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

MEMBER OF EOTA

European Technical Assessment ETA-20/0835 of 2021/05/21

I General Part

Technical Assessment Body issuing the ETA and designated according to Article 29 of the Regulation (EU) No 305/2011: ETA-Denmark A/S

Trade name of the construction product:	Rothoblaas ALU START
Product family to which the above construction product belongs:	Three-dimensional nailing plate (Angle Bracket for timber-to-concrete, timber-to-steel or timber-to-timber connections)
Manufacturer:	Rotho Blaas Via Dell'Adige N.2/1 I-39040 Cortaccia (BZ) Italy Internet www.rothoblaas.com
Manufacturing plant:	Rotho Blaas SRL Manufacturing Plants: 1A-2A-3A
This European Technical Assessment contains:	26 pages including 3 Annexes which form an integral part of the document
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of:	European Assessment Document EAD 130186-00-0603 for Three-dimensional nailing plates

II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product and intended use

Technical description of the product
The ALU START connectors are one-piece non- welded, face-fixed angle brackets to be used in connections with timber to a concrete, timber or steel base. The Connectors shall be produced from extruded aluminium alloy. They fixation of construction members made of timber or wood-based products is established with ringed shank nails or Rotho Blaas self- tapping screws according to EN 14592 or ETA-11/0030 and to a concrete or steel base with metal anchors, concrete screws or threaded bars and nuts according to EN 1992-4, EN 1993 or European Technical Assessment or national provisions that apply at the installation site.

Geometry and Material
Dimensions, hole positions are shown in Annex A and typical installations are shown in Annex B. Rotho Blaas "ALU START connectors" are made from aluminium EN AW-6060 T6 or equivalent or better according to EN 755-2.

2 Specification of the intended use in accordance with the applicable EAD

The connectors are intended for the use in connections in load bearing timber structures, such as a connection between wall and slab elements made of a rigid material, where requirements for mechanical resistance and stability and safety in use in the sense of the Basic Works Requirements 1 and 4 of Regulation (EU) 305/2011 shall be fulfilled.

The connection is made with a single angle bracket on one side of the fastened timber member since in contrast to common angle brackets the timber wall element rests on the top part of the ALU START connector (see Annex B and C).

The static behavior of the timber members or the supports shall be as described in Annex A and B.

The wood members may be of solid timber, glued laminated timber and similar glued members, or wood-based structural members with a characteristic density from 290 kg/m^3 to 440 kg/m^3. The wood members may be of Laminated Veneer Lumber (LVL) with a characteristic density up to 550 kg/m^3 with fasteners 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, glued solid timber according to EN 14080
- LVL according to EN 14374 or European Technical Assessment or national provisions that apply at the installation site
- Parallam PSL according to an European Technical Assessment or national provisions that apply at the installation site
- Intrallam LSL according to an European Technical Assessment or national provisions that apply at the installation site
- Cross laminated timber (CLT) according to European Technical Assessment or national provisions that apply at the installation site
- Plywood according to EN 636 or European Technical Assessment or national provisions that apply at the installation site
- Solid wood panels according to EN 13353 or European Technical Assessment or national provisions that apply at the installation site
- Wood-based panels for use in constructions according to EN 13986

Annex B states the load-carrying capacities of the angle bracket connections for a characteristic density of 385 kg/m^3. For connections of timber or wood-based material with a lower or higher characteristic density than 385 kg/m^3 the load-carrying capacities for ALU START connectors can be converted by the factor k_{dens}:

Load case F_1:

$$k_{dens} = \left(\frac{\rho_k}{385}\right)^{0,5} \quad \text{for } \rho_k\ 320\ \text{kg/m}^3 \leq\ 440\ \text{kg/m}^3$$

$$k_{dens} = \left(\frac{\rho_k}{385}\right)^{0,5} \quad \text{for LVL } \rho_k \leq\ 550\ \text{kg/m}^3$$

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

$$k_{dens} = \left(\frac{\rho_k}{385}\right)^{0,8} \text{ for } \rho_k \text{ } 320 \text{ kg/m}^3 \leq \text{ } 440 \text{ kg/m}^3$$

$$k_{dens} = \left(\frac{\rho_k}{385}\right)^{0,5} \text{ for LVL } \rho_k \leq \text{ } 550 \text{ kg/m}^3$$

Where

ρ_k Characteristic density of the timber in [kg/m³]

For CLT with C24 as base material, the values for a characteristic density of 385 kg/m³ should be considered. If a wood-based panel interlayer with a thickness of not more than 26 mm is placed between the connector plate and the timber member, the lateral load-carrying capacity of the screw, respectively, has to consider the effect of the interlayer.

The design of the connections shall be in accordance with the Eurocode 5 or a similar national timber standard. The wood members must have a thickness which is larger than the penetration depth of the fasteners into the structural parts.

The ALU START connectors made of aluminum are for use in timber structures subject to the conditions defined by the service classes 1, 2 and 3 of EN 1995-1-1 (Eurocode 5). Eccentricity of vertical loads onto the profile has to be avoid.

The scope of the connectors 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 angle brackets are intended be used for connections between a timber member and a member of concrete or steel or timber. For connections wood to concrete the connection has to fulfill the rules of Eurocode 2 or other European Technical Assessments or national standards.

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

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

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

Characteristic	Assessment of characteristic
3.1 Mechanical resistance and stability (BWR1)	
Joint strength	See Annex B
Joint stiffness	See Annex B
Joint ductility	No performance assessed
Resistance to seismic actions	No performance assessed
Resistance to corrosion	See 3.6
3.2 Safety in case of fire (BWR2)	
Reaction to fire	The angle brackets are made from aluminum classified as performance class A1 of the characteristic reaction to fire, in accordance with EN 13501-1 and the provisions of Commission Delegated Regulation 2016/364 and EC decision 96/603/EC, amended by EC Decision 2000/605/EC.
Resistance to fire	No performance assessed
3.3 General aspects related to the performance of the product)	The angle brackets have been assessed as having satisfactory durability and serviceability when used in timber structures using the timber species described in EN 1995-1-1 and subject to the conditions defined by service classes 1, 2 and 3

3.4 Methods of verification safety principles and partial factors

The characteristic load-carrying capacities are based on the characteristic values of the nail or screw connections and the aluminum plates and were determined by experimental tests.

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.

To obtain design values the capacities have to be divided by different partial factors for the material properties γ_M, in case of timber failure in addition multiplied with the modification factor k_{mod} to consider different service classes and load-duration classes (EN 1995-1-1).

Thus, the characteristic values of the load-carrying capacities are determined also for timber failure $F_{timber,Rk}$ (obtaining the withdrawal and embedment strength of fasteners subjected to shear or the withdrawal capacity of the most loaded fastener) as well as for aluminum plate failure $F_{alu,Rk}$. The design value of the load-carrying capacity has to considered according to equation (1).

$$F_{Rd} = min\left\{k_{mod} \cdot \frac{F_{timber,Rk}}{\gamma_M}, \frac{F_{alu,Rk}}{\gamma_{M,alu}}\right\} \qquad (1)$$

With

k_{mod}	Modification factor EN 1995-1-1
F_{Rd}	Design value of the strength property
$F_{timber,Rk}$	Characteristic strength of the nails/screws in timber
$F_{alu,Rk}$	Characteristic strength of the aluminum plates
γ_M	Partial factor for timber connections
$\gamma_{M,alu}$	Partial factor for the aluminum parts

Therefore, for timber failure the load duration class and the service class are included. The different partial factors γ_M for aluminum or timber, respectively, are also to be considered correctly.

