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DOCUMENT OF TECHNICAL APPROVAL PLUS: 390-p/13

Generic area/Predicted Use:

One coat mortar for the rendering of façades

Commercial Brand

MORCEMDUR-R

Manufacturer

GRUPO PUMA S.L

Head Office

Conrado del campo nº2 .Poligono industrial Trevez, 29590 Campanillas (Málaga). España

Production sites

La Cañada (Almería). Ctra Viator km 1,5.
Vilafranca del Penedés (Barcelona). Pol. Ind. Domenys II. C/ Enología, nº 15.
Arganda del Rey (Madrid) Pol.Ind. El Guijar. Av. del Guijar nº 37-39.
Dos Hermanas (Sevilla). Pol. La palmera. C/ La palma nº 20. Málaga. Conrado del campo nº 2. Pol. Ind. Trevez.

Validity from:

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Till:

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(Conditional to annual pursuit)

This Document consists of 16 pages



MEMBER OF:

UNIÓN EUROPEA PARA LA EVALUACIÓN DE LA IDONEIDAD TÉCNICA
UNION EUROPÉENNE POUR L'AGRÉMENT TECHNIQUE DANS LA CONSTRUCTION
EUROPEAN UNION OF AGREEMENT
EUROPÄISCHE UNION FÜR DAS AGREEMENT IN BAUWESEN

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VERY IMPORTANT

The TECHNICAL APPROVAL DOCUMENT (DIT) is, by definition, a favourable technical assessment, on behalf of the Building Science Institute Eduardo Torroja, of fitness for use in construction of non-conventional materials, systems and procedures destined to a particular and specific use. It has no administrative consequence, nor does it represent authorization for use or guarantee.

The TECHNICAL APPROVAL DOCUMENT PLUS (DIT plus) is a favourable technical assessment, on behalf of the Building Science Institute Eduardo Torroja, that is based on the DIT procedure and evaluates the voluntary aspects not covered by the CE mark. DIT plus is based on the principles established in the "Application document" drafted by the *Union Européenne pour l'Agrément technique dans la construction* (UEAtc), and which can be applied to both harmonized technical specifications established in the DPC: The Harmonized Standard and the European Technical Approval Document.

This document must be entirely understood before using the material, system or procedure referred to in this Document. Therefore, a full copy must be provided by the owner.

Modifying characteristics of the products, or not respecting the conditions of usage, as well as observations made by the commission of experts, invalidates the current technical report. The reproduction of any part of this Document must be authorized by the Building Science Institute Eduardo Torroja. This Document consists of 17 pages.

**C.D.U. 693.6
Mortero monocapa
Enduit monocouche
One coat mortar**

ISSUE No. 379-p

THE DIRECTOR OF THE BUILDING SCIENCE INSTITUTE EDUARDO TORROJA,

- By the right of Appointment no. 3652/1963 of 26th December approved by the Government Chairmanship, which empowers the Building Science Institute Eduardo Torroja (IETcc – Instituto de Ciencias de la Construcción Eduardo Torroja) to extend the TECHNICAL APPROVAL DOCUMENT of non-conventional materials, systems and procedures used in buildings and public works, and Order 1.2651/1998 of December 23 of the Ministry of Court Relations and the Secretary of the Government by which the concession is regulated,
- having considered article 5.2, section 5, of the Building Technical Code (CTE - Código Técnico de la Edificación) on the conformance of innovative systems, products and equipment with the CTE, which establishes if a constructive system in conformance with the CTE includes a favourable technical evaluation of its suitability for the planned use,
- having considered procedure IETcc-0405-DP of May 2005, which regulates the concession of DIT plus,
- having considered the specifications established in the Regulation on monitoring the DIT approved in 28/10/1998,
- having considered the application submitted by GRUPO PUMA S.L. for the issuing of a Technical Approval Document plus regarding the **One-coat mortar for the rendering of façades MORCEMDUR R**,
- having considered the reports and results of the tests forwarded by the IETcc, as well as the observations drawn up by the Commission of Experts,

HEREBY DECIDES:

To grant the TECHNICAL APPROVAL DOCUMENT No. 379-p to **One-coat mortar for the rendering of façades MORCEMDUR R**, taking into consideration that,

The technical evaluation carried out leads to the conclusion that this Product is IN CONFORMANCE WITH THE BUILDING TECHNICAL CODE, provided that the contents of this document are fulfilled and specifically under the following conditions:

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GENERAL CONDITIONS. The present DOCUMENT OF TECHNICAL APPROVAL evaluates exclusively the constructive Product proposed by the beneficiary, having for each case, in agreement with the effective Norm, to be accompanied by the construction mandatory project and to be carried on under the supervision of the corresponding work direction. The beneficiary, for each application, will provide technical attendance for the system and for each one of his components, in order to allow the complete definition and execution of the system.

