Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

Designated according to Article 29 of Regulation (EU) No 305/2011 and member of EOTA (European Organisation for Technical Assessment)

# European Technical Assessment

# ETA-23/0883 of 8 September 2025

English translation prepared by DIBt - Original version in German language

**General Part**

| | |
|---|---|
| Technical Assessment Body issuing the European Technical Assessment: | Deutsches Institut für Bautechnik |
| Trade name of the construction product | "STEICO GLVL" in the variants "STEICO GLVL R", "STEICO GLVL RS", "STEICO GLVL X" and "STEICO GLVL R/X" |
| Product family to which the construction product belongs | GLUED LAMINATED LVL |
| Manufacturer | STEICO SE<br>Otto-Lilienthal-Ring 30<br>85622 Feldkirchen<br>DEUTSCHLAND |
| Manufacturing plant | Manufacturing Plant 1,2 |
| This European Technical Assessment contains | 27 pages including 6 annexes 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 |

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## Specific part

### 1 Technical description of the product

Glued laminated elements made of LVL "STEICO GLVL" in the form of "STEICO GLVL R", "STEICO GLVL $R^S$", "STEICO GLVL X" and "STEICO GLVL R/X" from the company STEICO SE are elements which are made by structural gluing several LVL on their flatwise surfaces.

The comprised elements STEICO GLVL R" consist of a maximum of 34 prefabricated lamellae of the type "STEICO LVL R". The maximum size of "STEICO GLVL R" is: element height: H ≤ 400 mm; element width: B ≤ 1250 mm.

The comprised elements STEICO GLVL $R^S$" consist of a maximum of 34 prefabricated lamellae of the type "STEICO LVL $R^S$". The maximum size of "STEICO GLVL $R^S$" is: element height: H ≤ 400 mm; element width: B ≤ 1250 mm.

The comprised elements STEICO GLVL X" consist of a maximum of 12 prefabricated lamellae of the type "STEICO LVL X". The maximum size of "STEICO GLVL X" is: element height: H ≤ 400 mm; element width: B ≤ 400 mm.

The comprised elements STEICO GLVL R/X" consist of a maximum of 10 inner layers of "STEICO LVL R" and a maximum of 2 outer layers symmetrically on each side of "STEICO LVL X". The maximum size of "STEICO GLVL R/X" is: element height: H ≤ 400 mm; element width: B ≤ 400 mm.

The products "STEICO GLVL R" and "STEICO GLVL RS" only consist of veneer layers which are parallel oriented, the products "STEICO GLVL X" und "STEICO GLVL R/X" include some components with crossband veneers.

The laminated veneer lumber are made of spruce or pine or a mixture of those. They are laminated among each other on grinded or planed surfaces which have essentially the same direction of the grain. The products have a constant thickness.

The laminated veneer lumber used and the dimensions of the products are given in Annex 1.

The components, LVL and adhesives, comply to the information deposited with Deutsches Institut für Bautechnik with date February 1st, 2023. For the LVL EN 14374 applies.

When delivered, the products are not treated with wood preservatives or flame retardant. The application of wood preservatives and flame retardants is not subject of the ETA.

No recycled wood is used in the product.

Openings in the product are not subject of the ETA.

### 2 Specification of the intended use in accordance with the applicable European Assessment Document

The products "STEICO GLVL" are intended to be used as load-bearing and/or stiffening or not load-bearing elements (beams, columns, panels) in service classes 1 and 2 according to EN 1995-1-1 following the specifications laid out in Annex 2. The products can be used edgewise and/or flatwise.

The performances given in Section 3 are only valid if the product is used in compliance with the specifications and conditions given in Annex 2 and 3 of this European Technical Assessment.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the products of at least 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

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

### 3.1 Mechanical resistance and stability (BWR 1)

| **Essential characteristic** | **Performance** |
|---|---|
| Bending strength edgewise parallel to grain $f_{m,0,edge}$ and size effect parameter $s$ | Annex 3 |
| Bending strength flatwise parallel to grain $f_{m,0,flat}$ and size effect parameter $s_{flat,m}$ | Annex 3 |
| Bending strength edgewise perpendicular to grain $f_{m,90,edge}$ | Annex 3 |
| Bending strength edgewise perpendicular to grain (Mode 2) $f_{m,90,edge,mode2}$ | NPD |
| Bending strength edgewise perpendicular to grain (Mode 3) $f_{m,90,edge,mode3}$ | NPD |
| Bending strength flatwise perpendicular to grain $f_{m,90,flat}$ | Annex 3 |
| Tension strength parallel to grain and size effect parameter $f_{t,0}$ | Annex 3 |
| Tension strength edgewise perpendicular to grain $f_{t,90,edge}$ | Annex 3 |
| Tension strength flatwise perpendicular to grain $f_{t,90,flat}$ | Annex 3 |
| Compression strength parallel to grain $f_{c,0,SC1}$ in service class 1 conditions | Annex 3 |
| Compression strength parallel to grain $f_{c,0,SC2}$ in service class 2 conditions | Annex 3 |
| Compression strength perpendicular to grain edgewise $f_{c,90,edge}$ | Annex 3 |
| Compression strength perpendicular to grain flatwise $f_{c,90,flat}$ | Annex 3 |
| Shear strength edgewise $f_{v,edge}$ | Annex 3 |
| Shear strength flatwise parallel to grain $f_{v,0,flat}$ and size effect parameter $s_{flat,m}$ | Annex 3 |
| Shear strength flatwise perpendicular to grain $f_{v,90,flat}$ | Annex 3 |
| Modulus of elasticity parallel to grain $E_0$ | Annex 3 |
| Modulus of elasticity in bending parallel to grain $E_{0,flat}$ | Annex 3 |
| Modulus of elasticity perpendicular to grain edgewise $E_{90,edge}$ and flatwise $E_{90,flat}$ | Annex 3 |
| Modulus of elasticity in flatwise bending perpendicular to grain $E_{m,90,flat}$ | Annex 3 |
| Shear modulus edgewise $G_{edge}$ | Annex 3 |
| Shear modulus flatwise parallel to grain $G_{0,flat}$ | Annex 3 |
| Shear modulus flatwise perpendicular to grain $G_{90,flat}$ | Annex 3 |
| Dimensional stability | NPD |
| Bonding quality of the gluing of LVL components and the block gluing of GLVL components to GLVL products | Annex 3 |
| Density | Annex 3 |
| Embedment strength of fasteners in GLVL | No specific fasteners tested, NPD |
| Withdrawal strength of fasteners in GLVL | |
| Head pull-through strength of fasteners in GLVL | |

## 3.2 Safety in case of fire (BWR 2)

| Essential characteristic | Performance |
|---|---|
| Reaction to fire | Annex 4 |
| Resistance to fire | NPD |

## 3.3 Hygiene, health and the environment (BWR 3)

| Essential characteristic | Performance |
|---|---|
| Emission of formaldehyde | The LVL components comply to EN 14374 with class of formaldehyde E1. The products have a formaldehyde emission of ≤ 0,10 ppm according to EN 717-1. |

## 3.4 Energy economy and heat retention (BWR 6)

| Essential characteristic | Performance |
|---|---|
| Thermal conductivity | Annex 4 |

## 3.5 Aspects of durability

| Essential characteristic | Performance |
|---|---|
| Durability against biological attack | Annex 4 |

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

In accordance with EAD No. 130337-00-0304, the applicable European legal act is: 1997/176/EC amended by 2001/596/EC3.

