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

MEMBER OF EOTA

European Technical Assessment ETA-11/0496 of 2024/05/07

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:	Rotho Blaas TITAN Angle Brackets
Product family to which the above construction product belongs:	Three-dimensional nailing plate (Angle Bracket for timber-to-timber or timber-to-concrete or steel connections)
Manufacturer:	ROTHO BLAAS SRL Via dell'Adige 2/1 IT-39040 Cortaccia (BZ) Tel. + 39 0471 818400 Fax + 39 0471 818484 Internet www.rothoblaas.com
Manufacturing plant:	ROTHO BLAAS SRL Manufacturing Plants: T1, T2, T3
This European Technical Assessment contains:	29 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:	EAD 130186-00-0603 for Three-dimensional nailing Plates.
This version replaces:	The previous ETA with the same number and issued on 2018-18-06

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II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product

Rotho Blaas TITAN angle brackets are one-piece non-welded, face-fixed angle brackets to be used in timber to timber or in timber to concrete or timber to steel connections. They are connected to construction members made of timber or wood-based products with threaded (ring shank) nails according to EN 14592 or ETA-22/0002 or screws type LBS or LBSH according to ETA-11/0030 or screws type HBSP according to ETA-11/0030 or screws type VGS according to ETA-11/0030 or bolts according to EN 14592 and to concrete or steel members with bolts or metal anchors.

TITAN angle brackets with a steel plate thickness of up to 4 mm are made from the following materials:

- steel S355 / Z 275 or FeZn12c according to EN 10025:2005 with $R_e \geq 355$ N/mm², $R_m \leq 630$ N/mm² and $A_{80} \geq 22\%$
- steel S235 / Z 275 or FeZn12c according to EN 10025:2005 with $R_e \geq 235$ N/mm², $R_m \leq 510$ N/mm² and $A_{80} \geq 26\%$
- steel S275 / Z 275 or FeZn12c according to EN 10025:2005 with $R_e \geq 275$ N/mm², $R_m \leq 560$ N/mm² and $A_{80} \geq 23\%$
- steel DX51D / Z275 according to EN 10346:2015 with $R_e \geq 220$ N/mm², $R_m \leq 500$ N/mm² and $A_{80} \geq 22\%$
- steel S250GD / Z275 according to EN 10346:2015 with $R_e \geq 250$ N/mm², $R_m \leq 470$ N/mm² and $A_{80} \geq 19\%$
- stainless steel with $R_e \geq 355$ N/mm², $R_m \leq 630$ N/mm² and $A_{80} \geq 22\%$

Dimensions, hole positions and typical installations are shown in Annex B. ROTHO BLAAS SRL angle brackets are made from steel with tolerances according to EN 10143.

2 Specification of the intended use in accordance with the applicable European Assessment document (hereinafter 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 as a connection between wall and floor elements or as wall-to-wall connection and on concrete/steel elements, where requirements for mechanical resistance and stability and safety in use in the sense of the Basic Works Requirements 1 and 4 of Regulation (EU) 305/2011 shall be fulfilled.

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

The static and kinematical behaviour of the timber members or the supports shall be as described in Annex A and 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/m³ to 420 kg/m³. The wood members may be of Laminated Veneer Lumber (LVL) with a characteristic density up to 500 kg/m³ with nails/screws in the wide face of the LVL component. 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 or ETA,
- Glued solid timber according to EN14080 or ETA,
- LVL according to EN 14374 or ETA,
- Parallam PSL,
- Intrallam LSL,
- Cross laminated timber according to ETA,
- Plywood according to EN 636 or ETA.

Annex B states the load-carrying capacities of the angle bracket connections for a characteristic density of 350 kg/m³. For timber or wood-based material with a lower or higher characteristic density than 350 kg/m³ the load-carrying capacities shall be converted by the factor k_{dens}:

In load case F_1:

$$k_{dens} = \left(\frac{\rho_k}{350}\right)^{0,8} \text{ for } 290 \text{ kg/m}^3 \leq \rho_k \leq 350 \text{ kg/m}^3$$

$$k_{dens} = \left(\frac{\rho_k}{350}\right)^{0,5} \text{ for } 350 \text{ kg/m}^3 \leq \rho_k \leq 420 \text{ kg/m}^3$$

$$k_{dens} = \left(\frac{\rho_k}{350}\right)^{0,5} \text{ for LVL with } \rho_k \leq 500 \text{ kg/m}^3$$

In load case $F_{2/3}$ and $F_{4/5}$:

$$k_{dens} = \left(\frac{\rho_k}{350}\right)^{2} \text{ for } 290 \text{ kg/m}^3 \leq \rho_k \leq 350 \text{ kg/m}^3$$

$$k_{dens} = \left(\frac{\rho_k}{350}\right)^{0,5} \text{ for } 350 \text{ kg/m}^3 \leq \rho_k \leq 420 \text{ kg/m}^3$$

$$k_{dens} = \left(\frac{\rho_k}{350}\right)^{0,5} \text{ for LVL with } \rho_k \leq 500 \text{ kg/m}^3$$

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

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

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. This includes seismic actions.

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 strength and ultimate strength is employed.

The angle brackets may also be used for connections between a timber member and a member of concrete or steel (TITAN TCN, TCS and TCF).

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

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

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

Characteristic	Assessment of characteristic
3.1 Mechanical resistance and stability*) (BWR1)	
Joint Strength - Characteristic load-carrying capacity	See Annex B
Joint Stiffness	See Annex B
Joint Ductility	No performance assessed
Resistance to seismic actions	No performance assessed
Resistance to corrosion and deterioration	See section 3.6
3.2 Safety in case of fire (BWR2)	
Reaction to fire	The angle brackets are made from steel classified as Euroclass A1 in accordance with EN 13501-1 and Commission Delegated Regulation 2016/364
Resistance to fire	No performance assessed
3.3 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 3.4 – 3.7.

3.4 Methods of verification

Safety principles and partial factors

The characteristic load-carrying capacities are based on the characteristic values of the dowel-type fastener connections and the steel plates. To obtain design values the capacities must be divided by different partial factors for the material properties, in case of timber failure 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 $F_{Rk,T}$ (obtaining the embedment strength of fasteners subjected to shear or the withdrawal capacity of the most loaded fastener, 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.

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

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.

3.5 Mechanical resistance and stability

See annex B for the characteristic load-carrying capacity in the different directions F_1, F_2, F_3, F_4 and F_5

The characteristic capacities of the angle brackets are determined by calculation assisted by testing and by testing as described in EAD 130186-0-0-0603 clause 2.2.1. They should be used for designs in accordance with Eurocode 5 or a similar national Timber Code.

No performance has been assessed 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.

Other connector nails or screws according to EN 14592 or ETA with the same or better performance than the fasteners given in table A.4 may be used.

3.6 Aspects related to the performance of the product

3.6.1 Corrosion protection in service class 1, 2 and 3.

In accordance with EAD 130186-00-0603 the angle brackets are produced from:

- steel S355 / Z 275 or FeZn12c treated according to EN 10025:2005 with $R_e \geq 355$ N/mm², $R_m \leq 630$ N/mm² and $A_{80} \geq 22\%$
- steel S235 / Z 275 or FeZn12c treated according to EN 10025:2005 with $R_e \geq 235$ N/mm², $R_m \leq 510$ N/mm² and $A_{80} \geq 26\%$
- steel S275 / Z 275 or FeZn12c treated according to EN 10025 with $R_e \geq 275$ N/mm², $R_m \leq 560$ N/mm² and $A_{80} \geq 23\%$
- steel DX51D / Z275 according to EN 10346 with $R_e \geq 220$ N/mm², $R_m \leq 500$ N/mm² and $A_{80} \geq 22\%$
- steel S250GD / Z275 according to EN 10346 with $R_e \geq 250$ N/mm², $R_m \leq 470$ N/mm² and $A_{80} \geq 19\%$
- stainless steel with $R_e \geq 355$ N/mm², $R_m \leq 630$ N/mm² and $A_{80} \geq 22\%$

3.7 General aspects related to the use of the product

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

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

The following provisions apply:

- The structural members – the components 1 and 2 shown in the figure on page 15 - to which the brackets are fixed shall be:
  - Restrained against rotation.
  - Strength class C14 or better, see section II.2 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.
- With the following exceptions, the minimum nail's or screw's end and edge distances according to EN 1995-1-1 have to be provided for.
- End or edge distance in component 2 towards the angle brackets bend line (shown in the figure on page 19).

- Edge distance in component 2 timber members for member depth ≥ 38 mm:
  $a_{4,t} \geq 13$ mm
  $a_{4,c} \geq 13$ mm
- For CLT, minimum nail's end and edge distances are:
  $a_{3,t} = (7 + 3 \cos \alpha)\ d$
  $a_{3,c} = 6\ d$
  $a_{4,t} = (3 + 4 \cos \alpha)\ d$
  $a_{4,c} = 3\ d$
  α is the angle between load and grain direction of the outer layers.
- For CLT, minimum screw's spacing, end and edge distances are:
  $a_1 = 4\ d$
  $a_2 = 2,5\ d$
  $a_{3,t} = 6\ d$
  $a_{3,c} = 6\ d$
  $a_{4,t} = 6\ d$
  $a_{4,c} = 2,5\ d$
  α is the angle between load and grain direction of the outer layers.
- The soundproofing interlayer shall be arranged between the horizontal flange and the timber member (component 1 as shown in the figure on page 19).
- There are no specific requirements relating to preparation of the timber members.

The execution of the connection shall be in accordance with the assessment holder's technical literature.

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

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 provided for 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 prior to CE marking.

