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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 15/10/2014

### 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:

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](http://www.gah.de)

Manufacturing plant:

Gust. Alberts GmbH & Co KG  
Gewerbegebiet Grünenthal  
D-55845 Herscheid

This European Technical  
Assessment contains:

45 pages including 3 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 ETA with the same number issued on 2014/01/23

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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

GAH angle brackets with and without rib and GAH hold-downs are one-piece non-welded, face-fixed nailing plates 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 according to EN 14592 and to concrete or steel members with bolts or metal anchors.

The angle brackets and hold-downs are made from pre-galvanized steel DX 51 D / Z 275 according to EN 10346:2009 or stainless steel (1.4016, 1.4301, 1.4401, 1.4541, 1.4571) according to EN 10088-2:2005 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 and hold-downs are made with tolerances according to DIN 6930-2 from steel with tolerances according to EN 10143.

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

The angle brackets and hold downs 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<sup>3</sup> to 420 kg/m<sup>3</sup>. 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<sup>3</sup>. For timber or wood based material with a lower characteristic density than 350 kg/m<sup>3</sup> the load-carrying capacities shall be reduced by the  $k_{dens}$  factor:

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

Where  $\rho_k$  is the characteristic density of the timber in kg/m<sup>3</sup>.

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 3.11 of 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
<b>3.1 Mechanical resistance and stability*)</b>	
Characteristic load-carrying capacity	See Annex B
Stiffness	No performance determined
Ductility in cyclic testing	No performance determined
<b>3.2 Safety in case of fire</b>	
Reaction to fire	The angle brackets are made from steel classified as <b>Euroclass A1</b> in accordance with EN 1350-1 and EC decision 96/603/EC, amended by EC Decision 2000/605/EC
<b>3.3 Hygiene, health and the environment</b>	
Influence on air quality	No dangerous materials
<b>3.7 Sustainable use of natural resources (BR7)</b>	
	No Performance Determined
<b>3.8 General aspects related to the performance of the product</b>	
	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). In 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  $k_{\text{mod}}$ .

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  $F_{\text{Rk,H}}$  (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  $F_{\text{Rk,S}}$ . The design value of the load-carrying capacity is the smaller value of both load-carrying capacities.

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

Therefore, for timber failure the load duration class and the service class are included. The different partial factors  $\gamma_{\text{M}}$  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):

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

Where:

$f_{\text{ax,k}}$	Characteristic value of the withdrawal parameter in $\text{N/mm}^2$
$d$	Nail diameter in mm
$t_{\text{pen}}$	Penetration depth of the profiles shank in mm $t_{\text{pen}} \geq 30 \text{ mm}$

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:

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

Where:

$\sigma_{\text{k}}$	Characteristic density of the timber in $\text{kg/m}^3$
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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.

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.

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

The angle brackets and hold downs 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 B.

The following provisions concerning installation apply:

The structural members – the components 1 and 2 shown in the figure on page 21 - to which the brackets are fixed shall be:

- Restrained against rotation. At a load  $F_4/F_5$ , the component 2 is allowed to be restrained against rotation by the Angle brackets.
- Strength class C14 or better,
- Free from wane under the bracket.
- The gap between the timber members does not exceed 3 mm.
- There are no specific requirements relating to preparation of the timber members.

## **4 Assessment and verification of constancy of performance (AVCP)**

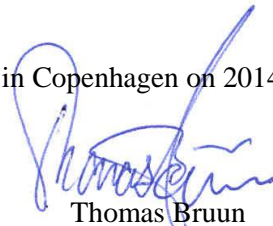
### **4.1 AVCP system**

According to the decision 97/638/EC of the European Commission<sup>1</sup>, 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

Issued in Copenhagen on 2014-10-15 by



Thomas Bruun  
Managing Director, ETA-Danmark

**Annex A**  
**Product details definitions**

Table A.1 Materials and Dimensions

<b>Bracket type</b>	<b>Height (mm) vertical</b>	<b>Height (mm) horizontal</b>	<b>Width (mm)</b>	<b>Thickness (mm)</b>	<b>Steel and coating specification</b>
8612	60	40	60	2,5	DX 51 D / Z 275 or stainless steel (1.4016, 1.4301, 1.4401, 1.4541, 1.4571)
8613	80	60	60	2,5	
8614	80	80	40	2,0	
8615	100	100	40	2,0	
8617	100	60	60	2,5	
8620	54	54	40	2,0	
8621	49	49	35,5	2,5	
8623	92	92	40	3,0	
8624	69	69	55	2,5	
8625	89	89	65	2,5	
8626	98	98	90	3,0	
8627	60	60	45	2,5	

<b>Bracket type</b>	<b>Height (mm) vertical</b>	<b>Height (mm) horizontal</b>	<b>Width (mm)</b>	<b>Thickness (mm)</b>	<b>Steel and coating specification</b>
8634	41	41	60	2,5	DX 51 D / Z 275 or stainless steel (1.4016, 1.4301, 1.4401, 1.4541, 1.4571)
8635	60	60	40	2,5	
8636	59	59	50	2,0	
8637	61	61	60	2,5	
8638	60	60	80	2,5	
8640	80	80	60	2,5	
8641	79,5	79,5	80	2,5	
8644	100	100	80	2,5	
8645	100	100	100	2,5	

<b>Bracket type</b>	<b>Height (mm) vertical</b>	<b>Height (mm) horizontal</b>	<b>Width (mm)</b>	<b>Thickness (mm)</b>	<b>Steel and coating specification</b>
8622	69	69	55	2,5	DX 51 D / Z 275 or stainless steel (1.4016, 1.4301, 1.4401, 1.4541, 1.4571)
8628	180	150	65	2,5	
8629	77	50	64	2,0	
8632	89	89	65	2,5	
8633	98	98	90	2,5	
8654	90,5	51	80	2,5	
8655	90,5	50,5	50	2,5	



Bracket type	Height (mm) vertical	Height (mm) horizontal	Width (mm)	Thickness (mm)	Steel and coating specification
8625 FH	90	90	65	2,5	DX 51 D / Z 275 or stainless steel (1.4016, 1.4301, 1.4401, 1.4541, 1.4571)
8626 FH	105	105	90	3,0	
8632 FH	90	90	65	2,5	
8633 FH	105	105	90	3,0	

Hold-down	Height (mm) vertical	Height (mm) horizontal	Width (mm)	Thickness (mm)	Steel and coating specification
8791	205	40	40	2,0	DX 51 D / Z 275 or stainless steel (1.4016, 1.4301, 1.4401, 1.4541, 1.4571)
8792	285	40	40	2,0	
8793	400	40	40	2,0	
8794	500	40	40	2,0	

Table A.2 Fastener specification

Fastener	Size (mm)			Finish
	Diameter	Length	Profiled length	
Threaded nail according to EN 14592	4,0	40	31	Electroplated zinc or stainless steel
<p>In the load-carrying-capacities of the nailed connection in Annex B the capacities calculated from the formulas of Eurocode 5 are used assuming a thick steel plate when calculating the lateral fastener load-carrying-capacity. The load-carrying-capacities of the angle brackets have been determined based on the use of connector nails <math>\varnothing</math> 4.0 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 1995-1-1:2010, paragraph 8.3.2 (head pull-through is not relevant):</p> $F_{ax,Rk} = f_{ax,k} \cdot d \cdot t_{pen}$ <p>where:</p> <p><math>f_{ax,k}</math> Characteristic value of the withdrawal parameter in <math>N/mm^2</math></p> <p><math>d</math> Nail diameter in mm</p> <p><math>t_{pen}</math> Penetration depth of the profiled shank in mm</p> <p>Based on tests by Versuchsanstalt für Stahl, Holz und Steine, Karlsruhe Institute of Technology, the characteristic value of the withdrawal resistance for the threaded nails used can be calculated as:</p> $f_{ax,k} = 50 \cdot 10^{-6} \cdot \rho_k^2$ <p>The shape of the nail or screw directly under the head shall be in the form of a truncated cone with a diameter under the head which fits or exceeds the hole diameter.</p>				
Bolt or Metal Anchor	Diameter		Correspondent Hole diameter	
Bolt according to EN 14592 Anchor according to ETA (see specification of the manufacturer)	10.0 mm , 12.0 mm		Max. 1 mm. larger than the bolt or anchor diameter	

**Annex B**  
**Characteristic load-carrying capacities**

**Angle brackets**  
**Connections timber to timber**

**Table 1:** Force  $F_1$  Column, 2 angle brackets per connection, timber to timber

EAN number	Type	Nail number $n_v$	Nail number $n_h$	$F_{1,Rk}$ [kN] (column)	
				Timber	Steel
	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 FH	1,2	12,13,14,15,17,18,19,21,22	4,45	2,20
	8626 FH	1,2,6,7	12,13,14,15,16,17,18,19,20, 21,22,23,25,26	6,75	2,60
	8632 FH	1,2	12,13,16,17,18,19,21,22	2,23	9,80
	8633 FH	1,2,6,7	12,13,14,15,16,17,18,19,20, 21,22,23,25,26	4,50	17,6

**Table 2:** Force  $F_1$  Column, 1 angle bracket per connection, timber to timber

EAN number	Type	Nail number $n_V$	Nail number $n_h$	$F_{1,Rk}$ [kN] (column)	
				Timber	Steel
	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 FH	1,2	12,13,14,15,17,18,19,21,22	2,23	1,10
	8626 FH	1,2,6,7	12,13,14,15,16,17,18,19,20, 21,22,23,25,26	3,38	1,30
	8632 FH	1,2	12,13,16,17,18,19,21,22	1,11	4,90
	8633 FH	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 per connection, timber to timber

EAN number	Type	Nail number $n_V$	Nail number $n_h$	$F_{1,Rk}$ [kN] (purlin)	
				Timber	Steel
	8612	1,2,3,4,6	10,11,12	2,28	2,22
	8613	1,2,3,4,6,7,8	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 FH	1,2,4,5,6,7	12,13,14,15,17,18,19,21,22	4,45	2,20
	8626 FH	1,2,4,5,6,7,8,9	12,13,14,15,16,17,18,19,20,21,22, 23,25,26	6,75	2,60
	8632 FH	1,2,4,5,6,7,8,9	12,13,16,17,18,19,21,22	2,23	9,80
	8633 FH	1,2,4,5,6,7,8,9	12,13,14,15,16,17,18,19,20,21, 22,23,25,26	4,50	17,6

**Table 4:** Force  $F_1$  Purlin, 1 angle bracket per connection, timber to timber

EAN number	Type	Nail number $n_v$	Nail number $n_h$	$F_{1,Rk}$ [kN] (purlin)	
				Timber	Steel
	8612	1,2,3,4,6	10,11,12	1,14	1,11
	8613	1,2,3,4,6,7,8	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 FH	1,2,4,5,6,7	12,13,14,15,17,18,19,21,22	2,23	1,10
	8626 FH	1,2,4,5,6,7,8,9	12,13,14,15,16,17,18,19,20,21,22, 23,25,26	3,38	1,30
	8632 FH	1,2,4,5,6,7,8,9	12,13,16,17,18,19,21,22	1,11	4,90
	8633 FH	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 per connection, timber to timber

EAN number	Type	Nail number $n_v$	Nail number $n_h$	$F_{2/3,Rk}$ [kN]
				Timber
	8612	1,2,3,4,6	10,11,12	4,40
	8613	1,2,3,4,6,7,8	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 FH	1,2,4,5,6,7	12,13,14,15,17,18,19,21,22	6,64
	8626 FH	1,2,4,5,6,7,8,9	12,13,14,15,16,17,18,19,21,22,23,25,26	10,1
	8632 FH	1,2,4,5,6,7,8,9	12,13,16,17,18,19,21,22	8,18
	8633 FH	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 per connection, timber to timber

EAN number	Type	Nail number $n_v$	Nail number $n_h$	$F_{2/3,Rk}$ [kN]	
				Timber	
	8612	1,2,3,4,6	10,11,12	2,20	
	8613	1,2,3,4,6,7,8	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 FH	1,2,4,5,6,7	12,13,14,15,17,18,19,21,22	3,32	
	8626 FH	1,2,4,5,6,7,8,9	12,13,14,15,16,17,18,19,21,22,23,25,26	5,05	
	8632 FH	1,2,4,5,6,7,8,9	12,13,16,17,18,19,21,22	4,09	
	8633 FH	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 per connection, timber to timber

