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Hagen

Design Guide E.u.r.o.Tec self-tapping screws

1 Joints with self-tapping screws

1.1 Joints with screws introduced perpendicularly to grain direction

Joints with self-tapping screws in timber constructions are usually single shear connections. Resulting of the reduced inner diameter of the screws there will often be a failure mode at ultimate limit state with a yielding of the screws (yield moment $M_{y,k}$). For these failure modes, the mechanical models for screws take into account the so-called rope effect, based on the high withdrawal resistance of the screws in tension and augmenting thus the total resistance of the shear connection .

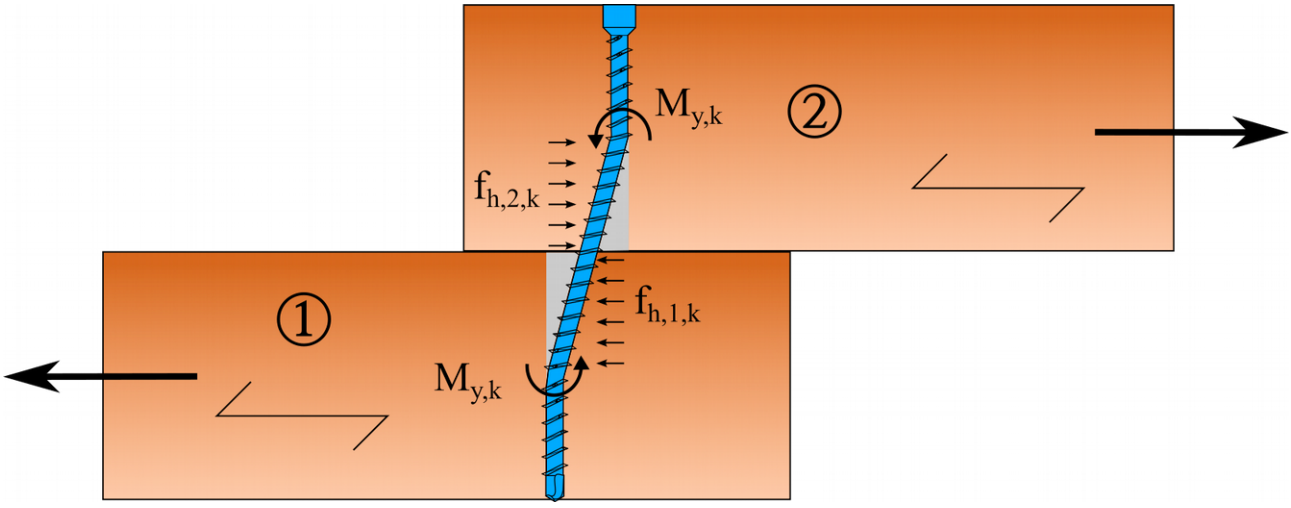


Figure 1: timber-timber shear joint

The mechanical properties for calculation are given in paragraph 3.1 and 3.2.

1.2 Joints with inclined screws

Because of the high withdrawal resistance of self-tapping screws, especially of the fully threaded screws, joints with inclined screws are more effective than joints with laterally loaded screws. The models for this type of joint assume pure tension or compression loading of the screws.

A single configuration as shown in figures 2 and 3 is only possible for loading force F_d not changing the direction, the screws shall only be loaded in tension. The force acting as tension on the screw is assumed to be $F_{ax,t,d}=\frac{F_d}{\cos(\alpha)}$, not taking into account additional friction forces due to the compression between timber members. This friction force would reduce the tension force acting on the screw.

If a group of screws is loaded in tension the effective number of screws is given by $n_{ef}=n^{0,9}$.

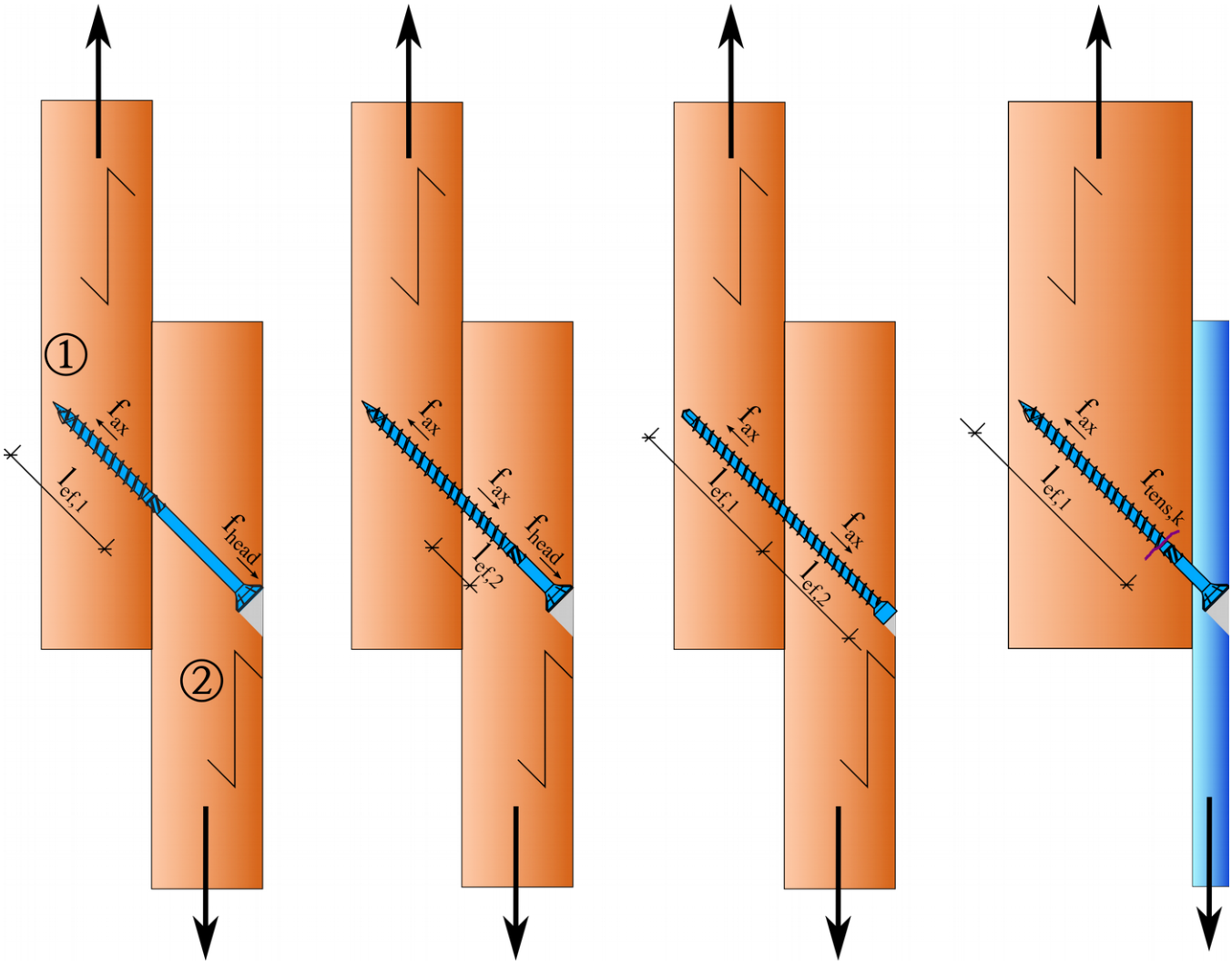


Figure 2: shear joint, screw in tension

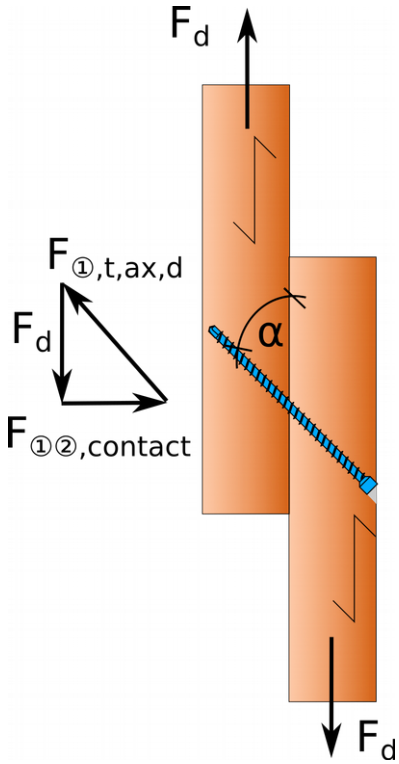


Figure 3:screw load in tension

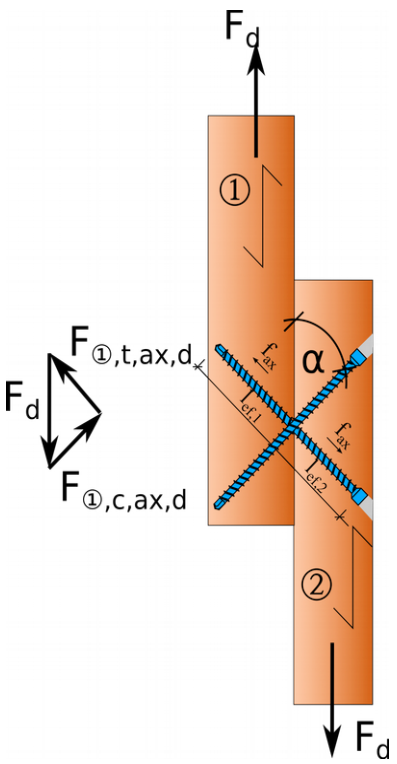


Figure 4: crosswise configuration, screws loaded in compression and tension

For the crosswise arrangement of the screws as shown in Figure 4 the direction of the load might change. One screw is loaded in compression the other in tension. The absolute value of the compression and tension forces acting on each screw are equal to $F_{t,ax,d} = |(F_{c,ax,d})| = \frac{F_d}{2 \cdot \cos(\alpha)}$.

The resistance of the screws is calculated for the fully threaded screws as the minor withdrawal resistance in member ① or ② respectively.

For the partially threaded screw it‘s the minor value of the withdrawal ① or head pull through resistance ②. With side members made of steel, which have to be arranged at the head’s side, the head-pull through resistance doesn’t have to be taken account of.

The mechanical and geometric properties are given in paragraphs 3 and 4.

2 Compression Reinforcement

A very effective usage of fully threaded screws is the reinforcement of bearings or the area of application of concentrated loads. In the contact area, the timber resistance to compression and the axial resistance of the screws to pushing in are added:

$$F_{90,Rd} = k_{c,90} \cdot b_{ef,1} \cdot l_{ef,1} \cdot f_{c,90,d} + n \cdot min\{F_{ax,Rd}; F_{ki,Rd}\}$$

with:

$F_{90,Rd}$: design resistance of reinforced contact area

$k_{c,90}$: factor for compression perpendicular to grain; for bearings of solid-timber $k_{c,90} = 1{,}5$ and with glulam $k_{c,90} = 1{,}75$

$b_{ef,1}$: effective bearing width

$l_{ef,1}$: effective length of contact area

$f_{c,90,d}$: design value of compressive strength perpendicular to grain

$F_{ax,Rd}$: design value of axial withdrawal resistance which is assumed to equal the push in resistance

$F_{ki,Rd}$: design buckling resistance of the screws (modeled as elastically founded column)

In the contact area, a steel plate has to be arranged for the concentrated forces acting on the screws heads'. For the mentioned addition of compression resistance of the timber and the resistance to push in of screws the heads must be placed in plane of the surface (Figure 6).

A second verification is done at the tips of the screws for the resistance of the timber in compression perpendicular to the grain. The area is enlarged compared to the direct contact area:

$$F_{90,Rd,tip} = B \cdot l_{ef,2} \cdot f_{c,90,d}$$

with:

B : bearing width

$l_{ef,2}$: effective distribution length in plane of screw tips

The mechanical and geometric properties are given in paragraphs 3 and 4.

