SUORITUSTASOILMOITUS

DoP W0012

fischer Power-Full-ruuveille

FI

1. Tuotetyypin yksilöllinen tunniste: **DoP W0012**

2. Aiottu käyttötarkoitus (aiotut käyttötarkoitukset): **Puurakenteissa käytettävät itsekierteittävät ruuvit, katso lisäys, erityisesti liitteet 1.**

3. Valmistaja: **fischerwerke GmbH & Co. KG, Klaus-Fischer-Str. 1, 72178 Waldachtal, Saksa**

4. Valtuutettu edustaja: **–**

5. Suoritustason pysyvyyden arvioinnissa ja varmentamisessa käytetty järjestelmä/käytetyt järjestelmät: **3**

6. Eurooppalainen arviointiasiakirja: **EAD 130118-00-0603**
   Eurooppalainen tekninen arviointi: **ETA-12/0073; 2017-07-06**
   Teknisestä arvioinnista vastaava laitos: **ETA-Danmark A/S**
   Ilmoitettu laitos/ilmoitetut laitokset: **0769 Karlsruher Institut für Technologie (KIT)**

7. Ilmoitettu suoritustaso/ilmoitetut suoritustasot:

Mekaaninen kestävyys ja vakaus (BWR 1), Käytön turvallisuus ja esteettömyys (BWR 4)

Mitat:	Liitteet 8-11
Tyypillinen tuottomomentti:	Liite 3
Taittokulma:	Liite 4
Tyypillinen vetäytymisparametri:	Liitteet 3, 4
Tyypillinen kannan vetoparametri:	Liite 4
Tyypillinen vetolujuus:	Liite 4
Tyypillinen myötölujuus:	Liite 4
Tyypillinen vääntölujuus:	Liite 2
Lisäysmomentti:	Liite 2
Ruuvien välistys, pääty- ja kulmaetäisyydet, sekä puupohjaisen materiaalin vähimmäispaksuus	Liitteet 5-7, 12-14
Pääosin aksiaalisesti kuormitettujen ruuvien ominaiskimmokerroin	Liite 5
Korroosionkesto	Liitteet 1,2,5

Turvallisuus tulipalon sattuessa (BWR 2)

Reaktio paloon:	Luokka (A1)

8. Asianmukainen tekninen asiakirja ja/tai tekninen erityisasiakirja: **–**

Edellä yksilöidyn tuotteen suoritustaso on ilmoitettujen suoritustasojen joukon mukainen. Tämä suoritustasoilmoitus on asetuksen (EU) N:o 305/2011 mukaisesti annettu edellä ilmoitetun valmistajan yksinomaisella vastuulla.

Valmistajan puolesta allekirjoittanut:

Dr.-Ing. Oliver Geibig, Toimitusjohtaja Liiketoimintayksikkö & Suunnittelu

Jürgen Grün, Toimitusjohtaja Kemia & Laatu

Tumlingen, 2021-10-01

Tämä suoritustasoilmoitus on laadittu useilla kielillä. Jos tulkinnasta syntyy erimielisyyttä, englanninkielinen versio on aina katsottava ensisijaiseksi.

Lisäys sisältää vapaaehtoisesti ilmoitettua ja täydentävää englanninkielistä tietoa, joka ylittää (kielestä riippumatta määritellyt) lakisääteiset vaatimukset.

II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product and intended use

Technical description of the product
fischer Power-Full screws are self-tapping screws to be used in timber structures. fischer FPF screws shall be threaded over the full length. fischer FIF screws shall be threaded over a part of the length. The screws shall be produced from carbon steel wire for nominal diameters of 6,5 mm to 11,3 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 6,5 mm and shall not be greater than 11,3 mm. The overall length, L, of screws shall not be less than 80 mm and shall not be greater than 1000 mm. Other dimensions are given in Annex A.

The ratio of inner thread diameter to outer thread diameter d_i/d ranges from 0,57 to 0,72.

The screws are threaded over a minimum length ℓg of $4 \cdot d$ (i.e. $\ell g > 4 \cdot d$).

The lead p (distance between two adjacent thread flanks) ranges from $0,56 \cdot d$ to $0,81 \cdot d$.

No cracks shall be observed at a bend angle, α, of less than $(45/d^{0,7} + 10)$ degrees.

2 Specification of the intended use in accordance with the applicable EAD

The screws are used for connections in load bearing timber structures between members of solid timber (softwood), glued laminated timber, cross-laminated timber, and laminated veneer lumber, similar glued members, wood-based panels or steel. The screws are also used as tensile or compressive reinforcement perpendicular to the grain.

Furthermore, fischer Power-Full screws with diameters between 6,5 mm and 11,3 mm may also be used for the fixing of thermal insulation on rafters.

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)
- Cement bonded particleboard
- Solid wood panels according to EN 13353 and EN 13986 and cross laminated timber according to ETA
- Laminated Veneer Lumber, LVL
- 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 predrilling or after pre-drilling with a diameter not larger than the inner thread diameter for the length of the threaded part and with a maximum of the smooth shank diameter for the length of the smooth shank.

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.

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 fischerwerke screws made from carbon steel.

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)**	
	Tensile strength	Characteristic value $f_{tens,k}$:
	fischer Power-Full screws FPF	Screw d = 6,5 mm: 17 kN Screw d = 8,0 mm: 25 kN Screw d = 10,0 mm: 33 kN Screw d = 11,3 mm: 50 kN
	Fischer Power-Full screws FIF	Screw d = 8,0 mm: 20 kN
	Insertion moment	Ratio of the characteristic torsional strength to the mean insertion moment: $f_{tor,k} / R_{tor,mean} \geq 1,5$
	Torsional strength	Characteristic value $f_{tor,k}$:
	fischer Power-Full screws FPF	Screw d = 6,5 mm: 19 Nm Screw d = 8,0 mm: 28 Nm Screw d = 10,0 mm: 48 Nm Screw d = 11,3 mm: 80 Nm
	Fischer Power-Full screws FIF	Screw d = 8,0 mm: 22 Nm
3.2	**Safety in case of fire (BWR2)**	
	Reaction to fire	The screws are made from steel classified as performance class A1 of the characteristic reaction to fire, in accordance with the provisions of EC decision 96/603/EC, amended by EC Decision 2000/605/EC.
3.7	**Sustainable use of natural resources (BR7)**	No Performance Determined
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 and 2
	Identification	See Annex A

*) See additional information in section 3.9 – 3.12.

3.9 Mechanical resistance and stability

The load-carrying capacities for fischer Power-Full 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 fischer Power-Full screws should be used for designs in accordance with Eurocode 5 or an appropriate national code.

For screws arranged under an angle between screw axis and grain direction $\alpha \leq 15°$, the minimum threaded penetration length is: $\ell_{ef} \geq \min(4 \cdot d/\sin\alpha; 20 \cdot d)$. For $15° < \alpha \leq 90°$ the minimum threaded penetration length must be $\ell_{ef} \geq 4 \cdot d$. For the fixing of rafters, point side penetration must be at least 40 mm, $\ell_{ef} \geq 40$ mm.

ETA's for structural members or wood-based panels must be considered where applicable.

Lateral load-carrying capacity
The characteristic lateral load-carrying capacity of fischer Power-Full screws shall be calculated according to EN 1995-1-1:2008 (Eurocode 5) using the outer thread diameter d as the nominal diameter of the screw. The contribution from the rope effect may be considered.

The characteristic yield moment, $M_{y,k}$ shall be calculated from:

fischer Power-Full screws FPF:
Screw d = 6,5 mm: 15000 Nmm
Screw d = 8,0 mm: 25000 Nmm
Screw d = 10,0 mm: 40000 Nmm
Screw d = 11,3 mm: 70000 Nmm

fischer Power-Full screws FIF
Screw d = 8,0 mm: 20000 Nm

where
d outer thread diameter [mm]

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

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

and accordingly for screws in pre-drilled holes:

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

Where
ρ_k characteristic timber density [kg/m³];
d outer thread diameter [mm];
α angle between screw axis and grain direction.

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

$$f_{h,k} = 20 \cdot d^{-0,5} \quad [N/mm^2]$$

Where
d outer thread diameter [mm]

The embedding strength for screws in the wide face of cross laminated timber should be assumed as for solid timber 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 cross laminated timber.

Axial withdrawal capacity
The characteristic axial withdrawal capacity of fischer Power-Full in solid timber (softwood), glued laminated timber or cross-laminated timber members at an angle of $0° \leq \alpha \leq 90°$ (screws with tip other than type BS) or $30° \leq \alpha \leq 90°$ (screws with tip type BS) to the grain shall be calculated according to EN 1995-1-1:2008 from:

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

Where

$F_{ax,\alpha,Rk}$	characteristic withdrawal capacity of the group of screw at an angle α to the grain [N]
n_{ef}	effective number of screws according to Eurocode 5
k_{ax}	$k_{ax} = 1,0$ for $45° \leq \alpha \leq 90°$ $k_{ax} = 0,3 + \frac{0,7 \cdot \alpha}{45°}$ for $0° \leq \alpha < 45°$
$f_{ax,k}$	Characteristic withdrawal parameter Screws with tip type BS: Screw d ≤ 10 mm: $f_{ax,k}$ = 9,0 N/mm² Screw d = 11,3 mm: $f_{ax,k}$ = 8,0 N/mm² Screws with tip other than type BS: Screw d = 6,5 mm: $f_{ax,k}$ = 11,4 N/mm² Screw d = 8,0 mm: $f_{ax,k}$ = 11,1 N/mm² Screw d = 10,0 mm: $f_{ax,k}$ = 10,8 N/mm² Screw d = 11,3 mm: $f_{ax,k}$ = 10,8 N/mm²
d	outer thread diameter [mm]
ℓ_{ef}	point side penetration length of the threaded part according to Eurocode 5 [mm]
α	angle between grain and screw axis ($\alpha \geq 0°$ for screws with tip other than type BS; $\alpha \geq 30°$ for screws with tip type BS
ρ_k	characteristic density [kg/m³]

For screws arranged under an angle between screw axis and grain direction $\alpha \leq 15°$, the minimum threaded penetration

length is: $\ell_{ef} \geq \min(4 \cdot d/\sin\alpha ; 20 \cdot d)$. For $15° < \alpha \leq 90°$ the minimum threaded penetration length must be $\ell_{ef} \geq 4 \cdot d$.

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

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

Bending angle
A minimum plastic bending angle of $45°/d^{0,7} + 20°$ was reached without breaking the screws.

