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Authorised and notified according to Article 29 of the Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011

MEMBER OF EOTA

European Technical Assessment ETA-08/0183 of 2022/04/12

I General Part

Technical Assessment Body issuing the ETA and designated according to Article 29 of the Regulation (EU) No 305/2011: ETA-Danmark A/S

Trade name of the construction product:	BB Angle Bracket 70 with and without rib BB Angle Bracket 90 with and without rib BB Angle Bracket 105 with and without rib BB Angle Bracket 145 with rib BB Angle Brackets KR100, KR135
Product family to which the above construction product belongs:	Three-dimensional nailing plate (angle bracket for timber to timber or timber to concrete / steel connections)
Manufacturer:	BB Stanz- und Umformtechnik GmbH Nordhäuser Str. 44 D-06536 Berga Tel. +49 34651 2988 0 Fax +49 34651 2988 20 Internet www.bb-berga.de
Manufacturing plant:	BB Stanz- und Umformtechnik GmbH Nordhäuser Str. 44 D-06536 Berga
This European Technical Assessment contains:	24 pages including 2 annexes which form an integral part of the document
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of:	EAD 130186-00-0603 for Three-dimensional nailing plates
This version replaces:	The ETA with the same number issued on 2021-05-28

II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product

Technical description of the product
BB angle brackets type 70, 90, 105 with and without rib, angle brackets type 145, and angle brackets type KR are one-piece non-welded, face-fixed angle brackets to be used in timber to timber or timber to concrete or to steel connections. They are connected to construction members made of timber or wood-based products with profiled (ringed shank) nails or screws according to EN 14592 or ETA and to concrete or steel members with bolts or metal anchors.

The angle brackets are made from pre-galvanized steel S250GD+Z (Z275) according to EN 10346 and are available with or without an embossed rib. Dimensions, hole positions and typical installations are shown in Annex A. BB angle brackets are made from steel with tolerances according to EN 10143.

2 Specification of the intended use in accordance with the applicable European Assessment Document (hereinafter EAD)

The angle brackets are intended for use in making connections in load bearing timber structures, where requirements for mechanical resistance and stability and safety in use in the sense of the Basic Works Requirements 1 and 4 of Regulation (EU) 305/2011 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 460 kg/m^3. This requirement to the material of the wood members can be fulfilled by using the following materials:

- Structural solid timber according to EN 14081,
- Glulam according to EN 14080,
- Glued solid timber according to EN 14080,
- LVL according to EN 14374,
- Cross laminated timber according to ETA.

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 is the 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 of Eurocode 5 and for connections subject to static or quasi-static loading. To avoid contact corrosion, stainless steel angle brackets shall be used with nails made from stainless steel.

The angle brackets can also be used in outdoor timber structures, service class 3, when a corrosion protection in accordance with Eurocode 5 is applied, or when stainless steel with similar or better characteristic yield and ultimate strength is employed.

The scope of the brackets regarding resistance to corrosion shall be defined according to national provisions that apply at the installation site considering environmental conditions.

The provisions made in this European Technical Assessment are based on an assumed intended working life of the hold downs of 50 years.

The indications given on the working life cannot be interpreted as a guarantee given by the producer or Assessment Body, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3 Performance of the product and references to the methods used for its assessment

Characteristic	Assessment of characteristic
3.1 Mechanical resistance and stability*) (BWR1)	
Joint Strength - Characteristic load-carrying capacity	See Annex B
Joint Stiffness	No performance assessed
Joint ductility	No performance assessed
Resistance to seismic actions	No performance assessed
Resistance to corrosion and deterioration	See section 3.6
3.2 Safety in case of fire (BWR2)	
Reaction to fire	The angle brackets are made from steel classified as Euroclass A1 in accordance with EN 13501-1 and Commission Delegated Regulation 2016/364
3.3 General aspects related to the performance of the product	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
Identification	See Annex A

*) See additional information in section 3.4 – 3.7.

3.4 Methods of verification

Safety principles and partial factors

The characteristic load-carrying capacities for angle brackets from steel with thickness from 2,0 to 4,0 mm are based on the characteristic values of the nail or screw connections 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 nail 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.

The characteristic load-carrying capacities for angle brackets from steel with thickness 1,5 mm and for angle brackets type KR are based on testing.

As steel and timber failure are both decisive, the design value for angle brackets from steel with thickness 1,5 mm and for angle brackets type KR shall be calculated according to EN 1995-1-1 by reducing the characteristic values of the load-carrying capacity with the partial factor for timber or wood-based materials.

The design value of the load-carrying capacity is:

$$F_{Rd} = \frac{k_{mod} \cdot F_{Rk}}{\gamma_M}$$

3.5 Mechanical resistance and stability

See annex B for the characteristic load-carrying capacity in the different directions F_1 to $F_{5.0,}$

The characteristic capacities of the angle brackets are determined by calculation assisted by testing as described in the EAD 130186-00-0603 for three-dimensional nailing plates. They should be used for designs in accordance with Eurocode 5 or a similar national Timber Code.

The angle brackets in part were calculated for the different load cases with different nail patterns. (see Annex A). If a connection is subjected to combined loading the nail patterns shall be the combination of all nail positions of the load cases involved.

In the formulas in Annex B the capacities for threaded nails calculated from the formulas of Eurocode 5 are used assuming a thick steel plate when calculating the lateral nail load-carrying-capacity.

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.

The angle brackets are fastened to timber members with nails 4,0x60 mm. Angle brackets 70 with thickness 2,5 mm with and without may be fastened with nails 4,0x40 mm. Angle brackets type KR may be fastened to timber members with nails 4,0x60 mm or screws 5,0x70 mm.

Additionally, the angle brackets can be fastened to the concrete structure or steel member by bolts or metal anchors in holes with a diameter up to 2 mm larger than the bolt diameter. If an additional washer ensures the transfer of the tensile load, angle brackets only loaded by a force F_1 may have smaller bolts or metal anchor diameters than d -2 mm.

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.

3.6 Aspects related to the performance of the product

3.6.1 Corrosion protection in service class 1 and 2.
In accordance with EAD 130186-00-0603 the angle brackets are made from pre-galvanized steel S 250 GD + Z 275 according to EN 10346.

3.7 General aspects related to the intended use of the product

The angle brackets are manufactured in accordance with the provisions of this European Technical Assessment using the manufacturing processes as identified in the inspection of the plant by the notified inspection body and laid down in the technical documentation

The following provisions concerning installation apply:

There shall be nails or bolts in all holes or at least in holes as specified in Annex A.

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.

Nails, screws or bolts 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 17 - 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 Attestation and verification of constancy of performance (AVCP)

4.1 AVCP system

According to the decision 97/638/EC of the European Commission1, as amended, the system(s) of assessment and verification of constancy of performance (see Annex V to Regulation (EU) No 305/2011) is 2+.

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

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at ETA-Danmark prior to CE marking.

Issued in Copenhagen on 2022-04-12 by

Thomas Bruun
Manager, ETA-Danmark

Annex A

Product details definitions

Table A.1 Materials specification

Article No.	Bracket type	Thickness [mm]	Steel specification	Coating specification
641 070 25	**70 without rib 2,5**	2,5	S 250 GD + Z 275	Z 275
641 090 25	**90 without rib 2,5**	2,5	S 250 GD + Z 275	Z 275
641 105 30	**105 without rib 3,0**	3,0	S 250 GD + Z 275	Z 275
641 970 25	**70 with rib 2,5**	2,5	S 250 GD + Z 275	Z 275
641 990 25	**90 with rib 2,5**	2,5	S 250 GD + Z 275	Z 275
641 905 30	**105 with rib 3,0**	3,0	S 250 GD + Z 275	Z 275
641 945 20	**145 with rib 2,0**	2,0	S 250 GD + Z 275	Z 275
641 945 25	**145 with rib 2,5**	2,5	S 250 GD + Z 275	Z 275
641 970 15	**70 with rib 1,5**	1,5	S 250 GD + Z 275	Z 275
641 990 15	**90 with rib 1,5**	1,5	S 250 GD + Z 275	Z 275
641 051 15	**105 with rib 1,5**	1,5	S 250 GD + Z 275	Z 275
641 119 20	**KR 100**	2,0	S 250 GD + Z 275	Z 275
	KR 135	4,0	DX51D or DD11	-

Table A.2 Range of sizes

Article No.	Bracket type	Height [mm]		Width [mm]	
		min	max	min	max
641 070 25	**70 without rib 2,5**	70	70	55	55
641 090 25	**90 without rib 2,5**	90	90	65	65
641 105 30	**105 without rib 3,0**	105	105	90	90
641 970 25	**70 with rib 2,5**	70	70	52	55
641 990 25	**90 with rib 2,5**	90	90	62	65
641 905 30	**105 with rib 3,0**	105	105	87	90
641 945 20	**145 with rib 2,0**	144	146	89	91
641 945 25	**145 with rib 2,5**	144	146	89	91
641 970 15	**70 with rib 1,5**	69	71	52	55
641 990 15	**90 with rib 1,5**	89	91	62	65
641 051 15	**105 with rib 1,5**	104	106	87	90

Article No.	Bracket type	Length vertical (mm)		Length horizontal (mm)		Width (mm)	
		max	min	max	max	min	max
641 119 20	**KR 100**	99,0	101,0	99,0	101,0	89,0	91,0
	KR 135	133,0	137,0	88,0	92,0	63,0	67,0

Table A.3 Fastener specification

Fastener	**Diameter [mm]**	**Length [mm]**	**Profiled Length [mm]**	**Withdrawal resistance**	**Nail type**
Nail	4.0	40	30	$f_{ax,k} \geq 6{,}13$ N/mm^2	Ringed shank nails according to EN 14592
Nail	4.0	60	51	$f_{ax,k} \geq 6{,}13$ N/mm^2	Ringed shank nails according to EN 14592
Screw	4.0	70	62	See ETA-11/0190	Screw according to ETA-11/0190
The shape of the fastener 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.					

