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to Article 29 of the Regulation (EU)
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MEMBER OF EOTA



European Technical Assessment ETA-09/0355 of 2019/06/11

I General Part

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

Trade name of the construction product:

BB Various Angle Brackets

Product family to which the above construction product belongs:

Three-dimensional nailing plate (Angle brackets for timber-to-timber connections)

Manufacturer:

BB Stanz- und Umformtechnik GmbH
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Manufacturing plant:

BB Stanz- und Umformtechnik GmbH
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This European Technical Assessment contains:

55 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 2015-01-05

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II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product and intended use

Technical description of the product

The following types of brackets are covered by this ETA are described in annex A:

BB angle brackets are one-piece non-welded, face-fixed angle brackets to be used in timber to timber or in timber to concrete or to steel connections. They are connected to construction members made of timber or wood-based products with profiled (ringed shank) nails or bolts according to EN 14592 and to concrete or steel members with bolts or metal anchors. They are available in various sizes.

The angle brackets with a steel plate thickness of up to 6 mm are made from pre-galvanized steel S250GD + Z275 according to EN 10346 with $R_e \geq 250 \text{ N/mm}^2$ and $R_m \geq 330 \text{ N/mm}^2$ and tolerances according to EN 10143 or steel grade DD11 + Fe/Zn 12 according to EN 10111 with $R_{eL} \geq 220 \text{ N/mm}^2$ and $R_m \geq 330 \text{ N/mm}^2$ and tolerances according to EN 10051. Dimensions, hole positions and typical installations are shown in Annex B.

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 B).

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

The wood members can be of solid timber, glued laminated timber and similar glued members, or wood-based structural members with a characteristic density from 290 kg/m^3 to 425 kg/m^3 . This requirement to the material of the wood members can be fulfilled by using

the following materials:

- Structural solid timber according to EN 14081,
- Glulam according to EN 14080,
- Glued solid timber according to EN 14080,
- LVL according to EN 14374,
- Cross laminated timber according to ETA,
- Plywood according to EN 636.

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

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

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

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

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

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

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 angle brackets are made from steel classified as Euroclass A1 in accordance with EN 13501-1 and Commission Delegated Regulation 2016/364
3.7 Sustainable use of natural resources (BWR7)	
3.8 General aspects related to the performance of the product	The angle brackets have been assessed as having satisfactory durability and serviceability when used in timber structures using the timber species described in Eurocode 5 and subject to the conditions defined by service class 1 and 2
Identification	See Annex A

*) See additional information in section 3.8 – 3.9.

3.9 Methods of verification

The characteristic load-carrying capacities are based on the characteristic values of the nail connections and the steel parts. To obtain design values the capacities have to be divided by different partial factors for the material properties, the nail connection in addition multiplied with the coefficient k_{mod} .

According to EN 1990 (Eurocode – Basis of design) paragraph 6.3.5 the design value of load-carrying capacity may 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 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 $\gamma_{M,H}$ for timber connections or $\gamma_{M,S} = \gamma_{M0}$ for steel, respectively, have to be taken into account.

3.10 Mechanical resistance and stability

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

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

Threaded nails (ringed shank nails) in accordance to EN 14592

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

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

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

Where:

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

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

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

Where:

σ_k	Characteristic density of the timber in kg/m^3
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The shape of the nail directly under the head shall be in the form of a truncated cone with a diameter under the nail head which exceeds the hole diameter.

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

Additionally, the angle brackets can be fastened to the concrete structure or steel member by bolts with a diameter of 12 mm or 14 mm in holes with a diameter up to 2 mm larger than the bolt.

No performance has been determined in relation to ductility of a joint under cyclic testing. The contribution to the performance of structures in seismic zones, therefore, has not been assessed.

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

3.11 Aspects related to the performance of the product

3.11.1 Corrosion protection in service class 1 and 2.

In accordance with ETAG 015 015 the angle brackets have a zinc coating Fe/Zn 12 according to EN ISO 2081 or a weight of min. Z275 according to EN 10346

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

BB angle brackets are manufactured in accordance with the provisions of this European Technical Assessment

using the manufacturing processes as identified in the inspection of the plant by the notified inspection body and laid down in the technical documentation.

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

The following provisions concerning installation apply:

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

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

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

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

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

The structural members – the components 1 and 2 - to which the brackets are fixed shall be:

- Restrained against rotation.
- Strength class C24 or better, see section 1 of this ETA
- Free from wane under the bracket.
- The actual end bearing capacity of the timber member to be used in conjunction with the bracket is checked by the designer of the structure to ensure it is not less than the bracket capacity and, if necessary, the bracket capacity reduced accordingly.
- The gap between the timber members does not exceed 3 mm.
- There are no specific requirements relating to preparation of the timber members.
- The execution of the connection shall be in accordance with the assessment holder's technical literature.

4 Attestation and verification of constancy of performance (AVCP)

4.1 AVCP system

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

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

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

Issued in Copenhagen on 2019-06-11 by



Thomas Bruun
Managing Director, ETA-Danmark

Annex A
Product details definitions

Table A.1: Materials specification

Bracket number	Bracket type	Comments	Steel specification	Coating specification
633 553 20	50 x 50 x 30 x 2,0	with slotted holes	S250GD	Z275
633 753 20	70 x 50 x 30 x 2,0	with slotted holes	S250GD	Z275
633 853 25	80 x 50 x 30 x 2,5	with slotted holes	S250GD	Z275
631 460 25	40 x 40 x 60 x 2,5	-	S250GD	Z275
631 480 25	40 x 40 x 80 x 2,5	-	S250GD	Z275
631 640 25	60 x 60 x 40 x 2,5	-	S250GD	Z275
631 650 25	60 x 60 x 50 x 2,5	-	S250GD	Z275
631 660 25	60 x 60 x 60 x 2,5	-	S250GD	Z275
631 680 25	60 x 60 x 80 x 2,5	-	S250GD	Z275
631 610 25	60 x 60 x 100 x 2,5	-	S250GD	Z275
631 480 25	80 x 80 x 40 x 2,5	-	S250GD	Z275
631 860 25	80 x 80 x 60 x 2,5	-	S250GD	Z275
631 880 25	80 x 80 x 80 x 2,5	-	S250GD	Z275
631 810 25	80 x 80 x 100 x 2,5	-	S250GD	Z275
631 160 25	100 x 100 x 60 x 2,5	-	S250GD	Z275
631 180 25	100 x 100 x 80 x 2,5	-	S250GD	Z275
631 110 25	100 x 100 x 100 x 2,5	-	S250GD	Z275
631 554 20	50 x 50 x 40 x 2,0	-	S250GD	Z275
634 100 20	40 x 40 x 100 x 2,0	-	S250GD	Z275
634 150 20	40 x 40 x 150 x 2,0	-	S250GD	Z275
634 200 20	40 x 40 x 200 x 2,0	-	S250GD	Z275
641 035 25	50 x 50 x 35 x 2,5	-	S250GD	Z275
641 040 30	50 x 50 x 40 x 3,0	-	S250GD	Z275
641 664 30	60 x 60 x 45 x 3,0	-	S250GD	Z275
641 994 30	90 x 90 x 40 x 3,0	-	S250GD	Z275
641 595 30	90 x 50 x 50 x 3,0	-	S250GD	Z275
500 313 62	90 x 50 x 116 x 3,0	-	S250GD	Z275
641 598 30	90 x 48 x 76 x 3,0	-	S250GD	Z275
641 912 30	120 x 90 x 40 x 3,0	-	S250GD	Z275
641 690 30	90 x 60 x 60 x 2,5	with slotted holes	S250GD	Z275
641 590 30	90 x 50 x 50 x 2,5	-	S250GD	Z275
641 490 25	90 x 40 x 40 x 2,5	-	S250GD	Z275
641 490 30	90 x 40 x 40 x 3,0	-	S250GD	Z275
651 554 25	50 x 50 x 40 x 2,5	135° angled	S250GD	Z275
651 070 25	70 x 70 x 55 x 2,5	-	S250GD	Z275
651 994 25	90 x 90 x 40 x 2,5	135° angled	S250GD	Z275
651 090 25	90 x 90 x 65 x 2,5	-	S250GD	Z275
651 105 30	105 x 105 x 90 x 3,0	-	S250GD	Z275
641 416 40	160 x 50 x 40 x 3,0	-	S250GD	Z275
631 460 20	40 x 40 x 60 x 2,0	-	S250GD	Z275
631 480 20	40 x 40 x 80 x 2,0	-	S250GD	Z275
631 610 20	60 x 60 x 100 x 2,0	-	S250GD	Z275
631 640 20	60 x 60 x 40 x 2,0	-	S250GD	Z275
631 650 20	60 x 60 x 50 x 2,0	-	S250GD	Z275
631 660 20	60 x 60 x 60 x 2,0	-	S250GD	Z275
631 680 20	60 x 60 x 80 x 2,0	-	S250GD	Z275
631 810 20	80 x 80 x 100 x 2,0	-	S250GD	Z275
631 480 20	80 x 80 x 40 x 2,0	-	S250GD	Z275
631 860 20	80 x 80 x 60 x 2,0	-	S250GD	Z275
631 880 20	80 x 80 x 80 x 2,0	-	S250GD	Z275

631 140 20	100 x 100 x 40 x 2,0	-	S250GD	Z275
631 160 20	100 x 100 x 60 x 2,5	-	S250GD	Z275
631 180 20	100 x 100 x 80 x 2,0	-	S250GD	Z275
631 110 20	100 x 100 x 100 x 2,0	-	S250GD	Z275
RHV 60	80 x 80 x 60 x 1,5	with curve	S250GD	Z275
RHV 80	120 x 120 x 75 x 1,5	with curve	S250GD	Z275
633 710 66	100 x 75 x 60 x 6,0	with slotted hole	S250GD	Z275
618 129 40	120 x 90 x 40 x 4,0	-	S250GD	Z275
618 149 40	140 x 90 x 40 x 4,0	-	S250GD	Z275
618 165 40	160 x 50 x 40 x 4,0	-	S250GD	Z275
618 166 40	160 x 80 x 60 x 4,0	-	S250GD	Z275
618 168 40	160 x 80 x 80 x 4,0	-	S250GD	Z275
631 444 20	40 x 40 x 40 x 2,0	-	S250GD	Z275
631 444 25	40 x 40 x 40 x 2,5	-	S250GD	Z275
631 642 20	60 x 40 x 25 x 2,0	-	S250GD	Z275
631 646 25	60 x 40 x 60 x 2,5	-	S250GD	Z275
631 669 20	60 x 60 x 90 x 2,0	-	S250GD	Z275
631 686 25	60 x 80 x 60 x 2,5	-	S250GD	Z275
632 060 20	60 x 60 x 25 x 2,0	-	S250GD	Z275
641 035 25	50 x 50 x 35 x 2,5	-	S250GD	Z275
641 070 20	70 x 70 x 55 x 2,0	-	S250GD	Z275
641 105 20	105 x 105 x 90 x 2,0	-	S250GD	Z275
641 140 34	40 x 140 x 2,5	-	S250GD	Z275
641 412 25	40 x 120 x 2,5	-	S250GD	Z275
641 416 40	40 x 160 x 2,5	-	S250GD	Z275
641 490 42	40 x 90 x 2,5	-	S250GD	Z275
641 553 20	50 x 50 x 35 x 2,0	-	DD11	Fe/Zn 12
641 665 30	65 x 65 x 55 x 3,0	-	S250GD	Z275
641 690 25	60 x 90 x 60 x 2,5	with slotted hole	S250GD	Z275
641 691 25	60 x 90 x 60 x 2,5	with slotted holes	S250GD	Z275
641 692 25	60 x 90 x 60 x 2,5	with slotted holes	S250GD	Z275
641 860 20	83 x 62 x 40 x 2,0	with rib	S250GD	Z275
641 905 25	105 x 105 x 90 x 2,5	with rib	S250GD	Z275
641 912 30	90 x 120 x 3,0	-	S250GD	Z275
641 970 20	70 x 70 x 55 x 2,0	with rib	S250GD	Z275
641 971 15	70 x 70 x 55 x 1,5	with rib	S250GD	Z275
641 990 20	90 x 90 x 65 x 2,0	with rib	S250GD	Z275
641 991 15	90 x 90 x 65 x 1,5	with rib	S250GD	Z275
651 070 25	70 x 70 x 55 x 2,5	135° angled	S250GD	Z275
651 090 25	90 x 90 x 65 x 2,5	135° angled	S250GD	Z275
651 105 30	105 x 105 x 90 x 3,0	135° angled	S250GD	Z275

Table A.2: Range of sizes

Bracket number	Dimensions in mm	Height vertical in mm		Height horizontal in mm		Width in mm	
633 553 20	52 x 52 x 30 x 2,0	51	53	51	53	29	31
633 753 20	72 x 52 x 30 x 2,0	71	73	51	53	29	31
633 853 25	82 x 52 x 30 x 2,5	81	83	51	53	29	31
631 460 25	40 x 40 x 60 x 2,5	39	41	39	41	59	61
631 480 25	42,5 x 42,5 x 80 x 2,5	41,5	43,5	41,5	43,5	79	81
631 640 25	60 x 60 x 40 x 2,5	59	61	59	61	39	41
631 650 25	62,5 x 62,5 x 50 x 2,5	61,5	63,5	61,5	63,5	49	51
631 660 25	60 x 60 x 60 x 2,5	59	61	59	61	59	61
631 680 25	60 x 60 x 80 x 2,5	59	61	59	61	79	81
631 610 25	62,5 x 62,5 x 100 x 2,5	61,5	63,5	61,5	63,5	99	101
631 480 25	80 x 80 x 40 x 2,5	79	81	79	81	39	41
631 860 25	82,5 x 82,5 x 60 x 2,5	81,5	83,5	81,5	83,5	59	61
631 880 25	82,5 x 82,5 x 80 x 2,5	81,5	83,5	81,5	83,5	79	81
631 810 25	80 x 80 x 100 x 2,5	79	81	79	81	99	101
631 160 25	102,5 x 102,5 x 60 x 2,5	101,5	103,5	101,5	103,5	59	61
631 180 25	102,5 x 102,5 x 80 x 2,5	101,5	103,5	101,5	103,5	79	81
631 110 25	100 x 100 x 100 x 2,5	99	101	99	101	99	101
631 554 20	50 x 50 x 40 x 2,0	49	51	49	51	39	41
634 100 20	40 x 40 x 100 x 2,0	39	41	39	41	99	101
634 150 20	42 x 42 x 150 x 2,0	41	43	41	43	149	151
634 200 20	42 x 42 x 200 x 2,0	41	43	41	43	199	201
641 035 25	50 x 50 x 35 x 2,5	49	51	49	51	34	36
641 040 30	50 x 50 x 40 x 3,0	49	51	49	51	39	41
641 664 30	60 x 60 x 45 x 3,0	59	61	59	61	44	46
641 994 30	90 x 90 x 40 x 3,0	89	91	89	91	39	41
641 595 30	93 x 52 x 51 x 3,0	92	94	51	53	50	52
500 313 62	90 x 50 x 116 x 3,0	89	91	49	51	115	117
641 598 30	90 x 48 x 76 x 3,0	89	91	47	49	75	77
641 912 30	123 x 93 x 40 x 3,0	122	124	92	94	39	41
641 690 30	90 x 60 x 60 x 2,5	89	91	59	61	59	61
641 590 30	92,5 x 51,5 x 51 x 2,5	91,5	93,5	50,5	52,5	50	52
641 490 25	83 x 42 x 40 x 2,5	82	84	41	43	39	41
641 490 30	83 x 42 x 40 x 3,0	82	84	41	43	39	41
651 554 25	50 x 50 x 40 x 2,5	49	51	49	51	39	41
651 070 25	70 x 70 x 55 x 2,5	69	71	69	71	54	56
651 994 25	90 x 90 x 40 x 2,5	89	91	89	91	39	41
651 090 25	90 x 90 x 65 x 2,5	89	91	89	91	64	66
651 105 30	105 x 105 x 90 x 3,0	104	106	104	106	89	91
641 416 40	166 x 50 x 40 x 3,0	165	167	49	51	39	41
631 460 20	40 x 40 x 60 x 2,0	39	41	39	41	59	61
631 480 20	40 x 40 x 80 x 2,0	39	41	39	41	79	81
631 610 20	62,5 x 62,5 x 100 x 2,0	61,5	63,5	61,5	63,5	99	101
631 640 20	60 x 60 x 40 x 2,0	59	61	59	61	39	41
631 650 20	60 x 60 x 50 x 2,0	59	61	59	61	49	51
631 660 20	60 x 60 x 60 x 2,0	59	61	59	61	59	61
631 680 20	60 x 60 x 80 x 2,5	59	61	59	61	79	81
631 810 20	80 x 80 x 100 x 2,0	79	81	79	81	99	101
631 480 20	80 x 80 x 40 x 2,0	79	81	79	81	39	41
631 860 20	80 x 80 x 60 x 2,0	79	81	79	81	59	61
631 880 20	80 x 80 x 80 x 2,0	79	81	79	81	79	81
631 140 20	102 x 102 x 40 x 2,0	101	103	101	103	39	41

631 160 20	102,5 x 102,5 x 60 x 2,5	101,5	103,5	101,5	103,5	59	61
631 180 20	100 x 100 x 80 x 2,0	99	101	99	101	79	81
631 110 20	100 x 100 x 100 x 2,0	99	101	99	101	99	101
RHV 60	80 x 80 x 57 x 1,5	79	81	79	81	56	58
RHV 80	123 x 123 x 74 x 1,5	122	124	122	124	73	75
633 710 66	103 x 71 x 60 x 6,0	102	104	70	72	59	61
618 129 40	120 x 90 x 40 x 4,0	119	121	89	91	39	41
618 149 40	140 x 90 x 40 x 4,0	139	141	89	91	39	41
618 165 40	160 x 50 x 40 x 4,0	159	161	49	51	39	41
618 166 40	164 x 84 x 60 x 4,0	163	165	83	85	59	61
618 168 40	164 x 84 x 80 x 4,0	163	165	83	85	79	81
631 444 20	40 x 40 x 40 x 2,0	39	41	39	41	39	41
631 444 25	40 x 40 x 40 x 2,5	39	41	39	41	39	41
631 642 20	62 x 42 x 25 x 2,0	61	63	41	43	24	26
631 646 25	62,5 x 42,5 x 60 x 2,5	61,5	63,5	41,5	43,5	59	61
631 669 20	60 x 60 x 90 x 2,0	59	61	59	61	89	91
631 686 25	80 x 60 x 60 x 2,5	79	81	59	61	59	61
632 060 20	62 x 62 x 25 x 2,0	61	63	61	63	24	26
641 035 25	50 x 50 x 35 x 2,5	49	51	49	51	34	36
641 070 20	70 x 70 x 55 x 2,0	69	71	69	71	54	56
641 105 20	105 x 105 x 90 x 2,0	104	106	104	106	89	91
641 140 34	140 x 40 x 40 x 2,5	139	141	39	41	39	41
641 412 25	120 x 40 x 40 x 2,5	119	121	39	41	39	41
641 416 40	160 x 40 x 40 x 2,5	159	161	39	41	39	41
641 490 42	90 x 40 x 40 x 2,5	89	91	39	41	39	41
641 553 20	50 x 50 x 35 x 2,0	49	51	49	51	34	36
641 665 30	65 x 65 x 55 x 3,0	64	66	64	66	54	56
641 690 25	90 x 60 x 60 x 2,5	89	91	59	61	59	61
641 691 25	90 x 60 x 60 x 2,5	89	91	59	61	59	61
641 692 25	90 x 60 x 60 x 2,5	89	91	59	61	59	61
641 860 20	82 x 62 x 40 x 2,0	81	83	61	63	39	41
641 905 25	104,5 x 104,5 x 90 x 2,5	103,5	105,5	103,5	105,5	89	91
641 912 30	120 x 90 x 40 x 3,0	119	121	89	91	39	41
641 970 20	69,5 x 69,5 x 55 x 2,0	68,5	70,5	68,5	70,5	54	56
641 971 15	69 x 69 x 55 x 1,5	68	70	68	70	54	56
641 990 20	89,5 x 89,5 x 65 x 2,0	88,5	90,5	88,5	90,5	64	66
641 991 15	89 x 89 x 65 x 1,5	88	90	88	90	64	66
651 070 25	70 x 70 x 55 x 2,5	69	71	69	71	54	56
651 090 25	90 x 90 x 65 x 2,5	89	91	89	91	64	66
651 105 30	105 x 105 x 90 x 3,0	104	106	104	106	89	91

Table A.3: Fastener specification

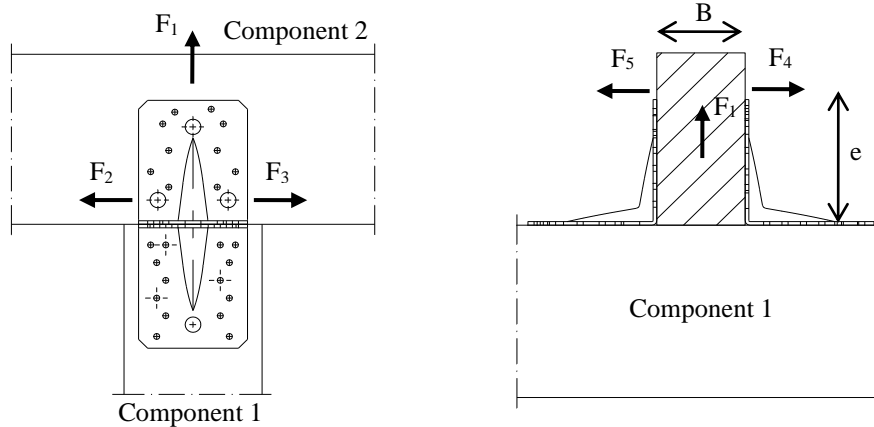
Three-dimensional nailing plate type	Nail diameter	Nail length	Nail type
Angle brackets	4.0 mm	min. 40 mm	Ringed shank nails according to EN 14592
<p>In the load-carrying capacities of the nailed connection, the capacities for threaded nails calculated from the formulas of Eurocode 5 are used assuming a thick steel plate when calculating the lateral nail load-carrying capacity.</p> <p>The load-carrying capacities of the angle brackets have been determined based on the use of connector nails 4,0 x 40 mm.</p> <p>The characteristic withdrawal capacity of the nails has to be determined by calculation in accordance with EN 1995-1-1:2004 + AC:2006 + A1:2008 + A2:2014, paragraph 8.3.2 (head pull-through is not relevant):</p> $F_{ax,Rk} = f_{ax,k} \times d \times t_{pen}$ <p>Where:</p> <p>$f_{ax,k}$ Characteristic value of the withdrawal parameter in N/mm²</p> <p>d Nail diameter in mm</p> <p>t_{pen} Penetration depth of the profiled shank including the nail point in mm, $t_{pen} \geq 30$ mm</p> <p>Based on tests by Versuchsanstalt für Stahl, Holz und Steine, University of Karlsruhe, the characteristic value of the withdrawal resistance for the threaded nails used can be calculated as:</p> $f_{ax,k} = 50 \times 10^{-6} \times \rho_k^2$ <p>Where:</p> <p>ρ_k Characteristic density of the timber in kg/m³</p> <p>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.</p>			

BOLTS diameter	Correspondence Hole diameter	Bolts type
12.0 and 14.0	Max. 2 mm. larger than the bolt diameter	See specification of the manufacturer

METAL ANCHORS diameter	Correspondence Hole diameter	Anchors type
12.0 and 14.0	Max. 2 mm. larger than the anchor diameter	See specification of the manufacturer

Annex B
Characteristic load-carrying capacities

Definitions of forces, their directions and eccentricity



Fastener specification

Holes are marked with numbers referring to the nailing pattern in Annex B.

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

Single angle bracket per connection

Acting forces:

- F_1 Lifting force acting in component 2. The component 2 shall be prevented from rotation.
- F_2 and F_3 Lateral force acting in component 2 in axial direction of component 2. The component 2 shall be prevented from rotation.
- 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 rotation. Only 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

It must be checked in accordance with Eurocode 5 or a similar national Timber Code 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:

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

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 B.1 to B.4

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:

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

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 .

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

B is the width of component 2.

