



## European Technical Approval ETA-12/0038

English translation prepared by DIBt - Original version in German language

Handelsbezeichnung  
*Trade name*

Holzbauschrauben Twin UD und PIR-FIX  
*Screws Twin UD and PIR-FIX*

Zulassungsinhaber  
*Holder of approval*

SFS intec AG  
FasteningSystems  
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SCHWEIZ

Zulassungsgegenstand  
und Verwendungszweck  
*Generic type and use  
of construction product*

Holzbauschrauben Twin UD und PIR-FIX als Holzverbindungsmittel  
*Screws Twin UD and PIR-FIX for use in timber constructions*

Geltungsdauer:  
*Validity:* vom  
from  
bis  
to

28 June 2013  
24 May 2017

Herstellwerk  
*Manufacturing plant*

Herstellwerk 1

Diese Zulassung umfasst  
*This Approval contains*

25 Seiten einschließlich 3 Anhänge  
*25 pages including 3 annexes*

Diese Zulassung ersetzt  
*This Approval replaces*

ETA-12/0038 mit Geltungsdauer vom 24.05.2012 bis 24.05.2017  
*ETA-12/0038 with validity from 24.05.2012 to 24.05.2017*

## I LEGAL BASES AND GENERAL CONDITIONS

- 1 This European technical approval is issued by Deutsches Institut für Bautechnik in accordance with:
  - Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products<sup>1</sup>, modified by Council Directive 93/68/EEC<sup>2</sup> and Regulation (EC) N° 1882/2003 of the European Parliament and of the Council<sup>3</sup>;
  - *Gesetz über das In-Verkehr-Bringen von und den freien Warenverkehr mit Bauprodukten zur Umsetzung der Richtlinie 89/106/EWG des Rates vom 21. Dezember 1988 zur Angleichung der Rechts- und Verwaltungsvorschriften der Mitgliedstaaten über Bauprodukte und anderer Rechtsakte der Europäischen Gemeinschaften (Bauproduktengesetz - BauPG) vom 28. April 1998<sup>4</sup>, as amended by Article 2 of the law of 8 November 2011<sup>5</sup>;*
  - Common Procedural Rules for Requesting, Preparing and the Granting of European technical approvals set out in the Annex to Commission Decision 94/23/EC<sup>6</sup>.
- 2 Deutsches Institut für Bautechnik is authorized to check whether the provisions of this European technical approval are met. Checking may take place in the manufacturing plant. Nevertheless, the responsibility for the conformity of the products to the European technical approval and for their fitness for the intended use remains with the holder of the European technical approval.
- 3 This European technical approval is not to be transferred to manufacturers or agents of manufacturers other than those indicated on page 1, or manufacturing plants other than those indicated on page 1 of this European technical approval.
- 4 This European technical approval may be withdrawn by Deutsches Institut für Bautechnik, in particular pursuant to information by the Commission according to Article 5(1) of Council Directive 89/106/EEC.
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- 6 The European technical approval is issued by the approval body in its official language. This version corresponds fully to the version circulated within EOTA. Translations into other languages have to be designated as such.

<sup>1</sup> Official Journal of the European Communities L 40, 11 February 1989, p. 12  
<sup>2</sup> Official Journal of the European Communities L 220, 30 August 1993, p. 1  
<sup>3</sup> Official Journal of the European Union L 284, 31 October 2003, p. 25  
<sup>4</sup> *Bundesgesetzblatt Teil I 1998*, p. 812  
<sup>5</sup> *Bundesgesetzblatt Teil I 2011*, p. 2178  
<sup>6</sup> Official Journal of the European Communities L 17, 20 January 1994, p. 34

## II SPECIFIC CONDITIONS OF THE EUROPEAN TECHNICAL APPROVAL

### 1 Definition of products and intended use

#### 1.1 Definition of the construction product

Twin UD and PIR-FIX screws are self-tapping screws made from special carbon steel. They have a corrosion protection according to Annex A 1.6. The outer thread diameter of the threaded part close to the head is 8.8 mm and 7.5 mm in the threaded part close to the tip. The overall length of the screws is ranging from 160 mm to 600 mm. Further dimensions are shown in Annex 3.

#### 1.2 Intended use

The screws are intended to be used for connecting wood-based members, where requirements for mechanical resistance and stability and safety in use in the sense of the essential requirements N 1 and N 4 of Council Directive 89/106/EEC shall be fulfilled.

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) of strength classes C14 – C40 according to EN 338<sup>7</sup>/ EN 14081-1<sup>8</sup>,
- Glued laminated timber (softwood) of at least strength class GL24c according to EN 1194<sup>9</sup>/ EN 14080<sup>10</sup>,
- Laminated veneer lumber LVL (softwood) according to EN 14374<sup>11</sup>,
- Glued laminated solid timber Duo- and Triobalken (softwood) according to EN 14080 or national provisions that apply at the installation site
- Cross-laminated timber (softwood) according to European technical approvals 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<sup>12</sup> and EN 13986<sup>13</sup>,
- Oriented Strand Board, OSB according to EN 300<sup>14</sup> and EN 13986,
- Particleboard according to EN 312<sup>15</sup> and EN 13986,
- Fibreboards according to EN 622-2<sup>16</sup>, EN 622-3<sup>17</sup> and EN 13986,

7	EN 338:2009	Timber structures - Strength classes
8	EN 14081-1:2005+A1:2011	Timber structures – Strength graded structural timber with rectangular cross section – Part 1: General requirements
9	EN 1194:1999	Timber structures – Glued laminated timber – Strength classes and determination of characteristic values
10	EN 14080:2013	Timber structures – Glued laminated timber and Glued laminated solid timber - Requirements
11	EN 14374:2004	Timber structures - Structural laminated veneer lumber - Requirements
12	EN 636:2003	Plywood - Specifications
13	EN 13986:2004	Wood-based panels for use in construction - Characteristics, evaluation of conformity and marking
14	EN 300:2006	Oriented strand boards (OSB) – Definition, classification and specifications
15	EN 312:2003	Particleboards - Specifications
16	EN 622-2:2004	Fibreboards – Specifications – Part 2: Requirements for hardboards
17	EN 622-3:2004	Fibreboards - Specifications - Part 3: Requirements for medium boards

- Cement-bonded particle boards according to national provisions that apply at the installation site,
- Solid-wood panels according to national provisions that apply at the installation site.

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

Twin UD and PIR-FIX screws may be used for the fixing of thermal insulation material on top of rafters or on wood-based members in vertical façades.

The scope of the screws regarding resistance to corrosion shall be defined according to national provisions that apply at the installation site considering environmental conditions. Annex 1.6 contains the corrosion protection for Twin UD and PIR-FIX screws.

The screws may be used for connections subject to static or quasi static loading.

The provisions made in this European technical approval are based on an assumed working life of the screws of 50 years, provided that the conditions laid down in section 4.2 for the installation are met. 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.

