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European Technical Assessment ETA-21/0670 of 2021/12/09

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:

Simpson Strong-Tie® Structural screws TTUFS, TTZNFS, TTSFS, TTUFP, TTZNFP, SSH, SSF, SWC, SWD, SWW, SWWZ

Product family to which the above construction product belongs:

Screws for use in timber constructions

Manufacturer:

SIMPSON STRONG-TIE Int. Ltd
For local branch refer to www.strongtie.eu

Manufacturing plant:

SIMPSON STRONG-TIE Manufacturing facilities

This European Technical Assessment contains:

42 pages including 3 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:

European Assessment Document EAD 130118-01-0603 "Screws for use in timber construction"

This version replaces:

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II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product

Technical description of the product

Simpson Strong-Tie “TT” (= “TTUFS” + “TTZNFS” + “TTSFS” + “TTUFP” + “TTZNFP”), “SWW” (= “SWW” + SWWZ), “SWC”, “SSH”, “SSF”, and “SWD” screws are self-tapping screws to be used in timber structures.

Simpson Strong-Tie “TT” (= “TTUFS” + “TTZNFS” + “TTSFS” + “TTUFP” + “TTZNFP”), “SWW” (= “SWW” + SWWZ), “SWC”, “SSH” and “SSF” screws shall be threaded over a part of the length.

“SWD” screws shall have two threaded parts over the length.

The screws shall be produced from carbon steel wire for nominal diameters of 4.5 mm to 12.0 mm and from stainless steel wire for nominal diameters of 4.5 mm to 12.0 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 4.5 mm and shall not be greater than 12.0 mm. The overall length, l , of screws shall not be less than 20 mm and shall not be greater than 1000 mm.

Other dimensions are given in ANNEX B

Screw types “TTUFS”, “TTZNFS”, “TTUFP”, “TTZNFP”, “SWW”, “SWWZ”, “SWC”, “SSH”, “SSF”, and “SWD” are made from carbon steel.

Screw types “TTSFS” are made from stainless steel according to EN10088.

The ratio of inner thread diameter to outer thread diameter d_i/d ranges from 0.56 to 0.9.

The screws are threaded over a minimum length l_g of $4.0 \times d$ (i.e. $l_g \geq 4.0 \times d$).

The screws covered by this ETA have a minimum bending angle, α , of $(45/d^{0.7} + 20)$ 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 members of solid timber, glued laminated timber, cross-laminated timber, and laminated veneer lumber (softwood), similar glued members, wood-based panels or steel.

Furthermore, Simpson Strong-Tie screws with diameters between 6 mm and 12 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 EN13986 and cross laminated timber according to ETA
- Laminated Veneer Lumber according to EN 14374 or ETA
- FST according to ETA-14/0354
- 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 can be driven into the wood with or without predrilling.

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 3.11 of this ETA contains the corrosion protection for Simpson Strong-Tie screws made from carbon steel and the material number of the stainless steel. The stainless steel screws are for use in timber structures subject to the conditions defined by the service classes 1, 2 and 3 of EN 1995-1-1 (Eurocode 5).

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 fasteners 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 Characteristics of product and assessment

Characteristic	Assessment of characteristic
3.1 Mechanical resistance and stability*) (BWR1) Tensile strength	SSH / SSF Screws See Annex C.1 SWC / SWW Screws See Annex C.2 SWD Screws See Annex C.3 TT Screws See Annex C.4
Insertion moment	Ratio of the characteristic torsional strength to the mean insertion moment: $f_{tor,k} / R_{tor,mean} \geq 1,5$
Torsional strength	SSH / SSF Screws See Annex C.1 SWC / SWW Screws See Annex C.2 SWD Screws See Annex C.3 TT Screws See Annex C.4
Slip Modulus	See Annex B.12
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.
3.8 General aspects related to the performance of the product	The screws have been assessed as having satisfactory durability and serviceability when used in timber structures using the timber species described in Eurocode 5 and subject to the conditions defined by service classes 1, 2 and 3.
Identification	See ANNEX C

*) See additional information in section 3.9 – 3.12.

3.9 Methods of verification Safety principles and partial factors

3.10 Mechanical resistance and stability

The load-carrying capacities for Simpson Strong-Tie 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 Simpson Strong-Tie screws should be used for designs in accordance with Eurocode 5 or an appropriate national code.

The minimum penetration length of the threaded part of the screw l_{ef} shall be:

$$l_{ef,req} = \min \left\{ \begin{array}{l} 4 \times d \\ \frac{4 \times d}{\sin \alpha} \\ 20 \times d \end{array} \right. \quad \text{Eq 1}$$

Where

d outer thread diameter

α angle between screw axis and grain direction.

For the fixing of rafters, point side penetration must be at least 40 mm, $l_{ef} \geq 40$ mm.

The inner thread diameter d_i of the screws shall be greater than the maximal width of the gaps in the layer.

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

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

For screws in pre-drilled holes, the drill hole diameter shall 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 shall be considered where applicable.

See ANNEX B for detailed design explanation.

3.11 Aspects related to the performance of the product

3.11.1 Corrosion protection

The Simpson Strong-Tie screws are produced from carbon or stainless steel wire. Screws made from carbon steel are hardened or non-hardened, electro-galvanised and yellow or blue chromated or non-electrolytically zinc flake coated or Zinc-Nickel coated. The coatings may have an anti-friction liquids or topcoats. The mean thickness of the zinc coating is 5µm but may be thicker.

Steel grade according to EN10088 is used for screws made from stainless steel (optional: hardened martensitic stainless steel).

Contact corrosion shall be avoided.

3.12 General aspects related to the use of the product

The screws are manufactured in accordance with the provisions of this 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 Simpson Strong-Tie shall be considered for installation.

The screws are used for connections in load bearing timber structures between members of solid timber (softwood), glued laminated timber (softwood), cross-laminated timber (softwood), laminated veneer lumber (softwood), similar glued members (softwood), 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.

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

A minimum of two screws should be used for connections in load bearing timber structures. This does not apply for reinforcements or for fixings of battens, rafters, pulins or similar on main beams or

top plates, if the member fixed with at least two screws in total and in special situations specified in National Annexes to EN 1995-1-1.

the surface of the connected structural member. A deeper countersink is not allowed.

The minimum penetration depth in structural members made of solid, glued or cross-laminated timber or laminated veneer lumber is $4 \times d$.

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

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

For structural members according to ETA's the terms of the ETA's must be considered.

If screws with an outer thread diameter $d \geq 8$ 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 with a diameter equal or less than the inner thread diameter.

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

Only the equipment prescribed by Simpson Strong-Tie shall be used for driving the screws.

In connections with screws with countersunk head according to Annex A the head must be flush with

4 Assessment and verification of constancy of performance (AVCP)

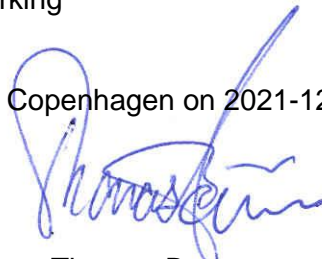
4.1 AVCP system

According to the decision 97/176/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 foreseen 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 2021-12-09 by



Thomas Bruun
Managing Director, ETA-Danmark

ANNEX A REVISION HISTORY

<i>Modifications and additions to the previous versions of ETA-XX/XXXX</i>	
Issue No.	Update
1.0	First release

ANNEX B BASIS OF DESIGN

The load-carrying capacities for Simpson Strong-Tie screws are also 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 Simpson Strong-Tie screws and threaded rods should be used for designs in accordance with Eurocode 5 or an appropriate national code.

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

Screws made of carbon steel shall be driven in pre-drilled holes if the characteristic member density exceeds 550 kg/m³.

Screws made of stainless steel shall be driven in pre-drilled holes if the characteristic member density exceeds 500 kg/m³.

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

Reductions in the cross-sectional area caused by Simpson Strong-Tie screws with a diameter of 10 mm or more 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.

B.1 Lateral load-carrying capacity

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

B.2 Yield moment

The characteristic yield moment is:

- SSH / SSF Screws See Annex C.1
- SWC / SWW Screws See Annex C.2
- SWD Screws See Annex C.3
- TT Screws See Annex C.4

B.3 Embedding Strength

General Case

The embedding strength for screws in non-pre-drilled holes in softwood (solid timber, glued laminated timber, and wood based panels) arranged at an angle between screw axis and grain direction, $0^\circ \leq \alpha \leq 90^\circ$ is:

$$f_{h,k} = \frac{0.082 \times \rho_k \times d^{-0.3}}{2.5 \times \cos^2 \alpha + \sin^2 \alpha} \quad [\text{N/mm}^2] \quad \text{Eq 2}$$

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

$$f_{h,k} = \frac{0.082 \times \rho_k \times (1 - 0.01 \times d)}{2.5 \times \cos^2 \alpha + \sin^2 \alpha} \quad [\text{N/mm}^2] \quad \text{Eq 3}$$

Where

- ρ_k characteristic timber density [kg/m^3], with a maximum characteristic density of 480 kg/m^3 ;
- d outer thread diameter [mm];
- α angle between screw or rod axis and grain direction.

Laminated-Veneer Lumber (LVL) Case

The embedding strength for screws in non-pre-drilled holes in softwood LVL arranged at an angle between screw axis and grain direction, $0^\circ \leq \alpha \leq 90^\circ$ is:

$$f_{h,k} = \frac{0.082 \times \rho_k \times d^{-0.3}}{(2.5 \times \cos^2 \alpha + \sin^2 \alpha) \times (1.5 \times \cos^2 \beta + \sin^2 \beta)} \quad [\text{N/mm}^2] \quad \text{Eq 4}$$

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

$$f_{h,k} = \frac{0.082 \times \rho_k \times (1 - 0.01 \times d)}{(2.5 \times \cos^2 \alpha + \sin^2 \alpha) \times (1.5 \times \cos^2 \beta + \sin^2 \beta)} \quad [\text{N/mm}^2] \quad \text{Eq 5}$$

Where

- ρ_k characteristic timber density [kg/m^3], with a maximum characteristic density of 550 kg/m^3 ;
- d outer thread diameter [mm];
- α angle between screw axis and grain direction.
- β angle between screw axis and LVL wide face ($0^\circ \leq \beta \leq 90^\circ$).

