KLH®
Massivholz GmbH

Engineering

VERSION 01/2008

www.KLH.cc

Panel Characteristics

Maximum dimensions	Length max. 16500 mm, Width max. 2950 mm, Thickness max. 500 mm
Board thicknesses	3-s TT : 57, 72, 94, 120 mm 3-s TL : 57, 60, 78, 90, 95, 108, 120 mm 5-s TT : 95, 125, 128, 158, 200 mm 5-s TL : 117, 125, 140, 146, 162, 182, 200 mm 7-s TL : 202, 226 mm 7-ss TL : 208, 230, 260, 280 mm (double longitudinal layers on faces of panel) 8-ss TL : 248, 300, 320 mm (double longitudinal layers on faces and centre of panel) TT = Top layer perpendicular to panel direction TL = Top layer parallel to panel direction s = Layers of boards Special board thicknesses available upon request for orders of 1000 m² and over
Production widths for calculation	2400 / 2500 / 2720 / 2950 mm
Deformation	In the plane of the panel : negligible Normal to the panel : 0.24 mm/m per % moisture
Moisture	12% (+/- 2%) – kiln dried
Fire resistance	0.67 mm/min for top layer(s) only 0.76 mm/min for other layers
Air tightness	The air tightness of a cross-laminated timber panel construction depends on the density of the panels and on the design of the panel joints. Tests on cross-laminated panels (1000 mm x 1000 mm) showed that 3-Layer panels in visible industrial quality [isi] and 5-Layer panels in non-visible quality [nsi] act as air tight panels. Tests on a room module with 3-Layer cross-laminated wall elements and 3-Layer floor elements including built-in windows and doors, but without insulation and façade construction resulted in the following average overpressure and under-pressure: n50< 0.6 h-1 – test certificate B03.851.007 (size of the test room module L/W/H 8000 mm x 4200 mm x 2500 mm, volume approx. 85 m³ – walls in domestic quality [wsi], ceiling in visible industry quality)
λ - value	0.13 W/(m²K)
Specific heat capacity	1600 J/(kgK)
ρ density	480 kg/m³
Thermal mass	Visible cross-laminated wall panel - without covering approx. 40 kg/m² - covered with 1 layer of gypsum plasterboard approx. 45 kg/m² - covered with 2 layers of gypsum plasterboard approx. 50 kg/m²

Technical Approvals and Certificates

European Technical Approval
ETA-06/0138

The European Technical Approval ETA-06/0138 has existed since July 2006. Extracts from this approval are included in this brochure. For specific projects, we can send you the full version of the European Technical Approval if required.

German Technical Approval
Z-9.1-482

The product has also been approved by the general building supervision authorities for Germany since May 2000. The German Institute for Civil Engineering issued this approval.
KLH Massivholz GmbH has been awarded the "Leimgenehmigung" (gluing approval) by the Research and Material Testing Institute (MPA) - Otto Graf Institute, Stuttgart according to stringent criteria. It has a valid supervision contract with MPA Stuttgart. This contract is a prerequisite for the validity of the approval.
Other quality tests range from delamination tests to testing the quality of glue joints.

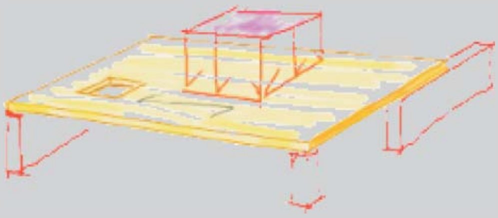
French Technical Approval
AT-3/06-477

The "KLH" cross-laminated timber panel has also been approved as a supporting wall, floor and roof element by the French Centre Scientifique et Technique du Bâtiment (CSTB) since the end of 2002.

РСС АТ.СЛ42.Н00041 РСС АТ.СЛ42.Н00264

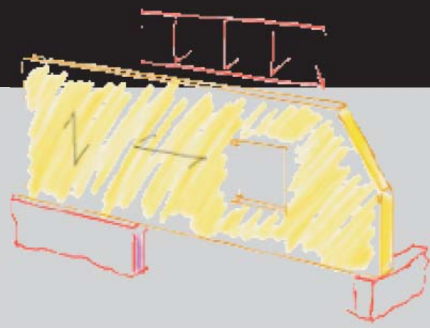
The PEFC certificate acknowledges that the timber used for production originates from sustainable forest cultivation.

Panel Strengths According to ETA-06/0138



LOAD APPLIED PARALLEL TO FACING GRAIN

MECHANICAL STRENGTH	VERIFICATION PROCEDURE	STRENGHT
Modulus of Elasticity		
– Parallel to the direction of the panel grain $E_{0,\ mean}$	$I_{eff,}$ Annex 4, CUAP 03.04/06, 4.1.1.1	12.000 MPa
– Normal to the direction of the panel grain $E_{90,\ mean}$	EN 338	370 MPa
Shear modulus		
– Parallel to the direction of the panel grain G_{mean}	EN 338	690 MPa
– Normal to the direction of the panel grain, Roll shear module $G_{R,\ mean}$	CUAP 03.04/06, 4.1.1.1	50 MPa
Bend strength		
– Parallel to the direction of the panel grain $f_{m,\ k}$	$W_{eff,}$ Annex 4, CUAP 03.04/06, 4.1.1.1	24 MPa
Tensile strength		
– Normal to the direction of the panel grain $f_{t,\ 90,\ k}$	EN 1194, reduced	0,12 MPa
Compressive strength		
– Normal to the direction of the panel grain $f_{c,\ 90,\ k}$	EN 1194	2,7 MPa
Shear strength		
– Parallel to the direction of the panel grain $f_{v,\ k}$	EN 1194	2,7 MPa
– Normal to the direction of the panel grain (Roll shear strength) $f_{R,\ V,\ k}$	$A_{gross,}$ Annex 4 CUAP 03.04/06, 4.1.1.3	1,5 MPa



LOAD APPLIED IN THE PLANE OF FACING GRAIN

MECHANICAL STRENGTH	VERIFICATION PROCEDURE	STRENGHT
Modulus of elasticity – Parallel to the direction of the panel grain $E_{0, mean}$	$A_{net,}$ $I_{net,}$ Annex 4, CUAP 03.04/06, 4.1.2.1	12.000 MPa
Shear modulus – Parallel to the direction of the panel grain G_{mean}	$A_{net,}$ Annex 4, CUAP 03.04/06, 4.1.2.3	250 MPa
Bending strength – Parallel to the direction of the panel grain $f_{m, k}$	$W_{net,}$ Annex 4, CUAP 03.04/06, 4.1.2.1	23 MPa
Tensile strength – Parallel to the direction of the panel grain $f_{t, 0, k}$	EN 1194	16,5 MPa
Compressive strength – Parallel to the direction of the panel grain $f_{c, 0, k}$ – Concentrated, parallel to panel grain $f_{c, 0, k}$	EN 1194 CUAP 03.04/06, 4.1.2.2	24 MPa 30 MPa
Shear strength – Parallel to the direction of the panel grain $f_{v, k}$	$A_{net,}$ Annex 4, CUAP 03.04/06, 4.1.2.3	5,2 MPa

CONNECTIONS

Spacings of screws/nails/bolts in accordance with European Technical Approval ETA-06/0138.
The grain direction of a cross laminated timber panel is to be taken as the grain direction of the facing layer of the panel.