Metal anchor diameter [mm]	**Corespondent hole diameter [mm]**	**Anchor type**
10.0	Max 2 mm larger than the anchor diameter	See specification of the manufacturer
12.0	Max 2 mm larger than the anchor diameter	See specification of the manufacturer

Table A.4 Fastener configuration

Article No.	**Bracket type**	**Fastener diameter x length [mm]**	**Metal anchor / Bolt diameter [mm]**
641 070 25	**70 without rib 2,5**	Nail 4,0 x 40 mm	10
641 090 25	**90 without rib 2,5**	Nail 4,0 x 60 mm	12
641 105 30	**105 without rib 3,0**	Nail 4,0 x 60 mm	12
641 970 25	**70 with rib 2,5**	Nail 4,0 x 40 mm	10
641 990 25	**90 with rib 2,5**	Nail 4,0 x 60 mm	12
641 905 30	**105 with rib 3,0**	Nail 4,0 x 60 mm	12
641 945 20	**145 with rib 2,0**	Nail 4,0 x 60 mm	12
641 945 25	**145 with rib 2,5**	Nail 4,0 x 60 mm	12
641 970 15	**70 with rib 1,5**	Nail 4,0 x 60 mm	10
641 990 15	**90 with rib 1,5**	Nail 4,0 x 60 mm	12
641 051 15	**105 with rib 1,5**	Nail 4,0 x 60 mm	12
641 119 20	**KR 100**	Nail 4,0 x 60 mm or Screw 5,0 x 70 mm	12
	KR 135	Nail 4,0 x 60 mm or Screw 5,0 x 70 mm	10, 12

