \frac{1{,}09}{0{,}340 \cdot 13{,}4} = 0{,}24 < 1{,}0$$

Proof of the load-bearing capacity of stiffening walls for MM HBE solid wood elements - Determination of the proportions per wall for shear reinforcement

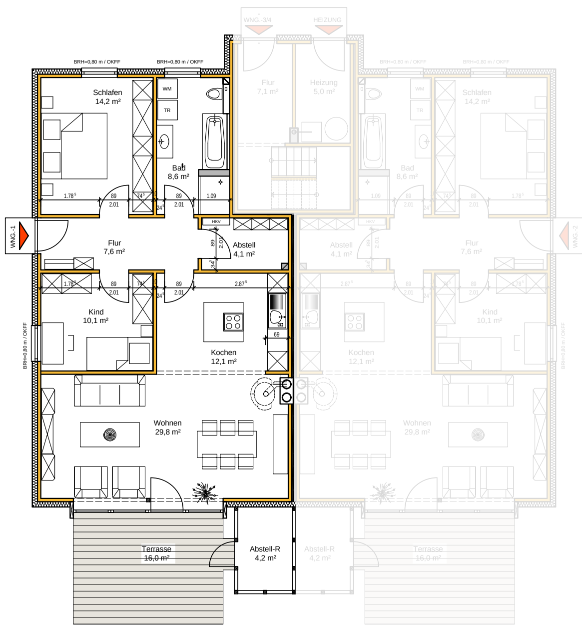
Coordinates of the centre of mass

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	-	12.9	-	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

$$x_M = \frac{\sum_{i=1}^{n} x \cdot l_x}{\sum_{i=1}^{n} l_x} = \frac{54{,}560}{16{,}280} = 3{,}35\,m \qquad y_M = \frac{\sum_{i=1}^{n} y \cdot l_y}{\sum_{i=1}^{n} l_y} = \frac{70{,}330}{11{,}480} = 6{,}13\,m$$



Reinforcement system with location and length of the stiffening walls.



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Determination of shear forces per wall and verification according to EN 1995-1-1

Determination of 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	17.0	-	-	76.6	-	-1.86	-	15.1
2	29.2	-	-	17.8	-	-1.18	-	28.1
3	15.3	-	-	11.6	-	0.686	-	16.0
4	23.2	-	-	17.6	-	1.04	-	24.3
5	10.8	-	-	59.7	-	1.31	-	12.1
6	-	12.6	43.5	-	-1.94	-	10.7	-
7	-	12.6	71.3	-	2.48	-	15.1	-
8	-	13.9	47.9	-	-2.13	-	11.8	-
9	-	13.9	26.6	-	1.59	-	15.5	-
Total	**95.5**	**53.0**	**189**	**183**				

Verification according to EN 1995-1-1

The verification in the limit state of load capacity is exclusively performed for the horizontal impact of wind.

As an example, the proof for the stiffening wall section 3 (wall length l_x = 1.835 m) is shown:

- The removal of the horizontal impacts is carried out by a gypsum fibreboard (t = 15 mm) attached on one side.
  The dimensioning value of the shear stress in the sheeting is (assumptions:
  Service class 1, load impact class (KLED):
  Wind “short/very short, k_{mod} = 0.95,
  component safety coefficient γ_M = 1.30)

$$f_{v,d} = k_{mod} \cdot \frac{f_{v,k}}{\gamma_M} = 0{,}95 \cdot \frac{3{,}50}{1{,}30} = 2{,}56 \text{ N/mn}$$

- Rated value of the horizontal impact: $F_{V,3,Ed}$ = 16.0 kN
- Shearing stress in the sheeting

$$f_{v,0,d} = \frac{F_{v,Ed}}{l_i \cdot t} = \frac{16{,}0 \cdot 10^3}{1.835 \cdot 15} = 0{,}581 \text{ N/mm}^2$$

Proof

$$\frac{\tau_{v,0,d}}{f_{v,0,d}} = \frac{0{,}581}{2{,}56} = 0{,}23 < 1{,}0$$

Proof of fasteners

Fasteners used: Clamps Ø 2 mm | l = 60 mm

- Bearing stress stability

$$f_{h,k} = 7 \cdot d^{-0.7} \cdot t^{0.9} = 7 \cdot 2{,}0^{-0.7} \cdot 15^{0.9} = 49{,}3 \text{ N/mm}^2$$

