NON-TRADITIONAL CONSTRUCTION MATERIALS AND PROCEDURES
TECHNICAL APPROVAL

CONCESSION

FAVEMANC XB

Ventilated cladding system with ceramic plates

Manufacturer:
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U.D.C. 69.022.325
Bardage
Cladding kit

VERY IMPORTANT

By definition, the TECHNICAL APPROVAL consists of a favourable technical appreciation on behalf of the Eduardo Torroja Institute of Construction Science regarding the aptitude for use in construction of non-traditional materials, systems and procedures designed for a specific use. It therefore has no administrative effect and represents no authorisation of use or guarantee.

Before using the material, system or procedure referred to, full knowledge of the document is essential therefore this should be supplied in full by the owner.

Changes in product features or not respecting the conditions of use as well as the observations of the Experts Committee will invalidate this technical evaluation.

The reproduction of this document must be authorised by the Eduardo Torroja Institute of Construction Science. This document consists of 23 pages.

AGREEMENT NUMBER 507

THE DIRECTOR OF THE EDUARDO TORROJA INSTITUTE OF CONSTRUCTION SCIENCE,

- under Decree 3652/1963 dated December 26 by the government presidency, empowering the Eduardo Torroja Institute of Construction Science to issue the TECHNICAL APPROVAL for non-traditional construction materials, systems and procedures used in construction and public works and Order 1265/1988 dated December 23 by the Ministry of Parliamentary Relations and the Government Secretary which regulate the concession,
- considering article 5.2, section 5 of the Technical Building Code (hereinafter CTE) regarding conformity with the CTE of innovative products, equipment and systems which establishes that a constructive system conforms with the CTE if it has a favourable technical evaluation regarding suitability for the intended use,
- considering the application made by the company GRESMANC INTERNACIONAL S.L. for the concession of a TECHNICAL APPROVAL for the **FAVEMANC XB ventilated cladding system with ceramic plates**,
- under the current statutes of l'Union Européene pour l'Agrément technique dans la construction (UEAtc),
- taking into account site reports carried out by representatives of the Eduardo Torroja Institute of Construction Science, reports on tests carried out at the IETcc, as well as observations by the Experts Committee at a meeting held on November 29, 2007,

DECIDES

to award in technical approval document number 507 TO the FAVEMANC XB ventilated cladding system with ceramic plates, considering that,

The technical evaluation form may conclude that the system CONFORMS WITH THE BUILDING TECHNICAL CODE provided that the full content of this document is respected and in particular the following conditions:

GENERAL CONDITIONS

This TECHNICAL APPROVAL exclusively approves the construction system proposed by the applicant and in accordance with current legislation each case must be accompanied by the mandatory building project and completed under the corresponding project management. The building project in each case will consider the actions of the system on the general building structure ensuring that these are admissible.

In each case, having seen the architectural project for the cladding created by the project architect, GRESMANC INTERNACIONAL, S.L. will provide a graphic definition from a technical viewpoint of the project for ventilated cladding and enough technical assistance to allow the calculation and definition for execution including all necessary information for each of the components.

In general, both project and the execution will consider all requirements contained in the current legislation. CTE is quoted as a reminder.

MANUFACTURING AND CONTROL CONDITIONS

The manufacturer must maintain the self-control overall materials, the manufacturing process and the finished product in accordance with the instructions given in section 5 this document.

CONDITIONS OF USE AND START UP

The FAVEMANC XB ventilated cladding system with ceramic plates is intended for outside cladding fixed by means of a metallic anchoring substructure. The system does not contribute to the structure stability.

The implementation of the system must be carried out by GRESMANC INTERNACIONAL S.L. or specialized, qualified and recognized companies under its technical management. These companies guarantee to use the system under the conditions and fields of application covered by this Document respecting the observations of the Experts Committee. An updated copy of the list of installation companies recognized by GRESMANC INTERNACIONAL S.L. will be available on the IETcc. In accordance with the above, this document only covers those works that have been carried out by GRESMANC INTERNACIONAL S.L. or qualified, recognized companies.

All necessary measures will be adopted regarding the stability of constructions during assembly, the risks of large suspended loads falling, protection of personnel and in general all provisions under current Health and Safety at Work regulations.

VALIDITY

This Technical Approval number 507 is valid for a period of five years provided that:

- the manufacturer does not change any product features indicated in this Technical Approval,
- that the manufacturer performs a systematic self control of the production as indicated in the Technical Report,
- that an annual follow up is carried out by the Institute which consists of the compliance with the above conditions, visiting if appropriate some of the most recent projects.

With the favourable result from the follow up, the IETcc will annually issue a certificate which should accompany the Technical Approval to ensure its validity.

This document should therefore be renewed before December 28, 2012.....

Madrid, December 28, 2007.....

THE DIRECTOR OF THE EDUARDO TORROJA

INSITUTE OF CONSTRUCTION SCIENCE

Juan Monjo Carrió

TECHNICAL REPORT

1. OBJECTIVE

FAVEMANC XB ventilated cladding with "extruded stoneware" ceramics made by the company GRESMANC INTERNACIONAL S.L. fixed to a vertical, aluminium substructure together with a support wall.

2. PRINCIPLE AND DESCRIPTION OF SYSTEM

The plates are fixed to the vertical substructure made up of vertical uprights with stainless steel clips anchored to the support wall and/or the building structure using adjustable brackets (support and retention brackets) (see figure 1).

The typical composition of the GRESMANC INTERNACIONAL S.L. ventilated cladding with ceramic plates consists of the following sheets:

1. FAVEMANC XB extruded stoneware ceramic plate.
2. Air ventilation chamber.
3. Fixing substructure anchored to the support.

The system can include insulation which will be defined by the Execution Project in accordance with CTE regarding Energy Efficiency (DB-HE and noise protection (DB-HR).

The system is structures using the appropriate fixings, spacing the ceramic plates between vertical and horizontal joints. The joints between ceramic plates should always be open.

This cladding system can be applied to factory work supports, concrete or metal structures in both new and restoration projects.

The system substructure is anchored to the building structure using support brackets, arranged in pairs on both sides of the vertical profile. The distance between support brackets is approximately 3.5m depending on the distance between floors (see figure 1).

Retention brackets are positioned between the support brackets, secured to the closure element and separated by a maximum distance of 1.1m.

The retention brackets are arranged one by one alternating either side of the profile (see figure 2) according to the calculation. In certain cases, more brackets may be placed on either side of the profile.

3. MATERIALS AND COMPONENTS

3.1 **Ceramic plates**

The ceramic plates are 1.5cm thick, manufactured from clay, silica, fluxes and other materials used only for cladding. They are manufactured by milling, screening, shaping and humidification, etc and are moulded by extrusion, generally at ambient temperatures. Subsequently they are dried and then baked at high temperatures.

The plates are waterproof on their visible side and practically waterproof along the side (a. a $\leq$ 3.0%).

The Committee Ruling 96/603/CE dated October 4, 1996 which sets the list of products classified as fire rating class A1 (non-combustible) includes ceramic products.

The physical, mechanical and geometric features correspond to the following classification according to regulation UNE-EN 14411:2004, applied to extruded stoneware ceramic tiling, including pre-mounted tiling sheets with water absorption, E $\leq$ 3% according to group A1 of regulation UNE-EN 14411:2004 designed for cladding interior and exterior walls and floors.

3.1.1 *Dimensional Tolerance*

-Length:	± 3mm.
-Width:	± 2mm.
-Thickness:	- 2.0%
	+ 3.0%
-Straightness of edges:	±0.3%
-Imbalance:	±0.5%.

3.1.2 *Physical and mechanical features*

-Apparent density of material:	2.3kg/dm^3
-Plate break module:	>8 N/mm^2
-Linear thermal expansion coefficient:	<0.007 mm/m·°C

3.1.3 *Geometric features:*

FORMAT Nominal mm	LENGTH mm	WIDTH mm	THICKNESS mm	WEIGHT of PIECE
293 x 800	800	293 approx.	15 approx.	6.00
293 x 700	700	293 approx.	15 approx.	5.30
293 x 600	600	293 approx.	15 approx.	4.50

Other plate measurements may be supplied for specific designs provided that the requests due to wind action for the working plates are less than those set out in this document.

3.1.4 *Identification*

The identifying label on the pallet shows:

-Manufacturer's commercial name.
-Colour and texture.
-Date of manufacture.
-Number of plates and corresponding nominal measurements.
-Identifying label with logo and Technical Approval Document number.

3.2 **Substructure for attaching plates**

3.2.1 *Profile and brackets*

The network of vertical profiles and brackets is made from extruded aluminium and must conform to technical specifications regarding aluminium alloy 6063 qualities with T5 treatment – the basic characteristics are detailed below:

Physical properties:

-Specific weight: 2.70 kg/dm^3.
-Linear expansion coefficient: $23.6 \cdot 10^{-6}$ °C^{-1} (20/100 °C)
-Elasticity module: 70,000 MPa (average traction and compression modules)
-Poisson's coefficient: 0.33.

Mechanical properties:

ALLOY AND TREATMENT	R_m Mpa	$R_{p0.2}$ Mpa	A %
6063 T5	≥175	≥130	≥8

According to UNE-EN 755-2:1998 for extruded profiles.

Profile characteristics
The measurements are gathered in figure 3.

TYPE	Section mm^2	Weight kg/m	Perimeter mm	X_c mm	I_{xc} cm^4	r_{xc} mm	y_c mm	I_{yc} cm^4	r_{yc} mm
T5 6063	290.48	0.783	357.39	50	9.55	18.13	47	14.27	22.17

Supporting and retention bracket features

The geometry and dimensions of a selection of brackets are set out in figure 5 for guidance purposes.

TYPE	Section mm^2	Perimeter mm	X_c mm	I_{xc} cm^4	r_{xc} mm	y_c mm	I_{yc} cm^4	r_{yc} mm
ECI 108-60/100-60/102-60/104-60	321	220	37.5	11.83	19.2	17.48	7.55	15.33
ECI 108-80/100-80/102-80/104-80	381	260	39.2	25.97	26.1	25.8	8.16	14.6
ECI 108-100/100-100/102-100/104-100	441	300	40.5	47.57	32.8	34.5	8.61	13.9
ECI 108-120/100-120/102-120/104-120	501	340	41.5	77.88	39.4	43.5	8.95	13.4

3.2.2 *Clips for fixing ceramic plates*

The clips are made of A2 AISI 304 stainless steel and general thickness 1.2mm (± 0.15) and dimension characteristics according to figure 4.

