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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-10/0010 of 09/08/2016

I General Part

Technical Assessment Body issuing the ETA and designated according to Article 29 of the Regulation (EU) No 305/2011: ETA-Danmark A/S	
Trade name of the construction product:	GH Angle brackets and hold-downs
Product family to which the above construction product belongs:	Three-dimensional nailing plate (Angle brackets and hold-downs for timber-to-timber or timber-to-concrete or steel connections)
Manufacturer:	GH-Baubeschläge GmbH Austraße 34 D-73235 Weilheim/Teck Tel. +49 7023 743323 0 Fax +49 7023 743323 90 Internet www.holzverbinder.de
Manufacturing plant:	Werk 1, Werk 2
This European Technical Assessment contains:	46 pages including 2 annexes which form an integral part of the document
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of:	Guideline for European Technical Approval (ETAG) No. 015 Three Dimensional Nailing Plates, April 2013, used as European Assessment Document (EAD).
This version replaces:	The previous ETA with the same number issued on 2015-01-26

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

II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product and intended use

Technical description of the product
GH angle brackets or hold-downs, respectively, are one-piece non-welded or welded, face-fixed angle brackets to be used in timber to timber or in timber to concrete or to steel connections. They are connected to construction members made of timber or wood-based products with profiled (ringed shank) nails or screws according to EN 14592 or screws and profiled nails according to ETA-13/0523 and to concrete or steel members with bolts or metal anchors.

The angle brackets or hold-downs with a steel plate thickness of 2 mm to 4 mm are made from pre-galvanized steel S250 GD / Z 275 or DX 51 D / Z 275 according to EN 10346 with $R_e \geq 250$ N/mm², $R_m \geq 360$ N/mm² and $A_{80} \geq 19\%$ or steel grade S355 according to EN 10025-2. The Washers are made from steel grade S235 according to EN 10025-2. Dimensions, hole positions and typical installations are shown in Annex A and B. GH angle brackets and hold-downs 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 and hold-downs are intended for use in making connections in load bearing timber structures, as a connection between a column or a purlin and a concrete or steel member, where requirements for mechanical resistance and stability and safety in use in the sense of the Basic Works Requirements 1 and 4 of Regulation (EU) 305/2011 shall be fulfilled.

The 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 classified to C14-C40 according to EN 14081,
- Glulam classified to GL24-GL36 according to EN 14080,
- LVL according to EN 14374,
- Parallam PSL,
- Intrallam LSL,
- Glued solid timber according to EN 14080,
- Cross laminated timber,
- Plywood according to EN 636

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

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

Where ρ_k 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 fasteners into the members. If a wood-based panel interlayer is placed between the connector plate and the timber member, the lateral load-carrying capacity of the nail or screw, respectively, has to take into account the effect of the interlayer.

The angle brackets and hold-downs 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 may 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. If a stainless steel with a lower characteristic yield or ultimate strength is employed, the load-carrying capacities $F_{m,Rk}$, $F_{v,Rk}$ or $F_{t,Rk}$ in Tables 1 and 2 (see annex B) are to be reduced proportionally.

The angle brackets and hold-downs may also be used for connections between two timber members.

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

The provisions made in this European Technical Assessment are based on an assumed intended working life of the connectors of 50 years.

The indications given on the working life cannot be interpreted as a guarantee given by the producer or Assessment Body, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

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

Characteristic	Assessment of characteristic
3.1 Mechanical resistance and stability*) (BWR1)	
Characteristic load-carrying capacity	See Annex B
Stiffness	No performance determined
Ductility in cyclic testing	No performance determined
3.2 Safety in case of fire (BWR2)	
Reaction to fire	The angle brackets and hold-downs are made from steel classified as **Euroclass A1** in accordance with EN 1350-1 and EC decision 96/603/EC, amended by EC Decision 2000/605/EC
3.3 Hygiene, health and the environment (BWR3)	
Influence on air quality	The product does not contain/release dangerous substances specified in TR 034, dated March 2012*)
3.7 Sustainable use of natural resources (BWR7)	No Performance Determined
3.8 General aspects related to the performance of the product	The angle brackets and hold-downs 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

The characteristic load-carrying capacities are based on the characteristic values of the nail or screw 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 or screws subjected to shear or the withdrawal capacity of the most loaded nail or screw, respectively) as well as for steel plate failure $F_{Rk,S}$. The design value of the load–carrying capacity is the smaller value of both load–carrying capacities.

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

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

3.10 Mechanical resistance and stability

See annex B for the characteristic load-carrying capacity in the different directions F_1 to F_3.

The characteristic capacities of the angle brackets and hold-downs 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.

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

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

3.11 Aspects related to the performance of the product

3.11.1 Corrosion protection in service class 1 and 2.
In accordance with ETAG 015 the zinc-coated hold downs and angle brackets have a zinc coating weight of min Z275. The steel employed is S250 GD+Z275 to EN 10346:2009 or DX51D with min Z275 according to EN 10346:2009, and steel grade S355 according to EN 10025-2 with Fe Zn 12C.

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

The performance given in this ETA are based on the following:

- The structural members – the components 1 and 2 shown in the figure on page 12 – to which the brackets are fixed shall be:
  - Restrained against rotation.
  - Strength class C14 or better, see section 3 of this evaluation report
  - 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.

4 Attestation and verification of constancy of performance (AVCP)

4.1 AVCP system

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

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

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

Issued in Copenhagen on 2016-08-09 by

Thomas Bruun
Managing Director, ETA-Danmark

Annex A - Product details definitions

Table A.1 Materials specification

Bracket type	Thickness (mm)	Steel specification	Coating specification
type HB 155x50x40x3,0	3,0	S250 GD or DX51D	Z 275
type HSB 200x40x40x2,0	2,0	S250 GD or DX51D	Z 275
type HSB 200x40x40x4,0	4,0	S250 GD or DX51D	Z 275
type HSB 300x40x40x2,0	2,0	S250 GD or DX51D	Z 275
type HSB 300x40x40x4,0	4,0	S250 GD or DX51D	Z 275
type HSB 400x40x40x2,0	2,0	S250 GD or DX51D	Z 275
type HSB 400x40x40x4,0	4,0	S250 GD or DX51D	Z 275
type HSB 500x40x40x2,0	2,0	S250 GD or DX51D	Z 275
type HSB 500x40x40x4,0	4,0	S250 GD or DX51D	Z 275
type HSB 600x40x40x2,0	2,0	S250 GD or DX51D	Z 275
type HSB 600x40x40x4,0	4,0	S250 GD or DX51D	Z 275
hold-down 340x180x40x2,0	2,0	S250 GD or DX51D	Z 275
hold-down 400x120x40x3,0	3,0	S250 GD or DX51D	Z 275
hold-down 420x220x60x2,0	2,0	S250 GD or DX51D	Z 275
hold-down 420x100x60x2,0	2,0	S250 GD or DX51D	Z 275
hold-down 480x120x60x2,5	2,5	S250 GD or DX51D	Z 275
hold-down 280x122x40x2,0	2,0	S250 GD or DX51D	Z 275
hold-down 142x93x60x2,0	2,0	S250 GD or DX51D	Z 275
hold-down 520x222x60x2,5	2,5	S250 GD or DX51D	Z 275
hold-down Top Vario 240x120x55x2,0	2,0	S250 GD or DX51D	Z 275
hold-down Top Vario 280x120x55x2,0	2,0	S250 GD or DX51D	Z 275
HT16 60/340	3,0	S355	Fe Zn 12c
HT22 60/440	3,0	S355	Fe Zn 12c
HT28 60/540	3,0	S355	Fe Zn 12c
HT30 80/420	3,0	S355	Fe Zn 12c
HT32 80/520	3,0	S355	Fe Zn 12c
HT34 80/620	3,0	S355	Fe Zn 12c
HT36 140/740	3,0	S355	Fe Zn 12c
HT28 60/540 Big Hole	3,0	S355	Fe Zn 12c
HT34 80/620 Big Hole	3,0	S355	Fe Zn 12c
Washer 40x43x10	10,0	S 235	Fe Zn 12c
Washer 160x50x15	15,0	S 235	Fe Zn 12c
Washer 110x60x15	15,0	S 235	Fe Zn 12c
Washer 200x60x20	20,0	S 235	Fe Zn 12c
Washer 85x60x20	20,0	S 235	Fe Zn 12c
Washer 115x70x20	20,0	S 235	Fe Zn 12c
Washer 220x60x25	25,0	S 235	Fe Zn 12c
Washer 90x50x12	12,0	S 235	Fe Zn 12c
Washer 114x55x20	20,0	S 235	Fe Zn 12c
Washer 56x50x10	10,0	S 235	Fe Zn 12c
Washer 77x70x20	20,0	S 235	Fe Zn 12c
Washer 80x130x40	40,0	S 235	Fe Zn 12c

Table A1.1 Materials specification bracket types HT2

Hold-down type	**Thickness (mm)**	**Steel specification**	**Coating specification**	**Tension plate**	**Base bracket**
HT2-G-Druckplatte-lang-Z-316	3,0	S355	Fe Zn 12c	GH-HT2 tension plate G M10 340x60x3,0mm	GH-HT2 base bracket 103x144x60x3,0 with washer
HT2-G-Stegwinkel-1Bo-Z-101	3,0	S355	Fe Zn 12c	GH-HT2 tension plate G M10 340x60x3,0mm	GH-HT2 base bracket with web 103x73x60x3,0
HT2-G-Stegwinkel-2Bo-Z-102	3,0	S355	Fe Zn 12c	GH-HT2 tension plate G 2xM10 340x60x3,0mm	GH-HT2 base bracket with web 103x73x60x3,0
HT2-GV-Druckplatte-kurz-Z-310	3,0	S355	Fe Zn 12c	GH-HT2 tension plate G M10 340x60x3,0mm	GH-HT2 base bracket 103x73x60x3,0 with washer
HT2-GV-Druckplatte-lang-Z-320-3	3,0	S355	Fe Zn 12c	GH-HT2 tension plate G M10 340x60x3,0mm	GH-HT2 base bracket with washer 103x144x60x3,0
HT2-GV-Stegwinkel-Z-100	3,0	S355	Fe Zn 12c	GH-HT2 tension plate G M10 340x60x3,0mm	GH-HT2 base bracket with web adjustable height 103x73x60x3,0
HT2-LV-340-Stegwinkel-Z-220	3,0	S355	Fe Zn 12c	GH-HT2 tension plate left M10 340x60/60x3,0mm	GH-HT2 base bracket with web adjustable height 103x73x60x3,0
HT2-LV-425-Stegwinkel-Z-230	3,0	S355	Fe Zn 12c	GH-HT2 tension plate left M10 425x60/60x3,0mm	GH-HT2 base bracket with web adjustable height 103x73x60x3,0
HT2-RV-340-Stegwinkel-Z-225	3,0	S355	Fe Zn 12c	GH-HT2 tension plate right M10 340x60/60x3,0mm	GH-HT2 base bracket with web adjustable height 103x73x60x3,0
HT2-RV-425-Stegwinkel-Z-235	3,0	S355	Fe Zn 12c	GH-HT2 tension plate right M10 425x60/60x3,0mm	GH-HT2 base bracket with web adjustable height 103x73x60x3,0
Washer 140x60x15	15,0	S 235	-	-	-
Washer 70x60x15	15,0	S 235	-	-	-

Table A.2 Range of sizes

Bracket type	Height (mm) vertical		Height (mm) horizontal		Width (mm)	
type HB 155x50x40x3,0	154	156	49	51	39	41
type HSB 200x40x40x2,0	199	201	39	41	39	41
type HSB 200x40x40x4,0	199	201	39	41	39	41
type HSB 300x40x40x2,0	299	301	39	41	39	41
type HSB 300x40x40x4,0	299	301	39	41	39	41
type HSB 400x40x40x2,0	399	401	39	41	39	41
type HSB 400x40x40x4,0	399	401	39	41	39	41
type HSB 500x40x40x2,0	499	501	39	41	39	41
type HSB 500x40x40x4,0	499	501	39	41	39	41
type HSB 600x40x40x2,0	599	601	39	41	39	41
type HSB 600x40x40x4,0	599	601	39	41	39	41
hold-down 340x180x40x2,0	339	341	179	181	39	41
hold-down 400x120x40x3,0	399	401	119	121	39	41
hold-down 420x220x60x2,0	319	421	219	221	59	61
hold-down 420x100x60x2,0	419	421	99	101	59	61
hold-down 480x120x60x2,5	479	481	119	121	59	61
hold-down 280x122x40x2,0	279	281	121	123	39	41
hold-down 142x93x60x2,0	141	143	92	94	59	61
hold-down 520x222x60x2,5	519	521	221	223	59	61
Top Vario 240x120x55x2,0	239	241	119	121	54	56
Top Vario 280x120x55x2,0	279	281	119	121	54	56
HT16 60/340	339	341	62	64	59	61
HT22 60/440	439	441	62	64	64	61
HT28 60/540	539	541	62	64	59	61
HT30 80/420	419	421	62/82	64/84	79	81
HT32 80/520	519	521	62/82	64/84	79	81
HT34 80/620	619	621	62/82	64/84	79	81
HT36 140/740	739	741	82	84	139	141
HT28 60/540 Big Hole	539	541	62	64	59	61
HT34 80/620 Big Hole	619	621	82	84	79	81
Washer 40x43x10	-	-	39	41	42	44
Washer 160x50x15	-	-	159	161	49	51
Washer 110x60x15	-	-	109	111	59	61
Washer 200x60x20	-	-	199	201	59	61
Washer 85x60x20	-	-	84	86	59	61
Washer 115x70x20	-	-	114	116	69	71
Washer 220x60x25	-	-	219	221	59	61
Washer 90x50x12	-	-	89	91	49	51
Washer 114x55x20	-	-	113	115	54	56
Washer 56x50x10	-	-	55	57	49	51
Washer 77x70x20	-	-	76	78	69	71
Washer 80x130x40	-	-	79	81	129	131

Table A.2.1 Range of sizes bracket type HT2

Hold-down type	Height (mm) vertical		Height (mm) horizontal		Width (mm)	
HT2-G-Druckplatte-lang-Z-316	349	351	146	148	59	61
HT2-G-Stegwinkel-1Bo-Z-101	387	389	75	77	59	61
HT2-G-Stegwinkel-2Bo-Z-102	347	349	75	77	59	61
HT2-GV-Druckplatte-kurz-Z-310	340	373	75	77	59	61
HT2-GV-Druckplatte-lang-Z-320-3	340	373	146	148	59	61
HT2-GV-Stegwinkel-Z-100	340	373	75	77	59	61
HT2-LV-340-Stegwinkel-Z-220	340	373	75	77	59	61
HT2-LV-425-Stegwinkel-Z-230	425	458	75	77	59	61
HT2-RV-340-Stegwinkel-Z-225	340	373	75	77	59	61
HT2-RV-425-Stegwinkel-Z-235	425	458	75	77	59	61
Washer 140x60x15	139	141	14,5	16	59	61
Washer 70x60x15	69	71	14,5	16	56	61

Table A.3 Fastener specification

FASTENER	Length Min – max	Nail type
Profiled nail 4.0 mm	40 – 100 mm	Ringed shank nails according to EN 14592
GH-Nail 4.0 mm	40 – 100 mm	Ringed shank nails according to ETA-13/0523
GH-Screw 5.0 mm	35 – 70 mm	Self-tapping screws according to ETA-13/0523

In the load-carrying-capacities of the nailed or screwed connection in Annex B the capacities calculated from the formulas of Eurocode 5 are used assuming a thick steel plate when calculating the lateral fastener load-carrying-capacity. The load-carrying-capacities of the hold downs have been determined based on the use of connector nails ø 4,0 mm or screws ø 5,0 mm in accordance with the european technical approval for the nails or the screws. The characteristic withdrawal capacity of the nails according to EN 14592 has to be determined by calculation in accordance with EN 1995-1-1, paragraph 8.3.2 (head pull-through is not relevant):

$F_{ax,Rk} = f_{1,k} \times d \times t_{pen}$

Where:

$f_{1,k}$ Characteristic value of the withdrawal parameter in N/mm^2

d Nail or screw diameter in mm

t_{pen} Penetration depth of the profiled shank in mm;
(4,0 x 40 mm $t_{pen} \geq 31$ mm; 4,0 x 50 mm $t_{pen} \geq 40$ mm; 4,0 x 60 mm $t_{pen} \geq 50$ mm)

Based on tests by Versuchsanstalt für Stahl, Holz und Steine, University of Karlsruhe, the characteristic value of the withdrawal resistance for the threaded nails according to EN 14592 can be calculated as:

$f_{1,k} = 50 \times 10^{-6} \times \rho_k^2$

Where:

ρ_k Characteristic density of the timber in kg/m^3

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

BOLTS diameter	Correspondent Hole diameter	Bolt type
10.0 - 30.0 mm	Max. 2 mm. larger than the bolt diameter	Bolt according to EN 14592

METAL ANCHORS diameter	Correspondent Hole diameter	Anchor type
10.0 - 30.0 mm	Max. 2 mm. larger than the anchor diameter	See specification of the manufacturer

Table A.3.1 Fastener specification for brackets type HT2 specifically

FASTENER	Length Min – max	Nail type
Nail 4.0 mm	40 – 100 mm	Ringed shank nails according to EN 14592 or ETA-13/0523
GH screw 5.0 mm	25 – 70 mm	Self-tapping screws according to EN 14592 or ETA-13/0523

BOLT diameter	Correspondent Hole diameter	Bolt type
16.0 mm	1 mm. larger than the bolt diameter	Bolt according to EN 14592

METAL ANCHOR diameter	Correspondent Hole diameter	Anchor type
16.0 mm	1 mm. larger than the anchor diameter	See specification of the manufacturer

Table A.4 Installation options for bracket type HT2 specifically

	HT2 base bracket			
HT2 tension plate	with web adjustable height	with washer 140	with washer 70	with web not adjustable
GH-HT2 tension plate G M10 340x60x3,0mm	x	x	x	x
GH-HT2 tension plate G 2xM10 340x60x3,0mm	-	-	-	x
GH-HT2 tension plate left M10 340x60/60x3,0mm	x	x	x	x
GH-HT2 tension plate right M10 340x60/60x3,0mm	x	x	x	x
GH-HT2 tension plate left M10 425x60/60x3,0mm	x	x	x	x
GH-HT2 tension plate right M10 425x60/60x3,0mm	x	x	x	x

Annex B
Characteristic load-carrying capacities

Table 1: Force F_1, 1 angle bracket / connection timber-timber

type	capacity per nail or screw in the vertical flange ($F_{v,Rk}$) [kN] [2]			capacity in the horizontal flange ($F_{ax,Rk}$) [kN] [1) 2)]			steel
	4x40/ 5x40	4x50/ 5x40	4x60/ 5x50	4x40/ 5x40	4x50/ 5x40	4x60/ 5x50	bending ($F_{m,Rk}$) [kN]
HB	1,57	1,87	1,93	1,0	1,3	1,7	1,3
HSB; t=2,0 mm	1,57	1,87	1,93	0,9	1,1	1,4	0,6
HSB; t=4,0 mm	1,57	1,87	1,93	0,9	1,1	1,4	2,4

[1)] Both nail holes in the horizontal flange next to the bending line have to be nailed or screwed

[2)] Given is the minimum load-carrying capacity of 4,0 mm nails according to EN 14592 and 5,0 mm screws according to ETA-13/0523. If a wood-based panel interlayer is placed between the connector plate and the timber member, the lateral load-carrying capacity of the nail or screw, respectively, has to take into account the effect of the interlayer.