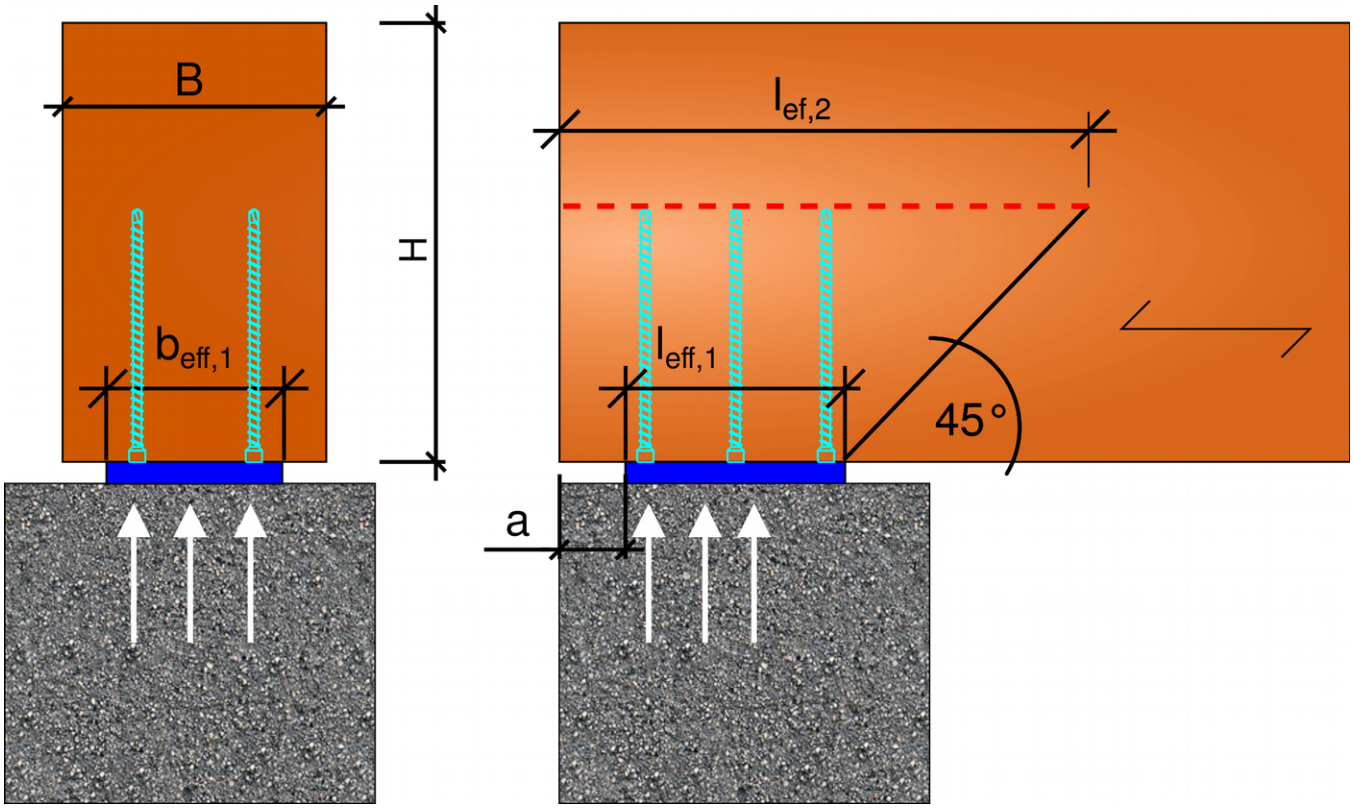


Figure 5: geometric properties of bearing reinforcement

Figure 6: screw heads in plane with timber surface, steel plate in contact area

3 Mechanical properties

3.1 Screws loaded laterally to their axes

Table 1 reports the calculation methods of the embedding strength as given in ETA-11/0024 (European Technical Assessment). The other tables in this chapter show the embedding strength in lbf/inch² for a specific gravity of 0,35 for solid timber, glulam or LVL, with diameters of the screws given in inch. As a higher specific gravity increases the embedding strength these values might be increased by a factor *SG/0,35*.

Table 1: Specification of embedding strength

<table>
<tr><td colspan="2"></td><td>Embedding strength</td></tr>
<tr><td rowspan="3">Driven in without pre-drilling:
Minimum distances and spacings as for nails in holes not predrilled</td><td>Solid timber, glulam and LVL</td><td>$f_{h,k}=\frac{0{,}082\cdot\rho_k\cdot d^{-0.3}}{2{,}5\cdot\cos^2(\alpha)+\sin^2(\alpha)}$</td></tr>
<tr><td>Particleboard or OSB</td><td>$f_{h,k}=65\cdot d^{-0{,}7}\cdot t^{0{,}1} \quad d\leqslant 6\,mm$
$f_{h,k}=50\cdot d^{-0{,}6}\cdot t^{0{,}2} \quad d>6\,mm$</td></tr>
<tr><td>Plywood</td><td>$f_{h,k}=0{,}11\cdot\rho_k\cdot d^{-0.3}$</td></tr>
<tr><td rowspan="3">Driven in with pre-drilling:
Minimum distances and spacings as for nails in predrilled holes</td><td>Solid timber, glulam and LVL</td><td>$f_{h,k}=\frac{0{,}082\cdot\rho_k\cdot(1-0{,}01\cdot d)}{2{,}5\cdot\cos^2(\alpha)+\sin^2(\alpha)}$</td></tr>
<tr><td>Cement bonded particleboard</td><td>$f_{h,k}=(75+1{,}9\cdot d)\cdot d^{-0.5}+d/10$</td></tr>
<tr><td>Plywood</td><td>$f_{h,k}=0{,}11\cdot(1-0.01\cdot d)\cdot\rho_k$</td></tr>
<tr><td colspan="3">ρ_k : characteristic density $[kg/m^3]$; d outer thread diameter [mm]; α angle between screw axis and grain direction</td></tr>
<tr><td colspan="3">Maximum diameter ∅ for pre-drilling:
• unthreaded axis part: diameter of smooth shank d_s
• threaded axis part: inner thread diameter $d_i \rightarrow d_i<d_s$</td></tr>
<tr><td colspan="3">For screws driven perpendicularly in the surface $\rightarrow \alpha=90° \rightarrow 2{,}5\cdot\cos^2(\alpha)+\sin^2(\alpha)=1$.</td></tr>
</table>

KonstruX fully threaded screw

Angle between screw axis and grain direction $\alpha = 90°$; *SG=0,35;* $\rho_k = 350\,kg/m^3$

⌀ d	⌀ d_i	⌀ d_s	$M_{y,k}$	$f_{h,k}$ **without pre-drilling**	$f_{h,k}$ **with pre-drilling**
1/4 in 6,5 mm	3/16 in 4,5 mm	fully threaded, no smooth shank	11 1/16 lbf ft 15 Nm	2378 lbf/in² 16,4 N/mm²	3887 lbf/in² 26,8 N/mm²
5/16 in 8 mm	7/32 in 5,2 mm		18 7/16 lbf ft 25 Nm	2233 lbf/in² 15,4 N/mm²	3829 lbf/in² 26,4 N/mm²
3/8 in 10 mm	1/4 in 6,0 mm		29 1/2 lbf ft 40 Nm	2088 lbf/in² 14,4 N/mm²	3742 lbf/in² 25,8 N/mm²
7/16 in 11,3 mm	5/16 in 8,0 mm		51 5/8 lbf ft 70 Nm	2016 lbf/in² 13,9 N/mm²	3698 lbf/in² 25,5 N/mm²

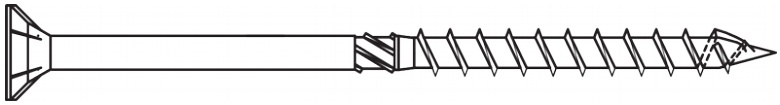
Paneltwistec partially threaded screw

Angle between screw axis and grain direction $\alpha = 90°$; SG=0,35; $\rho_k = 350\,kg/m^3$

⌀ d	⌀ d_i	⌀ d_s	$M_{y,k}$ Carbon steel or stainless steel hardened 1.4006	$M_{y,k}$ Stainless steel unhardened 1.4301; 1.4401; 1.4567 → A2; A4	$f_{h,k}$ **without pre-drilling**	$f_{h,k}$ **with pre-drilling**
1/8 in 3,0* mm	5/64 in 1,9 mm	5/64 in 2,1 mm	1 1/8 lbf ft 1,57 Nm	5/8 lbf ft 0,84 Nm	2988 lbf/in² 20,6 N/mm²	4032 lbf/in² 27,8 N/mm²
1/8 in 3,2mm*A4 ornamental head	5/64 in 2,1 mm	3/32 in 2,5 mm	-	3/4 lbf ft 0,99 Nm	2930 lbf/in² 20,2 N/mm²	4032 lbf/in² 27,8 N/mm²
9/64 in 3,5 mm	5/64 in 2,1 mm	3/32 in 2,3 mm	1 11/16 lbf ft 2,34 Nm	7/8 lbf ft 1,25 Nm	2857 lbf/in² 19,7 N/mm²	4018 lbf/in² 27,7 N/mm²
5/32 in 4,0 mm	3/32 in 2,5 mm	7/64 in 2,7 mm	2 7/16 lbf ft 3,31 Nm	1 1/4 lbf ft 1,76 Nm	2741 lbf/in² 18,9 N/mm²	4003 lbf/in² 27,6 N/mm²
3/16 in 4,5 mm	7/64 in 2,7 mm	1/8 in 3 mm	3 1/4 lbf ft 4,49 Nm	1 3/4 lbf ft 2,40 Nm	2654 lbf/in² 18,3 N/mm²	3974 lbf/in² 27,4 N/mm²
3/16 in 5,0 mm	1/8 in 3,3 mm	9/64 in 3,7 mm	4 5/16 lbf ft 5,91 Nm	2 5/16 lbf ft 3,15 Nm	2567 lbf/in² 17,7 N/mm²	3960 lbf/in² 27,3 N/mm²
1/4 in 6,0 mm	5/32 in 4 mm	11/64 in 4,4 mm	6 15/16 lbf ft 9,49 Nm	3 11/16 lbf ft 5,06 Nm	2437 lbf/in² 16,8 N/mm²	3916 lbf/in² 27,0 N/mm²
5/16 in 8,0 mm	13/64 in 5,3 mm	15/64 in 5,8 mm	14 3/4 lbf ft 20,06 Nm	7 7/8 lbf ft 10,70 Nm	2234 lbf/in² 15,4 N/mm²	3829 lbf/in² 26,4 N/mm²
3/8 in 10,0 mm	1/4 in 6,3 mm	9/32 in 7,1 mm	26 1/4 lbf ft 35,83 Nm	-	2089 lbf/in² 14,4 N/mm²	3742 lbf/in² 25,8 N/mm²
1/2 in 12,0 mm	9/32 in 7,3 mm	5/16 in 8,1 mm	42 3/8 lbf ft 57,56 Nm	-	1937 lbf/in² 13,6 N/mm²	3669 lbf/in² 25,3 N/mm²

* not specified in ETA-11/0024

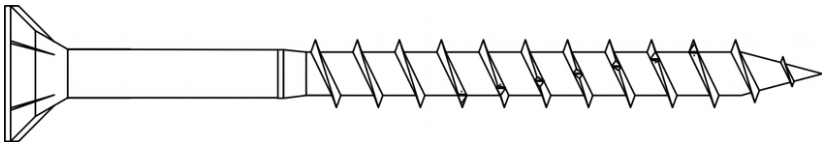
EcoPT partially threaded screw



Angle between screw axis and grain direction $\alpha = 90°$; SG=0,35; $\rho_k = 350\,kg/m^3$

⌀ d	⌀ d_i	⌀ d_s	$M_{y,k}$ Carbon steel or stainless steel hardened 1.4006	$f_{h,k}$ **without pre-drilling**	$f_{h,k}$ **with pre-drilling**
5/16 in 8,0 mm	13/64 in 5,3 mm	15/64 in 5,8 mm	14 ¾ lbf ft 20,06 Nm	2234 lbf/in² 15,4 N/mm²	3829 lbf/in² 26,4 N/mm²

EcoTec partially or fully threaded screw

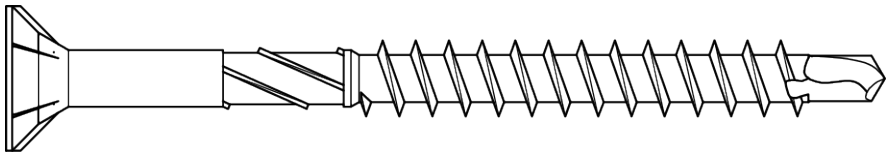


Angle between screw axis and grain direction $\alpha = 90°$; SG=0,35; $\rho_k = 350\,kg/m^3$

⌀ d	⌀ d_i	⌀ d_s	$M_{y,k}$ Carbon steel	$M_{y,k}$ A2 1.4301	$f_{h,k}$ **without pre-drilling**	$f_{h,k}$ **with pre-drilling**
1/8 in 3,0*mm	5/64 in 1,9 mm	5/64 in 2,1 mm	1 1/8 lbf ft 1,57 Nm	5/8 lbf ft 0,84 Nm	2988 lbf/in² 20,6 N/mm²	4032 lbf/in² 27,8 N/mm²
9/64 in 3,5 mm	5/64 in 2,1 mm	7/64 in 2,8 mm	1 11/16 lbf ft 2,34 Nm	15/16 lbf ft 1,25 Nm	2857 lbf/in² 19,7 N/mm²	4018 lbf/in² 27,7 N/mm²
5/32 in 4,0 mm	3/32 in 2,5 mm	7/64 in 2,7 mm	2 7/16 lbf ft 3,31 Nm	1 1/4 lbf ft 1,76 Nm	2741 lbf/in² 18,9 N/mm²	4003 lbf/in² 27,6 N/mm²
3/16 in 4,5 mm	7/64 in 2,7 mm	1/8 in 3 mm	3 1/4 lbf ft 4,49 Nm	1 3/4 lbf ft 2,40 Nm	2654 lbf/in² 18,3 N/mm²	3974 lbf/in² 27,4 N/mm²
13/64 in 5,0 mm	1/8 in 3,2 mm	9/64 in 3,7 mm	4 5/16 lbf ft 5,91 Nm	2 5/16 lbf ft 3,15 Nm	2567 lbf/in² 17,7 N/mm²	3960 lbf/in² 27,3 N/mm²
1/4 in 6,0 mm	9/64 in 3,7 mm	5/32 in 4 mm	4 3/8 lbf ft 6,00 Nm	3 11/16 lbf ft 5,06 Nm	2437 lbf/in² 16,8 N/mm²	3916 lbf/in² 27,0 N/mm²

