KLH®

MADE FOR BUILDING
BUILT FOR LIVING

RIB ELEMENTS

IMPRINT

Version: Rib Elements, 09/2019

Publisher and responsible for content: © KLH Massivholz GmbH

KLH®

CONTENT

RIB ELEMENTS

01 PRODUCT DESCRIPTION. AREAS OF APPLICATION AND ADVANTAGES

KLH® rib elements provide architects and planners with additional freedom in the design and realisation of long-span rooms.

From spans of about 6 m and more, the combination of rib and panel as composite cross-section usually offers more effective and more economical solutions. Moreover, this lightweight type of construction hardly adds any additional weight to a building due to its slim constructional design.

Use of KLH® rib elements at an event hall

The preferred arrangement of the ribs is on the lower side of the KLH® solid wood panel. Depending on individual preferences, the area of application or requirements as to the visual appearance, the ribs can also be arranged on the upper side of the KLH® solid wood panel.

MAIN ADVANTAGES

- Architectural freedom of design
- Flexible room concepts
- Free bridging of long spans
- Space between ribs can be used
- Lightweight construction with usable space between the ribs
- Free from pillars and trussed beams
- Economically sound solution
- ...

THE USEFUL SPACE IN BETWEEN

The space between the ribs can be used in order to route various installations, but it is also suitable for the installation of acoustic or decorative elements.
As can be seen in figures 1 and 2, it can be flush with the rib or in a recessed variant. Especially for public buildings such as school buildings, the requirements for pleasant room acoustics are much easier to fulfil this way.

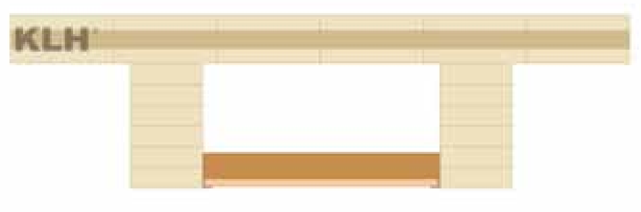


Fig. 1: Room between ribs with acoustic element - variant flush with the surface

FREELY SELECTABLE DIMENSIONS

The dimensions of KLH® rib elements can be freely selected. There are no restrictions whatsoever in terms of dimensions or thickness of the elements. The only thing that needs to be taken into consideration is the maximum size of the KLH® solid wood panel with its length of 16.5 m and width of 2.95 m, as well as the transport options for an economically sound delivery to the construction site.

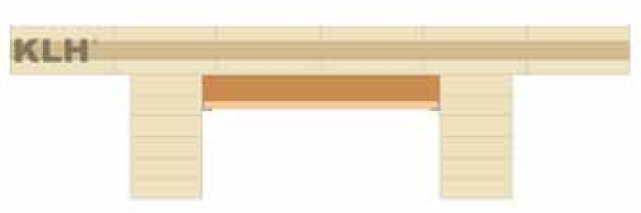


Fig. 2: Room between ribs with acoustic element – recessed variant

Acoustic element variants in the space between the ribs

PRODUCTION

KLH® rib elements are delivered to the construction site in the form of completely prefabricated elements. Glued laminated spruce timber is the preferred type of wood for the ribs. Both the ribs as well as the KLH® solid wood panels used have proven to meet the requirements of the E1 formaldehyde emission class.

The production of this composite unit is subject to strict quality controls based on the ÖNORM EN 14080:2013 for a permanent and reliable glued connection between ribs and panel. It is also possible to produce the elements with an additional elevation according to the structural requirements.

Both the glued laminated timber ribs and the KLH® solid wood panels can be installed in visible and non-visible quality. A mixture of surface qualities such as panels in non-visible quality and ribs in visible quality is also possible.

The manipulation is carried out using certified hoisting systems both during pre-manufacturing as well as during the installation at the construction site.

