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Authorised and notified according to Article 10 of the 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

MEMBER OF EOTA

European Technical Approval ETA-07/0245

This ETA replaces the previous ETA with the same number and issued on 2012-10-26 and expiry on 2017-10-26

Trade name:	SIMPSON STRONG-TIE® Joist End connector SIMPSON STRONG-TIE® concealed beam hangers
Holder of approval:	SIMPSON STRONG-TIE A/S Hedegaardsvej 4 – 11, Boulstrup DK-8300 Odder Tel. +45 87 81 74 00 Fax +45 87 81 74 09 Internet www.simpsonstrongtie.dk
Generic type and use of construction product:	Three-dimensional nailing plate (connector for wood to wood connections and wood to concrete or steel connections)
Valid from: to:	2013-01-21 2018-01-21
Manufacturing plant:	Simpson Strong-Tie A/S Hedegaardsvej 4-11, Boulstrup 8300 Odder Denmark Simpson Strong-Tie ZAC des Quatre Chemins 85400 Sainte Gemme La Plaine France Simpson Strong-Tie Winchester Road Cardinal Point Tamworth Staffordshire B78 3HG United Kingdom
This European Technical Approval contains:	72 pages including 4 annexes which form an integral part of the document

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1. LEGAL BASIS AND GENERAL CONDITIONS

1. This European Technical Approval is issued by ETA-Danmark A/S 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[1)], as amended by Council Directive 93/68/EEC of 22 July 1993[2)].

   - Bekendtgørelse 559 af 27-06-1994 (afløser bekendtgørelse 480 af 25-06-1991) om ikrafttræden af EF direktiv af 21. december 1988 om indbyrdes tilnærmelse af medlemsstaternes love og administrative bestemmelser om byggevarer.

   - Common Procedural Rules for Requesting, Preparing and the Granting of European Technical Approvals set out in the Annex to Commission Decision 94/23/EC[3)].

   - EOTA Guideline ETAG 015 *Three-dimensional nailing plates,* September 2002 edition.

2. ETA-Danmark A/S 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 ETA-Danmark A/S pursuant to Article 5(1) of Council Directive89/106/EEC.

5. Reproduction of this European Technical Approval including transmission by electronic means shall be in full. However, partial reproduction can be made with the written consent of ETA-Danmark A/S. In this case partial reproduction has to be designated as such. Texts and drawings of advertising brochures shall not contradict or misuse the European Technical Approval.

6. This European Technical Approval is issued by ETA-Danmark A/S in English. This version corresponds fully to the version circulated within EOTA. Translations into other languages have to be designated as such.

1) Official Journal of the European Communities N° L40, 11 Feb 1989, p 12.
2) Official Journal of the European Communities N° L220, 30 Aug 1993, p 1.
3) Official Journal of the European Communities N° L 17, 20 Jan 1994, p 34.

2. SPECIAL CONDITIONS OF THE EUROPEAN TECHNICAL APPROVAL

1. Definition of product and intended use

Definition of the product

The SIMSPON Strong-Tie Concealed Beam Hangers are three dimensional nailing plates made of pre-galvanized steel Grade S 250 GD + Z275 according to EN 10326:2004 or stainless steel 1.4401 and 1.4404 according to EN 10088 or a stainless steel with a minimum characteristic yield stress of 235 N/mm² or a minimum ultimate tensile strength of 330 N/mm². or aluminium AlMgSi 0,7 according to DIN 1749-1. The range addressed by this Approval consists of various hangers which have in common the necessity to practice a notch and holes in the joist for the dowels path : TU, TUB, TUS, TUBS, ETNM, BTN, BT4, BT, BTC, BTALU and CBH. They are intended for wood-wood connections and wood-concrete connections with angles varying from 30° to 90°. The geometry and standard dimensions are given in Annexes D.

ETB and ETS connectors are two-piece non-welded, face-fixed connectors to be used in timber to timber connections.
EL connectors are one-piece non-welded, face-fixed connectors to be used in timber to timber connections as well as connections between a timber joist and a concrete structure or a steel member.
EL-S connectors are one-piece non-welded, face-fixed connectors to be used in timber to timber connections.
The connectors are made from aluminium grade EN AW-6082 T6 according to EN 755-2:2000 with minimum yield strength of 250 MPa, a minimum tensile strength of 295 MPa and a minimum ultimate strain of 8 %. Dimensions, hole positions and aluminium type are shown in Annex D6 to D8. Typical installations are shown in Annex C.

Intended use

The SIMPSON Strong-Tie Concealed Beam Hangers are intended to be used for connections of joists with rectangular cross sections to their support. The joist may be either of solid sawn or Engineering Wood Product listed in Annex C1

This support may be either a solid sawn element, an Engineering Wood Product listed in Annex C1, or concrete. With regard to moisture behaviour of the support and/or joist, the use is possible in service classes 1 and 2 defined in EN 1995-1-1:2004 for the Concealed Beam Hangers made out of galvanised steel. The use is possible in service class 1, 2 and 3 defined in EN 1995-1-1:2004 for Concealed Beam Hangers made out of stainless steel 1.4401 and 1.4404 according to EN 10088, or another stainless steel as described before in structures subject to internal or external atmospheric exposure (including industrial and marine environment), or exposure in permanently damp internal conditions, if no particular aggressive conditions exist. Such particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used). A concealed joist hanger produced from steel, which is resistant for these atmospheres, may be used in these areas.

They are not intended to be used in areas where they might support seismic actions. They are supposed to be used with specified fasteners mentioned in Annex C3 and according to fastening combinations and nail patterns given in Annexes B.

The ETB, ETS, EL and EL-S connectors are intended for use in making end-grain to side-grain connections in load bearing timber structures, as a connection between a timber joist and a solid timber or wood based header, where requirements for mechanical resistance and stability and safety in use in the sense of the Essential Requirements 1 and 4 of Council Directive 89/106/EEC shall be fulfilled. The EL connectors are also intended for use in making an end-grain connection between a timber joist and a concrete structure or a steel member.

Assumed working life

The assumed intended working life of the joist connectors for the intended use is 50 years, provided that they are subject to appropriate use and maintenance.

The information on the working life should not be regarded as a guarantee provided by the manufacturer or ETA-Danmark. An “assumed intended working life” means that it is expected that, when this working life has elapsed, the real working life may be, in normal use conditions, considerably longer without major degradation affecting the essential requirements.

2. Characteristics of product and assessment

ETAG para.	Characteristic	Assessment of characteristic
	2.1 Mechanical resistance and stability*)	
6.1.1	Characteristic load-carrying capacity	See Annex D
6.1.2	Stiffness	No performance determined
6.1.3	Ductility in cyclic testing	No performance determined
	2.2 Safety in case of fire	
6.2.1	Reaction to fire	SIMPSON Strong-Tie Concealed Beam Hangers and Joist End connectors are classified as **Euroclass A1** in accordance with EN 13501-1 and EC decision 96/603/EC, amended by EC Decision 2000/605/EC
	2.3 Hygiene, health and the environment	
6.3.1	Influence on air quality	No dangerous materials **)
	2.4 Safety in use	Not relevant
	2.5 Protection against noise	Not relevant
	2.6 Energy economy and heat retention	Not relevant
	2.7 Related aspects of serviceability	
6.7.1	Durability	The Concealed Beam Hangers and Joist End connectors have been assessed as having satisfactory durability and serviceability when used in timber structures using the timber species described in Eurocode 5 and subject to the conditions defined by service class 1, 2 and 3
6.7.2	Serviceability	
6.7.3	Identification	See Annex A

*) See page 6 of this ETA

**) In accordance with http://europa.eu.int-/comm/enterprise/construction/internal/dangsub/dangmain.htm 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.

Safety principles and partial factors

2.1. Mechanical resistance and stability

See annex D for characteristic load-carrying capacities of the SIMPSON Strong-Tie Concealed Beam Hangers and SIMPSON Strong-Tie Joist End connectors.

The mechanical capacities of the concealed beam hangers and Joist End connectors are determined by calculation assisted by testing as described in the EOTA Guideline 015 clause 5.1.2. They should be used for designs in accordance with EN-1995-1-1 (Eurocode 5) or a similar national timber code.

The load-bearing capacities given in Annexes D of the concealed beam hangers and Joist End connectors have been determined based on the use of connector nails or 4.0 x 60 in accordance to ETA-04/0013 and screws are described in Annex C3. It is allowed to use connector screws or connector nails 4.0 x 50 or 4.2 x 50 or 4.2 x 60 in accordance to ETA-04/0013. Case by case calculations have to be carried out to determine the load-bearing capacity of the connection.

The design also allows the use of threaded nails in accordance to EN 14592 with a diameter in the range 4.0-4.2 mm and a minimum length of 35 mm, assuming a thick steel plate when calculating the lateral nail load-bearing capacity. If no calculations are made a reduction factor equal to the ratio between the characteristic withdrawal capacity of the actual used threaded nail and the characteristic withdrawal capacity of the corresponding connector nail according to table B1 in ETA-04/0013 is applicable for all load-bearing capacities of the connection.

No performance has been determined in relation to ductility of a joint under cyclic testing.

The contribution to the performance of structures in seismic zones, therefore, has not been assessed

2.7. Related aspects of serviceability

2.7.1 Corrosion protection in service class 1 and 2.
The thickness of galvanisation (Z275 according to EN 10143) or the aluminium AlMgSi 0,7 is such that a reasonable durability may be expected in service classes 1 and 2 according to EN 1995-1-1:2004, in the conditions stated in the Intended Use §1.2 above.

The use of stainless steel 1.4401 and 1.4404 according to EN 10088 extends the scope to service class 3 according to EN 1995-1-1:2004 in the conditions stated in the Intended Use §1.2 above.

The ETB, ETS, EL and EL-S connectors have been assessed as having satisfactory durability and serviceability when used in timber structures using the timber species described in Eurocode 5 and subject to the conditions defined by service class 1 and 2

Serviceability of the Concealed Beam Hangers is understood as their ability to resist loads without unacceptable deformations.

3. Attestation of Conformity and CE marking

3.1. Attestation of Conformity system

The system of attestation of conformity is 2+ described in Council Directive 89/106/EEC (Construction Products Directive) Annex III.

a) Tasks for the manufacturer:

(1) Factory production control,
(2) Initial type testing of the product,

b) Tasks for the notified body:

(1) Initial inspection of the factory and the factory production control,
(2) Continuous surveillance

3.2. Responsibilities

3.2.1 Tasks of the manufacturer

3.2.1.1 Factory production control

The manufacturer has a factory production control system in the plant and exercises permanent internal control of production. All the elements, requirements and provisions adopted by the manufacturer are documented in a systematic manner in the form of written policies and procedures. This production control system ensures that the product is in conformity with the European Technical Approval.

The manufacturer shall only use raw materials supplied with the relevant inspection documents as laid down in the control plan[1]. The incoming raw materials shall be subject to controls and tests by the manufacturer before acceptance. Check of materials, such as sheet metal, 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 zinc coating thickness.

The manufactured components are checked visually and for dimensions.

The control plan, which is part of the technical documentation of this European Technical Approval, includes details of the extent, nature and frequency of testing and controls to be performed within the factory production control and has been agreed between the approval holder and ETA-Danmark.

The results of factory production control are recorded and evaluated. The records 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 ETA-Danmark on request.

3.2.1.2 Initial type testing of the product

For initial type-testing the results of the tests performed as part of the assessment for the European Technical Approval shall 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 ETA-Danmark and the notified body.

3.2.2. Tasks of notified bodies

3.2.2.1 Initial inspection of the factory and the factory production control

The approved body should 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 joist hangers with the specifications given in part 2.

3.2.2.2 Continuous surveillance

The approved body shall visit the factory at least twice a year 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.

The results of product certification and continuous surveillance shall be made available on demand by the certification body to ETA-Danmark. Where the provisions of the European Technical

[1] The control plan has been deposited at ETA-Danmark and is only made available to the approved bodies involved in the conformity attestation procedure.

Approval and the control plan are no longer fulfilled, the certificate of conformity shall be withdrawn by the approved body.

3.3. CE marking

The CE marking shall be affixed on each packaging of connectors. The initials "CE" shall be accompanied by the following information:

- The identification number of the notified body.
- Name or identifying mark of the manufacturer.
- The last two digits of the year in which the marking was affixed.
- Number of the European Technical Approval.
- Name and size of product.
- Number of the EC certificate of conformity.
- Number of the ETA guideline (ETAG no. 015).

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

4.1. Manufacturing

Concealed Beam Hangers and Joist End connectors are manufactured in accordance with the provisions of this European Technical Approval using the manufacturing processes as identified in the inspection of the plant by the notified inspection body and laid down in the technical documentation.

4.2. Installation

SIMPSON Strong-Tie Concealed Beam Hangers and Joist End connectors shall be installed on the basis of a specific structural design for each installation, using the load-bearing capacities given in Annexes D and applying the appropriate kmod factor depending on the relevant service class / load duration and the appropriate National partial safety factor for materials.

The fixing of the Concealed Beam Hangers and Joist End connectors to the support shall use the appropriate nails or screws in case of solid wood or wood-based support, appropriate CE marked metal anchors for use in concrete in case of concrete support. The load bearing capacities indicated in the Annexes are given provided that the fixing device has been appropriately designed and installed.

The Concealed Beam Hangers shall be installed by appropriately qualified personnel, following an installation plan and relevant construction details worked out for each individual building project. The installation plan shall be based on the manufacturers general guide and provisions for installing SIMPSON Strong-Tie connections

4.3. Maintenance and repair

It is the manufacturer's responsibility to ensure that the information on the specific conditions according to 1 and 2 including Annexes is given to those who are concerned. This information may be made by reproduction of the respective parts of the European Technical Approval. In addition all installation data shall be shown clearly on the package and/or on an enclosed instruction sheet, preferably using illustration(s).

Minimum requirements for the different support:

- Nails, screws or dowels specifications
- Information on the installation procedure, preferably by means of an illustration
- minimum edge distances for fixing elements (in the case of nails, screws or dowels according to EN 1995-1-1:2004, in the case of anchors according to the relevant ETA)
- identification of the manufacturing batch.

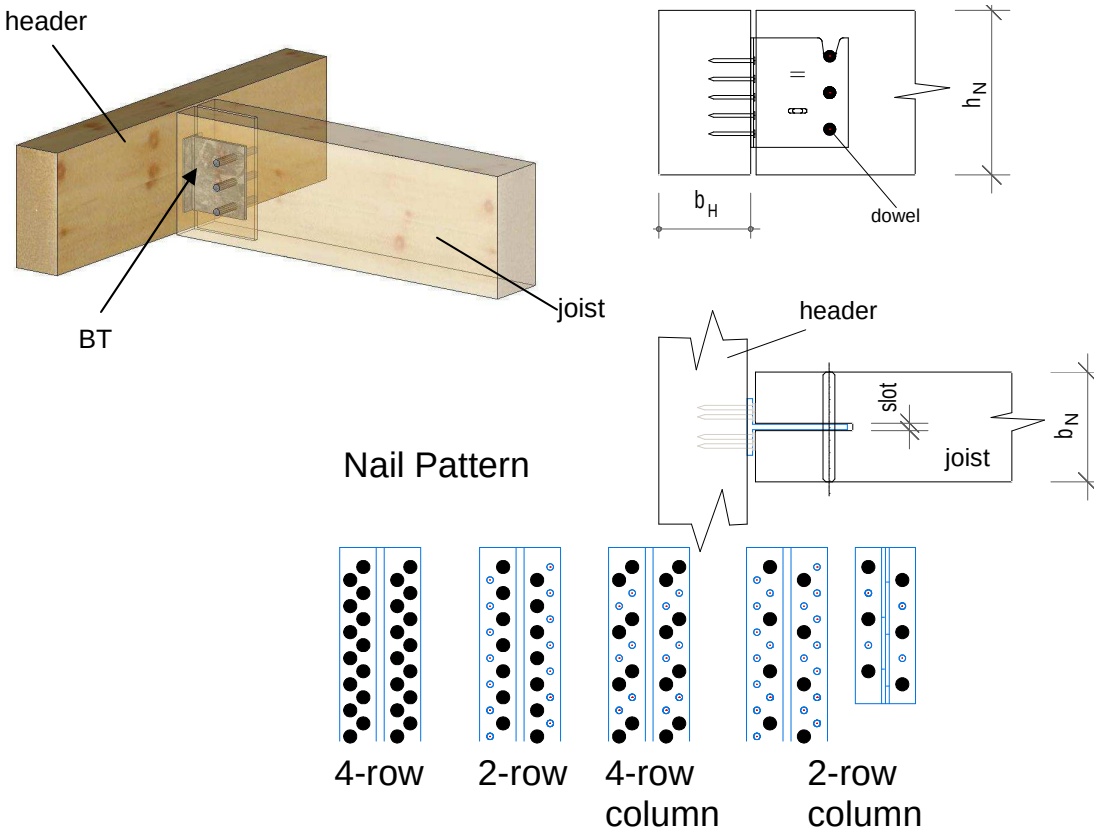
Thomas Bruun
Manager, ETA-Danmark

Annex A Revision History

Revision History	
Issue	update
3	TU for force direction axial and lateral Update BTN, BT4, BTALU up to size 240 BT280 up to BT600 BTC120 up to BTC600 Merged with the ETA 07/0245 Joist End connectors ET, ETB, ELS Added the possibility for a slope < 0°
4	Add ETS

Annex B: Typical Installation

B1. Concealed joist hangers typical installation



Other nail pattern is described in annex D.

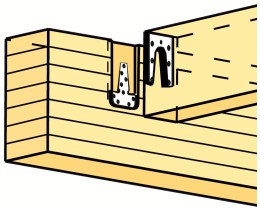
Concealed joist hangers ("BT" in the following text)

A BT connection is deemed fit for its intended use under following conditions:

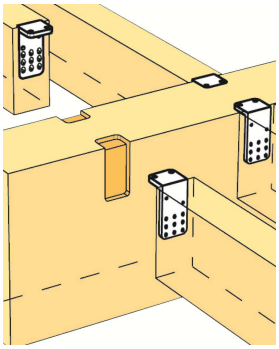
1. BT can be fastened to wood-based members by nails or screws.
2. There shall be nails or screws in all holes or a partial nailing pattern as shown in Annex A and prescribed in Annex B can be used.
3. The characteristic capacity of the BT connection is calculated according to the manufacturer's technical documentation.
4. The concealed Joist Hangers connection is designed in accordance with Eurocode 5 or an appropriate National Code.
5. The thickness of the beam shall be at least *l*, where *l* is the length of the fasteners in the beam. This is in accordance with Eurocode 5.
6. The depth of the Joist shall be so large that the steel dowel has at least a distance of 3d to the edge, where d = the diameter of the steel dowel.
7. The depth of the beam shall be so large that the fasteners have at least a distance according EN 1995-1-1, in relation to the force direction.
8. The slot for the BT in the joist may be t +1/ +2 mm , where t = the thickness of the bar of the BT, for the type TU12, TUS12, TUB12 and TUBS12 the slot may be 6 mm, for the other size of type TU, TUS, TUB and TUBS the slot may be 9-10mm
9. For connection to concrete the anchor bolts shall be mounted according to the approval of the used anchor bolt
10. For connection to steel the bolts shall be mounted according the relevant standard
11. The backside of the BT shall have contact along the full height of the connector.

12. BT made from stainless steel shall only be fastened with fasteners made from suitable stainless steel. Zinc-coated concealed joist hangers shall not be fastened with fasteners of stainless steel.
13. Nails or screws to be used shall have a diameter, which fits to the holes of the BTs. They shall have a diameter which is not smaller than the diameter of the hole minus 1 mm.
14. The execution of the connection shall be in accordance with the approval holder's technical literature.

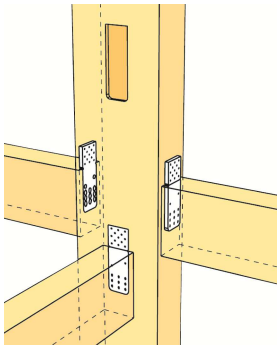
B2. Typical Installation for ETB, EL, ELS



ETB



EL



ELS

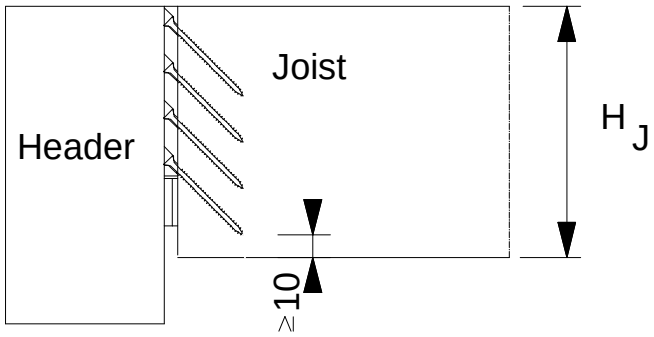
The connection to the header or the column for the ETB and ELS can be made with Nails or CSA screws and screws only for Type EL.
The connection to the end grain of the joist is made with screws Ø5 mm according to the corresponding Annex. The angle between the Joist End connector and the screws is 45°. A slope and a skew is possible in these product ranges.

An ETB, EL and EL-S connection is deemed fit for its intended use provided:

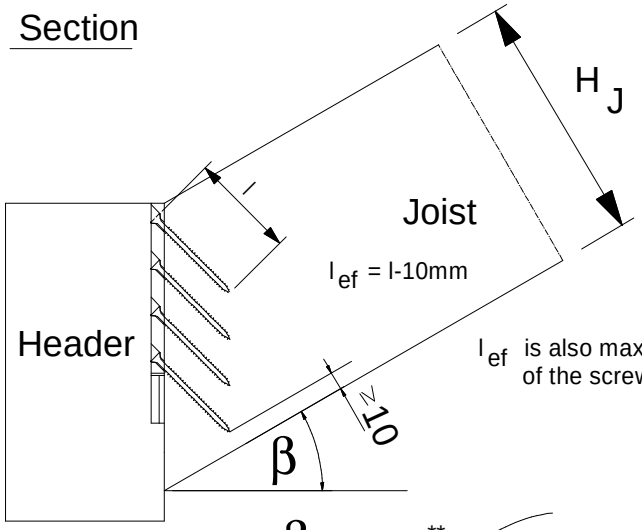
1. The header shall be restrained against rotation.
2. If the connection only has a connector on one side of the header, the eccentricity moment from the joists shall be considered when verifying the strength of the header.
3. For a header with joists from both sides but with different reaction forces a similar consideration applies.
4. There shall be nails or screws in all holes or a partial nailing pattern as prescribed in Annex A.
5. For EL connectors fastened to timber frame members as shown in arrangement 1 in Annex C, only the thread length in the timber member may be taken into account.
6. For EL connectors fastened to timber frame members as shown in arrangement 2 in Annex C, the sheathing (e.g. OSB) must be flush with the header surface.
7. The gap between the side grain of the header and the vertical flap of the hanger shall be limited.
8. The gap between the side grain of the header and the vertical flap of the connector shall be maximum 3 mm for connections made with the ETB connector
   For connections made with the ET and EL-S connectors the gap between the member surface and the connector shall be maximum 1 mm.
9. The EL connector shall be in close contact with the concrete or steel over the horizontal flap.
10. For ETB and EL-S connectors the width of the header shall be at least l+4d, where l is the length and d is the diameter of the nails or screws in the header.
11. For ETB, EL and EL-S connectors the depth of the joist shall allow an edge distance of at least 10 mm between the screw tip and the adjacent joist surface.
12. The header shall have a plane surface against the whole ETB, EL or EL-S connector.
13. Nails or screws to be used shall have a diameter, which fits the holes of the ETB, EL and EL-S connectors.

ETB

Section



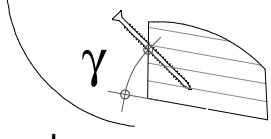
Section



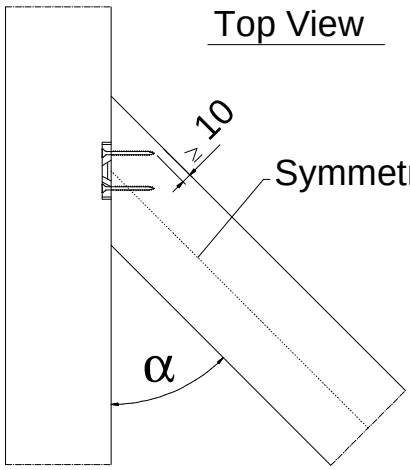
l_{ef} is also maximum threaded length of the screw

$-15° \leq \beta \leq 90°$ **

For a slope $\beta < 0°$ the angle $\gamma \geq 30°$, in accordance with the approval of the screws, which is used to determine $R_{ax,\alpha,k}$ **



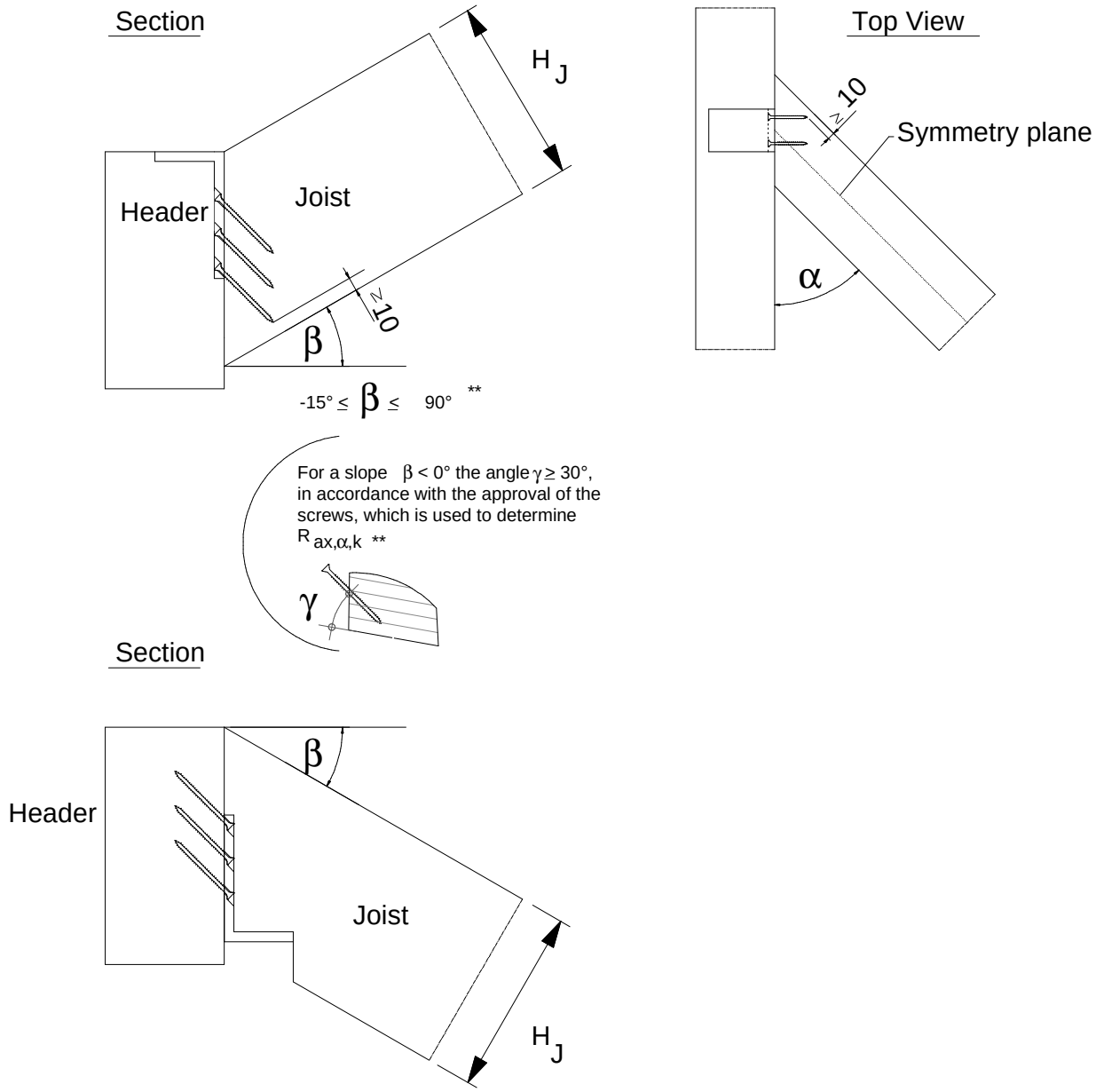
Top View



$15° \leq \alpha \leq 165°$

** if $\gamma < 30°$ and the screws are covered by approval for this application, the values for the connector may be evaluated accordingly.