Issued in Copenhagen on 2024-05-07 by

Thomas Bruun
Managing Director, ETA-Danmark

Annex A
Product details definitions

Table A.1 Materials specification

Angle Bracket type	Thickness (mm)	Steel specification	Coating specification
TITAN TTN160	3,0	S235/S275/S355/DX51D/S250GD	FeZn12c / Z 275
TITAN TTN200	3,0	S235/S275/S355/DX51D/S250GD	FeZn12c / Z 275
TITAN TTN240	3,0	S235/S275/S355/DX51D/S250GD	FeZn12c / Z 275
TITAN TTS140	3,0	S235/S275/S355/DX51D/S250GD	FeZn12c / Z 275
TITAN TTS195	3,0	S235/S275/S355/DX51D/S250GD	FeZn12c / Z 275
TITAN TTS240	3,0	S235/S275/S355/DX51D/S250GD	FeZn12c / Z 275
TITAN TCN160	3,0	S235/S275/S355/DX51D/S250GD	FeZn12c / Z 275
TITAN TCN200	3,0	S235/S275/S355/DX51D/S250GD	FeZn12c / Z 275
TITAN TCN240	3,0	S235/S275/S355/DX51D/S250GD	FeZn12c / Z 275
TITAN TCS140	3,0	S235/S275/S355/DX51D/S250GD	FeZn12c / Z 275
TITAN TCS195	3,0	S235/S275/S355/DX51D/S250GD	FeZn12c / Z 275
TITAN TCS240	3,0	S235/S275/S355/DX51D/S250GD	FeZn12c / Z 275
TITAN TTF200	3,0	S235/S275/S355/DX51D/S250GD	FeZn12c / Z 275
TITAN TCF200	3,0	S235/S275/S355/DX51D/S250GD	FeZn12c / Z 275
TITAN TTV240	4,0	S275/S355 [1)]	FeZn12c / Z 275
TITAN Washer TCW200	12,0	S235/S275/S355	FeZn12c / Z 275
TITAN Washer TCW240	12,0	S235/S275/S355	FeZn12c / Z 275

[1)] or steel DX51D with minimum and maximum mechanical properties of S275 with thickness of 4 mm. An inspection certificate 3.1 according to EN 10204 is required to confirm these values.

Table A.2 Materials specification – Soundproofing Interlayer

Interlayer type	Thickness (mm)
Xylofon or Xylofonplate	6,0
Aladin Stripe Soft	5,0
Aladin Stripe Extrasoft	7,0

Table A.3 Range of sizes

Angle Bracket type	Height (mm) vertical		Height (mm) horizontal		Width (mm)	
TITAN TTN160	119	121	92	94	159	161
TITAN TTN200	119	121	92	94	199	201
TITAN TTN240	119	121	92	94	239	241
TITAN TTS140	129	131	129	131	139	141
TITAN TTS195	129	131	129	131	194	196
TITAN TTS240	129	131	129	131	239	241
TITAN TCN160	119	121	102	104	159	161
TITAN TCN200	119	121	102	104	199	201
TITAN TCN240	119	121	122	124	239	241
TITAN TCS140	129	131	102	104	139	141
TITAN TCS195	129	131	102	104	194	196
TITAN TCS240	129	131	122	124	239	241
TITAN TTF200	70	72	70	72	199	201
TITAN TCF200	70	72	102	104	199	201
TITAN TTV240	119	121	92	93	239	241
TITAN Washer TCW200	-	-	71	73	189	191
TITAN Washer TCW240	-	-	73	75	229	231

Table A.4 Fastener specification

Fastener	Minimum Length	Minimum Threaded Length	Fastener type
Rotho Blaas Nail 4.0 mm, type LBA	40 mm	30 mm	Ringed shank nails according to ETA-22/0002
Ringed shank nail 4.0 mm	40 mm	30 mm	Ringed shank nails according to EN 14592
Rotho Blaas screw 5.0 mm, type LBS	40 mm	35 mm	Self-tapping screws according to ETA-11/0030
Rotho Blaas screw 5.0 mm, type LBSH	40 mm	35 mm	Self-tapping screws according to ETA-11/0030
Rotho Blaas screw 8.0 mm, type HBS+	60 mm	52 mm	Self-tapping screws according to ETA-11/0030
Rotho Blaas screw 11.0 mm, type VGS	150 mm	140 mm	Self-tapping screws according to ETA-11/0030
Rotho Blaas screw 11.0 mm, type VGS	200 mm	190 mm	Self-tapping screws according to ETA-11/0030

In the load-carrying-capacities of the nailed or with 5.0 mm 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. For the connection with 8.0 mm screws a thin steel plate is assumed. The load-carrying-capacities of the angle brackets have been determined based on the use of connector nails ø 4.0 mm in accordance with EN 14592 or ETA-22/002 and self-tapping screws according to ETA-11/0030. The characteristic withdrawal capacity of the nails or screws has to be determined by calculation in accordance with EN 1995-1-1, paragraph 8.3.2 (head pull-through is not relevant):

$$F_{ax,Rk} = f_{ax,k} \cdot d \cdot t_{pen} \left(\frac{\rho_k}{\rho_a}\right)^{0,8}$$ for the nails 4.0 mm

$$F_{ax,\alpha,Rk} = \min\left\{ f_{tens,k} ; \frac{n_{ef} \cdot k_{ax} \cdot f_{ax,k} \cdot d \cdot \ell_{ef}}{k_\beta} \left(\frac{\rho_k}{\rho_a}\right)^{0,8} \right\}$$ for the screws

where:

n_{ef} Effective number of fasteners
$f_{ax,k}$ Characteristic value of the withdrawal parameter in N/mm^2
d Nail or screw diameter in mm
t_{pen} Penetration depth of the ring shank in mm
ρ_k Characteristic density of the timber in kg/m^3
ρ_a Characteristic density of the timber in kg/m^3 according to $f_{ax,k}$

$f_{ax,k}$, $f_{tens,k}$, ρ_a, k_{ax} and k_β see ETA-11/0030 or ETA-22/0002.

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	Bolts type
12.0 or 16.0 mm	Max. 2 mm larger than the bolt diameter	See specification of the manufacturer

Metal Anchors diameter	Correspondent Hole diameter	Anchors type
12.0 or 16.0 mm	Max. 2 mm larger than the anchor diameter	See specification of the manufacturer

Annex B
Characteristic load-carrying capacities and slip moduli

Table B.1: Force F_1, 1 angle bracket / connection timber to concrete or steel

TITAN Type	timber					steel		Bolts inner row	concrete	$K_{1,ser}$ [kN/mm]
	capacity per fastener in the vertical flange $F_{v,Rk}$ [kN] $F_{1,Rk} = n_{ef} \cdot F_{v,Rk}$ [kN] [1]					$F_{1,Rk}$ [kN]		$k_{t,II}$	ℓ_D [mm]	
	Nail Ø4 x 60	LBA Nail Ø4 x 60	LBS screw Ø5 x 50	LBS screw Ø5 x 70	LBSH screw Ø5 x 50					
TCN200	1,93	2,66	2,27	2,56	2,65	11,8		1,09	7,3	3,0 [3]
TCN200 + Washer TCW200	1,93	2,66	2,27	2,56	2,65	Washer S235 45,7	Washer S355 69,0	1,09	7,3	-
TCN240	1,93	2,66	2,27	2,56	2,65	14,1		1,08	6,5	4,1 [3]
TCN240 + Washer TCW240	1,93	2,66	2,27	2,56	2,65	Washer S235 69,8	Washer S355 105,4	1,08	6,5	-
TCS 240	14 screws Ø8 x 80 [2]					16,2		1,08	6,5	5,5 [3]
	-									
TCS 240 + Washer TCW240	14 screws Ø8 x 80 [2]					75,9		1,08	6,5	11,5 [3]
	-									

[1] Fasteners must be arranged symmetrically.
[2] Number of screws in the vertical flange may be reduced. In this case, the load-carrying capacity for a steel-to-timber connection is $F_{1,Rk} = n_{ef} \cdot 3,77$ kN for screws Ø 8 x 80. Screws must be arranged symmetrically.
[3] Value is only valid when using the full number of fasteners given in column "timber".

Table B.2: Force F_1, 1 angle bracket with washer / connection timber to timber

TITAN Type	timber						steel	Bolts inner row
	capacity per fastener in the vertical flange $F_{v,Rk}$ [kN] $F_{1,Rk} = n_{ef} \cdot F_{v,Rk}$ [kN]					$F_{1,Rk}$ [kN]	$F_{1,Rk}$ [kN]	$k_{t,II}$
TCN200 + Washer TCW200	Nail Ø4 x 60	LBA Nail Ø4 x 60	LBS screw Ø5 x 50	LBS screw Ø5 x 70	LBSH screw Ø5 x 50	13,2	49,8	1,07
	1,93	2,66	2,27	2,56	2,65			
TCN240 + Washer TCW240	Nail Ø4 x 60	LBA Nail Ø4 x 60	LBS screw Ø5 x 50	LBS screw Ø5 x 70	LBSH screw Ø5 x 50	17,7	63,1	1,05
	1,93	2,66	2,27	2,56	2,65			
TCS240 + Washer TCW240	Screw Ø8 x 80					17,7	63,1	1,05
	3,77							

Table B.3: Force F_1, 1 angle bracket without washer / connection timber to timber

TITAN Type	**Number of fasteners**		**timber**					
			$F_{1,Rk}$ [kN]					$K_{1,ser}$ [kN/mm]
	n_V	n_H	LBA Ø4 x 60[a]	EN 14592 nails Ø4 x 60	LBS Ø5 x 50/70[c]	LBSH Ø5 x 50[b]	HBSP Ø8 x 80	Screws or nails
TTN240	36	36	7,37	7,37	16,2	16,2	-	11,5
TTS240	14	14	-	-	-	-	10,3	4,8
TTV240 (Pattern 1)	36	30+5	101	101	101/101	101	-	Nails:12,5
TTV240 (Pattern 2)	36	30+2	51,8	-	51,8	51,8	-	Screws: 17
TTV240 (Pattern 3)	24	24+5	64,5	64	64,5/64,5	64,5	-	Nails:10,5
TTV240 (Pattern 4)	24	24+2	51,3	-	51,3	51,3	-	Screws: 17
TTV240 (Pattern 1 + Xylofon)	36	30+5	99	99	99/99	99	-	-
TTV240 (Pattern 2 + Xylofon)	36	30+2	50,8	-	50,8	50,8	-	Screws: 17

[a] For LBA nails with shorter length, $F_{1,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,60,Rk}$; $F_{ax,short,Rk}/F_{ax,60,Rk}$}
[b] For LBSH screws with shorter length, $F_{1,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,50,Rk}$; $F_{ax,short,Rk}/F_{ax,50,Rk}$}
[c] For LBS screws with shorter length, $F_{1,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,70,Rk}$; $F_{ax,short,Rk}/F_{ax,70,Rk}$}

