Deutsches Institut für Bautechnik

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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 24 April 2019

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 Linfu Road 3#, Linpu Town XIAOSHAN, HANGZHOU ZHEJIANG VOLKSREPUBLIK CHINA
Manufacturing plant	
This European Technical Assessment contains	37 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	ETAG 015, used as EAD according to Article 66 Paragraph 3 of Regulation (EU) No 305/2011.

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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 according to EN 14592 and to concrete or steel members with metal anchors or bolts. They are made from carbon steel according to 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

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

In accordance with ETAG 015 used as EAD the applicable European legal act is: [97/638/EC (EU)].
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 24 April 2019 by Deutsches Institut für Bautechnik

Dr.-Ing. Lars Eckfeldt
p. p. Head of Department

beglaubigt:
Dewitt

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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 according to 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
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	

Ailong Metal Angle Brackets	Annex 1.1
Product details and definitions	

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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
Turnbuckles							
AL1010030	125x24x30x2,0	124	126	23	25	29	31
		-		**Diameter** in mm		**Width** in mm	
	∅ 10,0x100	-	-	9,7	10,1	98	102
	∅ 20,0x30	-	-	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	

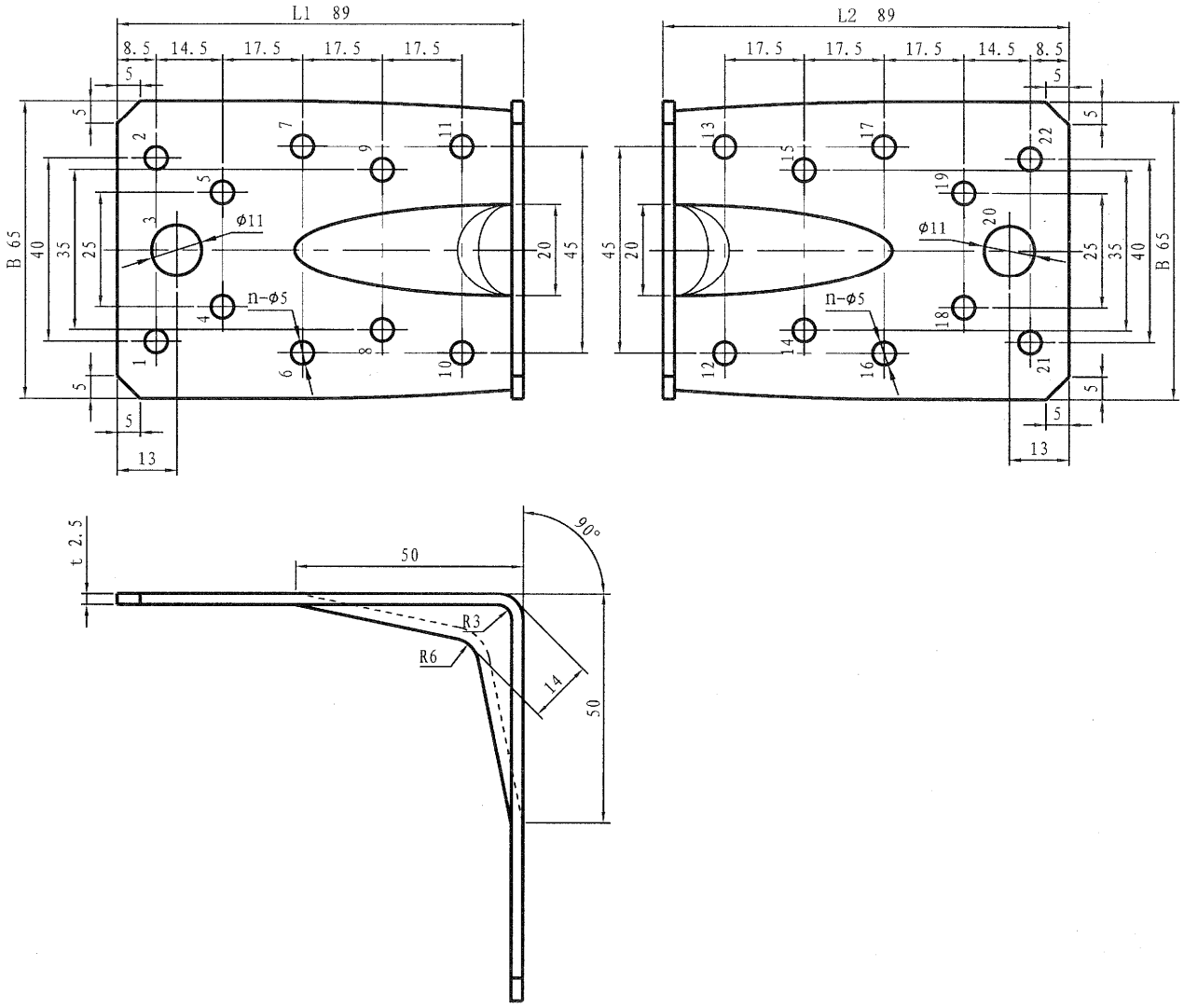
Table A.1.3: Nail specification

Three-dimensional nailing plate type	Nail diameter	Nail length	Nail type
Angle brackets and cantilever brackets	4.0 mm	≥ 40 mm	Ringed shank nails according to 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	4.0 mm	L 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 according to EN ISO 4032
Metal anchor (connection to concrete members)		
10.0 mm, 12.0 mm *)	Max. 2 mm larger than the anchor diameter	Metal anchors according to ETA See specification of the manufacturer
*) Bolts / Metal anchors have to be used with washers according to EN ISO 7091.		

