ETA-Danmark A/S
Göteborg Plads 1
DK-2150 Nordhavn
Tel. +45 72 24 59 00
Internet www.etadanmark.dk

Authorised and notified according to Article 29 of the Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011

MEMBER OF EOTA

European Technical Assessment ETA-20/0558 of 2023/05/26

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:	GoFix MS II, VG-S, VG-Z, DG-T / DG-Z, GoFix SH, Alu-TeFix and TeFix
Product family to which the above construction product belongs:	Screws for use in timber constructions
Manufacturer:	SIHGA GmbH Kleinreith-Gewerbepark 4 AU-4694 Ohlsdorf Telephone: +43 7612 743700 Internet: www.sihga.com
Manufacturing plant:	Manufacturing plant 1
This European Technical Assessment contains:	36 pages including 2 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) no. EAD 130118-01-0603 “Screws and threaded rods for use in timber constructions”
This version replaces:	The previous ETA with the same number and issued on 2022-11-10

II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product.

SIHGA GoFix MS II, VG-S, VG-Z, DG-T/DG-Z, GoFix SH, Alu-TeFix and TeFix are self-tapping screws to be used in timber structures. They shall be threaded over a part of the length or over the whole length. The screws shall be produced from carbon steel wire or stainless steel wire (Alu-TeFix and TeFix) with nominal diameters between 4,0 mm and 10,0 mm. Where corrosion protection is required, the material or coating shall be declared in accordance with the relevant specification given in Annex A of EN 14592.

Geometry and Material
The nominal diameter d (outer thread diameter) of the screws shall not be less than 4,0 mm and shall not be greater than 10,0 mm.

The overall length *L* of the screws, shall not be less than 30 mm and shall not be greater than 600 mm. Dimensions see Annex A.

The ratio of inner thread diameter to outer thread diameter d_i/d ranges from 0,50 to 0,80.

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

The thread pitch *p* (distance between two adjacent thread flanks) ranges from 0,28·d to 0,85·d.

The screws SIHGA GoFix MS II, VG-S, VG-Z, DG-T/DG-Z, GoFix SH and Alu-TeFix have a minimum bending angle of $(45/d^{0,7} + 20)$ degrees. For the bending angle of the TeFix screws a minimum plastic angle of $(45°/d^{0,7} + 10)$ degrees must be given.

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

The screws are used for connections in load bearing timber structures between members, softwood and hardwood of: Solid timber, glued laminated timber, cross-laminated timber (CLT) and laminated veneer lumber (LVL), similar glued members, wood-based panels or steel. SIHGA screws with a thread over the full length can also be used as tensile or compressive reinforcement perpendicular to the grain or as shear reinforcement.

Steel plates and wood-based panels except solid wood panels, laminated veneer lumber and cross laminated timber, shall only be fixed on the side of the screw head. DG-T/DG-Z screws are doubled threaded screws which can be used for the fixing of thermal insulation on rafters and facades.

Steel plates and wood-based panels except solid wood panels and EGGER Eurostrand OSB 4 TOP, laminated veneer lumber and CLT, shall only be fixed on the side of the screw head.

Alu-TeFix and TeFix screws are used in combination with aluminium profiles (Alu-TeFix) and in combination with timber slats to would wooden floors/lamellas.

The following wood-based panels may be used:

- Plywood according to EN 636 or European Technical Assessment or national provisions that apply at the installation site
- Particleboard according to EN 312 or European Technical Assessment or national provisions that apply at the installation site
- Oriented Strand Board according to EN 300 or European Technical Assessment or national provisions that apply at the installation site
- Fibreboard according to EN 622-2 and 622-3 or European Technical Assessment (minimum density 650 kg/m³) or national provisions that apply at the installation site
- Cement bonded particleboard according to EN 634 or European Technical Assessment or national provisions that apply at the installation site
- Solid wood panels according to EN 13353 or European Technical Assessment or national provisions that apply at the installation site
- Wood-based panels for use in constructions according to EN 13986
- Cross laminated timber according to European Technical Assessment
- Laminated Veneer Lumber according to EN 14374 or European Technical Assessment
- Engineered wood products according to European Technical Assessment, 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 timber 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 hole diameter in steel members must be pre-drilled with a suitable diameter.

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 countersunk is not allowed.
Washer head screws according to Annex A may be used together with washers according to EN ISO 7094.

The intended use of the screws is in timber connections for which all requirements of mechanical resistance, 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 EN 1995-1-1 or an appropriate national code.

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

The zinc-coated screws are for use in timber structures subject to the moisture content of internal conditions defined by the service classes 1, 2 and 3 regarding to EN 1995-1-1.

The provisions made in this European Technical Assessment are based on an assumed intended working life of the screws of 50 years.

The indications given on the working life cannot be interpreted as a guarantee given by the producer or Assessment Body, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

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

Characteristic	Assessment of characteristic	
3.1 Mechanical resistance and stability (BWR1)		
Dimensions	Information in Annex A	
Characteristic yield moment	Information in chapter 3.9.1	
Bending angle	SIHGA GoFix MS II, VG-S, VG-Z, DG-T/DG-Z, GoFix SH and Alu-TeFix: **Minimum bending angle (45/d^{0,7} + 20) degrees.** TeFix: **Minimum bending angle (45°/d^{0,7} + 10) degrees.**	
Characteristic withdrawal parameter	Information in chapter 3.9.1	
Characteristic head pull-through parameter of screws	Information in chapter 3.9.1	
Characteristic tensile strength of partial threaded screws	Characteristic values $f_{tens,k}$:	
GoFix MS II, carbon steel	d= 4,0 mm	5,0 kN
	d= 4,5 mm	5,8 kN
	d= 5,0 mm	8,8 kN
	d= 6,0 mm	12,8 kN
	d= 8,0 mm	22,7 kN
	d=10,0 mm	33,2 kN
DG-T / DG-Z, carbon steel	d= 8,0 mm	20,0 kN
GoFix SH	d= 8,0 mm	32,0 kN
TeFix, stainless-steel hardened (martensitic stainless-steel)	d= 4,0 mm	6,5 kN
	d= 4,5 mm	8,4 kN
	d= 5,0 mm	10,1 kN
	d= 5,5 mm	12,5 kN
	d= 6,0 mm	14,5 kN
TeFix, stainless-steel unhardened (austenitic-steel A2 and A4)	d= 4,0 mm	2,5 kN
	d= 4,5 mm	3,2 kN
	d= 5,0 mm	3,8 kN
	d= 5,5 mm	4,8 kN
	d= 6,0 mm	5,5 kN
Characteristic tensile strength of fully threaded screws	Characteristic values $f_{tens,k}$:	
VG-Z / S+, carbon steel	d= 6,5 mm	17,0 kN
	d= 8,0 mm	25,0 kN
	d=10,0 mm	33,0 kN
VG-Z / S+, stainless-steel unhardened (austenitic stainless-steel A2 and A4)	d= 8,0 mm	11,0 kN
Alu-TeFix, stainless-steel hardened (martensitic stainless-steel)	d= 5,0 mm	16,0 kN
Alu-TeFix, stainless-steel unhardened (austenitic-steel A2 and A4)	d= 5,0 mm	9,0 kN

Characteristic	**Assessment of characteristic**	
Characteristic yield strength	Information in chapter 3.9.1	
Characteristic torsional strength of partial threaded screws	Characteristic values $f_{tor,k}$:	
GoFix MS II, carbon steel	d= 4,0 mm	3,0 Nm
	d= 4,5 mm	4,2 Nm
	d= 5,0 mm	6,3 Nm
	d= 6,0 mm	10,1 Nm
	d= 8,0 mm	25,6 Nm
	d=10,0 mm	47,5 Nm
DG-T / DG-Z, carbon steel	d= 8,0 mm	22,0 Nm
GoFix SH, carbon steel	d= 8,0 mm	38,3 Nm
TeFix, stainless-steel hardened (martensitic stainless-steel)	d= 4,0 mm	3,9 Nm
	d= 4,5 mm	5,8 Nm
	d= 5,0 mm	7,6 Nm
	d= 5,5 mm	10,5 Nm
	d= 6,0 mm	13,0 Nm
TeFix, stainless-steel unhardened (austenitic stainless-steel A2 and A4)	d= 4,0 mm	1,2 Nm
	d= 4,5 mm	1,8 Nm
	d= 5,0 mm	2,3 Nm
	d= 5,5 mm	3,2 Nm
	d= 6,0 mm	4,0 Nm
Characteristic torsional strength of partial threaded screws	Characteristic values $f_{tor,k}$:	
VG-Z / S+, carbon steel	d= 6,5 mm	19,0 Nm
	d= 8,0 mm	25,5 Nm
	d=10,0 mm	48,0 Nm
VG-Z / S+, stainless-steel unhardened (austenitic stainless-steel A2 and A4)	d= 8,0 mm	13,0 Nm
Alu-TeFix, stainless-steel hardened (martensitic stainless-steel)	d= 5,0 mm	12,0 Nm
Alu-TeFix, stainless-steel unhardened (austenitic stainless-steel A2 and A4)	d= 5,0 mm	7,5 Nm
Insertion moment	Ratio of the characteristic torsional strength to the mean insertion moment: $F_{tor,k}/R_{tor,mean} \geq 1,5$	
Spacing, end and edge distances of the screws or threaded rods and minimum thickness of the timber material	Information in chapter 3.11	
Slip modulus for mainly axially loaded screws and threaded rods	Information in chapter 3.10	
3.2 Safety in case of fire (BWR2)		
Reaction to fire	The screws are made from steel classified as **Euroclass A1** in accordance with EN 13501-1 and Commission Delegated Regulation 2016/364 in accordance with the EC Decision 96/603/EC (as amended) without the need for testing.	
3.4 Safety and accessibility in use (BWR4)		
Same as BWR 1	Same as BWR 1	

See additional information in section 3.5 – 3.10.

3.5 Mechanical resistance and stability

The load-carrying capacities for the GoFix screws are applicable to the wood-based materials mentioned in paragraph 1 even though the term timber has been used in the following. European Technical Assessments for structural members or wood-based panels must be considered if applicable.

The characteristic lateral load-carrying capacities and the characteristic axial withdrawal capacities of GoFix screws should be used for designs in accordance with EN 1995-1-1 or an appropriate national code.

Reductions in the cross-sectional area caused by GoFix screws shall be taken into account in accordance to the EN 1995-1-1.

3.5.1 Lateral load-carrying capacity

The characteristic lateral load-carrying capacity of GoFix screws shall be calculated according to EN 1995-1-1. The contribution of the rope effect may be considered. For the calculation of the load-carrying capacity, the following parameters should be taken into account.

Embedment strength $f_{h,\alpha,k}$ for the use in Solid timber

The embedment strength for GoFix screws in non-pre-drilled holes arranged at an angle between screw axis and grain direction, 0° ≤ α ≤ 90° can be calculated with the help of equation (1).

$$f_{h,\alpha,k} = \frac{0,082 \cdot \rho_k \cdot d^{-0,3}}{2,5 \cdot \cos^2 \alpha + \sin^2 \alpha} \qquad (1)$$

The embedment strength for GoFix screws in pre-drilled holes arranged at an angle between screw axis and grain direction, 0° ≤ α ≤ 90° can be calculated with the help of equation (2).

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

Where

- α Angle between screw axis and grain direction [°]
- $f_{h,\alpha,k}$ Characteristic embedment strength [MPa]
- ρ_k Characteristic timber gross density [kg/m³]
- d Outer thread diameter of the screw [mm]

Embedment strength $f_{h,\alpha,k}$ for the use in Cross-Laminated-Timber

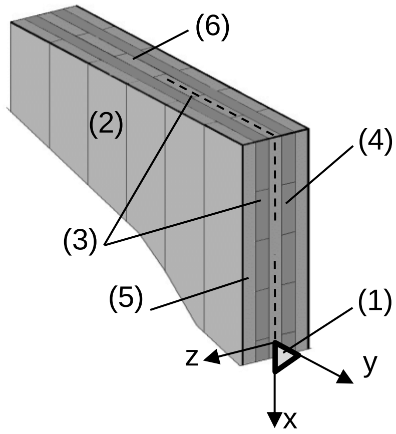


Figure 1: Notations CLT-elements

(1) Element plane
(2) Plane surface
(3) Edge surface (narrow side)
(4) Inner layer (lamellas)
(5) Outer layer (lamellas)
(6) Middle layer (lamella)

If there are no other technical specification (ETA or hEN) for Cross Laminated Timber (CLT), the embedment strength for screws can be calculated as following.

