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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 31/10/2014

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 s.r.l 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 s.r.l Manufacturing Plants: T1, T2, T3
This European Technical Assessment contains:	22 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 and issued on 2013-04-22 and expiry on 2018-02-18

II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product and intended use

Technical description of the product
Rotho Blaas srl. angle brackets are one-piece non-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 ETA or screws type HBS+ according to ETA-11/0030 and to concrete or steel members with bolts or metal anchors.

The angle brackets with a steel plate thickness of up to 3 mm are made from the following materials:

- pre-galvanized 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%
- pre-galvanized 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%
- pre-galvanized steel S275 / Z 275 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 10346:2009 with $R_e \geq$ 220 N/mm², $R_m \leq$ 500 N/mm² and $A_{80} \geq$ 22%
- steel S250GD / Z275 according to EN 10346:2009 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 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, 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/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 338 / EN 14081,
- Glulam classified to GL24-GL36 according to EN 1194 / EN 14080,
- LVL according to EN 14374,
- Parallam PSL,
- Intrallam LSL,
- Duo- and Triobalken,
- 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 factor k_{dens}:

$$k_{dens} = \left(\frac{\rho_k}{350}\right)^{0,5} \quad \text{in load case } F_1$$

$$k_{dens} = \left(\frac{\rho_k}{350}\right)^{2} \quad \text{in load case } F_{2,3}$$

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.
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)	
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 are made from steel classified as Euroclass A1 in accordance with EN 13501-1 and EC decision 96/603/EC, amended by EC Decision 2000/605/EC
3.3 Hygiene, health and the environment (BWR3)	
Influence on air quality	No dangerous materials
3.7 Sustainable use of natural resources (BWR7)	No performance determined
3.8 General aspects related to the performance of the product	The 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 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, F_2 and F_3

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.

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, 2 and 3.
In accordance with ETAG 015 the angle brackets are produced from:

- pre-galvanized 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%
- pre-galvanized 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%
- pre-galvanized steel S275 / Z 275 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 10346:2009 with $R_e \geq$ 220 N/mm², $R_m \leq$ 500 N/mm² and $A_{80} \geq$ 22%
- steel S250GD / Z275 according to EN 10346:2009 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%

3.12 General aspects related to the use of the product

The 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 14 - to which the brackets are fixed shall be:
  - Restrained against rotation. At a load F_4/F_5, the component 2 is allowed to be restrained against rotation by the Angle brackets.
  - Strength class C14 or better, see section 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.

- 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 assessment holder's technical literature.

4 Attestation and verification of constancy of performance (AVCP)

4.1 AVCP system

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

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

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

Issued in Copenhagen on 2014-10-31 by

Thomas Bruun
Managing Director, ETA-Danmark

Annex A
Product details definitions

Table A.1 Materials specification

Angel 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 TTS245	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 TCS245	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 Washer 200	12,0	S235/S355	FeZn12c / Z 275
Titan Washer 240	12,0	S235/S355	FeZn12c / Z 275

Table A.2 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 TTS245	129	131	129	131	244	246
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 TCS245	129	131	122	124	244	246
Titan TTF200	70	72	70	72	199	201
Titan TCF200	70	72	102	104	199	201
Titan Washer 200	-	-	71	73	189	191
Titan Washer 240	-	-	73	75	229	231

Table A.3 Fastener specification

Fastener	**Length**	**Profiled Length**	**Fastener type**
Nail 4.0 mm	60 mm	50 mm	Ringed shank nails according to EN 14592
Rotho Blaas screw 5.0 mm, type LBS	50 mm	46 mm	Self-tapping screws according to EN 14592 or ETA-11/0030
Rotho Blaas screw 8.0 mm	80 mm	52 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 the German national approval for the nails. The characteristic withdrawal capacity of the nails or screws has to be determined by calculation in accordance with EN 1995-1-1:2010, paragraph 8.3.2 and 8.7.2 (head pull-through is not relevant):

$F_{ax,Rk} = f_{ax,k} \cdot d \cdot t_{pen}$ for the nails 4.0 mm

$F_{ax,Rk} = \frac{n_{ef} \cdot f_{ax,k} \cdot d \cdot \ell_{ef}}{1,2 \cdot \cos^2 \alpha + \sin^2 \alpha} \left(\frac{\rho_k}{\rho_a} \right)^{0,8}$ 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 profiled 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 $f_{ax,k}$

Based on tests by Versuchsanstalt für Stahl, Holz und Steine, Karlsruhe Institute of Technology, the characteristic value of the withdrawal resistance for the threaded nails used can be calculated as:
$f_{ax,k} = 50 \cdot 10^{-6} \cdot \rho_k^2$

Based on ETA-11/030, the characteristic value of the withdrawal resistance for Rotho Blaas LBS screws d = 5.0 mm is:
$f_{ax,k} = 11,7$ N/mm²

Based on the ETA-11/0030 the characteristic value of the withdrawal resistance for the screws type HBS and HBS+, d = 8.0 mm used may be calculated as:
$f_{ax,k} = 11,7$ N/mm²

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, 16.0 or 20.0 mm	Max. 2 mm larger than the bolt diameter	See specification of the manufacturer

Metal Anchors diameter	**Correspondent Hole diameter**	**Anchors type**
12.0, 16.0 or 20.0 mm	Max. 2 mm larger than the anchor diameter	See specification of the manufacturer

Annex B
Characteristic load-carrying capacities

Table 1: Force F_1, 1 angle bracket with washer / connection timber to concrete or steel

Type	timber		steel		bolt	concrete
	capacity per fastener in the vertical flange $F_{v,Rk}$ [kN]		$F_{t,Rk}$ [kN]		$k_{t,II}$	ℓ_D [mm]
	Nail Ø4 x 60	Screw Ø5 x 50	washerS 235	washerS 355		
Titan TCN200 + TITAN Washer 200	1,93	2,32	45,7	69,0	1,09	7,3
Titan TCN240 + TITAN Washer 240	1,93	2,32	69,8	105,4	1,08	6,5

