Deutsches Institut für Bautechnik DIBt

Member of EOTA www.eota.eu

Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

Designated according to Article 29 of Regulation (EU) No 305/2011 and member of EOTA (European Organisation for Technical Assessment)

European Technical Assessment ETA-18/0375 of 11 August 2023

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the European Technical Assessment:	Deutsches Institut für Bautechnik
Trade name of the construction product	Ailong Metal Angle Brackets
Product family to which the construction product belongs	Three-dimensional nailing plates
Manufacturer	Hangzhou Ailong Metal Products Co., LTD Linpu Industrial Park, Tonger Village, Linpu Town XIAOSHAN DISTRICT, HANGZHOU VOLKSREPUBLIK CHINA
Manufacturing plant	Hangzhou Ailong Metal Products Co., LTD. Linpu Indistrial Park, Tonger Village, Linpu Town XIAOSHAN District, HANGZHOU ZHEJIANG VOLKSREPUBLIK CHINA
This European Technical Assessment contains	44 pages including 4 annexes which form an integral part of this assessment
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of	130186-00-0603 – THREE-DIMENSIONAL NAILING PLATES
This version replaces	ETA-18/0375 issued on 24 April 2019

The European Technical Assessment is issued by the Technical Assessment Body in its official language. Translations of this European Technical Assessment in other languages shall fully correspond to the original issued document and shall be identified as such.

Communication of this European Technical Assessment, including transmission by electronic means, shall be in full. However, partial reproduction may only be made with the written consent of the issuing Technical Assessment Body. Any partial reproduction shall be identified as such.

This European Technical Assessment may be withdrawn by the issuing Technical Assessment Body, in particular pursuant to information by the Commission in accordance with Article 25(3) of Regulation (EU) No 305/2011.

Specific part

1 Technical description of the product

Hangzhou Ailong three-dimensional nailing plates are non-welded, face-fixed angle brackets, cantilever brackets, joist hangers and turnbuckles to be used in timber-to-timber, timber-to-concrete or -steel or steel-to-steel connections. They are connected to construction members made of timber or wood-based products with profiled (ringed shank) nails in accordance with EN 14592[1] and to concrete or steel members with metal anchors or bolts. They are made from carbon steel in accordance with Annex 1. Form, dimensions, hole positions, corrosion protection and typical installations are given in Annex 1 and 2.

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

The performances given in Section 3 are only valid if the Hangzhou Ailong three-dimensional nailing plates are used in compliance with the specifications and conditions given in Annex 1 to 3.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the Hangzhou Ailong three-dimensional nailing plates of at least 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

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

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
Joint strength	See Annex 3
Joint stiffness	No performance assessed
Joint ductility	No performance assessed

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Class A1

3.3 Hygiene, health and the environment (BWR 3)

Essential characteristic	Performance
Release of dangerous substances	No performance assessed

[1] EN 14592:2022 Timber structures - Dowel-type fasteners - Requirements

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

In accordance with European Assessment Document EAD No. 130186-00-0603 the applicable European legal act is: 97/638/EC.

The system to be applied is: 2+

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

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

Issued in Berlin on 11 August 2023 by Deutsches Institut für Bautechnik

Anja Dewitt	*beglaubigt:*
Head of Section	Vössing

Annex 1 Product details and definitions

Table A.1.1: Materials specification

Article-No.	Dimensions (see also the following pages) in mm	Comments	Steel specification and Coating specification	Technical specification of the steel
Angle brackets				
AL1002090	90x48x116x3.0	with rib	S280 GD + Z275	EN 10346 with $R_{p0,2} \geq 280$ N/mm² and $R_m \geq 360$ N/mm² and tolerances in accordance with EN 10143
AL1003089	89x89x65x2.5	with rib		
AL1004105	105x105x90x3.0	with rib		
AL1005103	103x103x90x3.0	-		
AL1008138	138x85x65x4.0	with rib	S235JR + Hot dip galvanized ≥ 45 µm	EN 10025-2 with $R_{eH} \geq 235$ N/mm² and $R_m \geq 360$ N/mm²
AL1008138X	138x85x65x4.0	with rib		
AL1009285	285x85x65x4.0	with rib		
AL1009285X	285x85x65x4.0	with rib		
AL1006159	159x159x92.5x2.0	with rib	S280 GD + Z275	See above
Cantilever brackets				
AL1001220	220x20x180x2.0	two-piece	S280 GD + Z275	See above
Joist hanger				
AL1007725	72.5x72.5x135x2.0	one-piece	S280 GD + Z275	See above
AL1011140	184x114x248x4.0	one-piece	S235JR + Hot dip galvanized ≥ 45 µm	See above
AL1011160	184x114x268x4.0	one-piece	See above	See above
AL1011160X	244x114x268x4.0	one-piece	See above	See above
AL1011180	224x114x288x4.0	one-piece	See above	See above
Turnbuckles				
AL1010030	125x24x30x2.0	2 x tension straps	S280 GD + Z275	See above
	∅ 10.0 x 100	Tensioning bolt M10	S235JR + Fe/Zn 5	EN 10025-2 with $R_{eH} \geq 235$ N/mm² and $R_m \geq 360$ N/mm²
	∅ 20.0 x 30	2 x screw sleeve M10	S235JR + Fe/Zn 5	

Deutsches Institut für Bautechnik

DIBt

Table A.1.2: Range of sizes

Article-No.	Dimensions in mm	Height vertical in mm		Height horizontal in mm		Width in mm	
Angle Brackets							
AL1002090	90x48x116x3.0	89	91	47	49	115	117
AL1003089	89x89x65x2.5	88	90	88	90	64	66
AL1004105	105x105x90x3.0	104	106	104	106	89	91
AL1005103	103x103x90x3.0	102	104	102	104	89	91
AL1008138	138x85x65x4.0	137	139	84	86	64	66
AL1008138X	138x85x65x4.0	137	139	84	86	64	66
AL1009285	285x85x65x4.0	284	286	84	86	64	66
AL1009285X	285x85x65x4.0	284	286	84	86	64	66
AL1006159	159x159x92.5x2.0	158	160	158	160	91.5	93.5
Cantilever Brackets							
AL1001220	220x20x180x2.0	219	221	19	21	179	181
Joist Hanger							
AL1007725	72.5x72.5x135x2.0	71.5	73.5	71..,5	73.5	134	136
AL1011140	184x114x248x4.0	231	237	111.5	116.5	140	142
AL1011160	184x114x268x4.0	231	237	111.5	116.5	160	162
AL1011160X	244x114x268x4.0	291	297	111.5	116.5	160	162
AL1011180	224x114x288x4.0	271	277	111.5	116.5	180	182
Turnbuckles							
AL1010030	125x24x30x2.0	124	126	23	25	29	31
		-		**Diameter** in mm		**Width** in mm	
	∅ 10.0 x 100	-	-	9.7	10.1	98	102
	∅ 20.0 x 30	-	-	19.5	20.5	29	31

The tolerances of the nailing plate thicknesses are 2.0 mm ± 0.14 mm, 2.5 mm± 0.16 mm, 3.0 mm ± 0.18 mm and 4.0 mm ± 0.30 mm.

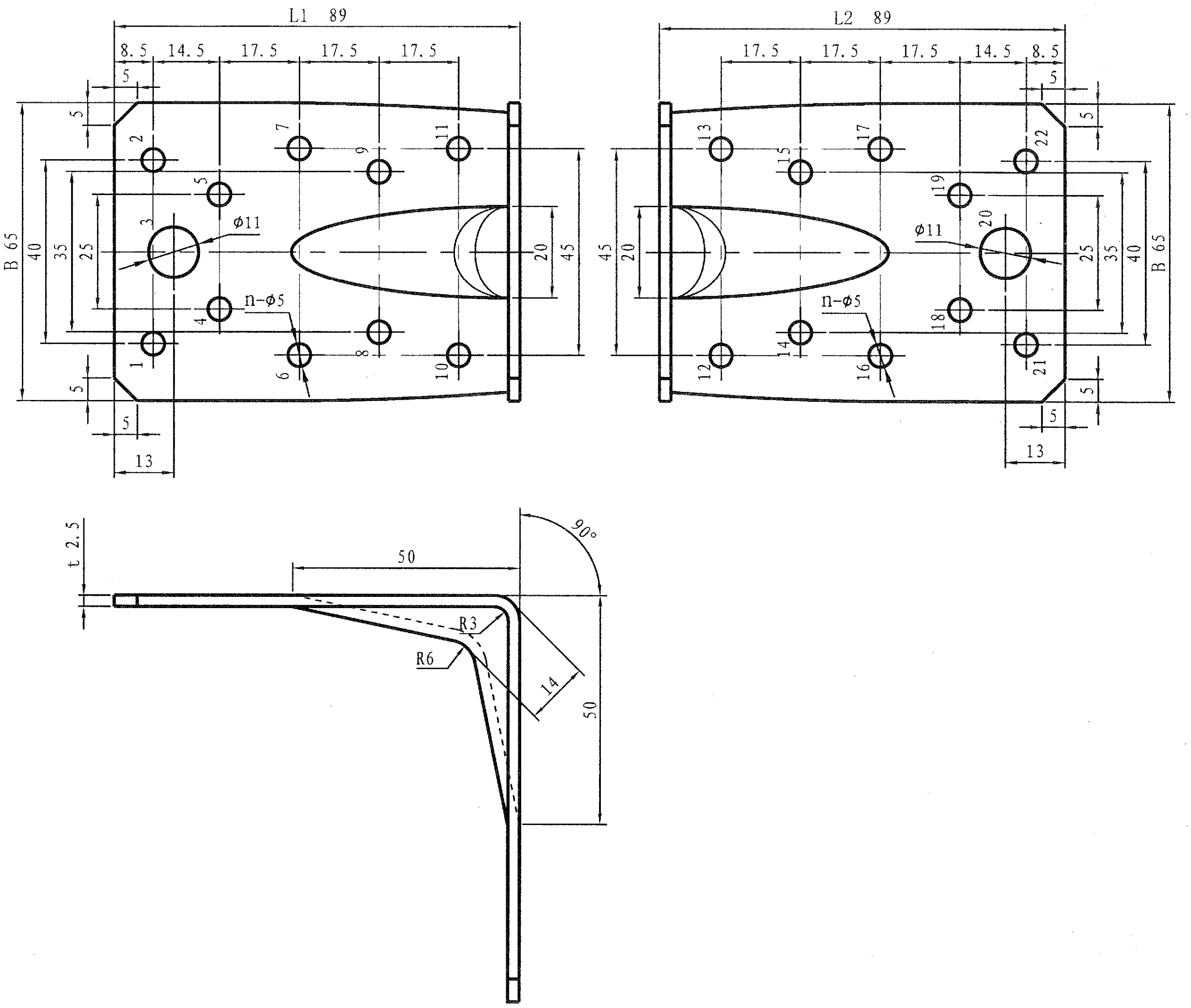
Ailong Metal Angle Brackets	Annex 1.2
Product details and definitions	

Table A.1.3: Nail specification

Three-dimensional nailing plate type	Nail diameter	Nail length	Nail type
Angle brackets and cantilever brackets	4.0 mm	≥ 40 mm	Ringed shank nails in accordance with EN 14592 with a minimum – threaded length of 30 mm, – characteristic withdrawal parameter of $f_{ax,k} = 50 \times 10^{-6} \times \rho_k^2$ N/mm², [ρ_k in kg/m³] – characteristic tension strength of the wire of $f_u \geq 600$ N/mm².
Joist hanger AL1007725	4.0 mm	L in mm	
Joist hangers AL1011140, AL1011160, AL1011160X, AL1011180	6.0 mm	60 mm	
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.			

Table A.1.4: Bolts and Metal anchors specification

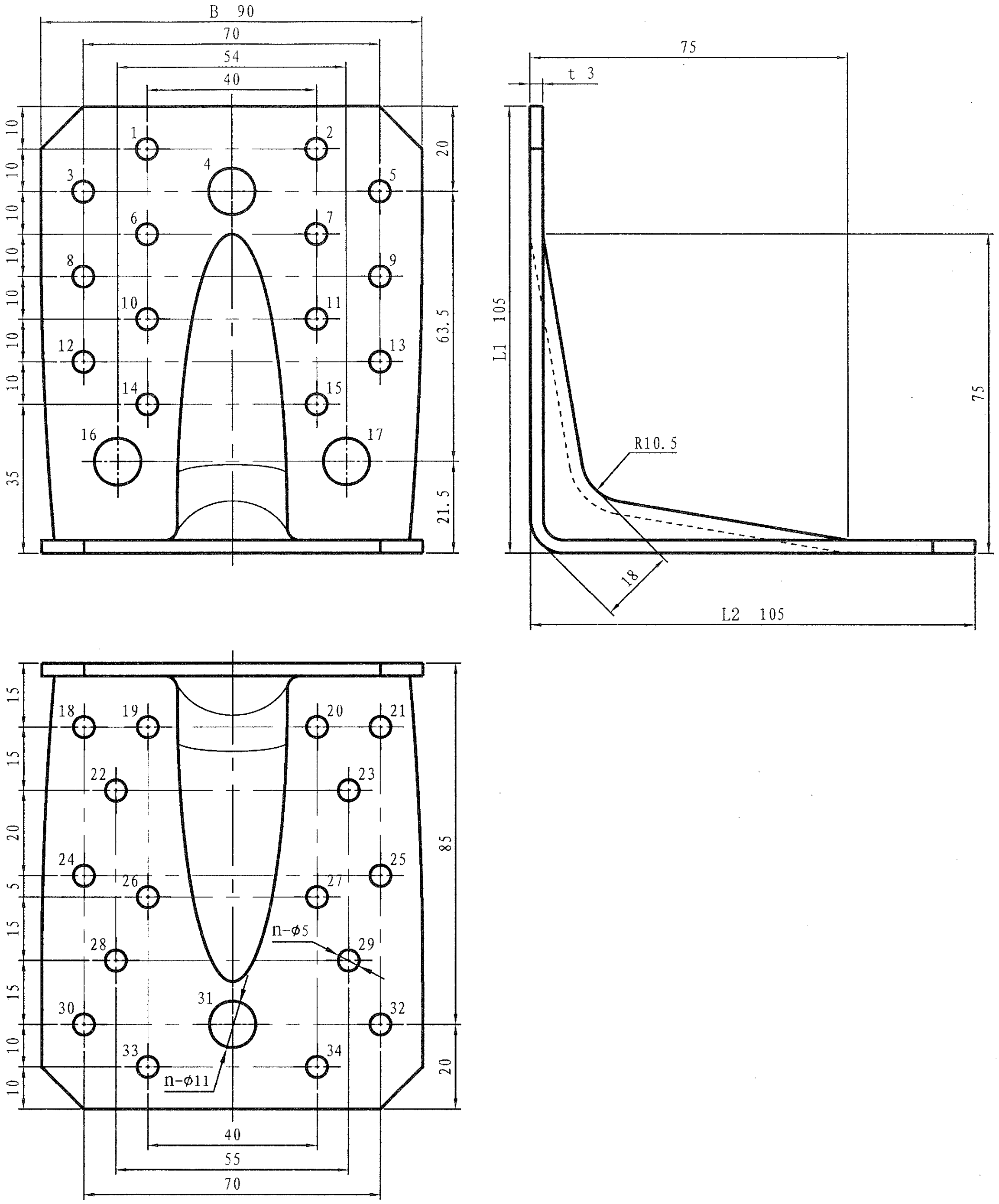
Nominal diameter	Correspondent hole diameter	Fastener specification
Bolts (connection to steel members)		
5.0 mm	5.0 mm	EN ISO 4017, Strength class 4.6 with nuts in accordance with EN ISO 4032
16.0 mm	18.0 mm	See above
Metal anchor (connection to concrete members)		
10.0 mm, 12.0 mm *)	Max. 2 mm larger than the anchor diameter	Metal anchors in accordance with ETA See specification of the manufacturer
16.0 mm	18.0 mm	See above
*) Bolts / Metal anchors have to be used with washers in accordance with EN ISO 7091.		



