ETA-Danmark A/S
Kollegievej 6
DK-2920 Charlottenlund
Tel. +45 72 24 59 00
Fax +45 72 24 59 04
Internet ww.etadanmark.dk

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

MEMBER OF EOTA

European Technical Assessment ETA-08/0165 of 2014/01/23

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:	GAH Angle Brackets
Product family to which the above construction product belongs:	EC PAC 13: Three-dimensional nailing plate (angle bracket for wood to wood connections)
Manufacturer:	Gust. Alberts GmbH & Co KG Gewerbegebiet Grünenthal D-55845 Herscheid Tel. +49 2357 907 0 Fax +49 2357 907 189 Internet www.gah.de
Manufacturing plant:	Gust. Alberts GmbH & Co KG Gewerbegebiet Grünenthal D-55845 Herscheid
This European Technical Assessment contains:	30 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:	ETA-08/0165 issued on 2013/06/28

II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product and intended use

Technical description of the product
The following bracket types are covered by this ETA:

GAH Angle Brackets (8612, 8613, 8614, 8615, 8617, 8620, 8621, 8623, 8624, 8625, 8626, 8627)
GAH Angle Brackets (8634, 8635, 8636, 8637, 8638, 8640, 8641, 8644, 8645)
GAH Angle Brackets with rib (8622, 8628, 8629, 8632, 8633, 8654, 8655)
GAH Angle Brackets FH (8625 90FH 1, 8626 10FH 1, 8632 90FH 1, 8633 10FH 1)

The GAH angle brackets with and without rib are one-piece non-welded, face-fixed angle brackets to be used in timber to timber connections. They are connected to the timber elements by a range of profiled nails.

The angle brackets are made from pre-galvanized steel DX 51 D / Z 275 according to EN 104346:2009 with a minimum yield strength R_e of 250 MPa, a minimum tensile strength R_m of 330 MPa and a minimum ultimate strain A_{80} of 22 % and are available with or without an embossed rib. Dimensions, hole positions and typical installations are shown in Annex A. GAH angle brackets are made from steel with tolerances according to EN 10143.

Additionally, the angle brackets can be made from stainless steel 1.4016, 1.4301, 1.4401, 1.4541 or 1.4571 according to EN 10088-2:2005 provided that the yield strength f_y for these steel grades is at least the same as the minimum yield strength of the zinc coated steel normally used for the brackets. The ultimate strength f_u and the ultimate strain A_{80} shall exceed the corresponding minimum values for the zinc coated steel.

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 305/2011 (EU) shall be fulfilled.

The connection may be with a single angle bracket or with an angle bracket on each side of the fastened timber member (see Annex A).

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

The wood members can be of solid timber, glued laminated timber and similar glued members, or wood-based structural members with a characteristic density from 290 kg/m^3 to 420 kg/m^3. This requirement to the material of the wood members can be fulfilled by using the following materials:

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

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

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

Where ρ_k ist he 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 scope of the brackets regarding resistance to corrosion shall be defined according to national provisions that apply at the installation site considering environmental conditions. Section 3.11of this ETA contains the corrosion protection for GAH Alberts angle brackets made from carbon steel and the material number of the stainless steel.

The angle brackets may also be used for connections between a timber member and a member of concrete or steel.

The provisions made in this European Technical Assessment are based on an assumed intended working life of the angle brackets 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*)	
Characteristic load-carrying capacity	See Annex B
Stiffness	No performance determined
Ductility in cyclic testing	No performance determined
3.2 Safety in case of fire	
Reaction to fire	The angle brackets are made from steel classified as **Euroclass A1** in accordance with EN 1350-1 and EC decision 96/603/EC, amended by EC Decision 2000/605/EC
3.3 Hygiene, health and the environment	
Influence on air quality	No dangerous materials
3.7 Sustainable use of natural resources (BR7)	No Performance Determined
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.

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

3.9 Methods of verification

Safety principles and partial factors

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

According to EN 1990 (Eurocode – Basis of design) paragraph 6.3.5 the design value of load-carrying capacity can be determined by reducing the characteristic values of the load-carrying capacity with different partial factors.

Thus, the characteristic values of the load–carrying capacity are determined also for timber failure $F_{Rk,H}$ (obtaining the embedment strength of nails subjected to shear or the withdrawal capacity of the most loaded nail, respectively) as well as for steel plate failure $F_{Rk,S}$. The design value of the load–carrying capacity is the smaller value of both load–carrying capacities.

$$F_{Rd} = \min\left\{\frac{k_{mod} \cdot F_{Rk,H}}{\gamma_{M,H}}; \frac{F_{Rk,S}}{\gamma_{M,S}}\right\}$$

Therefore, for timber failure the load duration class and the service class are included. The different partial factors γ_M for steel or timber, respectively, are also correctly taken into account.

3.10 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 load bearing capacities of the brackets has been determined based on the use of connector nails 4,0 x 40 mm in accordance with the German national approval for the nails.

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
$t_{pen} \geq 30$ mm

Based on tests by Versuchsanstalt für Stahl, Holz und Steine, University of Kalrsruhe, 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

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

The design models allow the use of fasteners described in the table on page 9 in Annex A

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 the angle brackets are made from pre-galvanized steel DX 51 D / Z 275 according to EN 10327:2004 with minimum yield strength R_e of 250 MPa, a minimum tensile strength R_m of 330 MPa and a minimum ultimate strain A_{80} of 22 %

3.11.2 Corrosion protection in service class 3.

In accordance with Eurocode 5 the angle brackets are made from stainless steel 1.4016, 1.4301, 1.4401, 1.4541 or 1.4571 according to EN 10088-2:2005 and the nails shall be produced from stainless steel.

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

5.1 Tasks of the manufacturer

5.1.1 Factory production control

The manufacturer has a factory production control system in the plant and exercises permanent internal control of production. All the elements, requirements and provisions adopted by the manufacturer are documented in a systematic manner in the form of written policies and procedures. This production control system ensures that the product is in conformity with the European Technical Assessment.

The manufacturer shall only use raw materials supplied with the relevant inspection documents as laid down in the control plan[1]. The incoming raw materials shall be subject to controls and tests by the manufacturer before acceptance. Check of materials, such as sheet metal, shall include control of the inspection documents presented by suppliers (comparison with nominal values) by verifying dimension and determining material properties, e.g. chemical composition, mechanical properties.

The manufactured components are checked visually and for dimensions.

The control plan, which is part of the technical documentation of this European Technical Assessment, includes details of the extent, nature and frequency of testing and controls to be performed within the factory production control and has been agreed between the assesment holder and ETA-Danmark.

The results of factory production control are recorded and evaluated. The records include at least the following information:

- Designation of the product, basic material and components;
- Type of control or testing;
- Date of manufacture of the product and date of testing of the product or basic material and components;
- Result of control and testing and, if appropriate, comparison with requirements;
- Signature of person responsible for factory production control.

The records shall be presented to ETA Danmark on request.

5.1.2 Initial type testing of the product

For initial type-testing the results of the tests performed as part of the assessment for the European Technical Assessment shall be used unless there are changes in the production line or plant. In such cases the necessary initial type testing has to be agreed between ETA-Danmark and the notified body.

5.2. Tasks of notified bodies

5.2.1 Initial inspection of factory and of factory production control

The Notified body shall ascertain that, in accordance with the control plan, the factory and the factory production control are suitable to ensure continuous and orderly manufacturing of the anchor according to the specifications mentioned in 2.1 as well as to the Annexes to the European Technical Assessment.

5.2.2 Continuous surveillance

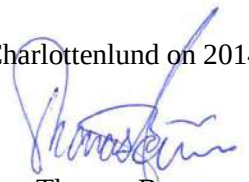
The Notified body shall visit the factory at least once a year for regular inspection. It has to be verified that the system of factory production control and the specified automated manufacturing process are maintained taking account of the control plan.

Continuous surveillance and assessment of factory production control have to be performed according to the control plan.

The results of product certification and continuous surveillance shall be made available on demand by the certification body or inspection body, respectively, to ETA-Danmark. In cases where the provisions of the European Technical Assessment and the control plan are no longer fulfilled the conformity certificate shall be withdrawn.

1 The control plan has been deposited at ETA-Danmark and is only made available to the approved bodies involved in the AVCP procedure.

Issued in Charlottenlund on 2014-01-23 by



Thomas Bruun
Managing Director, ETA-Danmark

Annex A
Product details definitions

Table A.1 Materials specification

Bracket type	Thickness (mm)	Steel specification	Coating specification
8612	2,5	DX 51 D / Z 275	Z 275
8613	2,5	DX 51 D / Z 275	Z 275
8614	2,0	DX 51 D / Z 275	Z 275
8615	2,0	DX 51 D / Z 275	Z 275
8617	2,5	DX 51 D / Z 275	Z 275
8620	2,0	DX 51 D / Z 275	Z 275
8621	2,5	DX 51 D / Z 275	Z 275
8623	3,0	DX 51 D / Z 275	Z 275
8624	2,5	DX 51 D / Z 275	Z 275
8625	2,5	DX 51 D / Z 275	Z 275
8626	3,0	DX 51 D / Z 275	Z 275
8627	2,5	DX 51 D / Z 275	Z 275

Bracket type	Thickness (mm)	Steel specification	Coating specification
8634	2,5	DX 51 D / Z 275	Z 275
8635	2,5	DX 51 D / Z 275	Z 275
8636	2,0	DX 51 D / Z 275	Z 275
8637	2,5	DX 51 D / Z 275	Z 275
8638	2,5	DX 51 D / Z 275	Z 275
8640	2,5	DX 51 D / Z 275	Z 275
8641	2,5	DX 51 D / Z 275	Z 275
8644	2,5	DX 51 D / Z 275	Z 275
8645	2,5	DX 51 D / Z 275	Z 275

Bracket type	Thickness (mm)	Steel specification	Coating specification
8622	2,5	DX 51 D / Z 275	Z 275
8628	2,5	DX 51 D / Z 275	Z 275
8629	2,0	DX 51 D / Z 275	Z 275
8632	2,5	DX 51 D / Z 275	Z 275
8633	2,5	DX 51 D / Z 275	Z 275
8654	2,5	DX 51 D / Z 275	Z 275
8655	2,5	DX 51 D / Z 275	Z 275

Bracket type	Thickness (mm)	Steel specification	Coating specification
8625 90 FH1	2,5	DX 51 D / Z 275	Z 275
8626 10 FH1	2,5	DX 51 D / Z 275	Z 275
8632 90 FH1	2,5	DX 51 D / Z 275	Z 275
8633 10 FH1	3,0	DX 51 D / Z 275	Z 275

Table A.2 Range of sizes

Bracket type	Height (mm)		Width (mm)	
	min	**max**	**min**	**max**
8612	40	60	60	60
8613	60	80	60	60
8614	80	80	40	40
8615	100	100	40	40
8617	60	100	60	60
8620	54,5	54	40	40
8621	48,5	51	35,5	35,5
8623	92	92,5	39,5	39,5
8624	69	69	55	55
8625	88,5	88,5	65	65
8626	97	98,5	90,5	90,5
8627	60	60	45	45

