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Designated according to Article 29 of Regulation (EU) No. 305/2011

Member of EOTA

www.eota.eu

European Technical Assessment

ETA 16/1010
of 24/05/2017

English translation prepared by LNEC; original version in Portuguese language

ISSN 2183-3362

Trade name of the construction product *Designação comercial do produto de construção*	**AL1** **AL2**
Product family to which the construction product belongs *Família de produtos a que o produto de construção pertence*	Kits composed by subframe and fixings for fastening cladding and external wall elements *Kits constituídos por subestrutura e fixações para revestimentos de fachada e elementos exteriores de fachada*
Manufacturer *Fabricante*	Tecnofront – Tecnologia de Fachadas, Lda. Rua Caminho do Senhor, 345 4510-083 Serzedo Vila Nova de Gaia Portugal http://www.tecnofront.pt/
Manufacturing plant(s) *Instalações de fabrico*	Tecnofront – Tecnologia de Fachadas, Lda, Rua Caminho do Senhor, 345 4510-083 Serzedo Vila Nova de Gaia Portugal
This European Technical Assessment contains *A presente Avaliação Técnica Europeia contém*	19 pages including 5 annexes which form an integral part of this assessment *19 páginas, incluindo 5 anexos que fazem parte desta avaliação*
This European Technical Assessment is issued in accordance with Regulation (EU) No. 305/2011, on the basis of *A presente Avaliação Técnica Europeia é emitida ao abrigo do Regulamento (UE) n.º 305/2011, com base no*	European Assessment Document (EAD) No. 090034-00-0404 Kit composed by subframe and fixings for fastening cladding and external wall elements, edition June 2016 *Documento de Avaliação Europeu (EAD) n.º 090034-00-0404* *Kit composed by subframe and fixings for fastening cladding and external wall elements, edição de junho de 2016*

1. Technical description of the product

The kits AL1 and AL2 are composed by subframe and fixings for fastening cladding and external wall elements.

The respective components, that are factory produced by the ETA holder or different suppliers, are identified in Table 1 and have the geometrical characteristics defined in Annexes 1 to 4. The ETA holder is ultimately responsible for the kits.

TABLE 1

Identification and characteristics of the kit components

	Components	References		Geometrical characteristics
		AL1	AL2	
Fixing devices	Load bracket[1]	ES 30-50-03-100	ES 60-60-04-100	See Annex 1
	Support bracket[2]	ES 30-50-03-60	ES 60-60-04-60	
	Hidden skin element fixing	GRA.AL.15.c GRA.AL.15.i	GRA.AL.15.c GRA.AL.15.i	See Annex 2
	Skin element fixing at sight	GRA.AL.21.5.c GRA.AL.21.5.i	GRA.AL.21.5.c GRA.AL.21.5.i	
	Self drilling screw between vertical profile and brackets	ST 5.5 × 22-A2	ST 5.5 × 22-A2	See Annex 3
	Self drilling screw between vertical profile and skin element fixing	ST 4.8 × 19-A2	ST 4.8 × 19-A2	
Subframe	Vertical profiles in the shape of "omega"	AL1-Omega	AL2-Omega	See Annex 4
	Vertical profiles in the shape of "L"	AL1-L	AL2-L	

[1] Fixing between vertical profile and building.

[2] Idem.

The load brackets (that supports wind and dead load) and the support brackets (that support wind load) are made of anodized aluminium (aluminium alloy 6063 with treatment T5, EN 755 and EN 12020), and can be applied to the right or left of the vertical profile.

The skin element fixings (GRA.AL.21.5c, GRA.AL.21.5i, GRA.AL.15c and GRA.AL.15i) are also made of anodized aluminium (aluminium alloy 6063 with treatment T5, EN 755 and EN 12020).

The self drilling screws between vertical profile and brackets are made of stainless steel class A2-70 (EN 3506-1) and have dimensions ST 5.5 × 22 and hexagon head (EN 15480).

The self drilling screws between skin element fixings and vertical profile are also made of stainless steel class A2-70 (EN 3506-1) and have dimensions ST 4.8 × 19 and hexagon head (EN 15480).

The vertical profiles are made of anodized aluminium (aluminium alloy 6063, with treatment T5, EN 755 and EN 12020).

2. Specification of the intended use in accordance with the applicable European Assessment Document (EAD)

The kits AL1 and AL2 are designed and installed in accordance with the ETA holder's design and installation instructions, deposited with LNEC.

Both have been designed to an horizontal distance between vertical profiles not greater than 1195 mm, the vertical distance between brackets not greater than 1165 m and cladding element size not greater than 1192 mm × 595 mm × 10 mm.

The kits can be used as a subframe for cladding in ventilated façades when the design and installation criteria specified by the manufacturer are met.

The assessment has been carried out based on an assumed intended working life of 25 years, which is expected to be reached provided that the kits are subjected to appropriate use and maintenance.

The product will be transported, stored and installed according to the manufacturer's instructions or (in absence of such instructions) according to the usual practice of the building professionals.

The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right product 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

3.1 General

Sampling, conditioning, testing and the assessment for the intended use of this kits according to the Essential Requirements were carried out in compliance with the EAD 090034-00-0404 – *Kit composed by subframe and fixings for fastening cladding and external wall elements*.

3.2 Safety in case of fire (BWR 2)

a) Reaction to fire

The reaction to fire of the kits AL1 and AL2 was verified from the reaction to fire of their components.

The main components of the kits are made of aluminium and stainless steel. Therefore, the kits and all their main components comply with the requirements of class A1, in accordance with the EC Decision 96/603/EC (as amended) without the need for testing on the basis of the list in that decision.

According to clause 2.1 of TR 021, "Reaction to fire requirements for small components", edition June 2005, it can be assumed that a component with mass ≤ 50 g and size ≤ 50 × 50 mm is a small component and does not need to be tested and classified separately.

The EPDM gasket protector applied in the skin element fixing at sight has a mass of nearly 0.36 g and a size of 6 mm × 9 mm × 12 mm (see Annex 3).

Therefore, the gasket protector is considered as a small component according to TR 021, and does not need to be tested for its reaction to fire performance and classified separately.

3.3 Safety and accessibility in use (BWR 4)

a) Wind load resistance

The wind load resistance was determined by calculation and also by testing according to the method specified in Annex B of EAD.

The test specimen was selected to include the biggest cladding, the thickest element, the maximum distance between cladding fixings, the maximum distance between vertical profiles and the maximum distance between brackets. The wind load test was carried out with positive and negative pressures.

The generic skin element had dimensions of 1192 mm × 595 mm × 10 mm and a mass of 25 kg/m^2. The maximum distance between vertical profiles was 1195 mm and the maximum distance between brackets was 1165 mm. With these data and test results of the kits components the wind load resistance was calculated and is given in Table 2, taking into account the maximum resistance of skin element fixings, the brackets' pull-out and pull-through resistance, and the profile deflection of no more than 1/250 of distance between brackets. The wind load resistance has the value of 400 Pa for the kit AL1 and 2245 Pa for the kit AL2.

Due to the high air permeability of gaps between cladding elements and the maximum resistance of the generic skin element, the maximum pressure difference applied was smaller than the calculated wind load resistance of 2245 Pa for kit AL2. In Table 3 are given the test results of maximum deflection (under load) and residual deflection of vertical profiles (at the midpoint between brackets), and the deflection in the central point of the generic skin element. In those cases, the results of maximum deflection have been interpolated using the linear relation between deformation and pressure obtained in the tests.

