



European Technical Assessment **ETA 20/0291** of 11/1/2021

I General Part

| | |
|--|--|
| Technical Assessment Body issuing the ETA | Eurofins Expert Services Oy |
| Trade name of the construction product | LVL G by Stora Enso |
| Product family to which the construction product belongs | 13 Structural timber products / elements and ancillaries 03.04 Wood based Glued laminated LVL (GLVL) |
| Manufacturer | Stora Enso Wood Products Oy Kanavaranta 1 FI-00160 Helsinki |
| Manufacturing plant | Annex N |
| This European Technical Assessment contains | 17 pages including 1 Annex which form an integral part of this assessment |
| This European Technical Assessment is issued in accordance with regulation (EU) No 305/2011, on the basis of | EAD 130337-00-0304, Glued laminated LVL (GLVL) |
| This European Technical Assessment replaces | European Technical Assessment ETA-20/0291 of 19.5.2020 |

Translations of this European Technical Assessment in other languages shall fully correspond to the original issued document and should be identified as such.

Communication of this European Technical Assessment, including transmission by electronic means, shall be in full excepted the confidential Annex(es) referred to above. However, partial reproduction may be made, with the written consent of the issuing Technical Assessment Body. Any partial reproduction has to be identified as such.

This European Technical Assessment may be withdrawn by the issuing Technical Assessment Body, pursuant to information by the Commission according to Article 25 Paragraph 3 of Regulation (EU) No 305/2011.

II Specific Part

1. Technical description of the product

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 1.

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

600 mm x 19 900 x 3 200 mm (wall elements): Type C. 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 ETA. 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 European technical assessment. Holes in LVL G edgewise beams are allowed and defined as a part of works.

2. Specification of the intended uses in accordance with the applicable EAD

2.1. Intended uses

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 1, Figure 1. Products are mainly used as beams and columns, in addition as bracing 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°C¹. This ETA does not cover LVL G by Stora Enso subjected to fatigue loads.

¹ EN 1995-1-1 does not cover the design of structures subject to prolonged exposure to temperatures over 60°C.

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)

2.1. Working life

The provisions made in this European Technical Assessment (ETA) 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 experience².

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 by EOTA when drafting this EAD nor by the Technical Assessment Body issuing an ETA, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

2.2. Design of works

For each individual building project, a specific structural design shall be made according to the instructions of the ETA holder by a person responsible for the task according to the laws *of the Member States (MS)*.

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.

2.3. Manufacturing

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

² 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.

2.4. 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 Member States in which the building is to be constructed. The procedures foreseen in the Member State for demonstrating compliance with the building regulations shall also be followed by the entity held responsible for this act. The ETA for LVL G by Stora Enso does not amend this process in any way.

2.5. Packaging, transport, storage, maintenance, replacement and repair

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 2.4 still can be followed.

3. Performance of the product and references to the methods used for its assessment

Table 1. Basic requirements for construction works and essential characteristics.

| Basic requirement and essential characteristics | Performance |
|--|--------------|
| BWR 1. Mechanical resistance and stability | |
| Mechanical resistance and stiffness | Clause 3.1.1 |
| Creep and duration of load | Clause 3.1.2 |
| Dimensional stability | Clause 3.1.3 |
| Bonding quality | Clause 3.1.4 |
| Density | Clause 3.1.5 |
| BWR 2. Safety in case of fire | |
| Reaction to fire | Clause 3.2.1 |
| Resistance to fire | Clause 3.2.2 |
| Façade fire performance | NPA |
| BWR 3. Hygiene, health and the environment | |
| Content, emission and/or release of dangerous substances | Clause 3.3.1 |
| BWR 6 Energy economy and heat retention | |
| Thermal resistance | Clause 3.4.1 |
| Thermal inertia | Clause 3.4.2 |
| Aspects of durability | |
| Durability against biological attack | Clause 3.5.1 |

3.1. Mechanical resistance and stability, BWR 1

3.1.1. Mechanical resistance and stiffness as well as serviceability

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 1.