Bracket type	Height (mm)		Width (mm)	
	min	**max**	**min**	**max**
8634	40,5	42	60	60
8635	60	61,5	40	40
8636	59,5	59	50	50
8637	60	61,5	60,5	60,5
8638	59	60	80	80
8640	79,5	80	60	60
8641	79,5	79,5	80	80
8644	100	100,5	80	80
8645	99,5	100	100	100

Bracket type	Height (mm)		Width (mm)	
	min	max	min	max
8622	68,5	69,5	55	55
8628	150	150	65	65
8629	50	62	64	64
8632	88,5	89	65,5	65,5
8633	98	98,5	90	90
8654	51	90,5	80,5	80,5
8655	50,5	90,5	50	50

Bracket type	Height (mm)		Width (mm)	
	min	max	min	max
8625 90 FH1	90	90	65	65
8626 10 FH1	105	105	90	90
8632 90 FH1	90	90	65	65
8633 10 FH1	105	105	90	90

Table A.3 Fastener specification

Nail type	Nail size (mm)		Finish
According to EN 14592	Diameter	Length	
Threaded nail with a profiled length of at least 31 mm	4,0	40	Electroplated zinc

GAH Angle Bracket (8612, 8613, 8614, 8615, 8617, 8620, 8621, 8623, 8624, 8625, 8626, 8627)

