

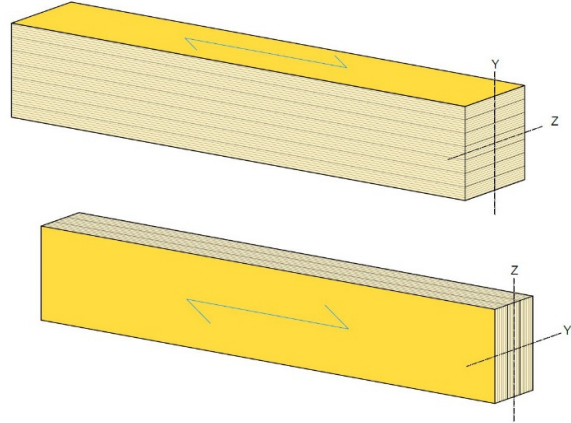
PRODUCT CERTIFICATE

NAME OF PRODUCT

LVL G by Stora Enso

MANUFACTURER

Stora Enso Wood Products Oy
 Kanavaranta 1
 FI-00160 Helsinki



PRODUCT DESCRIPTION

Glued laminated LVL (GLVL) with the trade name LVL G by Stora Enso, is comprised of structural laminated veneer lumber (LVL) components bonded together at their flatwise surfaces. The softwood LVL components are manufactured according to EN 14374. The product LVL G S contains LVL S type components without crossband veneers and LVL G X contains LVL X type components with crossband veneers. The LVL components have essentially the same grain direction. The products can be used edgewise and flatwise. LVL G by Stora Enso is intended to be used as structural or non-structural elements in buildings and bridges.

CERTIFICATION PROCEDURE

This certificate is based on an initial type assessment of the product, an initial inspection of the factory and the factory production control according to the certification criteria R084. The general certification procedures are based on the certification system of Eurofins Expert Services Oy.

The conditions of validity of this certificate are described in section 16.

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REGULATIONS, STANDARDS AND INSTRUCTIONS

1 Regulations and product requirement standards

This certificate describes LVL G by Stora Enso in accordance with EAD 130337-00-03.04 Glued Laminated LVL, EOTA, 2020 and other relevant European standards and gives the necessary design information according to the Eurocodes. Since the regulations are not harmonised, the user is recommended to consider separately the relevant national regulations regarding the intended use.

2 Other standards and instructions

The following European standards also have relevance for the use of LVL G by Stora Enso (any nationally determined parameters shall separately be considered):

EAD 130337-00-03.04	Glued Laminated LVL, EOTA, 2020
EN 335	Durability of wood and wood-based products - Use classes: Definitions, application to solid wood and wood-based products
EN 350	Durability of wood and wood-based products. Testing and classification of the durability to biological agents of wood and wood-based materials
EN 1995-1-1+A1+A2	Eurocode 5: Design of timber structures - Part 1-1: General - Common rules and rules for buildings
EN 1995-1-2	Eurocode 5: Design of timber structures - Part 1-2: General - Structural fire design
EN 1995-2	Eurocode 5: Design of timber structures - Part 2: Bridges
EN 14374	Timber structures – Structural laminated veneer lumber – Requirements
EN ISO 10456	Building materials and products. Hygrothermal properties - Tabulated design values and procedures for determining declared and design thermal values

PRODUCT INFORMATION

3 Product description, marking and quality control

Glued laminated LVL (GLVL) with the trade name LVL G by Stora Enso, is comprised of structural laminated veneer lumber (LVL) components bonded together with a glulam adhesive type EN 15425 I 90 GP 0,3 w according to EN 15425, at their flatwise surfaces. The softwood LVL components are manufactured according to EN 14374. The product LVL G S contains LVL S type components without crossband veneers and LVL G X contains LVL X type components with crossband veneers. The LVL component surfaces to be bonded are grinded and shall always have essentially the same grain direction. The products can be used edgewise and flatwise.

The material values, dimensions and tolerances are given in Annex A.

LVL G by Stora Enso is intended to be used as structural or non-structural elements in buildings and bridges.

The product has a uniform thickness. Edgewise loaded members may be straight, single or double tapered as presented in Figure 2. The maximum size ($b \times h \times L$) of the LVL G products are:

- 600 mm x 2 500 mm x 19 900 mm (beams, columns and slab elements): Type L (LVL G LS or LVL G LX)
- 600 mm x 19 900 x 3 200 mm (wall elements): Type C (LVL G CX). When the width h is larger than 2500mm, the product has butt joints in the edges of the LVL lamellas, see Figure 6.

Any treatment of the finalized products against biological attack or fire is outside of the scope of this certificate. Such treatments may be used provided that they do not have adverse effect on the performances of the products.

Holes in the LVL G are not subject of the product certificate. Holes in LVL G edgewise beams are allowed and defined as a part of works.

Marking

The LVL G by Stora Enso products covered by this Certificate are marked with the Eurofins product certificate marking.

Manufacture

LVL G by Stora Enso is manufactured of LVL and PU-adhesive in a vacuum press. Gluing of LVL G by Stora Enso shall be performed according to the certificate holder's instructions assessed by Eurofins Expert Services Oy. Gluing pressure in press as specified in detail in the instructions of the certificate holder. End or edge jointed products are not covered within this certificate. When the instructions are updated, Eurofins Expert Services Oy shall be informed about the changes before they are introduced.

Quality control

The manufacture of LVL G by Stora Enso products is covered by a certified quality system ISO 9001 at the Varkaus mill. The factory production control is regular and comprises the control of equipment, raw and incoming materials, production processes and finished products.

External quality control is carried out according to the contract on quality control / contract on certification between the manufacturer and Eurofins Expert Services Oy.

Assessment and verification of constancy of performance shall focus on glue bond quality that is provision for the performances given in this certificate.

