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

MEMBER OF EOTA

European Technical Assessment ETA-10/0046 of 2014-05-23

I General Part

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

Trade name of the construction product:	HVV Various Angle Brackets*) *) See bracket types in section II.1
Product family to which the above construction product belongs:	Three-dimensional nailing plate (timber-to-timber angle bracket)
Manufacturer:	Joh. Friedrich Behrens AG Bogenstr.43 – 45 DE-22926 Ahrensburg Tel. +49 04102/78-0 Fax +49 04102/78-250 Internet www.bea-group.com
Manufacturing plant:	Joh. Friedrich Behrens AG Manufacturing plant II
This European Technical Assessment contains:	102 pages including 2 annexes which form an integral part of the document
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of:	Guideline for European Technical Approval (ETAG) No. 015 Three Dimensional Nailing Plates, April 2013, used as European Assessment Document (EAD).
This version replaces:	The previous ETA with the same number issued on 2012-01-27 and expiry on 2016-11-28

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

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II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product and intended use

Technical description of the product
The following types of brackets are covered by this ETA:
HVV Various Angle Brackets type
type1/80x80x2,5x100, type1/80x80x2,5x120, type1/100x100x2,5x60, type1/100x100x2,5x80, type1/100x100x2,5x100, type1/40x60x2,5x60, type1/60x80x2,5x60, type1/200x100x2,5x100, type6/90x90x3,0x40, type6/120x90x3,0x40, type3/90x35x3,0x40, type3/160x50x3,0x40, type6/60x60x3,0x40, type7/65x65x3,0x55, type7/80x50x3,0x55, type8/160x80x3/4x60, type8/160x80x3/4x80, type8/160x80x3/4x100, type4/70 with rib, type4/70 without rib, type4/75x50x1,5x60-13, type4/125x50x2,5x70, type4/75x50x1,5x60EXP, type4/75x50x1,5x60-11, type4/155x100x2,5x80, type4/155x160x2,5x80, type4/175x60x2,5x75, type4/110x60x100, type4/170x115x3,0x95, type1/60x60x2,0/2,5x60, type1/60x60x2,0/2,5x80, type1/60x60x2,0/2,5x100, type1/80x80x2,0/2,5x40, type1/80x80x2,0/2,5x60, type1/80x80x2,0/2,5x80, type HVV Knagge

The angle brackets are made from pre-galvanized steel Grade S 250 GD + min. Z275 according to EN 10346:2009 with a minimum characteristic yield stress of 250 MPa or of steel grade 1.4301 according to EN 10088-2:2005 with a minimum characteristic yield strength of $R_{p0,2}$ = 290 N/mm². The bracket type 436 is made from pre-galvanized steel Grade S 350 GD + min. Z275 according to EN 10346:2009 with a minimum characteristic yield stress of 350 MPa Dimensions, hole positions and typical installations are shown in Annex A.

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 structures, as a connection between two timber beams or a timber beam and a timber column or between a timber member and a concrete or steel member, where requirements for mechanical resistance and stability and safety in use in the sense of the Basic Works Requirements 1 and 4 of Regulation (EU) 305/2011 shall be fulfilled.

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

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 0f 350 kg/m^3.

This requirement to the material of the wood members can be fulfilled by using the following materials:

- Solid timber classified to C14-C40 according to EN 338 / EN 14081
- Glued members of timber classified to C14-C40 according to EN 338 / EN 14081 when structural adhesives are used.
- Glued laminated timber classified to GL24c or better according to EN 1194 / EN 14080.
- Solid Wood Panels, SWP according to EN 13353.
- Laminated Veneer Lumber LVL according to EN 14374
- Laminated Strand Lumber, e.g. Parallam and Timber Strand
- Plywood according to EN 636
- Oriented Strand Board, OSB according to EN 300

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

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

The Angle brackets are primarily for use in timber structures subject to the dry, internal conditions defined by service class 1 and 2 of Eurocode 5, and for connections subject to static or quasi-static loading. Brackets made from stainless steel are for use in service classes 1, 2 and 3 of EN 1995-1-1:2004, (Eurocode 5).

The scope of the brackets regarding resistance to corrosion shall be defined according to national provisions that apply at the installation site considering environmental conditions.

The provisions made in this European Technical Assessment are based on an assumed intended working life of the 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*) (BWR1)	
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 (BWR2)	
Reaction to fire	The 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 (BWR3)	
Influence on air quality	No dangerous materials**)
3.7 Sustainable use of natural resources (BWR7)	No Performance Determined
3.8 General aspects related to the performance of the product	The brackets have been assessed as having satisfactory durability and serviceability when used in timber structures using the timber species described in Eurocode 5 and subject to the conditions defined by service class 1 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

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 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.

Joma connector nails

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.

The characteristic withdrawal capacity of the nails has been determined by testing in accordance with EN 1382: Timber structures - Test methods - Withdrawal capacity of timber fasteners:

For electroplated zinc covered nails

$F_k = f_u dl = 7{,}6dl$

Further, the angle brackets may be fastened to a concrete structure by bolts with a diameter of 10 mm in holes with a diameter up to 2 mm larger than the bolt.

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

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

3.11 Aspects related to the performance of the product

3.11.1 Corrosion protection in service class 1 and 2.
The joist hanger have a zinc coating weight of min Z275. The steel employed is S250 GD or S 350GD with min Z275 according to EN 10346:2009.

2.7.2 Corrosion protection in service class 3
In accordance with Eurocode 5 the brackets are made from steel grade 1.4301 according to EN 10088-2:2005 with a minimum characteristic yield strength of $R_{p0,2}$ = 290 N/mm²

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

HVV angle brackets are manufactured in accordance with the provisions of this European Technical Assessment using the manufacturing processes as identified in the inspection of the plant by the notified inspection body and laid down in the technical documentation.

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

The following provisions concerning installation apply:

The structural members – the components 1 and 2 shown in the figure on page 25 - 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, see section 1 of this ETA
- Free from wane under the bracket.
- The actual end bearing capacity of the timber member to be used in conjunction with the bracket is checked by the designer of the structure to ensure it is not less than the bracket capacity and, if necessary, the bracket capacity reduced accordingly.
- The gap between the timber members does not exceed 3 mm.
- There are no specific requirements relating to preparation of the timber members.

The execution of the connection shall be in accordance with the approval holder’s technical literature.

4 Attestation and verification of constancy of performance (AVCP)

4.1 AVCP system

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

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

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

Issued in Charlottenlund on 2014-05-23 by

Thomas Bruun
Managing Director, ETA-Danmark

Annex A
Product details and definitions

Table A.1 materials specification

Bracket type	Thickness (mm)	Steel specifications*	Coating specification
type1/60x60x2,0/2,5x60	2,0 and 2,5	S 250 GD + Z 275	Z 275
type1/60x60x2,0/2,5x80	2,0 and 2,5	S 250 GD + Z 275	Z 275
type1/60x60x2,0/2,5x100	2,0 and 2,5	S 250 GD + Z 275	Z 275
type1/80x80x2,0/2,5x40	2,0 and 2,5	S 250 GD + Z 275	Z 275
type1/80x80x2,0/2,5x60	2,0 and 2,5	S 250 GD + Z 275	Z 275
type1/80x80x2,0/2,5x80	2,0 and 2,5	S 250 GD + Z 275	Z 275
type1/80x80x2,5x100	2,5	S 250 GD + Z 275	Z 275
type1/80x80x2,5x120	2,5	S 250 GD + Z 275	Z 275
type1/100x100x2,5x60	2,5	S 250 GD + Z 275	Z 275
type1/100x100x2,5x80	2,5	S 250 GD + Z 275	Z 275
type1/100x100x2,5x100	2,5	S 250 GD + Z 275	Z 275
type1/40x60x2,5x60	2,5	S 250 GD + Z 275	Z 275
type1/60x80x2,5x60	2,5	S 250 GD + Z 275	Z 275
type1/200x100x2,5x100	2,5	S 250 GD + Z 275	Z 275
type6/90x90x3,0x40	3,0	S 250 GD + Z 275	Z 275
type6/120x90x3,0x40	3,0	S 250 GD + Z 275	Z 275
type3/90x35x3,0x40	3,0	S 250 GD + Z 275	Z 275
type3/160x50x3,0x40	3,0	S 250 GD + Z 275	Z 275
type6/60x60x3,0x40	3,0	S 250 GD + Z 275	Z 275
type7/65x65x3,0x55	3,0	S 250 GD + Z 275	Z 275
type4/75x50x1,5x60-13, type4/125x50x2,5x70, type4/75x50x1,5x60EXP, type4/75x50x1,5x60-11, type4/155x100x2,5x80, type4/155x160x2,5x80, type4/175x60x2,5x75	1,5 and 2,5	S 250 GD + Z 275	Z275
type7/80x50x3,0x55	3,0	S 250 GD + Z 275	Z 275
type8/160x80x3/4x60	3,0/4,0	S 250 GD + Z 275	Z 275
type8/160x80x3/4x80	3,0/4,0	S 250 GD + Z 275	Z 275
type8/160x80x3/4x100	3,0/4,0	S 250 GD + Z 275	Z 275
type4/110x60x100	3,0	S 350 GD + Z 275	Z 275
type4/170x115x3,0x95	3,0	S 250 GD + Z 275	Z 275
type4/70 with rib	2,0 and 2,5	S 250 GD + Z 275	Z 275
type4/70 without rib	2,0 and 2,5	S 250 GD + Z 275	Z 275
HVV Knagge	2,0	S 250 GD + Z 275	Z 275

* Or stainless steel 1.4301 for all types

Table A.2 Fastener specification

Nail type Joma	**Nail size (mm)**		**Finish**
According to prEN 14592	Diameter	Length	
Threaded nail	4,0	40	Electroplated zinc or stainless steel

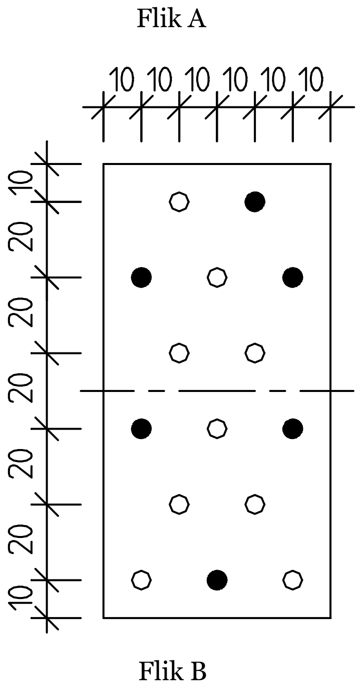


Figure A.1 Dimensions of
Angle Bracket type1/60x60x2,0/2,5x60

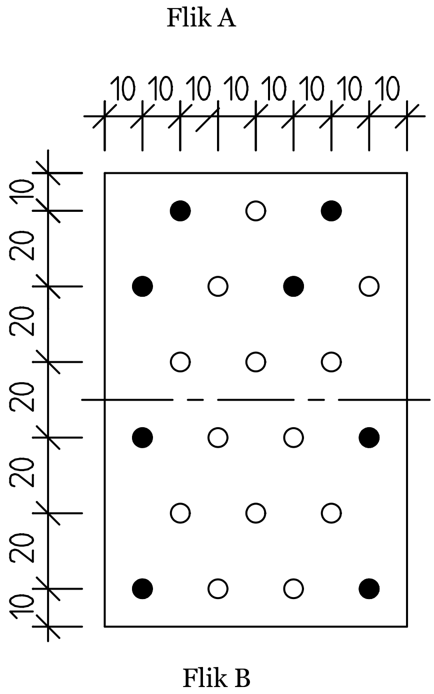


Figure A.2 Dimensions of
Angle Bracket type1/60x60x2,0/2,5x80

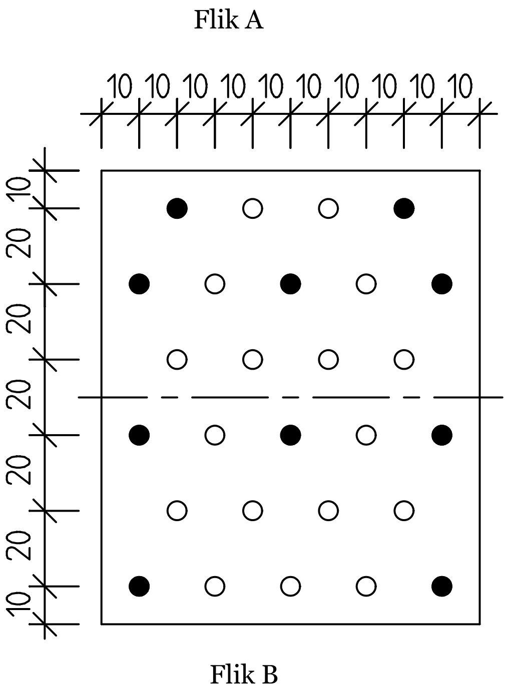


Figure A.3 Dimensions of
Angle Bracket type1/60x60x2,0/2,5x100

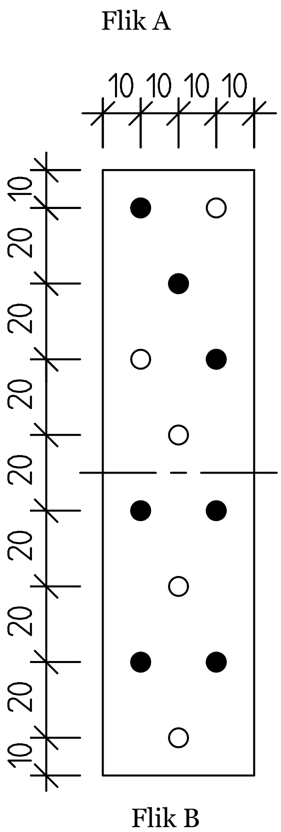


Figure A.4 Dimensions of
Angle Bracket type1/80x80x2,0/2,5x40

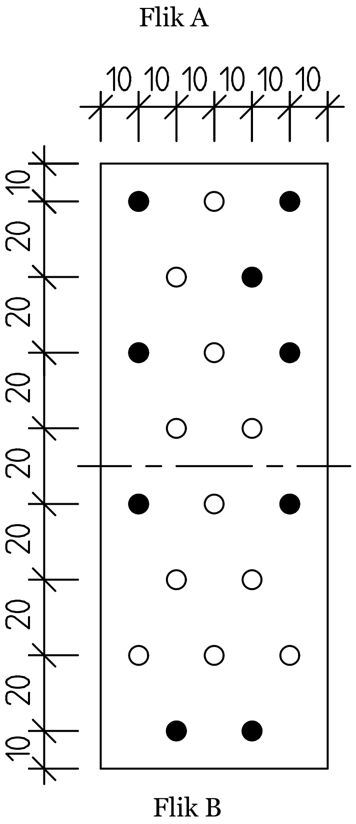


Figure A.5 Dimensions of
Angle Bracket type1/80x80x2,0/2,5x60

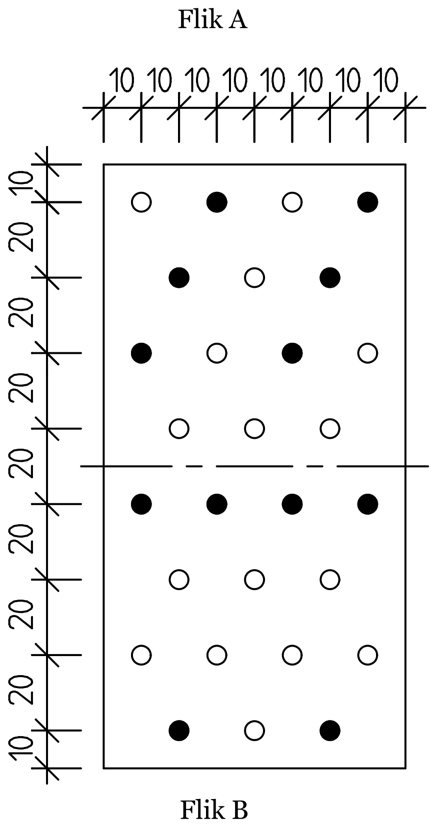


Figure A.6 Dimensions of
Angle Bracket type1/80x80x2,0/2,5x80

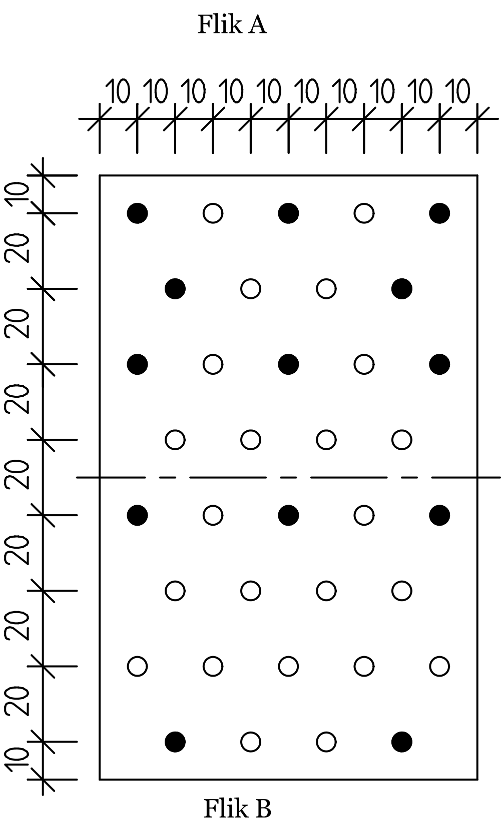


Figure A.7 Dimensions of
Angle Bracket type1/80x80x2,5x100

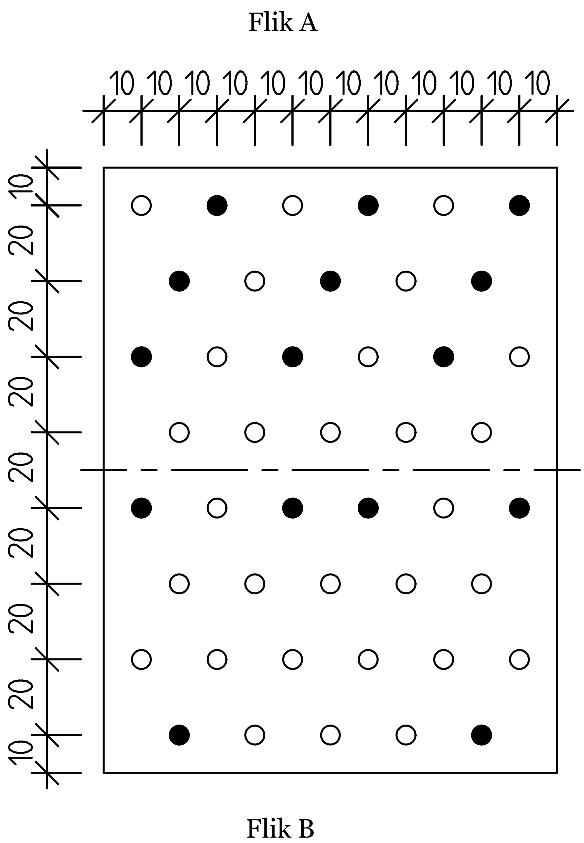


Figure A.8 Dimensions of
Angle Bracket type1/80x80x2,5x120

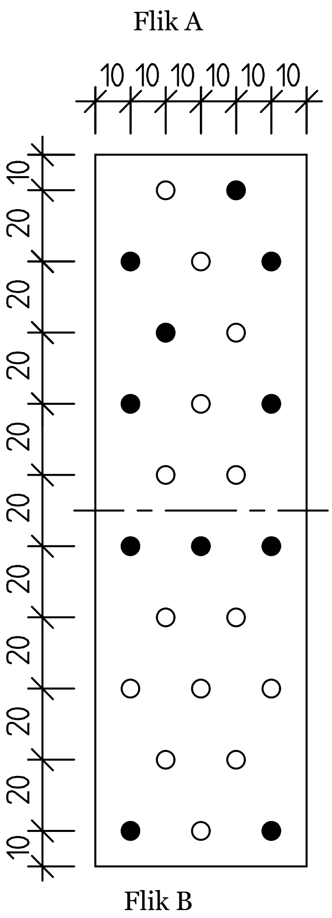


Figure A.9 Dimensions of
Angle Bracket type1/100x100x2,5x60

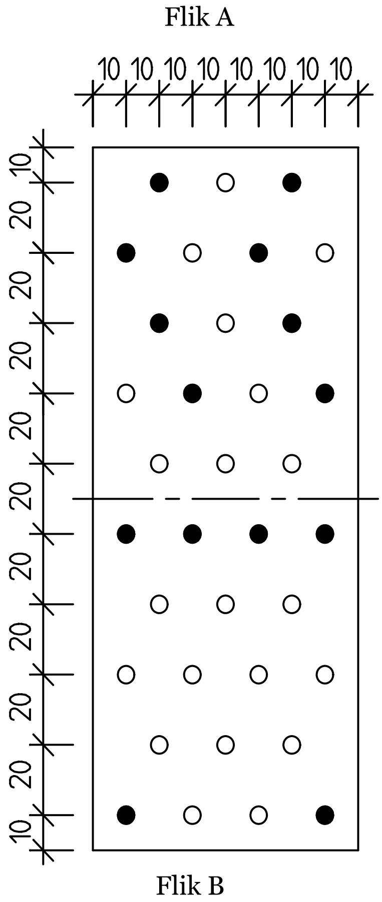


Figure A.10 Dimensions of
Angle Bracket type1/100x100x2,5x80

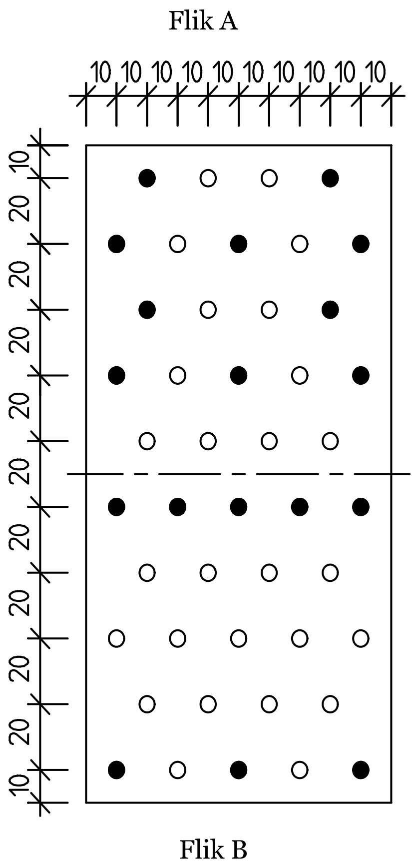


Figure A.11 Dimensions of
Angle Bracket type1/100x100x2,5x100

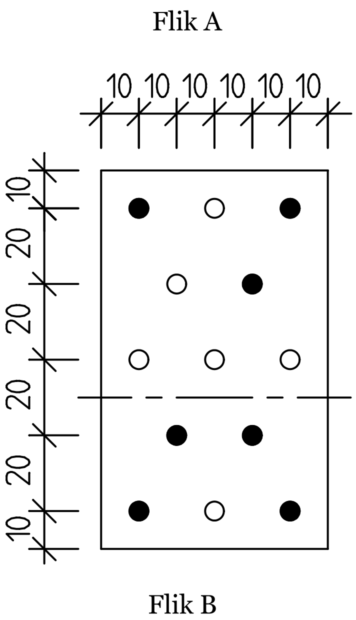


Figure A.12 Dimensions of
Angle Bracket type1/40x60x2,5x60

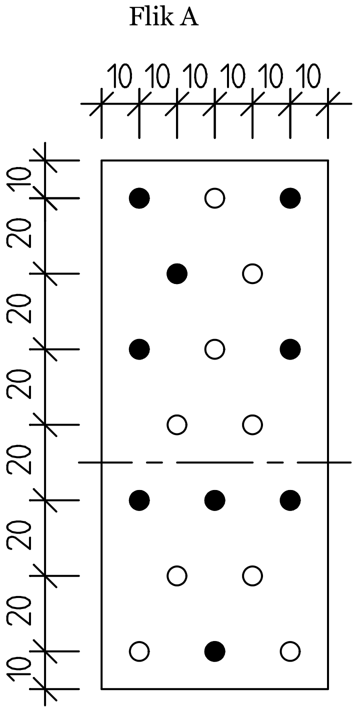


Figure A.13 Dimensions of
Angle Bracket type1/60x80x2,5x60

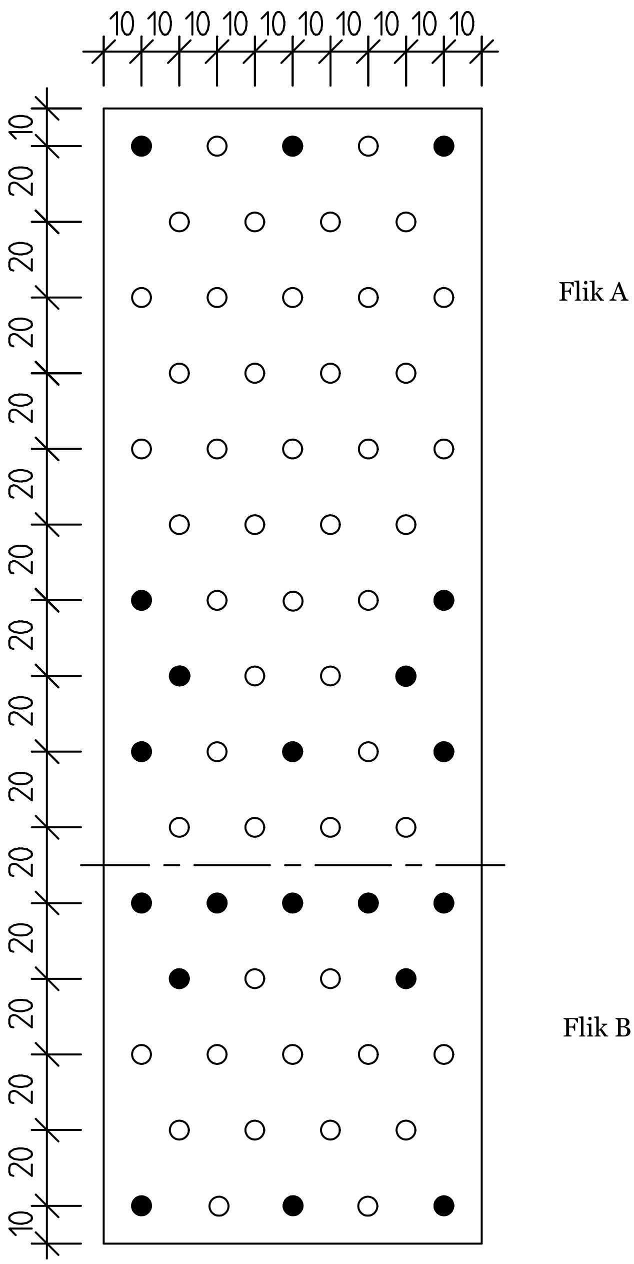
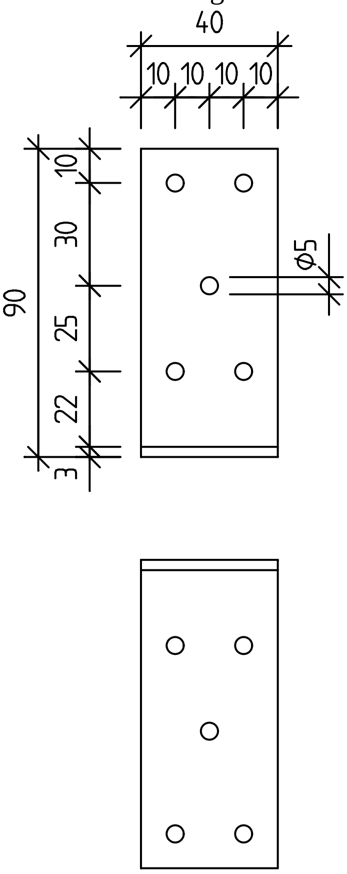