Screws in the plane surface:
The embedment strength for screws in the plane surface of CLT-elements should be assumed as for solid timber according to equation (1) or (2), based on the characteristic density of the outer layer. If relevant, the angle between force and grain direction of the outer layer should be considered.

Screws in the narrow (edge) side:
The embedment strength for screws in the narrow side of CLT-elements should be assumed according to equation (3).

$$f_{h,k} = 20 \cdot d_{ef}^{-0,5} \qquad (3)$$

Effective number of screws per row n_{ef}

For laterally loaded screws the rules for multiple fastener connections in EN 1995-1-1 should be applied.

Yield strength $f_{y,Rk}$

The characteristic yield strength of the different screw types of GoFix can be taken into account as shown below.

GoFix MS II

d= 4,0 mm	d_i= 2,42 mm	$f_{y,Rk}$= 980 MPa
d= 4,5 mm	d_i= 2,61 mm	$f_{y,Rk}$= 980 MPa
d= 5,0 mm	d_i= 3,09 mm	$f_{y,Rk}$= 980 MPa
d= 6,0 mm	d_i= 3,75 mm	$f_{y,Rk}$=1050 MPa
d= 8,0 mm	d_i= 5,04 mm	$f_{y,Rk}$=1050 MPa
d=10,0 mm	d_i= 5,89 mm	$f_{y,Rk}$=1050 MPa

DG-T / DG-Z

d= 8,0 mm	d_i= 5,10 mm	$f_{y,Rk}$=1050 MPa

VG-Z / S+

d= 6,5 mm	d_i= 4,20 mm	$f_{y,Rk}$=1100 MPa
d= 8,0 mm	d_i= 4,90 mm	$f_{y,Rk}$=1100 MPa
d=10,0 mm	d_i= 5,70 mm	$f_{y,Rk}$=1150 MPa

GoFix SH

d= 8,0 mm	d_i= 5,92 mm	$f_{y,Rk}$=1100 MPa

TeFix and Alu-TeFix

Stainless-steel hardened (martensitic stainless-steel)	$f_{y,Rk}$=950 MPa
Stainless-steel unhardened (austenitic stainless-steel A2 and A4)	$f_{y,Rk}$=320 MPa

Yield moment $M_{y,Rk}$

The characteristic yield moment for screws made of carbon or stainless-steel hardened (martensitic stainless-steel) shall be calculated with the help of equation (4).

$$M_{y,Rk} = 0{,}30 \cdot f_{y,Rk} \cdot d_i^{2{,}65} \qquad (4)$$

The characteristic yield moment for screws made of stainless-steel unhardened (austenitic stainless-steel A2 and A4) shall be calculated with the help of equation (5)

$$M_{y,Rk} = 0{,}15 \cdot 320 \cdot d_i^{2{,}6} \qquad (5)$$

Where

$M_{y,Rk}$	Characteristic yield moment [Nmm]
d_i	Inner diameter of the screw [mm]
$f_{y,Rk}$	Characteristic yield tension strength [MPa]

3.5.2 Axial withdrawal capacity

The axial withdrawal capacity is limited by the head pull-through capacity, the withdrawal capacity and the tensile or compressive capacity of the screw.
For GoFix screws, the withdrawal capacity of the thread in the member with the head may be taken into account instead of the head pull-through capacity.

Withdrawal capacity $F_{ax,Rk}$
Solid timber (EN 338 and EN 14080)

The characteristic axial withdrawal capacity of GoFix screws with an angle of 0° ≤ α ≤ 90° shall be calculated according to equation (3). For screws with an outer diameter d ≤ 5,0 mm equation (3) is only valid for 15° ≤ α ≤ 90°.

$$F_{ax,\alpha,Rk} = n_{ef} \cdot k_{ax} \cdot f_{ax,90,k} \cdot d \cdot l_{ef} \cdot \left(\frac{\rho_k}{350}\right)^{0,8} \qquad (3)$$

With

$$k_{ax} = \min \begin{cases} 0,3 + (0,7 \cdot \alpha)/45° \\ 1,00 \end{cases} \qquad (4)$$

According to equation (5) the point side penetration length has to be considered between the following range

$$l_{ef} = \min \begin{cases} \dfrac{4 \cdot d}{\sin \alpha} \\ 20 \cdot d \end{cases} \qquad (5)$$

Where

$F_{ax,\alpha,Rk}$	Characteristic withdrawal capacity of the screw with an angle α to the grain [N]
n_{ef}	Effective number of screws according to see equation (8) and (9)
$f_{ax,90,k}$	Characteristic withdrawal parameter with

GoFix MS II

d = 4,0 mm:	$f_{ax,90,k}$ = 14,50 MPa
d = 4,5 mm:	$f_{ax,90,k}$ = 14,00 MPa
d = 5,0 mm:	$f_{ax,90,k}$ = 13,80 MPa
d = 6,0 mm:	$f_{ax,90,k}$ = 13,40 MPa
d = 8,0 mm:	$f_{ax,90,k}$ = 12,40 MPa
d = 10,0 mm:	$f_{ax,90,k}$ = 11,50 MPa

DG-T / DG-Z

d = 8,0 mm:	$f_{ax,90,k}$ = 12,40 MPa

VG-Z / S+

d = 6,5 mm:	$f_{ax,90,k}$ = 12,80 MPa
d = 8,0 mm:	$f_{ax,90,k}$ = 12,00 MPa
d = 10,0 mm:	$f_{ax,90,k}$ = 11,50 MPa

GoFix SH in LVL acc. to ETA-14/0354

d = 8,0 mm: $f_{ax,90|90,k}$ = 40,50 MPa
$f_{ax,90|00,k}$ = 30,00 MPa
$f_{ax,00|00,k}$ = 30,00 MPa

TeFix

d = 4,0 mm: $f_{ax,90,k}$ = 13,0 MPa
d = 4,5 mm: $f_{ax,90,k}$ = 12,2 MPa
d = 5,0 mm: $f_{ax,90,k}$ = 11,5 MPa
d = 5,5 mm: $f_{ax,90,k}$ = 10,8 MPa
d = 6,0 mm: $f_{ax,90,k}$ = 10,0 MPa

Alu-TeFix stainless steel hardened
(martensitic stainless steel)

d= 5,2 mm: $F_{ax,Rk}$=1300 N

Alu-TeFix stainless steel unhardened
(austenitic stainless steel A2 and A4)

d= 5,2 mm: $F_{ax,Rk}$=850 N
with l_{ef} =3,0 mm

Where

d Outer thread diameter [mm]
l_{ef} Penetration length of the threaded part acc. to EN 1995-1-1; For fully threaded screws the thread length including the head length [mm]
α Angle between grain and screw axis [°]
ρ_k Characteristic timber gross density [kg/m³]

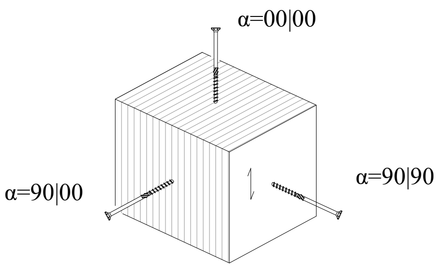


Figure 2: GoFix SH in LVL

Withdrawal capacity $F_{ax,Rk}$
Cross laminated timber

If there are no other technical specification (ETA or hEN) for Cross Laminated Timber (CLT), the withdrawal capacity for screws can be calculated as following.

Screws in the plane surface:
The withdrawal capacity for screws with d ≥ 8 mm in the plane surface of CLT-elements should be assumed as for solid timber according to equation (3) based on a characteristic density of equation (6), if there are no other especially specifications are given.

$$\rho_k = 1{,}1 \cdot \rho_{lay,k} \qquad (6)$$

With
$\rho_{lay,k}$ Lowest characteristic density of the lamella in the CLT-element [kg/m³]

Screws in the narrow side:
The withdrawal capacity for screws in the narrow side of CLT-elements should be assumed according to equation (7).

$$F_{ax,Rk} = 20 \cdot d^{0,8} \cdot l_{ef}^{\;0,9} \qquad (7)$$

Screws in the narrow side should be drilled perpendicular into the grain of the lamella. The penetration length has to be at least $3 \cdot d + l_{ef}$.
If it is guaranteed that the angle between the lamellas and the screw axis is 45° the characteristic withdrawal capacity from equation (7) can be increased of about 25%.

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

Effective number of screws n_{ef}
For axially loaded screws in tension, where the external force is parallel to the screw axis, the rules in EN 1995-1-1, 8.7.2 (8) should be applied.

$$n_{ef} = n^{0,9} \qquad (8)$$

For inclined screws in timber-to-timber or steel-to timber shear connections, where the screws are arranged under an angle 30° ≤ α ≤ 60° between the shear plane and the screw axis, the effective number of screws n_{ef} should be determined with equation

$$n_{ef} = \max \begin{cases} n^{0,9} \\ 0,9 \cdot n \end{cases} \qquad (9)$$

With
n Number of (inclined/cross pairs) screws in a row

For screws as compression reinforcement or inclined screws as fasteners in mechanically jointed beams or columns $n_{ef} = n$.

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

For the bending angle of the TeFix screws a minimum plastic angle of $45°/d^{0,7} + 10°$ must be considered.

Head pull-through capacity $f_{head,k}$

The characteristic head pull-through capacity of GoFix screws can be calculated as following.

$$F_{ax,\alpha,Rk} = n_{ef} \cdot \left(\frac{\rho_k}{350}\right)^{0,8} \cdot \min \begin{cases} k_{ax} \cdot f_{ax,90,k} \cdot d \cdot l_{ef} \\ f_{head,k} \cdot d_h^{\,2} \end{cases} \quad (10)$$

For the characteristic value of the head pull-through parameter $f_{head,k}$ for a characteristic density of 350 kg/m³ of the timber can be taken into account

GoFix MS II

d= 4,0 mm	$d_{h,min}$= 7,5 mm	$f_{head,k}$= 20,05 MPa
d= 4,5 mm	$d_{h,min}$= 8,4 mm	$f_{head,k}$= 19,71 MPa
d= 5,0 mm	$d_{h,min}$= 9,3 mm	$f_{head,k}$= 19,36 MPa
d= 6,0 mm	$d_{h,min}$= 12,8 mm	$f_{head,k}$= 18,15 MPa
d= 8,0 mm	$d_{h,min}$= 17,5 mm	$f_{head,k}$= 16,49 MPa
d=10,0 mm	$d_{h,min}$= 21,7 mm	$f_{head,k}$= 15,05 MPa

DG-T: Pull-through parameter including total length of threaded part + screw head

d= 8,0 mm	$d_{h,Z,min}$= 9,50 mm $d_{h,TS,min}$=15,70 mm	$f_{head,k}$= 31,50 MPa

TeFix

d= 4,0 mm	$d_{h,min}$= 6,35 mm	$f_{head,k}$= 18,00 MPa
d= 4,5 mm	$d_{h,min}$= 7,35 mm	$f_{head,k}$= 17,72 MPa
d= 5,0 mm	$d_{h,min}$= 8,35 mm	$f_{head,k}$= 17,44 MPa
d= 5,5 mm	$d_{h,min}$= 9,35 mm	$f_{head,k}$= 17,16 MPa
d= 6,0 mm	$d_{h,min}$= 11,35 mm	$f_{head,k}$= 16,88 MPa

For GoFix DG-Z the pull-through parameter has to be calculated with the value $f_{ax,90,k}$, with l_{ef} is including the height of the head.