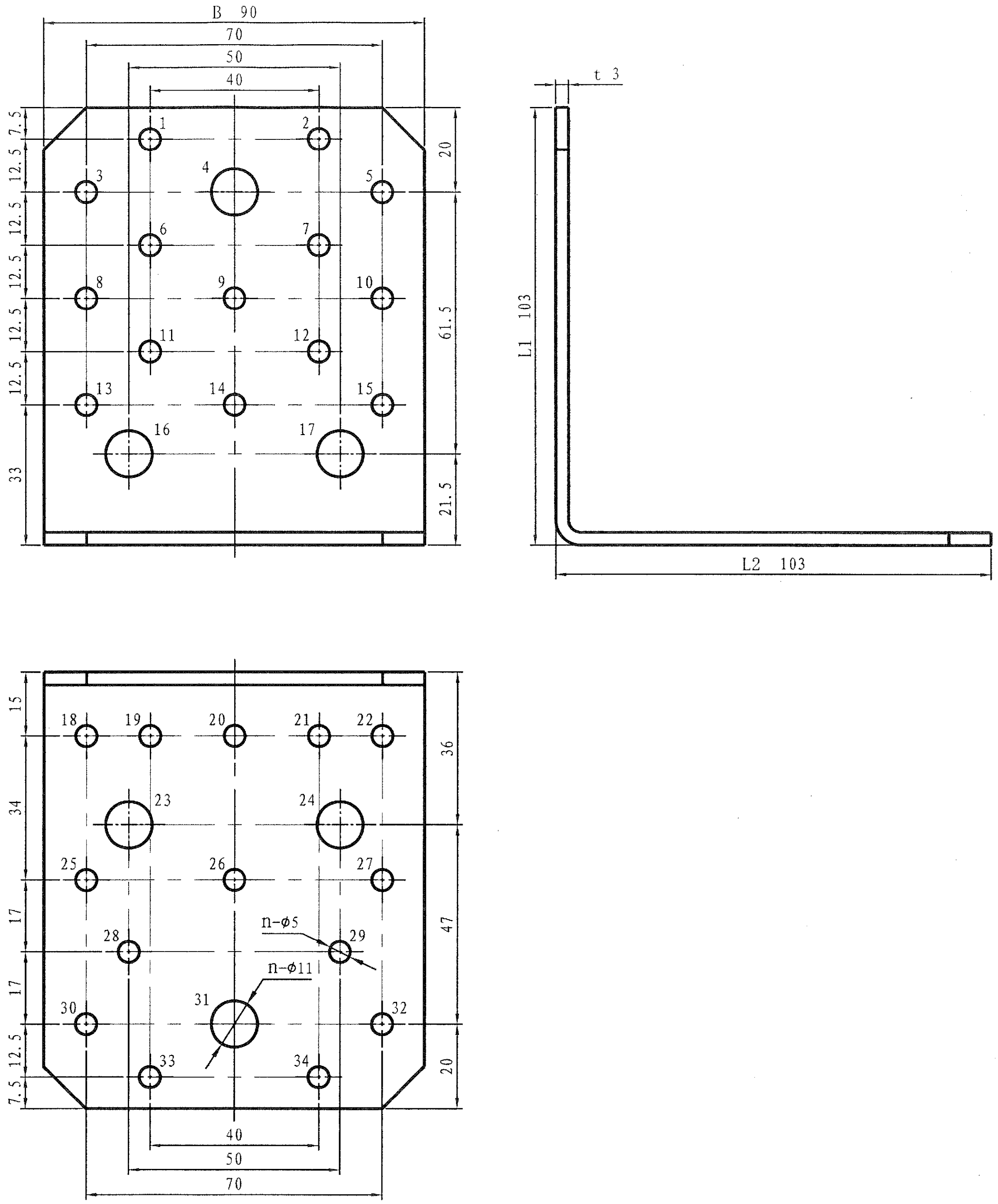
Ailong Metal Angle Brackets

Angle bracket AL1003089

Annex 1.4

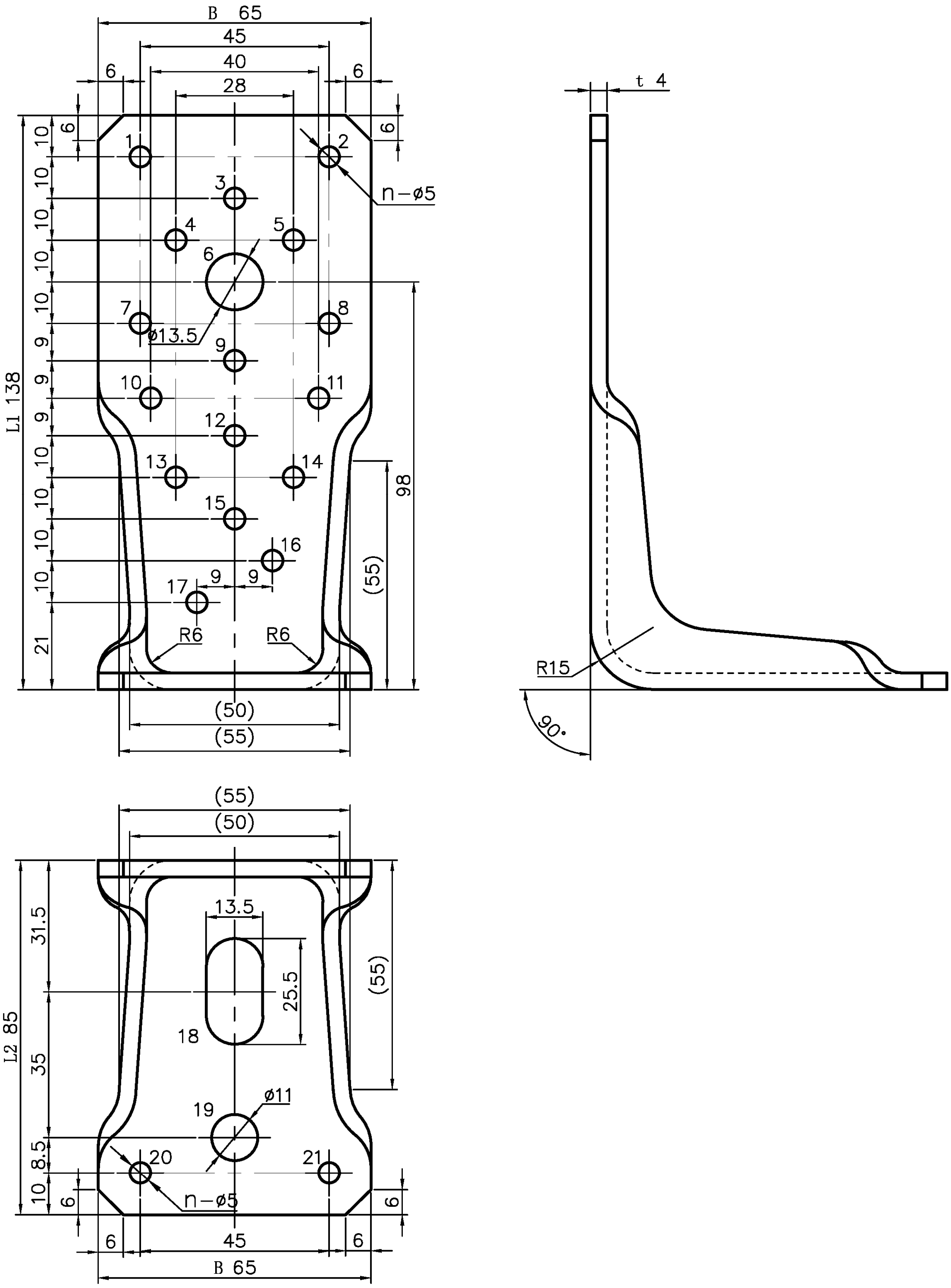


Ailong Metal Angle Brackets	Annex 1.5
Angle bracket AL1004105	

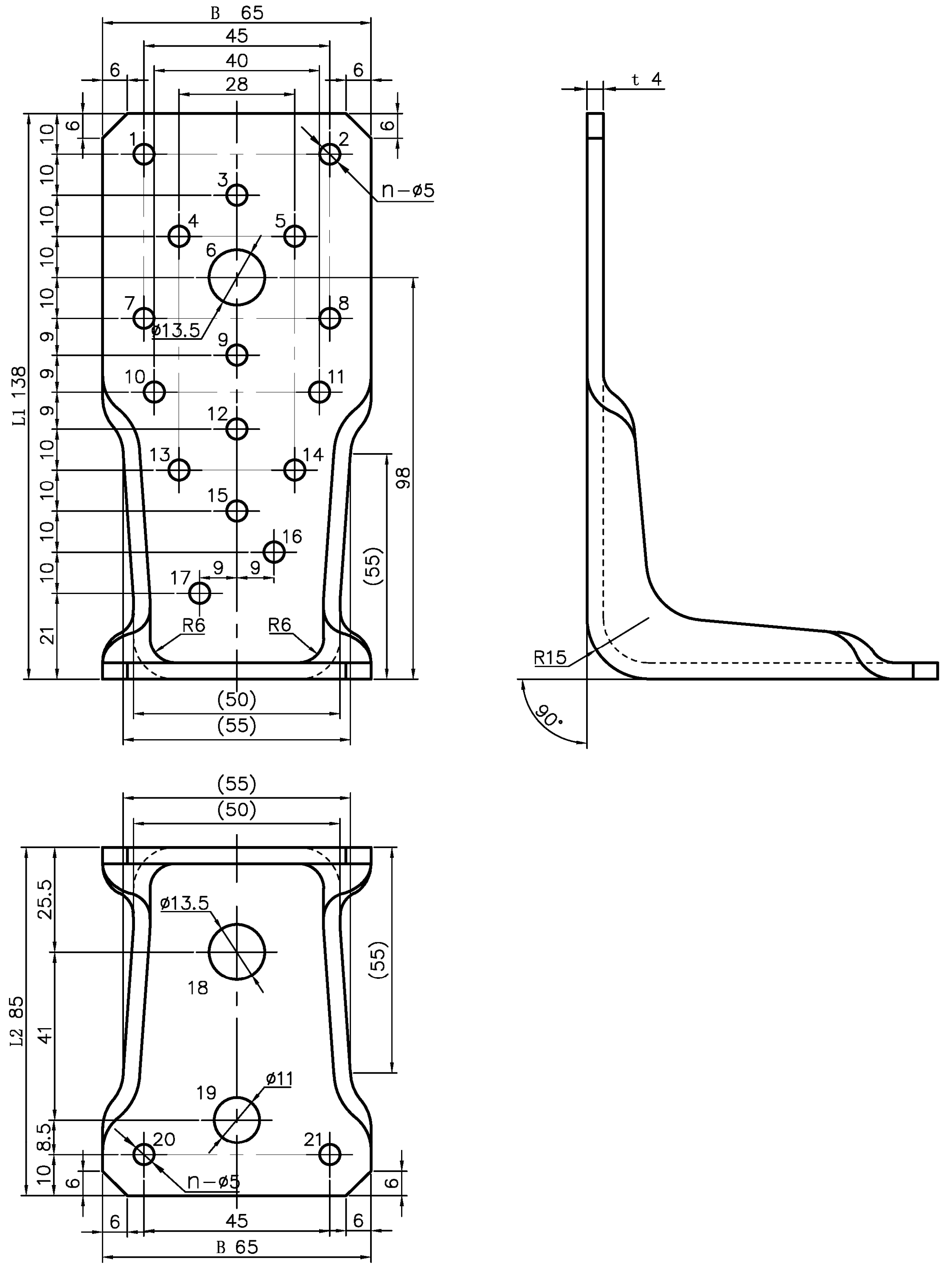


Ailong Metal Angle Brackets	Annex 1.6
Angle bracket AL1005103	

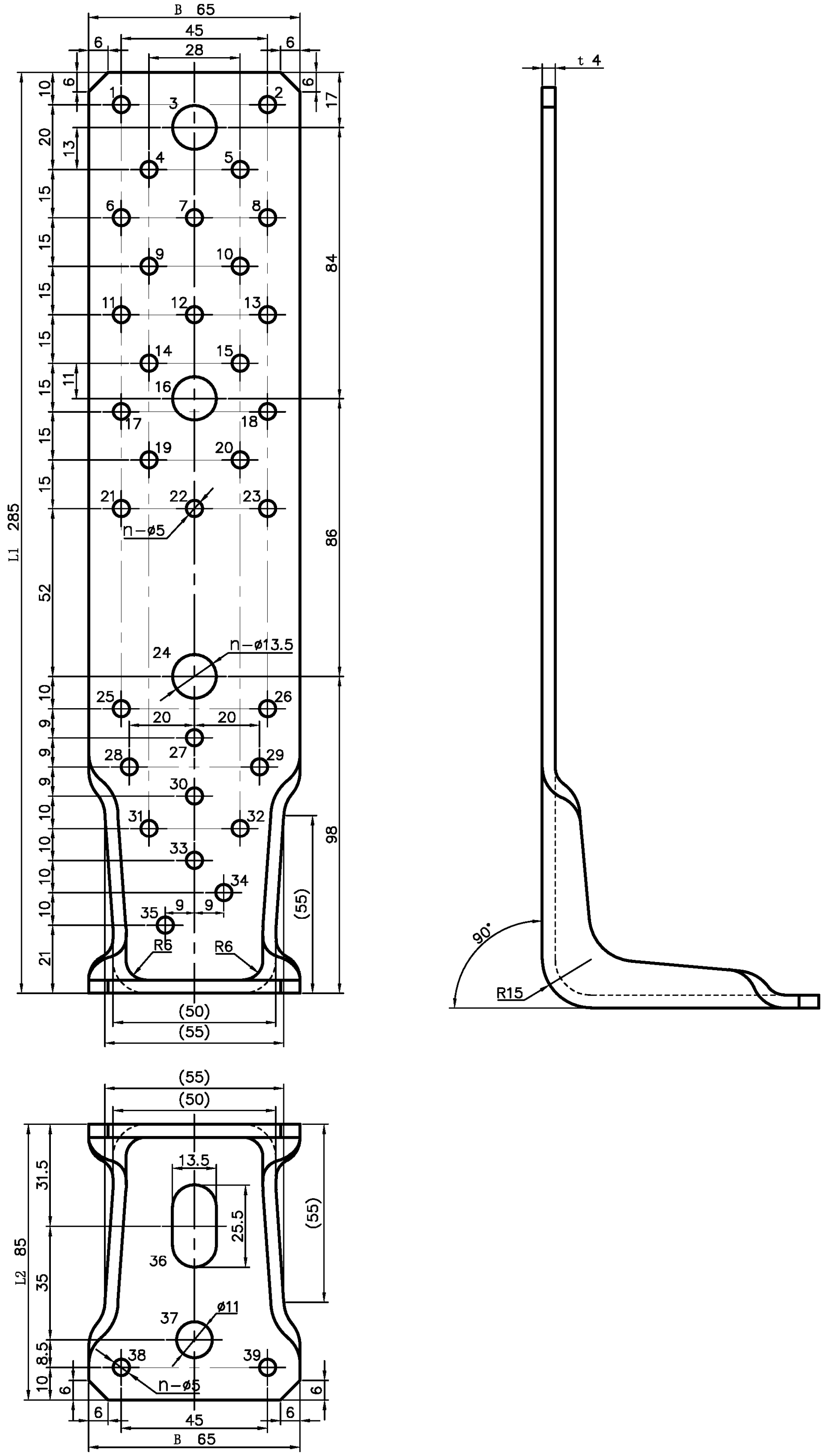