The system to be applied is: 1

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

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

Issued in Berlin on 8 September 2025 by Deutsches Institut für Bautechnik

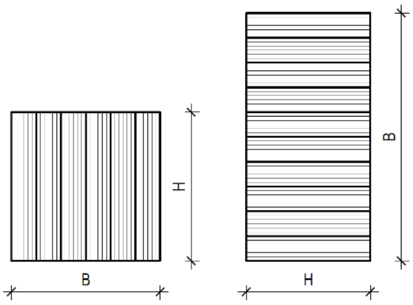
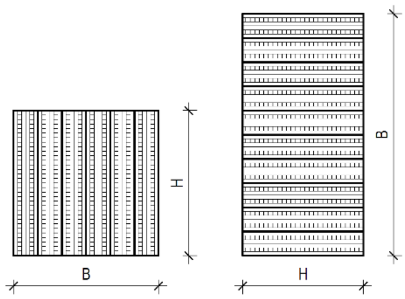
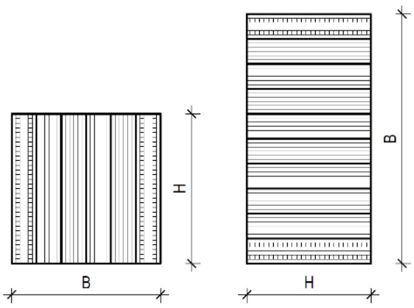
Anja Dewitt
Head of Section

*beglaubigt:*
Warns

"STEICO GLVL" Annex 1
Page 1

Elements and dimensions

Table A.1: Elements and dimensions

| Type | Element | Material | Sizes |
|---|---|---|---|
| STEICO GLVL R |  | STEICO LVL R | H ≤ 400 mm<br>B ≤ 1250 mm<br>L ≤ 18 m |
| STEICO GLVL $R^S$ | | STEICO LVL $R^S$ | H ≤ 400 mm<br>B ≤ 1250 mm<br>L ≤ 18 m |
| STEICO GLVL X |  | STEICO LVL X | H ≤ 400 mm<br>B ≤ 400 mm<br>L ≤ 18 m |
| STEICO GLVL R/X |  | STEICO LVL X and STEICO LVL R | H ≤ 400 mm<br>B ≤ 400 mm<br>L ≤ 18 m |

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Intended use

## A.2 Intended use

### A.2.1 General

The products "STEICO GLVL" are intended to be used as load-bearing and/or stiffening or not load-bearing elements in service classes 1 and 2 according to EN 1995-1-1. The products can be used edgewise and/or flatwise.

Regarding the temperature in use, EN 1995-1-1 applies.

The product is only intended to be used subject to static or quasi-static, non-fatigue actions. If used in seismic areas, the behavior factor q is limited to non-dissipative or low dissipative structures ($q \leq 1{,}5$ according to EN 1998-1:2010, clauses 1.5.2 and 8.1.3 b).

### A.2.2 Packaging, transport, storage

The products shall be protected during transport and storage against any damage and detrimental moisture effects. The manufacturer's instructions for packaging, transport and storage shall be observed.

### A.2.3 Installation provisions

EN 1995-1-1 applies for the installation. It has to be checked before installation that the product did not take any harm during transport or storage.

The manufacturer prepares assembling instructions in which the product-specific characteristics and important measures to be taken into consideration for assembling are described. The assembling instructions shall be available at every construction site.

## A.3 Mechanical resistance and stability

### A.3.1 General

The products according to this ETA are manufactured according to an individual design or delivered as standard products. The ETA covers products which are designed according to EN 1995-1-1 following the provisions below.

The elements "STEICO GLVL R/X" consist of lamellae "STEICO LVL R" and lamellae "STEICO LVL X" in a way that parts of the cross section are of the type "STEICO GLVL R" and connected parts are of the type "STEICO GLVL X". Design rules for the elements "STEICO GLVL R/X" apply as follows:

- The design shall follow linear composite theory. To do so, the verification of the parts of the cross section made of "STEICO LVL R" or "STEICO LVL X" respectively, shall be done with the effective strength and stiffness values as given in Tables A.4 to A.7 taking in to account the geometry and the position within the cross section. The scaling effects as well as the deviations described in the following shall be considered.
- Calculating bending parallel to the grain with flatwise oriented lamellae shall be done deviating from row 1 in Tables A.4 and A.5 by using the edge stresses from bending and the center tension stresses in the outer lamellae following linear composite theory.

  The characteristic strength for the design of the edge stresses from bending is $36\left(\frac{300}{B}\right)^{0,15}$ N/mm² for the "STEICO LVL X" part and $50\cdot\left(\frac{300}{B}\right)^{0,15}$ N/mm² for the "STEICO LVL R" part.
- When calculating the compression perpendicular to the grain flatwise, the outer layers made of "STEICO LVL X" are decisive for the elements "STEICO GLVL R/X".
- When calculating tension perpendicular to the grain edgewise to "STEICO GLVL R/X" (see Picture F in chapter A.3.3) the whole load must be carried by the "STEICO LVL X" lamellae.

### A.3.2 Creep and duration of load

The following parameters may be used for calculation according to EN 1995-1-1:

Table A.2: Modification factors $k_{mod}$ for all product types

| Service class | Load-duration class | | | | |
|---|---|---|---|---|---|
| | permanent | Long term | Medium term | Short term | Instantaneous |
| 1 | 0,6 | 0,7 | 0,8 | 0,9 | 1,1 |
| 2 | 0,6 | 0,7 | 0,8 | 0,9 | 1,1 |

Table A.3: Deformation factor $k_{def}$ for all product types

| Product type | $k_{def}$ in service class | |
|---|---|---|
| | 1 | 2 |
| „STEICO GLVL R“ and „STEICO GLVL R$^S$" | 0,6 | 0,8 |
| „STEICO GLVL X“ and „STEICO GLVL R/X“, if the product is not stressed by flatwise bending ($f_{m,flat,k}$) or flatwise shear ($f_{v,flat,k}$) | 0,6 | 0,8 |
| „STEICO GLVL X“ and „STEICO GLVL R/X“, “, if the product is stressed by flatwise bending ($f_{m,flat,k}$) or flatwise shear ($f_{v,flat,k}$) | 0,8 | 1,0 |

"STEICO GLVL"

Mechanical resistance and stability

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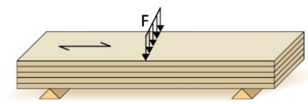
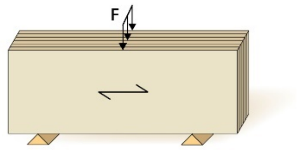
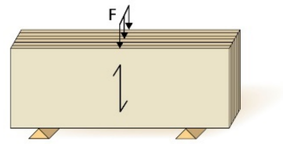
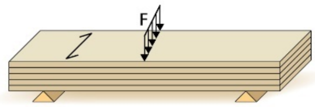
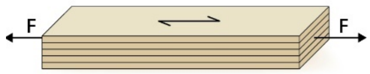
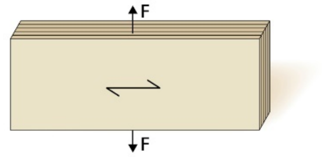
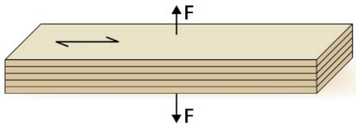
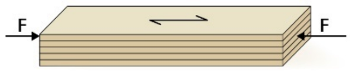
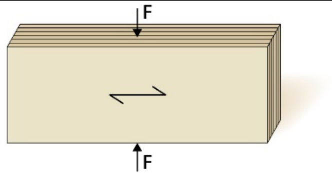
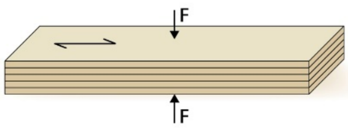
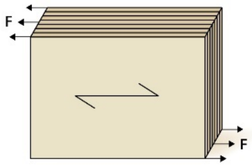
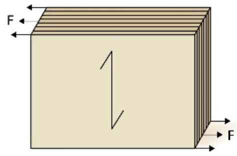
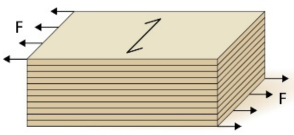
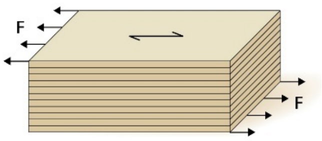
### A.3.3 Values of the product types

The values given in the following tables are defined according to picture A.1.