Results angle bracket force F_1 **Table B.1:** Force F_1 Column, 2 angle brackets / connection, timber-timber

Bracket number	Bracket type	Nail number n_V	Nail number n_H	$F_{1,Rk}$ [kN] (column)	
				Timber	Steel
633 753 20	70 x 50 x 30 x 2,0	1,2	7,8	1,66	0,28
633 853 25	80 x 50 x 30 x 2,5	1,2	9,10	2,11	0,68
631 860 25	80 x 80 x 60 x 2,5	1,2,3	11,12,13,14,15,16,17,18,19,20	3,70	2,81
631 880 25	80 x 80 x 80 x 2,5	1,2,3,4	15,16,17,18,19,20,21,22,23,24,25,26,27,28	4,93	3,75
631 810 25	80 x 80 x 100 x 2,5	1,2,3,4	19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36	5,10	6,25
631 160 25	100 x 100 x 60 x 2,5	1,2,3,4,5	14,15,16,17,18,19,20,21,22,23,24,25	2,63	3,91
631 180 25	100 x 100 x 80 x 2,5	1,2,3,4,5,6,7	18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35	5,26	4,69
631 110 25	100 x 100 x 100 x 2,5	1,2,3,4,5,6,7,8,9	24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45	5,26	7,38
641 994 30	90 x 90 x 40 x 3,0	1,2	11,12,14,15,19,20	2,30	1,82
641 595 30	90 x 50 x 50 x 3,0	1,3,5,6	13,14,16,17,18	1,60	2,15
500 313 62	90 x 50 x 116 x 3,0	1,2,3,5,6,9	23,24,25,26,31	2,61	2,57
641 598 30	90 x 48 x 76 x 3,0	1,2,3,6	16,17,20,21	1,95	4,11
641 912 30	120 x 90 x 40 x 3,0	1,2,3,4,5	10,11,12,13,14,15	2,56	2,93
641 690 30	90 x 60 x 60 x 2,5	1,2	6,7,8,9	1,76	1,42
641 590 30	90 x 50 x 50 x 2,5	1,3,5,6	13,14,16,17,18	1,58	1,49
641 490 25	90 x 40 x 40 x 2,5	1,2	8,9,11,12	1,83	1,67
641 490 30	90 x 40 x 40 x 3,0	1,2	8,9,11,12	1,83	2,41
651 554 25	50 x 50 x 40 x 2,5	-	-	-	-
651 070 25	70 x 70 x 55 x 2,5	1,2,3	12,13,14,15,16,20,21,22	3,05	1,56
651 994 25	90 x 90 x 40 x 2,5	1,2	11,12,14,15,19,20	2,28	1,23
651 090 25	90 x 90 x 65 x 2,5	1,2,4,5	10,11,12,13,15,16,17,19,20	4,84	2,34
651 105 30	105 x 105 x 90 x 3,0	1,2,4,5,6,8,10	18,19,20,21,27,28,29,33,34	4,85	4,50
641 416 40	160 x 50 x 40 x 3,0	1,2,3,4,5,6,7	13,14	1,40	1,44
631 810 20	80 x 80 x 100 x 2,0	1,2,3,4	19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36	5,10	4,00
631 860 20	80 x 80 x 60 x 2,0	1,2,3	11,12,13,14,15,16,17,18,19,20	3,82	2,25
631 880 20	80 x 80 x 80 x 2,0	1,2,3,4	15,16,17,18,19,20,21,22,23,24,25,26,27,28	5,10	3,00
631 140 20	100 x 100 x 40 x 2,0	1,2,3,4	11,12,13,14,15,16,17,18,19,20	2,58	1,25
631 160 20	100 x 100 x 60 x 2,5	1,2,3,4,5	14,15,16,17,18,19,20,21,22,23,24,25	2,61	3,55
631 180 20	100 x 100 x 80 x 2,0	1,2,3,4,5,6,7	18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35	5,26	3,00

631 110 20	100 x 100 x 100 x 2,0	1,2,3,4,5,6,7,8,9	24,25,26,27,28,29,30,31,32, 33,34,35,36,37,38,39,40,41, 42,43,44,45	5,26	4,00
RHV 60	80 x 80 x 60 x 1,5	1,3	8,9,10,12	1,76	4,15
RHV 80	120 x 120 x 75 x 1,5	1,2,4,6,7	12,13,15,18,19,21,23,24	2,12	6,95
618 129 40	120 x 90 x 40 x 4,0	1,2,3,4	8,9,10,14,15	1,21	4,67
618 149 40	140 x 90 x 40 x 4,0	1,2,3,4,5,6	10,11,12,16,17	1,21	4,67
618 165 40	160 x 50 x 40 x 4,0	1,2,3,4,5,6,7	11,12	1,37	2,50
618 166 40	160 x 80 x 60 x 4,0	1,2,3,4,5,6	9,10,11,12,13,14,15	3,63	6,43
618 168 40	160 x 80 x 80 x 4,0	1,2,3,4,5,6,7,8	12,13,14,15,16,17,18,19,20	4,84	8,57
631 444 20	40 x 40 x 40 x 2,0	-	-	-	-
631 444 25	40 x 40 x 40 x 2,5	-	-	-	-
631 642 20	60 x 40 x 25 x 2,0	-	-	-	-
631 646 25	60 x 40 x 60 x 2,5	-	-	-	-
631 669 20	60 x 60 x 90 x 2,0	-	-	-	-
631 686 25	60 x 80 x 60 x 2,5	1,2,3	13,14,15,16,17,18,19,20,21	3,61	3,52
632 060 20	60 x 60 x 25 x 2,0	-	-	-	-
641 035 25	50 x 50 x 35 x 2,5	-	-	-	-
641 070 20	70 x 70 x 55 x 2,0	1,2,3	12,13,14,20,21,22	3,05	1,00
641 105 20	105 x 105 x 90 x 2,0	1,2,6,7,8,9,10	18,19,20,21,27,28,29,33,34	4,85	2,00
641 140 34	40 x 140 x 2,5	1,2,4,5,7,8,10,11	21,22,24,25	2,10	2,34
641 412 25	40 x 120 x 2,5	1,2,4,5,7,8	18,19,21,22	2,10	2,34
641 416 40	40 x 160 x 2,5	1,2,4,5,7,8,10,11,13,14	24,25,27,28	2,10	2,34
641 490 42	40 x 90 x 2,5	2,3	13,14,16,17	2,10	2,34
641 553 20	50 x 50 x 35 x 2,0	-	-	-	-
641 665 30	65 x 65 x 55 x 3,0	1,2	8,9,13,14	2,21	3,38
641 690 25	60 x 90 x 60 x 2,5	1,2,3,4,5,6	10,12,14,15,16	1,98	1,69
641 691 25	60 x 90 x 60 x 2,5	1,2,4,5,6	10,11,13,14,15	1,98	1,74
641 692 25	60 x 90 x 60 x 2,5	1,2,4	8,9,11,12,13	1,98	1,74
641 860 20	83 x 62 x 40 x 2,0	1,2	6,7,8,9,10	2,32	1,31
641 905 25	105 x 105 x 90 x 2,5	1,2,6,7	14,15,16,17,20,21,27,28	6,39	17,4
641 912 30	90 x 120 x 3,0	1,2,4,5,7,8	18,19,21,22,24,25,27,28	2,59	3,38
641 970 20	70 x 70 x 55 x 2,0	1,2	8,9,10,11,13,14	2,98	5,44
641 971 15	70 x 70 x 55 x 1,5	1,2	8,9,10,11,13,14	2,98	4,21
641 990 20	90 x 90 x 65 x 2,0	1,2	12,13,14,15,21,22	3,56	5,95
641 991 15	90 x 90 x 65 x 1,5	1,2	12,13,14,15,21,22	3,55	4,42
651 070 25	70 x 70 x 55 x 2,5	-	-	-	-
651 090 25	90 x 90 x 65 x 2,5	1,2	17,18,21,22,29,30	1,61	3,49
651 105 30	105 x 105 x 90 x 3,0	4,5	18,19,20,21,27,28,29,33,34	6,36	6,35

Table B.2: Force F₁ Column, 1 angle brackets / connection, timber-timber

Bracket number	Bracket type	Nail number n _v	Nail number n _H	F _{1,Rk} [kN] (column)	
				Timber	Steel
633 753 20	70 x 50 x 30 x 2,0	1,2	7,8	0,83	0,14
633 853 25	80 x 50 x 30 x 2,5	1,2	9,10	1,06	0,34
631 860 25	80 x 80 x 60 x 2,5	1,2,3	11,12,13,14,15,16,17,18,19,20	1,85	1,41
631 880 25	80 x 80 x 80 x 2,5	1,2,3,4	15,16,17,18,19,20,21,22,23,24,25,26,27,28	2,47	1,88
631 810 25	80 x 80 x 100 x 2,5	1,2,3,4	19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36	2,55	3,13
631 160 25	100 x 100 x 60 x 2,5	1,2,3,4,5	14,15,16,17,18,19,20,21,22,23,24,25	1,32	1,95
631 180 25	100 x 100 x 80 x 2,5	1,2,3,4,5,6,7	18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35	2,63	2,34
631 110 25	100 x 100 x 100 x 2,5	1,2,3,4,5,6,7,8,9	24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45	2,63	3,69
641 994 30	90 x 90 x 40 x 3,0	1,2	11,12,14,15,19,20	1,15	0,91
641 595 30	90 x 50 x 50 x 3,0	1,3,5,6	13,14,16,17,18	0,80	1,07
500 313 62	90 x 50 x 116 x 3,0	1,2,3,5,6,9	23,24,25,26,31	1,31	1,28
641 598 30	90 x 48 x 76 x 3,0	1,2,3,6	16,17,20,21	0,97	2,06
641 912 30	120 x 90 x 40 x 3,0	1,2,3,4,5	10,11,12,13,14,15	1,28	1,47
641 690 30	90 x 60 x 60 x 2,5	1,2	6,7,8,9	0,88	0,71
641 590 30	90 x 50 x 50 x 2,5	1,3,5,6	13,14,16,17,18	0,79	0,74
641 490 25	90 x 40 x 40 x 2,5	1,2	8,9,11,12	0,91	0,84
641 490 30	90 x 40 x 40 x 3,0	1,2	8,9,11,12	0,91	1,21
651 070 25	70 x 70 x 55 x 2,5	1,2,3	12,13,14,15,16,20,21,22	1,53	0,78
651 994 25	90 x 90 x 40 x 2,5	1,2	11,12,14,15,19,20	1,14	0,62
651 090 25	90 x 90 x 65 x 2,5	1,2,4,5	10,11,12,13,15,16,17,19,20	2,42	1,17
651 105 30	105 x 105 x 90 x 3,0	1,2,4,5,6,8,10	18,19,20,21,27,28,29,33,34	2,43	2,25
641 416 40	160 x 50 x 40 x 3,0	1,2,3,4,5,6,7	13,14	0,70	0,72
631 810 20	80 x 80 x 100 x 2,0	1,2,3,4	19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36	2,55	2,00
631 860 20	80 x 80 x 60 x 2,0	1,2,3	11,12,13,14,15,16,17,18,19,20	1,91	1,13
631 880 20	80 x 80 x 80 x 2,0	1,2,3,4	15,16,17,18,19,20,21,22,23,24,25,26,27,28	2,55	1,50
631 140 20	100 x 100 x 40 x 2,0	1,2,3,4	11,12,13,14,15,16,17,18,19,20	1,29	0,63
631 160 20	100 x 100 x 60 x 2,5	1,2,3,4,5	14,15,16,17,18,19,20,21,22,23,24,25	1,30	1,78
631 180 20	100 x 100 x 80 x 2,0	1,2,3,4,5,6,7	18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35	2,63	1,50
631 110 20	100 x 100 x 100 x 2,0	1,2,3,4,5,6,7,8,9	24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45	2,63	2,00
RHV 60	80 x 80 x 60 x 1,5	1,3	8,9,10,12	0,88	2,07
RHV 80	120 x 120 x 75 x 1,5	1,2,4,6,7	12,13,15,18,19,21,23,24	1,06	3,48

618 129 40	120 x 90 x 40 x 4,0	1,2,3,4	8,9,10,14,15	0,61	2,33
618 149 40	140 x 90 x 40 x 4,0	1,2,3,4,5,6	10,11,12,16,17	0,61	2,33
618 165 40	160 x 50 x 40 x 4,0	1,2,3,4,5,6,7	11,12	0,69	1,25
618 166 40	160 x 80 x 60 x 4,0	1,2,3,4,5,6	9,10,11,12,13,14,15	1,81	3,21
618 168 40	160 x 80 x 80 x 4,0	1,2,3,4,5,6,7,8	12,13,14,15,16,17,18,19,20	2,42	4,29
631 444 20	40 x 40 x 40 x 2,0	-	-	-	-
631 444 25	40 x 40 x 40 x 2,5	-	-	-	-
631 642 20	60 x 40 x 25 x 2,0	-	-	-	-
631 646 25	60 x 40 x 60 x 2,5	-	-	-	-
631 669 20	60 x 60 x 90 x 2,0	-	-	-	-
631 686 25	60 x 80 x 60 x 2,5	1,2,3	13,14,15,16,17,18,19,20,21	1,80	1,76
632 060 20	60 x 60 x 25 x 2,0	-	-	-	-
641 035 25	50 x 50 x 35 x 2,5	-	-	-	-
641 070 20	70 x 70 x 55 x 2,0	1,2,3	12,13,14,20,21,22	1,53	0,50
641 105 20	105 x 105 x 90 x 2,0	1,2,6,7,8,9,10	18,19,20,21,27,28,29,33,34	2,43	1,00
641 140 34	40 x 140 x 2,5	1,2,4,5,7,8,10,11	21,22,24,25	1,05	1,17
641 412 25	40 x 120 x 2,5	1,2,4,5,7,8	18,19,21,22	1,05	1,17
641 416 40	40 x 160 x 2,5	1,2,4,5,7,8,10,11,13,14	24,25,27,28	1,05	1,17
641 490 42	40 x 90 x 2,5	2,3	13,14,16,17	1,05	1,17
641 553 20	50 x 50 x 35 x 2,0	-	-	-	-
641 665 30	65 x 65 x 55 x 3,0	1,2	8,9,13,14	1,10	1,69
641 690 25	60 x 90 x 60 x 2,5	1,2,3,4,5,6	10,12,14,15,16	0,99	0,85
641 691 25	60 x 90 x 60 x 2,5	1,2,4,5,6	10,11,13,14,15	0,99	0,87
641 692 25	60 x 90 x 60 x 2,5	1,2,4	8,9,11,12,13	0,99	0,87
641 860 20	83 x 62 x 40 x 2,0	1,2	6,7,8,9,10	1,16	0,66
641 905 25	105 x 105 x 90 x 2,5	1,2,6,7	14,15,16,17,20,21,27,28	3,19	8,68
641 912 30	90 x 120 x 3,0	1,2,4,5,7,8	18,19,21,22,24,25,27,28	1,30	1,69
641 970 20	70 x 70 x 55 x 2,0	1,2	8,9,10,11,13,14	1,49	2,72
641 971 15	70 x 70 x 55 x 1,5	1,2	8,9,10,11,13,14	1,49	2,10
641 990 20	90 x 90 x 65 x 2,0	1,2	12,13,14,15,21,22	1,78	2,97
641 991 15	90 x 90 x 65 x 1,5	1,2	12,13,14,15,21,22	1,78	2,21
651 070 25	70 x 70 x 55 x 2,5	-	-	-	-
651 090 25	90 x 90 x 65 x 2,5	1,2	17,18,21,22,29,30	0,81	1,74
651 105 30	105 x 105 x 90 x 3,0	4,5	18,19,20,21,27,28,29,33,34	3,18	3,18

Table B.3: Force F_1 Column, 2 angle brackets / connection, timber-concrete/steel

Article-No.	Dimension	Bolt number n_V	Bolt number n_H	$F_{1,Rk}$ [kN] (column)		Bolt k_t
				Timber	Steel	
633 710 66	100 x 75 x 60 x 6,0	1	2	-	7,62	0,78

Table B.4: Force F₁ Column, 1 angle bracket / connection, timber-concrete/steel

Bracket number	Bracket type	Bolt number n _v	Bolt number n _H	F _{1,Rk} [kN] (column)		Bolt k _t
				Timber	Steel	
633 710 66	100 x 75 x 60 x 6,0	1	2	-	3,81	1,55

Table B.5: Force F₁ Purlin, 2 angle brackets / connection, timber-timber

Bracket number	Bracket type	Nail number n _v	Nail number n _H	F _{1,Rk} [kN] (purlin)	
				Timber	Steel
633 553 20	50 x 50 x 30 x 2,0	1,2	5,6	1,66	0,28
633 753 20	70 x 50 x 30 x 2,0	1,2,3,4,5,6	7,8	1,66	0,28
633 853 25	80 x 50 x 30 x 2,5	1,2,3,4,5,6	9,10	2,11	0,68
631 460 25	40 x 40 x 60 x 2,5	1,2,3	6,7,8,9,10	3,15	3,52
631 480 25	40 x 40 x 80 x 2,5	1,2,3	8,9,10,11,12,13,14	2,94	4,06
631 640 25	60 x 60 x 40 x 2,5	1,2,3	6,7,8,9	1,11	2,04
631 650 25	60 x 60 x 50 x 2,5	1,2,3,4,5	8,9,10,11,12,13,14,15	3,45	2,19
631 660 25	60 x 60 x 60 x 2,5	1,2,3,4,5,6	10,11,12,13,14,15,16,17,18	3,34	2,63
631 680 25	60 x 60 x 80 x 2,5	1,2,3,4,5,6,7	12,13,14,15,16,17,18,19,20, 21	3,34	3,80
631 610 25	60 x 60 x 100 x 2,5	1,2,3,4,5,6,7,8,9	15,16,17,18,19,20,21,22,23, 24,25,26,27	4,76	5,68
631 480 25	80 x 80 x 40 x 2,5	1,2,3,4	7,8,9,10,11,12	1,27	2,73
631 860 25	80 x 80 x 60 x 2,5	1,2,3,4,5,6,7,8	11,12,13,14,15,16,17,18,19, 20	3,70	2,81
631 880 25	80 x 80 x 80 x 2,5	1,2,3,4,5,6,7,8,9,10,11	15,16,17,18,19,20,21,22,23, 24,25,26,27,28	4,93	3,75
631 810 25	80 x 80 x 100 x 2,5	1,2,3,4,5,6,7,8,9,10,11, 12,13	19,20,21,22,23,24,25,26,27, 28,29,30,31,32,33,34,35,36	5,10	6,25
631 160 25	100 x 100 x 60 x 2,5	1,2,3,4,5,6,7,8,9,10	14,15,16,17,18,19,20,21,22, 23,24,25	2,63	3,91
631 180 25	100 x 100 x 80 x 2,5	1,2,3,4,5,6,7,8,9,10,11, 12,13,14	18,19,20,21,22,23,24,25,26, 27,28,29,30,31,32,33,34,35	5,26	4,69
631 110 25	100 x 100 x 100 x 2,5	1,2,3,4,5,6,7,8,9,10,11, 12,13,14,15,16,17,18	24,25,26,27,28,29,30,31,32, 33,34,35,36,37,38,39,40,41, 42,43,44,45	5,26	7,38
631 554 20	50 x 50 x 40 x 2,0	1,2,3	7,8,9,10,11,12	1,14	1,75
634 100 20	40 x 40 x 100 x 2,0	1,2,3,4,5	10,11,12,13,14,15,16,17,18	4,67	2,94
634 150 20	40 x 40 x 150 x 2,0	1,2,3	11,12,13,14,15,16,17,18,19, 20	2,86	5,19
634 200 20	40 x 40 x 200 x 2,0	1,2,3,4,5	16,17,18,19,20,21,22,23,24, 25,26,27,28,29,30	4,77	6,73
641 035 25	50 x 50 x 35 x 2,5	1,2	6,7,9,10	2,12	1,56
641 040 30	50 x 50 x 40 x 3,0	1,2	6,7,9,10	1,80	1,93
641 664 30	60 x 60 x 45 x 3,0	1,2,3,5	8,9,13,14	2,00	2,25
641 994 30	90 x 90 x 40 x 3,0	1,2,4,5,6,7	11,12,14,15,19,20	2,30	1,82
641 595 30	90 x 50 x 50 x 3,0	1,3,5,6,7,8,9	13,14,16,17,18	1,60	2,15
500 313 62	90 x 50 x 116 x 3,0	1,2,3,5,6,9,11,12,13,14, 17,18,20	23,24,25,26,31	2,61	2,57

641 598 30	90 x 48 x 76 x 3,0	1,2,3,6,7,8,9,10,11,12	16,17,20,21	1,95	4,11
641 912 30	120 x 90 x 40 x 3,0	1,2,3,4,5,6,7,8	10,11,12,13,14,15	2,56	2,93
641 690 30	90 x 60 x 60 x 2,5	1,2,3	6,7,8,9	1,76	1,42
641 590 30	90 x 50 x 50 x 2,5	1,3,5,6,7,8,9	13,14,16,17,18	1,58	1,49
641 490 25	90 x 40 x 40 x 2,5	1,2,3,4	8,9,11,12	1,83	1,67
641 490 30	90 x 40 x 40 x 3,0	1,2,3,4	8,9,11,12	1,83	2,41
651 554 25	50 x 50 x 40 x 2,5	1,2	6,7,9,10	1,80	1,34
651 070 25	70 x 70 x 55 x 2,5	1,2,3,4,6,7,8,	12,13,14,15,16,20,21,22	3,05	1,56
651 994 25	90 x 90 x 40 x 2,5	1,2,4,5,6,7	11,12,14,15,19,20	2,28	1,23
651 090 25	90 x 90 x 65 x 2,5	1,2,4,5,6,7	10,11,12,13,15,16,17,19,20	4,84	2,34
651 105 30	105 x 105 x 90 x 3,0	1,2,4,5,6,8,10,11,12,13, 14,15	18,19,20,21,27,28,29,33,34	4,85	4,50
641 416 40	160 x 50 x 40 x 3,0	1,2,3,4,5,6,7,8,9,10	13,14	1,40	1,44
631 460 20	40 x 40 x 60 x 2,0	1,2,3	6,7,8,9,10	3,15	2,25
631 480 20	40 x 40 x 80 x 2,0	1,2,3	8,9,10,11,12,13,14	2,80	2,55
631 610 20	60 x 60 x 100 x 2,0	1,2,3,4,5,6,7,8,9	15,16,17,18,19,20,21,22,23, 24,25,26,27	4,81	4,00
631 640 20	60 x 60 x 40 x 2,0	1,2,3	6,7,8,9	1,11	1,31
631 650 20	60 x 60 x 50 x 2,0	1,2,3,4	7,8,9,10,11,12	2,41	2,00
631 660 20	60 x 60 x 60 x 2,0	1,2,3,4,5,6	10,12,13,14,15,16,18	3,61	2,25
631 680 20	60 x 60 x 80 x 2,0	1,2,3,4,5,6,7	12,13,14,15,16,17,18,19,20, 21	3,34	3,80
631 810 20	80 x 80 x 100 x 2,0	1,2,3,4,5,6,7,8,9,10,11, 12,13	19,20,21,22,23,24,25,26,27, 28,29,30,31,32,33,34,35,36	5,10	4,00
631 480 20	80 x 80 x 40 x 2,0	1,2,3,4	7,8,9,10,11,12	1,27	1,75
631 860 20	80 x 80 x 60 x 2,0	1,2,3,4,5,6,7,8	11,12,13,14,15,16,17,18,19, 20	3,82	2,25
631 880 20	80 x 80 x 80 x 2,0	1,2,3,4,5,6,7,8,9,10,11	15,16,17,18,19,20,21,22,23, 24,25,26,27,28	5,10	3,00
631 140 20	100 x 100 x 40 x 2,0	1,2,3,4,5,6,7,8	11,12,13,14,15,16,17,18,19, 20	2,58	1,25
631 160 20	100 x 100 x 60 x 2,5	1,2,3,4,5,6,7,8,9,10	14,15,16,17,18,19,20,21,22, 23,24,25	2,61	3,55
631 180 20	100 x 100 x 80 x 2,0	1,2,3,4,5,6,7,8,9,10,11, 12,13,14	18,19,20,21,22,23,24,25,26, 27,28,29,30,31,32,33,34,35	5,26	3,00
631 110 20	100 x 100 x 100 x 2,0	1,2,3,4,5,6,7,8,9,10,11, 12,13,14,15,16,17,18	24,25,26,27,28,29,30,31,32, 33,34,35,36,37,38,39,40,41, 42,43,44,45	5,26	4,00
RHV 60	80 x 80 x 60 x 1,5	1,3,4,5	8,9,10,12	1,76	4,15
RHV 80	120 x 120 x 75 x 1,5	1,2,4,6,7,10	12,13,15,18,19,21,23,24	2,12	6,95
618 129 40	120 x 90 x 40 x 4,0	1,2,3,4,5,6,7	8,9,10,14,15	1,21	4,67
618 149 40	140 x 90 x 40 x 4,0	1,2,3,4,5,6,7,8,9	10,11,12,16,17	1,21	4,67
618 165 40	160 x 50 x 40 x 4,0	1,2,3,4,5,6,7,8,9,10	11,12	1,37	2,50
618 166 40	160 x 80 x 60 x 4,0	1,2,3,4,5,6,7,8	9,10,11,12,13,14,15	3,63	6,43
618 168 40	160 x 80 x 80 x 4,0	1,2,3,4,5,6,7,8,9,10,11	12,13,14,15,16,17,18,19,20	4,84	8,57
631 444 20	40 x 40 x 40 x 2,0	1,2	4,5,6	2,10	1,50
631 444 25	40 x 40 x 40 x 2,5	1,2	4,5,6	2,10	2,34
631 642 20	60 x 40 x 25 x 2,0	1,2	4,5	0,99	0,85

631 646 25	60 x 40 x 60 x 2,5	1,2,3,4,5	8,9,10,11,12	2,94	2,81
631 669 20	60 x 60 x 90 x 2,0	1,2,3,4,5,6,7,8	13,14,15,16,17,18,19,20,21, 22,23,24	4,81	3,50
631 686 25	60 x 80 x 60 x 2,5	1,2,3,4,5,6,7,8,9	13,14,15,16,17,18,19,20,21	3,61	3,52
632 060 20	60 x 60 x 25 x 2,0	1,2	4,5,6	1,16	0,85
641 035 25	50 x 50 x 35 x 2,5	1,2	6,7,9,10	1,93	1,26
641 070 20	70 x 70 x 55 x 2,0	1,2,3,7,8	12,13,14,20,21,22	3,05	1,00
641 105 20	105 x 105 x 90 x 2,0	1,2,6,8,10,11,12,14,15	18,19,20,21,27,28,29,33,34	4,85	2,00
641 140 34	40 x 140 x 2,5	1,2,4,5,7,8,10,11,13,14, 16,17	21,22,24,25	2,10	2,34
641 412 25	40 x 120 x 2,5	1,2,4,5,7,8,10,11,13,14	18,19,21,22	2,10	2,34
641 416 40	40 x 160 x 2,5	1,2,4,5,7,8,10,11,13,14, 16,17,19,20	24,25,27,28	2,10	2,34
641 490 42	40 x 90 x 2,5	2,3,5,6,8,9	13,14,16,17	2,10	2,34
641 553 20	50 x 50 x 35 x 2,0	1,2	6,7,9,10	1,93	0,55
641 665 30	65 x 65 x 55 x 3,0	1,2,3,4	8,9,13,14	2,21	3,38
641 690 25	60 x 90 x 60 x 2,5	1,2,3,4,5,6,7,9	10,12,14,15,16	1,98	1,69
641 691 25	60 x 90 x 60 x 2,5	1,2,4,5,6,7,9	10,11,13,14,15	1,98	1,74
641 692 25	60 x 90 x 60 x 2,5	1,2,4,5,6	8,9,11,12,13	1,98	1,74
641 860 20	83 x 62 x 40 x 2,0	1,2,3,4,5	6,7,8,9,10	2,32	1,31
641 905 25	105 x 105 x 90 x 2,5	1,2,6,7,8,9,10,11	14,15,16,17,20,21,27,28	6,39	17,4
641 912 30	90 x 120 x 3,0	1,2,4,5,7,8,10,11,13,14	18,19,21,22,24,25,27,28	2,59	3,38
641 970 20	70 x 70 x 55 x 2,0	1,2,4,5	8,9,10,11,13,14	2,98	5,44
641 971 15	70 x 70 x 55 x 1,5	1,2,4,5	8,9,10,11,13,14	2,98	4,21
641 990 20	90 x 90 x 65 x 2,0	1,2,6,7,8,9	12,13,14,15,21,22	3,56	5,95
641 991 15	90 x 90 x 65 x 1,5	1,2,6,7,8,9	12,13,14,15,21,22	3,55	4,42
651 070 25	70 x 70 x 55 x 2,5	1,2,3	12,13,14,20,21,22	3,28	1,38
651 090 25	90 x 90 x 65 x 2,5	1,2,7,9,10	17,18,21,22,29,30	1,61	3,49
651 105 30	105 x 105 x 90 x 3,0	1,2,4,5,6,8,10	18,19,20,21,27,28,29,33,34	6,76	6,35

Table B.6: Force F_1 Purlin, 1 angle bracket / connection, timber-timber

Bracket number	Bracket type	Nail number n_V	Nail number n_H	$F_{1,Rk}$ [kN] (purlin)	
				Timber	Steel
633 553 20	50 x 50 x 30 x 2,0	1,2	5,6	0,83	0,14
633 753 20	70 x 50 x 30 x 2,0	1,2,3,4,5,6	7,8	0,83	0,14
633 853 25	80 x 50 x 30 x 2,5	1,2,3,4,5,6	9,10	1,06	0,34
631 460 25	40 x 40 x 60 x 2,5	1,2,3	6,7,8,9,10	1,58	1,76
631 480 25	40 x 40 x 80 x 2,5	1,2,3	8,9,10,11,12,13,14	1,47	2,03
631 640 25	60 x 60 x 40 x 2,5	1,2,3	6,7,8,9	0,56	1,02
631 650 25	60 x 60 x 50 x 2,5	1,2,3,4,5	8,9,10,11,12,13,14,15	1,73	1,09
631 660 25	60 x 60 x 60 x 2,5	1,2,3,4,5,6	10,11,12,13,14,15,16,17,18	1,67	1,31
631 680 25	60 x 60 x 80 x 2,5	1,2,3,4,5,6,7	12,13,14,15,16,17,18,19,20, 21	1,67	1,90