## 2 Characteristics of product

	Characteristic	Assessment of characteristic
2.1 Mechanical resistance and stability <sup>*)</sup>		
2.1.1	Dimensions	See Annex 3
2.1.2	Characteristic yield moment	See Annex 1
2.1.3	Characteristic withdrawal parameter	See Annex 1
2.1.4	Characteristic head pull-through parameter	See Annex 1
2.1.5	Characteristic tensile strength	See Annex 1
2.1.6	Characteristic yield strength	See Annex 2
2.1.7	Characteristic torsional strength	See Annex 1
2.1.8	Insertion moment	See Annex 1
2.1.9	Spacing, end and edge distances of the screws and minimum thickness of the wood based material	See Annex 1
2.1.10	Slip modulus for mainly axially loaded screws	See Annex 1

	Characteristic	Assessment of characteristic
2.2 Safety in case of fire		
2.2.1	Reaction to fire	Self-tapping 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.
2.3 Hygiene, health and the environment		
2.3.1	Content and/or release of dangerous substances	The product does not contain cadmium. There is no risk that chrome VI – contained in the chromated carbon steel screws – will be released by consideration of all possible release scenarios. <sup>**)</sup>
2.4 Safety in use		
2.4.1	Dimensions	See Annex 3
2.4.2	Characteristic yield moment	See Annex 1
2.4.3	Characteristic withdrawal parameter	See Annex 1
2.4.4	Characteristic head pull-through parameter	See Annex 1
2.4.5	Characteristic tensile strength	See Annex 1
2.4.6	Characteristic yield strength	See Annex 2
2.4.7	Characteristic torsional strength	See Annex 1
2.4.8	Insertion moment	See Annex 1
2.4.9	Spacing, end and edge distances of the screws and minimum thickness of the wood based material	See Annex 1
2.4.10	Slip modulus for mainly axially loaded screws	See Annex 1

<sup>\*\*)</sup> In accordance with <http://ec.europa.eu/enterprise/construction/cpd-ds/>. In addition to the specific clauses relating to dangerous substances contained in this European technical approval, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive, these requirements need also to be complied with, when and where they apply.

	Characteristic	Assessment of characteristic
	Protection against noise	Not relevant
	Energy economy and heat retention	Not relevant
2.5 General aspects relating to fitness for use		
2.5.1	Durability against corrosion	See Annex 1
2.5.2	Serviceability	The assessment for mechanical resistance and stability as well as durability against corrosion covers this property.

## 2.1 Mechanical resistance and stability

Annexes 1 to 2 contain the load-carrying capacities for Twin UD and PIR-FIX self-tapping screws.

The design and construction shall be carried out according to national provisions that apply at the installation site in line with the partial safety factor format, e.g. in accordance with EN 1995-1-1.

## 3 Evaluation and attestation of conformity and CE marking

### 3.1 System of attestation of conformity

According to the decision 97/638/EC of the European Commission<sup>18</sup> the system 2+ of attestation of conformity applies.

This system of attestation of conformity is defined as follows:

System 2+: Declaration of conformity of the product by the manufacturer on the basis of:

(a) Tasks for the manufacturer:

- (1) initial type-testing of the product;
- (2) factory production control;
- (3) testing of samples taken at the factory in accordance with a prescribed test plan.

(b) Tasks for the approved body:

- (4) certification of factory production control on the basis of:
  - initial inspection of factory and of factory production control;
  - continuous surveillance, assessment and approval of factory production control.

Note: Approved bodies are also referred to as "notified bodies".

### 3.2 Responsibilities

#### 3.2.1 Tasks for the manufacturer

##### 3.2.1.1 Factory production control

The manufacturer shall exercise permanent internal control of production. All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures, including records of results performed. This production control system shall insure that the product is in conformity with this European technical approval.

<sup>18</sup>

Official Journal of the European Communities L 268/36 of 19 September 1997

The manufacturer may only use raw materials stated in the technical documentation of this European technical approval supplied with the relevant inspection documents as laid down in the control plan.

The factory production control shall be in accordance with the "control plan relating to the European technical approval ETA-12/0038 issued on 28 June 2013" which is part of the technical documentation of this European technical approval. The control plan is laid down in the context of the factory production control system operated by the manufacturer and deposited with Deutsches Institut für Bautechnik.<sup>19</sup>

The incoming raw materials shall be subject to controls and tests by the manufacturer before acceptance. Check of materials, such as steel rods or wire, shall include control of the inspection documents presented by suppliers (comparison with nominal values) by verifying dimension and determining material properties, e.g. chemical composition, mechanical properties and corrosion protection.

The manufactured components shall be checked visually and for dimensions. The control plan includes details of the extent, nature and frequency of testing and controls to be performed within the factory production control.

The results of factory production control shall be recorded and evaluated in accordance with the provisions of the control plan. The records shall include at least the following information:

- Designation of the product, basic material and components,
- Type of control or testing,
- Date of manufacture of the product and date of testing of the product or basic material and components,
- Result of control and testing and, if appropriate, comparison with requirements,
- Signature of person responsible for factory production control.

The records shall be presented to the approved body involved in the continuous surveillance and shall be presented to Deutsches Institut für Bautechnik on request.

#### 3.2.1.2 Initial type testing

For initial type-testing the results of the tests performed as part of the assessment for the European technical approval may be used unless there are changes in the production line or plant. In such cases the necessary initial type-testing has to be agreed between Deutsches Institut für Bautechnik and the notified body.

#### 3.2.1.3 Other tasks for the manufacturer

The manufacturer shall, on the basis of a contract, involve a body which is approved for the tasks referred to in section 3.1 in the field of screws in order to undertake the actions laid down in section 3.2.2. For this purpose, the control plan referred to in sections 3.2.1.1 and 3.2.2 shall be handed over by the manufacturer to the approved body involved.

The manufacturer shall make a declaration of conformity, stating that the construction product is in conformity with the provisions of the European technical approval ETA-12/0038 issued on 28 June 2013.

<sup>19</sup> The "control plan" is a confidential part of the European technical approval and only handed over to the approved body involved in the procedure of attestation of conformity. See section 3.2.2.

### 3.2.2 Tasks for the approved bodies

The approved body shall perform the

- initial inspection of factory and of factory production control,
- continuous surveillance, assessment and approval of factory production control, in accordance with the provisions laid down in the control plan.

#### 3.2.2.1 Initial inspection of factory and factory production control

The approved body shall ascertain that, in accordance with the control plan, the factory, in particular the staff and equipment, and the factory production control, are suitable to ensure a continuous and orderly manufacturing of the screws with this European technical approval.

#### 3.2.2.2 Continuous surveillance

The approved body shall control the documentation of the factory production control (FPC) twice a year including an annual visit of the factory for routine inspections. It shall be verified that the system of factory production control and the specified manufacturing processes are maintained, taking account of the control plan.

#### 3.2.2.3 Other tasks of the approved body

The approved body shall retain the essential points of its actions referred to above and state the results obtained and conclusions drawn in a written report.

The results of certification and continuous surveillance shall be made available on demand by the certification body to Deutsches Institut für Bautechnik.

The approved certification body involved by the manufacturer shall issue an EC certificate of conformity of the factory production control stating the conformity with the provisions of this European technical approval.

