Deutsches Institut für Bautechnik

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Approval body for construction products and types of construction

Bautechnisches Prüfamt

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European Technical Assessment

ETA-11/0389 of 26 January 2017

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the European Technical Assessment:	Deutsches Institut für Bautechnik
Trade name of the construction product	PanelFix screws
Product family to which the construction product belongs	PanelFix screws for use in timber constructions
Manufacturer	BFU Fixing GmbH Kirchgärten 4 74626 Bretzfeld DEUTSCHLAND
Manufacturing plant	Hersteller 1, Hersteller 2, Hersteller 3, Hersteller 4, Hersteller 5
This European Technical Assessment contains	31 pages including 4 annexes which form an integral part of this assessment
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of	European Assessment Document (EAD) 130118-00-0603
This version replaces	ETA-11/0389 issued on 12 March 2012

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Specific Part

1 Technical description of the product

PanelFix screws are self-tapping screws made from special carbon steel. They are hardened. They have a corrosion protection according to Annex A.2.6. The outer thread diameter is not less than 3.5 mm and not greater than 10.0 mm. The overall length of the screws is ranging from 30 mm to 400 mm. Further dimensions are shown in Annex 4. They have an anti-friction coating. The washers are made from carbon steel. The dimensions of the washers are given in Annex 4.

2 Specification of the intended use in accordance with the applicable European Assessment Document

The performances given in Section 3 are only valid if the screws are used in compliance with the specifications and conditions given in Annex 1 and 2.

Durability is only ensured if the specifications of intended use according to Annex 1 and 2 are taken into account.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the screws of at least 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, 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

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
Dimensions	See Annex 4
Characteristic yield moment	See Annex 2
Characteristic withdrawal parameter	See Annex 2
Characteristic head pull-through parameter	See Annex 2
Characteristic tensile strength	See Annex 2
Characteristic yield strength	No performance determined
Characteristic torsional strength	See Annex 2
Insertion moment	See Annex 2
Spacing, end and edge distances of the screws and minimum thickness of the wood based material	See Annex 2
Slip modulus for mainly axially loaded screws	See Annex 2

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	The screws are made of steel classified as Euroclass A1 in accordance with EC decision 96/603/EC, as amended by EC decision 2000/605/EC.

3.3 Hygiene, health and the environment (BWR 3)

Not applicable

3.4 Safety and accessibility in use (BWR 4)

Same as BWR 1

3.5 Protection against noise (BWR 5)

Not applicable

3.6 Energy economy and heat retention (BWR 6)

Not applicable

3.7 Sustainable use of natural resources (BWR 7)

For the sustainable use of natural resources no performance was investigated for this product.

4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base

In accordance with EAD No. 130118-00-0603 the applicable European legal act is: 97/176/EC.

The system to be applied is: 3

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable EAD

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

Issued in Berlin on 26 January 2017 by Deutsches Institut für Bautechnik

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beglaubigt:
Dewitt

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Annex 1 Specifications of intended use

A.1.1 Use of the PanelFix screws only for:

- Static and quasi-static loads

A.1.2 Base materials

The screws are used for connections in load bearing timber structures between wood-based members or between those members and steel members:

- Solid timber (softwood) according to EN 14081-1[1],
- Glued laminated timber (softwood) according to EN 14080[2],
- Laminated veneer lumber LVL of softwood according to EN 14374[3], arrangement of the screws only perpendicular to the plane of the veneers,
- Glued solid timber (softwood) according to EN 14080 or national provisions that apply at the installation site,
- Cross-laminated timber (softwood) according to European Technical Approvals/Assessments or national provisions that apply at the installation site.

The screws may be used for connecting the following wood-based panels to the timber members mentioned above:

- Plywood according to EN 636[4] and EN 13986[5],
- Oriented Strand Board, OSB according to EN 300[6] and EN 13986,
- Particleboard according to EN 312[7] and EN 13986,
- Fibreboards according to EN 622-2[8], EN 622-3[9] and EN 13986,
- Cement-bonded particle boards according to EN 634-2[10] and EN 13986,
- Solid-wood panels according to EN 13353[11] and EN 13986.

Wood-based panels shall only be arranged on the side of the screw head.

PanelFix screws with an outer thread diameter of 6 mm may be used for the fixing of thermal insulation material on top of rafters or on wood-based members in vertical façades.

1	EN 14081-1:2005+A1:2011	Timber structures – Strength graded structural timber with rectangular cross section – Part 1: General requirements
2	EN 14080:2013	Timber structures - Glued laminated timber and glued solid timber - Requirements
3	EN 14374:2004	Timber structures - Structural laminated veneer lumber - Requirements
4	EN 636:2012+A1:2015	Plywood - Specifications
5	EN 13986:2004+A1:2015	Wood-based panels for use in construction - Characteristics, evaluation of conformity and marking
6	EN 300:2006	Oriented strand boards (OSB) – Definition, classification and specifications
7	EN 312:2010	Particleboards - Specifications
8	EN 622-2:2004	Fibreboards – Specifications – Part 2: Requirements for hardboards
9	EN 622-3:2004	Fibreboards - Specifications - Part 3: Requirements for medium boards
10	EN 634-2:2007	Cement-bonded particleboards – Specifications – Part 2: Requirements for OPC bonded particleboards for use in dry, humid and external conditions
11	EN 13353:2008+A1:2011	Solid wood panels (SWP) – Requirements

PanelFix screws	Annex 1
Specifications of intended use	

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A.1.3 Use Conditions (environmental conditions)

The corrosion protection of the PanelFix screws is specified in Annex A.2.6. With regards to the use and the environmental conditions, the national provisions of the place of installation apply.

A.1.4 Installation provisions

EN 1995-1-1[12] in conjunction with the respective national annex applies for the installation.

A minimum of two screws shall be used for connections in load bearing timber structures. This does not apply for special situations specified in National Annexes to EN 1995-1-1.

The screws are driven into the wood-based member made of softwood without pre-drilling. The screw holes in steel members shall be pre-drilled with an adequate diameter greater than the outer thread diameter.

If screws with an outer thread diameter $d \geq 8$ mm are driven into the wood-based member without pre-drilling, the structural solid or glued laminated timber, laminated veneer lumber and similar glued members shall be from spruce, pine or fir.

In the case of fastening battens on thermal insulation material on top of rafters the screws shall be driven in the rafter through the battens and the thermal insulation material without pre-drilling in one sequence.

Countersunk head screws may be used with washers according to Annex 4. After inserting the screw the washers shall touch the surface of the wood-based member completely.

By fastening screws in wood-based members the head of the screws shall be flush with the surface of the wood-based member. For wafer head and combi-head screws the head part remains unconsidered.

[12] EN 1995-1-1: 2004+AC:2006+A1:2008+A2:2014 Eurocode 5: Design of timber structures – Part 1-1: General - Common rules and rules for buildings

PanelFix screws	Annex 1
Installation provisions	

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ANNEX 2 – Characteristic values of the load-carrying capacities

Table A.2.1 Characteristic load-carrying capacities of PanelFix screws

Outer thread diameter [mm]	**3.5**	**4.0**	**4.5**	**5.0**	**6.0**	**8.0**	**10.0**
Characteristic yield moment $M_{y,k}$ [Nm]	2.5	3.3	4.5	5.9	9.5	22.0	36.0
Characteristic tensile strength $f_{tens,k}$ [kN]	4.3	5.7	7.2	8.8	12.0	15.0	31.0
Characteristic torsional strength $f_{tor,k}$ [Nm]	2.4	3.5	5.0	7.0	10.0	25.0	45.0

A.2.1 General

The minimum penetration length of the threaded part of the screw in the wood-based member l_{ef} shall be

$$l_{ef} = \min \begin{cases} \dfrac{4 \cdot d}{\sin \alpha} \\ 20 \cdot d \end{cases} \qquad (2.1)$$

where

α angle between screw axis and grain direction

d outer thread diameter of the screw.

The outer thread diameter of screws inserted in cross-laminated timber shall be at least 6 mm. The inner thread diameter d_1 of the screws shall be greater than the maximal width of the gaps in the layer of cross laminated timber.

A.2.2 Laterally loaded screws

A.2.2.1 General

The outer thread diameter d shall be used as effective diameter of the screw according to EN 1995-1-1.

The embedding strength for the screws in wood-based members or in wood-based panels shall be taken from EN 1995-1-1 or from national provisions that apply at the installation site unless otherwise specified in the following.

PanelFix screws	Annex 2
Characteristic values of the load-carrying capacities	

A.2.2.2 Cross laminated timber

The embedding strength for screws arranged in the edge surfaces parallel to the plane of cross laminated timber may be assumed according to equation (2.2) independent of the angle between screw axis and grain direction, $0° \le \alpha \le 90°$:

$$f_{h,k} = 20 \cdot d^{-0,5} \text{ in N/mm}^2 \qquad (2.2)$$

unless otherwise specified in the technical specification of the cross laminated timber.

Where d is the outer thread diameter of the screws in mm.

Equation (2.2) is only valid for softwood layers. The provisions in the European Technical Approval/ Assessment or in national provisions of the cross laminated timber apply.

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. Where applicable, the angle between force and grain direction of the outer layer shall 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.

