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MEMBER OF EOTA

European Technical Assessment ETA-25/0523 of 2025/08/20

I General Part

Technical Assessment Body issuing the ETA and designated according to Article 29 of the Regulation (EU) No 305/2011: ETA-Danmark A/S

Trade name of the construction product:	RAWLPLUG screws R-PTX, R-PTK, R-PVS, R-PVZ
Product family to which the above construction product belongs:	Screws for use in timber constructions
Manufacturer:	RAWLPLUG S.A. Kwidzynska 6 51-416 Wroclaw Poland Internet www.rawlplug.com
Manufacturing plant:	Manufacturing plant 27 Manufacturing plant 32
This European Technical Assessment contains:	32 pages including 7 annexes which form an integral part of the document
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of:	EAD 130118-01-0603: Screws and threaded rods for timber constructions
This version replaces:	

II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of the product

Rawlplug "R-PTX", "R-PTK", "R-PVS" and "R-PVZ" screws are self-tapping screws to be used in timber structures. Rawlplug "R-PTX" and "R-PTK" screws shall be threaded over a part of the length. Rawlplug "R-PVS" and "R-PVZ" screws shall be threaded over the full length. The screws shall be produced from carbon steel wire for nominal diameters of 3,0 mm to 10,0 mm. Where corrosion protection is required, the material or coating shall be declared in accordance with the relevant specification given in Annex A of EN 14592.

Geometry and Material
The nominal diameter (outer thread diameter), d, shall not be less than 3,0 mm and shall not be greater than 10,0 mm. The overall length, L, of screws shall not be less than 16 mm and shall not be greater than 600 mm. Other dimensions are given in Annex A.

The ratio of inner thread diameter to outer thread diameter d_1/d ranges from 0,62 to 0,70.

The screws are threaded over a minimum length L_G of $4{,}0 \cdot d$ (i.e. $L_G \geq 4{,}0 \cdot d$).

The lead p (distance between two adjacent thread flanks) ranges from $0{,}67 \cdot d$ to $0{,}76 \cdot d$.

No breaking shall be observed at a bend angle, α, of less than $(45/d^{0,7} + 20)$ degrees.

2 Specification of the intended use in accordance with the applicable European Assessment Document (hereinafter EAD)

The screws are used for connections in load bearing timber structures between softwood members of solid timber, glued laminated timber, cross-laminated timber, and laminated veneer lumber, similar glued members, wood-based panels or steel.

Rawlplug "R-PVS" and "R-PVZ" screws are also used as tensile, compressive reinforcement perpendicular to the grain or shear reinforcement. Furthermore, Rawlplug screws with diameters between 6 mm and 10 mm may also be used for the fixing of thermal insulation material on rafters and on vertical facades.

Steel plates and wood-based panels except solid wood panels and cross laminated timber shall only be located on the side of the screw head. The following wood-based panels may be used:

- Plywood according to EN 636 or ETA
- Particleboard according to EN 312 or ETA
- Oriented Strand Board, Type OSB/3 and OSB/4 according to EN 300 or ETA
- Fibreboard according to EN 622-2 and 622-3 or ETA (minimum density 650 kg/m³) or national provisions that apply at the installation site
- Cement bonded particleboard according to EN 634 or ETA
- Solid wood panels according to EN 13353 and EN 13986 and cross laminated timber according to ETA
- Laminated Veneer Lumber according to EN 14374 or European Technical Approval
- Engineered wood products according to ETA, provided that the ETA for the product provides provisions for the use of self-tapping screws and these provisions are applied

The screws shall be driven into the wood without pre-drilling or after pre-drilling.

The screws are intended to be used in timber connections for which requirements for mechanical resistance and stability and safety in use in the sense of the Basic Works Requirements 1 and 4 of Regulation 305/2011 (EU) shall be fulfilled.

The design of the connections shall be based on the characteristic load-carrying capacities of the screws. The design capacities shall be derived from the characteristic capacities in accordance with Eurocode 5 or an appropriate national code (e.g. DIN 1052:2008-12).

The screws are intended for use for connections subject to static or quasi static loading.

Section 3.5 of this ETA contains corrosion protection for Rawlplug screws made from carbon steel. The screws are for use in timber structures subject to service classes 1 and 2 of Eurocode 5. The corrosion protection is given according to EN1995-1-1, or by equivalent measures.

The scope of the screws regarding resistance to corrosion shall be defined according to national provisions that apply at the installation site considering environmental conditions.

The provisions made in this European Technical Assessment are based on an assumed intended working life of the screws of 50 years.
The indications given on the working life cannot be interpreted as a guarantee given by the producer or Assessment Body, 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

Characteristic	Assessment of characteristic
3.1 Mechanical resistance and stability*) (BWR1)	
Dimensions	See annex A
Characteristic yield moment	See section 3.4
Bending angle	No performance assessed
Characteristic withdrawal parameter	See section 3.4
Characteristic head pull-trough parameter of screws	See section 3.4
Characteristic tensile strength Screws made from carbon steel “R-PTX”, “R-PTK”, “R-PVS” and “R-PVZ”	Characteristic value $f_{tens,k}$: Screw d = 3,0 mm: 4,0 kN Screw d = 3,5 mm: 5,0 kN Screw d = 4,0 mm: 6,0 kN Screw d = 4,5 mm: 7,5 kN Screw d = 5,0 mm: 9,5 kN Screw d = 6,0 mm: 12,5 kN Screw d = 8,0 mm: 22,0 kN Screw d = 10,0 mm: 42,5 kN
Characteristic yield strength	See section 3.4
Characteristic torsional strength Screws made from carbon steel “R-PTX”, “R-PTK”, “R-PVS” and “R-PVZ”	Characteristic value $f_{tor,k}$: Screw d = 3,0 mm: 2,0 Nm Screw d = 3,5 mm: 2,5 Nm Screw d = 4,0 mm: 3,5 Nm Screw d = 4,5 mm: 5,0 Nm Screw d = 5,0 mm 7,0 Nm Screw d = 6,0 mm: 10,5 Nm Screw d = 8,0 mm: 24,5 Nm Screw d = 10,0 mm: 61,5 Nm
Insertion moment	Ratio of the characteristic torsional strength to the mean insertion moment: $\mathbf{f_{tor,k} / R_{tor,mean} > 1,5}$
Spacing, end and edge distances of the screws and minimum thickness of the timber material	See annex B
Slip modulus for mainly axially loaded screws	See section 3.4
Durability against corrosion	See section 3.5
3.2 Safety in case of fire (BWR2)	
Reaction to fire	The screws are made from steel classified as **class A1** in accordance with EN 13501-1 and Commission Delegated Regulation 2016/364.

*) See additional information in section 3.4 – 3.6.

3.4 Mechanical resistance and stability

The load-carrying capacities for Rawlplug screws are applicable to the wood-based materials mentioned in paragraph 1 even though the term timber has been used in the following.

The characteristic lateral load-carrying capacities and the characteristic axial withdrawal capacities of Rawlplug screws should be used for designs in accordance with Eurocode 5 or an appropriate national code.

Point side penetration length must be $\ell_{ef} \geq 4 \cdot d$, where d is the outer thread diameter of the screw. For the fixing of rafters, point side penetration must be at least 40 mm, $\ell_{ef} \geq 40$ mm.

European Technical Assessments for structural members or wood-based panels must be considered where applicable.

Reductions in the cross-sectional area caused by Rawlplug screws with a diameter of 10 mm shall be taken into account in the member strength verification both, in the tensile and compressive area of members.

For screws in pre-drilled holes, the drill hole diameter should be considered in the member strength verification, for screws driven without pre-drilling, the inner thread diameter.

For wood-based panels the relevant ETA's must be considered where applicable.

Lateral load-carrying capacity
The characteristic lateral load-carrying capacity of Rawlplug screws shall be calculated according to EN 1995-1-1:2008 (Eurocode 5) using the outer thread diameter d as the effective diameter of the screw.

The characteristic yield moment is:

Rawlplug screws made from carbon steel:

Screw d = 3,0 mm:	$M_{y,k}$ = 2,0 Nm
Screw d = 3,5 mm:	$M_{y,k}$ = 2,5 Nm
Screw d = 4,0 mm:	$M_{y,k}$ = 3,5 Nm
Screw d = 4,5 mm:	$M_{y,k}$ = 5,0 Nm
Screw d = 5,0 mm:	$M_{y,k}$ = 5,5 Nm
Screw d = 6,0 mm:	$M_{y,k}$ = 9,0 Nm
Screw d = 8,0 mm:	$M_{y,k}$ = 22,5 Nm
Screw d = 10,0 mm:	$M_{y,k}$ = 38,0 Nm

Where:
d outer thread diameter [mm]

The embedding strength for screws in non-pre-drilled holes in softwood arranged at an angle between screw axis and grain direction, $15° \leq \varepsilon \leq 90°$ is:

$$f_{h,k} = \frac{0,082 \cdot \rho_k \cdot d^{-0,3}}{2,5 \cdot \cos^2 \varepsilon + \sin^2 \varepsilon} \quad \text{[N/mm²]}$$

and accordingly for screws in pre-drilled holes:

$$f_{h,k} = \frac{0,082 \cdot \rho_k \cdot (1-0,01 \cdot d)}{2,5 \cdot \cos^2 \varepsilon + \sin^2 \varepsilon} \quad \text{[N/mm²]}$$

Where:
ρ_k characteristic timber density [kg/m³], with a maximum characteristic density of 440 kg/m³
d outer thread diameter [mm]
ε angle between screw or rod axis and grain direction.

The embedding strengths given above may be applied for screws within single softwood layers in cross laminated timber, if the single layer is considered as a separate softwood member and the minimum spacing, end and edge distances are observed for the single layer. For inner layers, the edge distance perpendicular to the grain may be reduced to 3 · d.

Alternatively, the embedding strength for screws arranged parallel to the plane of cross laminated timber (layers of softwood), independent of the angle between screw axis and grain direction, $0° \leq \varepsilon \leq 90°$, may be calculated from:

$$f_{h,k} = 20 \cdot d^{-0,5} \quad \text{[N/mm²]}$$

unless otherwise specified in the technical specification (ETA or hEN) for the cross laminated timber.

Where:
d outer thread diameter [mm]

The lateral force component perpendicular to the screw axis must not be directed away from the member surface.

The embedding strength for screws in non-pre-drilled holes in softwood LVL arranged at an angle between screw axis and grain direction, $15° \leq \varepsilon \leq 90°$ is:

$$f_{h,k} = \frac{0,082 \cdot \rho_k \cdot d^{-0,3}}{\left(2,5 \cdot \cos^2 \varepsilon + \sin^2 \varepsilon\right)\left(1,5 \cdot \cos^2 \beta + \sin^2 \beta\right)} \quad \text{[N/mm²]}$$

and accordingly for screws in pre-drilled holes in softwood LVL:

$$f_{h,k} = \frac{0,082 \cdot \rho_k \cdot (1-0,01 \cdot d)}{\left(2,5 \cdot \cos^2 \varepsilon + \sin^2 \varepsilon\right)\left(1,5 \cdot \cos^2 \beta + \sin^2 \beta\right)} \quad \text{[N/mm²]}$$

Where:
ρ_k characteristic timber density [kg/m³]
d outer thread diameter [mm]
ε angle between screw axis and grain direction
β angle between screw axis and the LVL's wide face ($0° \leq \beta \leq 90°$).

The definition of the angles α, β and ε is given in Annex G.

For laterally loaded screws, the rules for multiple fastener connections in EN 1995-1-1, 8.3.1.1 (8) should be applied.

The lateral slip modulus K_{ser} for the serviceability limit state of screws in non-predrilled holes is given in EN 1995-1-1 (Eurocode 5) clause 7.1 and table 7.1 as for nails in non-predrilled holes.