CROSS-SECTIONAL VALUES OF DIFFERENT KLH CROSS-LAMINATED PANEL TYPES

FACING LAYERS ALIGNED TO PANEL TRANSVERSE DIRECTION TT

Nominal thickness		⊥	=	⊥	=	⊥	A net	A q	I full	I effective (depending on span length L)			I effective / I full		
										L=1000mm	L=2000mm	L=2950mm	L=1000mm	L=2000mm	L=2950mm
in mm	Layers	t	l	t	l	t	$[mm^2]$	$[mm^2]$	$[10^4 mm^4]$	$[10^4 mm^4]$	$[10^4 mm^4]$	$[10^4 mm^4]$	%	%	%
57	3 s	19	19	19			38000	57000	1543	1075	1354	1422	69.7%	87.8%	92.2%
72	3 s	19	34	19			38000	72000	3110	1626	2354	2567	52.3%	75.7%	82.5%
94	3 s	30	34	30			60000	94000	6922	3233	5169	5845	46.7%	74.7%	84.4%
95	5 s	19	19	19	19	19	57000	95000	7145	3129	4692	5168	43.8%	65.7%	72.3%
128	5 s	30	19	30	19	30	90000	128000	17476	6805	11446	13146	38.9%	65.5%	75.2%
158	5 s	30	34	30	34	30	90000	158000	32869	7869	15997	19911	23.9%	48.7%	60.6%

FACING LAYERS ALIGNED TO PANEL LONGITUDINAL DIRECTION TL

Nominal thickness		=	⊥	=	⊥	=	⊥	=	A net	A q	I full	I effective (depending on span length L)				I effective / I full			
												L=2000mm	L=4000mm	L=6000mm	L=8000mm	L=2000mm	L=4000mm	L=6000mm	L=8000mm
in mm	Layers	l	t	l	t	l	t	l	$[mm^2]$	$[mm^2]$	$[10^4 mm^4]$	$[10^4 mm^4]$	$[10^4 mm^4]$	$[10^4 mm^4]$	$[10^4 mm^4]$	%	%	%	%
60	3 s	19	22	19					38000	60000	1800	1535	1663	1690	1699	85.3%	92.4%	93.9%	94.4%
78	3 s	19	40	19					38000	78000	3955	2814	3245	3341	3375	71.2%	82.0%	84.5%	85.3%
90	3 s	34	22	34					68000	90000	6075	5020	5707	5858	5913	82.6%	93.9%	96.4%	97.3%
95	3 s	34	27	34					68000	95000	7145	5629	6578	6795	6875	78.8%	92.1%	95.1%	96.2%
108	3 s	34	40	34					68000	108000	10498	7292	9113	9566	9736	69.5%	86.8%	91.1%	92.7%
120	3 s	40	40	40					80000	120000	14400	9752	12511	13227	13499	67.7%	86.9%	91.9%	93.7%
117	5 s	19	30	19	30	19			57000	117000	13347	6993	8585	8965	9107	52.4%	64.3%	67.2%	68.2%
125	5 s	19	34	19	34	19			57000	125000	16276	7892	9914	10410	10596	48.5%	60.9%	64.0%	65.1%
140	5 s	34	19	34	19	34			102000	140000	22867	14799	18416	19305	19638	64.7%	80.5%	84.4%	85.9%
146	5 s	34	22	34	22	34			102000	146000	25934	15761	20181	21307	21733	60.8%	77.8%	82.2%	83.8%
162	5 s	34	30	34	30	34			102000	162000	35429	18347	25181	27084	27822	51.8%	71.1%	76.4%	78.5%
182	5 s	34	40	34	40	34			102000	182000	50238	21608	31979	35161	36435	43.0%	63.7%	70.0%	72.5%
200	5 s	40	40	40	40	40			120000	200000	66667	27890	42995	47923	49938	41.8%	64.5%	71.9%	74.9%
202	7 s	34	22	34	22	34	22	34	136000	202000	68687	38927	49559	52243	53257	56.7%	72.2%	76.1%	77.5%
226	7 s	34	30	34	30	34	30	34	136000	226000	96193	45728	62232	66775	68533	47.5%	64.7%	69.4%	71.2%
208	7 ss	68	19	34	19	68			170000	208000	74991	43322	61508	66987	69167	57.8%	82.0%	89.3%	92.2%
230	7 ss	68	30	34	30	68			170000	230000	101392	45979	74100	84238	88534	45.3%	73.1%	83.1%	87.3%
* 260	7 ss	80	30	40	30	80			200000	260000	146467	62593	104691	120992	128094	42.7%	71.5%	82.6%	87.5%
* 280	7 ss	80	40	40	40	80			200000	280000	182933	64335	117634	141238	152124	35.2%	64.3%	77.2%	83.2%
248	8 ss	68	22	68	22	68			204000	248000	127108	66273	98047	108149	112241	52.1%	77.1%	85.1%	88.3%
* 300	8 ss	80	30	80	30	80			240000	300000	225000	92760	155646	179997	190606	42.1%	69.2%	80.0%	84.7%
* 320	8 ss	80	40	80	40	80			240000	320000	273067	92386	169137	203126	218802	33.8%	61.9%	74.4%	80.1%

* Special panel types, price upon request, all data refer to panel strips 1000 mm in width

- A net — Cross-sectional value for calculating the compressive stresses in the direction of the face layer orientation
- A q — Cross-sectional value for calculating the shear stresses for load transfer in the direction of the face layer
- I full — Moment of inertia of the full cross section – reference value only
- I effective — Moment of inertia for the composite cross section, including the percentage shear deformation for load transfer in the direction of the covering layers
- I effective / I full — Ratio that indicates how much the transverse layers change the moment of inertia of the cross section.
- W effective — Moment of resistance for calculating the stress resulting from bending moments = I effective / (h* 0.5)
- i effective — Radius of gyration of the composite cross section for calculating the slenderness = root (I effective / A net)

APPROXIMATELY REALISTIC CALCULATION METHOD

The exact calculation of load-bearing systems must take into account the flexible bond between the individual longitudinal layers (shear deformation). The shear modulus of the transverse layers (rolling shear) can be assumed to be $50N/mm^2$. The exact calculation method is set out in Eurocode 5 (EN 1995-1-1) Section 9.1.3 and Annex B.