Cross-Laminated Timber (CLT) Case

Alternatively, the embedding strength for screws in non-predrilled or predrilled holes arranged parallel to the plane of cross laminated timber (layers of softwood), independent of the angle between screw axis and grain direction, $0^\circ \leq \alpha \leq 90^\circ$, may be calculated from:

$$f_{h,k} = 20 \times d^{-0.5} \quad [\text{N/mm}^2] \quad \text{Eq 6}$$

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

Where

d outer thread diameter [mm]

The embedding strength for screws in the wide face of CLT should be assumed as for solid timber (general case) based on the characteristic density of the outer layer. If relevant, the angle between force and grain direction of the outer layer should be taken into account.

The direction of the lateral force shall be perpendicular to the screw axis and parallel to the wide face of the CLT.

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

B.4 Axial loading capacity

Timber to Timber

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

It is the minimum between Eq 7, Eq 9 and values $f_{tens.k}$ in ANNEX C

Timber to Steel

The axial withdrawal capacity is limited by the tensile capacity of the screw.

It is the minimum between Eq 7 and values $f_{tens.k}$ in ANNEX C

B.5 Characteristic withdrawal capacity

General Case

The characteristic axial withdrawal capacity of Simpson Strong-Tie screws at an angle of $0^\circ < \alpha < 90^\circ$ to the grain (SWD screws $d = \varnothing 8\text{mm}$ $15^\circ < \alpha < 90^\circ$) in solid timber, glued laminated timber and cross-laminated timber members shall be calculated according to EN 1995-1-1 from:

$$F_{ax,\alpha,k} = \frac{n_{ef} \times k_{ax} \times f_{ax,k} \times d \times l_{ef} \left(\frac{\rho_k}{350}\right)^{0.8}}{k_\beta} \quad [\text{N}] \quad \text{Eq 7}$$

Where

$F_{ax,}$ characteristic withdrawal capacity of the screws at an angle α to the grain [N]

n_{ef} effective number of screws according to EN1995-1-1:

$$k_{ax} = 1.0 \quad \text{for } 45^\circ \leq \alpha < 90^\circ$$

$$= a + \frac{b \times \alpha}{45^\circ} \quad \text{for } 0^\circ \leq \alpha < 45^\circ$$

$$a = \begin{cases} 0.5 & \text{for LVL} \\ 0.3 & \text{for timber} \end{cases}$$

$$b = \begin{cases} 0.5 & \text{for LVL} \\ 0.7 & \text{for timber} \end{cases}$$

$$k_\beta = 1.0 \quad \text{for timber}$$

$$= 1.5 \times \cos^2 \beta + \sin^2 \beta \quad \text{for LVL}$$

$f_{ax,}$ Characteristic withdrawal parameter :

- SSH / SSF Screws See Annex C.1
- SWC / SWW Screws See Annex C.2
- SWD Screws See Annex C.3
- TT Screws See Annex C.4

d outer thread diameter [mm]

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

α angle between grain and screw axis, $0^\circ \leq \alpha \leq 90^\circ$,

β angle between screw axis and the LVL's wide face ($0^\circ \leq \beta \leq 90^\circ$)

ρ_k characteristic density [kg/m³] with a maximum of 480 kg/m³ for softwood (solid timber, glued laminated timber, and wood based panels) and a maximum of 550 kg/m³ for laminated veneer lumber

CLT case

For screws penetrating more than one layer of CLT, the different layers may be taken into account proportionally.

The axial withdrawal capacity for screws arranged parallel to the plane of CLT, independent of the angle between screw axis and grain direction, $0^\circ \leq \alpha \leq 90^\circ$, may be calculated from:

$$F_{ax,k} = 20 \times d^{0.8} \times l_{ef}^{0.9} \quad [\text{N}] \quad \text{Eq 8}$$

Where

d outer thread diameter [mm];

l_{ef} penetration length of the threaded part according to EN 1995-1-1 [mm].

B.6 Head pull-through capacity

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

$$F_{ax,\alpha,k} = n_{ef} \times f_{head,k} \times d_h^2 \times \left(\frac{\rho_k}{350}\right)^{0.8} \quad [\text{N}] \quad \text{Eq 9}$$

where:

$F_{ax,\alpha,k}$ characteristic head pull-through capacity of the connection at an angle $\alpha > 30^\circ$ to the grain [N];

n_{ef} effective number of screws according to EN 1995-1-1. (See Annex B.13);

$f_{head,k}$ characteristic head pull-through parameter [N/mm²] (The parameters have been calculated for a maximum displacement of 15mm) :

- SSH Screws See Annex C.1
- SWC / SWW Screws See Annex C.2
- SWD Screws See Annex C.3
- TT Screws See Annex C.4

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 plywood $\rho_k = 400$ kg/m³.

When no performance is given (for example when used with extra washer) in ANNEX C for screws with a head diameter of at least 1,8 times the shank or inner thread diameter the characteristic head pull-through parameter for solid softwood according to EN 14081-1 (minimum strength class C24) and glued laminated timber made from softwood according to EN 14080 (minimum strength class GL24) may be assumed as follows.

The characteristic value of the head pull-through parameter for a characteristic density of 380 kg/m³ of the timber and for the following wood based panels:

- Plywood according to EN 636 and EN 13986;
- Oriented Strand Board, OSB according to EN 300 and EN 13986;
- Solid wood panel according to EN 13353 and EN 13986;
- Particleboard according to EN 312 and EN 13986;
- Cement-bonded particle board according to EN 634-2 and EN 13986;
- Fibreboards according to EN 622-2, EN 622-3 and EN 13986;

with thicknesses of more than 20 mm may be assumed to

$$f_{head,k} = 10 \text{ N/mm}^2.$$

For wood based panels with a thickness between 12 mm and 20 mm the characteristic value of the head pull-through parameter may be assumed to be

$$f_{head,k} = 8 \text{ N/mm}^2.$$

For wood based panels with a thickness of less than 12 mm, the characteristic head pull-through capacity shall be based on a characteristic value of the head pull-through parameter of 8 N/mm², and limited to 400 N complying with the minimum thicknesses of the wood based panels of $1,2 \times d$ with d as outer thread diameter.

The head diameter d_h shall be greater than $1,8 \times d_s$, where d_s is the smooth shank or the wire diameter. Otherwise the characteristic head pull-through capacity $F_{ax,\alpha,k} = 0$.

In addition, the minimum thicknesses of table below should apply

Wood based panel	Minimum thickness in mm
Plywood, Fibreboards	6
Particleboards, OSB, Cement-bonded particle boards	8
Solid wood panels	12

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

B.7 Tensile capacity

The characteristic tensile strengths $f_{tens,k}$ of screws made from carbon steel are:

- SSH / SSF Screws See Annex C.1
- SWC / SWW Screws See Annex C.2
- SWD Screws See Annex C.3
- TT Screws See Annex C.4

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

B.8 Combined laterally and axially loaded screws

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

$$\left(\frac{F_{ax,Ed}}{F_{ax,Rd}}\right)^2 + \left(\frac{F_{v,Ed}}{F_{v,Rd}}\right)^2 \leq 1 \quad \text{Eq 10}$$

where

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

B.9 Mechanically jointed beams

“SWD” screws with two distinctive threads may be used for connections in structural members which are composed of several parts in mechanically jointed beams or columns.

B.10 Compression loading

The design axial capacity $F_{ax,Rd}$ of Simpson Strong-Tie screws SWD embedded in solid timber, glued solid timber or glued laminated timber made from softwood with an angle between screw axis and grain direction of $30^\circ \leq \alpha \leq 90^\circ$ is the minimum of the axial resistance against pushing-in and the buckling resistance of the screw.

$$F_{ax,Rd} = \min \left\{ \begin{array}{l} k_{ax} \times f_{ax,d} \times d \times l_{ef} \\ \kappa_c \times N_{pl,d} \end{array} \right. \quad [\text{N}] \quad \text{Eq 11}$$

Where

k_{ax} Factor, taking into account the angle α between screw axis and grain direction according to Annex B.5;
 $f_{ax,d}$ design value of the axial withdrawal capacity of the threaded part of the screw [N/mm²];
 d outer thread diameter of the screw [mm];
 l_{ef} penetration length of the threaded part of the screw in the timber member [mm];

$$\begin{aligned} \kappa_c &= 1.0 && \text{For } \bar{\lambda}_k \leq 0.2 \\ &= \frac{1}{k + \sqrt{k^2 - \bar{\lambda}_k^2}} && \text{For } \bar{\lambda}_k > 0.2 \end{aligned}$$

$$k = 0.5 \times \left[1 + 0.49 \times (\bar{\lambda}_k - 0.2) + \bar{\lambda}_k^2 \right]$$

And a relative slenderness ratio $\bar{\lambda}_k = \sqrt{\frac{N_{pl,k}}{N_{ki,k}}}$

Where

$N_{pl,k}$ characteristic plastic normal force related to the net cross-section of the inner thread diameter:

$$N_{pl,k} = \pi \times \frac{d_1^2}{4} \times f_{y,k} \quad [\text{N}] \quad \text{Eq 12}$$

$f_{y,k}$ characteristic yield strength, C.3
 d_1 inner thread diameter of the screw [mm]

$$N_{pl,d} = \frac{N_{pl,k}}{\gamma_{M1}} \quad \text{Eq 13}$$

γ_{M1} partial factor according to EN 1993-1-1 in conjunction with the particular national annex

Characteristic ideal elastic buckling load:

$$N_{ki,k} = \sqrt{c_h \times E_s \times I_s} \quad [\text{N}] \quad \text{Eq 14}$$

Elastic foundation of the screw:

$$c_h = (0.19 + 0.012 \times d) \times \rho_k \times \left(\frac{90^\circ + \alpha}{180^\circ} \right) \quad [\text{N/mm}^2] \quad \text{Eq 15}$$

ρ_k characteristic density of the wood or wood-based member [kg/m³],
 α angle between screw axis and grain direction, $30^\circ \leq \alpha \leq 90^\circ$

Modulus of elasticity:

$$E_s = 210\,000 \text{ N/mm}^2$$

Second moment of area:

$$I_s = \frac{\pi \times d_1^4}{64} \quad [\text{mm}^4]$$

Eq 16

B.11 Thermal insulation material on top of rafters

Simpson Strong-Tie screws with an outer thread diameter $6 \text{ mm} \leq d \leq 12 \text{ mm}$ may be used for the fixing of thermal insulation material on top of rafters.