Table 2: Force $F_{2,3}$, 1 angle bracket / timber-timber connection

Type	number n_V	number n_H	Nails Ø4 x 60		Screws Ø5 x 50		Screws Ø8 x 80	
			e_1 [mm]	$F_{2,3Rk}$ [kN]	e_1 [mm]	$F_{2,3Rk}$ [kN]	e_1 [mm]	$F_{2,3Rk}$ [kN]
Titan TTN160	24	24	60,5	19,3	57,4	24,0	-	-
Titan TTN200	30	30	60,2	28,0	57,3	34,7	-	-
Titan TTN240	36	36	60,0	37,9	57,3	46,7	-	-
Titan TTS140	8	8	-	-	-	-	78,5	10,7
Titan TTS195	11	11	-	-	-	-	78,5	17,1
Titan TTS245	14	14	-	-	-	-	78,5	25,0
Titan TTF200, h=9cm*)	30	30	42,0	35,5	42,0	42,5	-	-
Titan TTF200, h=8cm*)	25	25	38,5	31,0	38,5	37,2	-	-
Titan TTF200, h=7cm*)	15	15	31,5	20,9	31,5	25,1	-	-
Titan TTF200, h=6cm*)	10	10	28,0	15,1	28,0	18,1	-	-

*) h = height of purlin (see Figure B.16, Annex B)

Table 3: Force $F_{2,3}$, 2 angle brackets / timber-timber connection

Type	number n_V	number n_H	Nails Ø4 x 60		Screws Ø5 x 50		Screws Ø8 x 80	
			e_1 [mm]	$F_{2,3Rk}$ [kN]	e_1 [mm]	$F_{2,3Rk}$ [kN]	e_1 [mm]	$F_{2,3Rk}$ [kN]
Titan TTN160	48	48	60,5	38,6	57,4	47,9	-	-
Titan TTN200	60	60	60,2	56,1	57,3	69,4	-	-
Titan TTN240	72	72	60,0	75,7	57,3	93,3	-	-
Titan TTS140	16	16	-	-	-	-	78,5	21,3
Titan TTS195	22	22	-	-	-	-	78,5	34,3
Titan TTS245	28	28	-	-	-	-	78,5	50,0
Titan TTF200, h=9cm*)	60	60	42,0	70,9	42,0	85,0	-	-
Titan TTF200, h=8cm*)	50	50	38,5	62,0	38,5	74,3	-	-
Titan TTF200, h=7cm*)	30	30	31,5	41,9	31,5	50,2	-	-
Titan TTF200, h=6cm*)	20	20	28,0	30,2	28,0	36,2	-	-

*) h = height of purlin (see Figure B.16, Annex B)

Table 4: Force $F_{2,3}$, 1 angle bracket / timber-concrete or steel connection

Type	number n_V	number n_H	Nails Ø4 x 60	Screws Ø5 x 50	Screws Ø8 x 80	Bolts inward	Bolts outward
			$F_{2,3Rk}$ [kN]	$F_{2,3Rk}$ [kN]	$F_{2,3Rk}$ [kN]	$k_{t,\perp}$	$k_{t,\perp}$
Titan TCN160	24	2	15,1	18,1	-	0,85	1,14
Titan TCN200	30	2	22,1	26,5	-	0,76	0,97
Titan TCN240	36	2	30,3	36,3	-	0,74	1,00
Titan TCS140	8	2	-	-	10,7	0,93	1,28
Titan TCS195	11	2	-	-	17,1	0,77	0,98
Titan TCS245	14	2	-	-	25,0	0,74	0,98
Titan TCF200, h=9cm*)	30	2	35,5	42,5	-	0,75	0,96
Titan TCF200, h=8cm*)	25	2	31,0	37,2	-	0,75	0,96
Titan TCF200, h=7cm*)	15	2	20,9	25,1	-	0,76	0,97
Titan TCF200, h=6cm*)	10	2	15,1	18,1	-	0,75	0,96

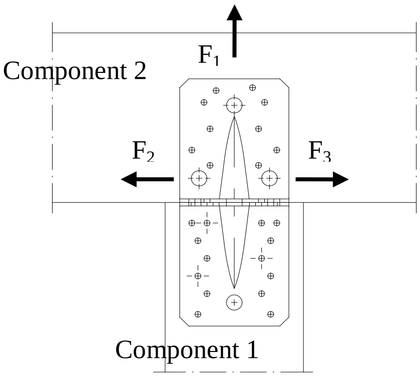
*) h = height of purlin (see Figure B.16, Annex B)

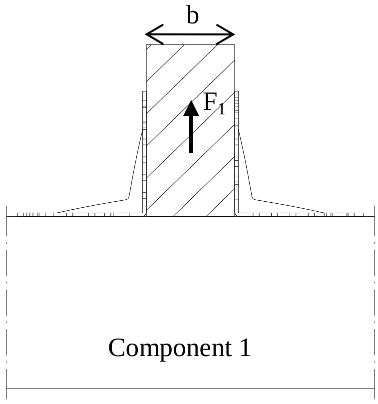
Table 5: Force $F_{2,3}$, 2 angle brackets / timber-concrete or steel connection

Type	number n_V	number n_H	Nails Ø4 x 60	Screws Ø5 x 50	Screws Ø8 x 80	Bolts inward	Bolts outward
			$F_{2,3Rk}$ [kN]	$F_{2,3Rk}$ [kN]	$F_{2,3Rk}$ [kN]	$k_{t,\perp}$	$k_{t,\perp}$
Titan TCN160	48	4	30,2	36,1	-	0,43	0,57
Titan TCN200	60	4	44,3	53,0	-	0,38	0,48
Titan TCN240	72	4	60,5	72,5	-	0,37	0,50
Titan TCS140	16	4	-	-	21,3	0,46	0,64
Titan TCS195	22	4	-	-	34,3	0,38	0,49
Titan TCS245	28	4	-	-	50,0	0,37	0,49
Titan TCF200, h=9cm*)	60	4	70,9	85,0	-	0,38	0,48
Titan TCF200, h=8cm*)	50	4	62,0	74,3	-	0,38	0,48
Titan TCF200, h=7cm*)	30	4	41,9	50,2	-	0,38	0,48
Titan TCF200, h=6cm*)	20	4	30,2	36,2	-	0,38	0,48

*) h = height of purlin (see Figure B.16, Annex B)

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.