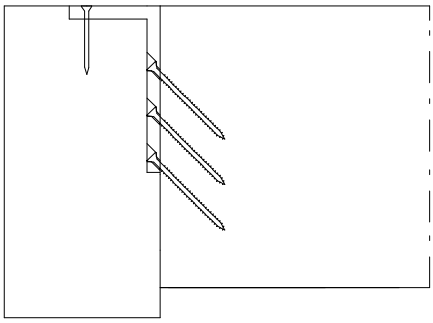
EL



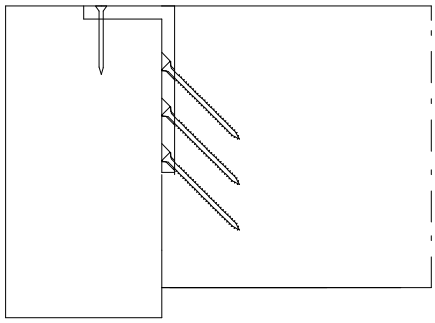
** if $\gamma < 30°$ and the screws are covered by approval for this application, the values for the connector may be evaluated accordingly.

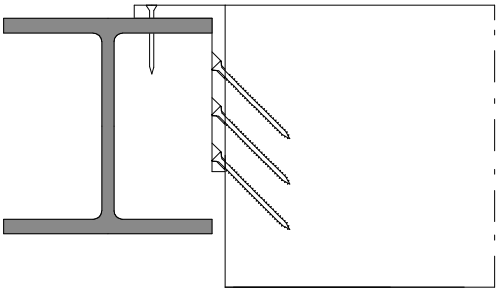
Installations

embed in the header

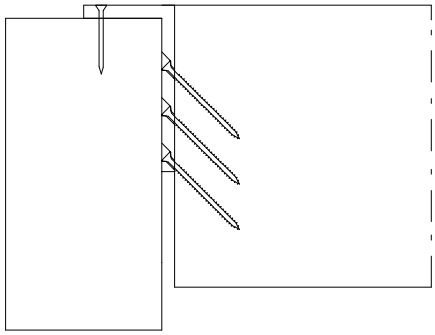


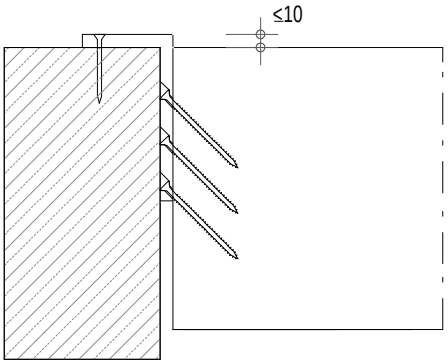
embed in the header and the front of joist



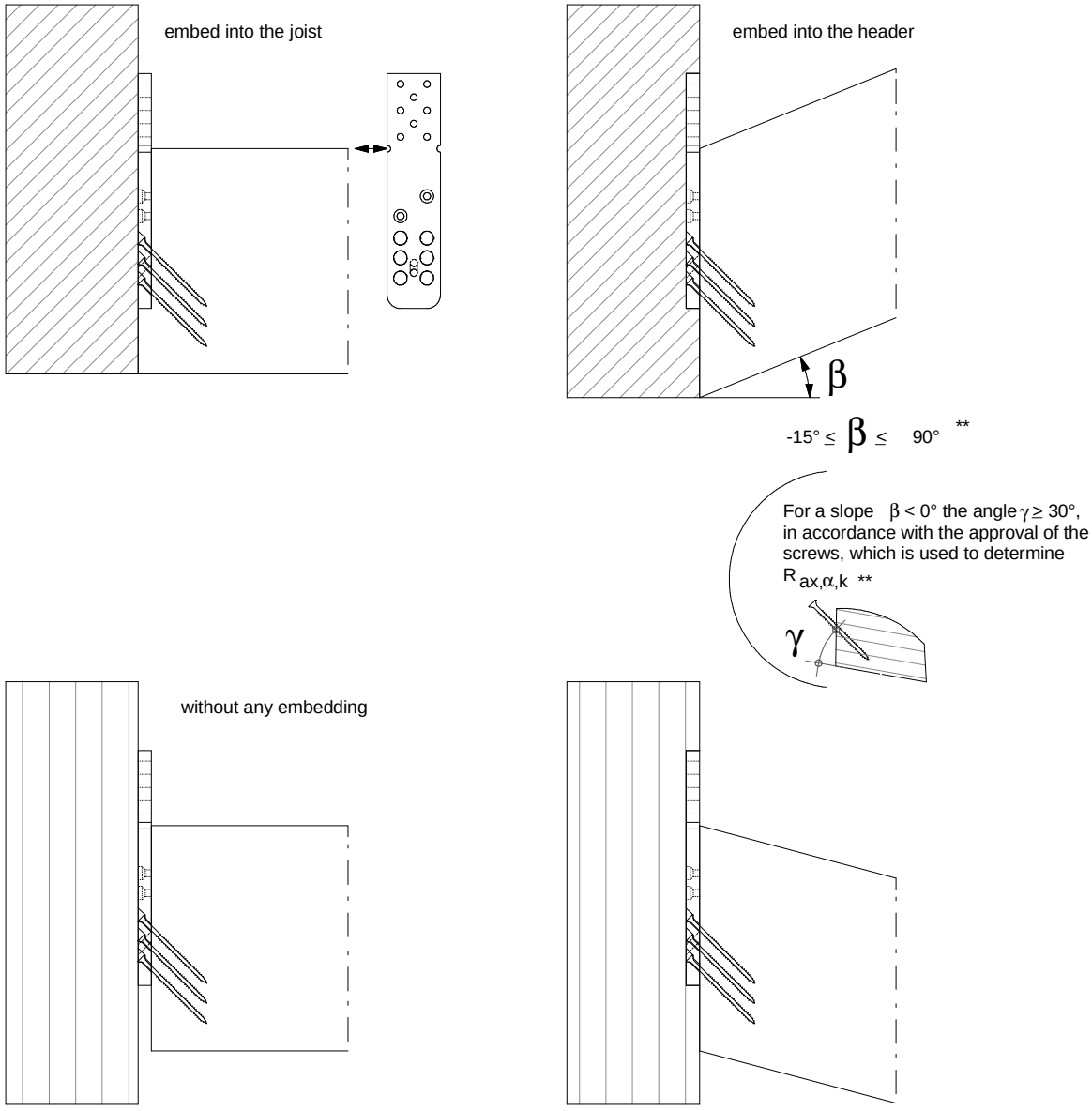


without any embedding





ELS



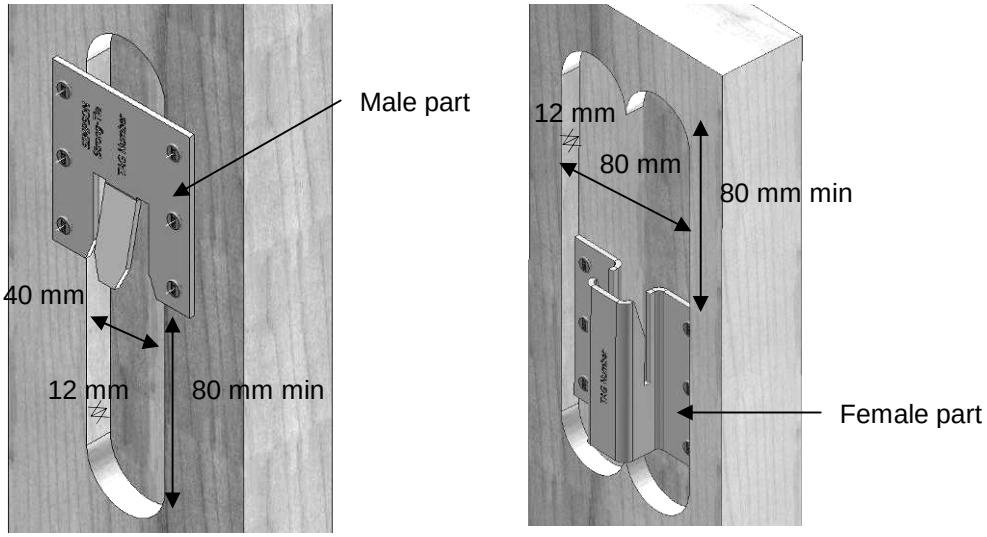
** if γ < 30° and the screws are covered by approval for this application, the values for the connector may be evaluated accordingly.

B3. Typical Installation of ICS:

A 12 mm deep pocket is necessary in each timber element before installing the ICS male and female part. The characteristic capacities given below are only available when the ICS are installed in these pockets.

The ICS male part needs to be fixed on the face of the timber element, on top of the 12 mm deep and 40 mm wide pocket as shown below. The pocket must continue at least 80 mm below the male part in order to connect the 2 parts

The ICS female part needs to be fixed in the back of the 12 mm deep and 80 mm wide pocket as shown below. The pocket must continue at least 80 mm above the female part in order to connect the 2 parts.



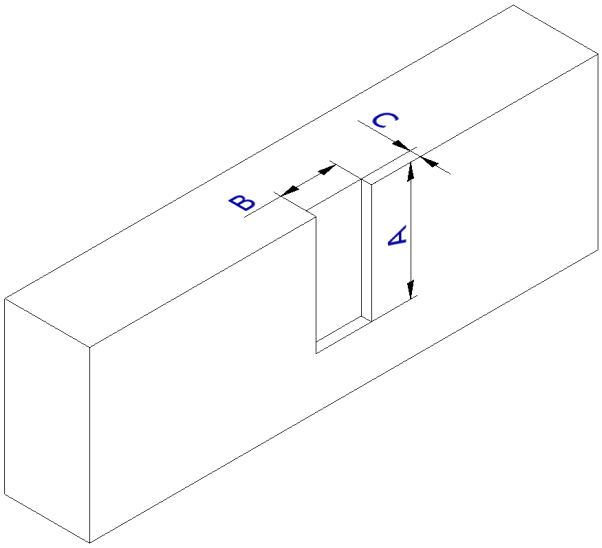
B4. Typical installation of ETS

The connection to the header for the ETS can be only made with CSA screws.
The connection to the end grain of the joist is made with screws Ø5 mm according to the corresponding Annex.
The angle between the Joist End connector and the screws is 45°. A slope and a skew is possible in these product ranges.

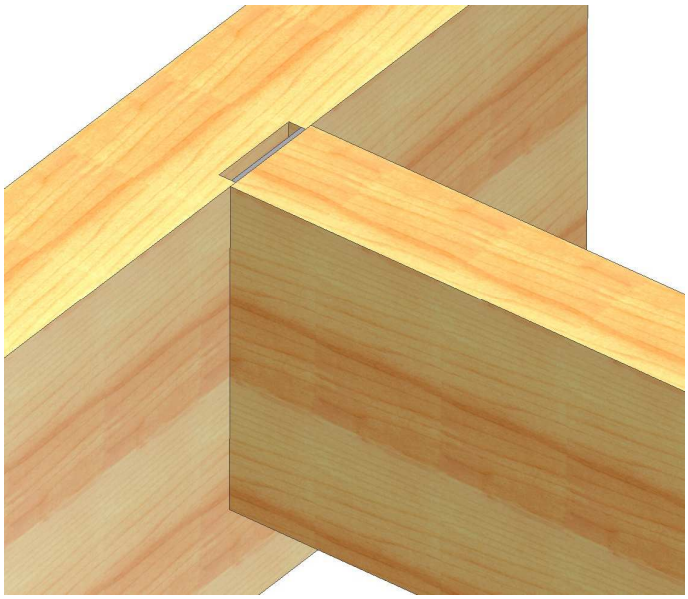
An ETS connection is deemed fit for its intended use provided:

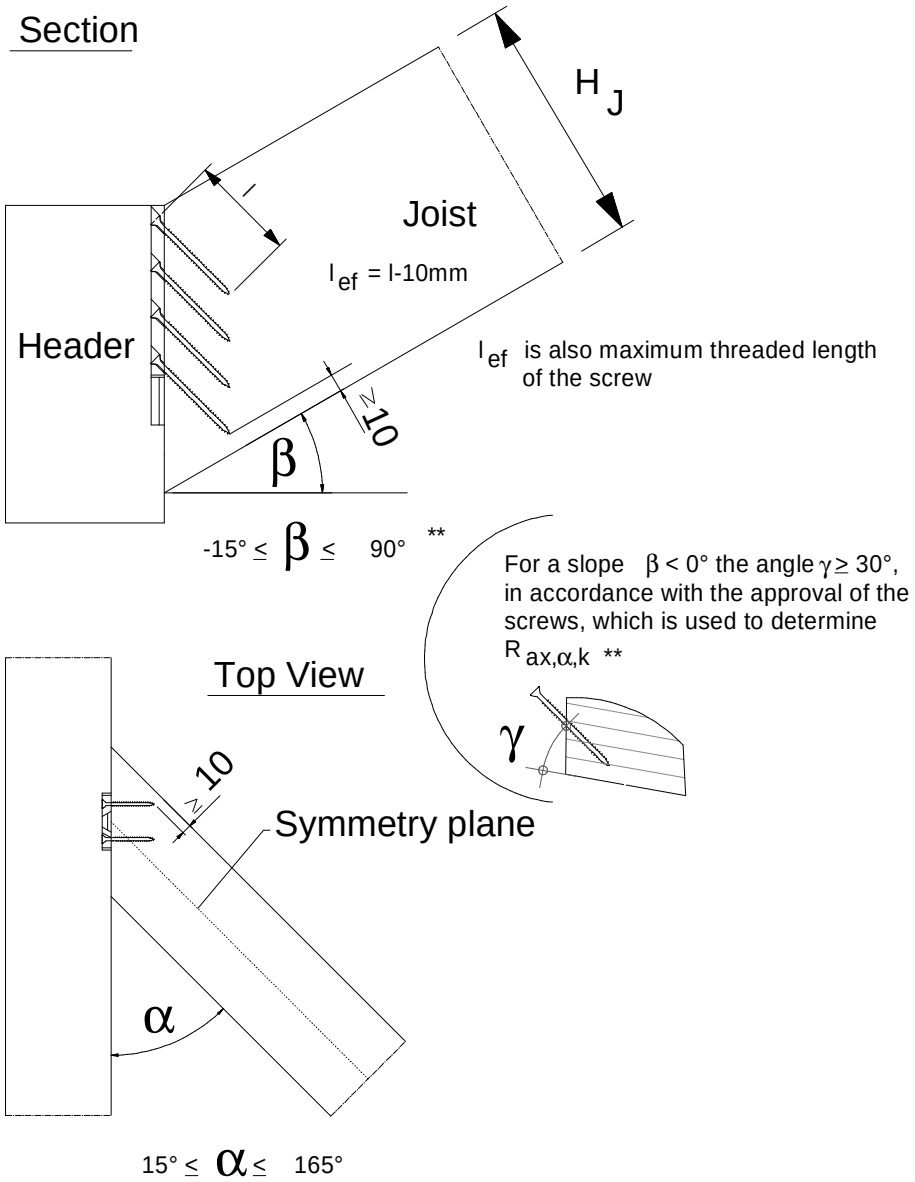
1. The header shall be restrained against rotation.
2. If the connection only has a connector on one side of the header, the eccentricity moment from the joists shall be considered when verifying the strength of the header.
3. For a header with joists from both sides but with different reaction forces a similar consideration applies.
4. There shall be screws in all holes.
5. For connections made with the ETS connectors the gap between the member surface and the connector shall be maximum 1 mm.
6. For ETS connectors the width of the header shall be at least l+4d, where l is the length and d is the diameter of the nails or screws in the header.
7. For ETS connectors the depth of the joist shall allow an edge distance of at least 10 mm between the screw tip and the adjacent joist surface.
8. The header shall have a plane surface against the whole ETS connector.
9. Screws to be used shall have a diameter, which fits the holes of the ETS connectors.

ETS
The header must be routed as described below.



Model	Dimensions of the routing		
	A (mm)	B (mm)	C (mm)
ETS100	100	65	12
ETS140	140	65	12
ETS180	180	75	12





** if γ < 30° and the screws are covered by approval for this application, the values for the connector may be evaluated accordingly.

Annex C

C1.Basis of Design

Characteristic capacities of the concealed joist hangers with nails or screws.

The formulas are applicable for connectors made from stainless steel with a characteristic yield stress of at least 235 Mpa or a characteristic ultimate tensile strength of at least 330 Mpa as for ordinary steel of the quality S250GD + Z275 according to EN 10346 or S235JR according to EN10025, or aluminium AlMgSi 0,7 to DIN 1749-1.

The Joist End connector are made from aluminium grade EN AW-6082 T6 according to EN 755-2:2000 with minimum yield strength of 250 MPa, a minimum tensile strength of 295 MPa and a minimum ultimate strain of 8 %.

Requirements for the header or the joist for the concealed beam hangers:

- The wood members can be of solid timber, glued laminated timber and similar glued members, or wood-based structural members.
- The requirements of the wood members can be fulfilled by using the following materials:
- Solid timber classified to C24 or better according to EN 338
- Glued members of timber classified to C24 or better according to EN 338 when structural adhesives are used.
- Glued laminated timber classified to GL24c or better according to EN 1194.
- Solid Wood Panels, SWP according to EN 13353.
- Laminated Veneer Lumber LVL according to EN 14374
- Plywood according to EN 636
- Other Engineering Wood products classified for their resistance and with certified mechanical performances for fasteners

The characteristic density of the wood members shall be at least 350 kg/m^3. Lower densities are applicable but the load bearing capacities shall be reduced by the k_{dens} factor, given by

$$k_{dens} = \left(\frac{\rho_k}{350} \right)^2$$

Where ρ_k is the characteristic density of the timber in kg/m^3.

In case of concrete support, concrete shall be specified according to EN 206-1 with a resistance class within the following range : C20/25 to C50/60.

The wood members shall have a thickness which is larger than the penetration depth of the fasteners into the members

Requirements for the header or the joist for the Joist End connectors:

For screws or nails in the end grain of the wood (joist) the requirement to the material of the wood members can be fulfilled by using the following materials:

- Solid timber classified to C14-C40 according to EN 338 / EN 14081,
- Glued members of timber classified to GL24c or better according to EN 1194 / EN 14080,
- Solid Wood Panels, SWP according to EN 13353,

For nailing in the side of the wood members (header) the requirement to the wood members can be fulfilled by using the following materials:

- Solid timber classified to C14-C40 according to EN 338 / EN 14081,
- Glued members of timber classified C14-C40 according to EN 338 / EN 14081 when structural adhesives are used,
- Glued members of timber classified to GL24c or better according to EN 1194 / EN 14080,
- Solid Wood Panels, SWP according to EN 13353,

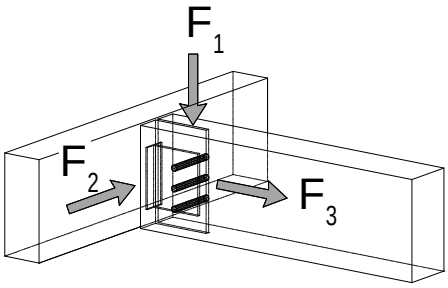
- Laminated Veneer Lumber LVL according to EN 14374,
- Parallam PSL,
- Laminated Strand Lumber LSL e.g. Parallam PSL and Timber Strand,
- Oriented Strand Board OSB according to EN 300
- Duo- and Triobalken,
- Layered wood plates,
- Plywood according to EN 636
- For EWP (Engineered Wood Products), pleace refer to manufacturer's specifications.

The load-carrying formulas stated in Annex B are applicable for a wood density from 290 kg/m^3 to 460 kg/m^3. It is allowed to use wood with a density up to 500 kg/m^3. However, increased load-carrying capacity than that for a density of 460 kg/m^3 should not be employed. For density between 420 and 500 kg/m^3 pre-drilling of nail and screw holes are necessary.

C2.Definition of force directions

The characteristic load-carrying capacities are for the following force directions:

F_1 Downward or uplift
F_2 Laterally – horizontal
F_3 Axial in the middle of the beam



C2.a. Concealed joist hangers type BTN, BT4, BTALU, BTx, BTCx

Force direction F_1 :
These are given in different tables for each connection.

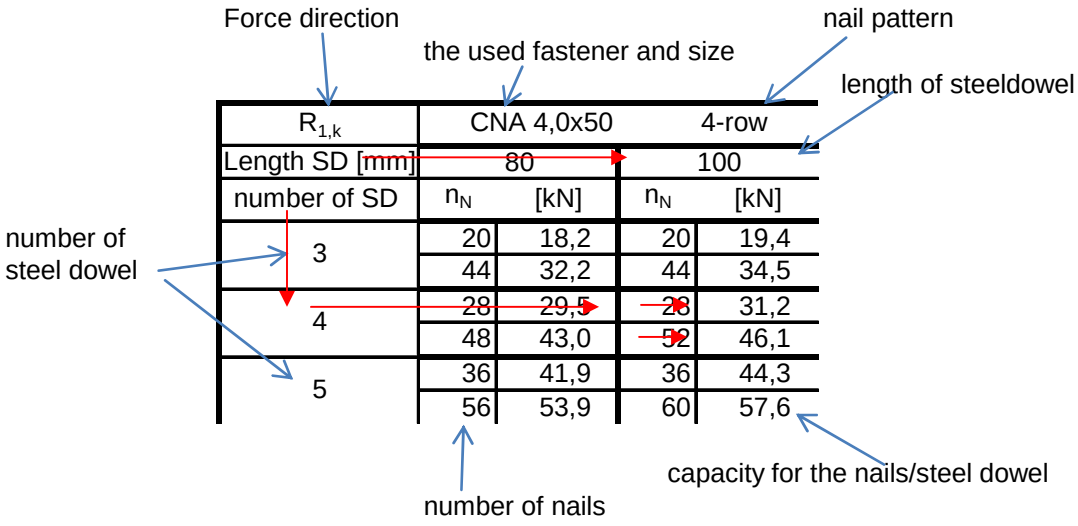
"Table for connection with header free from rotation". Here it is assumed, that the connection has a BT both sides of the header and the difference between the active forces is no more than 20%, or the header is clamped. In this case the calculation for the header may be made separately.

"Table for connection with header free to rotate". Here the eccentricity of the BT is used so the moment is absorbed in the BT – connection.

For the capacity for the header with b = 240 mm it is to multiply the values for b_{HT} = 180mm with the factor 0,77.

For an uplift force the upper dowel in the cut-out hole may not be used for the calculation.

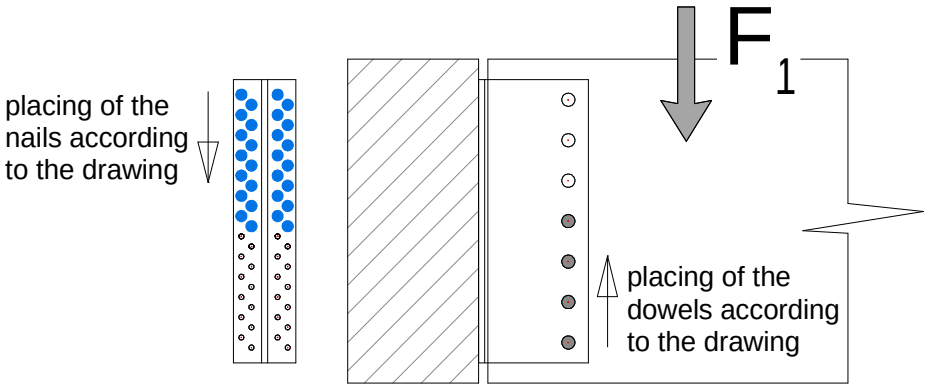
How to use the tables:



$R_{1,k}$	CNA 4,0x50		4-row	
Length SD [mm]	80		100	
number of SD	n_N	[kN]	n_N	[kN]
3	20	18,2	20	19,4
	44	32,2	44	34,5
4	28	29,5	28	31,2
	48	43,0	52	46,1
5	36	41,9	36	44,3
	56	53,9	60	57,6

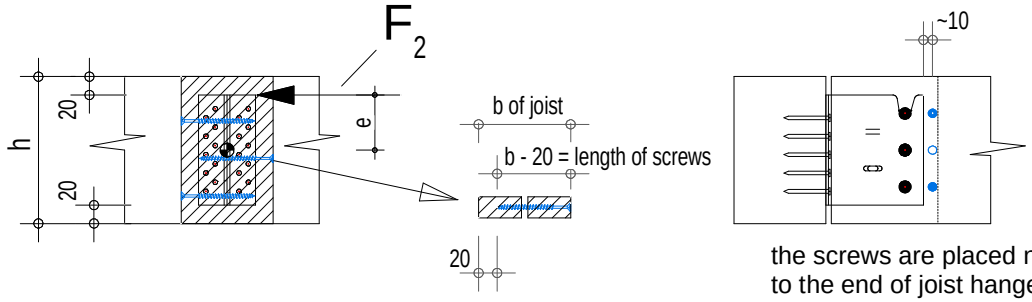
Sample: a connection with a BT with 4 Steel dowel with a length of 100mm, the width of joist is min. 100mm, nail pattern = 4-row, and 28 nails 4,0x50 is $R_{1,k}$ = 31,2 kN.
for the same connection with 52 nails $R_{1,k}$ = 46,1 kN.

For using another number of nails, it must be between the number of fasteners listed in the table, the capacity may be determined by linear interpolation based on the number of nails. In the sample before the number of nails may be between 28 and 52.

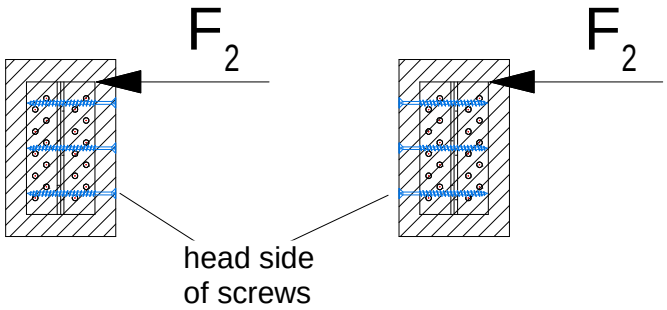


Force direction F_2 :
These are given in the table, with and without screws. For connections with screws, the screws are inserted perpendicular next to the BT, see following picture.