3.2.3 *Fixings for the support wall joint*

The definition of type, position and number of fixings for attaching the brackets to the support wall will be made regarding the base support material and the forces on it with the technical project reflecting the ventilated cladding.

These details will be provided by the system representative following the fixing manufacturer recommendations for each base support material.

In general, and for the most common cases, the following possibilities are quoted:

-Fixing for attaching brackets to enclosure:

When the base material is solid or perforated brick, hollow or lightweight concrete, the HRD fixing (variable length) will be used. This is made up of:

1) Polyamide PA 6/6.6 plug: No cadmium, lead, halogen or silicon content. Range of temperatures for use: from -40°C to +80°C; installation temperature: from -10°C to +40°C.
2) Lag set made up of A2 DIN 571 stainless steel hexagonal head bolt, 7mm diameter and 70mm length plus washer and 40 x 80 mounted Fischer stud or similar.

-Fixing for attaching brackets to slab edges:

HAS (CE approved) high load capacity fixing of variable length stainless steel, 8x75 A2 MTA plus DIN9021 washer and DIN 934 screw.

-Fixing for attaching brackets to brick support wall:

Chemical injection fixing for solid, perforated or hollow brick and block, Lusan polyester resin mortar without styrene or similar.

3.2.4 *Screws*

-Attaching the vertical profile to the brackets:

DIN 7054k, A2 stainless steel, hexagonal head 5.5x22 self-drilling screws.

-Attaching the clip to the vertical profile:

ETANCO DXP361, A2 stainless steel, 4.2mm diameter and 14mm length self-drilling screw or similar.

3.3 **Adhesive**

One component polyurethane sealant, medium modulus for adhesion to aluminum ≥ 15kp/cm^2 according to EN 1465. In high humidity areas medium-high modulus sealants will be required.

Features of nuts and bolts

Class product	Screws- rods- bolts				Nuts	
	Resistance class	Traction resistance Rm N/mm^2	Elastic limit $R_{p0.2}$ N/mm^2	Elongation at break A mm	Test load resistance S_p Type 1 nuts (m≥0.8d) N/mm^2	Narrow nuts (0.5 ≤m<0.8d) N/mm^2
A2	50	≥500	≥210	≥0.6d	≥500	≥250
	70	≥700	≥450	≥0.4d	≥700	≥350
	80	≥800	≥600	≥0.3d	≥800	≥400

M8	Resistance class	Torque N·m	Break limit kN	Elastic limit kN	Resistance section mm^2
	50	7.8	18.3	7.7	
	70	17.5	25.6	16.4	36.6
	80	22.0	29.2	21.9	

4. PLATE MANUFACTURE

The manufacturing process of the ceramic plates takes place at the GRESMANC INTERNACIONAL, S.L. factory in Los Yébenes (Toledo) and generally includes the following successive stages:

- Dosing, wet mixing and kneading of raw materials which will make up the ceramic plates support.
- Flat extrusion for forming plate.
- Decoration (enamelled, silkscreen)
- Baking.
- Mechanization (correction) and resistance testing.
- Classification.

Packing and storage prior to forwarding.

5. QUALITY CONTROL

5.1 **Plates**

At its factory, the manufacturer GRESMANC INTERNACIONAL S.L. has a quality management system certified by AENOR (certificate number ER-1280/2004) based on the guidelines in standard UNE-EN ISO 9001:2000. There are specific procedures explaining the types, characteristics and conditions for tests and controls.

5.1.1 *Raw materials*

Several tests are carried out in relation to the control of receipt of raw materials and their physical and chemical analysis.

-Sampling and determining physical characteristics of raw materials on receipt: moisture (5), chemical analysis, linear contraction, particle size distribution and rejection, presence of carbonates, loss by calcination and plasticity.

5.1.2 *Procedures*

-Preparation of pastes:
Moisture control of raw materials, verification of size of milling material ball, particle size test for clay and fireclay, humidity and presence of carbonates.

-Extrusion:
Extrusion pressure, weight of parts, exit and entrance temperature of the parts in the dryer post extrusion, vacuum control of the extruder, mass weighing control, deviation from the orthogonality and measurement control.

-Glazing and decoration:
Density and viscosity of the slip, glaze and engobe, Weight of the application.

-Baking:
Temperature control, gas atmosphere inside ovens during the baking cycle. Measurement control on exit from oven and water absorption.

-Mechanization:
Measurement control on exit of mechanization process.

-Classification:
Superficial control of appearance, determination of the measurement deviations regarding length and width, straightness of sides, orthogonality, smoothness of surface and warp.

5.1.3 *Finished products*

100% inspection of measurement and superficial characteristics of the ceramic plates and sampling to determine the physical and chemical properties of the item, specified as follows:

-Physical properties:
Water absorption (%).
Flexion resistance (N/mm^2).
Surface scratch resistance (Mohs scale)
Resistance to surface abrasion on enamel.
Thermal shock resistance.
Resistance to cracking.
Frost resistance.

-Chemical properties:
Stain resistance.
Resistance to domestic cleaning products and swimming pool additives.
Resistance to acids and alkalis.

All controls and inspections are periodically gathered in records as determined by the quality management system procedures. The finished product tests are carried out according to standard UNE-EN ISO 10545.

5.2 **Quality control on cladding fixing elements**

These elements are not manufactured by GRESMANC INTERNACIONAL, S.L. therefore

suppliers are requested to provide a certificate for each supply relating to the technical specifications and compliance of the relevant standard.

The controls used by GRESMANC INTERNACIONAL, S.L. for the brackets and vertical fixings on receipt of these items are:

- General appearance and finish.
- Measurements.
- Checking the certificate with regard to the technical specification.

5.2.1 *Anchoring*

The anchor supplier must guarantee that the anchorage system products have passed internal manufacturing and finished product controls in accordance with their internal standards and procedures. In addition, all these products meet material specifications and load values indicated in the supplier's current manuals and catalogues provided that they are installed according to their recommendations and instructions.

Where applicable, the anchorage must have CE approval.

6. PACKING, TRANSPORT, STORAGE AND HANDLING

The plates are distributed in wooden pallets, in skelped bales not exceeding 10 units with multiple glue points between each one of them to avoid friction. The pallet will consist of 3 layers with cardboard separators between them and finally the pallet is perfectly strapping and encased.

The ceramic plates are arranged in the transport medium in order to avoid movement that may damage them during transport.

The offloading of the material should be as close as possible to the place where they will be used, to avoid unnecessary rushing. To prevent damage due to friction of the surface with sharp items, care should be taken not to slide the plates over each other, lifting them one by one.

Materials being hit should also be prevented during offloading and during handling by avoiding them being dropped.

7. IMPLEMENTATION

7.1 **General specifications**

The assembly of plates on the aluminum frame should be performed by specialized personnel using the fixings described above, so that the plate is not under tension and has sufficient freedom of movement.

7.1.1 *Fixing system*

The fixing system should provide for the expansion of the plates and should be defined according to:

- Wind load
- Maximum distances between plate fixing points
- Plate format

Fitting the substructure to the base should be calculated to withstand the stress transmitted, for which the status and type of support will be studied, enabling the choice of suitable anchoring as described in section 3.2.3.

7.1.2 *Ventilation*

The existence of a constant air chamber of at least 3 cm thickness ventilated by natural ascending convection behind the cladding should be taken into account.

Regardless of the position of the facade and the type of joints, ventilation of the facade is ensured by the air inlet openings in the lower liner, lintels and the exit window sills and finishes at cladding level. The amount of ventilation opening should be determined by the height of construction:

- minimum:	20 cm2/ml.
- height $h \leq 3$ metres:	50 cm2/ml.
- height $3 < h \leq 6$ metres:	65 cm2/ml.
- height $6 < h \leq 10$ metres:	80 cm2/ml.
- height $10 < h \leq 18$ metres:	100 cm2/ml.

7.2 **Assembly**

The implementation sequence should be as follows:

- Layout.
- Placement of retention and support brackets.
- Placement of profiles.

- Placement of insulation if required.
- Placing the clips at the lower end of the facade.
- Placement of successive clips and ceramic plates, from the bottom up and establishment of boards.

7.2.1 *Layout*

The façade will be reassessed, checking the flatness of the support to be coated and the plane for a good choice of anchorage.

The distance between the profile axes will depend on the plate format, with a maximum separation distance of 80 cm.

The collapse and flatness characteristics of the supporting wall must meet the conditions laid down in the CTE, as well as the relevant standards and regulations.

7.2.2 *Placement of brackets*

Firstly, the brackets are fixed to the supporting wall using fixing anchorage.

The brackets will be placed and distributed vertically and abutted, distributed between cast edges. The vertical distance depends on the type and condition of the support and in turn, the loads that will be borne by the same, being less than 110 cm wherever possible.

7.2.3 *Placement of vertical profiles*

The vertical profiles will be arranged at a distance of 80cm or less.

The flatness of the framework of extruded aluminum uprights must be guaranteed via the suitable anchoring system, in order to ensure that the cladding system is flat.

The perfectly aligned vertical profiles will be fixed with fixed holes slotted to the brackets to ensure the proper motion of the substructure and good planimetry.

The minimum horizontal joint between vertical uprights shall be 2 mm per metre of profile.

7.2.4 *Placement of insulation*

Whenever applicable, the entire outer face of the supporting wall and the construction of the building will be covered as specified in the project.

7.2.5 *Placement of clips and plates*

First, the screwed lower clips are attached to the T profile and a bead of adhesive is applied as described in section 3.3 on the two T profiles supporting the plate.

Then the ceramic plate is coupled on the lower clamps, encasing the upper pins to the piece. Next, the upper clamps are positioned, fitting perfectly on the upper grooves. Thus, the pieces are stabilized.

The same procedure is used for the upper levels.

7.2.6 *Joints*

The joints between boards should always be open. The vertical joint should be between 4 and 6 mm; the horizontal joint is 4 to 6 mm.

The building expansion joints should always coincide with a cladding system vertical joint via a double profile.

8. REFERENCES OF USE

The manufacturer supplies the following works built in 2006-2007 for reference:

- Building in Zamora for "Tecozam Ferrallas y Armadas" (500m^2).
- Los Navalucillos Health Centre (Toledo) (220m^2).
- Wedding and Convention Centre in Chillón, Ciudad Real (800m^2).
- Road Conservation Centre in Zarauz, Guipuzcoa (900m^2).
- Residential building in Puertollano, Ciudad Real (291m^2). Puertollano (C. Real)
- Restoration of a residential building in Gijon (896m^2).