Finished rib elements, ready for transport

CROSS-SECTIONAL DESIGN

The preferred cross-sectional designs are either rib elements with slim edge ribs and element joints in the areas of the ribs or T-elements with floating element joints between the ribs.

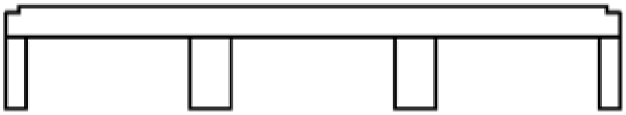


Fig. 3: Cross-sectional design for connections with top board

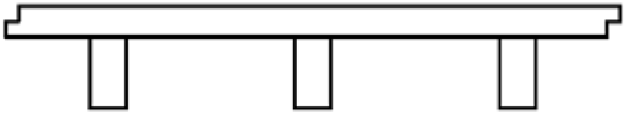


Fig. 4: Cross-sectional design for connections with stepped joint

TRANSPORT

The elements are best transported lengthwise and horizontally. If the rib elements are very high, it is reasonable to design the elements asymmetrically and to interlace them in pairs in order to optimise transport.

eos-af (estudio Orpinell & Sanchez—artesania fotogràfica)

02 CONSTRUCTION AND CALCULATION

EFFECTIVE WIDTH

The glued connection between rib and panel is a rigid connection. It must be taken into account that the top layer of the KLH® solid wood panel must always run in the direction of the glued laminated timber ribs. The structural calculation of rib elements is performed according to the compound theory in consideration of the shear elasticity of the transverse layers of the KLH® solid wood panel. The dimensioning is based on a net cross-section that consists of the cross-section of the ribs and the cross-section of the longitudinal layers of the KLH® solid wood panel.

The contributing panel width of the KLH® solid wood panel depends on a number of factors – such as the distance between ribs and its relation to the span and the type of load (uniformly distributed load or concentrated load).

Concerning this topic, reference can also be made to the latest research results of the Competence Centre at holz.bau forschungs GmbH at the Graz Technical University that has carried out in-depth research on the scientific determination of the effective width.

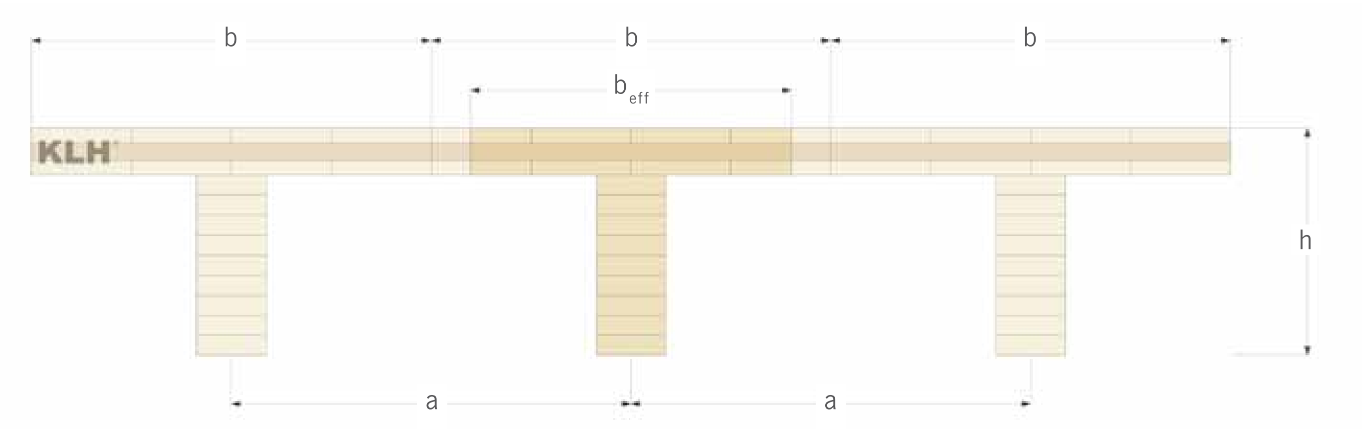


Fig. 5: Dimensions of the T-beam cross-section

For an economical dimensioning of the KLH® rib elements we recommend selecting the distance between the axes of the ribs for slab elements in the range between 40 to 60 cm as well as for roof elements in the range between 60 to 120 cm. Each element requires at least 2 ribs.