| | | |
|---|---|---|
|  A. Bending parallel to the grain, lamellae flatwise ($f_{m,0,flat}$ and $E_{m,0,flat}$) |  B. Bending parallel to the grain, lamellae edgewise ($f_{m,0,edge}$ and $E_{m,0,edge}$) |  C. Bending perpendicular to the grain, lamellae edgewise ($f_{m,90,edge}$ and $E_{m,90,edge}$) |
|  D. Bending perpendicular to the grain, lamellae flatwise ($f_{m,90,flat}$ and $E_{m,90,flat}$) |  E. tension parallel to the grain ($f_{t,0}$ and $E_{t,0}$) |  F. tension perpendicular to the grain, lamellae edgewise ($f_{t,90,edge}$ and $E_{t,90,edge}$) |
|  G. tension perpendicular to the grain, lamellae flatwise ($f_{t,90,flat}$) |  H. compression parallel to the grain ($f_{c,0}$ and $E_{c,0}$) |  I. compression perpendicular to the grain, lamellae edgewise ($f_{c,90,edge}$ and $E_{c,90,edge}$) |
|  J. compression perpendicular to the grain, lamellae flatwise ($f_{c,90,flat}$ and $E_{c,90,flat}$) |  K. Shear parallel to the grain, lamellae edgewise ($f_{v,0,edge}$ and $G_{0,edge}$) |  L. Shear perpendicular to the grain, lamellae edgewise ($f_{v,90,edge}$ and $G_{90,edge}$) |
|  M. Shear perpendicular to the grain, lamellae flatwise ($f_{v,90,flat}$ and $G_{90,flat}$) |  N. Shear parallel to the grain, lamellae flatwise ($f_{v,0,flat}$ and $G_{0,flat}$) | |

Picture A.1: Orientation and designation of strengths and stiffnesses

"STEICO GLVL" Annex 3
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Mechanical resistance and stability

The calculation of the GLVL elements can be done using the effective (referring to the brutto cross section) strength and stiffness values listed in the tables below

Legend to the Tables A.4 to A.7

- B: width of the element [mm]
- H: height of the element [mm]
- L: length of the element [mm]; the length should be assumed to be at least 840 mm regardless of the length of the element.
- t: thickness of the outermost lamella in the tension area [mm]

Table A.4: Strength values of the comprised elements "STEICO GLVL R" and "STEICO GLVL R$^S$"

| Denomination | Picture in A.3.3 | Formula sign | "STEICO GLVL R" [N/mm²] | "STEICO GLVL R$^S$" [N/mm²] |
|---|---|---|---|---|
| Bending parallel to the grain, lamellae flatwise a) | A | $f_{m,0,flat,k}$ | $\min\left\{50 \cdot \left(\frac{300}{B}\right)^{0,15} ; 36 \cdot \frac{\left(\frac{3000}{L}\right)^{0,075}}{\left(1-\frac{t}{B}\right)}\right\}$ | $\min\left\{50 \cdot \left(\frac{300}{B}\right)^{0,15} ; 37 \cdot \frac{\left(\frac{3000}{L}\right)^{0,075}}{\left(1-\frac{t}{B}\right)}\right\}$ |
| Bending parallel to the grain, lamellae edgewise | B | $f_{m,0,edge,k}$ | $44 \cdot \left(\frac{300}{H}\right)^{0,15}$ | $48 \cdot \left(\frac{300}{H}\right)^{0,15}$ |
| Tension parallel to the grain | E | $f_{t,0,k}$ | $36 \cdot \left(\frac{3000}{L}\right)^{0,075}$ | $37 \cdot \left(\frac{3000}{L}\right)^{0,075}$ |
| Tension perpendicular to the grain, lamellae edgewise | F | $f_{t,90,edge,k}$ | 0,9 | 0,9 |
| Tension perpendicular to the grain, lamellae flatwise | G | $f_{t,90,flat,k}$ | $0,35 \cdot \min\left\{1; \left(\frac{600}{B}\right)^{0,15}\right\}$ | |
| Compression parallel to the grain b) | H | $f_{c,0,k}$ | 40 | 48 |
| Compression perpendicular to the grain | I | $f_{c,90,edge,k}$ | 7,5 | 8,5 |
| | J | $f_{c,90,flat,k}$ | 3,6 | 3,7 |
| Shear parallel to the grain, lamellae edgewise | K | $f_{v,0,edge,k}$ | 4,6 | 4,8 |
| Shear parallel to the grain, lamellae flatwise | N | $f_{v,0,flat,k}$ | $\min\left\{2,6; 2,45 \cdot \left(\frac{300}{B}\right)^{0,25}\right\}$ | $\min\left\{3,2; 3,0 \cdot \left(\frac{300}{B}\right)^{0,25}\right\}$ |
| a) width smaller than B = 300 mm are to be considered as being 300 mm. | | | | |
| b) The value shall be divided by 1.2 in case of use in service class 2. | | | | |

"STEICO GLVL"



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Table A.5: Strength values of the comprised elements "STEICO GLVL X"

| Denomination | Picture in A.3.3 | Formula sign | "STEICO GLVL X" [N/mm²] |
|---|---|---|---|
| Bending parallel to the main grain direction, lamellae flatwise [a)] | A | $f_{m,0,flat,k}$ | $\min\left\{\begin{matrix} 36 \cdot \left(\frac{300}{B}\right)^{0,15} \\ 21 \cdot \frac{\left(\frac{3000}{L}\right)^{0,075}}{\left(1-\frac{t}{B}\right)} \end{matrix}\right\}$ |
| Bending parallel to the main grain direction, lamellae edgewise | B | $f_{m,0,edge,k}$ | $32 \cdot \left(\frac{300}{H}\right)^{0,15}$ |
| Bending perpendicular to the main grain direction | C | $f_{m,90,edge,k}$ | 8 |
| | D | $f_{m,90,flat,k}$ | $\frac{5}{\left(1-\frac{t}{B}\right)}$ |
| Tension parallel to the main grain direction | E | $f_{t,0,k}$ | $21 \cdot \left(\frac{3000}{L}\right)^{0,075}$ |
| Tension perpendicular to the main grain direction, lamellae edgewise | F | $f_{t,90,edge,k}$ | 5 |
| Tension perpendicular to the main grain direction, lamellae flatwise | G | $f_{t,90,flat,k}$ | $0,35 \cdot \min\left\{1;\left(\frac{600}{B}\right)^{0,15}\right\}$ |
| Compression parallel to the main grain direction [b)] | H | $f_{c,0,k}$ | 30 |
| Compression perpendicular to the main grain direction | I | $f_{c,90,edge,k}$ | 9 |
| | J | $f_{c,90,flat,k}$ | 4 |
| Shear parallel to the main grain direction, lamellae edgewise | K | $f_{v,0,edge,k}$ | 4,6 |
| Shear perpendicular to the main grain direction (rolling shear) | L | $f_{v,90,edge,k}$ | 4,6 |
| | M | $f_{v,90,flat,k}$ | 1,1 |
| Shear parallel to the main grain direction, lamellae flatwise | N | $f_{v,0,flat,k}$ | $\min\left\{1,1;1,1 \cdot \left(\frac{300}{B}\right)^{0,25}\right\}$ |
| a) | width smaller than B = 300 mm are to be considered as being 300 mm. | | |
| b) | The value shall be divided by 1.2 in case of use in service class 2. | | |

"STEICO GLVL"

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Mechanical resistance and stability

Table A.6: Stiffness values of the comprised elements "STEICO GLVL R" and "STEICO GLVL R$^S$"

| Denomination | Picture in A.3.3 | Formula sign | "STEICO GLVL R" [N/mm²] | "STEICO GLVL R$^S$" [N/mm²] |
|---|---|---|---|---|
| Modulus of elasticity parallel to the grain | A, B, E, H | $E_{0,mean}$ | 14000 | 15200 |
| | | $E_{0,k}$ | 12000 | 13200 |
| Modulus of elasticity perpendicular to the grain, lamellae edgewise | I | $E_{c,90,edge,mean}$ | 430 | 450 |
| | | $E_{c,90,edge,k}$ | 350 | 400 |
| Shear modulus parallel to the grain, lamellae edgewise | K | $G_{0,edge,mean}$ | 600 | 650 |
| | | $G_{0,edge,k}$ | 400 | 450 |
| Shear modulus parallel to the grain, lamellae flatwise | N | $G_{0,flat,mean}$ | 560 | 650 |
| | | $G_{0,flat,k}$ | 400 | 450 |