The manufacturer has instructions for manufacturing and factory production control for the manufacturing method. Integrity of the glue bond shall be tested, as specified in the instructions, with a shear test and cleavage test at least in type testing of the product.

Under continuous production, Eurofins Expert Services Oy shall visit the factory twice a year. Products may not be manufactured continuously. Only one yearly inspection visit may be carried out in case of production stop longer than half a year.

4 Delivery and storage on site

It is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport, storage, maintenance, replacement and repair of the product as he considers necessary.

LVL G by Stora Enso shall be protected against harmful wetting during transport and storage. LVL G by Stora Enso must not be lifted or stored in such a way that excessive deformation may cause damage to them.

Before the installation it shall be controlled that LVL G by Stora Enso members are not damaged during transport or storage. Damaged LVL G by Stora Enso shall be replaced by same ones. If there is a need to modify or repair the construction this may be done, if the installation plan mentioned under Clause 6 still can be followed.

DESIGN INFORMATION

5 General

The design information given in this certificate is based on the assumption that the structural solutions, fastening methods and other initial data are accordant to this certificate and the given requirements, instructions and standards are followed.

For each individual building project, a specific structural design shall be made according to the instructions of the certificate holder by a person responsible for the task according to the national laws of the country where the product is used.

Products are individually planned by somebody else than the manufacturer, who only makes the product according to the specification and does not take responsibility for the design or the products are individually planned by the manufacturer, who takes responsibility for the design.

LVL G by Stora Enso is intended to be used as a structural element for load-bearing applications in buildings and civil engineering structures. Product types presented in Annex A, Figure 1. Products are mainly used as beams and columns. Multiple glued LVL G panels can be used as wall and slab (slabs supported at two opposite ends) elements.

The products may be subject to prolonged exposure to temperatures up to 60°C . This certificate does not cover LVL G by Stora Enso subjected to fatigue loads.

With regard to moisture behaviour of the product, LVL G by Stora Enso is intended to be used in service class 1 and 2 according to EN 1995-1-1. If the products are intended to be a part of the external envelope of the building, they shall be protected adequately, e.g. by a roof or by cladding.

The product is only intended to be used subject to static or quasi-static actions. It is intended to be used in seismic areas. The behavior factor of LVL G is limited to non-dissipative or low-dissipative structures ($q \leq 1,5$), defined according to Eurocode 8 (EN 1998-1:2004 clauses 1.5.2 and 8.1.3 b)

The provisions made in certificate are based on an assumed intended working life of LVL G by Stora Enso of 50 years when installed in the works, provided that the LVL G components are subjected to appropriate installation, use and maintenance. These provisions are based upon the current state of the art and the available knowledge and experience¹. The indications given as to the working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor Eurofins Expert Services Oy, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

6 Installation

LVL G by Stora Enso shall be installed by appropriately qualified personnel, following the manufacturer's instructions and installation plan for each project. The product shall be protected against moisture. The completed building (the works) shall comply with the building regulations (regulations on the works) applicable in the country in which the building is to be constructed. The procedures foreseen in the country for demonstrating compliance with the building regulations shall also be followed by the entity held responsible for this act. The certificate for LVL G by Stora Enso does not amend this process in any way.

7 Structural performance

Mechanical resistance and stability

The LVL G by Stora Enso products are manufactured according to an individual design or delivered as standard products. In case of individual production, the design can be made on a case by case basis by the manufacturer or by a third party according to the design instructions of the manufacturer. The manufacturer declares the performance of the product by referring to geometry and material properties of the product. Strength and stiffness values of LVL G by Stora Enso to be used in design together with information of the dimensions of the products are given in Annex A.

The structural performance of LVL G by Stora Enso is considered in accordance with the limit state design principles specified in Eurocodes. Both ultimate limit state and serviceability limit state are considered. Calculation methods follow EN 1995-1-1. Methods are described in Stora Enso design manual for the product.

Eurofins Expert Services has assessed the design instructions of the manufacturer. In case of updating, the new versions shall be assessed by Eurofins Expert Services Oy.

¹ The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than referred to above.

Creep and duration of load

In calculation of the final deflection, creep is taken into account according to EN 1995-1-1. The following deformation factors k_{def} shall be used:

Table 1: Values of the deformation factor k_{def} .

LVL G S LVL G X edgewise		LVL G X flatwise	
Service class 1	Service class 2	Service class 1	Service class 2
0,60	0,80	0,80	1,00

Effects of duration of load are taken into account according to EN 1995-1-1. The following k_{mod} values apply in service classes 1 and 2 for both LVL G S and LVL G X products:

Table 2: Strength modification factor k_{mod} .

Permanent load	Long term load	Medium term load	Short term load	Instantaneous load
0,60	0,70	0,80	0,90	1,10

Dimensional stability

Tolerances of dimensions of LVL G by Stora Enso are given in Annex A.

Bonding quality

The bonding quality between the LVL components is equally strong as for primary LVL. Cleavage test according to EN 14374, Annex B: Pass, wood failure percentage $\geq 80\%$

Drill core shear tests according to EN14080, Annex D:

Glue line thickness $t_{glueline} \leq 0,3\text{mm}$

Shear strength $f_{v,k} \geq 3,8 \text{ N/mm}^2$ or $\geq 3,4 \text{ N/mm}^2$, when wood failure percentage is $\geq 80\%$

Density

Characteristic density ρ_k of LVL G by Stora Enso is 480 kg/m^3

8 Performance in relation to moisture

Cross sections of LVL G components are in general symmetrical or almost symmetrical thus minimizing any effects of moisture changes to overall shape of the cross section. No distortion of the cross sections is expected in normal use conditions.