631 610 25	60 x 60 x 100 x 2,5	1,2,3,4,5,6,7,8,9	15,16,17,18,19,20,21,22,23, 24,25,26,27	2,38	2,84
631 480 25	80 x 80 x 40 x 2,5	1,2,3,4	7,8,9,10,11,12	0,64	1,37
631 860 25	80 x 80 x 60 x 2,5	1,2,3,4,5,6,7,8	11,12,13,14,15,16,17,18,19, 20	1,85	1,41
631 880 25	80 x 80 x 80 x 2,5	1,2,3,4,5,6,7,8,9,10,11	15,16,17,18,19,20,21,22,23, 24,25,26,27,28	2,47	1,88
631 810 25	80 x 80 x 100 x 2,5	1,2,3,4,5,6,7,8,9,10,11, 12,13	19,20,21,22,23,24,25,26,27, 28,29,30,31,32,33,34,35,36	2,55	3,13
631 160 25	100 x 100 x 60 x 2,5	1,2,3,4,5,6,7,8,9,10	14,15,16,17,18,19,20,21,22, 23,24,25	1,32	1,95
631 180 25	100 x 100 x 80 x 2,5	1,2,3,4,5,6,7,8,9,10,11, 12,13,14	18,19,20,21,22,23,24,25,26, 27,28,29,30,31,32,33,34,35	2,63	2,34
631 110 25	100 x 100 x 100 x 2,5	1,2,3,4,5,6,7,8,9,10,11, 12,13,14,15,16,17,18	24,25,26,27,28,29,30,31,32, 33,34,35,36,37,38,39,40,41, 42,43,44,45	2,63	3,69
631 554 20	50 x 50 x 40 x 2,0	1,2,3	7,8,9,10,11,12	0,57	0,88
634 100 20	40 x 40 x 100 x 2,0	1,2,3,4,5	10,11,12,13,14,15,16,17,18	2,33	1,47
634 150 20	40 x 40 x 150 x 2,0	1,2,3	11,12,13,14,15,16,17,18,19, 20	1,43	2,60
634 200 20	40 x 40 x 200 x 2,0	1,2,3,4,5	16,17,18,19,20,21,22,23,24, 25,26,27,28,29,30	2,38	3,37
641 035 25	50 x 50 x 35 x 2,5	1,2	6,7,9,10	1,06	0,78
641 040 30	50 x 50 x 40 x 3,0	1,2	6,7,9,10	0,90	0,96
641 664 30	60 x 60 x 45 x 3,0	1,2,3,5	8,9,13,14	1,00	1,13
641 994 30	90 x 90 x 40 x 3,0	1,2,4,5,6,7	11,12,14,15,19,20	1,15	0,91
641 595 30	90 x 50 x 50 x 3,0	1,3,5,6,7,8,9	13,14,16,17,18	0,80	1,07
500 313 62	90 x 50 x 116 x 3,0	1,2,3,5,6,9,11,12,13,14, 17,18,20	23,24,25,26,31	1,31	1,28
641 598 30	90 x 48 x 76 x 3,0	1,2,3,6,7,8,9,10,11,12	16,17,20,21	0,97	2,06
641 912 30	120 x 90 x 40 x 3,0	1,2,3,4,5,6,7,8	10,11,12,13,14,15	1,28	1,47
641 690 30	90 x 60 x 60 x 2,5	1,2,3	6,7,8,9	0,88	0,71
641 590 30	90 x 50 x 50 x 2,5	1,3,5,6,7,8,9	13,14,16,17,18	0,79	0,74
641 490 25	90 x 40 x 40 x 2,5	1,2,3,4	8,9,11,12	0,91	0,84
641 490 30	90 x 40 x 40 x 3,0	1,2,3,4	8,9,11,12	0,91	1,21
651 554 25	50 x 50 x 40 x 2,5	1,2	6,7,9,10	0,90	0,67
651 070 25	70 x 70 x 55 x 2,5	1,2,3,4,6,7,8,	12,13,14,15,16,20,21,22	1,53	0,78
651 994 25	90 x 90 x 40 x 2,5	1,2,4,5,6,7	11,12,14,15,19,20	1,14	0,62
651 090 25	90 x 90 x 65 x 2,5	1,2,4,5,6,7	10,11,12,13,15,16,17,19,20	2,42	1,17
651 105 30	105 x 105 x 90 x 3,0	1,2,4,5,6,8,10,11,12,13, 14,15	18,19,20,21,27,28,29,33,34	2,43	2,25
641 416 40	160 x 50 x 40 x 3,0	1,2,3,4,5,6,7,8,9,10	13,14	0,70	0,72
631 460 20	40 x 40 x 60 x 2,0	1,2,3	6,7,8,9,10	1,58	1,13
631 480 20	40 x 40 x 80 x 2,0	1,2,3	8,9,10,11,12,13,14	1,40	1,27
631 610 20	60 x 60 x 100 x 2,0	1,2,3,4,5,6,7,8,9	15,16,17,18,19,20,21,22,23, 24,25,26,27	2,41	2,00
631 640 20	60 x 60 x 40 x 2,0	1,2,3	6,7,8,9	0,56	0,65
631 650 20	60 x 60 x 50 x 2,0	1,2,3,4	7,8,9,10,11,12	1,20	1,00
631 660 20	60 x 60 x 60 x 2,0	1,2,3,4,5,6	10,12,13,14,15,16,18	1,80	1,13

631 680 20	60 x 60 x 80 x 2,0	1,2,3,4,5,6,7	12,13,14,15,16,17,18,19,20,21	1,67	1,90
631 810 20	80 x 80 x 100 x 2,0	1,2,3,4,5,6,7,8,9,10,11,12,13	19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36	2,55	2,00
631 480 20	80 x 80 x 40 x 2,0	1,2,3,4	7,8,9,10,11,12	0,64	0,88
631 860 20	80 x 80 x 60 x 2,0	1,2,3,4,5,6,7,8	11,12,13,14,15,16,17,18,19,20	1,91	1,13
631 880 20	80 x 80 x 80 x 2,0	1,2,3,4,5,6,7,8,9,10,11	15,16,17,18,19,20,21,22,23,24,25,26,27,28	2,55	1,50
631 140 20	100 x 100 x 40 x 2,0	1,2,3,4,5,6,7,8	11,12,13,14,15,16,17,18,19,20	1,29	0,63
631 160 20	100 x 100 x 60 x 2,5	1,2,3,4,5,6,7,8,9,10	14,15,16,17,18,19,20,21,22,23,24,25	1,30	1,78
631 180 20	100 x 100 x 80 x 2,0	1,2,3,4,5,6,7,8,9,10,11,12,13,14	18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35	2,63	1,50
631 110 20	100 x 100 x 100 x 2,0	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45	2,63	2,00
RHV 60	80 x 80 x 60 x 1,5	1,3,4,5	8,9,10,12	0,88	2,07
RHV 80	120 x 120 x 75 x 1,5	1,2,4,6,7,10	12,13,15,18,19,21,23,24	1,06	3,48
618 129 40	120 x 90 x 40 x 4,0	1,2,3,4,5,6,7	8,9,10,14,15	0,61	2,33
618 149 40	140 x 90 x 40 x 4,0	1,2,3,4,5,6,7,8,9	10,11,12,16,17	0,61	2,33
618 165 40	160 x 50 x 40 x 4,0	1,2,3,4,5,6,7,8,9,10	11,12	0,69	1,25
618 166 40	160 x 80 x 60 x 4,0	1,2,3,4,5,6,7,8	9,10,11,12,13,14,15	1,81	3,21
618 168 40	160 x 80 x 80 x 4,0	1,2,3,4,5,6,7,8,9,10,11	12,13,14,15,16,17,18,19,20	2,42	4,29
631 444 20	40 x 40 x 40 x 2,0	1,2	4,5,6	1,05	0,75
631 444 25	40 x 40 x 40 x 2,5	1,2	4,5,6	1,05	1,17
631 642 20	60 x 40 x 25 x 2,0	1,2	4,5	0,50	0,43
631 646 25	60 x 40 x 60 x 2,5	1,2,3,4,5	8,9,10,11,12	1,47	1,41
631 669 20	60 x 60 x 90 x 2,0	1,2,3,4,5,6,7,8	13,14,15,16,17,18,19,20,21,22,23,24	2,41	1,75
631 686 25	60 x 80 x 60 x 2,5	1,2,3,4,5,6,7,8,9	13,14,15,16,17,18,19,20,21	1,80	1,76
632 060 20	60 x 60 x 25 x 2,0	1,2	4,5,6	0,58	0,43
641 035 25	50 x 50 x 35 x 2,5	1,2	6,7,9,10	0,96	0,63
641 070 20	70 x 70 x 55 x 2,0	1,2,3,7,8	12,13,14,20,21,22	1,53	0,50
641 105 20	105 x 105 x 90 x 2,0	1,2,6,8,10,11,12,14,15	18,19,20,21,27,28,29,33,34	2,43	1,00
641 140 34	40 x 140 x 2,5	1,2,4,5,7,8,10,11,13,14,16,17	21,22,24,25	1,05	1,17
641 412 25	40 x 120 x 2,5	1,2,4,5,7,8,10,11,13,14	18,19,21,22	1,05	1,17
641 416 40	40 x 160 x 2,5	1,2,4,5,7,8,10,11,13,14,16,17,19,20	24,25,27,28	1,05	1,17
641 490 42	40 x 90 x 2,5	2,3,5,6,8,9	13,14,16,17	1,05	1,17
641 553 20	50 x 50 x 35 x 2,0	1,2	6,7,9,10	0,96	0,27
641 665 30	65 x 65 x 55 x 3,0	1,2,3,4	8,9,13,14	1,10	1,69
641 690 25	60 x 90 x 60 x 2,5	1,2,3,4,5,6,7,9	10,12,14,15,16	0,99	0,85
641 691 25	60 x 90 x 60 x 2,5	1,2,4,5,6,7,9	10,11,13,14,15	0,99	0,87
641 692 25	60 x 90 x 60 x 2,5	1,2,4,5,6	8,9,11,12,13	0,99	0,87
641 860 20	83 x 62 x 40 x 2,0	1,2,3,4,5	6,7,8,9,10	1,16	0,66

641 905 25	105 x 105 x 90 x 2,5	1,2,6,7,8,9,10,11	14,15,16,17,20,21,27,28	3,19	8,68
641 912 30	90 x 120 x 3,0	1,2,4,5,7,8,10,11,13,14	18,19,21,22,24,25,27,28	1,30	1,69
641 970 20	70 x 70 x 55 x 2,0	1,2,4,5	8,9,10,11,13,14	1,49	2,72
641 971 15	70 x 70 x 55 x 1,5	1,2,4,5	8,9,10,11,13,14	1,49	2,10
641 990 20	90 x 90 x 65 x 2,0	1,2,6,7,8,9	12,13,14,15,21,22	1,78	2,97
641 991 15	90 x 90 x 65 x 1,5	1,2,6,7,8,9	12,13,14,15,21,22	1,78	2,21
651 070 25	70 x 70 x 55 x 2,5	1,2,3	12,13,14,20,21,22	1,64	0,69
651 090 25	90 x 90 x 65 x 2,5	1,2,7,9,10	17,18,21,22,29,30	0,81	1,74
651 105 30	105 x 105 x 90 x 3,0	1,2,4,5,6,8,10	18,19,20,21,27,28,29,33,34	3,38	3,18

Table B.7: Force F_1 Purlin, 2 angle brackets / connection, timber-concrete/steel

Article-No.	Dimension	Bolt number n_v	Bolt number n_H	$F_{1,Rk}$ [kN] (purlin)		Bolt k_t
				Timber	Steel	
633 710 66	100 x 75 x 60 x 6,0	1	2	-	7,62	0,78

Table B.8: Force F_1 Purlin, 1 angle bracket / connection, timber-concrete/steel

Bracket number	Bracket type	Bolt number n_v	Bolt number n_H	$F_{1,Rk}$ [kN] (purlin)		Bolt k_t
				Timber	Steel	
633 710 66	100 x 75 x 60 x 6,0	1	2	-	3,81	1,55

Results angle bracket force F_2 / F_3 **Table B.9:** Force $F_{2/3}$ Purlin, 2 angle brackets / connection, timber-timber

Bracket number	Bracket type	Nail number n_V	Nail number n_H	$F_{2/3,Rk}$ [kN]
				(purlin) Timber
633 553 20	50 x 50 x 30 x 2,0	1,2	5,6	2,38
633 753 20	70 x 50 x 30 x 2,0	1,2,3,4,5,6	7,8	2,83
633 853 25	80 x 50 x 30 x 2,5	1,2,3,4,5,6	9,10	2,26
631 460 25	40 x 40 x 60 x 2,5	1,2,3	6,7,8,9,10	5,31
631 480 25	40 x 40 x 80 x 2,5	1,2,3	8,9,10,11,12,13,14	6,35
631 640 25	60 x 60 x 40 x 2,5	1,2,3	6,7,8,9	2,18
631 650 25	60 x 60 x 50 x 2,5	1,2,3,4,5	8,9,10,11,12,13,14,15	6,27
631 660 25	60 x 60 x 60 x 2,5	1,2,3,4,5,6	10,11,12,13,14,15,16,17,18	7,23
631 680 25	60 x 60 x 80 x 2,5	1,2,3,4,5,6,7	12,13,14,15,16,17,18,19,20,21	9,22
631 610 25	60 x 60 x 100 x 2,5	1,2,3,4,5,6,7,8,9	15,16,17,18,19,20,21,22,23,24,25,26,27	13,8
631 480 25	80 x 80 x 40 x 2,5	1,2,3,4	7,8,9,10,11,12	3,15
631 860 25	80 x 80 x 60 x 2,5	1,2,3,4,5,6,7,8	11,12,13,14,15,16,17,18,19,20	8,38
631 880 25	80 x 80 x 80 x 2,5	1,2,3,4,5,6,7,8,9,10,11	15,16,17,18,19,20,21,22,23,24,25,26,27,28	12,9
631 810 25	80 x 80 x 100 x 2,5	1,2,3,4,5,6,7,8,9,10,11,12,13	19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36	17,7
631 160 25	100 x 100 x 60 x 2,5	1,2,3,4,5,6,7,8,9,10	14,15,16,17,18,19,20,21,22,23,24,25	8,85
631 180 25	100 x 100 x 80 x 2,5	1,2,3,4,5,6,7,8,9,10,11,12,13,14	18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35	15,5
631 110 25	100 x 100 x 100 x 2,5	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45	20,2
631 554 20	50 x 50 x 40 x 2,0	1,2,3	7,8,9,10,11,12	3,35
634 100 20	40 x 40 x 100 x 2,0	1,2,3,4,5	10,11,12,13,14,15,16,17,18	12,1
634 150 20	40 x 40 x 150 x 2,0	1,2,3	11,12,13,14,15,16,17,18,19,20	9,69
634 200 20	40 x 40 x 200 x 2,0	1,2,3,4,5	16,17,18,19,20,21,22,23,24,25,26,27,28,29,30	16,1
641 035 25	50 x 50 x 35 x 2,5	1,2	6,7,9,10	2,59
641 040 30	50 x 50 x 40 x 3,0	1,2	6,7,9,10	2,53
641 664 30	60 x 60 x 45 x 3,0	1,2,3,5	8,9,13,14	4,23
641 994 30	90 x 90 x 40 x 3,0	1,2,4,5,6,7	11,12,14,15,19,20	4,70
641 595 30	90 x 50 x 50 x 3,0	1,3,5,6,7,8,9	13,14,16,17,18	5,46
500 313 62	90 x 50 x 116 x 3,0	1,2,3,5,6,9,11,12,13,14,17,18,20	23,24,25,26,31	9,16
641 598 30	90 x 48 x 76 x 3,0	1,2,3,6,7,8,9,10,11,12	16,17,20,21	7,78
641 912 30	120 x 90 x 40 x 3,0	1,2,3,4,5,6,7,8	10,11,12,13,14,15	5,68
641 690 30	90 x 60 x 60 x 2,5	1,2,3	6,7,8,9	2,99
641 590 30	90 x 50 x 50 x 2,5	1,3,5,6,7,8,9	13,14,16,17,18	5,50

641 490 25	90 x 40 x 40 x 2,5	1,2,3,4	8,9,11,12	3,19
641 490 30	90 x 40 x 40 x 3,0	1,2,3,4	8,9,11,12	3,17
651 070 25	70 x 70 x 55 x 2,5	1,2,3,4,6,7,8,	12,13,14,15,16,20,21,22	7,18
651 090 25	90 x 90 x 65 x 2,5	1,2,4,5,6,7	10,11,12,13,15,16,17,19,20	7,10
651 105 30	105 x 105 x 90 x 3,0	1,2,4,5,6,8,10,11,12,13, 14,15	18,19,20,21,27,28,29,33,34	11,5
641 416 40	160 x 50 x 40 x 3,0	1,2,3,4,5,6,7,8,9,10	13,14	2,89
631 460 20	40 x 40 x 60 x 2,0	1,2,3	6,7,8,9,10	5,34
631 480 20	40 x 40 x 80 x 2,0	1,2,3	8,9,10,11,12,13,14	6,67
631 610 20	60 x 60 x 100 x 2,0	1,2,3,4,5,6,7,8,9	15,16,17,18,19,20,21,22,23, 24,25,26,27	14,3
631 640 20	60 x 60 x 40 x 2,0	1,2,3	6,7,8,9	2,20
631 650 20	60 x 60 x 50 x 2,0	1,2,3,4	7,8,9,10,11,12	4,36
631 660 20	60 x 60 x 60 x 2,0	1,2,3,4,5,6	10,12,13,14,15,16,18	6,28
631 680 20	60 x 60 x 80 x 2,0	1,2,3,4,5,6,7	12,13,14,15,16,17,18,19,20, 21	9,22
631 810 20	80 x 80 x 100 x 2,0	1,2,3,4,5,6,7,8,9,10,11, 12,13	19,20,21,22,23,24,25,26,27, 28,29,30,31,32,33,34,35,36	17,6
631 480 20	80 x 80 x 40 x 2,0	1,2,3,4	7,8,9,10,11,12	3,17
631 860 20	80 x 80 x 60 x 2,0	1,2,3,4,5,6,7,8	11,12,13,14,15,16,17,18,19, 20	8,77
631 880 20	80 x 80 x 80 x 2,0	1,2,3,4,5,6,7,8,9,10,11	15,16,17,18,19,20,21,22,23, 24,25,26,27,28	13,7
631 140 20	100 x 100 x 40 x 2,0	1,2,3,4,5,6,7,8	11,12,13,14,15,16,17,18,19, 20	7,06
631 160 20	100 x 100 x 60 x 2,5	1,2,3,4,5,6,7,8,9,10	14,15,16,17,18,19,20,21,22, 23,24,25	8,61
631 180 20	100 x 100 x 80 x 2,0	1,2,3,4,5,6,7,8,9,10,11, 12,13,14	18,19,20,21,22,23,24,25,26, 27,28,29,30,31,32,33,34,35	15,6
631 110 20	100 x 100 x 100 x 2,0	1,2,3,4,5,6,7,8,9,10,11, 12,13,14,15,16,17,18	24,25,26,27,28,29,30,31,32, 33,34,35,36,37,38,39,40,41, 42,43,44,45	20,9
RHV 60	80 x 80 x 60 x 1,5	1,3,4,5	8,9,10,12	3,82
RHV 80	120 x 120 x 75 x 1,5	1,2,4,6,7,10	12,13,15,18,19,21,23,24	5,76
618 129 40	120 x 90 x 40 x 4,0	1,2,3,4,5,6,7	8,9,10,14,15	4,89
618 149 40	140 x 90 x 40 x 4,0	1,2,3,4,5,6,7,8,9	10,11,12,16,17	4,94
618 165 40	160 x 50 x 40 x 4,0	1,2,3,4,5,6,7,8,9,10	11,12	2,80
618 166 40	160 x 80 x 60 x 4,0	1,2,3,4,5,6,7,8	9,10,11,12,13,14,15	7,42
618 168 40	160 x 80 x 80 x 4,0	1,2,3,4,5,6,7,8,9,10,11	12,13,14,15,16,17,18,19,20	9,43
631 444 20	40 x 40 x 40 x 2,0	1,2	4,5,6	2,64
631 444 25	40 x 40 x 40 x 2,5	1,2	4,5,6	2,62
631 642 20	60 x 40 x 25 x 2,0	1,2	4,5	1,82
631 646 25	60 x 40 x 60 x 2,5	1,2,3,4,5	8,9,10,11,12	5,20
631 669 20	60 x 60 x 90 x 2,0	1,2,3,4,5,6,7,8	13,14,15,16,17,18,19,20,21, 22,23,24	12,6
631 686 25	60 x 80 x 60 x 2,5	1,2,3,4,5,6,7,8,9	13,14,15,16,17,18,19,20,21	9,17
632 060 20	60 x 60 x 25 x 2,0	1,2	4,5,6	1,86
641 035 25	50 x 50 x 35 x 2,5	1,2	6,7,9,10	2,82

641 070 20	70 x 70 x 55 x 2,0	1,2,3,7,8	12,13,14,20,21,22	5,38
641 105 20	105 x 105 x 90 x 2,0	1,2,6,8,10,11,12,14,15	18,19,20,21,27,28,29,33,34	10,5
641 140 34	40 x 140 x 2,5	1,2,4,5,7,8,10,11,13,14, 16,17	21,22,24,25	5,73
641 412 25	40 x 120 x 2,5	1,2,4,5,7,8,10,11,13,14	18,19,21,22	5,73
641 416 40	40 x 160 x 2,5	1,2,4,5,7,8,10,11,13,14, 16,17,19,20	24,25,27,28	5,73
641 490 42	40 x 90 x 2,5	2,3,5,6,8,9	13,14,16,17	3,95
641 553 20	50 x 50 x 35 x 2,0	1,2	6,7,9,10	2,84
641 665 30	65 x 65 x 55 x 3,0	1,2,3,4	8,9,13,14	5,30
641 690 25	60 x 90 x 60 x 2,5	1,2,3,4,5,6,7,9	10,12,14,15,16	6,03
641 691 25	60 x 90 x 60 x 2,5	1,2,4,5,6,7,9	10,11,13,14,15	5,76
641 692 25	60 x 90 x 60 x 2,5	1,2,4,5,6	8,9,11,12,13	5,36
641 860 20	83 x 62 x 40 x 2,0	1,2,3,4,5	6,7,8,9,10	4,11
641 905 25	105 x 105 x 90 x 2,5	1,2,6,7,8,9,10,11	14,15,16,17,20,21,27,28	9,17
641 912 30	90 x 120 x 3,0	1,2,4,5,7,8,10,11,13,14	18,19,21,22,24,25,27,28	7,60
641 970 20	70 x 70 x 55 x 2,0	1,2,4,5	8,9,10,11,13,14	5,49
641 971 15	70 x 70 x 55 x 1,5	1,2,4,5	8,9,10,11,13,14	5,56
641 990 20	90 x 90 x 65 x 2,0	1,2,6,7,8,9	12,13,14,15,21,22	6,82
641 991 15	90 x 90 x 65 x 1,5	1,2,6,7,8,9	12,13,14,15,21,22	6,87
651 070 25	70 x 70 x 55 x 2,5	1,2,3	12,13,14,20,21,22	2,59
651 090 25	90 x 90 x 65 x 2,5	1,2,7,9,10	17,18,21,22,29,30	3,68
651 105 30	105 x 105 x 90 x 3,0	1,2,4,5,6,8,10	18,19,20,21,27,28,29,33,34	6,53

Table B.10: Force $F_{2/3}$ Purlin, 1 angle bracket / connection, timber-timber

Bracket number	Bracket type	Nail number n_V	Nail number n_H	$F_{2/3,Rk}$ [kN] (purlin)
				Timber
633 553 20	50 x 50 x 30 x 2,0	1,2	5,6	1,19
633 753 20	70 x 50 x 30 x 2,0	1,2,3,4,5,6	7,8	1,42
633 853 25	80 x 50 x 30 x 2,5	1,2,3,4,5,6	9,10	1,13
631 460 25	40 x 40 x 60 x 2,5	1,2,3	6,7,8,9,10	2,65
631 480 25	40 x 40 x 80 x 2,5	1,2,3	8,9,10,11,12,13,14	3,17
631 640 25	60 x 60 x 40 x 2,5	1,2,3	6,7,8,9	1,09
631 650 25	60 x 60 x 50 x 2,5	1,2,3,4,5	8,9,10,11,12,13,14,15	3,13
631 660 25	60 x 60 x 60 x 2,5	1,2,3,4,5,6	10,11,12,13,14,15,16,17,18	3,62
631 680 25	60 x 60 x 80 x 2,5	1,2,3,4,5,6,7	12,13,14,15,16,17,18,19,20, 21	4,61
631 610 25	60 x 60 x 100 x 2,5	1,2,3,4,5,6,7,8,9	15,16,17,18,19,20,21,22,23, 24,25,26,27	6,89
631 480 25	80 x 80 x 40 x 2,5	1,2,3,4	7,8,9,10,11,12	1,58
631 860 25	80 x 80 x 60 x 2,5	1,2,3,4,5,6,7,8	11,12,13,14,15,16,17,18,19, 20	4,19
631 880 25	80 x 80 x 80 x 2,5	1,2,3,4,5,6,7,8,9,10,11	15,16,17,18,19,20,21,22,23, 24,25,26,27,28	6,47

631 810 25	80 x 80 x 100 x 2,5	1,2,3,4,5,6,7,8,9,10,11,12,13	19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36	8,84
631 160 25	100 x 100 x 60 x 2,5	1,2,3,4,5,6,7,8,9,10	14,15,16,17,18,19,20,21,22,23,24,25	4,42
631 180 25	100 x 100 x 80 x 2,5	1,2,3,4,5,6,7,8,9,10,11,12,13,14	18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35	7,76
631 110 25	100 x 100 x 100 x 2,5	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45	10,1
631 554 20	50 x 50 x 40 x 2,0	1,2,3	7,8,9,10,11,12	1,68
634 100 20	40 x 40 x 100 x 2,0	1,2,3,4,5	10,11,12,13,14,15,16,17,18	6,08
634 150 20	40 x 40 x 150 x 2,0	1,2,3	11,12,13,14,15,16,17,18,19,20	4,85
634 200 20	40 x 40 x 200 x 2,0	1,2,3,4,5	16,17,18,19,20,21,22,23,24,25,26,27,28,29,30	8,08
641 035 25	50 x 50 x 35 x 2,5	1,2	6,7,9,10	1,29
641 040 30	50 x 50 x 40 x 3,0	1,2	6,7,9,10	1,27
641 664 30	60 x 60 x 45 x 3,0	1,2,3,5	8,9,13,14	2,11
641 994 30	90 x 90 x 40 x 3,0	1,2,4,5,6,7	11,12,14,15,19,20	2,35
641 595 30	90 x 50 x 50 x 3,0	1,3,5,6,7,8,9	13,14,16,17,18	2,73
500 313 62	90 x 50 x 116 x 3,0	1,2,3,5,6,9,11,12,13,14,17,18,20	23,24,25,26,31	4,58
641 598 30	90 x 48 x 76 x 3,0	1,2,3,6,7,8,9,10,11,12	16,17,20,21	3,89
641 912 30	120 x 90 x 40 x 3,0	1,2,3,4,5,6,7,8	10,11,12,13,14,15	2,84
641 690 30	90 x 60 x 60 x 2,5	1,2,3	6,7,8,9	1,50
641 590 30	90 x 50 x 50 x 2,5	1,3,5,6,7,8,9	13,14,16,17,18	2,75
641 490 25	90 x 40 x 40 x 2,5	1,2,3,4	8,9,11,12	1,59
641 490 30	90 x 40 x 40 x 3,0	1,2,3,4	8,9,11,12	1,58
651 070 25	70 x 70 x 55 x 2,5	1,2,3,4,6,7,8,	12,13,14,15,16,20,21,22	3,59
651 090 25	90 x 90 x 65 x 2,5	1,2,4,5,6,7	10,11,12,13,15,16,17,19,20	3,55
651 105 30	105 x 105 x 90 x 3,0	1,2,4,5,6,8,10,11,12,13,14,15	18,19,20,21,27,28,29,33,34	5,74
641 416 40	160 x 50 x 40 x 3,0	1,2,3,4,5,6,7,8,9,10	13,14	1,45
631 460 20	40 x 40 x 60 x 2,0	1,2,3	6,7,8,9,10	2,67
631 480 20	40 x 40 x 80 x 2,0	1,2,3	8,9,10,11,12,13,14	3,34
631 610 20	60 x 60 x 100 x 2,0	1,2,3,4,5,6,7,8,9	15,16,17,18,19,20,21,22,23,24,25,26,27	7,16
631 640 20	60 x 60 x 40 x 2,0	1,2,3	6,7,8,9	1,10
631 650 20	60 x 60 x 50 x 2,0	1,2,3,4	7,8,9,10,11,12	2,18
631 660 20	60 x 60 x 60 x 2,0	1,2,3,4,5,6	10,12,13,14,15,16,18	3,14
631 680 20	60 x 60 x 80 x 2,0	1,2,3,4,5,6,7	12,13,14,15,16,17,18,19,20,21	4,61
631 810 20	80 x 80 x 100 x 2,0	1,2,3,4,5,6,7,8,9,10,11,12,13	19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36	8,81
631 480 20	80 x 80 x 40 x 2,0	1,2,3,4	7,8,9,10,11,12	1,59
631 860 20	80 x 80 x 60 x 2,0	1,2,3,4,5,6,7,8	11,12,13,14,15,16,17,18,19,20	4,38
631 880 20	80 x 80 x 80 x 2,0	1,2,3,4,5,6,7,8,9,10,11	15,16,17,18,19,20,21,22,23,24,25,26,27,28	6,85

