VMG LIGNUM

VMG LIGNUM LVL

UNLOCK NEW LEVELS OF STRENGTH AND STABILITY!

CONTENT

ABOUT THE COMPANY

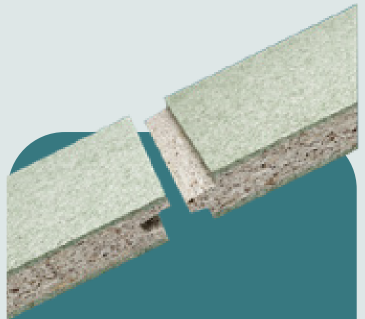
VMG LIGNUM COMPANIES SPECIALIZE IN THE PRODUCTION AND SUPPLY OF SUSTAINABLE ENGINEERED WOOD PRODUCTS FOR CONSTRUCTION.

VMG LIGNUM provides a unique opportunity to obtain three different products from a single source: LVL (laminated veneer lumber), I-joist and structural particle boards (P4-P7). All our high-quality engineered wood products are manufactured in Lithuania and can be ordered directly from our production centre in Naujoji Akmene. VMG LIGNUM develop the building system of prefabricated components for construction for new built projects, as well as renovation using engineered wood products. VMG LIGNUM also offers an extensive range of versatile building design, structural modelling, and consulting services.

PRODUCTION CAPABILITIES:

VMG LIGNUM JOIST
15 million m/year

VMG LIGNUM LVL
120,000 m³/year



VMG LIGNUM BOARD
200,000 m³/year

WE PROVIDE ADAPTABLE SOLUTIONS FOR COOPERATION:

- Technical guidance throughout the production process
- Manufacturing of products in accordance with the specified dimensions
- Certified products that meet international quality requirements
- Production in small, medium and ultra-large volumes
- A comprehensive quality control procedure in our laboratory
- On-time delivery to the desired country and continent

WHAT IS LVL?

LVL can be deservedly called "the new steel". It is the strongest of all sustainable building materials.

LVL, abbreviated from "laminated veneer lumber", is a type of engineered wood used for construction. It is suitable for various wooden structures and serves well where they are required to have highest strength, which is determined by the homogeneously glued structure of this building material. This makes it possible to use the special material properties of the wood itself in the best way.

HISTORY OF LVL

Parallel-oriented plywood products started to be used in the furniture industry at the beginning of the 20th century. During the Second World War, the demand for wood increased in particular, which led to its shortage. The first studies of engineered wood were then conducted in the United States. A plate material of wood fibre and ground newspapers for use in buildings was developed.

Later, the American Arthur Troutner created the technology of laminated veneer lumber, and the dimensions of this product made it suitable for use in construction. After the war, he studied architecture and began research aimed at developing stronger and more efficient products by combining different types of wood and applying new processing and production technologies. In 1971, Arthur Troutner created the first prototype of the current LVL and the product was successfully distributed in the market.

Since then, the production of LVL has been constantly growing, and today this product is made in ten countries of the world, on four continents (Europe, Asia, North America and Australia).

The total production capacity of LVL is about 4 million cubic meters per year and is constantly growing. Green policy, climate change solutions and the pursuit of energy efficiency in the construction industry shape favourable prospects for this material to become one of the dominant ones in sustainable construction.

Construction of the Troutner House, Boise, Idaho 1955
Photo: Art Troutner.

Troutner house in Gooding, Idaho 1952.

MAIN DESCRIPTION OF LVL

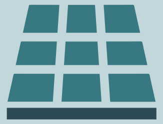
Laminated veneer lumber (LVL) is an engineered wood product. Its production uses rotary-made veneers with a thickness of 2.5–4 mm. In Europe, the types of wood mostly used for veneers are pine and spruce, while beech and birch are less common. In North America, the most common spices used for the purpose are pine, tulip tree and maple; in Australia – pine and eucalyptus; in Japan – larch and cedar; VMG Lignum LVL produced from pine veneers.

In order to glue veneers, adhesives resistant to outdoor conditions are used, the emissions of which are restricted by high ecological requirements, corresponding to Class 1 for load-bearing timber structures according to the standard EN 301:2006.

LVL demonstrates characteristics of a homogeneous material. It is widely applicable to various structures, ranging from new to renovated/reconstructed buildings. LVL can be used for:

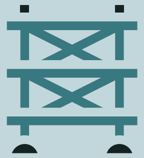
wall structures (panels, posts, frames, lintels)

roof structures (rafters, panels, consoles)

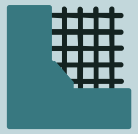


floor structures (beams, panels)

interior products (stairs, doors, furniture)

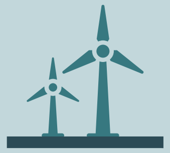


scaffolding



concrete formwork

bridges



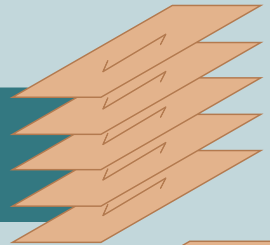
engineering and infrastructure structures (e.g. wind power plants or mobile antenna towers)

LVL is one of the most stable and strongest wood products. Despite this, however, LVL is easy to process: drill, cut, mill, etc. It is also easy to combine with other wood products.

There are two main types of LVL, in which:

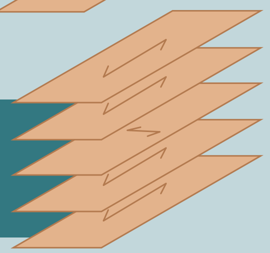
VMG LIGNUM LVL P

the veneer is glued parallel (LVL P)



VMG LIGNUM LVL C

up to 20 % of the veneer layers are glued across (LVL C)



LVL P is characterised by greater strength and longitudinal stiffness, while **LVL C** shows those properties perpendicular to the grain.
LVL P is more suitable for beams, posts and columns, while **LVL C** is better for panels and lintels.

FIRE RESISTANCE OF LVL

VMG LIGNUM LVL, like other wood products, is classified as a flammable material. However, with the appropriate selection of properties, it can be fire resistant*

When burning, laminated veneer lumber chars, which protects and insulates the LVL structure, thus slowing down the burning process.

The fire resistance of LVL is better than that of sawn timber because the charring rate of LVL is lower. The flammability class of additionally non-protected LVL is D-s2,d0. The fire resistance and flammability class indicators of LVL can be improved by the use of additional covering. The fire resistance of VMG LIGNUM LVL can be calculated according to the European standard EN 1995-1-2 and its national annexes.

Fig. 1 Charred LVL beam

*Fire resistance means the ability of a building structure or element (construction product) to withstand the specified loads and/or thermal-insulating properties and/or remain unaffected (tight, free of cracks) for a period of time determined by a standard fire resistance test.

PRODUCTION OF LVL

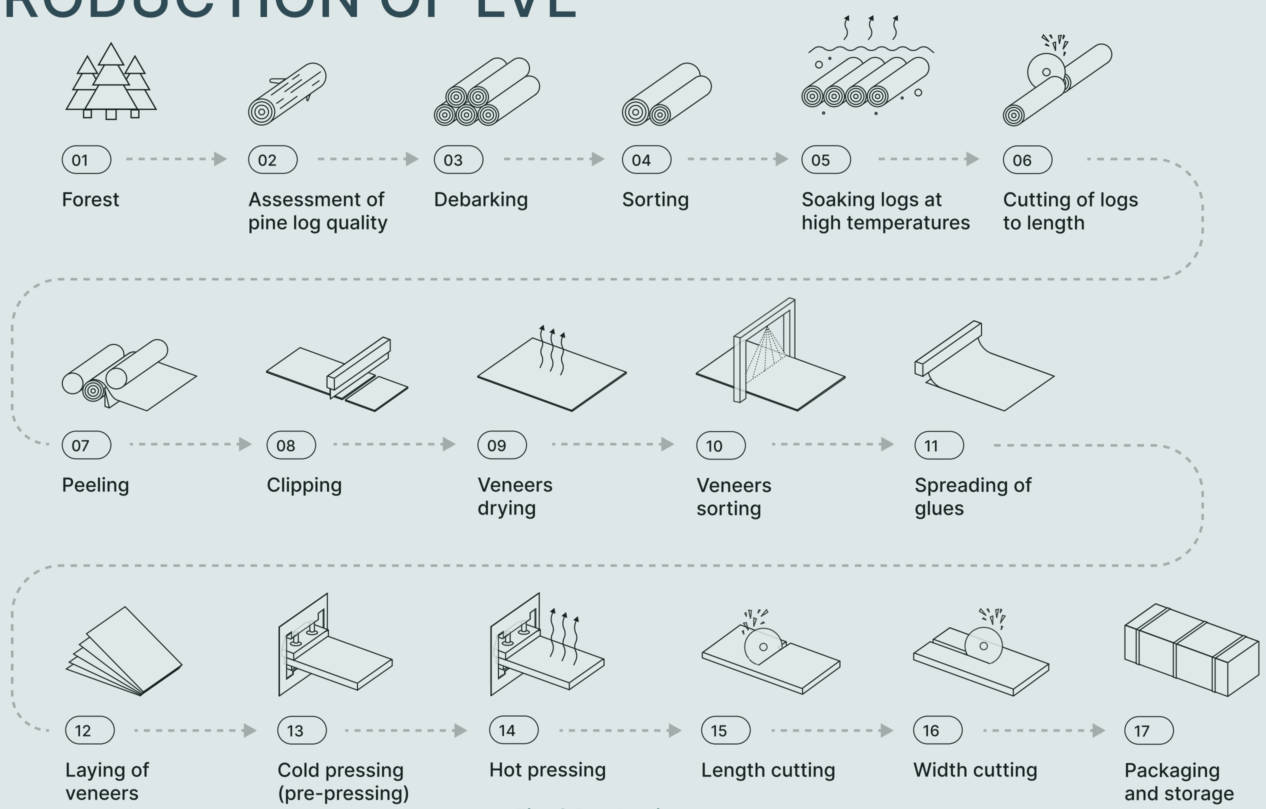


Fig. 2 Production process

In the production of LVL, logs with suitable parameters are first selected. Then they are stripped of the bark, soaked and peeled. The obtained veneer sheets are cut, sorted according to moisture content, dried, and then graded by sorting them according to strength class. The sorted sheets are coated with glue, layered and pressed with a mechanical press and then with a hot press. The obtained raw LVL panels are cut into products with the required dimensions.

The finished products are packed and shipped to the customer. During the entire process, continuous quality control is carried out, which allows ensuring the high quality of each product and compliance with the relevant requirements.

Where required, can be processed with CNC machines, i.e. milled, drilled, etc.

WHAT MAKES LVL BETTER THAN OTHER MATERIALS?

LVL is one of the strongest sustainable building materials. This is clearly demonstrated by the comparison of mechanical properties presented in Table 1. For example, an LVL beam is stronger and thinner than products with the same height (300 mm) made of sawn and glued timber. As a result, by using LVL for structures, we can reduce the amount of wood consumed, make the structures lighter, their installation easier, and logistics cheaper. The advantages of LVL are seen even more clearly when its properties are compared with those not only of other wood products, but also of steel and reinforced concrete (Fig. 3).

COMPARISON OF STRENGTHS OF ENGINEERED WOOD

Table 1. Comparison of strengths of engineered wood

	VMG LIGNUM LVL 48P h= 300 mm		Glued timber GL 24h h= 300 mm			Sawn timber C24 h=300mm		
	Strength Mpa	Thickness mm	Strength Mpa	Thickness mm	Increase in material consumption compared to LVL	Strength Mpa	Thickness mm	Increase in material consumption compared to LVL
Bending strength, edgewise, parallel to grain	44,0	45	24,0	80	78%	24,0	89	99%
Tension strength, parallel to grain	39,0	45	19,2	89	97%	14,5	131	191%
Compression strength, parallel to grain	39,0	45	24,0	76	69%	21,0	91	101%
Compression strength, perpendicular to grain	7,0	45	2,5	131	192%	2,5	137	203%
Shear strength, edgewise, parallel to grain	4,6	45	3,5	72	60%	4,0	75	66%
Modulus of elasticity, mean, parallel to grain	14 000	45	11 500	55	22%	11 000	57	27%
Density, mean	560 kg/m³		420 kg/m³			420 kg/m³		

COMPARISON OF BEAMS WHEN THE SPAN IS 7 m

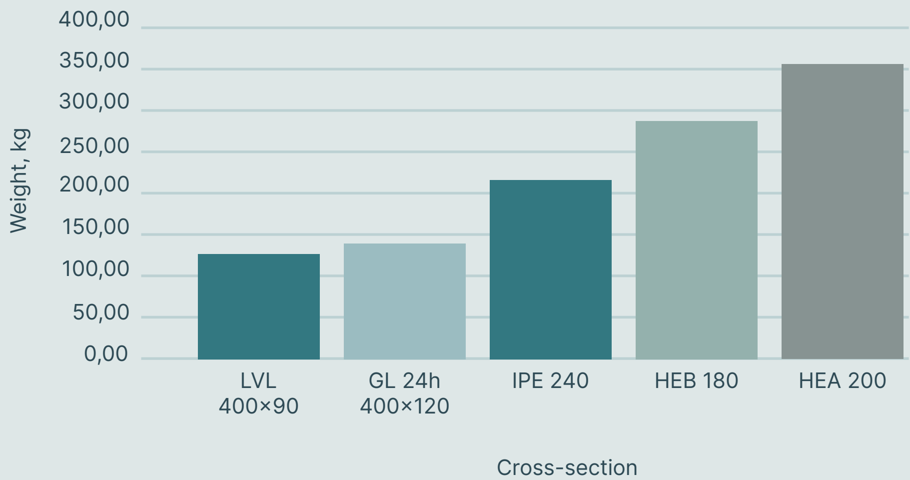


Fig. 3 Comparison of LVL beams with steel profile cross-sections (when the span is 7 m, continuous load is 2 kN/m, variable load is 3kN/m, and self-weight is estimated)

STRENGTH TO WEIGHT (DENSITY) RATIO

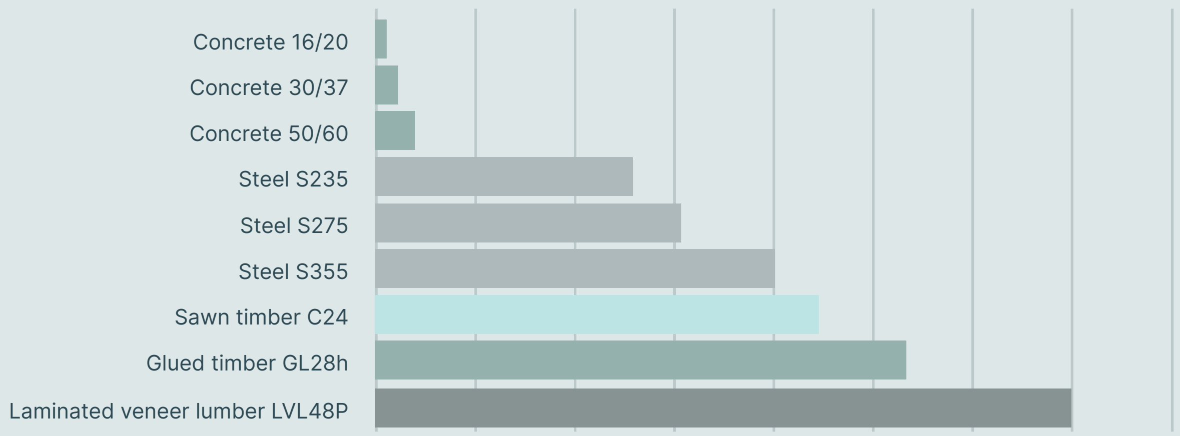


Fig. 4 Strength to weight (density) ratio

In order to demonstrate the advantage of wood over steel, preliminary calculations were made under the same conditions. On Fig. 3, we see that when a 7 m span is spanned with LVL beams, they will weigh less than steel profile beams. This is because the density of wood is about 15 times lower than that of steel.

On Fig. 4, we see how the strength-to-density ratio of materials changes. The higher the strength-to-density ratio, the stronger and lighter the material. As we see from Fig. 4, LVL structures lighter than steel structures will be required to withstand the same loads.

Calculation example:

Strength-to-density ratio of LVL:

$$\frac{f}{\rho} = \frac{35}{5,1} = 6863$$

Where f is the compressive strength of LVL [MPa], and ρ is the characteristic density of LVL [kN/m^3]

Strength-to-density ratio of steel:

$$\frac{f}{\rho} = \frac{275}{77} = 3572$$

Where f is the compressive strength of steel [MPa], and ρ is the characteristic density of steel [kN/m^3]

WHY LVL?

LVL is suitable for various wooden structures and serves well where they are required to have highest strength, which is determined by the homogeneously glued structure of this building material.

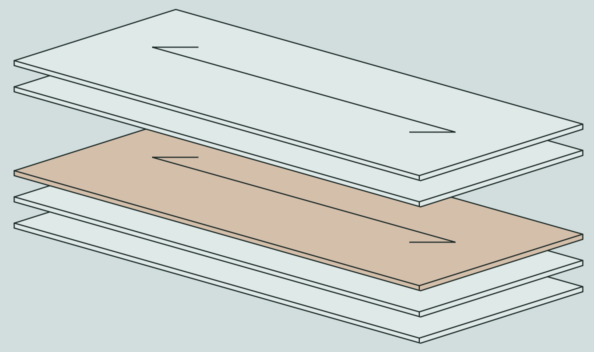
The most important features of LVL are:

- dimensional accuracy
- stable geometry
- strength and lightness
- resistance to high loads
- easy processing and installation
- tolerant of holes and notches

Construction is going through a transformation process that is aimed at better sustainability and efficiency. LVL opens the door to the construction of taller buildings of lightweight organic structures. We turn to laminated veneer lumber when we want to apply the advantages of wooden construction more widely. Among the engineered wood products used for load-bearing structures, LVL exploits biomass in the most efficient way. Also, owing to its strength and lightness, laminated veneer lumber is best option for the production of components of prefabricated buildings and the development of automation of this production.

