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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-22/0089 of 2022/08/25

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 NINO Angle Brackets and WKR Hold Downs
Product family to which the above construction product belongs:	Three-dimensional nailing plate (Angle Bracket or Hold Down 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, T4
This European Technical Assessment contains:	35 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:	

II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product

Technical description of the product
Rotho Blaas angle brackets and hold downs 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 (ringed shank) type LBA nails according to ETA-22/0002 or screws type LBS according to ETA-11/0030 or screws type HBS with or without HUS washer according to ETA-11/0030 or screws type HBSP with WU2 washer head according to ETA-11/0030 or screws type TBS with large washer head according to ETA-11/0030 or screws type VGS with or without HUS washer according to ETA-11/0030 or bolts according to EN 14592 and to concrete or steel members with bolts or metal anchors.

The angle brackets and hold downs with a steel plate thickness of up to 3,5 mm are made from the following material:

- 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 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 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 / Z 275 or FeZn12c according to EN 10346:2015 with $R_e \geq 235$ N/mm², $R_m \leq 500$ N/mm² and $A_{80} \geq 22\%$
- steel S250GD / Z 275 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 $R_e \geq 235$ 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 and hold downs 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 and hold downs 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 hold down or with an angle bracket or hold down 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,
- Glued solid timber according to EN14080,
- 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 or hold down 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:

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

$$k_{dens} = 1 \qquad \text{for } \rho_k > 350 \text{ kg/m}^3$$

In load case $F_{2/3}$, F_4 and F_{45} for timber materials except LVL:

$$k_{dens} = \left(\frac{\rho_k}{350}\right)^{0,5} \text{ for } 290 \text{ kg/m}^3 \leq \rho_k \leq 420 \text{ kg/m}^3$$

In load case $F_{2/3}$, F_4 and F_{45} for LVL:

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

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

If a wood-based panel or a soundproofing 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 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. This includes seismic actions.

The angle brackets and hold downs 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 and hold downs may also be used for connections between a timber member and a member of concrete or steel.

The scope of the angle brackets and hold downs 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 and hold downs 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 and hold downs are made from steel classified as Euroclass A1 in accordance with EN 13501-1 and Commission Delegated Regulation 2016/364
3.3 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 3.4 – 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 nail or screw 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 failure of connections between the angle bracket or hold down to a timber member 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 combined timber and steel plate failure $F_{Rk,T}$ (obtaining the compressive strength perpendicular to grain or the embedment strength of fasteners subjected to shear or the withdrawal capacity of the most loaded fastener, respectively) as well as for pure concrete or steel plate failure $F_{Rk,C/S}$. The design value of the load–carrying capacity is the smaller value of both load–carrying capacities.

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

Therefore, for combined timber and steel plate failure the load duration class and the service class are included. The different partial factors γ_M for concrete, 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 and hold downs are determined by calculation assisted by testing and testing as described in the EAD 130186-00-0603. 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.

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 and hold downs are produced from:

- 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 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 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 / Z 275 or FeZn12c according to EN 10346:2015 with $R_e \geq 235$ N/mm², $R_m \leq 500$ N/mm² and $A_{80} \geq 22\%$
- steel S250GD / Z 275 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 $R_e \geq 235$ N/mm², $R_m \leq 630$ N/mm² and $A_{80} \geq 22\%$

3.7 General aspects related to the use of the product

The angle brackets and hold downs 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 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 1995-1-1:2010 or ETA have to be provided for.
- End or edge distance in component 2 towards the angle brackets bend line (shown in the figure on page 17).
- 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 α) d
$a_{3,c}$ = 6 d
$a_{4,t}$ = (3 + 4 cos α) 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 of NINO angle brackets shall be arranged between the horizontal flange and the timber member (component 1 as shown in the figure on page 17).
- 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 prior to CE marking.

Issued in Copenhagen on 2022-08-25 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
NINO100100	2,5	S235/S355/S275/DX51D/S250GD	FeZn12c / Z 275
NINO15080	2,5	S235/S355/S275/DX51D/S250GD	FeZn12c / Z 275
NINO100200	3,0	S235/S355/S275/DX51D/S250GD	FeZn12c / Z 275
WKR095	3,0	S235/S355/S275/DX51D/S250GD	FeZn12c / Z 275
WKR135	3,5	S235/S355/S275/DX51D/S250GD	FeZn12c / Z 275
WKR215	3,5	S235/S355/S275/DX51D/S250GD	FeZn12c / Z 275
WKR285	3,5	S235/S355/S275/DX51D/S250GD	FeZn12c / Z 275
WKR410	3,5	S235/S355/S275/DX51D/S250GD	FeZn12c / Z 275
WKR530	3,5	S235/S355/S275/DX51D/S250GD	FeZn12c / Z 275
Washer NINOW15080	6,0	S235/S355/S275	FeZn12c / Z 275
Washer NINOW100200	8,0	S235/S355/S275	FeZn12c / Z 275

Table A.2 Materials specification – Soundproofing Interlayer for NINO angle brackets

Soundproofing interlayer type	Thickness (mm)
Xylofon or Xylofonplate	6,0

Table A.3 Range of sizes

Angle Bracket type	Height (mm) vertical		Height (mm) horizontal		Width (mm)	
NINO100100	99	101	77	79	103	105
NINO15080	76	78	54	56	145	147
NINO100200	196	198	121	123	103	105
WKR095	94	96	84	86	64	66
WKR135	134	136	84	86	64	66
WKR215	214	216	84	86	64	66
WKR285	284	286	84	86	64	66
WKR410	409	411	84	86	64	66
WKR530	529	531	84	86	64	66
Washer NINOW15080	-	-	49	51	145	147
Washer NINOW100200	-	-	119	121	103	105

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 10.0 mm, type HBS or HBSP or TBS	60 mm	48 mm	Self-tapping screws according to ETA-11/0030
Rotho Blaas screw 12.0 mm, type HBS or HBSP	80 mm	48 mm	Self-tapping screws according to ETA-11/0030
Rotho Blaas screw 9.0 mm, type VGS	100 mm	90 mm	Self-tapping screws according to ETA-11/0030
Rotho Blaas screw 11.0 mm, type VGS	60 mm	50 mm	Self-tapping screws according to ETA-11/0030
Rotho Blaas screw 13.0 mm, type VGS	75 mm	60 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 screws with larger diameter than 5.0 mm a thin steel plate is assumed. The load-carrying-capacities of the angle brackets and hold downs have been determined based on the use of Rotho Blaas nail 4.0 mm, type LBA in accordance with ETA-22/0002 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 1995-1-1:2010, paragraph 8.3.2:

$$F_{ax,Rk} = f_{ax,k} \cdot d \cdot t_{pen} \left(\frac{\rho_k}{350} \right)^{0,8} \quad \text{for the nails 4.0 mm}$$

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

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 ringed shank including the nail tip 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 ETA-22/0002 the characteristic value of the withdrawal resistance for the Rotho Blaas nail 4.0 mm, type LBA is: $f_{ax,k}$ = 6,43 N/mm² (with ρ_k =350 kg/m^3) for EP or SS nails

Based on ETA-11/0030 the characteristic value of the withdrawal resistance for the screws type LBS, HBS, HBSP, TBS and VGS is: $f_{ax,k}$ = 11,7 N/mm² (with ρ_k =350 kg/m^3)

The shape of the nail or LBS or HBSP screw directly under the head shall be in the form of a truncated cone with a diameter under the head which fits the hole diameter. TBS screws shall have a large washer head.

Head pull-through is relevant for HBS, HBSP, VGS screws without washer.

Bolts diameter	**Correspondent hole diameter**	**Bolts type**
12.0 mm	Max. 2 mm larger than the bolt diameter	See specification of the manufacturer

Metal Anchors diameter	**Correspondent Hole diameter**	**Anchors type**
12.0 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 timber

NINO Angle bracket	Fastener pattern	Timber-to-timber connection ρ_k = 350 kg/m³		
		$F_{1,Rk}$ [kN]		$K_{1,ser}$ [kN/mm]
		LBA nails 4x60 [c]	LBS screws 5x50 [d]	
100100 [a]	1	20,0	20,0	$F_{1,Rk}/6$
100100	2	5,9	6,8	$F_{1,Rk}/2$
15080 [a]	1	37,2/39,5 [b]	37,2/39,5 [b]	$F_{1,Rk}/6$
15080	2	4,0	6,0	$F_{1,Rk}/2$
15080	3	4,0	6,0	$F_{1,Rk}/2$
15080	4	4,0	6,0	$F_{1,Rk}/2$
15080	5	4,0	6,0	$F_{1,Rk}/2$
100200 [a]	1	41,2	41,2	$F_{1,Rk}/5$

[a] Load-carrying capacity is based on VGS screws ∅ 9xL and L ≥ 140 mm. For L < 140 mm, $F_{1,Rk}$ is reduced with the ratio L/140.
[b] The first value relates to connection with soundproofing interlayer, the second without.
[c] For LBA nails with shorter length, $F_{1,Rk}$ must be reduced by $\min\{F_{v,short,Rk}/F_{v,60,Rk} ; F_{ax,short,Rk}/F_{ax,60,Rk}\}$
For ringed shank nails according to EN 14592, $F_{1,Rk}$ must be reduced by $\min\{F_{v,EN14592,Rk}/F_{v,LBA,Rk} ; F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}\}$
[d] For LBS screws with shorter length, $F_{1,Rk}$ must be reduced by $\min\{F_{v,short,Rk}/F_{v,50,Rk} ; F_{ax,short,Rk}/F_{ax,50,Rk}\}$

Table B.2: Force F_1, 1 angle bracket / Load-carrying capacity of fasteners in the vertical flange and of the steel - connection timber to rigid support

NINO Angle bracket	Fastener pattern	Timber-to-rigid support connection ρ_k = 350 kg/m³							
		$F_{1,Rk}$ [kN]				$F_{1,Rk}$ [kN]			
		without washer				with NW washer			
		LBA nails 4x60 [a]	LBS screws 5x50 [b]	Bolts inner row k_{tII}	$K_{1,ser}$ [kN/mm]	LBA nails 4x60 [a]	LBS screws 5x50 [b]	Bolts inner row k_{tII}	$K_{1,ser}$ [kN/mm]
100100	6	14,0	14,0	1,21	$F_{1,Rk}/18$	-	-	-	-
100100	7	14,0	14,0	1,21	$F_{1,Rk}/18$	-	-	-	-
15080	6	14,7	14,7	1,38	$F_{1,Rk}/16$	24,9	20,9	1,75	$F_{1,Rk}/8$
15080	7	14,7	14,7	1,38	$F_{1,Rk}/16$	24,9	24,9	1,75	$F_{1,Rk}/8$
15080	8	14,7	14,7	1,38	$F_{1,Rk}/16$	24,9	22,5	1,75	$F_{1,Rk}/8$
15080	9	14,7	14,7	1,38	$F_{1,Rk}/16$	24,9	22,5	1,75	$F_{1,Rk}/8$
15080	10	13,3	11,3	1,38	$F_{1,Rk}/16$	13,3	11,3	1,75	$F_{1,Rk}/8$
15080	11	13,3	11,3	1,38	$F_{1,Rk}/16$	13,3	11,3	1,75	$F_{1,Rk}/8$
100200	2T/2P	14,7	14,7	1,11	$F_{1,Rk}/16$	34,7	29,3	1,23	$F_{1,Rk}/8$
100200	3T/3P	14,7	14,7	1,11	$F_{1,Rk}/16$	34,7	34,7	1,23	$F_{1,Rk}/8$
100200	4T/4P	14,7	14,7	1,11	$F_{1,Rk}/16$	34,7	34,7	1,23	$F_{1,Rk}/8$
100200	5T/5P	14,7	14,7	1,11	$F_{1,Rk}/16$	34,7	34,7	1,23	$F_{1,Rk}/8$
100200	6T/6P	14,7	14,7	1,11	$F_{1,Rk}/16$	34,7	34,7	1,23	$F_{1,Rk}/8$
100200	7T/7P	14,7	14,7	1,11	$F_{1,Rk}/16$	34,7	34,7	1,23	$F_{1,Rk}/8$

[a] For LBA nails with shorter length, $F_{1,Rk}$ must be reduced by $\min\{F_{v,short,Rk}/F_{v,60,Rk} ; F_{ax,short,Rk}/F_{ax,60,Rk}\}$
For ringed shank nails according to EN 14592, $F_{1,Rk}$ must be reduced by $\min\{F_{v,EN14592,Rk}/F_{v,LBA,Rk} ; F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}\}$
[b] For LBS screws with shorter length, $F_{1,Rk}$ must be reduced by $\min\{F_{v,short,Rk}/F_{v,50,Rk} ; F_{ax,short,Rk}/F_{ax,50,Rk}\}$

