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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

European Technical Assessment ETA-08/0064 of 2018-03-27

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:	FraP Angle Brackets
Product family to which the above construction product belongs:	Three-dimensional nailing plate (angle bracket for wood to wood and wood to concrete connections)
Manufacturer:	FraP Metall GmbH Triftstrasse 21B D-16348 Wandlitz Tel. +49 33 397 64 313 Fax +49 33 397 64 314 Internet www.frap-metall.de
Manufacturing plant:	UAB Toga FMG Obeniu k. Kietaviskiu sen. LT-21413 Elektrénu sav.
This European Technical Assessment contains:	58 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:	Guideline for European Technical Approval (ETAG) No. 015 Three Dimensional Nailing Plates, April 2013, used as European Assessment Document (EAD).
This version replaces:	The previous ETA with the same number issued on 2013-03-27 and expiry on 2018-03-27

Translations of this European Technical Assessment in other languages shall fully correspond to the original issued document and should be identified as such.

II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product and intended use

Technical description of the product
FraP Metall angle brackets, purlin ties and hold-downs are one-piece non-welded, face-fixed three-dimensional nailing plates to be used in timber to timber connections. They are connected to construction members made of timber or wood-based products with ring shank nails according to EN 14592 or screws according to ETA-11/0024 and to concrete or steel members with bolts or metal anchors.

The three-dimensional nailing plates with a steel plate thickness of up to 4 mm are made from steel DX51D + Z275 according to EN 10346:2009 with $R_e \geq 250$ N/mm², $R_m \geq 330$ N/mm² and $A_{80} \geq 19\%$ or from stainless steel (1.4301, 1.4401, 1.4541, 1.4571 or 1.4016 according to EN 10088) with equivalent characteristics. Dimensions, hole positions and typical installations are shown in Annex B. FraP Metall three-dimensional nailing plates are made from steel with tolerances according to EN 10143.

2 Specification of the intended use in accordance with the applicable EAD

The angle brackets are intended for use in making connections in load bearing timber structures, as a connection between a beam and a purlin, where requirements for mechanical resistance and stability and safety in use in the sense of the 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/m³ to 420 kg/m³. This requirement to the material of the wood members can be fulfilled by using the following materials:

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

Annex B states the load-carrying capacities of the angle bracket connections for a characteristic density of 350 kg/m³.
For different characteristic densities the lateral load-carrying capacity of the screws or nails changes.

Therefore, for a characteristic density of less than 350 kg/m³ the characteristic load-carrying capacity of the fasteners shall be reduced with the factor k_{dens}.

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

for $290 \text{ kg/m}^3 < \rho_k < 350 \text{ kg/m}^3$
where ρ_k is the characteristic density of the timber in kg/m³.

The load-carrying capacities for higher characteristic densities may be taken as equal to the characteristic capacities given in this document. Alternatively, the load-carrying capacities of the fasteners may be increased by the factor k_{dens}, given by

$$k_{dens} = \left(\frac{\rho_k}{350} \right)^{0,5}$$

for $350 \text{ kg/m}^3 < \rho_k < 420 \text{ kg/m}^3$
where ρ_k is the characteristic density of the timber in kg/m³.

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 or screws into the members.

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

The angle brackets, purlin ties and hold-downs 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 strength 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 connectors 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)	
Characteristic load-carrying capacity	See Annex B
Stiffness	No performance assessed
Ductility in cyclic testing	No performance assessed
3.2 Safety in case of fire (BWR2)	
Reaction to fire	The brackets are made from steel classified as **Euroclass A1** in accordance with EN 13501-1 and Commission Delegated Regulation 2016/364
3.3 Hygiene, health and the environment (BWR3)	
Influence on air quality	The product does not contain/release dangerous substances specified in TR 034, dated March 2012 0**)
3.7 Sustainable use of natural resources (BWR7)	No performance assessed
3.8 General aspects related to the performance of the product	The 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, 2 and 3
Identification	See Annex A

*) See additional information in section 3.9 – 3.11.

**) In addition to the specific clauses relating to dangerous substances contained in this European Technical Assessment, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the Construction Products Regulation, these requirements need also to be complied with, when and where they apply.

Safety principles and partial factors
The characteristic load-carrying capacities are based on the characteristic values of the nail 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.

3.9 Mechanical resistance and stability

See annex B for the characteristic load-carrying capacity in the different directions F_1 to F_5.

The characteristic capacities of the angle brackets are determined by calculation assisted by testing as described in the EOTA Guideline 015 clause 5.1.2. They should be used for designs in accordance with Eurocode 5 or a similar national Timber Code.

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

3.10 Aspects related to the performance of the product

3.10.1 In accordance with ETAG 015 the angle brackets have a zinc coating weight of min Z275. The steel employed is pre-galvanized steel Grade DX51D + Z275 according to EN 10346:2009 with

3.11 General aspects related to the fitness for use of the product

The nailing pattern used shall be either the maximum or the minimum pattern as defined in Annex A.

Wane under the flaps of the angle bracket is allowed provided it does not occur under the nails. Wane can reduce the load-bearing capacity of the connection.

A gap between the connector and the timber member is not allowed. However, where the angle bracket is used for a connection between a beam and a column a gap of 5 mm is allowed.

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 2018-03-27 by

Thomas Bruun
Managing Director, ETA-Danmark

Annex A
Product details definitions

Table A.1 Angle Brackets: Materials specification

Angle Bracket type	Thickness (mm)	Steel specification	Coating specification
242 070 055	2,5	DX51D / Stainless steel	Z 275
242 070 955	2,5	DX51D / Stainless steel	Z 275
242 090 065	2,5	DX51D / Stainless steel	Z 275
242 090 965	2,5	DX51D / Stainless steel	Z 275
242 100 090	3,0	DX51D / Stainless steel	Z 275
242 100 990	3,0	DX51D / Stainless steel	Z 275
242 072 055	2,0	DX51D / Stainless steel	Z 275
242 072 955	2,0	DX51D / Stainless steel	Z 275
242 092 065	2,0	DX51D / Stainless steel	Z 275
242 092 965	2,0	DX51D / Stainless steel	Z 275
242 102 090	2,5	DX51D / Stainless steel	Z 275
242 102 990	2,5	DX51D / Stainless steel	Z 275
242 050 035	2,5	DX51D / Stainless steel	Z 275
242 090 041	2,5	DX51D / Stainless steel	Z 275
243 129 040	3,0	DX51D / Stainless steel	Z 275
243 149 040	3,0	DX51D / Stainless steel	Z 275
243 409 040	3,0	DX51D / Stainless steel	Z 275
243 416 040	3,0	DX51D / Stainless steel	Z 275
243 608 040	2,0	DX51D / Stainless steel	Z 275
243 609 061	2,0	DX51D / Stainless steel	Z 275
243 609 062	2,0	DX51D / Stainless steel	Z 275
243 905 054	2,5	DX51D / Stainless steel	Z 275
243 915 965	2,5	DX51D / Stainless steel	Z 275
243 948 048	3,0	DX51D / Stainless steel	Z 275
243 948 076	3,0	DX51D / Stainless steel	Z 275
243 948 116	3,0	DX51D / Stainless steel	Z 275
241 446 200	2,0 or 2,5	DX51D / Stainless steel	Z 275
241 664 200	2,0 or 2,5	DX51D / Stainless steel	Z 275
241 665 200	2,0 or 2,5	DX51D / Stainless steel	Z 275
241 666 200	2,0 or 2,5	DX51D / Stainless steel	Z 275
241 661 200	2,0 or 2,5	DX51D / Stainless steel	Z 275
241 884 200	2,0 or 2,5	DX51D / Stainless steel	Z 275
241 886 200	2,0 or 2,5	DX51D / Stainless steel	Z 275
241 888 200	2,0 or 2,5	DX51D / Stainless steel	Z 275
241 116 200	2,0 or 2,5	DX51D / Stainless steel	Z 275
241 118 200	2,0 or 2,5	DX51D / Stainless steel	Z 275
241 111 200	2,0 or 2,5	DX51D / Stainless steel	Z 275

Table A.2 Angle Brackets: Range of sizes

Angle Bracket type	Height (mm) vertical		Height (mm) horizontal		Width (mm)		Thickness (mm)	Hole positions (mm)
	min	max	min	max	min	max		
242 070 055	69	71	69	71	55	56	± 0,13	± 0,5
242 070 955	69	71	69	71	53	56	± 0,13	± 0,5
242 090 065	89	91	89	91	65	65	± 0,13	± 0,5
242 090 965	89	91	89	91	61	65	± 0,13	± 0,5
242 100 090	104	106	104	106	89	91	± 0,13	± 0,5
242 100 990	104	106	104	106	84	91	± 0,13	± 0,5
242 072 055	69	71	68	71	54	56	± 0,13	± 0,5
242 072 955	69	71	68	71	53	56	± 0,13	± 0,5
242 092 065	89	91	89	91	64	66	± 0,13	± 0,5
242 092 965	89	91	89	91	61	66	± 0,13	± 0,5
242 102 090	104	106	104	106	89	91	± 0,13	± 0,5
242 102 990	104	106	104	106	84	91	± 0,13	± 0,5
242 050 035	49	51	49	51	34	36	± 0,13	± 0,5
242 090 041	89	91	89	91	37	40	± 0,13	± 0,5
243 129 040	88	91	116	118	39	41	± 0,13	± 0,5
243 149 040	89	91	139	141	39	41	± 0,13	± 0,5
243 409 040	88	91	39	41	39	41	± 0,13	± 0,5
243 416 040	152	156	39	41	38	40	± 0,13	± 0,5
243 608 040	79	84	59	63	39	41	± 0,13	± 0,5
243 609 061	83	85	59	61	55	61	± 0,13	± 0,5
243 609 062	83	85	59	61	55	61	± 0,13	± 0,5
243 905 054	89	91	49	51	54	56	± 0,13	± 0,5
243 915 965	89	91	148	150	62	64	± 0,13	± 0,5
243 948 048	89	91	47	49	47	49	± 0,13	± 0,5
243 948 076	89	91	47	49	75	77	± 0,13	± 0,5
243 948 116	89	91	47	49	115	117	± 0,13	± 0,5
241 446 200	39	41	39	41	55	61	± 0,13	± 0,5
241 664 200	59	61	59	61	37	41	± 0,13	± 0,5
241 665 200	59	61	59	61	49	51	± 0,13	± 0,5
241 666 200	59	61	59	61	57	61	± 0,13	± 0,5
241 661 200	59	61	59	61	95	101	± 0,13	± 0,5
241 884 200	79	81	79	81	37	41	± 0,13	± 0,5
241 886 200	79	81	79	81	55	61	± 0,13	± 0,5
241 888 200	79	81	79	81	75	81	± 0,13	± 0,5
241 116 200	99	101	99	101	55	61	± 0,13	± 0,5
241 118 200	99	101	99	101	75	81	± 0,13	± 0,5
241 111 200	99	101	99	101	95	101	± 0,13	± 0,5

Table A.3 Purlin Ties: Materials specification

Purlin Tie type		Thickness (mm)	Steel specification	Coating specification
170	170 x 34	2,0	DX51D / Stainless steel	Z 275
210	210 x 34	2,0	DX51D / Stainless steel	Z 275
250	250 x 34	2,0	DX51D / Stainless steel	Z 275
290	290 x 34	2,0	DX51D / Stainless steel	Z 275
330	330 x 34	2,0	DX51D / Stainless steel	Z 275
370	370 x 34	2,0	DX51D / Stainless steel	Z 275
uni 170	170 x 34	2,0	DX51D / Stainless steel	Z 275
uni 210	210 x 34	2,0	DX51D / Stainless steel	Z 275
uni 250	250 x 34	2,0	DX51D / Stainless steel	Z 275

Table A.4 Purlin Ties: Range of sizes

Purlin Tie type	Length (mm)		Width (mm)		Thickness (mm)	Hole positions (mm)
170	169	172	33,0	35,0	± 0,13	± 0,5
210	209	212	33,0	35,0	± 0,13	± 0,5
250	249	252	33,0	35,0	± 0,13	± 0,5
290	289	292	33,0	35,0	± 0,13	± 0,5
330	329	332	33,0	35,0	± 0,13	± 0,5
370	369	372	33,0	35,0	± 0,13	± 0,5
uni 170	169	172	33,0	35,0	± 0,13	± 0,5
uni 210	209	212	33,0	35,0	± 0,13	± 0,5
uni 250	249	252	33,0	35,0	± 0,13	± 0,5

Table A.5 Hold-downs: Materials specification

Hold-Down type		Thickness (mm)	Steel specification	Coating specification
hold-down 200, t = 2,0 mm	200 x 40	2,0	DX51D / Stainless steel	Z 275
hold-down 300, t = 2,0 mm	300 x 40	2,0	DX51D / Stainless steel	Z 275
hold-down 400, t = 2,0 mm	400 x 40	2,0	DX51D / Stainless steel	Z 275
hold-down 500, t = 2,0 mm	500 x 40	2,0	DX51D / Stainless steel	Z 275
hold-down 200, t = 4,0 mm	200 x 40	4,0	DX51D / Stainless steel	Z 275
hold-down 300, t = 4,0 mm	300 x 40	4,0	DX51D / Stainless steel	Z 275
hold-down 400, t = 4,0 mm	400 x 40	4,0	DX51D / Stainless steel	Z 275
hold-down 500, t = 4,0 mm	500 x 40	4,0	DX51D / Stainless steel	Z 275

Table A.6 Hold-downs: Range of sizes

Hold-Down type	Length (mm)		Width (mm)		Thickness (mm)	Hole positions (mm)
hold-down 200, t = 2,0 mm	199	202	39,0	41,0	± 0,13	± 0,5
hold-down 300, t = 2,0 mm	299	302	39,0	41,0	± 0,13	± 0,5
hold-down 400, t = 2,0 mm	399	402	39,0	41,0	± 0,13	± 0,5
hold-down 500, t = 2,0 mm	499	502	39,0	41,0	± 0,13	± 0,5
hold-down 200, t = 4,0 mm	199	202	39,0	41,0	± 0,13	± 0,5
hold-down 300, t = 4,0 mm	299	302	39,0	41,0	± 0,13	± 0,5
hold-down 400, t = 4,0 mm	399	402	39,0	41,0	± 0,13	± 0,5
hold-down 500, t = 4,0 mm	499	502	39,0	41,0	± 0,13	± 0,5

Table A.7 Fastener specification

Fastener	Length	Fastener type
Nail 4.0 mm	40 mm	Ring shank nails according to EN 14592 with a profiled length of at least 30 mm
Screw 5.0 mm	50 mm	Self-tapping screws according to ETA-11/0024 carbon steel or hardened stainless steel 1.4006

In the load-carrying-capacities of the nailed or screwed connection in Annex B the capacities calculated from the formulas of Eurocode 5 are used assuming a thick steel plate when calculating the lateral fastener load-carrying capacity. The characteristic withdrawal capacity of the nails and screws has to be determined by calculation in accordance with EN 1995-1-1:2010, paragraph 8.3.2 and 8.7.2 (head pull-through is not relevant):

$F_{ax,Rk} = f_{ax,k} \cdot d \cdot t_{pen}$ for the nails

$$F_{ax,Rk} = \frac{n_{ef} \cdot f_{ax,k} \cdot d \cdot \ell_{ef}}{1,2 \cdot \cos^2 \alpha + \sin^2 \alpha} \left(\frac{\rho_k}{\rho_a} \right)^{0,8}$$ for the screws

where:

n_{ef} Effective number of fasteners
$f_{ax,k}$ Characteristic value of the withdrawal parameter in N/mm^2
d Nail or screw diameter in mm
t_{pen} Penetration depth of the profiled shank in mm; (4.0 x 40 mm: $t_{pen} \geq 30$ mm)
l_{ef} Penetration depth of the threaded part in mm (5.0 x 50 mm: $l_{ef} \geq 41$ mm)
ρ_k Characteristic density of the timber in kg/m^3
ρ_a Characteristic density of the timber in kg/m^3 according to $f_{ax,k}$

Based on tests by Versuchsanstalt für Stahl, Holz und Steine, Karlsruhe Institute of Technology, the characteristic value of the withdrawal resistance for the threaded nails may be calculated as:
$f_{ax,k} = 50 \cdot 10^{-6} \cdot \rho_k^2$
Based on ETA-11/0024 the characteristic value of the withdrawal resistance and the characteristic yield Moment for the screws d = 5.0 mm may be calculated as:
$f_{ax,k}$ = 12,1 N/mm²
$M_{y,k} = 0,15 \cdot 600 \cdot d^{2,6} = 5909$ Nmm

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

Bolts or Metal Anchors diameter	Correspondent hole diameter	Bolts or Anchors type
12.0 mm	Max. 2 mm larger than the bolt diameter	See specification of the manufacturer