Head pull-through capacity
The characteristic head pull-through capacity of fischer Power-Full screws shall be calculated according to EN 1995-1-1:2008 from:

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

where:

$F_{ax,\alpha,Rk}$	characteristic head pull-through capacity of the connection at an angle $\alpha \geq 30°$ to the grain [N]
n_{ef}	effective number of screws according to EN 1995-1-1:2008
$f_{head,k}$	characteristic head pull-through parameter [N/mm²]
d_h	diameter of the screw head [mm]
ρ_k	characteristic density [kg/m³], for wood-based panels ρ_k = 380 kg/m³

Characteristic head pull-through parameter for fischer Power-Full screws with head type other than FK in connections with timber and in connections with wood-based panels with thicknesses above 20 mm:
$f_{head,k}$ = 12,0 N/mm²

Characteristic head pull-through parameter for fischer Power-Full screws with head type FK in connections with timber and in connections with wood-based panels with thicknesses above 20 mm:
$f_{head,k}$ = 10,0 N/mm²

For fischer Power-Full screws with head type ZK the characteristic head pull-through parameter shall be disregarded.
$f_{head,k}$ = 0 N/mm²

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

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

The minimum thickness of wood-based panels according to the clause 2.1 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 fischer Power-Full screws is:

fischer Power-Full screws FPF	
Screw d = 6,5 mm:	17 kN
Screw d = 8,0 mm:	25 kN
Screw d = 10,0 mm:	33 kN
Screw d = 11,3 mm:	50 kN
fischer Power-Full screws FIF	
Screw d = 8,0 mm:	20 kN

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.

Compressive capacity
The characteristic buckling capacity $F_{ki,k}$ of fischer Power-Full screws embedded in timber shall be calculated from:

$$F_{ki,Rk} = \kappa_c \cdot N_{pl,k} \quad [N]$$

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

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

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:
$f_{y,k}$ = 1000 [N/mm²]

Characteristic ideal elastic buckling load:

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

Elastic foundation of the screw:

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

Modulus of elasticity:

$E_s = 205000$ [N/mm²]

Second moment of area:

$$I_S = \frac{\pi}{64} \times d_i^4 \quad [mm^4]$$

d_i = inner thread diameter [mm]

α = angle between screw axis and grain direction [°]

Note: When determining design values of the compressive capacity it should be considered that $f_{ax,d}$ is to be calculated using k_{mod} and γ_M for timber according to EN 1995 while $N_{pl,d}$ is calculated using $\gamma_{M,1}$ for steel according to EN 1993.

Mechanically jointed beams

fischer Power-Full 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.

The axial slip modulus K_{ser} of a screw with a full thread for the serviceability limit state per side should be taken independent of angle α to the grain as:

$$C = K_{ser} = 780 \cdot d^{0,2} \cdot \ell_{ef}^{0,4} \quad [N/mm]$$

Where

d outer thread diameter [mm]

ℓ_{ef} penetration length in the structural member [mm] (see Annex B)

Compression reinforcement

See annex C

Tensile reinforcement

See annex D

Thermal insulation material on top of rafters

See annex E

Combined laterally and axially loaded screws

For screwed 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

3.11 Aspects related to the performance of the product

3.11.1 Corrosion protection in service class 1 and 2.

The fischer Power-Full screws are produced from carbon wire. Screws made from carbon steel are electrogalvanised and yellow or blue chromate. The mean thickness of the zinc coating is 5µm.

3.12 General aspects related to the intended use of the product

The screws are manufactured in accordance with the provisions of the European Technical Assessment 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 fischerwerke GmbH & Co. KG should be considered for installation.

The screws are used for connections in load bearing timber structures between members of solid timber (softwood), glued laminated timber, cross-laminated timber, and 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 a ETA is allowed.

fischer fully threaded Power-Full screws are also used as tensile or compressive reinforcement perpendicular to the grain.

Furthermore the screws with diameters of at least 6,5 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.

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·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 $d \geq 8$ 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 or for screws with drill tips.

The minimum angle between the screw axis of screws with tip type BS and the grain direction is $\alpha = 30°$. For other screws: $0° \leq \alpha \leq 90°$.

The screws shall be driven into the wood with or without pre-drilling. The maximum pre-drilling diameter is the inner thread diameter for the length of the threaded part and the smooth shank diameter for the depth of the smooth shank. The hole diameter in steel members must be predrilled with a suitable diameter.

Only the equipment prescribed by fischerwerke GmbH & Co. KG 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 structural timber members, minimum spacing and distances for 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 1995-1-1:2004 (Eurocode 5) clause 8.3.1.2 and table 8.2 as for nails in non-predrilled holes.

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

Minimum distances from loaded or unloaded ends must be $15 \cdot d$ for screws in non-predrilled holes with outer thread diameter $d \geq 8$ mm and timber thickness $t < 5 \cdot d$.

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 $25 \cdot d$.

Minimum distances and spacing for exclusively axially loaded screws in predrilled holes with a minimum thickness $t = 10 \cdot d$ and a minimum width of $8 \cdot d$ or 60 mm, whichever is the greater, may be taken as:

Spacing a_1 parallel to the grain	$a_1 = 5 \cdot d$
Spacing a_2 perpendicular to the grain	$a_2 = 5 \cdot d$
Distance $a_{1,c}$ from centre of the screw-part in timber to the end grain	$a_{1,c} = 10 \cdot d$
Distance $a_{2,c}$ from centre of the screw-part in timber to the edge	$a_{2,c} = 4 \cdot d$

Spacing a_2 perpendicular to the grain may be reduced from $5 \cdot d$ to $2{,}5 \cdot d$, if the condition $a_1 \cdot a_2 \geq 25 \cdot d^2$ is fulfilled.

Minimum distances and spacing for exclusively axially loaded screws in predrilled holes or for fischer Power-Full screws with tip type BS or rBS DAG non-predrilled holes in members with a minimum thickness $t = 10 \cdot d$ and a minimum width of $8 \cdot d$ or 60 mm, whichever is the greater, may be taken as:

Spacing a_1 parallel to the grain	$a_1 = 5 \cdot d$
Spacing a_2 perpendicular to the grain	$a_2 = 5 \cdot d$
Distance $a_{1,c}$ from centre of the screw-part in timber to the end grain	$a_{1,c} = 5 \cdot d$
Distance $a_{2,c}$ from centre of the screw-part in timber to the edge	$a_{2,c} = 3 \cdot d$

Spacing a_2 perpendicular to the grain may be reduced from $5 \cdot d$ to $2{,}5 \cdot d$, if the condition $a_1 \cdot a_2 \geq 25 \cdot d^2$ is fulfilled.

For a crossed screw couple the minimum spacing between the crossing screws is $1{,}5 \cdot d$.

Minimum thickness for 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, and $t = 40$ mm for screws with outer thread diameter $d = 10$ mm.

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 $a_{4,c} = 3 \cdot d$

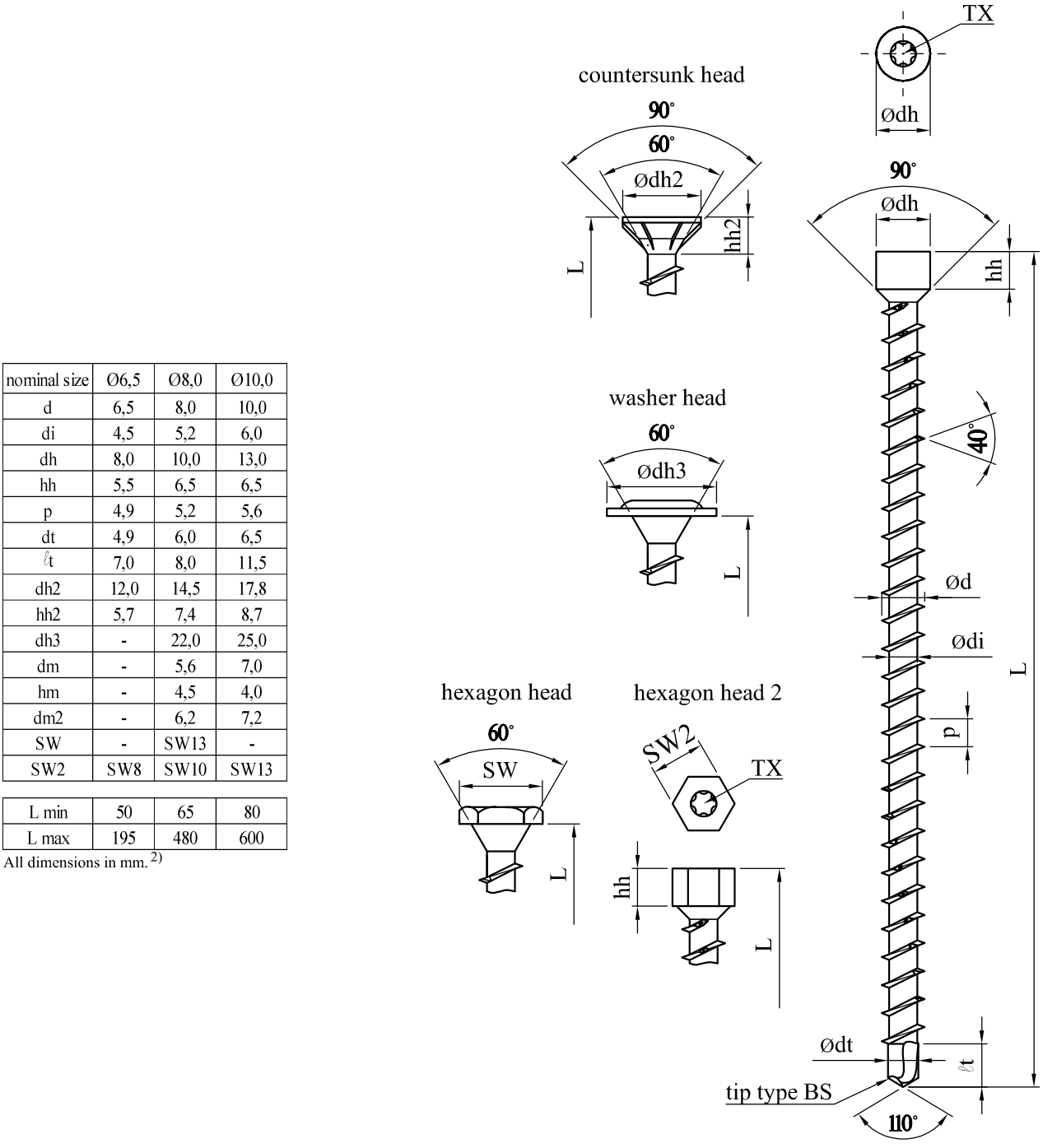
Distance $a_{4,t}$ from centre of the screw-part in timber to the loaded edge $a_{4,t} = 6 \cdot d$