In cases where the provisions of the European technical approval and its control plan are no longer fulfilled the certification body shall withdraw the certificate of conformity and inform Deutsches Institut für Bautechnik without delay.

### 3.3 CE marking

The CE marking shall be affixed on each packaging of the self-tapping screws. The letters "CE" shall be followed by the identification number of the approved certification body and be accompanied by the following additional information:

- the name and/or identifying mark of the producer (legal entity responsible for the manufacture),
- the last two digits of the year in which the CE marking was affixed,
- the number of the EC certificate for the factory production control,
- the number of the European technical approval,
- name of the product,
- outer thread diameter and length of the self-tapping screws,
- May be enclosed in the accompanying commercial documents: type and mean thickness of the corrosion protection.



#### **4 Assumptions under which the fitness of the product for the intended use was favourably assessed**

##### **4.1 Manufacturing**

Twin UD and PIR-FIX self-tapping screws shall be manufactured in accordance with the provisions of this European technical approval using the manufacturing processes as identified at the inspection of the plant by the notified inspection body and laid down in the technical documentation.

The European technical approval is issued for the product on the basis of agreed data/information, deposited with Deutsches Institut für Bautechnik, which identifies the product that has been assessed and judged. Changes to the product or production process, which could result in this deposited data/information being incorrect, shall be notified to Deutsches Institut für Bautechnik before the changes are introduced. Deutsches Institut für Bautechnik will decide whether or not such changes affect the approval and consequently the validity of the CE marking on the basis of the approval and if so whether further assessment or alterations to the approval shall be necessary.

##### **4.2 Installation**

The screws are driven into the wood-based member without pre-drilling. Deviating from this provision the screws may be driven into battens in pre-drilled holes with a diameter of 5.0 mm.

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 the rafter in one sequence.

The screw holes in steel members shall be pre-drilled with an adequate diameter greater than the outer thread diameter.

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

The structural solid or glued laminated timber, laminated veneer lumber, cross-laminated timber and similar glued members shall be from spruce, pine or fir.

#### **5 Indications to the manufacturer**

##### **5.1 Use, maintenance, repair**

The assessment of the fitness for use is based on the assumption that no maintenance is required during the assumed intended working life.

Uwe Bender  
Head of Department

*beglaubigt:*  
Dewitt

## ANNEX 1 – Characteristic values of the load-carrying capacities

**Table 1.1 Characteristic load-carrying capacities of Twin UD and PIR-FIX self-tapping screws**

Nominal diameter [mm]		Twin UD and PIR-FIX
		7.5
Characteristic yield moment $M_{y,k}$ [Nm]		13.0
Characteristic tensile strength $f_{tens,k}$ [kN]		12.0
Characteristic torsional strength $f_{tor,k}$ [Nm]	Thread close to the head	23.0
	Thread close to the tip	13.0

### A.1.1 General

The minimum penetration length of screws in the load-bearing wood-based members shall be  $4 \cdot d$ .  
The inner thread diameter  $d_1$  of the screws shall be greater than the maximal width of the gaps in the layer of the cross-laminated timber.

### A.1.2 Laterally loaded screws

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

### A.1.3 Axially loaded screws

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

$$K_{ser} = 780 \cdot d^{0,2} \cdot l_{ef}^{0,4} \quad [\text{N/mm}] \quad (1.1)$$

where

$d$  outer thread diameter of the screw [mm]  
 $l_{ef}$  penetration length of the screw in the wood-based member [mm].

#### A.1.3.1 Axial withdrawal capacity

The characteristic withdrawal parameter at an angle of  $30^\circ < \alpha \leq 90^\circ$  to the grain based on a characteristic density of the wood-based member of  $350 \text{ kg/m}^3$  is

$f_{ax,k} = 12.5 \text{ N/mm}^2$  for Twin UD and PIR-FIX screws.

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.

Screws Twin UD and PIR-FIX	Annex 1.1
Characteristic values of the load-carrying capacities	

The characteristic withdrawal parameter of the wood-based panels mentioned below at an angle of  $30^\circ < \alpha \leq 90^\circ$  to the grain is

$f_{ax,k} = 10.0 \text{ N/mm}^2$  for Twin UD and PIR-FIX screws.

This axial withdrawal capacity applies to:

- Plywood according to EN 636 and EN 13986 with a characteristic density of at least  $400 \text{ kg/m}^3$ ,
- Particle board according to EN 312 and EN 13986 of at least technical class P4,
- OSB/3 and OSB/4 according to EN 300 and EN 13986.

#### A.1.3.2 Head pull-through capacity

For Twin UD and PIR-FIX screws the withdrawal capacity of the thread in the wood-based member with the screw head shall be taken into account.

Screws Twin UD and PIR-FIX	Annex 1.2
Characteristic values of the load-carrying capacities	

#### A.1.4 Spacing, end and edge distances of the screws and minimum thickness of the wood based material

Minimum thickness for structural members is  $t = 30$  mm.

##### A.1.4.1 Laterally and/or axially loaded screws

Screws in pre-drilled holes in battens

Pre-drilling is only allowed in battens. For Twin UD and PIR-FIX screws in pre-drilled holes in battens the minimum spacings, end and edge distances are given in EN 1995-1-1:2004+A1: 2008, clause 8.3.1.2 and Table 8.2 as for nails in pre-drilled holes. Here, the outer thread diameter  $d$  of the thread close to the head shall be considered.

Screws in non pre-drilled holes

For Twin UD and PIR-FIX screws minimum spacing and distances are given in EN 1995-1-1:2004+A1:2008, clause 8.3.1.2 and Table 8.2 as for nails in non-predrilled holes. Here, the outer thread diameter  $d$  in the respective structural member 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  $15 \cdot d$  for timber thickness  $t < 5 \cdot d$ .

##### A.1.4.2 Only axially loaded screws

For Twin UD and PIR-FIX screws the minimum spacings, end and edge distances are given in EN 1995-1-1:2004+A1:2008, clause 8.7.2 and Table 8.6.

##### A.1.5 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 screws.

##### A.1.6 Durability against corrosion

Screws made from carbon steel may have the coatings according to Table 1.2

Table 1.2 Coatings of the Twin UD and PIR-FIX screws

Coating		Thickness of the coating [ $\mu\text{m}$ ]
Durocoat	DP1	5 - 15
	T	
	WB	
Electrolytically galvanised		5
Hot dip zinc coating		55

Screws Twin UD and PIR-FIX	Annex 1.3
Characteristic values of the load-carrying capacities	

## ANNEX 2 – Fastening of the thermal insulation material on top of rafters or on wood-based members in vertical façades

### A.2.1 General

Twin UD and PIR-FIX screws 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 400 mm. The thermal insulation material shall be applicable as insulation on top of rafters or on façades according to national provisions that apply at the installation site.

