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European Technical Assessment

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General Part

Technical Assessment Body issuing the European Technical Assessment	**VĮ Statybos produkcijos sertifikavimo centras**
Trade name of the construction product:	**Angle brackets** **Angle brackets with a rib** **Angle brackets with a two ribs**
Product family to which the above construction product belongs:	**EC PAC 13: Three-dimensional nailing plate (Angle brackets for timber to timber and timber to concrete connections)**
Manufacturer:	**UAB "METALISTAS LT"** **Šermukšnių g. 19, LT-35113 Panevėžys, Lithuania** **www.metalistas.lt**
Manufacturing plant:	**UAB "METALISTAS LT"** **Šermukšnių g. 19, LT-35113 Panevėžys, Lithuania** **www.metalistas.lt**
This European Technical Assessment contains:	**65 pages including 4 Annexes which form an integral part of this assessment.** **Annex – Control plan contain confidential information and is not included in the European Technical Assessment when that assessment is publicly disseminated**
This European Technical Assessment is issued in accordance with regulation (EU) No 305/2011, on the basis of:	**ETAG 015, edition November 2012, used as European Assessment Document (EAD).**
This version replaces:	**The previous ETA with the same number issued on 2013-06-30 and expired on 2016-04-04**

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Specific Parts

1. Technical description of the product

Angle brackets given in Table 1 are one-piece non-welded face fixed angle brackets to be used in timber to timber and timber to concrete connections. They are connected to the timber elements by ringed shank nails and to the concrete elements by steel anchors.

Table 1. Angle bracket type and overall dimensions

Angle bracket		
40×40×2,5×60	80×80×2×80	50×50×2×35
40×40×2×140	80×80×2.5×80	50×50×2,5×35
40×40×2,5×140	80×80×2.5×100	60×60×2×60
53×53×3×35	90×90×2.5×40	60×60×2,5×60
60×60×2×40	90×90×3×40	70×70×2,5×55
60×60×2,5×40	100×100×2×60	90×35×2,5×40
60×60×2,5×50	100×100×2,5×60	90×90×2,5×65
60×60×2×60	100×100×2,5×100	93×53×3×50
60×60×2,5×60	120×40×2×40	105×105×3×90
60×60×2,5×80	120×40×2,5×40	160×50×3×40
80×80×2×60	120×90×2,5×40	
80×80×2,5×60	120×90×3×40	
Angle brackets with a rib		
90×90×2,5×65	105×105×3×90	
Angle brackets with a two ribs		
70×70×2,5×55	90×55×2,5×55	

The angle brackets are made from pre-galvanized steel DX51D+Z275 according to standard EN 10346:2015[1] with minimum yield strength R_e of 280 MPa, minimum tensile strength R_m of 330 MPa and minimum elongation A_{80} of 22 %. Dimensions, hole positions are shown in the Annex C, typical installations are shown in Annex B. Angle brackets are made from steel with normal thickness tolerances according to EN 10143:2006[2].

1 EN 10346:2015 Continuously hot-dip coated steel flat products for cold forming - Technical delivery conditions.

2 EN 10143:2006 Continuously hot-dip coated steel sheet and strip - Tolerances on dimensions and shape.

2. Specifications of the intended use in accordance with the applicable EAD

Intended use of the angle brackets are the connections between beams, beams and columns of load bearing timber, load bearing timber and concrete structures, where the requirements for mechanical resistance, stability and safety in use in the sense of the Basic Requirements 1 and 4 of Regulation (EU) No 305/2011[3] of the European Parliament and of the Council of 9 March 2011 shall be fulfilled.

The angle brackets may also be used for connections between a timber members and masonry, if requirements for the characteristic axial withdrawal capacity of anchors and the characteristic load-carrying capacity for anchors per shear plane were fulfilled.

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

The wood members may be of solid timber or glued laminated timber with a characteristic density from 290 kg/m³ to 420 kg/m³. This requirement for material of the wood members may be fulfilled by using the following materials:

- structural solid timber classified to C14-C40 strength class according to EN 338:2010[4] and EN 14081-1:2005+A1:2011[5] or EN 14081-1:2016[6];;
- glulam classified to GL24-GL36 according to EN 14080:2013[7].

The concrete or reinforcing concrete members shall be of concrete with compressive strength class no less than C20/25 according to EN 206:2013[8].

For joints shall be used CNA Connector threaded nails according ETA-04/0013 “CNA Connector nails, PCR Connector nails and CSA Connector screws” with diameter 4,0 mm. Another type of threaded nails may be used with values of axial characteristic load-carrying capacity per nail not less than CNA Connector thread nails and with the tensile capacity of the wire for the nails equal to or greater than 600 N/mm².

Zinc-coated steel anchors for concrete S-KA, diameter 8 / 10 according ETA-08/0173 “SORMAT through bolts S-KA, S-KAK, S-KAH, and S-KAH HCR” shall be used for connections to the concrete members. Another type of steel anchors may be used with values of the characteristic axial withdrawal capacity and the characteristic load-carrying capacity per shear plane not less than above mentioned S-KA steel anchors.

Annex B states the load-carrying capacities of the angle brackets connections for a characteristic density of 350 kg/m³ of solid timber or glulam. For solid timber or glulam with a lower characteristic density than 350 kg/m³ the load-carrying capacities of the nailed connection shall be modified by the k_{dens} factor:

$$k_{dens} = \sqrt{\frac{\rho_k}{350}}$$

where:

ρ_k is the characteristic density of timber used in the connection.

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3 Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC (OJ L 88, 4.04.2011, p. 5).

4 EN 338:2009 Structural timber - Strength classes.

5 EN 14081-1:2005+A1:2011 Timber structures - Strength graded structural timber with rectangular cross section - Part 1: General requirements.

6 EN 14081-1:2016 Timber structures - Strength graded structural timber with rectangular cross section - Part 1: General requirements.

7 EN 14080:2013 Timber structures - Glued laminated timber and glued solid timber – Requirements.

8 EN 206:2013 Concrete - Specification, performance, production and conformity.

The design of the connections shall be in accordance with Eurocode 5[9] or according to similar national regulations for design. The wood members shall have the thickness which is larger than the penetration depth of the nails into the members.

Concrete or reinforcing concrete members shall be calculated using Eurocode 2[10] and / or similar national regulations for design of concrete structures.

The angle brackets are primarily intended for use in timber and timber-concrete structures subject to the dry, internal conditions defined by service class 1 and 2 of Eurocode 5 and for connections subject to static or quasi-static loading. The angle brackets can also be used in outdoor structures, defined by service class 3, when a corrosion protection in accordance with Eurocode 5 is applied, or when stainless steel with similar or better characteristic yield, ultimate strength and ductility is employed.

They are not intended for used in areas where they might support seismic actions.

The provisions made in this European Technical Assessment are based on an assumed intended working life of the three-dimensional nailing plates of 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, 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.

2.1 Installation

2.1.1 Joints

A connector (three dimensional nailing plates – angle brackets) is deemed fit for its intended use provided:

- joints are designed in accordance with Eurocode 5 or an appropriate national regulations for timber constructions design under the responsibility of an engineer experienced in timber structures;
- the structural members to which the angle brackets are fixed shall be restrained against rotation;
- the structural members of solid timber shall be of strength class C14 or better;
- the structural members of glulam shall be of strength class GL24 or better;
- the structural timber members shall be free from wane under the angle brackets;
- the tensile strength perpendicular to the grain capacity of the timber member to be used in conjunction with the angle brackets is to be checked by the designer of the structure to ensure that it is not less than the angle brackets capacity and, if necessary, the angle brackets capacity shall be reduced accordingly;
- the concrete compressive strength class no less than C20/25;
- the gap between the timber members or timber and concrete members does not exceed 3 mm;
- there are no specific requirements relating to preparation of the timber members.

2.1.2 Criteria

The fitness for use of the joint can be assumed if the connector is installed correctly in accordance with the following requirements:

- installation is carried out by personnel under the direction of supervisors, which are appropriately qualified for this work;
- installation is in accordance with the manufacturer's specifications and drawings prepared for that purpose, and the appropriate tools are used;
- the specified fasteners are used.

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9 EN 1995-1-1 Eurocode 5: Design of timber structures - Part 1-1: General - Common rules and rules for buildings.

10 EN 1992-1-1 Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings.

2.1.3 Responsibility of the manufacturer

It is the responsibility of the manufacturer to ensure that the information on the specific conditions given in sections 1, 2 and 3 of this European technical assessment, is given to those concerned. This information may be made by replicating the respective parts of this European Technical Assessment. In addition, all installation data shall be shown clearly on the package and / or on an instruction sheet, preferably using illustration(s).

The minimum information required is:

- fastener specification;
- requirements for timber members;
- requirements for concrete members (then applicable);
- identification of the manufacturing batch.

All data shall be presented in a clear and explicit form.

2.2 Recommendations

2.2.1 Recommendations on packaging, transport and storage

The angle brackets are packed in boxes bearing the manufacturer's name, product type, dimensions, quantity, date of fabrication and batch reference details.

In relation to transportation and storage, the connectors should be treated as conventional metallic building products.

2.2.2 Recommendations on use, maintenance and repair

The assessment of the fitness for use is based on the assumption that maintenance is not required during the assumed intended working life.

3. Performance of the product and references to the methods used for its assessment:

ETAG paragraph	Characteristic	Assessment of characteristic
3.1 Mechanical resistance and stability		
2.4.1	Characteristic load-carrying capacity	see Annex B
2.4.1	Stiffness	No performance assessed
2.4.1	Ductility in cyclic testing	No performance assessed
3.2 Safety in case of fire		
2.4.2.1	Reaction to fire	The angle brackets are made from steel classified as Euroclass A1 in accordance with EN 13501-1:2007+A1:2009[11] and EC decision 96/603/EC[12], amended by EC Decision 2000/605/EC[13]
2.4.2.2	Resistance to fire	No performance assessed
3.3 Hygiene, health and the environment		
2.4.3	Release of dangerous substances	No dangerous materials [1)]
3.4 General aspects relating to fitness for use (serviceability)		
2.4.7	Durability	
2.4.7.2	Resistance to corrosion and deterioration	The angle brackets have been assessed as having satisfactory durability and serviceability when used in timber and timber-concrete structures using the timber species described in Eurocode 5 and subject to the conditions defined by service class 1 and 2
2.4.8	Dimensional stability	Tests are carried out during the assessment for mechanical resistance and stability

[1)] Based on the declaration of the manufacturer and in accordance with TR 034[14] the three dimensional nailing plates do not contain harmful or dangerous substances as defined in the EU database.

In accordance with the Regulation (EC) No 1907/2006 of the European Parliament and the Council of 18 December 2006[15] and http://ec.europa.eu/growth/sectors/chemicals/reach/index_en.htm, the product does not contain/release dangerous substances.

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 Regulation (EU) No 305/2011, these requirements need also to be complied with, when and where they apply

[11] EN 13501-1:2007+A1:2009 Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests.

[12] OJ L 267, 19.10.1996, p. 23.

[13] OJ L 258, 12.10.2000, p. 36.

[14] Technical report TR 34. General BWR3 Checklist for EADs/ETAs - Content and/or release of dangerous substances in construction products, Edition October 2015.

[15] OJ L 396, 30.12.2006, p. 1.

3.1 Mechanical resistance and stability

The assessment of fitness for the intended use has been made in accordance with ETAG 015. The characteristic load-carrying capacities of the products are given in Annex B, which have been derived by calculation and verified by testing.

The characteristic load-carrying capacities are based on the characteristic values of the nail connections, anchor connections, timber components and steel plates. The calculations were performed according to Eurocode 3[16] and Eurocode 5.

The load-carrying capacities of the concrete (reinforcing concrete) beams or columns as structural members not assessed and shall be calculated according to Eurocode 2 and / or similar national regulations for design of concrete structures.

According to EN 1990[17] for structures or structural members that comprise more than one material acting in association, partial factors of all used materials shall be compute to obtain design values.

To obtain design values the capacities have to be divided by different partial factors of the material properties, the nail connection and the timber components in addition multiplied with the coefficient k_{mod}.

$$F_{1.d} = \frac{F_{1.k} \cdot k_{\mathrm{mod}}}{\gamma_M}$$

where:

$F_{1,k}$ is the characteristic load-carrying capacity;

k_{mod} is the modification factor depending on service class and load-duration classes, see EN 1995-1-1, § 3.1.3;

γ_M is the partial factor for a material property, according EN 1995-1-1, § 2.4.1.

The characteristic load-carrying capacities in the direction F is presented in the Annex B. These values are based on the assumption that there is a maximum gap of 3 mm between the timber or timber to concrete members (see Annex B, Figure B.1-B.11), the members are laterally restrained and wane is not present in the timber at the joint. Minimum spacings and edge and end distances for nails shall be according to Eurocode 5. The number and position of nails and anchors are shown in Annex D.

The characteristic capacities of the angle brackets are determined by calculation and verified by testing. They should be used for design in accordance with Eurocode 5 or a similar national regulation for timber structures design.

In the calculations and tests are used CNA Connector threaded nails 40 x 4,0 mm with a profiled length of at least 30 mm and a special conical part under the head.

The characteristic axial load-carrying withdrawal capacity of a nails is taken according ETA-04/0013 “CNA Connector nails, PCR Connector nails and CSA Connector screws”. The characteristic lateral load-carrying capacity of CNA Connector nails calculated from the formulas of Eurocode 5 by liner interpolation between the limiting thin and thick plate values, see EN 1995-1-1, expressions (8.9) and (8.10).

In the calculations and tests are used zinc-coated anchors for concrete S-KA, diameter 8 / 10 according ETA-08/0173 “SORMAT through bolts S-KA, S-KAK, S-KAH, and S-KAH HCR”.
The characteristic load-carrying capacity for anchor per shear plane, $F_{a.v.Rk}$ and the characteristic axial withdrawal capacity of the steel anchor embedded in the concrete, $F_{a.ax.Rk}$ is taken according above mentioned ETA.

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16 EN 1993-1-1 Eurocode 3: Design of steel structures - Part 1-1: General rules and rules for buildings.

17 EN 1990 Eurocode - Basis of structural design.

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.

3.2 Safety in case of fire

Performance in relation to fire resistance would be determined for the complete structural element with any associated finishes, therefore there are no relevant aspects of performance to this Basic Requirement for the connectors.

3.3 Hygiene, health and the environment

Based on the declaration of the manufacturer and in accordance with TR 034, dated March 2012, the three dimensional nailing plates do not contain harmful or dangerous substances as defined in the EU database.

3.4 General aspects relating to fitness for use (durability and serviceability)

3.4.1 Durability

The angle brackets have been assessed as having satisfactory durability and serviceability when used in timber or in timber-concrete structures with the timber species (including timbers preserved with organic solvent, boron diffusion and related preservatives) described in Eurocode 5 and subject to the dry, internal conditions defined by service classes 1 and 2 according Eurocode 5:

- service class 1 – is characterised by a moisture content in the materials corresponding to a temperature of 20°C and the relative humidity of the surrounding air only exceeding 65 % for a few weeks per year;
- service class 2 - characterised by a moisture content in the materials corresponding to a temperature of 20°C and the relative humidity of the surrounding air only exceeding 85 % for a few weeks per year.

In accordance with ETAG 015 the angle brackets are made from hot-dip zinc coating steel DX51D+Z275 according to EN 10346:2009 with a minimum yield strength R_e of 280 MPa, a minimum tensile strength R_m of 330 MPa and a minimum elongation A_{80} of 22 %.

3.4.2 Dimensional stability

Additional tests are not required for this property as it is covered during the assessment.

4. Assessment and verification of constancy of performance (AVPC) system applied, with reference to its legal base

According to the decision 97/638/EC[18] of the European Commission, the system of assessment and verification of constancy of performance applied to this product shall be as laid down in the Commission delegated regulation (EU) No 568/2014[19] amending Annex V to Regulation (EU) No 305/2011[20] of the European Parliament and of the Council, referred to as System 2+.

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

All the necessary technical details for the implementation of the AVCP system are laid down in the Control Plan deposited with the Statybos produkcijos sertifikavimo centras (SPSC), with which the factory production control shall be in accordance.

Issued in Vilnius on 2016-07-03
By State Enterprise Statybos produkcijos sertifikavimo centras (SPSC)

Director
Robertas Encius

[18] Commission Decision 97/638/EC of 19 September 1997 on the procedure for attesting the conformity of construction roducts pursuant to Article 20(2) of Council Directive 89/106/EEC as regards fasteners for structural timber (OJ L 268, 1.10.1997, p. 36).

[19] Commission delegated regulation (EU) No 568/2014 of 18 February 2014 amending Annex V to Regulation (EU) No 305/2011 of the European Parliament and of the Council as regards the assessment and verification of constancy of performance of construction products (OJ L 157, 27.05.2014, p. 76).

[20] Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC (OJ L 88, 4.04.2011, p. 5).

ANNEX A

Product details

Table A.1. Steel for angle brackets specification

Angle brackets identification	Steel thickness (mm)	Steel and coating specification [1)]
Angle brackets		
40×40×2,5×60	2,5	EN 10346 - DX51D + Z275
40×40×2×140	2,0	EN 10346 - DX51D + Z275
40×40×2,5×140	2,5	EN 10346 - DX51D + Z275
53×53×3×35	3,0	EN 10346 - DX51D + Z275
60×60×2×40	2,0	EN 10346 - DX51D + Z275
60×60×2,5×40	2,5	EN 10346 - DX51D + Z275
60×60×2,5×50	2,5	EN 10346 - DX51D + Z275
60×60×2×60	2,0	EN 10346 - DX51D + Z275
60×60×2,5×60	2,5	EN 10346 - DX51D + Z275
60×60×2,5×80	2,5	EN 10346 - DX51D + Z275
80×80×2×60	2,0	EN 10346 - DX51D + Z275
80×80×2,5×60	2,5	EN 10346 - DX51D + Z275
80×80×2×80	2,0	EN 10346 - DX51D + Z275
80×80×2,5×80	2,5	EN 10346 - DX51D + Z275
80×80×2,5×100	2,5	EN 10346 - DX51D + Z275
90×90×2,5×40	2,5	EN 10346 - DX51D + Z275
90×90×3×40	3,0	EN 10346 - DX51D + Z275
100×100×2×60	2,0	EN 10346 - DX51D + Z275
100×100×2,5×60	2,5	EN 10346 - DX51D + Z275
100×100×2,5×100	2,5	EN 10346 - DX51D + Z275
120×40×2×40	2,0	EN 10346 - DX51D + Z275
120×40×2,5×40	2,5	EN 10346 - DX51D + Z275
120×90×2,5×40	2,5	EN 10346 - DX51D + Z275
120×90×3×40	3,0	EN 10346 - DX51D + Z275
50×50×2×35	2,0	EN 10346 - DX51D + Z275
50×50×2,5×35	2,5	EN 10346 - DX51D + Z275
60×60×2×60	2,0	EN 10346 - DX51D + Z275
60×60×2,5×60	2,5	EN 10346 - DX51D + Z275
70×70×2,5×55	2,5	EN 10346 - DX51D + Z275
90×35×2,5×40	2,5	EN 10346 - DX51D + Z275
90×90×2,5×65	2,5	EN 10346 - DX51D + Z275
93×53×3×50	3,0	EN 10346 - DX51D + Z275
105×105×3×90	3,0	EN 10346 - DX51D + Z275
160×50×3×40	3,0	EN 10346 - DX51D + Z275

Table A.1. Steel for angle brackets specification (concluded)

Angle brackets identification	Steel thickness (mm)	Steel and coating specification [1)]
Angle brackets with a rib		
90×90×2,5×65	2,5	EN 10346 - DX51D + Z275
105×105×3×90	3,0	EN 10346 - DX51D + Z275
Angle brackets with a two ribs		
70×70×2,5×55	2,5	EN 10346 - DX51D + Z275
90×55×2,5×55	2,5	EN 10346 - DX51D + Z275
[1)] requirements according angle brackets manufacturer UAB “METALISTAS LT” documentation: - minimum yield strength, $R_{po,2}$ or R_{eL} – 280 MPa; - minimum tensile strength, R_m – 330 MPa; - minimum elongation, A_{80} – 22 % (according requirements of EN 10346:2015)		

The angle bracket drawings with dimensions presented in the Annex C.

Table A.2. Nails specification

Nail type according ETA-04/0013, edition 2015-05-12	Dimensions (mm)	Coating specification
CNA connector nail	40 × 4,0	ISO 2081 - Fe/Zn12/C
Characteristic capacities of CNA Connector nails for a characteristic density of the wood members 350 kg/m³: - axial, $F_{ax,Rk}$ – 740 N; - lateral, $F_{lat,Rk}$ –1830 N. For other than 350 kg/m³ density of timber members, see ETA-04/0013 (edition 2015-05-12), Table B1. Tensile capacity of the wire for nails – 600 MPa.		
Other types of threaded nails of the same dimensions and with values of axial characteristic load-carrying capacity and characteristic lateral load-carrying capacity per nail not less than CNA Connector nails and the tensile capacity of the wire for the nails is equal or greater than 600 N/mm² may be used.		

Table A.3. Anchor SORMAT through bolt S-KA components specification

Anchor type according ETA-08/0173, edition 2014-05-23	Dimensions (mm)	Steel and coating specification
Bolt	Ø8/10	Cold forged steel, EN 10263-2 zinc electroplated, EN ISO 4042, ≥ 5µm
Sleeve	Ø8/10	Cold rolled galvanized steel strip, EN 10346
Washer	Ø8/10	Steel, electroplated, EN ISO 7089 zinc electroplated, EN ISO 4042, ≥ 5µm
Hexagonal nut	Ø8/10	Steel electroplated, ISO 4032, grade 8 zinc electroplated, EN ISO 4042, ≥ 5µm
Characteristic capacities of anchors for tension and shear loads according ETA-08/0173, edition 2014-05-23 (depending on diameter and strength class of concrete). Other types of steel anchors with values of characteristic load-carrying capacity for anchor per shear plane and the characteristic axial withdrawal capacity of the steel anchor embedded in the concrete not less than values of above mentioned anchor SORMAT through bolt S-KA.		

ANNEX B

Characteristic load-carrying capacities

B.1 Support conditions

The distance between the timber members and the timber and concrete members in the area of the connection must not exceed 3 mm. The members shall be prevented from rotation.

B.2 Fastener specification

Number and position of nails and steel anchors presented in the Table B.1–B.11 and Annex D.

B.3 Wane

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

B.4 Characteristic load-carrying capacities

B.4.1 Timber beam to timber column connections with the angle brackets

Table B.1. Characteristic load-carrying capacities $F_{1,k}$ of timber beam to timber column connection for load direction according Figure B.1.

Angle bracket type	Nails dimensions (mm)	Number of nails		Position of nails shown in Figure[1)]	$F_{1,k}$ kN
		Beam	Column		
40×40×2,5×60	40 × 4,0	12	4	D.1	2,3
40×40×2×140	40 × 4,0	22	14	D.2	10,4
40×40×2,5×140	40 × 4,0	22	14	D.2	11,1
[1)] see Annex D					

When load-carrying capacity is calculated the possibility of splinting caused by the tension perpendicular to the grain, shall be taken into account.