FraP Metall Purlin Ties

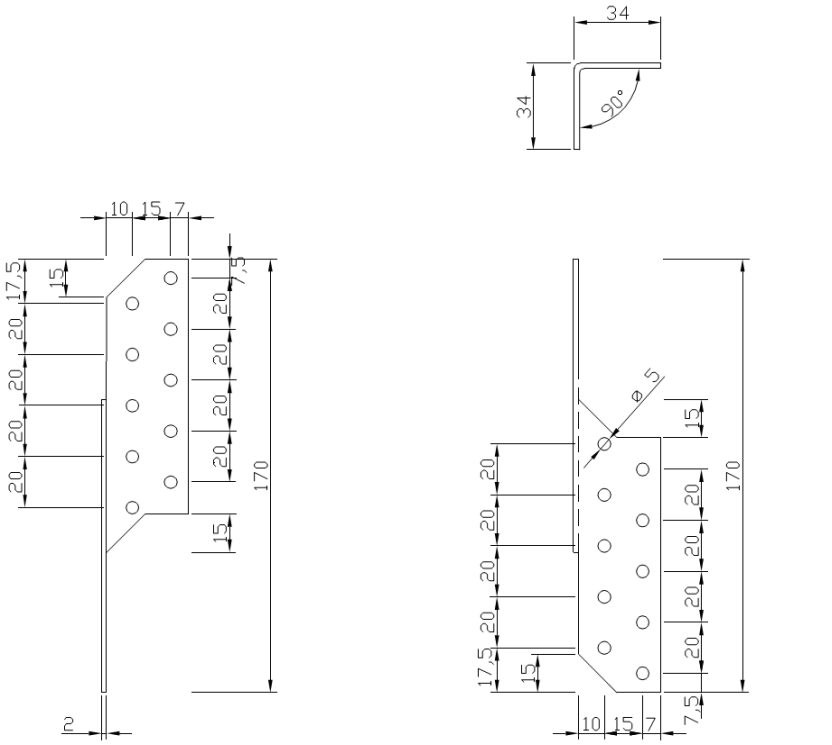


Figure A. 1 Purlin Tie 171

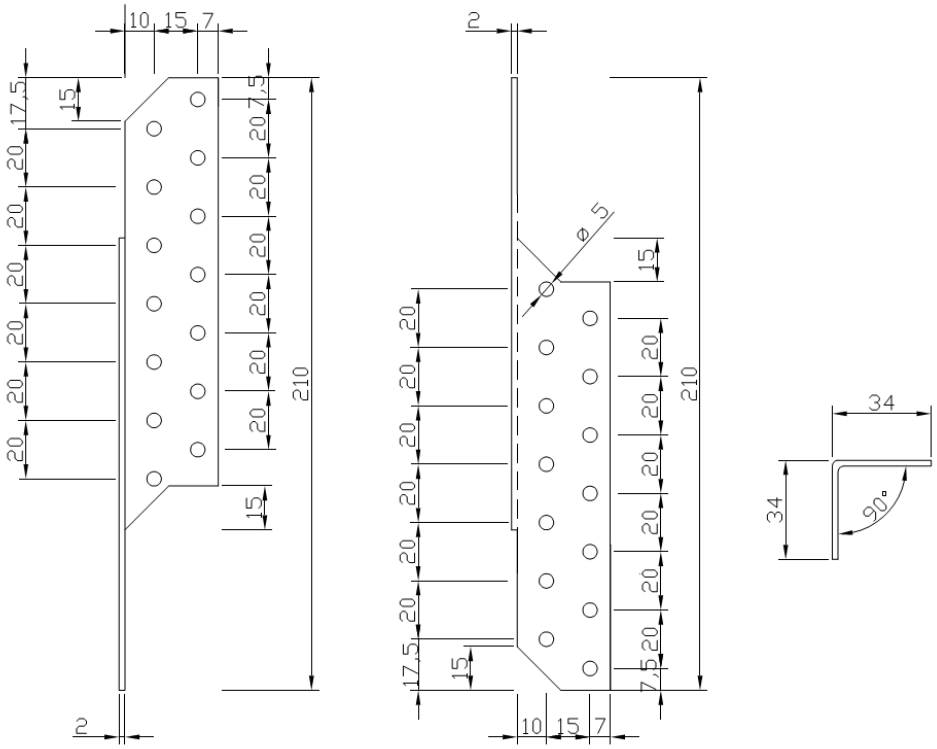


Figure A. 2 Purlin Tie 211

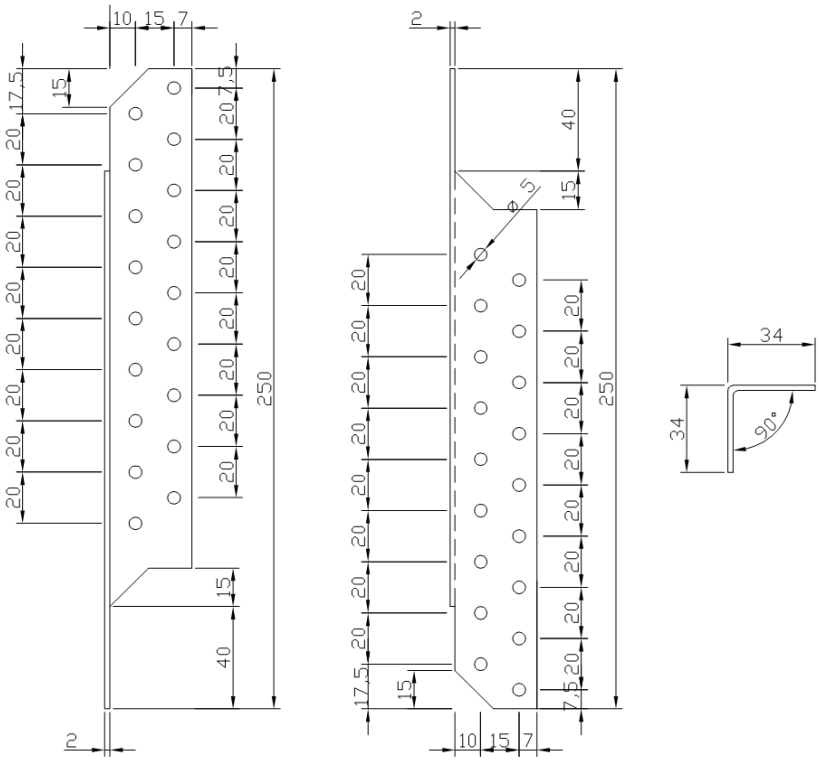


Figure A. 3 Purlin Tie 251

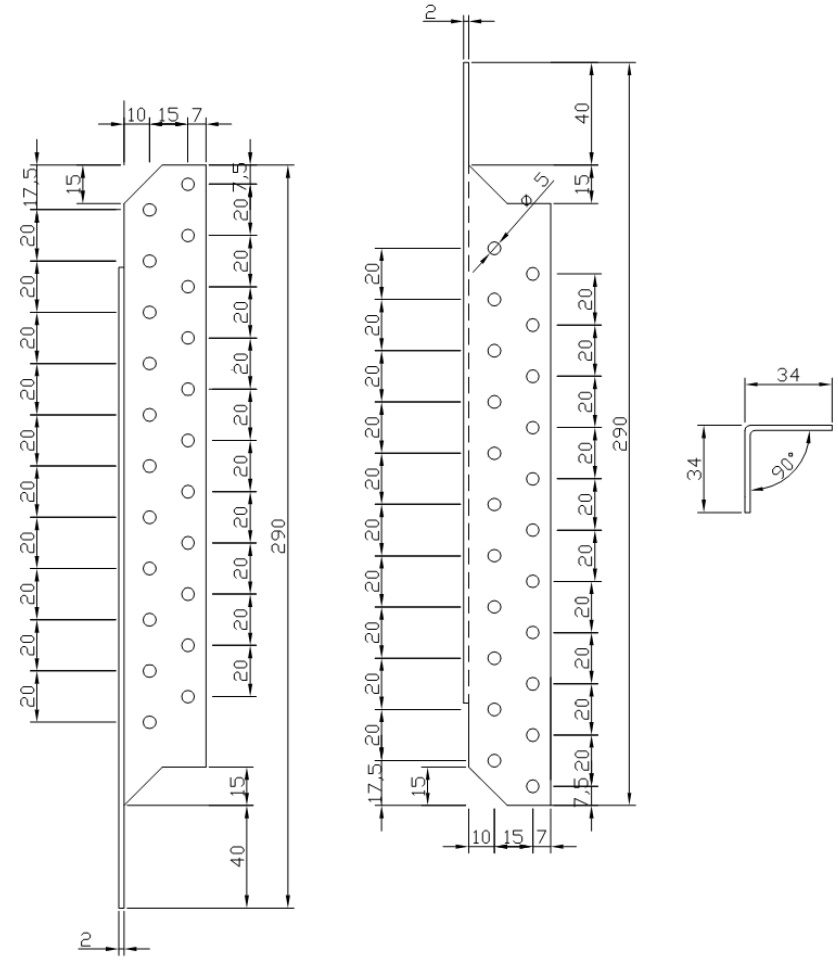


Figure A. 4 Purlin Tie 291

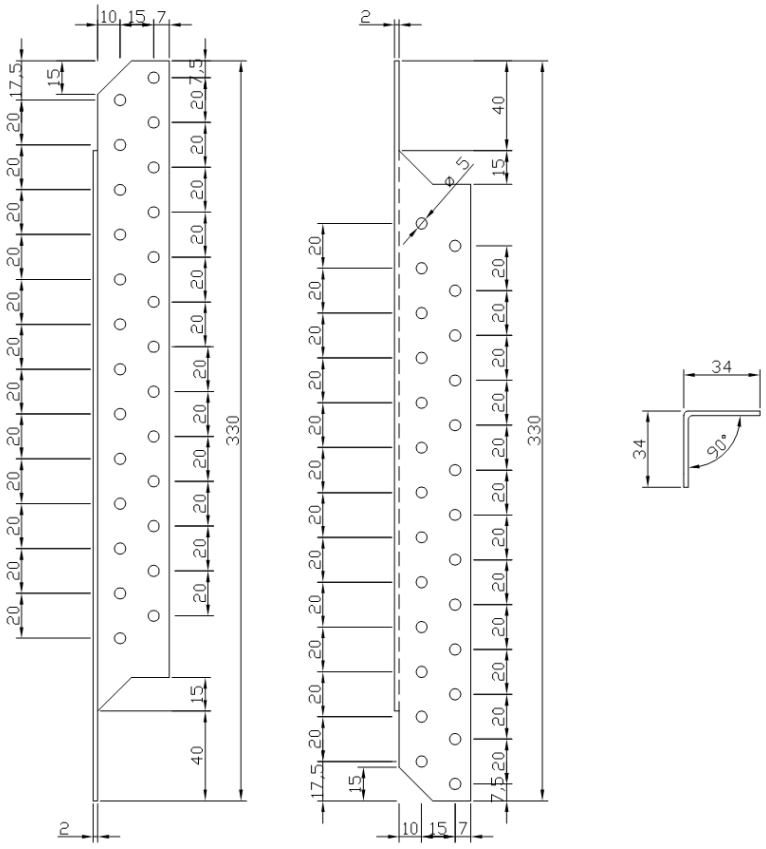


Figure A. 5 Purlin Tie 331

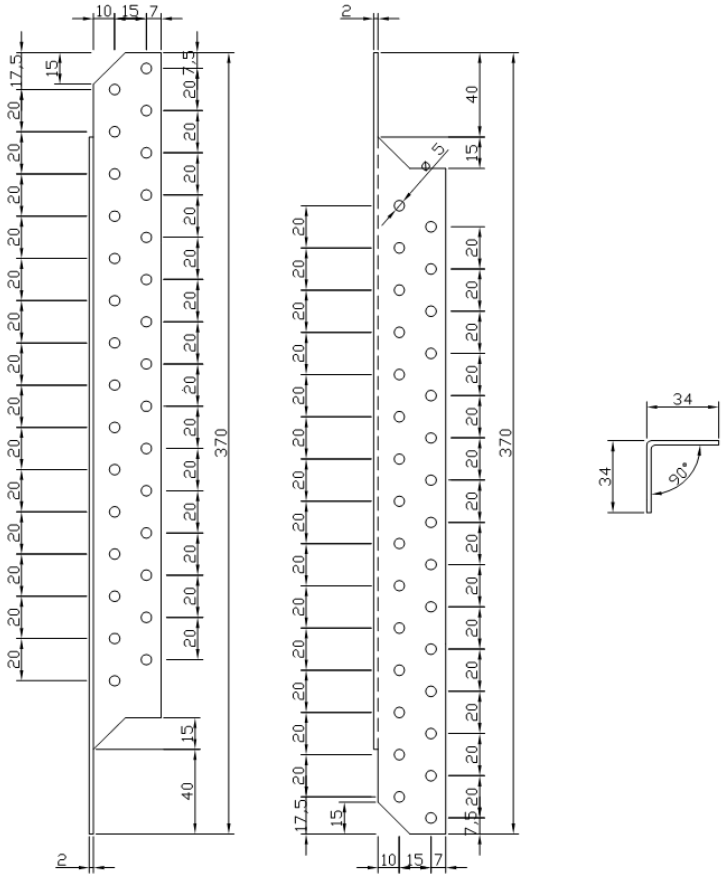


Figure A. 6 Purlin Tie 371

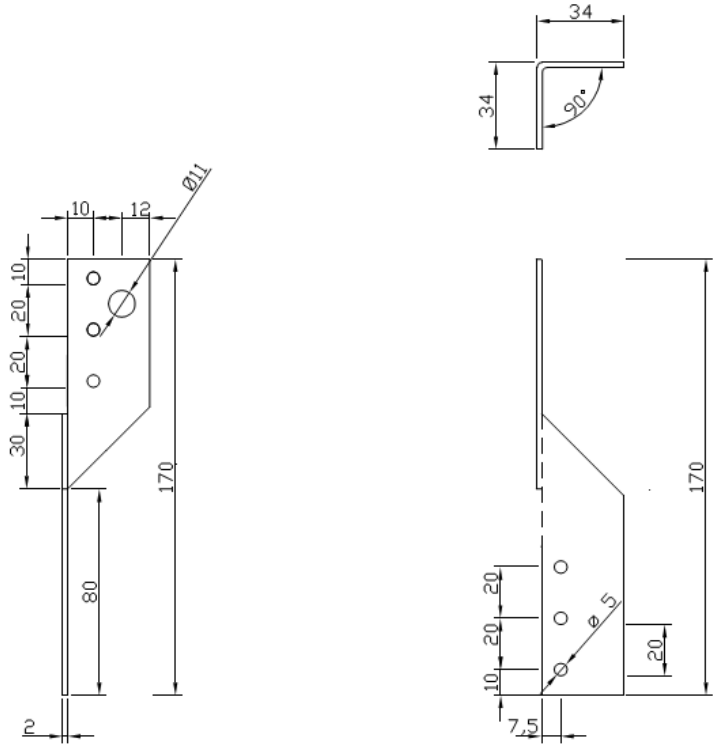


Figure A. 7 Purlin Tie Uni 170

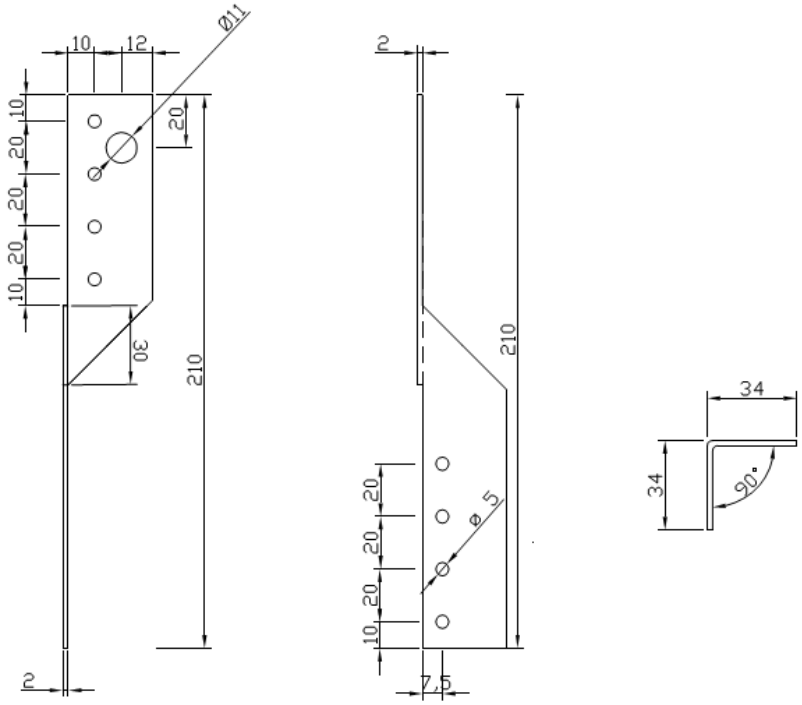


Figure A. 8 Purlin Tie Uni 210

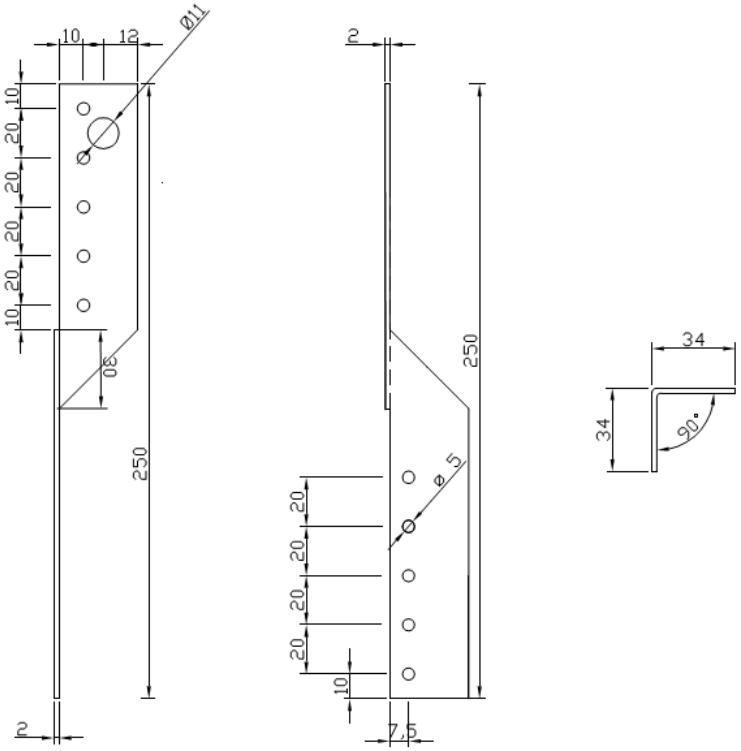


Figure A. 9 Purlin Tie Uni 250

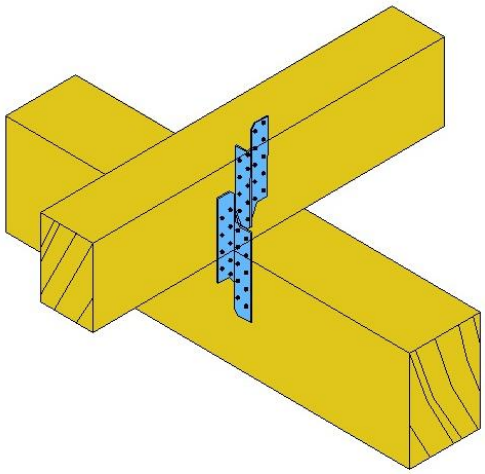


Figure A. 10 Typical installation of purlin ties

FraP Metall Hold-downs

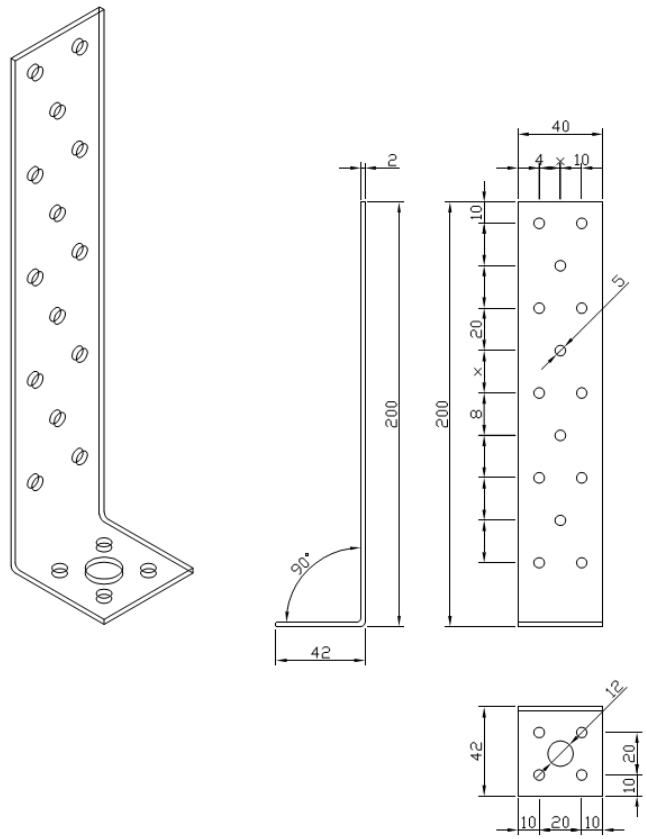


Figure A. 11 Hold-Down 200, t = 2,0 mm

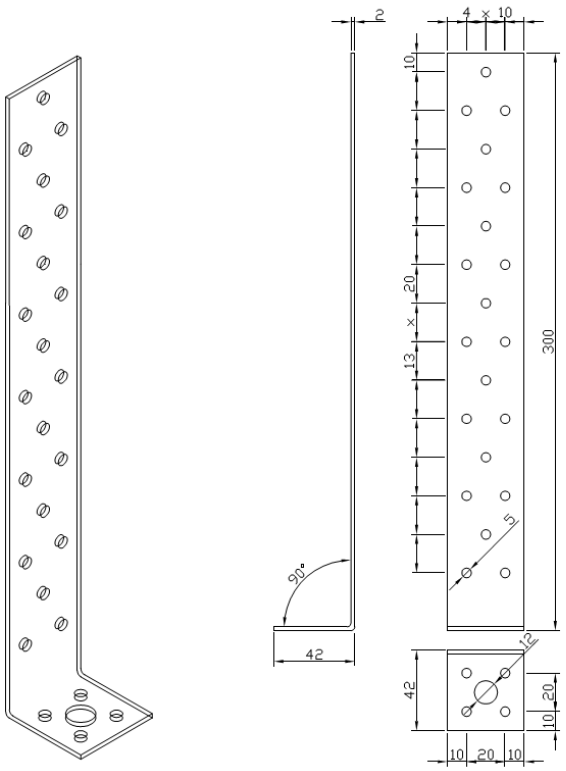


Figure A. 12 Hold-Down 300, t = 2,0 mm

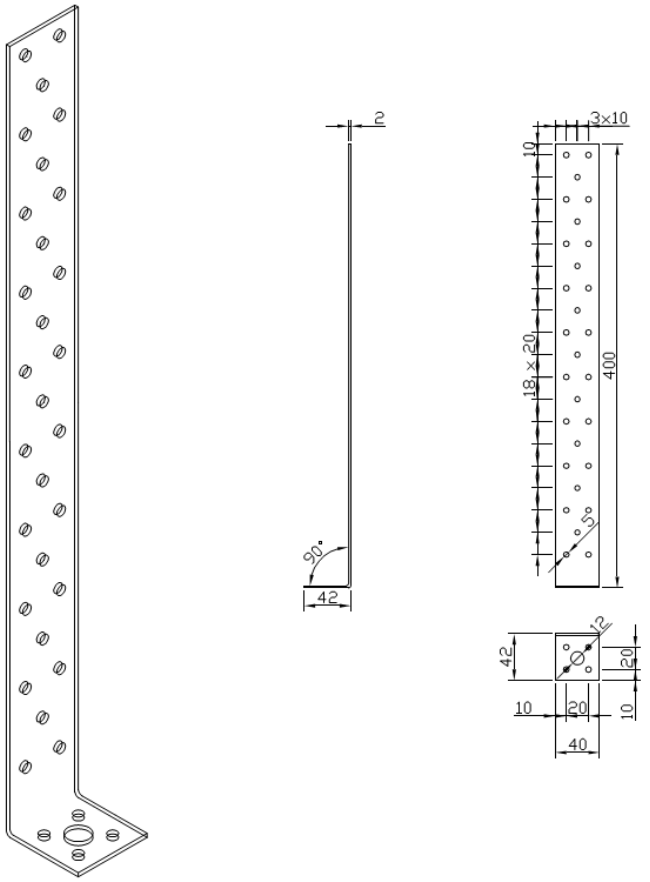


Figure A. 13 Hold-Down 400, t = 2,0 mm

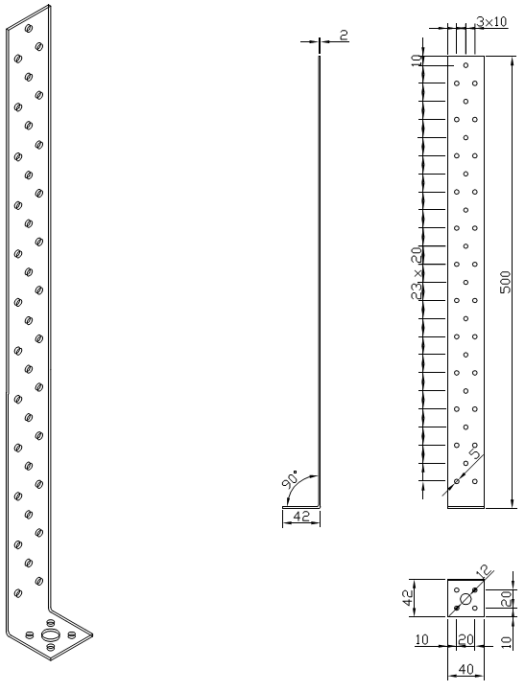


Figure A. 14 Hold-Down 500, t = 2,0 mm