* not specified in ETA-11/0024

Hobotec partially threaded screw



Angle between screw axis and grain direction $\alpha = 90°$; SG=0,35; $\rho_k = 350\,kg/m^3$

⌀ d	⌀ d_i	⌀ d_s	$M_{y,k}$ Carbon steel or stainless steel hardened 1.4006	$M_{y,k}$ Stainless steel unhardened 1.4401; 1.4567 → A2; A4	$f_{h,k}$ **without pre-drilling**	$f_{h,k}$ **with pre-drilling**
1/8 in 3,2*mm	5/94 in 2,1 mm	3/32 in 2,4 mm	1 11/32 lbf ft 1,85 Nm	3/4 lbf ft 0,99 Nm	2930 lbf/in² 20,2 N/mm²	4032 lbf/in² 27,8 N/mm²
5/32 in 4,0 mm	3/32 in 2,5 mm	7/64 in 2,8 mm	2 7/16 lbf ft 3,31 Nm	1 1/4 lbf ft 1,76 Nm	2741 lbf/in² 18,9 N/mm²	4003 lbf/in² 27,6 N/mm²
11/64 in 4,2* mm	7/64 in 2,7 mm	1/8 in 3,1 mm	2 3/4 lbf ft 3,76 Nm	1 7/16 lbf ft 2,00 Nm	2712 lbf/in² 18,7 N/mm²	3989 lbf/in² 27,5 N/mm²
11/64 in 4,5 mm	7/64 in 2,7 mm	1/8 in 3,0 mm	3 9/32 lbf ft 4,49 Nm	1 3/4 lbf ft 2,40 Nm	2654 lbf/in² 18,3 N/mm²	3974 lbf/in² 27,4 N/mm²
13/64 in 5,0 mm	1/8 in 3,2 mm	9/64 in 3,7 mm	4 5/16 lbf ft 5,91 Nm	2 5/16 lbf ft 3,15 Nm	2567 lbf/in² 17,7 N/mm²	3960 lbf/in² 27,3 N/mm²
15/64 in 6,0 mm	9/64 in 3,7 mm	5/32 in 4,0 mm	6 15/16 lbf ft 9,49 Nm	3 11/16 lbf ft 5,06 Nm	2437 lbf/in² 16,8 N/mm²	3916 lbf/in² 27,0 N/mm²

* not specified in ETA-11/0024

3.2 Screws loaded axially

The load bearing capacity of screws loaded exclusively axially as shown in figures 2, 3 and 4 is limited by the following failure modes:

1. side member ① of the screw's tip: withdrawal of the screw in side member where the tip of the screw is placed: $F_{ax,\alpha,Rk} = n_{ef} \cdot k_{ax} \cdot f_{ax,k,①} \cdot d \cdot l_{ef} \cdot \left(\frac{\rho_{k,①}}{350}\right)^{0.8}$
2. side member ② of the screw's head: the maximum value of:

   2.a) head pull-through resistance $F_{ax,head,\alpha,Rk} = n_{ef} \cdot f_{head,k} \cdot d_h^2 \cdot \left(\frac{\rho_{k,②}}{350}\right)^{0.8}$

   2.b) withdrawal resistance if a threaded part of the screw is present in this side member

   $$F_{ax,\alpha,Rk} = n_{ef} \cdot k_{ax} \cdot f_{ax,k,②} \cdot d \cdot l_{ef} \cdot \left(\frac{\rho_{k,②}}{350}\right)^{0.8}$$

   for KonstruX fully threaded screws only the verification 2.b) has to be applied

As in chapter 3.1 the values in equations 1 and 2 are to be used with metric units:

ρ_k : characteristic density $[kg/m^3]$; d outer thread diameter [mm];

l_{ef} effective length of threaded part [mm]; α angle between screw axis and grain direction;

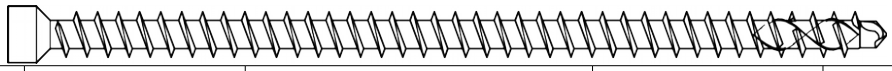
parameter for the influence of the angle $k_{ax} = \begin{cases} 1{,}0 \; für \; 45° \leqslant \alpha \leqslant 90° \\ 0{,}3 + \frac{0{,}7 \cdot \alpha}{45°} \; für \; 0° \leqslant \alpha \leqslant 45° \end{cases}$;

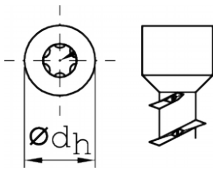
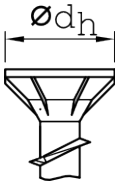
effective number of a screws group $n_{ef} = n^{0.9}$.

A higher specific gravity increases the axial withdrawal resistance, the corresponding factor might be applied $\left(\frac{SG}{0.35}\right)^{0.8} = \left(\frac{\rho_k}{350}\right)^{0.8}$.

For screws in usual designed shear connections neither buckling of the screws nor the tensile strength of the screw has to be verified. For longer KonstruX screws used as compression reinforcement the buckling must be verified (chapter 3.3). Tensile reinforcement in glulam beams is not covered by this Design Guide, for these types of reinforcement with longer KonstruX fully threaded screws the tensile strength has to be verified.

KonstruX fully threaded screw



⌀ d	Head type	$f_{head,k}$	Tip type	$f_{ax,k}$
1/4 in 6,5 mm	cylindrical 	For KonstruX fully threaded screws the dominating resistance is always the withdrawal resistance even in side member with head	rBS DAG 	1653 lbf/in² 11,4 N/mm²
5/16 in 8 mm				1610 lbf/in² 11,1 N/mm²
3/8 in 10 mm				1566 lbf/in² 10,8 N/mm²
7/16 in 11,3 mm	countersunk 		AG 	1566 lbf/in² 10,8 N/mm²

For long screws in tensile or compression reinforcement the tensile strength has to be verified $F_{t,Rk} = f_{tens,k,ETA}$

carbon steel: ⌀6,5: $F_{t,Rk} = 3822\,lbf$, $F_{t,Rk} = 17\,kN$; ⌀8,0: $F_{t,Rk} = 5620\,lbf$, $F_{t,Rk} = 25\,kN$;

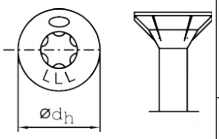
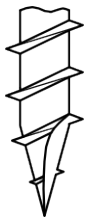
⌀10: $F_{t,Rk} = 7419\,lbf$, $F_{t,Rk} = 33\,kN$; ⌀11,3: $F_{t,Rk} = 11240\,lbf$, $F_{t,Rk} = 50\,kN$

KonstruX fully threaded screw

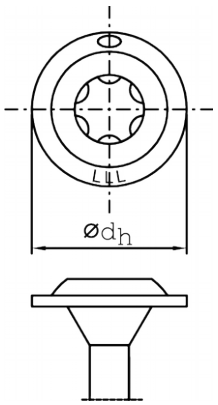
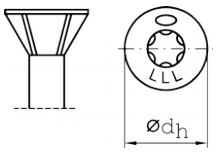
Angle between screw axis and grain direction $45° \le \alpha \le 90°$; *SG=0,35;* $\rho_k = 350\,kg/m^3$

⌀ d	Total length	$F_{ax,k,inch,45°-90°} = f_{ax,k} \cdot d \cdot inch$	$F_{tens,k}$
1/4 in 6,5 mm	4 ¾; 5 ½; 6 ¼; 7 11/16 120; 140; 160; 195 mm	423 lbf	3822 lbf 17 kN
5/16 in 8 mm	3 ¾; 4 15/16; 6 1/8; 7 11/16; 8 5/8; 9 5/8; 11 5/8; 13; 14 ¾; 15 ¾; 16 15/16; 18 7/8 inch 95; 125; 155; 195; 220; 245; 295; 330; 375; 400; 430; 480 mm	508 lbf	5620 lbf 25 kN
3/8 in 10 mm	11 ¾; 13; 14 3/16; 15 ¾; 17 ¾; 19 ¾; 21 5/8; 24 5/8 inch 300; 330; 360; 400; 450; 500; 550; 600 mm	617 lbf	7419 lbf 33 kN
7/16 in 11,3 mm	11 ¾; 13 3/8; 15; 16 ½; 18 1/8; 21 ¼; 22 7/8; 24 3/8; 26; 27 ½; 29 ½; 31 ½; 35 ½; 39 3/8 inch 300; 340; 380; 420; 460; 500; 540; 580; 620; 660; 700; 750; 800; 900; 1000 mm	697 lbf	11240 lbf 50 kN

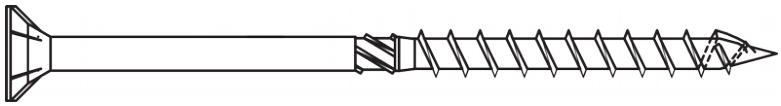
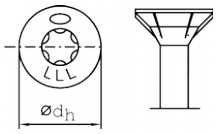
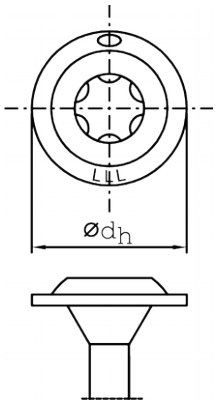
Paneltwistec partially threaded screw

⌀ d	Head type	d_h; $f_{head,k}$	Tip type	$f_{ax,k}$
Timber or wood based panels $t > 25/32\,in$ $f_{head,k} = 1740\,lbf/in^2$ wood based panels $15/32 \leqslant t \leqslant 25/32\,in$ $f_{head,k} = 1160\,lbf/in^2$ wood based panels $t < 15/32\,in$ $f_{head,k} = 1160\,lbf/in^2$ and $F_{ax,Rk} \leqslant 89\,½\,lbf$ and $t \geqslant 1{,}2 \cdot d$				
1/8 in 3,0* mm	countersunk  	$d_h = 7/32\,in$ $d_h = 5{,}6\,mm$	AG  17 	$f_{ax,k} = 1929\,lbf/in^2$ $f_{ax,k} = 13{,}3\,N/mm^2$
9/64 in 3,5 mm		$d_h = 9/32\,in$ $d_h = 7{,}0\,mm$		$f_{ax,k} = 1929\,lbf/in^2$ $f_{ax,k} = 13{,}3\,N/mm^2$
5/32 in 4,0 mm		$d_h = 5/16\,in$ $d_h = 8{,}0\,mm$		$f_{ax,k} = 1871\,lbf/in^2$ $f_{ax,k} = 12{,}9\,N/mm^2$
3/16 in 4,5 mm		$d_h = 3/8\,in$ $d_h = 9{,}0\,mm$		$f_{ax,k} = 1813\,lbf/in^2$ $f_{ax,k} = 12{,}5\,N/mm^2$
3/16 in 5,0 mm		$d_h = 3/8\,in$ $d_h = 10{,}0\,mm$		$f_{ax,k} = 1755\,lbf/in^2$ $f_{ax,k} = 12{,}1\,N/mm^2$
1/4 in 6,0 mm		$d_h = 1/2\,in$ $d_h = 12{,}0\,mm$		$f_{ax,k} = 1653\,lbf/in^2$ $f_{ax,k} = 11{,}4\,N/mm^2$
5/16 in 8,0 mm		$d_h = 9/16\,in$ $d_h = 14{,}5\,mm$		$f_{ax,k} = 1610\,lbf/in^2$ $f_{ax,k} = 11{,}1\,N/mm^2$
3/8 in 10,0 mm		$d_h = 11/16\,in$ $d_h = 18{,}0\,mm$		$f_{ax,k} = 1566\,lbf/in^2$ $f_{ax,k} = 10{,}8\,N/mm^2$
1/2 in 12,0 mm		$d_h = 13/16\,in$ $d_h = 20{,}0\,mm$		$f_{ax,k} = 1566\,lbf/in^2$ $f_{ax,k} = 10{,}8\,N/mm^2$