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

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.

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. Lifting force F_1 is only allowed for the angle brackets TCN200 and TCN240 with washers.

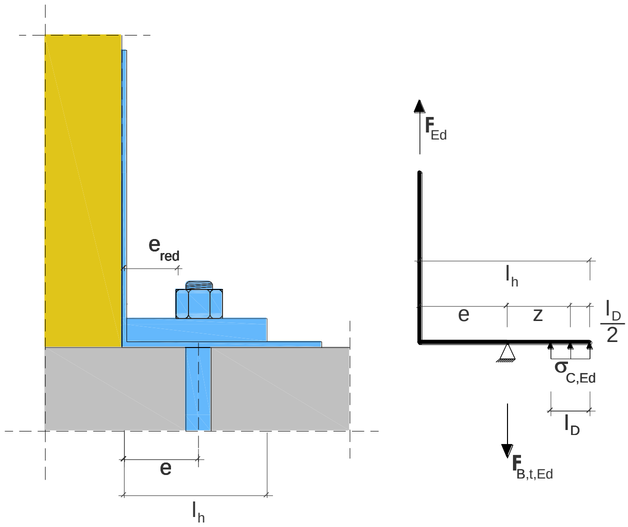
Connection of timber to concrete or steel with bolts or metal anchors

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

$$F_{B,t,Ed} = k_{t,\parallel} \times F_{1,Ed}$$

$$F_{B,v,Ed} = k_{t,\perp} \cdot F_{2,3,Ed}$$

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



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
$F_{1,Ed}$	Tensile load F_1 on vertical flap of the angle bracket in N
$F_{2,3,Ed}$	Shear load $F_{2,3}$ on vertical flap of the angle bracket or pair of angle brackets in N
b	Width of the washer in mm
$\sigma_{C,Ed}$	compressive stress on the support in N/mm^2