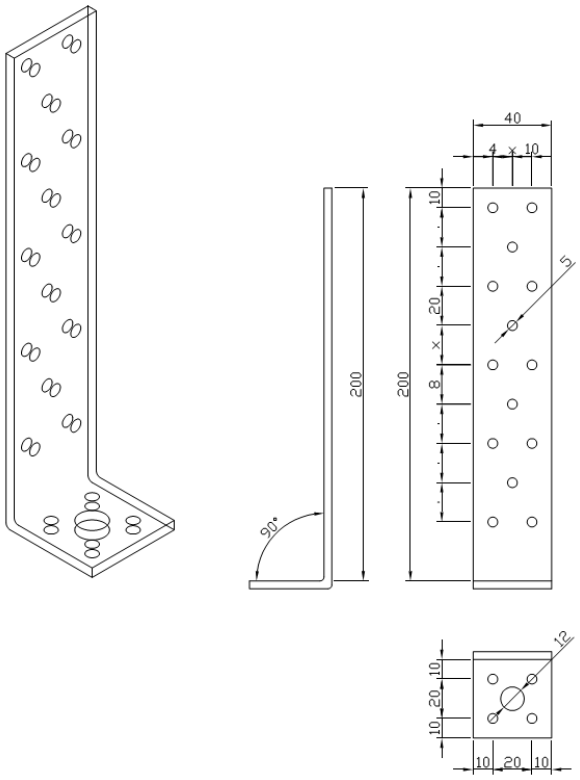


Figure A. 15 Hold-Down 200, t = 4,0 mm

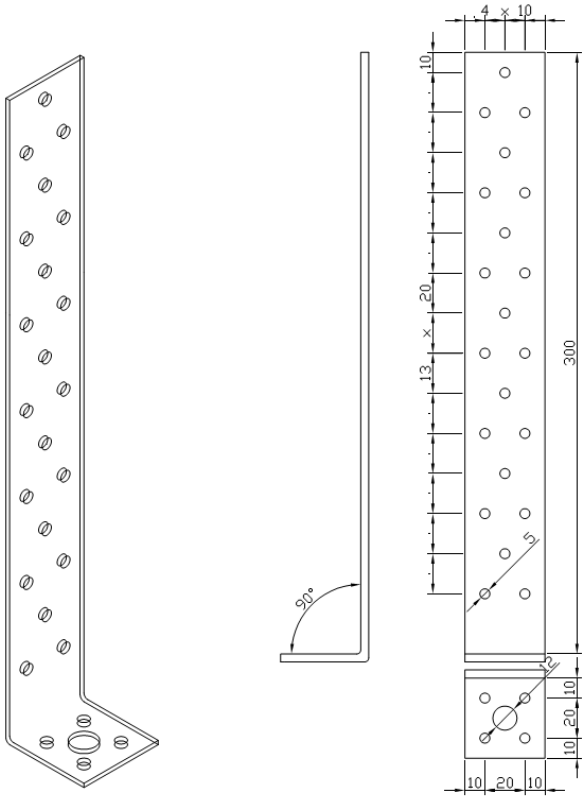


Figure A. 16 Hold-Down 300, t = 4,0 mm

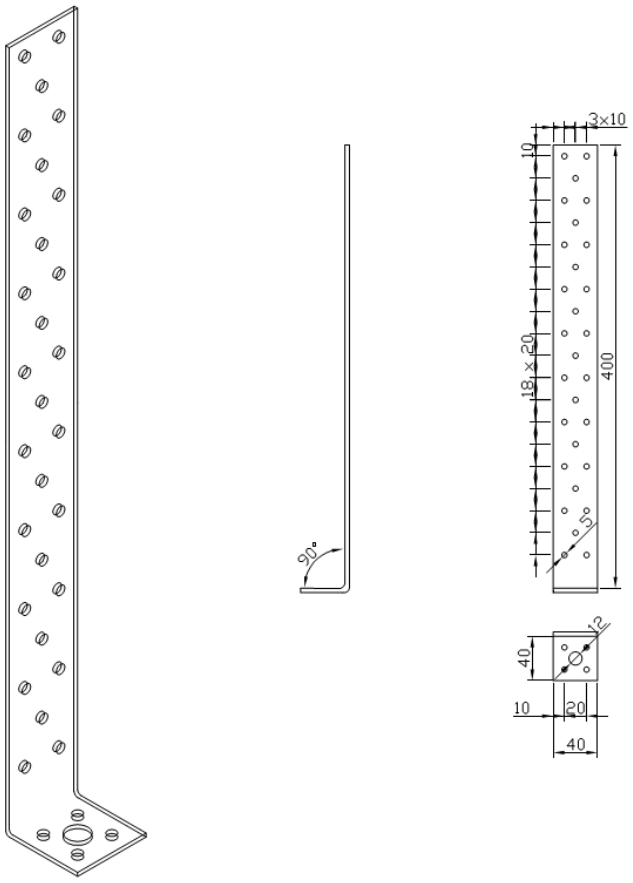


Figure A. 17 Hold-Down 400, t = 4,0 mm

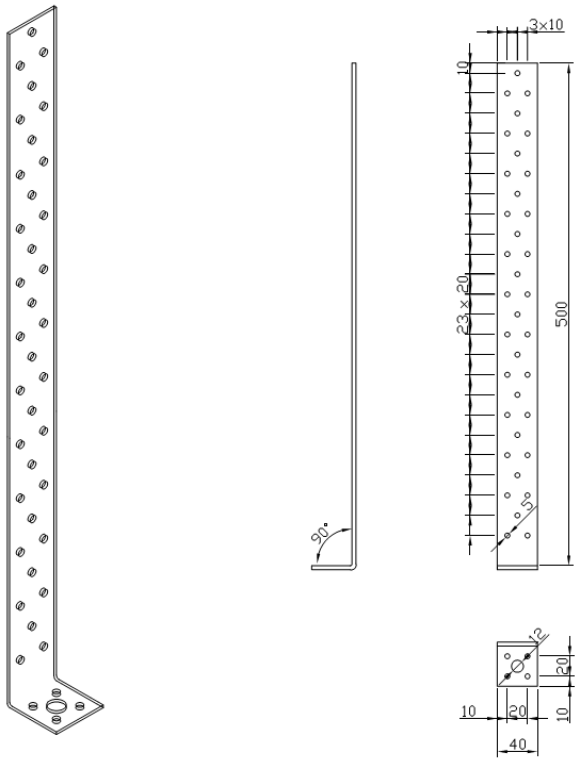


Figure A. 18 Hold-Down 500, t = 4,0 mm

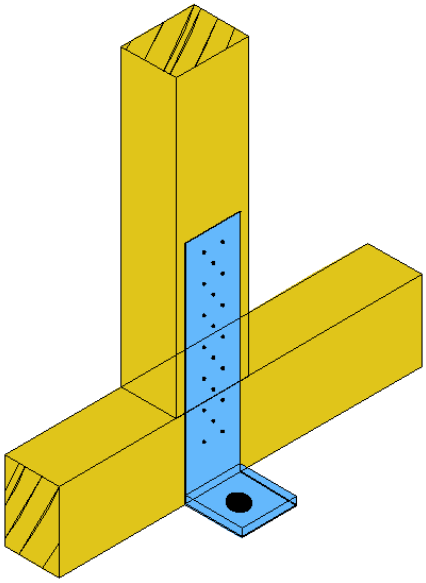


Figure A. 19 Typical installation of hold-downs

FraP Metall Angle Brackets

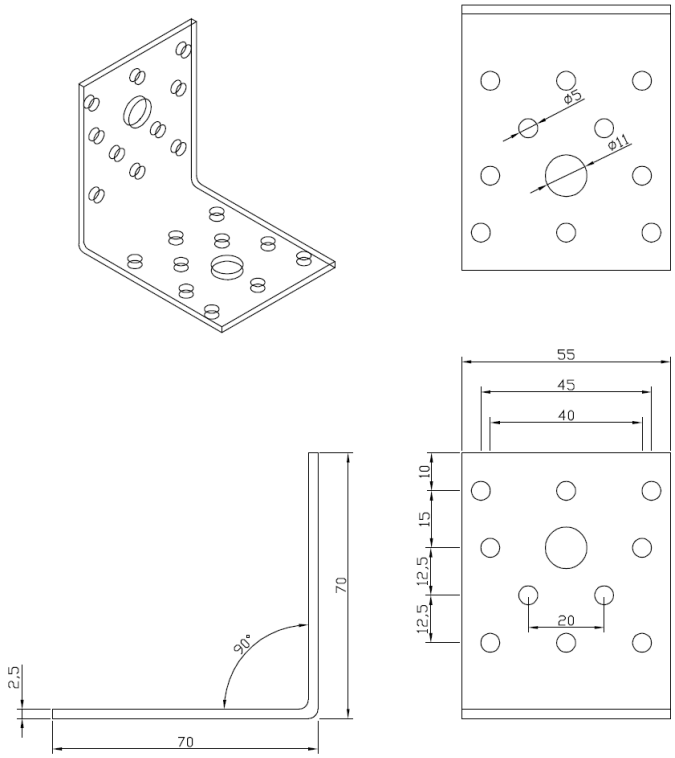


Figure A. 20 Angle Bracket 242 070 055 70x70x55 (70 without rib)

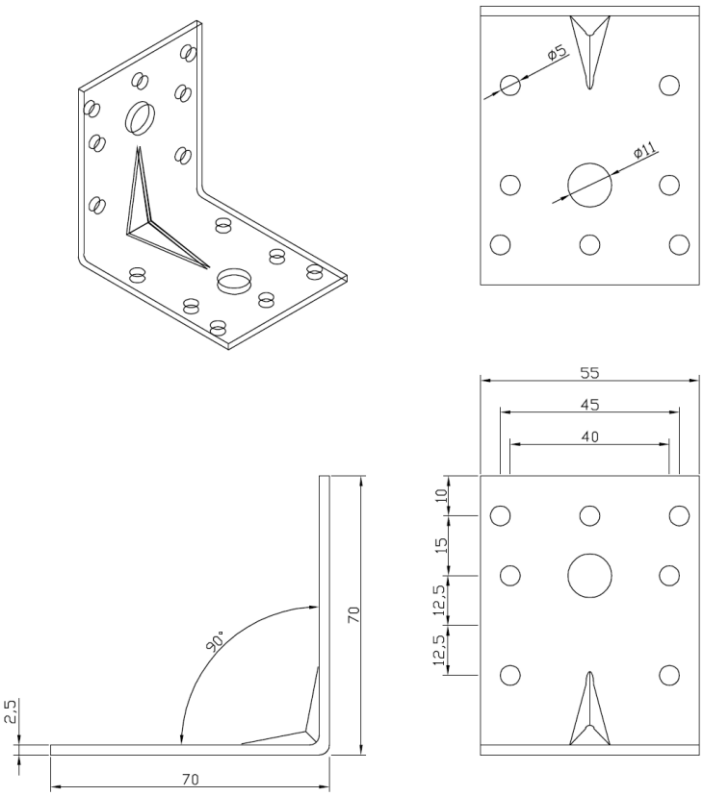


Figure A. 21 Angle Bracket 242 070 955 70x70x55 (70 with rib)

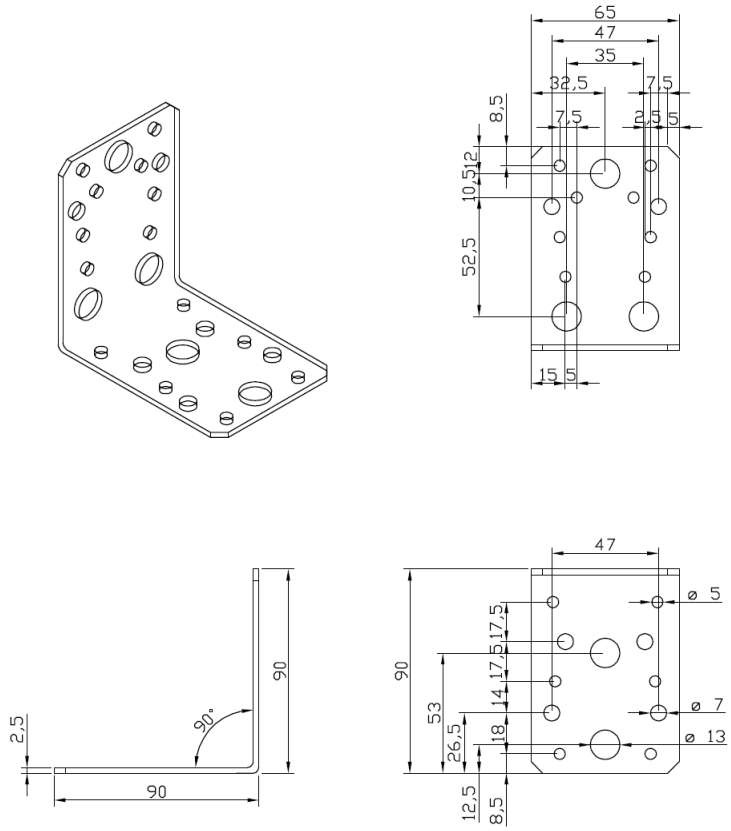


Figure A. 22 Angle Bracket 242 090 065 90x90x65 (90 without rib)

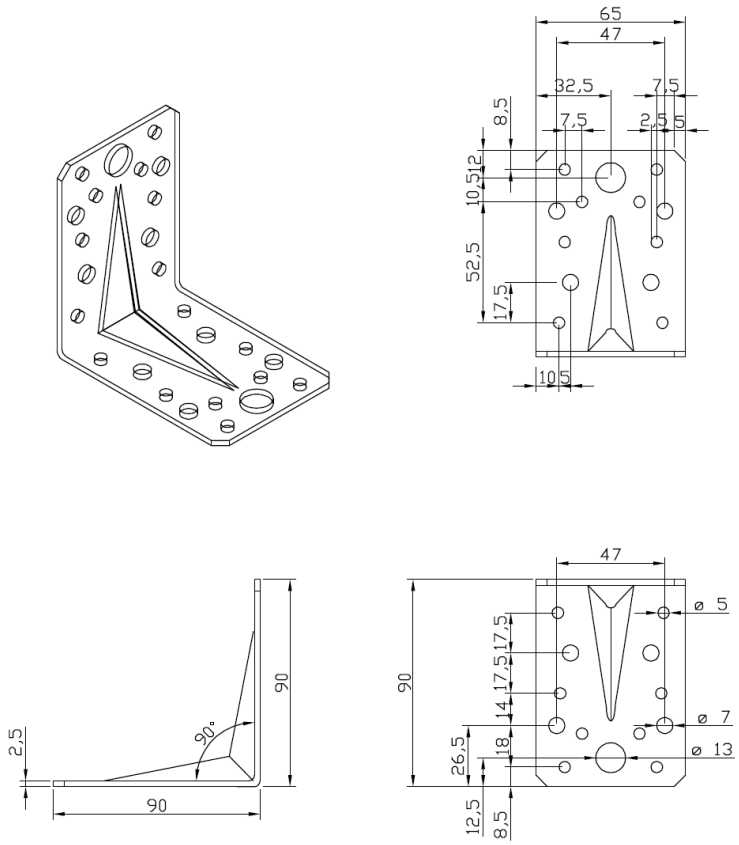


Figure A. 23 Angle Bracket 242 090 965 90x90x65 (90 with rib)

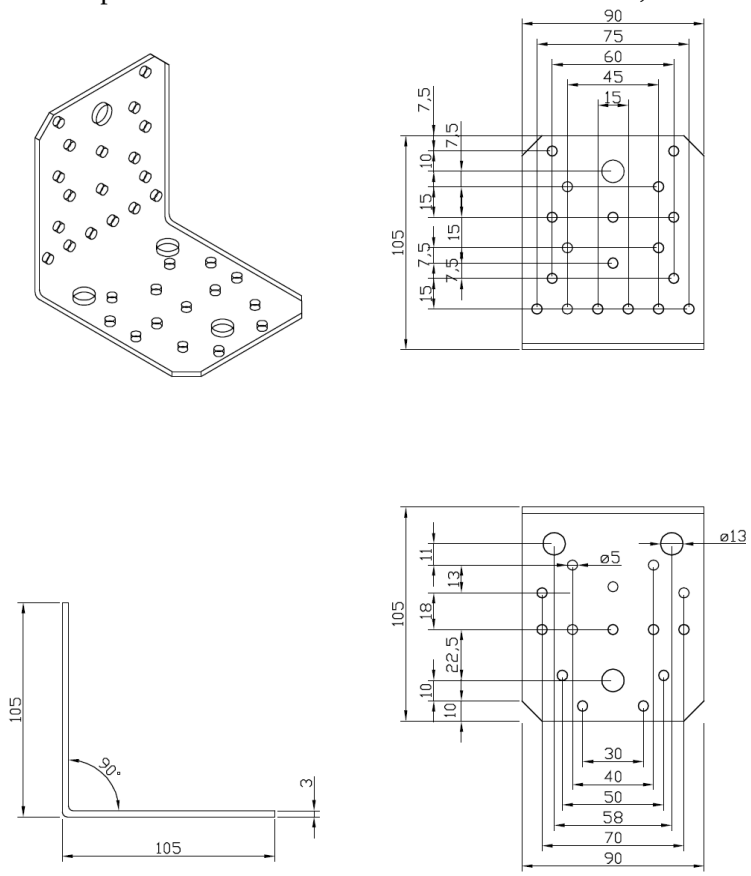


Figure A. 24 Angle Bracket 242 100 090 105x105x90 (105 without rib)

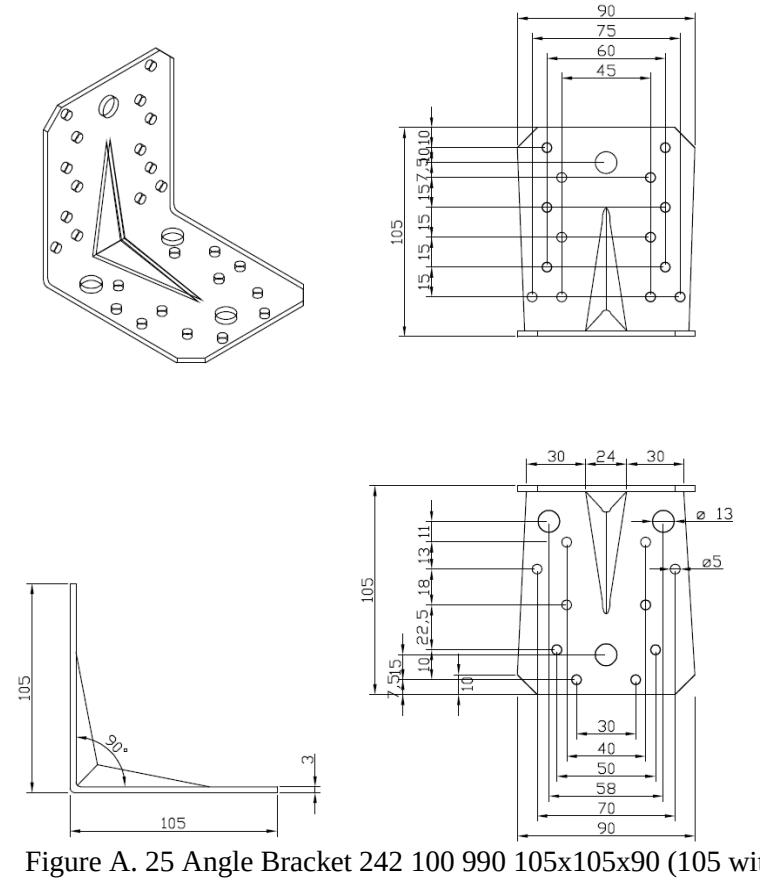


Figure A. 25 Angle Bracket 242 100 990 105x105x90 (105 with rib)