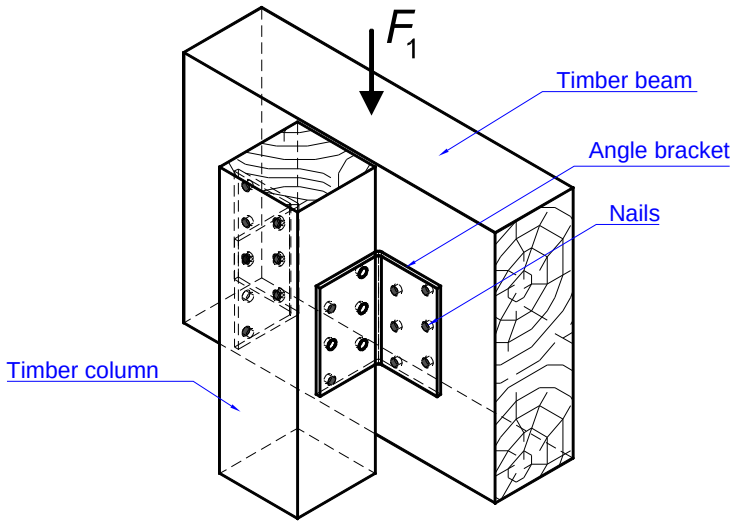


Figure B.1. Typical installation of the angle brackets in the timber beam to timber column connections

B.4.2 Timber beam to timber beam connections with an angle brackets

Table B.2. Characteristic load-carrying capacities $F_{1,k}$ of timber beam to timber beam connection for load direction according Figure B.2

Angle bracket type	Nails dimensions (mm)	Number of nails		Position of nails shown in Figure[1)]	$F_{1,k}$ kN
		Primary beam	Secondary beam		
53×53×3×35	40 × 4,0	8	4	D.3	0,83
60×60×2×40	40 × 4,0	12	4	D.4	0,87
60×60×2,5×40	40 × 4,0	12	4	D.4	0,93
60×60×2,5×50	40 × 4,0	14	6	D.5	2,06
60×60×2×60	40 × 4,0	18	6	D.6	1,73
60×60×2,5×60	40 × 4,0	18	6	D.6	1,85
60×60×2,5×80	40 × 4,0	24	8	D.7	3,02
80×80×2×60	40 × 4,0	24	12	D.8	3,64
80×80×2,5×60	40 × 4,0	24	12	D.8	3,89
80×80×2×80	40 × 4,0	32	16	D.9	5,52
80×80×2,5×80	40 × 4,0	32	16	D.9	5,90
80×80×2,5×100	40 × 4,0	40	20	D.10	8,30
90×90×2,5×40	40 × 4,0	10	6	D.11	1,50
90×90×3×40	40 × 4,0	10	6	D.11	1,60
100×100×2×60	40 × 4,0	30	18	D.12	5,75
100×100×2,5×60	40 × 4,0	30	18	D.12	6,14
100×100×2,5×100	40 × 4,0	50	30	D.13	12,1
120×40×2×40	40 × 4,0	8	16	D.14	1,91
120×40×2,5×40	40 × 4,0	8	16	D.14	1,93
120×90×2,5×40	40 × 4,0	16	16	D.15	3,79
120×90×3×40	40 × 4,0	16	16	D.15	3,83
50×50×2×35	40 × 4,0	6	4	D.16	1,20
50×50×2,5×35	40 × 4,0	6	4	D.16	1,28
60×60×2×60	40 × 4,0	16	6	D.17	1,73
60×60×2,5×60	40 × 4,0	16	6	D.17	1,85
70×70×2,5×55	40 × 4,0	16	8	D.18	2,7
90×35×2,5×40	40 × 4,0	4	6	D.19	1,67
90×90×2,5×65	40 × 4,0	18	12	D.20	5,8
93×53×3×50	40 × 4,0	8	12	D.21	3,27
105×105×3×90	40 × 4,0	22	14	D.22	8,4
160×50×3×40	40 × 4,0	4	16	D.23	1,06

[1)] see Annex A

When load-carrying capacity is calculated the possibility of splinting caused by the tension perpendicular to the grain, shall be taken into account.

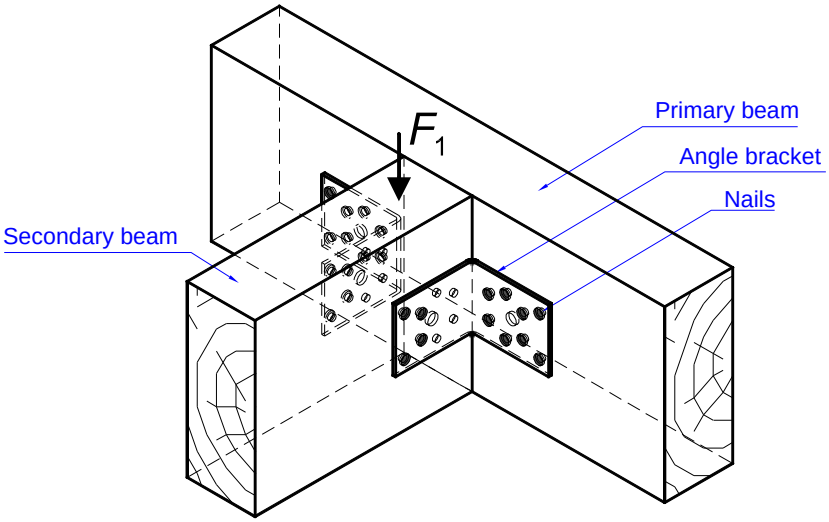


Figure B.2. Typical installation of the angle brackets in the timber beam to timber beam connections

B.4.3 Timber beam to timber column connections when a pair of angle brackets are placed in the vertical axis

Table B.3. Characteristic load-carrying capacities $F_{1,k}$ of timber beam to timber column connection for load direction according Figure B.3

Angle bracket type	Nails dimensions (mm)	Number of nails		Position of nails shown in Figure[1)]	$F_{1,k}$ kN
		beam	column		
70×70×2,5×55	40 × 4,0	8	16	D.24	5,1
90×90×2,5×65	40 × 4,0	12	16	D.25	5,9
105×105×3×90	40 × 4,0	22	14	D.26	10,8
[1)] see Annex D					

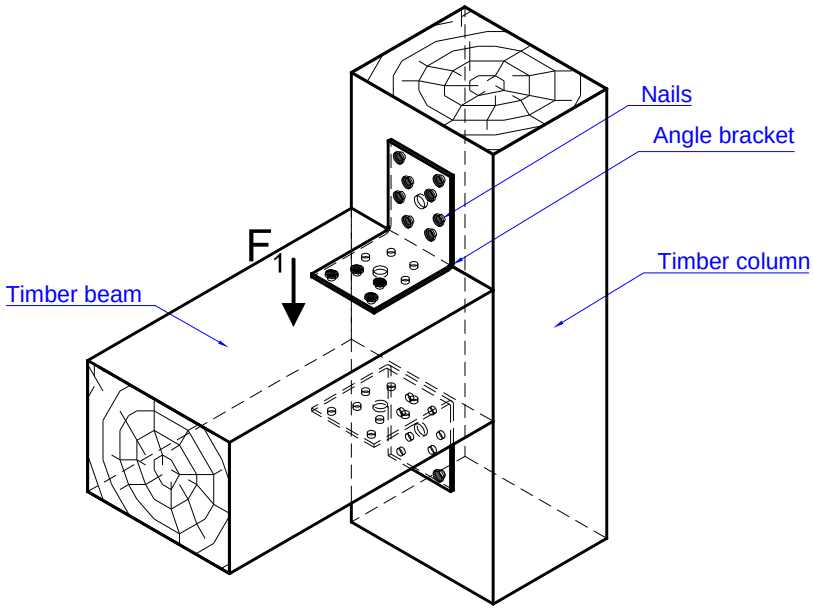


Figure B.3. Typical installation of pair of angle brackets in vertical axis in the timber beam to timber column connections

B.4.4 Timber beam to timber column connections when a pair of angle brackets are placed in the horizontal axis

Table B.4. Characteristic load-carrying capacities $F_{1,k}$ of timber beam to timber column connection for load direction according Figure B.4

Angle bracket type	Nails dimensions (mm)	Number of nails		Position of nails shown in Figure[1)]	$F_{1,k}$ kN
		beam	column		
70×70×2,5×55	40 × 4,0	8	12	D.27	2,7
90×90×2,5×65	40 × 4,0	12	14	D.28	5,8
105×105×3×90	40 × 4,0	14	18	D.29	8,4
[1)] see Annex D					

Then load-carrying capacity is calculated the possibility of splinting caused by the tension perpendicular to the grain, shall be taken into account.

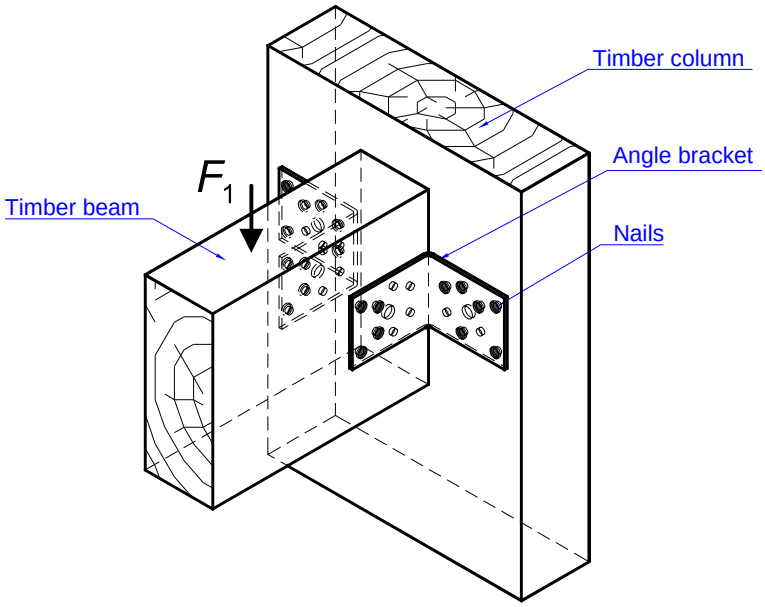


Figure B.4. Typical installation of the angle brackets in the timber beam to timber column connection with a pair of angle brackets in horizontal axis

B.4.5 Timber column to timber beam connections with an angle brackets when a load direction is in the column axis

Table B.5. Characteristic load-carrying capacities $F_{1,k}$ of timber column to timber beam connection for load direction according Figure B.5

Angle bracket type	Nails dimensions (mm)	Number of nails		Position of nails shown in Figure[1)]	$F_{1,k}$ kN
		beam	column		
70×70×2,5×55	40 × 4,0	16	4	D.30	2,4
90×90×2,5×65	40 × 4,0	18	8	D.31	4,9
105×105×3×90	40 × 4,0	22	10	D.32	7,3
[1)] see Annex D					

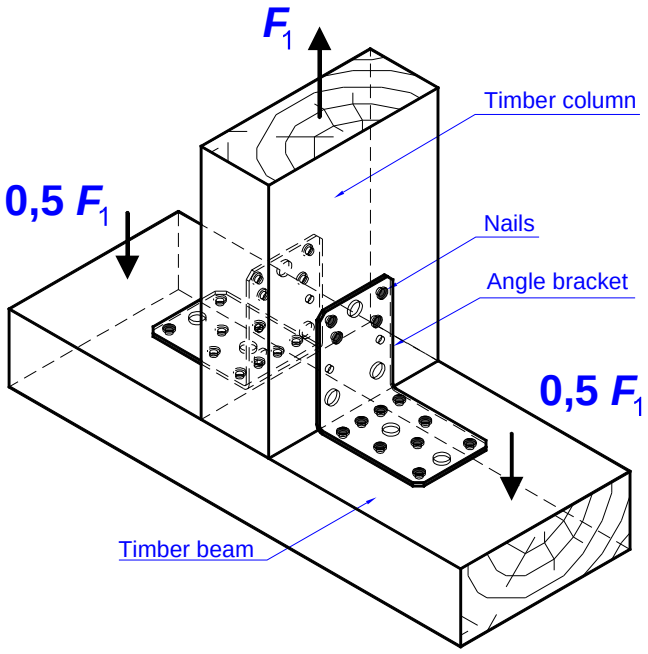


Figure B.5. Typical installation of a pair of angle brackets in the timber column to timber beam connections when a load direction is in the column axis

B.4.6 Timber beam to concrete column connections with an angle brackets

Table B.6. Characteristic load-carrying capacities $F_{1,k}$ of timber beam to concrete column connection for load direction according Figure B.6

Angle bracket type	Nails dimensions (mm)	Number of nails in the beam	Number of anchors in the column	Position of nails and anchors shown in Figure[1)]	$F_{1,k}$ kN
105×105×3×90	40 × 4,0	14	6	D.33	10,9
[1)] see Annex D					

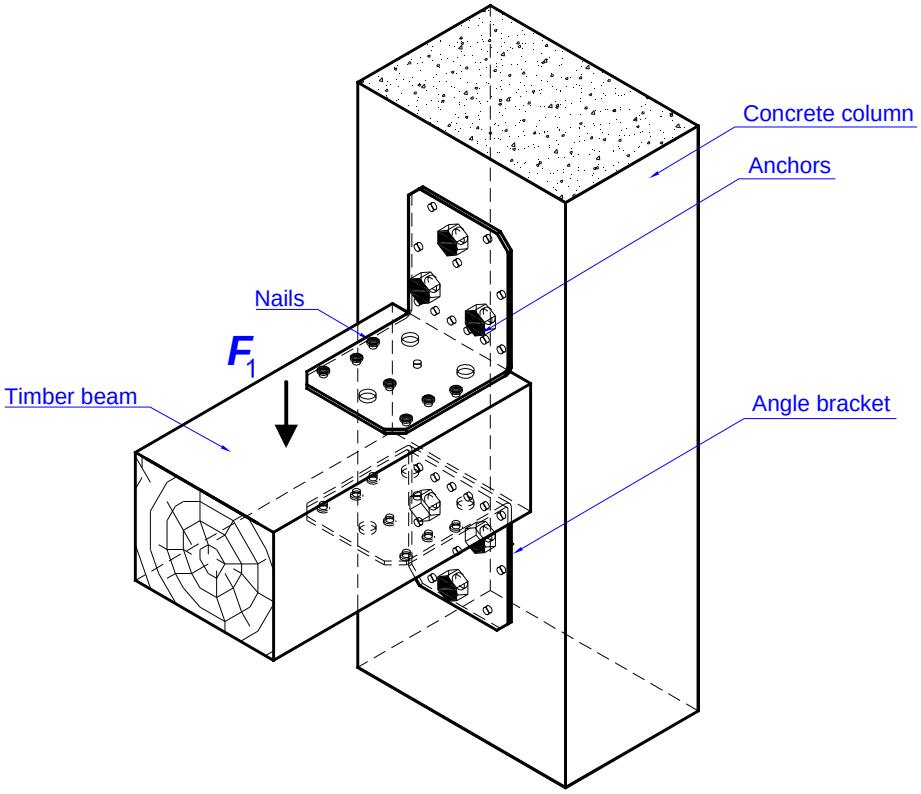


Figure B.6. Typical installation of the angle brackets in the timber beam to concrete column connections

B.4.7 Timber beam to concrete beam T-connections with an angle brackets

Table B.7. Characteristic load-carrying capacities $F_{1,k}$ of timber beam to concrete beam T-connection for load direction according Figure B.7

Angle bracket type	Nails dimensions (mm)	Number of nails in the beam	Number of anchors in the column	Position of nails and anchors shown in Figure[1)]	$F_{1,k}$ kN
105×105×3×90	40 × 4,0	14	6	D.34	8,8
[1)] see Annex D					

Then load-carrying capacity is calculated the possibility of splinting caused by the tension perpendicular to the grain, shall be taken into account.

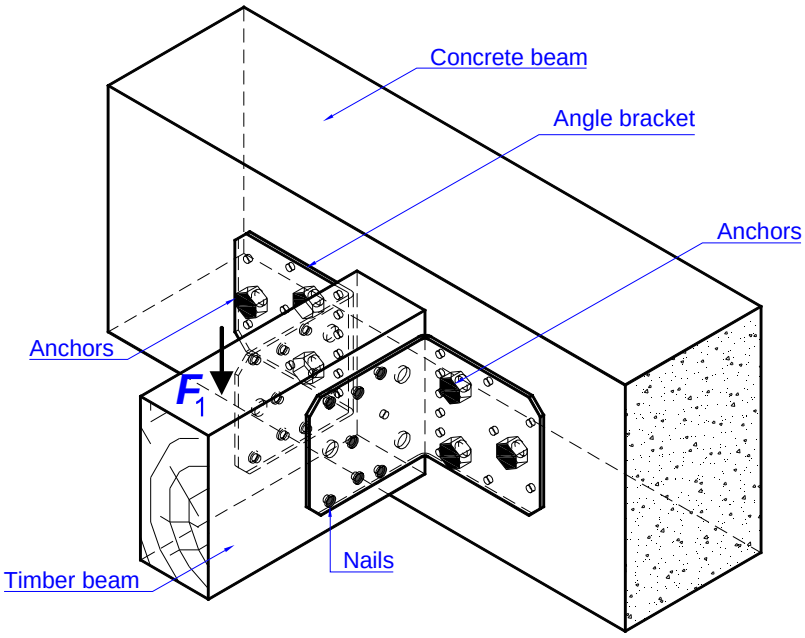


Figure B.7. Typical installation of the angle brackets in the timber beam to concrete beam T-connection

B.4.8 Timber beam to concrete beam cross-connection with an angle brackets

Table B.8. Characteristic load-carrying capacities $F_{1,k}$ of timber beam to concrete beam cross-connection for load direction according Figure B.8

Angle bracket type	Nails dimensions (mm)	Number of nails in the beam	Number of anchors in the column	Position of nails and anchors shown in Figure[1)]	$F_{1,k}$ kN
105×105×3×90	40 × 4,0	22	2	D.35	7,3
[1)] see Annex D					

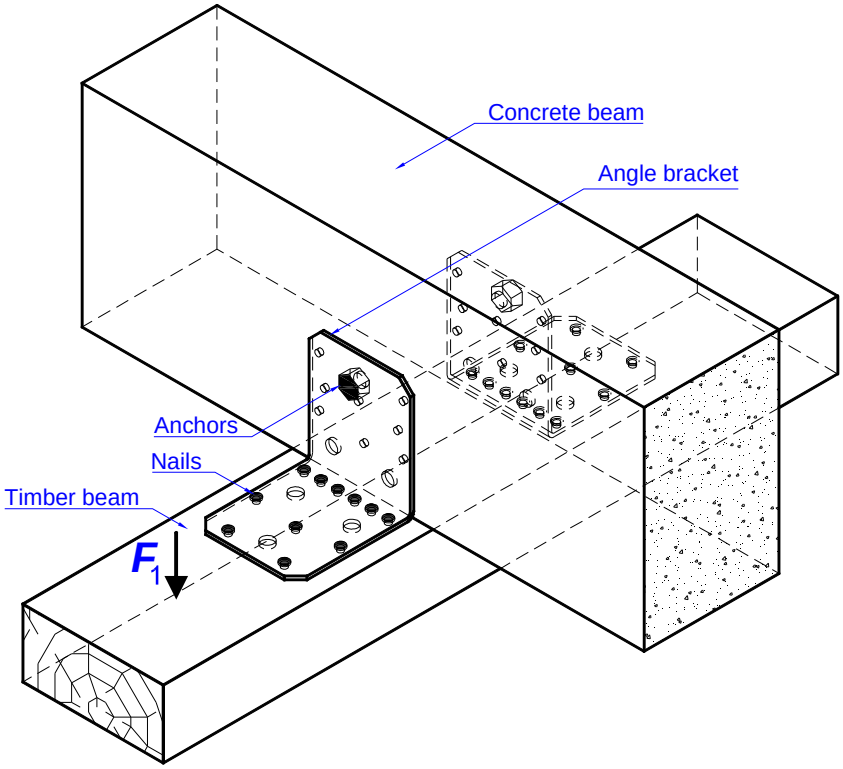


Figure B.8. Typical installation of the angle brackets in the timber beam to concrete beam cross-connection

B.4.9 Timber beam to timber beam connections with angle brackets with a rib (ribs)

Table B.9. Characteristic load-carrying capacities $F_{1,k}$ of timber beam to timber beam connection for load direction according Figure B.9

Angle bracket type	Nails dimensions (mm)	Number of nails		Position of nails shown in Figure[1)]	$F_{1,k}$ kN
		Upper beam	Bottom beam		
Angle brackets with a rib					
90×90×2,5×65	40 × 4,0	16	20	D.36	4,9
105×105×3×90	40 × 4,0	20	28	D.37	7,3
Angle brackets with a two ribs					
70×70×2,5×55	40 × 4,0	12	16	D.38	4,9
90×55×2,5×55	40 × 4,0	8	8	D.39	2,4
[1)] see Annex D					

Then load-carrying capacity is calculated the possibility of splinting caused by the tension perpendicular to the grain, shall be taken into account

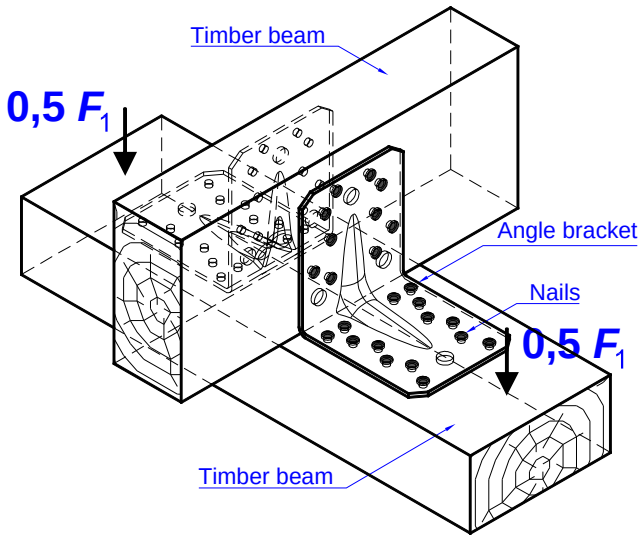


Figure B.9. Typical installation of the angle brackets with a rib (ribs) in the timber beam to timber beam connection

B.4.10 Timber beam to timber column connections with an angle bracket with a rib

Table B.10. Characteristic load-carrying capacities $F_{1,k}$ of timber beam to timber column connection for load direction according Figure B.10

Angle bracket type	Nails dimensions (mm)	Number of nails		Position of nails shown in Figure[1)]	$F_{1,k}$ kN
		beam	column		
Angle brackets with a rib					
90×90×2,5×65	40 × 4,0	6	10	D.40	5,2
105×105×3×90	40 × 4,0	8	14	D.41	7,5
[1)] see Annex D					

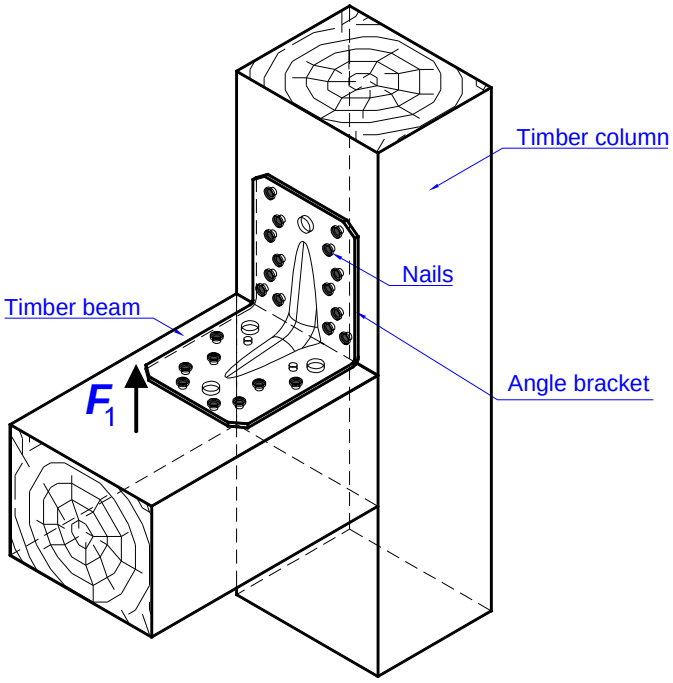


Figure B.10. Typical installation of the angle bracket with a rib in the timber beam to timber column connection

B.4.11 Timber beam to concrete column connections with an angle bracket with a rib

Table B.11. Characteristic load-carrying capacities $F_{1,k}$ of timber beam to concrete column connection for load direction according Figure B.11

Angle bracket type	Nails dimensions (mm)	Number of nails in the beam	Number of anchors in the column	Position of nails and anchors shown in Figure[1)]	$F_{1,k}$ kN
Angle bracket with a rib					
105×105×3×90	40 × 4,0	8	3	D.42	7,5
[1)] see Annex D					