631 140 20	100 x 100 x 40 x 2,0	1,2,3,4,5,6,7,8	11,12,13,14,15,16,17,18,19,20	3,53
631 160 20	100 x 100 x 60 x 2,5	1,2,3,4,5,6,7,8,9,10	14,15,16,17,18,19,20,21,22,23,24,25	4,30
631 180 20	100 x 100 x 80 x 2,0	1,2,3,4,5,6,7,8,9,10,11,12,13,14	18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35	7,81
631 110 20	100 x 100 x 100 x 2,0	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45	10,5
RHV 60	80 x 80 x 60 x 1,5	1,3,4,5	8,9,10,12	1,91
RHV 80	120 x 120 x 75 x 1,5	1,2,4,6,7,10	12,13,15,18,19,21,23,24	2,88
618 129 40	120 x 90 x 40 x 4,0	1,2,3,4,5,6,7	8,9,10,14,15	2,44
618 149 40	140 x 90 x 40 x 4,0	1,2,3,4,5,6,7,8,9	10,11,12,16,17	2,47
618 165 40	160 x 50 x 40 x 4,0	1,2,3,4,5,6,7,8,9,10	11,12	1,40
618 166 40	160 x 80 x 60 x 4,0	1,2,3,4,5,6,7,8	9,10,11,12,13,14,15	3,71
618 168 40	160 x 80 x 80 x 4,0	1,2,3,4,5,6,7,8,9,10,11	12,13,14,15,16,17,18,19,20	4,71
631 444 20	40 x 40 x 40 x 2,0	1,2	4,5,6	1,32
631 444 25	40 x 40 x 40 x 2,5	1,2	4,5,6	1,31
631 642 20	60 x 40 x 25 x 2,0	1,2	4,5	0,91
631 646 25	60 x 40 x 60 x 2,5	1,2,3,4,5	8,9,10,11,12	2,60
631 669 20	60 x 60 x 90 x 2,0	1,2,3,4,5,6,7,8	13,14,15,16,17,18,19,20,21,22,23,24	6,30
631 686 25	60 x 80 x 60 x 2,5	1,2,3,4,5,6,7,8,9	13,14,15,16,17,18,19,20,21	4,58
632 060 20	60 x 60 x 25 x 2,0	1,2	4,5,6	0,93
641 035 25	50 x 50 x 35 x 2,5	1,2	6,7,9,10	1,41
641 070 20	70 x 70 x 55 x 2,0	1,2,3,7,8	12,13,14,20,21,22	2,69
641 105 20	105 x 105 x 90 x 2,0	1,2,6,8,10,11,12,14,15	18,19,20,21,27,28,29,33,34	5,24
641 140 34	40 x 140 x 2,5	1,2,4,5,7,8,10,11,13,14,16,17	21,22,24,25	2,87
641 412 25	40 x 120 x 2,5	1,2,4,5,7,8,10,11,13,14	18,19,21,22	2,87
641 416 40	40 x 160 x 2,5	1,2,4,5,7,8,10,11,13,14,16,17,19,20	24,25,27,28	2,87
641 490 42	40 x 90 x 2,5	2,3,5,6,8,9	13,14,16,17	1,98
641 553 20	50 x 50 x 35 x 2,0	1,2	6,7,9,10	1,42
641 665 30	65 x 65 x 55 x 3,0	1,2,3,4	8,9,13,14	2,65
641 690 25	60 x 90 x 60 x 2,5	1,2,3,4,5,6,7,9	10,12,14,15,16	3,01
641 691 25	60 x 90 x 60 x 2,5	1,2,4,5,6,7,9	10,11,13,14,15	2,88
641 692 25	60 x 90 x 60 x 2,5	1,2,4,5,6	8,9,11,12,13	2,68
641 860 20	83 x 62 x 40 x 2,0	1,2,3,4,5	6,7,8,9,10	2,05
641 905 25	105 x 105 x 90 x 2,5	1,2,6,7,8,9,10,11	14,15,16,17,20,21,27,28	4,58
641 912 30	90 x 120 x 3,0	1,2,4,5,7,8,10,11,13,14	18,19,21,22,24,25,27,28	3,80
641 970 20	70 x 70 x 55 x 2,0	1,2,4,5	8,9,10,11,13,14	2,75
641 971 15	70 x 70 x 55 x 1,5	1,2,4,5	8,9,10,11,13,14	2,78
641 990 20	90 x 90 x 65 x 2,0	1,2,6,7,8,9	12,13,14,15,21,22	3,41
641 991 15	90 x 90 x 65 x 1,5	1,2,6,7,8,9	12,13,14,15,21,22	3,43
651 070 25	70 x 70 x 55 x 2,5	1,2,3	12,13,14,20,21,22	1,30

651 090 25	90 x 90 x 65 x 2,5	1,2,7,9,10	17,18,21,22,29,30	1,84
651 105 30	105 x 105 x 90 x 3,0	1,2,4,5,6,8,10	18,19,20,21,27,28,29,33,34	3,26

Results angle bracket force F_4 / F_5 **Table B.11:** Basic Force $F_{4/5}$ Purlin, 2 angle brackets / connection, timber-timber

Bracket number	Bracket type	Nail number n_v	Nail number n_H	$F_{4/5,Rk}$ [kN] (purlin)	
				Timber	Steel
633 553 20	50 x 50 x 30 x 2,0	1,2	5,6	4,09	1,14
633 753 20	70 x 50 x 30 x 2,0	1,2,3,4,5,6	7,8	4,28	1,14
633 853 25	80 x 50 x 30 x 2,5	1,2,3,4,5,6	9,10	4,15	1,52
631 460 25	40 x 40 x 60 x 2,5	1,2,3	6,7,8,9,10	7,22	3,20
631 480 25	40 x 40 x 80 x 2,5	1,2,3	8,9,10,11,12,13,14	10,6	4,77
631 640 25	60 x 60 x 40 x 2,5	1,2,3	6,7,8,9	3,56	2,49
631 650 25	60 x 60 x 50 x 2,5	1,2,3,4,5	8,9,10,11,12,13,14,15	7,18	2,97
631 660 25	60 x 60 x 60 x 2,5	1,2,3,4,5,6	10,11,12,13,14,15,16,17,18	7,40	3,86
631 680 25	60 x 60 x 80 x 2,5	1,2,3,4,5,6,7	12,13,14,15,16,17,18,19,20, 21	8,50	5,07
631 610 25	60 x 60 x 100 x 2,5	1,2,3,4,5,6,7,8,9	15,16,17,18,19,20,21,22,23, 24,25,26,27	11,4	6,31
631 480 25	80 x 80 x 40 x 2,5	1,2,3,4	7,8,9,10,11,12	4,04	2,59
631 860 25	80 x 80 x 60 x 2,5	1,2,3,4,5,6,7,8	11,12,13,14,15,16,17,18,19, 20	8,11	3,98
631 880 25	80 x 80 x 80 x 2,5	1,2,3,4,5,6,7,8,9,10,11	15,16,17,18,19,20,21,22,23, 24,25,26,27,28	11,0	5,27
631 810 25	80 x 80 x 100 x 2,5	1,2,3,4,5,6,7,8,9,10,11, 12,13	19,20,21,22,23,24,25,26,27, 28,29,30,31,32,33,34,35,36	12,7	4,75
631 160 25	100 x 100 x 60 x 2,5	1,2,3,4,5,6,7,8,9,10	14,15,16,17,18,19,20,21,22, 23,24,25	7,36	3,88
631 180 25	100 x 100 x 80 x 2,5	1,2,3,4,5,6,7,8,9,10,11, 12,13,14	18,19,20,21,22,23,24,25,26, 27,28,29,30,31,32,33,34,35	6,01	3,96
631 110 25	100 x 100 x 100 x 2,5	1,2,3,4,5,6,7,8,9,10,11, 12,13,14,15,16,17,18	24,25,26,27,28,29,30,31,32, 33,34,35,36,37,38,39,40,41, 42,43,44,45	13,2	7,64
618 129 40	120 x 90 x 40 x 4,0	1,2,3,4,5,6,7	8,9,10,14,15	4,86	4,96
618 149 40	140 x 90 x 40 x 4,0	1,2,3,4,5,6,7,8,9	10,11,12,16,17	5,01	4,95
618 165 40	160 x 50 x 40 x 4,0	1,2,3,4,5,6,7,8,9,10	11,12	4,21	5,03
618 166 40	160 x 80 x 60 x 4,0	1,2,3,4,5,6,7,8	9,10,11,12,13,14,15	7,31	7,17
618 168 40	160 x 80 x 80 x 4,0	1,2,3,4,5,6,7,8,9,10,11	12,13,14,15,16,17,18,19,20	9,27	9,39
631 444 20	40 x 40 x 40 x 2,0	1,2	4,5,6	3,46	1,52
631 444 25	40 x 40 x 40 x 2,5	1,2	4,5,6	4,08	1,93
631 642 20	60 x 40 x 25 x 2,0	1,2	4,5	2,51	1,12
631 646 25	60 x 40 x 60 x 2,5	1,2,3,4,5	8,9,10,11,12	6,85	3,60
631 669 20	60 x 60 x 90 x 2,0	1,2,3,4,5,6,7,8	13,14,15,16,17,18,19,20,21, 22,23,24	7,64	4,02
631 686 25	60 x 80 x 60 x 2,5	1,2,3,4,5,6,7,8,9	13,14,15,16,17,18,19,20,21	7,90	3,58
632 060 20	60 x 60 x 25 x 2,0	1,2	4,5,6	2,51	1,10
641 035 25	50 x 50 x 35 x 2,5	1,2	6,7,9,10	3,39	1,77
641 070 20	70 x 70 x 55 x 2,0	1,2,3,7,8	12,13,14,20,21,22	5,57	2,60
641 105 20	105 x 105 x 90 x 2,0	1,2,6,8,10,11,12,14,15	18,19,20,21,27,28,29,33,34	7,57	3,90

641 140 34	40 x 140 x 2,5	1,2,4,5,7,8,10,11,13,14,16,17	21,22,24,25	5,15	2,53
641 412 25	40 x 120 x 2,5	1,2,4,5,7,8,10,11,13,14	18,19,21,22	5,13	2,54
641 416 40	40 x 160 x 2,5	1,2,4,5,7,8,10,11,13,14,16,17,19,20	24,25,27,28	5,06	2,55
641 490 42	40 x 90 x 2,5	2,3,5,6,8,9	13,14,16,17	5,01	2,58
641 553 20	50 x 50 x 35 x 2,0	1,2	6,7,9,10	2,93	0,94
641 665 30	65 x 65 x 55 x 3,0	1,2,3,4	8,9,13,14	6,69	3,70
641 690 25	60 x 90 x 60 x 2,5	1,2,3,4,5,6,7,9	10,12,14,15,16	7,97	5,26
641 691 25	60 x 90 x 60 x 2,5	1,2,4,5,6,7,9	10,11,13,14,15	7,65	3,62
641 692 25	60 x 90 x 60 x 2,5	1,2,4,5,6	8,9,11,12,13	7,05	3,53
641 860 20	83 x 62 x 40 x 2,0	1,2,3,4,5	6,7,8,9,10	4,81	2,48
641 905 25	105 x 105 x 90 x 2,5	1,2,6,7,8,9,10,11	14,15,16,17,20,21,27,28	10,4	9,95
641 912 30	90 x 120 x 3,0	1,2,4,5,7,8,10,11,13,14	18,19,21,22,24,25,27,28	5,86	2,94
641 970 20	70 x 70 x 55 x 2,0	1,2,4,5	8,9,10,11,13,14	6,74	4,25
641 971 15	70 x 70 x 55 x 1,5	1,2,4,5	8,9,10,11,13,14	6,64	3,34
641 990 20	90 x 90 x 65 x 2,0	1,2,6,7,8,9	12,13,14,15,21,22	8,18	4,97
641 991 15	90 x 90 x 65 x 1,5	1,2,6,7,8,9	12,13,14,15,21,22	8,28	3,76
651 070 25	70 x 70 x 55 x 2,5	1,2,3	12,13,14,20,21,22	-	-
651 090 25	90 x 90 x 65 x 2,5	1,2,7,9,10	17,18,21,22,29,30	-	-
651 105 30	105 x 105 x 90 x 3,0	1,2,4,5,6,8,10	18,19,20,21,27,28,29,33,34	-	-

Table B.12: Basic Force F₄ Purlin, 1 angle bracket / connection, timber-timber

Bracket number	Bracket type	Nail number n _v	Nail number n _H	F _{4,Rk} [kN] (purlin)	
				Timber	Steel
641 860 20	83 x 62 x 40 x 2,0	1,2,3,4,5	6,7,8,9,10	4,22	1,53
641 905 25	105 x 105 x 90 x 2,5	1,2,6,7,8,9,10,11	14,15,16,17,20,21,27,28	11,7	7,47
641 970 20	70 x 70 x 55 x 2,0	1,2,4,5	8,9,10,11,13,14	7,03	3,26
641 971 15	70 x 70 x 55 x 1,5	1,2,4,5	8,9,10,11,13,14	6,68	2,59
641 990 20	90 x 90 x 65 x 2,0	1,2,6,7,8,9	12,13,14,15,21,22	7,68	3,89
641 991 15	90 x 90 x 65 x 1,5	1,2,6,7,8,9	12,13,14,15,21,22	7,67	2,98

Table B.13: Basic Force F₅ Purlin, 1 angle bracket / connection, timber-timber

Bracket number	Bracket type	Nail number n _v	Nail number n _H	F _{5,Rk} [kN] (purlin)	
				Timber	Steel
641 860 20	83 x 62 x 40 x 2,0	1,2,3,4,5	6,7,8,9,10	1,03	0,42
641 905 25	105 x 105 x 90 x 2,5	1,2,6,7,8,9,10,11	14,15,16,17,20,21,27,28	2,58	3,64
641 970 20	70 x 70 x 55 x 2,0	1,2,4,5	8,9,10,11,13,14	1,57	1,27
641 971 15	70 x 70 x 55 x 1,5	1,2,4,5	8,9,10,11,13,14	1,49	0,98
641 990 20	90 x 90 x 65 x 2,0	1,2,6,7,8,9	12,13,14,15,21,22	1,78	1,70
641 991 15	90 x 90 x 65 x 1,5	1,2,6,7,8,9	12,13,14,15,21,22	1,72	1,25

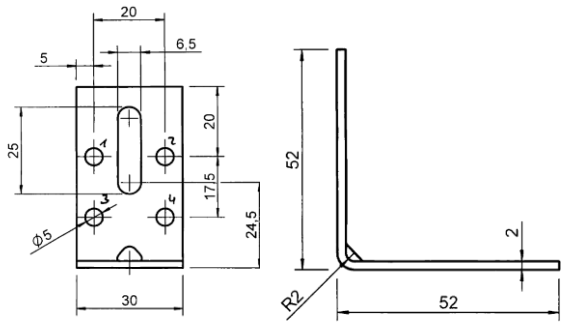


Figure B. 1 Dimensions of Angle Bracket 633 553 20

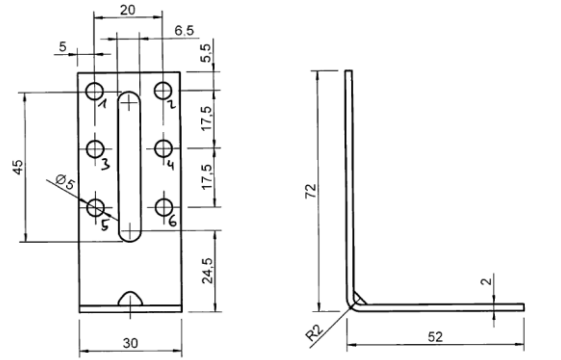


Figure B. 2 Dimensions of Angle Bracket 633 753 20

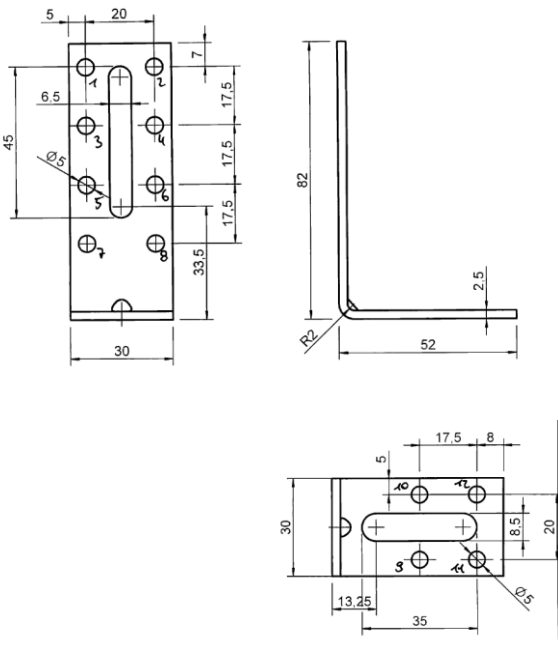


Figure B. 3 Dimensions of Angle Bracket 633 853 25

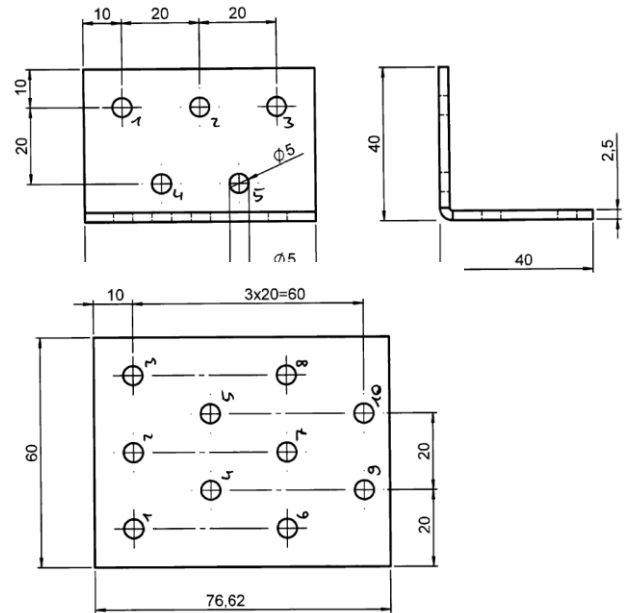


Figure B. 4 Dimensions of Angle Bracket 631 460 25

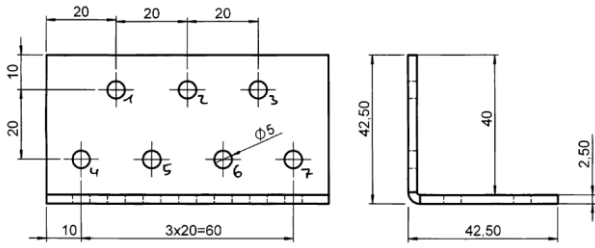


Figure B. 5 Dimensions of Angle Bracket 631 480 25

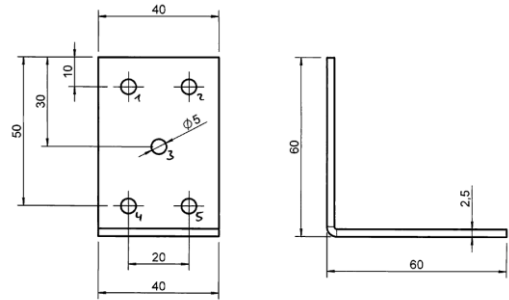


Figure B. 6 Dimensions of Angle Bracket 631 640 25

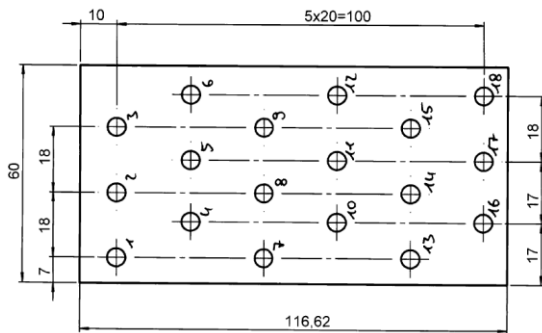
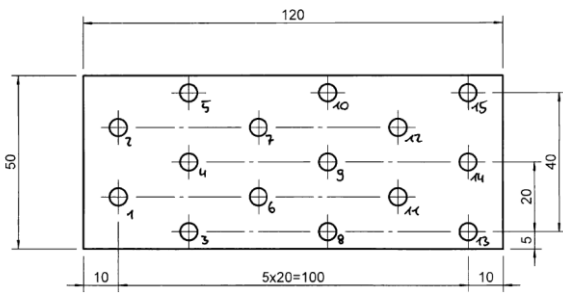
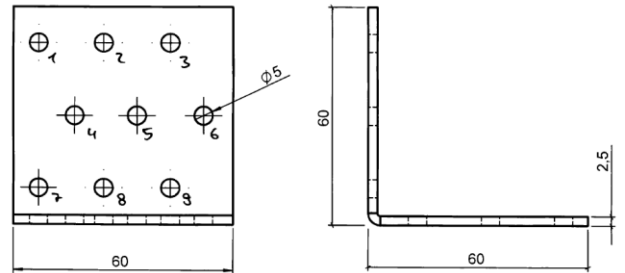
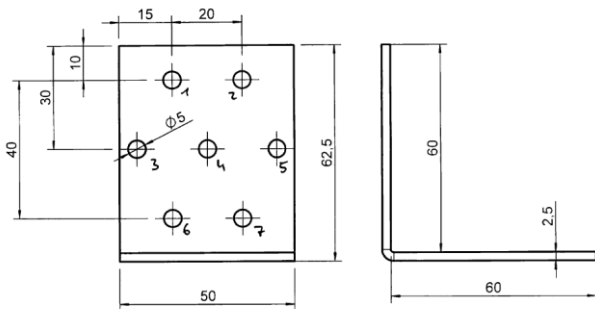
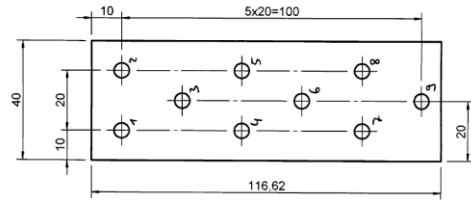
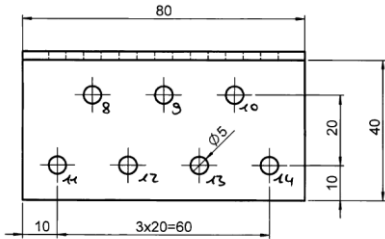