PRACTICAL APPROXIMATION METHOD FOR CALCULATING CUTTING FORCES AND DEFORMATION

It is also possible to determine the cutting forces by approximation from the bending strength (effective moment of inertia and net surface) (see ÖNORM B 4100/2 Ch. 4.1.7, or “Bauen mit Holz” 5/2001 Blaß/Görlacher, and EC 5).
The cutting forces calculated from the net moments of inertia and/or the resulting shear and longitudinal stresses are – especially with statically indeterminate systems - only approximations, with deviations of about 10% from the exact values.
However, since the stresses in supporting structures subject to bending under normal loads and applications are far below the permissible stresses, there is no need for a more precise calculation in normal cases.
For deformations, the effective moment of inertia can be used – but these figures depend on the span lengths in question:
Shorter supporting structures mean a lower effective moment of inertia, which means these calculations are on the safe side.
These calculation results are of course not exact for statistically indeterminate systems. Whether the approximation method can be applied must be assessed in each individual case, or clarified with the responsible authorities and inspecting structural engineers.
The effective moments of inertia are calculated for mainly uniform loads; in the case of high individual loads and very short supporting structure lengths, a more precise calculation method is required. (exact calculation of shear deformation – transverse layers with $G = 50N/mm^2$).
For calculating cutting forces using conventional computer programs, a ceiling strip, for example, of width 1000 mm * I_{eff} / I_{full} and cross-sectional height equal to the nominal thickness of the panel can be used.
Material quality to use is GL24 or GL28. The loads are to be assumed for a strip of 1000 mm. For a span of 4000 mm and a 146 mm thick floor, a floor strip would accordingly be 778 mm wide and 146 mm high. This already includes the shear deformation.

LOAD-BEARING CAPACITY OF THE PANELS TRANSVERSE TO THE DIRECTION OF STRESS IN THE COVERING LAYERS

The bending strength of the boards transverse to the direction of stress of the covering layers can be determined by calculating the cross-sectional values without accounting for the covering layers.

In many cases, the structure in the transverse direction corresponds to the structure of a 3-layer board, and can thus be taken from the chart. With 3-layer boards, the middle layer can be calculated as a solid wood cross section.

WINDOW AND DOOR LINTELS

Window and door lintels can be dimensioned by calculating solid wood beams with the dimensions of the laminations running in the direction of the lintel (for TT boards – e.g. walls – the longitudinal layers). As a rule, it can be assumed that the beam is fixed at both ends. If the adjoining wall pillar is narrower than the height of the beam, it must be assumed there is an articulated bearing.

WALL DIAPHRAGMS

For calculation of the walls as wall diaphragms, a frame system with longitudinal and transversal beams can be assumed. In this case, the longitudinal beams can be made using solid wood cross sections with longitudinal laminations (e.g. 34 x h in mm for a KLH 3-s 94 mm) and the transverse beams made using solid wood cross sections with transverse laminations (e.g. 60 x h in mm for a KLH 3-s 94 mm). The heights of the individual beam cross-sections must be determined in each individual case.

Wall diaphragms can also be calculated taking into account window and door openings.

KLH AND FIRE PROTECTION

The charring rate of KLH panels is 0.76 mm/min.
This figure takes account of the faster combustion at seams and joints and also the board joint by means of a rebate joint.
If other covering layer burns, a charring rate of 0.67 mm/min should be used.

Should a layer burn away entirely, the effective stiffness of the panel reduces accordingly. Panels with a 3-layer construction generally have a fire resistance period of 30 min (REI 30).
A 5-layer panel of the same or similar thickness generally have a fire resistance period of 60 min (REI 60), depending on the load. In the case of integral wall bearing walls, combustion from both sides must be considered. In this case it is recommended to use 5-layer panels with the covering layer in the longitudinal direction of the wall. The non-load-bearing longitudinal layers will burn away and the load-bearing transverse layers remain largely unaffected. Thus a fire-resistance period of 60 min or even 90 minutes or more with the appropriate board thickness can be achieved. 5-layer floor panels are as a rule REI 60, while in external walls, it is normally the wall pillars between windows or door openings that are the most critical. The fire resistance of floor panels and walls must be proven in each individual case, depending on load and corresponding national standard.

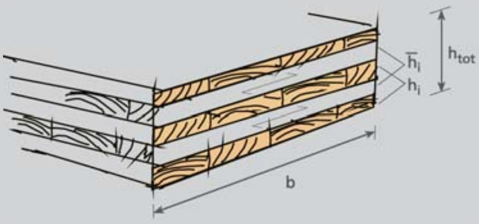
Depending on the statutory conditions, it is also possible to prove longer fire resistance durations by calculation (REI 90, REI 120, etc., depending on board thickness).
The reduced effective properties of a board can be calculated using the formula on page 6.

SPECIAL BOARD STRUCTURES

If sufficient quantities are ordered, it is also possible to produce panel structures different from those listed.
For example, to achieve greater bending strength, doubled edge laminates or doubled middle laminates can be used to increase the shear strength (the permissible shear stress for KLH must be complied with at the joint to the 1st transverse layer).
The transverse load-bearing capacity can be improved by using thinner longitudinal laminates and thicker transverse laminates.
As a general principle, given the production dimensions (length 16500 mm, width 2950 mm), only laminations with a thickness of 19 mm, 34 mm or 40 mm should be used in the direction of the length of the panel. In the direction of the width of the panel, only laminations of a thickness of 19 mm, 22 mm, 30 mm, 34 mm or 40 mm should be used. In special cases, it is also possible to use transverse laminations 27 mm thick.
The longitudinal layers cannot be swapped within one panel structure. However, with large quantities, it is possible to mix the transverse layers. The symmetrical panel structure must be retained in any event.
In order to achieve the surface qualities “visible industrial quality” (“Industriesicht” = ISI) and “domestic quality” (“Wohnsicht” = WSI), the boards of preference are TT panels with covering layers of 19 mm and 30 mm. TL panels would be with covering layers of 19 mm and 34 mm.