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

NINO Angle bracket	Fastener pattern	$F_{2/3,Rk}$ [kN] for timber-to-timber connection ρ_k = 350 kg/m³				
		LBA nails 4x60 [a]		LBS screws 5x50 [b]		$K_{2/3,ser}$ [kN/mm]
		No soundproofing interlayer	6 mm soundproofing interlayer	No soundproofing interlayer	6 mm soundproofing interlayer	
100100	1	38,1	34,6	18,5	16,9	$F_{2/3,Rk}/5$
100100	2	17,2	9,4	9,5	7,4	$F_{2/3,Rk}/5$
100100	3	9,8	8,9	9,1	7,4	$F_{2/3,Rk}/5$
100100	4	11,3	9,4	9,5	7,4	$F_{2/3,Rk}/5$
100100	5	9,8	8,9	9,0	7,4	$F_{2/3,Rk}/5$
15080	1	38,1	34,6	27,6	25,5	$F_{2/3,Rk}/5$
15080	2	15,5	13,0	13,1	10,2	$F_{2/3,Rk}/5$
15080	3	13,3	12,3	12,3	10,1	$F_{2/3,Rk}/5$
15080	4	15,5	13,0	13,1	10,2	$F_{2/3,Rk}/5$
15080	5	12,7	11,8	11,2	10,0	$F_{2/3,Rk}/5$
100200	1	26,7	18,7	18,7	17,2	$F_{2/3,Rk}/6$

[a] For LBA nails with shorter length, $F_{2/3,Rk}$ must be reduced by min$\{F_{v,short,Rk}/F_{v,60,Rk}$; $F_{ax,short,Rk}/F_{ax,60,Rk}\}$
For ringed shank nails according to EN 14592, $F_{2/3,Rk}$ must be reduced by min$\{F_{v,EN14592,Rk}/F_{v,LBA,Rk}$; $F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}\}$
[b] For LBS screws with shorter length, $F_{2/3,Rk}$ must be reduced by min$\{F_{v,short,Rk}/F_{v,50,Rk}$; $F_{ax,short,Rk}/F_{ax,50,Rk}\}$

Table B.4: Force $F_{2/3}$, 1 angle bracket / connection timber to rigid support with or without NINOW washer

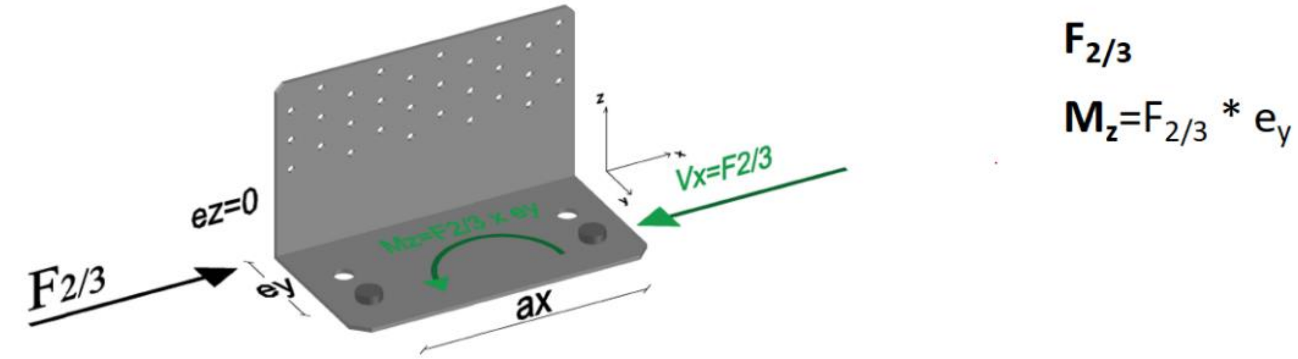
NINO Angle bracket	Fastener pattern	$F_{2/3,Rk}$ [kN] for timber-to- rigid support connection ρ_k = 350 kg/m³			
		LBA nails 4x60 [a]	e_z [c] [mm]	LBS screws 5x50 [b]	$K_{1,ser}$ [kN/mm]
100100	6	18,1	78,5	7,2	$F_{2/3,Rk}/5$
100100	7	18,1	54,5	9,8	$F_{2/3,Rk}/5$
100100	8	5,8	0	4,9	$F_{2/3,Rk}/5$
100100	9	7,8	0	6,6	$F_{2/3,Rk}/5$
100100	10	11,2	0	9,4	$F_{2/3,Rk}/5$
100100	11	9,3	42,5	4,2	$F_{2/3,Rk}/2$
100100	12	9,3	22,5	6,3	$F_{2/3,Rk}/2$
15080	6	26,7 with / 21,1 without washer	66,5	7,9	$F_{2/3,Rk}/4$
15080	7	21,3	0	17,9	$F_{2/3,Rk}/4$
15080	8	11,0	0	9,3	$F_{2/3,Rk}/4$
15080	9	15,7	0	13,2	$F_{2/3,Rk}/4$
15080	10	9,3	0	6,0	$F_{2/3,Rk}/4$
15080	11	10,0	0	8,5	$F_{2/3,Rk}/4$
100200	2T/2P	11,6 with / 8,3 without washer	174,5	3,5	$F_{2/3,Rk}/3$
100200	3T/3P	10,7	162,5	6,0	$F_{2/3,Rk}/3$
100200	4T/4P	10,7	138,5	7,0	$F_{2/3,Rk}/3$
100200	5T/5P	16,9	114,5	8,3	$F_{2/3,Rk}/3$
100200	6T/6P	16,9	90,5	10,1	$F_{2/3,Rk}/3$
100200	7T/7P	16,9	66,5	13,2	$F_{2/3,Rk}/3$

Shear loads per bolt or metal anchor, see Figure below:

- In x-direction: ± 0,5 · $F_{2/3,Ed}$ for NINO100100, NINO15080 and the inner bolt row of NINO100200,
- In y-direction: ± 0,43 · $F_{2/3,Ed}$ for NINO100100 or NINO100200 with two bolts close to the bend line, ± 0,25 · $F_{2/3,Ed}$ for NINO15080 and the inner bolt row of NINO100200 with four bolts.

[a] For LBA nails with shorter length, $F_{2/3,Rk}$ must be reduced by min$\{F_{v,short,Rk}/F_{v,60,Rk}$; $F_{ax,short,Rk}/F_{ax,60,Rk}\}$
For ringed shank nails according to EN 14592, $F_{2/3,Rk}$ must be reduced by min$\{F_{v,EN14592,Rk}/F_{v,LBA,Rk}$; $F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}\}$
[b] For LBS 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 nailed connections, for screwed connections e_z = 0

Explanation for footnotes in Table B.4



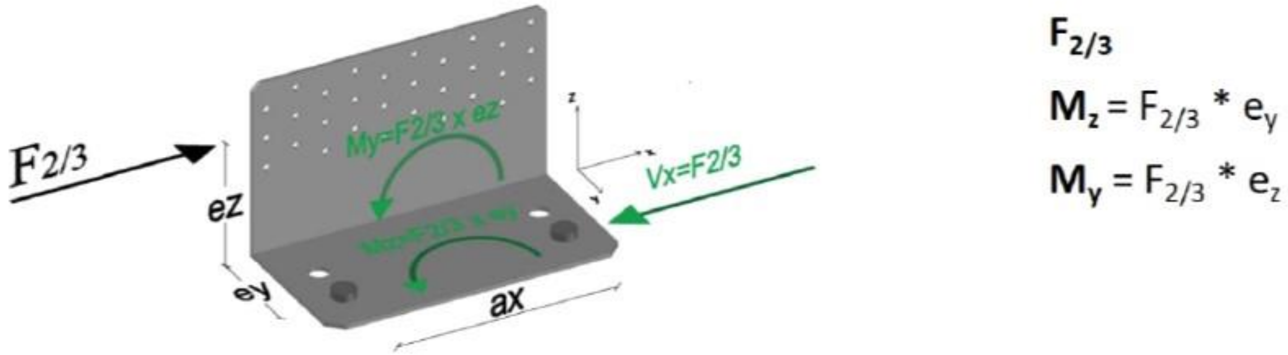


Table B.5: 1 angle bracket for force F_4 and F_5, and 2 angle brackets for force F_{45} / connection timber to timber

NINO Angle bracket	Fastener pattern	for timber-to-timber connection ρ_k = 350 kg/m³						
		LBA nails 4x60 [a]			LBS screws 5x50 [b]			$K_{4,ser}$ [kN/mm]
		$F_{4,Rk}$ [kN]	$F_{5,Rk}$ [kN]	$F_{45,Rk}$ [kN]	$F_{4,Rk}$ [kN]	$F_{5,Rk}$ [kN]	$F_{45,Rk}$ [kN]	
100100	1	23,2	1,8	25,0	22,0	1,8	23,8	$F_{4,Rk}$/1,5
100100	2	23,2	1,8	25,0	22,0	1,8	23,8	$F_{4,Rk}$/1,5
100100	3	7,4	1,8	9,2	7,4	1,8	9,2	$F_{4,Rk}$/1,5
100100	4	23,2	3,4	26,6	22,0	3,4	25,4	$F_{4,Rk}$/1,5
100100	5	9,2	3,4	12,6	9,2	3,4	12,6	$F_{4,Rk}$/6
15080	1	22,3	2,5	24,8	21,6	2,5	24,1	$F_{4,Rk}$/1,5
15080	2	22,3	2,5	24,8	21,6	2,5	24,1	$F_{4,Rk}$/1,5
15080	3	10,2	2,5	12,7	10,2	2,5	12,7	$F_{4,Rk}$/1,5
15080	4	18,7	4,8	23,5	17,7	4,8	22,5	$F_{4,Rk}$/1,5
15080	5	14,7	4,8	19,5	14,7	4,8	19,5	$F_{1,Rk}$/6
100200	1	19,1	2,6	21,7	19,1	2,6	21,7	$F_{4,Rk}$/1,5

[a] For LBA nails with shorter length, $F_{4,Rk}$ or $F_{5,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,60,Rk}$; $F_{ax,short,Rk}/F_{ax,60,Rk}$
For ringed shank nails according to EN 14592, $F_{4,Rk}$ or $F_{5,Rk}$ must be reduced by min{$F_{v,EN14592,Rk}/F_{v,LBA,Rk}$; $F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}$}

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

Table B.6: 1 angle bracket for force F_4 and F_5, and 2 angle brackets for force F_{45} / connection timber to rigid support

NINO Angle bracket	Fastener pattern	for timber-to-rigid support connection ρ_k = 350 kg/m³					
		LBA nails 4x60 [a]			LBS screws 5x50 [b]		
		$F_{4,Rk}$ [kN]	$F_{5,Rk}$ [kN]	$F_{45,Rk}$ [kN]	$F_{4,Rk}$ [kN]	$F_{5,Rk}$ [kN]	$F_{45,Rk}$ [kN]
100100	6	6,2	1,1	7,4	6,2	1,1	7,4
100100	7	23,2	1,8	25,0	22,0	1,8	23,8
100100	8	3,8	1,1	5,0	3,8	1,1	5,0
100100	9	7,4	1,8	9,2	7,4	1,8	9,2
100100	10	14,4	3,4	17,8	13,6	3,4	17,0
100100	11	6,3	1,8	8,1	5,9	1,8	7,7
100100	12	9,2	3,4	12,6	9,2	3,4	12,6
15080	6	8,7	1,6	10,3	8,7	1,6	10,3
15080	7	22,3	2,5	24,8	21,6	2,5	24,1
15080	8	10,2	2,5	12,7	10,2	2,5	12,7
15080	9	18,7	4,8	23,5	17,7	4,8	22,5
15080	10	8,4	2,5	10,9	7,9	2,5	10,4
15080	11	11,6	4,8	16,4	11,6	4,8	16,4
100200	2T/2P	2,1	0,7	2,8	2,1	0,7	2,8
100200	3T/3P	2,6	0,8	3,4	2,6	0,8	3,4
100200	4T/4P	3,4	1,0	4,4	3,4	1,0	4,4
100200	5T/5P	4,9	1,2	6,1	4,9	1,2	6,1
100200	6T/6P	8,5	1,7	10,2	8,5	1,7	10,2
100200	7T/7P	19,1	2,6	21,7	19,1	2,6	21,7

[a] For LBA nails with shorter length, $F_{4,Rk}$ or $F_{5,Rk}$ or $F_{45,Rk}$ must be reduced by $\min\{F_{v,short,Rk}/F_{v,60,Rk}\ ;\ F_{ax,short,Rk}/F_{ax,60,Rk}\}$
For ringed shank nails according to EN 14592, $F_{4,Rk}$ or $F_{5,Rk}$ or $F_{45,Rk}$ must be reduced by $\min\{F_{v,EN14592,Rk}/F_{v,LBA,Rk}\ ;\ F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}\}$

[b] For LBS screws with shorter length, $F_{4,Rk}$ or $F_{5,Rk}$ or $F_{45,Rk}$ must be reduced by $\min\{F_{v,short,Rk}/F_{v,50,Rk}\ ;\ F_{ax,short,Rk}/F_{ax,50,Rk}\}$

Table B.7: Force F_1, 1 hold-down / connection timber to timber or timber to rigid support

Hold-down - Fastener pattern	Connections without gap ρ_k = 350 kg/m³ [c]			
	$F_{1,no\ gap,Rk}$ [kN]		k_t	$K_{1,ser}$ [kN/mm]
	LBA nails 4x60 [a]	LBS screws 5x50 [b]		
WKR095-1/2	Min{15,0[1)]; $F_{ax,Rk}$/ k_t }	Min{13,3[1)]; $F_{ax,Rk}$/ k_t }	1,05	$F_{1,Rk}$/4
WKR135-1/2	Min{28,3[1)]; $F_{ax,Rk}$/ k_t }	Min{24,6[1)]; $F_{ax,Rk}$/ k_t }	1,05	$F_{1,Rk}$/4
WKR215-4	Min{8,0[1)]; $F_{ax,Rk}$/ k_t }	Min{6,8[1)]; $F_{ax,Rk}$/ k_t }	1,45	$F_{1,Rk}$/4
WKR215-3	Min{18,7[1)]; $F_{ax,Rk}$/ k_t }	Min{15,8[1)]; $F_{ax,Rk}$/ k_t }	1,45	$F_{1,Rk}$/4
WKR215-1/2	Min{47,0[1)]; $F_{ax,Rk}$/ k_t }	Min{40,3[1)]; $F_{ax,Rk}$/ k_t }	1,10	$F_{1,Rk}$/4
WKR285-5	Min{21,3[1)]; $F_{ax,Rk}$/ k_t }	Min{18,0[1)]; $F_{ax,Rk}$/ k_t }	1,45	$F_{1,Rk}$/4
WKR285-1/4	Min{37,3[1)]; $F_{ax,Rk}$/ k_t }	Min{36,0[1)]; $F_{ax,Rk}$/ k_t }	1,45	$F_{1,Rk}$/4
WKR285-2/3	Min{57,6[1)]; $F_{ax,Rk}$/ k_t }	Min{49,3[1)]; $F_{ax,Rk}$/ k_t }	1,10	$F_{1,Rk}$/4
WKR410-2	Min{37,3[1)]; $F_{ax,Rk}$/ k_t }	Min{31,5[1)]; $F_{ax,Rk}$/ k_t }	1,45	$F_{1,Rk}$/4
WKR410-1	Min{45,3[1)]; $F_{ax,Rk}$/ k_t }	Min{38,3[1)]; $F_{ax,Rk}$/ k_t }	1,45	$F_{1,Rk}$/4
WKR530-1/2	Min{42,6[1)]; $F_{ax,Rk}$/ k_t }	Min{36,0[1)]; $F_{ax,Rk}$/ k_t }	1,45	$F_{1,Rk}$/4

[1)] For nails in CLT, $a_{3,t}$ may be reduced to 40 mm, for screws in CLT to 30 mm.
For nails in CLT and $a_{3,t}$ < 60 mm, the value must be decreased by 7 %.