For angles $45° \le \alpha < 90°$ between screw axis and grain direction of the outer layer the characteristic load-carrying capacity may be assumed as 2/3 of the corresponding value for $\alpha = 90°$, if only the penetration depth perpendicular to the wide face is taken into account.

A.2.3 Axially loaded screws

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

$$K_{ser} = 780 \cdot d^{0,2} \cdot l_{ef}^{0,4} \quad [\text{N/mm}] \qquad (2.3)$$

Where

d outer thread diameter of the screw [mm]

l_{ef} penetration length of the threaded part of the screw in the wood-based member [mm].

A.2.3.1 Axial withdrawal capacity

The characteristic withdrawal capacity in solid timber, glued laminated timber, cross laminated timber or laminated veneer lumber members made from softwood at an angle of $15° \le \alpha \le 90°$ to the grain shall be calculated as:

$$F_{ax,\alpha,Rk} = n_{ef} \cdot k_{ax} \cdot f_{ax,k} \cdot d \cdot l_{ef} \cdot \left(\frac{\rho_k}{350} \right)^{0.8} \qquad (2.4)$$

where

$F_{ax,\alpha,Rk}$ Characteristic withdrawal capacity of a screw group at an angle α to the grain [N]

n_{ef} Effective number of screws according to EN 1995-1-1:2008, clause 8.7.2 (8)

For inclined screws with an angle between shear plane and screw axis $30° \le \alpha \le 60°$:

$$n_{ef} = \max \left\{ n^{0.9}; 0.9 \cdot n \right\} \qquad (2.5)$$

For inclined screws as fasteners in mechanically jointed beams or columns or for the fixing of thermal insulation material, $n_{ef} = n$.

n Number of screws acting together in a connection. If crossed pairs of screws are used in timber-to-timber connections, n is the number of crossed pairs of screws.

k_{ax} Factor, taking into account the angle α between screw axis and grain direction

$k_{ax} = 1.0$ for $45° \le \alpha \le 90°$

$$k_{ax} = 0.3 + \frac{0.7 \cdot \alpha}{45°} \quad \text{for } 15° \le \alpha < 45° \qquad (2.6)$$

PanelFix screws	Annex 2
Characteristic values of the load-carrying capacities	

$f_{ax,k}$ Characteristic withdrawal parameter at an angle $\alpha = 90°$ based on a characteristic density of the wood-based member ρ_k of 350 kg/m³

$f_{ax,k}$ = 14 N/mm² for PanelFix screws with 3.5 mm ≤ d ≤ 4.5 mm

$f_{ax,k}$ = 13 N/mm² for PanelFix screws with d = 5.0 mm

$f_{ax,k}$ = 12 N/mm² for PanelFix screws with d = 6.0 mm

$f_{ax,k}$ = 10.5 N/mm² for PanelFix screws with d > 6.0 mm

The characteristic withdrawal parameter is also valid for softwood layers of cross-laminated timber.

d outer thread diameter of the screw

l_{ef} penetration length of the threaded part of the screw in the wood-based member

ρ_k Characteristic density of the wood-based member, for LVL $\rho_k \leq 500$ kg/m³,

For screws penetrating more than one layer of cross laminated timber the different layers may be taken into account proportionally. In the lateral surfaces of the cross laminated timber the screws shall be fully inserted in one layer of cross-laminated timber.

A.2.3.2 Head pull-through capacity

The characteristic value of the head pull-through parameter for PanelFix screws for a characteristic density of 350 kg/m³ of the timber and for wood-based panels like

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

with a thickness of more than 20 mm is

$f_{head,k}$ = 12 N/mm² for $d_h \leq 22$ mm and
$f_{head,k}$ = 10 N/mm² for $d_h > 22$ mm with d_h as screw head or washer diameter.

For wood-based panels a maximum characteristic density of 380 kg/m³ and for LVL a maximum characteristic density of 500 kg/m³ shall be used in equation (8.40b) of EN 1995-1-1.

The head diameter shall be equal to or greater than $1.8 \cdot d_s$, where d_s is the smooth shank or the inner thread diameter. Otherwise the characteristic head pull-through capacity in equation (8.40b) of EN 1995-1-1 is for all wood-based materials: $F_{ax,\alpha,RK} = 0$.
For wood based panels with a thickness 12 mm ≤ t ≤ 20 mm the characteristic value of the head pull-through parameter for the screws is:

$f_{head,k}$ = 8 N/mm²

For wood based panels with a thickness of less than 12 mm the characteristic head pull-through capacity for screws shall be based on a characteristic value of the head pull-through parameter of 8 N/mm², and limited to 400 N complying with the minimum thickness of the wood based panels of 1.2·d, with d as outer thread diameter and the values in Table A.2.2.

PanelFix screws	Annex 2
Characteristic values of the load-carrying capacities	

Table A.2.2 Minimum thickness of wood based panels

Wood based panel	**Minimum thickness [mm]**
Plywood	6
Fibreboards (hardboards and medium boards)	6
Oriented Strand Boards, OSB	8
Particleboards	8
Cement-bonded particle board	8
Solid wood Panels	12

In steel-to-timber connections the head pull-through capacity is not governing.

A.2.4 Spacing, end and edge distances of the screws and minimum thickness of the wood based material

Minimum thickness for structural members made from solid timber, glued laminated timber, glued solid timber, laminated veneer lumber and cross laminated timber is t = 24 mm for screws with d ≤ 6 mm, t = 30 mm for screws with d = 8 mm and t = 40 mm for screws with d = 10 mm.

A.2.4.1 Laterally and/or axially loaded screws

Screws in non pre-drilled holes

For PanelFix screws minimum spacing and distances are given in EN 1995-1-1: 2004+AC:2006+A1:2008+A2:2014, clause 8.3.1.2 and Table 8.2 as for nails in non-predrilled holes. Here, the outer thread diameter d shall be considered.

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

Minimum distances from loaded or unloaded ends shall be at least 15·d for screws with outer thread diameter d ≥ 8 mm and timber thickness t < 5·d.

Minimum distances from the unloaded edge perpendicular to the grain may be reduced to 3·d also for timber thickness t < 5·d, if the spacing parallel to the grain and the end distance is at least 25·d.

A.2.4.2 Only axially loaded screws

For PanelFix screws the minimum spacings, end and edge distances are given in EN 1995-1-1: 2004+AC:2006+A1:2008+A2:2014, clause 8.3.1.2 and Table 8.2 as for nails in non-predrilled holes and clause 8.7.2, Table 8.6.

A.2.4.3 Cross laminated timber

The minimum requirements for spacing, end and edge distances of screws in the plane or edge surfaces of cross laminated timber are summarised in Table A.2.3. The definition of spacing, end and edge distance is shown in Figure A.2.1 and Figure A.2.2. The minimum spacing, end and edge distances in the edge surfaces are independent of the angle between screw axis and grain direction. They may be used based on the following conditions:

- Minimum thickness of cross laminated timber: 10 · d
- Minimum penetration depth in the edge surface: 10 · d

For load components perpendicular to the plane surface (see Figure A.2.2 right) the tensile stresses perpendicular to the grain should be transferred by reinforcing screws.

Table A.2.3 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 A.2.1)	4 · d	6 · d	6 · d	2,5 · d	6 · d	2,5 · d
Edge surface (see Figure A.2.2)	10 · d	12 · d	7 · d	4 · d	6 · d	3 · d