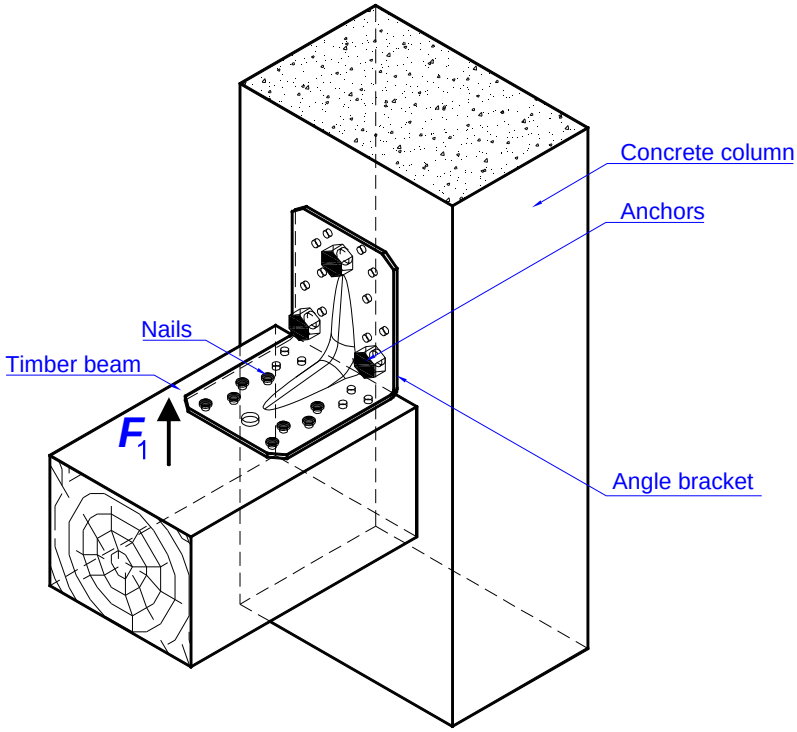


Figure B.11. Typical installation of the angle bracket with a rib in the of timber beam to concrete column connection

