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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-09/0322

This ETA replaces the previous ETA with the same number and validity from 2009-11-12 to 2014-11-12

Trade name:	Various Angle Brackets*)
Holder of approval:	
Generic type and use of construction product:	Three-dimensional nailing plate (angle bracket for timber-to-timber, timber-to-steel and timber-to-concrete connections)
Valid from:	2010-01-05
to:	2015-01-05
Manufacturing plant:	
This European Technical Approval contains:	69 pages including 2 annexes which form an integral part of the document

* see section II.1 of this ETA

I 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4 This European Technical Approval may be withdrawn by ETA-Danmark A/S pursuant to Article 5(1) of Council Directive89/106/EEC.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.

II SPECIAL CONDITIONS OF THE EUROPEAN TECHNICAL APPROVAL

1 Definition of product and intended use

Definition of the product

various angle brackets covers the following bracket types:

Type AB Top 80, AB Top 120, AB Top 80 Vario, AB Top 120 Vario, AB 1867, AB 2197, AB 110/170S, AB 50/595, AB 80/598, AB 110/5911, type AB 994, AB 1293, AB 645, AB 543, AB 993, AB 653, AB 26910 (nails/dowels), AB16910, AB 3691025 and AB 3691015.

They are one-piece non-welded, face-fixed angle brackets to be used in timber to timber, timber to steel and timber to concrete connections. They are connected to the timber elements by a range of profiled nails or by GH connector screws.

The angle brackets are made from pre-galvanized steel S 250 GD + Z275, S 235 JR + Z275 or DX 51 D + Z275 according to EN 10327:2004 with a minimum yield stress of 235 MPa, a minimum tensile strength R_m of 330 MPa and a minimum ultimate strain A_{80} of 22 %and are available with or without an embossed rib.

Additionally, all the angle brackets can be made from stainless steel 1.4301, 1.4401, 1.4541 or 1.4571 according to EN 10088-2:2005 with a minimum yield stress of 190 MPa. For all stainless steels a factor of 0.8 must be applied to the load-carrying capacity to accommodate for the difference in yield stress.

Dimensions, hole positions and typical installations are shown in Annex A.

Intended use

The angle brackets are intended for use in making connections in load bearing timber structures, as a connection between a beam and a purlin, 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 connection may be with a single angle bracket or with an angle bracket on each side of the fastened timber member (see Annex A).

The static and kinematic behaviour of the timber members or the supports shall be as described in Annex B.

The wood members can be of solid timber, glued laminated timber and similar glued members, or wood-based structural members with a characteristic density from 290 kg/m^3 to 420 kg/m^3. This requirement to the material of the wood members can be fulfilled by using the following materials:

- Structural solid timber classified to C14-C40 according to EN 338 / EN 14081,
- Glulam classified to GL24-GL36 according to EN 1194 / EN 14080,
- LVL according to EN 14374,
- Parallam PSL,
- Intrallam LSL,
- Duo- and Triobalken,
- Layered wood plates,
- Plywood according to EN 636

Annex B states the load-carrying capacities of the angle bracket connections for a characteristic density of 350 kg/m^3. For timber or wood based material with a lower characteristic density than 350 kg/m^3 the load-carrying capacities shall be reduced by the k_{dens} factor:

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

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

The design of the connections shall be in accordance with Eurocode 5 or a similar national Timber Code. The wood members shall have a thickness which is larger than the penetration depth of the nails into the members.

The angle brackets are primarily for use in timber structures subject to the dry, internal conditions defined by service class 1 and 2 or the wet conditions defined by service class 3 of Eurocode 5 and for connections subject to static or quasi-static loading.

The angle brackets may also be used for connections between a timber member and a member of concrete or steel.

Assumed working life

The assumed intended working life of the angle brackets 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 paragraph	Characteristic		Assessment of characteristic
	2.1	**Mechanical resistance and stability*)**	
6.1.1		Characteristic load-carrying capacity	See Annex B
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	The angle brackets are made from steel classified as **Euroclass A1** in accordance with EN 1350-1 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 angle brackets 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
6.7.2		Serviceability	
6.7.3		Identification	See Annex A

*) See page 5 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
The characteristic load-carrying capacities are based on the characteristic values of the connectors and the steel plates. To obtain design values the capacities have to be multiplied with different partial factors for the material properties, in addition the connection with the coefficient k_{mod}.

According to EN 1990 (Eurocode – Basis of design) paragraph 6.3.5 the design value of load-carrying capacity can be determined by reducing the characteristic values of the load-carrying capacity with different partial factors.

Thus, the characteristic values of the load–carrying capacity are determined also for timber failure $F_{Rk,H}$ (obtaining the embedment strength of nails subjected to shear or the withdrawal capacity of the most loaded nail, respectively) as well as for steel plate failure $F_{Rk,S}$. The design value of the load–carrying capacity is the smaller value of both load–carrying capacities.

$$F_{Rd} = \min\left\{\frac{k_{mod} \cdot F_{Rk,H}}{\gamma_{M,H}}; \frac{F_{Rk,S}}{\gamma_{M,S}}\right\}$$

Therefore, for timber failure the load duration class and the service class are included. The different partial factors γ_M for steel or timber, respectively, are also correctly taken into account.