The IETcc has carried out several site visits and a survey of users, all with satisfactory results.

9. CALCULATION CRITERIA

The definition of the actions is performed according to the CTE DB-SE-AE (Technical Building Code - Basic Document for Structural Safety – Building Actions). The calculation considers that:

- The ceramic plates must withstand wind load (pressure / suction) and pass it through the substructure and anchorage to the support, which must withstand that force. The ceramic plates, fixings, substructure and anchorage must withstand the stress caused by wind, together with its own weight.
- The arrow on the ceramic plates must not exceed 1/150 of the distance between fixing points.
- The weight of the ceramic plates is divided by the number of fixings to be transmitted by the requests provided.

10. TESTING

The following tests were carried out at the Eduardo Torroja Institute of Construction Sciences (IETcc) (Report No. 19.124-1 in accordance with the UNE-EN ISO 10545, the EOTA Technical Report TR 001 and the EOTA draft Guide "Guideline for European Technical Approval of Kits for external wall claddings. Part 1: Ventilated cladding elements and associated fixing devices".

10.1 **Ceramic plate identification tests**

10.1.1 *Geometric*

Test performed according to standard UNE-EN ISO 10545-2:1998.

The maximum, minimum and average values in the different measurements of 5 nominal size 800 mm x 293 mm x 15 mm plates are listed.

- Length: Maximum value L = 802.0 mm
  Minimum value L = 800.5 mm
  Average value L = 801.3 mm
- Width: Maximum value a = 295.0 mm
  Minimum value a = 294.0 mm
  Average value a = 294.5 mm
- Thickness: Maximum value e = 14.81 mm
  Minimum value e = 15.08 mm
  Average value e = 14.96 mm
- Straightness of edges: Maximum value R = 0.25 %
  Minimum value R = 0.05 %
  Average value R = 0.12 %
- Orthogonality: Maximum value R = 0.20 %
  Minimum value R = 0.05 %
  Average value R = 0.12 %

All results obtained are within the limits set by the manufacturer.

10.1.2 *Apparent density*

According to standard UNE-EN ISO 10545-3:1997 the following has been obtained:

$D_{ap} = 2.285$ g/cm^3

10.1.3 *Water absorption*

According to standard UNE-EN ISO 10545-3:1997 the average water absorption value is:

W= 2.896%

10.2 **Mechanical characteristics**

10.2.1 *Plate flexure test*

Tests performed in accordance with standard UNE-EN ISO 10545-4:1997.

The test was performed on 5 nominal size of 800 mm x 293 mm x 15 mm ceramics plates applying a load to the center of the plate.

The span between supports was 760 mm. The rupture tension values obtained were:

Maximum rupture tension: σmax = 19.65 MPa
Minimum rupture tension: σmin = 12.47 MPa
Average rupture tension: σaverage = 16.20 MPa
Uniform wind pressure[1]: Pv = 631 kp/m2

10.3 **Durability**

For each durability test, the tensile strength and rupture tension is determined for 5 nominal size 800 mm x 293 mm x 15 mm ceramic plates, according to paragraph 10.2, once the accelerated aging test has been completed.

[1] Uniform wind pressure corresponding to minimum rupture tension.

10.3.1 *Oven at 80°C*

The plates are kept in the oven at 80°C for 28 and 56 days with the following results for rupture tension and tensile load:

a) *Oven for 28 days*

Maximum rupture tension: σmax = 18.84 MPa
Minimum rupture tension: σmin = 16.52 MPa
Average rupture tension: σaverage = 17.55 MPa
Uniform wind pressure[2]: Pv = 849 kp/m2

b) *Oven for 56 days*

Maximum rupture tension: σmax = 20.61 MPa
Minimum rupture tension: σmin = 14.32 MPa
Average rupture tension: σaverage = 17.10 MPa
Uniform wind pressure[2]: Pv = 688 kp/m2

10.3.2 *Saturation and drying*

The ceramic plates are subjected to the following cycle as set by regulation UNE-EN 494:1995, test 7.3.5:

- Submersion in water at room temperature for 18 hours.
- Oven drying at 60 ± 5°C for 6 hours.

After 50 cycles the rupture tension and tensile load are:

Maximum rupture tension: σmax = 28.65 MPa
Minimum rupture tension: σmin = 24.64 MPa
Average rupture tension: σaverage = 26.62 MPa
Uniform wind pressure[2]: Pv = 1246 kp/m2

10.3.3 *Freeze – Thaw*

Test consisting of the following freeze-thaw cycle as set out in standard UNE-EN 494:1995, test 7.4.1:

- Cooling in freezer at -15°C for 3 hours.
- Immersion in water at room temperature for 3 hours.

The rupture tensions and tensile loads obtained after 50 cycles for the ceramic plates are:
Maximum rupture tension: σmax = 27.25 MPa
Minimum rupture tension: σmin = 22.83 MPa
Average rupture tension: σaverage = 25.80 MPa
Uniform wind pressure[2]: Pv = 1150 kp/m2

[2] Uniform wind pressure corresponding to minimum rupture tension.

10.4 **Proficiency testing for use of the system**

10.4.1 *Hard body impact test*

Test performed according to specifications set in the EOTA draft guide *"Guideline for European Technical Approval of Kits for external wall claddings. Part 1: Ventilated cladding elements and associated fixing devices"* (January 2006 edition) section 5.4.4.1 *"Resistance to hard body impact"*.

For carrying out the test a total of six nominal size 800 mm x 293 mm x 15 mm ceramic plates were arranged, with two horizontally and three vertically anchored to the aluminum substructure as described in technical report and this in turn was anchored to the test bench with a separation of 800 mm between uprights for the plates with 4 anchors and 400 mm for plates with 6 anchors.

The test was performed impacting steel balls weighing 0.5 and 1 kg on the plates tested on an undeformable bench. The following results were obtained for the two solutions tested:

a) Plates anchored at ends (4 anchors) [3]

Impact energy	
1 Joule	No deterioration
3 Joules	Cracked
10 Joules	Cracked

b) Plates attached at ends and in the centre (6 anchors) with polyurethane adhesive described in the technical report

Impact energy	
1 Joule	No deterioration
3 Joules	Cladding element not cracked
10 Joules	Cladding element not cracked

10.4.2 *Soft body impact test*

Test performed in accordance with specifications set out in the EOTA draft guide *"Guideline for European Technical Approval of Kits for external wall claddings. Part 1: Ventilated cladding elements and associated fixing devices"*

[3] Tests performed only with mechanical fixing without adhesive described in point 7.2.5.

(January 2006 edition) section 5.4.4.2 *"Resistance to soft body impact"*.

For carrying out the test a total of eight nominal size 800 mm x 293 mm x 15 mm ceramic plates were arranged, one on top of another and anchored to the aluminum substructure as described in technical report and this in turn was anchored to the test bench with a separation of 800 mm between uprights for the plates with 4 anchors and 400 mm for plates with 6 anchors.

The test was performed impacting sacks weighing 3 and 50 kg on the plates tested on an undeformable bench. The following results were obtained for the two solutions tested:

a) Plates anchored at ends (4 anchors)

Impact energy	
10 Joule	No deterioration
60 Joules	Crack
300 Joules	Crack

b) Plates attached at ends and in the centre (6 anchors) with polyurethane adhesive described in the technical report

Impact energy	
10 Joule	No deterioration
60 Joules	No deterioration

10.4.3 *Hygrothermal Behaviour Test*

Test performed in accordance with specifications set out in the EOTA draft guide *"Guideline for European Technical Approval of Kits for external wall claddings. Part 1: Ventilated cladding elements and associated fixing devices"* (January 2006 edition) section 5.4.7 *"Hygrothermal behaviour"*

For carrying out the test a total of eighteen nominal size 800 mm x 293 mm x 15 mm ceramic plates were arranged, with three horizontally and six vertically anchored to the aluminum substructure as described in technical report and this in turn was anchored to the test bench with a separation of 800 mm between uprights.

The test was performed in two stages, the first heat-rain and the second heat-ice.

a) Heat-rain

The set was subjected to 80 constant cycles, with each cycle consisting of:

- Heating at 70 ±5°C for 1 hour to reach temperature and 2 hours maintained temperature.
- Sprayed with water for 1 hour.
- Drained for 2 hours.
- Rested for 10 minutes ± 1 minute.

Checking that, after 80 cycles, no defect was apparent in the ceramic plates and no permanent deformations were visible on the anchors or substructure profiles.

b) Heat-cold

The set was subjected to 5 constant cycles, with each cycle consisting of:

- Heating at 70 ±5°C for 1 hour to reach temperature and 2 hours maintained temperature.
- Cooling to -20 ± 5°C for 1 hour to reach temperature and 14 hours maintained temperature.

Checking that, after 5 cycles, no defect was apparent in the ceramic plates and no permanent deformations were visible on the anchors or substructure profiles.

10.4.4 *Subframe tests. Vertical profile*

a) Resistance to wind load

Considering the doubly supported aluminum profile 1.50 m length, applying a load on the central section simulating wind force and obtaining the curve load-deformation it is verified that working elastically the profile supports a load of 1.621 kN total load, equivalent to a separation between uprights of 0.80 m and a separation between supports of 1.10 m at 500 kp/m^2.

b) Resistance to wind suction

Considering the doubly supported aluminum profile 1.50 m length, applying a load on the central section simulating wind suction and obtaining the curve load-deformation it is verified that working elastically the profile supports a load of 1.042 kN total load, equivalent to a separation between uprights of 0.80 m and a separation between supports of 1.10 m at 325 kp/m^2.

10.4.5 *Pressure-suction tests for fixing points. Anchors.*

Test performed according to internal DIT (technical approval document) Laboratory procedures to determine resistance to wind suction of ventilated cladding fixing systems.

To carry out the test a nominal size 800 mm x 293 mm x 15 mm plate was arranged, anchored to two aluminum profiles according to the specifications provided by the manufacturer and described in the technical report. These profiles are supported on an undeformable bench located in the test area of an INSTRON 5582.

The completion of the test is attained by the breaking of the plate edge, obtaining an average rupture load of 0.993 kN, equivalent to a uniform wind pressure-suction of 448 kp/m2.