TABLE 2

Wind load resistance: Calculation

Test specimen		Skin element fixing maximum load F_t (N)	Pressure (Pa)	Brackets maximum load F_t (N)	Pressure (Pa)	Profile deflection between brackets –	Pressure (Pa)
Profile	Skin element fixing						
AL1	GRA.AL.15.c	677	3820	4130	2910	1/250	400
	GRA.AL.21.5.c	544	3070				
AL2	GRA.AL.15.c	677	3820	5660	3990	1/250	2245
	GRA.AL.21.5.c	544	3070				

TABLE 3

Wind load resistance: Test results of profiles deflection

Test specimen		Profile			Centre of skin element		
Profile	Skin element fixing	Maximum deformation (mm)	Pressure (Pa)	Residual deformation (mm)	Maximum deformation (Pa)	Pressure (Pa)	Residual deformation (Pa)
AL1	GRA.AL.15.c	0.7	400	0.1	1.9	400	0.1
	GRA.AL.21.5.c	0.5	400	0.0	2.5	400	0.3
AL2	GRA.AL.15.c	0.2	2245	0.0	8.9	2245	0.0
	GRA.AL.21.5.c	0.3	2245	0.1	18.7	2245	0.9

For each specific building should be performed a calculation according to national regulation or standards.

b) Resistance to vertical load of the whole assembled system

The resistance to vertical load has been determined by calculation taking into account the mechanical resistance of the components (skin element fixings, brackets, profiles) and was 625 N for the kit with skin elements fixings at sight (GRA.AL.21.5.c) and 1297 N for hidden skin elements fixings (GRA.AL.15.c).

These values have been contrasted by testing according to Annex C of the EAD, using the mechanical weakest case (the weakest rail profile, maximum thickness of cladding element, maximum distance between vertical profiles). The dead load of the generic skin element (Q_w) is 175.4 N. The number of skin element fixings supporting the vertical force (N) was two. The additional dead load (Q_{ad}) had a value of 778 N for skin elements fixings at sight (GRA.AL.21.5.c) and 2376 N for hidden skin element fixings (GRA.AL.15.c).

Due to the maximum size and dead load of the skin elements proposed by the manufacturer, the applied dead load (Q_{ad}) was always 614 N, setting the maximum vertical load resistance of the whole assembled system to 788 N. The test was stopped 1 h after the beginning because the maximum deflection difference was 0.02 mm, so less than 0.1 mm as stated in EAD.

Test results are given in Table 4.

TABLE 4

Resistance to vertical load of the whole assembled system: Test results

Test specimen		R_v (N)	Dead load $Q_{ad} + Q_w$ [1] (N)	Deflection (mm)	Deflection after 1 hour (mm)	Deflection difference (mm)
Profile	Skin element fixing					
AL1	GRA.AL.15.c	1482	788	1.16	1.18	0.02
	GRA.AL.21.5.c	683	788	1.50	1.51	0.01
AL2	GRA.AL.15.c	1482	788	1.37	1.38	0.01
	GRA.AL.21.5.c	683	788	1.13	1.14	0.01

[1] 174 N due to the dead load of skin element (Q_w) and 614 N due to the applied dead load (Q_{ad}).

c) Resistance to vertical load of skin element fixings

The resistance to vertical load of skin element fixing has been tested according to Annex D.2 of EAD for skin element fixing type 1. All configurations of the kits AL1 and AL2 have been tested. Test results are given in Table 5 for skin element fixings at sight (reference GRA.AL.21.5.c) and in Table 6 for hidden skin element fixings (reference GRA.AL.15.c).

TABLE 5

Resistance to vertical load of skin element fixings (weight): Skin element fixing at sight (GRA.AL.21.5.c)

	1 mm irreversible deformation F_i (N)	Rupture F_{iu} (N)	Rupture type
Mean (F_m)	682.9	971.8	Bending at A and B and rupture at B (Figure A5.1, Annex 5)
Standard deviation (S)	24.9	11.5	
Characteristic force (F_c)[1]	624.8	944.9	

[1] Characteristic values giving 75% confidence that 95% of test results will be higher than this value.

TABLE 6

Resistance to vertical load of skin element fixings (weight): Hidden skin element fixing (GRA.AL.15.c)

	1 mm irreversible deformation F_i (N)	Rupture F_{iu} (N)	Rupture type
Mean (F_m)	1482	1564	Bending at A and B and rupture at B (Figure A5.2, Annex 5)
Standard deviation (S)	59.2	36.1	
Characteristic force (F_c)[1]	1297	1479	

[1] Characteristic values giving 75% confidence that 95% of test results will be higher than this value.

d) Resistance to horizontal load of skin element fixings

The resistance to horizontal load of skin element fixing has been tested according to Annex D.2 of EAD for skin element fixing type 1. Test results are given in Table 7 for skin element fixing at sight (reference GRA.AL.21.5.c) and in Table 8 for hidden skin element fixings (reference GRA.AL.15.c).

TABLE 7

Resistance to horizontal load of skin element fixings (wind): Skin element fixing at sight (GRA.AL.21.5.c)

	1 mm irreversible deformation F_i (N)	Rupture F_{iu} (N)	Rupture type
Mean (F_m)	206.7	918.9	Bending and rupture at A (Figure A5.3, Annex 5)
Standard deviation (S)	18.8	160.8	
Characteristic force (F_c)[1]	162.9	544.2	

[1] Characteristic values giving 75% confidence that 95% of test results will be higher than this value.

TABLE 8

Resistance to horizontal load of skin element fixings (wind): Hidden skin element fixing (GRA.AL.15.c)

	1 mm irreversible deformation F_i (N)	Rupture F_{iu} (N)	Rupture type
Mean (F_m)	164.9	825.0	Bending at A and B and rupture at B (Figure A5.4, Annex 5)
Standard deviation (S)	6.8	61.3	
Characteristic force (F_c)[1]	149.2	677.2	

[1] Characteristic values giving 75% confidence that 95% of test results will be higher than this value.

e) Resistance to pulsating load of skin element fixings

The resistance to pulsating load of skin element fixings has been tested according to Annex E of EAD for skin element fixing type 1. With upper load $F_{max} = 50\% \times F_{u,5\%}$; and lower load $F_{min} = 20\% \times F_{u,5\%}$. Test results are given in Table 9 for skin element fixing at sight (reference GRA.AL.21.5.c) and in Table 10 for hidden skin element fixings (reference GRA.AL.15.c), including the displacement after 10.000 cycles, rupture force and the ratio between the measured resistance to horizontal load mean values before and after pulsating loads.

TABLE 9

Resistance to pulsating load of skin element fixings: Skin element fixing at sight (GRA.AL.21.5.c)

Test specimen	F_{iu} Rupture (N)
Mean (F_m)	1649
Standard deviation (S)	311
Characteristic force (F_c)[1]	924
F_m before pulsating /F_m after pulsating	1.11

[1] Characteristic values giving 75% confidence that 95% of test results will be higher than this value.

TABLE 10

Resistance to pulsating load of skin element fixings: Hidden skin element fixing (GRA.AL.15.c)

Test specimen	F_{iu} Rupture (N)
Mean (F_m)	1675
Standard deviation (S)	155
Characteristic force (F_c)[1]	1314
F_m before pulsating /F_m after pulsating	0.98

[1] Characteristic values giving 75% confidence that 95% of test results will be higher than this value.

f) Pull-through resistance of fixings (from profiles)

The pull-through resistance of fixings from profile has been tested according to Annex G of EAD. Test results are given in Table 11 for kit AL1 and in Table 12 for kit AL2.

TABLE 11

Pull-through resistance of fixing from profile AL1

	Rupture F_{iu} (N)	Rupture type
Mean (F_m)	5394	Bending of profile and rupture in the connection between screw and profile
Standard deviation (S)	1112	
Characteristic force (F_c)[1]	2802	

[1] Characteristic values giving 75% confidence that 95% of test results will be higher than this value.

TABLE 12

Pull-through resistance of fixing from profile AL2

	Rupture F_{iu} (N)	Rupture type
Mean (F_m)	7374	Bending of profile and rupture in the connection between screw and profile
Standard deviation (S)	535	
Characteristic force (F_c)[1]	6127	

[1] Characteristic values giving 75% confidence that 95% of test results will be higher than this value.

g) Pull-out resistance of fixings (from profiles)

The pull-out resistance of fixings from profile has been tested according to Annex G of EAD. Test results are given in Table 13 for kit AL1 and in Table 14 for kit AL2.

