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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



# European Technical Assessment ETA-09/0311 of 02/07/2015

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: | AV Angle Brackets without rib (type 70921, 70923, 70924, 70925, 70926, 70929) and with rib (type 70931, 70932, 70933) |
| Product family to which the above construction product belongs: | Three-dimensional nailing plate (Angle Bracket for timber-to-timber connections) |
| Manufacturer: | August Vormann GmbH & Co. KG<br>Postfach 1552<br>Heilenbecker Strasse 191 - 205<br>DE-58256 Ennepetal<br>Tel. +49 02333 / 978 - 0<br>Fax +49 02333 / 978 - 241599<br>Internet www.vormann.com |
| Manufacturing plant: | August Vormann GmbH & Co. KG<br>Berliner Strasse 50<br>DE-04910 Elsterwerda |
| This European Technical Assessment contains: | 34 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 ETA with the same number issued on 2014-09-16 |

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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**
AV angle brackets with and without rib are one-piece non-welded, face-fixed angle brackets to be used in timber to timber connections. They are connected to construction members made of timber or wood-based products by a range of profiled (ringed shank) nails according to EN 14592.

The angle brackets are made from pre-galvanized steel S 250 GD / Z 275 according to EN 10346:2009 with $R_{p0,2} \geq 250$ N/mm², $R_m \geq 330$ N/mm² or from stainless steel according to EN 10088-2:2014 with $R_{p0,2} \geq 240$ N/mm² and $R_m \geq 500$ N/mm² and are available with or without an embossed rib. Dimensions, hole positions and typical installations are shown in Annex A. AV angle brackets are made from steel with tolerances according to EN 10143.

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

The angle brackets are intended for use in making connections in load bearing timber structures, as a connection between a beam and a purlin or a column, where requirements for mechanical resistance and stability and safety in use in the sense of the Basic Work Requirements 1 and 4 of the Regulation 305/2011 (EU) shall be fulfilled.

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

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

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

- Structural solid timber according to EN 14081,
- Glulam according to EN 14080,
- LVL according to EN 14374,
- Parallam PSL,
- Intrallam LSL,
- Cross laminated timber,
- Glued solid timber according to EN 14080,
- Plywood according to EN 636

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

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

Where $\rho_k$ is he characteristic density of the timber in kg/m$^3$.

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

The angle brackets are primarily for use in timber structures subject to the dry, internal conditions defined by service classes 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 timber structures, service class 3, when a corrosion protection in accordance with Eurocode 5 is applied, or when stainless steel with similar or better characteristic yield and ultimate strength is employed.

To avoid contact corrosion, stainless steel angle brackets shall be used with nails made from stainless steel.

The scope of the connectors regarding resistance to corrosion shall be defined according to national provisions that apply at the installation site considering environmental conditions and in conjunction with the admissible service conditions according to EN 1995-1-1 and the admissible corrosivity category as described and defined in EN ISO 12944-2.

The angle brackets are used for timber to timber connections.

**Assumed working life**
The assumed intended working life of the angle brackets for the intended use is 50 years, provided that they are subject to appropriate use and maintenance.

The information on the working life should not be regarded as a guarantee provided by the manufacturer or ETA Danmark. An “assumed intended working life” means that it is expected that, when this working life has elapsed, the real working life may be, in normal use conditions, considerably longer without major degradation affecting the essential requirements.

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

| Characteristic | Assessment of characteristic |
|---|---|
| **3.1 Mechanical resistance and stability (BWR 1)*)** | |
| 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 (BWR 2)** | |
| Reaction to fire | The angle brackets are made from steel classified as **Euroclass A1** in accordance with EN 1350-1 and EC decision 96/603/EC, amended by EC Decision 2000/605/EC |
| **3.3 Hygiene, health and the environment (BWR 3)** | |
| Influence on air quality | The product does not contain/release dangerous substances specified in TR 034, dated March 2012 |
| **3.7 Sustainable use of natural resources (BWR 7)** | No Performance Determined |
| **3.8 General aspects related to the performance of the product** | |
| | The angle brackets have been assessed as having satisfactory durability and serviceability when used in timber structures using the timber species described in Eurocode 5 and subject to the conditions defined by service class 1 and 2 |
| Identification | See Annex A |

*) See additional information in section 3.9 – 3.12.

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

### 3.9 Methods of verification

**Safety principles and partial factors**

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

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

Thus, the characteristic values of the load–carrying capacity are determined also for timber failure $F_{Rk,H}$ (obtaining the embedment strength of nails subjected to shear or the withdrawal capacity of the most loaded nail, respectively) as well as for steel 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 $\gamma_M$ for steel or timber, respectively, are also correctly taken into account.

### 3.10 Mechanical resistance and stability

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

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

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

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

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

The characteristic withdrawal capacity of the nails has to be determined by calculation in accordance with EN 1995-1-1: 2010, paragraph 8.3.2 (head pull-through is not relevant):

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

Where:

$f_{ax,k}$ Characteristic value of the withdrawal parameter in N/mm²

d Nail diameter in mm

$t_{pen}$ Penetration depth of the profiled shank including the nail point in mm, $t_{pen} \geq 31$ mm

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

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

Where:

$\rho_k$ Characteristic density of the timber in kg/m³

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

The design models allow the use of fasteners described in the Table A.3 on page 9 in Annex A.

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

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

### 3.11 Aspects related to the performance of the product

Corrosion protection in service class 1 and 2.

In accordance with ETAG 015 the angle brackets are made from pre-galvanized steel S 250 GD / Z 275 according to EN 10346:2009 with $R_{p0,2} \geq 250$ N/mm², $R_m \leq 330$ N/mm² or from stainless steel according to EN 10088-2:2014 with $R_{p0,2} \geq 240$ N/mm² and $R_m \geq 500$ N/mm².

Corrosion protection in service class 3.

In accordance with ETAG 015 the angle brackets are made from stainless steel according to EN 10088-2:2014 with $R_{p0,2} \geq 240$ N/mm² and $R_m \geq 500$ N/mm².

### 3.12 General aspects related to the use of the product

AV 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

**AV angle brackets**
The following provisions concerning installation apply:

The structural members – the components 1 and 2 shown in the figure on page 33 - to which the brackets are fixed shall be:

- Restrained against rotation. At a load $F_4/F_5$ and arrangement of two brackets per connection, 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 Assessment 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 Copenhagen on 2015-07-02 by

Thomas Bruun
Managing Director, ETA-Danmark

## Annex A
## Product details and definitions

Table A.1 Materials specification

| Bracket number | Bracket type | Thickness (mm) | Steel specification | Coating specification on the steel brackets |
|---|---|---|---|---|
| 070 921 000 | 50x50x35 | 2,5 | S250GD/stainless steel | Z 275 / - |
| 070 923 000 | 60x60x45 | 2,5 | S250GD/stainless steel | Z 275 / - |
| 070 924 000 | 70x70x55 | 2,0 | stainless steel | - |
| 070 924 000 | 70x70x55 | 2,5 | S250GD/stainless steel | Z 275 / - |
| 070 925 000 | 90x90x65 | 2,0 | stainless steel | - |
| 070 925 000 | 90x90x65 | 2,5 | S250GD/stainless steel | Z 275 / - |
| 070 926 000 | 103x103x90 | 2,5 | stainless steel | - |
| 070 926 000 | 103x103x90 | 3,0 | S250GD/stainless steel | Z 275 / - |
| 070 929 000 | 90x90x40 | 2,5 | stainless steel | - |
| 070 929 000 | 90x90x40 | 2,5 | S250GD/stainless steel | Z 275 / - |
| 070 931 000 | 70x70x55 with rib | 2,0 | stainless steel | - |
| 070 931 000 | 70x70x55 with rib | 2,5 | S250GD/stainless steel | Z 275 / - |
| 070 932 000 | 90x90x65 with rib | 2,0 | stainless steel | - |
| 070 932 000 | 90x90x65 with rib | 2,5 | S250GD/stainless steel | Z 275 / - |
| 070 933 000 | 105x105x90 with rib | 2,5 | stainless steel | - |
| 070 933 000 | 105x105x90 with rib | 3,0 | S250GD/stainless steel | Z 275 / - |

Table A.2 Range of sizes

| Bracket number | Bracket type | Height (mm) vertical | | Height (mm) horizontal | | Width (mm) | |
|---|---|---|---|---|---|---|---|
| | | min | max | min | max | min | max |
| 070 921 000 | 50x50x35 | 49,4 | 50,6 | 49,4 | 50,6 | 34,4 | 35,6 |
| 070 923 000 | 60x60x45 | 59,4 | 60,6 | 59,4 | 60,6 | 44,4 | 45,6 |
| 070 924 000 | 70x70x55 | 69 | 71 | 69 | 71 | 54 | 56 |
| 070 925 000 | 90x90x65 | 89 | 91 | 89 | 91 | 64 | 66 |
| 070 926 000 | 105x105x90 | 104 | 106 | 104 | 106 | 89 | 91 |
| 070 929 000 | 90x90x40 | 89,2 | 90,8 | 89,2 | 90,8 | 39,4 | 40,6 |
| 070 931 000 | 70x70x55 with rib | 68 | 71 | 68 | 71 | 51,5 | 56 |
| 070 932 000 | 90x90x65 with rib | 88 | 91 | 88 | 91 | 60 | 66 |
| 070 933 000 | 105x105x90 with rib | 103 | 106 | 103 | 106 | 87 | 91 |

Table A.3 Fastener specification

| **Nail type** | **Nail size (mm)** | | | **Finish** |
|---|---|---|---|---|
| According to EN 14592 | Diameter | Length | Threaded length | |
| Threaded nail | 4,0 | 40 | 31 | Electroplated zinc / stainless steel |

In the load-carrying-capacities of the nailed connection 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-carrying-capacities of the angle brackets have been determined based on the use of connector nails 4,0 x 40 mm in accordance with the German national specification for the nails. The characteristic withdrawal capacity of the nails has to be determined by calculation in accordance with EN 1995-1-1: 2010, paragraph 8.3.2 (head pull-through is not relevant):