Figure B. 7 Dimensions of Angle Bracket 631 650 25

Figure B. 8 Dimensions of Angle Bracket 631 660 25

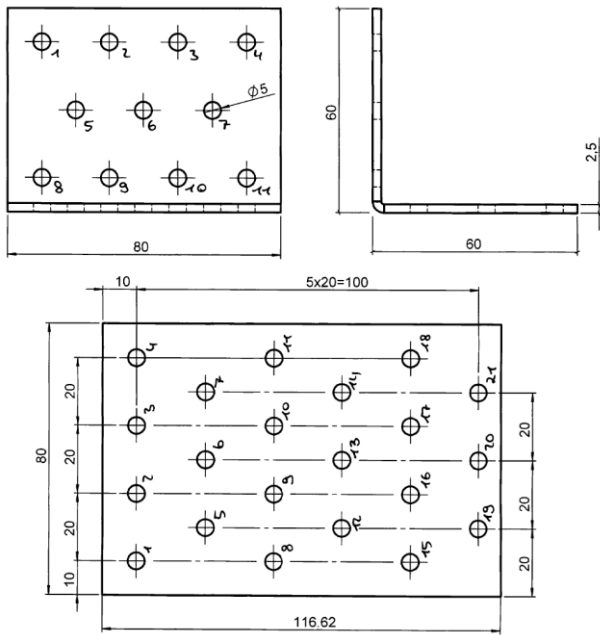


Figure B. 9 Dimensions of Angle Bracket 631 680 25

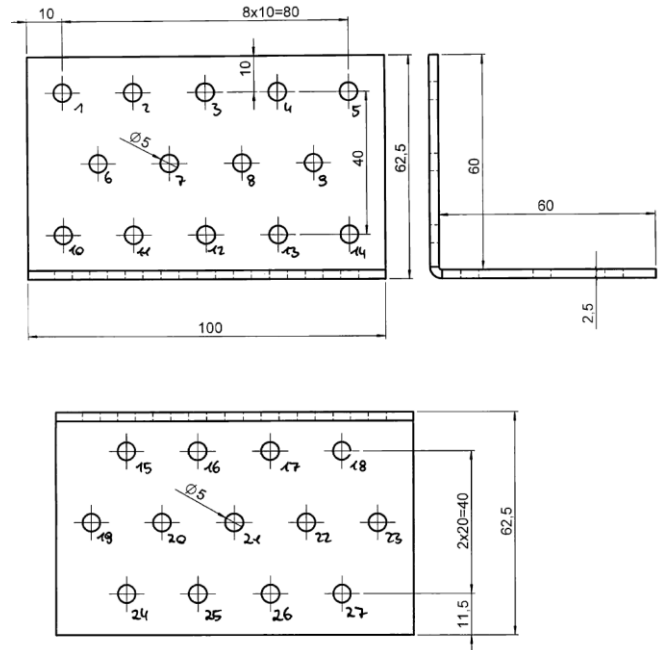


Figure B. 10 Dimensions of Angle Bracket 631 610 25

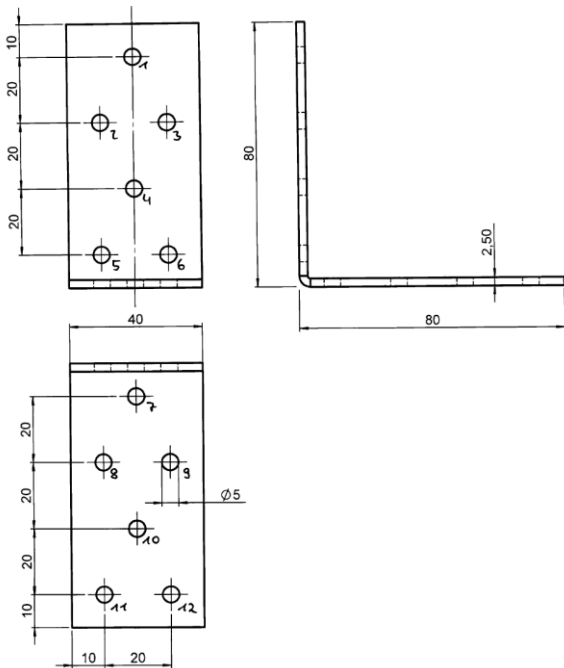


Figure B. 11 Dimensions of Angle Bracket 631 480 25

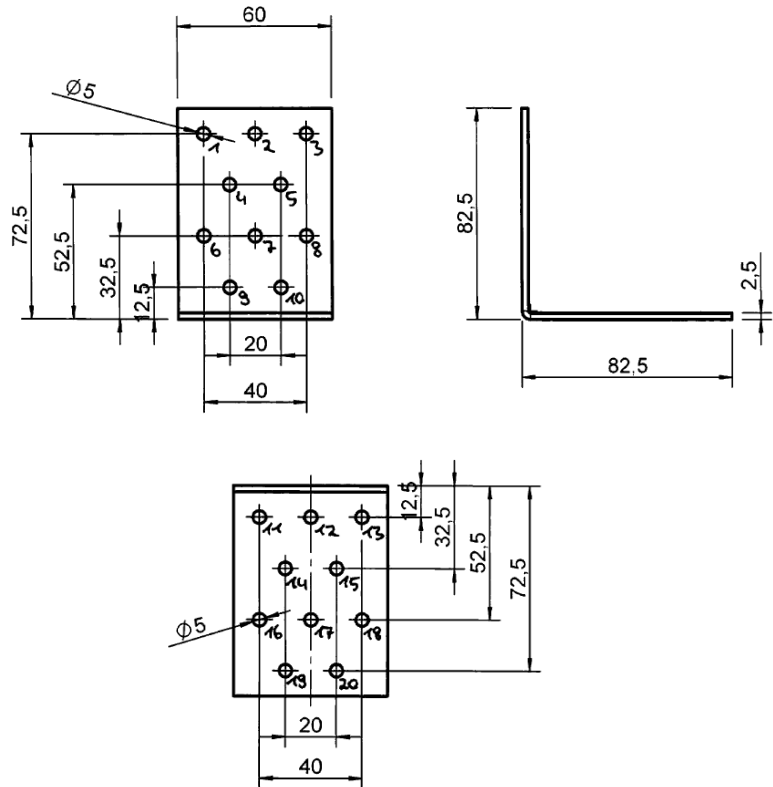


Figure B. 12 Dimensions of Angle Bracket 631 860 25

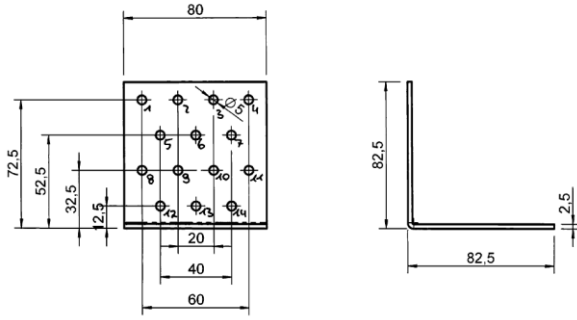


Figure B. 13 Dimensions of Angle Bracket 631 880 25

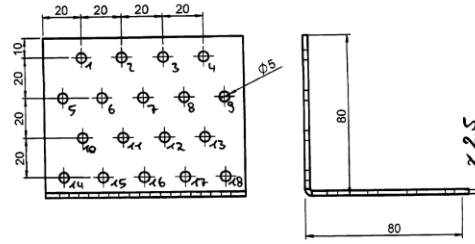


Figure B. 14 Dimensions of Angle Bracket 631 810 25

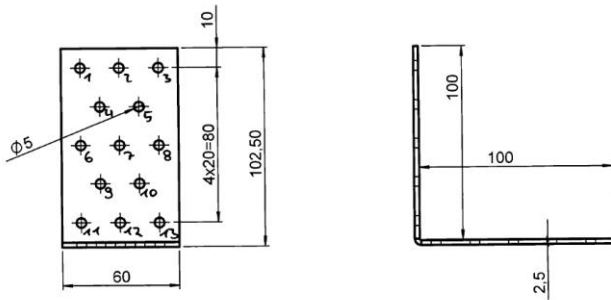
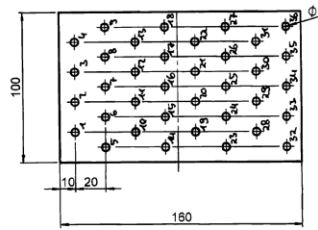
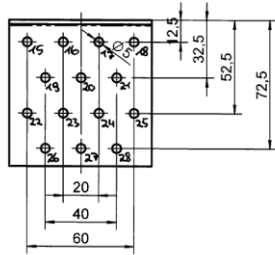


Figure B. 15 Dimensions of Angle Bracket 631 160 25

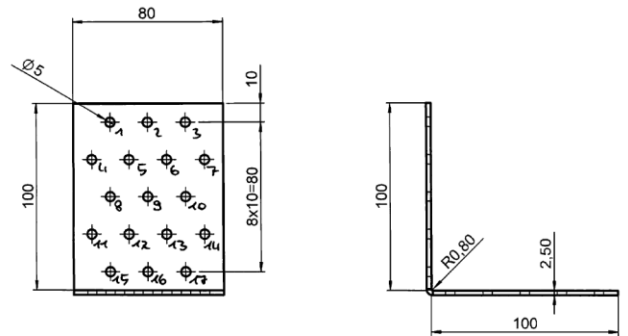
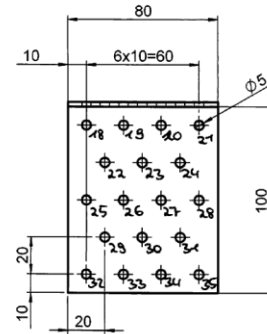
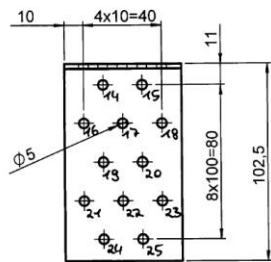


Figure B. 16 Dimensions of Angle Bracket 631 180 25



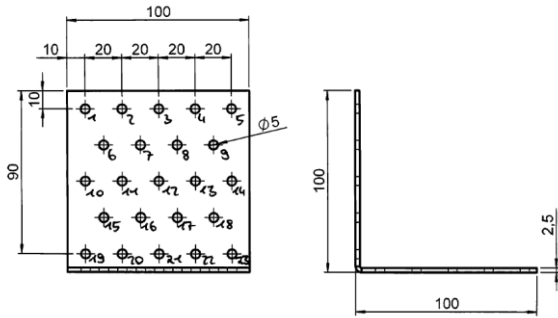


Figure B. 17 Dimensions of Angle Bracket 631 110 25

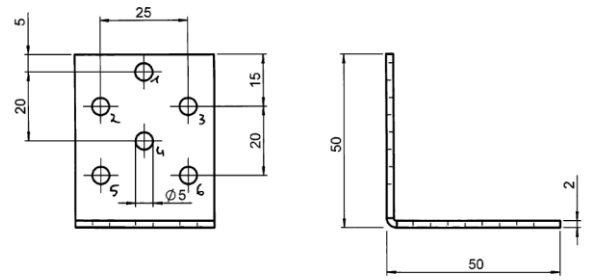


Figure B. 18 Dimensions of Angle Bracket 631 554 20

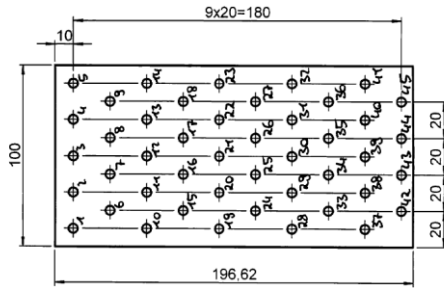


Figure B. 19 Dimensions of Angle Bracket 634 100 20

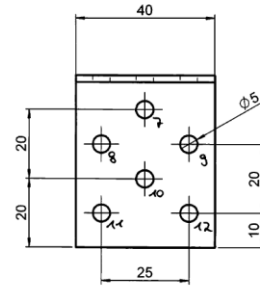
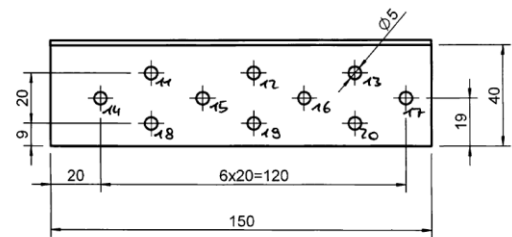
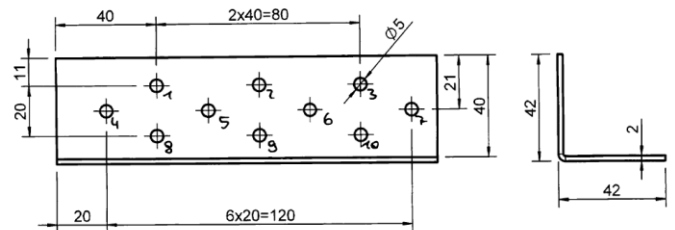
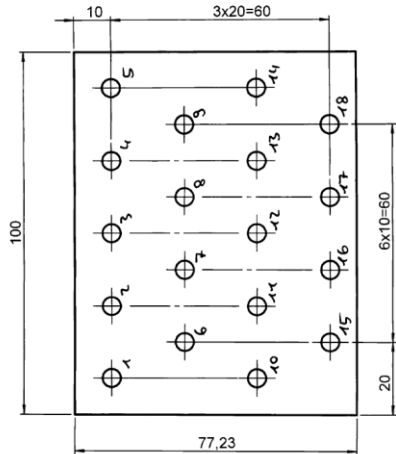
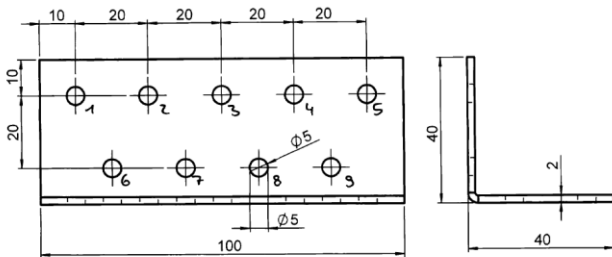


Figure B. 20 Dimensions of Angle Bracket 634 150 20



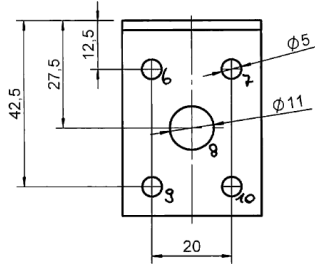
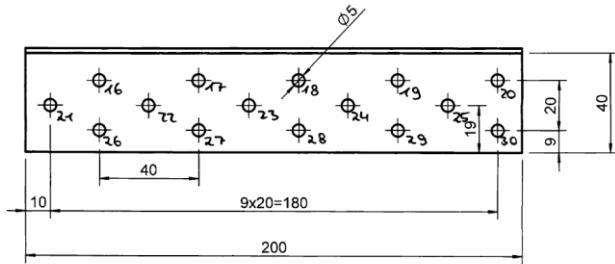
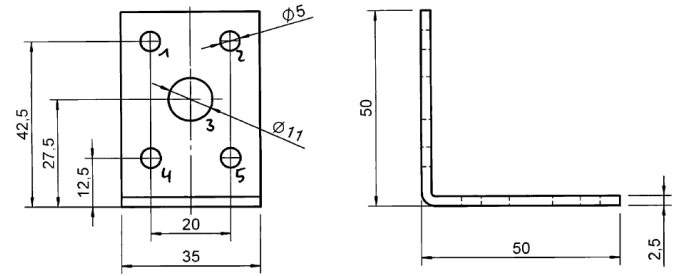
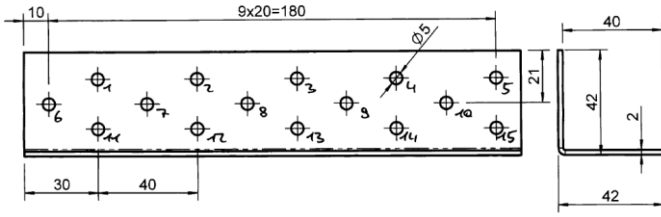


Figure B. 21 Dimensions of Angle Bracket 631 200 20

Figure B. 22 Dimensions of Angle Bracket 641 035 25

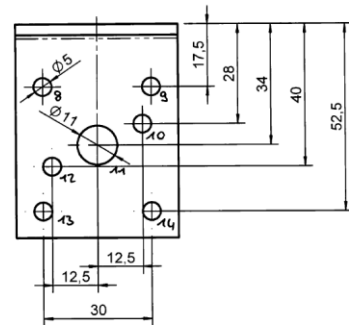
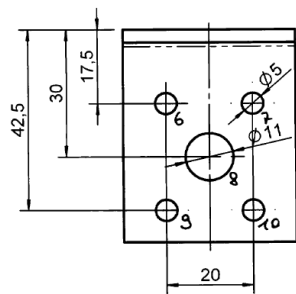
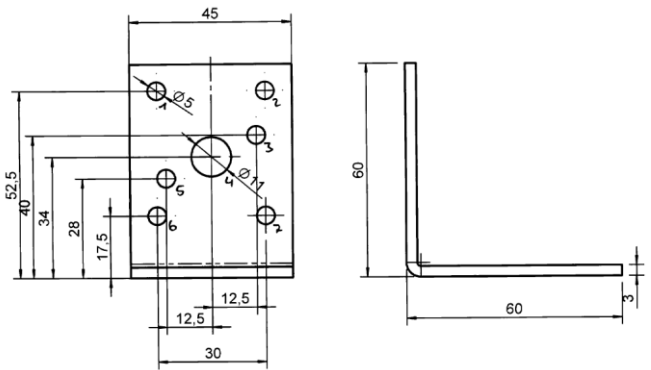
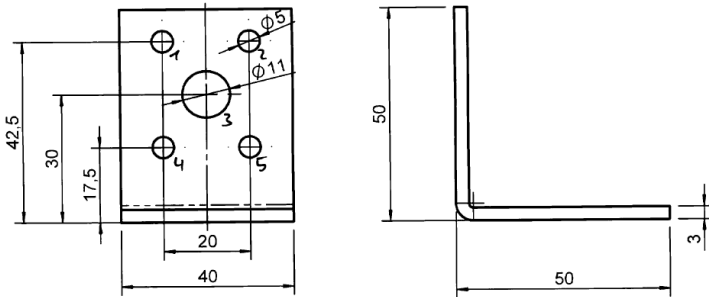