For Alu-TeFix the head pull through parameter can be assumed with $f_{head,k}$=11,0 MPa

Washers

head type S		
d= 5,0 mm	$d_{h,min}$= 15,50 mm	$f_{head,k}$=17,46 MPa
d= 6,0 mm	$d_{h,min}$= 19,50 mm	$f_{head,k}$=16,08 MPa
d= 8,0 mm	$d_{h,min}$= 24,50 mm	$f_{head,k}$=14,35 MPa
d=10,0 mm	$d_{h,min}$= 31,50 mm	$f_{head,k}$=11,94 MPa
head type MS II		
d= 8,0 mm	$d_{h,min}$= 27,00 mm	$f_{head,k}$=13,49 MPa

GoFix SH

d= 8,0 mm	$d_{h,min}$=14,00 mm	$f_{head,90\|90,k}$=50,00 MPa

For the following wood-based panels described in chapter 1 with a thickness of more than 20 mm the head pull-through parameter can constitute with

$$f_{head,k} = 10 \text{ MPa} \quad (11)$$

For wood-based panels with a thickness between 12 mm and 20 mm the characteristic value of the head pull-through parameter can taken into account with

$$f_{head,k} = 8 \text{ MPa} \quad (12)$$

For wood based panels with a thickness of less than 12 mm the characteristic head pull-through capacity shall be calculated with $f_{head,k}$=8 MPa with a limit of 400 N complying with a minimum thickness of the wood based panels of 1,2·d. In addition, to apply the minimum thickness of *Table 1*.

Table 1: Minimum thickness of wood based panels

Wood based panel	Min. thickness [mm]
Plywood	6
Oriented Strand board OSB	8
Solid wood panels	12
Particleboards	8
Cement bonded particle boards	8
Fibreboards (hardboards and medium boards)	6

Tensile capacity $f_{tens,k}$

The characteristic tensile capacity $f_{tens,k}$ of GoFix screws depending on the outer diameter is

Table 2: Characteristic tensile strength

GoFix MS II, carbon steel	
d= 4,0 mm	$f_{tens,k}$= 5,0 kN
d= 4,5 mm	$f_{tens,k}$= 5,8 kN
d= 5,0 mm	$f_{tens,k}$= 8,8 kN
d= 6,0 mm	$f_{tens,k}$=12,8 kN
d= 8,0 mm	$f_{tens,k}$=22,7 kN
d=10,0 mm	$f_{tens,k}$=33,2 kN
DG-T / DG-Z, carbon steel	
d= 8,0 mm	$f_{tens,k}$=20,0 kN
GoFix SH, carbon steel	
d= 8,0 mm	$f_{tens,k}$=32,0 kN
TeFix, stainless-steel hardened (martensitic stainless-steel)	
d= 4,0 mm	$f_{tens,k}$= 6,5 kN
d= 4,5 mm	$f_{tens,k}$= 8,4 kN
d= 5,0 mm	$f_{tens,k}$=10,1 kN
d= 5,5 mm	$f_{tens,k}$=12,5 kN
d= 6,0 mm	$f_{tens,k}$=14,5 kN
TeFix, stainless-steel unhardened (austenitic-steel A2 and A4)	
d= 4,0 mm	2,5 kN
d= 4,5 mm	3,2 kN
d= 5,0 mm	3,8 kN
d=5,5 mm	4,8 kN
d= 6,0 mm	5,5 kN
VG-Z / S+, carbon steel	
d= 6,5 mm	17,0 kN
d= 8,0 mm	25,0 kN
d=10,0 mm	33,0 kN
VG-Z / S+, stainless-steel unhardened (austenitic stainless-steel A2 and A4)	
d= 8,0 mm	11,0 kN
Alu-TeFix, stainless-steel hardened (martensitic stainless-steel)	
d= 5,0 mm	16,0 kN
Alu-TeFix, stainless-steel unhardened (austenitic-steel A2 and A4)	
d= 5,0 mm	9,0 kN

The tear-off capacity of the screw head is greater than the tensile capacity of the screw.

Compression capacity

The design compressive capacity $F_{ax,Rd}$ of GoFix screws with full thread along the length embedded in timber shall be calculated as following.

$$F_{ax,Rd} = \min \begin{cases} F_{ax,Rd} \\ F_{crit,Rd} \end{cases} \tag{13}$$

Where

$F_{ax,Rd}$ According to equation (3)

$F_{crit,Rd}$ According to equation (14)

$$\mathrm{F}_{\mathrm{crit,Rd}} = \kappa_c \cdot \mathrm{N}_{\mathrm{pl,d}} \tag{14}$$

With

$$\kappa_c = 1 \quad \text{for } \bar{\lambda}_k \le 0,2$$
$$\kappa_c = \frac{1}{k + \sqrt{k^2 - \bar{\lambda}_k^{\,2}}} \quad \text{for } \bar{\lambda}_k > 0,2 \tag{15}$$

and

$$k = 0,5 \cdot \left[1 + 0,49 \cdot (\bar{\lambda}_k - 0,2) + \bar{\lambda}_k^{\,2}\right] \tag{16}$$

The relative slenderness ratio shall be calculated with

$$\bar{\lambda}_k = \sqrt{\frac{\mathrm{N}_{\mathrm{pl,k}}}{\mathrm{N}_{\mathrm{ki,G,k}}}} \tag{17}$$

With the characteristic value for the axial capacity in case of plastic analysis referred to the inner thread diameter

$$\mathrm{N}_{\mathrm{pl,k}} = \pi \cdot \frac{d_i^{\,2}}{4} \cdot f_{y,k} \tag{18}$$

And the characteristic ideal elastic buckling load

$$N_{ki,G,k} = \sqrt{c_h \cdot E_s \cdot I_s} \tag{19}$$

With

Elastic foundation of the screw:

$$c_h = (0,19 + 0,012 \cdot d) \cdot \rho_k \cdot \left(\frac{\alpha}{180°} + 0,5\right) \tag{20}$$

Modulus of elasticity:

$$E_s = 210000 \text{ MPa} \tag{21}$$

Second moment of area:

$$I_s = \frac{\pi \cdot d_i^4}{64} \qquad (22)$$

Note: The compressive capacity must be modified for $f_{ax,d}$ with the factors k_{mod} and γ_M for timber according to EN 1995-1-1 while $N_{pl,d}$ the partial safety factor $\gamma_{M,1}$ for steel buckling according to EN 1993-1-1 and/or national standard respectively has to be considered.

3.5.3 Combined laterally and axially loaded screws

For connections subjected to a combination of axial and lateral load, the following expression has to be considered according to equation (23).

$$\left(\frac{F_{v,Ed}}{F_{v,Rd}}\right)^2 + \left(\frac{F_{ax,Ed}}{F_{ax,Rd}}\right)^2 \leq 1 \qquad (23)$$

With

$F_{ax,Ed}$ Axial design load

$F_{v,Ed}$ Lateral design load

$F_{ax,Rd}$ Design load-carrying capacity of an axially loaded screw

$F_{v,Rd}$ Design load-carrying capacity of a laterally loaded screw

3.6 Slip modulus

Laterally loaded screws

For laterally loaded GoFix screws the slip modulus for the serviceability limit state (SLS) could be calculated according to EN 1995-1-1 independent of the angle α to the grain:

$$K_{ser} = k_{sys} \cdot k_{sb} \cdot \frac{\rho_m^{1,5} \cdot d}{23} \qquad (24)$$

With

k_{sys} $k_{sys} = \begin{cases} 1 & \text{for timber-timber connections} \\ 2 & \text{for steel-timber connections} \end{cases}$

k_{sb} Number of shear bands

Where

K_{ser} Slip modulus in SLS [N/mm]

ρ_m Mean timber density [kg/m³]

Axially loaded screws

For axially loaded screws the slip modulus for the serviceability limit state (SLS) could be calculated independent on the angle α to the grain according to equation (25).

$$K_{ser} = \begin{cases} 25 \cdot d \cdot l_{ef} & \text{for softwood} \\ 35 \cdot d \cdot l_{ef} & \text{for hardwood} \end{cases} \qquad (25)$$

To consider the slip modulus K_u in the ultimate limit state (ULS), K_{ser} is to reduce for both directions, laterally and axially according to EN 1995-1-1.

$$K_u = \tfrac{2}{3} \cdot K_{ser} \qquad (26)$$

3.7 Minimum timber cross section, end and edge distances

Solid timber

For structural timber members, minimum spacing and distances for screws in predrilled holes are given in EN 1995-1-1:2014 clause 8.3.1.2 and table 8.2 as for nails in predrilled holes.

For non-predrilled holes the following minimum spacings and distances are listed in Table

Table 3: Minimum spacings and distances

Parameter	Distances
a_1	5·d
a_2	5·d
$a_{3,t}$	12·d

Minimum distances and spacing for exclusively axially loaded screws in predrilled holes or for screws with tip type X+, S+ and TeFix (see Annex A) in non-predrilled holes in members with a minimum thickness t = 10·d and a minimum width of 8·d or 60 mm, whichever is the greater, may be taken as:

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

Spacing a2 perpendicular to the grain 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.

The definition of the minimum thickness and cross sections of the timber elements are in accordance to the EN 1995-1-1:2014.

3.8 Aspects related to the performance of the product

3.8.1 Corrosion protection in service class 1 and 2

The GoFix screws are produced from carbon steel and stainless wire. They are zinc-plated, nickel-plated and bronze finished or electro-galvanized and e.g. yellow chromate or blue zinc with thicknesses of the zinc coating from 4 – 16 µm or have a zinc high corrosion coating with thicknesses from 10 – 30 µm.

3.9 Methods of verification

The characteristic values of the blind rivets are based on the EAD 130118-01-0603 “Screws and threaded rods for use in timber constructions”

3.10 General aspects related to the intended use of the product

The European Technical Assessment is issued for the GoFix screws based on agreed data/information, deposited with ETA-Danmark, which identifies the product that has been assessed and judged. Changes to the product or production process, which could result in this deposited data/information being incorrect, should be notified to ETA-Danmark before the changes are introduced. ETA-Danmark will decide if such changes affect the ETA and consequently the validity of the CE marking based on the ETA and if so whether further assessment or alterations to the ETA, shall be necessary.

The GoFix screws are manufactured in accordance with the provisions of this European Technical Assessment using the manufacturing processes as identified in the inspection of the plant by the assessment body issuing the ETA and the notified body and laid down in the technical documentation. The installation shall be carried out in accordance with EN 1995-1-1 (Eurocode 5) or an appropriate national code unless, otherwise is defined in the following.

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.

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

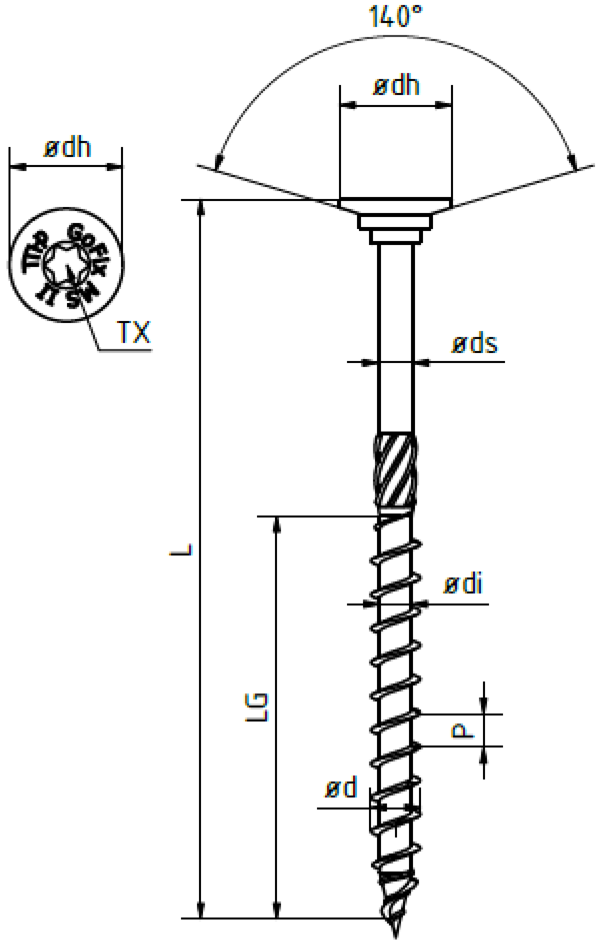
Issued in Copenhagen on 2023-05-26 by

Thomas Bruun
Managing Director, ETA-Danmark

Annex A
Product details and definitions

	LG					
L	Ø 4,0	Ø 4,5	Ø 5,0	Ø 6,0	Ø 8,0	Ø 10,0
30	18	18				
35	21	21				
40	24	24	24			
45	27	27	27			
50	30	30	30			
60	36	36	36			
70	42	42	42	42	42	
80	48	48	48	48	50	50
90		55	54	54	55	55
100		60	60	60	60	60
110		66	65	65	65	65
120		70	70	70	70	70
140		70	70	70	80	80
160				70	90	90
180				70	100	100
200				70	100	100
220				70	100	100
240				70	100	100
260				70	100	100
280				70	100	100
300				70	100	100
320					100	100
340					100	100
360					100	100
380					100	100
400					100	100
450					100	100
500					100	100
550						100
600						100