The lateral slip modulus K_{ser} for the serviceability limit state of screws in predrilled holes is given in EN 1995-1-1 (Eurocode 5) clause 7.1 and table 7.1 as for nails in predrilled holes.

Axial withdrawal capacity

The characteristic axial withdrawal capacity of Rawlplug screws (only softwood) in solid timber, glued laminated timber, cross-laminated timber or laminated veneer lumber members at an angle of $15° \leq \varepsilon \leq 90°$ to the grain shall be calculated according to EN 1995-1-1:2008 from:

$$F_{ax,\varepsilon,Rk} = \frac{n_{ef} \cdot k_{ax} \cdot f_{ax,k} \cdot d \cdot \ell_{ef}}{k_\beta} \left(\frac{\rho_k}{350}\right)^{0,8} \quad [N]$$

Where:

$F_{ax,\varepsilon,RK}$	characteristic withdrawal capacity of the screws at an angle ε to the grain [N]
n_{ef}	effective number of screws according to EN 1995-1-1:2008
k_{ax}	$k_{ax} = 1,0$ for $45° \leq \varepsilon \leq 90°$ $k_{ax} = a + \frac{b \cdot \varepsilon}{45°}$ for $0° \leq \varepsilon < 45°$ $a = \begin{cases} 0,5 & \text{for LVL} \\ 0,3 & \text{for timber} \end{cases}$ $b = \begin{cases} 0,5 & \text{for LVL} \\ 0,7 & \text{for timber} \end{cases}$
k_β	$k_\beta = 1,0$ for timber $k_\beta = 1,5 \cdot \cos^2\beta + \sin^2\beta$ for LVL
$f_{ax,k}$	Characteristic withdrawal parameter For screws in solid or glued laminated timber, cross laminated timber, LVL and SWP members with maximum characteristic density of 440 kg/m³: Screw d = 3,0 mm: $f_{ax,k}$ = 15,0 N/mm² Screw d = 3,5 mm: $f_{ax,k}$ = 15,0 N/mm² Screw d = 4,0 mm: $f_{ax,k}$ = 14,0 N/mm² Screw d = 4,5 mm: $f_{ax,k}$ = 10,5 N/mm² Screw d = 5,0 mm: $f_{ax,k}$ = 12,0 N/mm² Screw d = 6,0 mm: $f_{ax,k}$ = 13,5 N/mm² Screw d = 8,0 mm: $f_{ax,k}$ = 12,0 N/mm² Screw d = 10,0 mm: $f_{ax,k}$ = 12,0 N/mm²
d	outer thread diameter [mm]
ℓ_{ef}	penetration length of the threaded part according to EN 1995-1-1:2008 [mm]
ε	angle between grain direction and screw axis, $15° \leq \varepsilon \leq 90°$,
β	angle between screw axis and the LVL's wide face ($0° \leq \beta \leq 90°$)
ρ_k	characteristic density [kg/m³]

For screws penetrating more than one layer of cross laminated timber, the different layers may be considered proportionally.

The axial withdrawal capacity for screws arranged parallel to the plane of cross laminated timber, independent of the angle between screw axis and grain direction, $0° \leq \varepsilon \leq 90°$, may be calculated from:

$$F_{ax,Rk} = 20 \cdot d^{0,8} \cdot \ell_{ef}^{0,9} \quad [N] \qquad \text{for screws}$$

Where:

d outer thread diameter [mm]

ℓ_{ef} Penetration length of the threaded part according to EN 1995-1-1:2008 [mm]

The axial withdrawal capacity is limited by the head pull-through capacity and the tensile capacity of the screw.

For axially loaded screws in tension, where the external force is parallel to the screw axes, the rules in EN 1995-1-1, 8.7.2 (8) should be applied.

For inclined screws in timber-to-timber or steel-to-timber shear connections, where the screws are arranged under an angle $30° \leq \varepsilon \leq 60°$ between the shear plane and the screw axis, the effective number of screws n_{ef} should be determined as follows:

For one row of n screws parallel to the load, the load-carrying capacity should be calculated using the effective number of fasteners n_{ef}, where:

$$n_{ef} = \max\left\{n^{0,9}; 0,9 \cdot n\right\}$$

and n is the number of inclined screws in a row. If crossed pairs of screws are used in timber-to-timber connections, n is the number of crossed pairs of screws in a row.

Note: For screws as reinforcement or inclined screws as fasteners in mechanically jointed beams or columns or for the fixing of thermal insulation material or for shear connections in shear walls and diaphragms, n_{ef} = n.

The axial slip modulus K_{ser} of the threaded part of a screw for the serviceability limit state should be taken independent of angle ε to the grain as:

$K_{ser} = 25 \cdot d \cdot \ell_{ef}$ [N/mm] for fasteners in softwood

Where:

d outer thread diameter [mm]

ℓ_{ef} penetration length in the timber member [mm]

Head pull-through capacity

The characteristic head pull-through capacity of Rawlplug screws in softwoods and wood-based panels shall be calculated according to EN 1995-1-1:2008 from:

$$F_{ax,\varepsilon,Rk} = n_{ef} \cdot f_{head,k} \cdot d_h^2 \cdot \left(\frac{\rho_k}{350}\right)^{0,8} \quad [N]$$

where:

- $F_{ax,\varepsilon,RK}$ characteristic head pull-through capacity of the connection at an angle $\varepsilon \geq 30°$ to the grain [N]
- n_{ef} effective number of screws according to EN 1995-1-1:2008
  For inclined screws:
  $n_{ef} = \max\{n^{0,9}\,; 0,9 \cdot n\}$
  (see axial withdrawal capacity)
- $f_{head,k}$ characteristic head pull-through parameter [N/mm²]
- d_h diameter of the screw head or the washer [mm]. Outer diameter of washers $d_k > 32$ mm shall not be considered.
- ρ_k characteristic density [kg/m³], for wood-based panels maximum $\rho_k = 380$ kg/m³, for other members maximum $\rho_k = 440$ kg/m³

Characteristic head pull-through parameter for Rawlplug screws in connections with softwood and in connections with wood-based panels with thicknesses above 20 mm:

Screws $d_h \leq 20$ mm except R-PTX screws with d = 5 mm and R-PTK screws with d = 6 mm:

	$f_{head,k}$ = 14 N/mm²
R-PTX screws with d = 5 mm:	$f_{head,k}$ = 17 N/mm²
R-PTK screws with d = 6 mm:	$f_{head,k}$ = 19 N/mm²
d_h > 20 mm:	$f_{head,k}$ = 10 N/mm²

Characteristic head pull-through parameter for Rawlplug screws in connections with wood-based panels with thicknesses between 12 mm and 20 mm:
$f_{head,k}$ = 8 N/mm²

Characteristic head pull-through parameter for Rawlplug screws in connections with wood-based panels with a thickness below 12 mm (minimum thickness of the wood based panels of 1,2·d with d as outer thread diameter):
$f_{head,k}$ = 8 N/mm²
limited to $F_{ax,Rk}$ = 400 N.

The head diameter d_h of all screws shall be greater than $1,8 \cdot d_s$, where d_s is the smooth shank or wire diameter. Otherwise, the characteristic head pull-through capacity $F_{ax,\varepsilon,Rk} = 0$.

The minimum thickness of wood-based panels according to the clause 3.6 must be observed.

In steel-to-timber connections the head pull-through capacity may be disregarded.

Tensile capacity

The characteristic tensile strength $f_{tens,k}$ of screws is given in Section 3.1.

For screws used in combination with steel plates, the tear-off capacity of the screw head should be greater than the tensile strength of the screw.

When determining design values of the tensile capacity it should be used γ_{M2} partial factor according to EN 1993 or to the particular national annex.

Combined laterally and axially loaded screws

For connections subjected to a combination of axial and lateral load, the following expression should be satisfied:

$$\left(\frac{F_{ax,Ed}}{F_{ax,Rd}}\right)^2 + \left(\frac{F_{la,Ed}}{F_{la,Rd}}\right)^2 \leq 1$$

where

- $F_{ax,Ed}$ axial design load of the screw
- $F_{la,Ed}$ lateral design load of the screw
- $F_{ax,Rd}$ design load-carrying capacity of an axially loaded screw
- $F_{la,Rd}$ design load-carrying capacity of a laterally loaded screw

Mechanically jointed beams

Rawlplug “R-PVS” and “R-PVZ” screws with a full thread may be used for connections in structural members which are composed of several parts in mechanically jointed beams or columns.

Compressive capacity

The design compressive capacity $F_{c,90,Rd}$ of Rawlplug “R-PVS” and “R-PVZ” screws with full thread along the length embedded in timber with an angle between fastener axis and grain direction of $45° \leq \varepsilon \leq 90°$ is the minimum of the axial resistance against pushing-in and the buckling resistance:

$$F_{c,90,Rd} = \min\{F_{ax,Rd}\,; F_{ki,Rd}\}$$

$$F_{c,90,Rd} = \min\left\{f_{ax,d} \cdot d \cdot \ell_{ef} \cdot \left(\frac{\rho_k}{350}\right)^{0,8} ; \frac{k_c \cdot N_{pl,k}}{\gamma_{M1}}\right\}$$

Where:

$$\kappa_c = \begin{cases} 1 & \text{for } \bar{\lambda}_k \leq 0,2 \\ \dfrac{1}{k + \sqrt{k^2 - \bar{\lambda}_k^2}} & \text{for } \bar{\lambda}_k > 0,2 \end{cases}$$

$$k = 0,5 \cdot \left[1 + 0,49 \cdot (\bar{\lambda}_k - 0,2) + \bar{\lambda}_k^2\right]$$

The relative slenderness ratio shall be calculated from:

$$\bar{\lambda}_k = \sqrt{\frac{N_{pl,k}}{N_{ki,k}}}$$

Where:

$$N_{pl,k} = \pi \cdot \frac{d_1^2}{4} \cdot f_{y,k} \qquad [N]$$

is the characteristic value for the axial capacity in case of plastic analysis referred to the inner thread cross-section.

Characteristic yield strength of screws from carbon steel:
Screw d = 6,0 mm: $f_{y,k}$ = 980 N/mm²
Screw d = 8,0 mm: $f_{y,k}$ = 800 N/mm²
Screw d = 10,0 mm: $f_{y,k}$ = 780 N/mm²

Characteristic ideal elastic buckling load:

$$N_{ki,k} = \sqrt{c_h \cdot E_S \cdot I_S} \qquad [N]$$

Elastic foundation of the screw:

$$c_h = (0{,}19 + 0{,}012 \cdot d) \cdot \rho_k \cdot \left(\frac{\varepsilon}{180°} + 0{,}5\right) \qquad [N/mm^2]$$

Modulus of elasticity:
E_s = 210000 [N/mm²]

Second moment of area:

$$I_S = \frac{\pi}{64} \cdot d_1^4 \qquad [mm^4]$$

$f_{ax,d}$ design value of the axial withdrawal parameter of the threaded part of the screw [N/mm²]
d_1 inner thread diameter [mm]
d outer thread diameter [mm]
ℓ_{ef} penetration length of the threaded part [mm]
ε angle between screw axis and grain direction
ρ_k characteristic density [kg/m³]
γ_{M1} partial factor according to EN 1993 or to the particular national annex

Compression reinforcement
See Annex C

Thermal insulation material on top of rafters
See Annex D

Shear reinforcement
See Annex E

Tensile reinforcement
See Annex F

3.5 Aspects related to the performance of the product

3.5.1 Corrosion protection
Rawlplug screws are produced from steel wire. Screws are made from carbon steel are electrogalvanised and yellow or blue chromate. The thickness of the zinc coating is minimum 5 µm.