Figure B. 23 Dimensions of Angle Bracket 641 040 30

Figure B. 24 Dimensions of Angle Bracket 641 664 30

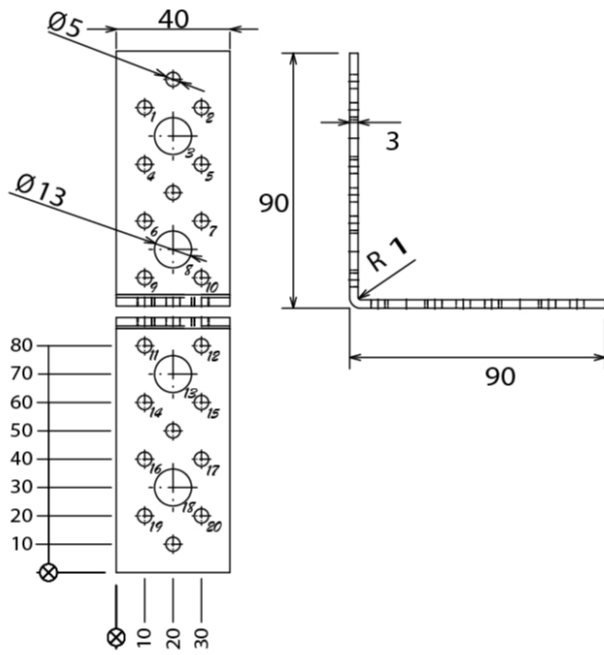


Figure B. 25 Dimensions of Angle Bracket 641 994 30

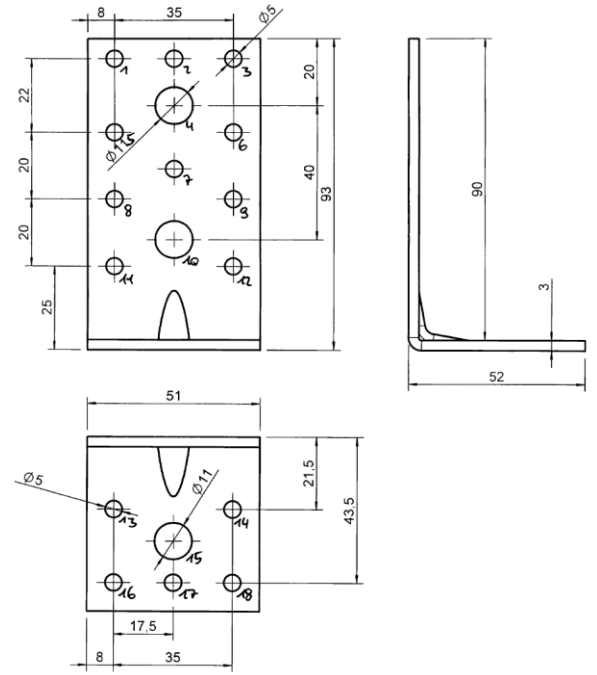


Figure B. 26 Dimensions of Angle Bracket 641 595 30

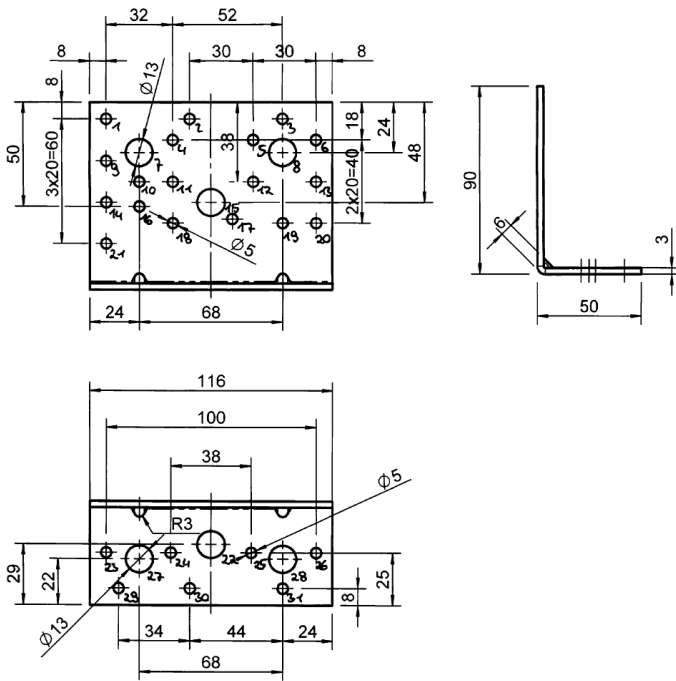


Figure B. 27 Dimensions of Angle Bracket 500 313 62

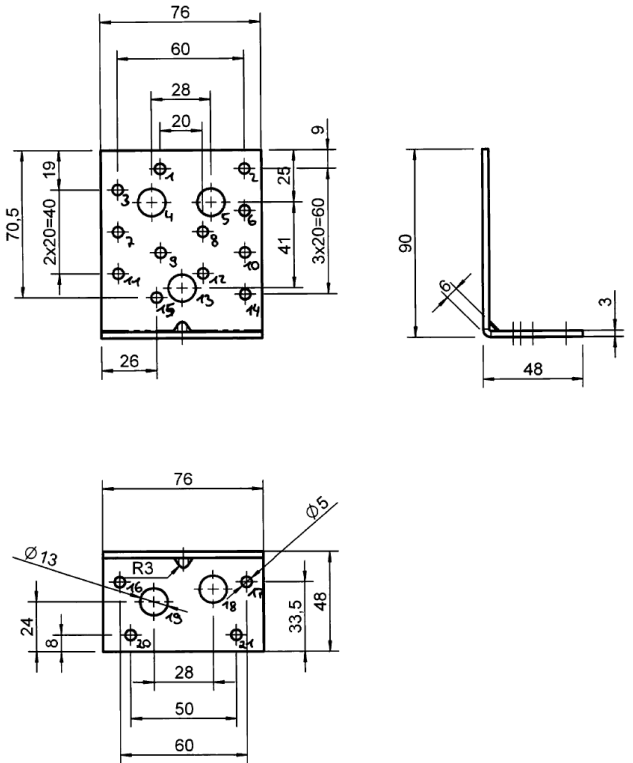


Figure B. 28 Dimensions of Angle Bracket 641 598 30

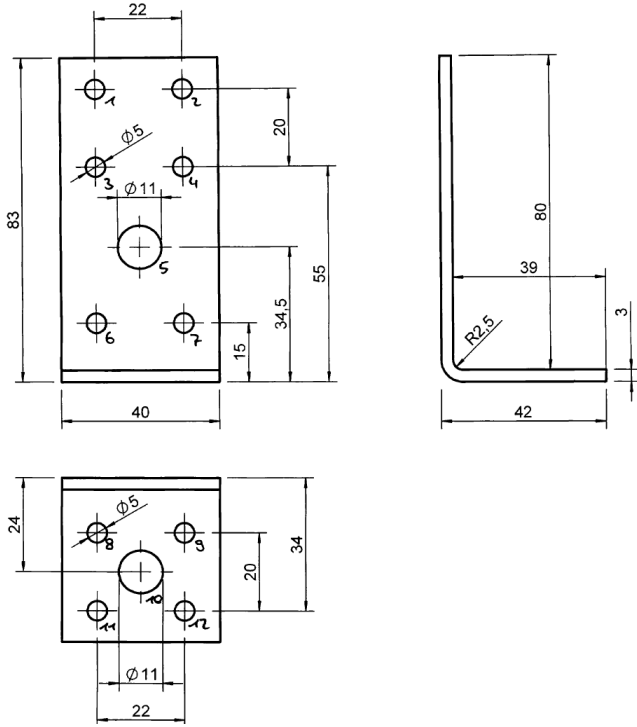


Figure B. 33 Dimensions of Angle Bracket 641 490 30

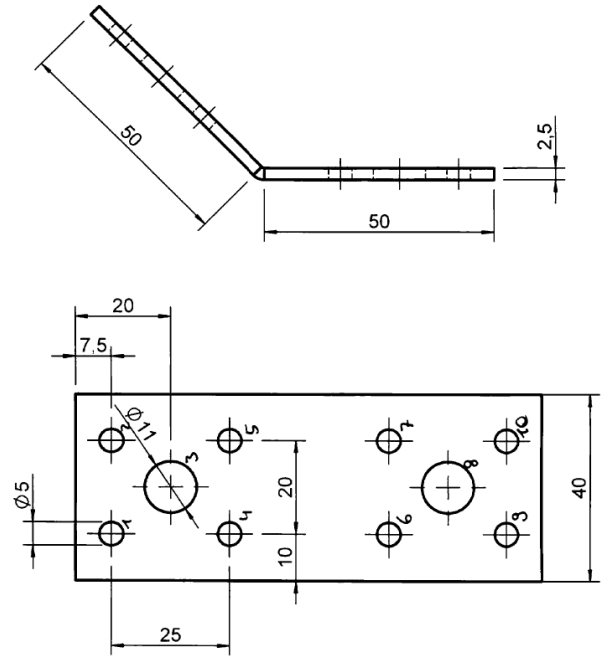


Figure B. 34 Dimensions of Angle Bracket 651 554 25

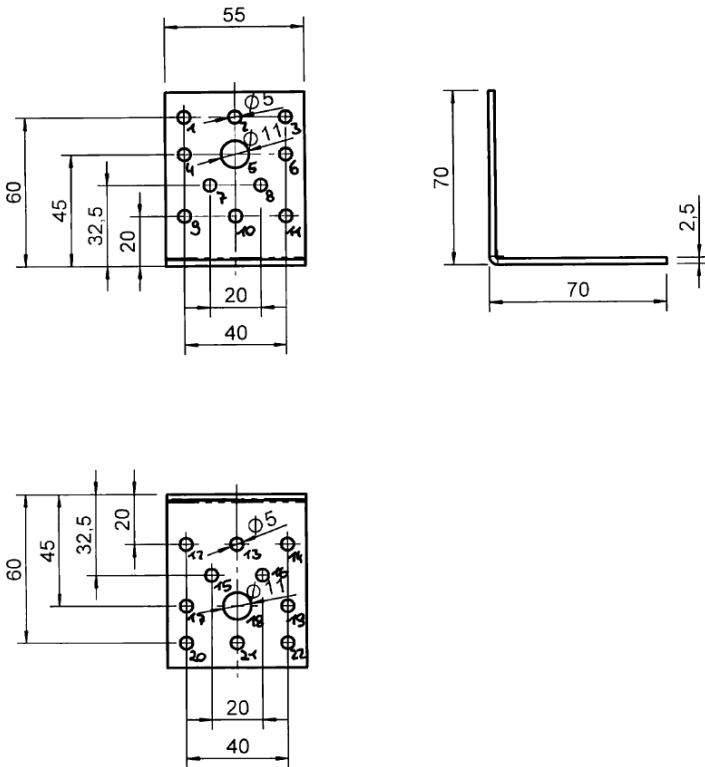


Figure B. 35 Dimensions of Angle Bracket 651 070 25

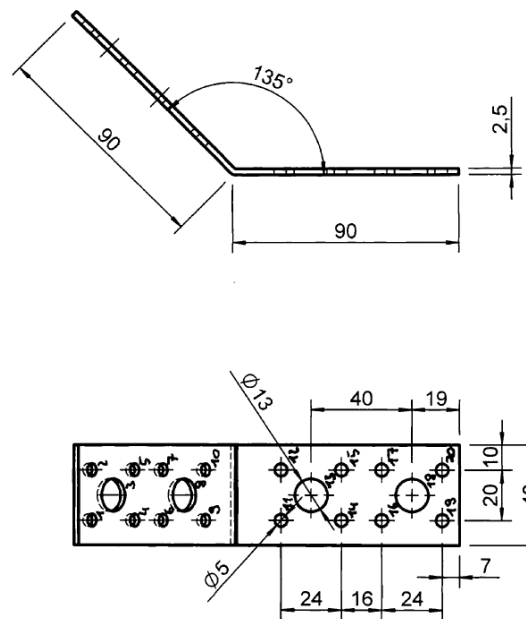


Figure B. 36 Dimensions of Angle Bracket 651 994 25

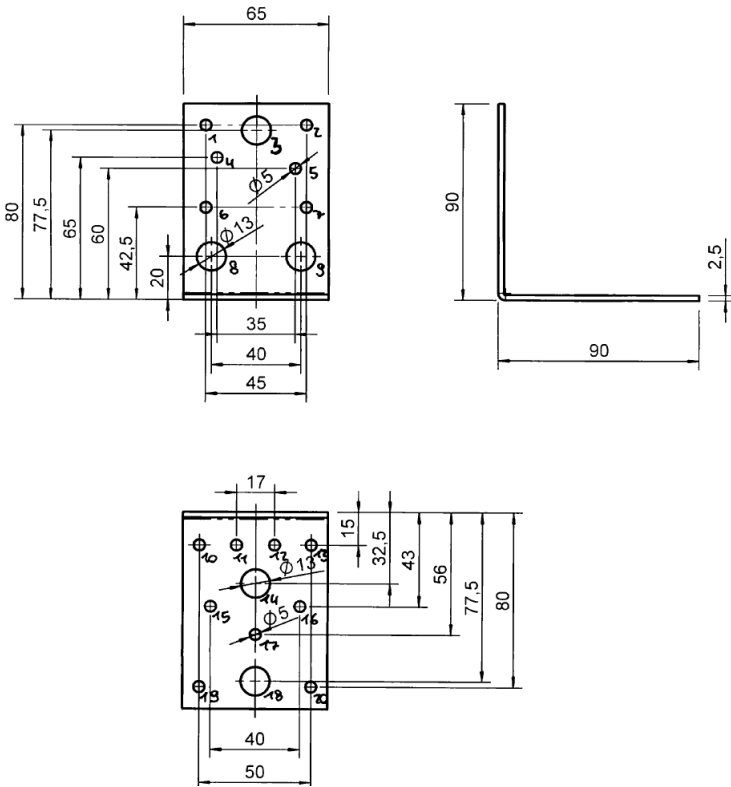


Figure B. 37 Dimensions of Angle Bracket 651 090 25

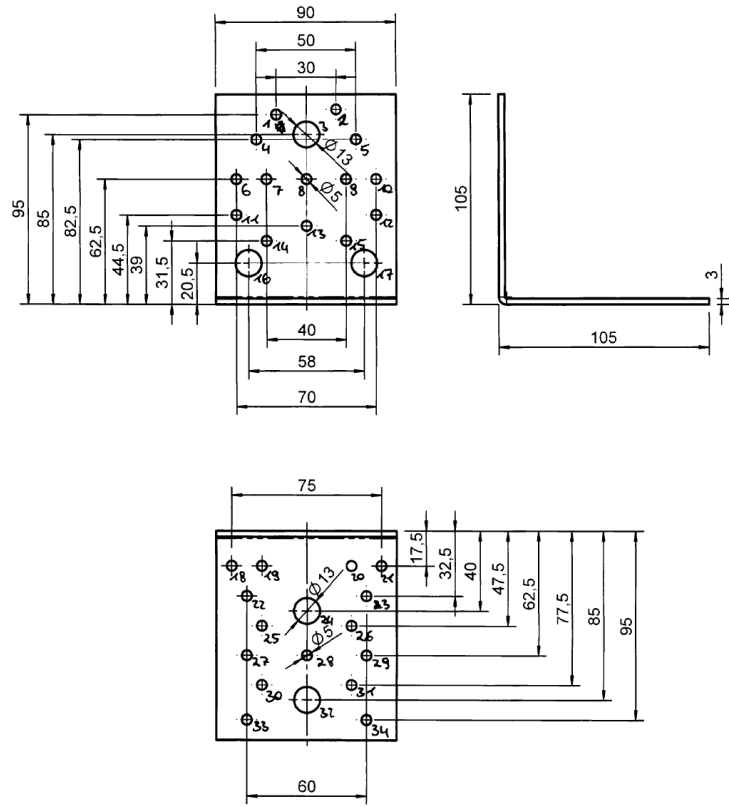


Figure B. 38 Dimensions of Angle Bracket 651 105 30

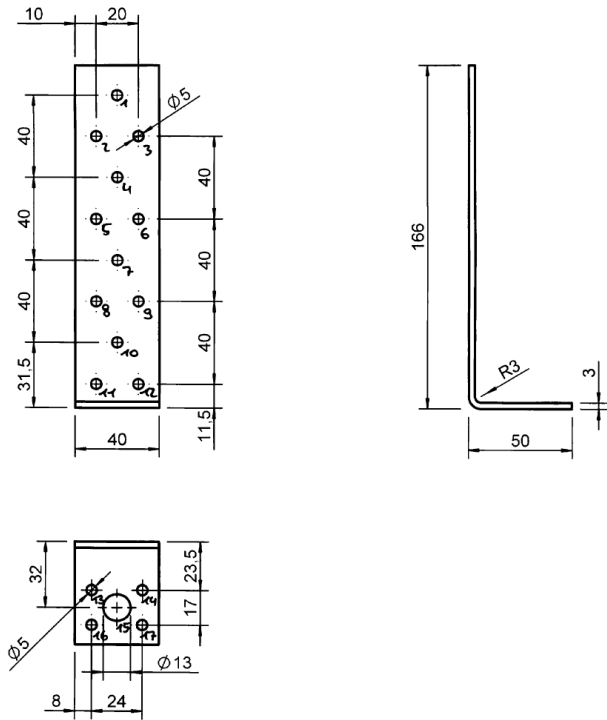


Figure B. 39 Dimensions of Angle Bracket 641 416 40

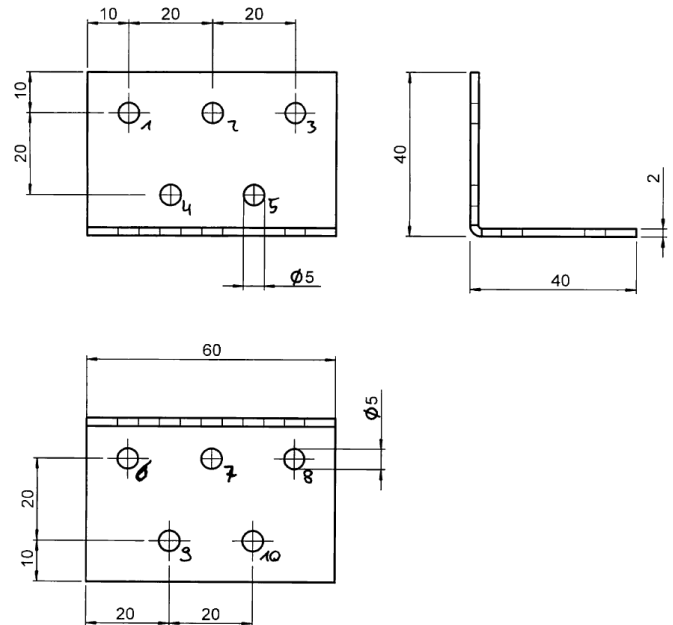


Figure B. 40 Dimensions of Angle Bracket 631 460 20

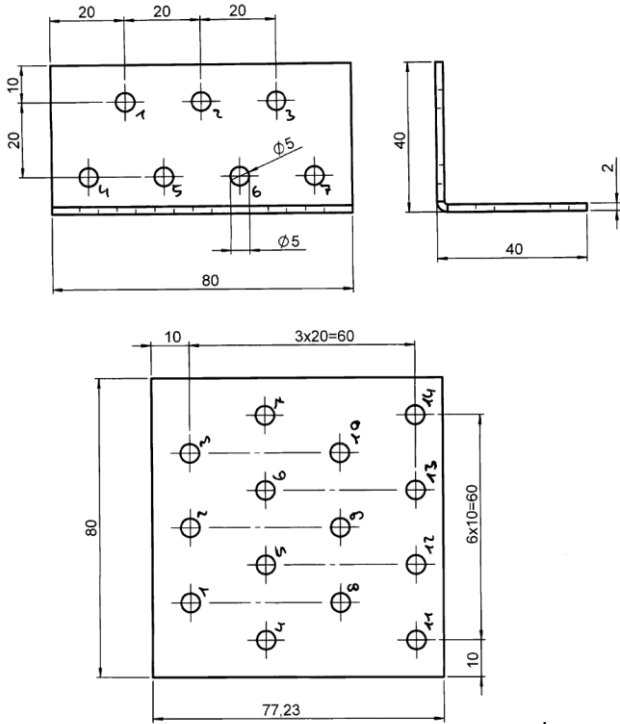


Figure B. 41 Dimensions of Angle Bracket 631 480 20

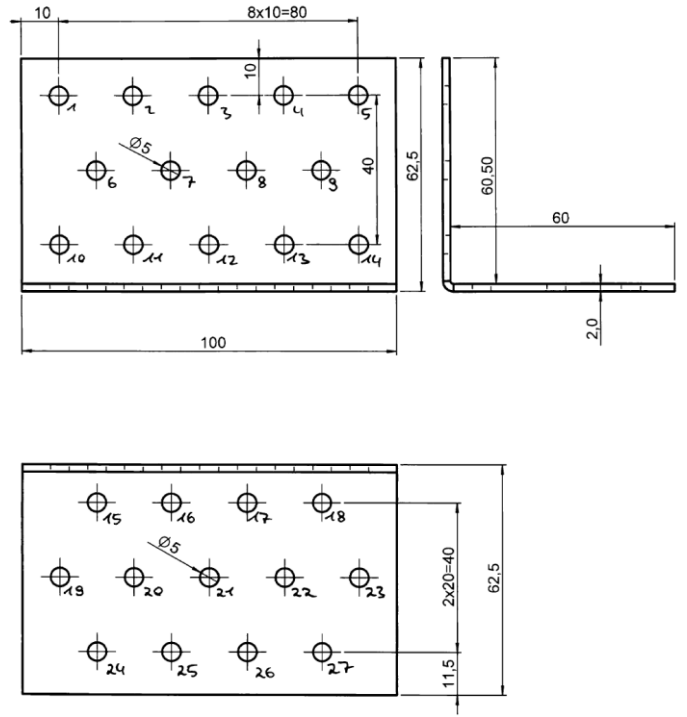


Figure B. 42 Dimensions of Angle Bracket 631 610 20

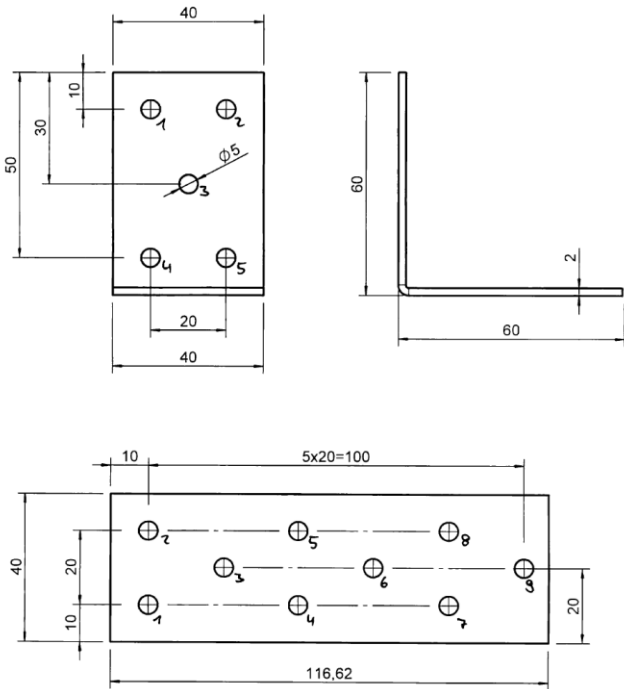


Figure B. 43 Dimensions of Angle Bracket 631 640 20

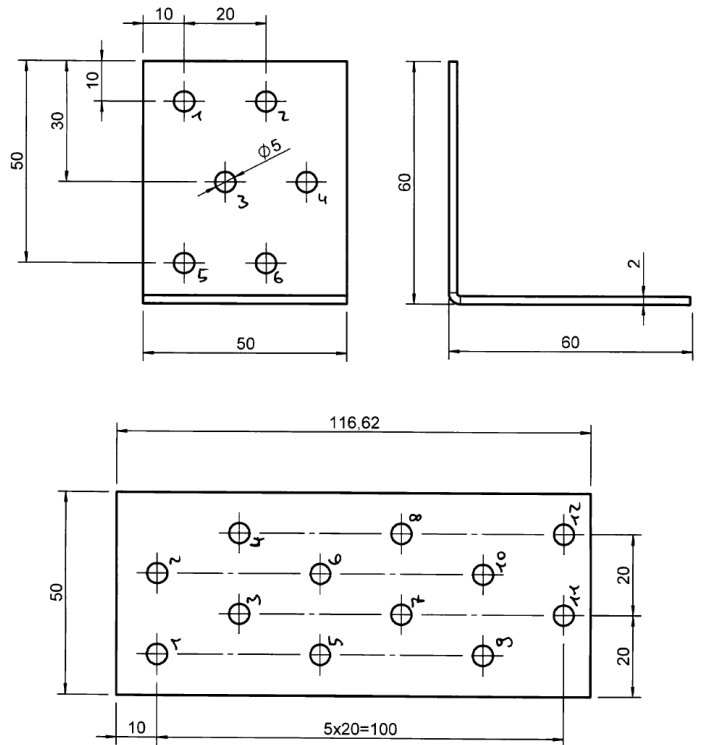


Figure B. 44 Dimensions of Angle Bracket 631 650 20

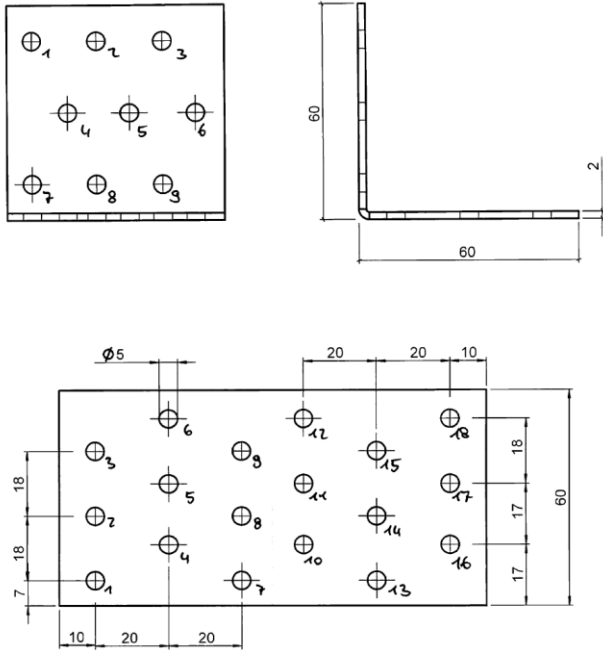


Figure B. 45 Dimensions of Angle Bracket 631 660 20

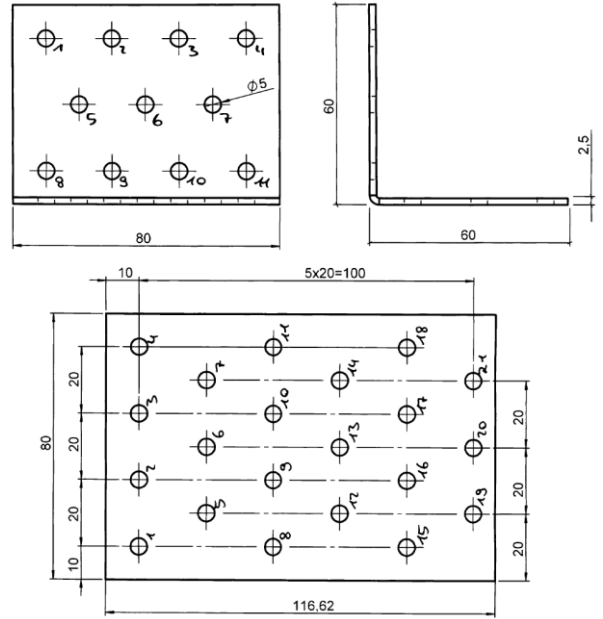


Figure B. 46 Dimensions of Angle Bracket 631 680 20

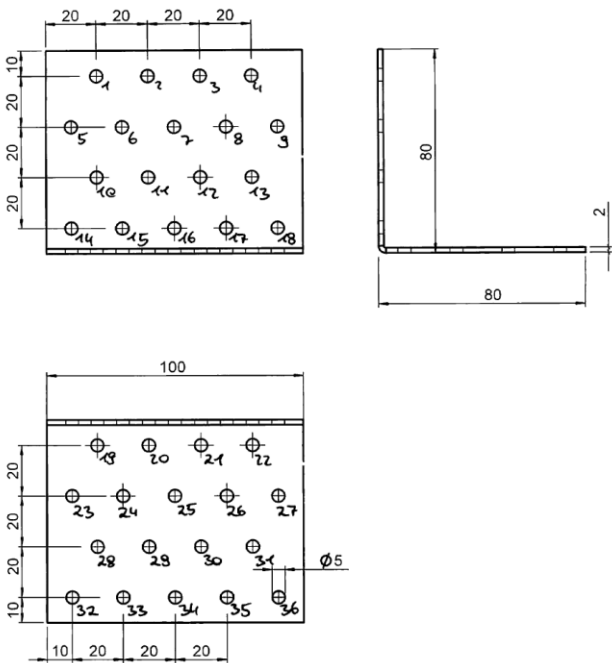


Figure B. 47 Dimensions of Angle Bracket 631 810 20

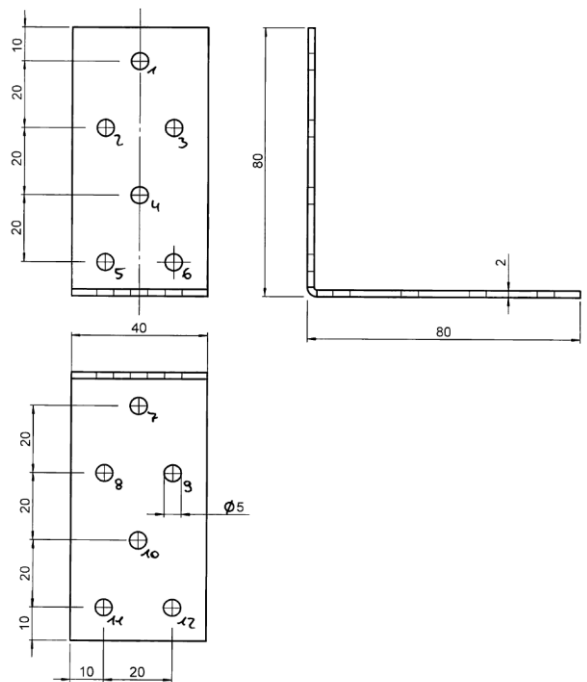


Figure B. 48 Dimensions of Angle Bracket 631 480 20

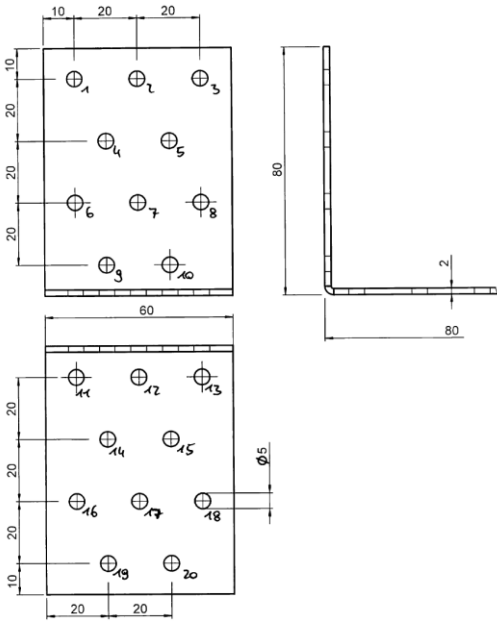


