

CLT solid wood elements

A natural choice of structure



CLT The product

There are many reasons why one would choose to specify Stora Enso CLT solid wood panels:

Superior quality

- Manufactured by Stora Enso, Europe's largest sawmilling company.
- Large panel sizes ensure less joints and rapid construction on site.
- Edge-glued panel faces for air tightness.
- Factory-sanded panel surfaces as standard.
- Modern, state-of-the-art production facility ensures highest quality standards.

Natural and Sustainable

- Only certified timber from sustainably managed forests is used for raw material.
- Only formaldehyde-free adhesives are used for bonding.
- Integrated sawmill and manufacturing plant helps reduce raw material transportation and is a natural benefit for quality control.
- CLT panels help regulate indoor climatic conditions resulting in healthier indoor environments.
- CLT panels are reusable, recyclable, and easily disposable (as biomass fuel).

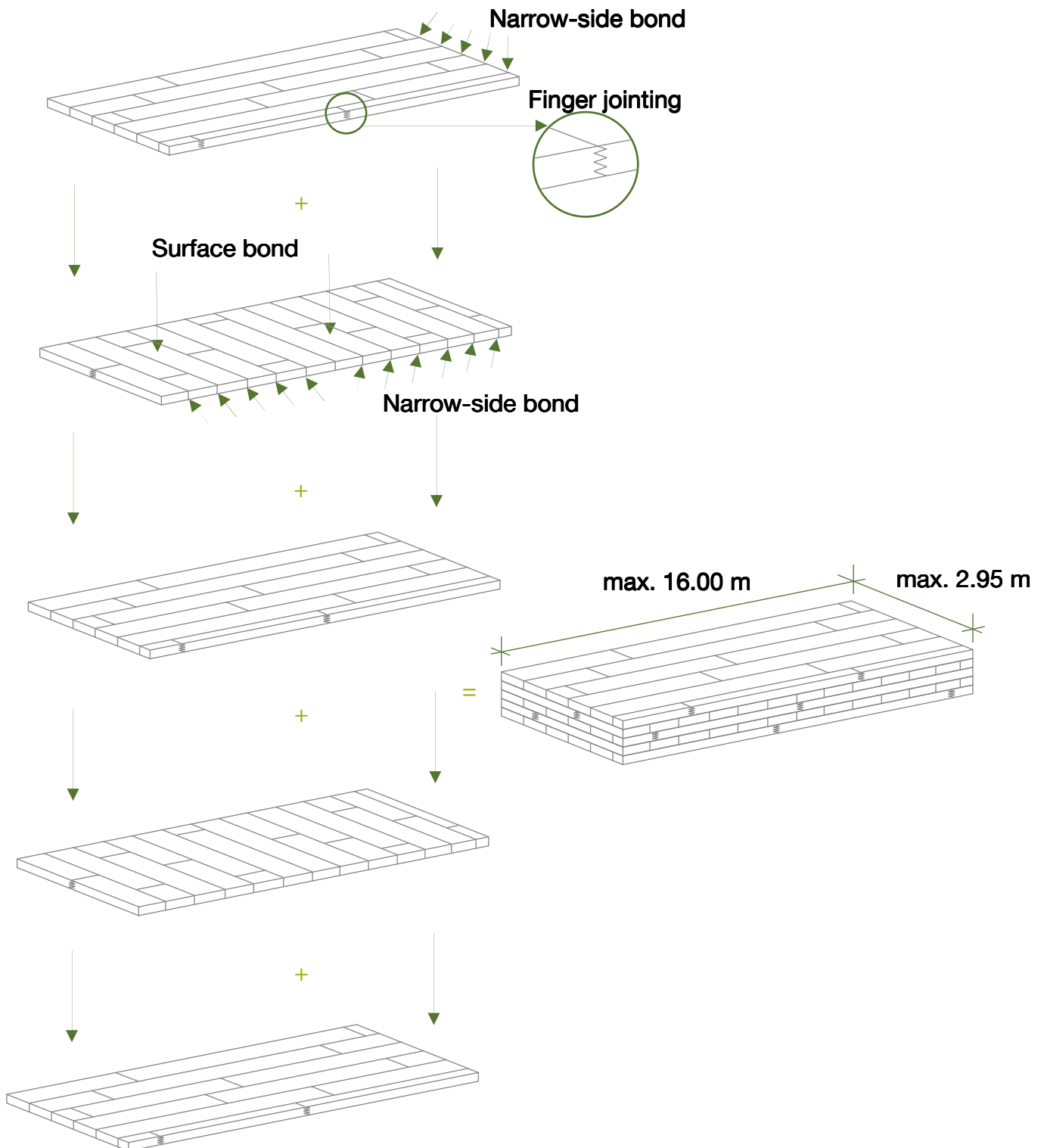
Low risk

- Cross-lamination and glueing ensures minimal shrinkage or settlement over time.
- CLT panels act as a vapour control layer - suitable for 'breathable' construction.
- Higher thermal mass and thermal stability when compared to timber frame.
- Predictable build period – unaffected by most weather conditions.
- Solid construction method suitable for large-scale and high-rise building types.
- Compatible with most common construction materials.
- Comparable to concrete but more sustainable.
- Suitable for earthquake zones.



Structure of CLT

CLT solid wood panels consist of bonded single-layer boards which are cross-laminated together. The maximum production width is 2.95m and the maximum production length 16.00 m.



Example: Design of a 5-layer CLT solid-wood panel

CLT - Cross Laminated Timber

General Information

Intended use	Primarily as a wall, ceiling and roof element in commercial and private buildings
Maximum width	2.95 m
Maximum length	16.00 m
Maximum thickness	400 mm
Layer structure	Cross-laminated single-layer edge-glued panels
Wood species	Spruce (pine and larch on request)
Grade	C24 (for structural calculations)
Moisture content	12% +/- 2%
Bonding adhesive	Formaldehyde-free PUR adhesive
Surface quality	Factory-sanded