The thickness of the insulation shall not exceed 300 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 α 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, 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. The minimum thickness t and the minimum width b of the battens is given as follows:

- Screws $d \leq 8,0 \text{ mm}$ $b_{min} = 50 \text{ mm}$ $t_{min} = 30 \text{ mm}$
- Screws $d = 10 \text{ mm}$ $b_{min} = 60 \text{ mm}$ $t_{min} = 40 \text{ mm}$
- Screws $d = 12 \text{ mm}$ $b_{min} = 80 \text{ mm}$ $t_{min} = 60 \text{ mm}$

The insulation must comply with an ETA.

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

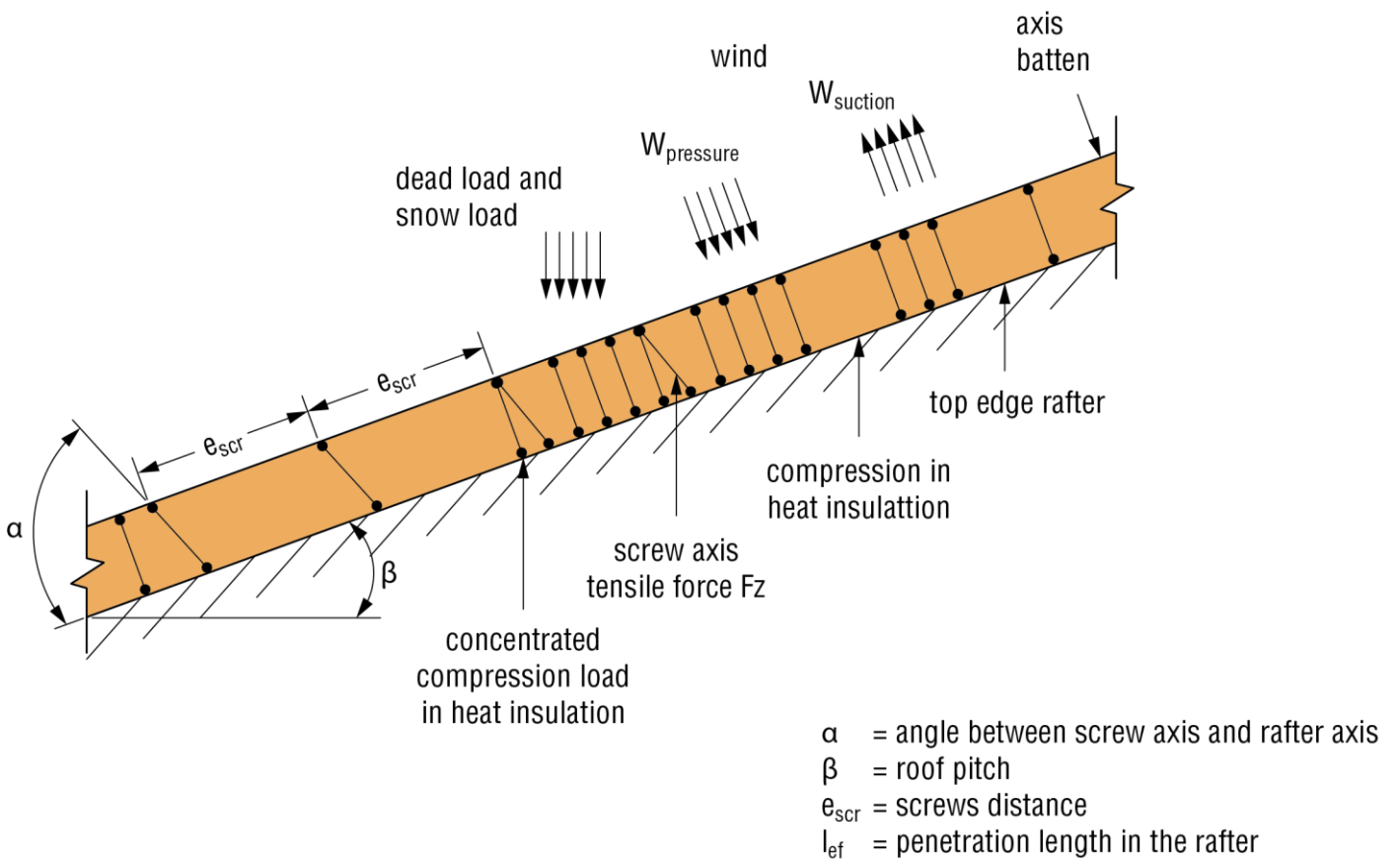
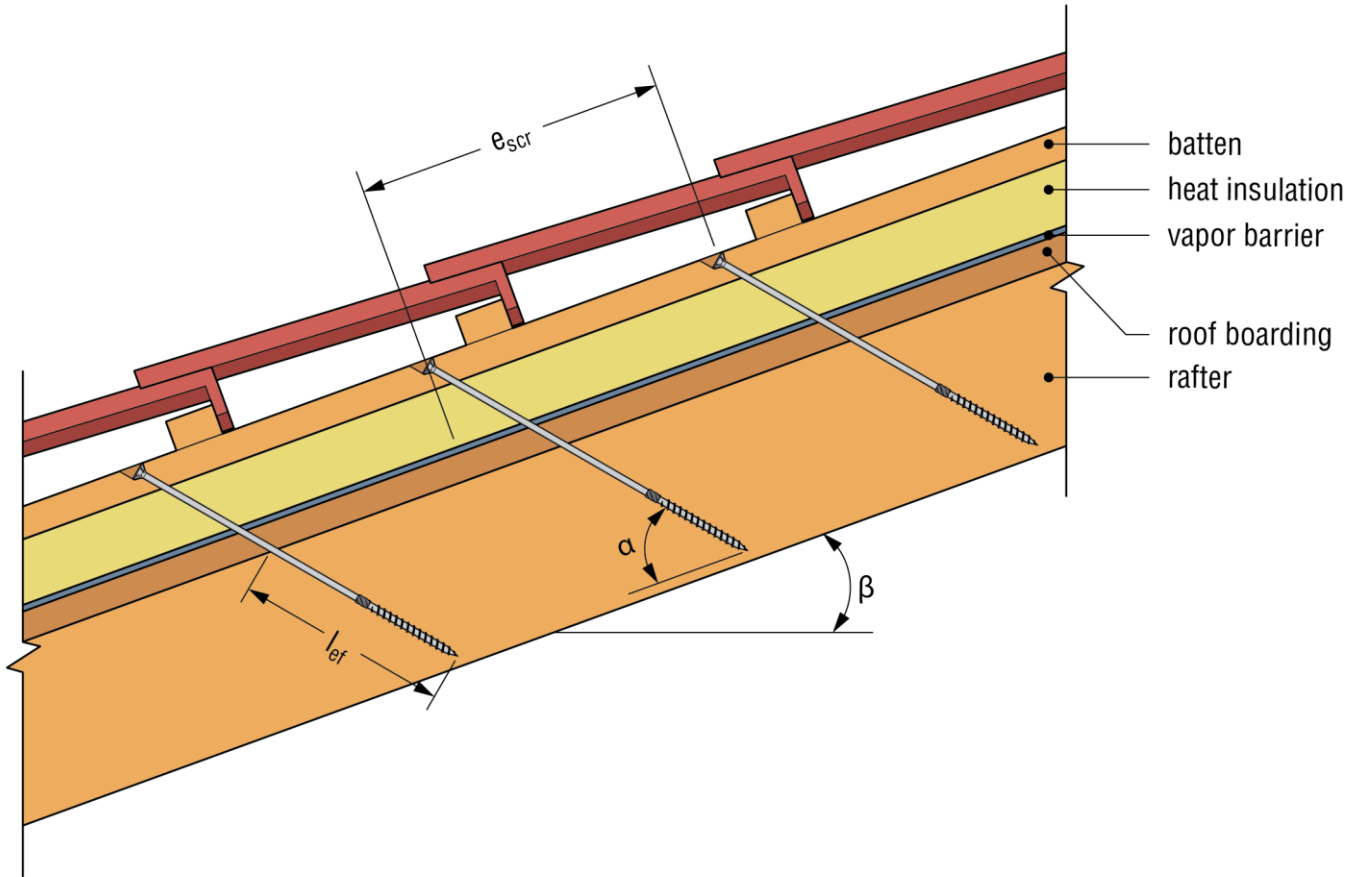
The anchorage of wind suction forces as well as the bending stresses of the battens or the boards, respectively, shall be considered in design. Additional screws perpendicular to the grain of the rafter (angle $\alpha = 90^\circ$) may be arranged if necessary.

The maximum screw spacing is $e_{scr} = 1,75 \text{ m}$.

Thermal insulation material on rafters with parallel inclined screws

Mechanical model

The system of rafter, heat insulation 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 heat insulation on top of the rafter the elastic foundation. The minimum compression stress of the heat insulation at 10 % deformation, measured according to EN 8261, shall be $\sigma(10 \%) = 0,05 \text{ N/mm}^2$. 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 battens into the screw heads.