Figure A.14 Dimensions of
Angle Bracket type1/200x100x2,5x100



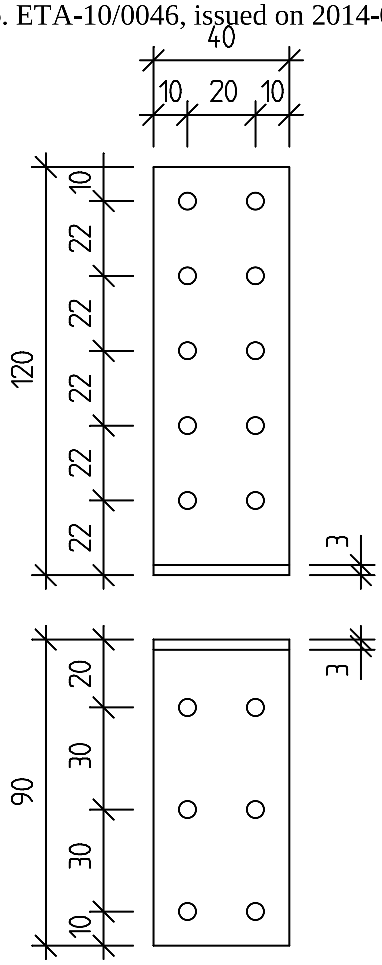
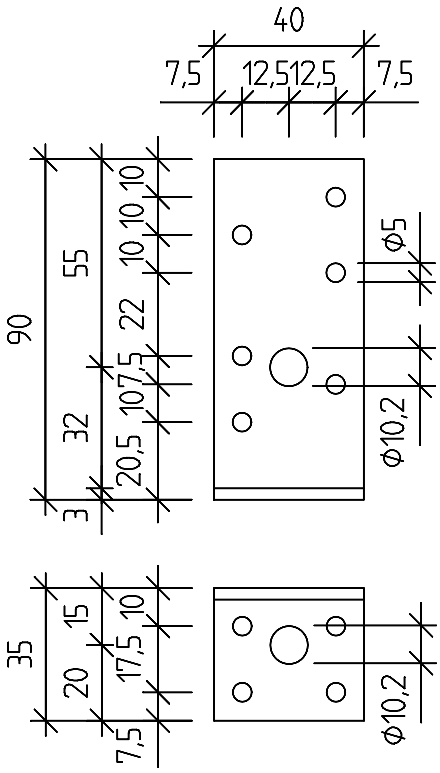


Figure A.15 Dimensions of
Angle Bracket type6/90x90x3,0x40

Figure A.16 Dimensions of
Angle Bracket type6/120x90x3,0x40



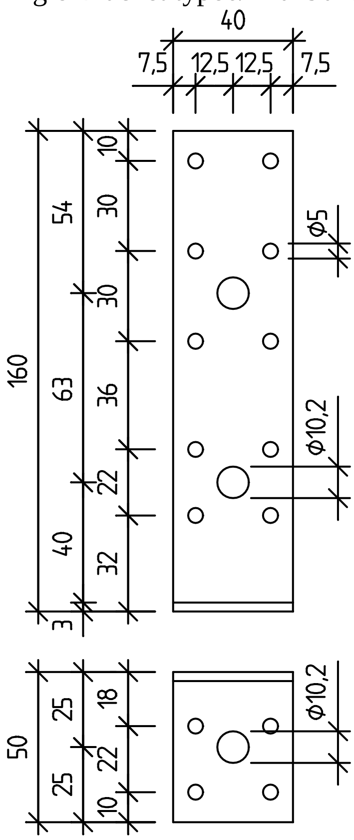


Figure A.17 Dimensions of
Angle Bracket type3/90x35x3,0x40

Figure A.18 Dimensions of
Angle Bracket type3/160x50x3,0x40

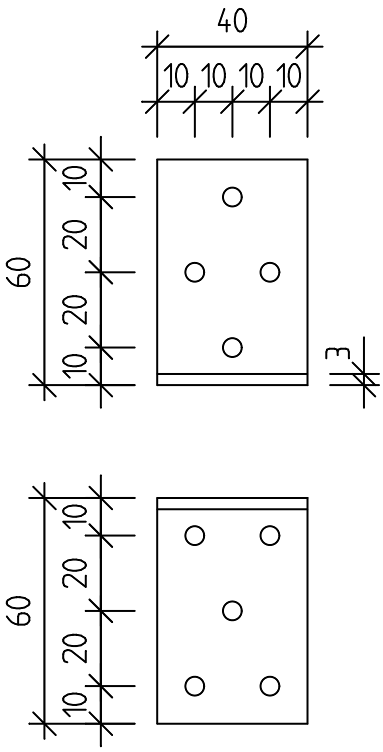


Figure A.19 Dimensions of
Angle Bracket type6/60x60x3,0x40

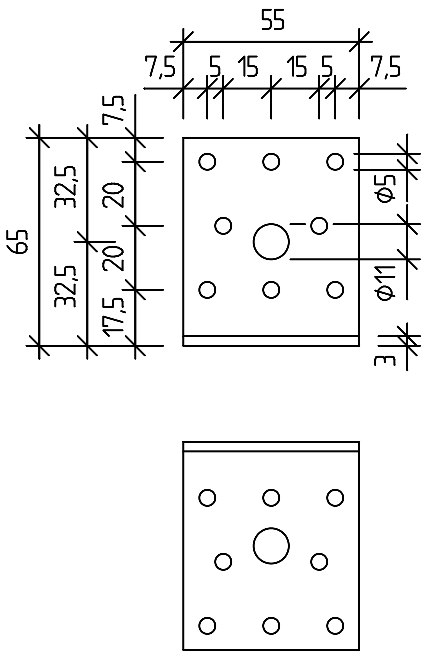


Figure A.20 Dimensions of
Angle Bracket type7/65x65x3,0x55

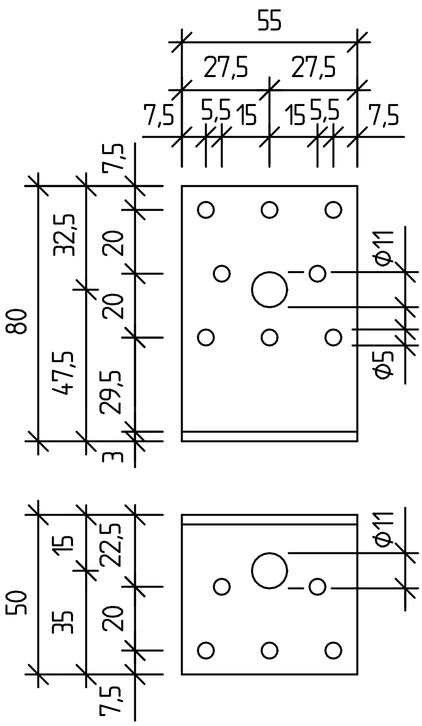


Figure A.21 Dimensions of
Angle Bracket type7/80x50x3,0x55

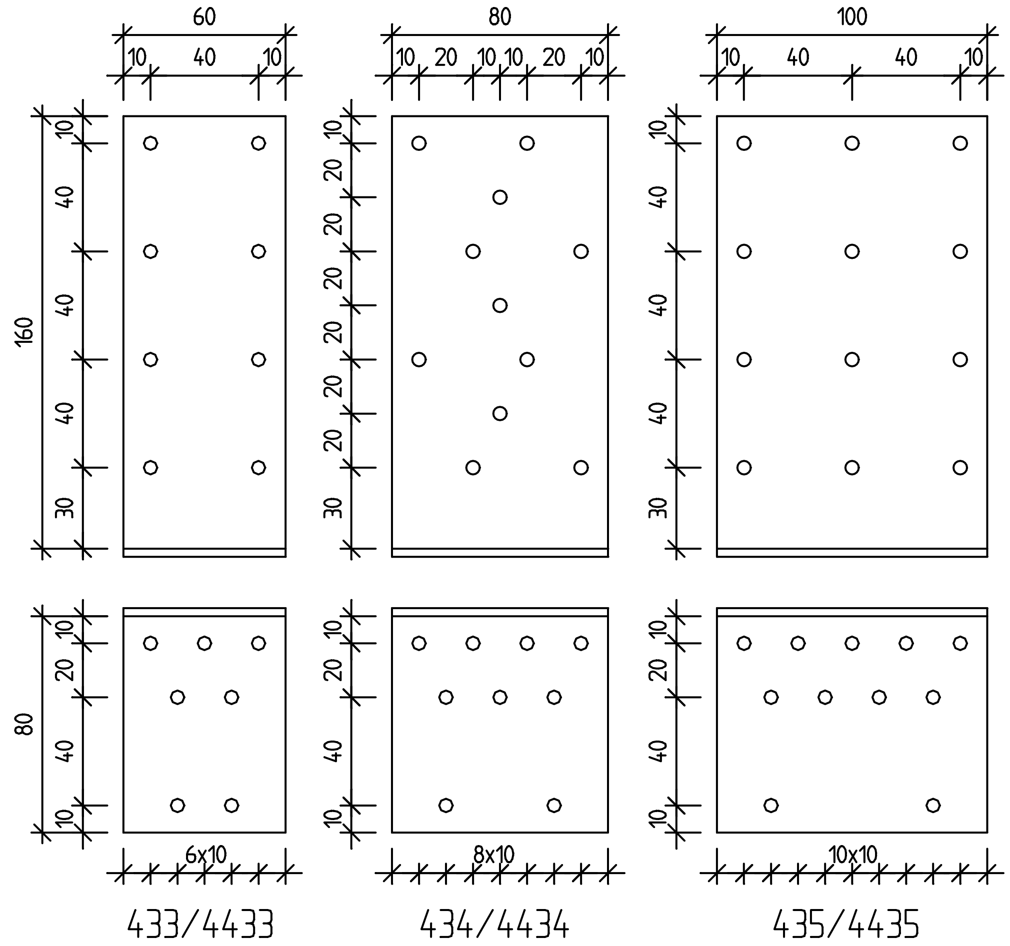


Figure A.22 Dimensions of
Angle Bracket type8/160x80x3/4x60, type8/160x80x3/4x80, type8/160x80x3/4x100

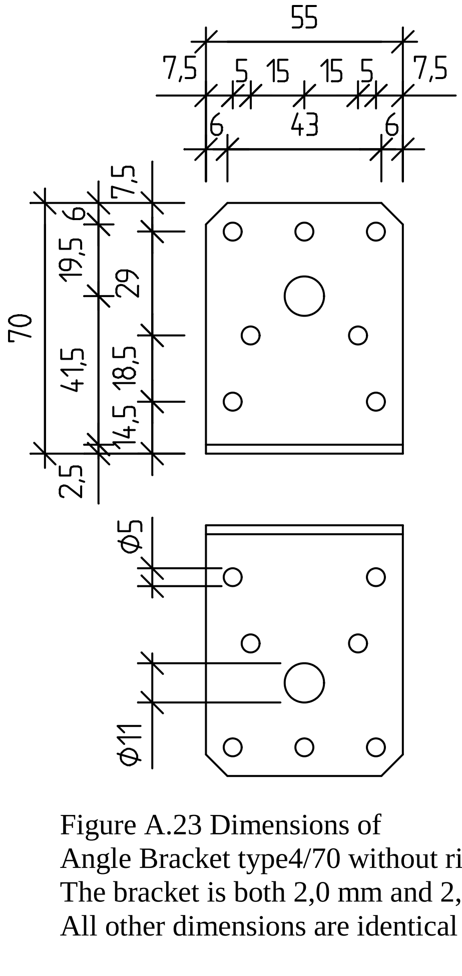


Figure A.23 Dimensions of
Angle Bracket type4/70 without rib
The bracket is both 2,0 mm and 2,5 mm thick
All other dimensions are identical

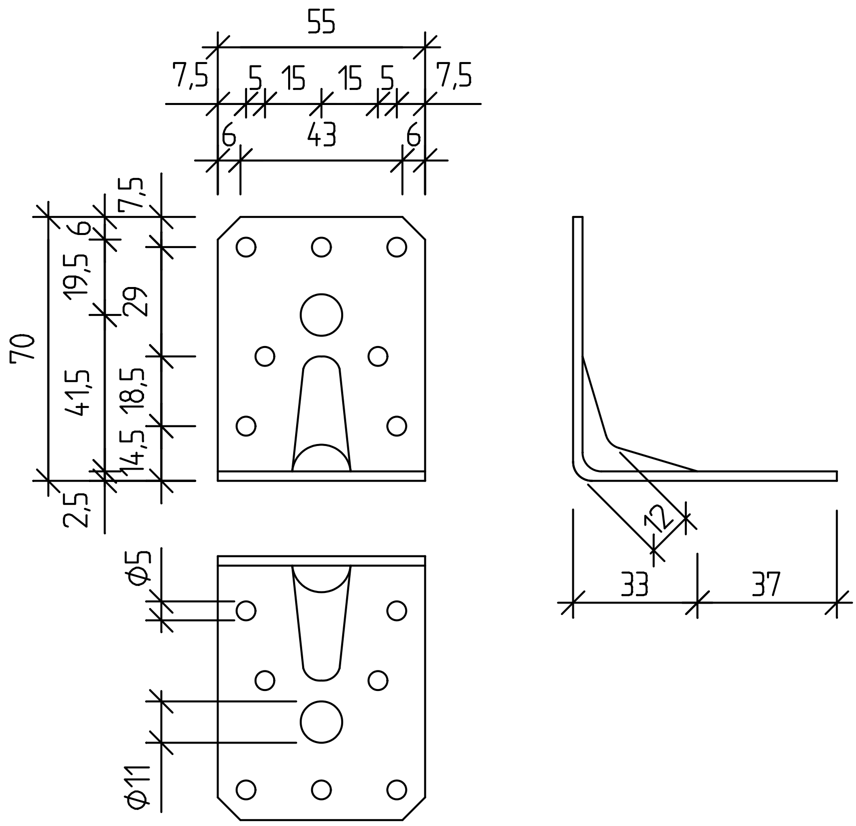


Figure A.24 Dimensions of
Angle Bracket type4/70 with rib
The bracket is both 2,0 mm and 2,5 mm thick
All other dimensions are identical

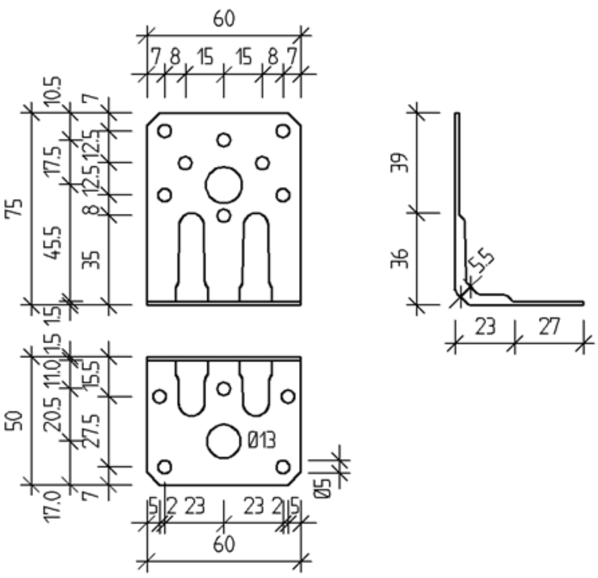


Figure A.25 Dimensions of
Angle Bracket type4/75x50x1,5x60-13 with rib
The bracket is 1,5mm thick
All other dimensions are identical.

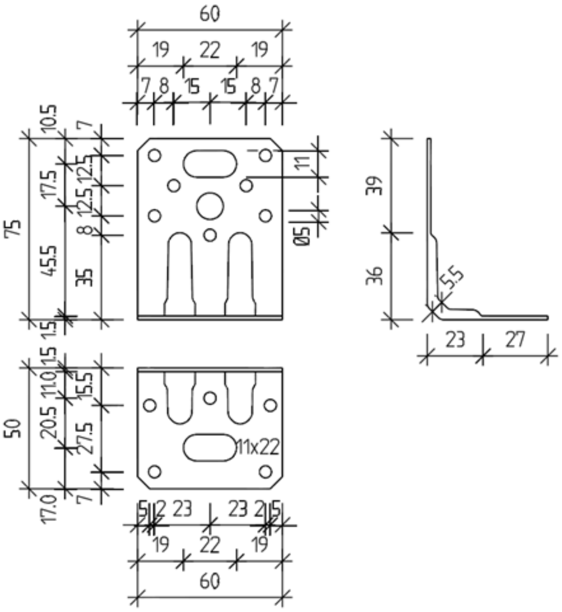


Figure A.26 Dimensions of
Angle Bracket type4/75x50x1,5x60EXP with rib
The bracket is 1,5mm thick
All other dimensions are identical.

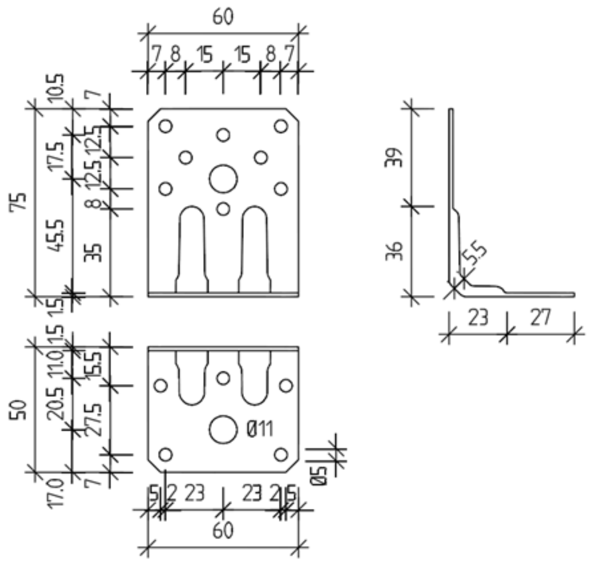


Figure A.27 Dimensions of
Angle Bracket type4/75x50x1,5x60-11 with rib
The bracket is 1,5mm thick
All other dimensions are identical.

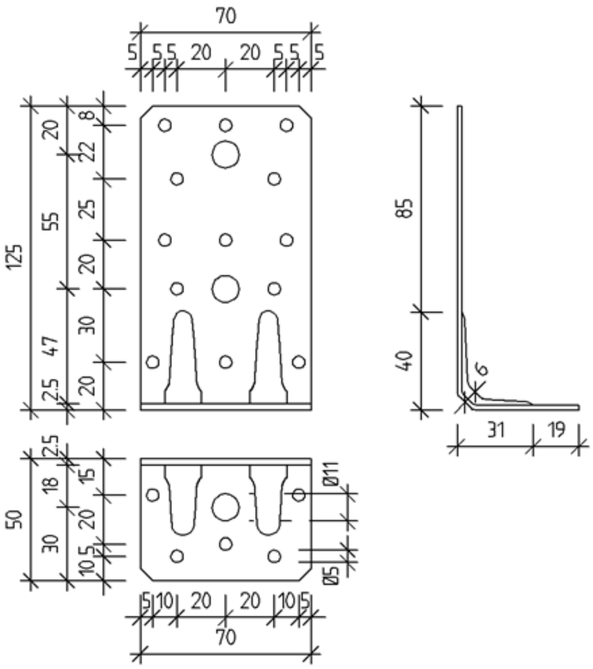


Figure A.28 Dimensions of
Angle Bracket type4/125x50x2,5x70 with rib
The bracket is 2,5 mm thick
l other dimensions are identical.

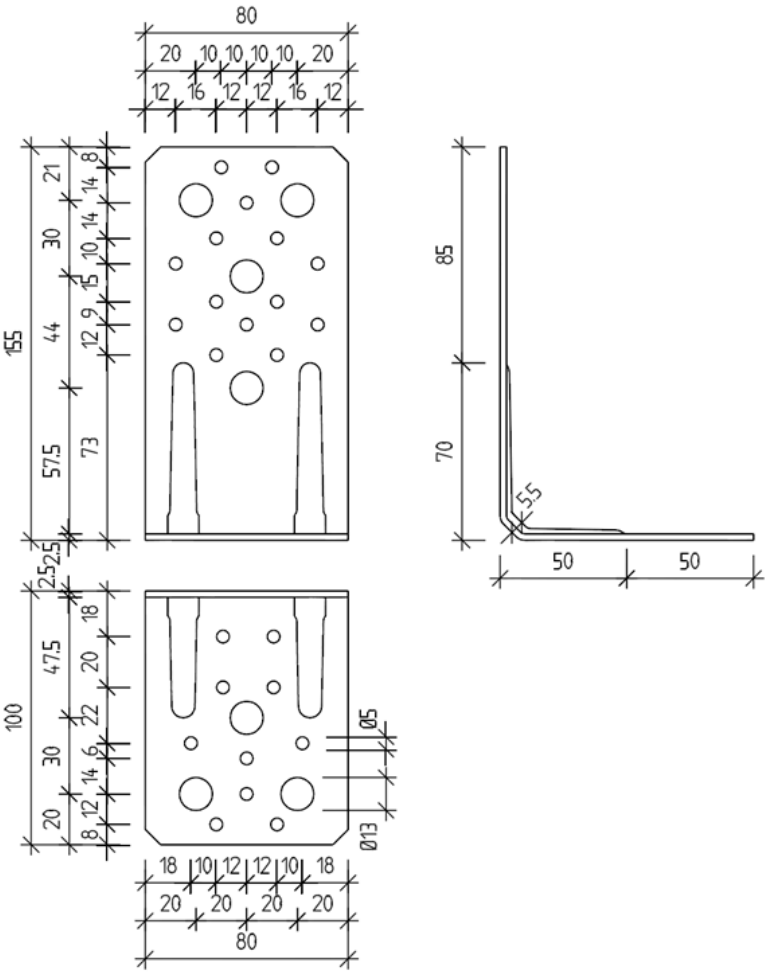


Figure A.29 Dimensions of
Angle Bracket type4/155x100x2,5x80 with rib
The bracket is 2,5 mm thick
All other dimensions are identical.

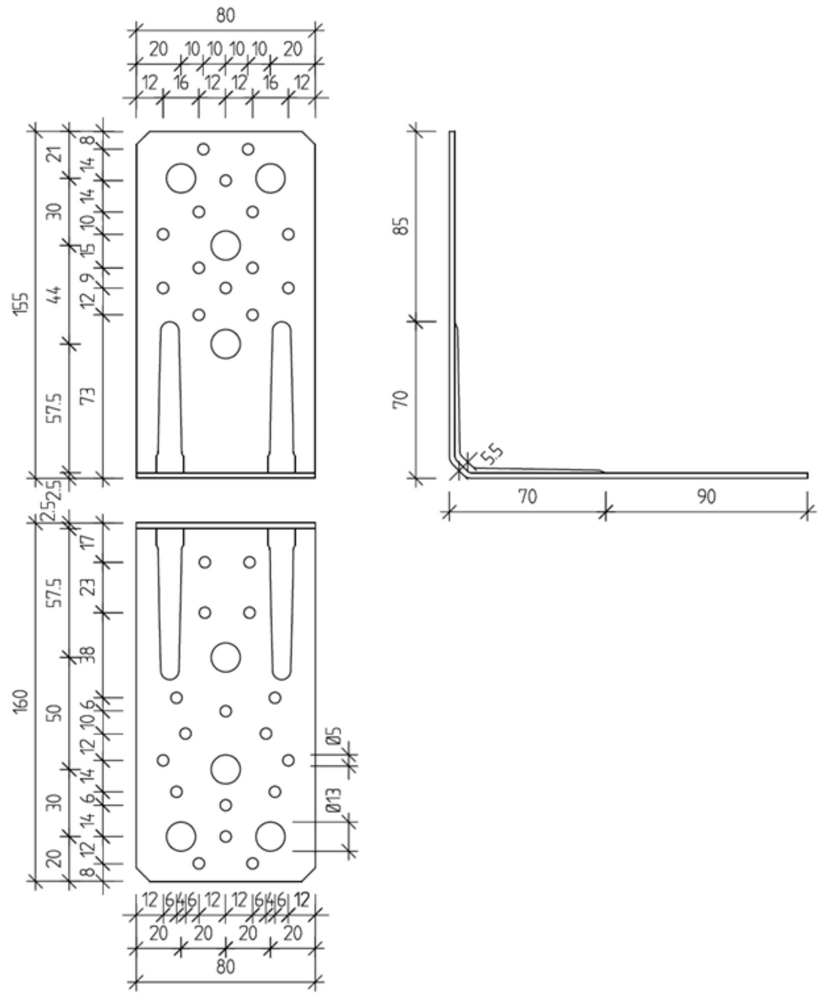


Figure A.30 Dimensions of
Angle Bracket type4/155x160x2,5x80 with rib
The bracket is 2,5 mm thick
All other dimensions are identical.

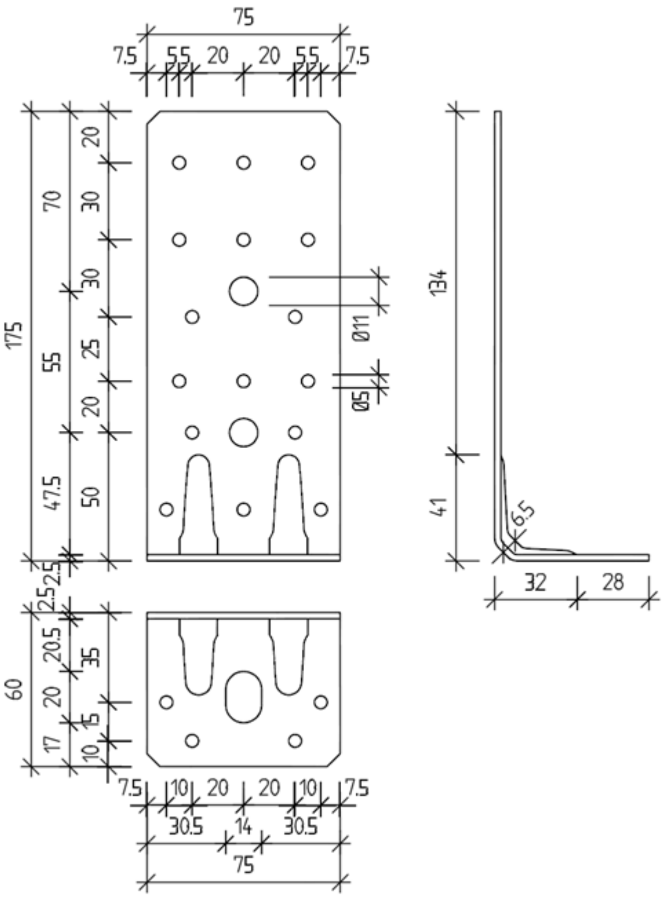


Figure A.31 Dimensions of
Angle Bracket type4/175x60x2,5x75 with rib
The bracket is 2,5 mm thick
All other dimensions are identical.