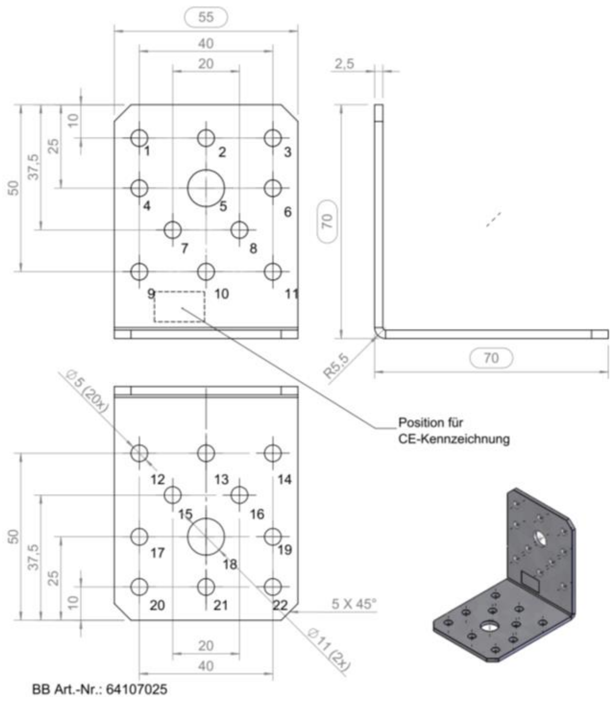


Figure A.1 Dimensions of Angle Bracket 70 without rib

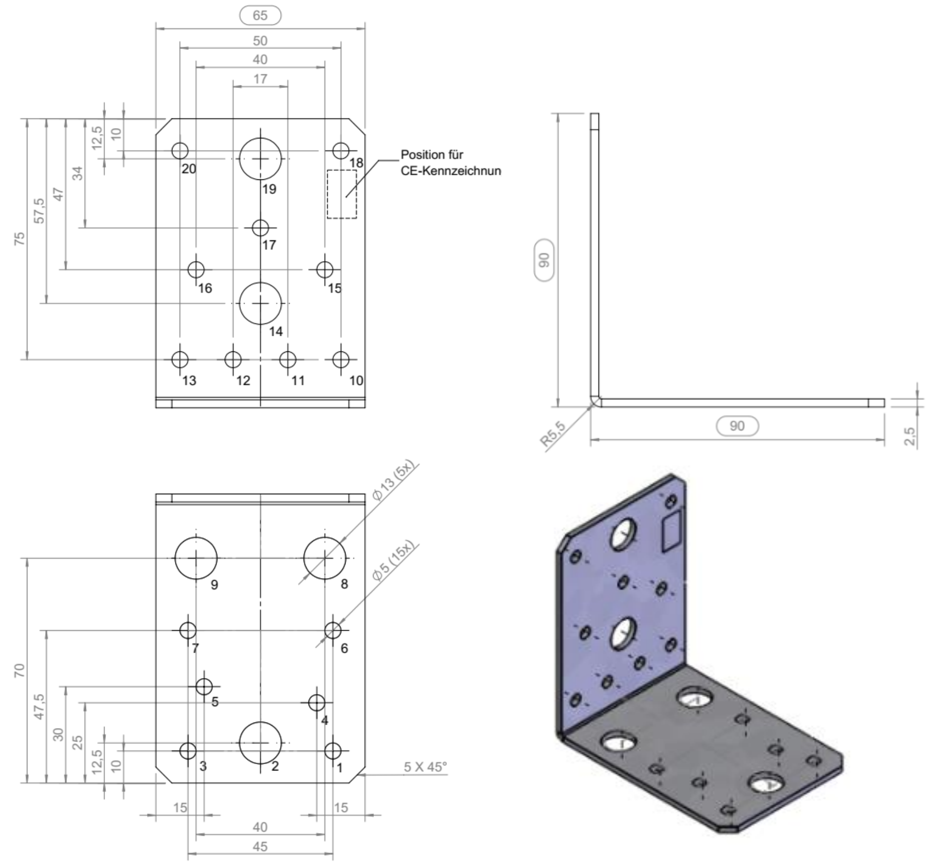


Figure A.2 Dimensions of Angle Bracket 90 without rib

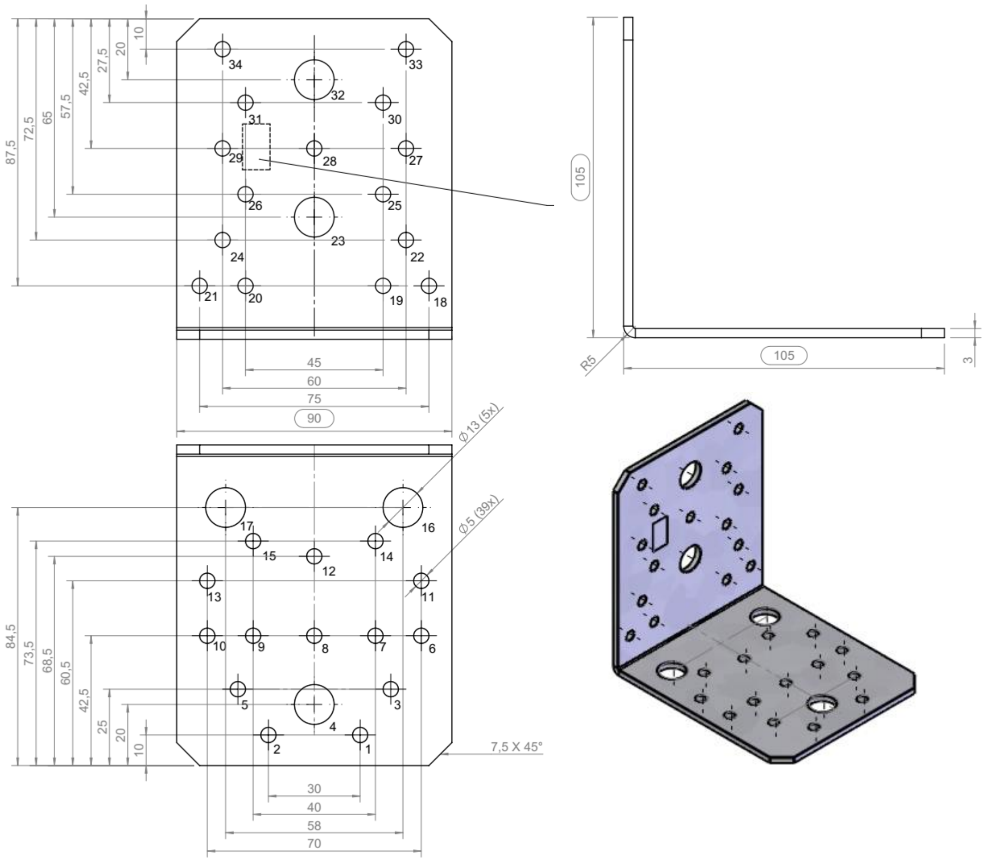


Figure A.3 Dimensions of Angle Bracket 105 without rib

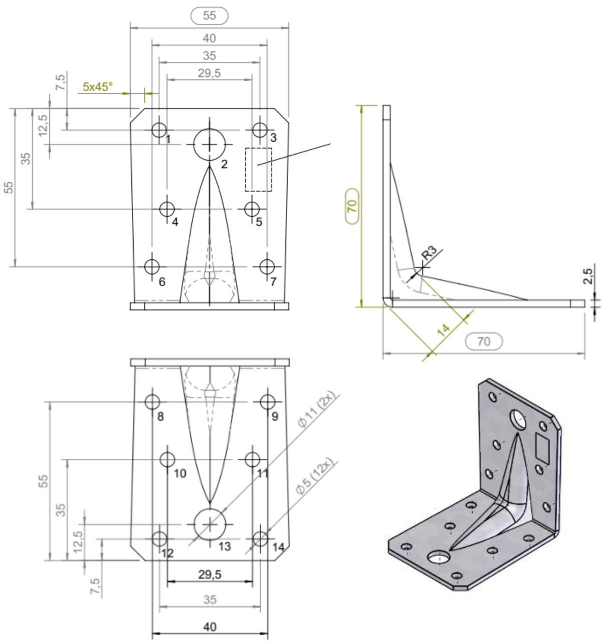


Figure A.4 Dimensions of Angle Bracket 70 with rib

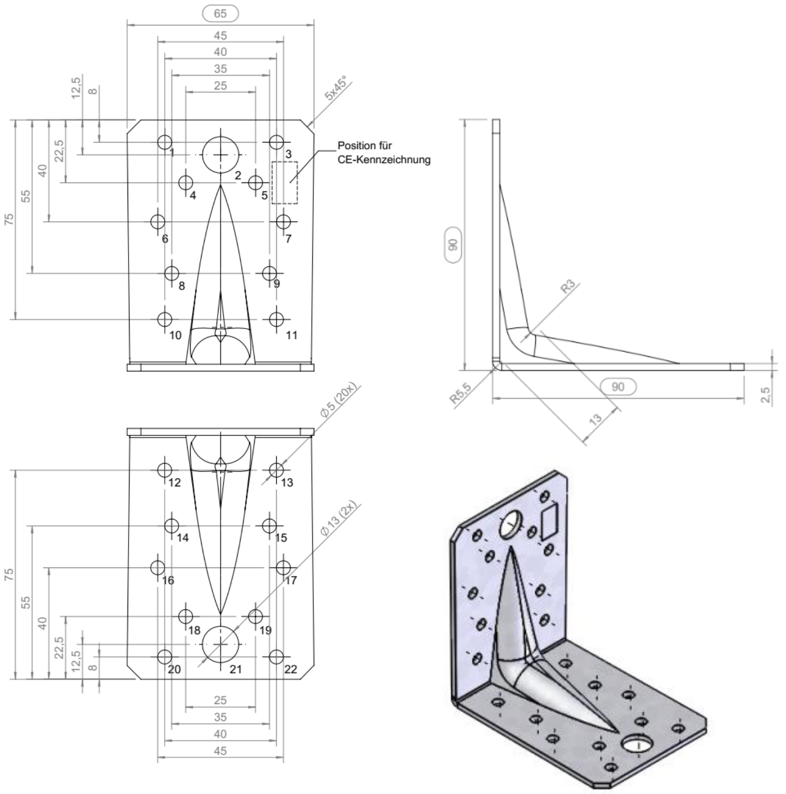


Figure A.5 Dimensions of Angle Bracket 90 with rib

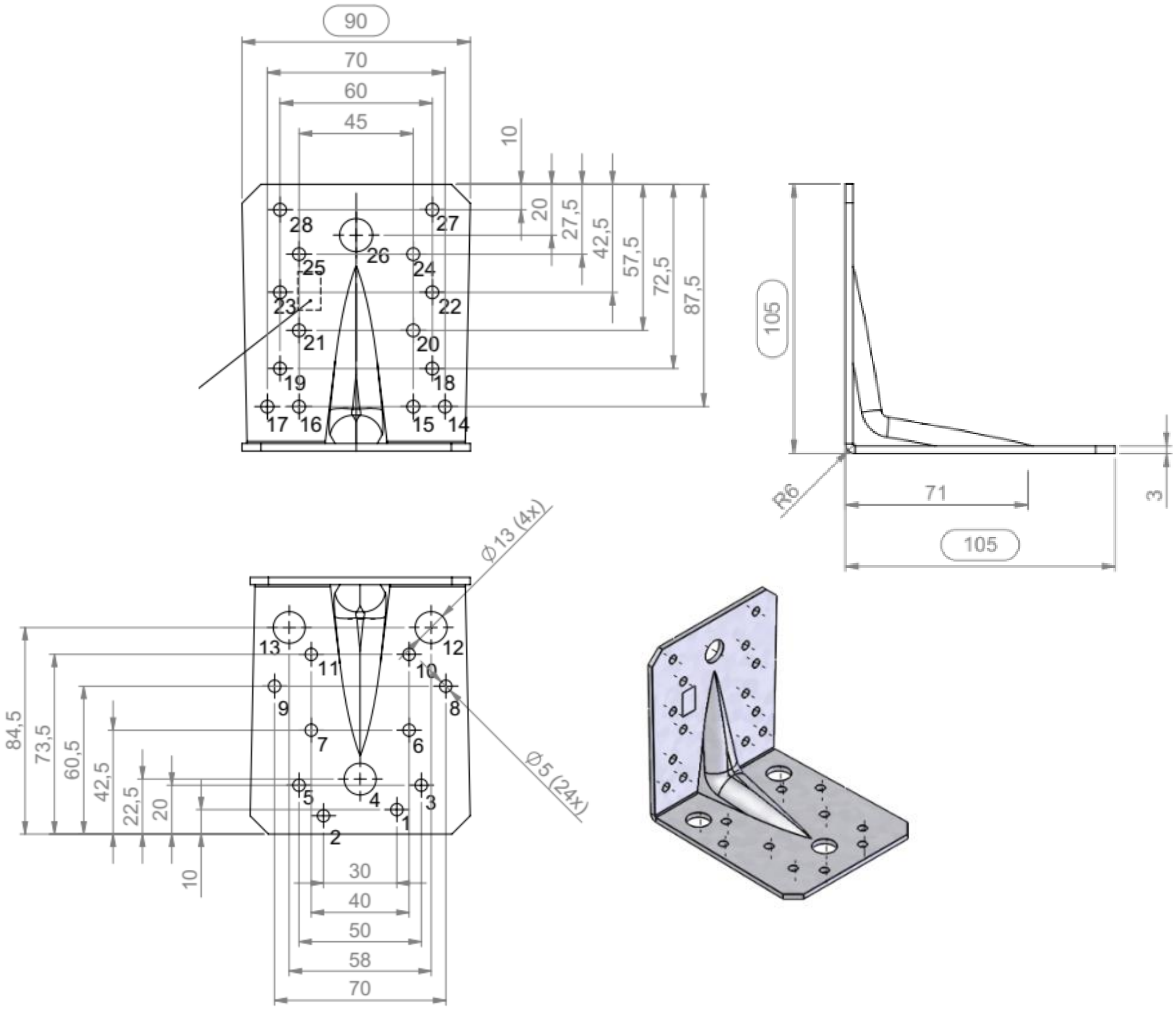


Figure A.6 Dimensions of Angle Bracket 105 with rib

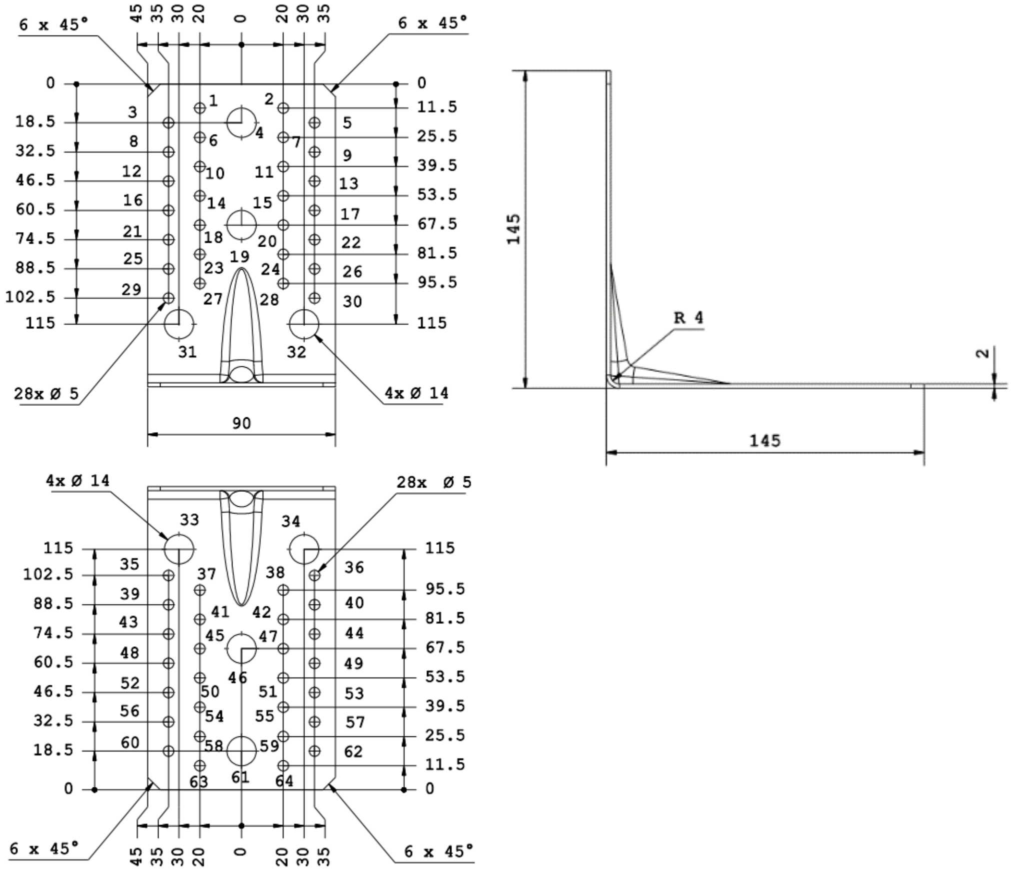


Figure A.7 Dimensions of Angle Bracket 145 with rib, thickness 2,0 mm