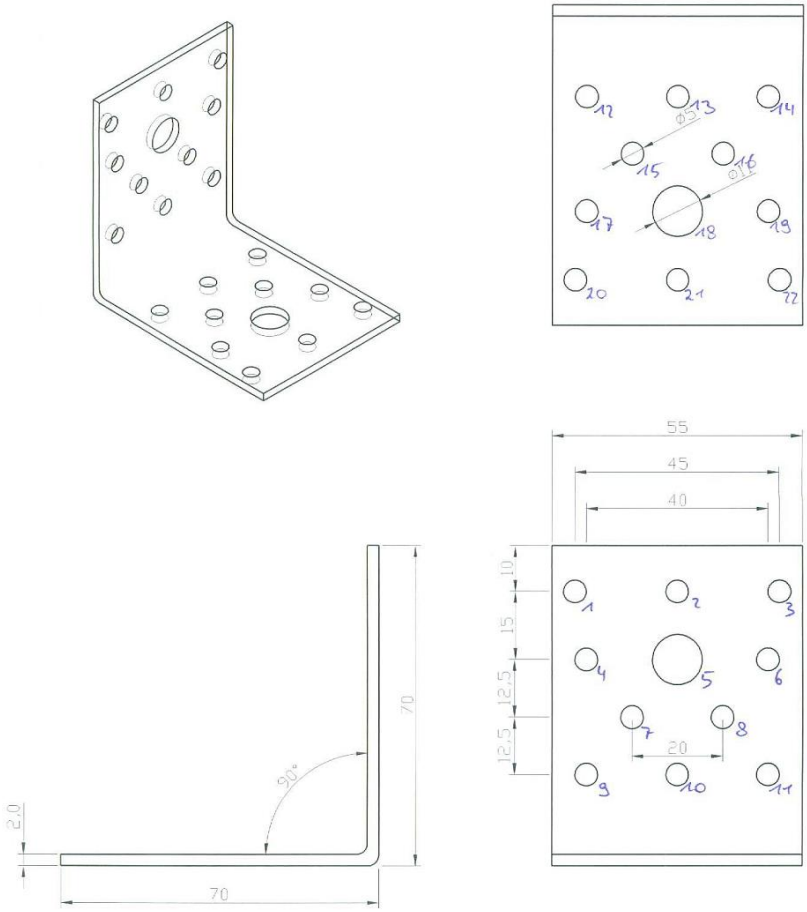


Figure A. 26 Angle Bracket 242 072 055 70x70x55

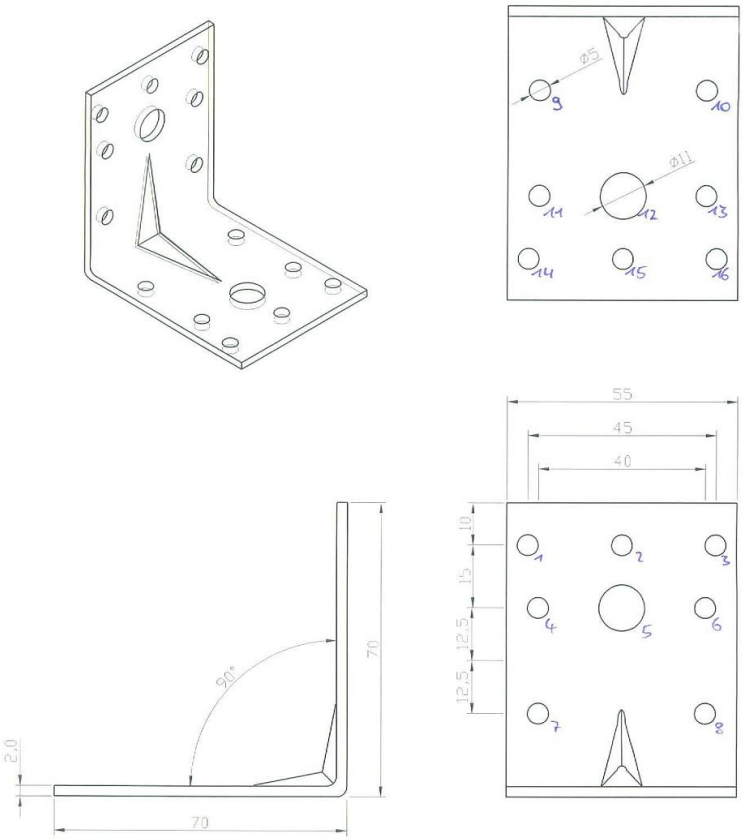


Figure A. 27 Angle Bracket 242 072 955 70x70x55

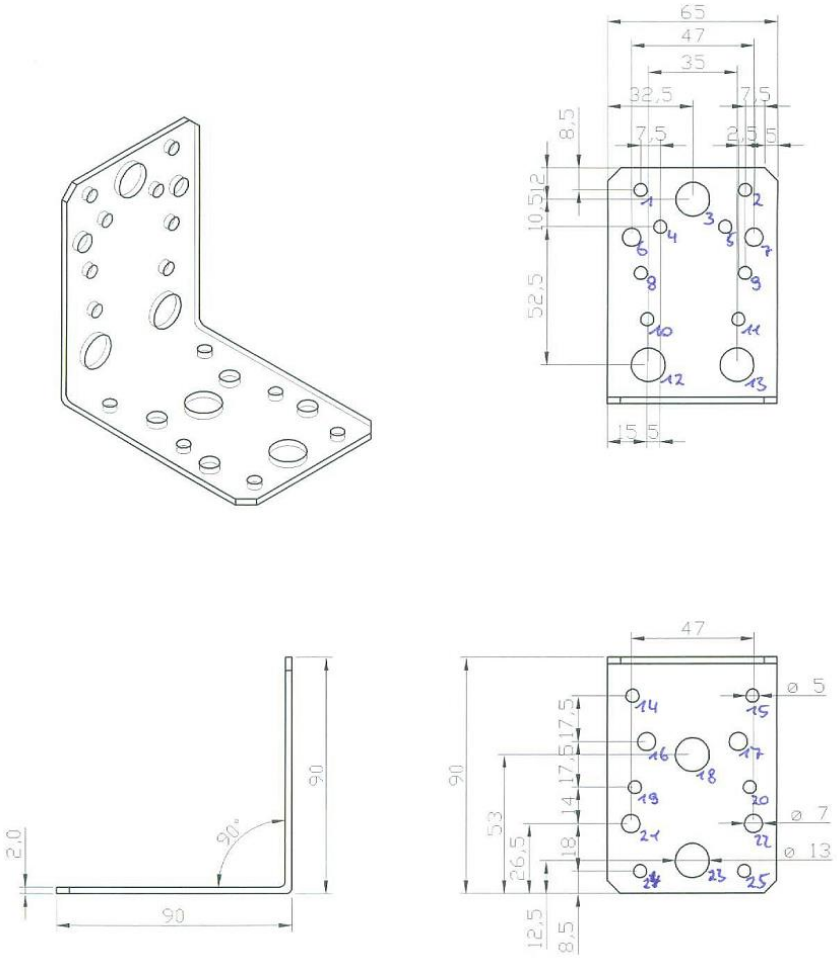


Figure A. 28 Angle Bracket 242 092 065 90x90x65

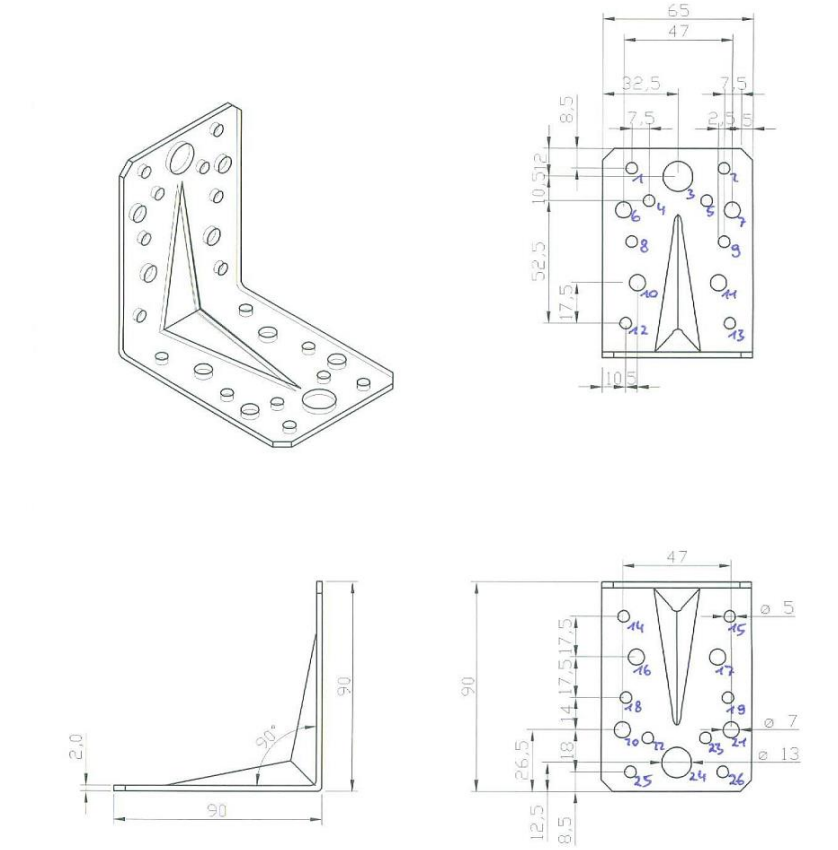


Figure A. 29 Angle Bracket 242 092 965 90x90x65

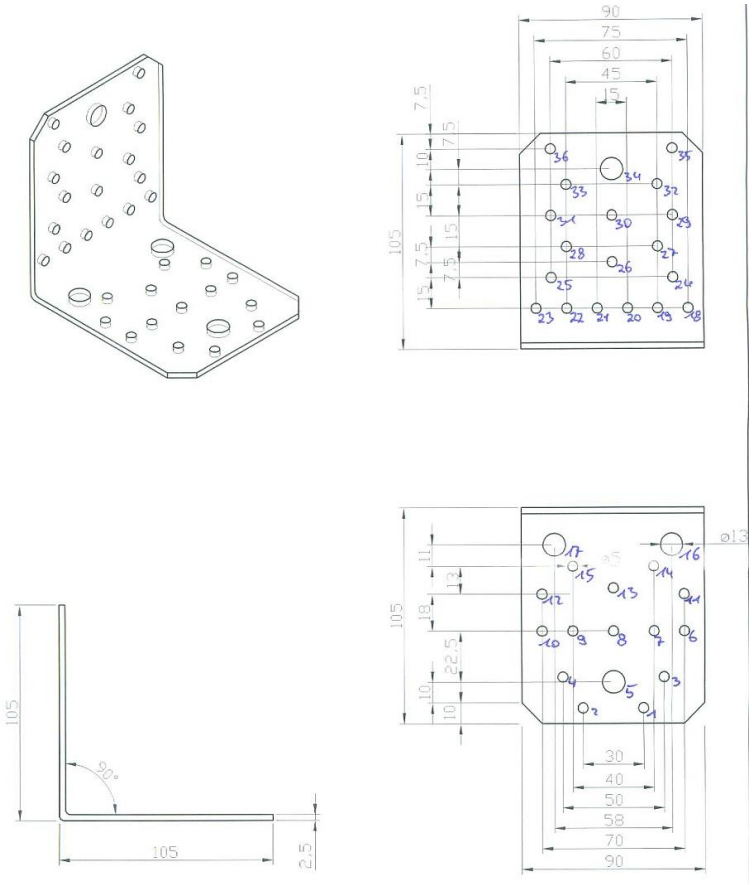


Figure A. 30 Angle Bracket 242 102 90 105x105x90

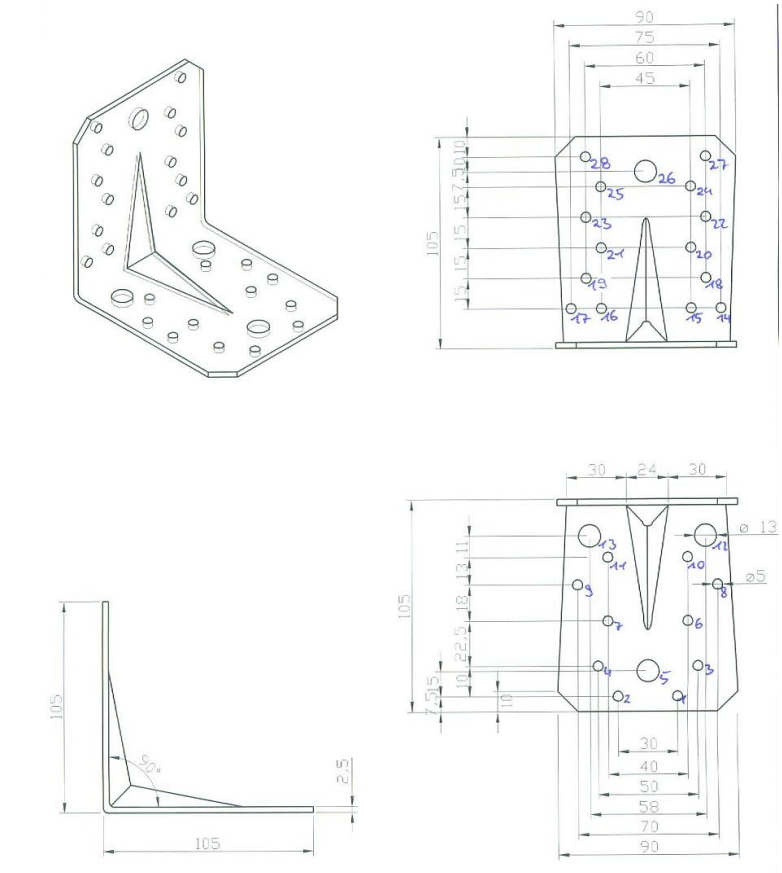


Figure A. 31 Angle Bracket 242 102 990 105x105x90

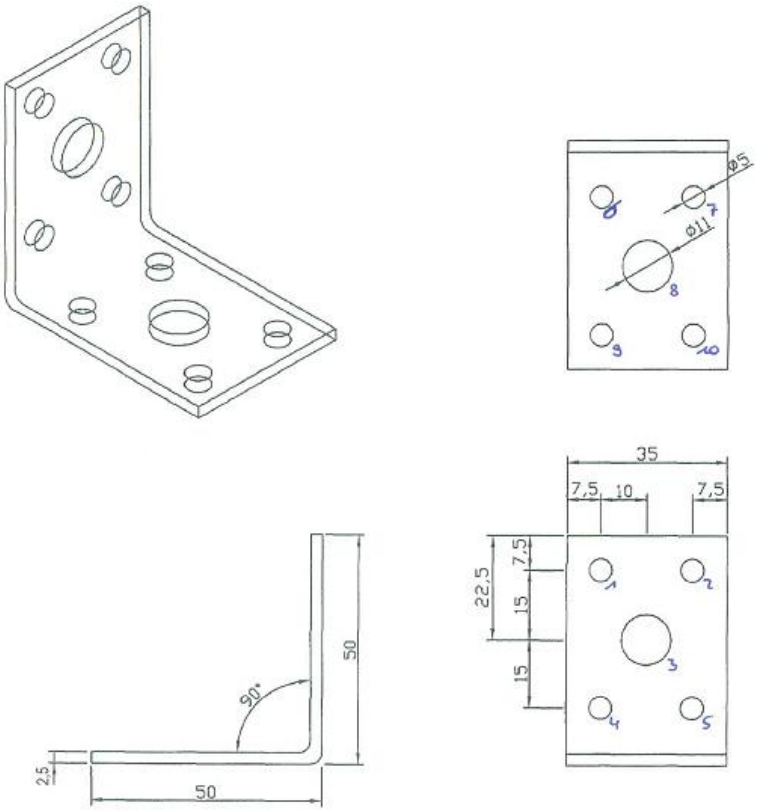


Figure A. 32 Angle Bracket 242 050 035 50x50x35

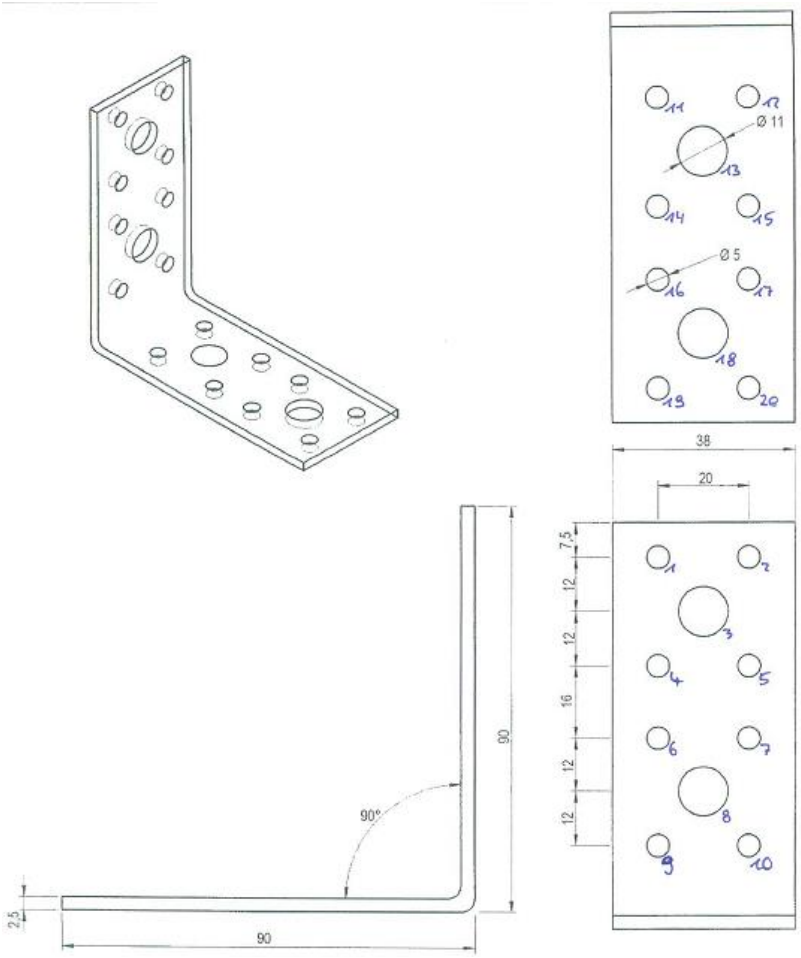


Figure A. 33 Angle Bracket 242 090 041 90x90x40

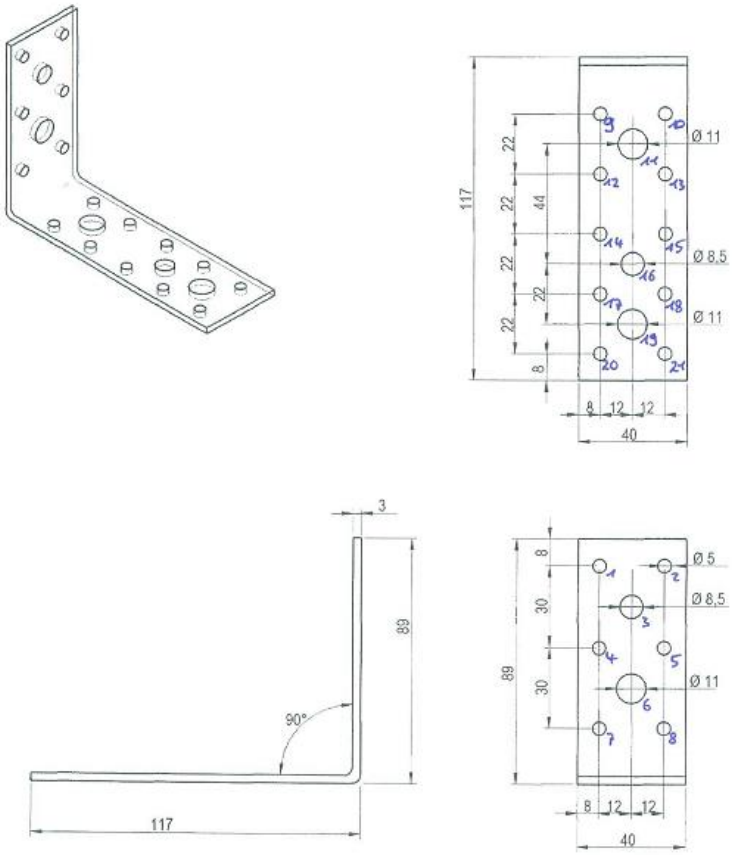


Figure A. 34 Angle Bracket 243 129 040 119x91x40

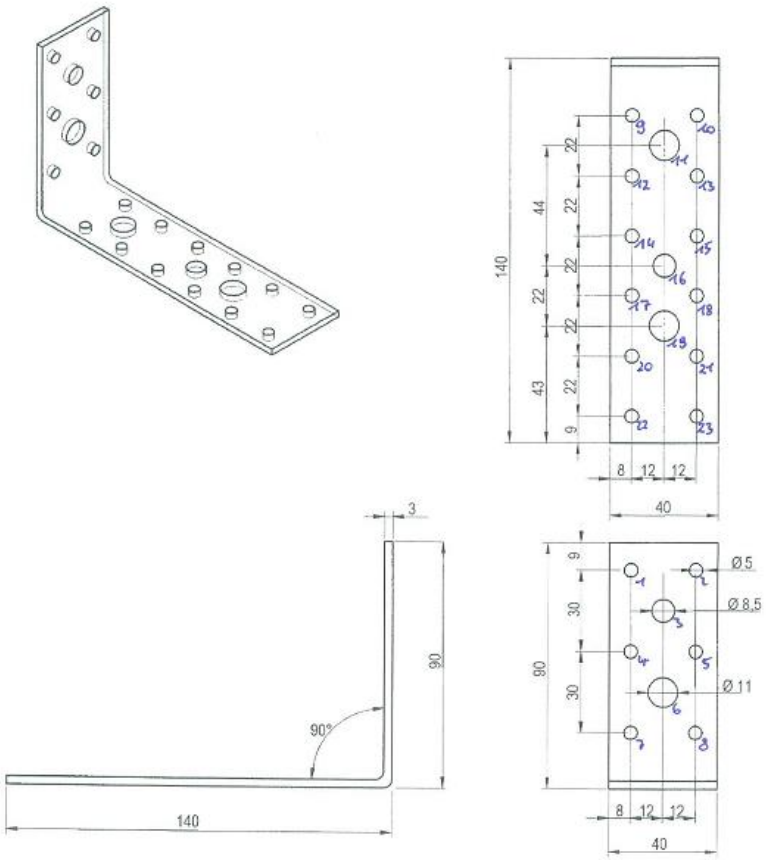


Figure A. 35 Angle Bracket 243 149 040 141x91x40

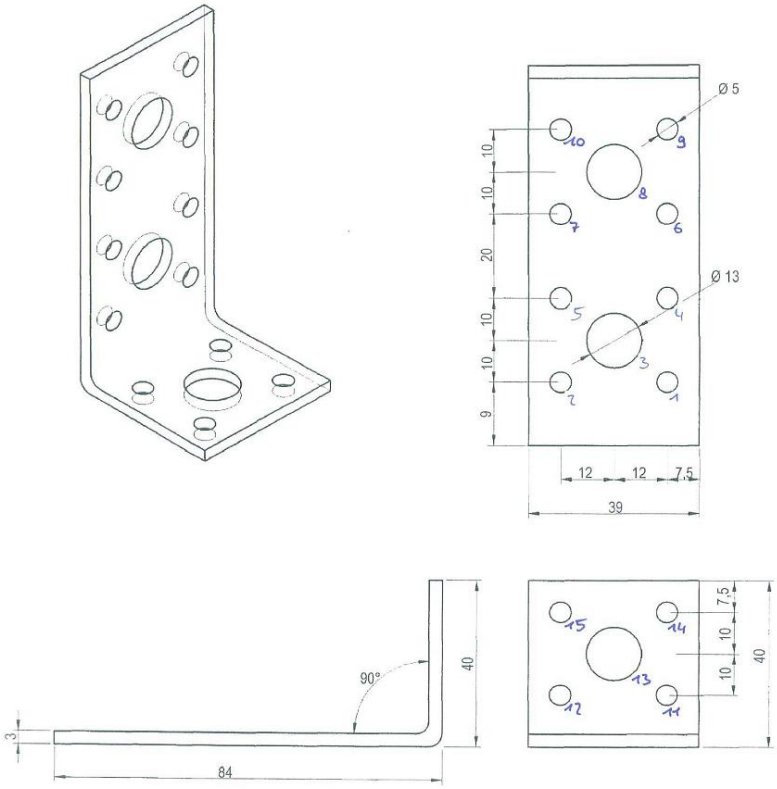


Figure A. 36 Angle Bracket 243 409 040 90x40x40

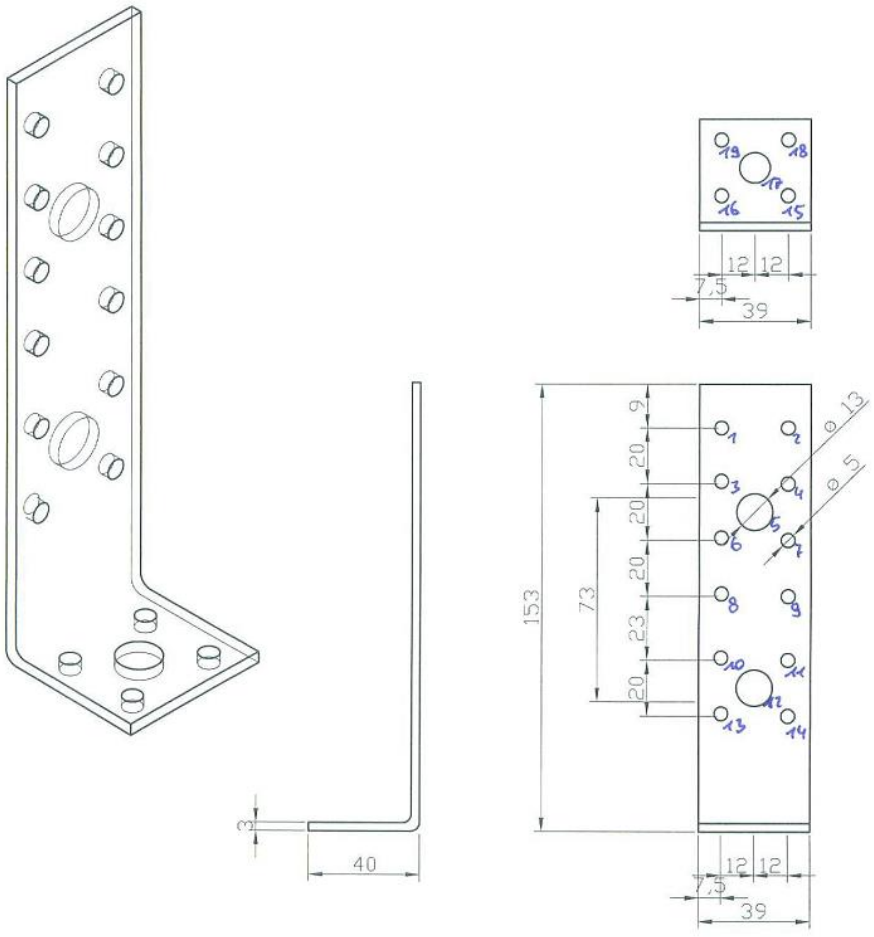


Figure A. 37 Angle Bracket 243 416 040 40x160x40

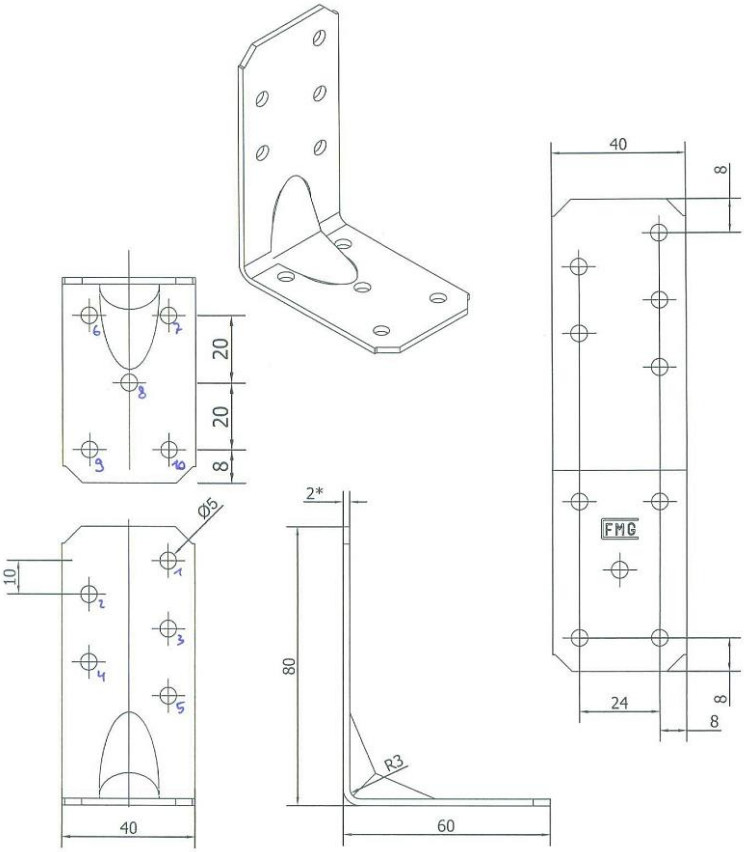


Figure A. 38 Angle Bracket 243 608 040 62x83x40

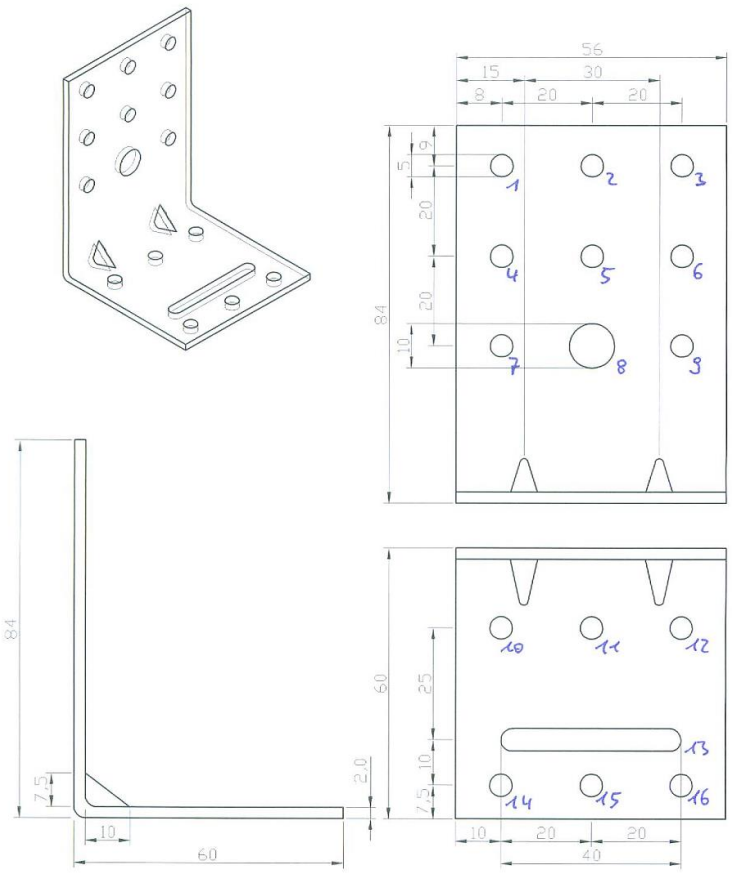


Figure A. 39 Angle Bracket 243 609 061 60x90x60

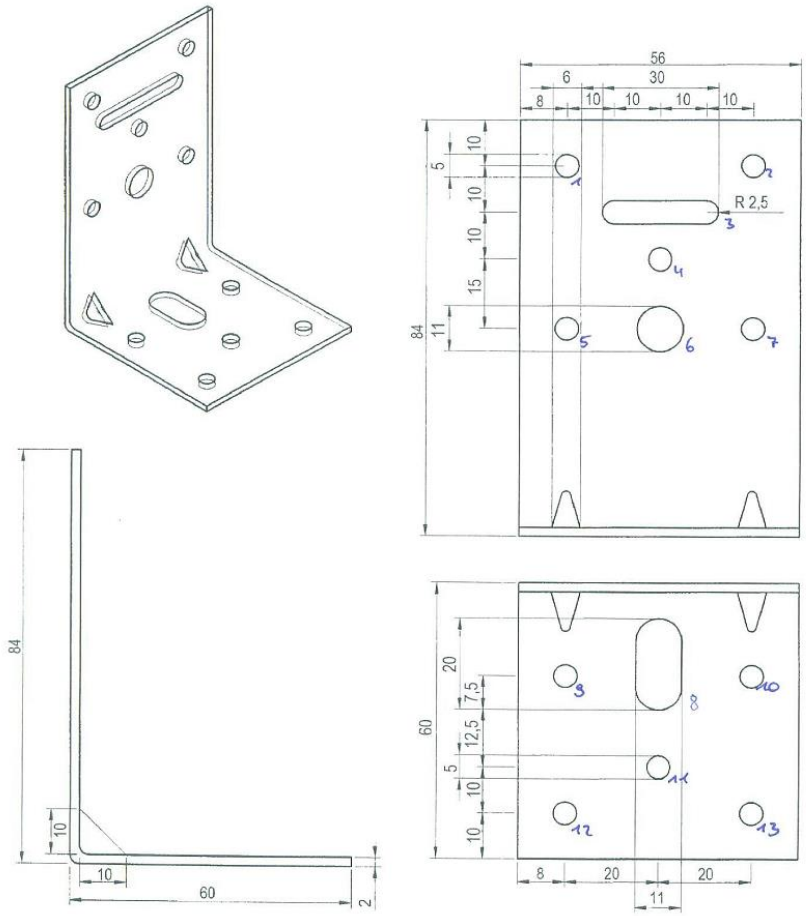


Figure A. 40 Angle Bracket 243 609 062 60x90x60

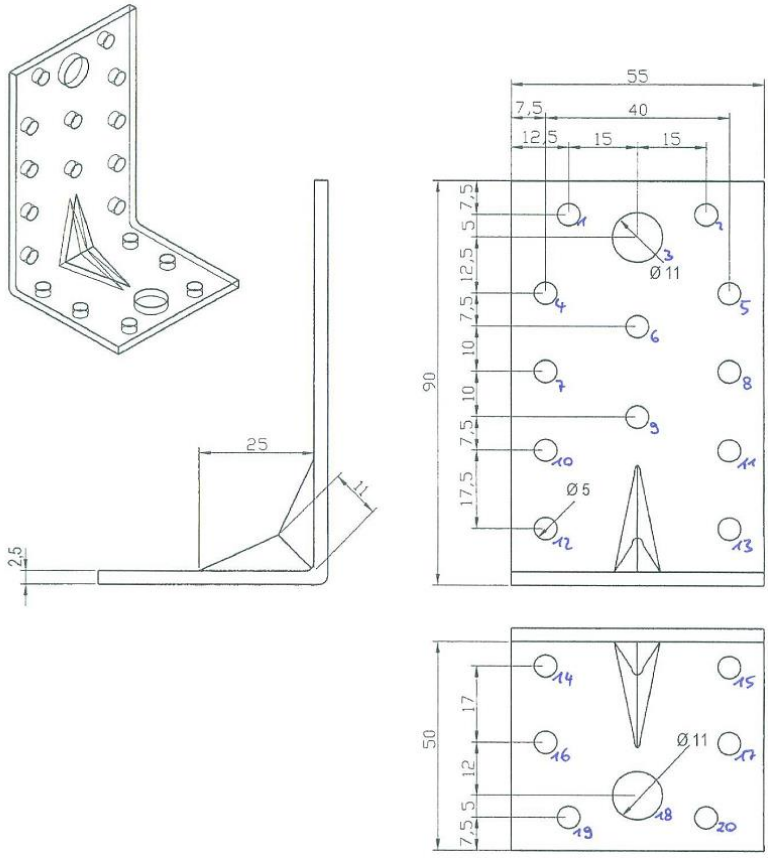


Figure A. 41 Angle Bracket 243 905 054 90x50x55

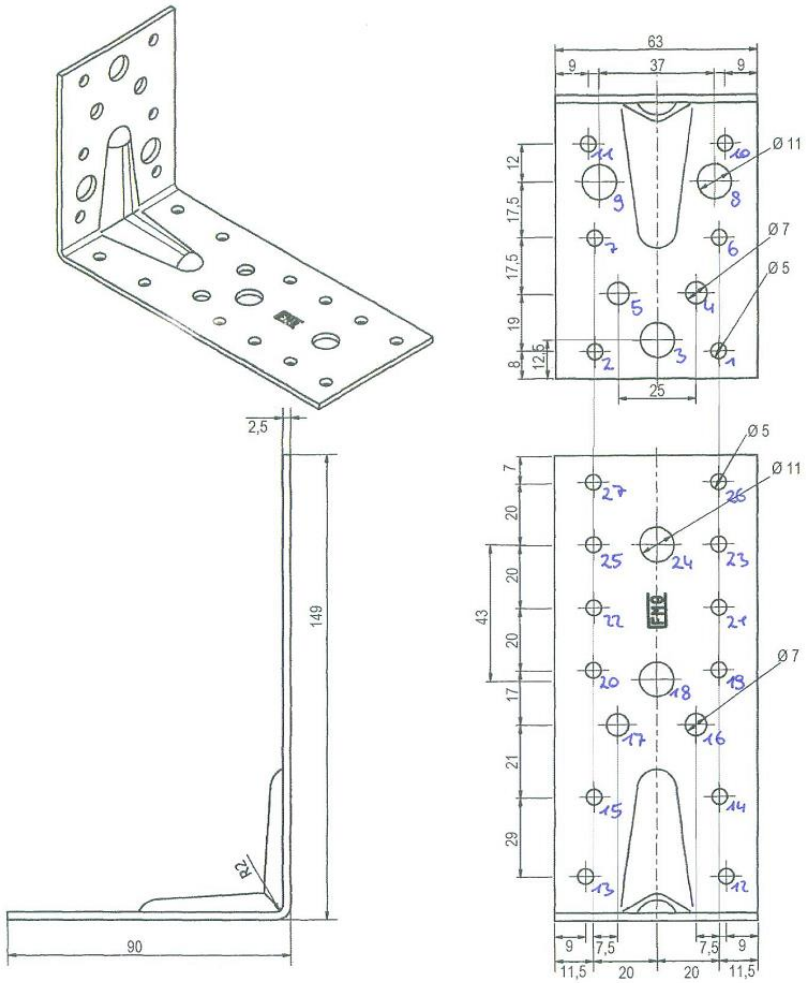


Figure A. 42 Angle Bracket 243 915 965 90x150x65

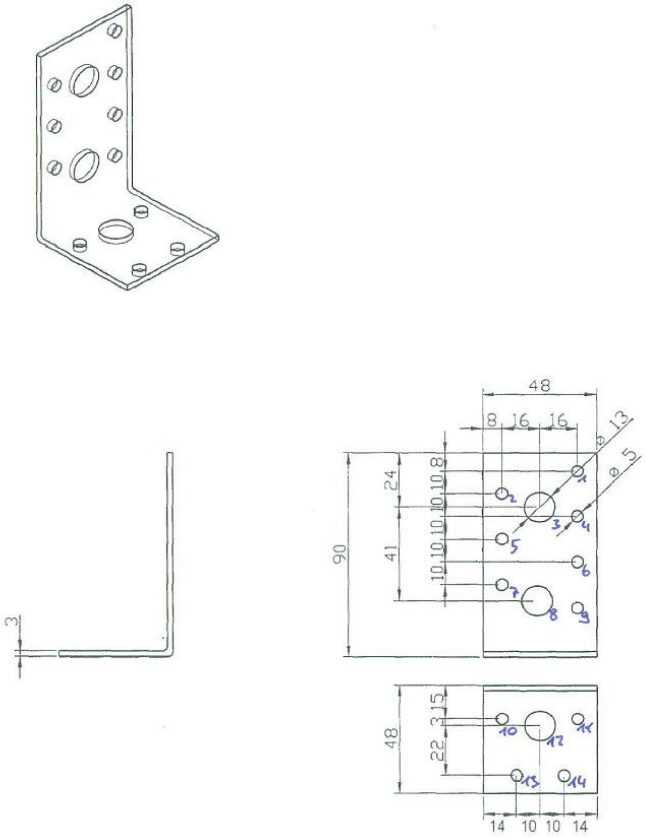


Figure A. 43 Angle Bracket 243 948 048 90x48x48

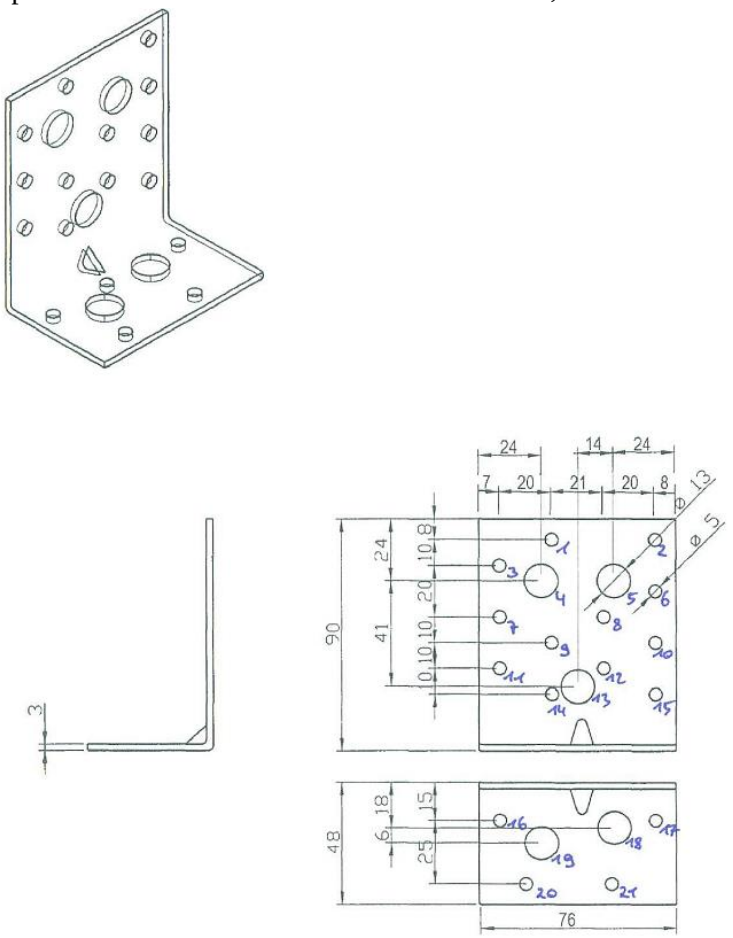


Figure A. 44 Angle Bracket 243 948 076 90x48x76

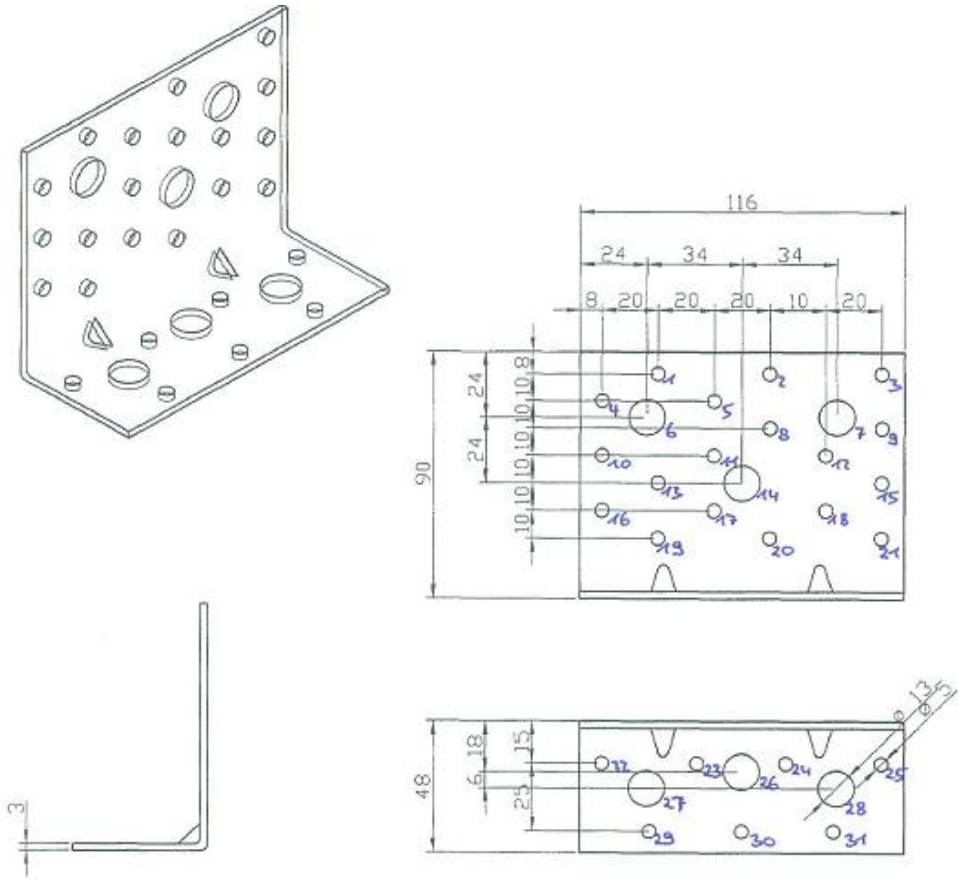


Figure A. 45 Angle Bracket 243 948 116 90x48x116

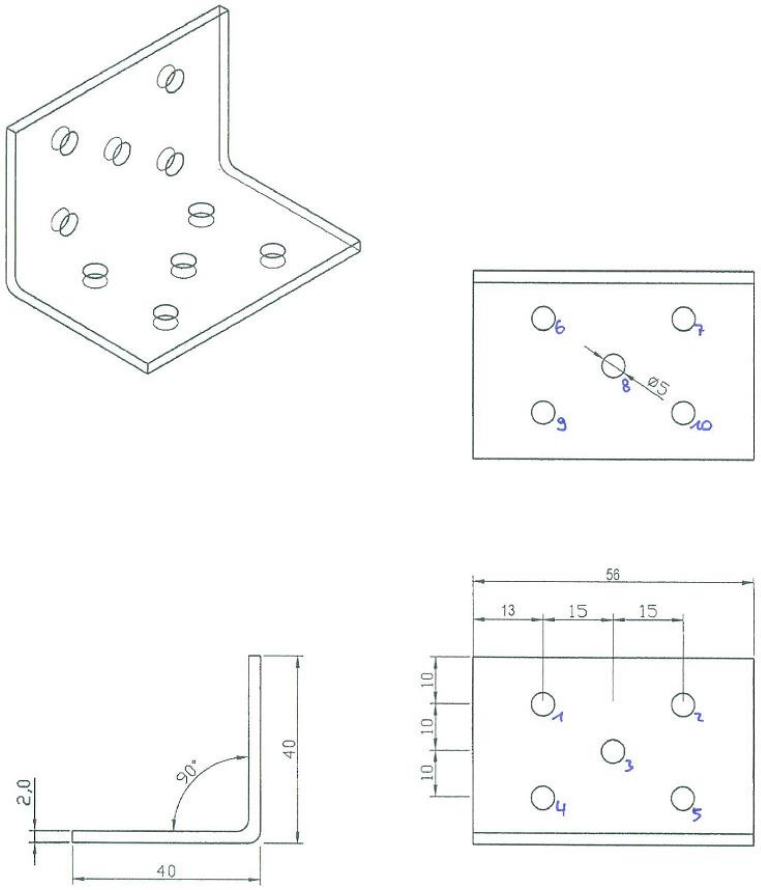


Figure A. 46 Angle Bracket 241 446 200 40x40x60

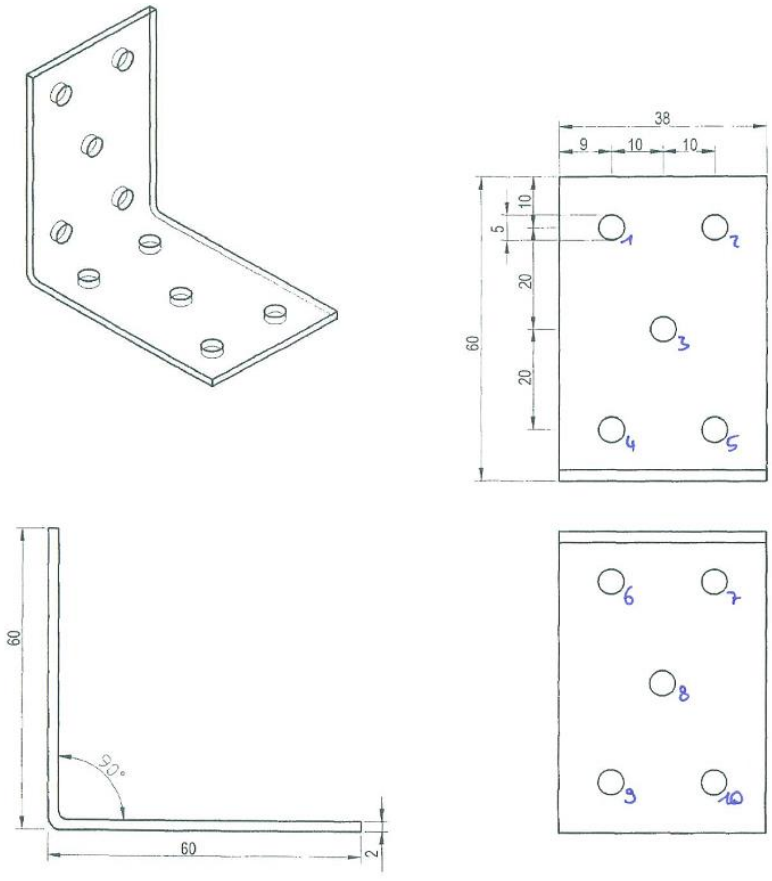


Figure A. 47 Angle Bracket 241 664 200 60x60x40

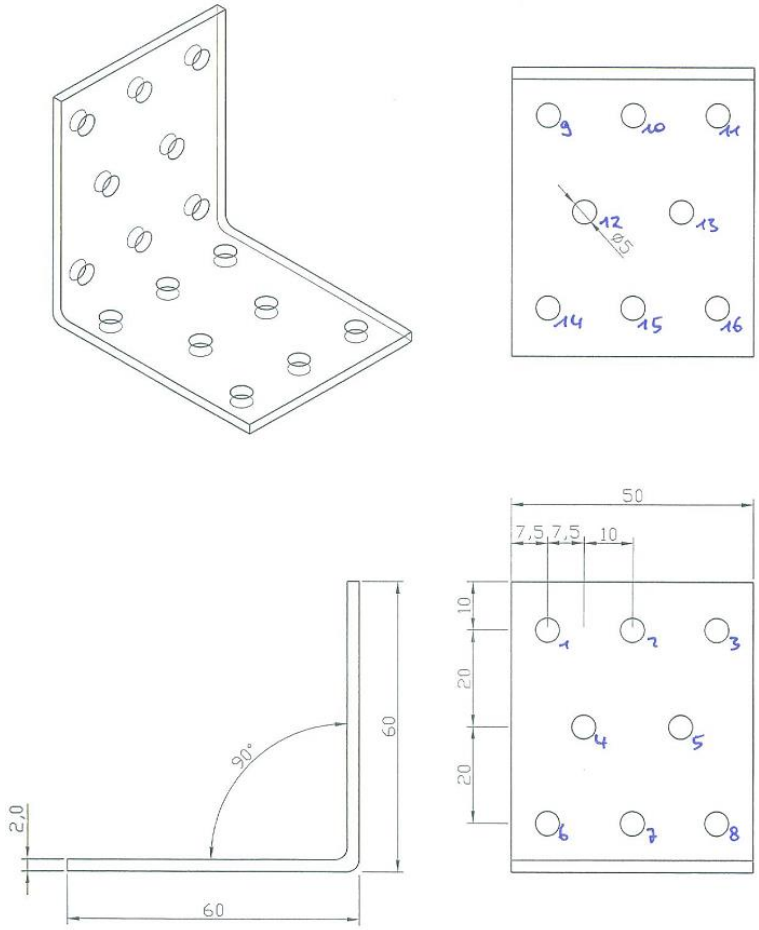


Figure A. 48 Angle Bracket 241 665 200 60x60x50

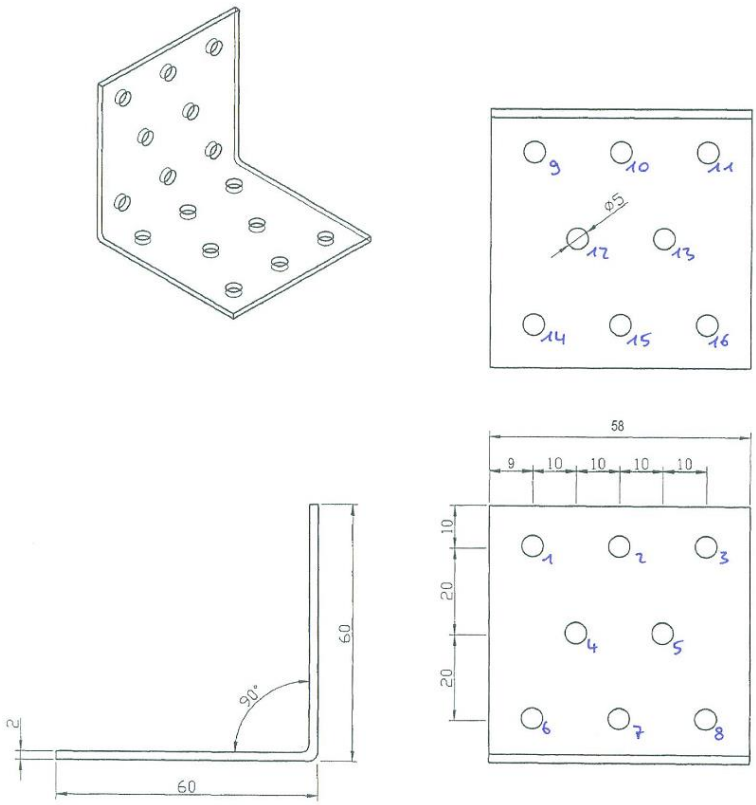


Figure A. 49 Angle Bracket 241 666 200 60x60x60

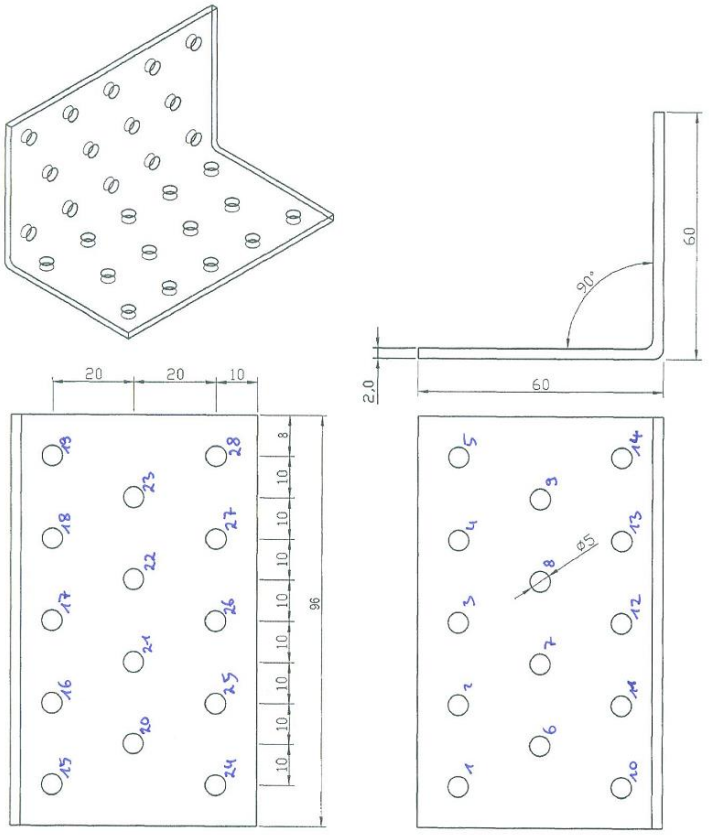


Figure A. 50 Angle Bracket 241 661 200 60x60x100

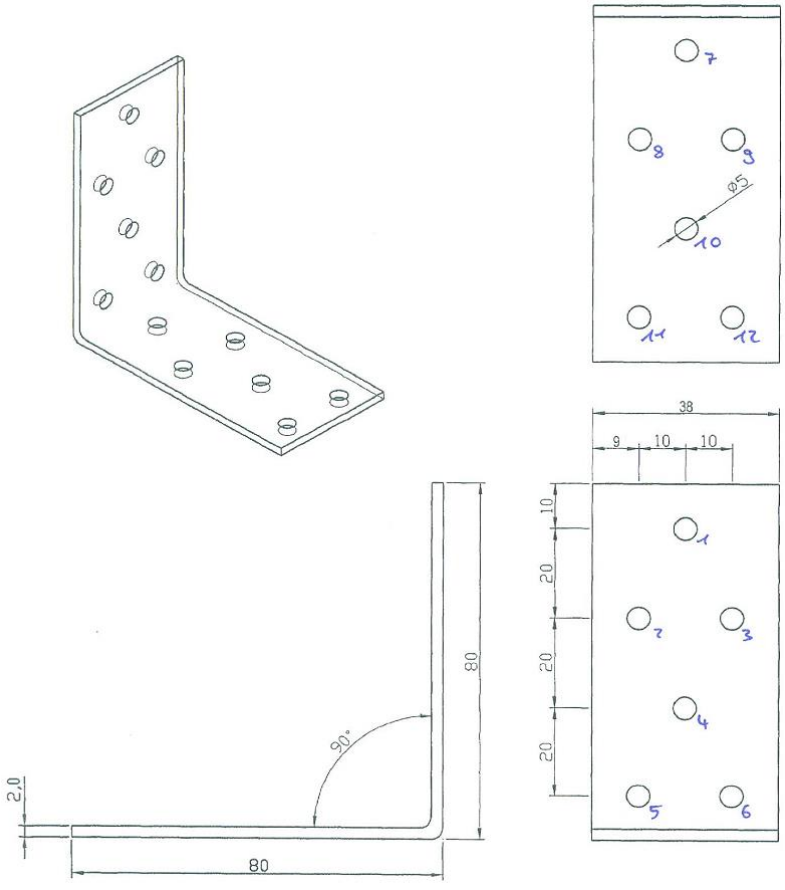


Figure A. 51 Angle Bracket 241 884 200 80x80x40

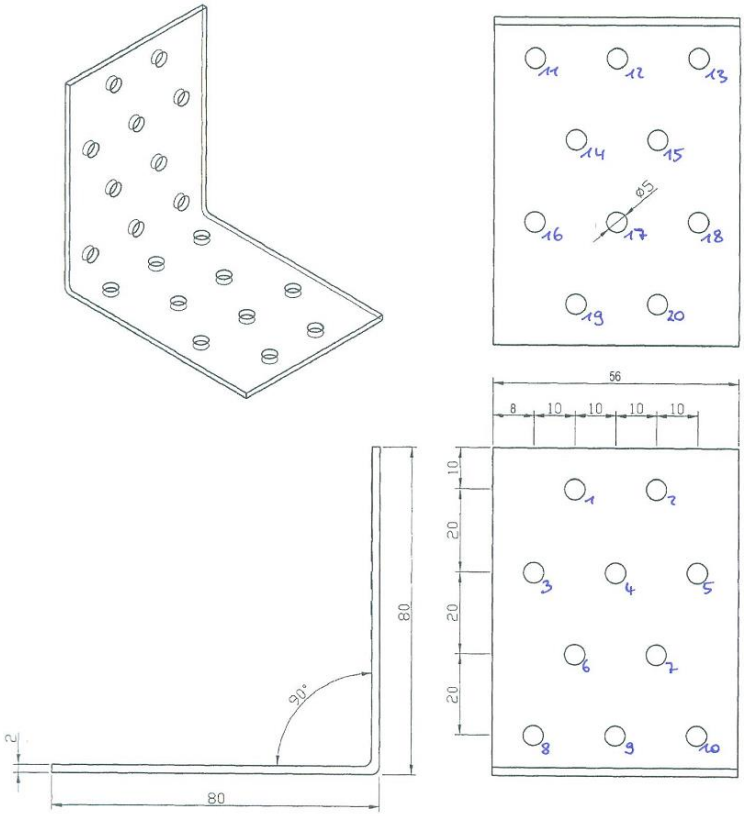


Figure A. 52 Angle Bracket 241 886 200 80x80x60

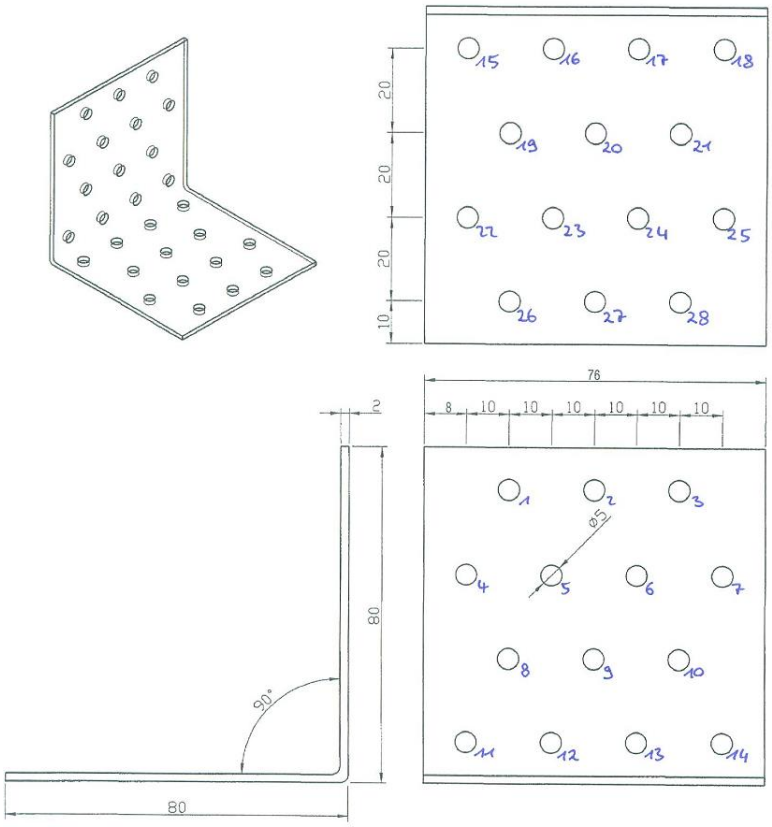


Figure A. 53 Angle Bracket 241 888 200 80x80x80

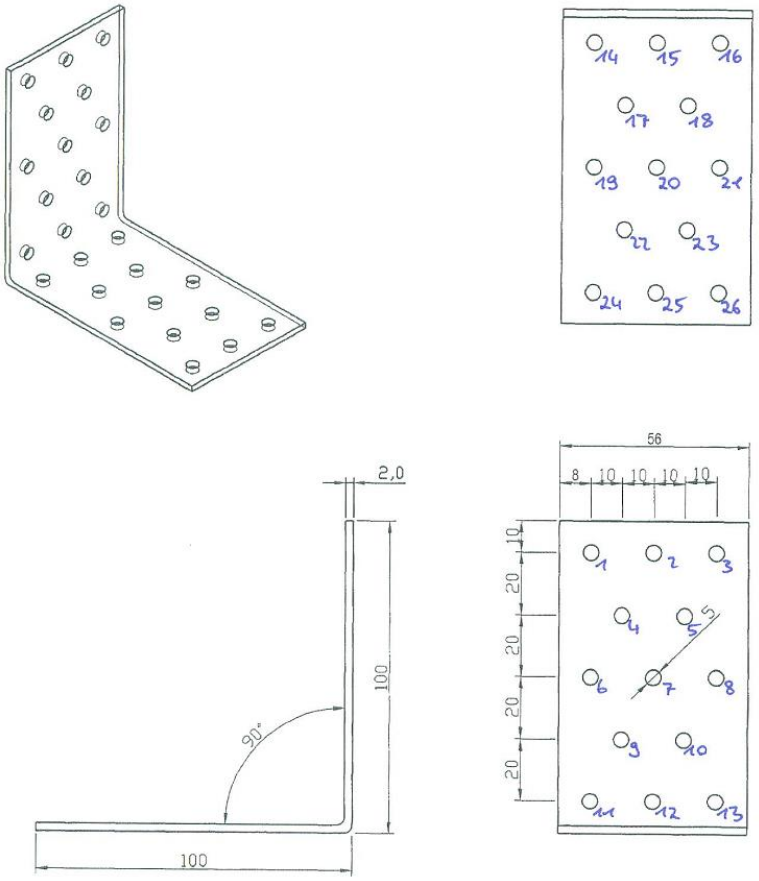


Figure A. 54 Angle Bracket 241 116 200 100x100x60

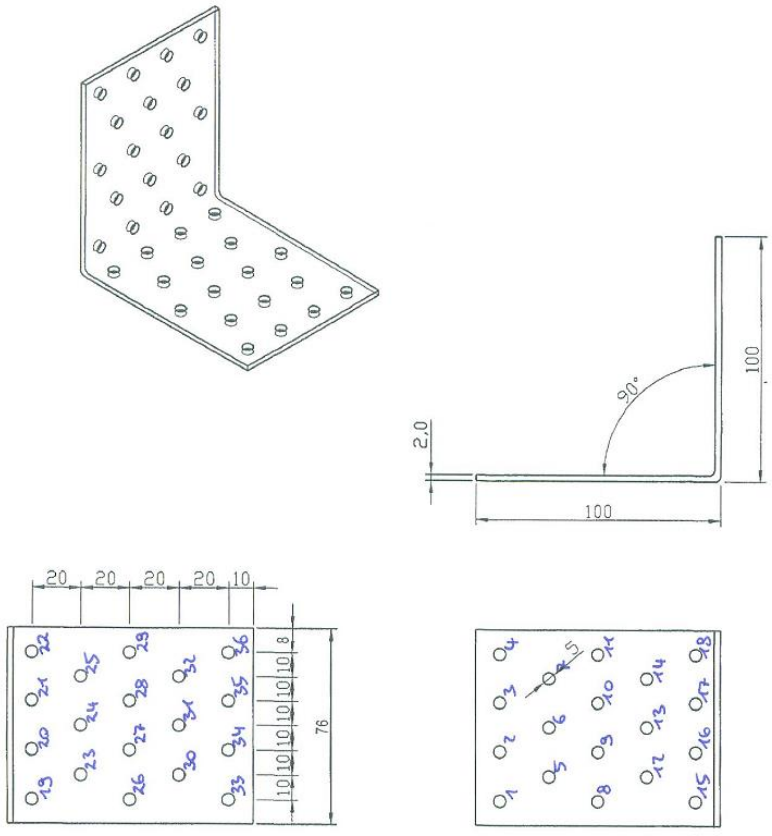


Figure A. 55 Angle Bracket 241 118 200 100x100x80

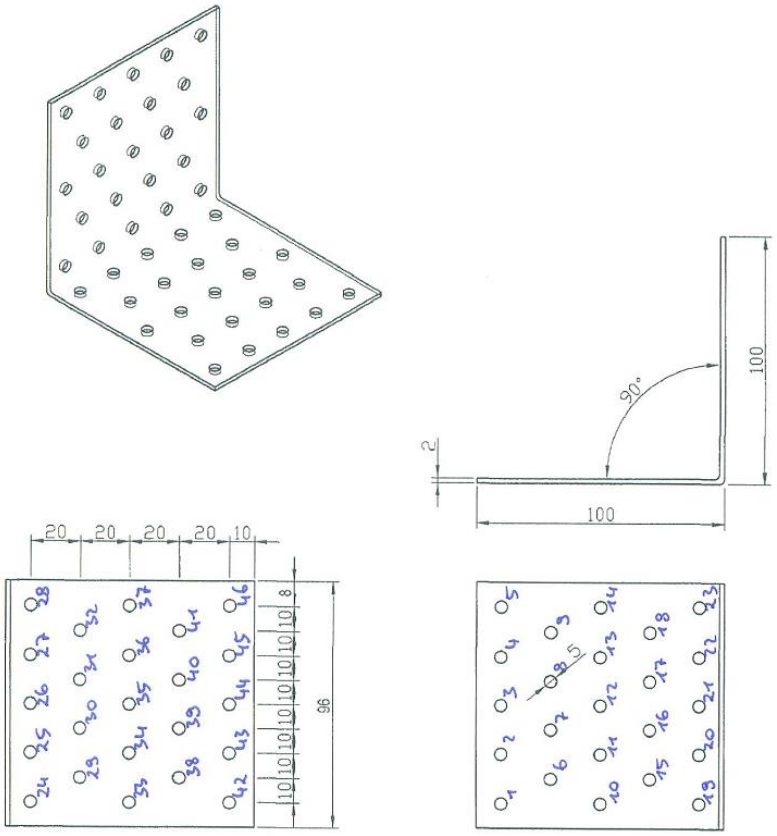


Figure A. 56 Angle Bracket 241 111 200 100x100x100

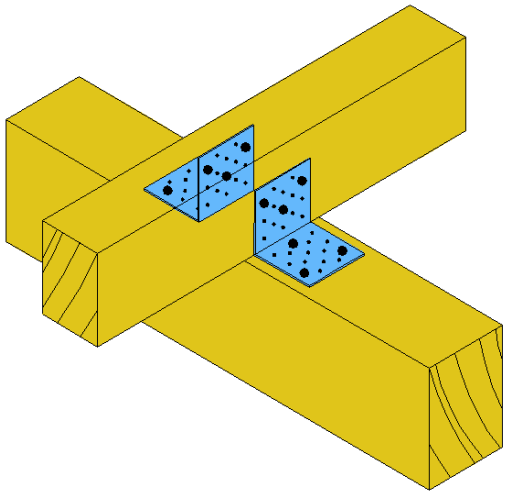


Figure A. 57 Typical installation of angle brackets