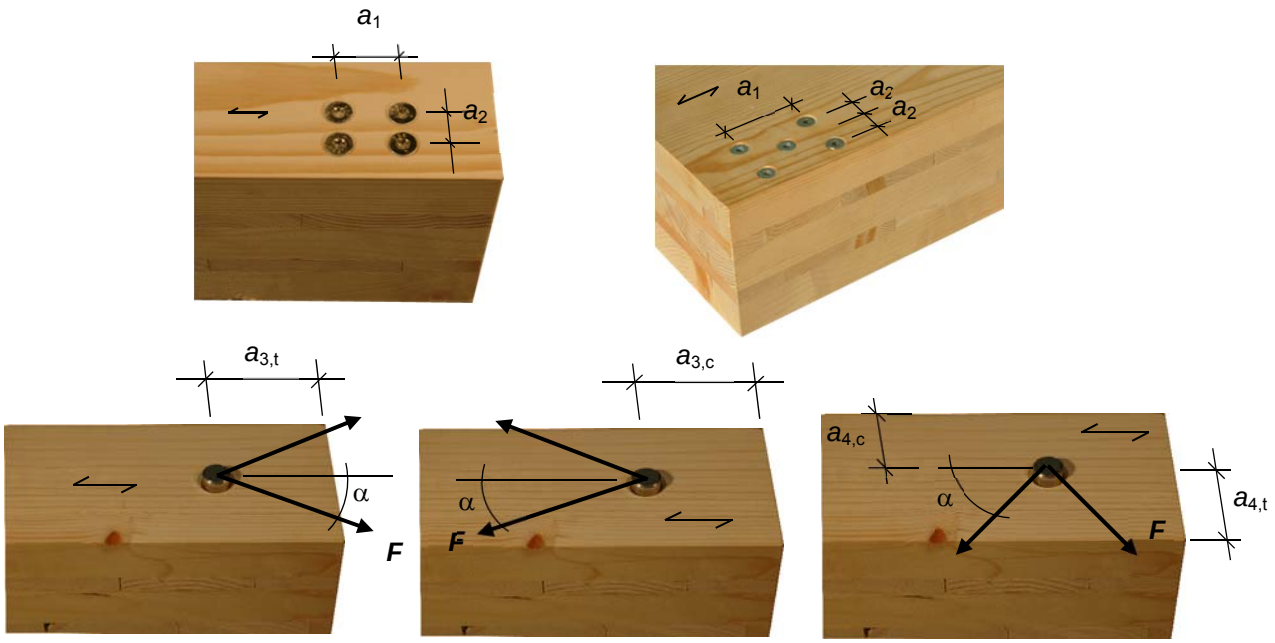

Figure A.2.1 Definition of spacing, end and edge distances in the plane surface

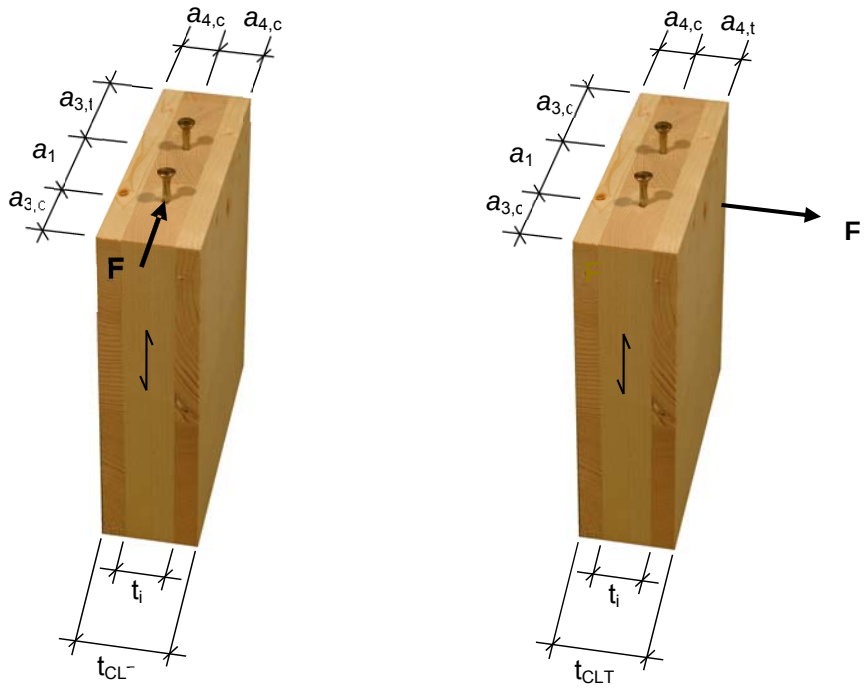

Figure A.2.2: Definition of spacing, end and edge distances in the edge surface

PanelFix screws	Annex 2
Spacing, end and edge distances	

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A.2.5 Insertion moment

The ratio between the characteristic torsional strength $f_{tor,k}$ and the mean value of insertion moment $R_{tor,mean}$ fulfills the requirement for all PanelFix screws.

A.2.6 Durability against corrosion

Screws and washers made from carbon steel may have the coatings according to Table A.2.4

Table A.2.4 Coatings of the PanelFix screws

Coating		**Mean thickness of the coating [µm]**
electrogalvanised	blue chromaed	6
	yellow chromated	
Zinc flake basecoat		5

PanelFix screws	Annex 2
Insertion moment and durability against corrosion	

ANNEX 3 - Fastening of thermal insulation material on top of rafters

A.3.1 General

PanelFix screws with an outer thread diameter of at least 6 mm may be used for the fixing of thermal insulation material on top of rafters or on wood-based members in vertical façades. In the following, the meaning of the word rafter includes wood-based members with inclinations between 0° and 90°.
The thickness of the thermal insulation material may be up to 300 mm. The thermal insulation material shall be applicable as insulation on top of rafters or for façades according to national provisions that apply at the installation site.
The battens have to be from solid timber according to EN 338/ EN 14081-1. The minimum thickness t and the minimum width b of the battens are given in table A.3.1:

Table A.3.1 Minimum thickness and minimum width of the battens

Outer thread diameter [mm]	Minimum thickness t [mm]	Minimum width b [mm]
6 and 8	30	50
10	40	60

Instead of battens the wood-based panels specified in chapter A.3.2.1 may be used. Only screws with countersunk head shall be used for fixing wood-based panels on rafters with thermal insulation material as interlayer.

The minimum width of the rafters shall be 60 mm.

The spacing between screws shall be not more than 1.75 m.

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

The anchorage of wind suction forces as well as the bending stresses of the battens shall be considered for design. Screws perpendicular to the grain of the rafter (angle $\alpha = 90\,°$) may be arranged where required considering the design of the battens.

A.3.2 Parallel inclined screws and thermal insulation material in compression

A.3.2.1 Mechanical model

The system of rafter, thermal insulation material on top of rafter and counter battens parallel to the rafter may be considered as a beam on elastic foundation. The counter batten represents the beam, and the thermal insulation material on top of the rafter the elastic foundation. The minimum compressive stress of the thermal insulation material at 10 % deformation, measured according to EN 826[13], shall be $\sigma_{(10\,\%)}$ = 0.05 N/mm². The counter batten is loaded perpendicular to the axis by point loads F_b transferred by regularly spaced battens. Further point loads F_s are caused by the shear load of the roof due to dead and snow load, which are transferred from the screw heads into the counter battens.

Instead of battens the following wood-based panels may be used to cover the thermal insulation material if they are suitable for that use:

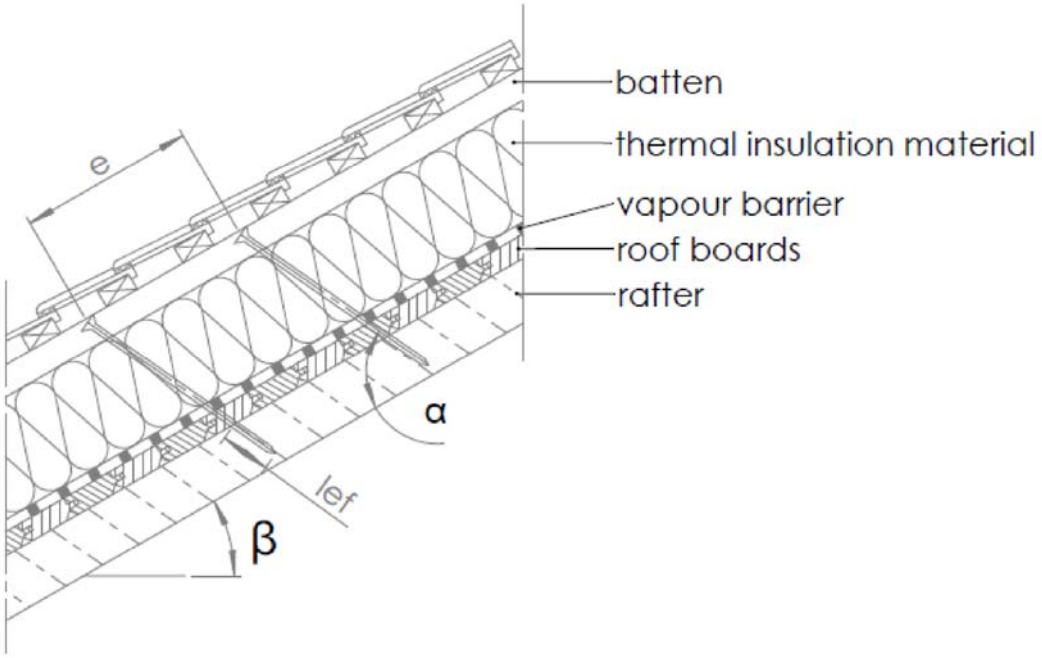
- Plywood according to EN 636 and EN 13986,
- Oriented Strand Board, OSB according to EN 300 and EN 13986,
- Particleboard according to EN 312 and EN 13986
- Fibreboards according to EN 622-2, EN 622-3 and EN 13986.

The minimum thickness of the wood-based panels shall be 22 mm.

The word batten includes the meaning of wood-based panels in the following.