ANNEX C

Angle brackets dimensions

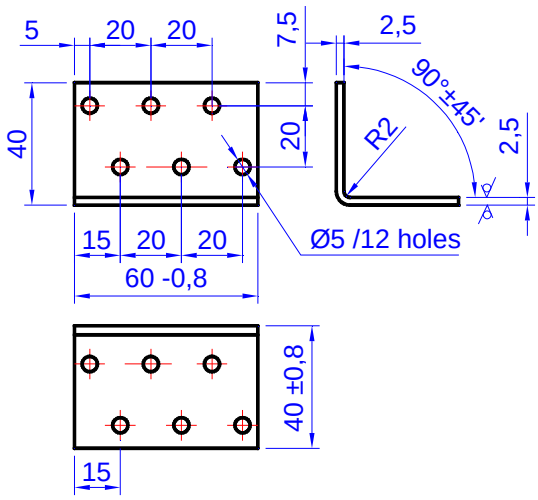


Figure C.1. Angle bracket 40×40×2.5×60

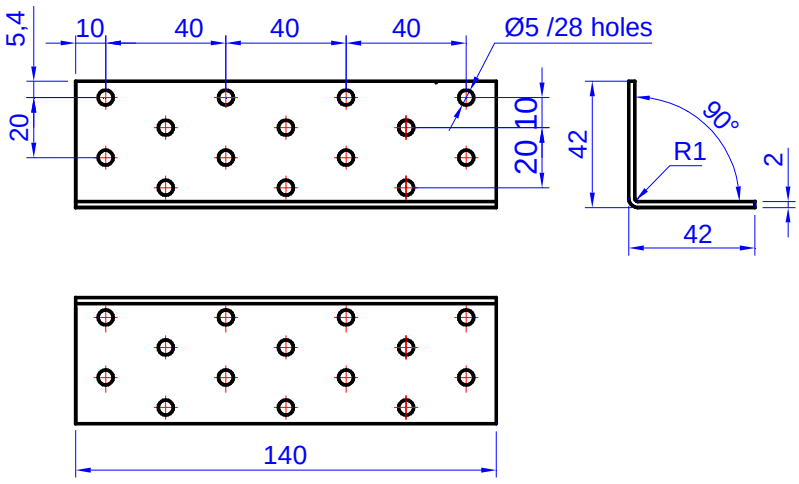


Figure C.2. Angle bracket 40×40×2×140

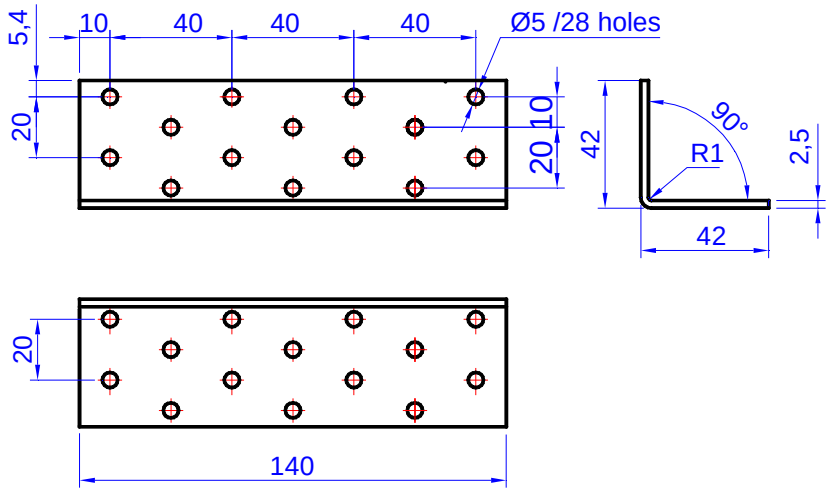


Figure C.3. Angle bracket 40×40×2.5×140

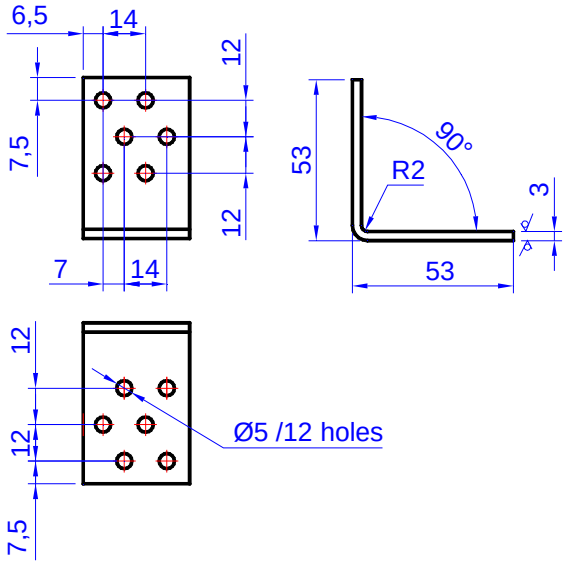


Figure C.4. Angle bracket 53×53×3×35

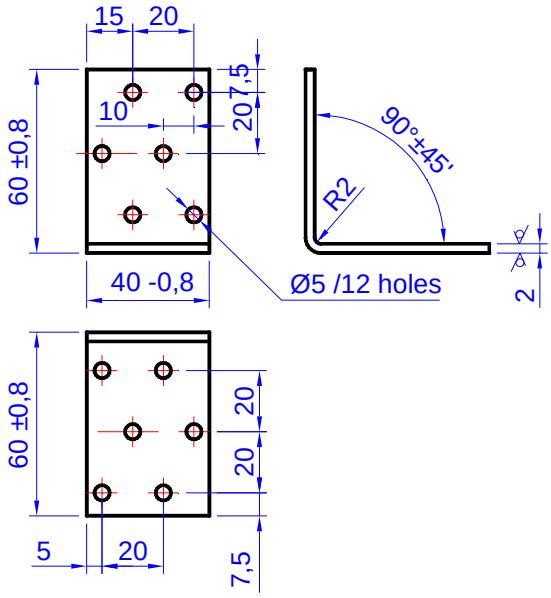


Figure C.5. Angle bracket 60×60×2×40

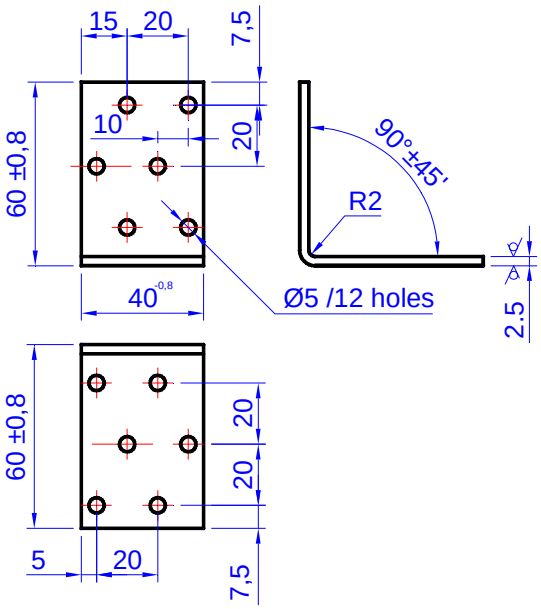


Figure C.6. Angle bracket 60×60×2.5×40

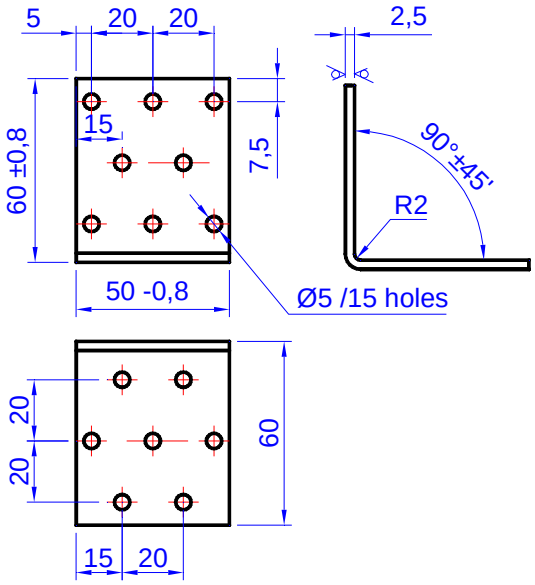


Figure C.7. Angle bracket 60×60×2.5×50

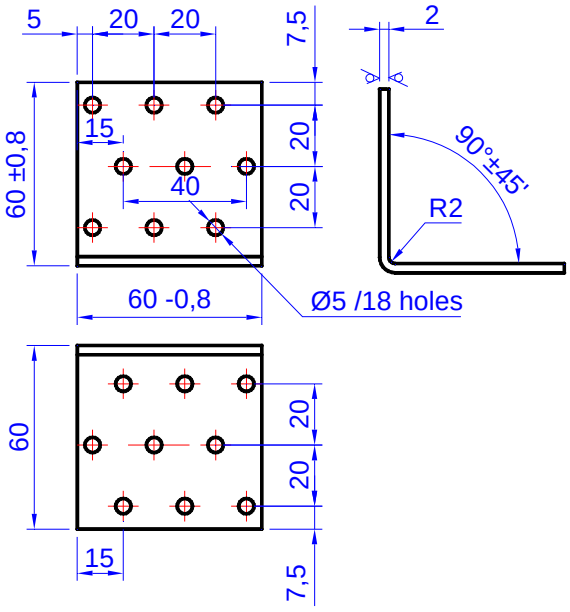


Figure C.8. Angle bracket 60×60×2×60

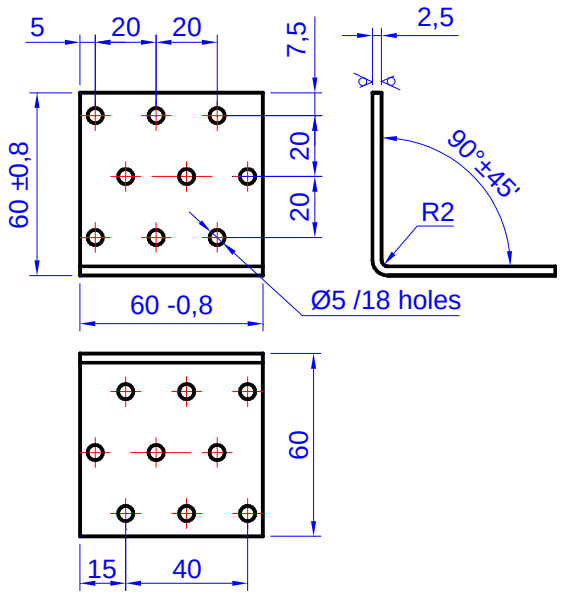


Figure C.9. Angle bracket 60×60×2.5×60

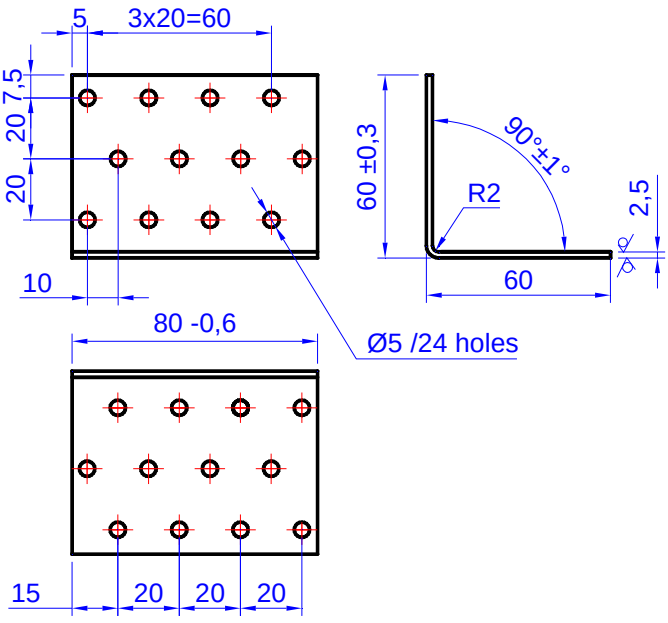


Figure C.10. Angle bracket 60×60×2.5×80

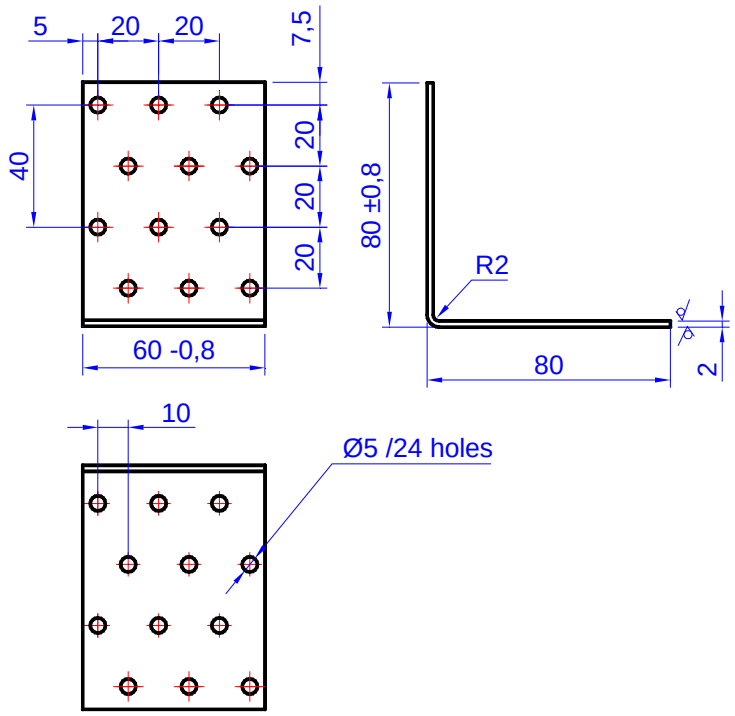


Figure C.11. Angle bracket 80×80×2×60

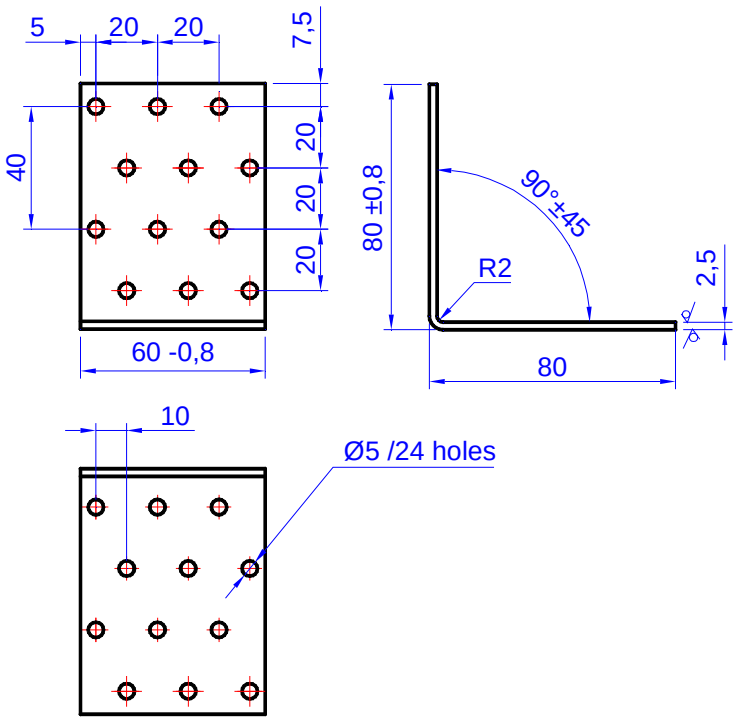


Figure C.12. Angle bracket 80×80×2.5×60

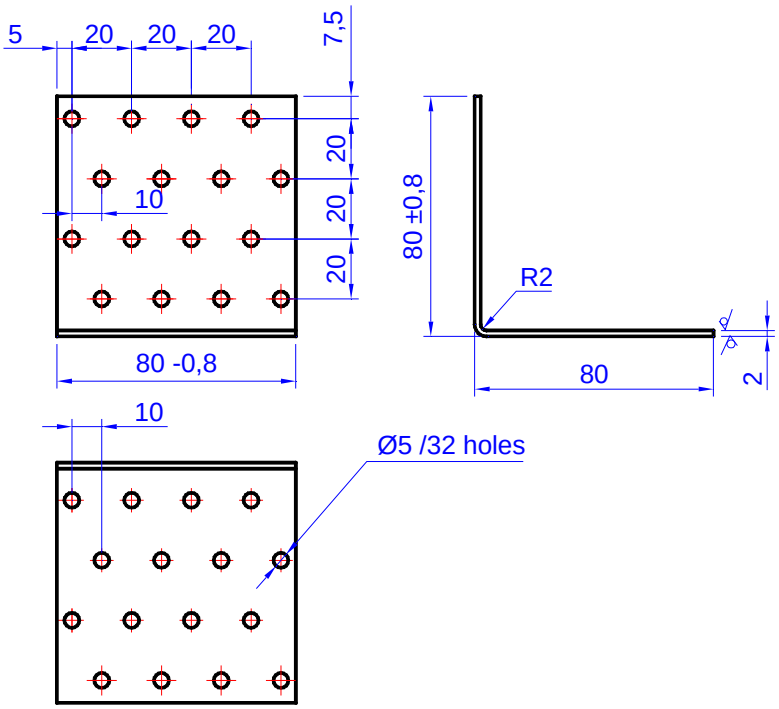


Figure C.13. Angle bracket 80×80×2×80

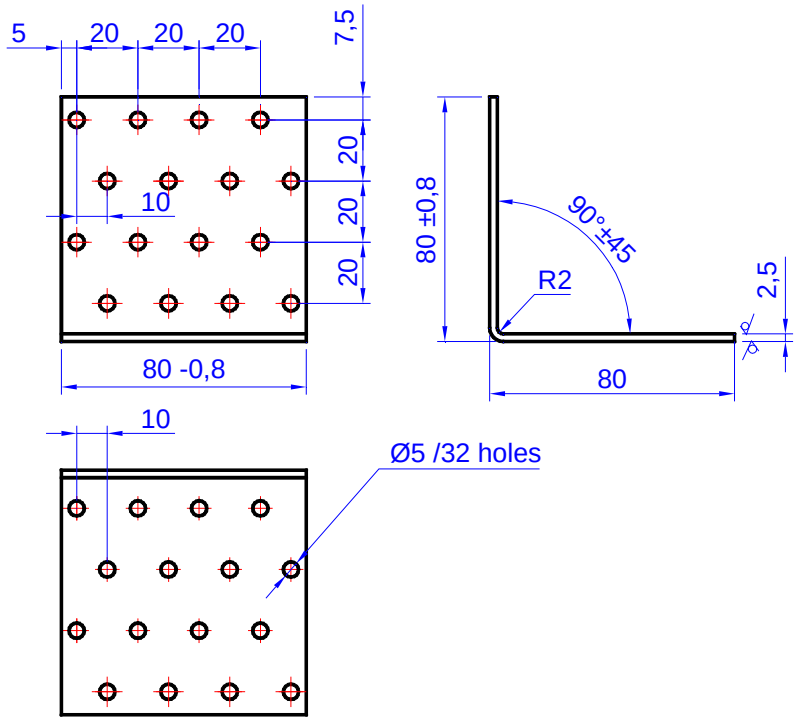


Figure C.14. Angle bracket 80×80×2.5×80

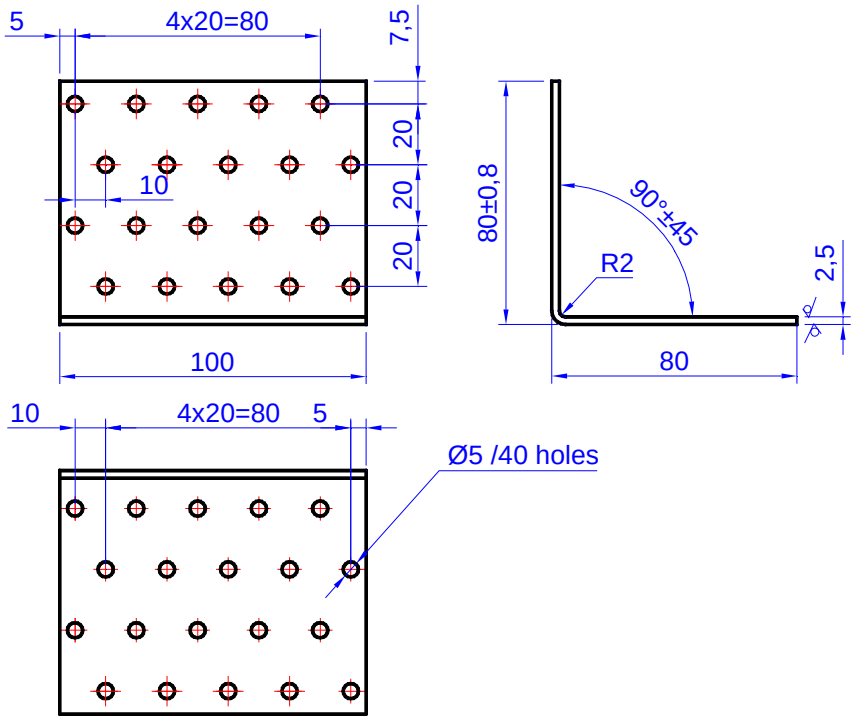


Figure C.15. Angle bracket 80×80×2.5×100

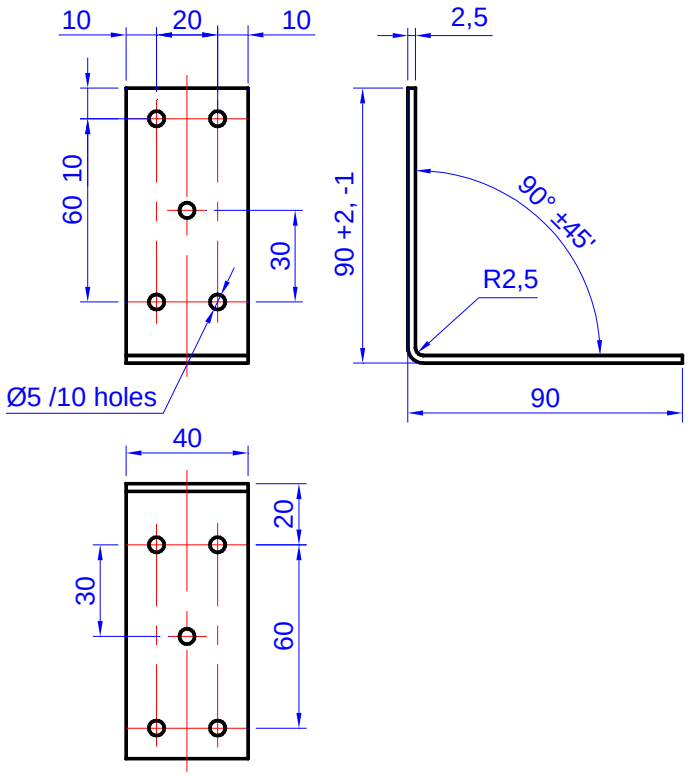


Figure C.16. Angle bracket 90×90×2.5×40

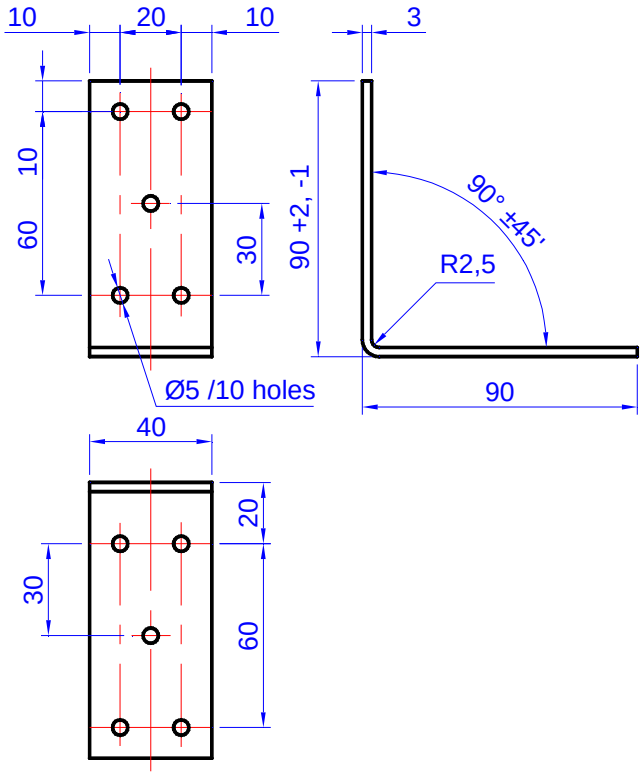


Figure C.17. Angle bracket 90×90×3×40

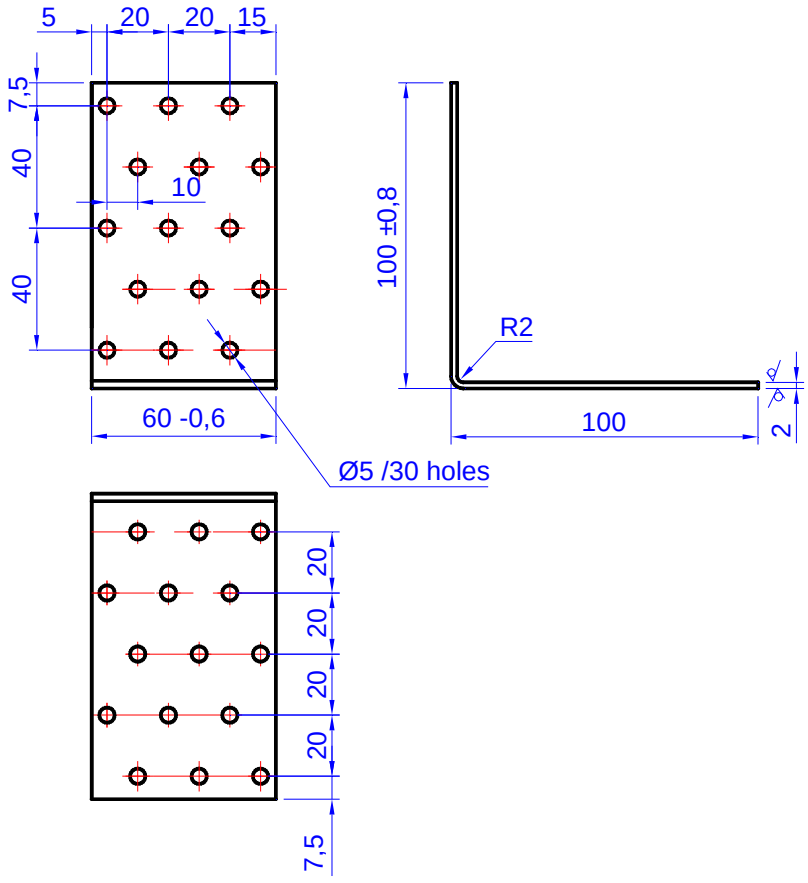


Figure C.18. Angle bracket 100×100×2×60

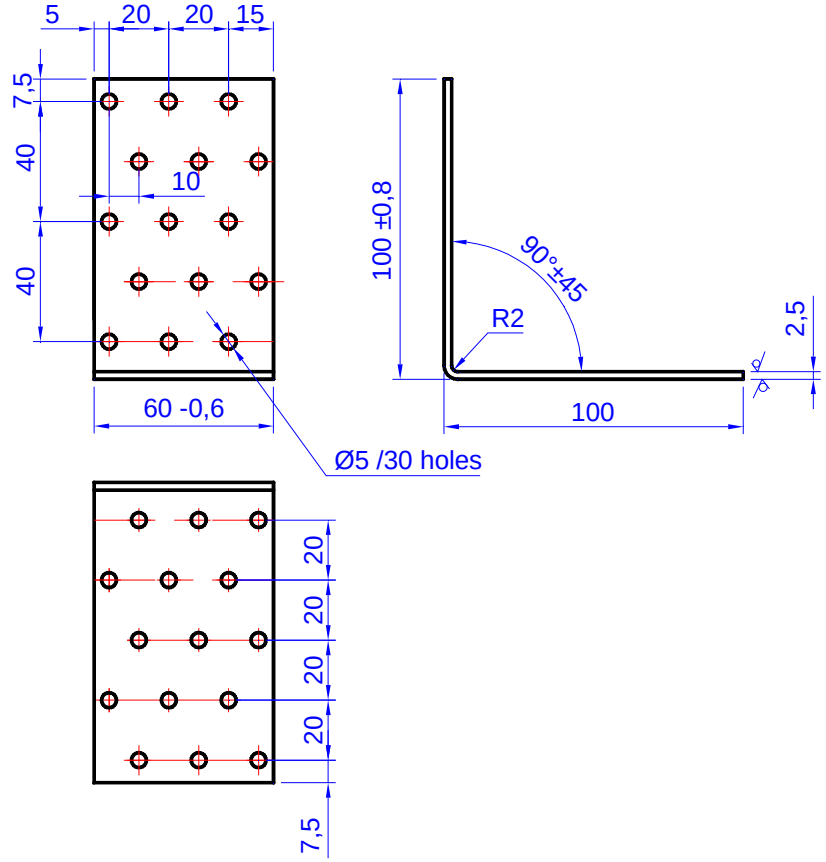


Figure C.19. Angle bracket 100×100×2.5×60

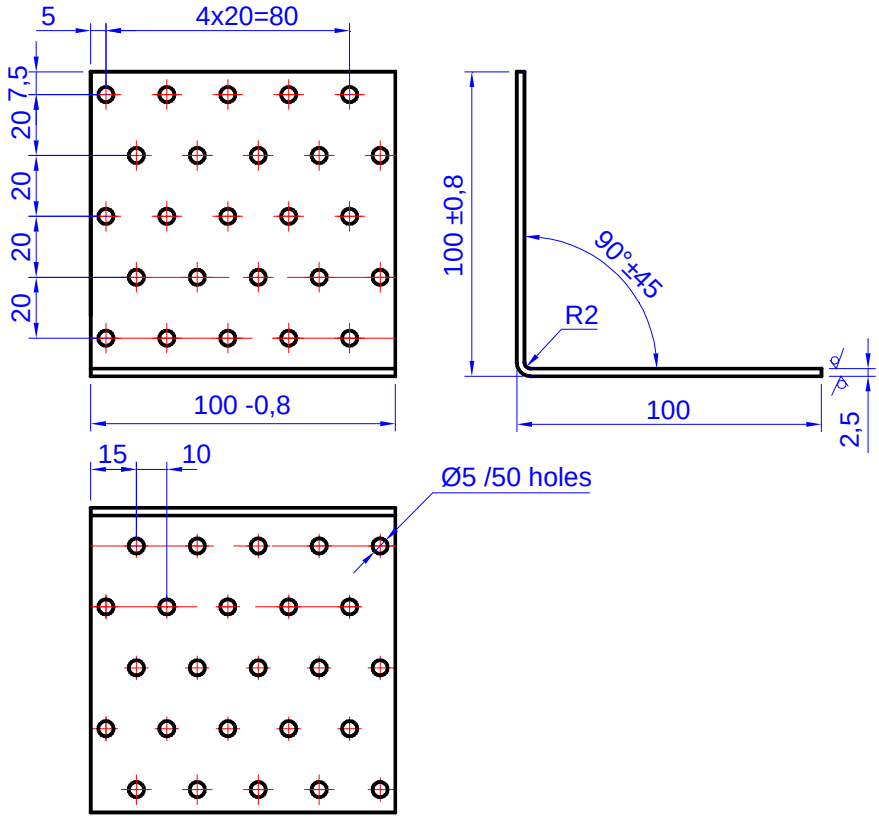


Figure C.20. Angle bracket 100×100×2.5×100

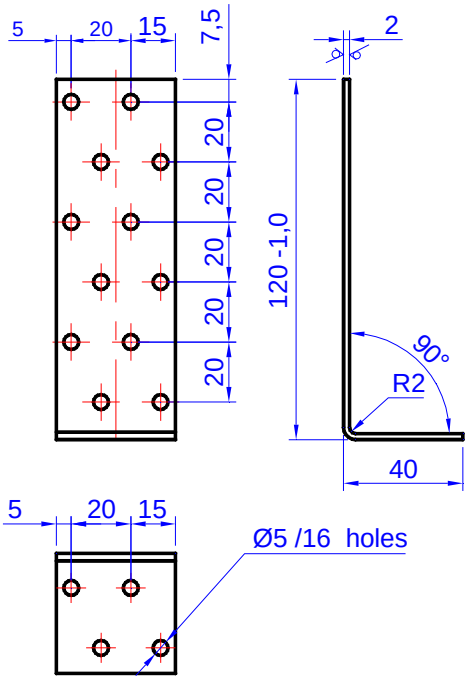


Figure C.21. Angle bracket 120×40×2×40

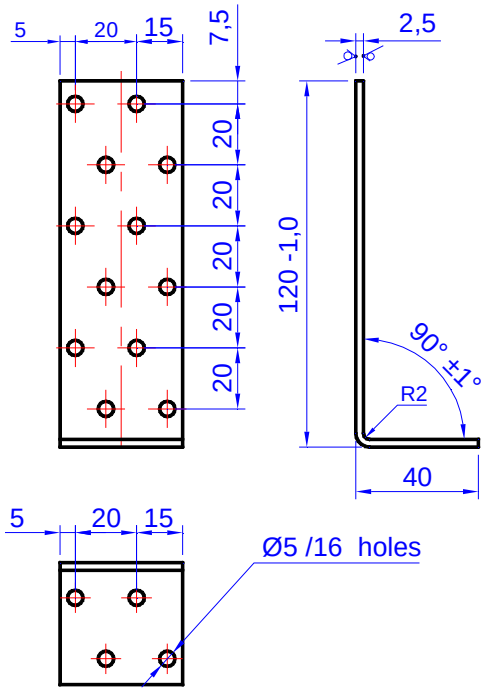


Figure C.22. Angle bracket 120×40×2.5×40

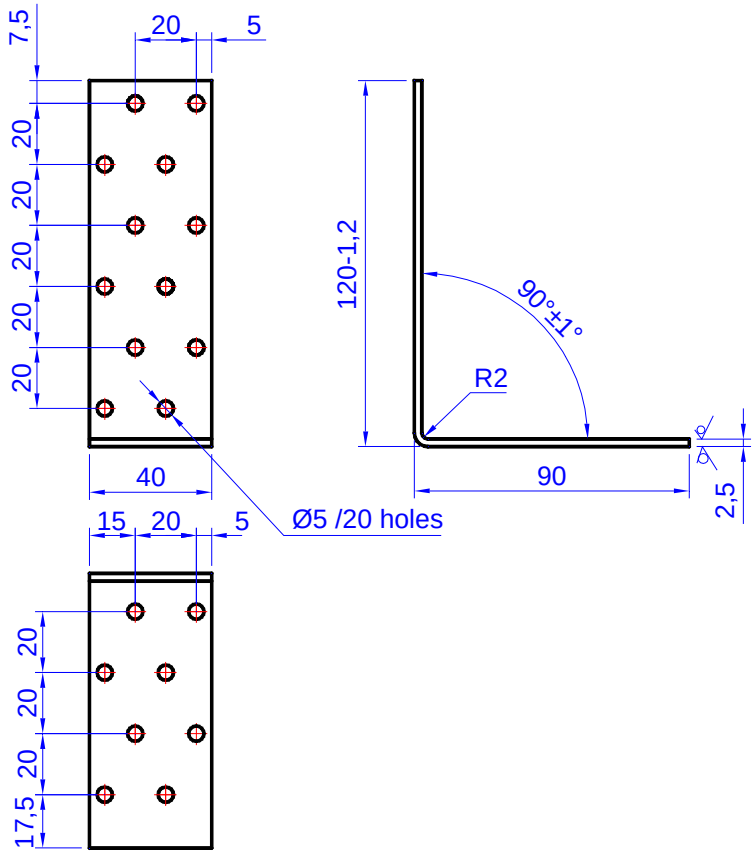