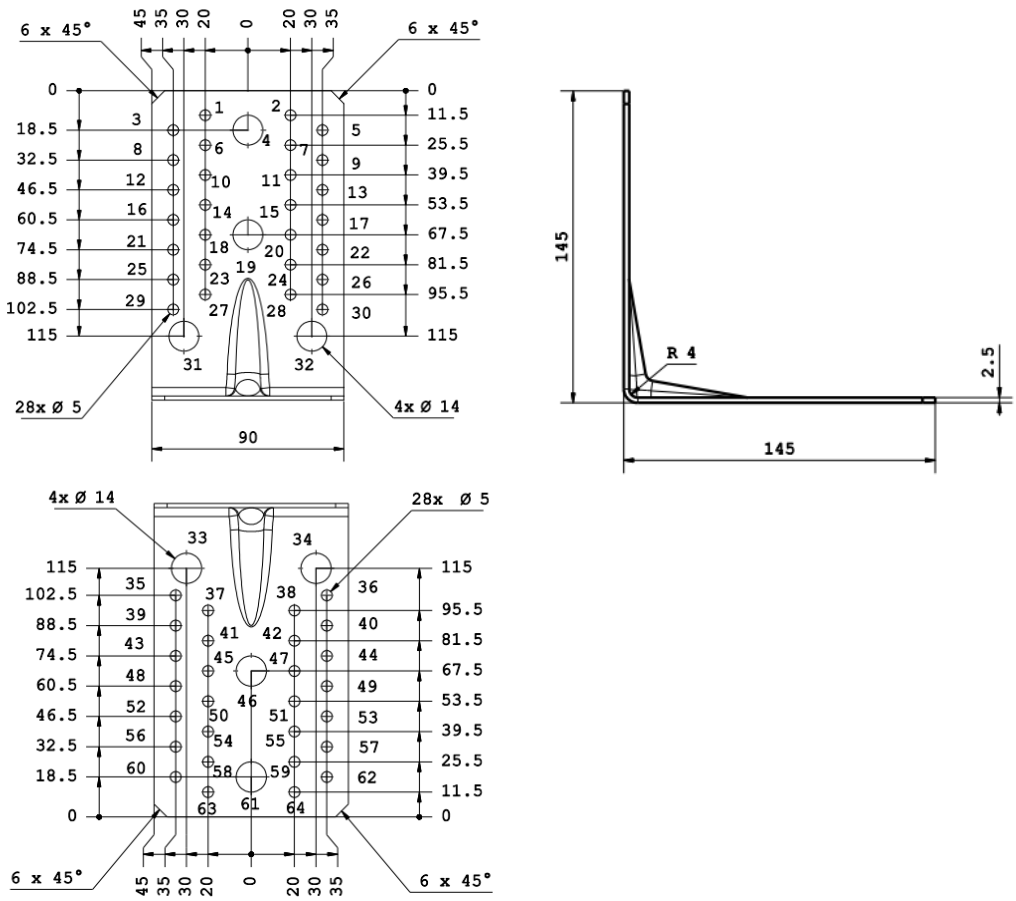


Figure A.8 Dimensions of Angle Bracket 145 with rib, thickness 2,5 mm

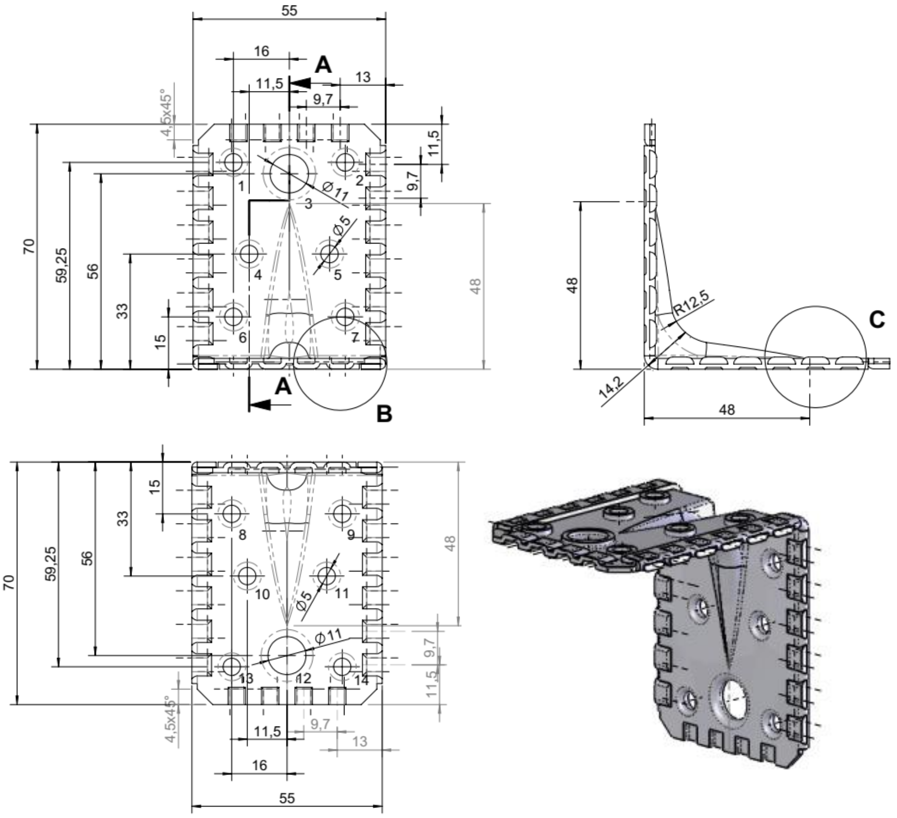


Figure A.9 Dimensions of Angle Bracket 70 with rib, thickness 1,5 mm

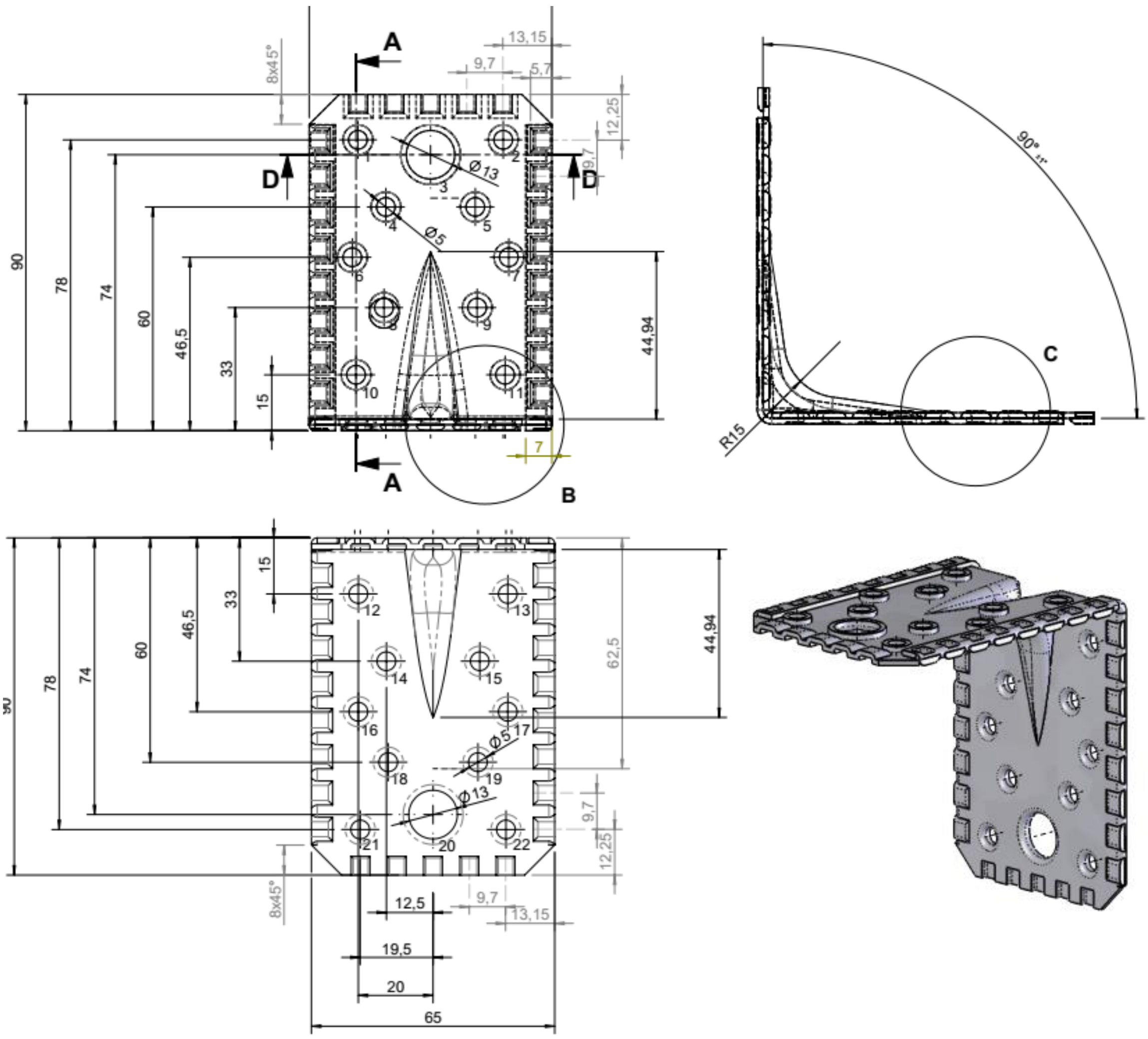


Figure A.10 Dimensions of Angle Bracket 90 with rib, thickness 1,5 mm

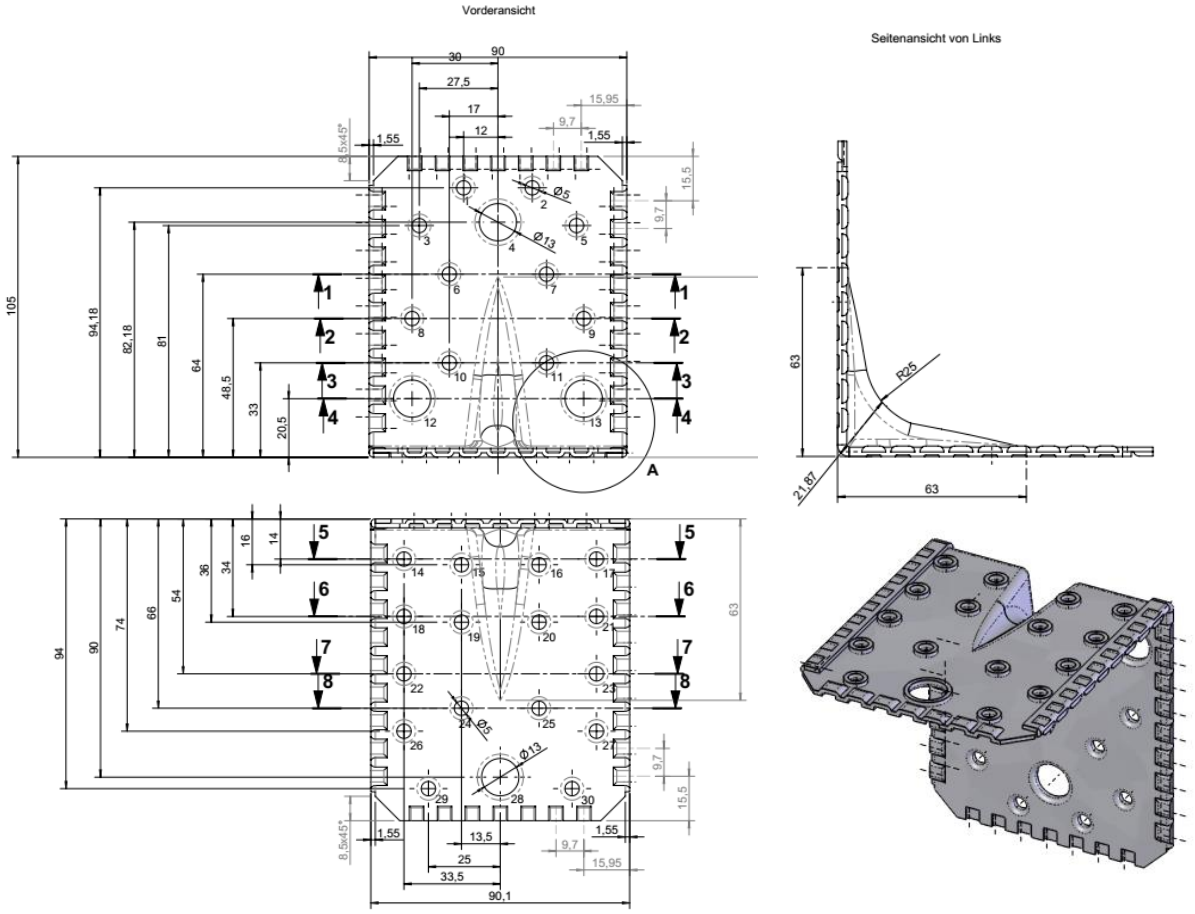


Figure A.11 Dimensions of Angle Bracket 105 with rib, thickness 1,5 mm

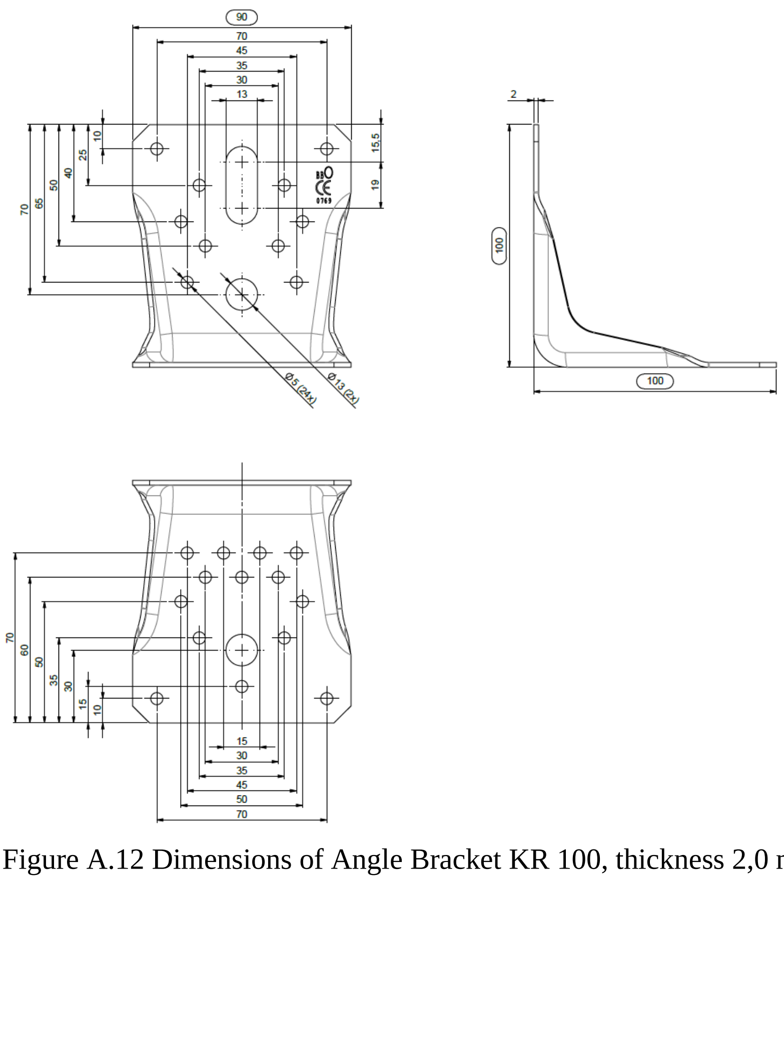


Figure A.12 Dimensions of Angle Bracket KR 100, thickness 2,0 mm

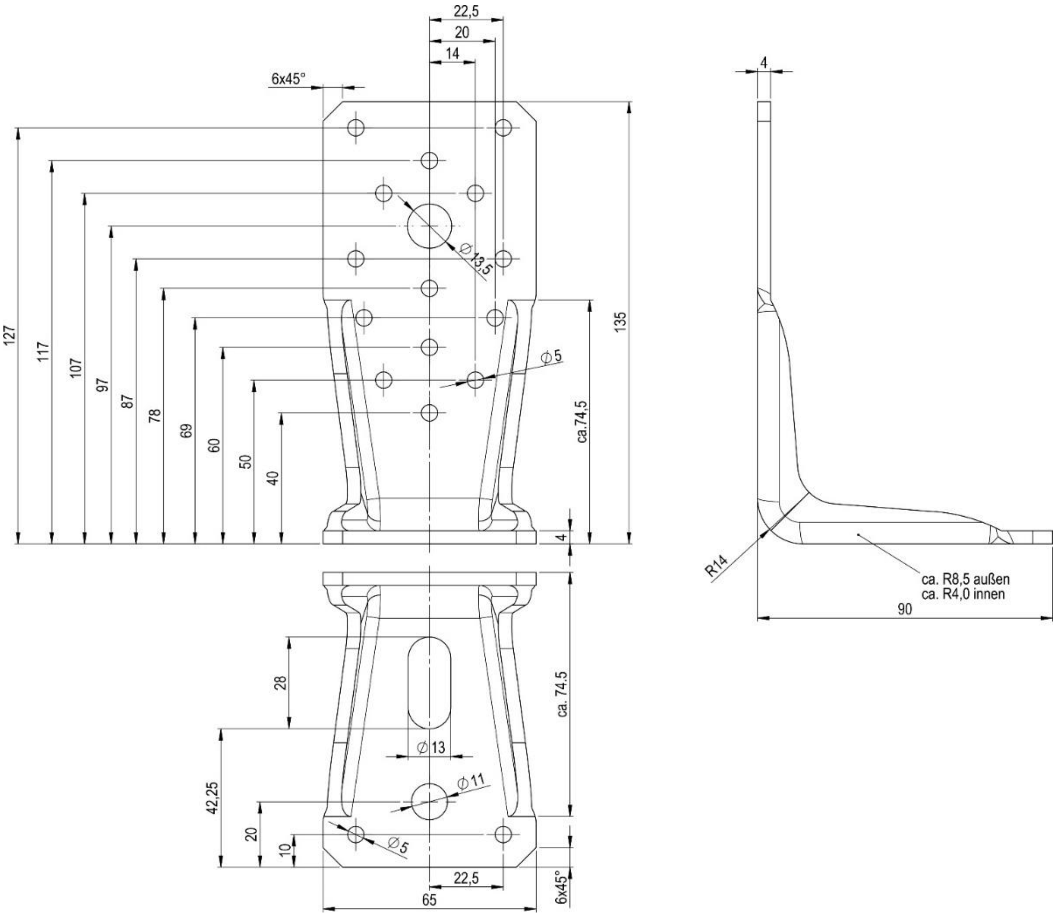


Figure A.13 Dimensions of Angle Bracket KR 135, thickness 4,0 mm

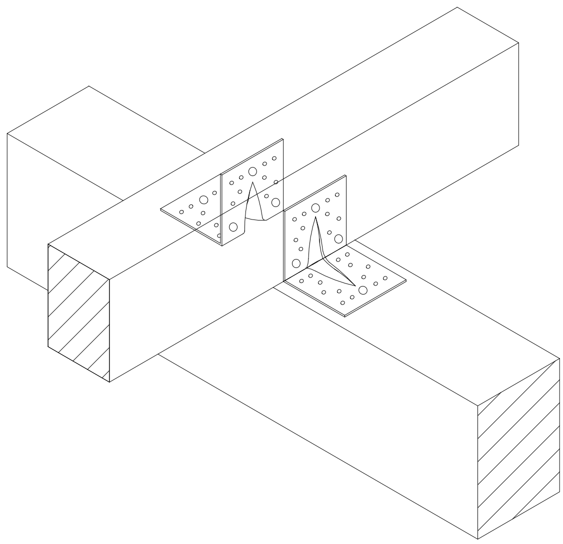
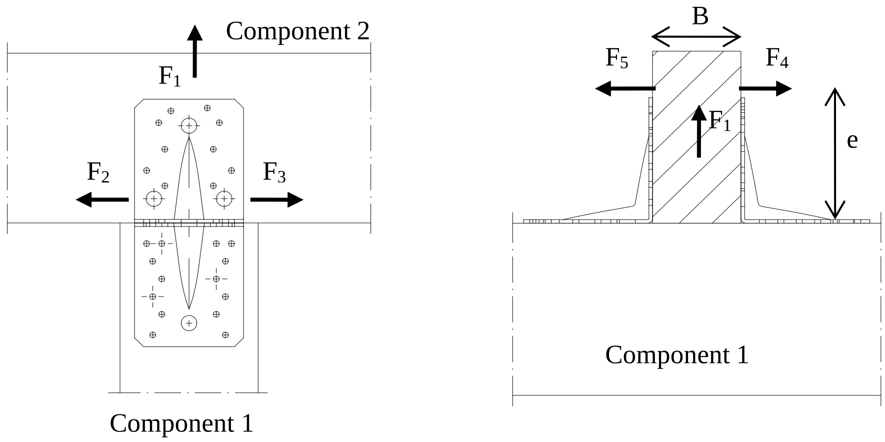


Figure A.14 Typical installation

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 Annex A.
The holes which have to be nailed are given in Annex A for the different forces. If a connection is subjected to combined loading the nail patterns shall be the combination of all nail positions of the forces involved:

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	Centrical lifting force acting in component 2.
F_2 and F_3	Centrical lateral force acting in component 2 in axial direction of component 2.
F_4 and F_5	Centrical lateral force acting in component 2 in axial direction of component 1. If the load is applied with an eccentricity e, a design for combined loading is required.