[a] For LBA nails with shorter length, $F_{1,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,60,Rk}$; $F_{ax,short,Rk}/F_{ax,60,Rk}$}
For ringed shank nails according to EN 14592, $F_{1,Rk}$ must be reduced by min{$F_{v,EN14592,Rk}/F_{v,LBA,Rk}$; $F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}$}

[b] For LBS 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 connections with gap, k_t = 1,0 and $F_{1,gap,Rk}$ = Min{$F_{1,no\ gap,Rk}$; 19 kN}

$F_{ax,Rk}$ is the axial load-carrying capacity of a metal anchor in concrete or a bolt in a timber or steel member or a screw according to ETA-11/0030 in a timber member. The head pull-through capacity of a fastener in the horizontal flap may be assumed according to Table B.8.

Explanation for connections with gap in Table B.7

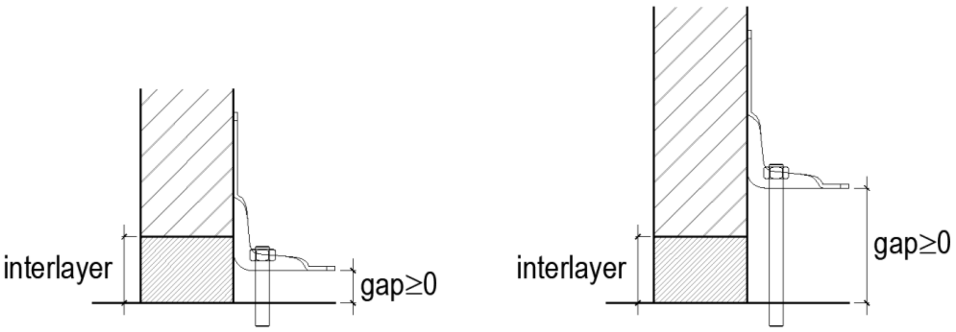


Table B.8: Force F_1, head pull-through capacity of a fastener in the horizontal flange

Fastener	WKR type	$F_{head,Rk}$ [kN]
Metal anchor M12 or bolt M12 in hold-down without gap	WKR095 to WKR530	26,0
Metal anchor M12 or bolt M12 in hold-down with gap	WKR095	8,3
Metal anchor M12 or bolt M12 in hold-down with gap	WKR135 to WKR530	19,0
Rotho Blaas screw type HBS or TBS ∅ 10 mm or ∅ 12 mm or VGS ∅ 11 mm or ∅ 13 mm with washer HUS or with large washer head according to ETA-11/0030	WKR095 to WKR530	$f_{tens,k}$
Rotho Blaas screw type HBSP ∅ 10 mm with WU2 washer head according to ETA-11/0030	WKR095	20,0
Rotho Blaas screw type HBSP ∅ 10 mm with WU2 washer head according to ETA-11/0030	WKR135 to WKR530	21,0
Rotho Blaas screw type HBSP ∅ 12 mm with WU2 washer head according to ETA-11/0030	WKR095	27,0
Rotho Blaas screw type HBSP ∅ 12 mm with WU2 washer head according to ETA-11/0030	WKR135 to WKR530	29,0

Table B.9: Force F_4, 1 hold-down / connection timber to timber

Hold-down - Fastener pattern	Timber-to-timber connection, no interlayer		
	$F_{4,Rk}$ [kN]		$K_{4,ser}$ [kN/mm]
	LBA nails 4x60 [a]	LBS screws 5x50	
WKR095-2	Min{14,7; $F_{vh,Rk}$}	Min{14,1; $F_{vh,Rk}$}	$F_{4,Rk}/6$
WKR135-2	Min{18,3; $F_{vh,Rk}$}	Min{17,2; $F_{vh,Rk}$}	$F_{4,Rk}/6$
WKR215-2	Min{23,0; $F_{vh,Rk}$}	Min{21,1; $F_{vh,Rk}$}	$F_{4,Rk}/6$
WKR285-3	Min{25,6; $F_{vh,Rk}$}	Min{23,4; $F_{vh,Rk}$}	$F_{4,Rk}/6$
Hold-down - Fastener pattern	Timber-to-timber connection, interlayer up to 20 mm		
	$F_{4,Rk}$ [kN]		$K_{4,ser}$ [kN/mm]
	LBA nails 4x60 [a]	LBS screws 5x50	
WKR095-2	Min{11,3; $F_{vh,Rk}$}	Min{10,7; $F_{vh,Rk}$}	$F_{4,Rk}/6$
WKR135-2	Min{14,9; $F_{vh,Rk}$}	Min{13,8; $F_{vh,Rk}$}	$F_{4,Rk}/6$
WKR215-2	Min{19,6; $F_{vh,Rk}$}	Min{17,7; $F_{vh,Rk}$}	$F_{4,Rk}/6$
WKR285-3	Min{22,3; $F_{vh,Rk}$}	Min{20,0; $F_{vh,Rk}$}	$F_{4,Rk}/6$

[a] For LBA nails with shorter length, $F_{4,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,60,Rk}$; $F_{ax,short,Rk}/F_{ax,60,Rk}$}
For ringed shank nails according to EN 14592, $F_{4,Rk}$ must be reduced by min{$F_{v,EN14592,Rk}/F_{v,LBA,Rk}$; $F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}$}
[b] For LBS screws with shorter length, $F_{4,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,50,Rk}$; $F_{ax,short,Rk}/F_{ax,50,Rk}$}

$F_{vh,Rk}$ is the lateral load-carrying capacity of a metal anchor in concrete or a bolt in a timber or steel member or a screw according to ETA-11/0030 in a timber member.

Table B.10: Force F_4, 1 hold-down / connection timber to rigid support

Hold-down - Fastener pattern	Timber-to-rigid support connection, no interlayer			
	$F_{4,Rk}$ [kN]		$K_{4,ser}$ [kN/mm]	
	LBA nails 4x60 [a]	LBS screws 5x50 [b]		
WKR095-1	Min{14,7; $F_{vh,Rk}$}	Min{14,1; $F_{vh,Rk}$}	$F_{4,Rk}/6$	
WKR135-1	Min{18,3; $F_{vh,Rk}$}	Min{17,2; $F_{vh,Rk}$}	$F_{4,Rk}/6$	
WKR215-1	Min{23,0; $F_{vh,Rk}$}	Min{21,1; $F_{vh,Rk}$}	$F_{4,Rk}/6$	
WKR285-1/4	Min{21,7; $F_{vh,Rk}$}	Min{20,0; $F_{vh,Rk}$}	$F_{4,Rk}/6$	
WKR285-2	Min{25,6; $F_{vh,Rk}$}	Min{23,4; $F_{vh,Rk}$}	$F_{4,Rk}/6$	
WKR410-1	Min{22,3; $F_{vh,Rk}$}	Min{20,6; $F_{vh,Rk}$}	$F_{4,Rk}/6$	
WKR530-1/2	Min{21,7; $F_{vh,Rk}$}	Min{20,0; $F_{vh,Rk}$}	$F_{4,Rk}/6$	
Hold-down - Fastener pattern	Timber-to-rigid support connection, interlayer thickness up to d_{ILmax}			
	$F_{4,Rk}$ [kN]		d_{ILmax} [mm]	$K_{4,ser}$ [kN/mm]
	LBA nails 4x60 [a]	LBS screws 5x50 [b]		
WKR095-1	Min{11,3; $F_{vh,Rk}$}	Min{10,7; $F_{vh,Rk}$}	20	$F_{4,Rk}/6$
WKR135-1	Min{14,9; $F_{vh,Rk}$}	Min{13,8; $F_{vh,Rk}$}	20	$F_{4,Rk}/6$
WKR215-1	Min{19,6; $F_{vh,Rk}$}	Min{17,7; $F_{vh,Rk}$}	20	$F_{4,Rk}/6$
WKR285-1/4	Min{13,0; $F_{vh,Rk}$}	Min{11,3; $F_{vh,Rk}$}	120	$F_{4,Rk}/6$
WKR285-2	Min{22,3; $F_{vh,Rk}$}	Min{20,0; $F_{vh,Rk}$}	20	$F_{4,Rk}/6$
WKR410-1	Min{12,5; $F_{vh,Rk}$}	Min{10,8; $F_{vh,Rk}$}	240	$F_{4,Rk}/6$
WKR530-1/2	Min{11,5; $F_{vh,Rk}$}	Min{9,8; $F_{vh,Rk}$}	360	$F_{4,Rk}/6$

[a] For LBA nails with shorter length, $F_{4,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,60,Rk}$; $F_{ax,short,Rk}/F_{ax,60,Rk}$}
For ringed shank nails according to EN 14592, $F_{4,Rk}$ must be reduced by min{$F_{v,EN14592,Rk}/F_{v,LBA,Rk}$; $F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}$}
[b] For LBS screws with shorter length, $F_{4,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,50,Rk}$; $F_{ax,short,Rk}/F_{ax,50,Rk}$}

$F_{vh,Rk}$ is the lateral load-carrying capacity of a metal anchor in concrete or a bolt in a timber or steel member or a screw according to ETA-11/0030 in a timber member.

Table B.11: Force F_5, 1 hold-down / connection timber to timber

Hold-down - Fastener pattern	Timber-to-timber connection		
	$F_{5,Rk}$ [kN]		ℓ_{BL} [mm]
	LBA nails 4x60 [a]	LBS screws 5x50 [b]	
WKR095-2	2,6	3,4	70
WKR135-2	2,6	3,6	70
WKR215-2	2,6	3,6	70
WKR285-3	2,6	3,6	70

[a] For LBA nails with shorter length, $F_{5,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,60,Rk}$; $F_{ax,short,Rk}/F_{ax,60,Rk}$}
For ringed shank nails according to EN 14592, $F_{5,Rk}$ must be reduced by min{$F_{v,EN14592,Rk}/F_{v,LBA,Rk}$; $F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}$}
[b] For LBS screws with shorter length, $F_{5,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,50,Rk}$; $F_{ax,short,Rk}/F_{ax,50,Rk}$}

Table B.12: Force F_5, 1 hold-down / connection timber to rigid support

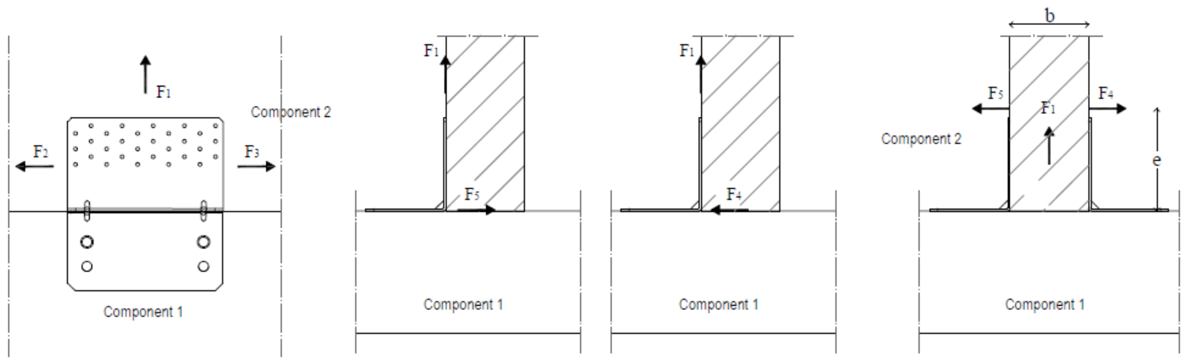
Hold-down - Fastener pattern	Timber-to-rigid support connection		
	$F_{5,Rk}$ [kN]		ℓ_{BL} [mm]
	LBA nails 4x60 [a]	LBS screws 5x50 [b]	
WKR095-1	2,6	3,4	70
WKR135-1	2,6	3,6	70
WKR215-1	2,6	3,6	70
WKR285-1/4	0,9	0,9	160
WKR285-2	2,6	3,6	70
WKR410-1	0,43	0,43	278
WKR530-1	0,33	0,33	343
WKR530-2	0,26	0,26	423

[a] For LBA nails with shorter length, $F_{5,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,60,Rk}$; $F_{ax,short,Rk}/F_{ax,60,Rk}$}
For ringed shank nails according to EN 14592, $F_{5,Rk}$ must be reduced by min{$F_{v,EN14592,Rk}/F_{v,LBA,Rk}$; $F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}$}
[b] For LBS screws with shorter length, $F_{5,Rk}$ must be reduced by min{$F_{v,short,Rk}/F_{v,50,Rk}$; $F_{ax,short,Rk}/F_{ax,50,Rk}$}

The combined action of $F_{ax,Ed}$ and $F_{v,Ed}$ on the fastener in the horizontal flange must be checked by the designer.

$$F_{ax,Ed} = \frac{F_{5,Ed} \cdot \ell_{BL}}{25\,\text{mm}} \qquad \text{(B.1)}$$

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



Fastener specification

Nailing patterns are given in figures B.8 to B.14, B.20 and B.22.