The screws are for use in timber structures subject to service classes 1 and 2 of Eurocode 5. The corrosion protection is given according to EN1995-1-1, or by equivalent measures.
Contact corrosion shall be avoided.

3.6 General aspects related to the intended use of the product

The screws are manufactured in accordance with the provisions of the ETA using the automated manufacturing process and laid down in the technical documentation.

The installation shall be carried out in accordance with Eurocode 5 or an appropriate national code unless otherwise is defined in the following. Instructions from Rawlplug SA should be considered for installation.

The screws are used for connections in load bearing timber structures between members of solid timber, glued laminated timber, cross-laminated timber, laminated veneer lumber, similar glued members, wood-based panels or steel members.

The screws may be used for connections in load bearing timber structures with structural members according to an associated ETA, if according to the associated ETA of the structural member a connection in load bearing timber structures with screws according to an ETA is allowed.

Rawlplug fully threaded “R-PVS” and “R-PVZ” screws are also used as tensile or compressive reinforcement perpendicular to the grain or as shear reinforcement.

Furthermore, the screws with diameters of at least 6 mm may also be used for the fixing of insulation on top of rafters.

A minimum of two screws should be used for connections in load bearing timber structures. This does not apply for reinforcements or for the fixing of battens, rafters, purlins or similar on main beams or top plates, if the member is fixed with at least two screws in total.

The minimum penetration depth in structural members made of solid, glued or cross-laminated timber or laminated veneer lumber is:

$$\ell_{ef,req} = \min\left\{\frac{4 \cdot d}{\sin\varepsilon}; 20 \cdot d\right\}$$

Wood-based panels and steel plates should only be arranged on the side of the screw head. The minimum thickness of wood-based panels should be $1{,}2 \cdot d$. Furthermore, the minimum thickness for following wood-based panels should be:

- Plywood, Fibreboards: 6 mm
- Particleboards, OSB, Cement Particleboards: 8 mm
- Solid wood panels: 12 mm

For structural members according to ETAs the terms of the ETAs must be considered.

If screws with an outer thread diameter $d > 8$ mm are used in load bearing timber structures, the structural solid or glued laminated timber, laminated veneer lumber and similar glued members must be from spruce, pine or fir. This does not apply for screws in pre-drilled holes.

The screws shall be driven into softwood with or without pre-drilling.

The maximum total penetration length of "R-PVS" and "R-PVZ" screws with 8 mm diameter without pre-drilling or after partial pre-drilling is limited to 400 mm.

The hole diameter in steel members must be predrilled with a suitable diameter.

Only the equipment prescribed by Rawlplug SA shall be used for driving the screws.

In connections with screws with countersunk head according to Annex A, the head must be flush with the surface of the connected structural member. A deeper countersink is not allowed.

For screws arranged at angles $\varepsilon < 90°$ between screw axis and grain direction minimum spacing and distances are defined as follows:

Minimum spacing a_1 or a_2 is defined perpendicular to the fastener axis, minimum end or edge distances $a_{1,c}$, $a_{1,t}$, $a_{2,c}$ or $a_{2,t}$ parallel or perpendicular to the grain, respectively, are defined between the centre of the threaded length (axial loading) or the length (lateral loading) in the respective timber member and the member surface as for axially loaded screws in Figure 8.11.a EN 1995-1-1.

Laterally and/or axially loaded screws

For structural timber members, minimum spacing and distances for laterally or axially loaded screws in predrilled holes are given in EN 1995-1-1:2008 (Eurocode 5) clause 8.3.1.2 and table 8.2 as for nails in predrilled holes. Here, the outer thread diameter d must be considered.

For screws in non-predrilled holes, minimum spacing and distances are given in EN 1995-1-1:2008 (Eurocode 5) clause 8.3.1.2 and table 8.2 as for nails in non-predrilled holes.

For screws in non-predrilled Douglas fir members minimum spacing and distances parallel to the grain shall be increased by 50%.

Minimum distances from the unloaded edge perpendicular to the grain may be reduced to $3 \cdot d$ also for timber thickness $t < 5 \cdot d$, if the spacing parallel to the grain and the end distance is at least $25 \cdot d$.

These requirements do not apply for structural wood-based panels or LVL with cross layers.

Exclusively axially loaded screws

For a crossed screw couple the minimum spacing between the crossing screws is $a_2 = 1{,}5 \cdot d$.
Minimum thickness for predrilled structural members is $t = 24$ mm for screws with outer thread diameter $d < 8$ mm, $t = 30$ mm for screws with outer thread diameter $d = 8$ mm, $t = 40$ mm for screws with outer thread diameter $d = 10$ mm. These minimum thickness values generally apply for non-predrilled softwood members, if the spacing parallel to the grain and the end distance is at least $25 \cdot d$.

In all other cases, minimum thicknesses for screws in non-predrilled softwood members are given in EN 1995-1-1 (Eurocode 5) clause 8.3.1.2 as for nails in non-predrilled holes. Equation (8.18) may be applied for softwood members made of pine or for the fixing of boards, battens or wind braces, if the member is fixed with at least two screws. Otherwise EN 1995-1-1 clause 8.3.1.2 (7) applies.

Cross Laminated Timber

Unless specified otherwise in the technical specification (ETA or hEN) of cross laminated timber, minimum distances and spacing for screws in the wide face of cross laminated timber members with a minimum thickness $t = 10 \cdot d$ may be taken as (see Annex B):

Spacing a_1 parallel to the grain	$a_1 = 4 \cdot d$
Spacing a_2 perpendicular to the grain	$a_2 = 2{,}5 \cdot d$
Distance $a_{3,c}$ from centre of the screw-part in timber to the unloaded end grain	$a_{3,c} = 6 \cdot d$
Distance $a_{3,t}$ from centre of the screw-part in timber to the loaded end grain	$a_{3,t} = 6 \cdot d$
Distance $a_{4,c}$ from centre of the screw-part in timber to the unloaded edge	$a_{4,c} = 2{,}5 \cdot d$
Distance $a_{4,t}$ from centre of the screw-part in timber to the loaded edge	$a_{4,t} = 6 \cdot d$

Unless specified otherwise in the technical specification (ETA or hEN) of cross laminated timber, minimum distances and spacing for screws in the edge surface of cross laminated timber members with a minimum thickness $t = 10 \cdot d$ and a minimum penetration depth perpendicular to the edge surface of $10 \cdot d$ may be taken as (see Annex B):

Spacing a_1 parallel to the CLT plane	$a_1 = 10 \cdot d$
Spacing a_2 perpendicular to the CLT plane	$a_2 = 4 \cdot d$
Distance $a_{3,c}$ from centre of the screw-part in timber to the unloaded end	$a_{3,c} = 7 \cdot d$
Distance $a_{3,t}$ from centre of the screw-part in timber to the loaded end	$a_{3,t} = 12 \cdot d$
Distance $a_{4,c}$ from centre of the screw-part in timber to the unloaded edge	$a_{4,c} = 3 \cdot d$
Distance $a_{4,t}$ from centre of the screw-part in timber to the loaded edge	$a_{4,t} = 6 \cdot d$

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

4.1 AVCP system

According to the decision 1997/176/EC of the European Commission1, as amended, the system(s) of assessment and verification of constancy of performance (see Annex V to Regulation (EU) No 305/2011) is **3**.

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

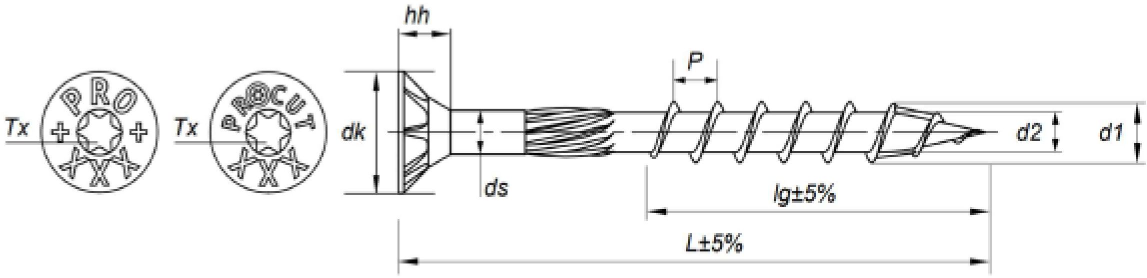
Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at ETA-Danmark prior to CE marking.

Issued in Copenhagen on 2025-08-20 by

Thomas Bruun
Managing Director, ETA-Danmark

Annex A
Drawings of Rawlplug screws

Countersunk head R-PTX

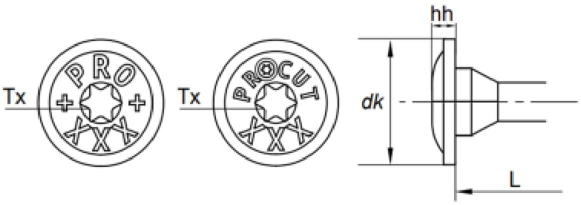


R-PTX	Ø dk	Ø ds.	Ø d1	Ø d2	P	TX	hh
Ø 3,0	6±0,9	2,3±0,15	3±0,15	2,15±0,15	2±0,4	T10	2,3±0,2
Ø 3,5	7±0,9	2,55±0,1	3,5±0,25	2,2±0,15	2,6±0,4	T15	3,4±0,2
Ø 4,0	8±0,9	2,85±0,1	4±0,3	2,5±0,15	3±0,4	T25	4,3±0,2
Ø 4,5	9±0,9	3,2±0,1	4,5±0,3	2,8±0,15	3,4±0,4	T25	4,4±0,2
Ø 5,0	10±0,9	3,6±0,1	5±0,3	3,1±0,15	3,8±0,4	T25	5±0,2
Ø 6,0	12±0,9	4,3±0,21	6±0,3	4±0,25	4,5±0,45	T25-30	5,8±0,3
Ø 8,0	15±1,2	5,9±0,29	8±0,4	5,3±0,3	5,7±0,57	T40	6,7±0,4

L							
Nominal diameter	Ø 3,0	Ø 3,5	Ø 4,0	Ø 4,5	Ø 5,0	Ø 6,0	Ø 8,0
L min	20	20	30	35	35	60	80
L max	35	50	70	80	120	300	400

lg							
Nominal diameter	Ø 3,0	Ø 3,5	Ø 4,0	Ø 4,5	Ø 5,0	Ø 6,0	Ø 8,0
lg min	12	14	17	21	21	35	50
lg max	21	30	40	50	60	70	100