Ailong Metal Angle Brackets	Annex 1.3
Product details and definitions	



Ailong Metal Angle Brackets	Annex 1.4
Angle bracket AL1003089	

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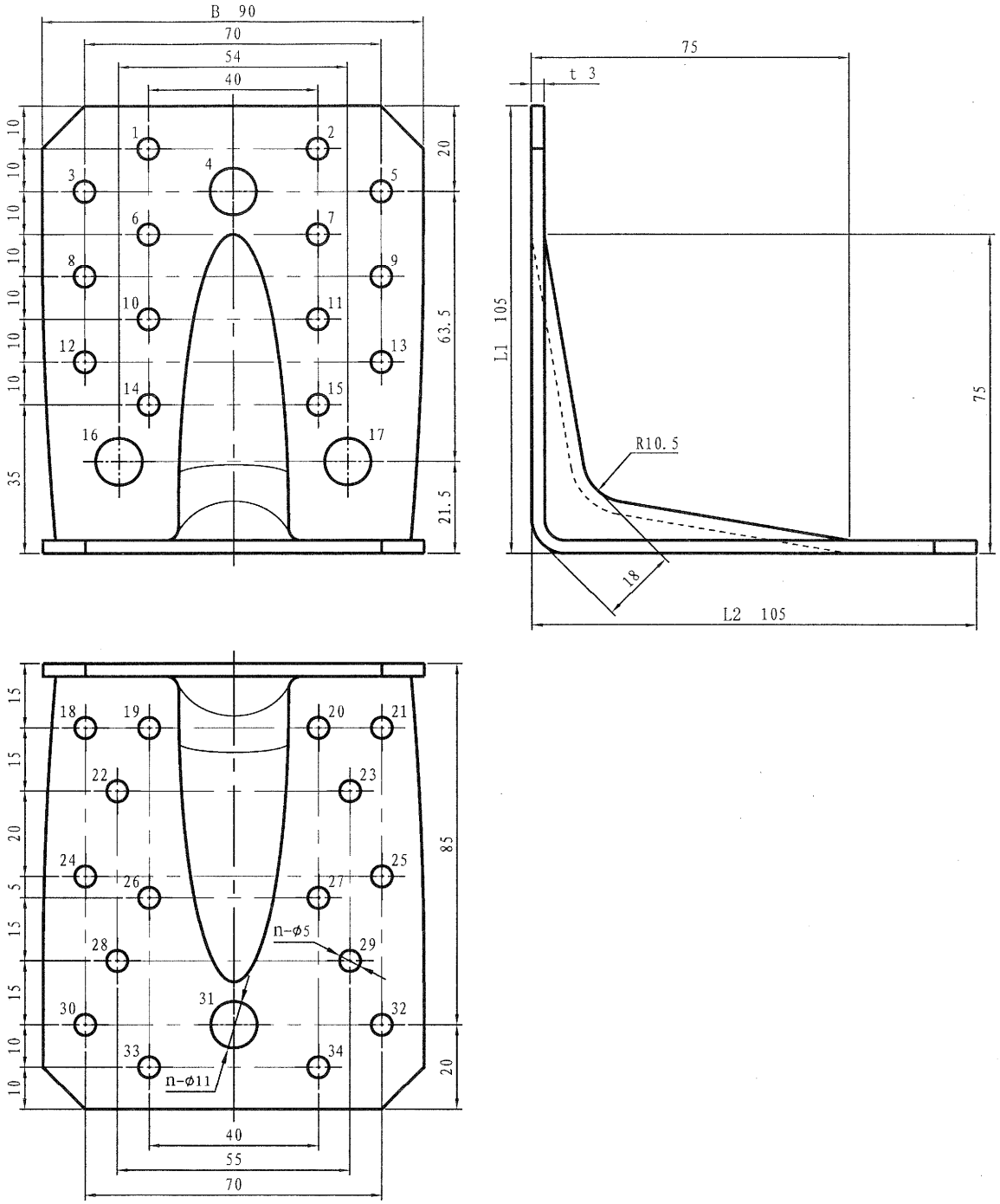

Ailong Metal Angle Brackets	Annex 1.5
Angle bracket AL1004105	

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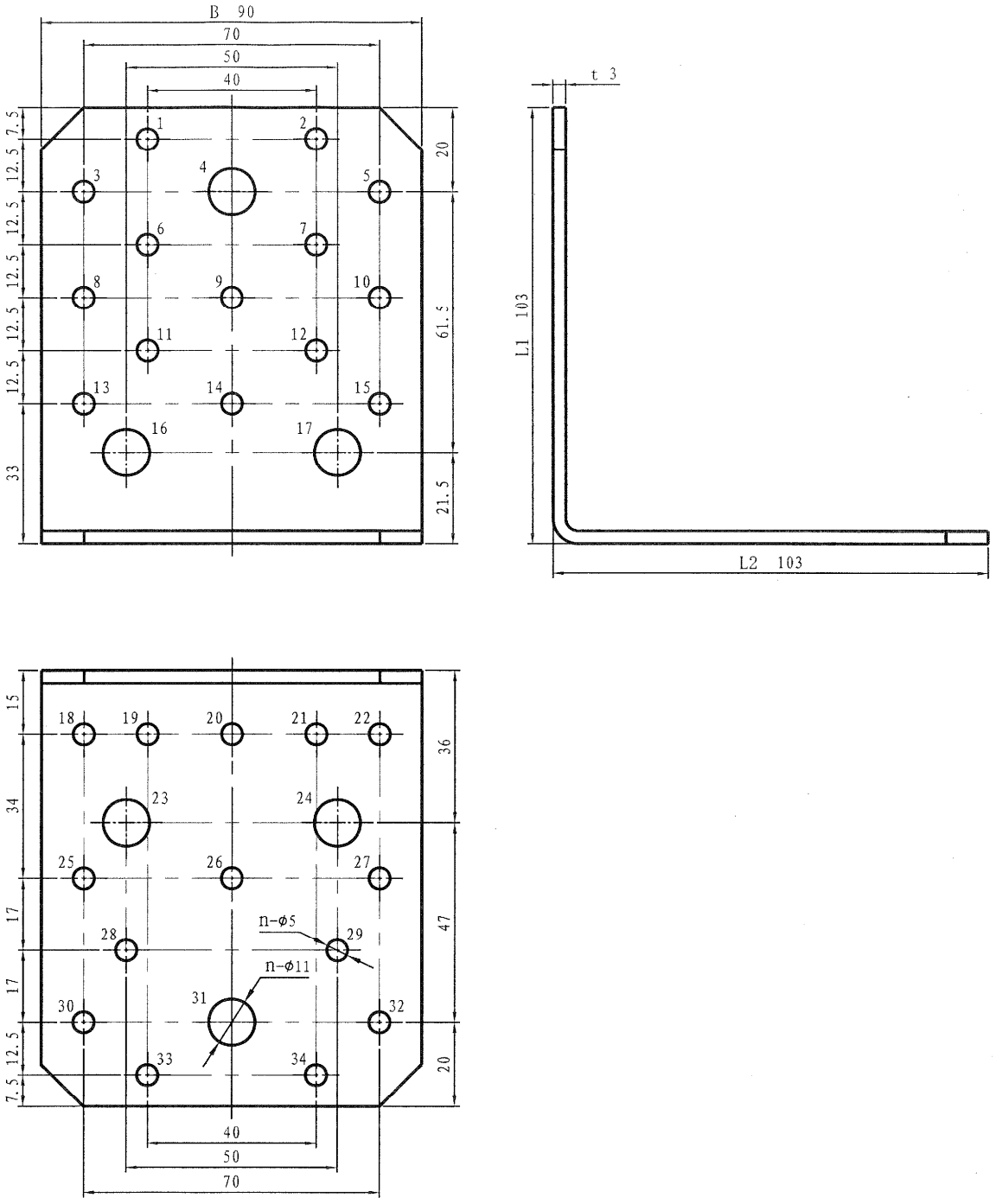