Design of the battens

The bending stresses are calculated as:

$$M = \frac{(F_b + F_s) \times l_{char}}{4} \quad [\text{Nmm}] \quad \text{Eq 17}$$

Where

$$l_{char} \quad \text{characteristic length } l_{char} = \sqrt[4]{\frac{4EI}{w_{ef} \times K}} \quad [\text{mm}]$$

EI bending stiffness of the batten [Nmm²];

K coefficient of subgrade;

w_{ef} effective width of the heat insulation [mm];

F_b Point loads perpendicular to the battens [N];

F_s Point loads perpendicular to the battens, load application in the area of the screw heads [N].

The coefficient of subgrade K may be calculated from the modulus of elasticity and the thickness t_{HI} of the heat insulation if the effective width w_{ef} of the heat insulation under compression is known. Due to the load extension in the heat insulation 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 heat insulation may be determined according to:

$$w_{ef} = w + t_{HI}/2 \quad [\text{mm}] \quad \text{Eq 18}$$

Where

w minimum width of the batten or rafter, respectively [mm];

t_{HI} thickness of the heat insulation [mm].

$$K = \frac{E_{HI}}{t_{HI}} \quad \text{Eq 19}$$

Where

E_{HI} the modulus of elasticity of the heat insulation [N/mm²].

The following condition shall be satisfied:

$$\frac{\sigma_{m,d}}{f_{m,d}} = \frac{M_d}{W \times f_{m,d}} \leq 1 \quad \text{Eq 20}$$

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

The shear stresses shall be calculated according to:

$$V = \frac{(F_b + F_s)}{2} \quad [\text{N}] \quad \text{Eq 21}$$

The following condition shall be satisfied:

$$\frac{\tau_d}{f_{v,d}} = \frac{1.5 \times V_d}{A \times f_{v,d}} \leq 1 \quad \text{Eq 22}$$

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

Design of the heat insulation

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

$$\sigma = \frac{1.5 \times F_b + F_s}{2 \times l_{char} \times w} \quad \text{Eq 23}$$

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 :

$$T_s = \frac{R_s}{\cos \alpha} \quad [\text{N}] \quad \text{Eq 24}$$

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:

$$F_{ax,\alpha,Rd} = \min \left\{ k_{ax} \times f_{ax,d} \times d \times l_{ef} \times k_1 \times k_2 \times \left(\frac{\rho_k}{350} \right)^{0.8}; f_{head,d} \times d_h^2 \times \left(\frac{\rho_k}{350} \right)^{0.8}; f_{tens,d} \right\} \quad \text{Eq 25}$$

For screws with double thread:

$$F_{ax,\alpha,Rd} = \min \left\{ \begin{array}{l} k_{ax} \times f_{ax,d} \times d \times l_{ef} \times k_1 \times k_2 \times \left(\frac{\rho_k}{350} \right)^{0.8} \\ \max \{ f_{head,d} \times d_h^2; k_{ax} \times f_{ax,d} \times d \times l_{ef,b} \times k_1 \times k_2 \} \times \left(\frac{\rho_k}{350} \right)^{0.8} \\ f_{tens,d} \end{array} \right\} \quad \text{Eq 26}$$

Where:

$f_{ax,d}$ design value of the axial withdrawal parameter of the threaded part of the screw [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 batten, $l_{ef} \geq 40$ mm [mm];

ρ_k characteristic density of the wood or wood-based member [kg/m³];

$f_{head,d}$ design value of the head pull-through capacity 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 $\min \{1; 200/t_{HI}\}$;

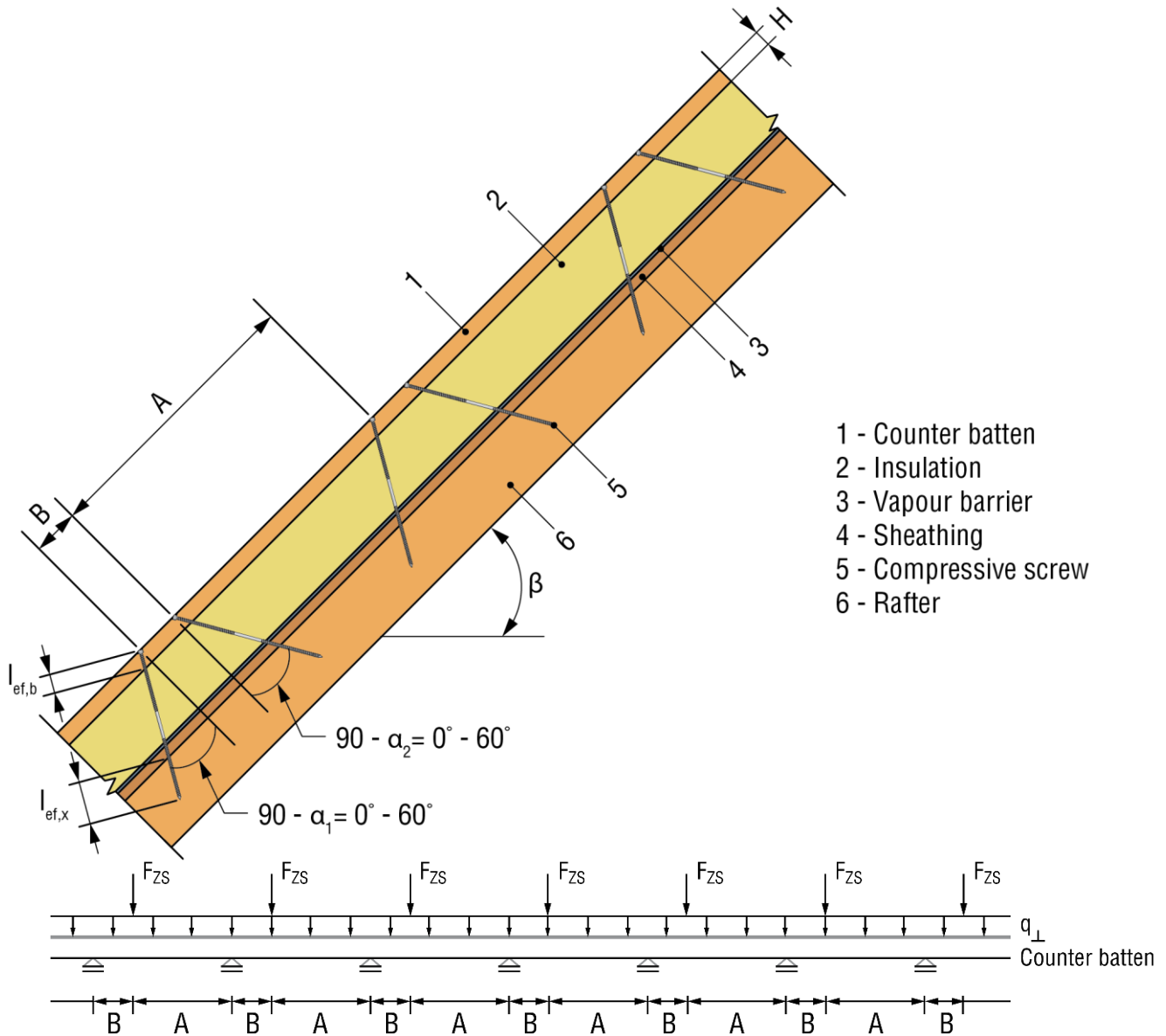
k_2 $\min \{1; \sigma_{10\%}/0,12\}$;

t_{HI} thickness of the heat insulation [mm];

$\sigma_{10\%}$ compressive stress of the heat insulation 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 22 mm from plywood according to EN 636, particle board according to EN 312, oriented strand board according to EN 300 or ETA and solid wood panels according to EN 13353 or CLT may be used.

Thermal insulation material on rafters with alternatively inclined 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_{\parallel} .
- 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 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:

$$F_{c,Ed} = (A+B) \times \left(\frac{q_{\parallel}}{\cos \alpha_1 + \sin \alpha_1 / \tan \alpha_2} - \frac{q_{\perp} \times \sin(90^\circ - \alpha_2)}{\sin(\alpha_1 + \alpha_2)} \right)$$

Tensile screw

$$F_{c,Ed} = (A+B) \times \left(\frac{q_{||}}{\cos \alpha_2 + \sin \alpha_2 / \tan \alpha_1} - \frac{q_{\perp} \times \sin(90^\circ - \alpha_1)}{\sin(\alpha_1 + \alpha_2)} \right) \quad \text{Eq 28}$$

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:

$$F_{ZS,Ed} = (A+B) \times \left(\frac{q_{||}}{1/\tan \alpha_2 + 1/\tan \alpha_1} - \frac{q_{\perp} \times \sin(90^\circ - \alpha_1) \times \sin \alpha_2}{\sin(\alpha_1 + \alpha_2)} \right) \quad \text{Eq 29}$$

Where:

- $q_{||}$ Constant line load parallel to batten;
 q_{\perp} Constant line load perpendicular to batten;
 α_1 Angle between compressive screw axis and grain direction;
 α_2 Angle between tensile screw axis and grain direction.