[13] EN 826:2013 Thermal insulating products for building applications - Determination of compression behaviour

PanelFix screws	Annex 3
Fastening of thermal insulation material on top of rafters	



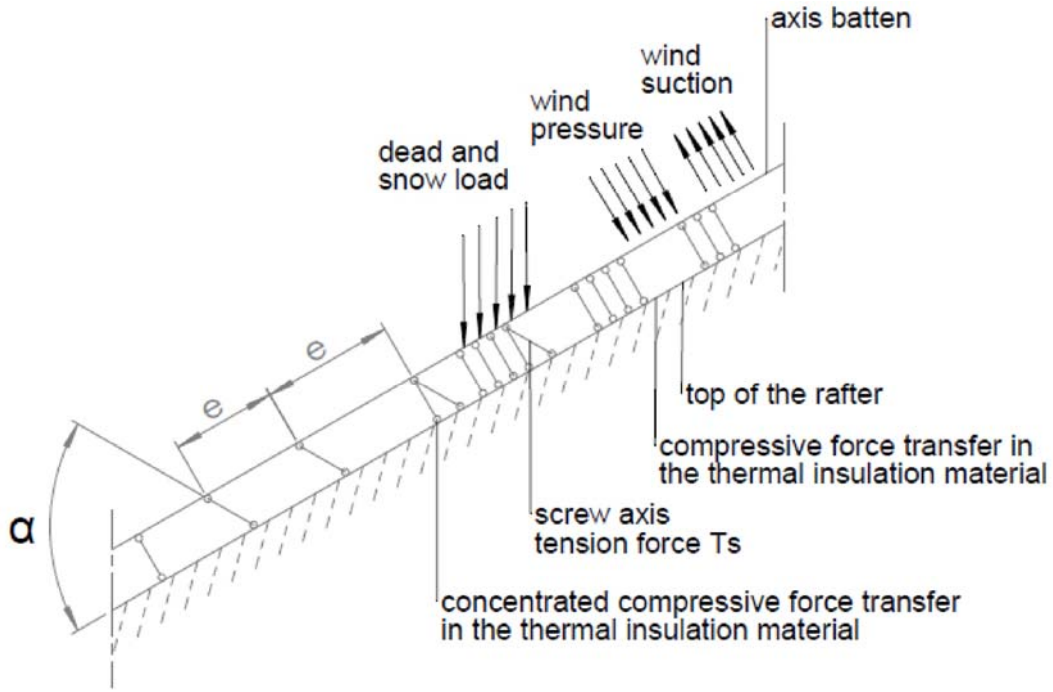


Figure A.3.1 Fastening of the thermal isulation material on top of rafters - structural system

PanelFix screws	Annex 3
Fastening of thermal insulation material on top of rafters	

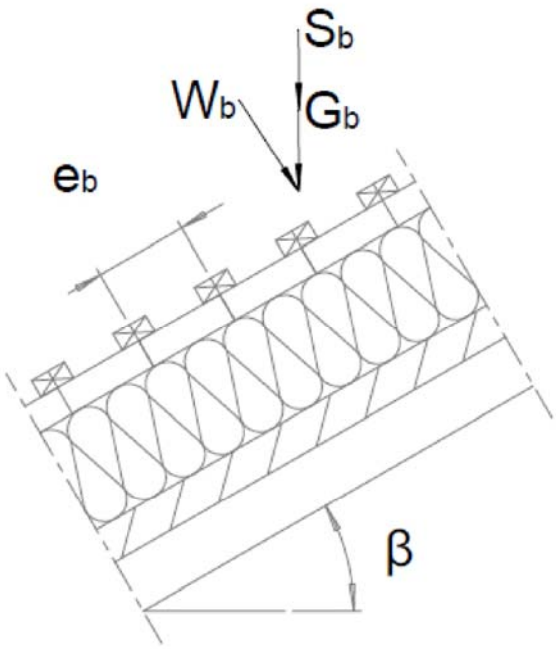


Figure A.3.2:
Point loads Fb perpendicular to the battens

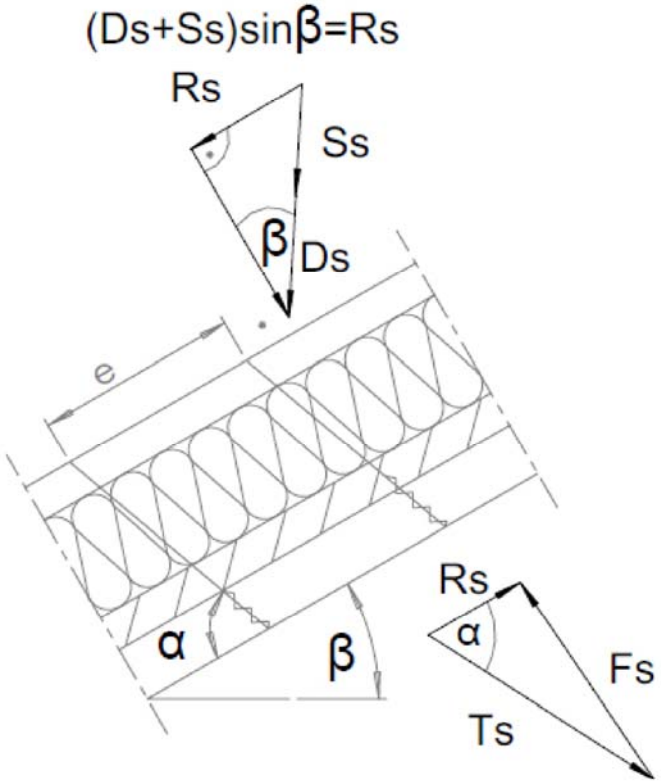


Figure A.3.3:
Point loads Fs perpendicular to the battens,
load application in the area of the screw heads

PanelFix screws	Annex 3
Fastening of thermal insulation material on top of rafters	

A.3.2.2 Design of the battens

It's assumed that the spacing between the counter battens exceeds the characteristic length l_{char}.

The characteristic values of the bending stresses are calculated as:

$$M_k = \frac{(F_{b,k} + F_{s,k}) \cdot l_{char}}{4} \tag{3.1}$$

where

$$l_{char} = \text{characteristic length } l_{char} = \sqrt[4]{\frac{4 \cdot EI}{w_{ef} \cdot K}} \tag{3.2}$$

EI = bending stiffness of the batten
K = coefficient of subgrade
w_{ef} = effective width of the thermal insulation material
$F_{b,k}$ = point loads perpendicular to the battens
$F_{s,k}$ = 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 thermal insulation material if the effective width w_{ef} of the thermal insulation material under compression is known. Due to the load extension in the thermal insulation material the effective width w_{ef} is greater than the width of the batten or rafter, respectively. For further calculations, the effective width w_{ef} of the thermal insulation material may be determined according to:

$$w_{ef} = w + t_{HI}/2 \tag{3.3}$$

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

$$K = \frac{E_{HI}}{t_{HI}} \tag{3.4}$$

The following condition shall be satisfied:

$$\frac{\sigma_{m,d}}{f_{m,d}} = \frac{M_d}{W \cdot f_{m,d}} \le 1 \tag{3.5}$$

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

The characteristic values of the shear stresses shall be calculated according to:

$$V_k = \frac{(F_b + F_s)}{2} \tag{3.6}$$

The following condition need to be satisfied:

$$\frac{\tau_d}{f_{v,d}} = \frac{1.5 \cdot V_d}{A \cdot f_{v,d}} \le 1 \tag{3.7}$$

For the calculation of the cross section area the net cross section shall be considered.

A.4.2.3 Design of the thermal insulation material

The characteristic value of the compressive stresses in the thermal insulation material shall be calculated according to:

$$\sigma_k = \frac{1.5 \cdot F_{b,k} + F_{s,k}}{2 \cdot l_{char} \cdot w} \qquad (3.8)$$

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

A.4.2.4 Design of the screws

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

$$T_{S,k} = \frac{R_{S,k}}{\cos \alpha} \qquad (3.9)$$

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 according to Annex 2.

In order to limit the deformation of the screw head for thermal insulation material with thickness over 220 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:

$$F_{ax,\alpha,Rd} = \min \left\{ \frac{k_{ax} \cdot f_{ax,d} \cdot d \cdot l_{ef} \cdot k_1 \cdot k_2}{1.2 \cdot \cos^2 \alpha + \sin^2 \alpha} \cdot \left(\frac{\rho_k}{350} \right)^{0.8} ; f_{head,d} \cdot d_h^2 \cdot \left(\frac{\rho_k}{350} \right)^{0.8} ; \frac{f_{tens,k}}{\gamma_{M2}} \right\} \qquad (3.10)$$

where:

k_{ax}	factor, taking into account the angle α between screw axis and grain direction according to A.2.3.1
$f_{ax,d}$	design value of the axial withdrawal parameter of the threaded part of the screw [N/mm²]
d	outer thread diameter of the screw [mm]
l_{ef}	penetration length of the threaded part of the screw in the rafter [mm], 40 mm ≤ l_{ef} ≤ 100 mm
ρ_k	characteristic density of the wood-based member [kg/m³], for LVL the assumed characteristic density shall not exceed 500 kg/m³
α	angle α between screw axis and grain direction, 15° ≤ α ≤ 90°
$f_{head,d}$	design value of the head pull-through parameter of the screw [N/mm²]
d_h	head diameter of the screw [mm]
$f_{tens,k}$	characteristic tensile capacity of the screw according to Annex 2 [N]
γ_{M2}	partial factor according to EN 1993-1-1 in conjunction with the particular national annex
k_1	min {1; 220/t_{HI}}
k_2	min {1; $\sigma_{10\%}$/0.12}
t_{HI}	thickness of the thermal insulation material [mm]
$\sigma_{10\%}$	compressive stress of the thermal insulation material under 10 % deformation [N/mm²]

If equation (3.10) is fulfilled, the deflection of the battens does not need to be considered when designing the load-carrying capacity of the screws.