The battens have to be from solid timber (softwood) according to EN 338/ EN 14081-1. The minimum thickness  $t$  and the minimum width  $b$  of the battens are given in table 2.1:

Table 2.1 Minimum thickness and minimum width of the battens

Outer thread diameter [mm]	Minimum thickness $t$ [mm]	Minimum width $b$ [mm]
7.5	40	60

Instead of battens the wood-based panels specified in chapter A.2.2.1 may be used in the system with parallel inclined screws and thermal insulation material in compression.

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  $\alpha = 90^\circ$ ) may be arranged where required considering the design of the battens.

### A.2.2 Parallel inclined screws and thermal insulation material in compression

#### A.2.2.1 Mechanical model

The system of rafter, thermal insulation material on top of rafter and battens parallel to the rafter may be considered as a beam on elastic foundation. The batten represents the beam, and the thermal insulation material on top of the rafter the elastic foundation. The minimum compression stress of the thermal insulation material at 10 % deformation, measured according to EN 826<sup>1</sup>, shall be  $\sigma_{(10\%)} = 0,05 \text{ N/mm}^2$ . The batten is loaded perpendicular to the axis by point loads  $F_b$ . Further point loads  $F_s$  are from the shear load of the roof due to dead and snow load, which are transferred from the thread near the screw head into the 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
- Laminated veneer lumber according to EN 14374.

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

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

<sup>1</sup> EN 826:1996 Thermal insulating products for building applications - Determination of compression behaviour

Screws Twin UD and PIR-FIX	Annex 2.1
Fastening of the thermal insulation material on top of rafters	

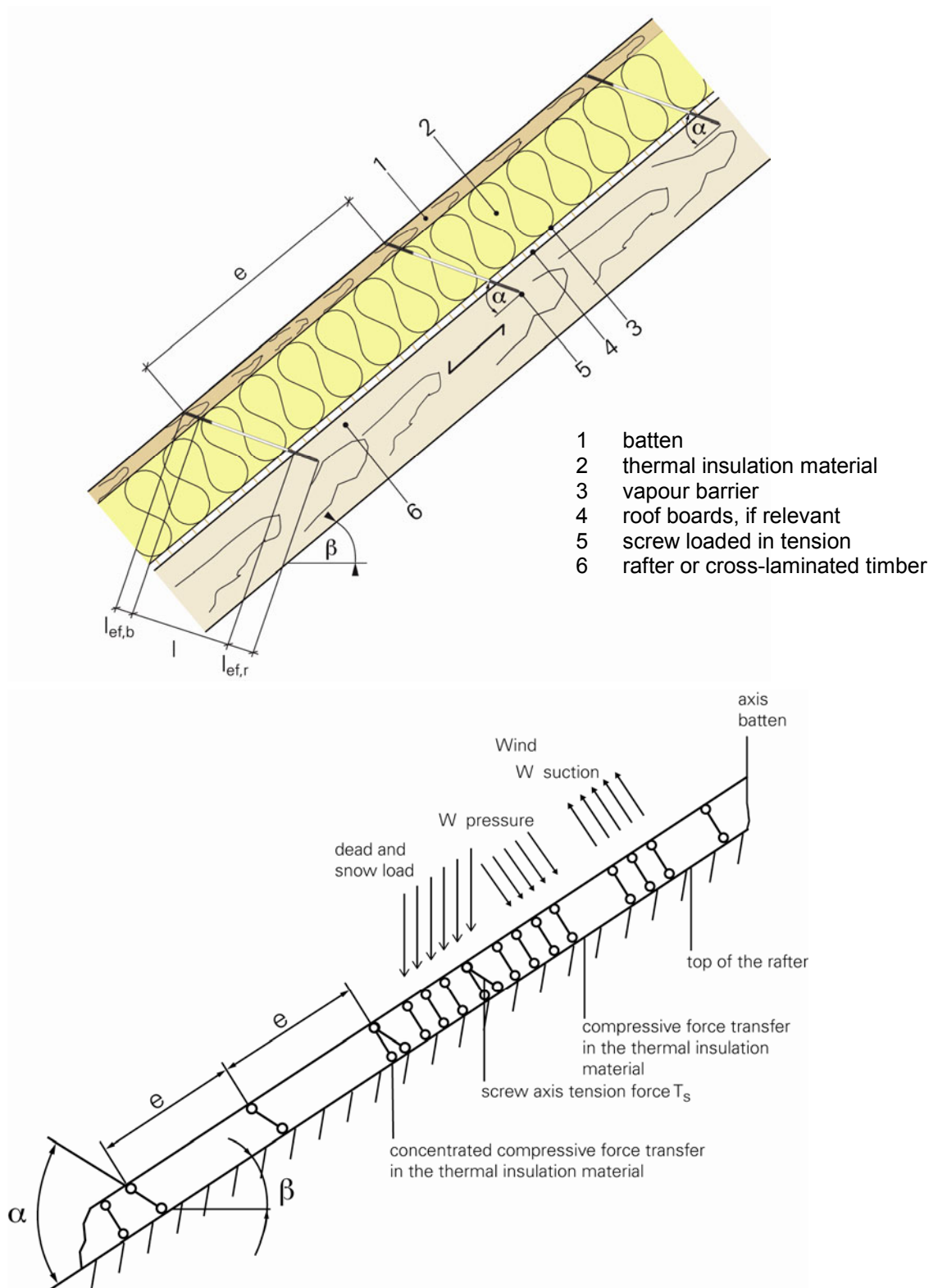


Figure 2.1 Fastening of the thermal insulation material on top of rafters - structural system for parallel inclined screws

Screws Twin UD and PIR-FIX	Annex 2.2
Fastening of the thermal insulation material on top of rafters	

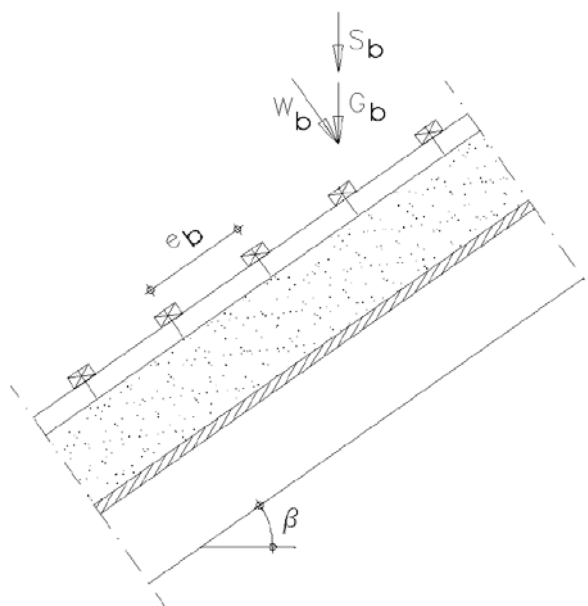


Figure 2.2 Point loads  $F_b$  perpendicular to the battens

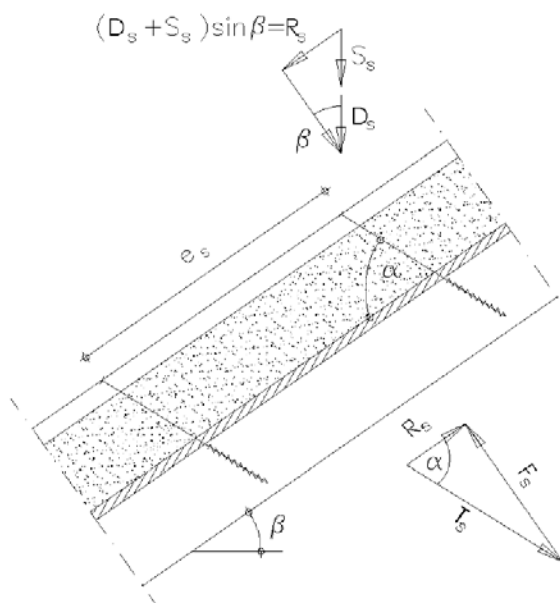


Figure 2.3 Point loads  $F_s$  perpendicular to the battens, load application in the area of the screw heads