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

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

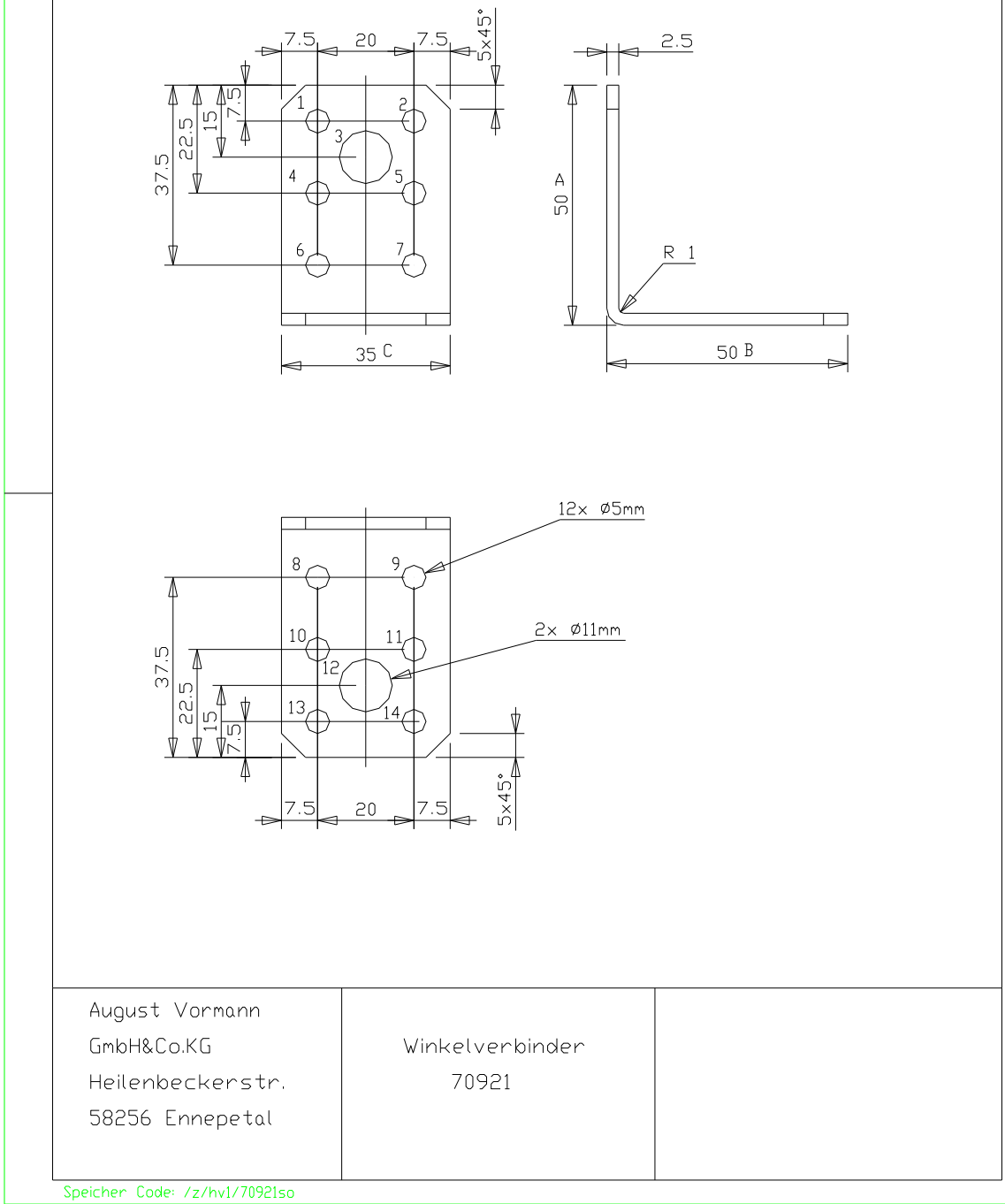
Based on tests by Versuchsanstalt für Stahl, Holz und Steine, Karlsruhe Institute of Technology (KIT), the characteristic value of the withdrawal resistance for the threaded nails used can be calculated as:

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

Where:
$\rho_k$ Characteristic density of the timber in $kg/m^3$

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

**AV angle brackets**

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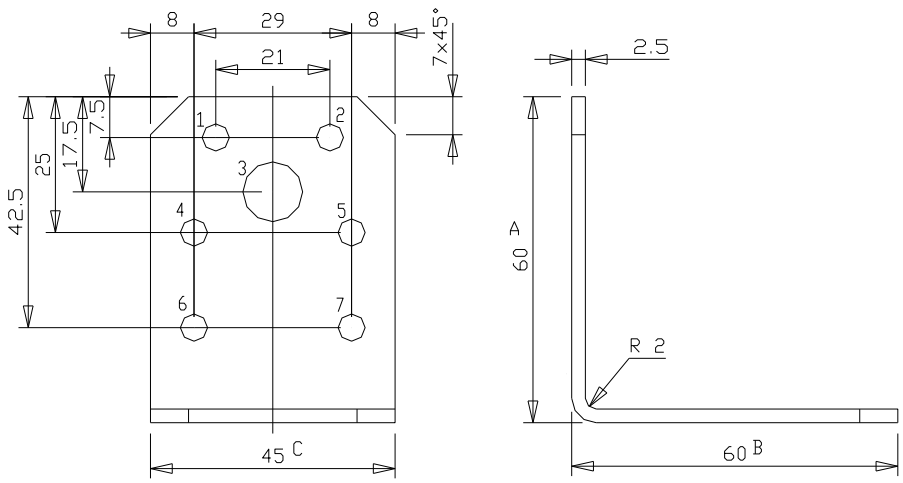


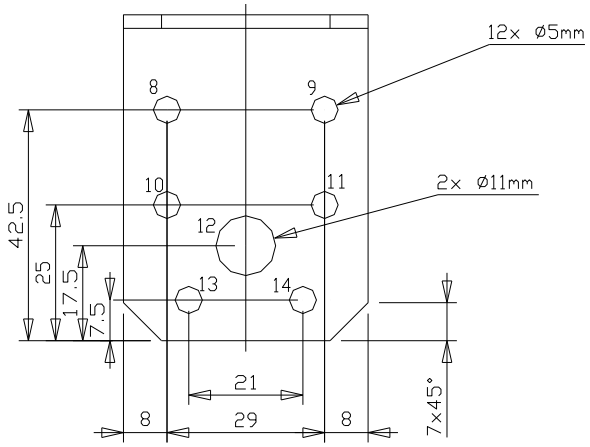


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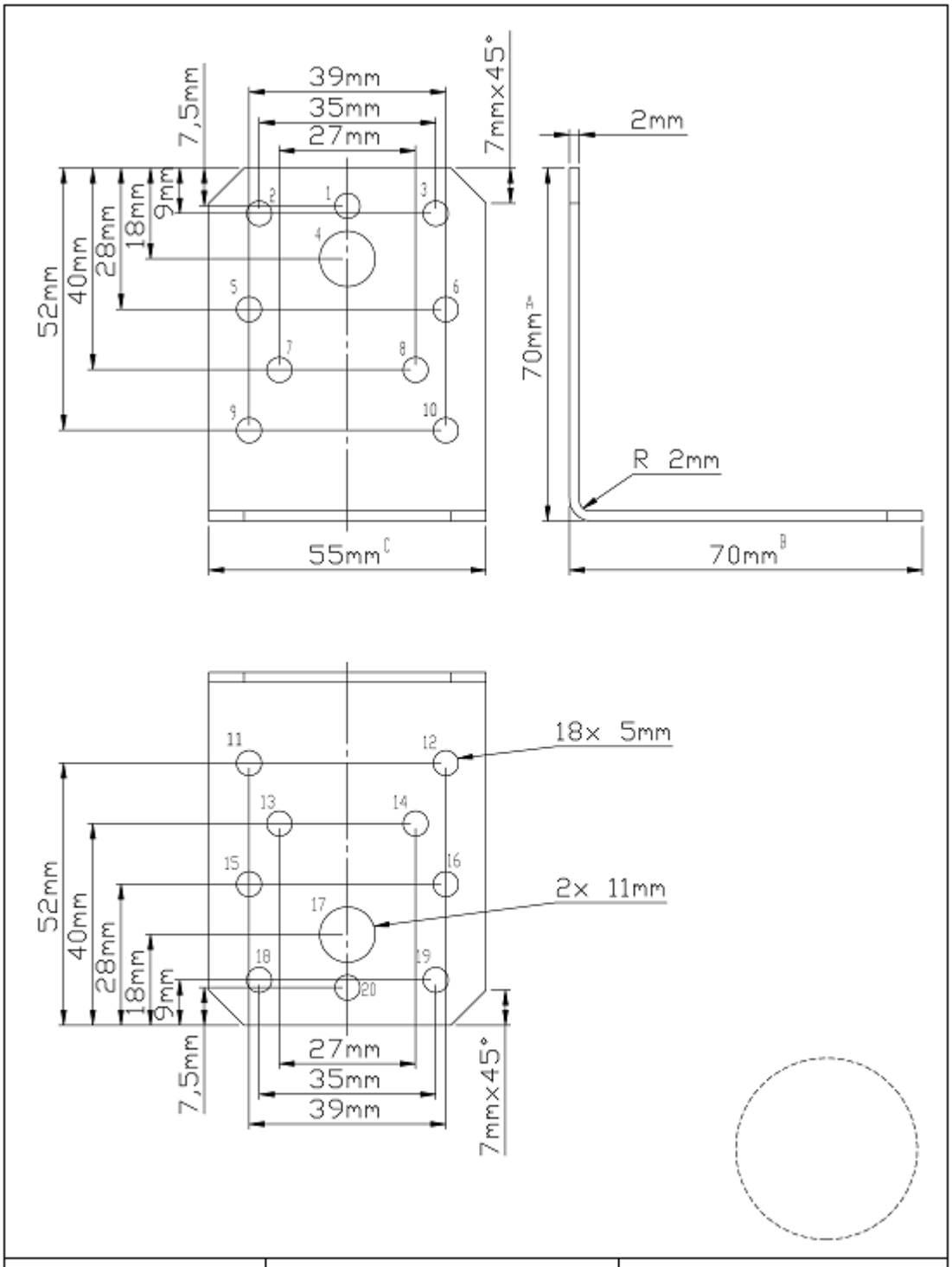


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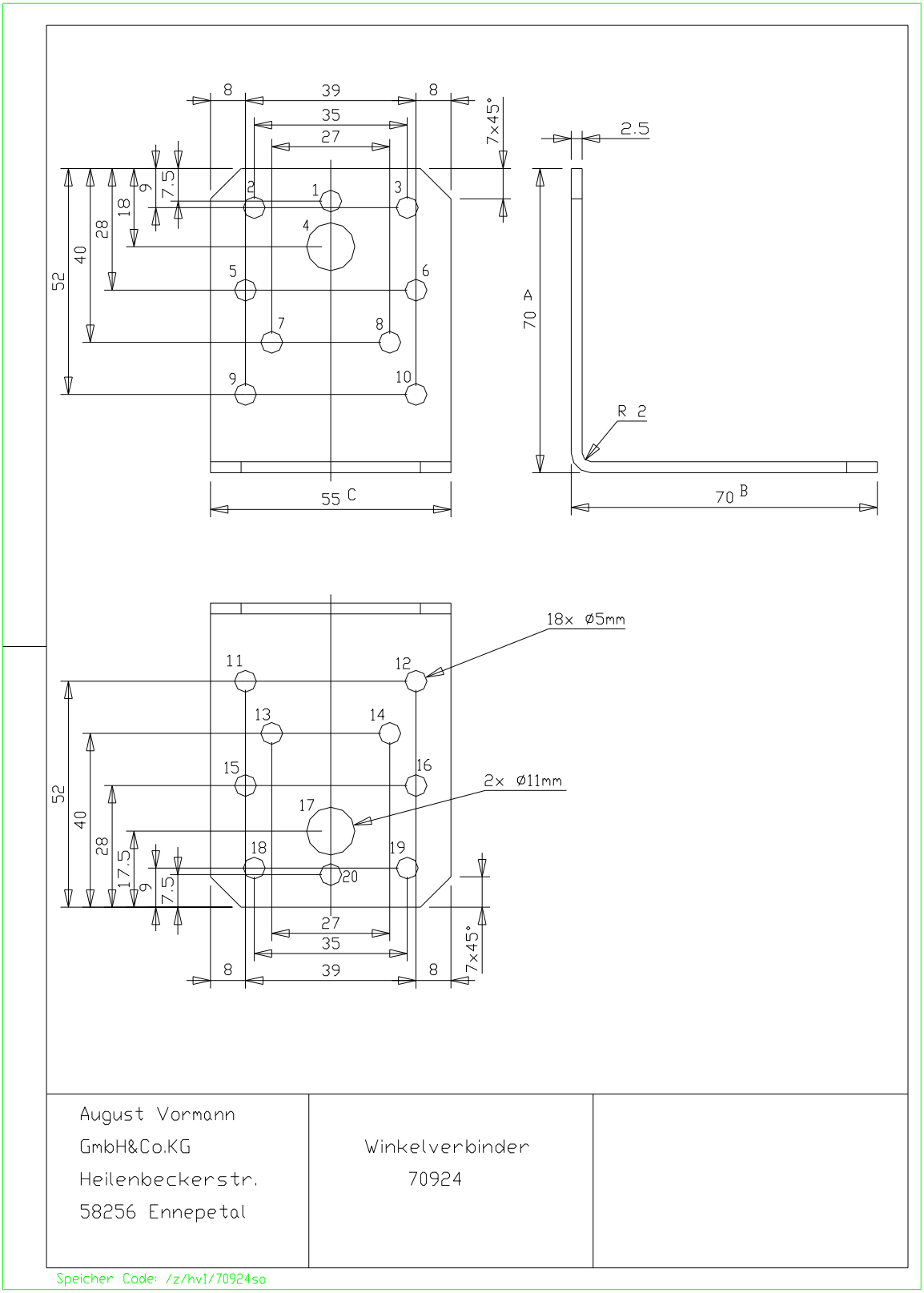


