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to Article 29 of the Regulation (EU)  
No 305/2011 of the European Par-  
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MEMBER OF EOTA



## European Technical Assessment ETA-22/0089 of 2026/01/28

### 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, WKR and WKRD 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 SRL  
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**Manufacturing plant:**

ROTHO BLAAS SRL  
Held on file by ETA-Danmark AS

**This European Technical Assessment contains:**

57 pages including 2 annexes which form an integral part of the document

**This European Technical Assessment is issued in accordance with Article 95(4) of Regulation (EU) 2024/3110, on the basis of:**

EAD 130186-00-0603 for Three-dimensional nailing plates

**This version replaces:**

The ETA with the same number issued on 2024/12/13

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## II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

### 1 Technical description of the product

Rotho Blaas NINO angle brackets and WKR 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. Rotho Blaas WKRD hold downs are two-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 ringed shank nails according to EN 14592 or screws type LBS or HBSPL 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 4,0 mm are made from the following material:

- steel S235 / Z 275 or FeZn12c according to EN 10025:2005 with  $R_e \geq 235 \text{ N/mm}^2$ ,  $R_m \leq 510 \text{ N/mm}^2$  and  $A_{80} \geq 26\%$
- steel S355 / Z 275 or FeZn12c according to EN 10025:2005 with  $R_e \geq 355 \text{ N/mm}^2$ ,  $R_m \leq 630 \text{ N/mm}^2$  and  $A_{80} \geq 22\%$
- steel S275 / Z 275 or FeZn12c according to EN 10025:2005 with  $R_e \geq 275 \text{ N/mm}^2$ ,  $R_m \leq 560 \text{ N/mm}^2$  and  $A_{80} \geq 23\%$
- steel DX51D / Z 275 or FeZn12c according to EN 10346:2015 with  $R_e \geq 235 \text{ N/mm}^2$ ,  $R_m \leq 500 \text{ N/mm}^2$  and  $A_{80} \geq 22\%$
- steel S250GD / Z 275 according to EN 10346:2015 with  $R_e \geq 250 \text{ N/mm}^2$ ,  $R_m \leq 470 \text{ N/mm}^2$  and  $A_{80} \geq 19\%$
- steel S350GD / Z 275 according to EN 10346:2015 with  $R_e \geq 350 \text{ N/mm}^2$ ,  $R_m \geq 420 \text{ N/mm}^2$  and  $A_{80} \geq 16\%$
- Stainless steel with  $R_e \geq 235 \text{ N/mm}^2$ ,  $R_m \leq 630 \text{ N/mm}^2$  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 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  $290 \text{ kg/m}^3$  to  $420 \text{ kg/m}^3$ . The wood members may be of Laminated Veneer Lumber (LVL) with a characteristic density up to  $500 \text{ kg/m}^3$  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,
- LVL according to EN 14374 or ETA,
- Parallam PSL,
- Intrallam LSL,
- Cross laminated timber according to ETA,
- Plywood according to EN 636 or ETA,
- Engineered wood products with certified load-carrying capacities for connections with dowel-type fasteners.

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

In load case F<sub>1</sub>:

$$k_{\text{dens}} = \left( \frac{\rho_k}{350} \right)^{0,8} \quad \text{for } 290 \text{ kg/m}^3 \leq \rho_k \leq 350 \text{ kg/m}^3$$
$$k_{\text{dens}} = 1 \quad \text{for } \rho_k > 350 \text{ kg/m}^3$$

In load case F<sub>2/3</sub>, F<sub>4</sub> and F<sub>45</sub> for timber materials except LVL:

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

In load case F<sub>2/3</sub>, F<sub>4</sub> and F<sub>45</sub> for LVL:

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

where  $\rho_k$  is the characteristic density of the timber material in kg/m<sup>3</sup>.

If a wood-based panel, GFB 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                                                                                                                                       |
|---------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>3.1 Mechanical resistance and stability*) (BWR1)</b> |                                                                                                                                                                    |
| 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                                                                                                                                                    |
| <b>3.2 Safety in case of fire (BWR2)</b>                |                                                                                                                                                                    |
| Reaction to fire                                        | The angle brackets and hold downs are made from steel classified as <b>Euroclass A1</b> in accordance with EN 13501-1 and Commission Delegated Regulation 2016/364 |
| Resistance to fire                                      | No performance assessed                                                                                                                                            |

\*) 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 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  $\gamma_M$  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 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 and hold downs are produced from:

- steel S235 / Z 275 or FeZn12c treated according to EN 10025:2005 with  $R_e \geq 235 \text{ N/mm}^2$ ,  $R_m \leq 510 \text{ N/mm}^2$  and  $A_{80} \geq 26\%$
- steel S355 / Z 275 or FeZn12c treated according to EN 10025:2005 with  $R_e \geq 355 \text{ N/mm}^2$ ,  $R_m \leq 630 \text{ N/mm}^2$  and  $A_{80} \geq 22\%$
- steel S275 / Z 275 or FeZn12c according to EN 10025:2005 with  $R_e \geq 275 \text{ N/mm}^2$ ,  $R_m \leq 560 \text{ N/mm}^2$  and  $A_{80} \geq 23\%$
- steel DX51D / Z 275 or FeZn12c according to EN 10346:2015 with  $R_e \geq 235 \text{ N/mm}^2$ ,  $R_m \leq 500 \text{ N/mm}^2$  and  $A_{80} \geq 22\%$
- steel S250GD / Z 275 according to EN 10346:2015 with  $R_e \geq 250 \text{ N/mm}^2$ ,  $R_m \leq 470 \text{ N/mm}^2$  and  $A_{80} \geq 19\%$
- steel S350GD / Z 275 according to EN 10346:2015 with  $R_e \geq 350 \text{ N/mm}^2$ ,  $R_m \geq 420 \text{ N/mm}^2$  and  $A_{80} \geq 16\%$
- Stainless steel with  $R_e \geq 235 \text{ N/mm}^2$ ,  $R_m \leq 630 \text{ N/mm}^2$  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 21 - 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 21).

- Edge distance in component 2 timber members for member depth  $\geq 38 \text{ mm}$ :
  - $a_{4,t} \geq 13 \text{ mm}$
  - $a_{4,c} \geq 12,5 \text{ mm}$
- For CLT, minimum nail's end and edge distances are:
  - $a_{3,t} = (7 + 3 \cos \alpha) d$
  - $a_{3,c} = 6 d$
  - $a_{4,t} = (3 + 4 \cos \alpha) d$
  - $a_{4,c} = 3 d$

$\alpha$  is the angle between load and grain direction of the outer layers.
- For CLT, minimum screw's spacing, end and edge distances are:
  - $a_1 = 4 d$
  - $a_2 = 2,5 d$
  - $a_{3,t} = 6 d$
  - $a_{3,c} = 6 d$
  - $a_{4,t} = 6 d$
  - $a_{4,c} = 2,5 d$

$\alpha$  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 21).
- 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**

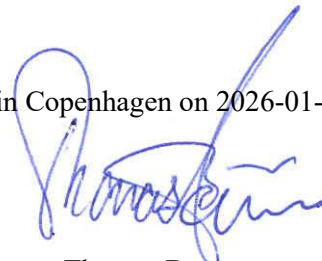
##### **4.1 AVCP system**

According to the decision 97/638/EC of the European Commission<sup>1</sup>, 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 2026-01-28 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       |
| NINO15080S         | 2,5            | S355/S350GD                 | FeZn12c / Z 275       |
| NINO100200         | 3,0            | S235/S355/S275/DX51D/S250GD | FeZn12c / Z 275       |
| WKR9530            | 3,0            | S235/S355/S275/DX51D/S250GD | FeZn12c / Z 275       |
| WKR13535           | 3,5            | S235/S355/S275/DX51D/S250GD | FeZn12c / Z 275       |
| WKR21535           | 3,5            | S235/S355/S275/DX51D/S250GD | FeZn12c / Z 275       |
| WKR28535           | 3,5            | S235/S355/S275/DX51D/S250GD | FeZn12c / Z 275       |
| WKR41035           | 3,5            | S235/S355/S275/DX51D/S250GD | FeZn12c / Z 275       |
| WKR53035           | 3,5            | S235/S355/S275/DX51D/S250GD | FeZn12c / Z 275       |
| WKR100C            | 4,0            | S355/S350GD                 | FeZn12c / Z 275       |
| WKR40              | 2,0            | S355/S350GD                 | FeZn12c / Z 275       |
| WKR60              | 2,5            | S355/S350GD                 | FeZn12c / Z 275       |
| WKR 60L/WKR60R     | 2,0            | S355/S350GD                 | FeZn12c / Z 275       |
| WKR60T             | 2,5            | S355/S350GD                 | FeZn12c / Z 275       |
| Washer NINOW15080  | 6,0            | S235/S355/S275              | -                     |
| Washer NINOW100200 | 8,0            | S235/S355/S275              | -                     |
| Washer WKRDW6020   | 20,0           | S235/S355/S275              | FeZn12c / Z 275       |

Note: Steel with equivalent or superior mechanical properties may also be used

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)<br>vertical |     | Height (mm)<br>horizontal |     | Width (mm) |     |
|--------------------|-------------------------|-----|---------------------------|-----|------------|-----|
| NINO100100         | 99                      | 101 | 77                        | 79  | 103        | 105 |
| NINO15080          | 76                      | 78  | 54                        | 56  | 145        | 147 |
| NINO15080S         | 93                      | 95  | 54                        | 56  | 155        | 157 |
| NINO100200         | 196                     | 198 | 121                       | 123 | 103        | 105 |
| WKR9530            | 94                      | 96  | 84                        | 86  | 64         | 66  |
| WKR13535           | 134                     | 136 | 84                        | 86  | 64         | 66  |
| WKR21535           | 214                     | 216 | 84                        | 86  | 64         | 66  |
| WKR28535           | 284                     | 286 | 84                        | 86  | 64         | 66  |
| WKR41035           | 409                     | 411 | 84                        | 86  | 64         | 66  |
| WKR53035           | 529                     | 531 | 84                        | 86  | 64         | 66  |
| WKR100C            | 99                      | 201 | 254                       | 256 | 67         | 69  |
| WKR40              | 274                     | 276 | -                         | -   | 39         | 41  |
| WKR60              | 304                     | 306 | -                         | -   | 59         | 61  |
| WKR 60L/WKR60R     | 402                     | 404 | 61                        | 63  | 54         | 56  |
| WKR60T             | 409                     | 411 | -                         | -   | 59         | 61  |
| Washer NINOW15080  | -                       | -   | 49                        | 51  | 145        | 147 |
| Washer NINOW100200 | -                       | -   | 119                       | 121 | 103        | 105 |
| Washer WKRDW6020   | -                       | -   | 239                       | 241 | 53         | 55  |



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 WKRD screw 6.3 mm                      | 25 mm          | 20 mm                   | Self-drilling screws according to ETA        |
| Rotho Blaas screw 8.0 mm, type HBSPL               | 100 mm         | 75 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:

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

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

where:

$n_{ef}$  Effective number of fasteners

$f_{ax,k}$  Characteristic value of the withdrawal parameter in N/mm<sup>2</sup>

$d$  Nail or screw diameter in mm

$t_{pen}$  Penetration depth of the ringed shank including the nail tip in mm

$\rho_k$  Characteristic density of the timber in kg/m<sup>3</sup>

$\rho_a$  Characteristic density of the timber in kg/m<sup>3</sup> according to  $f_{ax,k}$

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

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

| <b>Metal Anchors diameter</b> | <b>Correspondent Hole diameter</b>        | <b>Anchors type</b>                   |
|-------------------------------|-------------------------------------------|---------------------------------------|
| 12.0 mm                       | Max. 2 mm larger than the anchor diameter | See specification of the manufacturer |
| 16.0 mm                       | Max. 2 mm larger than the bolt diameter   | See specification of the manufacturer |
| 20.0 mm                       | Max. 2 mm larger than the bolt 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 $\rho_k = 350 \text{ kg/m}^3$ |                              |                             |
|-------------------------|------------------|-----------------------------------------------------------|------------------------------|-----------------------------|
|                         |                  | $F_{1,Rk} \text{ [kN]}$                                   |                              | $K_{1,ser} \text{ [kN/mm]}$ |
|                         |                  | LBA nails 4x60 <sup>c</sup>                               | LBS screws 5x50 <sup>d</sup> |                             |
| NINO100100 <sup>a</sup> | 1                | 20,0                                                      | 20,0                         | $F_{1,Rk}/6$                |
| NINO100100              | 2                | 5,9                                                       | 6,8                          | $F_{1,Rk}/2$                |
| NINO15080 <sup>a</sup>  | 1                | 37,2/39,5 <sup>b</sup>                                    | 37,2/39,5 <sup>b</sup>       | $F_{1,Rk}/6$                |
| NINO15080               | 2                | 4,0                                                       | 6,0                          | $F_{1,Rk}/2$                |
| NINO15080               | 3                | 4,0                                                       | 6,0                          | $F_{1,Rk}/2$                |
| NINO15080               | 4                | 4,0                                                       | 6,0                          | $F_{1,Rk}/2$                |
| NINO15080               | 5                | 4,0                                                       | 6,0                          | $F_{1,Rk}/2$                |
| NINO100200 <sup>a</sup> | 1                | 41,2                                                      | 41,2                         | $F_{1,Rk}/5$                |

<sup>a</sup> Load-carrying capacity is based on VGS screws  $\varnothing 9 \times L$  and  $L \geq 140 \text{ mm}$ . For  $L < 140 \text{ mm}$ ,  $F_{1,Rk}$  is reduced with the ratio  $L/140$ .

<sup>b</sup> The first value relates to connection with soundproofing interlayer, the second without.

<sup>c</sup> 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  $\min\{F_{v,EN14592,Rk}/F_{v,LBA,Rk} ; F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}\}$

<sup>d</sup> For LBS screws with shorter length,  $F_{1,Rk}$  must be reduced by  $\min\{F_{v,short,Rk}/F_{v,50,Rk} ; F_{ax,short,Rk}/F_{ax,50,Rk}\}$   
Note: the most severe applicable reduction of a, c or d applies.

**Table B.2:** Force  $F_1$ , 1 angle bracket / connection timber to timber

| NINO Angle bracket | Fastener pattern | Timber-to-timber connection $\rho_k = 350 \text{ kg/m}^3$ |                             |
|--------------------|------------------|-----------------------------------------------------------|-----------------------------|
|                    |                  | $F_{1,Rk} \text{ [kN]}$                                   | $K_{1,ser} \text{ [kN/mm]}$ |
|                    |                  | HBSPL screws 8x100 or 8xL where $L > 100 \text{ mm}$      |                             |
| NINO15080S         | 1                | 49,9                                                      | $F_{1,Rk}/5$                |
| NINO15080S         | 2                | 32,0                                                      | $F_{1,Rk}/5$                |

Note: Values apply to installation with or without 6 mm Xylofon

**Table B.3:** Force  $F_1$ , 1 angle bracket / connection timber to rigid support

| NINO Angle bracket | Fastener pattern | Timber-to-concrete connection without washer $\rho_k = 350 \text{ kg/m}^3$ |         |                             |
|--------------------|------------------|----------------------------------------------------------------------------|---------|-----------------------------|
|                    |                  | $F_{1,Rk} \text{ [kN]}$                                                    | Bolts   | $K_{1,ser} \text{ [kN/mm]}$ |
|                    |                  | HBSPL screws 8x100 or 8xL where $L > 100 \text{ mm}$                       | $k_t//$ |                             |
| NINO15080S         | 3                | 22,9                                                                       | 1,36    | $F_{1,Rk}/5$                |
| NINO15080S         | 4                | 18,4                                                                       | 1,36    | $F_{1,Rk}/5$                |

Note: Values apply to installation with timber, glulam or CLT

**Table B.4:** Force  $F_{1,Rk}$ , 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 $\rho_k = 350 \text{ kg/m}^3$ |                              |                           |                             |                             |                              |                           |                             |
|--------------------|------------------|------------------------------------------------------------------|------------------------------|---------------------------|-----------------------------|-----------------------------|------------------------------|---------------------------|-----------------------------|
|                    |                  | $F_{1,Rk} \text{ [kN]}$                                          |                              |                           |                             | $F_{1,Rk} \text{ [kN]}$     |                              |                           |                             |
|                    |                  | without washer                                                   |                              |                           |                             | with NW washer              |                              |                           |                             |
|                    |                  | LBA nails 4x60 <sup>a</sup>                                      | LBS screws 5x50 <sup>b</sup> | Bolts inner row $k_{t//}$ | $K_{1,ser} \text{ [kN/mm]}$ | LBA nails 4x60 <sup>a</sup> | LBS screws 5x50 <sup>b</sup> | Bolts inner row $k_{t//}$ | $K_{1,ser} \text{ [kN/mm]}$ |
| NINO100100         | 6                | 14,0                                                             | 14,0                         | 1,21                      | $F_{1,Rk}/18$               | -                           | -                            | -                         | -                           |
| NINO100100         | 7                | 14,0                                                             | 14,0                         | 1,21                      | $F_{1,Rk}/18$               | -                           | -                            | -                         | -                           |
| NINO15080          | 6                | 14,7                                                             | 14,7                         | 1,38                      | $F_{1,Rk}/16$               | 24,9                        | 20,9                         | 1,75                      | $F_{1,Rk}/8$                |
| NINO15080          | 7                | 14,7                                                             | 14,7                         | 1,38                      | $F_{1,Rk}/16$               | 24,9                        | 24,9                         | 1,75                      | $F_{1,Rk}/8$                |
| NINO15080          | 8                | 14,7                                                             | 14,7                         | 1,38                      | $F_{1,Rk}/16$               | 24,9                        | 22,5                         | 1,75                      | $F_{1,Rk}/8$                |
| NINO15080          | 9                | 14,7                                                             | 14,7                         | 1,38                      | $F_{1,Rk}/16$               | 24,9                        | 22,5                         | 1,75                      | $F_{1,Rk}/8$                |
| NINO15080          | 10               | 13,3                                                             | 11,3                         | 1,38                      | $F_{1,Rk}/16$               | 13,3                        | 11,3                         | 1,75                      | $F_{1,Rk}/8$                |
| NINO15080          | 11               | 13,3                                                             | 11,3                         | 1,38                      | $F_{1,Rk}/16$               | 13,3                        | 11,3                         | 1,75                      | $F_{1,Rk}/8$                |
| NINO100200         | 2T/2P            | 14,7                                                             | 14,7                         | 1,11                      | $F_{1,Rk}/16$               | 34,7                        | 29,3                         | 1,23                      | $F_{1,Rk}/8$                |
| NINO100200         | 3T/3P            | 14,7                                                             | 14,7                         | 1,11                      | $F_{1,Rk}/16$               | 34,7                        | 34,7                         | 1,23                      | $F_{1,Rk}/8$                |
| NINO100200         | 4T/4P            | 14,7                                                             | 14,7                         | 1,11                      | $F_{1,Rk}/16$               | 34,7                        | 34,7                         | 1,23                      | $F_{1,Rk}/8$                |
| NINO100200         | 5T/5P            | 14,7                                                             | 14,7                         | 1,11                      | $F_{1,Rk}/16$               | 34,7                        | 34,7                         | 1,23                      | $F_{1,Rk}/8$                |
| NINO100200         | 6T/6P            | 14,7                                                             | 14,7                         | 1,11                      | $F_{1,Rk}/16$               | 34,7                        | 34,7                         | 1,23                      | $F_{1,Rk}/8$                |
| NINO100200         | 7T/7P            | 14,7                                                             | 14,7                         | 1,11                      | $F_{1,Rk}/16$               | 34,7                        | 34,7                         | 1,23                      | $F_{1,Rk}/8$                |

<sup>a</sup> 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  $\min\{F_{v,EN14592,Rk}/F_{v,LBA,Rk} ; F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}\}$   
<sup>b</sup> 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.5:** Force  $F_{2/3}$ , 1 angle bracket / connection timber to timber

| NINO Angle bracket | Fastener pattern | Timber-to-timber connection $\rho_k = 350 \text{ kg/m}^3$ |                               |
|--------------------|------------------|-----------------------------------------------------------|-------------------------------|
|                    |                  | $F_{2/3,Rk} \text{ [kN]}$                                 | $K_{2/3,ser} \text{ [kN/mm]}$ |
|                    |                  | HBSPL screws 8x100 or 8xL where $L > 100 \text{ mm}$      |                               |
| NINO15080S         | 1                | 35,0                                                      | $F_{2/3,Rk}/5$                |
| NINO15080S         | 2                | 25,8                                                      | $F_{2/3,Rk}/5$                |

Note: Values apply to installation with or without 6 mm Xylofon

**Table B.6:** Force  $F_{2/3}$ , 1 angle bracket / connection timber to rigid support

| NINO Angle bracket | Fastener pattern | Timber-to-concrete connection without washer $\rho_k = 350 \text{ kg/m}^3$ |                               |
|--------------------|------------------|----------------------------------------------------------------------------|-------------------------------|
|                    |                  | $F_{2/3,Rk} \text{ [kN]}$                                                  | $K_{2/3,ser} \text{ [kN/mm]}$ |
|                    |                  | HBSPL screws 8x100 or 8xL where $L > 100 \text{ mm}$                       |                               |
| NINO15080S         | 3                | 41,3                                                                       | $F_{2/3,Rk}/5$                |
| NINO15080S         | 4                | 22,6                                                                       | $F_{2/3,Rk}/5$                |

Shear loads per bolt or metal anchor, see Figure below ( $e_z = 0$ ):

- In x-direction:  $\pm 0,5 \cdot F_{2/3,Ed}$ ,
- In y-direction:  $\pm 0,29 \cdot F_{2/3,Ed}$ .