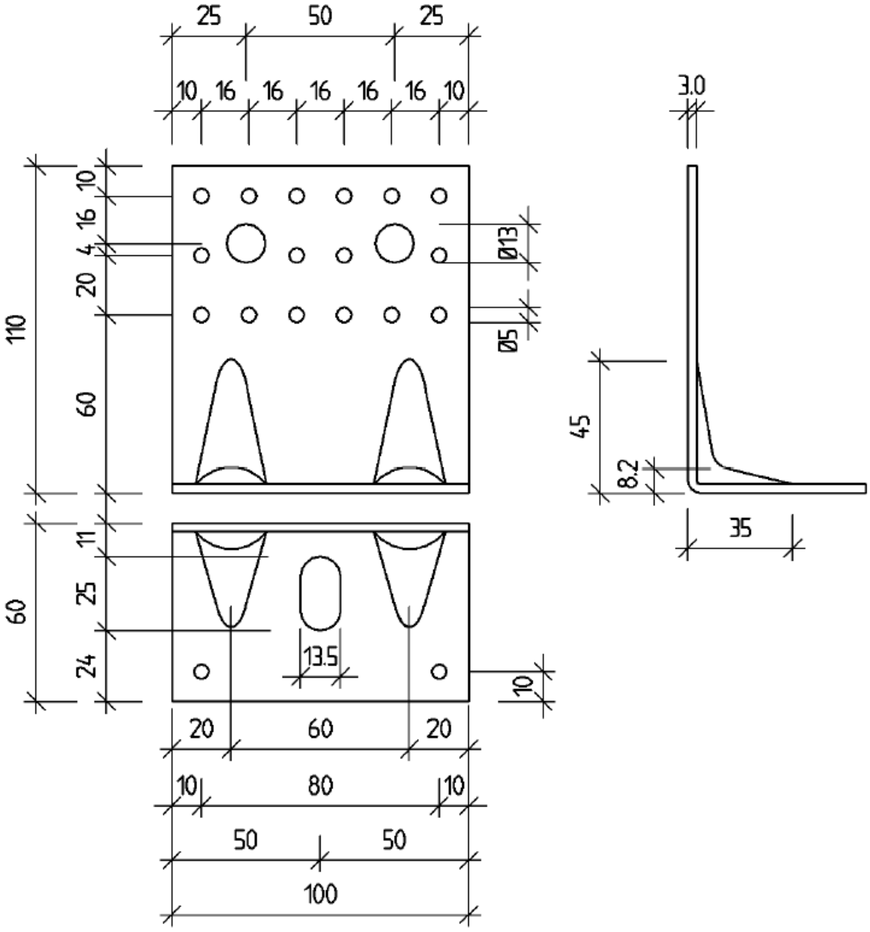


Figure A.32 Dimensions of
Angle Bracket type4/110x60x100 with rib, 3 mm thick

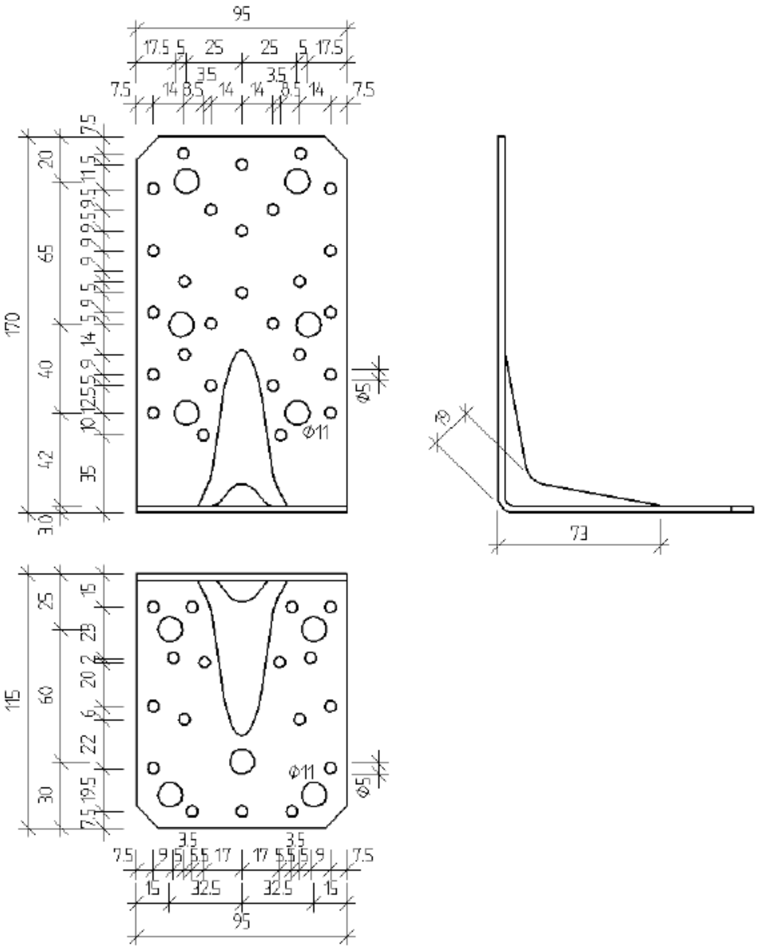
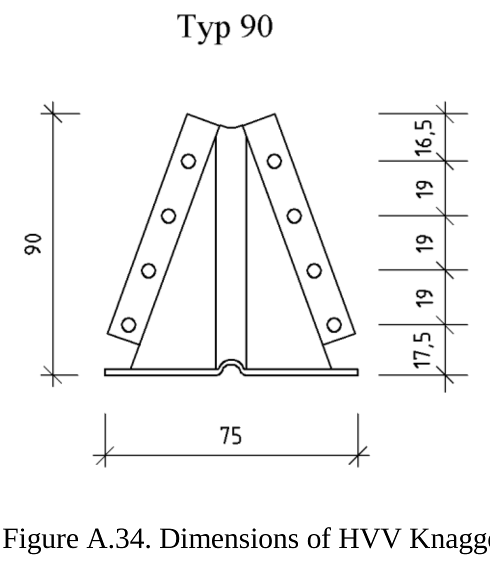


Figure A.33 Dimensions of
Angle Bracket type4/170x115x3,0x95 with rib, 3 mm thick



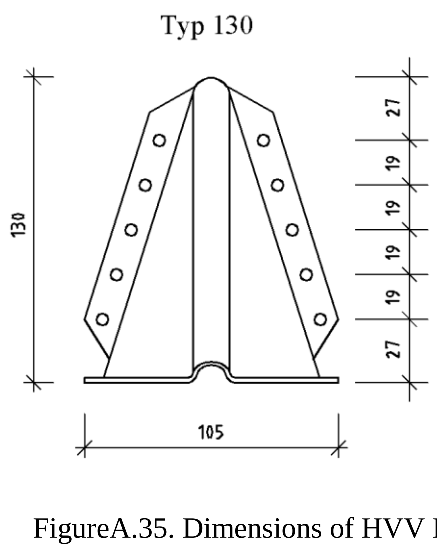


Figure A.34. Dimensions of HVV Knagge 90

FigureA.35. Dimensions of HVV Knagge 130

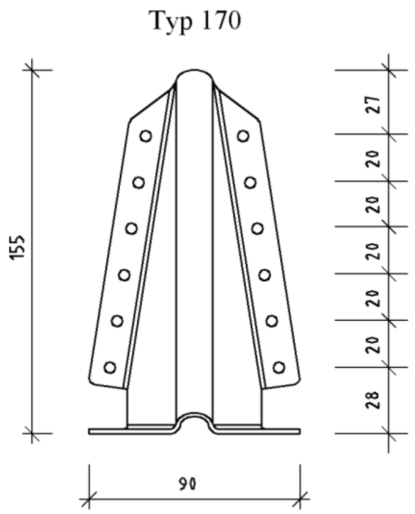


Figure A.36. Dimensions of HVV Knagge 170

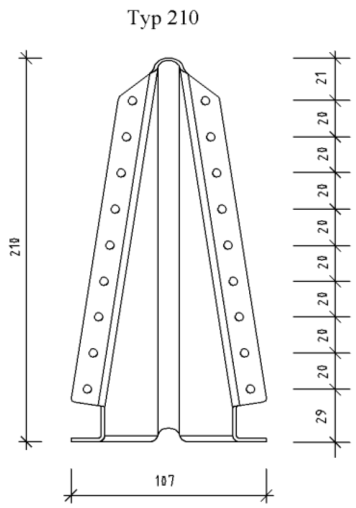
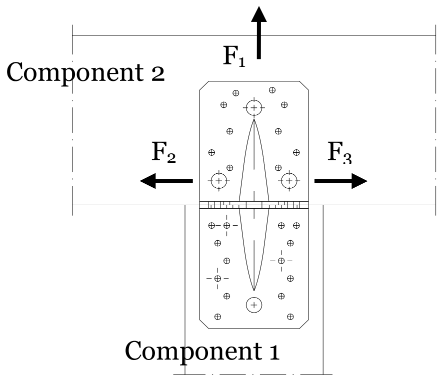


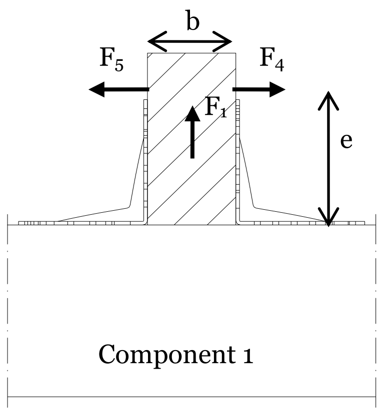
Figure A.37. Dimensions of HVV Knagge 210

Annex B
Characteristic load-carrying capacity

Design Basis - general

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





Fastener specification

The holes which have to be nailed are given in Annex A and the following tables give the characteristic capacities for the nailing patterns for the different forces.

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

For practical purposes the strength verification is always carried out for design forces and design capacities. If the forces are combined the following inequalities shall be fulfilled:

$$\left(\frac{F_{1k}}{R_{1k}}\right)^2 + \left(\frac{F_{2k}}{R_{2k}}\right)^2 + \left(\frac{F_{3k}}{R_{3k}}\right)^2 \leq 1$$

$$\frac{F_{1k}}{R_{1k}} + \frac{F_{4k}}{R_{4k}} + \frac{F_{5k}}{R_{5k}} \leq 1$$

F_k = Characteristic load (actual load)
R_k = Characteristic capacities from this ETA.

In the upper condition either F_2 or F_3 is zero. In the lower condition either F_4 or F_5 is zero.

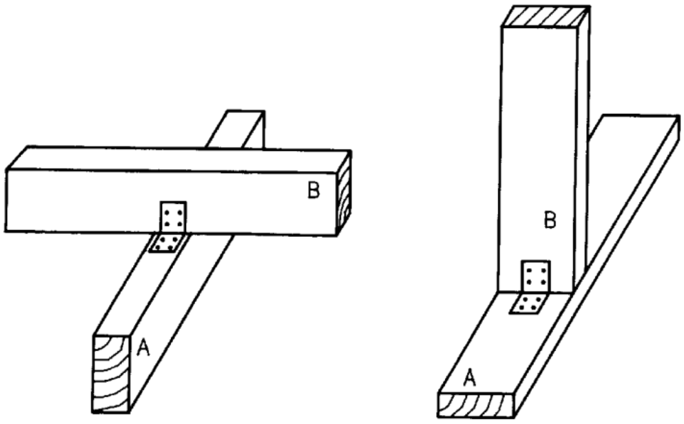
Density
The load-carrying capacities of the angle bracket connections are stated for a characteristic density of 350 kg/m^3.
For timber or wood based material with a lower characteristic density than 350 kg/m^3 the load-carrying capacities shall be reduced by the k_{dens} factor:

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

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

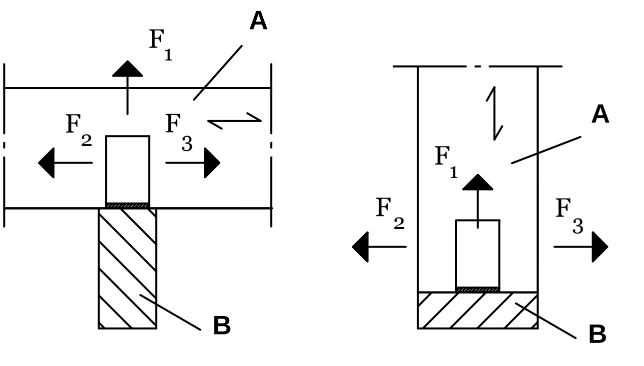
Angle Bracket
2,0 mm thick type1/60x60x2,0x60, type1/60x60x2,0x80, type1/60x60x2,0x100, type1/80x80x2,0x40, type1/80x80x2,0x60, type1/80x80x2,0x80
2,5 mm thick type1/60x60x2,5x60, type1/60x60x2,5x80, type1/60x60x2,5x100, type1/80x80x2,5x40, type1/80x80x2,5x60, type1/80x80x2,5x80, type1/80x80x2,5x100, type1/80x80x2,5x120, type1/100x100x2,5x60, type1/100x100x2,5x80, type1/100x100x2,5x100, type1/40x60x2,5x60, type1/60x80x2,5x60, type1/200x100x2,5x100

Basis for design



Type 1 Type 2

Figure B.1 Typical installation



Connection type 1 Connection type 2

Figure B.2 Load directions for the two types

The following tables and nailing patterns give the load carrying capacities for connection type 1 and 2 for load duration L, M and S. For load duration P, the value for load duration M shall be multiplied by 0,75 and for load duration I, the value for load duration M shall be multiplied by 1,38.

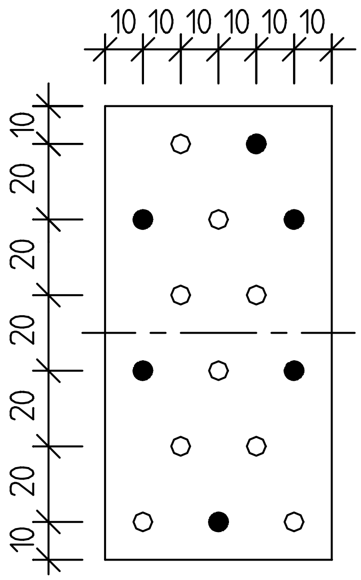
Connection type 1

type1/60x60x2,0/2,5x60

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	0,51	0,58	0,66	1,70	1,95	2,19
$R_{2k} = R_{3k}$	1,90	2,18	2,45	3,81	4,35	4,90

Table B.1 Connection type 1

Flik A

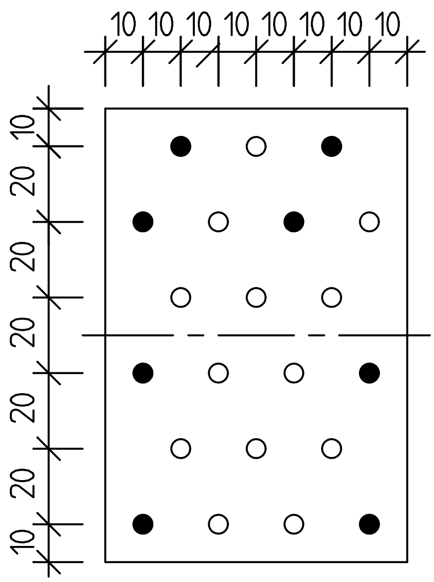


Flik A

type1/60x60x2,0/2,5x80

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	0,51	0,58	0,66	1,70	1,95	2,19
$R_{2k} = R_{3k}$	2,58	2,95	3,32	5,16	5,90	6,64

Table B.2 Connection type 1



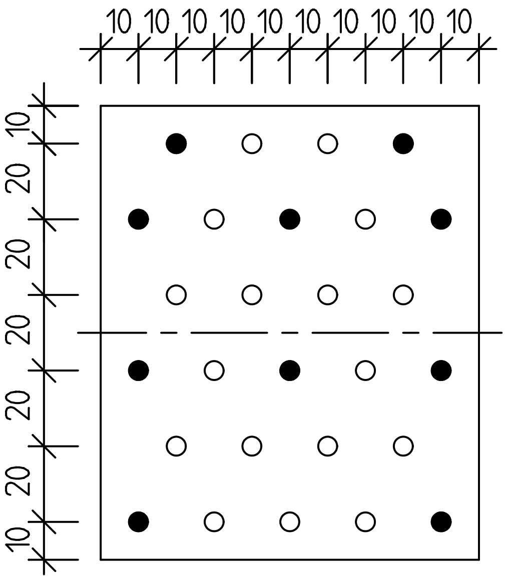
Flik B

type1/60x60x2,0/2,5x100

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	0,77	0,88	0,98	2,55	2,92	3,28
$R_{2k} = R_{3k}$	4,04	4,62	5,19	8,08	9,23	10,4

Table B.3 Connection type 1

Flik A



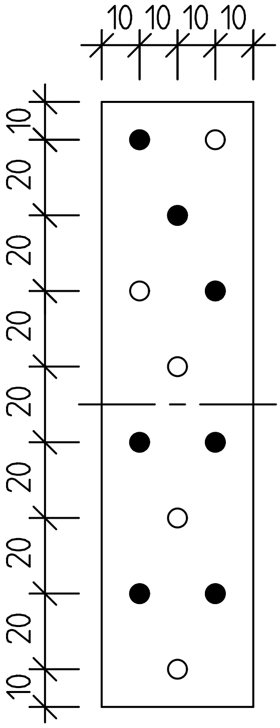
Flik B

Flik A

type1/80x80x2,0/2,5x40

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	0,54	0,61	0,69	1,79	2,04	2,30
$R_{2k} = R_{3k}$	1,16	1,33	1,49	2,32	2,66	2,99

Table B.4 Connection type 1

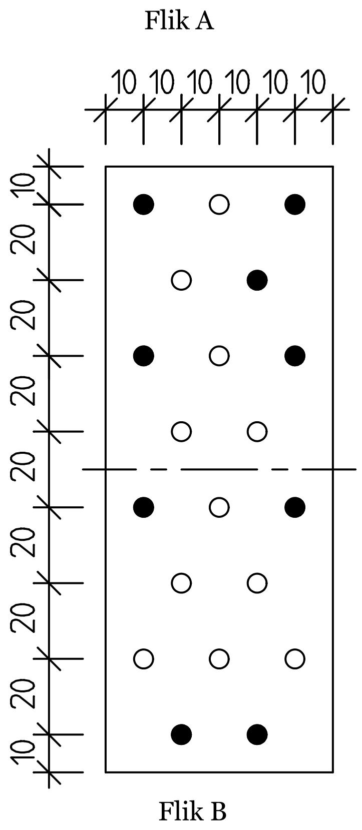


Flik B

type1/80x80x2,0/2,5x60

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	0,54	0,61	0,69	1,79	2,04	2,30
$R_{2k} = R_{3k}$	2,30	2,63	2,96	4,60	5,26	5,91

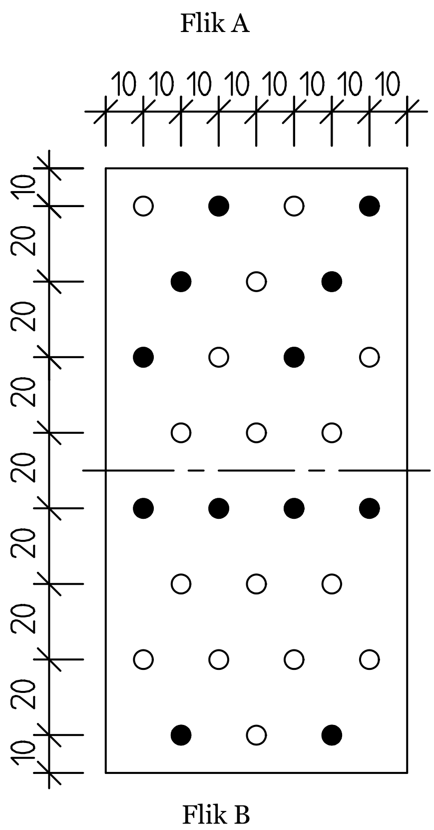
Table B.5 Connection type 1



type1/80x80x2,0/2,5x80

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	1,07	1,23	1,38	3,58	4,09	4,60
$R_{2k} = R_{3k}$	3,78	4,32	4,86	7,56	8,64	9,72

Table B.6 Connection type 1

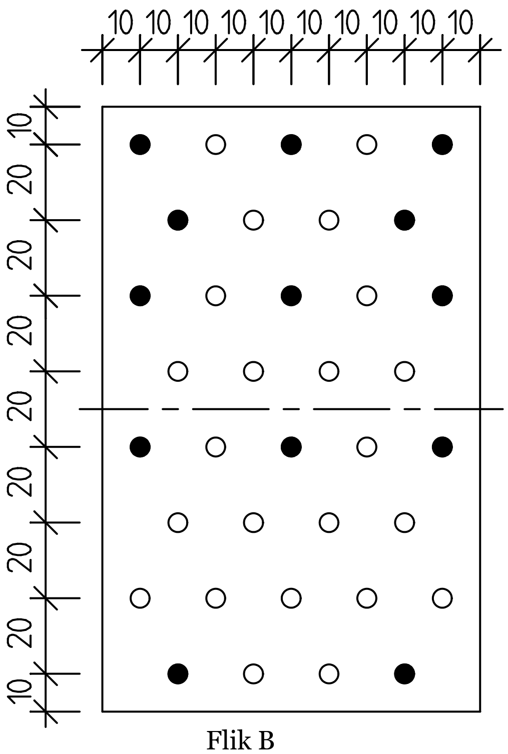


type1/80x80x2,5x100

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	0,80	0,92	1,03	2,68	3,06	3,45
$R_{2k} = R_{3k}$	3,93	4,49	5,05	7,86	8,98	10,1

Table B.7 Connection type 1

Flik A



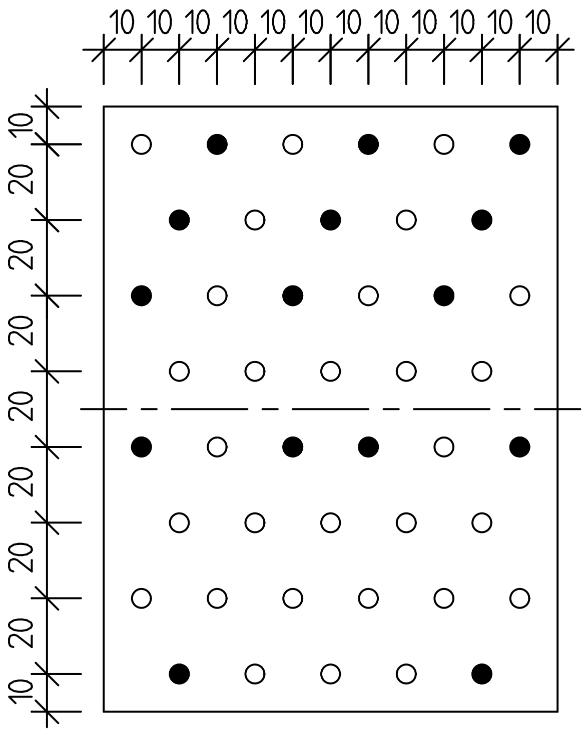
Flik B

type1/80x80x2,5x120

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	1,07	1,23	1,38	3,58	4,09	4,60
$R_{2k} = R_{3k}$	5,27	6,02	6,77	10,5	12,0	13,5

Table B.8 Connection type 1

Flik A



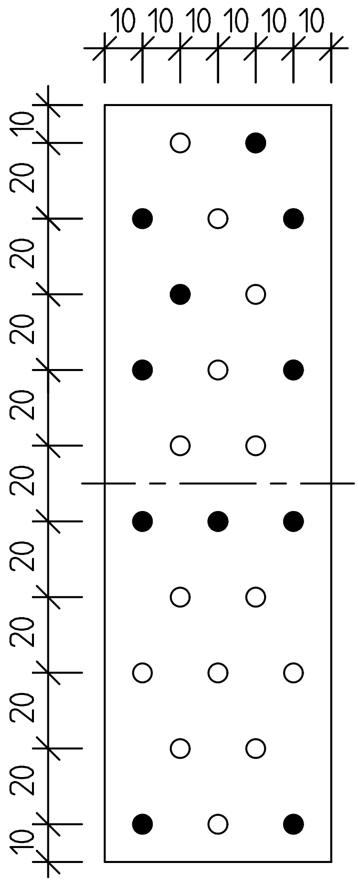
Flik B

type1/100x100x2,5x60

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	0,83	0,95	1,06	2,76	3,15	3,55
$R_{2k} = R_{3k}$	2,72	3,11	3,49	5,43	6,21	6,99

Table B.9 Connection type 1

Flik A



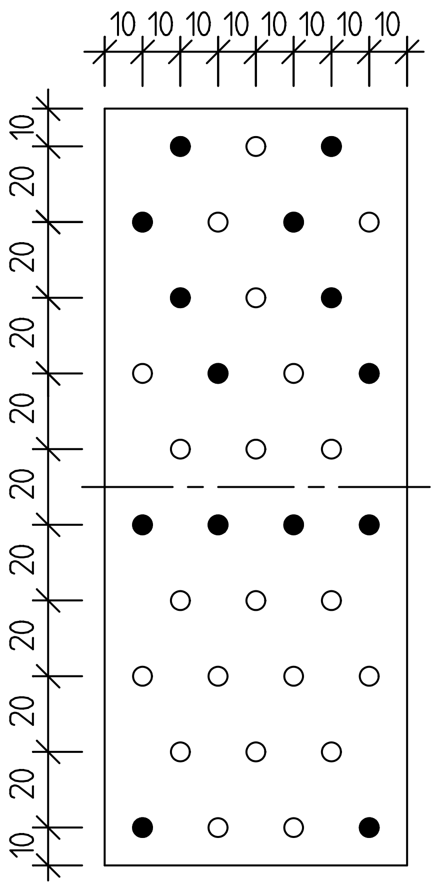
Flik B

type1/100x100x2,5x80,

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	1,10	1,26	1,42	3,68	4,20	4,73
$R_{2k} = R_{3k}$	3,59	4,10	4,62	7,18	8,21	9,24

Table B.10 Connection type 1

Flik A

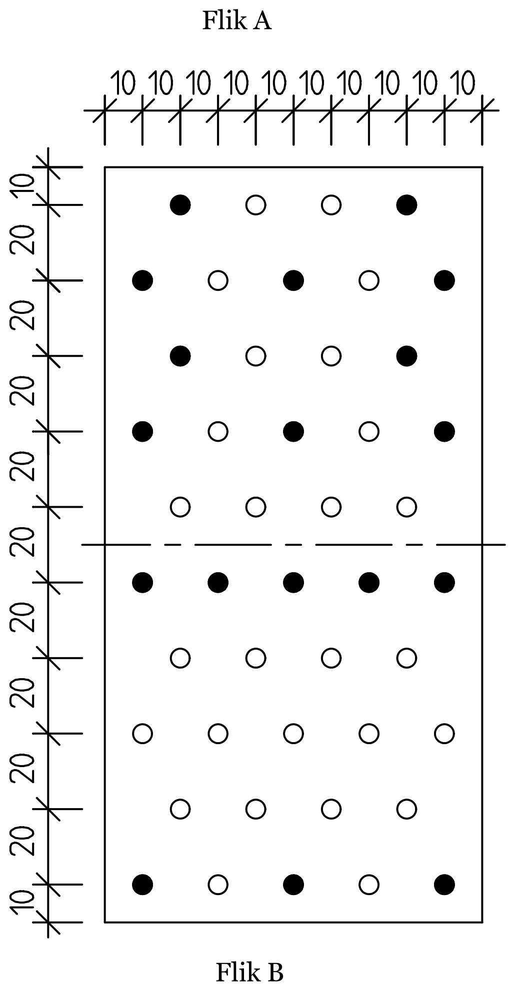


Flik B

type1/100x100x2,5x100

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	1,38	1,58	1,77	4,60	5,25	5,91
$R_{2k} = R_{3k}$	5,54	6,33	7,13	11,	12,7	14,3

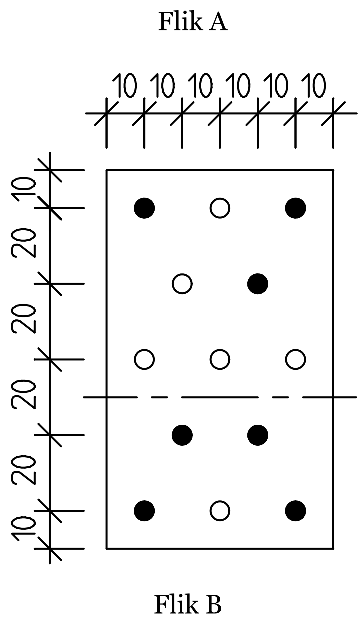
Table B.11 Connection type 1



type1/40x60x2,5x60

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	0,46	0,53	0,59	1,53	1,75	1,97
$R_{2k} = R_{3k}$	1,45	1,65	1,86	2,89	3,31	3,72

Table B.12 Connection type 1

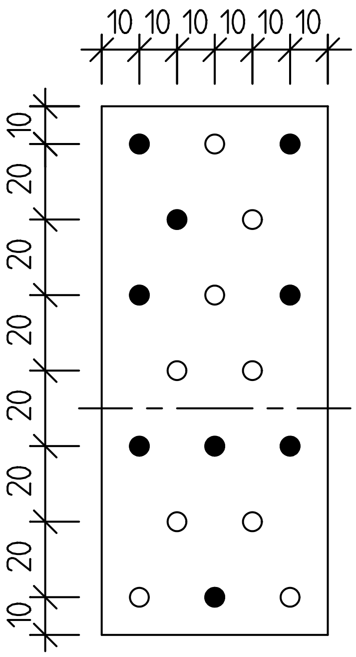


type1/60x80x2,5x60

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	0,77	0,88	0,98	2,55	2,92	3,28
$R_{2k} = R_{3k}$	2,38	2,72	3,06	4,76	5,44	6,12

Table B.13 Connection type 1

Flik A

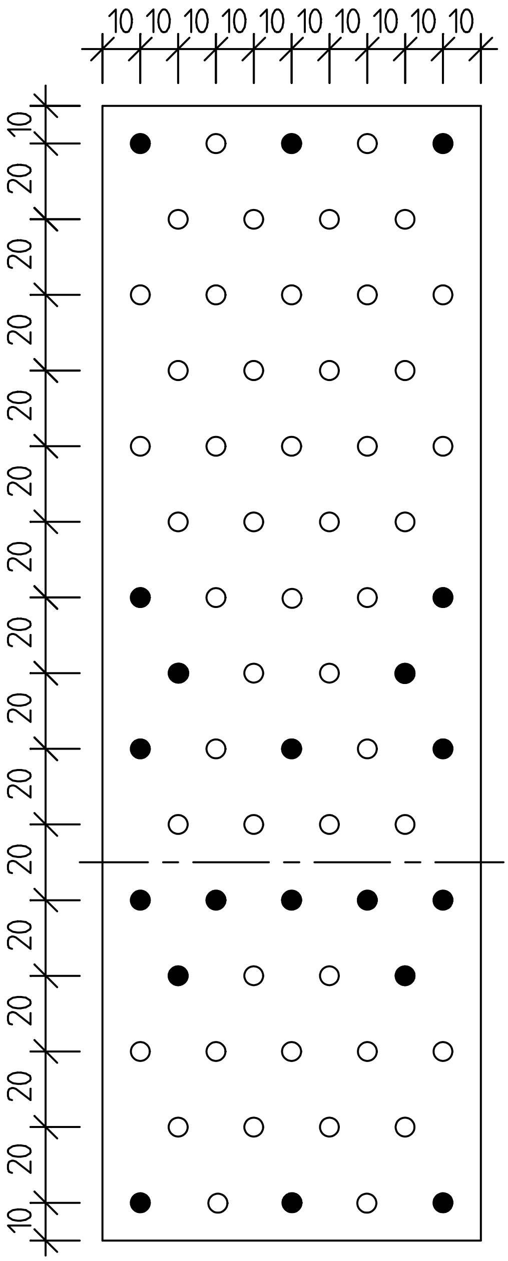


Flik B

type1/200x100x2,5x100

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	1,38	1,58	1,77	4,60	5,25	5,91
$R_{2k} = R_{3k}$	6,62	7,56	8,51	13,2	15,1	17,0