All dimensions in mm



	Ø 4,0		Ø 4,5		Ø 5,0		Ø 6,0		Ø 8,0		Ø 10,0	
Ø d	4,0	±0,3	4,5	±0,3	5,0	±0,3	6,0	±0,3	8,0	±0,4	10,0	±0,5
Ø di	2,55	±0,3	2,75	±0,3	3,25	±0,3	3,95	±0,3	5,30	±0,3	6,20	±0,31
Ø dh	8,0	±0,5	9,0	±0,6	10,0	±0,7	13,5	±0,7	18,3	±0,8	22,5	±0,8
Ø ds	2,8	±0,14	3,2	±0,16	3,5	±0,17	4,3	±0,21	5,9	±0,29	7,1	±0,35
p	2,2	±10%	2,4	±10%	2,7	±10%	3,4	±10%	5,6	±10%	6,6	±10%
TX	15		20		25		30		40		50	

All dimensions in mm

index	change and addition	date	name	general-tolerances ISO 2768 mittel/K	scale:		format:	A4
						date:	name:	
					drawn:	13.09.2022		
					appr.:			

SIHGA® GmbH
Gewerbepark Kleinreith 4
A-4694 Ohlsdorf bei Gmunden
Tel: +43 7612-74370 0
info@sihga.com

material:

designation:

GoFix MSII

drawing number: | index:

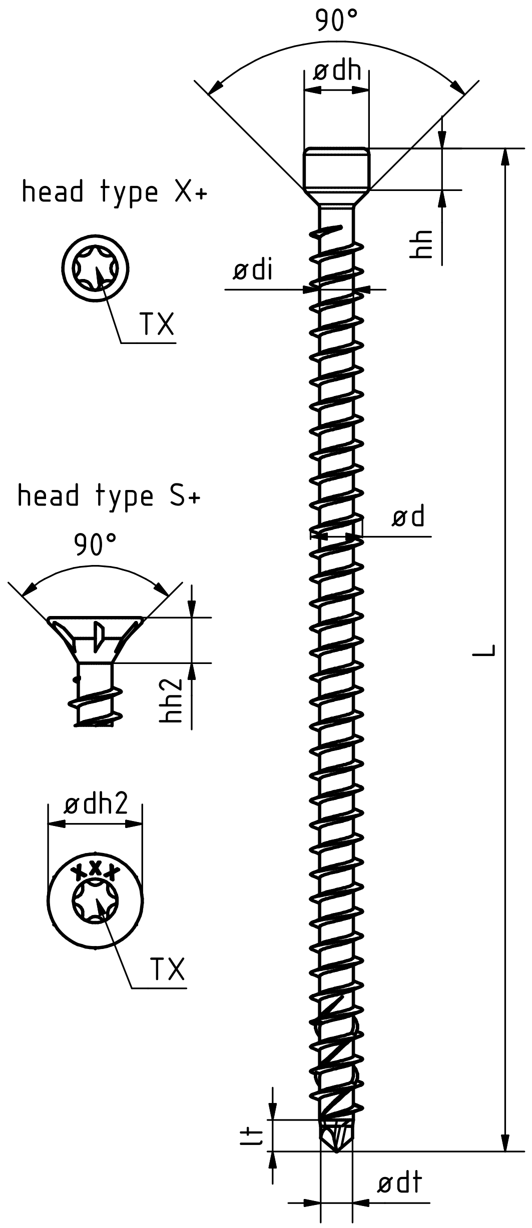
replacement for: | index:

		∅ 6,5	∅ 8,0	∅ 10,0
∅ d	min	6,20	7,60	9,60
	max	6,80	8,30	10,20
∅ di	min	4,20	4,90	5,70
	max	4,80	5,40	6,10
∅ dh	min	7,70	9,50	12,50
	max	8,30	10,50	13,50
hh	min	5,00	6,00	6,00
	max	6,00	7,00	7,00
∅ dh2	min	11,00	14,00	17,30
	max	12,00	15,00	18,30
hh2	min	5,40	7,00	7,30
	max	5,90	7,40	7,70
∅ dt	min	4,10	4,70	5,30
	max	4,50	5,10	5,70
lt	min	3,50	4,00	5,00
	max	5,00	5,00	6,00
p	min	4,41	4,68	5,04
	max	5,39	5,72	6,16
TX	size	TX30	TX40	TX50

All dimensions in mm

L					
∅ 6,5		∅ 8,0		∅ 10,0	
80	-2,0	95	-2,0	125	-2,0
100	-2,0	125	-2,0	155	-2,0
120	-2,0	155	-2,0	195	-2,0
140	-2,0	195	-2,0	220	-3,0
160	-2,0	220	-3,0	245	-3,0
195	-2,0	245	-3,0	270	-3,0
		275	-3,0	300	-3,0
		295	-3,0	330	-4,0
		330	-4,0	360	-4,0
		375	-4,0	400	-4,0
		400	-4,0	450	-5,0
		430	-5,0	500	-5,0
		480	-5,0	550	-5,0/+2,0
				600	-5,0/+2,0

All dimensions in mm



SIHGA GmbH
Pay attention to protection notes according to EN ISO 16016: 2007! Passing as well
Reproduction of this document, exploitation and communication of its contents
are prohibited unless expressly permitted. Violations
commit to damages. All rights in the case of patent,
Registered design or registered design.

				general-tolerances ISO 2768 mittel/K	scale:		format:	A4
						date:	name:	
					drawn:	22.01.2020		
index	change and addition	date	name		appr.:			

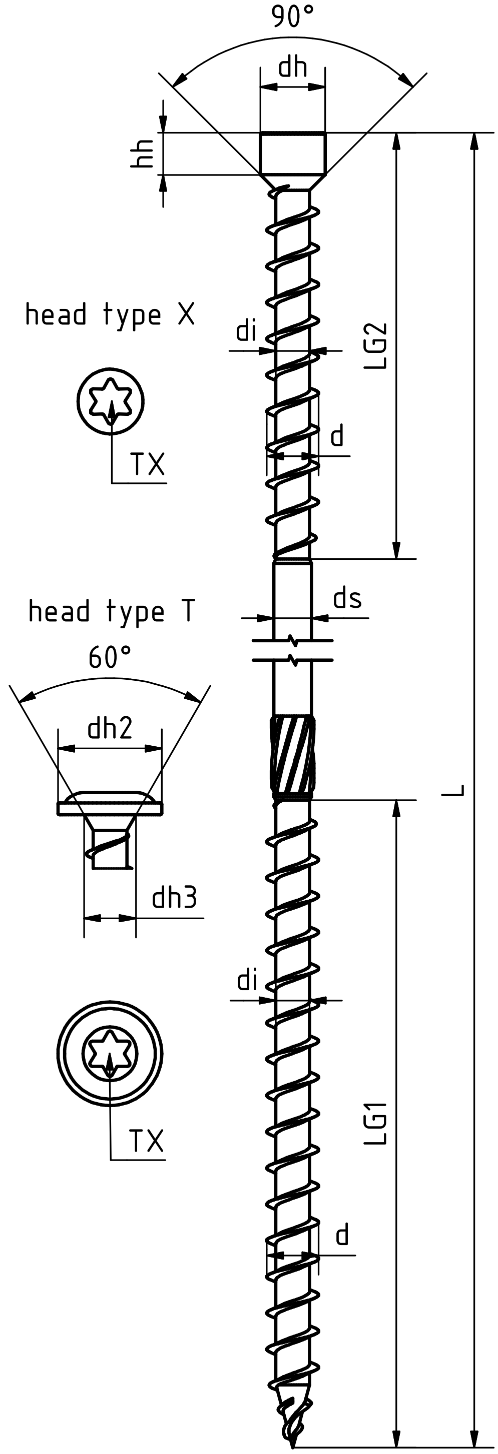
SIHGA® GmbH Gewerbepark Kleinreith 4 A-4694 Ohlsdorf bei Gmunden Tel: +43 7612-74370 0 info@sihga.com	material:	drawing number:	index:
	designation: GoFix X+/S+	replacement for:	index:

		∅ 8,0
∅ d	min	7,60
	max	8,20
∅ di	min	5,10
	max	5,50
∅ dh	min	9,50
	max	10,50
∅ dh2	min	15,70
	max	16,30
∅ dh3	min	7,50
	max	8,50
∅ ds	min	5,65
	max	5,80
hh	min	6,00
	max	7,00
TX	size	TX40

All dimensions in mm

L		∅ 8,0	
		LG1 ±1,5	LG2 ±1,5
165	+1,5/-2,0	80	65
195	+1,5/-2,0	100	65
225	+1,5/-3,0	100	65
235	+1,5/-3,0	100	65
255	+1,5/-3,0	100	65
275	+1,5/-3,0	100	65
302	+1,5/-4,0	100	65
335	+1,5/-4,0	100	65
365	+1,5/-4,0	100	65
397	+1,5/-4,0	100	65
435	+1,5/-4,9	100	65
472	+1,5/-4,9	100	65

All dimensions in mm



index	change and addition	date	name	general-tolerances ISO 2768 mittel/K	scale:		format: A4
						date:	name:
					drawn:	24.01.2020	
					appr.:		

SIHGA® GmbH
Gewerbepark Kleinreith 4
A-4694 Ohlsdorf bei Gmunden
Tel: +43 7612-74370 0
info@sihga.com

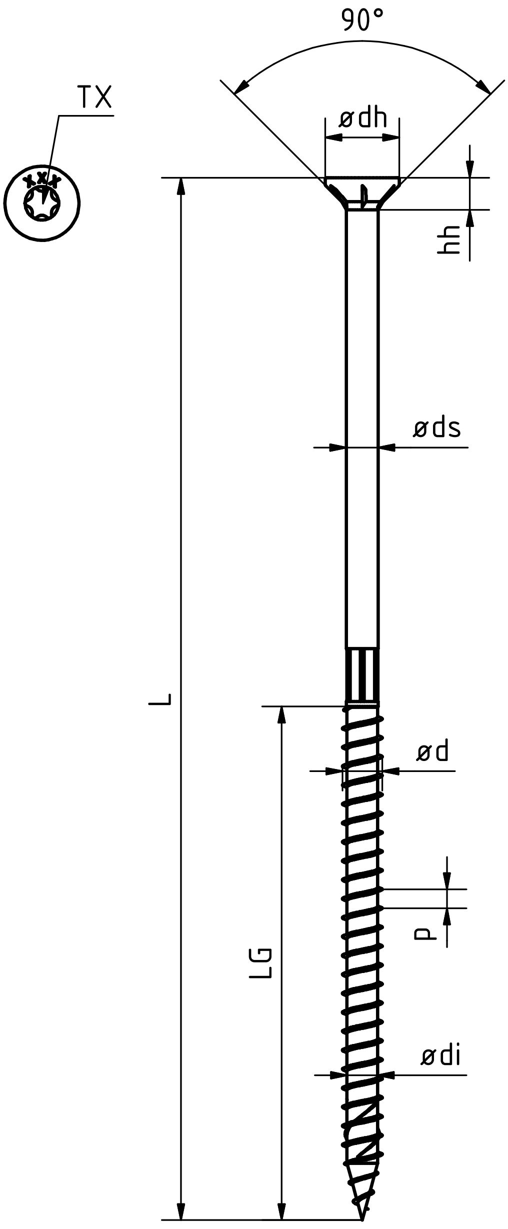
material:	drawing number:	index:
designation: GoFix ZS/TS	replacement for:	index:

L		LG ±1,5
80	-2,0	50
100	-2,0	80
120	-2,0	80
140	-2,0	80
160	-2,0	80
180	-2,0	80
200	-2,0	80
220	-3,0	80
240	-3,0	80

All dimensions in mm

		ø8,0
ød	min	7,6
	max	8,2
ødi	min	5,92
	max	6,32
øds	min	6,3
	max	6,5
ødh	min	14,5
	max	15,5
hh	min	6,7
	max	7,2
p	min	3,42
	max	4,18