3.5 Mechanical resistance and stability

The characteristic capacities of the angle brackets are determined by calculation assisted by 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.

Annex B includes the characteristic load-carrying capacities (identifications) in the different directions F_1, $F_{2/3}$, F_4 and F_5.

To ensure to transfer the loads from the ALU START connector to the structural adjoining elements nails or self-tapping screws according to table A.3 must be used.

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

3.6 Aspects related to the performance of the product

3.6.1 Corrosion protection

The angle brackets have been assessed as having satisfactory durability and serviceability when used in timber structures using timber species described in EN 1995-1-1 and subject to the conditions defined by service classes 1, 2 and service class 3.

In accordance with EAD 130186-00-0603 the connectors are produced with:

- Aluminum with a strength class AW-6060 T6 or equivalent or better according to EN 755-2, with a minimum yield strength $R_{p0,2}$ = 140 N/mm² and minimum tensile strength R_m= 170 N/mm

3.9 General aspects related to the intended use of the product

The angle brackets are manufactured in accordance with the provisions of the European Technical Assessment using the manufacturing process as identified during the inspection of the plant by the assessment body issuing the ETA and the notified body and laid down in the technical documentation.

The installation shall be carried out in accordance with Eurocode 5 or an appropriate national code unless, otherwise is defined in the following.

The following provisions apply:

The structural members– the components 1 and 2 shown in the figure on page 17 - to which the brackets are fixed shall be:

- Strength class C20/25 or better for the concrete basement
- 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.
- The minimum nail's end- and edge distances have to be for solid timber at least 40 mm. For CLT panels the end distance must not be considered as it is already included in the profile.
- The connected construction parts must be in contact to ensure that the compression forces in direction F_1 transferred directly over the contact area.
- There are no specific requirements relating to preparation of the timber members.

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

4 Attestation and verification of constancy of performance (AVCP)

4.1 AVCP system

According to the decision 97/176/EC of the European Commission1, as amended, the system(s) of assessment and verification of constancy of performance (see Annex V to Regulation (EU) No 305/2011) is 2+.

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

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

Issued in Copenhagen on 2021-05-21 by

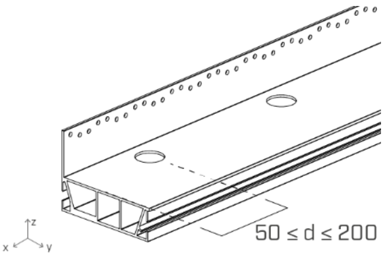
Thomas Bruun
Managing Director, ETA-Danmark

Annex A
Product details and definitions

Table A.1 Specifications of „ALU START“ connectors

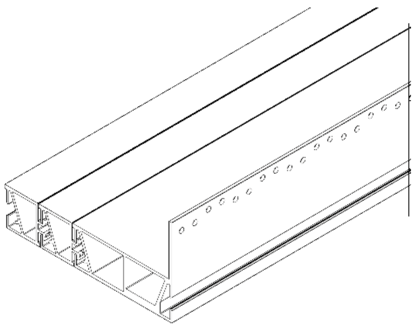
ALU START Type	Reference width [mm]	Dimension bottom part[1)] [b/h] [mm]	Thickness angle bracket [mm]	Material
ALU START 80	80	80/38	3	EN AW-6060 T6
ALU START 100	100	100/38	3	EN AW-6060 T6
ALU START 120	120	120/38	3	EN AW-6060 T6
ALU START 135	135	135/38	3	EN AW-6060 T6
ALU START 155	155	155/38	3	EN AW-6060 T6
ALU START 175	175	175/38	3	EN AW-6060 T6
ALU START 200	200	200/38	3	EN AW-6060 T6
ALU START 35 Extension	35	35/38	no angle bracket	EN AW-6060 T6
[1)] Different ALU START types and dimensions: see Annex C				

ALU START connectors are produced in variable lengths; they can be cut accordingly to the exigences. Resistance and stiffness of the connector can be obtained by multiplying its effective length by the relevant values in Annex B.
However, for load cases other than the compression $F_{1,c}$, the minimum cut length in order to consider ALU START as a load bearing element should be 600mm. Additionally, for load cases other than the compression $F_{1,c}$, the distance d of the anchor from the profile edge has to fulfill the following requirement:



$$50\text{mm} \leq d \leq 200mm$$

ALU START 35 *extension elements* can be installed on a profile to extent its width; on a single profile, a maximum amount of two extension elements can be placed. ALU START 35 needs to be fully supported (e.g. by a concrete foundation) as well as the profile to which is coupled. ALU START 35 element contributes only to the compression resistance of the profile; for further details, see Annex B.



Timber walls to be installed on the profiles can have reduce widths in comparison to the reference width. Moreover, the wall elements can exceed the reference widths following the Table A2 prescription.

Table A.2 Specifications of ALU START connectors

Reference width **[mm]**	**Exceeding width** **[mm]**
80 ≤ w ≤ 120	15
135 ≤ w ≤ 175	20
w ≥ 190	25

Table A.3: Fastener specification for timber parts

Fastener	**Type ALU START**	**Diameter [mm]**	**Minimum length [mm]**	**Minimum threaded length [mm]**	**Amount**
Ringed shank nails 4.0 mm according to EN 14592 or ETA	all types	4,0	60	50	see nailing pattern (Annex C)
Rotho Blaas self-tapping screws 5,0 mm, type LBS, according to ETA-11/0030	all types	5,0	50	46	see nailing pattern (Annex C)

Table A.4: Fastener specification for steel parts

Bolts diameter	**Correspondent hole diameter [mm]**	**Bolts type**
12,0 mm	Max. 2mm larger than the anchor diameter	See specification of the manufacturer

Table A.5: Fastener specification for concrete parts

Metal anchors diameter	**Correspondent hole diameter [mm]**	**Anchors type**
12,0 mm	Max. 2mm larger than the anchor diameter	See specification of the manufacturer

Annex B
Characteristic load-carrying capacities and slip modules

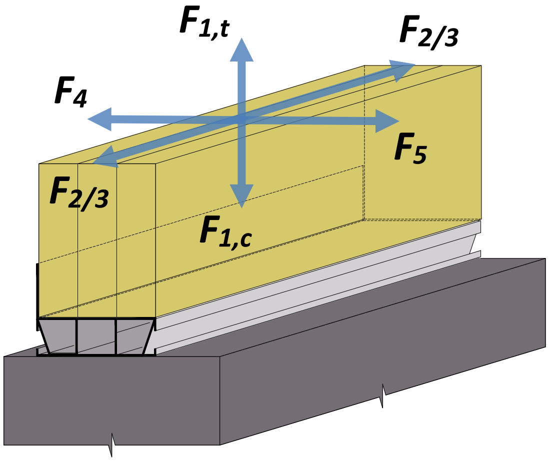


Figure B.1: Definition of forces and their directions

Table B.1: Characteristic compression resistance $F_{1,c}$

ALU START	Reference width [mm]	Aluminum	
		$F_{1,c,Rk}$ [kN/m]	$f_{1,c,Rk}$ [MPa]
35	-	88,8	2,54
80	80	504,2	6,30
100	100	630,2	6,30
120	120	961,1	80,1
100+35	135	719,0	6,30 [1)] +2,54 [2)]
135	135	1062,3	7,87
120+35	155	1049,9	8,01 [1)] +2,54 [2)]
155	155	1435,8	9,26
175	175	1540,6	8,80
155+35	190	1534,6	9,26 [1)] +2,54 [2)]
200	200	1449,2	7,25
175+35	210	1639,4	8,80 [1)] +2,54 [2)]
200+35	235	1538,0	7,25 [1)] +2,54 [2)]