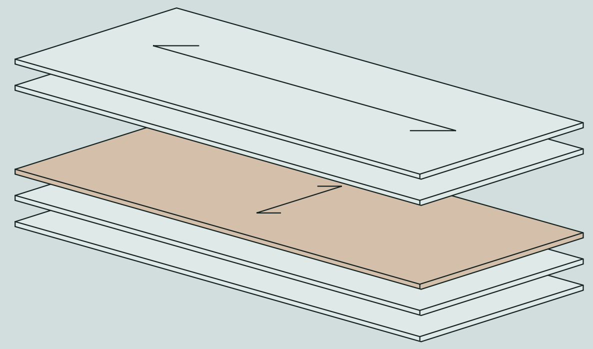
VMG LIGNUM LVL PRODUCTS

It is owing to its strength, lightness and other excellent properties that LVL is used especially universally in construction. So, these possibilities determined the range of VMG products. Our products:



VMG LIGNUM LVL P

(with veneers glued in parallel)



VMG LIGNUM LVL C

(with up to 20 % of the veneer layers cross-glued)

APPLICATIONS OF VMG LIGNUM LVL PRODUCTS

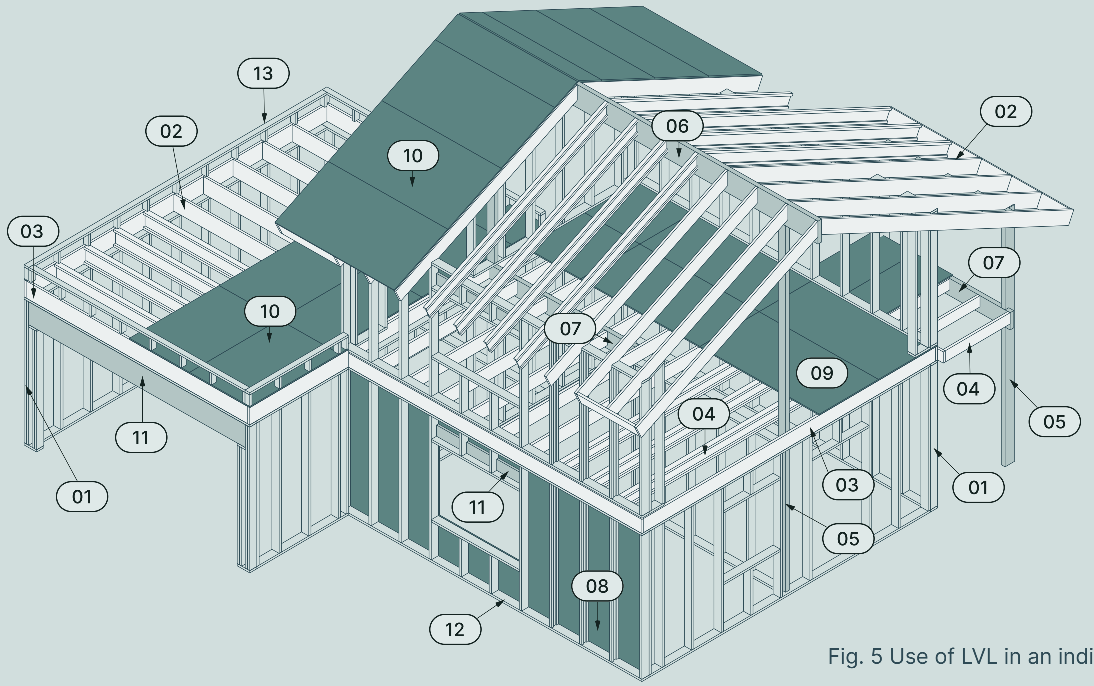


Fig. 5 Use of LVL in an individual house

In the construction of individual houses, LVL can be used in the following structures:

① Stud (VMG LIGNUM LVL P)
② Roof beam/rafter (VMG LIGNUM LVL P/C)
③ Rim board (VMG LIGNUM LVL C)
④ Floor joist (VMG LIGNUM LVL P)
⑤ Column (G LVL)
⑥ Ridge beam (VMG LIGNUM LVL P)
⑦ Ceiling supporting beam (VMG LIGNUM LVL P)
⑧ Wall stiffness panel (VMG LIGNUM LVL C)
⑨ Floor panel (VMG LIGNUM LVL C)
⑩ Roof panel (VMG LIGNUM LVL C)
⑪ Lintel (VMG LIGNUM LVL P/C)
⑫ Wall and window beam (VMG LIGNUM LVL P/C)
⑬ Parapet frame (VMG LIGNUM LVL P/C)

In the construction of multi-apartment buildings, LVL can be used in the following structures:

① Stud (VMG LIGNUM LVL P)
② Roof rafter (VMG LIGNUM LVL P)
③ Ceiling framing beam (VMG LIGNUM LVL P/C)
④ Combined closed ceiling panel (VMG LIGNUM LVL P/C)
⑤ Stiffness panel / wall panel (VMG LIGNUM LVL C)
⑥ Ceiling panel (VMG LIGNUM LVL C)
⑦ Roof panel (VMG LIGNUM LVL C)
⑧ Lintel (VMG LINGUM LVL C/P)
⑨ Wall and window beam (VMG LIGNUM LVL C)
⑩ Wall panel (VMG LIGNUM LVL C); lift shaft panel (VMG LIGNUM LVL C)
⑪ Combined open ceiling panel (VMG LIGNUM LVL P/C)
⑫ Balcony floor / roof panel (VMG LIGNUM LVL C)

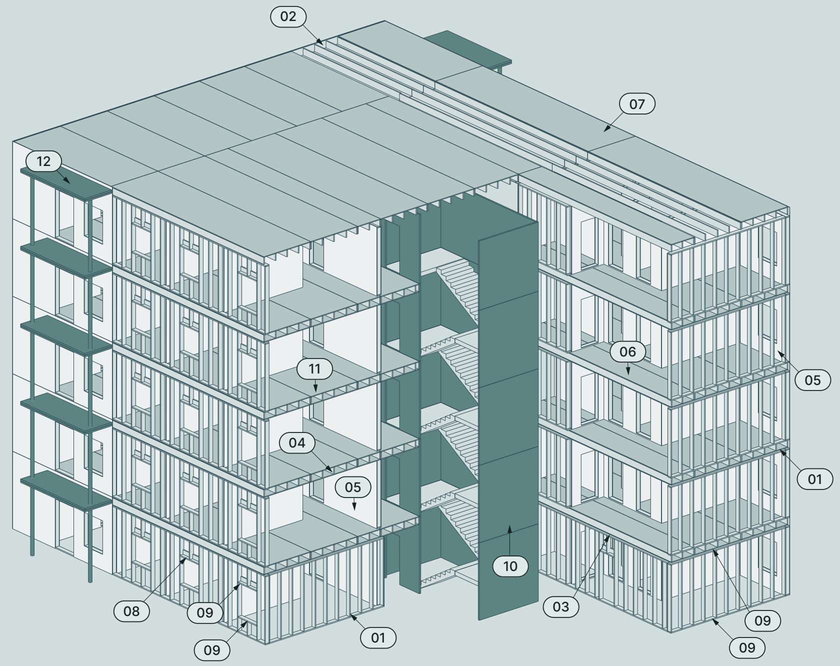


Fig. 6 Use of LVL in a high-rise building

In an industrial, storage, sports and similar building, LVL can be used as:

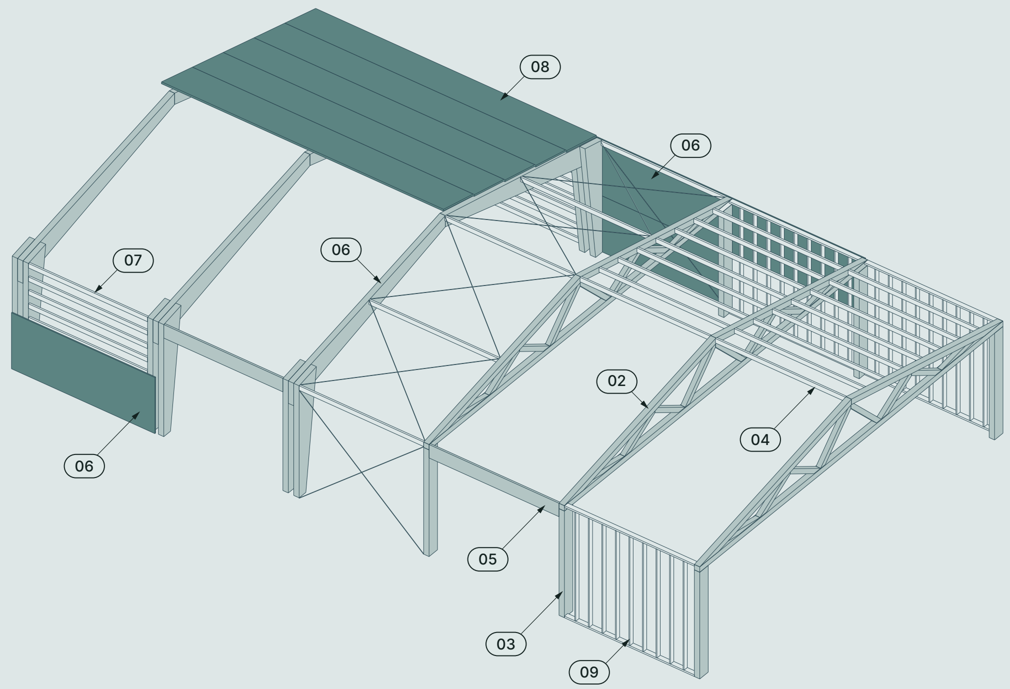
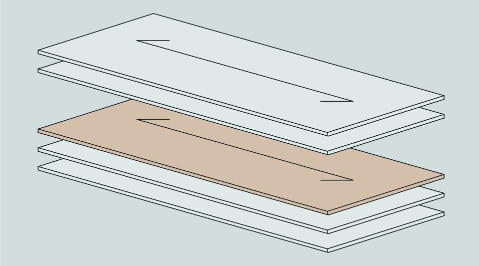


Fig. 7 Use of LVL in an industrial / storage building

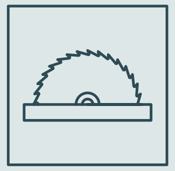
① Portal frame (VMG LIGNUM LVL P/C)
② Roof truss and its elements (VMG LIGNUM LVL P/C)
③ Columns (VMG LINGUM LVL)
④ Strip for one or more spans (VMG LIGNUM LVL P)
⑤ Lintel (VMG LIGNUM LVL P/C)
⑥ Wall stiffness panel (VMG LIGNUM LVL C)
⑦ Horizontal wall beam (VMG LIGNUM LVL P)
⑧ Roof stiffness panel (VMG LIGNUM LVL C)
⑨ Post (VMG LIGNUM LVL C)

VMG LIGNUM LVL P

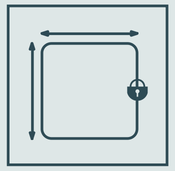
In VMG LIGNUM LVL P, all veneers are glued in parallel. Panels and beams made of VMG LIGNUM LVL P are effectively used owing to their height-to-thickness ratio. VMG LIGNUM LVL P can be used both vertically and horizontally. The produced panel is cut into products of standard dimensions. Where required, they can be cut according to the dimensions ordered by the customer.



VMG LIGNUM LVL P advantages:



Easy to process

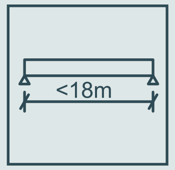


Dimensional stability (no twists, cracks or splinters)

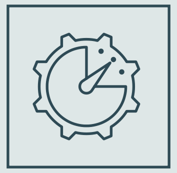
Homogeneous properties of the material

Moisture content 2–8 %

Easy to combine with other prod

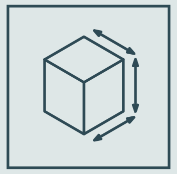


Can also be used for large spans



Effective use of the material

Renewable organic raw material of natural origin



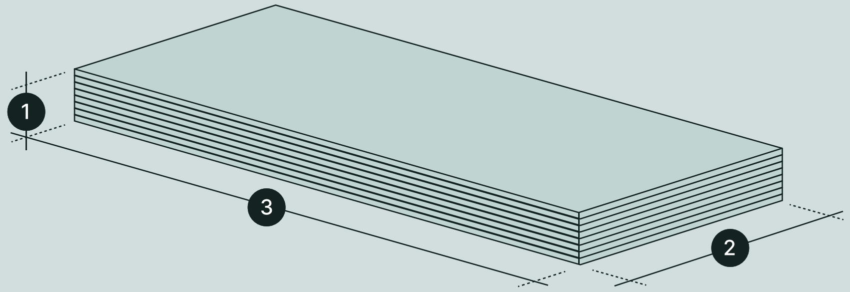
Variety of dimensions (large dimensions)

ARRANGEMENT OF LAYERS

Table 2. VMG LIGNUM LVL P layering

Thickness mm	Number of veneers	Layering
21	7	IIIIIII
24	8	IIIIIIII
27	9	IIIIIIIII
30	10	IIIIIIIIII
33	11	IIIIIIIIIII
36	12	IIIIIIIIIIII
39	13	IIIIIIIIIIIII
42	14	IIIIIIIIIIIIII
45	15	IIIIIIIIIIIIIII
48	16	IIIIIIIIIIIIIIII
51	17	IIIIIIIIIIIIIIIII
57	19	IIIIIIIIIIIIIIIIIII
63	21	IIIIIIIIIIIIIIIIIIIII
69	23	IIIIIIIIIIIIIIIIIIIIIII
75	25	IIIIIIIIIIIIIIIIIIIIIIIII

STANDARD SIZES



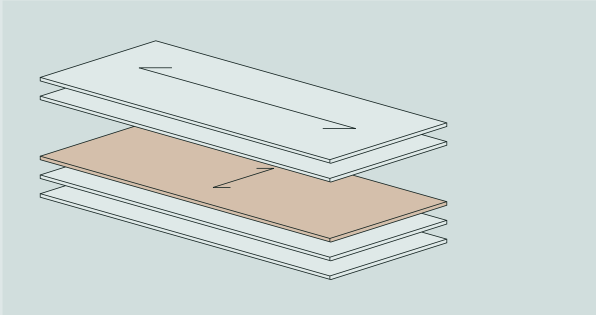
1. Thickness	21 – 90 mm
2. Width	45 – 1830 mm
3. Length	2500 – 18000 mm

Table 3. VMG LIGNUM LVL P standard dimensions

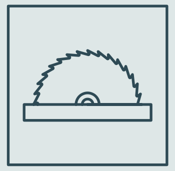
Product	Thickness, mm	Width/height, mm												
		90	95	120	140	150	180	190	200	240	290	300	360	400
VMG LIGNUM LVL-P	36								•					
	39								•					
	45								•	•		•		
	63					•	•		•	•		•		
	75													

VMG LIGNUM LVL C

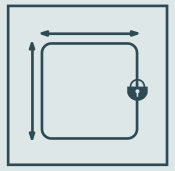
In VMG LIGNUM LVL C panels, 20 % of veneers are cross-glued. Cross-gluing improves the lateral bending strength and stiffness of the panel, and also enhances the shear strength of the product.



VMG LIGNUM LVL C advantages:



Easy to process



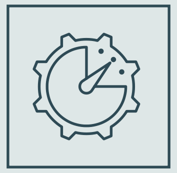
Dimensional stability (no twists, cracks or splinters)

Homogeneous properties of the material

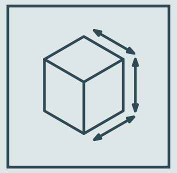
Moisture content 2–8 %

Easy to combine with other products

Smaller moisture deformations (owing to cross-glued veneers)



Ensured efficiency of materials for non-standard prod



Variety of dimensions (large dimensions)

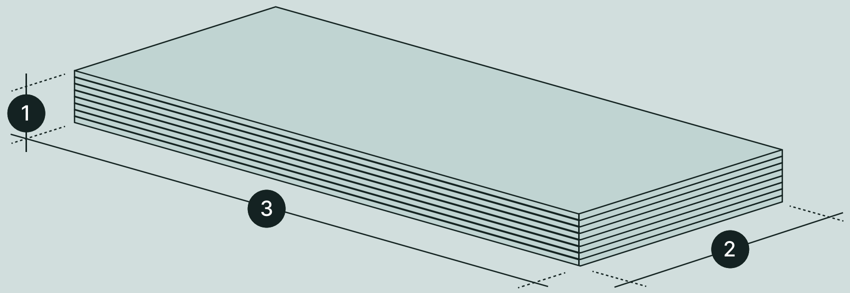
Renewable organic raw material of natural origin

ARRANGEMENT OF LAYERS

Table 4. VMG LIGNUM LVL C layering

Thickness mm	Number of veneers	Layering
21	7	I-III-I
21	7	II-I-II
24	8	II-II-II
27	9	II-III-II
30	10	II-IIII-II
33	11	II-IIIII-II
36	12	II-IIIIII-II
39	13	II-III-III-II
45	15	II-IIII-IIII-II
51	17	II-IIIII-IIIII-II
57	19	II-III-IIIII-III-II
63	21	II-III-III-III-III-II
69	23	II-IIII-III-III-IIII-II
75	25	II-IIIII-III-III-IIIII-II

STANDARD SIZES



1. Thickness 21 – 90 mm
2. Width 45 – 1830 mm
3. Length 2500 – 18000 mm

Table 5. VMG LIGNUM LVL C standard dimensions

Product	Thickness, mm	Width/height, mm												
		90	95	120	140	150	180	190	200	240	290	300	360	400
VMG LIGNUM LVL-C	36								•					
	39								•					
	45								•	•		•		
	63					•	•		•	•		•		
	75													

PROCESSING

VMG LIGNUM LVL standard processing

Processing	Description
Impregnation	Not impregnated
Anti-termite treatment	Only into the glue, no for the surface
Sanding	The surface is sanded, the edges are not
CNC cutting	Not cut
Other cuts	Cutting to lengths and widths

Where necessary, the products can be additionally processed by optical or calibration grinding. Optical grinding reduces the thickness of the product by about 2 mm (1 mm per surface). Calibration grinding is another possible grinding method. It can reduce the thickness of the product by about 3 mm (1.5 mm per side of the surface), and the thickness tolerance (deviation) after calibration is ± 0.5 mm. Calibration grinding is not recommended for surfaces that will be visible because it may reveal the dark glue line.