KLH Panels According to ETA-06/0138

KLH AS A FLOOR PANEL



h_i ......Thickness of the panel layers in the direction of the mechanical action

$\bar{h}_i$ ......Thickness of the panel layers normal to the direction of the mechanical action

For details on $I_{eff,}$ see Section 9.1.3 and Annex B of Eurocode 5 (EN 1995-1-1):

$$(EI)_{ef} = \sum_{i=1}^{3} (E_i\, I_i + \gamma_i\, E_i\, A_i\, a_i^2) \qquad \gamma_i = [1 + \pi^2 E_i\;\; A_i\, s_i /(K_i\, L^2)]^{1}$$

Where the beams are single-span beams with a span of L. For continuous beams, the equations can be used with L equal to 4/5 the size of the span and for cantilever beams with L as double the cantilever length.

The expression $\frac{s_i}{K_i}$ given in Eurocode 5 (EN 1995-1-1) should be substituted with $\frac{\bar{h}_i}{G_R \cdot b}$

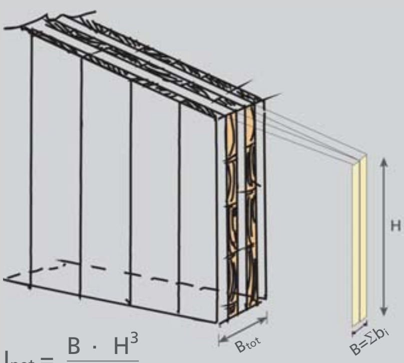
$$I_i = \frac{b_i \cdot h_i^3}{12} \qquad W_{eff} = \frac{2 \cdot I_{eff}}{h_{tot}}$$

$$A_i = b_i \cdot h_i \qquad h_{tot} = \sum_i (h_i + \bar{h}_i)$$

$$\tau_v = \frac{1{,}5 \cdot V}{A_{tot}} \qquad A_{tot} = b \cdot h_{tot}$$

For the two main directions of multi-axially suspended KLH boards, different stiffnesses in the two main directions must be taken into account.

KLH AS WALL DIAPHRAGM



H≤800 mm

b_i... Thicknesses of the parallel board layers

$$I_{net} = \frac{B \cdot H^3}{12} \qquad W_{net} = \frac{B \cdot H^2}{6}$$

$$\tau_v = \frac{1{,}5 \cdot V}{A_{net}} \qquad A_{net} = B \cdot H$$

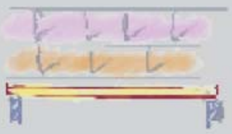
Wall diaphragms can be broken down into a frame system of longitudinal and transversal beams, with beam heights or width of max. 800 mm (Vierendeel truss).

The given height of 800 mm is due to the test setup with 800 mm high test bodies.

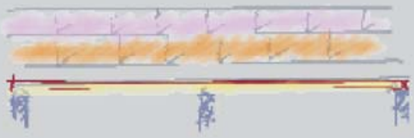
Reference Patterns

VERSION 01/2008

KLH as a wall



KLH as a single-span floor beam
(L/400, full load)



KLH as a double-span floor beam
(L/400, dead load, live load unfavourable on individual spans)

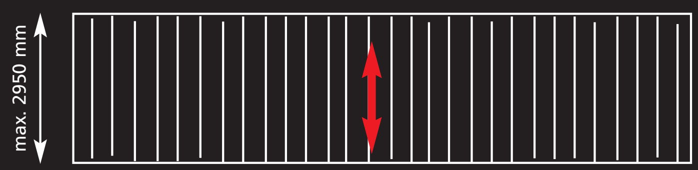
KLH as a triple-span floor beam
(L/400, dead load, live load unfavourable on individual spans)

KLH as a single-span roof beam
(L/300, full load)

KLH as a double-span roof beam
(L/300, full load)

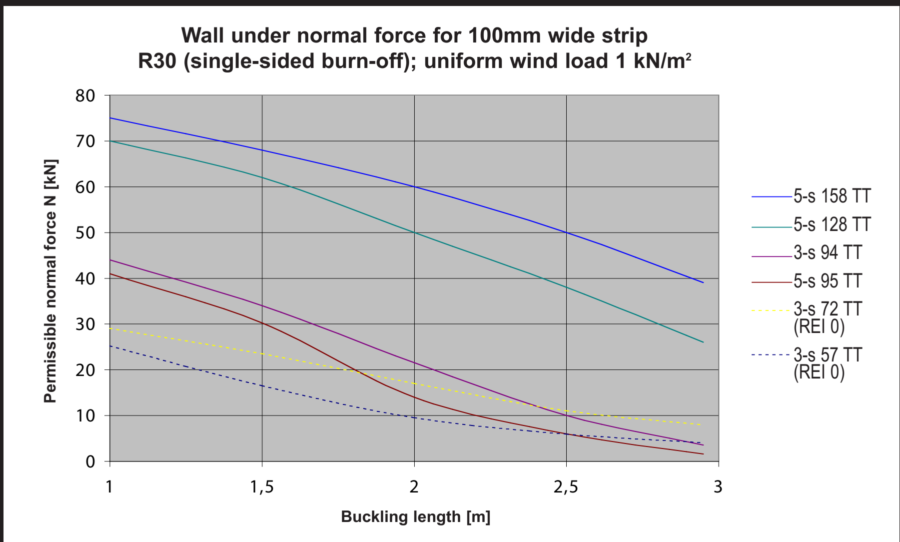
KLH as a triple-span roof beam
(L/300, full load)