Table B.4: Force $F_{2/3}$, 1 angle bracket / connection timber to timber

TITAN Type	**Number of fasteners**		**Timber**					
			$F_{2/3,Rk}$ [kN]					**$K_{2/3,ser}$ [kN/mm]**
	n_V	**n_H**	LBA Ø4 x 60[a]	EN 14592 Nails Ø4 x 60	LBS Ø5 x 50/70[c]	LBSH Ø5 x 50[b]	HBSP Ø8 x 80	
TTN160	24	24	19,3	19,3	24,0/24,0	24,0	-	-
TTN200	30	30	28,0	28,0	34,7/34,7	34,7	-	-
TTN240	36	36	51,3	37,9	46,7/58,0	52,8	-	11,0
TTN240 + Xylofon	36	36	41,7	24,8	22,8/43,8	43,8	-	9,0
TTN240 + Aladin stripe soft	36	36	41,7	28,9	27,5/43,8	43,8	-	9,0
TTN240 + Aladin stripe Extrasoft	36	36	41,7	27,5	25,7/43,8	43,8	-	9,0
TTS140	8	8	-	-	-	-	10,7	-
TTS195	11	11	-	-	-	-	17,1	-
TTS240	14	14	-	-	-	-	60,0	5,6
TTS240 + Xylofon	14	14	-	-	-	-	35,7	6,0
TTS240 + Aladin stripe soft	14	14	-	-	-	-	35,7	6,0
TTS240 + Aladin stripe Extrasoft	14	14	-	-	-	-	35,7	6,0
TTF200	30	30	48,9	35,5	42,5/55,1	48,5	-	10,0
TTF200 (Pattern 4)	25	25	42,7	31	37,2/41,0	42,4	-	-
TTF200 (Pattern 3)	15	15	28,8	20,9	25,1/36,3	28,6	-	7,0
TTF200 (Pattern 2)	10	10	20,8	15,1	18,1/20,0	20,7	-	7,0
TTF200 + Xylofon	30	30	40,8	17,2	15,8/45,1	39,0	-	7,0
TTF200 + Aladin stripe soft	30	30	40,8	20,0	19,0/45,1	39,0	-	7,0
TTF200 + Aladin stripe Extrasoft	30	30	40,8	19,0	17,9/45,1	39,0	-	7,0
TTF200 (Pattern 3) + Xylofon	15	15	24,1	-	-/28,3	23,1	-	-
TTF200 (Pattern 3) + Aladin stripe soft	15	15	24,1	-	-/28,3	23,1	-	-
TTF200 (Pattern 3) + Aladin stripe Extrasoft	15	15	24,1	-	-/28,3	23,1	-	-
TTV240 (Pattern 1)	36	30+5 [1)]	68,8	-	-/73,1	72,0	-	16,0
TTV240 (Pattern 2)	36	30+2 [1)]	59,7	59,7	59,7/59,7	59,7	-	6,6
TTV240 (Pattern 3)	24	24+5 [2)]	61,8	-	-/65,8	65,0	-	13,0
TTV240 (Pattern 4)	24	24+2 [2)]	51,5	51,5	51,5/51,5	51,5	-	4,8
TTV240 (Pattern 1 + Xylofon)	36	30+5 [1)]	61,0	-	61,0/61,0	61,0	-	10,0

[1)] VGS 11x200
[2)] VGS 11x150
[a] For LBA nails with shorter length, $F_{2/3,Rk}$ must be reduced by $\min\{F_{v,short,Rk}/F_{v,60,Rk} ; F_{ax,short,Rk}/F_{ax,60,Rk}\}$
[b] For LBSH screws with shorter length, $F_{2/3,Rk}$ must be reduced by $\min\{F_{v,short,Rk}/F_{v,50,Rk} ; F_{ax,short,Rk}/F_{ax,50,Rk}\}$
[c] For LBS screws with shorter length, $F_{2/3,Rk}$ must be reduced by $\min\{F_{v,short,Rk}/F_{v,70,Rk} ; F_{ax,short,Rk}/F_{ax,70,Rk}\}$

Table B.5: Force $F_{2/3}$, 1 angle bracket with washer / connection timber to timber

TITAN Type	Number of fasteners		Timber $F_{2/3,Rk}$ [kN]			Bolts inner row		a_x
	number n_V	number n_H	Nails[1] Ø4 x 60	Screws[2] Ø5 x 50/70	Screws Ø8 x 80	$k_{t,\perp}$	e_y	
TCN 200 + TCW 200	30	2	22,1	26,5	-	0,56	38,5	150
TCN 240 + TCW 240	36	2	30,3	36,3	-	0,56	39,5	162
TCS 240 + TCW 240	14	2	-	-	25,0	0,56	39,5	162

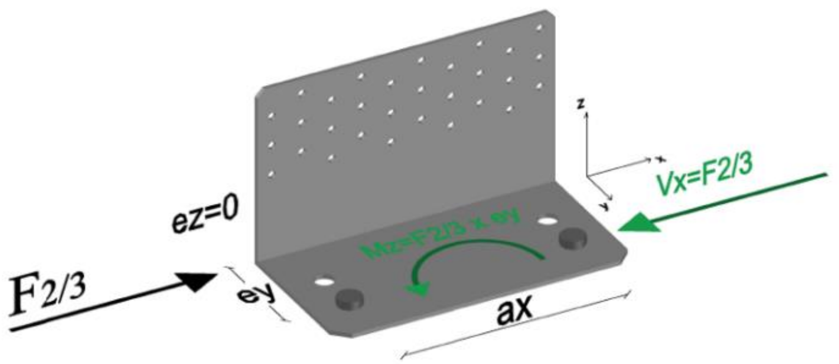
[1] Nails according to EN 14592 or LBA nails according to ETA-22/0002
[2] LBS or LBSH screws according to ETA-11/0030

Table B.6: Force $F_{2/3}$, 1 angle bracket / connection timber to concrete or steel

TITAN Type	Number of fasteners		Timber $F_{2/3,Rk}$ [kN]			Bolts inner row					$K_{2/3,ser}$ [kN/mm]
	n_V	n_H	Nails[1] Ø4 x 60	Screws[2] Ø5 x 50/70	Screws Ø8 x 80	$k_{t,\perp}$	e_y	$k_{t,\parallel}$	e_z	a_x	
TCN 200 + TCW 200	30	2	56,7	66,4	-	0,56	38,5	0,56	83,5	150	9,0
TCN 240 + TCW 240	36	2	70,5	82,6	-	0,56	39,5	0,52	83,5	162	9,0
TCS 240 + TCW 240	14	2	-	-	85,9	0,56	39,5	0,48	78,5	162	9,0

[1] Nails according to EN 14592 or LBA nails according to ETA-22/0002
[2] LBS or LBSH screws according to ETA-11/0030

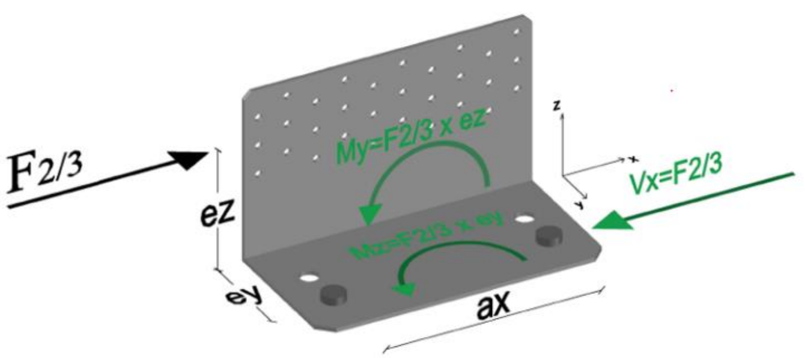
Explanation for table B.5 and B.7



$F_{2/3}$

$M_z = F_{2/3} * e_y$

Explanation for table B.6



$F_{2/3}$

$M_z = F_{2/3} * e_y$

$M_y = F_{2/3} * e_z$

Table B.7: Force $F_{2/3}$, 1 angle bracket / connection timber to concrete or steel

TITAN Type	Number of fasteners		Timber $F_{2/3,Rk}$ [kN]					Bolts inner row		Bolts outer row			$K_{2/3,ser}$ [kN/mm]
	n_V	n_H	LBA Ø4 x 60[a]	EN 14592 Nails Ø4 x 60	LBS Ø5 x 50/70[c]	LBSH Ø5 x 50[b]	HBSP Ø8 x 80	$k_{t,\perp}$	e_y	$k_{t,\perp}$	e_y	a_x	
TCN160	24	2	-	15,1	18,1/18,1	-	-	0,61	38,5	0,81	70	110	-
TCN200	30	2	30,5	22,1	26,5/42,1	30,3	-	0,56	38,5	0,68	70	150	9,0
TCN200 (Pattern 4)	25	2	24,0	17,4	20,4/37,9	23,9	-	0,56	38,5	0,68	70	150	7,0
TCN200 (Pattern 3)	20	2	18,8	13,7	16,0/18,0	18,7	-	0,56	38,5	0,68	70	150	-
TCN200 (Pattern 2)	15	2	13,2	9,6	11,2/12,7	13,1	-	0,56	38,5	0,68	70	150	-
TCN200 (Pattern 1)	10	2	8,8	6,4	7,48/8,4	8,7	-	0,56	38,5	0,68	70	150	-
TCN240	36	2	41,7	30,3	36,3/55,2	41,4	-	0,56	39,5	0,7	80,5	150	12,0
TCN240 (Pattern 4)	30	2	33,1	24	28,2/51,3	32,9	-	0,56	39,5	0,7	80,5	162	11,0
TCN240 (Pattern 3)	24	2	25,9	18,8	22,1/24,9	25,8	-	0,56	39,5	0,7	80,5	162	-
TCN240 (Pattern 2)	18	2	18,4	13,3	15,6/17,6	18,3	-	0,56	39,5	0,7	80,5	162	-
TCN240 (Pattern 1)	12	2	12,2	8,85	10,4/11,7	12,1	-	0,56	39,5	0,7	80,5	162	-
TCS140	8	2	-	-	-	-	10,7	0,66	38,5	0,92	70	90	-
TCS195	11	2	-	-	-	-	17,1	0,56	38,5	0,68	70	150	-
TCS240 (Full pattern)	14	2	-	-	-	-	70,3	0,56	39,5	0,7	80,5	162	8,2
TCS240 (Partial pattern	9	2	-	-	-	-	36,1	0,56	39,5	0,7	80,5	162	7,0
TCF200	30	2	48,9	35,5	42,5/51,8	48,5	-	0,56	38,5	0,68	70	150	9,0
TCF200 (Pattern 4)	25	2	42,7	31	37,2/41,0	42,4	-	0,56	38,5	0,68	70	150	-
TCF200 (Pattern 3)	15	2	28,7	20,9	25,1/27,7	28,6	-	0,56	38,5	0,68	70	150	-
TCF200 (Pattern 2)	10	2	20,8	15,1	18,1/20,0	20,7	-	0,56	38,5	0,68	70	150	4,0
TCF200 (Pattern 1)	10	2	17,2	-	-/27,5	17,1	-	0,56	38,5	0,68	70	150	3,0