Where necessary, the customer can also additionally cut VMG LIGNUM LVL products, round the corners, form connections at edges, and cut holes in the beams.

IMPREGNATION AND OTHER COATING METHODS

The customer can also choose to cover the LVL surface in various ways by painting or impregnating them in accordance with the instructions and recommendations of the paint / impregnant suppliers. The structural properties of LVL **will not be affected** by these types of surface coating.

The customer can use the following coating methods:

- → protection against moisture, which ensures greater resistance to the temporary effects of weather conditions during storage and transportation as well as at the construction site;
- → anti-mould treatment reduces the risk of mould and blue stains and is recommended for use in the structures of attics and sheds as well as roofs;
- → coating with fire-resistant materials improves the fire resistance of LVL products;
- → painting in the chosen colour or lacquering.

TECHNICAL SPECIFICATION

TABLE OF STRENGTHS

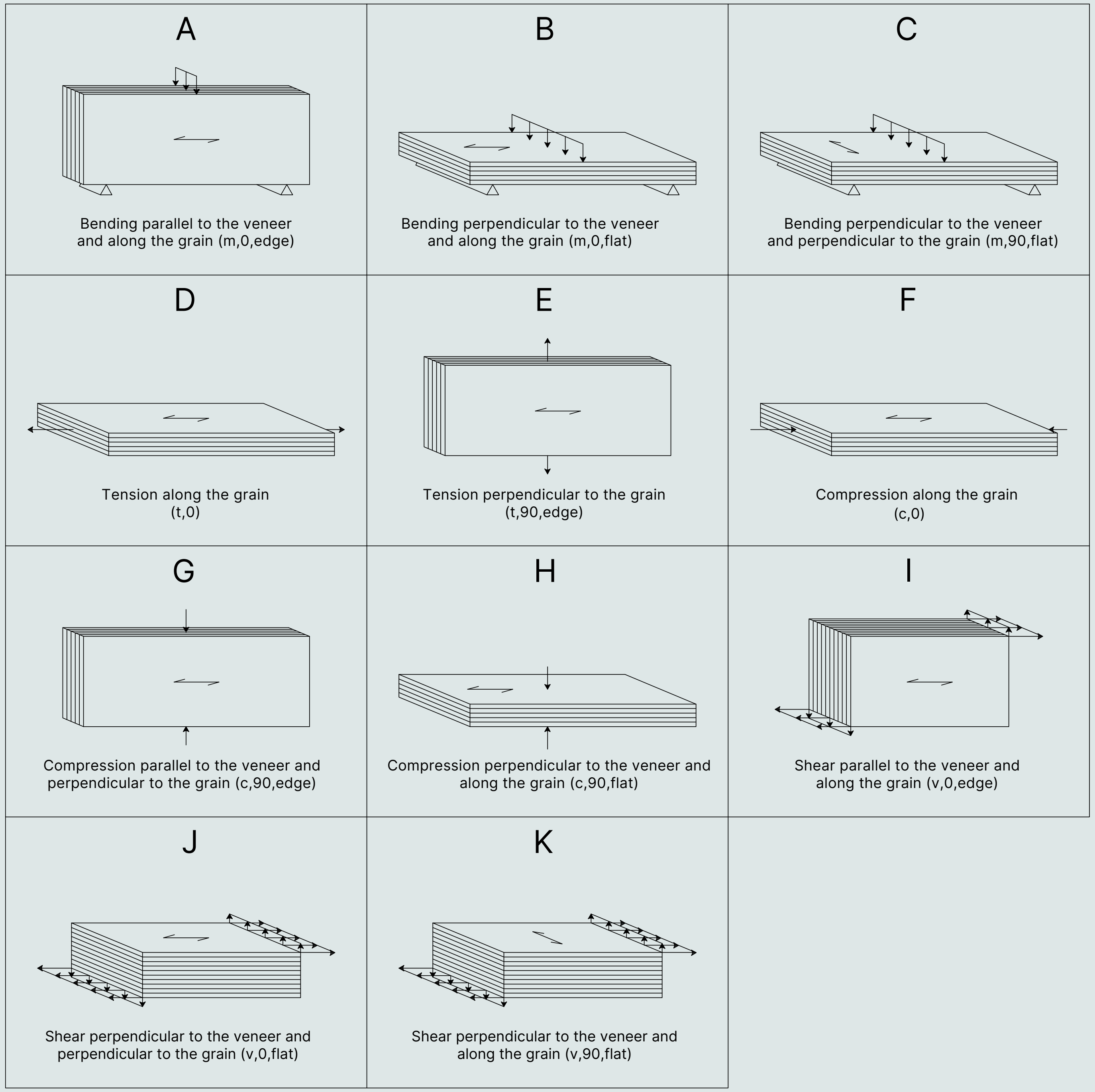


Fig. 8 Strength and stiffness orientations

Table 7. Characteristic and mean values of VMG LIGNUM LVL P used in design

	Value	Symbol	Figure	Unit of measure	LVL 32P*	LVL 35P	LVL 48 P
Bending strength	Edgewise, parallel to grain (depth 300 mm)	$f_{m,0,edge,k}$	A	N/mm²	27	30	44
	Flatwise, parallel to grain	$f_{m,0,flat,k}$	B	N/mm²	32	35	50
	Size effect parameter	S	A		0,15	-**	-**
Tension strength	Parallel to grain (length 3 000 mm)	$f_{t,0,k}$	D	N/mm²	22	22	-**
	Perpendicular to grain, edgewise	$f_{t,90,edge,k}$	E	N/mm²	0,5	0,5	-**
Compression strength	Parallel to grain for service class 1	$f_{c,0,k}$	F	N/mm²	26	30	39
	Parallel to grain for service class 2	$f_{c,0,k}$	F	N/mm²	21	25	29
	Perpendicular to grain, edgewise	$f_{c,90,edge,k}$	G	N/mm²	4	6	7
	Perpendicular to grain, flatwise (except pine)	$f_{c,90,flat,k}$	H	N/mm²	0,8		2,2
	Perpendicular to grain, flatwise, pine	$f_{c,90,flat,k,pine}$	H	N/mm²	MDV	3	2
Shear strength	Edgewise parallel to grain	$f_{v,0,edge,k}$	I	N/mm²	3,2	3,2	4,6
	Flatwise, parallel to grain	$f_{v,0,flat,k}$	J	N/mm²	2,0	2,3	2,6
Modulus of elasticity	Parallel to grain	$E_{0,mean}$	ABDF	N/mm²	9 600	12 000	14 000
	Parallel to grain	$E_{0,k}$	ABDF	N/mm²	8 000	10 000	11 600
	Perpendicular to grain, edgewise	$E_{c,90,edge,mean}$	G	N/mm²	MDV	370	420
	Perpendicular to grain, edgewise	$E_{c,90,edge,k}$	G	N/mm²	MDV	300	350
Shear modulus	Edgewise, parallel to grain	$G_{0,edge,mean}$	I	N/mm²	500	500	610
	Edgewise, parallel to grain	$G_{0,edge,k}$	I	N/mm²	300	350	400
	Flatwise, parallel to grain	$G_{0,flat,mean}$	J	N/mm²	320	380	570
	Flatwise, parallel to grain	$G_{0,flat,k}$	J	N/mm²	240	270	270
Density		O_{mean}	-	kg/m³	440	510	560
		O_{k}	-	kg/m³	410	480	480

* The data for the marked grades will be updated when the Declaration of Performance (DoP) is received.
** The starred positions are still to be determined.
MDV - manufacturer's declared value.

Table 8. Characteristic and mean values of VMG LIGNUM LVL C used in design

	Value	Symbol	Figure	Unit of measure	LVL 22 C*	LVL 25 C*	LVL 32 C*	LVL 36 C*
Bending strength	Edgewise, parallel to grain (depth 300 mm)	$f_{m,0,edge,k}$	A	N/mm²	19	20	28	32
	Flatwise, parallel to grain	$f_{m,0,flat,k}$	B	N/mm²	22	25	32	36
	Size effect parameter	S	A	-	0,15	0,15	0,15	0,15
	Flatwise, perpendicular to grain	$f_{m,90,flat,k}$	C	N/mm²	MDV	MDV	7	8
Tension strength	Parallel to grain (length 3 000mm)	$f_{t,0,k}$	D	N/mm²	14	15	18	22
	Perpendicular to grain, edgewise	$f_{t,90,edge,k}$	E	N/mm²	4	4	5	5
Compression strength	Parallel to grain for service class 1	$f_{c,0,k}$	F	N/mm²	18	18	18	26
	Parallel to grain for service class 2	$f_{c,0,k}$	F	N/mm²	15	15	15	21
	Perpendicular to grain, edgewise	$f_{c,90,edge,k}$	G	N/mm²	8	8	9	9
	Perpendicular to grain, flatwise, pine	$f_{c,90,flat,k,pine}$	H	N/mm²	MDV	MDV	3,5	3,5
Shear strength	Edgewise parallel to grain	$f_{v,0,edge,k}$	I	N/mm²	3,6	3,6	4,5	4,5
	Flatwise, parallel to grain	$f_{v,0,flat,k}$	J	N/mm²	1,1	1,1	1,3	1,3
	Flatwise, perpendicular to grain	$f_{v,90,flat,k}$	K	N/mm²	MDV	MDV	0,6	0,6
Modulus of elasticity	Parallel to grain	$E_{0,mean}$	ABDF	N/mm²	6 700	7 200	10 000	10 500
	Parallel to grain	$E_{0,k}$	ABDF	N/mm²	5 500	6 000	8 300	8 800
	Perpendicular to grain, edgewise	$E_{c,90,edge,mean}$	G	N/mm²	MDV	MDV	2 400	2 400
	Perpendicular to grain, edgewise	$E_{c,90,edge,k}$	G	N/mm²	MDV	MDV	2 000	2 000
	Perpendicular to grain, flatwise	$E_{m,90,flat,mean}$	C	N/mm²	MDV	MDV	1 200	2 000
	Perpendicular to grain, flatwise	$E_{m,90,flat,k}$	C	N/mm²	MDV	MDV	1 000	1 700
Shear modulus	Edgewise, parallel to grain	$G_{0,edge,mean}$	I	N/mm²	500	500	600	600
	Edgewise, parallel to grain	$G_{0,edge,k}$	I	N/mm²	300	300	400	400
	Flatwise, parallel to grain	$G_{0,flat,mean}$	J	N/mm²	70	70	80	120
	Flatwise, parallel to grain	$G_{0,flat,k}$	J	N/mm²	55	55	60	100
	Flatwise, perpendicular to grain	$G_{90,flat,mean}$	K	N/mm²	MDV	MDV	22	22
	Flatwise, perpendicular to grain	$G_{090,flat,k}$	K	N/mm²	MDV	MDV	16	16
Density	Mean	ρ_{mean}	-	kg/m³	440	440	510	510
	Characteristic	ρ_{k}	-	kg/m³	410	410	480	480

* The data for the marked grades will be updated when the Declaration of Performance (DoP) is received.
MDV - manufacturer's declared value.

TOLERANCE TABLE

The thickness, width and length of VMG LIGNUM LVL are measured according to the standard EN 324-1, at the actual humidity.
The permitted tolerances for VMG LIGNUM LVL are indicated in Table 9 and are applicable when the humidity of the beams is 10 ± 2%.

Table 9. Maximum deviations permitted for VMG LIGNUM LVL beams*

	Nominal value	Maximum deviations
Thickness *t*	*t ≤ 27 mm*	± 1 mm
	27 mm < t ≤ 57 mm	± 2 mm
	t > 57 mm	± 3 mm
Width *b*	*b ≤ 300 mm*	± 2 mm
	300 mm < b ≤ 600 mm	± 3 mm
	b > 600 mm	± 0,5 %
Length *l*	*l ≤ 5 m*	± 5 mm
	5 m < l ≤ 20 m	± 0,1 %
	l > 20 m	± 20 mm
Maximum deviation from the correct cross-section angle		1:50
Fig. No 1.61		(about 1,1°)

* The maximum permissible deviations from the nominal values and nominal angles; non-ground and non-impregnated and non-painted beams are evaluated according to EN 324-1.
The table has been drawn up according to the data published in Laminaten vaneer lumber (LVL) bulletin, New European strength classes, September, 2019.

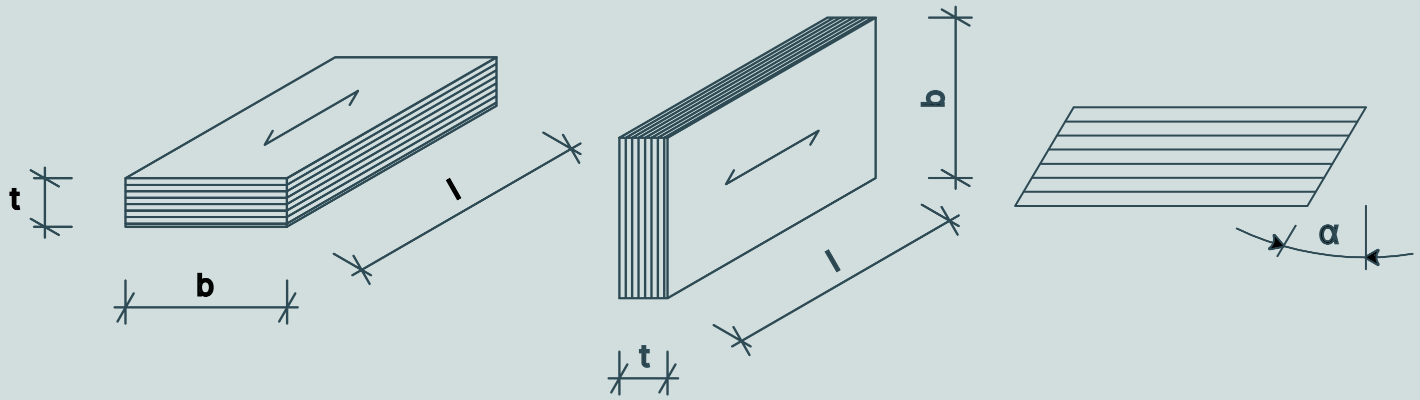


Fig. 9 Dimensions of VMG LIGNUM LVL (b – width, l – length, t – thickness, α – angle). The arrow shows the direction of the upper layer fibre.

DESIGN RECOMMENDATIONS

INITIAL CALCULATION DATA

When calculating the loads on the structures, it is important to take into account the duration of the load and the service class because they affect the strength and stiffness of the wooden elements. The exemplary calculations presented below account for the duration of a mean load. The possible load-duration classes are presented in Table 10.

Table 10. Load-duration classes (EN 1995-1-1 Table 2.1)

LOAD-DURATION CLASS	ORDER OF ACCUMULATED DURATION OF CHARACTERISTIC LOAD
Permanent	More than 10 years
Long-term	6 months to 10 years
Medium-term	1 week to 6 months
Short-term	Less than one week
Instantaneous	

VMG LIGNUM LVL can be used in Service classes 1 and 2 without additional protection. When using VMG LIGNUM LVL in Service class 3, the structures must be properly protected. Chemical additives can be used for protection, or the structures can be protected with additional coating. The cladding must be properly designed to prevent the formation of water pockets. The presented calculations are intended for Service class 1.

Service classes according to EN 1995-1-1:

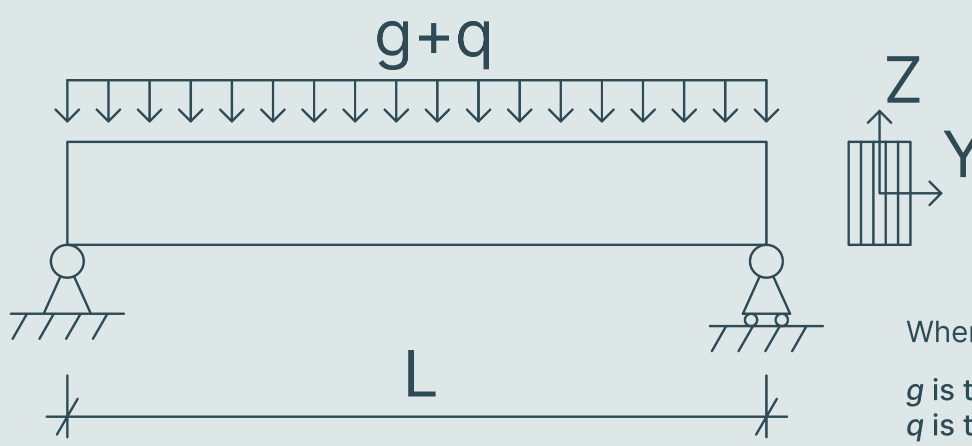
SERVICE CLASS 1
Service class 1 is characterised by a moisture content in the materials corresponding to a temperature of 20°C and the relative humidity of the surrounding air only exceeding 65 % for a few weeks per year.

SERVICE CLASS 2
Service class 1 is characterised by a moisture content in the materials corresponding to a temperature of 20°C and the relative humidity of the surrounding air only exceeding 85 % for a few weeks per year.

SERVICE CLASS 3
Service class 3 is characterised by climatic conditions leading to higher moisture contents than in service class 2.

CALCULATIONS OF THE BEARING STRENGTH OF LVL BEAMS

Calculations of the bearing strength of VMG LIGNUM LVL beams should be carried out according to the standard EN 1995-1-1. Calculation scheme:



Where:

g is the permanent load;
q is the variable load.

Fig. 10 Calculation scheme for a VMG LIGNUM LVL beam on two supports

The design strength value Xd of the material is calculated according to Formula 2.14 of EN 1995-1-1:

$$X_d = \frac{k_{mod} \cdot X_k}{\gamma_m}$$

Where:

X_k is the characteristic value of a strength property;
γ_m is the partial factor for a material property. The recommended value of the factor for LVL is 1,2;
k_{mod} is a modification factor taking into account the effect of the duration of load and moisture content. According to Table 3.1 of the standard EN 1995-1-1, under medium-term action, under the conditions of Service class 1 k_{mod}= 0,8.