Table A.7: Stiffness values of the comprised elements "STEICO GLVL X"

| Denomination | Picture in A.3.3 | Formula sign | "STEICO GLVL X" [N/mm²] |
|---|---|---|---|
| Modulus of elasticity parallel to the grain | A, B, E, H | $E_{0,mean}$ | 10600 |
| | | $E_{0,k}$ | 9000 |
| Modulus of elasticity perpendicular to the grain, lamellae edgewise | C, F, I | $E_{90,edge,mean}$ | 3000 |
| | | $E_{90,edge,k}$ | 2300 |
| E Modulus of elasticity perpendicular to the grain, lamellae flatwise | D | $E_{m,90,flat,mean}$ | 2500 |
| | | $E_{m,90,flat,k}$ | 1800 |
| Shear modulus parallel to the grain, lamellae edgewise | K | $G_{0,edge,mean}$ | 600 |
| | | $G_{0,edge,k}$ | 400 |
| Shear modulus perpendicular to the grain (rolling shear) | M | $G_{90,flat,mean}$ | 150 |
| | | $G_{90,flat,k}$ | 130 |
| Shear modulus parallel to the grain, lamellae flatwise | N | $G_{0,flat,mean}$ | 150 |
| | | $G_{0,flat,k}$ | 130 |

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Mechanical resistance and stability

### A.3.4 Bond integrity

The bonding strength between the LVL components is at least equally as high as the bonding strength within the LVL components. Cleavage test according to EN 14374, chapter 4.2 shows a wood failure percentage ≥ 70%. The glue line thickness for the bonding of the LVL components is $t_{glueline} \leq 0{,}3$mm

### A.3.5 Density

The characteristic density of the product is:

For GLVL R, GLVL X und GLVL R/X: $\rho_k$ = 480 kg/m³

For GLVL $R^S$: $\rho_k$ = 550 kg/m³

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Physical properties

### A.4.1 Reaction to fire

The glued LVL "STEICO GLVL" are classified as class D-s2, d0 or $D_{FL}$-s1 (when used as flooring) with regard to their reaction to fire performance according to delegated act (EU) 2017/2293. The classification applies for the following use cases:

- on any underground (adjacent materials) and
- with any distance (air gap) to adjacent materials.

The individual LVL are classified as class D-s1, d0 with regard to their reaction to fire performance according to EN 13501-1. This classification has the following boundary conditions:

- LVL made of spruce and/or pine with or without crossband veneers, glued with a phenol-formaldehyde-adhesive.
- Characteristic density $\rho_k \geq 480$ kg/m³,
- Thickness ≥ 19 mm
- Mounted without an air gap directly against a thermal insulation made of mineral wool with a density of ≥ 22,5 kg/m³ and a thickness of ≥ 20 mm and a reaction to fire performance class A1 or A2-s1, d0 according to EN 13501-1, or
- With a distance (air gap) > 80 to other plane materials / surfaces,
- When fixed mechanically to wooden frame constructions
- When used without joints or with joints ≤ 8 mm.

### A.4.2 Thermal conductivity

The thermal conductivity of the products according to EN ISO 10456 is:

| | |
|---|---|
| For GLVL R, GLVL X und GLVL R/X: | $\lambda$ = 0,13 W/(mK) |
| For GLVL $R^S$: | $\lambda$ = 0,14 W/(mK) |

### A.4.3 Durability against biological attack

The durability against biological attack is DC5 according to EN 350. Products treated with wood preservatives are not subject of this ETA.

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Annex 5 (informative)[1]
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Notes for the design of STEICO GLVL

## A.5.1 General

Design of the load bearing capacity of STEICO GLVL is generally done according to EN 1995-1-1 using the properties of the product given in Annex 3. In addition, the provisions of the following chapters may be used.

The abbreviations used in the following chapters are:

LVL R = STEICO GLVL R
LVL $R^S$ = STEICO GLVL $R^S$
LVL X = STEICO GLVL X

## A.5.2 Compression perpendicular to the grain

The verification of compression perpendicular to the grain can be done according to formula (6.3) of EN 1995-1-1. Calculation values for the factor $k_{c,90}$ for compression perpendicular to the grain, edgewise shall the be assumed as the values given in EN 1995-1-1 for solid softwood timber.

Alternatively to formula (6.3), compression perpendicular to the grain edgewise in the ultimate limit state can be verified by:

$$\frac{F_{c,90,d}}{A_{ef}} \leq f_{c,90,flat,d} \qquad (1)$$

Herein are:

$F_{c,90,d}$ Design value of the compression force in N

$f_{c,90,flat,d}$ Design value of the compression strength perpendicular to the grain, flatwise in N/mm²

In cases in which a high deformation due to compression perpendicular to the grain cannot lead to a failure in the ultimate limit state, the partial factor for material properties $\gamma_M$ and for actions $\gamma_F$ could be adapted. In these cases when calculation with formula (1) the following $\gamma_M$- und $\gamma_F$-values could be applied: $\gamma_M$ = 1,0; $\gamma_F$ = 1,0.

$A_{ef}$ effective contact area [mm²]: (2)

$$A_{ef} = b \cdot (k_{c,90} \cdot \ell + \ell_{dis,left} + \ell_{dis,right})$$

$\ell_{dis,(left/right)}$ The length of distances $\ell_{dis,left}$, $\ell_{dis,right}$ are: (3)

$$\ell_{\text{dis}} = min\,\{\ell;\ 40\ mm \cdot min\,(1;\ a/150;\ \ell_1/300)\}$$

$a, \ell$ , $\ell_1$ according to EN 1995-1-1, Picture 6.2, in mm

$b$ width of the contact are perpendicular to the grain in mm;

$k_{c,90}$ compression factor: (4)

$k_{c,90} = 1{,}6$ für "STEICOLVL R" und "STEICOLVL $R^s$"

$k_{c,90} = 1{,}4$ für "STEICOLVL X"

If a verification is done in the serviceability limit state, the verification can be done as follows:

$$F_{c,90,d} \leq k_{mod} \cdot f_{c,90,flat,k} \cdot b \cdot \left(k_{c,90} \cdot (1 - e^{-0{,}2 \cdot w}) \cdot \ell + \ell_{dis,left} + \ell_{dis,right}\right) \text{ in N} \qquad (5)$$

[1] The information given in this Annex is not based on an assessment according to the provisions of the EAD which is used as basis for the issuing of this ETA and is, thus, also not based on an agreement within EOTA. It is not linked to any provision of the Regulation (EU) no 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC and cannot be used when drawing up a declaration of performance according to this Regulation.

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Notes for the design of STEICO GLVL

Herein are:

| | | |
|---|---|---|
| $\ell_{dis}$ | $\ell_{\text{dis}} = k_w \cdot min\{\ell;\ 40\ mm \cdot min(1;\ a/150;\ \ell_1/300)\}$ in mm | (6) |
| *Factor* $k_w$ | $k_w = min\{1\ ;\ w/5\ \text{mm}\}$ | (7) |
| $F_{c,90,d}$ | Design value of the compression force in N for the characteristic combination of actions as given in chapter 6.5.3 (2) a) of EN 1990; $F_{c,90,d} = F_{c,90,k}$ | |
| $f_{c,90,flat,k}$ | Characteristic value of the compression strength perp. to the grain, flatwise in N/mm²; | |
| $w$ | assumed start deformation perpendicular to the grain in the contact area in mm, $w \leq 15$ mm. | |

The slip modulus for deformation up to 5 mm due to compression perpendicular to the grain in the contact area is:

$$K_{ser} = 0{,}5 \cdot b \cdot (K_2 \cdot \ell + \ell_{dis,left} + \ell_{dis,right}) \text{ in N/mm} \quad (8)$$

Herein are:

Factor $K_2$ — $K_2$ = 0,9 für "STEICOLVL R" und "STEICOLVL R$^s$"
$K_2$ = 0,8 für "STEICOLVL X"

*Note: For assemblies state are sensitive to settlement w ≤ 5 mm may be agreed upon. When choosing w > 5 mm larger indentations may appear, which should be accounted constructively if necessary. The verification "compression strength perpendicular to the grain, flatwise" shall be done in the ultimate limit state, if a large indentation reduces the cross section in a way, that other verifications in the ultimate limit state might fail, for example the verification of bending stresses on the reduced cross section.*

### A.5.3 Loads at an angle α

The verification of the bending stresses at an angle α may be done according to EN 1995-1-1 in addition to EN 1995-1-1:

$$\sigma_{m,\alpha,d} \leq \frac{f_{m,0,d}}{\frac{f_{m,0,d}}{f_{m,90,d}} sin^2\,\alpha + \frac{f_{m,0,d}}{f_{v,d}} sin\,\alpha \cdot cos\,\alpha + cos^2\,\alpha} \quad (9)$$

$\sigma_{m,\alpha,d}$ Design bending stress at an angle α

α see picture A.2 in Annex 6

In case the characteristic bending strength $f_{m,90,k}$ is not given in the declaration of conformity of the LVL, $f_{m,90,k} = f_{t,90,k}$ may be assumed.