[1)] Value referred to the main profile
[2)] Value referred to the extension profile ALU START 35

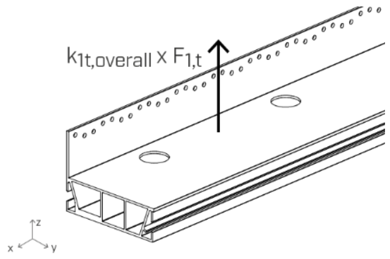
If the wall element to be fixed on one ALU START model has a different width from the reference value in the table, the value $f_{1,c,Rk}$ has to be used on the timber part in contact with the profile.

Table B.2: Characteristic tensile resistance $F_{1,t}$ and slip moduli, connection timber/foundation

ALU START	Timber			Aluminum	Foundation			Stiffness
	Nailing pattern	$F_{1,t,timber,Rk}$[1)] [kN/m]		$F_{1,t,timber,Rk}$[1)] [kN/m]	$k_{1,t,\ overall}$[1)] [-]			$K_{1,t,ser}$[1)] [N/mm*m]
		CLT	Other solid Timber		C25/30	Steel	Timber	
80	Total	130,0	113,5	102,0	1,88	1,86	2,13	7200
	Pattern 1	64,5	56,0					
	Pattern 2	42,0	36,5					
	Pattern 3	31,0	27,0					
100	Total	130,0	113,5		1,62	1,57	1,94	
	Pattern 1	64,5	56,0					
	Pattern 2	42,0	36,5					
	Pattern 3	31,0	27,0					
120	Total	130,0	113,5		1,44	1,42	1,76	
	Pattern 1	64,5	56,0					
	Pattern 2	42,0	36,5					
	Pattern 3	31,0	27,0					
135	Total	130,0	113,5		1,62	1,57	1,94	
	Pattern 1	64,5	56,0					
	Pattern 2	42,0	36,5					
	Pattern 3	31,0	27,0					
155	Total	130,0	113,5		1,27	1,27	1,28	
	Pattern 1	64,5	56,0					
	Pattern 2	42,0	36,5					
	Pattern 3	31,0	27,0					
175	Total	130,0	113,5		1,23	1,23	1,24	
	Pattern 1	64,5	56,0					
	Pattern 2	42,0	36,5					
	Pattern 3	31,0	27,0					
200	Total	130,0	113,5		1,19	1,19	1,20	
	Pattern 1	64,5	56,0					
	Pattern 2	42,0	36,5					
	Pattern 3	31,0	27,0					

[1)] No influence of mortar layers up to 30 mm, no influence of the extension profile ALU START 35

Explanation for table B.2



$$N_{Ed,z,bolts} = F_{1,t} \cdot k_{1,t,overall}$$

In the B.2 table, it is assumed that the timber element is prevented from the rotation. If this cannot be fulfilled in the design, the following expression should be used to determine the profile load bearing capacity:

$$\frac{F_{1,t,Ed}}{t_w \cdot l \cdot \frac{f_y}{\gamma_{M1}}} + \frac{3 \cdot F_{1,t,Ed} \cdot (t + t_w)}{{t_w}^2 \cdot l \cdot \frac{f_y}{\gamma_{M1}}} \leq 1$$

Where

t	Width of the timber element
t_w	Width of the vertical plate
l	Length of the profile
f_y	Yield strength of the aluminium
$F_{1,t,Ed}$	Design tension load according to EN 1990
γ_{M1}	Partial factor for aluminium tension failure, EN 1999-1-1

Table B3: Characteristic $F_{2/3}$ shear loads

ALU START	Timber			Foundation		
	Nailing pattern	$F_{2/3,Rk}$ [1) [kN/m]		$e_{y,bolts}$ [mm]	$e_{z,bolts}$ [mm]	$e_{z,fasteners}$ [mm]
		CLT	Solid Timber			
80	Total	112,4	-	29,5	80,5	42,5
	Pattern 1	55,4	48,22			
	Pattern 2	36,4	31,69			
	Pattern 3	26,9	23,42			
100	Total	112,4	-			
	Pattern 1	55,4	48,22			
	Pattern 2	36,4	31,69			
	Pattern 3	26,9	23,42			
120	Total	105,9	-			
	Pattern 1	52,2	45,42			
	Pattern 2	34,3	29,85			
	Pattern 3	25,3	22,06			
135	Total	102,0	-			
	Pattern 1	50,2	43,73			
	Pattern 2	33,0	28,74			
	Pattern 3	24,4	21,24			
155	Total	96,7	-			
	Pattern 1	47,7	41,49			
	Pattern 2	31,3	27,27			
	Pattern 3	23,1	20,15			
175	Total	90,2	-			
	Pattern 1	44,4	38,69			
	Pattern 2	29,2	25,42			
	Pattern 3	21,6	18,79			
200	Total	78,4	-			
	Pattern 1	38,6	33,64			
	Pattern 2	25,4	22,11			
	Pattern 3	18,7	16,34			

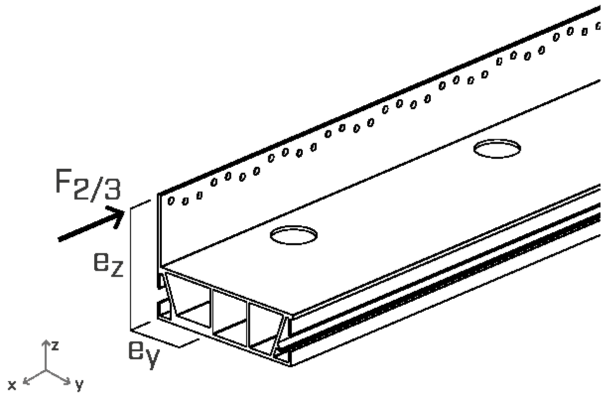
[1) No influence of mortar layers up to 30 mm, no influence of the extension profile ALU START 35

Depending on the nailing pattern the slip modules in SLS in shear should calculated like following:

Table B4: Slip modules, direction $F_{2/3}$ shear loads

Nailing pattern	Slip modules $K_{2/3,ser}$ [1) [N/mm*m]
Total	12000
Pattern 1	8000
Pattern 2	4000
Pattern 3	3000

Explanation for table B.3



$$V_{Ed,x,bolts} = F_{2/3}$$

$$M_{Ed,z,bolts} = F_{2/3} \cdot e_y$$

$$M_{Ed,y,bolts} = F_{2/3} \cdot e_z$$

In the B.3 table, it is assumed that the timber element is prevented from the rotation. If this cannot be fulfilled in the design, the following expression should be used to determine the profile load bearing capacity:

$$\frac{F_{2/3,Ed}}{l \cdot t_w \cdot \frac{f_y}{\gamma_{M1}}} + \frac{3 \cdot F_{2/3,Ed} \cdot (t + t_w)}{{t_w}^2 \cdot h_f \cdot \frac{f_y}{\gamma_{M1}}} + \frac{6 \cdot F_{2/3,Ed} \cdot e_{z,nails}}{t_w \cdot {h_f}^2 \cdot \frac{f_y}{\gamma_{M1}}} \leq 1$$