- Yield

$$M_{y,k} = 0{,}3 \cdot f_{u,k} \cdot d^{2.6} = 0{,}3 \cdot 850 \cdot 2{,}0^{2.6} = 1.546 \text{ Nmm}$$

- Load capacity per fastener

$$F_{v,Rk} = 0{,}7 \cdot \sqrt{2 \cdot M_{y,k} \cdot f_{h,k} \cdot d} = 2 \cdot 0{,}7 \cdot \sqrt{2 \cdot 1.546 \cdot 49{,}3 \cdot 2{,}0} = 773 \text{ N}$$

$$R_{d,ws} = k_{mod} \cdot \frac{F_{v,Rk}}{\gamma_M} \cdot \eta = 1{,}00 \cdot \frac{773}{1{,}10} = 703 \text{ N}$$

$$s = \frac{R_{d,ws}}{F_{v,l,d}} \cdot l = \frac{703}{16{,}0 \cdot 10^3} \cdot 1.835 = 80{,}6 \text{ mm} \approx 75 \text{ mm}$$

Proof for wall 3

$F_{v,3,d}$ = 16.0 kN | N_d = 37.4 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 the wall - tie anchoring required!

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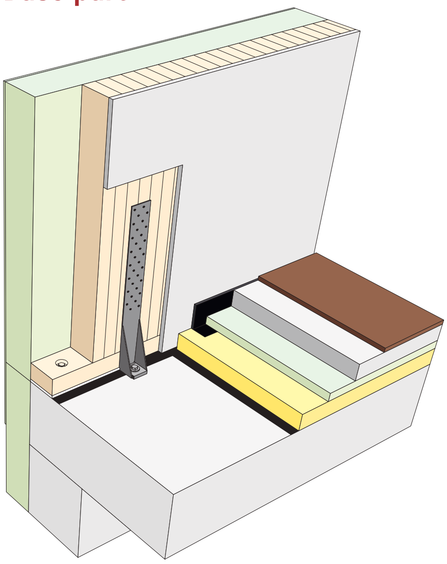
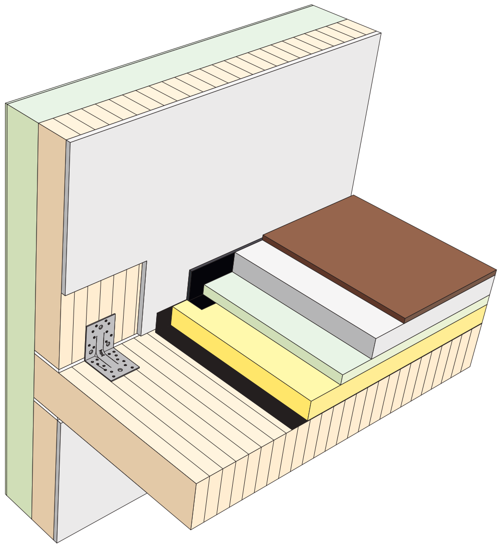
Schematic depiction of connection details

The following graphics show the exemplary connection of **MM HBE** elements as a wall, roof and ceiling element.