2.1 Mechanical resistance and stability
See annex B for the characteristic load-carrying capacity in the different directions F_1 to F_5.

The characteristic capacities of the angle brackets 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 Eurocode 5 or a similar national Timber Code.

Threaded nails (ringed shank nails) in accordance to EN 14592
In the formulas in Annex B the capacities for threaded nails and fully treaded GH Connector screws calculated from the formulas of Eurocode 5 are used assuming a thick steel plate when calculating the lateral nail load-carrying-capacity.

The load bearing capacities of the brackets has been determined based on the use of connector nails 4,0 x 40 mm and 4,0 mm x 60 mm in accordance with the German national approval for the nails.

The characteristic withdrawal capacity of the nails has to be determined by calculation in accordance with EN 1995-1-1: 2004, paragraph 8.3.2 (head pull-through is not relevant):

$$F_{ax,Rk} = f_{ax,k} \times d \times t_{pen}$$

Where:

$f_{ax,k}$ Characteristic value of the withdrawal parameter in N/mm^2
d Nail diameter in mm
t_{pen} Penetration depth of the profiles shank in mm
$t_{pen} \geq 31$ mm

Based on tests by Versuchsanstalt für Stahl, Holz und Steine, University of Kalrsruhe, the characteristic value of the withdrawal resistance for the threaded nails used can be calculated as:

$$f_{ax,k} = 50 \times 10^{-6} \times \sigma_k^{\,2}$$

Where:

σ_k Characteristic density of the timber in kg/m^3

The shape of the nail directly under the head shall be in the form of a truncated cone with a diameter under the nail head which exceeds the hole diameter.

4,0 mm threaded nails with a truncated cone below the head are used as fasteners, which are particularly suitable for nailed steel-to-timber connections. The specific shape below the head causes a clamping of nails in the steel plate.

Fully threaded screws in accordance with EN 14592
The capacity of GH Connector screws is in accordance with national German approval no. Z-9.1-375 issued by DIBt, and the load carrying capacities of joints with GH Connector screws apply in areas where the abovementioned national German approval is accepted as basis for the design.

Load bearing capacities for GH Connector screws 5,0x40 and 5,0x60 have been determined. If longer 5,0 mm Connector screws are used the capacities stated for GH Connector screw 5,0x60 are valid.

The design models allow the use of fasteners described in table A.3 on page 10 in Annex A

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.

No performance has been determined in relation to the joint's stiffness properties - to be used for the analysis of the serviceability limit state.

2.7 Related aspects of serviceability

2.7.1 Corrosion protection in service class 1 and 2.
In accordance with ETAG 015 the angle brackets are made from pre-galvanized steel S 250 GD + Z275, S 235 JR + Z275 or DX 51 D + Z275 according to EN 10327:2004

2.7.2 Corrosion protection in service class 3.
In accordance with Eurocode 5 the joist hangers are made from stainless steel 1.4301, 1.4401, 1.4541 or 1.4571 according to EN 10088-2:2005 and the nails and screws shall be produced from stainless steel.

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[4]. 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.

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

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

3.3 CE marking

The CE marking shall be affixed on each packaging of angle brackets. The initials "CE" shall be followed by the identification number of the notified body and shall be accompanied by the following information:

- 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 ETA Guideline (ETAG no. 015)
- Number of the EC Certificate of Conformity

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

4.1 Manufacturing

angle brackets 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

The following provisions concerning installation apply:

Angle brackets can be fastened to wood-based members by nails or screws. Angle brackets shall be connected to headers made of wood-based panels using GH connector screws.

There shall be nails or screws in all holes or at least in holes as specified on technical drawings in accordance with this document.

All minimum spacing's and edge/end distances in accordance with Eurocode 5 or an appropriate national code shall be complied with.

The angle bracket connection shall be designed in accordance with Eurocode 5 or an appropriate national code.

The cross section of the connected wooden elements shall have a plane surface against the whole angle bracket.

Angle brackets made from stainless steel should only be fastened with fasteners made from suitable stainless steel.

Zinc-coated angle brackets shall not be fastened with fasteners of stainless steel.

Nails or screws to be used shall have a diameter which fits the holes of the angle brackets.

The structural members – the components 1 and 2 shown in the figure on page 15 - to which the brackets are fixed shall be:

- Restrained against rotation. At a load F_4/F_5, the component 2 is allowed to be restrained against rotation by the Angle brackets.
- Strength class C24 or better, see section 1 of this ETA
- Free from wane under the bracket.
- The actual end bearing capacity of the timber member to be used in conjunction with the bracket is checked by the designer of the structure to ensure it is not less than the bracket capacity and, if necessary, the bracket capacity reduced accordingly.
- The gap between the timber members does not exceed 3 mm.
- There are no specific requirements relating to preparation of the timber members.