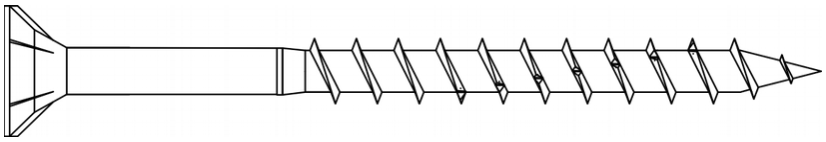
Paneltwistec partially threaded screw

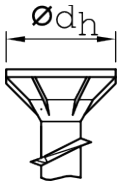
⌀ d	Head type	d_h; $f_{head,k}$	Tip type	$f_{ax,k}$
Timber or wood based panels $t > 25/32\,in$ $f_{head,k} = 1740\,lbf/in^2$ wood based panels $15/32 \leqslant t \leqslant 25/32\,in$ $f_{head,k} = 1160\,lbf/in^2$ wood based panels $t < 15/32\,in$ $f_{head,k} = 1160\,lbf/in^2$ and $F_{ax,Rk} \leqslant 89\,½\,lbf$ and $t \geqslant 1{,}2 \cdot d$				
9/64 in 3,5 mm	panhead 	$d_h = 3/8\ in$ $d_h = 10{,}0\,mm$	AG  17 	$f_{ax,k} = 1871\,lbf/in^2$ $f_{ax,k} = 12{,}9\,N/mm^2$
5/32 in 4,0 mm		$d_h = 7/16\ in$ $d_h = 11{,}0\,mm$		$f_{ax,k} = 1813\,lbf/in^2$ $f_{ax,k} = 12{,}5\,N/mm^2$
3/16 in 4,5 mm		$d_h = 1/2\ in$ $d_h = 12{,}0\,mm$		$f_{ax,k} = 1755\,lbf/in^2$ $f_{ax,k} = 12{,}1\,N/mm^2$
3/16 in 5,0 mm		$d_h = 9/16\ in$ $d_h = 14{,}0\,mm$		$f_{ax,k} = 1653\,lbf/in^2$ $f_{ax,k} = 11{,}4\,N/mm^2$
1/4 in 6,0 mm		$d_h = 14/16\ in$ $d_h = 22{,}0\,mm$		$f_{ax,k} = 1610\,lbf/in^2$ $f_{ax,k} = 11{,}1\,N/mm^2$
5/16 in 8,0 mm		$d_h = 1\ in$ $d_h = 25{,}0\,mm$		$f_{ax,k} = 1566\,lbf/in^2$ $f_{ax,k} = 10{,}8\,N/mm^2$
Paneltwistec A4 ornamental head				
1/8 in 3,2mm* A4 ornamental head	ornamental head 	$d_h = 13/64\ in$ $d_h = 5{,}1\,mm$		$f_{ax,k} = 1929\,lbf/in^2$ $f_{ax,k} = 13{,}3\,N/mm^2$

* not specified in ETA-11/0024

EcoPT partially threaded screw			
			
⌀ d	Head type	d_h; $f_{head,k}$	Tip type
Timber or wood based panels $t > 25/32\,in$ $f_{head,k} = 1740\,lbf/in^2$ wood based panels $15/32 \leqslant t \leqslant 25/32\,in$ $f_{head,k} = 1160\,lbf/in^2$ wood based panels $t < 15/32\,in$ $f_{head,k} = 1160\,lbf/in^2$ and $F_{ax,Rk} \leqslant 89\,½\,lbf$ and $t \geqslant 1{,}2 \cdot d$			
5/16 in 8,0 mm		$d_h = 9/16\ in$ $d_h = 14{,}5\,mm$	$f_{ax,k} = 1610\,lbf/in^2$ $f_{ax,k} = 11{,}1\,N/mm^2$
5/16 in 8,0 mm		$d_h = 14/16\ in$ $d_h = 22{,}0\,mm$	$f_{ax,k} = 1610\,lbf/in^2$ $f_{ax,k} = 11{,}1\,N/mm^2$

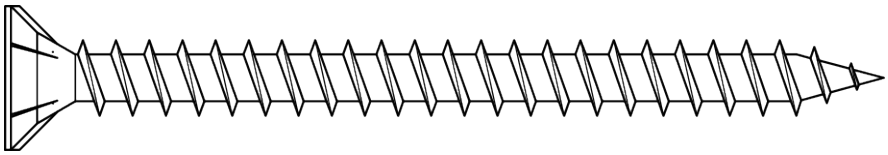
EcoTec partially threaded screw

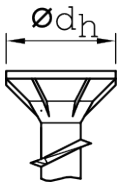


⌀ d	Head type	d_h	$f_{head,k}$	$f_{ax,k}$
1/8 in 3,0* mm	counter- sunk 	$d_h = 1/4\ in$ $d_h = 6{,}0\ mm$	Timber or wood based panels $t > 25/32\ in \quad f_{head,k} = 1740\ lbf/in^2$	$f_{ax,k} = 1929\ lbf/in^2$ $f_{ax,k} = 13{,}3\ N/mm^2$
9/64 in 3,5 mm		$d_h = 9/32\ in$ $d_h = 7{,}0\ mm$	wood based panels $15/32 \leqslant t \leqslant 25/32\ in$ $f_{head,k} = 1160\ lbf/in^2$	$f_{ax,k} = 1929\ lbf/in^2$ $f_{ax,k} = 13{,}3\ N/mm^2$
5/32 in 4,0 mm		$d_h = 5/16\ in$ $d_h = 8{,}0\ mm$	wood based panels $t < 15/32\ in$ $f_{head,k} = 1160\ lbf/in^2$ and $F_{ax,Rk} \leqslant 89\,½\ lbf$ and $t \geqslant 1{,}2 \cdot d$	$f_{ax,k} = 1871\ lbf/in^2$ $f_{ax,k} = 12{,}9\ N/mm^2$
3/16 in 4,5 mm		$d_h = 3/8\ in$ $d_h = 9{,}0\ mm$		$f_{ax,k} = 1813\ lbf/in^2$ $f_{ax,k} = 12{,}5\ N/mm^2$
3/16 in 5,0 mm		$d_h = 3/8\ in$ $d_h = 10{,}0\ mm$		$f_{ax,k} = 1755\ lbf/in^2$ $f_{ax,k} = 12{,}1\ N/mm^2$
1/4 in 6,0 mm		$d_h = 1/2\ in$ $d_h = 12{,}0\ mm$		$f_{ax,k} = 1653\ lbf/in^2$ $f_{ax,k} = 11{,}4\ N/mm^2$

* not specified in ETA-11/00

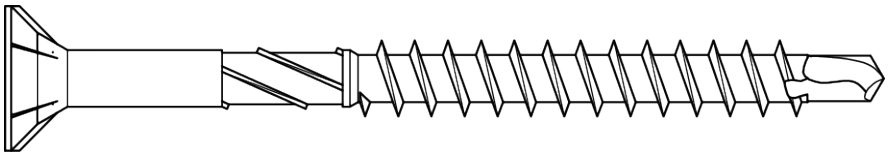
EcoTec partially threaded screw

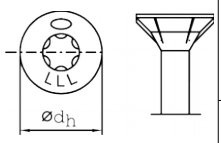
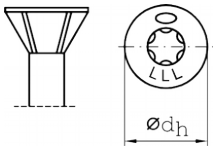


⌀ d	Head type	d_h	$f_{head,k}$	$f_{ax,k}$
1/8 in 3,0* mm	Senkkopf 		For fully threaded screws the dominating resistance is always the withdrawal resistance even in side member with head	$f_{ax,k}=1929\ lbf/in^2$ $f_{ax,k}=13{,}3\ N/mm^2$
9/64 in 3,5 mm		$d_h=9/32\ in$ $d_h=7{,}0\ mm$		$f_{ax,k}=1929\ lbf/in^2$ $f_{ax,k}=13{,}3\ N/mm^2$
5/32 in 4,0 mm		$d_h=5/16\ in$ $d_h=8{,}0\ mm$		$f_{ax,k}=1871\ lbf/in^2$ $f_{ax,k}=12{,}9\ N/mm^2$
3/16 in 4,5 mm		$d_h=3/8\ in$ $d_h=9{,}0\ mm$		$f_{ax,k}=1813\ lbf/in^2$ $f_{ax,k}=12{,}5\ N/mm^2$
3/16 in 5,0 mm		$d_h=3/8\ in$ $d_h=10{,}0\ mm$		$f_{ax,k}=1755\ lbf/in^2$ $f_{ax,k}=12{,}1\ N/mm^2$
1/4 in 6,0 mm		$d_h=1/2\ in$ $d_h=12{,}0\ mm$		$f_{ax,k}=1653\ lbf/in^2$ $f_{ax,k}=11{,}4\ N/mm^2$

* not specified in ETA-11/0024

Hobotec partially threaded screw



⌀ d	Head type	d_h; $f_{head,k}$	Tip type	⌀ d
Timber or wood based panels $t > 25/32\,in$ $f_{head,k} = 1740\,lbf/in^2$ wood based panels $15/32 \leqslant t \leqslant 25/32\,in$ $f_{head,k} = 1160\,lbf/in^2$ wood based panels $t < 15/32\,in$ $f_{head,k} = 1160\,lbf/in^2$ and $F_{ax,Rk} \leqslant 89\,½\,lbf$ and $t \geqslant 1{,}2 \cdot d$				
5/32 in 4,0 mm	countersunk 	$d_h = 9/32\,in$ $d_h = 7{,}0\,mm$	BS 	$f_{ax,k} = 1305\,lbf/in^2$ $f_{ax,k} = 9{,}0\,N/mm^2$
3/16 in 4,5 mm		$d_h = 3/8\,in$ $d_h = 9{,}0\,mm$		$f_{ax,k} = 1305\,lbf/in^2$ $f_{ax,k} = 9{,}0\,N/mm^2$
3/16 in 5,0 mm		$d_h = 3/8\,in$ $d_h = 10{,}0\,mm$		$f_{ax,k} = 1305\,lbf/in^2$ $f_{ax,k} = 9{,}0\,N/mm^2$
1/4 in 6,0 mm		$d_h = 1/2\,in$ $d_h = 12{,}0\,mm$		$f_{ax,k} = 1305\,lbf/in^2$ $f_{ax,k} = 9{,}0\,N/mm^2$
Ornamental head				
1/8 in 3,2mm*	Ornamental head	$d_h = 7/32\,in$ $d_h = 5{,}2\,mm$	BS 	$f_{ax,k} = 1305\,lbf/in^2$ $f_{ax,k} = 9{,}0\,N/mm^2$
5/32 in 4,0 mm		$d_h = 1/4\,in$ $d_h = 6{,}0\,mm$		$f_{ax,k} = 1305\,lbf/in^2$ $f_{ax,k} = 9{,}0\,N/mm^2$
4,2*		$d_h = 1/4\,in$ $d_h = 5{,}9\,mm$		$f_{ax,k} = 1305\,lbf/in^2$ $f_{ax,k} = 9{,}0\,N/mm^2$
3/16 in 4,5 mm		$d_h = 9/32\,in$ $d_h = 7{,}0\,mm$		$f_{ax,k} = 1305\,lbf/in^2$ $f_{ax,k} = 9{,}0\,N/mm^2$
3/16 in 5,0 mm		$d_h = 5/16\,in$ $d_h = 8{,}0\,mm$		$f_{ax,k} = 1305\,lbf/in^2$ $f_{ax,k} = 9{,}0\,N/mm^2$

* not specified in ETA-11/0024

3.3 Buckling of KonstruX fully threaded screws

The resistance against pushing in of screws is assumed to be equal to the pull-out resistance therefore the rules of chapter 3.2 are applied for a first verification:

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

For longer screws in compression a buckling failure might take place. The buckling of KonstruX fully threaded screws is verified according to ETA-11/0024:

$$F_{ki,Rk} = \kappa_c \cdot N_{pl,k}$$

with yield strength $N_{pl,k} = \frac{\pi \cdot d_1^2}{4} \cdot f_{y,k}$.

yield strength KonstruX

KonstruX	$d = 1/4\ in$	$d = 5/16\ in$	$d = 3/8\ in$	$d = 7/16\ in$
	$d = 6{,}5\ mm$	$d = 8{,}0\ mm$	$d = 10{,}0\ mm$	$d = 11{,}3\ mm$
Inner thread diameter d_1	$d_1 = 3/16\ in$	$d_1 = 7/32\ in$	$d_1 = 1/4\ in$	$d_1 = 5/16\ in$
yield strength	$f_{y,k} = 145 \cdot 10^3\ lbf/in^2$ $f_{y,k} = 1000\ N/mm^2$			
$N_{pl,k}$	3574 lbf	4775 lbf	6355 lbf	11301 lbf

The buckling load according to ETA-11/0024 is $N_{ki,k} = \sqrt{(c_h \cdot E_S \cdot I_S)}$ with:

screw‘s moment of inertia $I_S = \frac{\pi}{64} \cdot d_1^4$, modulus of elasticity $E_S = 205 \cdot 10^3\ N/mm^2$ and modulus of elastic foundation of the screw within the timber $c_h = (0{,}19 + 0{,}012 \cdot d) \cdot \rho_k \cdot \left(\frac{\alpha}{180°} + 0{,}5\right) [N/mm^2]$.