All dimensions in mm



index | change and addition | date | name

general-tolerances ISO 2768 mittel/K

scale: | format: A4

date: | name:

drawn: 23.01.2020

appr.:

SIHGA® GmbH
Gewerbepark Kleinreith 4
A-4694 Ohlsdorf bei Gmunden
Tel: +43 7612-74370 0
info@sihga.com

material:

designation:

GoFix SH

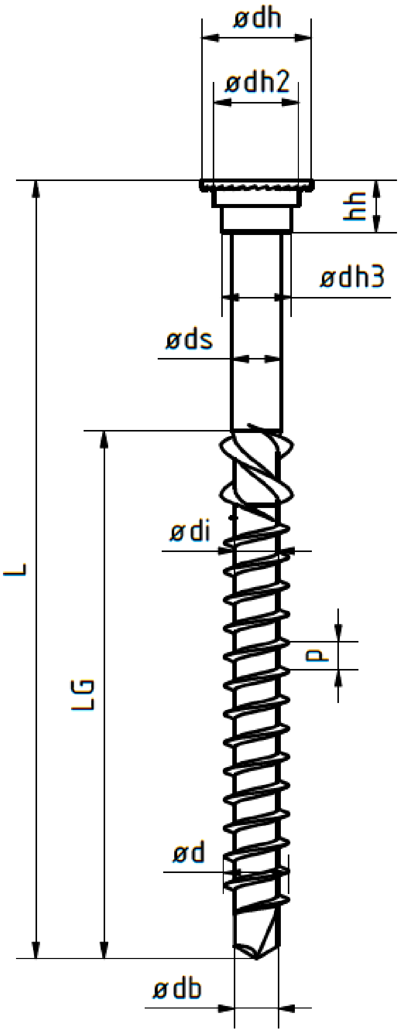
drawing number: | index:

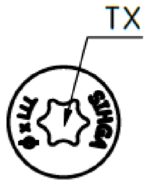
replacement for: | index:

Dim.	dh ± 0,15	dh2 ± 0,10	dh3 ± 0,10	hh ± 0,10	
4,0	6,50	4,92	3,99	3,20	
4,5	7,50	5,67	4,62	3,60	
Dim.	p ± 10%	ds + 0,10	di ± 0,10	d ± 0,10	db ± 0,10
4,0	1,76	3,00	2,70	4,00	2,60
4,5	1,98	3,40	3,10	4,50	3,00

Dim.	dh ± 0,20	dh2 ± 0,15	dh3 ± 0,10	hh ± 0,15	
5,0	8,50	6,52	5,36	4,00	
5,5	9,50	7,17	5,90	4,40	
6,0	11,50	8,22	6,43	4,80	
Dim.	p ± 10%	ds + 0,10	di ±0,10	d ± 0,10	db ± 0,10
5,0	2,20	3,80	3,40	5,00	3,45
5,5	2,42	4,20	3,80	5,50	3,85
6,0	2,64	4,60	4,10	6,00	4,15

L/LG - 1,0	ø 4,0	ø 4,5	ø 5,0	ø 5,5	ø 6,0
30,0	20,0				
35,0	23,0				
40,0	27,0	27,0			
45,0	30,0	30,0	30,0		
50,0	33,0	33,0	33,0	33,0	
60,0	40,0	40,0	40,0	40,0	
70,0		47,0	47,0	47,0	47,0
80,0			53,0	53,0	53,0
90,0			60,0	60,0	60,0
100,0			67,0	67,0	67,0
120,0				75,0	75,0
TX	15,0	15,0	20,0	25,0	25,0





index	change and addition	date	name	general-tolerances ISO 2768 mittel/K	scale:		format: A4
						date:	name:
					drawn:	28.10.2021	
					appr.:		

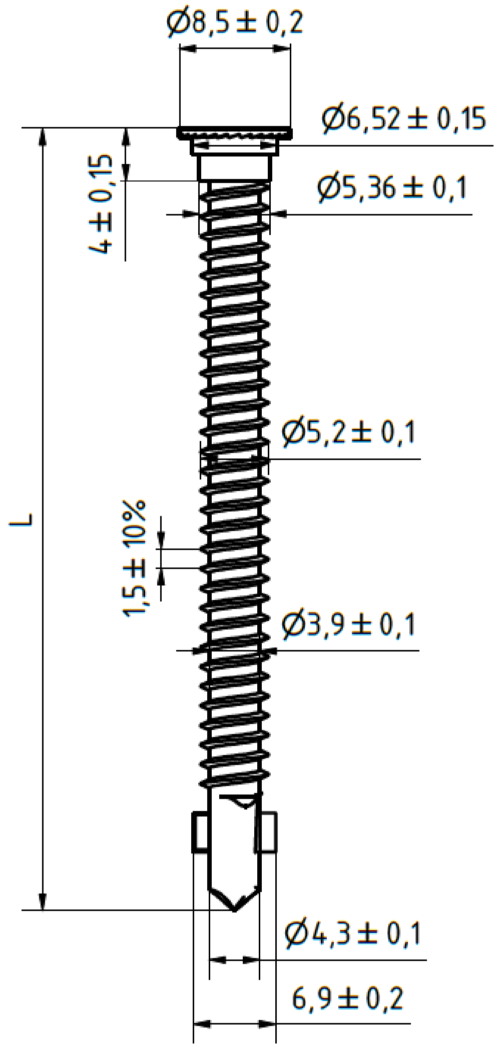
SIHGA® GmbH
Gewerbepark Kleinreith 4
A-4694 Ohlsdorf bei Gmunden
Tel: +43 7612-74370 0
info@sihga.com

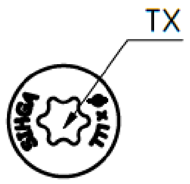
material:

designation: TeFix

drawing number: | index:

replacement for: | index:





	ø5,0x51	ø5,0x61	ø5,0x71
L -1,0	51	61	71
TX	20	20	20

index	change and addition	date	name	general-tolerances ISO 2768 mittel/K	scale:		format: A4
						date:	name:
					drawn:	28.10.2021	
					appr.:		

SIHGA® GmbH
Gewerbepark Kleinreith 4
A-4694 Ohlsdorf bei Gmunden
Tel: +43 7612-74370 0
info@sihga.com

material:

designation: Alu-TeFix

drawing number: | index:

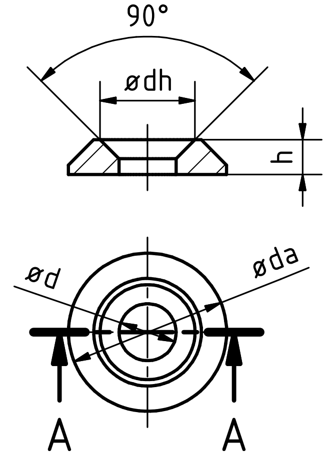
replacement for: | index:

Washer

(Carbon steel)

Washer 90°

A-A



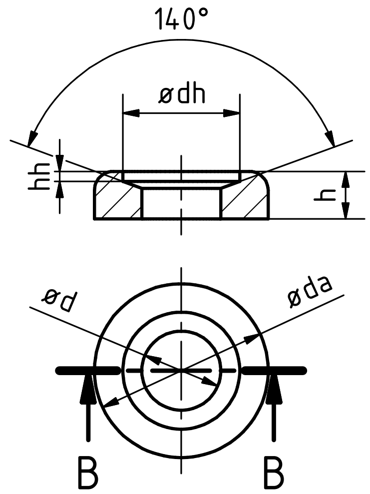
Washer for head type S

nominal size		ø5,0	ø6,0	ø8,0	ø10,0
ød	min	5,35	7,70	8,70	11,60
	max	5,85	8,30	9,30	12,40
øda	min	15,50	19,50	24,50	31,50
	max	16,50	20,50	25,50	32,50
ødh	min	9,90	13,60	16,00	22,00
	max	10,70	14,40	17,00	23,00
h	min	2,50	4,30	5,30	6,30
	max	2,90	4,70	5,70	6,70

All dimensions in mm

Washer MSZ

B-B



Washer for head type MSII

nominal size		ø8,0
ød	min	ø12,50
	max	ø12,80
øda	min	ø27,00
	max	ø28,00
ødh	min	ø18,5
	max	ø18,8
h	min	7,50
	max	7,80
hh	min	1,60
	max	1,90

All dimensions in mm

index	change and addition	date	name	general-tolerances ISO 2768 mittel/K	scale:		format: A4
						date:	name:
					drawn:	27.01.2020	
					appr.:		

SIHGA® GmbH
Gewerbepark Kleinreith 4
A-4694 Ohlsdorf bei Gmunden
Tel: +43 7612-74370 0
info@sihga.com

material:	drawing number:	index:
designation: Beilagscheibe / Washer	replacement for:	index:

Annex B
Examples of standard and special applications

Compression reinforcement

To reinforce the compression strength of timber elements GoFix screws can be used as shown in Figure 3. It has to be considered that the axially forces are uniform distributed over all screws. Therefore, the screws have to be screwed-in into the timber member in such a way that the head of the screws flush with the timber surface to provide the hybrid functionality. To transfer the load between the loads an appropriate intermediate steel plate between timber member and the support is essential.

The design load-carrying capacity for a contact area with fully threaded screws with an angle between 45°≤ α≤ 90° to the grain can be calculated for section 1 and 2 with equation (27), cf. 3.9.2 - compression capacity of the screws.

$$F_{c,\alpha,Rd} = \min \begin{cases} b \cdot l_{ef,1} \cdot k_{c,\alpha} \cdot f_{c,\alpha,d} + n \cdot F_{ax,\alpha,Rd} \\ b \cdot l_{ef,2} \cdot f_{c,90,d} \end{cases} \quad (27)$$

Where

- b Width of the timber column/beam
- $f_{c,\alpha,d}$ Design value of the compression strength depending on the load grain direction
- $F_{c,\alpha,Rd}$ Design value of the compression force perpendicular to the grain
- $F_{ax,\alpha,Rd}$ Design value of the withdrawal capacity of the screw
- $k_{c,90}$ Factor to taking into account the load configuration, the possibility of splitting and the degree of compressive deformation acc. to EN 1995-1-1
- $l_{ef,1}$ Effective supporting length
- $l_{ef,2}$ Effective length at the section of the screw tips
- n Number of screws axially loaded

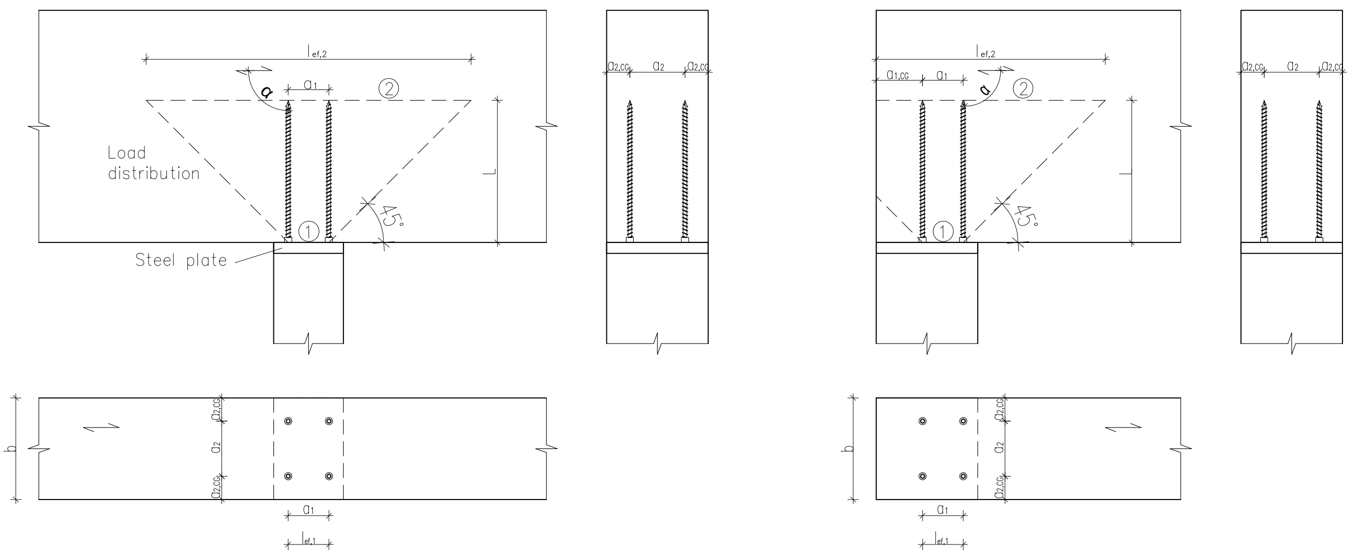


Figure 3: Compression reinforcement perpendicular to the grain with fully threaded screws