10.4.6 *Vertical load test*

Test performed in accordance with specifications set out in the EOTA draft guide *"Guideline for European Technical Approval of Kits for external wall claddings. Part 1: Ventilated cladding elements and associated fixing devices"* (January 2006 edition) section 5.4.2.6.2 *"Resistance of vertical load"*

To carry out the test a nominal size 800 mm x 293 mm x 15 mm plate was arranged, anchored to the aluminum substructure, which in turn was anchored to the test bench with a separation of 800 mm.

A fleximeter was then placed in the centre of the plate to measure vertical displacement thereof under a static load corresponding to the weight of the cladding elements (15 kg).

After 24 hours no deformities or obvious damage was observed to the plate or anchors.

10.5 **System durability tests**

10.5.1 *Pulsating load test*

Test performed according to internal DIT Laboratory procedures to determine resistance to wind suction of ventilated cladding fixing systems.

Tests were performed by applying a load at a frequency of 0.5 Hz for 25,000 cycles.

Having completed fatigue testing the initial static wind suction test was performed. Performing the test on three ceramic plates gave a mean rupture load value of 0.985 kN, equivalent to a uniform wind pressure of 444 kp/m^2.

10.5.2 *Colour durability test*

To evaluate colour durability two sets of samples of representative colours were taken. A series of samples was taken for measurement reference and the second was submitted to cycles of aging under UV rays in accordance with the technical report No. 10 "*Exposure procedure for artificial weathering*" of the EOTA and standard ISO 4892-3:2006.

To evaluate colour durability the requirements of the UNE-EN 438-2: 2005 were taken into account.

No significant differences were observed in any case, and there was no cracking, delaminating or any other defect by visual assessment.

11. PROFICIENCY FOR USE EVALUATION

11.1 **Compliance with national regulations**

11.1.1 ***SE – Structural safety***

The FAVEMANC XB ventilated cladding system does not contribute to the stability of the building.

The rear enclosure supporting the plate cladding must comply with the relevant regulations for structural safety requirements and the actions and requests that correspond to the incorporation of a ventilated façade should be considered.

The connection between the system substructure and the rear enclosure must be prepared so that during use stress or durability limits are not exceeded.

11.1.2 ***SI – Fire safety***

The composition of the enclosure, including,

where applicable, the insulation, must comply with the CTE Basic Fire Safety Document (DB-SI) with regard to fire resistance and the reaction to fire of materials in it.

According to the Committee Ruling 96/603/CE of October 4 1996, fired clay products have a fire classification of A1 (No contribution to fire) without requiring testing.

The material meets the requirement under CTE-DB-SI (SI-2 section 1.4) relating to outside materials for exterior cladding and interior surfaces of the ventilated façade chambers.

The vertical development of the air space will be limited to 3 floors or 10 metres, in compliance with the CTE-DB-SI, paragraph 3, on "Hidden Spaces. Passage of facilities through fire partitioning elements" and must be divided by a firewall element.

11.1.3 ***SU – Safety of use***

For the low areas of buildings, in areas accessible by the public, we recommend fixing the plates at 6 points (ends and centre of the upper and lower sides) as described in tests 10.4.2 and 10.4.3.

11.1.4 ***HS – Health***

The enclosure solution must guarantee the minimum degree of impermeability required for the building incorporating it as described in the CTE Basic Health Document (DB-HS), in order to meet the basic requirements for protection against humidity (HS 1, section 2.3).

From the definition of the system contained in the technical report, depending on the degree of impermeability required, ventilation of the air chamber may be increased as described in the CTE-DB-HS (HS-1, section 2.3).

Attention should be given to the design of the facades, the incorporation of windows and lighting elements, as well as the correct solution of the singular points such as external fixings, etc. to achieve an adequate seal at these points, preventing the accumulation and infiltration of water.

Verification of the limitation of humidity from surface and interstitial condensation must be made as provided in Section HE-1 (Limitation of energy demand) of the CTE-DB-HE (HE-1, point 3.2.2).

System components, as stated by the manufacturer thereof, must not contain or release hazardous substances according to the national and European legislation.

11.1.6 ***HR – Noise protection***

The complete enclosure solution and fundamentally the supporting wall plus insulation must comply with the requirements of the CTE with regard to noise protection.

11.1.5 ***HE – Energy efficiency***

The complete enclosure solution must meet the requirements of the CTE Basic Energy Saving Document (DB-HE) with regard to hygrothermal behavior.

The system as described in the technical report for the purpose of calculating thermal transmittance, as described in Appendix E of the CTE-DB-HE, the air chamber will be considered a "well ventilated air space" and the total thermal resistance of the enclosure is obtained neglecting the thermal resistance of the air chamber and other layers between the air chamber and the outside environment, including an outer surface resistance for still air, equal to the inner surface resistance of the same element (HE-1, Appendix E).

11.2 **Product use. Implementation and limits of use.**

11.2.1 ***Implementation***

Prior to installing the system, the type and condition of support should be identified for the definition of type and number of anchors.

The implementation of singular points such as sills, lintels, jambs, parapets, etc. should consider the tightness of the same and prior sealing if necessary as well as the proper disposal of water preventing its accumulation.

Recommendations given in point 6 of the technical report regarding plate handling will be followed.

In addition, protective gloves should be worn when handling the plates.

11.2.2 ***Limits of use***

The aspects concerning the calculation set out in point 8 of this document refer to the scope of the Basic Structural Safety regarding Building Actions by the CTE (DB-SE-AE).

For those cases leaving the scope of the Basic Document, or when stronger wind action to that considered in the CTE-DB-SE-AE is foreseen it is necessary to perform a specific study to determine wind action.

11.3 **Waste management**

The CTE does not specify requirements for waste management, however, for the waste produced during manufacturing processes and on-site implementation of the system, and particularly for adhesives and insulation and waterproofing materials, the manufacturer's instructions for each product must be followed in accordance with current regulations for each product.

For the purposes of waste management, XB FAVEMANC ceramic plates will be considered as "inert waste". There should be recycling for aluminum profiles, either for parts rejected during implementation or in case of removal of the ventilated cladding system.

11.4 **Maintenance and conditions of service**

According to durability tests and site visits, it is considered that the system has a satisfactory performance in accordance with the requirements for durability, provided that the cladding, installed as described in this document, is subject to proper use and maintenance, as set out in the CTE.

To clean the plates follow the manufacturer's recommendations.

11.5 **Aspects relating to the appearance and esthetics.**

The results of resistance to ultraviolet radiation enable the estimation that the stability of the color is satisfactory over time for the situation in Western Europe.

12. CONCLUSIONS

Verifying that the manufacturing process for GRESMANC INTERNACIONAL S.L. group plates includes a quality control comprising a self-control system whereby the manufacturer verifies the suitability of raw materials, manufacturing process and product control.

Considering that the manufacturing and implementation process is sufficiently contrasted by the practice and test results, the suitability of the system proposed by the manufacturer is deemed favorable with the observations of the Expert Committee in this DIT.

THE SPEAKERS

Tomas Amat Rueda, PhD in Civil Engineering

Rosa Senent Architect

12. OBSERVATIONS BY THE EXPERTS COMMITTEE

The main observations by the Expert Committee meeting at the Eduardo Torroja Institute of Construction Sciences on November 29, 2007[4], were as follows:

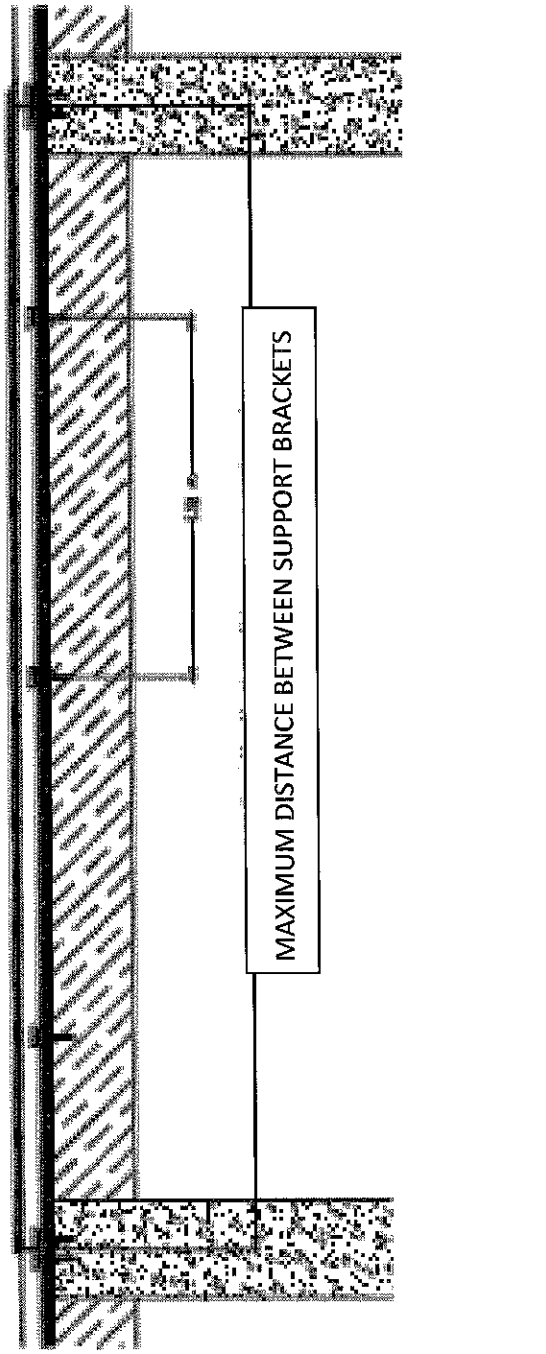
- It is advised that GRESMANC INTERNACIONAL, S.L. specifically advise on the suction values which plates may be subjected to, determining the number of screws connecting the guide rails to the uprights and the latter to the support and retention brackets as well as the proper tightening of the same , as set out in the technical report.

[4] The Expert Committee was made up of representatives from the following organizations:
-ACCIONA Infrastructures
-Superior Council of Colleges of Architects of Spain(CSCAE)
-Ferrovial Agroman
-INTEINCO
-INTEMAC
-Army Engineers Laboratory
-Ministry of housing
-QUALIBERICA
-SOCOTEC IBERIA
-Technical University of Madrid (UPM)
-Eduardo Torroja Institute of Construction Science (IETcc)

It should be remembered that according to the specific situation of the building, its shape and dimensions, the values of wind pressure and suction on certain points may be higher than described in the current regulations, which should be considered in the calculations.