Single angle bracket per connection
Acting forces:

F_1	Lifting force acting in component 2. The component 2 shall be 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 component 2 in axial direction of component 2. The component 2 shall be 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 component 2 in axial direction of component 1. F_4 is the lateral force towards the angle bracket; F_5 is the lateral force away from the angle bracket. Only characteristic load-carrying capacities for angle brackets with ribs are given. If the component 2 shall be prevented from rotation is defined individually, the information is given in the tables Table B.7 to Table B.14.

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.

Connection to concrete or steel with a bolt or metal anchor
The loads $F_{B,Ed}$ for the design of the maximal loaded bolt or metal anchor in a bolt or metal anchor group are calculated as:

$$F_{B,t,Ed} = k_{t,\square} \cdot F_{Ed} \quad \text{for tensile load}$$

$$F_{B,v,Ed} = k_{t,\perp} \cdot F_{Ed} \quad \text{for shear load}$$

Where:

$F_{B,t,Ed}$	Bolt tensile load in N
$F_{B,v,Ed}$	Bolt shear load in N
$k_{t,\perp}$	Coefficient for shear load
$k_{t,\parallel}$	Coefficient for tensile load
F_{Ed}	Load on vertical flap of the angle bracket in N

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:

$$\left(\frac{F_{1,Ed} + \Delta F_{1,Ed}}{F_{1,Rd}}\right)^2 + \left(\frac{F_{2/3,Ed}}{F_{2/3,Rd}}\right)^2 + \left(\frac{F_{4/5,Ed}}{F_{4/5,Rd}}\right)^2 \leq 1$$

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.

If the load F_4/F_5 is applied with an eccentricity e, a design for combined loading **for connections with double angle brackets** is required. Here, an additional force ΔF_1 has to be added to the existing force F_1.

$$\Delta F_{1,Ed} = F_{4/5,Ed} \cdot \frac{e}{B}$$

B is the width of component 2.

Table B.0 Summary of investigated load cases and reference to the Table numbers

		Timber-Timber					**Timber-Concrete**				
Article No.	**Bracket type**	$\mathbf{F_1}$	$\mathbf{F_2 / F_3}$	$\mathbf{F_4 / F_5}$	$\mathbf{F_4}$	$\mathbf{F_5}$	$\mathbf{F_1}$	$\mathbf{F_2 / F_3}$	$\mathbf{F_4 / F_5}$	$\mathbf{F_4}$	$\mathbf{F_5}$
641 070 25	**70 without rib 2,5**	B.1	B.3	B.5	-	-	B.2	B.4	B.6	-	-
641 090 25	**90 without rib 2,5**	B.1	B.3	B.5	-	-	B.2	B.4	B.6	-	-
641 105 30	**105 without rib 3,0**	B.1	B.3	B.5	-	-	B.2	B.4	B.6	-	-
641 970 25	**70 with rib 2,5**	B.1	B.3	B.5	B.11	B.12	B.2	B.4	B.6	B.9	B.10
641 990 25	**90 with rib 2,5**	B.1	B.3	B.5	B.11	B.13	B.2	B.4	B.6	B.9	B.10
641 905 30	**105 with rib 3,0**	B.1	B.3	B.5	B.11	B.14	B.2	B.4	B.6	B.9	B.10
641 945 20	**145 with rib 2,0**	B.1	B.3	B.5	B.7	B.8	B.2	B.4	B.6	B.9	B.10
641 945 25	**145 with rib 2,5**	B.1	B.3	B.5	B.7	B.8	B.2	B.4	B.6	B.9	B.10
641 970 15	**70 with rib 1,5**	B.1	B.3	B.5	-	-	B.2	B.4	B.6	B.9	B.10
641 990 15	**90 with rib 1,5**	B.1	B.3	B.5	-	-	B.2	B.4	B.6	B.9	B.10
641 051 15	**105 with rib 1,5**	B.1	B.3	B.5	-	-	B.2	B.4	B.6	B.9	B.10
641 119 20	**KR 100**	B.1	B.3	B.5	B.7	B.8	B.2	B.4	B.6	B.9	B.10
	KR 135	-	-	-	-	-	B.2	B.4	B.6	B.9	B.10

Characteristic load-carrying capacities 2 angle brackets per connection

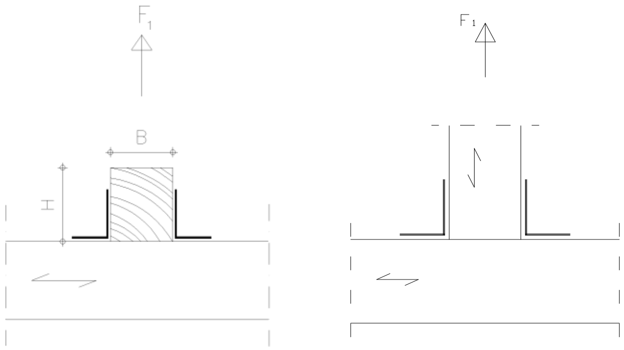


Table B.1: Characteristic load-carrying capacities Load F_1, 2 angle brackets per connection, timber-timber

Article No	Angle Bracket	Nail number n_V	Nail number n_h	Timber $F_{1,Rk,T}$	Steel $F_{1,Rk,S}$
641 070 25	**70 without rib 2,5**	1,2,3	12,13,14,20,21,22	3,05 kN	1,56 kN
641 090 25	**90 without rib 2,5**	1,3,5	10,11,12,13,15,16,17,18,20	8,07 kN	2,34 kN
641 105 30	**105 without rib 2,5**	1,2,6,7,8,9,10	18,19,20,21,25,26,30,31	8,09 kN	4,50 kN
641 970 25	**70 with rib 2,5**	1,3	8,9,10,11,12,14	3,16 kN	4,57 kN
641 990 25	**90 with rib 2,5**	1,3,6,7	12,13,14,15,18,19	6,46 kN	8,59 kN
641 905 30	**105 with rib 3,0**	1,2,6,7	14,15,16,17,20,21,24,25	11,8 kN	14,0 kN
641 945 20	**145 with rib 2,0**	3,5,6,7,12,13,14,15 ,21,22,23,24	35,36,39,40,43,44,48,49,52 ,53,56,57,60,62	6,10 kN	2,46 kN
641 945 25	**145 with rib 2,5**	3,5,6,7,12,13,14,15 ,21,22,23,24	35,36,39,40,43,44,48,49,52 ,53,56,57,60,62	6,75 kN	3,50 kN
641 970 15	**70 with rib 1,5**	Full nailing	Full nailing	10,8 kN	
641 990 15	**90 with rib 1,5**	Full nailing	Full nailing	9,8 kN	
641 051 15	**105 with rib 1,5**	Full nailing	Full nailing	18,4 kN	
641 119 20	**KR 100**	Nails in all holes	Nails in all holes	25,2 kN	
641 119 20	**KR 100**	Screws in all holes	Screws in all holes	34,4 kN	

Table B.2: Characteristic load-carrying capacities Load F_1, 2 angle brackets per connection, timber-concrete

Article No	Angle Bracket	Nail number n_V	Bolt number n_h	Timber $F_{1,Rk,T}$	Steel $F_{1,Rk,S}$	Bolt factor $k_{t,\parallel}$
641 070 25	**70 without rib 2,5**	1,2,3	18	9,65 kN	0,93 kN	1,4
641 090 25	**90 without rib 2,5**	1,3	14	7,74 kN	1,73 kN	0,8
641 105 30	**105 without rib 2,5**	27,28,29,33,34	16,17	19,3 kN	6,26 kN	0,3
641 970 25	**70 with rib 2,5**	1,3	13	3,33 kN	1,80 kN	2,1
641 990 25	**90 with rib 2,5**	1,3,6,7	21	7,48 kN	1,63 kN	2,4
641 905 30	**105 with rib 3,0**	24,25,27,28	12,13	15,5 kN	19,6 kN	0,3
641 945 20	**145 with rib 2,0**	1,2,3,5,6,7,12,13,14, 15,21,22,23,24	33,34	54,2 kN	2,90 kN	0,3
641 945 25	**145 with rib 2,5**	3,5,6,7,12,13,14,15, 21,22,23,24	33,34	46,4 kN	4,16 kN	0,3
641 970 15	**70 with rib 1,5**	1,2	12	6,05 kN	1,02 kN	1,7
641 990 15	**90 with rib 1,5**	1,2	20	4,60 kN	0,37 kN	3,5
641 051 15	**105 with rib 1,5**	24,25,26,27,29,30	12,13	23,2 kN	9,39 kN	0,3
641 119 20	**KR 100**	Nails in all holes	Centric position in long hole	18,0 KN		1,7
641 119 20	**KR 100**	Screws in all holes		19,2 kN		1,9
	KR 135	Screws in all holes		28,2 kN		1,1