The execution of the connection shall be in accordance with the approval holder's technical literature.

4.3 Maintenance and repair

Maintenance is not required during the assumed intended working life. Should repair prove necessary, it is normal to replace the angle bracket.

Thomas Bruun
Manager, ETA-Danmark

Annex A
Product details and definitions

Table A.1 materials specification

Bracket type	Thickness (mm)	Steel specifications*	Coating specification
AB 110/170S	3,0	S 250 GD + Z 275	Z 275

Table A.2 Range of sizes
See details and tolerences in the following drawings

Table A.3 Fastener specification

Fastener type	Nail size (mm)		Finish
According to EN 14592	Diameter	Length	
Threaded nail	4,0	40	Electroplated zinc
Threaded nail	4,0	60	Electroplated zinc
GH Connector screw	5,0	40	Electroplated zinc
GH Connector screw	5,0	60	Electroplated zinc

* Additionally, the angle brackets can be made from pre-galvanized steel S 235 JR + Z275 or DX 51 D + Z275 according to EN 10327:2004 with a minimum yield stress of 235 MPa, a minimum tensile strength R_m of 330 MPa and a minimum ultimate strain A_{80} of 22 % or from stainless steel 1.4301, 1.4401, 1.4541 or 1.4571 according to EN 10088-2:2005 with a minimum yield stress of 190 MPa. For all stainless steels a factor of 0.8 must be applied to the load-carrying capacity to accommodate for the difference in yield stress.