Table B.14 Connection type 1



Flik A

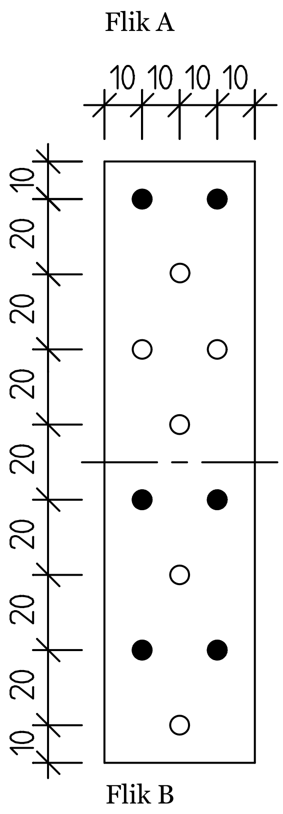
Flik B

Connection type 2

type1/80x80x2,5x40

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	0,54	0,61	0,69	1,79	2,04	2,30
$R_{2k} = R_{3k}$	0,36	0,41	0,46	0,72	0,82	0,92

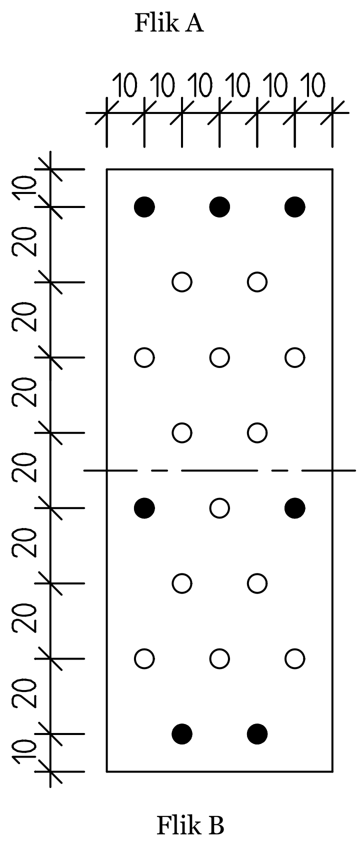
Table B.15 Connection type 2



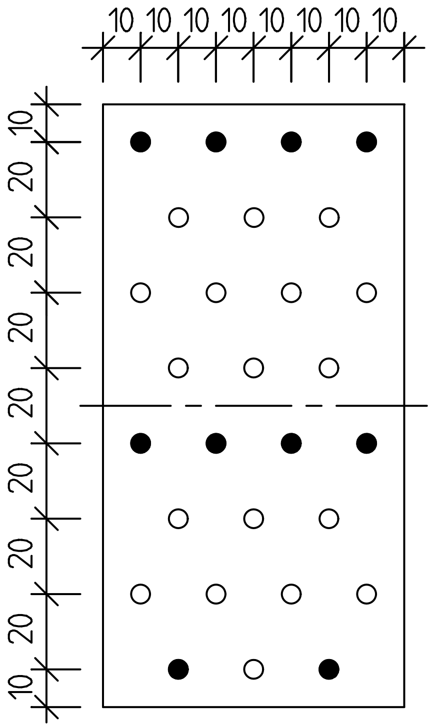
type1/80x80x2,5x60

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	0,54	0,61	0,69	1,79	2,04	2,30
$R_{2k} = R_{3k}$	1,11	1,27	1,43	2,22	2,54	2,86

Table B.16 Connection type 2



Flik A



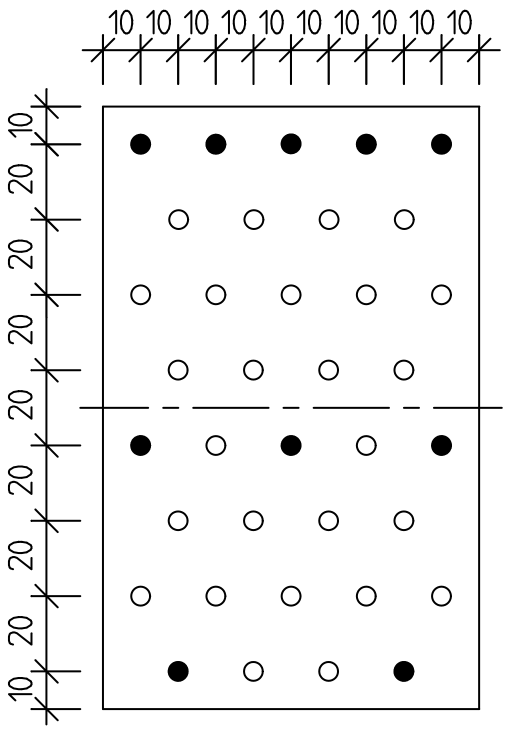
Flik B

type1/80x80x2,5x80

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	1,07	1,23	1,38	3,58	4,09	4,60
$R_{2k} = R_{3k}$	2,01	2,29	2,58	4,01	4,59	5,16

Table B.17 Connection type 2

Flik A



Flik B

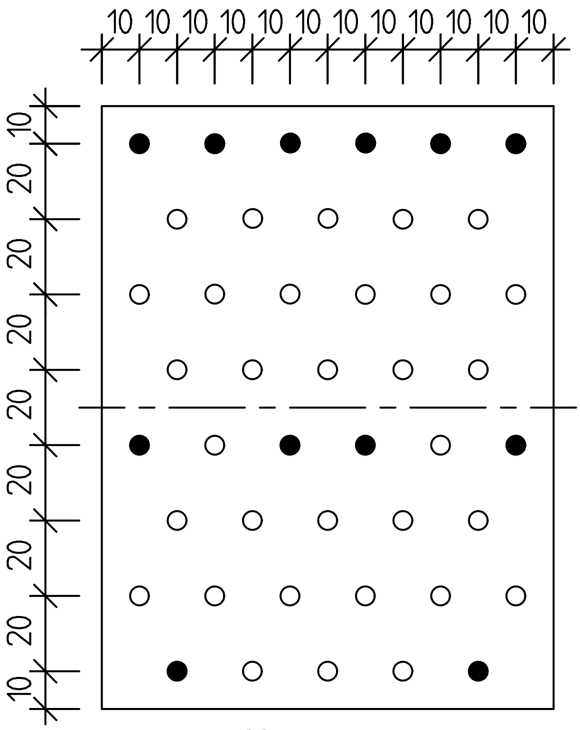
type1/80x80x2,5x100

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	0,80	0,92	1,03	2,68	3,06	3,45
$R_{2k} = R_{3k}$	2,56	2,92	3,29	5,11	5,84	6,57

Table B.18 Connection type 2

type1/80x80x2,5x120

Flik A



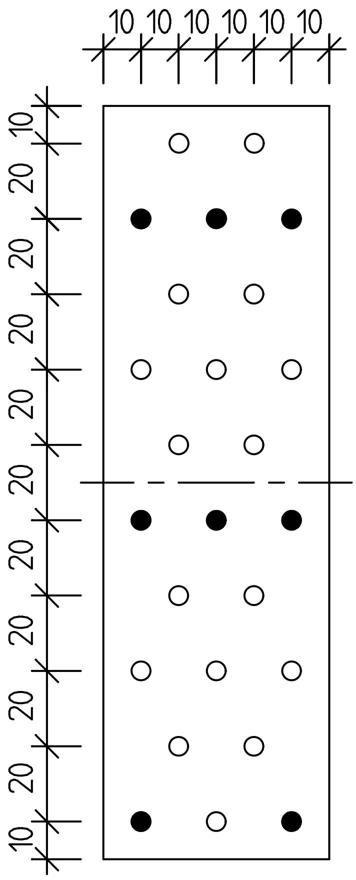
Flik B

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	1,07	1,23	1,38	3,58	4,09	4,60
$R_{2k} = R_{3k}$	3,52	4,02	4,52	7,04	8,04	9,05

Table B.19 Connection type 2

type1/100x100x2,5x60

Flik A



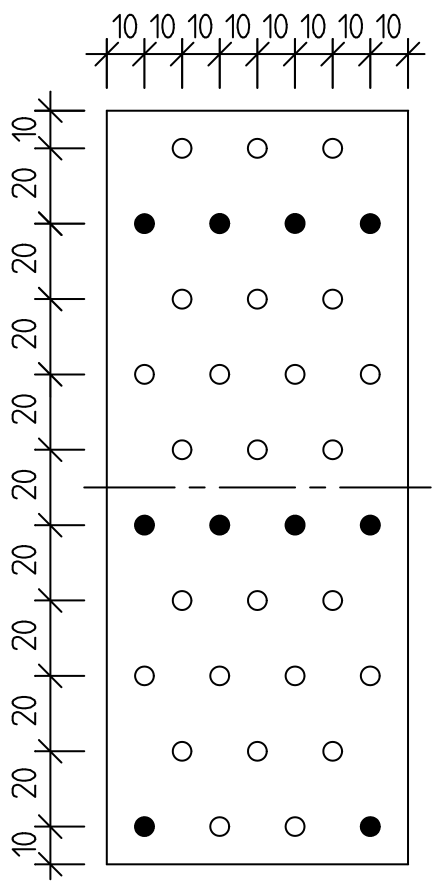
Flik B

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	0,83	0,95	1,06	2,76	3,15	3,55
$R_{2k} = R_{3k}$	1,29	1,48	1,66	2,59	2,95	3,32

Table B.20 Connection type 2

type1/100x100x2,5x80

Flik A



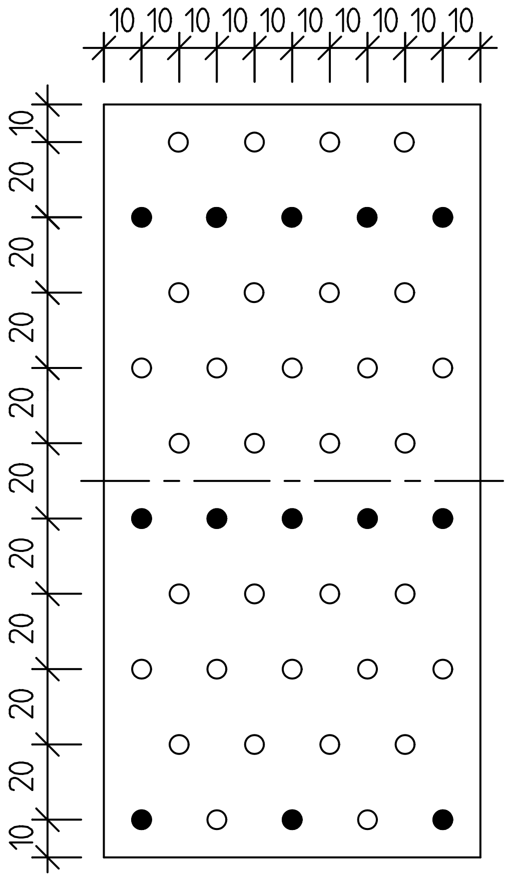
Flik B

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	1,10	1,26	1,42	3,68	4,20	4,73
$R_{2k} = R_{3k}$	2,11	2,41	2,71	4,21	4,81	5,41

Table B.21 Connection type 2

type1/100x100x2,5x100

Flik A



Flik B

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	1,38	1,58	1,77	4,60	5,25	5,91
$R_{2k} = R_{3k}$	3,14	3,59	4,04	6,29	7,18	8,08

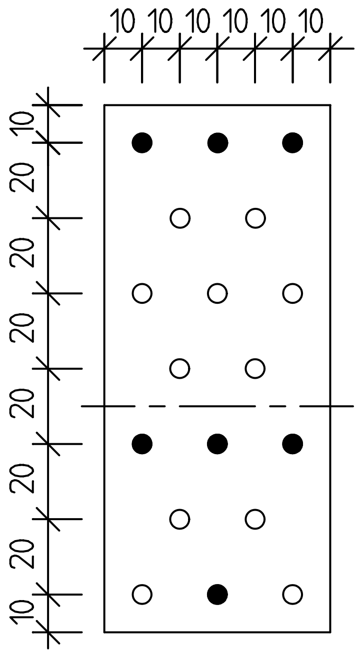
Table B.22 Connection type 2

type1/60x80x2,5x60

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	0,77	0,88	0,98	2,55	2,92	3,28
$R_{2k} = R_{3k}$	1,10	1,26	1,42	2,21	2,52	2,84

Table B.23 Connection type 2

Flik A

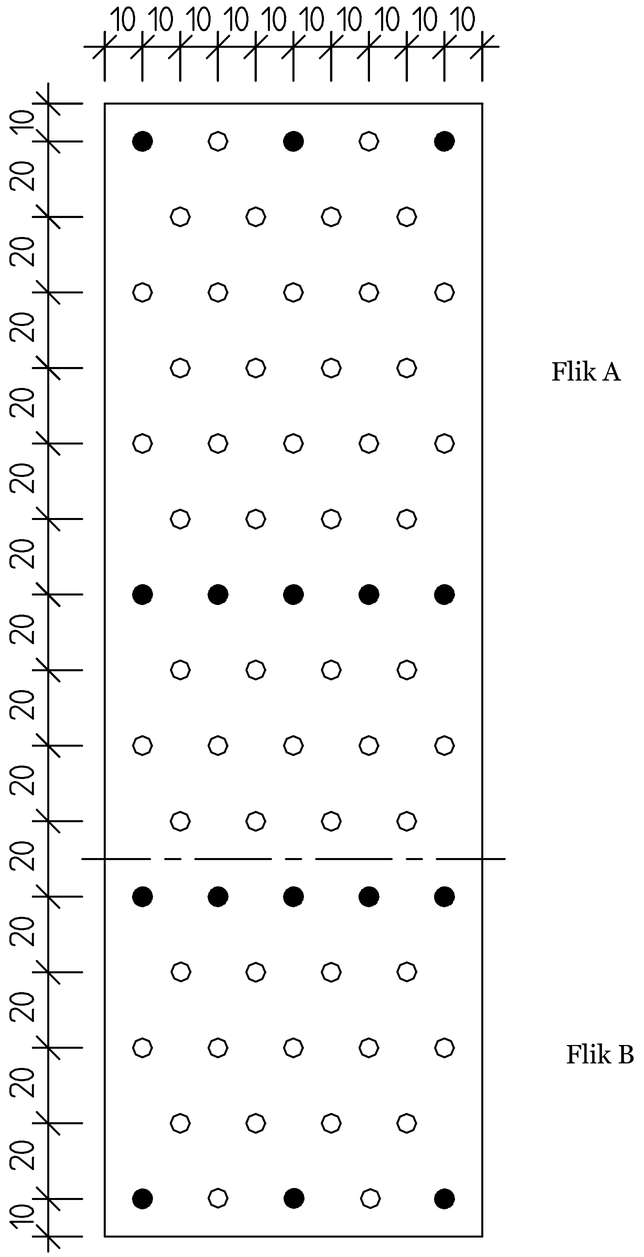


Flik B

type1/200x100x2,5x100

	One bracket			Two brackets		
	Load-duration class			Load-duration class		
	L	M	S	L	M	S
R_{1k}	1,38	1,58	1,77	4,60	5,25	5,91
$R_{2k} = R_{3k}$	4,59	5,25	5,91	9,19	10,5	11,8

Table B.24 Connection type 2



Angle bracket type6/90x90x3,0x40, type6/60x60x3,0x40, type7/65x65x3,0x55
Basis for design

Angle bracket type6/90x90x3,0x40 is always installed with two brackets pr. connection.

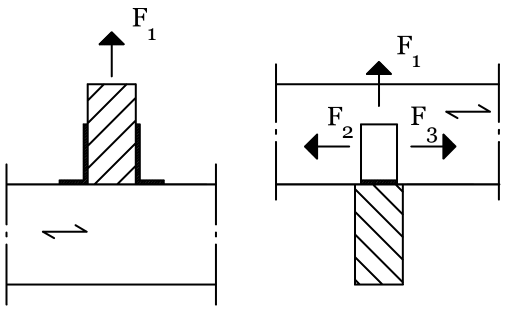


Figure B.3 Load directions

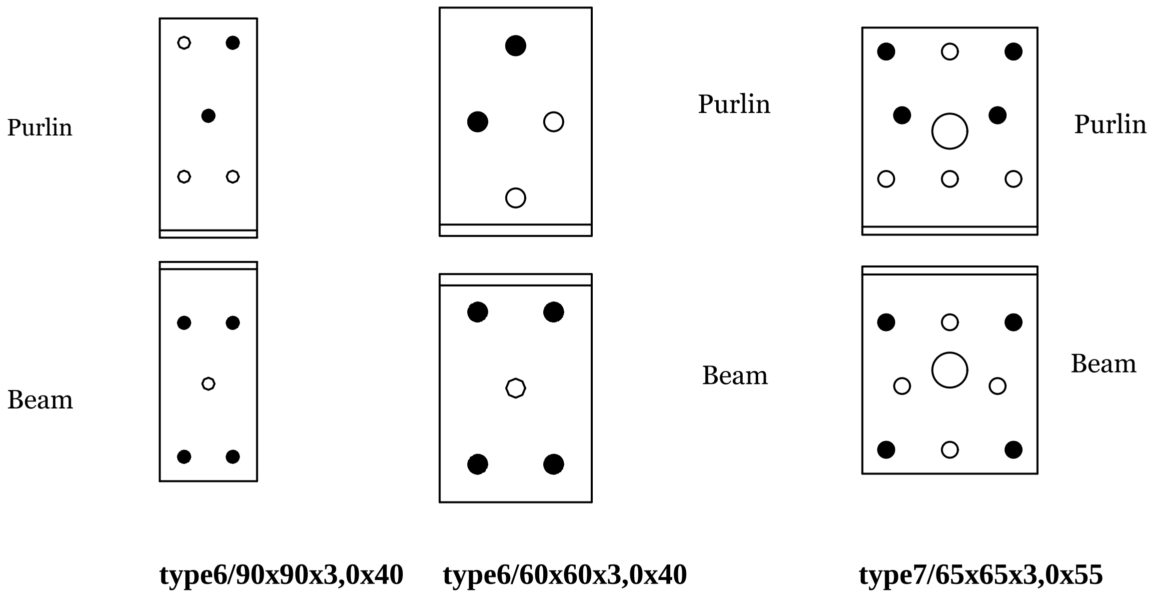


Figure B.4 Nailing pattern

The following tables indicate the load carrying capacities for the various load durations

Table B.25 apply to the connections with two angle brackets pr. Nail 4,0 x 40mm

Type	Load-duration class P (k_{mod} = 0,6)		Load-duration class L (k_{mod} = 0,7)		Load-duration class M (k_{mod} = 0,8)		Load-duration class S (k_{mod} = 0,9)		Load-duration class I (k_{mod} = 1,1)	
	R_{1k}	R_{2k}=R_{3k}	R_{1k}	R_{2k}=R_{3k}	R_{1k}	R_{2k}=R_{3k}	R_{1k}	R_{2k}=R_{3k}	R_{1k}	R_{2k}=R_{3k}
type6/90x90x3,0 x40	1,50	1,23	1,75	1,47	2,00	1,68	2,25	1,89	2,75	2,30
type6/60x60x3,0 x40	1,74	1,59	2,03	1,86	2,32	2,13	2,61	2,39	3,19	2,92
type7/65x65x3,0 x55	1,65	3,62	1,92	4,22	2,19	4,82	2,47	5,42	3,02	6,63

Table B.25

Angle bracket type6/120x90x3,0x40, type3/90x35x3,0x40, type3/160x50x3,0x40, type7/80x50x3,0x55
Basis for design

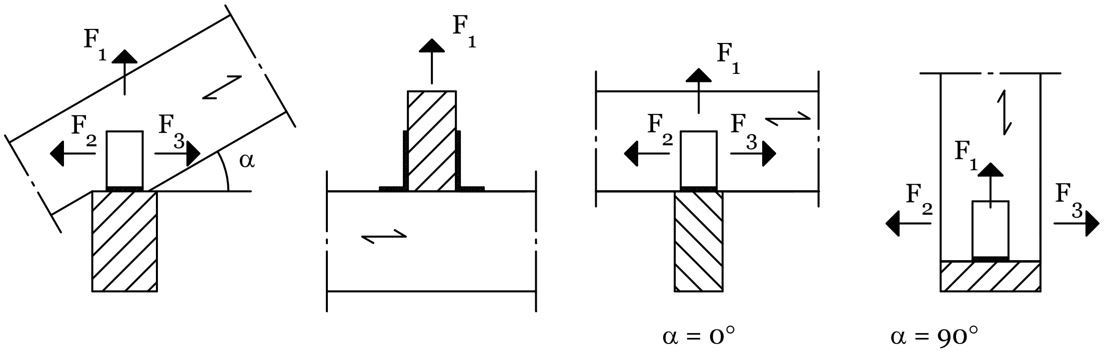
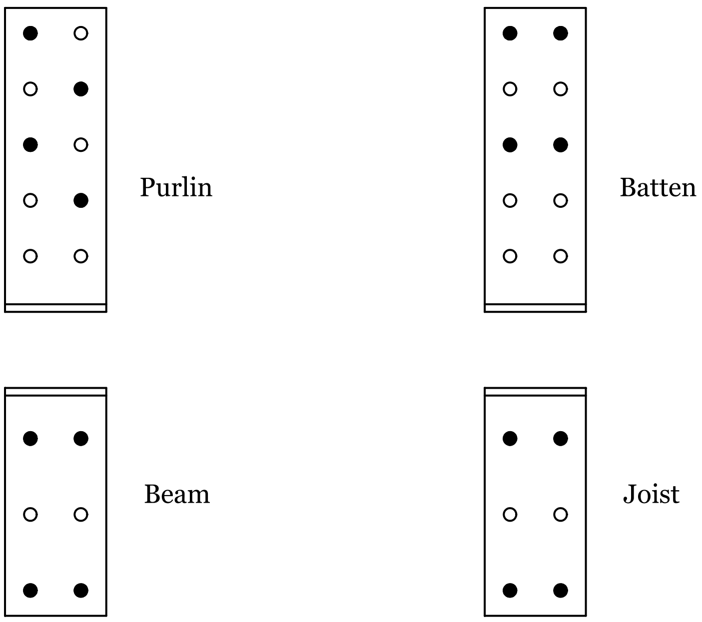


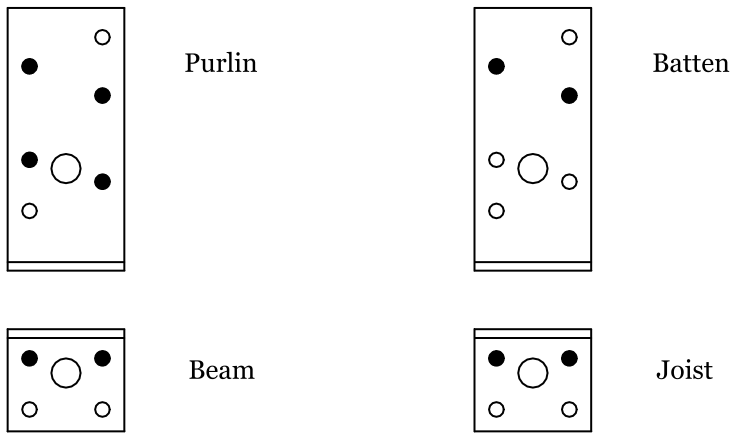
Figure B.5 Load directions



Nail pattern for
0 ≤ α < 45°

Nail pattern for
45° ≤ α ≤ 90°

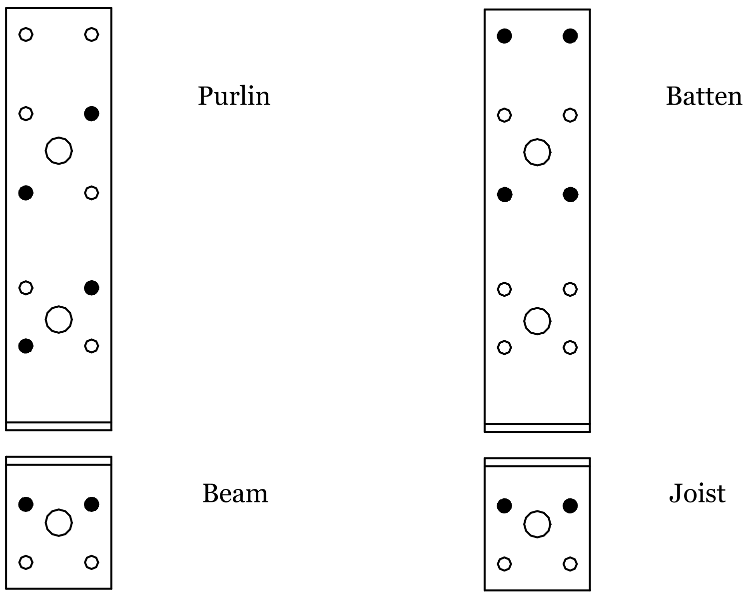
Figure B. 6a Nailing patterns bracket type type6/120x90x3,0x40



Nail pattern for
$0 \leq \alpha < 45°$

Nail pattern for
$45° \leq \alpha \leq 90°$

Figure B. 6b Nailing patterns bracket type3/90x35x3,0x40



Nail pattern for
$0 \leq \alpha < 45°$

Nail pattern
$45° \leq \alpha \leq 90°$

Figure B. 6c Nailing patterns bracket type3/160x50x3,0x40

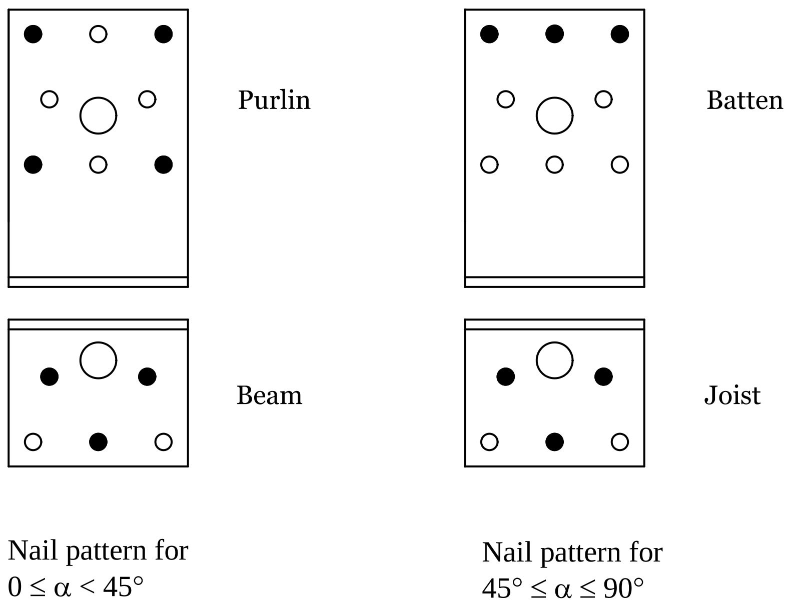


Figure B. 6d Nailing patterns bracket type7/80x50x3,0x55

The following tables indicate the load carrying capacities for the various load durations

Table B.26 apply to the connections with two angle brackets pr. connection and table B.27 apply to connections with one angle bracket pr. connection. Nail 4,0 x 40mm