Figure B. 49 Dimensions of Angle Bracket 631 860 20

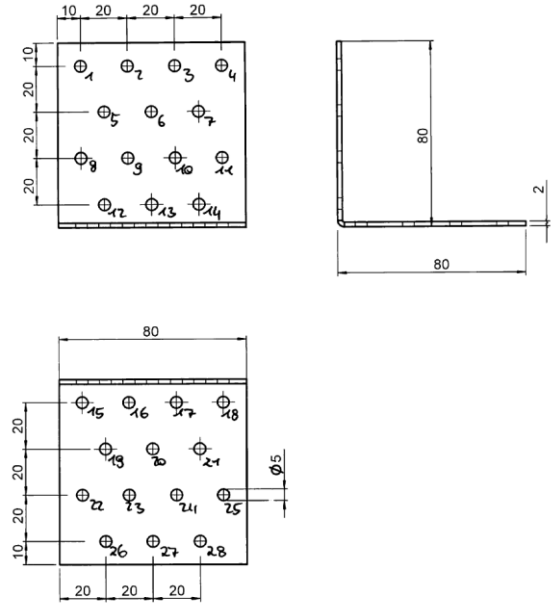


Figure B. 50 Dimensions of Angle Bracket 631 880 20

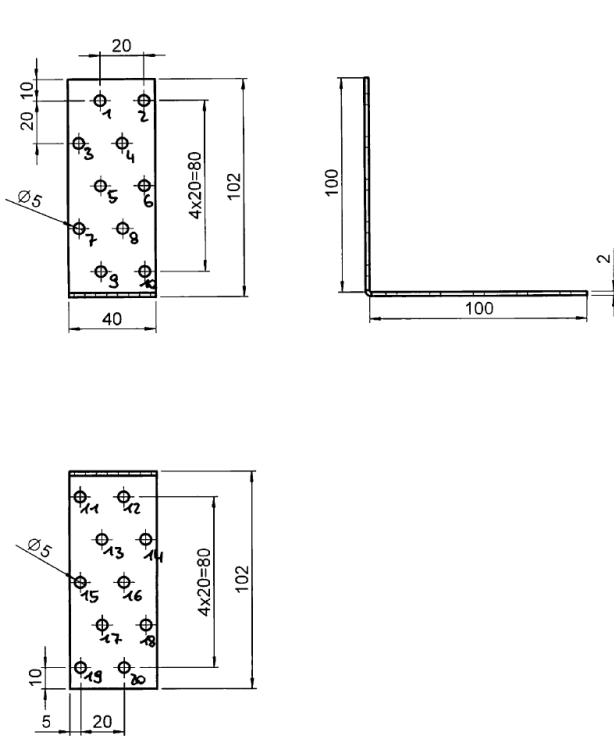


Figure B. 51 Dimensions of Angle Bracket 631 140 20

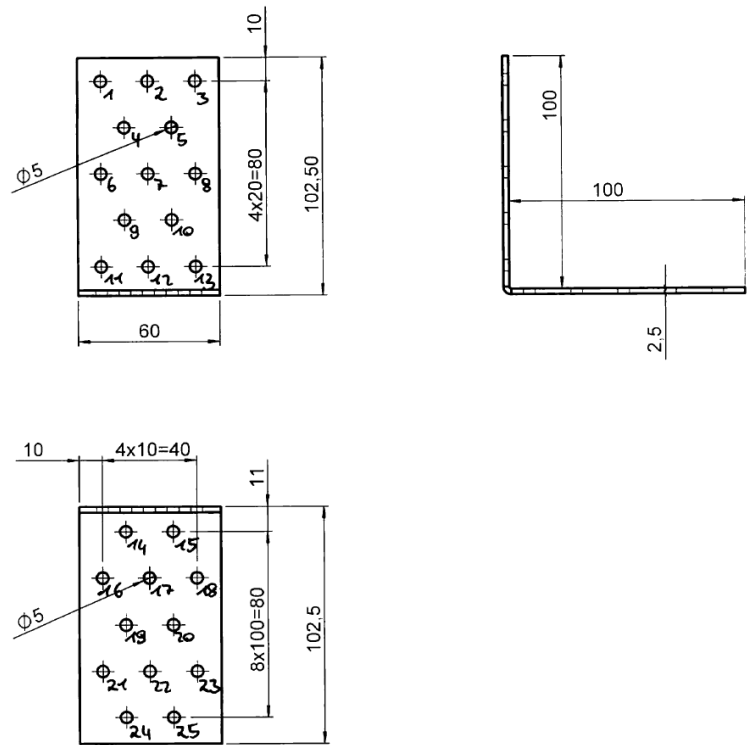


Figure B. 52 Dimensions of Angle Bracket 631 160 20

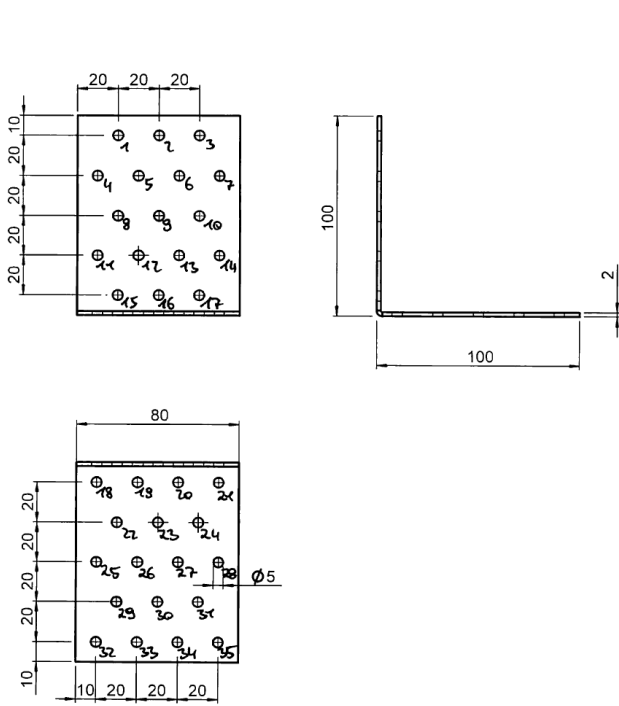


Figure B. 53 Dimensions of Angle Bracket 631 180 20

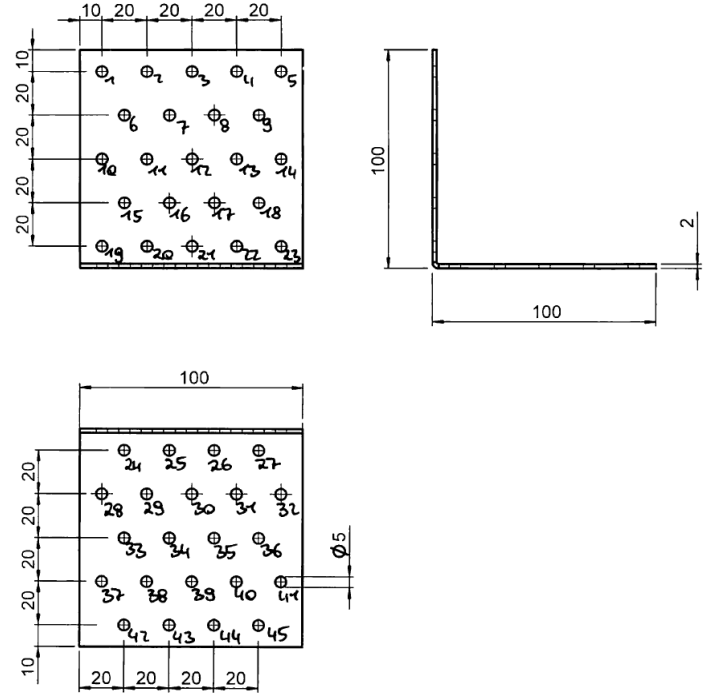


Figure B. 54 Dimensions of Angle Bracket 631 110 20

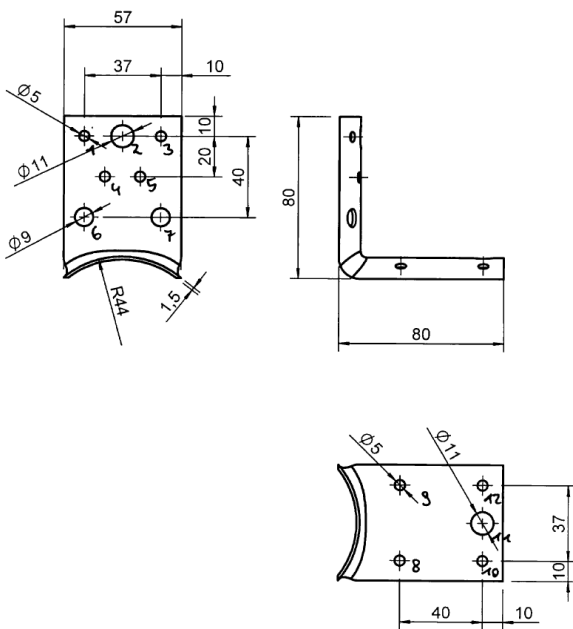


Figure B. 55 Dimensions of Angle Bracket RHV 60

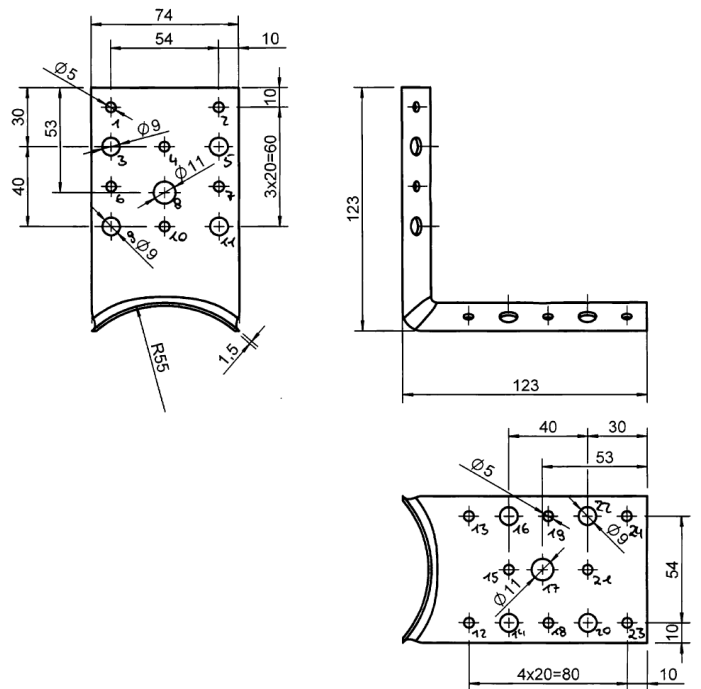


Figure B. 56 Dimensions of Angle Bracket RHV 80

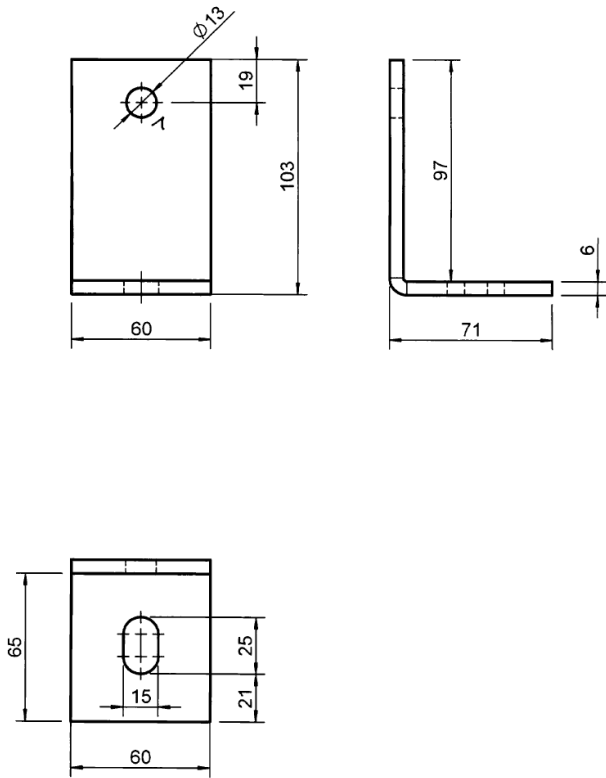


Figure B. 57 Dimensions of Angle Bracket 633 710 66

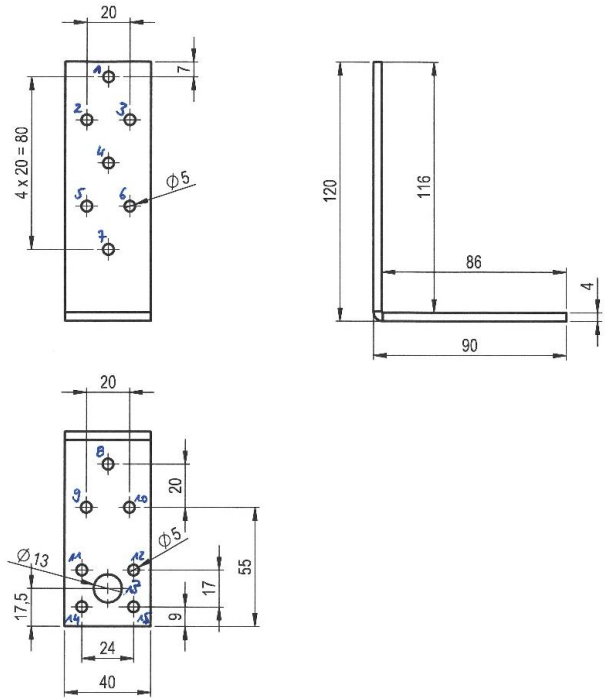


Figure B. 58 Dimensions of Angle Bracket 618 129 40

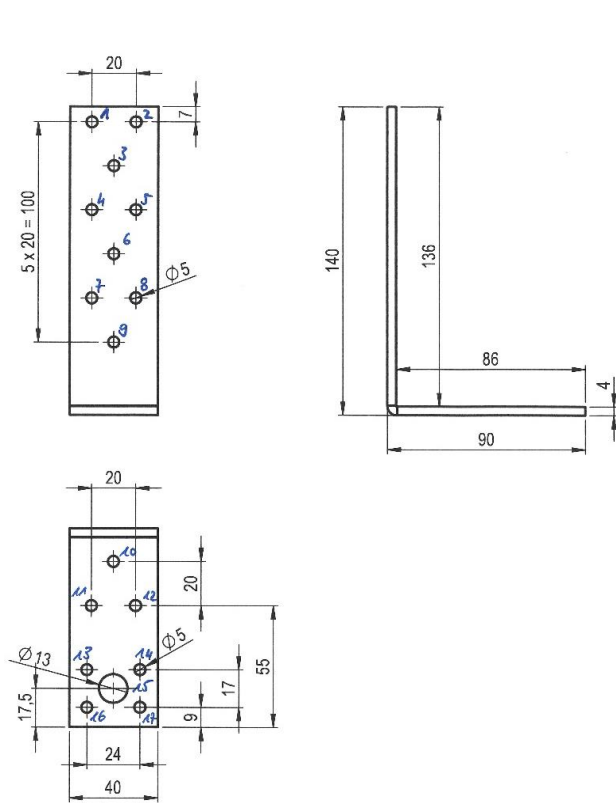


Figure B. 59 Dimensions of Angle Bracket 618 149 40

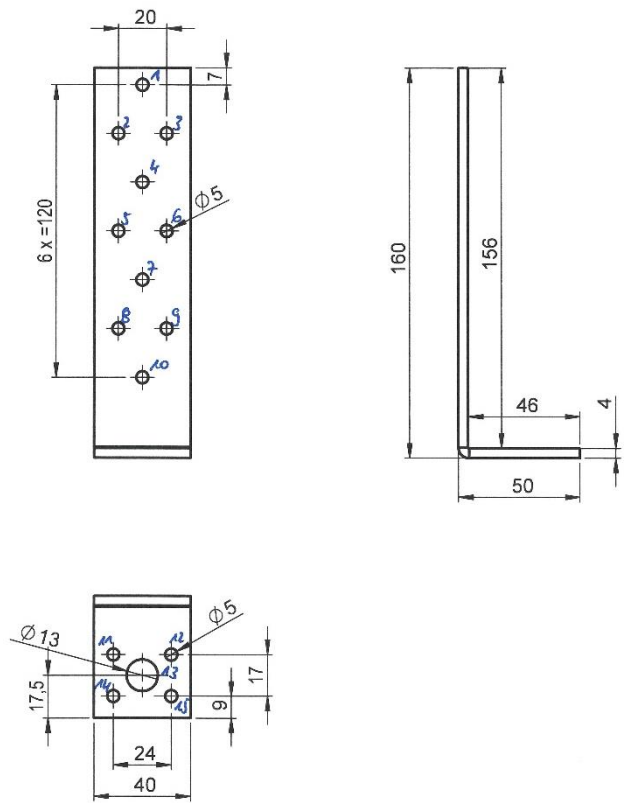


Figure B. 60 Dimensions of Angle Bracket 618 165 40

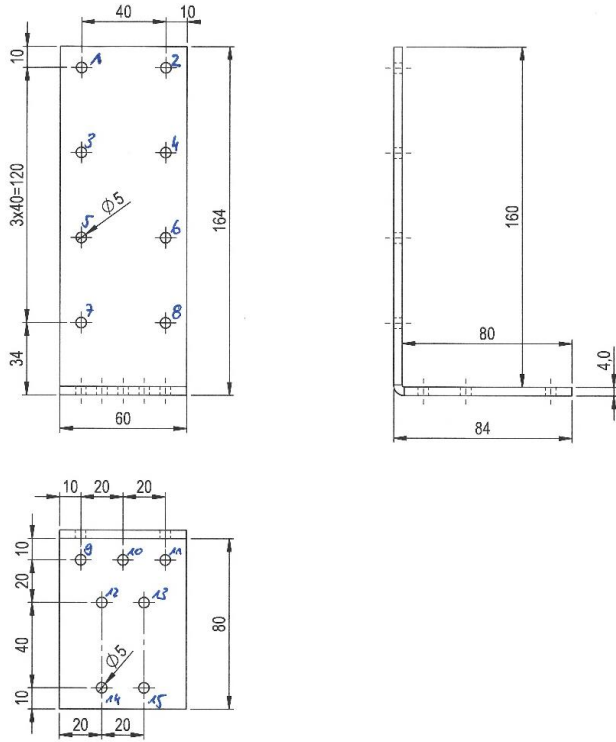


Figure B. 61 Dimensions of Angle Bracket 618 166 40

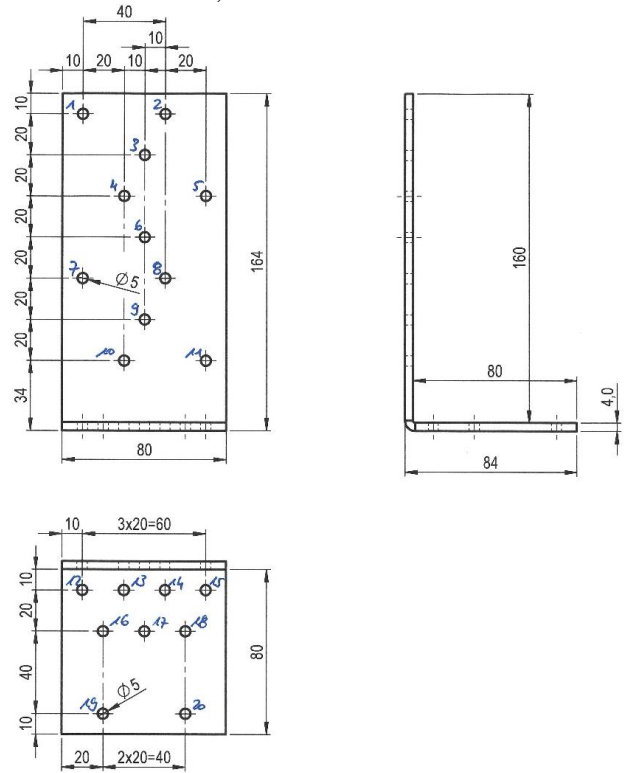


Figure B. 62 Dimensions of Angle Bracket 618 168 40

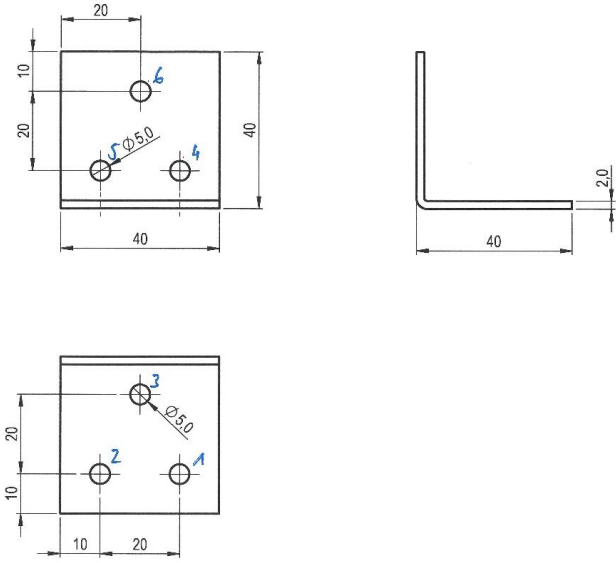


Figure B. 63 Dimensions of Angle Bracket 631 444 20

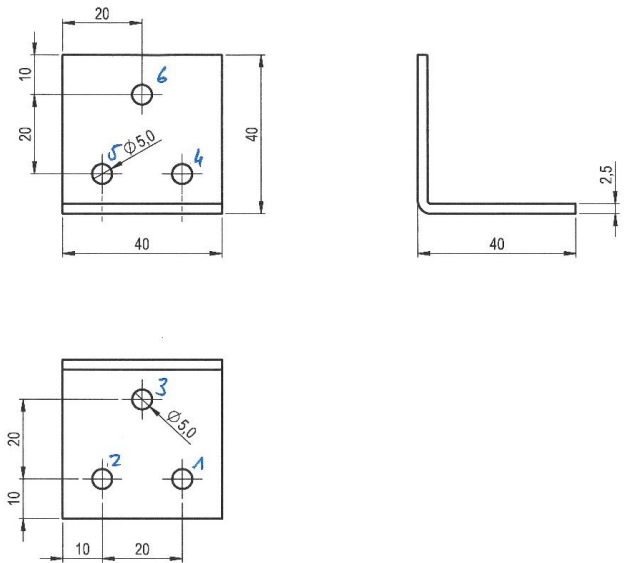


Figure B. 64 Dimensions of Angle Bracket 631 444 25

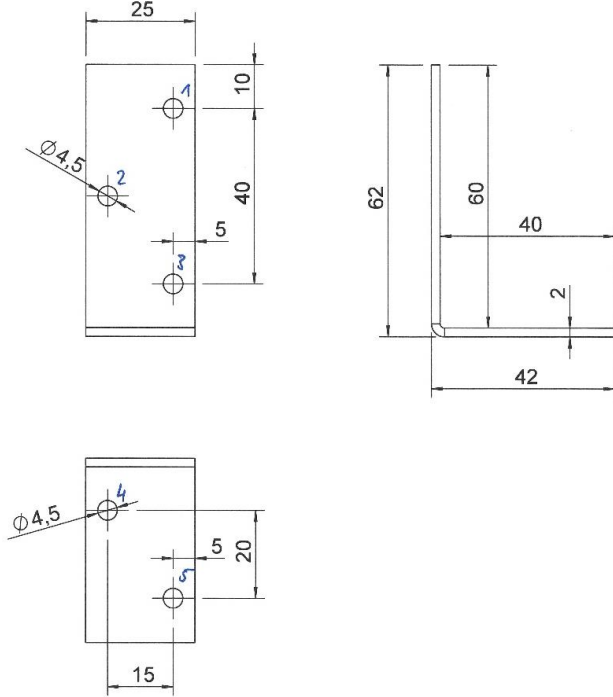


Figure B. 65 Dimensions of Angle Bracket 631 642 20

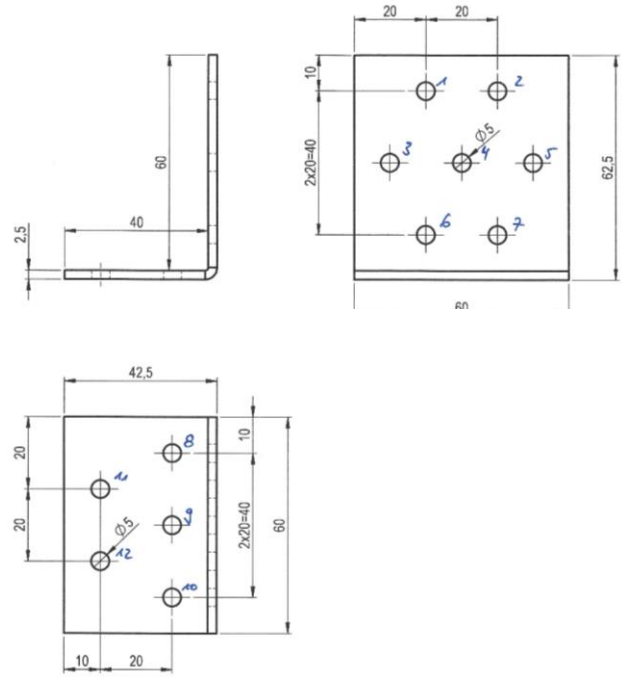


Figure B. 66 Dimensions of Angle Bracket 631 646 25

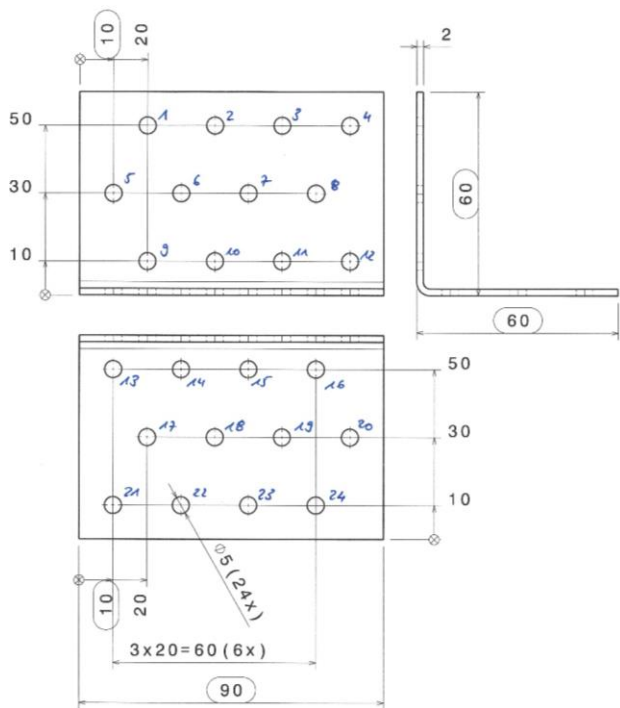


Figure B. 67 Dimensions of Angle Bracket 631 669 20

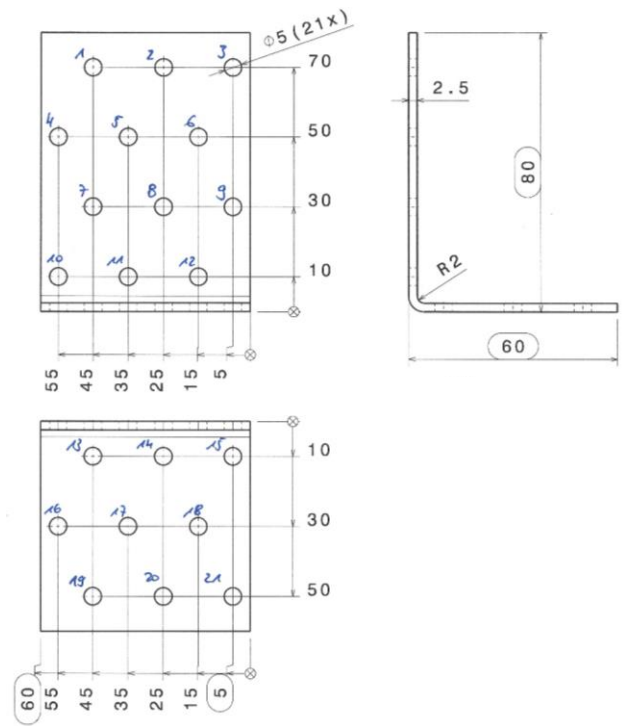


Figure B. 68 Dimensions of Angle Bracket 631 686 25

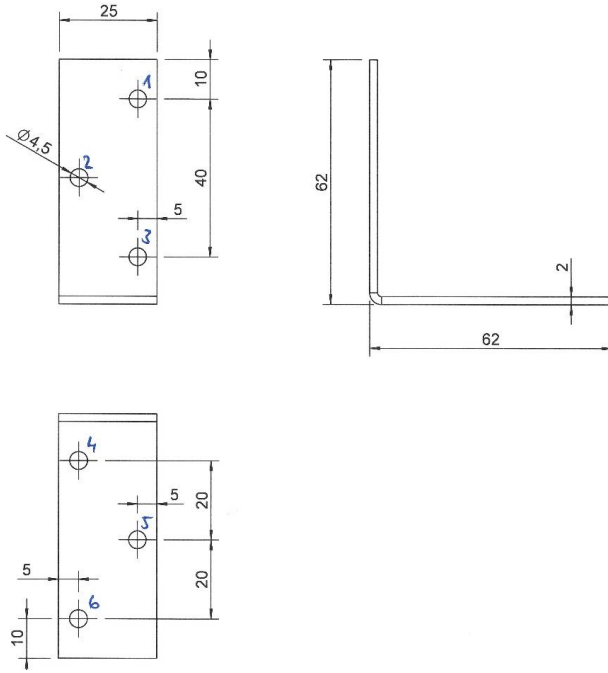


Figure B. 69 Dimensions of Angle Bracket 632 060 20

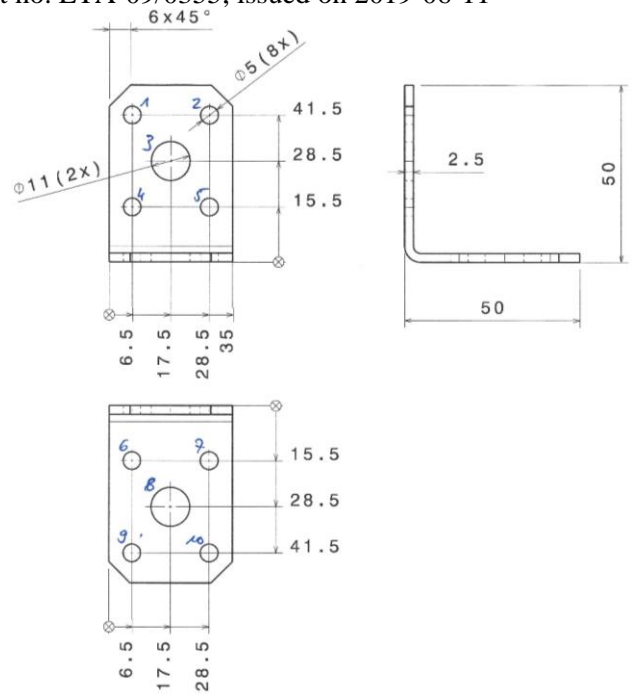


Figure B. 70 Dimensions of Angle Bracket 641 035 25

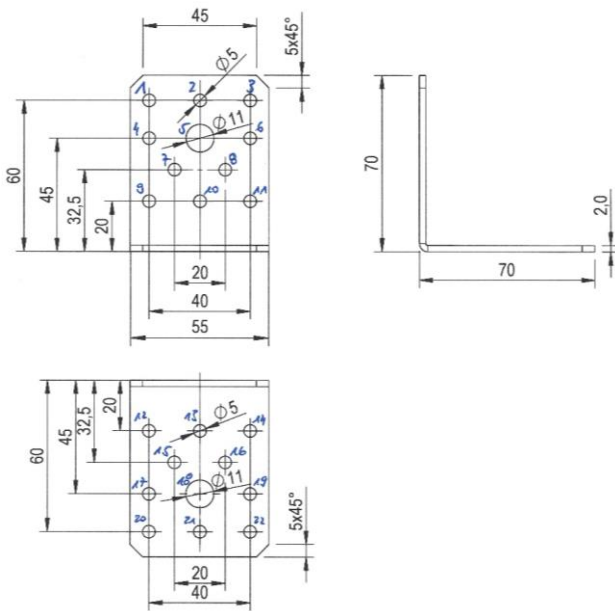