Double angle brackets per connection

The angle brackets must be placed at each side opposite to each other, symmetrically to the component axis.
Acting forces

F_1	Lifting force acting along the central axis of the joint.
F_2 and F_3	Lateral force acting in the joint between the component 2 and component 1 in the component 2 direction
F_4 and F_5	Lateral force acting in the component 1 direction along the central axis of the joint.

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.
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 or hold-down 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:

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

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, is able to act simultaneously with F_1, while the other shall be set to zero.

Rotho Blaas Angle Brackets

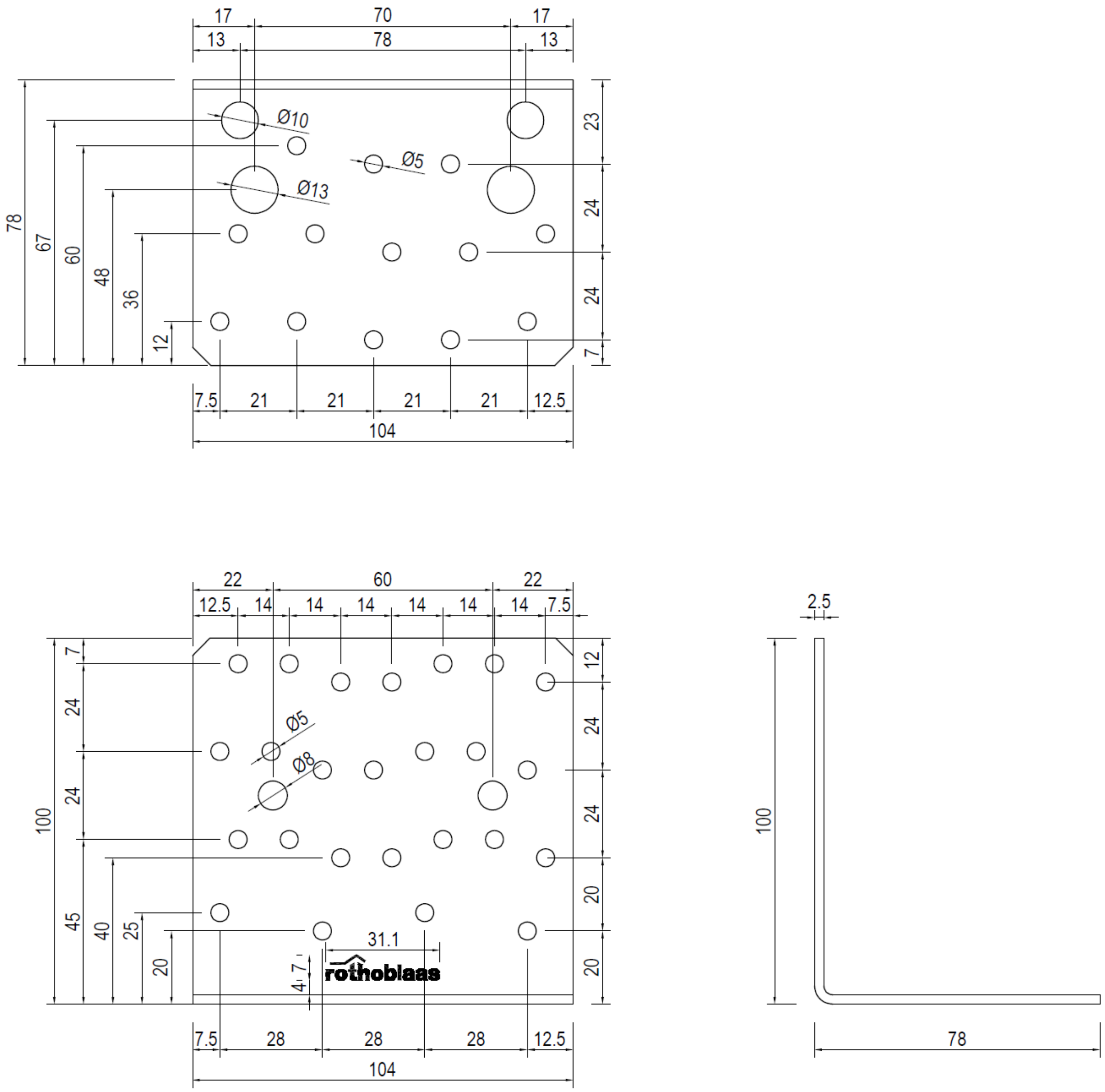


Figure B. 1 Dimensions of Angle Bracket NINO 100100

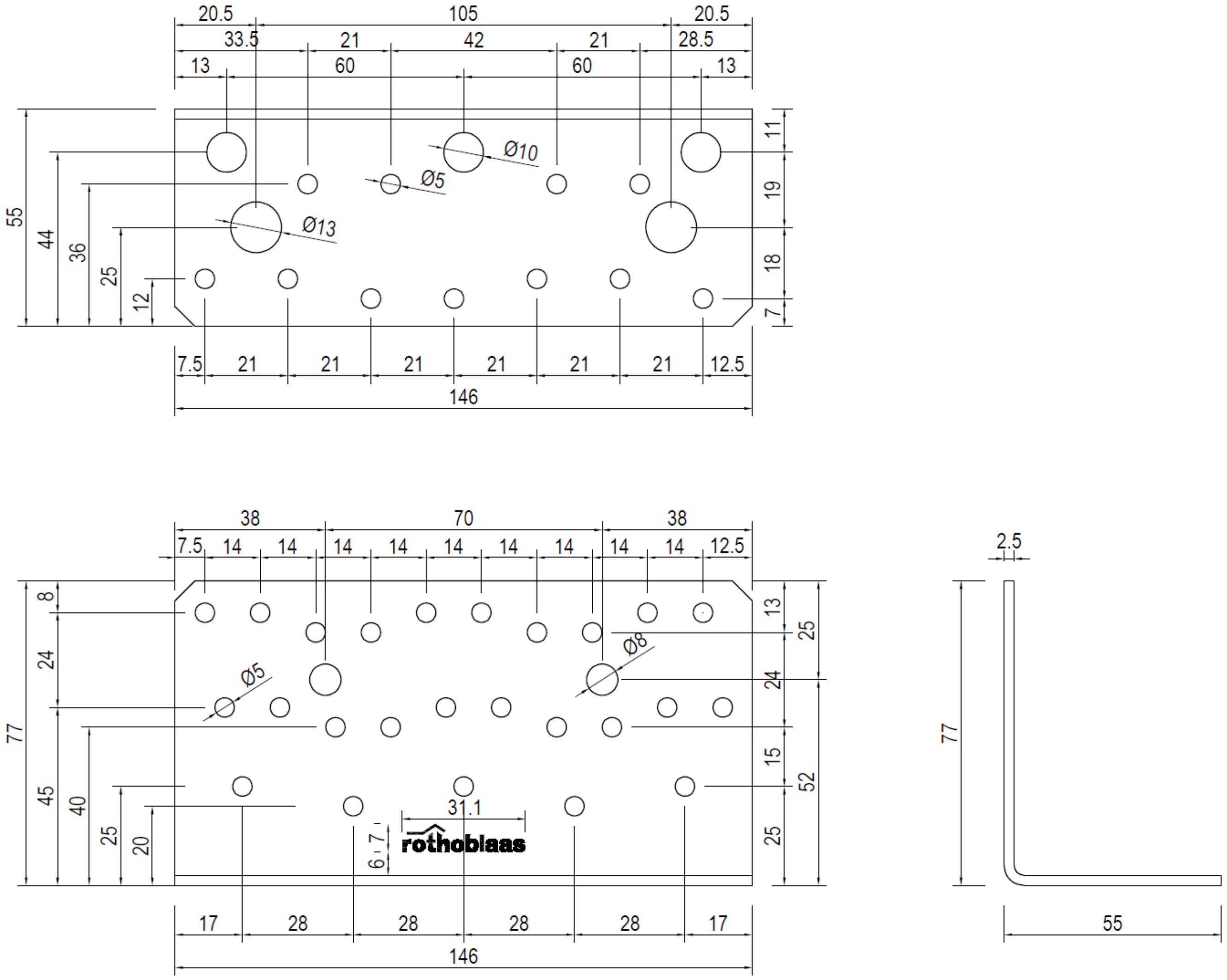


Figure B. 2 Dimensions of Angle Bracket NINO 15080

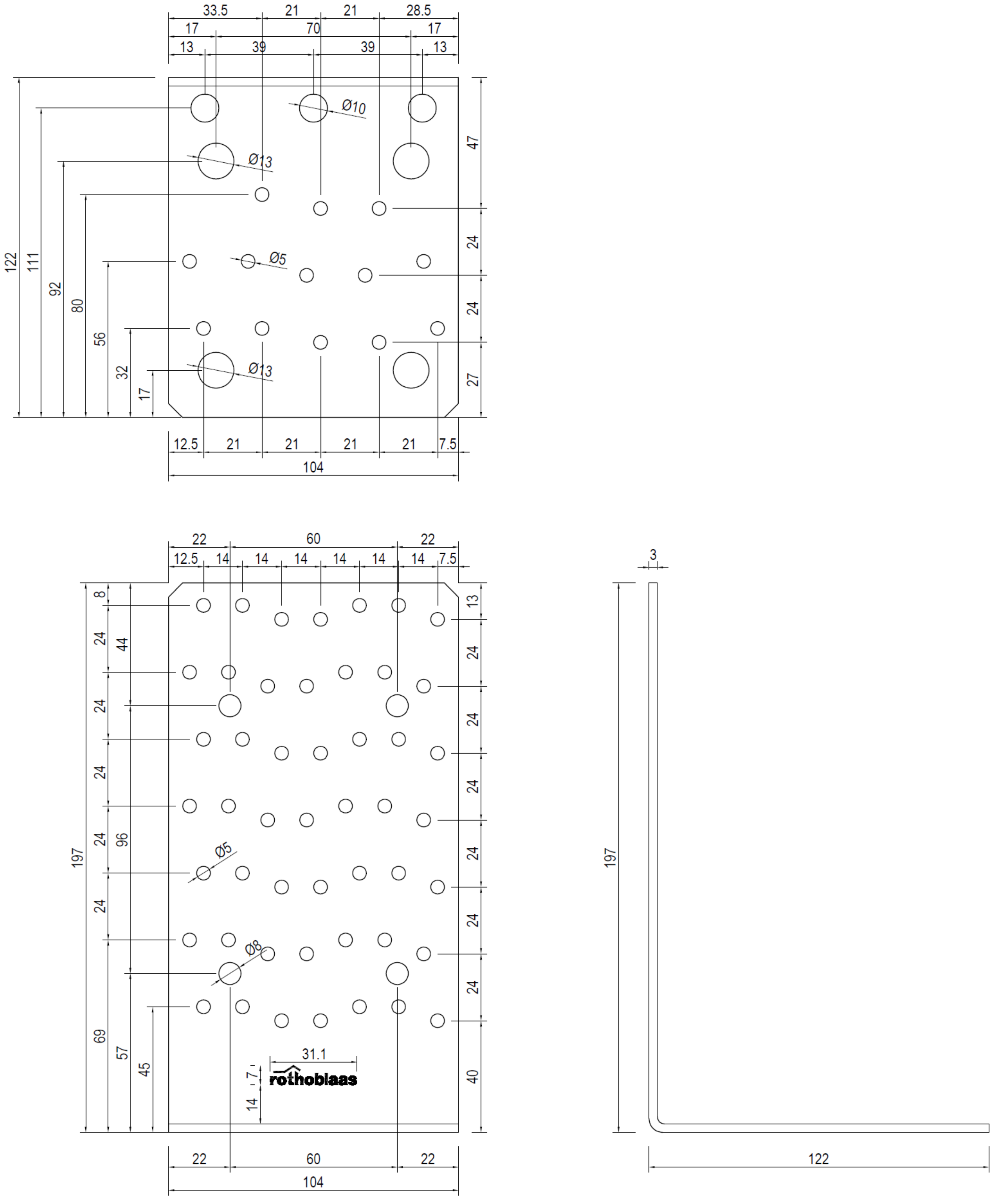


Figure B. 3 Dimensions of Angle Bracket NINO 100200

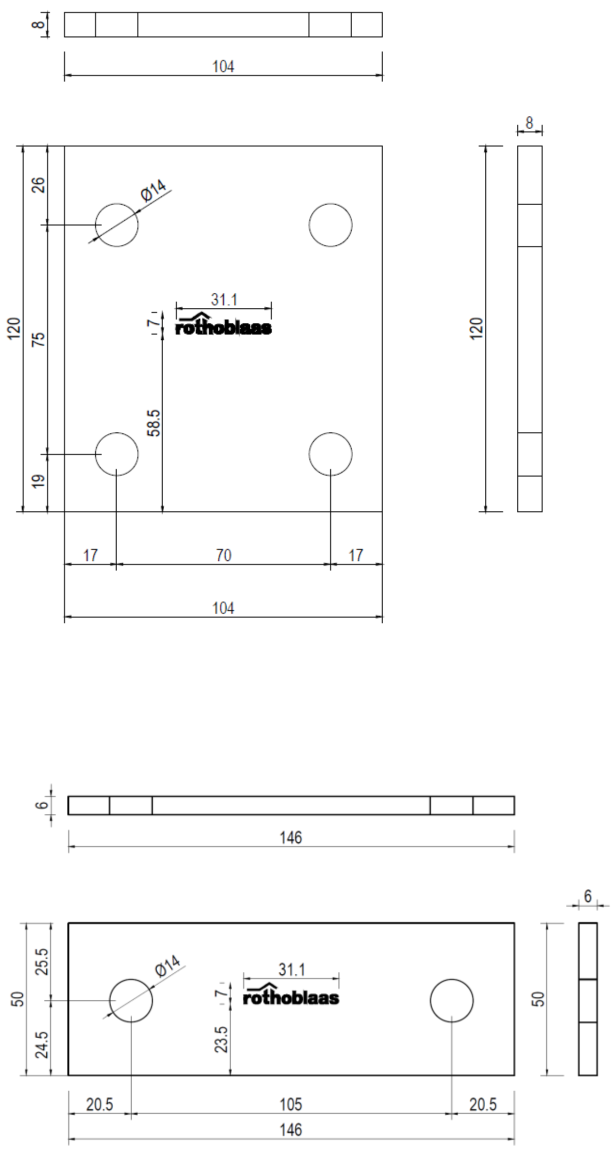


Figure B. 4 Dimensions of NINO Washers