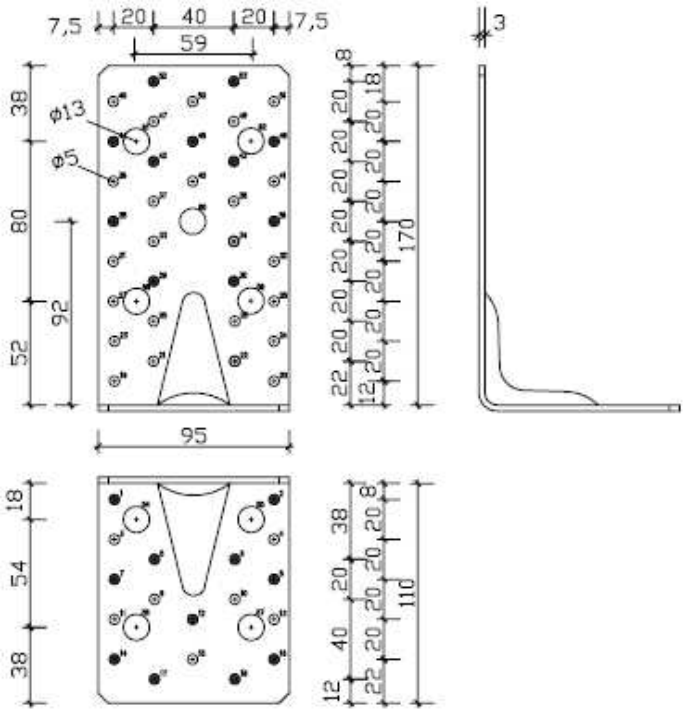


Figure A.7 Dimensions of
Angle Bracket 110/170S

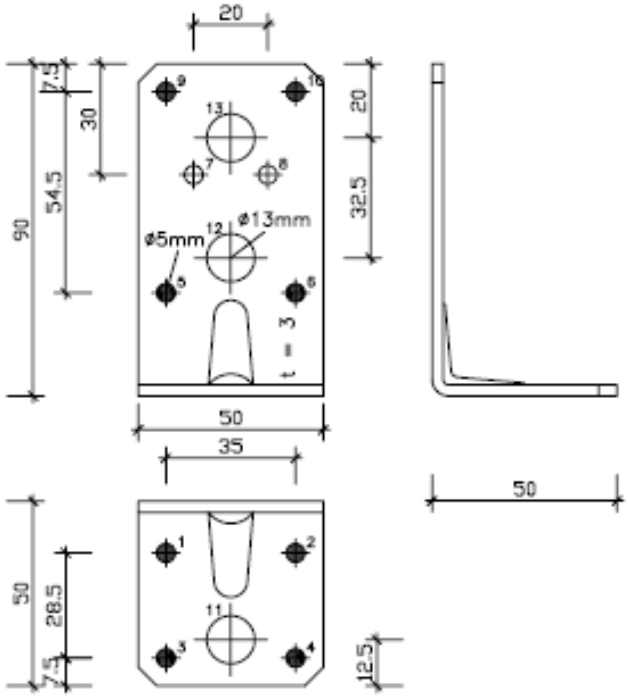


Figure A.8 Dimensions of
Angle Bracket 50/595

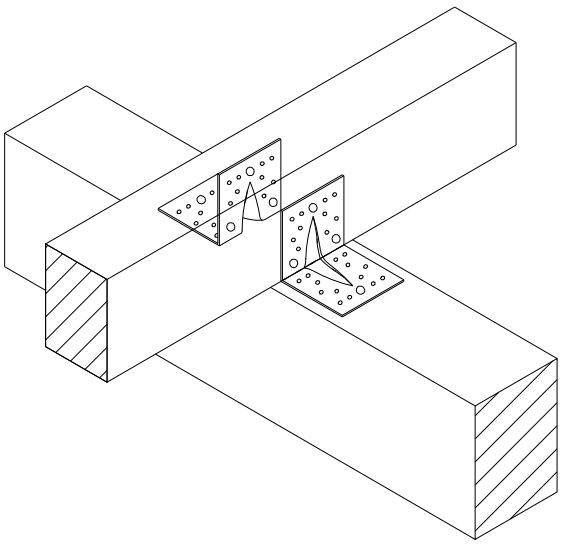
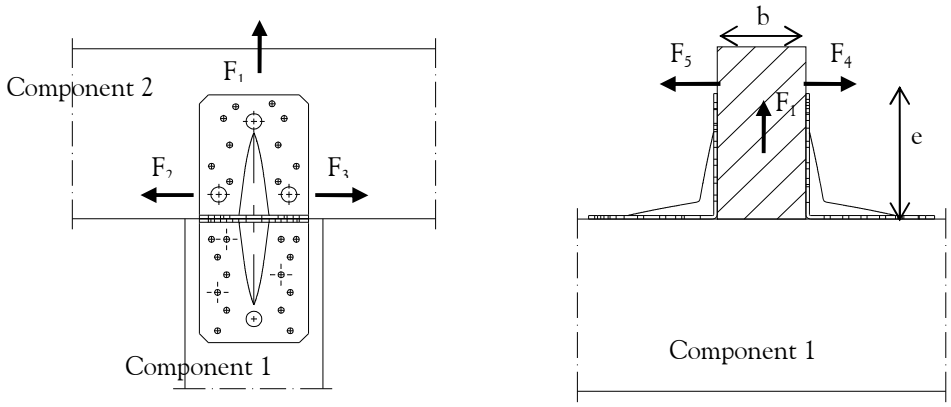


Figure A.20 Typical installation

Annex B
Characteristic load-carrying capacities

Definitions of forces, their directions and eccentricity
Forces - Beam to beam connection



Fastener specification
Holes are marked with numbers referring to the nailing pattern in the following tables.
The holes which have to be nailed are given in the following tables for the different forces.

Double angle brackets per connection
The angle brackets must be placed at each side opposite each other, symmetric to the component axis.

Acting forces

F_1	Lifting force acting along the central axis of the joint.
F_2 and F_3	Lateral force acting in the joint between the component 2 and component 1 in the component 2 direction
F_4 and F_5	Lateral force acting in the component 1 direction along the central axis of the joint. If the load is applied with an eccentricity e, a design for combined loading is required. The calculations applied for this ETA already contain the necessary input for eccentric loading,

Single angle bracket per connection
Acting forces

F_1	Lifting force acting in the central axis of the angle bracket. The component 2 shall be prevented from rotation. If the component 2 is prevented from rotation the load-carrying capacity will be half of a connection with double angle brackets.
F_2 and F_3	Lateral force acting in the joint between the component 2 and the component 1 in the component 2 direction. The component 2 shall be prevented from rotation. If the component 2 is prevented from rotation the load-carrying capacity will be half of a connection with double angle brackets.
F_4 and F_5	Lateral force acting in the component 1 direction in the height of the top edge of component 2. F_4 is the lateral force towards the angle bracket; F_5 is the lateral force away from the angle bracket.

Wane
Wane is not allowed, the timber has to be sharp-edged in the area of the angle brackets.

Timber splitting
For the lifting force F_1 it must be checked in accordance with Eurocode 5 or a similar national Timber Code that splitting will not occur.

Combined forces

If the forces F_1 and F_2/F_3 or F_4/F_5 act at the same time, the following inequality shall be fulfilled:

$$\left(\frac{F_{1,d}}{F_{Rd,1}}\right)^2+\left(\frac{F_{2,d}}{F_{Rd,2}}\right)^2+\left(\frac{F_{3,d}}{F_{Rd,3}}\right)^2+\left(\frac{F_{4,d}}{F_{Rd,4}}\right)^2+\left(\frac{F_{5,d}}{F_{Rd,5}}\right)^2 \le 1$$

The forces F_2 and F_3 or F_4 and F_5 are forces with opposite direction. Therefore only one force F_2 or F_3, respectively, and F_4 or F_5, respectively, is able to act simultaneously with F_1, while the other shall be set to zero.

The below table indicates the nailing patterns in the horizontal and vertical leg of the brackets for full and partial nailing. The numbers refer to the hole numbers indicated in the drawings in annex A.