Effect of varying moisture content to the nominal dimensions is normally negligible and within the tolerances given, so harmful deformations due to moisture changes of the LVL G by Stora Enso are not expected. When necessary, the dimensional change ΔL of the product due to change of moisture content can be calculated as follows:

$$\Delta L = \Delta\omega \cdot \alpha_H \cdot L$$

where $\Delta\omega$ is change of moisture content [%] from the equilibrium moisture content, α_H dimensional variation coefficient and L dimension [mm]. The dimensional variation coefficients for swelling and shrinkage are presented in Table 3. Table 3 Table 3. Dimensional variation coefficients

	LVL G S	LVL G X
Thickness	0.0030	0.0044
Width	0.0031	0.00033
Length	0.0001	0.0001

9 Performance in case of fire

Reaction to fire

Untreated LVL G by Stora Enso is classified to have reaction to fire class D-s1, d0. This classification is valid for the following end use applications:

- Free standing structure
- With or without an air gap between the product and a wood based product or any substrate of classes A1 and A2-s1,d0 with density of at least 337,5 kg/m³

Resistance to fire

For resistance to fire, load-bearing performance (class R) can be determined in accordance with EN 1995-1-2:2004 as a part of design of works. According to EN 1995-1-2:2004, table 3.1, for LVL with characteristic density $\rho_k \geq 480 \text{ kg/m}^3$ under standard fire exposure, the one dimensional design charring rate β_0 is 0,65 mm/min and notional design charring rate β_n is 0,70 mm/min.

The charring rates shall be used in the simplified bilinear model of clause 3.4.3 (Surface of beams and columns initially protected from fire exposure) of EN 1995-1-2:2004 including the tabulated multiplication factors of the clause to determine the charring depth according to time requirements, considering clause 4.2.2 (Residual cross section method) of EN 1995-1-2:2004. For the application of the simplified bilinear method, it should be highlighted that the fire exposed lamella shall be considered as a protective cladding of the subsequent lamella. Analogously, this procedure also applies to beams, columns, walls and floors/roofs.

10 Thermal insulation performance

Thermal resistance

The thermal conductivity λ for LVL G material is 0.13 W/(m K) according to EN ISO 10456. The natural density variation of the materials is taken into account in this value.

Thermal inertia

The thermal inertia, specific heat capacity c_p for LVL G material is 1600 J/(kg K) according to EN ISO 10456. The natural density variation of the materials is taken into account in this value.

11 Durability

Depending on use conditions building products are exposed to different types of environments with humidity and temperature variations. These environments have effect on the durability of the product.

The biological durability of LVL G by Stora Enso is DC5 (not durable) based on spruce sapwood classification according to EN 350. Therefore, the use of LVL G by Stora Enso is limited in service classes 1 and 2 according to EN1995-1-1 or the corresponding use classes 1 and 2 of EN 335. The product may be exposed to the weather for a short time during installation provided that they are allowed to dry afterwards.

Durability may be reduced by attack from insects such as long horn beetle, dry wood termites and anobium in regions where these may be found.

When necessary and required by the local authorities, LVL G by Stora Enso may be treated against biological attack according to the rules valid within the region. Any adverse effects of the treatment on other properties shall be taken into account. These kinds of treatments are not covered by this certificate.

12 Environmental aspects

Dangerous substances

The formaldehyde release class of the LVL components used in LVL G by Stora Enso is E1 in accordance with EN 14374. The product does not contain pentachlorophenol, or recycled wood. LVL

products by Stora Enso have formaldehyde releases less than E1 class requirement 0,10 ppm when determined in accordance with EN 717-1.

The manufacturer has not declared that the LVL G by Stora Enso would contain other dangerous substances.

In addition to the specific clauses relating to dangerous substances contained in this certificate, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Regulation, these requirements need to also be complied with, when and where they apply.

INSTRUCTIONS FOR INSTALLATION AND USE

13 Manufacturer's instructions

Manufacturer's structural design guide for LVL G by Stora Enso shall be followed in the design.

TECHNICAL SURVEY

14 Initial assessment

Eurofins Expert Services Oy has performed evaluation based on manufacturer's documentation, test results and calculations. Technical properties of materials and building parts are presented in clause 7 and in Annex A.

As a result of this assessment Eurofins Expert Services Ltd confirms that the glue bond quality of the multiple glued laminated veneer lumber products fulfils the requirements given in the certification criteria Sert R084. This certificate is valid only for products that are used in service class 1 or 2, manufactured of laminated veneer lumber and PU-adhesives in a vacuum press.

VALIDITY OF THE CERTIFICATE

15 Validity period of the certificate

This certificate is valid until September 7, 2025

The validity of the certificate will be ended, if the product falls into the scope of CE-marking.

The validity of the certificate may be confirmed at Eurofins Expert Services Oy web pages.

16 Conditions of validity

The certificate is valid assuming that no fundamental changes are made to the product, and that the manufacturer has a valid contract on quality control / certification.

17 Other conditions

The references made in this certificate to standards and instructions are valid in the format used at the time the certificate was signed.

The recommendations in this certificate concerning the safe use of this product are minimum requirements that shall be satisfied when using the product. The certificate does not override current or future requirements imposed by laws and statutes. In addition to the issues presented in this certificate, design, manufacturing and use shall follow appropriate construction methods.

The manufacturer is in charge of the product's quality and factory production control. In awarding this certificate, Eurofins Expert Services Oy does not bind itself to indemnification liability concerning personal injury or other damage that may directly or indirectly result from using the product described in this certificate.

This updated certificate EUFI29-20000564-C (issued first on September 7, 2020) has been granted as described above to LVL G by Stora Enso.