The modulus of elastic foundation is affected by the density ρ_k and the angle between screw axis and direction of the grain α. Relative slenderness ratio follows with $N_{pl,k}$ and $N_{ki,k}$ as

$\bar{\lambda}_k = \sqrt{\left(\frac{N_{pl,k}}{N_{ki,k}}\right)}$ and $k = 0{,}5 \cdot \left[1 + 0{,}49 \cdot (\bar{\lambda}_k - 0{,}2) + \bar{\lambda}_k^{\,2}\right]$ finally as buckling parameter

$$\kappa_c = \left\{ \begin{array}{ll} 1 & for\ \bar{\lambda}_k \le 0{,}2 \\ \frac{1}{k + \sqrt{(k^2 - \bar{\lambda}_k^{\,2})}} & for\ \bar{\lambda}_k > 0{,}2 \end{array} \right\}.$$

The design value for buckling failure mode is calculated with partial safety factor of steel construction

$\gamma_{M,1}=1{,}1:\ F_{ki,Rd}=\frac{\kappa_c \cdot N_{pl,k}}{\gamma_{M,1}}$.

The angle α between axis and grain direction and density ρ_k have minor influence; yield strength $f_{y,k}$ and inner thread diameter d_1 are the most important parameters.

Design values of critical load for buckling $F_{ki,Rd}$

$\rho_k=350\,kg/m^3 \quad SG=0{,}35$			
$d=1/4\ in$ $d_1=3/16\ in$	$d=5/16\ in$ $d_1=7/32\ in$	$d=3/8\ in$ $d_1=1/4\ in$	$d=7/16\ in$ $d_1=5/16\ in$
α=90°			
$\kappa_c=0{,}77$ $F_{ki,Rd}=2502\,lbf$ $F_{ki,Rd}=11{,}13\,kN$	$\kappa_c=0{,}80$ $F_{ki,Rd}=3473\,lbf$ $F_{ki,Rd}=15{,}45\,kN$	$\kappa_c=0{,}83$ $F_{ki,Rd}=4795\,lbf$ $F_{ki,Rd}=21{,}33\,kN$	$\kappa_c=0{,}78$ $F_{ki,Rd}=8012\,lbf$ $F_{ki,Rd}=35{,}64\,kN$
α=45°			
$\kappa_c=0{,}74$ $F_{ki,Rd}=2405\,lbf$ $F_{ki,Rd}=10{,}70\,kN$	$\kappa_c=0{,}77$ $F_{ki,Rd}=3343\,lbf$ $F_{ki,Rd}=14{,}87\,kN$	$\kappa_c=0{,}81$ $F_{ki,Rd}=4681\,lbf$ $F_{ki,Rd}=20{,}82\,kN$	$\kappa_c=0{,}75$ $F_{ki,Rd}=7704\,lbf$ $F_{ki,Rd}=34{,}27\,kN$

4 Fastener Specification

Pages taken from ETA-11/0024

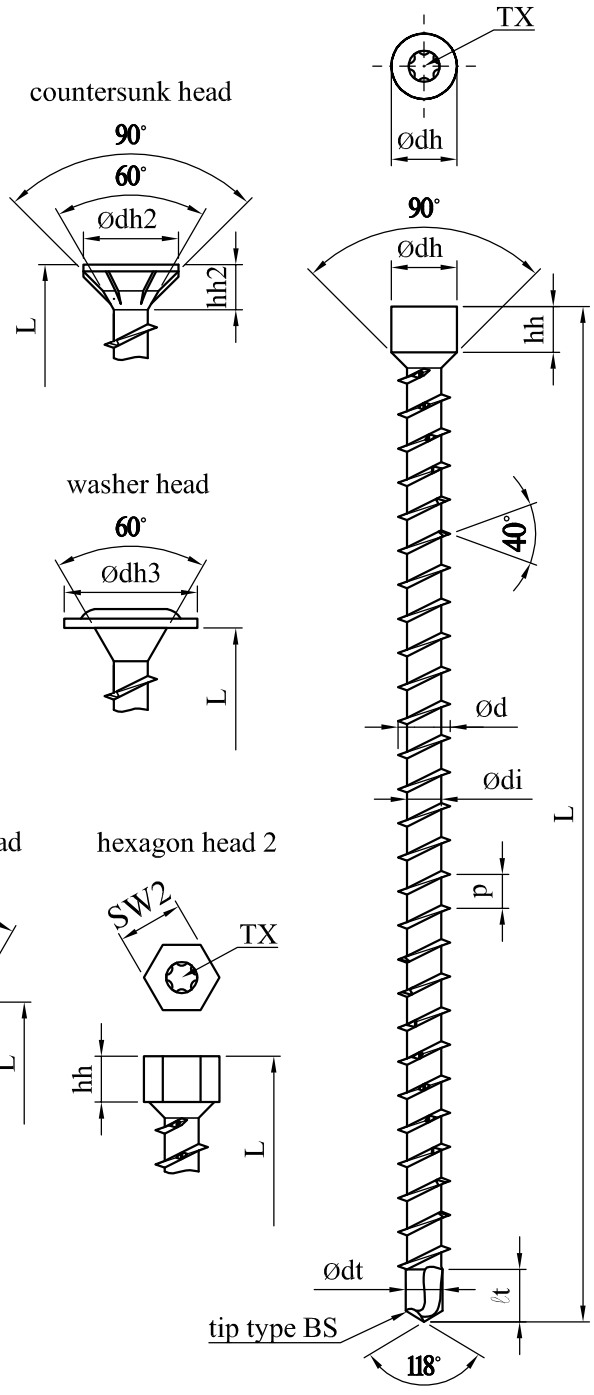
Annex A
KonstruX HF
carbon steel[1]

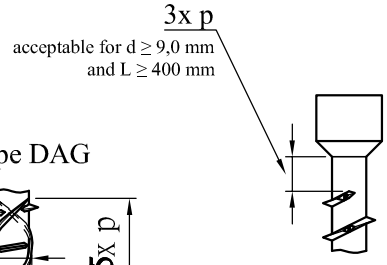
nominal size		Ø6,5	Ø8,0	Ø9,0	Ø10,0	Ø11,3
d	min	6,20	7,60	8,70	9,60	10,70
	max	6,80	8,30	9,30	10,30	11,30
di	min	4,20	5,00	6,10	5,70	7,70
	max	4,80	5,40	6,70	6,30	8,30
dh	min	7,70	9,50	9,50	12,50	12,50
	max	8,30	10,50	10,50	13,50	13,50
hh	min	5,20	6,60	6,60	6,00	6,00
	max	5,70	7,40	7,40	7,00	7,00
p	min	4,41	4,68	5,04	5,04	5,04
	max	5,39	5,72	6,16	6,16	6,16
dt	min	4,70	5,80	6,20	6,30	8,10
	max	5,10	6,20	6,60	6,70	8,50
ℓt	min	6,00	7,00	7,00	11,00	11,00
	max	8,00	9,00	9,00	12,00	13,00
dh2	min	11,50	14,00	14,00	17,30	18,00
	max	12,00	15,00	15,00	18,30	19,00
hh2	min	5,40	7,00	6,50	7,30	6,50
	max	5,90	7,40	7,50	7,70	7,50
dh3	min	-	21,50	21,50	19,50	21,50
	max		22,50	22,50	20,50	22,50
dm	min	-	5,40	-	6,80	-
	max		5,80		7,20	
hm	min	-	4,30	-	3,80	-
	max		4,70		4,20	
p2	min	-	16,80	-	26,40	-
	max		22,40		33,00	
dm2	min	-	6,10	-	7,10	-
	max		6,30		7,30	
TX	size	TX30	TX40	TX40	TX50	TX50
SW	wrench size	-	SW13	-	-	-
SW2	wrench size	SW8	SW10	SW10	SW13	SW13

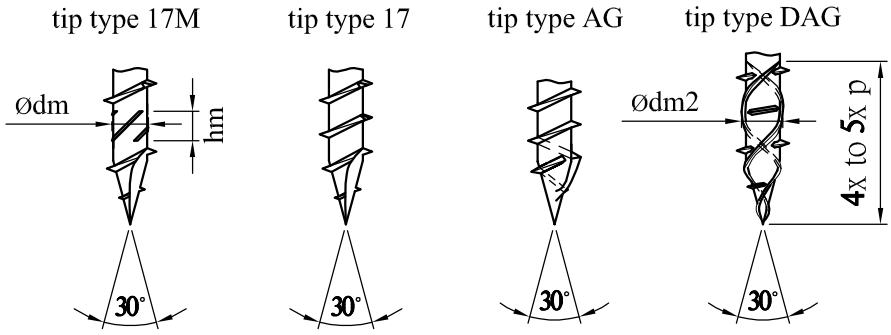
All dimensions in mm.

L				
Ø6,5	Ø8,0	Ø9,0	Ø10,0	Ø11,3
120 -2,0	95 -2,0	200 -2,0	100 -2,0	300 -3,0
140 -2,0	125 -2,0	220 -3,0	160 -2,0	330 -4,0
160 -2,0	155 -2,0	240 -3,0	200 -2,0	360 -4,0
195 -2,0	180 -2,0	260 -3,0	220 -3,0	400 -4,0
-	195 -2,0	280 -3,0	240 -3,0	450 -5,0
-	200 -3,0	300 -4,0	260 -3,0	500 -5,0
-	220 -3,0	330 -4,0	280 -3,0	550 -5,0/+2,0
-	240 -3,0	360 -4,0	300 -3,0	600 -5,0/+2,0
-	245 -3,0	400 -4,0	330 -4,0	650 -8,0/+2,0
-	260 -3,0	450 -5,0	360 -4,0	700 -8,0/+2,0
-	280 -3,0	500 -5,0	400 -4,0	750 -8,0/+2,0
-	295 -3,0	550 -5,0/+2,0	450 -5,0	800 -8,0/+2,0
-	300 -4,0	600 -5,0/+2,0	500 -5,0	850 -8,0/+2,0
-	330 -4,0	-	550 -5,0/+2,0	900 -8,0/+2,0
-	350 -4,0	-	600 -5,0/+2,0	1000 -8,0/+2,0
-	375 -4,0	-	-	-
-	400 -4,0	-	-	-

All dimensions in mm.







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

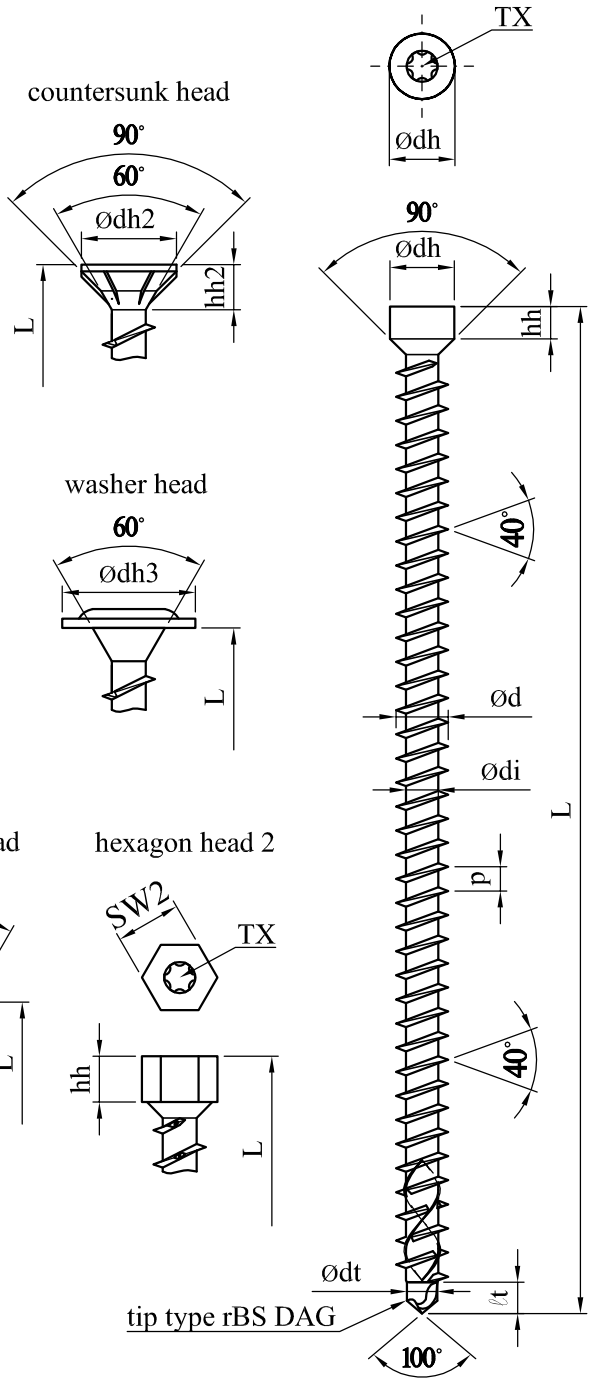
KonstruX ST
carbon steel[1]

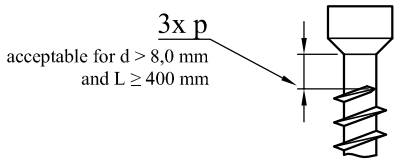
nominal size		Ø6,5	Ø8,0	Ø10,0
d	min	6,20	7,60	9,60
	max	6,80	8,30	10,20
di	min	4,20	5,00	5,70
	max	4,80	5,40	6,10
dh	min	7,70	9,50	12,50
	max	8,30	10,50	13,50
hh	min	5,00	6,00	6,00
	max	6,00	7,00	7,00
p	min	2,70	3,40	4,10
	max	3,30	4,20	5,10
dt	min	4,10	4,70	5,30
	max	4,50	5,10	5,70
ℓt	min	3,60	4,60	5,60
	max	4,50	5,50	6,50
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
dh3	min	-	21,50	19,50
	max		22,50	20,50
dm	min	4,75	5,65	19,50
	max	5,05	5,95	20,50
TX	size	TX30	TX40	TX50
SW	wrench size	-	SW13	-
SW2	wrench size	SW8	SW10	SW13

All dimensions in mm.