Appearance grade	C or A/B in accordance with EN 13017-1, Table 1
Weight	5.0 kN/m ³ (for structural calculations)

Basic characteristics

Dimensional stability (panel size)	0.02% change for every 1% change in panel moisture content
Dimensional stability (panel thickness)	0.24% change for every 1% change in panel moisture content
Reaction to fire	D-s2, d0 in accordance with Commission Decision 2003/43/EC
Resistance to fire	Charring rate of 0.65 mm/min in accordance with EN 1995-1-2
Water vapour resistance μ	20 to 50 in accordance with EN 12524
Thermal conductivity λ	0.13 W/(mK) in accordance with EN 12524
Specific heat capacity	1600 J/(kgK) in accordance with EN 12524
Air tightness	Effectively airtight when tested to EN 12114
Service class	1 and 2 only in accordance with EN 1995-1-1

Usage example of CLT

Commercial building



Property Nursery school
Location Graz (Austria)
CLT installed Approx. 175 m³

Structural Design

General information on the design of load-bearing structures with CLT

Because of the single-layer panels which are bonded alternately at right angles to each other the load is transferred in two axes – which was the preserve of reinforced steel structures in the past.

The advantage of this is more flexible room design at the design stage; designs can also be simplified, and lower bare ceiling heights are possible.

Although diagonally projecting or point-supported structures require greater design input, they are perfectly feasible.

CLT elements have a particularly high load capacity since the load-bearing width generally extends across the entire element width because of the transverse layers.

The high inherent stiffness of CLT also provides racking strength.

CLT calculation method

The difference from sizing solid timber or glulam lies in the loading of the transverse layers.

In a CLT element a load at right angles to the panel plane (e.g. a snow load on a flat roof) generates a shear load in the transverse layers which acts at right angles to the direction of grain.

This shear load is termed rolling shear since the wood fibres "roll off" at right angles in the event of a fracture.

As a result of the low shear strength or stiffness of the transverse layer (load at right angles to the grain), the stresses or deformations that occur cannot be ignored.