Ailong Metal Angle Brackets	Annex 1.6
Angle bracket AL1005103	

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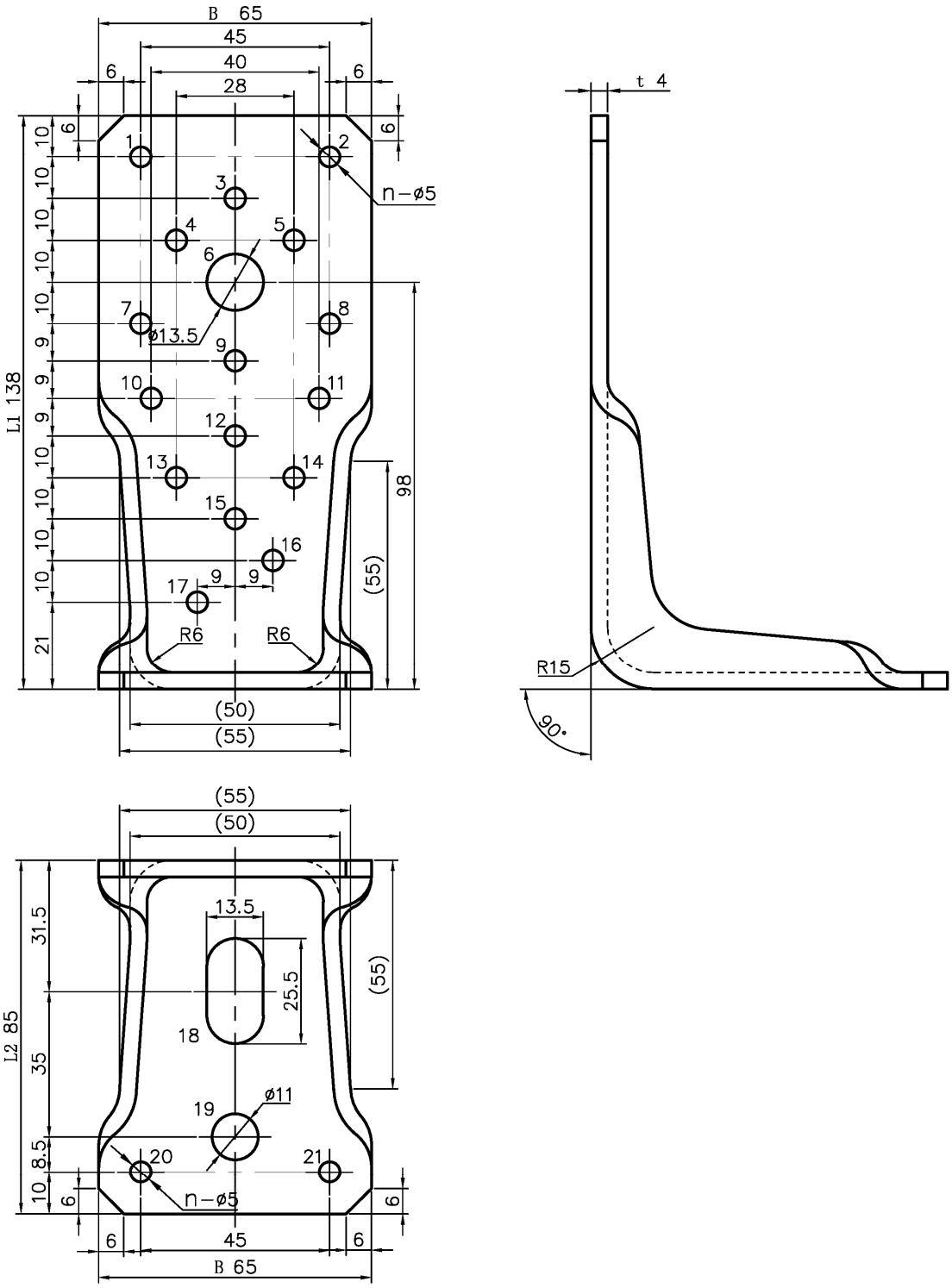

Ailong Metal Angle Brackets	Annex 1.7
Angle bracket AL1008138	

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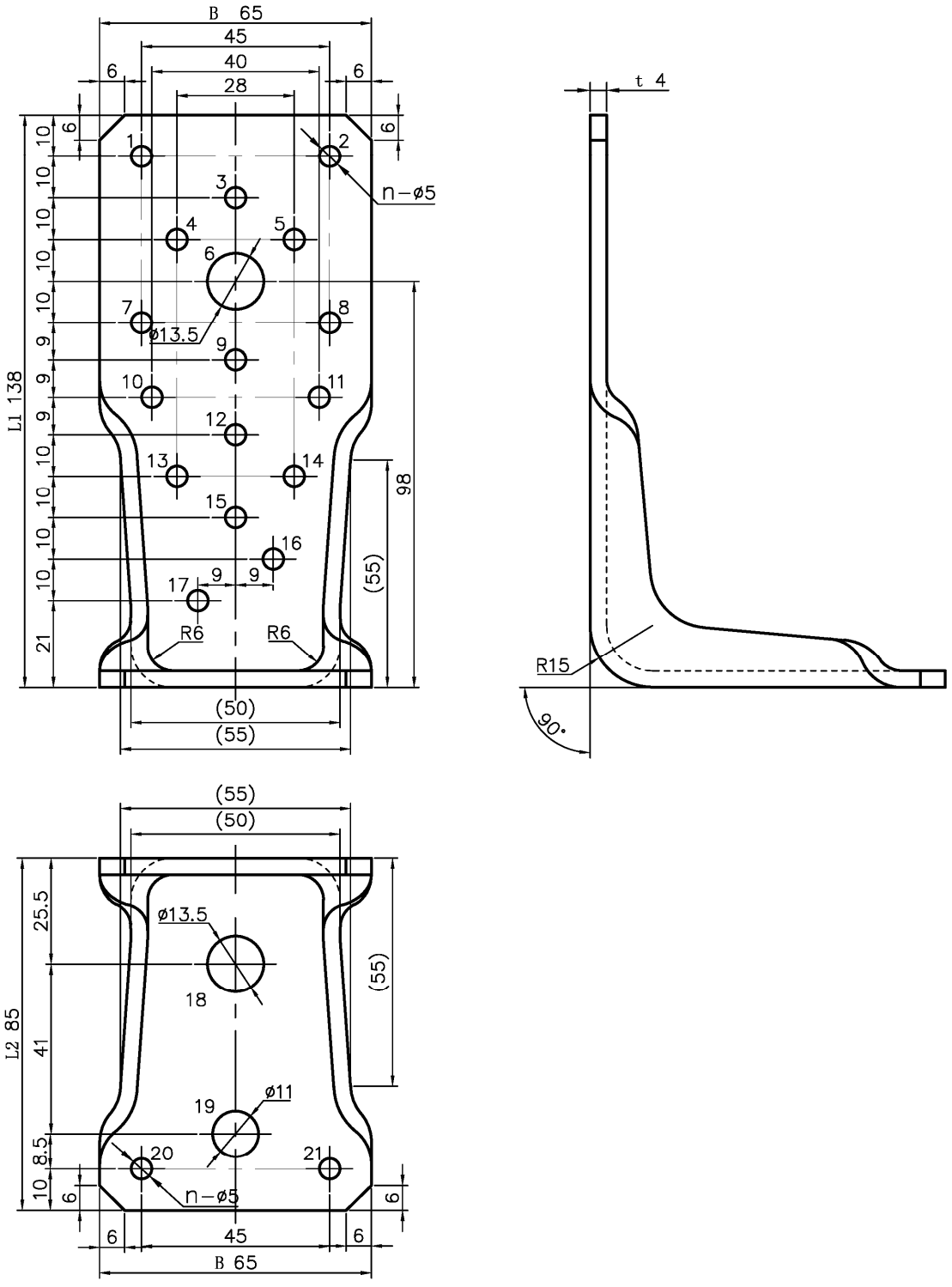