TABLE 13

Pull-out resistance of fixing from profile AL1

	Rupture F_{iu} (N)	Rupture type
Mean (F_m)	2883	Bending of profile and rupture in the connection between screw and profile
Standard deviation (S)	215	
Characteristic force (F_c)[1]	2383	

[1] Characteristic values giving 75% confidence that 95% of test results will be higher than this value.

TABLE 14

Pull-out resistance of fixing from profile AL2

	Rupture F_{iu} (N)	Rupture type
Mean (F_m)	2888	Bending of profile and rupture in the connection between screw and profile
Standard deviation (S)	149	
Characteristic force (F_c)[1]	2541	

[1] Characteristic values giving 75% confidence that 95% of test results will be higher than this value.

h) Inertia and resistance of profiles

The inertia and mechanical resistance properties of profiles are given in Table 15.

TABLE 15

Inertia and mechanical resistance of profiles

Vertical profile	AL1-L	AL1-Omega	AL2-L	AL2-Omega
Aluminium alloy	6063 T5	6063 T5	6063 T5	6063 T5
Inertia (cm^4)	I_{xx} = 1.26 cm^4 I_{yy} = 2.48 cm^4	I_{xx} = 4.43 cm^4 I_{yy} = 26.4 cm^4	I_{xx} = 9.41 cm^4 I_{yy} = 5.70 cm^4	I_{xx} = 25.0 cm^4 I_{yy} = 45.9 cm^4
Mass per unit length (kg/m)	0.455	1,025	0.757	1.726
Elasticity modulus E (GPa)	69	69	69	69
σ_{02} (MPa)	175	175	175	175
$\sigma_{rupture}$ (MPa)	220	220	220	220
Linear thermal expansion coefficient	23 × 10^{-6} °C	23 × 10^{-6} °C	23 × 10^{-6} °C	23 × 10^{-6} °C

i) Resistance to vertical load of brackets

The resistance to vertical load of brackets has been tested according to Annex H of EAD. Test results are given in Table 16 for brackets reference ES 30-50-03-100 (kit AL1) and in Table 17 for brackets reference ES 60-60-04-100 (kit AL2).

TABLE 16

Brackets resistance to vertical load: Reference ES 30-50-03-100 (kit AL1)

	Load at 0,2% L	Load at 1 mm displacement F_{1d} (N)	Load at 3 mm displacement F_{3d} (N)	Load at rupture F_s (N)
F_{mean}	Performance not assessed	1304	3356	7682
S		203.3	652.8	1031
$F_{u,5}$ [1]		829.8	1835	5280

[1] Characteristic values giving 75% confidence that 95% of test results will be higher than this value.

TABLE 17

Brackets resistance to vertical load: Reference ES 60-60-04-100 (kit AL2)

	Load at 0,2% L	Load at 1 mm displacement F_{1d} (N)	Load at 3 mm displacement F_{3d} (N)	Load at rupture F_s (N)
F_{mean}	Performance not assessed	1779	5722	14582
S		350.0	1688	309.1
$F_{u,5}$ [1]		963.8	1790	13862

[1] Characteristic values giving 75% confidence that 95% of test results will be higher than this value.

j) Resistance to horizontal load of brackets

The resistance to horizontal load of brackets has been tested according to Annex H of EAD. Test results are given in Table 18 for bracket reference ES 30-50-03-60 (kit AL1), in Table 19 for brackets reference ES 30-50-03-100 (kit AL1), in Table 20 for brackets reference ES 60-60-04-60 (kit AL2) and in Table 21 for brackets reference ES 60-60-04-100 (kit AL2).

TABLE 18

Brackets resistance to horizontal load: Reference ES 30-50-03-60
(kit AL1, bracket supporting only horizontal load)

	Load for 1 mm residual distortion F_m (N)	Load at rupture F_t (N)
F_{mean}	1884	2282
S	117.6	164.3
$F_{u,5}$ [1]	1610	1899

[1] Characteristic values giving 75% confidence that 95% of test results will be higher than this value.

TABLE 19

Brackets resistance to horizontal load: Reference ES 30-50-03-100
(kit AL1, bracket supporting vertical and horizontal loads)

	Load for 1 mm residual distortion F_m (N)	Load at rupture F_t (N)
F_{mean}	2814	4414
S	321.1	601.2
$F_{u,5}$ [1]	2066	3014

[1] Characteristic values giving 75% confidence that 95% of test results will be higher than this value.

TABLE 20

Brackets resistance to horizontal load: Reference ES 60-60-04-60
(kit AL2, bracket supporting only horizontal load)

	Load for 1 mm residual distortion F_m (N)	Load at rupture F_t (N)
F_{mean}	1701	2493
S	283.5	349.3
$F_{u,5}$ [1]	1040	1679

[1] Characteristic values giving 75% confidence that 95% of test results will be higher than this value.

TABLE 21

Brackets resistance to horizontal load: Reference ES 60-60-04-100
(kit AL2, bracket supporting vertical and horizontal loads)

	Load for 1 mm residual distortion F_m (N)	Load at rupture F_t (N)
F_{mean}	3129	3851
S	446.8	515.4
$F_{u,5}$ [1]	2088	2650

[1] Characteristic values giving 75% confidence that 95% of test results will be higher than this value.

k) Corrosion

All aluminium kits components are protected by anodizing or lacquer coating, complying with Qualanod or Qualicoat quality label and certification scheme, with characteristics that depend on the foreseen use.

The screws are made from stainless steel class A2-70.

Therefore, the kits may be used in the following external atmosphere exposure: rural environment, moderate industrial/urban environment, but excluding industrial and marine environment. The kits may be used in other external atmospheric conditions exposure, if the components are protected as specified in the standard EN 1999.

l) Mechanical characteristics of subframe fixings

Performance not assessed.

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

According to decision 2003/640/EC of the European Commission the system of assessment and verification of constancy of performance 2+ applies.

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

5.1 General

The ETA is issued on the basis of agreed data/information, deposited with LNEC, which identifies the kits that have been assessed and judged. It is the manufacturer's responsibility to make sure that all those who use the kits are appropriately informed of the specific conditions laid down in this ETA.

Changes to the kits or their application process should be notified to LNEC before the changes are introduced. LNEC will decide whether or not such changes affect the ETA and if so whether further assessment or alterations to the ETA shall be necessary.

5.2 Tasks for the manufacturer

Factory production control

The manufacturer shall exercise permanent internal control of production. All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures, including records of results performed.

This production control system shall ensure that the kits are in conformity with this ETA.

The manufacturer may only use components stated in the technical documentation of this ETA. The incoming raw materials are subjected to verifications by the manufacturer before acceptance.

For the components of the kits which the manufacturer does not manufacture by himself, he shall make sure that the factory production control carried out by the other manufacturers gives the guarantee of the components compliance with the ETA.

The factory production control shall be in accordance with the Control Plan[1], which is part of the Technical Documentation of this ETA. The control plan has been agreed between the manufacturer and the LNEC and is laid down in the context of the factory production control system operated by the manufacturer and deposited within LNEC. The results of factory production control shall be recorded and evaluated in accordance with the provisions of the control plan.

Other tasks for the manufacturer

The manufacturer shall, on the basis of a contract, involve a product certification body (bodies) notified to carry out constancy of performance certification in order to undertake the respective actions. For this purpose, the control plan shall be handed over by the manufacturer to the notified body (bodies) involved.

For assessing the product the results of the tests performed as part of the assessment for the ETA shall be used unless there are changes in the production line or plant. In such cases the necessary testing has to be agreed with LNEC.

The declaration of performance of the product to be drawn up by the manufacturer following the issuing of this ETA shall include its reference number and issuing date.

Changes to the kits, their production or their application process should be notified to LNEC before the changes are introduced. LNEC will decide whether or not such changes affect the ETA and if so whether further assessment or alterations to the ETA shall be necessary.

5.3 Tasks for the notified body (bodies)

Within the scope of the initial inspection of factory and of factory production control, the notified body (bodies) shall ascertain that, in accordance with the Control Plan, the factory (in particular the employees and the equipment) and the factory production control are suitable to ensure continuous and orderly manufacturing of the components according to the specifications mentioned in this ETA.