On behalf of Eurofins Expert Services Oy on January 21, 2020

Tiina Ala-Outinen
Manager, Certification and Inspection

Jouni Hakkarainen
Leading Expert

This document has been signed electronically

APPENDIX A: DESCRIPTION OF LVL G BY STORA ENSO

1. Cross sections and sizes

1.1. Beam and column elements, Type L (LVL G LS or LVL G LX)

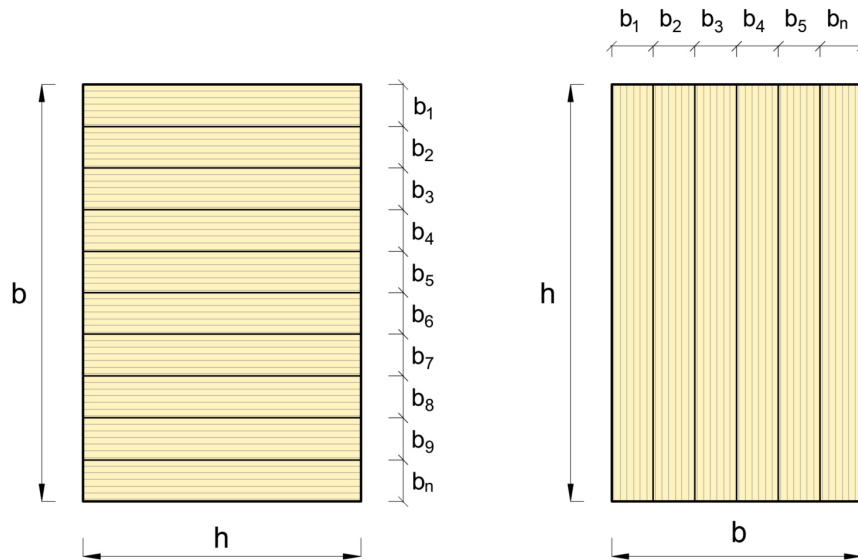


Figure 1: Beam and column cross sections of LVL G by Stora Enso (Flatwise and edgewise use) type L.

Overall width / depth h	$\leq 2\,500\text{mm}$
Thickness / width b	$60 - 600\text{ mm}$
Length L	$\leq 19\,900\text{ mm}$

When the product is used under edgewise loading, the product may have uniform height, or they may be single or double tapered.

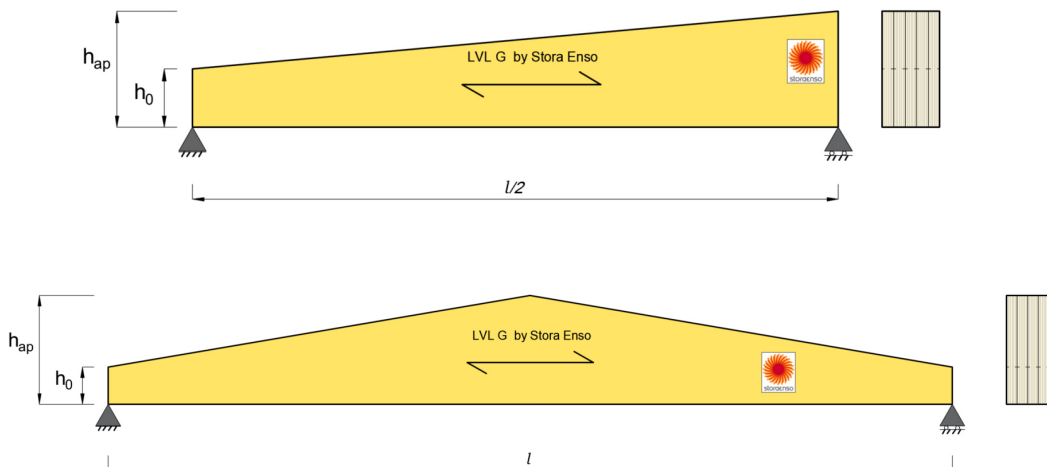


Figure 2: Single and double tapered LVL G beams by Stora Enso.

1.2. Slab elements, Type L_(LVL G LS or LVL G LX)

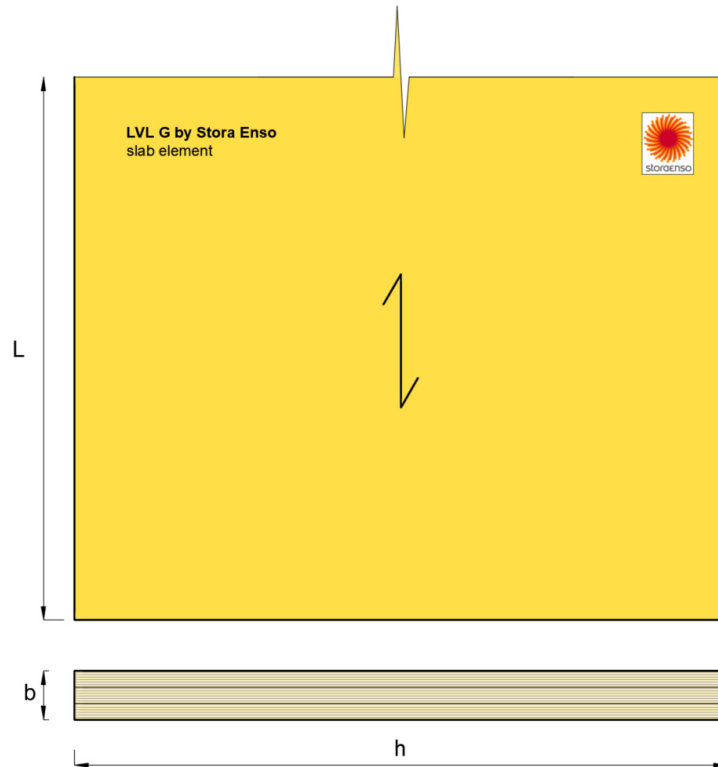


Figure 3: Slab cross section of LVL G by Stora Enso type L.