PanelFix screws	Annex 3
Fastening of thermal insulation material on top of rafters	

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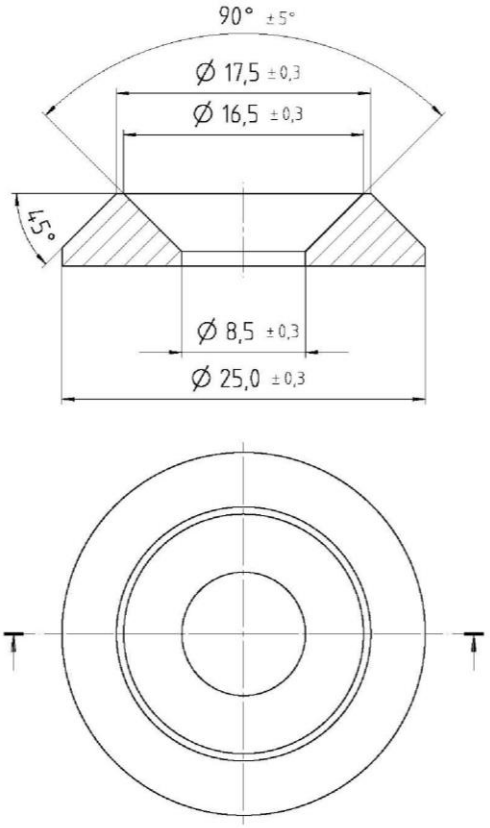
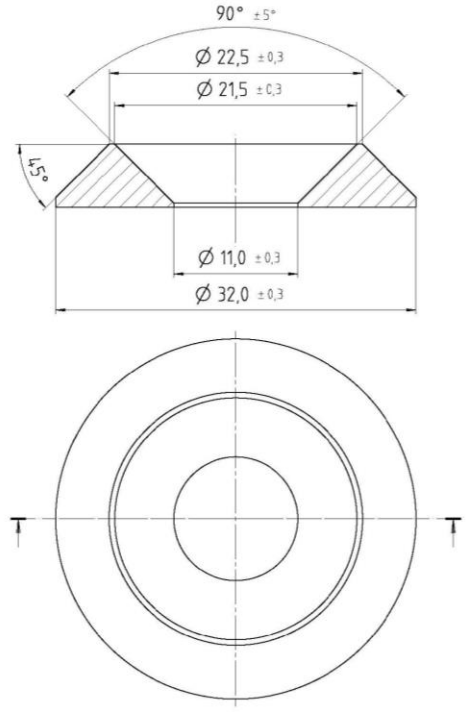
Wafer for PanelFix

Wafer for PanelFix diameter 8,0



Wafer for PanelFix diameter 10,0



PanelFix screws	Annex 4.1
Washers for screws with flat head	

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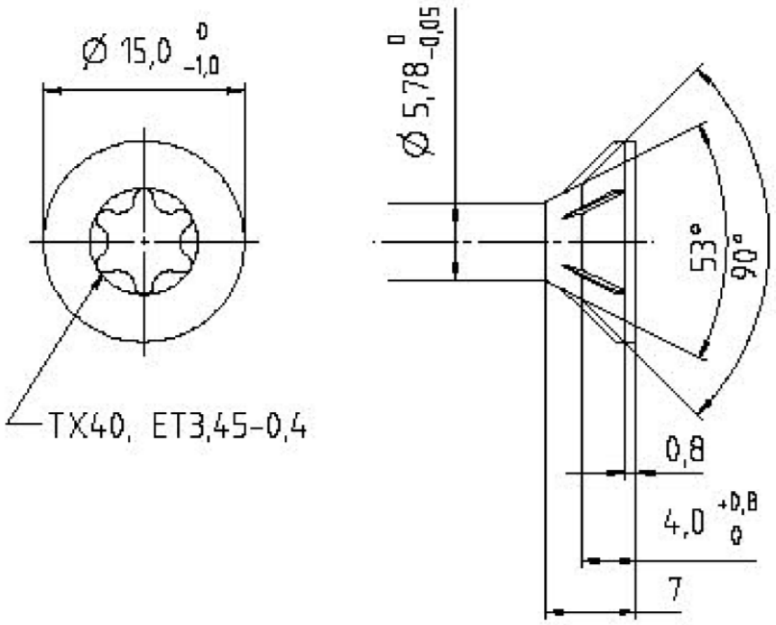
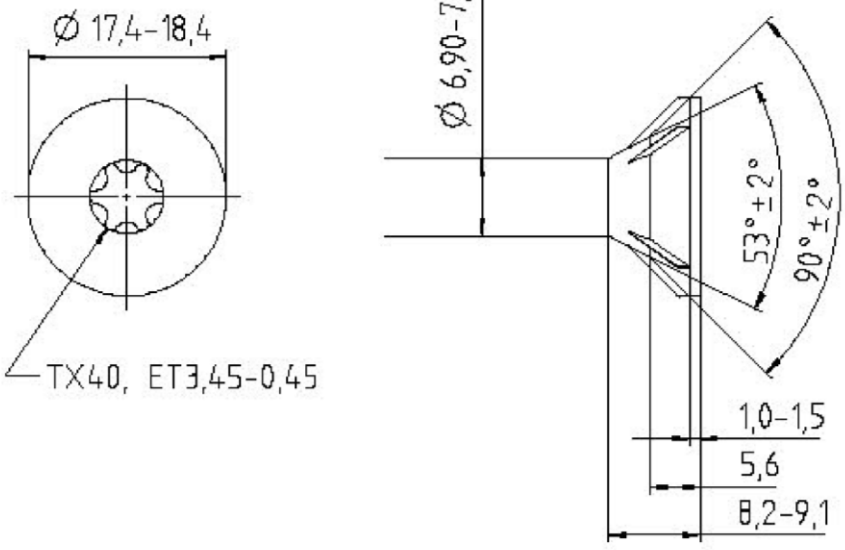
Flat head diameter 8,0