Rotho Blaas Angle Brackets

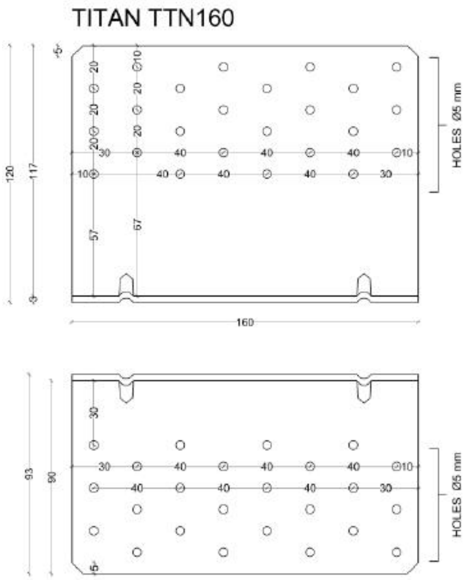


Figure B. 1
Dimensions of Angle Bracket Titan TTN160

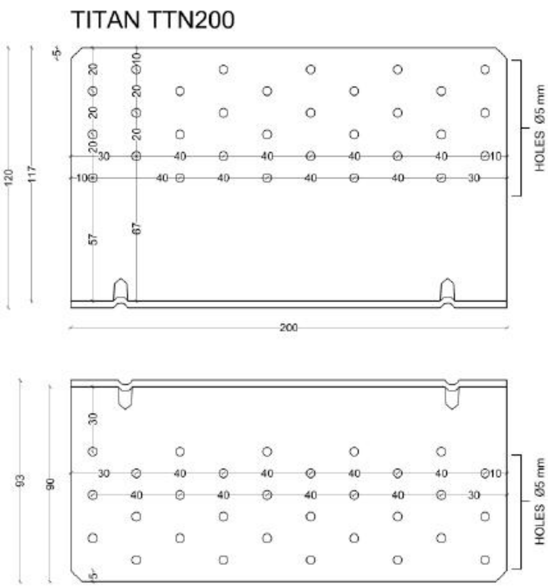


Figure B. 2
Dimensions of Angle Bracket Titan TTN200

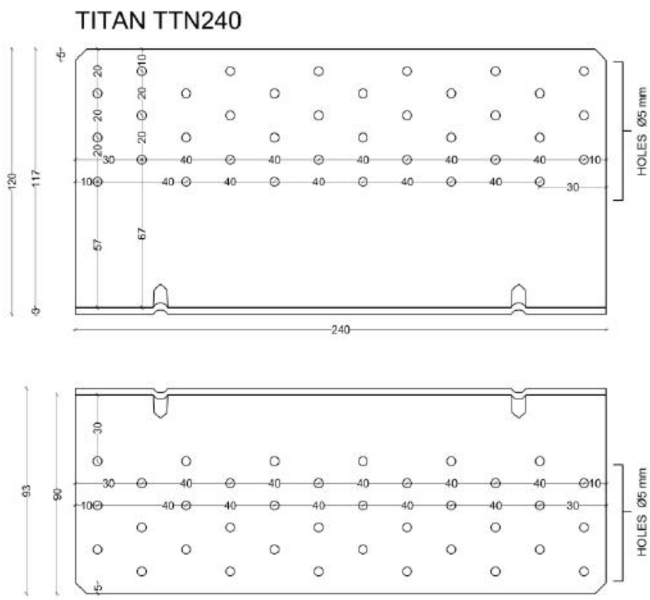


Figure B. 3
Dimensions of Angle Bracket Titan TTN240

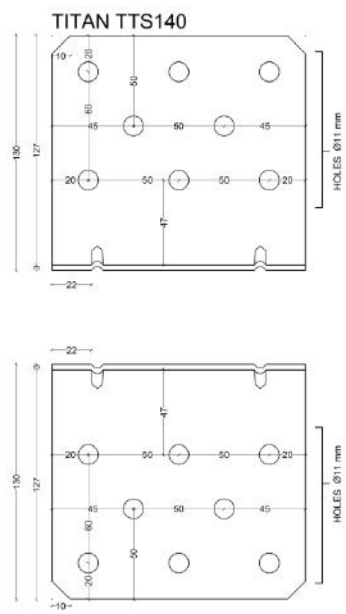


Figure B. 4
Dimensions of Angle Bracket Titan TTS140