Where

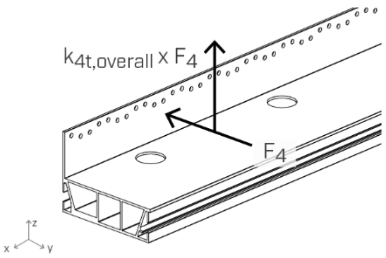
t	Width of the timber element
l	Length of the profile
t_w	Width of the vertical plate
h_f	Height of the vertical plate
$e_{z,nails}$	Vertical eccentricity of nails
f_y	Yield strength of the aluminium
$F_{2/3,Ed}$	Design shear load according to EN 1990
γ_{M1}	Partial factor for aluminium, according to EN 1999-1-1

Table B5: Characteristic F_4 shear loads and slip modules

ALU START	Timber				
	$F_{4,Rk}$ 1) [kN/m]	$k_{4t,\ overall}$ 1) [-]			$K_{4,ser}$ 1) [N/mm*m]
		C25/30	Steel	Timber	
All	100	1,84	1,94	1,87	27000

1) No influence of mortar layers up to 30 mm, no influence of the extension profile ALU START 35. The minimum strength class of the mortar has to be M10 according to EN 998-2

Explanation for table B.5



$$N_{Ed,z,bolts} = F_{4,Ed} \cdot k_{4t,overall}$$

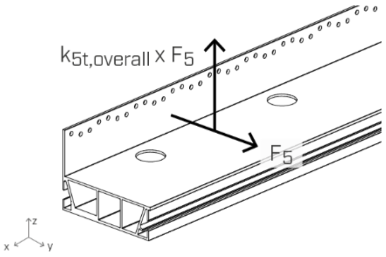
$$V_{Ed,y,bolts} = F_{4,Ed}$$

Table B5: Characteristic F_5 shear loads and slip modules

ALU START	Timber						
	Nailing pattern	$F_{5,Rk,}$ nails 1) [kN/m]	$F_{5,Rk,}$ screws 1) [kN/m]	$k_{5t,\ overall}$ 1) [-]			$K_{5,ser,Rk}$ 1) [N/mm*m]
				C25/30	Steel	Timber	
80	Total	25,8	25,8	1,83	1,83	1,81	-
	Pattern 1						-
	Pattern 2	18,9					-
	Pattern 3	13,5	21,1				-
100	Total	25,8	25,8	1,53	1,53	1,39	5500
	Pattern 1						-
	Pattern 2	18,9					-
	Pattern 3	13,5	21,1				-
120	Total	25,8	25,8	1,39	1,39	2,77 2,49	-
	Pattern 1						-
	Pattern 2	18,9					-
	Pattern 3	13,5	21,1				-
135	Total	25,8	25,8	1,43	1,37	2,01	-
	Pattern 1						-
	Pattern 2	18,9					-
	Pattern 3	13,5	21,1				-
155	Total	25,8	25,8	1,34	1,29	1,64	-
	Pattern 1						-
	Pattern 2	18,9					-
	Pattern 3	13,5	21,1				-
175	Total	25,8	25,8	1,28	1,24	1,46	-
	Pattern 1						-
	Pattern 2	18,9					-
	Pattern 3	13,5	21,1				-
200	Total	25,8	25,8	1,22	1,20	1,31	-
	Pattern 1						-
	Pattern 2	18,9					-
	Pattern 3	13,5	21,1				-

1) No influence of mortar layers up to 30 mm, no influence of the extension profile ALU START 35. The minimum strength class of the mortar has to be M10 according to EN 998-2

Explanation for table B.5

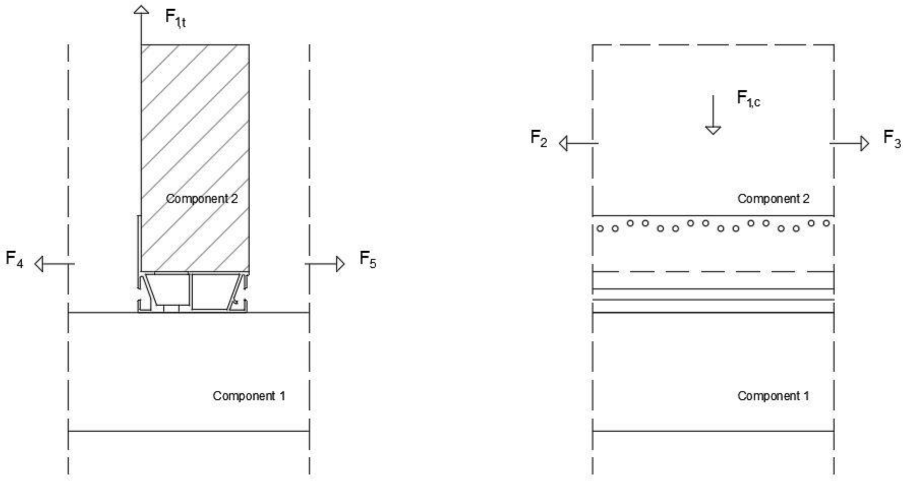


$$N_{Ed,z,bolts} = F_{5,Ed} \cdot k_{5t,overall}$$

$$V_{Ed,y,bolts} = F_{5,Ed}$$

Definitions of forces, their directions and eccentricity

Single angle bracket per connection



Acting forces

$F_{1,c}$ Compression force acting in the central axis of the wall fixed.

$F_{1,t}$ Lifting force acting in the central axis of the angle bracket. The component 2 shall be prevented from rotation. If the component 2 is not prevented from rotation, the force is assumed to act in the central axis of the wall element; the load-carrying capacity expression is given in the commentary of Table B2.

F_2 and F_3 Lateral force acting in the central axis of the angle bracket. The component 2 shall be prevented from rotation. If the component 2 is not prevented from rotation, the force is assumed to act in the central axis of the wall element; the load-carrying capacity expression is given in the commentary of Table B3.

F_4 and F_5 Lateral force acting in the component 1 direction along the central axis of the joint. The components must be prevented from rotation. F_4 causes compression between the angle bracket and component 2; F_5 causes tension between the angle bracket and component 2.

Wane

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

Timber splitting

For the lifting force $F_{1,t}$ 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 has to be considered with the help of equation **Fejl! Henvisningskilde ikke fundet.**

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

Or (2)

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

The forces F_4 and F_5 are forces with opposite direction. Therefore, only one force, F_4 or F_5, is able to act simultaneously with F_1 and $F_{2/3}$ while the other shall be set to zero.

For the ultimate limit state the slip modules in Table B.1 should be calculated according to equation (2)

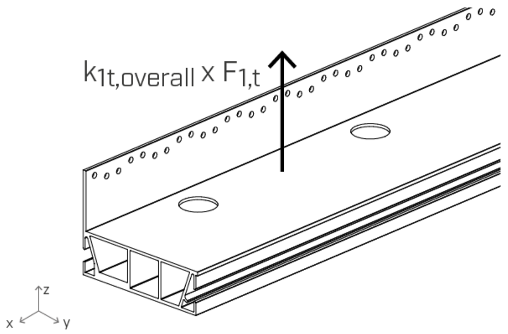
$$K_u = \frac{2}{3} \cdot K_{ser} \qquad (2)$$

Once the loads acting in different directions on the connection have been verified by equation (2), all the loads have to be applied simultaneously to the bolts/anchors in order to verify the load carrying capacity. The following parts explain how to consider the eccentricity effects when calculating the load acting on the bolt/anchor connection.