EAN number	Type	Nail number $n_v$	Nail number $n_h$	$F_{4/5,Rk}$ [kN]	
				Timber	Steel
	8612	1,2,3,4,6	10,11,12	5,64	3,69
	8613	1,2,3,4,6,7,8	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 FH	1,2,4,5,6,7	12,13,14,15,17,18,19,21,22	8,67	3,83
	8626 FH	1,2,4,5,6,7,8,9	12,13,14,15,16,17,18,19,21,22, 23,25,26	8,05	5,56
	8632 FH	1,2,4,5,6,7,8,9	12,13,16,17,18,19,21,22	7,68	6,56
	8633 FH	1,2,4,5,6,7,8,9	12,13,14,15,16,17,18,19,20,21, 22,23,25,26	11,2	9,48

**Table 8:** Basic Forces  $F_4$  1 angle bracket per connection, timber to timber

EAN number	Type	Nail number $n_v$	Nail number $n_h$	$F_{4,Rk}$ [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 FH	1,2,4,5,6,7	12,13,14,15,17,18,19,21,22	5,74	3,35
	8626 FH	1,2,4,5,6,7,8,9	12,13,14,15,16,17,18,19,21,22, 23,25,26	7,10	4,90
	8632 FH	1,2,4,5,6,7,8,9	12,13,16,17,18,19,21,22	7,68	4,78
	8633 FH	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 per connection, timber to timber

EAN number	Type	Nail number $n_v$	Nail number $n_h$	$F_{5,Rk}$ [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 FH	1,2,4,5,6,7	12,13,14,15,17,18,19,21,22	1,07	0,83
	8626 FH	1,2,4,5,6,7,8,9	12,13,14,15,16,17,18,19,21,22, 23,25,26	1,29	1,19
	8632 FH	1,2,4,5,6,7,8,9	12,13,16,17,18,19,21,22	2,31	1,97
	8633 FH	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



**Angle brackets****Connections timber to concrete or timber to steel****Table 10:** Force  $F_1$  Column, 2 angle brackets per connection, connection timber to concrete/steel

EAN number	Type	Nail number $n_v$	Bolt number $n_h$	$F_{1,Rk}$ [kN] (column)		bolt
				Timber	Steel	$k_{t,II}$
	8612	-	13	-	-	-
	8613	1,2,3	17	9,65	1,17	1,3
330149	8617	1,2,3,7,8,9	20	19,3	1,22	1,3
	8621	-	12	-	-	-
330408	8623	1,2,6,7	13	12,8	1,36	0,8
339630	8624	1,2	16	6,43	0,80	2,5
330835	8627	1,2	12	6,43	0,79	2,0
330354	8622	1,2	16	6,43	0,80	2,5
	8628	22,23,26,27,31,32	10	19,3	0,44	1,1
	8629	1,2	13	6,48	0,71	1,6
334659	8654	1,2,3	17 or 18	9,65	1,45	2,9
334666	8655	1,2,4,5	11	12,9	0,98	3,3
	8625 FH	1,2	16	6,43	1,72	0,8
	8626 FH	1,2,6,7	24	12,8	1,14	3,3
	8632 FH	1,2	20	6,43	0,61	5,7
	8633 FH	1,2,6,7	24	12,8	1,14	3,3

**Table 11:** Force  $F_1$  Column, 1 angle bracket per connection, connection timber to concrete/steel

EAN number	Type	Nail number $n_v$	Bolt number $n_h$	$F_{1,Rk}$ [kN] (column)		bolt
				Timber	Steel	$k_{t,II}$
330354	8622	1,2	16	3,22	0,40	4,9
	8628	22,23,26,27,31,32	10	9,65	0,22	2,1
	8629	1,2	13	3,24	0,36	3,1
334659	8654	1,2,3	17 or 18	4,83	0,73	5,8
334666	8655	1,2,4,5	11	6,43	0,49	6,5
	8632 FH	1,2	20	3,22	0,30	11,3
	8633 FH	1,2,6,7	24	6,38	0,57	6,7

**Table 12:** Force  $F_1$  Purlin, 2 angle brackets per connection, connection timber to concrete/steel

EAN number	Type	Nail number $n_v$	Bolt number $n_h$	$F_{1,Rk}$ [kN] (purlin)		bolt
				Timber	Steel	$k_{t,II}$
	8612	1,2,3,4,6	13	16,1	1,76	2,5
	8613	1,2,3,4,5,7,8	17	22,5	1,17	1,3
330149	8617	1,3,5,6,7,9,11,12	20	25,7	1,22	1,3
	8621	4,5	12	6,43	0,72	1,9
330408	8623	1,2,6,7	13	12,8	1,36	0,8
339630	8624	1,2,4,5	16	12,9	0,80	2,5

330835	8627	1,2,4,5	12	12,9	0,79	2,0
330354	8622	1,2,6,7	16	12,9	0,80	2,5
	8628	19,20,22,23,24,25,26,27,28,29,31,32	10	38,6	0,44	1,1
	8629	1,2,4,5	13	13,0	0,71	1,6
334659	8654	1,3,6,7,12,13	17 or 18	19,3	1,45	2,9
334666	8655	1,2,4,5,7,8	11	19,3	0,98	3,3
	8625 FH	1,2,4,5,6,7	16	19,3	1,72	0,8
	8626 FH	1,2,4,5,6,7,8,9	24	25,5	1,14	3,3
	8632 FH	1,2,4,5,6,7,8,9	20	25,7	0,61	5,7
	8633 FH	1,2,4,5,6,7,8,9	24	25,5	1,14	3,3

**Table 13:** Force  $F_1$  Purlin, 1 angle bracket per connection, connection timber to concrete/steel

EAN number	Type	Nail number $n_v$	Bolt number $n_h$	$F_{1,Rk}$ [kN] (purlin)		bolt $k_{t,  }$
				Timber	Steel	
330354	8622	1,2,6,7	16	6,43	0,40	4,9
	8628	19,20,22,23,24,25,26,27,28,29,31,32	10	19,3	0,22	2,1
	8629	1,2,4,5	13	6,48	0,36	3,1
334659	8654	1,3,6,7,12,13	17 or 18	9,65	0,73	5,8
334666	8655	1,2,4,5,7,8	11	9,65	0,49	6,5
	8632 FH	1,2,4,5,6,7,8,9	20	12,9	0,30	11,3
	8633 FH	1,2,4,5,6,7,8,9	24	12,8	0,57	6,7

**Table 14:** Forces  $F_{2,3}$ , 2 angle brackets per connection, connection timber to concrete/steel

EAN number	Type	Nail number $n_v$	Bolt number $n_h$	$F_{2/3,Rk}$ [kN]	bolt $k_{t,\perp}$
				Timber	
	8612	1,2,3,4,6	13	3,11	0,5
	8613	1,2,3,4,5,7,8	17	3,01	0,5
330149	8617	1,3,5,6,7,9,11,12	20	4,04	0,5
	8621	4,5	12	1,02	0,5
330408	8623	1,2,6,7	13	1,97	0,5
339630	8624	1,2,4,5	16	1,90	0,5
330835	8627	1,2,4,5	12	1,61	0,5
330354	8622	1,2,6,7	16	1,56	0,5
	8628	19,20,22,23,24,25,26,27,28,29,31,32	10	3,29	0,5
	8629	1,2,4,5	13	-	-
334659	8654	1,3,6,7,12,13	17 or 18	5,04	0,5
334666	8655	1,2,4,5,7,8	11	2,78	0,5
	8625 FH	1,2,4,5,6,7	16	3,70	0,5
	8626 FH	1,2,4,5,6,7,8,9	24	3,11	0,5
	8632 FH	1,2,4,5,6,7,8,9	20	2,78	0,5
	8633 FH	1,2,4,5,6,7,8,9	24	3,11	0,5

**Table 15:** Forces  $F_{2,3}$ , 1 angle bracket per connection, connection timber to concrete/steel

EAN number	Type	Nail number $n_v$	Bolt number $n_h$	$F_{2/3,Rk}$ [kN]		bolt
				Timber	Steel	$k_{t,\perp}$
330354	8622	1,2,6,7	16	0,78		1,0
	8628	19,20,22,23,24,25,26,27,28,29,31,32	10	1,64		1,0
	8629	1,2,4,5	13	-		1,0
334659	8654	1,3,6,7,12,13	17 or 18	2,52		1,0
334666	8655	1,2,4,5,7,8	11	1,39		1,0
	8632 FH	1,2,4,5,6,7,8,9	20	1,39		1,0
	8633 FH	1,2,4,5,6,7,8,9	24	1,55		1,0

**Table 16:** Basic Forces  $F_{4,5}$ , 2 angle brackets per connection, connection timber to concrete/steel

EAN number	Type	Nail number $n_v$	Bolt number $n_h$	$F_{4/5,Rk}$ [kN]		bolt	
				Timber	Steel	$k_{t,\perp}$	$k_{t,\parallel}$
	8612	1,2,3,4,6	13	6,57	3,36	0,8	0,2
	8613	1,2,3,4,5,7,8	17	6,01	3,51	0,8	0,2
330149	8617	1,3,5,6,7,9,11,12	20	6,52	3,47	0,8	0,2
	8621	4,5	12	4,14	1,82	0,7	0,2
330408	8623	1,2,6,7	13	5,66	2,88	0,8	0,1
339630	8624	1,2,4,5	16	6,13	3,09	0,8	0,1
330835	8627	1,2,4,5	12	5,26	2,59	0,8	0,2
330354	8622	1,2,6,7	16	5,33	3,63	0,7	0,2
	8628	19,20,22,23,24,25,26,27,28,29,31,32	10	8,38	5,86	0,7	0,2
	8629	1,2,4,5	13	7,04	4,00	0,8	0,2
334659	8654	1,3,6,7,12,13	17 or 18	6,20	5,83	0,7	0,2
334666	8655	1,2,4,5,7,8	11	5,43	3,70	0,7	0,2
	8625 FH	1,2,4,5,6,7	16	7,17	3,54	0,9	0,2
	8626 FH	1,2,4,5,6,7,8,9	24	9,10	6,59	0,8	0,1
	8632 FH	1,2,4,5,6,7,8,9	20	8,42	5,64	0,7	0,2
	8633 FH	1,2,4,5,6,7,8,9	24	10,2	9,41	0,4	0,2

**Table 17:** Basic Forces  $F_4$  1 angle bracket per connection, connection timber to concrete/steel

EAN number	Type	Nail number $n_v$	Bolt number $n_h$	$F_{4,Rk}$ [kN]		bolt
				Timber	Steel	$k_{t,\perp}$
330354	8622	1,2,6,7	16	5,61	2,67	1,0
	8628	19,20,22,23,24,25,26,27,28,29,31,32	10	9,88	4,35	1,0
	8629	1,2,4,5	13	6,32	3,25	1,0
334659	8654	1,3,6,7,12,13	17 or 18	8,16	4,35	1,0
334666	8655	1,2,4,5,7,8	11	5,84	2,64	1,0
	8632 FH	1,2,4,5,6,7,8,9	20	9,77	4,60	1,0
	8633 FH	1,2,4,5,6,7,8,9	24	13,0	6,92	1,0

**Table 18:** Basic Forces  $F_5$ , 1 angle bracket per connection, connection timber to concrete/steel

EAN number	Type	Nail number $n_v$	Bolt number $n_h$	$F_{5,Rk}$ [kN]		bolt	
				Timber	Steel	$k_{t,\perp}$	$k_{t,\parallel}$
330354	8622	1,2,6,7	16	1,40	1,06	1,0	0,6
	8628	19,20,22,23,24,25,26,27,28,29,31,32	10	2,16	1,64	1,0	0,7
	8629	1,2,4,5	13	1,32	0,91	1,0	1,2
334659	8654	1,3,6,7,12,13	17 or 18	1,72	1,62	1,0	0,8
334666	8655	1,2,4,5,7,8	11	1,61	1,10	1,0	0,7
	8632 FH	1,2,4,5,6,7,8,9	20	2,59	1,73	1,0	0,5
	8633 FH	1,2,4,5,6,7,8,9	24	2,72	2,52	1,0	0,7

## Hold-Downs

### Connections timber to concrete

**Table 19:** Force  $F_1$  Column, 1 hold-down per connection, timber to concrete, softwood<sup>1)</sup>  $\rho_k = 350 \text{ kg/m}^3$

