

LVL by Stora Enso **Technical brochure**





Stora Enso

The renewable materials company

Stora Enso is a leading provider of renewable solutions in packaging, biomaterials, wooden constructions and paper on global markets.

We believe that everything that is made from fossil-based materials today can be made from a tree tomorrow. Our materials are renewable, reusable and recyclable, and form the building blocks for a range of innovative solutions that can help replace products based on fossil fuels and other non-renewable materials.

With carbon captured in the wood, the products offer a truly sustainable means of combating climate change.

Stora Enso products are manufactured from responsibly sourced wood. The wood supply chains to Stora Enso's Wood Products units are covered by a wood traceability system, which is third-party certified according to PEFC™ or FSC® Chain of Custody system, or according to both systems.

Let's realise the wonder of precision engineered LVL

Laminated Veneer Lumber (LVL) is an advanced wood product developed for the demands of today's building and construction industry. LVL is engineered to be relatively stronger than steel, yet lighter than concrete, while being highly workable and durable.

This massive wood product harnesses the power of Nordic spruce. LVL has proven its value as the preferred choice for structural applications. Today, LVL is powering a new wave of agile, renewable construction, and bringing home to us the everlasting wonder of wood.



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LVL key data

Laminated Veneer Lumber (LVL) is an advanced wood product consisting of 3 mm spruce veneers glued together. It is suitable for a wide range of structural applications, from new build to repair. Being one of the strongest wood-based construction materials relative to its weight, LVL provides an ideal solution when strength, dimensional stability and high load-bearing capacity are essential. Not forgetting the consistent quality and excellent workability. LVL is CE-marked.



Use	Structural applications; studs, post-and-beam frames, wall, floor and roof panels
Maximum width	2500 mm
Maximum thickness	75 mm
Maximum length	24 m
Wood species	Spruce (Picea abies)
Adhesives	LVL is consisting of multiple layers of veneers that are bonded together with brown phenolic resin. Top face veneer scarf joints are bonded with clear melamine-formaldehyde resin. LVL meets the formaldehyde emission class E1 according to standard EN 717-1.
Moisture content	8–10% when leaves the mill
Surface quality	Intended for non-visual applications. Standard LVL is delivered unsanded with a clear glue line on the top face. Calibration and optical sanding available on request.
Density	Mean density 510 kg/m ³ (LVL S & X)
Thermal conductivity	$\lambda = 0.13 \text{ W/(mK)}$
Specific heat capacity	$c = 1800 \text{ J/(kg-K)}$
Service class	Service classes 1 and 2
Reaction to fire	D-s1, d0 (EN 13501-1)

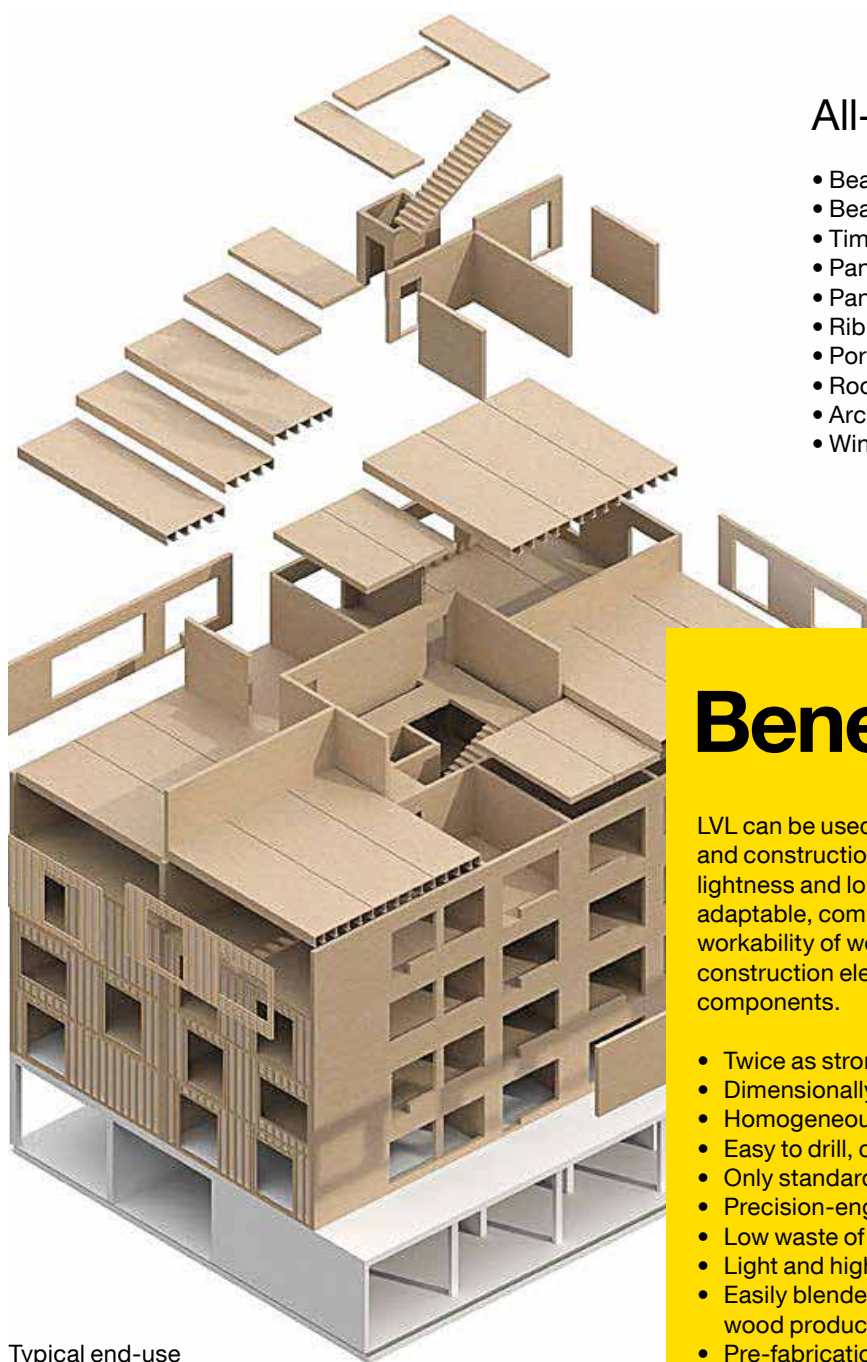
Produced and monitored according to the harmonised standard EN 14374 in Finland.

Applications

LVL embodies qualities that make it the preferred choice of structural engineers, installers, merchants and industrial integrators. It provides consistent quality, reliability and workability to meet any and all of your needs. From industrial to residential, large-scale high-rise buildings to homes, components and structural elements to studs, joists and beams.



Typical end-use applications in a single-family house.



Typical end-use applications in a multi-storey building.

All-purpose versatility

- Beams and rafters
- Beam reinforcement
- Timber frame walls
- Panels for floors
- Panels for roof structures
- Rib panels
- Portal frames
- Roof extensions
- Arch rafters for dormers
- Window frame components

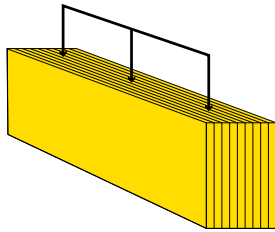
Benefits

LVL can be used in various challenging building and construction applications where strength, lightness and long span are required. It is highly adaptable, combining the strength of steel with the workability of wood. LVL can be used for large-scale construction elements as well as smaller, crafted components.

- Twice as strong as steel proportionate to weight
- Dimensionally stable, no warps, splinters or splits
- Homogeneous
- Easy to drill, cut, fasten and fit
- Only standard wood working tools needed
- Precision-engineered and easily tailored
- Low waste of material
- Light and highly portable
- Easily blended and bundled with other wood products
- Pre-fabrication cuts construction time
- Entirely sourced from renewable, recyclable wood and environmentally friendly

Three grades S, X and T

The layering of the veneers affects the strength, properties and capabilities of a grade, and makes it most suitable for a particular use. Each grade of LVL has key properties and benefits like strength, span or straightness.

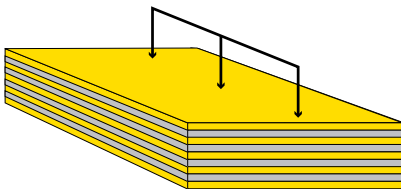


S grade – precision beams

With S grade all the veneers run in the same direction enhancing the strength properties of the material. This feature, along with its light weight and ease of re-working, makes it the ideal choice for the construction industry in a wide range of applications – from framing to beams and roof components to formwork.

Available dimensions*

- Thicknesses (mm): 27 / 30 / 33 / 39 / 45 / 51 / 57 / 63 / 69 / 75
- Widths (mm): 200 / 220 / 240 / 250 / 260 / 300 / 350 / 360 / 400 / 450 / 500 / 600, up to 2500 available on request
- Max length (m): 24

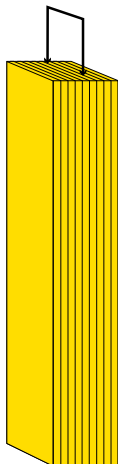


X grade – precision panels

Veneers regularly spaced crosswise through the element makes this ideal for construction panels and boards. The X grade has superior inherent dimensional stability which opens up a host of possibilities for how it can be used – especially where shear strength is a design driver.

Available dimensions*

- Thicknesses (mm): 27 / 30 / 33 / 39 / 45 / 51 / 57 / 63 / 69 / 75
- Widths (mm): 200 / 220 / 240 / 250 / 260 / 300 / 350 / 360 / 400 / 450 / 500 / 600
- Panels (mm): 1200-2500
- Max length (m): 24



T grade – precision studs

All the veneers in T grade run in the same direction, however these are lighter veneers. As such it has all the qualities exhibited by LVL in terms of dimensional accuracy, structural rigidity and lack of twisting. Therefore, the T grade is suitable for structures requiring dimensional stability and straightness as well as light weight. A typical application is wall studs for internal walls.

Available dimensions (mm)*

- 39x66, lengths 2550-6000
- 39x92, length 6000
- 45x45, lengths 2550-6000

*) Other dimensions upon request.

Design strength values

Evaluate the strength requirements of each LVL grade you'll be working with.