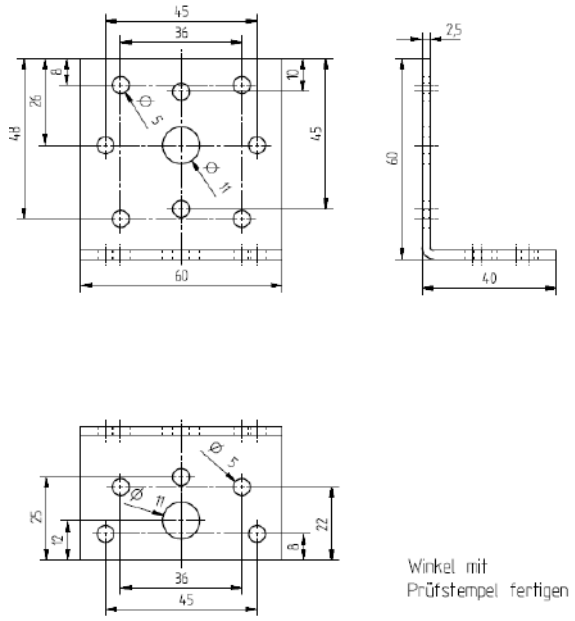


Figure A.1 Dimensions of Angle Bracket 8612

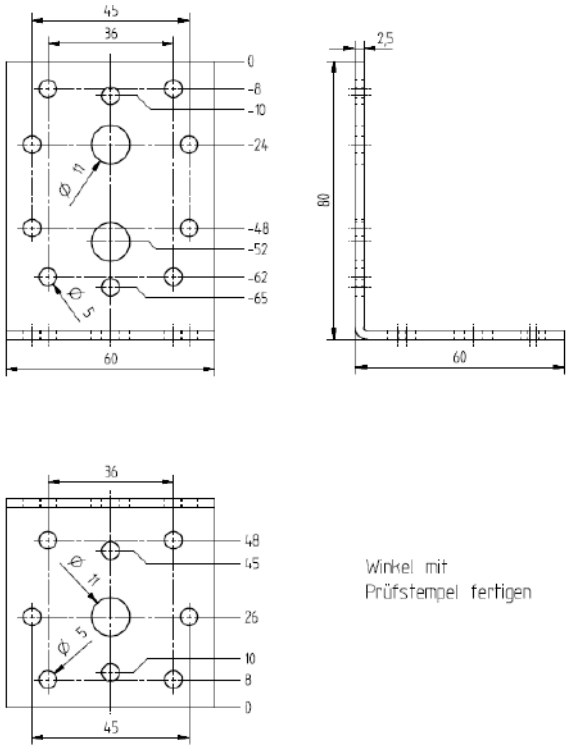


Figure A.2 Dimensions of Angle Bracket 8613

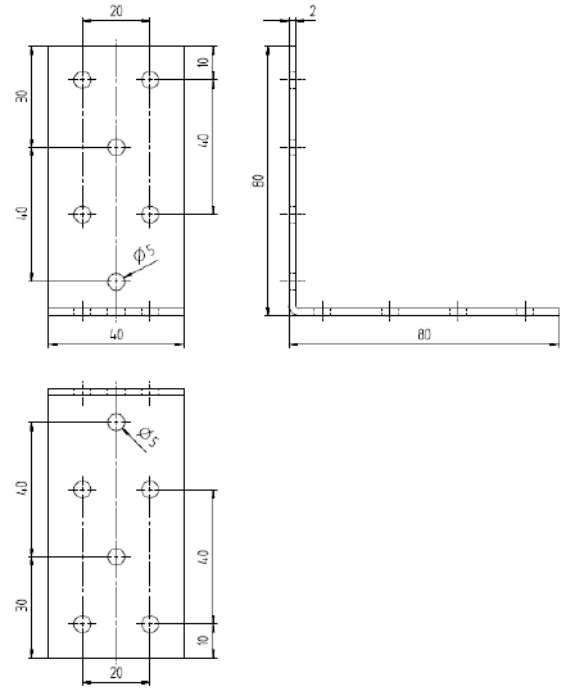


Figure A.3 Dimensions of Angle Bracket 8614

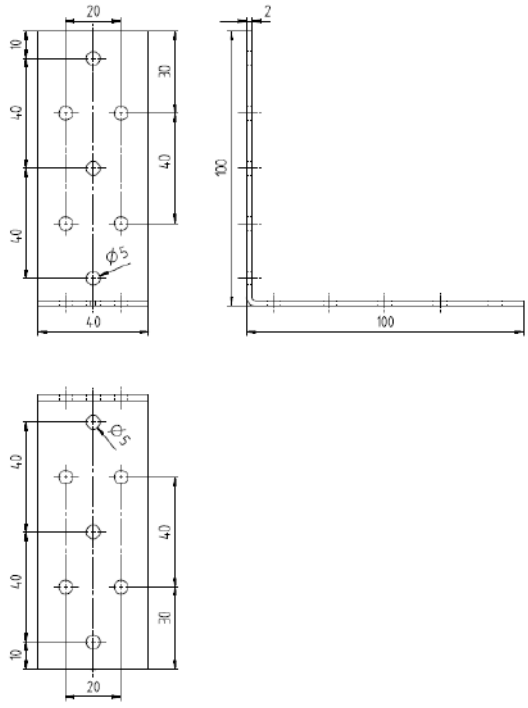


Figure A.4 Dimensions of Angle Bracket 8615

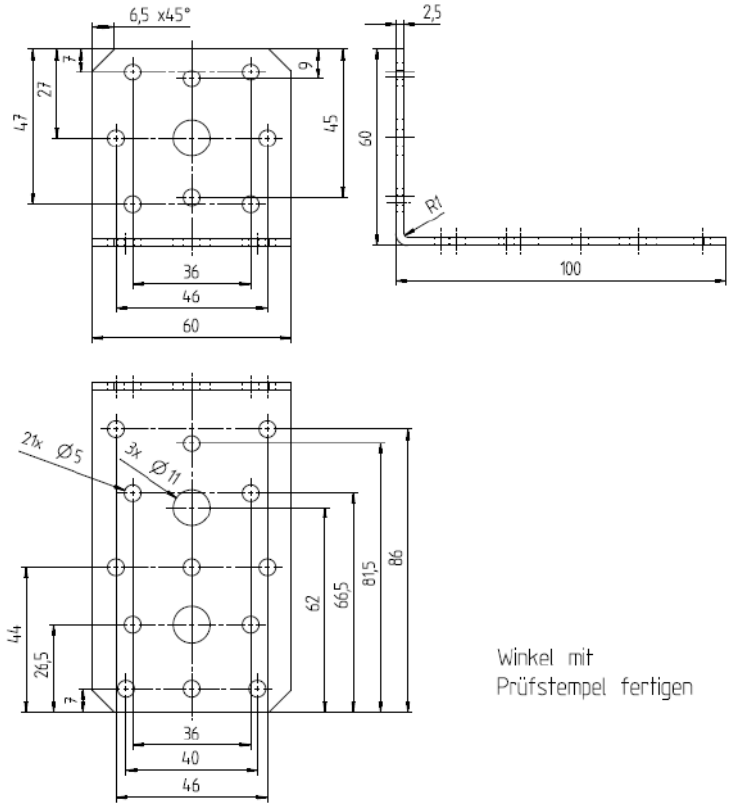


Figure A.5 Dimensions of Angle Bracket 8617

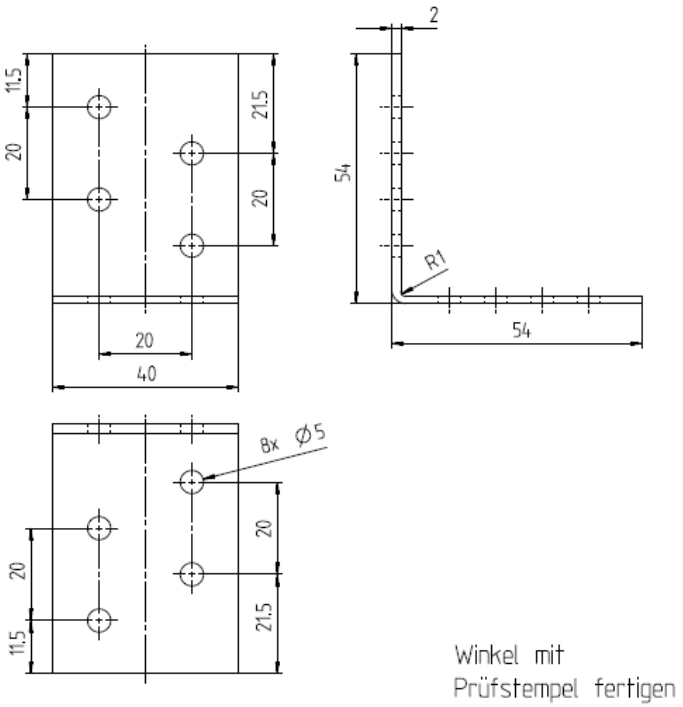


Figure A.6 Dimensions of Angle Bracket 8620

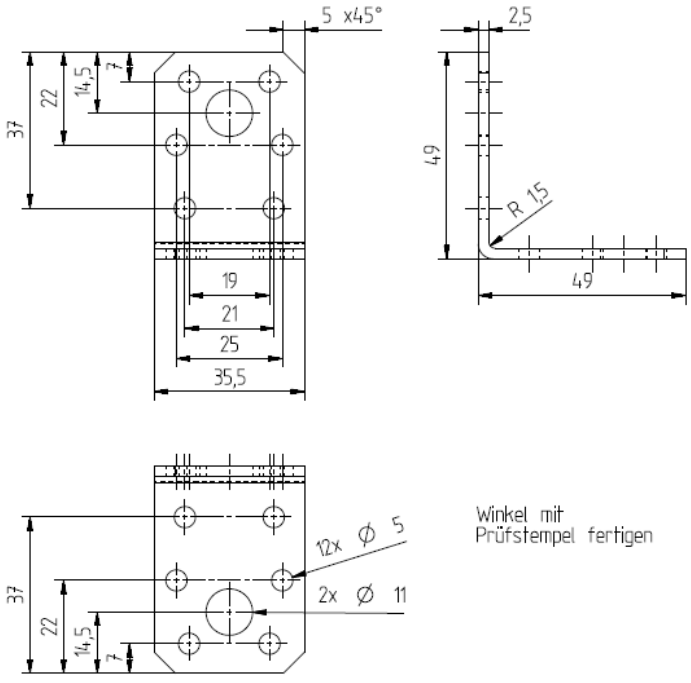