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.

3.1.2. 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 2: 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 3: 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 |

3.1.3. Dimensional stability

Tolerances of dimensions of LVL G by Stora Enso are given in Annex 1.

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 4.

Table 4. Dimensional variation coefficients

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

3.1.4. 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 $t_{\text{glueline}} \leq 0,3\text{mm}$
- 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 $\geq 80\%$

3.1.1. Density

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

3.2. Safety in case of fire, BWR 2

3.2.1. 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 $337,5 \text{ kg/m}^3$

3.2.2. 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.³ 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 lamellas. Analogously, this procedure also applies to beams, columns, walls and floors/roofs.

3.3. Hygiene, health and environment, BWR 3

3.3.1. Content, emission and/or release of dangerous substances

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 European Technical Assessment, 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.

3.4. Energy economy and heat retention, BWR 6

3.4.1. 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.

3.4.2. 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.

³ Resistance to fire (class REI) for structures where LVL G by Stora Enso products are incorporated should be determined for the complete construction.

3.5. Aspects of durability

3.5.1. Durability against biological attack

The biological durability of LVL G by Stora Enso is DC5 (not durable) based on of spruce sapwood according to EN 350. Therefore, the use of LVL G 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 ETA.

4. Assessment and verification of constancy of performance (hereinafter AVCP) system applied, with reference to its legal base

According to the Decision 97/176/EC of the European Commission, the system of assessment and verification of constancy of performance (see Annex V to the regulation (EU) No 305/2011) is System 1.

5. Technical details necessary for the implementation of the AVCP system, as provided for in the applicable EAD

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

5.1. Tasks of the manufacturer

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.

5.2. Tasks of the notified body

Under continuous production, the notified body 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.

Issued in Espoo 11.1.2021
by Eurofins Expert Services Oy

Tiina Ala-Outinen
Manager, Certification and Inspection

Jouni Hakkarainen
Leading Expert

ANNEX 1
DESCRIPTION OF LVL G BY STORA ENSO

1. Cross sections and sizes

1.1. Beam and column elements, Type L

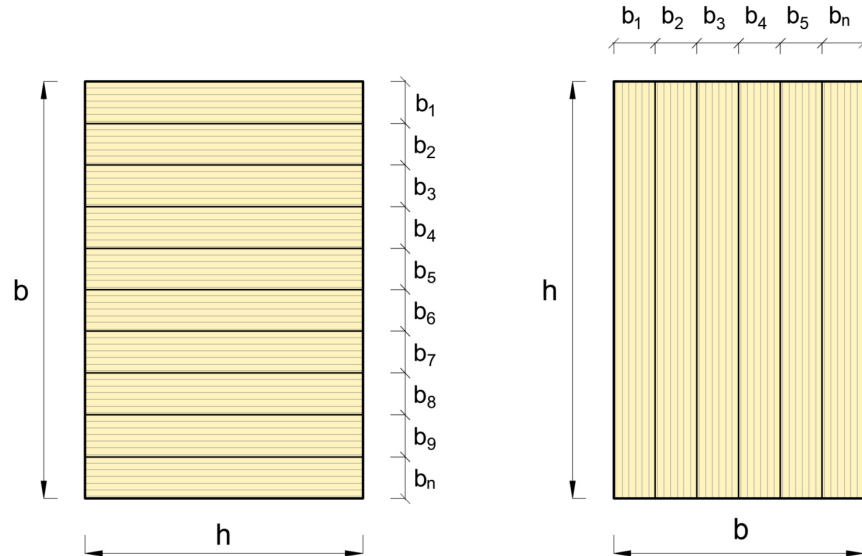


Figure 1: Beam and column cross sections of LVL G by Stora Enso (flatwise and edgewise use) type L.

| | |
|---------------------------|--------------------------|
| 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.