Annex B

Characteristic load-carrying capacities – Angle Brackets

Table B.1: Force F_1 Column, 2 angle brackets / connection

Type	Nail number n_V	Nail number n_h	$F_{1,Rk}$ [kN] (column)	
			Timber	Steel
242 070 055 70 without rib	1,2,3	12,13,14,20,21,22	3,1	1,6
242 090 065 90 without rib	1,2	14,15,19,20,24,25	2,4	3,0
242 100 090 105 without rib	1,2,6,7,8,9,10	18,19,20,21,22,23,27,28,30,35,36	7,1	3,4
242 070 955 70 with rib	1,2,3	9,10,14,15,16	2,0	2,1
242 090 965 90 with rib	1,2	14,15,18,19,25,26	2,4	7,7
242 100 990 105 with rib	1,2,6,7	14,15,16,17,20,21,27,28	4,9	12,5

Table B.2: Force F_1 Column, 1 angle bracket / connection

Type	Nail number n_V	Nail number n_h	$F_{1,Rk}$ [kN] (column)	
			Timber	Steel
242 070 055 70 without rib	1,2,3	12,13,14,20,21,22	1,5	0,8
242 090 065 90 without rib	1,2	14,15,19,20,24,25	1,2	1,5
242 100 090 105 without rib	1,2,6,7,8,9,10	18,19,20,21,22,23,27,28,30,35,36	3,5	1,7
242 070 955 70 with rib	1,2,3	9,10,14,15,16	1,0	1,0
242 090 965 90 with rib	1,2	14,15,18,19,25,26	1,2	3,8
242 100 990 105 with rib	1,2,6,7	14,15,16,17,20,21,27,28	2,4	6,3

Table B.3: Force F_1 Purlin, 2 angle brackets / connection

Type	Nail number n_V	Nail number n_h	$F_{1,Rk}$ [kN] (purlin)	
			Timber	Steel
242 070 055 70 without rib	1,3,4,6,7	12,13,14,20,21,22	3,1	1,6
242 090 065 90 without rib	1,2,4,8,9,10,11	14,15,19,20,24,25	2,4	3,0
242 100 090 105 without rib	1,2,6,8,10,14,15	18,19,20,21,22,23,27,28,30,35,36	7,1	4,0
242 070 955 70 with rib	1,3,4,6	9,10,14,15,16	2,0	7,7
242 090 965 90 with rib	1,2,4,8,9	14,15,18,19,25,26	2,4	9,1
242 100 990 105 with rib	1,2,6,7,8,9,10,11	14,15,16,17,20,21,27,28	4,9	12,5

Table B.4: Force F_1 Purlin, 1 angle bracket / connection

Type	Nail number n_V	Nail number n_h	$F_{1,Rk}$ [kN] (purlin)	
			Timber	Steel
242 070 055 70 without rib	1,3,4,6,7	12,13,14,20,21,22	1,5	0,8
242 090 065 90 without rib	1,2,4,8,9,10,11	14,15,19,20,24,25	1,2	1,5
242 100 090 105 without rib	1,2,6,8,10,14,15	18,19,20,21,22,23,27,28,30,35,36	3,5	1,7
242 070 955 70 with rib	1,3,4,6	9,10,14,15,16	1,0	1,0
242 090 965 90 with rib	1,2,4,8,9	14,15,18,19,25,26	1,2	3,8
242 100 990 105 with rib	1,2,6,7,8,9,10,11	14,15,16,17,20,21,27,28	2,4	6,3

Table B.5: Force F_2/F_3, 1 angle bracket / timber-timber connection

Art.-No.	Dimensions l_v x l_h x b x t [mm]	Hole-No. n_v/n_h	Nails Ø4,0x40		Screws Ø5,0x50	
			e_1 [mm]	$F_{2,Rk}/F_{3,Rk}$ [kN]	e_1 [mm]	$F_{2,Rk}/F_{3,Rk}$ [kN]
242 072 055 242 070 055	70x70x55x2,0	1,3,4,6,7 / 12,13,14,20,21,22	34,9	2,9	28,1	4,8
242 072 955 242 070 955	70x70x55x2,0	1,3,4,6 / 9,10,14,15,16	42,2	2,6	37,1	4,1
242 092 065 242 090 065	90x90x65x2,0	1,2,4,8,9,10,11/ 14,15,19,20,24,25	49,3	3,6	47,2	5,3
242 092 965 242 090 965	90x90x65x2,0	1,2,4,8,9 / 14,15,18,19,25,26	44,3	2,7	34,6	4,6
242 102 090 242 100 090	105x105x90x2,5	1,2,6,8,10,14,15 / 18,19,20,21,22,23,27, 28,30,35,36	41,7	4,3	31,0	7,5
242 102 990 242 100 990	105x105x90x2,5	1,2,6,7,8,9,10,11 / 14,15,16,17,20,21,27,28	45,4	4,5	39,1	7,1