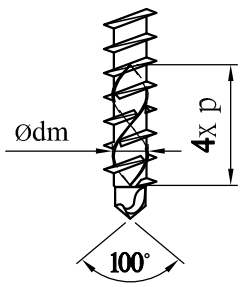
L		
Ø6,5	Ø8,0	Ø10,0
80 -2,0	95 -2,0	125 -2,0
100 -2,0	125 -2,0	155 -2,0
120 -2,0	155 -2,0	195 -2,0
140 -2,0	195 -2,0	220 -3,0
160 -2,0	220 -3,0	245 -3,0
195 -2,0	245 -3,0	270 -3,0
-	275 -3,0	300 -3,0
-	295 -3,0	330 -4,0
-	330 -4,0	360 -4,0
-	375 -4,0	400 -4,0
-	400 -4,0	450 -5,0
-	430 -5,0	500 -5,0
-	480 -5,0	550 -5,0/+2,0
-	-	600 -5,0/+2,0

All dimensions in mm.





tip type rBS DAG



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

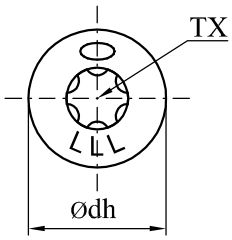
Paneltwistec countersunk head 90°
carbon steel [1]
stainless steel hardened [1]

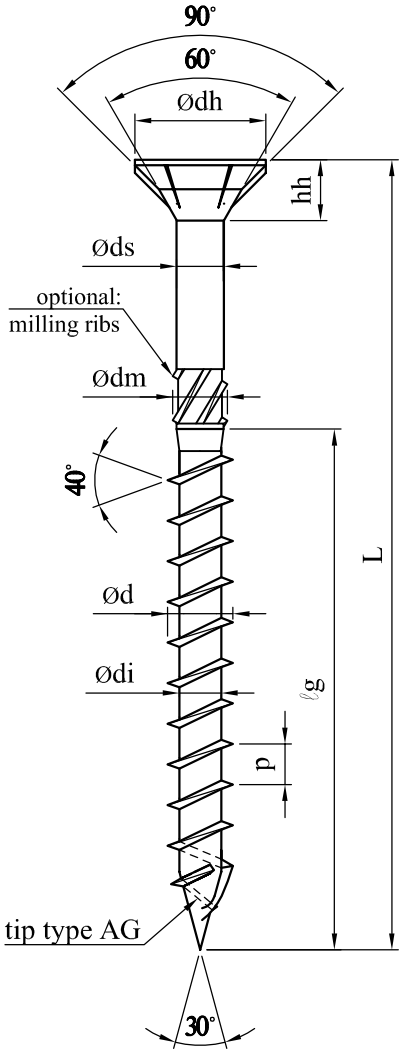
nominal size		Ø3,5	Ø4,0	Ø4,5	Ø5,0	Ø6,0	Ø8,0	Ø10,0	Ø12,0
d	min	3,30	3,75	4,25	4,70	5,75	7,60	9,70	11,50
	max	3,65	4,05	4,55	5,10	6,15	8,20	10,30	12,30
di	min	2,00	2,35	2,60	3,00	3,80	5,10	6,00	6,90
	max	2,25	2,65	2,80	3,45	4,20	5,50	6,50	7,40
dh	min	6,60	7,50	8,50	9,50	11,50	14,10	17,40	19,00
	max	7,00	8,00	9,00	10,00	12,00	14,90	18,20	21,00
hh	min	3,25	3,75	4,15	4,55	5,40	6,50	8,20	8,90
	max	3,65	4,25	4,65	5,05	5,90	7,50	9,20	9,70
p	min	2,02	2,27	2,52	2,79	4,41	5,04	5,94	5,94
	max	2,46	2,77	3,08	3,41	5,39	6,16	7,26	7,26
ds	min	2,20	2,60	2,80	3,60	4,30	5,70	6,90	7,90
	max	2,40	2,80	3,10	3,80	4,50	5,90	7,20	8,20
dm	min	2,65	2,85	3,35	3,75	4,80	6,60	7,90	9,40
	max	2,85	3,05	3,55	3,95	5,00	6,80	8,10	9,80
dc	min	3,30	3,75	5,15	5,75	6,95	7,65	9,60	-
	max	3,70	4,25	5,65	6,25	7,45	8,35	10,40	
hhc	min	3,70	4,00	4,50	5,10	5,40	7,00	8,00	-
	max	3,90	4,40	4,90	5,50	5,80	7,50	8,50	
dh2	min	-	5,30	6,65	8,25	11,00	-	-	-
	max		5,70	7,15	8,75	11,50			
p2	min	-	7,50	8,40	9,30	14,70	16,80	26,40	-
	max		10,00	11,20	12,40	19,60	22,40	33,00	
dm2	min	-	2,70	3,10	3,70	4,50	6,10	7,10	-
	max		2,90	3,30	3,90	4,70	6,30	7,30	
TX	size	TX20	TX20	TX20	TX20	TX30	TX40	TX50	TX50

All dimensions in mm.

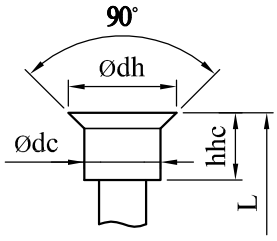
	ℓg +1,0/-1,0							
L	Ø3,5	Ø4,0	Ø4,5	Ø5,0	Ø6,0	Ø8,0	Ø10,0	Ø12,0
25	15	15	-	-	-	-	-	-
30	18	18	-	-	-	-	-	-
40	24	24	24	24	-	-	-	-
45	27	27	27	27	-	-	-	-
50	30	30	30	30	30	-	-	-
60	-	36	36	36	36	-	-	-
70	-	42	42	42	42	-	-	-
80	-	48	48	48	48	48/50*	48/50*	-
90	-	-	-	54	54	54/-*	-	-
100	-	-	-	60	60	60	60	-
110	-	-	-	66	70	80/-*	90/-*	-
120	-	-	-	70	70	80/70*	90/70*	80
140	-	-	-	-	70	80	90/80*	80
160	-	-	-	-	70	80/90*	90	80
180	-	-	-	-	70	80/100*	90/100*	80
200	-	-	-	-	70	80/100*	90/100*	80
+20 mm steps	-	-	-	-	70	80/100*	90/100*	100
300	-	-	-	-	70	80/100*	90/100*	100
320	-	-	-	-	-	80/100*	90/100*	100
+20 mm steps	-	-	-	-	-	80/100*	90/100*	120
400	-	-	-	-	-	80/100*	90/100*	120
420	-	-	-	-	-	80/100*	90/100*	-
440	-	-	-	-	-	80/100*	90/100*	-
460	-	-	-	-	-	80/100*	90/100*	-
480	-	-	-	-	-	80/100*	90/100*	-
500	-	-	-	-	-	80/100*	90/100*	-
550	-	-	-	-	-	80/100*	90/100*	-
600	-	-	-	-	-	80/100*	90/100*	-

All dimensions in mm. * ℓg for tip types 17 and N / tip type AG and DAG

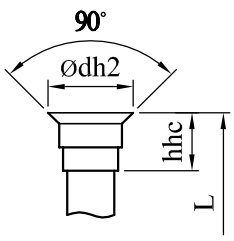




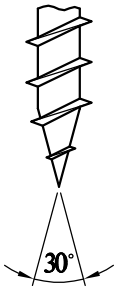
head type FK



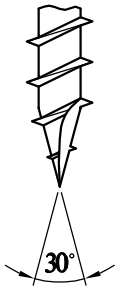
head type FK2



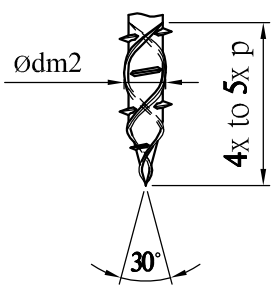
tip type N



tip type 17



tip type DAG



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

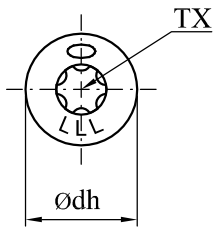
Paneltwistec countersunk head 60°
carbon steel [1]
stainless steel hardened [1]

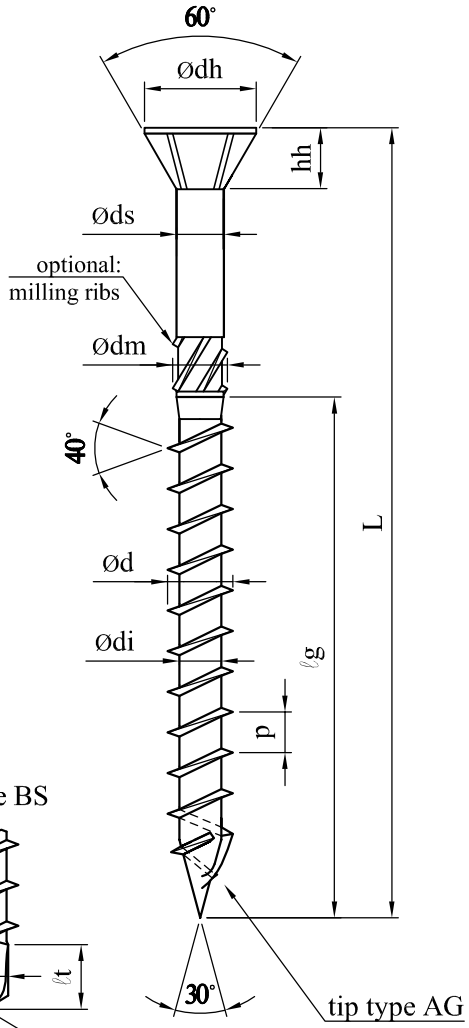
nominal size		Ø3,5	Ø4,0	Ø4,5	Ø5,0	Ø6,0	Ø8,0	Ø10,0
d	min	3,30	3,75	4,25	4,70	5,75	7,60	9,70
	max	3,65	4,05	4,55	5,10	6,15	8,20	10,30
di	min	2,00	2,35	2,60	3,00	3,80	5,10	6,00
	max	2,25	2,65	2,80	3,45	4,20	5,50	6,50
dh	min	4,50	5,50	6,00	6,50	10,00	12,00	15,40
	max	5,50	6,50	8,00	8,00	12,00	14,00	17,40
hh	min	1,75	2,00	2,25	2,50	3,00	n.s.	n.s
	max	2,10	2,50	2,75	3,00	4,00		
p	min	2,02	2,27	2,52	2,79	4,41	5,04	5,94
	max	2,46	2,77	3,08	3,41	5,39	6,16	7,26
ds	min	2,20	2,60	2,80	3,60	4,50	5,70	6,90
	max	2,40	2,80	3,10	3,80	4,50	5,90	7,20
dm	min	2,65	2,85	3,35	3,75	4,80	6,60	7,90
	max	2,85	3,05	3,55	3,95	5,00	6,80	8,10
dt	min	1,90	2,20	2,40	2,80	3,30	5,10	6,00
	max	2,10	2,40	2,60	3,00	3,50	5,50	6,50
ℓt	min	3,30	3,80	4,30	4,80	4,80	5,00	6,00
	max	3,50	4,00	4,50	5,00	5,00	5,20	6,20
dc	min	3,30	3,75	5,15	5,75	6,95	7,65	9,60
	max	3,70	4,25	5,65	6,25	7,45	8,35	10,40
hhc	min	3,70	4,20	4,70	5,30	5,60	6,00	6,50
	max	3,90	4,40	4,90	5,50	5,80	6,30	6,80
dh2	min	-	5,30	6,65	8,25	11,00	-	-
	max		5,70	7,15	8,75	11,50		
p2	min	-	7,50	8,40	9,30	14,70	16,80	26,40
	max		10,00	11,20	12,40	19,60	22,40	33,00
dm2	min	-	2,70	3,10	3,70	4,50	6,10	7,10
	max		2,90	3,30	3,90	4,70	6,30	7,30
TX	size	TX20	TX20	TX20	TX20	TX30	TX40	TX50

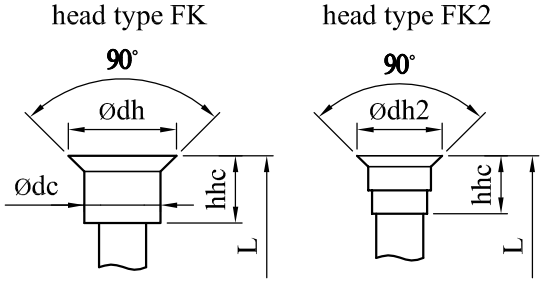
All dimensions in mm.