Name	Connectors / Application	Horizontal bracket	Vertical bracket	F1	F2/3	F4	F5
170L	Maximum	1-2-5-6-7-8-12-14-16-17-18	29-30-35-36-42-43-44-45-46-52-53	✓	✓	✓	✓

The characteristic capacities for connection with the angle brackets given in the following tables are based on calculations presuming brackets made from pre-galvanized steel S 2250 GD + Z275 with a minimum yield stress of 235 MPa. For all stainless steels a factor of 0.8 must be applied to the load-carrying capacity to accommodate for the difference in yield stress.

The below figure describes the geometric factors used in the following tables for the load-carrying capacities.

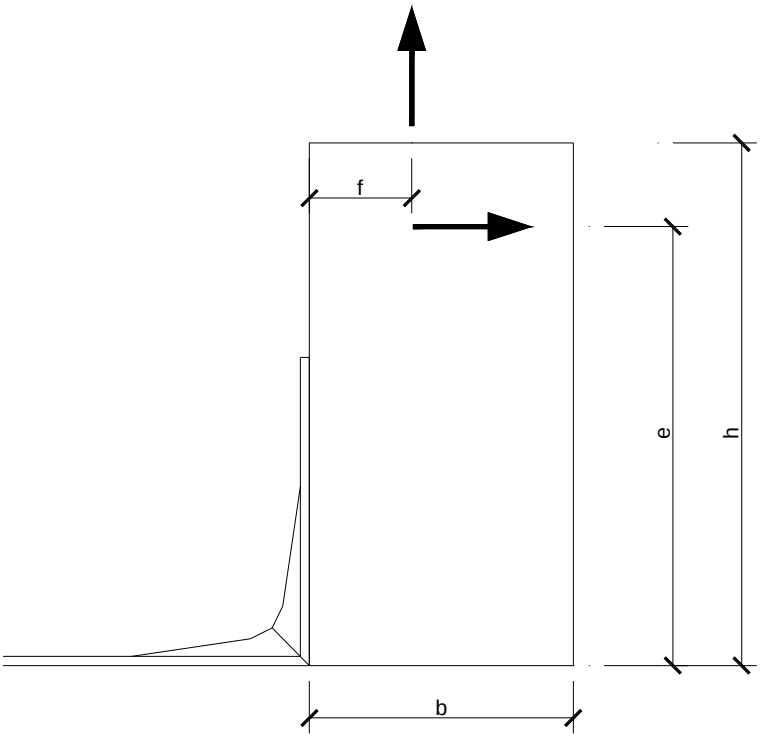


Table B.21 Characteristic load-carrying capacities angle brackets type 110/170S
Fastener: Nails 4,0x40 mm, fully nailed

Load capacity $F_{1,k}$ - one angle bracket

f [mm]	0	20	40	60	80	100	120	140	160	180	200	220	240
F_1 [N]	1943	138	69	46	34	28	23	20	17	15	14	13	11

$F_{1,k}$ - two angle brackets

f [mm]	
F_1 [N]	3885

Load capacity $F_{2/3,k}$ - one angle bracket

Δs [mm]	82
$F_{2/3}$ [N]	5028

$F_{2/3,k}$ - two angle brackets

Δs [mm]	82
$F_{2/3}$ [N]	10056

Load capacity $F_{4,k}$ - one angle bracket

e [mm]	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320
F_4 [N]	12553	6265	3132	2088	178	78	50	37	29	24	20	18	16	14	13	12	11

Load capacity $F_{5,k}$ [N] - one angle bracket

beam height [mm]	beam width [mm]												
	0	20	40	60	80	100	120	140	160	180	200	220	240
0	43	43	43	43	43	43	43	43	43	43	43	43	43
20	62	62	62	62	62	62	62	62	62	62	62	62	62
40	113	113	113	113	113	113	113	113	113	113	113	113	113
60	613	613	613	613	613	613	613	613	613	613	613	613	613
80	1139	1470	1470	1470	1470	1470	1470	1470	1470	1470	1470	1470	1470
100	911	1470	1470	1470	1470	1470	1470	1470	1470	1470	1470	1470	1470
120	760	1470	1470	1470	1470	1470	1470	1470	1470	1470	1470	1470	1470
140	651	1355	1470	1470	1470	1470	1470	1470	1470	1470	1470	1470	1470
160	570	1185	1470	1470	1470	1470	1470	1470	1470	1470	1470	1470	1470
180	506	1054	1470	1470	1470	1470	1470	1470	1470	1470	1470	1470	1470
200	456	948	1347	1470	1470	1470	1470	1470	1470	1470	1470	1470	1470
220	414	862	1225	1470	1470	1470	1470	1470	1470	1470	1470	1470	1470
240	380	790	1123	1468	1470	1470	1470	1470	1470	1470	1470	1470	1470
260	351	729	1036	1355	1470	1470	1470	1470	1470	1470	1470	1470	1470
280	326	677	962	1259	1470	1470	1470	1470	1470	1470	1470	1470	1470
300	304	632	898	1175	1457	1470	1470	1470	1470	1470	1470	1470	1470
320	285	593	842	1101	1366	1470	1470	1470	1470	1470	1470	1470	1470