		Symbol	Unit	LVL S 24–75 mm	LVL X 24–75 mm	LVL T 27–75 mm
Bending strength	edgewise, parallel to grain	$f_{m,0,edge,k}$	N/mm ²	44	32	27
	flatwise, parallel to grain	$f_{m,0,flat,k}$	N/mm ²	50	36	32
Size effect parameter		s	-	0,15	0,15	0,15
Tensile strength	parallel to grain	$f_{t,0,k}$	N/mm ²	35	26	24
	perpendicular to grain, edgewise	$f_{t,90,edge,k}$	N/mm ²	0,8	6	
Compressive strength	parallel to grain	$f_{c,0,k}$	N/mm ²	35	26	26
	perpendicular to grain, edgewise	$f_{c,90,edge,k}$	N/mm ²	6	9	
Shear strength	edgewise, parallel to grain	$f_{v,0,edge,k}$	N/mm ²	4,1	4,5	
	flatwise, parallel to grain	$f_{v,0,flat,k}$	N/mm ²	2,3	1,3	
Modulus of elasticity	parallel to grain	$E_{0,mean}$	N/mm ²	13 800	10 500	10 000
	parallel to grain	$E_{0,k}$	N/mm ²	11 600	8 800	8 800
Shear modulus	edgewise, parallel to grain	$G_{0,edge,mean}$	N/mm ²	600	600	
	edgewise, parallel to grain	$G_{0,edge,k}$	N/mm ²	400	400	
Density		ρ_{mean}	kg/m ³	510	510	440
		ρ_k	kg/m ³	480	480	410

	Nominal sizes	Tolerance
Thickness (<i>t</i>)	≤ 27	± 1 mm
	27 – 57 mm	± 2 mm
	> 57 mm	± 3 mm
Width (<i>b</i>)	≤ 300 mm	± 2 mm
	300 – 600 mm	± 3 mm
	> 600 mm	± 0.5%
Length (<i>l</i>)	≤ 5 m	± 5 mm
	5 – 20 m	± 0.1%
	> 20 m	± 20 mm

Maximum deviations from nominal sizes and nominal angles for LVL not treated by pressure treatment. LVL tolerances are based on standard main line production with a moisture content of 10%.






Comparison to other wood products

Compared to GL 24h or C24 sawn timber, LVL has strength properties that provide designers with greater flexibility and allow material savings.

Assumptions entered

L beam span	6 m
$I_{e,f}$ for bearing area	150 mm
Deflection w_{inst}	L/300
Deflection $w_{net,fin}$	L/200
Deflection w_{fin}	L/125

	LVL S by Stora Enso			Glulam GL 24h			Sawn Timber C24		
H=	300 mm			300 mm			300 mm		
	Property N/mm ²	Width mm	Material saving	Property N/mm ²	Width mm	Material increase	Property N/mm ²	Width mm	Material increase
Bending edgewise $f_{m,0,edge,k}$	44,0	39	0 %	24,0	69	78 %	24,0	89	128 %
	44,0	45	0 %	24,0	80	78 %	24,0	103	128 %
	44,0	51	0 %	24,0	90	78 %	24,0	115	128 %
	44,0	75	0 %	24,0	134	78 %	24,0	171	128 %
Shear edgewise $f_{v,0,edge,k}$	4,1	39	0 %	3,5	48	22 %	4,0	65	66 %
	4,1	45	0 %	3,5	55	22 %	4,0	75	66 %
	4,1	51	0 %	3,5	62	22 %	4,0	84	66 %
	4,1	75	0 %	3,5	92	22 %	4,0	125	66 %
Compression // $f_{c,0,k}$	35,0	39	0 %	24,0	59	52 %	21,0	70	81 %
	35,0	45	0 %	24,0	68	52 %	21,0	80	81 %
	35,0	51	0 %	24,0	78	52 %	21,0	93	81 %
	35,0	75	0 %	24,0	114	52 %	21,0	135	81 %
Compression ⊥ $f_{c,90,edge,k}$	6,0	39	0 %	2,5	98	150 %	2,5	101	160 %
	6,0	45	0 %	2,5	112	150 %	2,5	116	160 %
	6,0	51	0 %	2,5	127	150 %	2,5	132	160 %
	6,0	75	0 %	2,5	186	150 %	2,5	194	160 %
Tension // $f_{t,0,k}$	35,0	39	0 %	19,2	76	95 %	14,0	133	242 %
	35,0	45	0 %	19,2	88	95 %	14,0	154	242 %
	35,0	51	0 %	19,2	100	95 %	14,0	175	242 %
	35,0	75	0 %	19,2	145	95 %	14,0	255	242 %
Modulus of elasticity $E_{0,mean}$	13 800	39	0 %	11 500	47	20 %	11 000	49	25 %
	13 800	45	0 %	11 500	54	20 %	11 000	56	25 %
	13 800	51	0 %	11 500	61	20 %	11 000	64	25 %
	13 800	75	0 %	11 500	90	20 %	11 000	94	25 %
Mean density ρ_{mean}	510 kg/m ³			420 kg/m ³			420 kg/m ³		
Characteristic density ρ_k	480 kg/m ³			385 kg/m ³			350 kg/m ³		



Production

Stora Enso's Wood Products division provides versatile wood-based solutions for building and construction.

Our product range covers all areas of construction, including massive wood elements, wood components and sawn goods. We also offer pellets for sustainable heating.

Wood Products operates globally and has over 20 production units in Europe. Our global sales and distribution network ensures consistent and efficient deliveries to our customers.

LVL is produced in our state-of-the-art mill in Finland, with the capacity of 100 000 m³.



Services and further processing

As well as being dimensionally stable taken straight from the shelf, we can offer pre-cut elements that are made to measure.



Calibration and optical sanding

Standard LVL by Stora Enso is delivered unsanded. In order to obtain more accurate thicknesses and demanding tolerances the LVL can be calibrated or optically sanded.

Calibration decreases the thickness by approximately 3 mm (1,5 mm per surface). Thickness tolerance after calibration is $\pm 0,5$ mm. Optical sanding decreases the thickness by approximately 2 mm (1 mm per surface).



Moisture protection

LVL products can be treated with a water-borne wood oil (Teknoshield 4015). Moisture protection is accurately applied to all the four sides and also edges in order to achieve greater protection.

This treatment is intended only for temporary protection during the storage and construction time at site. Surfaces exposed to continuous weather strain are recommended to be retreated once a year.



Panel sawing

Delivered on time, cut-to-size with industrial millimeter precision, prefabricated elements are quick and easy to assemble ensuring higher productivity.

With the panel saw we are able to produce customised panel shaped elements and special cuttings. Further-processed elements are ideal as ridge beams, supporting beams, roof and wall elements.

Length tolerance

± 1.0 mm ($<12\ 000$ mm)
 ± 2.0 mm ($>12\ 000$ mm)

Width tolerance

± 0.5 ($<1\ 500$ mm)
 ± 1.0 ($>1\ 500$ mm)

Max width 3 200 mm
Max thickness 150 mm
Max length 24 000 mm

Material properties

Biological and chemical durability

The biological durability of the material is as good as the wood it came from. The glue is weather resistant. It is not recommended to use untreated LVL in use class 3. Avoid permanent contact with water.

Decay in wood is caused by fungal attack that may cause the wood to soften and lose strength. Fungi need moisture above 20% and a temperature between +3°C and +40°C to develop and grow. We recommend that the wood surface should be treated when used in exterior conditions. LVL has good resistance to mild acids and acid salt solutions.

Alkalis cause softening of wood. Direct contact with oxidizing agents such as chlorine, hypochlorites and nitrates should be avoided. Alcohols and some other organic liquids cause similar effects to water i.e. producing swelling and slight loss of strength. Petroleum oils have no effect to strength properties but causes discolouration. The chemical resistance can be improved with various types of coatings.



Thermal properties

The thermal conductivity of LVL depends on its moisture content. In RH 47% the moisture content is 9,3% and the thermal conductivity coefficient $\lambda = 0,110 \text{ M/(m}\cdot\text{K)}$. In RH 93% the moisture content is 25% and the thermal conductivity coefficient $\lambda = 0,132 \text{ M/W/(mK)}$.

LVL can be used at a temperature up to 100°C, temporarily 120°C. Wood products resist cold better than heat and can be used at a temperature of -200°C. The dimensions are very stable under heat and the thermal deformation can generally be disregarded.

Fire resistance

The temperature at which LVL ignites when it is exposed to a flame is about 270 °C.

The reaction to fire performance of LVL is classified as class D-s1, d0. According to EN 1995-1-2 the one-dimensional charring rate for LVL is given as 0,65 mm/min, and the notional charring rate as 0,70 mm/min.

Example, if the fire exposure time is 60 minutes.
$$d_{\text{char}, n} = \beta_n \cdot t = 0,70 \text{ mm/min} \cdot 60 \text{ min} = 42 \text{ mm}$$



Storage and handling

Careful and proper handling and storing of the material is essential to avoid defects on product's surfaces, edges or corners. Furthermore, the dimensional stability of the product may suffer as a result of incorrect handling.

Transportation

While you transport or store LVL, avoid increased moisture caused by rain or splashing. When using a forklift truck, make sure the forks are wide enough to prevent damage. The width of the forks is also important when lifting several packs of LVL at the same time.

Unloading

When you handle packs of LVL with a forklift truck or crane, our recommendation is to use web slings of proper condition and strength. Avoid using chains or wires since they may cause damage to the surface, edges and the dimensional stability.

Do not drop packs from trucks or push with the fork tips. When you use a forklift truck, please make sure proper stability is maintained.

Storing

Packs of LVL should be stored covered and protected from the weather. Make sure they are placed on wooden skids at least 30 cm of the ground on a flat and dry surface. The skids must be of suitable size, amount and should be spread evenly to prevent the material from twisting or cracking. If you need to store packs of LVL over a week, please cut the plastic open from the bottom corner to enable air circulation.



LVL rim board for timber frames

Rim boards are used as edge binders and load transfer members for timber floor assemblies, and also serve a purpose as fire separating components. The rim board is continuous and not broken by I-joists.

LVL rim boards by Stora Enso are manufactured using the cross-laminated structure that has inherent dimensional stability built in as well being easy to handle, work and nail. They are available in 30 mm thickness and depths from

195 to 400 mm to suit all I-joist and in 254 mm especially for metal web joist products.

The applications have been tested by International Fire Consultants Ltd (IFC) and satisfy the integrity and insulation performance criteria to BS476: Parts 21 and 22: 1987, for the relevant fire resistance for standard domestic dwellings and structures up to 4 storeys. Following table and illustrations are based on the IFC assessment report.

Minimum rim board and blocking thickness for LVL

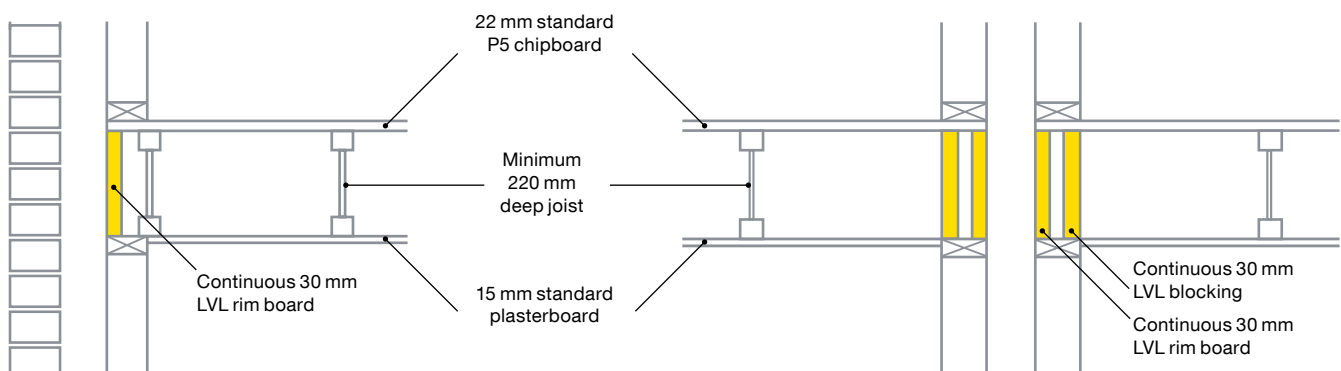
	30 min fire resistance	60 min fire resistance
Blocking type / minimum LVL thickness	–	30 mm*
Rim board type / minimum LVL thickness	30 mm*	30 mm*

*) The LVL rim board system thickness may need to be increased for buildings requiring a greater loadbearing capability than 2.5kN/m²

Floor joists perpendicular to wall 30 minutes



Floor joists parallel to wall 30 minutes



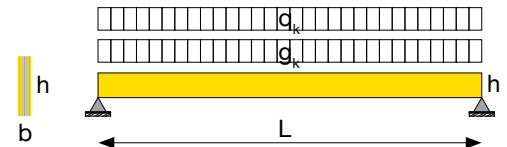
Floor Beams

Span table: LVL S – single span beam

In producing these tables the beam spacing has been set at 1.0 m for all design checks. The floor loads are given in kN/m².