Ailong Metal Angle Brackets	Annex 1.8
Angle bracket AL1008138X	

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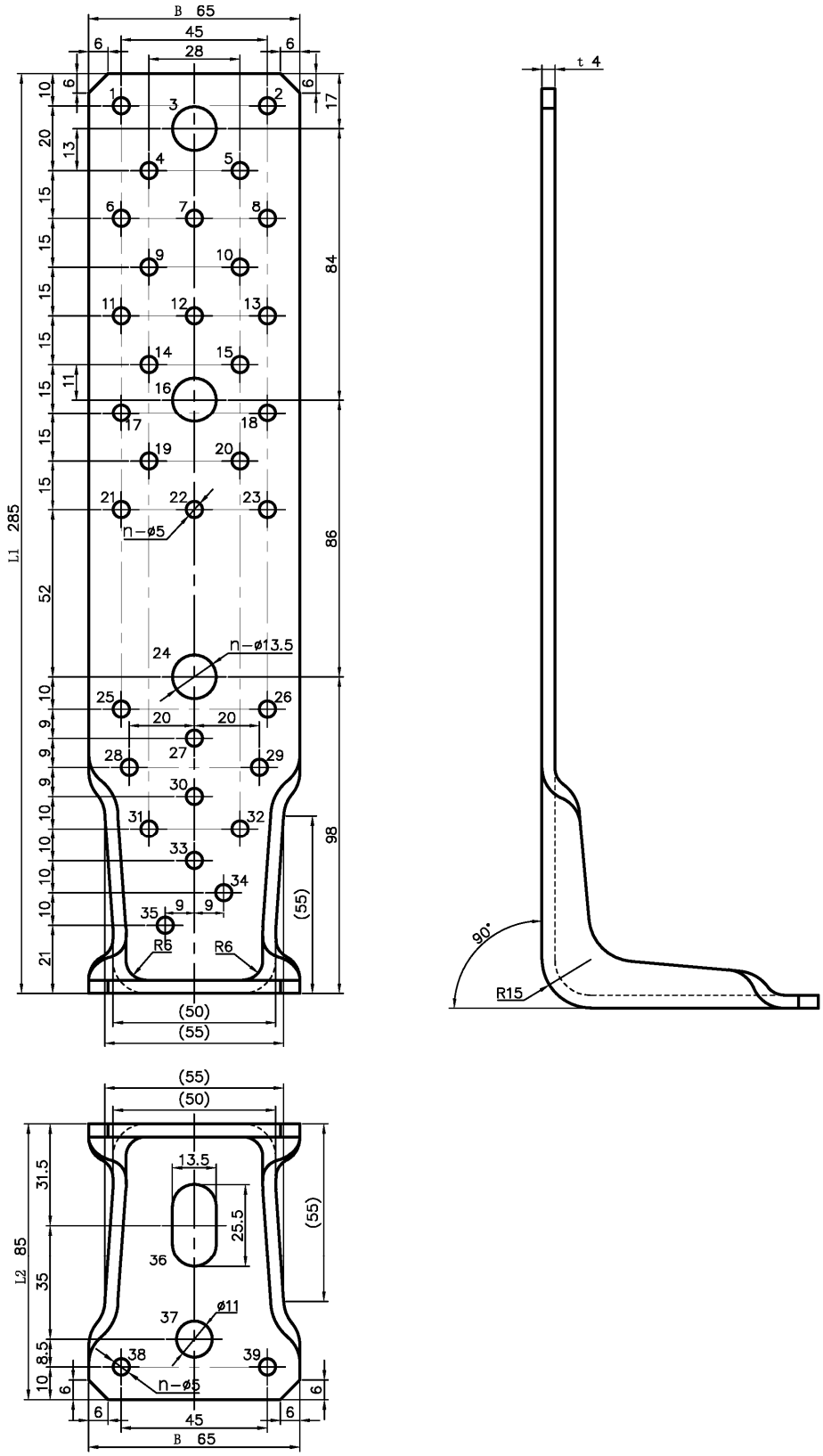

Ailong Metal Angle Brackets	Annex 1.9
Angle bracket AL1009285	

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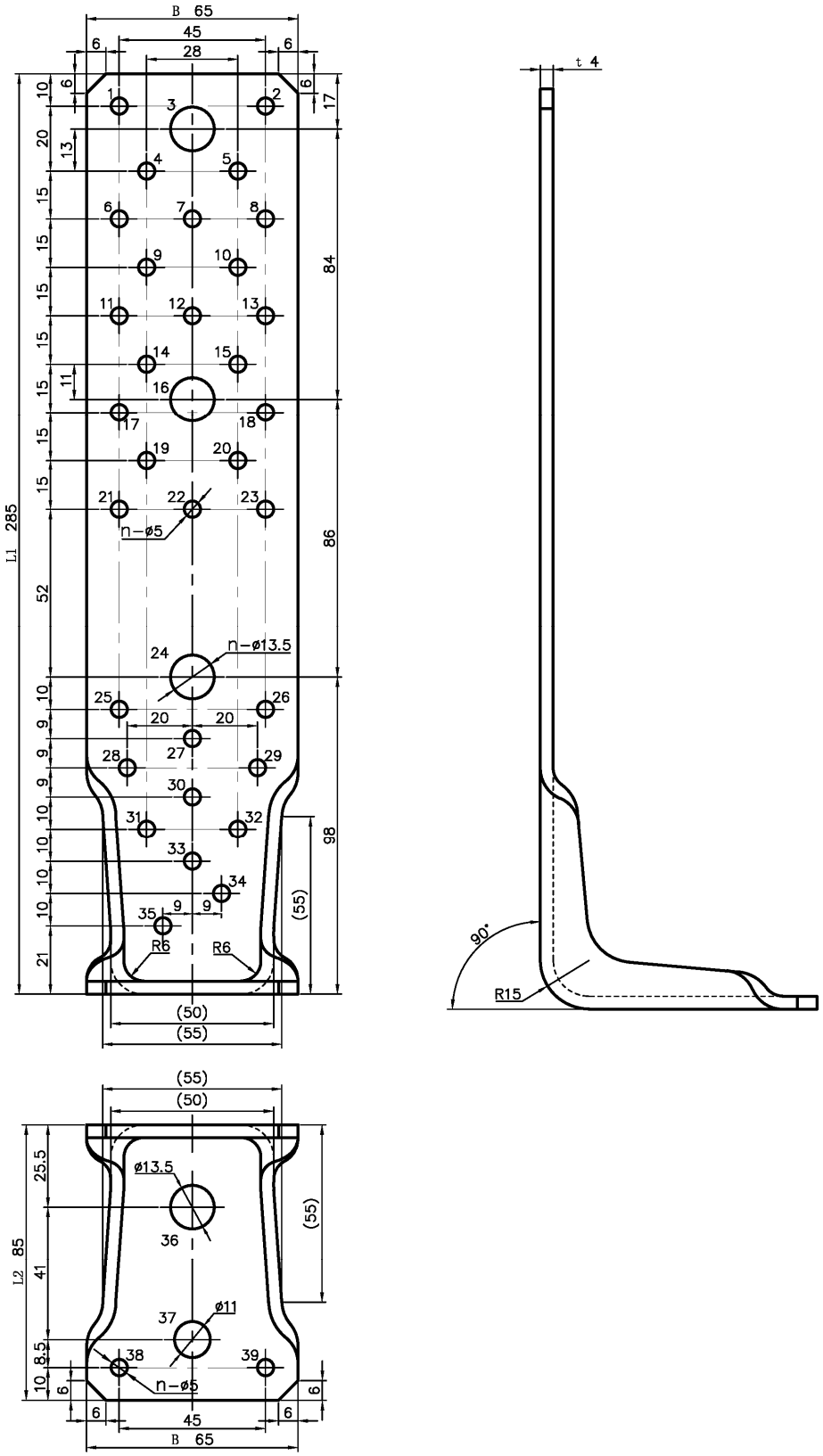

Ailong Metal Angle Brackets	Annex 1.10
Angle bracket AL1009285X	

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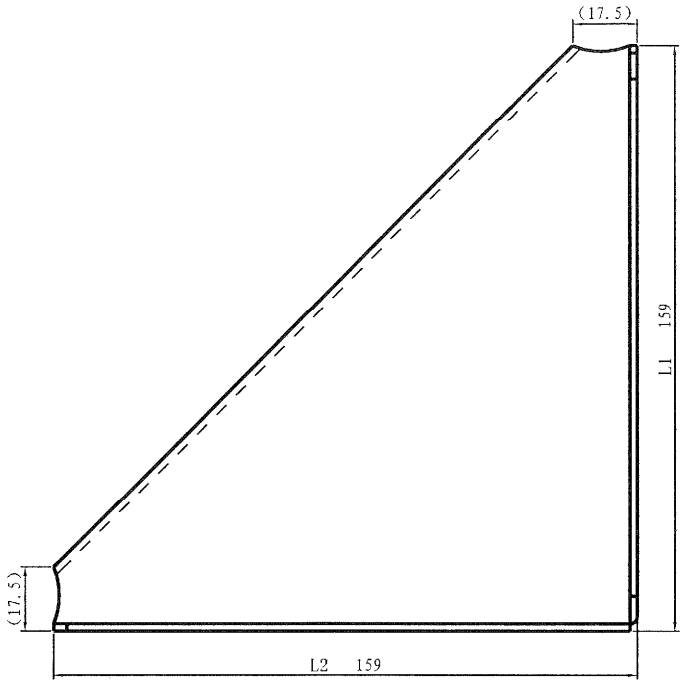