Figure C.23. Angle bracket 120×90×2.5×40

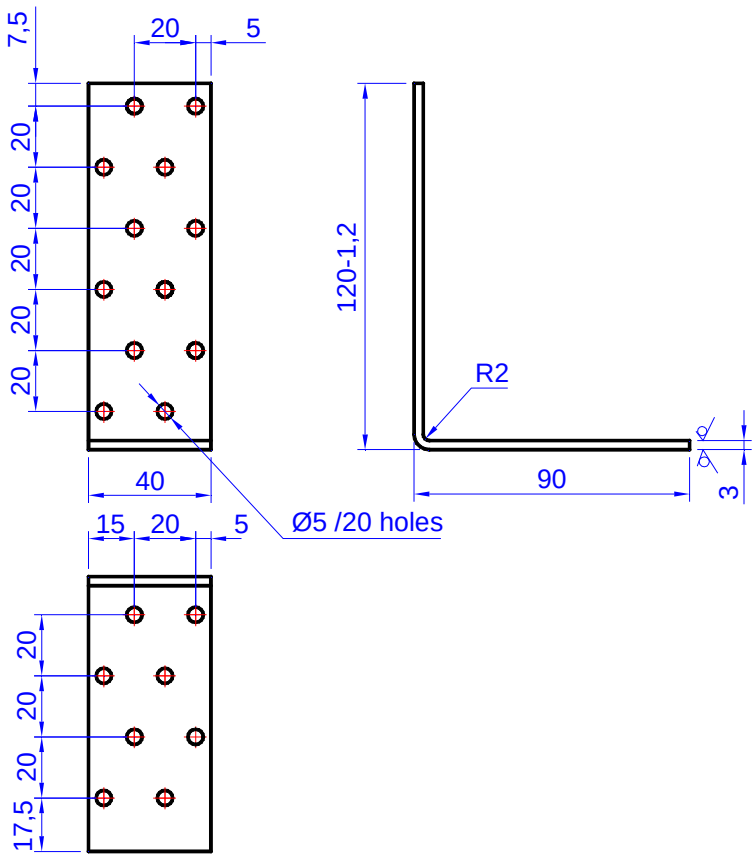


Figure C.24. Angle bracket 120×90×3×40

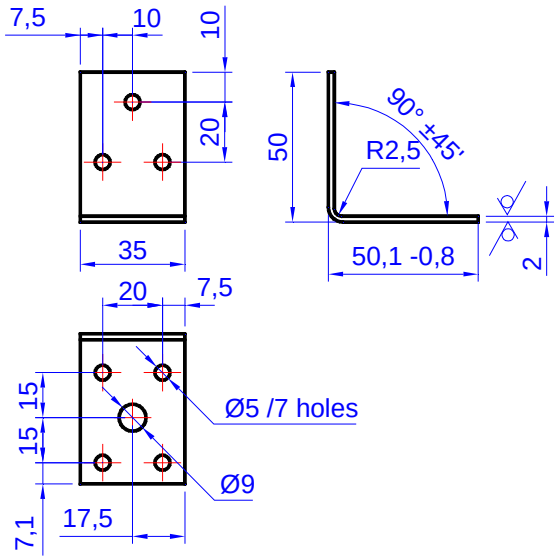


Figure C.25. Angle bracket 50×50×2×35

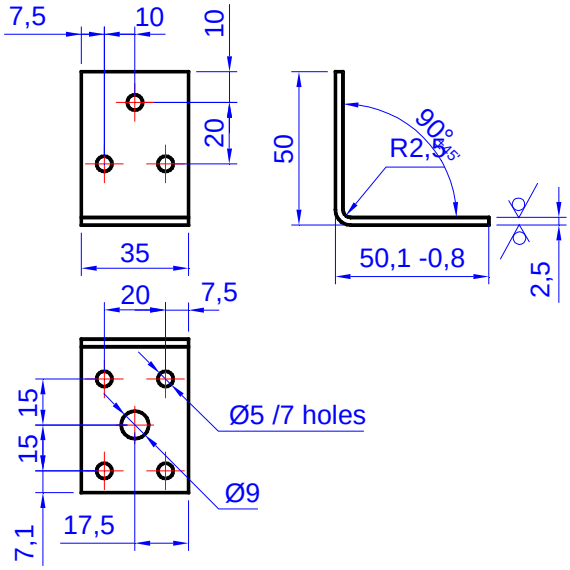


Figure C.26. Angle bracket 50×50×2.5×35

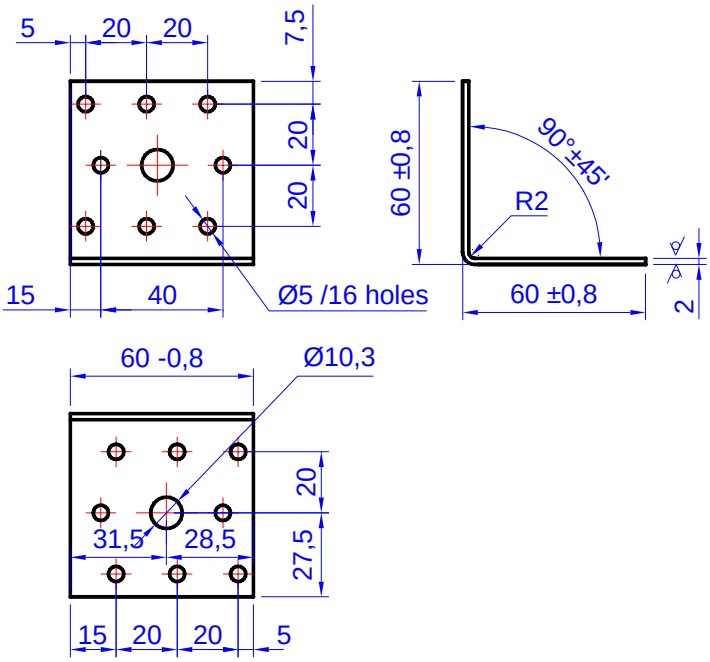


Figure C.27. Angle bracket 60×60×2×60

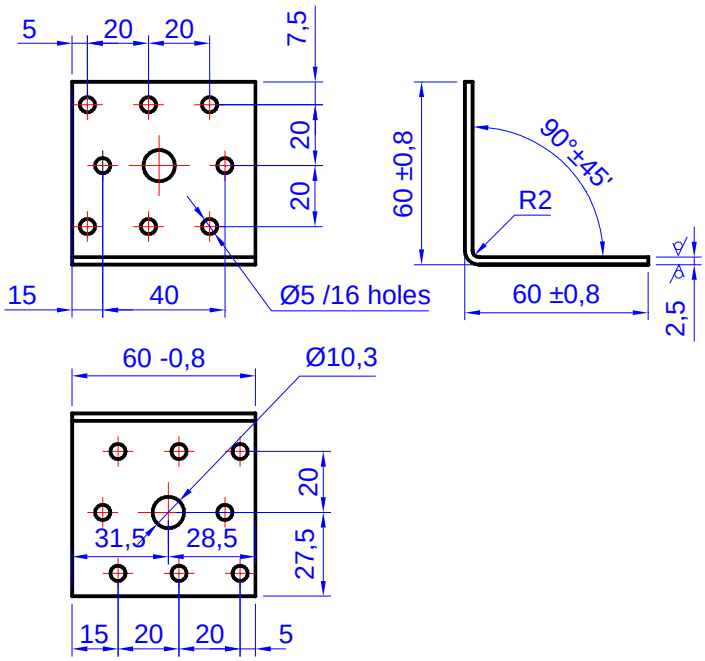


Figure C.28. Angle bracket 60×60×2.5×60

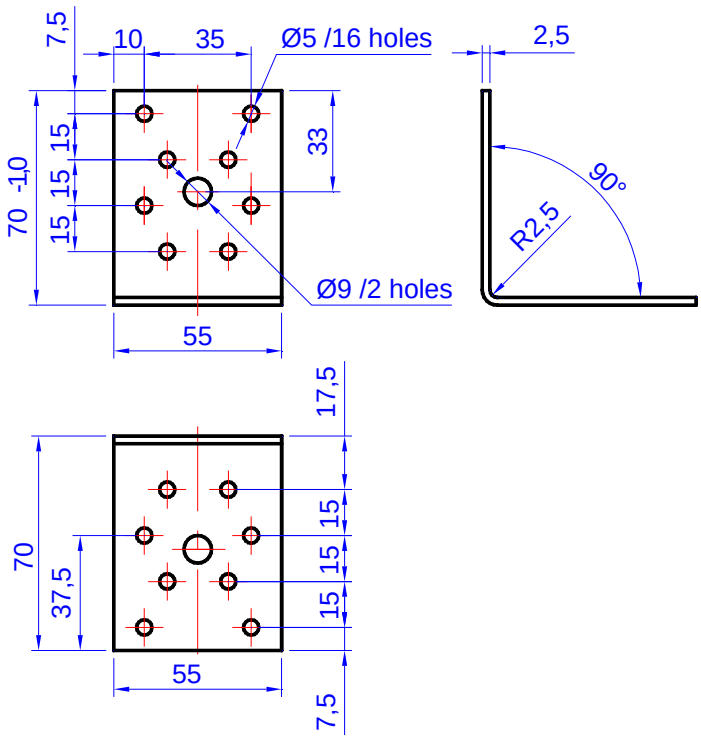


Figure C.29. Angle bracket 70×70×2.5×55

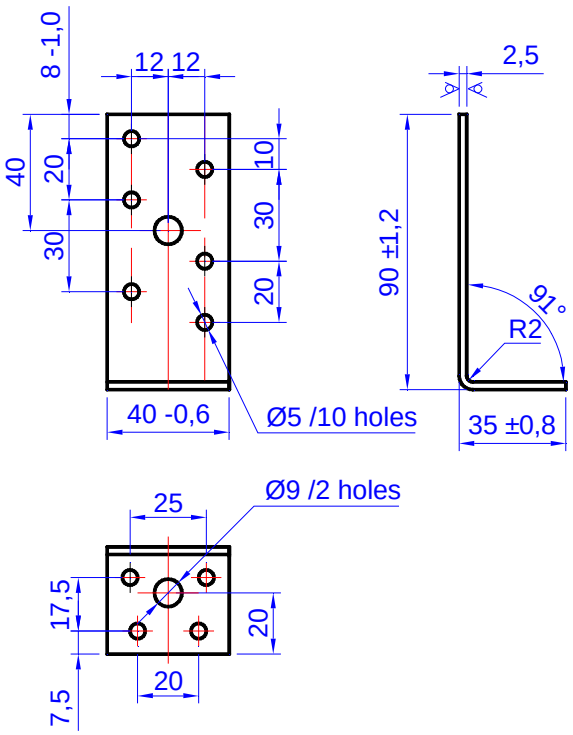


Figure C.30. Angle bracket 90×35×2.5×40

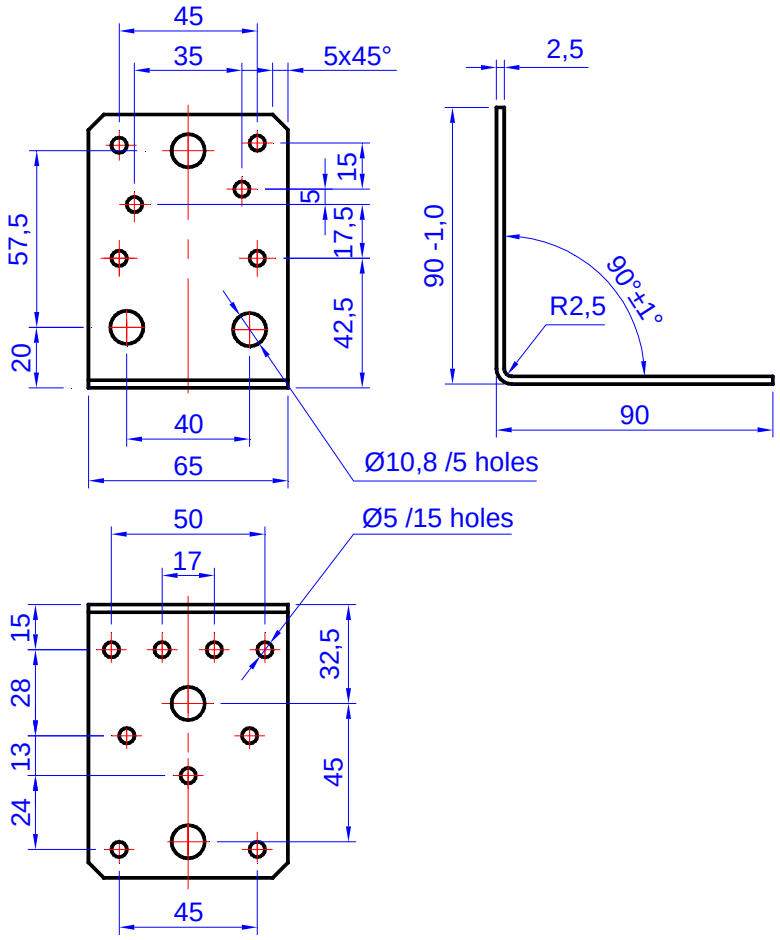


Figure C.31. Angle bracket 90×90×2.5×65

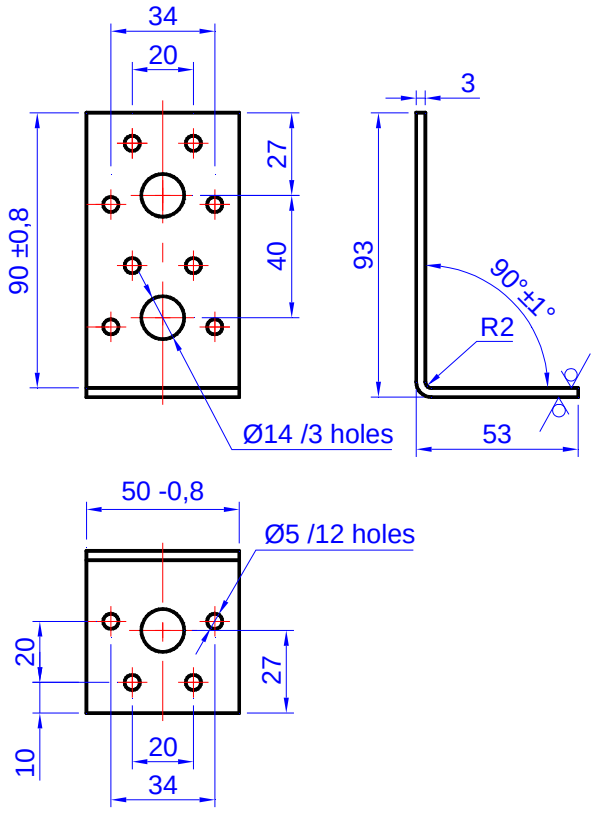


Figure C.32. Angle bracket 93×53×3×50

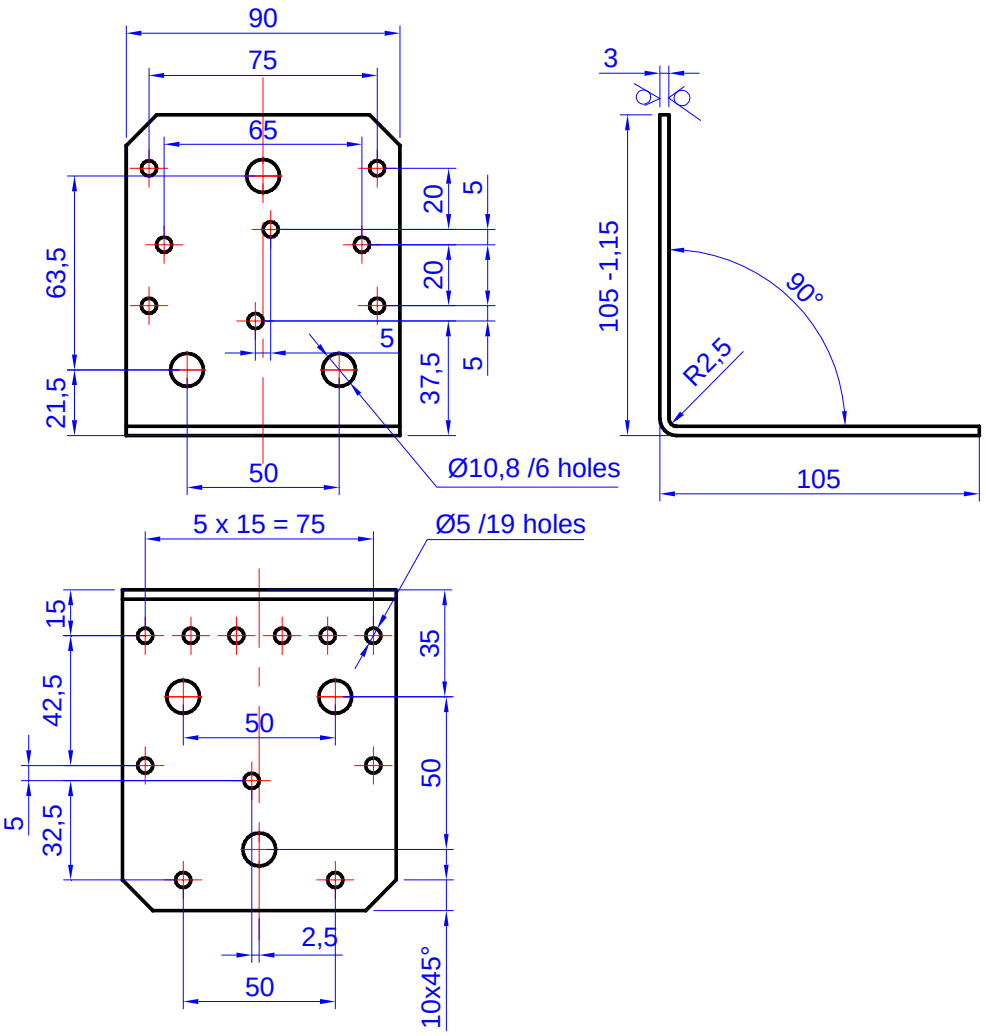


Figure C.33. Angle bracket 105×105×3×90

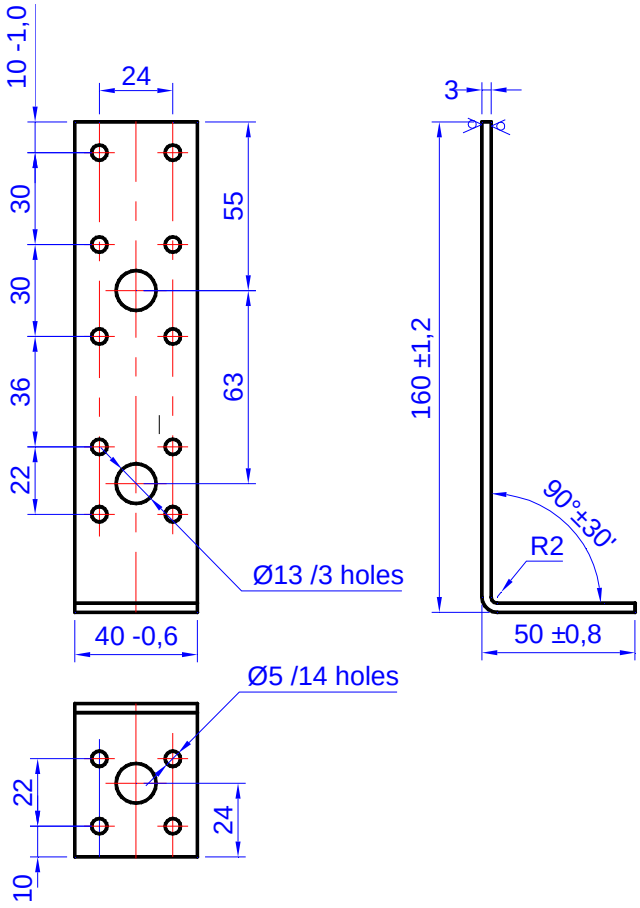


Figure C.34. Angle bracket 160×50×3×40

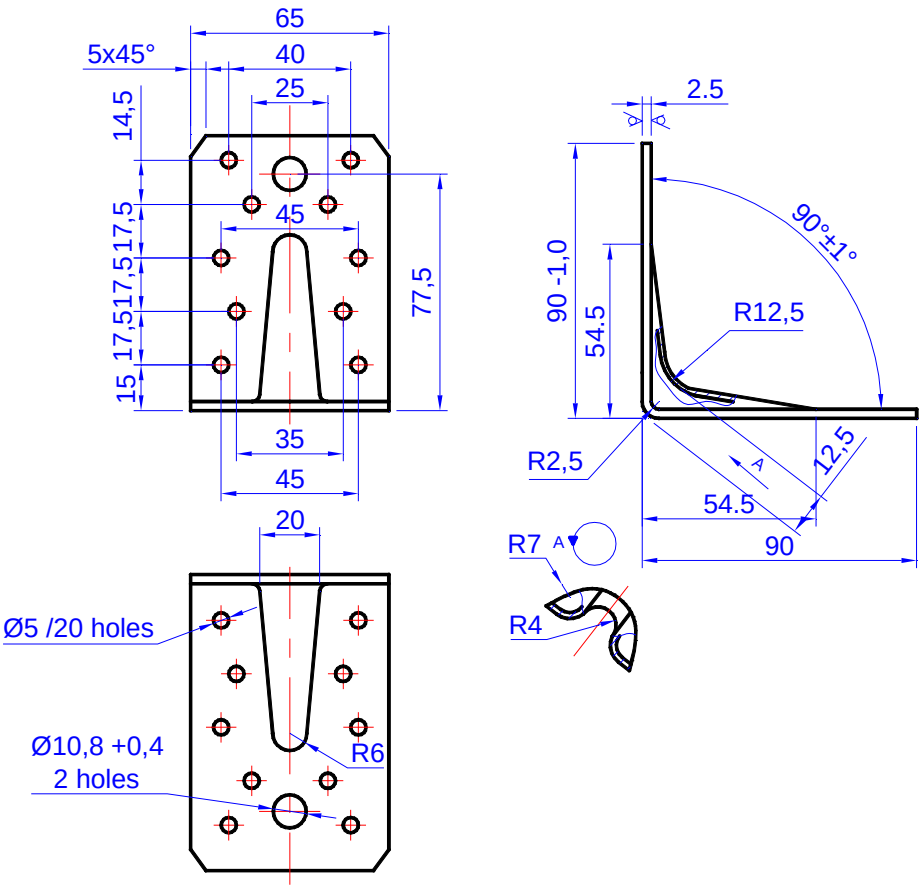


Figure C.35. Angle bracket with a rib 90×90×2.5×65

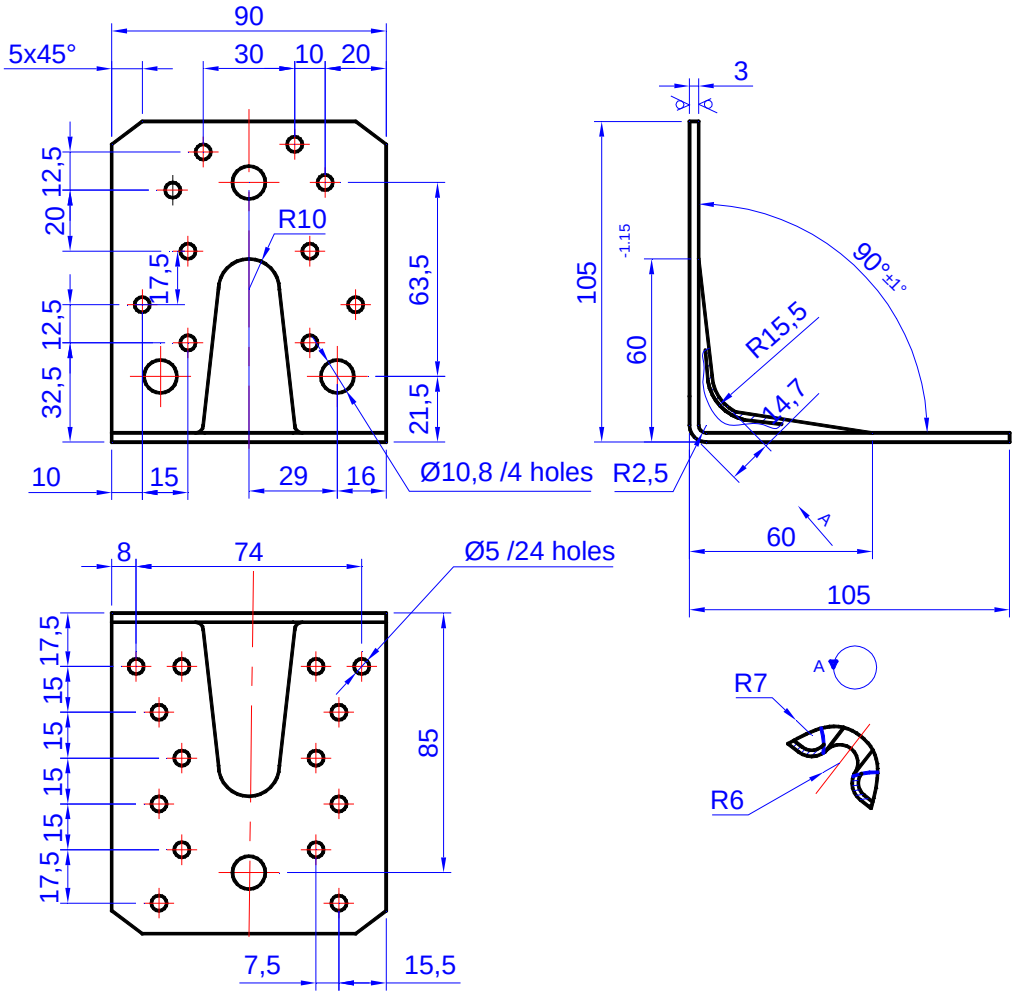


Figure C.36. Angle bracket with a rib 105×105×3×90

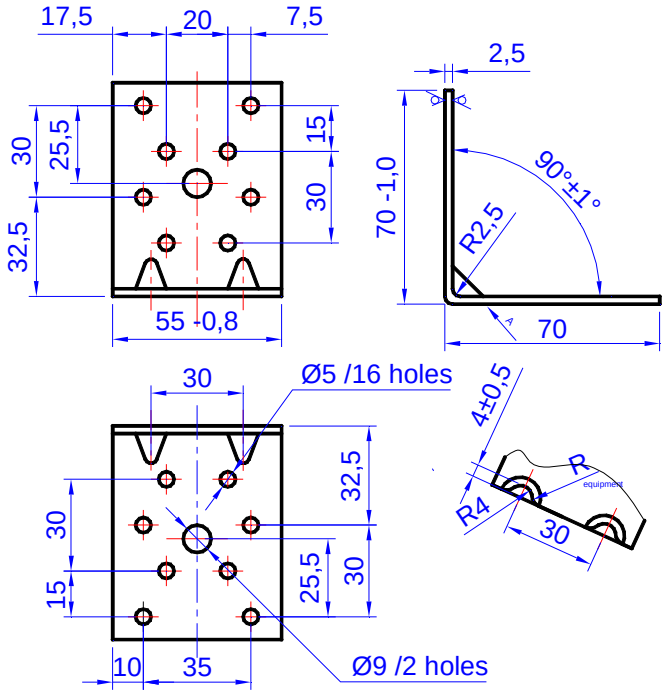


Figure C.37. Angle bracket with a two ribs 70×70×2.5×55

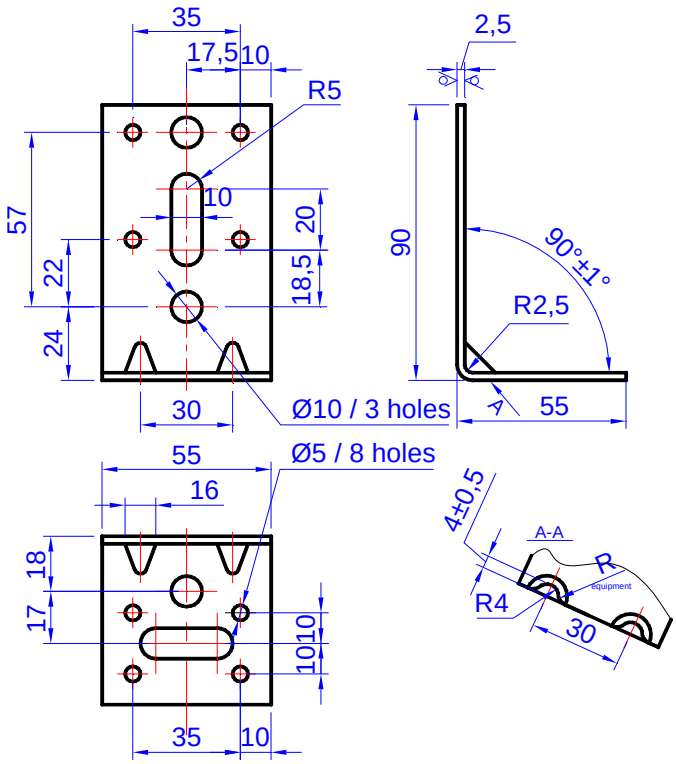


Figure C.38. Angle bracket with a two ribs 90×55×2.5×55

ANNEX D

Number and positions of nails and anchors in the angle brackets

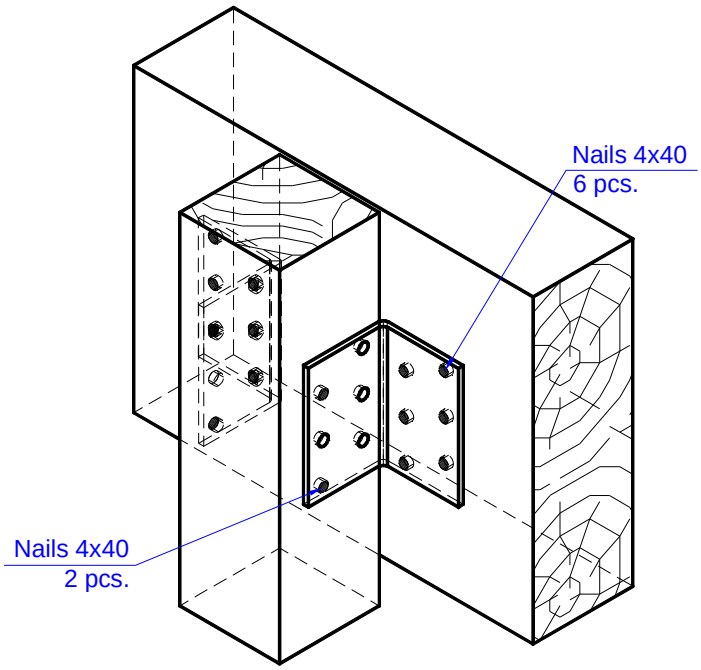


Figure D.1. Number and position of nails in the angle bracket 40×40×2.5×60

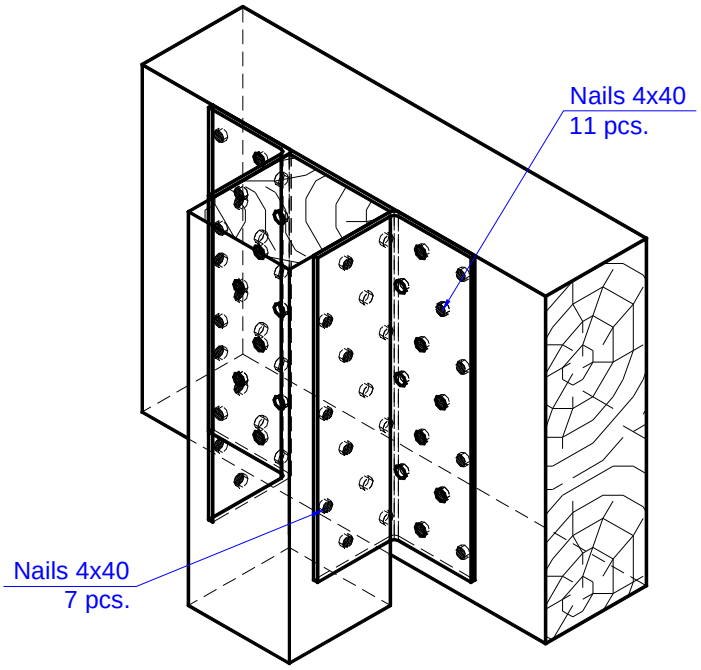


Figure D.2. Number and position of nails in the angle brackets 40×40×2×140 and 40×40×2.5×140

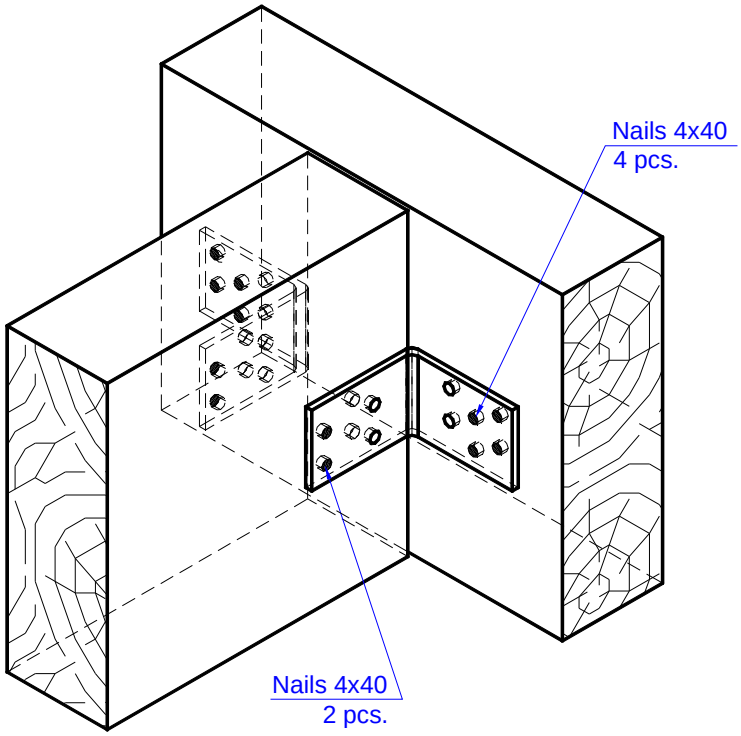


Figure D.3. Number and position of nails in the angle bracket 53×53×3×35

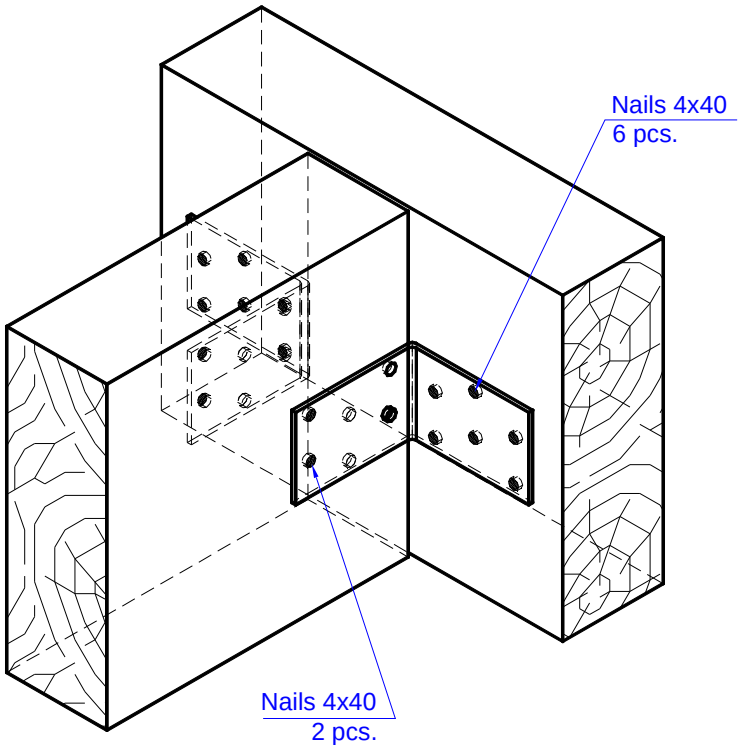


Figure D.4. Number and position of nails in the angle brackets 60×60×2×40 and 60×60×2.5×40