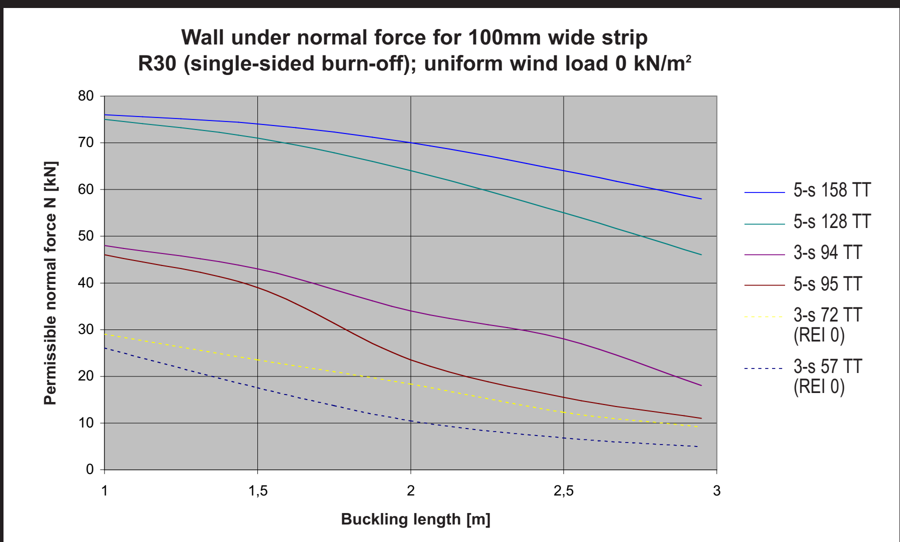
Reference Pattern



Produced board element

Orientation of covering layer transverse to the production length -> TT

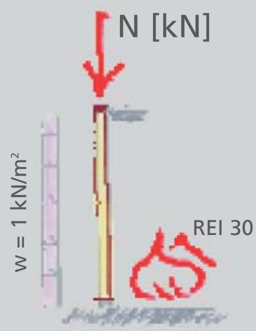




KLH AS A WALL

COMMENT

3-layer boards with a 19 mm covering layer do not achieve REI 30



Tabular values are calculated for a 100 mm wide wall post.

Tabular values are calculated for a 100 mm wide wall post.

Reference Pattern

Produced board lement

Panel length
max. 16500 mm

Orientation of covering layer longitudinal to the production length -> TL

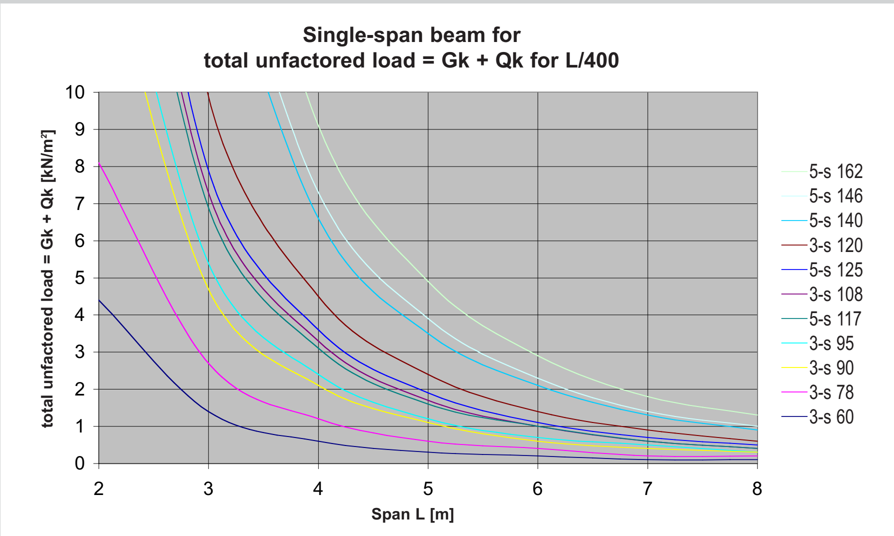
KLH AS A FLOOR

(L/400, full load)

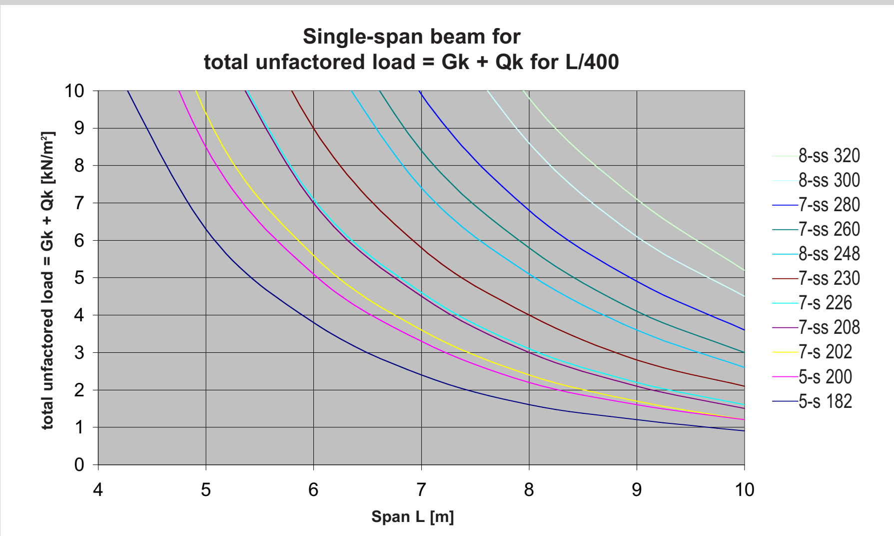
COMMENT

For large spans, the vibration of the floor must also be investigated.
However, if the span to depth ratio is limited to L/400, the floor panels usually have sufficient rigidity.

total unfactored load = Gk + Qk [kN/m²]



3-s panels with 34 mm thick edge laminations are rated REI 30 under normal building construction loads.



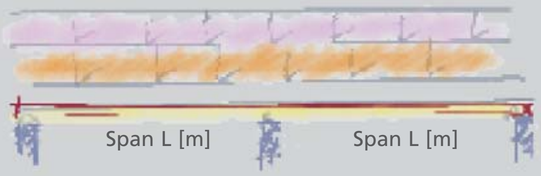
5-s and 7-s panels are rated REI 60 under normal building construction loads.

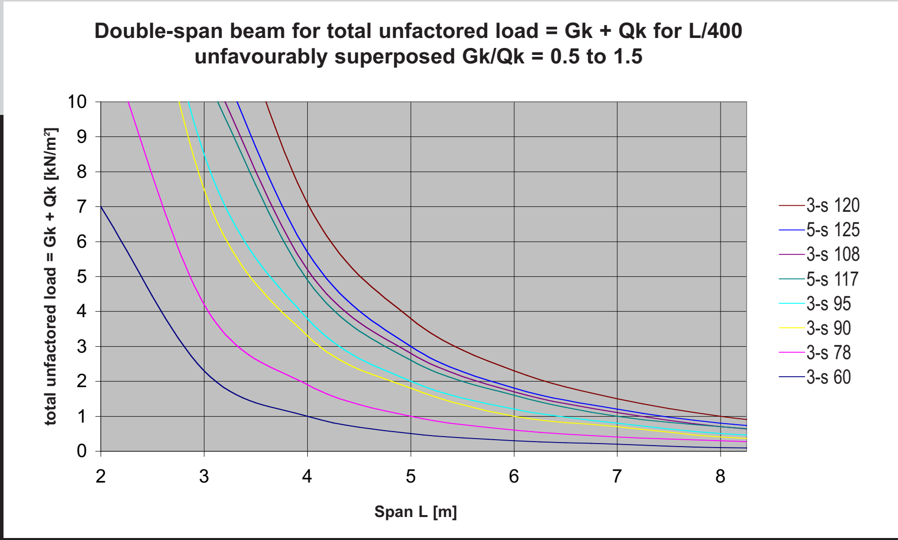
For higher permissible deformations, the tabular values can be converted using the following equation:

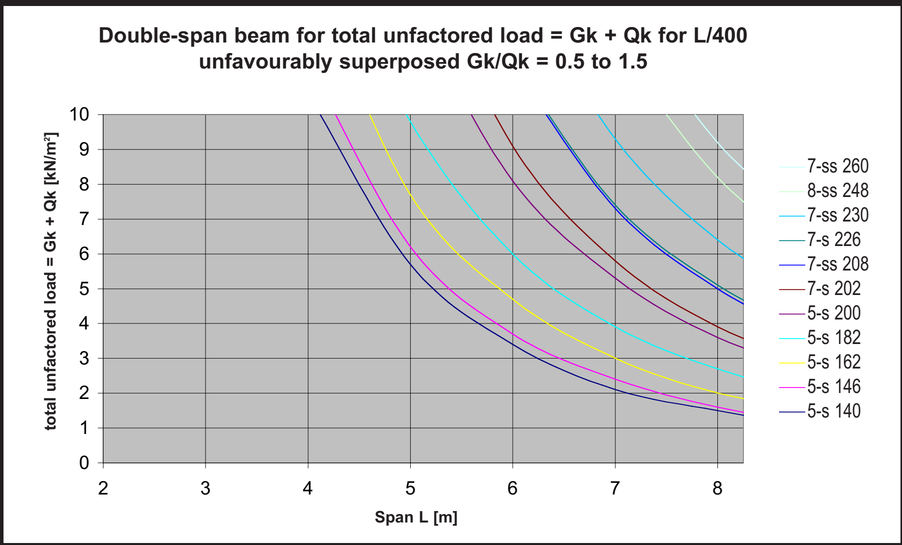
E.g. $u_{,\,perm\ L/300} = u_{perm\ L/400} \times \frac{400}{300}$

Reference Pattern

Load on Panel over 2 spans – e.g. for floor in a residential building







KLH AS A FLOOR

L/400, worst case total loads considering variable actions on full an alternate spans.

COMMENT

For large spans, the vibration of the floor must also be investigated.
However, if the span to depth ratio is limited to L/400, the floor panels usually have sufficient rigidity.

3-Ls panels with 34 mm thick edge laminations are rated REI 30 under normal loads.

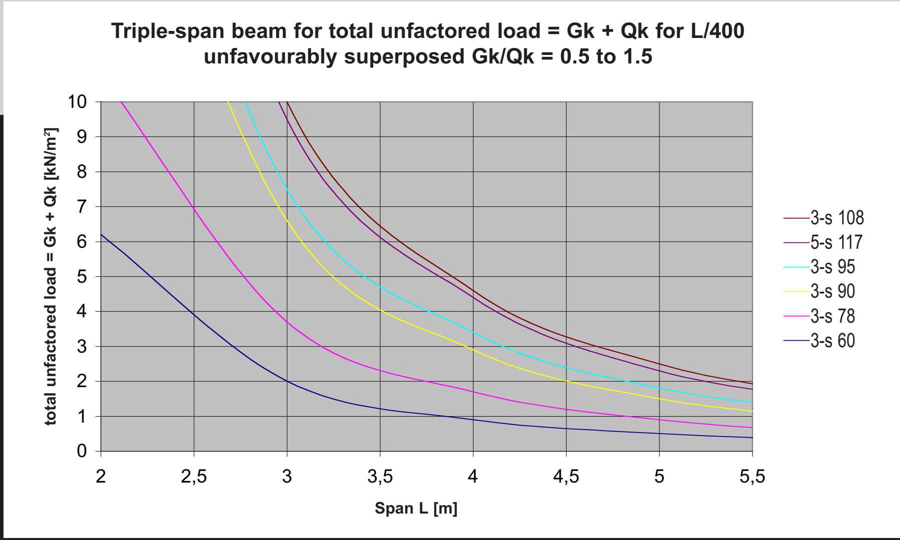
5-s and 7-s panels are rated REI 60 under normal loads.

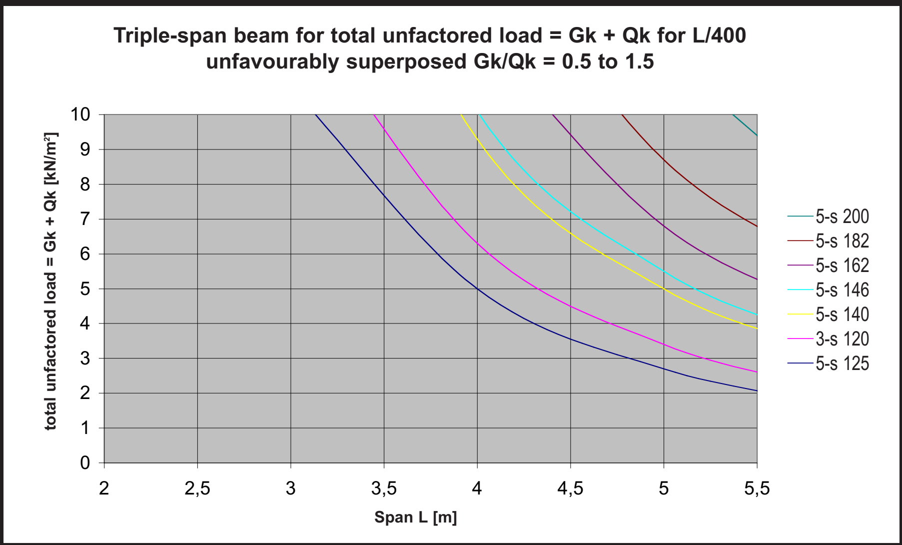
For higher permissible deformations, the chart values can be converted using the following equation :

E.g. $u_{\text{perm L/300}} = u_{\text{perm L/400}} \times \frac{400}{300}$

Reference Pattern

Load on panel over 3 spans – e.g. for floor in a residential building





KLH AS A FLOOR

L/400, worst case total loads considering variable actions on full an alternate spans.