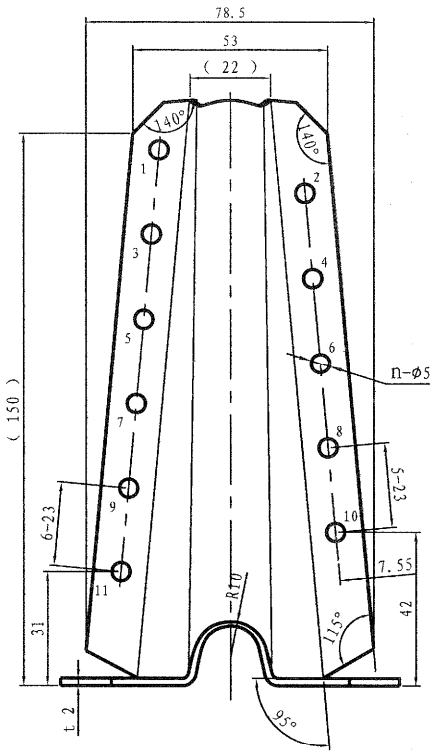

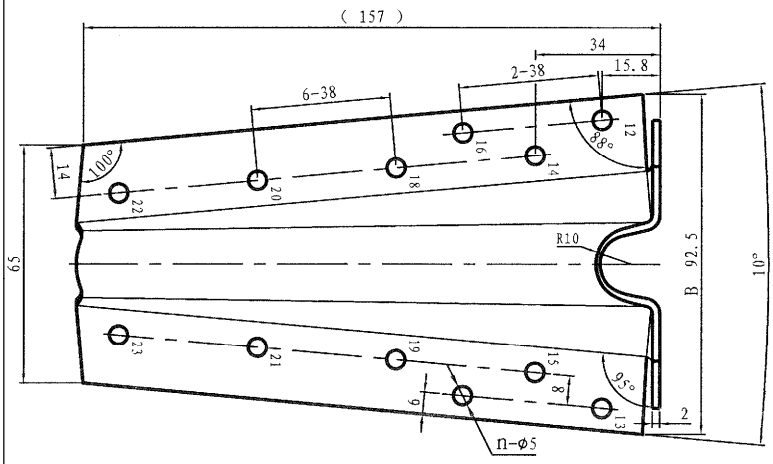

Ailong Metal Angle Brackets	Annex 1.11
Angle bracket Triangle U bracket AL1006159	

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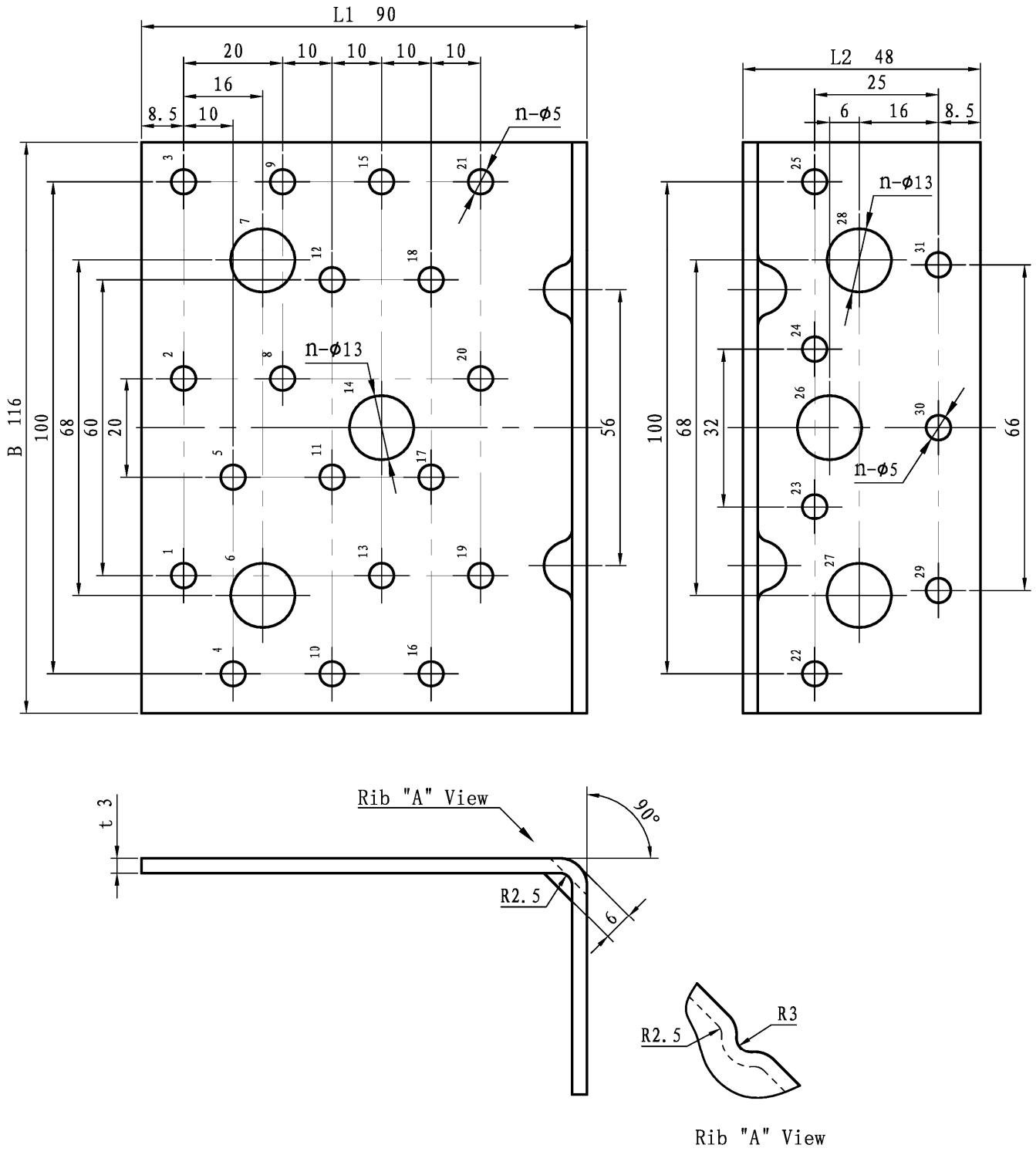