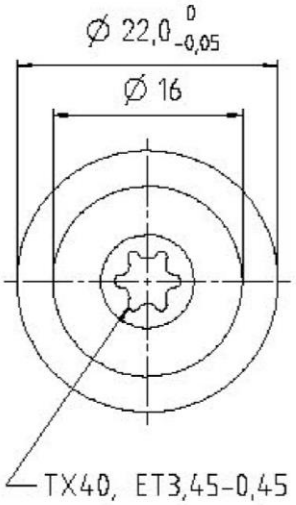
Flat head diameter 10,0

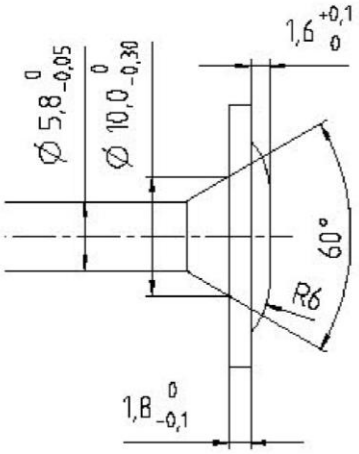


PanelFix screws	Annex 4.2
Flat head	

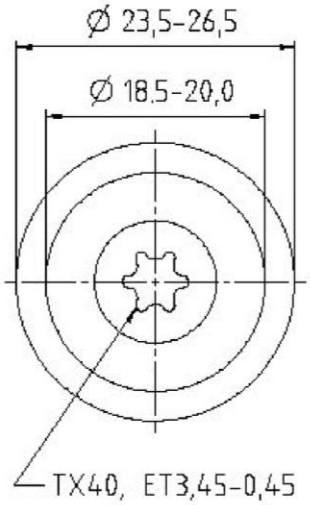
Deutsches Institut für Bautechnik DIBt

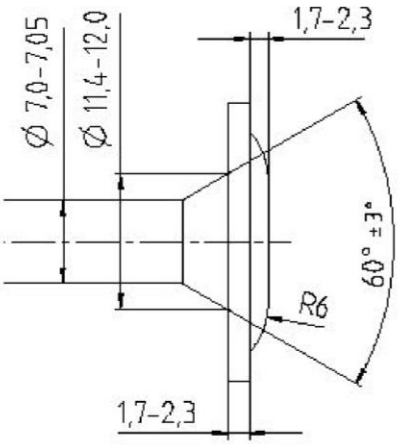
Wafer head for diameter 8,0





Wafer head for diameter 10,0

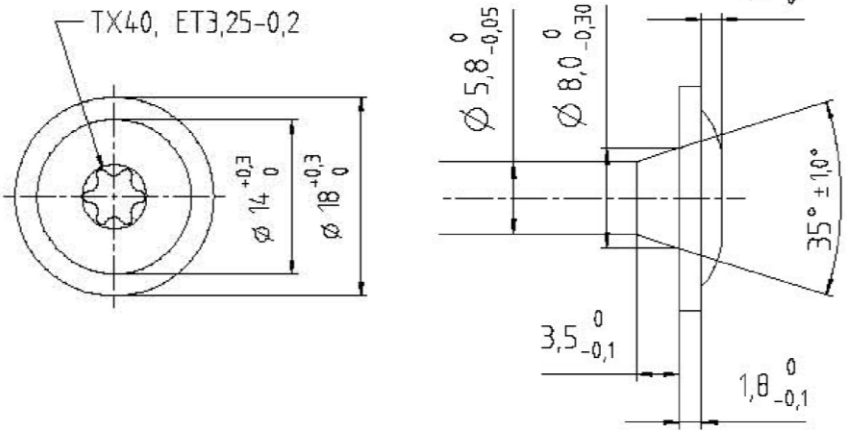




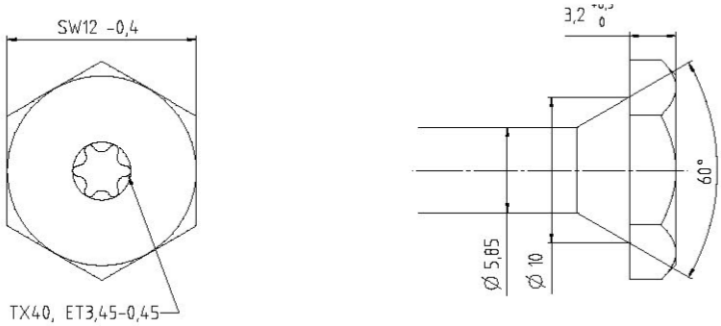
PanelFix screws	Annex 4.3
Wafer head	

Deutsches Institut für Bautechnik DIBt

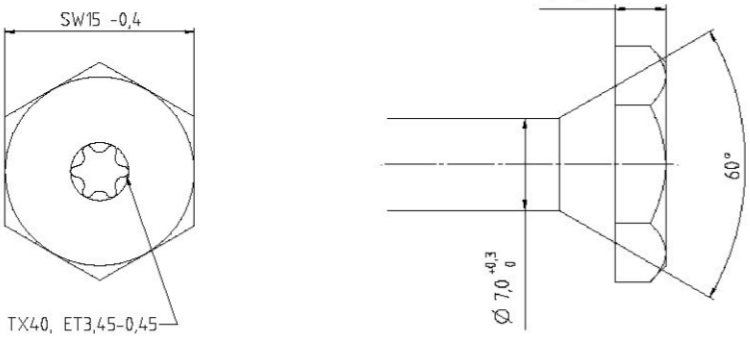
Wafer head for diameter 8,0



Combi-head for diameter 8,0



Combi-head for diameter 10,0



PanelFix screws	Annex 4.4
Wafer head and Combi-head	

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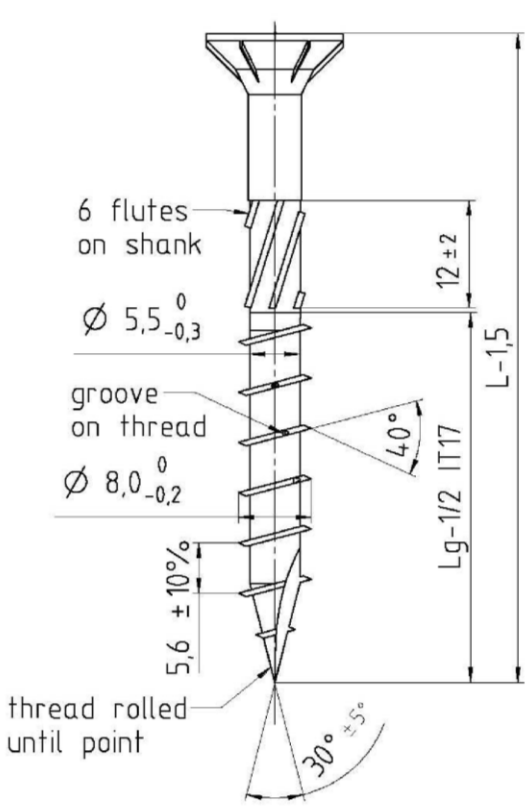
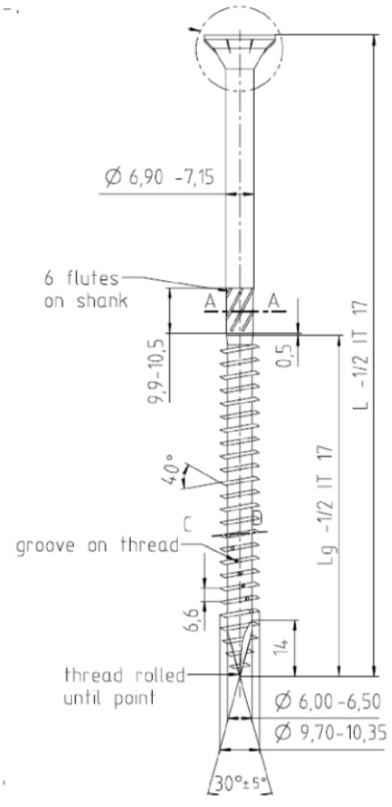
Flat head, normal thread and 1-cut point diameter 8,0



L	Lg
80	52
100	60
120	80
140	80
160	80/90
180	80/100
200	80/100
220	80/100
240	80/100
260	80/100
280	80/100
300	80/100
320	80/100
340	80/100
360	80/100
380	80/100
400	80/100

Flat head, normal thread and 1-cut point diameter 10,0



L	Lg
80	48
90	54
100	60
120	80
140	80
160	80/90
180	80/100
200	80/100
220	80/100
240	80/100
260	80/100
280	80/100
300	80/100
320	80/100
340	80/100
360	80/100
380	80/100
400	80/100

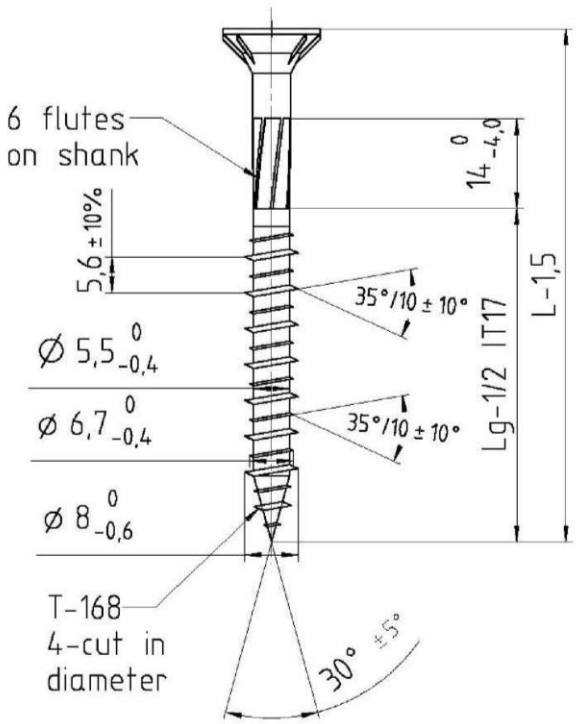
PanelFix screws

Flat head screw with normal thread

Annex 4.5

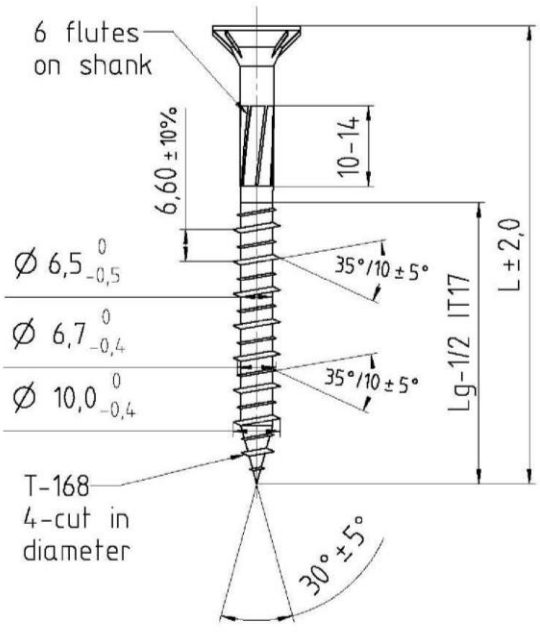
Deutsches Institut für Bautechnik DIBt

Flat head, hilo thread and 4-cut point diameter 8,0



L	Lg
80	52
100	60
120	80
140	80
160	80/90
180	80/100
200	80/100
220	80/100
240	80/100
260	80/100
280	80/100
300	80/100
320	80/100
340	80/100
360	80/100
380	80/100
400	80/100

Flat head, hilo thread and 4-cut point diameter 10,0



L	Lg
80	52
100	60
120	80
140	80
160	80/100
180	80/100
200	80/100
220	80/100
240	80/100
260	80/100
280	80/100
300	80/100
320	80/100
340	80/100
360	80/100
380	80/100
400	80/100