Deutsches Institut für Bautechnik DIBt



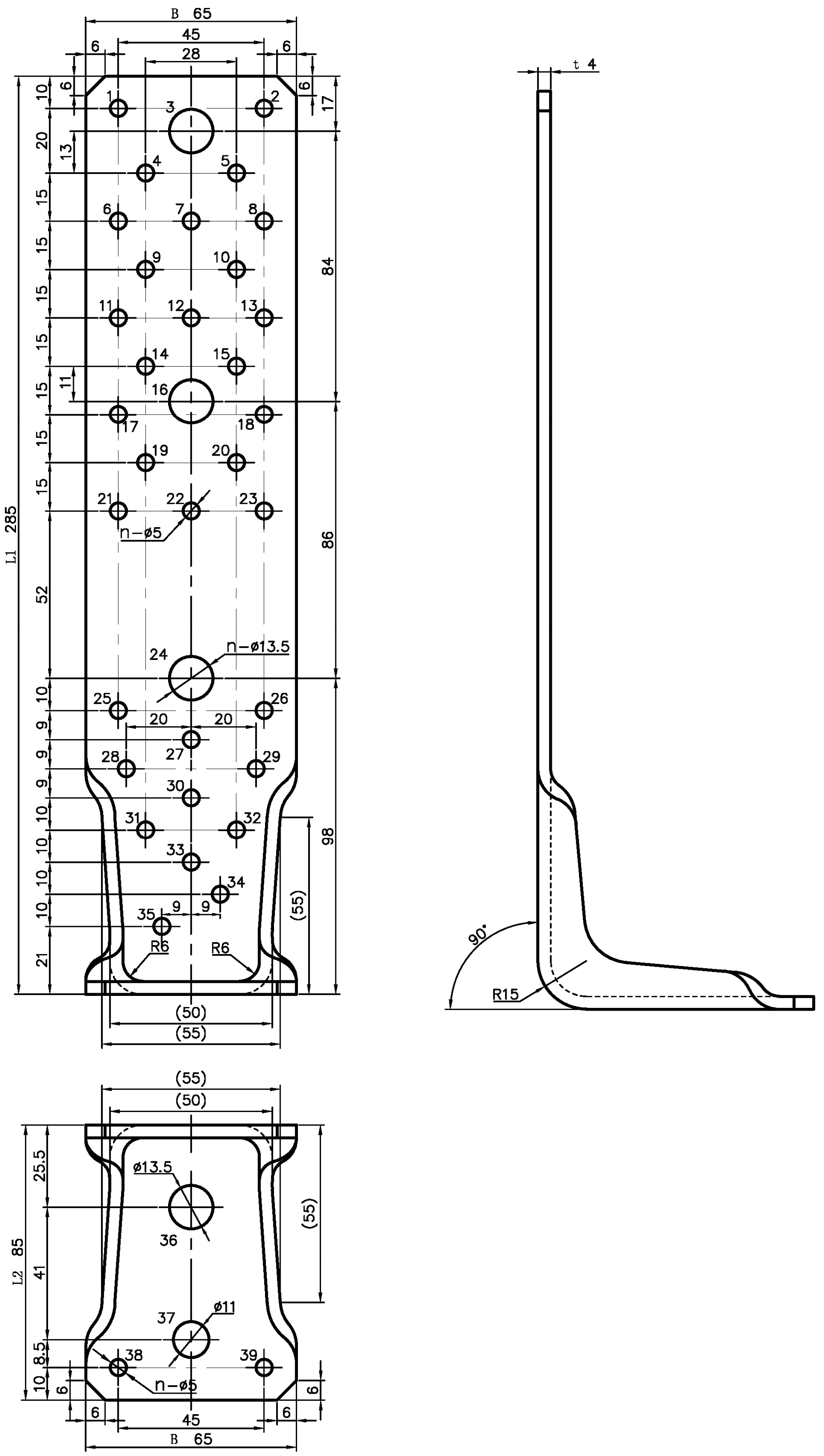
Ailong Metal Angle Brackets	Annex 1.7
Angle bracket AL1008138	



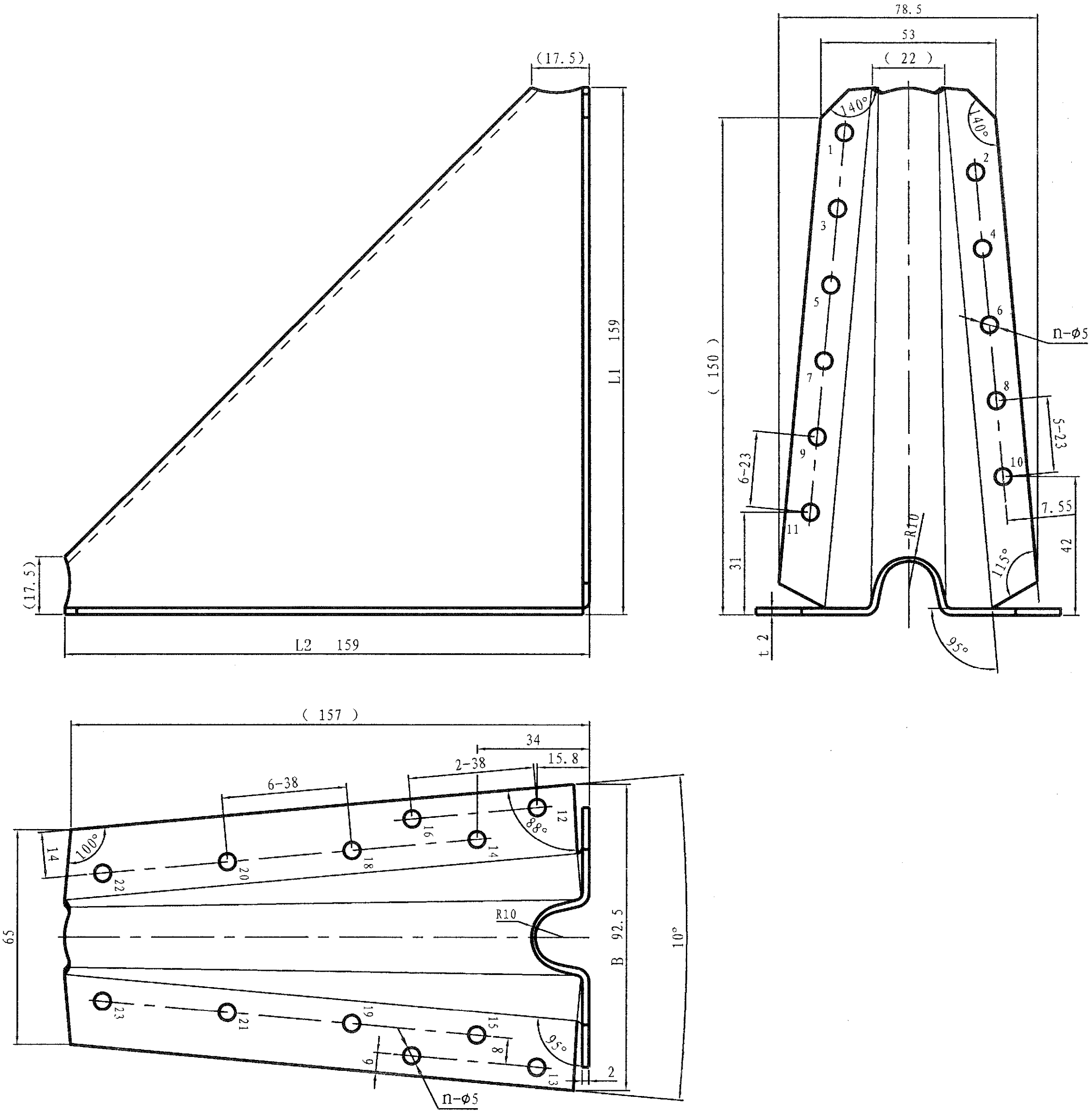
Ailong Metal Angle Brackets	Annex 1.8
Angle bracket AL1008138X	



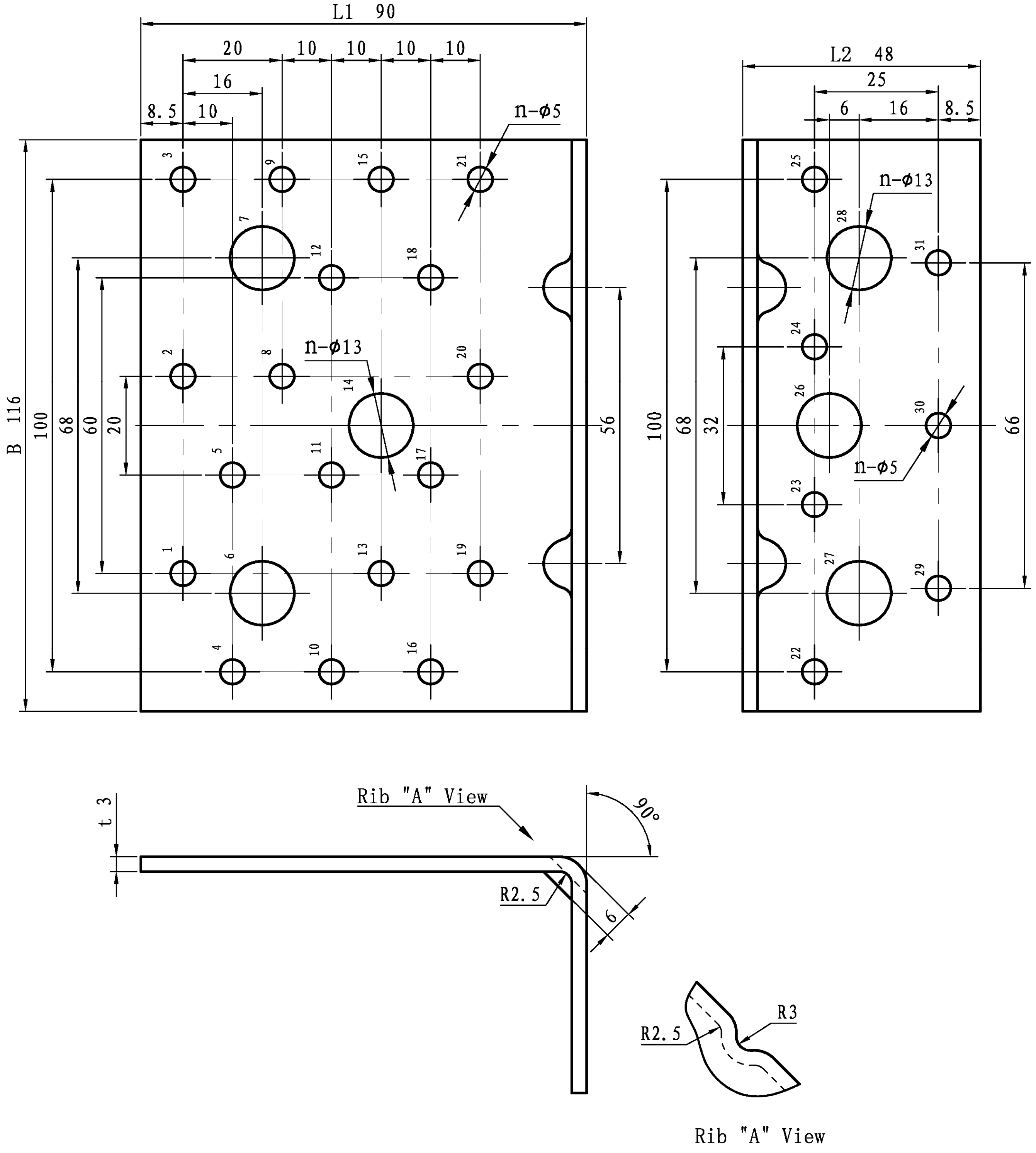
Ailong Metal Angle Brackets	Annex 1.9
Angle bracket AL1009285	