### A.5.4 Beams subjected to bending with a notch at the support

The verification of notch at the support of beams made of STEICO LVL with rectangular cross section can be done according to chapter 6.5.2 of EN 1995-1-1. The factor $k_n$ in formula (6.62) may be assumed with:

For STEICO LVL R und STEICO LVL R$^S$:

- Loaded edgewise: $k_n$ = 5,0
- Loaded flatwise: $k_n$ = 5,0

For STEICO LVL X:

- Loaded edgewise: $k_n$ = 15,0

Reinforcements to cover tension stresses perpendicular to the grain may lead to a more robust long term behaviour of these constructions. Beams made of STEICO LVL R und STEICO LVL R$^S$ loaded flatwise with notches at the support should be subject to reinforcements. Beams made of STEICO LVL X loaded flatwise with notches at the support need to be reinforced.

"STEICO GLVL"

Annex 6 (informative)[1]
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Design of connections with STEICO GLVL

## A.6.1 General

Fasteners may be calculated according to EN 1995-1-1 taking into account the following chapters. The following fasteners are addressed in this section:

- Split-ring connectors and Shear-plate connectors according to EN 912[2] and EN 14545[3]
- Nails with grooves, smooth nails, screws, staples, dowels, bolts and tight-fitting bolts according to EN 14592[4] or ETA-04/0013

The connectors may be applied as shown in Table A.8. End faces are the surfaces with a predominant amount of end grain. All other side surfaces are defined here as narrow surfaces. Values tor STEICO GLVL R" always apply for "STEICO GLVL $R^S$" if not stated otherwise in the following chapters.

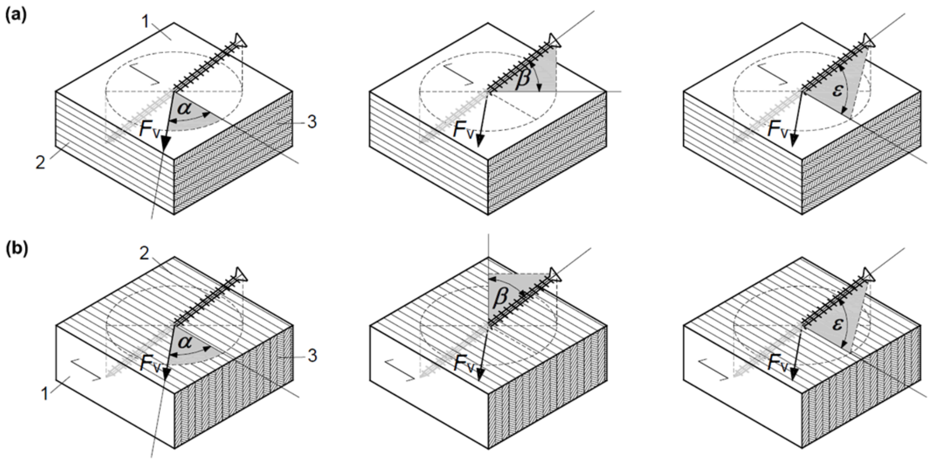
Table A.8: Allowed assembly of fasteners in the LVL "STEICO GLVL"

| Fastener | Assembly allowed in |
|---|---|
| Screws | end-, narrow and wide surfaces |
| Dowels, bolts and tight-fitting bolts | narrow and wide surfaces |
| Nails, staples | narrow and wide surfaces |
| Split-ring connectors and Shear-plate connectors | narrow and wide surfaces; Split-ring connectors Type A1 with $d_c \leq 126$ mm also in end surfaces |

The calculations shall be done with the density according to declaration of performance up to a maximum of characteristic density of $\rho_k = 550$ kg/m³. Combined loads shall be calculated according to EN 1995-1-1, chapter 8.3.3 or chapter 8.7.3 respectively.

Angles are defined in the following as given in picture A.2:

**Picture A.2: Definition of angles $\alpha$, $\beta$ und $\varepsilon$**




$\alpha$: angle between force and direction of the grain (0° ≤ $\alpha$ ≤ 90°)

$\beta$: angle between axis of the fastener and wide surface (0° ≤ $\beta$ ≤ 90°)

$\varepsilon$: angle between axis of the fastener and direction of the grain

1: wide surface; 2: narrow surface: 3: end surface with larger amount of end grain.

[2] EN 912:2011-09 Timber fasteners – Specifications for connectors for timbers
[3] EN 14545:2009-02 Timber structures – Connectors – Requirements
[4] EN 14592:2012-07 Timber structures – Dowel-type fasteners – Requirements

### A.6.2 Loads perpendicular to the axis of the fastener

Formula (8.4) of EN 1995-1-1 may be disregarded for butting connections in elements made of "LVL X" with fasteners in the wide surface.

Connections with nails and staples

The embedment strength $f_{h,k}$ for calculation according to EN 1995-1-1 for nails and staples (per shaft), which are applied perpendicular to the direction of the grain, may be assumed with ($f_{h,k}$ in N/mm²):

$$f_{h,k} = \frac{0{,}082 \cdot \rho_k \cdot d^{-0{,}3}}{k_c \cdot cos^2\beta + sin^2\beta}$$ For nails and staples in not predrilled holes (10)

$$f_{h,k} = \frac{0{,}082 \cdot \rho_k \cdot (1 - 0{,}01d)}{k_c \cdot cos^2\beta + sin^2\beta}$$ For nails in predrilled holes (11)

Herein are:

| | | |
|---|---|---|
| $\rho_k$ | characteristic density of the LVL [kg/m³] | |
| $d$ | nominal diameter of the fastener [mm] | |
| $\beta$ | angle between axis of the fastener and wide surface as in picture A.2 | |
| $k_c$ | $k_c = 1$ | for LVL R, LVL $R^S$ |
| | $k_c = \dfrac{1}{max\begin{Bmatrix}1-2/d\\0{,}333\end{Bmatrix}}$ | for LVL X |

The effective number of nails $n_{ef}$ for a series of n nails in direction of the grain is calculated by:

- $n_{ef} = n^{k_{ef}}$ with $k_{ef}$ according to table 8.1 of EN 1995-1-1 for LVL R, $R^S$, nails in the wide surface
- $n_{ef} = n$ for LVL X, nails in the wide surface
- $n_{ef} = n^{k_{ef}}$ with $k_{ef} = min\ \{1; 1 - 0{,}03 \cdot (20 - a_1/d)\}$ for all LVL, nails in the narrow surface with $a_1$ and d according to table 8.1 of EN 1995-1-1 or table A.9d of this document.

For smooth nails in not predrilled holes or for staples the penetration depth on the side of the tip in narrow surfaces should be at least 12d. In the narrow surface of STEICO LVL X the angle between staple and direction of the grain may not be less than 30°. For smooth nails in predrilled holes the provisions of EN 1995-1-1 regarding the penetration depth apply.