When calculating, the serviceability limit state must be taken into account (Section 7 of EN 1995-1-1). The maximum beam deflection is assumed to be L/250. When checking the structure deflection from a point load of 1 kN, the maximum permissible deflection is 1,5 mm. The limit value of the natural frequency of oscillation of beams is f_{lim} = 8 Hz. The stiffness of the floor structure in the direction perpendicular to the beams is not evaluated in the calculations.

When considering the serviceability limit state $E_{m,fin}$, which is applied for the calculation of the final deformation, must be calculated according to Formula 2.7 of EN 1995-1-1:

$$E_{m,\,fin} = \frac{E_m}{1+k_{def}}$$

Where:

E_m is the mean value of modulus of elasticity;
k_{def} is the creep deformation factor to be selected taking into account the service class of the structure. According to Table 3.2 of the standard EN 1995-1-1, the value k_{def} for Service class 1 is 0,6.

The other assumptions relied upon in the calculations, the results of which are presented in Tables 11–34:

- Width of beam supports 45 mm.
- The impact of the beam support reactions on the supports is not evaluated.
- In the calculations, it is assumed that the lateral displacements of the beams are restrained: the beams are restrained by ties in the beam supports and at least every 1000 mm along the entire length of the beam. The impact of the stiffness of these ties is not evaluated in the vibration calculations of the beams in question.
- The loads presented in the tables below are cumulative ones, i.e. permanent and variable characteristic distributed loads. Permanent loads account for no more than 40 % of the total amount of loads.
- The tables for spans have been drawn up for different combinations of working loads, where the variable loads are (q_k) 1,5;2,0 and 2,5 kN/m² (the load values have been selected taking into account the service load variations presented in the standard EN 1991-1-1), and the permanent loads are (g_k) from 0,5 to 3,0 kN/m².

Table 11. Maximum characteristic loads of VMG LIGNUM LVL 32P beams, kN/m²

L, m	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
2,5		3,22	3,71	5,20	3,62	4,18	5,85	3,61	4,17	5,83
3,0		-	2,20	3,08	3,01	3,48	4,87	3,00	3,46	4,85
3,5		-	-	-	1,97	2,38	3,33	2,56	2,96	4,14
4,0		-	-	-	-	-	-	2,24	2,58	3,61
4,5		-	-	-	-	-	-	-	-	2,35

Table 12. Maximum spans (m) of VMG LIGNUM LVL 32P beams when the variable load q_k equals to 1,5 kN/m²

g_k, kN/m²	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
0,5		2,62	2,75	3,07	3,14	3,29	3,69	3,93	4,12	4,61
1,0		2,62	2,75	3,07	3,14	3,29	3,69	3,67	4,12	4,48
1,5		2,50	2,60	3,00	3,00	3,20	3,50	3,14	3,62	4,13
2,0		-	2,50	2,80	2,74	3,00	3,29	2,74	3,16	3,89
2,5		-	-	2,60	2,44	2,80	3,13	2,44	2,81	3,70
3,0		-	-	2,50	2,19	2,53	3,00	2,19	2,53	3,54

Table 13. Maximum spans (m) of VMG LIGNUM LVL 32P beams when the variable load q_k equals to 2,0 kN/m²

g_k, kN/m²	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
0,5		2,62	2,75	3,07	3,14	3,29	3,69	3,49	4,03	4,61
1,0		2,50	2,70	3,00	3,01	3,20	3,60	3,01	3,47	4,48
1,5		-	2,50	2,80	2,64	3,00	3,40	2,64	3,05	4,13
2,0		-	-	2,70	2,35	2,75	3,20	2,35	2,72	3,80
2,5		-	-	2,50	2,12	2,45	3,10	2,12	2,45	3,43
3,0		-	-	-	1,93	2,23	2,90	1,93	2,23	3,13

Table 14. Maximum spans (m) of VMG LIGNUM LVL 32P beams when the variable load q_k quals to 2,5 kN/m²

g_k, kN/m²	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
0,5		2,60	2,70	3,07	2,89	3,29	3,69	2,89	3,33	4,60
1,0		-	2,50	2,90	2,55	2,94	3,50	2,55	2,94	4,11
1,5		-	-	2,70	2,28	2,63	3,30	2,28	2,63	4,68
2,0		-	-	2,60	2,06	2,38	3,10	2,06	2,38	3,33
2,5		-	-	2,50	1,88	2,17	3,00	1,88	2,17	3,04
3,0		-	-	-	0,00	2,00	2,80	1,73	2,00	2,80

Table 15. Maximum characteristic loads of VMG LIGNUM LVL 35P beams, kN/m²

L, m	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
2,5		3,93	4,53	6,34	5,46	6,30	8,82	5,45	6,29	8,80
3,0		2,35	2,71	3,80	3,92	4,52	6,33	4,53	5,23	7,32
3,5		-	-	2,42	2,54	2,93	4,10	3,87	4,47	6,26
4,0		-	-	-	-	-	2,45	3,16	3,76	5,27
4,5		-	-	-	-	-	-	-	2,04	3,15

Table 16. Maximum spans (m) of VMG LIGNUM LVL 35P beams when the variable load q_k equals to 1,5kN/m²

g_k, kN/m²	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
0,5		2,82	2,96	3,31	3,38	3,55	3,97	4,23	4,44	4,96
1,0		2,82	2,96	3,31	3,38	3,55	3,97	4,20	4,36	4,74
1,5		2,70	2,80	3,20	3,20	3,40	3,70	3,88	4,02	4,37
2,0		2,50	2,70	3,00	3,00	3,20	3,48	3,64	3,78	4,11
2,5		-	2,50	2,80	2,90	3,00	3,31	3,47	3,60	3,91
3,0		-	-	2,70	2,70	2,90	3,18	3,28	3,45	3,75

Table 17. Maximum spans (m) of VMG LIGNUM LVL 35P beams when the variable load q_k equals to 2,0 kN/m²

g_k, kN/m²	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
0,5		2,82	2,96	3,31	3,38	3,55	3,97	4,23	4,44	4,96
1,0		2,70	2,90	3,30	3,30	3,50	3,90	4,10	4,30	4,74
1,5		2,60	2,70	3,00	3,10	3,20	3,70	3,88	4,02	4,37
2,0		-	2,50	2,90	2,90	3,10	3,48	3,53	3,78	4,11
2,5		-	-	2,70	2,80	2,90	3,30	3,19	3,60	3,91
3,0		-	-	2,60	2,60	2,80	3,18	2,90	3,35	3,75

Table 18. Maximum spans (m) of VMG LIGNUM LVL 35P beams when the variable load q_k equals to 2,5 kN/m²

g_k, kN/m²	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
0,5		2,80	2,90	3,30	3,38	3,50	3,97	4,20	4,40	4,96
1,0		2,60	2,70	3,10	3,10	3,30	3,70	3,82	4,10	4,70
1,5		-	2,60	2,90	2,90	3,10	3,50	3,42	3,90	4,37
2,0		-	2,50	2,80	2,80	3,00	3,30	3,09	3,57	4,11
2,5		-	-	2,70	2,70	2,80	3,20	2,83	3,26	3,91
3,0		-	-	2,60	2,60	2,70	3,10	2,60	3,00	3,75

Table 19. Maximum characteristic loads of VMG LIGNUM LVL 48P beams, kN/m²

L, m	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
2,5		4,55	5,25	7,34	5,46	6,30	8,82	5,45	6,29	8,80
3,0		2,72	3,14	4,39	4,54	5,24	7,33	4,53	5,23	7,32
3,5		-	-	2,81	2,94	3,39	4,75	3,87	4,47	6,26
4,0		-	-	-	-	-	2,95	3,38	3,90	5,46
4,5		-	-	-	-	-	-	2,04	2,47	3,75
5,0		-	-	-	-	-	-	-	-	2,17

Table 20. Maximum spans (m) of VMG LIGNUM LVL 48P beams when the variable load q_k equals to 1,5 kN/m²

g_k, kN/m²	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
0,5		2,95	3,10	3,47	3,54	3,72	4,16	4,43	4,65	5,20
1,0		2,95	3,10	3,47	3,54	3,72	4,15	4,35	4,51	4,91
1,5		2,80	3,00	3,34	3,39	3,52	3,83	4,01	4,16	4,52
2,0		2,70	2,80	3,14	3,19	3,31	3,60	3,77	3,91	4,26
2,5		2,50	2,60	2,99	3,00	3,15	3,43	3,59	3,72	4,02
3,0		-	2,50	2,87	2,90	3,00	3,29	3,28	3,57	3,89

Table 21. Maximum spans (m) of VMG LIGNUM LVL 48P beams when the variable load q_k equals to 2,0 kN/m²

g_k, kN/m²	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
0,5		2,95	3,10	3,47	3,54	3,72	4,16	4,43	4,65	5,20
1,0		2,90	3,00	3,40	3,50	3,70	4,10	4,35	4,51	4,91
1,5		2,70	2,80	3,20	3,20	3,40	3,83	3,96	4,16	4,52
2,0		2,50	2,70	3,00	3,10	3,20	3,60	3,53	3,91	4,26
2,5		-	2,60	2,90	2,90	3,10	3,43	3,10	3,68	4,05
3,0		-	-	2,80	2,80	2,90	3,29	2,90	3,35	3,89

Table 22. Maximum spans (m) of VMG LIGNUM LVL 48P beams when the variable load q_k equals to 2,5 kN/m²

g_k, kN/m²	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
0,5		2,90	3,10	3,47	3,50	3,70	4,16	4,33	4,65	5,20
1,0		2,70	2,90	3,30	3,30	3,50	3,90	3,82	4,40	4,90
1,5		2,60	2,70	3,10	3,10	3,30	3,70	3,42	3,95	4,52
2,0		2,50	2,60	2,90	3,00	3,10	3,50	3,09	3,57	4,26
2,5		-	2,50	2,80	2,80	3,00	3,40	2,83	3,26	4,05
3,0		-	-	2,70	2,60	2,90	3,20	2,60	3,00	3,89

Table 23. Maximum characteristic loads of VMG LIGNUM LVL 25C beams, kN/m²

L, m	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
2,5		2,47	2,85	3,99	4,14	4,77	6,68	7,28	8,40	11,76
3,0		-	-	2,34	2,46	2,84	3,98	4,63	5,34	7,47
3,5		-	-	-	-	-	2,53	2,99	3,45	4,83
4,0		-	-	-	-	-	-	-	-	3,00

Table 24. Maximum spans (m) of VMG LIGNUM LVL 25C beams when the variable load q_k equals to 1,5kN/m²

g_k, kN/m²	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
0,5		2,38	2,49	2,79	2,85	2,99	3,35	3,57	3,74	4,19
1,0		2,38	2,49	2,79	2,85	2,99	3,35	3,57	3,74	4,17
1,5		-	-	2,70	2,70	2,90	3,20	3,40	3,53	3,85
2,0		-	-	2,50	2,60	2,70	3,06	3,20	3,32	3,62
2,5		-	-	-	-	2,60	2,90	3,00	3,17	3,44
3,0		-	-	-	-	-	2,80	2,90	3,04	3,30

Table 25. Maximum spans (m) of VMG LIGNUM LVL 25C beams when the variable load q_k equals to 2,0 kN/m²

g_k, kN/m²	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
0,5		2,38	2,49	2,79	2,85	2,90	3,35	3,57	3,74	4,19
1,0		-	-	2,70	2,80	2,90	3,30	3,50	3,70	4,10
1,5		-	-	2,60	2,60	2,70	3,10	3,30	3,40	3,85
2,0		-	-	-	2,50	2,60	2,90	3,10	3,30	3,62
2,5		-	-	-	-	2,50	2,80	2,90	3,10	3,44
3,0		-	-	-	-	-	2,70	2,80	3,00	3,30

Table 26. Maximum spans (m) of VMG LIGNUM LVL 25C beams when the variable load q_k equals to 2,5 kN/m²

g_k, kN/m²	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
0,5		-	2,49	2,79	2,80	2,99	3,35	3,57	3,74	4,19
1,0		-	-	2,60	2,70	2,80	3,10	3,30	3,50	3,90
1,5		-	-	2,50	2,50	2,60	3,00	3,10	3,30	3,70
2,0		-	-	-	-	2,50	2,80	3,00	3,10	3,50
2,5		-	-	-	-	-	2,70	2,80	3,00	3,40
3,0		-	-	-	-	-	2,60	2,70	2,90	3,30

Table 27. Maximum characteristic loads of VMG LIGNUM LVL 32C beams, kN/m²

L, m	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
2,5		3,40	3,92	5,49	5,66	6,54	9,15	8,20	9,46	13,25
3,0		2,01	2,32	3,25	3,39	3,92	5,48	6,33	7,30	10,22
3,5		-	-	-	2,09	2,51	3,51	4,12	4,75	6,65
4,0		-	-	-	-	-	-	2,50	2,99	4,49
4,5		-	-	-	-	-	-	-	-	2,49

Table 28. Maximum spans (m) of VMG LIGNUM LVL 32C beams when the variable load q_k equals to 1,5 kN/m²

g_k, kN/m²	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
0,5		2,65	2,78	3,11	3,18	3,34	3,74	3,98	4,17	4,67
1,0		2,65	2,78	3,11	3,18	3,34	3,74	3,98	4,16	4,53
1,5		2,50	2,70	3,00	3,10	3,20	3,53	3,70	3,84	4,17
2,0		-	2,50	2,80	2,90	3,00	3,32	3,48	3,61	3,93
2,5		-	-	2,70	2,70	2,90	3,16	3,32	3,44	3,74
3,0		-	-	2,60	2,60	2,70	3,03	3,18	3,30	3,59

Table 29. Maximum spans (m) of VMG LIGNUM LVL 32C beams when the variable load q_k equals to 2,0 kN/m²

g_k, kN/m²	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
0,5		2,65	2,78	3,11	3,18	3,34	3,74	3,98	4,17	4,67
1,0		2,60	2,70	3,10	3,10	3,30	3,70	3,90	4,10	4,53
1,5		-	2,60	2,90	2,90	3,10	3,50	3,70	3,84	4,17
2,0		-	-	2,70	2,80	2,90	3,30	3,48	3,60	3,93
2,5		-	-	2,60	2,60	2,80	3,10	3,30	3,44	3,74
3,0		-	-	2,50	2,50	2,70	3,00	3,18	3,30	3,59

Table 30. Maximum spans (m) of VMG LIGNUM LVL 32C beams when the variable load q_k equals to 2,5 kN/m²

g_k, kN/m²	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
0,5		2,60	2,78	3,10	3,18	3,34	3,74	3,98	4,17	4,67
1,0		2,50	2,60	2,90	3,00	3,10	3,50	3,70	3,90	4,40
1,5		-	2,50	2,80	2,80	3,00	3,30	3,50	3,70	4,17
2,0		-	-	2,60	2,70	2,80	3,20	3,30	3,50	3,93
2,5		-	-	2,50	2,50	2,70	3,00	3,20	3,40	3,74
3,0		-	-	-	-	2,60	2,90	3,10	3,50	3,59

Table 31. Maximum characteristic loads of VMG LIGNUM LVL 36C beams, kN/m²

L, m	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
2,5		3,56	4,10	5,74	5,91	6,82	9,55	8,20	9,46	13,25
3,0		2,11	2,43	3,40	3,55	4,09	5,73	6,60	7,62	10,66
3,5		-	-	2,02	2,23	2,63	3,68	4,30	4,96	6,95
4,0		-	-	-	-	-	2,04	2,66	3,19	4,75
4,5		-	-	-	-	-	-	-	-	2,65

Table 32. Maximum spans (m) of VMG LIGNUM LVL 36C beams when the variable load q_k equals to 1,5kN/m²

g_k, kN/m²	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
0,5		2,70	2,83	3,16	3,24	3,39	3,80	4,04	4,24	4,75
1,0		2,70	2,83	3,16	3,24	3,39	3,80	4,04	4,21	4,58
1,5		2,60	2,70	3,10	3,10	3,29	3,57	3,75	3,88	4,23
2,0		-	2,60	2,90	2,90	3,09	3,36	3,53	3,65	3,97
2,5		-	-	2,70	2,80	2,90	3,20	3,36	3,48	3,78
3,0		-	-	2,60	2,80	2,80	3,07	3,22	3,34	3,63

Table 33. Maximum spans (m) of VMG LIGNUM LVL 36C beams when the variable load q_k equals to 2,0 kN/m²

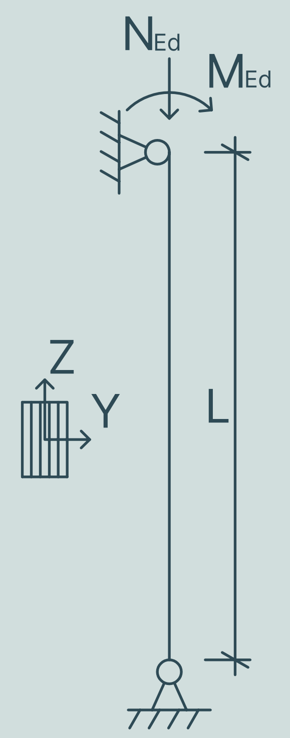
g_k, kN/m²	h, mm	200			240			300		
	b, mm	39	45	63	39	45	63	39	45	63
0,5		2,70	2,83	3,16	3,24	3,39	3,80	4,04	4,24	4,75
1,0		2,60	2,80	3,10	3,20	3,30	3,80	4,00	4,20	4,58
1,5		2,50	2,60	2,90	3,00	3,10	3,50	3,70	3,88	4,23
2,0		-	2,50	2,80	2,80	3,00	3,30	3,50	3,65	3,97
2,5		-	-	2,60	2,70	2,80	3,20	3,36	3,48	3,78
3,0		-	-	2,50	2,60	2,70	3,00	3,20	3,34	3,63

Table 34. Maximum spans (m) of VMG LIGNUM LVL 36C beams when the variable load q_k equals to 2,5 kN⁄m²

g_k, kN⁄m²	h, mm	200			240			300		
	b, mm	**39**	**45**	**63**	**39**	**45**	**63**	**39**	**45**	**63**
0,5		2,70	2,80	3,16	3,20	3,39	3,80	4,04	4,24	4,75
1,0		2,50	2,60	3,00	3,00	3,20	3,60	3,80	4,00	4,50
1,5		-	2,50	2,80	2,80	3,00	3,40	3,60	3,80	4,20
2,0		-	-	2,70	2,70	2,80	3,20	3,40	3,60	3,97
2,5		-	-	2,60	2,60	2,70	3,10	3,20	3,40	3,78
3,0		-	-	2,50	2,50	2,60	3,00	3,10	3,30	3,63

CALCULATIONS OF THE BEARING STRENGTH OF LVL POSTS

Calculations of the bearing strength of VMG LIGNUM LVL posts should be carried out according to the standard EN 1995-1-1. Calculation scheme:



Where:

N_{Ed} is the axial force;

M_{Ed} is the bending moment.