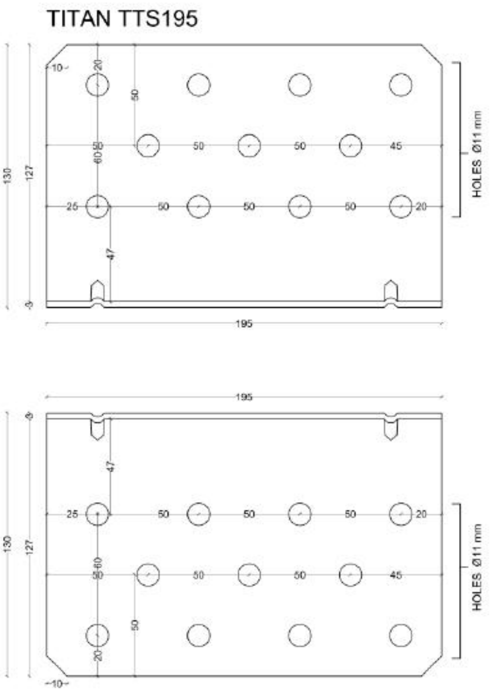


Figure B. 5
Dimensions of Angle Bracket Titan TTS195

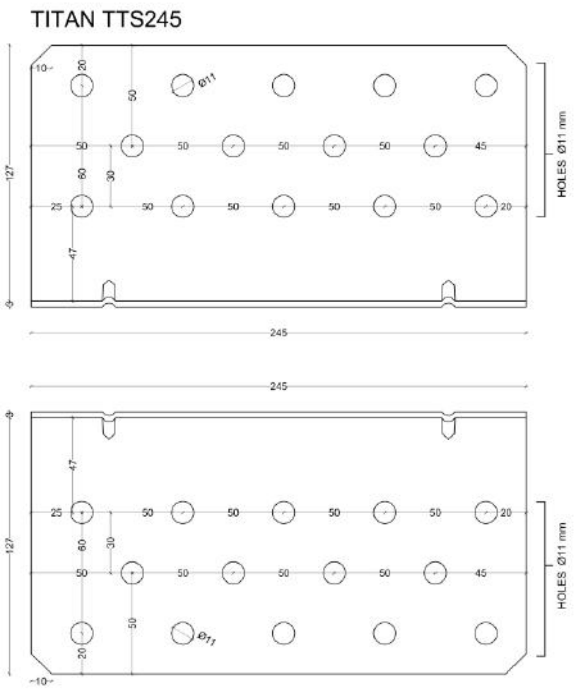


Figure B. 6
Dimensions of Angle Bracket Titan TTS245

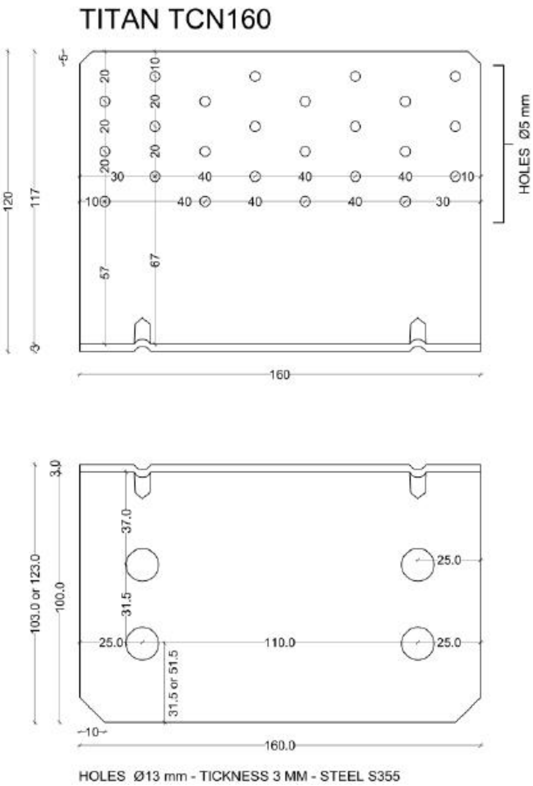


Figure B. 7
Dimensions of Angle Bracket Titan TCN160

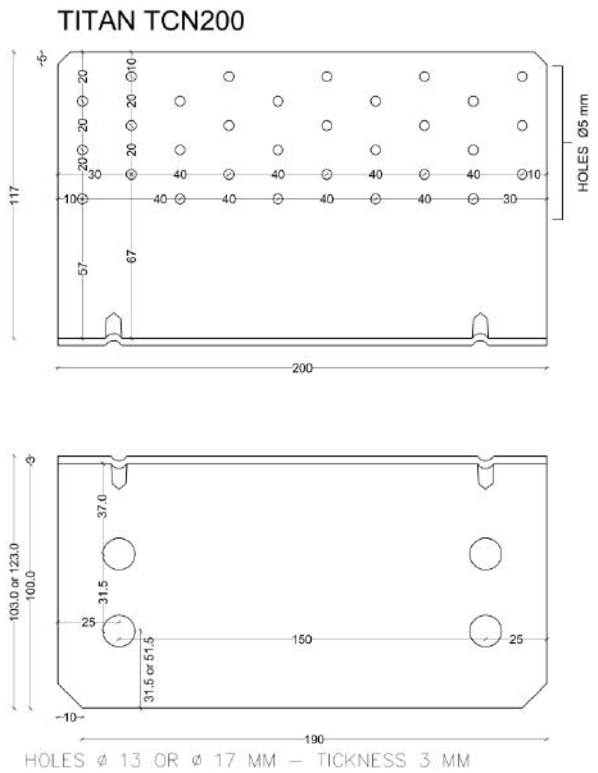


Figure B. 8
Dimensions of Angle Bracket Titan TCN200

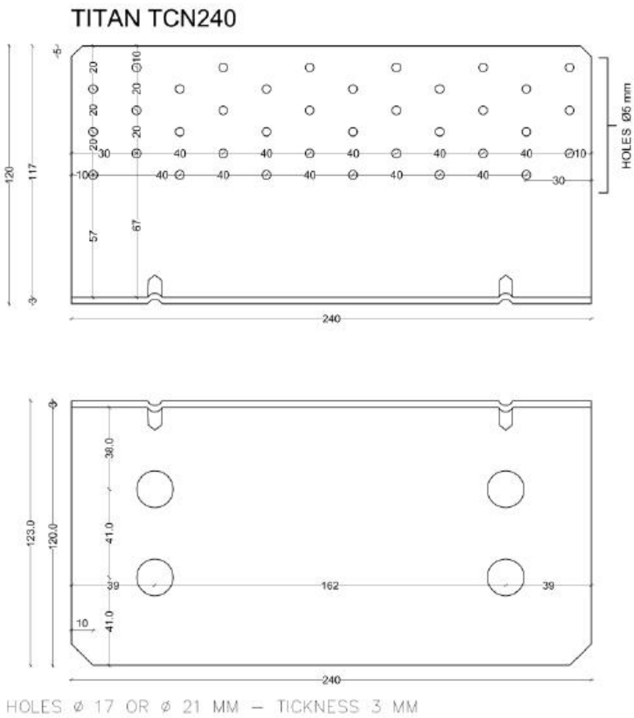