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Design of connections with STEICO GLVL

Connections with nails or wood screws and intermediate layers of OSB, particle board or plywood

The characteristic value of the load bearing capacity of nails with grooves, d = 4 mm, or wood screws, d = 5 mm, according to ETA-04/0013 in steel plate – wood connections with intermediate layers made of OSB, particle board or plywood up to a maximum thickness of 15 mm as shown in picture A.3 may be calculated with formula (12). The steel plates are at least 2 mm thick. The fasteners are applied in the narrow surface of the laminated veneer lumber.

$$F_{v,Rk} = \begin{cases} f_{h,1,k} \cdot d \cdot t_1 \\ 2 \cdot f_{h,1,k} \cdot d \cdot \left( \sqrt{t_{ZW}^2 + \frac{M_{y,k}}{f_{h,1,k} \cdot d} + \frac{\delta \cdot t_{ZW}^2}{4} + t_1 \cdot t_{ZW} + \frac{t_1^2}{2}} - t_{ZW} \right) - f_{h,1,k} \cdot d \cdot t_1 + \frac{F_{ax,Rk}}{4} \\ 1{,}15 \cdot f_{h,1,k} \cdot d \cdot \left( \sqrt{t_{ZW}^2 + \frac{4 \cdot M_{y,k}}{f_{h,1,k} \cdot d} + \frac{\delta \cdot t_{ZW}^2}{2}} - t_{ZW} \right) + \frac{F_{ax,Rk}}{4} \end{cases} \quad (12)$$

with

| | |
|---|---|
| d | nominal diameter of the nail or wood screw in mm |
| $f_{h,1,k}$ | characteristic embedment strength of the LVL in N/mm² |
| $f_{h,zw,k}$ | characteristic embedment strength of the intermediate layer in N/mm² |
| $t_1$ | penetration depth of the nail or screw in the LVL in mm |
| $t_{zw}$ | thickness of the intermediate layer in mm |
| $M_{y,k}$ | characteristic yield moment of the nail or screw in Nmm |
| δ | ratio of the embedment strengths, $\delta = f_{h,zw,k} / f_{h,1,k}$ |
| $F_{ax,Rk}$ | Withdrawal capacity of the nail or screw in the LVL in N: $F_{ax,Rk} = \min \{f_{tens,k}; f_{ax,k} \cdot d \cdot t_1\}$ |

The effective number of nails or screws $n_{ef}$ for a series of n nails or screws in direction of the grain is calculated as for nails (see prior chapter).

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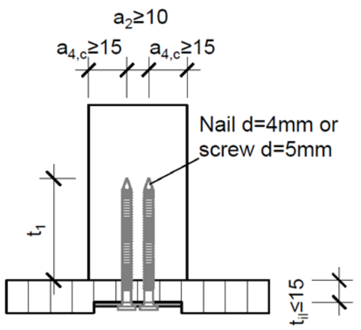
Design of connections with STEICO GLVL

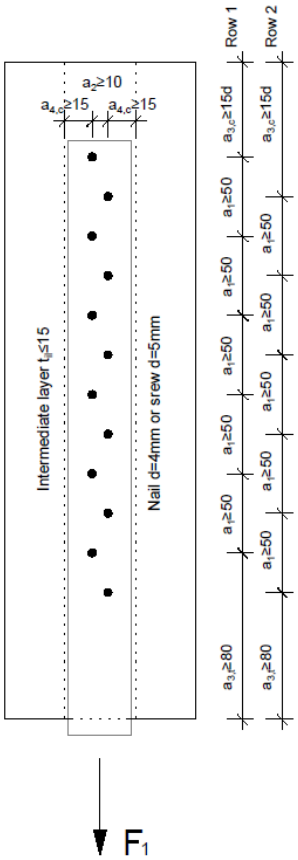
**Picture A.3: Connection for tension**

## Connection with two rows

Cross section

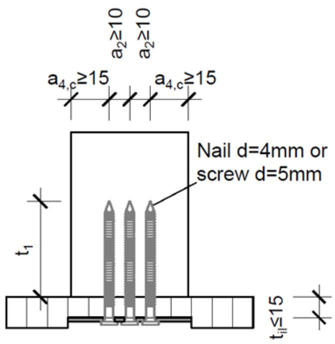



Frontal view

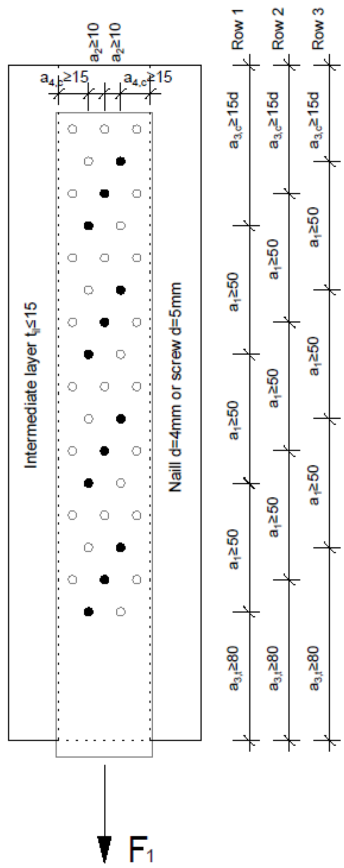



## Connection with more rows

Cross section




Frontal view




Legend:

● Nail d = 4 mm or screw d = 5 mm;

○ Hole in the plate without fastener

measured in mm

Connections with dowels, bolts and tight-fitting bolts

The characteristic embedment strength for calculation of the load bearing capacity according to EN 1995-1-1 for dowels, bolts and tight-fitting bolts, which are applied perpendicular to the direction of the grain, may be assumed with ($f_{h,\alpha,\beta,k}$ in N/mm²):

$$f_{h,\alpha,\beta,k} = \frac{0{,}082 \cdot \rho_k \cdot (1 - 0{,}01 \cdot d)}{(k_{90} \cdot sin^2\,\alpha + cos^2\,\alpha)(k_c \cdot cos^2\,\beta + sin^2\,\beta)} \qquad (13)$$

with

$\rho_k$ characteristic density of the LVL [kg/m³]

$d$ diameter of the dowels, bolts or tight-fitting bolts [mm]

$\alpha,\beta$ as shown in picture A.2. For dowels, bolts or tight-fitting bolts in the wide surface of STEICO LVL X $\alpha$ = 45° may be assumed even if $\alpha$ > 45°.

$k_{90}$ $k_{90} = 1{,}15 + 0{,}015 \cdot d$

$k_c$ $k_c = max\begin{cases} d/(d-2) \\ 1{,}15 \end{cases}$

Connections with wood screws

The characteristic embedment strength for calculation of the load bearing capacity in LVL according to EN 1995-1-1 for wood screws may be assumed with ($f_{h,k}$ in N/mm²):

- Wood screws with d ≤ 12 mm in not predrilled holes:

$$f_{h,k} = \frac{0{,}082 \cdot \rho_k \cdot d^{-0{,}3}}{(k_c \cdot cos^2\,\beta + sin^2\,\beta) \cdot (2{,}5 \cdot cos^2\,\varepsilon + sin^2\,\varepsilon)} \qquad (14)$$

- Wood screws with d ≤ 12 mm in predrilled holes:

$$f_{h,k} = \frac{0{,}082 \cdot \rho_k \cdot (1 - 0{,}01d)}{(k_c \cdot cos^2\,\beta + sin^2\,\beta) \cdot (2{,}5 \cdot cos^2\,\varepsilon + sin^2\,\varepsilon)} \qquad (15)$$

- Wood screws with d > 12 mm in predrilled holes:

$$f_{h,k} = \frac{0{,}082 \cdot \rho_k \cdot (1 - 0{,}01d)}{(k_{90} \cdot sin^2\,\alpha + cos^2\,\alpha) \cdot (k_c \cdot cos^2\,\beta + sin^2\,\beta) \cdot (2{,}5 \cdot cos^2\,\varepsilon + sin^2\,\varepsilon)} \qquad (16)$$

with

$d$ nominal diameter of the wood screw in mm

$\alpha,\beta,\varepsilon$ as shown in picture A.2

$\rho_k$ characteristic density of the LVL [kg/m³]

$k_{90}$ $k_{90} = 1{,}15 + 0{,}015 \cdot d$ (17)

$k_c$: $k_c = 1$ for LVL R and $R^S$ and d ≤ 12 mm

$k_c = min\begin{cases} d/(d-2) \\ 3 \end{cases}$ for LVL X and d ≤ 12 mm

$k_c = max\begin{cases} d/(d-2) \\ 1{,}15 \end{cases}$ for LVL X, R, $R^S$ and d > 12 mm

Connections with Split-ring connectors and Shear-plate connectors

For connections with Split-ring connectors Type A or Shear-plate connectors Type B according to EN 912 and EN 14545 with diameters up to 200 mm in the wide surface of the LVL the characteristic load carrying capacity in direction of the grain $F_{v,0,Rk}$ per connector and shear plane can be assumed according to formula (8.61) of EN 1995-1-1.