Within the scope of continuous surveillance, assessment and evaluation of factory production control, the notified body (bodies) shall visit the factory at least once a year for surveillance. It has to be verified that the factory production control is maintained in suitable conditions.

These tasks shall be performed in accordance with the provisions laid down in the Control Plan.

The notified body (bodies) shall retain the essential points of its (their) actions referred to above and state the results obtained and conclusions drawn in a written report.

The notified body(ies) involved by the manufacturer shall issue a certificate of conformity of the factory production control on the basis of the assessments and verifications carried out by that (those) body(ies).

In cases where the provisions of the ETA and its control plan are no longer fulfilled, the notified body(ies) shall withdraw the certificate(s) issued and inform LNEC without delay.

Issued in Lisbon on 24/05/2017

By

Laboratório Nacional de Engenharia Civil (LNEC)

The Board of Directors

Carlos Pina

President

1 The Control Plan is a confidential part of this European Technical Assessment and is only handed over to the notified body or bodies involved in the procedure of assessment and verification of constancy of performance. See section 5.3.

Annex 1

Brackets

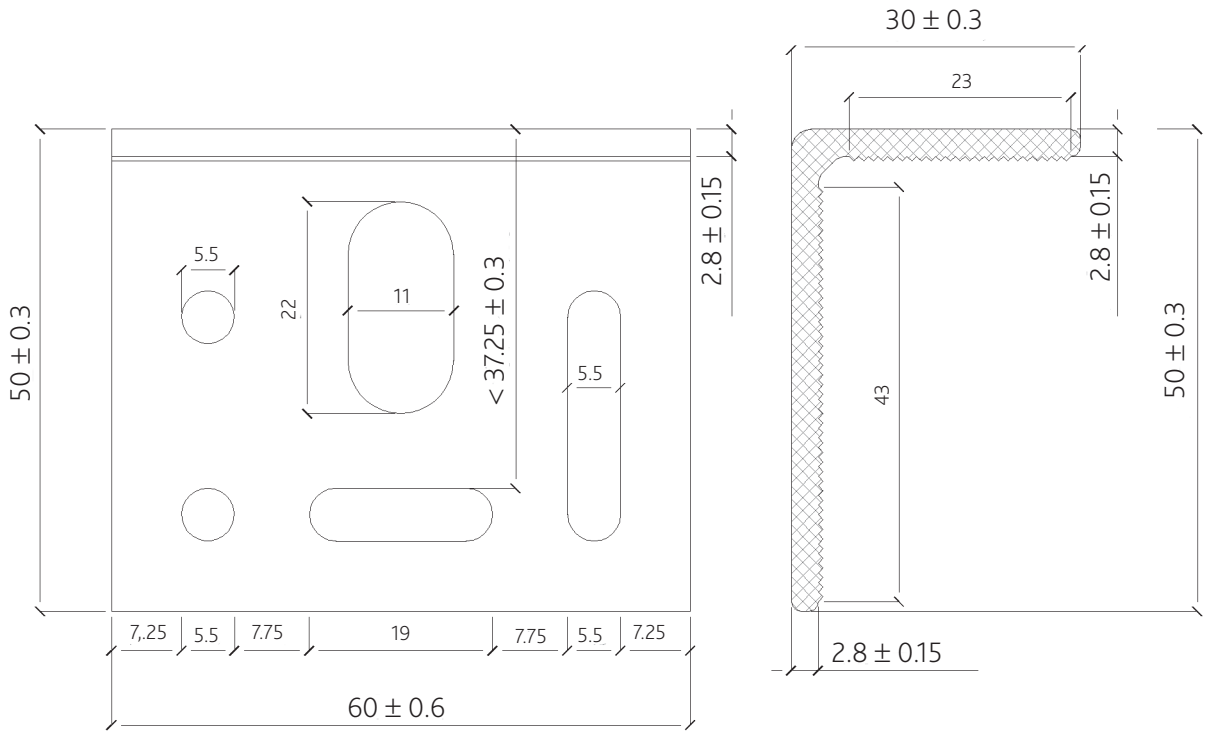

Figure A1.1 – Support bracket ES 30-50-03-60

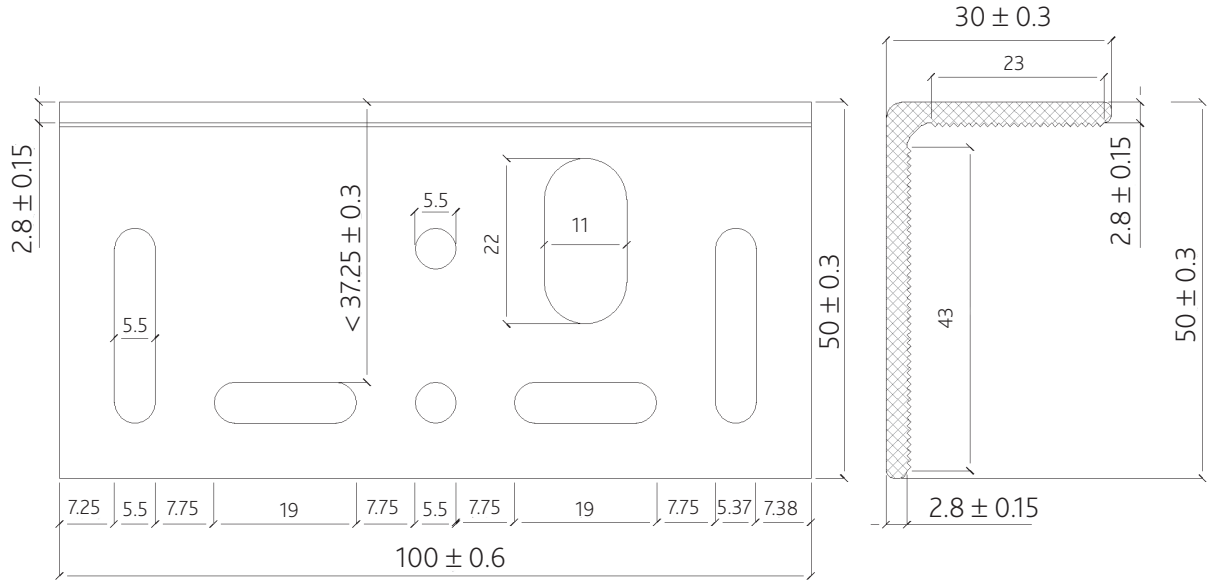

Figure A1.2 – Support bracket ES 30-50-03-100

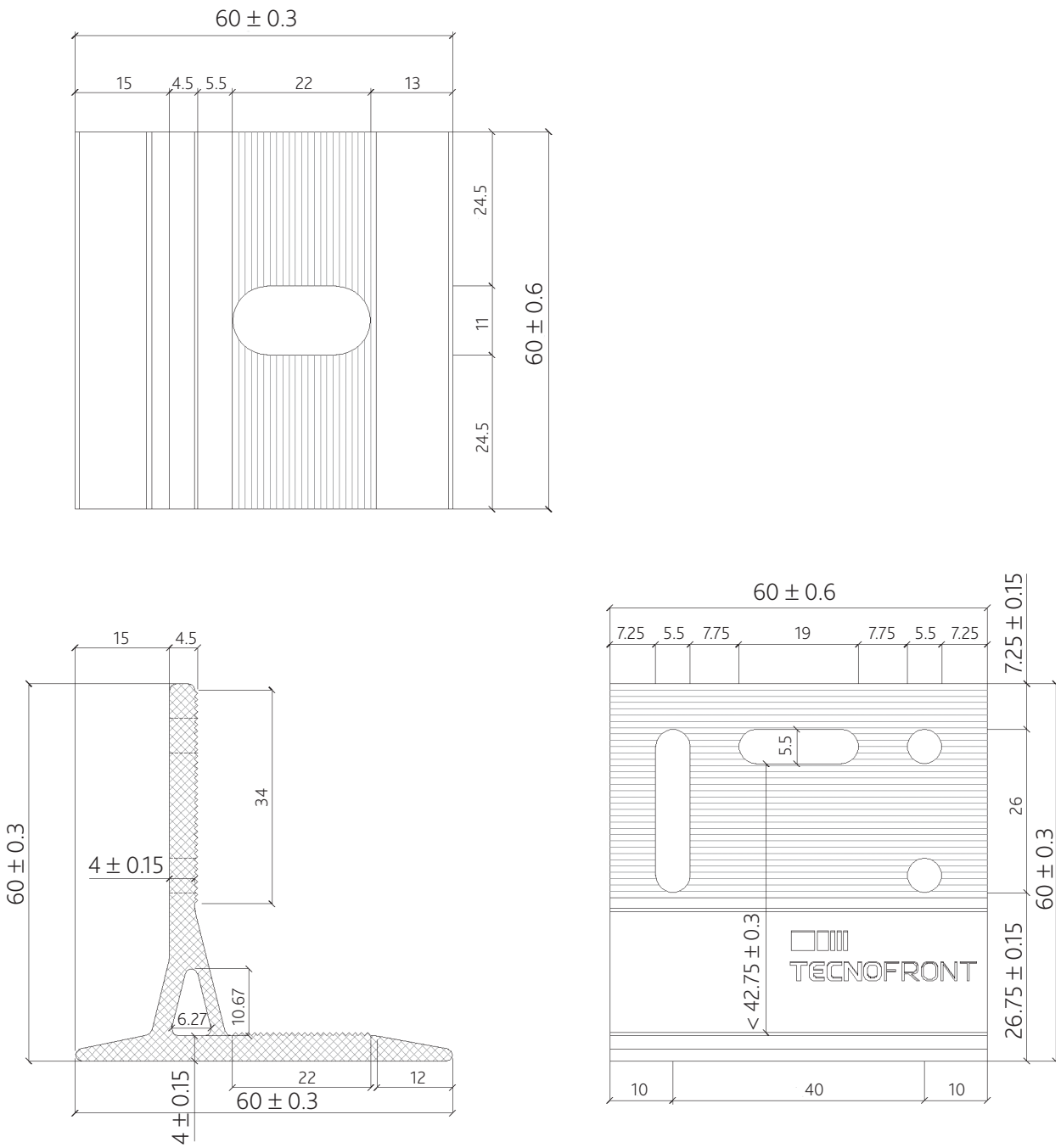

Figure A1.3 – Load bracket ES 60-60-04-60

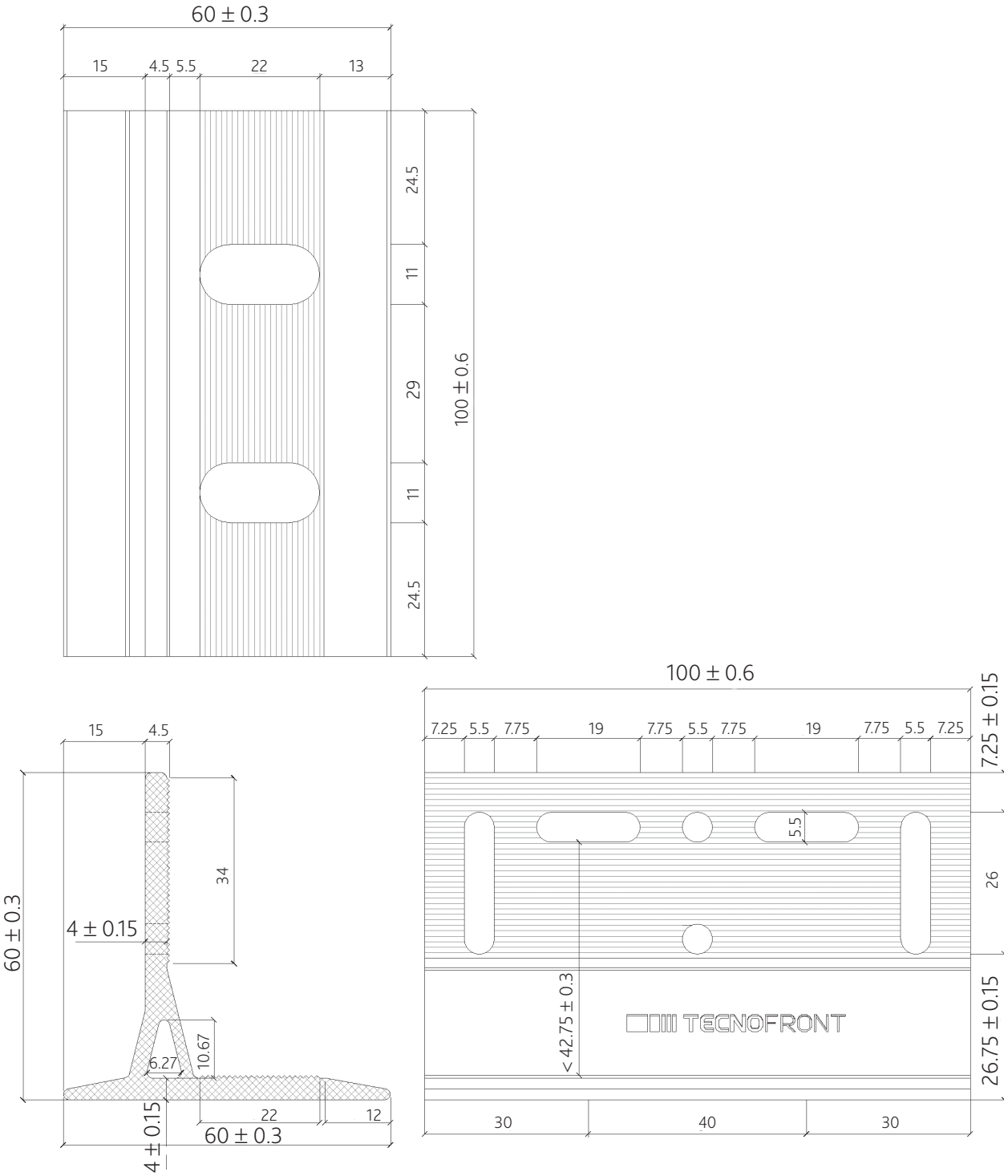

Figure A1.4 – Load bracket ES 60-60-04-100

Annex 2

Skin element fixings

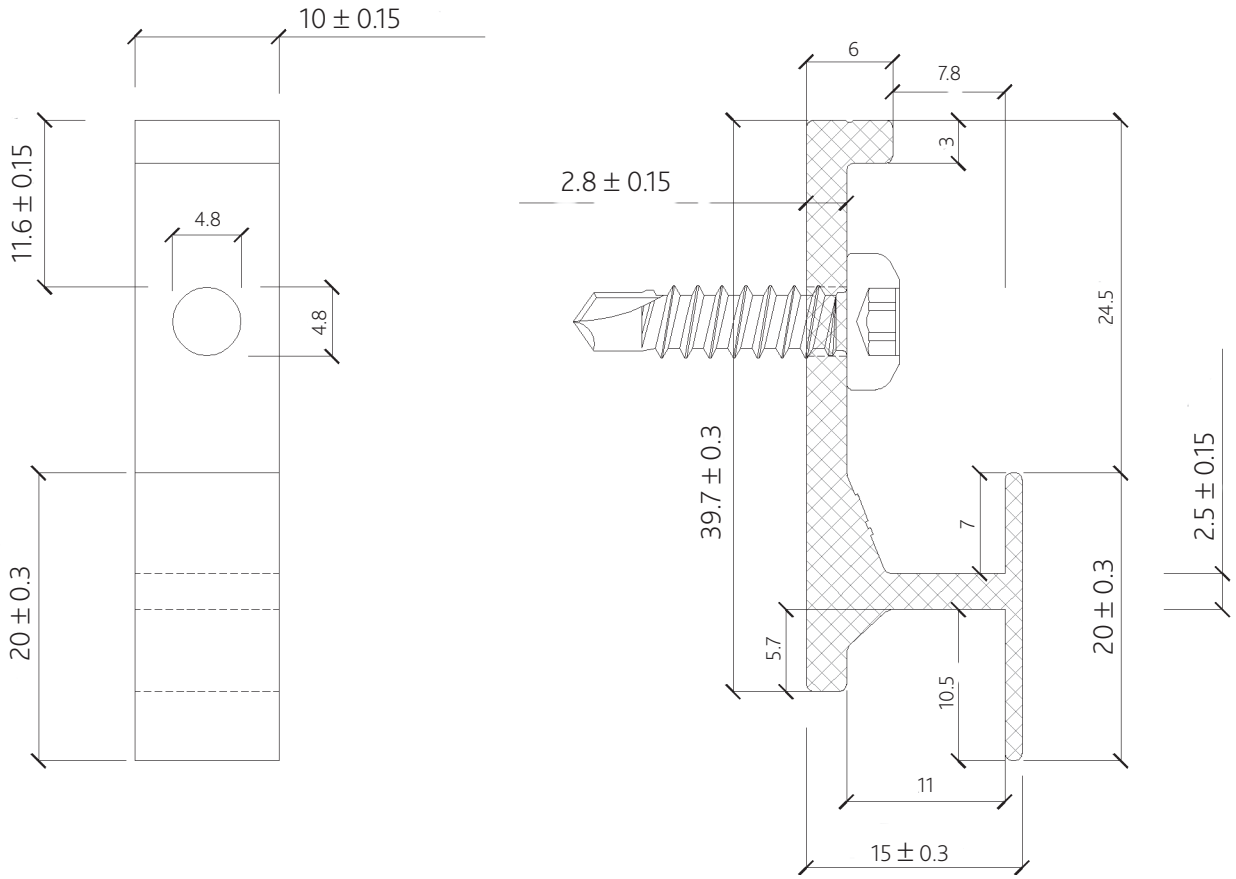

Figure A2.1 – Hidden skin element fixing GRA.AL.15.c

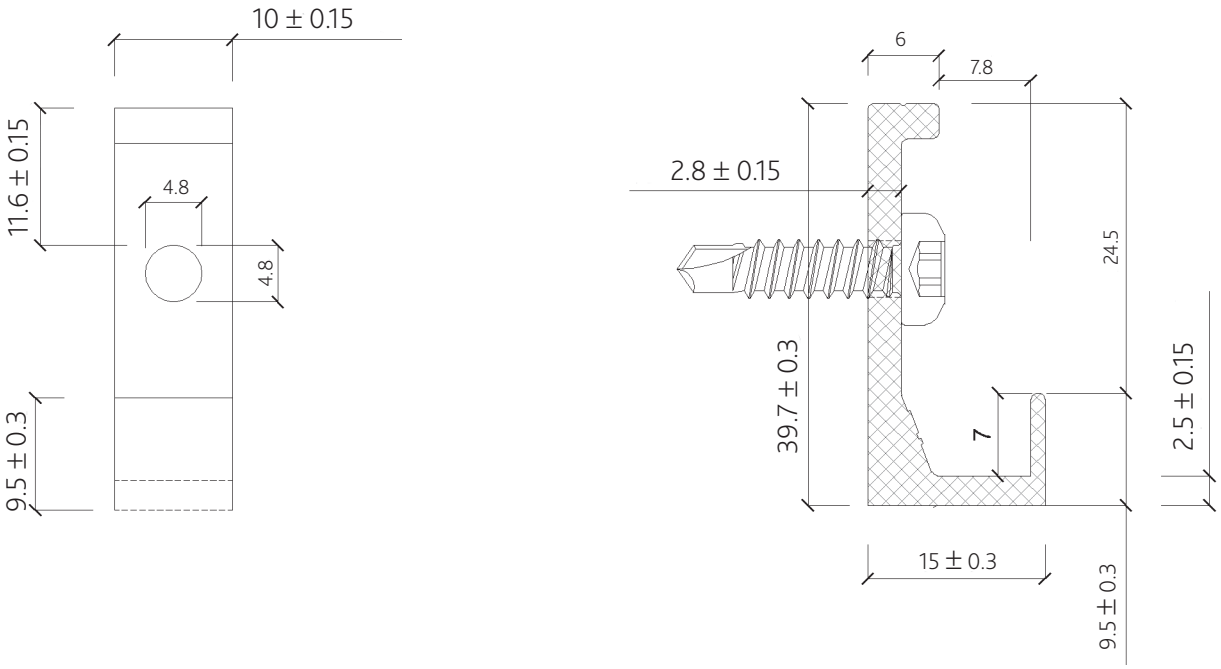

Figure A2.2 – Hidden skin element fixing, for the top and bottom pieces GRA.AL.15.i