MANUFACTURING CONDITIONS. The current technical evaluation is valid provided that the manufacturer carries out a systematic control on the homogeneity of the product and the identification characteristics are maintained, in accordance with the requirements defined in the current DIT plus and the conditions established in the **Regulation on Monitoring the issuing and processing of the DIT** of October 1998.

CONDITIONS OF USAGE. MORCEMDUR P constitutes a continuous render for façades and provides protection against rain and an aesthetic finish due to its technical features. Its usage shall be carried out under the technical guidance of the manufacturer, under the conditions and application scopes covered by this Document, and respecting the observations forwarded by the Commission of Experts.

CONDITIONS OF THE CONCESSION. This product is covered by the application scope of the Harmonized European Standard UNE-EN 998-1 "Specification for mortar for brickwork. Part 1: Rendering and plastering mortar". The entry into force of the Standard requires all the systems covered by said standard feature the CE mark.

To grant a one-coat mortar the concession of a **DIT plus**, the product must meet the specifications indicated in the aforementioned Standard. However, within the different categories of a one-coat mortar, this evaluation only considers those products with values of resistance to compression equal or greater than 5 MPa and a capillarity equal or lower than $0.2 \text{ kg/m}^2 \text{ min}^{1/2}$ (W2). Likewise, the one-coat mortar evaluated must present a value of shrinkage equal or smaller than 1.2 mm/m, of water retention equal or higher than 90%, of adhesion to the substrate equal or greater than 0.3 MPa, and a modulus of elasticity smaller than 12,000 MPa.

The requirements established for the concession of a **DIT plus** define more demanding production controls than those established by the Standard for the obtainment of the CE mark. The IETcc or a Laboratory of its choice will visit the site works at least twice per year.

This DIT plus does not exempt the manufacturer from the obligation of obtaining the CE mark.

VALIDITY. This TECHNICAL APPROVAL DOCUMENT PLUS No. 379-p is valid for a period of five years from the issuing date under the following conditions:

- The manufacturer must not modify the product characteristics indicated in this Technical Approval Document plus.
- The manufacturer shall carry out a systematic internal control of production as established in the Technical Report.
- The IETcc shall carry out a control yearly to ensure that the above mentioned conditions have been met, and any of the most recent sites may be visited if considered necessary.
- The validity of the CE mark shall be maintained.

Following the favourable result of the control, the IETcc shall issue a certificate yearly attached to the DIT plus, thus providing it validity.

This document must be renewed before March the 12th, 2018.

Madrid, March the 12th, 2013.

DIRECTOR OF THE BUILDING SCIENCE
INSTITUTE EDUARDO TORROJA

Angel Arteaga Iriarte

TECHNICAL REPORT

1. DESCRIPTION

Continuous one-coat render for protection against rain⁽¹⁾ and finish on façade brickwork or concrete walls, consisting of a modified and coloured⁽²⁾ mortar that, once applied and still fresh, is subsequently applied a projection of a larger aggregate than that used in the mortar.

2. MATERIALS

Binders. White Portland Cement BL II/A-L 42.5 R, BL II/A-LL 52.5 R, BL I/52.5R, in accordance with Standard UNE 80 305- 2001. The cement must be certified CE. Total content in weight (approximate): $19 \pm 2 \%$.

Aggregates or mineral filler. Siliceous and limestone with compensated grain-size distribution (must be certified CE). Total content in weight (approximate): $78 \pm 2\%$.

Additives and others. Water retainers, light aggregates, water repellents, fibres, air entraining agents and inorganic pigments. Total content in weight (approximate): $3 \pm 0.5 \%$.

3. CHARACTERISTICS (provided by the manufacturer)

Characteristics	
Bulk density of powder mortar (kg/m ³)	1.250 ± 150
Density of paste (kg/m ³)	1.650 ± 100
Density of hardened mortar (kg/m ³)	1.400 ± 150
Mixing water (%)	24 ± 2
Water retention (50 mm of Hg, 5 min) (%)	≥ 90%
Capillarity (kg/m ² min ^{1/2})	≤ 0.2
Compression strength 28 days (MPa)	5 - 8
Flexural strength 28 days (MPa)	3 ± 1
Shrinkage (mm/m) 28 days	≤ 1.2
Adhesion (MPa)	≥ 0.3

4. PRODUCTION

4.1 Manufacturer

One-coat Mortar MORCEMDUR R is produced in the following 5 factories of GRUPO PUMA S.L.:

- La Cañada (Almería).
- Vilafranca del Penedés (Barcelona).
- Arganda del Rey (Madrid).
- Dos Hermanas (Sevilla).