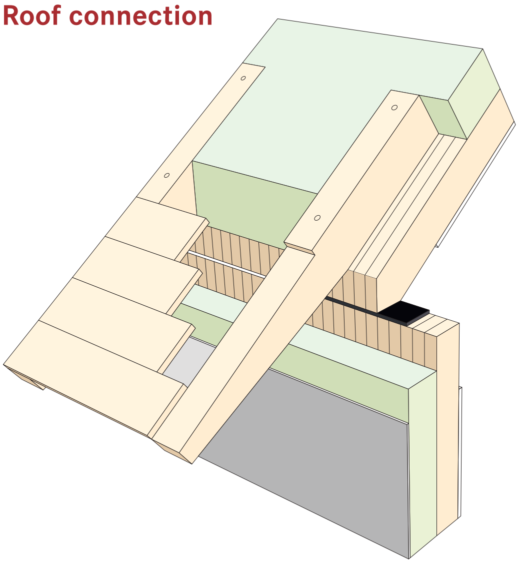
Base part



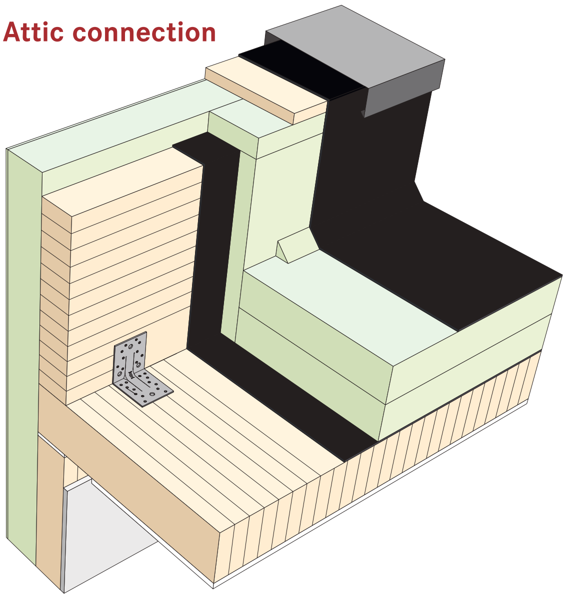
Storey ceiling connection



Roof connection



Attic connection



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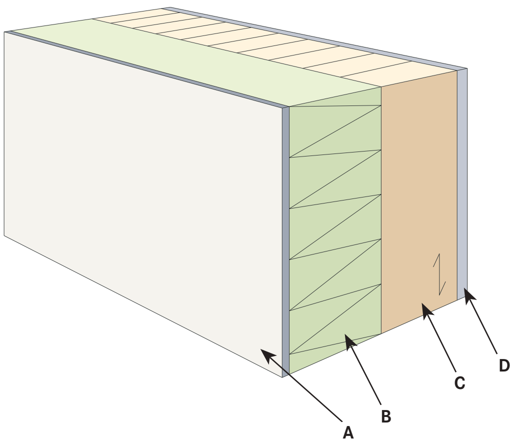
Building physics

The following component assemblies are suggestions. The specified building physics parameters serve as reference values and may vary depending on the construction product used.

Exterior wall with compound thermal insulation system

Component structure	
A Rendering system	7 mm
B Rock wool	120 mm
C **MM HBE** Solid timber element (according to structural analysis)	100 mm
D Gypsum fibreboard	15 mm
Total component thickness	**242 mm**

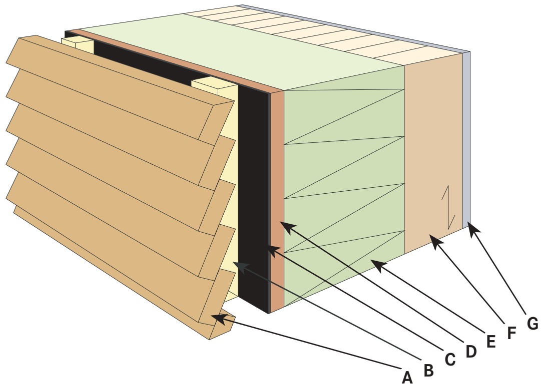
Building physics key data	
Heat protection U-value	**0.25 W / (m²K)**
Diffusion behaviour	suitable
Sound protection $R_w(C; C_{tr})$	39 (-1; -6) dB
Fire protection REI from inside REI from outside	90 min 60 min



Exterior wall with wooden facade and rear ventilation

Component structure	
A Wooden exterior wall facing	20 mm
B Battens (30/50 mm)	30 mm
C Film allowing diffusion	–
D Gypsum fibreboard	15 mm
E Wooden fibre insulation board	200 mm
F **MM HBE** Solid timber element (according to structural analysis)	100 mm
G Gypsum fibreboard	15 mm
Total component thickness	**380 mm**

Building physics key data	
Heat protection U-value	**0.17 W / (m²K)**
Diffusion behaviour	suitable
Sound protection $R_w(C; C_{tr})$	43 dB
Fire protection REI from inside REI from outside	60 min 30 min



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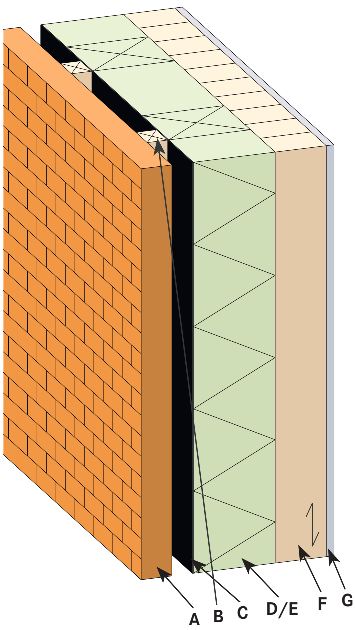
Clinker facade