Calculations are carried out in accordance with the lamination theory, taking account of shear distortions.

There are now various options for calculating cross-laminated timber; one of these is the "theory of flexibly connected layers" (also termed the "gamma method". The gamma method is the commonest method and is also described in ETA-08/0271.

Fastenings

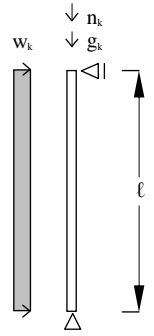
Verification of the fastenings is described and regulated in the approvals.

CLT preliminary design tables

The preliminary design tables shown on the next few pages have been compiled by Stora Enso in good faith but are not a substitute for a structural analysis for the particular application and circumstances. All the information contained in the tables is in line with the state of the art, though errors and omissions cannot be ruled out.

Stora Enso therefore accepts no liability and explicitly states that the user of these preliminary design tables is responsible for checking the individual results.

External walls



In accordance with approval Z 9.1-559
DIN 1052 (2008) and/or EN 1995-1-1 (2006)

Permanent load $g_k^{*1)}$ [KN/m]	Imposed load n_k [KN/m]	HEIGHT (buckle length l)														
		2.45 m				2.75 m				2.95 m						
		R 0	R 30	R 60	R 90	R 0	R 30	R 60	R 90	R 0	R 30	R 60	R 90			
10.00	10.00	57 C3s	83 C3s	83 C3s	97 C3s	57 C3s	97 C3s	97 C3s	97 C3s	57 C3s	97 C3s	97 C3s	97 C3s			
	20.00		97 C3s	97 C3s	138 C5s			83 C3s	95 C5s			138 C5s	83 C3s	95 C5s	138 C5s	
	30.00			97 C3s												95 C5s
	40.00	83 C3s	97 C3s	95 C5s	138 C5s	83 C3s	97 C3s	95 C5s	138 C5s	83 C3s	97 C3s	95 C5s	138 C5s			
	50.00															
	60.00															
20.00	10.00	57 C3s	97 C3s	97 C3s	97 C3s	57 C3s	97 C3s	97 C3s	97 C3s	57 C3s	97 C3s	97 C3s	97 C3s			
	20.00			97 C3s	97 C3s			138 C5s	83 C3s			95 C5s	138 C5s	83 C3s	95 C5s	138 C5s
	30.00				97 C3s											
	40.00	83 C3s	97 C3s	95 C5s	138 C5s	83 C3s	97 C3s	95 C5s	138 C5s	83 C3s	97 C3s	95 C5s	138 C5s			
	50.00															
	60.00															
30.00	10.00	57 C3s	97 C3s	97 C3s	97 C3s	57 C3s	97 C3s	97 C3s	97 C3s	57 C3s	97 C3s	97 C3s	97 C3s			
	20.00			97 C3s	97 C3s			138 C5s	83 C3s			95 C5s	138 C5s	83 C3s	95 C5s	138 C5s
	30.00				97 C3s											
	40.00	83 C3s	97 C3s	95 C5s	138 C5s	83 C3s	97 C3s	95 C5s	138 C5s	83 C3s	97 C3s	95 C5s	138 C5s			
	50.00															
	60.00															
40.00	10.00	57 C3s	97 C3s	97 C3s	97 C3s	57 C3s	97 C3s	97 C3s	97 C3s	57 C3s	97 C3s	97 C3s	97 C3s			
	20.00			97 C3s	97 C3s			138 C5s	83 C3s			95 C5s	138 C5s	83 C3s	95 C5s	138 C5s
	30.00				97 C3s											
	40.00	83 C3s	97 C3s	95 C5s	138 C5s	83 C3s	97 C3s	95 C5s	138 C5s	83 C3s	97 C3s	95 C5s	138 C5s			
	50.00															
	60.00															
50.00	10.00	57 C3s	97 C3s	97 C3s	97 C3s	57 C3s	97 C3s	97 C3s	97 C3s	57 C3s	97 C3s	97 C3s	97 C3s			
	20.00			97 C3s	97 C3s			138 C5s	83 C3s			95 C5s	138 C5s	83 C3s	95 C5s	138 C5s
	30.00				97 C3s											
	40.00	83 C3s	97 C3s	95 C5s	138 C5s	83 C3s	97 C3s	95 C5s	138 C5s	83 C3s	97 C3s	95 C5s	138 C5s			
	50.00															
	60.00															
60.00	10.00	83 C3s	97 C3s	97 C3s	97 C3s	83 C3s	97 C3s	97 C3s	97 C3s	83 C3s	97 C3s	97 C3s	97 C3s			
	20.00			97 C3s	97 C3s			138 C5s	83 C3s			95 C5s	138 C5s	83 C3s	95 C5s	138 C5s
	30.00				97 C3s											
	40.00	83 C3s	97 C3s	95 C5s	138 C5s	83 C3s	97 C3s	95 C5s	138 C5s	83 C3s	97 C3s	95 C5s	138 C5s			
	50.00															
	60.00															