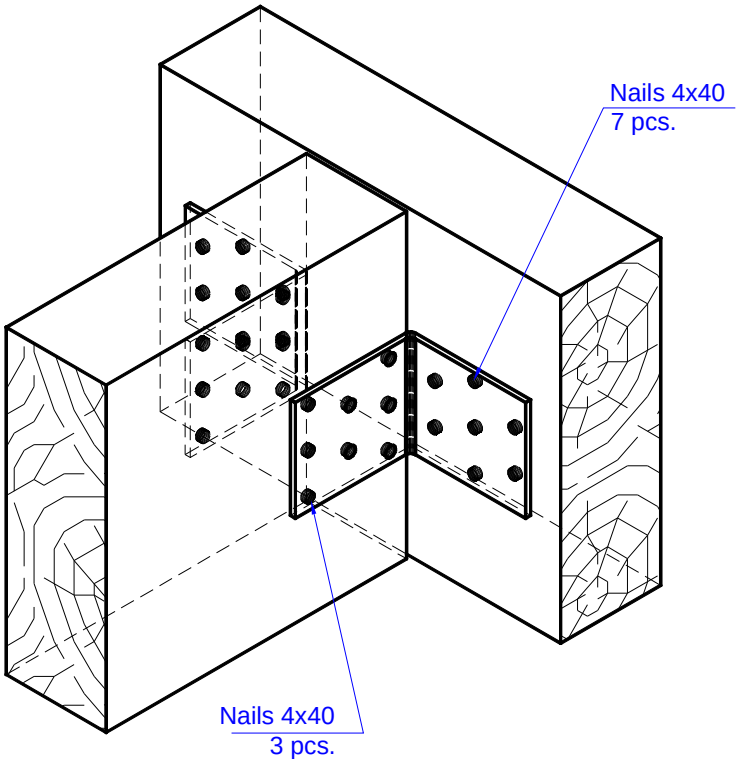


Figure D.5. Number and position of nails in the angle bracket 60×60×2.5×50

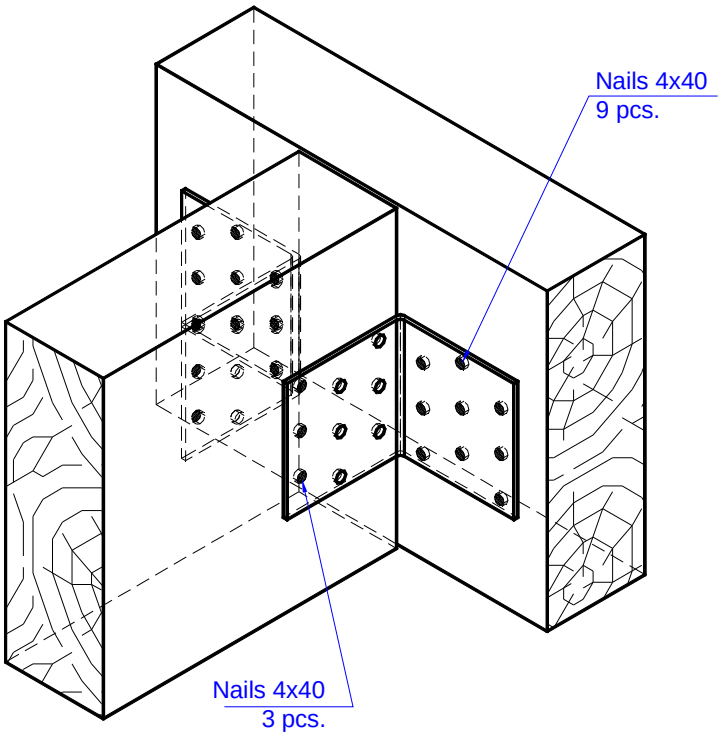


Figure D.6. Number and position of nails in the angle brackets 60×60×2×60 and 60×60×2.5×60

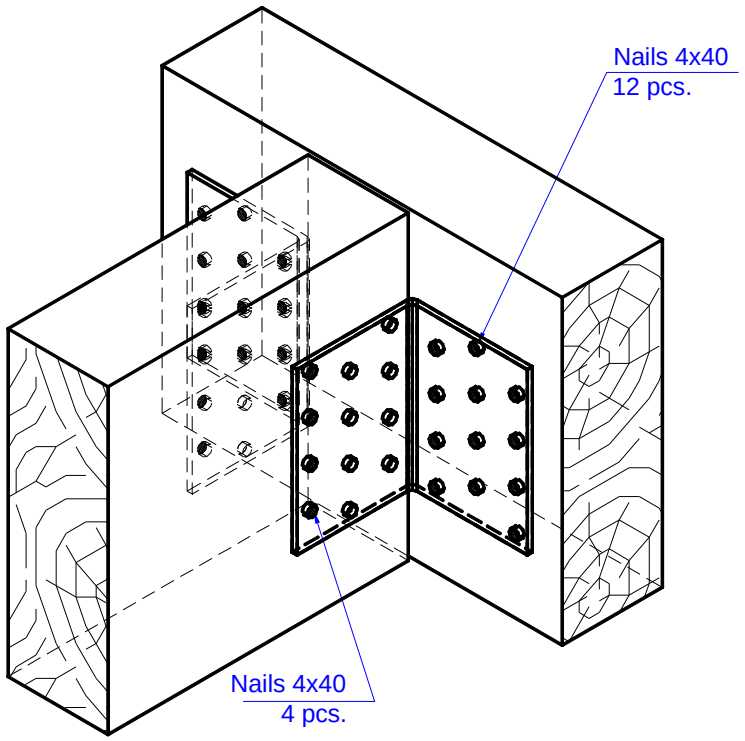


Figure D.7. Number and position of nails in the angle bracket 60×60×2.5×80

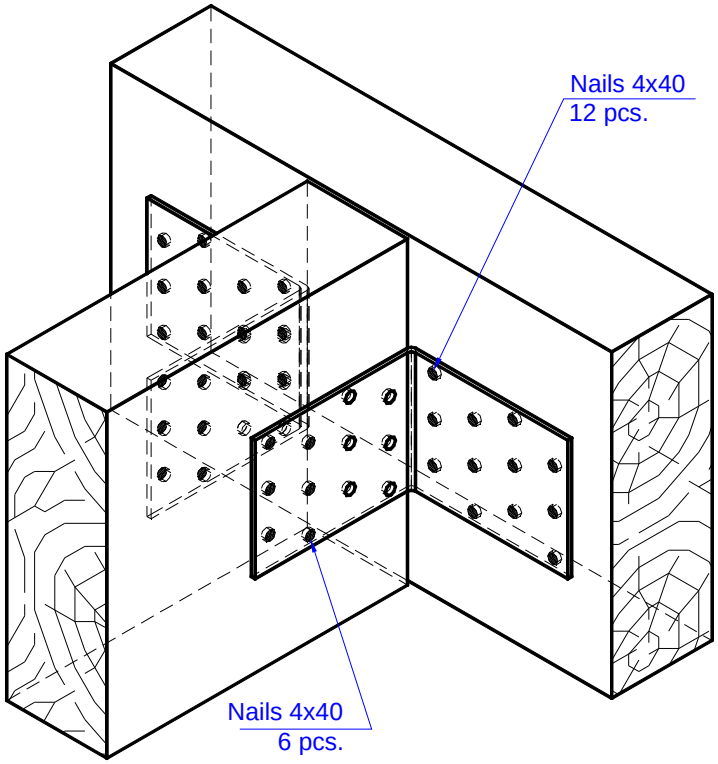


Figure D.8. Number and position of nails in the angle brackets 80×80×2×60 and 80×80×2.5×60

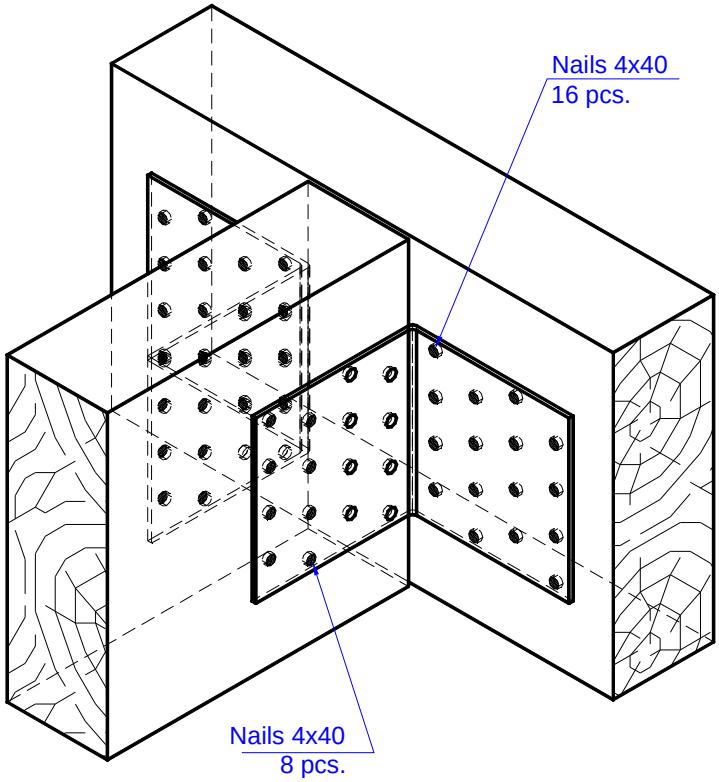


Figure D.9. Number and position of nails in the angle brackets 80×80×2×80 and 80×80×2.5×80

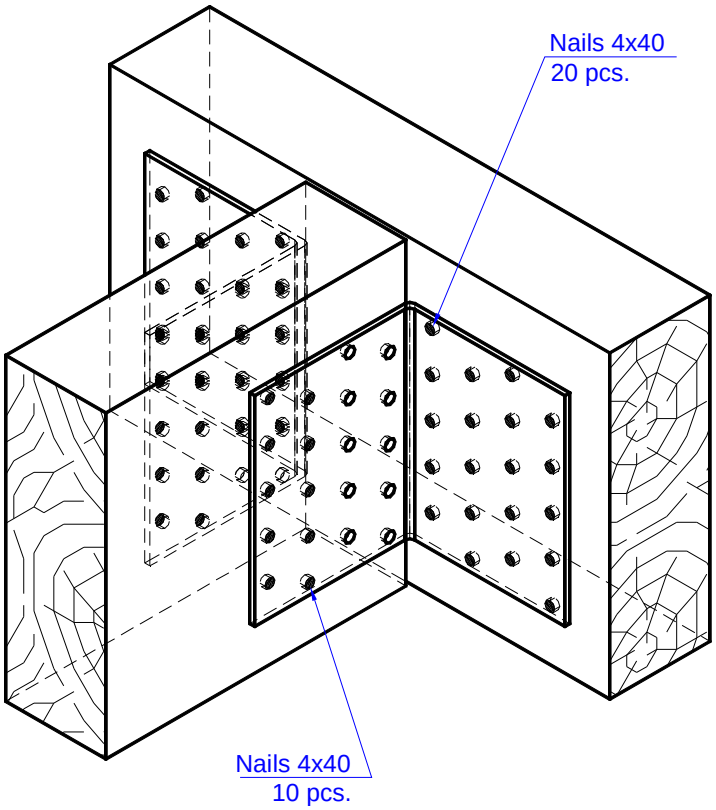


Figure D.10. Number and position of nails in the angle bracket 80×80×2.5×100

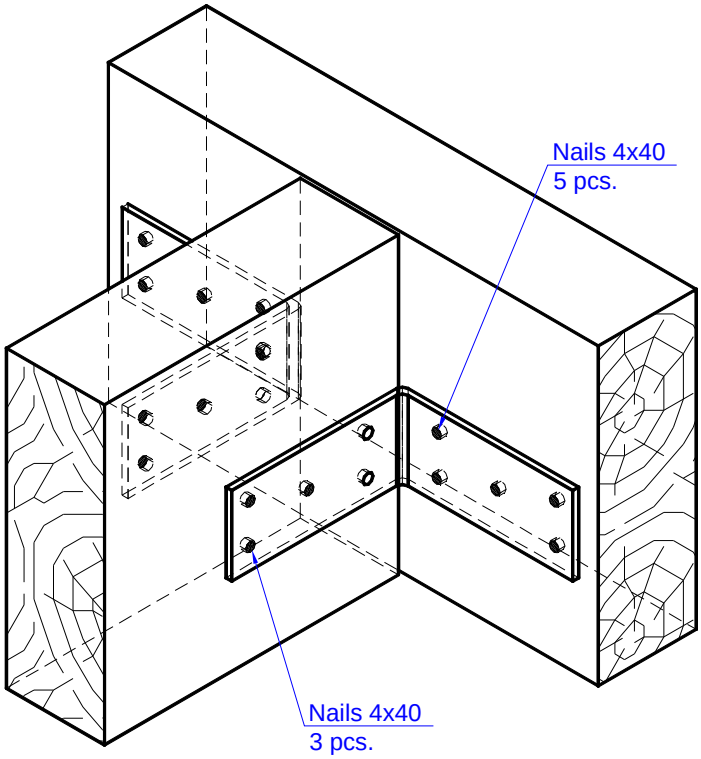


Figure D.11. Number and position of nails in the angle brackets 90×90×2.5×40 and 90×90×3×40

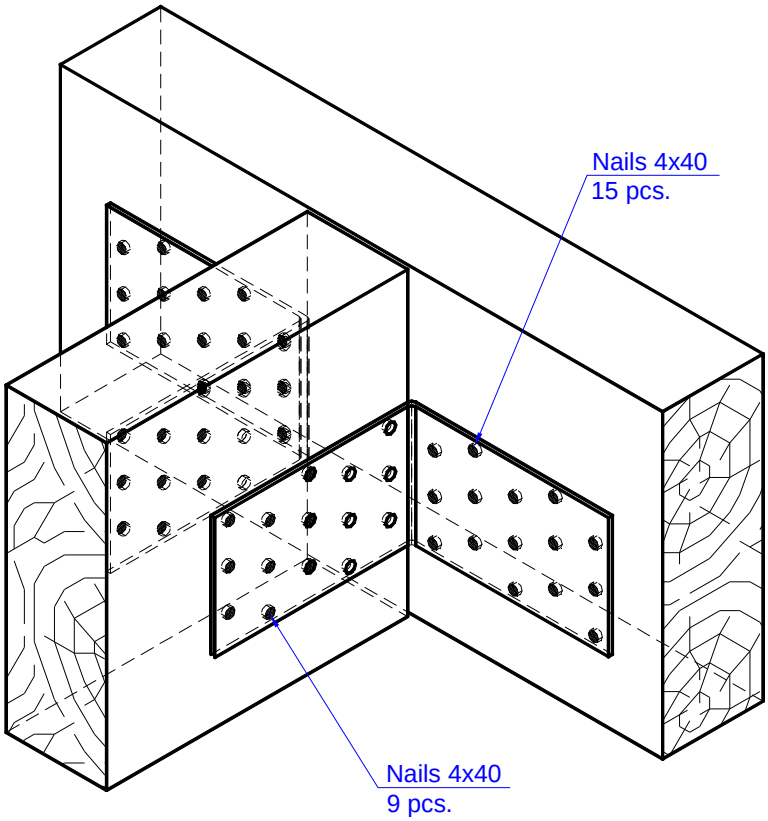


Figure D.12. Number and position of nails in the angle brackets 100×100×2×60 and 100×100×2.5×60

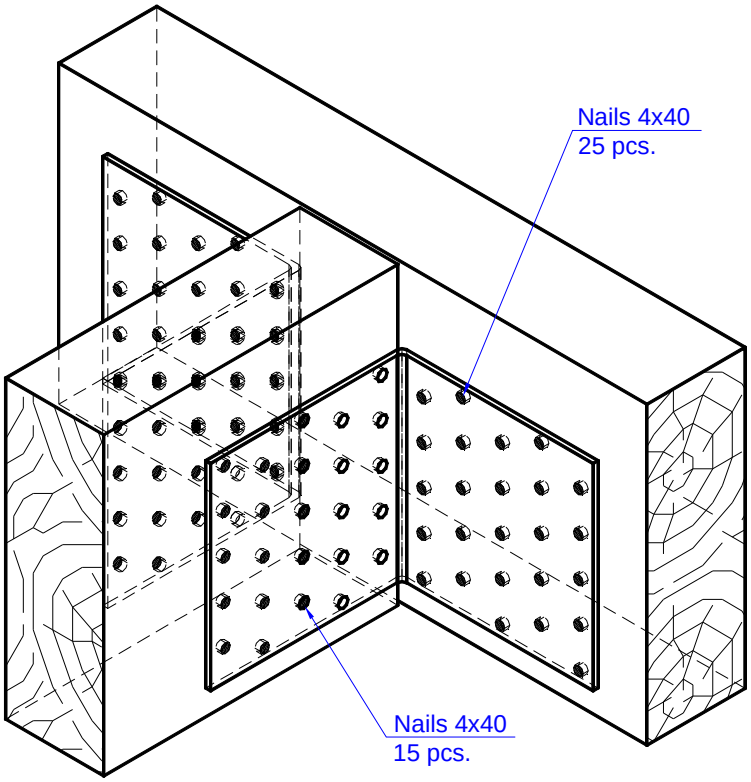


Figure D.13. Number and position of nails in the angle bracket 100×100×2.5×100

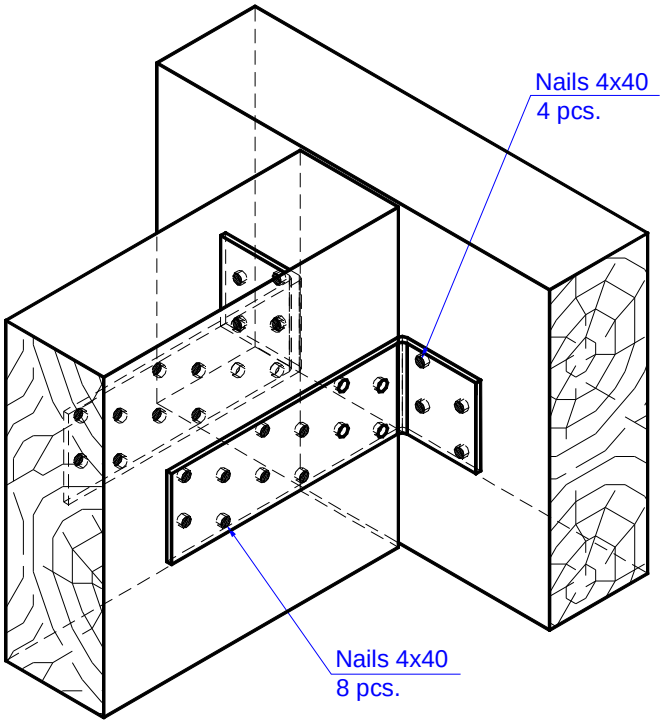


Figure D.14. Number and position of nails in the angle brackets 120×40×2×40 and 120×40×2.5×40

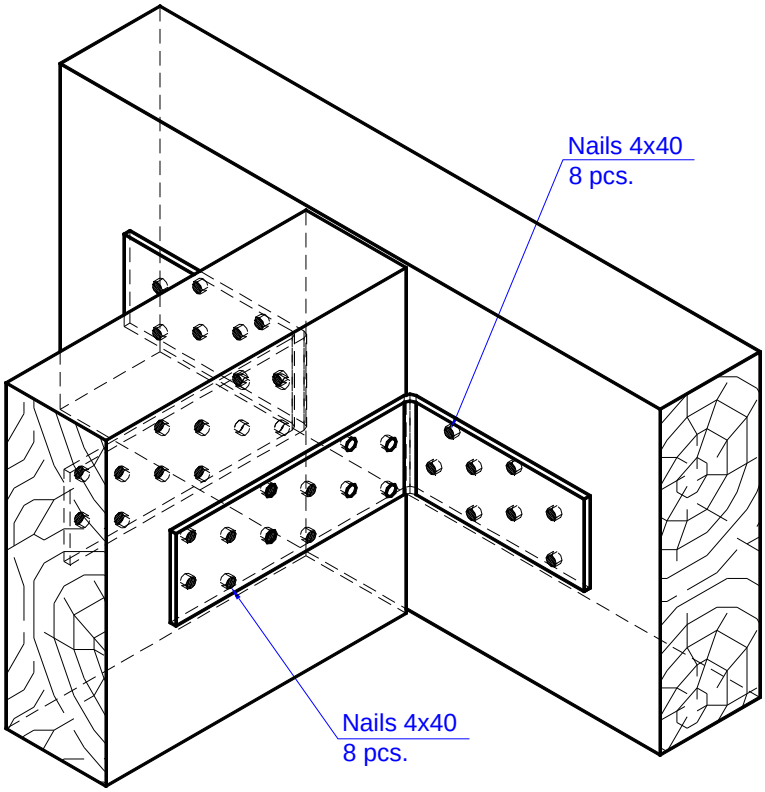


Figure D.15. Number and position of nails in the angle brackets 120×90×2.5×40 and 120×90×3×40

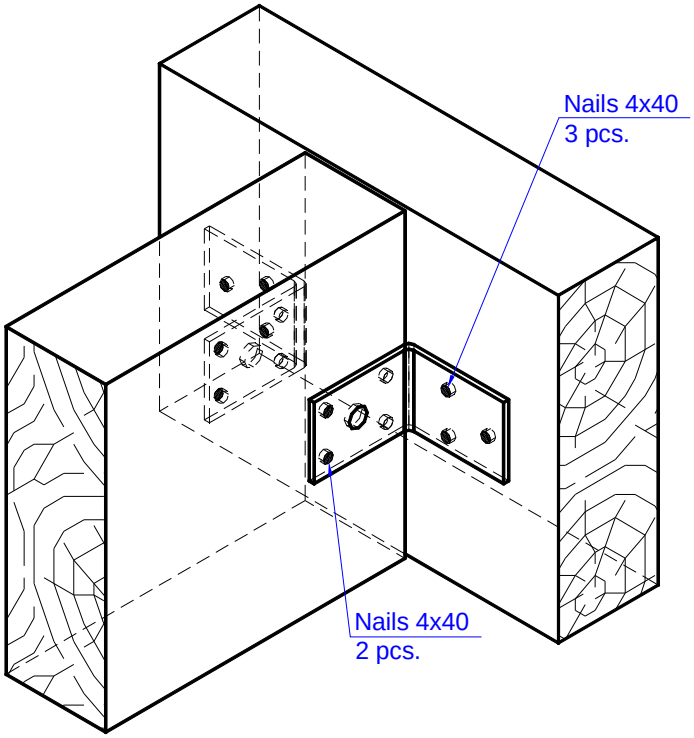


Figure D.16. Number and position of nails in the angle brackets 50×50×2×35 and 50×50×2.5×35