		Timber	Concrete	Steel
EAN number	Type	capacity per nail in the vertical flange $F_{v,Rk}$ [kN]		tensile capacity $F_{t,Rk}$ [kN]
	8791	$n \cdot 1,62$	see EN1992	17,8
	8792	$n \cdot 1,62$		17,8
	8793	$n \cdot 1,62$		17,8
	8794	$n \cdot 1,62$		17,8

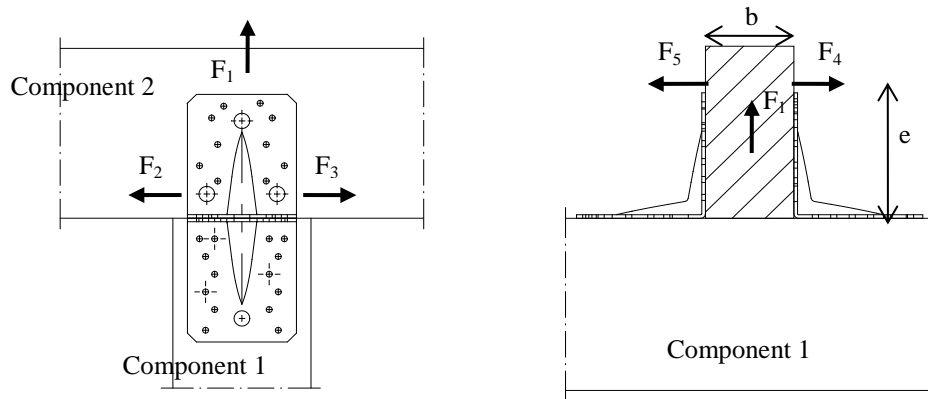
<sup>1)</sup> For other characteristic softwood densities,  $F_{v,Rk}$  is multiplied by  $k_{dens} = \left(\frac{\rho_k}{350}\right)^{0,5}$ ;

For hardwoods,  $F_{v,Rk}$  is calculated according to EN 1995-1-1;

If a wood-based panel interlayer with a thickness of not more than 26 mm is placed between the connector plate and the timber member, the lateral load-carrying capacity of the nail or screw, respectively, has to take into account the effect of the interlayer.

## 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 B.

### 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:

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

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  $F_3$ , 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  $\Delta F_1$  has to be added to the existing force  $F_1$ .

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

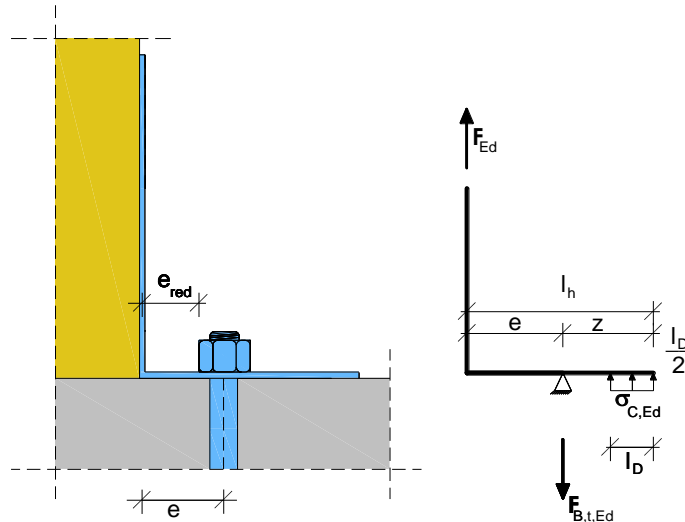
$B$  is the width of component 2.

### Connection of timber to concrete or steel with bolts or metal anchors

The load  $F_{B,Ed}$  for the design of the maximally loaded bolt or metal anchor is calculated as:

$$F_{B,t,Ed} = k_{t,\parallel} \cdot F_{Ed}$$

$$F_{B,v,Ed} = k_{t,\perp} \cdot F_{Ed}$$



where:

- $F_{B,t,Ed}$  Resulting tensile load on the maximally loaded bolt in the group in N
- $F_{B,v,Ed}$  Resulting shear load on the maximally loaded bolt in the group in N
- $k_{t,\parallel}$  Coefficient taking into account the resulting axial force
- $k_{t,\perp}$  Coefficient taking into account the moment arm or hole tolerance, respectively
- $F_{Ed}$  Load on vertical flap of the angle bracket or pair of angle brackets in N
- $b$  Width of the washer in mm
- $\sigma_{C,Ed}$  compressive stress on the support in  $N/mm^2$
- $l_D$  Length of the section under compressive stress in mm (usually 10 mm)

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

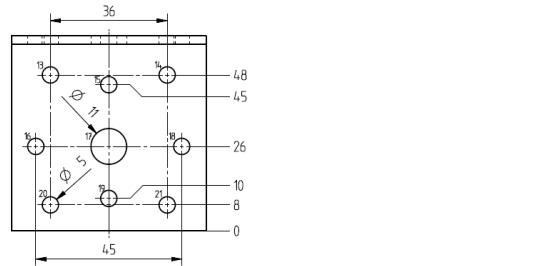
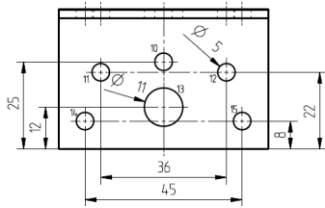
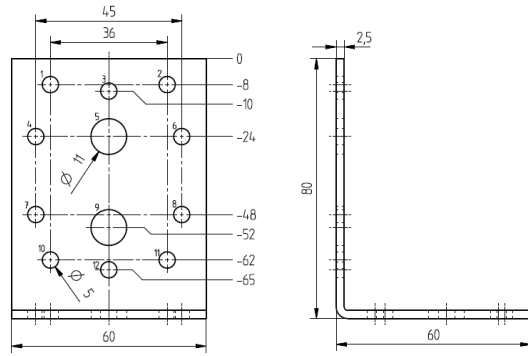
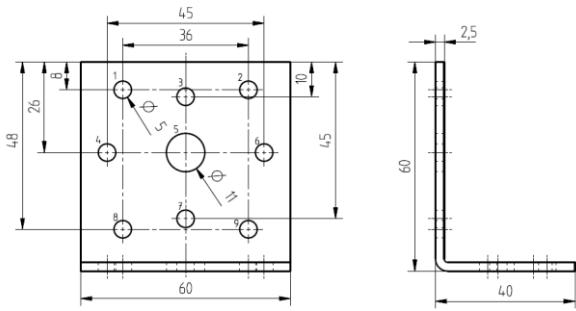


Figure A.1 Dimensions of Angle Bracket 8612

Figure A.2 Dimensions of Angle Bracket 8613

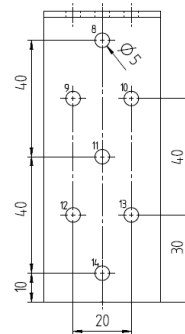
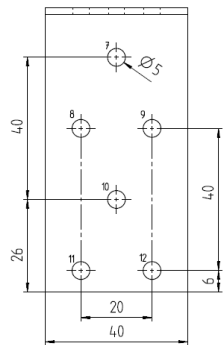
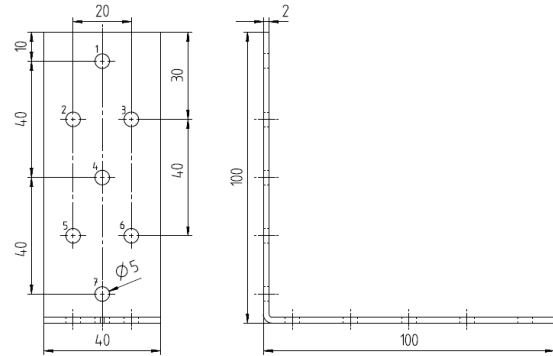
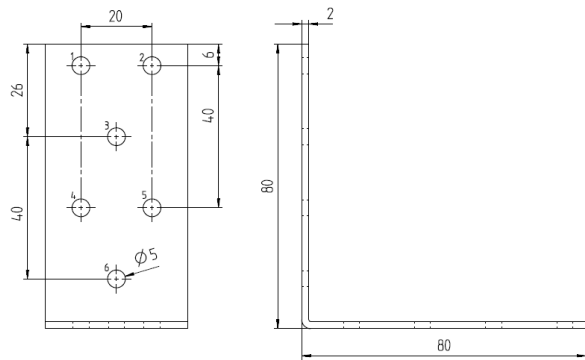