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Screws Twin UD and PIR-FIX	Annex 2.3
Fastening of the thermal insulation material on top of rafters	

### A.2.2.2 Design of the battens

The characteristic value of the bending stresses are calculated as:

$$M_k = \frac{(F_{b,k} + F_{s,k}) \cdot l_{char}}{4} \quad (2.1)$$

where

$$l_{char} = \text{characteristic length } l_{char} = 4 \sqrt{\frac{4 \cdot EI}{w_{ef} \cdot K}} \quad (2.2)$$

EI = bending stiffness of the batten

K = coefficient of subgrade

w<sub>ef</sub> = effective width of the thermal insulation material

F<sub>b,k</sub> = characteristic value of the point loads perpendicular to the battens

F<sub>s,k</sub> = characteristic value of the 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<sub>HI</sub> and the thickness t<sub>HI</sub> of the thermal insulation material if the effective width w<sub>ef</sub> of the thermal insulation material under compression is known. Due to the load extension in the thermal insulation material the effective width w<sub>ef</sub> is greater than the width of the batten or rafter, respectively. For further calculations, the effective width w<sub>ef</sub> of the thermal insulation material may be determined according to:

$$w_{ef} = w + t_{HI} / 2 \quad (2.3)$$

where

w = minimum from width of the batten or rafter, respectively

t<sub>HI</sub> = thickness of the thermal insulation material

$$K = \frac{E_{HI}}{t_{HI}} \quad (2.4)$$

The following condition shall be satisfied:

$$\frac{\sigma_{m,d}}{f_{m,d}} = \frac{M_d}{W \cdot f_{m,d}} \leq 1 \quad (2.5)$$

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

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

$$V_k = \frac{(F_{b,k} + F_{s,k})}{2} \quad (2.6)$$

The following condition need to be satisfied:

$$\frac{\tau_d}{f_{v,d}} = \frac{1.5 \cdot V_d}{A \cdot f_{v,d}} \leq 1 \quad (2.7)$$

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

### A.2.2.3 Design of the thermal insulation material

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

$$\sigma_k = \frac{1.5 \cdot F_{b,k} + F_{s,k}}{2 \cdot l_{char} \cdot w} \quad (2.8)$$

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

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Fastening of the thermal insulation material on top of rafters	



#### A.2.2.4 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  $R_s$ :

$$T_{S,k} = \frac{R_{S,k}}{\cos \alpha} \quad (2.9)$$

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 in the rafter or the batten or the tensile capacity of the screw according to Annex 1.

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/mm<sup>2</sup>, respectively, the axial withdrawal capacity of the screws shall be reduced by the factors  $k_1$  and  $k_2$ :

$$F_{ax,\alpha,Rd} = \min \left\{ \frac{f_{ax,d} \cdot d \cdot l_{ef,r} \cdot k_1 \cdot k_2}{1.2 \cdot \cos^2 \alpha + \sin^2 \alpha} \cdot \left( \frac{\rho_k}{350} \right)^{0.8}; \frac{f_{ax,d} \cdot d \cdot l_{ef,b}}{1.2 \cdot \cos^2 \alpha + \sin^2 \alpha} \cdot \left( \frac{\rho_k}{350} \right)^{0.8}; \frac{f_{tens,k}}{\gamma_{M2}} \right\} \quad (2.10)$$

where:

$f_{ax,d}$	design value of the axial withdrawal capacity of the threaded part of the screw [N/mm <sup>2</sup> ]
$d$	outer thread diameter of the screw [mm]
$l_{ef,r}$	penetration length of the threaded part of the screw in the rafter, $l_{ef} \geq 40$ mm
$l_{ef,b}$	penetration length of the threaded part of the screw in the batten or in the wood-based panel [mm]
$\rho_k$	characteristic density of the wood-based member [kg/m <sup>3</sup> ], for wood-based panels $\rho_k = 350$ kg/m <sup>3</sup>
$\alpha$	angle $\alpha$ between screw axis and grain direction, $30^\circ \leq \alpha \leq 90^\circ$
$f_{tens,k}$	characteristic tensile capacity of the screw according to Annex 1 [N]
$\gamma_{M2}$	partial factor according to EN 1993-1-1 or to 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/mm <sup>2</sup> ]

If equation (2.10) is fulfilled, the deflection of the battens does not need to be considered when designing the load-carrying capacity of the screws.

#### A.2.3 Alternatively inclined screws and thermal insulation material non in compression

##### A.2.3.1 Mechanical model

Depending on the screw spacing and the arrangement of tensile and compressive screws with different inclinations the battens are loaded by significant bending moments. The bending moments are derived based on the following assumptions:

- The tensile and compressive loads in the screws are determined based on equilibrium conditions from the actions parallel and perpendicular to the roof plane. These actions are constant line loads  $q_{\perp}$  and  $q_{\parallel}$ .
- The screws act as hinged columns supported 10 mm within the batten or rafter, respectively. The effective column length consequently equals the length of the screw between batten and rafter plus 20 mm.

Screws Twin UD and PIR-FIX	Annex 2.5
Fastening of the thermal insulation material on top of rafters	

- The batten is considered as a continuous beam with a constant span  $\ell = A + B$ . The compressive screws constitute the supports of the continuous beam while the tensile screws transfer concentrated loads perpendicular to the batten axis.