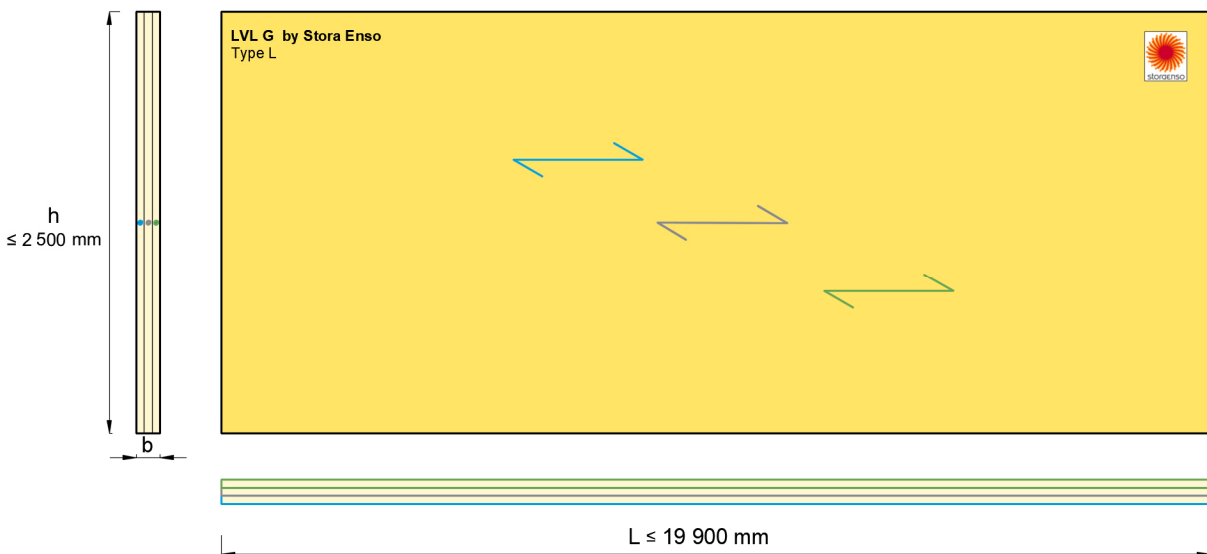


Figure 4: Example of LVL G slab type L - LVL layers. Colours: first outer layer (blue), inner layer (gray), second outer layer (green).

Width h ≤ 2 500mm

Thickness b 60 – 600 mm

Length L ≤ 19 900 mm

1.3. Wall elements, Type C (LVL G CX)

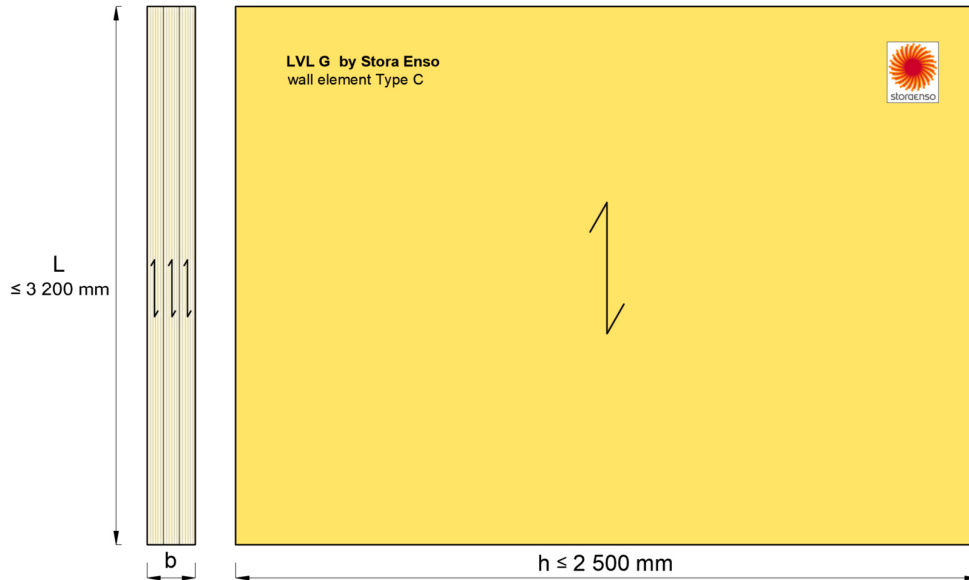


Figure 5: Wall cross section of LVL G by Stora Enso type C, when $h \leq 2500\text{mm}$.