Note: Values apply to installation with timber, glulam or CLT

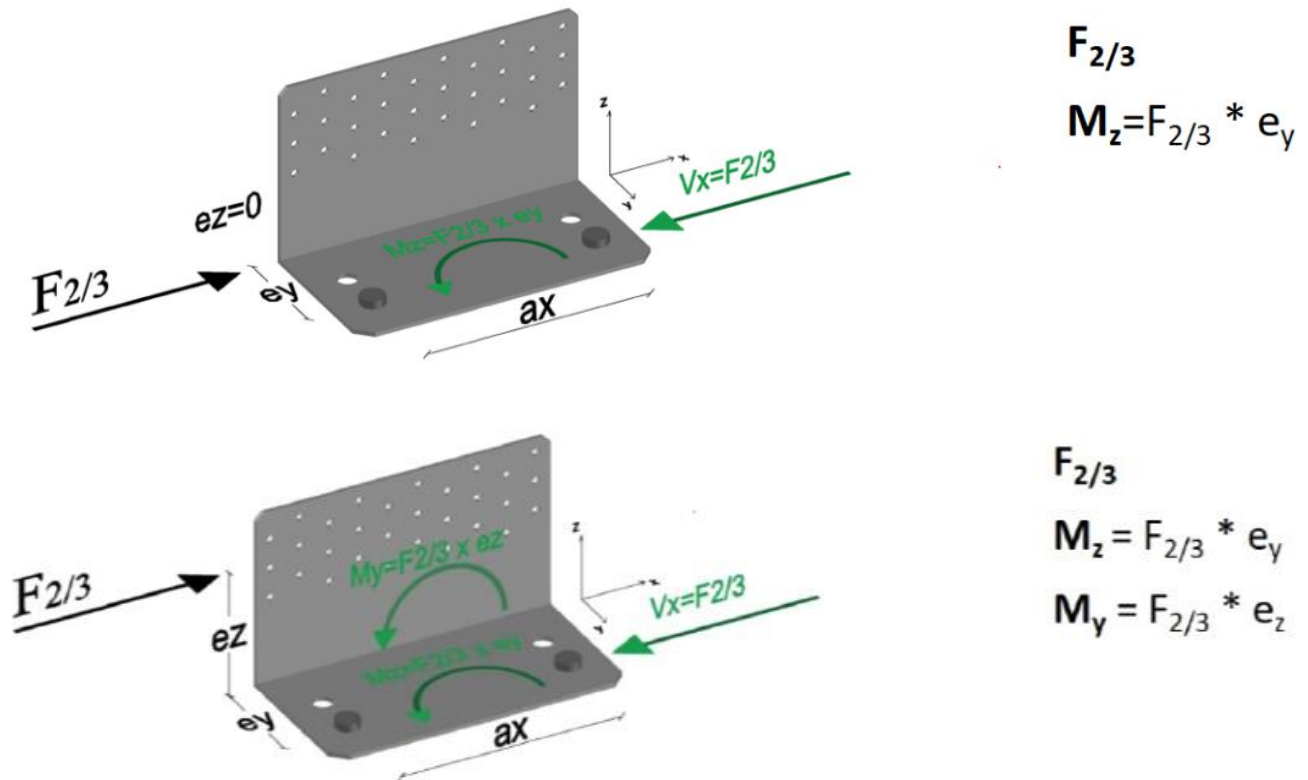
**Table B.7:** Force  $F_{2/3}$ , 1 angle bracket / connection timber to timber

| NINO<br>Angle<br>bracket                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Fastener<br>pattern | F <sub>2/3,Rk</sub> [kN] for timber-to-timber connection ρ <sub>k</sub> = 350 kg/m³ |                                  |                              |                                  |                                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-------------------------------------------------------------------------------------|----------------------------------|------------------------------|----------------------------------|---------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                     | LBA nails 4x60 <sup>a</sup>                                                         |                                  | LBS screws 5x50 <sup>b</sup> |                                  | K <sub>2/3,ser</sub><br>[kN/mm] |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                     | No inter-<br>layer                                                                  | 6 mm soundproofing<br>interlayer | No inter-<br>layer           | 6 mm soundproofing<br>interlayer |                                 |
| NINO100100 <sup>c</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1                   | 38,1                                                                                | 34,6                             | 18,5                         | 16,9                             | F <sub>2/3,Rk</sub> /5          |
| NINO100100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 2                   | 17,2                                                                                | 9,4                              | 9,5                          | 7,4                              | F <sub>2/3,Rk</sub> /5          |
| NINO100100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 3                   | 9,8                                                                                 | 8,9                              | 9,1                          | 7,4                              | F <sub>2/3,Rk</sub> /5          |
| NINO100100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 4                   | 11,3                                                                                | 9,4                              | 9,5                          | 7,4                              | F <sub>2/3,Rk</sub> /5          |
| NINO100100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 5                   | 9,8                                                                                 | 8,9                              | 9,0                          | 7,4                              | F <sub>2/3,Rk</sub> /5          |
| NINO15080 <sup>c</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1                   | 38,1                                                                                | 34,6                             | 27,6                         | 25,5                             | F <sub>2/3,Rk</sub> /5          |
| NINO15080                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 2                   | 15,5                                                                                | 13,0                             | 13,1                         | 10,2                             | F <sub>2/3,Rk</sub> /5          |
| NINO15080                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 3                   | 13,3                                                                                | 12,3                             | 12,3                         | 10,1                             | F <sub>2/3,Rk</sub> /5          |
| NINO15080                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 4                   | 15,5                                                                                | 13,0                             | 13,1                         | 10,2                             | F <sub>2/3,Rk</sub> /5          |
| NINO15080                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 5                   | 12,7                                                                                | 11,8                             | 11,2                         | 10,0                             | F <sub>2/3,Rk</sub> /5          |
| NINO100200 <sup>c</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1                   | 26,7                                                                                | 18,7                             | 18,7                         | 17,2                             | F <sub>2/3,Rk</sub> /6          |
| <sup>a</sup> For LBA nails with shorter length, F <sub>2/3,Rk</sub> must be reduced by min {F <sub>v,short,Rk</sub> /F <sub>v,60,Rk</sub> ; F <sub>ax,short,Rk</sub> /F <sub>ax,60,Rk</sub> }<br>For ringed shank nails according to EN 14592, F <sub>2/3,Rk</sub> must be reduced by min {F <sub>v,EN14592,Rk</sub> /F <sub>v,LBA,Rk</sub> ;<br>F <sub>ax,EN14592,Rk</sub> /F <sub>ax,LBA,Rk</sub> }<br><sup>b</sup> For LBS screws with shorter length, F <sub>2/3,Rk</sub> must be reduced by min {F <sub>v,short,Rk</sub> /F <sub>v,50,Rk</sub> ; F <sub>ax,short,Rk</sub> /F <sub>ax,50,Rk</sub> }<br><sup>c</sup> Load-carrying capacity is based on VGS screws Ø 9xL and L ≥ 140 mm. For L < 140 mm, F <sub>2/3,Rk</sub> is reduced<br>with the ratio L/140.<br>Note: the most severe applicable reduction of a, b or c applies. |                     |                                                                                     |                                  |                              |                                  |                                 |

**Table B.8:** 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 $\rho_k = 350 \text{ kg/m}^3$ |                         |                              |                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|----------------------------------------------------------------------------------------|-------------------------|------------------------------|---------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                  | LBA nails 4x60 <sup>a</sup>                                                            | $e_z$ <sup>c</sup> [mm] | LBS screws 5x50 <sup>b</sup> | $K_{1,ser}$ [kN/mm] |
| NINO100100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 6                | 18,1                                                                                   | 78,5                    | 7,2                          | $F_{2/3,Rk}/5$      |
| NINO100100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 7                | 18,1                                                                                   | 54,5                    | 9,8                          | $F_{2/3,Rk}/5$      |
| NINO100100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 8                | 5,8                                                                                    | 0                       | 4,9                          | $F_{2/3,Rk}/5$      |
| NINO100100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 9                | 7,8                                                                                    | 0                       | 6,6                          | $F_{2/3,Rk}/5$      |
| NINO100100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 10               | 11,2                                                                                   | 0                       | 9,4                          | $F_{2/3,Rk}/5$      |
| NINO100100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 11               | 9,3                                                                                    | 42,5                    | 4,2                          | $F_{2/3,Rk}/2$      |
| NINO100100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 12               | 9,3                                                                                    | 22,5                    | 6,3                          | $F_{2/3,Rk}/2$      |
| NINO15080                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 6                | 26,7 with / 21,1 without washer                                                        | 66,5                    | 7,9                          | $F_{2/3,Rk}/4$      |
| NINO15080                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 7                | 21,3                                                                                   | 0                       | 17,9                         | $F_{2/3,Rk}/4$      |
| NINO15080                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 8                | 11,0                                                                                   | 0                       | 9,3                          | $F_{2/3,Rk}/4$      |
| NINO15080                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 9                | 15,7                                                                                   | 0                       | 13,2                         | $F_{2/3,Rk}/4$      |
| NINO15080                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 10               | 9,3                                                                                    | 0                       | 6,0                          | $F_{2/3,Rk}/4$      |
| NINO15080                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 11               | 10,0                                                                                   | 0                       | 8,5                          | $F_{2/3,Rk}/4$      |
| NINO100200                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2T/2P            | 11,6 with / 8,3 without washer                                                         | 174,5                   | 3,5                          | $F_{2/3,Rk}/3$      |
| NINO100200                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 3T/3P            | 10,7                                                                                   | 162,5                   | 6,0                          | $F_{2/3,Rk}/3$      |
| NINO100200                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 4T/4P            | 10,7                                                                                   | 138,5                   | 7,0                          | $F_{2/3,Rk}/3$      |
| NINO100200                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 5T/5P            | 16,9                                                                                   | 114,5                   | 8,3                          | $F_{2/3,Rk}/3$      |
| NINO100200                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 6T/6P            | 16,9                                                                                   | 90,5                    | 10,1                         | $F_{2/3,Rk}/3$      |
| NINO100200                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 7T/7P            | 16,9                                                                                   | 66,5                    | 13,2                         | $F_{2/3,Rk}/3$      |
| Shear loads per bolt or metal anchor, see Figure below: <ul style="list-style-type: none"> <li>In x-direction: <math>\pm 0,5 \cdot F_{2/3,Ed}</math> for NINO100100, NINO15080 and the inner bolt row of NINO100200, <math>\pm 0,01 \cdot F_{2/3,Ed}</math> for the outer bolt row of NINO100200</li> <li>In y-direction: <math>\pm 0,43 \cdot F_{2/3,Ed}</math> for NINO100100 or NINO100200 with two bolts close to the bend line, <math>\pm 0,25 \cdot F_{2/3,Ed}</math> for NINO15080 and the inner bolt row of NINO100200 with four bolts.</li> </ul> <sup>a</sup> For LBA nails with shorter length, $F_{2/3,Rk}$ must be reduced by $\min\{F_{v,short,Rk}/F_{v,60,Rk} ; F_{ax,short,Rk}/F_{ax,60,Rk}\}$<br>For ringed shank nails according to EN 14592, $F_{2/3,Rk}$ must be reduced by $\min\{F_{v,EN14592,Rk}/F_{v,LBA,Rk} ; F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}\}$<br><sup>b</sup> For LBS screws with shorter length, $F_{2/3,Rk}$ must be reduced by $\min\{F_{v,short,Rk}/F_{v,50,Rk} ; F_{ax,short,Rk}/F_{ax,50,Rk}\}$<br><sup>c</sup> For nailed connections, for screwed connections $e_z = 0$ |                  |                                                                                        |                         |                              |                     |

## Explanation for footnotes in Table B.6 and B.8



**Table B.9:** 1 angle bracket for force  $F_4$  and  $F_5$ , and 2 angle brackets for force  $F_{4/5}$  / connection timber to timber with or without soundproofing interlayer

| NINO Angle bracket      | Fastener pattern | Timber-to-timber connection $\rho_k = 350 \text{ kg/m}^3$ |                 |                   |                              |                 |                   |                        |
|-------------------------|------------------|-----------------------------------------------------------|-----------------|-------------------|------------------------------|-----------------|-------------------|------------------------|
|                         |                  | LBA nails 4x60 <sup>a</sup>                               |                 |                   | LBS screws 5x50 <sup>b</sup> |                 |                   | $K_{4,ser}$<br>[kN/mm] |
|                         |                  | $F_{4,Rk}$ [kN]                                           | $F_{5,Rk}$ [kN] | $F_{4/5,Rk}$ [kN] | $F_{4,Rk}$ [kN]              | $F_{5,Rk}$ [kN] | $F_{4/5,Rk}$ [kN] |                        |
| NINO100100 <sup>c</sup> | 1                | 23,2                                                      | 1,8             | 25,0              | 22,0                         | 1,8             | 23,8              | $F_{4,Rk}/1,5$         |
| NINO100100              | 2                | 23,2                                                      | 1,8             | 25,0              | 22,0                         | 1,8             | 23,8              | $F_{4,Rk}/1,5$         |
| NINO100100              | 3                | 7,4                                                       | 1,8             | 9,2               | 7,4                          | 1,8             | 9,2               | $F_{4,Rk}/1,5$         |
| NINO100100              | 4                | 23,2                                                      | 3,4             | 26,6              | 22,0                         | 3,4             | 25,4              | $F_{4,Rk}/1,5$         |
| NINO100100              | 5                | 9,2                                                       | 3,4             | 12,6              | 9,2                          | 3,4             | 12,6              | $F_{4,Rk}/6$           |
| NINO15080 <sup>c</sup>  | 1                | 22,3                                                      | 2,5             | 24,8              | 21,6                         | 2,5             | 24,1              | $F_{4,Rk}/1,5$         |
| NINO15080               | 2                | 22,3                                                      | 2,5             | 24,8              | 21,6                         | 2,5             | 24,1              | $F_{4,Rk}/1,5$         |
| NINO15080               | 3                | 10,2                                                      | 2,5             | 12,7              | 10,2                         | 2,5             | 12,7              | $F_{4,Rk}/1,5$         |
| NINO15080               | 4                | 18,7                                                      | 4,8             | 23,5              | 17,7                         | 4,8             | 22,5              | $F_{4,Rk}/1,5$         |
| NINO15080               | 5                | 14,7                                                      | 4,8             | 19,5              | 14,7                         | 4,8             | 19,5              | $F_{4,Rk}/6$           |
| NINO100200 <sup>c</sup> | 1                | 19,1                                                      | 2,6             | 21,7              | 19,1                         | 2,6             | 21,7              | $F_{4,Rk}/1,5$         |

<sup>a</sup> 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  $\min\{F_{v,EN14592,Rk}/F_{v,LBA,Rk}; F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}\}$

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

<sup>c</sup> Load-carrying capacity is based on VGS screws  $\varnothing 9 \times L$  and  $L \geq 100 \text{ mm}$ .

**Table B.10:** 1 angle bracket for force  $F_4$  and  $F_5$ , and 2 angle brackets for force  $F_{4/5}$  / connection timber to timber

| NINO Angle bracket | Fastener pattern | Timber-to-timber connection $\rho_k = 350 \text{ kg/m}^3$ |                 |                   |
|--------------------|------------------|-----------------------------------------------------------|-----------------|-------------------|
|                    |                  | HBSPL screws 8x100 or 8xL where $L > 100 \text{ mm}$      |                 |                   |
|                    |                  | $F_{4,Rk}$ [kN]                                           | $F_{5,Rk}$ [kN] | $F_{4/5,Rk}$ [kN] |
| NINO15080S         | 1                | 18,9                                                      | 2,4             | 21,3              |
| NINO15080S         | 2                | 14,2                                                      | 2,4             | 16,6              |

Note: Values apply to installation with or without 6 mm Xylofon

**Table B.11:** 1 angle bracket for force  $F_4$  and  $F_5$ , and 2 angle brackets for force  $F_{4/5}$  / connection timber to rigid support

| NINO Angle bracket | Fastener pattern | Timber-to-rigid support connection $\rho_k = 350 \text{ kg/m}^3$                                                                                                                    |                         |                           |                              |                         |                           |
|--------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|---------------------------|------------------------------|-------------------------|---------------------------|
|                    |                  | LBA nails 4x60 <sup>a</sup>                                                                                                                                                         |                         |                           | LBS screws 5x50 <sup>b</sup> |                         |                           |
|                    |                  | $F_{4,Rk} \text{ [kN]}$                                                                                                                                                             | $F_{5,Rk} \text{ [kN]}$ | $F_{4/5,Rk} \text{ [kN]}$ | $F_{4,Rk} \text{ [kN]}$      | $F_{5,Rk} \text{ [kN]}$ | $F_{4/5,Rk} \text{ [kN]}$ |
| NINO100100         | 6                | 6,2                                                                                                                                                                                 | 1,1                     | 7,4                       | 6,2                          | 1,1                     | 7,4                       |
| NINO100100         | 7                | 23,2                                                                                                                                                                                | 1,8                     | 25,0                      | 22,0                         | 1,8                     | 23,8                      |
| NINO100100         | 8                | 3,8                                                                                                                                                                                 | 1,1                     | 5,0                       | 3,8                          | 1,1                     | 5,0                       |
| NINO100100         | 9                | 7,4                                                                                                                                                                                 | 1,8                     | 9,2                       | 7,4                          | 1,8                     | 9,2                       |
| NINO100100         | 10               | 14,4                                                                                                                                                                                | 3,4                     | 17,8                      | 13,6                         | 3,4                     | 17,0                      |
| NINO100100         | 11               | 6,3                                                                                                                                                                                 | 1,8                     | 8,1                       | 5,9                          | 1,8                     | 7,7                       |
| NINO100100         | 12               | 9,2                                                                                                                                                                                 | 3,4                     | 12,6                      | 9,2                          | 3,4                     | 12,6                      |
| NINO15080          | 6                | 8,7                                                                                                                                                                                 | 1,6                     | 10,3                      | 8,7                          | 1,6                     | 10,3                      |
| NINO15080          | 7                | 22,3                                                                                                                                                                                | 2,5                     | 24,8                      | 21,6                         | 2,5                     | 24,1                      |
| NINO15080          | 8                | 10,2                                                                                                                                                                                | 2,5                     | 12,7                      | 10,2                         | 2,5                     | 12,7                      |
| NINO15080          | 9                | 18,7                                                                                                                                                                                | 4,8                     | 23,5                      | 17,7                         | 4,8                     | 22,5                      |
| NINO15080          | 10               | 8,4                                                                                                                                                                                 | 2,5                     | 10,9                      | 7,9                          | 2,5                     | 10,4                      |
| NINO15080          | 11               | 11,6                                                                                                                                                                                | 4,8                     | 16,4                      | 11,6                         | 4,8                     | 16,4                      |
| NINO100200         | 2T/2P            | 2,1                                                                                                                                                                                 | 0,7                     | 2,8                       | 2,1                          | 0,7                     | 2,8                       |
| NINO100200         | 3T/3P            | 2,6                                                                                                                                                                                 | 0,8                     | 3,4                       | 2,6                          | 0,8                     | 3,4                       |
| NINO100200         | 4T/4P            | 3,4                                                                                                                                                                                 | 1,0                     | 4,4                       | 3,4                          | 1,0                     | 4,4                       |
| NINO100200         | 5T/5P            | 4,9                                                                                                                                                                                 | 1,2                     | 6,1                       | 4,9                          | 1,2                     | 6,1                       |
| NINO100200         | 6T/6P            | 8,5                                                                                                                                                                                 | 1,7                     | 10,2                      | 8,5                          | 1,7                     | 10,2                      |
| NINO100200         | 7T/7P            | 19,1                                                                                                                                                                                | 2,6                     | 21,7                      | 19,1                         | 2,6                     | 21,7                      |
| <sup>a</sup>       |                  | For LBA nails with shorter length, $F_{4,Rk}$ or $F_{5,Rk}$ or $F_{4/5,Rk}$ must be reduced by $\min\{F_{v,short,Rk}/F_{v,60,Rk} ; F_{ax,short,Rk}/F_{ax,60,Rk}\}$                  |                         |                           |                              |                         |                           |
|                    |                  | For ringed shank nails according to EN 14592, $F_{4,Rk}$ or $F_{5,Rk}$ or $F_{4/5,Rk}$ must be reduced by $\min\{F_{v,EN14592,Rk}/F_{v,LBA,Rk} ; F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}\}$ |                         |                           |                              |                         |                           |
| <sup>b</sup>       |                  | For LBS screws with shorter length, $F_{4,Rk}$ or $F_{5,Rk}$ or $F_{4/5,Rk}$ must be reduced by $\min\{F_{v,short,Rk}/F_{v,50,Rk} ; F_{ax,short,Rk}/F_{ax,50,Rk}\}$                 |                         |                           |                              |                         |                           |

**Table B.12:** 1 angle bracket for force  $F_4$  and  $F_5$ , and 2 angle brackets for force  $F_{4/5}$  / connection timber to rigid support

| NINO Angle bracket | Fastener pattern | Timber-to-concrete connection without washer $\rho_k = 350 \text{ kg/m}^3$ |                         |                           |
|--------------------|------------------|----------------------------------------------------------------------------|-------------------------|---------------------------|
|                    |                  | HBSPL screws 8x100 or 8xL where $L > 100 \text{ mm}$                       |                         |                           |
|                    |                  | $F_{4,Rk} \text{ [kN]}$                                                    | $F_{5,Rk} \text{ [kN]}$ | $F_{4/5,Rk} \text{ [kN]}$ |
| NINO15080S         | 3 CLT            | 18,9                                                                       | 2,3                     | 21,3                      |
| NINO15080S         | 4 CLT            | 14,2                                                                       | 1,4                     | 15,6                      |
| NINO15080S         | 3 glulam         | 17,6                                                                       | 2,4                     | 20,0                      |
| NINO15080S         | 4 glulam         | 13,6                                                                       | 1,4                     | 15,0                      |

**Table B.13:** Force  $F_1$ , 1 hold-down / connection timber to timber or timber to rigid support

| WKR<br>hold down | Fastener<br>pattern | Connections without gap $\rho_k = 350 \text{ kg/m}^3$ <sup>c</sup> |                                                 |       |                               |
|------------------|---------------------|--------------------------------------------------------------------|-------------------------------------------------|-------|-------------------------------|
|                  |                     | $F_{1,\text{no gap,Rk}}$ [kN]                                      |                                                 | $k_t$ | $K_{1,\text{ser}}$<br>[kN/mm] |
|                  |                     | LBA nails 4x60 <sup>a</sup>                                        | LBS screws 5x50 <sup>b</sup>                    |       |                               |
| WKR9530          | 1-2                 | $\text{Min}\{15,0^{1)}; F_{\text{ax,Rk}}/k_t\}$                    | $\text{Min}\{13,3^{1)}; F_{\text{ax,Rk}}/k_t\}$ | 1,05  | $F_{1,\text{Rk}}/4$           |
| WKR13535         | 1-2                 | $\text{Min}\{28,3^{1)}; F_{\text{ax,Rk}}/k_t\}$                    | $\text{Min}\{24,6^{1)}; F_{\text{ax,Rk}}/k_t\}$ | 1,05  | $F_{1,\text{Rk}}/4$           |
| WKR21535         | 4                   | $\text{Min}\{8,0^{1)}; F_{\text{ax,Rk}}/k_t\}$                     | $\text{Min}\{6,8^{1)}; F_{\text{ax,Rk}}/k_t\}$  | 1,45  | $F_{1,\text{Rk}}/4$           |
| WKR21535         | 3                   | $\text{Min}\{18,7^{1)}; F_{\text{ax,Rk}}/k_t\}$                    | $\text{Min}\{15,8^{1)}; F_{\text{ax,Rk}}/k_t\}$ | 1,45  | $F_{1,\text{Rk}}/4$           |
| WKR21535         | 1-2                 | $\text{Min}\{47,0^{1)}; F_{\text{ax,Rk}}/k_t\}$                    | $\text{Min}\{40,3^{1)}; F_{\text{ax,Rk}}/k_t\}$ | 1,10  | $F_{1,\text{Rk}}/4$           |
| WKR28535         | 5                   | $\text{Min}\{21,3^{1)}; F_{\text{ax,Rk}}/k_t\}$                    | $\text{Min}\{18,0^{1)}; F_{\text{ax,Rk}}/k_t\}$ | 1,45  | $F_{1,\text{Rk}}/4$           |
| WKR28535         | 1-4                 | $\text{Min}\{37,3^{1)}; F_{\text{ax,Rk}}/k_t\}$                    | $\text{Min}\{36,0^{1)}; F_{\text{ax,Rk}}/k_t\}$ | 1,45  | $F_{1,\text{Rk}}/4$           |
| WKR28535         | 2-3                 | $\text{Min}\{57,6^{1)}; F_{\text{ax,Rk}}/k_t\}$                    | $\text{Min}\{49,3^{1)}; F_{\text{ax,Rk}}/k_t\}$ | 1,10  | $F_{1,\text{Rk}}/4$           |
| WKR41035         | 2                   | $\text{Min}\{37,3^{1)}; F_{\text{ax,Rk}}/k_t\}$                    | $\text{Min}\{31,5^{1)}; F_{\text{ax,Rk}}/k_t\}$ | 1,45  | $F_{1,\text{Rk}}/4$           |
| WKR41035         | 1                   | $\text{Min}\{45,3^{1)}; F_{\text{ax,Rk}}/k_t\}$                    | $\text{Min}\{38,3^{1)}; F_{\text{ax,Rk}}/k_t\}$ | 1,45  | $F_{1,\text{Rk}}/4$           |
| WKR53035         | 1-2                 | $\text{Min}\{42,6^{1)}; F_{\text{ax,Rk}}/k_t\}$                    | $\text{Min}\{36,0^{1)}; F_{\text{ax,Rk}}/k_t\}$ | 1,45  | $F_{1,\text{Rk}}/4$           |

<sup>1)</sup> 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 %.

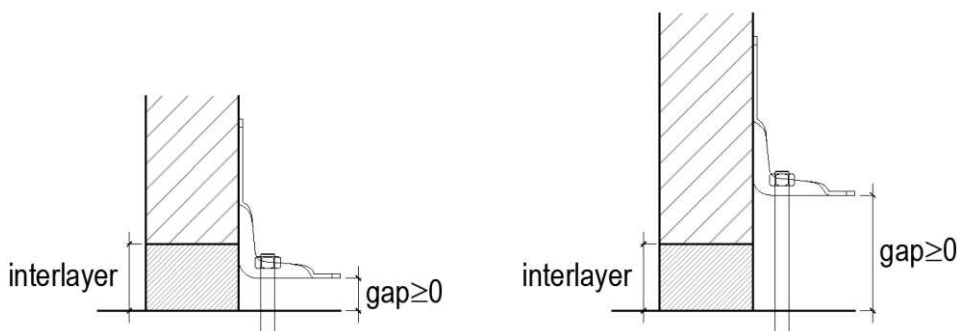
<sup>a</sup> For LBA nails with shorter length,  $F_{1,\text{Rk}}$  must be reduced by  $\text{min}\{F_{\text{v,short,Rk}}/F_{\text{v},60,\text{Rk}}; F_{\text{ax,short,Rk}}/F_{\text{ax},60,\text{Rk}}\}$   
For ringed shank nails according to EN 14592,  $F_{1,\text{Rk}}$  must be reduced by  $\text{min}\{F_{\text{v,EN14592,Rk}}/F_{\text{v,LBA,Rk}};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

<sup>b</sup> For LBS screws with shorter length,  $F_{1,\text{Rk}}$  must be reduced by  $\text{min}\{F_{\text{v,short,Rk}}/F_{\text{v},50,\text{Rk}}; F_{\text{ax,short,Rk}}/F_{\text{ax},50,\text{Rk}}\}$

<sup>c</sup> For connections with gap,  $k_t = 1,0$  and  $F_{1,\text{gap,Rk}} = \text{Min}\{F_{1,\text{no gap,Rk}}; 19 \text{ kN}\}$

$F_{\text{ax,Rk}}$  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.14.