A positive value for F_{ZS} means a load towards the rafter, a negative value is 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:

$$F_{ax,\alpha,Rd} = \min \left\{ k_{ax} \times f_{ax,d} \times d \times l_{ef,b} \times \left(\frac{\rho_{b,k}}{350} \right)^{0.8} ; k_{ax} \times f_{ax,d} \times d \times l_{ef,r} \times \left(\frac{\rho_{r,k}}{350} \right)^{0.8} ; f_{tens,d} \right\} \quad \text{Eq 30}$$

Screws loaded in compression:

$$F_{ax,\alpha,Rd} = \min \left\{ k_{ax} \times f_{ax,d} \times d \times l_{ef,b} \times \left(\frac{\rho_{b,k}}{350} \right)^{0.8} ; k_{ax} \times f_{ax,d} \times d \times l_{ef,r} \times \left(\frac{\rho_{r,k}}{350} \right)^{0.8} ; \frac{\kappa_c \times N_{pl,k}}{\gamma_{M1}} \right\} \quad \text{Eq 31}$$

where:

- $f_{ax,d}$ design value of the axial withdrawal capacity of the threaded part of the screw;
 d outer thread diameter of the screw;
 $l_{ef,b}$ penetration length of the threaded part of the screw in the batten;
 $l_{ef,r}$ penetration length of the threaded part of the screw in the rafter, $l_{ef} \geq 40$ mm;
 $\rho_{b,k}$ characteristic density of the batten [kg/m³];
 $\rho_{r,k}$ characteristic density of the rafter [kg/m³];
 α angle α_1 or α_2 between screw axis and grain direction, $30^\circ \leq \alpha_1 \leq 90^\circ$, $30^\circ \leq \alpha_2 \leq 90^\circ$;
 $f_{tens,d}$ design value of the tensile capacity of the screw;
 γ_{M1} partial factor according to EN 1993-1-1 or to the particular national annex;
 $\kappa_c \times N_{pl,k}$ Buckling capacity of the screw.

Free screw length [mm]	SWD screw \varnothing 6,5 mm	SWD screw \varnothing 8 mm
	$\kappa_c \times N_{pl,k}$ [kN]	$\kappa_c \times N_{pl,k}$ [kN]
≤100	1.51	4.07
120	1.15	3.11
140	0.89	2.44
160	0.72	1.98
180	0.59	1.62
200	-	1.36
220	-	1.15
240	-	0.99
260	-	0.86

B.12 Slip Modulus

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

For screws in softwood:

$$K_{ser} = 25 \times d \times l_{ef} \quad [\text{N/mm}] \quad \text{Eq 32}$$

Where

d outer thread diameter [mm];

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

B.13 Effective number of screws

The solution given in this part can be used for solid timber, CLT and LVL and other timber based panels.

Axially loaded screws

The effective number of screws (n_{ef}) for mainly axially loaded screws is given in EN 1995-1-1 (Eurocode 5) clause 8.7.2 (8):

$$n_{ef} = n^{0.9} \quad \text{Eq 33}$$

Where

n the number of screw on the line.

Laterally loaded screws

The effective number of screws (n_{ef}) for mainly laterally loaded screws is given in EN 1995-1-1 (Eurocode 5) clause 8.3.1.1 (8). For one row of n screws parallel to the grain, unless the screws are staggered perpendicular to the grain by at least $1d$, the load-carrying capacity parallel to the grain should be calculated using the effective number of screws:

$$n_{ef} = n^{k_{ef}} \quad \text{Eq 34}$$

Where

n the number of screw on the line;

k_{ef} depends of the spacing of the screws on the line a_1 .

Spacing	k_{ef}	
	Not predrilled	Predrilled
$a_1 \geq 14d$	1.0	1.0
$a_1 = 10d$	0.85	0.85
$a_1 = 7d$	0.7	0.7
$a_1 = 4d$	-	0.5

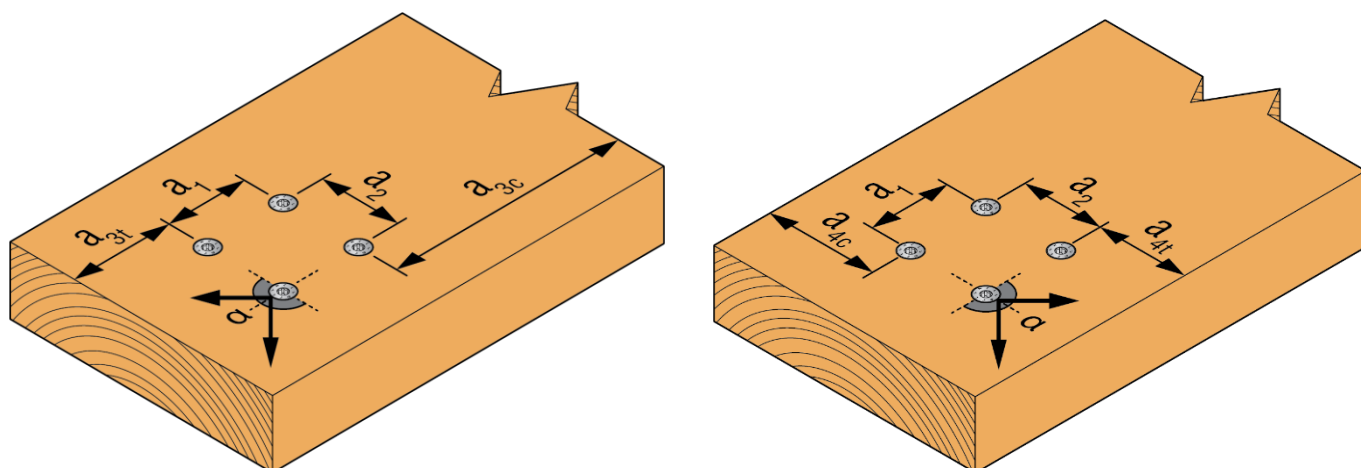
For intermediate spacings, linear interpolation of k_{ef} is permitted

B.14 Minimum Spacing and Edge Distances

General Case

For screws arranged at angles $\alpha \leq 90^\circ$ 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 $a_{3,c}$, $a_{3,t}$, $a_{4,c}$ or $a_{4,t}$ 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.



Lateral loading or combined loadings

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

For Douglas fir members minimum spacing and distances parallel to the grain shall be increased by 50%.

Axial Loading

When no other information are given, for axially loaded screws in non-predrilled holes, minimum spacing and distances are as given in EN 1995-1-1 (Eurocode 5) clause 8.7.2 and table 8.6.

Other general information

Minimum distances from the unloaded edge perpendicular to the grain may be reduced to $a_{4,c} = 3 \times d$ if the spacing parallel to the grain (a_1) and the end distance ($a_{3,t}$) is at least $25 \times d$.

For screws the minimum width / thickness for structural member shall be in accordance with :

Screw diameter		$d < 8 \text{ mm}$	$d = 8 \text{ mm}$	$d = 10 \text{ mm}$	$d = 12 \text{ mm}$
Minimum thickness t for structural members	mm	24	30	40	80

Panel to timber Case

Refer to EN 1995-1-1 (Eurocode 5) clause 8.3.1.3

Steel to timber Case

Refer to EN 1995-1-1 (Eurocode 5) clause 8.3.1.4

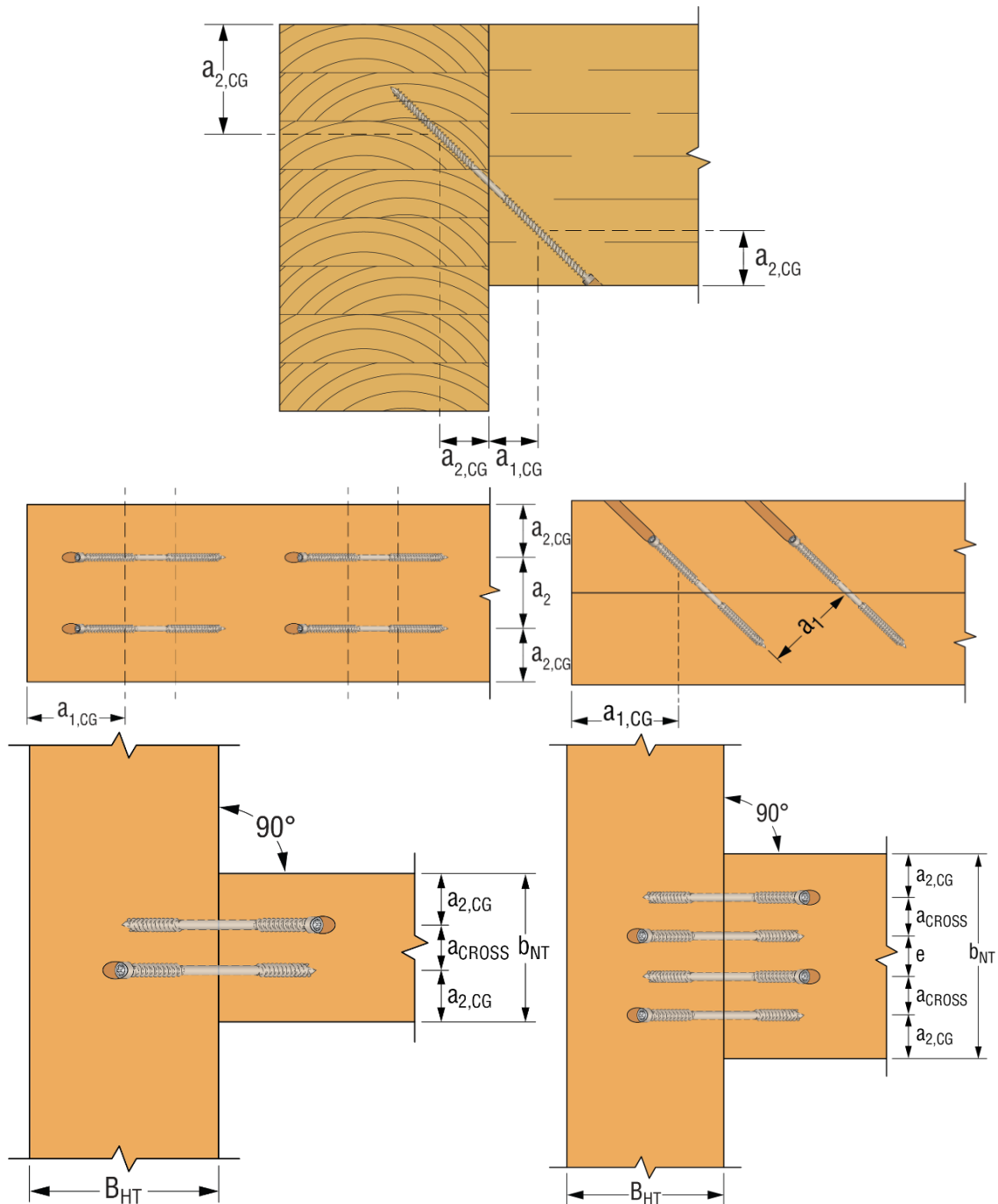
SWD – Axially loaded

Minimum distances and spacing for exclusively axially loaded screws in pre-drilled and non-pre-drilled holes in

members with a minimum thickness $t = 10 \times d$ and a minimum width of $6 \times d$, may be taken as:

- Spacing a_1 parallel to the grain $a_1 = 10 \times d$
- Spacing a_2 perpendicular to the grain $a_2 = 3 \times d$
- Distance $a_{1,CG}$ from centre of the screw-part in timber to the end grain $a_{1,CG} = 8 \times d$
- Distance $a_{2,CG}$ from centre of the screw-part in timber to the edge $a_{2,CG} = 3 \times d$
- B_{HT} is the thickness of the header
- b_{NT} is the thickness of the joist

For a crossed screw couple in solid timber, glued laminated timber and similar glued products or in laminated veneer lumber the minimum spacing between the crossing screws a_{cross} is $1.5 \times d$. Appropriate means have to ensure that the crossed screw threads do not touch each other when being driven into the timber member.