4 Attestation 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.

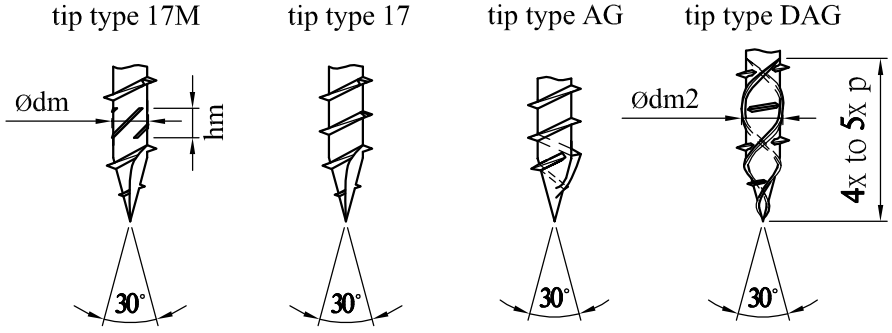
Annex A
fischer Power-Full FPF-ZT
carbon steel [1)]



nominal size	Ø6,5	Ø8,0	Ø10,0
d	6,5	8,0	10,0
di	4,5	5,2	6,0
dh	8,0	10,0	13,0
hh	5,5	6,5	6,5
p	4,9	5,2	5,6
dt	4,9	6,0	6,5
ℓt	7,0	8,0	11,5
dh2	12,0	14,5	17,8
hh2	5,7	7,4	8,7
dh3	-	22,0	25,0
dm	-	5,6	7,0
hm	-	4,5	4,0
dm2	-	6,2	7,2
SW	-	SW13	-
SW2	SW8	SW10	SW13

L min	50	65	80
L max	195	480	600

All dimensions in mm. [2)]



[1)] Material specification held on file by ETA Danmark.

[2)] Tolerances according to EAD 130118-XX-0603.

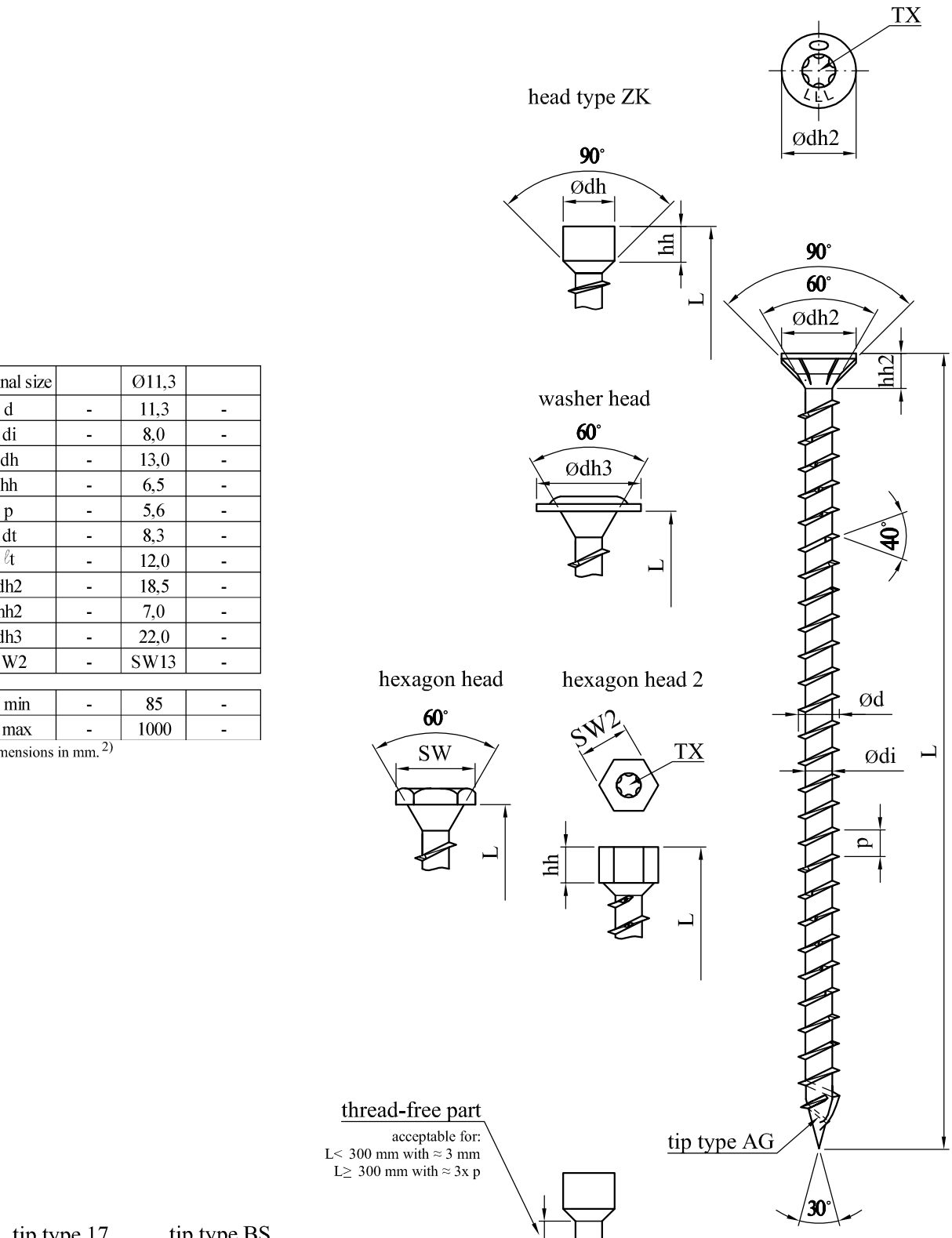
fischer Power-Full FPF-ST 11,3

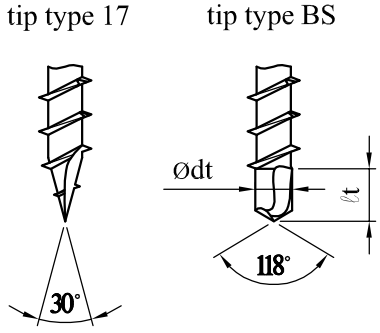
carbon steel[1)]

nominal size		Ø11,3	
d	-	11,3	-
di	-	8,0	-
dh	-	13,0	-
hh	-	6,5	-
p	-	5,6	-
dt	-	8,3	-
ℓt	-	12,0	-
dh2	-	18,5	-
hh2	-	7,0	-
dh3	-	22,0	-
SW2	-	SW13	-

L min	-	85	-
L max	-	1000	-

All dimensions in mm.[2)]





[1)] Material specification held on file by ETA Danmark.

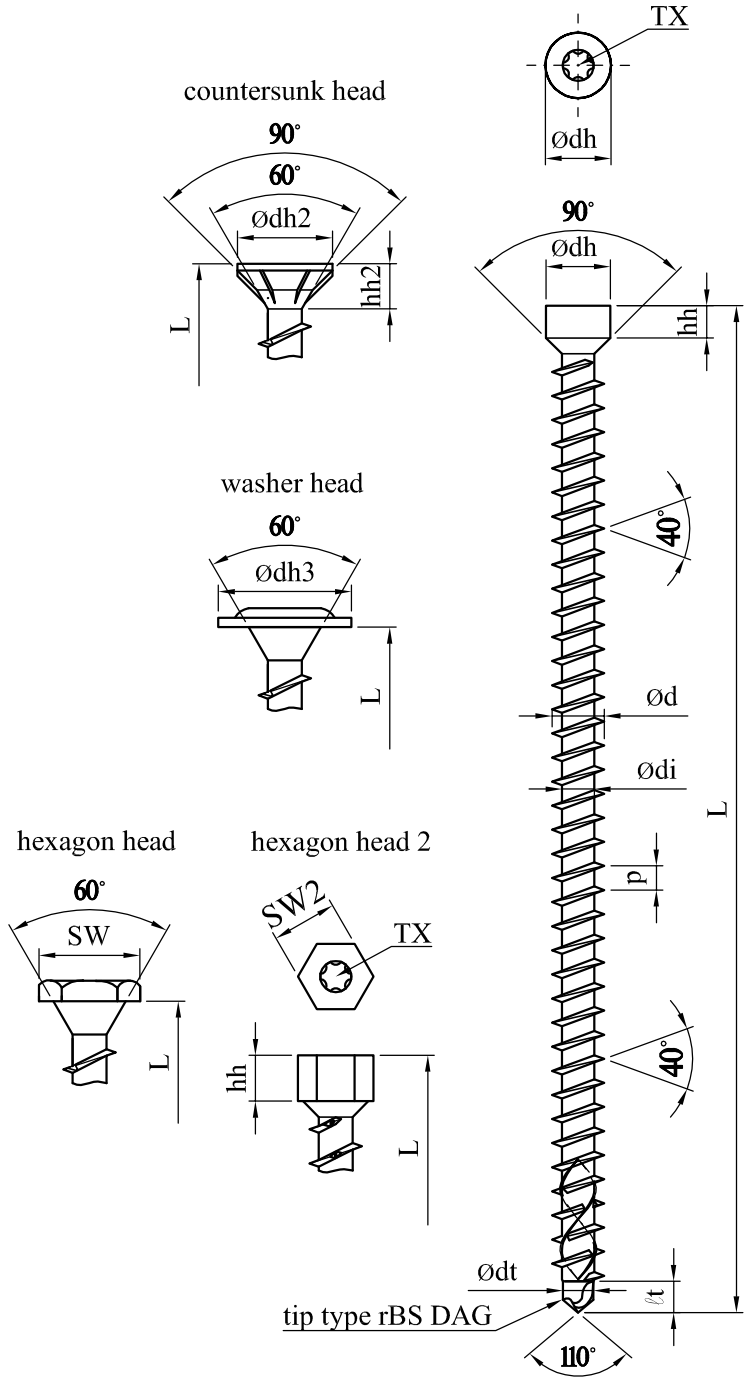
[2)] Tolerances according to EAD 130118-XX-0603.