242 050 035	50x50x35x2,5	1,2 / 6,7,8,10	22,7	1,3	14,6	2,6
242 090 041	90x90x38x2,5	1,2,6,7 / 11,12,16,17,19,20	48,1	2,1	39,0	3,4
243 129 040	89x117x40x3,0	1,2,4,5 / 9,10,12,13,14,15,17, 18,20,21	35,0	2,4	21,5	4,6
243 149 040	90x140x40x3,0	1,2,4,5 / 9,10,12,13,14,15,17,18, 20,21,22,23	30,8	2,6	16,8	5,2
243 409 040	90x40x39x3,0	1,2,4,5,6,7 / 11,12,14,15	53,4	2,4	48,3	3,8
243 416 040	153x40x39x3,0	1,2,3,4,6,7,8,9,10, 11,13,14 / 15,16,18,19	100,0	2,9	100,0	4,1
243 608 040	80x60x40x2,0	1÷5 / 6÷10	40,0	4,2	32,0	3,5

Continuation of table B.5: Force F_2/F_3, 1 angle bracket / timber-timber connection

Art.-No.	Dimensions l_v x l_h x b x t [mm]	Hole-No. n_v/n_h	Nails Ø4,0x40		Screws Ø5,0x50	
			e_1 [mm]	$F_{2,Rk}/F_{3,Rk}$ [kN]	e_1 [mm]	$F_{2,Rk}/F_{3,Rk}$ [kN]
243 609 061	84x60x56x2,0	1,2,3,4,5,6,7,9 / 10,11,12,14,15,16	50,1	3,6	46,2	5,4
243 609 062	84x60x56x2,0	1,2,4,5,7 / 9,10,11,12,13	45,7	5,5	40,9	4,2
243 905 054	90x50x55x2,5	1,2,4,5,7,8,10,11 / 14,15,19,20	56,3	3,3	56,3	4,8
243 915 965	90x149x63x2,5	1,2,6,7 / 12,13,14,15,19,20,21, 22,23,25,26,27	12,7	4,3	7,6	7,1
243 948 048	90x48x48x3,0	1,2,4,5,6,7 / 10,11,13,14	53,4	2,5	51,7	3,7
243 948 076	90x48x76x3,0	1,2,3,6,7,8,9,10, 11,12 / 16,17,20,21	55,0	3,5	55,0	5,0
243 948 116	90x48x116x3,0	1,2,3,4,5,8,9,10,11,12, 13,15,16,17,18 / 22,23,24,25,29,30,31	56,7	6,8	56,7	9,7
241 446 200	40x40x56x2,0	1,2 / 6,7,9,10	15,2	2,3	8,3	4,0
241 664 200	60x60x38x2,0	1÷3 / 6÷10	24,4	1,4	15,2	2,7
241 665 200	60x60x50x2,0	1,3,4,5 / 9,10,11,14,15,16	25,2	2,7	17,5	4,9
241 666 200	60x60x58x2,0	1÷5 / 9÷16	24,6	3,1	16,4	5,7
241 661 200	60x60x96x2,0	1÷9 / 9÷28	24,2	7,8	16,7	13,5
241 884 200	80x80x38x2,0	1÷4 / 7÷12	35,2	1,6	26,4	2,8
241 886 200	80x80x56x2,0	1÷7 / 11÷20	34,1	3,5	25,5	6,1
241 888 200	80x80x76x2,0	1÷10 / 15÷28	33,6	5,9	25,7	10,1
241 116 200	100x100x56x2,0	1÷10 / 14÷26	46,1	4,7	36,3	8,0
241 118 200	100x100x76x2,0	1÷14 / 19÷36	44,9	7,5	36,0	12,5
241 111 200	100x100x96x2,0	1÷18 / 24÷46	42,2	11,3	37,3	17,3

Table B.6: Force F_2/F_3, 2 angle brackets / timber-timber connection

Art.-No.	Dimensions l_v x l_h x b x t [mm]	Hole-No. n_v/n_h	Nails Ø4,0x40		Screws Ø5,0x50	
			e_1 [mm]	$F_{2,Rk}/F_{3,Rk}$ [kN]	e_1	$F_{2,Rk}/F_{3,Rk}$ [mm]
242 072 055 242 070 055	70x70x55x2,0	1,3,4,6,7 / 12,13,14,20,21,22	34,9	5,8	28,1	9,6
242 072 955 242 070 955	70x70x55x2,0	1,3,4,6 / 9,10,14,15,16	42,2	5,2	37,1	8,1
242 092 065 242 090 065	90x90x65x2,0	1,2,4,8,9,10,11/ 14,15,19,20,24,25	49,3	7,2	47,2	10,6
242 092 965 242 090 965	90x90x65x2,0	1,2,4,8,9 / 14,15,18,19,25,26	44,3	5,4	34,6	9,2
242 102 090 242 100 090	105x105x90x2,5	1,2,6,8,10,14,15 / 18,19,20,21,22,23,27, 28,30,35,36	41,7	8,7	31,0	15,0
242 102 990 242 100 990	105x105x90x2,5	1,2,6,7,8,9,10,11 / 14,15,16,17,20,21, 27,28	45,4	9,0	39,1	14,2
242 050 035	50x50x35x2,5	1,2 / 6,7,8,10	22,7	2,6	14,6	5,2
242 090 041	90x90x38x2,5	1,2,6,7 / 11,12,16,17,19,20	48,0	4,2	39,0	6,8
243 129 040	89x117x40x3,0	1,2,4,5 / 9,10,12,13,14,15,17, 18,20,21	35,0	4,8	21,5	9,1