Figure A.7 Dimensions of Angle Bracket 8621

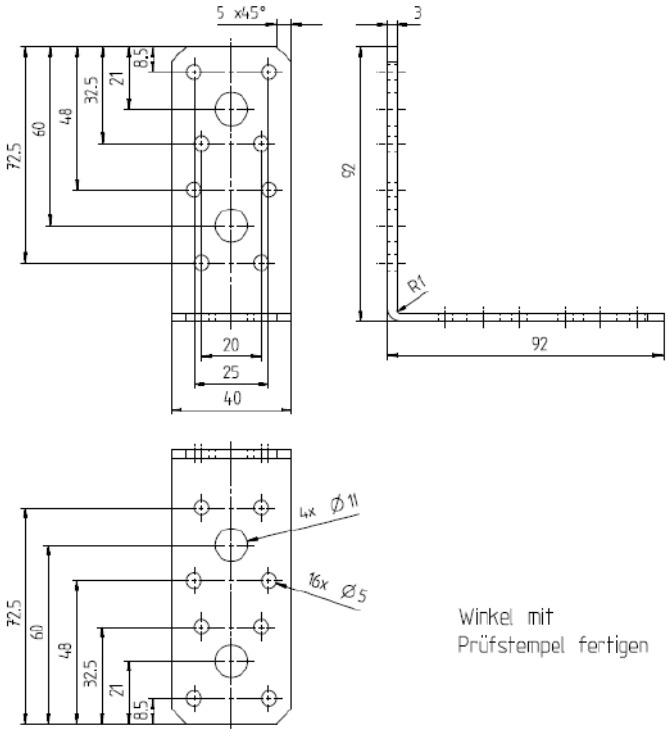


Figure A.8 Dimensions of Angle Bracket 8623

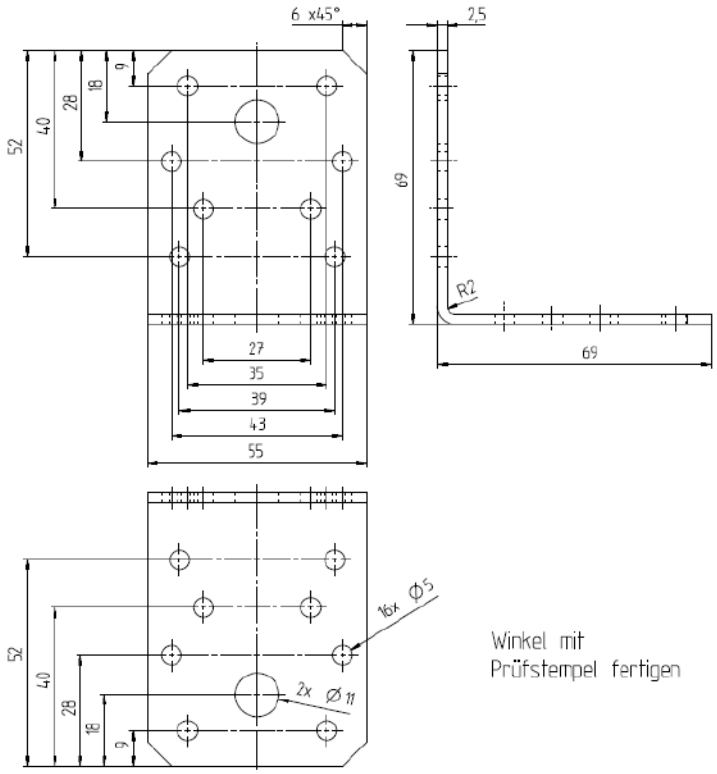


Figure A.9 Dimensions of Angle Bracket 8624

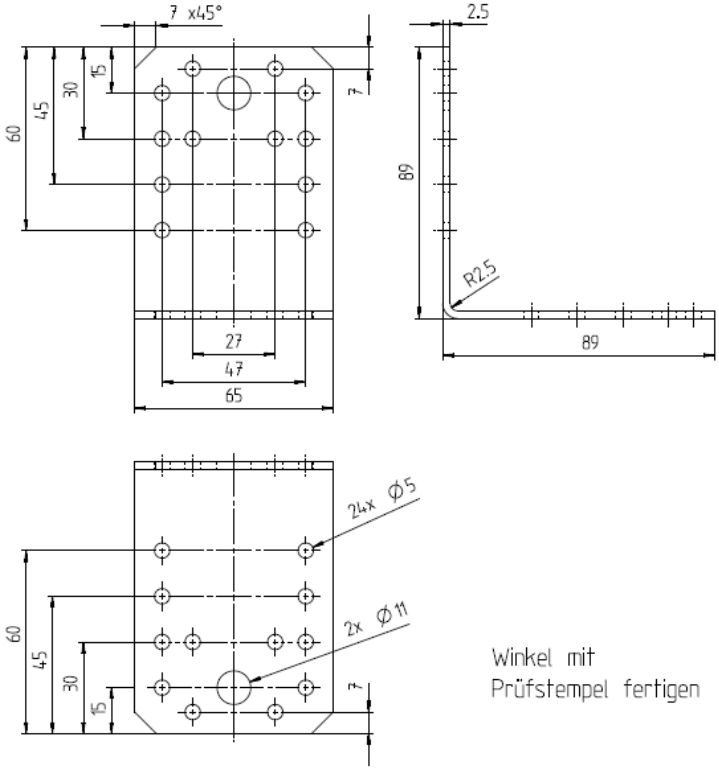


Figure A.10 Dimensions of Angle Bracket 8625

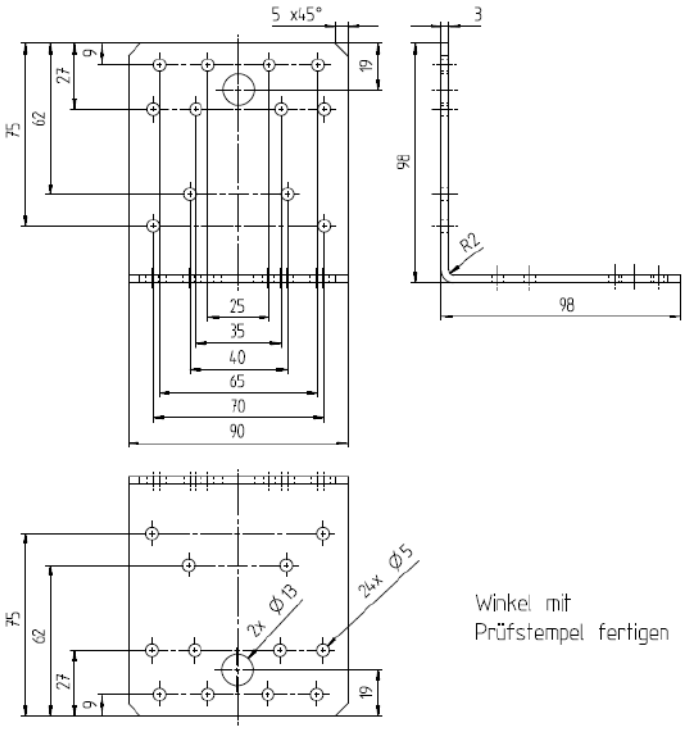


Figure A.11 Dimensions of Angle Bracket 8626

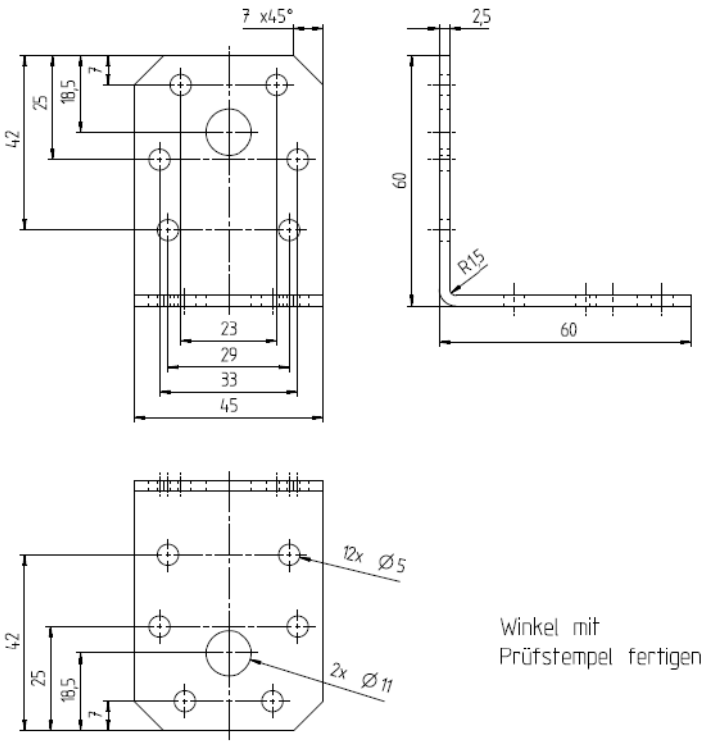


Figure A.12 Dimensions of Angle Bracket 8627

GAH Angle Brackets (8634, 8635, 8636, 8637, 8638, 8640, 8641, 8644, 8645)