It is assumed that the LVL posts are exposed to the axial force and bending moment.

The relative slenderness ratios are calculated according to Formulas 6.21 and 6.22 of EN 1995-1-1:

$$\lambda_{rel,y} = \frac{\lambda_y}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,05}}} \qquad \lambda_{rel,z} = \frac{\lambda_z}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,05}}}$$

Where:

λ_y is the slenderness ratio corresponding to bending about the y-axis;
λ_z is the slenderness ratio corresponding to bending about the z-axis;
$f_{(c,0,k)}$ is the characteristic compressive force along the grain;
$E_{0,05}$ is the fifth percentile value of the modulus of elasticity.

If $\lambda_{rel,z} \leq 0,3$ and $\lambda_{rel,y} \leq 0,3$, the compressive stresses should meet the conditions according to Formulas 6.19 and 6.20 of EN 1995-1-1:

$$\left(\frac{\sigma_{c,0,d}}{f_{c,0,d}}\right)^2 + \frac{\sigma_{m,y,d}}{f_{m,y,d}} + k_m \frac{\sigma_{m,z,d}}{f_{m,z,d}} \leq 1,0$$

$$\left(\frac{\sigma_{c,0,d}}{f_{c,0,d}}\right)^2 + k_m \frac{\sigma_{m,z,d}}{f_{m,z,d}} + \frac{\sigma_{m,y,d}}{f_{m,y,d}} \leq 1,0$$

Where:

$\sigma_{c,0,d}$ is the design compressive stress along the grain,
$f_{c,0,d}$ is the design compressive strength along the grain,
$\sigma_{m,y,d}$ is the design bending stress about the principal y-axis,
$f_{m,y,d}$ is the design bending strength about the principal y-axis,
$\sigma_{m,z,d}$ is the design bending stress about the principal z-axis,
$f_{m,z,d}$ is the design bending strength about the principal z-axis,
k_m is the factor considering re-distribution of bending stresses in a cross-section. The value of the factor should be assumed as 0.7 for rectangular cross-sections and 1.0 for cross-sections of other shapes.

In all other cases (when $\lambda_{rel} > 0,3$) the compressive stresses should meet the following conditions according to Formulas 6.23 and 6.24 of EN 1995-1-1:

$$\frac{\sigma_{c,0,d}}{k_{c,y} f_{c,0,d}} + \frac{\sigma_{m,y,d}}{f_{m,y,d}} + k_m \frac{\sigma_{m,z,d}}{f_{m,z,d}} \leq 1$$

$$\frac{\sigma_{c,0,d}}{k_{c,z} f_{c,0,d}} + k_m \frac{\sigma_{m,z,d}}{f_{m,z,d}} + \frac{\sigma_{m,y,d}}{f_{m,y,d}} \leq 1$$

Where:

$k_{c,y}$ ir $k_{c,z}$ are the instability factors.

The instability factor is calculated according to Formulas 6.25, 6.26, 6.27, and 6.28 of EN 1995-1-1:

$$k_{c,y} = \frac{1}{k_y + \sqrt{k_y^2 - \lambda_{rel,y}^2}} \qquad k_{c,z} = \frac{1}{k_z + \sqrt{k_z^2 - \lambda_{rel,z}^2}}$$

$$k_y = 0,5(1+\beta_c(\lambda_{rel,y}-0,3)+\lambda_{rel,y}^2) \qquad k_z = 0,5(1+\beta_c(\lambda_{rel,z}-0,3)+\lambda_{rel,z}^2)$$

β_c is a factor for members within the straightness limits defined in Formula 6.29 of EN 1995-1-1:

$$\beta_c = \begin{cases} 0,2\text{-solid wood} \\ 0,1\text{-glued laminated timber and LVL} \end{cases}$$

Where:

$\lambda_{rel,y}$ slenderness ratio corresponding to bending about the y-axis (deflection in the z-direction);
$\lambda_{rel,z}$ slenderness ratio corresponding to bending about the z-axis (deflection in the y-direction).

The slenderness ratios are calculated as follows:

$$\lambda_{rel,y} = \frac{\lambda_y}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,k}}} \qquad \lambda_{rel,z} = \frac{\lambda_z}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,k}}}$$

Where:

λ_y and λ_z are slenderness ratios;
$E_{0,k}$ is the modulus of elasticity in the grain direction.

The other assumptions relied upon in the calculations, the results of which are presented in Tables 35–64:

- The tables provide calculations for the posts of a frame house.
- The maximum bearing capacity has been calculated according to the standard EN 1995-1-1 for the stronger axis of the cross-section (in z-direction).
- The buckling of the post along the weak axis (in y-direction) is not evaluated, assuming that the buckling of the post is limited by the rigid wall plate.
- Each post is loaded by the vertical force (N_{Ed}) and bending moments 1,0kNm, 2,0kNm, 3,0kNm or 4,0kNm.
- The height of the calculated post is 2.7 m.

Table 35. Maximum bearing capacity of VMG LIGNUM LVL 32P posts R_d,kN

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	18,9	36,8	61,2	113,3	134,9	150,8	154,6	195,3
45	21,8	42,5	70,6	130,7	155,7	174,0	178,4	225,3
63	30,5	59,4	98,9	183,0	217,9	243,6	249,8	315,5

Table 36. Maximum bearing capacity of VMG LIGNUM LVL 32P posts R_d,kN, when the bending moment in y-direction is 1 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	3,8	17,8	38,9	89,4	112,2	129,1	133,3	176,8
45	6,7	23,4	48,3	106,9	132,9	152,3	157,0	206,8
63	15,4	40,4	76,5	159,1	195,2	221,9	228,4	296,9

Table 37. Maximum bearing capacity of VMG LIGNUM LVL 32P posts R_d,kN, when the bending moment in y-direction is 2 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	-	-	16,6	65,6	89,4	107,5	111,9	158,2
45	-	4,4	26,0	83,0	110,2	130,7	135,7	188,2
63	-	21,4	54,2	135,3	172,4	200,3	207,1	278,4

Table 38. Maximum bearing capacity of VMG LIGNUM LVL 32P posts R_d,kN, when the bending moment in y-direction is 3 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	-	-	-	41,7	66,7	85,9	90,5	139,7
45	-	-	3,7	59,1	87,4	109,1	114,3	169,7
63	-	2,3	31,9	111,4	149,7	178,6	185,7	259,8

Table 39. Maximum bearing capacity of VMG LIGNUM LVL 32P posts R_d,kN, when the bending moment in y-direction is 4 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	-	-	-	17,8	43,9	64,2	69,2	121,1
45	-	-	-	35,2	64,7	87,4	93,0	151,2
63	-	-	9,6	87,5	127,0	157,0	164,3	241,3

Table 40. Maximum bearing capacity of VMG LIGNUM LVL 35P posts R_d,kN

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	23,5	45,6	74,9	133,5	157,6	175,5	179,8	226,3
45	27,1	52,6	86,5	154,1	181,8	202,5	207,5	261,1
63	38,0	73,6	121,1	215,7	254,5	283,4	290,5	365,5

Table 41. Maximum bearing capacity of VMG LIGNUM LVL 35P posts R_d,kN, when the bending moment in y-direction is 1 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	6,6	24,4	50,4	108,2	133,7	152,8	157,5	206,9
45	10,3	31,4	61,9	128,8	157,9	179,8	185,1	241,8
63	21,1	52,4	96,5	190,4	230,6	260,8	268,1	346,2

Table 42. Maximum bearing capacity of VMG LIGNUM LVL 35P posts R_d,kN, when the bending moment in y-direction is 2 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	-	3,1	25,8	82,9	109,8	130,1	135,1	187,6
45	-	10,2	37,3	103,4	134,0	157,1	162,8	222,4
63	4,2	31,2	71,9	165,1	206,7	238,1	245,8	326,9

Table 43. Maximum bearing capacity of VMG LIGNUM LVL 35P posts R_d,kN, when the bending moment in y-direction is 3 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	-	-	1,2	57,6	85,9	107,5	112,8	168,3
45	-	-	12,7	78,1	110,1	134,5	140,4	203,1
63	-	10,0	47,3	139,8	182,8	215,5	223,4	307,5

Table 44. Maximum bearing capacity of VMG LIGNUM LVL 35P posts R_d,kN, when the bending moment in y-direction is 4 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	-	-	-	32,2	62,0	84,8	90,4	148,9
45	-	-	-	52,8	86,2	111,8	118,1	183,7
63	-	-	22,7	114,4	158,9	192,8	201,1	288,2

Table 45. Maximum bearing capacity of VMG LIGNUM LVL 48P posts R_d,kN

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	27,3	52,9	87,1	155,6	183,7	204,6	209,7	263,9
45	31,5	61,1	100,5	179,5	211,9	236,1	241,9	304,5
63	44,0	85,5	140,7	251,3	296,7	330,5	338,7	426,3

Table 46. Maximum bearing capacity of VMG LIGNUM LVL 48P posts R_d,kN, when the bending moment in y-direction is 1 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	13,9	36,1	67,6	135,5	164,7	186,6	191,9	248,5
45	18,1	44,3	81,0	159,4	192,9	218,1	224,2	289,1
63	30,7	68,7	121,2	231,2	277,7	312,5	321,0	411,0

Table 47. Maximum bearing capacity of VMG LIGNUM LVL 48P posts R_d,kN, when the bending moment in y-direction is 2 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	-	19,3	48,1	115,4	145,7	168,6	174,1	233,2
45	4,8	27,5	61,5	139,3	173,9	200,0	206,4	273,8
63	17,4	51,9	101,7	211,1	258,7	294,5	303,2	395,6

Table 48. Maximum bearing capacity of VMG LIGNUM LVL 48P posts R_d,kN, when the bending moment in y-direction is 3 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	-	2,5	28,6	95,2	126,7	150,5	156,4	217,8
45	-	10,7	42,0	119,2	154,9	182,0	188,6	258,4
63	4,0	35,1	82,2	191,0	239,7	276,4	285,4	380,2

Table 49. Maximum bearing capacity of VMG LIGNUM LVL 48P posts R_d,kN, when the bending moment in y-direction is 4 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	-	-	9,2	75,1	107,7	132,5	138,6	202,4
45	-	-	22,6	99,1	135,9	164,0	170,9	243,0
63	-	18,3	62,8	170,9	220,7	258,4	267,6	364,8

Table 50. Maximum bearing capacity of VMG LIGNUM LVL 25C posts R_d,kN

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	14,1	27,4	45,0	80,1	94,5	105,3	107,9	135,8
45	16,3	31,6	51,9	92,5	109,1	121,5	124,5	156,7
63	22,8	44,2	72,6	129,4	152,7	170,1	174,3	219,3

Table 51. Maximum bearing capacity of VMG LIGNUM LVL 25C posts R_d,kN, when the bending moment in y-direction is 1 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	-	8,3	22,8	57,3	73,0	84,9	87,8	118,4
45	1,1	12,5	29,8	69,7	87,6	101,1	104,4	139,3
63	7,6	25,1	50,5	106,6	131,2	149,7	154,2	201,9

Table 52. Maximum bearing capacity of VMG LIGNUM LVL 25C posts R_d,kN, , when the bending moment in y-direction is 2 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	-	-	0,7	34,5	51,5	64,5	67,7	101,0
45	-	-	7,6	46,9	66,1	80,7	84,3	121,8
63	-	6,0	28,4	83,9	109,7	129,3	134,1	184,5

Table 53. Maximum bearing capacity of VMG LIGNUM LVL 25C posts R_d,kN, when the bending moment in y-direction is 3 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	-	-	-	11,7	30,0	44,1	47,5	83,6
45	-	-	-	24,1	44,5	60,3	64,1	104,4
63	-	-	6,3	61,1	88,2	108,9	113,9	167,1

Table 54. Maximum bearing capacity of VMG LIGNUM LVL 25C posts R_d,kN, when the bending moment in y-direction is 4 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	-	-	-	-	8,5	23,7	27,4	66,1
45	-	-	-	1,3	23,0	39,9	44,0	87,0
63	-	-	-	38,3	66,7	88,5	93,8	149,7

Table 55. Maximum bearing capacity of VMG LIGNUM LVL 32C posts R_d,kN

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	19,1	35,8	54,4	84,7	97,8	107,9	110,4	137,6
45	22,0	41,3	62,8	97,7	112,8	124,5	127,4	158,7
63	30,8	57,8	88,0	136,8	157,9	174,3	178,4	222,2

Table 56. Maximum bearing capacity of VMG LIGNUM LVL 32C posts R_d,kN, when the bending moment in y-direction is 1 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	4,4	17,9	35,3	67,5	81,9	93,0	95,7	125,0
45	7,3	23,4	43,7	80,5	96,9	109,6	112,7	146,1
63	16,1	39,9	68,8	119,6	142,1	159,4	163,7	209,6

Table 57. Maximum bearing capacity of VMG LIGNUM LVL 32C posts R_d,kN, when the bending moment in y-direction is 2 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	-	0,1	16,2	50,3	66,0	78,0	81,0	112,4
45	-	5,6	24,5	63,3	81,0	94,6	98,0	133,5
63	1,5	22,1	49,7	102,4	126,2	144,5	148,9	197,0

Table 58. Maximum bearing capacity of VMG LIGNUM LVL 32C posts R_d,kN, when the bending moment in y-direction is 3 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	-	-	3,0	33,1	50,1	63,1	66,3	99,8
45	-	-	5,4	46,1	65,1	79,7	83,3	120,9
63	-	4,3	30,5	85,2	110,3	129,5	134,2	184,4

Table 59. Maximum bearing capacity of VMG LIGNUM LVL 32C posts R_d,kN, when the bending moment in y-direction is 4 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	-	-	-	15,9	34,2	48,2	51,6	87,2
45	-	-	-	28,9	49,2	64,8	68,6	108,3
63	-	-	11,4	68,0	94,4	114,6	119,5	171,8

Table 60. Maximum bearing capacity of VMG LIGNUM LVL 36C posts R_d,kN

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	20,7	40,0	65,7	116,2	136,8	152,3	156,1	196,3
45	23,8	46,2	75,8	134,0	157,9	175,7	180,1	226,5
63	33,4	64,7	106,1	187,6	221,1	246,0	252,1	317,0

Table 61. Maximum bearing capacity of VMG LIGNUM LVL 36C posts R_d,kN, when the bending moment in y-direction is 1 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	6,8	22,6	45,5	95,5	117,4	133,9	137,9	180,5
45	9,9	28,7	55,6	113,4	138,4	157,3	161,9	210,7
63	19,5	47,2	85,9	167,0	201,6	227,6	233,9	301,3

Table 62. Maximum bearing capacity of VMG LIGNUM LVL 36C posts R_d,kN, when the bending moment in y-direction is 2 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	-	5,1	25,3	74,9	97,9	115,4	119,7	164,8
45	-	11,2	35,4	92,7	119,0	138,8	143,7	195,0
63	5,6	29,7	65,7	146,3	182,1	209,1	215,7	285,6

Table 63. Maximum bearing capacity of VMG LIGNUM LVL 36C posts R_d,kN, when the bending moment in y-direction is 3 kNm

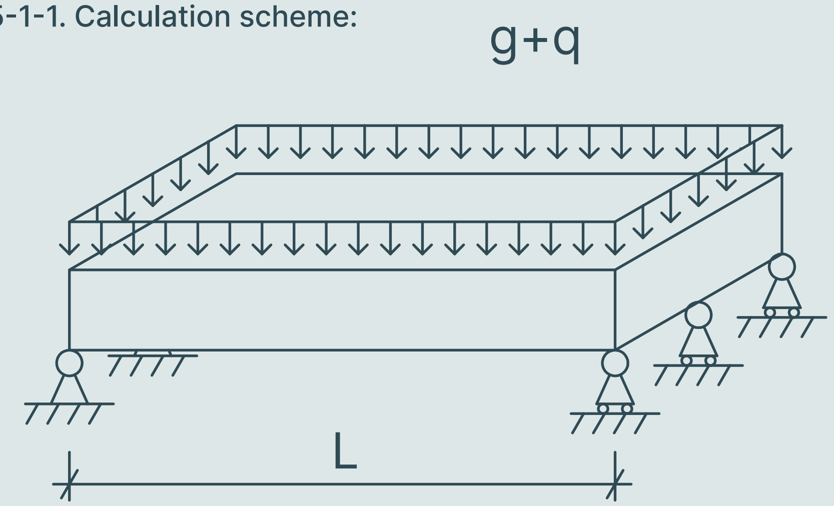
Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	-	-	5,1	54,2	78,5	97,0	101,5	149,1
45	-	-	15,2	72,1	99,5	120,4	125,5	179,3
63	-	12,3	45,5	125,7	162,7	190,7	197,5	269,9

Table 64. Maximum bearing capacity of VMG LIGNUM LVL 36C posts R_d,kN, when the bending moment in y-direction is 4 kNm

Width, b, mm	Height, h, mm							
	95	**120**	**145**	**195**	**200**	**240**	**245**	**300**
39	-	-	-	33,6	59,0	78,5	83,3	133,4
45	-	-	-	51,4	80,0	102,0	107,3	163,5
63	-	-	25,3	105,0	143,2	172,3	179,3	254,1

CALCULATION OF THE BEARING STRENGTH OF LVL PANELS

Calculations of the bearing strength of VMG LIGNUM LVL panels should be carried out according to the standard EN 1995-1-1. Calculation scheme:



Where:

g is the permanent load;
q is the variable load.