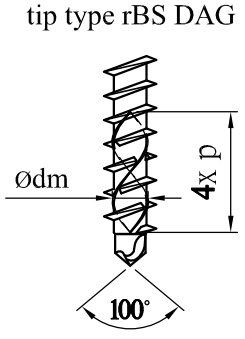
fischer Power-Full FPF-ZTN
carbon steel[1)]

nominal size	Ø6,5	Ø8,0	Ø10,0
d	6,5	8,0	10,0
di	4,5	5,2	5,9
dh	8,0	10,0	13,0
hh	5,5	6,5	6,5
p	3,0	3,8	4,6
dt	4,3	4,9	5,5
ℓt	4,0	5,0	6,0
dh2	12,0	14,5	17,8
hh2	5,7	7,4	8,7
dh3	-	22,0	25,0
dm	4,9	5,8	6,5
SW	-	SW13	-
SW2	SW8	SW10	SW13

L min	50	65	80
L max	195	480	600

All dimensions in mm. [2)]





[1)] Material specification held on file by ETA Danmark.

[2)] Tolerances according to EAD 130118-XX-0603.

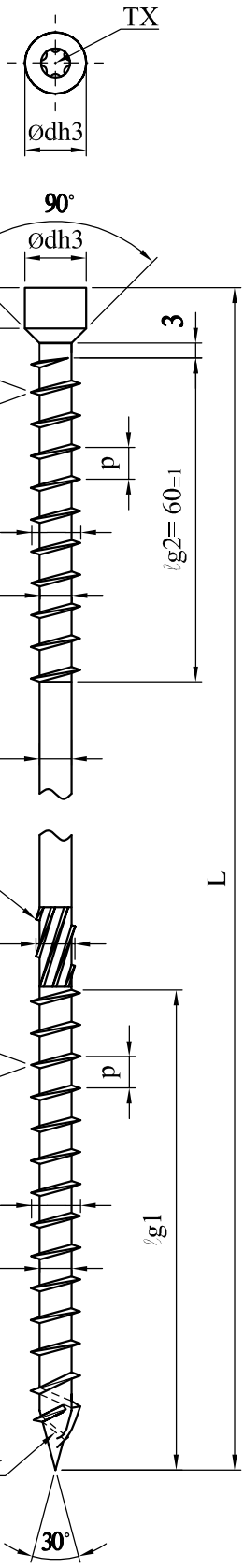
fischer Power-Full FIF-ZT
carbon steel[1)]

nominal size		Ø8,0	
d	-	8,0	-
di	-	5,3	-
dh	-	16,0	-
dc	-	8,0	-
p	-	5,6	-
ds	-	5,8	-
dm	-	6,5	-
dh2	-	14,5	-
hh2	-	7,4	-
dh3	-	10,0	-
hh3	-	6,5	-
dh4	-	18,3	-
hh4	-	7,3	-
dm2	-	6,20	-

All dimensions in mm.[2)]

	ℓg1		
L		Ø8,0	
165	-	80	-
195	-	100	-
225	-	100	-
235	-	100	-
255	-	100	-
275	-	100	-
302	-	100	-
335	-	100	-
365	-	100	-
397	-	100	-
435	-	100	-
472	-	100	-

All dimensions in mm.[2)]

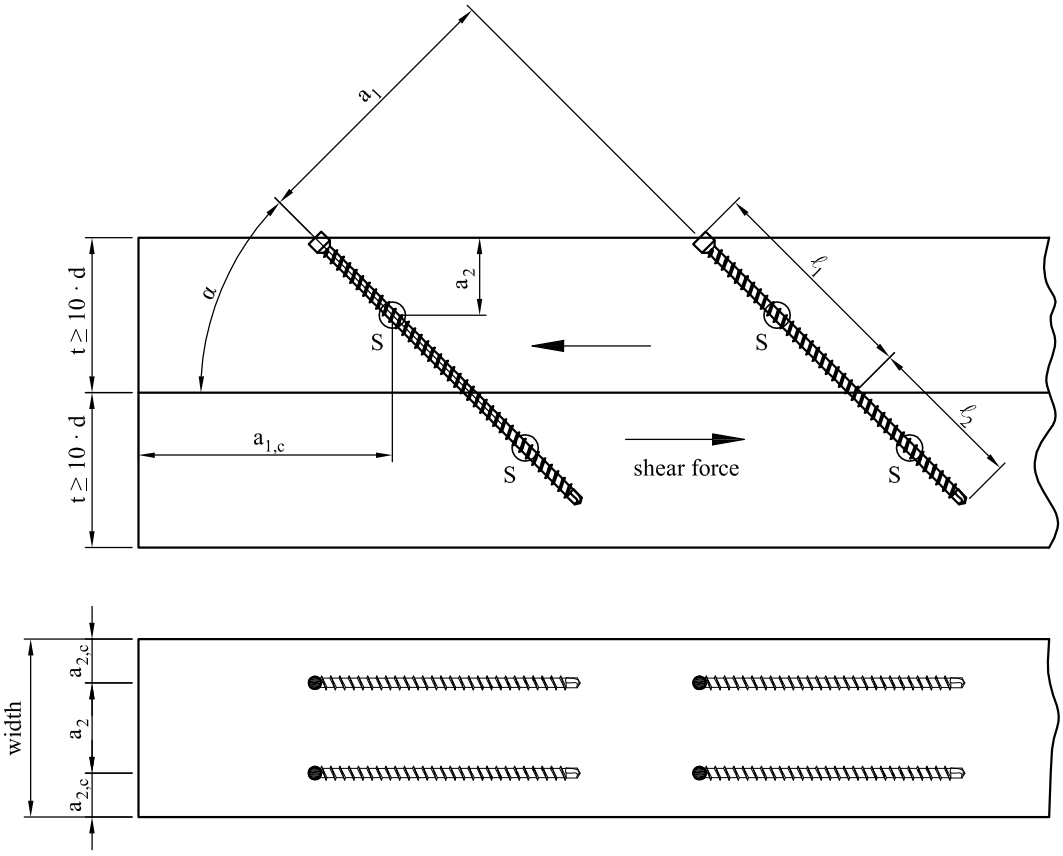


[1)] Material specification held on file by ETA Danmark.

[2)] Tolerances according to EAD 130118-XX-0603.

Annex B
Minimum distances and spacing

Axially loaded screws
Single configuration



S = centroid of the part of the screw in the timber

Minimum distances and spacings for exclusively axially loaded screws in non-predrilled holes. Minimum timber thickness t = 10 · d, minimum timber width w = max {8 · d; 60 mm}.
$a_1 \geq 5 \cdot d$ $a_2 \geq 5 \cdot d$ $a_{1,c} \geq 10 \cdot d$ $a_{2,c} \geq 4 \cdot d$

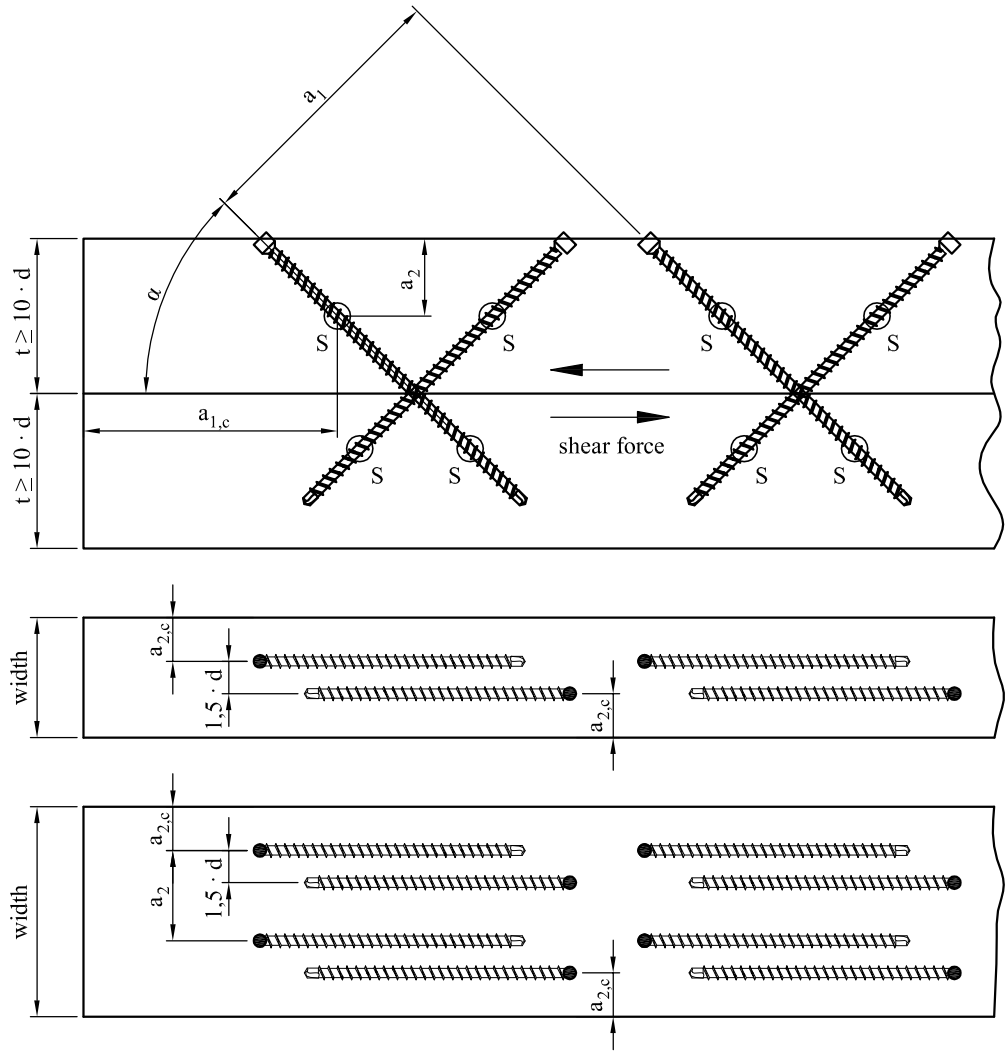
Minimum distances and spacings for exclusively axially loaded screws in predrilled holes or for screws with tip type BS or rBS DAG in non-predrilled holes. Minimum timber thickness t = 10 · d, minimum timber width w = max {8 · d; 60 mm}.
$a_1 \geq 5 \cdot d$ $a_2 \geq 5 \cdot d$ $a_{1,c} \geq 5 \cdot d$ $a_{2,c} \geq 3 \cdot d$

Spacing a_2 may be reduced from 5 · d to 2,5 · d, if the condition $a_1 \cdot a_2 \geq 25 \cdot d^2$ is fulfilled.