Table 2: Force F_1, 1 angle bracket / connection timber-concrete

type	capacity per nail or screw in the vertical flange ($F_{v,Rk}$) [kN] [2]			concrete	steel [3]			bolt
	4x40/ 5x40	4x50/ 5x40	4x60/ 5x50		bending ($F_{m,Rk}$) [kN]	shear ($F_{v,Rk}$) [kN]	tensile ($F_{t,Rk}$) [kN]	$k_{t\ II}$
type HB	1,57	1,87	1,93	see EN 1992	**3,5**	17,3	25,8	3,08
type HSB, t=2,0 mm	1,57	1,87	1,93		23,3	**11,6**	17,8	3,16
type HSB, t=4,0 mm	1,57	1,87	1,93		23,9	**23,1**	35,6	4,00
hold-down 340	1,57	1,87	1,93		41,9	**11,6**	17,8	1,20
hold-down 400	1,57	1,87	1,93		60,4	**17,3**	26,7	1,33
hold-down 420x222x60	1,57	1,87	1,93		62,0	**17,3**	26,7	1,23
hold-down 420x100x60	1,57	1,87	1,93		71,3	**17,3**	26,7	1,88
hold-down 480	1,57	1,87	1,93		83,4	**21,7**	33,4	1,50
hold-down 280	1,57	1,87	1,93		24,4	**11,5**	17,8	1,51
hold-down 142	1,57	1,87	1,93		30,0	**17,3**	29,7	1,51
hold-down 520	1,57	1,87	1,93		58,0	**21,7**	37,1	1,31
Top Vario 240	1,57	1,87	1,93		54,4	**15,9**	23,8	1,49
Top Vario 280	1,57	1,87	1,93		54,4	**15,9**	23,8	1,49
HT16, HT22, HT28 without base plate	1,57	1,87	1,93		**42,0**	**42,0**	63,4	1
HT16, HT22, HT28, HT28 big hole	1,57	1,87	1,93		63,4	63,4	**63,4**	1
HT30, HT32, HT34 without base plate	1,57	1,87	1,93		**42,0**	**42,0**	85,2	1
HT30, HT32, HT34, HT34 big hole	1,57	1,87	1,93		85,2	85,2	**85,2**	1
HT36	1,57	1,87	1,93		158	158	**158**	1

[2)] Given is the minimum load-carrying capacity of 4,0 mm nails according to EN 14592 and 5,0 mm screws according to ETA-13/0523. Alternative fasteners according to Table A.3 may be used and their load-carrying capacity calculated based on EN 1995-1-1 and ETA-13/0523. If a wood-based panel interlayer is placed between the connector plate and the timber member, the lateral load-carrying capacity of the nail or screw, respectively, has to take into account the effect of the interlayer.

[3)] base plates/washers according to the engineering drawings must be used except where otherwise specified

Table 2 contd.: Force F_1, 1 hold-down / connection timber-concrete

Type	capacity per nail or screw in the vertical flange ($F_{v,Rk}$) [kN] [2)]			concrete	steel [3)]			bolt
	4x40/ 5x40	4x50/ 5x40	4x60/ 5x50		bending $F_{m,Rk}$ [kN]	shear $F_{v,Rk}$ [kN]	tensile $F_{t,Rk}$ [kN]	k_{tII}
HT2-G-Druckplatte-lang-Z-316	1,57	1,87	1,93	see EN 1992	19,4*	21,4	36,9	1,40
HT2-G-Stegwinkel-1Bo-Z-101	1,57	1,87	1,93		-	21,4	36,9	1,00
HT2-G-Stegwinkel-2Bo-Z-102	1,57	1,87	1,93		-	30,0	36,9	1,00
HT2-GV-Druckplatte-kurz-Z-310	1,57	1,87	1,93		16,0*	21,4	36,9	2,66
HT2-GV-Druckplatte-lang-Z-320-3	1,57	1,87	1,93		19,4*	21,4	36,9	1,40
HT2-GV-Stegwinkel-Z-100	1,57	1,87	1,93		-	21,4	36,9	1,00
HT2-LV-340-Stegwinkel-Z-220	1,57	1,87	1,93		-	21,4	36,9	1,00
HT2-LV-425-Stegwinkel-Z-230	1,57	1,87	1,93		-	21,4	36,9	1,00
HT2-RV-340-Stegwinkel-Z-225	1,57	1,87	1,93		-	21,4	36,9	1,00
HT2-RV-425-Stegwinkel-Z-235	1,57	1,87	1,93		-	21,4	36,9	1,00
* with base plate t = 15 mm								

[2)] 4,0 mm nails or 5,0 mm screws may be used

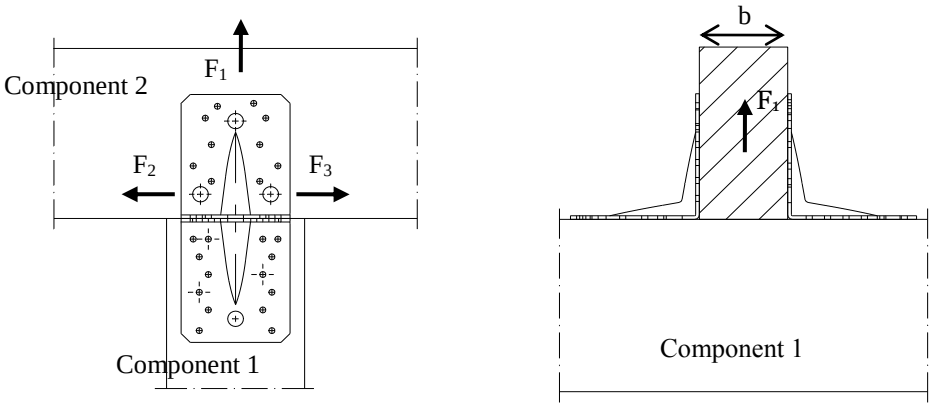
[3)]) base plates/washers according to the engineering drawings are used

Table 3: Force $F_{2,3}$, 1 angle bracket (nails 4,0 x 50 mm, 4,0 x 60 mm or screws 5,0 x 40 mm, 5,0 x 50 mm)

type	nail-number n_V	nail number n_H	bolt number n_H	$F_{2,3Rk}$ [kN]		bolt
				timber-timber	timber-concrete	$k_{t\perp}$
HB 155x50x40x3,0	1,2,4,5,6,7,8,9,11,12	13,14,16,17	15	3,1	2,9	1,00
HSB 200x40x40x2,0	1,2,3,4,5,6,7,8,9,10,11,12, 13,14	16,17,19,20	18	3,1	3,6	1,18[4)]
HSB 200x40x40x4,0	1,2,3,4,5,6,7,8,9,10,11,12, 13,14	16,17,19,20	18	3,1	3,6	1,18[4)]

[4)] incl. factor 1/0,85 considering hole tolerance

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



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

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.
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.

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. The load-carrying capacity is twice the load-carrying capacity of a connection with one angle bracket.
F_2 and F_3	Lateral force acting in the joint between the component 2 and component 1 in the component 2 direction. The load-carrying capacity is twice the load-carrying capacity of a connection with one angle bracket.

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.

Connection to timber, concrete or steel with a bolt or metal anchor

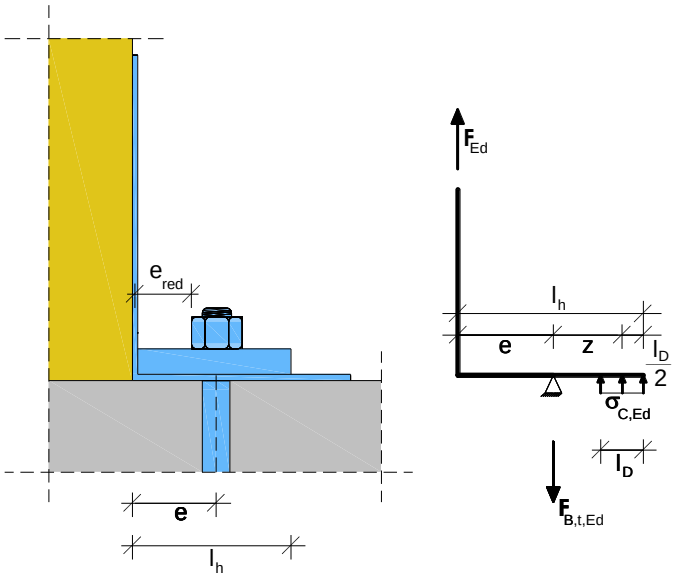
The load $F_{B,Ed}$ for the design of a bolt or metal anchor is calculated as:

$F_{B,t,Ed} = k_{t\,II} \cdot F_{Ed}$ for tensile load

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

Where:

$F_{B,t,Ed}$	Bolt tensile load in N
$F_{B,v,Ed}$	Bolt shear load in N
k_t	Coefficient taking into account the moment arm or hole tolerance, respectively
F_{Ed}	Tensile load F_1 on vertical flap of the angle bracket or shear load $F_{2,3}$ in N