The design strength value Xd of the material is calculated according to Formula 2.14 of EN 1995-1-1:

$$X_d = \frac{k_{mod} \cdot X_k}{Y_m}$$

Where:

X_k is the characteristic value of a strength property;
Y_m is the partial factor for a material property. The recommended value of the factor for LVL is 1,2;
k_{mod} is a modification factor taking into account the effect of the duration of load and moisture content. According to Table 3.1 of the standard EN 1995-1-1, under medium-term action, under the conditions of Service class k_{mod}= 0,8.

When calculating, the serviceability limit state must be taken into account (Section 7 of EN 1995-1-1). The maximum beam deflection is assumed to be L/250. When checking the structure deflection from a point load of 1 kN, the maximum permissible deflection is 1,5 mm. The limit value of the natural frequency of oscillation of beams is f_{lim} = 8 Hz. The stiffness of the floor structure in the direction perpendicular to the beams was not evaluated in the calculations.

When considering the serviceability limit state $E_{m,fin}$, which is applied for the calculation of the final deformation, must be calculated according to Formula 2.7 of EN 1995-1-1:

$$E_{m,fin} = \frac{E_m}{1+k_{def}}$$

Where:

E_m is the mean value of modulus of elasticity;

k_{def} is the creep deformation factor to be selected taking into account the service class of the structure. According to Table 3.2 of the standard EN 1995-1-1, the value k_{def} for Service class 1 is 0,6.

The other assumptions relied upon in the calculations, the results of which are presented in Tables 65–84:

- Width of panel supports 45 mm.
- The impact of the panel support reactions on the supports was not evaluated.
- The loads presented in the tables below are cumulative permanent and variable characteristic distributed loads. Permanent loads account for no more than 40 % of the total amount of loads.
- The tables for spans have been drawn up for different combinations of working loads: for variable loads (q_k) 1,5;2,0 and 2,5 kN/m² (the load values have been selected taking into account the service load variations presented in the standard EN 1991-1-1), and permanent loads (g_k) from 0,5 to 3,0 kN/m².

Table 65. Maximum characteristic loads of VMG LIGNUM LVL 32P panels, kN/m²

L, m	b, mm	1000			
	h, mm	**39**	**45**	**63**	**75**
0,5		73,42	107,54	131,45	131,39
1,0		10,17	15,47	40,60	65,51
1,5		2,95	4,57	12,54	20,88
2,0		-	-	5,23	8,87
2,5		-	-	-	4,42

Table 66. Maximum spans (m) of VMG LIGNUM LVL 32P panels when the variable load q_k=1,5 kN/m²

q_k kN/m²	b, mm	1000			
	h, mm	**39**	**45**	**63**	**75**
0,5		1,51	1,74	2,43	2,89
1,0		1,51	1,74	2,43	2,89
1,5		1,44	1,68	2,40	2,88
2,0		1,32	1,56	2,28	2,64
2,5		1,32	1,44	2,16	2,52
3,0		1,20	1,44	2,04	2,40

Table 67. Maximum spans (m) of VMG LIGNUM LVL 32P panels when the variable load q_k= 2 kN/m²

q_k kN/m²	b, mm	1000			
	h, mm	39	45	63	75
0,5		1,51	1,74	2,43	2,89
1,0		1,44	1,68	2,40	2,88
1,5		1,44	1,56	2,28	2,76
2,0		1,32	1,56	2,16	2,52
2,5		1,20	1,44	2,04	2,40
3,0		1,20	1,44	1,92	2,40

Table 68. Maximum spans (m) of VMG LIGNUM LVL 32P panels when the variable load q_k= 2,5 kN/m²

q_k kN/m²	b, mm	1000			
	h, mm	39	45	63	75
0,5		1,51	1,74	2,43	2,89
1,0		1,44	1,68	2,28	2,76
1,5		1,32	1,56	2,16	2,64
2,0		1,32	1,44	2,04	2,52
2,5		1,20	1,44	2,04	2,40
3,0		1,20	1,32	1,92	2,28

Table 69. Maximum characteristic loads of VMG LIGNUM LVL 35P panels, kN/m²

L, m	b, mm	1000			
	h, mm	39	45	63	75
0,5		91,11	133,16	189,10	225,12
1,0		12,73	19,34	50,55	81,76
1,5		3,73	5,76	15,71	26,10
2,0		-	-	6,60	11,15
2,5		-	-	3,26	5,61

Table 70. Maximum spans (m) of VMG LIGNUM LVL 35P panels when the variable load q_k= 1,5 kN/m²

q_k kN/m²	b, mm	1000			
	h, mm	39	45	63	75
0,5		1,62	1,87	2,62	3,12
1,0		1,62	1,87	2,62	3,12
1,5		1,56	1,80	2,52	3,08
2,0		1,44	1,68	2,40	2,88
2,5		1,44	1,68	2,28	2,76
3,0		1,32	1,56	2,16	2,64

Table 70. Maximum spans (m) of VMG LIGNUM LVL 35P panels when the variable load q_k= 2 kN/m²

q_k kN/m²	b, mm	1000			
	h, mm	39	45	63	75
0,5		1,62	1,87	2,62	3,12
1,0		1,56	1,80	2,62	3,12
1,5		1,44	1,68	2,40	2,88
2,0		1,44	1,68	2,28	2,76
2,5		1,32	1,56	2,16	2,64
3,0		1,32	1,56	2,16	2,52

Table 70. Maximum spans (m) of VMG LIGNUM LVL 35P panels when the variable load q_k= 2,5 kN/m²

q_k kN/m²	b, mm	1000			
	h, mm	39	45	63	75
0,5		1,62	1,87	2,62	3,12
1,0		1,56	1,80	2,52	3,00
1,5		1,44	1,68	2,40	2,76
2,0		1,32	1,56	2,28	2,64
2,5		1,32	1,56	2,16	2,52
3,0		1,20	1,44	1,04	2,52

Table 73. Maximum characteristic loads of VMG LIGNUM LVL 48P panels, kN/m²

L, m	b, mm	1000			
	h, mm	39	45	63	75
0,5		102,41	135,07	189,10	225,12
1,0		14,57	22,08	57,25	92,06
1,5		4,31	6,64	17,98	29,76
2,0		-	-	7,60	12,80
2,5		-	-	3,79	6,49
3,0		-	-	-	3,63

Table 74. Maximum spans (m) of VMG LIGNUM LVL 48P panels when the variable load q_k= 1,5 kN/m²

q_k kN/m²	b, mm	1000			
	h, mm	39	45	63	75
0,5		1,70	1,96	2,74	3,27
1,0		1,70	1,96	2,74	3,27
1,5		1,68	1,92	2,64	3,19
2,0		1,56	1,80	2,52	3,00
2,5		1,44	1,68	2,40	2,86
3,0		1,44	1,68	2,28	2,74

Table 74. Maximum spans (m) of VMG LIGNUM LVL 48P panels when the variable load q_k= 2 kN⁄m²

q_k kN⁄m²	b, mm	1000			
	h, mm	39	45	63	75
0,5		1,70	1,96	2,74	3,27
1,0		1,68	1,92	2,74	3,24
1,5		1,56	1,80	2,52	3,12
2,0		1,44	1,68	2,40	2,88
2,5		1,44	1,68	2,28	2,76
3,0		1,32	1,56	2,28	2,64

Table 74. Maximum spans (m) of VMG LIGNUM LVL 48P panels when the variable load q_k= 2,5 kN⁄m²

q_k kN⁄m²	b, mm	1000			
	h, mm	39	45	63	75
0,5		1,68	1,92	2,74	3,27
1,0		1,56	1,80	2,64	3,12
1,5		1,56	1,80	2,52	3,00
2,0		1,44	1,68	2,40	2,76
2,5		1,32	1,56	2,28	2,64
3,0		1,32	1,56	2,16	2,64

Table 77. Maximum characteristic loads of VMG LIGNUM LVL 25C panels kN⁄m²

L, m	b, mm	1000			
	h, mm	39	45	63	75
0,5		40,34	55,16	90,27	107,47
1,0		6,86	10,16	24,25	36,71
1,5		-	3,17	8,31	13,33
2,0		-	-	3,58	5,96
2,5		-	-	-	3,02

Table 78. Maximum spans (m) of VMG LIGNUM LVL 25C panels when the variable load q_k= 1,5 kN⁄m²

q_k kN⁄m²	b, mm	1000			
	h, mm	39	45	63	75
0,5		1,37	1,58	2,21	2,63
1,0		1,37	1,56	2,21	2,63
1,5		1,32	1,44	2,16	2,52
2,0		1,20	1,44	1,92	2,40
2,5		1,08	1,32	1,92	2,28
3,0		1,08	1,20	1,80	2,16

Table 78. Maximum spans (m) of VMG LIGNUM LVL 25C panels when the variable load q_k= 2 kN⁄m²

q_k kN⁄m²	b, mm	1000			
	h, mm	39	45	63	75
0,5		1,37	1,58	2,21	2,63
1,0		1,32	1,56	2,16	2,52
1,5		1,20	1,44	2,04	2,40
2,0		1,20	1,32	1,92	2,28
2,5		1,08	1,32	1,80	2,16
3,0		1,08	1,20	1,68	2,04

Table 78. Maximum spans (m) of VMG LIGNUM LVL 25C panels when the variable load q_k= 2,5 kN⁄m²

q_k kN⁄m²	b, mm	1000			
	h, mm	39	45	63	75
0,5		1,32	1,56	2,16	2,63
1,0		1,20	1,44	2,04	2,40
1,5		1,20	1,32	1,92	2,28
2,0		1,08	1,32	1,80	2,16
2,5		1,08	1,20	1,80	2,04
3,0		0,96	1,20	1,68	2,04

Table 81. Maximum characteristic loads of VMG LIGNUM LVL 36C panels, kN⁄m²

L, m	b, mm	1000			
	h, mm	39	45	63	75
0,5		62,43	76,25	106,74	127,08
1,0		10,29	15,30	37,08	56,76
1,5		3,12	4,78	12,55	20,22
2,0		-	-	5,44	9,03
2,5		-	-	2,71	4,63

Table 82. Maximum spans (m) of VMG LIGNUM LVL 36C panels when the variable load q_k= 1,5 kN⁄m²

q_k kN⁄m²	b, mm	1000			
	h, mm	39	45	63	75
0,5		1,55	1,79	2,50	2,98
1,0		1,55	1,79	2,50	2,98
1,5		1,44	1,68	2,40	2,88
2,0		1,44	1,56	2,28	2,76
2,5		1,32	1,56	2,16	2,64
3,0		1,20	1,44	2,04	2,52

Table 82. Maximum spans (m) of VMG LIGNUM LVL 36C panels when the variable load q_k = 2 kN⁄m²

q_k kN⁄m²	b, mm	1000			
	h, mm	**39**	**45**	**63**	**75**
0,5		1,55	1,79	2,50	2,98
1,0		1,55	1,79	2,50	2,98
1,5		1,44	1,68	2,28	2,76
2,0		1,32	1,56	2,16	2,64
2,5		1,32	1,44	2,04	2,52
3,0		1,20	1,44	2,04	2,40

Table 82. Maximum spans (m) of VMG LIGNUM LVL 36C panels when the variable load q_k = 2,5 kN⁄m²

q_k kN⁄m²	b, mm	1000			
	h, mm	**39**	**45**	**63**	**75**
0,5		1,55	1,79	2,50	2,98
1,0		1,44	1,68	2,40	2,76
1,5		1,32	1,56	2,16	2,64
2,0		1,32	1,44	2,16	2,52
2,5		1,20	1,44	2,04	2,40
3,0		1,20	1,32	1,92	2,28

HOLE DRILLING METHODOLOGY AND CALCULATIONS

Since the European standard EN 1995-1-1 for wooden structures does not regulate the inspection of holes, the Austrian national standard ÖNORM EN 1995-1-1 is used as the practical guidance.

Fig.13 and 14 show the geometrical limit conditions of the holes.

The rules presented in this section below are applicable only if the geometrical limit conditions are met.

General conditional limit:
- $l_V \geq h$
- $l_A \geq 0{,}5 \cdot h$

FOR ROUND HOLES:

- $h_d = d \leq 0{,}7 \cdot h$
- When the centre of the hole is in the neutral axis:
  $h_{ro} \geq 0{,}15 \cdot h$ and $h_{ru} \geq 0{,}15 \cdot h$
- When the centre of the hole is eccentrically in the neutral axis:
  $h_{ro} \geq 0{,}25 \cdot h$ and $h_{ru} \geq 0{,}25 \cdot h$
- $h_{ro} \geq \max \begin{cases} 1{,}0 \cdot h \\ 2{,}0 \cdot h \end{cases}$

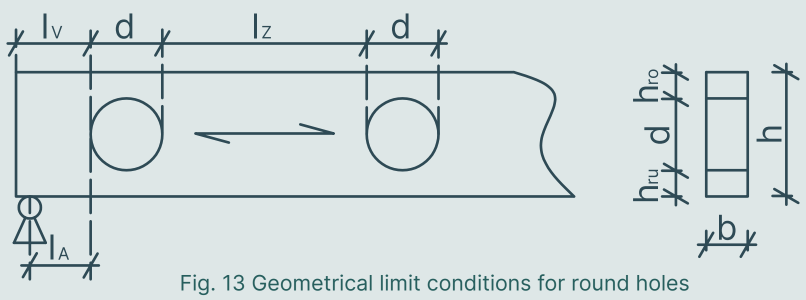


Fig. 13 Geometrical limit conditions for round holes

FOR RECTANGULAR HOLES:

The radius of the curve in each corner must be at least 15 mm.

- $h_d \leq 0{,}3 \cdot h$ VMG LIGNUM LVL P;
  $h_d \leq 0{,}4 \cdot h$ VMG LIGNUM LVL C;
- $a \leq 1{,}5 \cdot h$
- $h_{ro} \geq 0{,}35 \cdot h$ and $h_{ru} \geq 0{,}35 \cdot h$ VMG LIGNUM LVL P;
  $h_{ro} \geq 0{,}30 \cdot h$ and $h_{ru} \geq 0{,}30 \cdot h$ VMG LIGNUM LVL C;
- $l_z \geq 1{,}5 \cdot h$

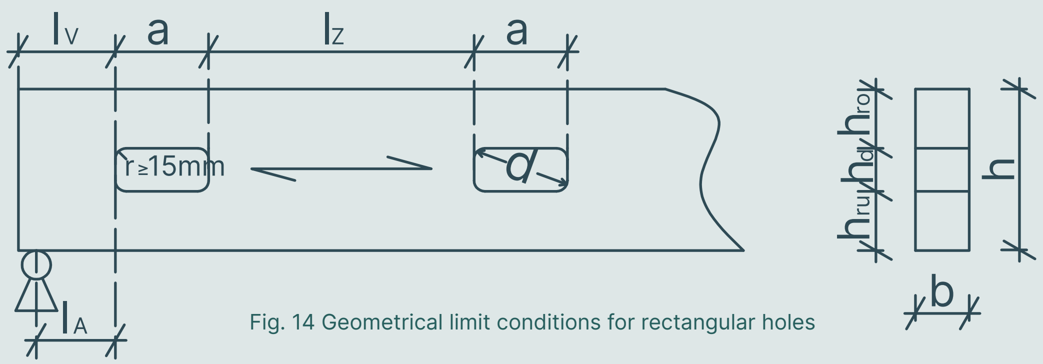


Fig. 14 Geometrical limit conditions for rectangular holes

Where:

h - Beam height [mm]
h_d - Hole diameter and height [mm]
l_z - Distance between two holes [mm]
a - Rectangular hole length [mm]

Table 85. Geometrical limits of VMG LIGNUM LVL P/C round holes

Beam height	Minimum distance from the beam edge	Minimum distance from the support	Minimum distance between holes	When the hole is in the neutral axis		When the hole is not in the neutral axis	
				Maximum hole diameter	Distance from the beam edges	Maximum hole diameter	Distance from the beam edges
h [mm]	**L_V min [mm]**	**L_A min [mm]**	**L_Z min [mm]**	**d [mm]**	**h_{ro} ir h_{ru} min [mm]**	**d [mm]**	**h_{ro} ir h_{ru} min [mm]**
90	90	45	126	63	13,5	45	22,5
95	95	47,5	133	66,5	14,25	47,5	23,75
120	120	60	168	84	18	60	30
140	140	70	196	98	21	70	35
150	150	75	210	105	22,5	75	37,5
180	180	90	252	126	27	90	45
190	190	95	266	133	28,5	95	47,5
200	200	100	280	140	30	100	50
240	240	120	336	168	36	120	60
290	290	145	406	203	43,5	145	72,5
300	300	150	420	210	45	150	75
360	360	180	504	252	54	180	90
400	400	200	560	280	60	200	100

Table 86. Geometrical limits of VMG LIGNUM LVL P/C rectangular holes

Beam height	Minimum distance from the beam edge	Minimum distance from the support	Minimum distance between holes	Maximum length of two holes	Maximum hole height P/C	Distance from the beam edges P/C
h [mm]	**L_V min [mm]**	**L_A min [mm]**	**L_Z min [mm]**	**a max [mm]**	**h_d max [mm]**	**h_{ro} and h_{ru} min [mm]**
90	90	45	135	135	27 / 36	31,5 / 27
95	95	47,5	142,5	142,5	28,5 / 38	33,25 / 28,5
120	120	60	180	180	36 / 48	42 / 36
140	140	70	210	210	42 / 56	49 / 42
150	150	75	225	225	45 / 60	52,5 / 45
180	180	90	270	270	54 / 72	63 / 54
190	190	95	285	285	57 / 76	66,5 / 57
200	200	100	300	300	60 / 80	70 / 60
240	240	120	360	360	72 / 96	84 / 72
290	290	145	435	435	87 / 116	101,5 / 87
300	300	150	450	450	90 / 120	105 / 90
360	360	180	540	540	108 / 144	126 / 108
400	400	200	600	600	120 / 160	140 / 120

MINIMUM SPACINGS BETWEEN FASTENERS AND END AND EDGE DISTANCES

The rules for connections without drilling in VMG LIGNUM LVL P flat surface are the same as for sawn timber. However, the spacings between the fasteners and end and edge distances must be evaluated. These parameters can be reduced because the product is more resistant to splitting owing to cross-glued veneers.