Figure B. 71 Dimensions of Angle Bracket 641 070 20

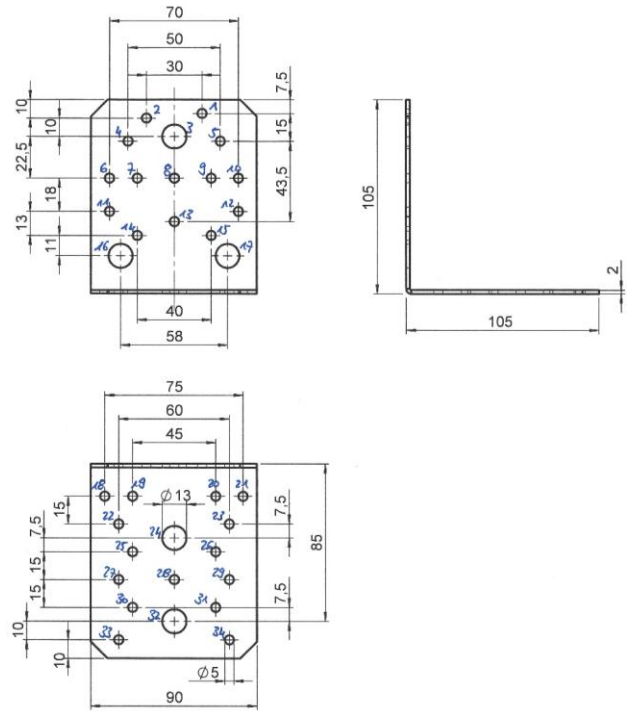


Figure B. 72 Dimensions of Angle Bracket 641 105 20

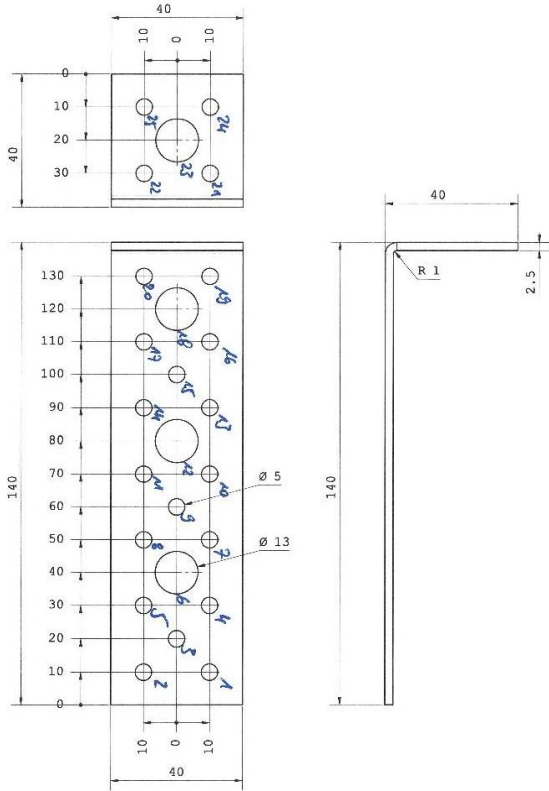


Figure B. 73 Dimensions of Angle Bracket 641 140 34

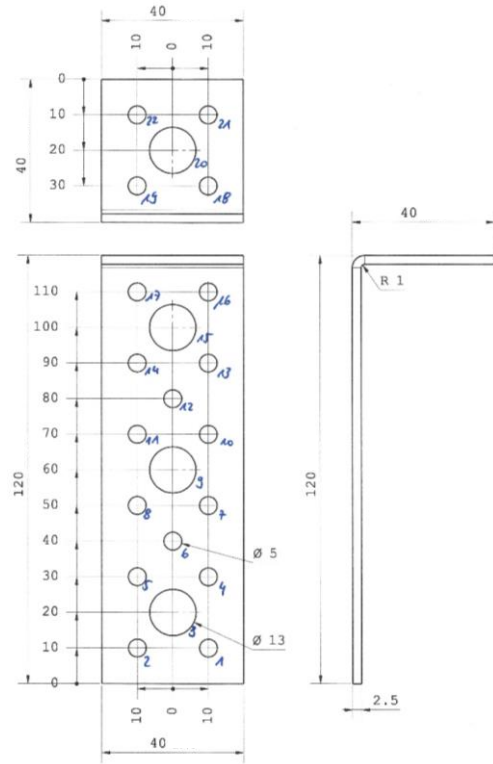


Figure B. 74 Dimensions of Angle Bracket 641 412 25

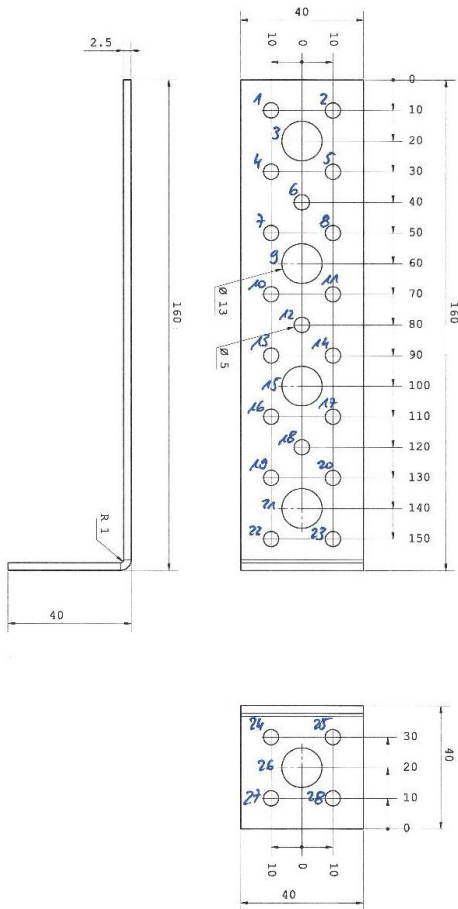


Figure B. 75 Dimensions of Angle Bracket 641 416 40

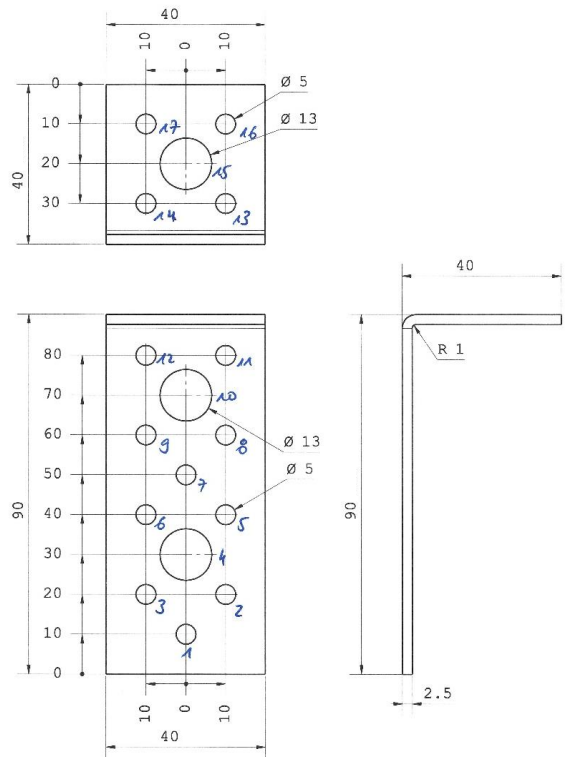


Figure B. 76 Dimensions of Angle Bracket 641 490 42

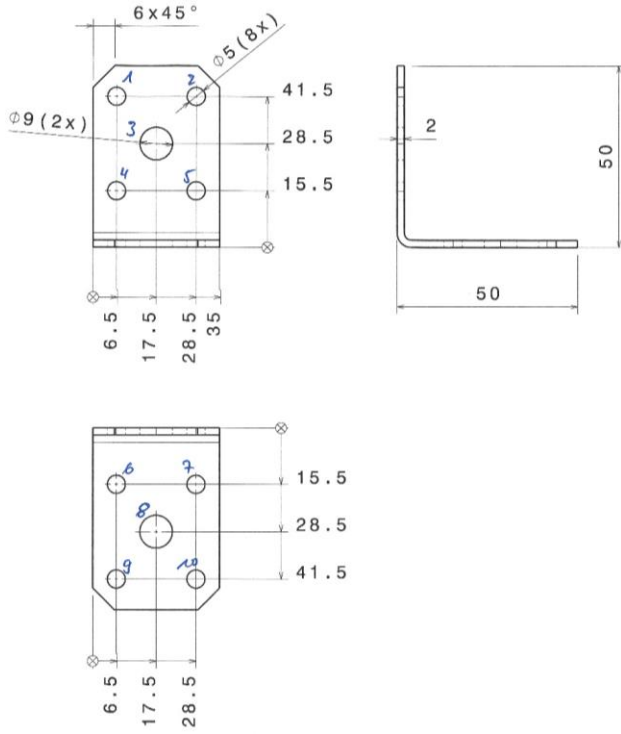


Figure B. 77 Dimensions of Angle Bracket 641 553 20

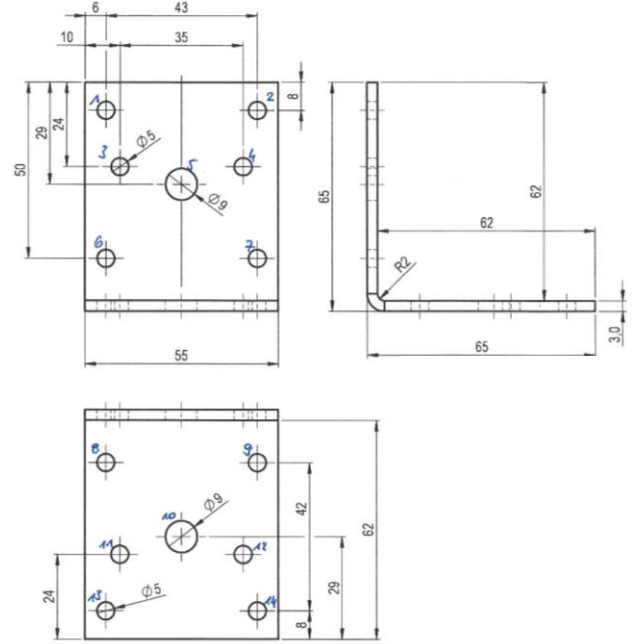


Figure B. 78 Dimensions of Angle Bracket 641 665 30

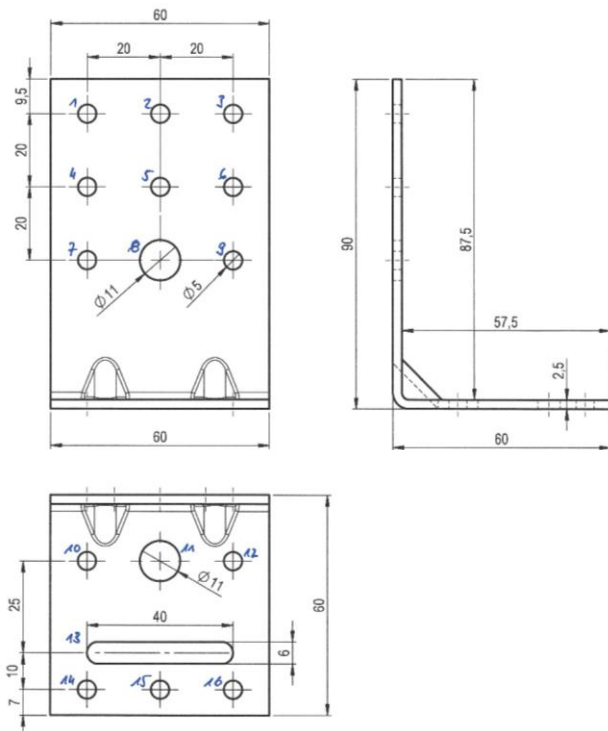


Figure B. 79 Dimensions of Angle Bracket 641 690 25

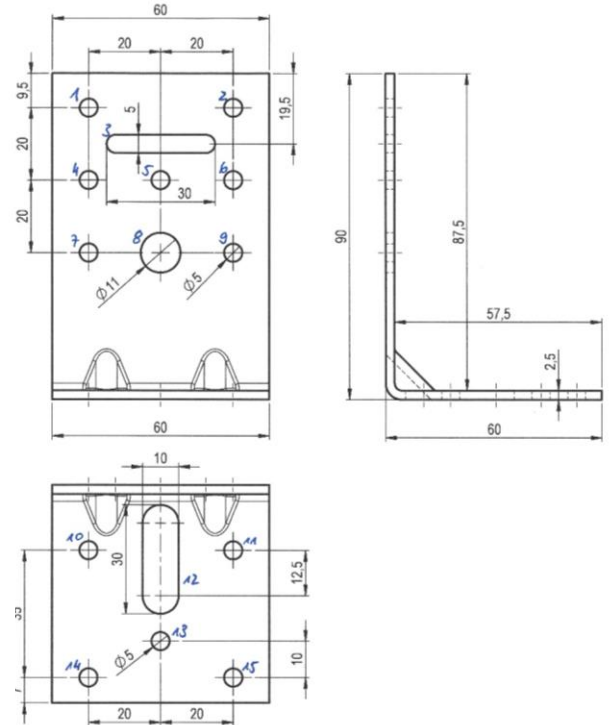


Figure B. 80 Dimensions of Angle Bracket 641 691 25

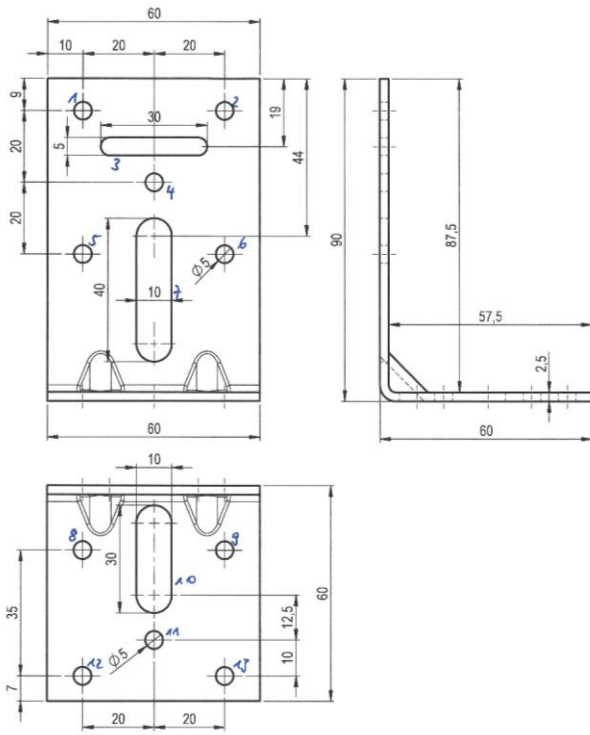


Figure B. 81 Dimensions of Angle Bracket 641 692 25

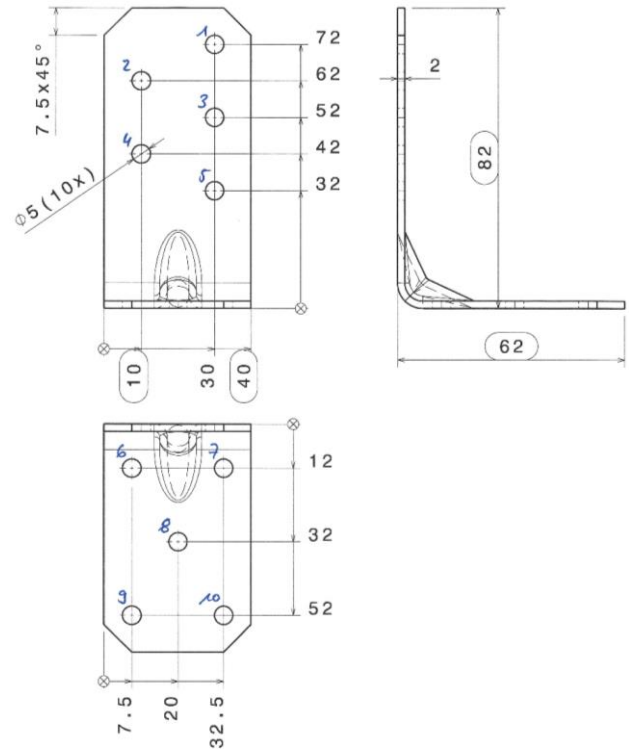


Figure B. 82 Dimensions of Angle Bracket 641 860 20

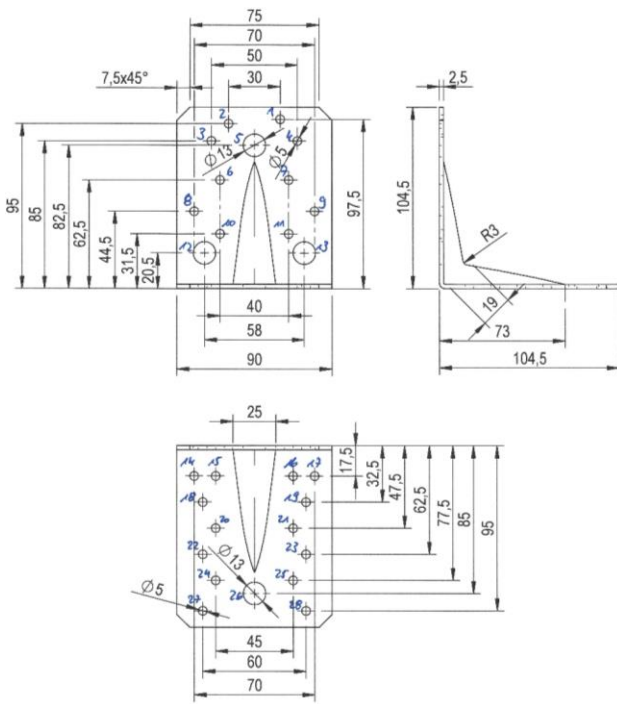


Figure B. 83 Dimensions of Angle Bracket 641 905 25

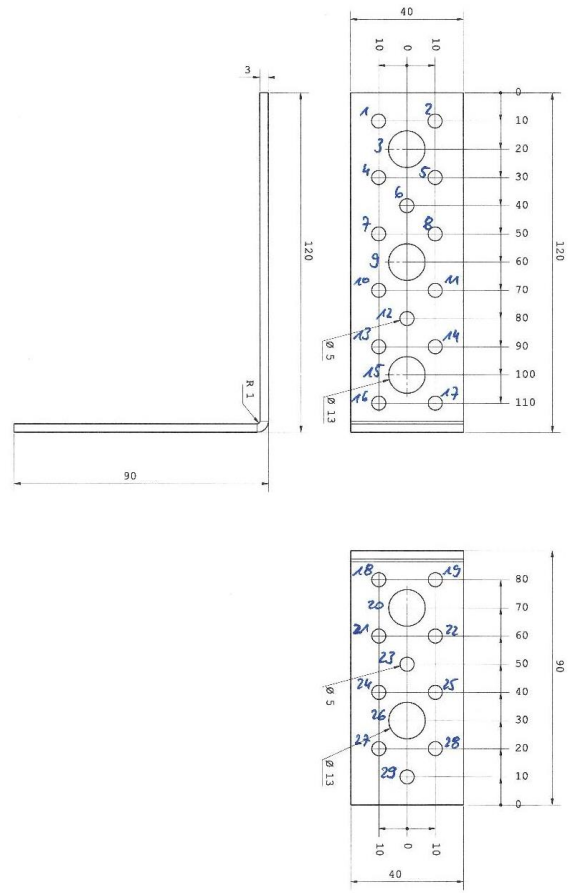


Figure B. 84 Dimensions of Angle Bracket 641 912 30

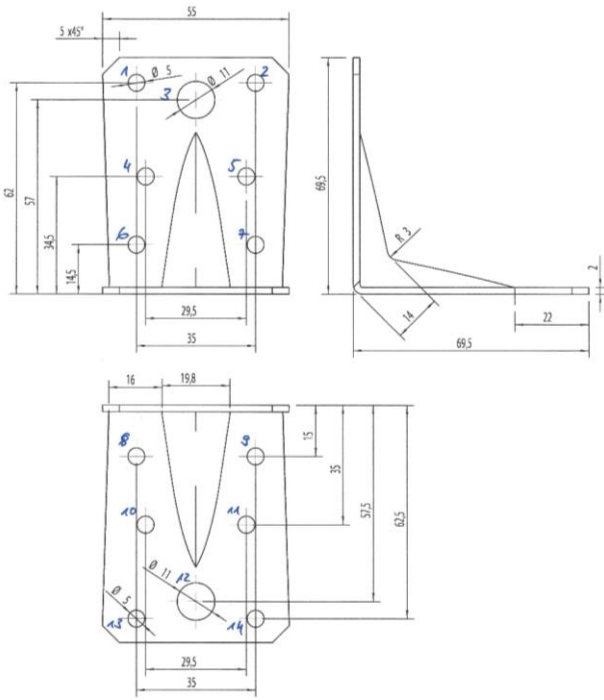


Figure B. 85 Dimensions of Angle Bracket 641 970 20

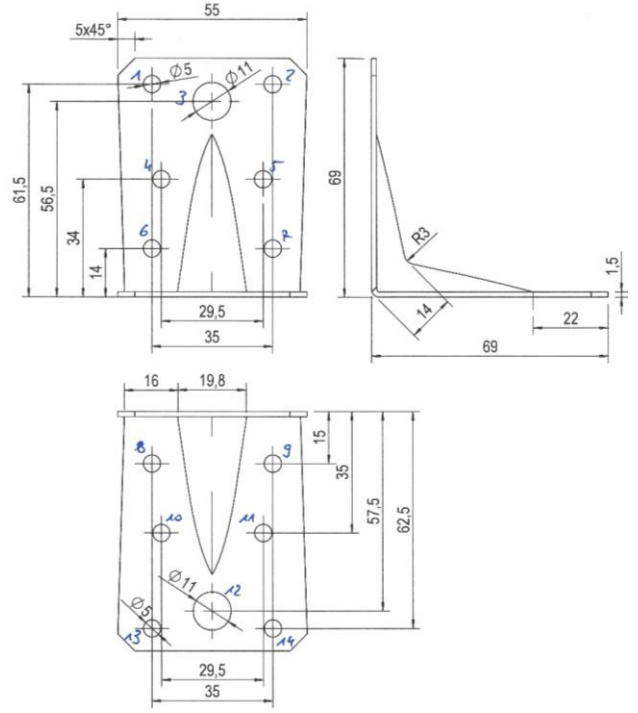


Figure B. 86 Dimensions of Angle Bracket 641 971 15

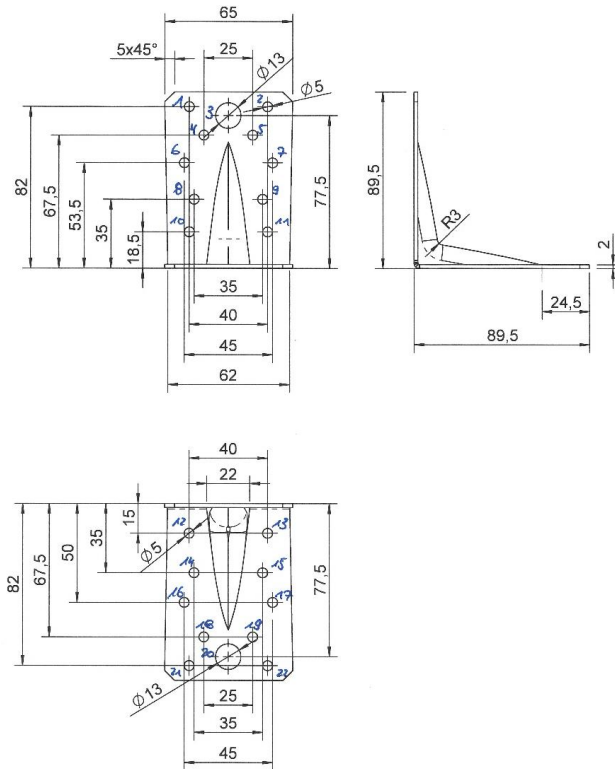


Figure B. 87 Dimensions of Angle Bracket 641 990 20

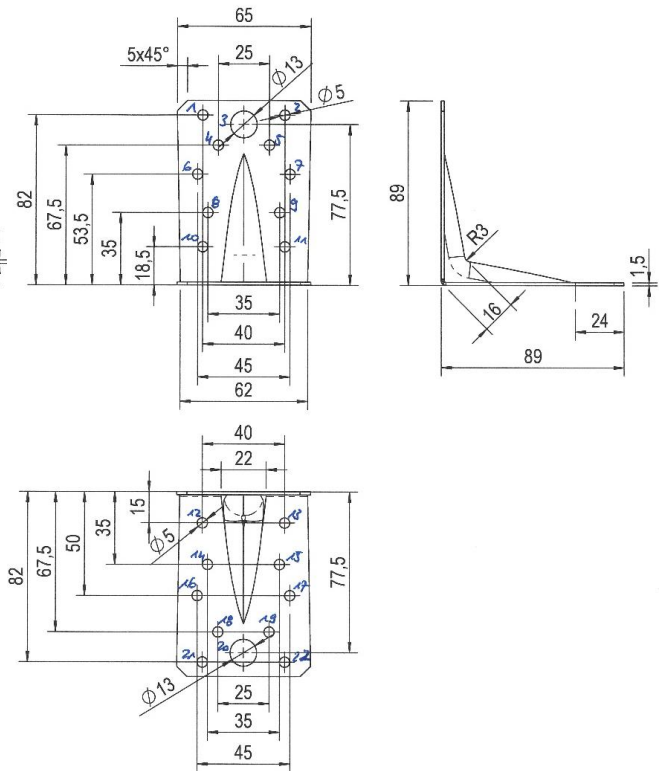


Figure B. 88 Dimensions of Angle Bracket 641 991 15

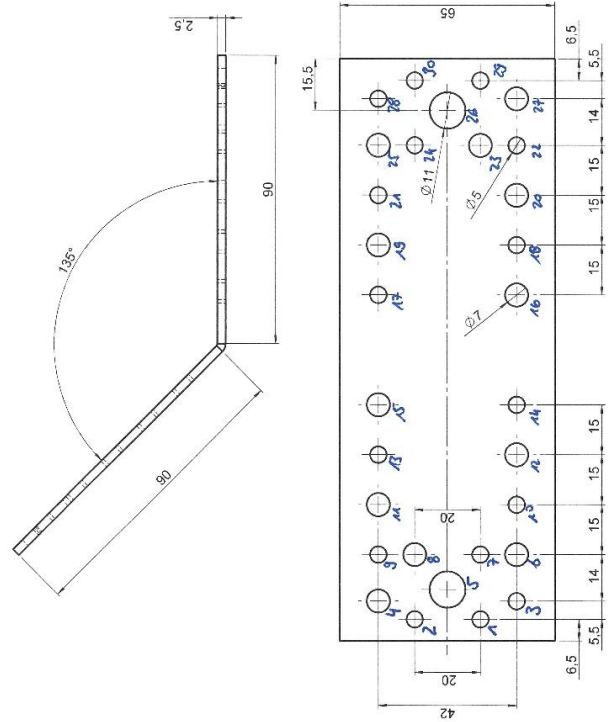
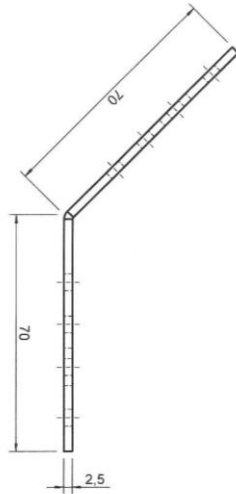
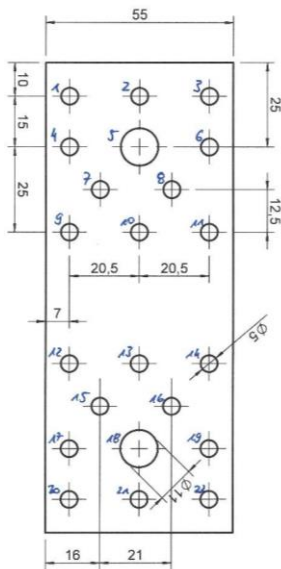


Figure B. 89 Dimensions of Angle Bracket 651 070 25

Figure B. 90 Dimensions of Angle Bracket 651 090 25

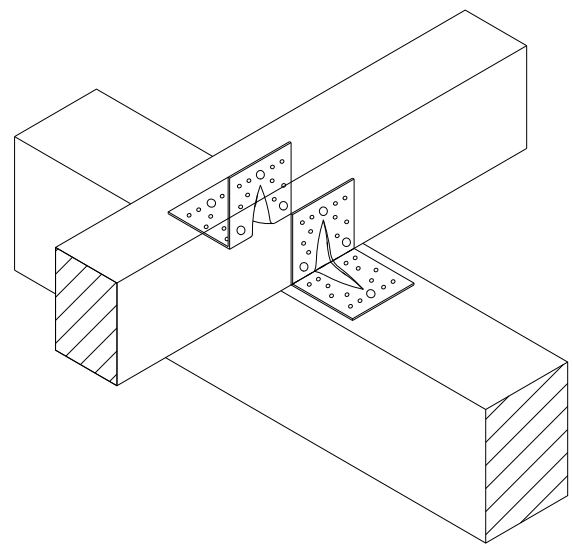
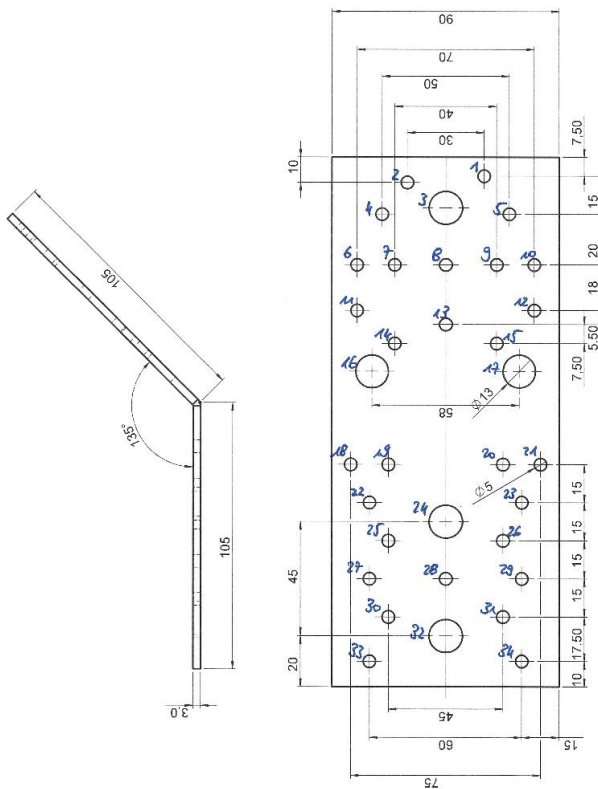


Figure B. 91 Dimensions of Angle Bracket 651 105 30

Figure B. 92 Typical installation