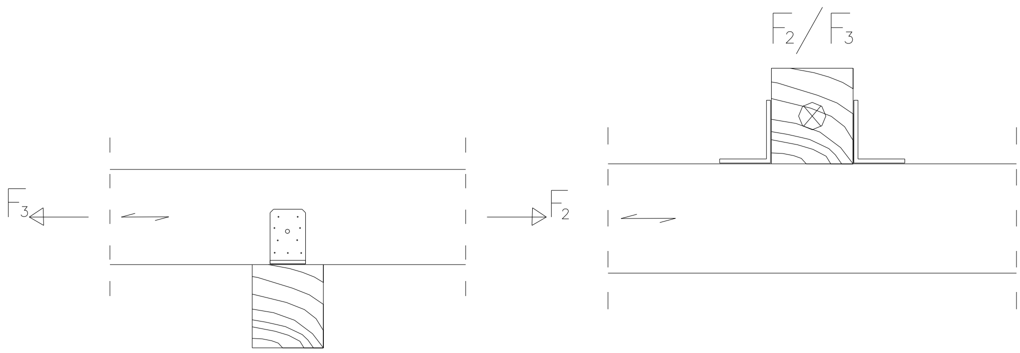


Table B.3: Characteristic load-carrying capacities Load $F_{2/3}$, 2 angle brackets per connection, timber-timber

Article No	Angle Bracket	Nail number n_V	Nail number n_h	Timber $F_{2/3,Rk,T}$
641 070 25	**70 without rib 2,5**	1,3,4,6,9,11	12,13,14,20,21,22	7,57 kN
641 090 25	**90 without rib 2,5**	1,3,4,5,6,7	10,11,12,13,15,16,17,18,20	9,55 kN
641 105 30	**105 without rib 2,5**	1,2,6,8,10,11,13, 14,15	18,19,20,21,27,28,29,33,34	12,8 kN
641 970 25	**70 with rib 2,5**	1,3,4,5	8,9,10,11,12,14	5,49 kN
641 990 25	**90 with rib 2,5**	1,3,6,7,8,9	12,13,16,17,20,22	8,39 kN
641 905 30	**105 with rib 3,0**	1,2,6,7,10,11	14,15,16,17,22,23,27,28	9,60 kN
641 945 20	**145 with rib 2,0**	3,5,8,9,12,13,16,17,21, 22,25,26,29,30	35,36,39,40,43,44,48, 49,52,53,56,57,60,62	17,3 kN
641 945 25	**145 with rib 2,5**	3,5,8,9,12,13,16,17,21, 22,25,26,29,30	35,36,39,40,43,44,48, 49,52,53,56,57,60,62	17,3 kN
641 970 15	**70 with rib 1,5**	Full nailing	Full nailing	12,7 kN
641 990 15	**90 with rib 1,5**	Full nailing	Full nailing	12,2 kN
641 051 15	**105 with rib 1,5**	Full nailing	Full nailing	17,0 kN
641 119 20	**KR 100**	Nails in all holes	Nails in all holes	20,8 kN
641 119 20	**KR 100**	Screws in all holes	Screws in all holes	26,2 kN

Table B.4: Characteristic load-carrying capacities Load $F_{2/3}$, 2 angle brackets per connection, timber-concrete

Article No	Angle Bracket	Nail number n_V	Bolt number n_h	Timber $F_{2/3,Rk,T}$	Bolt factor $k_{t,\perp}$
641 070 25	**70 without rib 2,5**	1,3,4,6,9,11	18	3,54 kN	0,5
641 090 25	**90 without rib 2,5**	1,3,4,5,6,7	14	5,40 kN	0,5
641 105 30	**105 without rib 2,5**	22,24,25,26,27,28,29,30,31,33, 34	16,17	11,5 kN	0,3
641 970 25	**70 with rib 2,5**	1,3,4,5	13	1,47 kN	0,5
641 990 25	**90 with rib 2,5**	1,3,6,7,8,9	21	3,07 kN	0,5
641 905 30	**105 with rib 3,0**	18,19,20,21,22,23,24,25,27,28	12,13	12,6 kN	0,3
641 945 20	**145 with rib 2,0**	3,5,8,9,12,13,16,17,21,22,25, 26,29,30	33,34	17,3 kN	0,4
641 945 25	**145 with rib 2,5**	3,5,8,9,12,13,16,17,21,22,25, 26,29,30	33,34	17,3 kN	0,4
641 970 15	**70 with rib 1,5**	1,2,4	12	1,30 kN	0,5
641 990 15	**90 with rib 1,5**	1,2,6,7	20	2,30 kN	0,5
641 051 15	**105 with rib 1,5**	18,19,20,21,22,23,24,25,27,28	12,13	12,6 kN	0,3
641 119 20	**KR 100**	Nails in all holes	Centric position in long hole	18,4 kN	-
641 119 20	**KR 100**	Screws in all holes		21,2 kN	-
	KR 135	Screws in all holes		15,8 kN	-

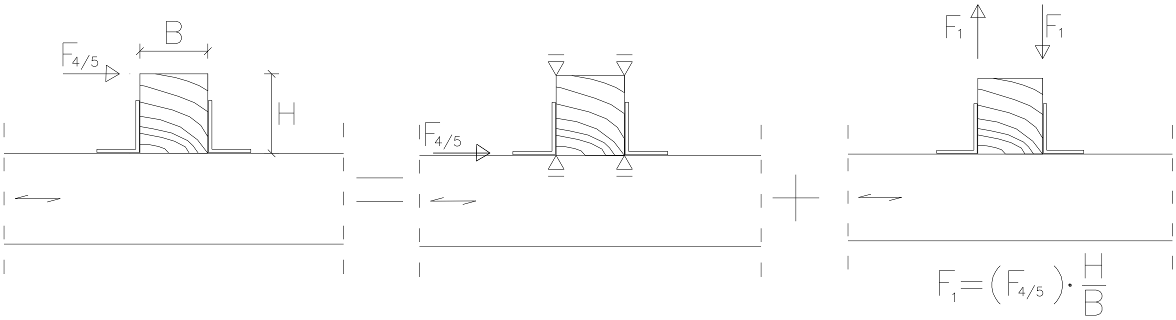


Table B.5: Characteristic load-carrying capacities Load $F_{4/5}$, 2 angle brackets per connection, timber-timber

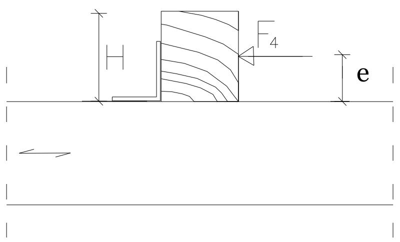
Article No	Angle Bracket	Nail number n_V	Nail number n_h	Timber $F_{4/5,Rk,T}$	Steel $F_{4/5,Rk,S}$
641 070 25	**70 without rib 2,5**	1,2,3,4,6,7,8,	12,13,14,20,21,22	6,10 kN	3,63 kN
641 090 25	**90 without rib 2,5**	1,3,4,5,6,7	10,11,12,13,15,16,17,18,20	9,67 kN	3,99 kN
641 105 30	**105 without rib 2,5**	1,2,3,5,6,8,10,12,14, 15	18,19,20,21,27,28,29,33,34	10,6 kN	7,98 kN
641 970 25	**70 with rib 2,5**	1,3,4,5	8,9,10,11,12,14	5,65 kN	4,12 kN
641 990 25	**90 with rib 2,5**	1,3,4,5,6,78,9	12,13,14,15,18,19	8,91 kN	6,55 kN
641 905 30	**105 with rib 3,0**	1,2,3,5,6,7,8,9,10,11	14,15,16,17,20,21,24,25	11,9 kN	11,8 kN
641 945 20	**145 with rib 2,0**	3,5,8,9,12,13,16,17, 21,22,25,26,29,30	35,36,39,40,43,44,48, 49,52,53,56,57,60,62	12,2 kN	5,45 kN
641 945 25	**145 with rib 2,5**	3,5,8,9,12,13,16,17, 21,22,25,26,29,30	35,36,39,40,43,44,48, 49,52,53,56,57,60,62	13,9 kN	6,84 kN
641 970 15	**70 with rib 1,5**	Full nailing	Full nailing	11,0 kN	
641 990 15	**90 with rib 1,5**	Full nailing	Full nailing	13,5 kN	
641 051 15	**105 with rib 1,5**	Full nailing	Full nailing	16,4 kN	
641 119 20	**KR 100**	Nails in all holes	Nails in all holes	23,4 kN	
641 119 20	**KR 100**	Screws in all holes	Screws in all holes	29,4 kN	

Table B.6: Characteristic load-carrying capacities Load $F_{4/5}$, 2 angle brackets per connection, timber-concrete