Type	Load-duration class P (k_{mod} = 0,6)		Load-duration class L (k_{mod} = 0,7)		Load-duration class M (k_{mod} = 0,8)		Load-duration class S (k_{mod} = 0,9)		Load-duration class I (k_{mod} = 1,1)	
type6/120x90x3,0x40	R_{1k}	R_{2k}=R_{3k}	R_{1k}	R_{2k}=R_{3k}	R_{1k}	R_{2k}=R_{3k}	R_{1k}	R_{2k}=R_{3k}	R_{1k}	R_{2k}=R_{3k}
$0 \leq \alpha < 45°$	1,58	2,12	1,84	2,47	2,11	2,83	2,37	3,18	2,90	3,89
$45 \leq \alpha \leq 90°$	1,58	2,15	1,84	2,50	2,11	2,86	2,37	3,22	2,90	3,93
type3/90x35x3,0x40										
$0 \leq \alpha < 45°$	1,75	2,39	2,04	2,79	2,33	3,19	2,63	3,59	3,21	4,39
$45 \leq \alpha \leq 90°$	1,75	0,82	2,04	0,96	2,33	1,10	2,63	1,23	3,21	1,51
type3/160x50x3,0x40										
$0 \leq \alpha < 45°$	1,62	2,48	1,89	2,89	2,16	3,30	2,43	3,72	2,90	4,54
$45 \leq \alpha \leq 90°$	1,57	1,96	1,83	2,29	2,09	2,62	2,36	2,95	2,88	3,60
type7/80x50x3,0x55										
$0 \leq \alpha < 45°$	1,67	2,53	1,95	2,95	2,23	3,37	2,50	3,79	2,95	4,64
$45 \leq \alpha \leq 90°$	1,63	1,53	1,90	1,78	2,17	2,03	2,44	2,29	2,99	2,79

Table B.26 Two angle brackets

Type	Load-duration class P (k_{mod} = 0,6)		Load-duration class L (k_{mod} = 0,7)		Load-duration class M (k_{mod} = 0,8)		Load-duration class S (k_{mod} = 0,9)		Load-duration class I (k_{mod} = 1,1)	
type6/120x90x3,0x40	R_{1k}	$R_{2k}=R_{3k}$	R_{1k}	$R_{2k}=R_{3k}$	R_{1k}	$R_{2k}=R_{3k}$	R_{1k}	$R_{2k}=R_{3k}$	R_{1k}	$R_{2k}=R_{3k}$
0 ≤ α < 45°	0,47	1,05	0,55	1,22	0,63	1,40	0,71	1,57	0,87	1,92
45 ≤ α ≤ 90°	0,47	1,05	0,55	1,22	0,63	1,40	0,71	1,57	0,87	1,92
type3/90x35x3,0x40										
0 ≤ α < 45°	0,53	1,20	0,61	1,40	0,70	1,60	0,79	1,79	0,96	2,19
45 ≤ α ≤ 90°	0,53	0,41	0,61	0,48	0,70	0,55	0,79	0,62	0,96	0,75
type3/160x50x3,0x40										
0 ≤ α < 45°	0,49	1,24	0,57	1,45	0,65	1,65	0,73	1,86	0,87	2,27
45 ≤ α ≤ 90°	0,47	0,98	0,55	1,14	0,63	1,30	0,71	1,47	0,86	1,79
type7/80x50x3,0x55										
0 ≤ α < 45°	0,50	1,26	0,58	1,47	0,67	1,69	0,75	1,90	0,88	2,32
45 ≤ α ≤ 90°	0,49	0,59	0,57	0,69	0,65	0,79	0,73	0,88	0,90	1,08

Table B.27 One angle brackets

Angle Bracket type4/70 with rib, type4/70 without rib
Basis for design

Table B.28 apply to the connections with two angle brackets pr. connection and table B. 29 apply to connections with one angle bracket pr. connection. Bracket type 470M can be used in connections with one or two brackets, whereas type 470U can be used in connections with one bracket

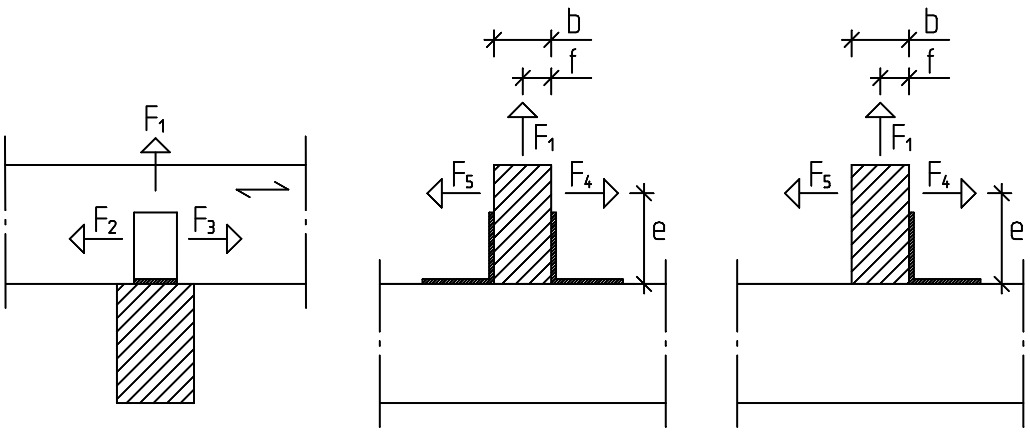


Figure B.7 Load directions

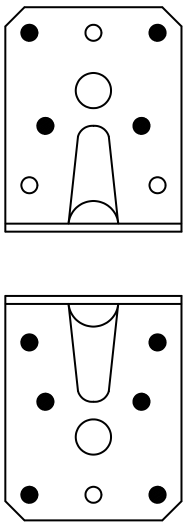


Figure B.8a Nailing pattern type4/70 with rib

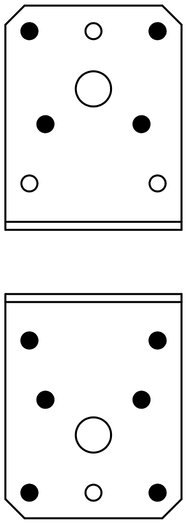


Figure B.8b Nailing pattern type4/70 without rib

Table B.28 apply to the connections with two angle brackets. Nails 4,0 x 40mm. Measurements e and b are in mm.

Type	Load-duration class P (k_{mod} = 0,6)			Load-duration class L (k_{mod} = 0,7)			Load-duration class M (k_{mod} = 0,8)		
	R_{1k}	R_{2k}=R_{3k}	R_{4k}=R_{5k}	R_{1k}	R_{2k}=R_{3k}	R_{4k}=R_{5k}	R_{1k}	R_{2k}=R_{3k}	R_{4k}=R_{5k}
type4/70 with rib 2,5 mm thick	2,93	4,15	The lesser of $\frac{73+1{,}46b}{e}$ 6,09	3,42	4,84	The lesser of $\frac{77+1{,}71b}{e}$ 7,18	3,91	5,53	The lesser of $\frac{81+1{,}95b}{e}$ 8,27
type4/70 with rib 2,0 mm thick	2,93	4,15	The lesser of $\frac{66+1{,}46b}{e}$ 6,09	3,42	4,84	The lesser of $\frac{70+1{,}71b}{e}$ 7,18	3,91	5,53	The lesser of $\frac{73+1{,}95b}{e}$ 8,27
type4/70 without rib 2,5 mm thick	2,26	4,15	The lesser of $\frac{21+1{,}13b}{e}$ 4,35	2,42	4,84	The lesser of $\frac{21+1{,}21b}{e}$ 5,07	2,58	5,53	The lesser of $\frac{21+1{,}29b}{e}$ 5,79
type4/70 without rib 2,0 mm thick	1,79	4,15	The lesser of $\frac{14+0{,}89b}{e}$ 4,35	1,83	4,84	The lesser of $\frac{14+0{,}92b}{e}$ 5,07	1,83	5,53	The lesser of $\frac{14+0{,}92b}{e}$ 5,79

Table B.28A Bracket 470M and 470U with two brackets in the connection

Type	Load-duration class S (k_{mod} = 0,9)			Load-duration class I (k_{mod} = 1,1)		
	R_{1k}	$R_{2k}=R_{3k}$	$R_{4k}=R_{5k}$	R_{1k}	$R_{2k}=R_{3k}$	$R_{4k}=R_{5k}$
type4/70 with rib 2,5 mm thick	4,39	6,22	The lesser of $\frac{84+2{,}20b}{e}$ 9,35	5,37	7,61	The lesser of $\frac{92+2{,}68b}{e}$ 11,51
type4/70 with rib 2,0 mm thick	4,39	6,22	The lesser of $\frac{77+2{,}20b}{e}$ 9,35	5,37	7,61	The lesser of $\frac{84+2{,}68b}{e}$ 11,51
type4/70 without rib 2,5 mm thick	2,73	6,22	The lesser of $\frac{21+1{,}37b}{e}$ 6,52	2,86	7,61	The lesser of $\frac{21+1{,}43b}{e}$ 7,97
type4/70 without rib 2,0 mm thick	1,83	6,22	The lesser of $\frac{14+0{,}92b}{e}$ 6,52	1,83	7,61	The lesser of $\frac{14+0{,}92b}{e}$ 7,97

Table B.28B Bracket 470M and 470U with two brackets in the connection

Table B.29 apply to the connections with one angle bracket. Nails 4,0 x 40mm. Measurements e and b are in mm.

Type	Load-duration class P (k_{mod} = 0,6)			
	R_{1k}	$R_{2k}=R_{3k}$	R_{4k}	R_{5k}
type4/70 with rib 2,5 mm thick	0,57 for $f \leq 25$	1,24	6,09 for $e \leq 5$ $\frac{33{,}3}{e}$ for $5<e\leq70$	$\frac{25{,}4}{62-e}$ for $e \leq 35$ $\frac{33{,}2}{e}$ for $35<e\leq70$
type4/70 with rib 2,0 mm thick	0,47 for $f \leq 25$	1,24	6,24 for $e \leq 4$ $\frac{27{,}0}{e}$ for $4<e\leq57$	$\frac{25{,}4}{62-e}$ for $e \leq 32$ $\frac{27{,}5}{e}$ for $32<e\leq56$

Table B.29a Bracket 470M with one bracket in the connection

Type	Load-duration class L (k_{mod} = 0,7)			
	R_{1k}	$R_{2k}=R_{3k}$	R_{4k}	R_{5k}
type4/70 with rib 2,5 mm thick	0,62 for $f \leq 25$	1,45	7,18 for $e \leq 5$ $\frac{36,0}{e}$ for $5<e\leq65$	$\frac{29,6}{62-e}$ for $e \leq 34$ $\frac{36,2}{e}$ for $34<e\leq64$
type4/70 with rib 2,0 mm thick	0,51 for $f \leq 25$	1,45	7,32 for $e \leq 4$ $\frac{29,6}{e}$ for $5<e\leq53$	$\frac{29,6}{62-e}$ for $e \leq 31$ $\frac{30,4}{e}$ for $31<e\leq52$

Table B.29b Bracket 470M with one bracket in the connection

Type	Load-duration class M (k_{mod} = 0,8)			
	R_{1k}	$R_{2k}=R_{3k}$	R_{4k}	R_{5k}
type4/70 with rib 2,5 mm thick	0,66 for $f \leq 25$	1,66	8,27 for $e \leq 5$ $\frac{38,6}{e}$ for $5<e\leq61$	$\frac{33,9}{62-e}$ for $e \leq 33$ $\frac{39,1}{e}$ for $33<e\leq60$
type4/70 with rib 2,0 mm thick	0,56 for $f \leq 25$	1,66	8,40 for $e \leq 4$ $\frac{32,3}{e}$ for $5<e\leq51$	$\frac{33,9}{62-e}$ for $e \leq 31$ $\frac{33,3}{e}$ for $31<e\leq50$

Table B.29c Bracket 470M with one bracket in the connection

Type	Load-duration class S (k_{mod} = 0,9)			
	R_{1k}	$R_{2k}=R_{3k}$	R_{4k}	R_{5k}
type4/70 with rib 2,5 mm thick	0,71 for $f \leq 25$	1,87	9,35 for $e \leq 4$ $\frac{41,2}{e}$ for $4<e\leq58$	$\frac{38,1}{62-e}$ for $e \leq 32$ $\frac{41,5}{e}$ for $32<e\leq57$
type4/70 with rib 2,0 mm thick	0,60 for $f \leq 25$	1,87	9,47 for $e \leq 4$ $\frac{34,9}{e}$ for $4<e\leq49$	$\frac{38,1}{62-e}$ for $e \leq 30$ $\frac{36,2}{e}$ for $30<e\leq48$

Table B.29d Bracket 470M with one bracket in the connection

Type	Load-duration class I (k_{mod} = 1,1)			
	R_{1k}	$R_{2k}=R_{3k}$	R_{4k}	R_{5k}
type4/70 with rib 2,5 mm thick	0,80 for $f \leq 25$	2,28	11,51 for $e \leq 4$ $\frac{46,5}{e}$ for $4<e\leq53$	$\frac{46,5}{62-e}$ for $e \leq 30$ $\frac{43,9}{e}$ for $30<e\leq554$
type4/70 with rib 2,0 mm thick	0,69 for $f \leq 25$	2,28	11,62 for $e \leq 3$ $\frac{40,1}{e}$ for $4<e\leq46$	$\frac{46,5}{62-e}$ for $e \leq 29$ $\frac{40,0}{e}$ for $29<e\leq46$

Table B.29e Bracket 470M with one bracket in the connection

Angle Bracket type8/160x80x3/4x60, type8/160x80x3/4x80, type8/160x80x3/4x100
Basis for design

Table B.30 apply to the connections with two angle brackets pr. connection and table B. 31 apply to connections with one angle bracket pr. connection.

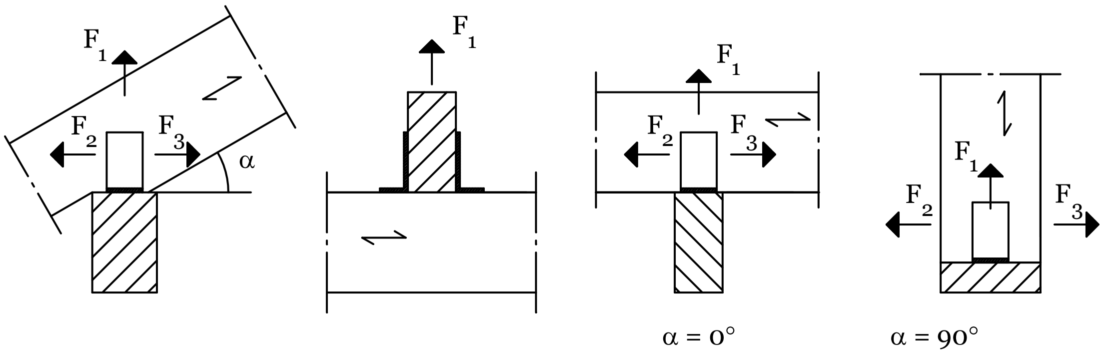


Figure B.9 Load directions

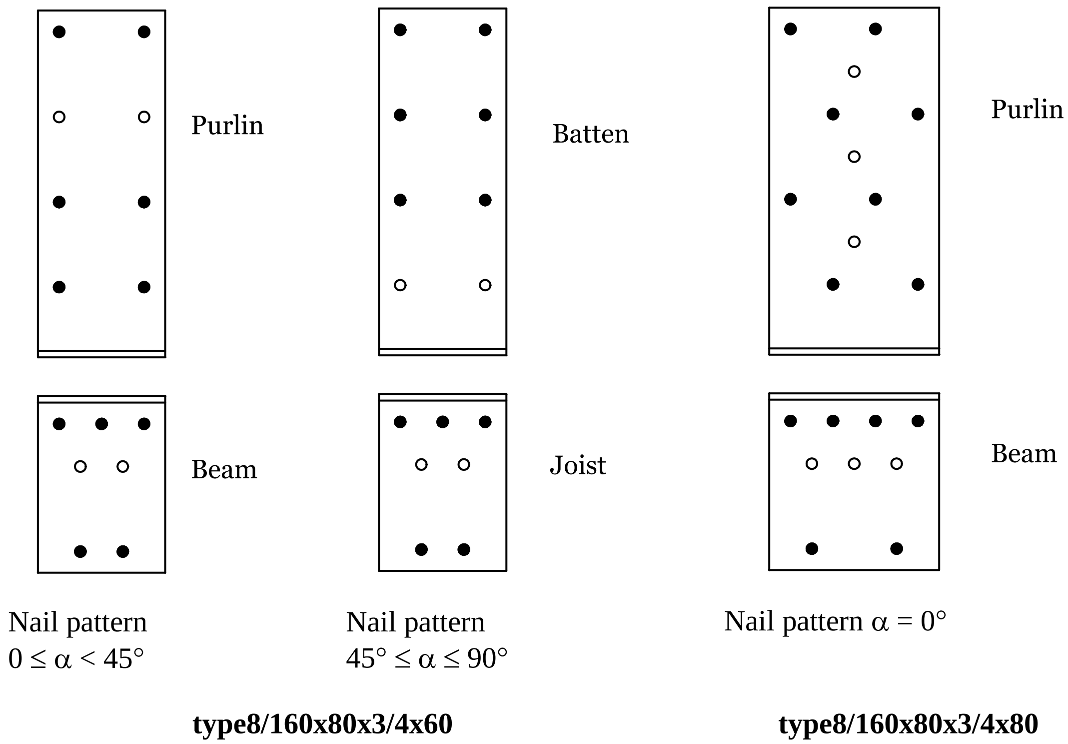


Figure B.10a Nailing pattern type8/160x80x3/4x60 and type8/160x80x3/4x80

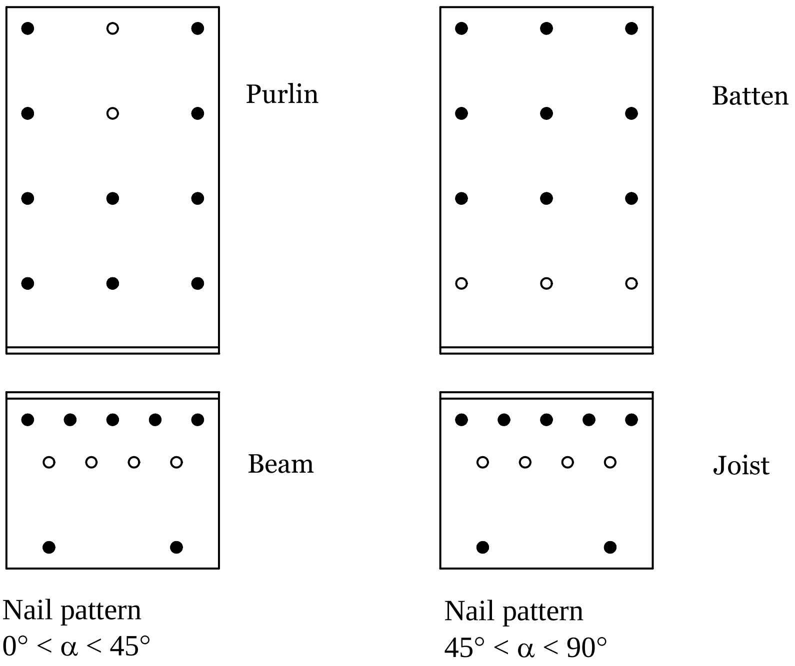


Figure B.10b Nailing pattern type8/160x80x3/4x100

Table B.30 apply to the connections with two angle brackets. Nails 4,0 x 40mm. Measurements e and b are in mm.

Load-duration class P (k_{mod} = 0,6)				
		Nails	R_{1k}	R_{2k}=R_{3k}
type8/160x80x 3/4x60	0 ≤ α < 45°	4,0x40	2,30	5,22
	45 ≤ α ≤ 90°	4,0x40	2,30	3,43
	0 ≤ α < 45°	4,0x60	4,21	5,78
	45 ≤ α ≤ 90°	4,0x60	4,21	3,97
type8/160x80x 3/4x80	α = 0°	4,0x40	3,06	6,06
	α = 0°	4,0x60	5,62	6,92
type8/160x80x 3/4x100	0 ≤ α < 45°	4,0x40	3,83	9,21
	45 ≤ α ≤ 90°	4,0x40	3,83	6,33
	0 ≤ α < 45°	4,0x60	7,02	10,31
	45 ≤ α ≤ 90°	4,0x60	7,02	7,51

Table B.30a With two brackets in the connection

Load-duration class L (k_{mod} = 0,7)				
		Nails	R_{1k}	$R_{2k}=R_{3k}$
type8/160x80x 3/4x60	$0 \leq \alpha < 45°$	4,0x40	2,68	6,09
	$45 \leq \alpha \leq 90°$	4,0x40	2,68	4,00
	$0 \leq \alpha < 45°$	4,0x60	4,92	6,74
	$45 \leq \alpha \leq 90°$	4,0x60	4,92	4,63
type8/160x80x 3/4x80	$\alpha = 0°$	4,0x40	3,58	7,07
	$\alpha = 0°$	4,0x60	6,55	8,08
type8/160x80x 3/4x100	$0 \leq \alpha < 45°$	4,0x40	4,47	10,75
	$45 \leq \alpha \leq 90°$	4,0x40	4,47	7,38
	$0 \leq \alpha < 45°$	4,0x60	8,19	12,03
	$45 \leq \alpha \leq 90°$	4,0x60	8,19	8,77

Table B.30b With two brackets in the connection

Load-duration class M (k_{mod} = 0,8)				
		Nails	R_{1k}	$R_{2k}=R_{3k}$
type8/160x80x 3/4x60	$0 \leq \alpha < 45°$	4,0x40	3,06	6,96
	$45 \leq \alpha \leq 90°$	4,0x40	3,06	4,57
	$0 \leq \alpha < 45°$	4,0x60	5,62	7,70
	$45 \leq \alpha \leq 90°$	4,0x60	5,62	5,29
type8/160x80x 3/4x80	$\alpha = 0°$	4,0x40	4,09	8,08
	$\alpha = 0°$	4,0x60	7,49	9,23
type8/160x80x 3/4x100	$0 \leq \alpha < 45°$	4,0x40	5,11	12,28
	$45 \leq \alpha \leq 90°$	4,0x40	5,11	8,44
	$0 \leq \alpha < 45°$	4,0x60	9,36	13,75
	$45 \leq \alpha \leq 90°$	4,0x60	9,36	10,02

Table B.30c With two brackets in the connection

Load-duration class S (k_{mod} = 0,9)				
		Nails	R_{1k}	$R_{2k}=R_{3k}$
type8/160x80x 3/4x60	$0 \leq \alpha < 45°$	4,0x40	3,45	7,83
	$45 \leq \alpha \leq 90°$	4,0x40	3,45	5,14
	$0 \leq \alpha < 45°$	4,0x60	6,32	8,67
	$45 \leq \alpha \leq 90°$	4,0x60	6,32	5,95
type8/160x80x 3/4x80	$\alpha = 0°$	4,0x40	4,60	9,09
	$\alpha = 0°$	4,0x60	8,43	10,39
type8/160x80x 3/4x100	$0 \leq \alpha < 45°$	4,0x40	5,75	13,82
	$45 \leq \alpha \leq 90°$	4,0x40	5,75	9,49
	$0 \leq \alpha < 45°$	4,0x60	10,53	15,46
	$45 \leq \alpha \leq 90°$	4,0x60	10,53	11,27

Table B.30d With two brackets in the connection

Load-duration class I (k_{mod} = 1,1)				
		Nails	R_{1k}	$R_{2k}=R_{3k}$
type8/160x80x 3/4x60	$0 \leq \alpha < 45°$	4,0x40	4,21	9,57
	$45 \leq \alpha \leq 90°$	4,0x40	4,21	6,28
	$0 \leq \alpha < 45°$	4,0x60	7,72	10,59
	$45 \leq \alpha \leq 90°$	4,0x60	7,72	7,28
type8/160x80x 3/4x80	$\alpha = 0°$	4,0x40	5,62	11,11
	$\alpha = 0°$	4,0x60	10,30	12,70
type8/160x80x 3/4x100	$0 \leq \alpha < 45°$	4,0x40	7,02	16,89
	$45 \leq \alpha \leq 90°$	4,0x40	7,02	11,60
	$0 \leq \alpha < 45°$	4,0x60	12,87	18,90
	$45 \leq \alpha \leq 90°$	4,0x60	12,87	13,77

Table B.30e With two brackets in the connection

Load-duration class P (k_{mod} = 0,6)				
		Nails	R_{1k}	$R_{2k}=R_{3k}$
type8/160x80x 3/4x60	$0 \leq \alpha < 45°$	4,0x40	0,77	2,60
	$45 \leq \alpha \leq 90°$	4,0x40	0,77	1,68
	$0 \leq \alpha < 45°$	4,0x60	1,40	2,87
	$45 \leq \alpha \leq 90°$	4,0x60	1,40	1,92
type8/160x80x 3/4x80	$\alpha = 0°$	4,0x40	1,02	3,02
	$\alpha = 0°$	4,0x60	1,87	3,45
type8/160x80x 3/4x100	$0 \leq \alpha < 45°$	4,0x40	1,28	4,52
	$45 \leq \alpha \leq 90°$	4,0x40	1,28	2,93
	$0 \leq \alpha < 45°$	4,0x60	2,34	5,01
	$45 \leq \alpha \leq 90°$	4,0x60	2,34	3,32

Table B.31a With one bracket in the connection

Load-duration class L (k_{mod} = 0,7)				
		Nails	R_{1k}	$R_{2k}=R_{3k}$
type8/160x80x 3/4x60	$0 \leq \alpha < 45°$	4,0x40	0,89	3,03
	$45 \leq \alpha \leq 90°$	4,0x40	0,89	1,96
	$0 \leq \alpha < 45°$	4,0x60	1,64	3,35
	$45 \leq \alpha \leq 90°$	4,0x60	1,64	2,24
type8/160x80x 3/4x80	$\alpha = 0°$	4,0x40	1,19	3,53
	$\alpha = 0°$	4,0x60	2,18	4,03
type8/160x80x 3/4x100	$0 \leq \alpha < 45°$	4,0x40	1,49	5,27
	$45 \leq \alpha \leq 90°$	4,0x40	1,49	3,42
	$0 \leq \alpha < 45°$	4,0x60	2,73	5,85
	$45 \leq \alpha \leq 90°$	4,0x60	2,73	3,88

Table B.31b With one bracket in the connection

Load-duration class M (k_{mod} = 0,8)				
		Nails	R_{1k}	$R_{2k}=R_{3k}$
type8/160x80x 3/4x60	$0 \leq \alpha < 45°$	4,0x40	1,02	3,47
	$45 \leq \alpha \leq 90°$	4,0x40	1,02	2,24
	$0 \leq \alpha < 45°$	4,0x60	1,87	3,83
	$45 \leq \alpha \leq 90°$	4,0x60	1,87	2,56
type8/160x80x 3/4x80	$\alpha = 0°$	4,0x40	1,36	4,03
	$\alpha = 0°$	4,0x60	2,50	4,60
type8/160x80x 3/4x100	$0 \leq \alpha < 45°$	4,0x40	1,70	6,02
	$45 \leq \alpha \leq 90°$	4,0x40	1,70	3,90
	$0 \leq \alpha < 45°$	4,0x60	3,12	6,68
	$45 \leq \alpha \leq 90°$	4,0x60	3,12	4,43

Table B.31c With one bracket in the connection

Load-duration class S (k_{mod} = 0,9)				
		Nails	R_{1k}	$R_{2k}=R_{3k}$
type8/160x80x 3/4x60	$0 \leq \alpha < 45°$	4,0x40	1,15	3,90
	$45 \leq \alpha \leq 90°$	4,0x40	1,15	2,52
	$0 \leq \alpha < 45°$	4,0x60	2,11	4,31
	$45 \leq \alpha \leq 90°$	4,0x60	2,11	2,88
type8/160x80x 3/4x80	$\alpha = 0°$	4,0x40	1,53	4,53
	$\alpha = 0°$	4,0x60	2,81	5,18
type8/160x80x 3/4x100	$0 \leq \alpha < 45°$	4,0x40	1,92	6,78
	$45 \leq \alpha \leq 90°$	4,0x40	1,92	4,39
	$0 \leq \alpha < 45°$	4,0x60	3,51	7,52
	$45 \leq \alpha \leq 90°$	4,0x60	3,51	4,99

Table B.31d With one bracket in the connection

Load-duration class I (k_{mod} = 1,1)				
		Nails	R_{1k}	R_{2k}=R_{3k}
type8/160x80x 3/4x60	$0 \leq \alpha < 45°$	4,0x40	1,40	4,77
	$45 \leq \alpha \leq 90°$	4,0x40	1,40	3,08
	$0 \leq \alpha < 45°$	4,0x60	2,57	5,27
	$45 \leq \alpha \leq 90°$	4,0x60	2,57	3,52
type8/160x80x 3/4x80	$\alpha = 0°$	4,0x40	1,87	5,54
	$\alpha = 0°$	4,0x60	3,43	6,33
type8/160x80x 3/4x100	$0 \leq \alpha < 45°$	4,0x40	2,34	8,28
	$45 \leq \alpha \leq 90°$	4,0x40	2,34	5,37
	$0 \leq \alpha < 45°$	4,0x60	4,29	9,19
	$45 \leq \alpha \leq 90°$	4,0x60	4,29	6,09

Table B.31e With one bracket in the connection

Angle Bracket type4/75x50x1,5x60-13, type4/125x50x2,5x70, type4/75x50x1,5x60EXP, type4/75x50x1,5x60-11, type4/155x100x2,5x80, type4/155x160x2,5x80, type4/175x60x2,5x75

Basis for design – wood to wood connections

The characteristic capacities in wood to wood connections are given in tables 32a to 32j. The tables 32a to 32e apply to connections with two brackets and tables 32f to 32j apply to connections with one bracket.