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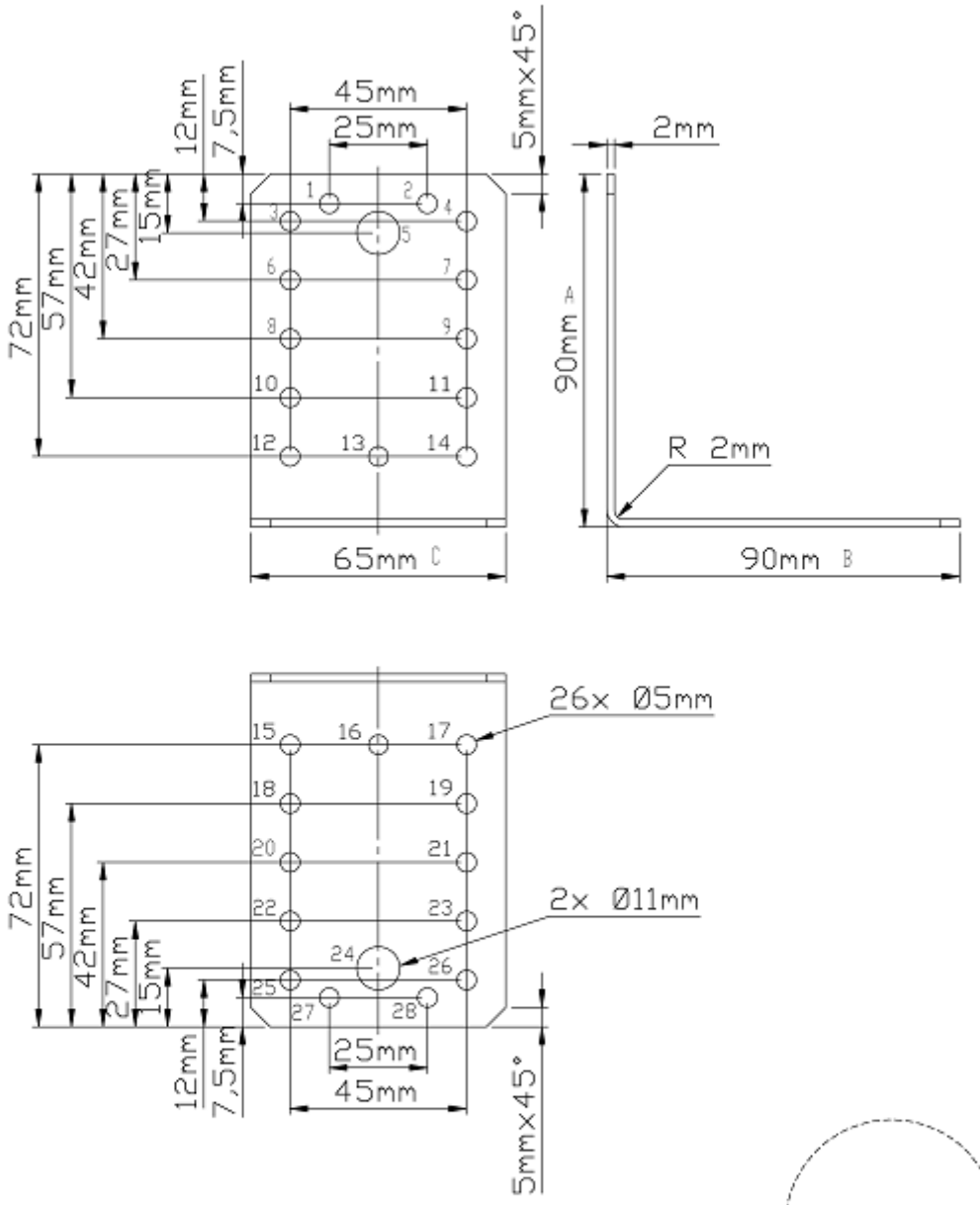


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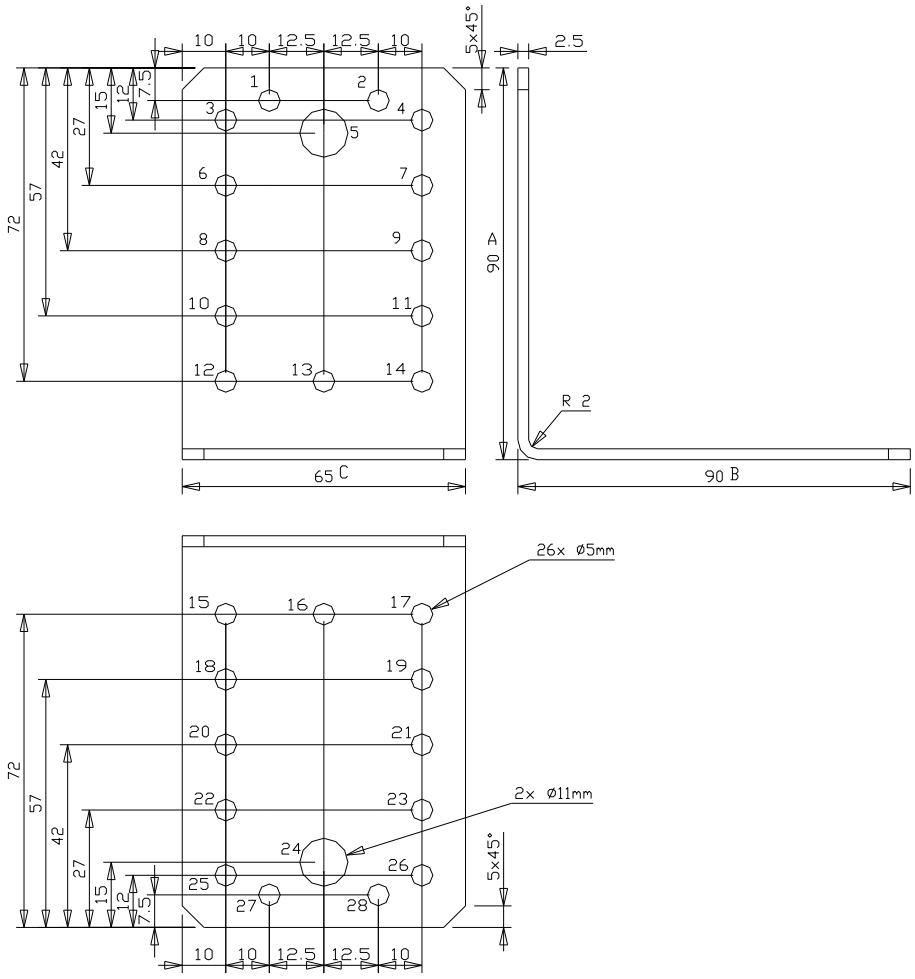


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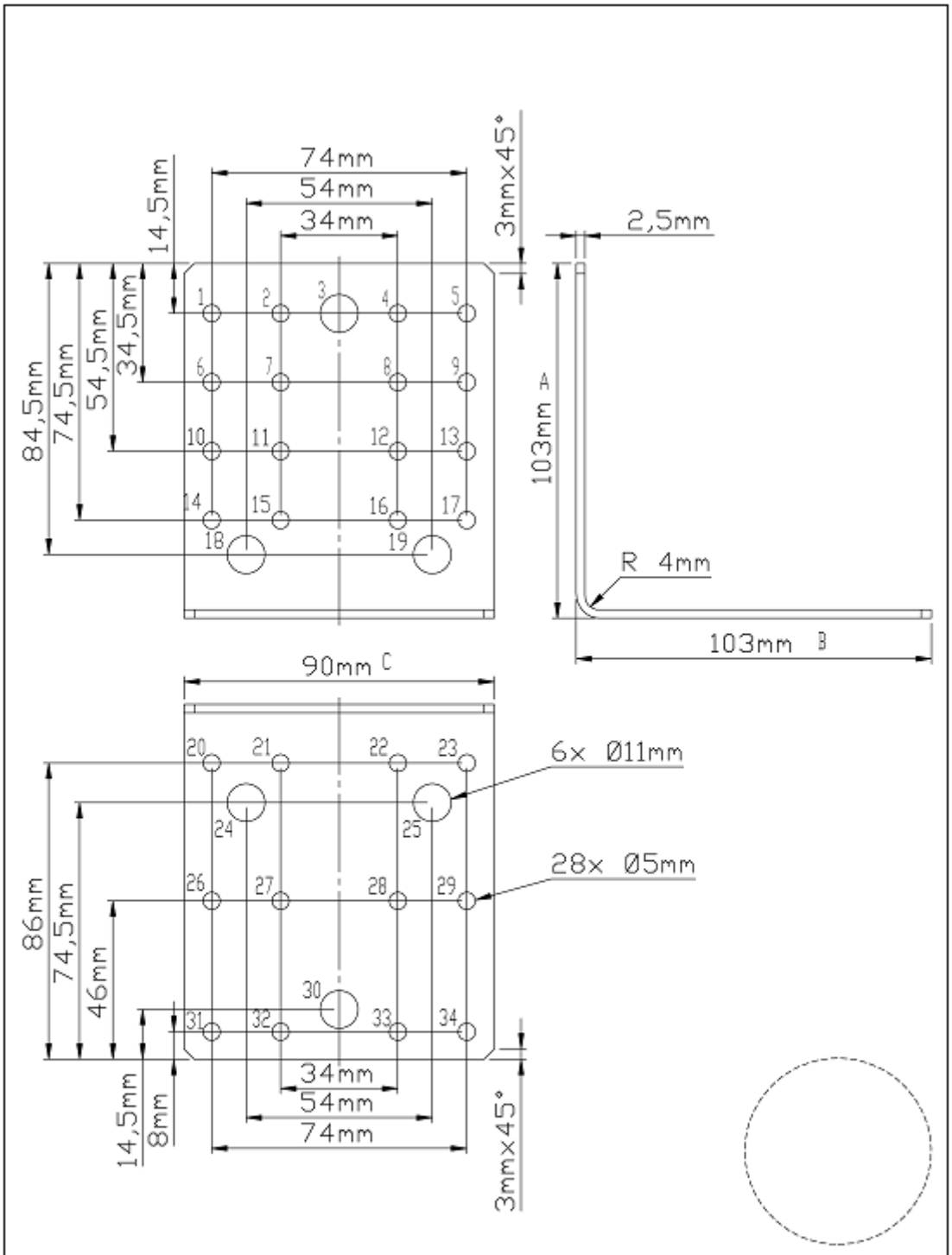