In determining the bending strength, the design table assumes that the beam is fully restrained to prevent lateral torsional buckling.

Beam spacing 1,00 m
 Floor deck material 22 mm P5 particleboard 3000 N/mm²
 Ceiling material 12,5 mm plasterboard 2000 N/mm²
 Floor joist (secondary framing) C16 38x200 @ 600 c/c



Char. permanent load g_k		1,0 kN/m ²	1,5 kN/m ²	2,0 kN/m ²	1,0 kN/m ²	1,5 kN/m ²	2,0 kN/m ²	1,0 kN/m ²	1,5 kN/m ²	2,0 kN/m ²
Char. live load q_k		1,5 kN/m ²			2,5 kN/m ²			5,0 kN/m ²		
Live load category		Category A1 Single occupancy residential			Category B1 Office building			Category C Public buildings		
b [mm]	h [mm]	Clear span [m]								
39	195	2,98	2,76	2,59	2,68	2,52	2,40	2,23	2,14	2,07
39	220	3,37	3,12	2,93	3,03	2,85	2,71	2,52	2,42	2,34
39	240	3,68	3,41	3,20	3,31	3,12	2,96	2,75	2,65	2,56
39	245	3,76	3,48	3,27	3,38	3,18	3,02	2,81	2,70	2,61
39	300	4,60	4,15	3,86	4,14	3,91	3,71	3,45	3,32	3,21
39	360	5,28	4,77	4,44	4,98	4,70	4,44	4,15	4,00	3,86
39	400	5,72	5,17	4,80	5,54	5,17	4,80	4,62	4,44	4,29
45	195	3,14	2,91	2,73	2,82	2,66	2,53	2,35	2,26	2,19
45	220	3,55	3,29	3,09	3,19	3,01	2,86	2,66	2,56	2,47
45	240	3,87	3,59	3,37	3,48	3,28	3,12	2,90	2,79	2,70
45	245	3,96	3,67	3,43	3,55	3,35	3,19	2,96	2,85	2,76
45	300	4,77	4,31	4,01	4,36	4,11	3,91	3,64	3,50	3,39
45	360	5,48	4,95	4,60	5,24	4,95	4,60	4,37	4,21	4,07
45	400	5,93	5,36	4,98	5,83	5,36	4,98	4,87	4,69	4,53
75	195	3,76	3,49	3,28	3,38	3,19	3,04	2,83	2,73	2,64
75	220	4,25	3,87	3,60	3,82	3,61	3,44	3,20	3,08	2,98
75	240	4,58	4,14	3,85	4,17	3,94	3,75	3,49	3,37	3,26
75	245	4,66	4,20	3,91	4,26	4,03	3,83	3,57	3,44	3,33
75	300	5,43	4,90	4,56	5,23	4,90	4,56	4,38	4,22	4,08
75	360	6,23	5,63	5,23	6,23	5,63	5,23	5,26	5,08	4,91
75	400	6,75	6,09	5,67	6,75	6,09	5,67	5,85	5,65	5,46

Vibration is design governing

The following EN 1995-1-1:2004+A1:2008 design parameters have been used to produce these tables for service class 1 environments.

Design limits to control floor vibration are taken from the UK National Annex to BS EN 1995-1-1:2004+A1:2008: $f_1 \geq 8$ Hz

The flexural rigidity of the supported floor (EI)_b is set at 340765 N.m²/m

$k_{mod,perm}$	0,6	f_1	8
$k_{mod,med}$	0,8	γ_m	1,2
k_{def}	0,6	$\gamma_{F,g}$	1,35
$k_{mod,short}$	0,9	$\gamma_{F,q}$	1,5
k_{amp}	1,05	ψ_2	0,3
k_{dist}	1,36		
w_{inst}	L/300		
$w_{net,fin}$	L/250		

This table does not replace the requirement to carry out a full, project-specific structural design.

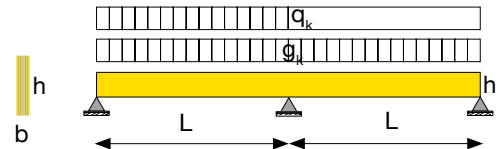
The bearing support length should be calculated on a project specific basis appropriate to the proposed connection detail.

Floor Beams

Span table: LVL S – 2 bay continuous beam

In producing these tables the beam spacing has been set at 1.0 m for all design checks. The floor loads are given in kN/m². Pattern imposed loading is applied to the multi-span floor beam table. The multi-span beam tables are based on multiple equal spans. In determining the bending strength, the design table assumes that the beam is fully restrained to prevent lateral torsional buckling.

Beam spacing 1,00 m
 Floor deck material 22 mm P5 particleboard 3000 N/mm²
 Ceiling material 12,5 mm plasterboard 2000 N/mm²
 Floor joist (secondary framing) C16 38x200 @ 600 c/c



Char. permanent load g_k		1,0 kN/m ²	1,5 kN/m ²	2,0 kN/m ²	1,0 kN/m ²	1,5 kN/m ²	2,0 kN/m ²	1,0 kN/m ²	1,5 kN/m ²	2,0 kN/m ²
Char. live load q_k		1,5 kN/m ²			2,5 kN/m ²			5,0 kN/m ²		
Live load category		Category A1 Single occupancy residential			Category B1 Office building			Category C5 Public buildings		
b [mm]	h [mm]	Clear span [m]								
39	195	3,47	3,26	3,08	3,07	2,93	2,81	2,52	2,45	2,32
39	220	3,92	3,68	3,48	3,47	3,31	3,17	2,85	2,77	2,63
39	240	4,28	4,02	3,73	3,79	3,62	3,47	3,11	3,02	2,87
39	245	4,37	4,08	3,79	3,87	3,69	3,54	3,18	3,09	2,93
39	300	5,27	4,75	4,42	4,75	4,53	4,35	3,90	3,79	3,60
39	360	6,05	5,46	5,08	5,71	5,45	5,08	4,69	4,56	4,33
39	400	6,55	5,91	5,50	6,35	5,91	5,50	5,21	5,07	4,82
45	195	3,65	3,43	3,25	3,23	3,08	2,96	2,66	2,58	2,51
45	220	4,12	3,87	3,62	3,65	3,49	3,34	3,00	2,92	2,84
45	240	4,50	4,16	3,87	3,99	3,81	3,65	3,28	3,19	3,10
45	245	4,60	4,23	3,93	4,07	3,89	3,73	3,35	3,25	3,17
45	300	5,46	4,93	4,58	5,00	4,77	4,58	4,11	3,99	3,89
45	360	6,27	5,66	5,26	6,00	5,66	5,26	4,94	4,80	4,67
45	400	6,79	6,13	5,70	6,68	6,13	5,70	5,49	5,34	5,20
75	195	4,37	4,05	3,76	3,87	3,70	3,55	3,19	3,11	3,03
75	220	4,91	4,43	4,12	4,38	4,18	4,02	3,61	3,51	3,42
75	240	5,25	4,74	4,40	4,78	4,57	4,38	3,94	3,83	3,74
75	245	5,33	4,81	4,47	4,88	4,66	4,47	4,02	3,91	3,81
75	300	6,21	5,61	5,22	5,98	5,61	5,22	4,94	4,80	4,68
75	360	7,13	6,44	5,99	7,13	6,44	5,99	5,93	5,77	5,63
75	400	7,72	6,97	6,48	7,72	6,97	6,48	6,60	6,42	6,26

Vibration is design governing

The following EN 1995-1-1:2004+A1:2008 design parameters have been used to produce these tables for service class 1 environments.

Design limits to control floor vibration are taken from the UK National Annex to BS EN 1995-1-1:2004+A1:2008: $f_1 \geq 8$ Hz

The flexural rigidity of the supported floor (EI)_b is set at 340765 N.m²/m

$k_{mod,perm}$	0,6	f_1	8
$k_{mod,med}$	0,8	γ_m	1,2
k_{def}	0,6	$\gamma_{F,g}$	1,35
$k_{mod,short}$	0,9	$\gamma_{F,q}$	1,5
k_{amp}	1,05	ψ_2	0,3
k_{dist}	1,36		
w_{inst}	L/300		
$w_{net,fin}$	L/250		

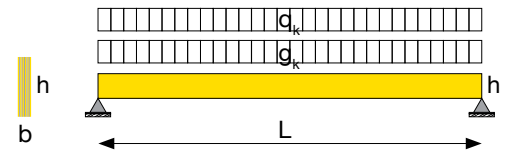
This table does not replace the requirement to carry out a full, project-specific structural design.

The bearing support length should be calculated on a project specific basis appropriate to the proposed connection detail.

Roof Purlins

Span table: LVL S – single span beam

In determining the bending strength, the design table assumes that the beam is fully restrained to prevent lateral torsional buckling.



Char. permanent load g_k		1,0 kN/m ²	1,5 kN/m ²	2,0 kN/m ²	1,0 kN/m ²	1,5 kN/m ²	2,0 kN/m ²	1,0 kN/m ²	1,5 kN/m ²	2,0 kN/m ²
Char. live load q_k		1,5 kN/m ²			2,5 kN/m ²			5,0 kN/m ²		
Live load category		Category A1 Single occupancy residential			Category B1 Office building			Category C5 Public buildings		
		Clear span [m]								
b [mm]	h [mm]									
39	195	2,91	2,71	2,55	2,42	2,34	2,26	2,13	2,08	2,03
39	220	3,29	3,06	2,88	2,74	2,64	2,56	2,41	2,35	2,29
39	240	3,60	3,35	3,15	2,99	2,88	2,79	2,64	2,57	2,51
39	245	3,67	3,42	3,22	3,05	2,95	2,85	2,69	2,62	2,56
39	300	4,51	4,19	3,95	3,75	3,62	3,50	3,31	3,22	3,15
39	360	5,42	5,04	4,75	4,50	4,35	4,21	3,98	3,88	3,78
39	400	6,02	5,61	5,28	5,01	4,84	4,69	4,42	4,31	4,21
45	195	3,07	2,85	2,69	2,55	2,46	2,38	2,25	2,19	2,14
45	220	3,47	3,23	3,04	2,88	2,78	2,70	2,55	2,48	2,42
45	240	3,78	3,52	3,32	3,15	3,04	2,95	2,78	2,71	2,65
45	245	3,86	3,60	3,39	3,22	3,11	3,01	2,84	2,77	2,70
45	300	4,74	4,41	4,16	3,95	3,81	3,69	3,49	3,40	3,32
45	360	5,70	5,31	5,00	4,75	4,58	4,44	4,20	4,09	3,99
45	400	6,34	5,90	5,56	5,28	5,10	4,94	4,67	4,55	4,44
75	195	3,67	3,42	3,23	3,07	2,96	2,87	2,72	2,65	2,59
75	220	4,15	3,87	3,65	3,47	3,35	3,25	3,07	3,00	2,93
75	240	4,53	4,22	3,98	3,78	3,66	3,55	3,35	3,27	3,20
75	245	4,63	4,31	4,07	3,86	3,74	3,62	3,43	3,34	3,26
75	300	5,68	5,29	4,99	4,74	4,58	4,44	4,20	4,10	4,01
75	360	6,82	6,36	6,00	5,70	5,51	5,34	5,05	4,93	4,82
75	400	7,58	7,07	6,67	6,34	6,13	5,94	5,62	5,48	5,36

The following EN 1995-1-1:2004+A1:2008 design parameters have been used to produce these tables for service class 1 environments.