⁽¹⁾ These renderings are not watertight but give the substrate an extra waterproofing quality against rainwater.

⁽²⁾ Industrial mortar (prepared in a factory), OC (One-coat mortar), in compliance with Standard UNE-EN 998-1, designed for external one-coat rendering that acts like a multi-layer system (which constitutes the traditional execution of render) and is prepared with normal and light aggregates, as defined by the aforementioned European Standard.

- Málaga.

The current maximum production capacity of mortar, according to the manufacturer, is of 500,000 tonnes per annum, and the annual average production of material is of 47,000 tonnes.

The company has implemented a quality assurance system that is in accordance with Standard ISO 9001, which is certified by AENOR.

4.2 Production process

The production is carried out using mechanical procedures by mixing the main components and part of the secondary components, previously measured on a computerized automatic scale, to which the rest of secondary additives are added manually by means of a control scale-hopper in the mixer.

Once the mixing procedure has ended, which is controlled by an automatic timer, the product is placed in finished product hoppers that feed the bag fillers where the material is packed.

4.3 Production controls

The characteristics monitored in the production and the frequency of these controls is as follows:

4.3.1 Raw Materials (each batch)

Raw Materials	Characteristics
Cement	Colour. Manufacturer certificate
Aggregates	Grain-size distribution, Manufacturer certificate Colour, Content of humidity ⁽³⁾
Additives	Effectiveness, by means of rebuilt material ⁽⁴⁾ Manufacturer certificate
Pigments	Manufacturer certificate Effectiveness, by means of rebuilt material ⁽⁴⁾

The pigments used in the production of the one-coat mortar must be inorganic, stable to light and compatible with the rest of the material's components.

4.3.2 During the production process

- Weight of the components comprising the finished product.
- Mixing time
- Weight of the bags.

⁽³⁾ The humidity of the mineral filler (sand) before it is introduced in the mixer must never exceed 2%, thus avoiding any phenomena such as cement hydration.

⁽⁴⁾ Only in those cases when modified (counter-type).

4.3.3 Finish product

Characteristics	Frequency
Colour	Batch
Bulk density of powder	Daily
Grain-size distribution	
Consistency	
Bulk density of paste	
Water retention	
Shrinkage	Monthly
Bulk density when hardened	
Capillarity	
Mechanical resistance	
Adhesion	

The results of the test shall be recorded in a quantity control registry.

5. STORAGE

The packed product shall be stored in a ventilated and sheltered place. The maximum product storage time in its original packaging, sheltered from humidity, shall be of 12 months.

6. PRESENTATION OF THE PRODUCT

Packaging. The product is presented in double Kraft paper bags including an intermediate lining of high-density polyethylene. The net weight of the bag is 25 kg ($\pm 2\%$). The bags are stacked on 1,400 kg pallets (56 bags) in Almeria and 1,200 kg pallets (48 bags) in the rest of plants, and they are sheltered from the weather by means of a plastic cover or film. This product is available in several colours as presented in the manufacturer's colour chart.

Label marking. The bag features a print showing the name of the Company, product, weight, basic instructions of use and storage, date of manufacture, number of manufacturing lot, date of expiry, anagram and number of **DIT plus**.

7. ON-SITE APPLICATION

7.1 Allowed substrates

This mortar can be applied on the following bases or substrates: normal concrete, lightweight concrete blocks and ceramic bricks. It must never be used on substrates including water repellent, on plaster, or plastic paints or coatings. The use of the one-coat mortar on different substrates to those mentioned above have not been evaluated in this DIT plus.

7.2 Substrate conditions

The substrate must present the following qualities:

- **Size.** It must have the dimensions required to provide a suitable behaviour to deformations, vibrations or deterioration so, in accordance with the Basic Documentation of the Building Technical Code DB SE (chapter 4.3), the effect of the foreseen actions does not reach the limits established for said effects.

Regarding deflections (chapter 4.3.3.1 of the DB SE), for substrates suggested by the manufacturer (brick and concrete) rendered with the one-coat mortar, the integrity of constructive elements should not present any issues if the relative deflections do not exceed the value of the Span/500. This value shall be limited to a maximum of 1 cm in order to avoid cracking, in accordance with the experience of the IETcc in real cases.