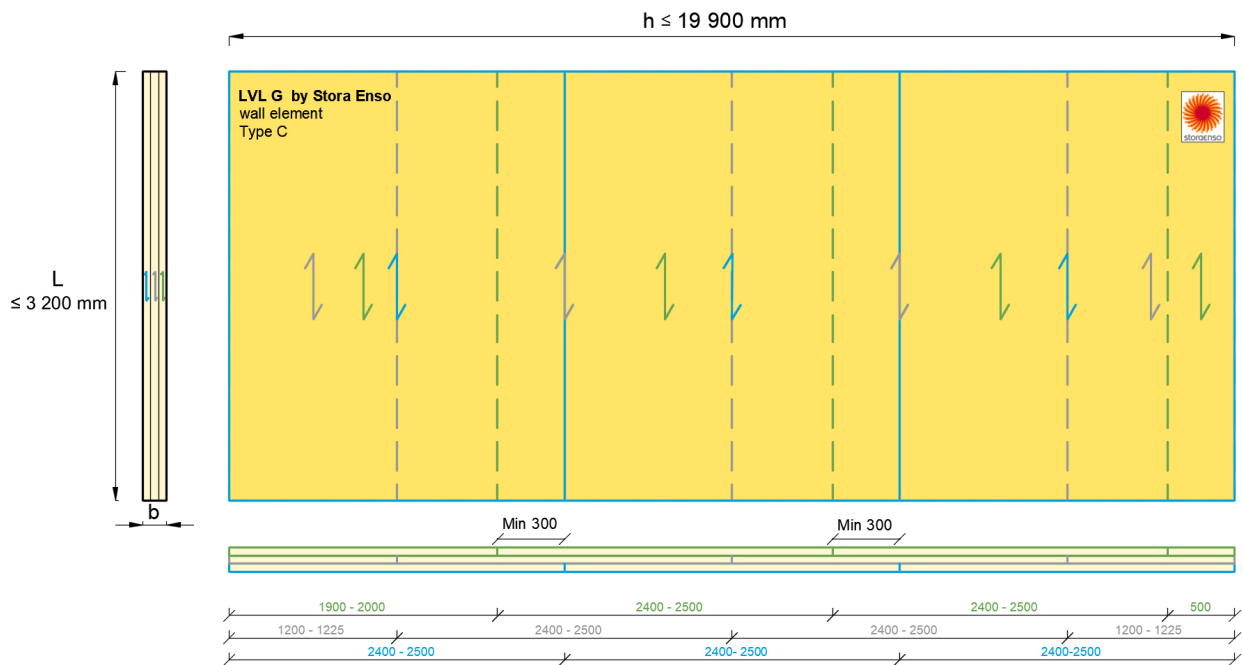


Figure 6: Example of LVL G by Stora Enso wall type C - LVL layers have a minimum 300mm overlapping in the lay ups. Colours: first outer layer (blue), inner layer (gray), second outer layer (green). The product has butt joints at the edges of the LVL lamellas.

Overall height L	$\leq 3\,200\text{ mm}$
Thickness b	60 – 600 mm
Width h	$\leq 19\,900\text{ mm}$

2. Tolerances of dimensions

Tolerances of LVL G by Stora Enso of dimensions at the reference moisture content of $10 \pm 2\%$ are presented in Table 5.

Table 4. Tolerances of LVL G by Stora Enso

Dimension		Size, mm	Tolerance, mm or %
Overall depth	h	< 400	± 2 mm
		≥ 400	$\pm 0,5$ %
Overall width or thickness	b	All	± 3 mm
Overall length	L	All	± 5 mm

Table 5. Standard dimensions of Stora Enso LVL G beams and columns

b [mm]	Calibrated lamella thicknesses [mm]										Height / width [mm]																		
	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_8	b_9	b_{10}	h																		
72	72										200	240	260	300	350	400	450	500	600										
84	42	42									200	240	260	300	350	400	450	500	600										
90	30	30	30								200	240	260	300	350	400	450	500	600										
96	48	48									200	240	260	300	350	400	450	500	600										
108	36	36	36								200	240	260	300	350	400	450	500	600										
120	60	60									200	240	260	300	350	400	450	500	600										
126	42	42	42								200	240	260	300	350	400	450	500	600										
144	48	48	48								200	240	260	300	350	400	450	500	600										
150	30	30	30	30	30						200	240	260	300	350	400	450	500	600										
168	42	42	42	42						200	240	260	300	350	400	450	500	600											
180	60	60	60								200	240	260	300	350	400	450	500	600										
192	48	48	48	48						200	240	260	300	350	400	450	500	600											
210	42	42	42	42	42	42					200	240	260	300	350	400	450	500	600										
216	36	36	36	36	36	36	36				200	240	260	300	350	400	450	500	600										
240	60	60	60	60								200	240	260	300	350	400	450	500	600									
252	42	42	42	42	42	42	42				200	240	260	300	350	400	450	500	600										
270	30	30	30	30	30	30	30	30	30	30						200	240	260	300	350	400	450	500	600					
288	48	48	48	48	48	48	48					200	240	260	300	350	400	450	500	600									
294	42	42	42	42	42	42	42	42			200	240	260	300	350	400	450	500	600										
300	60	60	60	60	60								200	240	260	300	350	400	450	500	600								
324	36	36	36	36	36	36	36	36	36	36	36					200	240	260	300	350	400	450	500	600					
336	48	48	48	48	48	48	48	48				200	240	260	300	350	400	450	500	600									
360	60	60	60	60	60	60						200	240	260	300	350	400	450	500	600									
378	42	42	42	42	42	42	42	42	42	42					200	240	260	300	350	400	450	500	600						
384	48	48	48	48	48	48	48	48	48				200	240	260	300	350	400	450	500	600								
420	60	60	60	60	60	60	60	60					200	240	260	300	350	400	450	500	600								
432	48	48	48	48	48	48	48	48	48	48					200	240	260	300	350	400	450	500	600						
480	60	60	60	60	60	60	60	60	60						200	240	260	300	350	400	450	500	600						
540	60	60	60	60	60	60	60	60	60	60						200	240	260	300	350	400	450	500	600					
600	60	60	60	60	60	60	60	60	60	60	60						200	240	260	300	350	400	450	500	600				

For panels used as slab elements, the width “ h ” ranges up to 2500mm.

3. Specifications of components

The LVL S and LVL X components (lamella) of LVL G by Stora Enso are produced by Stora Enso mill. Their material properties comply with EN 14374. Nominal unsanded thickness of the lamella are 24 – 69mm and they are calibrated to max. 3mm smaller nominal sanded thickness (1.5mm sanding per side). Number of lamellas are 2 - 10. The width of the lamella is the full depth h of the LVL G product.

The adhesive used in manufacturing of LVL G by Stora Enso of type EN15425 I 90 GP 0,3 w (full exposure to the weather) as defined in EN15425. The adhesive used is approved for gluing of load-bearing structures and suitable for gluing of LVL.