$k_{mod,perm}$	0,6	f_1	8
$k_{mod,med}$	0,8	γ_m	1,2
k_{def}	0,6	$\gamma_{F,g}$	1,35
$k_{mod,short}$	0,9	$\gamma_{F,q}$	1,5
k_{amp}	1,05	Ψ_2	0,0 (Snow)
k_{dist}	1,36		
w_{inst}	L/300		
$w_{net,fin}$	L/250		

This table does not replace the requirement to carry out a full, project-specific structural design.

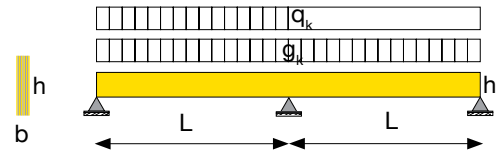
The bearing support length should be calculated on a project specific basis appropriate to the proposed connection detail.

Roof Purlins

Span table: LVL S – 2 bay continuous beam

Full imposed loading is applied to all spans in the multi-span roof beam table. The multispan beam tables are based on multiple equal spans.

In determining the bending strength, the design table assumes that the beam is fully restrained to prevent lateral torsional buckling.



Char. permanent load g_k		1,0 kN/m ²	1,5 kN/m ²	2,0 kN/m ²	1,0 kN/m ²	1,5 kN/m ²	2,0 kN/m ²	1,0 kN/m ²	1,5 kN/m ²	2,0 kN/m ²
Char. live load q_k		1,5 kN/m ²			2,5 kN/m ²			5,0 kN/m ²		
Live load category		Category A1 Single occupancy residential			Category B1 Office building			Category C5 Public buildings		
		b [mm]	h [mm]	Clear span [m]						
39	195	3,64	3,39	3,19	3,03	2,90	2,78	2,55	2,41	2,28
39	220	4,11	3,83	3,60	3,42	3,30	3,20	2,89	2,73	2,58
39	240	4,49	4,18	3,93	3,73	3,61	3,49	3,16	2,98	2,82
39	245	4,58	4,27	4,02	3,81	3,68	3,57	3,23	3,04	2,88
39	300	5,62	5,23	4,93	4,68	4,52	4,38	3,96	3,74	3,54
39	360	6,76	6,29	5,92	5,62	5,43	5,26	4,77	4,49	4,25
39	400	7,51	6,99	6,59	6,25	6,04	5,85	5,30	5,00	4,73
45	195	3,83	3,57	3,36	3,19	3,08	2,98	2,82	2,75	2,61
45	220	4,33	4,03	3,79	3,60	3,48	3,37	3,18	3,10	2,95
45	240	4,72	4,40	4,14	3,93	3,80	3,68	3,48	3,39	3,22
45	245	4,82	4,49	4,23	4,02	3,88	3,76	3,55	3,46	3,29
45	300	5,92	5,51	5,19	4,93	4,76	4,61	4,36	4,25	4,04
45	360	7,11	6,62	6,24	5,92	5,72	5,54	5,24	5,11	4,86
45	400	7,90	7,36	6,93	6,59	6,36	6,16	5,83	5,68	5,40
75	195	4,58	4,27	4,03	3,83	3,70	3,59	3,40	3,31	3,24
75	220	5,18	4,83	4,55	4,33	4,18	4,05	3,84	3,74	3,66
75	240	5,65	5,27	4,97	4,72	4,57	4,43	4,19	4,09	3,99
75	245	5,77	5,38	5,07	4,82	4,66	4,52	4,28	4,17	4,08
75	300	7,08	6,60	6,22	5,92	5,72	5,55	5,25	5,12	5,00
75	360	8,50	7,93	7,48	7,11	6,87	6,66	6,31	6,15	6,01
75	400	9,45	8,81	8,31	7,90	7,64	7,41	7,01	6,84	6,68

The following EN 1995-1-1:2004+A1:2008 design parameters have been used to produce these tables for service class 1 environments.

$k_{mod,perm}$	0,6	f_1	8
$k_{mod,med}$	0,8	γ_m	1,2
k_{def}	0,6	$\gamma_{F,g}$	1,35
$k_{mod,short}$	0,9	$\gamma_{F,q}$	1,5
k_{amp}	1,05	Ψ_2	0,0 (Snow)
k_{dist}	1,36		
w_{inst}	L/300		
$w_{net,fin}$	L/250		

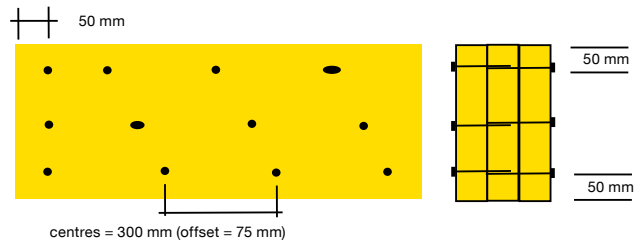
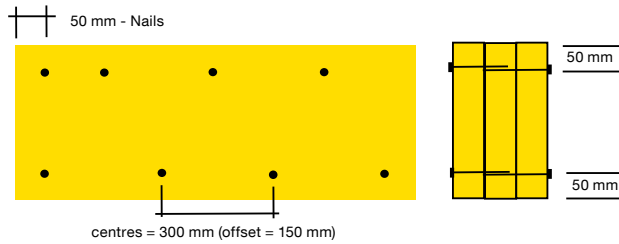
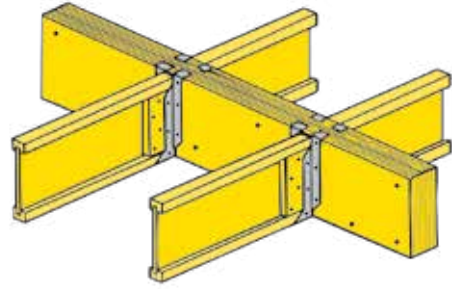
This table does not replace the requirement to carry out a full, project-specific structural design.

The bearing support length should be calculated on a project specific basis appropriate to the proposed connection detail.

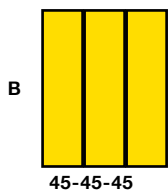
Multiple Ply Beams

Joist applied to one or both sides of the beam.

Side loads are not recommended for 180 mm wide beams unless applied to both beam faces.

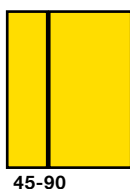


Medium term loading $k_{mod} = 0,8$ $\gamma_m = 1,3$



Connections	Shear plane resistance	EC5 Mode	Maximum side load ¹⁾
Ø 3.35 x 90 smooth nail 2 rows @ 300	4,75 kN/m	f	9,50 kN/m
Ø 3.35 x 90 smooth nail 3 rows @ 300	7,12 kN/m	f	14,20 kN/m
Ø 3.75 x 90 smooth nail 2 rows @ 300	5,72 kN/m	f	11,40 kN/m
Ø 3.75 x 90 smooth nail 3 rows @ 300	8,58 kN/m	f	17,20 kN/m
Partially threaded screw Ø 10 x 80 2 rows @ 600	6,79 kN/m	c	6,79 kN/m
Partially threaded screw Ø 10 x 80 2 rows @ 300	13,59 kN/m	c	13,59 kN/m
Fully threaded screw Ø 8 x 80 2 rows @ 600	7,67 kN/m	c	7,67 kN/m
Fully threaded screw Ø 8 x 80 2 rows @ 300	15,34 kN/m	c	15,34 kN/m
Fully threaded screw Ø 8 x 80 3 rows @ 600	11,50 kN/m	c	11,50 kN/m
Fully threaded screw Ø 8 x 80 3 rows @ 300	23,00 kN/m	c	23,00 kN/m
Fully threaded screw Ø 10 x 80 2 rows @ 600	9,38 kN/m	c	9,38 kN/m
Fully threaded screw Ø 10 x 80 2 rows @ 300	18,75 kN/m	c	18,75 kN/m
Ø 3.35 x 90 smooth nail 2 rows @ 300	4,75 kN/m	f	7,1 kN/m
Ø 3.35 x 90 smooth nail 3 rows @ 300	7,12 kN/m	f	10,7 kN/m
Ø 3.75 x 90 smooth nail 2 rows @ 300	5,72 kN/m	f	8,6 kN/m
Ø 3.75 x 90 smooth nail 3 rows @ 300	8,58 kN/m	f	12,9 kN/m
Partially threaded screw Ø 10 x 120 2 rows @ 600	9,10 kN/m	h	18,21 kN/m
Partially threaded screw Ø 10 x 120 2 rows @ 300	18,21 kN/m	h	36,42 kN/m
Fully threaded screw Ø 8 x 130 2 rows @ 600	10,28 kN/m	h	20,55 kN/m
Fully threaded screw Ø 8 x 130 2 rows @ 300	20,55 kN/m	h	41,10 kN/m
Fully threaded screw Ø 8 x 130 3 rows @ 600	15,41 kN/m	h	30,83 kN/m
Fully threaded screw Ø 8 x 130 3 rows @ 300	30,83 kN/m	h	61,65 kN/m
Fully threaded screw Ø 10 x 130 2 rows @ 600	12,57 kN/m	h	25,13 kN/m
Fully threaded screw Ø 10 x 130 2 rows @ 300	25,13 kN/m	h	50,26 kN/m