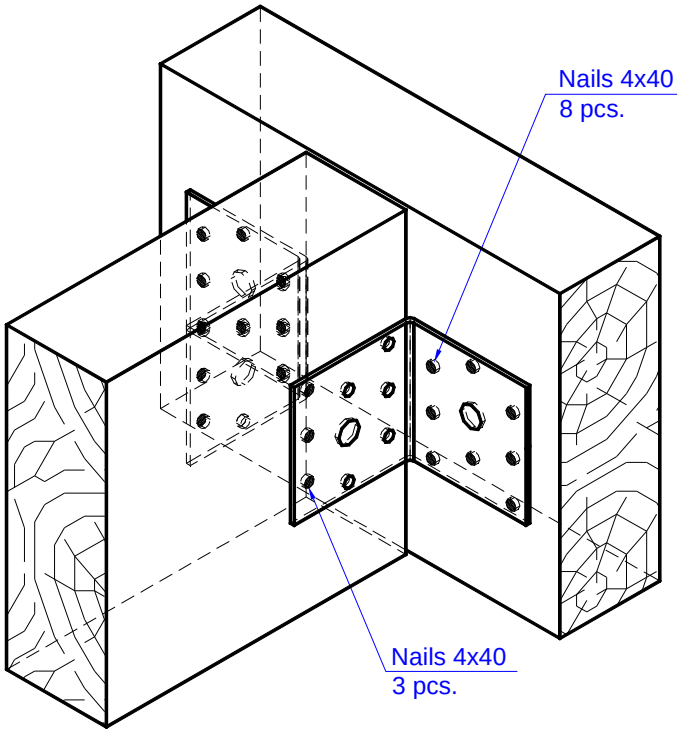


Figure D.17. Number and position of nails in the angle brackets 60×60×2×60 and 60×60×2.5×60