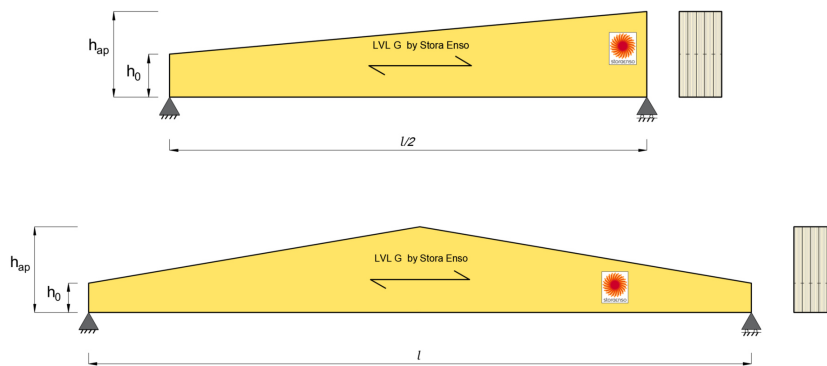


Figure 2: Single and double tapered LVL G beams by Stora Enso.

1.2. Slab elements, Type L

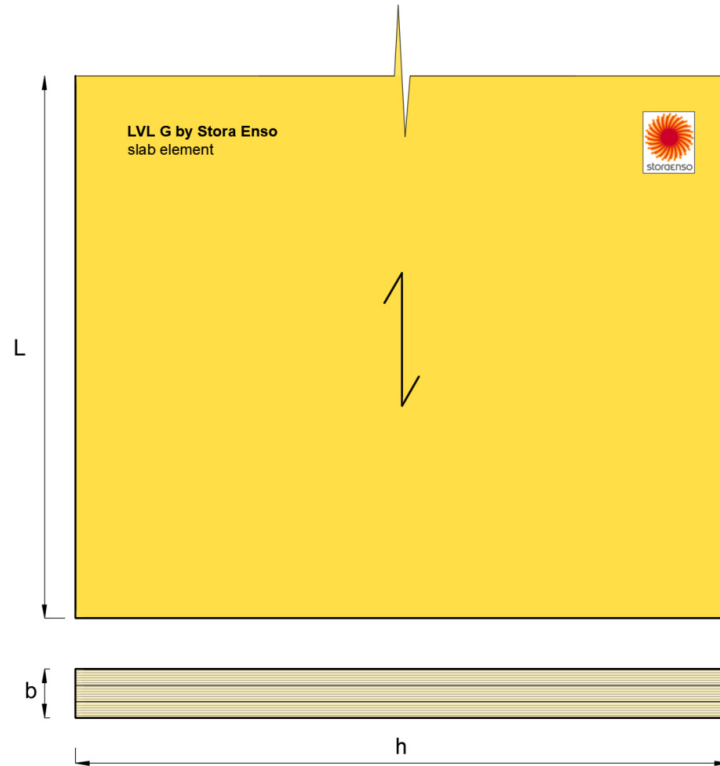


Figure 3: Slab cross section of LVL G by Stora Enso type L.