The screws for reinforcement of the joist shall have a length < the width of the joist. The assumed length for the tables in Annex B is width of the joist -20mm. The screws are inserted from both sides.

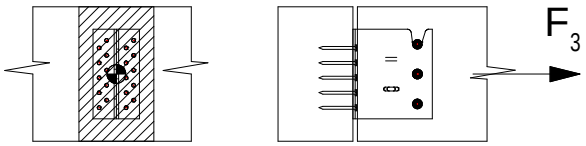


Where screws are inserted from one side, it shall be the side of the applied force. Otherwise the capacity is reduced with the factor 0,8 ; see following picture

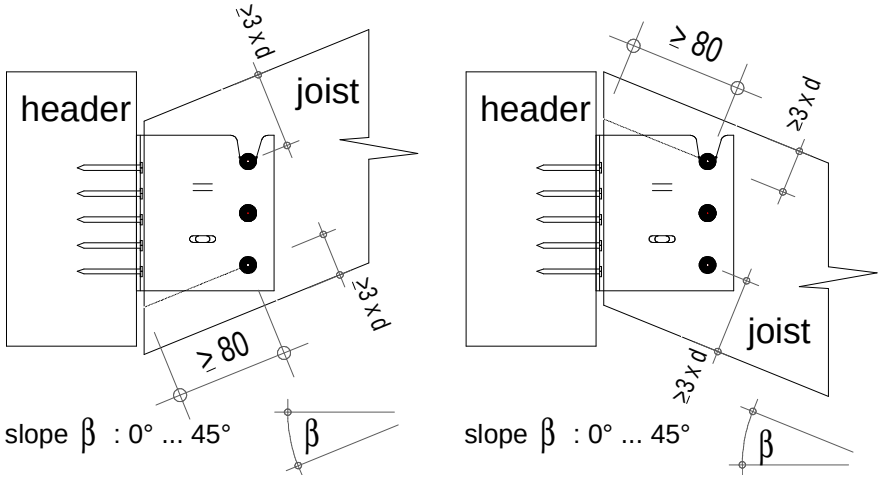


Use the table values use the table values x 0,8

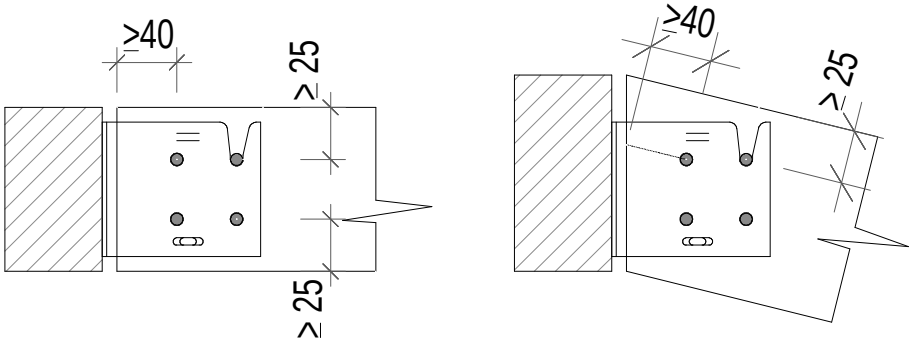
Force direction F_3
The force is in the direction of joist and in the middle of the joist



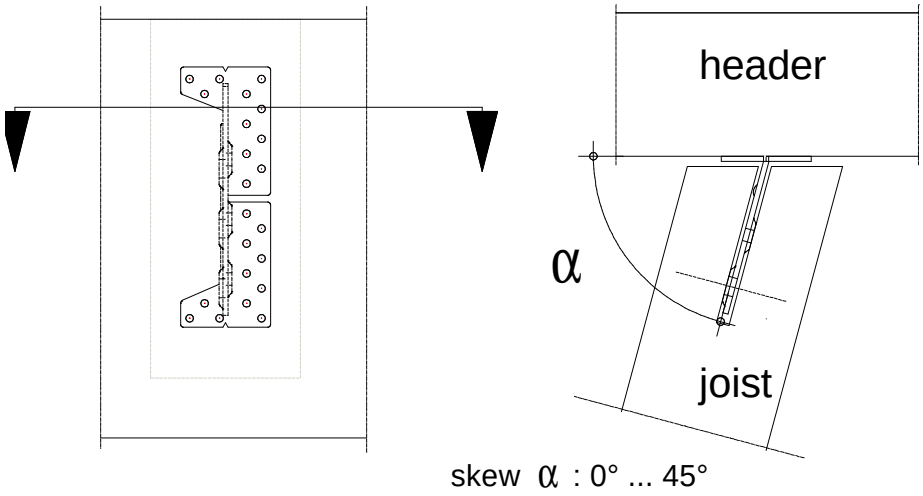
General



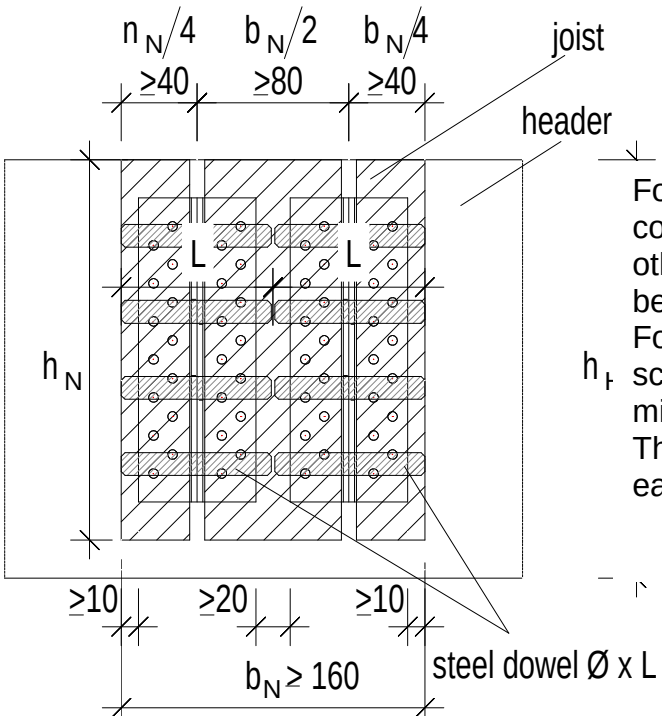
Type BTN-90 and BT4-90.



For the types TUS and TUBS; additional skews are possible:



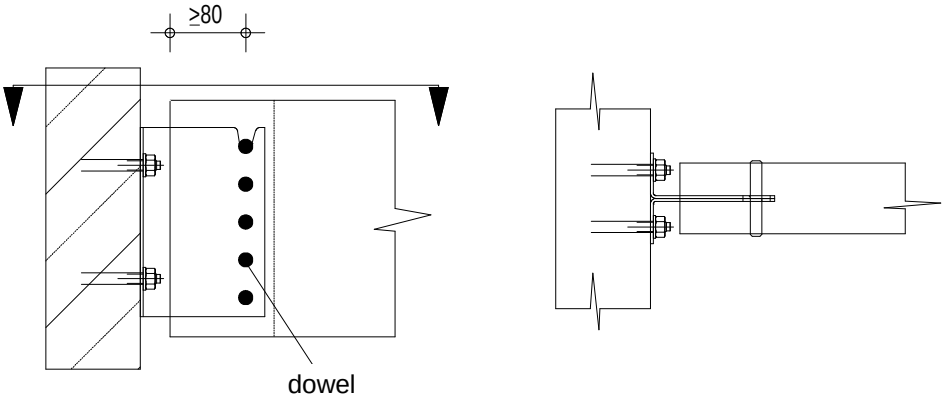
The above picture shows a skew to the left side. The design for right is the same.



For installations where the BT connectors are next to each other, the value for one BT may be multiplied by 2
For F_2 – it is necessary to use screws for reinforcement with a minimum length of B_N – 20mm
The length of the steel dowel for each BT = L_{max} = 0.5 x B_N

The dowels should be inserted from both sides meeting in the middle of the joist.

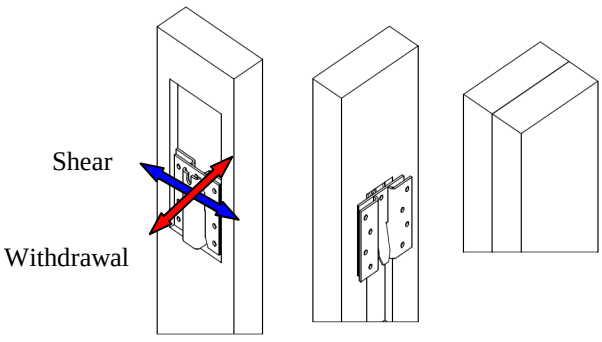
Connection to concrete / steel



The connection for force direction F_1 is with min. 2 anchor bolts, used in the upper holes.

For an uplift force, F_2 and F_3 a minimum of 4 anchor bolts, must be used in the upper and lower holes.

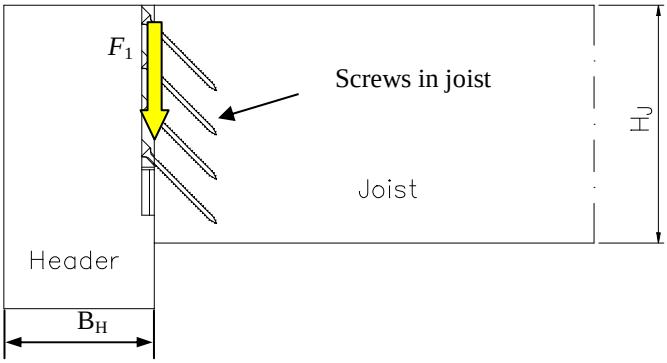
C2.b. ICS

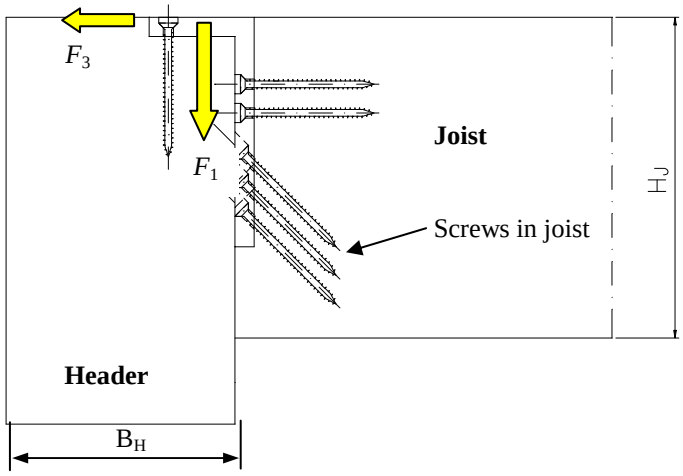


C2.c. ETB, EL, ELS, ETS

The part in the header has to be fixed with nails or CSA screws or only with CSA screws for ETS connectors. The part in the joist has to be fixed with screws with an angle of 45° to the connector. The screws have to have a angle between grain of timber and the screw according the approval of the screws. For the ETB and ETS both parts of the connector are to be fixed separately on the header and the joist before assembly of the connection

For the types EL and EL-S the connector has to be fixed to the joist and then connected to the header or the column.





C3.Fastener specification and capacities

Nail and screw type	Nail and screw size (mm)		Finish
According to ETA 04/0013 Annex A drawing 1 and 2	Diameter	Length	
Connector nail	4	35, 40, 50, 60, 75, 100	Electroplated zinc
Connector screw	5	35, 40, 50	
Connector nail	4,2	35, 50, 60	
Connector nail	4	35, 40, 50, 60, 75, 100	stainless steel as described
Connector screw	5	35, 40, 50	

other fastener	size [mm]		Finish
	Diameter	Length	
Screws according to EN 14592 or according to a ETA	5	60-120	Electroplated zinc
Screws according to EN 14592 or according to a ETA	8	Up to 300	Electroplated zinc
dowel according to EN 14529	8	-	Electroplated zinc hot dip galvanised stainless steel
	12	-	
Bolt M10	10	-	For relevant concealed joist hangers see the assumed characteristic capacities of the bolt connection and compare with the specification of the manufacturer
Bolt M12	12	-	

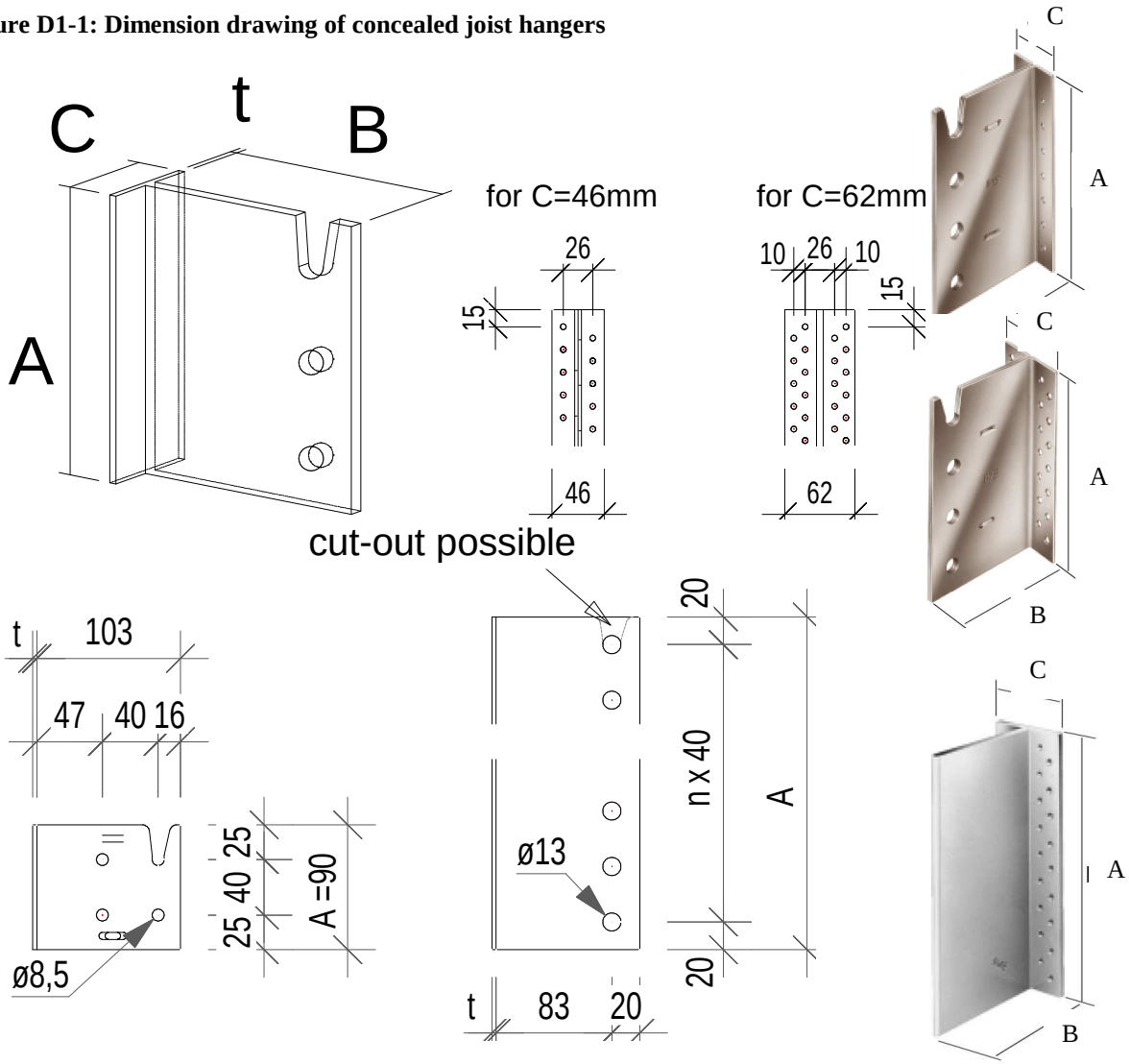
The capacities are given in the named standards or relevant approvals.

Annex D- Product definition and capacities

D1.Concealed joist hanger BTN, BT4, BTALU, BTx

Product Name	alternative names				old name
	Branch 36	Branch 40	Branch 46	Branch 47	
BTN			BTN	BTN	2 rows
BT4			BT4	BT4	4 rows
BTALU			BTALU	BTALU	ALU
BT			BT	BT	-

Figure D1-1: Dimension drawing of concealed joist hangers



Type BTALU connectors are produces without holes for the dowels, these holes should be made before or during installation by the user, the hole pattern is shown above.

The concealed joist hanger BTN and BT4 up to size 240 are supplied with the cut-out for the upper dowel and is an option for the other sizes.

Table D1-1: Size specification

Type	A [mm]	B [mm]	C [mm]	t [mm]	no of holes Ø 5mm	no of holes Ø13mm dowel
BTN90	90	103	46	3	8	4*
BTN120	120	103	46	3	10	3
BTN160	160	103	46	3	14	4
BTN200	200	103	46	3	18	5
BTN240	240	103	46	3	22	6
BT4-90	90	103	62	3	16	4*
BT4-120	120	103	62	3	20	3
BT4-160	160	103	62	3	28	4
BT4-200	200	103	62	3	36	5
BT4-240	240	103	62	3	44	6
BTALU90	90	103	62	6	16	4*, **
BTALU120	120	103	62	6	20	3**
BTALU160	160	103	62	6	28	4**
BTALU200	200	103	62	6	36	5**
BTALU240	240	103	62	6	44	6**
BTALUx ***	up to 600	103	62	6	up to 112	up to 12 x Ø13 **
BTx ***	up to 600	103	62	3	up to 112	up to 12x Ø13

* Ø8,5mm

** hole pattern according the types BT4, to drill additional

*** here is given the high in mm, same as the size “A” in the table.

Table D1-2: Material specification

Material thickness	Material Grades	Coating specification
3	S 250 GD	Z275
6	AlMgSi 0,7 to DIN 1749-1	
3	stainless steel as described	

Characteristic capacities

The tables are based on a timber having a density of 350 kg/m³ and a slope of 0°
For other configurations the following modification are necessary:

for different density the values shall be multiplied by:

ρ =	380	410	430,0
factor	1,05	1,10	1,13

for different slope β

β	0	15	30	45
factor	1	0,95	0,9	0,85

only for less as 7 SD, for 7 or more SD no reducing is necessary

SD = Steel dowel

For using steel dowels with a length of 60mm the values for steel dowel with 80mm may be multiplied by 0,95; only for the types BTN90 and BT4-90 the values for a dowel with l=60mm are given directly.

Characteristic capacity $R_{1,k}$ [kN] for BTN90/ BT4-90

BTN90 / BT4-90	$R_{1,k}$ [kN]			
CNA 4,0x50	350	kg/m³		
	Timber width = length of steel dowel [mm]			
n_N	60	80	100	≥ 120
8	8,3	9,2	10,3	11,02
16	10,8	11,8	12,9	13,72

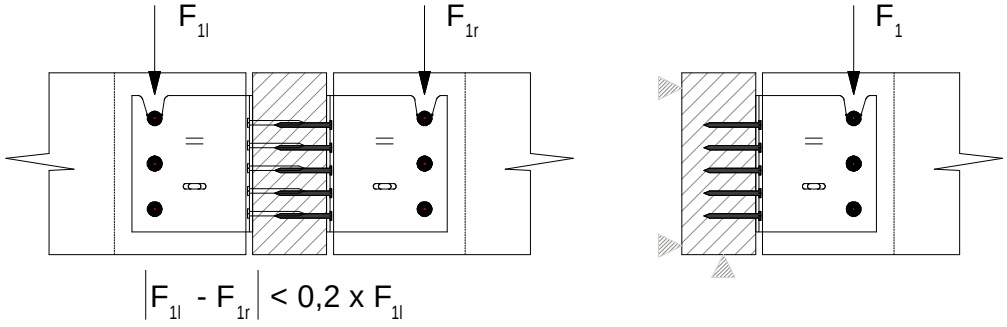
The characteristic capacities for the different load directions F_1, F_2, F_3 for the other dimensions of BTs, please refer to table 1 to 27 on the following pages.

No of table	force direction	nail /screw	nail pattern with/without screws
1	F_1	CNA4,0x50	4-row
2	F_1	CNA 4,0x60	4-row
3	F_1	CSA 5,0x50	4-row
4	F_1	CNA4,0x50	2-row
5	F_1	CNA 4,0x60	2-row
6	F_1	CSA 5,0x50	2-row
7	F_1	CNA4,0x50	4-row c
8	F_1	CNA 4,0x60	4-row c
9	F_1	CSA 5,0x50	4-row c
10	F_1	CNA4,0x50	2-row c
11	F_1	CNA 4,0x60	2-row c
12	F_1	CSA 5,0x50	2-row c

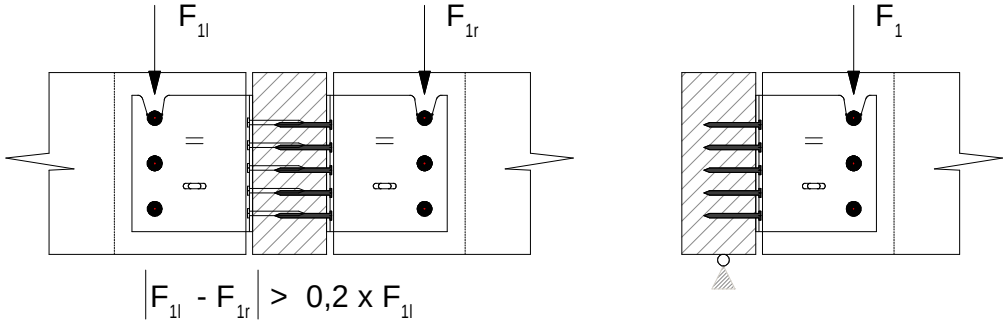
F_1 f.H. : the header is free for rotation

No of table	force direction	nail /screw	nail pattern with/without screws	b_H [mm]
13	F_1 f. H.	CNA 4,0x60	4-row	120
14	F_1 f. H.	CNA 4,0x60	4-row	180
15	F_1 f. H.	CSA 5,0x50	4-row	120
16	F_1 f. H.	CSA 5,0x50	4-row	180
17	F_1 f. H.	CNA 4,0x60	2-row	120
18	F_1 f. H.	CNA 4,0x60	2-row	180
19	F_1 f. H.	CSA 5,0x50	2-row	120
20	F_1 f. H.	CSA 5,0x50	2-row	180
21	F_2	CNA 4,0x50	with screws	
22	F_2	CNA 4,0x50	without screws	
23	F_2	CNA 4,0x60	with screws	
24	F_2	CNA 4,0x60	without screws	
25	F_2	CSA 5,0x50	with screws	
26	F_2	CSA 5,0x50	without screws	
27	F_3	all		

Refer to Tables 1 to 12: for header with clamped or lateral hold, or nearly same load each side (free from rotation)



Refer to Tables 13 to 20: header free to rotate, and/or unequal load on both side



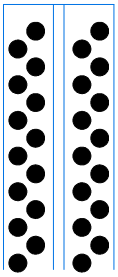
For tables 21 to 26: The note *with screws* or *without screws* means extra screws for an reinforcement of the timber perpendicular to the fibre.