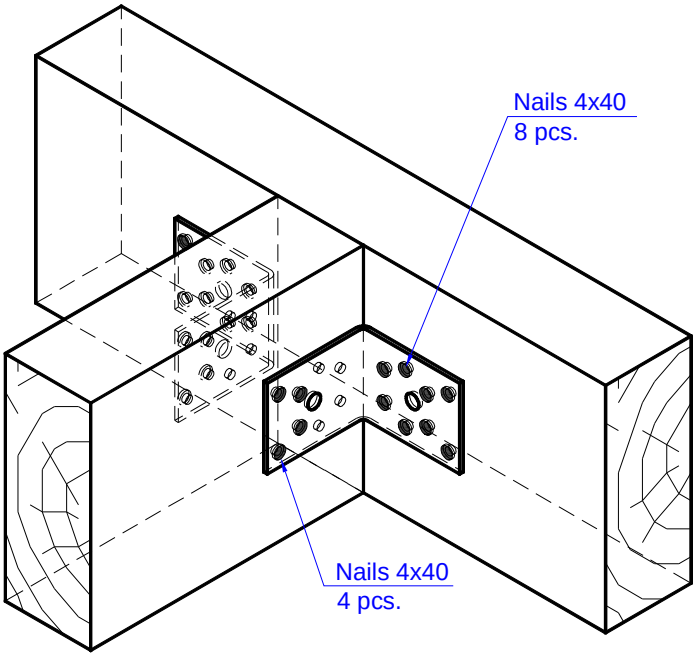


Figure D.18. Number and position of nails in the angle bracket 70×70×2.5×55

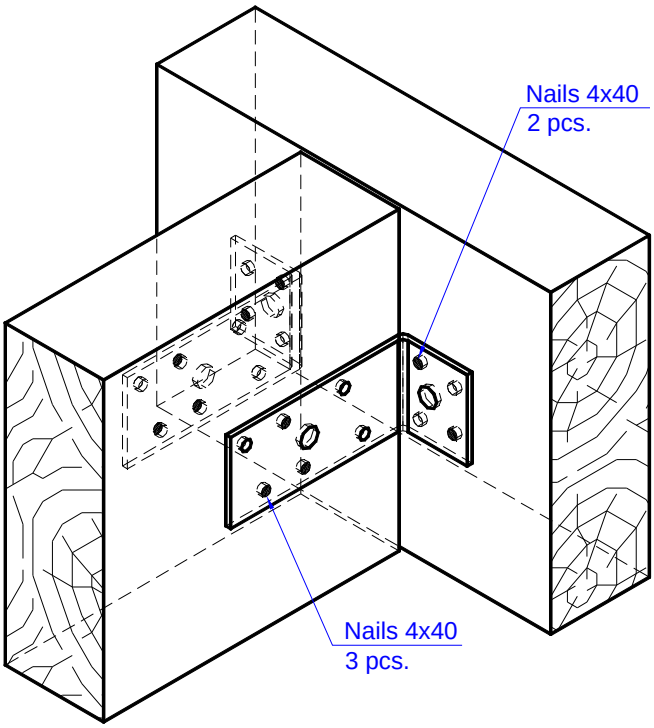


Figure D.19. Number and position of nails in the angle bracket 90×35×2.5×40

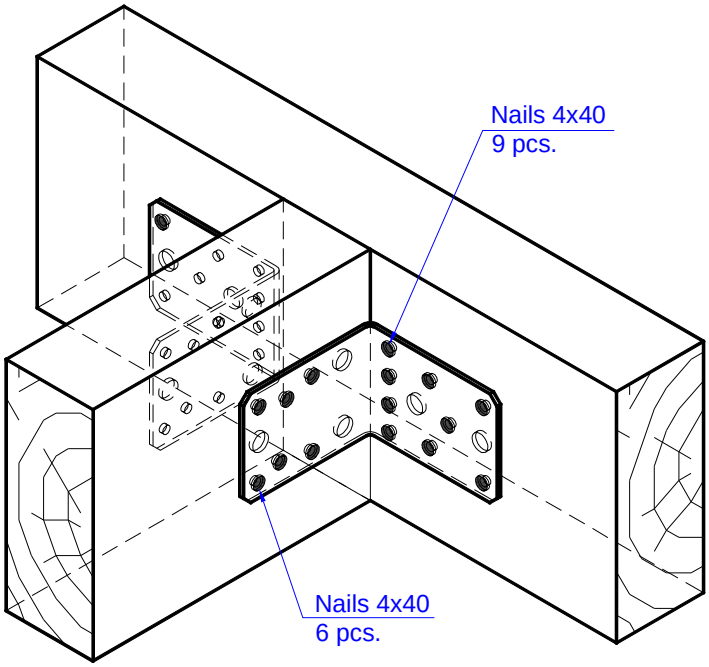


Figure D.20. Number and position of nails in the angle bracket 90×90×2.5×65

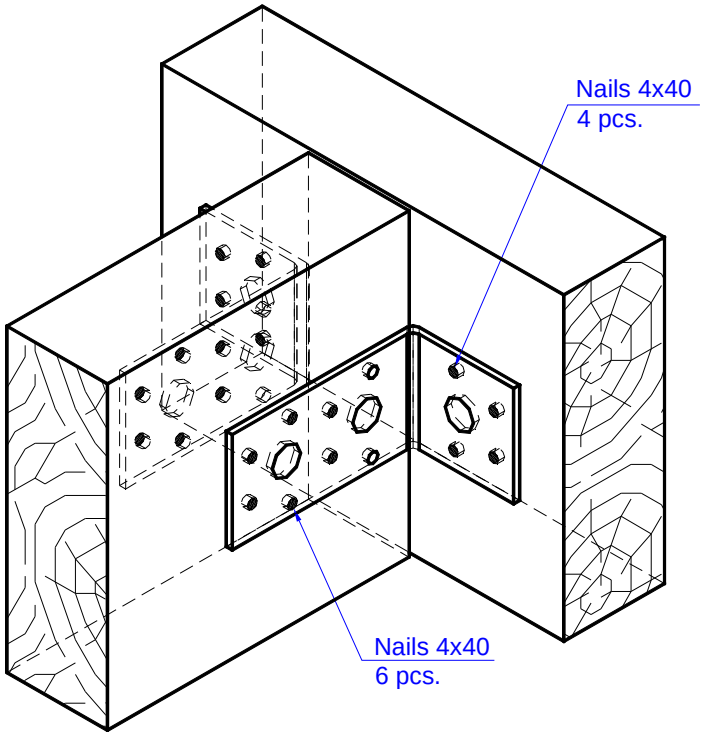


Figure D.21. Number and position of nails in the angle bracket 93×53×3×50

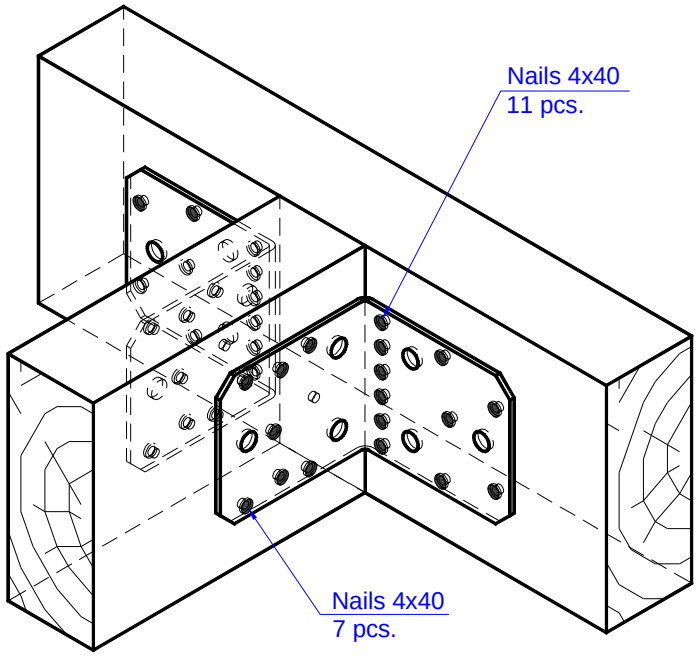


Figure D.22. Number and position of nails in the angle bracket 105×105×3×90

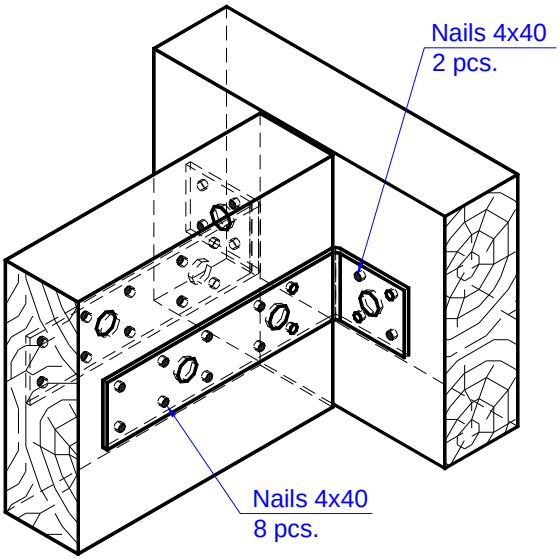


Figure D.23. Number and position of nails in the angle bracket 160×50×3×40

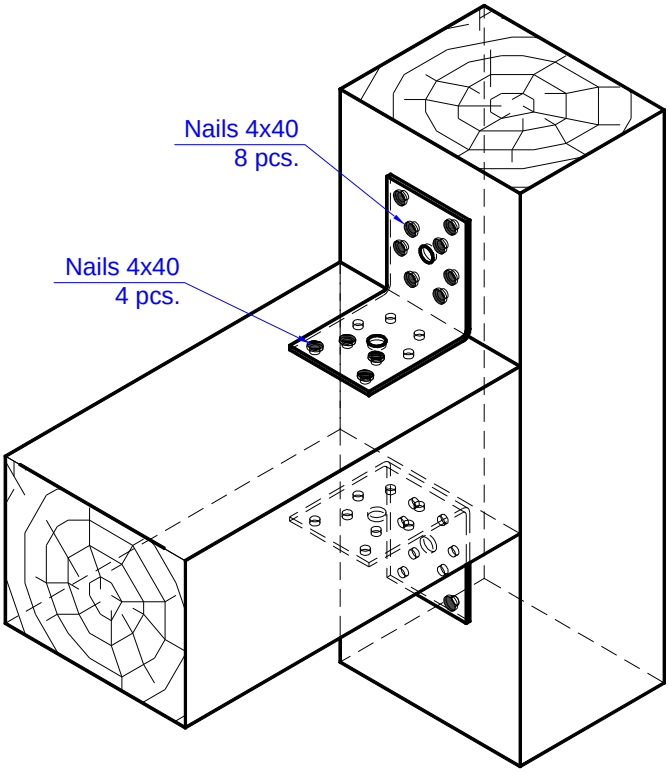


Figure D.24. Number and position of nails in the angle bracket 70×70×2.5×55

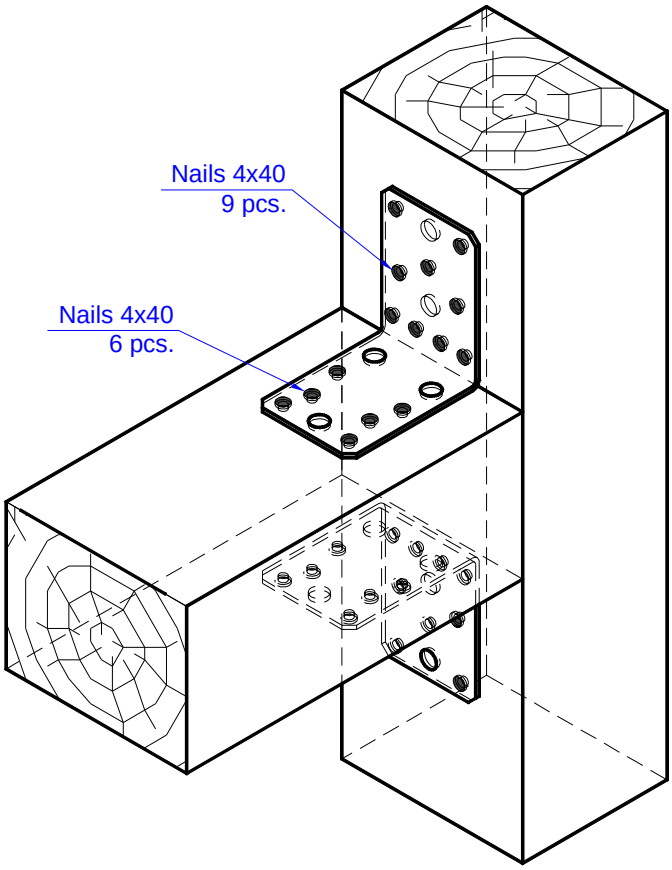


Figure D.25. Number and position of nails in the angle bracket 90×90×2.5×65

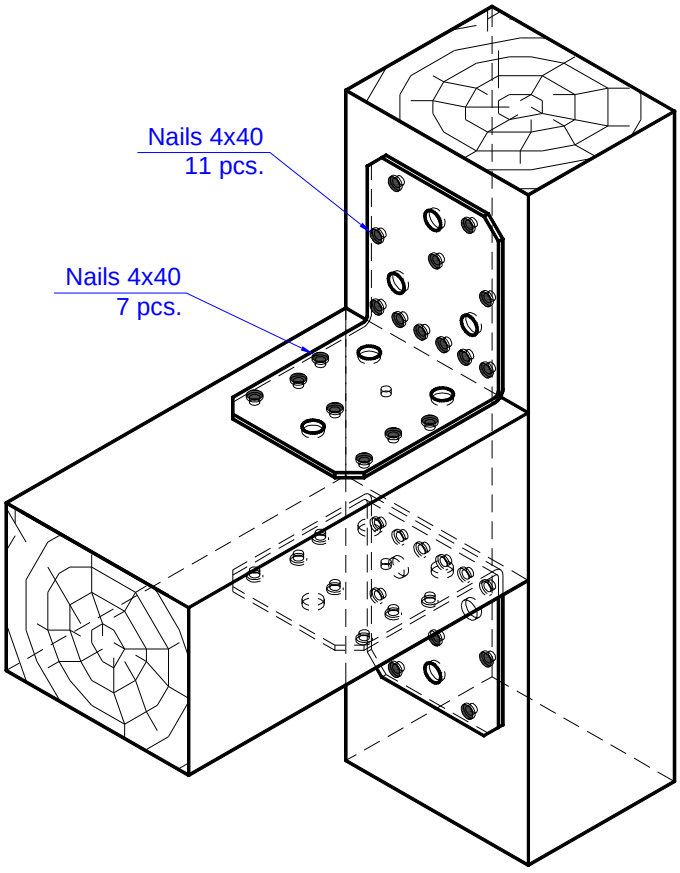


Figure D.26. Number and position of nails in the angle bracket 105×105×3×90

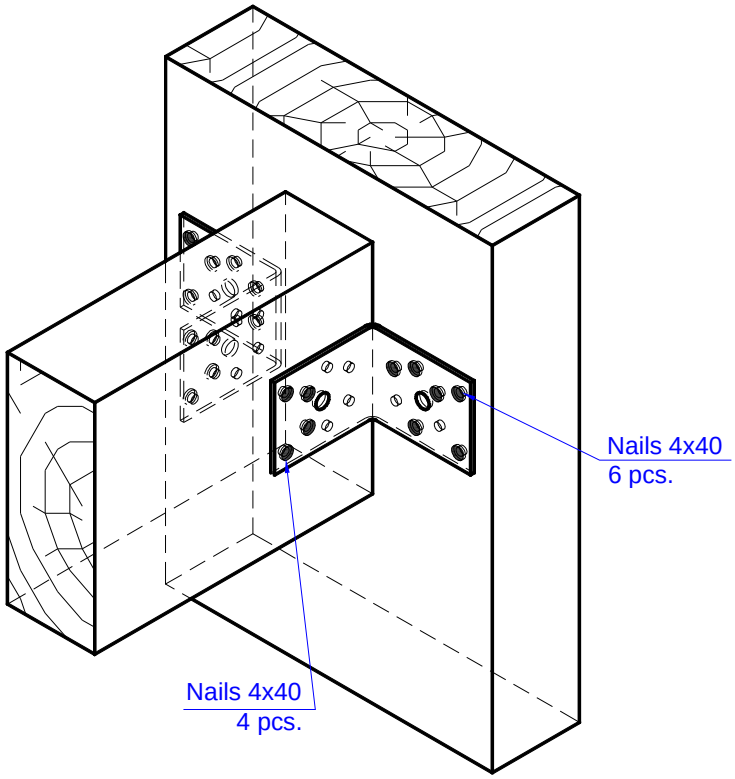


Figure D.27. Number and position of nails in the angle bracket 70×70×2.5×55

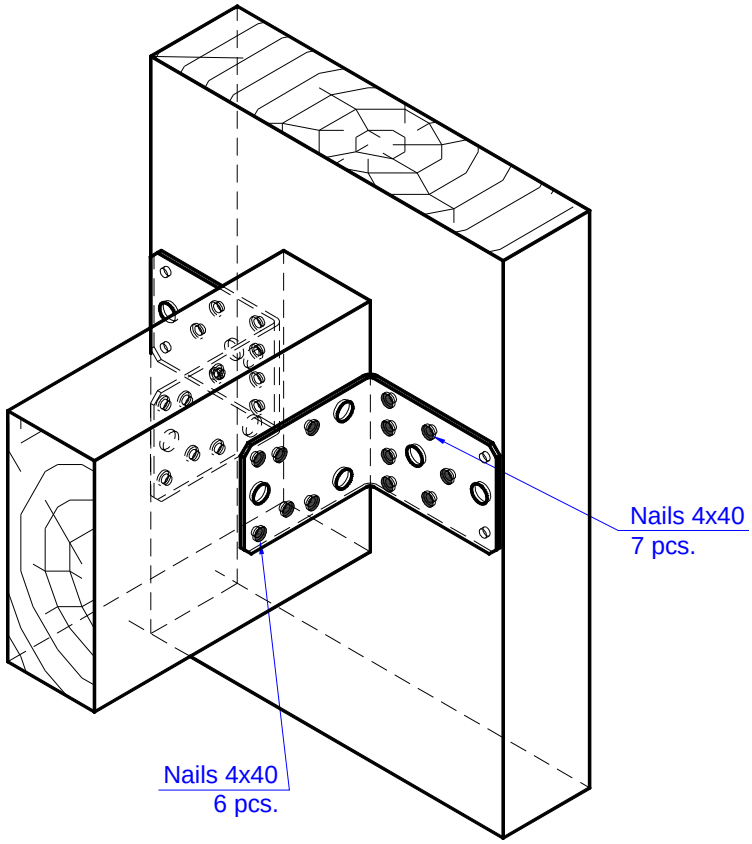


Figure D.28. Number and position of nails in the angle bracket 90×90×2.5×65

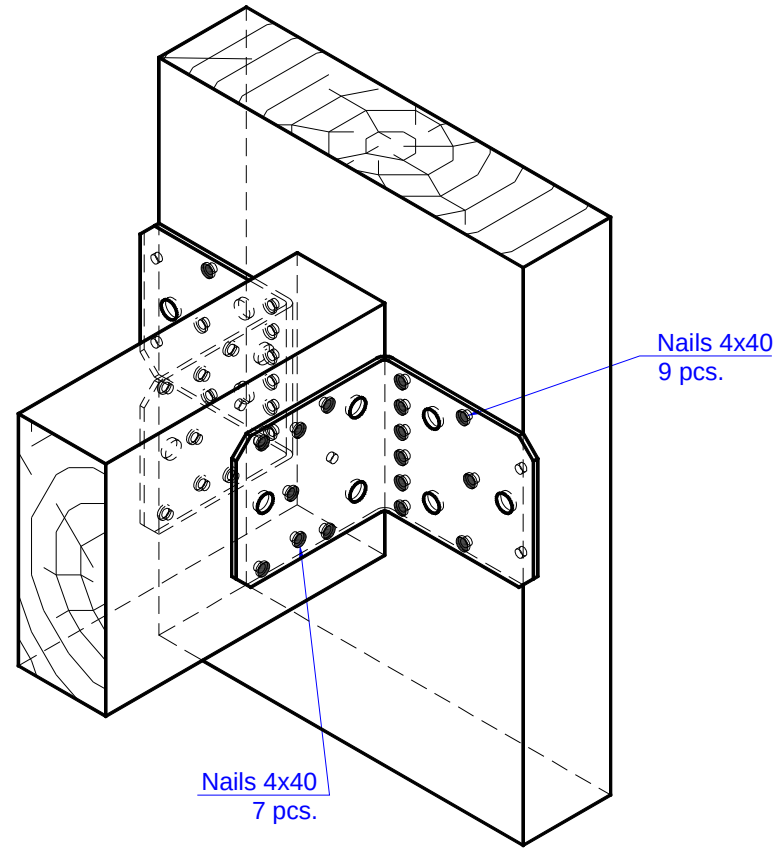


Figure D.29. Number and position of nails in the angle bracket 105×105×3×90

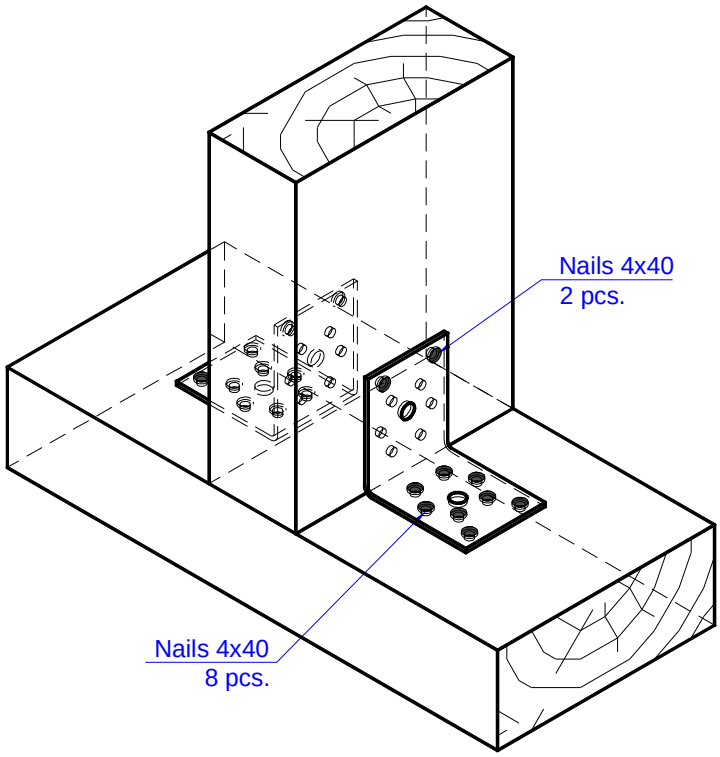


Figure D.30. Number and position of nails in the angle bracket 70×70×2.5×55

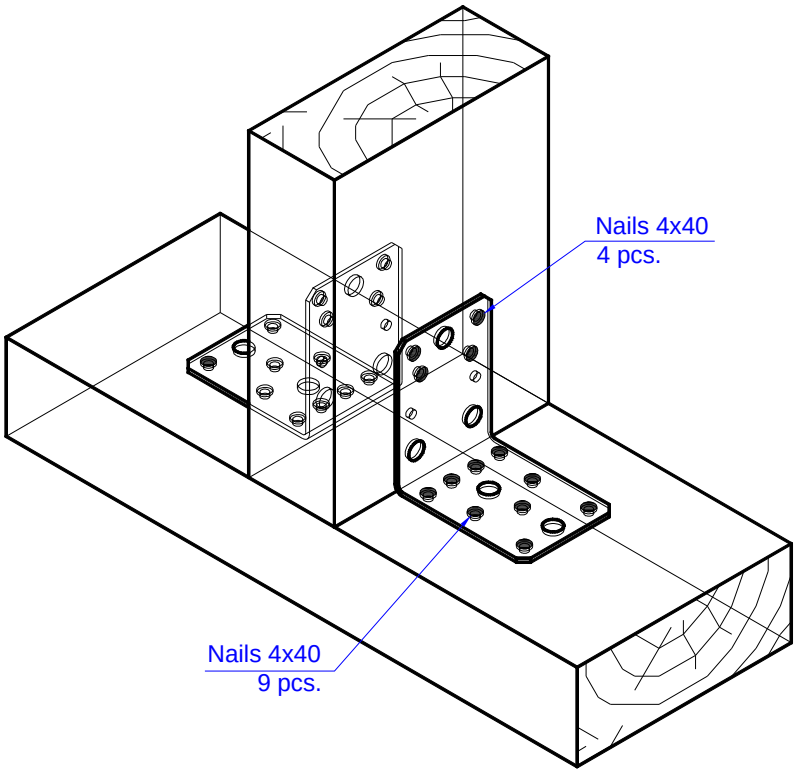


Figure D.31. Number and position of nails in the angle bracket 90×90×2.5×65

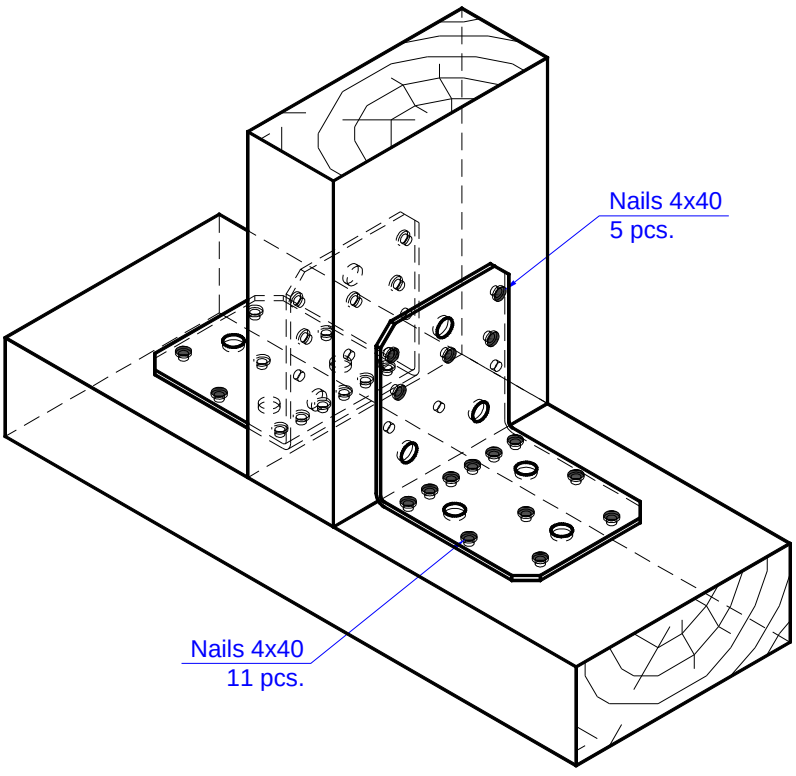


Figure D.32. Number and position of nails in the angle bracket 105×105×3×90

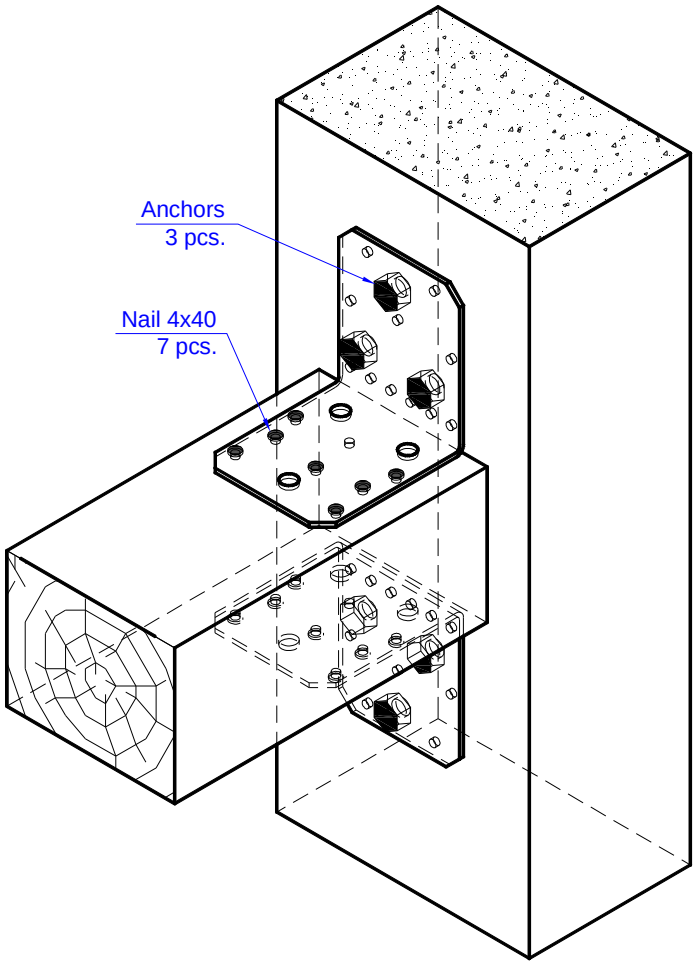


Figure D.33. Number and position of nails and anchors in the angle bracket 105×105×3×90

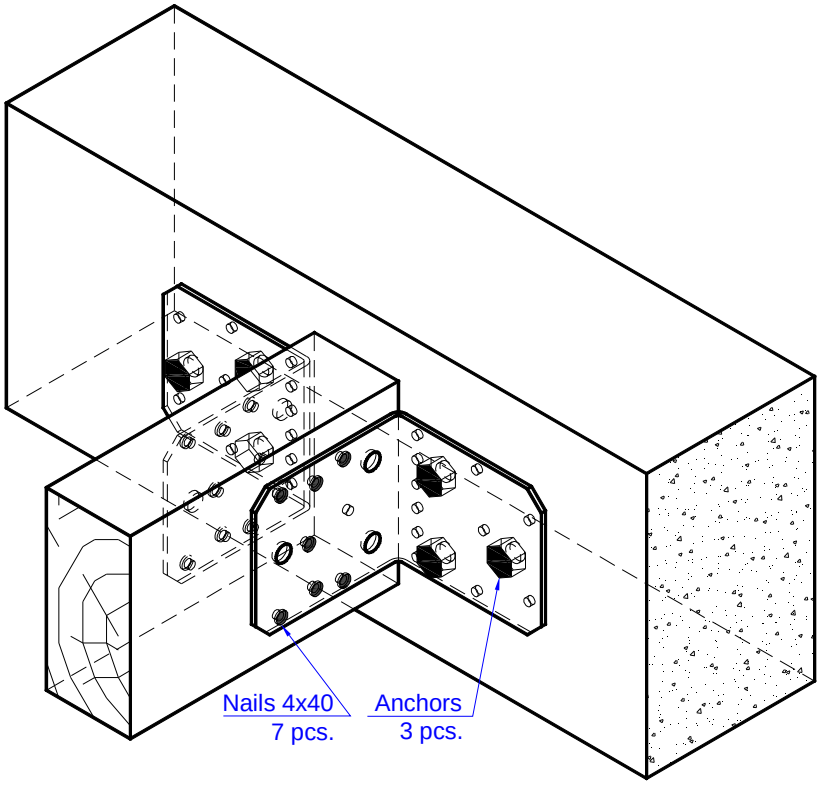


Figure D.34. Number and position of nails and anchors in the angle bracket 105×105×3×90

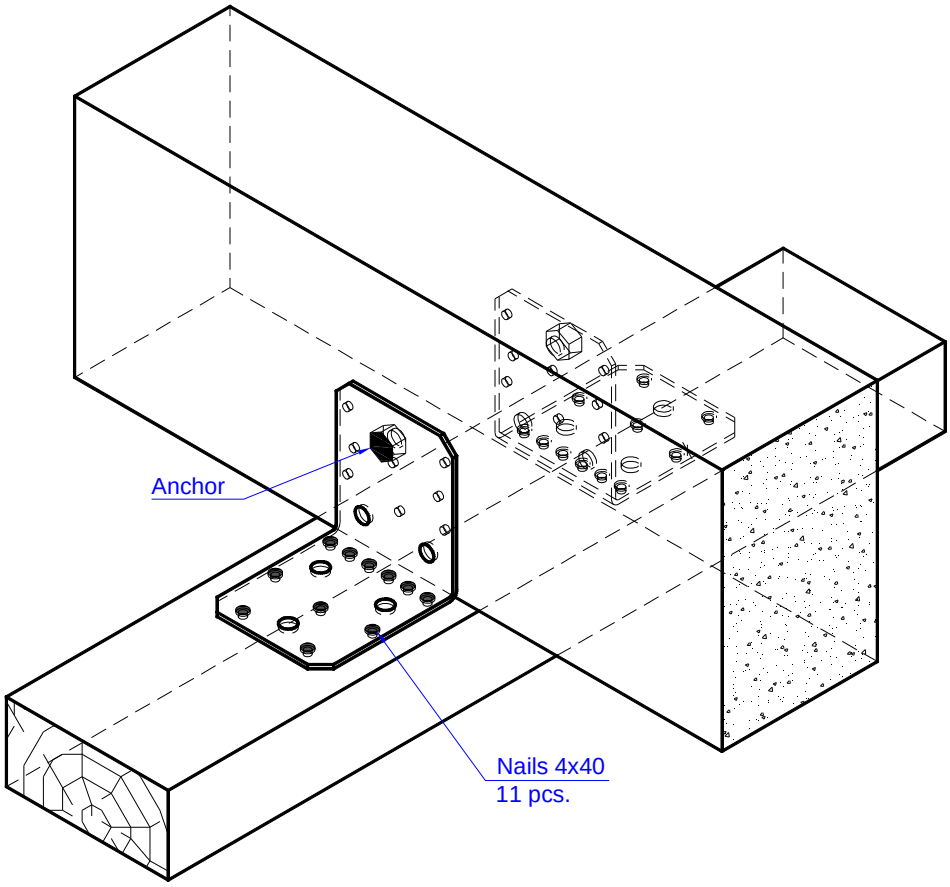


Figure D.35. Number and position of nails and anchors in the angle bracket 105×105×3×90

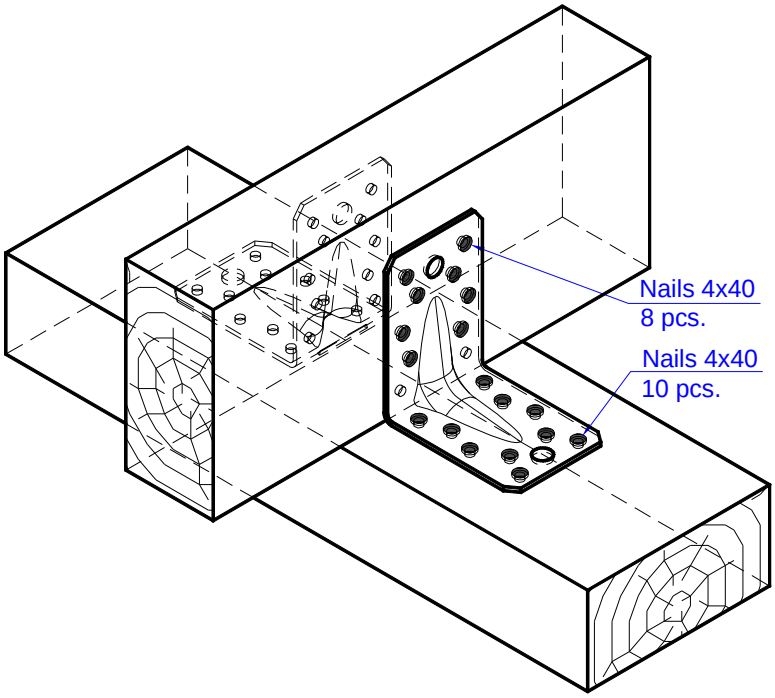


Figure D.36. Number and position of nails in the angle bracket with a rib 90×90×2.5×65

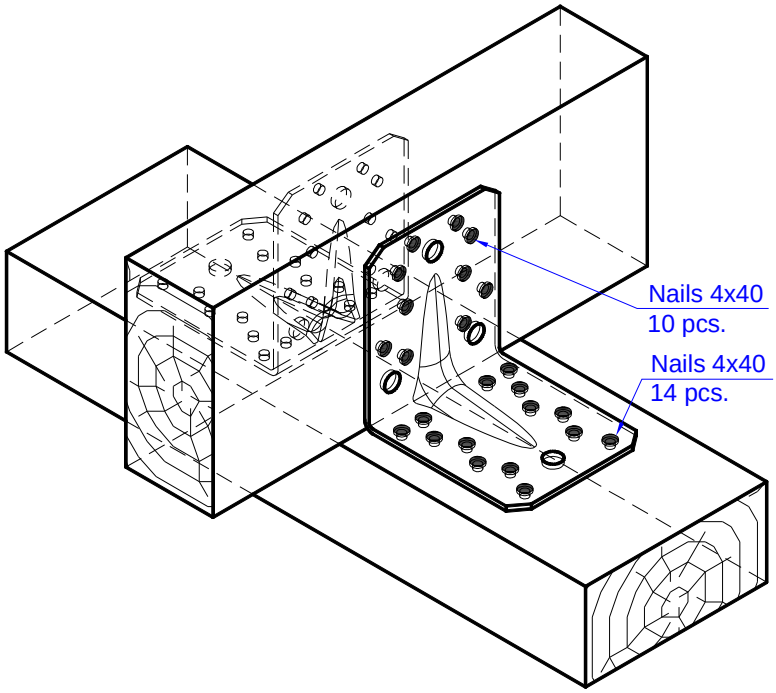


Figure D.37. Number and position of nails in the angle bracket with a rib 105×105×3×90

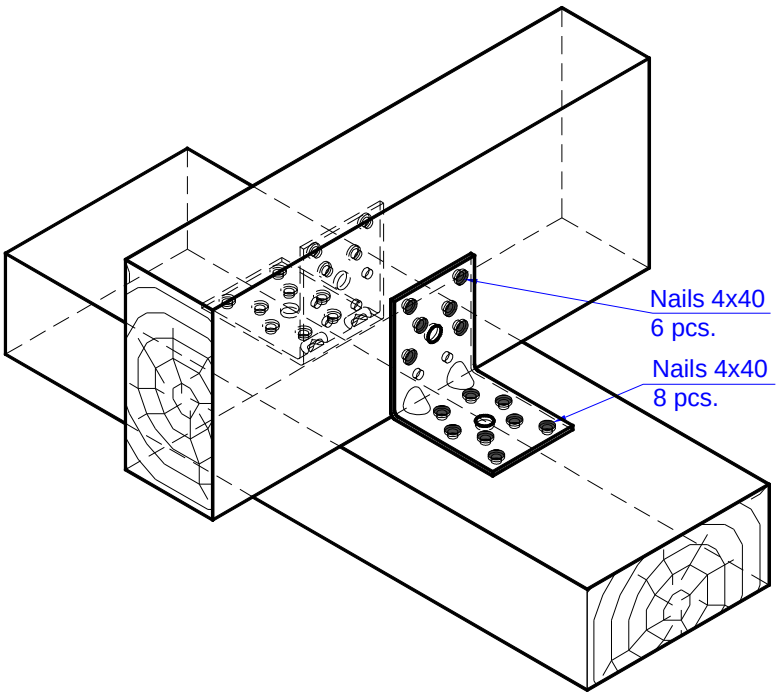


Figure D.38. Number and position of nails in the angle bracket with a two ribs 70×70×2.5×55

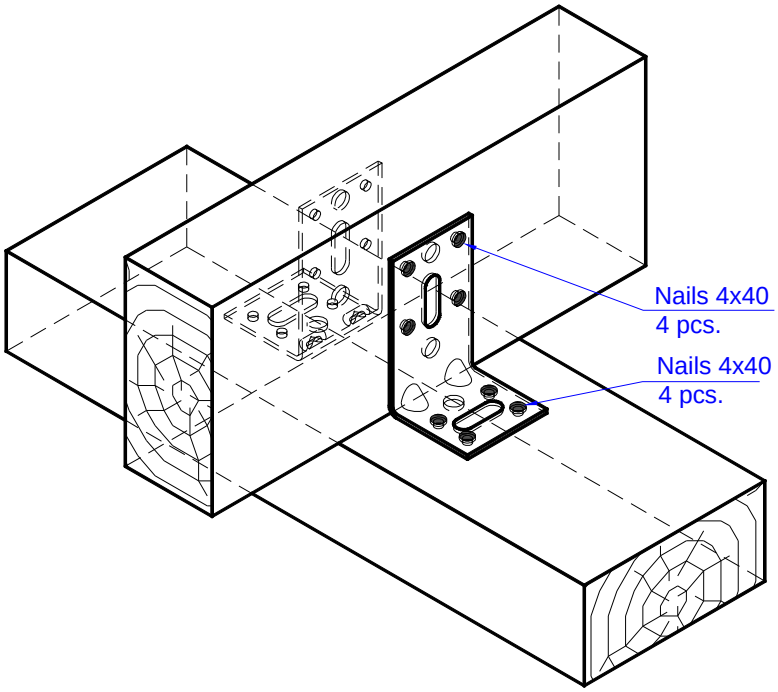


Figure D.39. Number and position of nails in the angle bracket with a two ribs 90×55×2.5×55

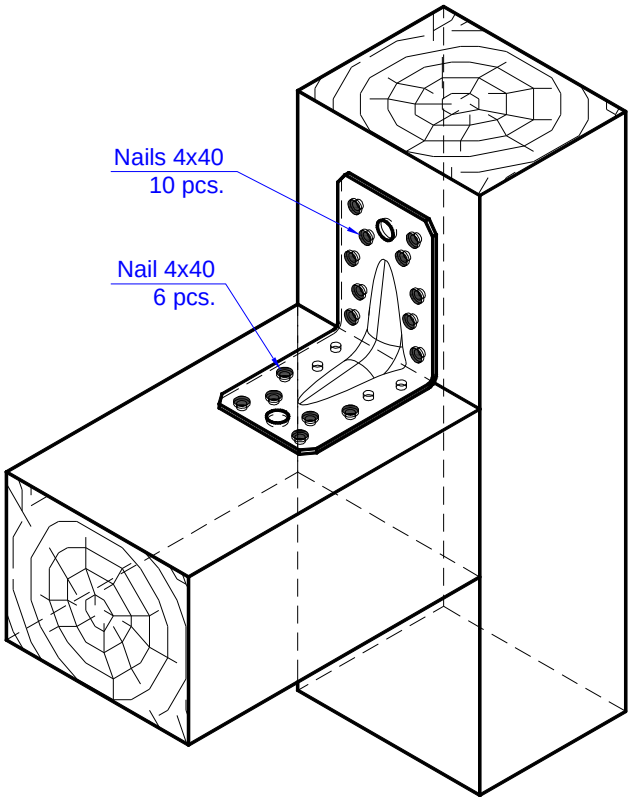


Figure D.40. Number and position of nails in the angle bracket with a rib 90×90×2.5×65

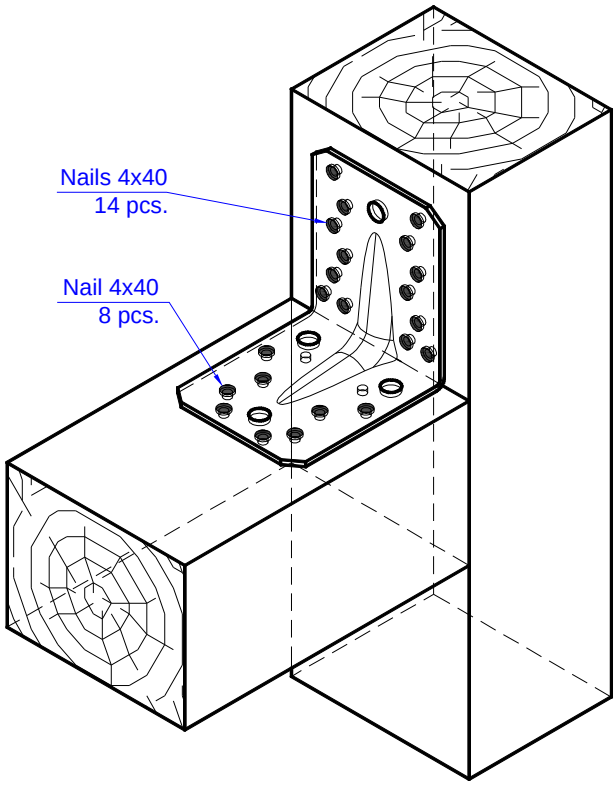


Figure D.41. Number and position of nails in the angle bracket with a rib 105×105×3×90

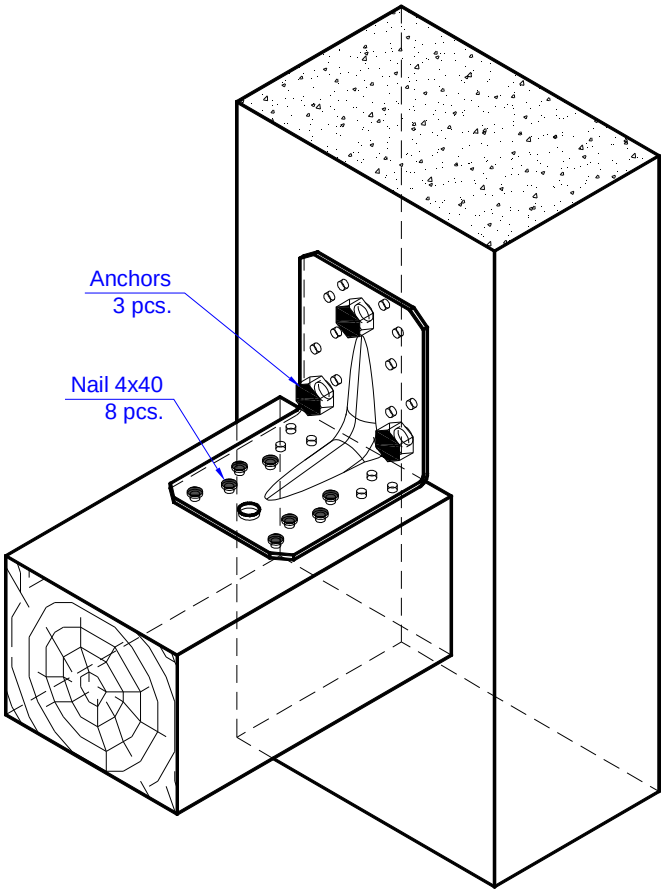


Figure D.42. Number and position of nails and anchors in the angle brackets with a rib 105×105×3×90