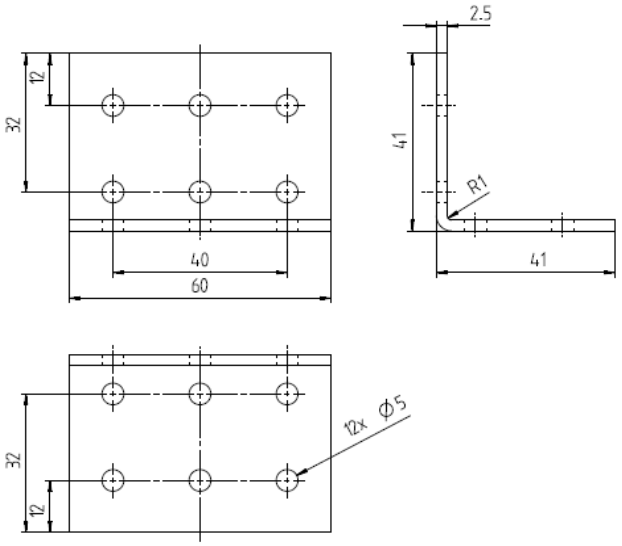


Figure A.13 Dimensions of Angle Bracket 8634

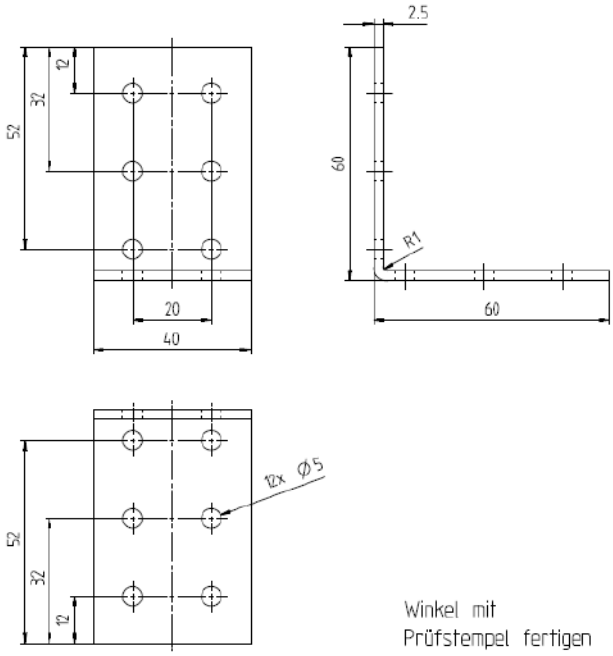


Figure A.14 Dimensions of Angle Bracket 8635

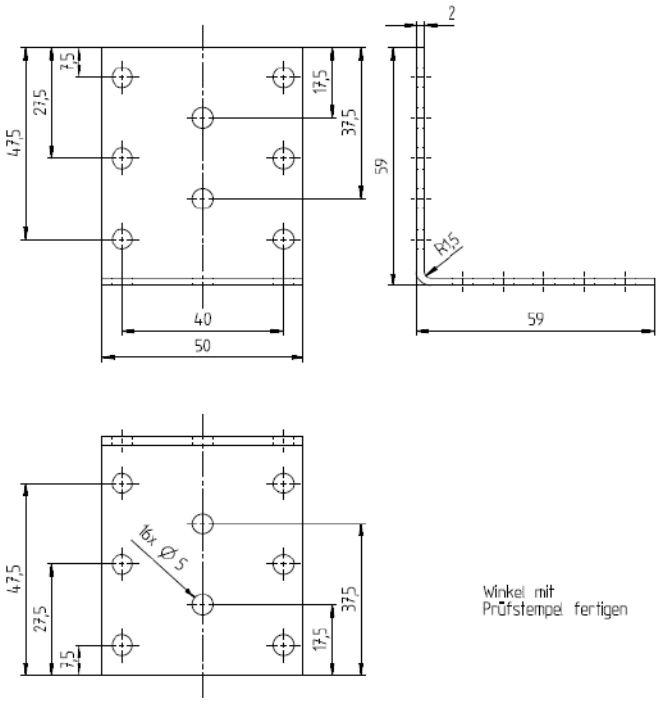


Figure A.15 Dimensions of Angle Bracket 8636

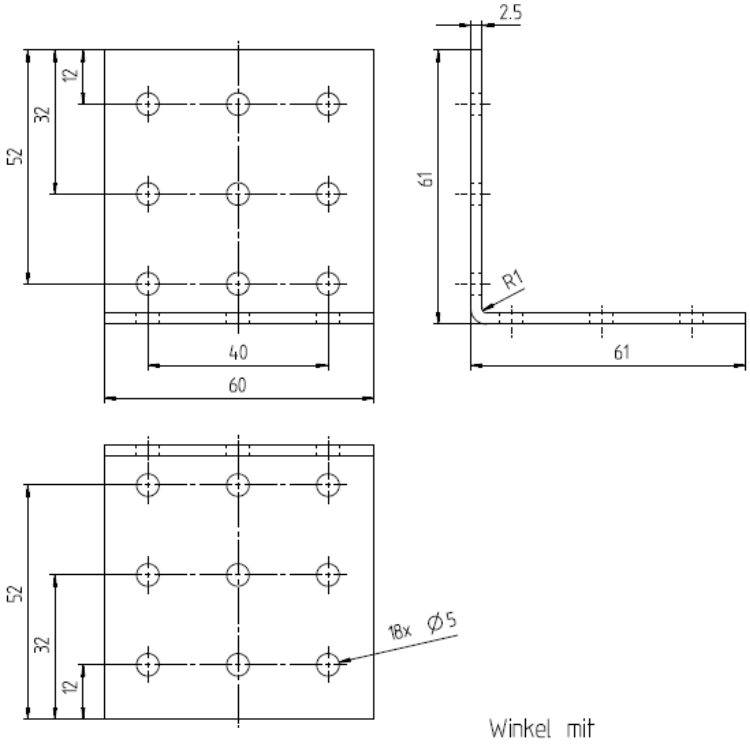


Figure A.16 Dimensions of Angle Bracket 8637

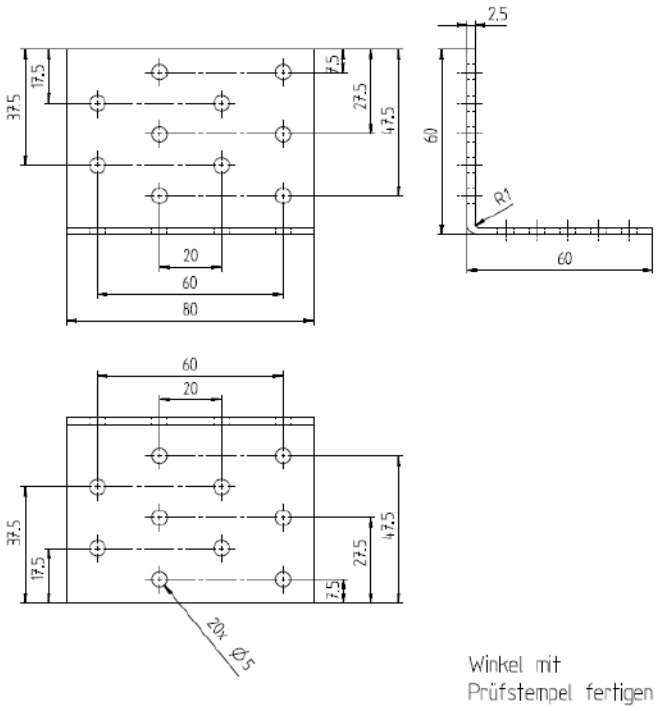


Figure A.17 Dimensions of Angle Bracket 8638

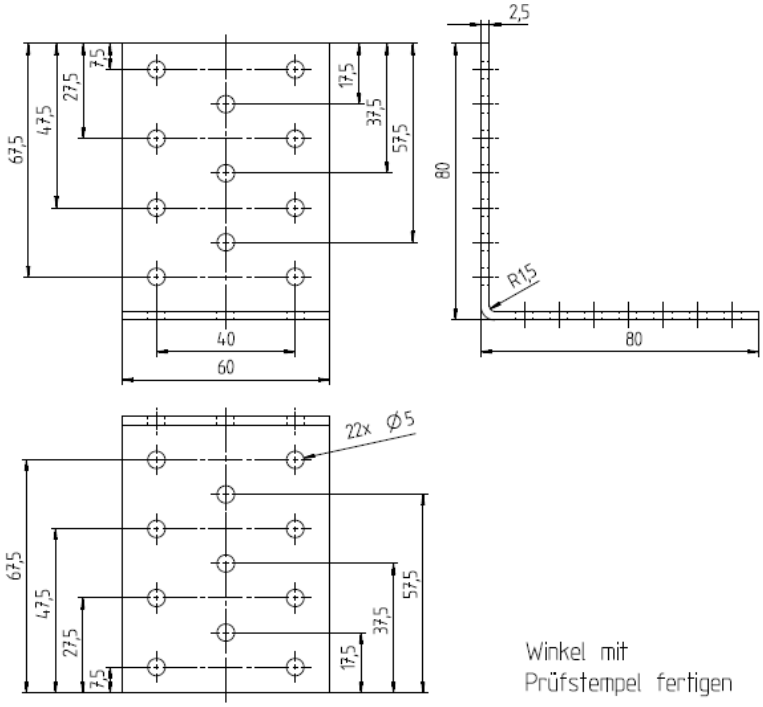


Figure A.18 Dimensions of Angle Bracket 8640

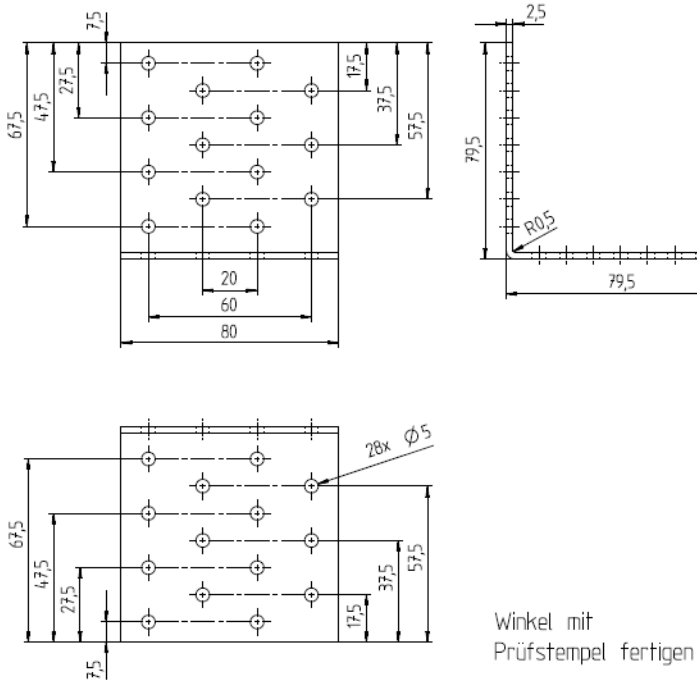


Figure A.19 Dimensions of Angle Bracket 8641

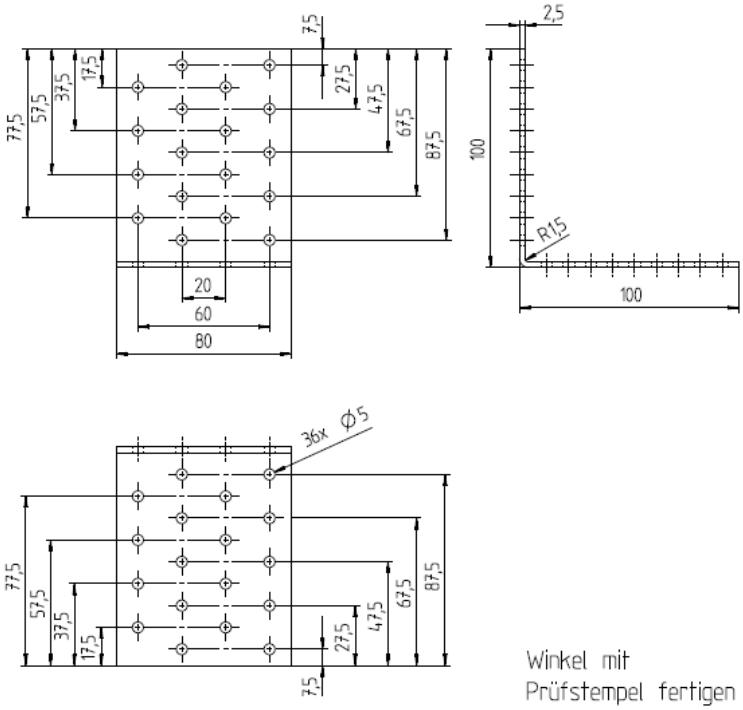


Figure A.20 Dimensions of Angle Bracket 8644

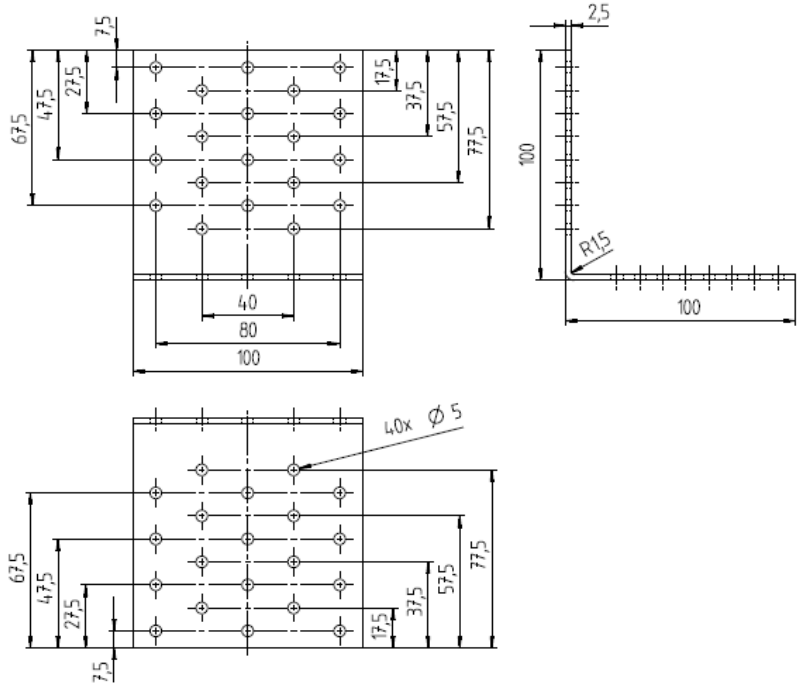


Figure A.21 Dimensions of
Angle Bracket 8645

GAH Angle Brackets with rib (8622, 8628, 8629, 8632, 8633, 8654, 8655)