Ailong Metal Angle Brackets	Annex 1.12
Angle bracket AL1002090	

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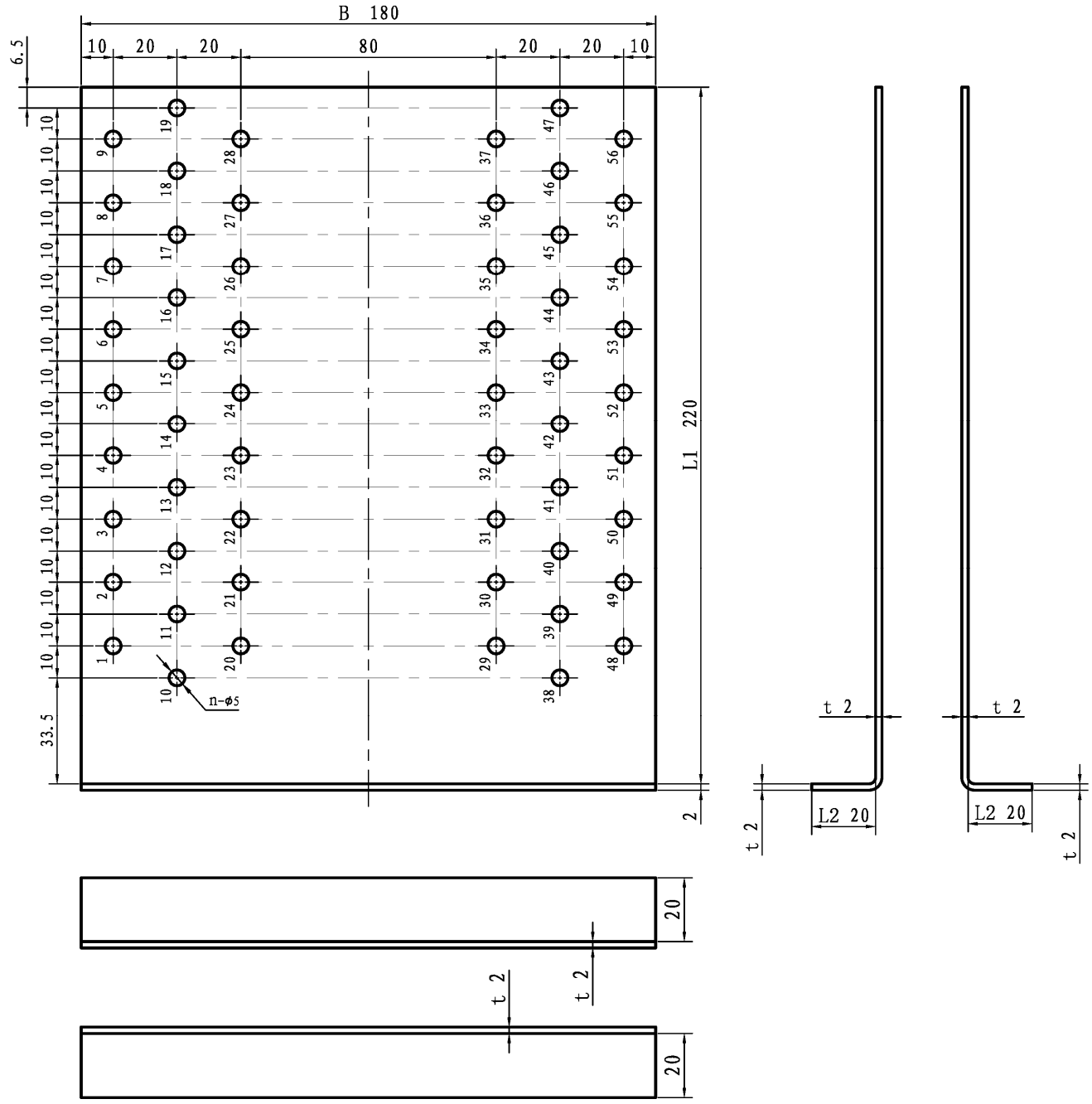

Ailong Metal Angle Brackets

Cantilever bracket AL1001220

Annex 1.13

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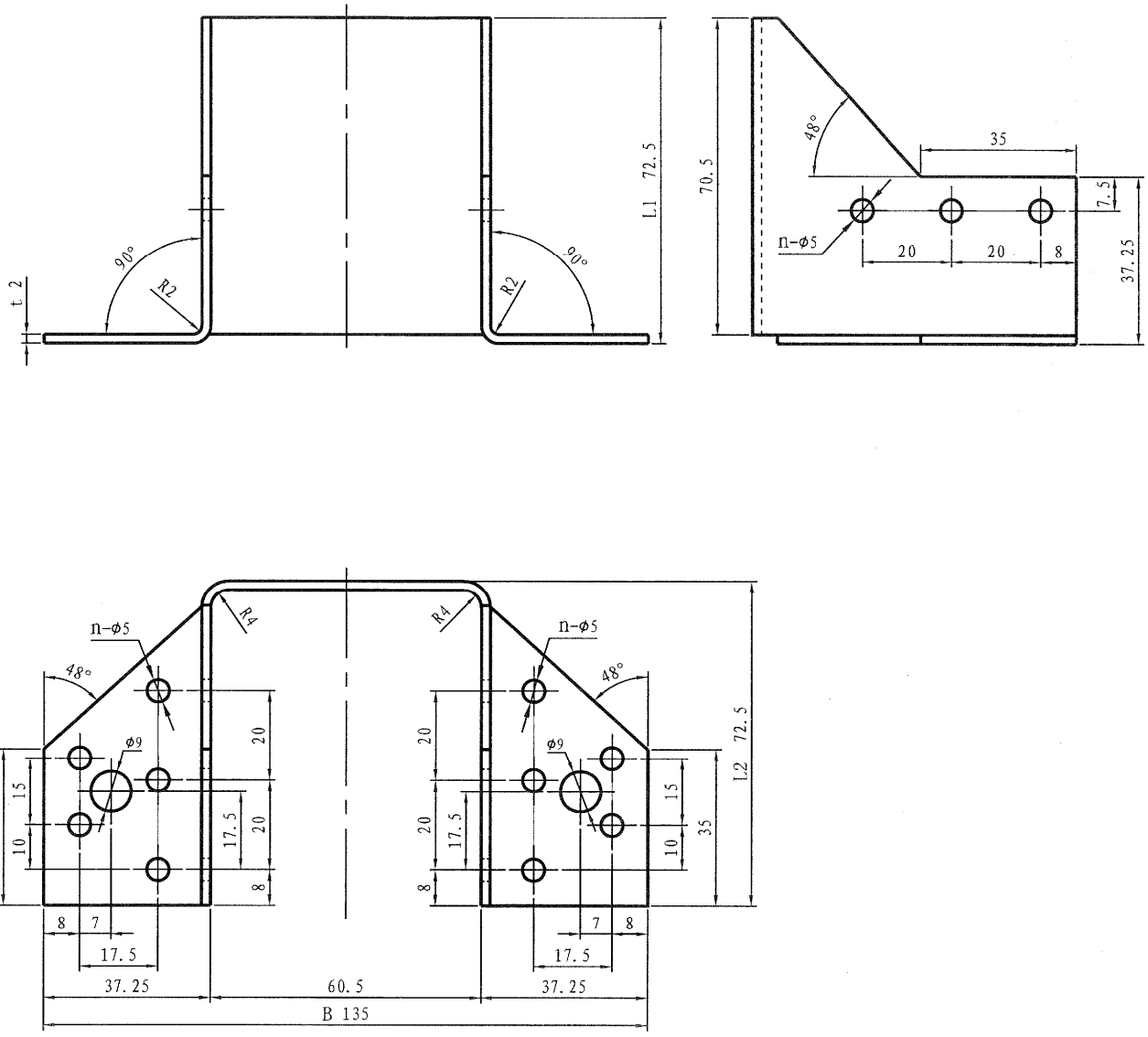
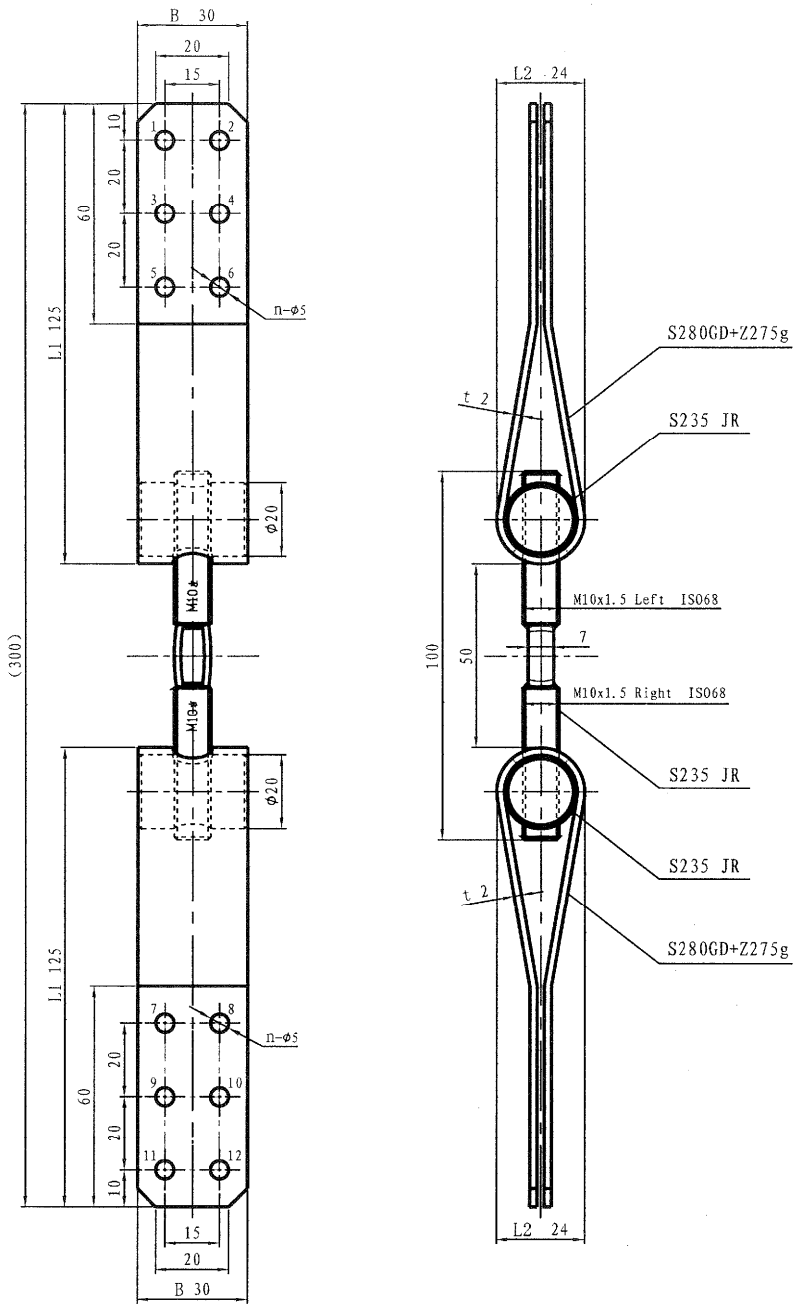