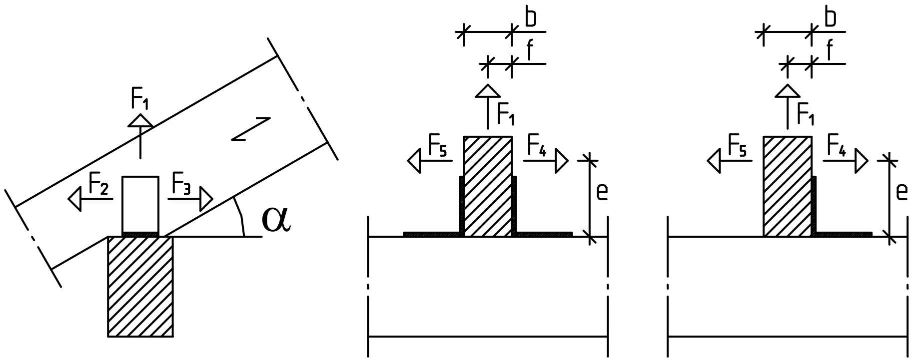
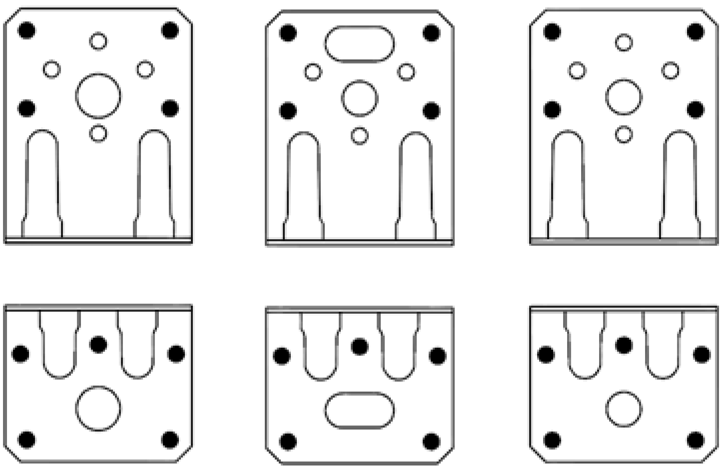


Figure B.11 Load directions

With two brackets in a connection the nails shall not overlap more than what is described in Eurocode 5 section 8.3.1.1. If the purlin is too thin, then brackets shall be staggered.

Type 4230001 | Type 4230002 | Type 4230003

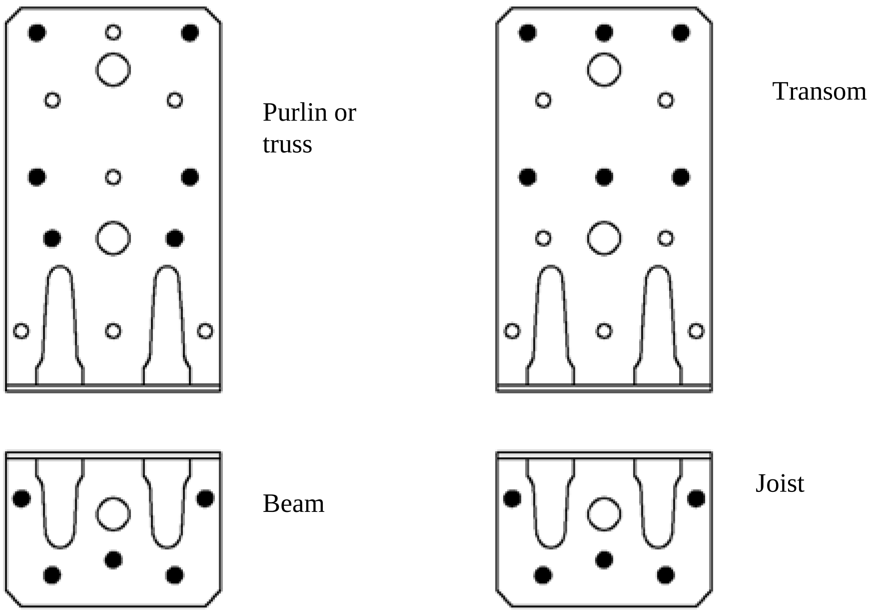


Purlin

Beam

Nailing pattern for α = 0° | Nailing pattern for α = 0° | Nailing pattern for α = 0°

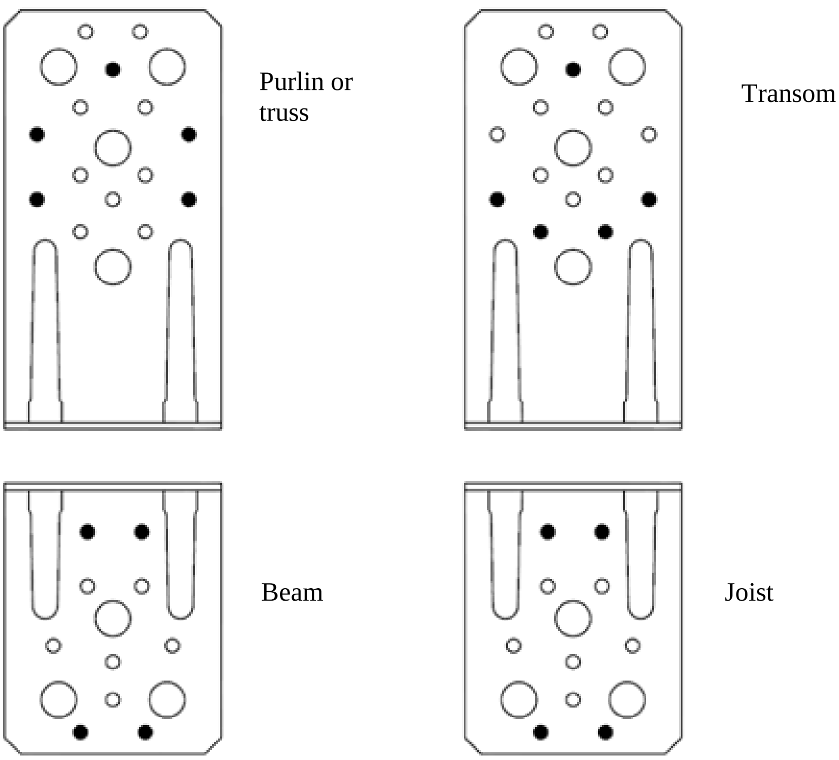
Figure B.11a Nailing pattern type 4230001, 4230002, 4230003



Nailing pattern for
$0 \leq \alpha < 45°$

Nailing pattern
$45° \leq \alpha \leq 90°$

Figure B.11b Nailing pattern type 4230101



Nailing pattern for
$0 \leq \alpha < 45°$

Nailing pattern for
$45° \leq \alpha \leq 90°$

Figure B.11c Nailing pattern type 4230201

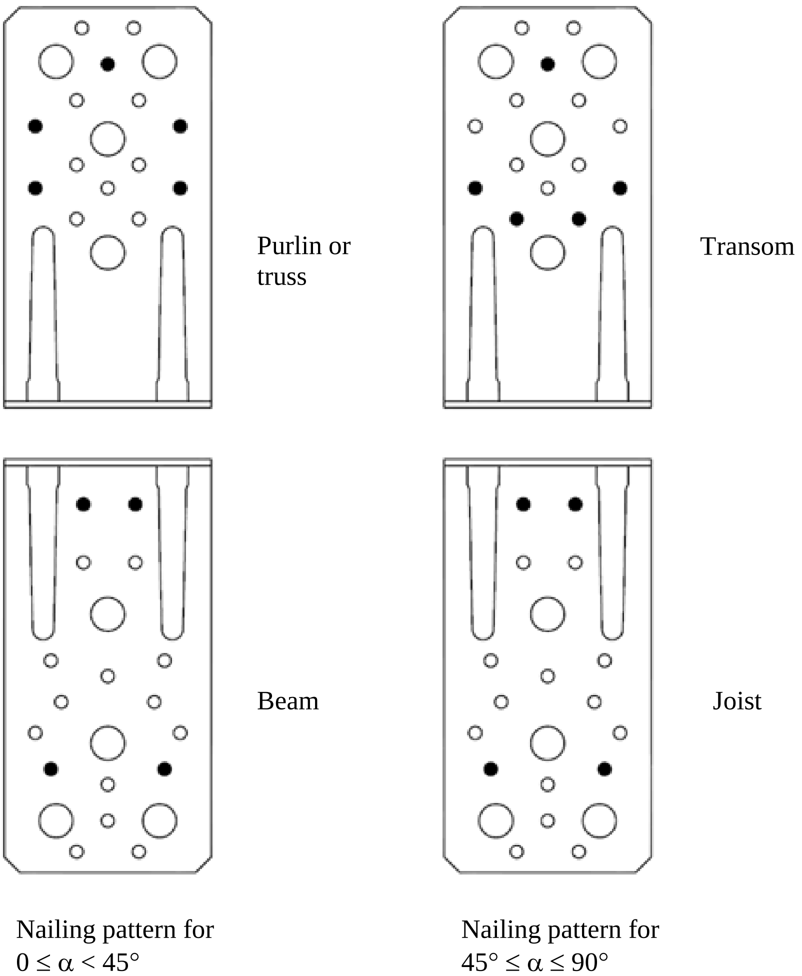


Figure B.11d Nailing pattern type 4230202

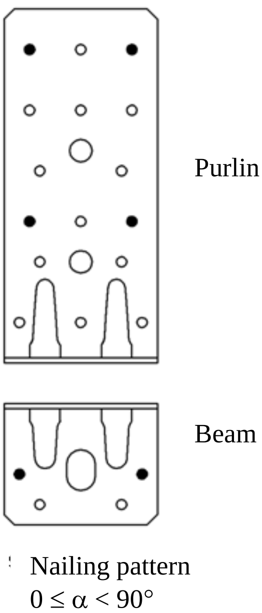


Figure B.11e Nailing pattern type 4230203.

Load-duration class P (k_{mod} = 0,6).				
		Nail	R_{1k}	R_{2k}=R_{3k}
4230001 4230002 4230003	α =0°	4,0x40	2,24	3,00
4230101	0 ≤ α < 45°	4,0x40	1,96	4,76
	45 ≤ α ≤ 90°	4,0x40	1,96	3,81
4230201	0 ≤ α < 45°	4,0x40	1,60	2,71
	45 ≤ α ≤ 90°	4,0x40	1,60	3,63
4230202	0 ≤ α < 45°	4,0x40	1,76	2,84
	45 ≤ α ≤ 90°	4,0x40	1,76	3,76
4230203	0 ≤ α ≤ 90°	4,0x40	1,16	2,79

Table B.32a with two brackets in the connection

Load-duration class L (k_{mod} = 0,7)				
		Nail	R_{1k}	R_{2k}=R_{3k}
4230001 4230002 4230003	α =0°	4,0x40	2,68	3,50
4230101	0 ≤ α < 45°	4,0x40	2,28	5,56
	45 ≤ α ≤ 90°	4,0x40	2,28	4,44
4230201	0 ≤ α < 45°	4,0x40	1,88	3,16
	45 ≤ α ≤ 90°	4,0x40	1,88	4,24
4230202	0 ≤ α < 45°	4,0x40	2,06	3,32
	45 ≤ α ≤ 90°	4,0x40	2,06	4,39
4230203	0 ≤ α ≤ 90°	4,0x40	1,36	3,25

Table B.32b with two brackets in the connection

Load-duration class M (k_{mod} = 0,8).				
		Nail	R_{1k}	R_{2k}=R_{3k}
4230001 4230002 4230003	α =0°	4,0x40	3,10	4,00
4230101	0 ≤ α < 45°	4,0x40	2,62	6,35
	45 ≤ α ≤ 90°	4,0x40	2,62	5,08
4230201	0 ≤ α < 45°	4,0x40	2,14	3,61
	45 ≤ α ≤ 90°	4,0x40	2,14	4,84
4230202	0 ≤ α < 45°	4,0x40	2,34	3,79
	45 ≤ α ≤ 90°	4,0x40	2,34	5,01
4230203	0 ≤ α ≤ 90°	4,0x40	1,56	3,71

Table B.32c with two brackets in the connection

Load-duration class S (k_{mod} = 0,9).				
		Nail	R_{1k}	R_{2k}=R_{3k}
4230001 4230002 4230003	α =0°	4,0x40	3,54	4,50
4230101	0 ≤ α < 45°	4,0x40	2,90	7,15
	45 ≤ α ≤ 90°	4,0x40	2,90	5,71
4230201	0 ≤ α < 45°	4,0x40	2,40	4,06
	45 ≤ α ≤ 90°	4,0x40	2,40	5,45
4230202	0 ≤ α < 45°	4,0x40	2,64	4,26
	45 ≤ α ≤ 90°	4,0x40	2,64	5,64
4230203	0 ≤ α ≤ 90°	4,0x40	1,76	4,18

Table B.32d with two brackets in the connection

Load-duration class I (k_{mod} = 1,1).				
		Nail	R_{1k}	$R_{2k}=R_{3k}$
4230001 4230002 4230003	α =0°	4,0x40	4,42	5,50
4230101	$0 \leq \alpha < 45°$	4,0x40	3,60	8,73
	$45 \leq \alpha \leq 90°$	4,0x40	3,60	6,98
4230201	$0 \leq \alpha < 45°$	4,0x40	2,94	4,96
	$45 \leq \alpha \leq 90°$	4,0x40	2,94	6,66
4230202	$0 \leq \alpha < 45°$	4,0x40	3,20	5,21
	$45 \leq \alpha \leq 90°$	4,0x40	3,20	6,89
4230203	$0 \leq \alpha \leq 90°$	4,0x40	2,16	5,11

Table B.32e with two brackets in the connection

Load-duration class P (k_{mod} = 0,6)				
		Nail	R_{1k}	$R_{2k}=R_{3k}$
4230001 4230002 4230003	α =0°	4,0x40	$\frac{7,0}{f+14,5}$ för $f < 25$	1,50
4230101	$0 \leq \alpha < 45°$	4,0x40	$\frac{30,6}{f+50}$ för $f < 25$	2,38
	$45 \leq \alpha \leq 90°$	4,0x40		1,90
4230201	$0 \leq \alpha < 45°$	4,0x40	$\frac{71,8}{f+100}$ för $f < 25$	1,35
	$45 \leq \alpha \leq 90°$	4,0x40		1,82
4230202	$0 \leq \alpha < 45°$	4,0x40	$\frac{124,8}{f+160}$ för $f < 25$	1,42
	$45 \leq \alpha \leq 90°$	4,0x40		1,88
4230203	$0 \leq \alpha \leq 90°$	4,0x40	$\frac{21,9}{f+60}$ för $f < 25$	1,39

Table B.32f with one bracket in the connection

Load-duration class L (k_{mod} = 0,7)				
		Nail	R_{1k}	$R_{2k}=R_{3k}$
4230001 4230002 4230003	α =0°	4,0x40	$\frac{7,0}{f+14,5}$ för $f < 25$	1,75
4230101	$0 \leq \alpha < 45°$	4,0x40	$\frac{35,8}{f+50}$ för $f < 25$	2,78
	$45 \leq \alpha \leq 90°$	4,0x40		2,22
4230201	$0 \leq \alpha < 45°$	4,0x40	$\frac{83,8}{f+100}$ för $f < 25$	1,58
	$45 \leq \alpha \leq 90°$	4,0x40		2,12
4230202	$0 \leq \alpha < 45°$	4,0x40	$\frac{145,6}{f+160}$ för $f < 25$	1,66
	$45 \leq \alpha \leq 90°$	4,0x40		2,19
4230203	$0 \leq \alpha \leq 90°$	4,0x40	$\frac{25,5}{f+60}$ för $f < 25$	1,62

Table B.32g with one bracket in the connection

Load-duration class M (k_{mod} = 0,8)				
		Nail	R_{1k}	$R_{2k}=R_{3k}$
4230001 4230002 4230003	α =0°	4,0x40	$\frac{7,0}{f+14,5}$ för $f < 25$	2,00
4230101	$0 \leq \alpha < 45°$	4,0x40	$\frac{40,9}{f+50}$ för $f < 25$	3,18
	$45 \leq \alpha \leq 90°$	4,0x40		2,54
4230201	$0 \leq \alpha < 45°$	4,0x40	$\frac{95,7}{f+100}$ för $f < 25$	1,80
	$45 \leq \alpha \leq 90°$	4,0x40		2,42
4230202	$0 \leq \alpha < 45°$	4,0x40	$\frac{166,4}{f+160}$ för $f < 25$	1,90
	$45 \leq \alpha \leq 90°$	4,0x40		2,51
4230203	$0 \leq \alpha \leq 90°$	4,0x40	$\frac{29,2}{f+60}$ för $f < 25$	1,86

Table B.32h with one bracket in the connection

Load-duration class S (k_{mod} = 0,9)				
		Nail	R_{1k}	$R_{2k}=R_{3k}$
4230001 4230002 4230003	α =0°	4,0x40	$\frac{7,0}{f+14,5}$ för $f < 25$	2,25
4230101	$0 \leq \alpha < 45°$	4,0x40	$\frac{46}{f+50}$ för $f < 25$	3,57
	$45 \leq \alpha \leq 90°$	4,0x40		2,86
4230201	$0 \leq \alpha < 45°$	4,0x40	$\frac{107,7}{f+100}$ för $f < 25$	2,03
	$45 \leq \alpha \leq 90°$	4,0x40		2,72
4230202	$0 \leq \alpha < 45°$	4,0x40	$\frac{187,1}{f+160}$ för $f < 25$	2,13
	$45 \leq \alpha \leq 90°$	4,0x40		2,82
4230203	$0 \leq \alpha \leq 90°$	4,0x40	$\frac{32,8}{f+60}$ för $f < 25$	2,09

Table B.32i with one bracket in the connection

Load-duration class I (k_{mod} = 1,1)				
		Nail	R_{1k}	$R_{2k}=R_{3k}$
4230001 4230002 4230003	α =0°	4,0x40	$\frac{7,0}{f+14,5}$ för $f < 25$	2,75
4230101	$0 \leq \alpha < 45°$	4,0x40	$\frac{56,2}{f+50}$ för $f < 25$	4,37
	$45 \leq \alpha \leq 90°$	4,0x40		3,49
4230201	$0 \leq \alpha < 45°$	4,0x40	$\frac{27,3}{f+18}$ för $f < 25$	2,48
	$45 \leq \alpha \leq 90°$	4,0x40		3,33
4230202	$0 \leq \alpha < 45°$	4,0x40	$\frac{27,3}{f+17,5}$ för $f < 25$	2,61
	$45 \leq \alpha \leq 90°$	4,0x40		3,45
4230203	$0 \leq \alpha \leq 90°$	4,0x40	$\frac{40,1}{f+60}$ för $f < 25$	2,55

Table B.32i with one bracket in the connection

Combined forces

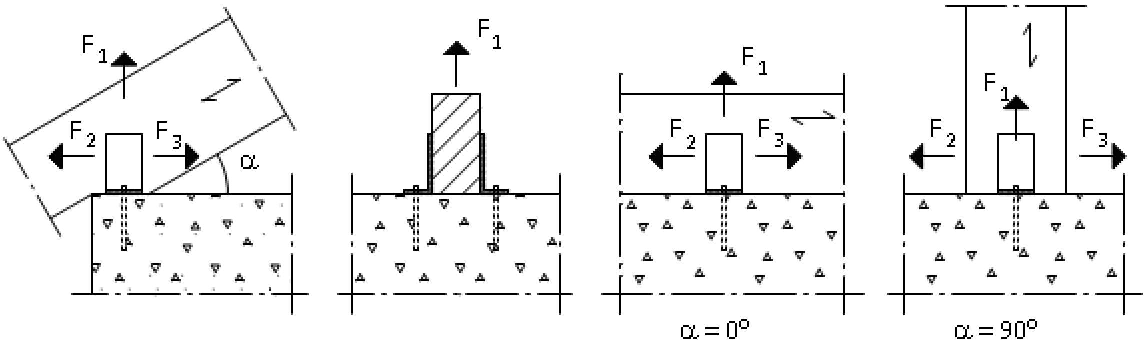
For practical purposes the strength verification is always carried out for design forces and design capacities. If the forces are combined the following inequalities shall be fulfilled:

$$\left(\frac{F_{1\mathrm{k}}}{R_{1\mathrm{k}}}\right)^2 + \left(\frac{F_{2\mathrm{k}}}{R_{2\mathrm{k}}}\right)^2 + \left(\frac{F_{3\mathrm{k}}}{R_{3\mathrm{k}}}\right)^2 \leq 1$$

F_k = Characteristic load (actual load)
R_k = Characteristic capacities from this ETA according to tables 32a to 32j.

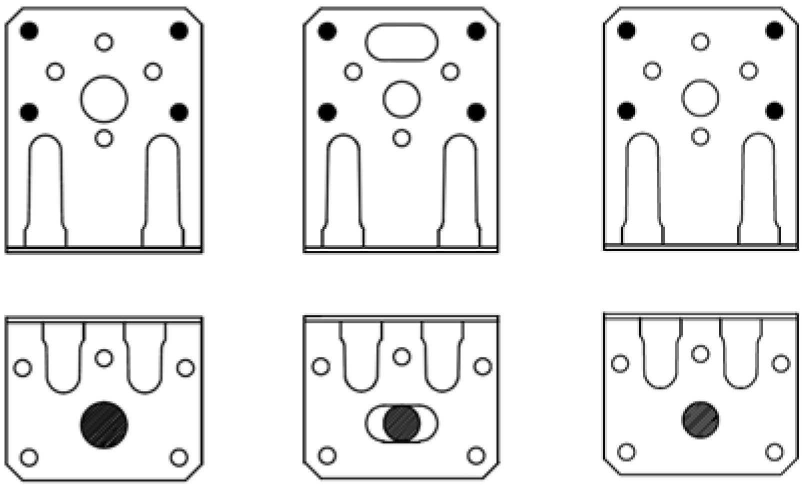
In the upper condition either F_2 or F_3 is zero

Angle Bracket Type 4
Basis for design – wood to concrete connections



With two brackets in a connection the nails shall not overlap more than what is described in Eurocode 5 section 8.3.1.1. If the purlin is too thin, then brackets shall be staggered.

Type type4/75x50x1,5x 60-13	Type type4/75x50x1,5 x60EXP	Type type4/75x50x1,5 x60-11	



Purlin

Beam

Nailing pattern for $\alpha = 0°$	Nailing pattern for $\alpha = 0°$	Nailing pattern for $\alpha = 0°$

Figure B.12a Nailing pattern type type4/75x50x1,5x60-13, type4/75x50x1,5x60EXP, type4/75x50x1,5x60-11

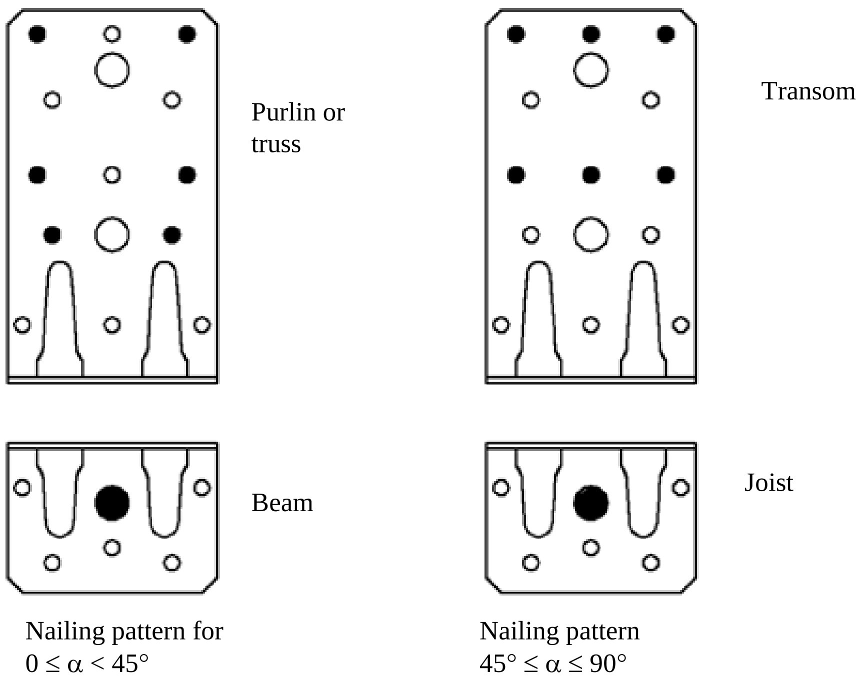


Figure B.12b Nailing pattern type4/125x50x2,5x70

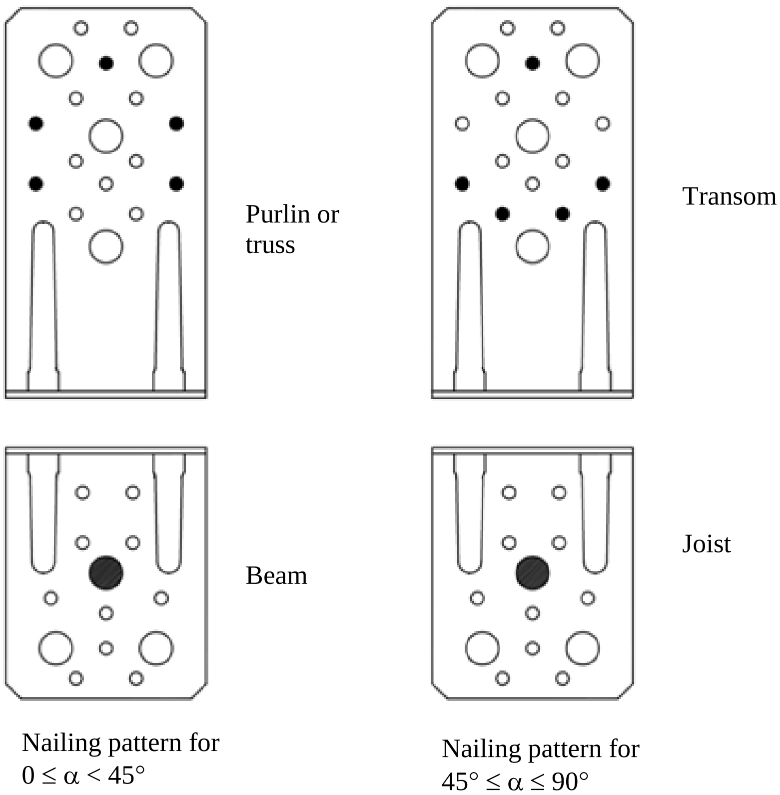
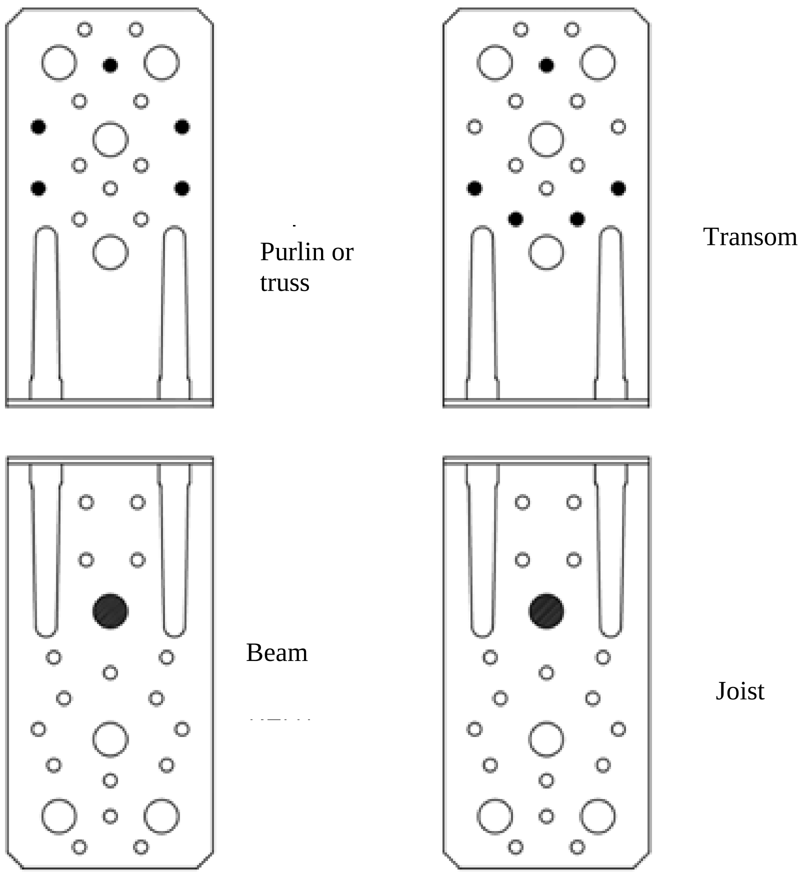


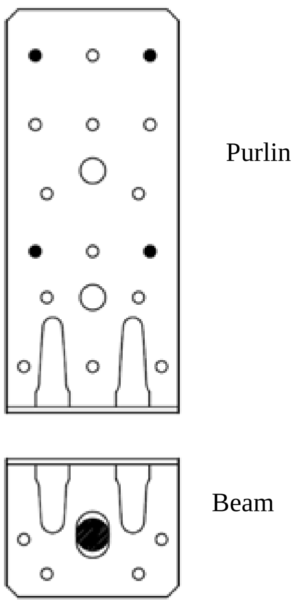
Figure B.12c Nailing pattern type4/155x100x2,5x80



Nailing pattern for
$0 \leq \alpha < 45°$

Nailing pattern for
$45° \leq \alpha \leq 90°$

Figure B.12d Nailing pattern type4/155x160x2,5x80



Nailing pattern
$0 \leq \alpha < 90°$

Figure B.12e Nailing pattern type4/175x60x2,5x75

The characteristic capacities in wood to concrete connections are given in tables 33a to 33j. The tables 33a to 33e apply to connections with two brackets and tables 33f to 33j apply to connections with one bracket.