Tension reinforcement perpendicular to the grain

Connection perpendicular to the grain

Unless specified otherwise in national provisions that apply at the installation site, the axial capacity of a screw reinforcement of a timber beam loaded by a connection force perpendicular to the grain (Figure 4) shall fulfil equation (28).

$$\frac{\left(1-3\cdot\alpha^2+2\cdot\alpha^3\right)\cdot F_{90,Ed}}{F_{ax,Rd}} \leq 1 \tag{28}$$

Where

$F_{90,Ed}$ Design value of the load perpendicular to the grain

$F_{ax,Rd}$ Minimum withdrawal and tensile capacity of the reinforcing screw depending on the effective length $l_{ad,c}$ or $l_{ad,t}$

with

$$\alpha = \frac{a}{h} \tag{29}$$

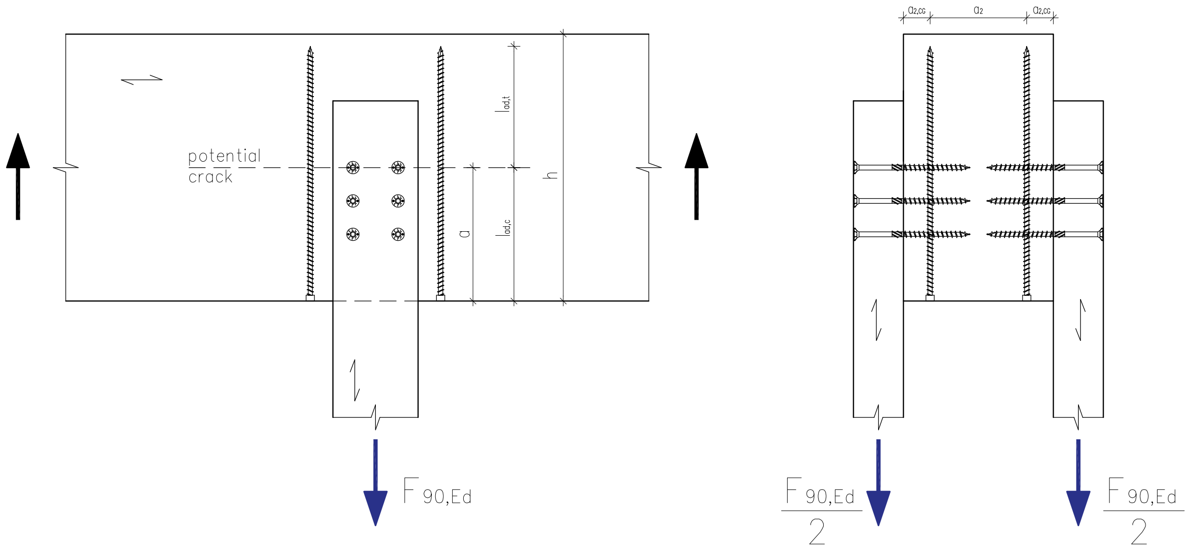


Figure 4: Reinforcement of connection perpendicular to the grain with fully threaded screws

Notched beam support

Unless specified otherwise in national provisions that apply at the installation site, the axial capacity of a screw reinforcement of a notched timber beam support (Figure 5) shall fulfil equation (30) .

$$\frac{1,3 \cdot V_{Ed} \cdot \left[3 \cdot (1-\alpha)^2 - 2 \cdot (1-\alpha)^3\right]}{F_{ax,Rd}} \leq 1 \tag{30}$$

Where

V_{Ed} Design value of the shear load at the edge of the notch

and

$$\alpha = \frac{h_{ef}}{h} \tag{31}$$

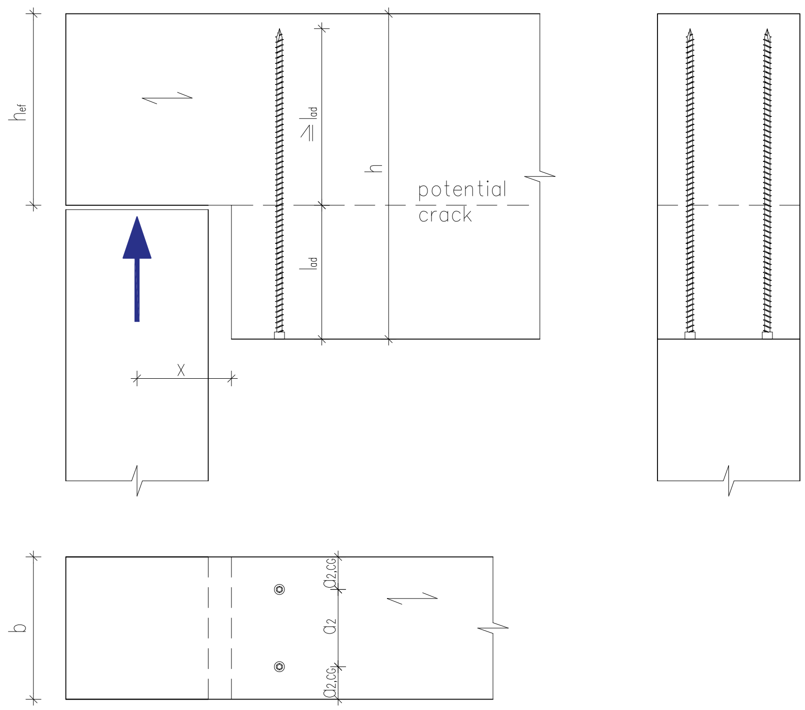


Figure 5: Reinforcement of notched beam support

Holes in beams

Unless specified otherwise in national provisions that apply at the installation site, the axial capacity of a screw reinforcement of holes in timber beams () shall fulfil equation (32).

$$\frac{F_{t,V,Ed} + F_{t,M,Ed}}{F_{ax,Rd}} \leq 1 \tag{32}$$

with

$$F_{t,V,Ed} = \frac{V_{Ed} \cdot h_d}{4 \cdot h} \cdot \left[3 - \left(\frac{h_d}{h} \right)^2 \right] \tag{33}$$

$$F_{t,M,Ed} = 0{,}008 \cdot \frac{M_{Ed}}{h_r} \tag{34}$$

and

$$h_r = \min \begin{cases} h_{ru} \\ h_{rl} \end{cases} \quad \text{for rectangular holes}$$

$$h_r = \min \begin{cases} h_{ru} + 0{,}15 \cdot h_d \\ h_{rl} + 0{,}15 \cdot h_d \end{cases} \quad \text{for circular holes} \tag{35}$$

Where

$F_{t,V,Ed}$	Design value of the force perpendicular to the grain direction due to shear forces
$F_{t,M,Ed}$	Design value of the force perpendicular to the grain due to bending moment
$F_{ax,Rd}$	Minimum withdrawal and tensile capacity of the reinforcing screw depending on the effective length l_{ad}
d	Height of the beam
h_d	Height of the hole
h_r	Calculated height for different shapes of holes

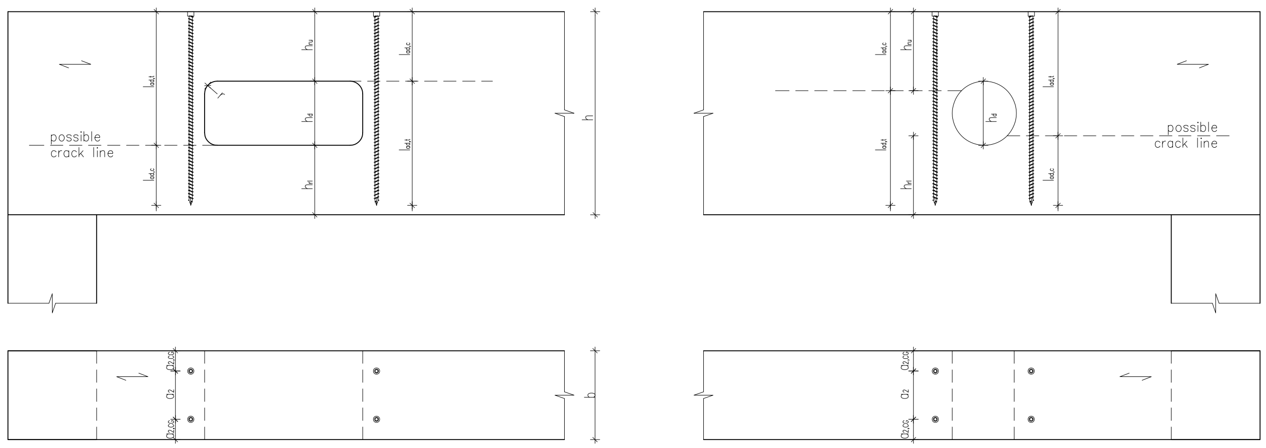


Figure 6: Reinforcement of holes in beams

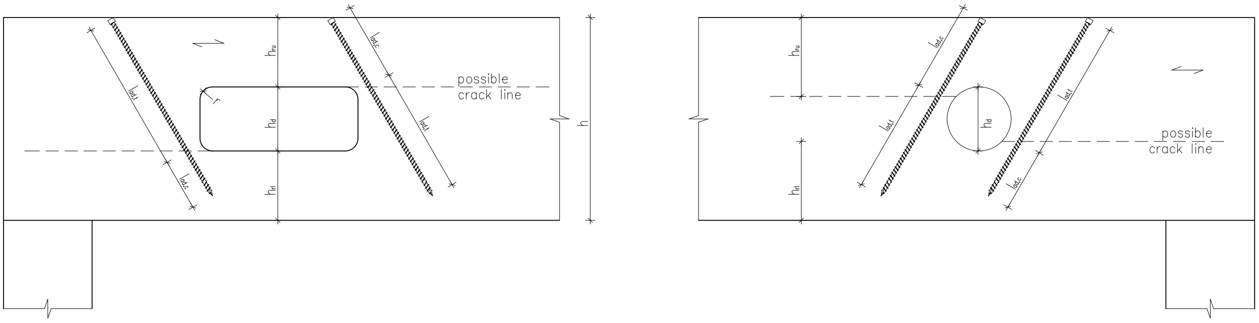


Figure 7: Reinforcement of holes in beams with inclined screws

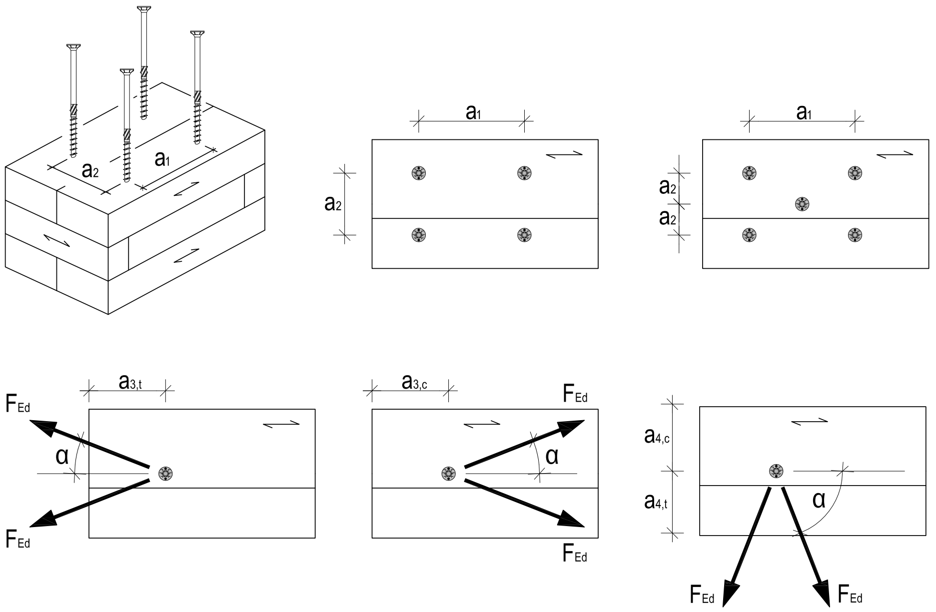


Figure 8: Recommended minimum spacing, end- and edge distances for screws in the plane side of CLT -elements