#### Explanation for connections with gap in Table B.13

**Table B.14:** Force  $F_1$ , head pull-through capacity of a fastener in the horizontal flange

| Fastener                                                                                                                                      | $F_{\text{head,Rk}}$ [kN] |       |       |       |       |
|-----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|-------|-------|-------|-------|
|                                                                                                                                               | WKR                       |       |       |       |       |
|                                                                                                                                               | 9530                      | 13535 | 21535 | 28535 | 53035 |
| Metal anchor M12 or bolt M12 without gap                                                                                                      | 26                        | 26    | 26    | 26    | 26    |
| Metal anchor M12 or bolt M12 with washer ULS13373 without gap                                                                                 | 26                        | 37    | 37    | 37    | 37    |
| Metal anchor M12 or bolt M12 with gap                                                                                                         | 8,3                       | 19    | 19    | 19    | 19    |
| Metal anchor M12 or bolt M12 with washer ULS13373 with gap                                                                                    | 16                        | 35    | 35    | 35    | 35    |
| Rotho Blaas screw type HBS or TBS Ø10 mm or Ø12 mm or VGS Ø11 mm or Ø13 mm with washer HUS or with large washer head according to ETA-11/0030 | $f_{\text{tens,k}}$       |       |       |       |       |
| Rotho Blaas screw type HBSP Ø10 mm with WU2 washer head according to ETA-11/0030                                                              | 20                        | 21    | 21    | 21    | 21    |
| Rotho Blaas screw type HBSP Ø12 mm with WU2 washer head according to ETA-11/0030                                                              | 27                        | 29    | 29    | 29    | 29    |



The load-carrying capacity for WKRD hold-downs for configurations according to Fig. B. 37 to Fig. B. 42 is:

$$F_{l,Rk} = \min \left\{ F_{vf,Rk}; F_{wp,Rk}; F_{s,Rk}; F_{hd,Rk}; \frac{F_{ax,Rk}}{k_t} \right\} \text{ in N} \quad (B.1)$$

Where:

$F_{vf,Rk}$  Characteristic load-carrying capacity of the nails or screws in the vertical wall plate WKRD40, WKRD60, WKRD60L or WKRD60R in N,

$$F_{vf,Rk} = n \cdot k_{nef} \cdot k_{a4} \cdot F_{v,Rk}$$

$n$  Number of nails or screws in wall plate

$k_{nef}$  Factor considering effective number of nails or screws in the wall plate

$$k_{nef} = 1 \text{ for } n \leq 8$$

$$k_{nef} = n_{ll}^{-0,15} \text{ for } n > 8 \text{ according to EN 1995-1-1 Equation (8.17)}$$

$n_{ll}$  Number of nails or screws in load direction parallel to grain

$k_{a4}$  Factor considering influence of edge distance and load eccentricity for groups of up to 20 nails or screws

$$k_{a4} = 0,6 \text{ for nails or screws in wall plate WKRD60L/R}$$

$$k_{a4} = 0,8 \cdot \sqrt{350/\rho_k} \text{ for up to 20 nails in LVL in wall plates WKRD40 or WKRD60 and}$$

$$12,5 \text{ mm} \leq a_{4,c} < 5d$$

$$k_{a4} = 1,0 \text{ in all other cases}$$

$F_{v,Rk}$  Characteristic lateral load-carrying capacity of an LBA nail according to ETA-22/0002 or an LBS screw according to ETA-11/0030,

$$F_{v,Rd} = k_{mod} \cdot F_{v,Rk} / \gamma_M$$

$F_{wp,Rk}$  Characteristic tensile capacity of a wall plate

$$F_{wp,Rd} = N_{t,Rd} \text{ according to EN 1993-1-1, 6.2.3}$$

$F_{s,Rk}$  Characteristic lateral load-carrying capacity of the self-drilling WKRD screws between WKR hold-down or wall plate WKRD60T and vertical wall plate WKRD40, WKRD60, WKRD60L or WKRD60R in N,

$$F_{s,Rk} = n_s \cdot 6.200 \text{ N, } F_{s,Rd} = F_{s,Rk} / \gamma_{M2}$$

$n_s$  Number of self-drilling WKRD screws

$F_{hd,Rk}$  Characteristic load-carrying capacity of the WKR hold-down according to Table B.15 or the WKRD60T steel wall plate according to EN 1993-1-1

$$F_{hd,Rd} = F_{hd,Rk} / \gamma_{M2}$$

$F_{ax,Rk}$  Characteristic axial load-carrying capacity of the fastener in the horizontal flange in N.

Head pull-through capacity see Table B.14. Head pull-through capacity for WKRD100C is not governing.

$k_t$  Factor according to Table B.15

**Table B.15:** Load-carrying capacity  $F_{hd,Rk}$  in N for Rotho Blaas WKRD hold-downs

| Hold-down          | $F_{hd,Rk}$ in [N] |                      |                         |             |       |
|--------------------|--------------------|----------------------|-------------------------|-------------|-------|
|                    | Washer             | Bolt or Metal Anchor | Bolt position           | $F_{hd,Rk}$ | $k_t$ |
| WKR09530, WKR13535 | -                  | M12                  | Inner hole              | 26.000      | 1,05  |
| WKR21535, WKR28535 | -                  | M12                  | Inner hole              | 26.000      | 1,10  |
| WKR09530           | ULS 13373          | M12                  | Inner hole              | 26.000      | 1,05  |
| WKR13535           | ULS 13373          | M12                  | Inner hole              | 37.000      | 1,05  |
| WKR21535, WKR28535 | ULS 13373          | M12                  | Inner hole              | 37.000      | 1,10  |
| WKRD100C           | -                  | M16 in slotted hole  | Inner or outer position | 17.600      | 1,20  |
| WKRD100C           | WHTW 6016          |                      | Inner position          | 25.300      | 1,05  |
| WKRD100C           | WHTW 6016          |                      | Outer position          | 25.300      | 1,35  |
| WKRD100C           | WKRWD6020          |                      | Inner position          | 39.800      | 1,10  |
| WKRD100C           | WKRWD6020          |                      | Outer position          | 39.800      | 1,35  |
| WKRD100C           | WHTW 6020          | M20 in circular hole | M20 hole                | 18.800      | 1,70  |
| WKRD100C           | WKRWD6020          |                      | M20 hole                | 27.200      | 1,90  |

The slip modulus for WKRD hold-downs for configurations according to Fig. B. 37 to Fig. B. 42 is:

$$K_{l,ser} = \frac{F_{l,Rk}}{6 \text{ mm}} \quad (\text{B.2})$$

**Table B.16:** Force  $F_4$ , 1 hold-down / connection timber to timber

| WKR hold down                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Fastener pattern | $F_{4,Rk}$ [kN] for timber-to-timber connection |                                 |                        |                                 |                                 |                        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-------------------------------------------------|---------------------------------|------------------------|---------------------------------|---------------------------------|------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                  | no interlayer                                   |                                 |                        | interlayer up to 20 mm          |                                 |                        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                  | LBA nails<br>4x60 <sup>a</sup>                  | LBS screws<br>5x50 <sup>b</sup> | $K_{4,ser}$<br>[kN/mm] | LBA nails<br>4x60 <sup>a</sup>  | LBS screws<br>5x50 <sup>b</sup> | $K_{4,ser}$<br>[kN/mm] |
| WKR9530                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 2                | $\text{Min}\{14,7; F_{vh,Rk}\}$                 | $\text{Min}\{14,1; F_{vh,Rk}\}$ | $F_{4,Rk}/6$           | $\text{Min}\{11,3; F_{vh,Rk}\}$ | $\text{Min}\{10,7; F_{vh,Rk}\}$ | $F_{4,Rk}/6$           |
| WKR13535                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 2                | $\text{Min}\{18,3; F_{vh,Rk}\}$                 | $\text{Min}\{17,2; F_{vh,Rk}\}$ | $F_{4,Rk}/6$           | $\text{Min}\{14,9; F_{vh,Rk}\}$ | $\text{Min}\{13,8; F_{vh,Rk}\}$ | $F_{4,Rk}/6$           |
| WKR21535                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 2                | $\text{Min}\{23,0; F_{vh,Rk}\}$                 | $\text{Min}\{21,1; F_{vh,Rk}\}$ | $F_{4,Rk}/6$           | $\text{Min}\{19,6; F_{vh,Rk}\}$ | $\text{Min}\{17,7; F_{vh,Rk}\}$ | $F_{4,Rk}/6$           |
| WKR28535                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 3                | $\text{Min}\{25,6; F_{vh,Rk}\}$                 | $\text{Min}\{23,4; F_{vh,Rk}\}$ | $F_{4,Rk}/6$           | $\text{Min}\{22,3; F_{vh,Rk}\}$ | $\text{Min}\{20,0; F_{vh,Rk}\}$ | $F_{4,Rk}/6$           |
| <sup>a</sup> For LBA nails with shorter length, $F_{4,Rk}$ must be reduced by $\min\{F_{v,short,Rk}/F_{v,60,Rk}; F_{ax,short,Rk}/F_{ax,60,Rk}\}$<br>For ringed shank nails according to EN 14592, $F_{4,Rk}$ must be reduced by $\min\{F_{v,EN14592,Rk}/F_{v,LBA,Rk}; F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}\}$<br><sup>b</sup> 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.17:** Force  $F_4$ , 1 hold-down / connection timber to rigid support

| WKR hold down                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Fastener pattern | $F_{4,Rk}$ [kN] for timber-to-rigid support connection |                                 |                        |                                         |                                 |                      |                        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------------------------------------------------|---------------------------------|------------------------|-----------------------------------------|---------------------------------|----------------------|------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                  | no interlayer                                          |                                 |                        | interlayer thickness up to $d_{IL,max}$ |                                 |                      |                        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                  | LBA nails<br>4x60 <sup>a</sup>                         | LBS screws<br>5x50 <sup>b</sup> | $K_{4,ser}$<br>[kN/mm] | LBA nails<br>4x60 <sup>a</sup>          | LBS screws<br>5x50 <sup>b</sup> | $d_{IL,max}$<br>[mm] | $K_{4,ser}$<br>[kN/mm] |
| WKR9530                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1                | $\text{Min}\{14,7; F_{vh,Rk}\}$                        | $\text{Min}\{14,1; F_{vh,Rk}\}$ | $F_{4,Rk}/6$           | $\text{Min}\{11,3; F_{vh,Rk}\}$         | $\text{Min}\{10,7; F_{vh,Rk}\}$ | 20                   | $F_{4,Rk}/6$           |
| WKR13535                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1                | $\text{Min}\{18,3; F_{vh,Rk}\}$                        | $\text{Min}\{17,2; F_{vh,Rk}\}$ | $F_{4,Rk}/6$           | $\text{Min}\{14,9; F_{vh,Rk}\}$         | $\text{Min}\{13,8; F_{vh,Rk}\}$ | 20                   | $F_{4,Rk}/6$           |
| WKR21535                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1                | $\text{Min}\{23,0; F_{vh,Rk}\}$                        | $\text{Min}\{21,1; F_{vh,Rk}\}$ | $F_{4,Rk}/6$           | $\text{Min}\{19,6; F_{vh,Rk}\}$         | $\text{Min}\{17,7; F_{vh,Rk}\}$ | 20                   | $F_{4,Rk}/6$           |
| WKR28535                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1-4              | $\text{Min}\{21,7; F_{vh,Rk}\}$                        | $\text{Min}\{20,0; F_{vh,Rk}\}$ | $F_{4,Rk}/6$           | $\text{Min}\{13,0; F_{vh,Rk}\}$         | $\text{Min}\{11,3; F_{vh,Rk}\}$ | 120                  | $F_{4,Rk}/6$           |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 2                | $\text{Min}\{25,6; F_{vh,Rk}\}$                        | $\text{Min}\{23,4; F_{vh,Rk}\}$ | $F_{4,Rk}/6$           | $\text{Min}\{22,3; F_{vh,Rk}\}$         | $\text{Min}\{20,0; F_{vh,Rk}\}$ | 20                   | $F_{4,Rk}/6$           |
| WKR41035                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1                | $\text{Min}\{22,3; F_{vh,Rk}\}$                        | $\text{Min}\{20,6; F_{vh,Rk}\}$ | $F_{4,Rk}/6$           | $\text{Min}\{12,5; F_{vh,Rk}\}$         | $\text{Min}\{10,8; F_{vh,Rk}\}$ | 240                  | $F_{4,Rk}/6$           |
| WKR53035                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1-2              | $\text{Min}\{21,7; F_{vh,Rk}\}$                        | $\text{Min}\{20,0; F_{vh,Rk}\}$ | $F_{4,Rk}/6$           | $\text{Min}\{11,5; F_{vh,Rk}\}$         | $\text{Min}\{9,8; F_{vh,Rk}\}$  | 360                  | $F_{4,Rk}/6$           |
| <sup>a</sup> For LBA nails with shorter length, $F_{4,Rk}$ must be reduced by $\min\{F_{v,short,Rk}/F_{v,60,Rk}; F_{ax,short,Rk}/F_{ax,60,Rk}\}$<br>For ringed shank nails according to EN 14592, $F_{4,Rk}$ must be reduced by $\min\{F_{v,EN14592,Rk}/F_{v,LBA,Rk}; F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}\}$<br><sup>b</sup> 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.18:** Force  $F_5$ , 1 hold-down / connection timber to timber

| WKR hold down | Fastener pattern | Timber-to-timber connection |                              |                  |
|---------------|------------------|-----------------------------|------------------------------|------------------|
|               |                  | $F_{5,Rk}$ [kN]             |                              | $\ell_{BL}$ [mm] |
|               |                  | LBA nails 4x60 <sup>a</sup> | LBS screws 5x50 <sup>b</sup> |                  |
| WKR9530       | 2                | 2,6                         | 3,4                          | 70               |
| WKR13535      | 2                | 2,6                         | 3,6                          | 70               |
| WKR21535      | 2                | 2,6                         | 3,6                          | 70               |
| WKR28535      | 3                | 2,6                         | 3,6                          | 70               |

<sup>a</sup> 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  $\min\{F_{v,EN14592,Rk}/F_{v,LBA,Rk} ; F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}\}$   
<sup>b</sup> 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.19:** Force  $F_5$ , 1 hold-down / connection timber to rigid support

| WKR hold down | Fastener pattern | Timber-to-rigid support connection |                              |                  |
|---------------|------------------|------------------------------------|------------------------------|------------------|
|               |                  | $F_{5,Rk}$ [kN]                    |                              | $\ell_{BL}$ [mm] |
|               |                  | LBA nails 4x60 <sup>a</sup>        | LBS screws 5x50 <sup>b</sup> |                  |
| WKR9530       | 1                | 2,6                                | 3,4                          | 70               |
| WKR13535      | 1                | 2,6                                | 3,6                          | 70               |
| WKR21535      | 1                | 2,6                                | 3,6                          | 70               |
| WKR28535      | 1-4              | 0,9                                | 0,9                          | 160              |
| WKR28535      | 2                | 2,6                                | 3,6                          | 70               |
| WKR41035      | 1                | 0,43                               | 0,43                         | 278              |
| WKR53035      | 1                | 0,33                               | 0,33                         | 343              |
| WKR53035      | 2                | 0,26                               | 0,26                         | 423              |

<sup>a</sup> 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  $\min\{F_{v,EN14592,Rk}/F_{v,LBA,Rk} ; F_{ax,EN14592,Rk}/F_{ax,LBA,Rk}\}$   
<sup>b</sup> For LBS screws with shorter length,  $F_{5,Rk}$  must be reduced by  $\min\{F_{v,short,Rk}/F_{v,50,Rk} ; F_{ax,short,Rk}/F_{ax,50,Rk}\}$

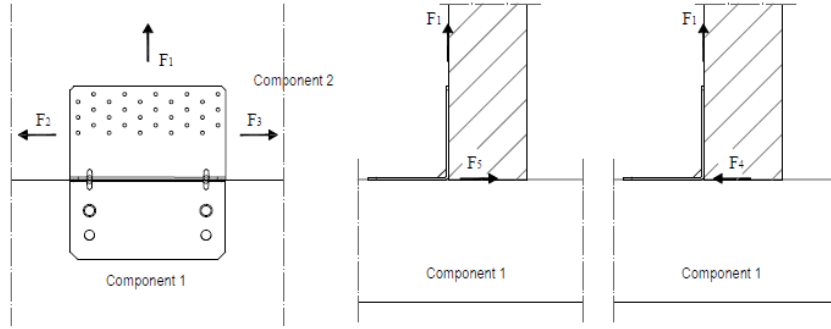
The combined action of axial load  $F_{ax,Ed}$  and lateral load  $F_{5,Ed}$  on the fastener in the horizontal flange must be checked by the designer.

Where:

$$F_{ax,Ed} = \frac{F_{5,Ed} \cdot \ell_{BL}}{25 \text{ mm}} \quad (B.3)$$

## 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.

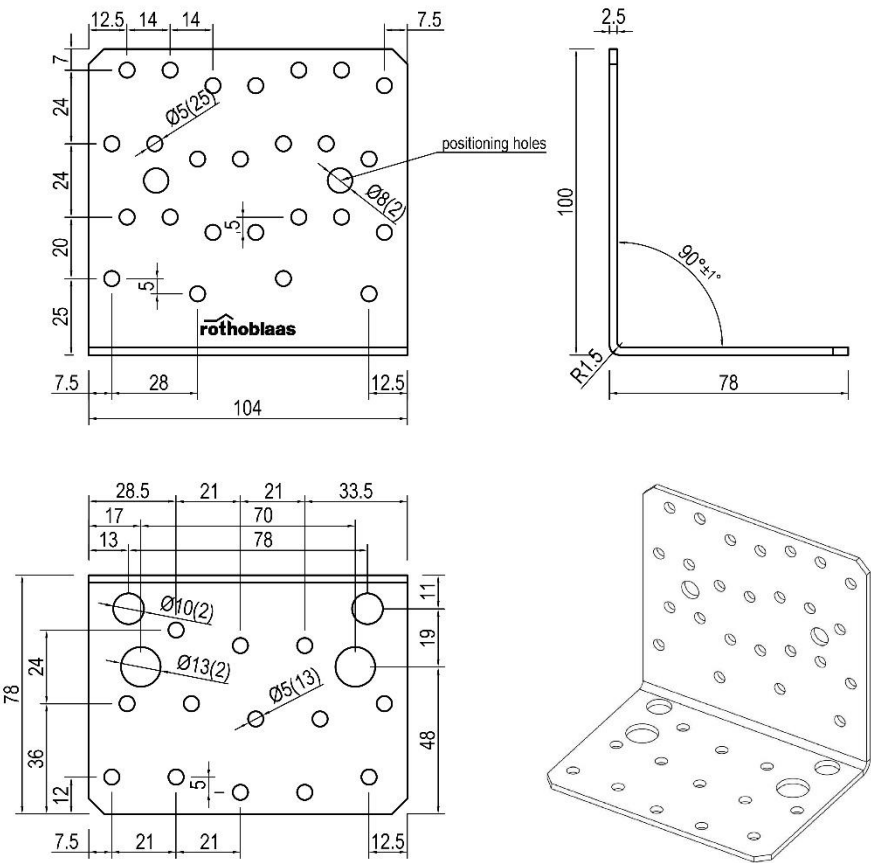
### Combined forces

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:

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

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

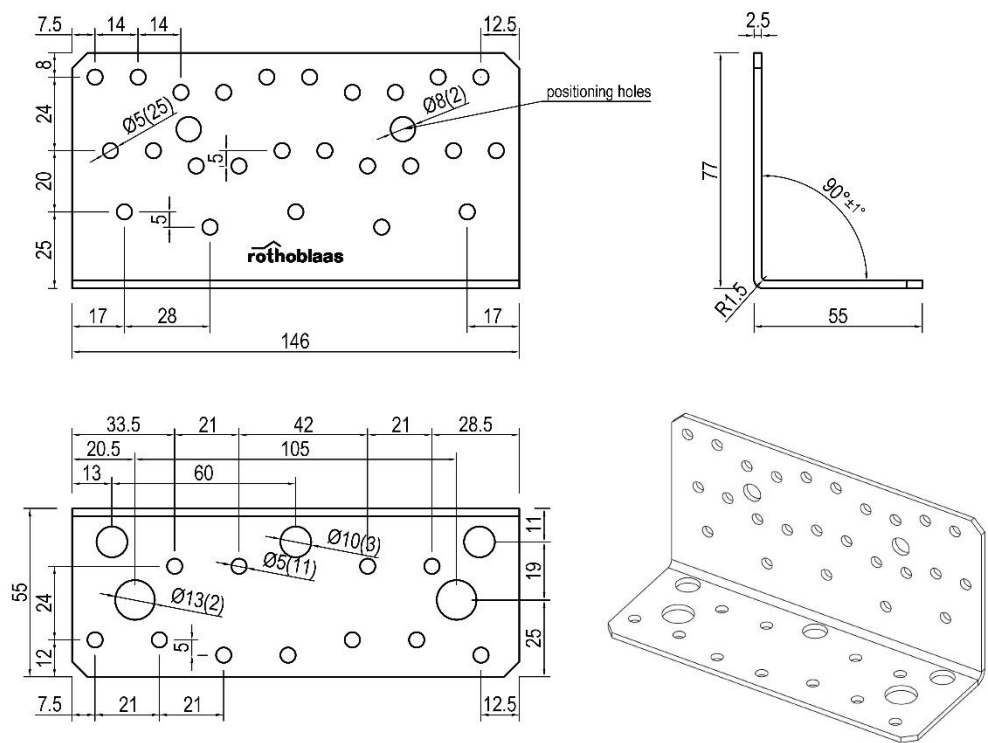
Rotho Blaas Angle Brackets



All dimension in mm

|                                                                                                                                                                                                                                                                                                                                                 |                                |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|--|
| <br><b>Rotho Blaas Srl - GmbH</b><br>Via Dell'Adige 2/1 Etschweg<br>I-39040 Cortaccia-Kurtatsch (BZ)<br>Tel. +39 0471 81 84 00<br><a href="http://www.rothoblaas.com">www.rothoblaas.com</a><br><a href="mailto:info@rothoblaas.com">info@rothoblaas.com</a> | Object:<br>NINO angle brackets |  |
|                                                                                                                                                                                                                                                                                                                                                 | Product code:<br>NINO100100    |  |
|                                                                                                                                                                                                                                                                                                                                                 |                                |  |

Figure B. 1 Dimensions of Angle Bracket NINO 100100



All dimension in mm

|                                                                                                                                                                                                                                                                                                                                                 |               |                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|---------------------|
| <br><b>Rotho Blaas Srl - GmbH</b><br>Via Dell'Adige 2/1 Etschweg<br>I-39040 Cortaccia-Kurtatsch (BZ)<br>Tel. +39 0471 81 84 00<br><a href="http://www.rothoblaas.com">www.rothoblaas.com</a><br><a href="mailto:info@rothoblaas.com">info@rothoblaas.com</a> | Object:       | NINO angle brackets |
|                                                                                                                                                                                                                                                                                                                                                 | Product code: | NINO15080           |
|                                                                                                                                                                                                                                                                                                                                                 |               |                     |