The substrate shall be designed and executed in such a way that cracks are not produced due to the forces and stresses produced from the position and size of openings (windows, doors), joints to frames (columns or beams), etc.

- **Stability.** Before applying the material, ensure that the substrate has suffered its maximum shrinkage (through drying, etc), which usually happens approximately a month after its execution in the case of ceramic substrates (bricks) and more than two months in the case of concrete blocks, and that cracks have stabilized.

The expansion limits due to water absorption in ceramic materials must also be taken into consideration.

- **Resistance.** If rendered with a coat of mortar, the resistance and adhesion of this coat shall be at least equal to that of the one-coat mortar.
- **Cleanliness.** (Absence of dust, moss, oil, damaged paints, etc) ⁽⁵⁾.
- **Flatness.** Proud parts of the surface greater than a third of the coat thickness must be levelled out. On irregular walls or walls with cavities, a layer/coat of mortar shall be applied to normalise the surface, which can be prepared with the same product or cement based mortar.

This layer/coat of mortar must meet the following conditions:

⁽⁵⁾ In old concrete or block substrates, the elimination of plaster or paint may be carried out by means of sand blasting or pressurized water. In walls obtained from plank moulds (phenolic type, etc), necessary precautions must be taken so as to ensure strong adherence to the rendering coat.

- have an equal or greater resistance than the one-coat mortar,
- joints shall be included in the aforementioned layer/coat if it has a large surface with the aim of avoiding cracks (NTE-RTE establishes sections with a width not greater than 3 m),
- a rough finish shall be provided, thus obtaining a suitable adhesion of the coat.
- the mortar shall be applied after levelling and hardening (never before 7 days), leaving a rough substrate for proper adhesion of render, by wetting the prop previously.

If the layer/coat is small, it is advisable to use the one-coat mortar; the render shall be applied within 24 hours in normal weather conditions, after having applied the levelling layer, and 6 hours in very hot weather.

The application of render with different thicknesses (on joints with faulty seals or with excessive thickness) may cause visible imperfections (or visible substrate joints), colour differences and cracks in the render.

- **Roughness.** If the surface of the wall is too smooth (the case of certain plank moulds), it is advisable to create irregularities with a chisel, by sand blasting, etc.

Placing an adhesion primer⁽⁶⁾ is recommended or improve the adhesion of the one-coat mortar on a smooth concrete substrate. Another way to ensure the adhesion of the mortar to the base or substrate consists in fitting a glass fibre mesh resistant to alkali or polyester, which is fixed with special round expanding nails made of plastic ⁷⁾ (5 cm diameter heads maximum), or with special anchors (plastic washers, etc) fixed mechanically.

- **Porosity.** The substrate must have sufficient porosity. However, low porosity of the substrate can be compensated with an improvement of the roughness, which can be achieved by using the procedures explained in the previous section.
- **Level of humidity.** The **substrate** must not be too dry, so, depending on its conditions and the environment, **it must be wetted previously and the water allowed to be absorbed. It must not be applied on substrates saturated with water.**

⁽⁶⁾ The adherence primer may be:

- A 3-4 mm thin layer of mortar mixed with a compatible acrylic resin. Mix in the following proportion: 2.0 kg retail resin (50% solid) per 1 bag of material (30 kg), resulting in an approximate 3% resin. Water is then added for a workable mix and render applied over freshly primed prop.
- An existing product on the market, DIT certified is recommended.

⁽⁷⁾ Never use steel fixings.

With dry wind or high temperatures; therefore, the substrate must be wetted before applying the one-coat mortar and 24 hours afterwards with the aim of rehydrating the cement. We also recommend the installation of protective mesh or awnings on the façade.

7.3 Preparation of the mixture

The proportion of water must be of 24 % of water⁽⁸⁾ in weight (approximately 6 litres of water per 25 kg bag of one-coat mortar). The mix shall be prepared mechanically in a concrete mixer with low revolutions (at around 500 r.p.m.), or with a spray machine; a manual mix is not recommended since it does not guarantee an optimum mix. High-speed mixers (higher than 500 r.p.m.) may cause a significant amount of air pockets in the material, thus modifying its performance.

If the mix is carried out with an electrical mixer, the mixing time should be of 3-5 minutes, until a uniform mix without any lumps is obtained. Once the product has been mixed, let it set for approximately 5 minutes before use so the additives included work properly. The maximum open time of the mix is 1 hour, depending on the weather conditions.