The CLT self-weight is taken into account.

Wind pressure: $w_k = 0.80 \text{ kN/m}^2$

Service class 1, imposed load category A ($\psi_0 = 0.7$; $\psi_1 = 0.5$; $\psi_2 = 0.3$)

Ultimate limit state:

- a) Verification as a column (compression and flexion in accordance with equivalent member method)
- b) Shear stresses

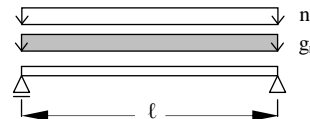
$k_{mod} = 0.8$

Fire resistance:
 $\beta = 0.65 \text{ mm/min}$

R0
R30
R60
R90

This table is only for preliminary design purposes and is not a substitute for a structural analysis!

Single-span floors



In accordance with approval Z 9.1-559
DIN 1052 (2008) and/or EN 1995-1-1 (2006)

Permanent load [KN/m]	Imposed load [KN/m]	SPAN OF SINGLE-SPAN BEAM l									
		3.00 m	3.50 m	4.00 m	4.50 m	5.00 m	5.50 m	6.00 m	6.50 m	7.00 m	
1.00	1.00	74 L3s	83 L3s	103 L3s	103 L3s	112 L3s	150 L5s	165 L5s	182 L5s	211 L5s	
	2.00	74 L3s	97 L3s	97 L3s	112 L3s	126 L3s			196 L5s	196 L5s	209 L7s-2
	2.80	83 L3s	97 L3s	103 L3s	119 L3s	126 L3s	150 L5s	165 L5s	182 L5s	211 L5s	223 L7s-2
	3.50	83 L3s		112 L3s		138 L5s					249 L7s-2
	4.00	83 L3s	103 L3s	112 L3s	126 L3s	150 L5s	165 L5s	196 L5s	209 L7s-2	209 L7s-2	
	5.00	97 L3s	103 L3s	119 L3s	150 L5s	150 L5s	165 L5s	196 L5s	209 L7s-2	209 L7s-2	
1.50	1.00	74 L3s	97 L3s	103 L3s	112 L3s	126 L3s	150 L5s	182 L5s	196 L5s	223 L7s-2	
	2.00	83 L3s	97 L3s	103 L3s	119 L3s	150 L5s			165 L5s	196 L5s	211 L5s
	2.80	83 L3s		112 L3s	126 L3s		150 L5s	165 L5s			196 L5s
	3.50	83 L3s	103 L3s	119 L3s	150 L5s	165 L5s			196 L5s	223 L7s-2	
	4.00	83 L3s	103 L3s	119 L3s	150 L5s	165 L5s	196 L5s	211 L5s	211 L5s	223 L7s-2	
	5.00	97 L3s	103 L3s	119 L3s	150 L5s	150 L5s	165 L5s	196 L5s	211 L5s	211 L5s	
2.00	1.00	83 L3s	97 L3s	103 L3s	119 L3s	150 L5s	165 L5s	182 L5s	196 L5s	209 L7s-2	
	2.00	83 L3s	103 L3s	112 L3s	126 L3s				150 L5s	165 L5s	196 L5s
	2.80	83 L3s		103 L3s	119 L3s	138 L5s	150 L5s	165 L5s			
	3.50	97 L3s	103 L3s	119 L3s	150 L5s	165 L5s			196 L5s	211 L5s	211 L5s