C



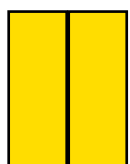
45-90

D



45-90-45

E



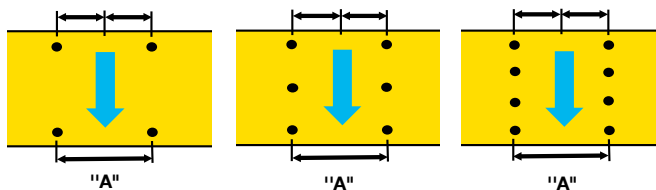
90-90

Connections	Shear plane resistance	EC5 Mode	Maximum side load ¹⁾
Ø 3.35 x 90 smooth nail 2 rows @ 300	4,75 kN/m	f	7,10 kN/m
Ø 3.35 x 90 smooth nail 3 rows @ 300	7,12 kN/m	f	10,70 kN/m
Ø 3.75 x 90 smooth nail 2 rows @ 300	5,72 kN/m	f	8,60 kN/m
Ø 3.75 x 90 smooth nail 3 rows @ 300	8,58 kN/m	f	12,90 kN/m
Partially threaded screw Ø 10 x 120 2 rows @ 600	10,59 kN/m	c	10,59 kN/m
Partially threaded screw Ø 10 x 120 2 rows @ 300	21,18 kN/m	c	21,18 kN/m
Fully threaded screw Ø 8 x 130 2 rows @ 600	13,28 kN/m	c	13,28 kN/m
Fully threaded screw Ø 8 x 130 2 rows @ 300	26,56 kN/m	c	26,56 kN/m
Fully threaded screw Ø 8 x 130 3 rows @ 600	19,92 kN/m	c	19,92 kN/m
Fully threaded screw Ø 8 x 130 3 rows @ 300	39,83 kN/m	c	39,83 kN/m
Fully threaded screw Ø 10 x 130 2 rows @ 600	16,24 kN/m	c	16,24 kN/m
Fully threaded screw Ø 10 x 130 2 rows @ 300	32,47 kN/m	c	32,47 kN/m
Ø 3.35 x 90 smooth nail 2 rows @ 300	4,75 kN/m	f	6,30 kN/m
Ø 3.35 x 90 smooth nail 3 rows @ 300	7,12 kN/m	f	9,50 kN/m
Ø 3.75 x 90 smooth nail 2 rows @ 300	5,72 kN/m	f	7,60 kN/m
Ø 3.75 x 90 smooth nail 3 rows @ 300	8,58 kN/m	f	11,40 kN/m
Partially threaded screw Ø 10 x 180 2 rows @ 600	13,18 kN/m	d	26,37 kN/m
Partially threaded screw Ø 10 x 180 2 rows @ 300	26,37 kN/m	d	52,74 kN/m
Fully threaded screw Ø 8 x 180 2 rows @ 600	17,03 kN/m	f	34,07 kN/m
Fully threaded screw Ø 8 x 180 2 rows @ 300	34,07 kN/m	f	68,13 kN/m
Fully threaded screw Ø 8 x 180 3 rows @ 600	25,55 kN/m	f	51,10 kN/m
Fully threaded screw Ø 8 x 180 3 rows @ 300	51,10 kN/m	f	102,20 kN/m
Fully threaded screw Ø 10 x 180 2 rows @ 600	21,67 kN/m	d	43,33 kN/m
Fully threaded screw Ø 10 x 180 2 rows @ 300	43,33 kN/m	d	86,66 kN/m
Ø 3.35 x 90 smooth nail 2 rows @ 300	N/A	N/A	N/A
Ø 3.35 x 90 smooth nail 3 rows @ 300	N/A	N/A	N/A
Ø 3.75 x 90 smooth nail 2 rows @ 300	N/A	N/A	N/A
Ø 3.75 x 90 smooth nail 3 rows @ 300	N/A	N/A	N/A
Partially threaded screw Ø 10 x 180 2 rows @ 600	14,07 kN/m	f	14,07 kN/m
Partially threaded screw Ø 10 x 180 2 rows @ 300	28,14 kN/m	f	28,14 kN/m
Fully threaded screw Ø 8 x 180 2 rows @ 600	17,03 kN/m	c	17,03 kN/m
Fully threaded screw Ø 8 x 180 2 rows @ 300	34,05 kN/m	c	34,05 kN/m
Fully threaded screw Ø 8 x 180 3 rows @ 600	25,54 kN/m	c	25,54 kN/m
Fully threaded screw Ø 8 x 180 3 rows @ 300	51,08 kN/m	c	51,08 kN/m
Fully threaded screw Ø 10 x 180 2 rows @ 600	20,82 kN/m	c	20,82 kN/m
Fully threaded screw Ø 10 x 180 2 rows @ 300	41,64 kN/m	c	41,64 kN/m

1) The values given in this table are maximum medium term design side loads meeting the the capacities of the fixing details. The Engineer should also check that all other strength and stiffness design criteria are met (e.g. moment, shear, bearing and deflection).

Point Loads

"A" is not greater than 300 mm

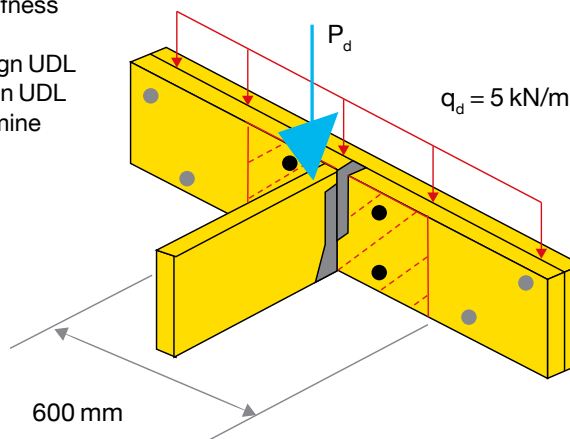


A	Ø 3.35 x 90 smooth nail 2 rows @ 300	6,84 kN	10,26 kN	13,68 kN
	Ø 3.75 x 90 smooth nail 2 rows @ 300	8,21 kN	12,31 kN	16,42 kN
	Partially threaded screw Ø 10 x 80 2 rows @ 300	9,78 kN	14,67 kN	19,57 kN
	Fully threaded screw Ø 8 x 80 2 rows @ 300	11,04 kN	16,56 kN	22,08 kN
	Fully threaded screw Ø 10 x 80 2 rows @ 300	13,50 kN	20,25 kN	27,00 kN
B	Ø 3.35 x 90 smooth nail 2 rows @ 300	5,11 kN	7,67 kN	10,22 kN
	Ø 3.75 x 90 smooth nail 2 rows @ 300	6,19 kN	9,29 kN	12,38 kN
	Partially threaded screw Ø 10 x 120 2 rows @ 300	26,22 kN	39,33 kN	52,44 kN
	Fully threaded screw Ø 8 x 130 2 rows @ 300	29,59 kN	44,39 kN	59,19 kN
	Fully threaded screw Ø 10 x 130 2 rows @ 300	36,19 kN	54,28 kN	72,38 kN
C	Ø 3.35 x 90 smooth nail 2 rows @ 300	5,11 kN	7,67 kN	10,22 kN
	Ø 3.75 x 90 smooth nail 2 rows @ 300	6,19 kN	9,29 kN	12,38 kN
	Partially threaded screw Ø 10 x 120 2 rows @ 300	15,25 kN	22,87 kN	30,50 kN
	Fully threaded screw Ø 8 x 130 2 rows @ 300	19,12 kN	28,68 kN	38,24 kN
	Fully threaded screw Ø 10 x 130 2 rows @ 300	23,38 kN	35,07 kN	46,76 kN
D	Ø 3.35 x 90 smooth nail 2 rows @ 300	4,54 kN	6,80 kN	9,07 kN
	Ø 3.75 x 90 smooth nail 2 rows @ 300	5,47 kN	8,21 kN	10,94 kN
	Partially threaded screw Ø 10 x 180 2 rows @ 300	37,97 kN	56,96 kN	75,94 kN
	Fully threaded screw Ø 8 x 180 2 rows @ 300	49,06 kN	73,58 kN	98,11 kN
	Fully threaded screw Ø 10 x 180 2 rows @ 300	62,40 kN	93,60 kN	124,80 kN
E	Ø 3.35 x 90 smooth nail 2 rows @ 300	0,00 kN	0,00 kN	0,00 kN
	Ø 3.75 x 90 smooth nail 2 rows @ 300	0,00 kN	0,00 kN	0,00 kN
	Partially threaded screw Ø 10 x 180 2 rows @ 300	20,26 kN	30,39 kN	40,52 kN
	Fully threaded screw Ø 8 x 180 2 rows @ 300	24,52 kN	36,77 kN	49,03 kN
	Fully threaded screw Ø 10 x 180 2 rows @ 300	29,98 kN	44,97 kN	59,96 kN

The values given in this table are maximum medium term design side loads meeting the capacities of the fixing details. The Engineer should also check that all other strength and stiffness design criteria are met (e.g. moment, shear, bearing and deflection). The values given in this table include any design UDL load adjacent to, and supported by, the fixings. The design UDL must be subtracted from the table value in order to determine the maximum point load, for example:

- 2No 45 x 360 LVL-S connected by 2 rows of Fully threaded screw Ø 10 with a spacing of 600 mm
- The incoming beam is supported by 4 Fully threaded screw Ø 10 x 80
- The multiple ply beam also supports a uniformly distributed side load q_d of 5 kN/m.
- The maximum design load from the incoming beam:
- $P_{d,max} = 11,25 - 0.6 \times 5 = 8,25 \text{ kN}^*$

* subject to the additional design checks described in note 1.



Circular holes – LVL S

Guidance on the design of beams with circular holes

Notes:

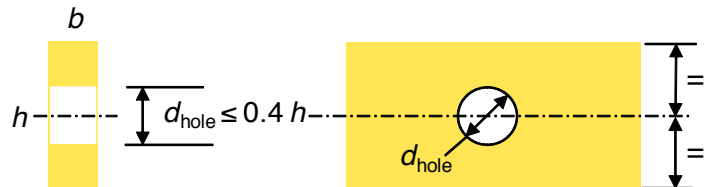
1. The hole design tables are based on the following expression from cl.11.3 of PD 6933-1-2012:

$$\sigma_{t,90,d} = \frac{1,8V_{hole,d} \cdot d_{hole} + 0,07 \cdot M_{hole,d}}{bh^2}$$

2. The hole design tables assume medium term loading, service class 1 or 2, $k_{mod} = 0.8$
3. For LVL $\gamma_m = 1.2$
4. Floor beams and roof purlins are primary structural members and as such any notch must be designed as per the requirements of section 6.5 of EC5.

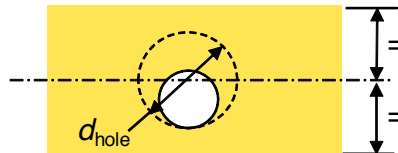
Rule 1

Maximum hole size = $0.4h$ for holes equidistant from the top and bottom edges of the beam.



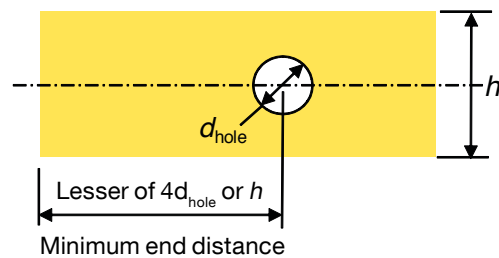
Rule 2

Offset holes. d_{hole} is the diameter of a hole that is equidistant from the top and bottom edges of the beam that wholly contains an offset hole.



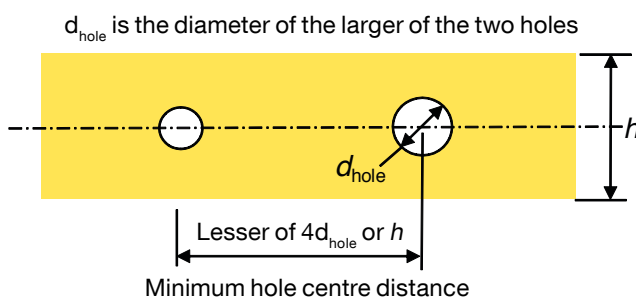
Rule 3

The minimum distance of the hole centre from the nearest beam end is d_{hole} or h .