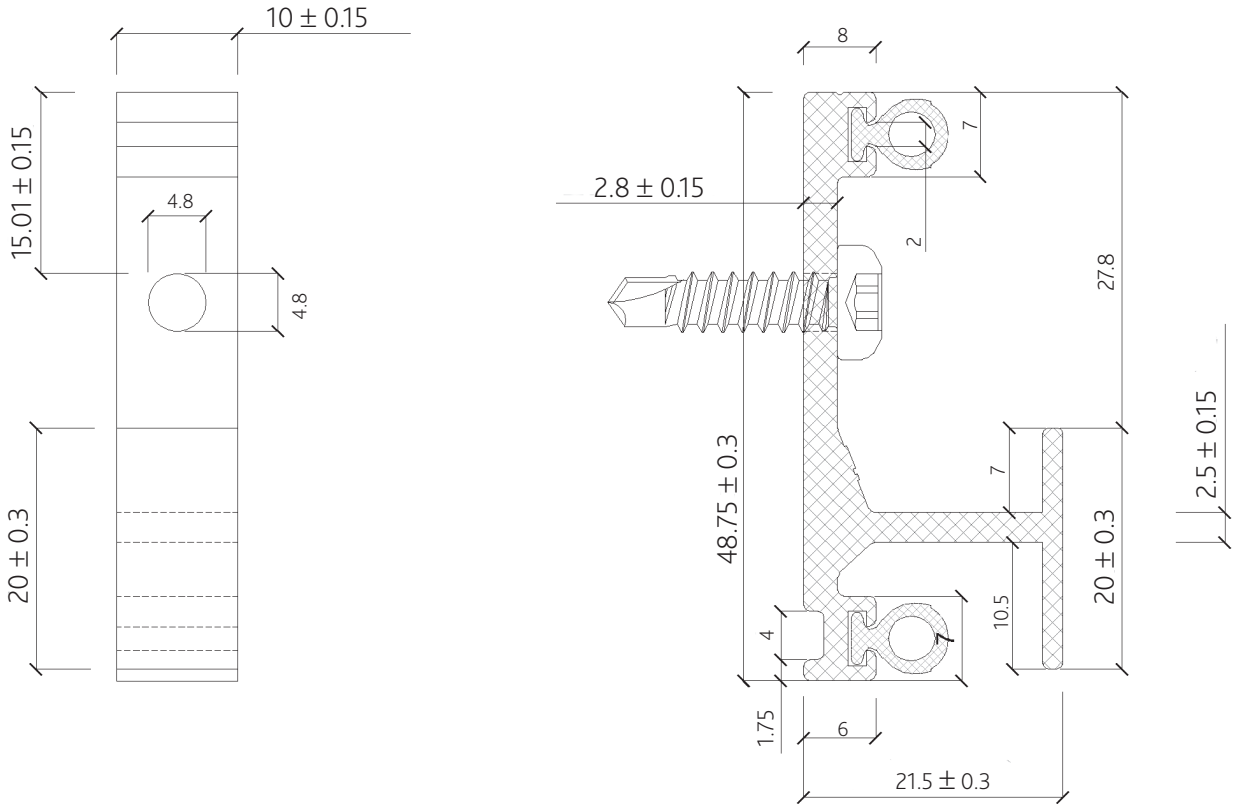

Figure A2.3 – Skin element fixing at sight GRA.AL.21.5.c

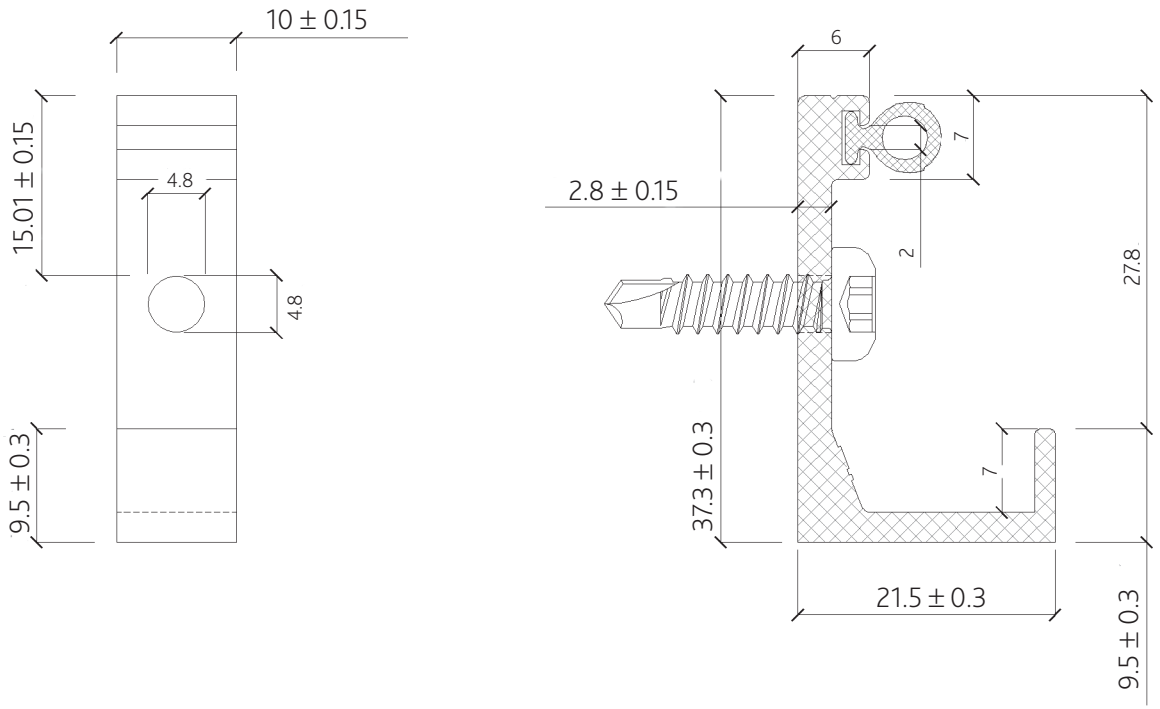

Figure A2.4 – Skin element fixing at sight, for the top and bottom pieces GRA.AL.21.5.i