Figure B. 2 Dimensions of Angle Bracket NINO 15080

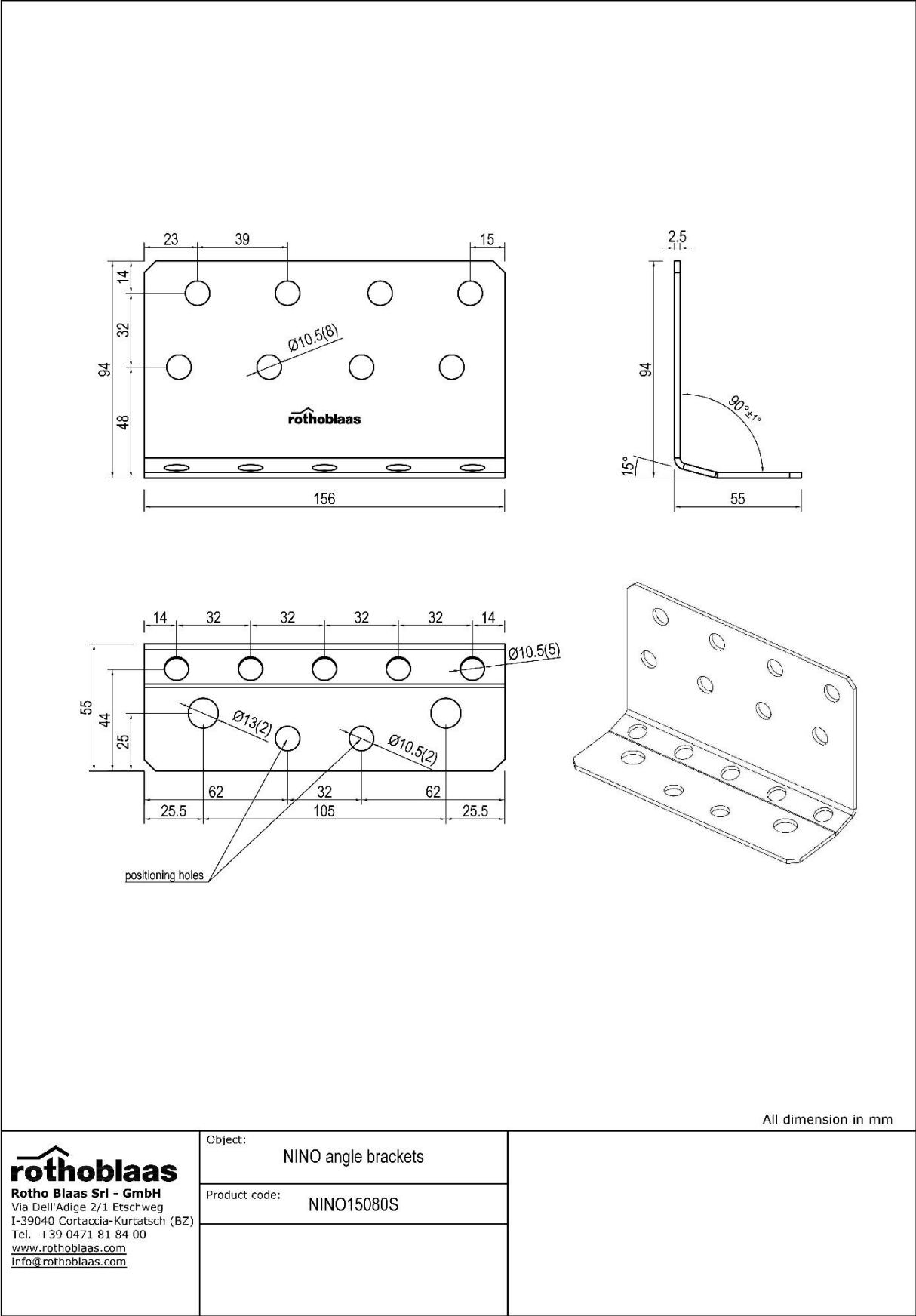
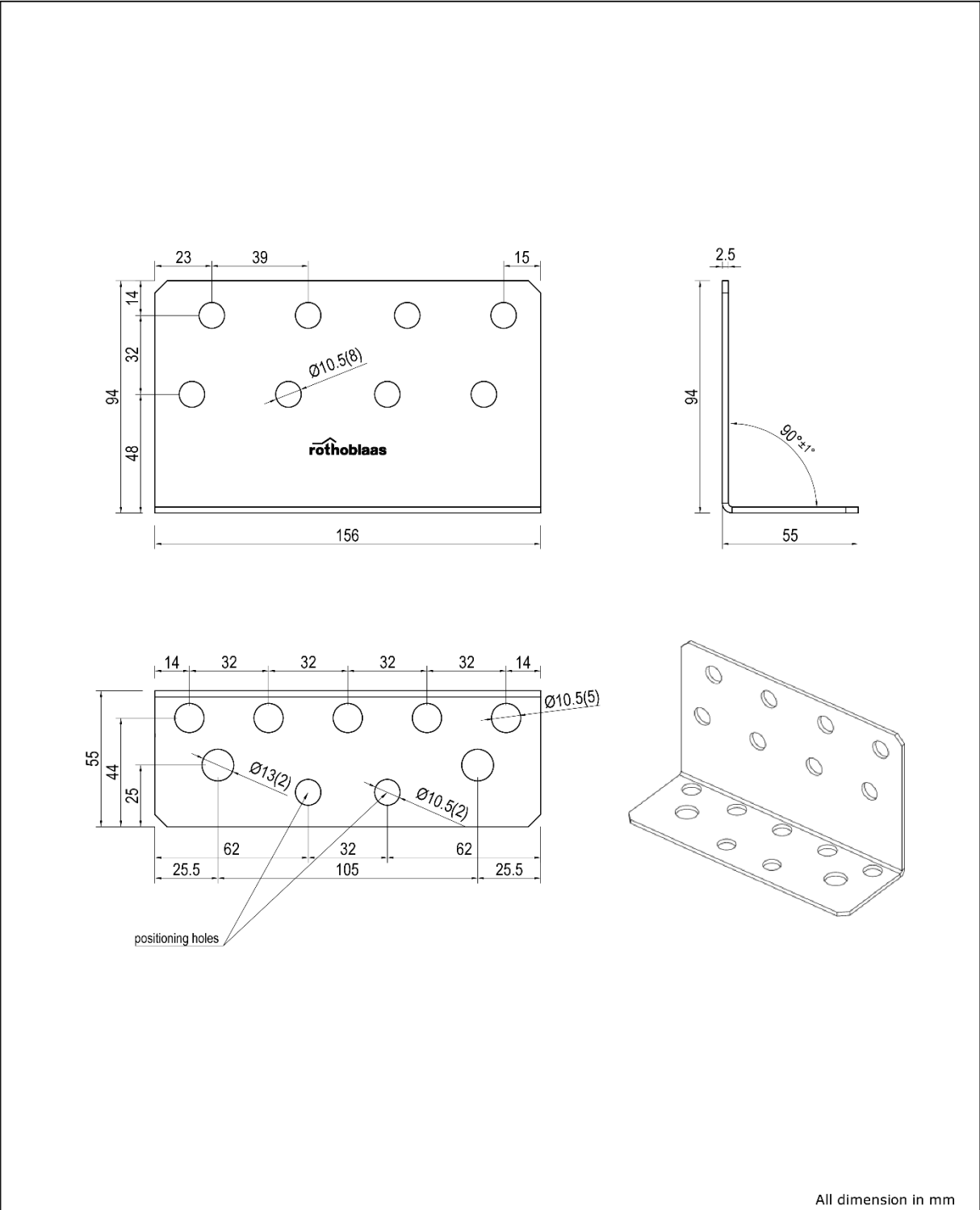


Figure B. 3a Dimensions of Angle Bracket NINO 15080S



All dimension in mm

|                                                                                                                                                                                                                                                              |               |                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|---------------------|
| <br><b>Rotho Blaas Srl - GmbH</b><br>Via Dell'Adige 2/1 Etschweg<br>I-39040 Cortaccia-Kurtatsch (BZ)<br>Tel. +39 0471 81 84 00<br><a href="http://www.rothoblaas.com">www.rothoblaas.com</a><br><a href="mailto:info@rothoblaas.com">info@rothoblaas.com</a> | Object:       | NINO angle brackets |
|                                                                                                                                                                                                                                                              | Product code: | NINO15080S          |
|                                                                                                                                                                                                                                                              |               |                     |

Figure B. 4b Dimensions of Angle Bracket NINO 15080S



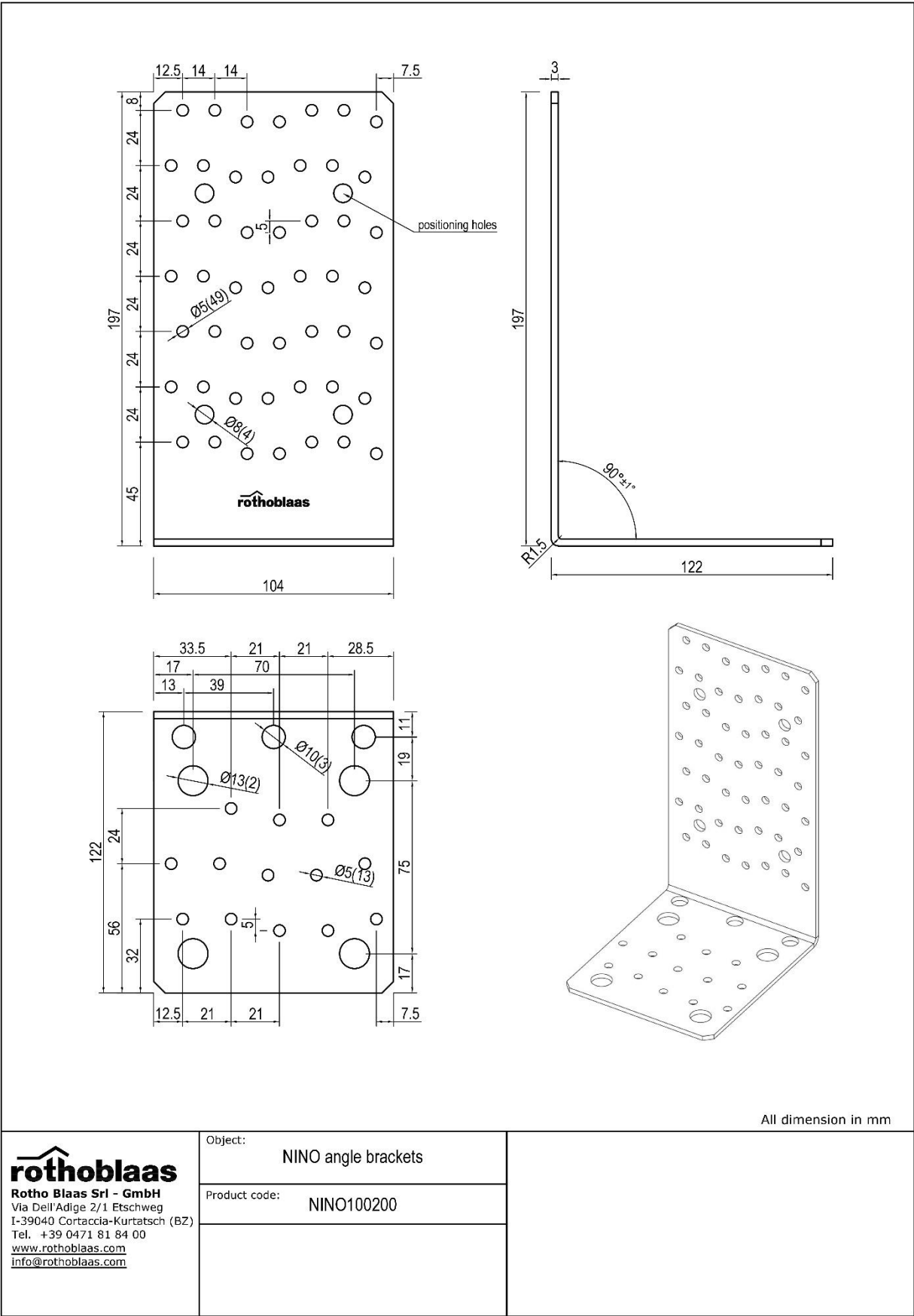


Figure B. 5 Dimensions of Angle Bracket NINO 100200

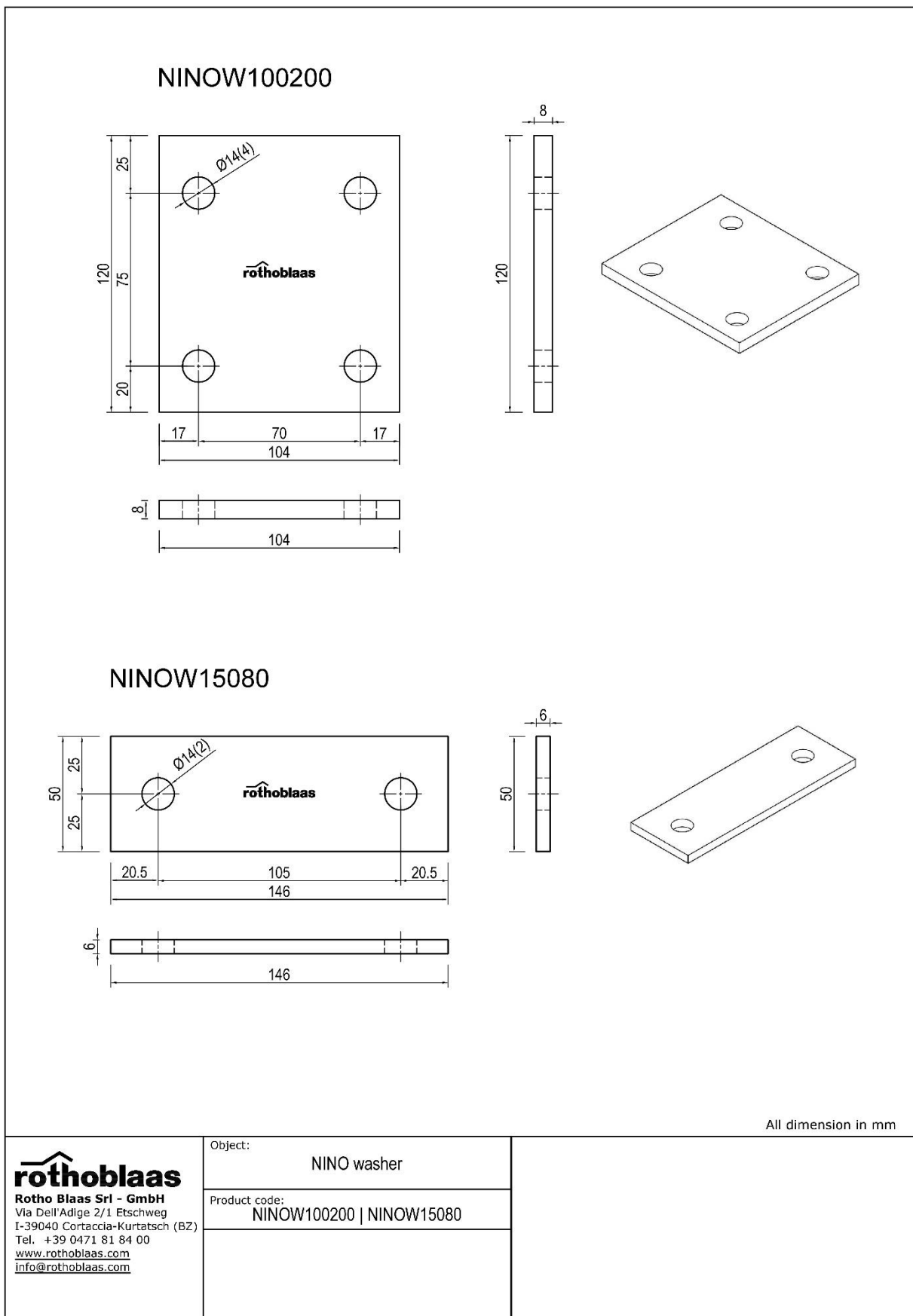


Figure B. 6 Dimensions of NINO Washers



Figure B. 7 Typical installation NINO100100

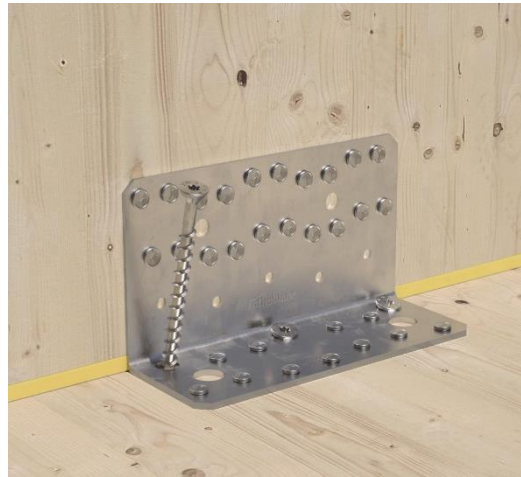


Figure B. 8 Typical installation NINO15080



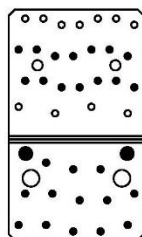
Figure B. 9 Typical installation NINO15080S