F_{EBt} is the axial load resistance for each bolt at the load effect equivalent to the characteristic capacity F_{Rd}.

Load-duration class P (k_{mod} = 0,6)				
		Nail	R_{1k}	R_{2k}=R_{3k}
type4/75x50x1,5x 60-13,	α =0°	4,0x40	2,40 F_{Bt} = 1,59 F_{Bv} = 0,70	0,59 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/75x50x1,5x 60EXP	α =0°	4,0x40	1,80 F_{Bt} = 1,21 F_{Bv} = 0,50	-
type4/75x50x1,5x 60-11	α =0°	4,0x40	2,40 F_{Bt} = 1,59 F_{Bv} = 0,70	0,59 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/125x50x2,5 x70	0 ≤ α < 45°	4,0x40	8,20 F_{Bt} = 5,18 F_{Bv} = 1,00	4,07 F_{Bt} = 1,30 F_{Bv} = 2,04
	45 ≤ α ≤ 90°	4,0x40	8,60 F_{Bt} = 5,38 F_{Bv} = 0,90	3,30 F_{Bt} = 1,30 F_{Bv} = 1,65
type4/155x100x2, 5x80	0 ≤ α ≤ 90°	4,0x40	3,20 F_{Bt} = 2,12 F_{Bv} = 0,70	1,43 F_{Bt} = 0,91 F_{Bv} = 0,72
type4/155x160x2, 5x80	0 ≤ α ≤ 90°	4,0x40	2,80 F_{Bt} = 1,66 F_{Bv} = 0,80	1,20 F_{Bt} = 0,90 F_{Bv} = 0,60
type4/175x60x2,5 x75	0 ≤ α ≤ 90°	4,0x40	3,90 F_{Bt} = 2,95 F_{Bv} = 0,75	1,92 F_{Bt} = 0,91 F_{Bv} = 0,96

Table B.33a with two brackets in the connection

Load-duration class L (k_{mod} = 0,7)				
		Nail	R_{1k}	R_{2k}=R_{3k}
type4/75x50x1,5x 60-13,	α =0°	4,0x40	2,40 F_{Bt} = 1,59 F_{Bv} = 0,70	0,59 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/75x50x1,5x 60EXP	α =0°	4,0x40	1,80 F_{Bt} = 1,21 F_{Bv} = 0,50	-
type4/75x50x1,5x 60-11	α =0°	4,0x40	2,40 F_{Bt} = 1,59 F_{Bv} = 0,70	0,59 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/125x50x2,5 x70	0 ≤ α < 45°	4,0x40	8,80 F_{Bt} = 5,48 F_{Bv} = 1,10	4,39 F_{Bt} = 1,30 F_{Bv} = 2,19
	45 ≤ α ≤ 90°	4,0x40	9,60 F_{Bt} = 5,88 F_{Bv} = 1,00	3,77 F_{Bt} = 1,30 F_{Bv} = 1,88
type4/155x100x2, 5x80	0 ≤ α ≤ 90°	4,0x40	3,60 F_{Bt} = 2,32 F_{Bv} = 0,90	1,43 F_{Bt} = 0,91 F_{Bv} = 0,72
type4/155x160x2, 5x80	0 ≤ α ≤ 90°	4,0x40	3,00 F_{Bt} = 1,76 F_{Bv} = 0,90	1,20 F_{Bt} = 0,90 F_{Bv} = 0,60
type4/175x60x2,5 x75	0 ≤ α ≤ 90°	4,0x40	4,40 F_{Bt} = 3,20 F_{Bv} = 0,80	1,92 F_{Bt} = 0,91 F_{Bv} = 0,96

Table B.33b with two brackets in the connection

Load-duration class M (k_{mod} = 0,8)				
		Nail	R_{1k}	R_{2k}=R_{3k}
type4/75x50x1,5x 60-13,	α =0°	4,0x40	2,40 F_{Bt} = 1,59 F_{Bv} = 0,70	0,59 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/75x50x1,5x 60EXP	α =0°	4,0x40	1,80 F_{Bt} = 1,21 F_{Bv} = 0,50	-
type4/75x50x1,5x 60-11	α =0°	4,0x40	2,40 F_{Bt} = 1,59 F_{Bv} = 0,70	0,59 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/125x50x2,5 x70	$0 \leq \alpha < 45°$	4,0x40	9,50 F_{Bt} = 5,48 F_{Bv} = 1,20	4,39 F_{Bt} = 1,30 F_{Bv} = 2,19
	$45 \leq \alpha \leq 90°$	4,0x40	10,40 F_{Bt} = 6,28 F_{Bv} = 1,20	4,23 F_{Bt} = 1,30 F_{Bv} = 2,11
type4/155x100x2, 5x80	$0 \leq \alpha \leq 90°$	4,0x40	3,60 F_{Bt} = 2,32 F_{Bv} = 0,90	1,43 F_{Bt} = 0,91 F_{Bv} = 0,72
type4/155x160x2, 5x80	$0 \leq \alpha \leq 90°$	4,0x40	3,00 F_{Bt} = 1,76 F_{Bv} = 0,90	1,20 F_{Bt} = 0,90 F_{Bv} = 0,60
type4/175x60x2,5 x75	$0 \leq \alpha \leq 90°$	4,0x40	4,80 F_{Bt} = 3,40 F_{Bv} = 0,90	1,92 F_{Bt} = 0,91 F_{Bv} = 0,96

Table B.33c with two brackets in the connection

Load-duration class S (k_{mod} = 0,9)				
		Nail	R_{1k}	$R_{2k}=R_{3k}$
type4/75x50x1,5x 60-13,	α =0°	4,0x40	2,40 F_{Bt} = 1,59 F_{Bv} = 0,70	0,59 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/75x50x1,5x 60EXP	α =0°	4,0x40	1,80 F_{Bt} = 1,21 F_{Bv} = 0,50	-
type4/75x50x1,5x 60-11	α =0°	4,0x40	2,40 F_{Bt} = 1,59 F_{Bv} = 0,70	0,59 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/125x50x2,5 x70	$0 \leq \alpha < 45°$	4,0x40	10,20 F_{Bt} = 6,18 F_{Bv} = 1,40	4,39 F_{Bt} = 1,30 F_{Bv} = 2,19
	$45 \leq \alpha \leq 90°$	4,0x40	11,20 F_{Bt} = 6,68 F_{Bv} = 1,30	4,39 F_{Bt} = 1,30 F_{Bv} = 2,19
type4/155x100x2, 5x80	$0 \leq \alpha \leq 90°$	4,0x40	3,60 F_{Bt} = 2,32 F_{Bv} = 0,90	1,43 F_{Bt} = 0,91 F_{Bv} = 0,72
type4/155x160x2, 5x80	$0 \leq \alpha \leq 90°$	4,0x40	3,00 F_{Bt} = 1,76 F_{Bv} = 0,90	1,20 F_{Bt} = 0,90 F_{Bv} = 0,60
type4/175x60x2,5 x75	$0 \leq \alpha \leq 90°$	4,0x40	5,10 F_{Bt} = 3,55 F_{Bv} = 1,00	1,92 F_{Bt} = 0,91 F_{Bv} = 0,96

Table B.33d with two brackets in the connection

Load-duration class I (k_{mod} = 1,1)				
		Nail	R_{1k}	R_{2k}=R_{3k}
type4/75x50x1,5x 60-13,	α =0°	4,0x40	2,40 F_{Bt} = 1,59 F_{Bv} = 0,70	0,59 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/75x50x1,5x 60EXP	α =0°	4,0x40	1,80 F_{Bt} = 1,21 F_{Bv} = 0,50	-
type4/75x50x1,5x 60-11	α =0°	4,0x40	2,40 F_{Bt} = 1,59 F_{Bv} = 0,70	0,59 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/125x50x2,5 x70	$0 \leq \alpha < 45°$	4,0x40	11,80 F_{Bt} = 6,98 F_{Bv} = 1,70	4,39 F_{Bt} = 1,30 F_{Bv} = 2,19
	$45 \leq \alpha \leq 90°$	4,0x40	11,80 F_{Bt} = 6,98 F_{Bv} = 1,70	4,39 F_{Bt} = 1,30 F_{Bv} = 2,19
type4/155x100x2, 5x80	$0 \leq \alpha \leq 90°$	4,0x40	3,60 F_{Bt} = 2,32 F_{Bv} = 0,90	1,43 F_{Bt} = 0,91 F_{Bv} = 0,72
type4/155x160x2, 5x80	$0 \leq \alpha \leq 90°$	4,0x40	3,00 F_{Bt} = 1,76 F_{Bv} = 0,90	1,20 F_{Bt} = 0,90 F_{Bv} = 0,60
type4/175x60x2,5 x75	$0 \leq \alpha \leq 90°$	4,0x40	5,10 F_{Bt} = 3,55 F_{Bv} = 1,00	1,92 F_{Bt} = 0,91 F_{Bv} = 0,96

Table B.33e with two brackets in the connection

Load-duration class P (k_{mod} = 0,6)				
		Nail	R_{1k}	R_{2k}=R_{3k}
type4/75x50x1,5x 60-13,	α =0°	4,0x40	0,72 F_{Bt} = 0,95 F_{Bv} = 0,42	0,29 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/75x50x1,5x 60EXP	α =0°	4,0x40	0,54 F_{Bt} = 0,73 F_{Bv} = 0,30	-
type4/75x50x1,5x 60-11	α =0°	4,0x40	0,72 F_{Bt} = 0,95 F_{Bv} = 0,42	0,29 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/125x50x2,5 x70	0 ≤ α < 45°	4,0x40	2,46 F_{Bt} = 3,11 F_{Bv} = 0,60	2,04 F_{Bt} = 1,30 F_{Bv} = 2,04
	45 ≤ α ≤ 90°	4,0x40	2,58 F_{Bt} = 3,23 F_{Bv} = 0,54	1,65 F_{Bt} = 1,30 F_{Bv} = 1,65
type4/155x100x2, 5x80	0 ≤ α ≤ 90°	4,0x40	0,96 F_{Bt} = 1,27 F_{Bv} = 0,42	0,72 F_{Bt} = 0,91 F_{Bv} = 0,72
type4/155x160x2, 5x80	0 ≤ α ≤ 90°	4,0x40	0,84 F_{Bt} = 1,00 F_{Bv} = 0,48	0,60 F_{Bt} = 0,90 F_{Bv} = 0,60
type4/175x60x2,5 x75	0 ≤ α ≤ 90°	4,0x40	1,17 F_{Bt} = 1,77 F_{Bv} = 0,45	0,96 F_{Bt} = 0,91 F_{Bv} = 0,96

Table B.33f With one bracket in the connection

Load-duration class L (k_{mod} = 0,7)				
		Nail	R_{1k}	$R_{2k}=R_{3k}$
type4/75x50x1,5x 60-13,	α =0°	4,0x40	0,72 F_{Bt} = 0,95 F_{Bv} = 0,42	0,29 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/75x50x1,5x 60EXP	α =0°	4,0x40	0,54 F_{Bt} = 0,73 F_{Bv} = 0,30	-
type4/75x50x1,5x 60-11	α =0°	4,0x40	0,72 F_{Bt} = 0,95 F_{Bv} = 0,42	0,29 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/125x50x2,5 x70	$0 \le \alpha < 45°$	4,0x40	2,64 F_{Bt} = 3,29 F_{Bv} = 0,66	2,19 F_{Bt} = 1,30 F_{Bv} = 2,19
	$45 \le \alpha \le 90°$	4,0x40	2,88 F_{Bt} = 3,53 F_{Bv} = 0,60	1,88 F_{Bt} = 1,30 F_{Bv} = 1,88
type4/155x100x2, 5x80	$0 \le \alpha \le 90°$	4,0x40	1,08 F_{Bt} = 1,39 F_{Bv} = 0,54	0,72 F_{Bt} = 0,91 F_{Bv} = 0,72
type4/155x160x2, 5x80	$0 \le \alpha \le 90°$	4,0x40	0,90 F_{Bt} = 1,06 F_{Bv} = 0,54	0,60 F_{Bt} = 0,90 F_{Bv} = 0,60
type4/175x60x2,5 x75	$0 \le \alpha \le 90°$	4,0x40	1,32 F_{Bt} = 1,92 F_{Bv} = 0,48	0,96 F_{Bt} = 0,91 F_{Bv} = 0,96

Table B.33g With one bracket in the connection

Load-duration class M (k_{mod} = 0,8)				
		Nail	R_{1k}	R_{2k}=R_{3k}
type4/75x50x1,5x 60-13,	α =0°	4,0x40	0,72 F_{Bt} = 0,95 F_{Bv} = 0,42	0,29 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/75x50x1,5x 60EXP	α =0°	4,0x40	0,54 F_{Bt} = 0,73 F_{Bv} = 0,30	-
type4/75x50x1,5x 60-11	α =0°	4,0x40	0,72 F_{Bt} = 0,95 F_{Bv} = 0,42	0,29 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/125x50x2,5 x70	0 ≤ α < 45°	4,0x40	2,85 F_{Bt} = 3,50 F_{Bv} = 0,72	2,19 F_{Bt} = 1,30 F_{Bv} = 2,19
	45 ≤ α ≤ 90°	4,0x40	3,12 F_{Bt} = 3,77 F_{Bv} = 0,72	2,11 F_{Bt} = 1,30 F_{Bv} = 2,11
type4/155x100x2, 5x80	0 ≤ α ≤ 90°	4,0x40	1,08 F_{Bt} = 1,39 F_{Bv} = 0,54	0,72 F_{Bt} = 0,91 F_{Bv} = 0,72
type4/155x160x2, 5x80	0 ≤ α ≤ 90°	4,0x40	0,90 F_{Bt} = 1,06 F_{Bv} = 0,54	0,60 F_{Bt} = 0,90 F_{Bv} = 0,60
type4/175x60x2,5 x75	0 ≤ α ≤ 90°	4,0x40	1,44 F_{Bt} = 2,04 F_{Bv} = 0,54	0,96 F_{Bt} = 0,91 F_{Bv} = 0,96

Table B.33h With one bracket in the connection

Load-duration class S (k_{mod} = 0,9)				
		Nail	R_{1k}	R_{2k}=R_{3k}
type4/75x50x1,5x 60-13,	α =0°	4,0x40	0,72 F_{Bt} = 0,95 F_{Bv} = 0,42	0,29 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/75x50x1,5x 60EXP	α =0°	4,0x40	0,54 F_{Bt} = 0,73 F_{Bv} = 0,30	-
type4/75x50x1,5x 60-11	α =0°	4,0x40	0,72 F_{Bt} = 0,95 F_{Bv} = 0,42	0,29 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/125x50x2,5 x70	0 ≤ α < 45°	4,0x40	3,06 F_{Bt} = 3,71 F_{Bv} = 0,84	2,19 F_{Bt} = 1,30 F_{Bv} = 2,19
	45 ≤ α ≤ 90°	4,0x40	3,36 F_{Bt} = 4,01 F_{Bv} = 0,78	2,19 F_{Bt} = 1,30 F_{Bv} = 2,19
type4/155x100x2, 5x80	0 ≤ α ≤ 90°	4,0x40	1,08 F_{Bt} = 1,39 F_{Bv} = 0,54	0,72 F_{Bt} = 0,91 F_{Bv} = 0,72
type4/155x160x2, 5x80	0 ≤ α ≤ 90°	4,0x40	0,90 F_{Bt} = 1,06 F_{Bv} = 0,54	0,60 F_{Bt} = 0,90 F_{Bv} = 0,60
type4/175x60x2,5 x75	0 ≤ α ≤ 90°	4,0x40	1,53 F_{Bt} = 2,13 F_{Bv} = 0,60	0,96 F_{Bt} = 0,91 F_{Bv} = 0,96

Table B.33i With one bracket in the connection

Load-duration class I (k_{mod} = 1,1)				
		Nail	R_{1k}	R_{2k}=R_{3k}
type4/75x50x1,5x 60-13,	α =0°	4,0x40	0,72 F_{Bt} = 0,95 F_{Bv} = 0,42	0,29 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/75x50x1,5x 60EXP	α =0°	4,0x40	0,54 F_{Bt} = 0,73 F_{Bv} = 0,30	-
type4/75x50x1,5x 60-11	α =0°	4,0x40	0,72 F_{Bt} = 0,95 F_{Bv} = 0,42	0,29 F_{Bt} = 0,33 F_{Bv} = 0,29
type4/125x50x2,5 x70	0 ≤ α < 45°	4,0x40	3,54 F_{Bt} = 4,19 F_{Bv} = 1,02	2,19 F_{Bt} = 1,30 F_{Bv} = 2,19
	45 ≤ α ≤ 90°	4,0x40	3,54 F_{Bt} = 4,19 F_{Bv} = 1,02	2,19 F_{Bt} = 1,30 F_{Bv} = 2,19
type4/155x100x2, 5x80	0 ≤ α ≤ 90°	4,0x40	1,08 F_{Bt} = 1,39 F_{Bv} = 0,54	0,72 F_{Bt} = 0,91 F_{Bv} = 0,72
type4/155x160x2, 5x80	0 ≤ α ≤ 90°	4,0x40	0,90 F_{Bt} = 1,06 F_{Bv} = 0,54	0,60 F_{Bt} = 0,90 F_{Bv} = 0,60
type4/175x60x2,5 x75	0 ≤ α ≤ 90°	4,0x40	1,53 F_{Bt} = 2,13 F_{Bv} = 0,60	0,96 F_{Bt} = 0,91 F_{Bv} = 0,96

Table B.33j With one bracket in the connection

Combined forces

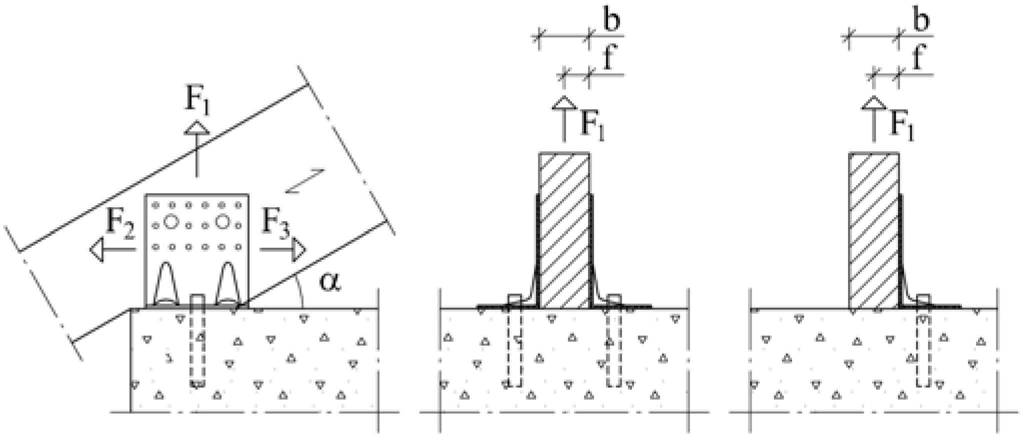
For practical purposes the strength verification is always carried out for design forces and design capacities. If the forces are combined the following inequalities shall be fulfilled:

$$\left(\frac{F_{1k}}{R_{1k}}\right)^2 + \left(\frac{F_{2k}}{R_{2k}}\right)^2 + \left(\frac{F_{3k}}{R_{3k}}\right)^2 \leq 1$$

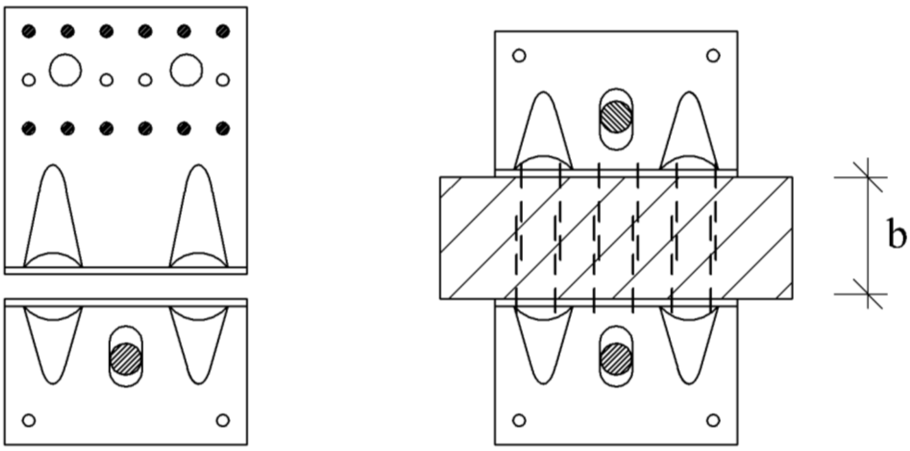
F_k = Characteristic load (actual load)
R_k = Characteristic capacities from this ETA according to tables 33a to 33j.

In the upper condition either F_2 or F_3 is zero

Angle Bracket type4/110x60x100
Basis for design – wood to concrete connections

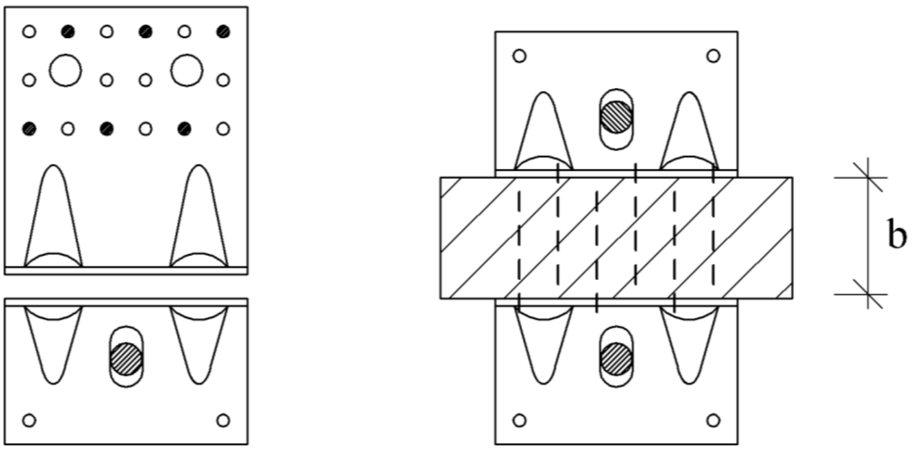


With two brackets in a connection the nails shall not overlap more than what is described in Eurocode 5 section 8.3.1.1. If the purlin is too thin, then brackets shall be staggered.



Nailing pattern for $\alpha = 90°$

Figure B.13a Nailing pattern 1 for type type4/110x60x100. When the nail overlap, the lowest value of b in accordfance with the tables apply.



Nailing pattern for $0 \leq \alpha \leq 90°$

Figure B.13b Nailing pattern 2 for type type4/110x60x100. When two brackets are used the nail shall be staggered to avoid overlap

The characteristic capacities in wood to concrete connections are given in tables 34a to 34i. The tables 34a to 34e apply to connections with two brackets and tables 34f to 34i apply to connections with one bracket.

F_{EBt} is the axial load resistance for each bolt at the load effect equivalent to the characteristic capacity F_{Rd}.