4. Moisture content

When manufactured, the moisture content of the components is below the equilibrium value in use conditions. Due to changing temperature and relative humidity of the surrounding air the moisture content of LVL G by Stora Enso will continuously change.

5. Mechanical properties

Table 6. The characteristic values of LVL G by Stora Enso to be used in the design according to EN1995-1-1.

Property	Reference in Figure 7	Symbol	LVL G S	LVL G X
			N/mm ² or kg/m ³	N/mm ² or kg/m ³
			Thickness 60 - 600 mm	Thickness 60 - 600 mm
Bending strength:				
Edgewise (reference depth 300 mm)	A	$f_{m,0,edge,k}$	44	32
Size effect parameter	A	$S_{m,edgewise}$	0,12	0,12
Flatwise (reference depth 90mm)	A'	$f_{m,90,edge,k}$	-	8,0 ^a
	B	$f_{m,0,flat,k}$	45	31
	B	$S_{m,flatwise}$	0,11	0,13
	C	$f_{m,90,flat,k}$	-	8,0 ^a
Tension strength:				
Parallel to grain (length 3000 mm)	D	$f_{t,0,k}$	35	26
Perpendicular to grain, edgewise	E	$f_{t,90,edge,k}$	0,8	6,0 ^a
Perpendicular to grain, flatwise	F	$f_{t,90,flat,k}$	0,2	-
Compression strength:				
Parallel to grain in service class 1	G	$f_{c,0,k,SC1}$	35	26
Parallel to grain in service class 2	G	$f_{c,0,k,SC2}$	29	21
Perpendicular to grain, edgewise	H	$f_{c,90,edge,k}$	6,0	9,0
Perpendicular to grain, flatwise	I	$f_{c,90,flat,k}$	2,2	2,2
Shear strength:				
Edgewise	J	$f_{v,edge,k}$	4,2	4,5 ^a
Flatwise, parallel to grain (reference depth 90mm)	K	$f_{v,0,flat,k}$	2,3	1,3 ^a
	K	$S_{v,flatwise}$	-	0,13
Flatwise, perpendicular to grain	L	$f_{v,90,flat,k}$	-	0,6 ^a
Modulus of elasticity:				
Parallel to grain, along, (mean)	A, D, G	$E_{0,mean}$	13800	10500
Parallel to grain, along, (5%-fractile)	A, D, G	$E_{0,k}$	11600	8800
Bending parallel to grain, flatwise (mean)	B	$E_{0,flatwise,mean}$	12400	10100
Bending parallel to grain, flatwise (5% fractile)	B	$E_{0,flatwise,k}$	11200	8800
Perpendicular to grain, edgewise (mean)	H	$E_{90,edge,mean}$	-	2400
Perpendicular to grain, edgewise (5%-fractile)	H	$E_{90,edge,k}$	-	2000
Bending perpendicular to grain, edgewise (mean)	A'	$E_{90,edgewise,mean}$	-	2400
Bending perpendicular to grain, edgewise(5% fractile)	A'	$E_{90,edgewise,k}$	-	1800
Bending perpendicular to grain, flatwise (mean)	C	$E_{90,flatwise,mean}$	-	2000
Bending perpendicular to grain, flatwise (5%-fractile)	C	$E_{90,flatwise,k}$	-	1700
Shear modulus:				
Edgewise (mean)	J	$G_{edge,mean}$	600	600
Edgewise (5%-fractile)	J	$G_{edge,k}$	400	400
Flatwise, parallel to grain, (mean)	K	$G_{0,flat,mean}$	440	120
Flatwise, parallel to grain, (5%-fractile)	K	$G_{0,flat,k}$	380	100
Flatwise, perpendicular to grain, (mean)	L	$G_{90,flat,mean}$	-	22
Flatwise, perpendicular to grain, (5%-fractile)	L	$G_{90,flat,k}$	-	16
Density:				
Mean		ρ_{mean}	510	510
5%-fractile		ρ_k	480	480

^a see next page.

^a For product type C which has butt joints at the edges the LVL lamellas (see Figure 6), the flatwise bending resistance in perpendicular to grain, edgewise tension resistance in perpendicular to grain and shear resistance shall be calculated based on an effective thickness $b_{eff} = b \cdot (n-1) / n$, where n = number of lamella, when they have an equal thickness.

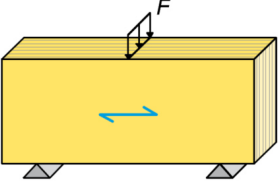
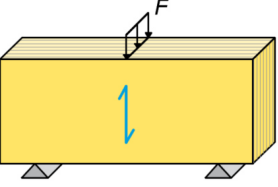
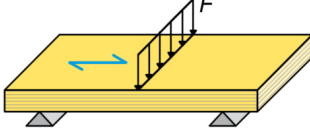
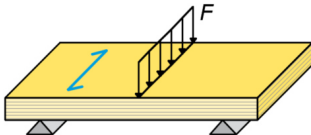
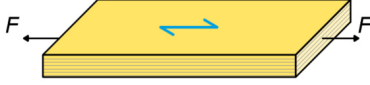
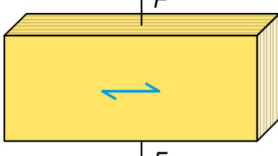
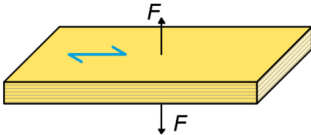