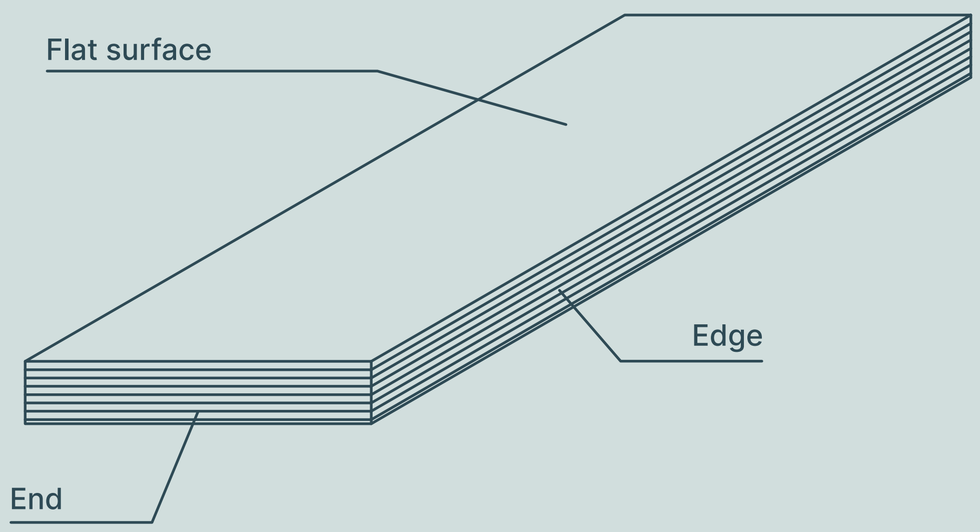


Fig. 15 LVL surfaces

However, connections at the edge are associated with a greater risk of cracking, which requires larger spacings between the fasteners as well as edge and end distances. This is relevant for both VMG LIGNUM LVL P and VMG LIGNUM LVL C. The risk of splitting is reduced when drilling holes, so there can be smaller spaces between fasteners as well as edge and end distances.

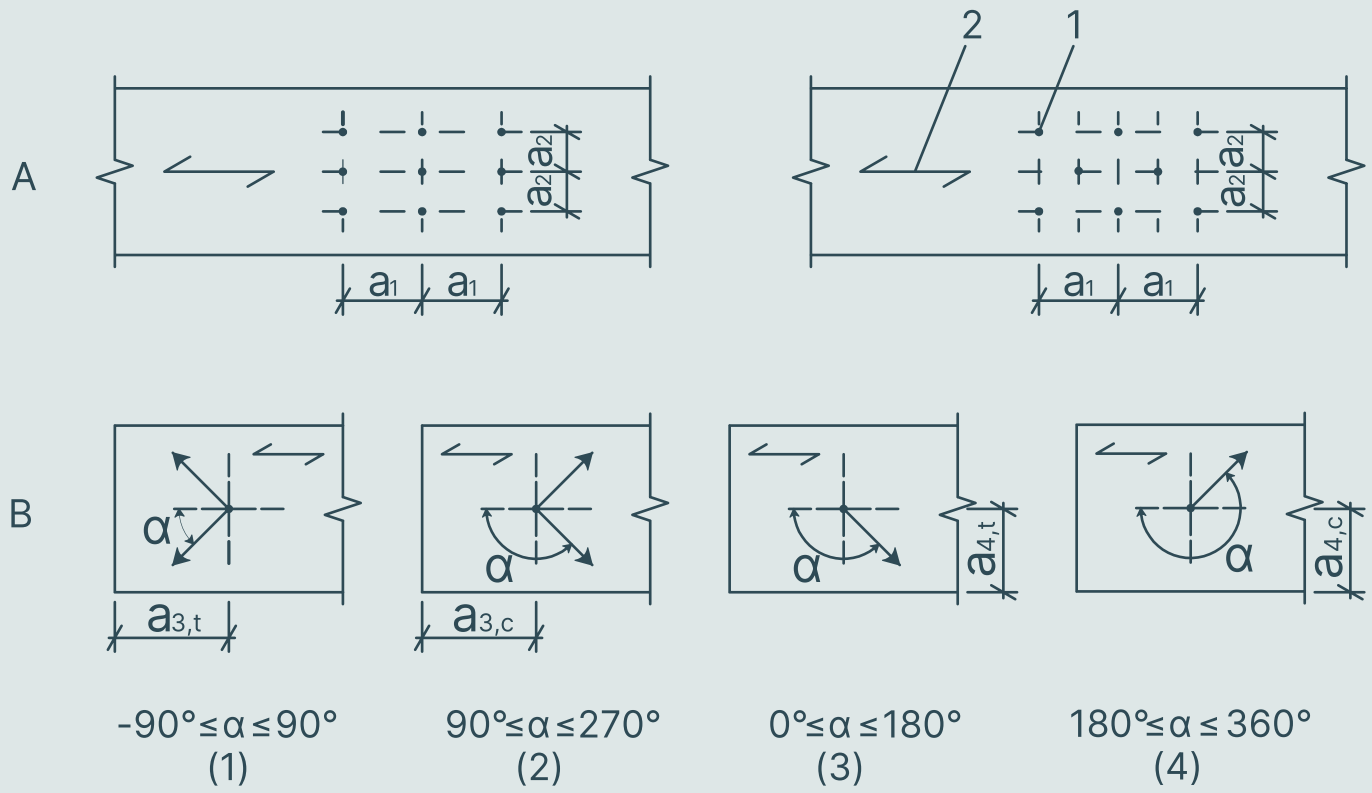


Fig. 16 Spaces and distances from the end and the edge when the connecting members are loaded with transverse load (connections 1, grain direction 2 (EN 1995-1-1, Fig. 8.7))

(A) Spacing parallel to grain in a row and perpendicular to grain between rows.
(B) Edge and end distances: (1) loaded end, (2) unloaded end, (3) loaded edge, (4) unloaded edge.

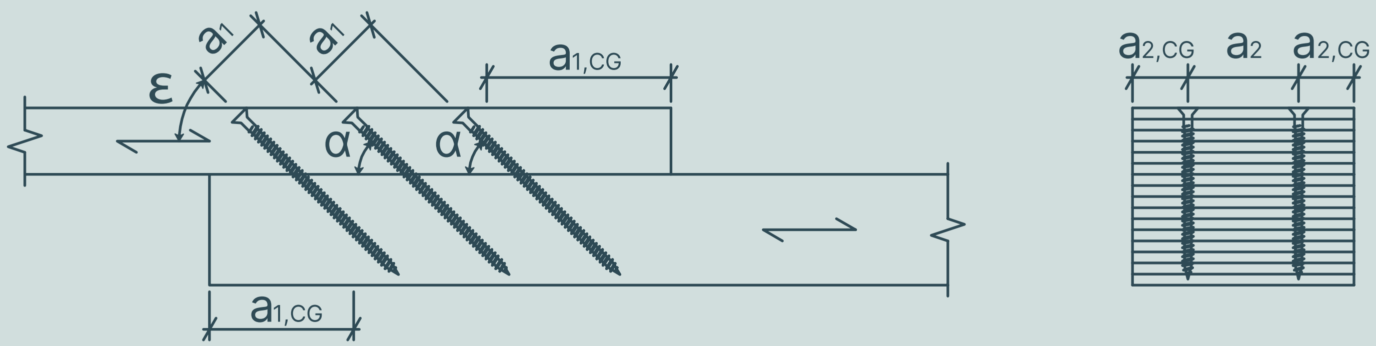


Fig. 17 Spacings between fasteners and end and edge distances when the connecting members are loaded with axial load

Where:
- α the angle between the shear plane and the screw axis;
- ε the angle between the screw axis and the grain direction.

Table 87. Minimum spacings and edge and end distances for laterally loaded nails and wood screws (Table 8.2 of EN 1995-1-1)

Spacing or distance (see Figure 16)	Angle α	Without predrilled holes		With predrilled holes
		Flat surface	Edge	
a_1(parallel to the grain)	0°≤α≤360°	d<5 mm: (5+5|cos α|)d; d≥5mm: (5+7|cos α|)d;	(7+8|cos α|)d;	(4+|cos α|)d
a_2(perpendicular to the grain)	0°≤α≤360°	5d	7d	(3+|sin α|)d
$a_{3,t}$(to the loaded end)	-90°≤α≤90°	(10+5 cos α)d	(15+5 cos α)d	(7+5 cos α)d
$a_{3,c}$(to the unloaded end)	90°≤α≤270°	10d	15d	7d
$a_{4,t}$(to the loaded end)	0°≤α≤180°	d<5 mm: (5+2|sin α|)d; d≥5mm: (5+5|sin α|)d;	d<5 mm: (7+2|sin α|)d; d≥5mm: (7+5|sin α|)d;	d<5 mm: (3+2|sin α|)d; d≥5mm: (3+4|sin α|)d;
$a_{4,c}$(to the unloaded end)	180°≤α≤360°	5d	7d	3d

Table 88. Minimum spacings and edge distances for axially loaded wood screws (Table 8.6 of EN 1995-1-1)

Wood crews (driven)	Minimum spacing	Minimum edge distance
At right angle to the grain	4d	4d
In end grain	4d	2,5d

Table 89. Minimum spacings and edge and end distances for staples (Table 8.3 of EN 1995-1-1)

Spacing or distance	Angle α	Minimum spacing or edge/ end distance
a_1 (parallel to the grain) Where θ≥30° Where θ<30°	0°≤α≤360°	(10+5|cos α |)d (15+5|cos α |)d
a_2(perpendicular to the grain)	0°≤α≤360°	15d
$a_{3,t}$(to the loaded end)	-90°≤α≤90°	(15+5|cos α |)d
$a_{3,c}$(to the unloaded end)	90°≤α≤270°	15d
$a_{4,t}$(to the loaded edge)	0°≤α≤180°	(15+5|cos α |)d
$a_{4,c}$(to the unloaded edge)	180°≤α≤360°	10d

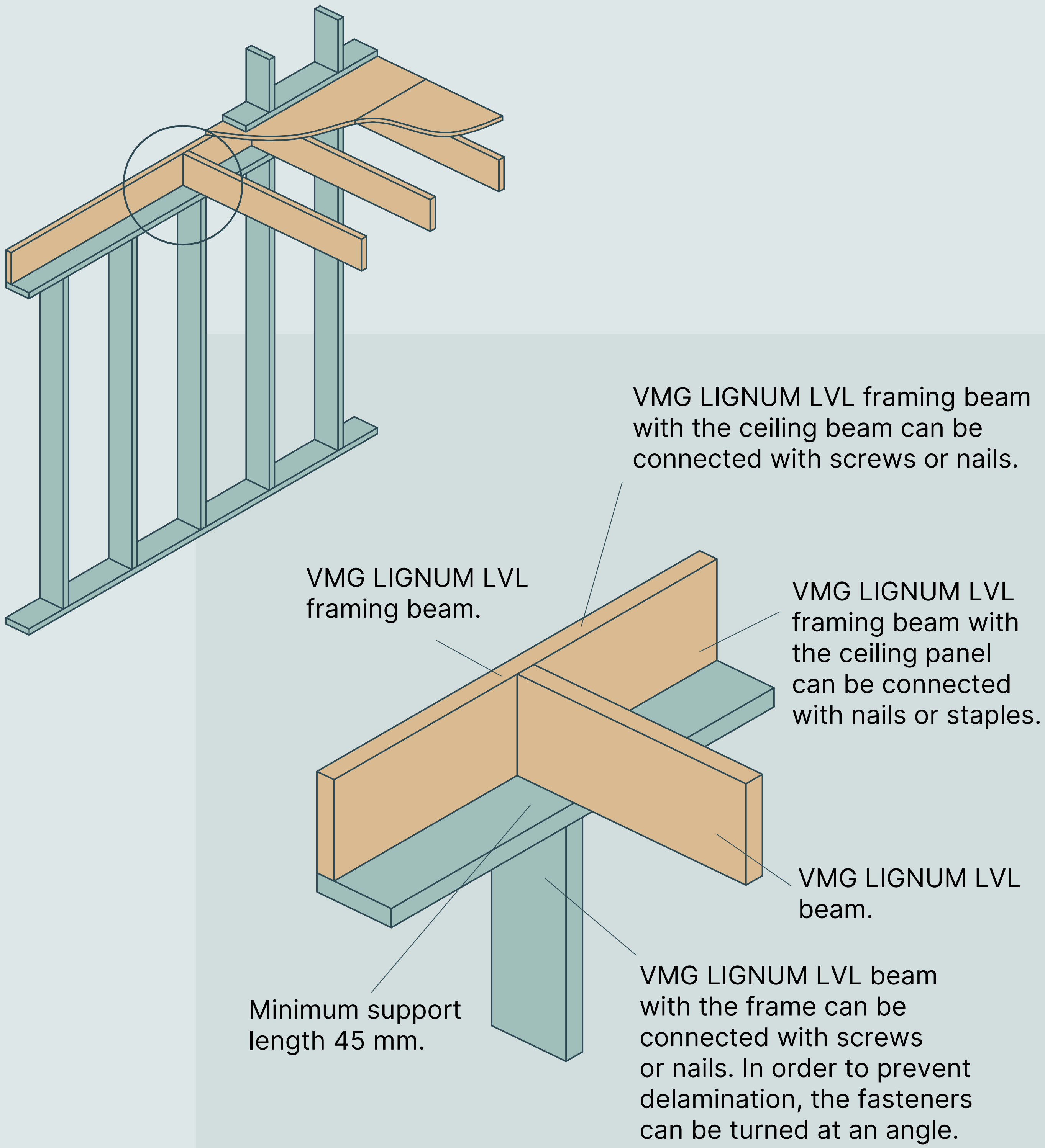
Table 90. Minimum spacings and edge and end distances for bolts (Table 8.4 of EN 1995-1-1)

Spacing or distance	Angle α	Minimum spacing or edge/ end distance
a_1 (parallel to the grain)	0°≤α≤360°	(4+|cos α |)d
a_2(perpendicular to the grain)	0°≤α≤360°	4d
$a_{3,t}$(to the loaded end)	-90°≤α≤90°	max(7d; 80mm)
$a_{3,c}$(to the unloaded end)	90°≤α≤150° 150°≤α≤210° 210°≤α≤270°	max[(1+6 sin α)d;4d] 4d max[(1+6 sin α)d;4d]
$a_{4,t}$(to the loaded edge)	0°≤α≤180°	max[(2+2 sin α)d;3d
$a_{4,c}$(to the unloaded edge)	180°≤α≤360°	3d

Table 91. Minimum spacings and edge and end distances for dowels (Table 8.5 of EN 1995-1-1)

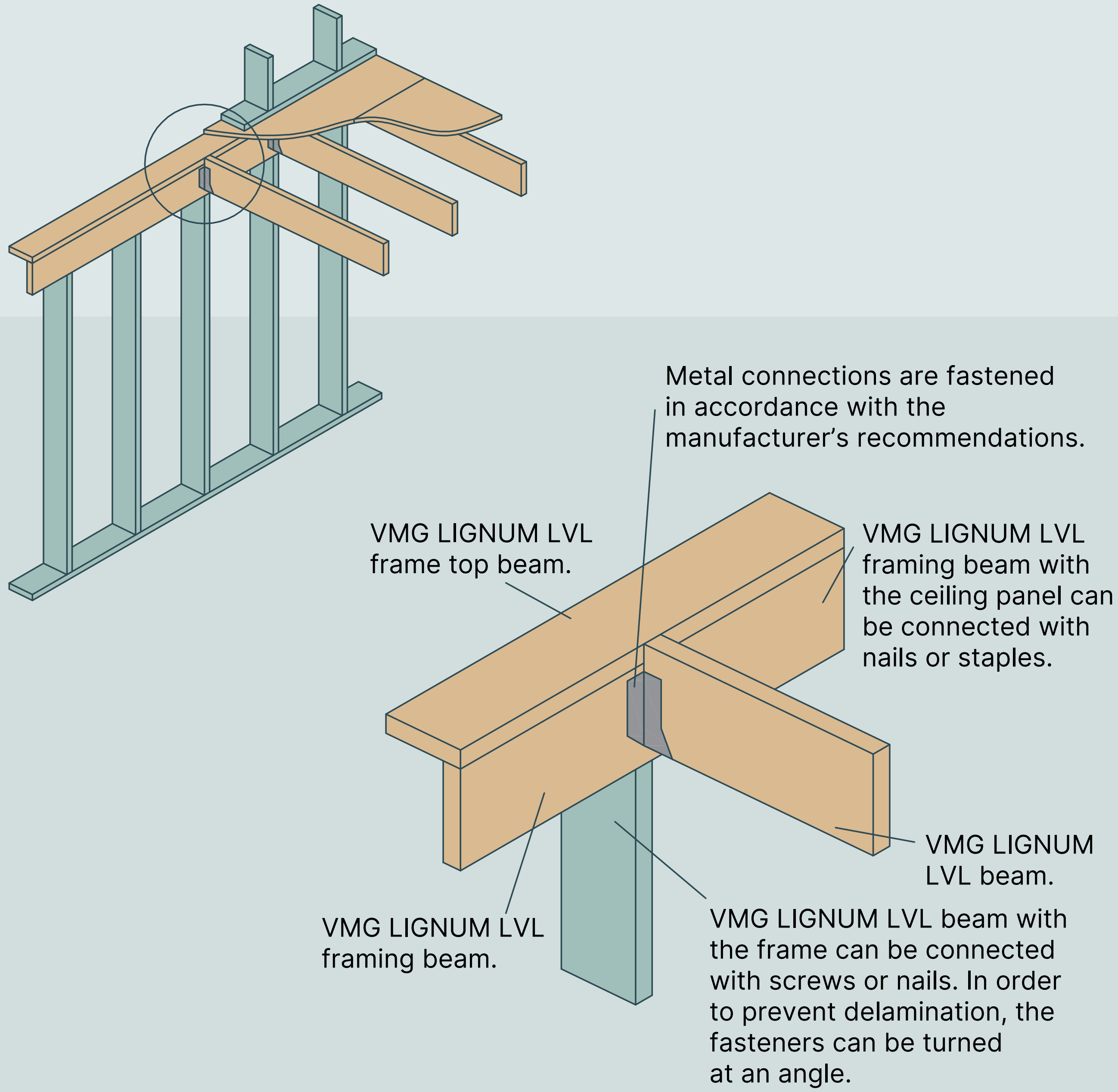
Spacing or distance	Angle α	Minimum spacing or edge/ end distance
a_1 (parallel to the grain)	0°≤α≤360°	(3+2|cos α |)d
a_2(perpendicular to the grain)	0°≤α≤360°	3d
$a_{3,t}$(to the loaded end)	-90°≤α≤90°	max(7d; 80mm)
$a_{3,c}$(to the unloaded end)	90°≤α≤150° 150°≤α≤210° 210°≤α≤270°	max[$a_{3,t}$+5|cos α|)d;3d 3d max[$a_{3,t}$+5|cos α|)d;3d
$a_{4,t}$(to the loaded edge)	0°≤α≤180°	max[(2+2 sin α)d;3d
$a_{4,c}$(to the unloaded edge)	180°≤α≤360°	3d