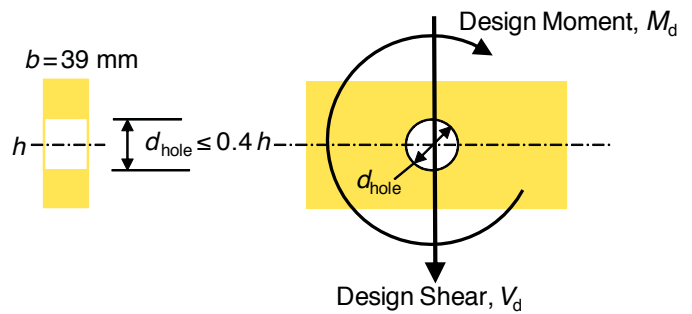
Rule 4

The minimum distance of the hole centre to an adjacent hole centre is $4d_{hole}$ or h .



$b = 39 \text{ mm}$

$h = 195 \text{ mm}$						
d_{hole}	20 mm		39 mm		78 mm	
	M_d	V_d	M_d	V_d	M_d	V_d
	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	13,86	0,00	11,27	0,00	5,63
	0,72	13,86	0,72	10,55	0,68	5,29
	1,45	13,86	1,44	9,83	1,36	4,96
	2,17	13,86	2,16	9,12	2,04	4,62
	2,90	13,86	2,88	8,40	2,71	4,28
	3,62	13,86	3,60	7,68	3,39	3,94
	4,35	13,52	4,32	6,96	4,07	3,60
	5,07	12,11	5,03	6,25	4,75	3,26
	5,79	10,70	5,75	5,53	5,43	2,93
	6,52	9,30	6,47	4,81	6,11	2,59
$M_{d,\text{Max}}$	7,24	7,89	7,19	4,10	6,79	2,25



$h = 240 \text{ mm}$						
d_{hole}	24 mm		48 mm		96 mm	
	M_d	V_d	M_d	V_d	M_d	V_d
	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	17,06	0,00	13,87	0,00	6,93
	1,10	17,06	1,09	12,98	1,03	6,52
	2,19	17,06	2,18	12,10	2,06	6,10
	3,29	17,06	3,27	11,22	3,08	5,68
	4,39	17,06	4,36	10,34	4,11	5,27
	5,49	17,06	5,45	9,45	5,14	4,85
	6,58	17,06	6,54	8,57	6,17	4,43
	7,68	15,29	7,63	7,69	7,20	4,02
	8,78	13,51	8,72	6,81	8,22	3,60
	9,87	11,73	9,81	5,92	9,25	3,19
$M_{d,\text{Max}}$	10,97	9,96	10,89	5,04	10,28	2,77

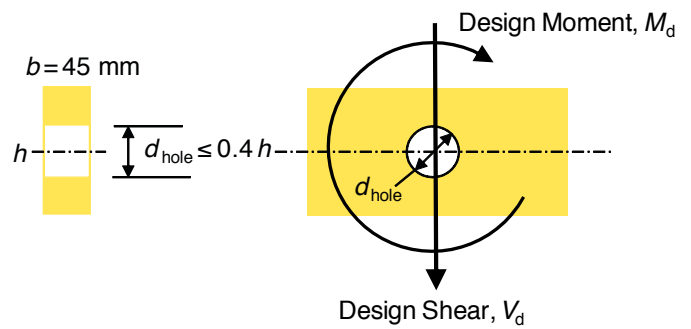
$h = 300 \text{ mm}$						
d_{hole}	30 mm		60 mm		120 mm	
	M_d	V_d	M_d	V_d	M_d	V_d
	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	21,32	0,00	17,33	0,00	8,67
	1,71	21,32	1,70	16,23	1,61	8,15
	3,43	21,32	3,40	15,13	3,21	7,63
	5,14	21,32	5,11	14,02	4,82	7,11
	6,86	21,32	6,81	12,92	6,42	6,58
	8,57	21,32	8,51	11,82	8,03	6,06
	10,29	21,32	10,21	10,71	9,64	5,54
	12,00	19,11	11,92	9,61	11,24	5,02
	13,71	16,89	13,62	8,51	12,85	4,50
	15,43	14,67	15,32	7,40	14,46	3,98
$M_{d,\text{Max}}$	17,14	12,44	17,02	6,30	16,06	3,46

$h = 360 \text{ mm}$						
d_{hole}	36 mm		72 mm		144 mm	
	M_d	V_d	M_d	V_d	M_d	V_d
	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	25,58	0,00	20,80	0,00	10,40
	2,40	25,58	2,40	19,50	2,31	9,78
	4,81	25,58	4,81	18,20	4,63	9,15
	7,21	25,58	7,21	16,90	6,94	8,53
	9,62	25,58	9,62	15,61	9,25	7,90
	12,02	25,58	12,02	14,31	11,56	7,28
	14,43	25,58	14,43	13,01	13,88	6,65
	16,83	23,42	16,83	11,71	16,19	6,03
	19,24	20,82	19,24	10,41	18,50	5,40
	21,64	18,22	21,64	9,11	20,82	4,78
$M_{d,\text{Max}}$	24,04	15,63	24,04	7,81	23,13	4,15

$h = 400 \text{ mm}$						
d_{hole}	40 mm		80 mm		160 mm	
	M_d	V_d	M_d	V_d	M_d	V_d
	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	28,43	0,00	23,11	0,00	11,56
	2,92	28,43	2,92	21,69	2,86	10,86
	5,84	28,43	5,84	20,27	5,71	10,17
	8,77	28,43	8,77	18,85	8,57	9,47
	11,69	28,43	11,69	17,43	11,42	8,78
	14,61	28,43	14,61	16,01	14,28	8,09
	17,53	28,43	17,53	14,59	17,13	7,39
	20,45	26,34	20,45	13,17	19,99	6,70
	23,37	23,50	23,37	11,75	22,84	6,00
	26,30	20,66	26,30	10,33	25,70	5,31
$M_{d,\text{Max}}$	29,22	17,82	29,22	8,91	28,55	4,62

b = 45 mm

h = 195 mm						
d _{hole}	20 mm		39 mm		78 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	15,99	0,00	13,00	0,00	6,50
	0,84	15,99	0,83	12,17	0,78	6,11
	1,67	15,99	1,66	11,35	1,57	5,72
	2,51	15,99	2,49	10,52	2,35	5,33
	3,34	15,99	3,32	9,69	3,13	4,94
	4,18	15,99	4,15	8,86	3,92	4,55
	5,01	15,60	4,98	8,04	4,70	4,16
	5,85	13,98	5,81	7,21	5,48	3,77
	6,69	12,35	6,64	6,38	6,26	3,38
	7,52	10,73	7,47	5,55	7,05	2,99
M _{d,Max}	8,36	9,10	8,30	4,73	7,83	2,60



h = 240 mm						
d _{hole}	24 mm		48 mm		96 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	19,68	0,00	16,00	0,00	8,00
	1,27	19,68	1,26	14,98	1,19	7,52
	2,53	19,68	2,51	13,96	2,37	7,04
	3,80	19,68	3,77	12,94	3,56	6,56
	5,06	19,68	5,03	11,93	4,74	6,08
	6,33	19,68	6,29	10,91	5,93	5,60
	7,60	19,68	7,54	9,89	7,12	5,12
	8,86	17,64	8,80	8,87	8,30	4,64
	10,13	15,59	10,06	7,85	9,49	4,16
	11,39	13,54	11,31	6,83	10,67	3,68
M _{d,Max}	12,66	11,49	12,57	5,82	11,86	3,20

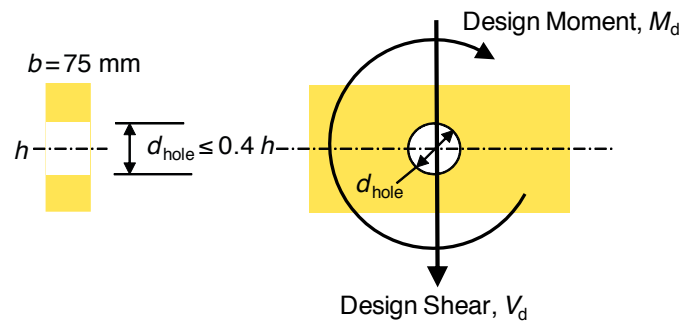
h = 300 mm						
d _{hole}	30 mm		60 mm		120 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	24,60	0,00	20,00	0,00	10,00
	1,98	24,60	1,96	18,73	1,85	9,40
	3,96	24,60	3,93	17,45	3,71	8,80
	5,93	24,60	5,89	16,18	5,56	8,20
	7,91	24,60	7,86	14,91	7,41	7,60
	9,89	24,60	9,82	13,63	9,27	7,00
	11,87	24,60	11,78	12,36	11,12	6,40
	13,85	22,05	13,75	11,09	12,97	5,80
	15,82	19,49	15,71	9,82	14,83	5,20
	17,80	16,92	17,68	8,54	16,68	4,59
M _{d,Max}	19,78	14,36	19,64	7,27	18,53	3,99

h = 360 mm						
d _{hole}	36 mm		72 mm		144 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	29,52	0,00	24,00	0,00	12,00
	2,77	29,52	2,77	22,50	2,67	11,28
	5,55	29,52	5,55	21,00	5,34	10,56
	8,32	29,52	8,32	19,50	8,01	9,84
	11,10	29,52	11,10	18,01	10,67	9,12
	13,87	29,52	13,87	16,51	13,34	8,40
	16,65	29,52	16,65	15,01	16,01	7,68
	19,42	27,02	19,42	13,51	18,68	6,95
	22,19	24,02	22,19	12,01	21,35	6,23
	24,97	21,03	24,97	10,51	24,02	5,51
M _{d,Max}	27,74	18,03	27,74	9,02	26,69	4,79

h = 400 mm						
d _{hole}	40 mm		80 mm		160 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	32,80	0,00	26,67	0,00	13,33
	3,37	32,80	3,37	25,03	3,29	12,53
	6,74	32,80	6,74	23,39	6,59	11,73
	10,11	32,80	10,11	21,75	9,88	10,93
	13,49	32,80	13,49	20,11	13,18	10,13
	16,86	32,80	16,86	18,47	16,47	9,33
	20,23	32,80	20,23	16,83	19,77	8,53
	23,60	30,39	23,60	15,19	23,06	7,73
	26,97	27,11	26,97	13,56	26,36	6,93
	30,34	23,83	30,34	11,92	29,65	6,13
M _{d,Max}	33,71	20,56	33,71	10,28	32,95	5,33

b = 75 mm

d _{hole}	h = 195 mm					
	20 mm		39 mm		78 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	26,65	0,00	21,67	0,00	10,83
	1,39	26,65	1,38	20,29	1,31	10,18
	2,79	26,65	2,77	18,91	2,61	9,53
	4,18	26,65	4,15	17,53	3,92	8,88
	5,57	26,65	5,53	16,15	5,22	8,23
	6,96	26,65	6,92	14,77	6,53	7,58
	8,36	26,00	8,30	13,39	7,83	6,93
	9,75	23,29	9,68	12,01	9,14	6,28
	11,14	20,59	11,06	10,63	10,44	5,63
	12,53	17,88	12,45	9,25	11,75	4,98
M _{d,Max}	13,93	15,17	13,83	7,88	13,05	4,33