You can use our KLH® structural pre-analysis software available for download at www.klh.at so you can pre-dimension KLH® rib elements quickly and easily.

TRANSVERSE CONNECTION OF ELEMENTS

The detailed design of the element transverse connection is best selected in a way that the rib elements can be connected at the construction site by means of simple screw connections. The transverse connection can either be a stepped joint or top board connection.

These shear-resistant connections couple the individual elements to form a structurally effective floor slab or roof diaphragm.

If vertical, differential forces can be expected to build up between the elements, then an additional crosswise screw connection of elements is usually made in the joint by means of self-drilling, fully-threaded screws.

STEPPED JOINT CONNECTION

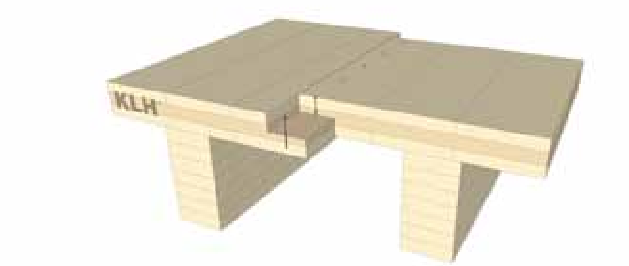


Fig. 6: Element connection with screw-connected stepped joint

TOP BOARD CONNECTION

Fig. 7: Element connection with screw-connected top board

Making of transverse connections

eos-af (estudio Orpinell & Sanchez—artesania fotográfica)

DETAILED DESIGN AT THE SUPPORT

SUPPORT SETTINGS

Fig. 8: Adjusted opening for the ribs in the wall element

Fig. 9: Support of ribs at the wall element with suitable filling of the space in between

Fig. 10: Support of the slab against the wall.
The ribs are fixed against the wall element with suitable connectors

The high load-bearing capacity of the KLH® rib elements, especially with regard to the bending stiffness and strength in the field area, is due to both the panel and the rib. The greatest transverse forces, and therefore also the greatest shear stress, build up in the area of the supports. These forces are almost exclusively absorbed by the ribs. It is therefore important to design the supports of rib elements in a way that the elements are directly supported by the ribs.

As regards the detailed design, it must be taken into account that volume changes due to swelling or shrinking of wood in case of changes in the moisture of the wood are possible without causing any damage.

In some cases it might be necessary that only the panel is rested on the support and that the ribs already end before the support and will not actually be supported themselves (e.g. if space is required for transverse installations along the wall). In such cases, thicker KLH® solid wood panels must be chosen, because they are able to transmit the transverse forces onto the support.

Furthermore, additional transverse force reinforcements between rib and panel must be installed at the rib ends in order to ensure a permanent connection in the glue joint.

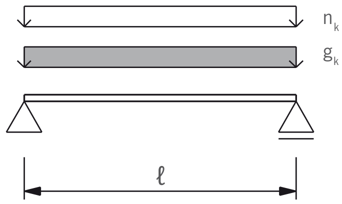
For more detailed information, please contact our technical customer support.