[a] For LBA nails with shorter length, $F_{2/3,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,60,Rk}$; $F_{ax,short,Rk}/F_{ax,60,Rk}$}
[b] For LBSH screws with shorter length, $F_{2/3,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,50,Rk}$; $F_{ax,short,Rk}/F_{ax,50,Rk}$}
[c] For LBS screws with shorter length, $F_{2/3,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,70,Rk}$; $F_{ax,short,Rk}/F_{ax,70,Rk}$}

Table B.8: Force $F_{4/5}$, 2 angle brackets / connection timber to timber, concrete or steel

TITAN Type	Number of fasteners		$F_{4/5,Rk}$ [kN]				Bolts inner row	
			timber			steel		
	n_V	n_H	LBA nails Ø4 x 60[a]	LBSH screws Ø5 x 50[b]	LBS screws Ø5 x 70[c]		$k_{t,\perp}$	$k_{t,\parallel}$
TTN240	72	72	26,7			31,6	-	-
TTS240	28	28	25,2			23,4	-	-
TTF200	60	60	36,2	39,2	39,2	-	-	-
TTF200 (Pattern 4)	50	50	36,2	39,2	39,2	-	-	-
TTF200 (Pattern 3)	30	30	36,2	39,2	38,9	-	-	-
TTF200 (Pattern 2)	20	20	27,1	30,2	29,9	-	-	-
TTF200 + Xylofon	60	60	30,6	33,7	33,7	-	-	-
TTV240 (Pattern 1)	72	60+10 [1)]	55,3	55,8	55,8	-	-	-
TTV240 (Pattern 2)	72	60+4 [1)]	55,3	55,8	55,8	-	-	-
TTV240 (Pattern 3)	48	48+10 [2)]	55,3	55,8	55,3	-	-	-
TTV240 (Pattern 4)	48	48+4 [2)]	55,3	55,8	55,3	-	-	-
TTV240 (Pattern 1 + Xylofon)	72	60+10 [1)]	48,4	48,9	48,9	-	-	-
TCN200	60	4	25,6			14,9	0,41	0,09
TCN200 (Pattern 2)	30	4	22,4			20,9	0,46	0,06
TCN240	72	4	27,8			24,7	0,43	0,06
TCN240 (Pattern 2)	36	4	25,2			30,6	0,48	0,04
TCS240 (Full pattern)	28	4	27,4			18,8	0,39	0,08
TCN200	60	4	25,6			14,9	0,41	0,09
TCF200	60	4	25,0	28,1	28,1	-	0,31	0,10
TCF200 (Pattern 4)	50	4	25,0	28,1	28,1	-	0,31	0,10
TCF200 (Pattern 3)	30	4	25,0	28,1	28,1	-	0,31	0,10
TCF200 (Pattern 2)	20	4	17,5	20,6	20,6	-	0,31	0,10
TCF200 (Pattern 1)	20	4	13,0	13,0	13,0	-	0,31	0,10

1) VGS 11 x 200 mm

2) VGS 11 x 150 mm

a For LBA nails with shorter length, $F_{4/5,Rk}$ must be reduced by $\min\{F_{v,short,Rk}/F_{v,60,Rk}\ ;\ F_{ax,short,Rk}/F_{ax,60,Rk}\}$

b For LBSH screws with shorter length, $F_{4/5,Rk}$ must be reduced by $\min\{F_{v,short,Rk}/F_{v,50,Rk}\ ;\ F_{ax,short,Rk}/F_{ax,50,Rk}\}$

c For LBS screws with shorter length, $F_{4/5,Rk}$ must be reduced by $\min\{F_{v,short,Rk}/F_{v,70,Rk}\ ;\ F_{ax,short,Rk}/F_{ax,70,Rk}\}$

Table B.9: Force F_4, 1 angle bracket / connection timber to timber, concrete or steel

TITAN Type	**Number of fasteners**		**$F_{4,Rk}$ [kN]**		**Bolts inner row**	
			Timber	steel		
	n_V	**n_H**	LBA4x60[a] or LBSH 5x50[b] or LBS5x70[c]		$k_{t,\perp}$	$k_{t,\parallel}$
TTN240	36	36	23,8	31,1	-	-
TTS240	14	14	20,7	20,9	-	-
TTF200	30	30	29,7	-	-	-
TTF200 (Pattern 4)	25	25	29,7	-	-	-
TTF200 (Pattern 3)	15	15	29,4	-	-	-
TTF200 (Pattern 2)	10	10	20,4	-	-	-
TTF200 + Xylofon	30	30	24,2	-	-	-
TTV240 (Pattern 1)	36	30+5 [1)]	47,6	-	-	-
TTV240 (Pattern 2)	36	30+2 [1)]	40,7	-	-	-
TTV240 (Pattern 3)	24	24+5 [2)]	47,0	-	-	-
TTV240 (Pattern 4)	24	24+2 [2)]	47,0	-	-	-
TTV240 (Pattern 1 + Xylofon)	36	30+5 [1)]	40,7	-	-	-
TTV240 (Pattern 2 + Xylofon)	36	30+2 [1)]	40,7	-	-	-
TCN200	30	2	20,9	22,4	0,50	-
TCN200 (Pattern 2)	15	2	20,7	24,3	0,50	-
TCN240	36	2	24,1	26,9	0,50	-
TCN240 (Pattern 2)	18	2	23,9	29,1	0,50	-
TCS240	14	2	21,1	18,1	0,50	-
TCF200	30	2	18,6	-	0,50	-
TCF200 (Pattern 4)	25	2	18,6	-	0,50	-
TCF200 (Pattern 3)	15	2	18,6	-	0,50	-
TCF200 (Pattern 2)	10	2	11,0	-	0,50	-
TCF200 (Pattern 1)	10	2	6,8	-	0,50	-

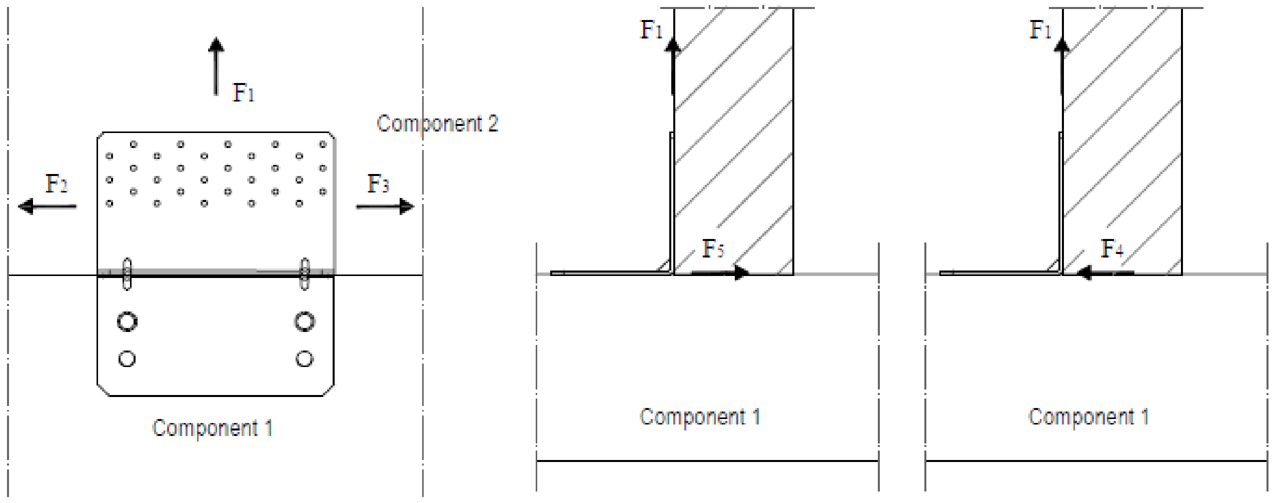
[1)] VGS 11 x 200 mm
[2)] VGS 11 x 150 mm
[a] For LBA nails with shorter length, $F_{4,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,60,Rk}$; $F_{ax,short,Rk}/F_{ax,60,Rk}$}
[b] For LBSH screws with shorter length, $F_{4,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,50,Rk}$; $F_{ax,short,Rk}/F_{ax,50,Rk}$}
[c] For LBS screws with shorter length, $F_{4,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,70,Rk}$; $F_{ax,short,Rk}/F_{ax,70,Rk}$}

Table B.10: Force F_5, 1 angle bracket / connection timber to timber, concrete or steel

TITAN Type	**Number of fasteners**		**$F_{5,Rk}$ [kN]**				**Bolts inner row**	
	n_V	**n_H**	timber			steel		
			LBA 4x60[a]	LBSH 5x50[b]	LBS 5x 70[c]		$k_{t,\perp}$	$k_{t,\parallel}$
TTN240	36	36	7,26			3,41	-	-
TTS240	14	14	16,8			4,24	-	-
TTF200	30	30	6,4	13,2	19,3	9,5	-	-
TTF200 (Pattern 4)	25	25	6,4	13,2	19,3	9,5	-	-
TTF200 (Pattern 3)	15	15	6,4	13,2	19,3	9,5	-	-
TTF200 (Pattern 2)	10	10	6,4	13,2	19,3	9,5	-	-
TTF200 + Xylofon	30	30	6,4	13,2	19,3	9,5	-	-
TTV240 (Pattern 1)	36	30+5 [1)]	7,7	15,8	23,2	8,3	-	-
TTV240 (Pattern 2)	36	30+2 [1)]	7,7	15,8	23,2	8,3	-	-
TTV240 (Pattern 3)	24	24+5 [2)]	7,7	15,8	23,2	8,3	-	-
TTV240 (Pattern 4)	24	24+2 [2)]	7,7	15,8	23,2	8,3	-	-
TTV240 (Pattern 1 + Xylofon)	36	30+5 [1)]	7,7	15,8	23,2	8,3	-	-
TTV240 (Pattern 2 + Xylofon)	36	30+2 [1)]	7,7	15,8	23,2	8,3	-	-
TCN200	30	2	6,64			2,74	0,50	0,47
TCN200 (Pattern 2)	15	2	3,60			1,58	0,50	0,83
TCN240	36	2	8,02			3,28	0,50	0,48
TCN240 (Pattern 2)	18	2	4,33			1,89	0,50	0,83
TCS240	14	2	17,1			4,30	0,50	0,36
TCF200	30	2	6,4	13,2	19,3	9,5	0,50	0,27
TCF200 (Pattern 4)	25	2	6,4	13,2	19,3	9,5	0,50	0,27
TCF200 (Pattern 3)	15	2	6,4	13,2	19,3	9,5	0,50	0,27
TCF200 (Pattern 2)	10	2	6,4	13,2	19,3	9,5	0,50	0,27
TCF200 (Pattern 1)	10	2	6,4	13,2	19,3	9,5	0,50	0,27

[1)] VGS 11 x 200 mm
[2)] VGS 11 x 150 mm
[a] For LBA nails with shorter length, $F_{5,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,60,Rk}$; $F_{ax,short,Rk}/F_{ax,60,Rk}$}
[b] For LBSH screws with shorter length, $F_{5,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,50,Rk}$; $F_{ax,short,Rk}/F_{ax,50,Rk}$}
[c] For LBS screws with shorter length, $F_{5,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,70,Rk}$; $F_{ax,short,Rk}/F_{ax,70,Rk}$}

Definitions of forces, their directions and eccentricity
Forces – Example:



Fastener specification
Nailing patterns are given in figures B.18, B.19 and B.20. Unless otherwise stated the load-carrying capacities are applicable for connections with nails ø 4.0 mm as well as for LBS screws ø 5.0 mm. In connections with bolts or metal anchors, there are always two bolts/metal anchors per angle bracket. Unless otherwise stated, their position is in the first row from the bend line (inward).