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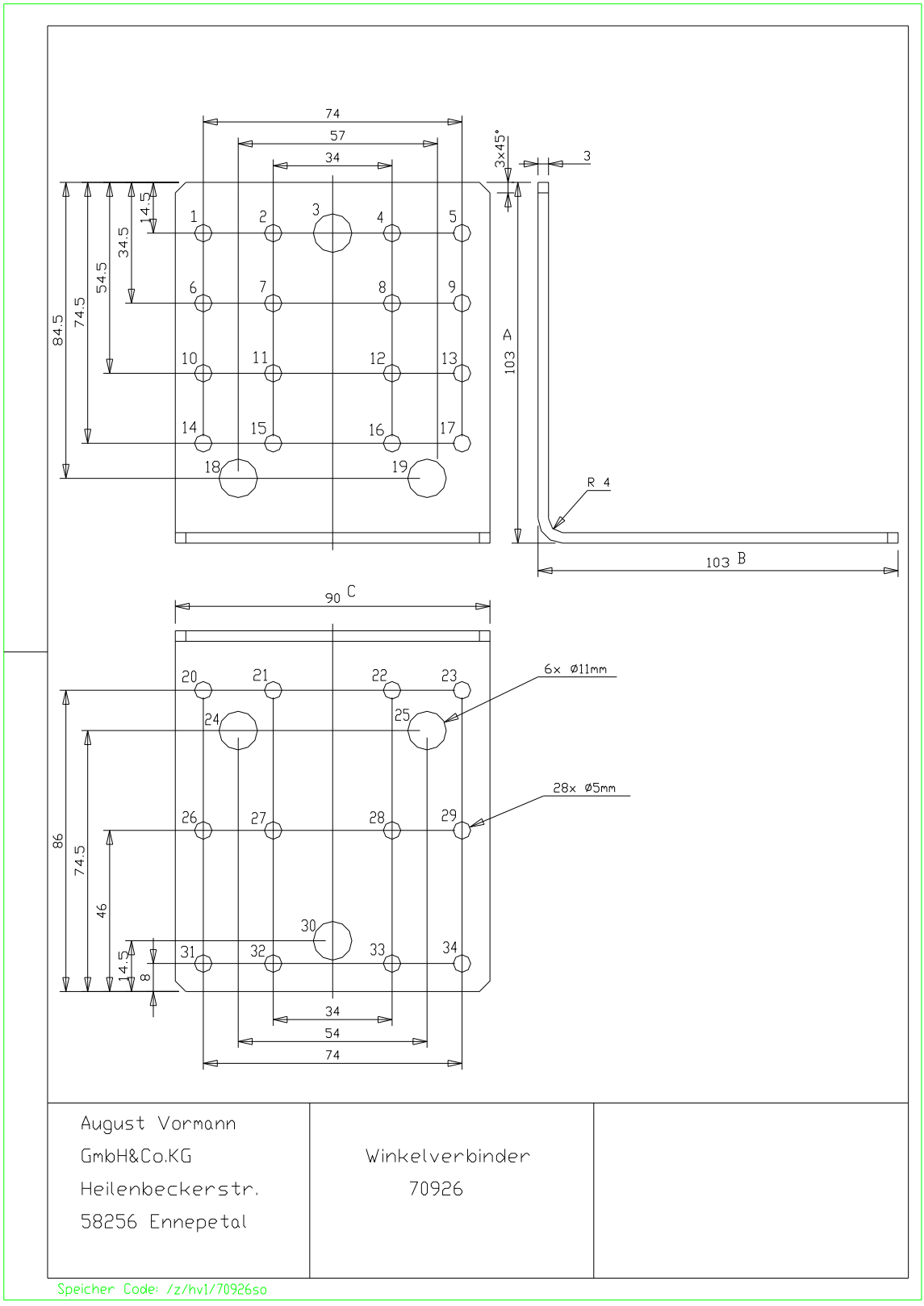
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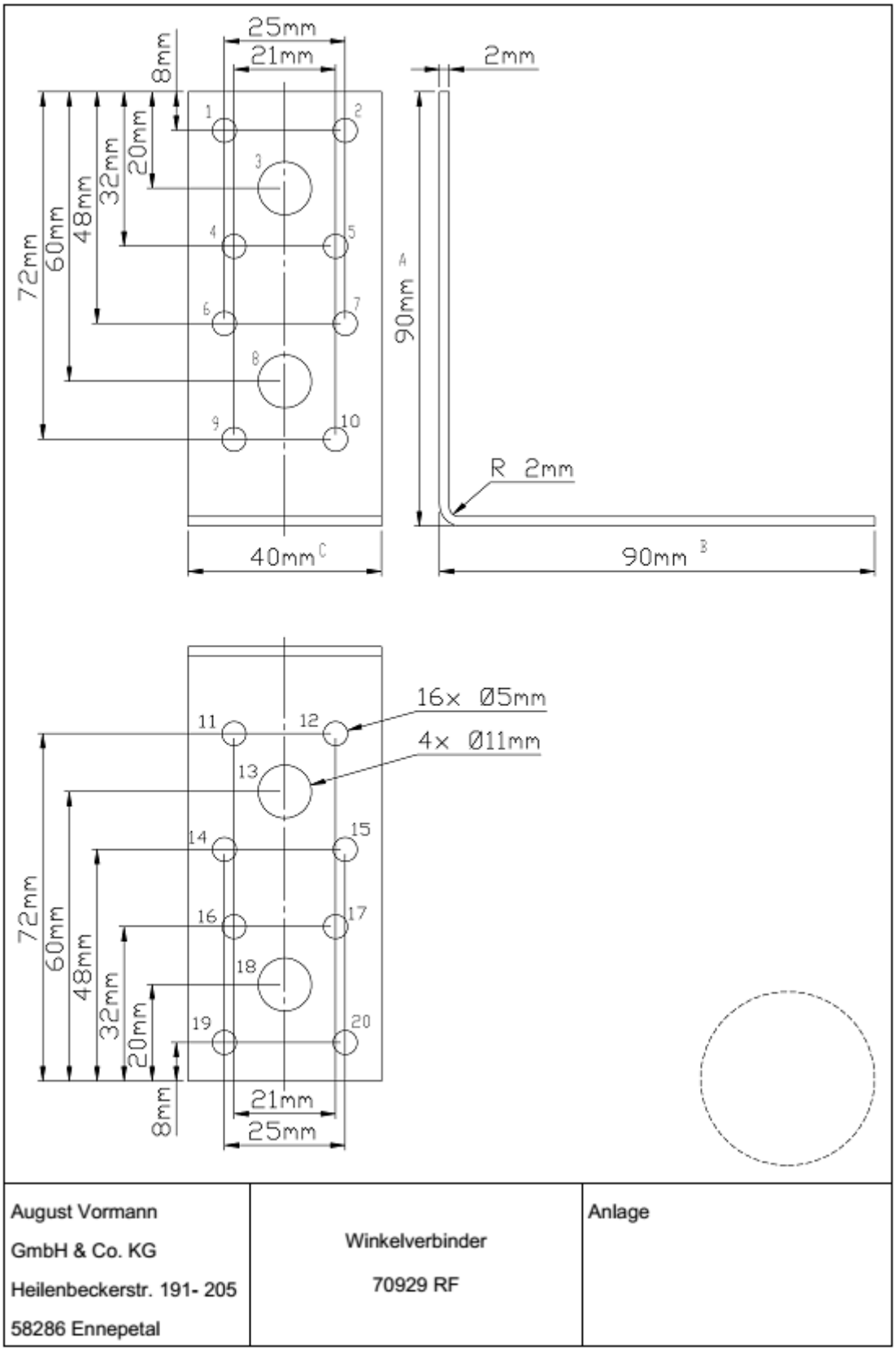


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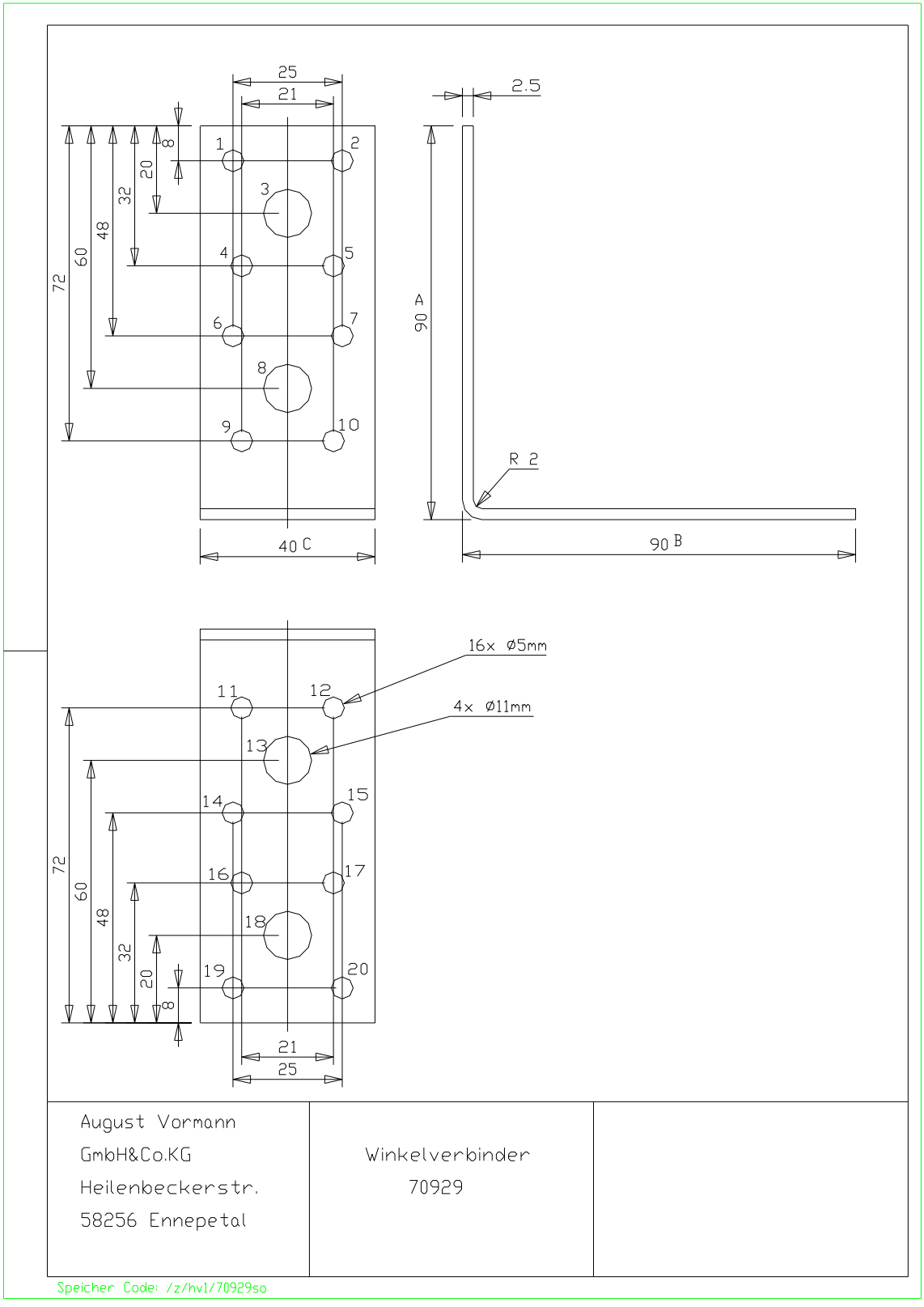
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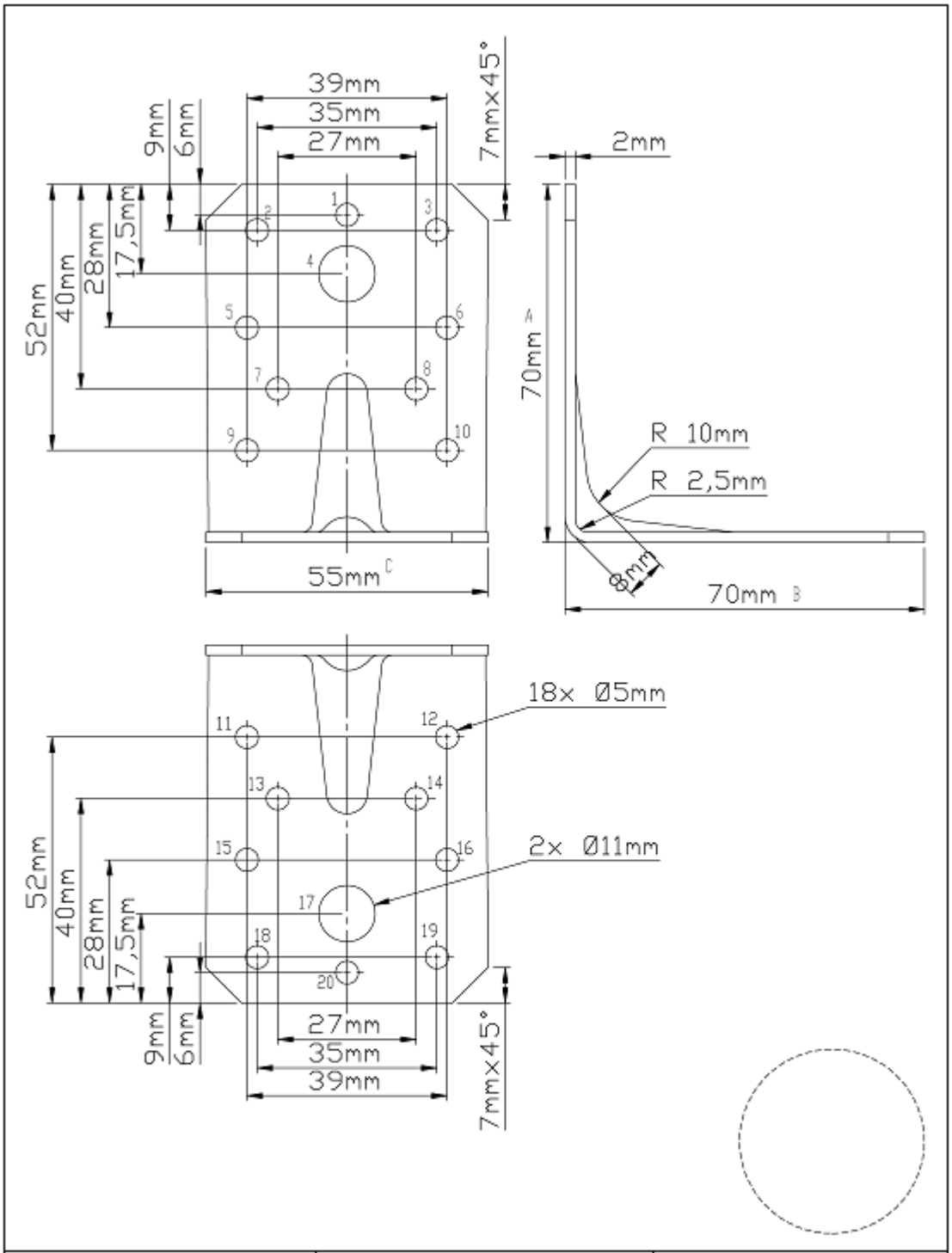