Combined forces

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

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

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

GH Angle Brackets

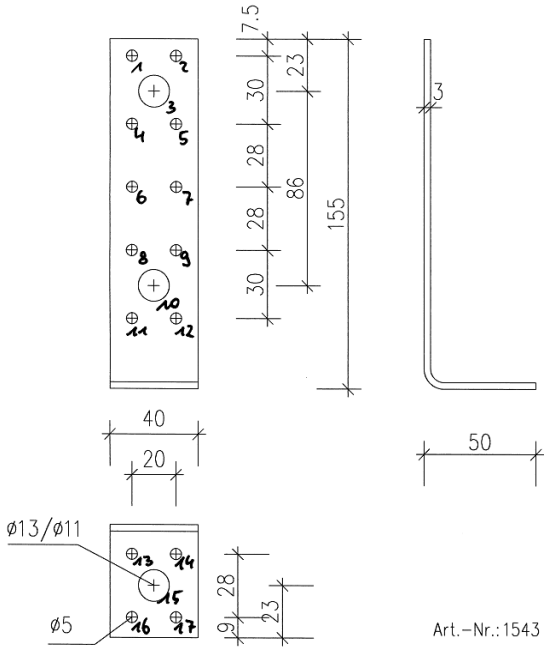


Figure B. 1 Dimensions of type HB 155x50x40x3,0

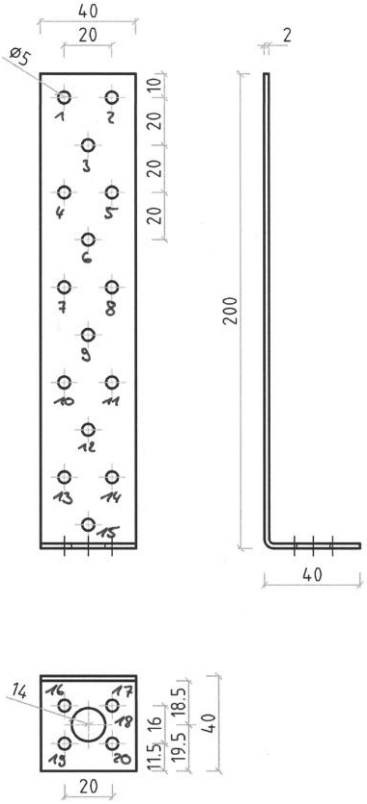


Figure B. 2 Dimensions of type HSB 200x40x40x2,0

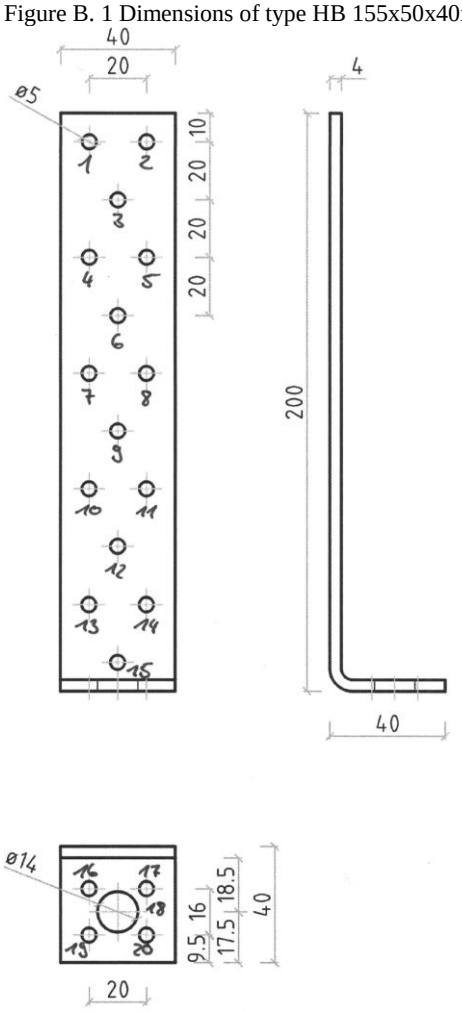


Figure B. 3 Dimensions of type HSB 200x40x40x4,0

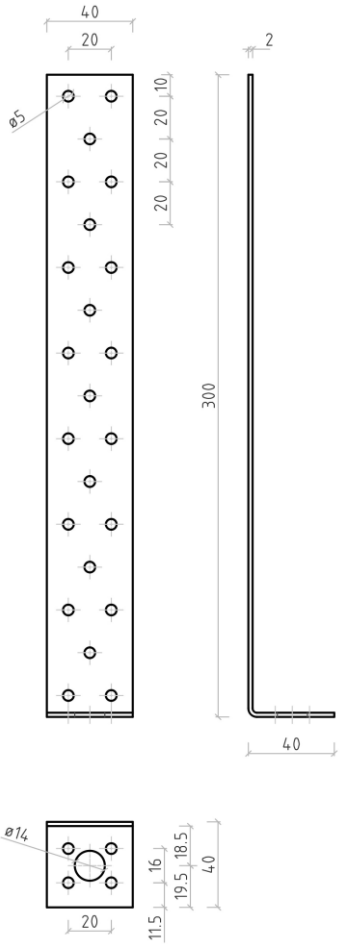


Figure B. 4 Dimensions of type HSB 300x40x40x2,0

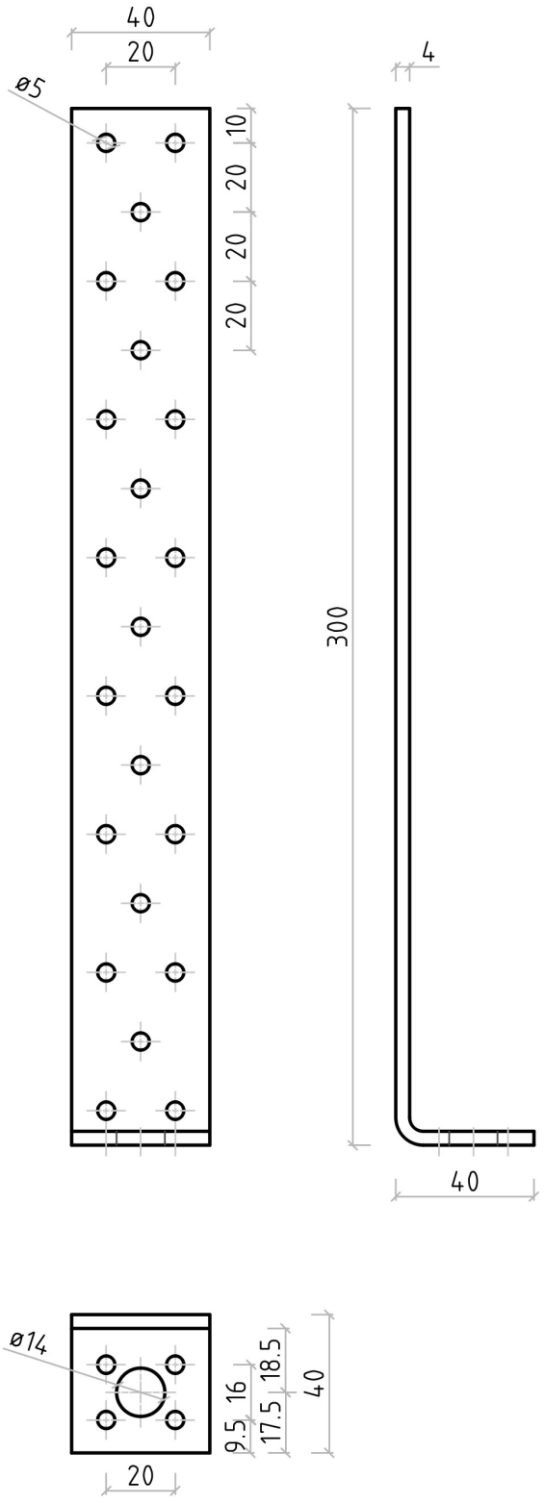


Figure B. 5 Dimensions of type HSB 300x40x40x4,0

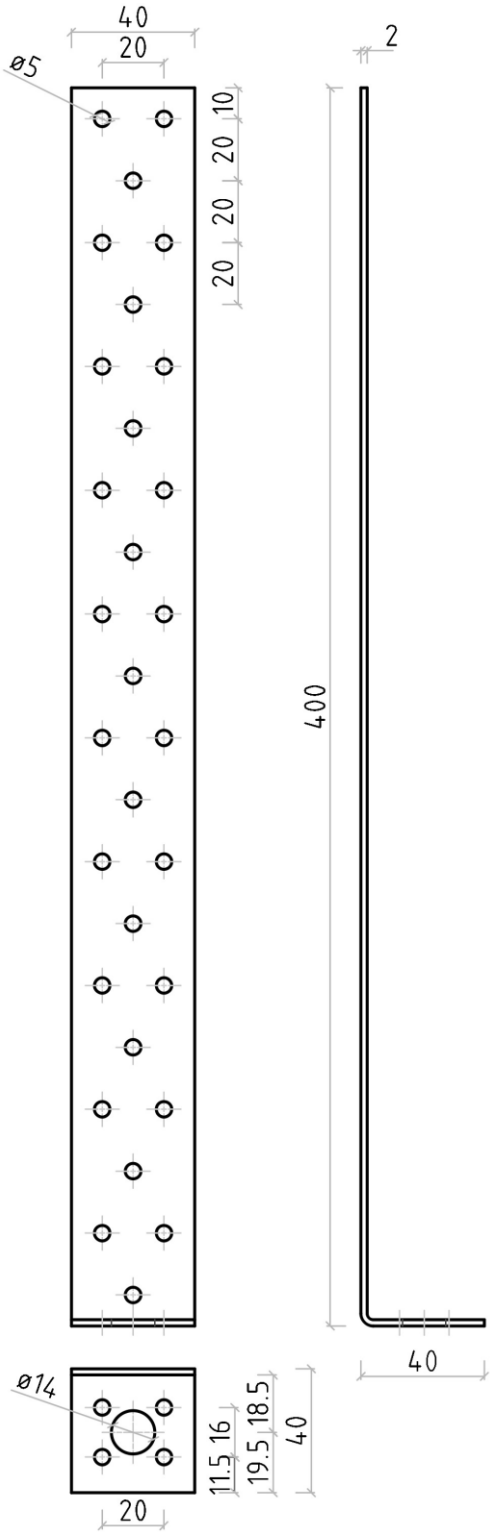


Figure B. 6 Dimensions of type HSB 400x40x40x2,0

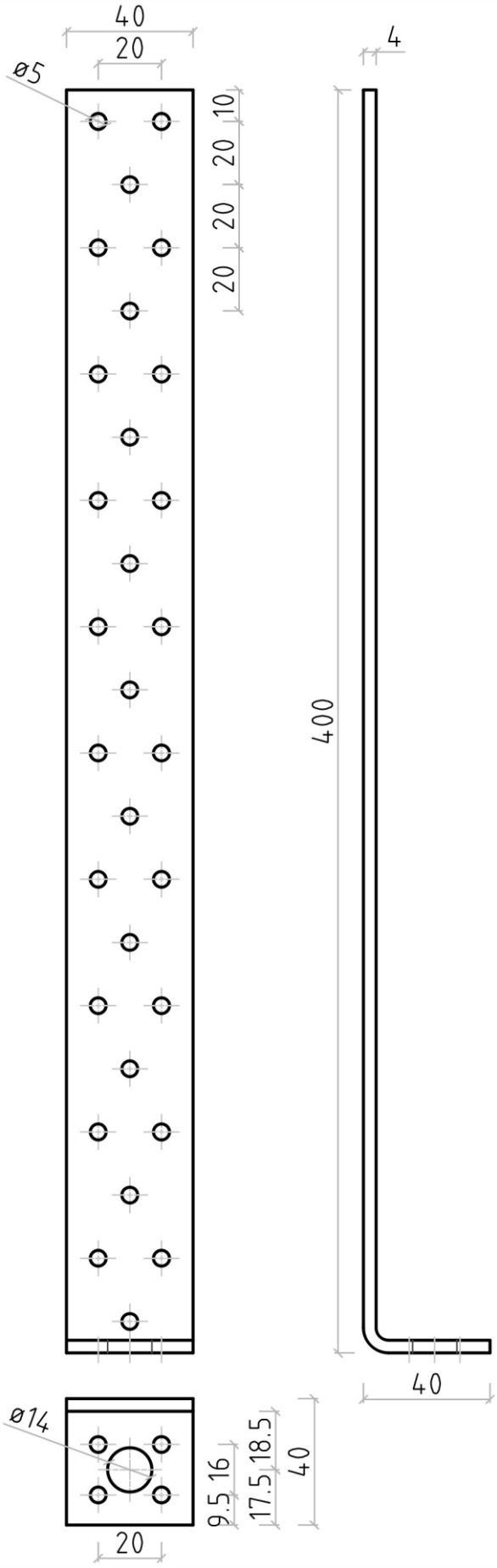


Figure B. 7 Dimensions of type HSB 400x40x40x4,0

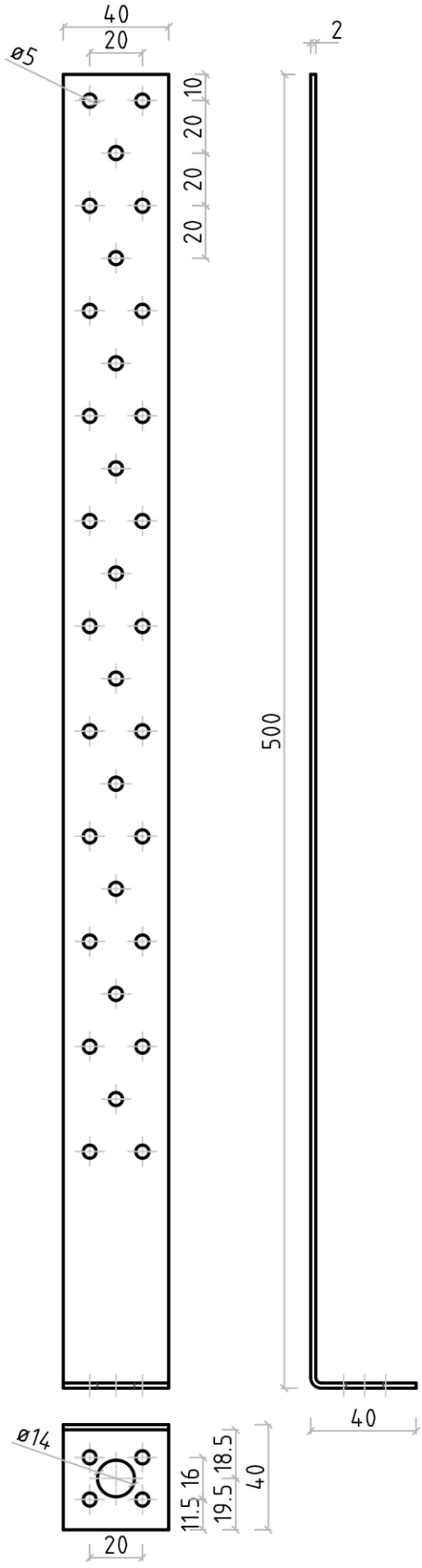


Figure B. 8 Dimensions of type HSB 500x40x40x2,0

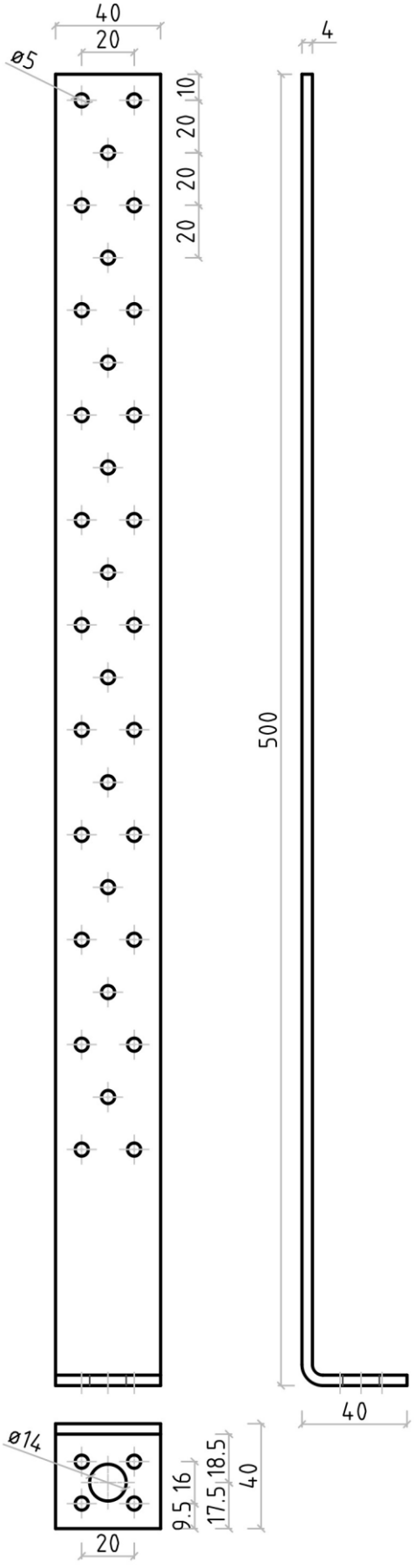


Figure B. 9 Dimensions of type HSB 500x40x40x4,0