Annex 3

Self drilling screws

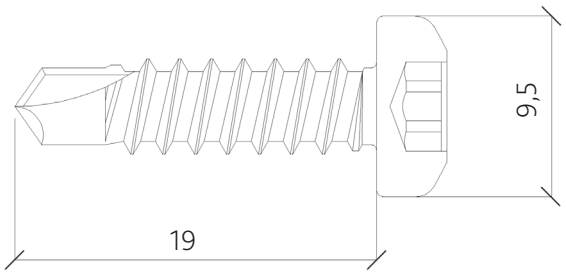

Figure A3.1 – Self drilling screw ST 4.8×19-A2

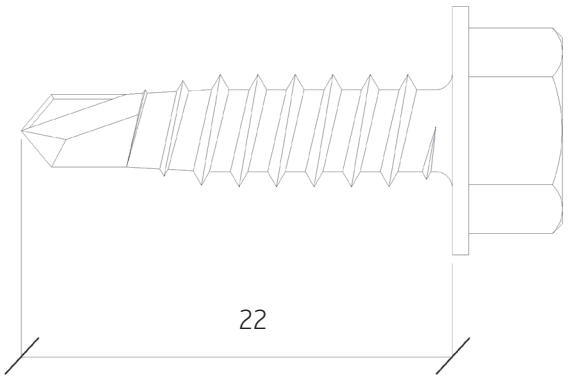

Figure A3.2 – Self drilling screw ST 5.5×22-A2

Annex 4

Vertical profiles

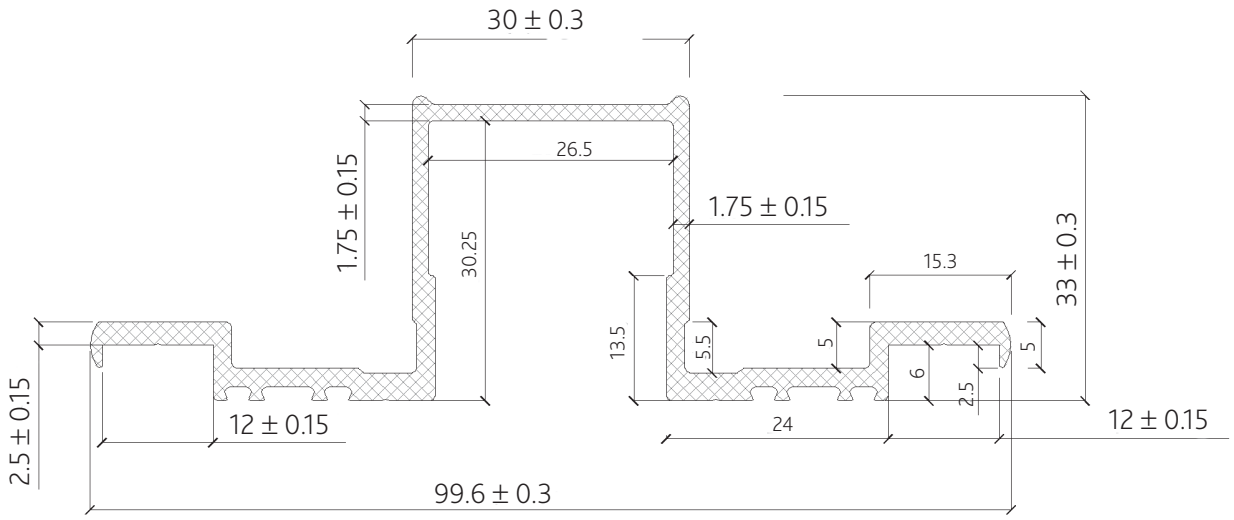

Figure A4.1 – Symmetrical vertical profiles in the shape of "omega" AL1-Omega

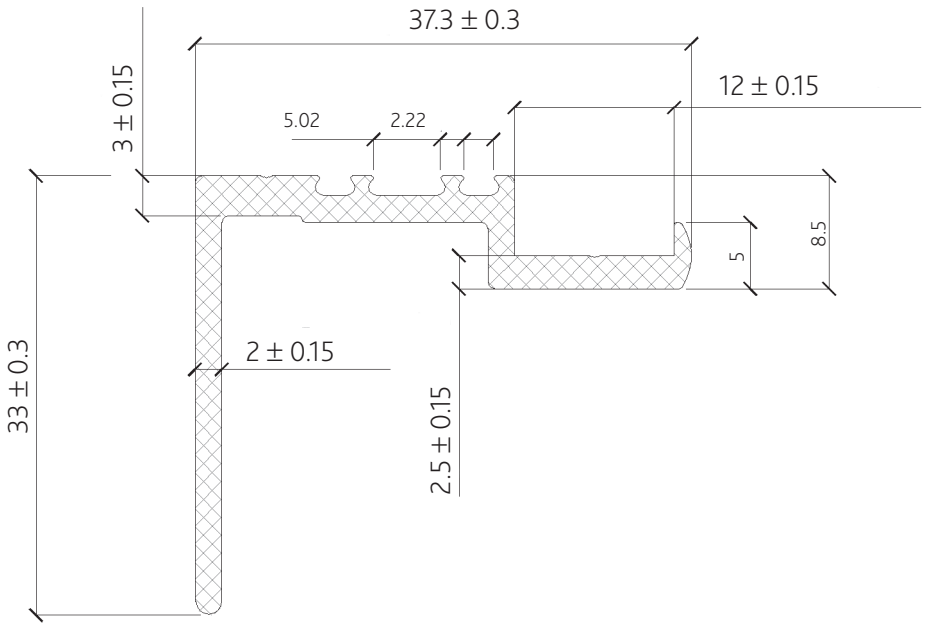

Figure A4.2 – Symmetrical vertical profiles in the shape of "L" AL1-L

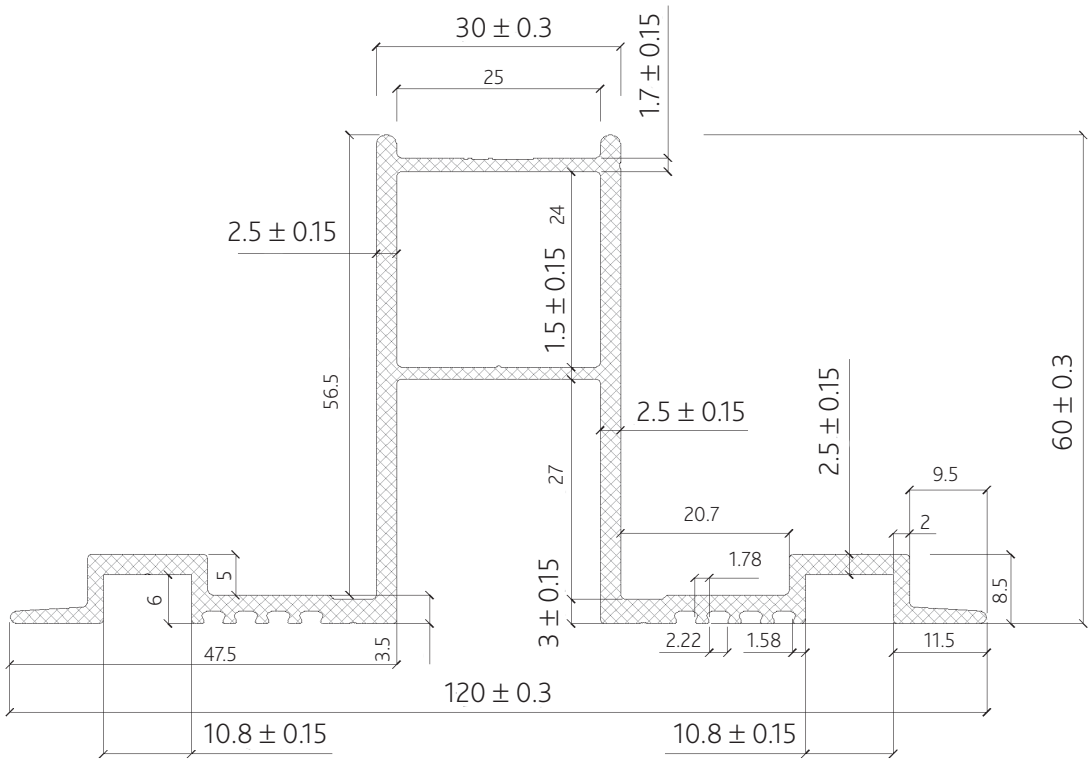

Figure A4.3 – Symmetrical vertical profiles in the shape of "omega" AL2-Omega

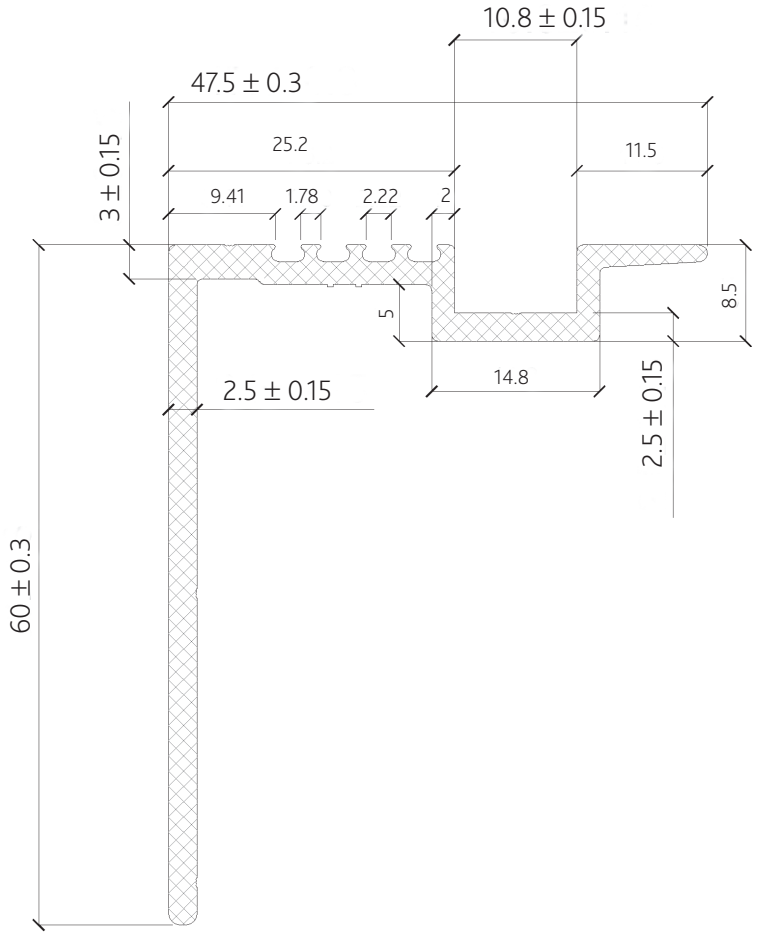

Figure A4.4 – Symmetrical vertical profiles in the shape of "L" AL2-L

Annex 5

Types of rupture in skin element fixings testing

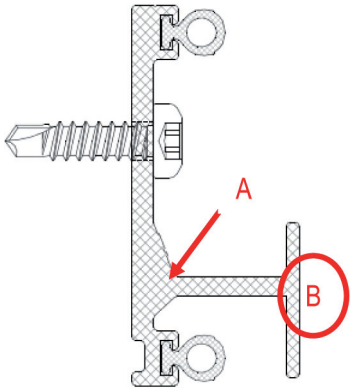