APPLICATION EXAMPLES



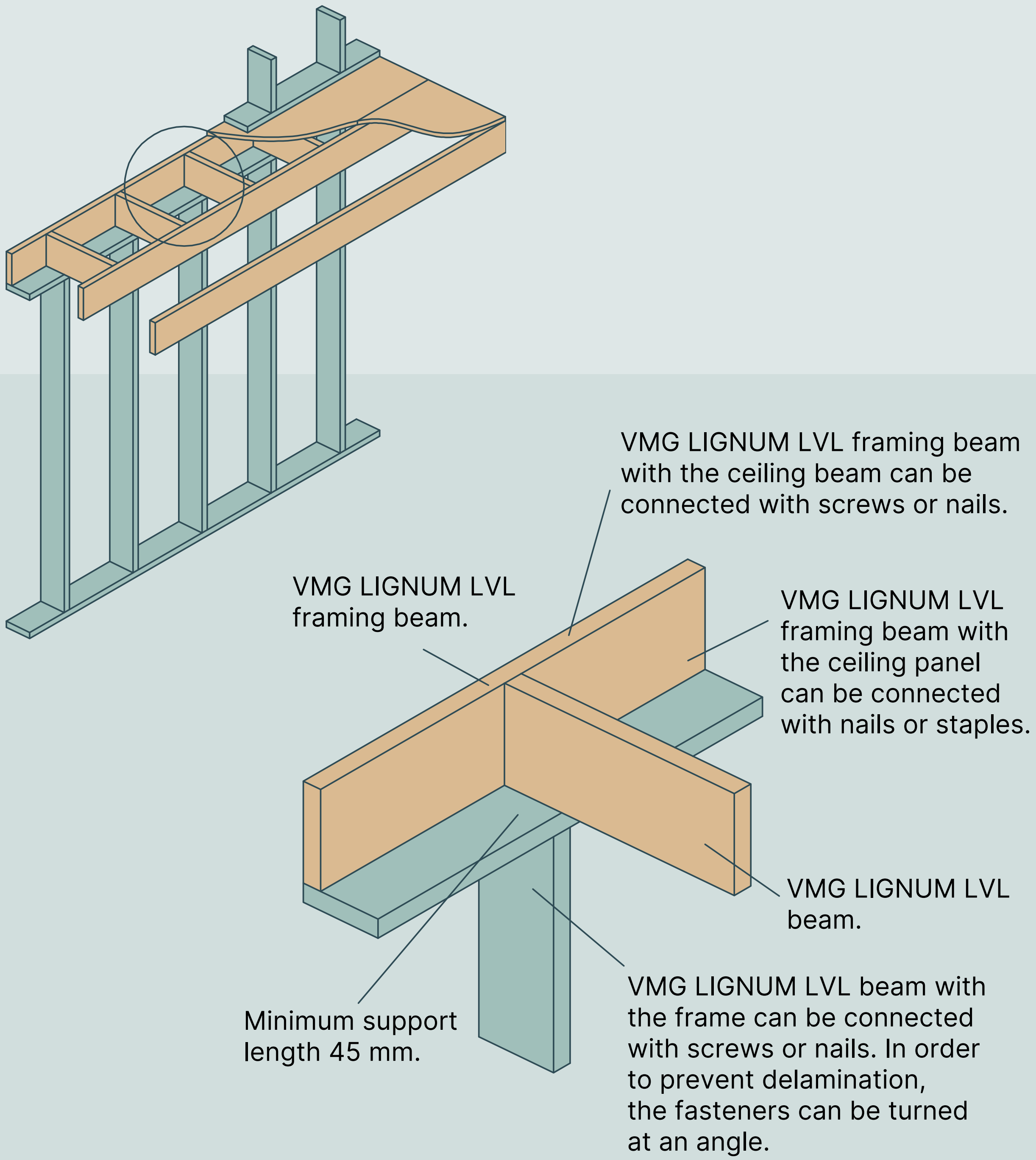
- VMG LIGNUM LVL wall elements
- VMG LIGNUM LVL ceiling elements

Fig. 17 VMG LIGNUM LVL application example No 1



- VMG LIGNUM LVL wall elements
- VMG LIGNUM LVL ceiling elements

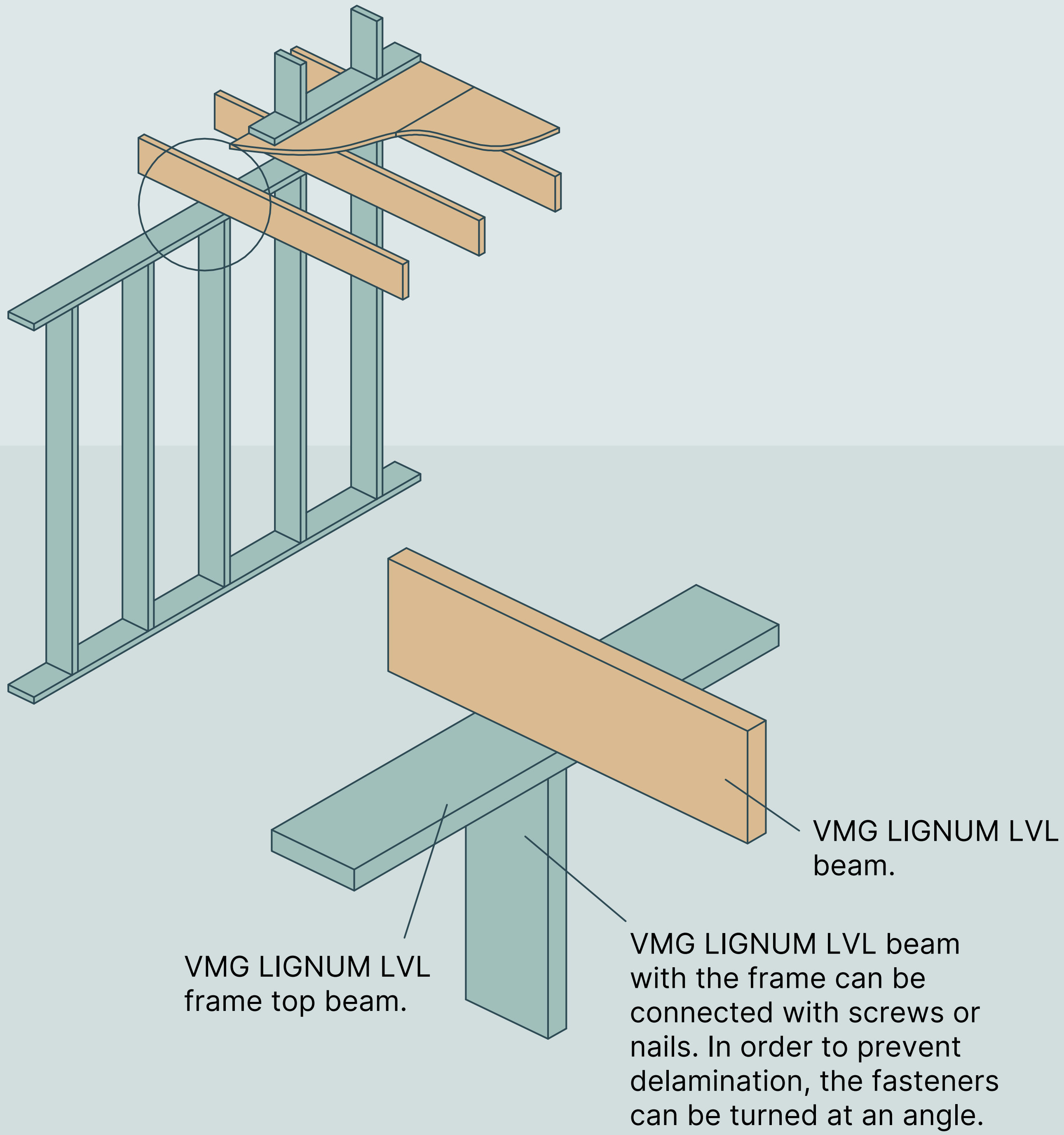
Fig. 18 VMG LIGNUM LVL application example No 2



VMG LIGNUM LVL wall elements

VMG LIGNUM LVL ceiling elements

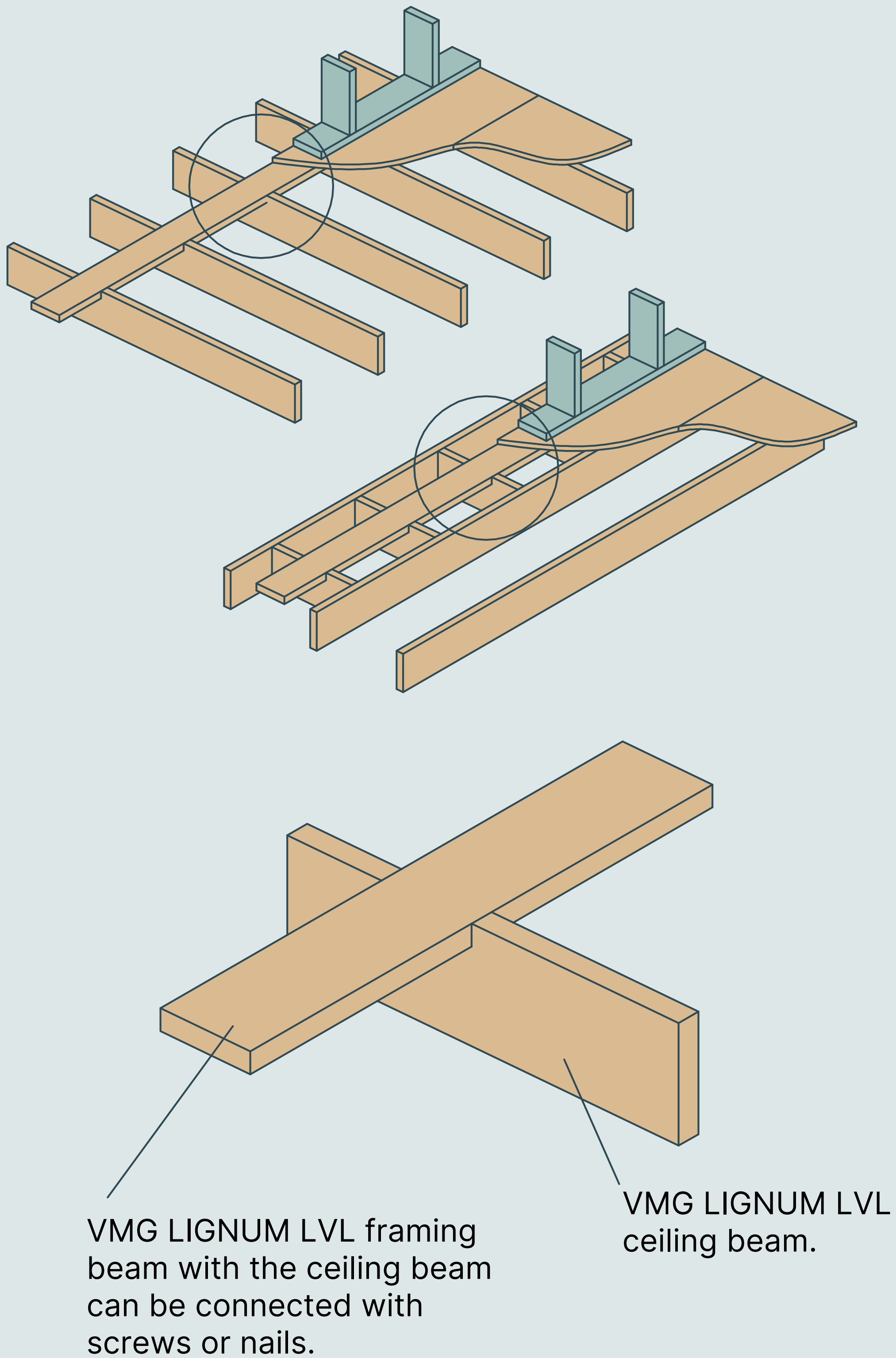
Fig. 19 VMG LIGNUM LVL application example No 3



VMG LIGNUM LVL wall elements

VMG LIGNUM LVL ceiling elements

Fig. 20 VMG LIGNUM LVL application example No 4



VMG LIGNUM LVL wall elements

VMG LIGNUM LVL ceiling elements

Fig. 21 VMG LIGNUM LVL application example No 5

STORAGE AND TRANSPORTATION

VMG LIGNUM LVL products are delivered in plastic packages. Each delivery packaging bears the number and dimensions of the products and the delivery address or order number.

The plastic packaging is only intended to protect the products during shipment and does not provide sufficient weather protection. The bottom of each package must always be open to allow for the free circulation of air and evaporation of moisture.

If the products are stored in the same place for more than a week, the packages must be covered with an additional protective coating, but ensuring that the packages will “breathe”. During storage, it is necessary to regularly monitor the condition of the product and the protective film in order to avoid direct damage.

Under no circumstances can VMG LIGNUM LVL be stored in direct contact with the ground.

VMG LIGNUM LVL products can be stored on the construction site only temporarily. In this case, a firm, straight and dry platform must be used. The height of the ground-mounted supports must be at least 30 cm.

During the transportation and storage of the product, direct exposure to moisture, such as rain or water splashes, must be avoided.

If you are moving the product with a forklift, use sufficiently wide in order to prevent damage. When lifting several packages at the same time, the distance between the forks must be sufficiently wide to ensure safe lifting.

The legs/supports of the packages must be vertically aligned so that the product does not twist or crack. There must be the appropriate number of supports of the suitable size, and they must be evenly distributed along the entire length of the package.

INSTALLATION RECOMMENDATIONS

VMG LIGNUM LVL products must be used with care in order to protect them from damage and dirt.

When installing and using VMG LIGNUM LVL products, the general instructions for wooden structures must be observed. VMG LIGNUM LVL products can be processed using common woodworking tools, such as sawing, planing, drilling, nailing and driving wood screws or tightening screws. When using standard woodworking tools and machines, make sure to wear appropriate PPE (personal protective equipment).

1. As with standard wood products, the colour of these products may change as a result of exposure to light.
2. As with standard coniferous wood, mould formation is possible if there is an increased amount of moisture. In this case, the mould must be removed immediately by sanding or coating with appropriate chemicals.
3. When coating the surface, it is necessary to follow the rules and regulations of the surface coating manufacturer (grinding, edge smoothing, coating thickness, etc.).
4. After use, VMG LIGNUM LVL products must be disposed of in accordance with national regulations and directives. The products can usually be reused or recycled, composted or burned to produce energy.
5. For composting, the LVL must be shredded, and a long composting process must also be taken into account.
6. The products can also be landfilled, although LVL degrades very slowly.
7. LVL does not contain any products classified as hazardous waste.

PACKAGING FORMATS

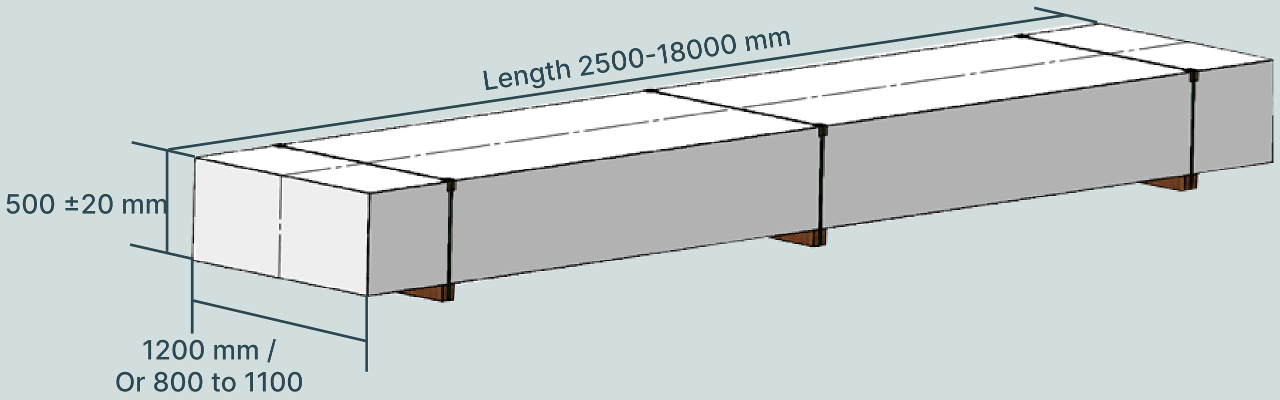


Fig. 23 VMG LIGNUM LVL standard packaging

CERTIFICATES

Structural LVL has its own harmonized European standard EN 14374, which provides the basis for the CE-marking of LVL products and issuing a Declaration of Performance (DoP). VMG LIGNUM LVL is certified by CE and Eurofins OY certification body*.

VMG LIGNUM LVL, like other our products, is made from FSC or PEFC-certified raw materials.

*Note: LVL products treated against fire and biological impact cannot be CE-marked according to EN 14374:2004 because now the treatment is not included in the scope of the standard.

COMPANY STRUCTURE:

VMG LIGNUM

Engineered wood product sales and distribution

VMG LIGNUM CONSTRUCTION

Engineered wood product manufacturing

VMG LIGNUM SYSTEMS

Structural engineering design and consultancy services

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