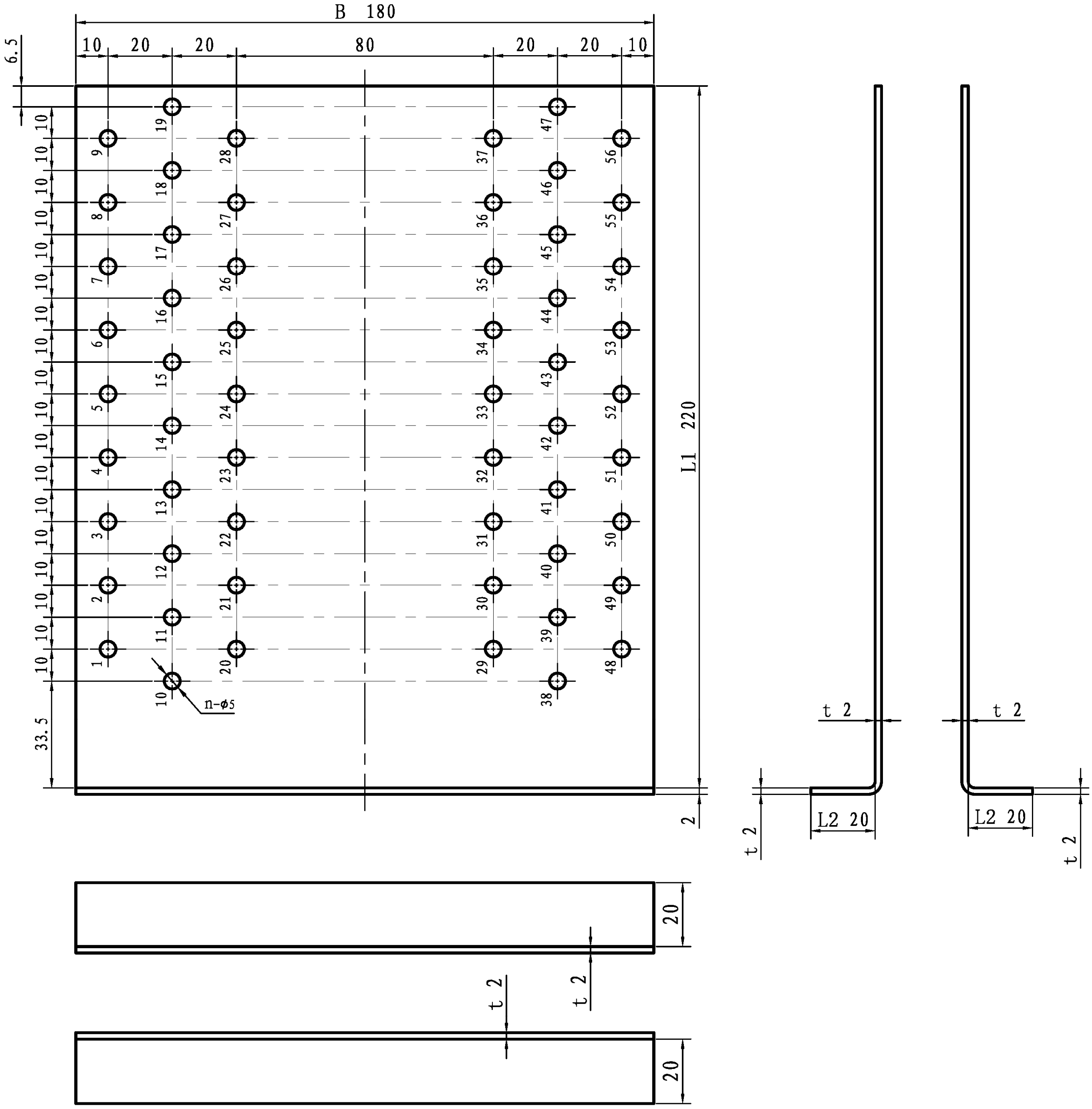
Ailong Metal Angle Brackets	Annex 1.10
Angle bracket AL1009285X	



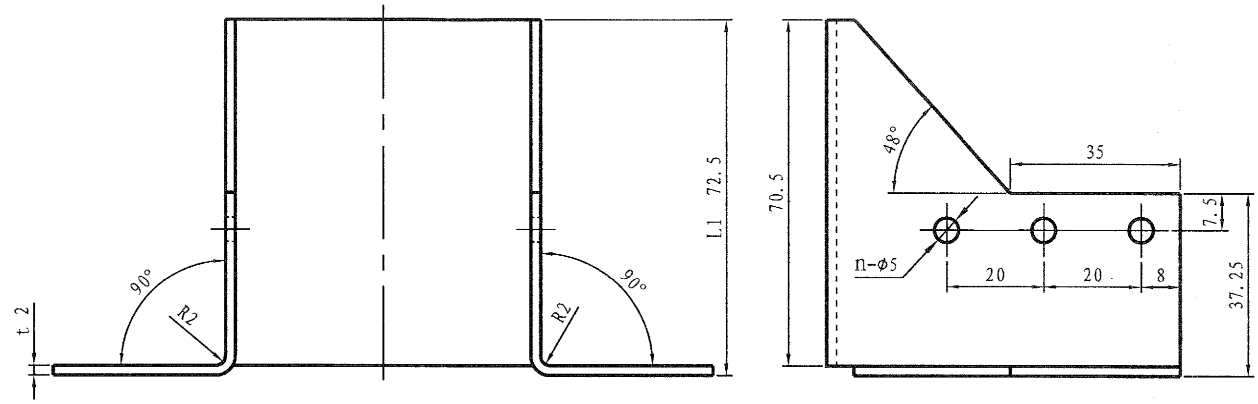
Ailong Metal Angle Brackets	Annex 1.11
Angle bracket Triangle U bracket AL1006159	

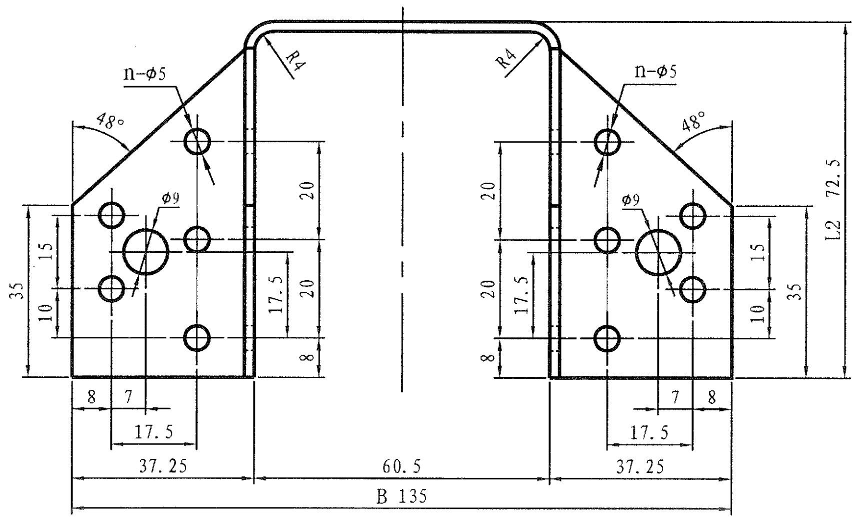


Ailong Metal Angle Brackets	Annex 1.12
Angle bracket AL1002090	

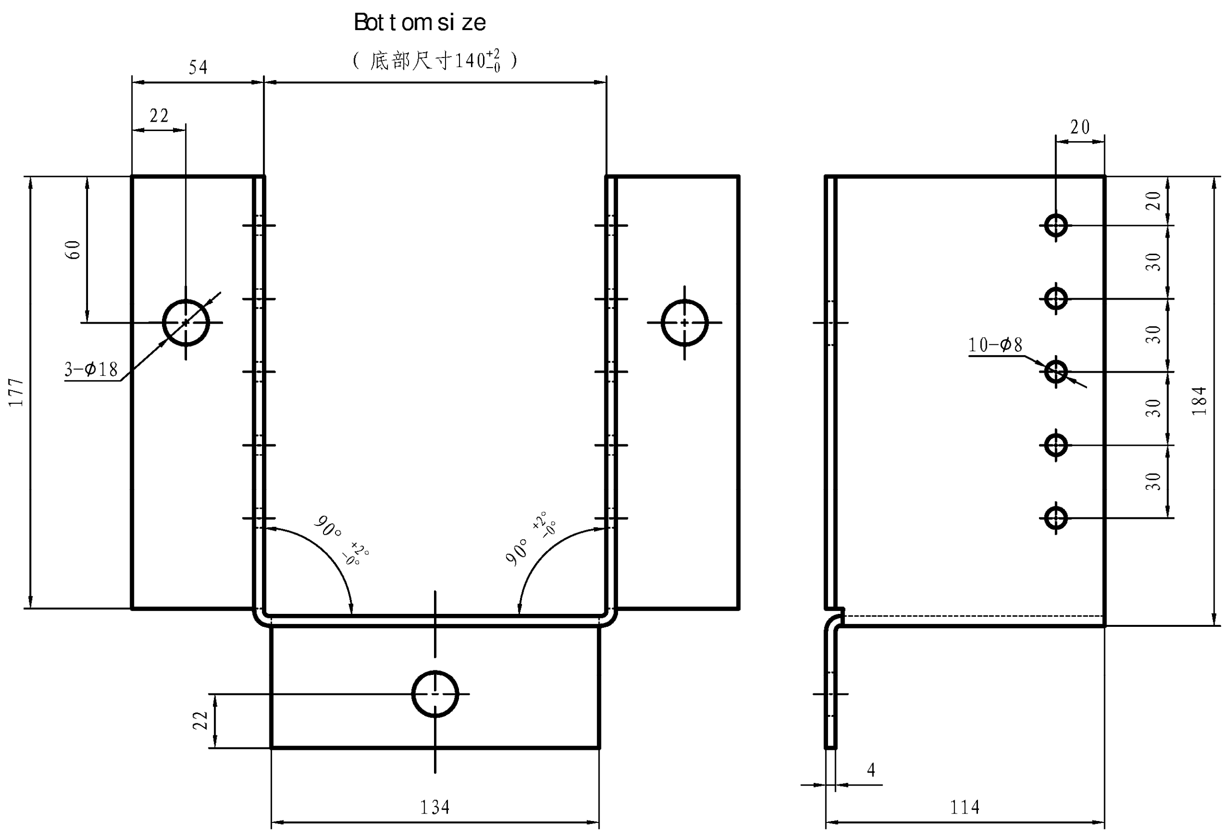


Ailong Metal Angle Brackets	Annex 1.13
Cantilever bracket AL1001220	

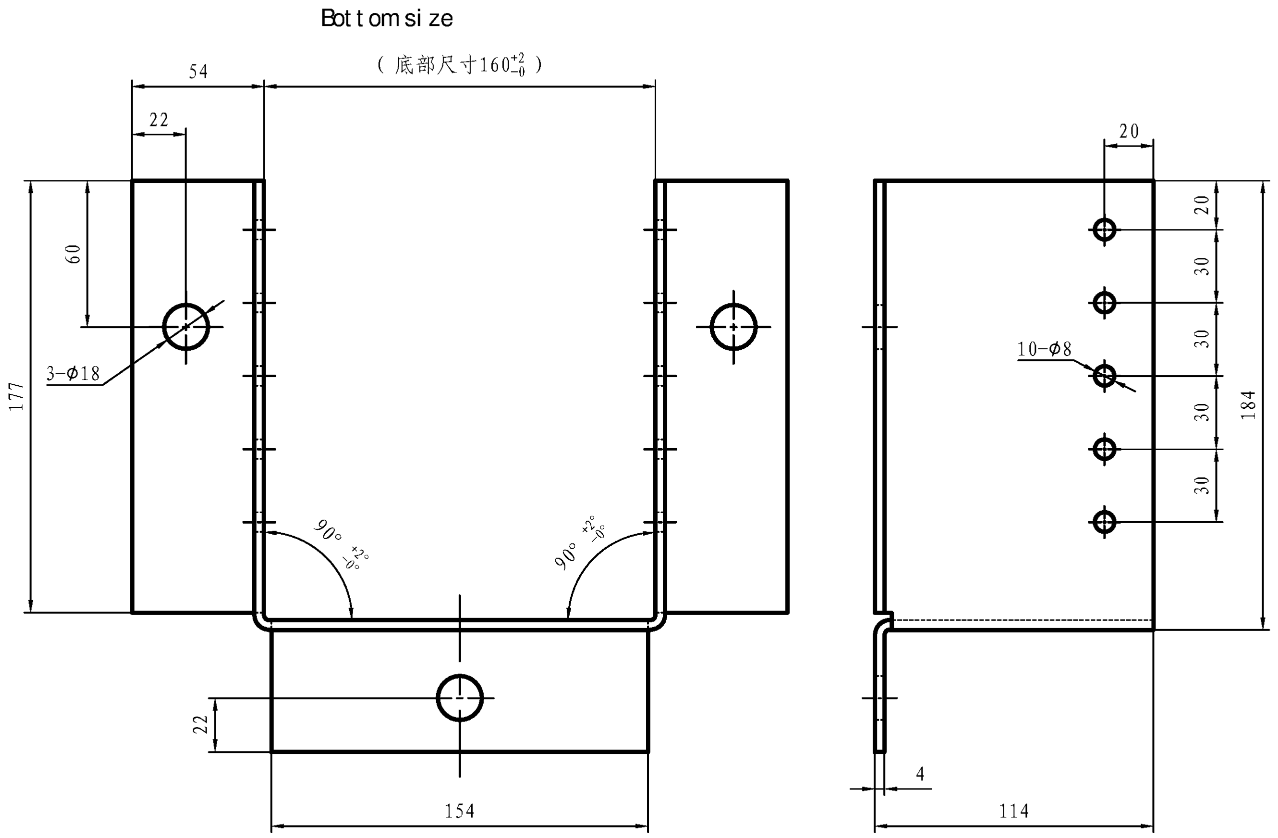




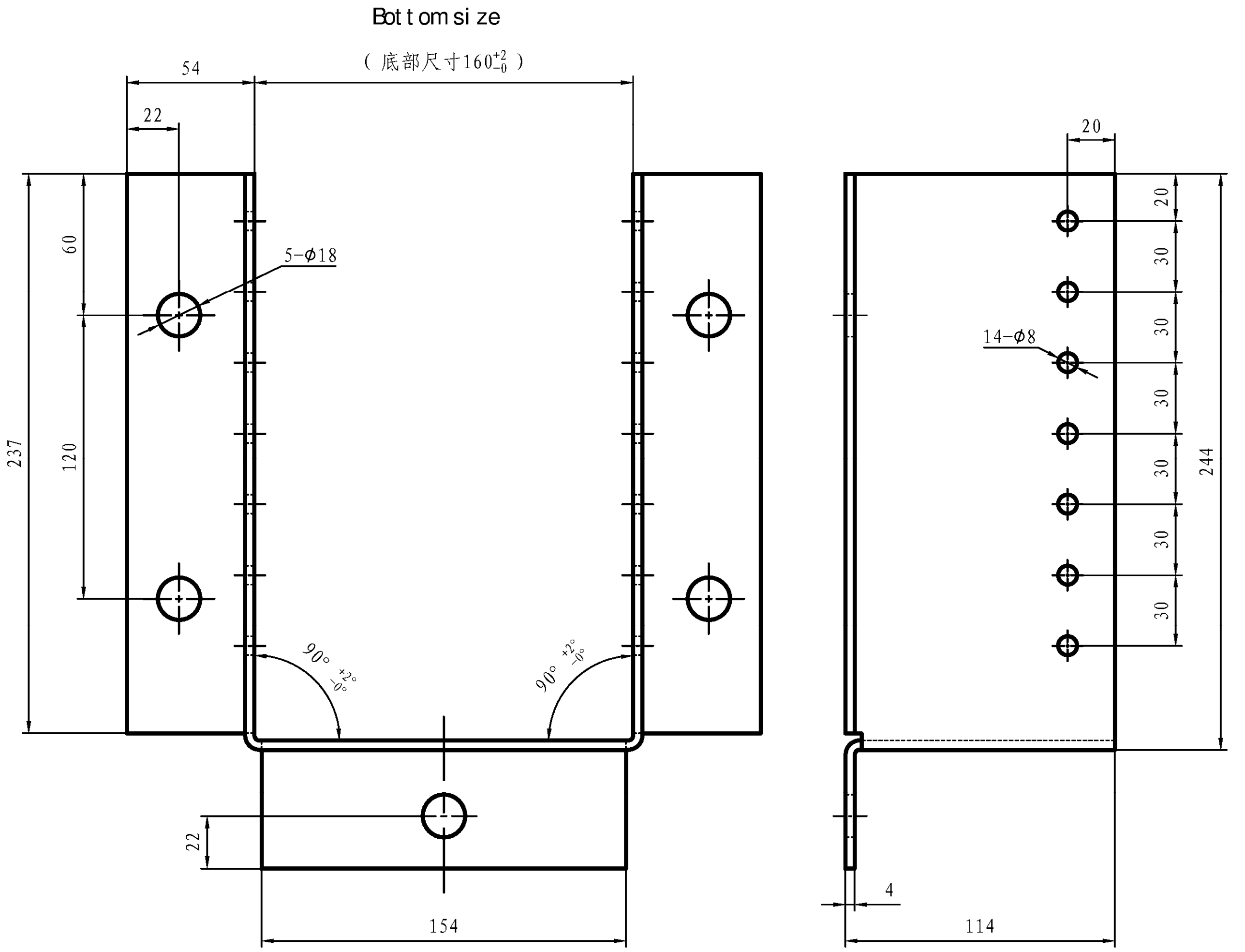
Ailong Metal Angle Brackets	Annex 1.14
Joist hanger AL1007725	