- It is advised that GRESMANC INTERNACIONAL, S.L. advise in the design and implementation of gaps and singular points.
- Depending on the type and condition of the support, the most suitable type of anchorage will be used.
- It is recommended that during assembly, the uprights are positioned first and then the insulation, if applicable.
- Because profiles are not continuous, tracks must be extremely level.
- All metal components incorporated into the system must not cause corrosion problems.
- For exceptional conditions of high exposure to chlorides, the use a stainless steel AISI-316 for screws and clips is recommended.
- Cladding joints will be considered in relation to the building expansion joints.
- It should be noted that dark colour plates are more sensitive to sunlight, so that those located in areas of high temperatures and exposure to sunlight must be carefully assessed when choosing colour.
- It is noted that the ventilated cladding systems do not guarantee sealing the enclosure with only the outer coating. In any case, please study the joint behavior of the complete enclosure, as described in the CTE Basic Health Document (DB-HS) regarding protection against moisture (HS-1).

FIGURE 1: VERTICAL SECTION

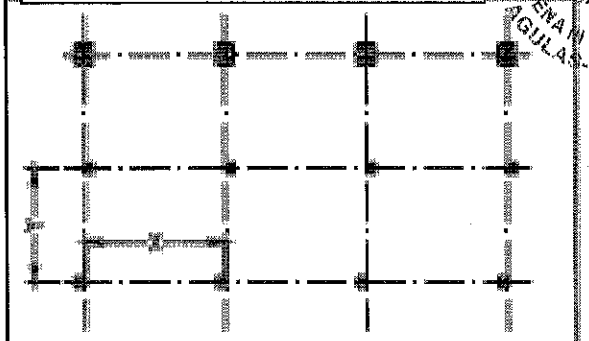


ANCHORAGE OF SUPPORT BRACKET TO FRAMEWORK

ANCHORAGE OF RETENTION BRACKETS TO EXTERIOR WALL SUPPORT

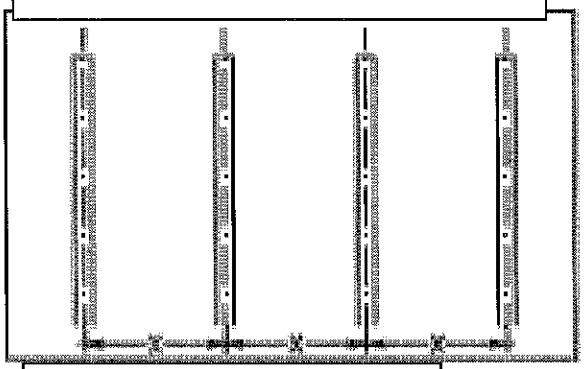
FIGURE 2: ASSEMBLY STAGES

1. PLACEMENT OF SEPARATORS

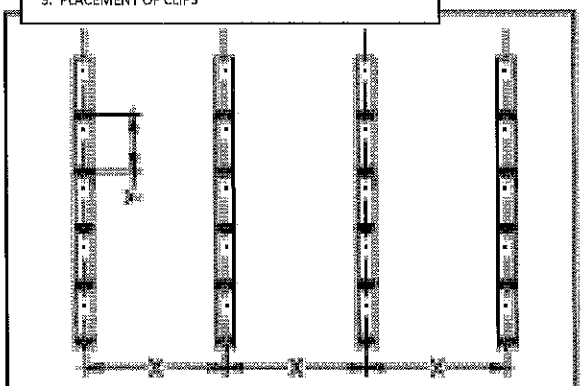


X regarding selected format, no greater than 800mm.
Y maximum = 1100mm.

2. PLACEMENT OF VERTICAL PROFILES



3. PLACEMENT OF CLIPS



Y regarding format of chosen plate.

4. PLACEMENT OF CERAMIC PLATES

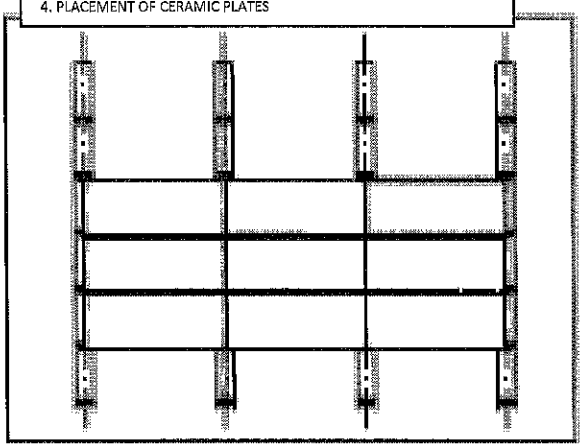
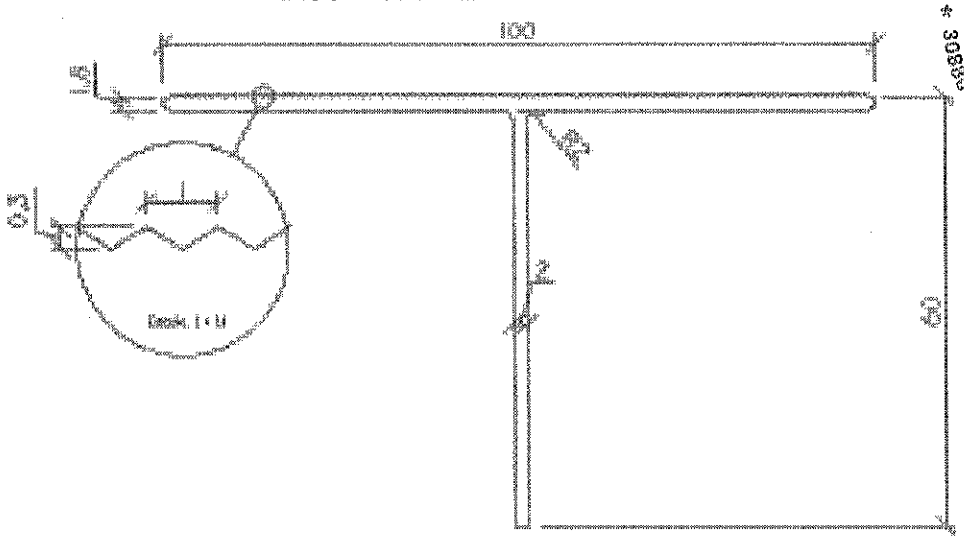


FIGURE 3: VERTICAL PROFILE



TYPE	Section mm^2	Weight kg/m	Perimeter mm	X_c mm	I_{xc} cm^4	r_{xc} mm	y_c mm	I_{yc} cm^4	r_{yc} mm
T5 6063	290.48	0.783	357.39	50	9.55	18.13	47	14.27	22.17

FIGURE 4: FIXING CLIPS

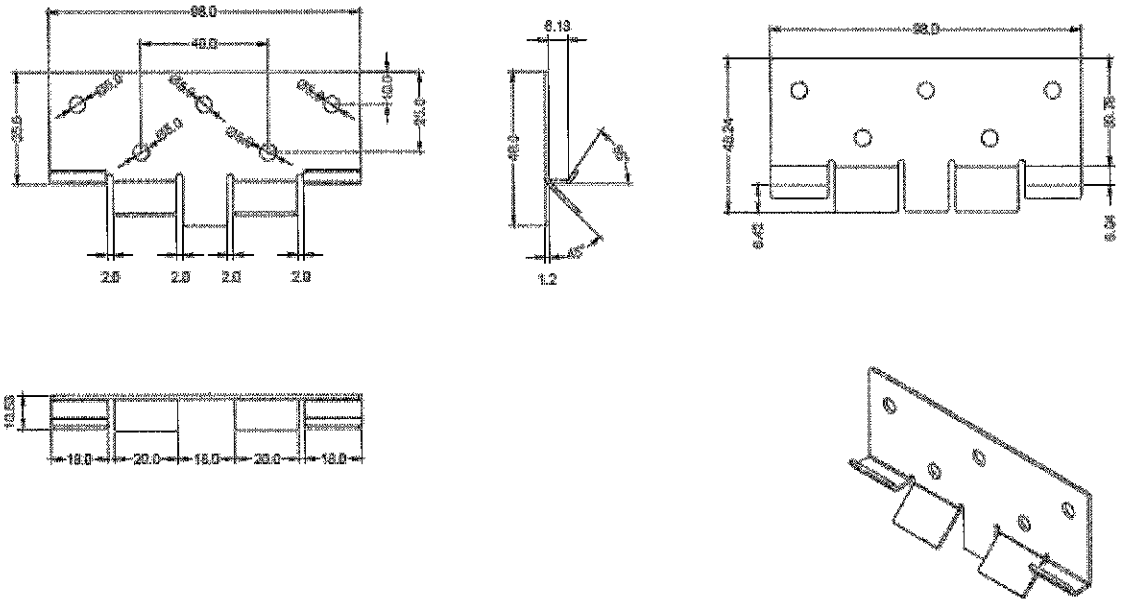
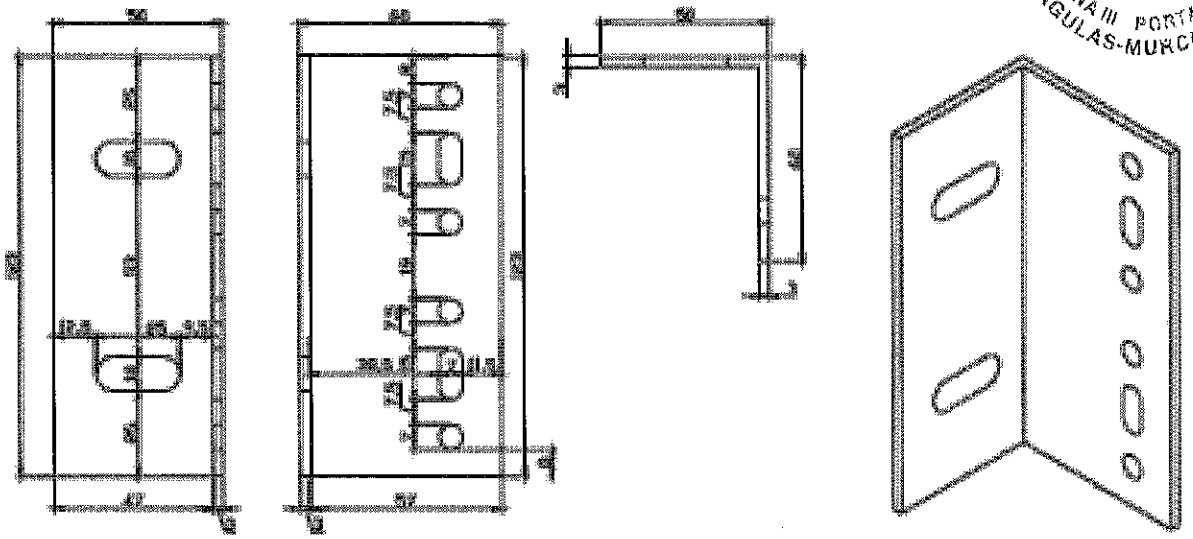
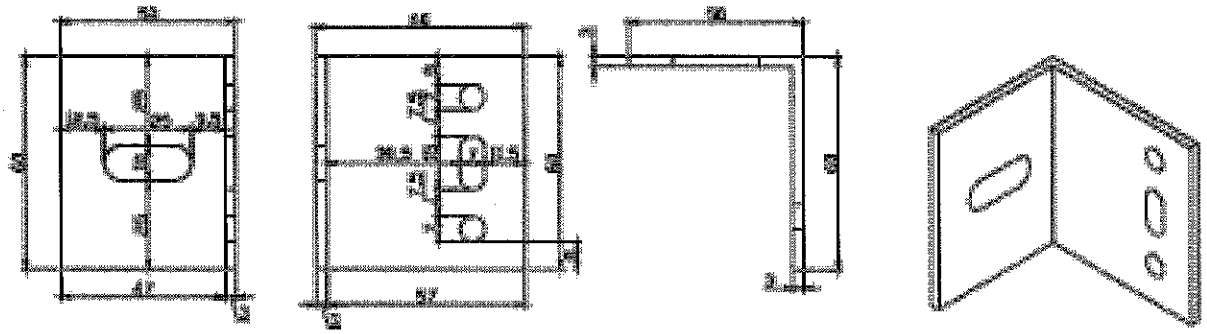