Figure A.3 Dimensions of Angle Bracket 8614

Figure A.4 Dimensions of Angle Bracket 8615



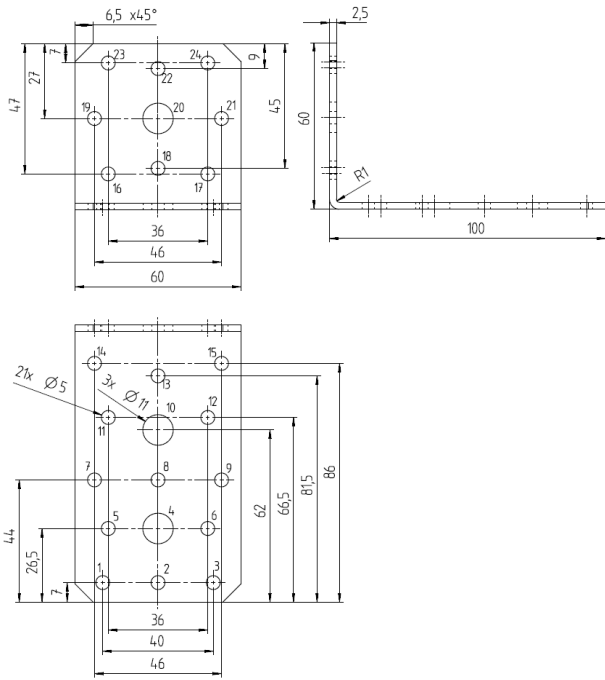


Figure A.5 Dimensions of Angle Bracket 8617

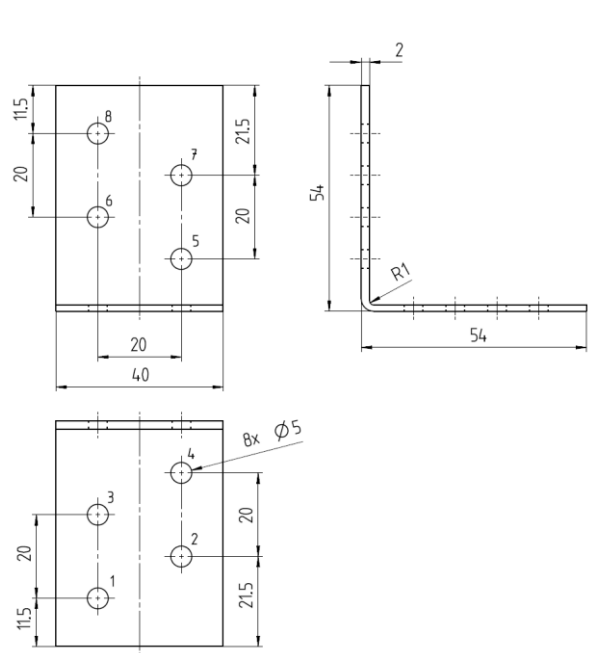


Figure A.6 Dimensions of Angle Bracket 8620

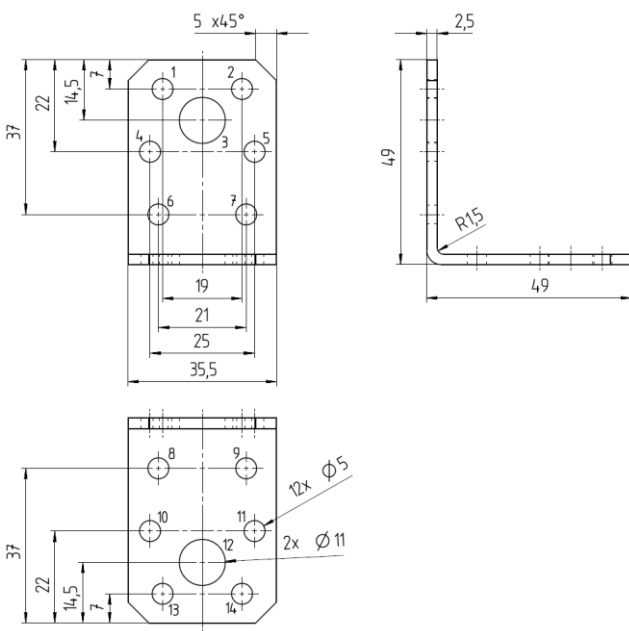


Figure A.7 Dimensions of Angle Bracket 8621

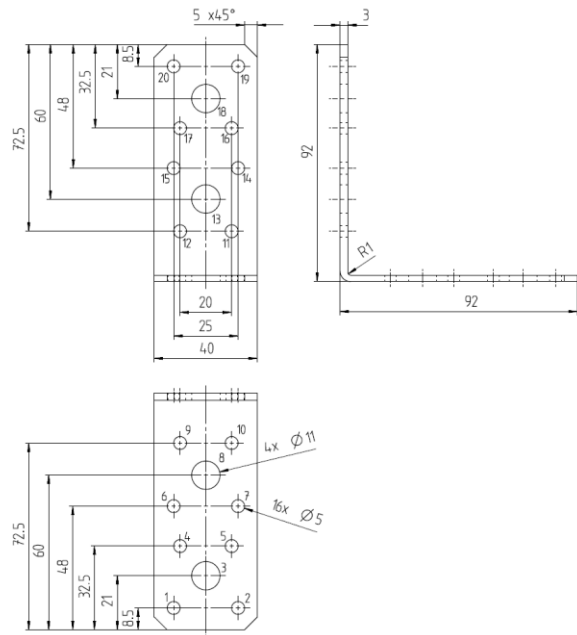


Figure A.8 Dimensions of Angle Bracket 8623

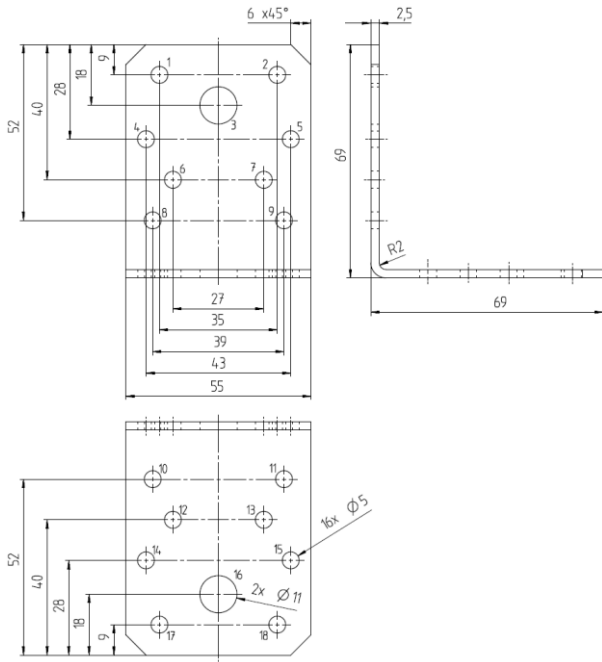


Figure A.9 Dimensions of Angle Bracket 8624

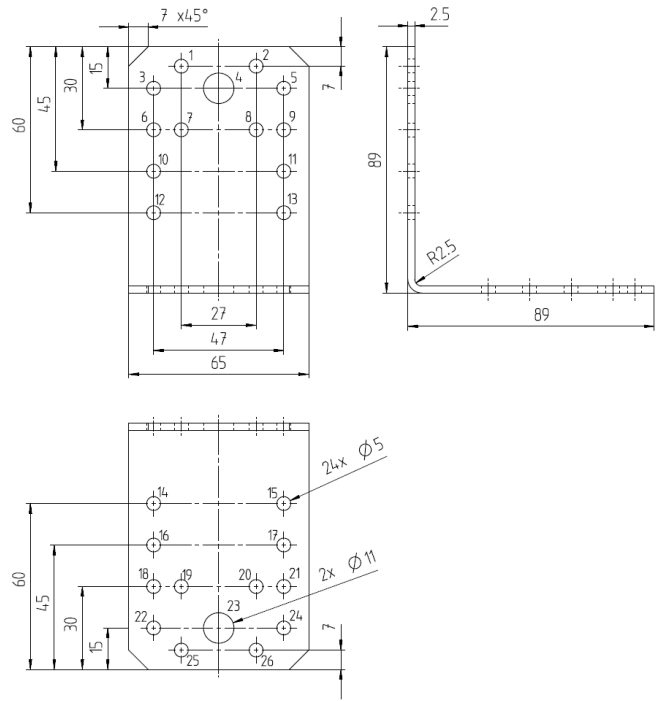


Figure A.10 Dimensions of Angle Bracket 8625

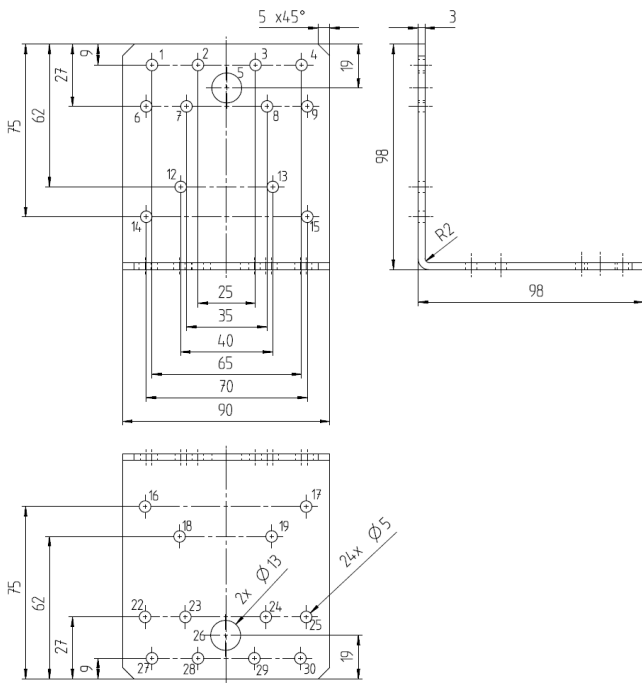


Figure A.11 Dimensions of Angle Bracket 8626

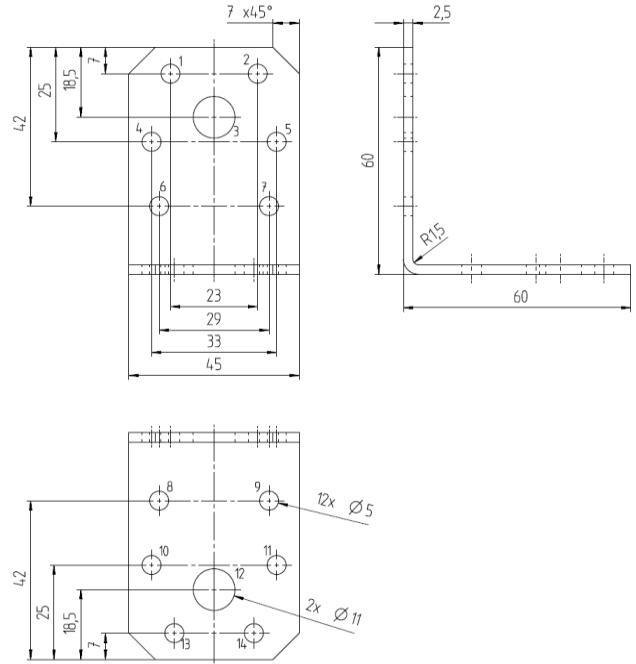


Figure A.12 Dimensions of Angle Bracket 8627

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

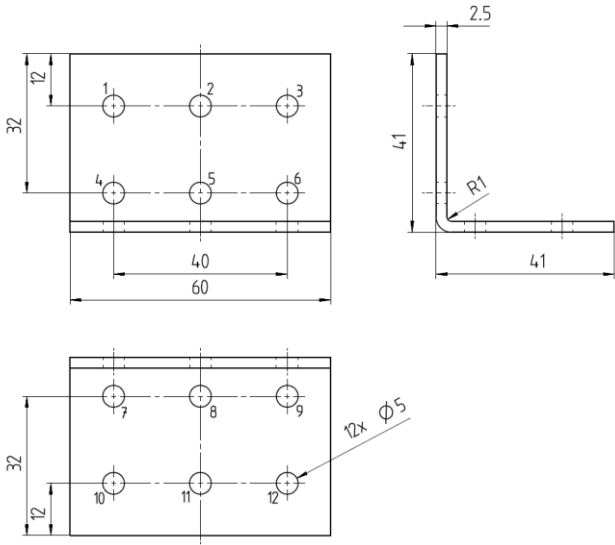


Figure A.13 Dimensions of Angle Bracket 8634