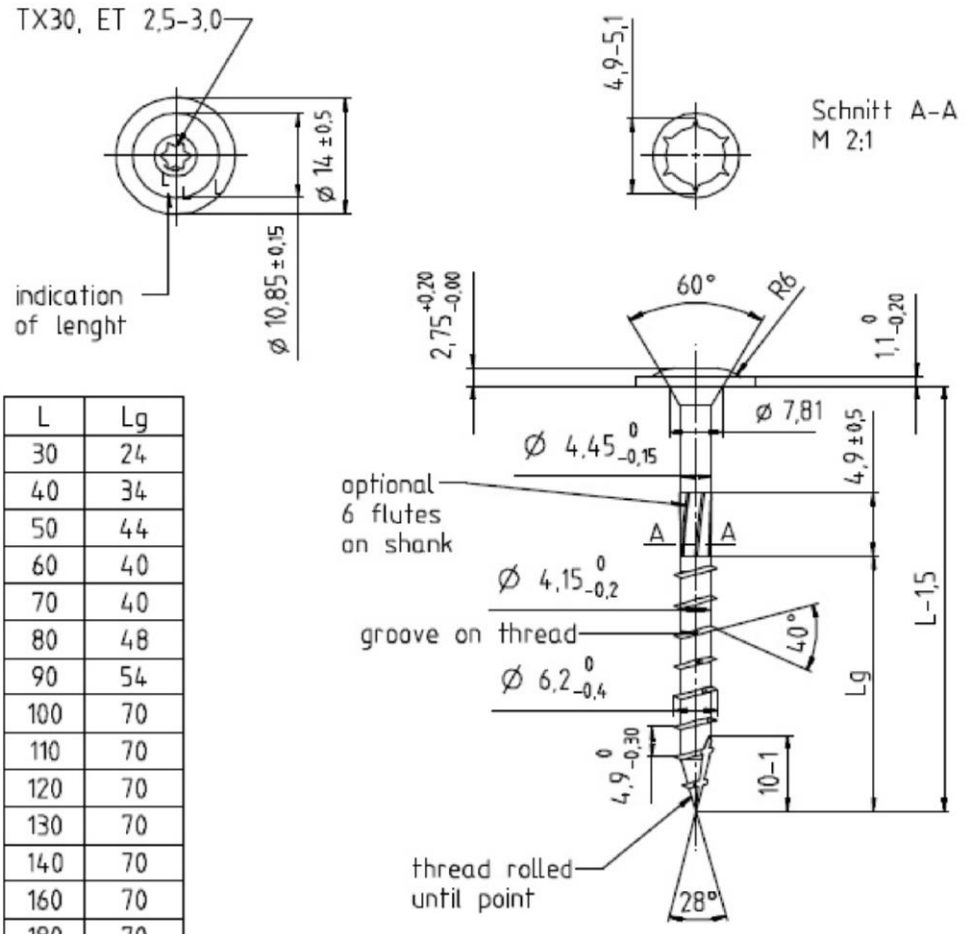
PanelFix screws

Flat head screw with hilo thread

Annex 4.6

Deutsches Institut für Bautechnik DIBt

Wafer head, normal thread and 1-cut point diameter 6,0



L	Lg
30	24
40	34
50	44
60	40
70	40
80	48
90	54
100	70
110	70
120	70
130	70
140	70
160	70
180	70
200	70
220	70
240	70
260	70
280	70
300	70

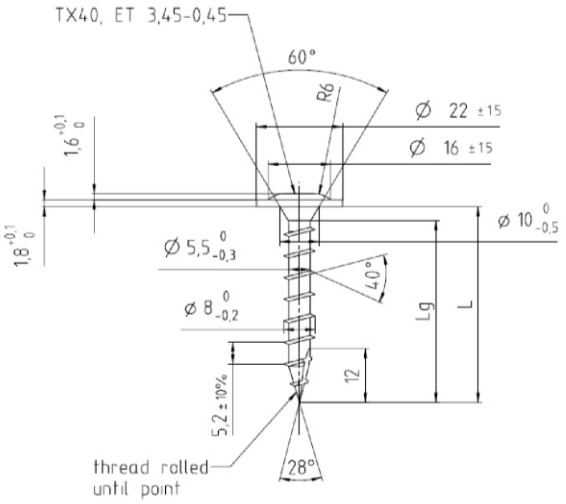
PanelFix screws

Wafer head screw with normal thread

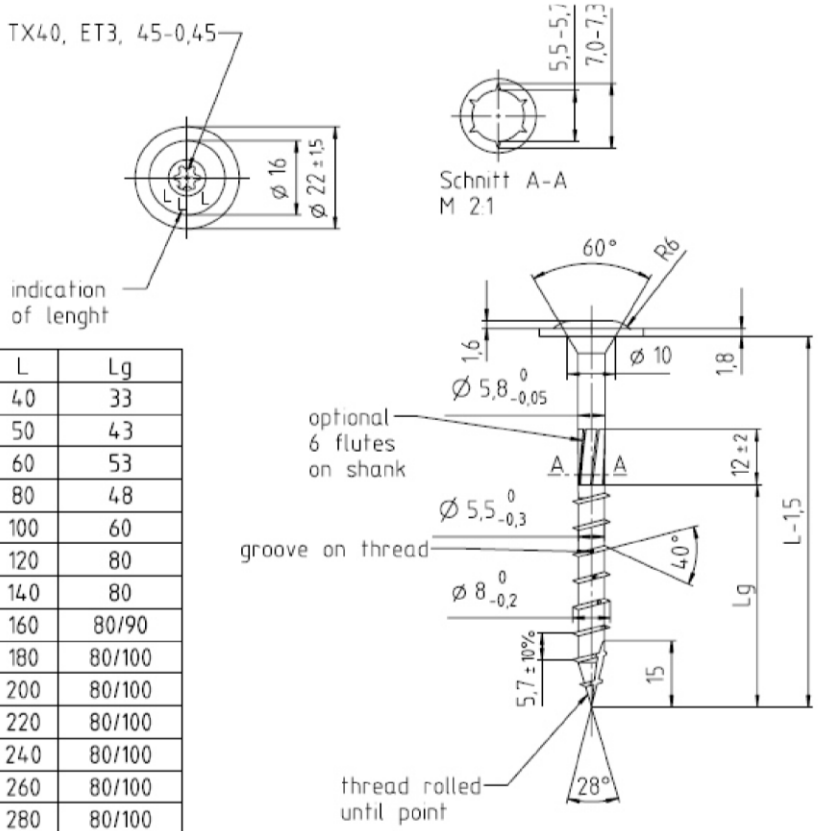
Annex 4.7

Deutsches Institut für Bautechnik

Wafer head, full thread and 1-cut point diameter 8,0



Wafer head, normal thread and 1-cut point diameter 8,0



L	Lg
40	33
50	43
60	53
80	48
100	60
120	80
140	80
160	80/90
180	80/100
200	80/100
220	80/100
240	80/100
260	80/100
280	80/100
300	80/100
320	80/100
340	80/100
360	80/100
380	80/100
400	80/100

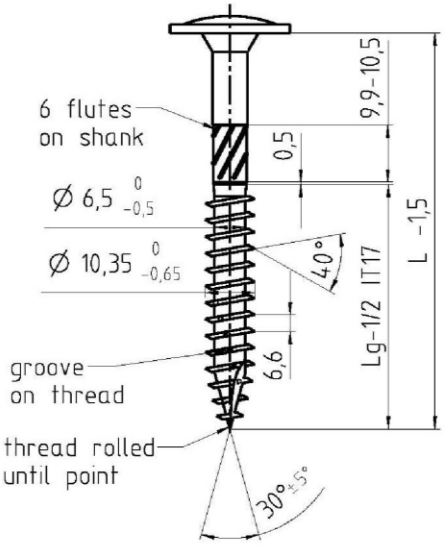
PanelFix screws

Wafer head screw with normal thread

Annex 4.8

Deutsches Institut für Bautechnik DIBt

Wafer head, normal thread and 1-cut point diameter 10,0



L	Lg
80	48
90	54
100	60
120	80
140	80
160	80/90
180	80/100
200	80/100
220	80/100
240	80/100
260	80/100
280	80/100
300	80/100
320	80/100
340	80/100
360	80/100
380	80/100
400	80/100

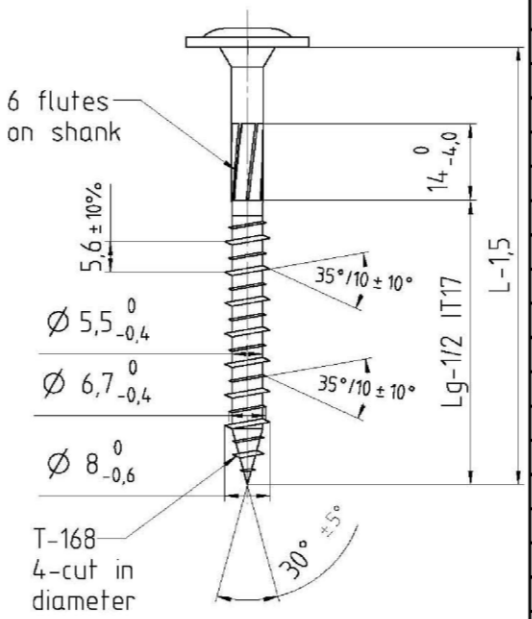
PanelFix screws

Wafer head screw with normal thread

Annex 4.9

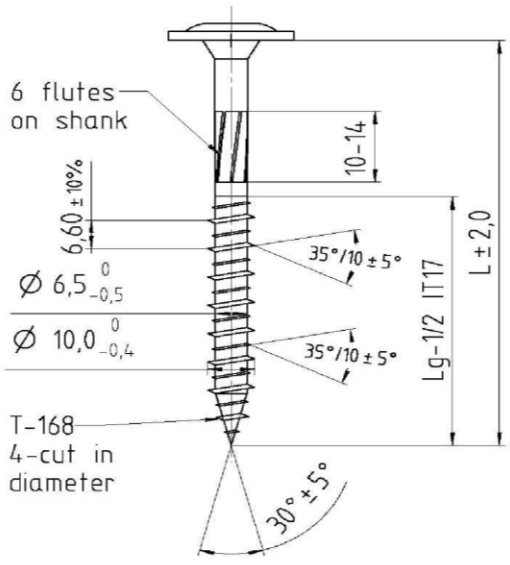
Deutsches Institut für Bautechnik DIBt

Wafer head, hilo thread and 4-cut point diameter 8,0



L	Lg
40	33
50	43
60	53
80	48
100	60
120	80
140	80
160	80/90
180	80/100
200	80/100
220	80/100
240	80/100
260	80/100
280	80/100
300	80/100
320	80/100
340	80/100
360	80/100
380	80/100
400	80/100