d _{hole}	h = 240 mm					
	24 mm		48 mm		96 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	32,80	0,00	26,67	0,00	13,33
	2,11	32,80	2,10	24,97	1,98	12,53
	4,22	32,80	4,19	23,27	3,95	11,73
	6,33	32,80	6,29	21,57	5,93	10,93
	8,44	32,80	8,38	19,88	7,91	10,13
	10,55	32,80	10,48	18,18	9,88	9,33
	12,66	32,80	12,57	16,48	11,86	8,53
	14,77	29,40	14,67	14,78	13,84	7,73
	16,88	25,98	16,76	13,09	15,81	6,93
	18,99	22,56	18,86	11,39	17,79	6,13
M _{d,Max}	21,10	19,15	20,95	9,69	19,77	5,33

d _{hole}	h = 300 mm					
	30 mm		60 mm		120 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	41,00	0,00	33,33	0,00	16,67
	3,30	41,00	3,27	31,21	3,09	15,67
	6,59	41,00	6,55	29,09	6,18	14,66
	9,89	41,00	9,82	26,97	9,27	13,66
	13,19	41,00	13,09	24,85	12,36	12,66
	16,48	41,00	16,37	22,72	15,44	11,66
	19,78	41,00	19,64	20,60	18,53	10,66
	23,08	36,75	22,92	18,48	21,62	9,66
	26,37	32,48	26,19	16,36	24,71	8,66
	29,67	28,21	29,46	14,24	27,80	7,66
M _{d,Max}	32,97	23,93	32,74	12,12	30,89	6,66

d _{hole}	h = 360 mm					
	36 mm		72 mm		144 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	49,20	0,00	40,00	0,00	20,00
	4,62	49,20	4,62	37,50	4,45	18,80
	9,25	49,20	9,25	35,01	8,90	17,60
	13,87	49,20	13,87	32,51	13,34	16,40
	18,50	49,20	18,50	30,01	17,79	15,20
	23,12	49,20	23,12	27,51	22,24	13,99
	27,74	49,20	27,74	25,02	26,69	12,79
	32,37	45,04	32,37	22,52	31,14	11,59
	36,99	40,04	36,99	20,02	35,58	10,39
	41,61	35,05	41,61	17,52	40,03	9,19
M _{d,Max}	46,24	30,05	46,24	15,03	44,48	7,99

d _{hole}	h = 400 mm					
	40 mm		80 mm		160 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	54,67	0,00	44,44	0,00	22,22
	5,62	54,67	5,62	41,71	5,49	20,89
	11,24	54,67	11,24	38,98	10,98	19,55
	16,86	54,67	16,86	36,25	16,47	18,22
	22,48	54,67	22,48	33,52	21,96	16,88
	28,09	54,67	28,09	30,79	27,46	15,55
	33,71	54,67	33,71	28,06	32,95	14,21
	39,33	50,65	39,33	25,32	38,44	12,88
	44,95	45,19	44,95	22,59	43,93	11,54
	50,57	39,72	50,57	19,86	49,42	10,21
M _{d,Max}	56,19	34,26	56,19	17,13	54,91	8,88

Rectangular holes – LVL S

Guidance on the design of beams with rectangular holes

Notes:

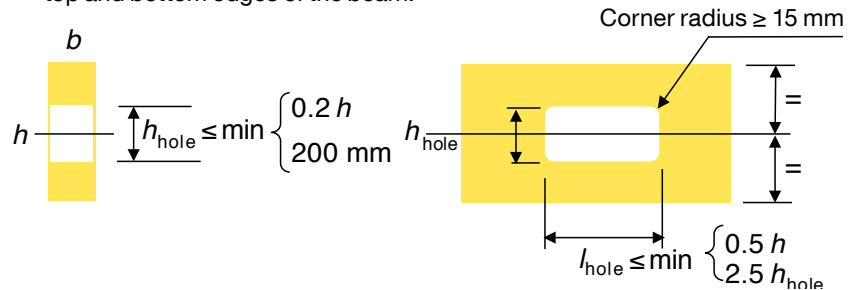
1. The hole design tables are based on the following expressions from cl.11.3 of PD 6933-1-2012:

$$\sigma_{t,90,d} = \frac{2.7V_{hole,d} \cdot d_{hole} + 0.07 \cdot M_{hole,d}}{bh^2}$$

2. The moment and shear values are valid for $h_{hole} < l_{hole} \leq 2.5h_{hole}$
3. The hole design tables assume medium term loading, service class 1 or 2, $k_{mod} = 0.8$
4. For LVL $\gamma_m = 1.2$
5. Floor beams and roof purlins are primary structural members and as such any notch must be designed as per the requirements of section 6.5 of EC5.

Rule 1

Maximum hole height, $h_{hole} \leq 0.2h$ or 200 mm for holes equidistant from the top and bottom edges of the beam.



Rule 2

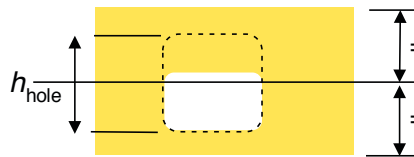
Maximum hole length, $l_{hole} = 0.5h$ or $2.5h_{hole}$ for holes equidistant from the top and bottom edges of the beam.

Rule 3

Corners of the hole are cut to a minimum radius of 15 mm.

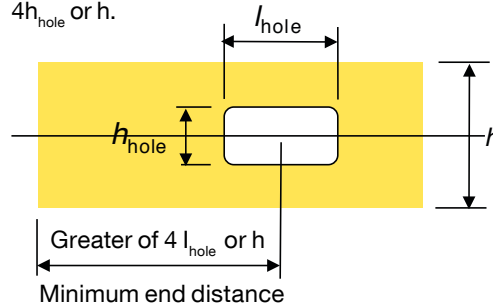
Rule 4

Offset holes, h_{hole} is the diameter of a hole that is equidistant from the top and bottom edges of the beam that wholly contains an offset hole.



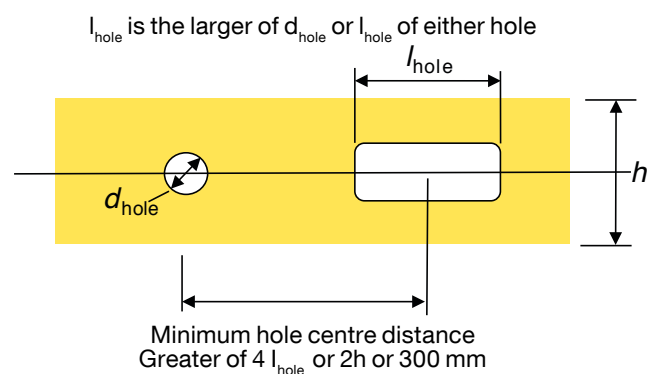
Rule 5

The minimum distance of the hole centre from the nearest beam end is $4h_{hole}$ or h .



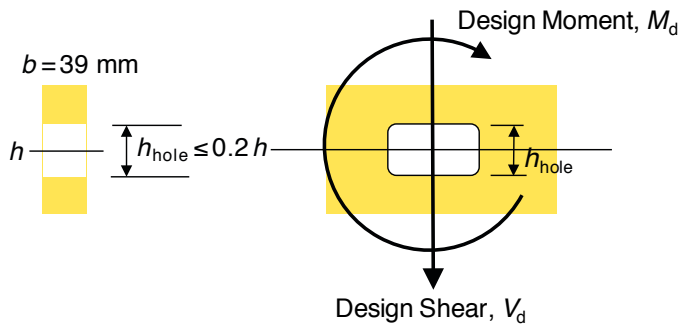
Rule 6

The minimum distance of the hole centre to an adjacent hole centre is $4h_{hole}$ or h .



b = 39 mm

h = 195 mm						
h_{hole}	10 mm		20 mm		39 mm	
	M_d	V_d	M_d	V_d	M_d	V_d
$V_{d,\text{Max}}$	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	13,858	0,00	13,86	0,00	7,51
	0,72	13,86	0,72	13,71	0,72	7,03
	1,45	13,86	1,45	12,77	1,44	6,56
	2,17	13,86	2,17	11,83	2,16	6,08
	2,90	13,86	2,90	10,89	2,88	5,60
	3,62	13,86	3,62	9,95	3,60	5,12
	4,35	13,86	4,34	9,01	4,31	4,64
	5,07	13,86	5,07	8,08	5,03	4,17
	5,80	13,86	5,79	7,14	5,75	3,69
$M_{d,\text{Max}}$	6,52	12,38	6,52	6,20	6,47	3,21
	7,25	10,50	7,24	5,26	7,19	2,73



h = 240 mm						
h_{hole}	12 mm		24 mm		48 mm	
	M_d	V_d	M_d	V_d	M_d	V_d
$V_{d,\text{Max}}$	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	17,06	0,00	17,06	0,00	9,24
	1,10	17,06	1,10	17,06	1,09	8,66
	2,20	17,06	2,19	16,12	2,18	8,07
	3,29	17,06	3,29	14,93	3,27	7,48
	4,39	17,06	4,39	13,75	4,36	6,89
	5,49	17,06	5,49	12,56	5,45	6,30
	6,59	17,06	6,58	11,38	6,53	5,71
	7,69	17,06	7,68	10,19	7,62	5,13
	8,78	17,06	8,78	9,01	8,71	4,54
$M_{d,\text{Max}}$	9,88	15,63	9,87	7,82	9,80	3,95
	10,98	13,25	10,97	6,64	10,89	3,36