Wafer head R-PTK

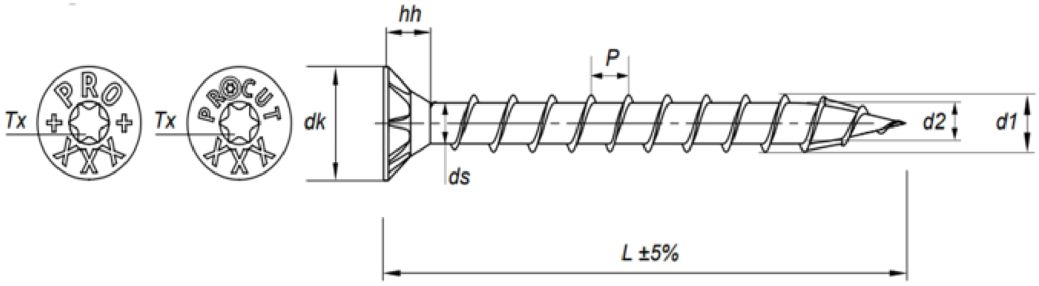


R-PTK	Ø dk	TX	hh
Ø 6,0	14±0,9	T30	2,6±0,3
Ø 8,0	20±1,2	T40	3,2±0,3

L		
Nominal diameter	Ø 6,0	Ø 8,0
L min	40	80
L max	220	400

lg		
Nominal diameter	Ø 6,0	Ø 8,0
lg min	25	50
lg max	70	100

Countersunk head R-PVS

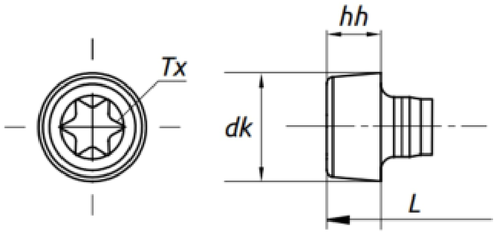


R-PVS	Ø dk	Ø ds.	Ø d1	Ø d2	P	TX	hh
Ø 3,0	6±0,9	2,3±0,15	3±0,15	2,15±0,15	2±0,4	T10	2,3±0,2
Ø 3,5	7±0,9	2,55±0,1	3,5±0,25	2,2±0,15	2,6±0,4	T15	3,4±0,2
Ø 4,0	8±0,9	2,85±0,1	4±0,3	2,5±0,15	3±0,4	T25	4,3±0,2
Ø 4,5	9±0,9	3,2±0,1	4,5±0,3	2,8±0,15	3,4±0,4	T25	4,4±0,2
Ø 5,0	10±0,9	3,6±0,1	5±0,3	3,1±0,15	3,8±0,4	T25	5,0±0,2
Ø 6,0	12±0,9	4,3±0,21	6±0,3	4±0,25	4,5±0,45	T25-30	5,7±0,3
Ø 8,0	15±1,2	5,9±0,29	8±0,4	5,3±0,3	5,7±0,57	T40	6,7±0,4
Ø 10,0	18,5±1,5	7,1±0,35	10±0,5	6,4±0,5	6,1±0,61	T50	8,2±0,4

L								
Nominal diameter	Ø 3,0	Ø 3,5	Ø 4,0	Ø 4,5	Ø 5,0	Ø 6,0	Ø 8,0	Ø 10,0
L min	16	20	20	30	35	60	100	100
L max	16	50	50	50	120	180	590	600

lg								
Nominal diameter	Ø 3,0	Ø 3,5	Ø 4,0	Ø 4,5	Ø 5,0	Ø 6,0	Ø 8,0	Ø 10,0
lg min	13	14	16	25	30	54	90	88
lg max	13	45	45	50	115	174	577	576

Cylinder head R-PVZ



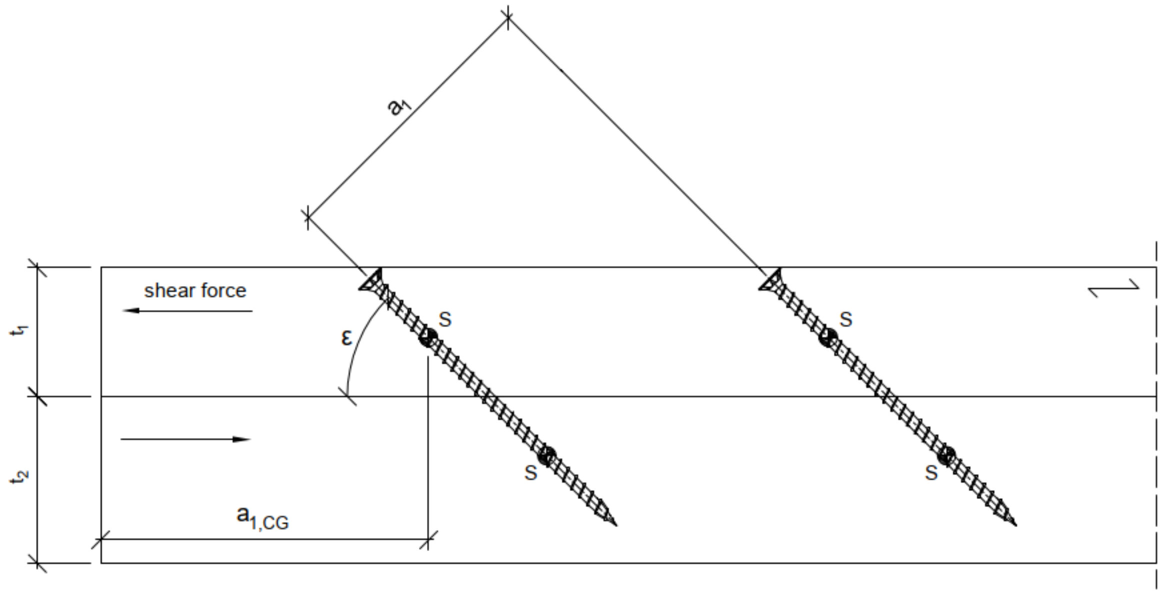
R-PVZ	Ø dk	TX	hh
Ø 6,0	8,5±0,4	T30	4,7±0,2
Ø 8,0	10,2±0,51	T40	7,5±0,4
Ø 10,0	13,4±0,67	T50	8,0±0,4

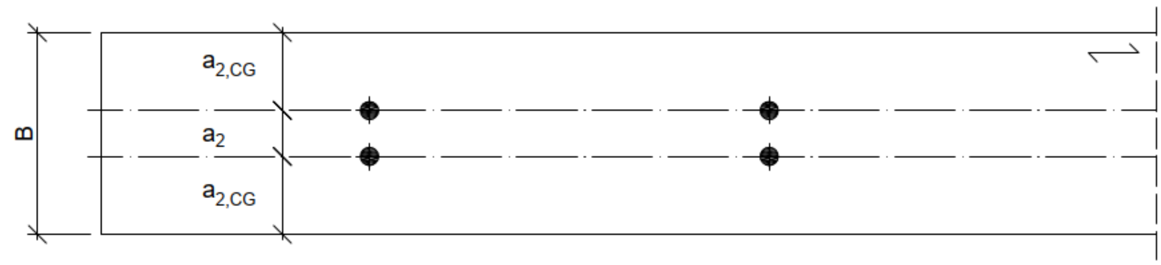
L			
Nominal diameter	Ø 6,0	Ø 8,0	Ø 10,0
L min	80	100	100
L max	200	590	600

lg			
Nominal diameter	Ø 6,0	Ø 8,0	Ø 10,0
lg min	73	90	88
lg max	193	577	576

Annex B
Minimum distances and spacing

Axially loaded screws
Single configuration



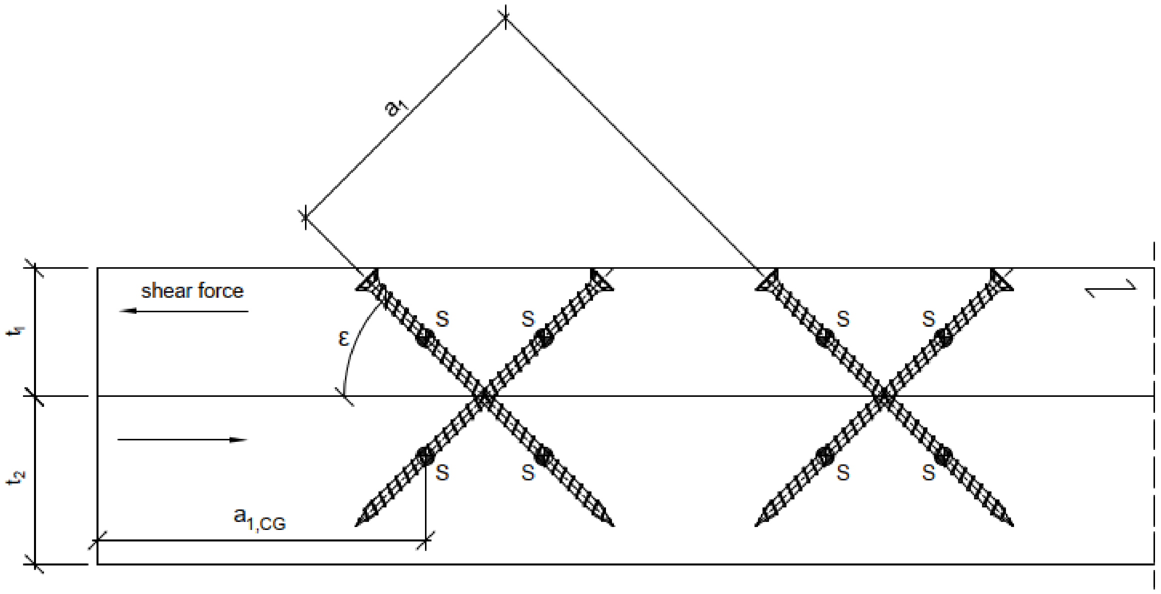


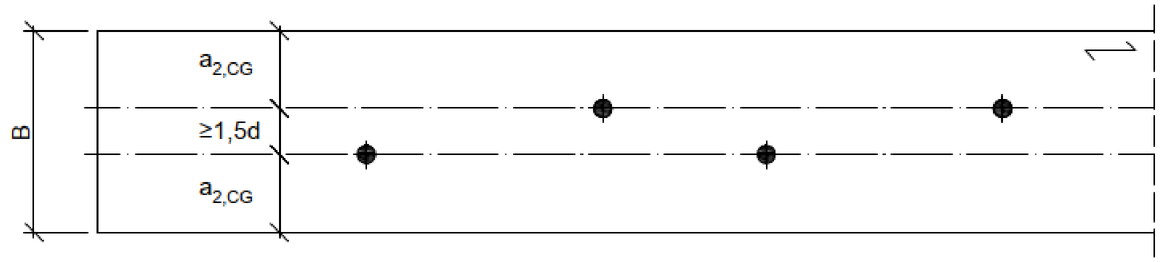
$a_1 \geq 5 \cdot d$
$a_2 \geq 2{,}5 \cdot d$ if $a_1 \cdot a_2 \geq 25 \cdot d^2$
$a_{3,c} \geq 10 \cdot d$
$a_{4,c} \geq 4 \cdot d$

Minimum distance and spacing see also 3.6
Minimum timber thickness $t = 12 \cdot d$, see also 3.6

S = centroid of the part of the screw or threaded rod in the timber

Axially loaded screws
Crosswise configuration





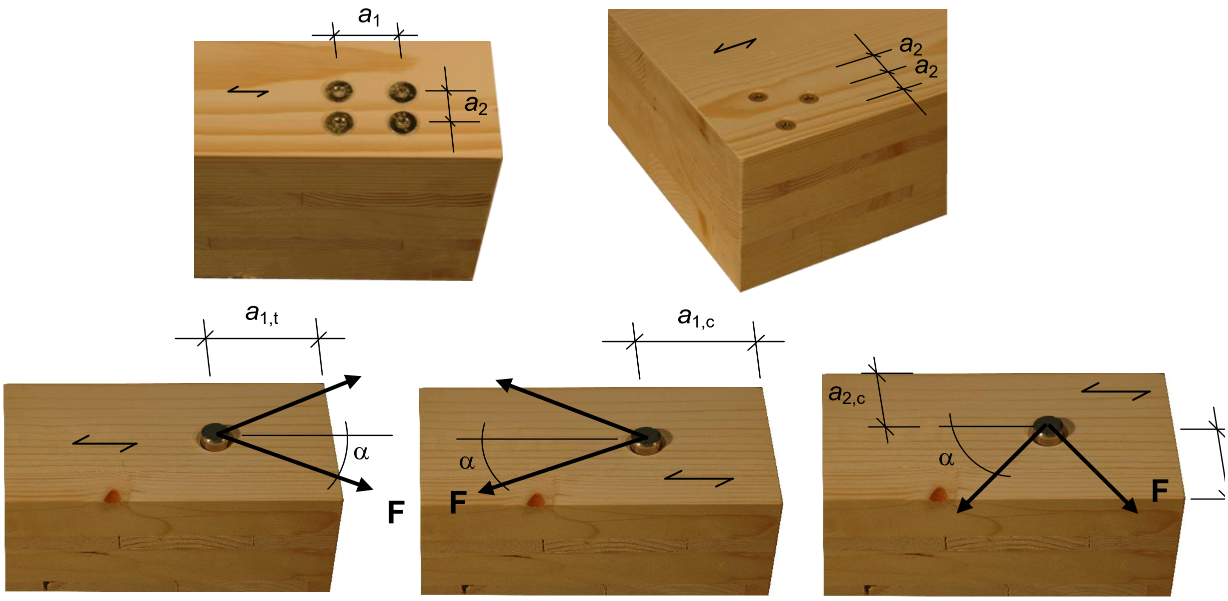
$a_1 \geq 5 \cdot d$
$a_2 \geq 1{,}5 \cdot d$ if $a_1 \cdot a_2 \geq 25 \cdot d^2$
$a_{3,c} \geq 10 \cdot d$
$a_{4,c} \geq 4 \cdot d$