Figure B. 10 Typical installation NINO100200

## Nailing pattern for NINO100100

PATTERN 1

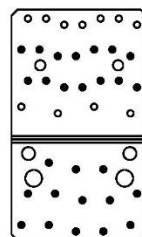


14 nails/screws

2 VGS screws Ø9  
13 nails/screws

timber to timber

PATTERN 2

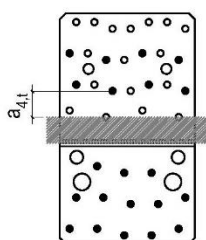


14 nails/screws

13 nails/screws

timber to timber

PATTERN 3



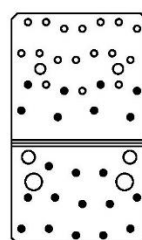
8 nails/screws

interlayer

13 nails/screws

timber to timber

PATTERN 4

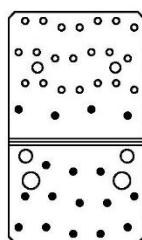


8 nails/screws

13 nails/screws

timber to timber

PATTERN 5

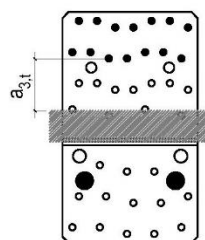


4 nails/screws

13 nails/screws

timber to timber

PATTERN 6



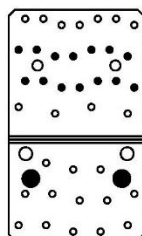
14 nails/screws

interlayer

2 concrete anchors  
or steel bolts

timber to rigid support

PATTERN 7

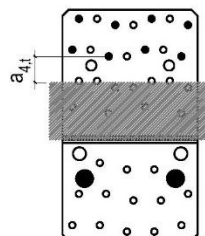


14 nails/screws

2 concrete anchors  
or steel bolts

timber to rigid support

PATTERN 8



8 nails/screws

interlayer

2 concrete anchors  
or steel bolts

timber to rigid support

Figure B. 11 Nailing patterns for Angle Bracket NINO 100100

Nailing pattern for NINO100100

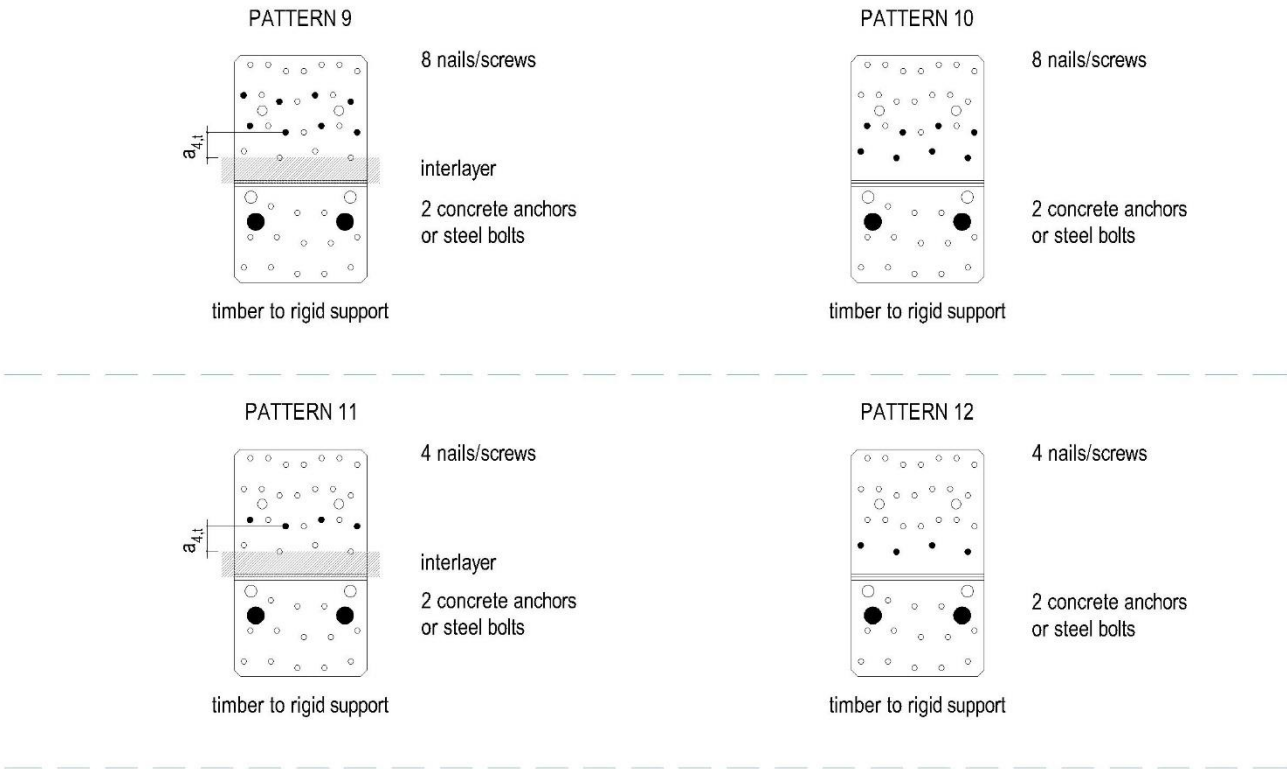


Figure B. 12 Nailing patterns for Angle Bracket NINO 100100

Nailing pattern for NINO15080

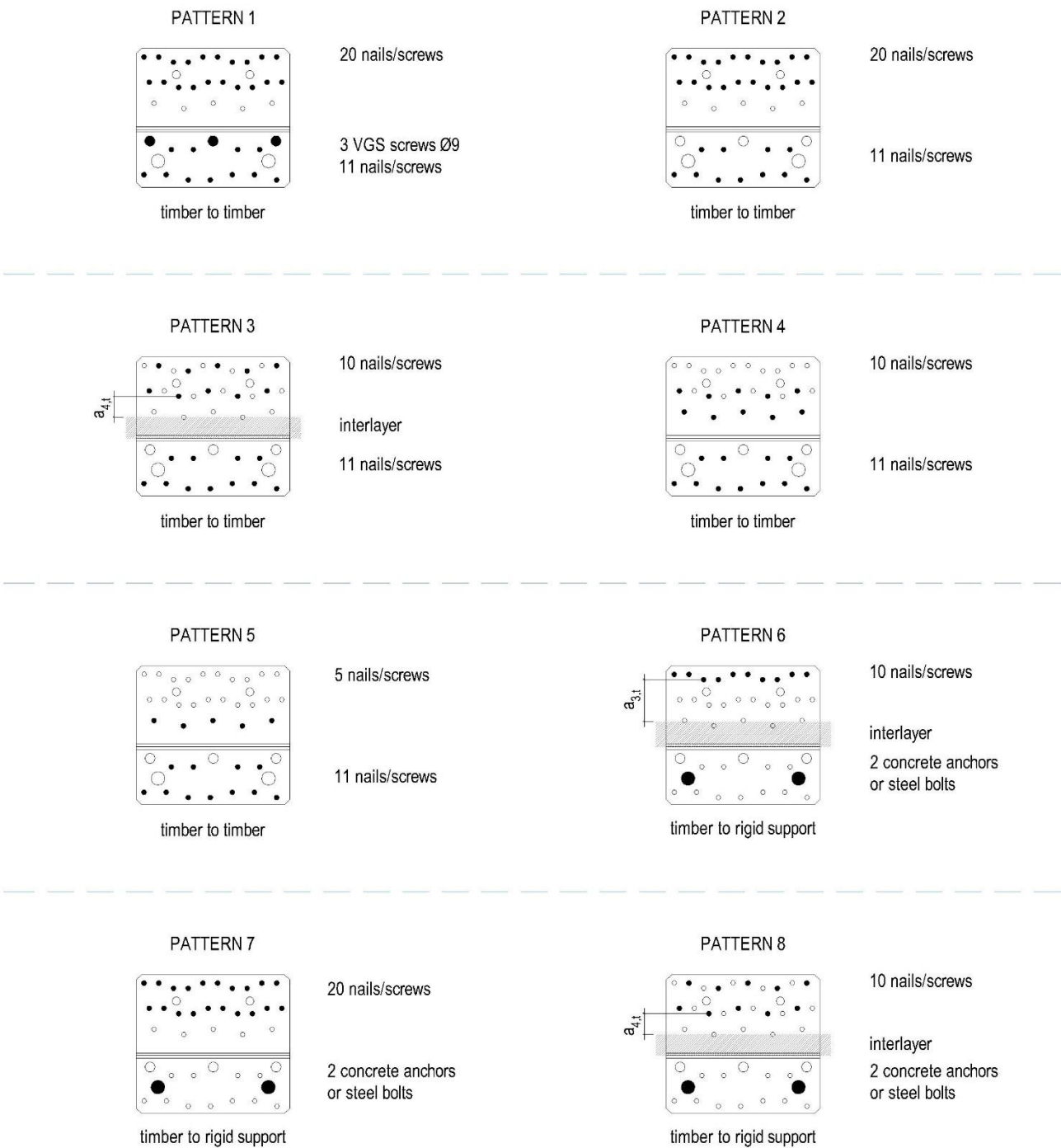


Figure B. 13 Nailing patterns for Angle Bracket NINO 15080

Nailing pattern for NINO15080

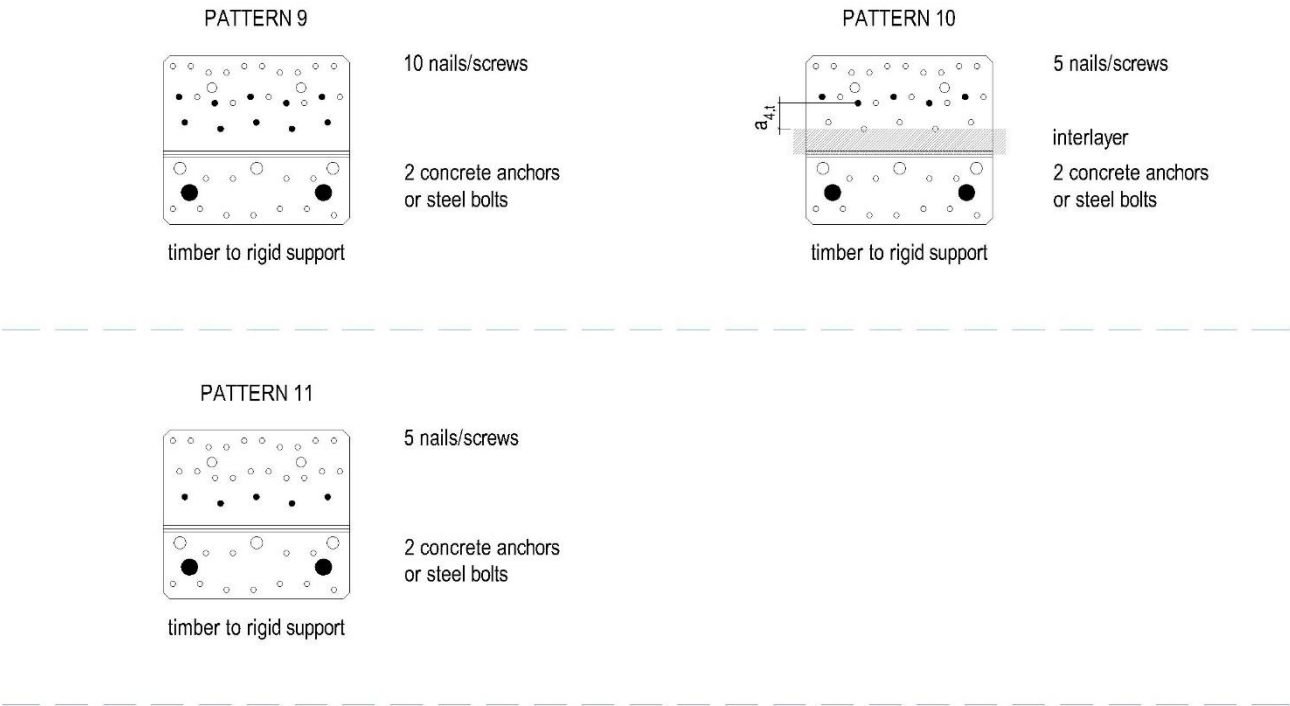


Figure B. 14 Nailing patterns for Angle Bracket NINO 15080

Nailing pattern for NINO15080S

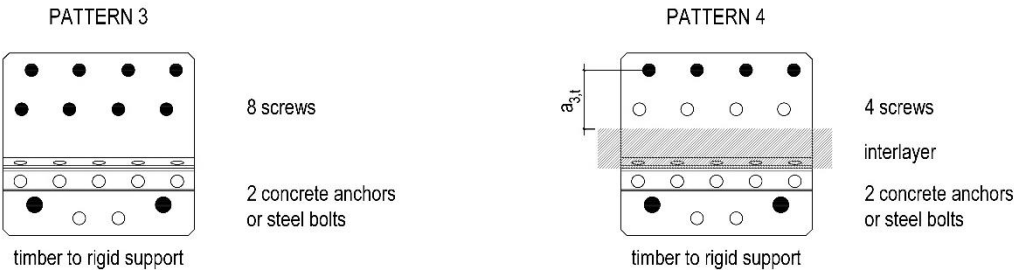
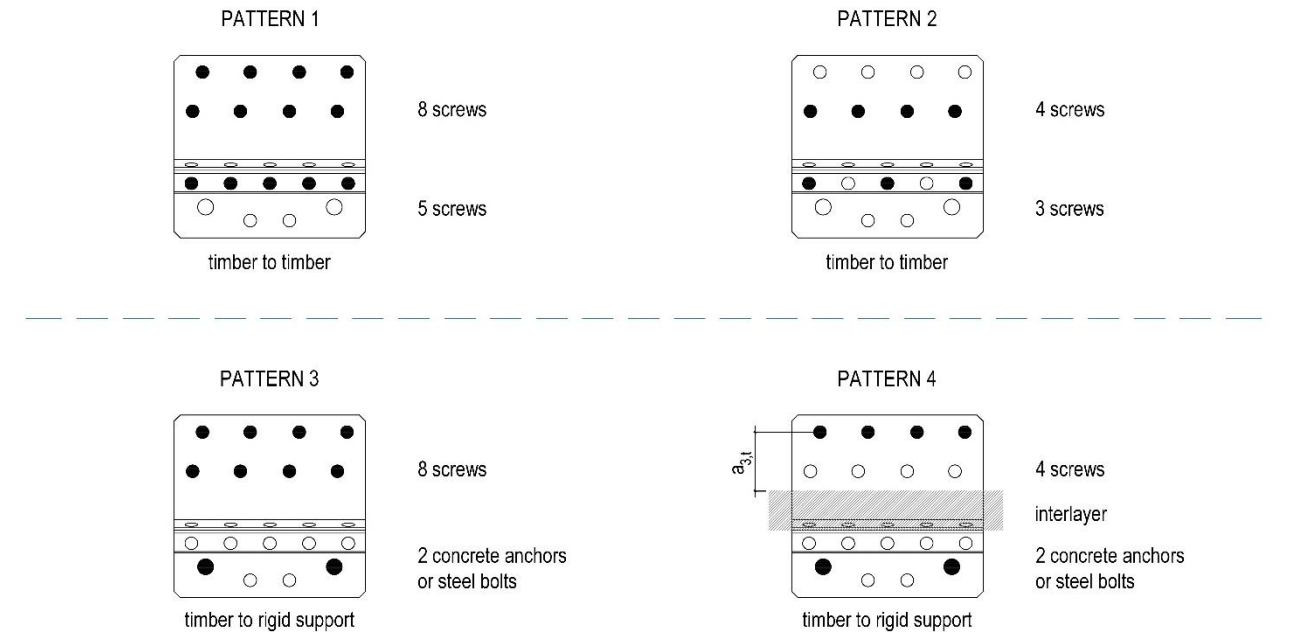


Figure B. 15 Nailing patterns for Angle Bracket NINO 15080S



Nailing pattern for NINO100200

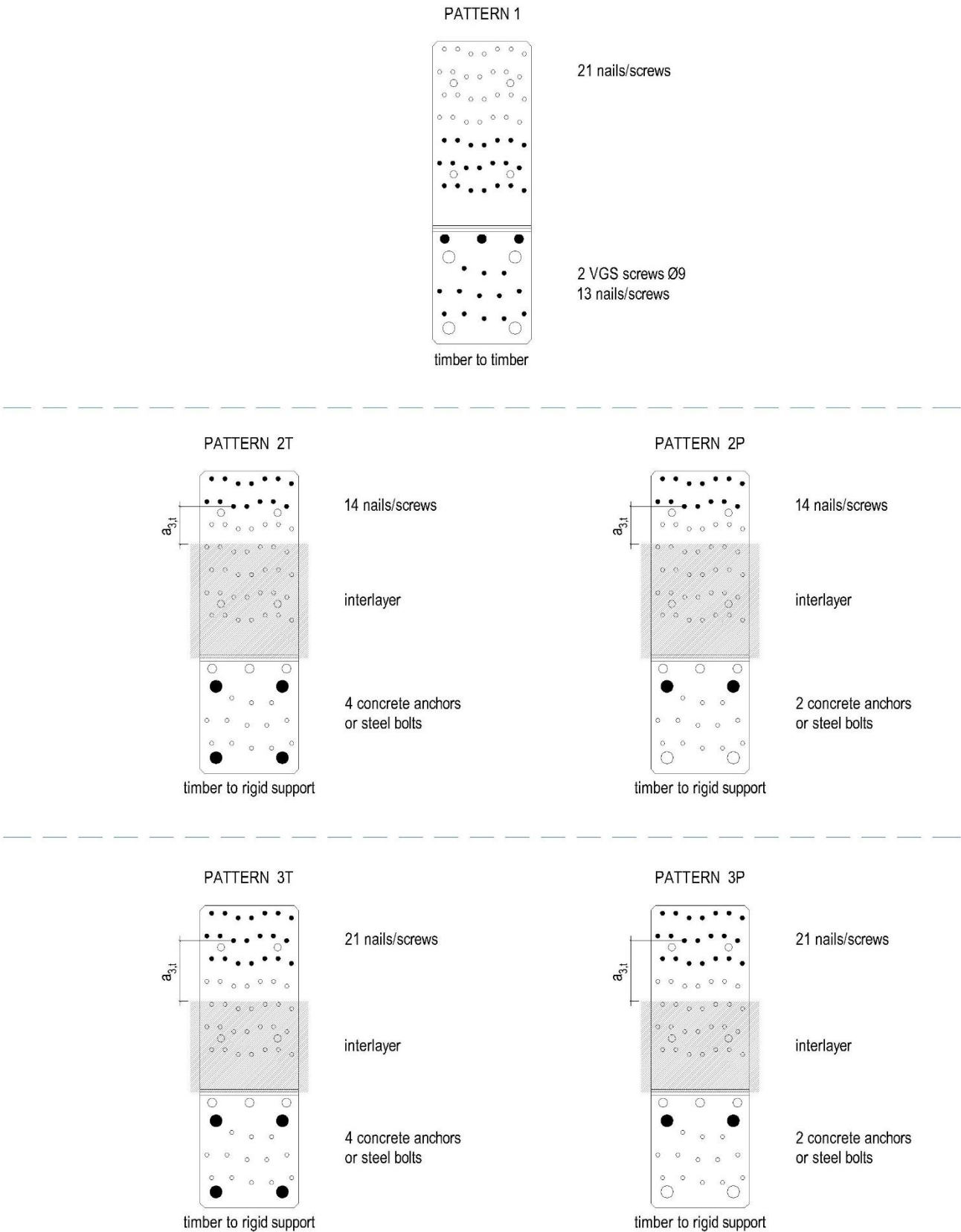


Figure B. 16 Nailing patterns for Angle Bracket NINO 100200



Nailing pattern for NINO100200

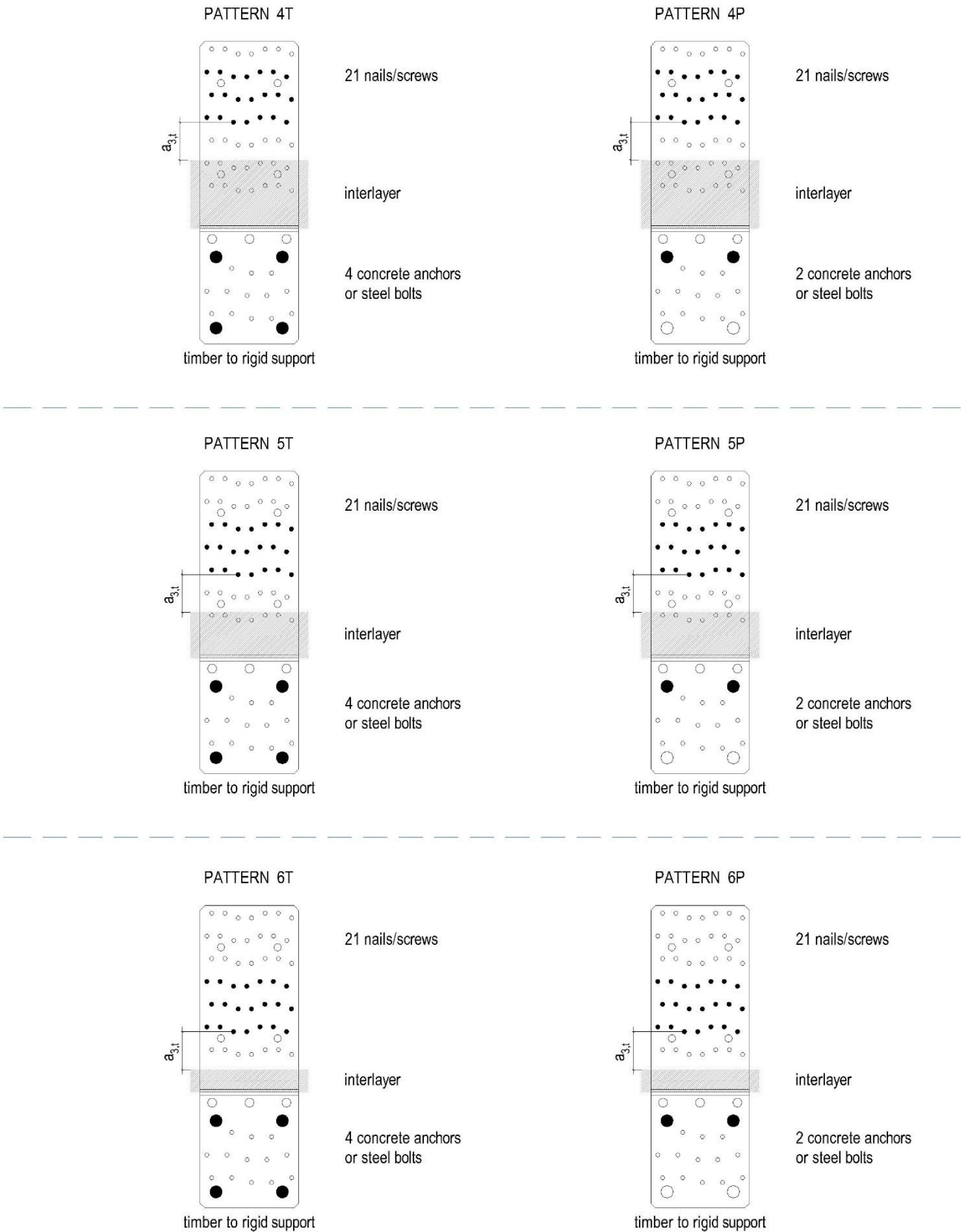


Figure B. 17 Nailing patterns for Angle Bracket NINO 100200

Nailing pattern for NINO100200

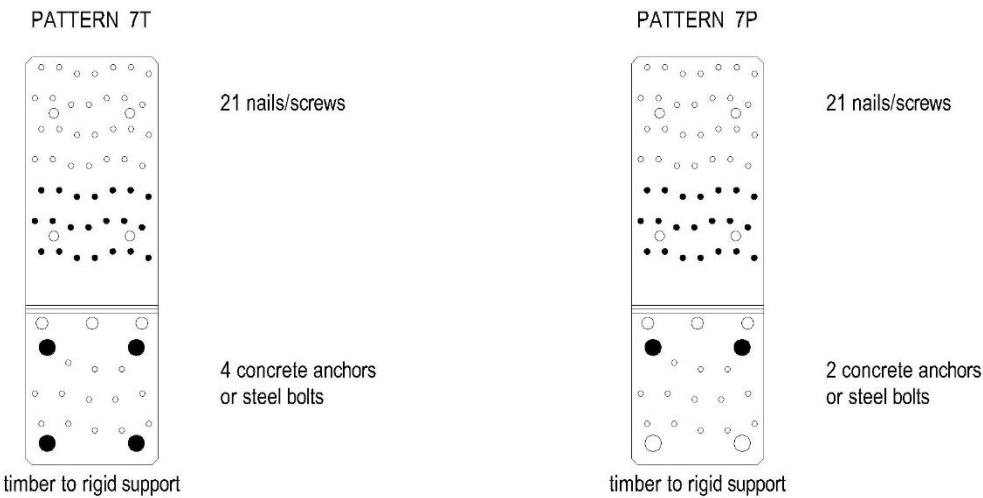
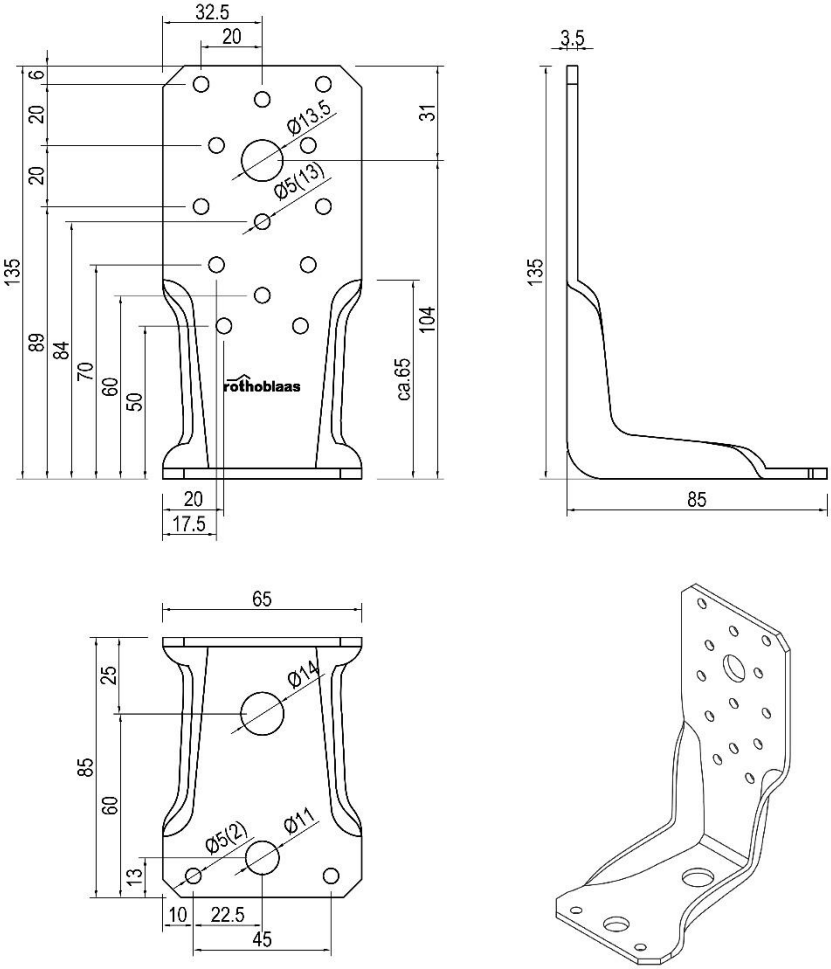


Figure B. 18 Nailing pattern for Angle Bracket NINO 100200



|               |         |
|---------------|---------|
| Product code: | WKR9530 |
|---------------|---------|

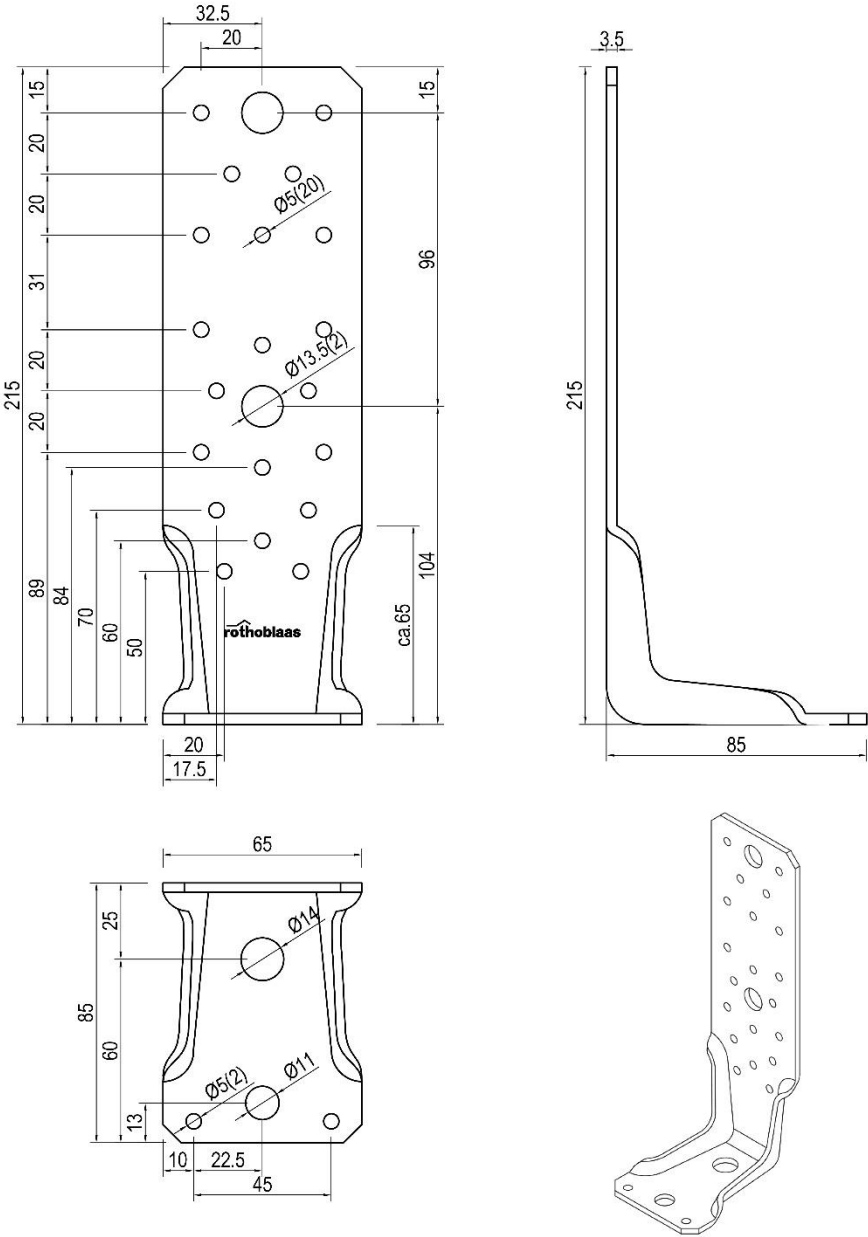
Figure B. 19 Dimensions of Rotho Blaas WKR9530



All dimension in mm

|                                                                                                                                                                                                                                                                                                                                                 |                               |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|--|
| <br><b>Rotho Blaas Srl - GmbH</b><br>Via Dell'Adige 2/1 Etschweg<br>I-39040 Cortaccia-Kurtatsch (BZ)<br>Tel. +39 0471 81 84 00<br><a href="http://www.rothoblaas.com">www.rothoblaas.com</a><br><a href="mailto:info@rothoblaas.com">info@rothoblaas.com</a> | Object:<br>WKR angle brackets |  |
|                                                                                                                                                                                                                                                                                                                                                 | Product code:<br>WKR13535     |  |
|                                                                                                                                                                                                                                                                                                                                                 | Material/Coating:             |  |