Load capacity $F_{4+5,k}$ [N] - two angle bracket

beam height [mm]	beam width [mm]												
	0	20	40	60	80	100	120	140	160	180	200	220	240
0		12595	12595	12595	12595	12595	12595	12595	12595	12595	12595	12595	12595
20		1943	3885	5828	7770	9713	11655	12556	12561	12565	12568	12570	12572
40		971	1943	2914	3885	4856	5828	6799	7770	8742	9713	10684	11655
60		648	1295	1943	2590	3238	3885	4533	5180	5828	6475	7123	7770
80		486	971	1457	1943	2428	2914	3400	3885	4371	4856	5342	5828
100		389	777	1166	1554	1943	2331	2720	3108	3497	3885	4274	4662
120		324	648	971	1295	1619	1943	2266	2590	2914	3238	3561	3885
140		278	555	833	1110	1388	1665	1943	2220	2498	2775	3053	3330
160		243	486	728	971	1214	1457	1700	1943	2185	2428	2671	2914
180		216	432	648	863	1079	1295	1511	1727	1943	2158	2374	2590
200		194	389	583	777	971	1166	1360	1554	1748	1943	2137	2331
220		177	353	530	706	883	1060	1236	1413	1589	1766	1943	2119
240		162	324	486	648	809	971	1133	1295	1457	1619	1781	1943
260		149	299	448	598	747	897	1046	1195	1345	1494	1644	1793
280		139	278	416	555	694	833	971	1110	1249	1388	1526	1665
300		130	259	389	518	648	777	907	1036	1166	1295	1425	1554
320		121	243	364	486	607	728	850	971	1093	1214	1336	1457

Table B.22 Characteristic load-carrying capacities angle brackets type 110/170S
Fastener: Nails 4,0x60 mm, fully nailed

Load capacity $F_{1,k}$ - one angle bracket

f [mm]	0	20	40	60	80	100	120	140	160	180	200	220	240
F_1 [N]	3238	230	115	77	57	46	38	33	29	26	23	21	19

$F_{1,k}$ - two angle brackets

f [mm]	
F_1 [N]	6475

Load capacity $F_{2/3,k}$ - one angle bracket

Δs [mm]	75,4
$F_{2/3}$ [N]	6325

$F_{2/3,k}$ - two angle brackets

Δs [mm]	75,4
$F_{2/3}$ [N]	12650

Load capacity $F_{4,k}$ - one angle bracket

e [mm]	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320
F_4 [N]	14878	10441	5221	3480	296	129	83	61	48	40	34	30	26	23	21	20	18

Load capacity $F_{5,k}$ [N] - one angle bracket

beam height [mm]	beam width [mm]												
	0	20	40	60	80	100	120	140	160	180	200	220	240
0	71	71	71	71	71	71	71	71	71	71	71	71	71
20	103	103	103	103	103	103	103	103	103	103	103	103	103
40	188	188	188	188	188	188	188	188	188	188	188	188	188
60	1021	1021	1021	1021	1021	1021	1021	1021	1021	1021	1021	1021	1021
80	1899	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450
100	1519	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450
120	1266	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450
140	1085	2258	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450
160	949	1975	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450
180	844	1756	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450
200	760	1580	2246	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450
220	690	1437	2041	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450
240	633	1317	1871	2447	2450	2450	2450	2450	2450	2450	2450	2450	2450
260	584	1216	1727	2259	2450	2450	2450	2450	2450	2450	2450	2450	2450
280	543	1129	1604	2098	2450	2450	2450	2450	2450	2450	2450	2450	2450
300	506	1054	1497	1958	2428	2450	2450	2450	2450	2450	2450	2450	2450
320	475	988	1404	1836	2276	2450	2450	2450	2450	2450	2450	2450	2450