Ailong Metal Angle Brackets	Annex 1.15
Joist hanger AL1011140	



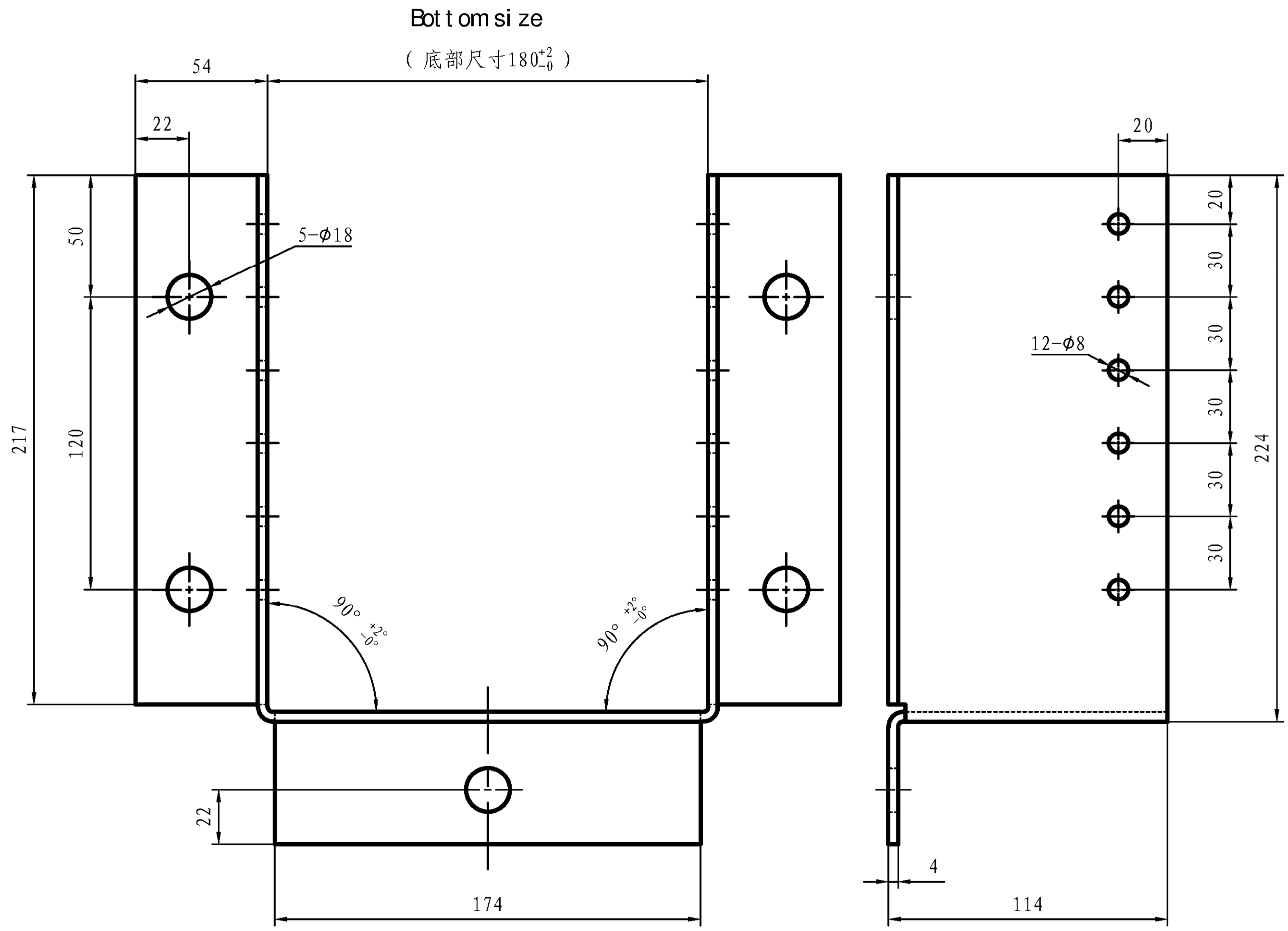
Ailong Metal Angle Brackets	Annex 1.16
Joist hanger AL1011160	



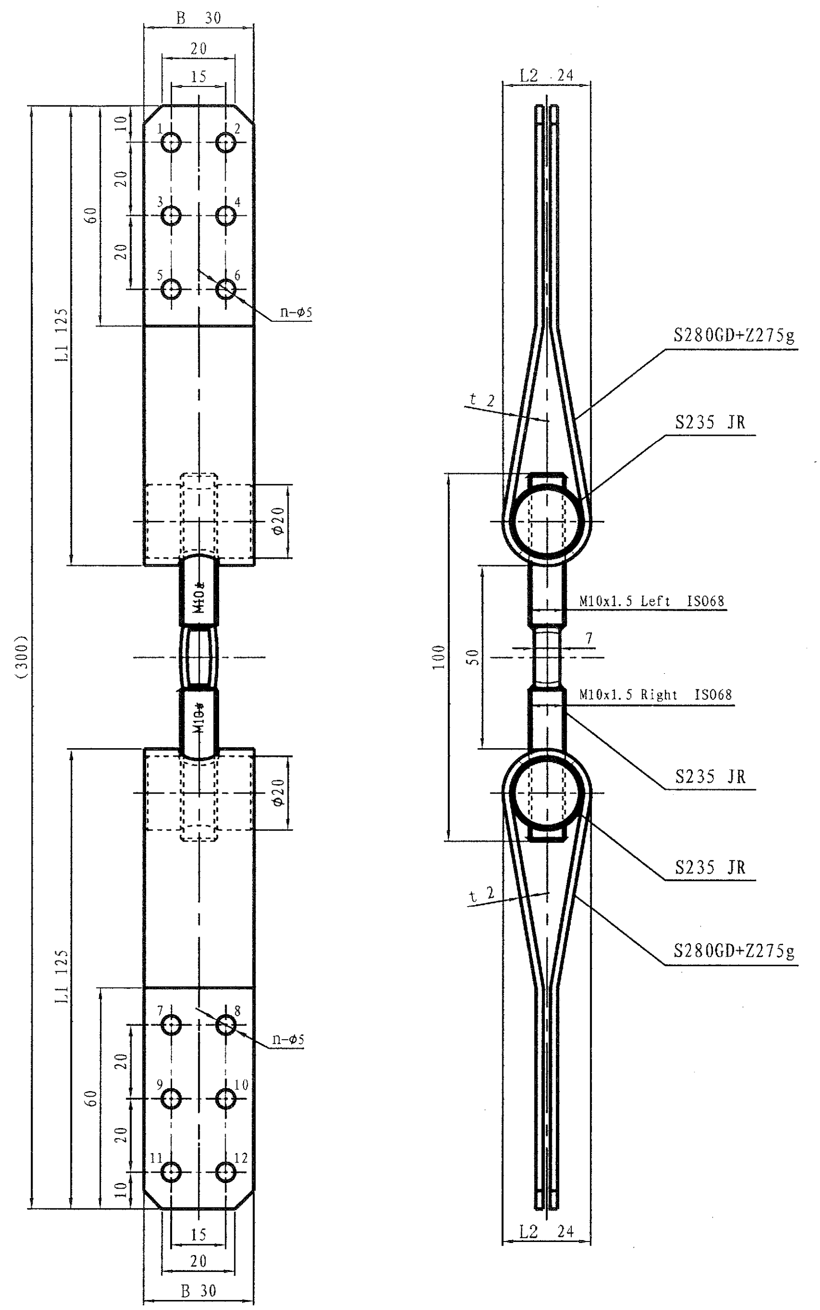
Ailong Metal Angle Brackets

Joist hanger AL1011160X

Annex 1.17



Ailong Metal Angle Brackets	Annex 1.18
Joist hanger AL1011180	



Ailong Metal Angle Brackets	Annex 1.19
Turnbuckles AL1010030	

Annex 2 Specifications of intended use

A.2.1 Intended use

Hangzhou Ailong three-dimensional nailing plates are used for connections in load bearing timber structures between wood members and concrete or steel members.

The angle brackets are intended for use in making connections between two timber members or a timber member and a member of concrete or steel.

The cantilever brackets are intended for use in making end-grain to end-grain connections in load bearing timber structures, as a connection between two wood-based members (see Figure A.2.2). A connection always consists of a pair of cantilever brackets on each side of the fastened timber member.

The joist hangers are intended for use in making end-grain to side-grain connections in load bearing timber structures, as a connection between a wood-based joist and a solid timber or wood-based header. The assessment of the load-carryring capacity of the connection of bolts to steel members and of the embedment of metal anchors in concrete structures is not covered by this ETA.

The turnbuckles are intended for use in tensioning steel members, e.g. wind braces.

The support conditions of the timber members shall be as described in Annex 3.

A.2.2 Use of the three-dimensional nailing plates subject only for:

- non-fatigue-relevant static and quasi-static actions

A.2.3 Materials, which can be fastened

The angle brackets, cantilever brackets and joist hangers may be used for connecting the following timber members:

- Solid timber (softwood) of strength classes C14 - C50 in accordance with EN 338/ EN 14081-1,
- Structural finger jointed solid timber (softwood) in accordance with EN 15497,
- Glued laminated timber in accordance with EN 14080,
- Glued solid timber in accordance with EN 14080,
- Cross laminated timber (softwood) in accordance with European Technical Assessment, arrangement of the nails only perpendicular to the lateral face,
- Laminated veneer lumber LVL (softwood) in accordance with EN 14374, arrangement of the nails only perpendicular to the plane of the veneers,
- Plywood (softwood) in accordance with EN 636 and EN 13986, arrangement of the nails only perpendicular to the plane of the plies.

Regarding concrete and steel members the provisions in the respective ETA of the anchor shall be considered.

A.2.4 Use conditions (Environmental conditions)

The corrosion protection of Hangzhou Ailong three-dimensional nailing plates is given in Annex 1. It shall be ensured that the nails, bolts and anchors, used to connect the three-dimensional nailing plates, have a sufficient corrosion protection.

A.2.5 Installation provisions

General

EN 1995-1-1 applies for the installation.

The nail patterns given in Table A.3.2.1 to A.3.5.1 shall be complied with.

The timber members shall have a thickness which is larger than the penetration depth of the nails into the members.

The angle and cantilever brackets as well as the joist hangers shall fit closely to the surface of the wood, concrete or steel member without any intermediate layer.

The connection may be with a single angle bracket or with an angle bracket on each side of the fastened timber member. For single angle brackets the wood member (component 2 in accordance with Figure A.3.1) shall be prevented from rotation.

Wane

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

Fastener specification

See Annex 1.3, Table A.1.3 and A.1.4

The nail/ bolt patterns are specified in

- Table A.3.2.1 to A.3.2.18 for angle brackets,
- Table A.3.3.1 to A.3.3.3 for cantilever brackets,
- Table A.3.4.1 for joist hangers,
- Table A.3.5.1 for turnbuckles.

For the nails the minimum edge spacings given in EN 1995-1-1 as for nails in non-predrilled holes shall be kept.

The nails shall be inserted without pre-drilling of the timber members.

The provisions in the ETA of the metal anchor shall be considered.

For bolts connecting steel members the provisions in EN 1993-1-8 shall be considered.

For cross laminated timber, LVL and plywood the arrangement of the nails shall be only perpendicular to the lateral face or plane of the veneers.

The inner thread diameter of the nails shall be greater than the maximal width of the gaps in the layer of the cross laminated timber.

The provisions of the European Technical Assessment of the cross laminated timber should be considered.