03 KLH® RIB ELEMENT AS A FLOOR SLAB – SINGLE-SPAN GIRDER

3.1 VIBRATION TEST FOR LOW REQUIREMENTS

Minimum panel thicknesses for R 0 (cold dimensioning)

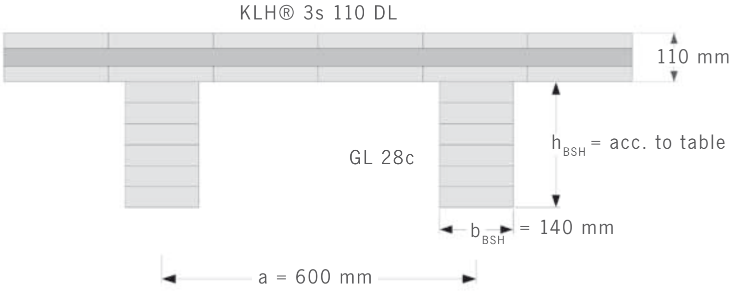
according to ETA-06/0138
ÖNORM EN 1995-1-1:2019 and ÖNORM B 1995-1-1:2019
ÖNORM EN 1995-1-2:2011 and ÖNORM B 1995-1-2:2011



Constant load g_k*) [kN/m²]	KAT	Imposed load n_k [kN/m²]	REQUIRED RIB HEIGHT [mm] FOR A SPAN OF ℓ: 6.00 m		7.00 m		8.00 m		9.00 m		10.00 m	
			Dry screed	Wet screed	Dry screed	Wet screed	Dry screed	Wet screed	Dry screed	Wet screed	Dry screed	Wet screed
1.00	A	1.50	160		200		240		280		360	
		2.00										
		2.80										
	B	3.00										
		3.50										
	C	4.00	200		240		280		320			
		5.00							360		400	
1.50	A	1.50	160	160	200	200	240	240	320	320	400	360
		2.00										
		2.80										
	B	3.00										
		3.50										
	C	4.00	200	200	240	240	280	280	360	360		400
		5.00					320	320				
2.00	A	1.50	160	160	200	200	280	240	360	320	400	320
		2.00										360
		2.80										
	B	3.00			240	240		280				
		3.50										
	C	4.00	200	200			320	320		360		400
		5.00			280	280						440
2.50	A	1.50	160	160	240	240	320	280	360	320	440	360
		2.00										
		2.80	200	200								
	B	3.00										
		3.50										
	C	4.00			280	280		320		360		440
		5.00	240	240					400	400		
3.00	A	1.50	200	200	240	240	320	280	400	320	480	360
		2.00										400
		2.80								360		
	B	3.00										
		3.50										
	C	4.00	240	240	280	280		320		400		440
		5.00					360	360				

Dry screed | Wet screed

*) in addition to the rib elements' own weight (the rib elements' own weight is already taken into account in the table)



Service class 2

$k_{def} = 0.8$

Imposed load categories A and B ($\psi_0 = 0.7$ and $\psi_2 = 0.3$): $k_{mod} = 0.8$

Imposed load category C ($\psi_0 = 0.7$ and $\psi_2 = 0.6$): $k_{mod} = 0.9$

Deflection limits above the requirements of ÖNORM EN 1995-1-1:2019

a) characteristic structural design situation: $w_{Q.inst} \leq \ell/400$ and $(w_{fin} - w_{G.inst}) \leq \ell/250$

b) quasi-permanent structural design situation: $w_{fin} \leq \ell/300$

Vibration test according to ÖNORM B 1995-1-1:2019

a) floor slab class II: slab within the utilisation unit (e.g. detached house); floating wet screed (even without filler); dry screed, floating on heavy filler (at least 60 kg/m²)

b) Limit value of the frequency and stiffness criterion: $f_{1.min} \geq 4.5$ Hz; $f_1 \geq f_{gr} = 6$ Hz; $w_{stat} \leq w_{gr} = 0.50$ mm

c) Attenuation factor for cross-laminated timber floor slabs with floating screed and heavy floor structure: $\zeta = 4.0$ %

d) Limit value acceleration (required at $f_{1.min} \leq f_1 \leq f_{gr}$): $a_{rms} \leq a_{gr} = 0.10$ m/s²

Load-bearing capacity

a) Test of bending stress

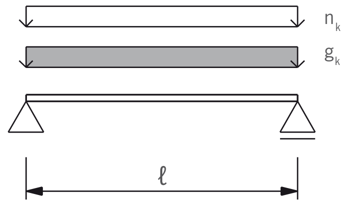
b) Test of shear stress

Structural fire design (one-sided burn-off on panel, 3-sided burn-off on rib)

The fire analysis is currently not taken into account in the structural pre-analysis tables. According to our experience, the specified building components achieve a fire resistance of at least REI 30. Higher fire resistance classes require additional measures (increase of board or rib dimensions, panelling of essential building components).