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 joint between the component 2 and component 1 in the component 1 direction.

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 along the central axis of the joint. The components must be prevented from rotation. F_4 causes compression between the angle bracket and component 2; F_5 causes tension between the angle bracket and component 2.

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

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

Combined forces

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

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

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

Bolt design

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

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

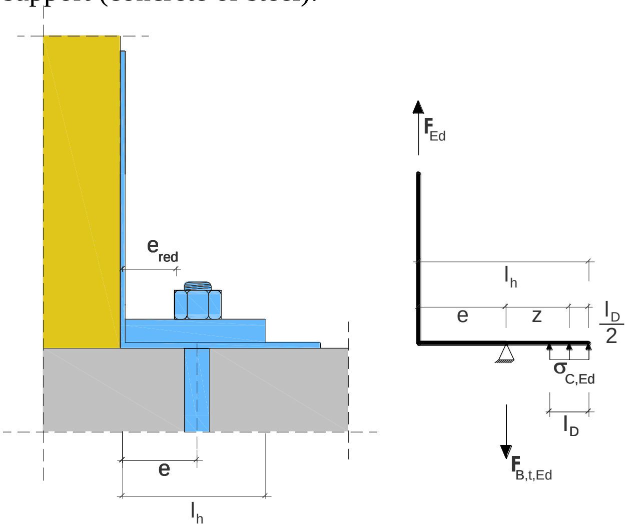
$$F_{B,v,Ed}=k_{t,\perp}\cdot F_{Ed}$$

where:

$F_{B,t,Ed}$	Resulting tensile load on the maximally loaded bolt in the group in N
$F_{B,v,Ed}$	Resulting shear load on the maximally loaded bolt in the group in N
$k_{t,\parallel}$	Coefficient taking into account the resulting axial force
$k_{t,\perp}$	Coefficient taking into account the moment arm or hole tolerance, respectively
F_{Ed}	Load on vertical flap of the angle bracket or pair of angle brackets in N

Load combinations have to be considered.

Compressive stress on the support (concrete or steel):



$$\sigma_{C,Ed}=\frac{F_{1,Ed}\cdot\left(2\cdot k_{t,\parallel}-1\right)}{b\cdot \ell_D}$$

where:

$F_{1,Ed}$	Tensile load F_1 on vertical flap of the angle bracket in N
b	Width of the washer in mm
$\sigma_{C,Ed}$	Compressive stress on the support (concrete or steel) in N/mm^2
e	Bolt distance
l_h	Washer depth
z	distance bolt- compression center
l_D	Compression length