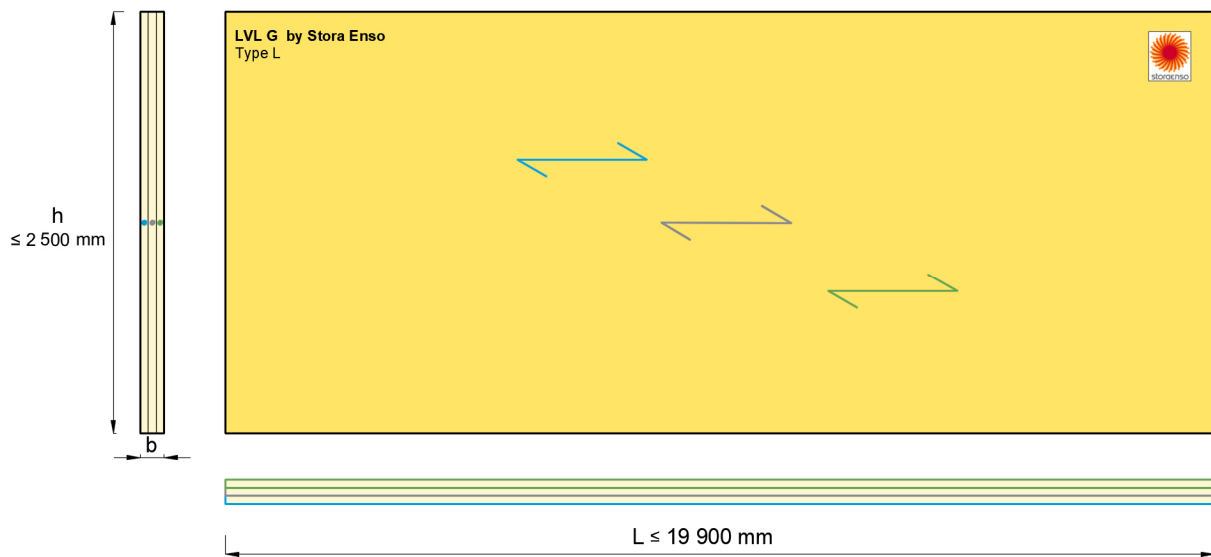


Figure 4: Example of LVL G slab type L - LVL layers. Colours: first outer layer (blue), inner layer (gray), second outer layer (green).

| | |
|---------------|--------------------------|
| Width h | $\leq 2\,500\text{ mm}$ |
| Thickness b | $60 - 600\text{ mm}$ |
| Length L | $\leq 19\,900\text{ mm}$ |

1.3. Wall elements, Type C

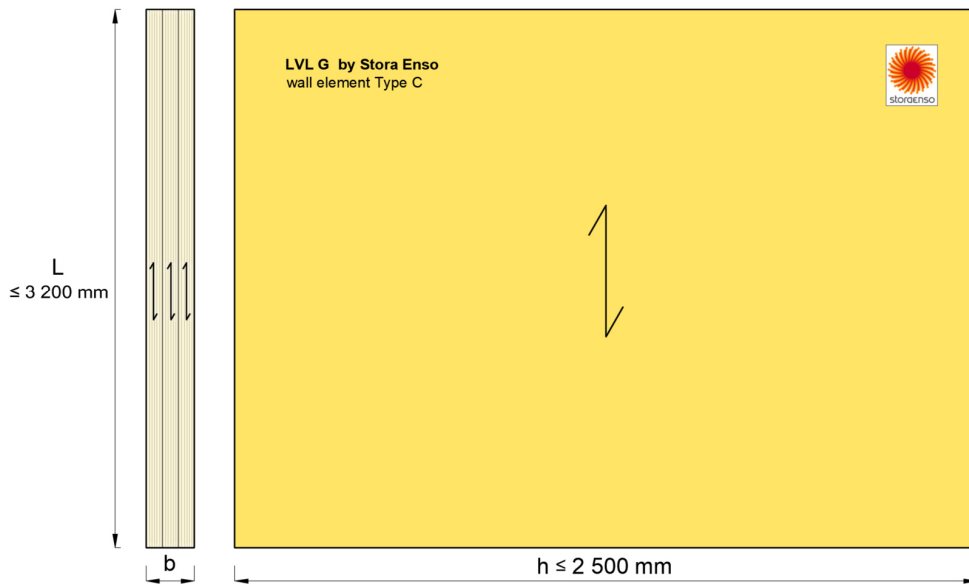


Figure 5: Wall cross section of LVL G by Stora Enso type C, when $h \leq 2500\text{mm}$.