If the mix is carried out with a spraying machine, the water in the mix shall be regulated by means of the flow meter featured in the machine until an ideal consistency of the mix is obtained. Machines featuring a double mixing system produce a better quality final mix.

Variations in the conditions of the mix may cause colour differences in the mortar; therefore, using the same proportion of water, type of mixer, mixing conditions (mixing time, speed of the mixer, etc.) and setting time from one mix to another is recommended.

7.4 Method of application

The product must be applied site by an authorized company and therefore under its supervision and technical assistance.

The fresh mortar shall be applied on the wall to cover either mechanically or manually, with a traditional trowel in the latter case.

When applying mechanically, a suitable section and length of hose shall be chosen for the machinery and the specific conditions of the site (climate conditions, etc), as well as the optimum ratio of water/one-coat mortar, which is achieved by testing an initial amount of 0.2 and increasing progressively.

⁽⁸⁾ Mixing water should comply with EHE Instruction, Art.27. Water.

A variation in the amount of water will cause colour differences in the mortar. **An excess of water may increase shrinkage and reduce mechanical resistance.**

The minimum application thickness is 10 mm ⁽⁹⁾, usually resulting in averages of 15 mm (applicable in one or two coats)⁽¹⁰⁾. If the product is applied in thicknesses above 15 mm, it must be carried out in two coats, with the aim of preventing detachments or cracks from forming. The first coat should be slightly rough to provide a good grip for the second coat. If the product is applied on thicknesses smaller than 10 mm, this may cause, as mentioned in section 7.2, visible substrate joints, colour differences and cracks on the render, and a decrease of its protection against water.

The application of one-coat mortar on horizontal surfaces (roofs) does not require special conditions, and a thickness of 8 to 10 mm should be applied, thus preventing detachments. The techniques of finished more usual of this one coat render are the following ones:

Scraped: The rendering is applied in a coat of 13 to 15 mm of thickness, straightened and smoothed out. The material must be partially hardened, depending on the kind of substrate and the weather conditions. Afterwards, the surface must be scraped with an appropriate tool for this job (a spiked trowel, a saw blade, the edge of a trowel) and finally, 3-5 days later, the surface must be brushed (soft bristled brush) to eliminate any loose particles.

It must be considered that if the scraped of this material is made when this one presents/displays different curing times (under the same environmental conditions), differences in the colour tones can be appreciated, being more evident in the dark colours. Scraping material when it is softer than the advised, it gives darker tones, and when it is harder, the result is clearer tones.

On the other hand, the different scraped times can originate changes in the mortar texture. Therefore scraping a soft mortar gives rise to a more bush-hammered aspect, and, on the contrary, when this one is scraped harder, a finer aspect.

Drop or Tyrol: This is achieved by sprinkling the same material over the first coat, while this one is partially hardened, normally after 2 - 8 hours,

⁽⁹⁾ The thickness of the mortar for joints (see Section 7.6) depends on the thickness of mortar over which the batons are placed. Batons must not be placed in thicknesses lower than 8 mm. (fig. 4).

⁽¹⁰⁾ The one-coat mortar is usually first applied in a coat of 2 to 5 mm. This coat should be compact with the aim of levelling and regulating the substrate's absorption. The rest of the material should then be applied until the required thickness is obtained.

depending on the atmospheric conditions. It is advisable that the first coat be not totally dried, that means it maintains sufficient humidity degree to improve the adhesion of the drop to first coat.

Rustic: This is achieved by spraying an even second coat with no extra operation. To avoid differences of the structure of the pattern, there must be a constant air pressure, distance and angle of spraying.

Trowel spray finish: It is obtained by smoothing the protruding irregularities of the rustic finish with a wooden trowel before the product begins to set, more or less after half an hour.

Floated finish: The smooth floated finishes, due to they offer a clear-dark water aspect, similar to the ones left by lime mortars, make that it be impossible to obtain colour homogeneity of the coating.

7.5 Conditions of execution

The same conditions of good practice required by the technological hydraulic rendering standard NTE-RPE must be followed when applying the one-coat mortar:

- When applying the render, it is advisable that the temperature of the substrate is between 5°C and 30°C, requiring special precautions when the temperature exceeds these limits.
- **In hot and dry weather, the render must be wetted 24 hours after it has been applied** to favour the setting of the render and to avoid the irregularities (cracking, powdery areas on the surface, etc.) mentioned in section 7.2. The higher the temperatures, the more these irregularities appear.
- Low temperatures and high levels of humidity (rainfall after rendering) must be taken into account, as there is a higher risk that carbonation efflorescence may appear. This phenomenon is emphasized in darker colour coats. In this case, it is advisable that the façade be protected from the rain by means of, for example, awnings.