Minimum distance and spacing see also 3.6
Minimum timber thickness t = 12·d, see also 3.6

S = centroid of the part of the screw or threaded rod in the timber

Axially or laterally loaded screws in the plane or edge surface of cross laminated timber

Definition of spacing, end and edge distances in the plane surface unless otherwise specified in the technical specification (ETA or hEN) for the cross laminated timber:



Definition of spacing, end and edge distances in the edge surface unless otherwise specified in the technical specification (ETA or hEN) for the cross laminated timber:

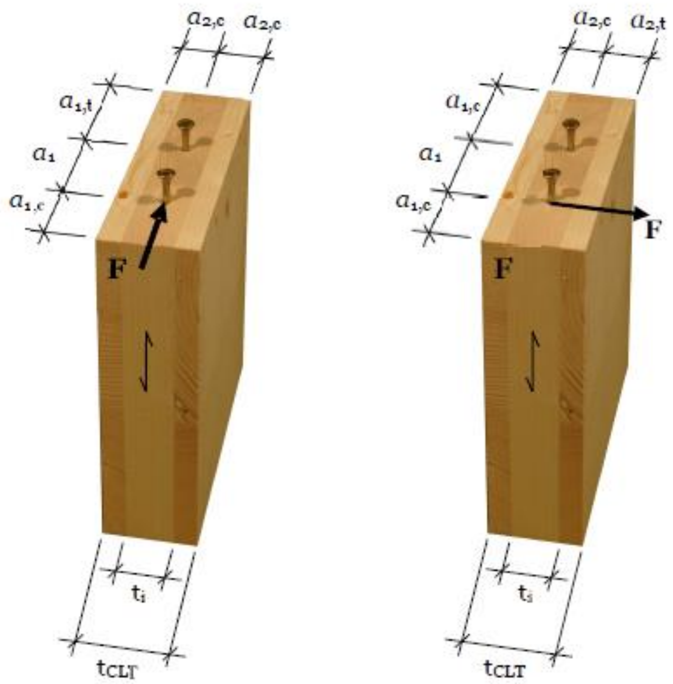


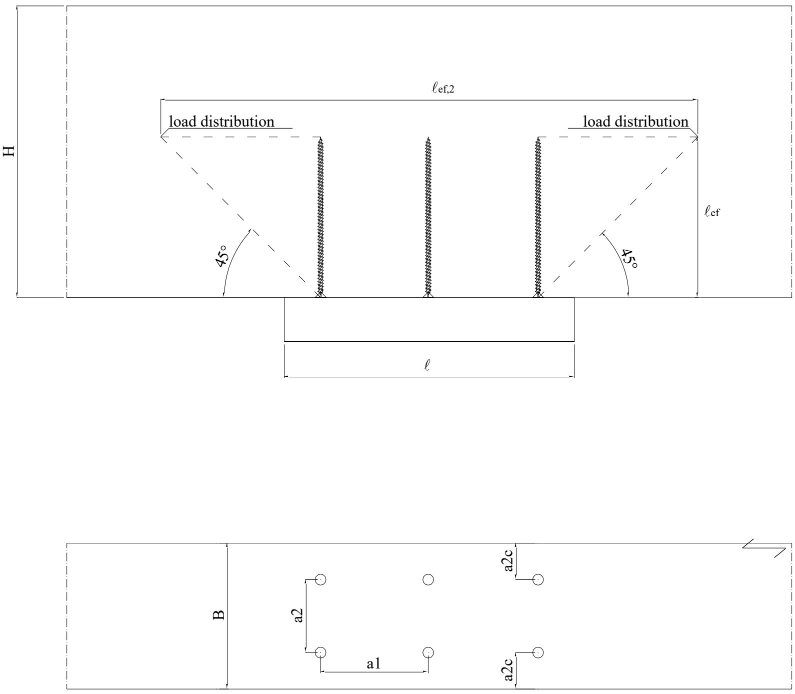
Table B1: Minimum spacing, end and edge distances of screws in the plane or edge surfaces of cross laminated timber

	a_1	$a_{3,t}$	$a_{3,c}$	a_2	$a_{4,t}$	$a_{4,c}$
Plane surface (see Figure 1)	$4 \cdot d$	$6 \cdot d$	$6 \cdot d$	$2{,}5 \cdot d$	$6 \cdot d$	$2{,}5 \cdot d$
Edge surface (see Figure 2)	$10 \cdot d$	$12 \cdot d$	$7 \cdot d$	$4 \cdot d$	$6 \cdot d$	$3 \cdot d$

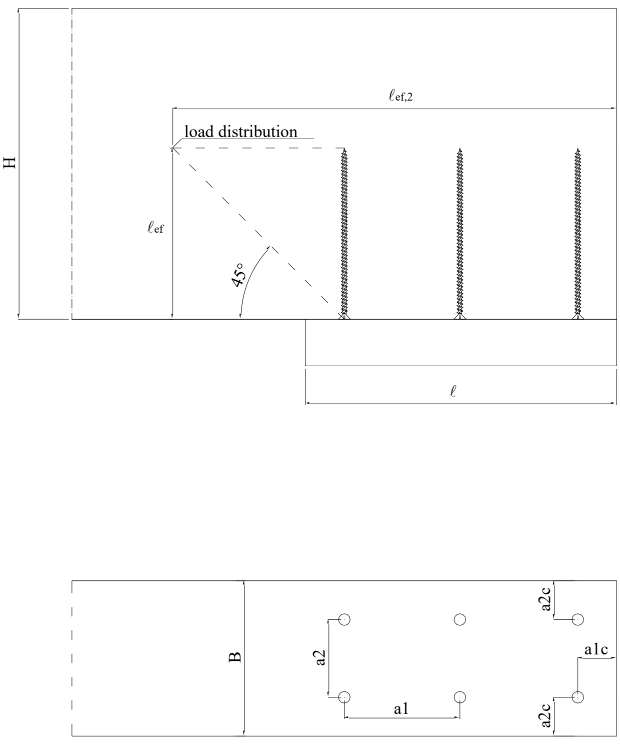
Annex C
Compression reinforcement

RAWLPLUG screws R-PVS and R-PVZ with a full thread may be used for reinforcement of timber members with compression stresses at an angle α to the grain of 45° < α < 90°. The compression force must be evenly distributed over all screws.

Reinforced centre-bearings



Reinforced end-bearings



The design load-carrying capacity for a reinforced contact area with screws with a full thread at an angle α to the grain of 45° < α < 90° shall be calculated from:

$$F_{90,Rd} = \min \begin{cases} k_{c,90} \cdot B \cdot \ell_{ef,1} \cdot f_{c,90,d} + n \cdot F_{c,90,Rd} \\ B \cdot \ell_{ef,2} \cdot f_{c,90,d} \end{cases}$$

Where:

$F_{90,Rd}$	design load-carrying capacity of reinforced contact area [N]
$k_{c,90}$	factor for compression perpendicular to the grain according to EN 1995-1-1, 6.1.5
B	bearing width [mm]
H	component height [mm]
$\ell_{ef,1}$	effective length of contact area according to EN 1995-1-1, 6.1.5 [mm]
$f_{c,90,d}$	design compressive strength perpendicular to the grain [N/mm²]
n	number of reinforcement fasteners, $n = n_0 \cdot n_{90}$
n_0	number of reinforcement fasteners arranged in a row parallel to the grain
n_{90}	number of reinforcement fasteners arranged in a row perpendicular to the grain
$\ell_{ef,2}$	effective distribution length in the plane of the fastener tips [mm]
$\ell_{ef,2}$	$= 2 \cdot \ell_{ef} + (n_0 - 1) \cdot a_1$ for reinforced centre-bearings
$\ell_{ef,2}$	$= \ell_{ef} + (n_0 - 1) \cdot a_1 + \min(\ell_{ef}; a_{1,c})$ for reinforced end-bearings
ℓ_{ef}	point side penetration length [mm]
a_1	spacing parallel to grain [mm]
$a_{1,CG}$	end grain distance of the centre of the screw-part in timber [mm]
$F_{c,90,Rd}$	design compressive capacity [N]

An appropriate steel plate as intermediate layer between timber member and support has to be installed. The screws have to be driven into the timber member flush with the surface to provide both direct contact with the steel plate and direct contact between steel plate and timber.

Reinforcing screws for wood-based panels are not covered by this European Technical Assessment.

Annex D
Thermal insulation material on top of rafters or facades

Rawlplug screws with an outer thread diameter of at least 6 mm may also be used for the fixing of thermal insulation on top of rafters.

The thickness of the insulation shall not exceed 400 mm. The rafter insulation must be placed on top of solid timber or glued laminated timber rafters or cross laminated timber members and be fixed by battens arranged parallel to the rafters or by wood-based panels on top of the insulation layer. The insulation of vertical facades is also covered by the rules given here.

Screws must be screwed in the rafter through the battens or panels and the insulation without pre-drilling in one sequence.

The angle ε between the screw axis and the grain direction of the rafter should be between 30° and 90°.

The rafter consists of solid timber (softwood) according to EN 338 or EN 14081, glued laminated timber according to EN 14081, cross-laminated timber, or laminated veneer lumber according to EN 14374 or to ETA or similar glued members according to ETA.

The battens must be from solid timber (softwood) according to EN 338:2003-04 or EN 14081. The minimum thickness t and the minimum width b of the battens is given as follows:

Screws d = 6 mm:	b_{min} = 48 mm	t_{min} = 24 mm
Screws d = 8 mm:	b_{min} = 50 mm	t_{min} = 30 mm
Screws d = 10 mm:	b_{min} = 60 mm	t_{min} = 40 mm

Alternatively to the battens, boards with a minimum thickness of 20 mm from plywood according to EN 636, particle board according to EN 312, oriented strand board OSB/3 and OSB/4 according to EN 300, solid wood panels according to EN 13353 or to ETA or national provision that apply at the installation site or cross laminated timber according to ETA may be used.

The insulation must comply with a European Technical Specification.

Friction forces shall not be considered for the design of the characteristic axial capacity of the screws.