Figure B. 20 Dimensions of Rotho Blaas WKR13535



All dimension in mm

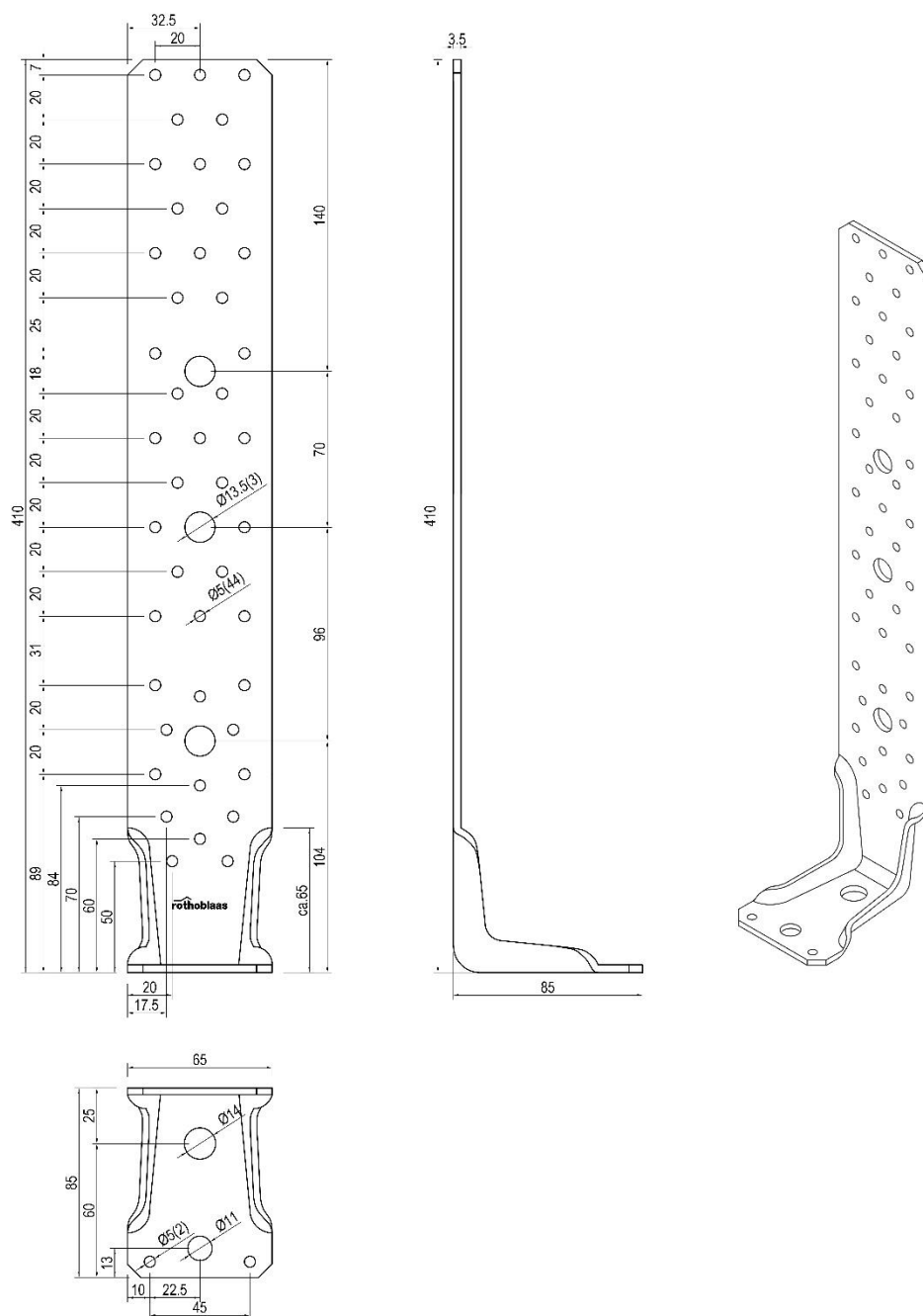
|                                                                                                                                                                                                                                                                                                                                                 |               |                    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------------------|
| <br><b>Rotho Blaas Srl - GmbH</b><br>Via Dell'Adige 2/1 Etschweg<br>I-39040 Cortaccia-Kurtatsch (BZ)<br>Tel. +39 0471 81 84 00<br><a href="http://www.rothoblaas.com">www.rothoblaas.com</a><br><a href="mailto:info@rothoblaas.com">info@rothoblaas.com</a> | Object:       | WKR angle brackets |
|                                                                                                                                                                                                                                                                                                                                                 | Product code: | WKR21535           |
|                                                                                                                                                                                                                                                                                                                                                 |               |                    |

Figure B. 21 Dimensions of Rotho Blaas WKR21535

**rothoblaas**  
**Rotho Blaas Srl - GmbH**  
 Via Dell'Adige 2/1 Etschweg  
 I-39040 Cortaccia-Kurtatsch (BZ)  
 Tel. +39 0471 81 84 00  
[www.rothoblaas.com](http://www.rothoblaas.com)  
[info@rothoblaas.com](mailto:info@rothoblaas.com)

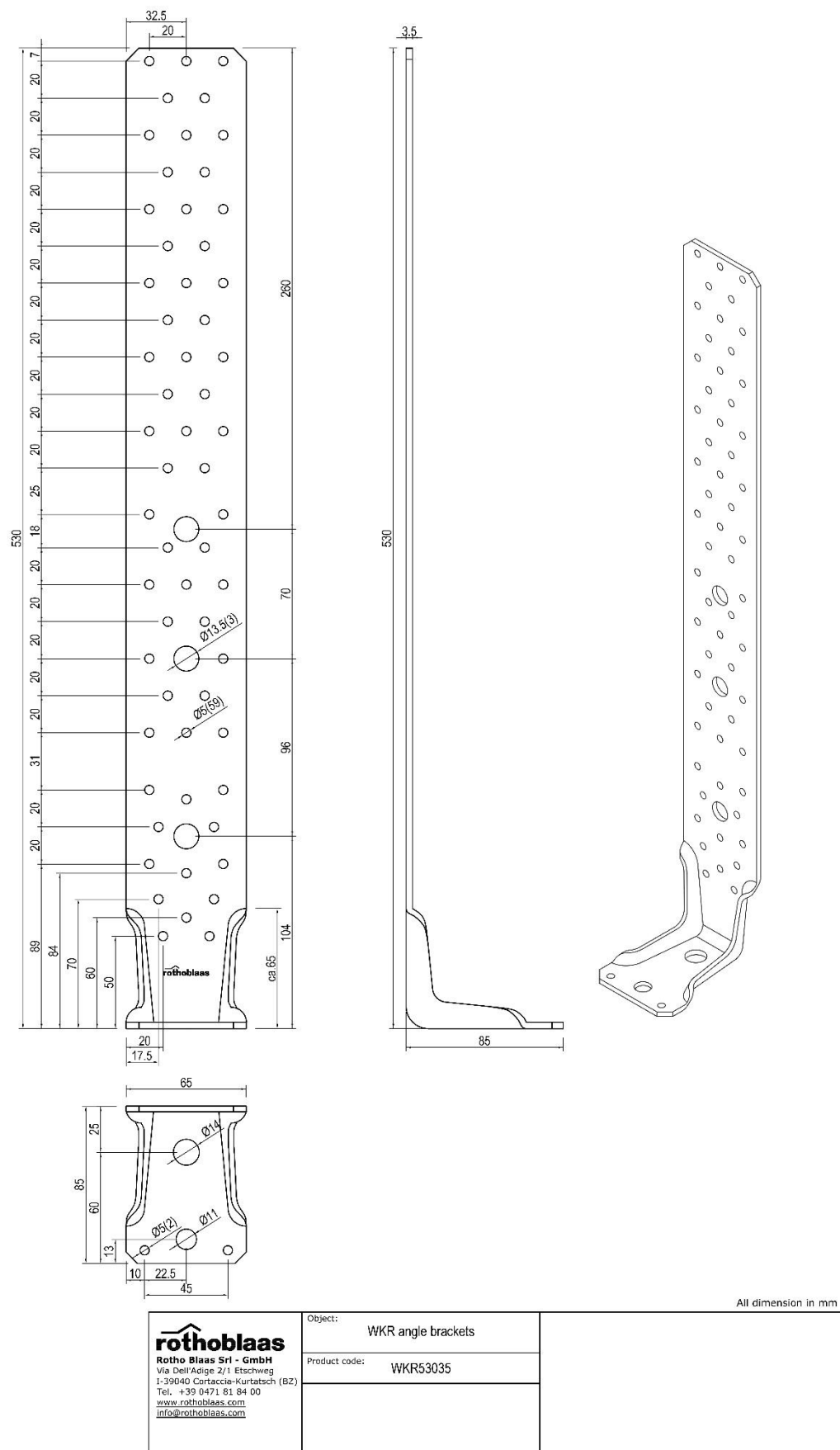
|               |          |
|---------------|----------|
| Product code: | WKR28535 |
|---------------|----------|

Figure B. 22 Dimensions of Rotho Blaas WKR28535



All dimension in mm

|                                                                                                                                                                                                                                                                                                                                                                                                              |                                      |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|--|
|  <p><b>Rothoblaas</b><br/> <b>Rotho Blaas Srl - GmbH</b><br/>         Via Dell'Adige 2/1 Etschweg<br/>         I-39040 Cortaccia-Kurtatsch (BZ)<br/>         Tel. +39 0471 81 84 00<br/> <a href="http://www.rothoblaas.com">www.rothoblaas.com</a><br/> <a href="mailto:info@rothoblaas.com">info@rothoblaas.com</a></p> | Object:<br><p>WKR angle brackets</p> |  |
|                                                                                                                                                                                                                                                                                                                                                                                                              | Product code:<br><p>WKR410</p>       |  |