243 149 040	90x140x40x3,0	1,2,4,5 / 9,10,12,13,14,15,17,18,20,2 1,22,23	30,8	5,2	16,8	10,3
243 409 040	90x40x39x3,0	1,2,4,5,6,7 / 11,12,14,15	53,4	4,9	48,3	7,5
243 416 040	153x40x39x3,0	1,2,3,4,6,7,8,9,10, 11,13,14 / 15,16,18,19	100,0	5,8	100,0	8,2
243 608 040	80x60x40x2,0	1÷5 / 6÷10	40,0	4,2	32	7,1
243 609 061	84x60x56x2,0	1,2,3,4,5,6,7,9 / 10,11,12,14,15,16	50,1	7,2	46,2	10,8
243 609 062	84x60x56x2,0	1,2,4,5,7 / 9,10,11,12,13	45,7	5,5	40,9	8,4
243 905 054	90x50x55x2,5	1,2,4,5,7,8,10,11 / 14,15,19,20	56,3	6,7	56,3	9,5
243 915 965	90x149x63x2,5	1,2,6,7 / 12,13,14,15,19,20,21, 22,23,25,26,27	12,7	8,6	7,6	14,2
243 948 048	90x48x48x3,0	1,2,4,5,6,7 / 10,11,13,14	53,4	5,1	51,7	7,4
243 948 076	90x48x76x3,0	1,2,3,6,7,8,9,10, 11,12 / 16,17,20,21	55,0	7,0	55,0	10,0
243 948 116	90x48x116x3,0	1,2,3,4,5,8,9,10,11,12, 13,15,16,17,18 / 22,23,24,25,29,30,31	56,7	13,6	56,7	19,3

Continuation of table B.6: Force F_2/F_3, 2 angle brackets / timber-timber connection

Art.-No.	Dimensions l_v x l_h x b x t [mm]	Hole-No. n_v/n_h	Nails Ø4,0x40		Screws Ø5,0x50	
			e_1 [mm]	$F_{2,Rk}/F_{3,Rk}$ [kN]	e_1	$F_{2,Rk}/F_{3,Rk}$ [mm]
241 446 200	40x40x56x2,0	1,2 / 6,7,9,10	15,2	4,5	8,3	8,0
241 664 200	60x60x38x2,0	1÷3 / 6÷10	24,4	2,8	15,2	5,5
241 665 200	60x60x50x2,0	1,3,4,5 / 9,10,11,14,15,16	25,2	5,5	17,5	9,8
241 666 200	60x60x58x2,0	1÷5 / 9÷16	24,6	6,2	16,4	11,4
241 661 200	60x60x96x2,0	1÷9 / 9÷28	24,2	15,6	16,7	27,1
241 884 200	80x80x38x2,0	1÷4 / 7÷12	35,2	3,2	26,4	5,6
241 886 200	80x80x56x2,0	1÷7 / 11÷20	34,1	7,0	25,5	12,3
241 888 200	80x80x76x2,0	1÷10 / 15÷28	33,6	11,8	25,7	20,2
241 116 200	100x100x56x2,0	1÷10 / 14÷26	46,1	9,5	36,3	16,0
241 118 200	100x100x76x2,0	1÷14 / 19÷36	44,9	15,1	36,0	25,0
241 111 200	100x100x96x2,0	1÷18 / 24÷46	42,2	22,5	37,3	34,7

Table B.7: Basic Forces F_4/F_5, 2 angle brackets / connection

Type	Nail number n_V	Nail number n_h	$F_{4,Rk}/F_{5,Rk}$ [kN]	
			Timber	Steel
242 070 055 70 without rib	1,3,4,6,7	12,13,14,20,21,22	4,8	3,6
242 090 065 90 without rib	1,2,4,8,9,10,11	14,15,19,20,24,25	6,1	3,8
242 100 090 105 without rib	1,2,6,8,10,14,15	18,19,20,21,22,23,27,28,30,35,36	6,9	7,6
242 070 955 70 with rib	1,3,4,6	9,10,14,15,16	6,6	4,5
242 090 965 90 with rib	1,2,4,8,9	14,15,18,19,25,26	7,0	5,7
242 100 990 105 with rib	1,2,6,7,8,9,10,11	14,15,16,17,20,21,27,28	8,6	12,6

Table B.8: Basic Forces F_4, 1 angle bracket / connection

Type	Nail number n_V	Nail number n_h	$R_{k,4,5}$ [kN]	
			Timber	Steel
242 070 955 70 with rib	1,3,4,6	9,10,14,15,16	8,0	3,6
242 090 965 90 with rib	1,2,4,8,9	14,15,18,19,25,26	9,2	4,4
242 100 990 105 with rib	1,2,6,7,8,9,10,11	14,15,16,17,20,21,27,28	12,5	7,4

Table B.9: Basic Forces F_5, 1 angle bracket / connection

Type	Nail number n_V	Nail number n_h	$R_{k,4,5}$ [kN]	
			Timber	Steel
242 070 955 70 with rib	1,3,4,6	9,10,14,15,16	1,3	0,9
242 090 965 90 with rib	1,2,4,8,9	14,15,18,19,25,26	1,6	1,3
242 100 990 105 with rib	1,2,6,7,8,9,10,11	14,15,16,17,20,21,27,28	2,6	3,5

