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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-20/0555 of 2020/07/02

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:	MFI TK and SK self-tapping screws
Product family to which the above construction product belongs:	Screws for use in timber constructions
Manufacturer:	mfi Metall + Fastening Industrie GmbH Hermannstraße 19 D-49767 Twist Deutschland Tel.: +49 59 36 - 90 40 41 Fax: +49 59 36 - 90 40 42 Internet www.mfi-fastening.com
Manufacturing plant:	mfi Metall + Fastening Industrie GmbH
This European Technical Assessment contains:	16 pages including 3 annexes which form an integral part of the document
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of:	European Assessment document (EAD) no. EAD 130118-01-0603 “Screws and threaded rods for use in timber constructions”
This version replaces:	-

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II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product and intended use

Technical description of the product
MFI screws are self-tapping screws to be used in timber structures. MFI screws shall be threaded over a part of the length. The screws shall be produced from carbon steel wire for nominal diameters of 6 mm to 10,0 mm. Where corrosion protection is required, the material or coating shall be declared in accordance with the relevant specification given in Annex A of EN 14592.

Geometry and Material
The nominal diameter (outer thread diameter), d, shall not be less than 6 mm and shall not be greater than 10,0 mm. The overall length, L, of screws shall not be less than 40 mm and shall not be greater than 400 mm. Other dimensions are given in Annex A.

The ratio of inner thread diameter to outer thread diameter d_i/d ranges from 0,62 to 0,68.

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

The lead p (distance between two adjacent thread flanks) ranges from 0,65·d to 0,78·d.

The screws covered by this ETA have a bending angle, α, of at least $(45/d^{0,7} + 20)$ 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.

Furthermore, MFI screws with diameters between 6 mm and 10 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 pre-drilling 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 MFI 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 Screws made of carbon steel	Characteristic value $f_{tens,k}$: Screw d = 6,0 mm: 12 kN Screw d = 8,0 mm: 24 kN Screw d = 10,0 mm: 32 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 Screws made of carbon steel	Characteristic value $f_{tor,k}$: Screw d = 6,0 mm: 12 Nm Screw d = 8,0 mm: 24 Nm Screw d = 10,0 mm: 45 Nm
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
3.7 Sustainable use of natural resources (BWR7)	No Performance assessed
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

*) See additional information in section 3.9 – 3.12.

3.9 Mechanical resistance and stability

The load-carrying capacities for MFI 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 MFI 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 $\alpha < 90°$, the minimum threaded penetration length is: $\ell_{ef} \geq \min(4 \cdot d/\sin\alpha\ ;\ 20 \cdot d)$. 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 MFI screws shall be calculated according to 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 is:

Screw d = 6,0 mm: $M_{y,k}$ = 10 Nm
Screw d = 8,0 mm: $M_{y,k}$ = 25 Nm
Screw d = 10,0 mm: $M_{y,k}$ = 40 Nm

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

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

and accordingly for screws in pre-drilled holes:

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

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:

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

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 MFI screws in solid timber (softwood), glued laminated timber or cross-laminated timber members at an angle of $15° \leq \alpha \leq 90°$ to the grain shall be calculated from:

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

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 $15° \leq \alpha < 45°$
$f_{ax,k}$ Characteristic withdrawal parameter
Screw d = 6,0 mm: $f_{ax,k}$ = 12,0 N/mm²
Screw d = 8,0 mm: $f_{ax,k}$ = 11,0 N/mm²
Screw d = 10,0 mm: $f_{ax,k}$ = 11,0 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
ρ_k characteristic density [kg/m³]

For screws arranged under an angle between screw axis and grain direction $\alpha < 90°$, the minimum threaded penetration length is: $\ell_{ef} \geq \min(4 \cdot d/\sin\alpha;\ 20 \cdot d)$.

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 $45°/d^{0{,}7} + 20°$ is reached without breaking the screws.

Head pull-through capacity
The characteristic head pull-through capacity of MFI screws shall be calculated according to Eurocode 5 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 Eurocode 5
$f_{head,k}$	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 MFI screws in connections with timber and in connections with wood-based panels with thicknesses above 20 mm:
$f_{head,k}$ = 9,4 N/mm²

Characteristic head pull-through parameter for MFI 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·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.

Outer diameter of washers d_h > 2,5 d mm shall not be considered.