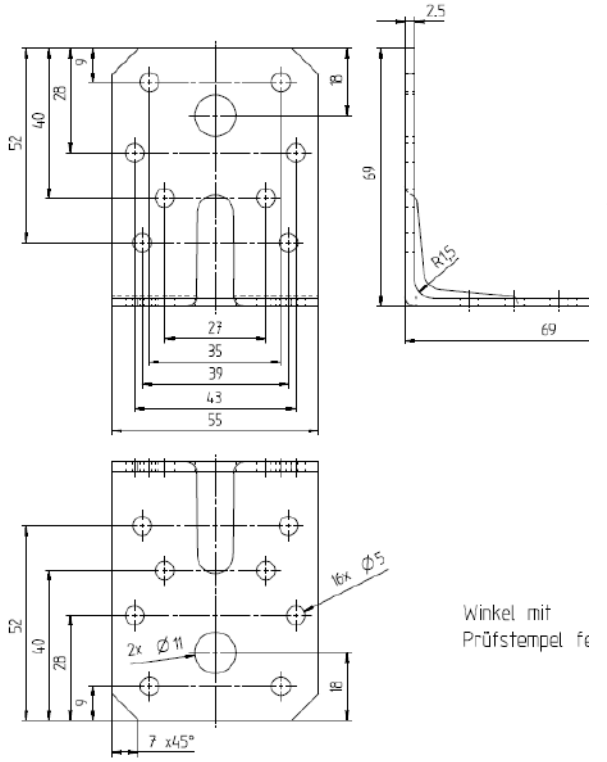


Figure A.22 Dimensions of Angle Bracket 8622

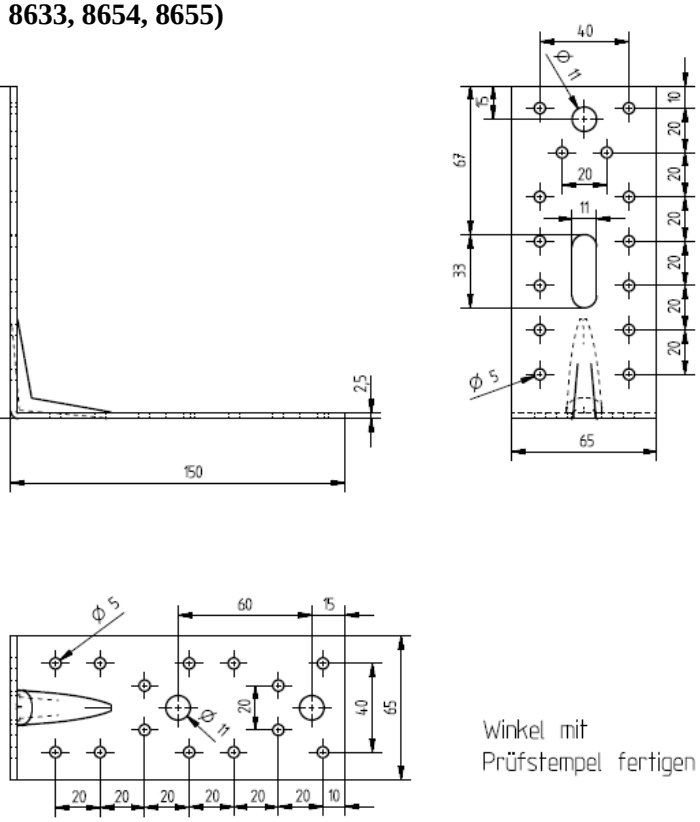


Figure A.23 Dimensions of Angle Bracket 8628

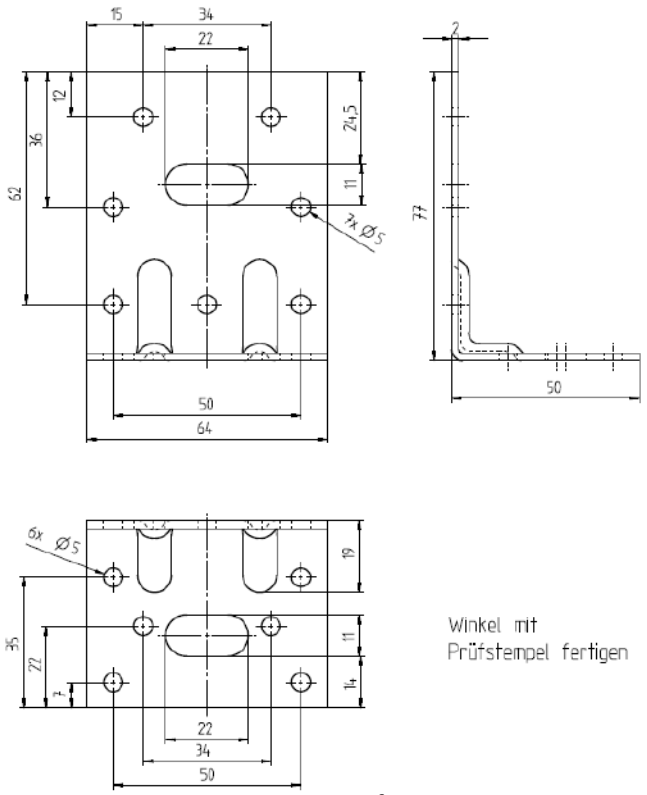


Figure A.24 Dimensions of Angle Bracket 8629

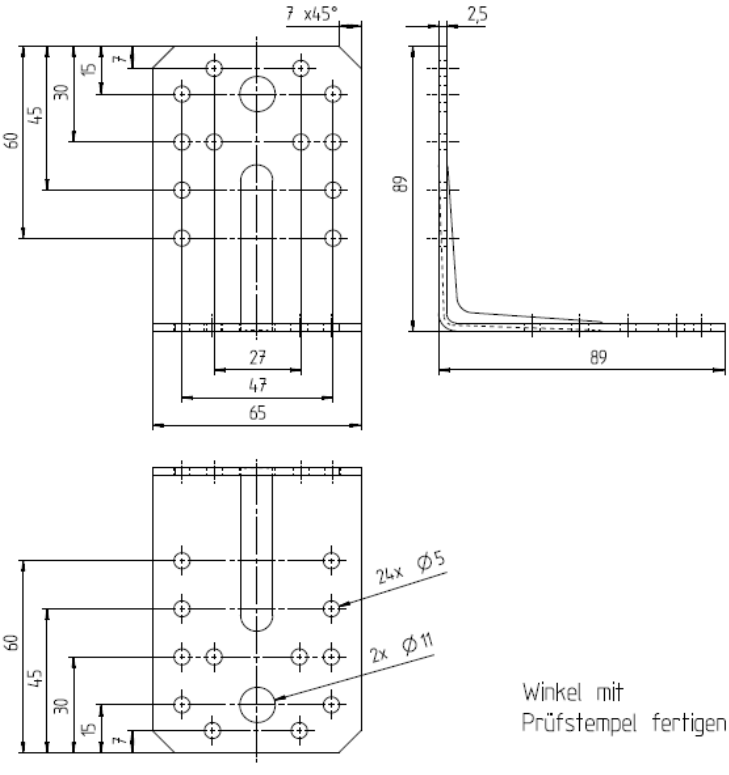


Figure A.25 Dimensions of Angle Bracket 8632

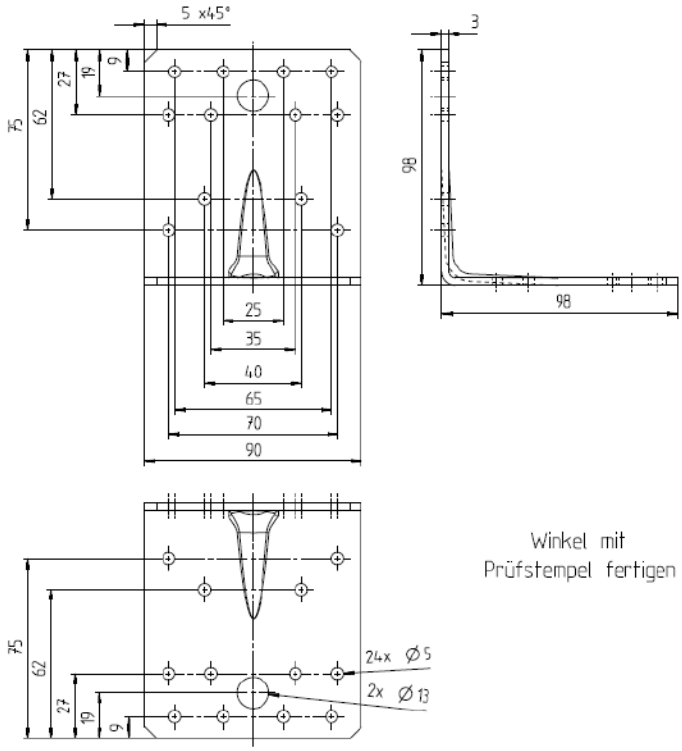


Figure A.26 Dimensions of Angle Bracket 8633

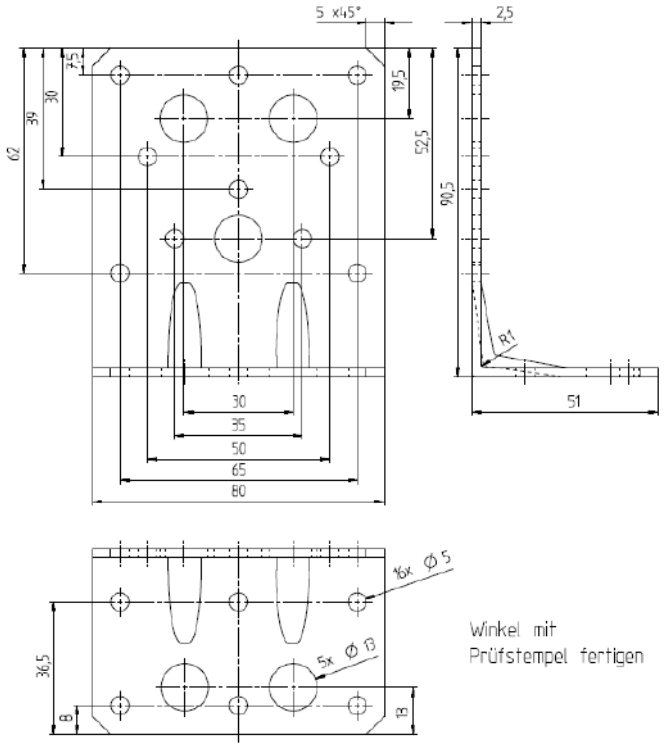


Figure A.27 Dimensions of Angle Bracket 8654

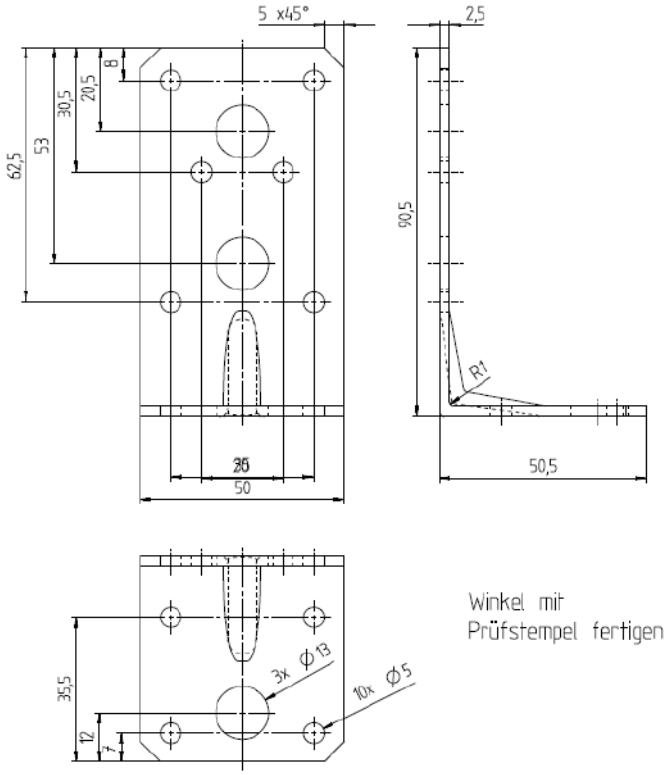


Figure A.28 Dimensions of Angle Bracket 8655

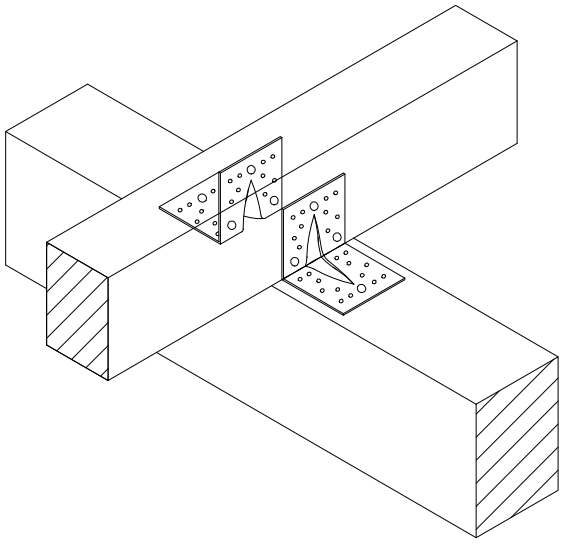


Figure A.29 Typical installation

GAH Angle Brackets FH (8625 90 FH1, 8626 10 FH1, 8632 90 FH1, 8633 10 FH1)