Characteristic load-carrying capacities – Purlin Ties

Table B.10: Characteristic load-carrying capacities Load F_1 – 2 Purlin Ties / connection

Purlin Ties	Number of nails	Nail failure $F_{Rk,N}$ [kN]	Screw failure $F_{Rk,N}$ [kN]	Steel failure $F_{Rk,S}$[kN]	Transverse tensile failure
Type 171 ÷ 371	2x2	2,12	3,00	10,2	see EN 1995
	2x3	3,36	4,75	10,2	
	2x4	5,33	7,54	10,2	
	2x5	8,37	11,8	10,2	
	2x6	9,71	13,7	10,2	
	2x7	13,7	19,3	10,2	
	2x8	15,1	21,3	10,2	
	2x9	19,4	27,5	10,2	
	2x10	21,1	29,8	10,2	
	2x11	25,6	36,2	10,2	
	2x12	27,5	38,9	10,2	
	2x13	32,1	45,4	10,2	
	2x14	34,2	48,3	10,2	
	2x15	38,8	54,8	10,2	
	2x16	41,0	58,0	10,2	
Uni 170 ÷ 250	2 x 2	4,14	5,85	9,74	
	2 x 3	7,20	10,2	9,74	
	2 x 4	10,5	14,8	9,74	
	2 x 5	13,8	19,6	9,74	

Characteristic load-carrying capacities – Hold-Downs

Table B.11: Characteristic load-carrying capacities Load F_1 – 1 hold-down /connection; timber-concrete/steel

type	capacity per nail $F_{v,Rk}$ [kN] [1) 2)]	capacity per screw $F_{v,Rk}$ [kN] [1) 2)]	concrete	steel [3)]			bolt
				bending $F_{m,Rk}$ [kN]	shear $F_{v,Rk}$ [kN]	tensile $F_{t,Rk}$ [kN]	k_t
hold-down 200 ÷ 500 t = 2 mm	1,62	2,28	see EN 1992	3,67	11,5	17,8	3,2
hold-down 200 ÷ 500 t = 4 mm	1,57	2,28		4,72	23,1	35,6	3,4

[1)] screws 5,0 x 50 mm according ETA-11/0024

[2)] The effective number of fasteners n_{ef} must be considered according EN 1995-1-1:2010, paragraph 8.3.1.1 (8)

[3)] base plate dimensions: 40 x 40 x 4,0 mm

Definitions of forces, their directions and eccentricity

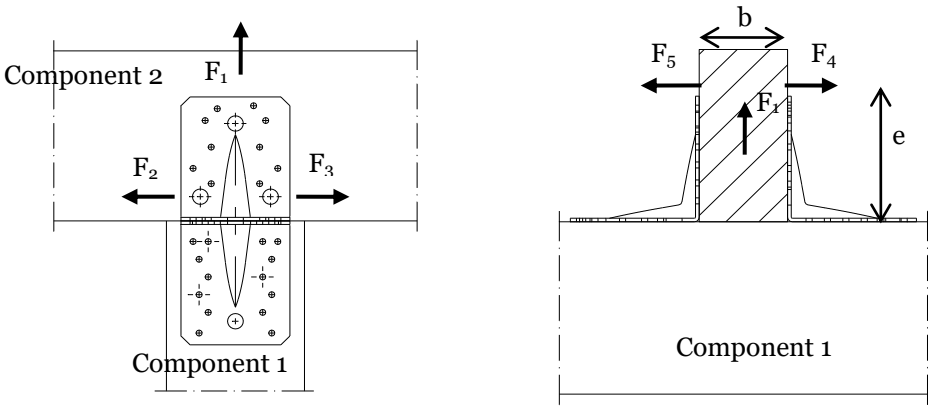


Figure B.58: Forces - Beam to beam connection with angle brackets

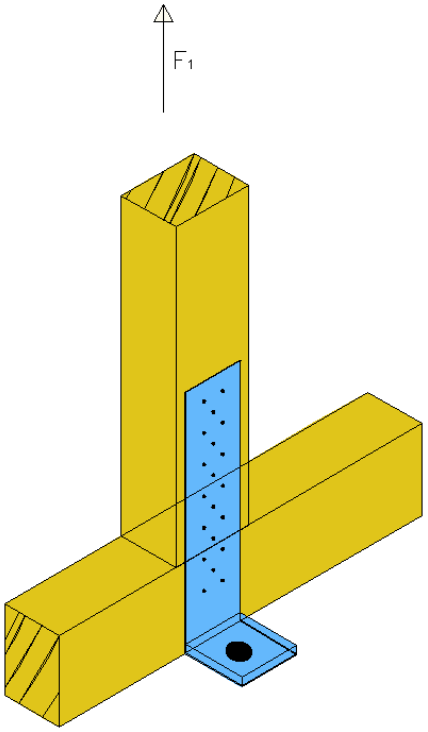


Figure B.59: Forces – Column to concrete or steel connection with hold-downs (F_1)

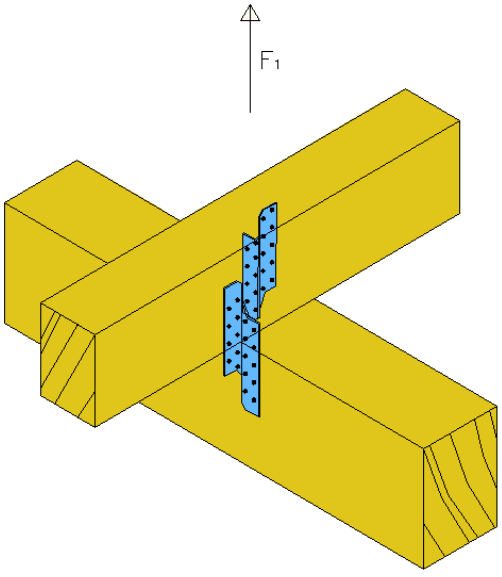


Figure B.60: Forces - Beam to beam connection with purlin ties (F_1)

Fastener specification
Angle Brackets: Holes are marked with numbers referring to the nailing pattern in Annex B.
Purlin Ties/Hold-Downs: The holes are to be nailed beginning at the end of the purlin tie/hold-down.

Support conditions
Purlin Ties: The distance between the timber elements in the area of the connection must not exceed 3 mm. The timber members are prevented from rotation.

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	Lifting force acting along the central axis of the joint.
F_2 and F_3	Lateral force acting in the joint between the component 2 and component 1 in the component 2 direction
F_4 and F_5	Lateral force acting in the component 1 direction along the central axis of the joint. If the load is applied with an eccentricity e, a design for combined loading is required.

Single angle bracket per connection
Acting forces

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

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

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

Combined forces

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

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

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

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

B is the width of component 2.

Connection to concrete or steel with a bolt or metal anchor
The load $F_{B,Ed}$ for the design of a bolt or metal anchor is calculated as:

$$F_{B,t,Ed} = k_t \cdot F_{Ed}$$

where:

$F_{B,t,Ed}$	Bolt tensile load in N
k_t	Coefficient taking into account the moment arm (k_t =1+e/z)
F_{Ed}	Load on vertical flap of the hold-down in N

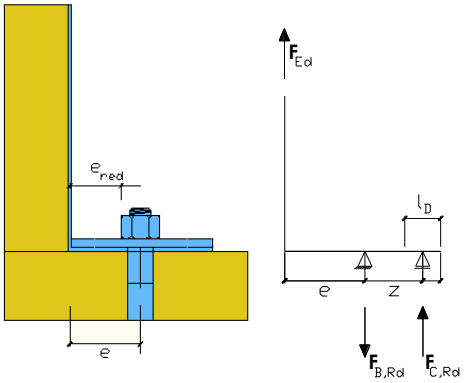
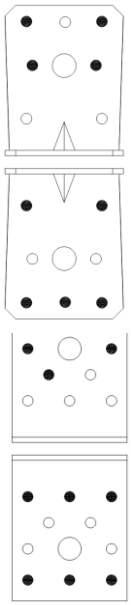


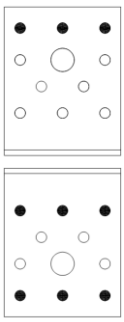
Figure B.61: Forces - Beam to beam connection with purlin ties (F_1)



Nail Patterns – Angle Bracket s in Load Cases F_1, F_2/F_3, F_4/F_5

Angle Bracket 242070055 70x70x55

F_1– column
Nails in hole number:
1,2,3 /
12,13,14,20,21,22

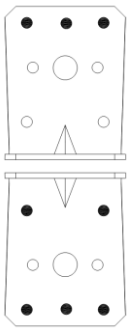


F_1 – purlin, F_2/F_3, F_4/F_5
Nails in hole number:
1,3,4,6,7 /
12,13,14,20,21,22

Angle Bracket 242070955 70x70x55

F_1– column

Nails in hole number:
1,2,3 /
9,10,14,15,16



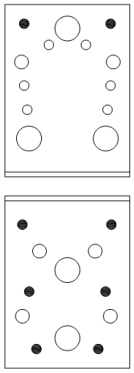
F_1 – purlin, F_2/F_3, F_4/F_5

Nails in hole number:
1,3,4,6 /
9,10,14,15,16

Angle Bracket 242090065 90x90x65

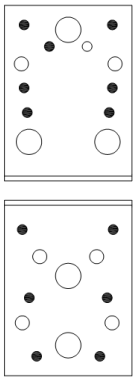
F_1– column

Nails in hole number:
1,2 /
14,15,19,20,24,25



F_1 – purlin, F_2/F_3, F_4/F_5

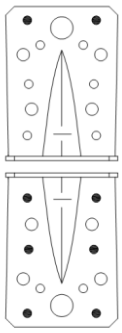
Nails in hole number:
1,2,4,8,9,10,11 /
14,15,19,20,24,25



Angle Bracket 242090965 90x90x65

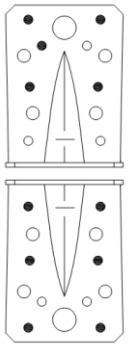
F_1– column

Nails in hole number:
1,2 /
14,15,18,19,25,26



F_1 – purlin, F_2/F_3, F_4/F_5

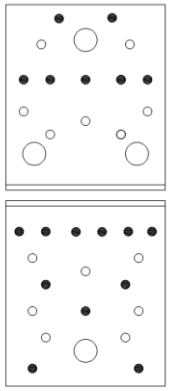
Nails in hole number:
1,2,4,8,9 /
14,15,18,19,25,26



Angle Bracket 242 100 90 105x105x90

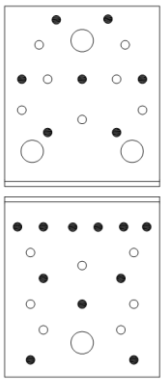
F_1– column

Nails in hole number:
1,2,6,7,8,9,10 /
18,19,20,21,22,23
27,28,30,35,36



F_1 – purlin, F_2/F_3, F_4/F_5

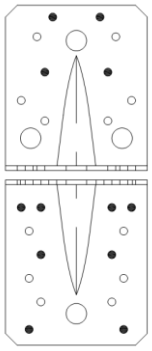
Nails in hole number:
1,2,6,8,10,14,15 /
18,19,20,21,22,23,
27,28,30,35,36



Angle Bracket 242 100 990 105x105x90

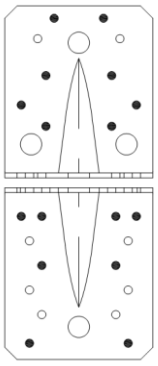
F_1– column

Nails in hole number:
1,2,6,7 /
14,15,16,17,20,21,27,28



F_1 – purlin, F_2/F_3, F_4/F_5

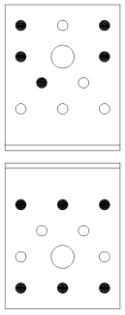
Nails in hole number:
1,2,6,7,8,9,10,11 /
14,15,16,17,20,21,27,28



Nail Patterns – Angle Brackets in Loadcase F_2/F_3

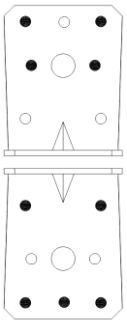
242 072 055 70x70x55

Nails in hole number:
1,3,4,6,7/
12,13,14,20,21,22



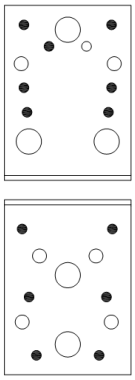
242 072 955 70x70x55

Nails in hole number:
1,3,4,6/
9,10,14,15,16



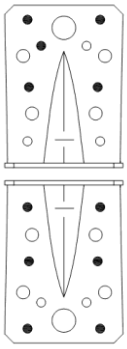
242 092 065 90x90x65

Nails in hole number:
1,2,4,8,9,10,11/
14,15,19,20,24,25



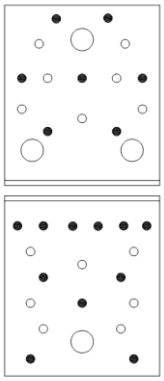
242 092 965 90x90x65

Nails in hole number:
1,2,4,8,9/
14,15,18,19,25,26



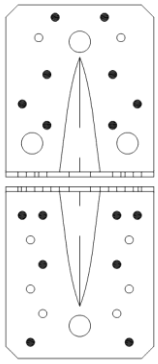
242 102 90 105x105x90

Nails in hole number:
1,2,6,8,10,14,15/
18,19,20,21,22,23,27
,28,30, 35,36



242 102 990 105x105x90

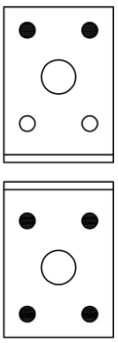
Nails in hole number:
1,2,6,7,8,9,10,11/
14,15,16,17,20,21,27,28



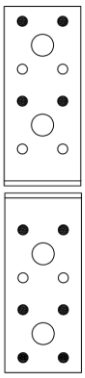
242 050 035 50x50x35

242 090 041 90x90x38

Nails in hole number:
1,2/
6,7,8,10



Nails in hole number:
1,2,6,7/
11,12,16,17,19,20

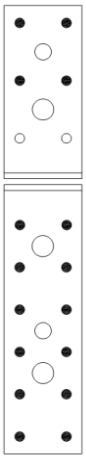


243 129 040 89x117x40

Nails in hole number:
1,2,4,5/
9,10,12,13,14,15,17,
18,20,21

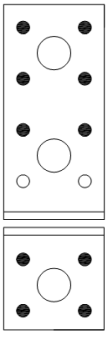
243 149 040 90x140x40

Nails in hole number:
1,2,4,5/
9,10,12,13,14,15,17,
18,20,21,22,23



243 409 040 90x40x40

Nails in hole number:
1,2,4,5,6,7/
11,12,14,15



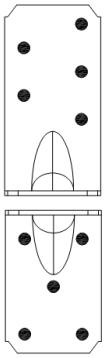
243 416 040 153x40x39

Nails in hole number:
1,2,3,4,6,7,8,9,10,
11,13,14/
15,16,18,19

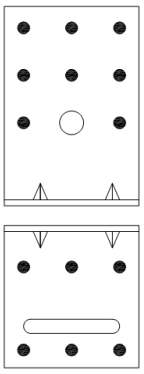
243 608 040 80x60x40

243 609 060 84x60x56

Nails in hole number:
1÷5/
6÷10

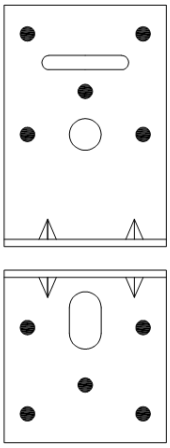


Nails in hole number:
1,2,3,4,5,6,7,9/
10,11,12,14,15,16



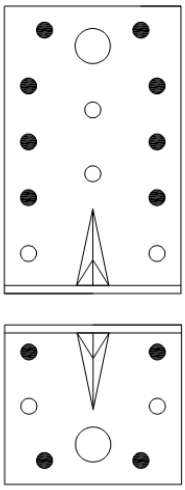
243 609 062 84x60x56

Nails in hole number:
1,2,4,5,7/
9,10,11,12,13



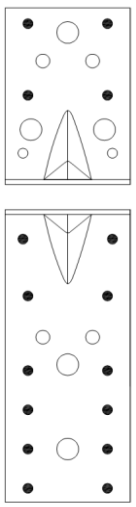
243 905 054 90x50x55

Nails in hole number:
1,2,4,5,7,8,10,11/
14,15,19,20



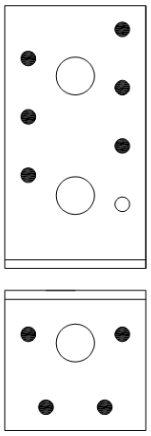
243 915 965 90x149x63

Nails in hole number:
1,2,6,7/
12,13,14,15,19,20,21,
22,23,25,26,27



243 948 048 90x48x48

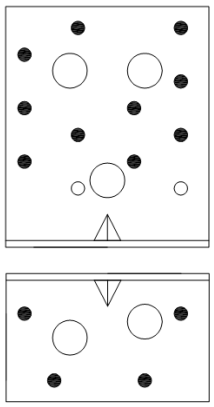
Nails in hole number:
1,2,4,5,6,7/
10,11,13,14



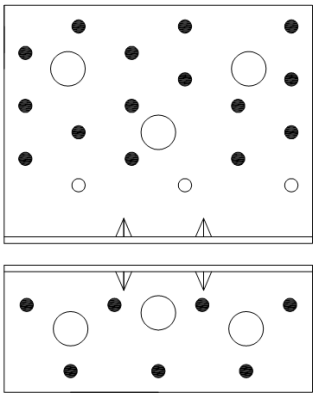
243 948 076 90x48x76

243 948 116 90x48x116

Nails in hole number:
1,2,3,6,7,8,9,10, 11,12/
16,17,20,21

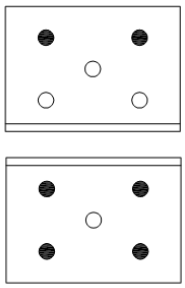


Nails in hole number:
1,2,3,4,5,8,9,10,11,
12,13,15,16,17,18/
22,23,24,25,29,30,31



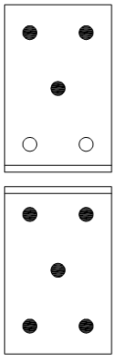
241 446 200 40x40x56

Nails in hole number:
1,2/
6,7,9,10



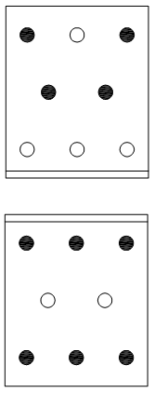
241 664 200 60x60x38

Nails in hole number:
1÷3/
6÷10



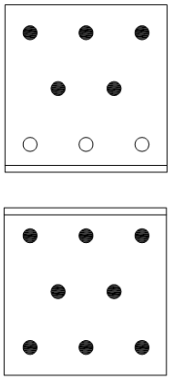
241 665 200 60x60x50

Nails in hole number:
1,3,4,5/
9,10,11,14,15,16



241 666 200 60x60x58

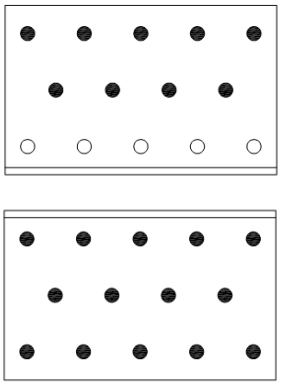
Nails in hole number:
1÷5/
9÷16



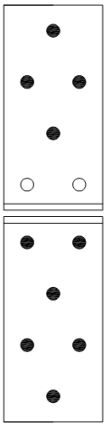
241 661 200 60x60x96

241 884 200 80x80x38

Nails in hole number:
1÷9/
9÷28

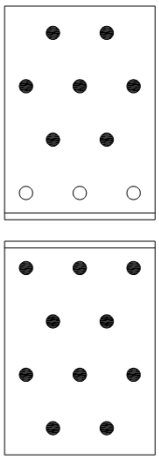


Nails in hole number:
1÷4/
7÷12



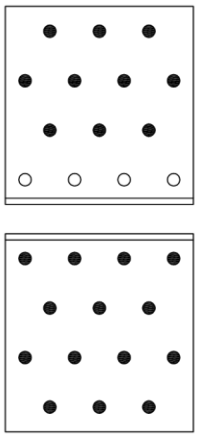
241 886 200 80x80x56

Nails in hole number:
1÷7/
11÷20



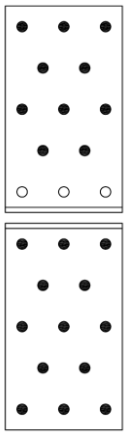
241 888 200 80x80x76

Nails in hole number:
1÷10/
15÷28



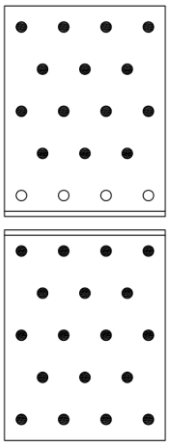
241 116 200 100x100x56

Nails in hole number:
1÷10/
14÷26



241 118 200 100x100x76

Nails in hole number:
1÷14/
19÷36



241 111 200 100x100x96

Nails in hole number:
1÷18/
24÷46