This table is only intended for structural pre-analysis purposes and does not replace necessary structural calculations!

3.2 VIBRATION TEST FOR INCREASED REQUIREMENTS



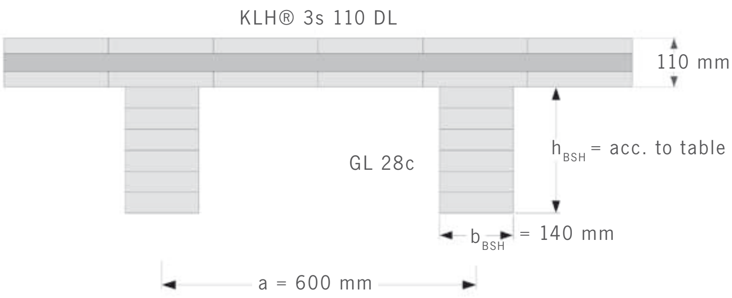
Minimum panel thicknesses for R 0 (cold dimensioning)

according to ETA-06/0138
ÖNORM EN 1995-1-1:2019 and ÖNORM B 1995-1-1:2019
ÖNORM EN 1995-1-2:2011 and ÖNORM B 1995-1-2:2011

Constant load g_k*) [kN/m²]	KAT	Imposed load n_k [kN/m²]	REQUIRED RIB HEIGHT [mm] FOR A SPAN OF ℓ: 6.00 m (Dry screed)	6.00 m (Wet screed)	7.00 m (Dry screed)	7.00 m (Wet screed)	8.00 m (Dry screed)	8.00 m (Wet screed)	9.00 m (Dry screed)	9.00 m (Wet screed)	10.00 m (Dry screed)	10.00 m (Wet screed)
1.00	A	1.50	240		280		360		400		480	
		2.00										
		2.80										
	B	3.00										
		3.50										
	C	4.00										
		5.00										
1.50	A	1.50	240	200	280	240	360	320	400	400	520	480
		2.00										
		2.80										
	B	3.00										
		3.50										
	C	4.00										
		5.00										
2.00	A	1.50	240	200	280	280	360	360	440	440	560	520
		2.00										
		2.80										
	B	3.00										
		3.50										
	C	4.00										
		5.00										
2.50	A	1.50	240	240	320	320	400	400	480	440	560	520
		2.00										
		2.80										
	B	3.00										
		3.50										
	C	4.00										
		5.00										
3.00	A	1.50	240	240	320	320	400	400	520	440	600	520
		2.00										
		2.80										
	B	3.00										
		3.50										
	C	4.00										
		5.00										

Dry screed | Wet screed

*) in addition to the rib elements' own weight (the rib elements' own weight is already taken into account in the table)



Service class 2

$k_{def} = 0.8$
Imposed load categories A and B ($\psi_0 = 0.7$ and $\psi_2 = 0.3$): $k_{mod} = 0.8$
Imposed load category C ($\psi_0 = 0.7$ and $\psi_2 = 0.6$): $k_{mod} = 0.9$

Deflection limits above the requirements of ÖNORM EN 1995-1-1:2019

a) characteristic structural design situation: $w_{Q.inst} \leq \ell/400$ and $(w_{fin} - w_{G.inst}) \leq \ell/250$
b) quasi-permanent structural design situation: $w_{fin} \leq \ell/300$