FIGURE 5: SUPPORT AND RETENTION BRACKETS

ECI 60 SUPPORT BRACKET



ECI 60 RETENTION BRACKET



TYPE	Section cm^2	Perimeter mm	X_c mm	I_{xc} cm^4	r_{xc} mm	y_c mm	I_{yc} cm^4	r_{yc} mm
ECI 108-60 / ECI 100-60 / ECI 102-60 / ECI 104-60	321	220	37.5	11.83	19.2	17.48	7.55	15.33

FIGURE 6: CERAMIC PLATE

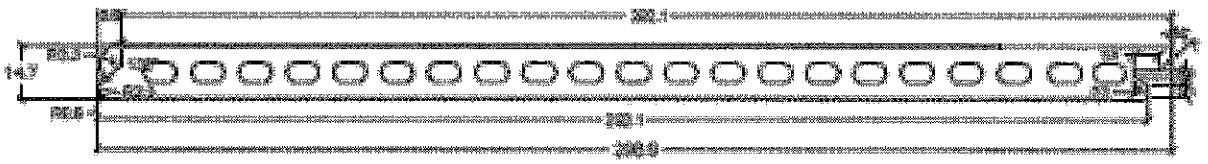


FIGURE 7: VERTICAL SECTION THROUGH WINDOW WITH METAL REVEAL-LINTEL

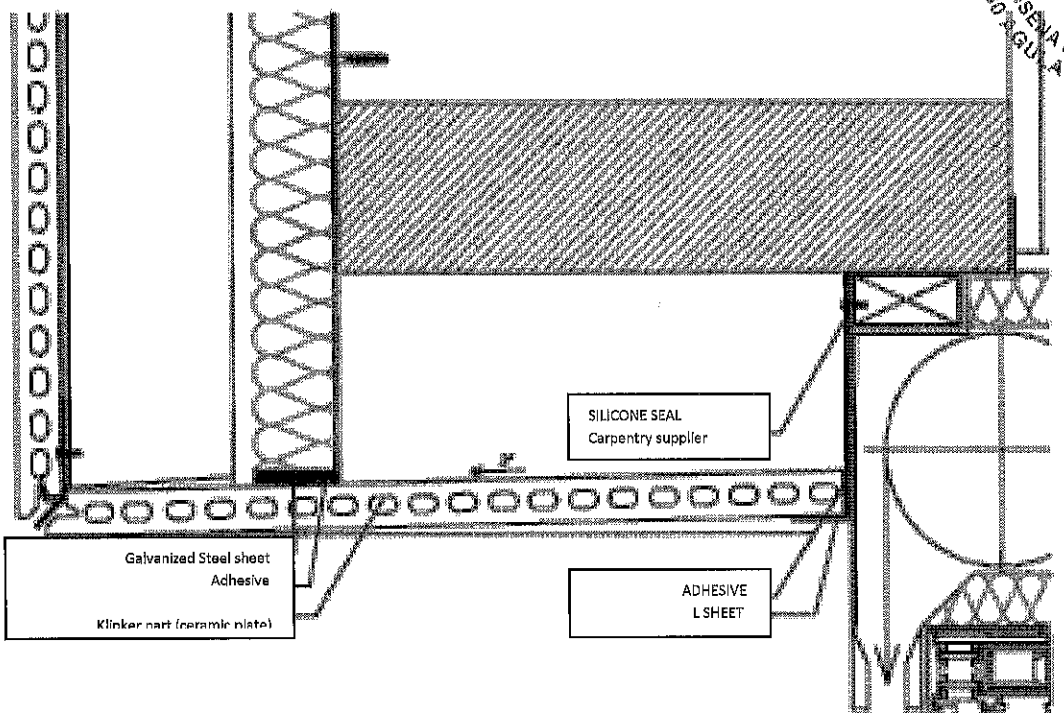


FIGURE 8: VERTICAL SECTION THROUGH WINDOW WITH METAL REVEAL- WINDOWSILL

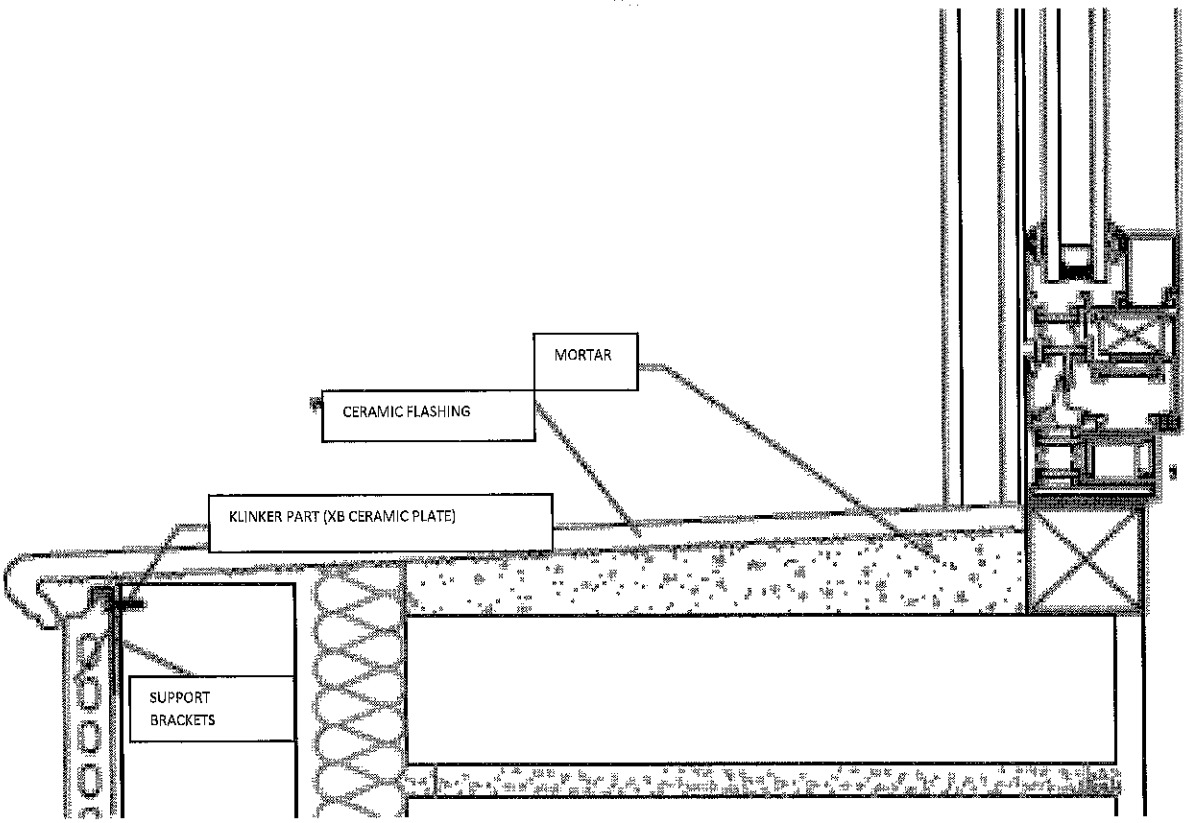


FIGURE 9: VERTICAL SECTION THROUGH WINDOW WITH CERAMIC REVEAL-LINTEL