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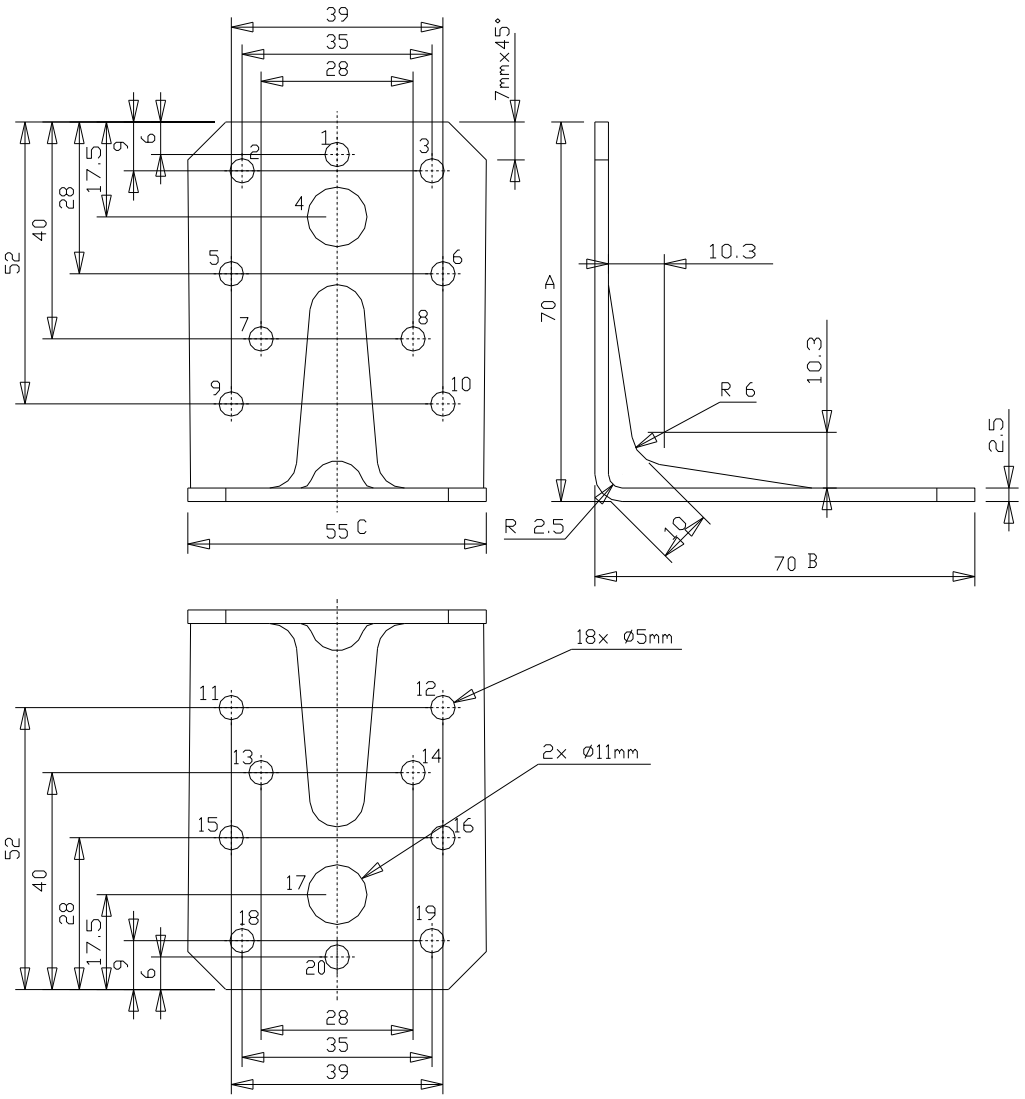


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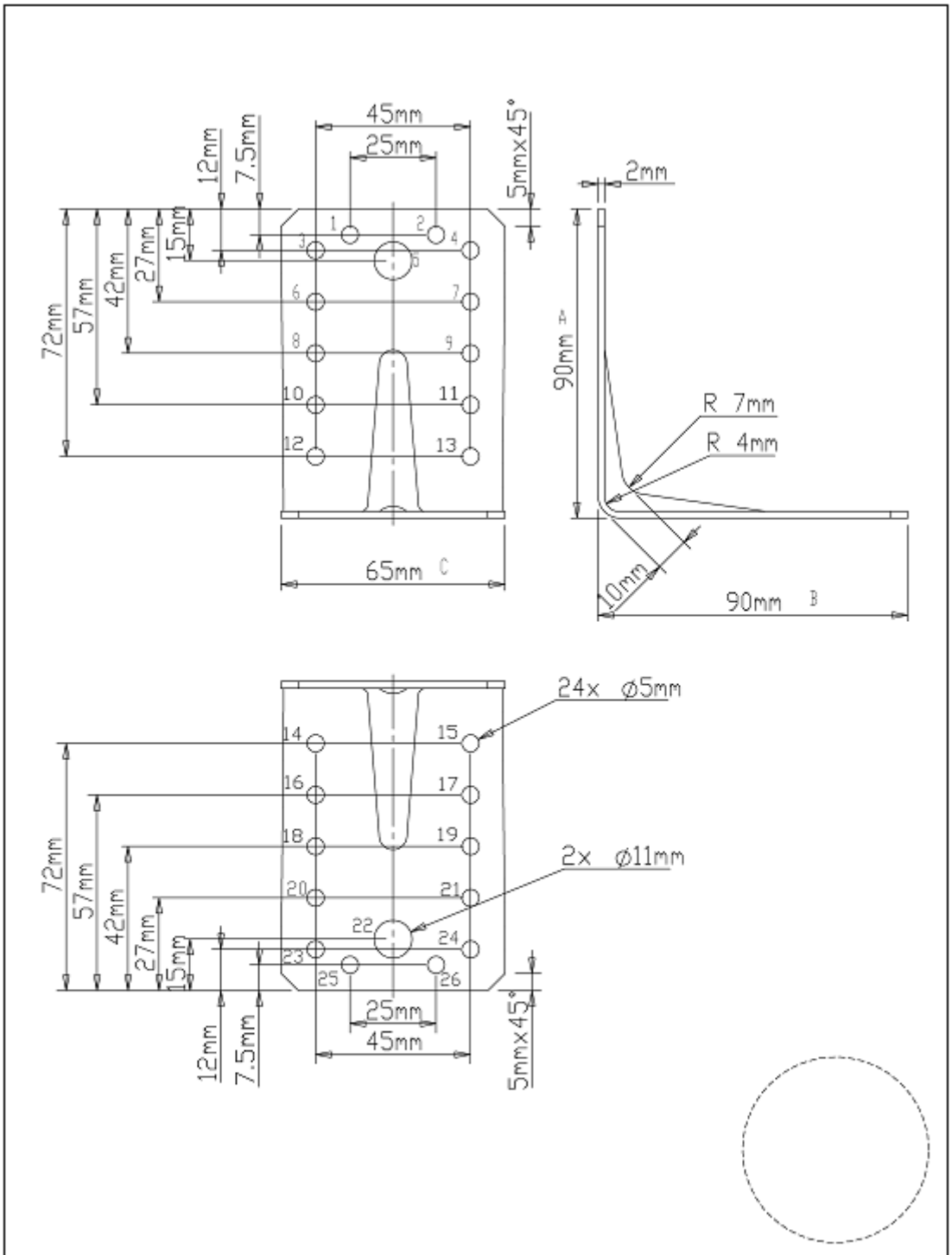