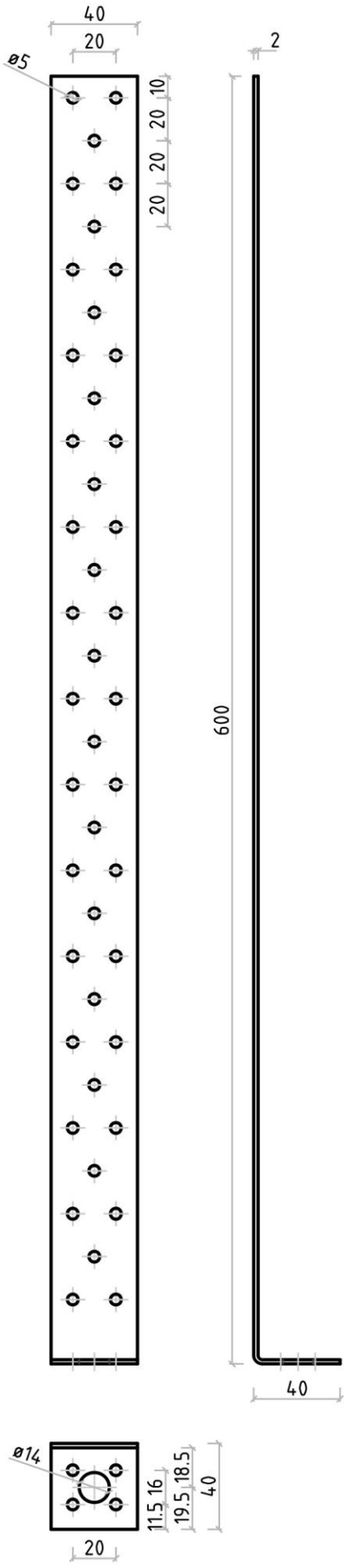


Figure B. 10 Dimensions of type HSB 600x40x40x2,0

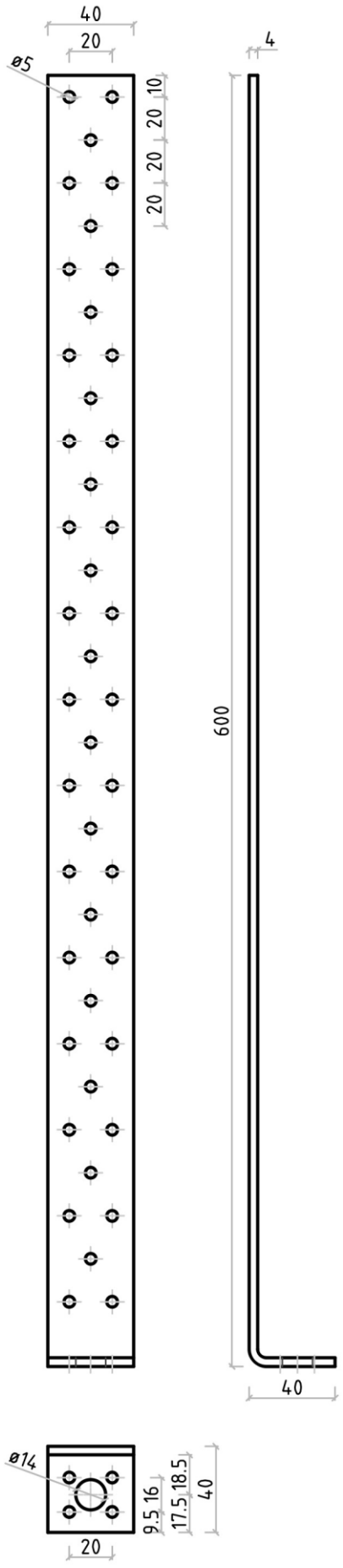


Figure B. 11 Dimensions of type HSB 600x40x40x4,0

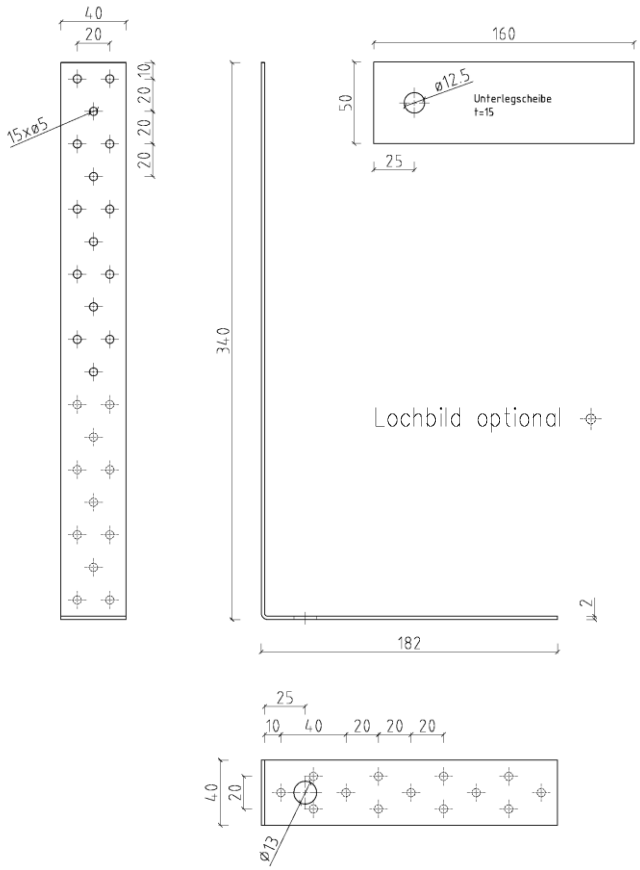


Figure B. 12 Dimensions of type 340x182x40x2,0

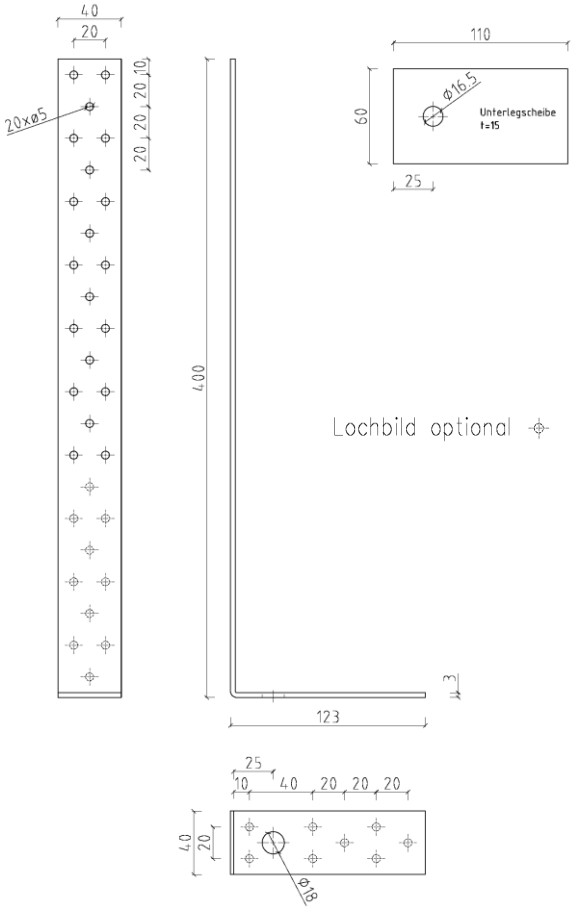


Figure B. 13 Dimensions of type 400x123x40x3,0

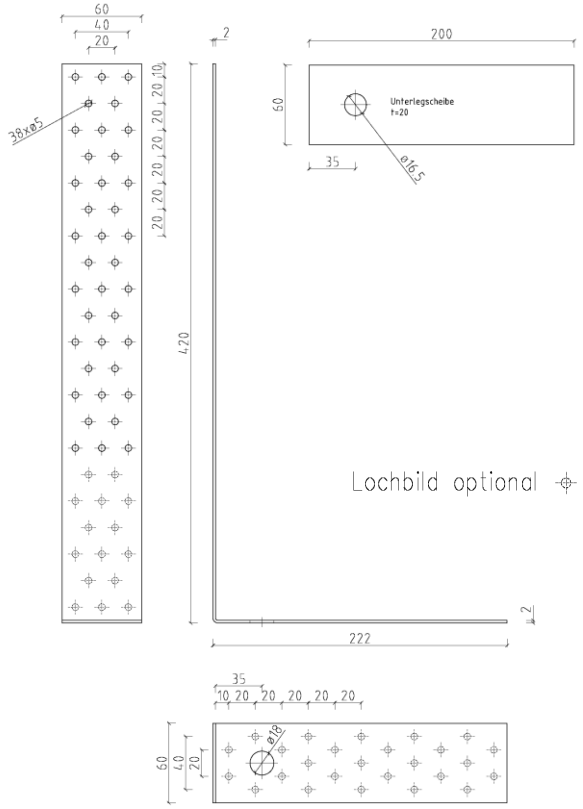


Figure B. 14 Dimensions of type 420x222x60x2,0

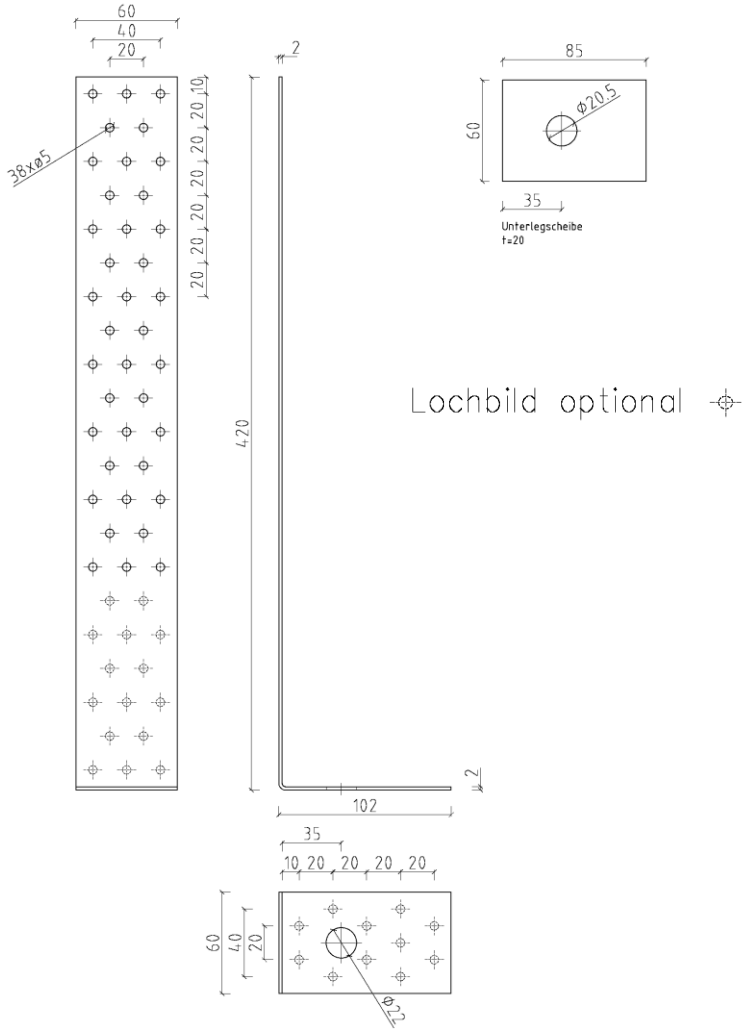


Figure B. 15 Dimensions of type 420x102x60x2,0

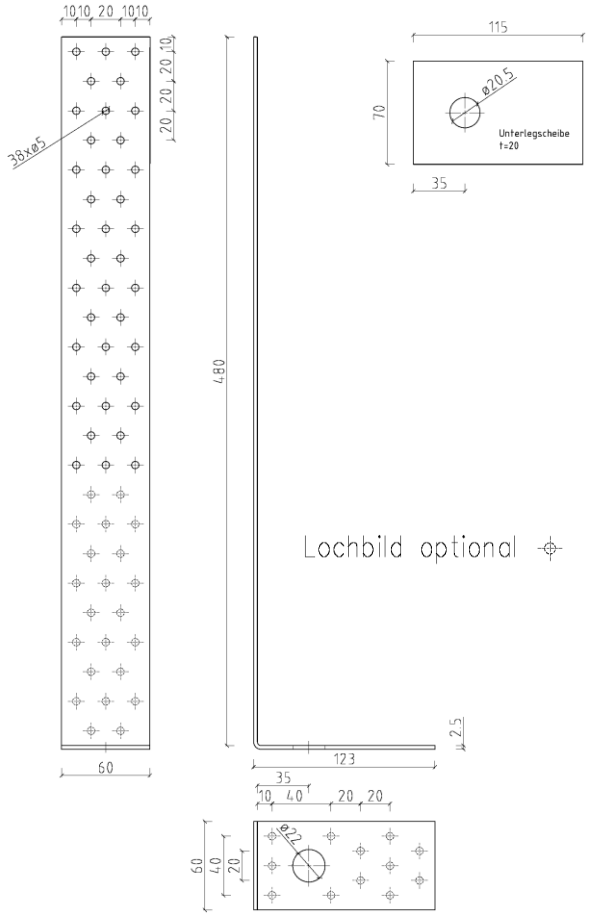


Figure B. 16 Dimensions of type 480x123x60x2,5

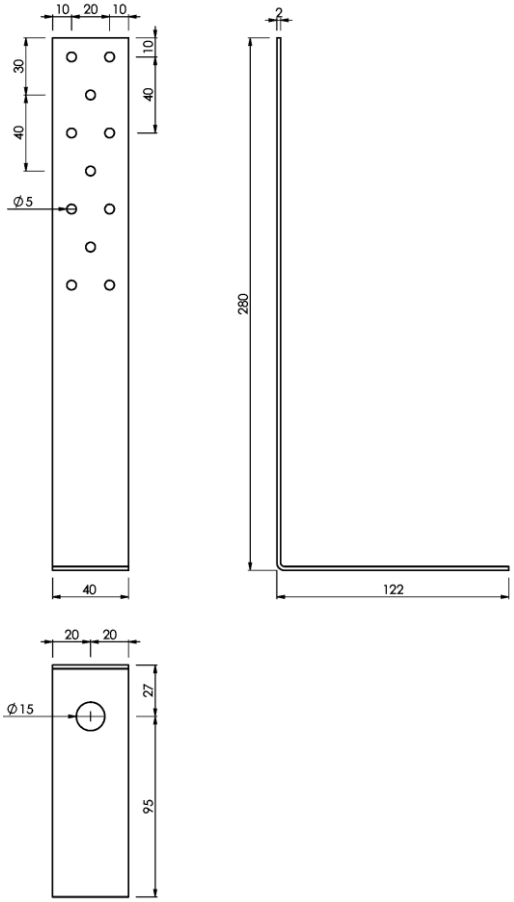


Figure B. 17 Dimensions of type 280x122x40x2

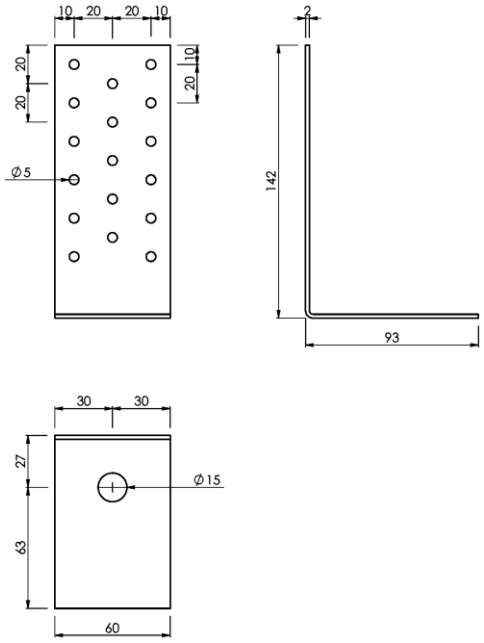


Figure B. 18 Dimensions of type 142x93x60x2

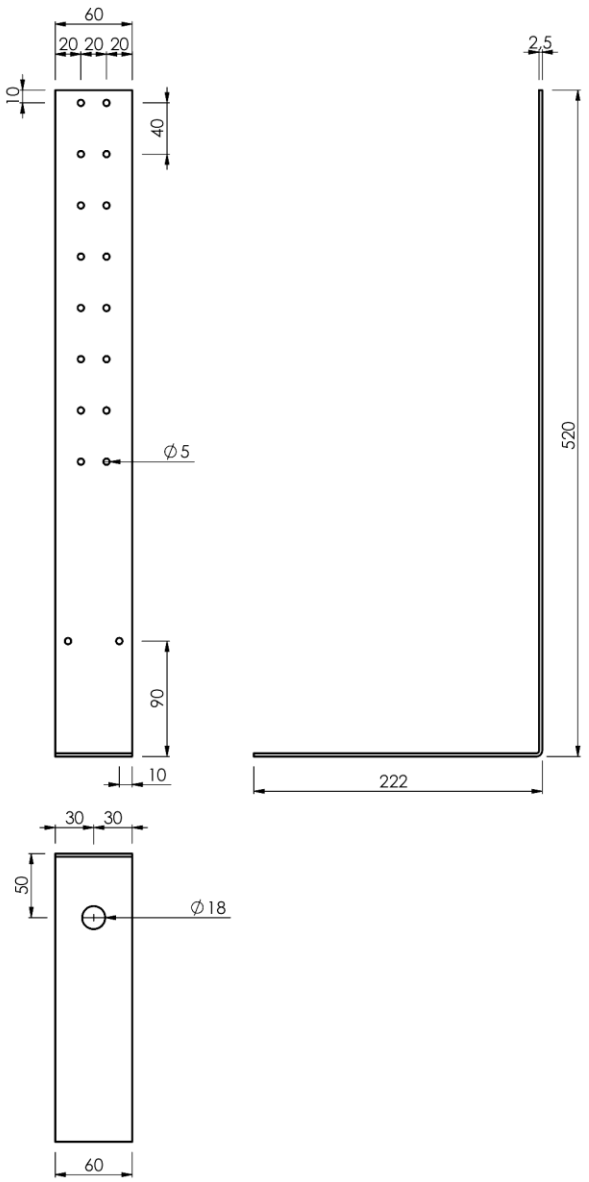


Figure B. 19 Dimensions of type 520x222x60x2,5

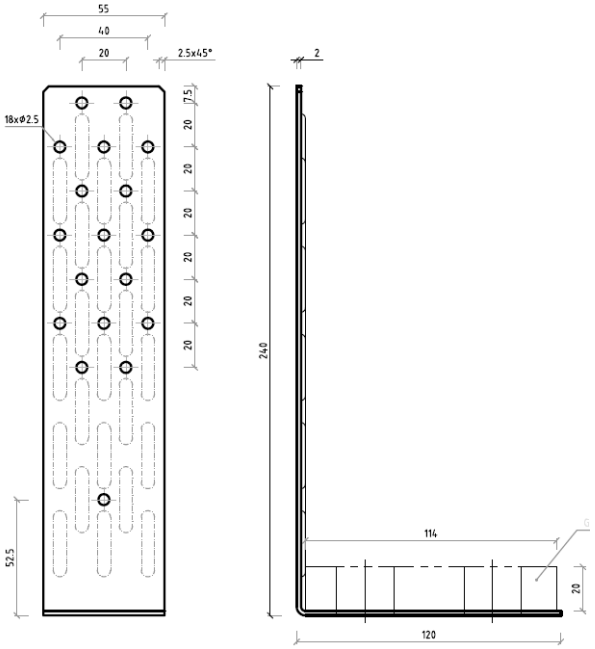


Figure B. 20 Dimensions of Top Vario 240x120x55x2,0

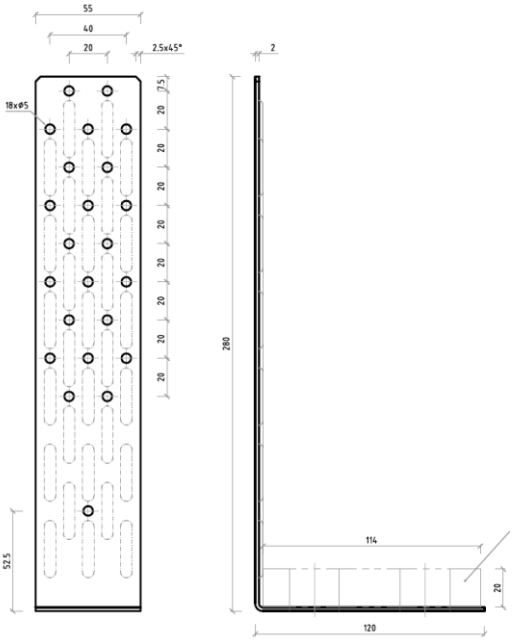