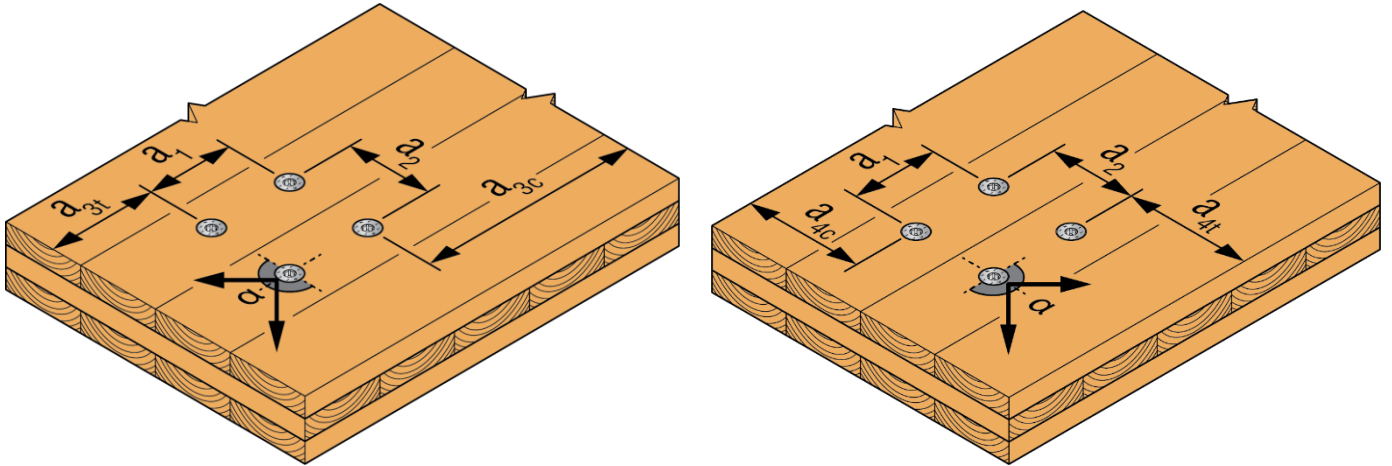


Note : $a_{cross} + e = a_2$

CLT case

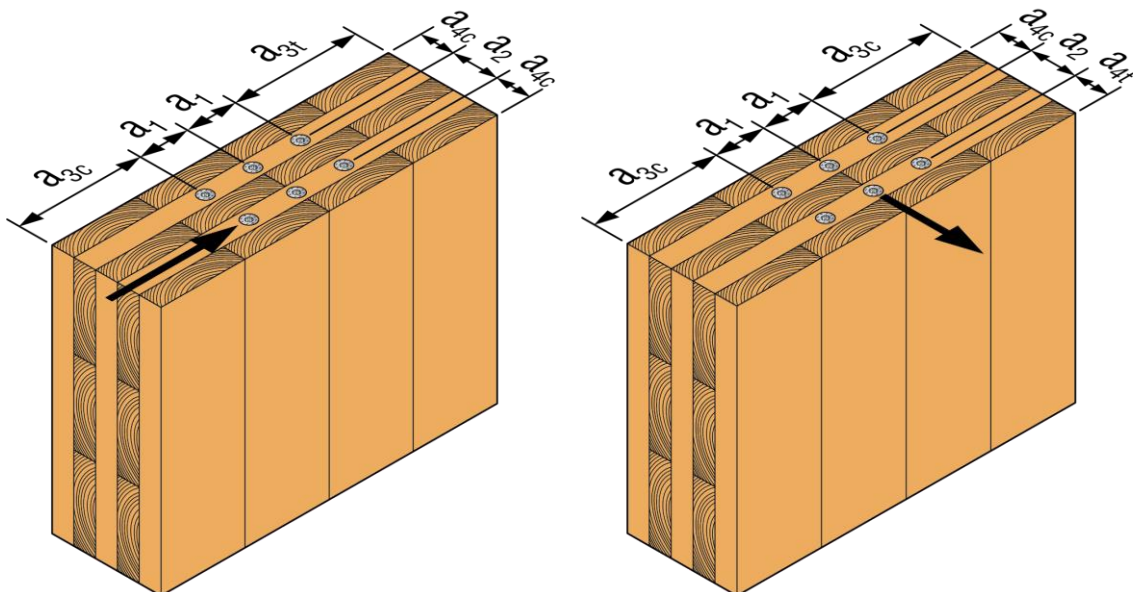
Unless specified otherwise in the technical specification (ETA or hEN) of CLT, minimum distances and spacing for laterally or axially loaded screws in non-predrilled holes, in the wide face of cross laminated timber members with a minimum thickness $t = 10 \times d$ may be taken as:

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



Unless specified otherwise in the technical specification (ETA or hEN) of CLT, minimum distances and spacing for laterally or axially loaded screws in non-predrilled holes, in the edge surface of CLT members with a minimum thickness $t = 10 \times d$ and a minimum penetration depth perpendicular to the edge surface of $10 \times d$ may be taken as:

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



ANNEX C

PRODUCT DEFINITION AND PARAMETERS

C.1 SSF / SSH Screws

Table C.1.1: Material

Article code	Material	Coating	Table
-	Carbon Steel	Electrogalvanised	Table C.1.2, Table C.1.3, Table C.1.4 and Table C.1.5
-		Yellow Zinc Plated	
SSF / SSH		Zinc Nickel	
-		Zinc Flake	

SSF Screws	
SSH Screws Ø6	
SSH Screws Ø8, Ø10 and Ø12	

Note: The friction part is optional

Table C.1.2: Geometry (Carbon Steel)

SSF / SSH Screws						SSF	SSH	Drive size
d [mm]	d _i [mm]	l [mm]		l _g [mm]		d _h [mm]	d _h [mm]	
		min	max	min	max			
6.0	3.7	40	1000	24	990	-	14.5	T-30 / SW-10*
8.0	5.1	40	1000	32	990	13.0	12.9	T-40 / SW-13*
10.0	6.2	50	1000	40	990	15.0	14.9	T-40 / SW-15*
12.0	6.7	50	1000	48	990	-	16.9	T-40 / SW-17*

*SW is only for SSH Screws

The diameter of the cylinder under the head is the same as the diameter of the thread.

Table C.1.3: Mechanical parameters (Carbon Steel)

SSF / SSH Screws						SSF	SSH
d [mm]	$M_{y,k}$ [Nmm]	$f_{ax,k}$ [N/mm ²]	$f_{tens,k}$ [kN]	$f_{tor,k}$ [Nm]	$f_{y,k}$ [N/mm ²]	$f_{head,k}$ [N/mm ²]	$f_{head,k}$ [N/mm ²]
6.0	10400	13.3	13.1	11.0	-	-	17.9
8.0	25300	13.9	24.1	26.4	-	-	19.5
10.0	38700	12.1	32.8	43.0	-	-	19.3
12.0	52300	12.2	40.4	62.4	-	-	18.8

$f_{ax,k}$ is the characteristic withdrawal parameter for timber with a characteristic density of 350 kg/m³

$f_{head,k}$ is the characteristic head pull through parameter for timber with a characteristic density of 350 kg/m³.