The minimum thickness of wood-based panels according to the clause 3.12 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 MFI screws is:

Screw d = 6,0 mm:	12 kN
Screw d = 8,0 mm:	24 kN
Screw d = 10,0 mm:	32 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.

Thermal insulation material on top of rafters
See annex C.

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 MFI screws with nominal diameters of 6 mm to 10,0 mm are produced from carbon wire. Screws made from carbon steel are electrogalvanised or otherwise coated appropriate for the expected working life and service class. 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 MFI GmbH 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.

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

A minimum of two screws should be used for connections in load bearing timber structures.

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 ETA's the terms of the ETA's must be considered.

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

The screws shall be driven into 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 MFI GmbH 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 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 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·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·d also for timber thickness $t < 5 \cdot d$, if the spacing parallel to the grain and the end distance is at least 25·d.

Minimum distances and spacing for screws in non-predrilled holes in members with a maximum characteristic density ρ_k = 420 kg/m³ may be taken as:

Spacing a_1 parallel to the grain, d < 5mm $a_1 = (5+5 |\cos\alpha|)\ d$
Spacing a_1 parallel to the grain, d ≥ 5mm $a_1 = (5+7 |\cos\alpha|)\ d$
Spacing a_2 perpendicular to the grain $a_2 = 5\ d$
Distance $a_{3,t}$ from centre of the screw-part in timber to the end grain $a_{3,c} = (10+5 \cos\alpha)\ d$
Distance $a_{3,c}$ from centre of the screw-part in timber to the end grain $a_{3,c} = 10\ d$
Distance $a_{4,t}$ from centre of the screw-part in timber to the edge, d < 5mm $a_{4,t} = (5+2 \sin\alpha)\ d$
Distance $a_{4,t}$ from centre of the screw-part in timber to the edge, d ≥ 5mm $a_{4,t} = (5+5 \sin\alpha)\ d$
Distance $a_{4,c}$ from centre of the screw-part in timber to the edge $a_{4,c} = 5\ d$

Minimum distances and spacing for screws in non-predrilled holes in members with a maximum characteristic density ρ_k = 500 kg/m³ may be taken as:

Spacing a_1 parallel to the grain $a_1 = (7+8 |\cos\alpha|)\ d$
Spacing a_2 perpendicular to the grain $a_2 = 7\ d$
Distance $a_{3,t}$ from centre of the screw-part in timber to the end grain $a_{3,c} = (15+5 \cos\alpha)\ d$
Distance $a_{3,c}$ from centre of the screw-part in timber to the end grain $a_{3,c} = 15\ d$
Distance $a_{4,t}$ from centre of the screw-part in timber to the edge, d < 5mm $a_{4,t} = (7+2 \sin\alpha)\ d$
Distance $a_{4,t}$ from centre of the screw-part in timber to the edge, d ≥ 5mm $a_{4,t} = (7+5 \sin\alpha)\ d$
Distance $a_{4,c}$ from centre of the screw-part in timber to the edge $a_{4,c} = 7\ d$

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·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·d and a minimum penetration depth perpendicular to the edge surface of 10·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.