Figure B. 21 Dimensions of Top Vario 280x120x55x2,0

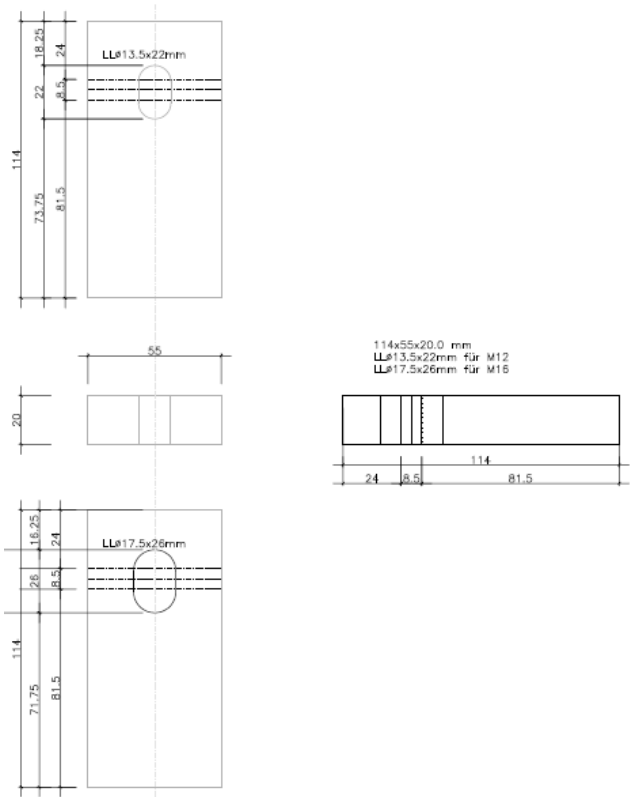


Figure B. 22 Dimensions of washer for Top Vario

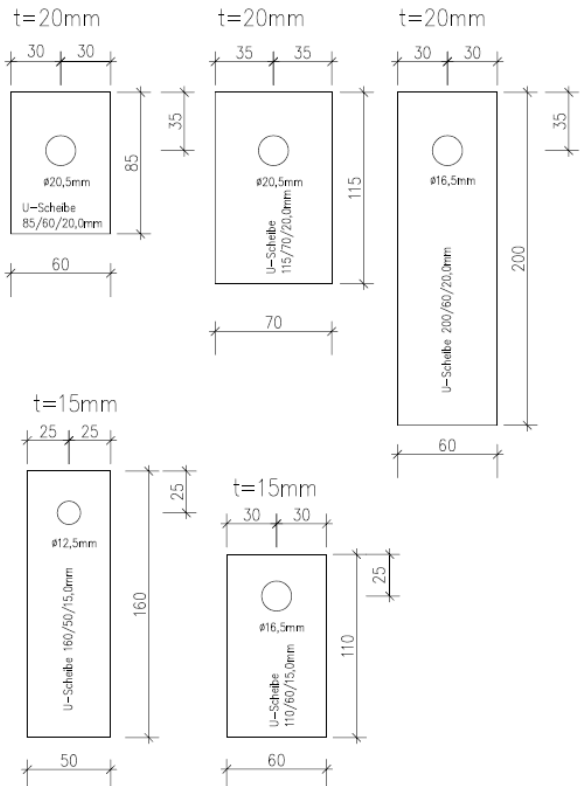


Figure B. 23 Dimensions of washers for hold-downs

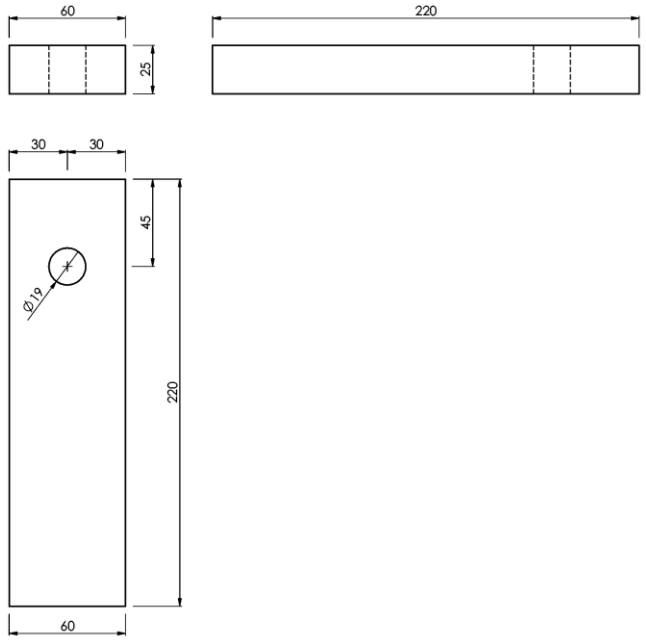


Figure B. 24 Dimensions of washer for hold-down 520x222x60x2,5

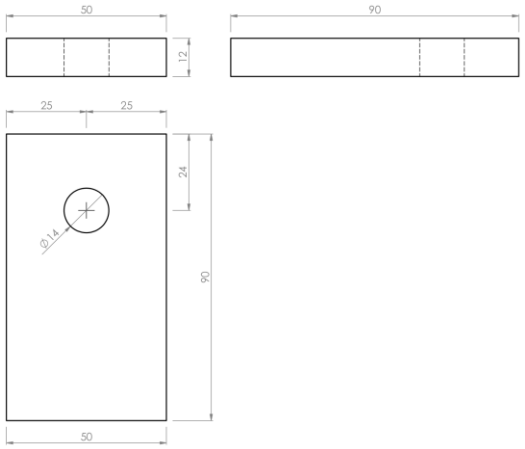


Figure B. 25 Dimensions of washer for hold-downs 142x93x60x2, 280x122x40x2

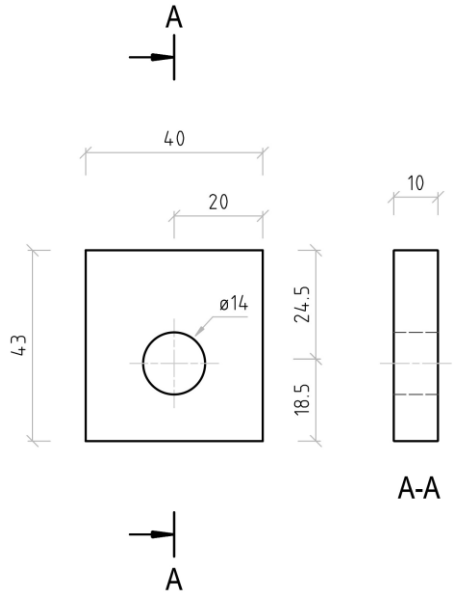


Figure B. 26 Dimensions of washer for type HB and HSB

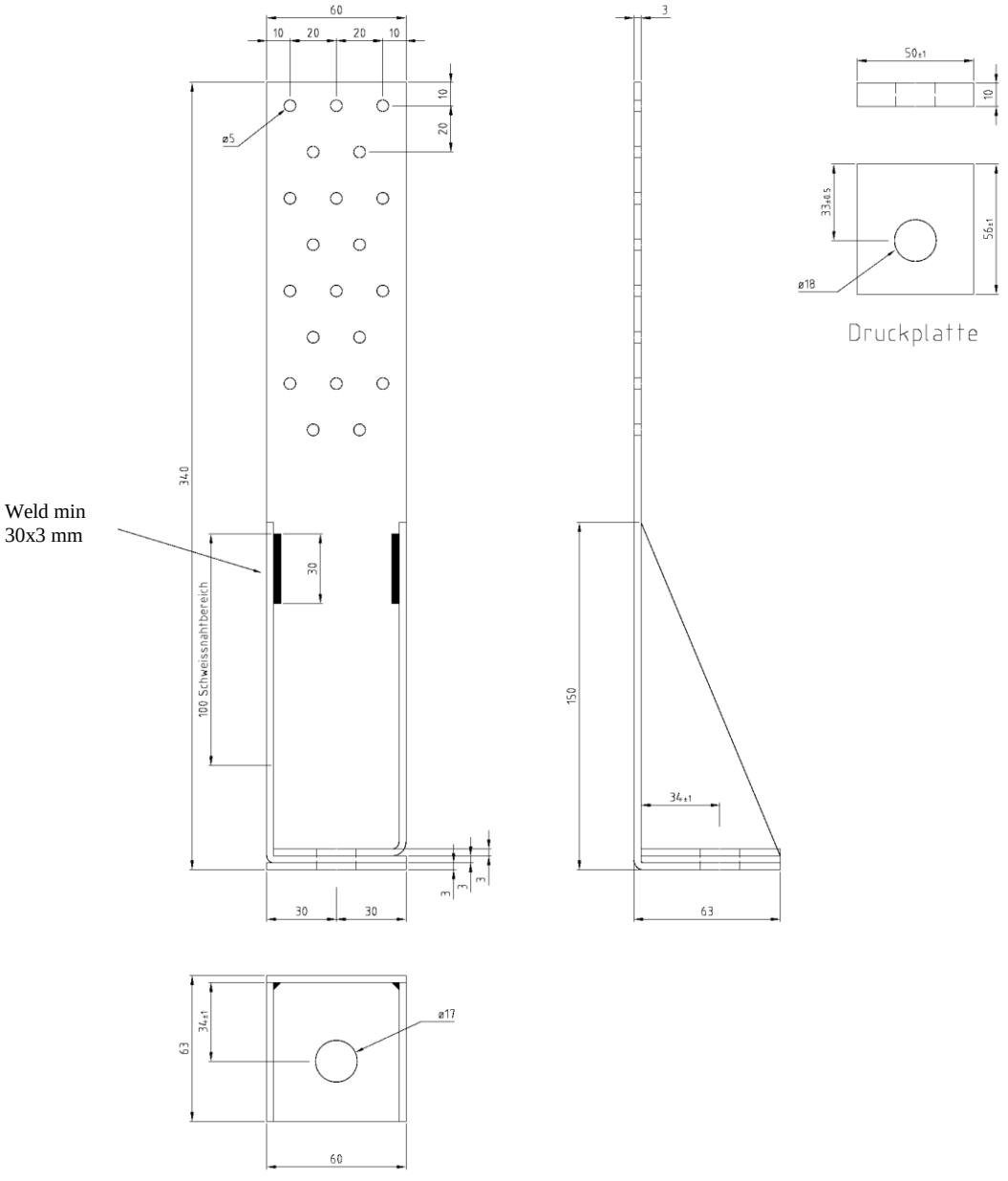


Figure B. 27 Dimensions of type GH HT16 60/340 (drawing with washer 56x50x10)

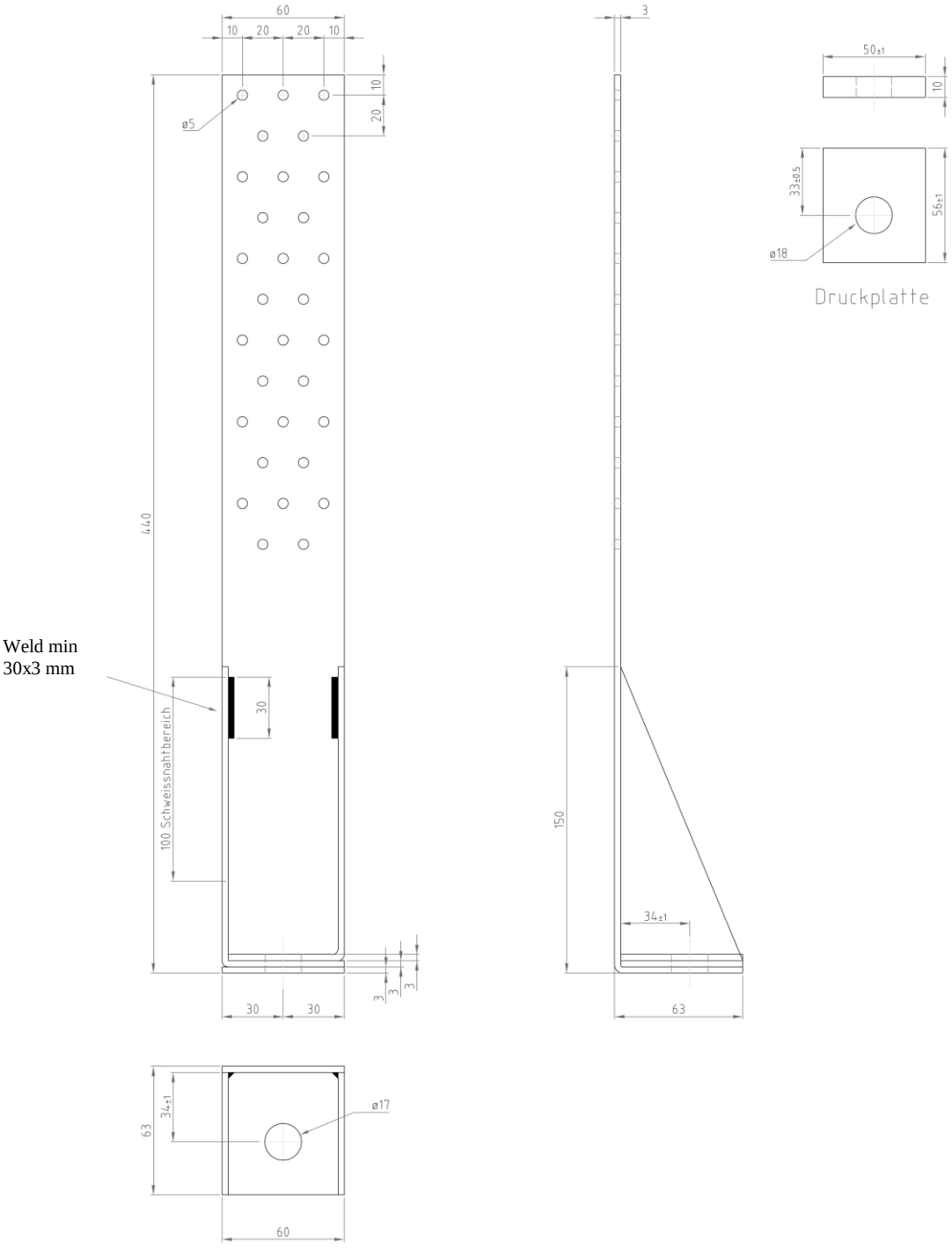


Figure B. 28 Dimensions of type GH HT22 60/440 (drawing with washer 56x50x10)

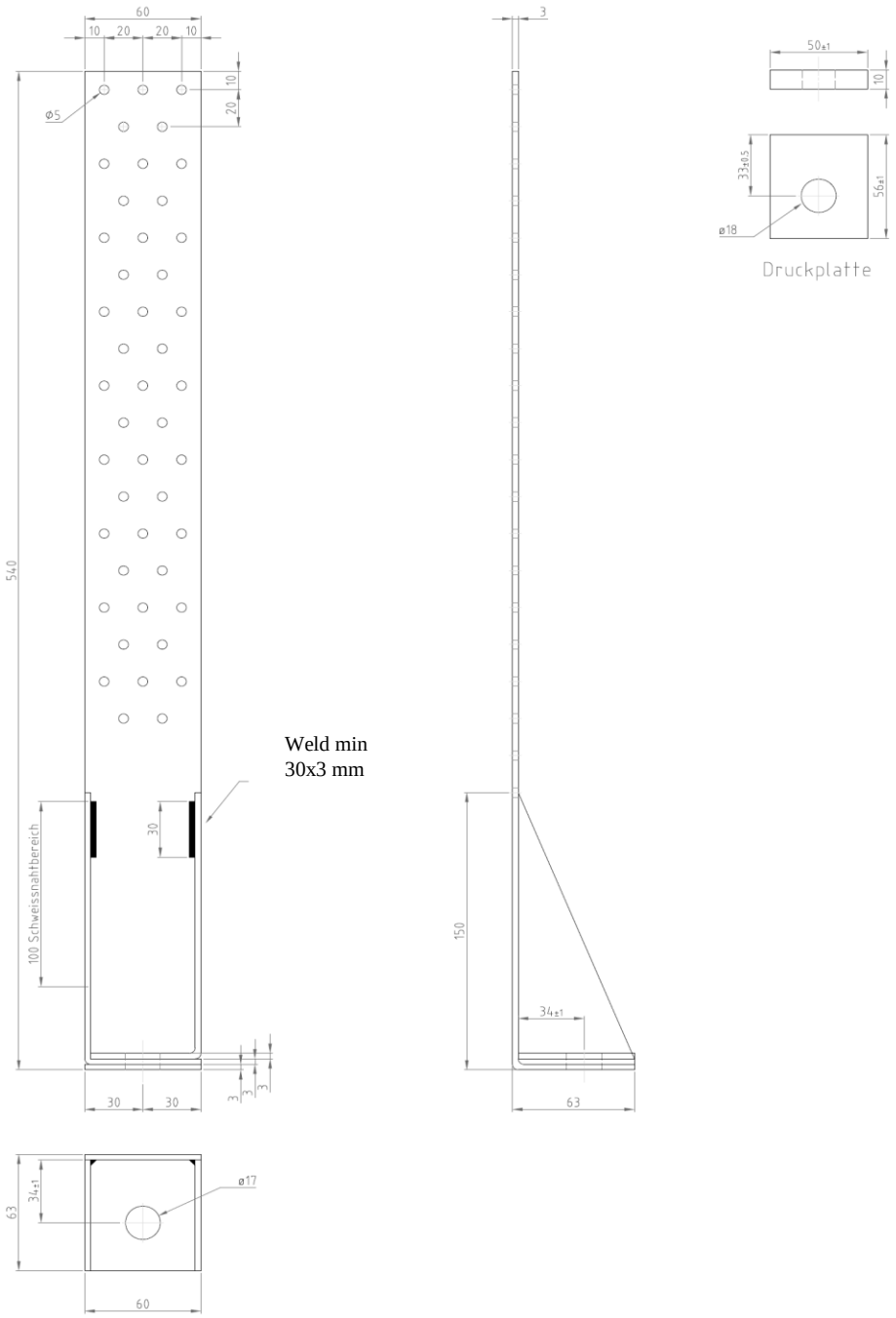


Figure B. 29 Dimensions of type GH HT28 60/540 (drawing with washer 56x50x10)

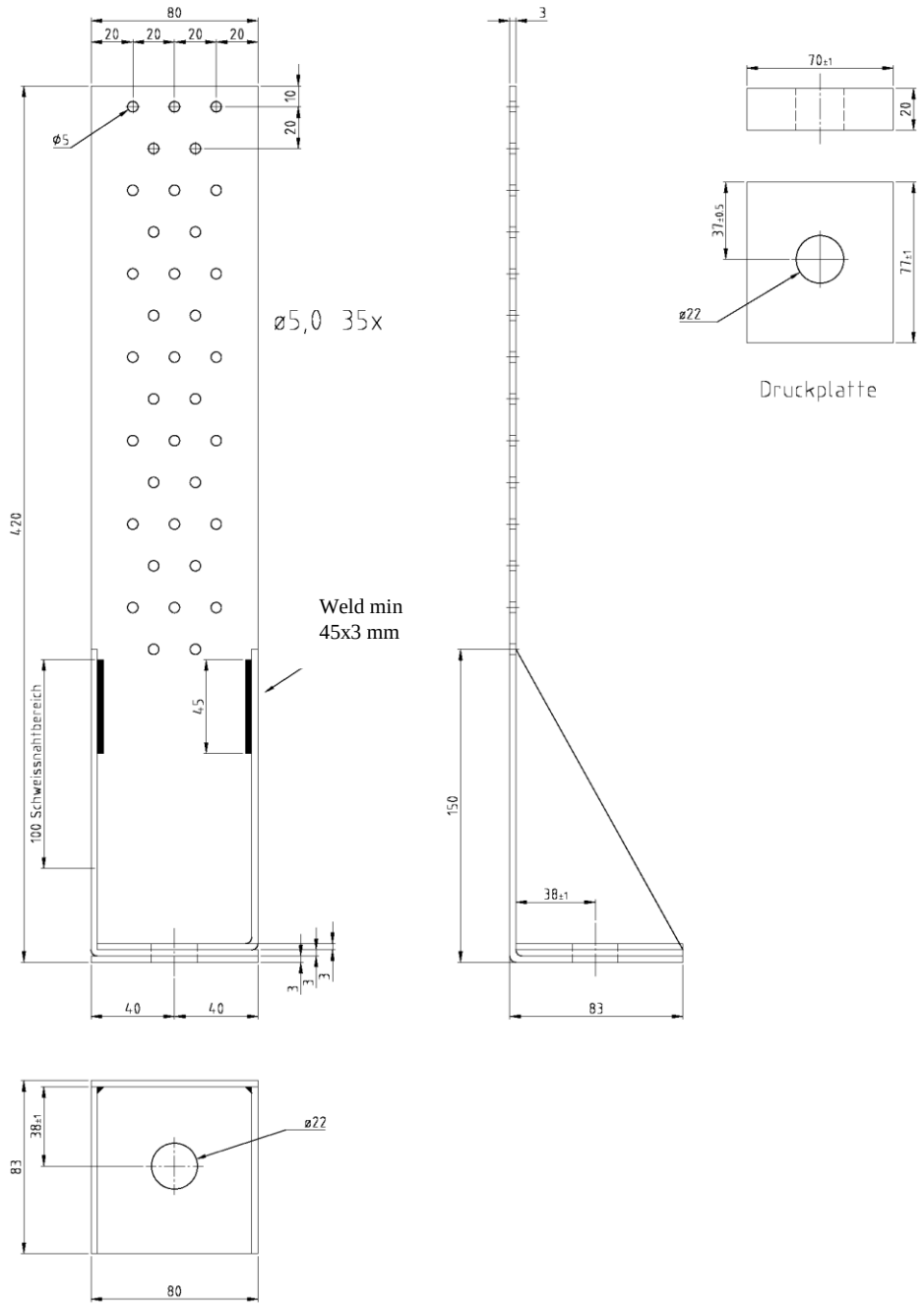


Figure B. 30 Dimensions of type GH HT30 80/420 (drawing with washer 77x70x20)