For connections with Split-ring connectors or Shear-plate connectors in the narrow surface of LVL R and $R^S$ the characteristic load carrying capacity according to formula (8.61) of EN 1995-1-1 should be reduced by 15%, in the narrow surface of LVL X by 25%.

Split-ring connectors Type A1 with diameters $d_c \leq 126$ mm may be assembled perpendicular or inclined ($\phi \geq 45°$) to the direction of the grain of end grain surfaces of LVL R, $R^S$ or LVL X and may be taken into account for the transmission of support loads.

## A.6.3 Withdrawal loads

<u>Connections with nails and staples</u>

For smooth nails and staples in not predrilled LVL elements the penetration depth on the side of the point side should be at least 12d. The characteristic point side withdrawal strength then is:

$f_{ax,k} = 20 \cdot 10^{-6} \cdot \rho_k^2$ in N/mm² for fasteners in the wide surface (18)

$f_{ax,k} = 0{,}32 \cdot d + 0{,}8$ in N/mm² for fasteners in the narrow surface (19)

$\rho_k$ characteristic density of the LVL [kg/m³]

*d* nominal diameter of the fastener [mm]

<u>Connections with wood screws</u>

For connections with screws assembled with inclination (see picture A.4):

- Connections with crossed pairs of screws:
  $F_{Rk} = n_{ef} \cdot (F_{c,Rk} + F_{t,Rk}) \cdot cos\, \alpha$ (20)
- Connections with parallel assembled, inclined screws:
  $F_{Rk} = n_{ef} \cdot F_{t,Rk} \cdot (cos\, \alpha + 0{,}25 \cdot sin\, \alpha)$ (21)

Herein are:

$n_{ef}$ effective number of assembled crossed or parallel, inclined pairs of screws in succession in the direction of the force in that connection, $n_{ef} = max\,\{n^{0,9}; 0{,}9 \cdot n\}$

n number of assembled crossed or parallel, inclined pairs of screws in succession

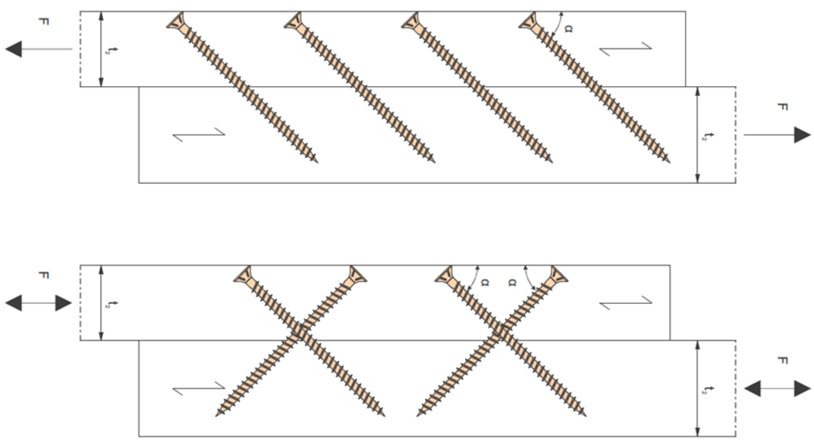
$F_{c,Rk}$ characteristic value of the compressive carrying capacity of a screw taking into account for buckling, see ETA

$F_{t,Rk}$ characteristic value of the tension carrying capacity

$\alpha$ Angle between axis of the screw and shear plane

For continuous connections such as in mechanically jointed beams $n_{ef}$ = n may be assumed.

**Picture A.4: Presentation of inclined and crosswise assembled screws**



For wood screws with a diameter of 5 mm ≤ d ≤ 12 mm the characteristic point side withdrawal strength from LVL is:

$$F_{ax,\varepsilon,Rk} = \frac{n_{ef} \cdot k_{ax} \cdot 15 \cdot d \cdot l_{ef}}{(1{,}5 \cdot cos^2 \beta + sin^2 \beta)} \left(\frac{\rho_k}{500}\right)^{0{,}8} \qquad (22)$$

$$k_{ax} = \begin{cases} 0{,}5 + \frac{0{,}5 \cdot \varepsilon}{45°} & f\ddot{u}r\ 15° \leq \varepsilon < 45° \\ 1 & f\ddot{u}r\ 45° \leq \varepsilon \leq 90° \end{cases} \qquad (23)$$

Herein are:

$F_{ax,\varepsilon,Rk}$ characteristic point side withdrawal strength of the connection at an angle ε to the direction of the grain, in N;

$\rho_k$ characteristic density of the LVL [kg/m³]

d outer thread diameter in mm;

$l_{ef}$ penetration depth of the part with thread, in mm;

β angle between axis of the fastener and wide surface;

ε angle between axis of the screw and direction of the grain (see picture A.2), ε ≥ 15°

## A.6.4 Implementation

<u>Assembling nails, staples or wood screws</u>

Against withdrawal loads in the narrow surfaces of LVL X only threaded nails with a pointside withdrawal strength of at least $f_{ax,k} \geq 50 \cdot 10^{-6} \cdot \rho_k^2$ and a diameter of at least 4 mm or screws with a diameter of at least 6 mm shall be used

The minimum spacing of nails and staples among each other and to the end grain are given in table A.9a and A.9b. For the minimum spacing of axial loaded screws with penetration depth t ≥ 12 d the values of table A.9c apply instead of EN 1995-1-1, table 8.6. For the minimum spacing of nails with grooves, d = 4 mm, and screws, d = 5 mm, according to ETA 04/0013 in the narrow or wide surface of LVL R and $R^S$ in steel plate – wood connections with intermediate layers and with staggered arrangement (see chapter A.6.2 and picture A.3) the values of table A.9d apply.

The minimum thickness for elements made of LVL, which are not predrilled is:

- Nails in the wide surface of LVL R, $R^S$: according to formula (8.18) of EN 1995-1-1.
- Nails in the narrow surface of LVL $R^S$: according to formula (8.18)[5] of EN 1995 1-1.
- Nails in the narrow surface of LVL R und X: according to formula (8.19) of EN 1995-1-1. If $a_4$ ≥ 14d applies, formula (8.18) should be used instead.

Predrilling is not required for nails in the wide surface of LVL X regardless of the thickness of the LVL, EN 1995-1-1, chapter 8.3.1.1 (2) does not need to be considered. EN 1995-1-1, chapter 8.3.1.1 (2), 1st hyphen, may be disregarded for GLVL-products in general.

The anchorage length of the threaded part on the pointside of the wood screw needs to be at least:

$$l_{ef} = min\,\{4\ d/sin\ \varepsilon;\ 20d\} \qquad (24)$$

5 Formula (8.18) may be used for product type LVL R or LVL X, if it can be shown, that the product is made only from pine wood without the use of any spruce wood.