Load duration class P (k_{mod} = 0,6)					
Nail pattern	Nail	Angle α	Minimum width bredd b	F_{R1d}	$F_{R2d} = F_{R3d}$
1	12+12 4,0x40	$\alpha = 90°$	53 mm	13,00 $F_{Bt} = 8,64$	6,46 $F_{Bt} = 1,87$ $F_{Bv} = 3,23$
2	6+6 4,0x40	$0 \leq \alpha \leq 90°$	45 mm	8,40 $F_{Bt} = 6,34$	4,54 $F_{Bt} = 1,87$ $F_{Bv} = 2,27$

Table B.34a with two brackets in the connection

Load duration class L (k_{mod} = 0,7)					
Nail-pattern	Nail	Angle α	Minimum width bredd *b*	F_{R1d}	$F_{R2d} = F_{R3d}$
1	12+12 4,0x40	α = 90°	53 mm	14,60 F_{Bt} = 9,44	6,46 F_{Bt} = 1,87 F_{Bv} = 3,23
2	6+6 4,0x40	0 ≤ α ≤ 90°	45 mm	9,60 F_{Bt} = 6,94	5,03 F_{Bt} = 1,87 F_{Bv} = 2,52

Table B.34b with two brackets in the connection

Load duration class M (k_{mod} = 0,8)					
Nail-pattern	Nail	Angle α	Minimum width bredd *b*	F_{R1d}	$F_{R2d} = F_{R3d}$
1	12+12 4,0x40	α = 90°	53 mm	16,00 F_{Bt} = 10,14	6,46 F_{Bt} = 1,87 F_{Bv} = 3,23
2	6+6 4,0x40	0 ≤ α ≤ 90°	45 mm	10,60 F_{Bt} = 7,44	5,52 F_{Bt} = 1,87 F_{Bv} = 2,76

Table B.34c with two brackets in the connection

Load duration class S (k_{mod} = 0,9)					
Nail-pattern	Nail	Angle α	Minimum width *b*	F_{R1d}	$F_{R2d} = F_{R3d}$
1	12+12 4,0x40	α = 90°	53 mm	17,60 F_{Bt} = 10,94	6,46 F_{Bt} = 1,87 F_{Bv} = 3,23
2	6+6 4,0x40	0 ≤ α ≤ 90°	45 mm	12,00 F_{Bt} = 8,14	6,01 F_{Bt} = 1,87 F_{Bv} = 3,01

Table B.34d with two brackets in the connection

Load duration class I (k_{mod} = 1,1)					
Nail-pattern	Nail	Angle α	Minimum width bredd *b*	F_{R1d}	$F_{R2d} = F_{R3d}$
1	12+12 4,0x40	α = 90°	53 mm	18,40 F_{Bt} = 11,34	6,46 F_{Bt} = 1,87 F_{Bv} = 3,23
2	6+6 4,0x40	0 ≤ α ≤ 90°	45 mm	14,00 F_{Bt} = 9,14	6,46 F_{Bt} = 1,87 F_{Bv} = 3,23

Table B.34e with two brackets in the connection

Load duration class P (k_{mod} = 0,6)					
Nail-pattern	Nail	Angle α	Minimum width bredd *b*	F_{R1d}	$F_{R2d} = F_{R3d}$
1	12 4,0x40	α = 90°	45 mm	3,90 F_{Bt} = 5,18	3,23 F_{Bt} = 1,87 F_{Bv} = 3,23
2	6 4,0x40	0 ≤ α ≤ 90°	45 mm	2,52 F_{Bt} = 3,80	2,27 F_{Bt} = 1,87 F_{Bv} = 2,27

Table B.34e with one bracket in the connection

Load duration class L (k_{mod} = 0,7)					
Nail-pattern	Nail	Angle α	Minimum width bredd *b*	F_{R1d}	$F_{R2d} = F_{R3d}$
1	12 4,0x40	α = 90°	45 mm	4,38 F_{Bt} = 5,66	3,23 F_{Bt} = 1,87 F_{Bv} = 3,23
2	6 4,0x40	0 ≤ α ≤ 90°	45 mm	2,88 F_{Bt} = 4,16	2,52 F_{Bt} = 1,87 F_{Bv} = 2,52

Table B.34f with one bracket in the connection

Load duration class M (k_{mod} = 0,8)					
Nail-pattern	Nail	Angle α	Minimum width bredd *b*	F_{R1d}	$F_{R2d} = F_{R3d}$
1	12 4,0x40	α = 90°	45 mm	4,80 F_{Bt} = 6,08	3,23 F_{Bt} = 1,87 F_{Bv} = 3,23
2	6 4,0x40	0 ≤ α ≤ 90°	45 mm	3,18 F_{Bt} = 4,46	2,76 F_{Bt} = 1,87 F_{Bv} = 2,76

Table B.34g with one bracket in the connection

Load duration class S (k_{mod} = 0,9)					
Nail-pattern	Nail	Angle α	Minimum width bredd *b*	F_{R1d}	$F_{R2d} = F_{R3d}$
1	12 4,0x40	α = 90°	45 mm	5,28 F_{Bt} = 6,56	3,23 F_{Bt} = 1,87 F_{Bv} = 3,23
2	6 4,0x40	0 ≤ α ≤ 90°	45 mm	3,60 F_{Bt} = 4,88	3,01 F_{Bt} = 1,87 F_{Bv} = 3,01

Table B.34h with one bracket in the connection

Load duration class I (k_{mod} = 1,1)					
Nail-pattern	Nail	Angle α	Minimum width bredd *b*	F_{R1d}	$F_{R2d} = F_{R3d}$
1	12 4,0x40	α = 90°	45 mm	5,52 F_{Bt} = 6,80	3,23 F_{Bt} = 1,87 F_{Bv} = 3,23
2	6 4,0x40	0 ≤ α ≤ 90°	45 mm	4,20 F_{Bt} = 5,48	3,23 F_{Bt} = 1,87 F_{Bv} = 3,23

Table B.34i with one bracket in the connection

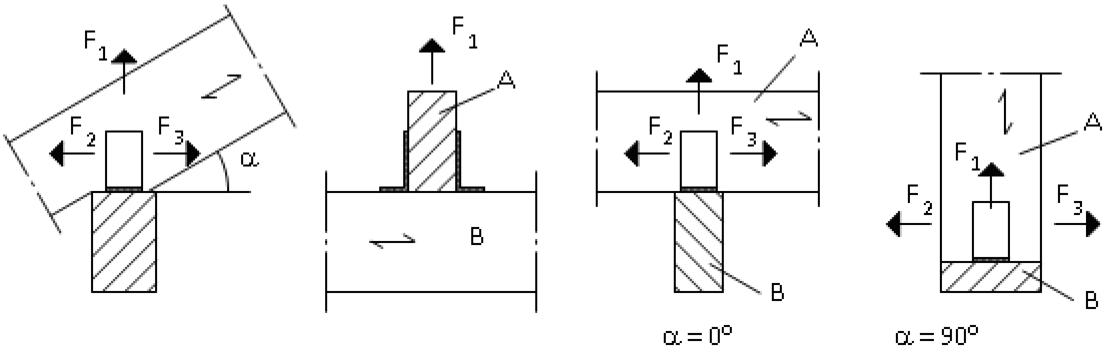
Combined forces
For practical purposes the strength verification is always carried out for design forces and design capacities. If the forces are combined the following inequalities shall be fulfilled:

$$\left(\frac{F_{1k}}{R_{1k}}\right)^2 + \left(\frac{F_{2k}}{R_{2k}}\right)^2 + \left(\frac{F_{3k}}{R_{3k}}\right)^2 \leq 1$$

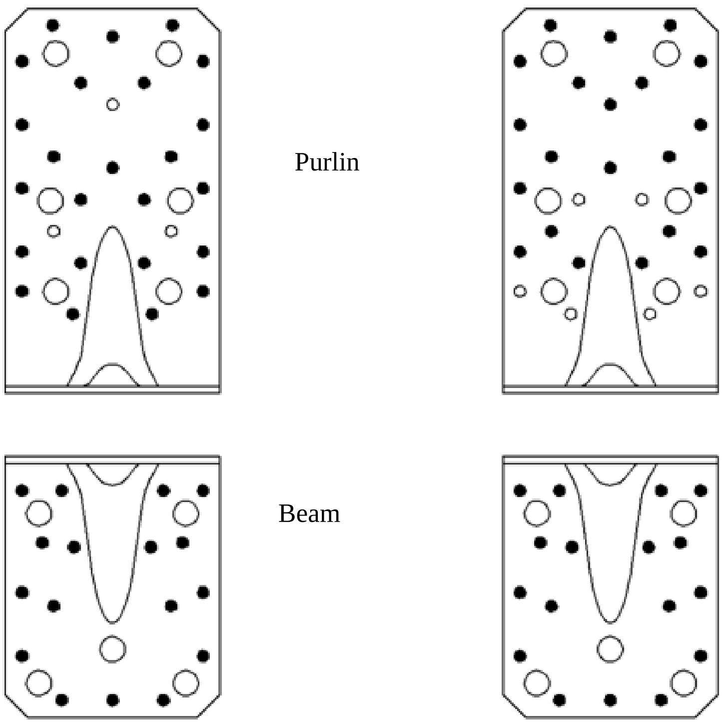
F_k = Characteristic load (actual load)
R_k = Characteristic capacities from this ETA according to tables 34a to 34i.

In the upper condition either F_2 or F_3 is zero

Angle Bracket type4/170x115x3,0x95
Basis for design – wood to wood connections



With two brackets in a connection the nails shall not overlap more than what is described in Eurocode 5 section 8.3.1.1. If the purlin is too thin, then brackets shall be staggered.



Nailing pattern for
$0 \leq \alpha < 45°$

Nailing pattern
$45° \leq \alpha \leq 90°$

Figure B.14a Nailing pattern type type4/170x115x3,0x95

The characteristic capacities in wood to wood connections are given in tables 32a to 32j. The tables 32a to 32e apply to connections with two brackets and tables 32f to 32j apply to connections with one bracket.

Load-duration class P (k_{mod} = 0,6).				
		Nail	R_{1k}	R_{2k}=R_{3k}
type4/170x115x3,0x95	$0 \le \alpha < 45°$	4,0x40	6,61	12,88
	$45 \le \alpha \le 90°$	4,0x40	6,49	9,65

Table B.35a with two brackets in the connection

Load-duration class L (k_{mod} = 0,7)				
		Nail	R_{1k}	R_{2k}=R_{3k}
type4/170x115x3,0x95	$0 \le \alpha < 45°$	4,0x40	7,71	15,02
	$45 \le \alpha \le 90°$	4,0x40	7,57	11,25

Table B.35b with two brackets in the connection

Load-duration class M (k_{mod} = 0,8).				
		Nail	R_{1k}	R_{2k}=R_{3k}
type4/170x115x3,0x95	$0 \le \alpha < 45°$	4,0x40	8,81	17,17
	$45 \le \alpha \le 90°$	4,0x40	8,65	12,86

Table B.35c with two brackets in the connection

Load-duration class S (k_{mod} = 0,9).				
		Nail	R_{1k}	R_{2k}=R_{3k}
type4/170x115x3,0x95	$0 \le \alpha < 45°$	4,0x40	9,91	19,31
	$45 \le \alpha \le 90°$	4,0x40	9,73	14,47

Table B.35d with two brackets in the connection

Load-duration class I (k_{mod} = 1,1).				
		Nail	R_{1k}	R_{2k}=R_{3k}
type4/170x115x3,0x95	0 ≤ α < 45°	4,0x40	12,11	23,61
	45 ≤ α ≤ 90°	4,0x40	11,89	17,68

Table B.35e with two brackets in the connection

Load-duration class P (k_{mod} = 0,6).				
		Nail	R_{1k}	R_{2k}=R_{3k}
type4/170x115x3,0x95	0 ≤ α < 45°	4,0x40	1,98	6,44
	45 ≤ α ≤ 90°	4,0x40	1,95	4,82

Table B.35f with one bracket in the connection

Load-duration class L (k_{mod} = 0,7)				
		Nail	R_{1k}	R_{2k}=R_{3k}
type4/170x115x3,0x95	0 ≤ α < 45°	4,0x40	2,31	7,51
	45 ≤ α ≤ 90°	4,0x40	2,27	5,63

Table B.35g with one bracket in the connection

Load-duration class M (k_{mod} = 0,8).				
		Nail	R_{1k}	R_{2k}=R_{3k}
type4/170x115x3,0x95	0 ≤ α < 45°	4,0x40	2,64	8,58
	45 ≤ α ≤ 90°	4,0x40	2,59	6,43

Table B.35h with one bracket in the connection

Load-duration class S (k_{mod} = 0,9).				
		Nail	R_{1k}	R_{2k}=R_{3k}
type4/170x115x3,0x95	0 ≤ α < 45°	4,0x40	2,97	9,66
	45 ≤ α ≤ 90°	4,0x40	2,92	7,23

Table B.35i with one bracket in the connection

Load-duration class I (k_{mod} = 1,1).				
		Nail	R_{1k}	R_{2k}=R_{3k}
type4/170x115x3,0x95	0 ≤ α < 45°	4,0x40	3,63	11,80
	45 ≤ α ≤ 90°	4,0x40	3,57	8,84

Table B.35j with one bracket in the connection

Combined forces

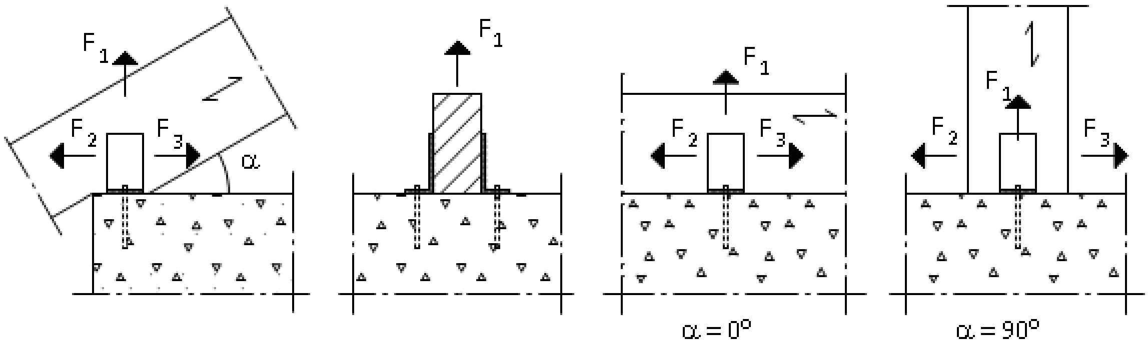
For practical purposes the strength verification is always carried out for design forces and design capacities. If the forces are combined the following inequalities shall be fulfilled:

$$\left(\frac{F_{1k}}{R_{1k}}\right)^2 + \left(\frac{F_{2k}}{R_{2k}}\right)^2 + \left(\frac{F_{3k}}{R_{3k}}\right)^2 \leq 1$$

F_k = Characteristic load (actual load)
R_k = Characteristic capacities from this ETA according to tables 35a to 35j.

In the upper condition either F_2 or F_3 is zero

Angle Bracket type4/170x115x3,0x95
Basis for design – wood to concrete connections



With two brackets in a connection the nails shall not overlap more than what is described in Eurocode 5 section 8.3.1.1. If the purlin is too thin, then brackets shall be staggered.

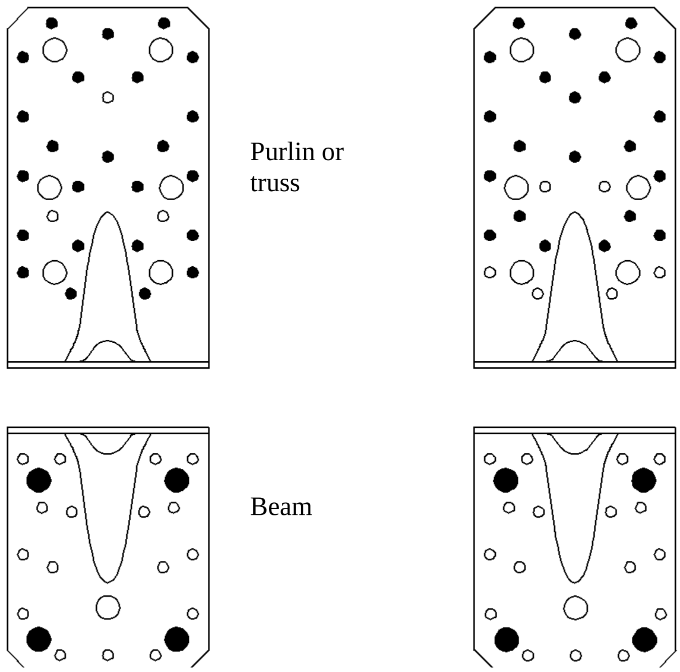


Figure B.15a Nailing pattern type type4/170x115x3,0x95

The characteristic capacities in wood to concrete connections are given in tables 36a to 36j. The tables 36a to 36e apply to connections with two brackets and tables 36f to 36j apply to connections with one bracket.

F_{EBt} is the axial load resistance for each bolt at the load effect equivalent to the characteristic capacity F_{Rd}.

Load-duration class P (k_{mod} = 0,6)					
	Angle α	Nail	Bolts	F_{R1k}	$F_{R2k} = F_{R3k}$
type4/170x115x3,0x95	0 ≤ α < 45°	24 4,0x40	4 ∅10	26,00 F_{EBt} = 7,03 F_{EBv} = 1,95	15,85 F_{EBt} = 0,77 F_{EBv} = 4,20
	45 ≤ α ≤ 90°	21 4,0x40	4 ∅10	23,00 F_{EBt} = 6,28 F_{EBv} = 1,45	12,29 F_{EBt} = 0,77 F_{EBv} = 3,25

Table B.36a with two brackets in the connection

Load-duration class L (k_{mod} = 0,7)					
	Angle α	Nail	Bolts	F_{R1k}	$F_{R2k} = F_{R3k}$
type4/170x115x3,0x95	0 ≤ α < 45°	24 4,0x40	4 ∅10	29,00 F_{EBt} = 7,78 F_{EBv} = 2,30	18,34 F_{EBt} = 0,77 F_{EBv} = 4,86
	45 ≤ α ≤ 90°	21 4,0x40	4 ∅10	26,00 F_{EBt} = 7,03 F_{EBv} = 1,70	14,19 F_{EBt} = 0,77 F_{EBv} = 3,76

Table B.36b with two brackets in the connection

Load-duration class M (k_{mod} = 0,8)					
	Angle α	Nail	Bolts	F_{R1k}	$F_{R2k} = F_{R3k}$
type4/170x115x3,0x95	0 ≤ α < 45°	24 4,0x40	4 ∅10	30,60 F_{EBt} = 8,18 F_{EBv} = 2,45	20,83 F_{EBt} = 0,77 F_{EBv} = 5,52
	45 ≤ α ≤ 90°	21 4,0x40	4 ∅10	29,00 F_{EBt} = 7,78 F_{EBv} = 2,00	16,09 F_{EBt} = 0,77 F_{EBv} = 4,26

Table B.36c with two brackets in the connection

Load-duration class S (k_{mod} = 0,9)					
	Angle α	Nail	Bolts	F_{R1k}	$F_{R2k} = F_{R3k}$
type4/170x115x3,0x95	0 ≤ α < 45°	24 4,0x40	4 ∅10	30,60 F_{EBt} = 8,18 F_{EBv} = 2,45	23,32 F_{EBt} = 0,77 F_{EBv} = 6,18
	45 ≤ α ≤ 90°	21 4,0x40	4 ∅10	30,60 F_{EBt} = 8,18 F_{EBv} = 2,15	17,99 F_{EBt} = 0,77 F_{EBv} = 4,76

Table B.36d with two brackets in the connection

Load-duration class I (k_{mod} = 1,1)					
	Angle α	Nail	Bolts	F_{R1k}	$F_{R2k} = F_{R3k}$
type4/170x115x3,0x95	0 ≤ α < 45°	24 4,0x40	4 ∅10	30,60 F_{EBt} = 8,18 F_{EBv} = 2,45	28,30 F_{EBt} = 0,77 F_{EBv} = 7,50
	45 ≤ α ≤ 90°	21 4,0x40	4 ∅10	30,60 F_{EBt} = 8,18 F_{EBv} = 2,15	21,79 F_{EBt} = 0,77 F_{EBv} = 5,77

Table B.36e with two brackets in the connection

Load-duration class P (k_{mod} = 0,6)					
	Angle α	Nail	Bolts	F_{R1k}	$F_{R2k} = F_{R3k}$
type4/170x115x3,0x95	0 ≤ α < 45°	24 4,0x40	4 ∅10	7,80 F_{EBt} = 4,22 F_{EBv} = 1,17	7,92 F_{EBt} = 0,77 F_{EBv} = 4,20
	45 ≤ α ≤ 90°	21 4,0x40	4 ∅10	6,90 F_{EBt} = 3,77 F_{EBv} = 0,87	6,14 F_{EBt} = 0,77 F_{EBv} = 3,25

Table B.36f with one bracket in the connection

Load-duration class L (k_{mod} = 0,7)					
	Angle α	Nail	Bolts	F_{R1k}	$F_{R2k} = F_{R3k}$
type4/170x115x3,0x95	0 ≤ α < 45°	24 4,0x40	4 ∅10	8,70 F_{EBt} = 4,67 F_{EBv} = 1,38	9,17 F_{EBt} = 0,77 F_{EBv} = 4,86
	45 ≤ α ≤ 90°	21 4,0x40	4 ∅10	7,80 F_{EBt} = 4,22 F_{EBv} = 1,02	7,09 F_{EBt} = 0,77 F_{EBv} = 3,76

Table B.36g with one bracket in the connection

Load-duration class M (k_{mod} = 0,8)					
	Angle α	Nail	Bolts	F_{R1k}	$F_{R2k} = F_{R3k}$
type4/170x115x3,0x95	0 ≤ α < 45°	24 4,0x40	4 ∅10	9,18 F_{EBt} = 4,91 F_{EBv} = 1,47	10,41 F_{EBt} = 0,77 F_{EBv} = 5,52
	45 ≤ α ≤ 90°	21 4,0x40	4 ∅10	8,70 F_{EBt} = 4,67 F_{EBv} = 1,20	8,04 F_{EBt} = 0,77 F_{EBv} = 4,26

Table B.36h with one bracket in the connection

Load-duration class S (k_{mod} = 0,9)					
	Angle α	Nail	Bolts	F_{R1k}	$F_{R2k} = F_{R3k}$
type4/170x115x3,0x95	0 ≤ α < 45°	24 4,0x40	4 ∅10	9,18 F_{EBt} = 4,91 F_{EBv} = 1,47	11,61 F_{EBt} = 0,77 F_{EBv} = 6,18
	45 ≤ α ≤ 90°	21 4,0x40	4 ∅10	9,18 F_{EBt} = 4,91 F_{EBv} = 1,29	8,99 F_{EBt} = 0,77 F_{EBv} = 4,76

Table B.36i with one bracket in the connection

Load-duration class I (k_{mod} = 1,1)					
	Angle α	Nail	Bolts	F_{R1k}	$F_{R2k} = F_{R3k}$
type4/170x115x3,0x95	0 ≤ α < 45°	24 4,0x40	4 ∅10	9,18 F_{EBt} = 4,91 F_{EBv} = 1,47	14,15 F_{EBt} = 0,77 F_{EBv} = 7,50
	45 ≤ α ≤ 90°	21 4,0x40	4 ∅10	9,18 F_{EBt} = 4,91 F_{EBv} = 1,29	10,89 F_{EBt} = 0,77 F_{EBv} = 5,77

Table B.36j with one bracket in the connection

Combined forces

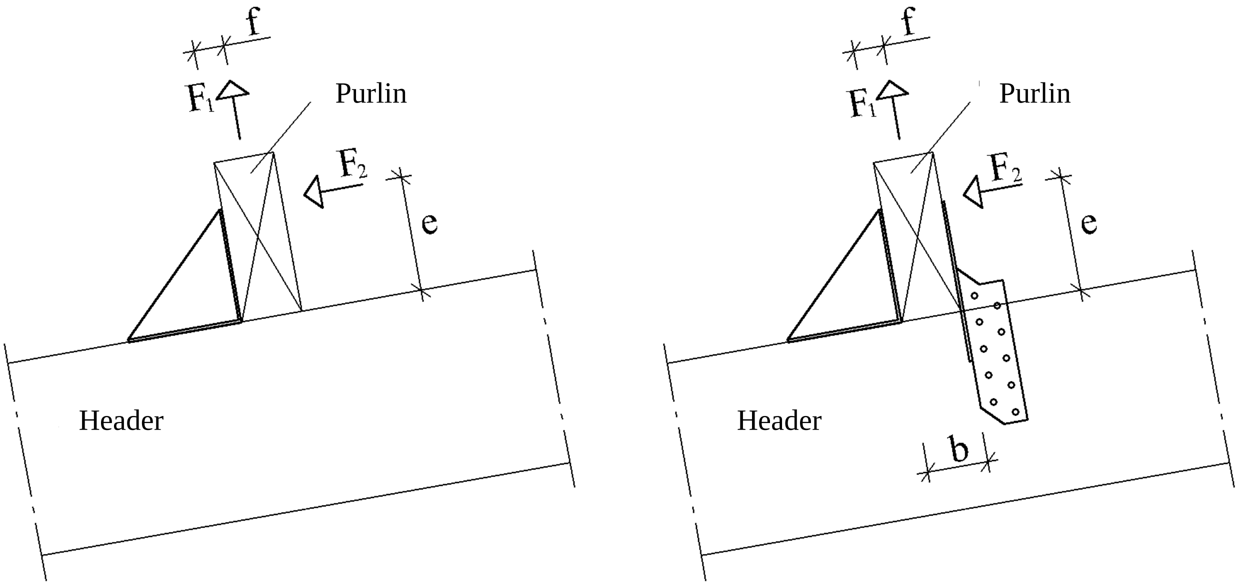
For practical purposes the strength verification is always carried out for design forces and design capacities. If the forces are combined the following inequalities shall be fulfilled:

$$\left(\frac{F_{1k}}{R_{1k}}\right)^2 + \left(\frac{F_{2k}}{R_{2k}}\right)^2 + \left(\frac{F_{3k}}{R_{3k}}\right)^2 \leq 1$$

F_k = Characteristic load (actual load)
R_k = Characteristic capacities from this ETA according to tables 36a to 36j.

In the upper condition either F_2 or F_3 is zero

Bracket type HVV Knagge
Basis for design – wood to wood connections



In the header the ”HVV Knagge” shall be nailed with 4,0x60 nails. In the purlin the ”HVV Knagge” shall be nailed with 4,0x40 nails. The purlin ties in both header and purlin shall be nailed with 4,0x40 nails.

The nailing pattern in the purlin tie shall be in accordance with ETA-09/0315 for the purlin ties.

The requirements in EN 1995-1-1:2004 to the edge distance shall be fulfilled. In table 1 is indicated the minimum width of the header and minimum purlin heights for the respective types of ”HVV Knagge”.

Table B37.a Minimum width of the header and minimum purlin heights.

Knagge	minimum purlin heights	Minimum width of the header
90	100	105
130	125	135
170	150	115
210	210	130

Table B37.b Characteristic capacity F_{Rk} in kN with only HVV Knagge type 90. Load duration class M (k_{mod} = 0,8). Service class 1 and 2. The dimensions *e* and *f* shall be given in mm.

HVV Knagge typ 90 without purlin tie			
Nails in header	Nails in purlin tie	F_{R1k}	F_{R2k}
8 st 4,0x60	8 st 4,0x40	$\frac{166}{f+75}$ for $f \leq 90$	$\frac{166}{e}$ for $e \leq 150$ Max 8,19

Table B37.c Characteristic capacity F_{Rk} in kN HVV Knagge typ 90 with two purlin ties type 170. Load duration class M (k_{mod} = 0,8). Service class 1 and 2. The dimensions *e* and *b* shall be given in mm.

HVV Knagge type 90 with two purlin ties type 170			
Nails in header	Nails in purlin tie	F_{R1k}	F_{R2k}
8 st 4,0x60	8 st 4,0x40	4,78	$\frac{74+7{,}8b}{(e-62)}$ for $e \leq 150$ Max 8,34

Table B37.d Characteristic capacity F_{Rk} in kN with only HVV Knagge type 130. Load duration class M (k_{mod} = 0,8). Service class 1 and 2. The dimensions *e* and *f* shall be given in mm.

HVV Knagge type 130 with out purlin tie			
Nails in header	Nails in purlin tie	F_{R1k}	F_{R2k}
10 st 4,0x60	10 st 4,0x40	$\frac{286}{f+105}$ för $f \leq 125$	$\frac{286}{e}$ för $e \leq 175$ Dock max 10,61

Table B37.e Characteristic capacity F_{Rk} in kN HVV Knagge type 130 with two purline ties type 210. Load duration class M (k_{mod} = 0,8). Service class 1 and 2. The dimensions e and b shall be given in mm.

HVV Knagge type 130 with two purlin ties type 210			
Nails in header	Nails in purlin tie	F_{R1k}	F_{R2k}
10 st 4,0x60	10 st 4,0x40	5,68	$\frac{179+10{,}76b}{(e-87)}$ for $e \leq 175$ Max 8,72

Table B37.f Characteristic capacity F_{Rk} in kN with only HVV Knagge type 170. Load duration class M (k_{mod} = 0,8). Service class 1 and 2. The dimensions e and f shall be given in mm.

HVV Knagge type 170 without purlin tie			
Nails in header	Nails in purlin tie	F_{R1k}	F_{R2k}
12 st 4,0x60	12 st 4,0x40	$\frac{423}{f+125}$ for $f \leq 150$	$\frac{423}{e}$ for $e \leq 200$ Max 13,15

Table B37.g Characteristic capacity F_{Rk} in kN HVV Knagge type 170 with two purlin ties type 250. Load duration class M (k_{mod} = 0,8). Service class 1 and 2. The dimensions e and b shall be given in mm.

HVV Knagge type 170 with two purlin ties type 250			
Nails in header	Nails in purlin tie	F_{R1k}	F_{R2k}
12 st 4,0x60	12 st 4,0x40	6,89	$\frac{13{,}3(b+93{,}5)-18}{e}$ for $e \leq 200$ Max 13,62

Table B37.h Characteristic capacity F_{Rk} in kN with only HVV Knagge type 210. Load duration class M (k_{mod} = 0,8). Service class 1 and 2. The dimensions e and f shall be given in mm.

HVV Knagge type 210 without purlin tie			
Nails in header	Nails in purlin tie	F_{R1k}	F_{R2k}
18 st 4,0x60	18 st 4,0x40	$\frac{912}{f+175}$ for $f \leq 200$	$\frac{912}{e}$ for $e \leq 250$ Max 20,68

Table B37.i Characteristic capacity F_{Rk} in kN HVV Knagge type 210 with two purlin ties type 290. Load duration class M (k_{mod} = 0,8). Service class 1 and 2. The dimensions *e* and *b* shall be given in mm.

HVV Knagge type 210 with two purlin ties type 290			
Nails in header	Nails in purlin tie	F_{R1k}	F_{R2k}
18 st 4,0x60	18 st 4,0x40	10,42	$\frac{468+20{,}86b}{(e-135)}$ for $e \leq 250$ Max 16,40

Table B37.j Correction factor at different load duration classes.

Load-duration class k_{mod}				
P	L	M	S	I
0,75	0,88	1,0	1,0	1,0

Combined forces
For practical purposes the strength verification is always carried out for design forces and design capacities. If the forces are combined the following inequalities shall be fulfilled:

$$\left(\frac{F_{\mathrm{E1k}}}{F_{\mathrm{Rik}}}\right)+\left(\frac{F_{\mathrm{E2k}}}{F_{\mathrm{R2k}}}\right)\leq 1$$

F_k = Characteristic load (actual load)
R_k = Characteristic capacities from this ETA according to tables 37a to 37j.