For combination of load direction it should be to check:

$$\left(\frac{F_{1,d}}{R_{1,d}}\right)+\left(\frac{F_{2,d}}{R_{2,d}}\right)+\left(\frac{F_{3,d}}{R_{3,d}}\right)\leq 1$$

$R_{1,k}$	CNA 4,0x50		4-row								table	**1**
Length SD [mm]	80		100		120		140		160		180	
number of SD	n_N	[kN]	n_N	[kN]	n_N	[kN]	n_N	[kN]	n_N	[kN]	n_N	[kN]
3	20	18,2	20	19,4	20	20,7	20	22,3	20	23,9	20	23,9
	44	32,2	44	34,5	48	37,6	48	41,2	52	45,0	52	49,1
4	28	29,5	28	31,2	28	33,3	28	35,7	28	38,2	28	38,5
	48	43,0	52	46,1	56	50,1	56	55,0	60	60,1	64	65,5
5	36	41,9	36	44,3	36	47,2	36	50,4	36	53,9	36	54,9
	56	53,9	60	57,6	60	62,7	64	68,7	68	75,1	72	81,9
6	44	54,9	44	57,9	44	61,7	44	65,9	44	70,3	44	72,3
	64	64,6	64	69,2	68	75,3	72	82,4	76	90,1	80	98,3
7	52	68,0	56	74,4	60	82,0	64	90,3	68	99,1	72	108,3
	68	75,4	72	80,7	76	87,8	80	96,1	84	105,2	88	114,7
8	56	78,5	60	85,5	64	93,8	68	103,0	72	112,8	80	125,7
	72	86,2	76	92,3	80	100,5	84	109,9	88	120,2	96	131,2
9	64	91,6	68	99,0	72	108,2	76	118,4	80	129,3	88	143,0
	80	97,0	84	103,8	88	113,0	92	123,6	96	135,3	104	147,6
10	68	102,2	72	110,3	76	120,2	80	131,4	88	145,5	92	158,0
	84	107,8	88	115,4	92	125,6	96	137,4	104	150,3	108	164,0
11	72	112,9	76	121,5	80	132,3	88	146,6	92	159,6	100	175,4
	88	118,6	92	126,9	96	138,1	104	151,2	108	165,3	116	180,4
12	76	123,6	80	132,9	88	146,5	92	159,7	100	175,8	100	188,1
	92	129,3	96	138,4	104	150,7	108	164,9	116	180,4	116	195,8

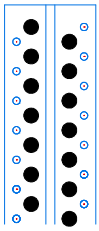
$R_{1,k}$	CNA 4,0x60		4-row								table	**2**
Length SD [mm]	80		100		120		140		160		180	
number of SD	n_N	[kN]	n_N	[kN]	n_N	[kN]	n_N	[kN]	n_N	[kN]	n_N	[kN]
3	20	19,7	20	20,8	20	22,2	20	23,7	20	25,3	20	25,4
	40	32,2	40	34,5	40	37,6	44	41,1	48	45,0	48	49,1
4	28	31,8	28	33,5	28	35,6	28	37,9	28	40,4	28	40,9
	44	43,1	48	46,1	48	50,2	52	54,9	52	60,0	56	65,6
5	36	44,9	36	47,2	36	50,2	36	53,4	36	56,8	36	58,1
	52	53,8	52	57,7	56	62,7	60	68,6	60	75,1	64	82,0
6	44	58,4	44	61,4	44	65,2	44	69,5	44	73,9	44	76,3
	56	64,6	60	69,2	60	75,3	64	82,5	68	90,2	72	98,4
7	44	65,8	48	72,5	52	80,3	56	88,9	60	97,9	64	107,3
	60	75,4	64	80,7	68	87,8	72	96,1	76	105,2	80	114,7
8	52	79,5	52	83,8	56	92,4	60	101,8	64	111,8	72	125,2
	68	86,2	68	92,3	72	100,5	76	109,9	80	120,3	88	131,2
9	56	90,3	60	98,0	64	107,4	68	117,7	72	128,7	76	140,2
	72	97,0	76	103,8	80	113,0	84	123,6	88	135,3	92	147,6
10	60	101,1	64	109,4	68	119,6	72	130,8	76	142,8	84	158,0
	76	107,8	80	115,3	84	125,5	88	137,4	92	150,3	100	164,0
11	64	112,0	68	120,9	72	131,8	76	144,0	84	159,6	88	173,1
	80	118,6	84	126,9	88	138,1	92	151,1	100	165,4	104	180,4
12	68	122,9	72	132,4	80	146,4	84	159,6	88	173,7	96	190,9
	84	129,4	88	138,5	96	150,7	100	164,9	104	180,4	112	196,8



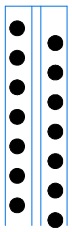
$R_{1,k}$	CSA 5,0x50		4-row								table	**3**
Length SD [mm]	80		100		120		140		160		180	
Anzahl SD	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]
3	20	28,2	20	29,2	20	30,5	20	31,9	20	33,3	20	33,8
	24	32,3	28	34,5	28	37,6	28	41,2	32	45,0	32	49,1
4	28	42,7	28	44,6	28	46,9	28	49,2	28	51,5	28	52,8
	32	43,0	32	46,1	32	50,2	36	54,9	36	60,1	40	65,5
5	36	53,8	36	57,6	36	62,5	36	66,4	36	69,9	36	72,6
	36	53,8	36	57,6	40	62,7	40	68,6	44	75,1	44	81,9
6	44	64,6	44	69,2	44	75,3	44	82,3	44	87,9	44	92,4
	40	64,6	40	69,2	44	75,3	48	82,4	48	90,1	52	98,3
7	28	60,6	28	63,2	32	71,9	36	81,1	40	90,6	40	92,8
	44	75,4	44	80,8	48	87,8	52	96,1	56	105,2	56	114,7
8	32	71,6	32	74,5	36	83,7	40	93,4	44	103,5	48	112,8
	48	86,2	48	92,3	52	100,4	56	109,9	60	120,2	64	131,2
9	36	82,6	36	85,7	40	95,4	44	105,6	48	116,0	56	132,8
	52	97,0	52	103,8	56	113,0	60	123,7	64	135,3	72	147,6
10	40	93,6	44	102,8	44	106,9	52	123,9	56	135,0	60	145,5
	56	107,8	60	115,3	60	125,5	68	137,4	72	150,3	76	164,0
11	44	104,5	48	114,0	52	124,7	56	135,9	60	147,3	68	165,4
	60	118,5	64	126,9	68	138,1	72	151,1	76	165,3	84	180,4
12	48	115,3	52	125,2	56	136,3	60	147,7	68	166,2	72	177,7
	64	129,3	68	138,4	72	150,7	76	164,9	84	180,4	88	196,8

$R_{1,k}$	CNA 4,0x50		2-row								table	**4**
Length SD [mm]	80		100		120		140		160		180	
number of SD	n_N	[kN]	n_N	[kN]	n_N	[kN]	n_N	[kN]	n_N	[kN]	n_N	[kN]
3	10	14,5	10	15,6	10	16,9	10	18,3	10	19,5	10	19,5
	32	32,2	32	34,6	34	37,6	36	41,1	38	45,0	40	49,1
4	14	23,2	14	24,7	14	26,6	14	28,5	14	30,1	14	30,1
	36	43,0	38	46,2	40	50,2	42	55,0	44	60,0	48	65,5
5	18	32,7	18	34,7	18	37,0	18	39,1	18	39,9	18	39,9
	42	53,9	44	57,6	46	62,8	48	68,6	52	75,1	54	82,0
6	22	42,6	22	45,0	22	47,5	22	48,8	22	48,8	22	48,8
	46	64,6	50	69,2	52	75,3	54	82,4	58	90,2	58	97,0
7	44	70,9	46	76,0	48	82,2	50	88,9	50	93,7	50	97,0
	52	75,4	54	80,8	56	87,8	58	95,5	58	101,8	58	107,4
8	48	81,4	50	87,0	50	91,9	50	97,0	50	101,9	50	104,4
	56	86,2	58	92,2	58	98,8	58	105,1	58	111,1	58	115,5
9	50	90,1	50	94,3	50	99,4	50	104,4	50	108,6	50	110,0
	58	96,2	58	101,3	58	107,4	58	113,6	58	119,3	58	122,7
10	50	96,9	50	101,2	50	106,1	50	110,0	50	110,8	50	110,8
	58	104,2	58	109,2	58	115,2	58	121,1	58	126,0	58	127,8
11	50	103,2	50	107,3	50	110,6	50	110,8	50	110,8	50	110,8
	58	111,3	58	116,4	58	122,2	58	127,1	58	128,5	58	128,5
12	50	108,6	50	110,8	50	110,8	50	110,8	50	110,8	50	110,8
	58	118,0	58	122,8	58	127,5	58	128,5	58	128,5	58	128,5

$R_{1,k}$	CNA 4,0x60		2-row								table	**5**
Length SD [mm]	80		100		120		140		160		180	
number of SD	n_N	[kN]	n_N	[kN]	n_N	[kN]	n_N	[kN]	n_N	[kN]	n_N	[kN]
3	10	15,2	10	16,3	10	17,6	10	18,9	10	20,1	10	20,1
	28	32,3	30	34,5	30	37,6	32	41,2	34	45,1	36	49,1
4	14	24,3	14	25,8	14	27,6	14	29,5	14	31,3	14	31,3
	34	43,0	34	46,1	36	50,2	38	55,0	40	60,1	42	65,5
5	18	34,2	18	36,1	18	38,4	18	40,6	18	42,3	18	42,4
	38	53,9	40	57,6	42	62,7	44	68,7	46	75,1	50	81,9
6	22	44,5	22	46,8	22	49,4	22	51,6	22	52,0	22	52,0
	42	64,7	44	69,2	46	75,3	50	82,4	52	90,1	56	98,4
7	38	68,7	42	76,1	44	82,4	48	91,4	50	98,6	50	102,8
	46	75,4	50	80,7	52	87,9	56	96,1	58	105,2	58	112,4
8	44	81,6	46	87,4	48	94,3	50	101,7	50	106,8	50	110,0
	52	86,2	54	92,3	56	100,4	58	109,1	58	116,2	58	122,1
9	48	92,4	50	98,6	50	103,9	50	109,2	50	113,8	50	115,9
	56	97,0	58	103,8	58	111,6	58	118,6	58	124,8	58	129,2
10	50	101,2	50	105,6	50	110,8	50	115,4	50	118,1	50	118,2
	58	107,5	58	113,4	58	120,1	58	126,5	58	132,0	58	134,8
11	50	107,6	50	111,9	50	116,3	50	118,2	50	118,2	50	118,2
	58	115,7	58	121,1	58	127,4	58	133,0	58	136,7	58	137,1
12	50	113,3	50	116,8	50	118,2	50	118,2	50	118,2	50	118,2
	58	122,7	58	127,9	58	133,5	58	137,0	58	137,1	58	137,1



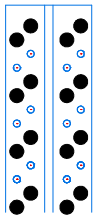
2-row



$R_{1,k}$	CSA 5,0x50		2-row								table	**6**
Length SD [mm]	80		100		120		140		160		180	
Anzahl SD	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]
3	10	19,0	10	19,8	10	20,7	10	21,7	10	22,7	10	22,7
	20	32,2	20	34,5	22	37,6	22	41,1	24	45,0	26	49,1
4	14	29,3	14	30,4	14	31,6	14	32,8	14	33,9	14	33,9
	24	43,0	24	46,1	26	50,1	28	54,9	30	60,0	32	65,5
5	18	40,0	18	41,2	18	42,6	18	43,9	18	44,8	18	44,9
	28	53,8	30	57,6	30	62,7	34	68,6	36	75,1	38	81,9
6	22	50,8	22	52,2	22	53,6	22	54,7	22	55,2	22	55,2
	32	64,6	34	69,2	36	75,3	38	82,4	42	90,1	44	98,3
7	28	65,2	30	70,5	32	76,2	36	85,9	38	91,9	42	101,6
	36	75,4	38	80,7	40	87,8	44	96,1	46	105,2	50	114,7
8	32	76,0	34	81,5	36	87,4	40	97,3	44	107,5	48	117,5
	40	86,2	42	92,2	44	100,4	48	109,9	52	120,2	56	131,2
9	36	86,7	38	92,3	42	102,3	46	112,6	50	123,0	50	124,3
	44	97,0	46	103,8	50	113,0	54	123,6	58	135,3	58	141,5
10	40	97,3	42	103,0	46	113,2	50	123,6	50	125,1	50	125,5
	48	107,8	50	115,4	54	125,5	58	137,3	58	142,4	58	144,3
11	44	107,8	48	117,6	50	124,0	50	125,4	50	125,5	50	125,5
	52	118,5	56	126,9	58	137,9	58	142,8	58	144,9	58	145,5
12	48	118,3	50	124,2	50	125,4	50	125,5	50	125,5	50	125,5
	56	129,3	58	138,1	58	142,9	58	145,1	58	145,6	58	145,6

$R_{1,k}$	CNA 4,0x50				4-row column						table **7**	
Length SD [mm]	80		100		120		140		160		180	
Anzahl SD	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]
3	12	15,5	12	16,6	12	17,9	12	19,4	12	20,7	12	20,7
	32	32,2	32	34,5	36	37,6	36	41,2	40	45,0	40	49,2
4	16	24,4	16	26,0	16	27,9	16	30,0	16	32,0	16	32,0
	40	43,0	40	46,1	40	50,2	44	54,9	48	60,0	48	65,5
5	20	34,1	20	36,2	20	38,7	20	41,2	20	43,4	20	43,5
	44	53,8	44	57,7	48	62,7	52	68,6	52	75,2	56	81,9
6	24	44,3	24	46,8	24	49,7	24	52,3	24	53,2	24	53,2
	48	64,6	52	69,2	52	75,4	56	82,4	60	90,1	60	98,0
7	36	62,7	40	69,9	44	77,9	44	82,3	44	86,6	44	88,7
	52	75,5	56	80,7	60	87,8	60	96,1	60	103,2	60	109,2
8	40	73,4	44	81,0	44	85,4	44	90,0	44	94,1	44	95,5
	56	86,2	60	92,2	60	99,7	60	106,6	60	112,9	60	118,0
9	44	84,0	44	87,9	44	92,4	44	96,3	44	97,5	44	97,5
	60	96,9	60	102,4	60	108,9	60	115,4	60	121,5	60	125,5
10	44	90,4	44	94,1	44	97,3	44	97,5	44	97,5	44	97,5
	60	105,4	60	110,7	60	117,0	60	123,4	60	128,8	60	131,3
11	44	95,8	44	97,5	44	97,5	44	97,5	44	97,5	44	97,5
	60	112,9	60	118,2	60	124,4	60	130,0	60	133,0	60	133,0
12	44	97,5	44	97,5	44	97,5	44	97,5	44	97,5	44	97,5
	60	119,8	60	125,0	60	130,5	60	133,0	60	133,0	60	133,0

$R_{1,k}$	CNA 4,0x60				4-row column						table **8**	
Length SD [mm]	80		100		120		140		160		180	
Anzahl SD	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]
3	12	16,5	12	17,5	12	18,8	12	20,2	12	21,6	12	21,6
	28	32,3	32	34,5	32	37,6	32	41,1	36	45,0	36	49,2
4	16	25,8	16	27,3	16	29,2	16	31,2	16	33,2	16	33,2
	36	43,0	36	46,1	36	50,2	40	54,9	40	60,0	44	65,5
5	20	35,9	20	37,9	20	40,3	20	42,8	20	45,1	20	45,3
	40	53,8	40	57,7	44	62,7	44	68,7	48	75,1	52	81,9
6	24	46,4	24	48,8	24	51,7	24	54,5	24	56,5	24	56,6
	44	64,6	44	69,2	48	75,3	52	82,4	56	90,1	56	98,4
7	32	61,7	36	69,2	36	72,9	40	81,8	44	91,0	44	93,6
	48	75,4	52	80,7	52	87,9	56	96,1	60	105,2	60	113,8
8	36	72,6	40	80,6	44	89,5	44	94,2	44	98,4	44	100,3
	52	86,2	56	92,2	60	100,4	60	109,8	60	117,8	60	124,3
9	40	83,4	44	91,9	44	96,4	44	100,7	44	103,7	44	104,0
	56	97,0	60	103,8	60	112,5	60	120,3	60	127,0	60	132,1
10	44	94,3	44	98,2	44	102,2	44	104,0	44	104,0	44	104,0
	60	107,8	60	114,5	60	121,8	60	128,7	60	134,8	60	138,2
11	44	99,9	44	103,1	44	104,0	44	104,0	44	104,0	44	104,0
	60	117,0	60	122,8	60	129,5	60	135,8	60	140,5	60	141,7
12	44	103,8	44	104,0	44	104,0	44	104,0	44	104,0	44	104,0
	60	124,5	60	130,0	60	136,2	60	140,9	60	141,8	60	141,8

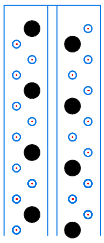


4-row column

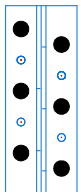
$R_{1,k}$	CSA 5,0x50				4-row column						table **9**	
Length SD [mm]	80		100		120		140		160		180	
Anzahl SD	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]
3	12	20,2	12	20,7	12	21,4	12	22,1	12	23,0	12	23,8
	24	35,1	24	38,0	24	44,5	28	46,1	28	55,0	28	55,8
4	16	30,7	16	31,4	16	32,3	16	33,3	16	34,3	16	35,4
	28	47,2	28	54,6	28	56,3	32	65,9	36	75,3	36	76,4
5	20	41,6	20	42,5	20	43,6	20	44,7	20	45,9	20	47,0
	32	59,3	32	66,4	36	75,8	40	85,2	40	88,3	44	91,9
6	24	52,7	24	53,6	24	54,9	24	56,1	24	57,3	24	58,4
	36	75,2	36	77,9	40	88,0	44	98,4	48	109,0	52	110,6
7	24	55,8	28	64,8	32	74,3	36	84,2	40	94,4	40	95,7
	40	86,9	44	96,4	48	107,0	52	118,2	56	129,4	56	131,0
8	28	66,5	32	75,8	36	85,5	40	95,6	44	105,8	44	107,1
	44	98,3	48	108,4	52	119,3	56	130,5	60	141,6	60	143,3
9	32	77,2	36	86,7	44	105,3	44	106,8	44	108,1	44	109,1
	48	109,5	52	119,9	60	137,9	60	142,1	60	144,2	60	145,7
10	36	87,8	44	106,0	44	107,5	44	108,8	44	109,8	44	110,3
	52	120,7	60	137,9	60	142,4	60	144,6	60	146,3	60	147,7
11	44	106,9	44	108,1	44	109,3	44	110,1	44	110,4	44	110,4
	60	138,1	60	142,4	60	144,9	60	146,7	60	148,2	60	149,3
12	44	108,8	44	109,7	44	110,3	44	110,4	44	110,4	44	110,4
	60	142,6	60	145,0	60	146,9	60	148,4	60	149,6	60	150,3

$R_{1,k}$	CNA 4,0x50		2-row column								table **10**	
Length SD [mm]	80		100		120		140		160		180	
Anzahl SD	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]
3	6	13,0	6	13,3	6	13,3	6	13,3	6	13,3	6	13,3
	24	32,2	26	34,5	26	37,7	28	41,1	30	45,0	30	48,7
4	8	17,7	8	17,7	8	17,7	8	17,7	8	17,7	8	17,7
	28	43,0	30	46,1	30	49,4	30	51,8	30	53,9	30	55,3
5	10	22,2	10	22,2	10	22,2	10	22,2	10	22,2	10	22,2
	30	51,5	30	53,3	30	55,5	30	57,7	30	59,7	30	60,6
6	12	26,6	12	26,6	12	26,6	12	26,6	12	26,6	12	26,6
	30	56,6	30	58,4	30	60,6	30	62,8	30	64,6	30	65,0
7	22	48,6	22	48,8	22	48,8	22	48,8	22	48,8	22	48,8
	30	61,1	30	62,9	30	64,9	30	66,2	30	66,5	30	66,5
8	22	48,8	22	48,8	22	48,8	22	48,8	22	48,8	22	48,8
	30	64,9	30	66,1	30	66,5	30	66,5	30	66,5	30	66,5
9	22	48,8	22	48,8	22	48,8	22	48,8	22	48,8	22	48,8
	30	66,5	30	66,5	30	66,5	30	66,5	30	66,5	30	66,5
10	22	48,8	22	48,8	22	48,8	22	48,8	22	48,8	22	48,8
	30	66,5	30	66,5	30	66,5	30	66,5	30	66,5	30	66,5
11	22	48,8	22	48,8	22	48,8	22	48,8	22	48,8	22	48,8
	30	66,5	30	66,5	30	66,5	30	66,5	30	66,5	30	66,5
12	22	48,8	22	48,8	22	48,8	22	48,8	22	48,8	22	48,8
	30	66,5	30	66,5	30	66,5	30	66,5	30	66,5	30	66,5

$R_{1,k}$	CNA 4,0x60		2-row column								table **11**	
Length SD [mm]	80		100		120		140		160		180	
Anzahl SD	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]
3	6	13,0	6	13,8	6	14,2	6	14,2	6	14,2	6	14,2
	22	32,2	22	34,5	24	37,6	26	41,1	28	45,0	28	49,2
4	8	18,9	8	18,9	8	18,9	8	18,9	8	18,9	8	18,9
	26	43,0	28	46,1	30	50,1	30	54,8	30	57,8	30	59,8
5	10	23,6	10	23,6	10	23,6	10	23,6	10	23,6	10	23,6
	30	53,9	30	56,7	30	59,2	30	61,5	30	63,6	30	64,7
6	12	28,4	12	28,4	12	28,4	12	28,4	12	28,4	12	28,4
	30	60,2	30	62,1	30	64,3	30	66,4	30	68,3	30	68,8
7	22	51,2	22	52,0	22	52,0	22	52,0	22	52,0	22	52,0
	30	64,7	30	66,5	30	68,5	30	70,1	30	70,9	30	70,9
8	22	52,0	22	52,0	22	52,0	22	52,0	22	52,0	22	52,0
	30	68,4	30	69,9	30	70,8	30	70,9	30	70,9	30	70,9
9	22	52,0	22	52,0	22	52,0	22	52,0	22	52,0	22	52,0
	30	70,7	30	70,9	30	70,9	30	70,9	30	70,9	30	70,9
10	22	52,0	22	52,0	22	52,0	22	52,0	22	52,0	22	52,0
	30	70,9	30	70,9	30	70,9	30	70,9	30	70,9	30	70,9
11	22	52,0	22	52,0	22	52,0	22	52,0	22	52,0	22	52,0
	30	70,9	30	70,9	30	70,9	30	70,9	30	70,9	30	70,9
12	22	52,0	22	52,0	22	52,0	22	52,0	22	52,0	22	52,0
	30	70,9	30	70,9	30	70,9	30	70,9	30	70,9	30	70,9



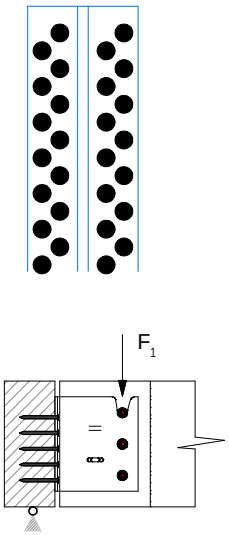
2-row column



$R_{1,k}$	CSA 5,0x50		2-row column								table **12**	
Length SD [mm]	80		100		120		140		160		180	
Anzahl SD	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]
3	6	13,2	6	13,6	6	14,1	6	14,5	6	14,9	6	15,1
	18	35,1	18	38,9	20	44,0	22	49,3	24	54,6	24	55,1
4	8	19,2	8	19,6	8	19,9	8	20,1	8	20,1	8	20,1
	22	49,3	24	54,4	26	59,9	28	65,3	30	70,8	30	71,3
5	10	24,9	10	25,1	10	25,1	10	25,1	10	25,1	10	25,1
	26	60,3	28	65,6	30	71,0	30	71,7	30	72,3	30	72,7
6	12	30,1	12	30,1	12	30,1	12	30,1	12	30,1	12	30,1
	30	71,1	30	71,8	30	72,4	30	73,0	30	73,5	30	73,9
7	22	54,1	22	54,4	22	54,8	22	55,1	22	55,2	22	55,2
	30	72,6	30	73,1	30	73,6	30	74,1	30	74,5	30	74,9
8	22	55,0	22	55,2	22	55,2	22	55,2	22	55,2	22	55,2
	30	73,7	30	74,1	30	74,6	30	74,9	30	75,2	30	75,3
9	22	55,2	22	55,2	22	55,2	22	55,2	22	55,2	22	55,2
	30	74,6	30	74,9	30	75,2	30	75,3	30	75,3	30	75,3
10	22	55,2	22	55,2	22	55,2	22	55,2	22	55,2	22	55,2
	30	75,2	30	75,3	30	75,3	30	75,3	30	75,3	30	75,3
11	22	55,2	22	55,2	22	55,2	22	55,2	22	55,2	22	55,2
	30	75,3	30	75,3	30	75,3	30	75,3	30	75,3	30	75,3
12	22	55,2	22	55,2	22	55,2	22	55,2	22	55,2	22	55,2
	30	75,3	30	75,3	30	75,3	30	75,3	30	75,3	30	75,3

$R_{1,k}$	CNA 4,0x60		4-row		The header is free to rotate, b_{HT} =				120mm		table	**13**
Length SD [mm]	80		100		120		140		160		180	
number of SD	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]
3	20	6,4	20	6,4	20	6,4	20	6,4	20	6,4	20	6,4
	36	17,2	36	19,0	40	21,2	44	23,6	44	26,0	44	26,0
4	28	12,0	28	12,0	28	12,0	28	12,0	28	12,0	28	12,0
	44	26,8	48	29,5	48	32,8	52	36,5	56	40,4	56	40,6
5	36	19,2	36	19,2	36	19,2	36	19,2	36	19,2	36	19,2
	52	37,3	56	41,0	60	45,5	64	50,5	68	55,9	68	56,8
6	44	27,9	44	27,9	44	27,9	44	27,9	44	27,9	44	27,9
	60	48,5	64	53,1	68	58,8	72	65,2	76	72,0	76	74,0
7	52	38,1	56	43,6	60	49,6	64	55,8	68	62,3	72	69,0
	68	59,9	72	65,4	76	72,3	80	80,1	84	88,4	88	91,8
8	60	49,6	64	55,8	68	62,3	72	69,0	76	76,1	80	83,4
	76	71,4	80	77,9	84	86,0	88	95,1	92	104,9	96	110,0
9	64	55,8	68	62,3	76	76,1	80	83,4	84	90,9	88	98,6
	80	83,1	84	90,4	92	99,7	96	110,1	100	121,3	104	128,3
10	72	69,0	76	76,1	80	83,4	88	98,6	92	106,6	96	114,7
	88	94,7	92	102,9	96	113,3	104	125,1	108	137,7	112	146,6
11	76	76,1	84	90,9	88	98,6	92	106,6	100	123,0	100	123,0
	92	106,4	100	115,4	104	126,9	108	140,0	116	154,0	116	157,8
12	84	90,9	88	98,6	96	114,7	100	123,0	100	123,0	100	123,0
	100	117,9	104	127,8	112	140,4	116	154,7	116	157,8	116	157,8

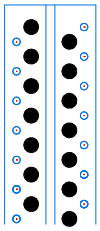
$R_{1,k}$	CNA 4,0x60		4-row		The header is free to rotate, b_{HT} =				180mm		table	**14**
Length SD [mm]	80		100		120		140		160		180	
number of SD	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]
3	20	5,3	20	5,3	20	5,3	20	5,3	20	5,3	20	5,3
	32	12,2	36	13,5	36	15,1	40	16,9	40	18,3	40	18,3
4	28	10,0	28	10,0	28	10,0	28	10,0	28	10,0	28	10,0
	44	19,7	44	21,8	48	24,3	48	27,1	52	29,5	52	29,5
5	36	16,0	36	16,0	36	16,0	36	16,0	36	16,0	36	16,0
	52	28,4	52	31,3	56	34,9	60	38,9	64	42,7	64	42,7
6	44	23,4	44	23,4	44	23,4	44	23,4	44	23,4	44	23,4
	60	38,0	60	41,9	64	46,6	68	51,9	72	57,4	72	57,4
7	52	32,1	56	36,8	60	41,9	64	47,3	68	52,9	68	52,9
	68	48,3	72	53,2	76	59,1	80	65,7	84	72,7	84	73,2
8	60	41,9	60	41,9	68	52,9	72	58,8	76	65,0	76	65,0
	76	59,2	76	65,0	84	72,2	88	80,1	92	88,6	92	90,0
9	64	47,3	68	52,9	76	65,0	80	71,4	84	78,0	88	84,8
	80	70,4	84	77,2	92	85,6	96	94,9	100	104,9	104	107,3
10	72	58,8	76	65,0	80	71,4	88	84,8	92	91,9	96	99,2
	88	81,8	92	89,6	96	99,2	104	109,9	108	121,4	112	125,1
11	80	71,4	84	78,0	88	84,8	96	99,2	100	106,6	100	106,6
	96	93,4	100	102,1	104	112,9	112	125,1	116	138,0	116	138,3
12	84	78,0	92	91,9	96	99,2	100	106,6	100	106,6	100	106,6
	100	105,1	108	114,7	112	126,7	116	138,3	116	138,3	116	138,3



$R_{1,k}$	CSA 5,0x50		4-row		The header is free to rotate, b_{HT} =				120mm		table	**15**
Length SD [mm]	80		100		120		140		160		180	
number of SD	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]
3	20	15,4	20	15,4	20	15,4	20	15,4	20	15,4	20	15,4
	24	17,2	24	19,0	24	21,2	28	23,6	28	26,0	28	26,0
4	28	26,8	28	27,9	28	27,9	28	27,9	28	27,9	28	27,9
	28	26,8	32	29,5	32	32,8	36	36,5	36	40,4	36	40,6
5	36	37,3	36	41,0	36	43,2	36	43,2	36	43,2	36	43,2
	36	37,3	36	41,0	40	45,5	40	50,5	44	55,9	44	56,8
6	44	48,5	44	53,1	44	58,8	44	60,5	44	60,5	44	60,5
	40	48,5	44	53,1	44	58,8	48	65,2	52	72,0	52	74,0
7	28	27,9	32	35,2	36	43,2	40	51,6	40	51,6	44	60,5
	44	59,9	48	65,4	52	72,3	56	80,1	56	88,4	60	91,8
8	36	43,2	36	43,2	40	51,6	44	60,5	48	69,8	52	79,4
	52	71,4	52	77,9	56	86,0	60	95,1	64	104,9	68	110,0
9	40	51,6	44	60,5	48	69,8	52	79,4	56	89,2	56	89,2
	56	83,1	60	90,4	64	99,7	68	110,1	72	121,3	72	128,3
10	44	60,5	48	69,8	52	79,4	56	89,2	60	99,3	64	109,6
	60	94,7	64	102,9	68	113,3	72	125,1	76	137,7	80	146,6
11	48	69,8	52	79,4	56	89,2	60	99,3	68	120,0	72	130,5
	64	106,4	68	115,4	72	126,9	76	140,0	84	154,0	88	164,9
12	52	79,4	56	89,2	60	99,3	68	120,0	72	130,5	76	141,1
	68	117,9	72	127,8	76	140,4	84	154,7	88	170,2	92	183,2