Wafer head, hilo thread and 4-cut point diameter 10,0



L	Lg
40	33
50	43
60	53
80	48
100	60
120	80
140	80
160	80/90
180	80/100
200	80/100
220	80/100
240	80/100
260	80/100
280	80/100
300	80/100
320	80/100
340	80/100
360	80/100
380	80/100
400	80/100

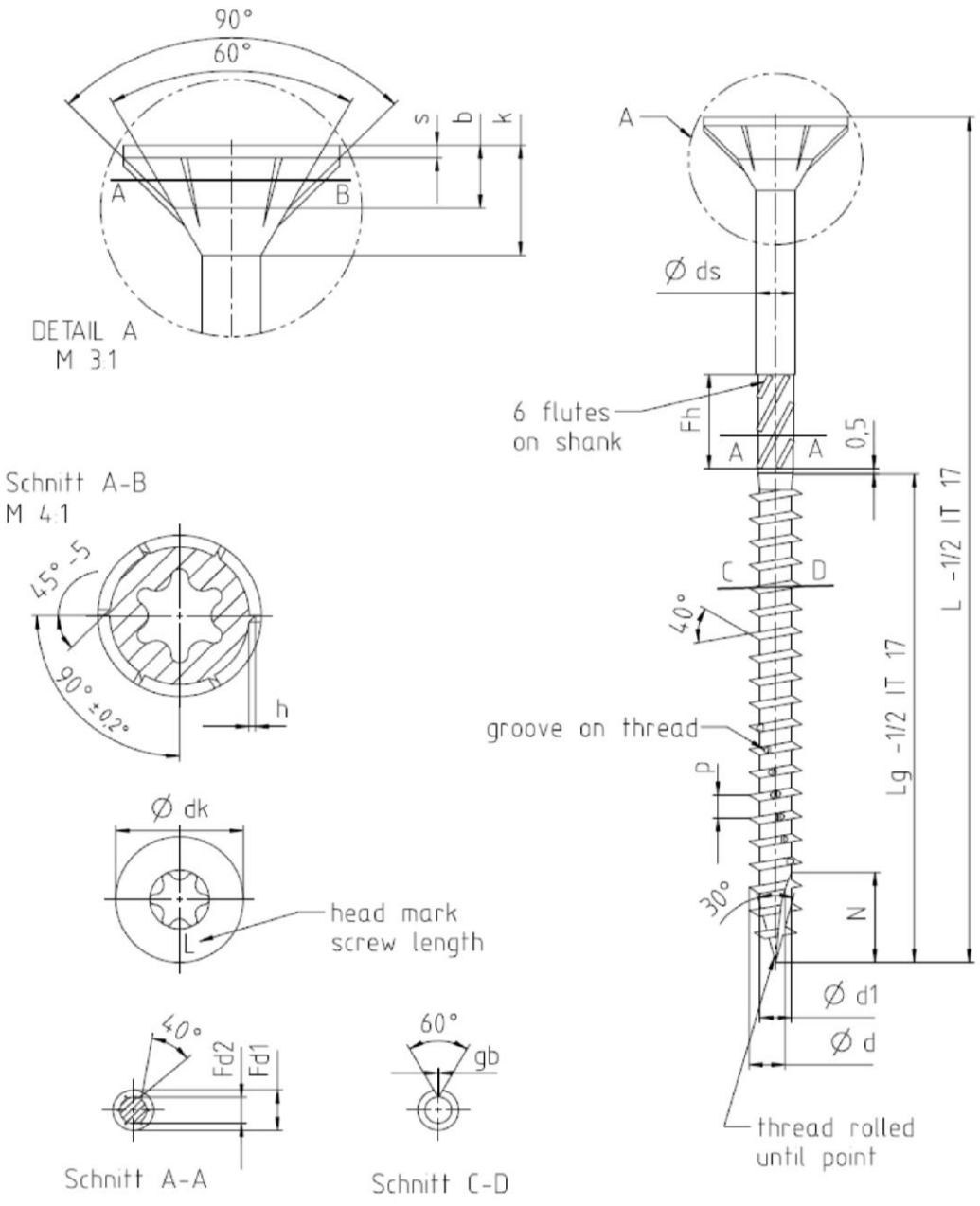
PanelFix screws

Wafer head screw with hilo thread

Annex 4.10

Deutsches Institut für Bautechnik DIBt

Flat head, normal thread and 1-cut point diameter 3,5 – 6,0



PanelFix screws	Annex 4.11
Flat head screw with normal thread	

Deutsches Institut für Bautechnik DIBt

Flat head, normal thread and 1-cut point diameter 3,5 – 6,0

Nenngröße		Ø 3,5	Ø 4,0	Ø 4,5	Ø 5,0	Ø 6,0
d	min	3,30	3,75	4,25	4,70	5,75
	max	3,70	4,10	4,60	5,15	6,20
d_1	min	2,00	2,35	2,60	3,00	3,80
	max	2,25	2,65	2,80	3,45	4,20
d_k	min	6,60	7,50	8,50	9,50	11,50
	max	7,00	8,00	9,00	10,00	12,00
k	min	3,00	3,45	4,15	4,50	5,40
	max	3,30	3,75	4,65	5,00	5,95
b	min	1,45	1,55	1,90	2,00	2,20
	max	1,75	1,85	2,20	2,30	2,50
h	min	0,20	0,25	0,30	0,35	0,40
	max	0,40	0,45	0,50	0,55	0,60
s	min	0,35	0,45	0,70	0,70	1,10
	max	0,65	0,70	1,00	1,10	1,35
N		6,0-7,0	7,0-8,0	8,0-9,0	9,0-10	10,0-12,0
hs	min					
	max					
Ls						
F_h	~	3,8-4,0	4,8-5,0	6,8-7,0	7,9 - 8,5	9,9-10,5
d_s	min	2,20	2,60	2,80	3,60	4,30
	max	2,40	2,80	3,10	3,80	4,50
F_{d1}		2,60 - 2,80	2,80 - 3,05	3,30 - 3,50	3,80- 4,00	4,50 - 5,00
F_{d2}		2,05-2,25	2,50- 2,80	2,65 - 2,80	3,15 - 3,30	4,15 - 4,30
g_b		0,2	0,2	0,2	0,20	0,20
P	± 10%	2,24	2,52	2,80	3,10	4,90
TX		**20**	**20**	**20/25**	**25/30**	**30**
ET	min	**1,65**	**2,00**	**2,20**	**2,30**	**2,60**
	max	**1,80**	**2,15**	**2,30**	**2,40**	**3,05**

Diameter		Ø 3,5	Ø 4,0	Ø 4,5	Ø 5,0	Ø 6,0
Length		Thread length lg				
L max.	L min.					
30	28,95	18				
40	38,75	24	24	24	24	
45	43,75	27	27	27	27	
50	48,75	30	30	30	30	
60	58,50		36	36	36	36
70	68,50		42	42	42	42
80	78,50		48	48	48	48
90	88,25				54	54
100	98,25				60	60
110	108,25				70	70
120	118,25				70	70
130	128,00					70
140	138,00					70
150	148,00					70
160	158,00					70
180	178,00					70
200	197,70					70
240	237,70					70
260	257,40					70
280	277,40					70
300	297,40					70

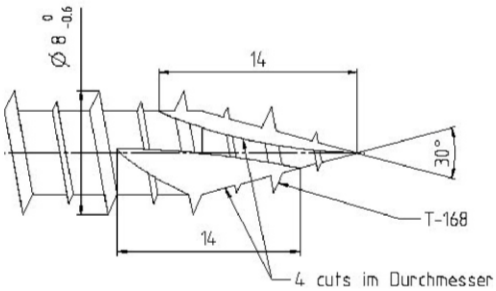
PanelFix screws

Flat head screw with normal thread

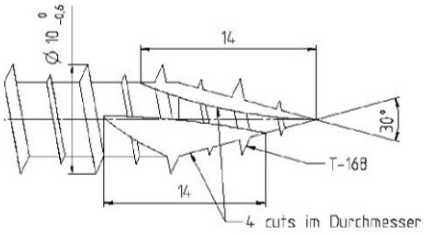
Annex 4.12

Deutsches Institut für Bautechnik DIBt

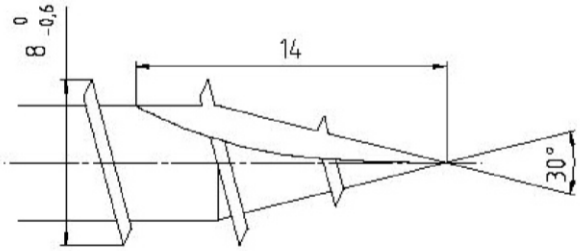
4-cut point for diameter 8,0



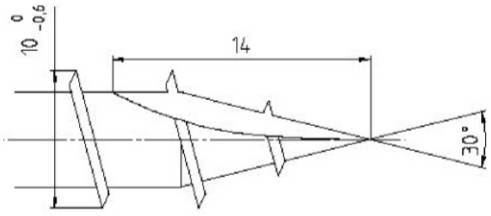
4-cut point for diameter 10,0



1-cut point for diameter 8,0



1-cut point for diameter 10,0



PanelFix screws	Annex 4.13
Screw points	