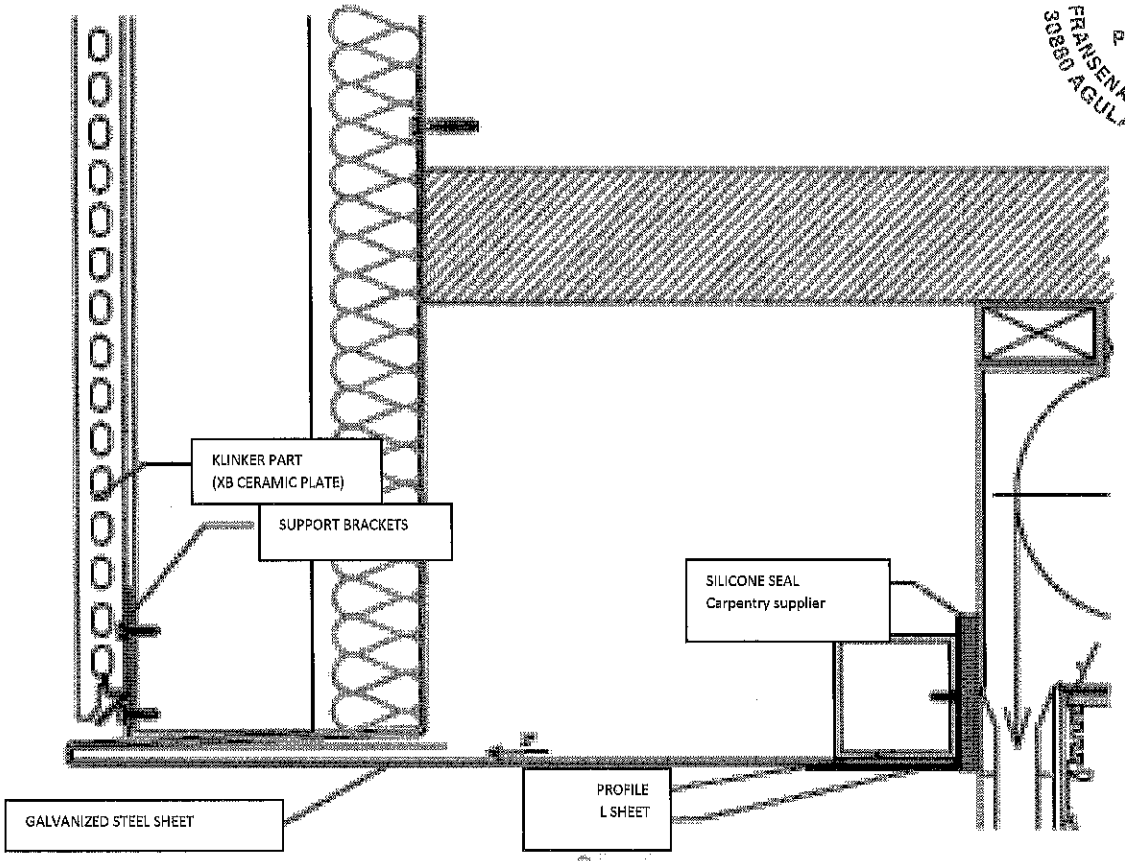


FIGURE 10: VERTICAL SECTION THROUGH WINDOW WITH CERAMIC REVEAL - WINDOWSILL

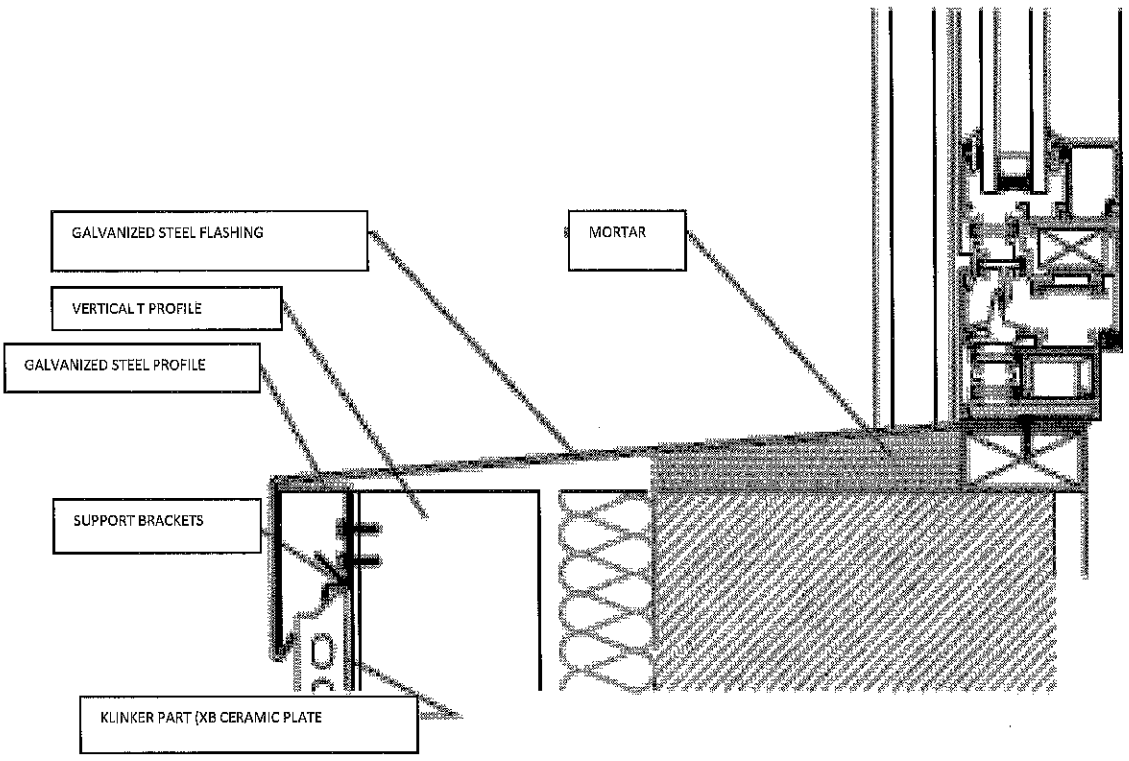


FIGURE 11: HORIZONTAL SECTION THROUGH WINDOW WITH CERAMIC REVEAL

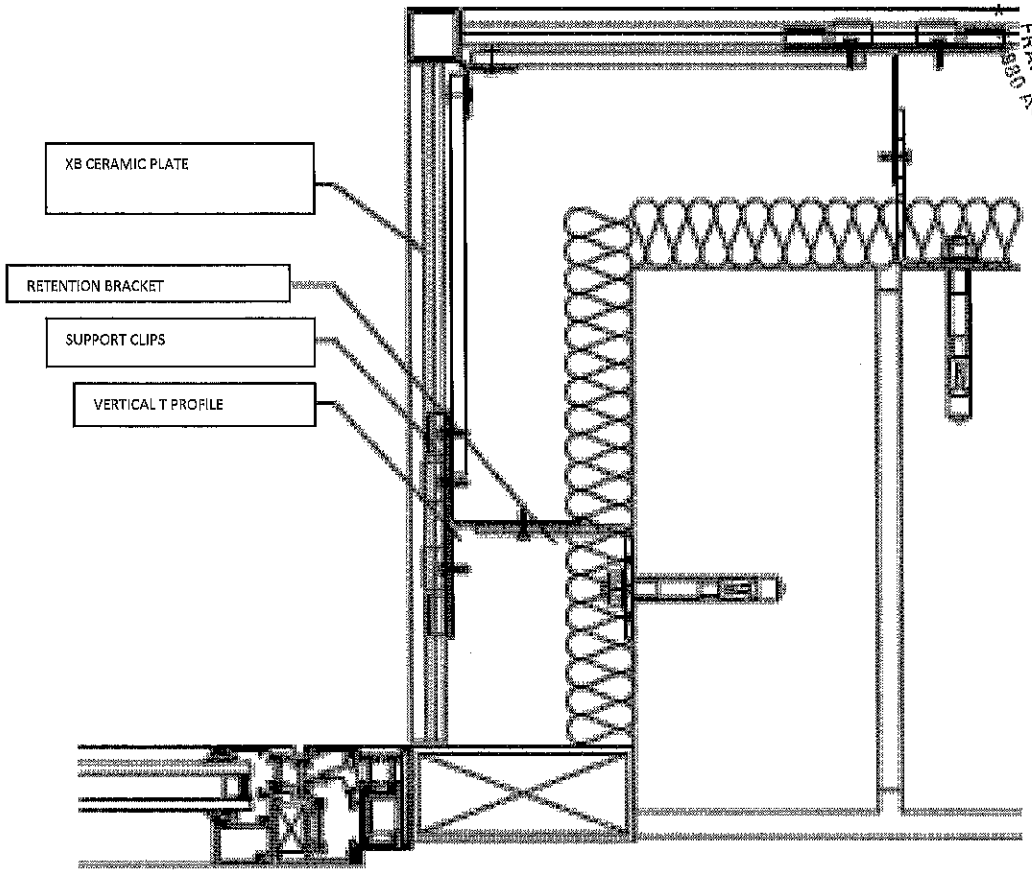


FIGURE 12: HORIZONTAL SECTION THROUGH WINDOW WITH METAL REVEAL

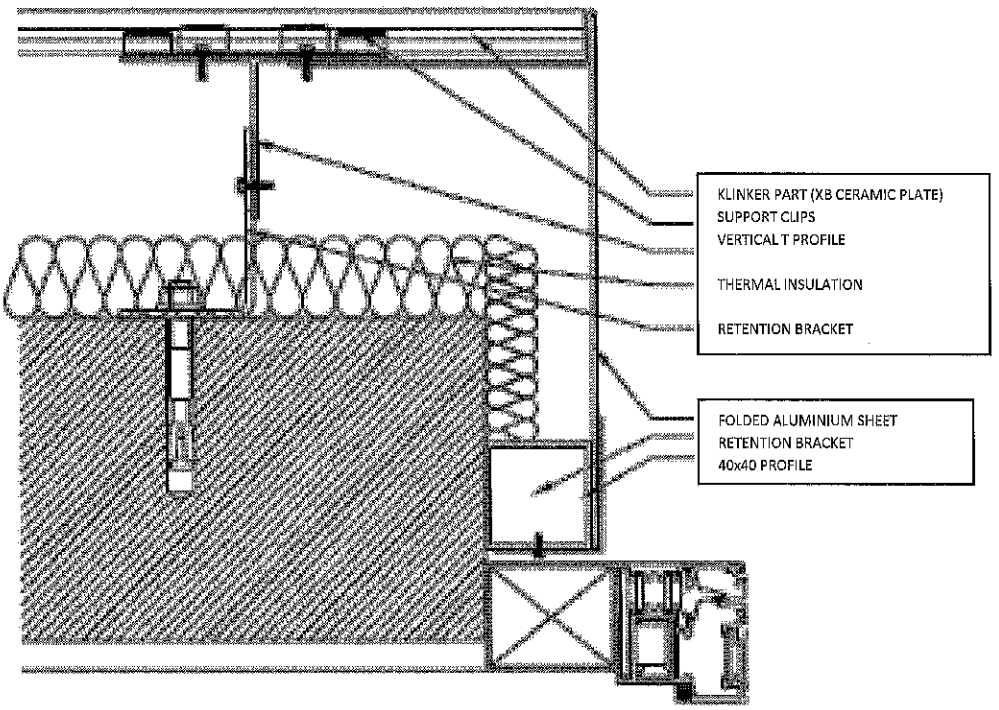


FIGURE 13: CROWNING DETAIL

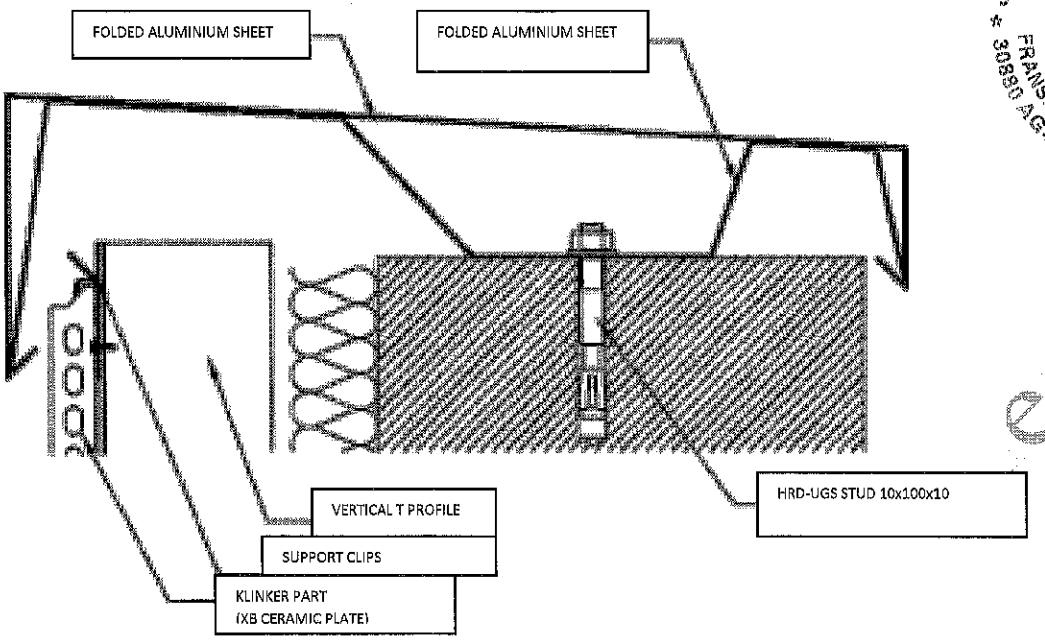


FIGURE 14: HORIZONTAL JOINT DETAIL BETWEEN PLATES

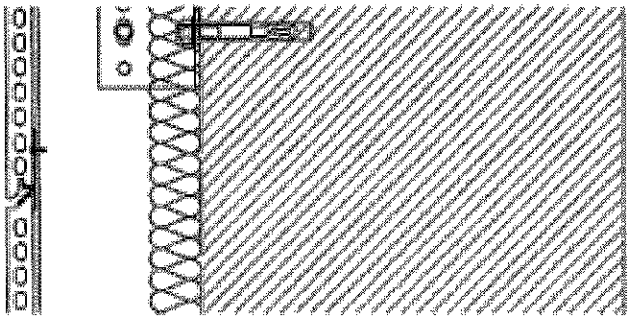


FIGURE 15: BASE DETAIL