Rotho Blaas TITAN Angle Brackets

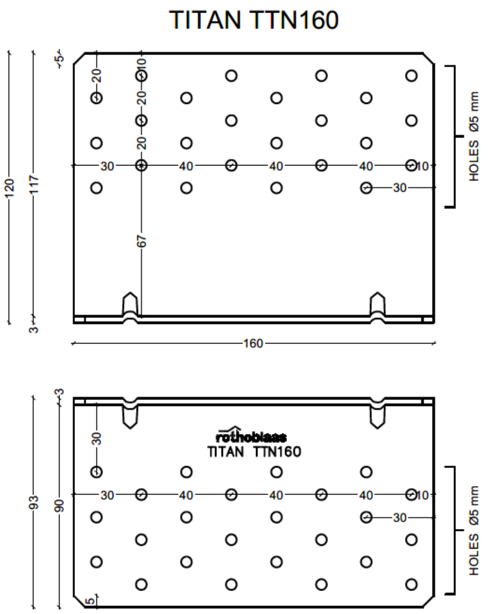


Figure B. 1
Dimensions of Angle Bracket TITAN TTN160

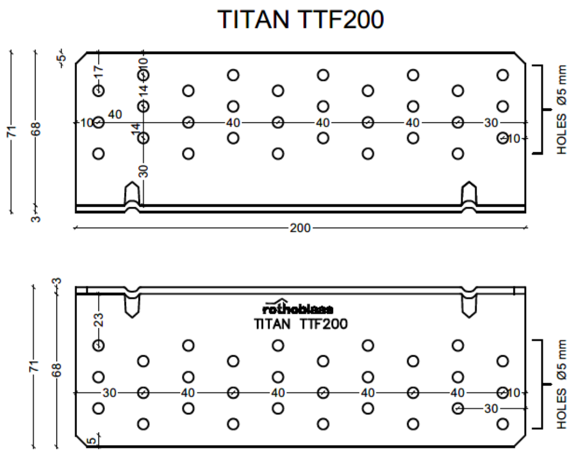


Figure B. 2
Dimensions of Angle Bracket TITAN TTF200

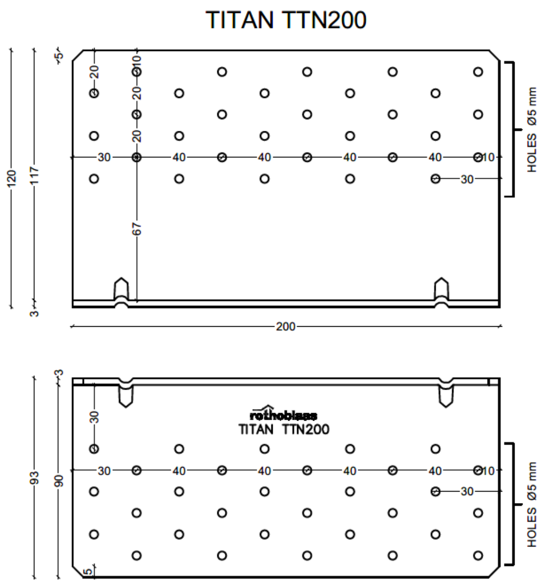


Figure B. 3
Dimensions of Angle Bracket TITAN TTN200

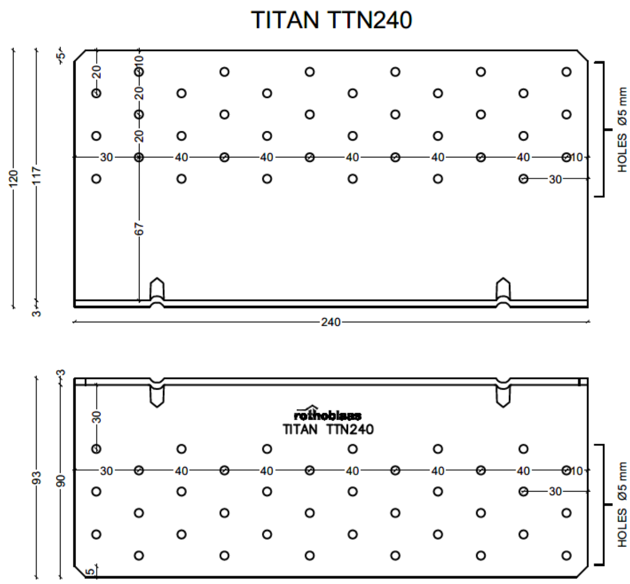


Figure B. 4
Dimensions of Angle Bracket TITAN TTN240

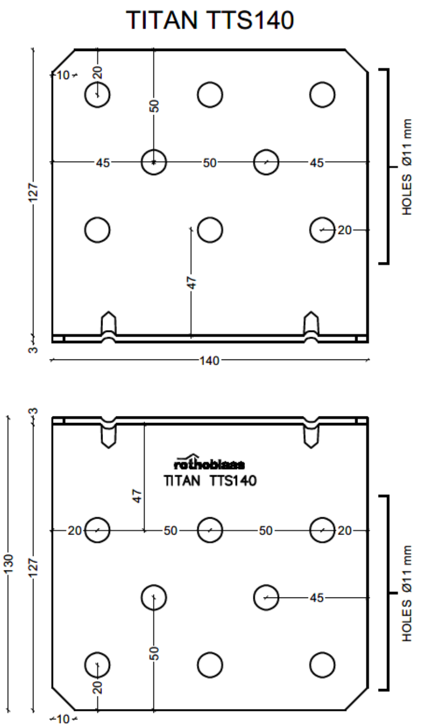


Figure B. 5
Dimensions of Angle Bracket TITAN TTS140

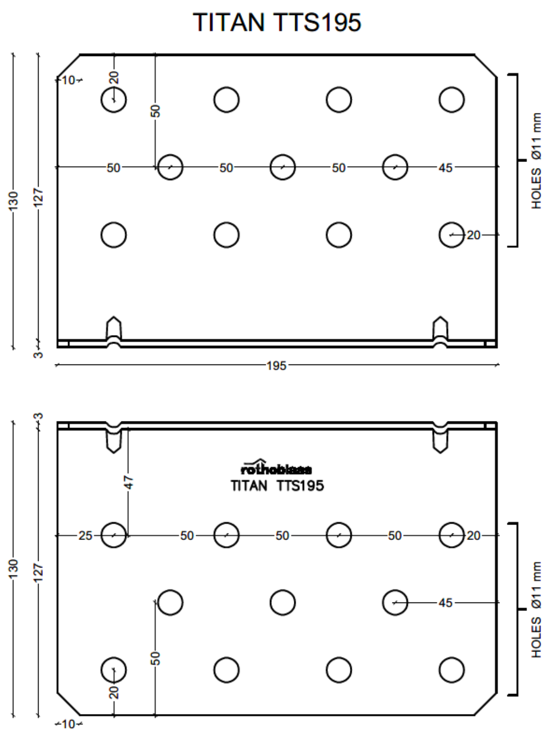


Figure B. 6
Dimensions of Angle Bracket TITAN TTS195

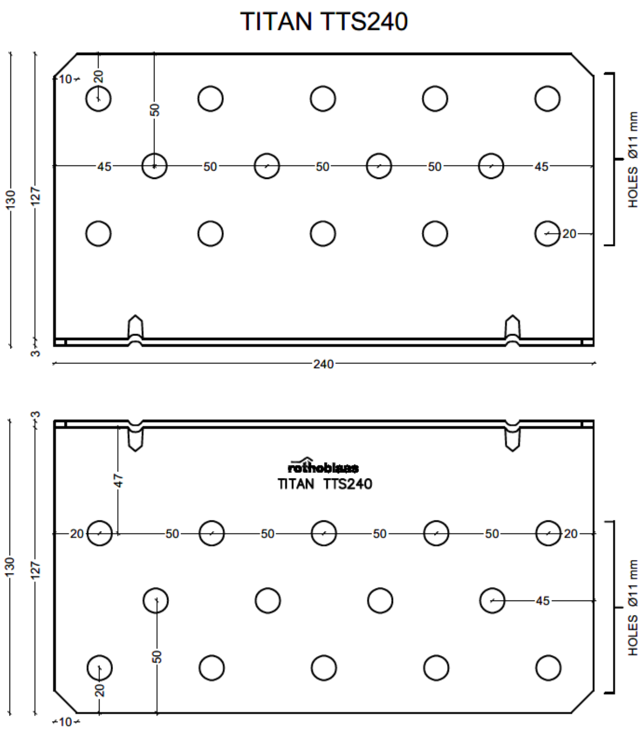


Figure B. 7
Dimensions of Angle Bracket TITAN TCS240

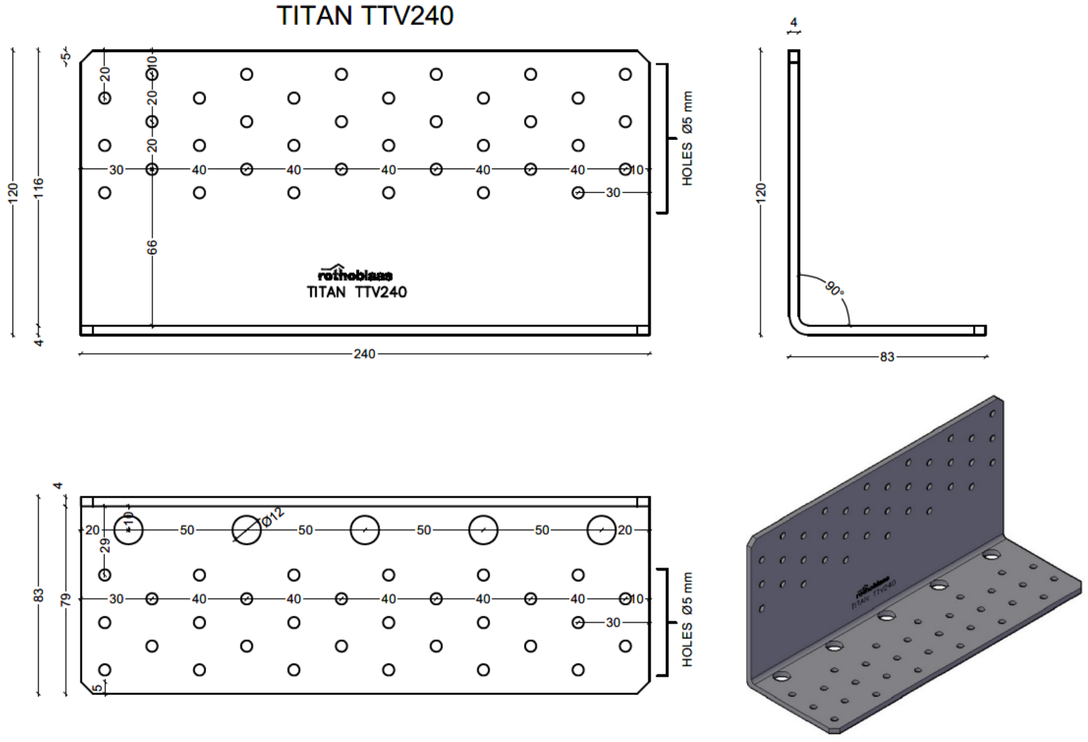
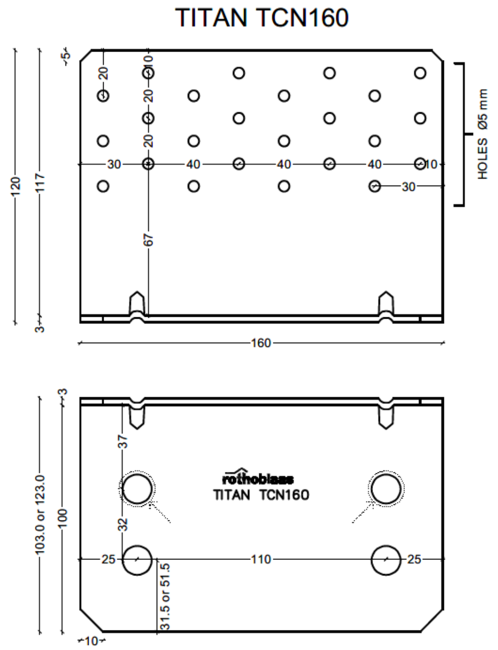