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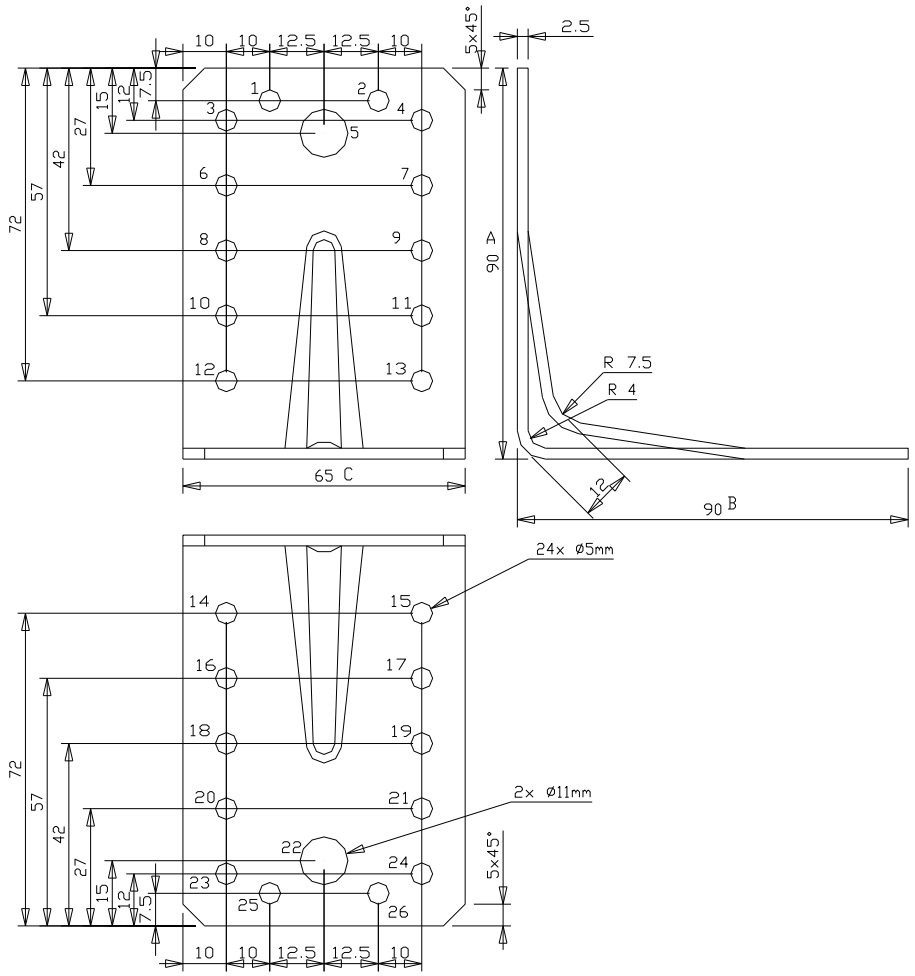


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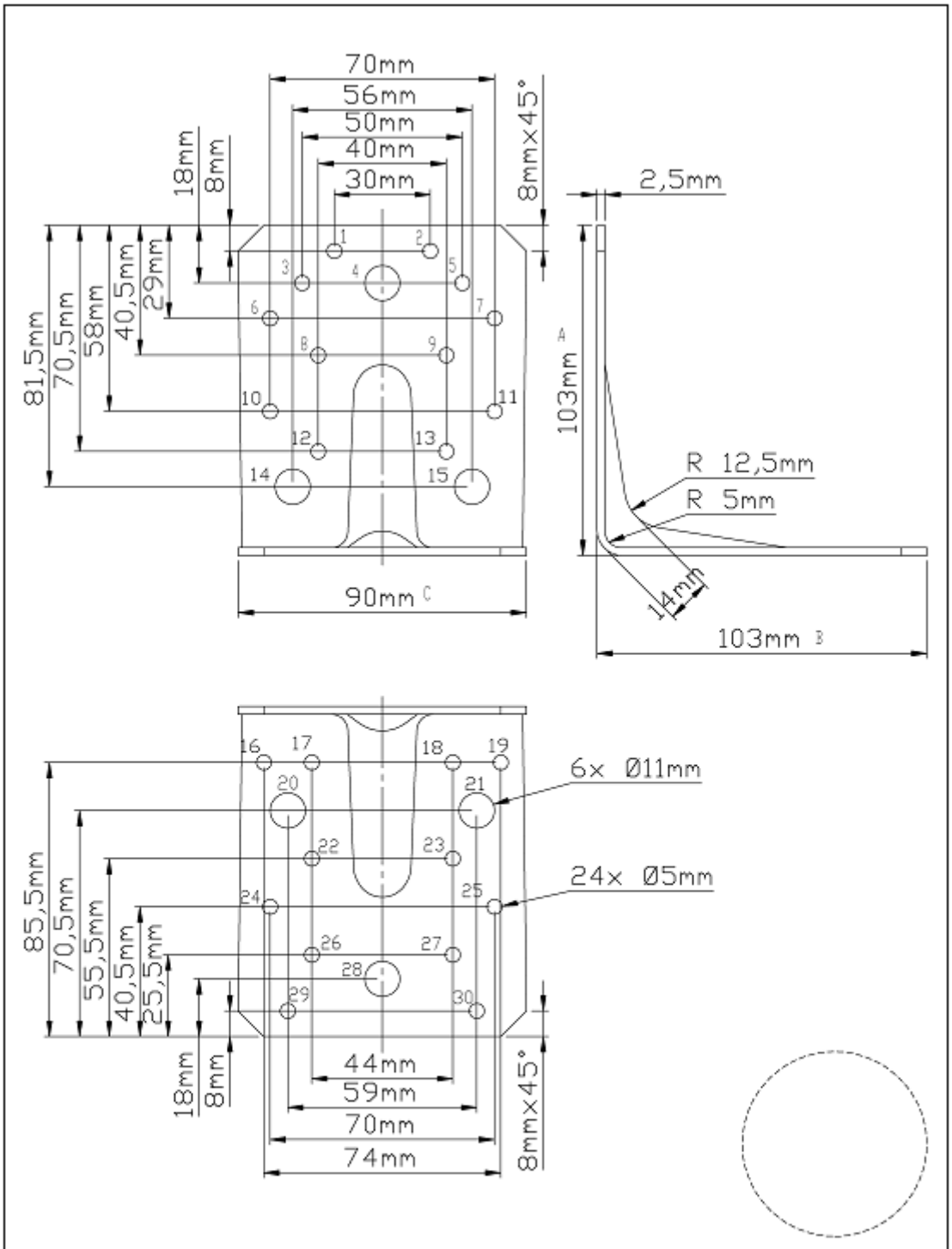


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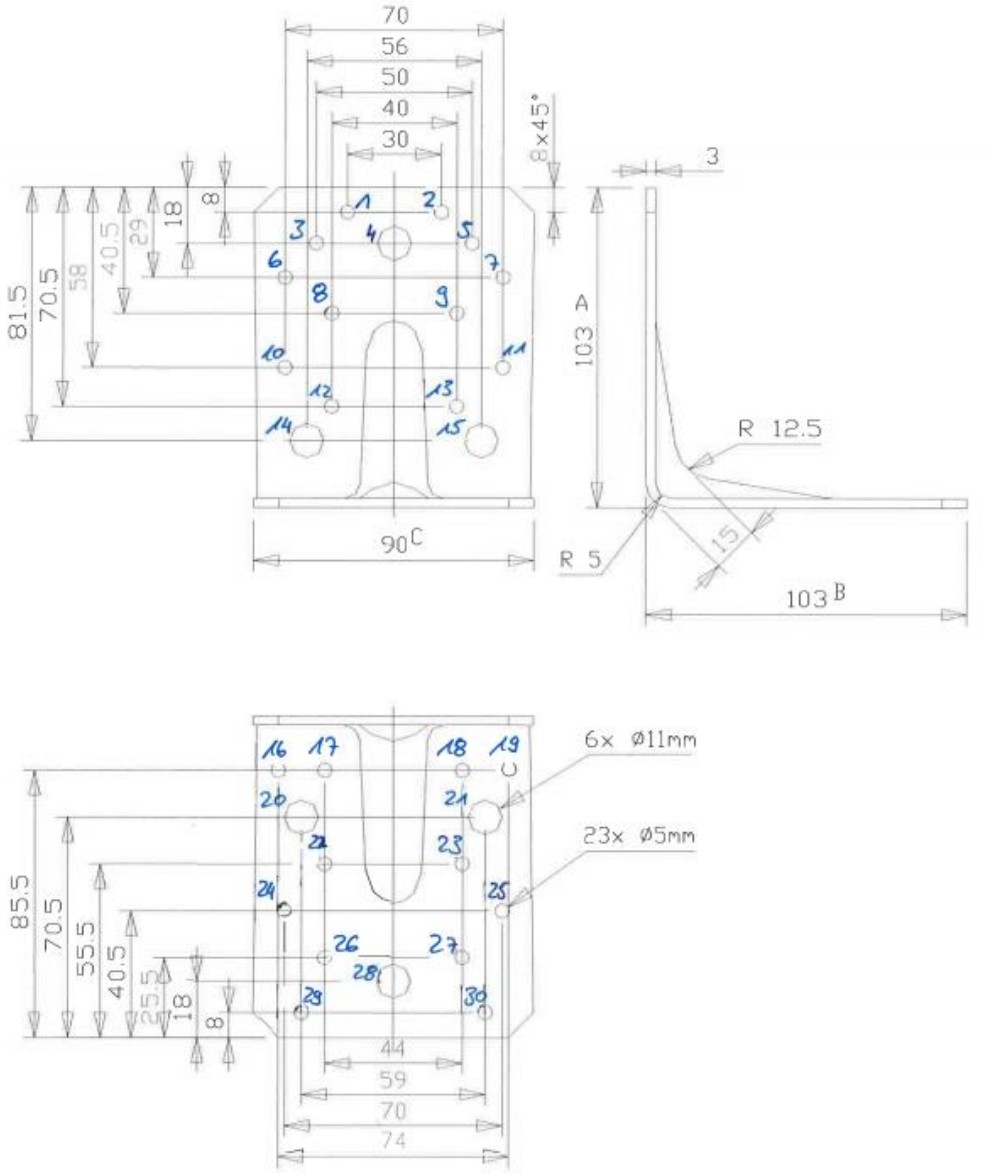
| August Vormann<br>GmbH & Co. KG<br>Heilenbeckerstr. 191- 205<br>58286 Ennepetal | Winkelverbinder<br>70933 RF | Anlage |




070 933 000 with 103 x 103 x 90 x 3.0 mm

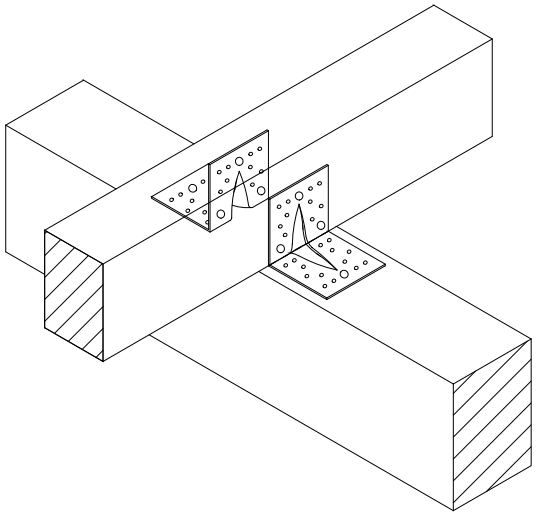


Figure A.1: Typical installation

## Annex B
## Characteristic load-carrying capacities

The following tables contain the characteristic values for the load carrying capacities of the angle brackets for the column or purlin and beam connections. The minimum rated value resulting from timber failure and steel failure is applicable. It must be ensured that the timber members are restrained against rotation. The hole numbers specified must be provided with nails.

### S 250 GD / Z275 Steel brackets

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

| Bracket number | Nail number $n_V$ | Nail number $n_H$ | $F_{1,Rk}$ [kN] (column) | |
|---|---|---|---|---|
| | | | Timber | Steel |
| 070 921 000 50x50x35x2,5 | - | - | - | - |
| 070 923 000 60x60x45x2,5 | 1,2 | 8,9,13,14 | 2,11 | 1,53 |
| 070 924 000 70x70x55x2,5 | 1,2,3 | 11,12,15,16,18,19 | 2,20 | 1,95 |
| 070 925 000 90x90x65x2,5 | 1,2,6,7 | 15,16,17,20,21,25,26 | 3,59 | 2,17 |
| 070 926 000 103x103x90x3,0 | 1,2,4,5,6,7,8,9 | 20,21,22,23,26,27,28,29,31,32,33,34 | 5,02 | 4,63 |
| 070 929 000 90x90x40x2,5 | 1,2,4,5 | 11,12,14,15,16,17,19,20 | 2,39 | 1,30 |
| 070 931 000 70x70x55x2,5 | 1,2,3 | 11,12,15,16,18,19 | 3,18 | 3,46 |
| 070 932 000 90x90x65x2,5 | 1,2,6,7 | 14,15,18,19,23,24 | 4,05 | 4,53 |
| 070 933 000 103x103x90x3,0 | 1,2,6,7 | 16,17,18,19,22,23,24,25,29,30 | 5,72 | 16,50 |

The table contains the characteristic values of the load carrying capacity for a column connection. Values must be halved for one joint per connection.