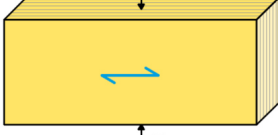
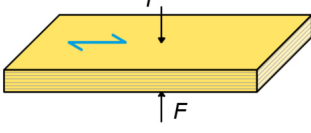
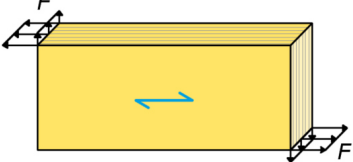
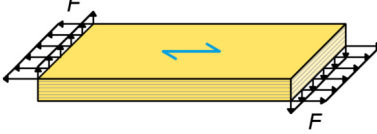
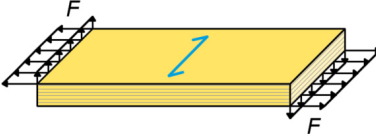

<p>A</p>  <p>Edgewise bending parallel to grain $f_{m,0,edge}$, $E_{m,0,edge}$</p>	<p>A'</p>  <p>Edgewise bending perpendicular to grain $f_{m,90,edge}$, $E_{m,90,edge}$</p>	<p>B</p>  <p>Flatwise bending parallel to grain $f_{m,0,flat}$, $s_{flat,m}$, $E_{m,0,flat}$</p>
<p>C</p>  <p>Flatwise bending perpendicular to grain $f_{m,90,flat}$ and $E_{m,90,flat}$</p>	<p>D</p>  <p>Tension parallel to grain $f_{t,0}$, $E_{t,0}$</p>	<p>E</p>  <p>Edgewise tension perpendicular to grain $f_{t,90,edge}$</p>
<p>F</p>  <p>Flatwise tension perpendicular to grain $f_{t,90,flat}$</p>	<p>G</p>  <p>Compression parallel to grain $f_{c,0}$, $E_{c,0}$</p>	<p>H</p>  <p>Edgewise compression perpendicular to grain $f_{c,90,edge}$, $E_{c,90,edge}$</p>
<p>I</p>  <p>Flatwise compression perpendicular to grain $f_{c,90,flat}$, $E_{c,90,flat}$</p>	<p>J</p>  <p>Edgewise shear parallel to grain $f_{v,edge}$, G_{edge}</p>	<p>K</p>  <p>Flatwise shear parallel to grain $f_{v,0,flat}$, $s_{flat,v}$, $G_{0,flat}$</p>
<p>L</p>  <p>Flatwise shear perpendicular to grain $f_{v,90,flat}$, $G_{90,flat}$</p>	<p>LVL by Stora Enso</p> <p>Symbols for strengths, moduli of elasticity and shear moduli in different directions of LVL</p>  <p>storaenso</p>	

Figure 7: Definitions and symbols of the strength and stiffness properties in different directions of the product.

The characteristic strength values are given at an equilibrium moisture content resulting from a temperature of 20 °C and a relative humidity of 65 % exposed to duration of load of 5 minutes. The characteristic values given in Table 4 can be used without any modifications for temperatures below or equal to 50 °C for a prolonged period of time.

Furthermore, the effect of member size needs to be taken into account for edgewise and flatwise bending strength and tension strength LVL G S and LVL G X as well as the flatwise shear strength of LVL G X. The reference depth of the beam h in edgewise bending is 300mm and reference thickness in flatwise bending is 90mm. The reference length l in tensile parallel to grain is 3000 mm and the reference thickness in flatwise shear is 90mm. The s -values for each property are given in Table 7. The general equation of a strength property taking into account the effect of the member size is:

$$f_i(x) = f_i(x_0) \left(\frac{x_0}{x} \right)^{s_i} \quad (1)$$

For the sake of clarity the characteristic strength properties taking into account the effect of member size are given as the equations below:

LVL G S:

$$f_{m,0,edgewise,k}(h) = 44 \frac{N}{mm^2} \cdot \min \left[1, 2; \left(\frac{300mm}{h} \right)^{0,12} \right] \quad (2)$$

$$f_{m,0,flatwise,k}(b) = 45 \frac{N}{mm^2} \cdot \left(\frac{90mm}{b} \right)^{0,11}, \text{ when } b > 75mm \quad (3)$$

$$f_{t,0,k}(l) = 35 \frac{N}{mm^2} \cdot \min \left[1, 1; \left(\frac{3000mm}{l} \right)^{0,06} \right] \quad (4)$$

LVL G X:

$$f_{m,0,edgewise,k}(h) = 32 \frac{N}{mm^2} \cdot \min \left[1, 2; \left(\frac{300mm}{h} \right)^{0,12} \right] \quad (5)$$

$$f_{m,0,flatwise,k}(b) = 31 \frac{N}{mm^2} \cdot \left(\frac{90mm}{b} \right)^{0,13}, \text{ when } b > 75mm \quad (6)$$

$$f_{t,0,k}(l) = 26 \frac{N}{mm^2} \cdot \min \left[1, 1; \left(\frac{3000mm}{l} \right)^{0,06} \right] \quad (7)$$

$$f_{v,0,flatwise,k}(b) = 1,3 \frac{N}{mm^2} \cdot \min \left[1; \left(\frac{90mm}{b} \right)^{0,13} \right] \quad (8)$$

The modification factors k_{mod} and k_{def} for LVL, as defined in Eurocode 5, shall be used in the design of LVL G by Stora Enso, see clause 3.1.2. Partial safety factor γ_m of LVL is defined in National Annex of 1995-1-1.

Since the dimensions of LVL G by Stora Enso remain quite stable during temperature changes, it is not usually necessary to consider any effects of temperature variations on the structural design.

6. Other instructions

Connections of LVL G by Stora Enso are designed as a part of works. The information in chapter 5 of the European LVL Handbook (Finnish Woodworking Industries, 2019) and structural design manual of LVL G by Stora Enso, may be used for the design.

Holes in LVL G edgewise beams are designed as a part of works. The information in chapter 4.3.12 of the European LVL Handbook (Finnish Woodworking Industries, 2019) and structural design manual of LVL G by Stora Enso may be used for the design.