	4.00	97 L3s	103 L3s	119 L3s	150 L5s	165 L5s	196 L5s	211 L5s	211 L5s	223 L7s-2	
	5.00	97 L3s	103 L3s	119 L3s	150 L5s	150 L5s	165 L5s	196 L5s	209 L7s-2	249 L7s-2	
2.50	1.00	83 L3s	103 L3s	112 L3s	138 L5s	150 L5s	165 L5s	182 L5s	196 L5s	223 L7s-2	
	2.00	97 L3s	103 L3s	119 L3s	150 L5s				165 L5s	182 L5s	196 L5s
	2.80		103 L3s	119 L3s		150 L5s	165 L5s	182 L5s			
	3.50	97 L3s	103 L3s	126 L3s	150 L5s				165 L5s	196 L5s	211 L5s
	4.00	97 L3s	112 L3s	126 L3s	150 L5s	165 L5s	196 L5s	211 L5s	211 L5s	223 L7s-2	
	5.00	97 L3s	112 L3s	126 L3s	150 L5s	165 L5s	196 L5s	211 L5s	211 L5s	223 L7s-2	
3.00	1.00	97 L3s	103 L3s	119 L3s	150 L5s	165 L5s	182 L5s	196 L5s	211 L5s	211 L5s	
	2.00		103 L3s	119 L3s				150 L5s	165 L5s	182 L5s	196 L5s
	2.80	97 L3s	112 L3s	126 L3s	150 L5s	165 L5s	196 L5s				
	3.50	97 L3s	112 L3s	126 L3s	150 L5s	165 L5s	196 L5s	211 L5s	223 L7s-2	249 L7s-2	
	4.00	97 L3s	112 L3s	126 L3s	150 L5s	165 L5s	196 L5s	211 L5s	223 L7s-2	249 L7s-2	
	5.00	103 L3s	112 L3s	138 L5s	150 L5s	165 L5s	196 L5s	211 L5s	211 L5s	223 L7s-2	

The CLT self-weight is taken into account.

Service class 1, imposed load category A ($\psi_0 = 0.7$; $\psi_1 = 0.5$; $\psi_2 = 0.3$)

Ultimate limit state:

- a) Verification of bending stresses
- b) Verification of shear stresses

$k_{mod} = 0.8$

Serviceability:

- a) Quasi-constant design situation: $w_{in} = 1/250$
 - b) Infrequent design situation: $w_{Q,inst} = 1/300$; $w_{in} - w_{G,inst} = 1/200$;
- $k_{def} = 0.6$

Fire resistance:

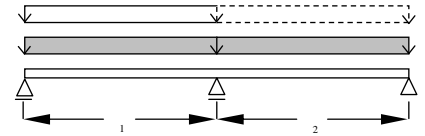
$\beta = 0.65 \text{ mm/min}$

R0
R30
R60
R90

This table specifies the required thicknesses for the normal design situation (R0). The colour shading represents the fire resistance rating which is also attained with this thickness. If a higher fire resistance rating is required, a separate analysis must be carried out.

This table is only for preliminary design purposes and is not a substitute for a structural analysis!