Article No	Angle Bracket	Nail number n_V	Bolt number n_h	Timber $F_{4/5,Rk,T}$	Steel $F_{4/5,Rk,S}$	Bolt factor $k_{t,\perp}$	Bolt factor $k_{t,\parallel}$
641 070 25	**70 without rib 2,5**	1,3,4,6,9,11	18	5,90 kN	3,06 kN	0,7	0,2
641 090 25	**90 without rib 2,5**	1,3,4,5,6,7	14	8,14 kN	3,54 kN	0,8	0,2
641 105 30	**105 without rib 2,5**	22,24,25,26,27,28, 29, 30,31,33,34	16,17	12,0 kN	6,65 kN	0,4	0,2
641 970 25	**70 with rib 2,5**	1,3,4,5	13	5,71 kN	3,59 kN	0,7	0,2
641 990 25	**90 with rib 2,5**	1,3,6,7,8,9	21	10,2 kN	4,46 kN	0,7	0,2
641 905 30	**105 with rib 3,0**	18,19,20,21,22,23, 24, 25,27,28	12,13	14,2 kN	9,15 kN	0,4	0,3
641 945 20	**145 with rib 2,0**	3,5,8,9,12,13,16,17,21, 22,25,26,29,30	33,34	14,5 kN	5,42 kN	0,4	0,2
641 945 25	**145 with rib 2,5**	3,5,8,9,12,13,16,17,21, 22,25,26,29,30	33,34	16,3 kN	6,50 kN	0,4	0,2
641 970 15	**70 with rib 1,5**	1,2,4	12	7,54 kN	3,25 kN	0,7	0,2
641 990 15	**90 with rib 1,5**	1,2,6,7	20	6,98 kN	4,40 kN	0,8	0,1
641 051 15	**105 with rib 1,5**	18,19,20,21,22,23,24, 25,27,28	12,13	16,7 kN	6,03 kN	0,3	0,3
641 119 20	**KR 100**	Nails in all holes	Centric position in long hole	25,4 kN		-	-
641 119 20	**KR 100**	Screws in all holes		25,2 kN		-	-
	KR 135	Screws in all holes		30,3 kN		-	-

Characteristic load-carrying capacities with one angle bracket per connection

For forces F_1 and F_2 / F_3 the load-carrying capacity with a single angle bracket - provided that the components are prevented from rotation - equals half of the load carrying capacity of a connection with double angle brackets.



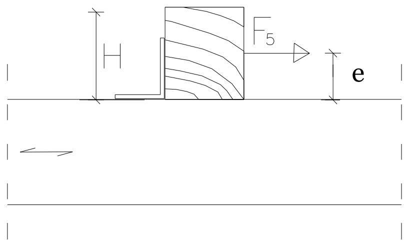


Table B.7: Characteristic load-carrying capacities Load F_4, timber-timber

Article No	Angle Bracket	Nail number n_V	Nail number n_h	Timber $F_{4,Rk,T}$	Steel $F_{4,Rk,S}$
641 945 20	**145 with rib 2,0**	3,5,8,9,12,13,16,17, 21,22,25,26,29,30	35,36,39,40,43,44,48, 49,52,53,56,57,60,62	9,89 kN	4,40 kN
641 945 25	**145 with rib 2,5**	3,5,8,9,12,13,16,17, 21,22,25,26,29,30	35,36,39,40,43,44,48, 49,52,53,56,57,60,62	10,8 kN	5,33 kN
641 119 20	**KR 100**	Nails in all holes	Nails in all holes	15,1 kN	
641 119 20	**KR 100**	Screws in all holes	Screws in all holes	17,0 kN	
The components shall be prevented from rotation by additional measures. The eccentricity e equals zero.					

Table B.8: Characteristic load-carrying capacities Load F_5, timber-timber

Article No	Angle Bracket	Nail number n_V	Nail number n_h	Timber $F_{5,Rk,T}$	Steel $F_{5,Rk,S}$
641 945 20	**145 with rib 2,0**	3,5,8,9,12,13,16,17, 21,22,25,26,29,30	35,36,39,40,43,44,48, 49,52,53,56,57,60,62	3,46 kN	1,33 kN
641 945 25	**145 with rib 2,5**	3,5,8,9,12,13,16,17, 21,22,25,26,29,30	35,36,39,40,43,44,48, 49,52,53,56,57,60,62	3,80 kN	1,84 kN
641 119 20	**KR 100**	Nails in all holes	Nails in all holes	8,3 kN	
641 119 20	**KR 100**	Screws in all holes	Screws in all holes	12,4 kN	
The components shall be prevented from rotation by additional measures. The eccentricity e equals zero.					

Table B.9: Characteristic load-carrying capacities Load F_4, timber-concrete

Article No	Angle Bracket	Nail number n_V	Bolt number n_h	Timber $F_{4,Rk,T}$	Steel $F_{4,Rk,S}$	Bolt factor $k_{t,\perp}$	Bolt factor $k_{t,\parallel}$
641 970 25	**70 with rib 2,5**	1,3,4,5	13	7,62 kN	2,54 kN	1,0	-
641 990 25	**90 with rib 2,5**	1,3,6,7,8,9	21	10,4 kN	3,22 kN	1,0	-
641 905 30	**105 with rib 3,0**	18,19,20,21,22,23, 24, 25,27,28	12,13	13,9 kN	6,48 kN	0,5	0,1
641 945 20	**145 with rib 2,0**	3,5,8,9,12,13,16,17, 21, 22,25,26,29,30	33,34	11,1 kN	4,16 kN	0,5	-
641 945 25	**145 with rib 2,5**	3,5,8,9,12,13,16,17, 21, 22,25,26,29,30	33,34	16,4 kN	6,50 kN	0,4	0,2
641 970 15	**70 with rib 1,5**	1,2,4	12	7,28 kN	2,77 kN	1,0	-
641 990 15	**90 with rib 1,5**	1,2,6,7	20	5,56 kN	5,85 kN	1,0	-
641 051 15	**105 with rib 1,5**	18,19,20,21,22,23, 24,25,27,28	12,13	11,9 kN	4,13 kN	0,5	0,3
641 119 20	**KR 100**	Nails in all holes	Centric position in long hole	15,7 kN		-	-
641 119 20	**KR 100**	Screws in all holes		14,0 kN		-	-
	KR 135	Screws in all holes		15,2 kN		-	-
The components shall be prevented from rotation by additional measures. The eccentricity e equals zero.							

Table B.10: Characteristic load-carrying capacities Load F_5, timber-concrete

Article No	Angle Bracket	Nail number n_V	Bolt number n_h	Timber $F_{5,Rk,T}$	Steel $F_{5,Rk,S}$	Bolt factor $k_{t,\perp}$	Bolt factor $k_{t,\parallel}$
641 970 25	**70 with rib 2,5**	1,3,4,5	13	1,76 kN	1,10 kN	1,0	0,7
641 990 25	**90 with rib 2,5**	1,3,6,7,8,9	21	3,35 kN	1,47 kN	1,0	0,7
641 905 30	**105 with rib 3,0**	18,19,20,21,22,23, 24, 25,27,28	12,13	4,15 kN	5,43 kN	0,5	0,9
641 945 20	**145 with rib 2,0**	3,5,8,9,12,13,16,17, 21, 22,25,26,29,30	33,34	4,14 kN	1,39 kN	0,5	0,8
641 945 25	**145 with rib 2,5**	3,5,8,9,12,13,16,17, 21, 22,25,26,29,30	33,34	4,10 kN	2,11 kN	0,5	0,7
641 970 15	**70 with rib 1,5**	1,2,4	12	2,48 kN	1,07 kN	1,0	0,7
641 990 15	**90 with rib 1,5**	1,2,6,7	20	2,08 kN	0,89 kN	1,0	0,6
641 051 15	**105 with rib 1,5**	18,19,20,21,22,23, 24,25,27,28	12,13	5,28 kN	2,42 kN	0,5	0,9
641 119 20	**KR 100**	Nails in all holes	Centric position in long hole	9,7 kN		-	-
641 119 20	**KR 100**	Screws in all holes		11,2 kN		-	-
	KR 135	Screws in all holes		15,1 kN		-	-
The components shall be prevented from rotation by additional measures. The eccentricity e equals zero.							

Table B.11: Characteristic load-carrying capacities ($F_{4,Rk,T}$ / $F_{4,Rk,S}$) Load F_4 in kN, timber-timber

	H in m					
Angle Bracket	**0,08**	**0,10**	**0,12**	**0,14**	**0,16**	**0,20**
70 with rib 2,5	0,82 / 0,38	0,66 / 0,28	-	0,47 / 0,21	-	-
90 with rib 2,5	-	-	1,11 / 0,46	0,95 / 0,40	0,84 / 0,35	-
105 with rib 3,0	-	-	2,42 / 1,02	-	1,82 / 0,69	1,37 / 0,52
The force F_4 is applied on the upper beam edge: The eccentricity e equals the height of the beam H.						

Table B.12: Characteristic load-carrying capacities ($F_{5,Rk,T}$ / $F_{5,Rk,S}$) Load F_5 in kN, timber-timber

70 with rib 2,5	**H in m**		
B in m	**0,08**	**0,10**	**0,14**
0,06	1,58 / 0,93	1,73 / 1,12	2,45 / 1,06
0,10	1,44 / 1,30	1,58 / 1,19	1,56 / 1,26
0,14	1,45 / 1,29	1,47 / 1,28	1,48 / 1,26
The force F_5 is applied on the upper beam edge: The eccentricity e equals the height of the beam H.			

Table B.13: Characteristic load-carrying capacities ($F_{5,Rk,T}$ / $F_{5,Rk,S}$) Load F_5 in kN, timber-timber

90 with rib 2,5	**H in m**		
B in m	**0,12**	**0,14**	**0,16**
0,08	3,85 / 1,83	4,24 / 1,72	4,89 / 1,62
0,10	3,49 / 1,98	3,65 / 1,90	3,88 / 1,82
0,14	3,23 / 2,12	3,30 / 2,08	3,37 / 2,03
The force F_5 is applied on the upper beam edge: The eccentricity e equals the height of the beam H.			

Table B.14: Characteristic load-carrying capacities ($F_{5,Rk,T}$ / $F_{5,Rk,S}$) Load F_5 in kN, timber-timber

105 with rib 3,0	**H in m**		
B in m	**0,12**	**0,16**	**0,20**
0,08	5,94 / 3,14	5,45 / 2,67	4,68 / 2,30
0,10	5,24 / 3,55	6,09 / 3,13	5,27 / 2,80
0,14	4,68 / 3,99	5,00 / 3,72	5,35 / 3,47
The force F_5 is applied on the upper beam edge: The eccentricity e equals the height of the beam H.			