Figure B. 9
Dimensions of Angle Bracket Titan TCN240

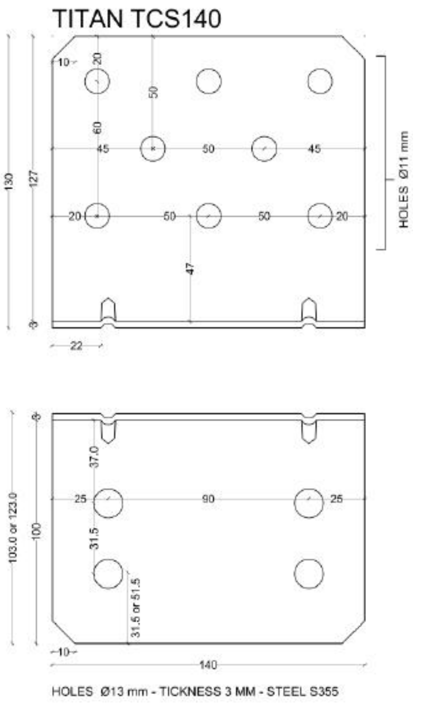


Figure B. 10
Dimensions of Angle Bracket Titan TCS140

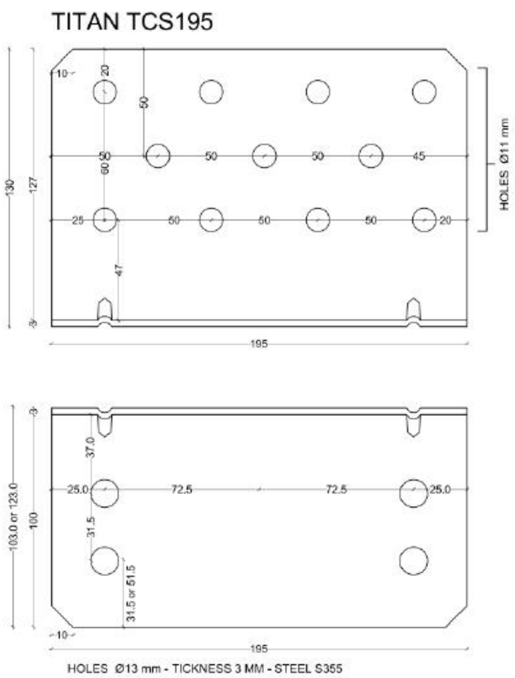


Figure B. 11
Dimensions of Angle Bracket Titan TCS195

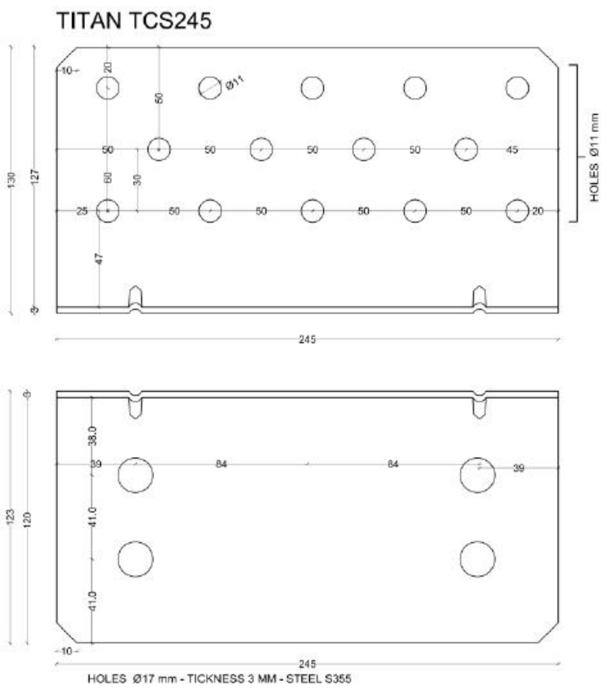


Figure B. 12
Dimensions of Angle Bracket Titan TCS245

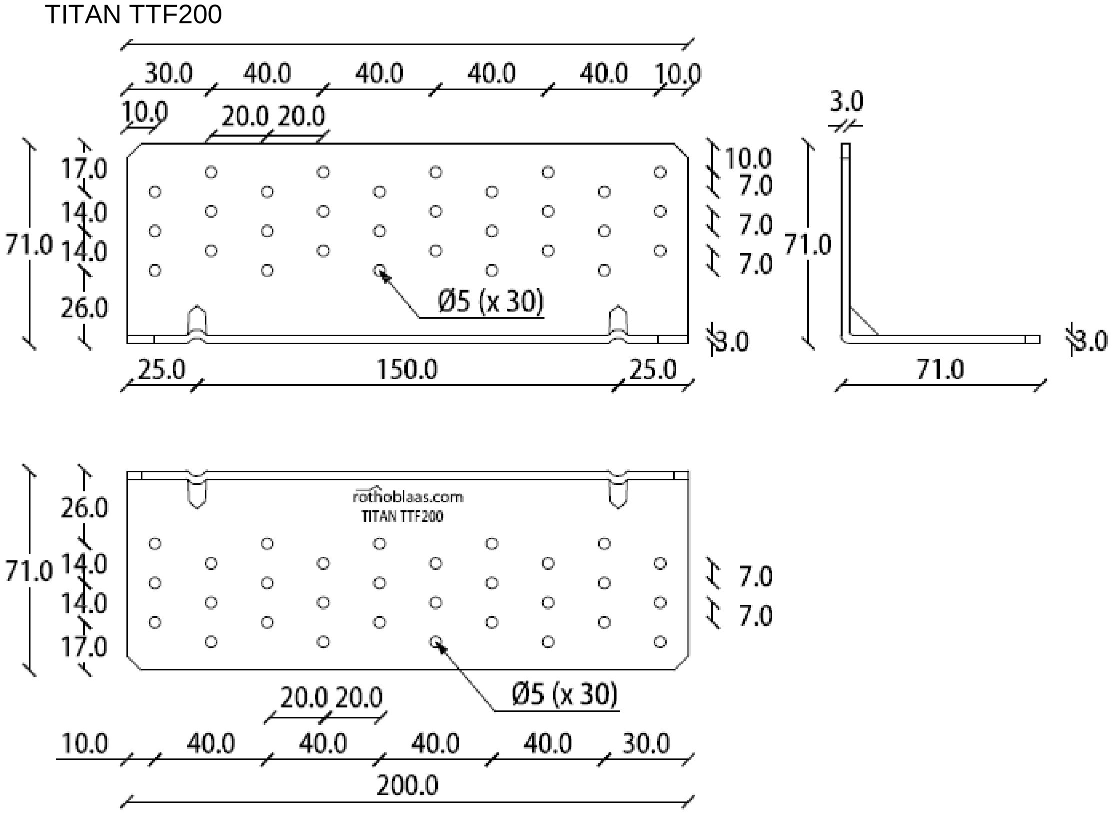