Component structure	
A Clinker	60 mm
B Rear ventilation	40 mm
C Film allowing diffusion	–
D Construction wood	160 mm
E Mineral wool	160 mm
F **MMHBE** Solid timber element (according to structural analysis)	100 mm
G Rigips fire protection slab	15 mm
Total component thickness	**535 mm**

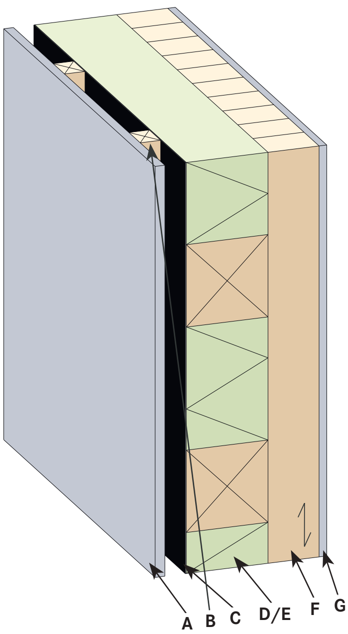
Building physics key data	
Heat protection U-value	**0.21 W / (m²K)**
Diffusion behaviour	suitable
Sound protection $R_w(C; C_{tr})$	45 dB
Fire protection REI	60 min



Wooden material facade

Component structure	
A Wooden exterior wall facing	19 mm
B Battens (40 / 60 mm)	40 mm
C Film allowing diffusion	–
D Construction wood	160 mm
E Mineral wool	160 mm
F **MMHBE** Solid timber element (according to structural analysis)	100 mm
G Rigips fire protection slab	15 mm
Total component thickness	**494 mm**

Building physics key data	
Heat protection U-value	**0.21 W / (m²K)**
Diffusion behaviour	suitable
Sound protection $R_w(C; C_{tr})$	45 dB
Fire protection REI	60 min



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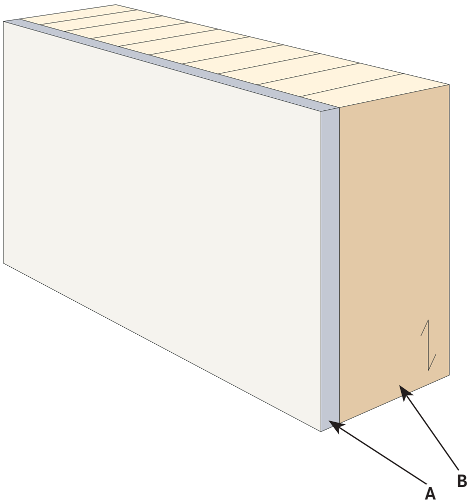
Interior wall - one-sided in visible quality

Component structure	
A Gypsum fibreboard	15 mm
B **MM HBE** Solid timber element (according to structural analysis)	100 mm
Total component thickness	**115 mm**

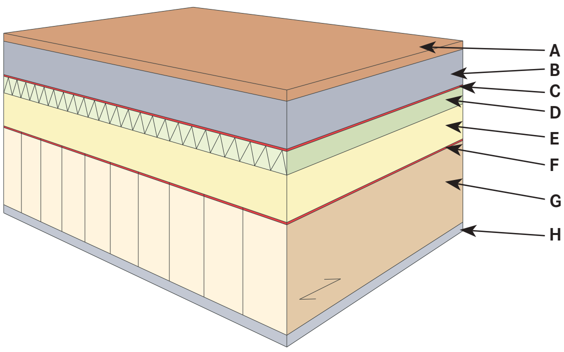
Building physics key data	
Heat protection U-value	**k.A.**
Diffusion behaviour	suitable
Sound protection $R_w(C; C_{tr})$	k.A.
Fire protection REI	30 min



Storey ceiling with wet floor screed

Component structure	
A Flooring	15 mm
B Cement screed	60 mm
C Plastic separation layer	–
D Footfall insulation 35/30	30 mm
E Bonded split filling	60 mm
F Film	–
G **MM HBE** Solid timber element (according to structural analysis)	140 mm
H Gypsum fibreboard	15 mm
Total component thickness	**320 mm**

Building physics key data	
Heat protection U-value	**0.43 W / (m²K)**
Diffusion behaviour	suitable
Sound protection $R_w(C; C_{tr})$ $L_{n,w}$ (C_I)	62 dB 52 dB
Fire protection REI	60 min