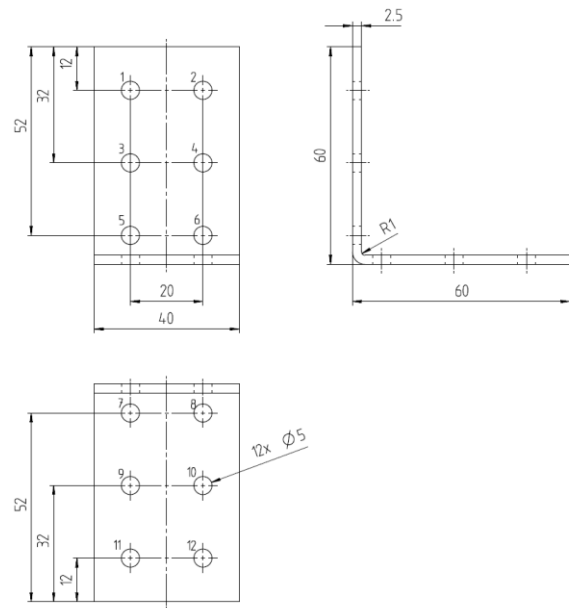


Figure A.14 Dimensions of Angle Bracket 8635

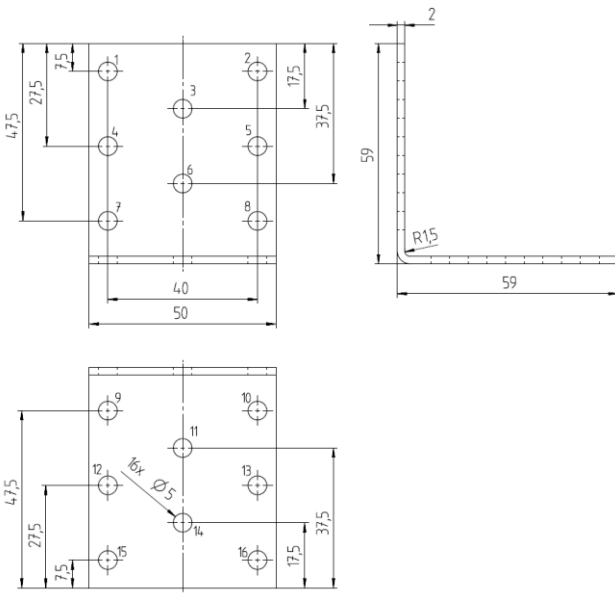


Figure A.15 Dimensions of Angle Bracket 8636

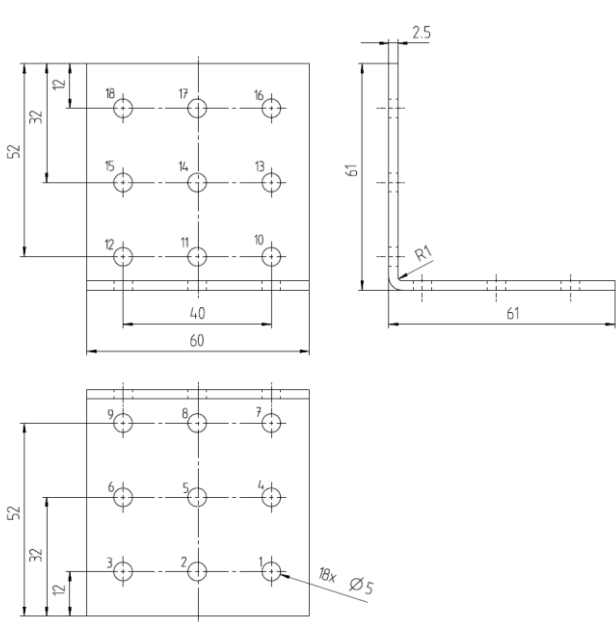


Figure A.16 Dimensions of Angle Bracket 8637

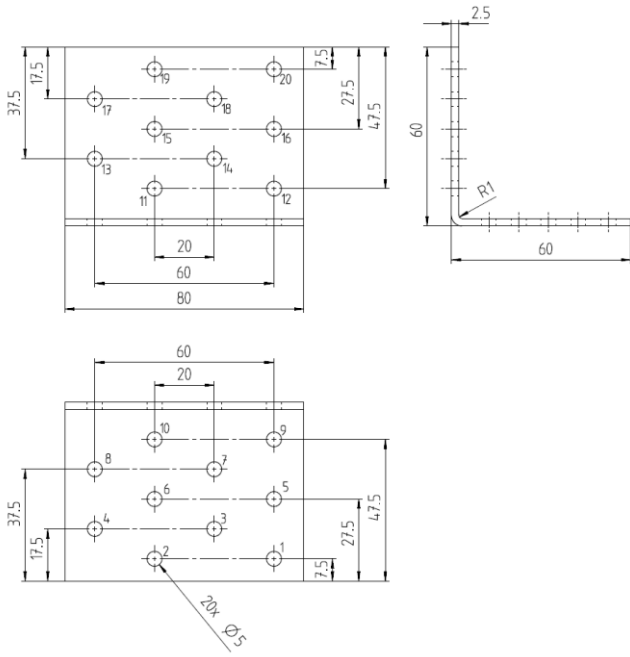


Figure A.17 Dimensions of Angle Bracket 8638

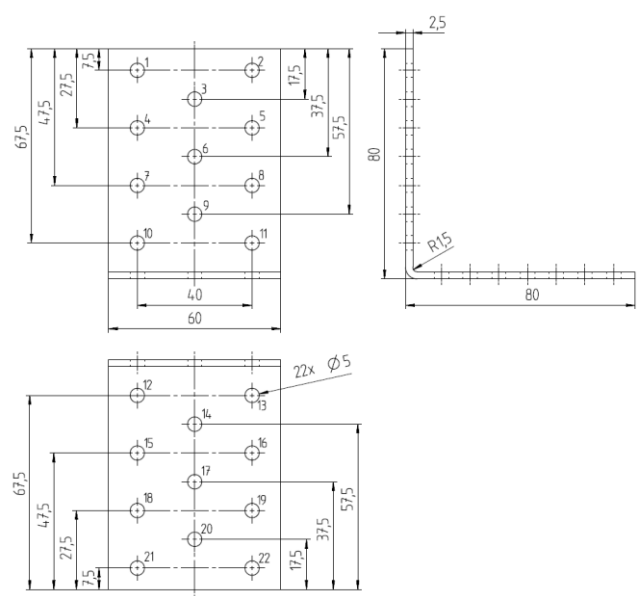


Figure A.18 Dimensions of Angle Bracket 8640

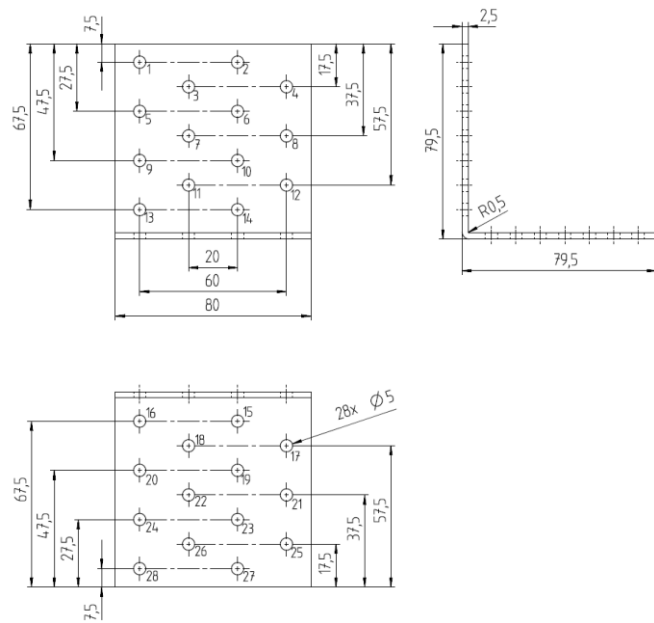


Figure A.19 Dimensions of Angle Bracket 8641

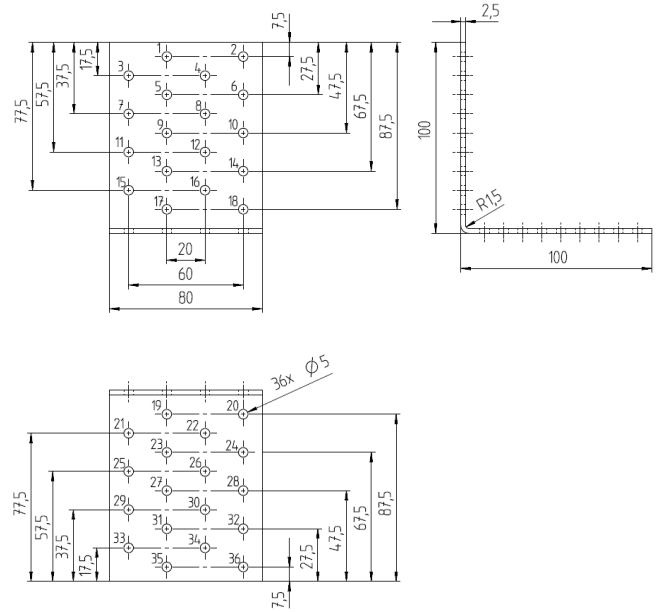


Figure A.20 Dimensions of Angle Bracket 8644

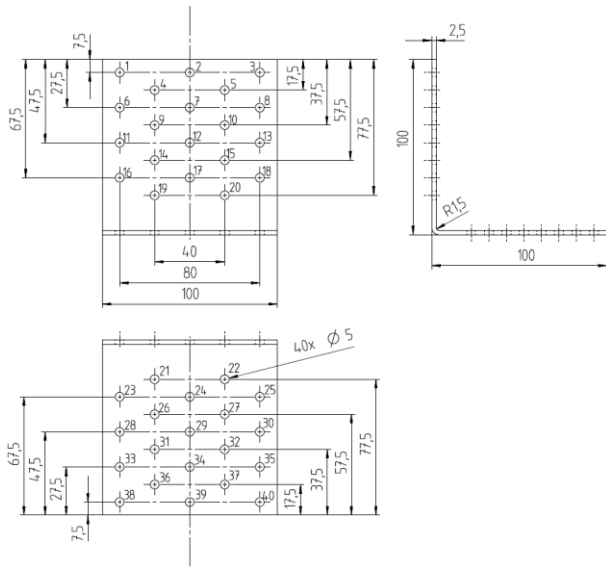


Figure A.21 Dimensions of Angle Bracket 8645

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

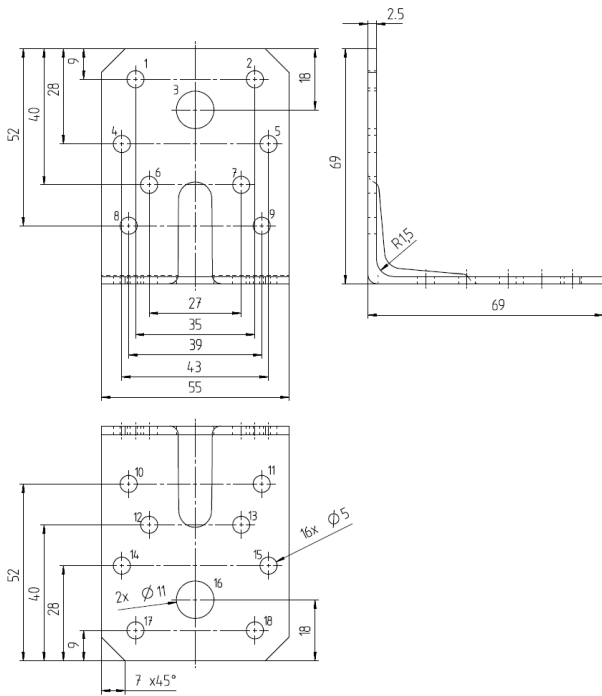


Figure A.22 Dimensions of Angle Bracket 8622

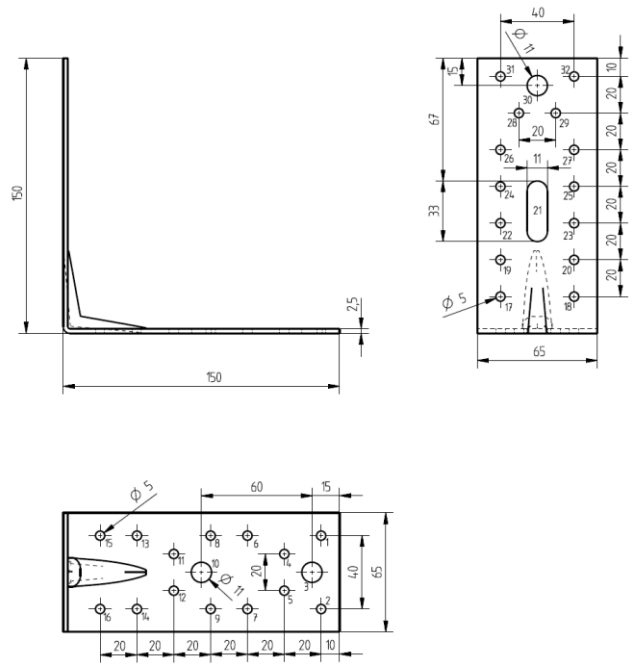


Figure A.23 Dimensions of Angle Bracket 8628

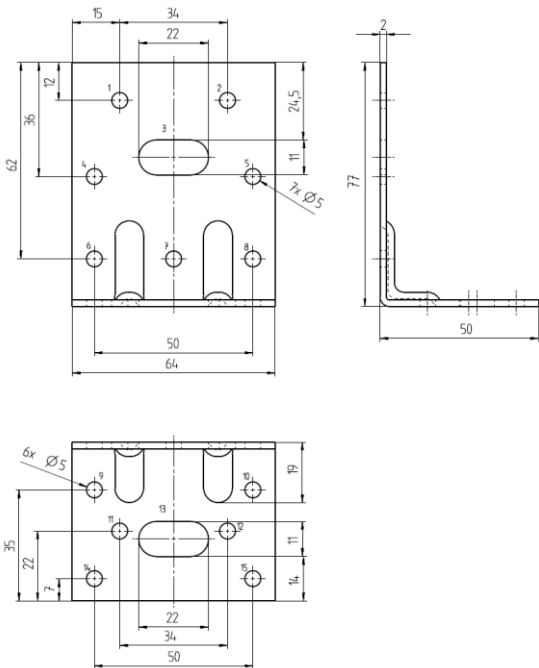