Typical uses

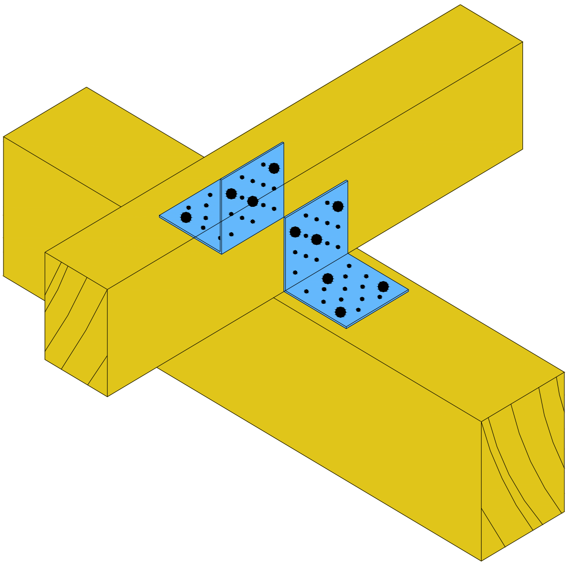


Figure A.2.1 Typical use of angle brackets

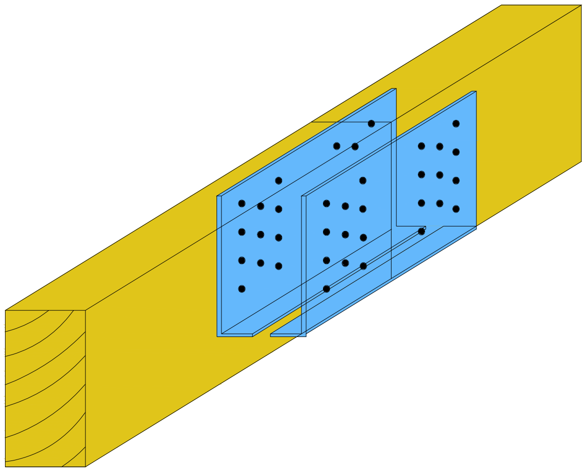


Figure A.2.2 Typical use of a cantilever bracket

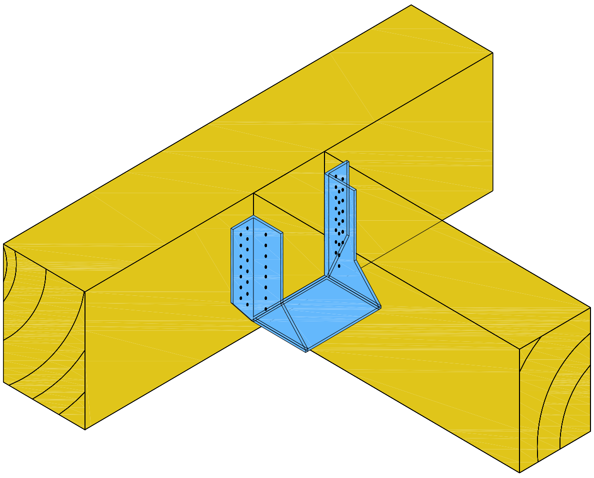


Figure A.2.3 Typical use of a joist hanger

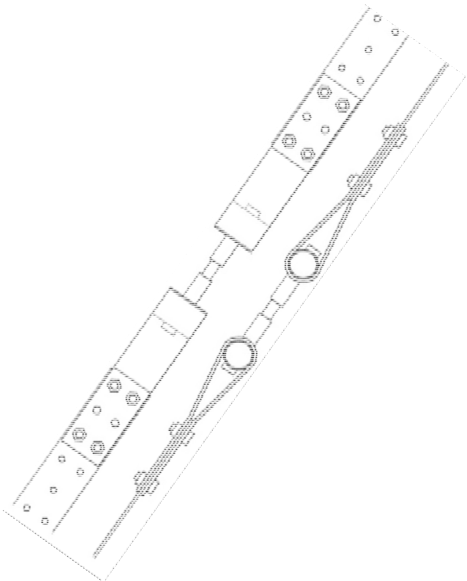


Figure A.2.4 Typical use of a turnbuckle

Ailong Metal Angle Brackets	Annex 2.3
Typical uses	

Annex 3 Joint strength – Characteristic load-carrying capacities

A.3.1 General

The connection of the nailing plates to concrete or steel members has to be verified. The verification of this connection is not subject of this European Technical Assessment.

The following tables state the load-carrying capacities of the angle and cantilever bracket connections for a characteristic density of 350 kg/m³. For timber material with a lower characteristic density than 350 kg/m³ the load-carrying capacity shall be reduced by the factor $k_{dens,1}$:

$$k_{dens,1} = \left(\frac{\rho_k}{350}\right)^{0.8} \tag{A.3.1}$$

Where ρ_k is the characteristic density of the timber material in kg/m³, 290 kg/m³ ≤ ρ_k < 350 kg/m³.

For timber members with a characteristic density of more than 350 kg/m³ the load-carrying capacity may be increased by the factor $k_{dens,2}$:

$$k_{dens,2} = \left(\frac{\rho_k}{350}\right)^{0.5} \tag{A.3.2}$$

with 350 kg/m³ < ρ_k ≤ 460 kg/m³.

For connection of the nailing plates to cross laminated timber the grain direction of the outer layer is decisive.

A.3.2 Angle brackets

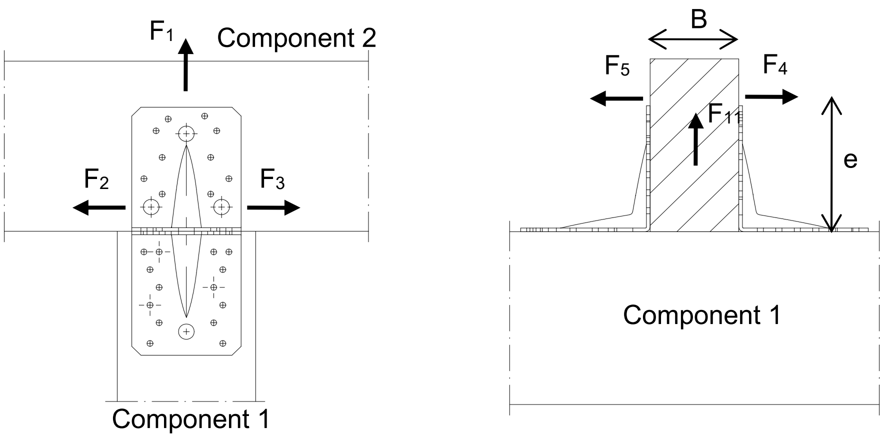


Figure A.3.1 Definitions of forces, their directions and eccentricity

Double angle brackets per connection

The angle brackets must be placed at each side opposite to each other, symmetrically 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 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 axial rotation.
F_2 and F_3	Lateral force acting in component 2 in axial direction of component 2. The component 2 shall be prevented from axial rotation.
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. The component 2 shall be prevented from axial rotation. Only characteristic load-carrying capacities for angle brackets with ribs are given.

Load components perpendicular to the grain

For load components perpendicular to the grain of the timber member it has to be verified in accordance with EN 1995-1-1 that splitting will not occur.

Connection to timber, 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:

$$F_{B,t,Ed} = k_{t,II} \cdot F_{E,d} \quad \text{for tensile load} \tag{A.3.3}$$

$$F_{B,v,Ed} = k_{t,\perp} \cdot F_{E,d} \quad \text{for shear load} \tag{A.3.4}$$

Where:

$F_{B,t,Ed}$	Bolt tensile load in N
$F_{B,v,Ed}$	Bolt shear load in N
k_t	Coefficient, in accordance with the tables A.3.2.1 to A.3.2.18
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:

$$\left(\frac{F_{1,Ed}}{F_{1,Rd}}\right)^2 + \left(\frac{F_{2,Ed}}{F_{2,Rd}}\right)^2 + \left(\frac{F_{3,Ed}}{F_{3,Rd}}\right)^2 + \left(\frac{F_{4,Ed}}{F_{4,Rd}}\right)^2 + \left(\frac{F_{5,Ed}}{F_{5,Rd}}\right)^2 \leq 1 \tag{A.3.5}$$

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, 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.

$$\Delta F_{1,Ed} = F_{4/5,Ed} \cdot \frac{e}{B} \tag{A.3.6}$$

Where B is the width of component 2.

Characteristic load bearing capacities - Force F_1

Table A.3.2.1: Force F_1 Column, Two angle brackets / connection, timber-timber

Article-No.	Dimension	Nail number n_V	Nail number n_H	$F_{1,Rk}$ [kN]	
				Timber	Steel
AL1002090	90x48x116x3,0	1,2,3,4,5,8,9	22,23,24,25,29,30,31	3,90	8,34
AL1003089	89x89x65x2,5	1,2	12,13,16,17,21,22	2,47	12,6
AL1004105	105x105x90x3,0	1,2,8,9	18,19,20,21,24,25,26,27,30,32,33,34	8,74	34,7
AL1005103	103x103x90x3,0	1,2,3,5	18,19,20,21,22,25,26,27,30,32,33,34	6,23	5,46

Table A.3.2.2: Force F_1 Column, One angle bracket / connection, timber-timber

Article-No.	Dimension	Nail number n_V	Nail number n_H	$F_{1,Rk}$ [kN]	
				Timber	Steel
AL1002090	90x48x116x3,0	1,2,3,4,5,8,9	22,23,24,25,29,30,31	1,95	4,17
AL1003089	89x89x65x2,5	1,2	12,13,16,17,21,22	1,23	6,28
AL1004105	105x105x90x3,0	1,2,8,9	18,19,20,21,24,25,26,27,30,32,33,34	4,37	17,4
AL1005103	103x103x90x3,0	1,2,3,5	18,19,20,21,22,25,26,27,30,32,33,34	3,11	2,73

Table A.3.2.3: Force F_1 Purlin, Two angle brackets / connection, timber-timber

Article-No.	Dimension	Nail number n_V	Nail number n_H	$F_{1,Rk}$ [kN]	
				Timber	Steel
AL1002090	90x48x116x3,0	1,2,3,4,5,8,9,10,11,12,13,15,16,17,18	22,23,24,25,29,30,31	3,90	8,34
AL1003089	89x89x65x2,5	1,2,6,7,8,9	12,13,16,17,21,22	2,47	12,6
AL1004105	105x105x90x3,0	1,2,3,5,6,7,8,9,10,11,12,13,14,15	18,19,20,21,24,25,26,27,30,32,33,34	8,74	34,7
AL1005103	103x103x90x3,0	1,2,3,5,6,7,8,9,10,11,12,13,14,15	18,19,20,21,22,25,26,27,30,32,33,34	6,23	5,46

Table A.3.2.4: Force F_1 Purlin, One angle bracket / connection, timber-timber

Article-No.	Dimension	Nail number n_V	Nail number n_H	$F_{1,Rk}$ [kN]	
				Timber	Steel
AL1002090	90x48x116x3,0	1,2,3,4,5,8,9,10,11,12, 13,15,16,17,18	22,23,24,25,29,30,31	1,95	4,17
AL1003089	89x89x65x2,5	1,2,6,7,8,9	12,13,16,17,21,22	1,23	6,28
AL1004105	105x105x90x3,0	1,2,3,5,6,7,8,9,10,11, 12,13,14,15	18,19,20,21,24,25,26, 27,30,32,33,34	4,37	17,4
AL1005103	103x103x90x3,0	1,2,3,5,6,7,8,9,10,11, 12,13,14,15	18,19,20,21,22,25,26, 27,30,32,33,34	3,11	2,73
AL1006159	159x159x92,5x2,0	1,2,3,4,5,6,7,8,9,10, 11	12,13,16,17,20,21,22, 23	2,60	3,14

Table A.3.2.5: Force F_1 Column, Two angle brackets / connection, timber-concrete/steel

Article-No.	Dimension	Nail number n_V	Bolt number n_H	$F_{1,Rk}$ [kN]		Bolt
				Timber	Steel	$k_{t,II}$
AL1002090	90x48x116x3,0	1,2,3,4,5,8,9	27,28	22,3	7,82	0,6
AL1003089	89x89x65x2,5	1,2	20	2,64	1,38	0,5
AL1004105	105x105x90x3,0	34,33,32,30	17,16	12,7	22,9	0,3
AL1005103	103x103x90x3,0	34,33,32,30	17,16	12,7	6,35	0,3
AL1008138	138x85x65x4,0	1,2,4,5,10,11	18	18,8	8,82	0,9
AL1008138X	138x85x65x4,0	1,2,4,5,10,11	18	18,8	21,3	0,7
AL1009285	285x85x65x4,0	1,2,6,7,8,11,12,13,17, 18,21,22,23,25,26,27	36	50,1	8,82	0,9
AL1009285X	285x85x65x4,0	1,2,6,7,8,11,12,13,17, 18,21,22,23,25,26,27	36	50,1	21,3	0,7

Table A.3.2.6: Force F_1 Column, One angle bracket / connection, timber-concrete/steel

Article-No.	Dimension	Nail number n_V	Bolt number n_H	$F_{1,Rk}$ [kN]		Bolt
				Timber	Steel	$k_{t,II}$
AL1002090	90x48x116x3,0	1,2,3,4,5,8,9	27,28	11,1	3,91	1,1
AL1003089	89x89x65x2,5	1,2	20	1,32	0,69	1,0
AL1004105	105x105x90x3,0	34,33,32,30	17,16	6,36	11,4	0,6
AL1005103	103x103x90x3,0	34,33,32,30	17,16	6,36	3,17	0,6
AL1008138	138x85x65x4,0	1,2,4,5,10,11	18	9,39	4,41	1,9
AL1008138X	138x85x65x4,0	1,2,4,5,10,11	18	9,39	10,6	1,5
AL1009285	285x85x65x4,0	1,2,6,7,8,11,12,13,17, 18,21,22,23,25,26,27	36	25,0	4,41	1,9
AL1009285X	285x85x65x4,0	1,2,6,7,8,11,12,13,17, 18,21,22,23,25,26,27	36	25,0	10,6	1,5

Table A.3.2.7: Force F_1 Purlin, Two angle brackets / connection, timber-concrete/steel

Article-No.	Dimension	Nail number n_V	Bolt number n_H	$F_{1,Rk}$ [kN]		Bolt
				Timber	Steel	$k_{t,II}$
AL1002090	90x48x116x3,0	1,2,3,4,5,8,9	27,28	47,7	7,82	0,6
AL1003089	89x89x65x2,5	1,2	20	4,50	1,60	0,5
AL1004105	105x105x90x3,0	34,33,32,30	17,16	31,8	22,9	0,3
AL1005103	103x103x90x3,0	34,33,32,30	17,16	28,6	6,35	0,3
AL1008138	138x85x65x4,0	1,2,4,5,10,11	18	34,4	8,82	0,9
AL1008138X	138x85x65x4,0	1,2,4,5,10,11	18	34,4	21,3	0,7
AL1009285	285x85x65x4,0	1,2,6,7,8,11,12,13,17, 18,21,22,23,25,26,27	36	62,6	8,82	0,9
AL1009285X	285x85x65x4,0	1,2,6,7,8,11,12,13,17, 18,21,22,23,25,26,27	36	62,6	21,3	0,7

Table A.3.2.8: Force F_1 Purlin, One angle bracket / connection, timber-concrete/steel

Article-No.	Dimension	Nail number n_V	Bolt number n_H	$F_{1,Rk}$ [kN]		Bolt
				Timber	Steel	$k_{t,II}$
AL1002090	90x48x116x3,0	1,2,3,4,5,8,9	27,28	23,8	3,91	1,1
AL1003089	89x89x65x2,5	1,2	20	2,25	0,80	1,0
AL1004105	105x105x90x3,0	34,33,32,30	17,16	15,9	11,4	0,6
AL1005103	103x103x90x3,0	34,33,32,30	17,16	14,3	3,17	0,6
AL1008138	138x85x65x4,0	1,2,4,5,10,11	18	17,2	4,41	1,9
AL1008138X	138x85x65x4,0	1,2,4,5,10,11	18	17,2	10,6	1,5
AL1009285	285x85x65x4,0	1,2,6,7,8,11,12,13,17, 18,21,22,23,25,26,27	36	31,3	4,41	1,9
AL1009285X	285x85x65x4,0	1,2,6,7,8,11,12,13,17, 18,21,22,23,25,26,27	36	31,3	10,6	1,5

Characteristic load bearing capacities - Force $F_{2/3}$

Table A.3.2.9: Force $F_{2/3}$ Purlin, Two angle brackets / connection, timber-timber

Article-No.	Dimension	Nail number n_V	Nail number n_H	$F_{2/3,Rk}$ [kN]
				Timber
AL1002090	90x48x116x3,0	1,2,3,4,5,8,9,10,11,12, 13,15,16,17,18	22,23,24,25,29,30, 31	13,6
AL1003089	89x89x65x2,5	1,2,6,7,8,9	12,13,16,17,21,22	7,13
AL1004105	105x105x90x3,0	1,2,3,5,6,7,8,9,10,11, 12,13,14,15	18,19,20,21,24,25, 26, 27,30,32,33,34	14,7
AL1005103	103x103x90x3,0	1,2,3,5,6,7,8,9,10,11, 12,13,14,15	18,19,20,21,22,25, 26, 27,30,32,33,34	14,6