The screws are predominantly loaded in withdrawal or compression, respectively. The characteristic values of the screw's normal forces are determined based on the loads parallel and perpendicular to the roof plane:

$$\text{Compressive screw: } N_{c,k} = (A+B) \cdot \left( -\frac{q_{||,k} \cdot \sin \alpha_2 + q_{\perp,k} \cdot \cos \alpha_2}{\sin(\alpha_1 + \alpha_2)} \right) \quad (2.11)$$

$$\text{Tensile screw: } N_{t,k} = (A+B) \cdot \left( \frac{q_{||,k} \cdot \sin \alpha_1 - q_{\perp,k} \cdot \cos \alpha_1}{\sin(\alpha_1 + \alpha_2)} \right) \quad (2.12)$$

- A distance of the screws according to Figure 2.5  
 B distance of the alternatively inclined screws according to Figure 2.5  
 $q_{||,k}$  characteristic value of the loads parallel to the roof plane  
 $q_{\perp,k}$  characteristic value of the loads perpendicular to the roof plane  
 $\alpha$  Angle  $\alpha_1$  and  $\alpha_2$  between screw axis and grain direction,  $30^\circ \leq \alpha_1 \leq 90^\circ$ ,  $30^\circ \leq \alpha_2 \leq 90^\circ$

The bending moments in the batten follow from the constant line load  $q_{\perp}$  and the load components perpendicular to the batten from the tensile screws. The span of the continuous beam is  $(A + B)$ . The characteristic value of the load component perpendicular to the batten from the tensile screw is:

$$F_{zs,k} = (A+B) \cdot \left( \frac{q_{||,k} \cdot \sin \alpha_1 \cdot \sin \alpha_2 - q_{\perp,k} \cdot \cos \alpha_1 \cdot \sin \alpha_2}{\sin(\alpha_1 + \alpha_2)} \right) \quad (2.13)$$

A positive value for  $F_{zs,k}$  means a load towards the rafter, a negative value a load away from the rafter. The system of the continuous beam is shown in Figure 2.5.

The battens or wood-based panels fixed on the rafter shall be supported perpendicular to the load-bearing plane.

Screws Twin UD and PIR-FIX	Annex 2.6
Fastening of the thermal insulation material on top of rafters	

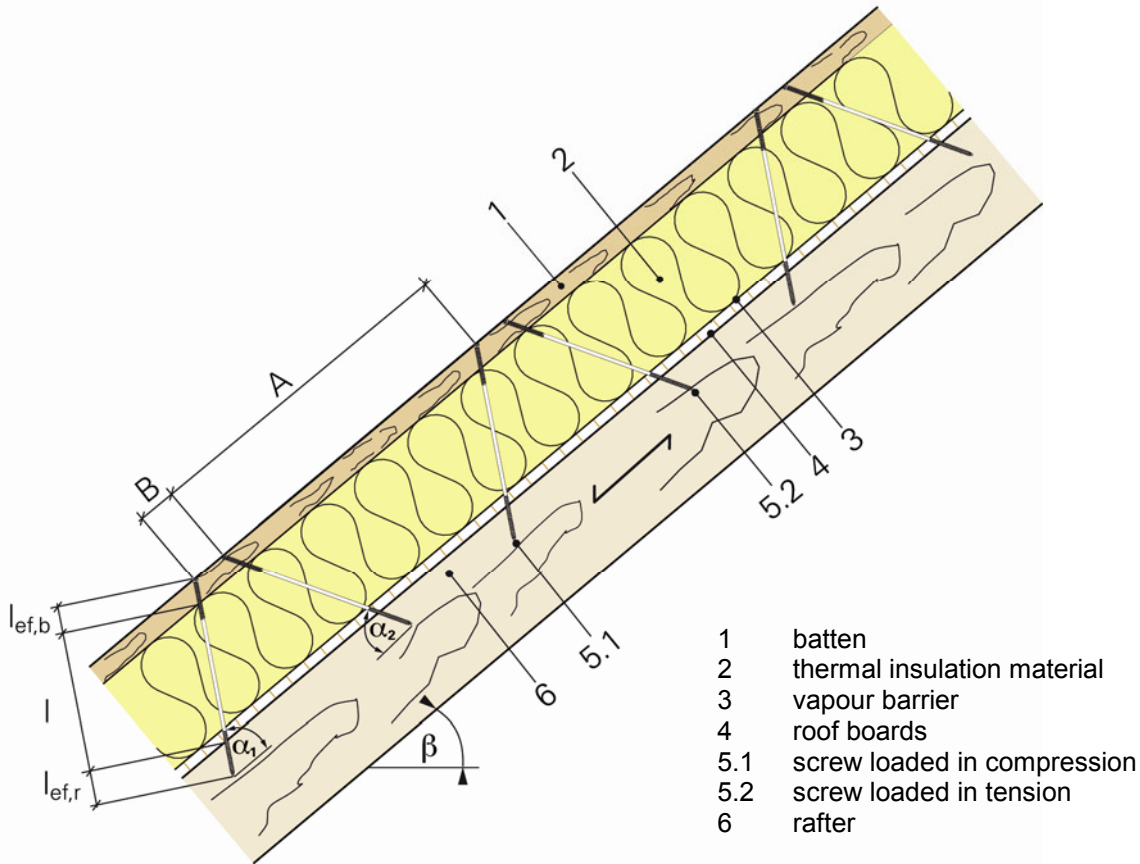


Figure 2.4 Fastening of thermal insulation material on top of rafters - structural system for alternatively inclined screws

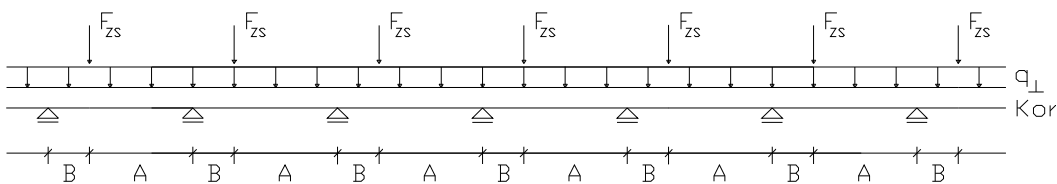


Figure 2.5: Continuous batten under constant line loads from actions on the roof plane  $q_{\perp}$  and concentrated loads from tensile screws  $F_{zs}$

**A.2.3.2 Design of the screws**

The design value of the load-carrying capacity of the screws shall be calculated according to equation (2.14) and (2.15).

Screws loaded in tension:

$$F_{ax,\alpha,Rd} = \min \left\{ \frac{f_{ax,d} \cdot d \cdot l_{ef,b}}{1.2 \cdot \cos^2 \alpha_2 + \sin^2 \alpha_2} \cdot \left( \frac{\rho_{b,k}}{350} \right)^{0.8}; \frac{f_{ax,d} \cdot d \cdot l_{ef,r}}{1.2 \cdot \cos^2 \alpha_2 + \sin^2 \alpha_2} \cdot \left( \frac{\rho_{r,k}}{350} \right)^{0.8}; \frac{f_{tens,k}}{\gamma_{M2}} \right\} \quad (2.14)$$

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Screws Twin UD and PIR-FIX	Annex 2.7
Fastening of the thermal insulation material on top of rafters	

Screws loaded in compression:

$$F_{ax,\alpha,Rd} = \min \left\{ \frac{f_{ax,d} \cdot d \cdot l_{ef,b}}{1.2 \cdot \cos^2 \alpha_1 + \sin^2 \alpha_1} \cdot \left( \frac{\rho_{b,k}}{350} \right)^{0.8}; \frac{f_{ax,d} \cdot d \cdot l_{ef,r}}{1.2 \cdot \cos^2 \alpha_1 + \sin^2 \alpha_1} \cdot \left( \frac{\rho_{r,k}}{350} \right)^{0.8}; \frac{\kappa_c \cdot N_{pl,k}}{\gamma_{M1}} \right\} \quad (2.15)$$

where:

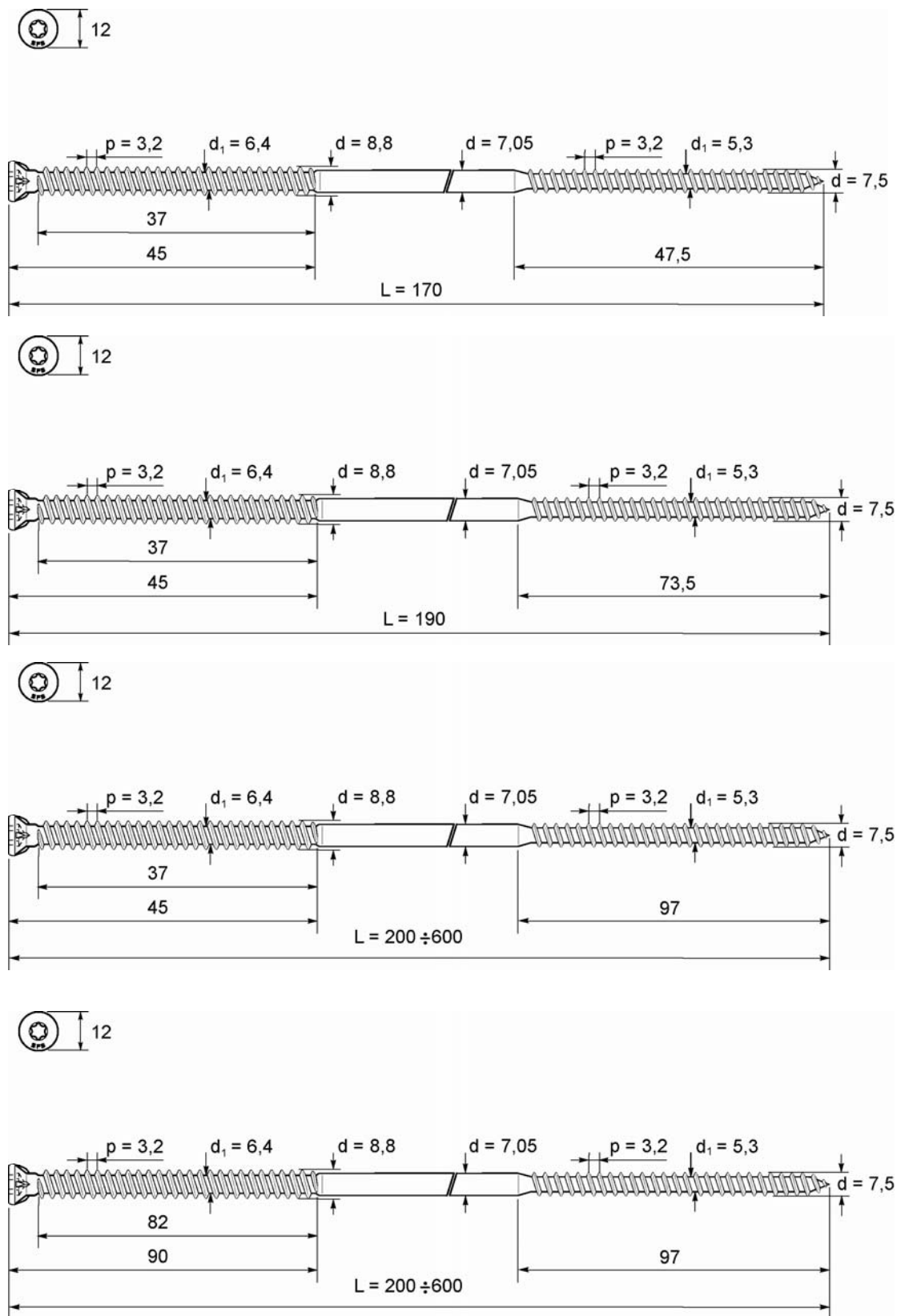
- $f_{ax,d}$  design value of the axial withdrawal capacity of the threaded part of the screw in the batten [N/mm<sup>2</sup>]  
 $d$  outer thread diameter of the screw [mm]  
 $l_{ef,b}$  penetration length of the threaded part of the screw in the batten [mm]  
 $l_{ef,r}$  penetration length of the threaded part of the screw in the rafter,  $l_{ef} \geq 40$  mm  
 $\rho_{b,k}$  characteristic density of the batten [kg/m<sup>3</sup>]  
 $\rho_{r,k}$  characteristic density of the rafter [kg/m<sup>3</sup>]  
 $\alpha$  angle  $\alpha_1$  or  $\alpha_2$  between screw axis and grain direction,  $30^\circ \leq \alpha_1 \leq 90^\circ$ ,  $30^\circ \leq \alpha_2 \leq 90^\circ$   
 $f_{tens,k}$  characteristic tensile capacity of the screw according to Annex 1 [N]  
 $\gamma_{M1}, \gamma_{M2}$  partial factor according to EN 1993-1-1 or to the particular national Annex  
 $\kappa_c \cdot N_{pl,k}$  Buckling capacity of the screw according to table 2.2 [N]

Screws Twin UD and PIR-FIX	Annex 2.8
Fastening of the thermal insulation material on top of rafters	

Table 2.2 Characteristic load-carrying capacity of the screws  $\kappa_c \cdot N_{pl,k}$  in kN

Free screw length between batten and rafter [mm]	Twin UD and PIR-FIX screws
	Outer thread diameter d [mm]
	7.5/ 8.8
	$\kappa_c \cdot N_{pl,k}$ [kN]
≤ 100	10.1
120	8.3
140	6.8
160	5.7
180	4.8
200	4.1
220	3.5
240	3.0
260	2.7
280	2.3
300	2.1
320	1.9
340	1.7
360	1.5
380	1.4
400	1.3
420	1.2
440	1.1
460	1.0
480	0.9

Screws Twin UD and PIR-FIX	Annex 2.9
Fastening of the thermal insulation material on top of rafters	