For a crossed screw couple the minimum spacing between the crossing screws is 1,5 · d.

Minimum distances and spacings, see also 3.12
$0° \leq \alpha \leq 90°$ for all tip types ecxept tip type BS, see also 3.9
$30° \leq \alpha \leq 90°$ for screws with tip type BS, see also 3.9

Axially loaded screws
Crosswise configuration



S = centroid of the part of the screw in the timber

Minimum distances and spacings for exclusively axially loaded screws in non-predrilled holes.
Minimum timber thickness $t = 10 \cdot d$, minimum timber width $w = \max \{8 \cdot d; 60\ mm\}$.
$a_1 \geq 5 \cdot d$ $a_2 \geq 5 \cdot d$ $a_{1,c} \geq 10 \cdot d$ $a_{2,c} \geq 4 \cdot d$

Minimum distances and spacings for exclusively axially loaded screws in predrilled holes or for screws with tip type BS or rBS DAG in non-predrilled holes. Minimum timber thickness $t = 10 \cdot d$, minimum timber width $w = \max \{8 \cdot d; 60\ mm\}$.
$a_1 \geq 5 \cdot d$ $a_2 \geq 5 \cdot d$ $a_{1,c} \geq 5 \cdot d$ $a_{2,c} \geq 3 \cdot d$

Spacing a_2 may be reduced from $5 \cdot d$ to $2{,}5 \cdot d$, if the condition $a_1 \cdot a_2 \geq 25 \cdot d^2$ is fulfilled.

For a crossed screw couple the minimum spacing between the crossing screws is $1{,}5 \cdot d$.

Minimum distances and spacings, see also 3.12
$0° \leq \alpha \leq 90°$ for all tip types ecxept tip type BS, see also 3.9
$30° \leq \alpha \leq 90°$ for screws with tip type BS, see also 3.9

Figure 1: Definition of spacing, end and edge distances in the plane surface (wide face) unless otherwise specified in the technical specification (ETA or hEN) for the cross laminated timber:

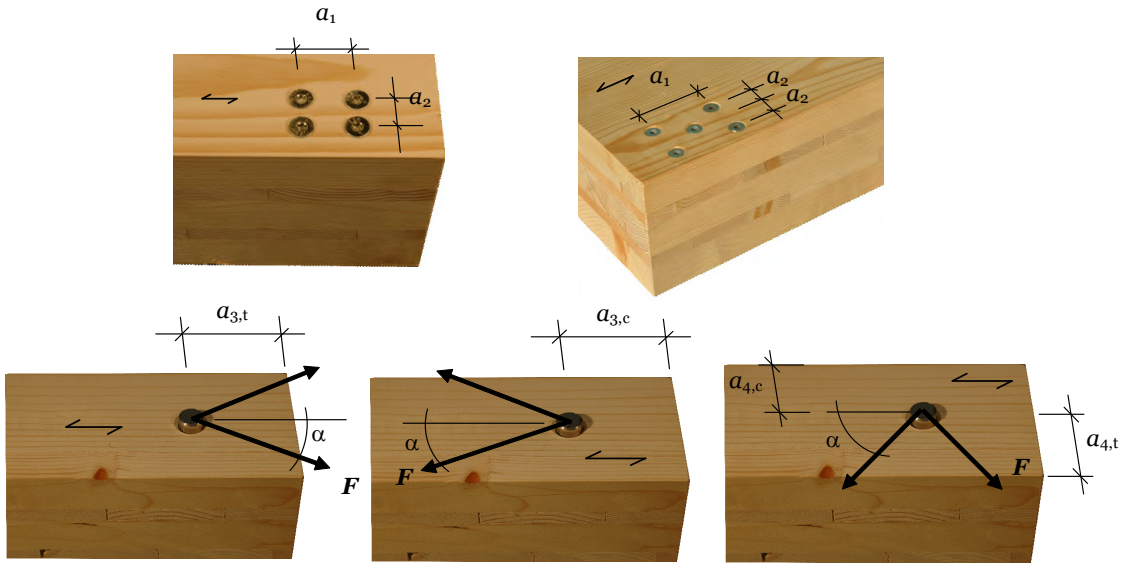
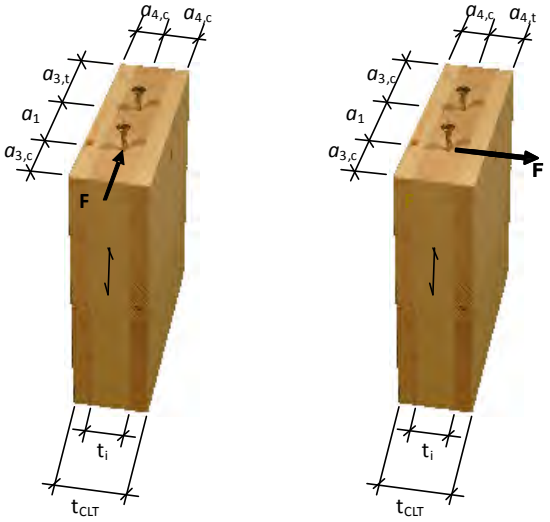


Figure 2: Definition of spacing, end and edge distances in the edge surface unless otherwise specified in the technical specification (ETA or hEN) for the cross laminated timber:



Minimum distances and spacing for screws in the plane surface (wide surface) or edge surface of cross laminated timber

	a_1	$a_{3,t}$	$a_{3,c}$	a_2	$a_{4,t}$	$a_{4,c}$
Plane surface (wide face), see figure 1	4 · d	6 · d	6 · d	2,5 · d	6 · d	2,5 · d
Edge surface, see figure 2	10 · d	12 · d	7 · d	4 · d	6 · d	3 · d

Annex C
Compression reinforcement

fischer Power-Full screws FPF 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.

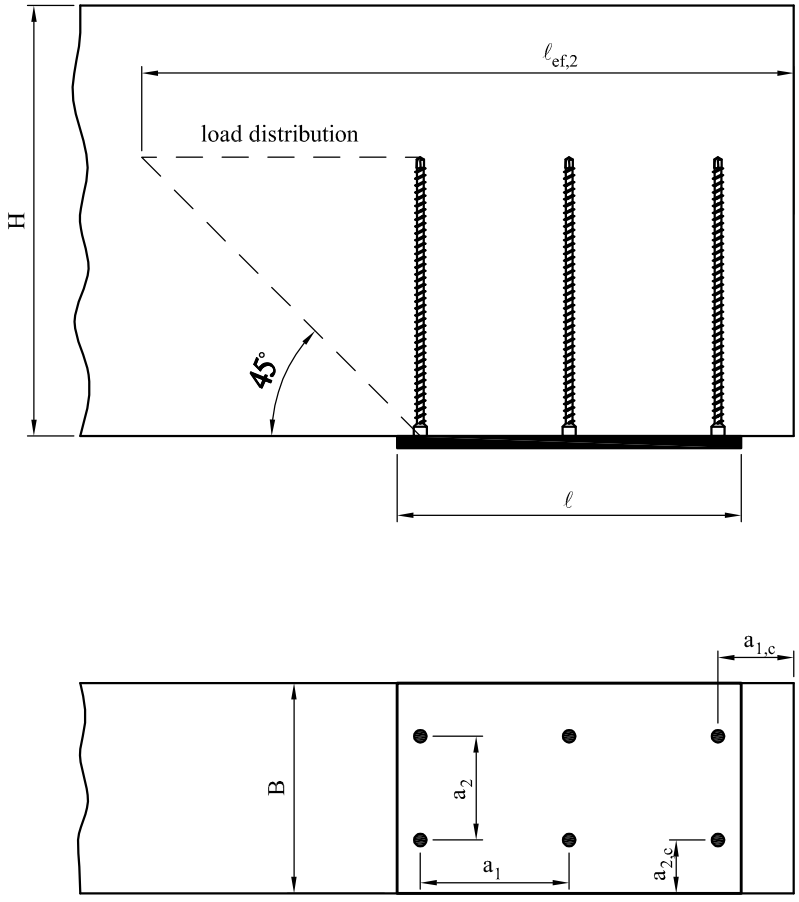
The characteristic load-carrying capacity for a contact area with screws with a full thread at an angle α to the grain of 45° < α < 90° shall be calculated from:

$$F_{90,Rd} = \min \left\{ \begin{array}{l} k_{c,90} \cdot B \cdot \ell_{ef,1} \cdot f_{c,90,d} + n \cdot \min (F_{ax,Rd}; F_{ki,Rd}) \\ B \cdot \ell_{ef,2} \cdot f_{c,90,d} \end{array} \right\}$$