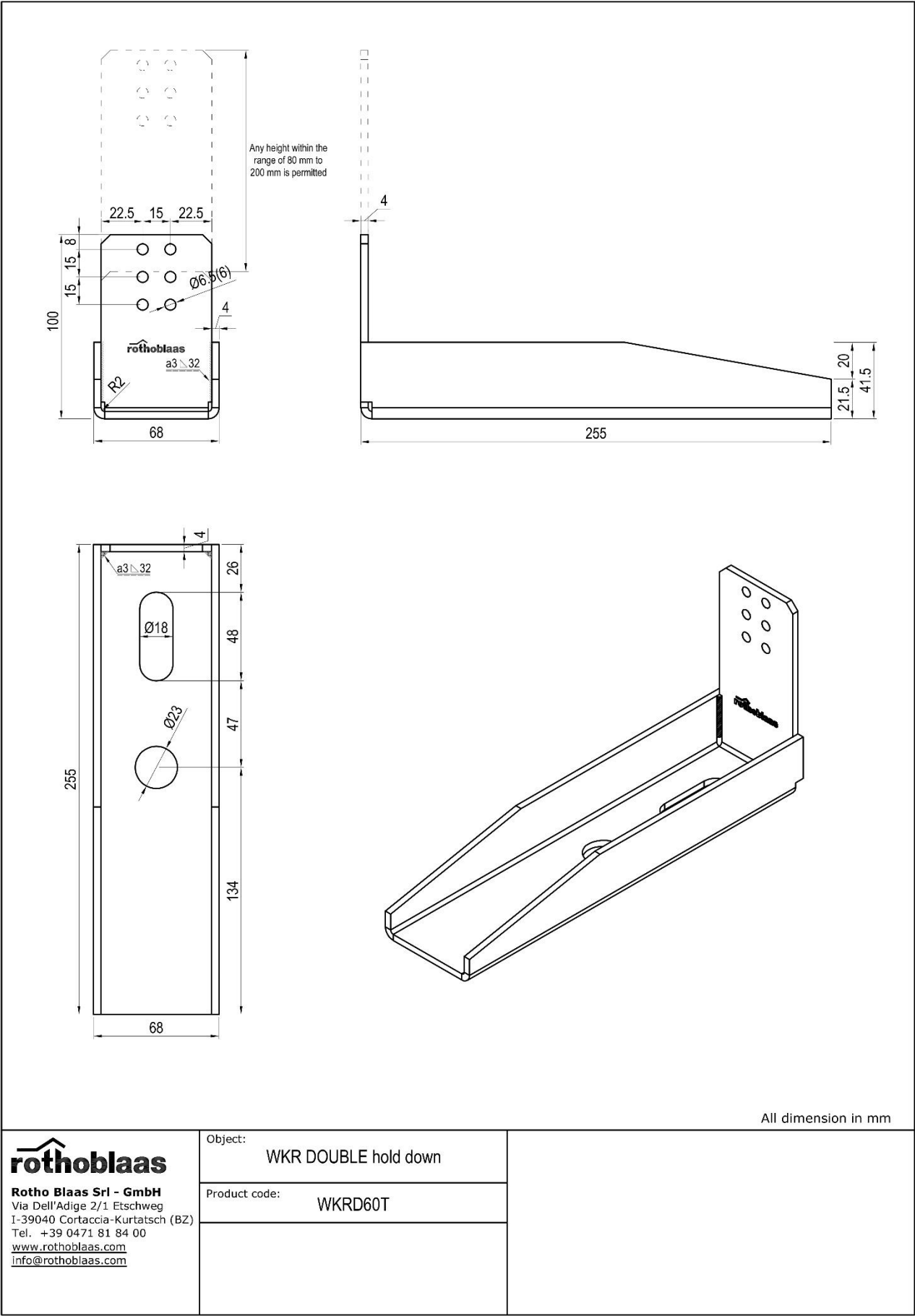


Figure B. 25 Dimensions of Rotho Blaas WKRD100C

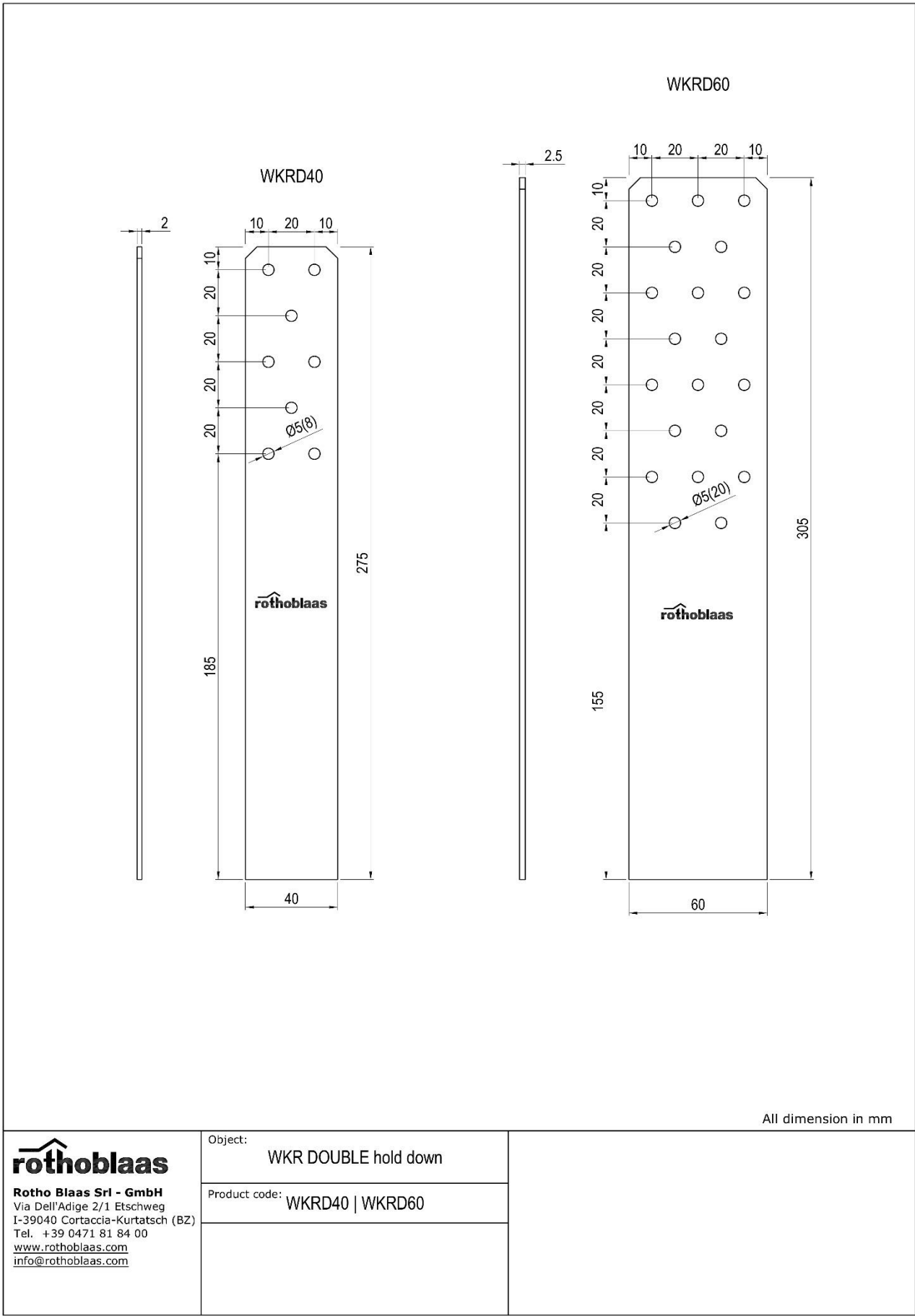


Figure B. 26 Dimensions of Rotho Blaas WKRD40 and WKRD60

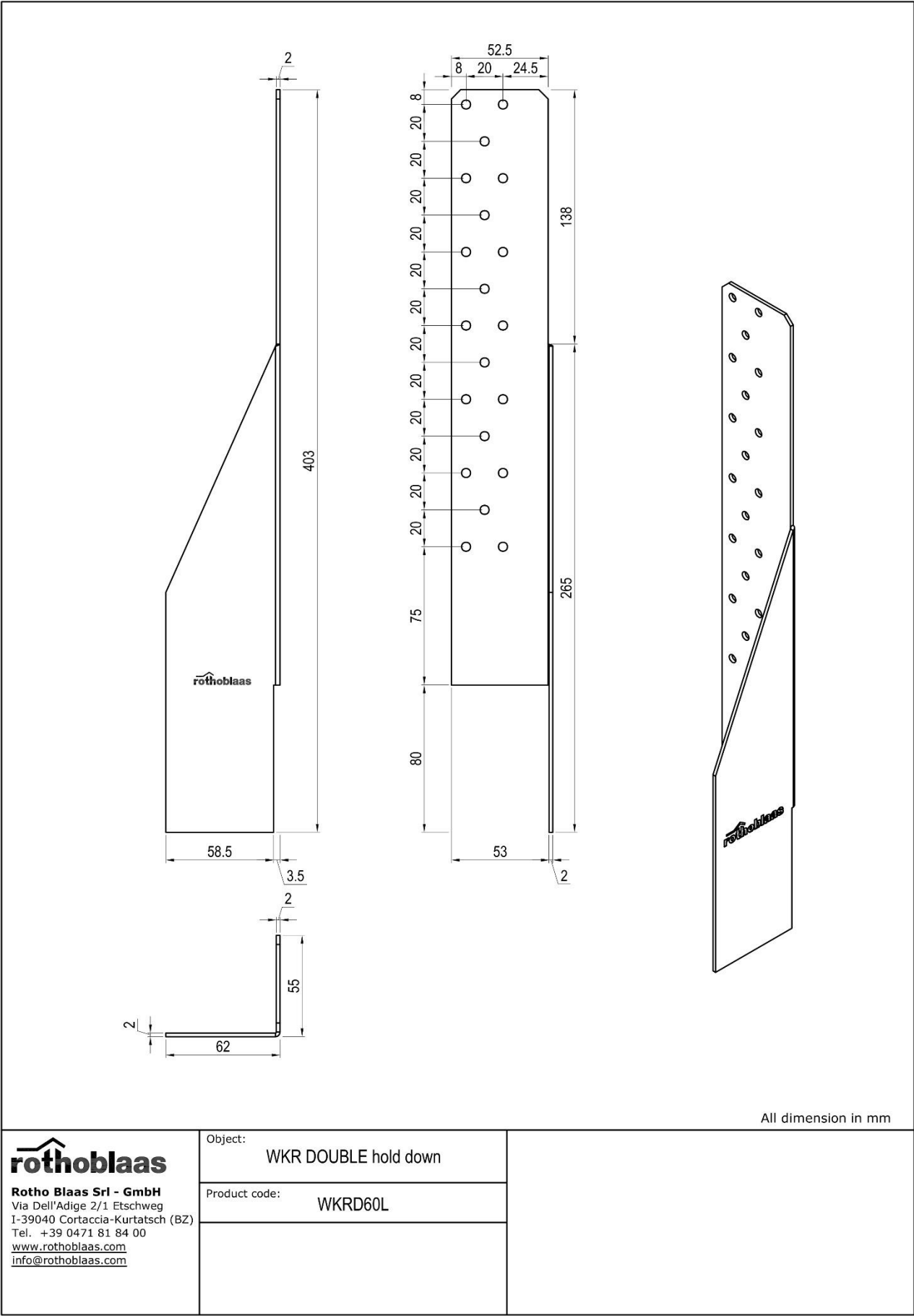


Figure B. 27     Dimensions of Rotho Blaas WKRD60L

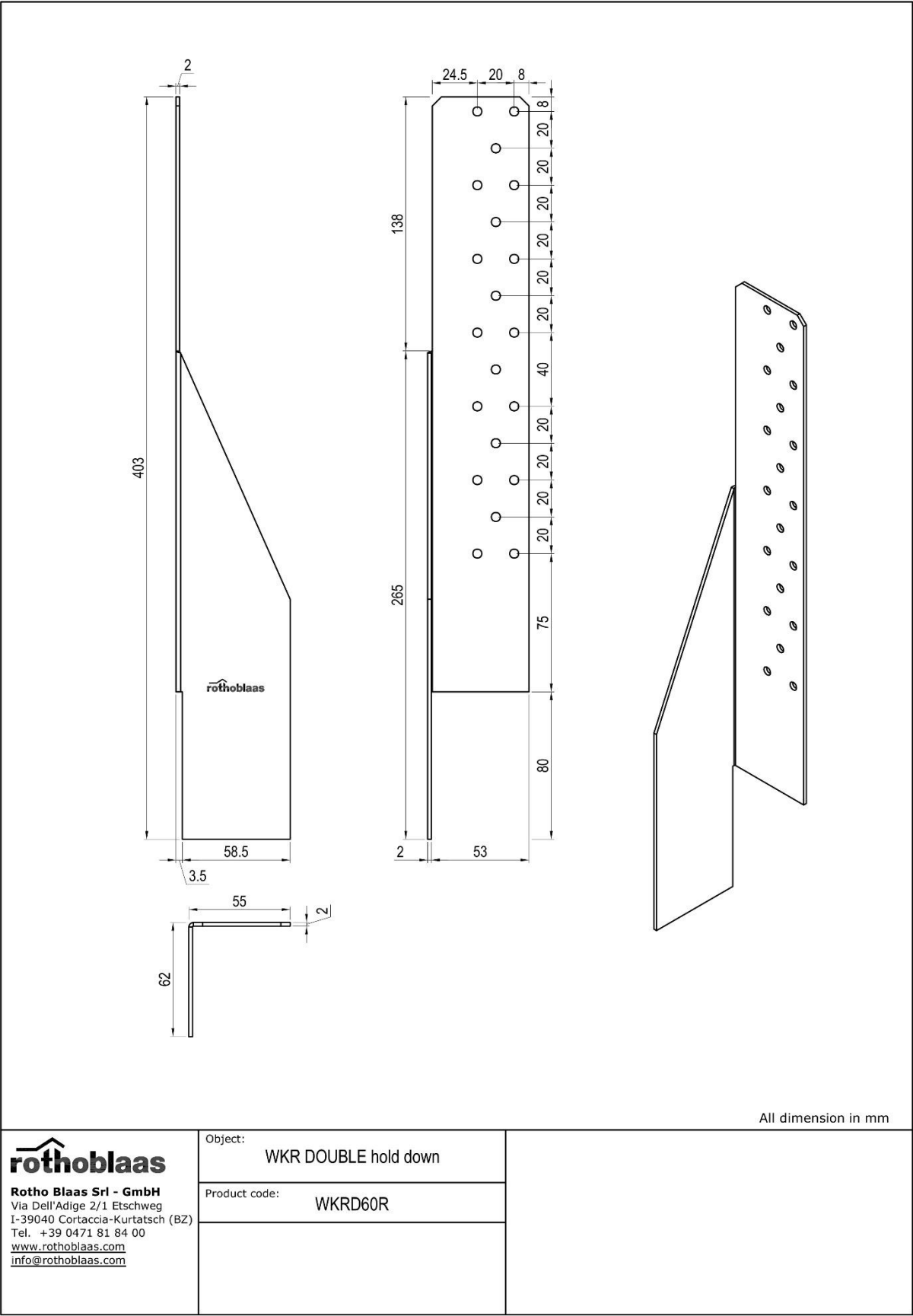


Figure B. 28     Dimensions of Rotho Blaas WKRD60R

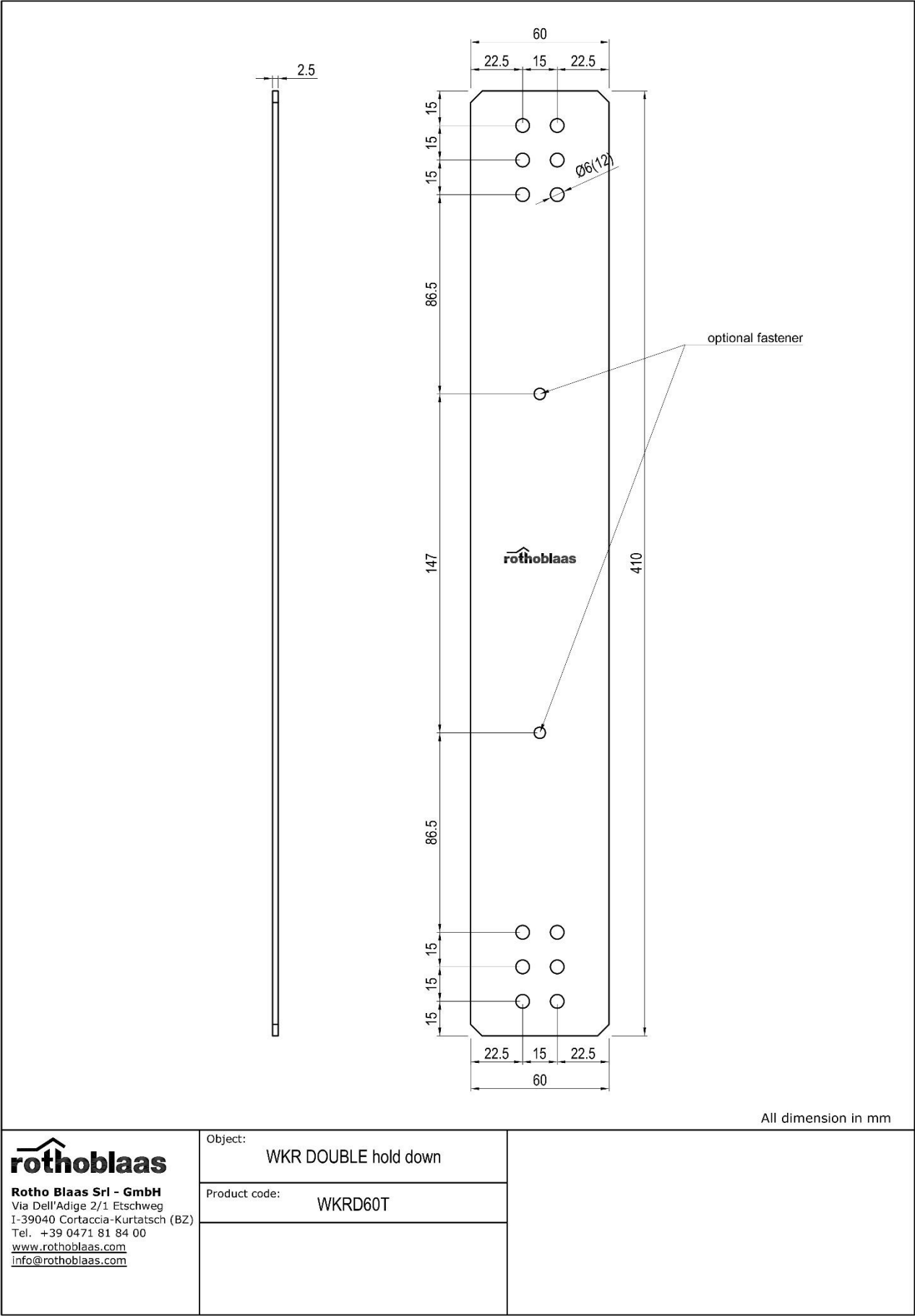


Figure B. 29 Dimensions of Rotho Blaas WKRD60T

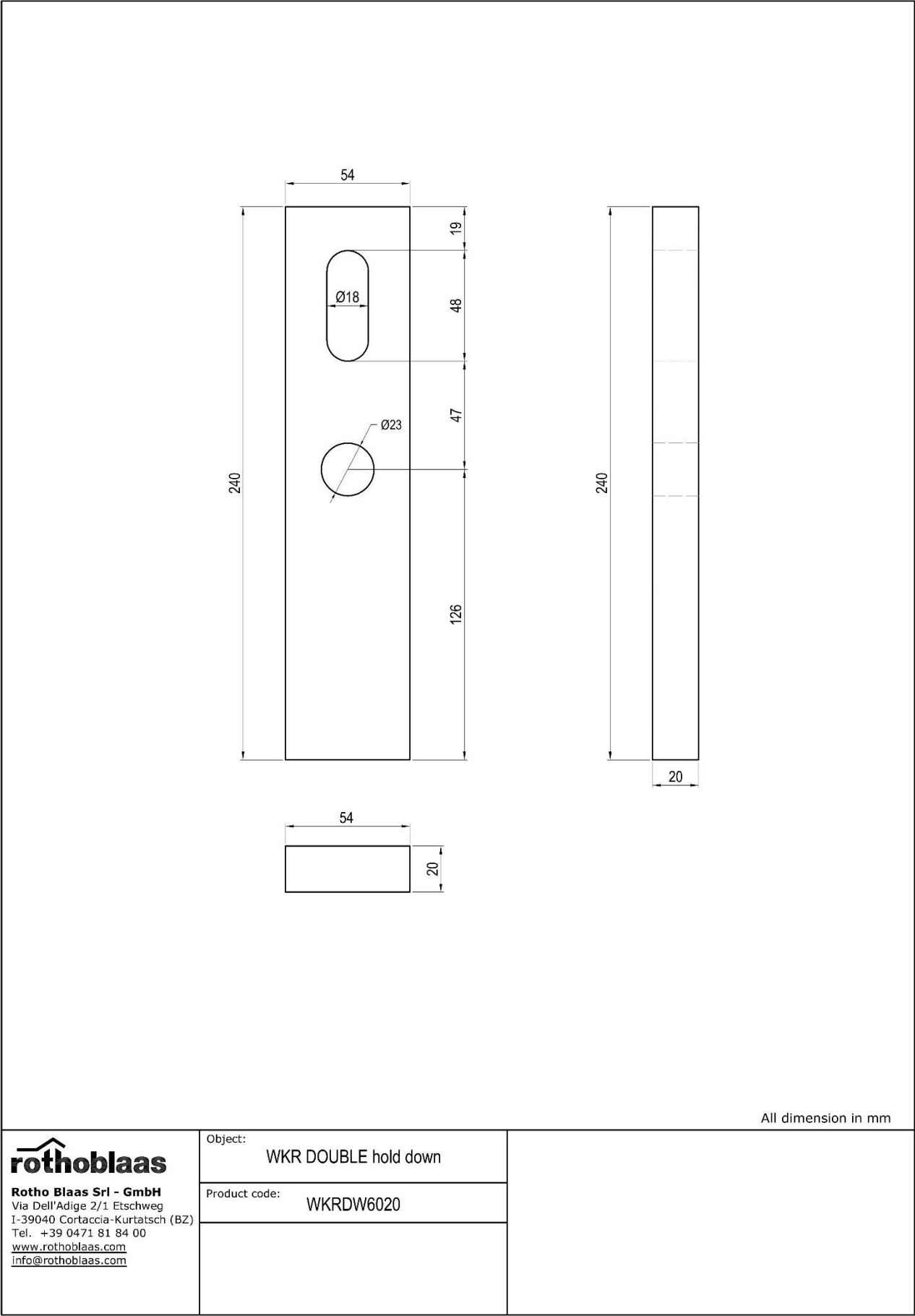


Figure B. 30     Dimensions of Rotho Blaas WKRDW6020

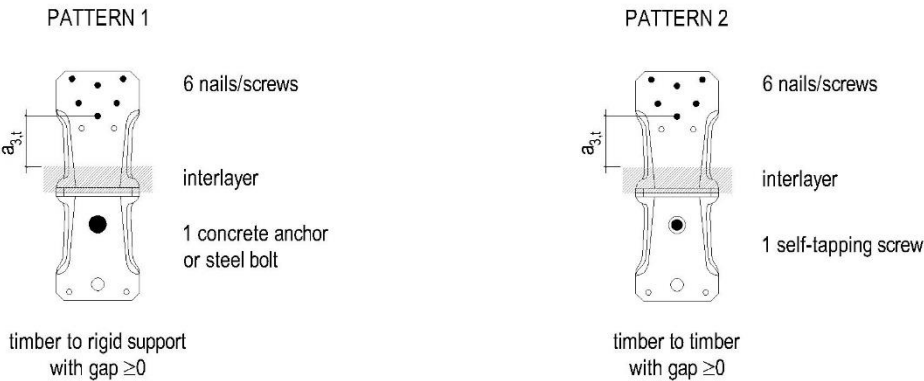


Figure B. 31 Typical installation WKR135



Figure B. 32 Typical installation WKR285

**Nailing pattern for WKR095**



**Nailing pattern for WKR135**

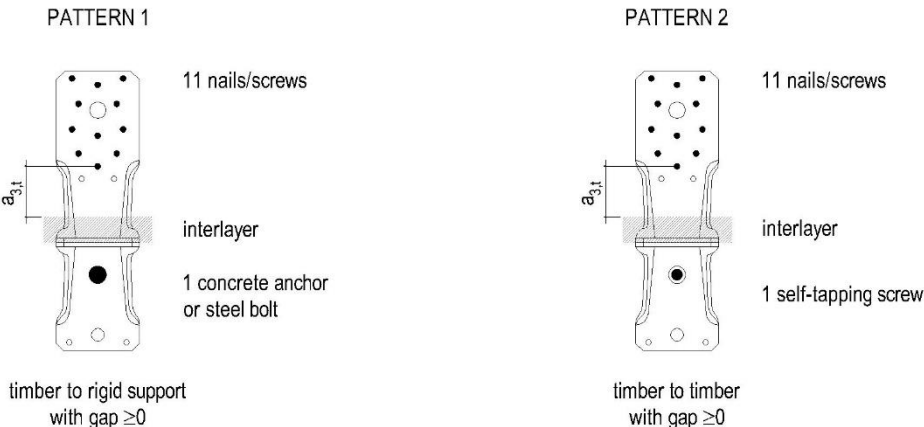


Figure B. 33 Nailing patterns for WKR095 and WKR135

Nailing pattern for WKR215

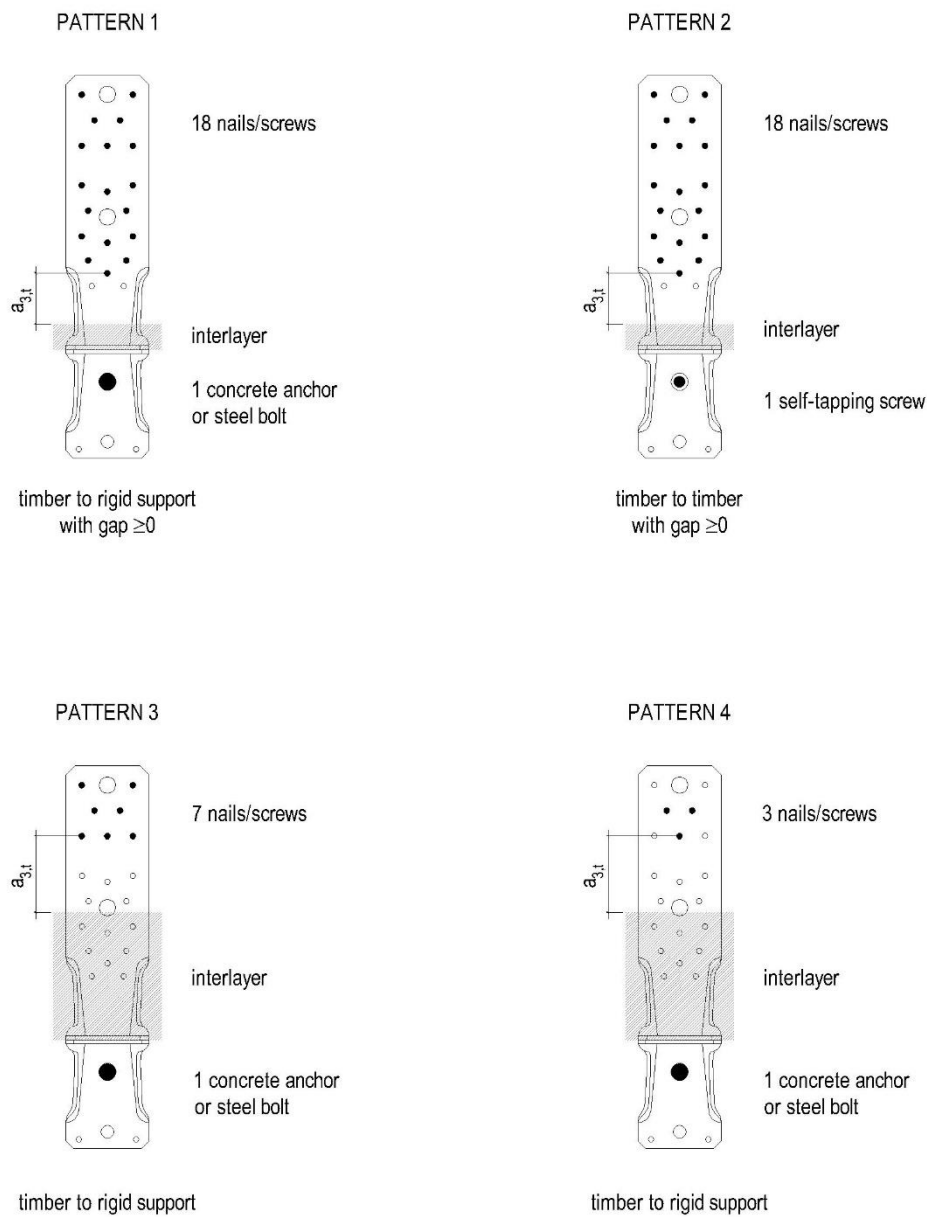


Figure B. 34 Nailing patterns for WKR215



Nailing pattern for WKR285

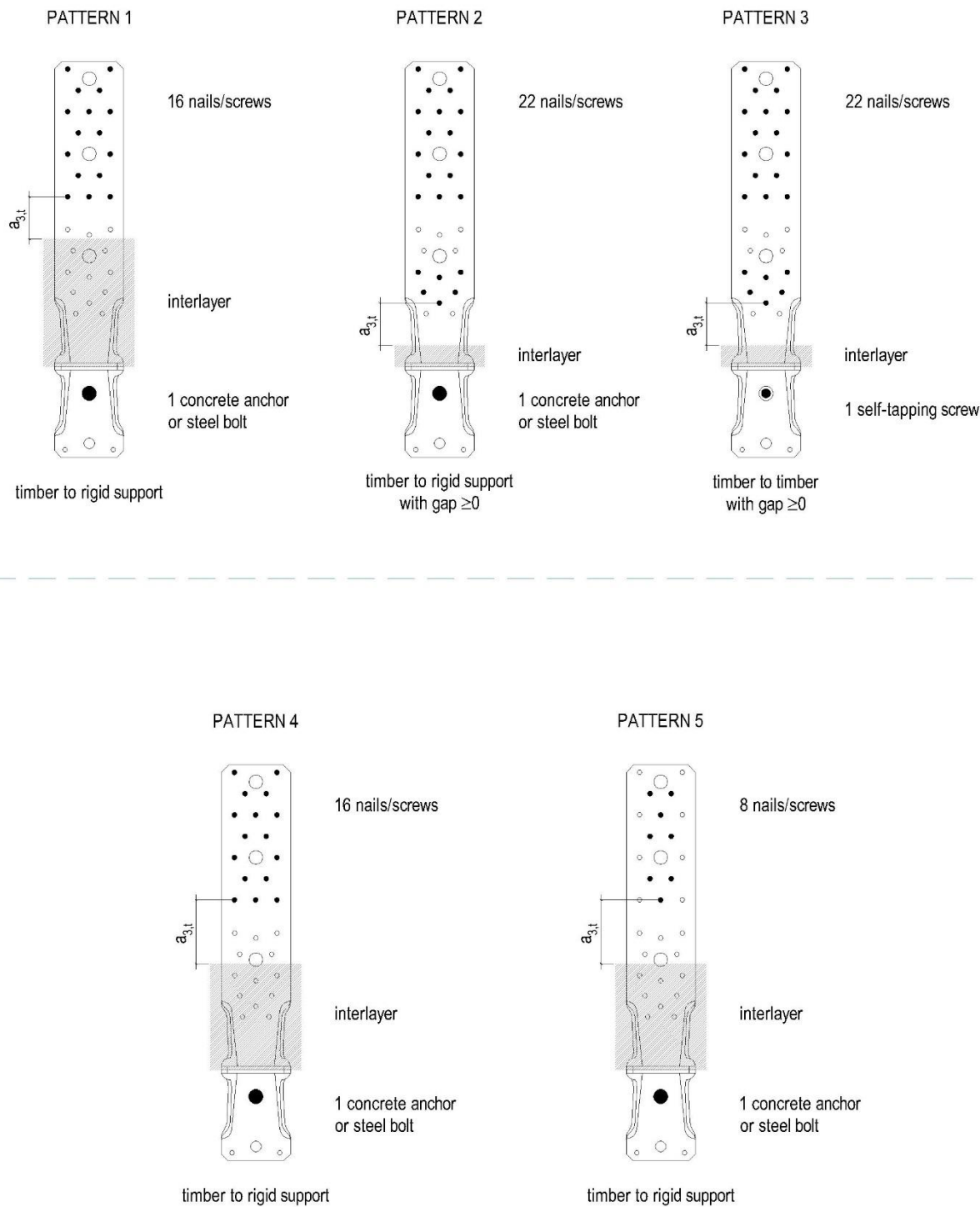
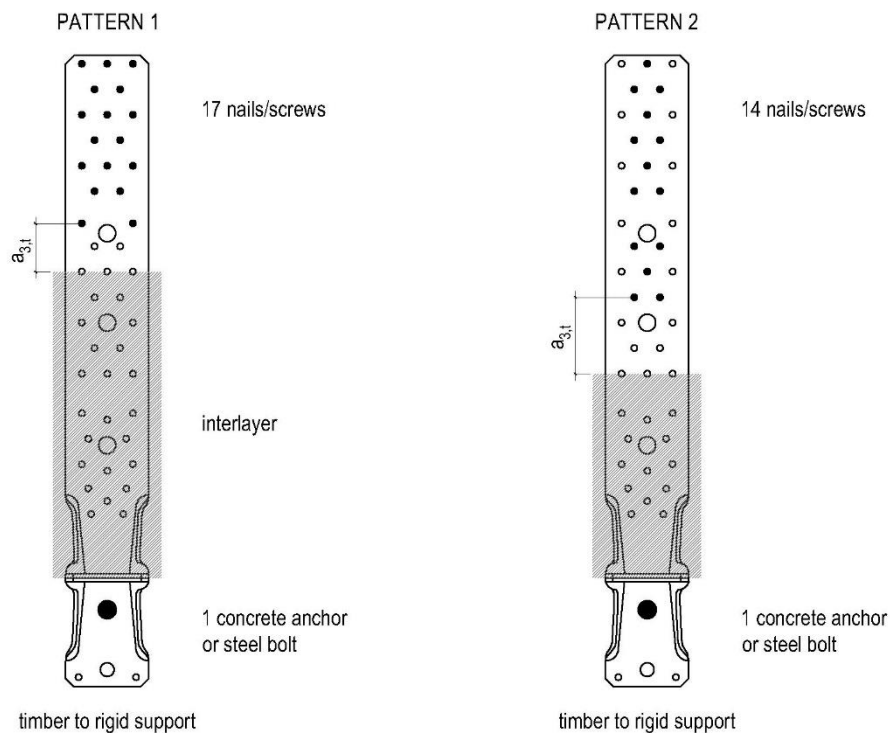


Figure B. 35 Nailing patterns for WKR285

Nailing pattern for WKR410



Nailing pattern for WKR530

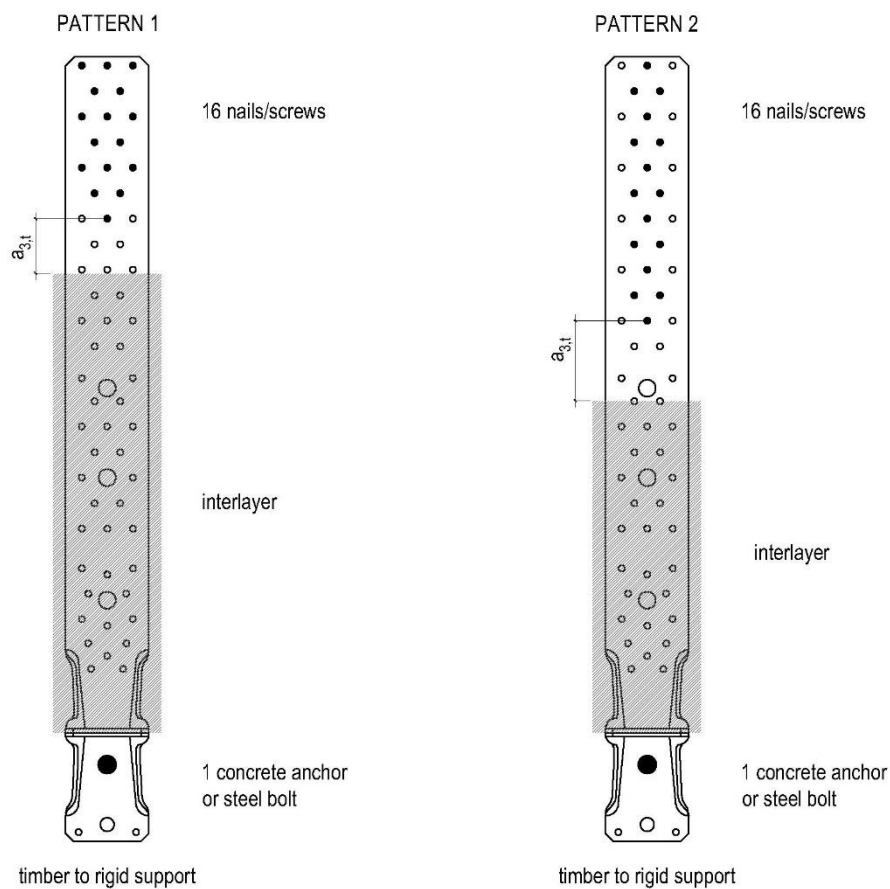
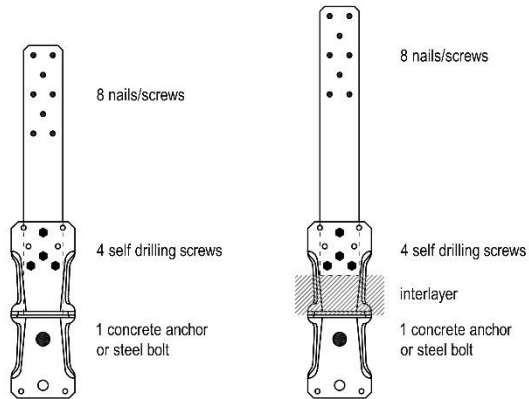


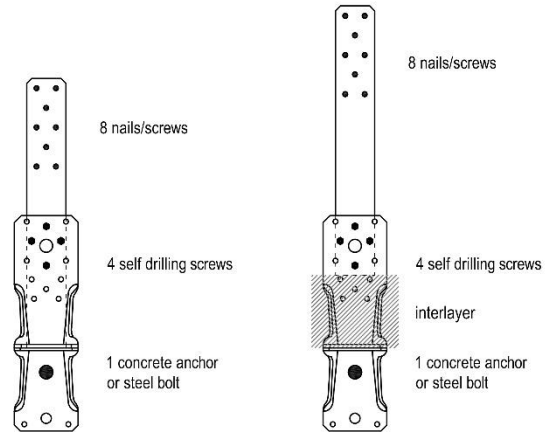
Figure B. 36 Nailing patterns for WKR410 and WKR 530