Figure A.24 Dimensions of Angle Bracket 8629

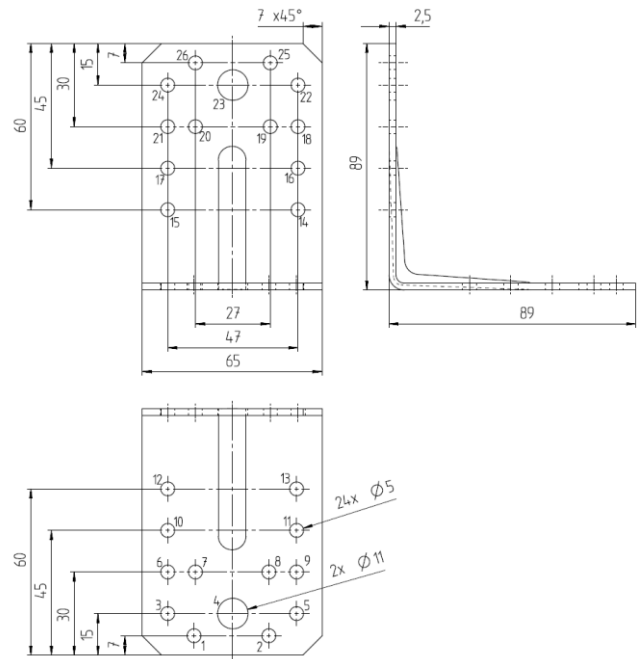


Figure A.25 Dimensions of Angle Bracket 8632

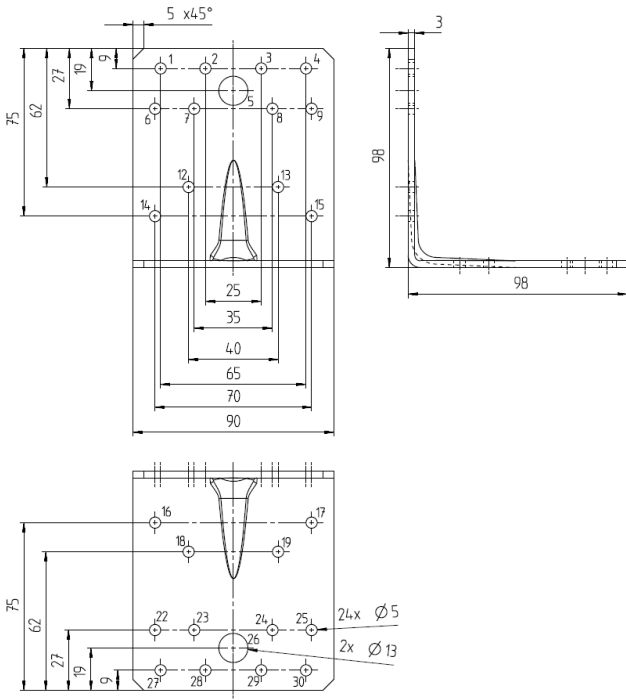


Figure A.26 Dimensions of Angle Bracket 8633

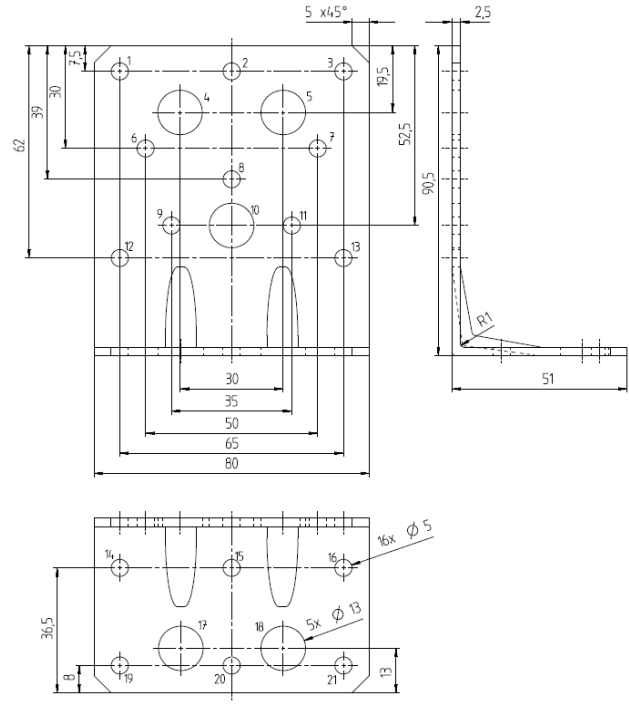


Figure A.27 Dimensions of Angle Bracket 8654

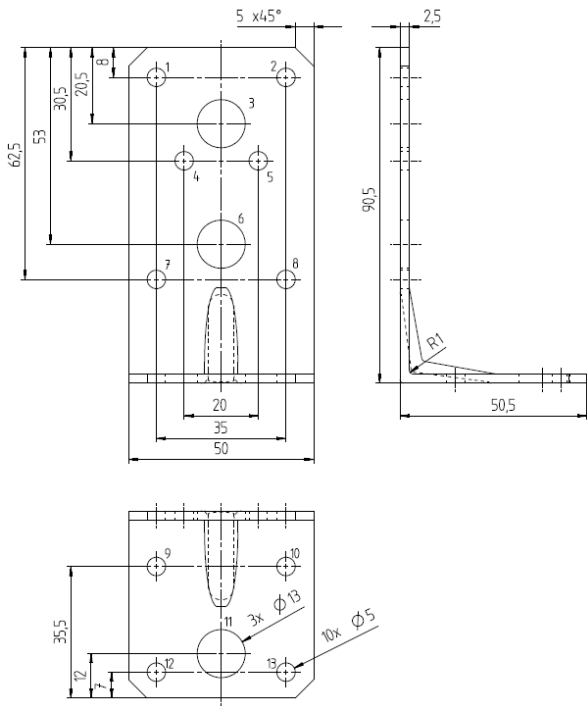


Figure A.28 Dimensions of Angle Bracket 8655

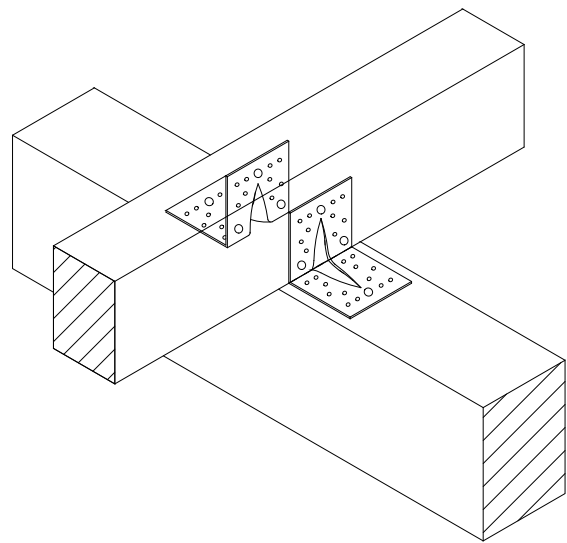


Figure A.29 Typical installation

**GAH Angle Brackets FH (8625 FH, 8626 FH, 8632 FH, 8633 FH)**

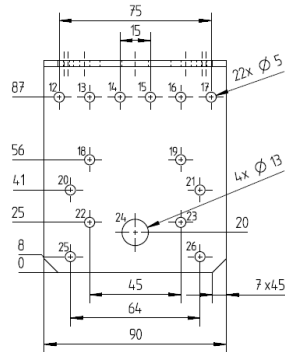
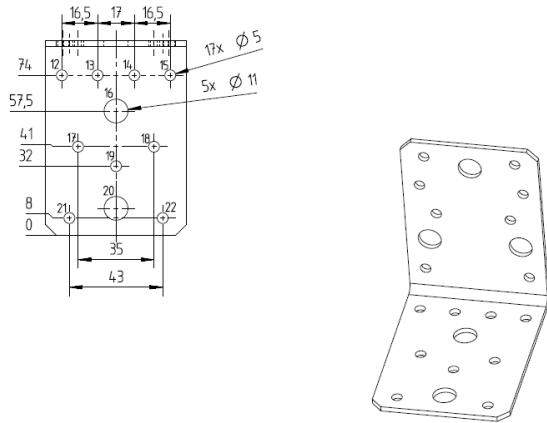
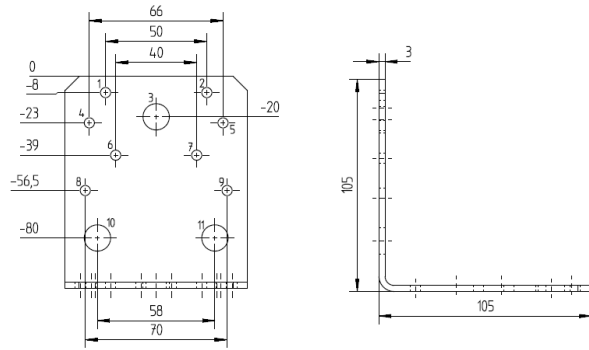
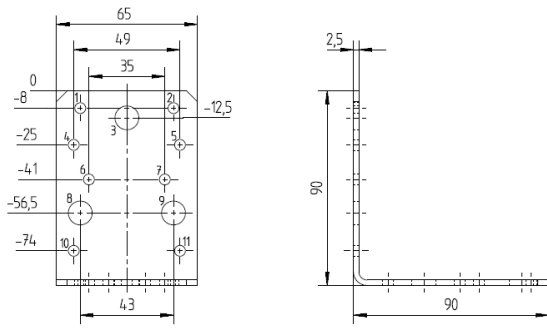


Figure A.30 Dimensions of AB 8625 FH

Figure A.31 Dimensions of AB 8626 FH

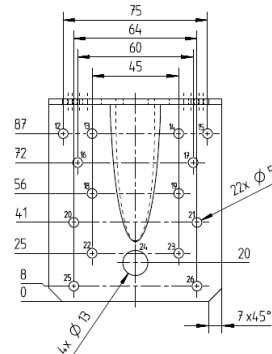
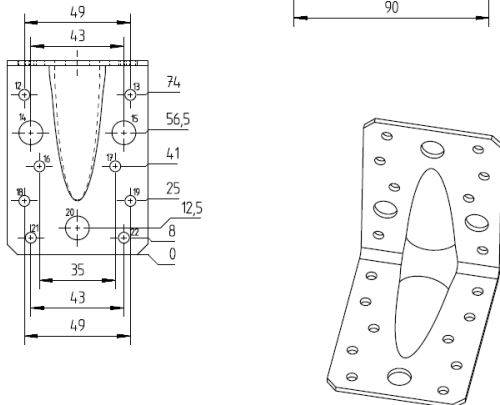
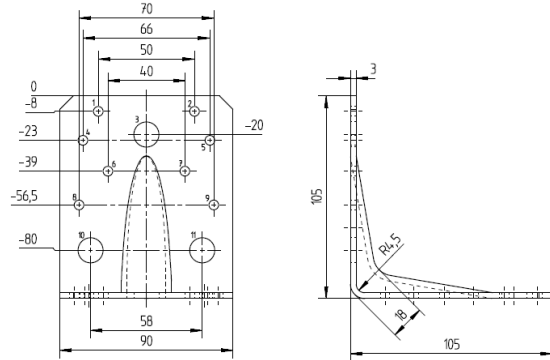
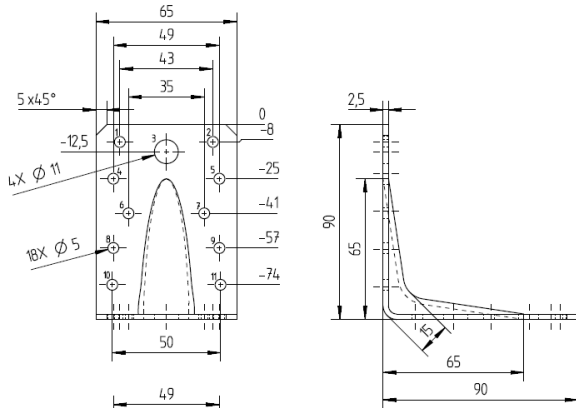