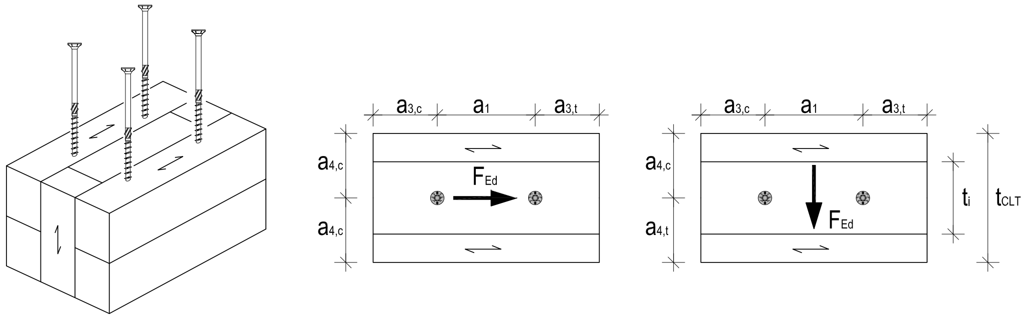


Figure 9: Recommended minimum spacing, end- and edge distances for screws in the narrow side of CLT-elements

Table 3: Recommended minimum spacing, end- and edge distances for screws in CLT-elements

Situation of the screw	a_1	a_2	$a_{3,t}$	$a_{3,c}$	$a_{4,t}$	$a_{4,c}$
Plane surface	4·d	2,5·d	6·d	6·d	6·d	2,5·d
Edge surface	10·d	3·d	12·d	7·d	5·d	3·d

Mechanically jointed beams

The slip modulus K_{ser} to calculate the effective bending stiffness in the serviceability limit state (SLS) according to EN 1995-1-1 for screws with an inclination of 45° to connect individual timber parts to a cross section shown in equation can be used.

$$K_{ser} = \frac{234 \cdot (\rho_m \cdot d)^{0.2}}{\frac{1}{l_1^{0,4}} + \frac{1}{l_2^{0,4}}} \text{ in [N/mm]} \tag{36}$$

Where

d	Outer diameter of the screw [mm]
K_{ser}	Slip modulus in SLS [N/mm]
$l_{1,2}$	Length of the threaded part of the screw into the particular timber beam [mm]
ρ_m	Mean timber density [kg/m³]

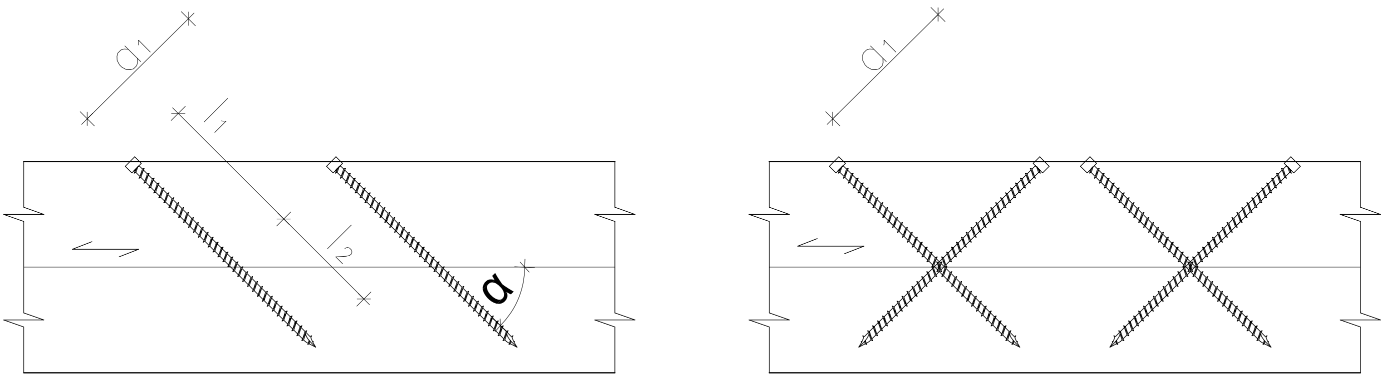
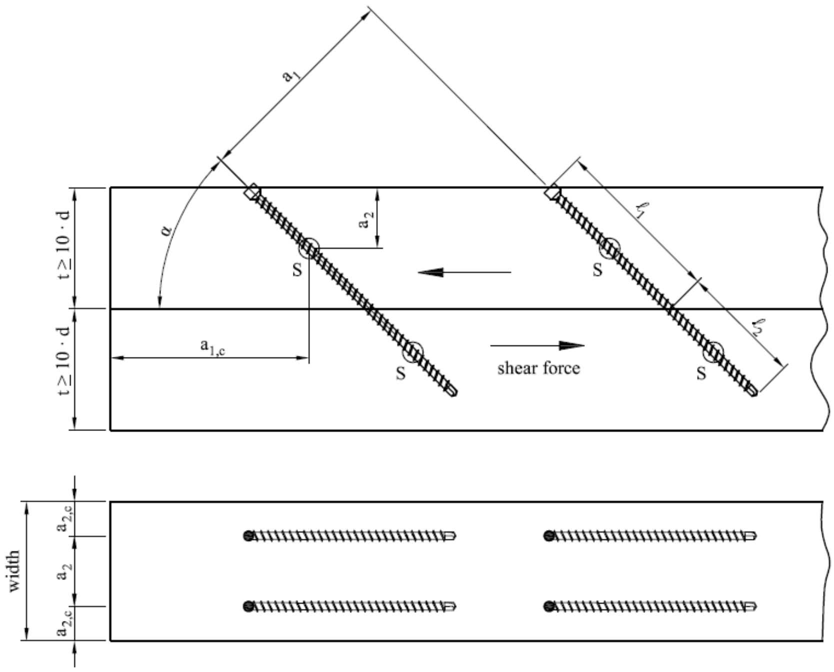


Figure 10: Mechanical jointed beam

Axially loaded screws
- Single configuration-



With
S…centroid of the part of the screw in 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}
$a_1 \geq 5 \cdot d$ $a_2 \geq 5 \cdot d$ $a_{1,c} \geq 10 \cdot d$ $a_{2,c} \geq 4 \cdot d$

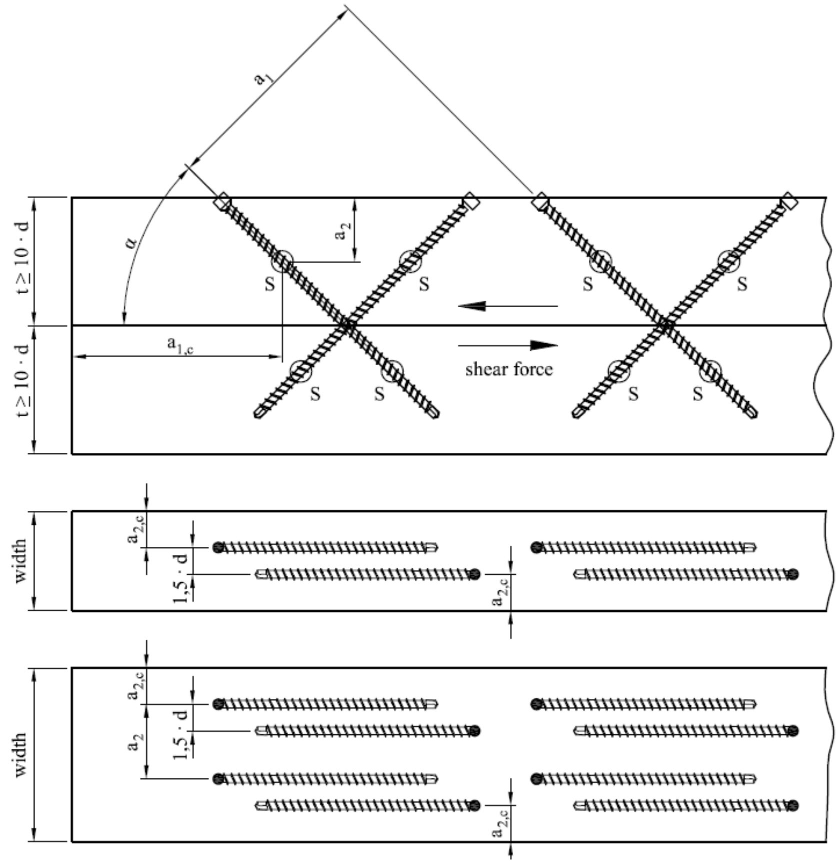
Minimum distances and spacings for exclusively axially loaded screws in predrilled holes.
Minimum timber thickness t=10·d, minimum timber width w=max {8·d; 60 mm}
$a_1 \geq 5 \cdot d$ $a_2 \geq 5 \cdot d$ $a_{1,c} \geq 5 \cdot d$ $a_{2,c} \geq 3 \cdot d$

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

Axially loaded screws

- Single configuration-



With

S…centroid of the part of the screw in 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}

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

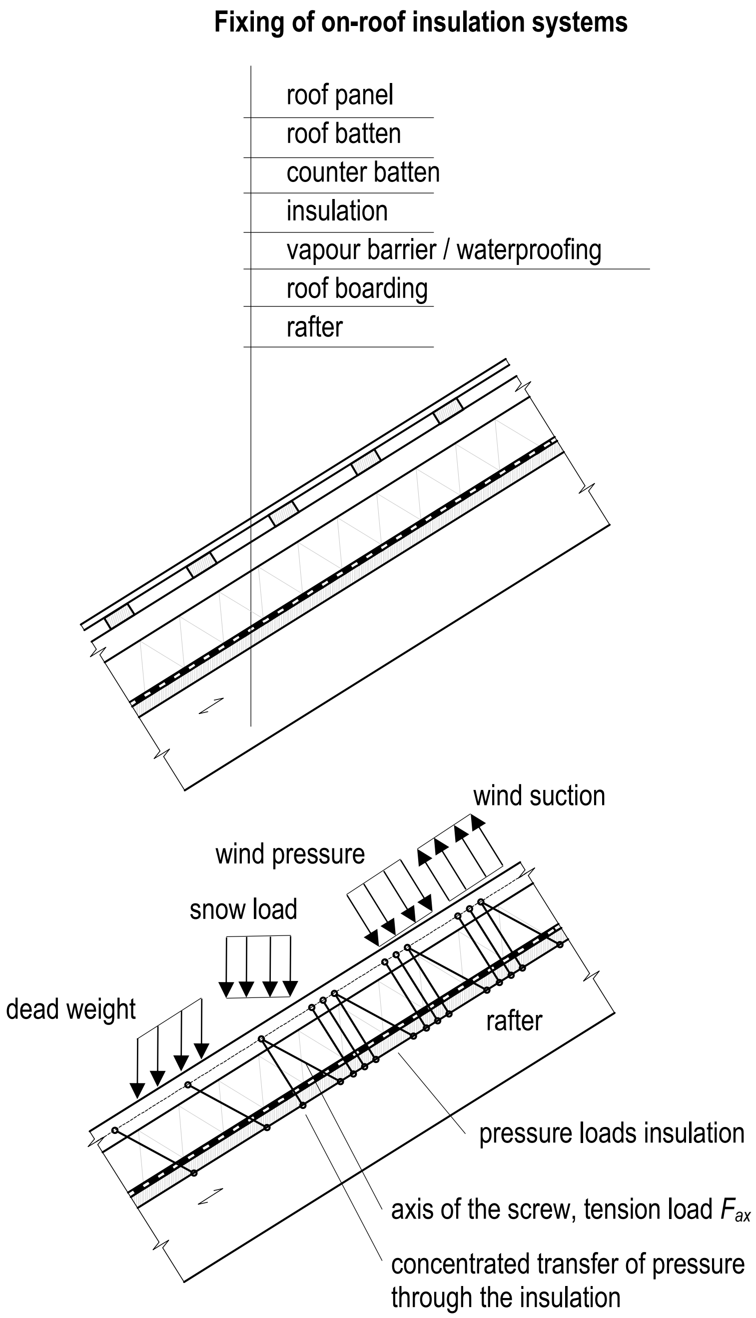
Minimum distances and spacings for exclusively axially loaded screws in predrilled holes.
Minimum timber thickness t=10·d, minimum timber width w=max {8·d; 60 mm}

$a_1 \geq 5 \cdot d$ $a_2 \geq 5 \cdot d$ $a_{1,c} \geq 5 \cdot d$ $a_{2,c} \geq 3 \cdot d$

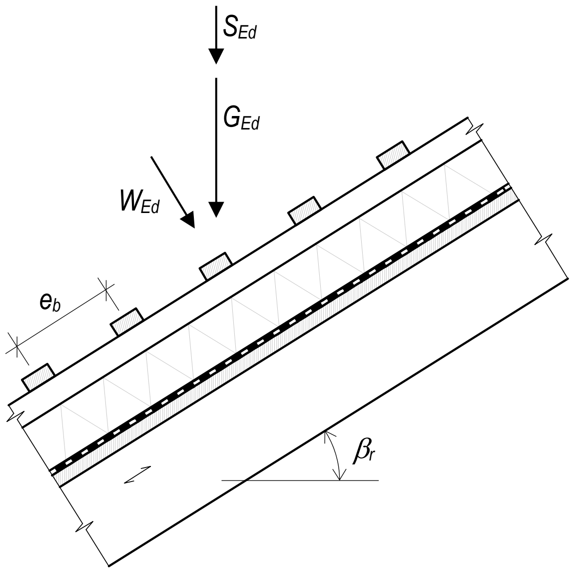
Spacing a_2 may be reduced from 5·d to 2,5·d if the condition $a_1 \cdot a_2 \geq 25 \cdot d^2$ is fulfilled.