Figure B. 5 Typical installation NINO100100

Figure B. 6 Typical installation NINO15080

Figure B. 7 Typical installation NINO100200

Nailing pattern for NINO100100

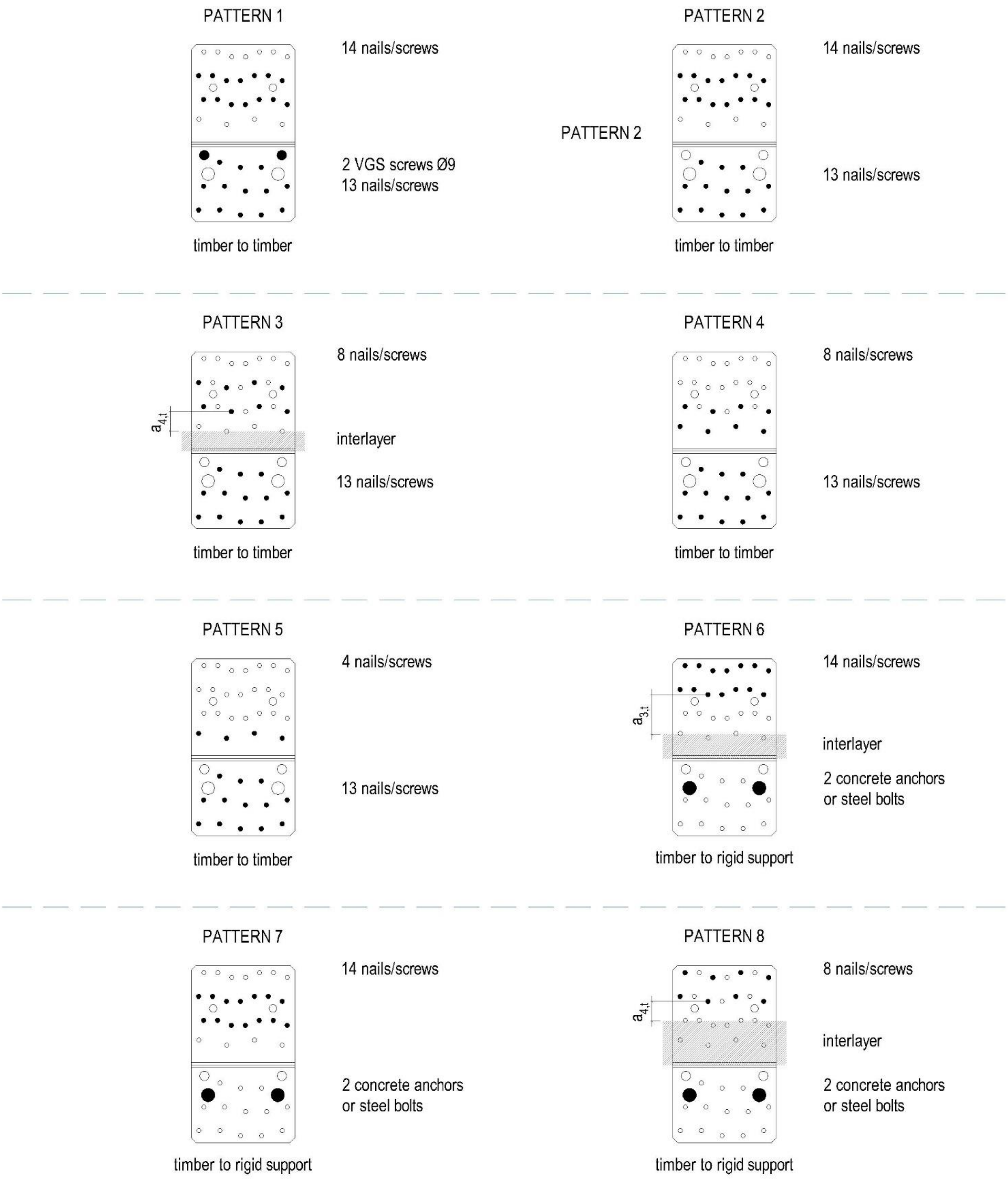


Figure B. 8 Nailing patterns for Angle Bracket NINO 100100

Nailing pattern for NINO100100

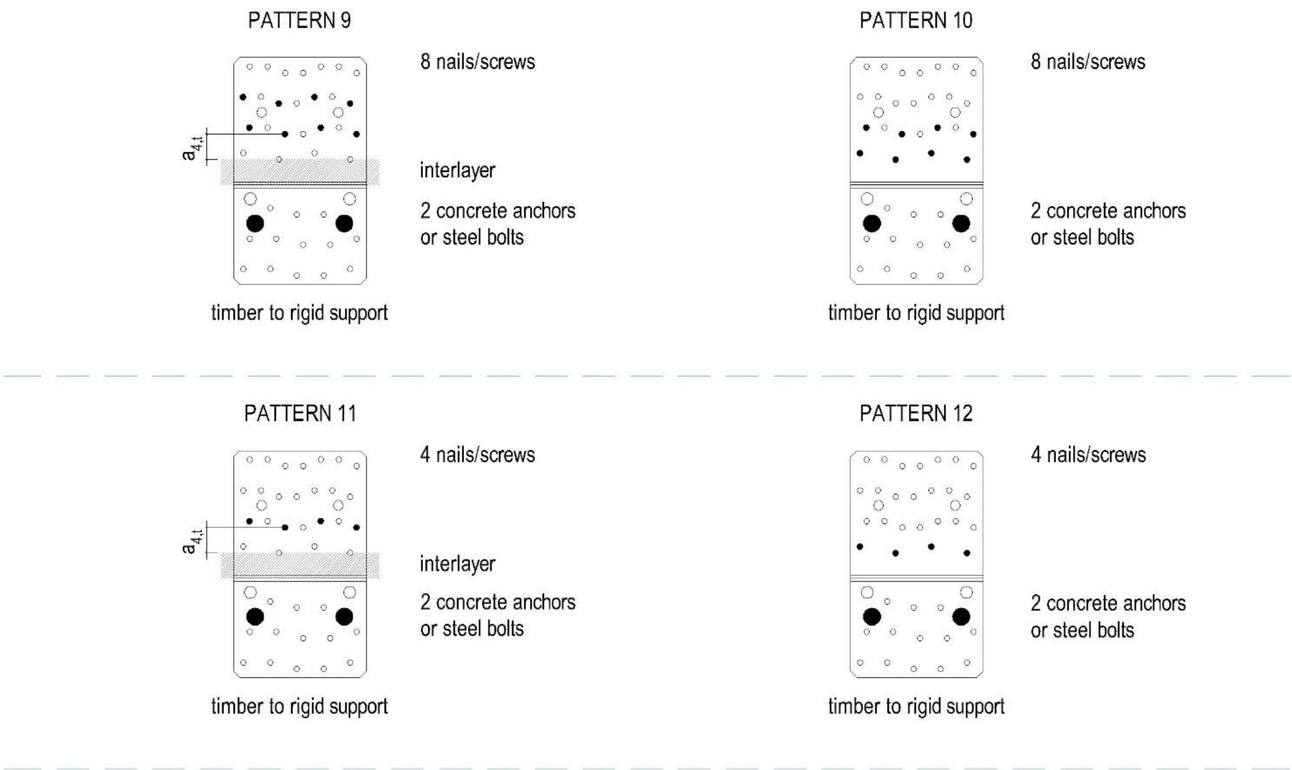


Figure B. 9 Nailing patterns for Angle Bracket NINO 100100

Nailing pattern for NINO15080

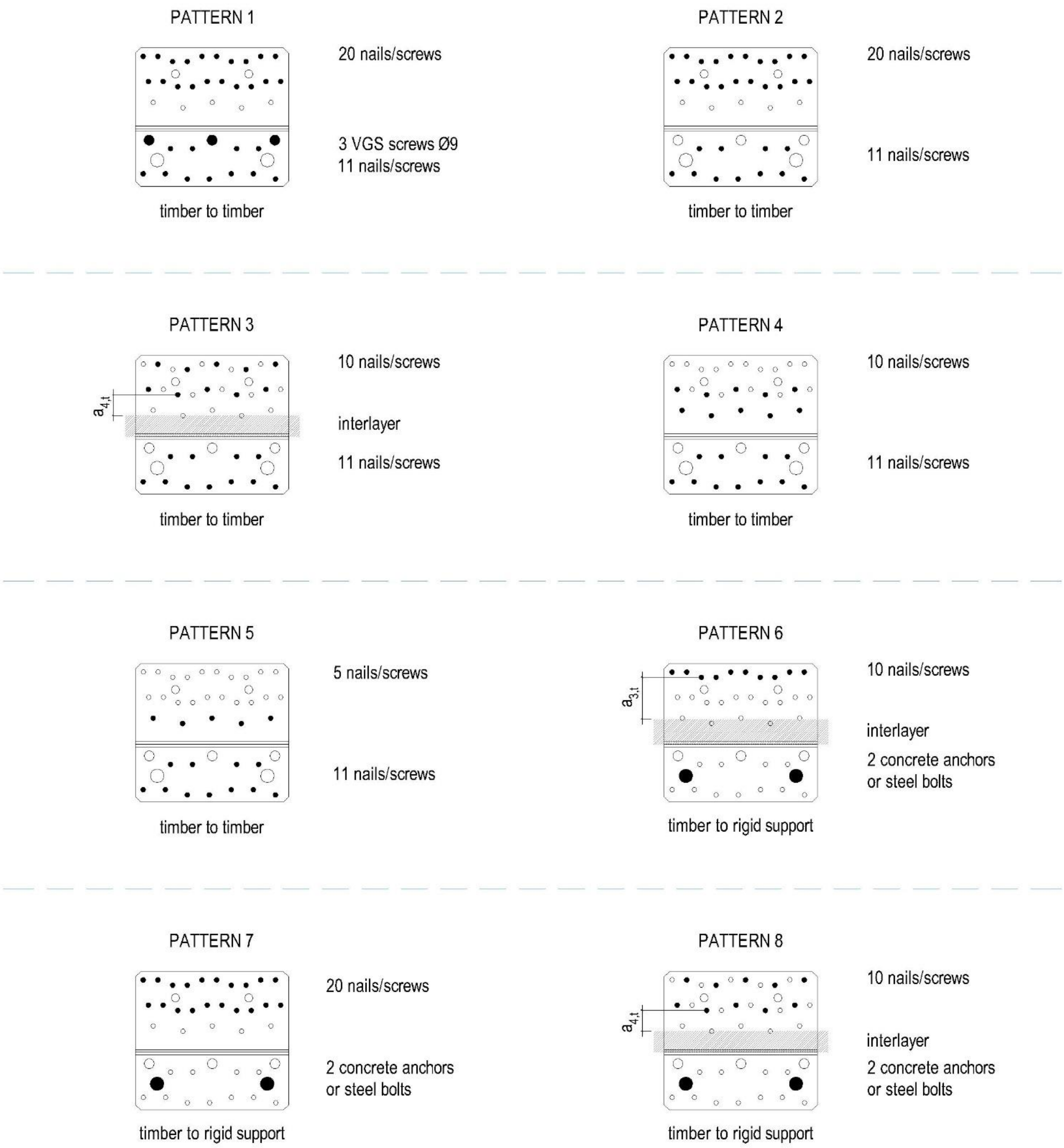


Figure B. 10 Nailing patterns for Angle Bracket NINO 15080

Nailing pattern for NINO15080

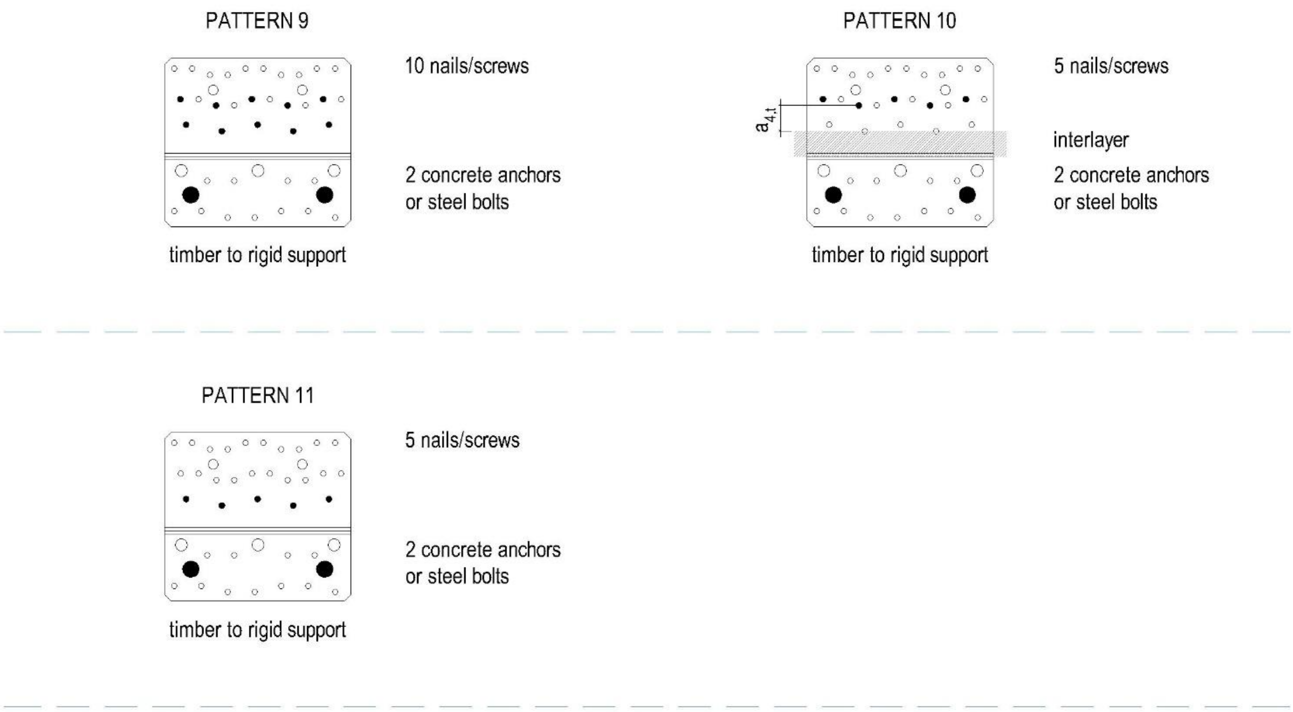