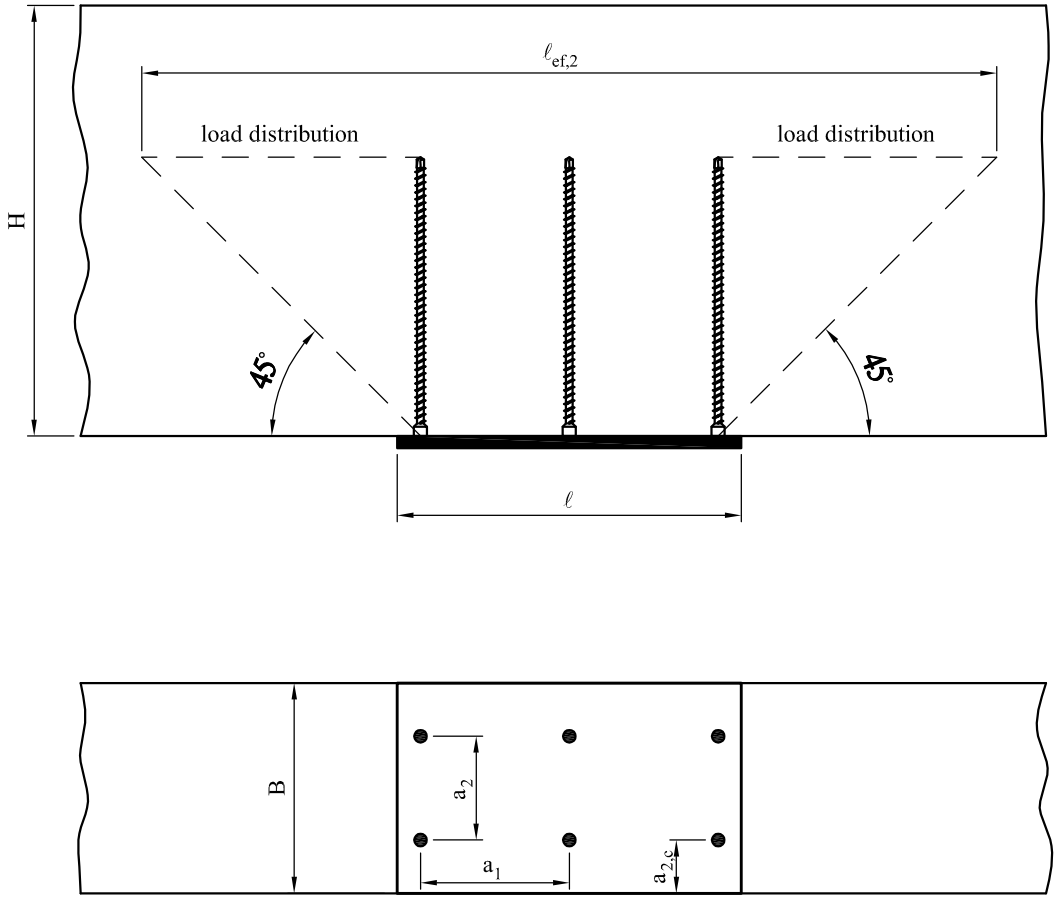
Where

$F_{90,Rd}$ 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
B bearing width [mm]
$\ell_{ef,1}$ effective length of contact area according to EN 1995-1-1 [mm]
$f_{c,90,d}$ design compressive strength perpendicular to the grain [N/mm²]
n number of reinforcement screws, $n = n_0 \cdot n_{90}$
n_0 number of reinforcement screws arranged in a row parallel to the grain
n_{90} number of reinforcement screws arranged in a row perpendicular to the grain
$F_{ax,Rd}$ design axial withdrawal capacity [N]
$F_{ki,Rd}$ design buckling capacity [N]
$\ell_{ef,2}$ effective distribution length in the plane of the screw tips [mm]
$\ell_{ef,2} = \ell_{ef} + (n_0 - 1) \cdot a_1 + \min (\ell_{ef}; a_{1,c})$ for end bearings [mm]
$\ell_{ef,2} = 2 \cdot \ell_{ef} + (n_0 - 1) \cdot a_1$ for centre-bearings [mm]
a_1 spacing parallel to the grain [mm]
$a_{1,c}$ end distance [mm]

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



H component height [mm]
B bearing width [mm]
ℓ_{ef} point side penetration length [mm]
$\ell_{ef,2}$ effective distribution length in the plane of the screw tips [mm]
$= \ell_{ef} + (n_0 - 1) \cdot a_1 + \min(\ell_{ef}; a_{1,c})$ for end bearings



H component height [mm]
B bearing width [mm]
ℓ_{ef} point side penetration length [mm]
$\ell_{ef,2}$ effective distribution length in the plane of the screw tips [mm]
$= 2 \cdot \ell_{ef} + (n_0 - 1) \cdot a_1$ for centre-bearings

Annex D
Tensile reinforcement perpendicular to grain

Timber member loaded by a connection force perpendicular to the grain

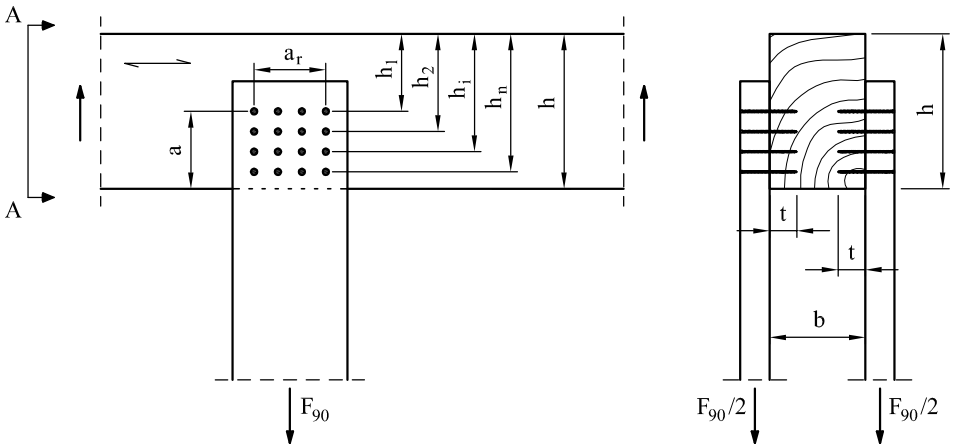
fischer Power-Full screws FPF with a full thread may be used for reinforcement of timber members with tensile stresses perpendicular to the grain. The tensile force must be evenly distributed over all screws.

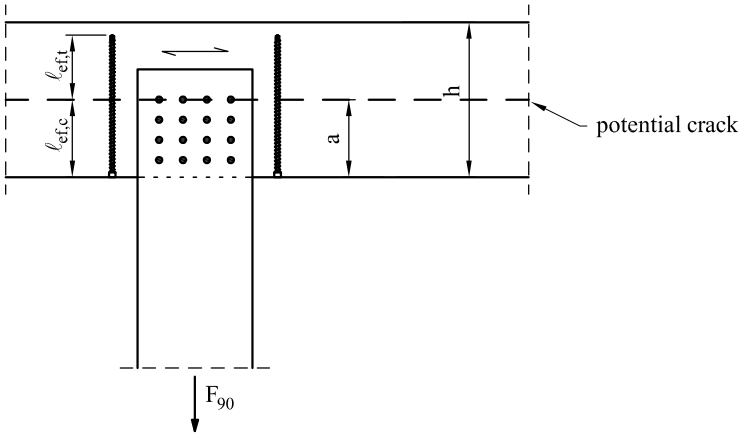
Unless specified otherwise in national provisions that apply at the installation site, the axial capacity of a reinforcement of a timber member loaded by a connection force perpendicular to the grain shall fulfil the following condition:

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

Where

$F_{90,d}$ design value of the force component perpendicular to the grain [N]
α = a/h [mm]
h member depth [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 [N]





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:

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

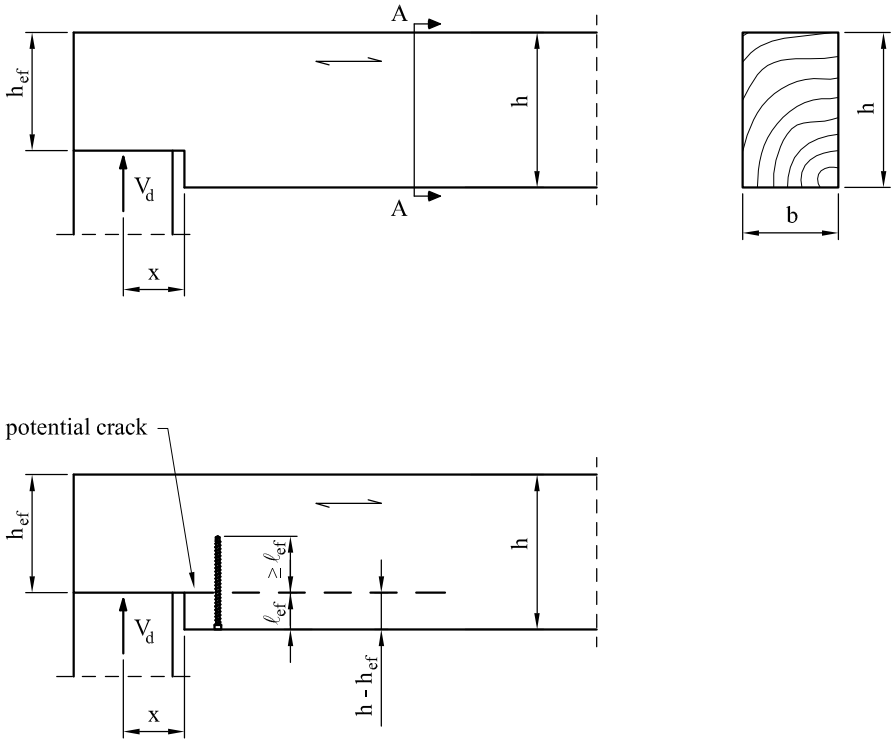
Where

V_d design value of the shear force [N]

α $= h_{ef} / h$ [mm]

h member depth [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 [N]



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

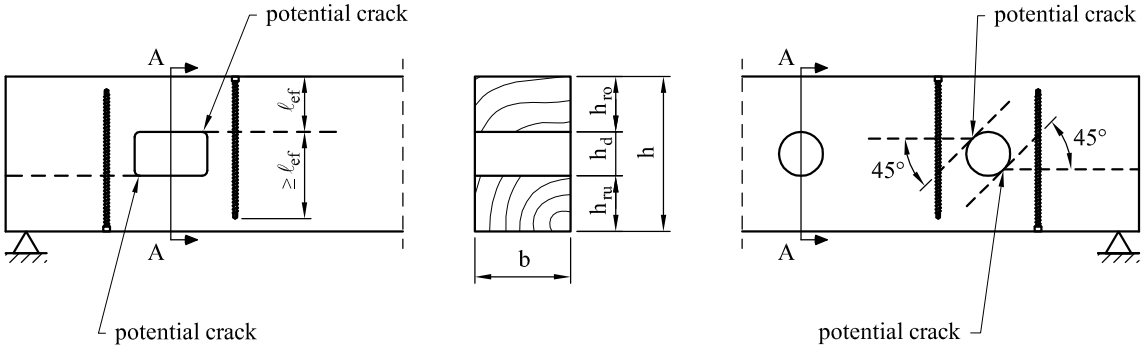
$F_{t,V,d}$ design value of the force perpendicular to the grain due to shear force:

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

V_d design value of the shear force [N]
h member depth [mm]
h_d hole depth for rectangular holes [mm]
h_d 70 % of hole diameter for circular holes [mm]
$F_{t,M,d}$ design value of the force perpendicular to the grain due to bending moment:

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

M_d design value of the member bending moment at the hole end [Nmm]
h_r = min (h_{ro} ; h_{ru}) for rectangular holes [mm]
h_r = min (h_{ro} ; h_{ru}) + 0,15 · h_d for circular holes [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 [N]



Annex E
Thermal insulation on top of rafters

fischer Power-Full screws with an outer thread diameter 6,5 mm ≤ d ≤ 11,3 mm may be used for the fixing of heat 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 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 European Technical Assessment or similar glued members according to European Technical Assessment.