Figure B. 8
Dimensions of Angle Bracket TITAN TTV240



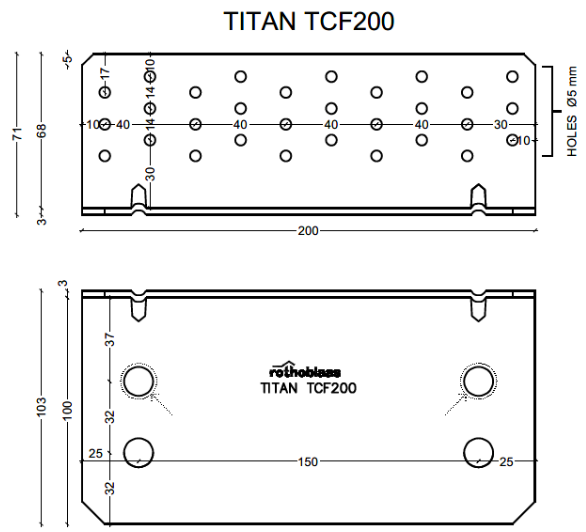


Figure B. 9
Dimensions of Angle Bracket TITAN TCN160

Figure B. 10
Dimensions of Angle Bracket TITAN TCF200

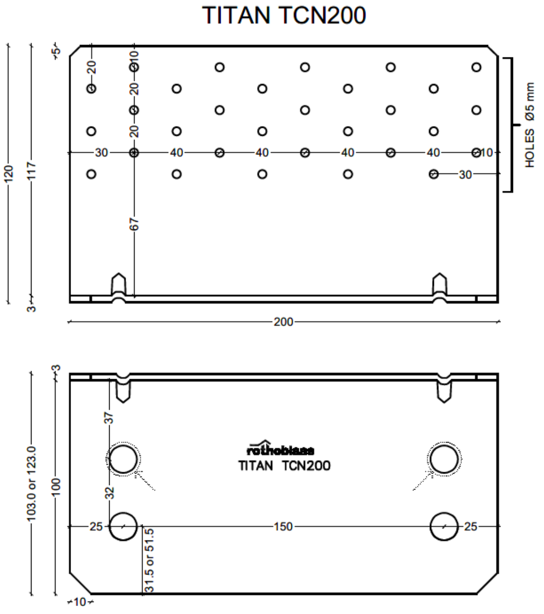


Figure B. 11
Dimensions of Angle Bracket TITAN TCN200

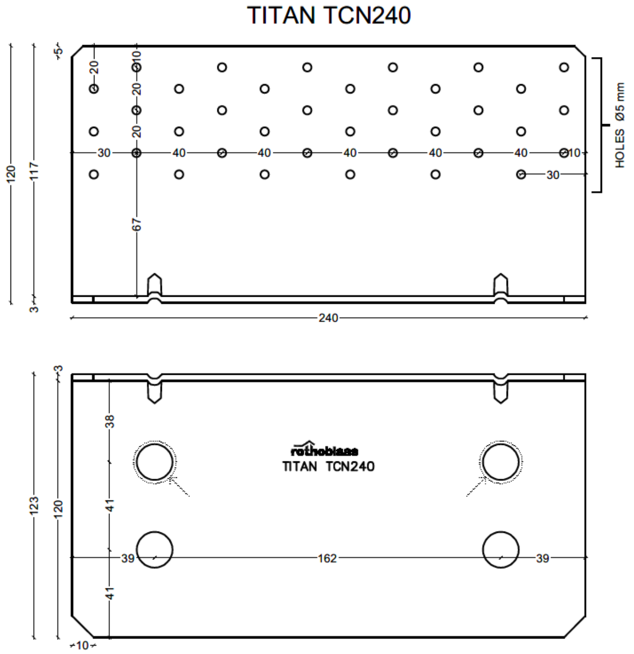


Figure B. 12
Dimensions of Angle Bracket TITAN TCN240

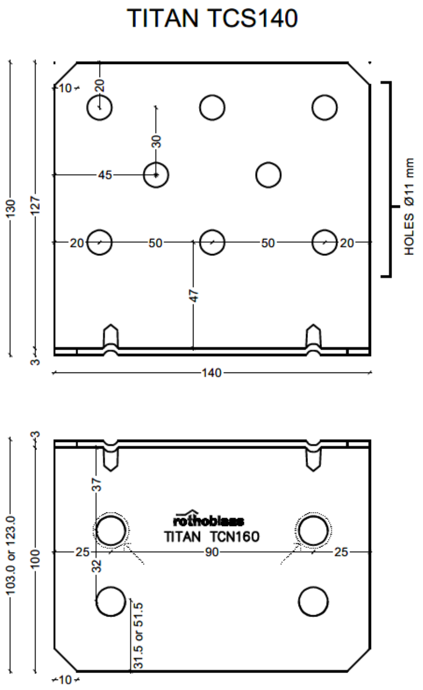


Figure B. 13
Dimensions of Angle Bracket TITAN TCS140

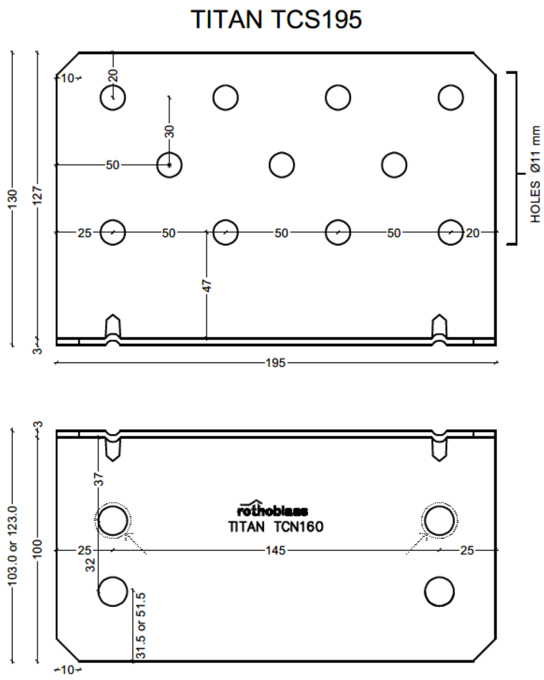


Figure B. 14
Dimensions of Angle Bracket TITAN TCS195

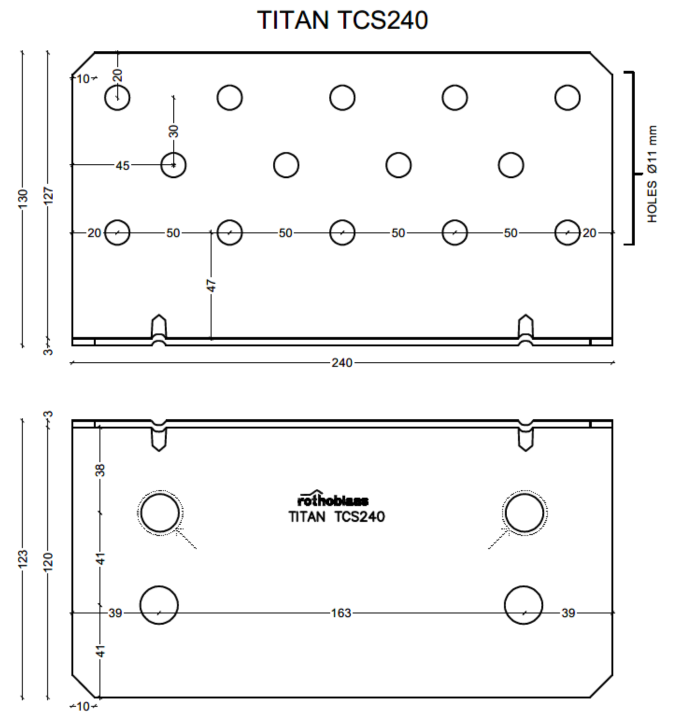


Figure B. 15 Dimensions of Angle Bracket TITAN TCS240