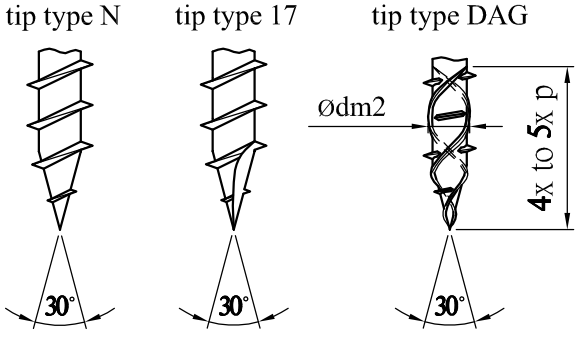
	ℓg +1,0/-1,0						
L	Ø3,5	Ø4,0	Ø4,5	Ø5,0	Ø6,0	Ø8,0	Ø10,0
25	15	15	-	-	-	-	-
30	18	18	-	-	-	-	-
40	24	24	24	24	-	-	-
45	27	27	27	27	-	-	-
50	30	30	30	30	30	-	-
60	-	36	36	36	36	-	-
70	-	42	42	42	42	-	-
80	-	48	48	48	48	48/50*	48/50*
90	-	-	-	54	54	54/-*	-
100	-	-	-	60	60	60	60
110	-	-	-	66	70	80/-*	90/-*
120	-	-	-	70	70	80/70*	90/70*
140	-	-	-	-	70	80	90/80*
160	-	-	-	-	70	80/90*	90
180	-	-	-	-	70	80/100*	90/100*
200	-	-	-	-	70	80/100*	90/100*
+20 mm steps	-	-	-	-	70	80/100*	90/100*
300	-	-	-	-	70	80/100*	90/100*
320	-	-	-	-	-	80/100*	90/100*
+20 mm steps	-	-	-	-	-	80/100*	90/100*
460	-	-	-	-	-	80/100*	90/100*
480	-	-	-	-	-	80/100*	90/100*
500	-	-	-	-	-	80/100*	90/100*
550	-	-	-	-	-	80/100*	90/100*
600	-	-	-	-	-	80/100*	90/100*

All dimensions in mm. * ℓg for tip types 17 and N / tip type AG and DAG









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

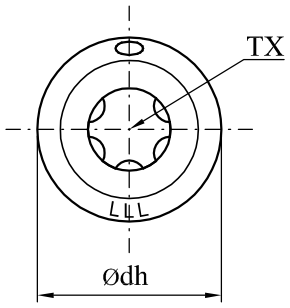
Paneltwistec washer head
carbon steel [1]
stainless steel hardened [1]

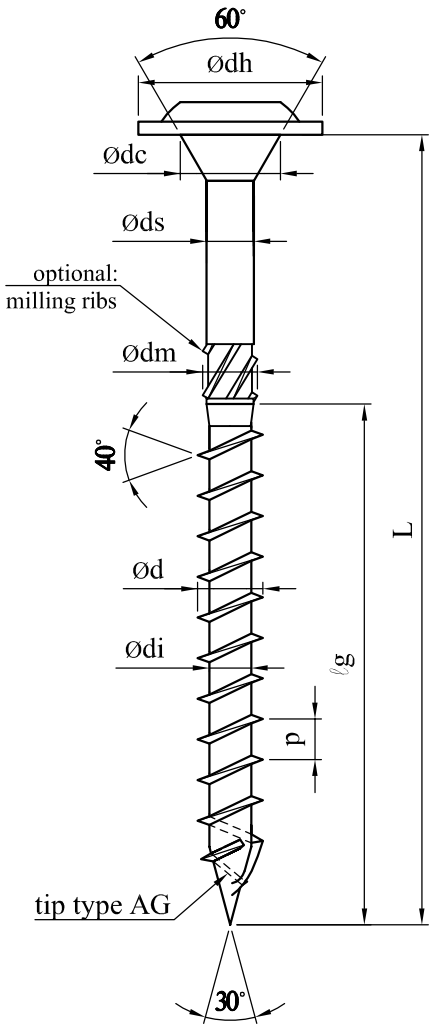
nominal size		Ø4,0	Ø4,5	Ø5,0	Ø6,0	Ø8,0	Ø10,0
d	min	3,75	4,25	4,70	5,75	7,80	9,70
	max	4,05	4,55	5,10	6,15	8,20	10,30
di	min	2,35	2,60	3,00	3,60	5,10	6,00
	max	2,65	2,80	3,45	4,10	5,50	6,50
dh	min	9,50	10,50	11,50	13,50	21,00	24,00
	max	10,50	11,50	12,50	14,50	23,00	26,00
dc	min	4,50	5,20	5,70	6,40	9,50	11,20
	max	5,10	5,80	6,30	7,00	10,50	12,00
p	min	2,27	2,52	2,79	4,41	5,04	5,94
	max	2,77	3,08	3,41	5,39	6,16	7,26
ds	min	2,50	2,80	3,30	3,80	5,70	6,90
	max	2,90	3,20	3,70	4,50	5,90	7,20
dm	min	2,85	3,35	3,75	4,80	6,60	7,90
	max	3,05	3,55	3,95	5,10	6,80	8,10
p2	min	7,50	8,40	9,30	14,70	16,80	26,40
	max	10,00	11,20	12,40	19,60	22,40	33,00
dm2	min	2,70	3,10	3,70	4,50	6,10	7,10
	max	2,90	3,30	3,90	4,70	6,30	7,30
TX	size	TX20	TX20	TX20	TX30	TX40	TX40

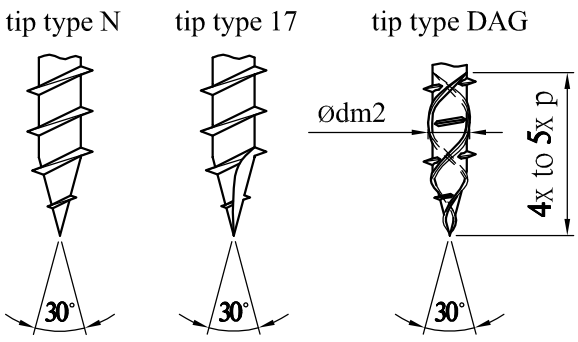
All dimensions in mm.

	ℓg +1,0/-1,0					
L	Ø4,0	Ø4,5	Ø5,0	Ø6,0	Ø8,0	Ø10,0
25	15	-	-	-	-	-
30	18	-	-	30	-	-
40	24	24	24	40	-	40
45	27	27	27	-	-	-
50	30	30	30	30	-	50
60	36	36	36	36	-	36
70	42	42	42	42	-	-
80	48	48	48	48	48/50*	52/50*
90	-	-	54	54	-	-
100	-	-	60	70/60*	60	80/60*
110	-	-	66	70	-	-
120	-	-	70	70	80/70*	90/70*
130	-	-	-	70	-	-
140	-	-	-	70	80	90/80*
150	-	-	-	70	-	-
160	-	-	-	70	80/90*	90
180	-	-	-	70	80/100*	90/100*
+20 mm steps	-	-	-	70	80/100*	90/100*
300	-	-	-	70	80/100*	90/100*
+20 mm steps	-	-	-	-	80/100*	90/100*
460	-	-	-	-	80/100*	90/100*
480	-	-	-	-	80/100*	90/100*
500	-	-	-	-	80/100*	90/100*
550	-	-	-	-	80/100*	90/100*
600	-	-	-	-	80/100*	90/100*

All dimensions in mm. * ℓg for tip types 17 and N / tip type AG and DAG







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

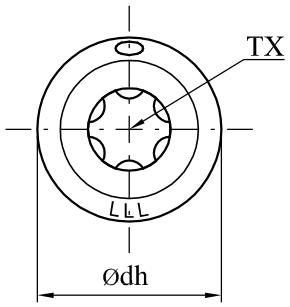
Paneltwistec small washer head
carbon steel[1]
stainless steel hardened[1]

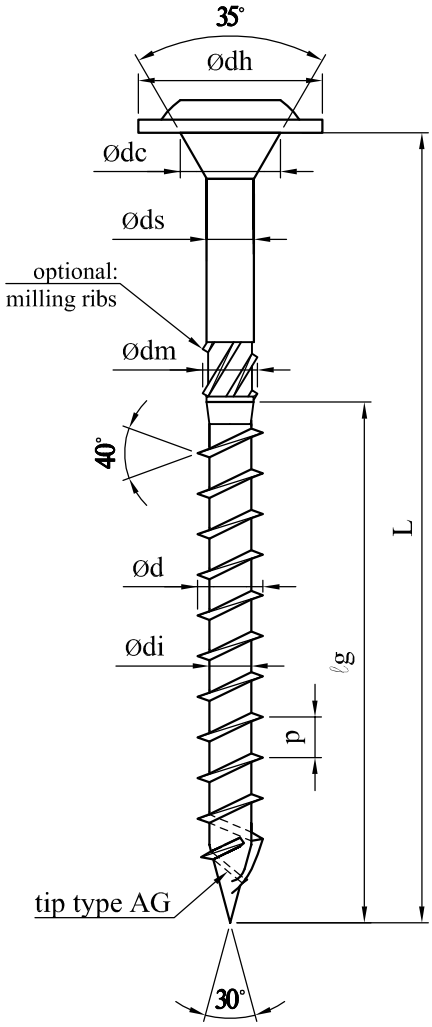
nominal size			Ø8,0	
d	min	-	7,80	-
	max	-	8,20	-
di	min	-	5,10	-
	max	-	5,50	-
dh	min	-	17,50	-
	max	-	18,50	-
dc	min	-	7,70	-
	max	-	8,00	-
p	min	-	4,68	-
	max	-	5,72	-
ds	min	-	5,70	-
	max	-	5,90	-
dm	min	-	6,60	-
	max	-	6,80	-
p2	min	-	16,80	-
	max	-	22,40	-
dm2	min	-	6,10	-
	max	-	6,30	-
TX	size	-	TX40	-

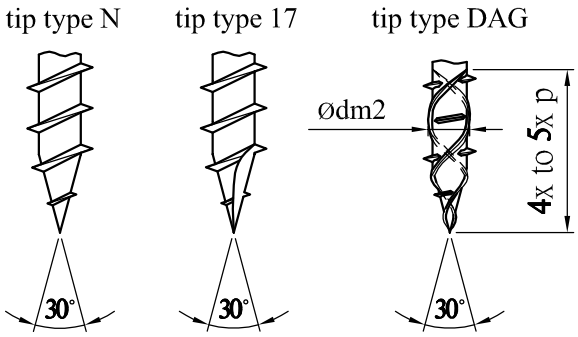
All dimensions in mm.