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

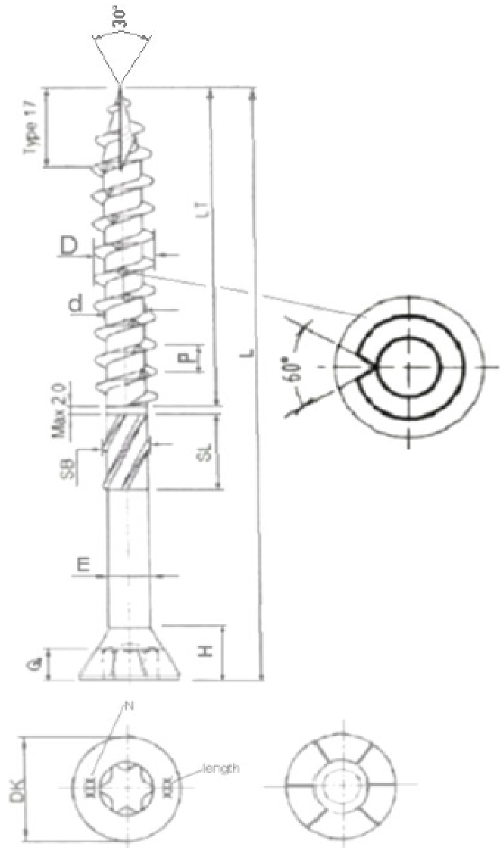
Issued in Copenhagen on 2020-07-02 by

Thomas Bruun
Managing Director, ETA-Danmark

Annex A
Drawings of MFI screws

Size [mm]	DK	H	Q	TORX	E	D	d	P	SL	SB
6.0	11.50-12.00	5.40-5.95	2.30-3.90	T 30	4.10-4.35	5.80-6.10	3.80-4.15	4.30-5.00	9.5-10.5	4.60-5.00
8.0	14.00-15.00	6.75-7.05	3.00-3.50	T 40	5.70-5.90	7.60-8.30	5.10-5.50	5.00-5.80	11.0-13.0	6.20-7.30
10.0	17.30-18.20	8.20-9.10	3.10-4.10	T 40	6.85-7.25	9.70-10.15	6.00-6.50	6.00-7.00	11.0-13.0	7.60-8.20

Bending angle: min.45°



L [mm]	6.0 mm LT ±1.5	8.0 mm LT ±1.5	10.0 mm LT ±1.5
16			
20			
25			
30			
35			
40	24	Full	
45			
50	30	32	
60	35	35	
70	42		
80	50	50	50
90	50	50	
100	60	60	60
120	70	70	70
130	70		
140	70	80	80
150	70		
160	70	80	80
180	70	80	80
200	70	80	80
220	70	80	80
240	70	80	80
260	70	80	80
280	70	80	80
300	70	80	80
320		80	80
340		80	80
360		80	80
380		80	80
400		80	80

LENGTH TOLERANCES	
Screw Diameter	L [mm]
6.0 mm	±2.0
8.0 mm	±2.0
10.0 mm	±2.0

Ind.	Anmerkung	Datum	Name	Maßstab	Name
				Bearb.	Fr.
				Date	

MFI METALL + FASTENING INDUSTRIE

Kernhärte/ core hardness:

Oberflächenhärte/ SURFACE HARDNESS:

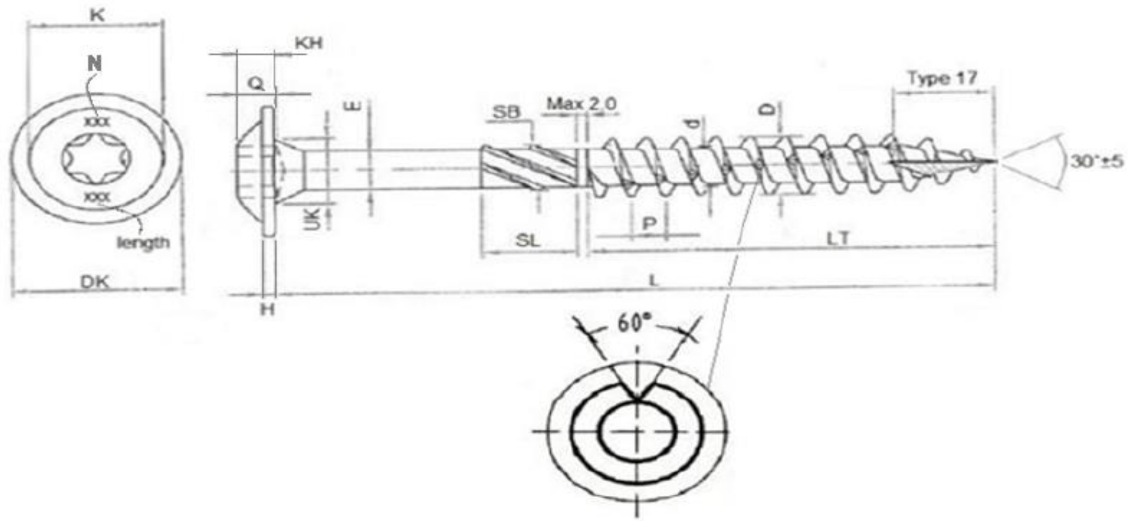
Biegewinkel/ BENDING ANGLE: min. 45°

Bruchdrehmoment/ BREAKING TORQUE:

Surface:
Coating: zinc/ yellow zinc/ others
Material: C10B21

Naming: wood screw (countersunk)

Article No:



Note: 1. Material: C10B21 2. Bending angle: min 45°

Size [mm]	DK	K	H	KH	Q	UK	TORX
6.0	14.50-16.10	10.0-12.0	1.40-1.80	2.70-3.50	2.30-3.90	7.30-8.50	T 30
8.0	20.00-22.00	15.0-17.0	1.65-2.00	3.05-3.90	3.00-4.20	9.00-10.00	T 40
10.0	23.50-26.50	19.0-21.0	1.80-2.20	3.60-4.50	3.10-4.90	11.30-12.50	T 40

Size [mm]	D	d	P	SL	SB	E
6.0	5.80-6.10	3.80-4.15	4.30-5.00	9.50-13.00	4.60-5.00	4.10-4.35
8.0	7.60-8.30	5.10-5.50	5.00-5.80	11.00-13.00	6.20-7.30	5.70-5.90
10.0	9.70-10.15	6.00-6.50	6.00-7.00	11.00-13.00	7.60-8.20	6.85-7.25

L [mm]	6.0 mm	8.0 mm	10.0 mm
±2.0	LT ±1.5	LT ±1.5	LT ±1.5
40	24	FULL	
50	30	32	
60	35	35	
70	42		
80	50	50	50
90	50		
100	60	60	60
110	60		
120	60	60	60
130	70		
140	70	80	80
150	70		
160	70	80	80
180	70	80	80
200	70	80	80
220	70	80	80
240	70	80	80
260	70	80	80
280	70	80	80
300	70	80	80
320		80	80
340		80	80
360		80	80
380		80	80
400		80	80

Rev.	Anmerkung	Datum	Name		Name
				Bearb.	Fr.
				Gepr.	
				Maßstab	

Kernhärte/ core hardness:

Oberflächenhärte/ SURFACE HARDNESS:

Biegewinkel/ BENDING ANGLE:

Bruchdrehmoment/ BREAKING TORQUE:

Surface:
Coating: **zinc/ yellow zinc/ others**
Material: **C10B21**

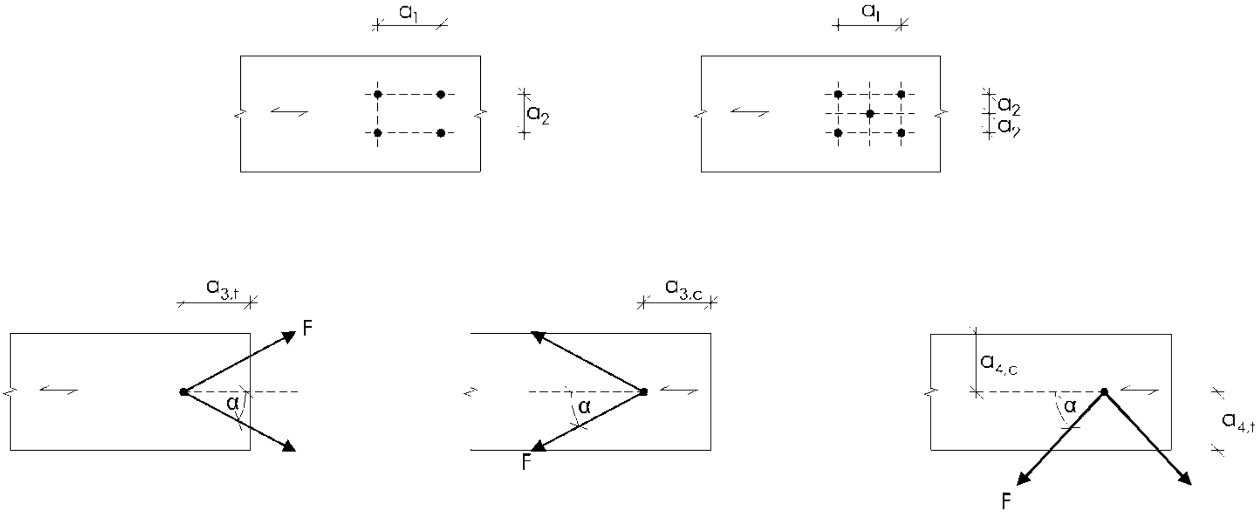
Naming: wood screw (flat head)

Article No:

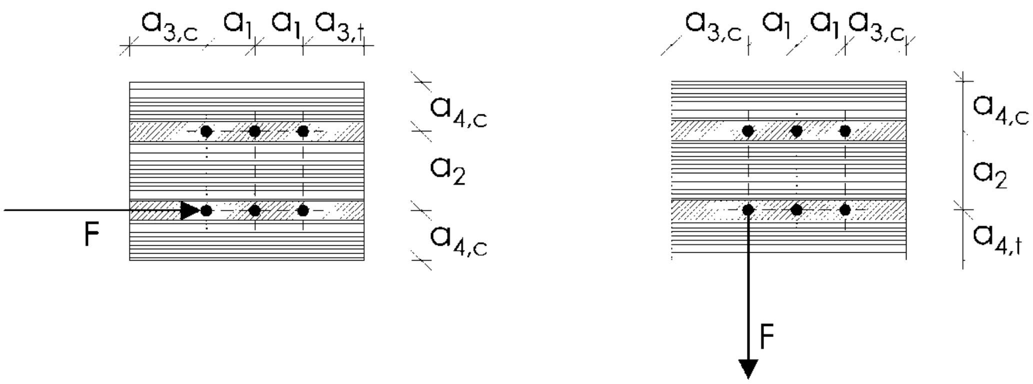
Annex B
Minimum distances and spacing

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

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



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



For screws in the edge surface, a_1 and a_3 are parallel to the CLT plane face, a_2 and a_4 perpendicular to CLT plane face.

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

	a_1	$a_{3,t}$	$a_{3,c}$	a_2	$a_{4,t}$	$a_{4,c}$
Plane surface (see Figure 1)	4 · 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
Thermal insulation material on top of rafters

MFI screws with an outer thread diameter 6 mm $\leq$ d $\leq$ 10 mm may be used for the fixing of thermal insulation material on top of rafters.

The thickness of the insulation shall not exceed 300 mm. The rafter insulation must be placed on top of solid timber or glued laminated timber rafters or cross-laminated timber members and be fixed by battens arranged parallel to the rafters or by wood-based panels on top of the insulation layer. The insulation of vertical facades is also covered by the rules given here.

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

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

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

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

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

The insulation must comply with a European Technical Approval.

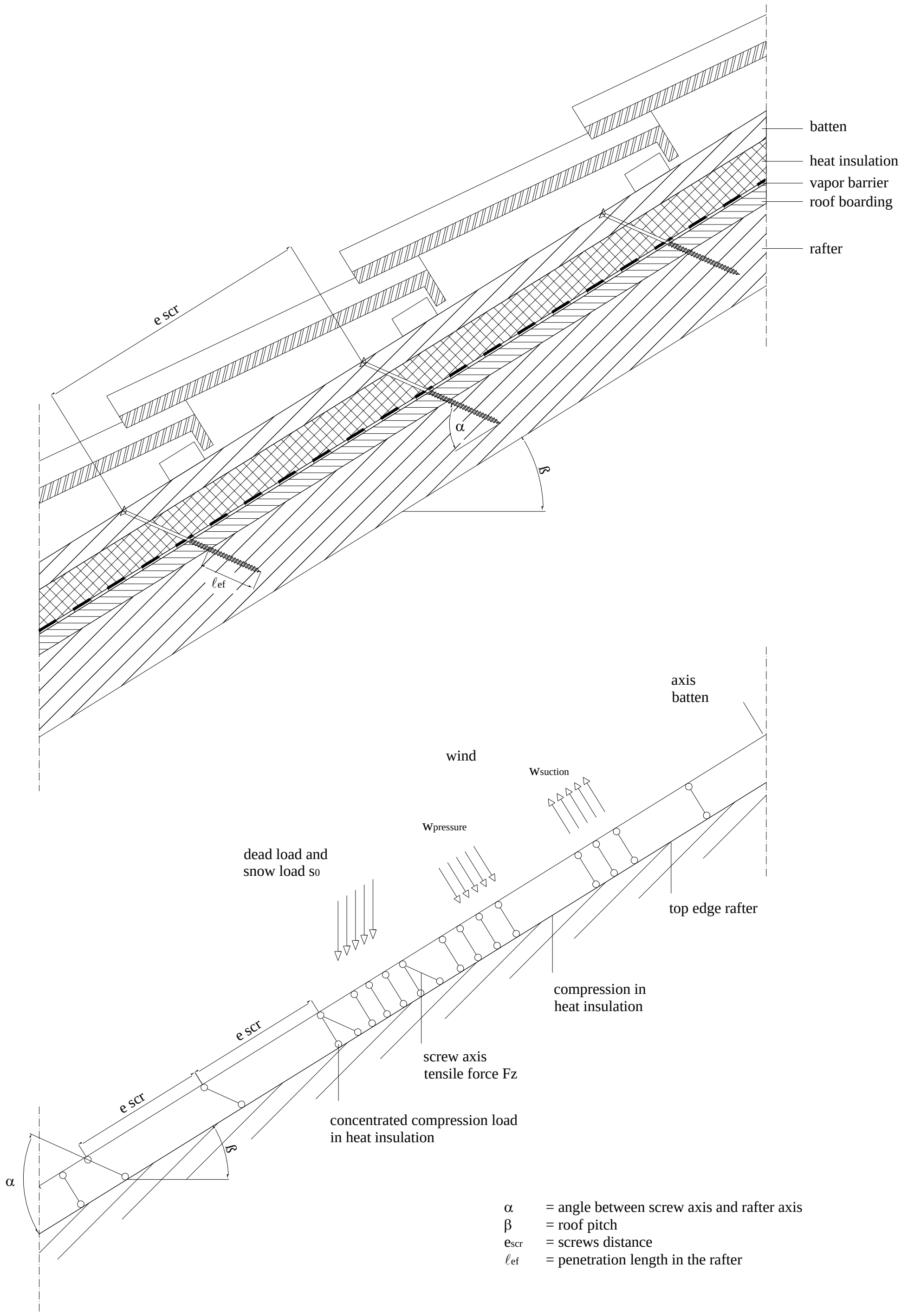
Friction forces shall not be considered for the design of the characteristic axial capacity of the screws.