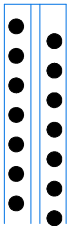
for header with b=240mm, the values for b=180mm are multiply with 0,77

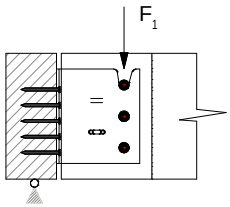
$R_{1,k}$	CSA 5,0x50		4-row		The header is free to rotate, b_{HT} =				180mm		table	**16**
Length SD [mm]	80		100		120		140		160		180	
number of SD	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]
3	20	12,2	20	12,9	20	12,9	20	12,9	20	12,9	20	12,9
	20	12,2	24	13,5	24	15,1	24	16,9	28	18,3	28	18,3
4	28	19,7	28	21,8	28	23,7	28	23,7	28	23,7	28	23,7
	28	19,7	28	21,8	32	24,3	32	27,1	32	29,5	32	29,5
5	36	28,4	36	31,3	36	34,9	36	37,1	36	37,1	36	37,1
	32	28,4	36	31,3	36	34,9	40	38,9	40	42,7	40	42,7
6	44	38,0	44	41,9	44	46,6	44	51,9	44	52,7	44	52,7
	40	38,0	40	41,9	44	46,6	44	51,9	48	57,4	48	57,4
7	28	23,7	32	30,1	32	30,1	36	37,1	40	44,7	40	44,7
	44	48,3	48	53,2	48	59,1	52	65,7	56	72,7	56	73,2
8	32	30,1	36	37,1	40	44,7	44	52,7	44	52,7	48	61,2
	48	59,2	52	65,0	56	72,2	60	80,1	60	88,6	64	90,0
9	40	44,7	40	44,7	44	52,7	48	61,2	52	70,0	52	70,0
	56	70,4	56	77,2	60	85,6	64	94,9	68	104,9	68	107,3
10	44	52,7	48	61,2	52	70,0	56	79,2	60	88,6	60	88,6
	60	81,8	64	89,6	68	99,2	72	109,9	76	121,4	76	125,1
11	48	61,2	52	70,0	56	79,2	60	88,6	64	98,3	68	108,2
	64	93,4	68	102,1	72	112,9	76	125,1	80	138,0	84	143,2
12	52	70,0	56	79,2	60	88,6	68	108,2	72	118,3	76	128,6
	68	105,1	72	114,7	76	126,7	84	140,2	88	154,7	92	161,5



2-row

$R_{1,k}$	CNA 4,0x60		2-row		The header is free to rotate, b_{HT} =				120mm		table	**17**
Length SD [mm]	80		100		120		140		160		180	
number of SD	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]
3	10	3,2	10	3,2	10	3,2	10	3,2	10	3,2	10	3,2
	26	17,2	26	19,0	28	21,2	30	23,6	32	26,0	32	26,0
4	14	6,0	14	6,0	14	6,0	14	6,0	14	6,0	14	6,0
	32	26,8	34	29,5	36	32,8	38	36,5	40	40,4	40	40,6
5	18	9,6	18	9,6	18	9,6	18	9,6	18	9,6	18	9,6
	38	37,3	40	41,0	44	45,5	46	50,5	48	55,9	48	56,8
6	22	13,9	22	13,9	22	13,9	22	13,9	22	13,9	22	13,9
	44	48,5	46	53,1	50	58,8	52	65,2	56	72,0	56	74,0
7	42	45,4	44	49,3	48	57,3	50	61,5	50	61,5	50	61,5
	50	59,9	52	65,4	56	72,3	58	78,9	58	78,9	58	78,9
8	48	57,3	50	61,5	50	61,5	50	61,5	50	61,5	50	61,5
	56	71,4	58	77,9	58	78,9	58	78,9	58	78,9	58	78,9
9	50	61,5	50	61,5	50	61,5	50	61,5	50	61,5	50	61,5
	58	78,9	58	78,9	58	78,9	58	78,9	58	78,9	58	78,9
10	50	61,5	50	61,5	50	61,5	50	61,5	50	61,5	50	61,5
	58	78,9	58	78,9	58	78,9	58	78,9	58	78,9	58	78,9
11	50	61,5	50	61,5	50	61,5	50	61,5	50	61,5	50	61,5
	58	78,9	58	78,9	58	78,9	58	78,9	58	78,9	58	78,9
12	50	61,5	50	61,5	50	61,5	50	61,5	50	61,5	50	61,5
	58	78,9	58	78,9	58	78,9	58	78,9	58	78,9	58	78,9

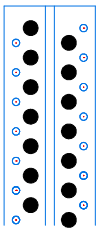




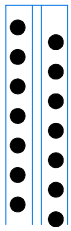
$R_{1,k}$	CNA 4,0x60		2-row		The header is free to rotate, b_{HT} =				180mm		table	**18**
Length SD [mm]	80		100		120		140		160		180	
number of SD	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]
3	10	2,7	10	2,7	10	2,7	10	2,7	10	2,7	10	2,7
	24	12,2	24	13,5	26	15,1	28	16,9	28	18,3	28	18,3
4	14	5,0	14	5,0	14	5,0	14	5,0	14	5,0	14	5,0
	30	19,7	32	21,8	34	24,3	36	27,1	38	29,5	38	29,5
5	18	8,0	18	8,0	18	8,0	18	8,0	18	8,0	18	8,0
	36	28,4	38	31,3	40	34,9	42	38,9	46	42,7	46	42,7
6	22	11,7	22	11,7	22	11,7	22	11,7	22	11,7	22	11,7
	42	38,0	44	41,9	48	46,6	50	51,9	54	57,4	54	57,4
7	40	35,7	42	39,0	46	46,0	50	53,3	50	53,3	50	53,3
	48	48,3	50	53,2	54	59,1	58	65,7	58	69,1	58	69,1
8	46	46,0	48	49,6	50	53,3	50	53,3	50	53,3	50	53,3
	54	59,2	56	65,0	58	69,1	58	69,1	58	69,1	58	69,1
9	50	53,3	50	53,3	50	53,3	50	53,3	50	53,3	50	53,3
	58	69,1	58	69,1	58	69,1	58	69,1	58	69,1	58	69,1
10	50	53,3	50	53,3	50	53,3	50	53,3	50	53,3	50	53,3
	58	69,1	58	69,1	58	69,1	58	69,1	58	69,1	58	69,1
11	50	53,3	50	53,3	50	53,3	50	53,3	50	53,3	50	53,3
	58	69,1	58	69,1	58	69,1	58	69,1	58	69,1	58	69,1
12	50	53,3	50	53,3	50	53,3	50	53,3	50	53,3	50	53,3
	58	69,1	58	69,1	58	69,1	58	69,1	58	69,1	58	69,1

for header with b=240mm, the values for b=180mm are multiply with 0,77

$R_{1,k}$	CSA 5,0x50		2-row		The header is free to rotate, b_{HT} =		120mm		table	**19**		
Length SD [mm]	80		100		120		140		160		180	
number of SD	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]
3	10	7,7	10	7,7	10	7,7	10	7,7	10	7,7	10	7,7
	16	17,2	18	19,0	18	21,2	20	23,6	22	26,0	22	26,0
4	14	13,9	14	13,9	14	13,9	14	13,9	14	13,9	14	13,9
	22	26,8	22	29,5	24	32,8	26	36,5	28	40,4	28	40,6
5	18	21,6	18	21,6	18	21,6	18	21,6	18	21,6	18	21,6
	26	37,3	28	41,0	30	45,5	32	50,5	34	55,9	34	56,8
6	22	30,2	22	30,2	22	30,2	22	30,2	22	30,2	22	30,2
	30	48,5	32	53,1	34	58,8	36	65,2	40	72,0	40	74,0
7	26	39,7	30	49,7	32	54,8	34	60,0	38	70,6	38	70,6
	34	59,9	38	65,4	40	72,3	42	80,1	46	88,4	46	91,8
8	32	54,8	34	60,0	36	65,3	40	75,9	44	86,7	46	92,1
	40	71,4	42	77,9	44	86,0	48	95,1	52	104,9	54	110,0
9	36	65,3	38	70,6	42	81,3	46	92,1	50	102,9	50	102,9
	44	83,1	46	90,4	50	99,7	54	110,1	58	121,3	58	124,6
10	40	75,9	42	81,3	46	92,1	50	102,9	50	102,9	50	102,9
	48	94,7	50	102,9	54	113,3	58	124,6	58	124,6	58	124,6
11	44	86,7	48	97,5	50	102,9	50	102,9	50	102,9	50	102,9
	52	106,4	56	115,4	58	124,6	58	124,6	58	124,6	58	124,6
12	48	97,5	50	102,9	50	102,9	50	102,9	50	102,9	50	102,9
	56	117,9	58	124,6	58	124,6	58	124,6	58	124,6	58	124,6

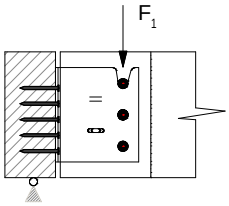


2-row



$R_{1,k}$	CSA 5,0x50		2-row		The header is free to rotate, b_{HT} =		180mm		table	**20**		
Length SD [mm]	80		100		120		140		160		180	
number of SD	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]	n	[kN]
3	10	6,5	10	6,5	10	6,5	10	6,5	10	6,5	10	6,5
	16	12,2	16	13,5	16	15,1	18	16,9	18	18,3	18	18,3
4	14	11,9	14	11,9	14	11,9	14	11,9	14	11,9	14	11,9
	20	19,7	20	21,8	22	24,3	24	27,1	24	29,5	24	29,5
5	18	18,6	18	18,6	18	18,6	18	18,6	18	18,6	18	18,6
	24	28,4	26	31,3	26	34,9	28	38,9	30	42,7	30	42,7
6	22	26,4	22	26,4	22	26,4	22	26,4	22	26,4	22	26,4
	28	38,0	30	41,9	32	46,6	34	51,9	36	57,4	36	57,4
7	24	30,6	26	35,0	28	39,6	32	49,2	34	54,1	34	54,1
	32	48,3	34	53,2	36	59,1	40	65,7	42	72,7	42	73,2
8	28	39,6	32	49,2	34	54,1	38	64,3	40	69,5	40	69,5
	36	59,2	40	65,0	42	72,2	46	80,1	48	88,6	48	90,0
9	34	54,1	36	59,2	40	69,5	42	74,7	46	85,3	48	90,7
	42	70,4	44	77,2	48	85,6	50	94,9	54	104,9	56	107,3
10	38	64,3	40	69,5	44	80,0	48	90,7	50	96,1	50	96,1
	46	81,8	48	89,6	52	99,2	56	109,9	58	117,7	58	117,7
11	42	74,7	46	85,3	50	96,1	50	96,1	50	96,1	50	96,1
	50	93,4	54	102,1	58	112,9	58	117,7	58	117,7	58	117,7
12	46	85,3	50	96,1	50	96,1	50	96,1	50	96,1	50	96,1
	54	105,1	58	114,7	58	117,7	58	117,7	58	117,7	58	117,7

for header with b=240mm, the values for b=180mm are multiply with 0,77



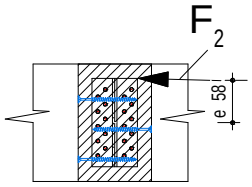
$R_{2,k}$	CNA 4,0x50			with screws *					table	21
	number of		joist			R2, k [kN] bei b =				
Typ	SD	nails	b / h [mm]	60	80	100	120	140	160	180
90-2	4	8	... / 100	1,9	3,7	4,7	5,8	6,8	6,9	6,9
120-2	3	10	... / 160	2,2	3,1	4,8	5,8	5,8	5,8	5,8
160-2	4	14	... / 200	2,9	4,7	7,1	7,9	7,9	7,9	7,9
200-2	5	18	... / 240	3,5	5,0	7,8	10,0	10,0	10,0	10,0
240-2	6	22	... / 280	4,2	5,4	8,6	11,9	12,1	12,1	12,1
90-4	4	16	... / 100	1,9	3,7	4,7	5,8	6,8	7,8	8,9
120-4	3	20	... / 160	2,2	3,1	4,8	6,6	8,3	10,1	11,9
160-4	4	28	... / 200	2,9	4,7	7,3	9,9	12,5	15,1	16,5
200-4	5	36	... / 240	3,5	5,0	8,1	13,0	16,7	20,2	20,6
240-4	6	44	... / 280	4,2	5,4	8,6	13,7	20,2	23,5	24,8
TU12	4	6	... / 120	1,6	3,4	5,3	5,3	5,3	5,3	5,3
TU16	3	18	... / 160	1,6	3,1	4,8	6,6	8,3	10,1	11,9
TU20	4	22	... / 200	2,2	3,8	7,0	9,9	12,5	15,1	17,8
TU24	5	26	... / 240	2,7	4,0	7,3	12,0	16,7	20,2	20,2
TU28	6	30	... / 280	3,2	4,4	7,7	12,4	19,3	22,5	22,5
TU12c	4	6	... / 120	1,6	3,4	5,3	5,3	5,3	5,3	5,3
TU16c	3	14	... / 160	1,6	3,1	4,8	6,6	8,3	10,1	11,9
TU20c	4	14	... / 200	2,2	3,8	7,0	9,9	12,5	13,2	13,2
TU24c	5	18	... / 240	2,7	4,0	7,3	12,0	15,1	15,1	15,1
TU28c	6	18	... / 280	3,2	4,4	7,7	12,4	15,6	15,6	15,6
360-2	8	34	... / 400	6,1	7,6	9,7	14,4	18,6	18,6	18,6
480-2	10	46	... / 520	7,9	9,8	11,9	16,1	21,3	25,2	25,2
600-2	12	58	... / 640	9,8	12,1	14,7	17,6	23,4	30,6	31,8
360-4	8	68	... / 400	6,1	7,6	9,7	14,5	21,8	30,6	37,7
480-4	10	92	... / 520	7,9	9,8	11,9	16,1	23,2	32,0	44,0
600-4	12	116	... / 640	9,8	12,1	14,7	17,6	24,2	33,6	46,1

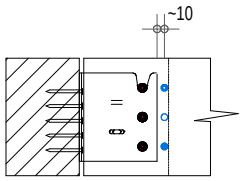
$R_{2,k}$	CNA 4,0x50			without screws *					table	22
	number of		joist			R2, k [kN] bei b =				
Typ	SD	nails	b / h [mm]	60	80	100	120	140	160	180
90-2	4	8	... / 100	1,5	1,9	2,3	2,7	3,1	3,6	4,0
120-2	3	10	... / 160	2,2	2,9	3,5	4,1	4,6	5,2	5,7
160-2	4	14	... / 200	2,9	3,6	4,4	5,2	6,0	6,6	7,3
200-2	5	18	... / 240	3,5	4,4	5,4	6,4	7,2	8,1	9,0
240-2	6	22	... / 280	4,2	5,3	6,4	7,4	8,6	9,5	10,5
90-4	4	16	... / 100	1,5	1,9	2,3	2,7	3,1	3,6	4,0
120-4	3	20	... / 160	2,2	2,9	3,5	4,2	4,8	5,6	6,2
160-4	4	28	... / 200	2,9	3,6	4,4	5,3	6,2	7,0	7,7
200-4	5	36	... / 240	3,5	4,4	5,4	6,4	7,4	8,4	9,5
240-4	6	44	... / 280	4,2	5,3	6,4	7,4	8,6	9,8	11,1
TU12	4	6	... / 120	1,2	1,7	2,2	2,8	3,3	3,8	4,3
TU16	3	18	... / 160	1,6	2,2	2,9	3,6	4,4	5,1	5,7
TU20	4	22	... / 200	2,2	2,9	3,8	4,6	5,6	6,4	7,3
TU24	5	26	... / 240	2,7	3,6	4,7	5,8	6,7	7,9	8,8
TU28	6	30	... / 280	3,2	4,4	5,5	6,7	7,9	9,2	10,3
TU12c	4	6	... / 120	1,2	1,7	2,2	2,8	3,3	3,8	4,3
TU16c	3	14	... / 160	1,6	2,2	2,9	3,6	4,4	5,1	5,7
TU20c	4	14	... / 200	2,2	2,9	3,8	4,6	5,6	6,4	7,3
TU24c	5	18	... / 240	2,7	3,6	4,7	5,8	6,7	7,9	8,8
TU28c	6	18	... / 280	3,2	4,4	5,5	6,7	7,9	9,2	10,3
360-2	8	34	... / 400	6,1	7,6	9,2	10,9	12,4	13,9	15,4
480-2	10	46	... / 520	7,9	9,8	11,9	14,3	16,5	18,2	20,1
600-2	12	58	... / 640	9,8	12,1	14,7	17,6	20,4	23,0	24,9
360-4	8	68	... / 400	6,1	7,6	9,2	10,9	12,4	14,4	15,9
480-4	10	92	... / 520	7,9	9,8	11,9	14,3	16,6	18,7	20,7
600-4	12	116	... / 640	9,8	12,1	14,7	17,6	20,4	23,0	25,4

screw 6,0x L
with L = b-20mm

(for timber with b=60mm
use screws 5,0x50)

number of screws =
number of steel dowel





* - with / without screws: for reinforcement of the joist, see Annex C2

$R_{2,k}$	CNA 4,0x60			with screws *					table	23
	number of		joist			R2, k [kN] bei b =				
Typ	SD	nails	b / h [mm]	60	80	100	120	140	160	180
90-2	4	8	... / 100	1,9	3,7	4,7	5,8	6,8	7,3	7,3
120-2	3	10	... / 160	2,2	3,1	4,8	6,2	6,2	6,2	6,2
160-2	4	14	... / 200	2,9	4,7	7,3	8,4	8,4	8,4	8,4
200-2	5	18	... / 240	3,5	5,0	8,1	10,6	10,6	10,6	10,6
240-2	6	22	... / 280	4,2	5,4	8,6	12,4	12,9	12,9	12,9
90-4	4	16	... / 100	1,9	3,7	4,7	5,8	6,8	7,8	8,9
120-4	3	20	... / 160	2,2	3,1	4,8	6,6	8,3	10,1	11,9
160-4	4	28	... / 200	2,9	4,7	7,3	9,9	12,5	15,1	17,6
200-4	5	36	... / 240	3,5	5,0	8,1	13,0	16,7	20,2	22,0
240-4	6	44	... / 280	4,2	5,4	8,6	13,7	20,2	23,5	26,4
TU12	4	6	... / 120	1,6	3,4	5,7	5,7	5,7	5,7	5,7
TU16	3	18	... / 160	1,6	3,1	4,8	6,6	8,3	10,1	11,9
TU20	4	22	... / 200	2,2	3,8	7,0	9,9	12,5	15,1	17,8
TU24	5	26	... / 240	2,7	4,0	7,3	12,0	16,7	20,2	21,6
TU28	6	30	... / 280	3,2	4,4	7,7	12,4	19,3	23,5	24,0
TU12c	4	6	... / 120	1,6	3,4	5,7	5,7	5,7	5,7	5,7
TU16c	3	14	... / 160	1,6	3,1	4,8	6,6	8,3	10,1	11,9
TU20c	4	14	... / 200	2,2	3,8	7,0	9,9	12,5	14,0	14,0
TU24c	5	18	... / 240	2,7	4,0	7,3	12,0	16,1	16,1	16,1
TU28c	6	18	... / 280	3,2	4,4	7,7	12,4	16,7	16,7	16,7
360-2	8	34	... / 400	6,1	7,6	9,7	14,5	19,3	19,9	19,9
480-2	10	46	... / 520	7,9	9,8	11,9	16,1	22,2	26,9	26,9
600-2	12	58	... / 640	9,8	12,1	14,7	17,6	24,2	31,4	34,0
360-4	8	68	... / 400	6,1	7,6	9,7	14,5	21,8	30,6	38,1
480-4	10	92	... / 520	7,9	9,8	11,9	16,1	23,2	32,0	44,0
600-4	12	116	... / 640	9,8	12,1	14,7	17,6	24,2	33,6	46,1

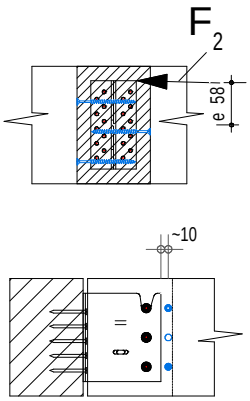
$R_{2,k}$	CNA 4,0x60			without screws *					table	24
	number of		joist			R2, k [kN] bei b =				
Typ	SD	nails	b / h [mm]	60	80	100	120	140	160	180
90-2	4	8	... / 100	1,5	1,9	2,3	2,7	3,1	3,6	4,0
120-2	3	10	... / 160	2,2	2,9	3,5	4,2	4,8	5,4	5,9
160-2	4	14	... / 200	2,9	3,6	4,4	5,3	6,2	6,9	7,5
200-2	5	18	... / 240	3,5	4,4	5,4	6,4	7,4	8,4	9,3
240-2	6	22	... / 280	4,2	5,3	6,4	7,4	8,6	9,8	10,8
90-4	4	16	... / 100	1,5	1,9	2,3	2,7	3,1	3,6	4,0
120-4	3	20	... / 160	2,2	2,9	3,5	4,2	4,8	5,6	6,2
160-4	4	28	... / 200	2,9	3,6	4,4	5,3	6,2	7,0	7,7
200-4	5	36	... / 240	3,5	4,4	5,4	6,4	7,4	8,4	9,5
240-4	6	44	... / 280	4,2	5,3	6,4	7,4	8,6	9,8	11,1
TU12	4	6	... / 120	1,2	1,7	2,2	2,8	3,3	3,8	4,3
TU16	3	18	... / 160	1,6	2,2	2,9	3,6	4,4	5,1	5,7
TU20	4	22	... / 200	2,2	2,9	3,8	4,6	5,6	6,4	7,3
TU24	5	26	... / 240	2,7	3,6	4,7	5,8	6,7	7,9	8,8
TU28	6	30	... / 280	3,2	4,4	5,5	6,7	7,9	9,2	10,3
TU12c	4	6	... / 120	1,2	1,7	2,2	2,8	3,3	3,8	4,3
TU16c	3	14	... / 160	1,6	2,2	2,9	3,6	4,4	5,1	5,7
TU20c	4	14	... / 200	2,2	2,9	3,8	4,6	5,6	6,4	7,3
TU24c	5	18	... / 240	2,7	3,6	4,7	5,8	6,7	7,9	8,8
TU28c	6	18	... / 280	3,2	4,4	5,5	6,7	7,9	9,2	10,3
360-2	8	34	... / 400	6,1	7,6	9,2	10,9	12,4	14,4	15,9
480-2	10	46	... / 520	7,9	9,8	11,9	14,3	16,6	18,7	20,7
600-2	12	58	... / 640	9,8	12,1	14,7	17,6	20,4	23,0	25,4
360-4	8	68	... / 400	6,1	7,6	9,2	10,9	12,4	14,4	15,9
480-4	10	92	... / 520	7,9	9,8	11,9	14,3	16,6	18,7	20,7
600-4	12	116	... / 640	9,8	12,1	14,7	17,6	20,4	23,0	25,4

* - with / without screws: for reinforcement of the joist, see Annex C2

screw 6,0x L
with L = b-20mm

(for timber with b=60mm
use screws 5,0x50)

number of screws =
number of steel dowel



$R_{2,k}$	CSA 5,0x50			with screws *					table	25
	number of		joist			R2, k [kN] bei b =				
Typ	SD	nails	b / h [mm]	60	80	100	120	140	160	180
90-2	4	8	... / 100	1,9	3,7	4,7	5,8	6,8	7,8	7,8
120-2	3	10	... / 160	2,2	3,1	4,8	6,6	6,6	6,6	6,6
160-2	4	14	... / 200	2,9	4,7	7,3	8,9	8,9	8,9	8,9
200-2	5	18	... / 240	3,5	5,0	8,1	11,3	11,3	11,3	11,3
240-2	6	22	... / 280	4,2	5,4	8,6	13,4	13,7	13,7	13,7
90-4	4	16	... / 100	1,9	3,7	4,7	5,8	6,8	7,8	8,9
120-4	3	20	... / 160	2,2	3,1	4,8	6,6	8,3	10,1	11,9
160-4	4	28	... / 200	2,9	4,7	7,3	9,9	12,5	15,1	17,8
200-4	5	36	... / 240	3,5	5,0	8,1	13,0	16,7	20,2	22,9
240-4	6	44	... / 280	4,2	5,4	8,6	13,7	20,2	23,5	26,6
TU12	4	6	... / 120	1,6	3,4	5,9	6,1	6,1	6,1	6,1
TU16	3	18	... / 160	1,6	3,1	4,8	6,6	8,3	10,1	11,9
TU20	4	22	... / 200	2,2	3,8	7,0	9,9	12,5	15,1	17,8
TU24	5	26	... / 240	2,7	4,0	7,3	12,0	16,7	20,2	22,9
TU28	6	30	... / 280	3,2	4,4	7,7	12,4	19,3	23,5	25,5
TU12c	4	6	... / 120	1,6	3,4	5,9	6,1	6,1	6,1	6,1
TU16c	3	14	... / 160	1,6	3,1	4,8	6,6	8,3	10,1	11,9
TU20c	4	14	... / 200	2,2	3,8	7,0	9,9	12,5	14,9	14,9
TU24c	5	18	... / 240	2,7	4,0	7,3	12,0	16,7	17,2	17,2
TU28c	6	18	... / 280	3,2	4,4	7,7	12,4	17,7	17,7	17,7
360-2	8	34	... / 400	6,1	7,6	9,7	14,5	20,8	21,1	21,1
480-2	10	46	... / 520	7,9	9,8	11,9	16,1	23,2	28,6	28,6
600-2	12	58	... / 640	9,8	12,1	14,7	17,6	24,2	33,6	36,1
360-4	8	68	... / 400	6,1	7,6	9,7	14,5	21,8	30,6	38,1
480-4	10	92	... / 520	7,9	9,8	11,9	16,1	23,2	32,0	44,0
600-4	12	116	... / 640	9,8	12,1	14,7	17,6	24,2	33,6	46,1