Bolts / anchors design

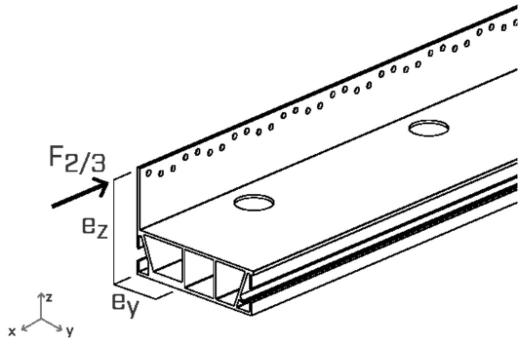
The loads acting on the whole bolted connection needed to design the connection are the following:

F_1



$$N_{Ed,z,bolts} = F_{1,t,Ed} \cdot k_{1,t,overall}$$

$F_{2/3}$

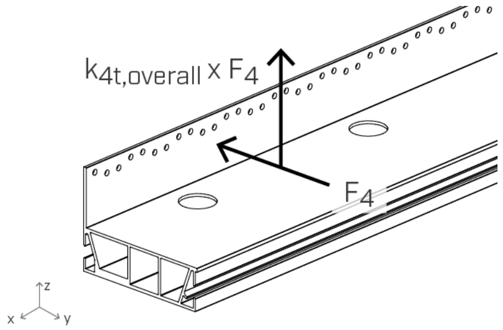


$$V_{Ed,x,bolts} = F_{2/3,Ed}$$

$$M_{Ed,z,bolts} = F_{2/3,Ed} \cdot e_y$$

$$M_{Ed,y,bolts} = F_{2/3,Ed} \cdot e_z$$

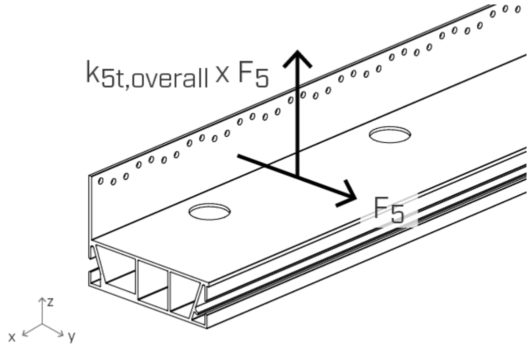
F_4



$$N_{Ed,z,bolts} = F_{4,Ed} \cdot k_{4t,overall}$$

$$V_{Ed,y,bolts} = F_{4,Ed}$$

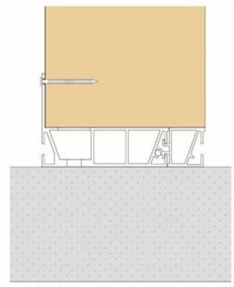
F_5



$$N_{Ed,z,bolts} = F_{5,Ed} \cdot k_{5t,overall}$$

$$V_{Ed,y,bolts} = F_{5,Ed}$$

Annex C
Geometry, dimensions and assembling; Nailing patterns



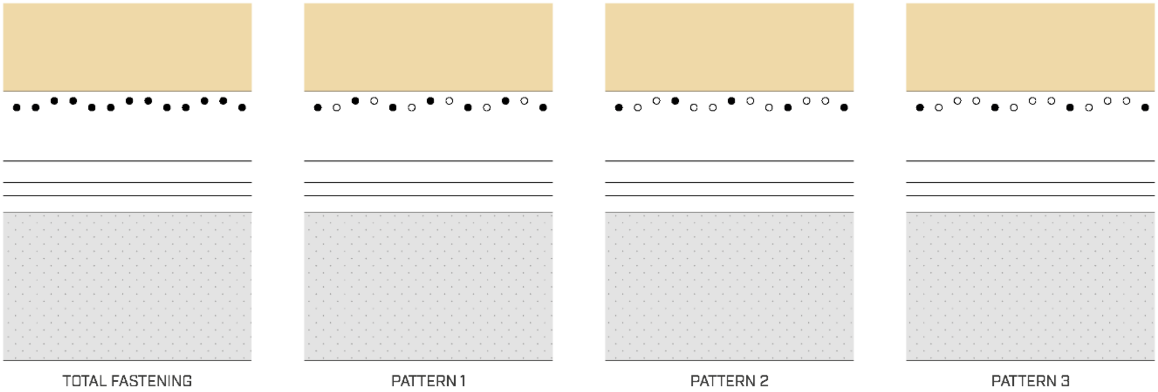


Figure C.1: Nailing patterns – Total, Pattern 1-2-3

Table C.1: Nailing patterns – Total, Pattern 1-2-3

ALU START	Nailing pattern	Nail *per meter*
All	Total	71
	Pattern 1	35
	Pattern 2	23
	Pattern 3	17