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 on top of rafter and battens parallel to the rafter may be considered as a beam on elastic foundation. The batten represents the beam, and the heat insulation on top of the rafter the elastic foundation. The minimum compression stress of the heat insulation at 10 % deformation, measured according to EN 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.



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

Design of the battens

The bending stresses are calculated as:

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

Where

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

EI = bending stiffness of the batten
K = coefficient of subgrade
w_{ef} = effective width of the heat insulation
F_b = Point loads perpendicular to the battens
F_s = Point loads perpendicular to the battens, load application in the area of the screw heads

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

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

where
w = minimum width of the batten or rafter, respectively
t_{HI} = thickness of the heat insulation

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

The following condition shall be satisfied:

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

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

The shear stresses shall be calculated according to:

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

The following condition shall be satisfied:

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

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

Design of the heat insulation

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

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

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

Design of the screws

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

$$T_S = \frac{R_S}{\cos \alpha}$$

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

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

$$F_{ax,\alpha,Rd} = \min\left\{k_{ax} \cdot f_{ax,d} \cdot d \cdot \ell_{ef} \cdot k_1 \cdot k_2 \cdot \left(\frac{\rho_k}{350}\right)^{0.8}; f_{head,d} \cdot d_h^2 \cdot \left(\frac{\rho_k}{350}\right)^{0.8}; f_{tens,d}\right\}$$

Where:

$f_{ax,d}$	design value of the axial withdrawal parameter of the threaded part of the screw
d	outer thread diameter of the screw
ℓ_{ef}	Point side penetration length of the threaded part of the screw in the batten, $l_{ef} \geq 40$ mm
α	Angle between grain and screw axis ($\alpha \geq 30°$)
ρ_k	characteristic density of the wood-based member [kg/m³]
$f_{head,d}$	design value of the head pull-through capacity of the screw
d_h	head diameter
$f_{tens,d}$	design tensile capacity of the screw
k_1	min {1; 200/t_{HI}}
k_2	min {1; $\sigma_{10\%}$/0,12}
t_{HI}	thickness of the heat insulation [mm]
$\sigma_{10\%}$	compressive stress of the heat insulation under 10 % deformation [N/mm²]

If k_1 and k_2 are considered, the deflection of the battens does not need to be considered. Alternatively to the battens, panels with a minimum thickness of 22 mm from plywood according to EN 636, particle board according to EN 312, oriented strand board according to EN 300 or European Technical Approval and solid wood panels according to EN 13353 or cross laminated timber may be used.