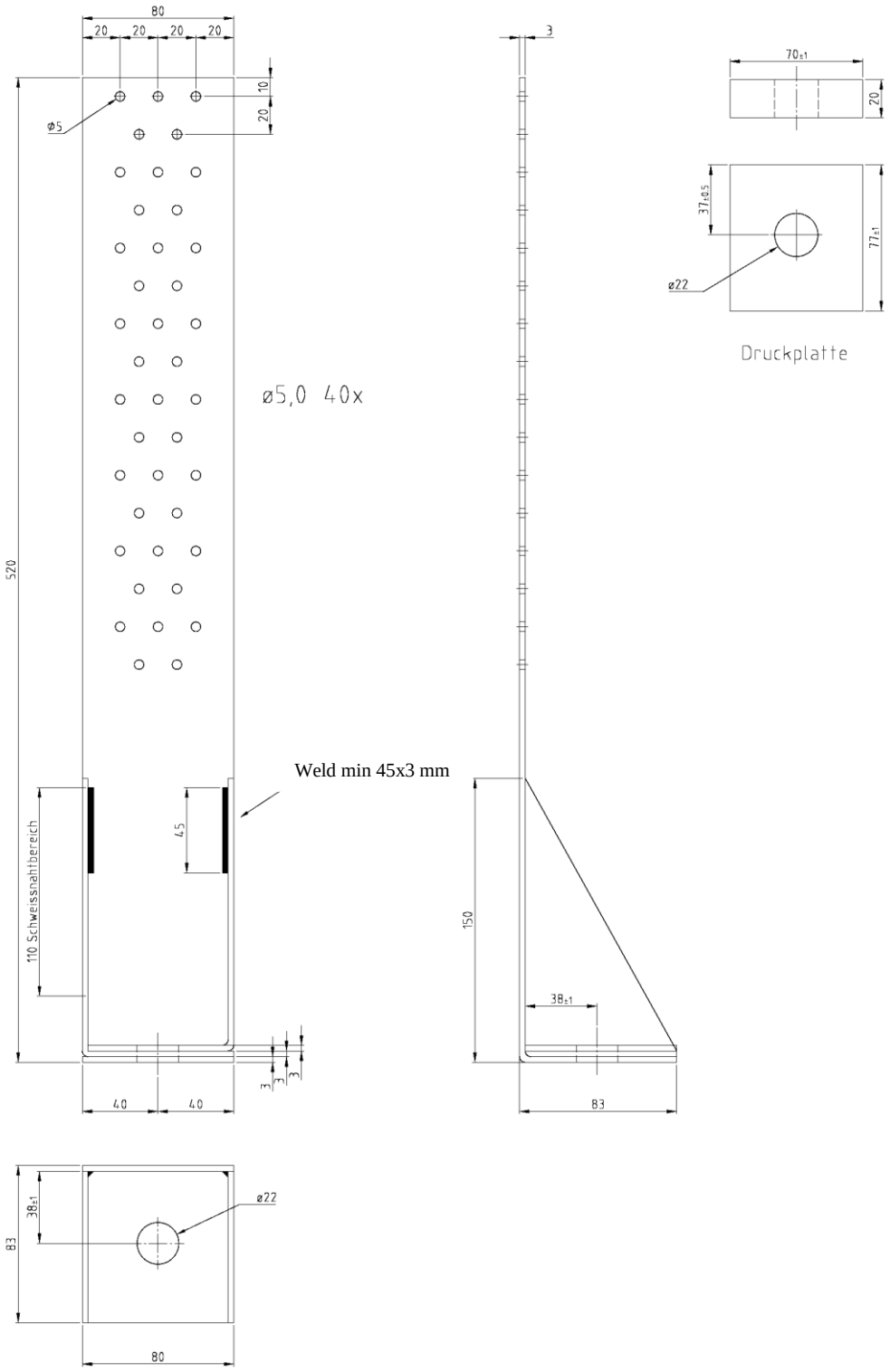


Figure B. 31 Dimensions of type GH HT32 80/520 (drawing with washer 77x70x20)

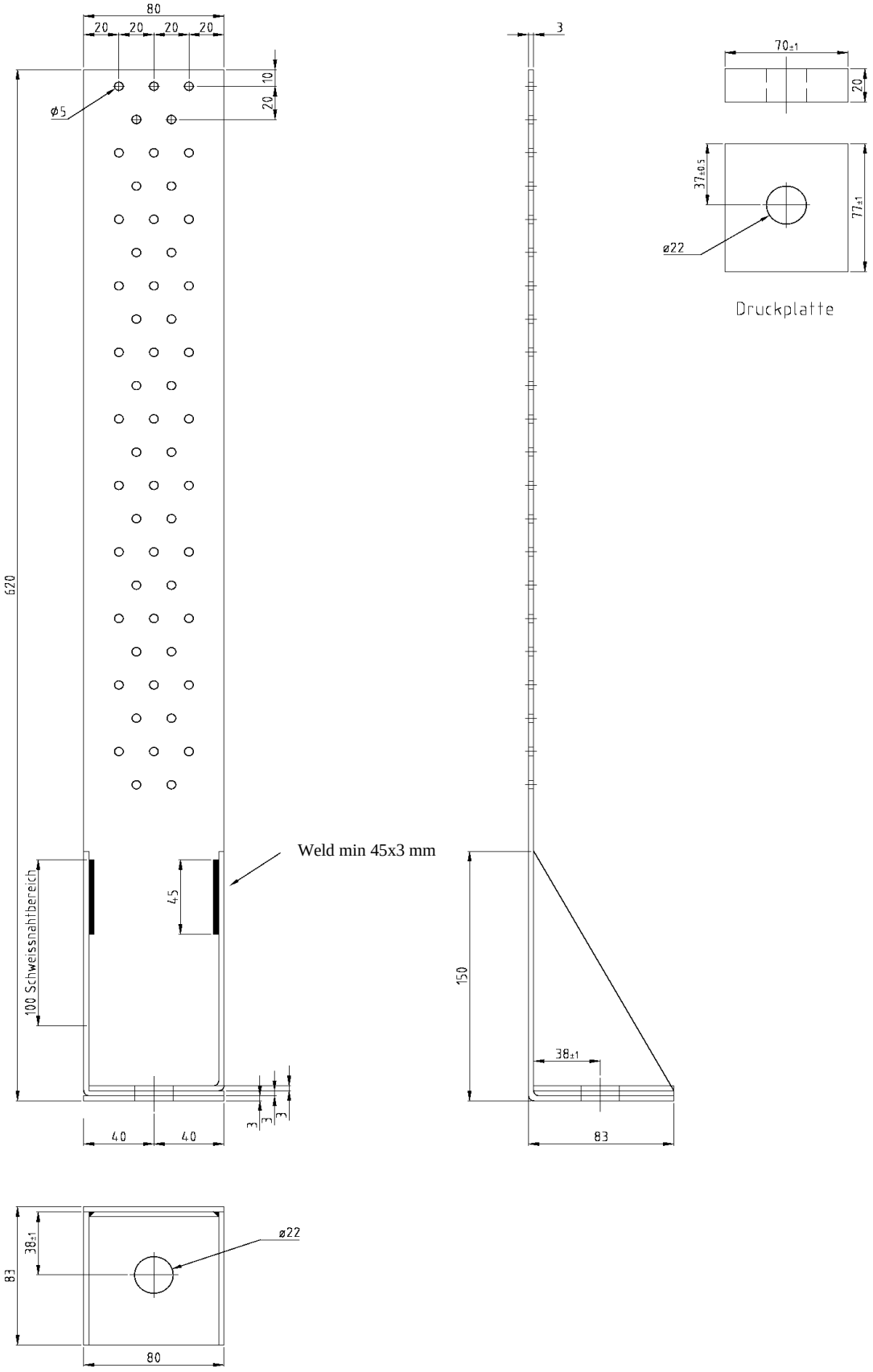


Figure B. 32 Dimensions of type GH HT34 80/620 (drawing with washer 77x70x20)

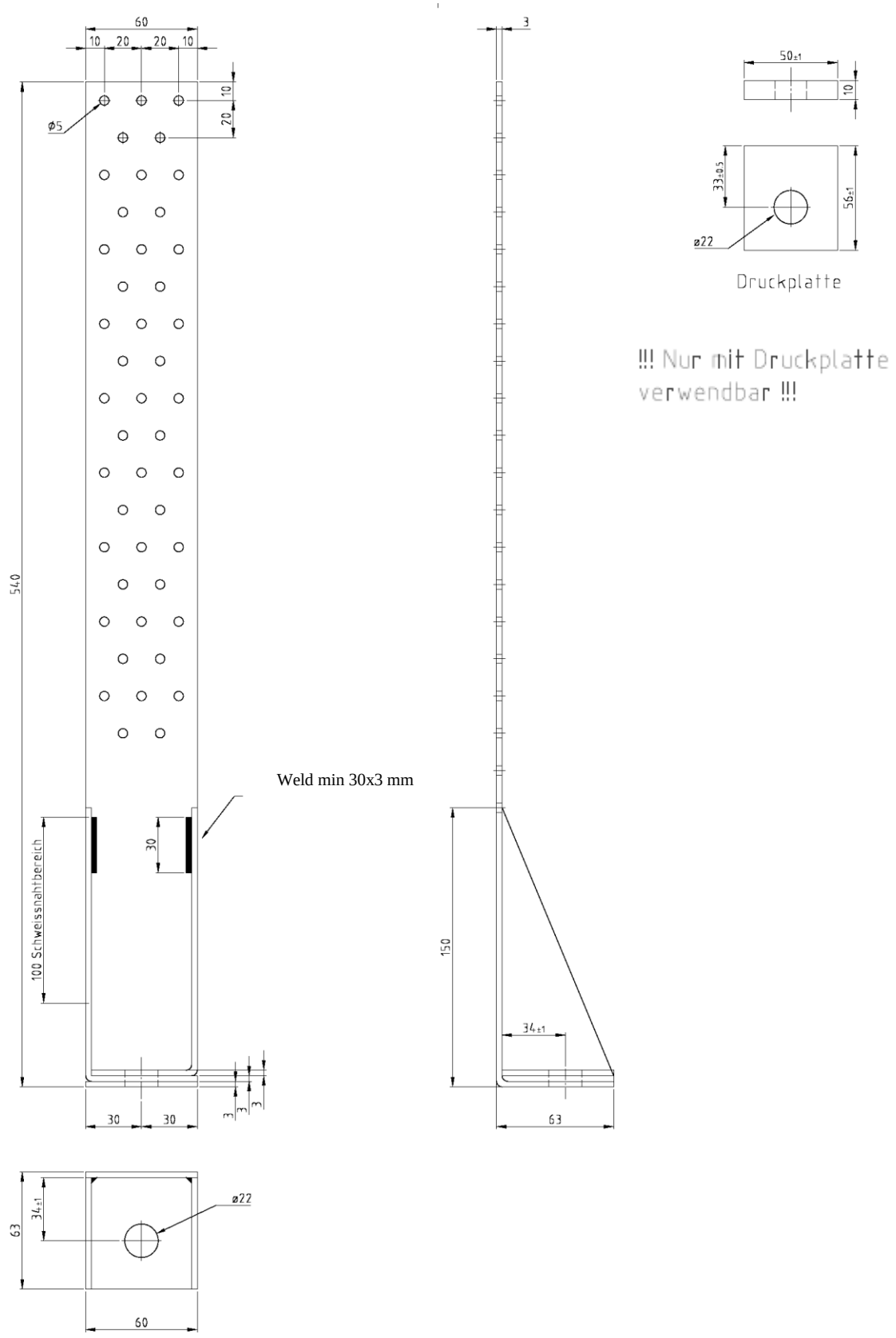


Figure B. 33 Dimensions of type GH HT28 60/540 Big Hole (with washer 56x50x10)

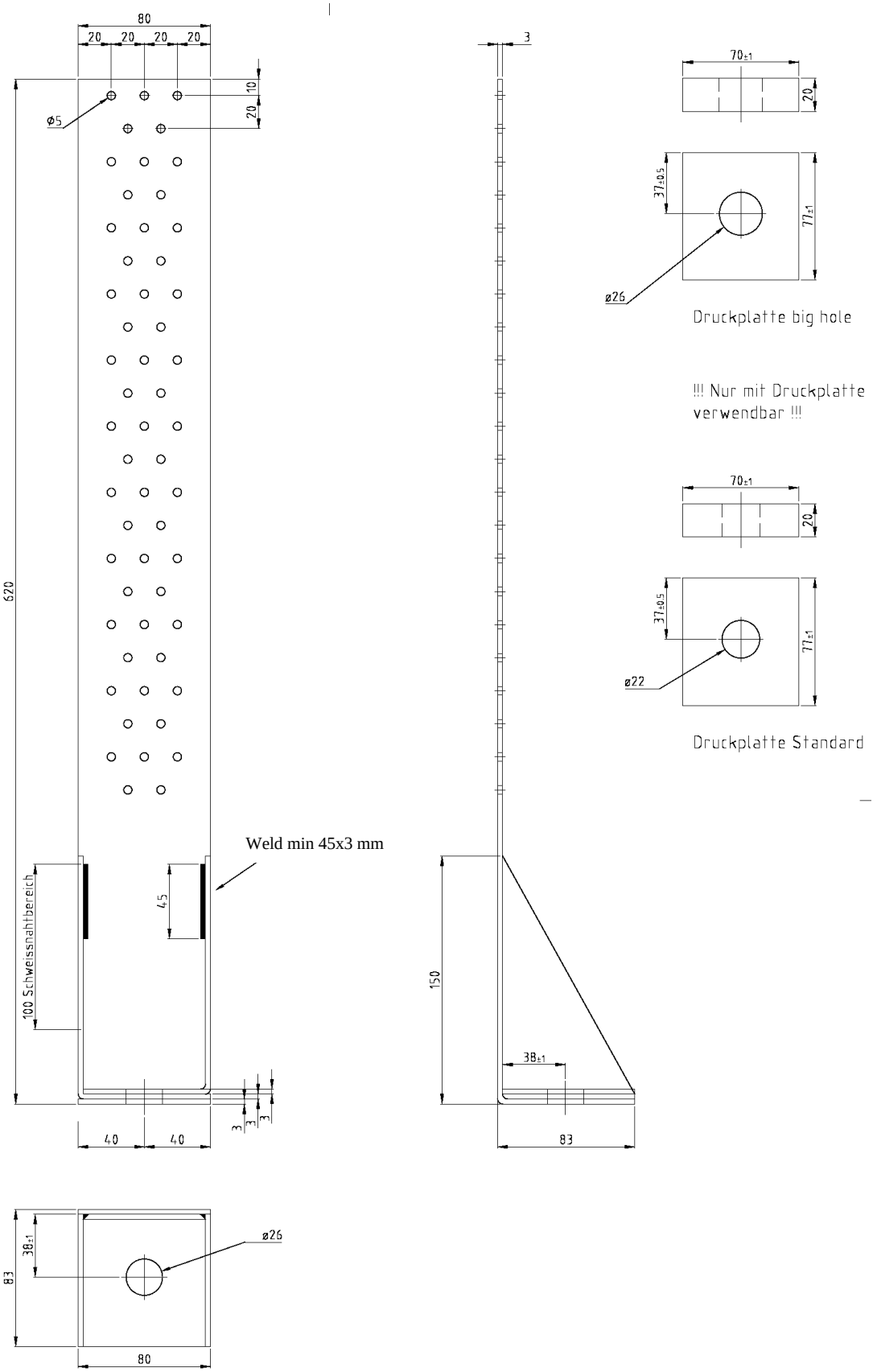


Figure B. 34 Dimensions of type GH HT34 80/620 Big hole (with washer 77x70x20xØ22 or 77x70x20xØ26)

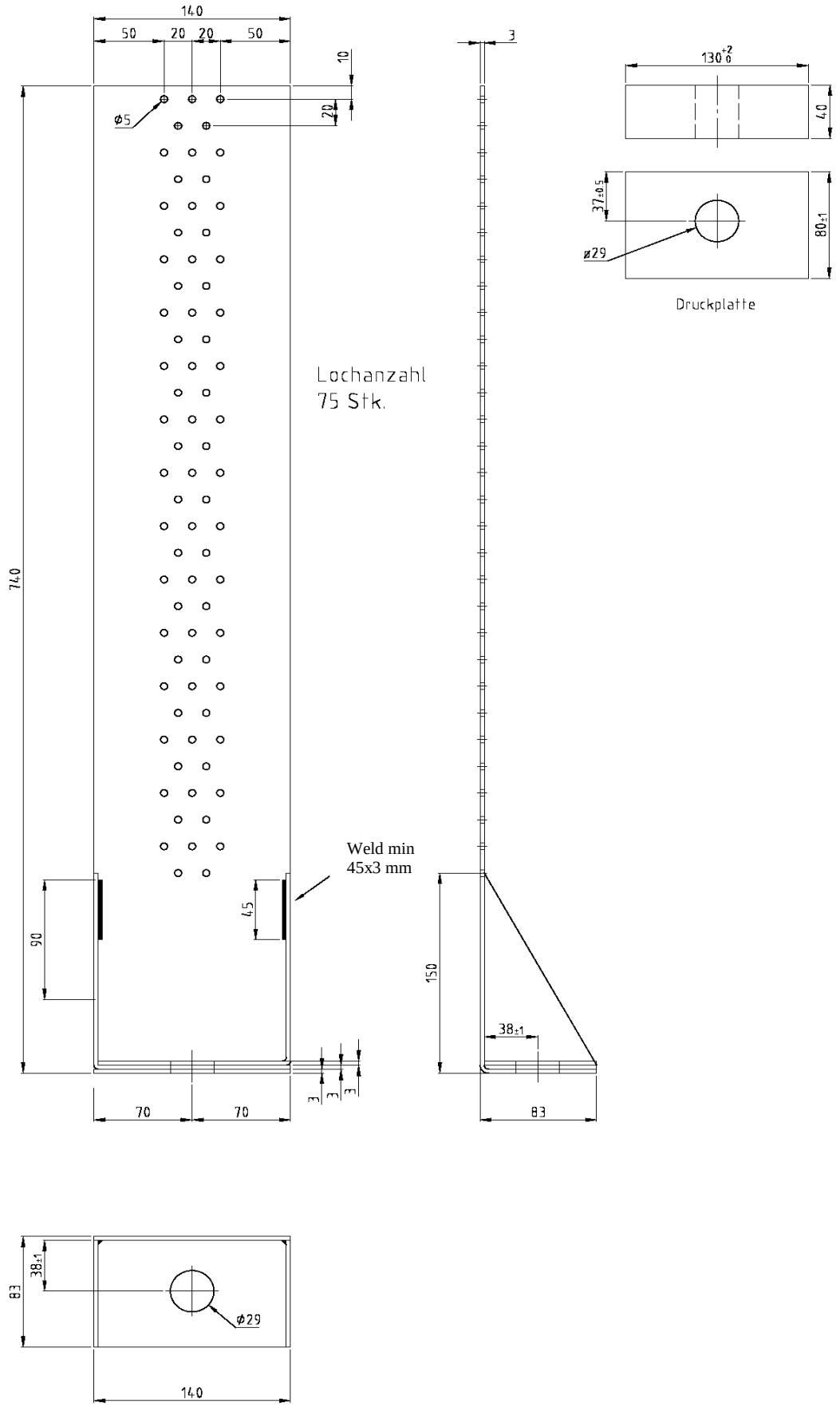


Figure B. 35 Dimensions of type GH HT36 140/740 (drawing with washer 80x130x40)