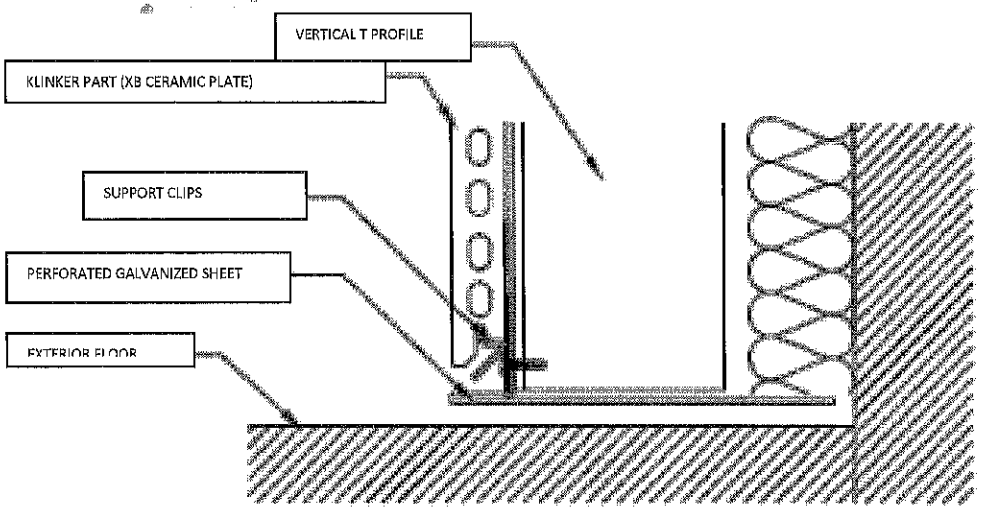
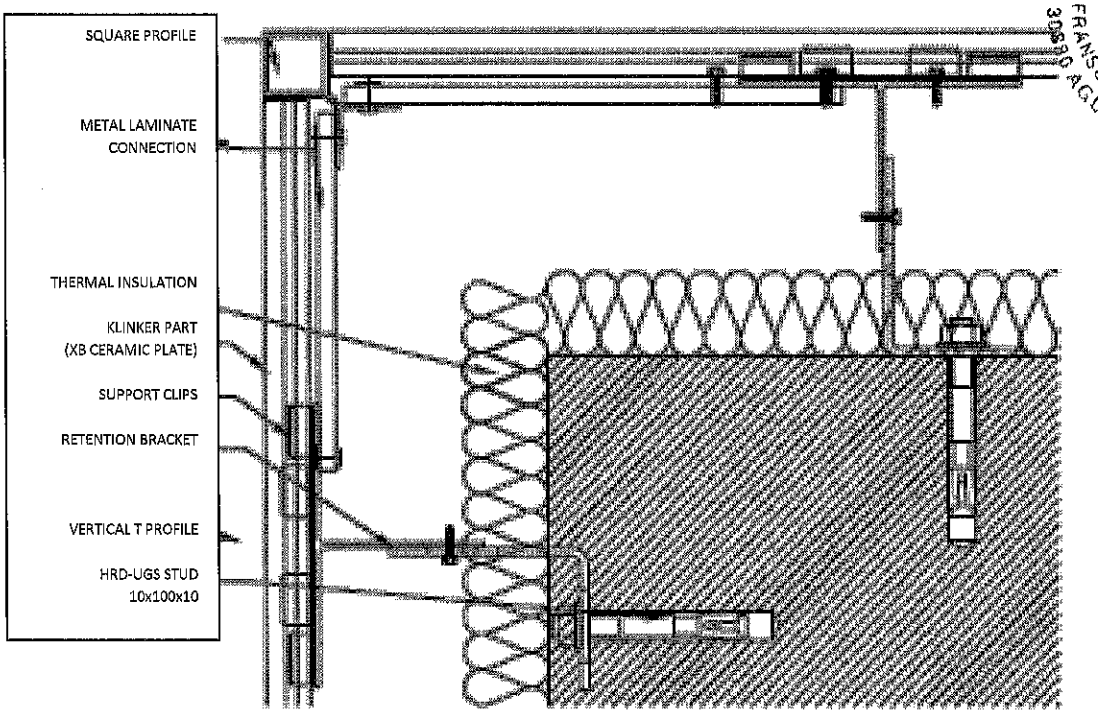
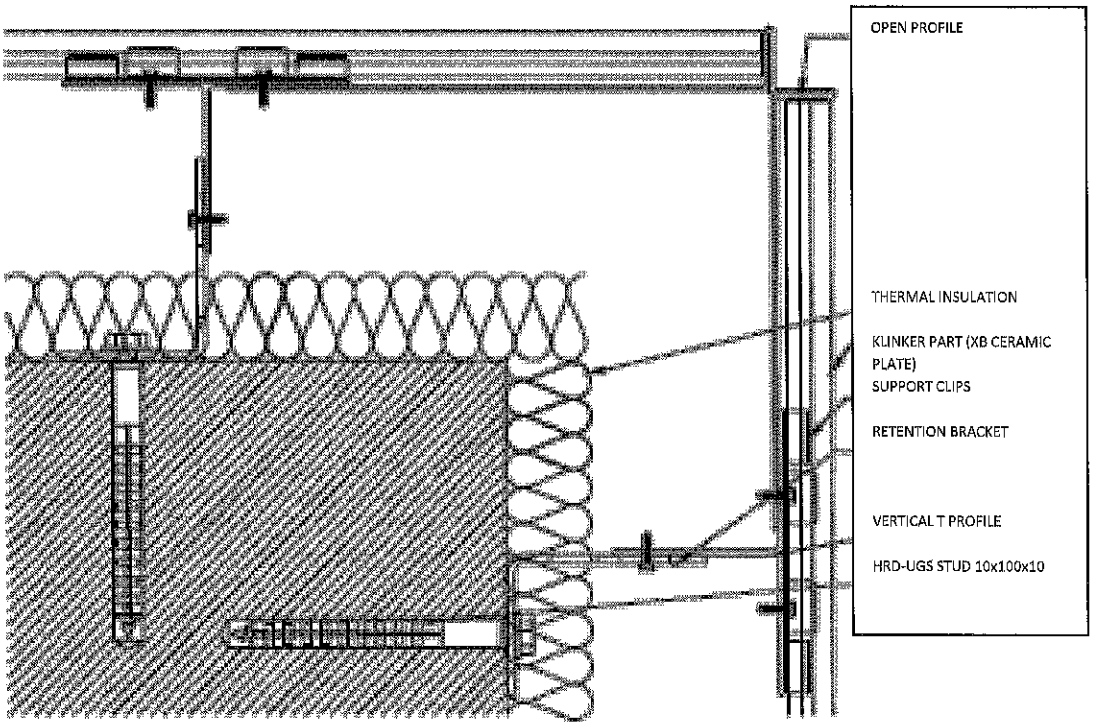


FIGURE 16: CORNER DETAILS





Don Juan Amor Fernández, Intérprete Jurado de Inglés, certifica que la que antecede es traducción fiel y completa al inglés de un documento redactado en español.

I the undersigned Juan Amor Fernández, sworn translator for the English Language do hereby certify that the foregoing is a true and faithful version of the original Spanish document hereunto attached.

Águilas (Murcia) Spain, 12th June 2012

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