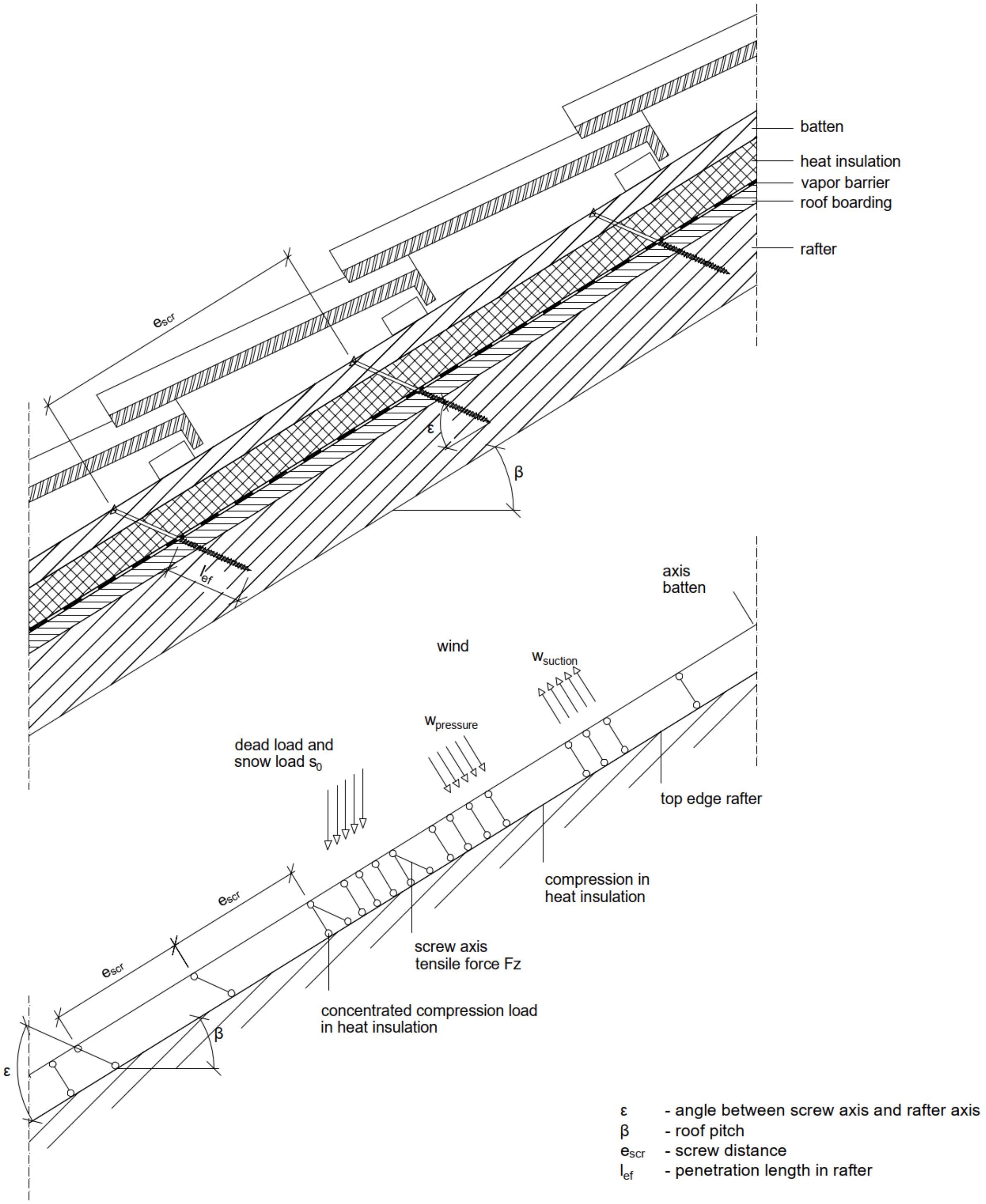
The anchorage of wind suction forces as well as the bending stresses of the battens or the boards, respectively, shall be considered in design. Additional screws perpendicular to the grain of the rafter (angle ε = 90°) may be arranged if necessary.

The maximum screw spacing is e_S = 1,75 m.

Thermal insulation on rafters with parallel inclined screws

Mechanical model

The system of rafter, thermal insulation material on top of rafter and battens parallel to the rafter may be considered as a beam on elastic foundation. The batten represents the beam, and the thermal insulation material on top of the rafter the elastic foundation. The minimum compression stress of the thermal insulation material at 10 % deformation, measured according to EN 826 (1), shall be $\sigma_{(10\,\%)} = 0{,}05$ N/mm². The batten is loaded perpendicular to the axis by point loads F_b. Further point loads F_s are from the shear load of the roof due to dead and snow load, which are transferred from the screw heads into the battens. The battens or boards, respectively, must have sufficient strength and stiffness.



(1) EN 826:1996 Thermal insulating products for building applications - Determination of compression behaviour

Design of the battens

The bending stresses are calculated as:

$$M = \frac{(F_b + F_s) \cdot \ell_{char}}{4}$$

where

ℓ_{char} = characteristic length $\ell_{char} = \sqrt[4]{\frac{4 \cdot EI}{w_{ef} \cdot K}}$

EI = bending stiffness of the batten

K = coefficient of subgrade

w_{ef} = effective width of the thermal insulation material

F_b = point loads perpendicular to the battens

F_s = point loads perpendicular to the battens, load application in the area of the screw heads

The coefficient of subgrade K may be calculated from the modulus of elasticity E_{HI} and the thickness t_{HI} of the thermal insulation material if the effective width w_{ef} of the thermal insulation material under compression is known. Due to the load extension in the thermal insulation material the effective width w_{ef} is greater than the width of the batten or rafter, respectively. For further calculations, the effective width w_{ef} of the thermal insulation material may be determined according to:

$$w_{ef} = w + t_{HI} / 2$$

where

w = minimum width of the batten or rafter, respectively

t_{HI} = thickness of the thermal insulation material

$$K = \frac{E_{HI}}{t_{HI}}$$

The following condition shall be satisfied:

$$\frac{\sigma_{m,d}}{f_{m,d}} = \frac{M_d}{W \cdot f_{m,d}} \leq 1$$

For the calculation of the section modulus W the net cross section has to be considered.

The shear stresses shall be calculated according to:

$$V = \frac{(F_b + F_s)}{2}$$

The following condition shall be satisfied:

$$\frac{\tau_d}{f_{v,d}} = \frac{1,5 \cdot V_d}{A \cdot f_{v,d}} \leq 1$$

For the calculation of the cross section area the net cross section has to be considered.

Design of the thermal insulation material

The compressive stresses in the thermal insulation material shall be calculated according to:

$$\sigma = \frac{1,5 \cdot F_b + F_s}{2 \cdot \ell_{char} \cdot w}$$

The design value of the compressive stress shall not be greater than 110 % of the compressive stress at 10 % deformation calculated according to EN 826.

Design of the screws

The screws are loaded predominantly axially. The axial tension force in the screw may be calculated from the shear loads of the roof R_s:

$$T_s = \frac{R_s}{\cos\varepsilon}$$

The load-carrying capacity of axially loaded screws is the minimum design value of the axial withdrawal capacity of the threaded part of the screw, the head pull-through capacity of the screw and the tensile capacity of the screw.

In order to limit the deformation of the screw head for thermal insulation material thicknesses over 200 mm or with compressive strength below 0,12 N/mm², respectively, the axial withdrawal capacity of the screws shall be reduced by the factors k_1 and k_2:

- for screws with partial thread:

$$F_{ax,\varepsilon,Rd} = \min\left\{\frac{k_{ax}\cdot f_{ax,d}\cdot d\cdot \ell_{ef}\cdot k_1\cdot k_2}{k_\beta}\cdot\left(\frac{\rho_k}{\rho_a}\right)^{0.8}; f_{head,d}\cdot d_h^2\cdot\left(\frac{\rho_k}{\rho_a}\right)^{0.8}; f_{tens,d}\right\}$$

- for screws with full thread:

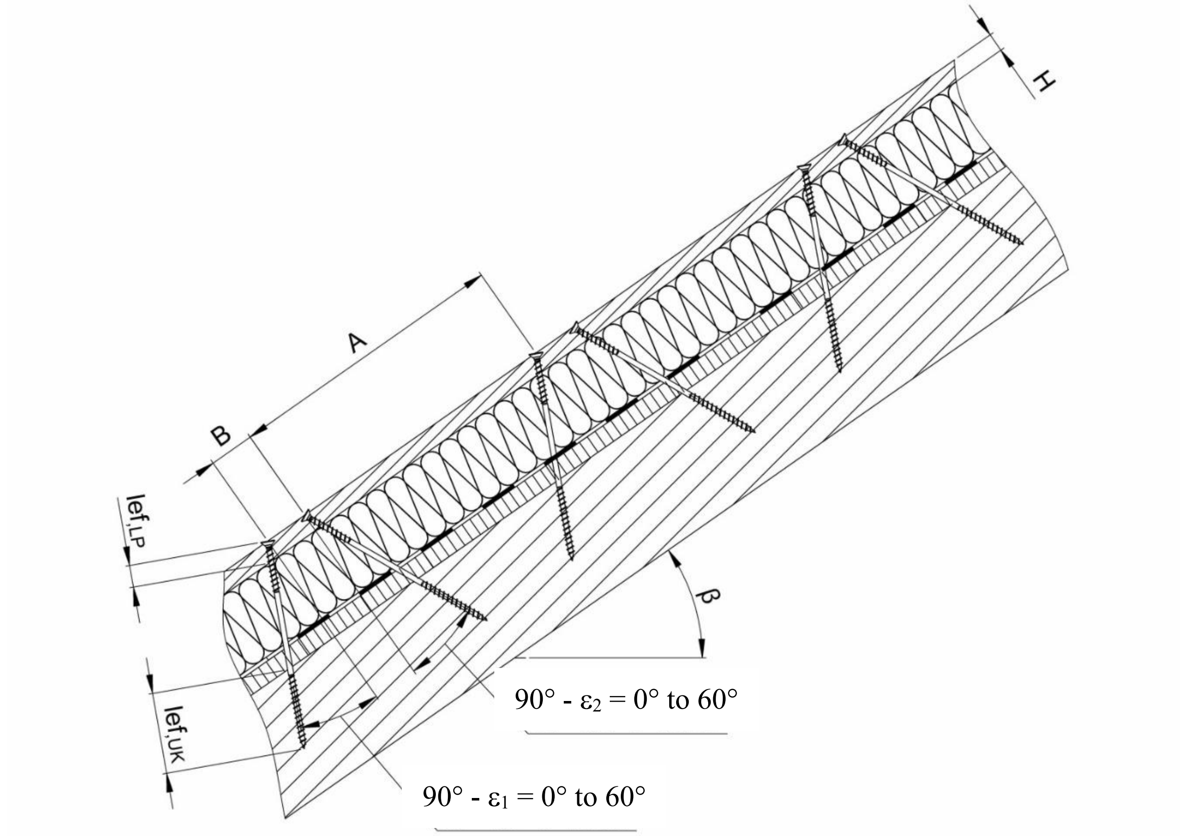
$$F_{ax,\varepsilon,Rd} = \min\left\{\begin{array}{l} \dfrac{k_{ax}\cdot f_{ax,d}\cdot d\cdot \ell_{ef}\cdot k_1\cdot k_2}{k_\beta}\cdot\left(\dfrac{\rho_k}{\rho_a}\right)^{0,8} \\ \max\left\{f_{head,d}\cdot d_h^2; \dfrac{k_{ax}\cdot f_{ax,d}\cdot d\cdot \ell_{ef,b}\cdot k_1\cdot k_2}{k_\beta}\right\}\cdot\left(\dfrac{\rho_k}{\rho_a}\right)^{0,8} \\ f_{tens,d} \end{array}\right.$$

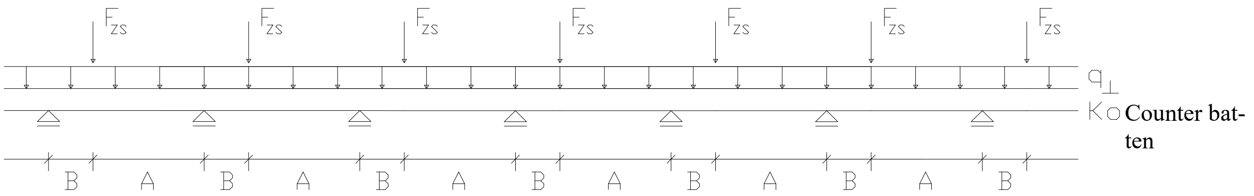
where:

$F_{ax,\varepsilon,d}$	design value of the load-carrying capacity of axially loaded screws [N]
$f_{ax,d}$	design value of the axial withdrawal parameter of the threaded part of the screw in the rafter or batten [N/mm²]
d	outer thread diameter of the screw [mm]
ℓ_{ef}	point side penetration length of the threaded part of the screw in the rafter, $l_{ef} \geq 40$ mm [mm]
$\ell_{ef,b}$	length of the threaded part in the batten including the head for tensile force [mm]
ρ_k	characteristic density of the wood-based member [kg/m³]
ρ_a	associated density [kg/m³]
$f_{head,d}$	design value of the head pull-through parameter of the screw [N/mm²]
d_h	head diameter [mm]
$f_{tens,d}$	design value of the tensile capacity of the screw [N]
k_1	min {1; 200/t_{HI}}
k_2	min {1; $\sigma_{10\%}$/0,12}
t_{HI}	thickness of the thermal insulation material [mm]
$\sigma_{10\%}$	compressive stress of the thermal insulation material under 10 % deformation [N/mm²]

If k_1 and k_2 are considered, the deflection of the battens does not need to be considered. Alternatively to the battens, panels with a minimum thickness of 20 mm from plywood according to EN 636 or an ETA or national provisions that apply at the installation site, particle board according to EN 312 or an ETA or national provisions that apply at the installation site, oriented strand board according to EN 300 or an ETA or national provisions that apply at the installation site and solid wood panels according to EN 13353 or an ETA or national provisions that apply at the installation site or cross laminated timber according to an ETA may be used.

Thermal insulation on rafters with alternatively inclined fully threaded screws





Mechanical model

Depending on the screw spacing and the arrangement of tensile and compressive screws with different inclinations the battens are loaded by significant bending moments. The bending moments are derived based on the following assumptions:

- The tensile and compressive loads in the screws are determined based on equilibrium conditions from the actions parallel and perpendicular to the roof plane.
  These actions are constant line loads $q_\perp$ and $q_{||}$.
- The screws act as hinged columns supported 10 mm within the batten or rafter, respectively. The effective column length consequently equals the length of the screw between batten and rafter plus 20 mm.
- The batten is considered as a continuous beam with a constant span ℓ = A + B. The battens or boards, respectively, must have sufficient strength and stiffness.
  The compressive screws constitute the supports of the continuous beam while the tensile screws transfer concentrated loads perpendicular to the batten axis.

The screws are predominantly loaded in withdrawal or compression, respectively. The screw's normal forces are determined based on the loads parallel and perpendicular to the roof plane:

Compressive screw: $$F_{c,Ed} = (A+B)\cdot\left(-\frac{q_{\parallel}\cdot\sin\varepsilon_2 + q_\perp\cdot\cos\varepsilon_2}{\sin(\varepsilon_1+\varepsilon_2)}\right)$$

Tensile screw: $$F_{t,Ed} = (A+B) \cdot \left(\frac{q_{\parallel} \cdot \sin\varepsilon_1 - q_{\perp} \cdot \cos\varepsilon_1}{\sin(\varepsilon_1 + \varepsilon_2)} \right)$$

The bending moments in the batten follow from the constant line load $q_{\perp}$ and the load components perpendicular to the batten from the tensile screws. The span of the continuous beam is (A + B). The load component perpendicular to the batten from the tensile screw is:

$$F_{ZS,Ed} = (A+B) \cdot \left(\frac{q_{\parallel} \cdot \sin\varepsilon_1 \cdot \sin\varepsilon_2 - q_{\perp} \cdot \cos\varepsilon_1 \cdot \cos\varepsilon_2}{\sin(\varepsilon_1 + \varepsilon_2)} \right)$$

where:

$q_{\parallel}$	constant line load parallel to batten
$q_{\perp}$	constant line load perpendicular to batten
ε_1	angle between compressive screw axis and grain direction
ε_2	angle between tensile screw axis and grain direction

A positive value for F_{ZS} means a load towards the rafter, a negative value a load away from the rafter.

Design of the screws

The load-carrying capacity of the screws shall be calculated as follows:

Screws loaded in tension:

$$F_{ax,\varepsilon,Rd} = \min\left\{ \frac{k_{ax} \cdot f_{ax,d} \cdot d \cdot \ell_{ef,b}}{k_\beta} \cdot \left(\frac{\rho_{b,k}}{\rho_a}\right)^{0.8} ; \frac{k_{ax} \cdot f_{ax,d} \cdot d \cdot \ell_{ef,r}}{k_\beta} \cdot \left(\frac{\rho_{r,k}}{\rho_a}\right)^{0.8} ; f_{tens,d} \right\}$$

Screws loaded in compression:

$$F_{ax,\varepsilon,Rd} = \min\left\{ \frac{k_{ax} \cdot f_{ax,d} \cdot d \cdot \ell_{ef,b}}{k_\beta} \cdot \left(\frac{\rho_{b,k}}{\rho_a}\right)^{0.8} ; \frac{k_{ax} \cdot f_{ax,d} \cdot d \cdot \ell_{ef,r}}{k_\beta} \cdot \left(\frac{\rho_{r,k}}{\rho_a}\right)^{0.8} ; \frac{\kappa_c \cdot N_{pl,k}}{\gamma_{M1}} \right\}$$

where:

$F_{ax,\varepsilon,Rd}$	design value of the load-carrying capacity of the screw [N]
$f_{ax,d}$	design value of the axial withdrawal parameter of the threaded part of the screw in the rafter or batten [N/mm²]
d	outer thread diameter of the screw [mm]
$\ell_{ef,b}$	penetration length of the threaded part of the screw in the batten including the head for tensile and excluding the head for compressive force [mm]
$\ell_{ef,r}$	penetration length of the threaded part of the screw in the rafter, $l_{ef} \geq 40$ mm [mm]
$\rho_{b,k}$	characteristic density of the batten [kg/m³]
$\rho_{r,k}$	characteristic density of the rafter [kg/m³]
ε	angle ε_1 or ε_2 between screw axis and grain direction, $30° \leq \varepsilon_1 \leq 90°$, $30° \leq \varepsilon_2 \leq 90°$
$f_{tens,d}$	design value of the tensile capacity of the screw [N]
γ_{M1}, γ_{M2}	partial factor according to EN 1993 or to the particular national annex
$\kappa_c \cdot N_{pl,k}$	buckling capacity of the screw [N]

Buckling capacity of the screw

Free screw length [mm]	Rawlplug R-PVS or R-PVZ screws		
	6 mm	8 mm	10 mm
	$\kappa_c \cdot N_{pl,k}$ [kN]	$\kappa_c \cdot N_{pl,k}$ [kN]	$\kappa_c \cdot N_{pl,k}$ [kN]
≤ 100	1,51	4,22	8,27
120	1,14	3,25	6,48
140	0,89	2,57	5,19
160		2,08	4,23
180		1,71	3,51
200		1,44	2,96
220		1,23	2,52
240		1,05	2,19
260		0,92	1,90
280		0,80	1,67
300		0,71	1,48
320		0,63	1,32
340		0,57	1,18
360		0,51	1,07
380		0,46	0,97
400		0,42	0,88
420			0,81
440			0,74
460			0,68
480			0,63
500			0,59
520			0,54

where
free screw length = $t_{HI} / \sin \varepsilon$ [mm] ($\varepsilon = \varepsilon_1$ or ε_2)

Annex E
Shear reinforcement

Unless specified otherwise in national provisions that apply at the installation site, the shear stress in reinforced areas of timber members with a stress component parallel to the grain shall fulfil the following condition:

$$\tau_d \leq \frac{f_{v,d} \cdot k_\tau}{\eta_H}$$

Where: τ_d is the design shear stress disregarding the reinforcement [N/mm²];

$f_{v,d}$ is the design shear strength [N/mm²];

$k_\tau = 1 - 0{,}46 \cdot \sigma_{90,d} - 0{,}052 \cdot \sigma_{90,d}^2$

$\sigma_{90,d}$ is the design stress perpendicular to the grain (negative value for compression) [N/mm²];

$$\sigma_{90,d} = \frac{F_{ax,d}}{\sqrt{2} \cdot b \cdot a_1}$$

$$F_{ax,d} = \frac{\sqrt{2} \cdot (1 - \eta_H) \cdot V_d \cdot a_1}{H}$$

$$\eta_H = \frac{G \cdot b}{G \cdot b + \cfrac{1}{2 \cdot \sqrt{2}\left(\cfrac{6}{\pi \cdot d \cdot H \cdot k_{ax}} + \cfrac{a_1}{EA_S}\right)}}$$

V_d is the design shear force [N];

G is the shear modulus of the timber member, G = 650 N/mm²,

b is the width of the timber member in mm,

d is the outer thread diameter in mm,

H is the depth of the timber member in mm,

k_{ax} is the connection stiffness between screw or rod and timber member in N/mm³, k_{ax} = 12,5 N/mm³ for Rawlplug screws d = 8 mm,

a_1 is the spacing parallel to the grain of the screws or rods arranged in one row in mm,

EA_S is the axial stiffness of one rod or screw [N],

$$EA_S = \frac{E \cdot \pi \cdot d_1^2}{4} = 165.000\, d_1^2$$

d_1 is the inner thread diameter of the rod or screw in mm.

The axial capacity of a threaded screw or rod shall fulfil the following condition:

$$\frac{F_{ax,d}}{F_{ax,Rd} \cdot n_r} \leq 1$$

Where:

$F_{ax,Rd}$ Minimum of the design values of the withdrawal capacity and the tensile capacity of the reinforcing rods or screws [N]. The effective penetration length is 50 % of the threaded length.

N_r Number of screw rows. Multiple screw rows should be arranged evenly and symmetrically over the width of the timber.

A minimum of four screws or rods in a row are required in each reinforced area. Outside reinforced areas (shaded area in Figure E.1) the shear design shall fulfil the conditions for unreinforced members.