Figure A5.1 – Type of skin element fixing rupture:
Skin element fixing at sight GRA.AL.21.5.c

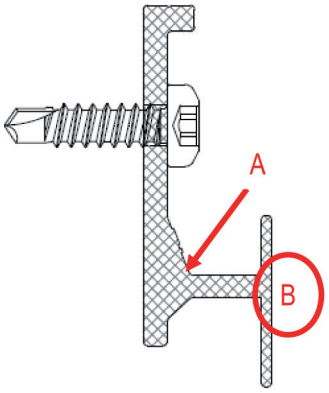

Figure A5.2 – Type of skin element fixing rupture:
Hidden skin element fixing GRA.AL.15.c

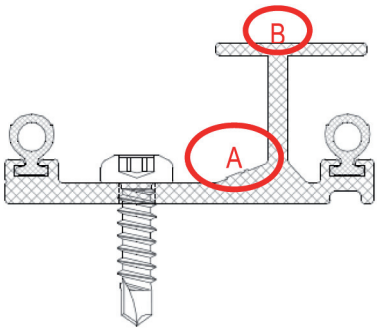

Figure A5.3 – Type of skin element fixing rupture:
Skin element fixing at sight GRA.AL.21.5.c

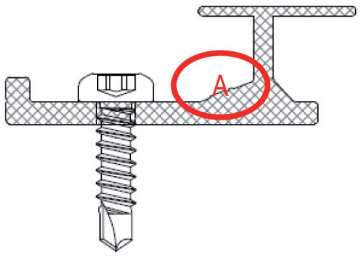

Figure A5.4 – Type of skin element fixing rupture:
Hidden skin element fixing GRA.AL.15.c

CDU 691.88(4)
ISSN 2183-3362

Descriptors: Fixings for construction elements / Screw / Profile / Wall covering / Façade / Europe
Descritores: Fixação de elementos de construção / Parafuso / Perfil / Revestimento de paredes / Parede fachada / Europa

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