GH Angle Brackets

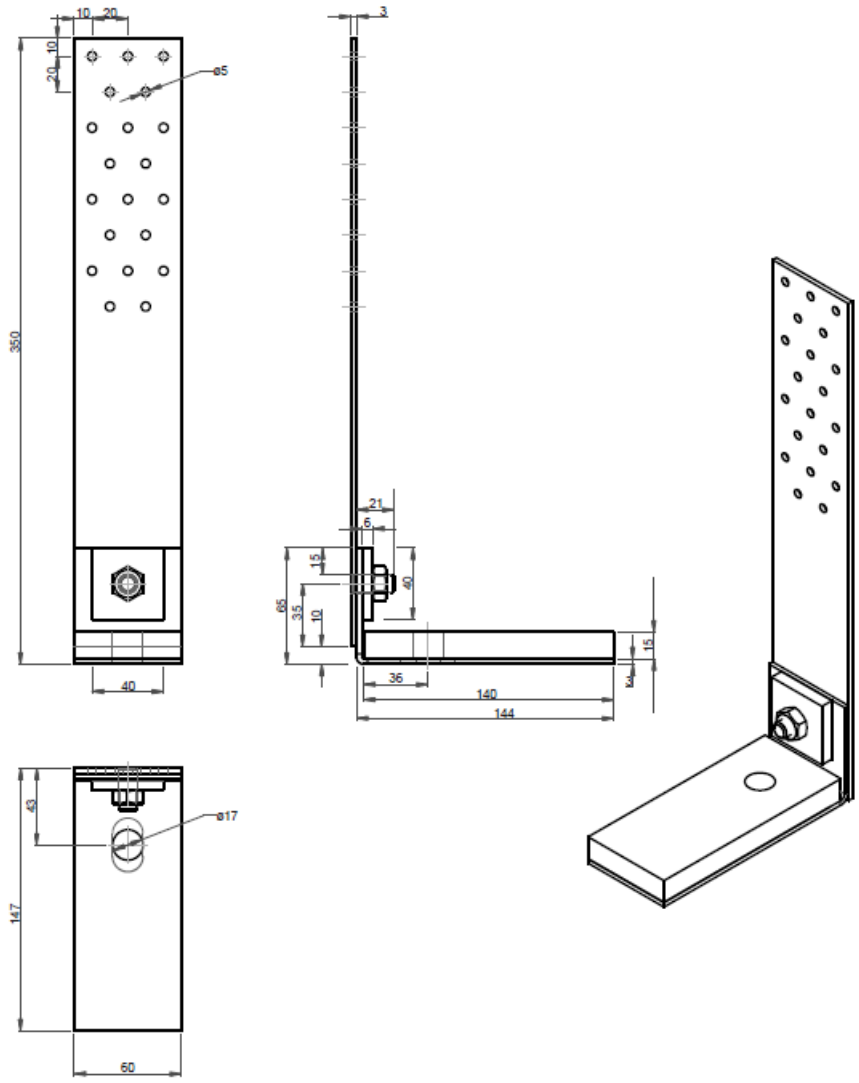


Figure B. 36 HT2-G-Druckplatte-lang-Z-316

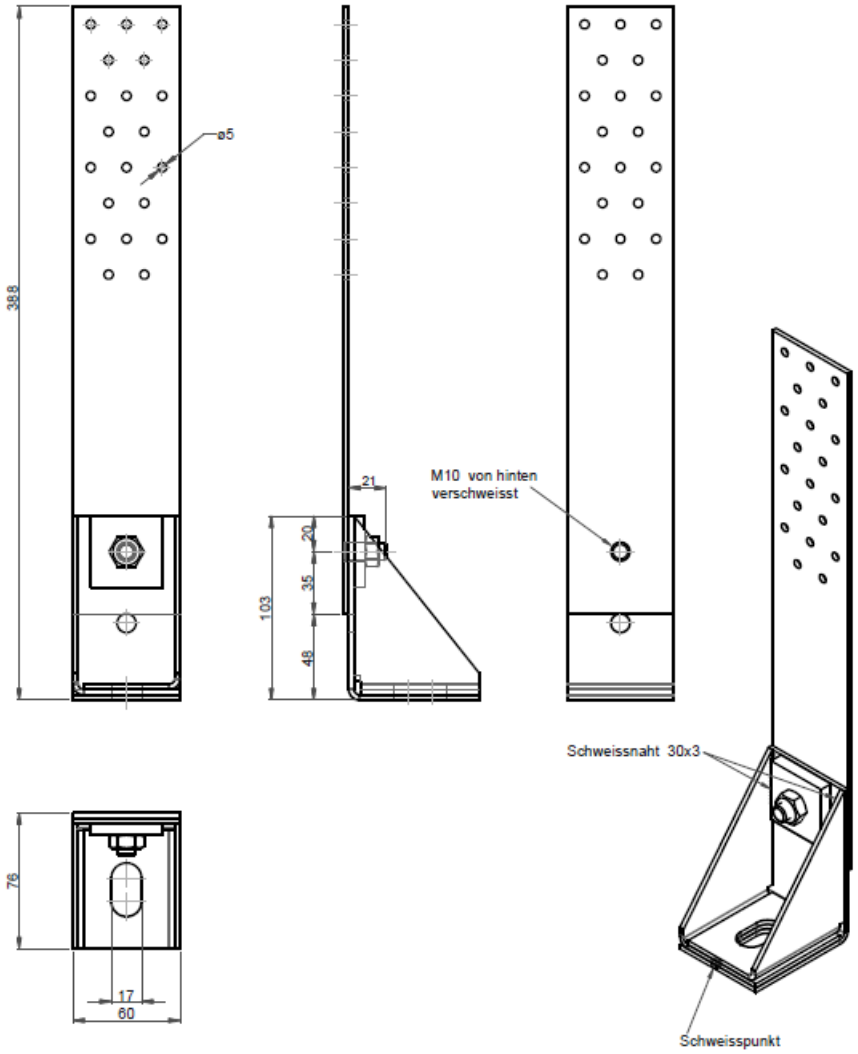


Figure B. 37 HT2-G-Stegwinkel-1Bo-Z-101

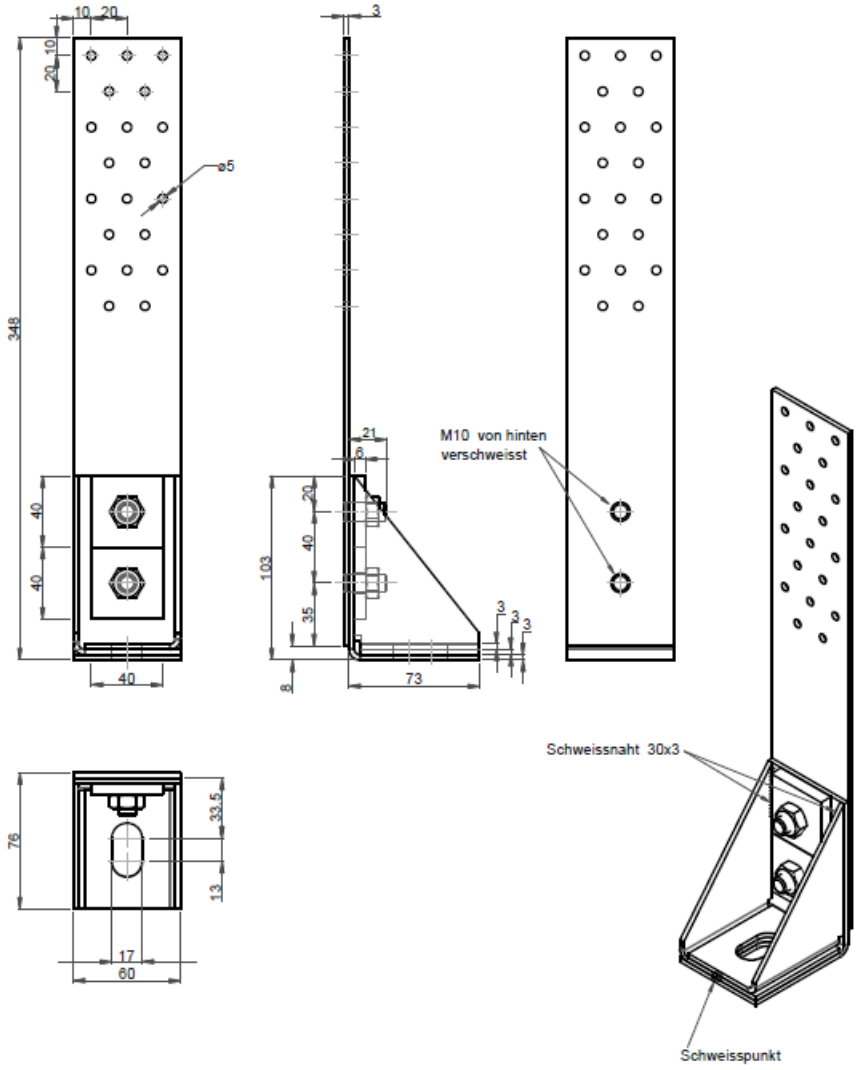


Figure B.38 HT2-G-Stegwinkel-2Bo-Z-102

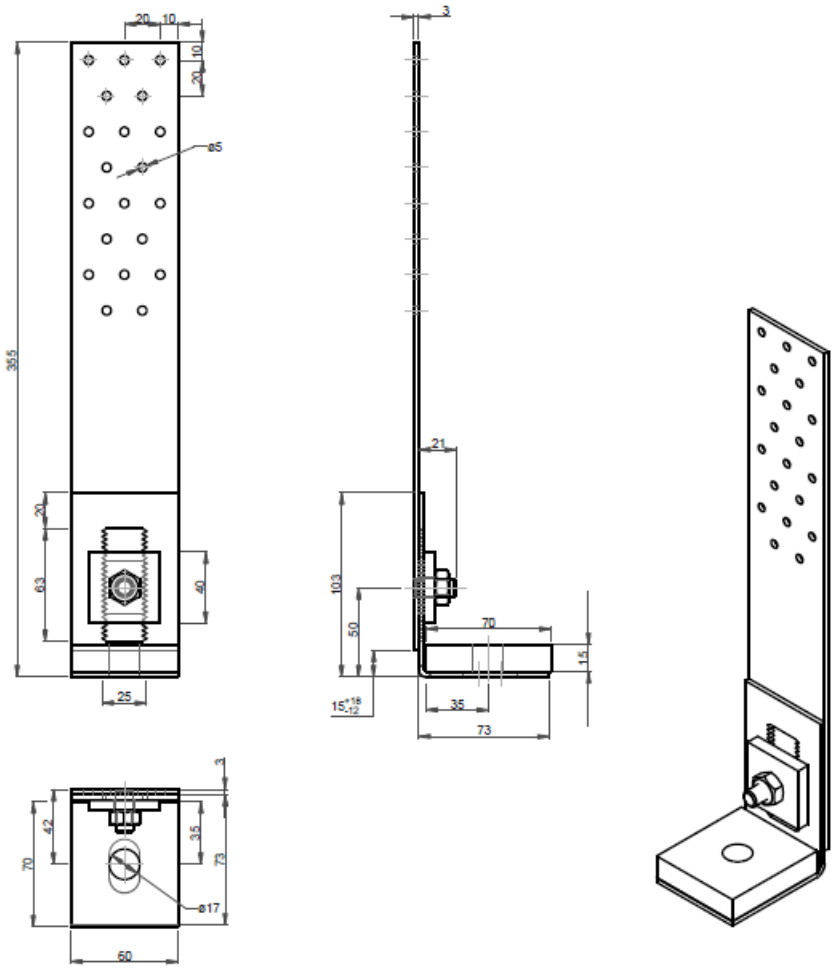


Figure B.39 HT2-GV-Druckplatte-kurz-Z-310

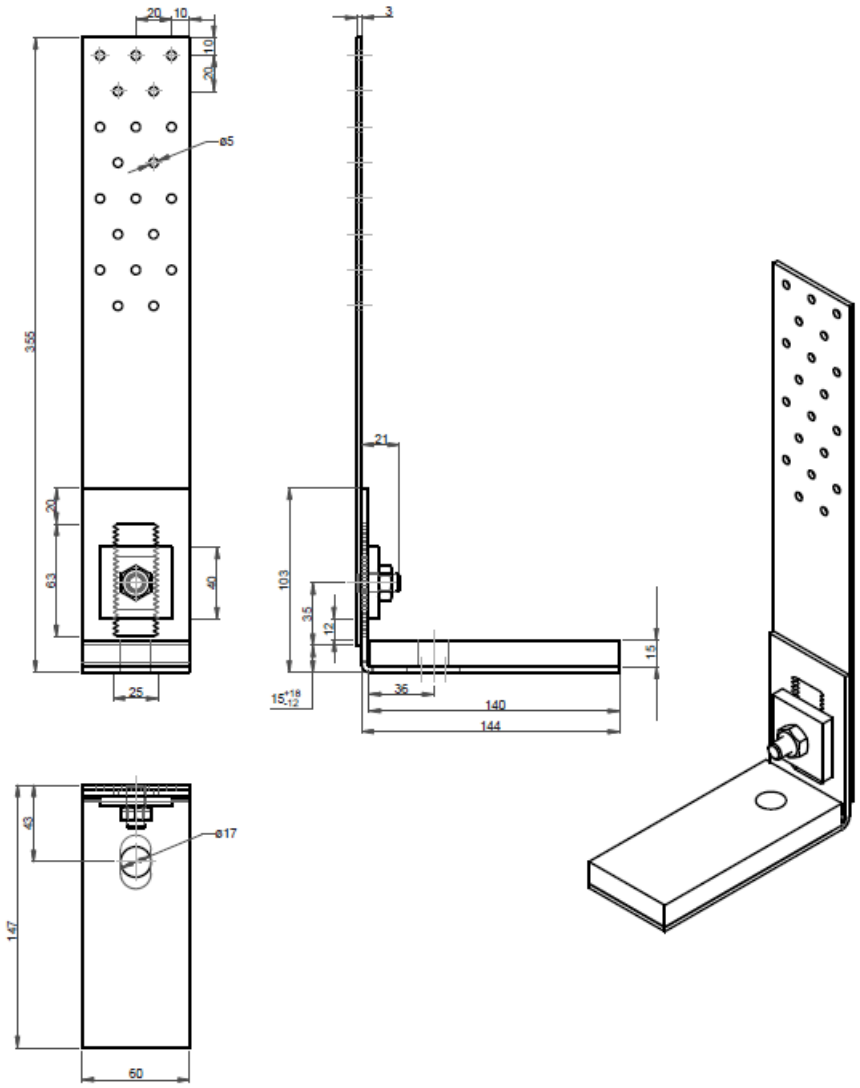


Figure B.40 HT2-GV-Druckplatte-lang-Z-320-3

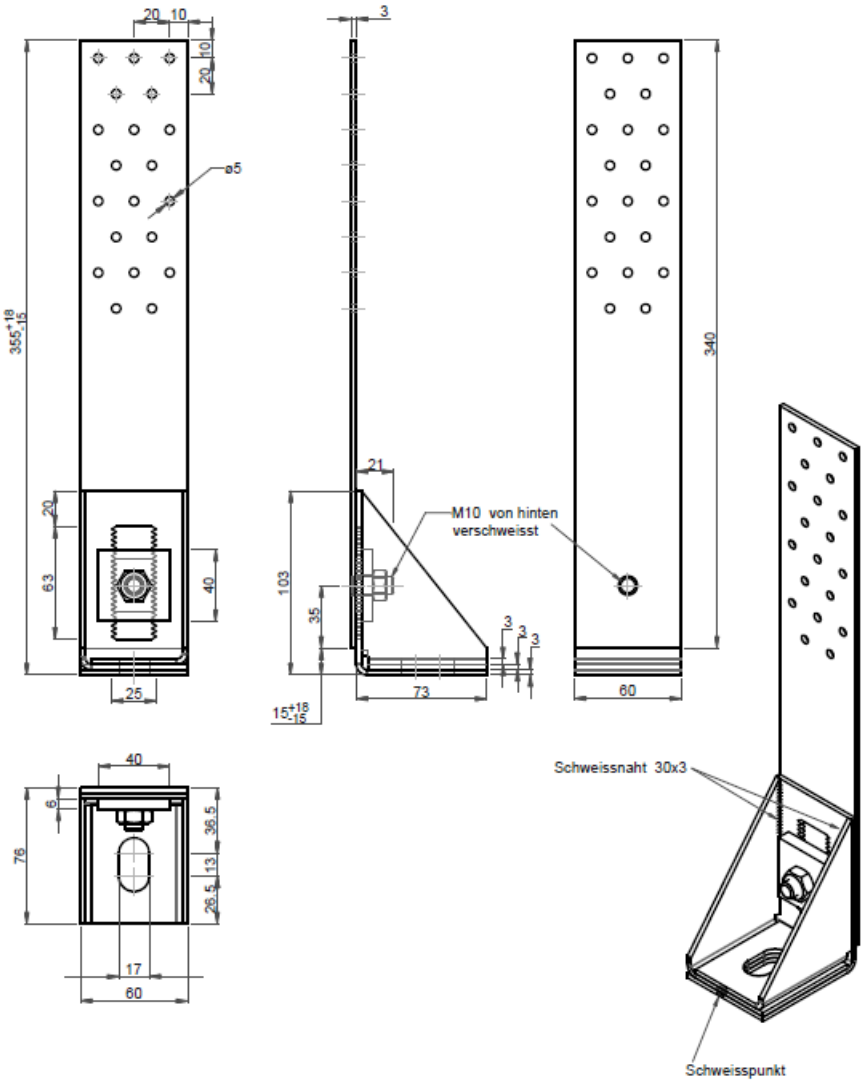