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

Screws d ≤ 8,0 mm:	b_{min} = 50 mm	t_{min} = 30 mm
Screws d = 10,0 mm:	b_{min} = 60 mm	t_{min} = 40 mm
Screws d = 12,0 mm:	b_{min} = 80 mm	t_{min} = 100 mm

The insulation must comply with a European Technical Assessment.

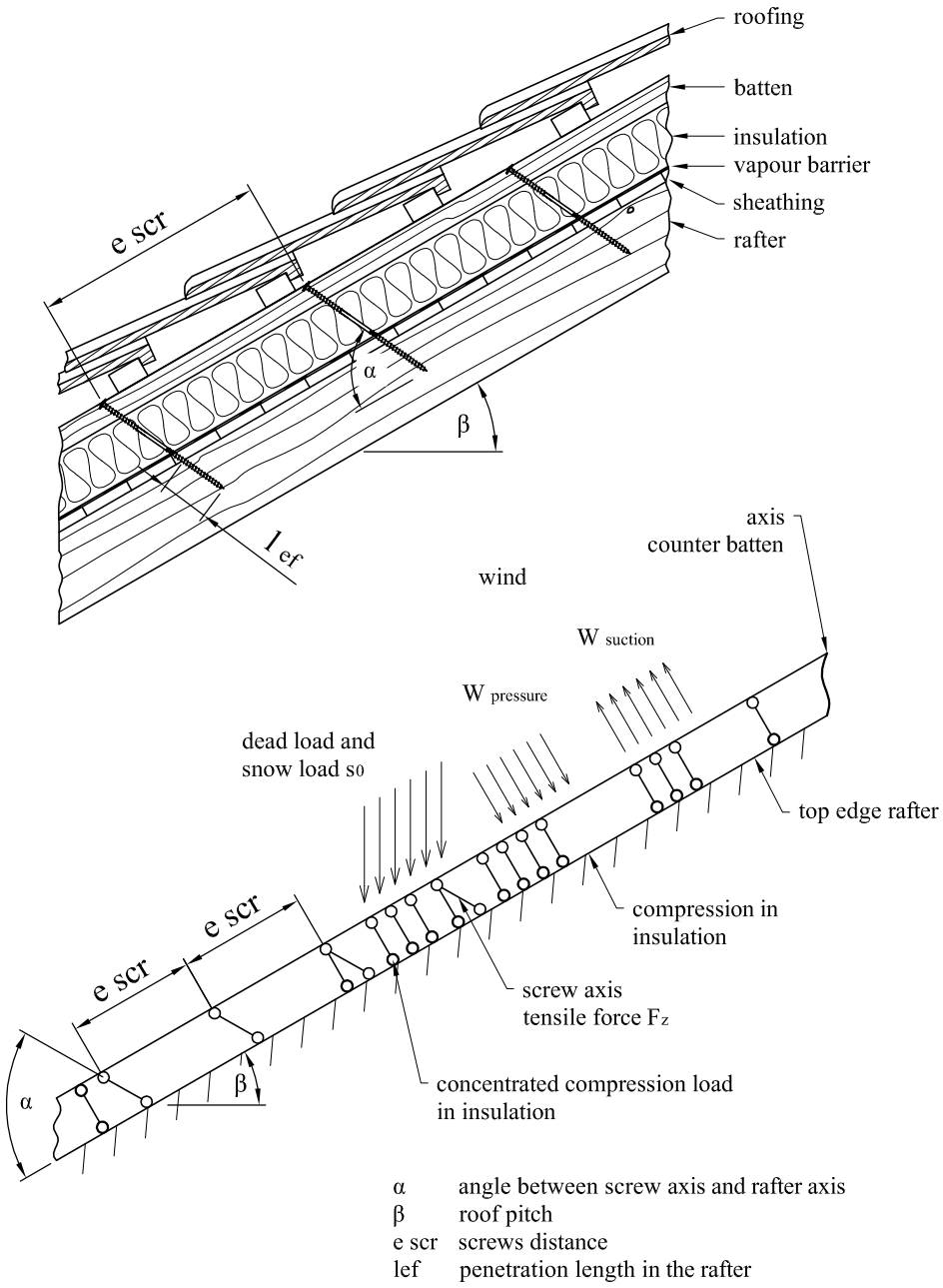
Friction forces shall not be considered for the design of the characteristic axial capacity of the screws.

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 α= 90°) may be arranged if necessary.

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

Mechanical model

The system of rafter, heat 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 heat insulation material on top of the rafter the elastic foundation. The minimum compression stress of the heat 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.



α angle between screw axis and rafter axis
β roof pitch
e scr screws distance
lef penetration length in the rafter

[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
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]

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

EI bending stiffness of the batten [N/mm² · mm⁴]
w_{ef} effective width of the thermal insulation material [mm]
K coefficient of subgrade

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

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

Where
w minimum width of the batten or rafter, respectively [mm]
t_{HI} thickness of the heat insulation [mm]

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

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 of 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:

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

Design of the heat 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

Alternatively to the battens, wood-based panels 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 or European Technical Approval and solid wood panels ac cording to EN 13353 or cross laminated timber may be used.

The insulation must have a minimum compressive stress of $\sigma_{10\%} = 0{,}05$ N/mm² at 10 % deformation according to EN 826.

The analysis of the fixing of the insulation and battens or boards, respectively, may be carried out using the static model showed on previous pages. The battens or boards, respectively, must have sufficient strength and stiffness. The maximum design value of the compressive stress between the battens or boards, respectively, and the insulation shall not exceed $1{,}1 \cdot \sigma_{10\%}$.

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:

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

The design axial capacity of the fischer Power-Full screws for rafter or facade insulation shall be calculated from:

$$F_{ax,\alpha,Rd} = \min \left\{ k_{ax} \cdot f_{ax,d} \cdot d \cdot \ell_{ef,r} \cdot k_1 \cdot k_2 \cdot \left(\frac{\rho_{k,r}}{350}\right)^{0,8} ; \; \max \left\{ \frac{f_{head,d} \cdot d_h^2}{k_{ax} \cdot f_{ax,d} \cdot d \cdot \ell_{ef,b}} \right\} \cdot \left(\frac{\rho_{k,b}}{350}\right)^{0,8} ; \; \frac{f_{tens,k}}{\gamma_{M2}} \right\}$$

Where

$F_{ax,\alpha,Rd}$	design axial capacity of the screw at an angle α to the grain [N]
k_{ax}	= 1,0 for $45° \le \alpha \le 90°$
	= 0,3 + (0,7 · α/45°) for $0° \le \alpha < 45°$
$f_{ax,d}$	design withdrawal parameter [N/mm²]
d	outer thread diameter [mm]
d_h	head diameter [mm]
$\ell_{ef,r}$	point side penetration length of the threaded part according to EN 1995-1-1 [mm]
$\ell_{ef,b}$	length of the threaded part in the batten [mm]
α	angle between grain and screw axis ($\alpha \ge 30°$)
k_1	min {1; $220/t_{HI}$}
k_2	min {1; $\sigma_{10\%}/0{,}12$}
	If equation k_1 and k_2 are considered, the deflection of the battens does not need to be considered.
t_{HI}	thickness of the heat insulation [mm]
$\sigma_{10\%}$	compressive stress of the heat insulation under 10 % deformation [N/mm²]
	$\sigma_{10\%} \ge 0{,}05$ N/mm²
$\rho_{k,r}$	characteristic density of the rafter [kg/m³]
$\rho_{k,b}$	characteristic density of the batten [kg/m³]
$f_{head,d}$	design head pull-through parameter [N/mm²]
$f_{tens,k}$	characteristic tensile capacity [N]
γ_{M2}	partial safety factor according to EN 1993-1-1 or according to national annex

Fixing of battens with parallel screws perpendicular to the roof plane

Alternatively to the battens, wood-based panels 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 or European Technical Assessment and solid wood panels according to EN 13353 or cross laminated timber may be used.

The insulation must have a minimum compressive stress of $\sigma_{10\%} = 0{,}05$ N/mm² at 10 % deformation according to EN 826.

The battens or wood-based panels, respectively, must have sufficient strength and stiffness. The maximum design value of the compressive stress between the battens or boards, respectively, and the insulation shall not exceed $1{,}1 \cdot \sigma_{10\%}$.

The characteristic load-carrying capacity of the screws loaded in shear may be calculated from:

$$F_{v,Rk} = \min \begin{cases} f_{h,b,k} \cdot d \cdot t_b \\ f_{h,r,k} \cdot d \cdot t_r \\ \frac{f_{h,b,k} \cdot d \cdot \beta}{1+\beta} \cdot \left(\sqrt{4t_{il}^2 + \left(2 + \frac{1}{\beta}\right) t_b^2 + (2+\beta) t_r^2 + 4t_{il}(t_b + t_r) + 2t_b t_r} - 2t_{il} - t_b - t_r \right) + \frac{F_{ax,Rk}}{4} \\ 1{,}05 \cdot \frac{f_{h,b,k} \cdot d \cdot \beta}{\frac{1}{2}+\beta} \cdot \left(\sqrt{t_{il}^2 + t_{il} t_b + \frac{t_b^2}{2}\left(1 + \frac{1}{\beta}\right) + \frac{M_{y,k}}{f_{h,b,k} \cdot d}\left(1 + \frac{2}{\beta}\right)} - t_{il} - \frac{t_b}{2} \right) + \frac{F_{ax,Rk}}{4} \\ 1{,}05 \cdot \frac{f_{h,b,k} \cdot d \cdot \beta}{\frac{1}{2}+\beta} \cdot \left(\sqrt{t_{il}^2 + t_{il} t_r + \frac{t_r^2}{2}\left(1 + \beta\right) + \frac{M_{y,k}}{f_{h,b,k} \cdot d}\left(2 + \frac{1}{\beta}\right)} - t_{il} - \frac{t_r}{2} \right) + \frac{F_{ax,Rk}}{4} \\ 1{,}15 \cdot \frac{f_{h,b,k} \cdot d \cdot \beta}{1+\beta} \cdot \left(\sqrt{\beta^2 t_{il}^2 + 4\beta(\beta+1) \cdot \frac{M_{y,k}}{f_{h,b,k} \cdot d}} - \beta t_{il} \right) + \frac{F_{ax,Rk}}{4} \end{cases}$$