## Configurations for WKRD40

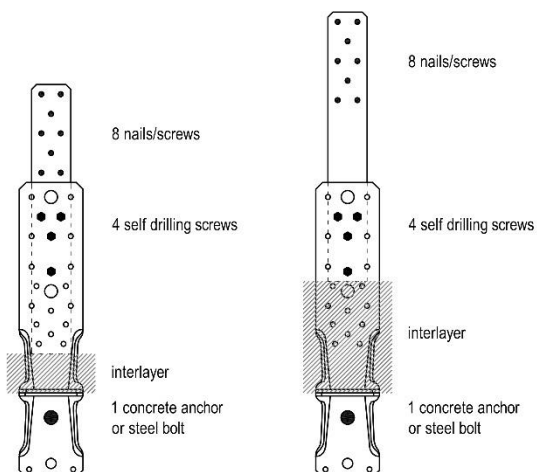
### WKRD40+WKR9530



### WKRD40+WKR13535



### WKRD40+WKR21535



### WKRD40+WKR28535

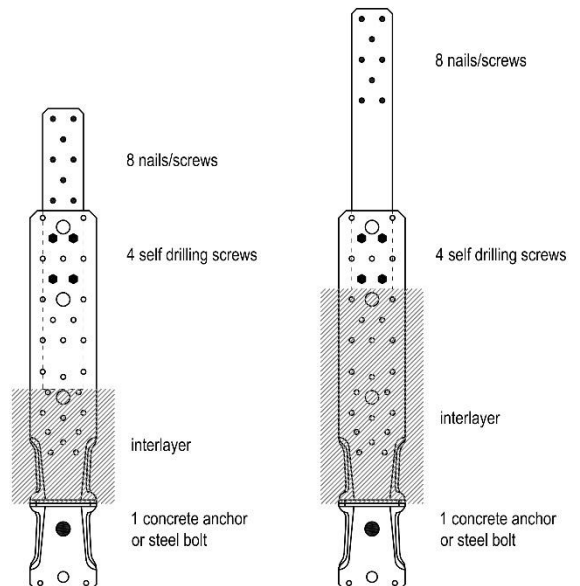
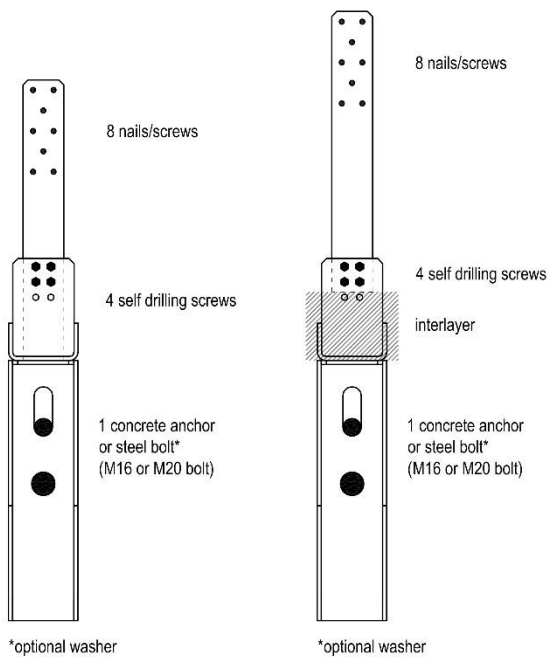


Figure B. 37 Nailing patterns for WKR410 and WKR 530

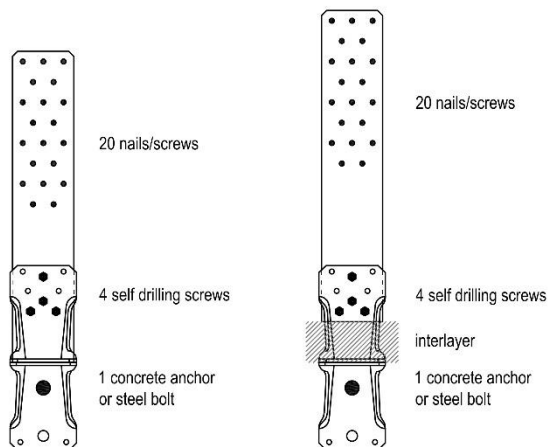
Configurations for WKRD40

WKRD40+WKR100C



Configurations for WKRD60

WKRD60+WKR9530



WKRD60+WKR13535

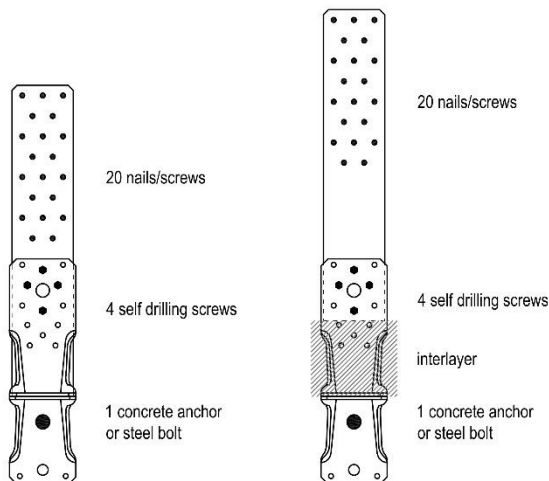
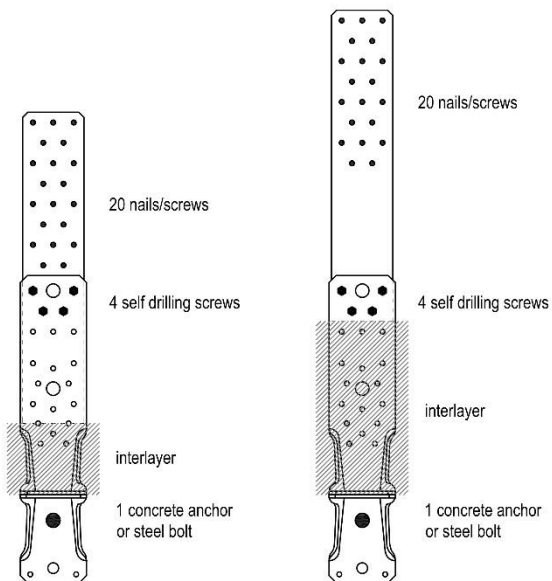


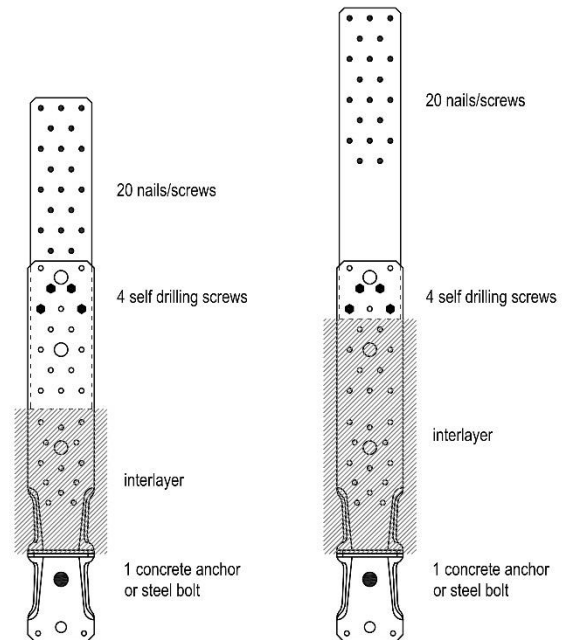
Figure B. 38 Nailing patterns for WKRD40 and WKRD60

## Configurations for WKRD60

### WKRD60+WKR21535



### WKRD60+WKR28535



### WKRD60+WKRD100C

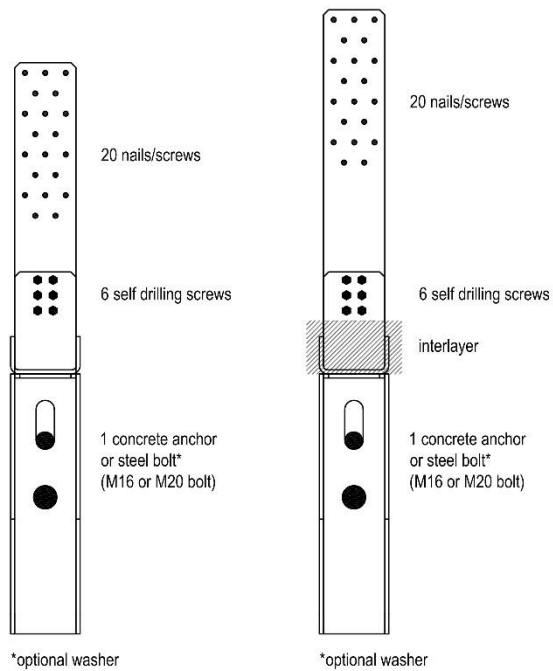
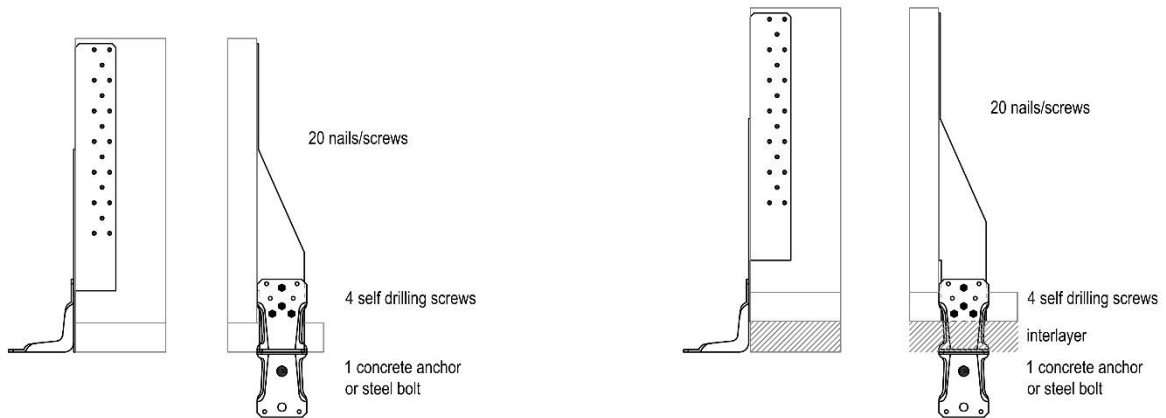


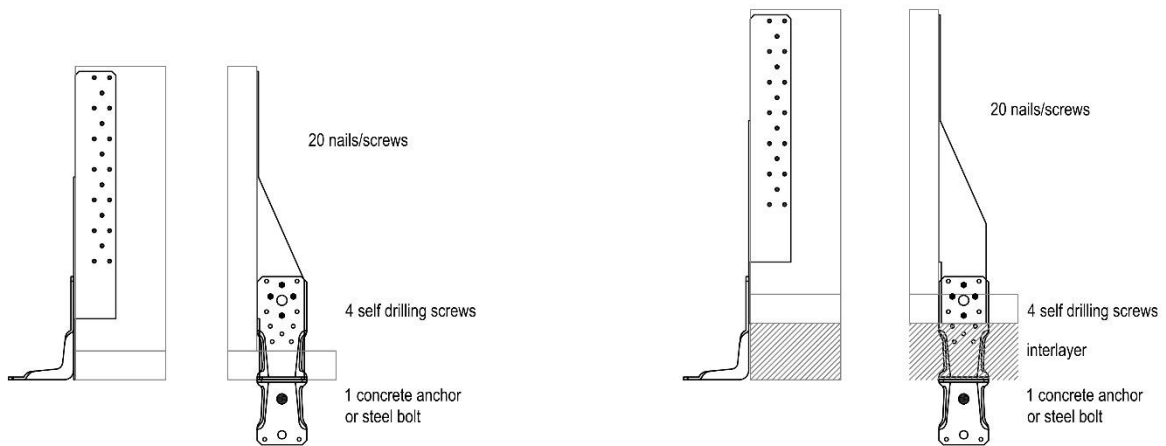
Figure B. 39 Nailing patterns for WKRD60 and WKRD100C

## Configurations for WKRD60L/R

### WKRD60L/R+WKR9530



### WKRD60L/R+WKR13535



### WKRD60L/R+WKR21535

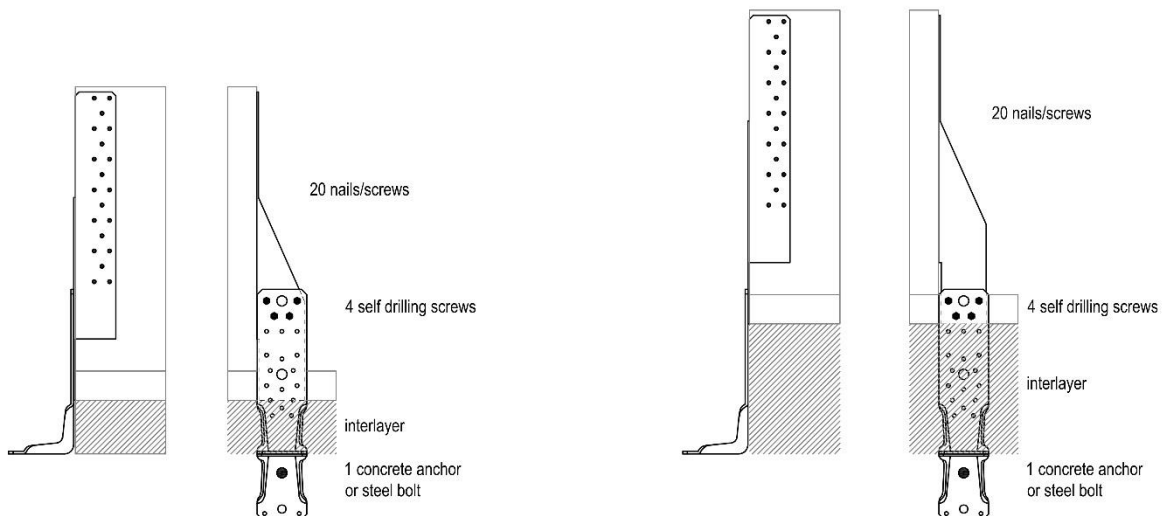
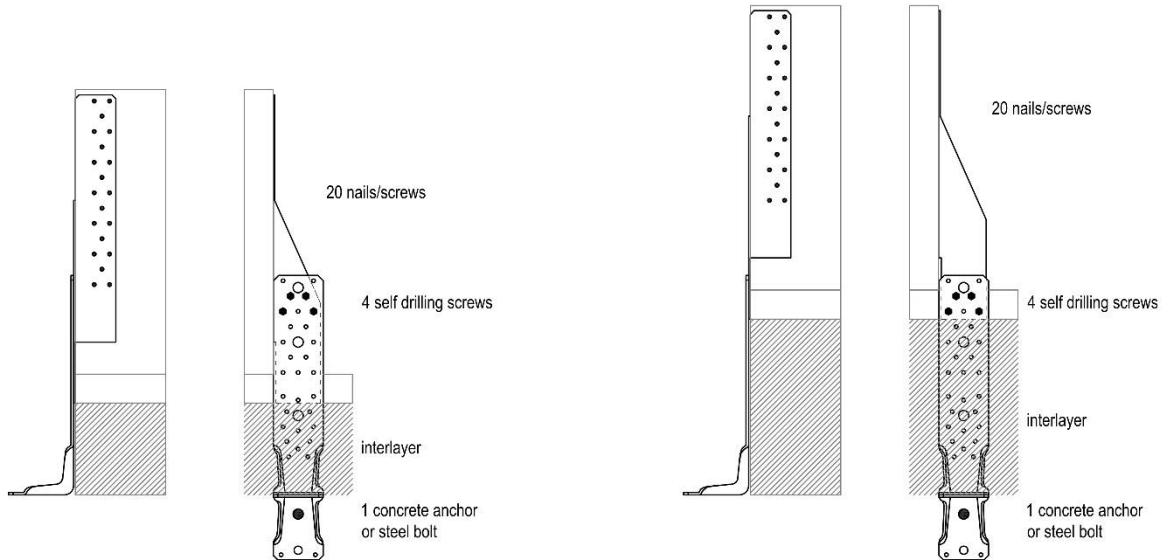


Figure B. 40 Nailing patterns for WKRD60L and WKRD60R

## Configurations for WKRD60L/R

### WKRD60L/R+WKR28535



### WKRD60L/R+WKRD100C

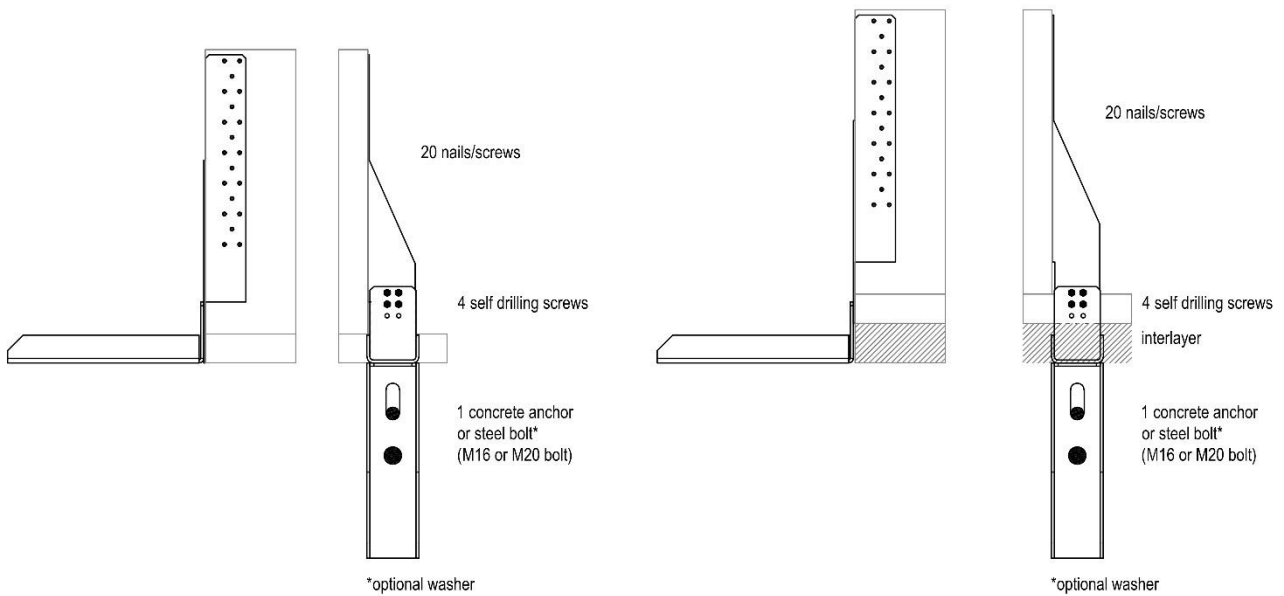
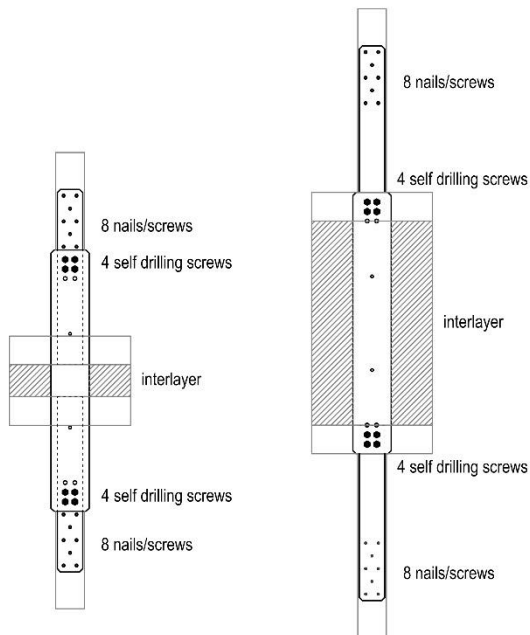


Figure B. 41 Nailing patterns for WKRD60L, WKRD60R and WKRD100C

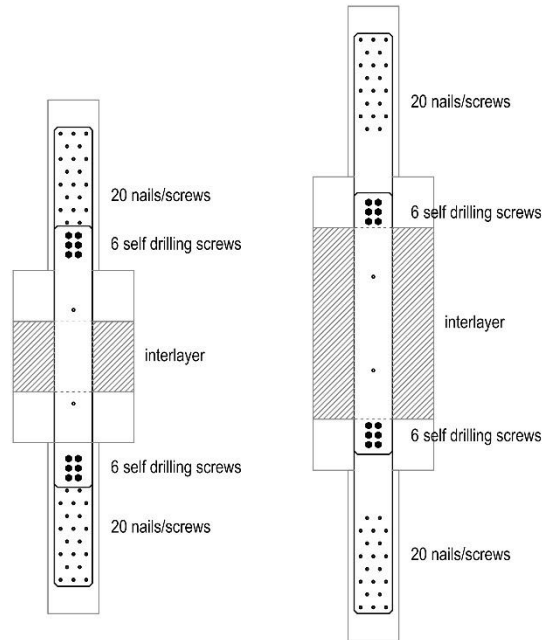


## Configurations for WKRD60L/R

### WKRD40+WKRD60T



### WKRD60+WKRD60T



### WKRD60L/R+WKRD60T

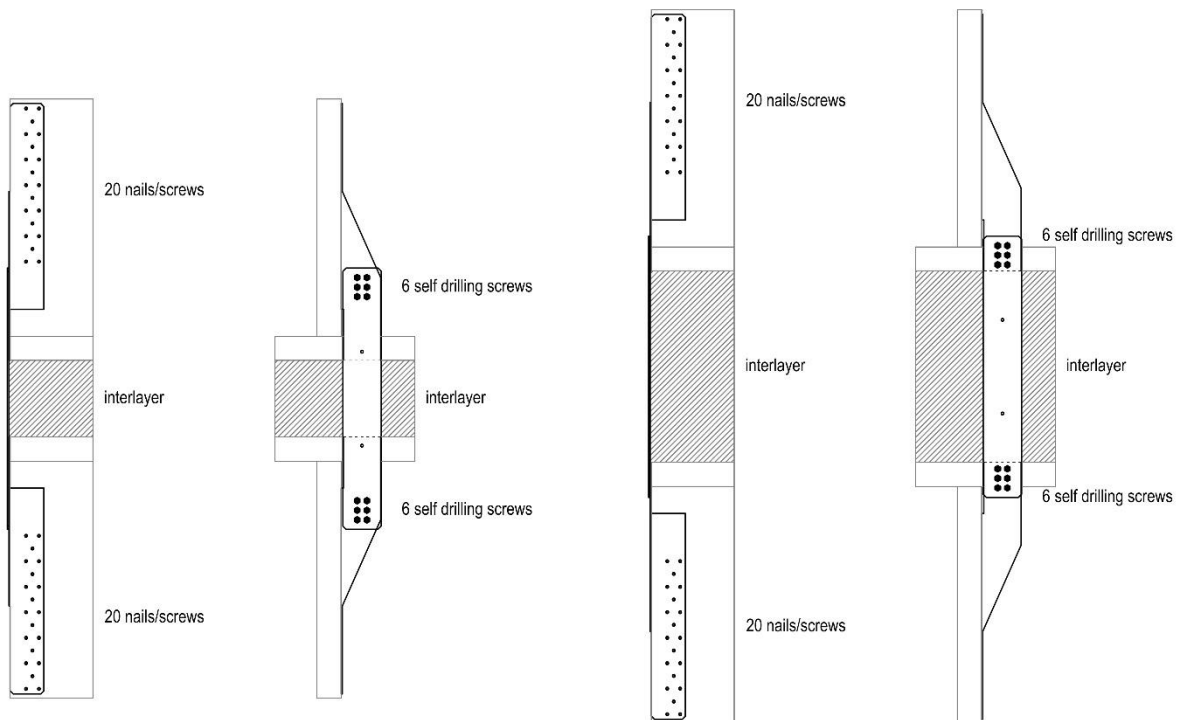


Figure B. 42 Nailing patterns for WKRD40, WKRD60, WKRD60L, WKRD60R and WKRD 60T



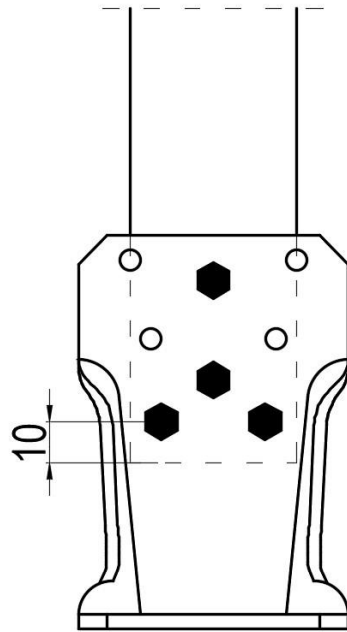


Figure B. 43 Minimum edge distance for self-drilling screws  $\varnothing 6,3$  mm