**Table 2:** Force $F_1$ Purlin, 2 angle brackets / connection, Timber to timber

| Bracket number | Nail number $n_V$ | Nail number $n_H$ | $F_{1,Rk}$ [kN] (purlin) | |
|---|---|---|---|---|
| | | | Timber | Steel |
| 070 921 000 50x50x35x2,5 | 1,2 | 8,9,13,14 | 2,25 | 1,58 |
| 070 923 000 60x60x45x2,5 | 1,2,4,5 | 8,9,13,14 | 2,11 | 1,53 |
| 070 924 000 70x70x55x2,5 | 2,3,7,8 | 11,12,15,16,18,19 | 2,20 | 1,95 |
| 070 925 000 90x90x65x2,5 | 3,4,6,7,8,9,10,11 | 15,16,17,20,21,25,26 | 3,59 | 2,17 |

| | | | | |
|---|---|---|---|---|
| 070 926 000<br>103x103x90x3,0 | 1,2,4,5,6,7,8,9,<br>10,11,12,13,14,15,16,17 | 20,21,22,23,26,27,28,29,31,32,33,34 | 5,02 | 4,63 |
| 070 929 000<br>90x90x40x2,5 | 1,2,4,5,6,7 | 11,12,14,15,16,17,19,20 | 2,39 | 1,30 |
| 070 931 000<br>70x70x55x2,5 | 2,3,7,8 | 11,12,15,16,18,19 | 3,18 | 3,46 |
| 070 932 000<br>90x90x65x2,5 | 3,4,6,7,8,9,10,11 | 14,15,18,19,23,24 | 4,05 | 4,53 |
| 070 933 000<br>103x103x90x3,0 | 1,2,6,7,8,9,10,11,12,13 | 16,17,18,19,22,23,24,25,29,30 | 5,72 | 16,50 |

The table contains the characteristic values of the load carrying capacity for a purlin connection. Values must be halved for one joint per connection.

**Table 3:** Forces $F_{2,3}$, 2 angle brackets / connection, Timber to timber

| Bracket number | Nail number $n_V$ | Nail number $n_H$ | $F_{2,3,Rk}$ [kN] |
|---|---|---|---|
| | | | Timber |
| 070 921 000<br>50x50x35x2,5 | 1,2,4,5 | 8,9,13,14 | 4,39 |
| 070 923 000<br>60x60x45x2,5 | 1,2,4,5 | 8,9,13,14 | 3,99 |
| 070 924 000<br>70x70x55x2,5 | 2,3,7,8 | 11,12,15,16,18,19 | 5,89 |
| 070 925 000<br>90x90x65x2,5 | 3,4,6,7,8,9,10,11 | 15,16,17,20,21,25,26 | 8,68 |
| 070 926 000<br>103x103x90x3,0 | 1,2,4,5,6,7,8,9,<br>10,11,12,13,14,15,16,17 | 20,21,22,23,26,27,28,29,31,32,33,34 | 15,50 |
| 070 929 000<br>90x90x40x2,5 | 1,2,4,5,6,7 | 11,12,14,15,16,17,19,20 | 5,41 |
| 070 931 000<br>70x70x55x2,5 | 2,3,7,8 | 11,12,15,16,18,19 | 5,89 |
| 070 932 000<br>90x90x65x2,5 | 3,4,6,7,8,9,10,11 | 14,15,18,19,23,24 | 7,72 |
| 070 933 000<br>103x103x90x3,0 | 1,2,6,7,8,9,10,11,12,13 | 16,17,18,19,22,23,24,25,29,30 | 11,50 |

The table contains the characteristic values of the load carrying capacity for a purlin connection. Values must be halved for one joint per connection.

**Table 4:** Basic Forces $F_{4,5}$, 2 angle brackets / connection, Timber to timber

| Bracket number | Nail number $n_V$ | Nail number $n_H$ | $F_{4,5,Rk}$ [kN] | |
|---|---|---|---|---|
| | | | Timber | Steel |
| 070 921 000<br>50x50x35x2,5 | 1,2,4,5 | 8,9,13,14 | 4,47 | 1,96 |
| 070 923 000<br>60x60x45x2,5 | 1,2,4,5 | 8,9,13,14 | 5,00 | 2,61 |

| | | | | |
|---|---|---|---|---|
| 070 924 000<br>70x70x55x2,5 | 2,3,7,8 | 11,12,15,16,18,19 | 5,24 | 3,72 |
| 070 925 000<br>90x90x65x2,5 | 3,4,6,7,8,9,10,11 | 15,16,17,20,21,25,26 | 6,87 | 4,13 |
| 070 926 000<br>103x103x90x3,0 | 1,2,4,5,6,7,8,9,<br>10,11,12,13,14,15,16,17 | 20,21,22,23,26,27,28,29,31,32,33,34 | 11,40 | 7,79 |
| 070 929 000<br>90x90x40x2,5 | 1,2,4,5,6,7 | 11,12,14,15,16,17,19,20 | 4,80 | 2,34 |
| 070 931 000<br>70x70x55x2,5 | 2,3,7,8 | 11,12,15,16,18,19 | 5,51 | 4,85 |
| 070 932 000<br>90x90x65x2,5 | 3,4,6,7,8,9,10,11 | 14,15,18,19,23,24 | 7,17 | 5,65 |
| 070 933 000<br>103x103x90x3,0 | 1,2,6,7,8,9,10,11,12,13 | 16,17,18,19,22,23,24,25,29,30 | 10,60 | 11,10 |

The table contains the characteristic values of the load carrying capacity for a purlin connection. Load case $F_{4/5}$ describes a connection with two angle joints per connection. The component 2 is allowed to be restrained against rotation by the angle brackets. In this case, an additional force $\Delta F_1$ has to be considered.

**Table 5:** Basic Forces $F_4$, 1 angle bracket / connection, Timber to timber

| Bracket number | Nail number $n_V$ | Nail number $n_H$ | $F_{4,Rk}$ [kN] | |
|---|---|---|---|---|
| | | | Timber | Steel |
| 070 931 000<br>70x70x55x2,5 | 2,3,7,8 | 11,12,15,16,18,19 | 6,26 | 3,61 |
| 070 932 000<br>90x90x65x2,5 | 3,4,6,7,8,9,10,11 | 14,15,18,19,23,24 | 8,04 | 3,98 |
| 070 933 000<br>103x103x90x3,0 | 1,2,6,7,8,9,10,11,12,13 | 16,17,18,19,22,23,24,25,29,30 | 11,67 | 7,81 |

The table specifies the characteristic value of the load carrying capacity for a purlin connection with only one angle joint. In the case of load case $F_4$, force facing towards to the angle.

**Table 6:** Basic Forces $F_5$, 1 angle bracket / connection, Timber to timber

| Bracket number | Nail number $n_V$ | Nail number $n_H$ | $F_{5,Rk}$ [kN] | |
|---|---|---|---|---|
| | | | Timber | Steel |
| 070 931 000<br>70x70x55x2,5 | 2,3,7,8 | 11,12,15,16,18,19 | 1,57 | 1,41 |
| 070 932 000<br>90x90x65x2,5 | 3,4,6,7,8,9,10,11 | 14,15,18,19,23,24 | 2,13 | 1,82 |
| 070 933 000<br>103x103x90x3,0 | 1,2,6,7,8,9,10,11,12,13 | 16,17,18,19,22,23,24,25,29,30 | 3,16 | 3,66 |

The table**Table 6** specifies the characteristic value of the load carrying capacity for a purlin connection with only one angle joint. In the case of load case $F_5$, force is averted from the angle.

**Stainless steel brackets**

**Table 7:** Force $F_1$ Column, 2 angle brackets / connection, stainless steel, Timber to timber

| Bracket number | Nail number $n_V$ | Nail number $n_H$ | $F_{1,Rk}$ [kN] (column) | |
|---|---|---|---|---|
| | | | Timber | Steel |
| 070 924 000 70x70x55x2,0 | 1,2,3 | 11,12,15,16,18,19 | 2,20 | 1,20 |
| 070 924 000 70x70x55x2,5 | 1,2,3 | 11,12,15,16,18,19 | 2,20 | 1,88 |
| 070 925 000 90x90x65x2,5 | 1,2,6,7 | 15,16,17,20,21,25,26 | 3,59 | 1,33 |
| 070 925 000 90x90x65x2,0 | 1,2,6,7 | 15,16,17,20,21,25,26 | 3,59 | 2,08 |
| 070 926 000 103x103x90x2,5 | 1,2,4,5,6,7,8,9 | 20,21,22,23,26,27,28,29,31,32,33,34 | 5,02 | 3,09 |
| 070 926 000 103x103x90x3,0 | 1,2,4,5,6,7,8,9 | 20,21,22,23,26,27,28,29,31,32,33,34 | 5,02 | 4,45 |
| 070 929 000 90x90x40x2,0 | 1,2,4,5 | 11,12,14,15,16,17,19,20 | 2,39 | 0,80 |
| 070 929 000 90x90x40x2,5 | 1,2,4,5 | 11,12,14,15,16,17,19,20 | 2,39 | 1,25 |
| 070 931 000 70x70x55x2,0 | 1,2,3 | 11,12,15,16,18,19 | 2,64 | 2,47 |
| 070 931 000 70x70x55x2,5 | 1,2,3 | 11,12,15,16,18,19 | 3,18 | 3,33 |
| 070 932 000 90x90x65x2,0 | 1,2,6,7 | 14,15,18,19,23,24 | 3,62 | 3,28 |
| 070 932 000 90x90x65x2,5 | 1,2,6,7 | 14,15,18,19,23,24 | 4,05 | 4,35 |
| 070 933 000 103x103x90x2,5 | 1,2,6,7 | 16,17,18,19,22,23,24,25,29,30 | 5,71 | 13,40 |
| 070 933 000 103x103x90x3,0 | 1,2,6,7 | 16,17,18,19,22,23,24,25,29,30 | 5,72 | 15,90 |

The table contains the characteristic values of the load carrying capacity for a column connection. Values must be halved for one joint per connection.