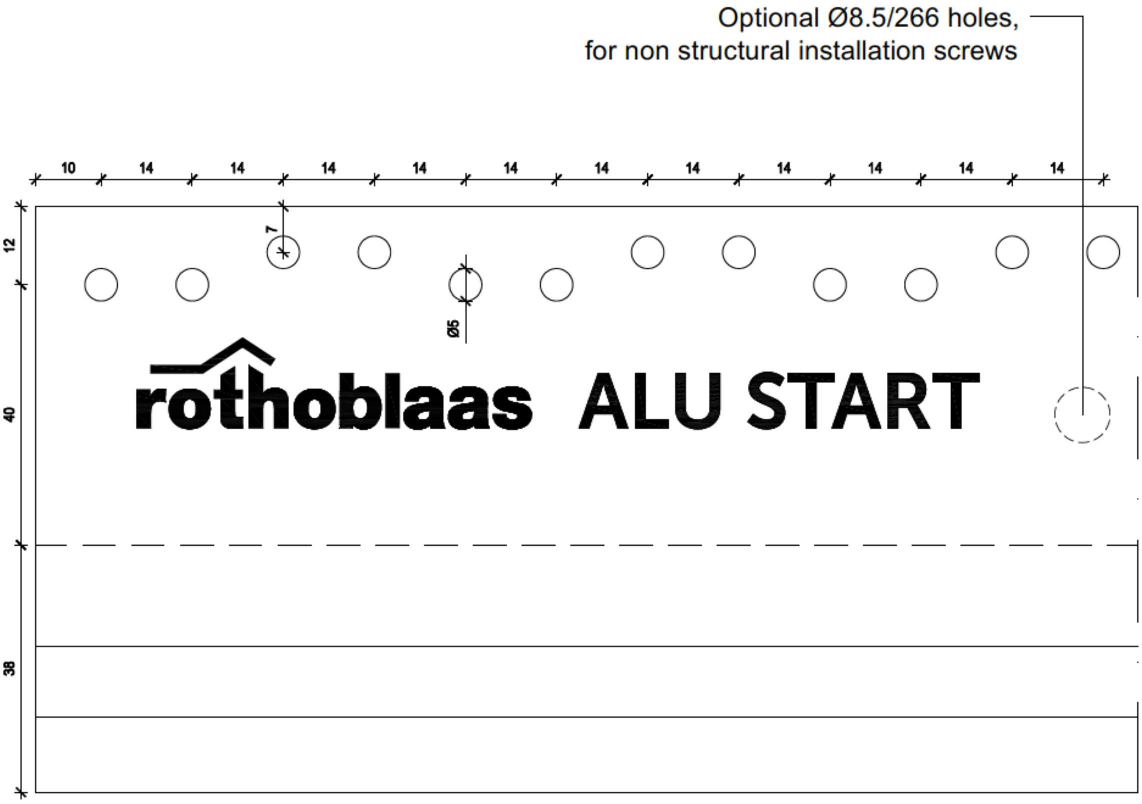


Figure C.2 ALU START – all profiles – Flange back view

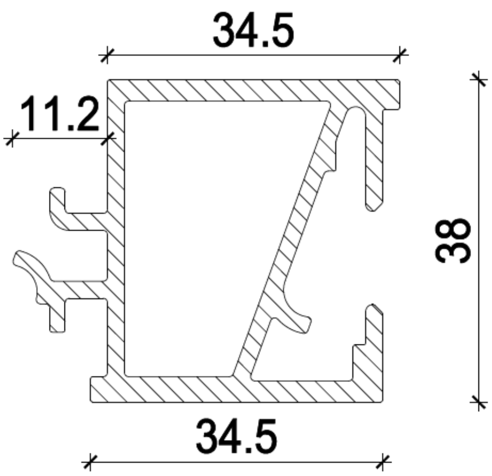


Figure C.3: ALU START 35 extension – Longitudinal section

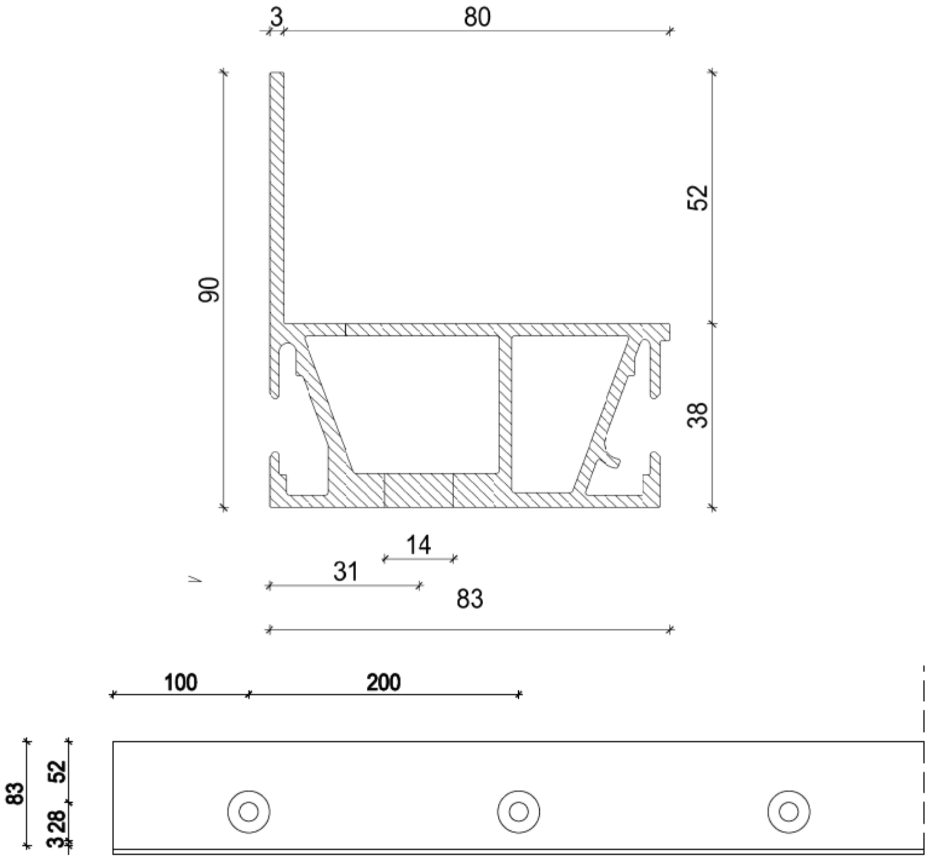


Figure C.4 ALU START 80 – Longitudinal section and top view