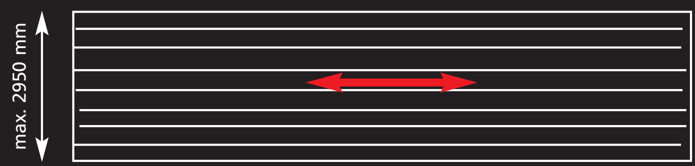
3-s panels with 34 mm thick edge laminations are rated REI 30 under normal loads.

5-s and 7-s panels are rated REI 60 under normal loads.

For higher permissible deformations, the chart values can be converted using the following equation :

E.g. $u_{\text{perm L/300}} = u_{\text{perm L/400}} \times \frac{400}{300}$

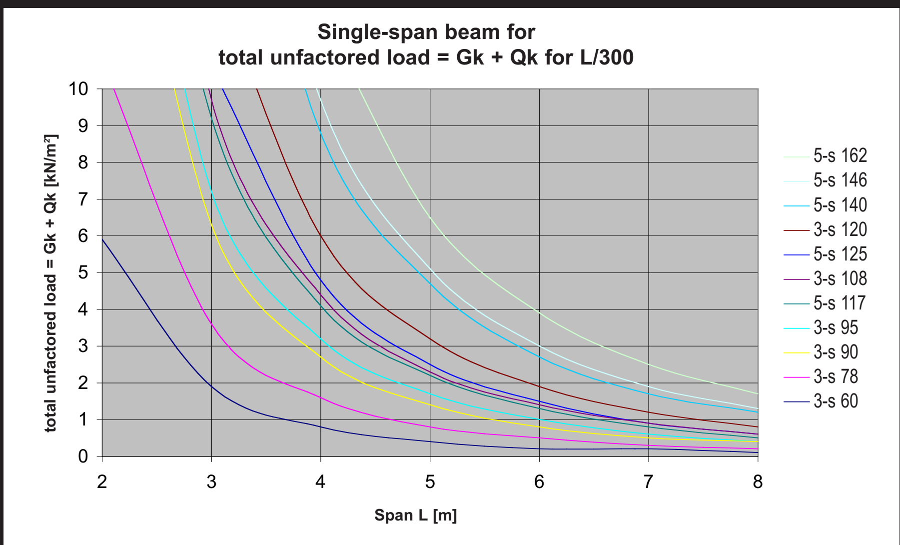
Reference Pattern

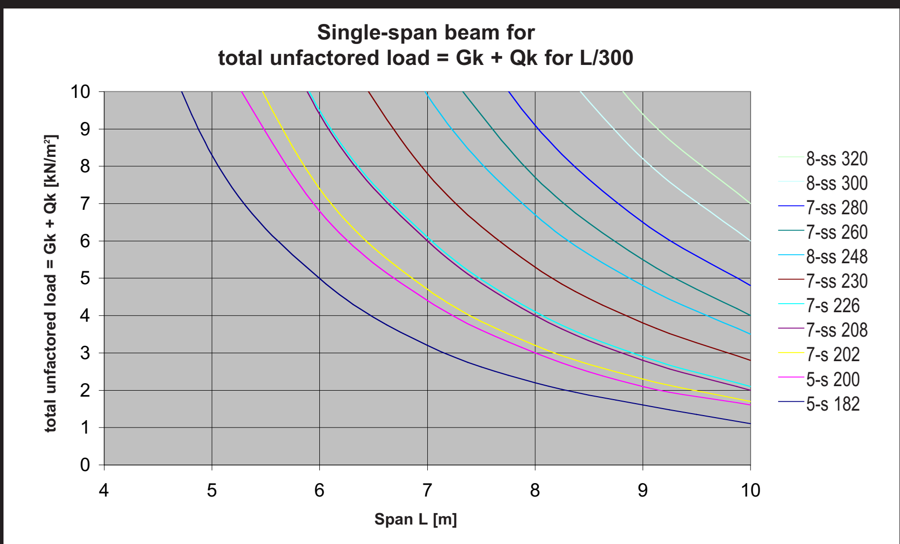


Produced board element

Board length
max. 16500 mm

Orientation of covering layer longitudinal to the production length -> TT





KLH AS A ROOF

L/300, worst case total loads considering variable actions on full spans.

3-s panels with 34 mm thick edge laminations are rated REI 30 under normal loads.

5-s and 7-s panels are rated REI 60 under normal loads.

For higher permissible deformations, the chart values can be converted using the following equation :

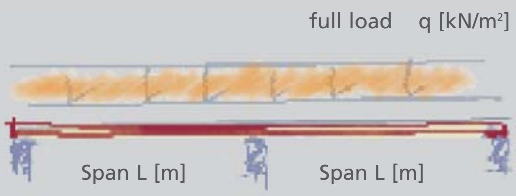
E.g. $u_{perm\ L/250} = u_{perm\ L/300} \times \frac{300}{250}$

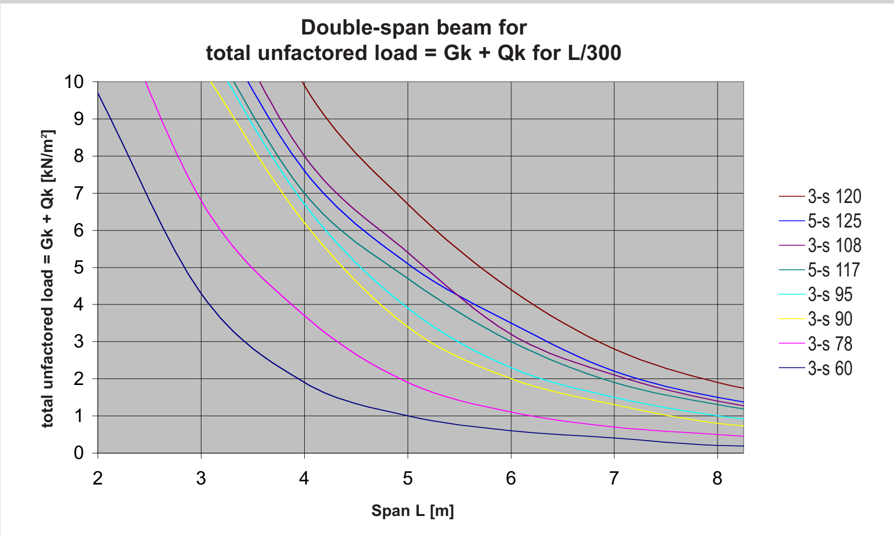
Reference Pattern

KLH AS A ROOF

L/300, worst case total loads considering variable actions on full spans.