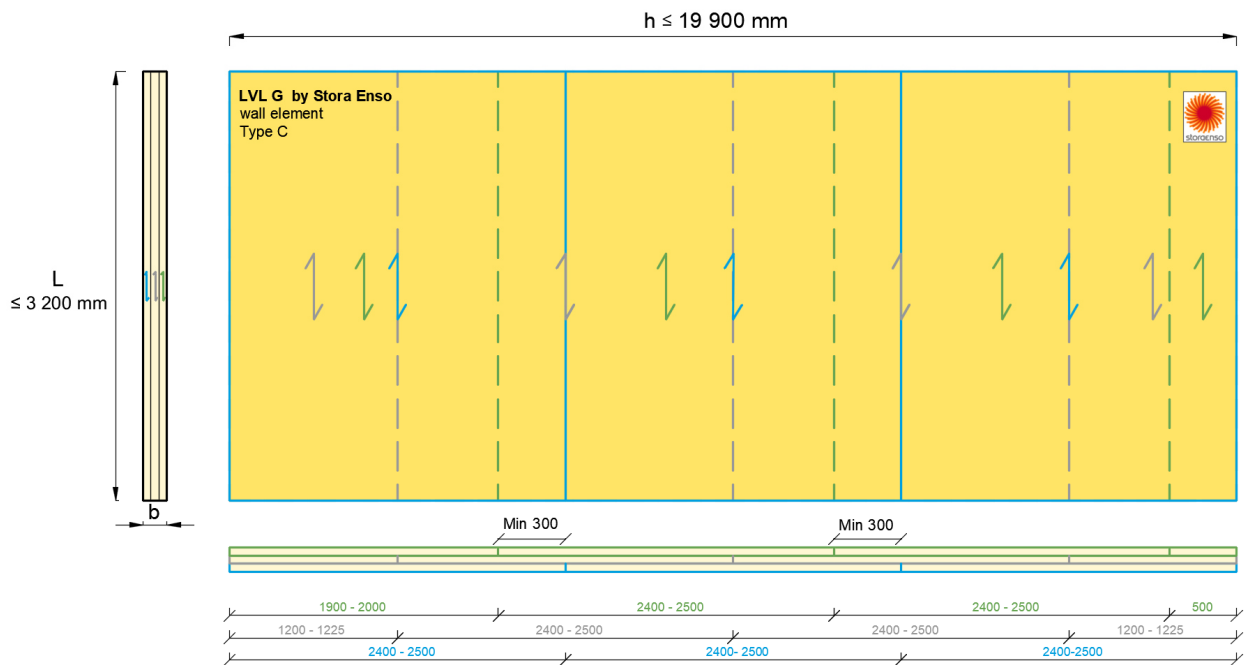


Figure 6: Example of LVL G by Stora Enso wall type C - LVL layers have a minimum 300mm overlapping in the lay ups. Colours: first outer layer (blue), inner layer (gray), second outer layer (green). The product has butt joints at the edges of the LVL lamellas.

| | |
|--------------------|--------------------------|
| 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 5. 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 6. 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 | | | | | 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 | | | | | 200 | 240 | 260 | 300 | 350 | 400 | 450 | 500 | 600 | | |
| 270 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | | | | | | | | | | | | |
| 288 | 48 | 48 | 48 | 48 | 48 | 48 | | | | | 200 | 240 | 260 | 300 | 350 | 400 | 450 | 500 | 600 | | |
| 294 | 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 | | | | | | | | | | | | |
| 336 | 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 | | | | | | | | | | | |
| 384 | 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 | | | | | 200 | 240 | 260 | 300 | 350 | 400 | 450 | 500 | 600 | |
| 432 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | | | | | | | | | | | |
| 480 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | | | | | | | | | | | | | |
| 540 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | | | | | | | | | | | | |
| 600 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | | | | | | | | | | | |

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

3. Specifications of components

The LVL S and LVL X components (lamellas) of LVL G by Stora Enso are produced by Stora Enso mill. Their material properties comply with EN 14374. Nominal unsanded thickness of the lamellas 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 lamellas 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 7. The characteristic values of LVL G S and LVL G X by Stora Enso to be used in the design according to EN1995-1-1.