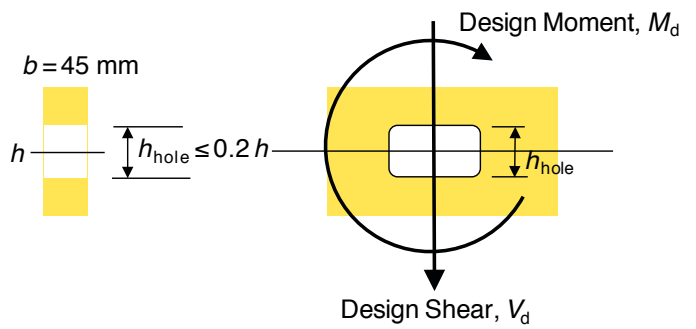
h = 300 mm						
h_{hole}	15 mm		30 mm		60 mm	
	M_d	V_d	M_d	V_d	M_d	V_d
$V_{d,\text{Max}}$	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	21,32	0,00	21,32	0,00	11,56
	1,72	21,32	1,71	21,32	1,70	10,82
	3,43	21,32	3,43	20,15	3,40	10,08
	5,15	21,32	5,14	18,67	5,11	9,35
	6,86	21,32	6,86	17,19	6,81	8,61
	8,58	21,32	8,57	15,70	8,51	7,88
	10,29	21,32	10,28	14,22	10,21	7,14
	12,01	21,32	12,00	12,74	11,91	6,41
	13,73	21,32	13,71	11,26	13,61	5,67
$M_{d,\text{Max}}$	15,44	19,53	15,43	9,78	15,32	4,94
	17,16	16,57	17,14	8,30	17,02	4,20

h = 360 mm						
h_{hole}	18 mm		36 mm		72 mm	
	M_d	V_d	M_d	V_d	M_d	V_d
$V_{d,\text{Max}}$	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	25,58	0,00	25,58	0,00	13,87
	2,47	25,58	2,47	25,58	2,40	13,00
	4,94	25,58	4,94	24,18	4,81	12,14
	7,41	25,58	7,40	22,40	7,21	11,27
	9,88	25,58	9,87	20,62	9,62	10,40
	12,35	25,58	12,34	18,85	12,02	9,54
	14,82	25,58	14,81	17,07	14,43	8,67
	17,29	25,58	17,28	15,29	16,83	7,81
	19,76	25,58	19,75	13,51	19,24	6,94
$M_{d,\text{Max}}$	22,24	23,44	22,21	11,74	21,64	6,07
	24,71	19,88	24,68	9,96	24,04	5,21

h = 400 mm						
h_{hole}	20 mm		40 mm		80 mm	
	M_d	V_d	M_d	V_d	M_d	V_d
$V_{d,\text{Max}}$	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	28,43	0,00	28,43	0,00	15,41
	3,05	28,43	3,05	28,43	2,92	14,46
	6,10	28,43	6,09	26,86	5,84	13,51
	9,15	28,43	9,14	24,89	8,77	12,57
	12,20	28,43	12,19	22,91	11,69	11,62
	15,25	28,43	15,24	20,94	14,61	10,67
	18,30	28,43	18,28	18,96	17,53	9,73
	21,35	28,43	21,33	16,99	20,45	8,78
	24,40	28,43	24,38	15,01	23,37	7,83
$M_{d,\text{Max}}$	27,45	26,04	27,43	13,04	26,30	6,89
	30,50	22,09	30,47	11,06	29,22	5,94

b = 45 mm

h = 195 mm						
h _{hole}	10 mm		20 mm		39 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
V _{d,Max}	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	15,99	0,00	15,99	0,00	8,67
	0,84	15,99	0,84	15,82	0,83	8,12
	1,67	15,99	1,67	14,73	1,66	7,56
	2,51	15,99	2,51	13,65	2,49	7,01
	3,35	15,99	3,34	12,57	3,32	6,46
	4,18	15,99	4,18	11,48	4,15	5,91
	5,02	15,99	5,01	10,40	4,98	5,36
	5,85	15,99	5,85	9,32	5,81	4,81
	6,69	15,99	6,68	8,24	6,64	4,25
	7,53	14,28	7,52	7,15	7,47	3,70
	8,36	12,12	8,36	6,07	8,30	3,15
M _{d,Max}						



h = 240 mm						
h _{hole}	12 mm		24 mm		48 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
V _{d,Max}	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	19,68	0,00	19,68	0,00	10,67
	1,27	19,68	1,27	19,68	1,26	9,99
	2,53	19,68	2,53	18,60	2,51	9,31
	3,80	19,68	3,80	17,23	3,77	8,63
	5,07	19,68	5,06	15,86	5,03	7,95
	6,33	19,68	6,33	14,50	6,28	7,27
	7,60	19,68	7,59	13,13	7,54	6,59
	8,87	19,68	8,86	11,76	8,80	5,92
	10,14	19,68	10,13	10,39	10,05	5,24
	11,40	18,03	11,39	9,03	11,31	4,56
	12,67	15,29	12,66	7,66	12,57	3,88
M _{d,Max}						

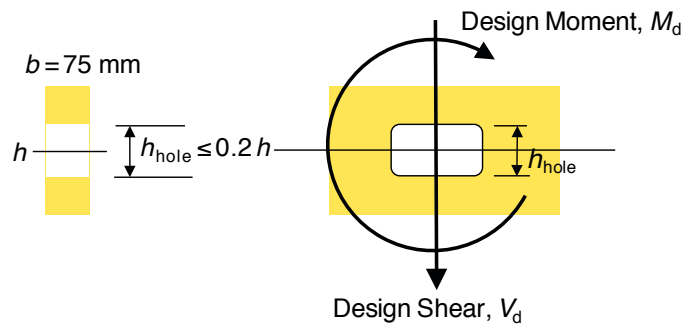
h = 300 mm						
h _{hole}	15 mm		30 mm		60 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
V _{d,Max}	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	24,60	0,00	24,60	0,00	13,33
	1,98	24,60	1,98	24,60	1,96	12,48
	3,96	24,60	3,96	23,25	3,93	11,64
	5,94	24,60	5,93	21,54	5,89	10,79
	7,92	24,60	7,91	19,83	7,85	9,94
	9,90	24,60	9,89	18,12	9,82	9,09
	11,88	24,60	11,87	16,41	11,78	8,24
	13,86	24,60	13,84	14,70	13,75	7,39
	15,84	24,60	15,82	12,99	15,71	6,55
	17,82	22,54	17,80	11,28	17,67	5,70
	19,80	19,12	19,78	9,57	19,64	4,85
M _{d,Max}						

h = 360 mm						
h _{hole}	18 mm		36 mm		72 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
V _{d,Max}	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	29,52	0,00	29,52	0,00	16,00
	2,85	29,52	2,85	29,52	2,77	15,00
	5,70	29,52	5,70	27,90	5,55	14,00
	8,55	29,52	8,54	25,85	8,32	13,00
	11,40	29,52	11,39	23,80	11,10	12,00
	14,25	29,52	14,24	21,74	13,87	11,01
	17,10	29,52	17,09	19,69	16,65	10,01
	19,95	29,52	19,94	17,64	19,42	9,01
	22,81	29,52	22,78	15,59	22,19	8,01
	25,66	27,05	25,63	13,54	24,97	7,01
	28,51	22,94	28,48	11,49	27,74	6,01
M _{d,Max}						

h = 400 mm						
h _{hole}	20 mm		40 mm		80 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
V _{d,Max}	kN.m	kN	kN.m	kN	kN.m	kN
	0,00	32,80	0,00	32,80	0,00	17,78
	3,52	32,80	3,52	32,80	3,37	16,69
	7,04	32,80	7,03	31,00	6,74	15,59
	10,56	32,80	10,55	28,72	10,11	14,50
	14,08	32,80	14,06	26,44	13,49	13,41
	17,60	32,80	17,58	24,16	16,86	12,31
	21,12	32,80	21,10	21,88	20,23	11,22
	24,64	32,80	24,61	19,60	23,60	10,13
	28,16	32,80	28,13	17,32	26,97	9,04
	31,67	30,05	31,64	15,05	30,34	7,94
	35,19	25,49	35,16	12,77	33,71	6,85
M _{d,Max}						

b = 75 mm

h = 195 mm						
h _{hole}	10 mm		20 mm		39 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
	kN.m	kN	kN.m	kN	kN.m	kN
V _{d,Max}	0,00	26,65	0,00	26,65	0,00	14,44
	1,39	26,65	1,39	26,36	1,38	13,53
	2,79	26,65	2,79	24,56	2,77	12,61
	4,18	26,65	4,18	22,75	4,15	11,69
	5,58	26,65	5,57	20,95	5,53	10,77
	6,97	26,65	6,96	19,14	6,91	9,85
	8,36	26,65	8,36	17,34	8,30	8,93
	9,76	26,65	9,75	15,53	9,68	8,01
	11,15	26,65	11,14	13,73	11,06	7,09
	12,55	23,81	12,53	11,92	12,44	6,17
	13,94	20,19	13,93	10,11	13,83	5,25
M _{d,Max}	13,94	20,19	13,93	10,11	13,83	5,25



h = 240 mm						
h _{hole}	12 mm		24 mm		48 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
	kN.m	kN	kN.m	kN	kN.m	kN
V _{d,Max}	0,00	32,80	0,00	32,80	0,00	17,78
	2,11	32,80	2,11	32,80	2,09	16,65
	4,22	32,80	4,22	31,00	4,19	15,52
	6,33	32,80	6,33	28,72	6,28	14,38
	8,45	32,80	8,44	26,44	8,38	13,25
	10,56	32,80	10,55	24,16	10,47	12,12
	12,67	32,80	12,66	21,88	12,57	10,99
	14,78	32,80	14,77	19,60	14,66	9,86
	16,89	32,80	16,88	17,32	16,76	8,73
	19,00	30,05	18,99	15,05	18,85	7,60
	21,12	25,49	21,10	12,77	20,94	6,46
M _{d,Max}	21,12	25,49	21,10	12,77	20,94	6,46

h = 300 mm						
h _{hole}	15 mm		30 mm		60 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
	kN.m	kN	kN.m	kN	kN.m	kN
V _{d,Max}	0,00	41,00	0,00	41,00	0,00	22,22
	3,30	41,00	3,30	41,00	3,27	20,81
	6,60	41,00	6,59	38,75	6,55	19,39
	9,90	41,00	9,89	35,90	9,82	17,98
	13,20	41,00	13,19	33,05	13,09	16,57
	16,50	41,00	16,48	30,20	16,36	15,15
	19,80	41,00	19,78	27,35	19,64	13,74
	23,10	41,00	23,07	24,50	22,91	12,32
	26,40	41,00	26,37	21,66	26,18	10,91
	29,69	37,56	29,67	18,81	29,45	9,50
	32,99	31,86	32,96	15,96	32,73	8,08
M _{d,Max}	32,99	31,86	32,96	15,96	32,73	8,08

h = 360 mm						
h _{hole}	18 mm		36 mm		72 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
	kN.m	kN	kN.m	kN	kN.m	kN
V _{d,Max}	0,00	49,20	0,00	49,20	0,00	26,67
	4,75	49,20	4,75	49,20	4,62	25,00
	9,50	49,20	9,49	46,50	9,25	23,34
	14,25	49,20	14,24	43,08	13,87	21,67
	19,00	49,20	18,99	39,66	18,50	20,01
	23,76	49,20	23,73	36,24	23,12	18,34
	28,51	49,20	28,48	32,82	27,74	16,68
	33,26	49,20	33,23	29,40	32,37	15,01
	38,01	49,20	37,97	25,99	36,99	13,35
	42,76	45,08	42,72	22,57	41,61	11,68
	47,51	38,23	47,47	19,15	46,24	10,02
M _{d,Max}	47,51	38,23	47,47	19,15	46,24	10,02

h = 400 mm						
h _{hole}	20 mm		40 mm		80 mm	
	M _d	V _d	M _d	V _d	M _d	V _d
	kN.m	kN	kN.m	kN	kN.m	kN
V _{d,Max}	0,00	54,67	0,00	54,67	0,00	29,63
	5,87	54,67	5,86	54,67	5,62	27,81
	11,73	54,67	11,72	51,66	11,24	25,99
	17,60	54,67	17,58	47,86	16,86	24,17
	23,46	54,67	23,44	44,07	22,48	22,35
	29,33	54,67	29,30	40,27	28,09	20,52
	35,19	54,67	35,16	36,47	33,71	18,70
	41,06	54,67	41,02	32,67	39,33	16,88
	46,93	54,67	46,88	28,87	44,95	15,06
	52,79	50,09	52,74	25,08	50,57	13,24
	58,66	42,48	58,60	21,28	56,19	11,42
M _{d,Max}	58,66	42,48	58,60	21,28	56,19	11,42





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