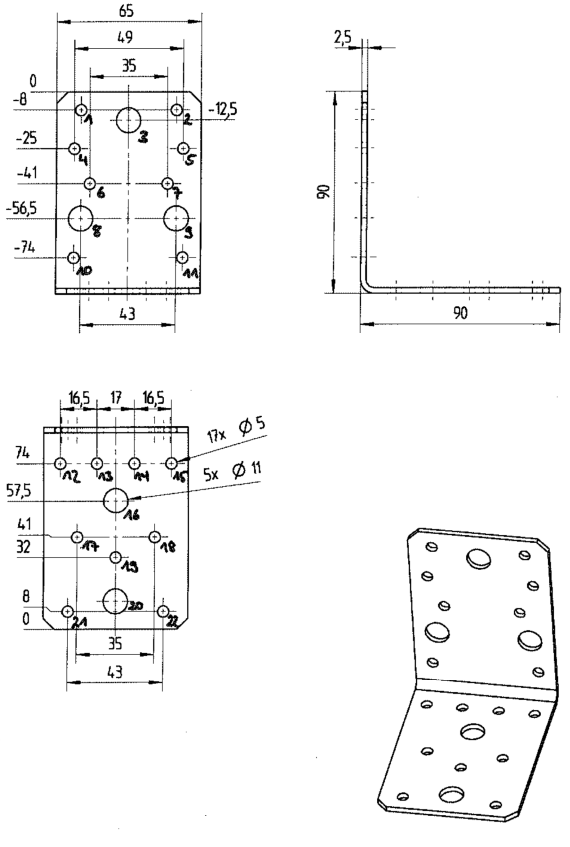


Figure A.13 Dimensions of AB 8625 90 FH1

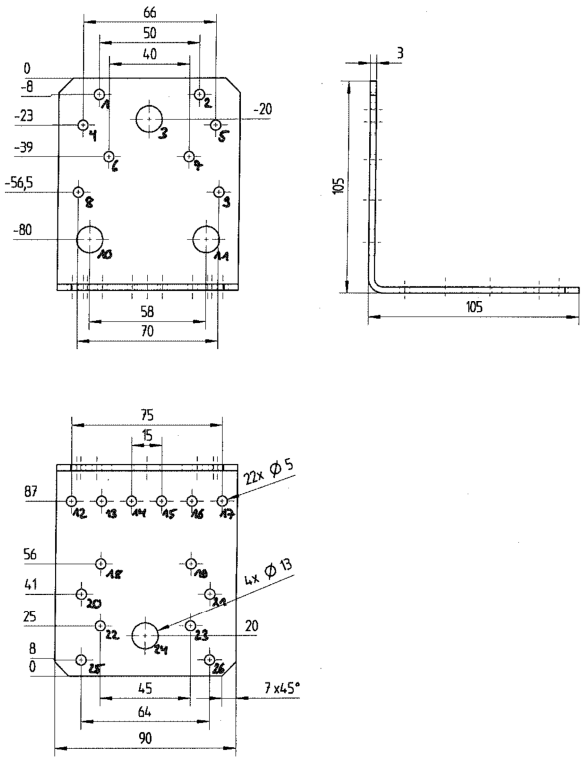


Figure A.14 Dimensions of AB 8626 10 FH1

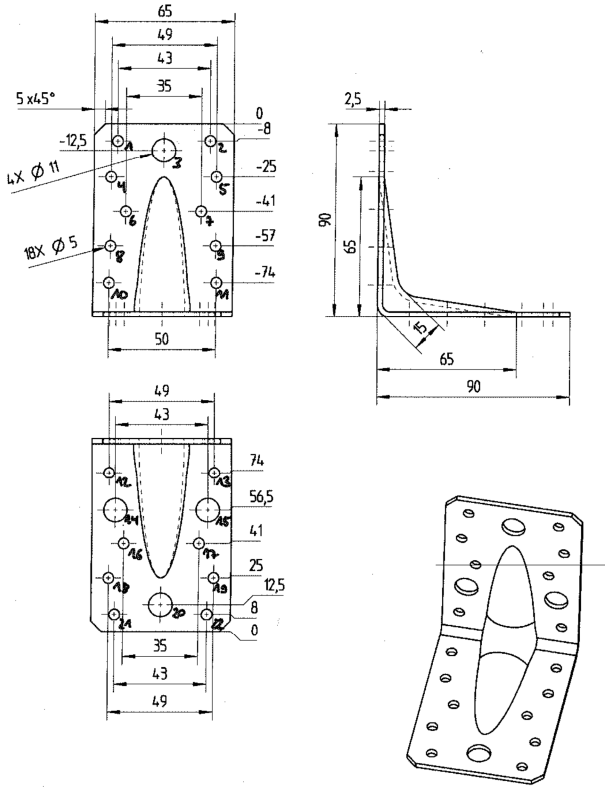


Figure A.15 Dimensions of AB 8632 90 FH1

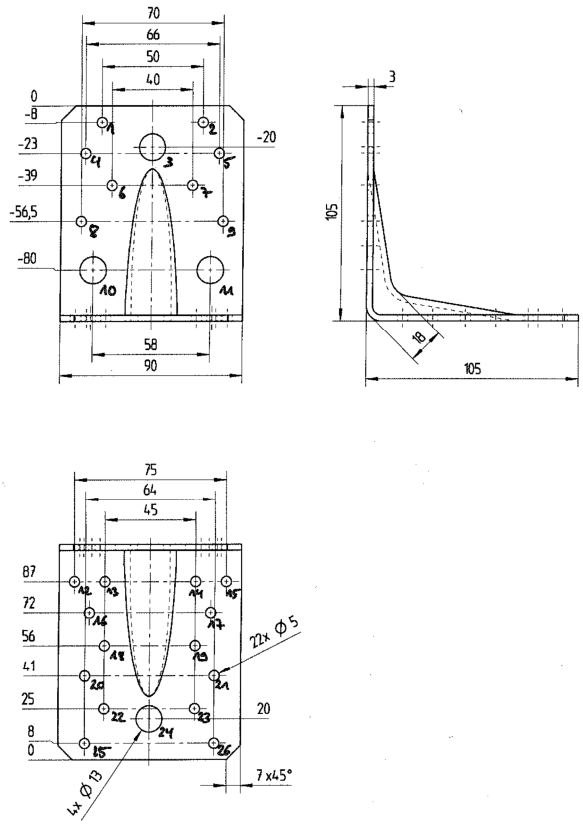


Figure A.16 Dimensions of AB 8633 10 FH1

Annex B
Characteristic load-carrying capacities

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

EAN number	Type	Nail number n_V	Nail number n_h	$R_{1,Rk}$ [kN] (column)	
				Timber	Steel
	8612	#	#	#	#
	8613	1,2,3	13,14,15,16,18,19,20,21	3,46	2,78
	8614	1,2	7,8,9,10,11,12	1,23	1,21
	8615	1,2,3	8,9,10,11,12,13,14	1,36	1,69
330149	8617	1,2,3,7,8,9	16,17,19,21,23,24	2,37	3,15
330408	8623	1,2,6,7	11,12,14,15,19,20	2,40	1,73
339630	8624	1,2	10,11,14,15,17,18	2,30	2,26
330453	8625	1,2,10,11	14,15,18,21,25,26	2,00	1,44
330507	8626	2,3,6,9	16,17,23,24,27,30	2,31	3,90
330835	8627	1,2	8,9,10,11,13,14	2,13	1,65
330705	8635	1,2	7,8,9,10,11,12	2,51	2,55
331481	8636	1,2	9,10,11,12,13,14,15,16	2,52	2,11
330750	8637	1,2,3	10,11,12,13,14,15,16,17,18	3,78	3,81
330804	8638	1,2	11,12, 13, 14,15,16,17,18,19,20	2,52	5,94
331498	8640	1,2,4,5	12, 13, 14,15, 16,17,18,19,20,21,22	2,67	4,24
330859	8641	1,2,5,6	15, 16,17, 18,19,20,21, 22,23,24,25,26,27,28	2,66	5,94
332068	8644	1,2,5,6,9,10	19,20,21, 22,23,24,25,26,27, 28,29,30,31,32,33,34,35,36	2,75	5,94
330903	8645	1,2,3,6,7,8	21,22,28,29,30,33,34,35,38,39,40	2,40	3,56
330354	8622	1,2	10,11,14,15,17,18	2,23	1,99
	8628	1,2,6,7,11,12	17,18,22,23,26,27,31,32	2,62	7,02
	8629	1,2	9,10,14,15	2,03	3,36
330552	8632	1,2,10,11	14,15,18,21,25,26	2,59	1,40
330606	8633	2,3,12,13	16,17,23,24,27,28,29,30	2,59	2,06
334659	8654	1,2,3	14,15,16,19,20,21	3,20	3,78
334666	8655	1,2,4,5	9,10,12,13	2,12	2,33
	8625 90 FH1	1,2	12,13,14,15,17,18,19,21,22	4,45	2,20
	8626 10 FH1	1,2,6,7	12,13,14,15,17,18,19,20, 21,22,23,25,26	6,75	2,60
	8632 90 FH1	1,2	12,13,16,17,18,19,21,22	2,23	9,80
	8633 10 FH1	1,2,6,7	12,13,14,15,16,17,18,19,20, 21,22,23,25,26	4,50	17,64

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

EAN number	Type	Nail number n_V	Nail number n_h	$R_{k,1}$ [kN] (column)	
				Timber	Steel
	8612	#	#	#	#
	8613	1,2,3	13,14,15,16,18,19,20,21	1,73	1,39
	8614	1,2	7,8,9,10,11,12	0,62	0,60
	8615	1,2,3	8,9,10,11,12,13,14	0,68	0,85
330354	8622	1,2	10,11,14,15,17,18	1,11	0,99
	8628	1,2,6,7,11,12	17,18,22,23,26,27,31,32	1,31	3,51
	8629	1,2	9,10,14,15	1,01	1,68
330552	8632	1,2,10,11	14,15,18,21,25,26	1,29	0,69
330606	8633	2,3,12,13	16,17,23,24,27,28,29,30	1,29	1,03
334659	8654	1,2,3,	14,15,16,19,20,21	1,60	1,89
334666	8655	1,2,4,5	9,10,12,13	1,06	1,16
	8625 90 FH1	1,2	12,13,14,15,17,18,19,21,22	2,23	1,10
	8626 10 FH1	1,2,6,7	12,13,14,15,17,18,19,20, 21,22,23,25,26	3,38	1,30
	8632 90 FH1	1,2	12,13,16,17,18,19,21,22	1,11	4,90
	8633 10 FH1	1,2,6,7	12,13,14,15,16,17,18,19,20, 21,22,23,25,26	2,25	8,82

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

EAN number	Type	Nail number n_V	Nail number n_h	$R_{1,Rk}$ [kN] (column)	
				Timber	Steel
	8612	1,2,3,4,6	10,11,12	2,28	2,22
	8613	1,2,3,4,5,7,8	13,14,15,16,18,19,20,21	3,46	2,78
	8614	1,2,3,4,5	7,8,9,10,11,12	1,23	1,21
	8615	1,2,3,4,5,6	8,9,10,11,12,13,14	1,36	1,69
330149	8617	1,3,5,6,7,9,11,12	16,17,19,21,23,24	2,37	3,15
330255	8620	1,2	5,6,7,8	1,15	1,44
330309	8621	4,5	8,9,13,14	1,92	1,18
330408	8623	1,2,6,7	11,12,16,17	2,37	1,73
339630	8624	1,2,4,5	10,11,14,15,17,18	2,30	2,26
330453	8625	1,2,6,9,12,13	14,15,22,24	2,00	1,44
330507	8626	1,4,7,8,14,15	16,17,23,24	2,31	3,89
330835	8627	1,2,4,5	8,9,10,11,13,14	2,13	1,65
330651	8634	1,2,3	7,8,9,10,11,12	3,27	3,81
330705	8635	1,2,3,4	7,8,9,10,11,12	2,51	2,54
331481	8636	1,2,3,4,5	9,10,11,12,13,14,15,16	2,52	2,11
330750	8637	1,2,3,4,5,6	10,11,12,13,14,15,16,17,18	3,77	3,81
330804	8638	1,2,3,4,5,6	11,12,13,14,15,16,17,18,19,20	2,52	5,94
331498	8640	1,2,3,4,5,6,7,8	12,13,14,15,16,17, 18,19,20,21,22	2,66	4,24
330859	8641	1,2,3,4,5,6,7, 8,9,10	15,16,17,18,19,20,21,22,23,24, 25,26,27,28	2,66	5,94
332068	8644	1,2,3,4,5,6,7, 8,9,10,11,12, 13,14	19,20,21,22,23,24,25,26,27,28,29, 30,31,32,33,34,35,36	2,75	5,94
330903	8645	1,2,3,4,5,6,7,8, 9,10,11,12,13,14, 15,16,17,18	21,22,23,24,25,26,27,28,29,30,31, 32,33,34,35,36,37,38,39,40	2,40	3,56
330354	8622	1,2,6,7	10,11,14,15,17,18	2,23	1,99
	8628	1,2,4,5,6,7,8,9,11, 12,13,14	17,18,22,23,26,27,31,32	2,62	7,02
	8629	1,2,4,5	9,10,14,15	2,03	3,36
330552	8632	1,2,6,9,12,13	14,15,18,21,25,26	2,59	1,39
330606	8633	1,4,6,9,12,13	16,17,18,19,22,25,27,30	2,59	2,06
334659	8654	1,3,6,7,12,13	14,15,16,19,20,21	3,20	3,78
334666	8655	1,2,4,5,7,8	9,10,12,13	2,11	2,33
	8625 90 FH1	1,2,4,5,6,7	12,13,14,15,17,18,19,21,22	4,45	2,20
	8626 10 FH1	1,2,4,5,6,7,8,9	12,13,14,15,17,18,19,20,21,22, 23,25,26	6,75	2,60
	8632 90 FH1	1,2,4,5,6,7,8,9	12,13,16,17,18,19,21,22	2,23	9,80
	8633 10 FH1	1,2,4,5,6,7,8,9	12,13,14,15,16,17,18,19,20,21, 22,23,25,26	4,50	17,64

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

EAN number	Type	Nail number n_V	Nail number n_h	$R_{1,Rk}$ [kN] (column)	
				Timber	Steel
	8612	1,2,3,4,6	10,11,12	1,14	1,11
	8613	1,2,3,4,5,7,8	13,14,15,16,18,19,20,21	1,73	1,39
	8614	1,2,3,4,5	7,8,9,10,11,12	0,62	0,60
	8615	1,2,3,4,5,6	8,9,10,11,12,13,14	0,68	0,85
330354	8622	1,2,6,7	10,11,14,15,17,18	1,11	0,99
	8628	1,2,4,5,6,7,8,9,11, 12,13,14	17,18,22,23,26,27,31,32	1,31	3,51
	8629	1,2,4,5	9,10,14,15	1,01	1,68
330552	8632	1,2,6,9,12,13	14,15,18,21,25,26	1,29	0,69
330606	8633	1,4,6,9,12,13	16,17,18,19,22,25,27,30	1,29	1,03
334659	8654	1,3,6,7,12,13	14,15,16,19,20,21	1,60	1,89
334666	8655	1,2,4,5,7,8	9,10,12,13	1,05	1,16
	8625 90 FH1	1,2,4,5,6,7	12,13,14,15,17,18,19,21,22	2,23	1,10
	8626 10 FH1	1,2,4,5,6,7,8,9	12,13,14,15,17,18,19,20,21,22, 23,25,26	3,38	1,30
	8632 90 FH1	1,2,4,5,6,7,8,9	12,13,16,17,18,19,21,22	1,11	4,90
	8633 10 FH1	1,2,4,5,6,7,8,9	12,13,14,15,16,17,18,19,20,21, 22,23,25,26	2,25	8,82

Table 5: Forces $F_{2,3}$, 2 angle brackets / connection

EAN number	Type	Nail number n_V	Nail number n_h	$R_{2,3,Rk}$ [kN]
				Timber
	8612	1,2,3,4,6	10,11,12	4,40
	8613	1,2,3,4,5,7,8	13,14,15,16,18,19,20,21	7,46
	8614	1,2,3,4,5	7,8,9,10,11,12	4,54
	8615	1,2,3,4,5,6	8,9,10,11,12,13,14	4,97
330149	8617	1,3,5,6,7,9,11,12	16,17,19,21,23,24	6,30
330255	8620	1,2	5,6,7,8	2,22
330309	8621	4,5	8,9,13,14	3,11
330408	8623	1,2,6,7	11,12,16,17	3,39
339630	8624	1,2,4,5	10,11,14,15,17,18	4,73
330453	8625	1,2,6,9,12,13	14,15,22,24	4,20
330507	8626	1,4,7,8,14,15	16,17,23,24	1,99
330835	8627	1,2,4,5	8,9,10,11,13,14	3,06
330651	8634	1,2,3	7,8,9,10,11,12	5,34
330705	8635	1,2,3,4	7,8,9,10,11,12	2,85
331481	8636	1,2,3,4,5	9,10,11,12,13,14,15,16	5,86
330750	8637	1,2,3,4,5,6	10,11,12,13,14,15,16,17,18	9,72
330804	8638	1,2,3,4,5,6	11,12,13,14,15,16,17,18,19,20	7,72
331498	8640	1,2,3,4,5,6,7,8	12,13,14,15,16,17,18,19,20,21,22	7,57
330859	8641	1,2,3,4,5,6,7, 8,9,10	15,16,17,18,19,20,21,22,23,24,25,26,27,28	10,2
332068	8644	1,2,3,4,5,6,7, 8,9,10,11,12, 13,14	19,20,21,22,23,24,25,26,27,28,29, 30,31,32,33,34, 35,36	12,2
330903	8645	1,2,3,4,5,6,7,8,9, 10,11,12,13,14, 15,16, 17,18	21,22,23,24,25,26,27,28,29, 30,31,32,33,34,35,36 37,38,39,40	16,0
330354	8622	1,2,6,7	10,11,14,15,17,18	5,23
	8628	1,2,4,5,6,7,8,9,11, 12,13,14	17,18,22,23,26,27,31,32	8,37
	8629	1,2,4,5	9,10,14,15	5,71
330552	8632	1,2,6,9,12,13	14,15,18,21,25,26	4,83
330606	8633	1,4,6,9,12,13	16,17,18,19,22,25,27,30	6,34
334659	8654	1,3,6,7,12,13	14,15,16,19,20,21	8,03
334666	8655	1,2,4,5,7,8	9,10,12,13	3,09
	8625 90 FH1	1,2,4,5,6,7	12,13,14,15,17,18,19,21,22	6,64
	8626 10 FH1	1,2,4,5,6,7,8,9	12,13,14,15,17,18,19,20,21,22,23,25,26	10,09
	8632 90 FH1	1,2,4,5,6,7,8,9	12,13,16,17,18,19,21,22	8,18
	8633 10 FH1	1,2,4,5,6,7,8,9	12,13,14,15,16,17,18,19,20,21,22,23,25,26	7,08