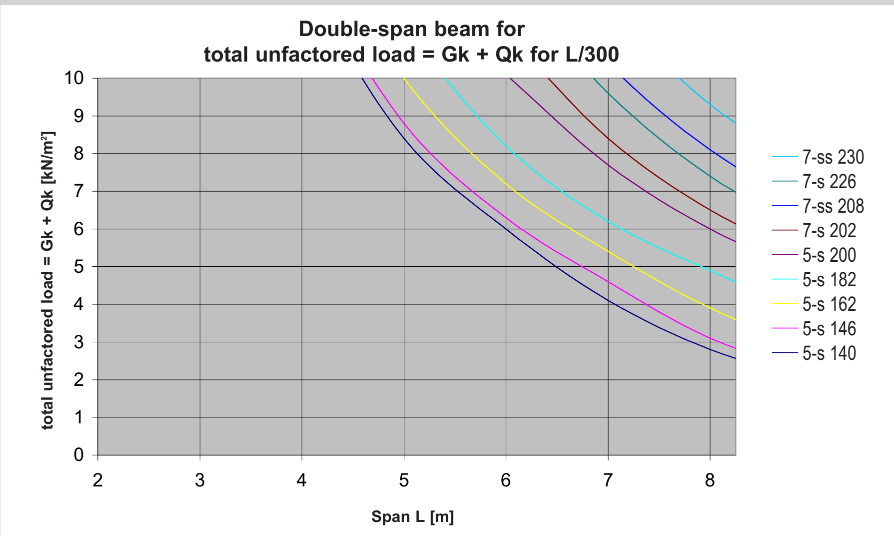
Load on panel over 2 spans –
e.g. in roof panels





COMMENT

Live loads for accessible roofs must be applied to individual spans



3-s panels with 34 mm thick edge laminations are rated REI 30 under normal loads.

5-s and 7-s panels are rated REI 60 under normal loads.

For higher permissible deformations, the chart values can be converted using the following equation:

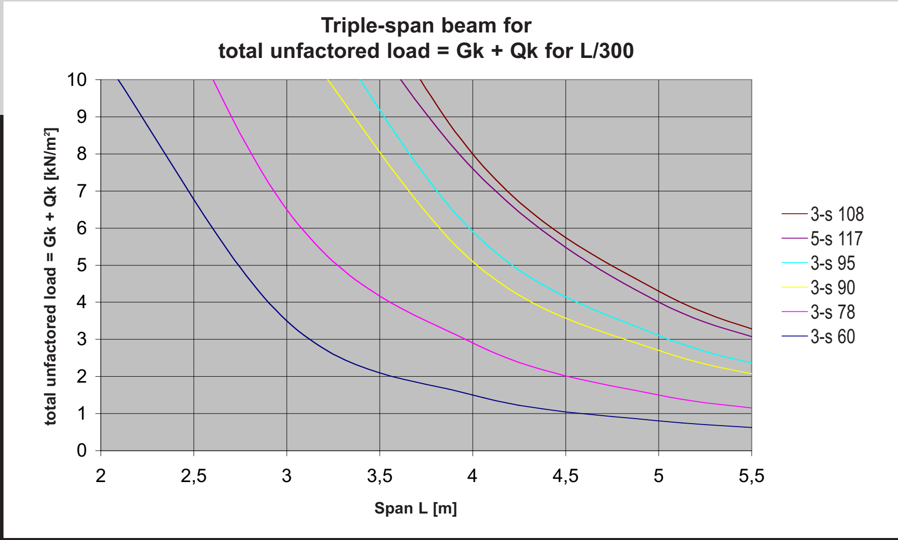
E.g. $u_{,\,perm\,L/250} = u_{perm\,L/300} \times \frac{300}{250}$

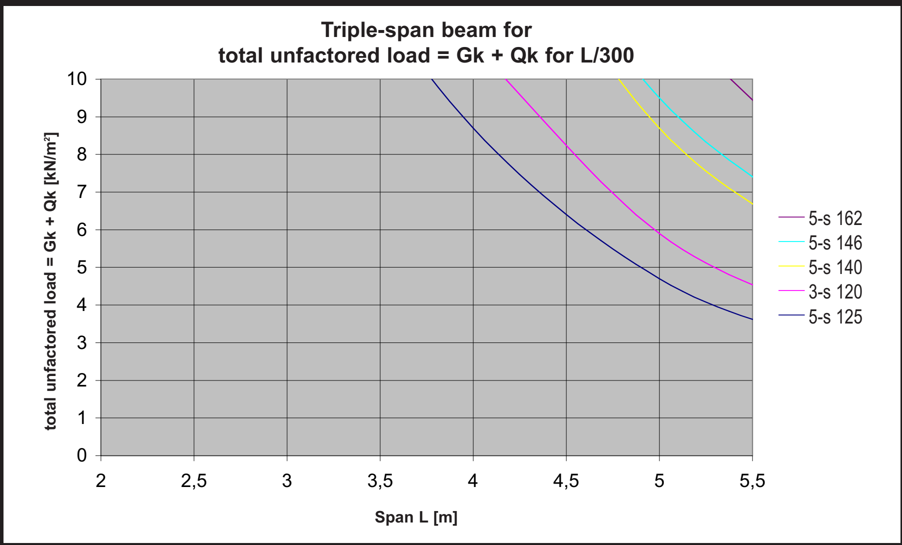
Reference Pattern

Full load on triple-span beam –
e.g. in roof panels

KLH AS A ROOF

L/300, worst case total loads considering variable actions on full spans.





COMMENT

Live loads for accessible roofs must be applied to individual spans

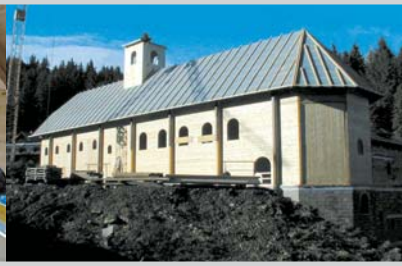
3-s panels with 34 mm thick edge laminations are rated REI 30 under normal building construction loads.

5-s and 7-s panels are rated REI 60 under normal building construction loads.

For higher permissible deformations, the tabular values can be converted using the following equation :

E.g. $u_{\text{, perm L/250}} = u_{\text{perm L/300}} \times \frac{300}{250}$



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