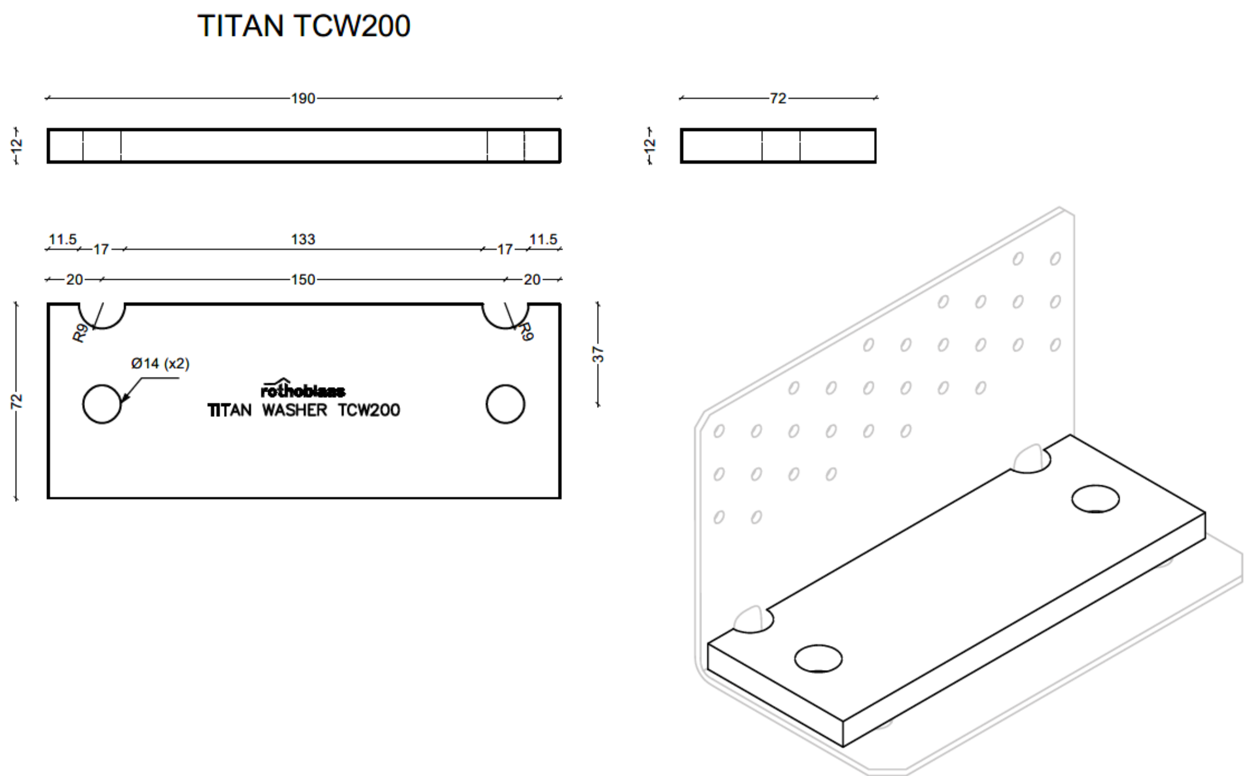


Figure B. 16 Dimensions of TITAN Washer TCW200

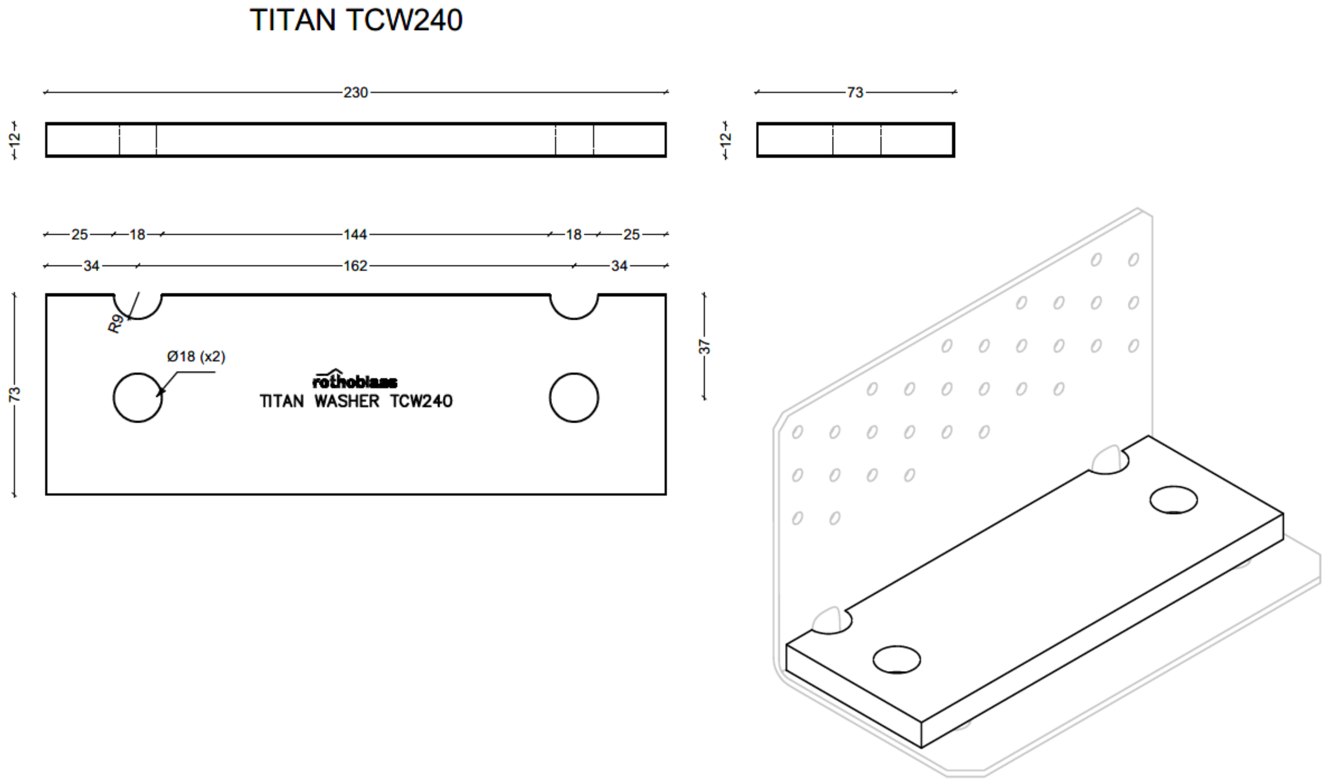


Figure B. 17 Dimensions of TITAN Washer TCW240

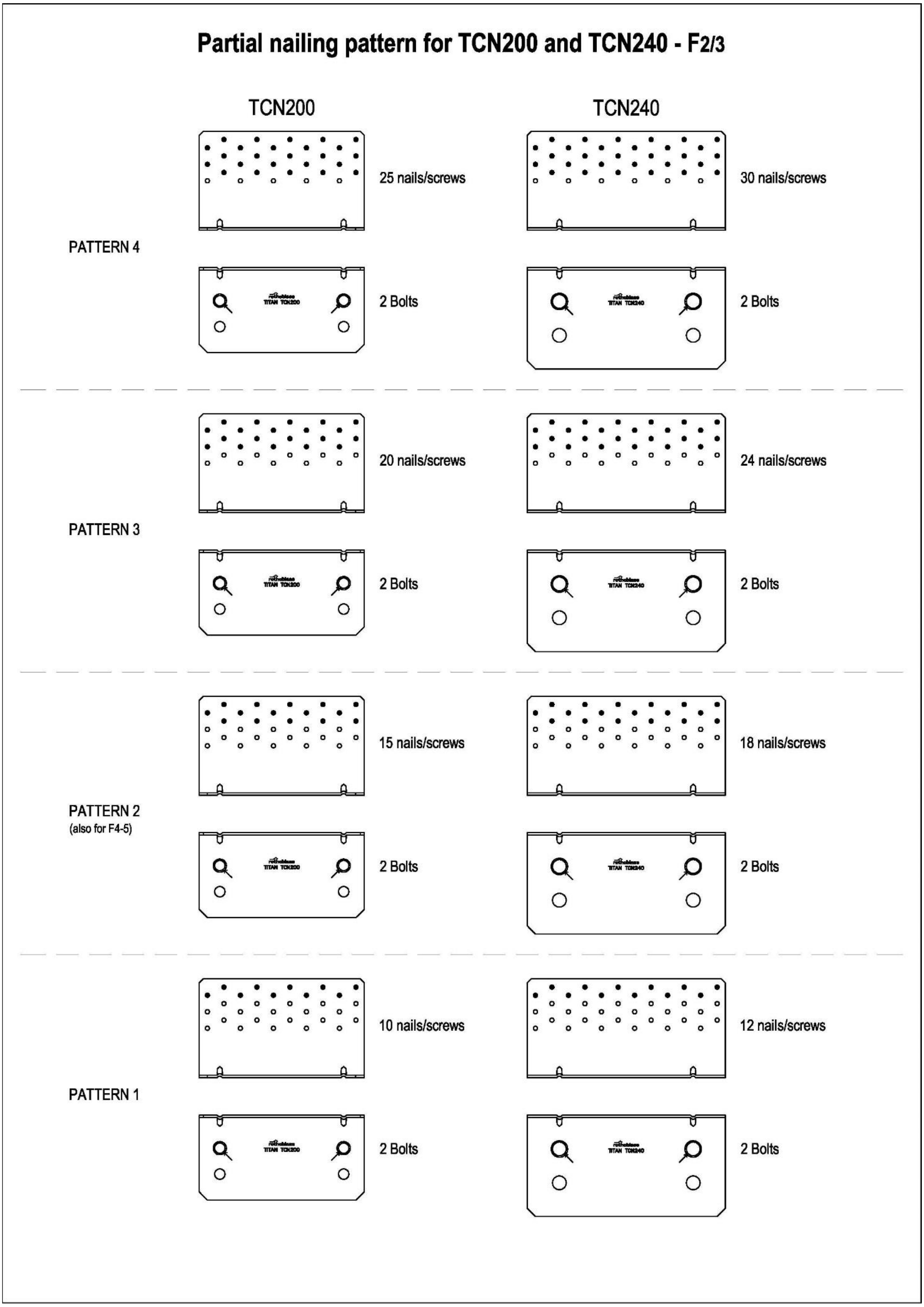


Figure B. 18 Nailing patterns for Angle Bracket TITAN TCN200 and TCN240

Nailing patterns for TTF200 and TCF200

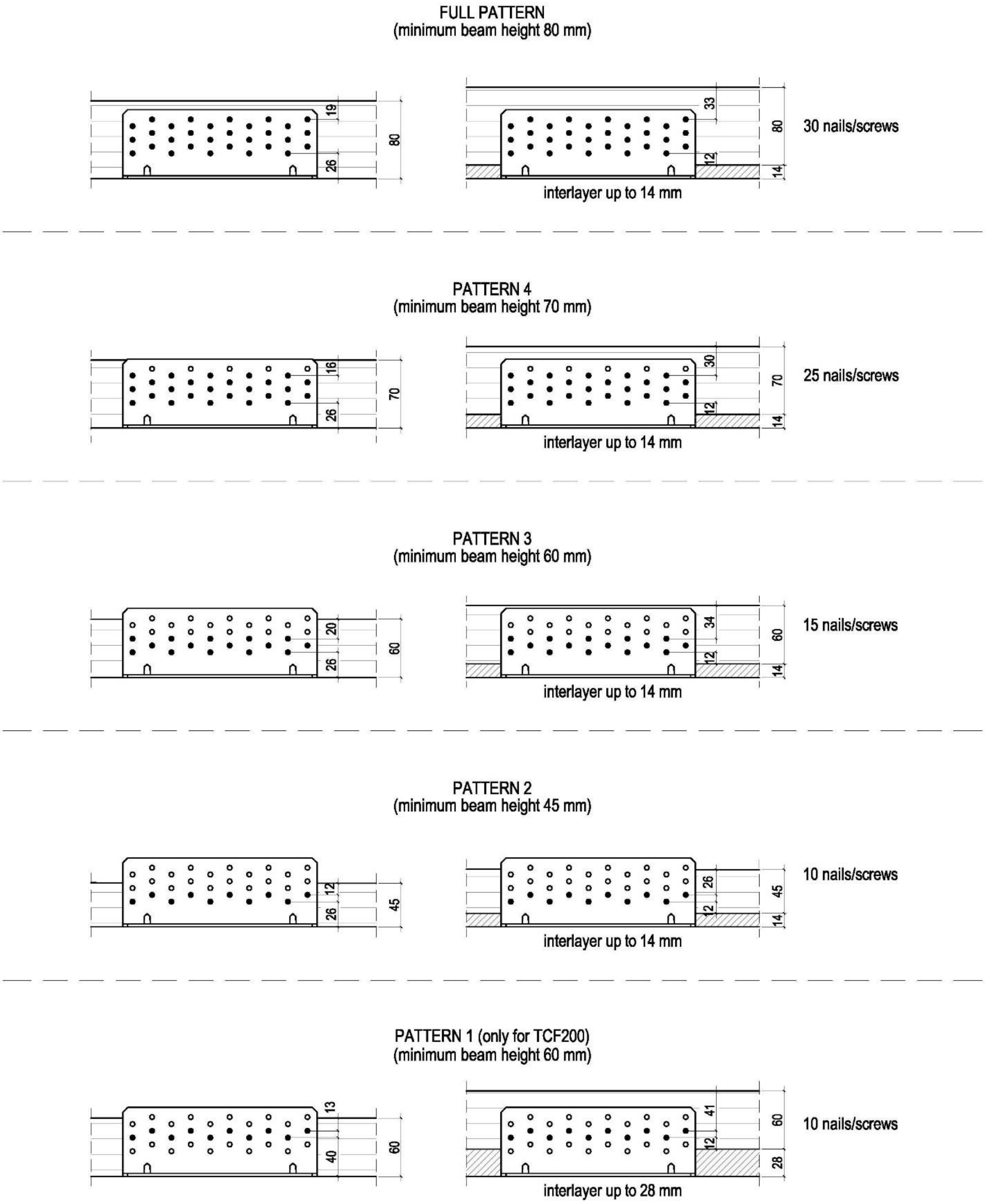
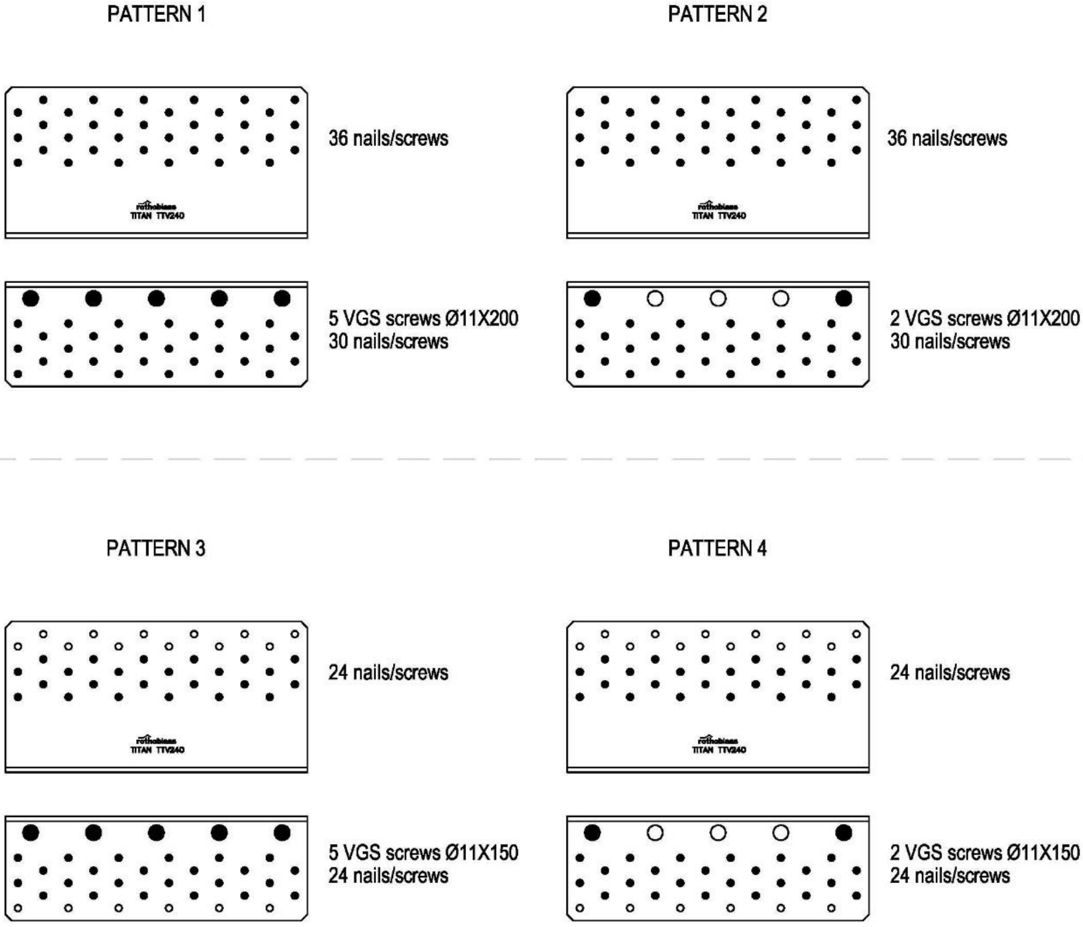


Figure B. 19 Nailing patterns for Angle Bracket TITAN TTF200 and TCF200

Nailing patterns for TTV240



Insertion angle VGS screw for TTV240

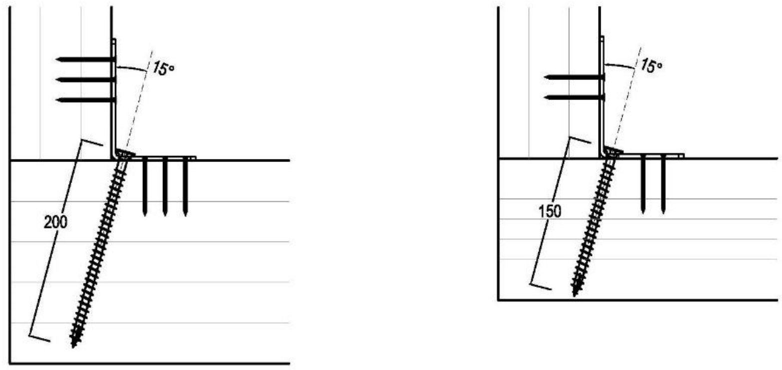


Figure B. 20 Nailing patterns for Angle Bracket TITAN TTV240