Figure B. 13 Dimensions of Angle Bracket Titan TTF200

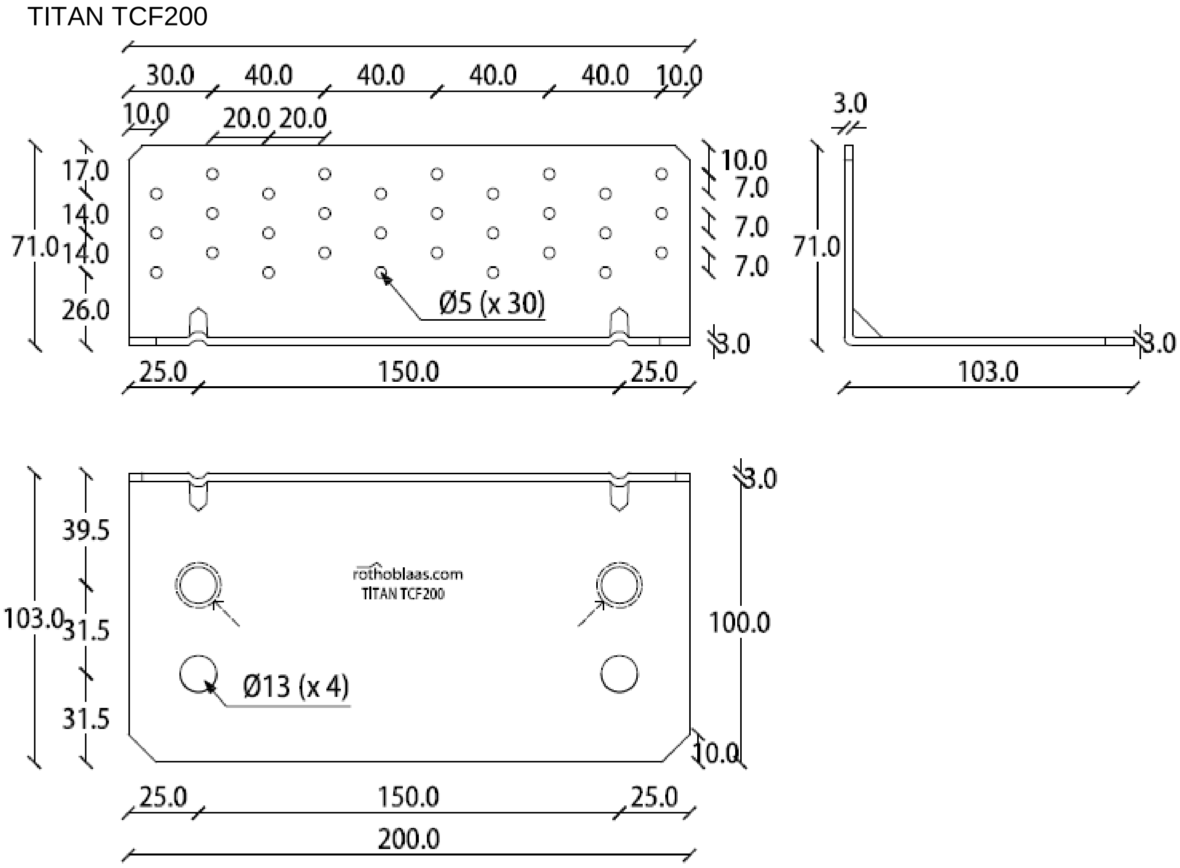


Figure B. 14 Dimensions of Angle Bracket Titan TCF200

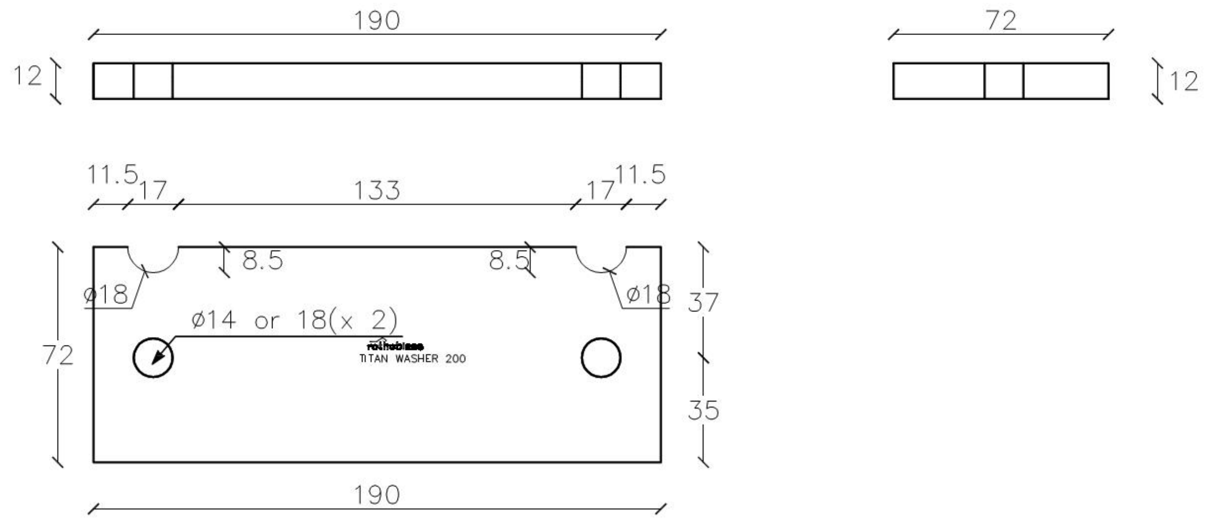


Figure B. 15 Dimensions of TITAN Washer 200 for Titan TCN200

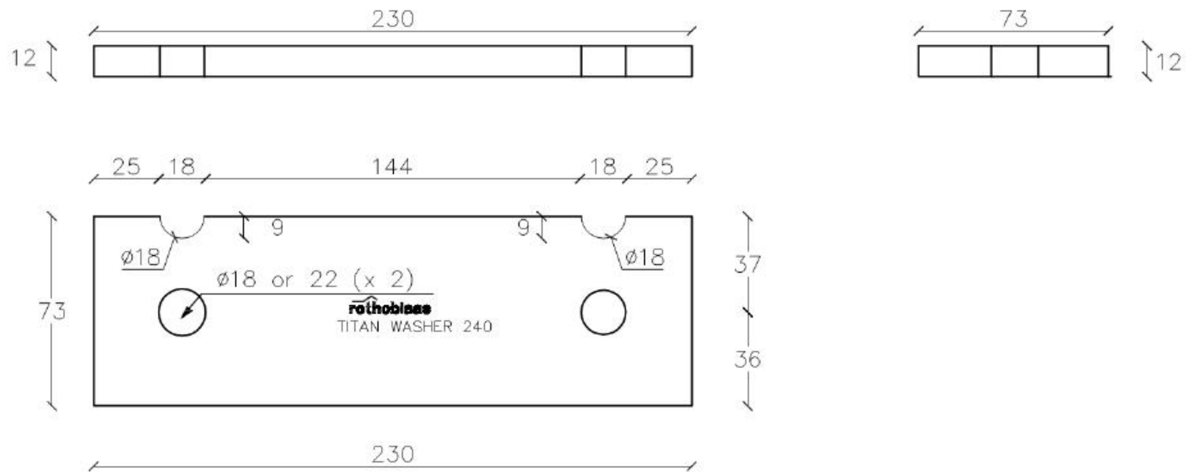


Figure B. 16 Dimensions of TITAN Washer 240 for Titan TCN240

Figure B. 17 Typical installation