Design of connections with STEICO GLVL

Table A:9a: Minimum spacing of nails under shear load

| Spacings as in Figure 8.7 of EN 1995-1-1 | Angle α as in picture A.2 | Minimum spacing | | | |
|---|---|---|---|---|---|
| | | Not predrilled | | | predrilled (all LVL, all surfaces) |
| | | LVL R, $R^S$, wide face, *LVL X wide face (penetration depth < 10d) | LVL R, $R^S$,X narrow face | LVL X, wide face (penetration depth at least 10d) | |
| $a_1$ (in direction of the grain) | 0° ≤ α ≤ 360° | d < 5 mm: (5+5\|cos α\|)d<br>d ≥ 5 mm: (5+7\|cos α\|)d | (7+8\|cos α\|)d | (5+2\|cos α\|)d | (4+ \|cos α\|)d |
| $a_2$ (perp. to the grain) | 0° ≤ α ≤ 360° | 5d | 7d | 5d | (3+ \|sin α\|)d |
| $a_{3,t}$ (loaded end) | -90° ≤ α ≤ 90° | (10+5 cos α)d | (15+5 cos α)d | (4+3 cos α)d | (7+5 cos α)d a) |
| $a_{3,c}$ (unloaded end) | 90° ≤ α ≤ 270° | 10d | 15d | 5d | 7d b) |
| $a_{4,t}$ (loaded edge) | 0° ≤ α ≤ 180° | d < 5 mm: (5+2 sin α)d<br>d ≥ 5 mm: (5+5 sin α)d | d < 5 mm: (7+2 sin α)d<br>d ≥ 5 mm: (7+5 sin α)d | (3+4 sin α)d | d < 5 mm: (3+2 sin α)d<br>d ≥ 5 mm: (3+4 sin α)d |
| $a_{4,c}$ (unloaded edge) | 180° ≤ α ≤ 360° | 5d | 7d | 3d | 3d |

a) STEICO LVL X wide face and minimum penetration depth 10d: (4+ 3cos α)d
b) STEICO LVL X wide face and minimum penetration depth 10d: 5d

Table A:9b: Minimum spacing of staples under shear load

| Spacings as in Figure 8.10 of EN 1995-1-1 | Angle α | Minimum spacing |
|---|---|---|
| $a_1$ (in direction of the grain) | 0° ≤ α ≤ 360° | Θ ≥ 30°: (10+5 cos α) d<br>Θ < 30°: (15+5 cos α) d |
| $a_2$ (perp. to the grain) | 0° ≤ α ≤ 360° | Θ ≥ 30°: (5+10 sin Θ) d<br>Θ < 30°: 10d |
| $a_{3,t}$ (loaded end) | -90° ≤ α ≤ 90° | (15+5 cos α)d |
| $a_{3,c}$ (unloaded end) | 90° ≤ α ≤ 270° | 15d |
| $a_{4,t}$ (loaded edge) | 0° ≤ α ≤ 180° | (10+5 sin α)d |
| $a_{4,c}$ (unloaded edge) | 180° ≤ α ≤ 360° | (5+5 sin Θ)d |

α is the angle between force and direction of the grain and Θ is the angle between staple crown and direction of the grain.

Table A.9c: Minimum spacings for axially loaded screws

| Spacings as in chapter 8.7.2 of EN 1995-1-1 | In | Perpendicular to | End distance | Edge distance |
|---|---|---|---|---|
| | a plane parallel to the grain and the axis of the screw | | of the centre of gravity of the threaded part of the screw in the member | |
| | $a_1$ | $a_2$ | $a_{1,CG}$ | $a_{2,CG}$ |
| Wide surface | 7d | 5d | 10d | 4d |
| Narrow surface | 10d | 5d | 12d | 4d |

Table A.9d: Minimum spacing of nails with grooves, d = 4 mm, and screws, d = 5 mm, according to ETA 04/0013 in the narrow and wide surfaces of LVL $R^L$, R and $R^S$ in steel plate – wood connections with intermediate layers and staggered arrangement

| End and Edge spacing | Angle α | Minimum spacing |
|---|---|---|
| $a_1$ (in direction of the grain) | α = 0° | 50 mm |
| $a_2$ (perp. to the grain) | α = 0° | 10 mm |
| $a_{3,t}$ (loaded end) | α = 0° | 80 mm |
| $a_{3,c}$ (unloaded end) | α = 0° | 15d |
| $a_{4,c}$ (unloaded edge) | α = 0° | 15 mm |
| α is the angle between force and direction of the grain | | |

Assembling of dowels, bolts and tight-fitting bolts

The minimum spacing of bolts among each other and to the end grain or edges are given in table A.10a and A.10b.

The minimum spacing of dowels and tight-fitting bolts among each other and to the end grain or edges are given in table A.11.

Table A.10a: minimum spacing of bolts in the laminated veneer lumber – Table part a

| Spacing in circular stiff connections with bolts in three-member connections* | Minimum spacing | | |
|---|---|---|---|
| | LVL R, $R^S$ all surfaces; LVL X narrow surface | LVL X wide surface | Side member: LVL X wide surface middle member: LVL R, $R^S$ all surfaces or LVL X narrow surface |
| $a_1$ (below each other on the circle) | 6d | 4d | 5d |
| $a_2$ (below each other between circles) | 5d | 4d | 5d |
| $a_{3,t}$ (loaded end) | 6d | 4d | 6d in the middle member<br>4d in the side member |
| $a_{4,t}$ (loaded edge) | 4d | 3d | 4d in the middle member<br>3d in the side member |

* "Side member" describes the outer members of a three-member connection (frame corner), "middle member" describes the middle part in this connection.

Table A.10b: minimum spacing of bolts in the laminated veneer lumber – Table part b

| Spacing as in figure 8.7 of EN 1995-1-1 | Angle α as in picture A.2 | Minimum spacing | |
|---|---|---|---|
| | | LVL R, $R^S$ all surfaces; LVL X narrow surface | LVL X wide surface |
| $a_1$ (in direction of the grain) | 0° ≤ α ≤ 360° | (4+3\|cos α\|)d [a)] | 4d |
| $a_2$ (perp. to the grain) | 0° ≤ α ≤ 360° | 4d | |
| $a_{3,t}$ (loaded end) | -90° ≤ α ≤ 90° | max{7d; 105 mm} [b)] | max{4d; 60 mm} [c)] |
| $a_{3,c}$ (unloaded end) | 90° ≤ α ≤ 150° | (1+6sin α)d | 4d |
| | 150° ≤ α ≤ 210° | 4d | |
| | 210° ≤ α ≤ 270° | (1+6\|sin α\|)d | |
| $a_{4,t}$ (loaded edge) | 0° ≤ α ≤ 180° | max{(2+2sin α)d; 3d} | |
| $a_{4,c}$ (unloaded edge) | 180° ≤ α ≤ 360° | 3d | |

a) The minimum spacing $a_1$ may be reduced to 5d, if $f_{h,0,k}$ is multiplied with $\sqrt{a_1/(4+3|cos\,\alpha|)d}$

b) The minimum spacing $a_{3,t}$ may be reduced to 7d for d < 15 mm, if $f_{h,0,k}$ is multiplied with $a_{3,t}$ / 105 mm

c) The minimum spacing $a_{3,t}$ may be reduced to 4d for d < 15 mm, if $f_{h,0,k}$ is multiplied with $a_{3,t}$ / 60 mm

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Annex 6 (informative)
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Design of connections with STEICO GLVL

Table A.11: minimum spacing of dowels and tight-fitting bolts in the laminated veneer lumber

| Spacing as in figure 8.7 of EN 1995-1-1 | | Angle α as in picture A.2 | Minimum spacing | |
|---|---|---|---|---|
| | | | LVL R, $R^S$ all surfaces; LVL X narrow surface | LVL X wide surface |
| $a_1$ | (in direction of the grain) | 0° ≤ α ≤ 360° | (4+3\|cos α\|)d [a)] | (3+\|cos α\|)d |
| $a_2$ | (perp. to the grain) | 0° ≤ α ≤ 360° | 3d | |
| $a_{3,t}$ | (loaded end) | -90° ≤ α ≤ 90° | max{7d; 105 mm} [b)] | max{4d; 60 mm} [c)] |
| $a_{3,c}$ | (unloaded end) | 90° ≤ α < 150° | $a_{3,t}$ \|sin α\| | (3+\|sin α\|)d |
| | | 150° ≤ α < 210° | 3d | |
| | | 210° ≤ α ≤ 270° | $a_{3,t}$ \|sin α\| | |
| $a_{4,t}$ | (loaded edge) | 0° ≤ α ≤ 180° | max{(2+2sin α)d; 3d} | |
| $a_{4,c}$ | (unloaded edge) | 180° ≤ α ≤ 360° | 3d | |
| a) , b) , c) : see table A.10b | | | | |