Figure B. 11 Nailing patterns for Angle Bracket NINO 15080

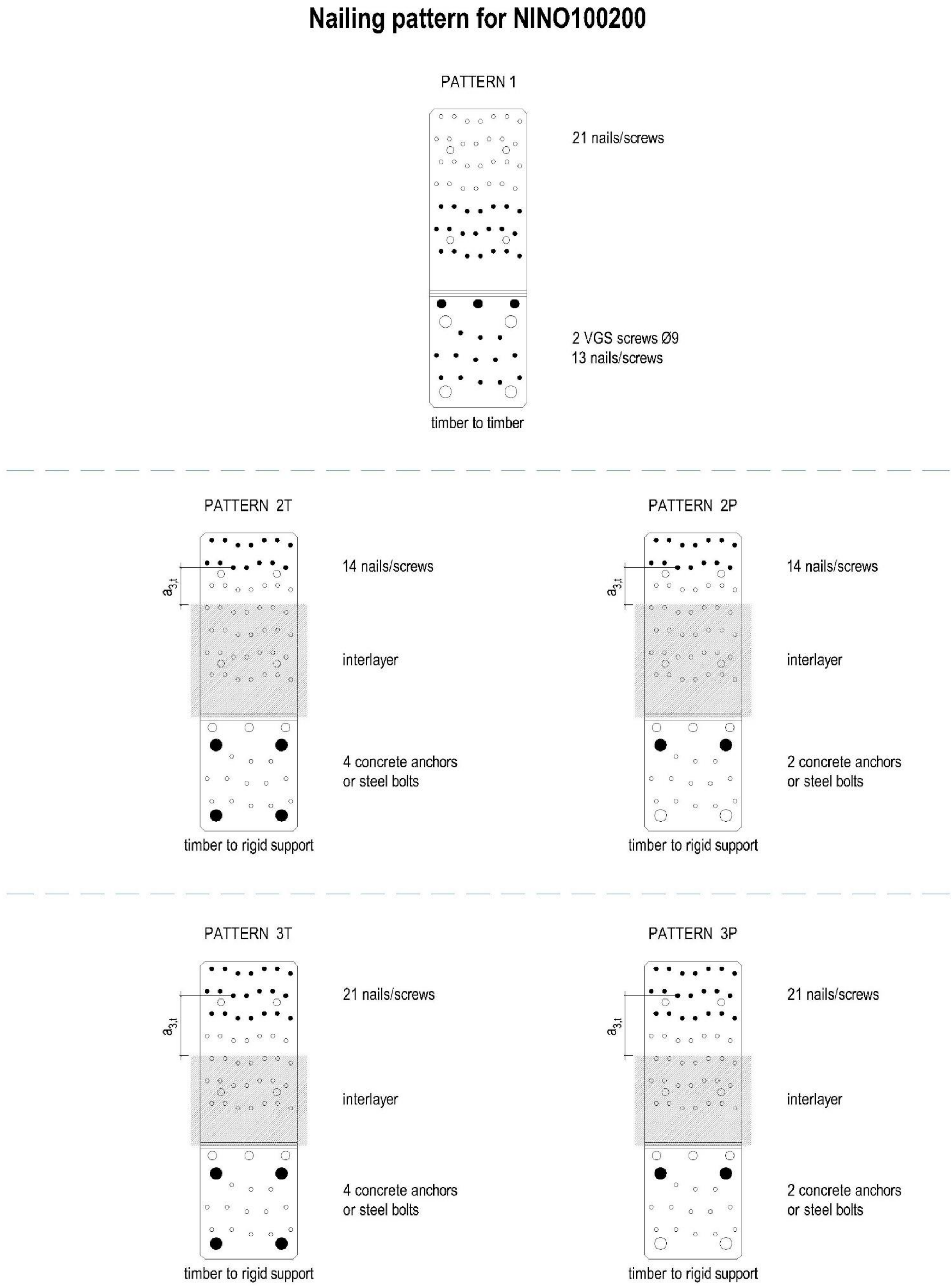


Figure B. 12 Nailing patterns for Angle Bracket NINO 100200

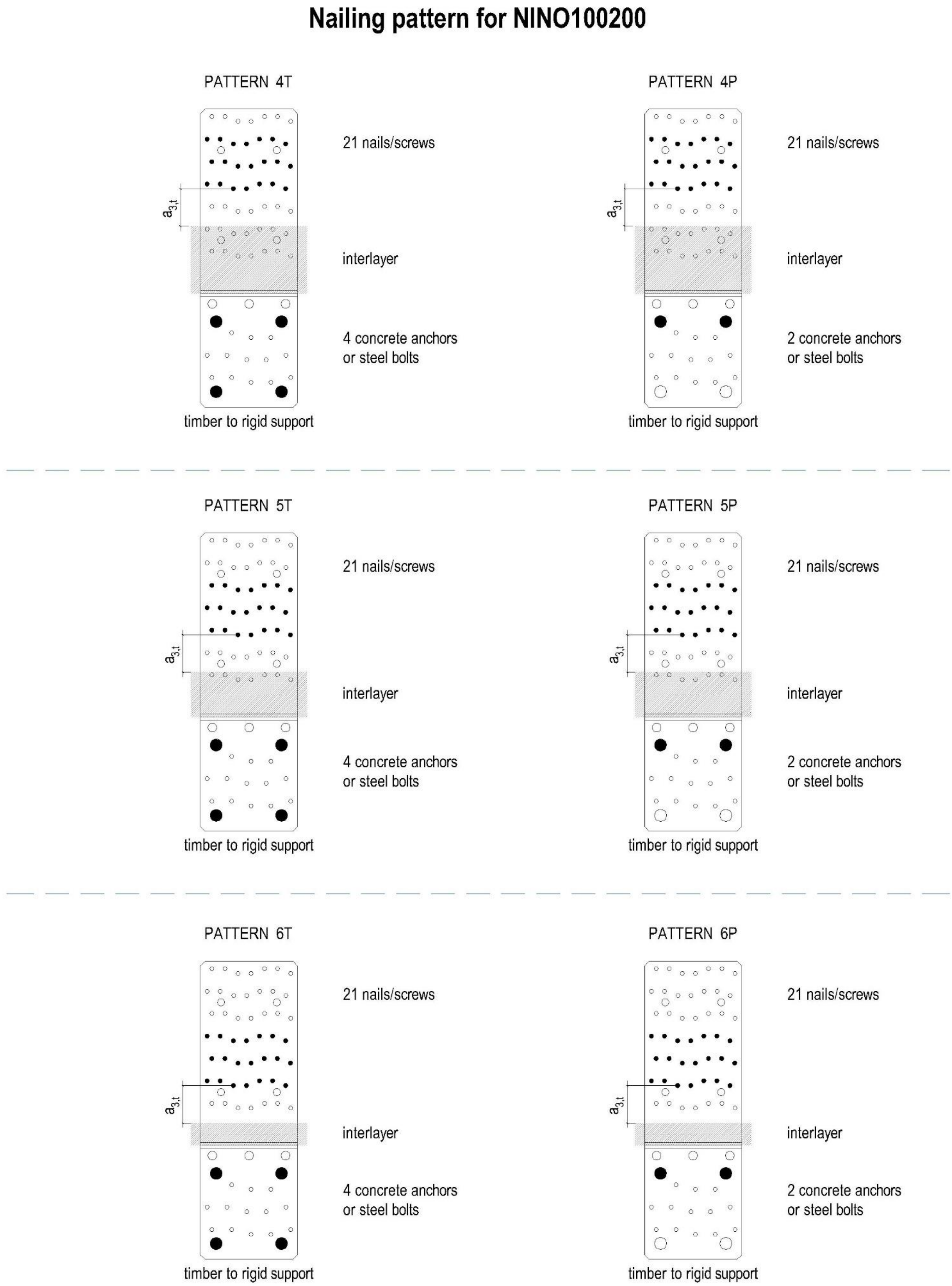


Figure B. 13 Nailing patterns for Angle Bracket NINO 100200

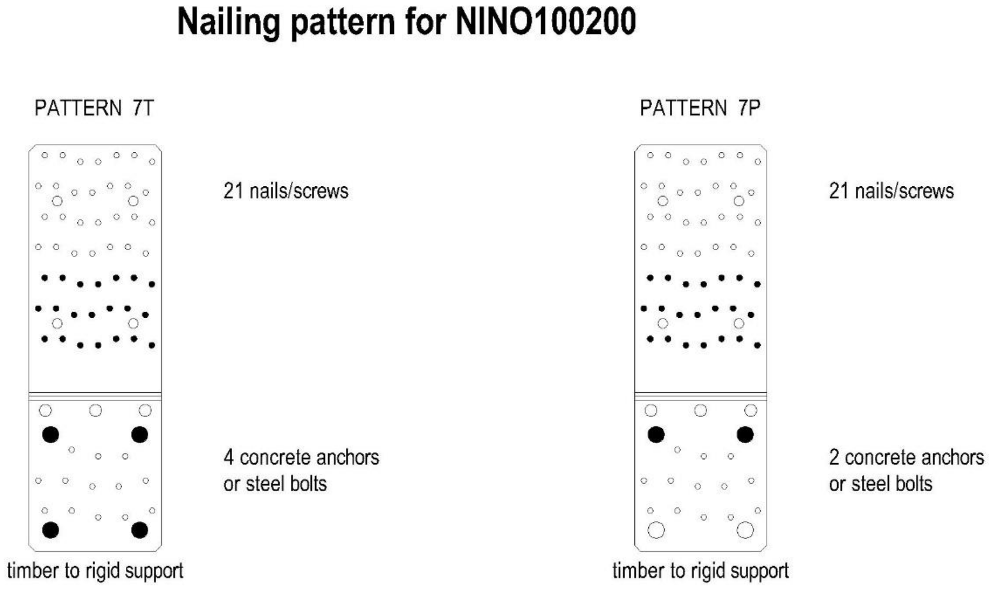


Figure B. 14 Nailing pattern for Angle Bracket NINO 100200

Rotho Blaas Hold-downs

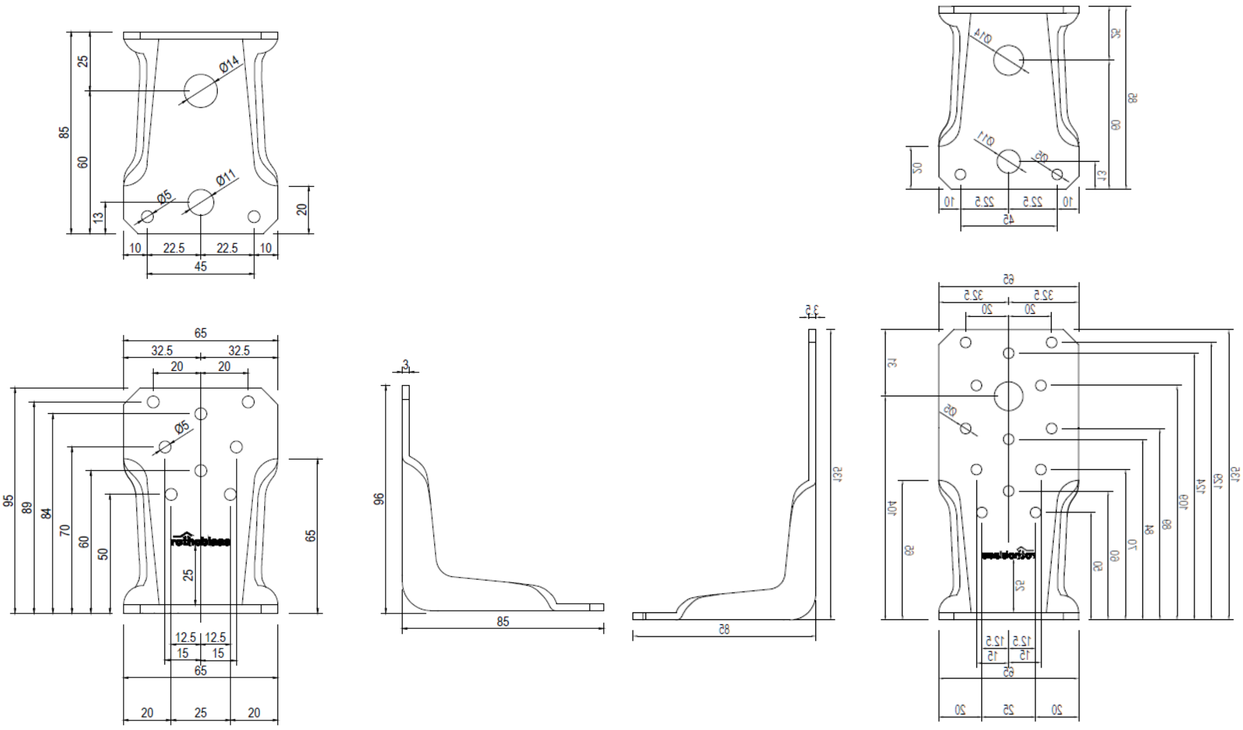


Figure B. 15 Dimensions of Rotho Blaas WKR095 and WKR135 hold-downs

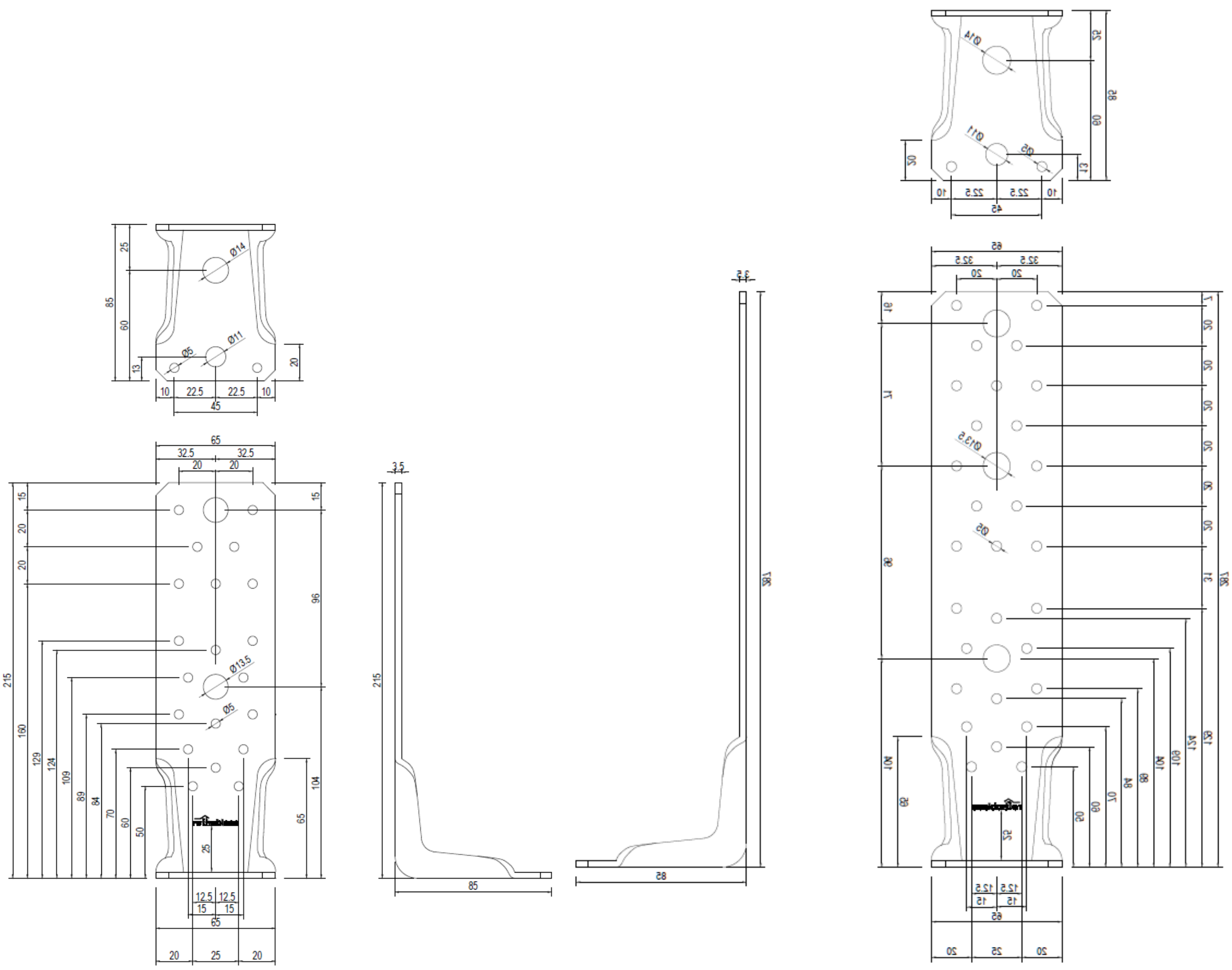


Figure B. 16 Dimensions of Rotho Blaas WKR215 and WKR285 hold-downs