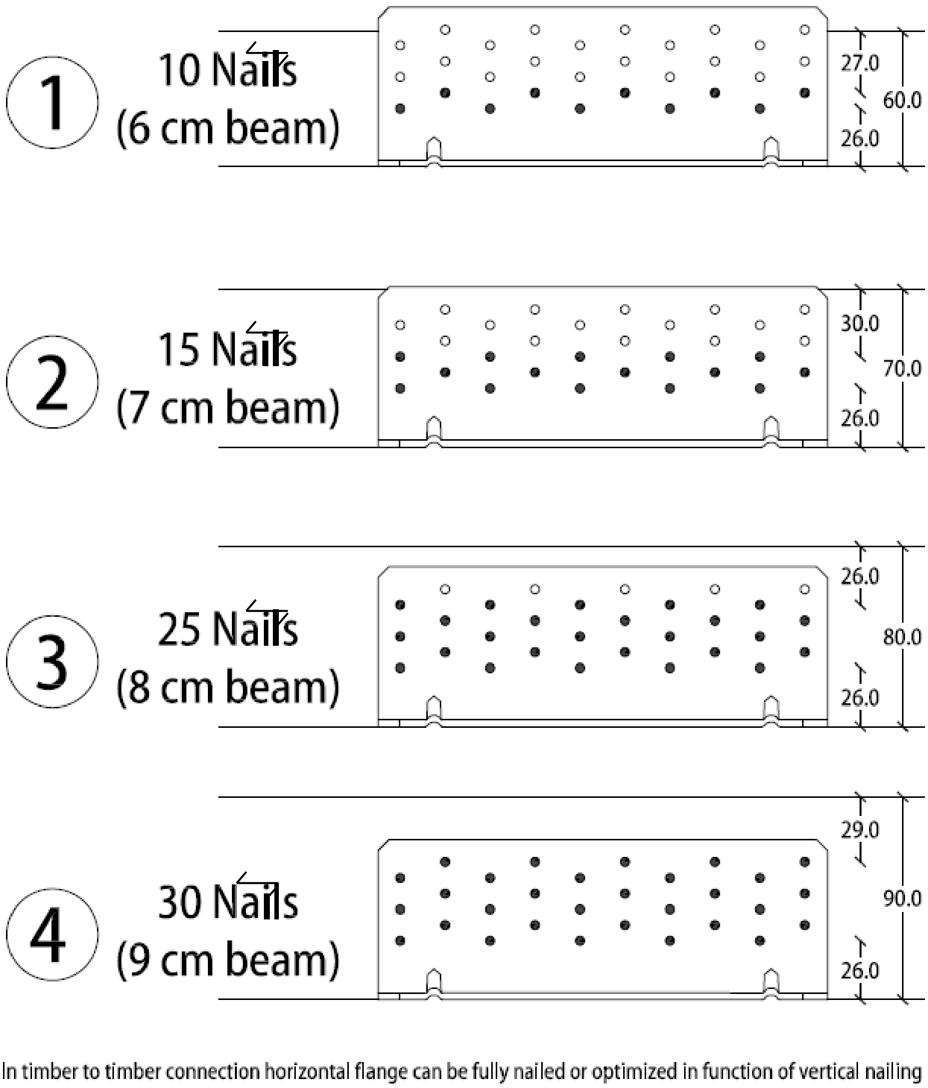


Figure B. 18 Typical installation for Angle Bracket TITAN TTF200 and TCF200
(for TTF200: symmetrical hole-pattern for horizontal and vertical flange)

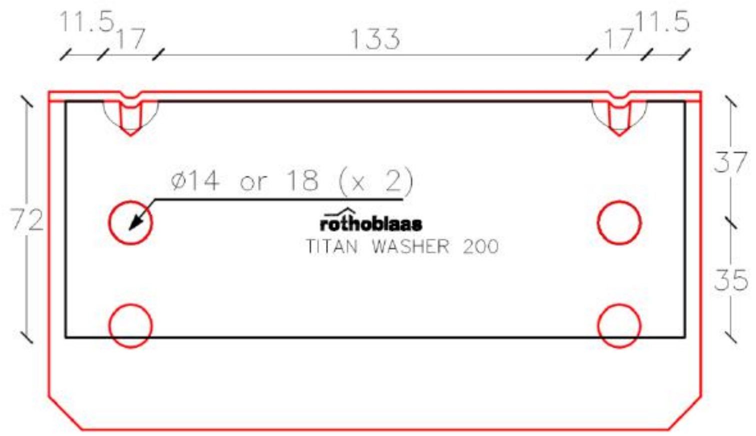


Figure B.19 Typical installation for Angle Bracket TITAN TCN200 with Washer

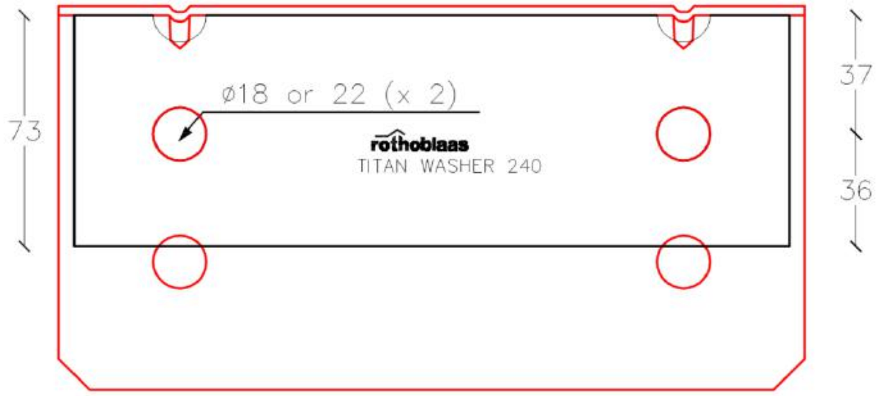


Figure B.20 Typical installation for Angle Bracket TITAN TCN240 with Washer