Figure A.32 Dimensions of AB 8632 FH

Figure A.33 Dimensions of AB 8633 FH



**GAH Hold-downs (8791, 8792, 8793, 8794)**

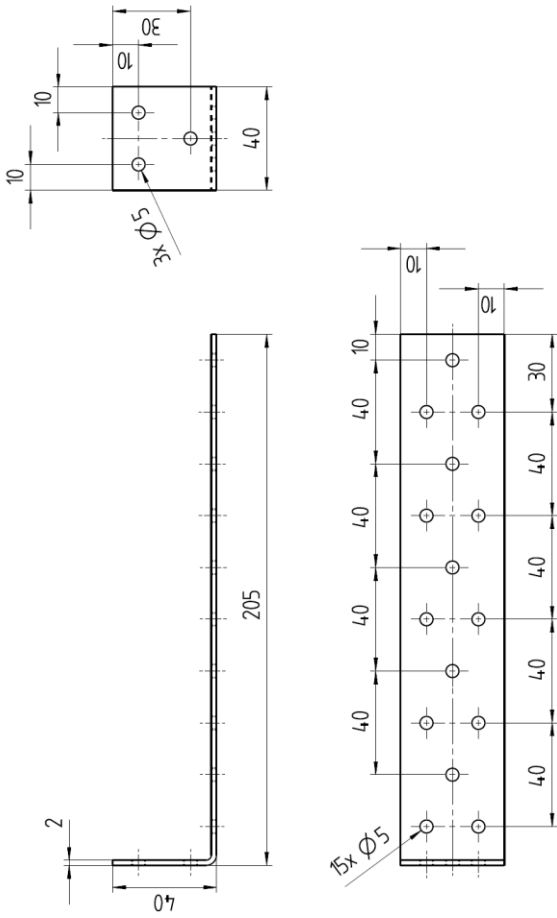


Figure A.34 Dimensions of hold-down 8791

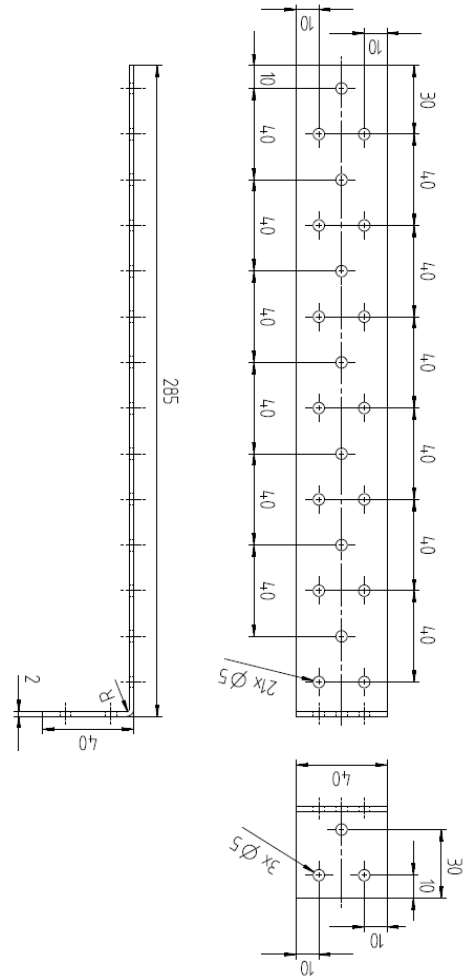


Figure A.35 Dimensions of hold-down 8792

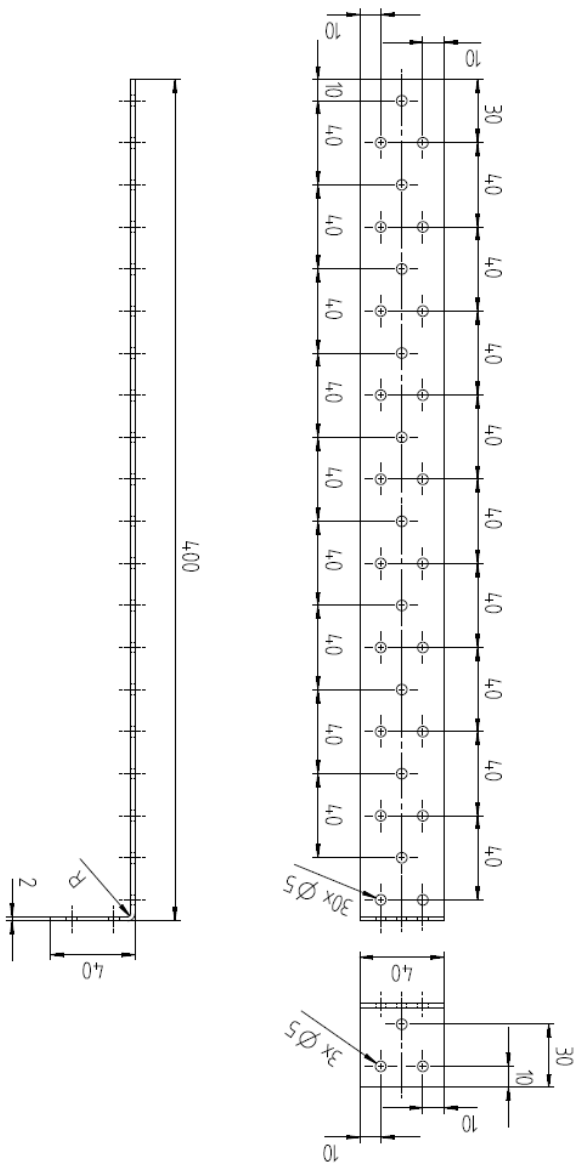


Figure A.36 Dimensions of hold-down 8793

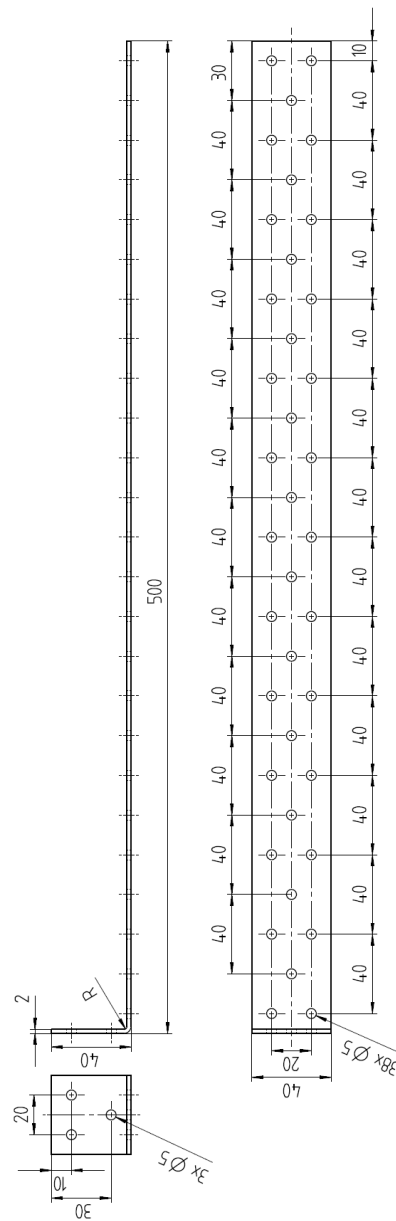
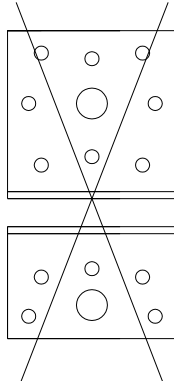


Figure A.37 Dimensions of hold-down 8794

**Nail Patterns – Angle Bracket 8612**

**LC 1 – column**

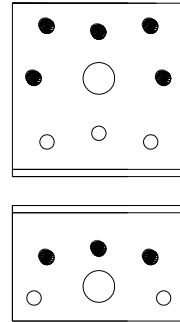
Nails in hole number:



**LC 1 – purlin, LC 2,3, LC 4,5**

Nails in hole number:

1,2,3,4,6 /  
10,11,12

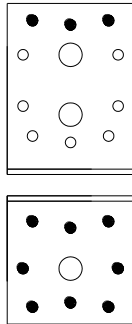


**Nail Patterns – Angle Bracket 8613**

**LC 1 – column**

Nails in hole number:

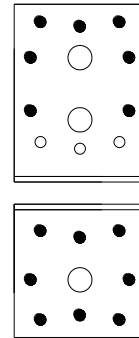
1,2,3 /  
13,14,15,16,18,19,20,21



**LC 1 – purlin, LC 2,3, LC 4,5**

Nails in hole number:

1,2,3,4,6,7,8 /  
13,14,15,16,18,19,20,21

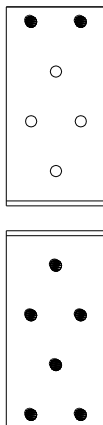


**Nail Patterns – Angle Bracket 8614**

**LC 1 – column**

Nails in hole number:

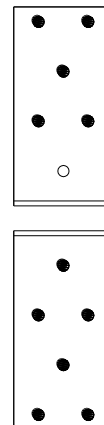
1,2 /  
7,8,9,10,11,12



**LC 1 – purlin, LC 2,3, LC 4,5**

Nails in hole number:

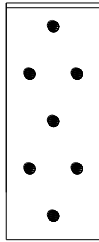
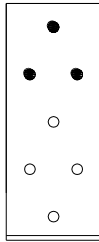
1,2,3,4,5 /  
7,8,9,10,11,12



**Nail Patterns – Angle Bracket 8615**

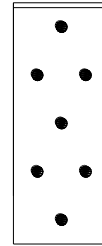
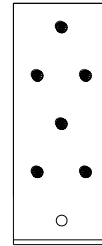
**LC 1 – column**

Nails in hole number:  
1,2,3 /  
8,9,10,11,12,13,14



**LC 1 – purlin, LC 2,3, LC 4,5**

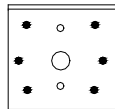
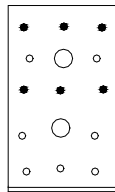
Nails in hole number:  
1,2,3,4,5,6 /  
8,9,10,11,12,13,14



**Nail Patterns – Angle Bracket 8617**

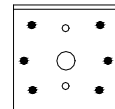
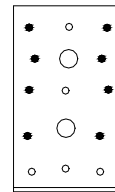
**LC 1 – column**

Nails in hole number:  
1,2,3,7,8,9 /  
16,17,19,21,23,24



**LC 1 – purlin, LC 2,3, LC 4,5**

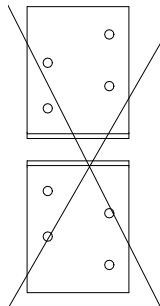
Nails in hole number:  
1,3,5,6,7,9,11,12 /  
16,17,19,21,23,24



**Nail Patterns – Angle Bracket 8620**

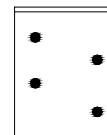
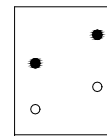
**LC 1 – column**

Nails in hole number:



**LC 1 – purlin, LC 2,3, LC 4,5**

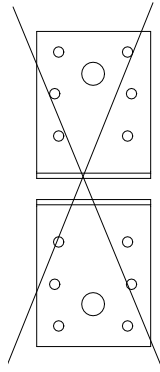
Nails in hole number:  
1,2 /  
5,6,7,8



**Nail Patterns – Angle Bracket 8621**

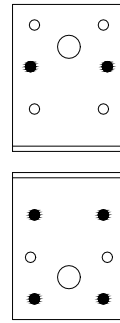
**LC 1 – column**

Nails in hole number:



**LC 1 – purlin, LC 2,3, LC 4,5**

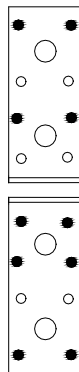
Nails in hole number:  
4,5 /  
8,9,13,14



**Nail Patterns – Angle Bracket 8623**

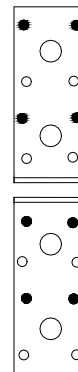
**LC 1 – column**

Nails in hole number:  
1,2,6,7 /  
11,12,14,15,19,20



**LC 1 – purlin, LC 2,3, LC 4,5**

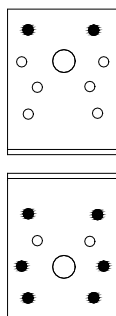
Nails in hole number:  
1,2,6,7 /  
11,12,16,17



**Nail Patterns – Angle Bracket 8624**

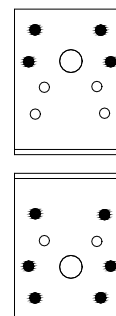
**LC 1 – column**

Nails in hole number:  
1,2 /  
10,11,14,15,17,18



**LC 1 – purlin, LC 2,3, LC 4,5**

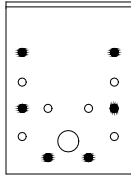
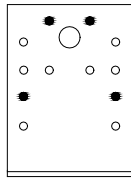
Nails in hole number:  
1,2,4,5 /  
10,11,14,15,17,18



**Nail Patterns – Angle Bracket 8625**

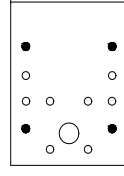
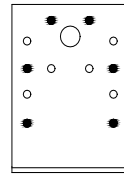
**LC 1 – column**

Nails in hole number:  
1,2,10,11 /  
14,15,18,21,25,26



**LC 1 – purlin, LC 2,3, LC 4,5**

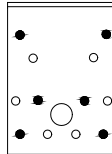
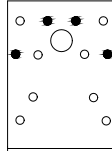
Nails in hole number:  
1,2,6,9,12,13 /  
14,15,22,24



**Nail Patterns – Angle Bracket 8626**

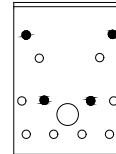
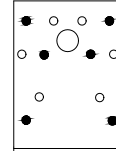
**LC 1 – column**

Nails in hole number:  
2,3,6,9 /  
16,17,23,24,27,30



**LC 1 – purlin, LC 2,3, LC 4,5**

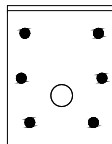
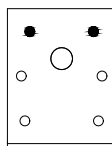
Nails in hole number:  
1,4,7,8,14,15 /  
16,17,23,24



**Nail Patterns – Angle Bracket 8627**

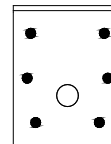
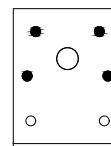
**LC 1 – column**

Nails in hole number:  
1,2 /  
8,9,10,11,13,14



**LC 1 – purlin, LC 2,3, LC 4,5**

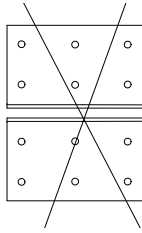
Nails in hole number:  
1,2,4,5 /  
8,9,10,11,13,14



**Nail Patterns – Angle Bracket 8634**

**LC 1 – column**

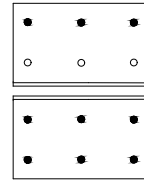
Nails in hole number:



**LC 1 – purlin, LC 2,3, LC 4,5**

Nails in hole number:

1,2,3 /  
7,8,9,10,11,12

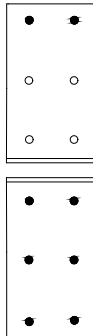


**Nail Patterns – Angle Bracket 8635**

**LC 1 – column**

Nails in hole number:

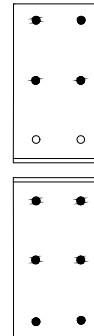
1,2 /  
7,8,9,10,11,12



**LC 1 – purlin, LC 2,3, LC 4,5**

Nails in hole number:

1,2,3,4 /  
7,8,9,10,11,12

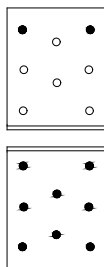


**Nail Patterns – Angle Bracket 8636**

**LC 1 – column**

Nails in hole number:

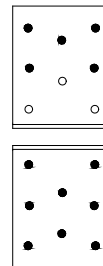
1,2 /  
9,10,11,12,13,14,15,16



**LC 1 – purlin, LC 2,3, LC 4,5**

Nails in hole number:

1,2,3,4,5 /  
9,10,11,12,13,14,15,16

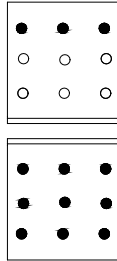


**Nail Patterns – Angle Bracket 8637**

**LC 1 – column**

Nails in hole number:

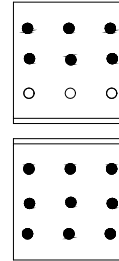
1,2,3 /  
10,11,12,13,  
14,15,16,17,18



**LC 1 – purlin, LC 2,3, LC 4,5**

Nails in hole number:

1,2,3,4,5,6 /  
10,11,12,13,  
14,15,16,17,18

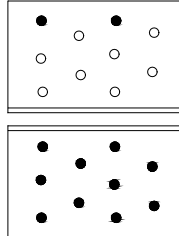


**Nail Patterns – Angle Bracket 8638**

**LC 1 – column**

Nails in hole number:

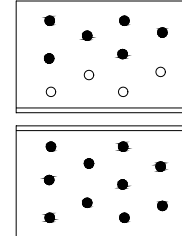
1,2 /  
11,12,13,14,15,  
16,17,18,19,20



**LC 1 – purlin, LC 2,3, LC 4,5**

Nails in hole number:

1,2,3,4,5,6 /  
11,12,13,14,15,  
16,17,18,19,20

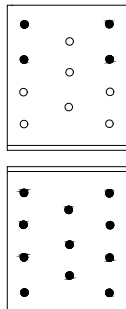


**Nail Patterns – Angle Bracket 8640**

**LC 1 – column**

Nails in hole number:

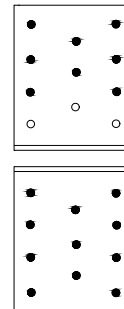
1,2,4,5 /  
12,13,14,15,16,17,  
18,19,20,21,22



**LC 1 – purlin, LC 2,3, LC 4,5**

Nails in hole number:

1,2,3,4,5,6,7,8 /  
12,13,14,15,16,17,  
18,19,20,21,22

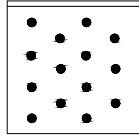
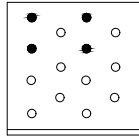




**Nail Patterns – Angle Bracket 8641**

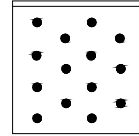
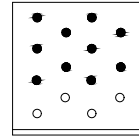
**LC 1 – column**

Nails in hole number:  
1,2,5,6 /  
15,16,17,18,19,20,21,  
22,23,24,25,26,27,28



**LC 1 – purlin, LC 2,3, LC 4,5**

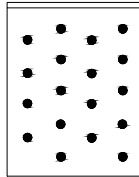
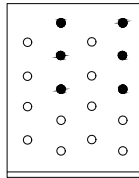
Nails in hole number:  
1,2,3,4,5,6,7,8,9,10 /  
15,16,17,18,19,20,21,  
22,23,24,25,26,27,28



**Nail Patterns – Angle Bracket 8644**

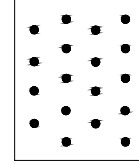
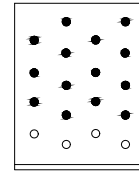
**LC 1 – column**

Nails in hole number:  
1,2,5,6,9,10 /  
19,20,21,22,23,24,25,  
26,27,28,29,30,31,  
32,33,34,35,36



**LC 1 – purlin, LC 2,3, LC 4,5**

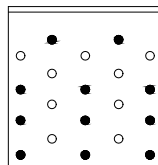
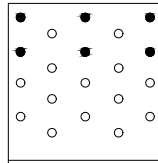
Nails in hole number:  
1,2,3,4,5,6,7,  
8,9,10,11,12,13,14 /  
19,20,21,22,23,24,25,  
26,27,28,29,30,31,  
32,33,34,35,36



**Nail Patterns – Angle Bracket 8645**

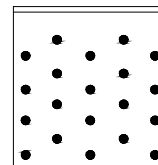
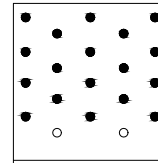
**LC 1 – column**

Nails in hole number:  
1,2,3,6,7,8 /  
21,22,28,29,30,  
33,34,35,38,39,40



**LC 1 – purlin, LC 2,3, LC 4,5**

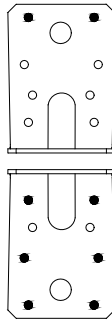
Nails in hole number:  
1,2,3,4,5,6,7,8,9,10,11  
12,13,14,15,16,17,18 /  
21,22,23,24,25,26,27,  
28,29,30,31,32,33,34,  
35,36,37,38,39,40



**Nail Patterns – Angle Bracket with rib 8622**

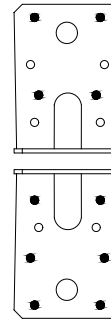
**LC 1 – column**

Nails in hole number:  
1,2 /  
10,11,14,15,17,18



**LC 1 – purlin, LC 2,3, LC 4,5**

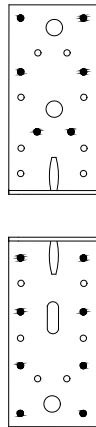
Nails in hole number:  
1,2,6,7 /  
10,11,14,15,17,18



**Nail Patterns – Angle Bracket with rib 8628**

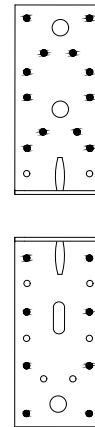
**LC 1 – column**

Nails in hole number:  
1,2,6,7,11,12 /  
17,18,22,23,26,27,31,32



**LC 1 – purlin, LC 2,3, LC 4,5**

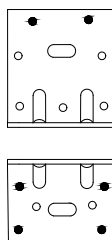
Nails in hole number:  
1,2,4,5,6,7,8,9,11,12,13,14 /  
17,18,22,23,26,27,31,32



**Nail Patterns – Angle Bracket with rib 8629**

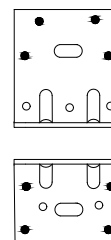
**LC 1 – column**

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



**LC 1 – purlin, LC 2,3, LC 4,5**

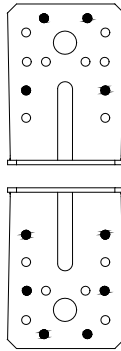
Nails in hole number:  
1,2,4,5 /  
9,10,14,15



**Nail Patterns – Angle Bracket with rib 8632**

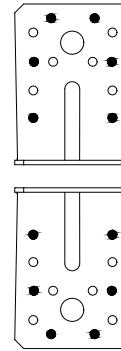
**LC 1 – column**

Nails in hole number:  
1,2,10,11 /  
14,15,18,21,25,26



**LC 1 – purlin, LC 2,3, LC 4,5**

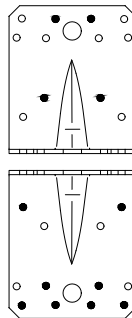
Nails in hole number:  
1,2,6,9,12,13 /  
14,15,18,21,25,26



**Nail Patterns – Angle Bracket with rib 8633**

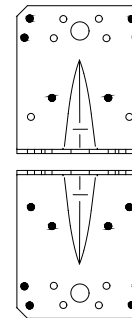
**LC 1 – column**

Nails in hole number:  
2,3,12,13 /  
16,17,23,24,27,28,29,30



**LC 1 – purlin, LC 2,3, LC 4,5**

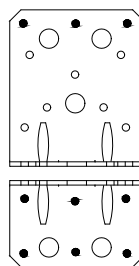
Nails in hole number:  
1,4,6,9,12,13 /  
16,17,18,19,22,25,27,30



**Nail Patterns – Angle Bracket with rib 8654**

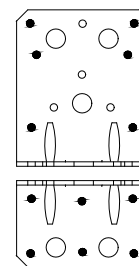
**LC 1 – column**

Nails in hole number:  
1,2,3 /  
14,15,16,19,20,21



**LC 1 – purlin, LC 2,3, LC 4,5**

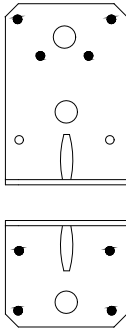
Nails in hole number:  
1,3,6,7,12,13 /  
14,15,16,19,20,21



**Nail Patterns – Angle Bracket with rib 8655**

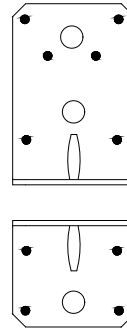
**LC 1 – column**

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



**LC 1 – purlin, LC 2,3, LC 4,5**

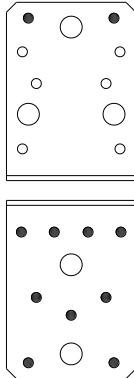
Nails in hole number:  
1,2,4,5,7,8 /  
9,10,12,13



**Nail Patterns – Angle Bracket with rib 8625FH**

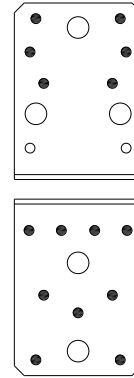
**LC 1 – column**

Nails in hole number:  
1,2, /  
12,13,14,15,17,18,19,21,22



**LC 1 – purlin, LC 2,3, LC 4,5**

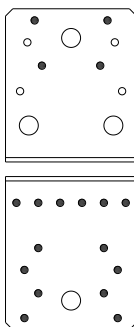
Nails in hole number:  
1,2,4,5,6,7 /  
12,13,14,15,17,18,19,21,22



**Nail Patterns – Angle Bracket with rib 8626FH**

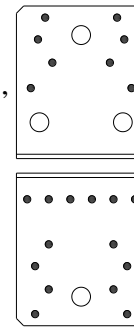
**LC 1 – column**

Nails in hole number:  
1,2,6,7 /  
12,13,14,15,16,17,18,19,20,21,  
22,23,25,26



**LC 1 – purlin, LC 2,3, LC 4,5**

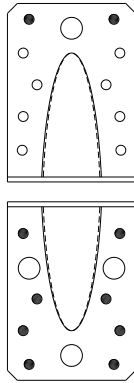
Nails in hole number:  
1,2,4,5,6,7,8,9 /  
12,13,14,15,16,17,18,19,20,21,  
22,23,25,26



**Nail Patterns – Angle Bracket with rib 8632FH**

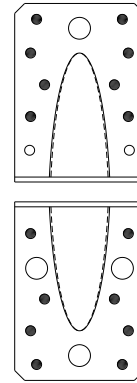
**LC 1 – column**

Nails in hole number:  
1,2 /  
12,13,16,17,18,19,21,22



**LC 1 – purlin, LC 2,3, LC 4,5**

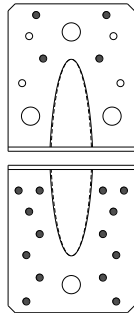
Nails in hole number:  
1,2,4,5,6,7,8,9, /  
12,13,16,17,18,19,21,22



**Nail Patterns – Angle Bracket with rib 8633FH**

**LC 1 – column**

Nails in hole number:  
1,2,6,7 /  
12,13,14,15,16,17,18,19,20,21,  
22,23,25,26



**LC 1 – purlin, LC 2,3, LC 4,5**

Nails in hole number:  
1,2,4,5,6,7,8,9 /  
12,13,14,15,16,17,18,19,20,21,  
22,23,25,26