	ℓg +1,0/-1,0		
L		Ø8,0	
80	-	48/50*	-
100	-	80/60*	-
110	-	-	-
120	-	80/70*	-
130	-	-	-
140	-	80	-
150	-	-	-
160	-	80/90*	-
180	-	80/100*	-
200	-	80/100*	-
+20 mm steps	-	80/100*	-
460	-	80/100*	-

All dimensions in mm.
* ℓg for tip types 17 and N / tip type AG and DAG







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

Hobotec, Hapatec, Paneltwistec V4A countersunkhead 90°

carbon steel [1]

stainless steel hardened [1]

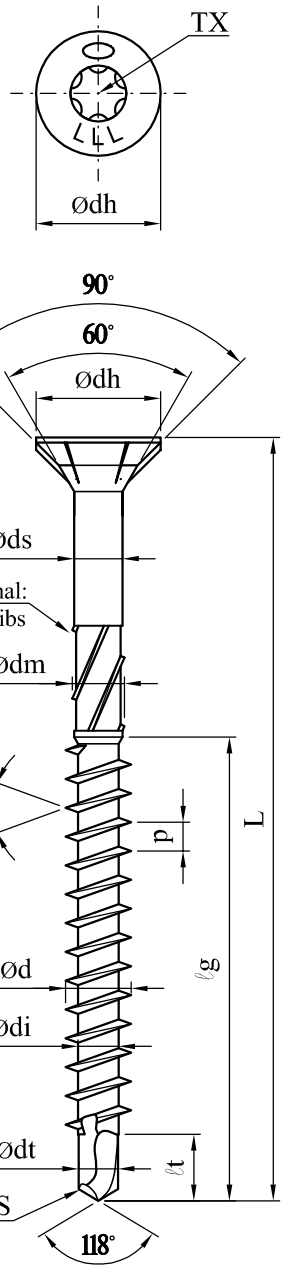
stainless steel unhardened [1]

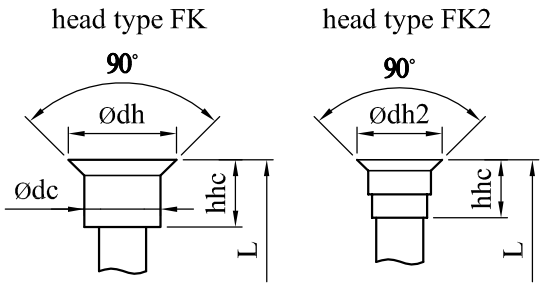
nominal size		Ø3,5	Ø4,0	Ø4,5	Ø5,0	Ø6,0
d	min	3,40	3,85	4,35	4,85	5,80
	max	3,70	4,20	4,70	5,20	6,20
di	min	2,00	2,30	2,50	2,90	3,50
	max	2,25	2,60	2,80	3,40	3,80
dh	min	6,30	7,25	8,25	9,20	11,15
	max	7,50	8,50	9,50	10,50	12,00
hh	min	3,70	4,20	4,70	5,30	5,60
	max	3,90	4,40	4,90	5,50	5,80
p	min	1,44	1,62	1,80	1,98	2,34
	max	1,76	1,98	2,20	2,42	2,86
ds	min	2,20	2,70	2,80	3,50	3,80
	max	2,50	2,90	3,20	3,80	4,20
dm	min	2,80	3,40	3,80	3,90	4,50
	max	3,00	3,60	4,00	4,10	4,70
dt	min	1,90	2,20	2,40	2,80	3,30
	max	2,10	2,40	2,60	3,20	3,50
ℓ_t	min	3,30	3,80	4,30	3,50	4,80
	max	3,50	4,00	4,50	5,00	5,00
dc	min	3,30	3,75	5,15	5,75	6,95
	max	3,70	4,25	5,65	6,25	7,45
dh2	min	-	4,00	4,50	5,10	5,40
	max		4,40	4,90	5,50	5,80
hh2	min	-	5,30	6,65	8,25	11,00
	max		5,70	7,15	8,75	11,50
TX	size	TX10	TX15	TX20	TX25	TX25

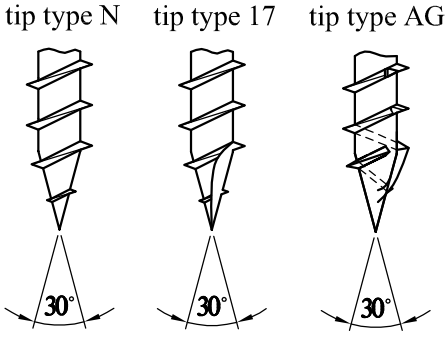
All dimensions in mm.

	ℓ_g +1,0/-1,0				
L	Ø3,5	Ø4,0	Ø4,5	Ø5,0	Ø6,0
25	18	-	-	-	-
30	21	21	21	21	21
35	24	24	24	24	24
40	26	26	26	26	26
45	28	28	28	28	28
50	30	30	30	30	30
60	-	36	36	36	36
70	-	42	42	42	42
80	-	48	48	48	48
90	-	-	-	54	54
100	-	-	-	60	60
110	-	-	-	60	60
120	-	-	-	60	60
130	-	-	-	-	70
140	-	-	-	-	70
150	-	-	-	-	70
160	-	-	-	-	70
180	-	-	-	-	70
200	-	-	-	-	70
+20 mm steps	-	-	-	-	70
300	-	-	-	-	70

All dimensions in mm.







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

Hobotec, Hapatec, Paneltwistec V4A countersunkhead 60°

carbon steel [1]

stainless steel hardened [1]

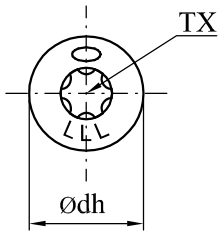
stainless steel unhardened [1]

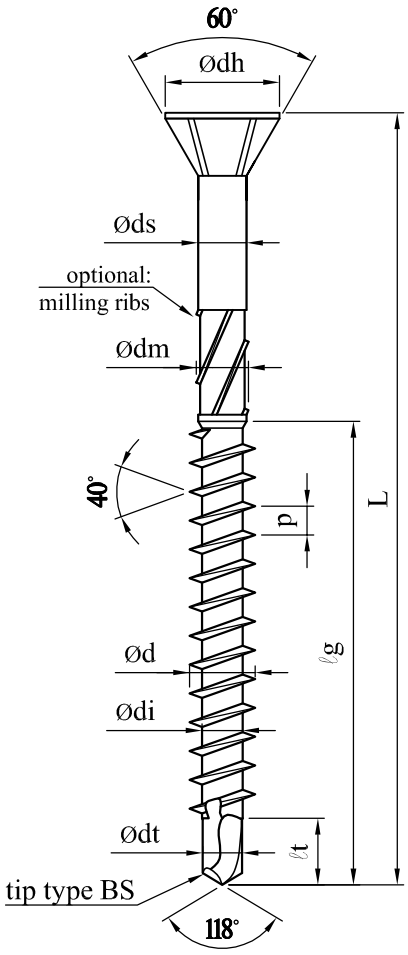
nominal size		Ø3,5	Ø4,0	Ø4,5	Ø5,0	Ø6,0
d	min	3,40	3,85	4,35	4,85	5,80
	max	3,70	4,20	4,70	5,20	6,20
di	min	2,00	2,30	2,50	2,90	3,50
	max	2,25	2,60	2,80	3,40	3,80
dh	min	4,50	5,50	6,00	6,50	10,00
	max	5,50	6,50	8,00	8,50	12,00
hh	min	3,70	4,20	4,70	5,30	5,60
	max	3,90	4,40	4,90	5,50	5,80
p	min	1,44	1,62	1,80	1,98	2,34
	max	1,76	1,98	2,20	2,42	2,86
ds	min	2,20	2,70	2,80	3,50	3,80
	max	2,50	2,90	3,20	3,80	4,20
dm	min	2,80	3,40	3,80	3,90	4,50
	max	3,00	3,60	4,00	4,10	4,70
dt	min	1,90	2,20	2,40	2,80	3,30
	max	2,10	2,40	2,60	3,20	3,50
ℓt	min	3,30	3,80	4,30	3,50	4,80
	max	3,50	4,00	4,50	5,00	5,00
dc	min	3,30	3,75	5,15	5,75	6,95
	max	3,70	4,25	5,65	6,25	7,45
dh2	min	-	4,00	4,50	5,10	5,40
	max		4,40	4,90	5,50	5,80
hh2	min	-	5,30	6,65	8,25	11,00
	max		5,70	7,15	8,75	11,50
TX	size	TX10	TX15	TX20	TX25	TX25

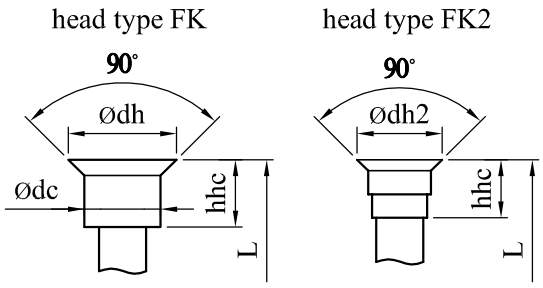
All dimensions in mm.

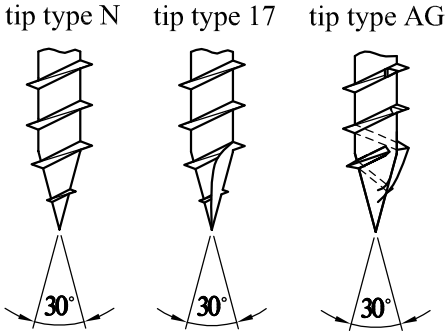
	ℓg +1,0/-1,0				
L	Ø3,5	Ø4,0	Ø4,5	Ø5,0	Ø6,0
25	18	-	-	-	-
30	21	21	21	21	21
35	24	24	24	24	24
40	26	26	26	26	26
45	28	28	28	28	28
50	30	30	30	30	30
60	-	36	36	36	36
70	-	42	42	42	42
80	-	48	48	48	48
90	-	-	-	54	54
100	-	-	-	60	60
110	-	-	-	60	60
120	-	-	-	60	60
130	-	-	-	-	70
140	-	-	-	-	70
150	-	-	-	-	70
160	-	-	-	-	70
180	-	-	-	-	70
200	-	-	-	-	70
+20 mm steps	-	-	-	-	70
300	-	-	-	-	70

All dimensions in mm.







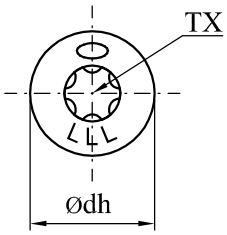


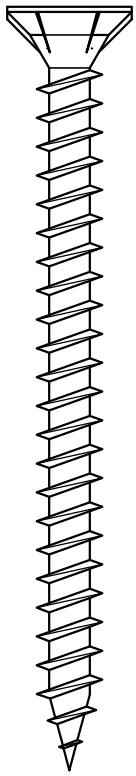
[1] Material specification held on file by ETA Danmark.

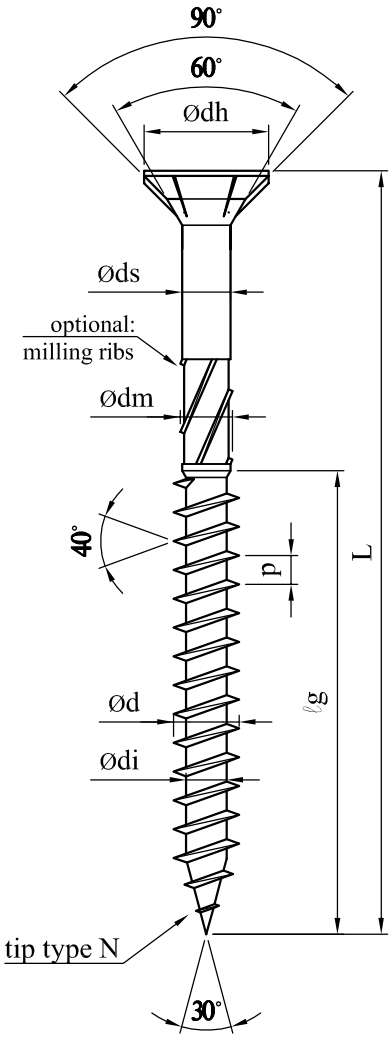
Ecotec countersunk head 90°
carbon steel[1]
stainless steel unhardened[1]

nominal size		Ø3,5	Ø4,0	Ø4,5	Ø5,0	Ø6,0
d	min	3,40	3,85	4,35	4,85	5,80
	max	3,70	4,20	4,70	5,20	6,20
di	min	2,00	2,30	2,50	2,90	3,50
	max	2,25	2,60	2,80	3,40	3,80
dh	min	6,30	7,25	8,25	9,20	11,15
	max	7,50	8,50	9,50	10,50	12,00
hh	min	3,70	4,20	4,70	5,30	5,60
	max	3,90	4,40	4,90	5,50	5,80
p	min	1,44	1,62	1,80	1,98	2,34
	max	1,76	1,98	2,20	2,42	2,86
ds	min	2,20	2,70	2,80	3,50	3,80
	max	2,50	2,90	3,20	3,80	4,20
dm	min	2,80	3,40	3,80	3,90	4,50
	max	3,00	3,60	4,00	4,10	4,70
TX	size	TX20	TX20	TX20	TX20	TX30

All dimensions in mm.







Ecotec partially threaded

	ℓg +1,0/-1,0				
L	Ø3,5	Ø4,0	Ø4,5	Ø5,0	Ø6,0
35	21	-	-	-	-
40	23	23	23	23	-
45	25	25	25	25	-
50	30	30	30	30	30
60	-	39	39	39	39
70	-	44	44	44	44
80	-	44	44	44	44
90	-	-	-	54	54
100	-	-	-	54	60
120	-	-	-	70	70
140	-	-	-	-	70
+20 mm steps	-	-	-	-	70
300	-	-	-	-	70

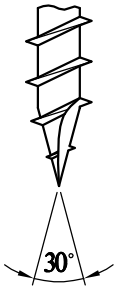
All dimensions in mm.

Ecotec fully threaded

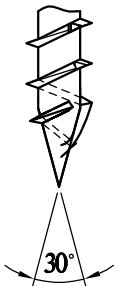
L	Ø3,5	Ø4,0	Ø4,5	Ø5,0	Ø6,0
15	x	x	-	-	-
20	x	x	x	x	-
25	x	x	x	x	x
30	x	x	x	x	x
35	-	x	x	x	x
40	-	x	x	x	x
45	-	x	x	x	x
50	-	x	x	x	x
60	-	-	-	x	x
70	-	-	-	-	x

All dimensions in mm.

tip type 17



tip type AG



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