**Table 8:** Force $F_1$ Purlin, 2 angle brackets / connection, stainless steel, Timber to timber

| Bracket number | Nail number $n_V$ | Nail number $n_H$ | $F_{1,Rk}$ [kN] (purlin) | |
|---|---|---|---|---|
| | | | Timber | Steel |
| 070 924 000 70x70x55x2,0 | 2,3,7,8 | 11,12,15,16,18,19 | 2,20 | 1,20 |
| 070 924 000 70x70x55x2,5 | 2,3,7,8 | 11,12,15,16,18,19 | 2,20 | 1,88 |
| 070 925 000 90x90x65x2,5 | 3,4,6,7,8,9,10,11 | 15,16,17,20,21,25,26 | 3,59 | 1,33 |

| | | | | |
|---|---|---|---|---|
| 070 925 000<br>90x90x65x2,0 | 3,4,6,7,8,9,10,11 | 15,16,17,20,21,25,26 | 3,59 | 2,08 |
| 070 926 000<br>103x103x90x2,5 | 1,2,4,5,6,7,8,9,<br>10,11,12,13,14,15,16,17 | 20,21,22,23,26,27,28,29,31,32,33,34 | 5,02 | 3,09 |
| 070 926 000<br>103x103x90x3,0 | 1,2,4,5,6,7,8,9,<br>10,11,12,13,14,15,16,17 | 20,21,22,23,26,27,28,29,31,32,33,34 | 5,02 | 4,45 |
| 070 929 000<br>90x90x40x2,0 | 1,2,4,5,6,7 | 11,12,14,15,16,17,19,20 | 2,39 | 0,80 |
| 070 929 000<br>90x90x40x2,5 | 1,2,4,5,6,7 | 11,12,14,15,16,17,19,20 | 2,39 | 1,25 |
| 070 931 000<br>70x70x55x2,0 | 2,3,7,8 | 11,12,15,16,18,19 | 2,64 | 2,47 |
| 070 931 000<br>70x70x55x2,5 | 2,3,7,8 | 11,12,15,16,18,19 | 3,18 | 3,33 |
| 070 932 000<br>90x90x65x2,0 | 3,4,6,7,8,9,10,11 | 14,15,18,19,23,24 | 3,62 | 3,28 |
| 070 932 000<br>90x90x65x2,5 | 3,4,6,7,8,9,10,11 | 14,15,18,19,23,24 | 4,05 | 4,35 |
| 070 933 000<br>103x103x90x2,5 | 1,2,6,7,8,9,10,11,12,13 | 16,17,18,19,22,23,24,25,29,30 | 5,71 | 13,40 |
| 070 933 000<br>103x103x90x3,0 | 1,2,6,7,8,9,10,11,12,13 | 16,17,18,19,22,23,24,25,29,30 | 5,72 | 15,90 |

The table contains the characteristic values of the load carrying capacity for a purlin connection. Values must be halved for one joint per connection.

**Table 9:** Forces $F_{2,3}$, 2 angle brackets / connection, stainless steel, Timber to timber

| Bracket number | Nail number $n_V$ | Nail number $n_H$ | $F_{2,3,Rk}$ [kN] |
|---|---|---|---|
| | | | Timber |
| 070 924 000<br>70x70x55x2,0 | 2,3,7,8 | 11,12,15,16,18,19 | 5,93 |
| 070 924 000<br>70x70x55x2,5 | 2,3,7,8 | 11,12,15,16,18,19 | 5,89 |
| 070 925 000<br>90x90x65x2,5 | 3,4,6,7,8,9,10,11 | 15,16,17,20,21,25,26 | 8,74 |
| 070 925 000<br>90x90x65x2,0 | 3,4,6,7,8,9,10,11 | 15,16,17,20,21,25,26 | 8,68 |
| 070 926 000<br>103x103x90x2,5 | 1,2,4,5,6,7,8,9,<br>10,11,12,13,14,15,16,17 | 20,21,22,23,26,27,28,29,31,32,33,34 | 15,60 |
| 070 926 000<br>103x103x90x3,0 | 1,2,4,5,6,7,8,9,<br>10,11,12,13,14,15,16,17 | 20,21,22,23,26,27,28,29,31,32,33,34 | 15,50 |
| 070 929 000<br>90x90x40x2,0 | 1,2,4,5,6,7 | 11,12,14,15,16,17,19,20 | 5,44 |
| 070 929 000<br>90x90x40x2,5 | 1,2,4,5,6,7 | 11,12,14,15,16,17,19,20 | 5,41 |

| | | | |
|---|---|---|---|
| 070 931 000<br>70x70x55x2,0 | 2,3,7,8 | 11,12,15,16,18,19 | 5,93 |
| 070 931 000<br>70x70x55x2,5 | 2,3,7,8 | 11,12,15,16,18,19 | 5,89 |
| 070 932 000<br>90x90x65x2,0 | 3,4,6,7,8,9,10,11 | 14,15,18,19,23,24 | 7,78 |
| 070 932 000<br>90x90x65x2,5 | 3,4,6,7,8,9,10,11 | 14,15,18,19,23,24 | 7,72 |
| 070 933 000<br>103x103x90x2,5 | 1,2,6,7,8,9,10,11,12,13 | 16,17,18,19,22,23,24,25,29,30 | 11,60 |
| 070 933 000<br>103x103x90x3,0 | 1,2,6,7,8,9,10,11,12,13 | 16,17,18,19,22,23,24,25,29,30 | 11,50 |

The table contains the characteristic values of the load carrying capacity for a purlin connection. Values must be halved for one joint per connection.

**Table 10:** Basic Forces $F_{4,5}$, 2 angle brackets / connection, stainless steel, Timber to timber

| Bracket number | Nail number $n_V$ | Nail number $n_H$ | $F_{4,5,Rk}$ [kN] | |
|---|---|---|---|---|
| | | | Timber | Steel |
| 070 924 000<br>70x70x55x2,0 | 2,3,7,8 | 11,12,15,16,18,19 | 5,49 | 2,72 |
| 070 924 000<br>70x70x55x2,5 | 2,3,7,8 | 11,12,15,16,18,19 | 5,24 | 3,57 |
| 070 925 000<br>90x90x65x2,5 | 3,4,6,7,8,9,10,11 | 15,16,17,20,21,25,26 | 6,49 | 3,05 |
| 070 925 000<br>90x90x65x2,0 | 3,4,6,7,8,9,10,11 | 15,16,17,20,21,25,26 | 6,87 | 3,96 |
| 070 926 000<br>103x103x90x2,5 | 1,2,4,5,6,7,8,9,<br>10,11,12,13,14,15,16,17 | 20,21,22,23,26,27,28,29,31,32,33,34 | 10,10 | 5,71 |
| 070 926 000<br>103x103x90x3,0 | 1,2,4,5,6,7,8,9,<br>10,11,12,13,14,15,16,17 | 20,21,22,23,26,27,28,29,31,32,33,34 | 11,40 | 7,47 |
| 070 929 000<br>90x90x40x2,0 | 1,2,4,5,6,7 | 11,12,14,15,16,17,19,20 | 3,87 | 1,72 |
| 070 929 000<br>90x90x40x2,5 | 1,2,4,5,6,7 | 11,12,14,15,16,17,19,20 | 4,80 | 2,25 |
| 070 931 000<br>70x70x55x2,0 | 2,3,7,8 | 11,12,15,16,18,19 | 5,48 | 3,68 |
| 070 931 000<br>70x70x55x2,5 | 2,3,7,8 | 11,12,15,16,18,19 | 5,51 | 4,65 |
| 070 932 000<br>90x90x65x2,0 | 3,4,6,7,8,9,10,11 | 14,15,18,19,23,24 | 7,42 | 4,75 |
| 070 932 000<br>90x90x65x2,5 | 3,4,6,7,8,9,10,11 | 14,15,18,19,23,24 | 7,17 | 5,42 |
| 070 933 000<br>103x103x90x2,5 | 1,2,6,7,8,9,10,11,12,13 | 16,17,18,19,22,23,24,25,29,30 | 10,40 | 9,19 |

| | | | | |
|---|---|---|---|---|
| 070 933 000<br>103x103x90x3,0 | 1,2,6,7,8,9,10,11,12,13 | 16,17,18,19,22,23,24,25,29,30 | 10,60 | 10,70 |

The table contains the characteristic values of the load carrying capacity for a purlin connection. Load case $F_{4/5}$ describes a connection with two angle joints per connection. The component 2 is allowed to be restrained against rotation by the angle brackets. In this case, an additional force $\Delta F_1$ has to be considered.

**Table 11:** Basic Forces $F_4$, 1 angle bracket / connection, stainless steel, Timber to timber

| Bracket number | Nail number $n_V$ | Nail number $n_H$ | $F_{4,Rk}$ [kN] | |
|---|---|---|---|---|
| | | | Timber | Steel |
| 070 931 000<br>70x70x55x2,0 | 2,3,7,8 | 11,12,15,16,18,19 | 6,07 | 2,67 |
| 070 931 000<br>70x70x55x2,5 | 2,3,7,8 | 11,12,15,16,18,19 | 6,26 | 3,47 |
| 070 932 000<br>90x90x65x2,0 | 3,4,6,7,8,9,10,11 | 14,15,18,19,23,24 | 7,44 | 3,46 |
| 070 932 000<br>90x90x65x2,5 | 3,4,6,7,8,9,10,11 | 14,15,18,19,23,24 | 8,04 | 3,82 |
| 070 933 000<br>103x103x90x2,5 | 1,2,6,7,8,9,10,11,12,13 | 16,17,18,19,22,23,24,25,29,30 | 11,42 | 6,50 |
| 070 933 000<br>103x103x90x3,0 | 1,2,6,7,8,9,10,11,12,13 | 16,17,18,19,22,23,24,25,29,30 | 11,67 | 7,50 |

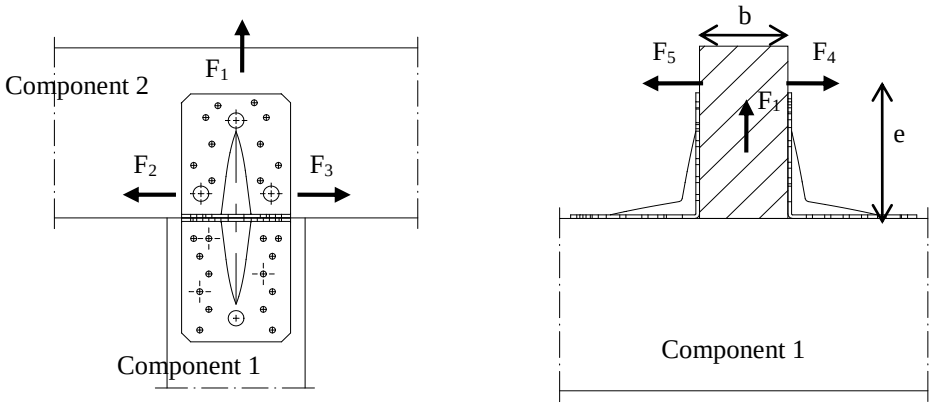
The table specifies the characteristic value of the load carrying capacity for a purlin connection with only one angle joint. In the case of load case $F_4$, force facing towards to the angle.

**Table 12:** Basic Forces $F_5$, 1 angle bracket / connection, stainless steel, Timber to timber

| Bracket number | Nail number $n_V$ | Nail number $n_H$ | $F_{5,Rk}$ [kN] | |
|---|---|---|---|---|
| | | | Timber | Steel |
| 070 931 000<br>70x70x55x2,0 | 2,3,7,8 | 11,12,15,16,18,19 | 1,50 | 1,02 |
| 070 931 000<br>70x70x55x2,5 | 2,3,7,8 | 11,12,15,16,18,19 | 1,57 | 1,35 |
| 070 932 000<br>90x90x65x2,0 | 3,4,6,7,8,9,10,11 | 14,15,18,19,23,24 | 2,02 | 1,32 |
| 070 932 000<br>90x90x65x2,5 | 3,4,6,7,8,9,10,11 | 14,15,18,19,23,24 | 2,13 | 1,75 |
| 070 933 000<br>103x103x90x2,5 | 1,2,6,7,8,9,10,11,12,13 | 16,17,18,19,22,23,24,25,29,30 | 3,05 | 2,97 |
| 070 933 000<br>103x103x90x3,0 | 1,2,6,7,8,9,10,11,12,13 | 16,17,18,19,22,23,24,25,29,30 | 3,16 | 3,51 |

The table specifies the characteristic value of the load carrying capacity for a purlin connection with only one angle joint. In the case of load case $F_5$, force is averted from the angle.

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




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

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

Acting forces

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

**Single angle bracket per connection**
Acting forces

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

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

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

**Combined forces**

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

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

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

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

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

B is the width of component 2.