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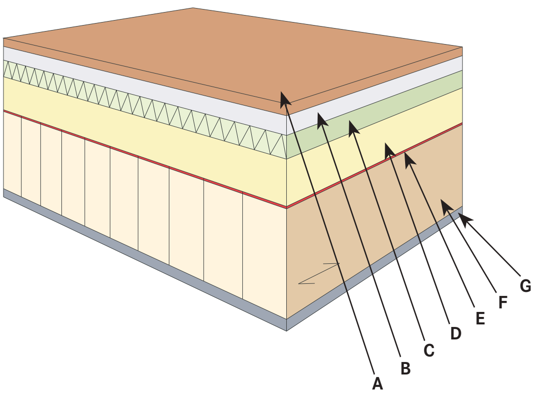
Storey ceiling with dry floor screed

Component structure	
A Flooring	15 mm
B Dry screed	25 mm
C Footfall insulation 35/30	30 mm
D Filling bound elasticallyn	60 mm
E Film	–
F **MM HBE** Solid timber element (according to structural analysis)	140 mm
G Gypsum fibreboard	15 mm
Total component thickness	**285 mm**

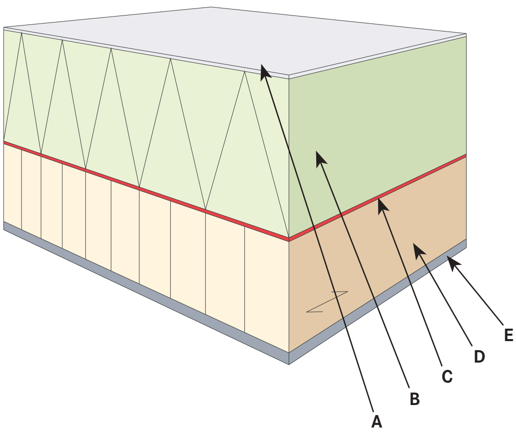
Building physics key data	
Heat protection U-value	k.A.
Diffusion behaviour	suitable
Sound protection $R_w(C; C_{tr})$ $L_{n,w}$ (C_I)	62 (-5; -13) dB 50 (-1) dB
Fire protection REI	60 min



Flat roof with sealing film

Component structure	
A Roof sealing sheeting	7 mm
B Wooden fibre insulation board	120 mm
C Sealing sheeting	–
D **MM HBE** Solid timber element (according to structural analysis)	100 mm
E Gypsum fibreboard	15 mm
Total component thickness	**242 mm**

Building physics key data	
Heat protection U-value	**0.21 W / (m²K)**
Diffusion behaviour	suitable
Sound protection $R_w(C; C_{tr})$	43 (-2; -7) dB
Fire protection REI	30 min



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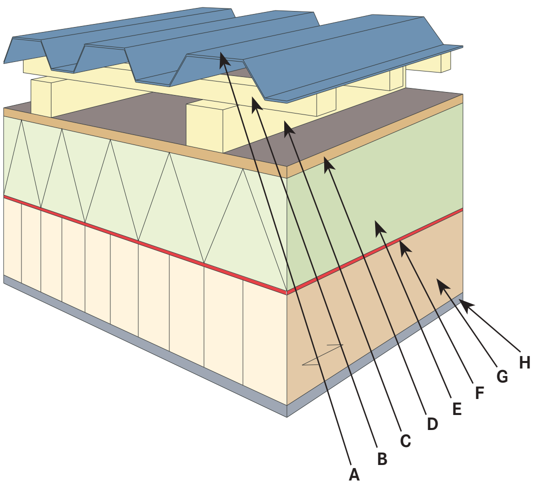
Flat roof with tin roof

Component structure	
A Trapezoidal sheet metal	–
B Roof battens (50/30 mm)	30 mm
C Counter lathing (80/50 mm)	50 mm
D Underlay sheeting	–
E Insulation on rafters	180 mm
F Sealing sheeting	–
G **MM HBE** Solid timber element (according to structural analysis)	100 mm
H Gypsum fibreboard	15 mm
Total component thickness	**375 mm**