| Property | Reference in Figure 7 | Symbol | LVL G S N/mm ² or kg/m ³ Thickness 60 - 600 mm | LVL G X N/mm ² or kg/m ³ 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 |
| | A' | $f_{m,90,edge,k}$ | - | 8,0 ^a |
| Flatwise (reference depth 90mm) | B | $f_{m,0,flat,k}$ | 45 | 31 |
| Size effect parameter | 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, flatwise, along (mean) | B | $E_{0,flatwise,mean}$ | 12400 | 10100 |
| Bending, flatwise, along (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, perp to grain, (mean) | L | $G_{90,flat,mean}$ | - | 22 |
| Flatwise, perp 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 of the LVL lamellas (see Figure 6), the edgewise and 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 $b_{\text{eff}} = b \cdot (n-1) / n$, where n = number of lamellas, when they have an equal thickness.

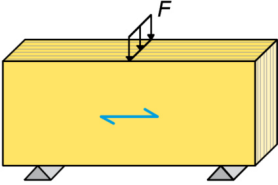
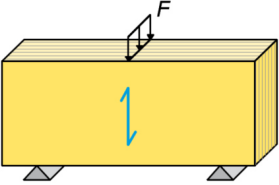
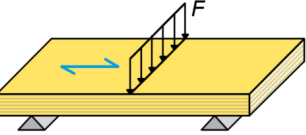
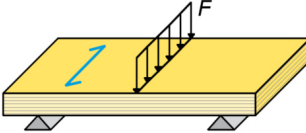

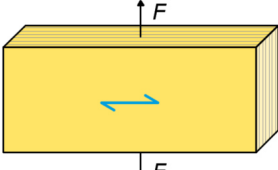
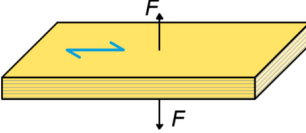
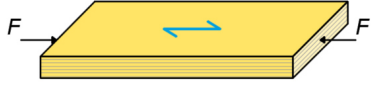
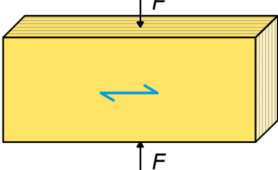
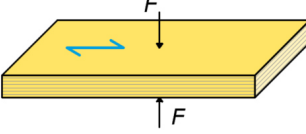
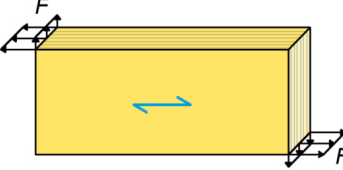
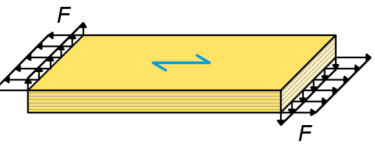
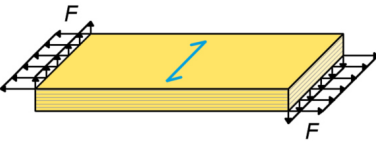

| | | |
|---|---|---|
| <p>A</p>  <p>Edgewise bending parallel to grain $f_{m,0,edge}$, $E_{m,0,edge}$</p> | <p>A'</p>  <p>Edgewise bending perpendicular to grain $f_{m,90,edge}$, $E_{m,90,edge}$</p> | <p>B</p>  <p>Flatwise bending parallel to grain $f_{m,0,flat}$, $s_{flat,m}$, $E_{m,0,flat}$</p> |
| <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 h_{ref} of the beam in edgewise bending is 300mm and reference thickness b_{ref} in flatwise bending is 90mm. The reference length l_{ref} in tension parallel to grain is 3000 mm. 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, 2020) 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, 2020) and structural design manual of LVL G by Stora Enso may be used for the design.