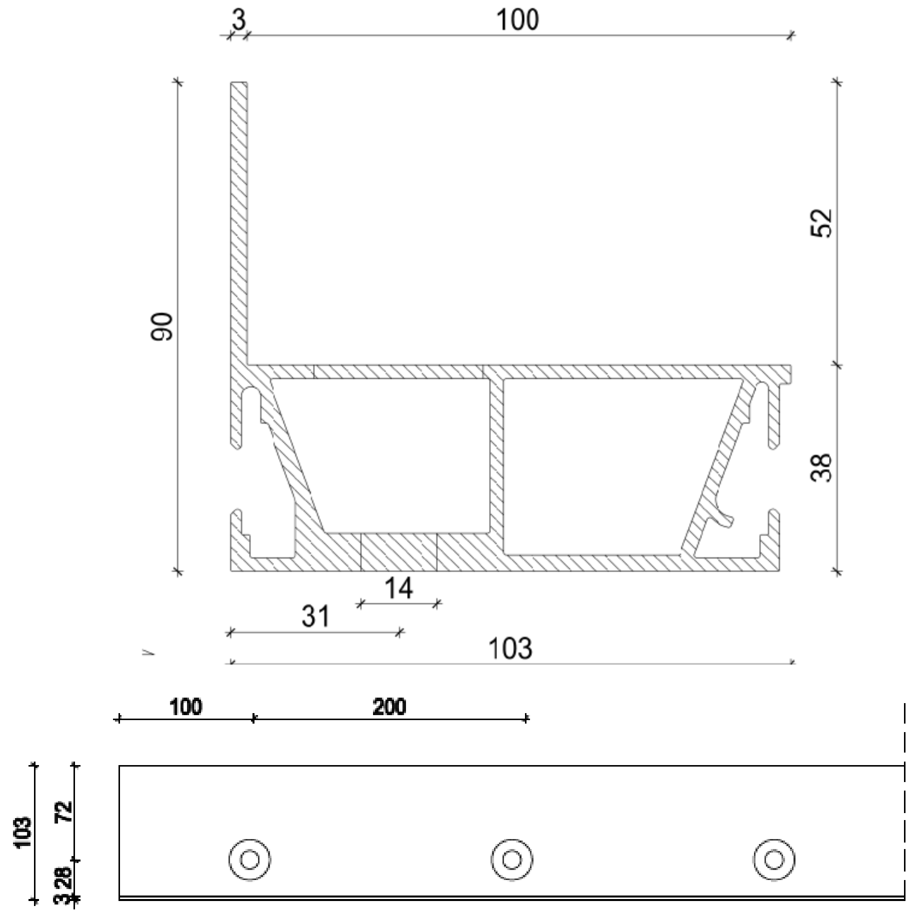


Figure C.5 ALU START 100 – Longitudinal section and top view

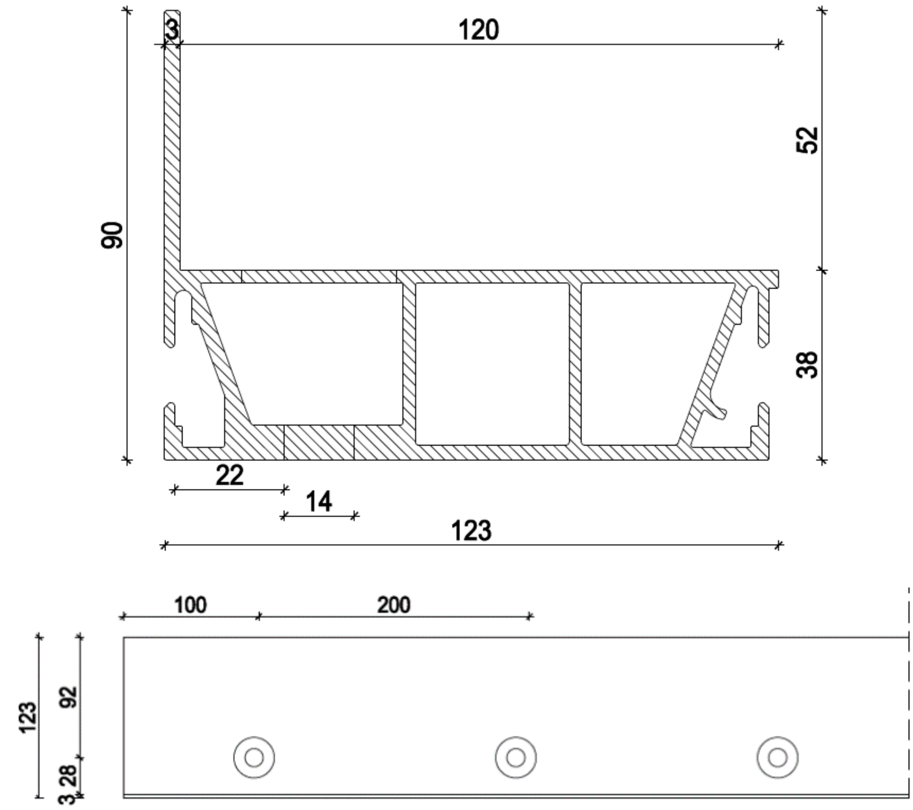


Figure C.6: ALU START 120 – Longitudinal section and top view

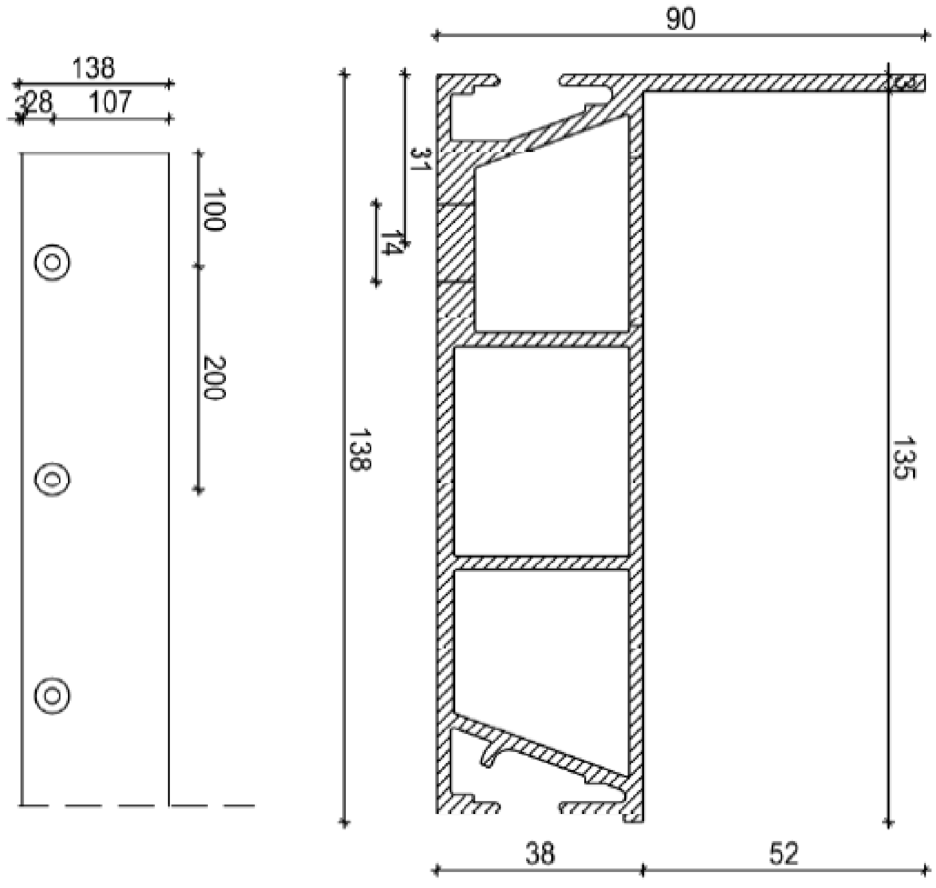


Figure C.7: ALU START 135 – Longitudinal section and top view