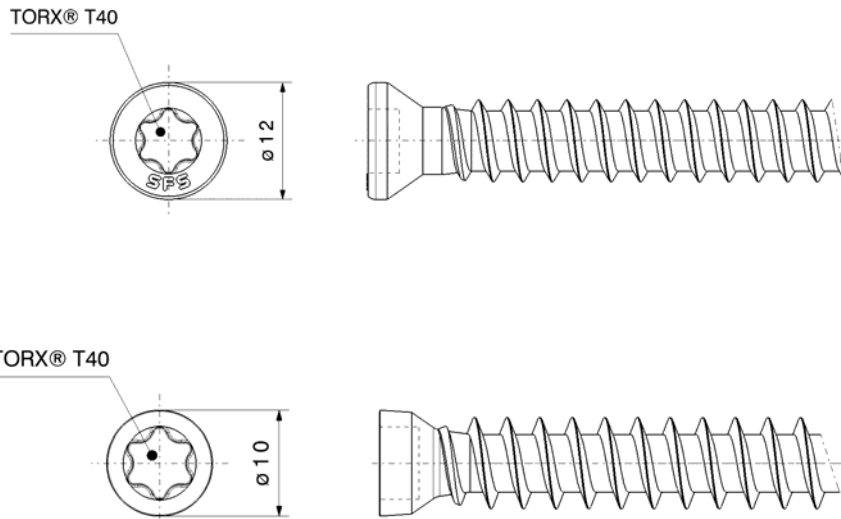


Screws Twin UD and PIR-FIX

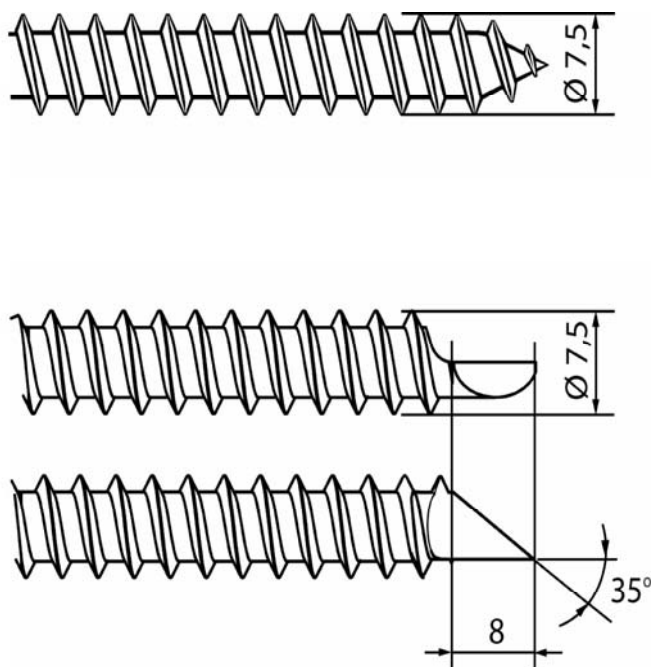
Twin UD screws

Annex 3.1

### Alternative screw heads



### Alternative screw tips

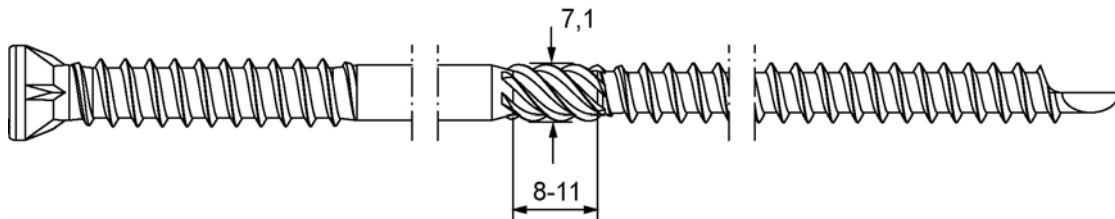


Screws Twin UD and PIR-FIX

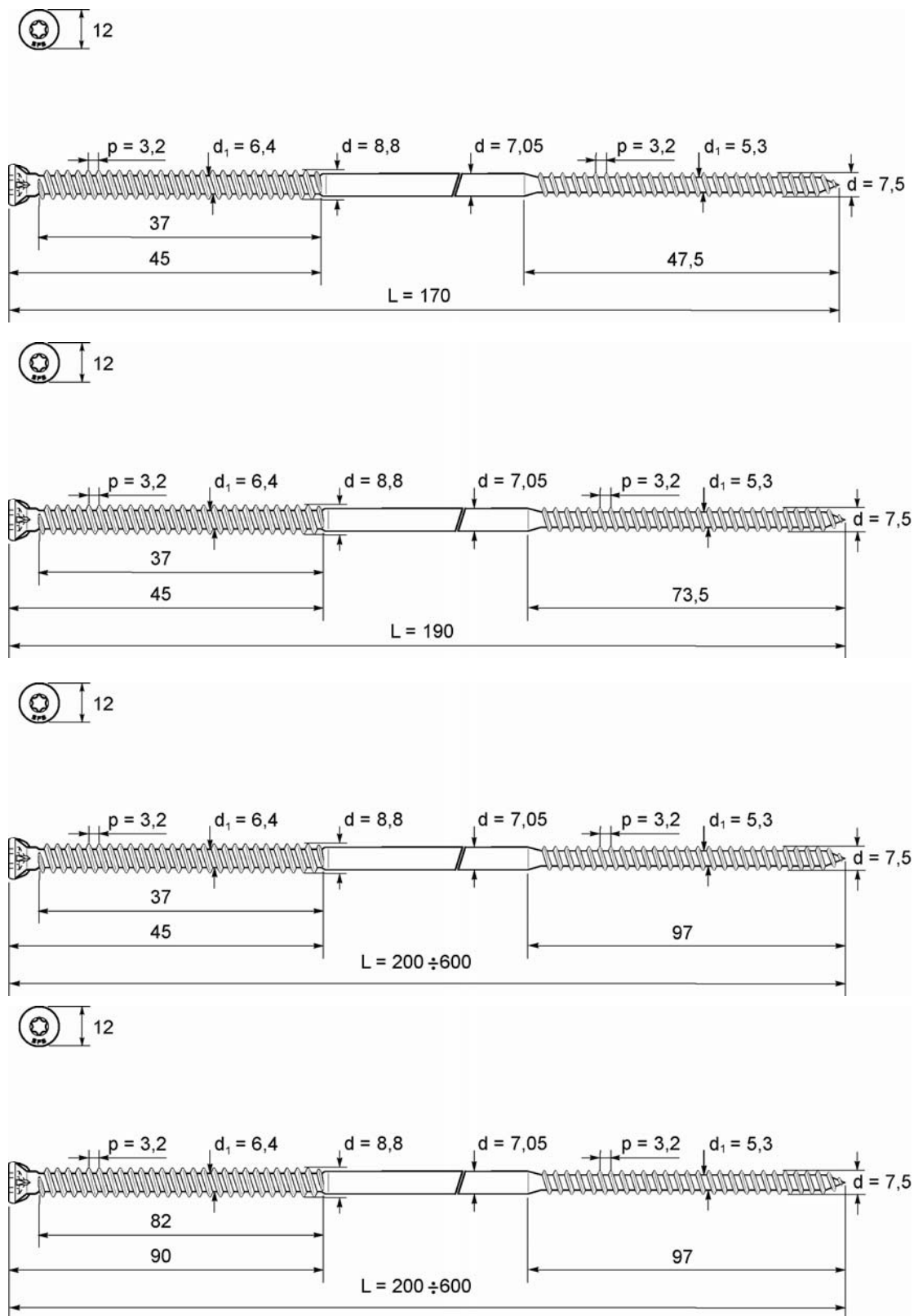
Twin UD screws – Alternative screw heads and screw tips

Annex 3.2

### Alternative rough thread in the area of the shank







Alternative screw heads, screw tips and rough thread are similar to Twin UD screws

Screws Twin UD and PIR-FIX

PIR-FIX screws

Annex 3.4