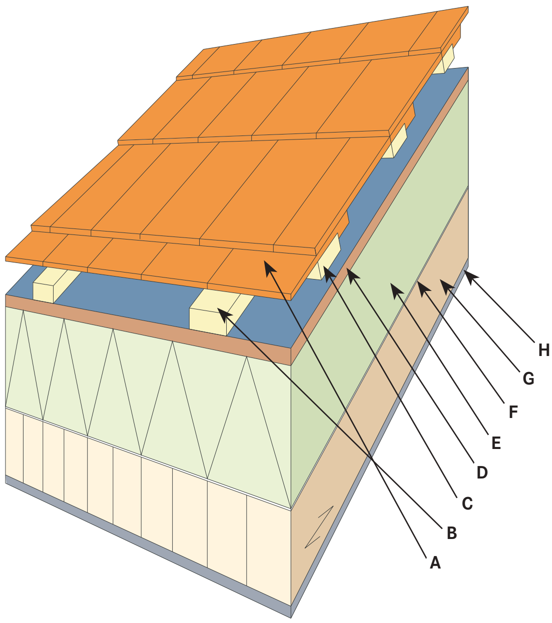
Building physics key data	
Heat protection U-value	**0.16 W / (m²K)**
Diffusion behaviour	suitable
Sound protection $R_w(C; C_{tr})$	45 dB
Fire protection REI	30 min



Steep roof with tile cover

Component structure	
A Tile covered roofing	–
B Roof battens (50/30 mm)	30 mm
C Counter lathing (80/50 mm)	50 mm
D Under-roof board	22 mm
E Wooden fibre insulation board	180 mm
F Sealing sheeting	–
G **MM HBE** Solid timber element (according to structural analysis)	120 mm
H Gypsum fibreboard	15 mm
Total component thickness	**417 mm**

Building physics key data	
Heat protection U-value	**0.16 W / (m²K)**
Diffusion behaviour	suitable
Sound protection $R_w(C; C_{tr})$	45 (-1; -7) dB
Fire protection REI	30 min



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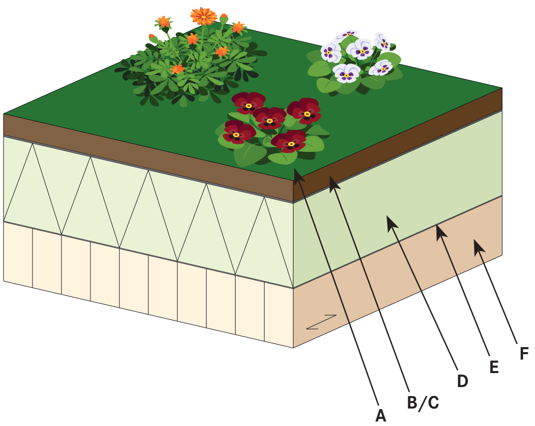
Green roof with visible surface inside

Component structure	
A Filling	50 mm
B Separation fleece	–
C Roof sealing sheeting	–
D Wooden fibre insulation board	200 mm
E Sealing sheeting	–
F **MM HBE** Solid timber element (according to structural analysis)	140 mm
Total component thickness	**390 mm**

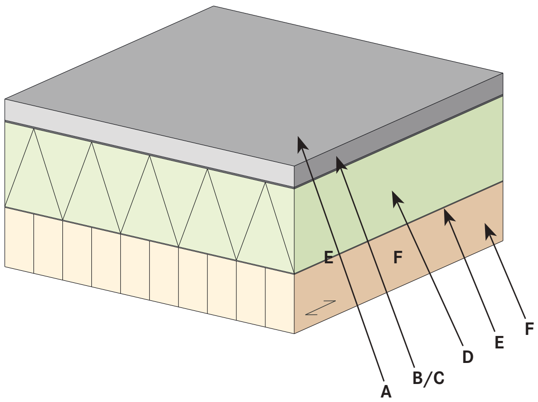
Building physics key data	
Heat protection U-value	**0.21 W / (m²K)**
Diffusion behaviour	suitable
Sound protection $R_w(C; C_{tr})$	50 dB
Fire protection REI	30 min



Roof with visible surface inside

Component structure	
A Filling	50 mm
B Separation fleece	–
C Roof sealing sheeting	–
D Wooden fibre insulation board	200 mm
E Sealing sheeting	–
F **MM HBE** Solid timber element (according to structural analysis)	140 mm
Total component thickness	**390 mm**

Building physics key data	
Heat protection U-value	**0.21 W / (m²K)**
Diffusion behaviour	suitable
Sound protection $R_w(C; C_{tr})$	50 dB
Fire protection REI	30 min



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