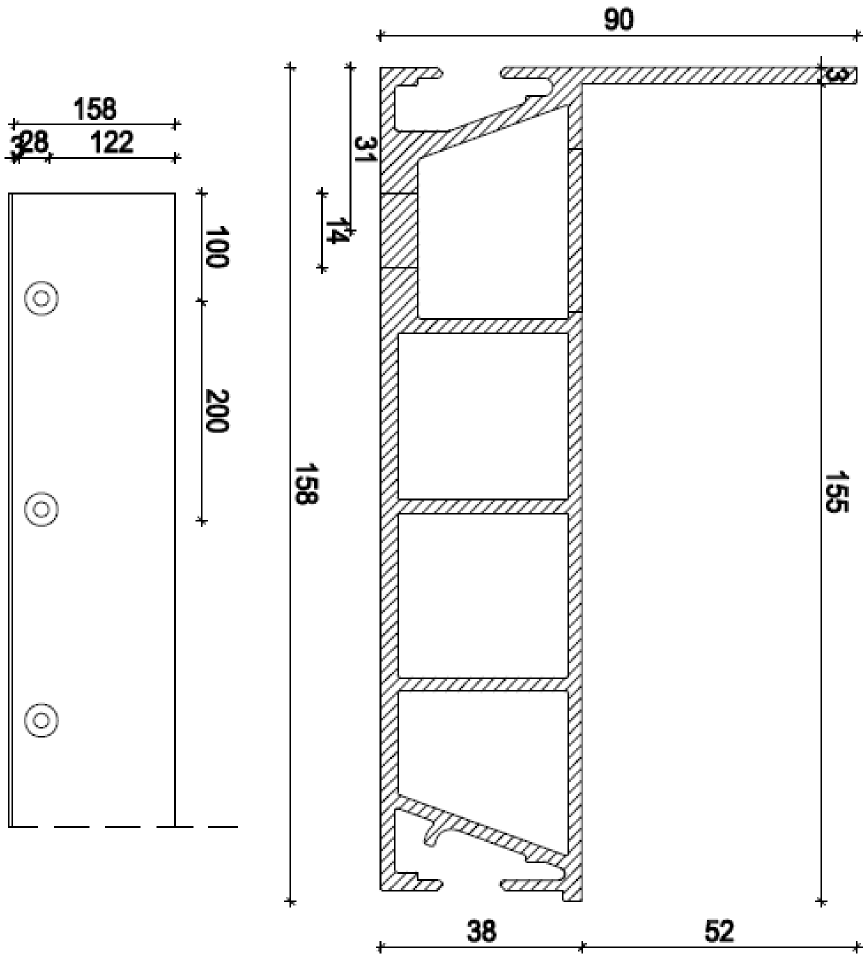


Figure C.8: ALU START 155 – Longitudinal section and top view

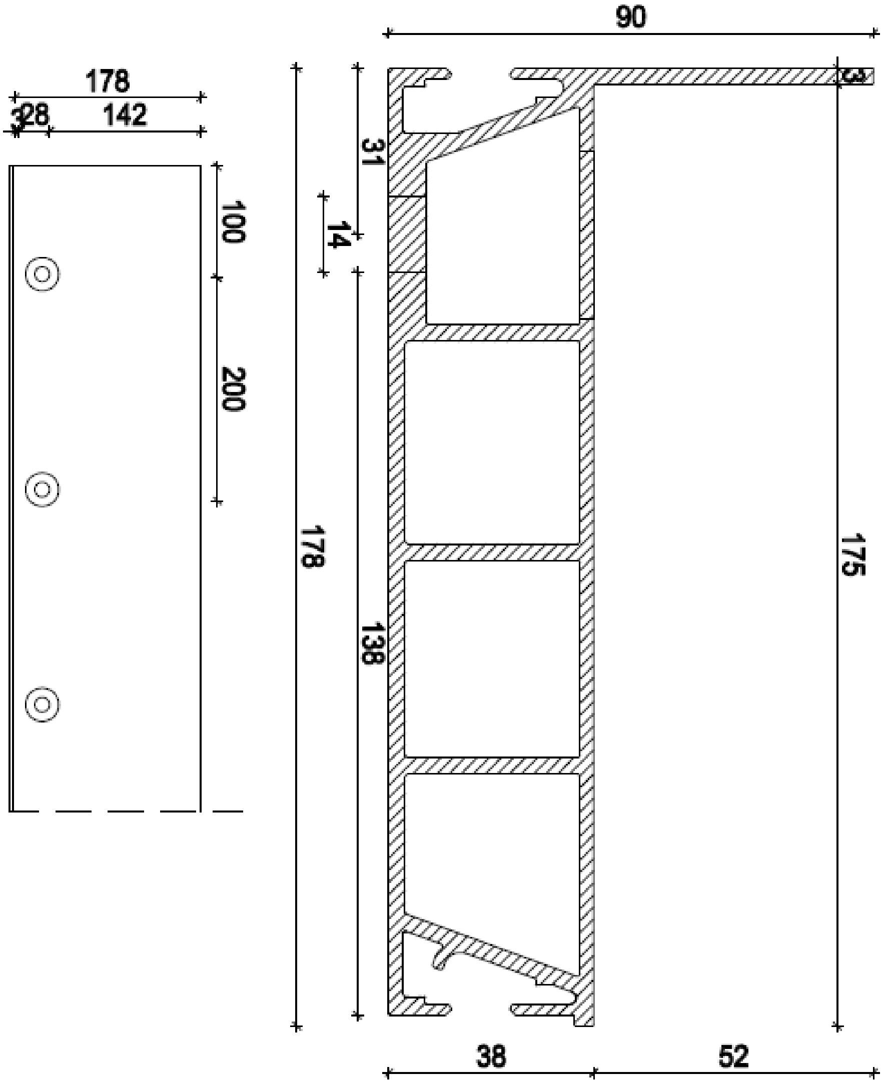


Figure C.9: ALU START 175 – Longitudinal section and top view

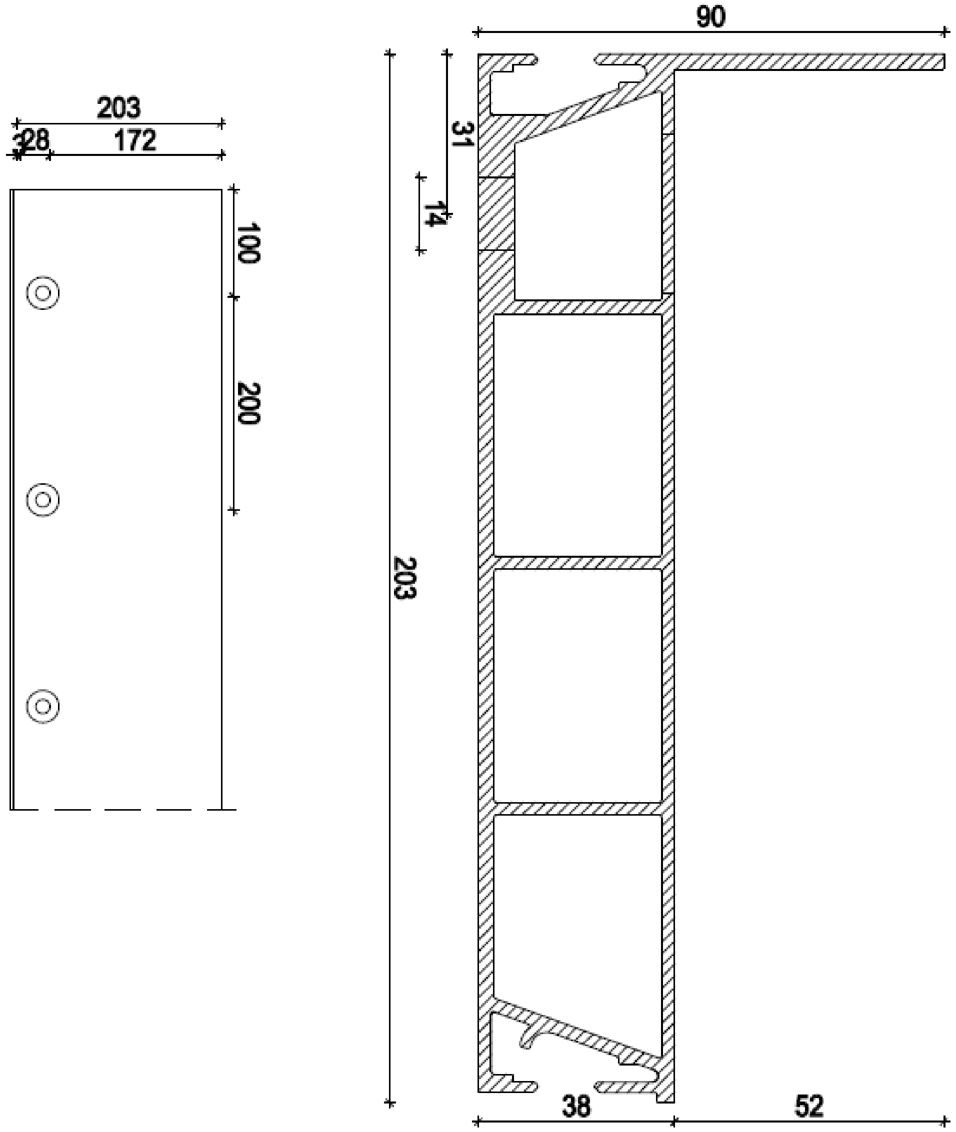


Figure C.10: ALU START 200 – Longitudinal section and top view