Where

$f_{h,b,k}$	characteristic batten embedding strength [N/mm²]
$f_{h,r,k}$	characteristic rafter embedding strength [N/mm²]
β	$f_{h,r,k} / f_{h,b,k}$
d	outer thread diameter [mm]
t_b	batten thickness [mm]
t_r	lower value of rafter thickness or screw penetration length [mm]
t_{il}	interlayer thickness [mm]
$M_{y,k}$	characteristic fastener yield moment [Nmm]
$F_{ax,Rk}$	characteristic axial capacity of the screw [N]

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_{II}.
- 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 $\ell = A + B$. 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: $$F_{c,Ed} = (A + B) \cdot \left(- \frac{q_{II}}{\cos\alpha_1 + \sin\alpha_1 / \tan\alpha_2} - \frac{q_{\perp} \cdot \sin(90° - \alpha_2)}{\sin(\alpha_1 + \alpha_2)} \right)$$

tensile screw: $$F_{t,Ed} = (A + B) \cdot \left(\frac{q_{II}}{\cos\alpha_2 + \sin\alpha_2 / \tan\alpha_1} - \frac{q_{\perp} \cdot \sin(90° - \alpha_1)}{\sin(\alpha_1 + \alpha_2)} \right)$$

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:

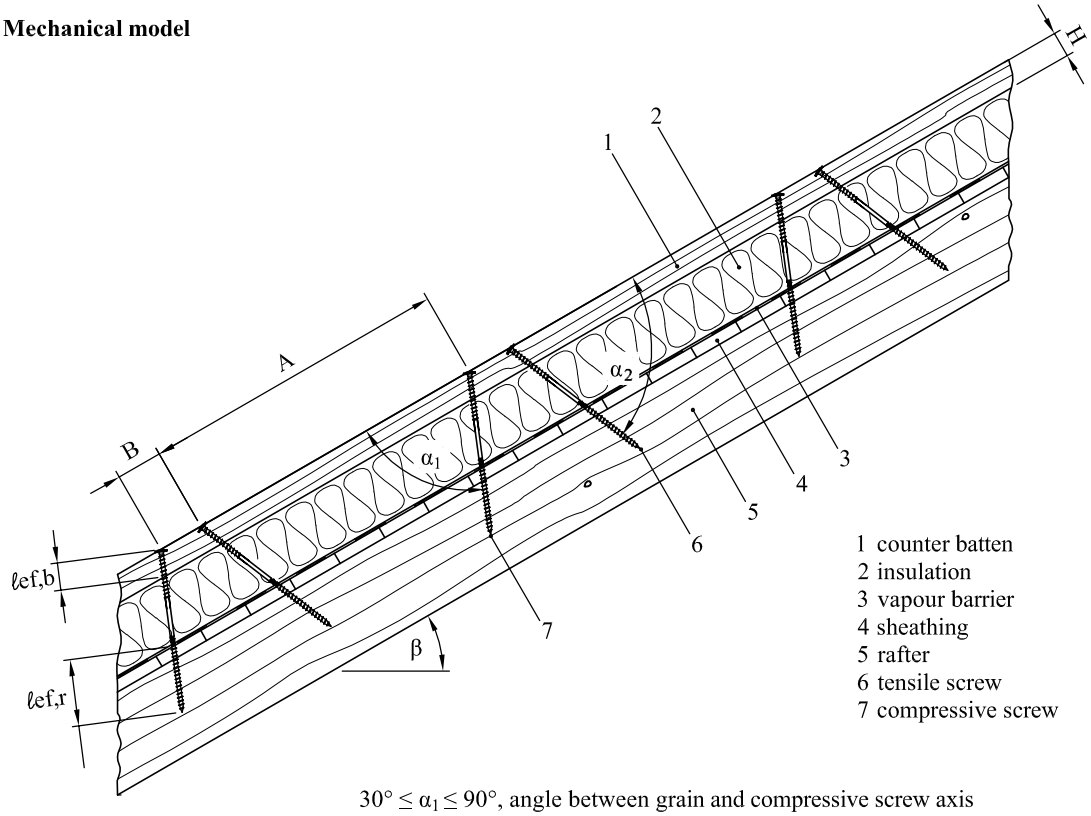
$$F_{ZS,Ed} = (A + B) \cdot \left(\frac{q_{II}}{1 / \tan\alpha_1 + 1 / \tan\alpha_2} - \frac{q_{\perp} \cdot \sin(90° - \alpha_1) \cdot \sin\alpha_2}{\sin(\alpha_1 + \alpha_2)} \right)$$

Where

q_{II} 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

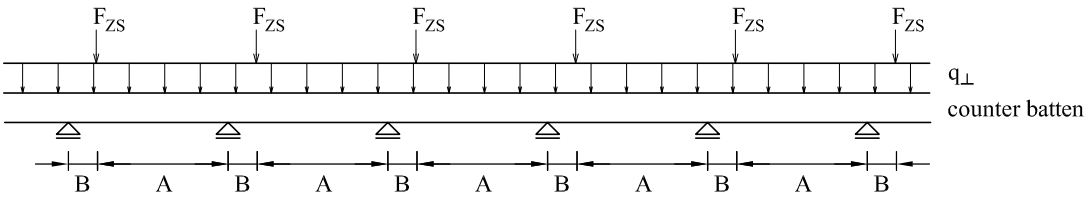
A positive value for F_{ZS} means a load towards the rafter, a negative value a load away from the rafter.

Mechanical model



1 counter batten
2 insulation
3 vapour barrier
4 sheathing
5 rafter
6 tensile screw
7 compressive screw

$30° \le \alpha_1 \le 90°$, angle between grain and compressive screw axis
$30° \le \alpha_2 \le 90°$, angle between grain and tensile screw axis



compressive screw: $$F_{c,Ed} = (A + B) \cdot \left(- \frac{q_{II}}{\cos\alpha_1 + \sin\alpha_1 / \tan\alpha_2} - \frac{q_\perp \cdot \sin(90° - \alpha_2)}{\sin(\alpha_1 + \alpha_2)} \right)$$

tensile screw: $$F_{t,Ed} = (A + B) \cdot \left(\frac{q_{II}}{\cos\alpha_2 + \sin\alpha_2 / \tan\alpha_1} - \frac{q_\perp \cdot \sin(90° - \alpha_1)}{\sin(\alpha_1 + \alpha_2)} \right)$$

concentrated load: $$F_{ZS,Ed} = (A + B) \cdot \left(\frac{q_{II}}{1 / \tan\alpha_1 + 1 / \tan\alpha_2} - \frac{q_\perp \cdot \sin(90° - \alpha_1) \cdot \sin\alpha_2}{\sin(\alpha_1 + \alpha_2)} \right)$$

Where
q_{II} 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 a load away from the rafter.

Design of the screws

The analysis of the fixing of the insulation and battens may be carried out using the static model showed on previous page. The battens must have sufficient strength and stiffness.

The design axial tensile capacity of the fischer Power-Full screws for rafter or facade insulation shall be calculated from:

$$F_{ax,\alpha,Rd} = \min \left\{ \max \left\{ \begin{matrix} f_{head,d} \cdot d_h^2 \\ k_{ax} \cdot f_{ax,d} \cdot d \cdot \ell_{ef,b} \end{matrix} \right\} \cdot \left(\frac{\rho_{k,b}}{350}\right)^{0,8} ; \quad k_{ax} \cdot f_{ax,d} \cdot d \cdot \ell_{ef,r} \cdot \left(\frac{\rho_{k,r}}{350}\right)^{0,8} ; \frac{f_{tens,k}}{\gamma_{M2}} \right\}$$

The design axial compressive capacity of the fischer Power-Full screws for rafter or facade insulation shall be calculated from:

$$F_{ax,\alpha,Rd} = \min \left\{ k_{ax} \cdot f_{ax,d} \cdot d \cdot \ell_{ef,b} \cdot \left(\frac{\rho_{k,b}}{350}\right)^{0,8} ; \quad k_{ax} \cdot f_{ax,d} \cdot d \cdot \ell_{ef,r} \cdot \left(\frac{\rho_{k,r}}{350}\right)^{0,8} ; \frac{F_{ki,Rk}}{\gamma_{M1}} \right\}$$

Where

$F_{ax,\alpha,Rd}$	design axial capacity of the screw at an angle α to the grain [N]
$f_{head,d}$	design head pull-through parameter [N/mm²]
d_h	head diameter [mm]
k_{ax}	= 1,0 for 45° ≤ α ≤ 90°
	= 0,3 + (0,7 · α/45°) for 0° ≤ α < 45°
$f_{ax,d}$	design withdrawal parameter [N/mm²]
d	outer thread diameter [mm]
$\ell_{ef,b}$	length of the threaded part in the batten [mm]
$\ell_{ef,r}$	point side penetration length of the threaded part according to EN 1995-1-1 [mm]
α	angle between grain and screw axis (α ≥ 30°)
$\rho_{k,b}$	characteristic density of the batten [kg/m³]
$\rho_{k,r}$	characteristic density of the rafter [kg/m³]
$f_{tens,k}$	characteristic tensile capacity [N]
$F_{ki,Rk}$	characteristic compressive capacity depending on free screw length between counter batten and rafter [N]
γ_{M1}, γ_{M2}	partial safety factor according to EN 1993-1-1 or according to national annex

Free screw length [mm]	FPF				FIF
	Ø6,5	Ø8,0	Ø10,0	Ø11,3	Ø8,0
	$F_{ki,Rk}$ [kN]	$F_{ki,Rk}$ [kN]	$F_{ki,Rk}$ [kN]	$F_{ki,Rk}$ [kN]	$F_{ki,Rk}$ [kN]
≤ 120	2,32	4,28	6,76	18,80	5,97
140	1,75	3,27	5,21	14,90	4,59
160	1,38	2,57	4,12	12,00	3,62
180	1,10	2,08	3,33	9,85	2,93
200	0,91	1,71	2,75	8,20	2,42
220	0,76	1,43	2,31	6,93	2,03
240	0,64	1,21	1,96	5,92	1,72
260	0,55	1,04	1,69	5,12	1,48
280	0,48	0,91	1,47	4,48	1,29
300	0,42	0,79	1,29	3,94	1,13
320	0,37	0,70	1,14	3,49	1,00
340	0,33	0,62	1,01	3,12	0,89
360	0,29	0,56	0,91	2,80	0,80
380	0,26	0,50	0,82	2,52	0,72
400	0,24	0,46	0,74	2,29	0,65
420	0,22	0,42	0,68	2,09	0,59