Table A.3.2.10: Force $F_{2/3}$ Purlin, One angle bracket / connection, timber-timber

Article-No.	Dimension	Nail number n_V	Nail number n_H	$F_{2/3,Rk}$ [kN] Timber
AL1002090	90x48x116x3,0	1,2,3,4,5,8,9,10,11,12, 13,15,16,17,18	22,23,24,25,29,30,31	6,81
AL1003089	89x89x65x2,5	1,2,6,7,8,9	12,13,16,17,21,22	3,56
AL1004105	105x105x90x3,0	1,2,3,5,6,7,8,9,10,11, 12,13,14,15	18,19,20,21,24,25,26, 27,30,32,33,34	7,34
AL1005103	103x103x90x3,0	1,2,3,5,6,7,8,9,10,11, 12,13,14,15	18,19,20,21,22,25,26, 27,30,32,33,34	7,32

Table A.3.2.11: Force $F_{2/3}$ Purlin, Two angle brackets / connection, timber-concrete/steel

Article-No.	Dimension	Nail number n_V	Bolt number n_H	$F_{2/3,Rk}$ [kN]	Bolt
				Timber	$k_{t,\perp}$
AL1002090	90x48x116x3,0	1,2,3,4,5,8,9	27,28	18,3	0,3
AL1003089	89x89x65x2,5	1,2	20	1,97	0,5
AL1004105	105x105x90x3,0	34,33,32,30	17,16	10,2	0,3
AL1005103	103x103x90x3,0	34,33,32,30	17,16	8,36	0,3
AL1008138	138x85x65x4,0	1,2,4,5,10,11	18	4,68	0,5
AL1008138X	138x85x65x4,0	1,2,4,5,10,11	18	5,59	0,5
AL1009285	285x85x65x4,0	1,2,6,7,8,11,12,13,17, 18,21,22,23,25,26,27	36	9,16	0,5
AL1009285X	285x85x65x4,0	1,2,6,7,8,11,12,13,17, 18,21,22,23,25,26,27	36	10,4	0,5

Table A.3.2.12: Force $F_{2/3}$ Purlin, One angle bracket / connection, timber-concrete/steel

Article-No.	Dimension	Nail number n_V	Bolt number n_H	$F_{2/3,Rk}$ [kN]	Bolt
				Timber	$k_{t,\perp}$
AL1002090	90x48x116x3,0	1,2,3,4,5,8,9	27,28	9,15	0,6
AL1003089	89x89x65x2,5	1,2	20	0,99	1,0
AL1004105	105x105x90x3,0	34,33,32,30	17,16	5,10	0,6
AL1005103	103x103x90x3,0	34,33,32,30	17,16	4,18	0,7
AL1008138	138x85x65x4,0	1,2,4,5,10,11	18	2,34	1,0
AL1008138X	138x85x65x4,0	1,2,4,5,10,11	18	2,80	1,0
AL1009285	285x85x65x4,0	1,2,6,7,8,11,12,13,17, 18,21,22,23,25,26,27	36	4,58	1,0
AL1009285X	285x85x65x4,0	1,2,6,7,8,11,12,13,17, 18,21,22,23,25,26,27	36	5,18	1,0

Characteristic load bearing capacities - Force F_4 / F_5

Table A.3.2.13: Basic Force $F_{4,5}$ Purlin, Two angle brackets / connection, timber-timber

Article-No.	Dimension	Nail number n_V	Nail number n_H	$F_{4/5,Rk}$ [kN]	
				Timber	Steel
AL1002090	90x48x116x3,0	1,2,3,4,5,8,9,10,11,12, 13,15,16,17,18	22,23,24,25,29,30,31	12,3	10,9
AL1003089	89x89x65x2,5	1,2,6,7,8,9	12,13,16,17,21,22	7,92	7,25
AL1004105	105x105x90x3,0	1,2,3,5,6,7,8,9,10,11, 12,13,14,15	18,19,20,21,24,25,26, 27,30,32,33,34	14,4	13,4
AL1005103	103x103x90x3,0	1,2,3,5,6,7,8,9,10,11, 12,13,14,15	18,19,20,21,22,25,26, 27,30,32,33,34	11,0	7,77

Table A.3.2.14: Basic Force F_4 Purlin, One angle bracket / connection, timber-timber

Article-No.	Dimension	Nail number n_V	Nail number n_H	$F_{4,Rk}$ [kN]	
				Timber	Steel
AL1003089	89x89x65x2,5	1,2,6,7,8,9	12,13,16,17,21,22	9,04	5,28
AL1004105	105x105x90x3,0	1,2,3,5,6,7,8,9,10,11, 12,13,14,15	18,19,20,21,24,25,26, 27,30,32,33,34	14,1	9,51
AL1006159	159x159x92,5x2, 0	1,2,3,4,5,6,7,8,9,10, 11	12,13,16,17,20,21,22, 23	9,16	-

Table A.3.2.15: Basic Force F_5 Purlin, One angle bracket / connection, timber-timber

Article-No.	Dimension	Nail number n_V	Nail number n_H	$F_{5,Rk}$ [kN]	
				Timber	Steel
AL1003089	89x89x65x2,5	1,2,6,7,8,9	12,13,16,17,21,22	2,15	2,27
AL1004105	105x105x90x3,0	1,2,3,5,6,7,8,9,10,11, 12,13,14,15	18,19,20,21,24,25,26, 27,30,32,33,34	4,17	4,75

Table A.3.2.16: Basic Force $F_{4/5}$ Purlin, Two angle brackets / connection, timber-concrete/steel

Article-No.	Dimension	Nail number n_V	Bolt number n_H	$F_{4/5,Rk}$ [kN]		Bolt	
				Timber	Steel	$k_{t,II}$	$k_{t,\perp}$
AL1002090	90x48x116x3,0	1,2,3,4,5,8,9	27,28	11,70	9,88	0,4	0,2
AL1003089	89x89x65x2,5	1,2	20	6,53	5,51	0,7	0,1
AL1004105	105x105x90x3,0	34,33,32,30	17,16	9,14	10,8	0,4	0,2
AL1005103	103x103x90x3,0	34,33,32,30	17,16	10,50	6,67	0,4	0,2
AL1008138X	138x85x65x4,0	1,2,4,5,10,11	18	9,39	9,83	0,8	0,5
AL1009285X	285x85x65x4,0	1,2,6,7,8,11, 12,13,17,18, 21,22,23,25, 26,27	36	9,85	9,83	0,7	0,5

Table A.3.2.17: Basic Force F_4 Purlin, One angle bracket / connection, timber-concrete/steel

Article-No.	Dimension	Nail number n_V	Bolt number n_H	$F_{4,Rk}$ [kN]		Bolt	
				Timber	Steel	$k_{t,II}$	$k_{t,\perp}$
AL1003089	89x89x65x2,5	1,2	20	9,96	5,08	1,0	0,0
AL1004105	105x105x90x3,0	34,33,32,30	17,16	15,1	8,03	0,5	0,1
AL1008138X	138x85x65x4,0	1,2,4,5,10,11	18	15,3	7,41	1,0	0,1
AL1009285X	285x85x65x4,0	1,2,6,7,8,11, 12,13,17,18, 21,22,23,25, 26,27	36	16,2	7,38	1,0	0,0

Table A.3.2.18: Basic Force F_5 Purlin, One angle bracket / connection, timber-concrete/steel

Article-No.	Dimension	Nail number n_V	Bolt number n_H	$F_{5,Rk}$ [kN]		Bolt	
				Timber	Steel	$k_{t,II}$	$k_{t,\perp}$
AL1003089	89x89x65x2,5	1,2	20	2,17	1,83	1,0	0,4
AL1004105	105x105x90x3,0	34,33,32,30	17,16	2,38	9,23	0,5	0,8
AL1008138X	138x85x65x4,0	1,2,4,5,10,11	18	2,32	3,99	1,0	1,9
AL1009285X	285x85x65x4,0	1,2,6,7,8,11, 12,13,17,18, 21,22,23,25, 26,27	36	2,46	3,44	1,0	1,9

A.3.3 Cantilever brackets

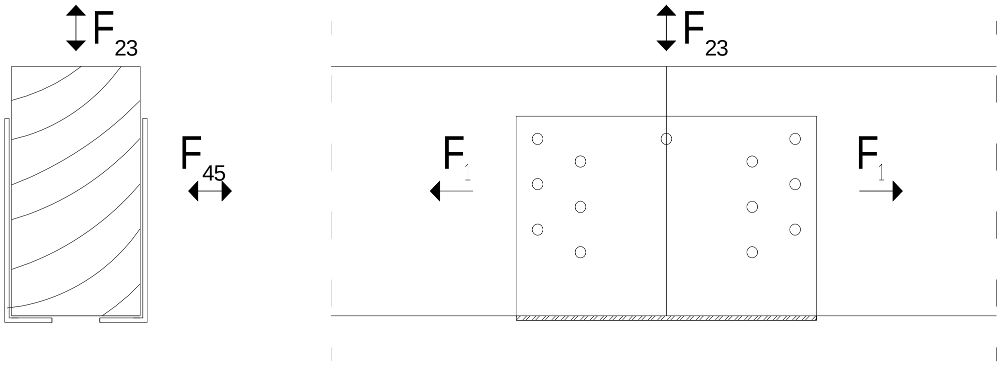


Figure A.3.2 Definitions of forces and their directions

Double cantilever brackets per connection

The cantilever brackets must be placed at each side opposite to each other, symmetrically to the component axis (see Figure A.3.2).

Acting forces:

F_1	Centrical tensional force at the height of the centroid of the nail group. If the load is applied with an eccentricity, resulting moments have to be considered by the designer.
F_2 and F_3	Centrical lateral force acting vertical in the contact area of both components.
F_4 and F_5	Centrical lateral force at the height of the centroid of the nail group, acting horizontal in the contact area of both components. The components shall be prevented from rotation. If the load is applied with an eccentricity, resulting moments have to be considered by the designer.

Timber splitting caused by load components perpendicular to the grain

It must be checked in accordance with Eurocode 5 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:

$$\left(\frac{F_{1,Ed}}{F_{1,Rd}}\right)^2 + \left(\frac{F_{2,Ed}}{F_{2,Rd}}\right)^2 + \left(\frac{F_{3,Ed}}{F_{3,Rd}}\right)^2 + \left(\frac{F_{4,Ed}}{F_{4,Rd}}\right)^2 + \left(\frac{F_{5,Ed}}{F_{5,Rd}}\right)^2 \leq 1 \qquad \text{(A.3.7)}$$

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, and F_4 or F_5, respectively, is able to act simultaneously with F_1, while the other shall be set to zero.

Characteristic load-carrying capacities

Table A.3.3.1: Force F_1, Two cantilever brackets / connection, timber-timber

Article-No.	Dimension	Nail number n_V	Nail number n_H	$F_{1,Rk}$ [kN]
				Timber
AL1001220	220x20x180x2,0	1,2,3,4,5,6,7,8,9,10,11, 12,13,14,15,16,17,18, 19	38,39,40,41,42,43,44, 45,46,47,48,49,50,51, 52,53,54,55,56	61,3

Table A.3.3.2: Force $F_{2/3}$, Two cantilever brackets / connection, timber-timber

Article-No.	Dimension	Nail number n_V	Nail number n_H	$F_{2/3,Rk}$ [kN]
				Timber
AL1001220	220x20x180x2,0	1,2,3,4,5,6,7,8,9,10,11, 12,13,14,15,16,17,18, 19	38,39,40,41,42,43,44, 45,46,47,48,49,50,51, 52,53,54,55,56	25,7

Table A.3.3.3: Force $F_{4/5}$, Two cantilever brackets / connection, timber-timber

Article-No.	Dimension	Nail number n_V	Nail number n_H	$F_{4/5,Rk}$ [kN]	
				Timber	Steel
AL1001220	220x20x180x2,0	1,2,3,4,5,6,7,8,9,10,11, 12,13,14,15,16,17,18, 19	38,39,40,41,42,43,44, 45,46,47,48,49,50,51, 52,53,54,55,56	6,85	3,39

A.3.4 Joist hangers

Definitions of forces, their directions and eccentricities

The downward and the upward directed forces are assumed to act in the middle of the joist. The lateral force is assumed to act at an distance $e_{z,J}$ or $e_{z,H}$ above the centre of gravity of the nails in the joist or header, respectively. The joist axial force is assumed to act in the centre of gravity of the fasteners in the joist. The header shall be sufficiently torsional rigid. Torsional moments in the header, caused by the eccentricity ($b_H/2+e_{x,J}$) of the vertical load, shall be considered.

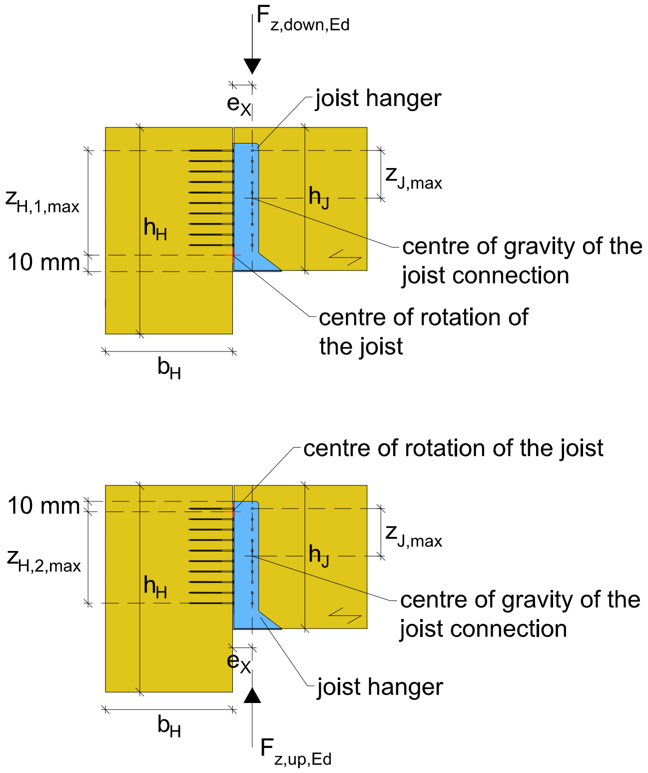


Figure A.3.3 Load direction Z: notation and joist hanger dimensions

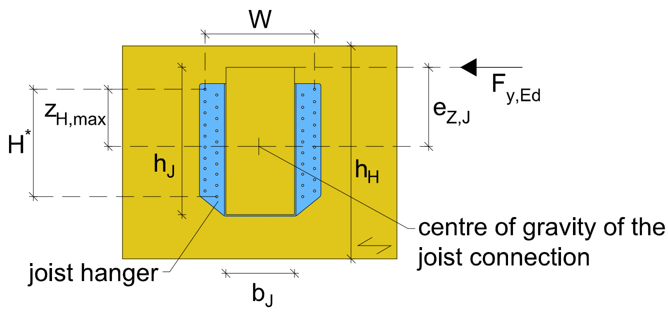


Figure A.3.4 Load direction Y: notation and joist hanger dimensions

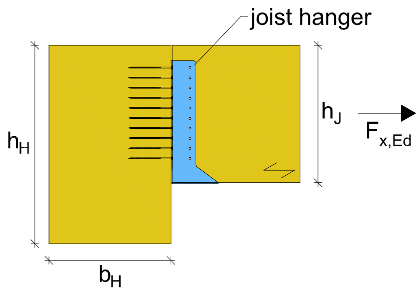


Figure A.3.5 Load direction X: notation and joist hanger dimensions

Fastener specification

The width of the joist hangers shall be at least the penetration length of the fasteners + 4·d, where d is the nominal diameter of the nails.