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

Thermal insulation on rafters with parallel inclined screws



Point loads F_{Ed} perpendicular to the battens



$$G_{Ed} = \gamma_G \cdot g_k \cdot e_b \cdot e_r$$

$$S_{Ed} = \gamma_Q \cdot s_k{'} \cdot e_b \cdot e_r \cdot \cos \beta_r$$

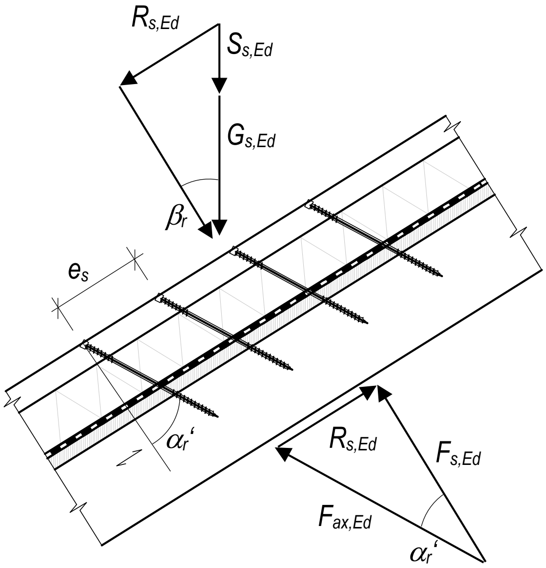
$$W_{Ed} = \gamma_Q \cdot w_{k,pressure} \cdot e_b \cdot e_r$$

$$F_{Ed} = W_{Ed} + \left(G_{Ed} + S_{Ed}\right) \cdot \cos \beta_r$$

Where

F_{Ed}	Design point load perpendicular to the battens [N]
G_{Ed}	Design point load by dead weight [N]
S_{Ed}	Design point load by snow load [N]
W_{Ed}	Design point load by wind pressure [N]
e_b	Distance of the battens [mm]
e_r	Distance of the rafters / counter battens [mm]
g_k	Characteristic dead load per m² roof area [N/m²]
$s_k{'}$	Characteristic snow load per m² roof area [N/m²]
$w_{k,pressure}$	Characteristic wind pressure per m² roof area [N/m²]
β_r	Roof inclination [°]
γ_G	Partial factor for permanent action acc. to EN 1990
γ_Q	Partial factor for variable action acc. to EN 1990

Point loads $F_{s,Ed}$ perpendicular to the battens by screws



$$G_{s,Ed} = \gamma_G \cdot g_k \cdot e_s \cdot e_r$$
$$S_{s,Ed} = \gamma_Q \cdot s_k' \cdot e_s \cdot e_r \cdot \cos\beta_r$$
$$R_{s,Ed} = \left(G_{s,Ed} + S_{s,Ed}\right) \cdot \sin\beta_r$$
$$F_{s,Ed} = R_{s,Ed} / \tan\alpha_r$$

Where

$F_{ax,Ed}$	Design axial load of the screws [N]
$F_{s,Ed}$	Design point loads perpendicular to the battens by screws [N]
$G_{s,Ed}$	Design point load by dead weight [N]
$R_{s,Ed}$	Design shear load due to dead weight and snow load [N]
$S_{s,Ed}$	Design point load by snow load [N]
W_{Ed}	Design point load by wind pressure [N]
e_s	Distance of the screws [mm]
e_r	Distance of the rafters [mm]
g_k	Characteristic dead load on the roof [N/m²]
s_k'	Characteristic snow load on the roof [N/m²]
α_r	Inclination of the screw axis (see figure) [°]
β_r	Roof inclination [°]
γ_G	Partial factor for permanent action acc. to EN 1990
γ_Q	Partial factor for variable action acc. to EN 1990

Design of the battens

The bending stresses of the battens are calculated with

$$M_{Ed} = \frac{\left(F_{Ed} + F_{s,Ed}\right) \cdot l_{char}}{4}$$

Where

F_{Ed}	Point loads perpendicular to the battens [N]
$F_{s,Ed}$	Point loads perpendicular to the battens in the area of the screw heads [N]
M_{Ed}	Design bending moment of the batten [Nmm]
l_{char}	Characteristic length of the batten [mm]

with $l_{char} = \sqrt[4]{\frac{4 \cdot EI}{w_{ef} \cdot K}}$, where

EI	Bending stiffness of the batten [Nmm²]
w_{ef}	Effective width of the thermal insulation [mm]

with $w_{ef} = w + t_{ti} / 2$, where

w Mimimum width of the batten or rafter [mm]

t_{ti} Thickness of the thermal insulation [mm]

K Bedding modulus [N/mm³]

The coefficient K may be calculated from the modulus of elasticity E_{ti} and the thickness t_{ti} of the thermal insulation if the effective width w_{ef} of the thermal insulation under compression is known. Due to the load extension in the 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 thermal insulation may be determined with $K = \frac{E_{ti}}{t_{ti}}$, where

E_{ti} Modulus of elasticity of the thermal insulation [N/mm²]

t_{ti} Thickness of the thermal insulation [mm]

The following conditions shall be satisfied:

a) $$\frac{\sigma_{m,Ed}}{f_{m,d}} \leq 1$$

Where

$\sigma_{m,Ed}$	Design value of the bending stress of the batten [N/mm²]
$f_{m,d}$	Design value of the bending strength [N/mm²]

b) $$\frac{\tau_{Ed}}{f_{v,d}} = \frac{3 \cdot V_{Ed}}{2 \cdot A_{ef} \cdot f_{v,d}} \leq 1$$

Where

$f_{v,d}$	Design value of the shear strength of the batten [N/mm²]
A_{ef}	Net cross section of the batten [mm²]
V_{Ed}	Design shear load onto the batten [N]

with $V_{Ed} = \frac{F_{Ed} + F_{s,Ed}}{2}$

τ_{Ed}	Design value of the shear stress of the batten [N/mm²]

Design of the heat insulation

The compressive stresses in the thermal insulation shall be calculated with

$$\sigma_{c,Ed} = \frac{1{,}5 \cdot F_{Ed} + F_{s,Ed}}{2 \cdot l_{char} \cdot w_{ef}}$$

Where

F_{Ed} Point loads perpendicular to the battens [N]

$F_{s,Ed}$ Point loads perpendicular to the battens in the area of the screw heads [N]

l_{char} Characteristic length of the batten [mm]

with $l_{char} = \sqrt[4]{\frac{4 \cdot EI}{w_{ef} \cdot K}}$, where

- EI Bending stiffness of the batten [Nmm²]
- w_{ef} Effective width of the thermal insulation [mm]
  with $w_{ef} = w + t_{ti} / 2$, where
  - w Mimimum width of the batten or rafter [mm]
  - t_{ti} Thickness of the thermal insulation [mm]
- K Bedding modulus [N/mm³]
  The coefficient K may be calculated from the modulus of elasticity E_{ti} and the thickness t_{ti} of the thermal insulation if the effective width w_{ef} of the thermal insulation under compression is known. Due to the load extension in the 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 thermal insulation may be determined with $K = \frac{E_{ti}}{t_{ti}}$, where
  - E_{ti} Modulus of elasticity of the thermal insulation [N/mm²]
  - t_{ti} Thickness of the thermal insulation [mm]

$\sigma_{c,Ed}$ Design value of the compression stresses of the thermal insulation

$\sigma_{c,Ed}$

Note: 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

$$F_{ax,Ed} = \frac{R_{s,Ed}}{\cos\alpha_r} \leq F_{ax,\alpha,Rd}$$

Where

$F_{ax,Ed}$	Design value of the axial tension forces onto the screw [N]
$F_{ax,\alpha,Rd}$	Design value of the withdrawal capacity of the screw [N]
$R_{s,Ed}$	Shear loads onto the screw [N]
α_r	Angle inclined screw (see figure B1.3) [°]

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 heat insulation 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.

$$F_{ax,\alpha,Rd} = \min\left\{k_{ax} \cdot f_{ax,d} \cdot d \cdot l_{ef} \cdot k_1 \cdot k_2 \cdot \left(\frac{\rho_k}{350}\right)^{0,8},\ f_{head,d} \cdot d_h^{\,2} \cdot \left(\frac{\rho_k}{350}\right)^{0,8}, f_{tens,d}\right\}$$

Where

$F_{ax,\alpha,Rd}$	Design value of the withdrawal capacity of the screw [N]	
d	Diameter of the screw [mm]	
d_h	Head diameter of the screw [mm]	
$f_{ax,d}$	Design value of the withdrawal parameter of the threaded part of the screw [N/mm²]	
$f_{head,d}$	Design value of the head pull-through capacity of the screw [N/mm²]	
$f_{tens,d}$	Design value of the tensile capacity of the screw [N]	
k_{ax}	Coefficient according to equation (8)	
k_1	$\min\{1; 200 / t_{ti}\}$ [-]	
k_2	$\min\{1; \sigma_{10\%,Ed} / 0,12\}$ [-], where	
	$\sigma_{10\%,Ed}$	Compressive stress of the heat insulation at 10 % deformation [N/mm²]
	t_{ti}	Thickness of the thermal insulation [mm]
l_{ef}	Point side penetration length of the threaded part in the rafter with $l_{ef} \geq 40$ mm [mm]	
α	Angle between grain and screw axis ($\alpha \geq 30°$) [°]	
ρ_k	Characteristic density of the timber element [kg/m³]	

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

Thermal insulation material on rafters with parallel screws perpendicular to the roof plane

Alternatively to the battens, panels with a minimum thickness of 20 mm from plywood according to EN 636, particleboard according to EN 312, oriented strand board OSB/3 and OSB/4 according to EN 300 or European Technical Approval and solid wood panels according to EN 13353 may be used.

Characteristic load-carrying capacity of a screw loaded in shear:

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

Where

$F_{v,RK}$	Characteristic load-carrying capacity of a screw loaded in shear [N]
$M_{y,k}$	Characteristic yield moment of the screw [Nmm]
$F_{ax,Rk}$	The minimum characteristic load-carrying capacity of the axially loaded screws acc. to EN 1995-1-1 [N]
$f_{h,b,k}$	Characteristic embedment strength of the batten [N/mm²]
$f_{h,r,k}$	Characteristic embedment strength of the rafter [N/mm²]
d	Outer thread diameter [mm]
t_b	Batten thickness [mm]
t_r	The lower value of rafter thickness or screw penetration length [mm]
t_{ti}	Thickness of the thermal insulation [mm]
β	Coefficient of the embedment strength of the rafter to the batten [-] with $\beta = \dfrac{f_{h,r,k}}{f_{h,b,k}}$