Load capacity $F_{4+5,k}$ [N] - two angle bracket

beam height [mm]	beam width [mm]												
	0	20	40	60	80	100	120	140	160	180	200	220	240
0		14949	14949	14949	14949	14949	14949	14949	14949	14949	14949	14949	14949
20		3238	6475	9713	12950	14884	14895	14903	14908	14913	14917	14920	14922
40		1619	3238	4856	6475	8094	9713	11332	12950	14569	14884	14890	14895
60		1079	2158	3238	4317	5396	6475	7554	8634	9713	10792	11871	12950
80		809	1619	2428	3238	4047	4856	5666	6475	7285	8094	8903	9713
100		648	1295	1943	2590	3238	3885	4533	5180	5828	6475	7123	7770
120		540	1079	1619	2158	2698	3238	3777	4317	4856	5396	5936	6475
140		463	925	1388	1850	2313	2775	3238	3700	4163	4625	5088	5550
160		405	809	1214	1619	2024	2428	2833	3238	3642	4047	4452	4856
180		360	719	1079	1439	1799	2158	2518	2878	3238	3597	3957	4317
200		324	648	971	1295	1619	1943	2266	2590	2914	3238	3561	3885
220		294	589	883	1177	1472	1766	2060	2355	2649	2943	3238	3532
240		270	540	809	1079	1349	1619	1889	2158	2428	2698	2968	3238
260		249	498	747	996	1245	1494	1743	1992	2241	2490	2740	2989
280		231	463	694	925	1156	1388	1619	1850	2081	2313	2544	2775
300		216	432	648	863	1079	1295	1511	1727	1943	2158	2374	2590
320		202	405	607	809	1012	1214	1416	1619	1821	2024	2226	2428

Table B.23 Characteristic load-carrying capacities angle brackets type 110/170S
Fastener: Screws 5,0x40 mm, fully fastened

Load capacity $F_{1,k}$ - one angle bracket

f [mm]	0	20	40	60	80	100	120	140	160	180	200	220	240
F_1 [N]	6632	505	253	168	126	101	84	72	63	56	51	46	42

$F_{1,k}$ - two angle brackets

f [mm]	
F_1 [N]	13264

Load capacity $F_{2/3,k}$ - one angle bracket

Δs [mm]	65,3
$F_{2/3}$ [N]	8369

$F_{2/3,k}$ - two angle brackets

Δs [mm]	65,3
$F_{2/3}$ [N]	16738

Load capacity $F_{4,k}$ - one angle bracket

e [mm]	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320
F_4 [N]	19800	16059	8030	5353	652	285	182	134	106	87	75	65	58	52	47	43	40

Load capacity $F_{5,k}$ [N] - one angle bracket

beam height [mm]	beam width [mm]												
	0	20	40	60	80	100	120	140	160	180	200	220	240
0	157	157	157	157	157	157	157	157	157	157	157	157	157
20	227	227	227	227	227	227	227	227	227	227	227	227	227
40	412	412	412	412	412	412	412	412	412	412	412	412	412
60	2245	2245	2245	2245	2245	2245	2245	2245	2245	2245	2245	2245	2245
80	4015	5388	5388	5388	5388	5388	5388	5388	5388	5388	5388	5388	5388
100	3212	4950	5388	5388	5388	5388	5388	5388	5388	5388	5388	5388	5388
120	2677	4125	5388	5388	5388	5388	5388	5388	5388	5388	5388	5388	5388
140	2294	3536	4888	5388	5388	5388	5388	5388	5388	5388	5388	5388	5388
160	2007	3094	4277	5388	5388	5388	5388	5388	5388	5388	5388	5388	5388
180	1784	2750	3802	4888	5388	5388	5388	5388	5388	5388	5388	5388	5388
200	1606	2475	3421	4399	5388	5388	5388	5388	5388	5388	5388	5388	5388
220	1460	2250	3110	3999	4902	5388	5388	5388	5388	5388	5388	5388	5388
240	1338	2062	2851	3666	4494	5329	5388	5388	5388	5388	5388	5388	5388
260	1235	1904	2632	3384	4148	4919	5388	5388	5388	5388	5388	5388	5388
280	1147	1768	2444	3142	3852	4568	5288	5388	5388	5388	5388	5388	5388
300	1071	1650	2281	2933	3595	4263	4935	5388	5388	5388	5388	5388	5388
320	1004	1547	2138	2749	3370	3997	4627	5259	5388	5388	5388	5388	5388

Load capacity $F_{4+5,k}$ [N] - two angle bracket

beam height [mm]	beam width [mm]												
	0	20	40	60	80	100	120	140	160	180	200	220	240
0		19956	19956	19956	19956	19956	19956	19956	19956	19956	19956	19956	19956
20		6632	13264	19801	19839	19863	19878	19889	19898	19904	19909	19914	19917
40		3316	6632	9948	13264	16580	19801	19823	19839	19852	19863	19871	19878
60		2211	4421	6632	8842	11053	13264	15474	17685	19801	19816	19829	19839
80		1658	3316	4974	6632	8290	9948	11606	13264	14922	16580	18238	19801
100		1326	2653	3979	5305	6632	7958	9285	10611	11937	13264	14590	15916
120		1105	2211	3316	4421	5527	6632	7737	8842	9948	11053	12158	13264
140		947	1895	2842	3790	4737	5684	6632	7579	8527	9474	10421	11369
160		829	1658	2487	3316	4145	4974	5803	6632	7461	8290	9119	9948
180		737	1474	2211	2947	3684	4421	5158	5895	6632	7369	8106	8842
200		663	1326	1990	2653	3316	3979	4642	5305	5969	6632	7295	7958
220		603	1206	1809	2412	3014	3617	4220	4823	5426	6029	6632	7235
240		553	1105	1658	2211	2763	3316	3869	4421	4974	5527	6079	6632
260		510	1020	1530	2041	2551	3061	3571	4081	4591	5101	5612	6122
280		474	947	1421	1895	2369	2842	3316	3790	4263	4737	5211	5684
300		442	884	1326	1768	2211	2653	3095	3537	3979	4421	4863	5305
320		414	829	1243	1658	2072	2487	2901	3316	3730	4145	4559	4974