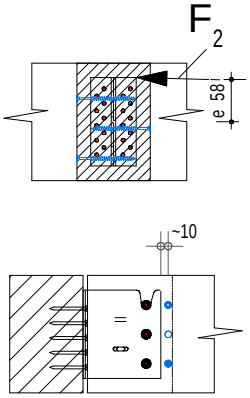
$R_{2,k}$	CSA 5,0x50			without screws *					table	26
	number of		joist			R2, k [kN] bei b =				
Typ	SD	nails	b / h [mm]	60	80	100	120	140	160	180
90-2	4	8	... / 100	1,5	1,9	2,3	2,7	3,1	3,6	4,0
120-2	3	10	... / 160	2,2	2,9	3,5	4,2	4,8	5,6	6,2
160-2	4	14	... / 200	2,9	3,6	4,4	5,3	6,2	7,0	7,7
200-2	5	18	... / 240	3,5	4,4	5,4	6,4	7,4	8,4	9,5
240-2	6	22	... / 280	4,2	5,3	6,4	7,4	8,6	9,8	11,1
90-4	4	16	... / 100	1,5	1,9	2,3	2,7	3,1	3,6	4,0
120-4	3	20	... / 160	2,2	2,9	3,5	4,2	4,8	5,6	6,2
160-4	4	28	... / 200	2,9	3,6	4,4	5,3	6,2	7,0	7,7
200-4	5	36	... / 240	3,5	4,4	5,4	6,4	7,4	8,4	9,5
240-4	6	44	... / 280	4,2	5,3	6,4	7,4	8,6	9,8	11,1
TU12	4	6	... / 120	1,2	1,7	2,2	2,8	3,3	3,8	4,3
TU16	3	18	... / 160	1,6	2,2	2,9	3,6	4,4	5,1	5,7
TU20	4	22	... / 200	2,2	2,9	3,8	4,6	5,6	6,4	7,3
TU24	5	26	... / 240	2,7	3,6	4,7	5,8	6,7	7,9	8,8
TU28	6	30	... / 280	3,2	4,4	5,5	6,7	7,9	9,2	10,3
TU12c	4	6	... / 120	1,2	1,7	2,2	2,8	3,3	3,8	4,3
TU16c	3	14	... / 160	1,6	2,2	2,9	3,6	4,4	5,1	5,7
TU20c	4	14	... / 200	2,2	2,9	3,8	4,6	5,6	6,4	7,3
TU24c	5	18	... / 240	2,7	3,6	4,7	5,8	6,7	7,9	8,8
TU28c	6	18	... / 280	3,2	4,4	5,5	6,7	7,9	9,2	10,3
360-2	8	34	... / 400	6,1	7,6	9,2	10,9	12,4	14,4	15,9
480-2	10	46	... / 520	7,9	9,8	11,9	14,3	16,6	18,7	20,7
600-2	12	58	... / 640	9,8	12,1	14,7	17,6	20,4	23,0	25,4
360-4	8	68	... / 400	6,1	7,6	9,2	10,9	12,4	14,4	15,9
480-4	10	92	... / 520	7,9	9,8	11,9	14,3	16,6	18,7	20,7
600-4	12	116	... / 640	9,8	12,1	14,7	17,6	20,4	23,0	25,4

* - with / without screws: for reinforcement of the joist, see Annex C2

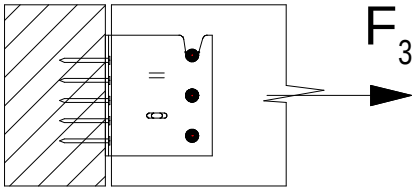
screw 6,0x L
with L = b-20mm

(for timber with b=60mm
use screws 5,0x50)

number of screws =
number of steel dowel



$R_{3,k}$							table	27
	number of		joist	CNA4,0x40	CNA4,0x50	CNA4,0x60	CSA5,0x40	CSA5,0x50
Typ	SD	nails	b / h [mm]					
90-2	4	8	.../100	5,9	7,8	9,5	13,9	13,9
120-2	3	10	.../160	7,4	9,8	12,2	17,6	21,7
160-2	4	14	.../200	10,3	13,7	16,7	24,4	28,7
200-2	5	18	.../240	13,2	17,6	21,2	31,1	35,8
240-2	6	22	.../280	16,2	21,6	25,8	37,8	42,8
90-4	4	16	.../100	5,9	7,8	9,5	13,9	13,9
120-4	3	20	.../160	7,4	9,8	12,2	17,6	21,7
160-4	4	28	.../200	10,3	13,7	16,7	24,4	28,7
200-4	5	36	.../240	13,2	17,6	21,2	31,1	35,8
240-4	6	44	.../280	16,2	21,6	25,8	37,8	42,8
TU12	4	6	.../120	4,1	4,9	5,7	8,4	8,4
TU16	3	18	.../160	6,1	7,5	8,9	11,4	11,4
TU20	4	22	.../200	8,2	9,8	11,5	16,2	16,2
TU24	5	26	.../240	10,2	12,1	14,1	21,0	21,0
TU28	6	30	.../280	11,8	14,4	16,7	25,4	25,8
TU12c	4	6	.../120	4,1	4,9	5,7	8,4	8,4
TU16c	3	14	.../160	5,3	6,4	7,5	11,4	11,4
TU20c	4	14	.../200	5,9	7,6	8,7	13,1	16,2
TU24c	5	18	.../240	7,4	9,8	11,3	16,8	21,0
TU28c	6	18	.../280	7,4	9,8	12,3	17,9	23,0
ALU120	3	20	.../160	7,4	9,8	12,3	21,8	29,4
ALU160	4	28	.../200	10,3	13,7	17,2	30,5	40,3
ALU200	5	36	.../240	13,2	17,6	22,1	39,2	51,3
ALU240	6	44	.../280	16,2	21,6	27,0	48,0	62,2
ALU280	7	52	.../320	20,6	27,4	34,3	61,0	76,7



D2. Concealed joist hanger TU, TUB, TUS, TUBS

Product Name	alternative names				old name
	France	UK	Denmark	Germany	
TU		TU			JANE TU
TUB					
TUS					JANE TUS
TUSB					

Figure D2-1: drawings ;

TU

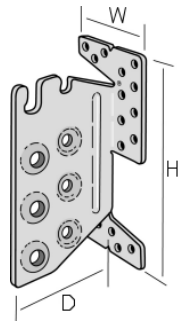
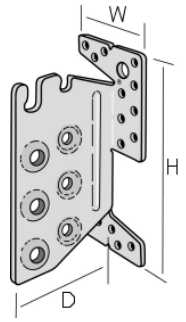


Table D2-1: size specification

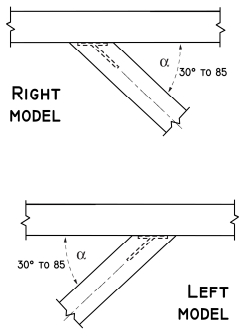
Model N°	Width W	Height H	Depth	Skew Angle	
	(mm)			degree	Direction
TU12	40	96	101	90°	~
TU16	60	134	108	90°	~
TU20	60	174	108	90°	~
TU24	60	214	108	90°	~
TU28	60	254	108	90°	~

TUB



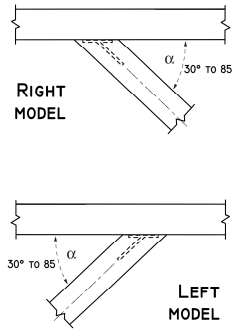
Model N°	Width W	Height H	Depth	Skew Angle	
	(mm)			degree	Direction
TUB16	60	134	108	90°	~
TUB20	60	174	108	90°	~
TUB24	60	214	108	90°	~
TUB28	60	254	108	90°	~

TUS



Model N°	Width W	Height H	Depth	Angle	
	(mm)			degree	Direction
TU/SL12	40	96	101	30 to 85°	Left
TU/SL16	60	134	108	30 to 85°	Left
TU/SL20	60	174	108	30 to 85°	Left
TU/SL24	60	214	108	30 to 85°	Left
TU/SL28	60	254	108	30 to 85°	Left
TU/SR12	40	96	101	30 to 85°	Right
TU/SR16	60	134	108	30 to 85°	Right
TU/SR20	60	174	108	30 to 85°	Right
TU/SR24	60	214	108	30 to 85°	Right
TU/SR28	60	254	108	30 to 85°	Right

TUBS



Model N°	Width W	Height H	Depth	Angle	
	(mm)			degree	Direction
TUBSL16	60	134	108	30 to 85°	Left
TUBSL20	60	174	108	30 to 85°	Left
TUBSL24	60	214	108	30 to 85°	Left
TUBSL28	60	254	108	30 to 85°	Left
TUBSR16	60	134	108	30 to 85°	Right
TUBSR20	60	174	108	30 to 85°	Right
TUBSR24	60	214	108	30 to 85°	Right
TUBSR28	60	254	108	30 to 85°	Right

Hanger Type	Header Fasteners		Joist Fasteners	
	Ø4.0 Connector nails	Bolt M12 Concrete screw	Dowels Ø8	Dowels Ø12
TU12	6	~	4	~
TU16	18	~	~	3
TU20	22	~	~	4
TU24	26	~	~	5
TU28	30	~	~	6
TUB16	16	2	~	3
TUB20	20	2	~	4
TUB24	24	2	~	5
TUB28	28	2	~	6
TUS 12	6	~	4	~
TUS 16	18	~	~	3
TUS 20	22	~	~	4
TUS 24	26	~	~	5
TUS 28	30	~	~	6
TUBS16	16	2	~	3
TUBS20	20	2	~	4
TUBS24	24	2	~	5
TUBS28	28	2	~	6

Table D2-2: Material specification

Material thickness	Material Grades	Coating specification
3	S 250 GD	Z275
3	stainless steel as described	

Table D2-3: Characteristic capacities TU and TUS full nailing

	Characteristic capacity with CNA 4,0x50 full nailing, connection beam to beam											
	Width of joist = length of dowel [mm]											
skew α	60	80	120	160	60	80	120	160	60	80	120	160
90°	β = 0°				β = 25°				β = 45°			
TU12	8,1	9,0	10,7	10,7	8,1	9,0	10,7	10,7	8,1	9,0	10,7	10,7
TU16	17,5	18,1	20,5	23,5	16,6	17,0	18,8	21,2	15,9	16,4	17,9	20,0
TU20	26,7	27,6	31,1	35,6	25,3	25,8	28,5	32,2	24,4	25,1	27,4	30,5
TU24	36,6	37,7	42,5	48,3	34,8	35,5	39,1	43,9	33,6	34,7	37,8	42,0
TU28	46,9	48,3	54,1	61,1	44,5	45,6	50,0	55,9	43,4	44,9	48,7	53,9
45°	β = 0°				β = 25°				β = 45°			
TUS12	7,4	8,2	9,5	9,5	6,9	7,6	9,1	9,1	6,6	7,1	8,5	8,7
TUS16	16,3	16,9	18,9	21,4	15,6	15,9	17,4	19,5	15,0	15,4	16,6	18,4
TUS20	24,9	25,6	28,7	32,3	23,7	24,1	26,5	29,5	22,9	23,5	25,4	28,0
TUS24	34,2	35,2	39,2	44,1	32,6	33,2	36,3	40,4	31,5	32,5	35,0	38,6
TUS28	44,0	45,2	50,3	56,1	42,0	42,8	46,7	51,7	40,8	42,0	45,3	49,7
85°	β = 0°				β = 25°				β = 45°			
TUS12	7,6	8,4	9,7	9,7	7,1	7,7	9,3	9,3	6,7	7,3	8,7	8,9
TUS16	16,7	17,3	19,5	22,1	15,9	16,2	17,9	20,1	15,3	15,7	17,1	18,9
TUS20	25,6	26,4	29,6	33,4	24,3	24,8	27,2	30,5	23,4	24,1	26,1	28,9
TUS24	35,1	36,2	40,4	45,3	33,5	34,1	37,3	41,6	32,3	33,3	36,1	39,8
TUS28	45,2	46,5	51,6	57,0	43,0	43,9	48,0	53,1	41,8	43,2	46,6	51,2

Intermediary values shall be find by interpolation.
For a skew between 30° and 45° the values for 45° shall be used.

Table D2-4: Characteristic capacities TUB and TUBS full nailing

	Characteristic capacity with CNA 4,0x50 full nailing, connection beam to beam											
	Width of joist = length of dowel [mm]											
skew α	60	80	120	160	60	80	120	160	60	80	120	160
90°	β = 0°				β = 25°				β = 45°			
TUB16	16,7	17,3	19,7	22,6	15,7	16,1	17,9	20,4	15,1	15,1	17,0	19,1
TUB20	25,6	26,5	30,0	34,4	24,2	24,7	27,4	31,0	23,3	23,3	26,2	29,3
TUB24	35,3	36,5	41,1	46,8	33,5	34,2	37,7	42,5	32,3	32,3	36,4	40,5
TUB28	45,5	46,9	52,6	59,1	43,1	44,1	48,5	54,3	41,9	41,9	47,1	52,2
45°	β = 0°				β = 25°				β = 45°			
TUBS16	15,4	15,9	17,9	20,3	14,6	14,9	16,5	18,5	14,1	14,4	15,6	17,4
TUBS20	23,6	24,4	27,3	30,9	22,4	22,9	25,2	28,2	21,6	22,2	24,1	26,7
TUBS24	32,7	33,7	37,6	42,3	31,1	31,7	34,7	38,7	30,0	30,9	33,4	36,9
TUBS28	42,3	43,5	48,4	53,8	40,4	41,1	44,9	49,8	39,0	40,2	43,4	47,7
85°	β = 0°				β = 25°				β = 45°			
TUBS16	15,8	16,4	18,5	21,0	15,0	15,3	17,0	19,1	14,4	14,8	16,1	18,0
TUBS20	24,4	25,2	28,3	31,8	23,1	23,6	26,0	29,1	22,2	22,9	24,9	27,6
TUBS24	33,7	34,8	38,8	43,1	32,1	32,7	35,9	39,9	30,9	31,9	34,6	38,1
TUBS28	43,6	44,8	49,7	53,8	41,5	42,3	46,3	51,0	40,2	41,5	44,9	49,2

Intermediary values shall be find by interpolation.
For a skew between 30° and 45° the values for 45° shall be used.

Table D2-4: Characteristic capacities TU and TUS
with nail pattern as given below

	Characteristic capacity with CNA 4,0x50 partial nailing, connection beam to post											
	Width of joist = length of dowel [mm]											
skew α	60	80	120	160	60	80	120	160	60	80	120	160
90°	β = 0°				β = 25°				β = 45°			
TU12	8,1	9,0	10,7	10,7	8,1	9,0	10,7	10,7	8,1	9,0	10,7	10,7
TU16	16,1	16,7	19,0	21,9	15,2	15,5	17,3	19,7	14,5	14,9	16,4	18,4
TU20	22,9	23,7	26,8	30,1	21,6	22,1	24,6	27,7	20,7	21,3	23,4	26,1
TU24	31,9	33,0	36,9	39,9	30,2	30,9	34,1	37,9	29,0	30,0	32,7	36,2
TU28	38,0	38,9	39,9	39,9	36,3	36,9	39,6	39,9	35,0	36,0	38,6	39,9
45°	β = 0°				β = 25°				β = 45°			
TUS12	7,4	8,2	9,5	9,5	6,9	7,6	9,1	9,1	6,6	7,1	8,5	8,7
TUS16	15,0	15,5	17,4	19,7	14,2	14,5	16,0	18,0	13,7	14,0	15,2	16,9
TUS20	21,3	22,0	24,5	26,1	20,2	20,7	22,7	25,2	19,5	20,0	21,7	23,9
TUS24	29,5	30,4	33,7	34,4	28,1	28,7	31,4	34,4	27,1	27,8	30,1	33,0
TUS28	35,3	36,1	36,1	36,1	33,9	34,4	36,1	36,1	32,8	33,5	35,8	36,1
85°	β = 0°				β = 25°				β = 45°			
TUS12	7,6	8,4	9,7	9,7	7,1	7,7	9,3	9,3	6,7	7,3	8,7	8,9
TUS16	15,3	15,9	17,9	20,3	14,5	14,8	16,4	18,5	13,9	14,3	15,6	17,4
TUS20	21,8	22,5	25,0	26,1	20,6	21,1	23,2	25,6	19,8	20,4	22,2	24,4
TUS24	30,3	31,2	34,1	34,4	28,8	29,4	32,1	34,4	27,7	28,5	30,9	33,6
TUS28	35,7	36,1	36,1	36,1	34,5	35,0	36,1	36,1	33,4	34,2	36,0	36,1

Intermediary values shall be find by interpolation.
For a skew between 30° and 45° the values for 45° shall be used.

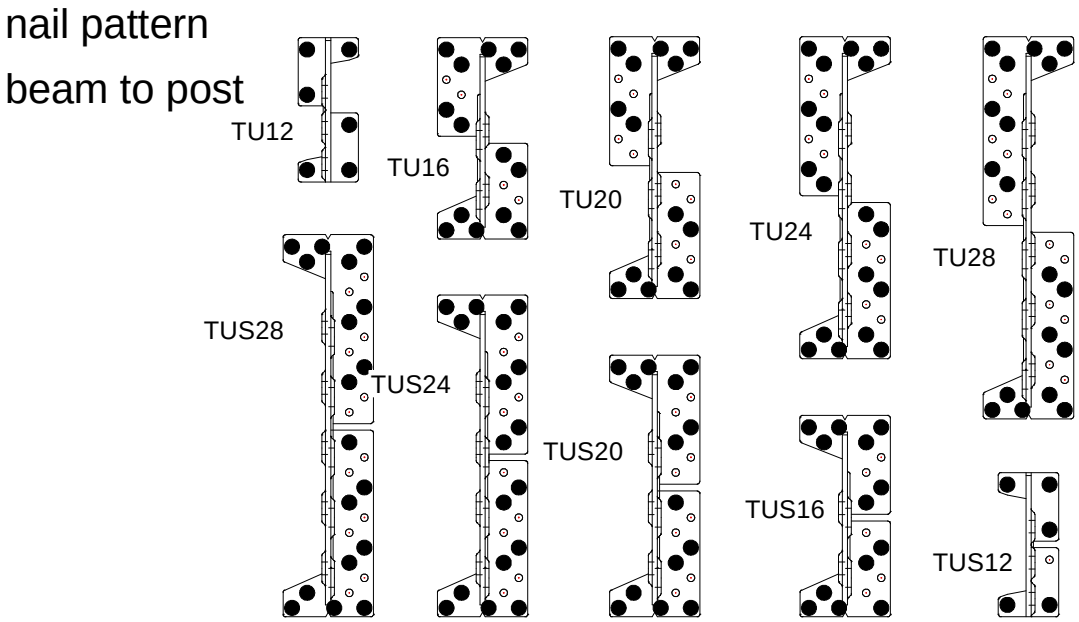
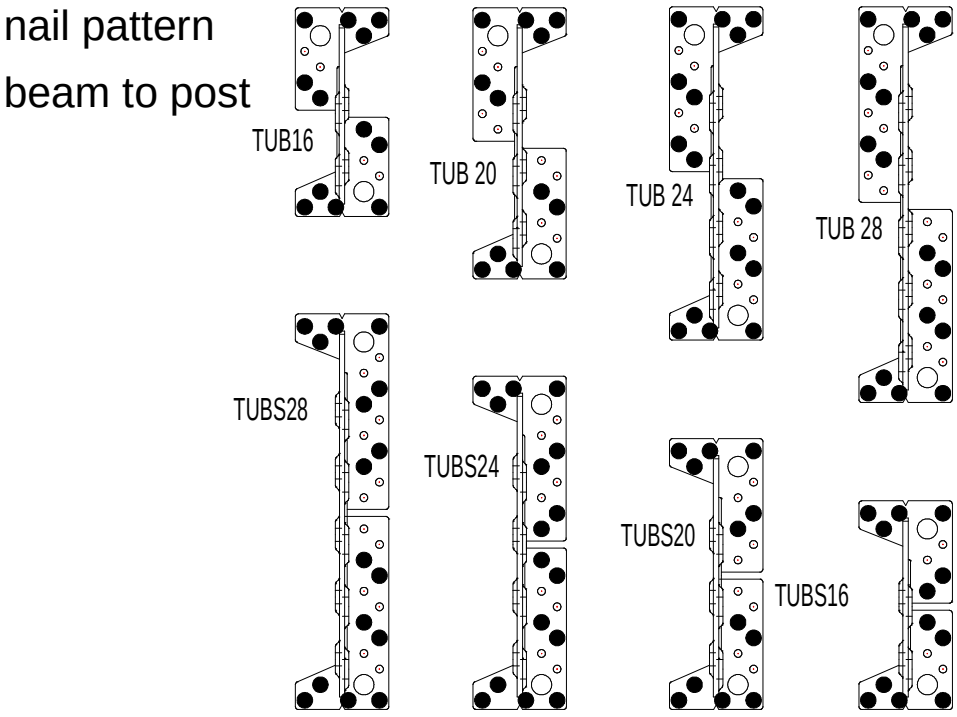


Table D2-5: Characteristic capacities TUB and TUBS
with nail pattern as given below

	Characteristic capacity with CNA 4,0x50 partial nailing, connection beam to post											
	Width of joist = length of dowel [mm]											
skew α	60	80	120	160	60	80	120	160	60	80	120	160
90°	β = 0°				β = 25°				β = 45°			
TUB16	15,2	15,8	18,1	20,8	14,3	14,7	16,4	18,8	13,7	13,7	15,5	17,5
TUB20	21,5	22,3	25,1	26,6	20,3	20,8	23,2	25,8	19,5	19,5	22,0	24,5
TUB24	30,4	31,4	34,8	35,5	28,7	29,4	32,4	35,4	27,5	27,5	31,0	34,1
TUB28	35,3	35,5	35,5	35,5	34,1	34,6	35,5	35,5	33,0	33,0	35,4	35,5
45°	β = 0°				β = 25°				β = 45°			
TUBS16	13,9	14,4	16,3	18,5	13,2	13,5	15,0	16,9	12,7	13,0	14,2	15,8
TUBS20	19,8	20,4	22,3	22,3	18,8	19,2	21,1	22,3	18,1	18,5	20,1	22,1
TUBS24	27,7	28,6	30,3	30,3	26,4	26,9	29,5	30,3	25,4	26,1	28,2	30,3
TUBS28	31,9	31,9	31,9	31,9	31,5	31,9	31,9	31,9	30,6	31,2	31,9	31,9
85°	β = 0°				β = 25°				β = 45°			
TUBS16	14,3	14,9	16,8	18,9	13,6	13,9	15,5	17,4	13,0	13,3	14,6	16,3
TUBS20	20,2	20,9	22,3	22,3	19,2	19,7	21,5	22,3	18,5	18,9	20,6	22,2
TUBS24	28,4	29,2	30,3	30,3	27,1	27,7	29,9	30,3	26,1	26,8	28,9	30,3
TUBS28	31,9	31,9	31,9	31,9	31,8	31,9	31,9	31,9	31,1	31,6	31,9	31,9

Intermediary values shall be find by interpolation.
For a skew between 30° and 45° the values for 45° shall be used.



Load duration F_2

The characteristic capacity for load duration F_2 may be find in tables 21 to 26 for the type TU, where the table D2-4 and D2-5 are given for the nail pattern to a column.

D3.Concealed joist hanger ETNM

Product Name	alternative names			
	France	UK	Danmark	Germany
ETNM		ETNM		

Figure D3-1: drawings

ETNM

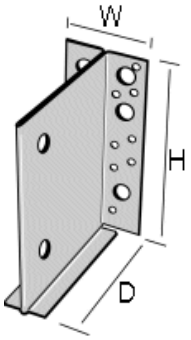


Table D3-1: size specification

Model N°	Width W	Height H	Depth	Angle	
	(mm)			degree	Direction
ETNM135/130/2	70	135	130	90°	~
ETNM155/130/2	70	155	130	90°	~
ETNM185/130/2	70	185	130	90°	~
ETNM230/130/2	80	230	130	90°	~

Table D3-2 number of fastener

Hanger Type	Header Fasteners		Joist Fasteners	
	Ø4.0 connector nails	Bolt M12 Concrete screw	Dowels Ø8	Dowels Ø12
ETNM135/130/2	14	5	~	2
ETNM155/130/2	15	6	~	2
ETNM185/130/2	18	6	~	2
ETNM230/130/2	22	6	~	3

Table D3-3: Material specification

Material thickness	Material Grades	Coating specification
3	S 250 GD	Z275
3	stainless steel as described	

Table D3-4: Characteristic capacities ETNM $R_{1,k}$
Beam to beam

Joist width [mm]	Characteristic capacity $R_{1,k}$ [kN] with CNA4,0x50 connection beam to beam			
	ETNM135	**ETNM155**	**ETNM185**	**ETNM230**
60	11,7	14,4	17,1	26,2
80	12,2	15,0	17,8	27,0
100	13,1	16,0	18,9	28,6
120	14,2	17,2	20,4	30,6
140	15,4	18,6	22,0	32,8
160	16,6	20,0	23,8	35,1

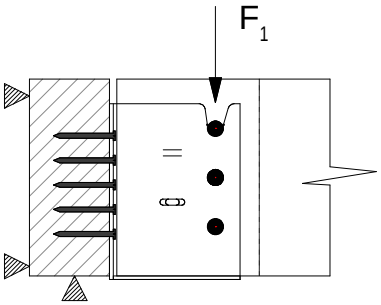


Table D3-5: Characteristic capacities ETNM $R_{1,k}$
Beam to post

Joist width [mm]	Characteristic capacity $R_{1,k}$ [kN] with CNA4,0x50 connection beam to post			
	ETNM135	**ETNM155**	**ETNM185**	**ETNM230**
60	11,0	13,1	15,5	25,1
80	11,6	13,7	16,2	25,9
100	12,5	14,7	17,3	27,4
120	13,6	15,8	18,7	29,3
140	14,7	17,1	20,3	31,3
160	15,9	18,4	21,9	33,4

Figure D3-2: Nail pattern ETNM

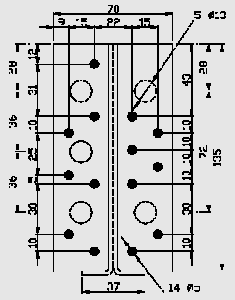
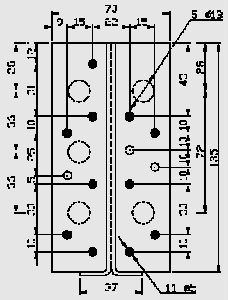
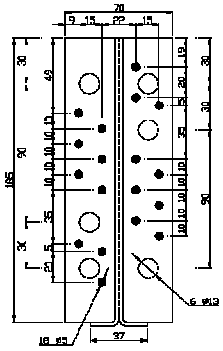
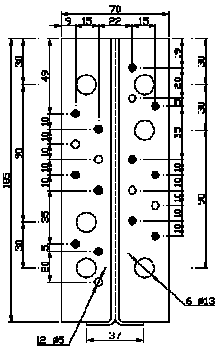
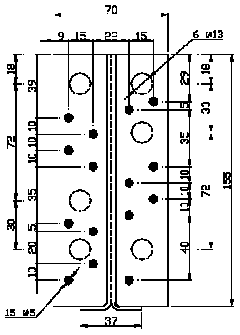
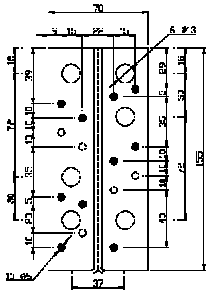
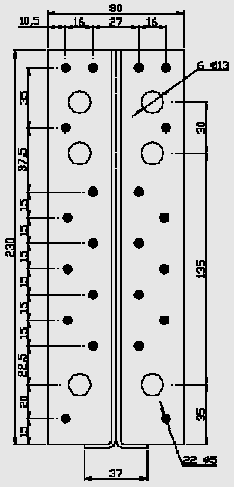
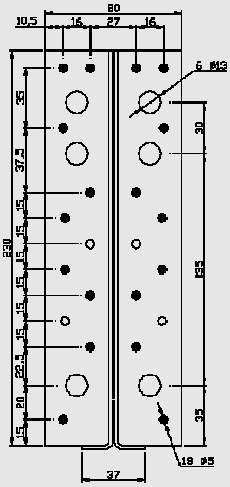
TYPE	BEAM to BEAM	BEAM to POST	TYPE	BEAM to BEAM	BEAM to POST
135	 14 nails 2 dowels Ø12	 11 nails 2 dowels Ø12	185	 18 nails 5 dowels Ø2	 12 nails 5 dowels Ø12
155	 15 nails 2 dowels Ø12	 10 nails 2 dowels Ø12	230	 22 nails 3 dowels Ø12	 18 nails 3 dowels Ø12