Two-span floors



In accordance with approval Z 9.1-559
DIN 1052 (2008) and/or EN 1995-1-1 (2006)

Permanent load	Imposed load	SPAN OF TWO-SPAN BEAM l_1 $l_2 = 0,8 \cdot l_1$ bis $1,0 \cdot l_1$										
		g_k^*	n_k	3.00 m	3.50 m	4.00 m	4.50 m	5.00 m	5.50 m	6.00 m	6.50 m	7.00 m
[KN/m]	[KN/m]											
1.00	1.00	74 L3s	83 L3s	74 L3s	97 L3s	112 L3s	150 L5s	165 L5s	182 L5s	196 L5s	211 L5s	
	2.00		74 L3s	83 L3s	103 L3s	119 L3s			182 L5s	211 L5s	223 L7s-2	
	2.80		74 L3s	97 L3s	103 L3s	126 L3s	165 L5s	182 L5s	211 L5s	249 L7s-2		
	3.50		83 L3s	103 L3s	112 L3s	138 L5s						
	4.00		97 L3s	103 L3s	112 L3s	150 L5s	196 L5s	223 L7s-2	211 L5s			
	5.00		83 L3s	103 L3s	119 L3s	150 L5s	196 L5s	223 L7s-2	211 L5s			
1.50	1.00	74 L3s	74 L3s	97 L3s	103 L3s	126 L3s	150 L5s	165 L5s	182 L5s	211 L5s	223 L7s-2	
	2.00		74 L3s	97 L3s	112 L3s	150 L5s			182 L5s	211 L5s	249 L7s-2	
	2.80	74 L3s	83 L3s	103 L3s	119 L3s	150 L5s	165 L5s	196 L5s	209 L7s-2	196 L5s		
	3.50								223 L7s-2	211 L5s		
	4.00	97 L3s	103 L3s	119 L3s	150 L5s	182 L5s	211 L5s	211 L5s				
	5.00	83 L3s	103 L3s	126 L3s	150 L5s	182 L5s	211 L5s	196 L5s	209 L7s-2			
2.00	1.00	74 L3s	74 L3s	97 L3s	112 L3s	150 L5s	165 L5s	196 L5s	209 L7s-2	196 L7s-2		
	2.00		74 L3s	103 L3s	119 L3s				223 L7s-2	211 L5s		
	2.80	74 L3s	83 L3s	103 L3s	126 L3s	150 L5s	182 L5s	211 L5s	182 L5s	209 L7s-2		
	3.50								196 L5s		211 L5s	
	4.00	97 L3s	103 L3s	138 L5s	165 L5s	165 L5s	182 L5s	211 L5s	211 L5s			
	5.00	83 L3s	97 L3s	112 L3s	150 L5s	165 L5s	196 L5s	182 L5s	211 L5s	223 L7s-2		
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	2.00			103 L3s	119 L3s				196 L5s	196 L5s	209 L7s-2	
	2.80	74 L3s	97 L3s	112 L3s	138 L5s	165 L5s	196 L5s	165 L5s	182 L5s	211 L5s	223 L7s-2	
	3.50			112 L3s	150 L5s							150 L5s
	4.00	97 L3s	112 L3s	150 L5s	165 L5s	165 L5s	182 L5s	211 L5s	211 L5s			
	5.00	83 L3s	119 L3s	150 L5s	165 L5s	165 L5s	182 L5s	211 L5s	249 L7s-2			
3.00	1.00	74 L3s	97 L3s	112 L3s	138 L5s	165 L5s	196 L5s	182 L5s	165 L5s	196 L5s	223 L7s-2	
	2.00			112 L3s	150 L5s				196 L5s	211 L5s	211 L5s	
	2.80	74 L3s	97 L3s	112 L3s	150 L5s	165 L5s	196 L5s	182 L5s	182 L5s	211 L5s	249 L7s-2	
	3.50											119 L3s
	4.00	83 L3s	119 L3s	150 L5s	165 L5s	165 L5s	182 L5s	211 L5s	211 L5s			
	5.00	103 L3s	119 L3s	150 L5s	182 L5s	196 L5s	209 L7s-2	211 L5s				

The CLT self-weight is taken into account.

Service class 1, imposed load category A ($\psi_0 = 0.7$; $\psi_1 = 0.5$; $\psi_2 = 0.3$)

Ultimate limit state:

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Fire resistance:
 $\beta = 0.65$ mm/min

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R60
R90

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