Load-carrying capacities

Table A.3.4.1: Dimensions, Ailong joist hangers with exterior flanges, timber-timber

Type	Dimensions in mm													
	B	H	t	e_1	e_2	$e_{x,J}$	$e_{z,J}$	$e_{z,H}$	b_J	ℓ	n_H	n_J	$k_{H,1}$	$k_{H,2}$
AL 1007725	135	72.5	2.0	609	290	29.75	48.0	48.0	60,5	70,5	6*)	6	5,39	5,95
AL1011140	248	180	4.0	476	355	94	-	-	140	110	3	10	2.34	3.23
AL1011160	268	180	4.0	533	362	94	-	-	160	110	3	10	2.34	3.23
AL1011160X	268	240	4.0	784	742	94	-	-	160	110	5	14	3.93	5.36
AL1011180	288	220	4.0	892	738	94	-	-	180	110	5	14	3.62	5.01

*) The nails in the header shall be put in the holes closest to the bend line.

Force downward toward the bottom plate:

$$F_{Z,Rk} = \min \begin{cases} n_J \cdot F_{v,J,Rk} + 3,24 \cdot t \cdot \sqrt{\ell \cdot (\ell + 30) \cdot \rho_k} \\ \dfrac{1}{\sqrt{\left(\dfrac{1}{n_H \cdot F_{v,H,Rk}}\right)^2 + \left(\dfrac{1}{k_{H,1} \cdot F_{ax,H,Rk}}\right)^2}} \end{cases} \quad [N] \qquad (A.3.8)$$

Force upward away from the bottom plate:

$$F_{Z,Rk} = \min \begin{cases} n_J \cdot F_{v,J,Rk} \\ \dfrac{1}{\sqrt{\left(\dfrac{1}{n_H \cdot F_{v,H,Rk}}\right)^2 + \left(\dfrac{1}{k_{H,2} \cdot F_{ax,H,Rk}}\right)^2}} \end{cases} \quad [N] \qquad (A.3.9)$$

Ailong Metal Angle Brackets	Annex 3.12
Characteristic load-carrying capacities – Joist hangers	

Lateral force:

$$F_{Y,Rk} = \min \begin{cases} \dfrac{n_J \cdot F_{v,J,Rk}}{\sqrt{\left(\dfrac{2 \cdot \sqrt{e_{x,J}^2 + e_{z,J}^2}}{b_J}\right)^2 + \left(\dfrac{F_{v,J,Rk}}{F_{ax,J,Rk}}\right)^2}} \\ \dfrac{F_{v,H,Rk}}{\sqrt{\left(\dfrac{1}{n_H} + \dfrac{e_{z,H}}{e_1}\right)^2 + \left(\dfrac{e_{z,H}}{e_2}\right)^2}} \end{cases} \quad \text{[N]} \qquad \text{(A.3.10)}$$

Loads perpendicular to the header surface (only types AL1011140, AL1011160, AL1011160X and AL1011180):

$$F_{X,Rk} = \min \begin{cases} n_J \cdot F_{v,J,Rk} \\ 0{,}35 \cdot n_H \cdot F_{ax,H,Rk} \\ 3{,}91 \cdot (b_J + 2 \cdot H - n_H \cdot 18\,\text{mm}) \cdot t^2 \end{cases} \quad \text{[N]} \qquad \text{(A.3.11)}$$

Where

n_J total number of nails in both sides of the joist,

n_H total number of nails in both header flaps,

t steel plate thickness of joist hanger,

ℓ length of joist hanger's bottom plate parallel to joist axis,

ρ_k characteristic joist density,

$F_{v,Rk}$ Characteristic lateral load-carrying capacity of the nails in the joist or in the header indicated by the indices J or H; a thick steel plate in single shear may be assumed.

$F_{ax,Rk}$ Characteristic axial load-carrying capacity of the nails in the joist or in the header indicated by the indices J or H.

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

$f_{ax,k} = 50 \times 10^{-6} \times \rho_k^2$ [N/mm²]

ρ_k characteristic density of the timber [kg/m³],

d nail diameter [mm],

t_{pen} penetration depth of the profiled shank including the nail point in mm, $t_{pen} \geq 30$ mm,

b_J width of the joist hanger or nominal joist width, see Figure A.3.4,

H inner depth of the joist hanger,

$e_{z,J}$ distance of the lateral force $F_{Y,Ed}$ above the centre of gravity of the nails in the joist perpendicular to the grain of the joist, see Figure A.3.4,

$e_{x,J}$ distance of the lateral force $F_{Y,Ed}$ from the centre of gravity of the nails in the joist to the surface of the header, see Figure A.3.3,

$e_{z,H}$ distance of the lateral force $F_{Y,Ed}$ above the centre of gravity of the nails in the header,

$k_{H,1}$ form factor,

$k_{H,2}$ form factor,

e_1, e_2 auxiliary quantities.

Ailong Metal Angle Brackets	Annex 3.13
Characteristic load-carrying capacities – Joist hangers	

Timber splitting caused by load components perpendicular to the grain

It must be checked in accordance with Eurocode 5 that splitting will not occur.

Combined forces

In case of combined forces, the following inequality shall be fulfilled:

$$\left(\frac{F_{X,Ed}}{F_{X,Rd}}\right)^2+\left(\frac{F_{Y,Ed}}{F_{Y,Rd}}\right)^2+\left(\frac{F_{Z,Ed}}{F_{Z,Rd}}\right)^2\leq 1 \qquad (A.3.12)$$

Characteristic load-carrying-capacities of the joist hanger connections with bolts

For joist hangers connected to a wall of concrete, lightweight concrete or to a steel member the assumptions for the calculation of the load-carrying capacity of the connection are:

- The force transfer from the joist to the joist hanger is as for a timber-to-timber connection.
- The bolts shall always be positioned symmetrically about the vertical axis of the joist hanger.
- Washers in accordance with EN ISO 7094 shall be installed under the upper 2 bolt heads or nuts.

Description of the static model

For a downward directed force toward the bottom plate the static behaviour is basically the same as for a timber-to-timber connection with nails.

The fasteners in the joist are subjected to a lateral force, which is equally distributed over the nails in the joist.

Since the concrete and steel have a larger compressive strength than timber subjected perpendicular to the grain the rotation point may be assumed positioned at the top of the bottom plate.

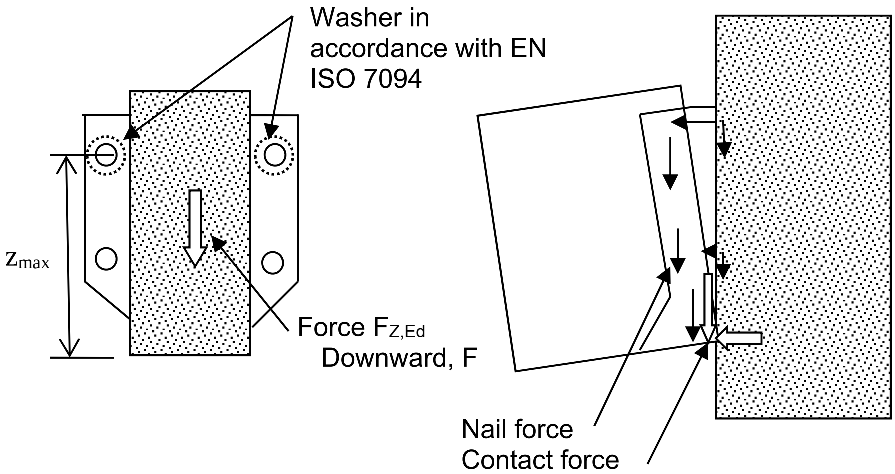


Figure A.3.6
Left: Cross section in joist. Right: The joist will deflect and rotate, at the bottom a contact force will occur at the bottom plate, and the withdrawal forces in the bolts in the wall will vary linearly as assumed for nailed connections in the header.

The forces in the bolts will be partly lateral forces, partly withdrawal forces. The lateral forces are distributed evenly over all bolts. The withdrawal forces are on the safe side assumed to be taken by the 2 upper bolts with washers. The maximum withdrawal force in an upper bolt can be calculated from:

$$F_{ax,bolt} = \frac{F_{Z,Ed} \cdot e_x}{2 \cdot z_{H,max}} \qquad \text{(A.3.13)}$$

Where

$F_{Z,Ed}$ downward directed force toward the bottom plate,

e_x distance from the centre of gravity of the fasteners in the joist to the surface of the header,

$z_{H,max}$ maximum distance from upper bolt to the bottom plate (rotation point), see Figure A.3.6.

The upper 2 bolts are critical. They are subjected to a lateral force and a withdrawal force. The lateral force is determined assuming an even distribution of the downward force $F_{Z,Ed}$.

$$F_{lat,bolt} = F_{Z,Ed} / n_{bolt} \qquad \text{(A.3.14)}$$

Characteristic capacities of a bolted joist hanger connection

The characteristic capacity of the connection between the joist and the joist hanger can be calculated from the same assumptions and formulas as for joist hangers nailed to a wooden header.

$$F_{Z,Rk} = n_J \cdot F_{v,J,Rk} + 3{,}24 \cdot t \cdot \sqrt{\ell \cdot (\ell + 30) \cdot \rho_k} \qquad \text{(A.3.15)}$$

It shall be verified by the design of the bolted connection that the upper bolts have sufficient load-carrying design capacity to carry the combined lateral and axial forces.

From the characteristic capacity of the bearing resistance between the bolt and the plate of the joist hanger the following maximum characteristic capacity of the joist hanger connection can be determined.

$$F_{bear,Rk} = n_{bolt} \cdot f_{u,k} \cdot d \cdot t \qquad \text{(A.3.16)}$$

Where

n_{bolt} total number of bolts in the 2 flaps

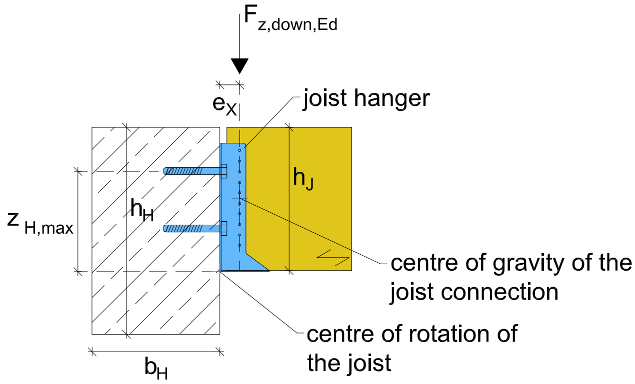
$f_{u,k}$ characteristic ultimate tensile strength of the steel, 330 MPa

d diameter of the bolt

t thickness of the steel plate of the joist hanger

The characteristic load-carrying capacity of the joist hanger connections is the minimum of:

- The capacity determined from (A.3.15) from the nails in the joist
- The capacity determined from (A.3.16) from the embedding strength of the steel plate against the bolt
- The capacity controlled by the bolt forces given by (A.3.13) and A.3.14).



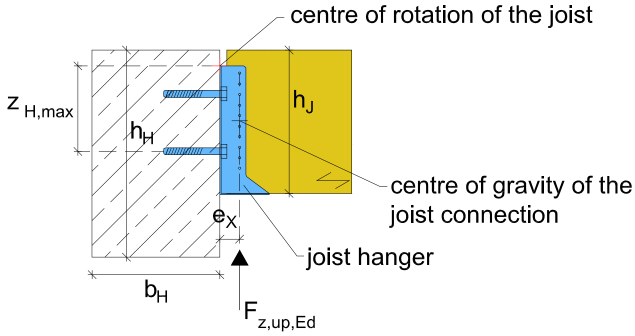


Figure A.3.7 Load direction Z: notation and joist hanger dimensions

A.3.5 Turnbuckles

Definitions of forces, their directions and eccentricity

The turnbuckle is loaded exclusively by a tensional force F_1. The threaded part of the tensioning bolt has to tie in fully in the screw sleeve. The load-carrying capacity of the connected wind braces has to be determined separately.

Load carrying capacity

Table A.3.5.1: Force F_1, One turnbuckle / connection, steel-steel

Article-No.	Dimension	Bolt number n	$F_{1,Rk}$ [kN]
			Steel
AL1010030	125x24x30x2	1,2,5,6,7,8,11,12	13,1

Annex 4 Reference documents

The following documents, in whole or in part, are normatively referenced in this European Technical Assessment and are indispensable for its application.

EN 338:2016	Structural timber – Strength classes
EN 636:2012+A1:2015	Plywood – Specifications
EN 1993-1-4:2006+A1:2015	Design of steel structures – Part 1-4-: General rules – Supplementary rules for stainless steels
EN 1993-1-8:2005+AC:2009	Design of steel structures – Part 1-8-: General rules – Design of joints
EN 1995-1-1: 2004+A1:2008+A2:2014	Design of timber structures – Part 1-1: General – Common rules and rules for buildings
EN 10025-2:2019	Hot rolled products of structural steels. Part 2: Technical delivery conditions for non-alloy structural steels
EN 10111:2008	Continuously hot rolled low carbon steel sheet and strip for cold forming – Technical delivery conditions
EN 10346:2015	Continuously hot-dip coated steel flat products for cold forming – Technical delivery conditions
EN 13986:2004+A1:2015	Wood-based panels for use in construction – Characteristics, evaluation of conformity and marking
EN 14080:2013	Timber structures – Glued laminated timber – Requirements
EN 14081-1:2005+A1:2011	Timber structures – Strength graded structural timber with rectangular cross section – Part 1: General requirements
EN 14374:2004	Timber structures – Structural laminated veneer lumber – Requirements
EN 14592:2008+A1:2012	Timber structures – Dowel-type fasteners – Requirements
EN 15497:2014	Structural finger jointed solid timber – Performance requirements and minimum production requirements
EN ISO 4017:2014	Fasteners – Hexagon head screws – Product grades A and B
EN ISO 4032:2012	Hexagon regular nuts (style 1) – Product grades A and B
EN ISO 7091:2000	Plain washers – Normal series, Product grade C