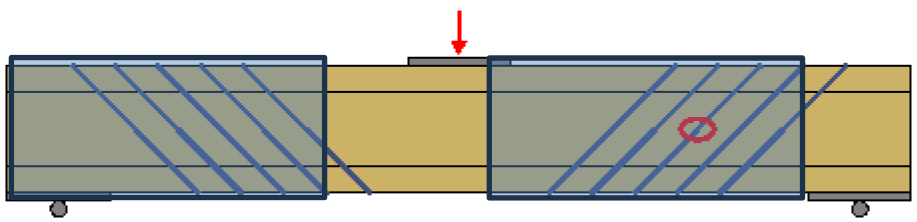


Figure E.1: Timber member with shear reinforcement; shaded areas: reinforced areas with screws arranged under 45°

Annex F
Tensile reinforcement perpendicular to grain

Timber members loaded by a connection force perpendicular to the grain

Unless specified otherwise in national provisions that apply at the installation site, the axial capacity of a reinforcement of a timber member loaded by a connection force perpendicular to the grain shall fulfil the following condition:

$$\frac{\left[1-3\cdot\alpha^2+2\cdot\alpha^3\right]\cdot F_{90,d}}{F_{ax,Rd}}\leq 1$$

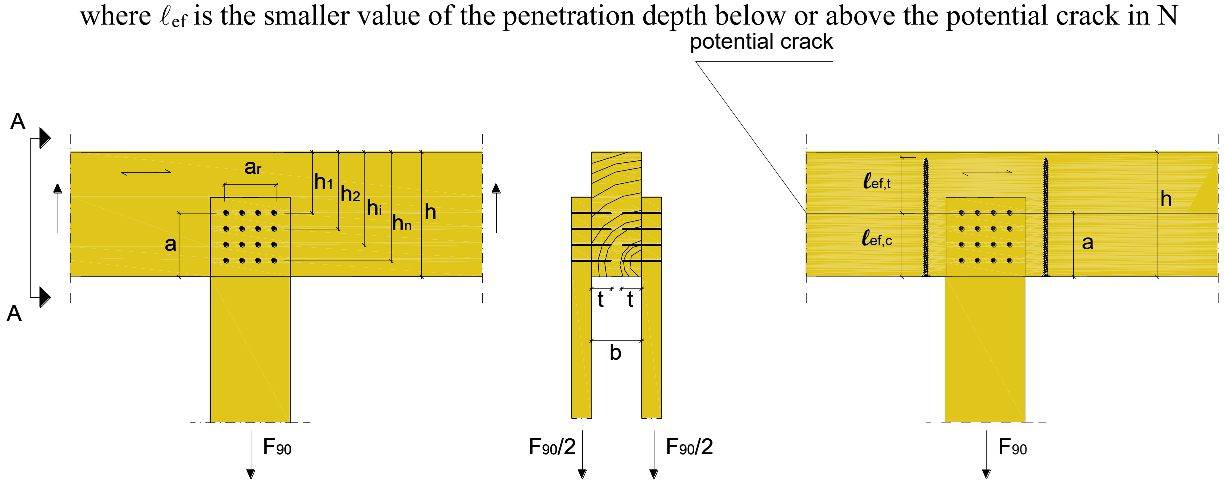
Where

$F_{90,d}$ Design value of the force component perpendicular to the grain in N,

α = a/H

H = member depth in mm

$F_{ax,Rd}$ Minimum of the design values of the withdrawal capacity and the tensile capacity of the reinforcing screws where ℓ_{ef} is the smaller value of the penetration depth below or above the potential crack in N



Notched beam supports

Unless specified otherwise in national provisions that apply at the installation site, the axial capacity of a reinforcement of a notched beam support shall fulfil the following condition:

$$\frac{1{,}3\cdot V_d\cdot\left[3\cdot(1-\alpha)^2-2\cdot(1-\alpha)^3\right]}{F_{ax,Rd}}\leq 1$$

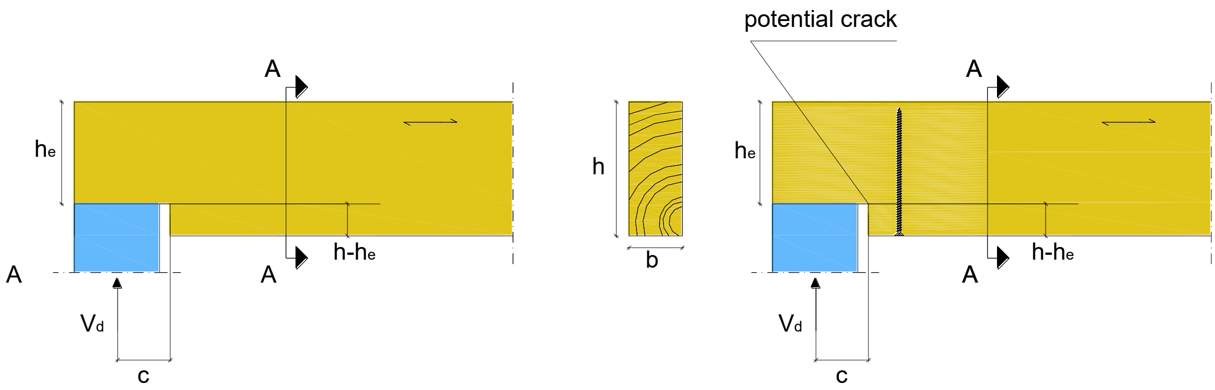
Where

V_d Design value of the shear force in N,

α = h_e/H

H = member depth in mm

$F_{ax,Rd}$ Minimum of the design values of the withdrawal capacity and the tensile capacity of the reinforcing screws where ℓ_{ef} is the smaller value of the penetration depth below or above the potential crack in N



Beams with holes

Unless specified otherwise in national provisions that apply at the installation site, the axial capacity of a reinforcement of a hole in a beam shall fulfil the following condition:

$$\frac{F_{t,V,d} + F_{t,M,d}}{F_{ax,Rd}} \leq 1$$

Where

$F_{t,V,d}$ Design value of the force perpendicular to the grain due to shear force in N:

$$F_{t,V,d} = \frac{V_d \cdot h_d}{4 \cdot H} \cdot \left[3 - \frac{h_d^2}{H^2}\right]$$

V_d Design value of the member shear force at the hole end in N,

H = member depth in mm

h_d = hole depth for rectangular holes in mm

h_d = 70 % of hole diameter for circular holes in mm

$F_{t,M,d}$ Design value of the force perpendicular to the grain due to bending moment in N:

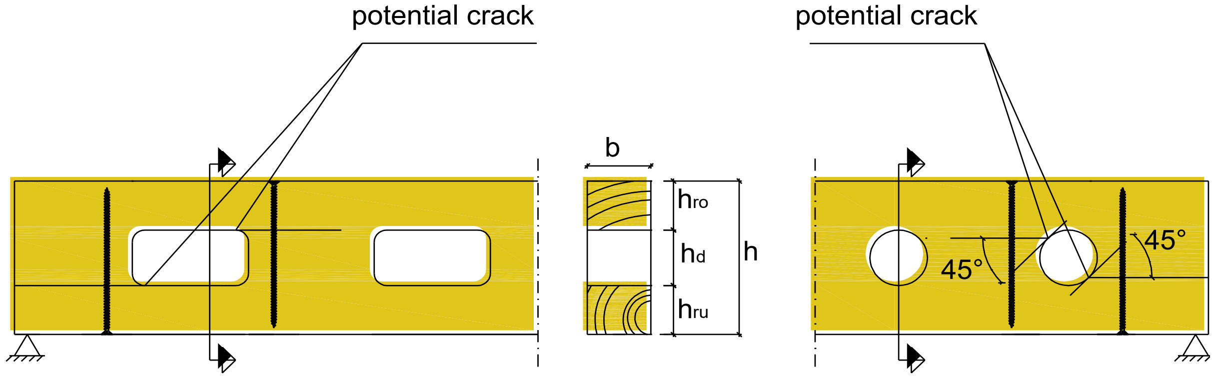
$$F_{t,M,d} = 0,008 \cdot \frac{M_d}{h_r}$$

M_d Design value of the member bending moment at the hole end in Nm,

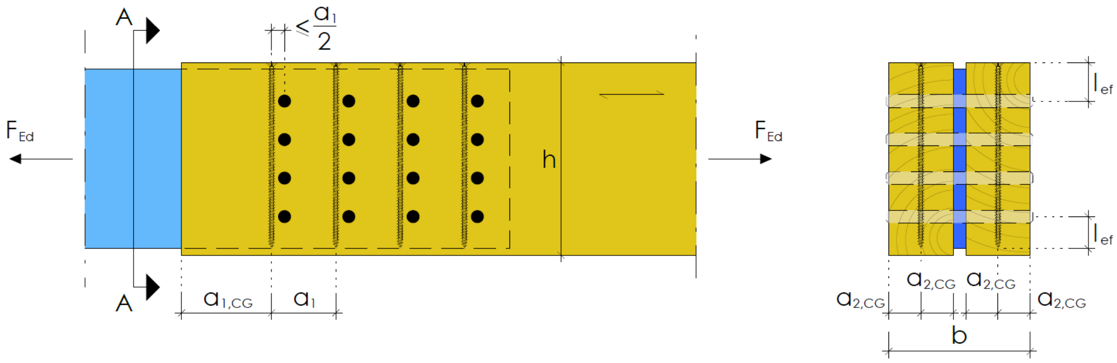
h_r = min (h_{ro} ; h_{ru}) for rectangular holes in mm

h_r = min (h_{ro} ; h_{ru}) + 0,15·h_d for circular holes in mm

$F_{ax,Rd}$ Minimum of the design values of the withdrawal capacity and the tensile capacity of the reinforcing screws where ℓ_{ef} is the smaller value of the penetration depth below or above the potential crack in N.



Connections with dowel-type fasteners



Unless specified otherwise in national provisions that apply at the installation site, the axial capacity of a reinforcement of a steel-to-timber or timber-to-timber connection with laterally loaded dowel-type fasteners loaded by a connection force parallel to the grain shall fulfil the following condition:

$$\frac{0,3 \cdot F_{v,0,Ed}}{F_{ax,Rd}} \leq 1$$

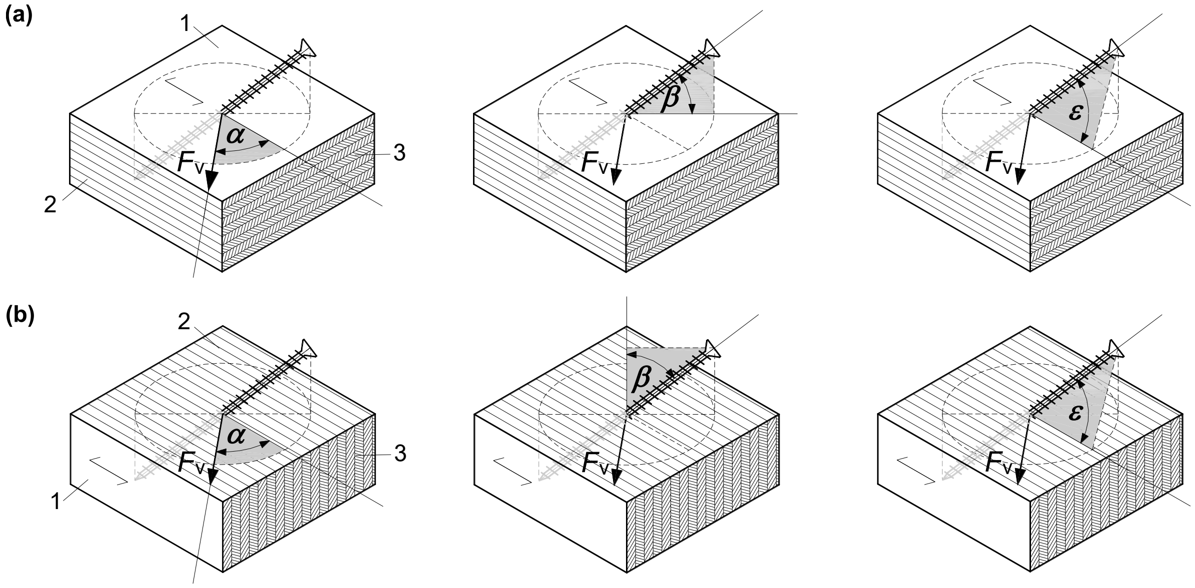
Where:

$F_{v,0,Ed}$ Design value of the fastener force component parallel to the grain [N],
For outer timber members $F_{v,0,Ed}$ is the load per fastener per shear plane, for inner timber members $F_{v,0,Ed}$ is the accumulated load per fastener for the two shear planes

$F_{ax,Rd}$ Minimum of the design values of the withdrawal capacity and the tensile capacity of the reinforcing full thread screws where ℓ_{ef} is the smaller value of the penetration depth at the screw tip or head

If the timber under each fastener in a connection is reinforced, the effective number n_{ef} according to EN 1995-1-1 equation (8.34) may be taken as $n_{ef} = n$.

Annex G
Definition of angles in LVL



Key:
1 wide face
2 edge face
3 end grain

α: angle between load and grain direction (0° ≤ α ≤ 90°)
β: angle between screw axis and the LVL's wide side (0° ≤ β ≤ 90°)
ε: angle between screw axis and grain direction