Table C.1.4: Dimensions (SSF)

SSF	d [mm]	l [mm]	l_g [mm]	d_h [mm]	d_i [mm]
8x40	8.0	40	32	13.0	5.1
8x60	8.0	60	42	13.0	5.1
8x80	8.0	80	42	13.0	5.1
10x60	10.0	60	42	15.0	6.15
10x80	10.0	80	42	15.0	6.15

Note: other dimensions may exist

Table C.1.5: Dimensions (SSH)

SSH	d [mm]	l [mm]	l_g [mm]	d_h [mm]	d_i [mm]
6x40	6.0	40	24	14.5 (10)	3.65
6x50	6.0	50	33	14.5 (10)	3.65
6x60	6.0	60	42	14.5 (10)	3.65
6x75	6.0	75	42	14.5 (10)	3.65
6x90	6.0	90	42	14.5 (10)	3.65
6x120	6.0	120	75	14.5 (10)	3.65
8x40	8.0	40	32	13.0	5.1
8x50	8.0	50	42	13.0	5.1
8x60	8.0	60	42	13.0	5.1
8x70	8.0	70	42	13.0	5.1
8x80	8.0	80	42	13.0	5.1
8x90	8.0	90	55	13.0	5.1
8x100	8.0	100	85	13.0	5.1
8x120	8.0	120	85	13.0	5.1
8x140	8.0	140	110	13.0	5.1
8x160	8.0	160	110	13.0	5.1
8x180	8.0	180	110	13.0	5.1
8x200	8.0	200	110	13.0	5.1
8x240	8.0	240	110	13.0	5.1
8x260	8.0	260	110	13.0	5.1
8x280	8.0	280	110	13.0	5.1
8x300	8.0	300	110	13.0	5.1

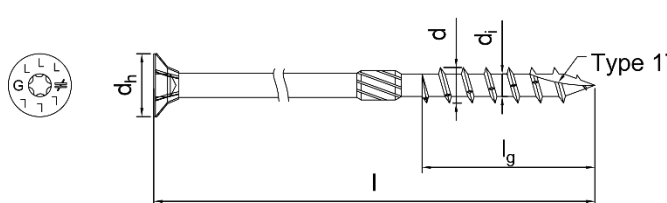
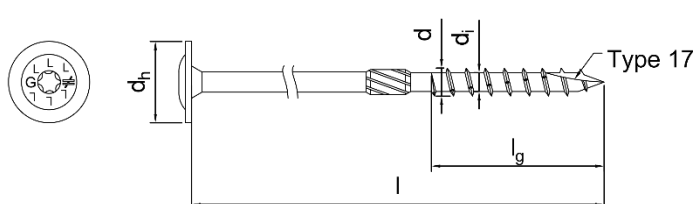
10x50	10.0	50	42	15.0	6.15
10x60	10.0	60	42	15.0	6.15
10x80	10.0	80	42	15.0	6.15
10x90	10.0	90	42	15.0	6.15
10x100	10.0	100	55	15.0	6.15
10x120	10.0	120	85	15.0	6.15
10x140	10.0	140	85	15.0	6.15
10x160	10.0	160	110	15.0	6.15
10x180	10.0	180	110	15.0	6.15
10x200	10.0	200	110	15.0	6.15
10x240	10.0	240	125	15.0	6.15
10x280	10.0	280	125	15.0	6.15
12x60	12.0	60	48	17.0	6.7
12x80	12.0	80	48	17.0	6.7
12x90	12.0	90	48	17.0	6.7
12x100	12.0	100	55	17.0	6.7
12x120	12.0	120	85	17.0	6.7
12x140	12.0	140	85	17.0	6.7
12x160	12.0	160	110	17.0	6.7
12x180	12.0	180	110	17.0	6.7

Note: other dimensions may exist. The values in parentheses for SSH d=6mm is the dimension of the hexagonal head

C.2 SWC / SWW Screws

Table C.2.1: Material

Article code	Material	Coating	Table
-	Carbon Steel	Electrogalvanised	Table C.2.2, Table C.2.3 and Table C.2.4
SWC / SWW		Yellow Zinc Plated	
SWWZ		Zinc Nickel	
-		Zinc Flake	

SWC Screws	
SWW Screws	

Note: The friction part is optional

Table C.2.2: Geometry (Carbon Steel)

SWC / SWW Screws						SWC	SWW	Drive size
d [mm]	d _i [mm]	l [mm]		l _g [mm]		d _h [mm]	d _h [mm]	
		min	max	min	max			
6.0	3.9	40	1000	24	990	11.8	14.0	T-30
8.0	5.2	40	1000	32	990	14.6	22.0	T-40
10.0	6.2	40	1000	40	990	17.8	25.0	T-40

Table C.2.3: Mechanical parameters (Carbon Steel)

SWC / SWW Screws						SWC	SWW	
d [mm]	M _{y,k} [Nmm]	f _{ax,k} [N/mm ²]	f _{tens,k} [kN]	f _{tor,k} [Nm]	f _{y,k} [N/mm ²]	f _{head,k} [N/mm ²]	f _{head,k} [N/mm ²] Plywood	f _{head,k} [N/mm ²]
6.0	10500	13.0	12.3	11.0	-	11.9	13.3	16.1
8.0	25900	12.6	23.7	27.4	-	12.5	10.8	10.5
10.0	43700	12.2	33.8	48.9	-	11.2	10.6	10.2

f_{ax,k} is the characteristic withdrawal parameter for timber with a characteristic density of 350 kg/m³

f_{head,k} is the characteristic head pull through parameter for timber with a characteristic density of 350 kg/m³.

Table C.2.4: Dimensions

SWC/SWW	d [mm]	l [mm]	l_g [mm]	$d_h - SWC$ [mm]	$d_h - SWW$ [mm]	d_i [mm]
6x60	6.0	60	42	11.8	14.0	3.9
6x80	6.0	80	50	11.8	14.0	3.9
6x90	6.0	90	50	11.8	14.0	3.9
6x100	6.0	100	50	11.8	14.0	3.9
6x120	6.0	120	50	11.8	14.0	3.9
6x140	6.0	140	70	11.8	14.0	3.9
6x160	6.0	160	70	11.8	14.0	3.9
6x180	6.0	180	70	11.8	14.0	3.9
6x200	6.0	200	70	11.8	14.0	3.9
6x220	6.0	220	70	11.8	14.0	3.9
6x240	6.0	240	70	11.8	14.0	3.9
6x260	6.0	260	70	11.8	14.0	3.9
6x280	6.0	280	70	11.8	14.0	3.9
6x300	6.0	300	70	11.8	14.0	3.9
8x80	8.0	80	50	14.6	22.0	5.2
8x90	8.0	90	50	14.6	22.0	5.2
8x100	8.0	100	50	14.6	22.0	5.2
8x120	8.0	120	80	14.6	22.0	5.2
8x140	8.0	140	80	14.6	22.0	5.2
8x160	8.0	160	80	14.6	22.0	5.2
8x180	8.0	180	80	14.6	22.0	5.2
8x200	8.0	200	80	14.6	22.0	5.2
8x220	8.0	220	80	14.6	22.0	5.2
8x240	8.0	240	80	14.6	22.0	5.2
8x260	8.0	260	80	14.6	22.0	5.2
8x280	8.0	280	80	14.6	22.0	5.2
8x300	8.0	300	80	14.6	22.0	5.2
8x320	8.0	320	80	14.6	22.0	5.2
8x340	8.0	340	80	14.6	22.0	5.2
8x360	8.0	360	80	14.6	22.0	5.2
8x380	8.0	380	80	14.6	22.0	5.2
8x400	8.0	400	80	14.6	22.0	5.2
10x100	10.0	100	50	17.8	25.0	6.2
10x120	10.0	120	50	17.8	25.0	6.2
10x140	10.0	140	80	17.8	25.0	6.2
10x160	10.0	160	80	17.8	25.0	6.2
10x180	10.0	180	80	17.8	25.0	6.2
10x200	10.0	200	80	17.8	25.0	6.2
10x220	10.0	220	80	17.8	25.0	6.2
10x240	10.0	240	80	17.8	25.0	6.2
10x260	10.0	260	80	17.8	25.0	6.2
10x280	10.0	280	80	17.8	25.0	6.2
10x300	10.0	300	80	17.8	25.0	6.2
10x320	10.0	320	80	17.8	25.0	6.2

10x340	10.0	340	80	17.8	25.0	6.2
10x360	10.0	360	80	17.8	25.0	6.2
10x380	10.0	380	80	17.8	25.0	6.2
10x400	10.0	400	80	17.8	25.0	6.2

Note: other dimensions may exist

C.3 SWD

Table C.3.1: Material

Article code	Material	Coating	Table
-	Carbon Steel	Electrogalvanised	Table C.3.2, Table C.3.3 and Table C.3.4
-		Yellow Zinc Plated	
-		Zinc Nickel	
SWD		Zinc Flake	

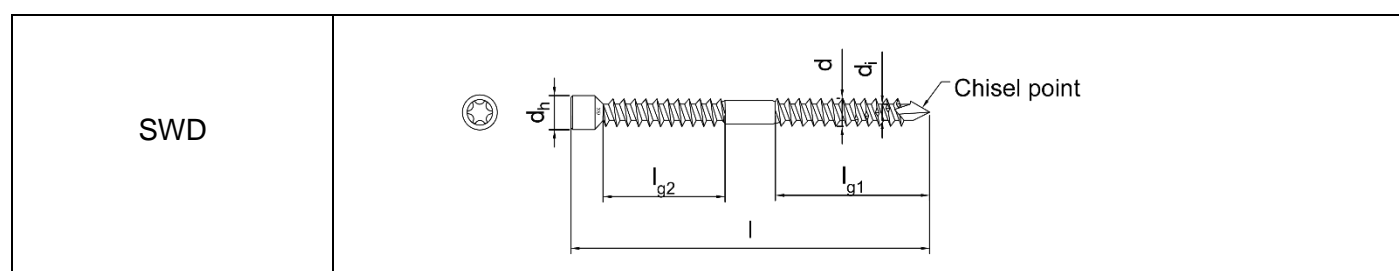


Table C.3.2: Geometry (Carbon Steel)

SWD Screws									Drive size
d [mm]	d _i [mm]	l [mm]		l _{g1} [mm]		l _{g2} [mm]		d _h [mm]	
		min	max	min	max	min	max		
6.5	4.0	65	1000	26	450	21.5	450	8.0	T-30
8.0	5.4	80	1000	32	450	32	450	10.0	T-40

Table C.3.3: Mechanical parameters (Carbon Steel)

SWD Screws						
d [mm]	M _{y,k} [Nmm]	$f_{ax,k} l_{g1} = f_{ax,k} l_{g2}$ [N/mm ²]	f _{tens,k} [kN]	f _{tor,k} [Nm]	f _{y,k} [N/mm ²]	f _{head,k} [N/mm ²]
6.5	12400	13.7	14.5	12.6	1000	-
8.0	26800	13.1	25.3	27.7	1000	-

$f_{ax,k}$ is the characteristic withdrawal parameter for timber with a characteristic density of 350 kg/m³

$f_{head,k}$ is the characteristic head pull through parameter for timber with a characteristic density of 350 kg/m³.