Table B.24 Characteristic load-carrying capacities angle brackets type 110/170S
Fastener: Screws 5,0x60 mm, fully fastened

Load capacity $F_{1,k}$ - one angle bracket

f [mm]	0	20	40	60	80	100	120	140	160	180	200	220	240
F_1 [N]	6632	821	410	274	205	164	137	117	103	91	82	75	68

$F_{1,k}$ - two angle brackets

f [mm]	
F_1 [N]	13264

Load capacity $F_{2/3,k}$ - one angle bracket

Δs [mm]	60,6
$F_{2/3}$ [N]	9322

$F_{2/3,k}$ - two angle brackets

Δs [mm]	60,6
$F_{2/3}$ [N]	18645

Load capacity $F_{4,k}$ - one angle bracket

e [mm]	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320
F_4 [N]	24444	16059	8030	5353	836	365	233	172	136	112	96	83	74	66	60	55	51

Load capacity $F_{5,k}$ [N] - one angle bracket

beam height [mm]	beam width [mm]												
	0	20	40	60	80	100	120	140	160	180	200	220	240
0	201	201	201	201	201	201	201	201	201	201	201	201	201
20	291	291	291	291	291	291	291	291	291	291	291	291	291
40	529	529	529	529	529	529	529	529	529	529	529	529	529
60	2878	2878	2878	2878	2878	2878	2878	2878	2878	2878	2878	2878	2878
80	4015	6187	8553	8755	8755	8755	8755	8755	8755	8755	8755	8755	8755
100	3212	4950	6843	8755	8755	8755	8755	8755	8755	8755	8755	8755	8755
120	2677	4125	5702	7332	8755	8755	8755	8755	8755	8755	8755	8755	8755
140	2294	3536	4888	6284	7704	8755	8755	8755	8755	8755	8755	8755	8755
160	2007	3094	4277	5499	6741	7994	8755	8755	8755	8755	8755	8755	8755
180	1784	2750	3802	4888	5992	7106	8226	8755	8755	8755	8755	8755	8755
200	1606	2475	3421	4399	5393	6395	7403	8415	8755	8755	8755	8755	8755
220	1460	2250	3110	3999	4902	5814	6730	7650	8572	8755	8755	8755	8755
240	1338	2062	2851	3666	4494	5329	6169	7012	7858	8705	8755	8755	8755
260	1235	1904	2632	3384	4148	4919	5695	6473	7253	8035	8755	8755	8755
280	1147	1768	2444	3142	3852	4568	5288	6011	6735	7461	8188	8755	8755
300	1071	1650	2281	2933	3595	4263	4935	5610	6286	6964	7642	8322	8755
320	1004	1547	2138	2749	3370	3997	4627	5259	5893	6529	7165	7802	8439

Load capacity $F_{4+5,k}$ [N] - two angle bracket

beam height [mm]	beam width [mm]												
	0	20	40	60	80	100	120	140	160	180	200	220	240
0		24644	24644	24644	24644	24644	24644	24644	24644	24644	24644	24644	24644
20		6632	13264	19896	24459	24496	24521	24538	24551	24562	24570	24577	24582
40		3316	6632	9948	13264	16580	19896	23211	24459	24480	24496	24509	24521
60		2211	4421	6632	8842	11053	13264	15474	17685	19896	22106	24317	24459
80		1658	3316	4974	6632	8290	9948	11606	13264	14922	16580	18238	19896
100		1326	2653	3979	5305	6632	7958	9285	10611	11937	13264	14590	15916
120		1105	2211	3316	4421	5527	6632	7737	8842	9948	11053	12158	13264
140		947	1895	2842	3790	4737	5684	6632	7579	8527	9474	10421	11369
160		829	1658	2487	3316	4145	4974	5803	6632	7461	8290	9119	9948
180		737	1474	2211	2947	3684	4421	5158	5895	6632	7369	8106	8842
200		663	1326	1990	2653	3316	3979	4642	5305	5969	6632	7295	7958
220		603	1206	1809	2412	3014	3617	4220	4823	5426	6029	6632	7235
240		553	1105	1658	2211	2763	3316	3869	4421	4974	5527	6079	6632
260		510	1020	1530	2041	2551	3061	3571	4081	4591	5101	5612	6122
280		474	947	1421	1895	2369	2842	3316	3790	4263	4737	5211	5684
300		442	884	1326	1768	2211	2653	3095	3537	3979	4421	4863	5305
320		414	829	1243	1658	2072	2487	2901	3316	3730	4145	4559	4974