Table 6: Forces $F_{2,3}$, 1 angle bracket / connection

EAN number	Type	Nail number n_V	Nail number n_h	$R_{2,3,Rk}$ [kN]
				Timber
	8612	1,2,3,4,6	10,11,12	2,20
	8613	1,2,3,4,5,7,8	13,14,15,16,18,19,20,21	3,73
	8614	1,2,3,4,5	7,8,9,10,11,12	2,27
	8615	1,2,3,4,5,6	8,9,10,11,12,13,14	2,49
330354	8622	1,2,6,7	10,11,14,15,17,18	2,61
	8628	1,2,4,5,6,7,8,9,11, 12,13,14	17,18,22,23,26,27,31,32	4,19
	8629	1,2,4,5	9,10,14,15	2,85
330552	8632	1,2,6,9,12,13	14,15,18,21,25,26	2,41
330606	8633	1,4,6,9,12,13	16,17,18,19,22,25,27,30	3,17
334659	8654	1,3,6,7,12,13	14,15,16,19,20,21	4,01
334666	8655	1,2,4,5,7,8	9,10,12,13	1,54
	8625 90 FH1	1,2,4,5,6,7	12,13,14,15,17,18,19,21,22	3,32
	8626 10 FH1	1,2,4,5,6,7,8,9	12,13,14,15,17,18,19,20,21,22,23,25,26	5,05
	8632 90 FH1	1,2,4,5,6,7,8,9	12,13,16,17,18,19,21,22	4,09
	8633 10 FH1	1,2,4,5,6,7,8,9	12,13,14,15,16,17,18,19,20,21,22,23,25,26	3,54

Table 7: Basic Forces $F_{4,5}$, 2 angle brackets / connection

EAN number	Type	Nail number n_V	Nail number n_h	$R_{4,5,Rk}$ [kN]	
				Timber	Steel
	8612	1,2,3,4,6	10,11,12	5,64	3,69
	8613	1,2,3,4,5,7,8	13,14,15,16,18,19,20,21	6,44	3,63
	8614	1,2,3,4,5	7,8,9,10,11,12	5,98	1,82
	8615	1,2,3,4,5,6	8,9,10,11,12,13,14	6,02	1,81
330149	8617	1,3,5,6,7,9,11,12	16,17,19,21,23,24	6,38	3,63
330255	8620	1,2	5,6,7,8	3,85	1,38
330309	8621	4,5	8,9,13,14	5,36	3,85
330408	8623	1,2,6,7	11,12,16,17	5,42	3,90
339630	8624	1,2,4,5	10,11,14,15,17,18	4,73	3,68
330453	8625	1,2,6,9,12,13	14,15,22,24	5,15	4,07
330507	8626	1,4,7,8,14,15	16,17,23,24	10,3	10,6
330835	8627	1,2,4,5	8,9,10,11,13,14	5,28	2,66
330651	8634	1,2,3	7,8,9,10,11,12	8,76	3,27
330705	8635	1,2,3,4	7,8,9,10,11,12	4,84	2,39
331481	8636	1,2,3,4,5	9,10,11,12,13,14,15,16	5,90	2,18
330750	8637	1,2,3,4,5,6	10,11,12,13,14,15,16,17,18	7,26	3,58
330804	8638	1,2,3,4,5,6	11,12,13, 14,15,16,17,18,19,20	7,81	4,44
331498	8640	1,2,3,4,5,6,7,8	12,13,14,15,16,17,18,19,20,21,22	7,18	2,89
330859	8641	1,2,3,4,5,6,7, 8,9,10	15,16,17,18,19,20,21,22,23, 24,25,26,27,28	8,75	4,73
332068	8644	1,2,3,4,5,6,7,8,9, 10,11,12,13,14	19,20,21,22,23,24,25,26,27,28,29, 30,31,32,33,34,35,36	9,66	4,67
330903	8645	1,2,3,4,5,6,7,8,9, 10,11,12,13,14, 15,16,17,18	21,22,23,24,25,26,27,28,29,30,31, 32,33,34,35,36,37,38,39,40	13,1	5,97
330354	8622	1,2,6,7	10,11,14,15,17,18	5,15	3,69
	8628	1,2,4,5,6,7,8,9,11, 12,13,14	17,18,22,23,26,27,31,32	13,8	6,51
	8629	1,2,4,5	9,10,14,15	5,96	3,26
330552	8632	1,2,6,9,12,13	14,15,18,21,25,26	6,11	7,70
330606	8633	1,4,6,9,12,13	16,17,18,19,22,25,27,30	6,70	9,32
334659	8654	1,3,6,7,12,13	14,15,16,19,20,21	5,39	6,93
334666	8655	1,2,4,5,7,8	9,10,12,13	4,82	4,12
	8625 90 FH1	1,2,4,5,6,7	12,13,14,15,17,18,19,21,22	8,67	3,83
	8626 10 FH1	1,2,4,5,6,7,8,9	12,13,14,15,17,18,19,20,21,22, 23,25,26	8,05	5,56
	8632 90 FH1	1,2,4,5,6,7,8,9	12,13,16,17,18,19,21,22	7,68	6,56
	8633 10 FH1	1,2,4,5,6,7,8,9	12,13,14,15,16,17,18,19,20,21, 22,23,25,26	11,19	9,48

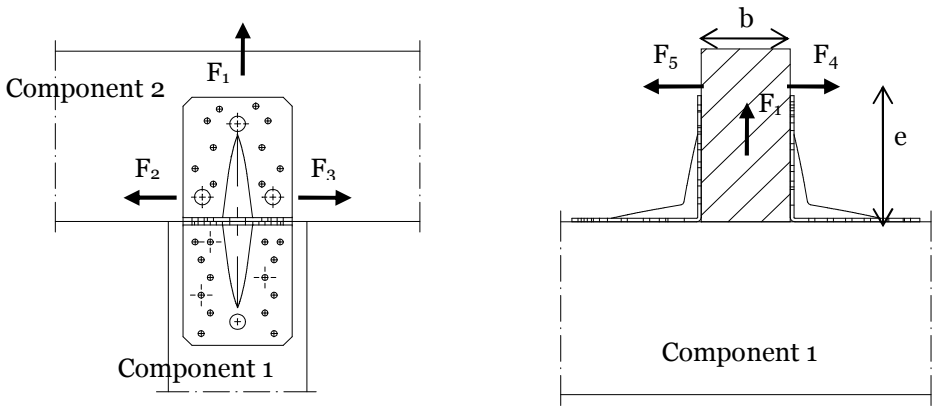
Table 8: Basic Forces F_4 1 angle bracket / connection

EAN number	Type	Nail number n_V	Nail number n_h	$R_{4,Rk}$ [kN]	
				Timber	Steel
330354	8622	1,2,6,7	10,11,14,15,17,18	7,53	2,71
	8628	1,2,4,5,6,7,8,9,11, 12,13,14	17,18,22,23,26,27,31,32	12,8	4,81
	8629	1,2,4,5	9,10,14,15	6,48	2,92
330552	8632	1,2,6,9,12,13	14,15,18,21,25,26	7,38	5,34
330606	8633	1,4,6,9,12,13	16,17,18,19,22,25,27,30	10,0	6,53
334659	8654	1,3,6,7,12,13	14,15,16,19,20,21	4,92	4,69
334666	8655	1,2,4,5,7,8	9,10,12,13	4,84	3,77
	8625 90 FH1	1,2,4,5,6,7	12,13,14,15,17,18,19,21,22	5,74	3,35
	8626 10 FH1	1,2,4,5,6,7,8,9	12,13,14,15,17,18,19,20,21,22, 23,25,26	7,10	4,90
	8632 90 FH1	1,2,4,5,6,7,8,9	12,13,16,17,18,19,21,22	7,68	4,78
	8633 10 FH1	1,2,4,5,6,7,8,9	12,13,14,15,16,17,18,19,20,21, 22,23,25,26	11,19	7,48

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

EAN number	Type	Nail number n_V	Nail number n_h	$R_{5,Rk}$ [kN]	
				Timber	Steel
330354	8622	1,2,6,7	10,11,14,15,17,18	1,34	1,11
	8628	1,2,4,5,6,7,8,9,11, 12,13,14	17,18,22,23,26,27,31,32	2,09	1,98
	8629	-	-	-	-
330552	8632	1,2,6,9,12,13	14,15,18,21,25,26	1,81	2,38
330606	8633	1,4,6,9,12,13	16,17,18,19,22,25,27,30	1,72	2,94
334659	8654	1,3,6,7,12,13	14,15,16,19,20,21	1,52	2,18
334666	8655	1,2,4,5,7,8	9,10,12,13	1,47	1,34
	8625 90 FH1	1,2,4,5,6,7	12,13,14,15,17,18,19,21,22	1,07	0,83
	8626 10 FH1	1,2,4,5,6,7,8,9	12,13,14,15,17,18,19,20,21,22, 23,25,26	1,29	1,19
	8632 90 FH1	1,2,4,5,6,7,8,9	12,13,16,17,18,19,21,22	2,31	1,97
	8633 10 FH1	1,2,4,5,6,7,8,9	12,13,14,15,16,17,18,19,20,21, 22,23,25,26	2,36	2,56

Definitions of forces, their directions and eccentricity
Forces - Beam to beam connection



Fastener specification
Holes are marked with numbers referring to the nailing pattern in Annex A.

Double angle brackets per connection
The angle brackets must be placed at each side opposite each other, symmetric to the component axis.

Acting forces

F_1	Lifting force acting along the central axis of the joint.
F_2 and F_3	Lateral force acting in the joint between the component 2 and component 1 in the component 2 direction
F_4 and F_5	Lateral force acting in the component 1 direction along the central axis of the joint. If the load is applied with an eccentricity e, a design for combined loading is required.

Single angle bracket per connection
Acting forces

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

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

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

Combined forces

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

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

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

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

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

B is the width of component 2.