Table D3-6: Tolerances

	Unit	Tolerance
dimension	[mm]	+1,5 / -1,5
angular	[degree °]	+1,0 / -1,0
hole's on center distances	[mm]	+0,2 / -0,2
hole's diameter	[mm]	+0,2 / -0,2

D4.Concealed joist hanger BTCx

Product Name	alternative names			
	Branch 36	Branch 40	Branch 46	Branch 47
BTCx				BTCx

Figure D4-1: Dimension drawing of concealed joist hangers

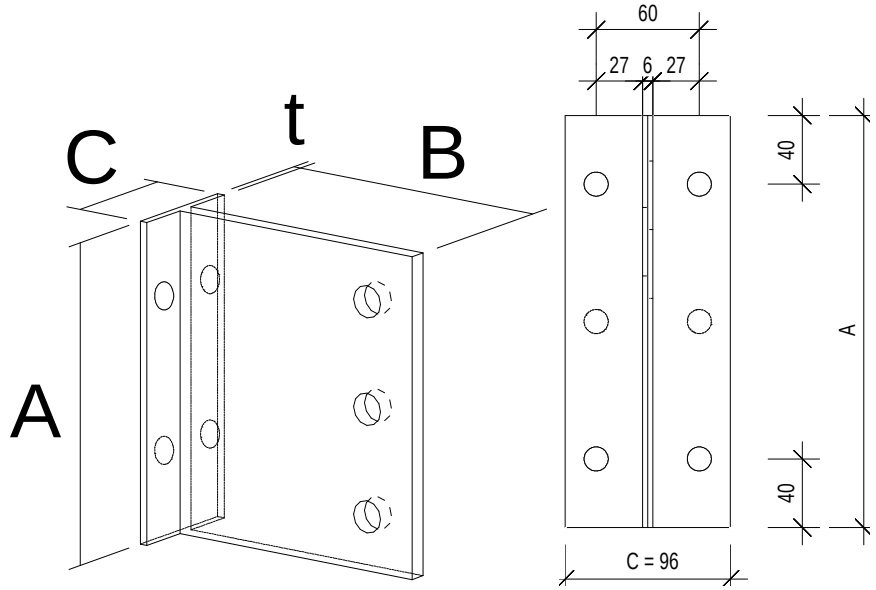


Figure D4-2: Size specification

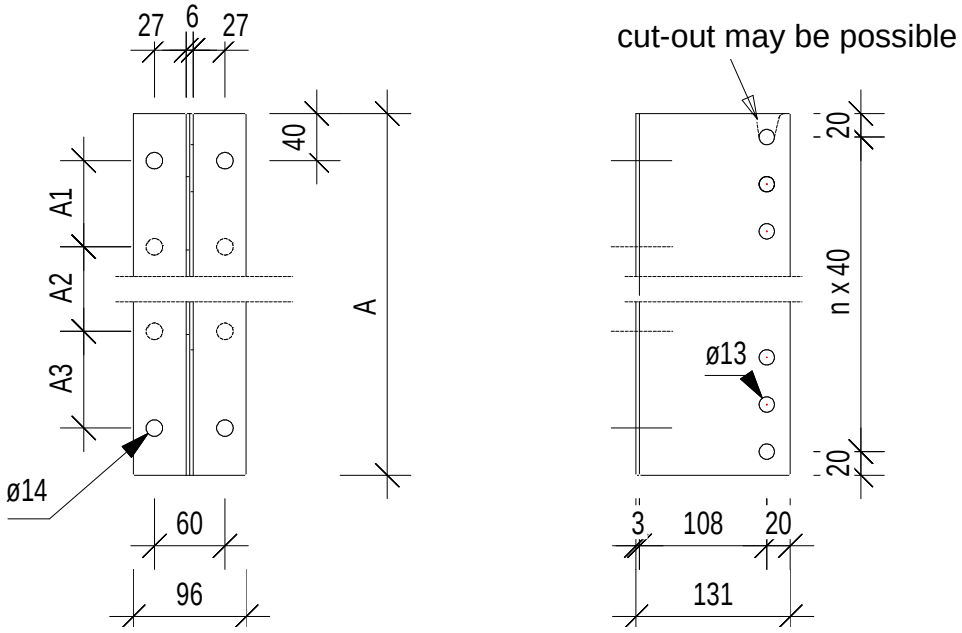


Table D4-1: Size specification

	all size in [mm]							no of holes	
Type	A	A1	A2	A3	B	C	t	Ø14mm anchor	Ø13mm dowel
BTC120	120				128	96	3	2	3
BTC160	160	80			128	96	3	4	4
BTC200	200	120			128	96	3	4	5
BTC240	240	160			128	96	3	4	6
BTC280	280	100	100		128	96	3	6	7
BTC320	320	120	120		128	96	3	6	8
BTC360	360	140	140		128	96	3	6	9
BTC400	400	120	120	80	128	96	3	8	10
BTC440	440	120	120	120	128	96	3	8	11
BTC480	480	120	120	160	128	96	3	8	12
BTC520	520	160	160	120	128	96	3	8	13
BTC560	560	160	160	160	128	96	3	8	14
BTC600	600	160	160	200	128	96	3	8	15

Table D4-2: Material specification

Material thickness	Material Grades	Coating stecification
3	S 250 GD	Z275
3	stainless steel as destriped	

Table D4-3: Characteristic capacities F_1

Characteristic capacity $R_{1,k}$ [kN]

b	3 SD	4 SD	5 SD	6 SD	7 SD	8 SD	9 SD	10 SD	11 SD	12 SD
80	**11,5**	**18,5**	**26,7**	**35,8**	**45,6**	**56,0**	**66,8**	**77,9**	**89,1**	**100,5**
100	**12,7**	**20,4**	**29,4**	**39,4**	**50,1**	**61,4**	**73,1**	**85,1**	**97,2**	**109,5**
120	**14,2**	**22,8**	**32,7**	**43,8**	**55,6**	**68,1**	**80,9**	**94,0**	**107,3**	**120,7**
140	**15,8**	**25,3**	**36,4**	**48,6**	**61,7**	**75,5**	**89,6**	**104,1**	**118,7**	**133,4**
160	**17,2**	**27,8**	**40,3**	**53,8**	**68,3**	**83,4**	**99,0**	**114,8**	**130,9**	**147,0**
180				**54,3**	**69,4**	**85,5**	**102,2**	**119,5**	**133,3**	**147,0**

b = min width [mm] of timber and length of the dowel

The necessary capacity of the bolts should be calculated as:

$$R_{bolt,lat,d} \geq \frac{F_{1,d}}{n}$$

For the upper bolts additional:

$$R_{bolt,ax,d} \geq \frac{F_{1,d} \times 14{,}4}{d}$$

With:

$R_{bolt,lat,d}$ design capacity of one anchor bolt for shear load
$R_{bolt,ax,d}$ design capacity of one anchor bolt for tension load
d height of the BTC -10mm
n number of anchor bolts

Table D4-4: Characteristic capacities F_2

It is assumed that the force F_2 is action at the top of the BTC. For a force F_2 with a lower distance to the middle of the BTC, the same capacities may be to use.

	number of		joist	$R_{2,k}$ [kN] bei b =						
Typ	SD	bolts	b / h [mm]	60	80	100	120	140	160	180
120-4	3	2	... / 160	2,6	2,9	3,5	4,0	4,5	5,2	5,3
160-4	4	4	... / 200	3,2	3,9	4,4	5,0	5,9	6,5	7,0
200-4	5	4	... / 240	4,0	4,9	5,5	6,3	7,2	7,8	8,8
240-4	6	4	... / 280	4,8	5,7	6,6	7,5	8,4	9,1	10,4
360-4	8	≤ 6	... / 400	7,2	8,1	9,5	10,8	12,0	13,2	14,9
480-4	10	≤ 8	... / 520	9,6	10,6	12,4	14,1	15,6	17,6	19,3
600-4	12	≤ 8	... / 640	12,0	13,2	15,2	17,3	19,2	22,0	23,8

The connection of the bolts to the concrete must be check:

The bolt group must be able to resist the min :

$F_{2,d}$ [kN]
$M_{Y,F2,d} = F_{2,d}$ x 40mm [kNmm]
$M_{X,F2,d} = F_{2,d}$ x (A/2) [kNmm] ,

with A = the height of the BTC

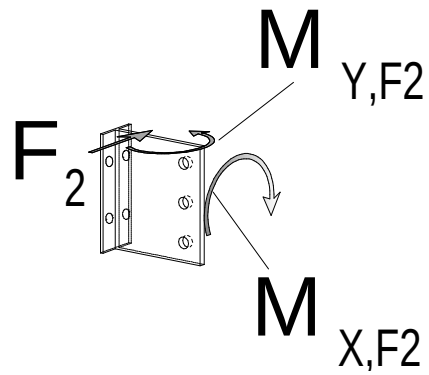
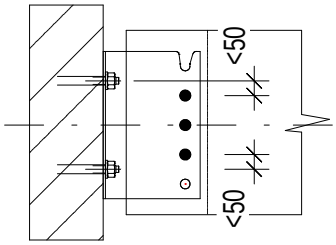


Table D4-5: Characteristic capacities F_3

no of bolts	$R_{3,k}$ [kN]	min no dowel
2	$6,7/k_{mod}$	3
4	$13,4/k_{mod}$	3
6	$20,1/k_{mod}$	5
8	$26,8/k_{mod}$	6



The force is acting in the middle of the joist.

The dowel and anchor bolts should be placed symmetrical to the centreline of the joist, and with a max distance of the anchor to the dowel of 50mm.

It should be checked, that the capacity of bolt is: $R_{bolt,ax,d} \geq \frac{F_{1,d} \times 1,44}{n_b}$

Where:
$R_{bolt,ax,d}$ the axial design capacity of each anchor bolts / bolts
n_b the number of anchor bolts / bolts
$F_{1,d}$ the design load in direction of the joist

For combination it should be checked:

$$\left(\frac{F_{1,d}}{R_{1,d}}\right)^2 + \left(\frac{F_{2,d}}{R_{2,d}}\right)^2 + \left(\frac{F_{3,d}}{R_{3,d}}\right)^2 \leq 1$$

The anchor bolts should be checked separately for the combination of load.

D5.ICS

Product Name	alternative names			
	Branch 36	Branch 40	Branch 46	Branch 47
ICS				

Figure D5-1: Drawings

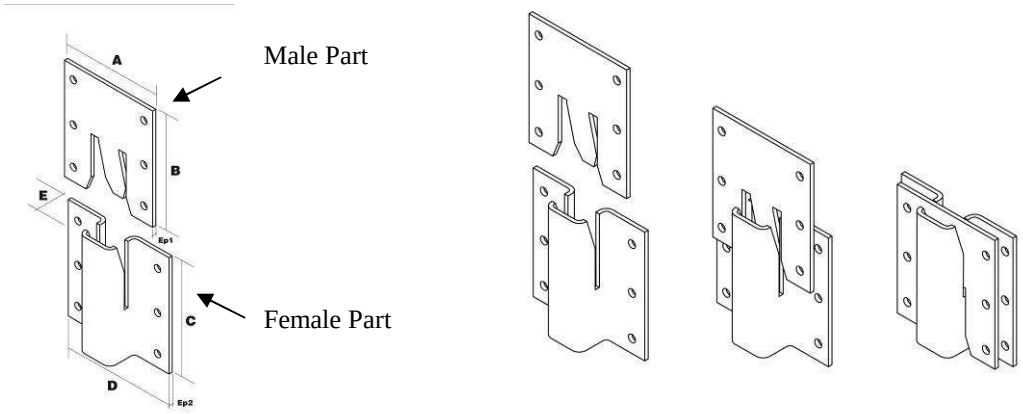


Table D5-2: dimensions and number of fastener

ICS	A	B	C	D	E	Thickness	Holes
Male Part	70	80	--	--	--	2.5	6 Ø5
Female Part	--	--	80	80	23.5	2.5	6 Ø5

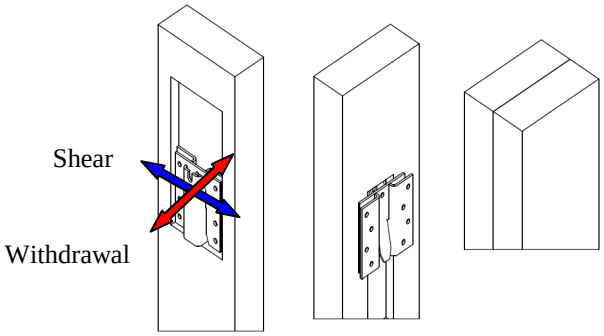
Table D5-3: Material specification

Material thickness	Material Grades	Coating specification
3	S 250 GD	Z275
3	stainless steel as described	

Table D5-4:Characteristic capacities :
Characteristic capacities for single ICS and for timber grade C24:

	Fasteners		Characteristic Capacities C24 [kN]	
			Load direction	
	Male part	Female part	Shear	Withdrawal
ICS	6 screws CSA Ø5.0x35	6 screws CSA Ø5.0x35	7.21 (1)	4.17 (3)
			3.84 (2)	

(1) Shear capacity is given for a displacement of 15 mm.
(2) Shear capacity is given for a displacement of 5 mm
(3) Withdrawal capacity is given for a displacement of 3 mm.



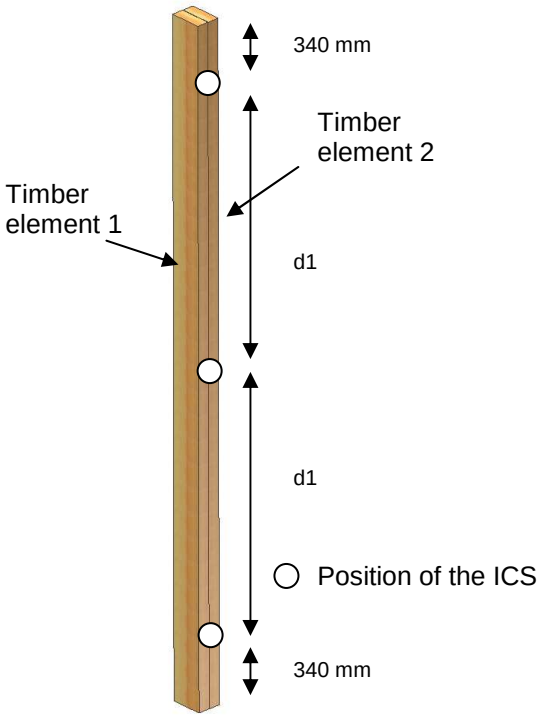


Figure 1 : Timber element and position of ICS

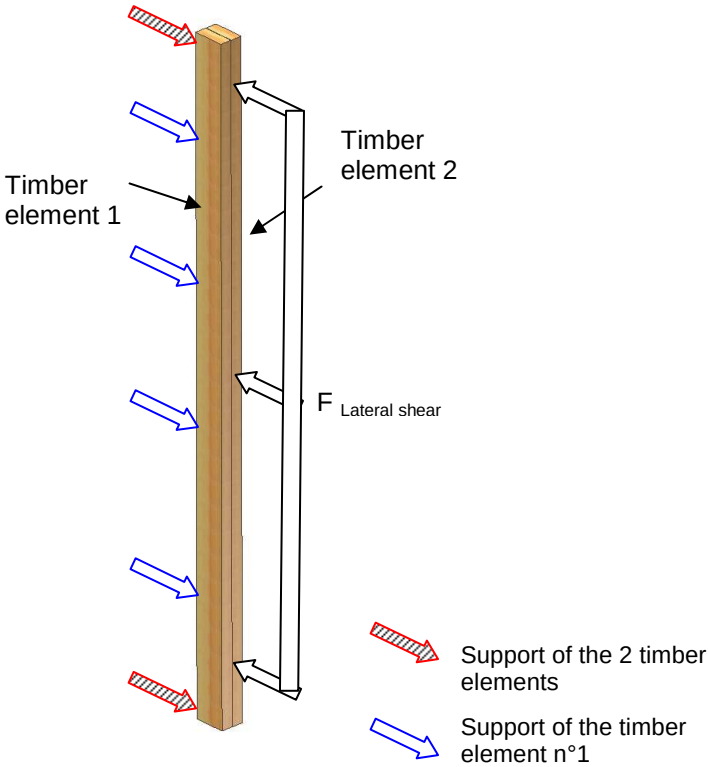


Figure 2 : Lateral shear tests

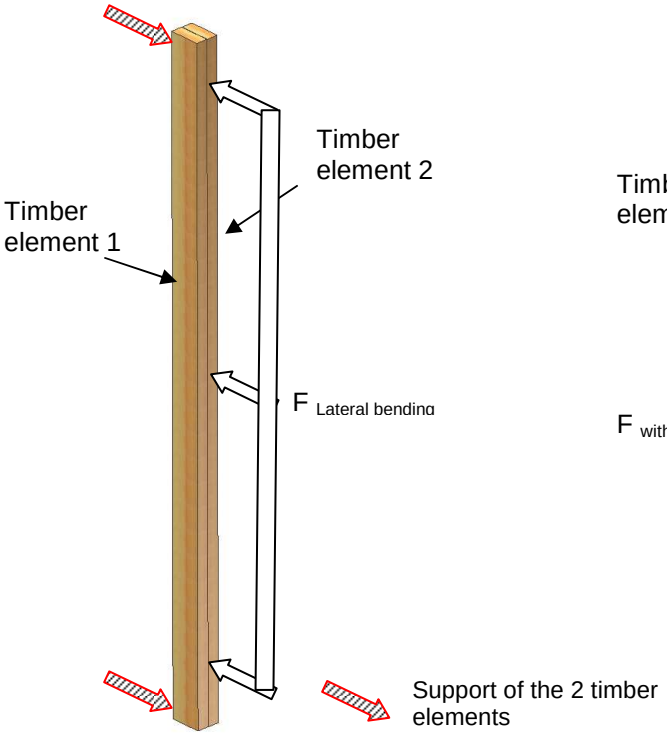


Figure 3 : Lateral bending tests

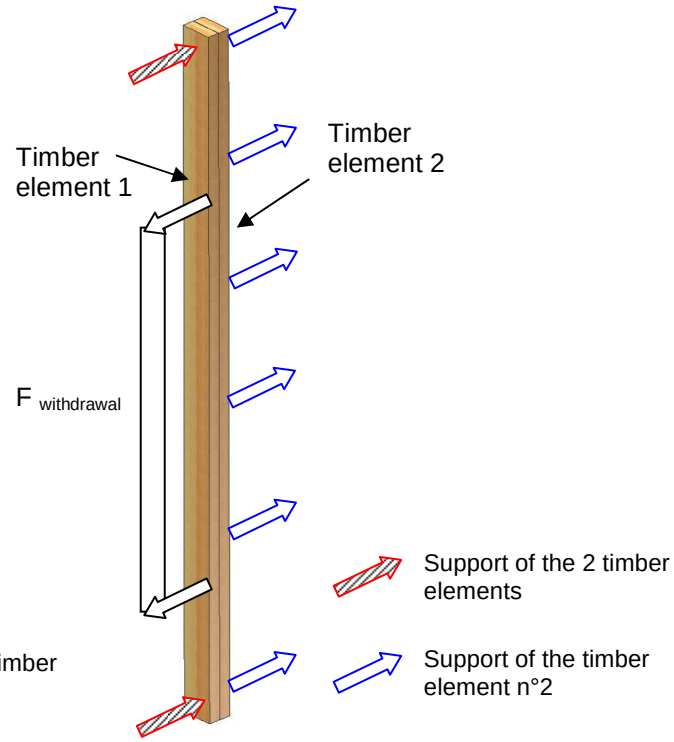


Figure 4 : Withdrawal tests

	Fasteners		Characteristic Capacities C24 [kN]		
			Load direction / configuration		
	Male part	Female part	Lateral Shear	Lateral Bending	Withdrawal
3 ICS	3 x 6 screws CSA Ø5.0x35	3 x 6 screws CSA Ø5.0x35	24.3 (1)	13.83 (1)	5.57 (3)
			6.31 (2)	4.02 (2)	

(1) Lateral capacity is given for a displacement of 15 mm.
(2) Lateral capacity is given for a displacement of 5 mm
(3) Withdrawal capacity is given for a displacement of 3 mm.

For other timber grade with a lower density, the following k_{dens} ratio should be applied: $k_{dens} = (\frac{\rho_k}{350})^2$

D6.ETB

Product Name	alternative names			
	Branch 36	Branch 40	Branch 46	Branch 47
ETB				

Figure D6-1: Drawings

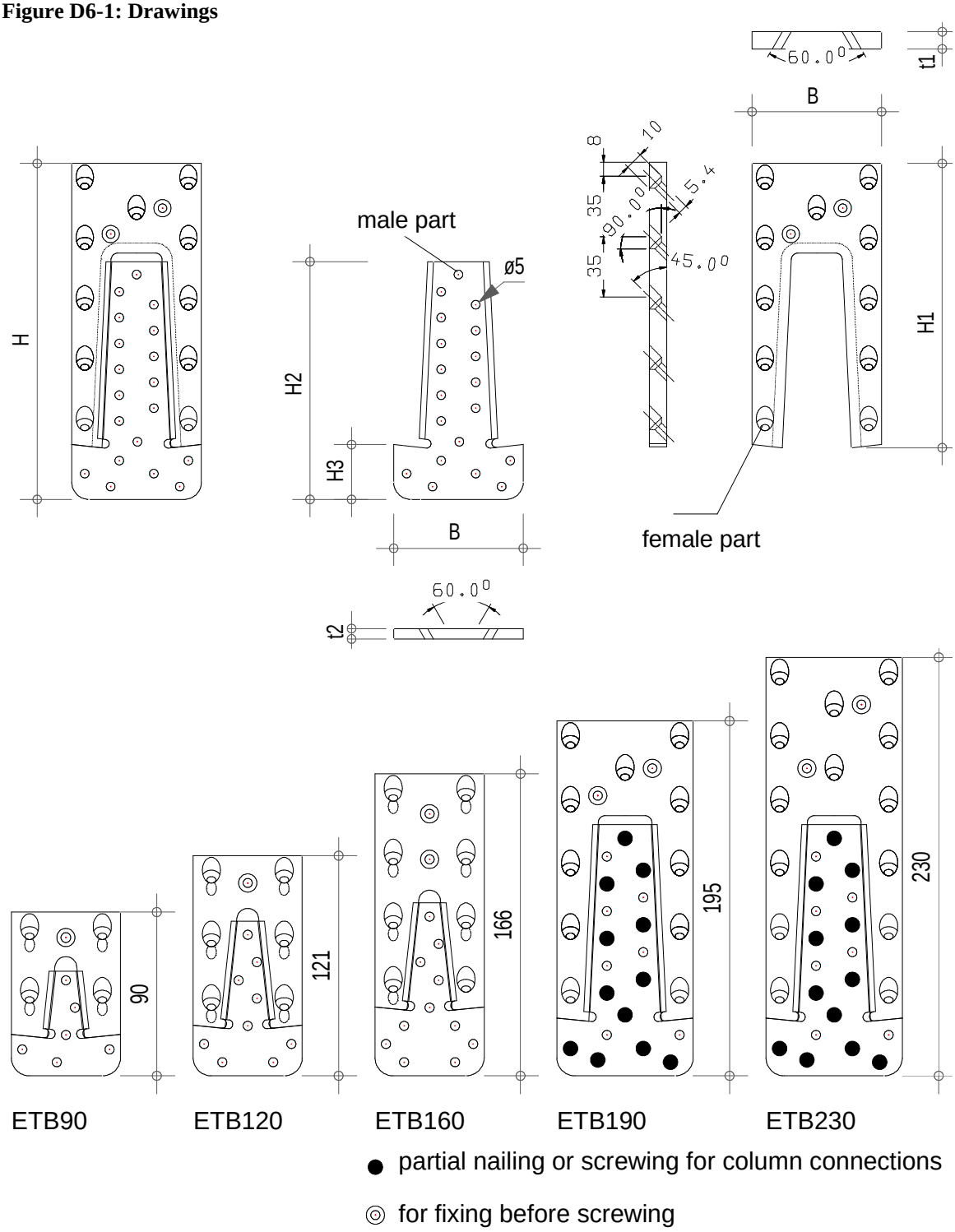


Table D6-1: dimensions and number of fastener

Type	sizes [mm]						n	n
	H	B	H1	H2	H3	t1 / t2	Ø5,4	Ø5
ETB90	90	60	69	58	22,8	10 / 6	4	6
ETB120	121	60	95	85	27,8	10 / 6	6	9
ETB160	166	60	130	95	37,8	10 / 6	8	11
ETB190	195	75	165	138	31,8	10 / 6	11	19
ETB230	230	75	200	138	31,8	10 / 6	14	19

Table D6-2: Material specification

Material thickness [mm]	Material Grades	Coating specification
6	Aluminium EN AW-6082 T6 according to EN 755-2:1997 stainless steel as described	
10		

Table D6-3:Characteristic capacities :

ETB connectors - Force downward

$$R_{1,k} = \min\begin{cases} \dfrac{n_J{}^{0,9} \times R_{ax,\alpha,k}}{\sqrt{2}} \\ n_H \times R_{lat,k} \end{cases}$$

n_J number of screws in the joist

n_H number of screws or nails in the side grain of the header or column

$R_{lat,k}$ Characteristic value of the load-carrying-capacity of a laterally loaded header/column nail or screw in single shear in a steel-to-timber connection with a thick steel plate according to EN 1995-1-1 or ETA 04/0013 in N

$R_{ax,\alpha,k}$ characteristic axial load-carrying capacity of the screws in the joist according to EN 1995-1-1:2004:2008+A1:2008(E) in N, for the angle between the fiber of timber and the axis of the screw.