Table C.3.4: Dimensions

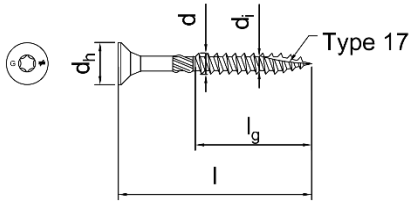
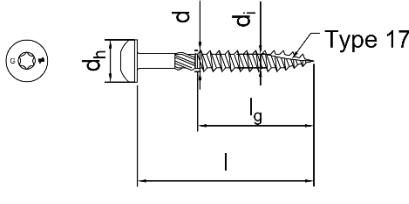
SWD	d [mm]	l [mm]	l_{g1} [mm]	l_{g2} [mm]	d_h [mm]	d_i [mm]
6.5x65	6.5	65	28	21.5	8.0	4.0
6.5x90	6.5	90	40	33.5	8.0	4.0
6.5x130	6.5	130	40	33.5	8.0	4.0
6.5x160	6.5	160	65	58.5	8.0	4.0
6.5x190	6.5	190	80	73.5	8.0	4.0
6.5x220	6.5	220	95	88.5	8.0	4.0
8x90	8.0	90	40	31.5	10.0	5.4
8x130	8.0	130	40	31.5	10.0	5.4
8x160	8.0	160	65	56.5	10.0	5.4
8x190	8.0	190	80	71.5	10.0	5.4
8x220	8.0	220	95	86.5	10.0	5.4
8x245	8.0	245	107	99	10.0	5.4
8x275	8.0	275	107	99	10.0	5.4
8x300	8.0	300	135	126.5	10.0	5.4
8x330	8.0	330	135	126.5	10.0	5.4

Note: other dimensions may exist

C.4 TT screws: TTUFS / TTZNFS / TTSFS / TTUFP / TTZNFP

Table C.4.1: Material

Article code	Material	Coating	Table
TTUFS / TTUFP	Carbon Steel	Electrogalvanised	Table C.4.2, Table C.4.3 and Table C.4.5
-		Yellow Zinc Plated	
TTZNFS / TTZNFP		Zinc Nickel	
-		Zinc Flake	
TTSFS	Stainless Steel	Stainless Steel	Table C.4.2 and Table C.4.4 and Table C.4.6

TTxxS Screws	
TTxxP Screws	

Note: The friction part is optional

Table C.4.2: Geometry (Carbon Steel and Stainless Steel)

TT Screws						TT..S	TT..P	Drive size
d [mm]	d _i [mm]	l [mm]		l _g [mm]		d _h [mm]	d _h [mm]	
		min	max	min	max			
4.5	2.8	23	1000	18	L-5mm	8.4	-	T-20
5.0	3.1	25	1000	20	L-5mm	9.5	9.7	T-20 / T-25
6.0	3.7	30	1000	24	L-5mm	11.6	11.7	T-30

Table C.4.3: Mechanical parameters (Carbon Steel)

TTUFS / TTZNFS / TTUFP / TTZNFP						TT..S	TT..P	
d [mm]	M _{y,k} [Nmm]	f _{ax,k} [N/mm ²]	f _{tens,k} [kN]	f _{tor,k} [Nm]	f _{y,k} [N/mm ²]	f _{head,k} [N/mm ²]	f _{head,k} [N/mm ²] Plywood	f _{head,k} [N/mm ²]
4.5	4660	14.7	7.8	4.7	-	15.6	19.0	-
5.0	6720	15.0	7.9	6.0	-	17.1	18.7	16.9
6.0	9500	12.5	11.1	9.4	-	16.6	18.8	17.4

f_{ax,k} is the characteristic withdrawal parameter for timber with a characteristic density of 350 kg/m³

f_{head,k} is the characteristic head pull through parameter for timber with a characteristic density of 350 kg/m³.

Table C.4.4: Mechanical parameters (Stainless Steel)

TTSFS							
d [mm]	$M_{y,k}$ [Nmm]	$f_{ax,k}$ [N/mm ²]	$f_{tens,k}$ [kN]	$f_{tor,k}$ [Nm]	$f_{y,k}$ [N/mm ²]	$f_{head,k}$ [N/mm ²]	$f_{head,k}$ [N/mm ²] Plywood
5.0	4710	14.9	6.3	4.9	-	16.0	17.8
6.0	8570	13.6	9.5	8.8	-	16.2	16.7

$f_{ax,k}$ is the characteristic withdrawal parameter for timber with a characteristic density of 350 kg/m³

$f_{head,k}$ is the characteristic head pull through parameter for timber with a characteristic density of 350 kg/m³.

Table C.4.5: Dimensions (Carbon Steel)

TTUFS / TTZNFS / TTUFP / TTZNFP	d [mm]	l [mm]	l_g [mm]	d_h - TT..S [mm]	d_h - TT..P [mm]	d_i [mm]
4.5x25	4.5	25	20	8.4	-	2.8
4.5x30	4.5	30	25	8.4	-	2.8
4.5x35	4.5	35	30	8.4	-	2.8
4.5x40	4.5	40	35	8.4	-	2.8
4.5x45	4.5	45	29	8.4	-	2.8
4.5x50	4.5	50	30	8.4	-	2.8
4.5x60	4.5	60	35	8.4	-	2.8
4.5x70	4.5	70	40	8.4	-	2.8
4.5x80	4.5	80	50	8.4	-	2.8
5x30	5	30	25	9.5	9.7	3.1
5x40	5	40	35	9.5	9.7	3.1
5x50	5	50	30	9.5	9.7	3.1
5x60	5	60	35	9.5	9.7	3.1
5x70	5	70	40	9.5	9.7	3.1
5x80	5	80	40	9.5	9.7	3.1
5x90	5	90	45	9.5	9.7	3.1
5x100	5	100	60	9.5	9.7	3.1
5x120	5	120	60	9.5	9.7	3.1
6x40	6	40	34	11.6	11.7	3.7
6x50	6	50	30	11.6	11.7	3.7
6x60	6	60	35	11.6	11.7	3.7
6x70	6	70	40	11.6	11.7	3.7
6x80	6	80	40	11.6	11.7	3.7
6x90	6	90	45	11.6	11.7	3.7
6x100	6	100	60	11.6	11.7	3.7
6x120	6	120	70	11.6	11.7	3.7
6x140	6	140	70	11.6	11.7	3.7
6x160	6	160	70	11.6	11.7	3.7
6x180	6	180	70	11.6	11.7	3.7

Note: other dimensions may exist

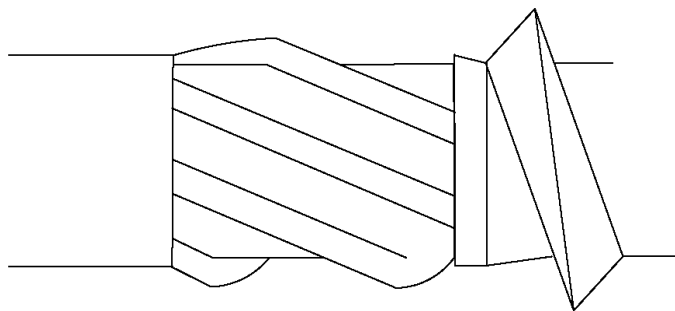
Table C.4.6: Dimensions (Stainless Steel)

TTSFS	d [mm]	l [mm]	l_g [mm]	d_h [mm]	d_i [mm]
5x60	5	60	32	9.5	3.1
5x70	5	70	35	9.5	3.1
5x80	5	80	40	9.5	3.1
5x90	5	90	45	9.5	3.1
5x100	5	100	55	9.5	3.1
5x120	5	120	60	9.5	3.1
6x70	6	70	35	11.6	3.7
6x80	6	80	40	11.6	3.7
6x90	6	90	45	11.6	3.7
6x100	6	100	55	11.6	3.7
6x120	6	120	60	11.6	3.7
6x140	6	140	65	11.6	3.7

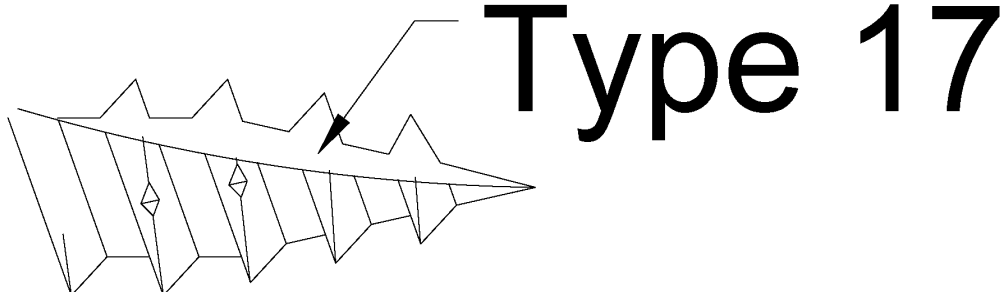
Note: other dimensions may exist

C.5 Screw features

All screws may have an optional friction part (also called milling thread):



All screws may have an optional type 17 point:



Type 17

C.6 Optional Washer

When optional washer is used, see Annex B.6 for $f_{head.k}$.

- For countersunk head screws, an optional countersunk washer can be used :

	Example of dimensions [mm]				
	Diameter of screw	d_w	d_6	d_5	t_w
	5.0	14.2	10	5.6	2.9
	6.0	16	12	7.1	3.5
	8.0	28.0	19.0	10.0	6.0
	10.0	35.0	22.5	12.0	7.0
12.0	42.0	25.0	14.0	7.5	

- For hexagonal head screws, an optional large flat washer can be used :

	Minimum dimension of the washer [mm]			
	Diameter of screw	d_w	d_i	t_w
	6.0	18	7	1.8
	8.0	24	9	2.4
	10.0	30	11	3.0
12.0	36	14	3.6	