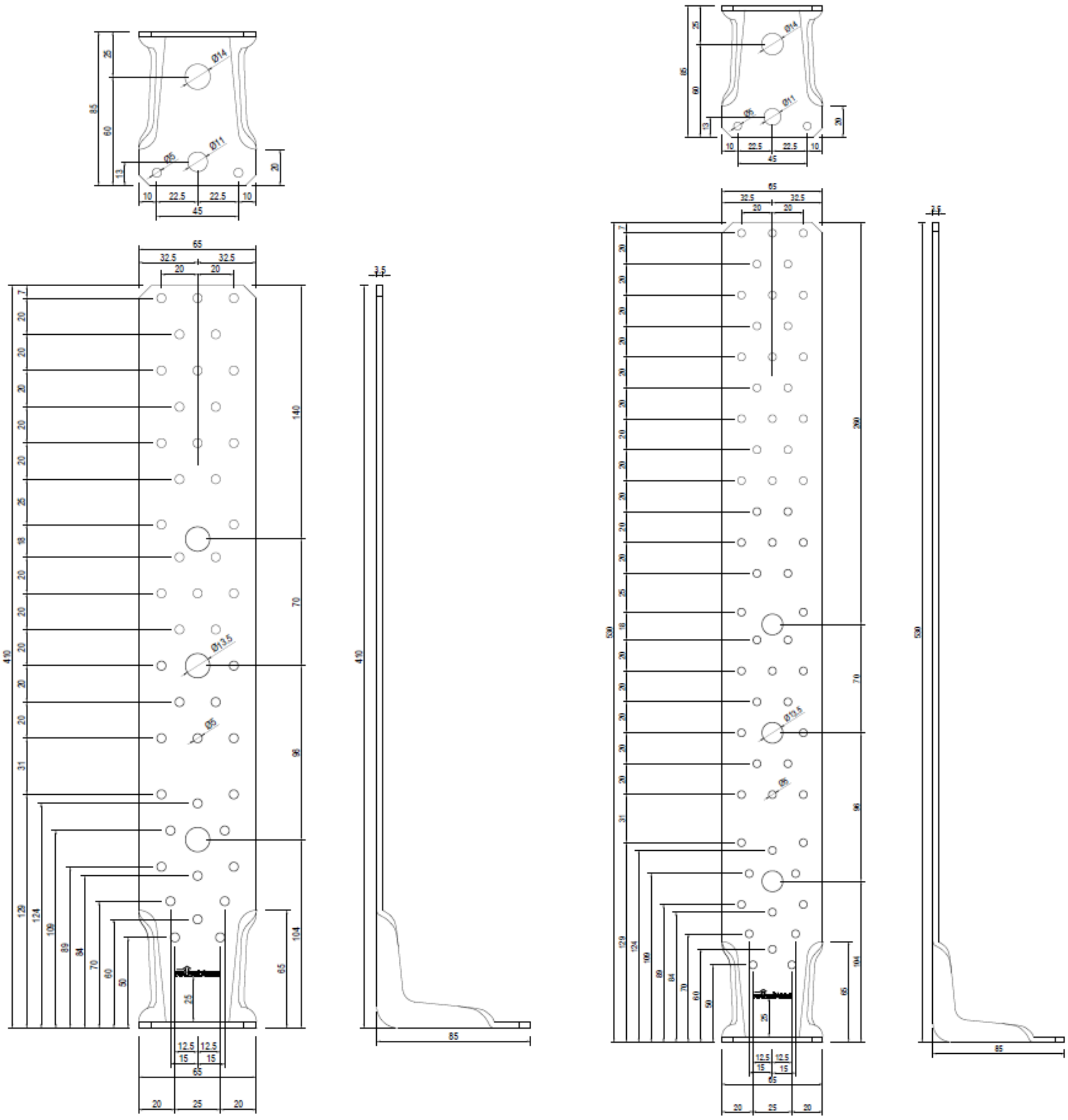


Figure B. 17 Dimensions of Rotho Blaas WKR410 and WKR530 hold-downs

Figure B. 18 Typical installation WKR135

Figure B. 19 Typical installation WKR285

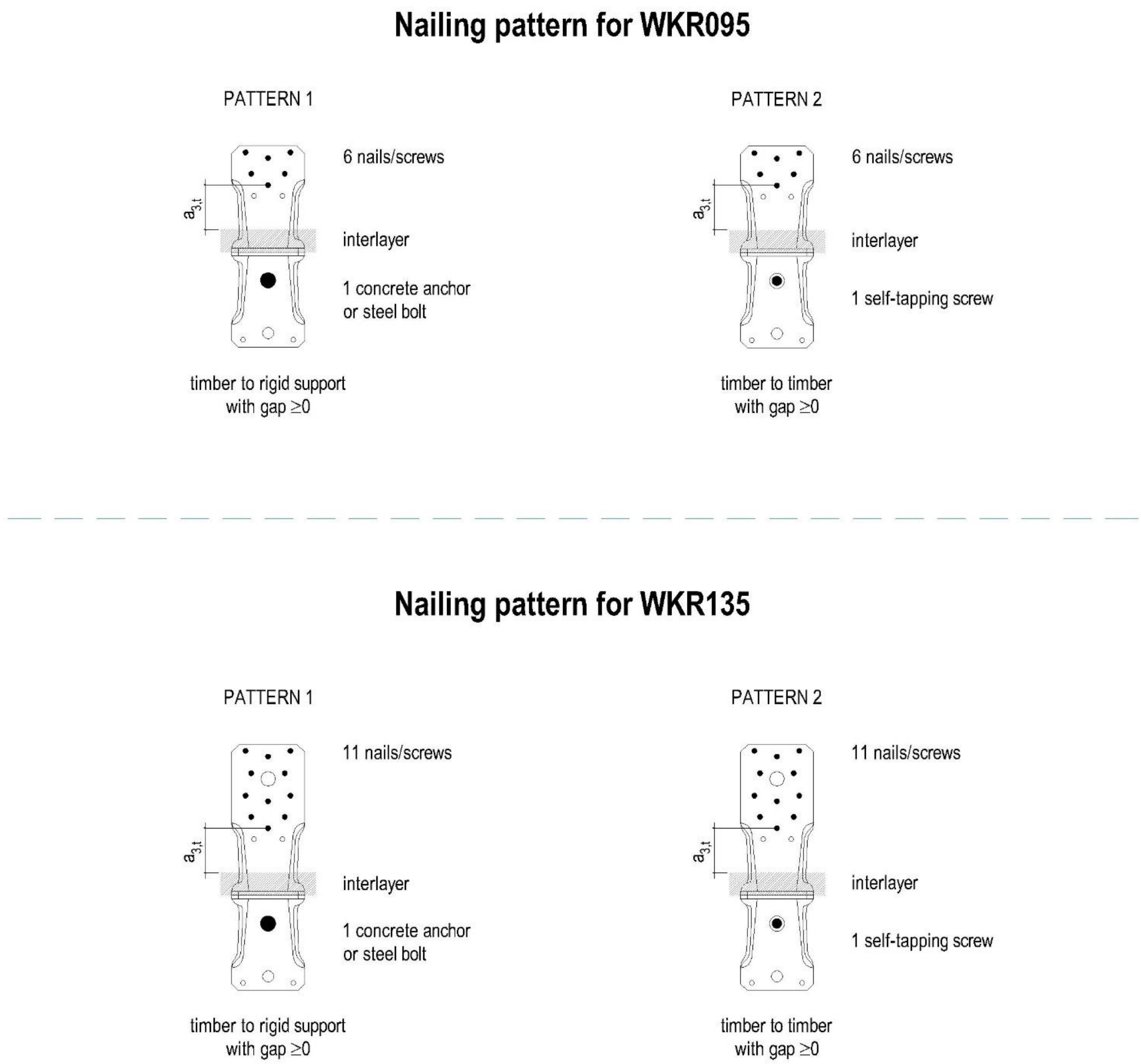


Figure B. 20 Nailing patterns for WKR095 and WKR135

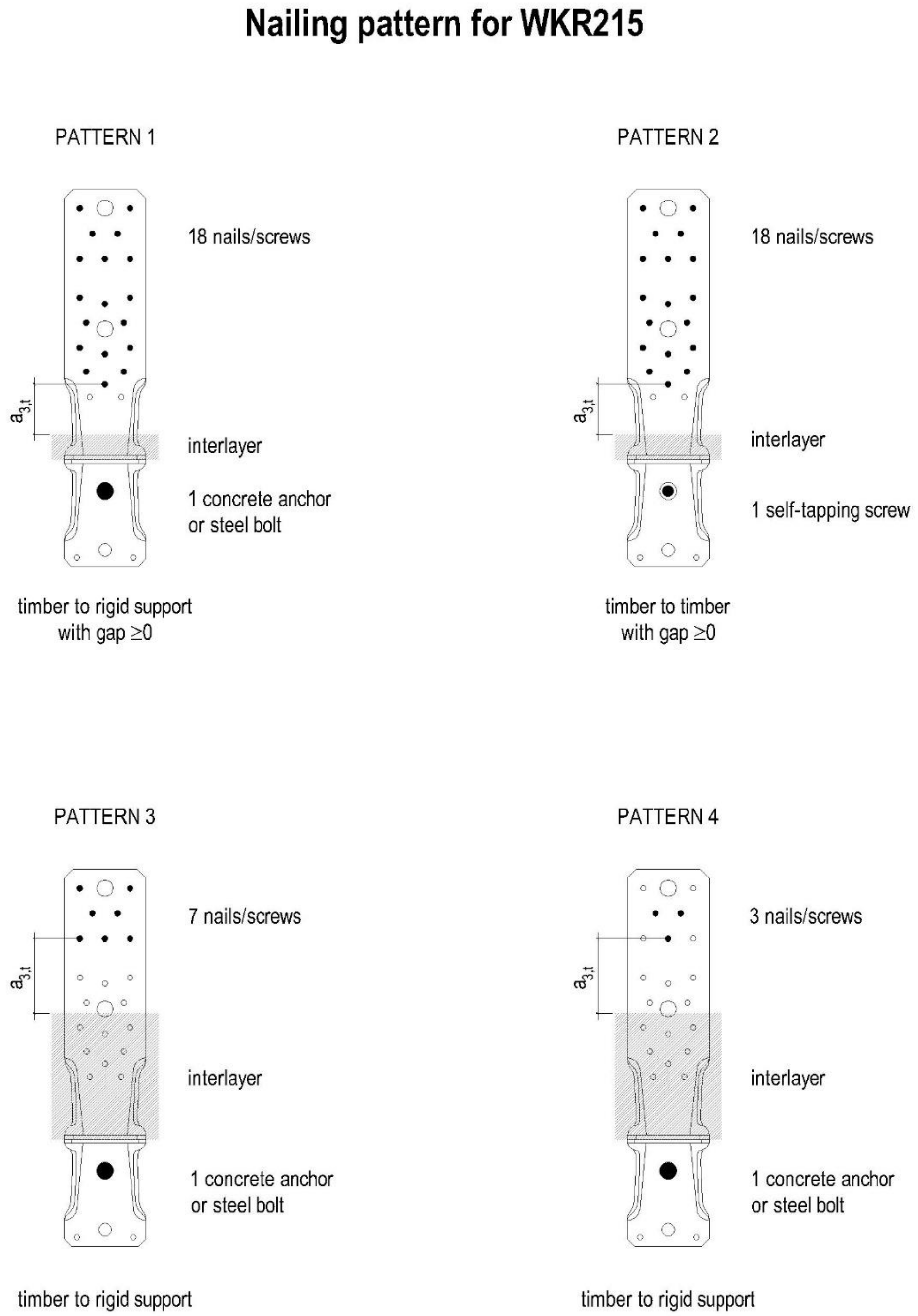


Figure B. 21 Nailing patterns for WKR215

Nailing pattern for WKR285

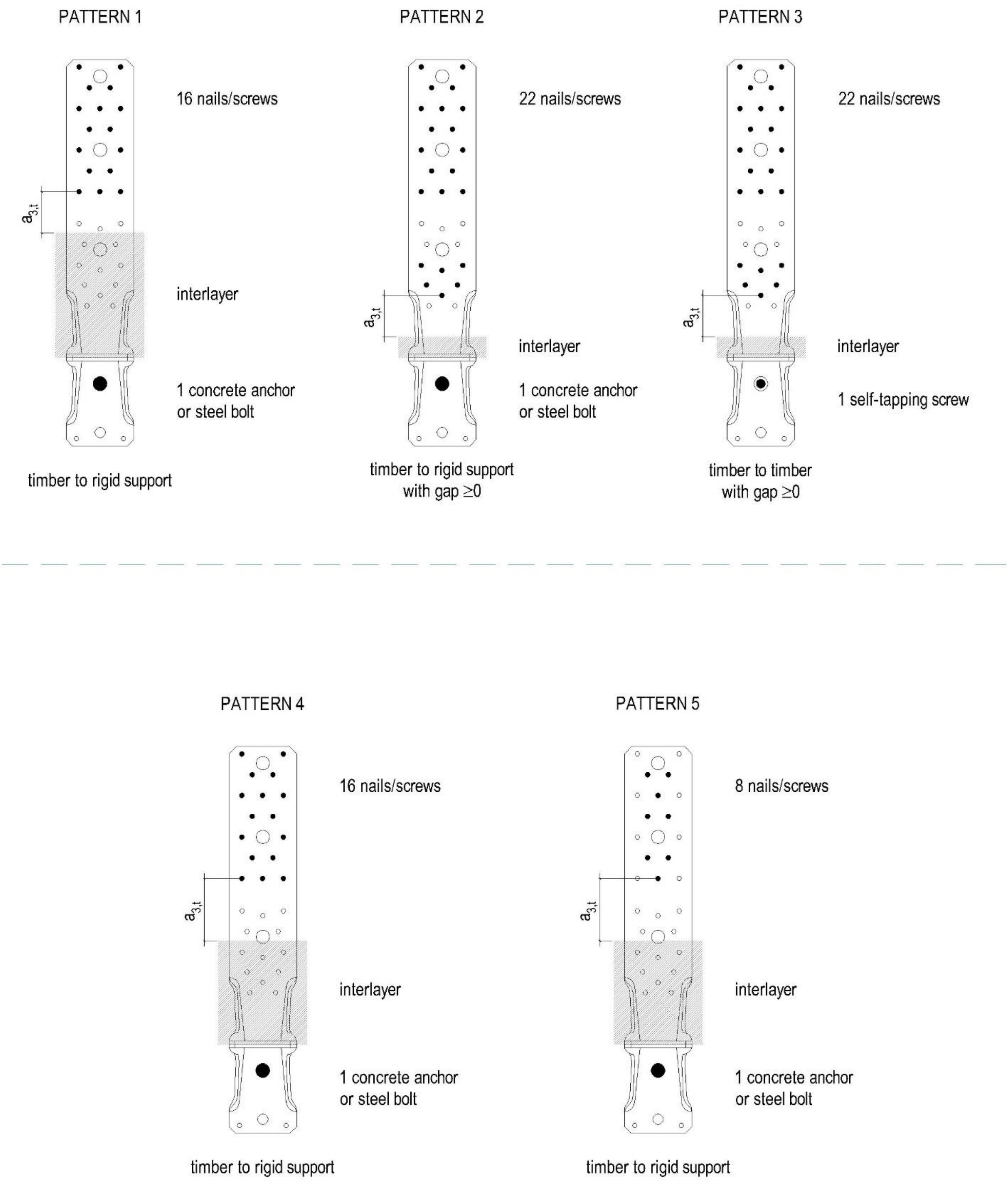


Figure B. 22 Nailing patterns for WKR285

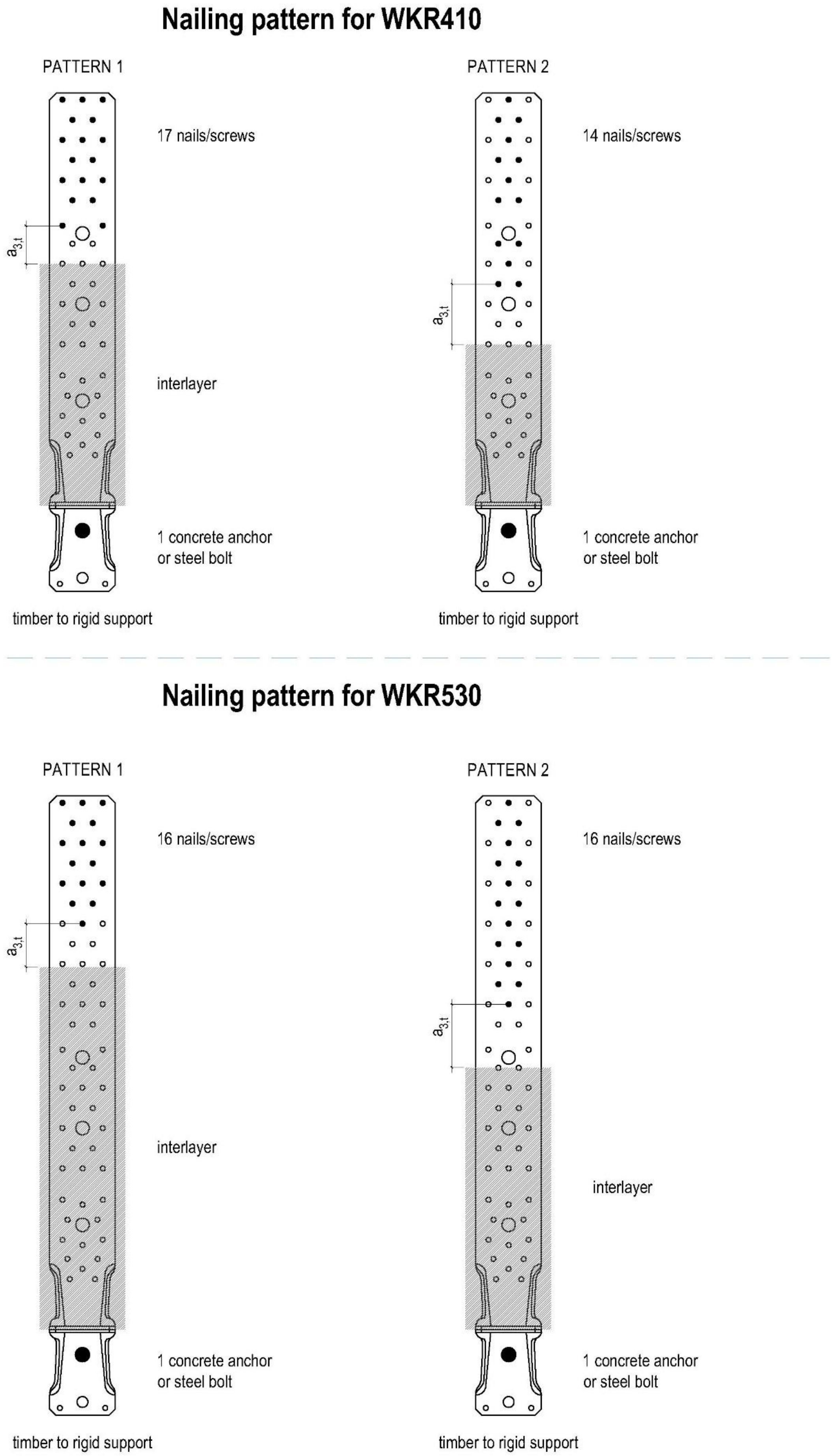


Figure B. 23 Nailing patterns for WKR410 and WKR 530