Ailong Metal Angle Brackets	Annex 1.14
Joist hanger AL1007725	



Ailong Metal Angle Brackets	Annex 1.15
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. Connections to a concrete structure or a steel member are 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 according to EN 338/ EN 14081-1,
- Structural finger jointed solid timber (softwood) according to EN 15497,
- Glued laminated timber (softwood) according to EN 14080,
- Glued solid timber (softwood) according to EN 14080 or national provisions that apply at the installation site,
- Cross laminated timber (softwood) according to European Technical Assessment, arrangement of the nails only perpendicular to the lateral face,
- Laminated veneer lumber LVL (softwood) according to 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 or in the respective national technical building regulations 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. Regarding use and environmental conditions national provisions at the building site shall apply. It shall be ensured that the nails, bolts and anchors, used to connect the three-dimensional nailing plates, have a sufficient corrosion protection according to the national provisions at the building site.

Ailong Metal Angle Brackets	Annex 2.1
Specifications of intended use	

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A.2.5 Installation provisions

General

EN 1995-1-1 in conjunction with the respective national annex 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 according to 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 in combination with the respective national annex 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.

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Typical uses

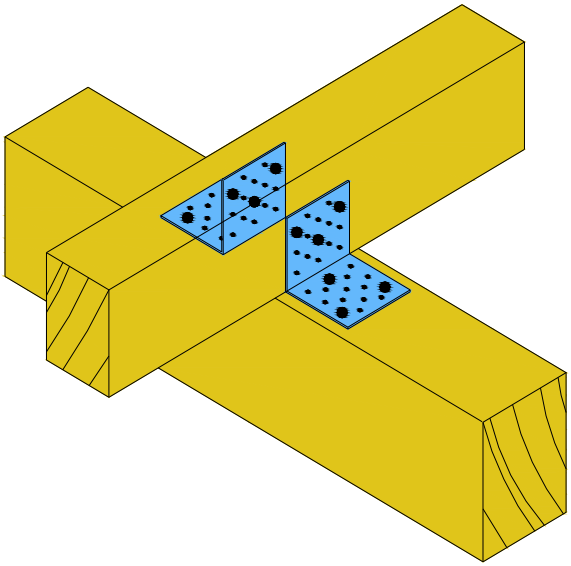

Figure A.2.1: Typical use of angle brackets

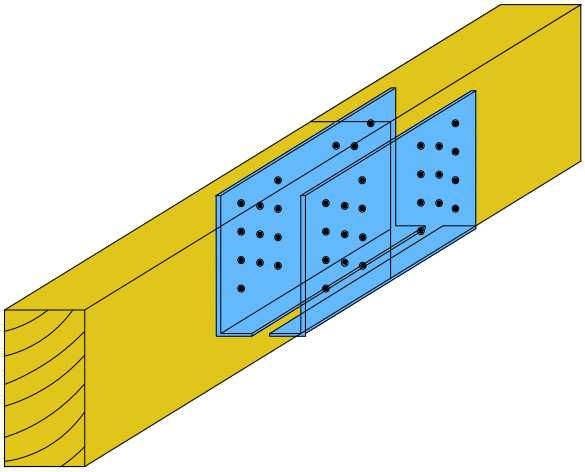

Figure A.2.2: Typical use of a cantilever bracket

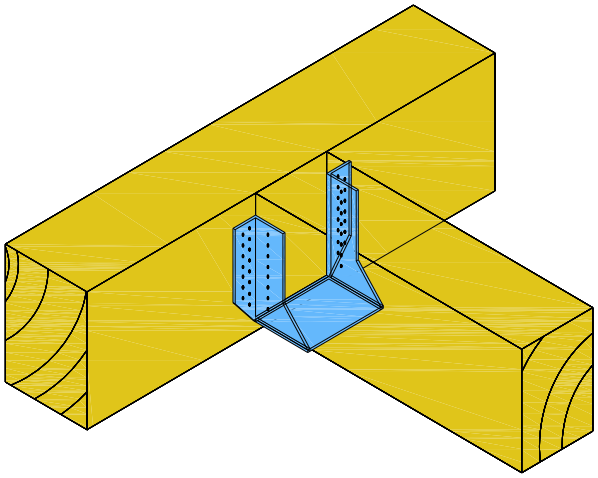

Figure A.2.3: Typical use of a joist hanger

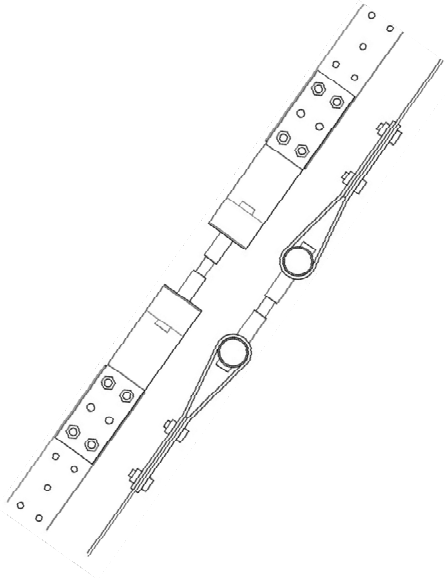

Figure A.2.4: Typical use of a turnbuckle

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 $k_{dens,1}$:

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

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 $k_{dens,2}$:

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

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

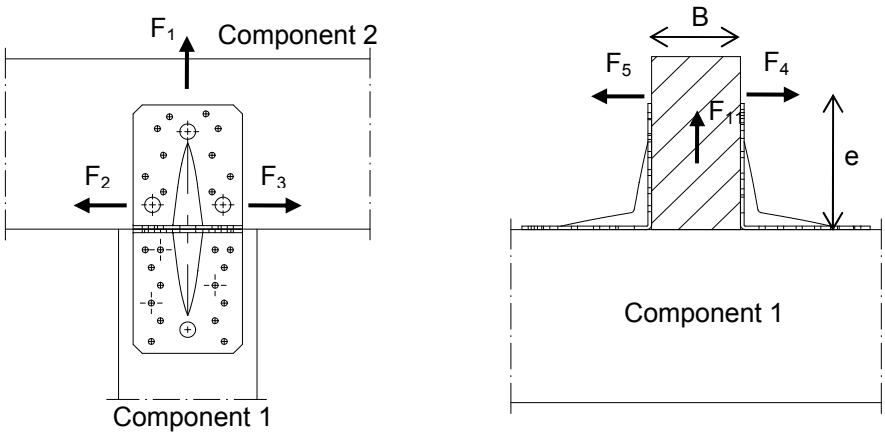

Figure A.3.1 Definitions of forces, their directions and eccentricity

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.

Ailong Metal Angle Brackets	Annex 3.1
Characteristic load-carrying capacities	

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 according to EN 1995-1-1 and the associated national Annex 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:

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

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

Where:

$F_{B,t,Ed}$ Bolt tensile load in N

$F_{B,v,Ed}$ Bolt shear load in N

k_t Coefficient, according to 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:

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

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.

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

Where B is the width of component 2.

Ailong Metal Angle Brackets	Annex 3.2
Characteristic load-carrying capacities - Angle brackets	

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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

Ailong Metal Angle Brackets	Annex 3.4
Characteristic load-carrying capacities - Angle brackets	

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

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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

Ailong Metal Angle Brackets	Annex 3.7
Characteristic load-carrying capacities - Angle brackets	

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

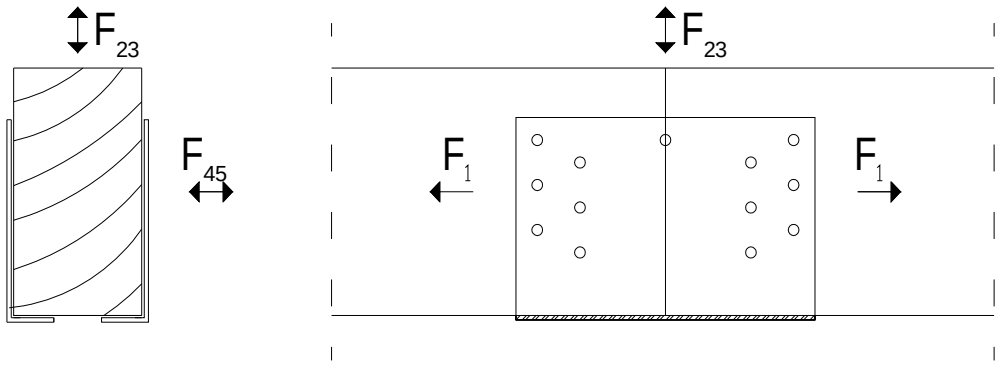

Figure A.3.2 Definitions of forces and their directions

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 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:

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

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.

Ailong Metal Angle Brackets	Annex 3.9
Characteristic load-carrying capacities - Cantilever brackets	

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

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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 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.

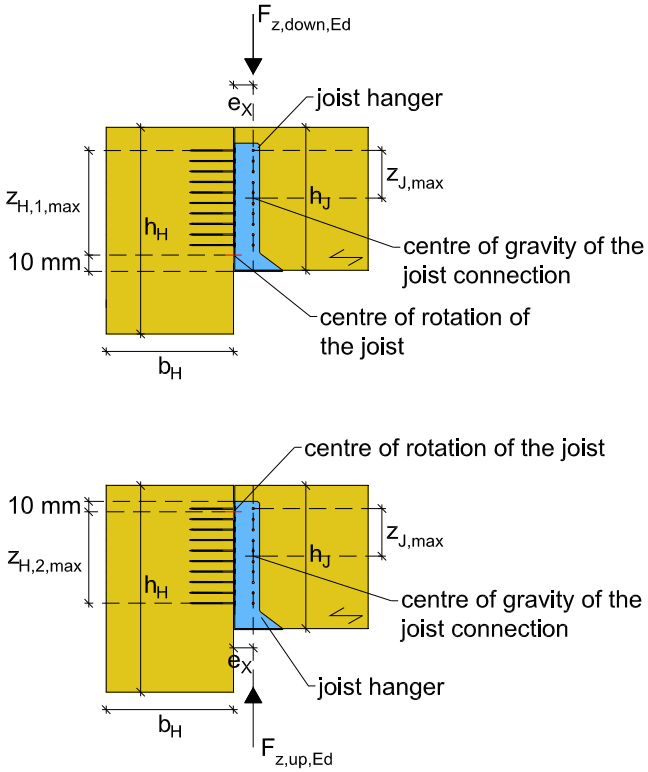

Figure A.3.3 Load direction Z: notation and joist hanger dimensions

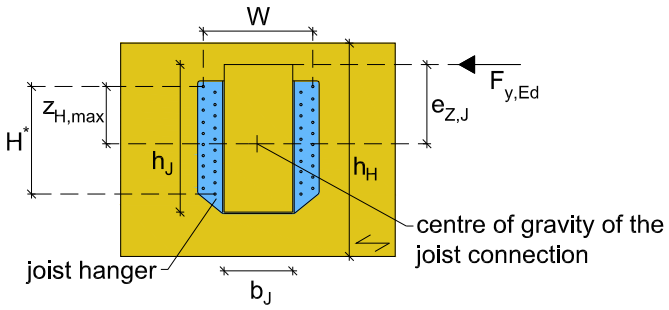

Figure A.3.4 Load direction Y: notation and joist hanger dimensions

Fastener specification

The width of the joist hangers shall be at least the penetration length of the nails + 16 mm.

Ailong Metal Angle Brackets	Annex 3.11
Characteristic load-carrying capacities – Joist hangers	

Load-carrying capacities

Table A.3.4.1: Dimensions, joint hanger AL 1007725 with exterior flanges, timber-timber

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	$k_{H,1}$	$k_{H,2}$
72,5	135	2,0	609	290	29,75	48,0	48,0	60,5	70,5	6*)	6	5,39	5,95

*) 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:

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

Lateral force:

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

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.

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

$F_{ax,Rk}$ 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.

$e_{z,J}$ 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

Timber splitting caused by load components perpendicular to the grain

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_Z and F_Y act at the same time, the following inequality shall be fulfilled:

$$\left(\frac{F_{Y,Ed}}{F_{Y,Rd}}\right)^2 + \left(\frac{F_{Z,Ed}}{F_{Z,Rd}}\right)^2 \leq 1 \qquad \text{(A.3.11)}$$

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

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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

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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 10025-2:2004	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