Figure B.41 HT2-GV-Stegwinkel-Z-100

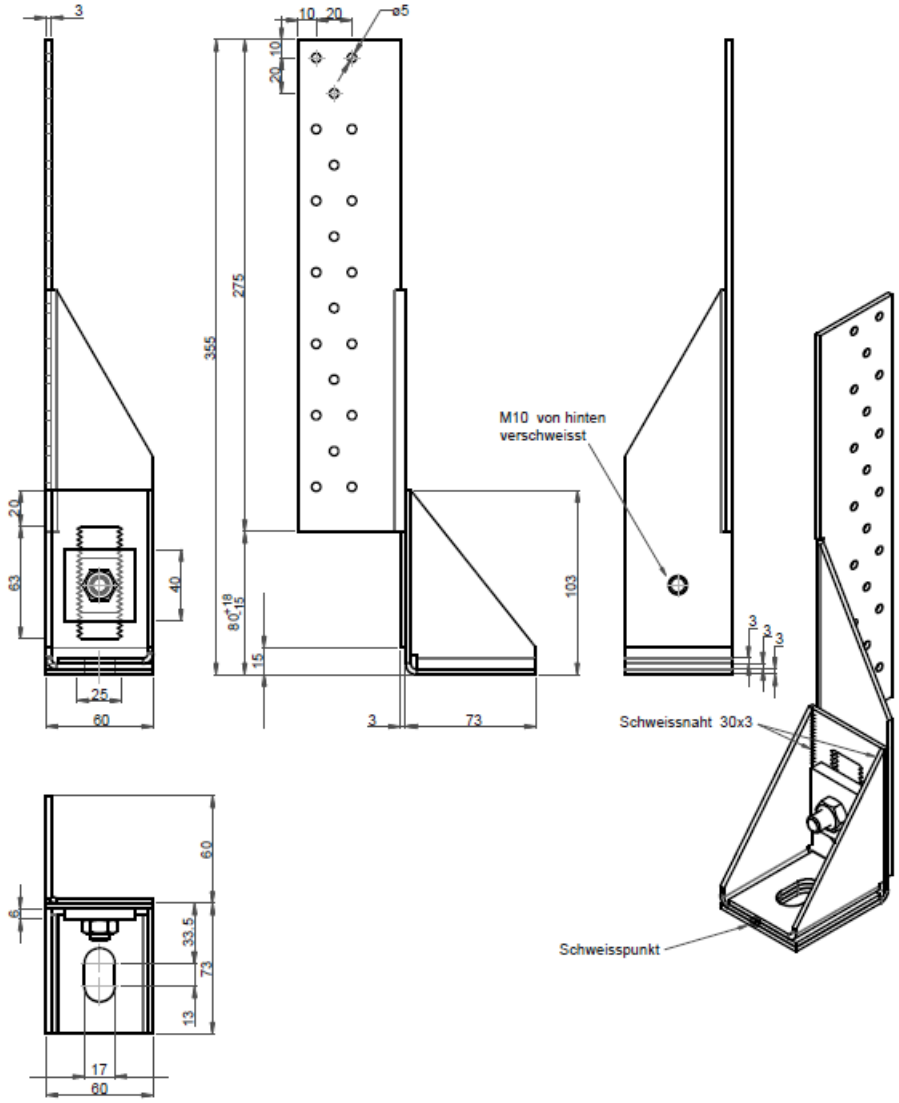


Figure B.42 HT2-LV-340-Stegwinkel-Z-220

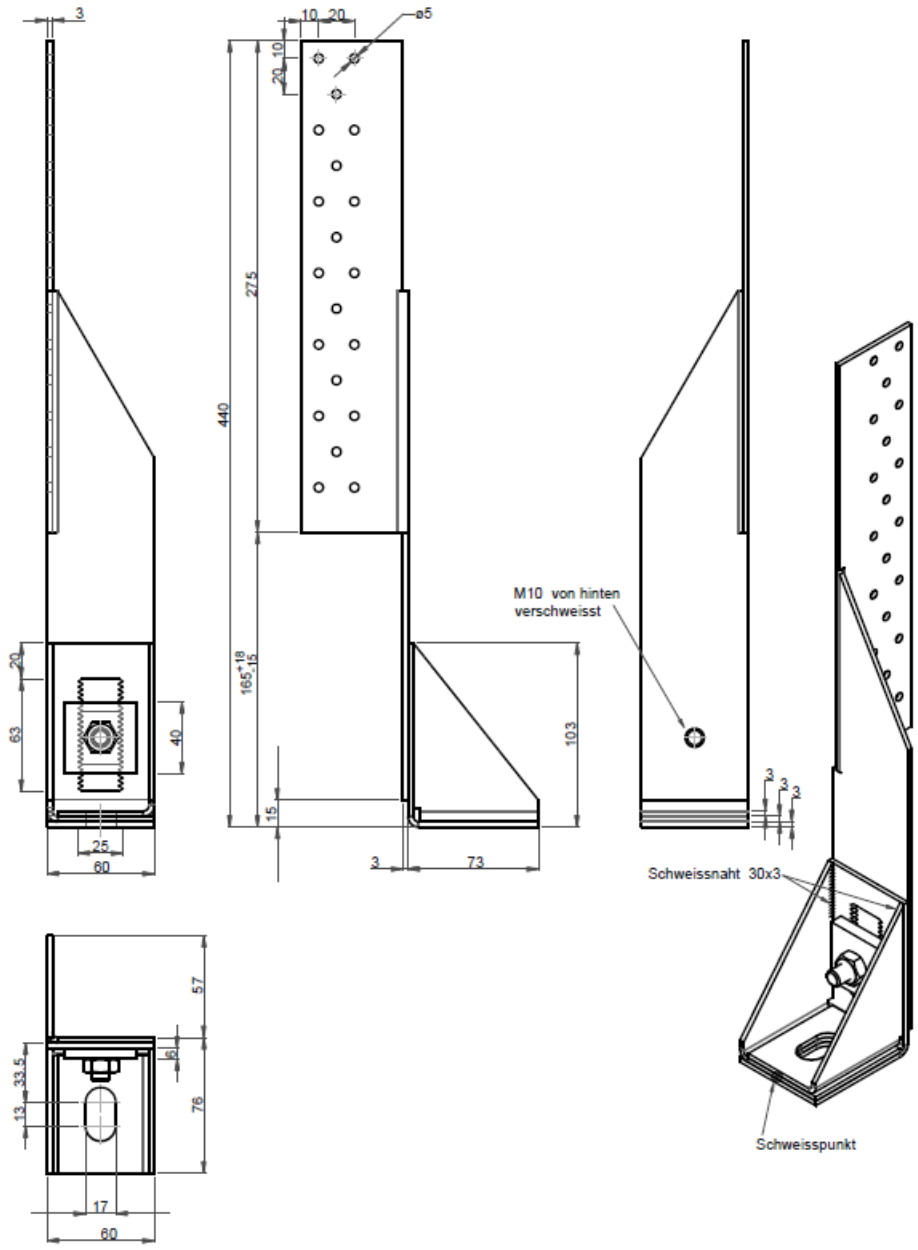


Figure B. 43 HT2-LV-425-Stegwinkel-Z-230

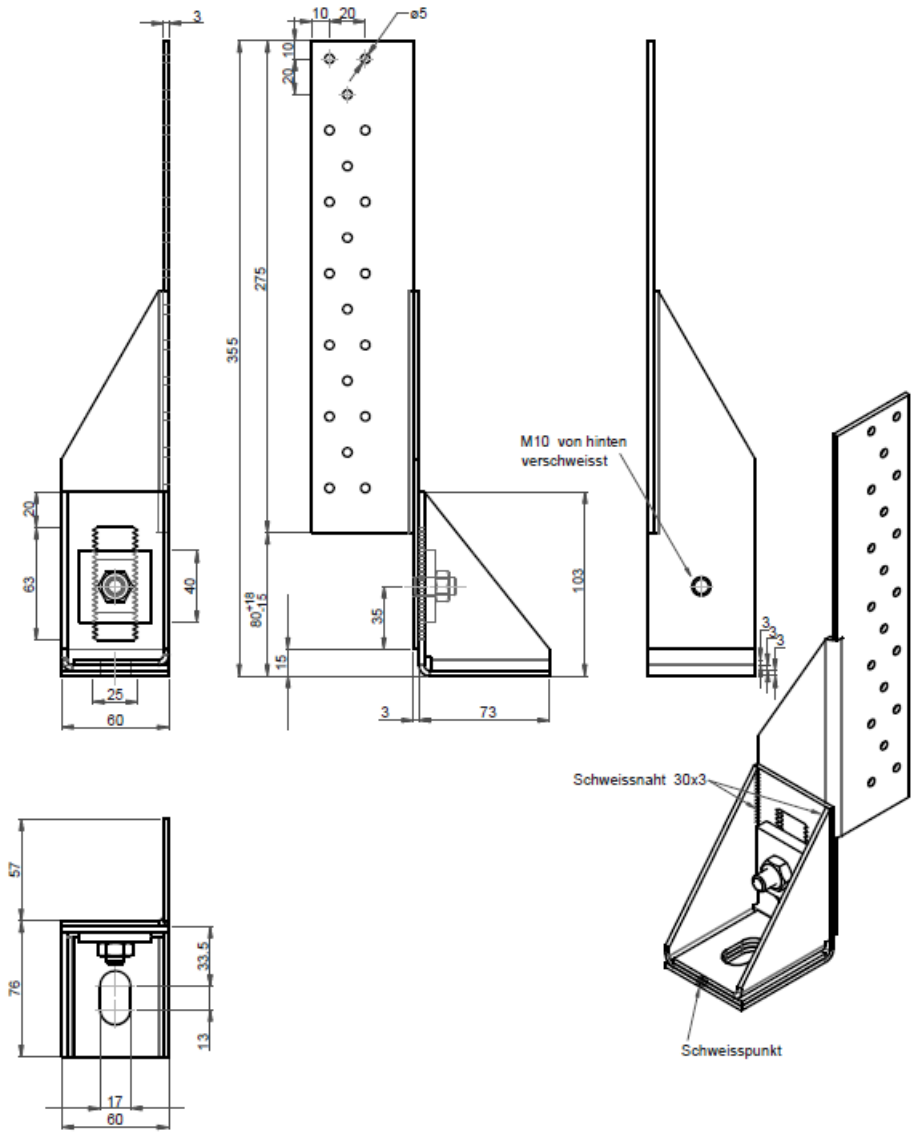


Figure B.44 HT2-RV-340-Stegwinkel-Z-225

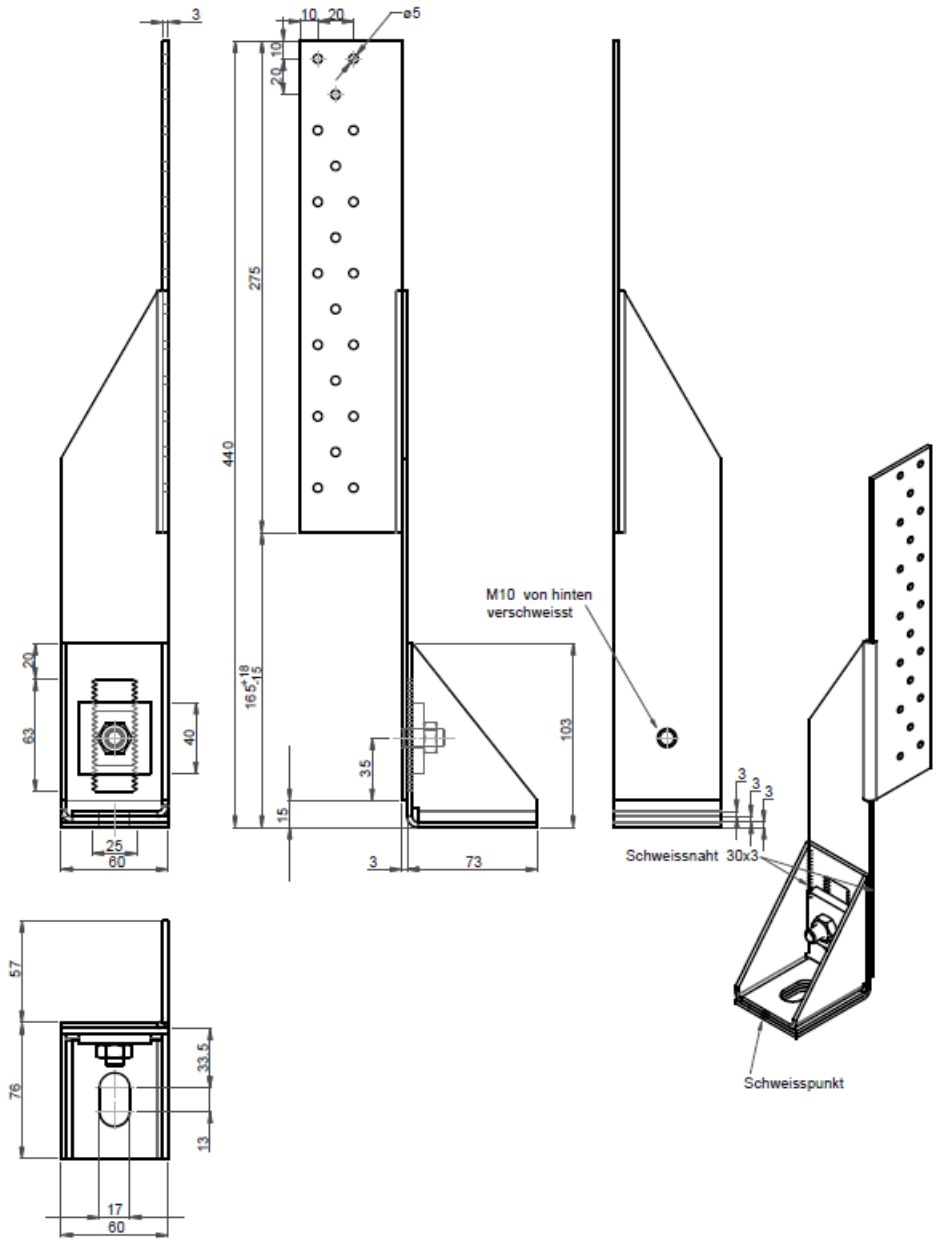


Figure B.45 HT2-RV-425-Stegwinkel-Z-235

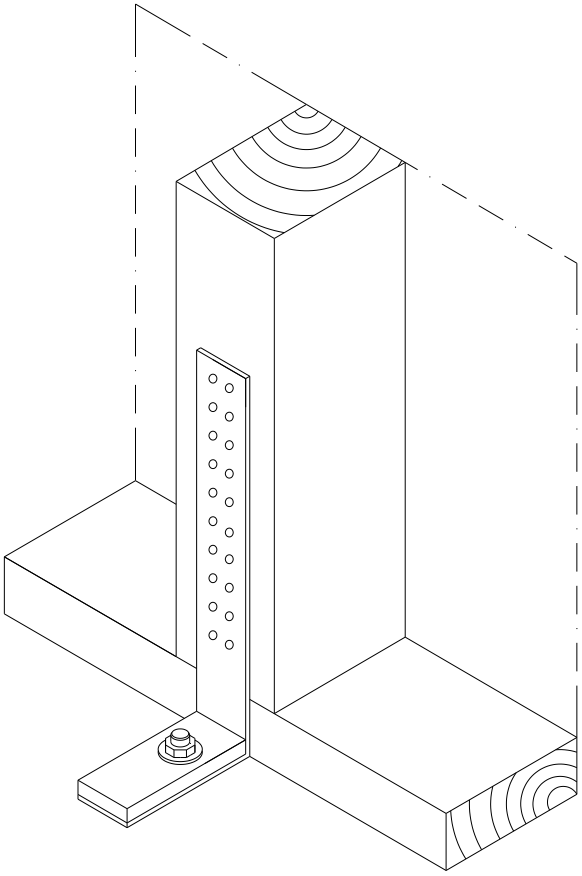


Figure B. 46Typical installation