Vibration test according to ÖNORM B 1995-1-1:2019

a) floor slab class I: slab between different utilisation units (e.g. separating floor slabs for apartments or offices); wet screed, floating on filler; dry screed, floating on heavy filler (at least 60 kg/m²)
b) Limit value of the frequency and stiffness criterion: $f_{1.min} \geq 4.5$ Hz; $f_1 \geq f_{gr} = 8$ Hz; $w_{stat} \leq w_{gr} = 0.25$ mm
c) Attenuation factor for cross-laminated timber floor slabs with floating screed and heavy floor structure: $\zeta = 4.0$ %
d) Limit value acceleration (required at $f_{1.min} \leq f_1 \leq f_{gr}$): $a_{rms} \leq a_{gr} = 0.05$ m/s²

Load-bearing capacity

a) Test of bending stress
b) Test of shear stress

Structural fire design (one-sided burn-off on panel, 3-sided burn-off on rib)

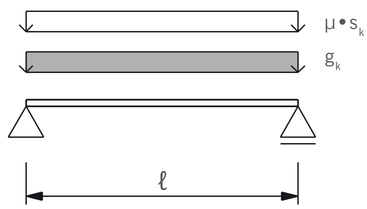
The fire analysis is currently not taken into account in the structural pre-analysis tables. According to our experience, the specified building components achieve a fire resistance of at least REI 30. Higher fire resistance classes require additional measures (increase of board or rib dimensions, panelling of essential building components).

This table is only intended for structural pre-analysis purposes and does not replace necessary structural calculations!

04 KLH® RIB ELEMENT AS A ROOF – SINGLE-SPAN GIRDER

Deflection

Appearance and avoidance of damage
Minimum panel thicknesses for R 0 (cold dimensioning)



according to ETA-06/0138
ÖNORM EN 1995-1-1:2019 and ÖNORM B 1995-1-1:2019
ÖNORM EN 1995-1-2:2011 and ÖNORM B 1995-1-2:2011

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FOR A SPAN OF ℓ</th></tr>
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[kN/m²]</th><th>$s = \mu * s_k$
[kN/m²]</th><th>8.00 m</th><th>9.00 m</th><th>10.00 m</th><th>11.00 m</th><th>12.00 m</th></tr>
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<tr><td>7.00</td><td>360</td><td>520</td></tr>
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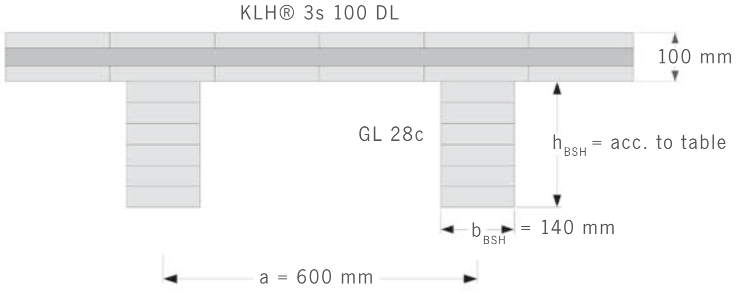
*) in addition to the rib elements' own weight (the rib elements' own weight is already taken into account in the table)



Service class 2

$k_{def} = 0.8$

Snow load at an altitude ≤ 1.000 m above sea level ($\psi_0 = 0.5$ und $\psi_2 = 0$): $k_{mod} = 0.9$

Deflection limits above the requirements of ÖNORM EN 1995-1-1:2019

a) characteristic structural design situation: $w_{Q.inst} \leq \ell/400$ and $(w_{fin} - w_{G.inst}) \leq \ell/250$

b) quasi-permanent structural design situation: $w_{fin} \leq \ell/300$

Load-bearing capacity

a) Test of bending stress

b) Test of shear stress

Structural fire design (one-sided burn-off on panel, 3-sided burn-off on rib)

The fire analysis is currently not taken into account in the structural pre-analysis tables. According to our experience, the specified building components achieve a fire resistance of at least REI 30. Higher fire resistance classes require additional measures (increase of board or rib dimensions, panelling of essential building components).

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NOTES

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For love of nature

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