D7.EL

Product Name	alternative names			
	Branch 36	Branch 40	Branch 46	Branch 47
EL xx				

xx = size of EL

Figure D7-1: Drawings

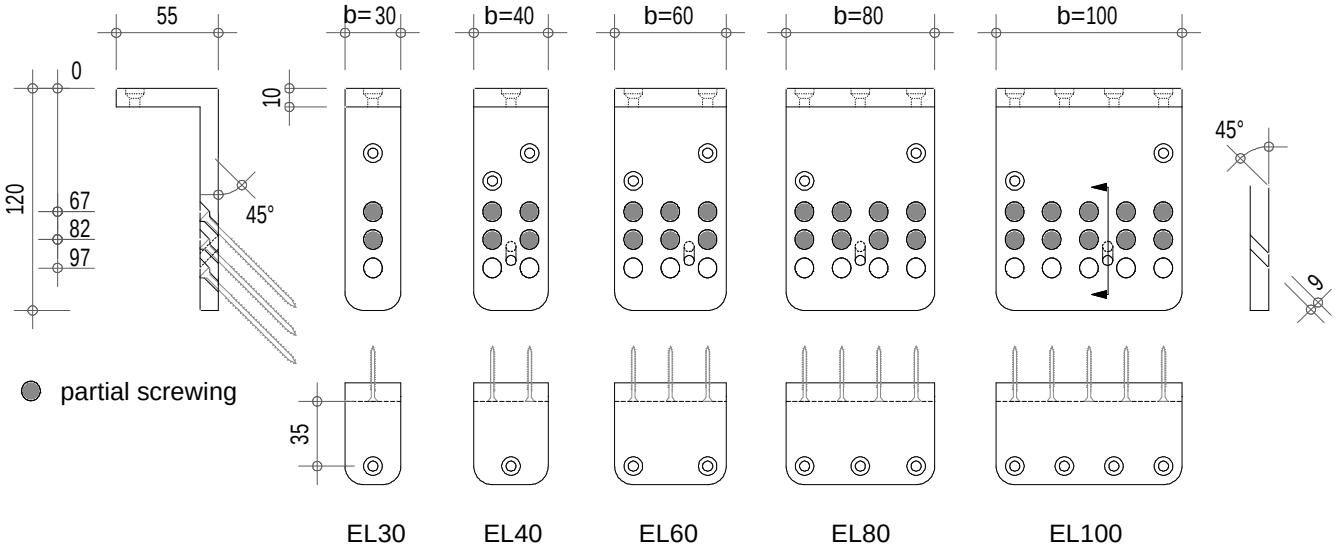


Table D7-1: dimensions and number of fastener

type	number of holes Ø5,4mm	
	45°	top
EL30	3	1
EL40	6	1
EL60	9	2
EL80	12	3
EL100	15	4

Table D7-2: Material specification

Material thickness	Material Grades	Coating specification
6	Aluminium EN AW-6082 T6 according to EN 755-2:1997 stainless steel as described	
10		

Table D7-3:Characteristic capacities :

$$R_{1,k} = \min\begin{cases} \dfrac{n_J^{0,9} \times R_{ax,\alpha,k}}{\sqrt{2}} \\ \dfrac{k_{c,90} \times f_{c,90ck} \times A_{ef} \times b}{A} \times \left(11{,}25 + \sqrt{\dfrac{25 \times f_{y,k} \times A}{k_{c,90} \times f_{c,90,k} \times A_{ef}} - 380} \right) \\ \dfrac{278 \times b}{k_{\mathrm{mod}}} \end{cases}$$

$$R_{3,k} = \min\begin{cases} 0{,}3 \times F_{1,d} \\ n_H \times R_{lat,k} \end{cases}$$

n_J number of screws in the joist

n_H number of screws in the upper surface of the header

$k_{c,90}$ Factor according to EN 1995-1-1:A1 taking into account the load configuration, the possibility of splitting and the degree of compressive deformation

$f_{c,90,k}$ Characteristic compressive strength perpendicular to the grain in N/mm²

A_{ef} Effective contact area perpendicular to the grain in mm² according to EN 1995-1-1:A1

A Actual contact area perpendicular to the grain in mm²

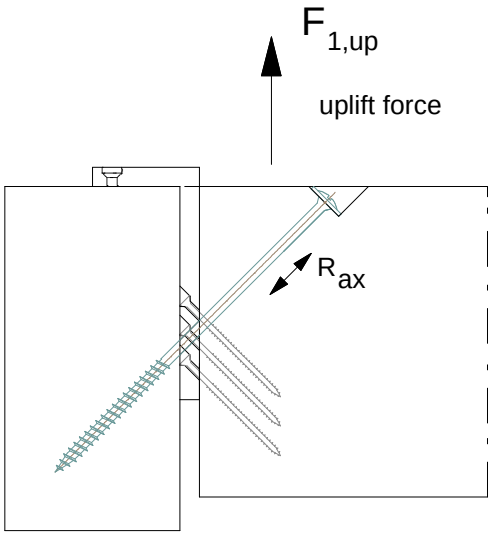
b Width of the SIMPSON STRONG-TIE® EL hanger in mm

$f_{y,k}$ Aluminium minimum yield strength in N/mm²; $f_{y,k}$ = 250 N/mm²

$F_{1,d}$ design value of the joist support load perpendicular to the joist axis in N

$R_{ax,\alpha,k}$ characteristic axial load-carrying capacity of the screws in the joist according to EN 1995-1-1:2004:2008+A1:2008(E) in N, for the angle between the fiber of timber and the axis of the screw.

$R_{lat,k}$ Characteristic value of the load-carrying-capacity of a laterally loaded header nail or screw in N



An uplift force may be adsorbed by an extra screw as shown above.

$$R_{1up,k} = \frac{R_{ax,k(Screw)}}{\sqrt{2}}$$

$R_{ax,k(Screw)}$ characteristic axial load-carrying capacity of the extra screw as the min of threaded part and pull through capacity of the head.

D8.ELS

Product Name	alternative names			
	Branch 36	Branch 40	Branch 46	Branch 47
ELS xx				

xx = size of ELS

Figure D8-1: Drawings

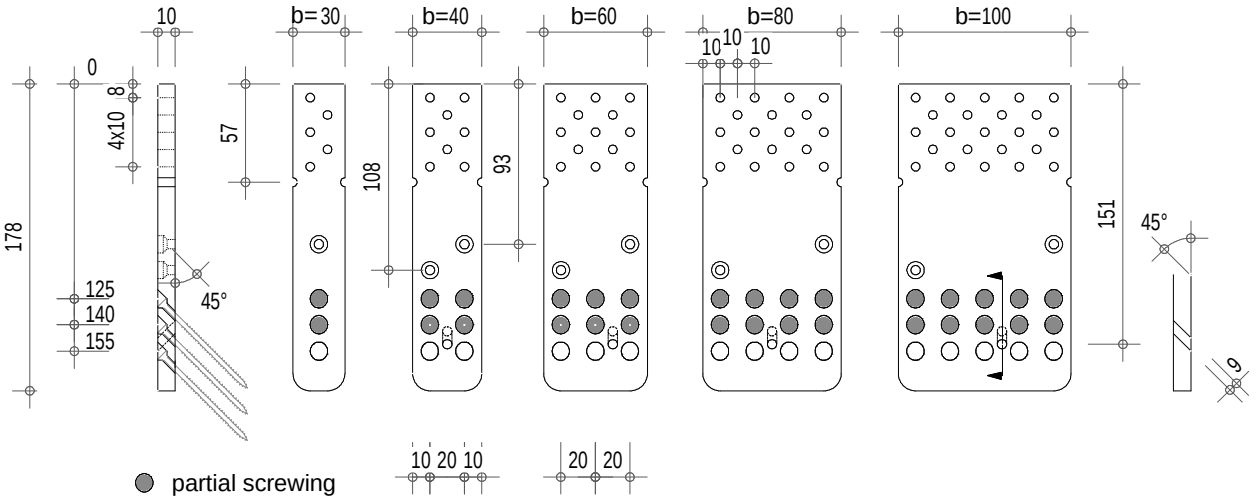


Table D8-1: dimensions and number of fastener

type	number of holes Ø5,4 45°	Ø5,0 top
ELS30	3	5
ELS40	6	8
ELS60	9	13
ELS80	12	15
ELS100	15	19

Table D8-2: Material specification

Material thickness	Material Grades	Coating specification
10	Aluminium EN AW-6082 T6 according to EN 755-2:1997 stainless steel as described	

Table D8-3:Characteristic capacities :

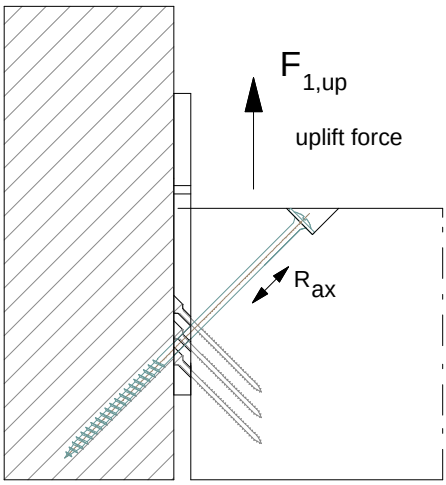
$$R_{1,k} = \min\begin{cases} \dfrac{n_J^{\,0,9} \times R_{ax,\alpha,k}}{\sqrt{2}} \\ n_H \times R_{lat,k} \end{cases}$$

n_J number of screws in the joist

n_H number of screws in the upper surface of the header

$R_{ax,\alpha,k}$ characteristic axial load-carrying capacity of the screws in the joist according to EN 1995-1-1:2004:2008+A1:2008(E)
For a connection with a slope < 0°, it shall be check the permission for angle between the fiber of timber and the axis of the screw.

$R_{lat,k}$ Characteristic value of the load-carrying-capacity of a laterally loaded header nail or screw in N



An uplift force may be adsorbed by an extra screw as shown above.

$$R_{1up,k} = \frac{R_{ax,k(Screw)}}{\sqrt{2}}$$

$R_{ax,k}$ characteristic axial load-carrying capacity of the extra screw as the min of threaded part and pull through capacity of the head.

D9.CBH

Product Name	alternative names			
	Branch 36	Branch 40	Branch 46	Branch 47
CBH xxx / 2.5				

xxx = size of CBH

Figure D9-1: Drawings

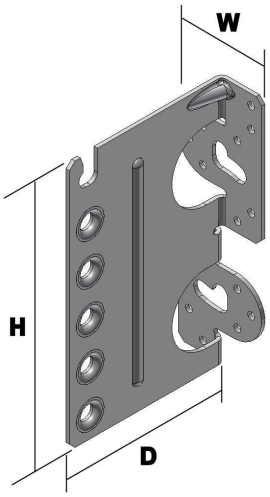


Table D9-1: dimensions and number of fastener

Model	Width W	Height H	Depth D	Angle	
	[mm]			degree	Direction
CBH150/2,5	60	150	113,5	90°	~
CBH180/2,5	60	180	113,5	90°	~
CBH220/2,5	60	220	113,5	90°	~

Model	Header Fasteners		Joist Fasteners
	nails or screws *	Bolts Anchors Wood screws	Dowel Ø10 acc. To EN 14592
CBH150/2,5	14	1-Ø10 1-Ø8	5
CBH180/2,5	16	2-Ø10	6
CBH220/2,5	22	2-Ø10	7

* According to ETA 04/0013 or according to EN14592

Washer for a wood/ rigid support connection.
The minimum dimension have to be used:

- Bolt Ø10 + Washer M10 (Øext = 20 – Øint = 11mm)
- Bolt Ø8 + Washer M8 (Øext = 16 – Øint = 8,5mm) for CBH150

Table D9-2: Material specification

Material thickness	Material Grades	Coating specification
3	S 250 GD	Z275
3	stainless steel as described	

Table D9-3:Characteristic capacities timber to timber:

Characteristic value [kN] of a CBH concealed loist hangers for connections between timber header beam and timber supported joist.

Widths	**60**	**80**	**100**	**120**	**140**	**160**	**60**	**80**	**100**	**120**	**140**	**160**	**60**	**80**	**100**	**120**	**140**	**160**
Slope	**0**						**5**						**10**					
CBH150	18,0	18,6	20,7	22,4	24,0	24,0	17,8	18,4	20,3	22,0	23,8	23,8	17,5	18,1	20,0	21,6	23,4	23,5
CBH180	25,0	26,4	29,5	32,1	32,6	32,6	24,7	26,1	29,1	31,6	32,4	32,4	24,3	25,6	28,5	31,0	32,1	32,1
CBH220	32,6	34,2	37,9	41,1	42,8	42,8	32,2	33,7	37,3	40,4	42,4	42,4	31,8	33,2	36,6	39,7	42,0	42,0

Widths	**60**	**80**	**100**	**120**	**140**	**160**	**60**	**80**	**100**	**120**	**140**	**160**	**60**	**80**	**100**	**120**	**140**	**160**
Slope	**15**						**20**						**25**					
CBH150	17,3	17,9	19,6	21,2	22,9	23,3	17,1	17,6	19,3	20,8	22,4	23,0	16,9	17,4	19,0	20,4	22,0	22,7
CBH180	24,0	25,2	28,0	30,5	31,8	31,8	23,6	24,8	27,5	29,9	31,4	31,4	23,4	24,5	27,0	29,3	31,1	31,1
CBH220	31,4	32,7	35,9	38,9	41,6	41,6	31,0	32,3	35,3	38,2	41,1	41,1	30,7	31,8	34,8	37,5	40,4	40,7

Widths	**60**	**80**	**100**	**120**	**140**	**160**	**60**	**80**	**100**	**120**	**140**	**160**	**60**	**80**	**100**	**120**	**140**	**160**
Slope	**30**						**35**						**40**					
CBH150	16,7	17,2	18,7	20,1	21,6	22,5	16,6	17,0	18,4	19,8	21,2	22,3	16,5	16,8	18,2	19,5	20,9	22,1
CBH180	23,1	24,1	26,6	28,8	30,8	30,8	22,8	23,8	26,2	28,4	30,5	30,5	22,7	23,6	25,9	28,0	30,1	30,3
CBH220	30,4	31,5	34,3	37,0	39,7	40,4	30,1	31,2	33,9	36,5	39,1	40,0	30,0	31,0	33,6	36,1	38,7	39,8

Widths	**60**	**80**	**100**	**120**	**140**	**160**
Slope	**45**					
CBH150	16,3	16,7	18,0	19,3	20,6	21,9
CBH180	22,5	23,4	25,6	27,6	29,7	30,1
CBH220	29,8	30,8	33,3	35,7	38,3	39,5

Table D9-4:Characteristic capacities timber to steel/concrete:

Characteristic values [kN] for connection where the CBH joist hanger is bolted to a steel or reinforced concrete structural member and carrying a timber supported joist.

1. Dowel characteristic capacity
$F_{k,dowels}$

Widths	60	80	100	120	140	160	60	80	100	120	140	160	60	80	100	120	140	160
Slope	0						5						10					
CBH150	12,4	13,2	15,6	17,7	19,5	19,5	12,2	13,0	15,2	17,3	19,3	19,3	12,0	12,7	14,9	16,9	19,0	19,0
CBH180	19,3	21,1	25,2	28,8	29,7	29,7	18,9	20,7	24,6	28,1	29,2	29,2	18,5	20,2	23,9	27,4	28,8	28,8
CBH220	23,8	25,9	30,6	34,9	37,1	37,1	23,4	25,4	29,8	34,0	36,6	36,6	22,9	24,8	29,0	33,0	36,0	36,0

Widths	60	80	100	120	140	160	60	80	100	120	140	160	60	80	100	120	140	160
Slope	15						20						25					
CBH150	11,7	12,4	14,5	16,4	18,4	18,7	11,5	12,1	14,1	15,9	17,9	18,3	11,3	11,8	13,7	15,4	17,3	18,0
CBH180	18,2	19,7	23,3	26,6	28,3	28,3	17,8	19,2	22,6	25,8	27,8	27,8	17,4	18,8	22,0	25,0	27,3	27,3
CBH220	22,4	24,2	28,2	32,1	35,3	35,3	22,0	23,6	27,4	31,1	34,7	34,7	21,5	23,0	26,7	30,2	34,0	34,1

Widths	60	80	100	120	140	160	60	80	100	120	140	160	60	80	100	120	140	160
Slope	30						35						40					
CBH150	11,0	11,6	13,4	15,0	16,8	17,7	10,8	11,3	13,0	14,6	16,3	17,4	10,7	11,1	12,7	14,2	15,9	17,1
CBH180	17,0	18,3	21,4	24,3	26,8	26,8	16,7	17,9	20,9	23,6	26,4	26,4	16,4	17,6	20,4	23,1	26,0	26,0
CBH220	21,1	22,5	26,0	29,4	33,0	33,5	20,7	22,1	25,4	28,6	32,2	33,0	20,4	21,7	24,9	28,0	31,4	32,6

Widths	60	80	100	120	140	160
Slope	45					
CBH150	10,5	10,9	12,5	13,9	15,5	16,9
CBH180	16,2	17,3	20,0	22,6	25,4	25,7
CBH220	20,1	21,3	24,4	27,4	30,8	32,2

2. Max characteristic capacity [kN] of the steel part $F_{k,steel}$

Model	$F_{k,steel}$
CBH150	15,9
CBH180	23,3
CBH220	26,1

3. Design capacity of the CBH – $F_{d,CBH}$

$$F_{d,CBH} = \min\begin{cases} \dfrac{F_{k,dowels} \times k_{\mathrm{mod}}}{\gamma_M} \\ \dfrac{F_{k,steel}}{\gamma_M} \end{cases}$$

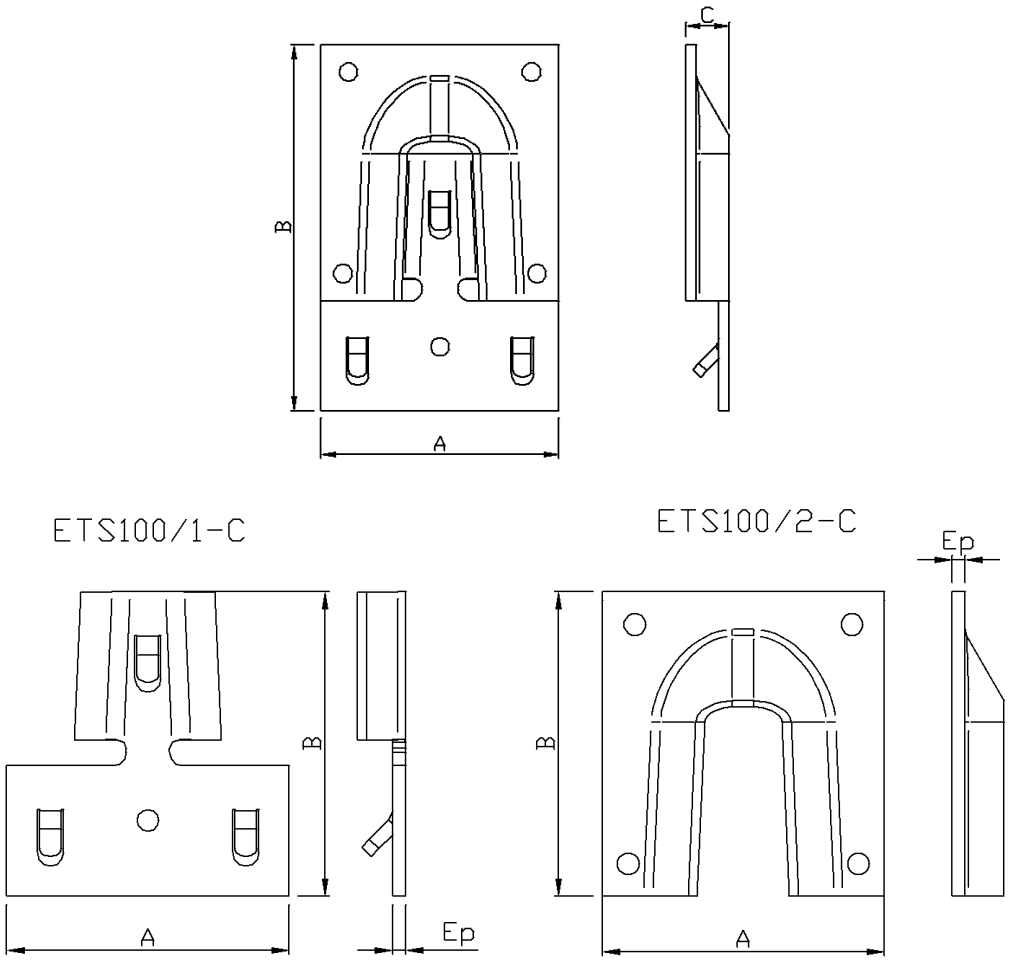
D10. ETS

Product Name	alternative names			
	Branch 36	Branch 40	Branch 46	Branch 47
ETS				

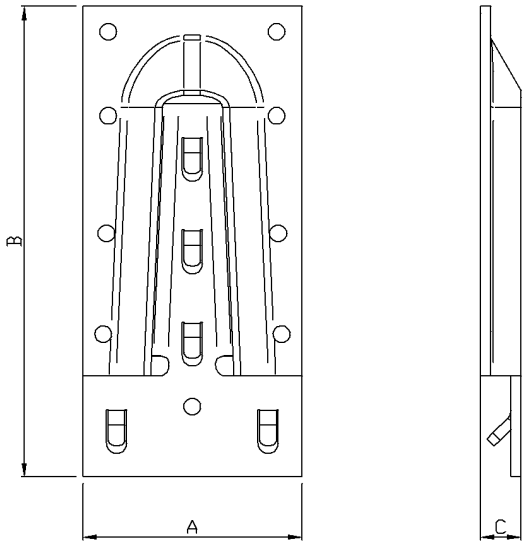
Figure D10-1: Drawings

Each ETS is made using two parts:

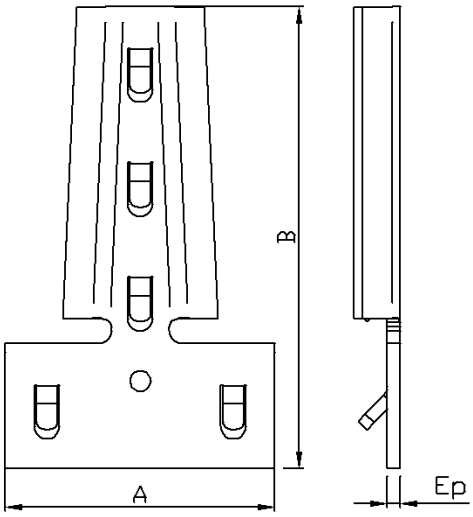
ETS100 = ETS100/1-C + ETS100/2-C



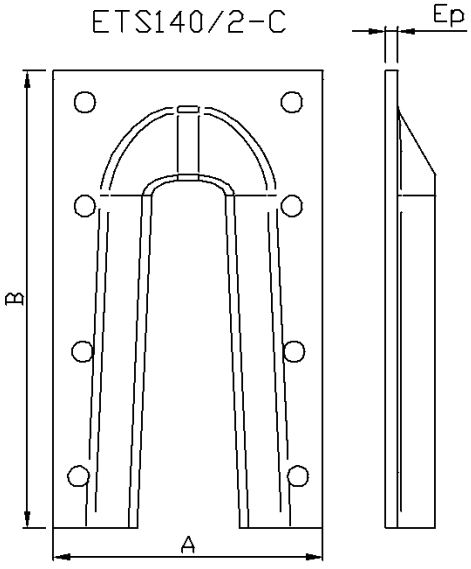
ETS140 = ETS140/1-C + ETS140/2-C



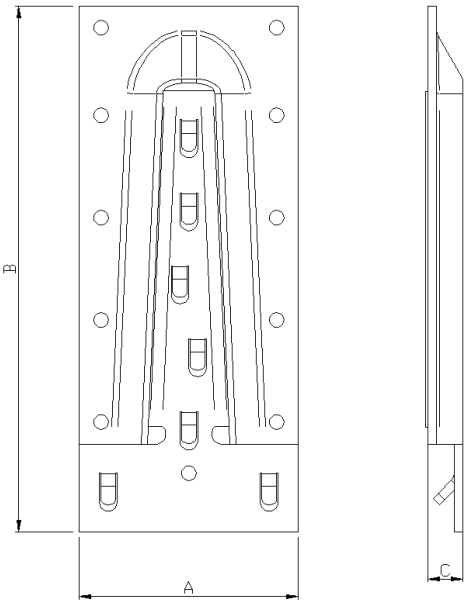
ETS140/1-C

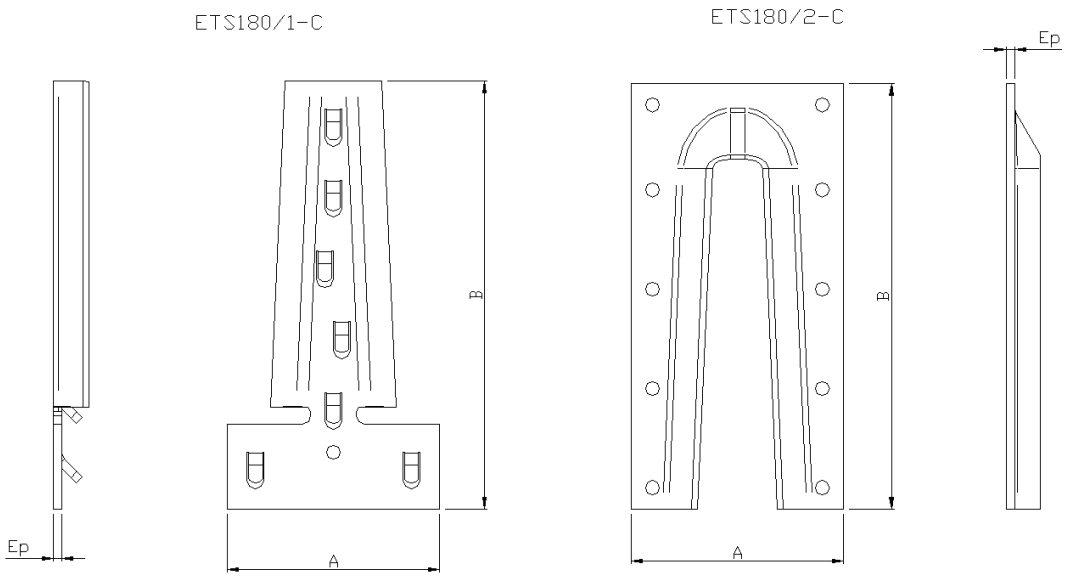


ETS140/2-C



ETS180 = ETS180/1-C + ETS180/2-C





ETSxxx/1-C is for the joist
ETSxxx/2-C is for the header

Table D10-1: dimensions and number of fastener

Model		Dimensions			Fasteners	
	A (mm)	**B (mm)**	**C (mm)**	**Ep (mm)**	**SPAX screws 5.0x80**	**CSA5.0x40**
ETS100	65	100	12	-	-	-
- ETS100/1-C	65	70	-	3	3	1
- ETS100/2-C	65	70	-	3	0	4
ETS140	65	140	12	-	-	-
- ETS140/1-C	65	110	-	3	5	1
- ETS140/2-C	65	110	-	3	0	8
ETS180	75	180	12	-	-	-
- ETS180/1-C	75	150	-	3	7	1
- ETS180/2-C	75	150	-	3	0	10

Table D10-2: Material specification

Material thickness [mm]	Material Grades
3	Pre-galvanized steel Grade S250GD + Z (min Z275) according to EN 10346 with tolerances according to EN 10143 except if another material is precised. Or Stainless steel number 1.4401 or number 1.4404 according to EN 10088-2 with a minimum characteristic 0.2% yield stress of 240 MPa, a minimum 1.0% yield stress of 270 MPa and a minimum ultimate tensile strength of 530 MPa or a stainless steel with a minimum characteristic 0.2% yield stress of 240 MPa, a minimum 1.0% yield stress of 270 MPa and a minimum ultimate tensile strength of 530 MPa. If ETS are made using Stainless Steel, stainless fasteners need to be used.

Table D10-3:Characteristic capacities :

ETS connectors - Force downward

$$R_{1,k} = \min \begin{cases} \dfrac{n_J{}^{0,9} \times R_{ax,\alpha,k}}{\sqrt{2}} \\ n_H \times R_{lat,k} \end{cases}$$

n_J number of screws at 45° in the joist

n_H number of screws in the side grain of the header

$R_{lat,k}$ Characteristic value of the load-carrying-capacity of a laterally loaded header/column nail or screw in single shear in a steel-to-timber connection with a thick steel plate according to EN 1995-1-1 or ETA 04/0013 in N

$R_{ax,\alpha,k}$ characteristic axial load-carrying capacity of the screws in the joist according to EN 1995-1-1:2004:2008+A1:2008(E) in N, for the angle between the fiber of timber and the axis of the screw.