7.5.1 Geometrical characteristics

The flatness characteristics of the coating must meet the same requirements as the traditional ones established in the Technological Standard NTE-RPE (3 mm measured with a 1 m ruler).

7.6 Specific points

Structural joints. The rendering must be interrupted necessarily on reaching the structural joints (fig. 1) so stresses generated are not

transferred, otherwise cracks and even detachments could occur.

Constructive joints. In addition to structural joints, constructive joints shall also be included to facilitate application and eliminate unnecessary joints. By adopting constructive joints, colour differences in a continuous section corresponding to different levels of scaffolding are also reduced. So are colour differences of joints, which may only be reduced by sectioning the surface to apply. The separation between constructive joints is set by the surface of the section that can be applied in one execution. A correct placement and execution of joints facilitates the organization of work and the obtainment of the desired finish.

The recommended maximum separation between constructive joints is as follows:

- Vertical distance between horizontal joints: 2.5 m.
- Horizontal distance between vertical joints: 7 m.

However, in special cases and taking the necessary precautions, larger sections can be carried out.

The execution of quartering and joints is performed by means of placing plastic or aluminium batons in the required places before applying the rendering; once set, the batons are extracted. If using aluminium batons, they must be conveniently lacquered or protected. Marking of these joints can be carried out in two ways:

- 1) Before applying the render, the material is extended in a 5 cm wide and 1 cm thick band over which the baton is placed. Once the render has been completed, the baton is removed and the joint is marked.
- 2) The baton is nailed directly to the wall and after the render has been completed, the baton is extracted and the gap is filled with a 10 mm thick paste⁽¹¹⁾.

Note. – The aforementioned joints, in addition to allowing for a uniform finish, also, usually, avoid the formation of uncontrolled cracks due to shrinkage.

Joining points between different substrates. Joining points between different substrates can be carried out:

- a) Marking the joint, which in the case of joining points with framework CTE (point 2.3.3.3) establishes that *“an expansion joint shall be placed between the main layer and each framework underneath it leaving a spacing of 2 cm that must be filled, after the shrinkage of the main layer has been produced, with a*

⁽¹¹⁾ This type of finish is less usual than the former and is limited to decorative purposes, which is normally used with coloured pastes or putties.

material whose elasticity is compatible with the deformation foreseen of the framework, and it shall be protected from leakage by means of a throat.”

- b) Joining it and reinforcing the render (in order to reinforce the one-coat mortar against stresses created in specific points of the façade) using fibre glass mesh treated against the action of alkali or polyester, and featuring a tensile strength of 25 kp/cm before applying the render, as required in conventional renders.

The mesh must cover each side of the joint in a minimum thickness of 20 cm (fig. 2) - the CTE requires a minimum of 15 cm, and shall be placed diagonally in 20x40 cm pieces in the angles (fig. 3). The mesh should be in the middle of the render thickness, neither too near the substrate nor too near the surface, to avoid exposure during the execution of the final scraping (fig. 4).

Edges. Edges limit the meeting point of two planes or surfaces. The execution of edges in corners, door and window jambs, windows and existing openings shall be carried out by using a rectangular straightedge with one of the sides cut in a bevelled edge or 45°, or using plastic corner protectors. The following method is used in the execution of these edges with the aid of a straightedge, usually made of aluminium:

- Place the straightedge on the plane that is not going to be initially rendered. Place the straightedge lengthwise to the edge, aligning the edge with the straightedge. Hold the straightedge by applying a bead of mortar with a thickness of 2-3 mm in such a way that the bevelled face of the straightedge stands out with respect to the surface that is going to be rendered and level.
- Render the plane or surface applying mortar until the bevelled face of the straightedge has been covered. The thickness must be so that after the finish a minimum thickness of 10 mm is obtained.
- When the one-coat mortar has hardened sufficiently, remove the straightedge with a sharp blow. The execution of the first edge will delimit the thickness of the other plane. Subsequently, without the aid of the straightedge, render the other plane.

In the event of including plastic protectors on the edges, these must be resistant to alkali and weatherproof.

The installation of plastic protectors in corners must be carried out taking into consideration the following steps:

- Apply a bead of mortar with a thickness of 2-3 mm on the sides of the corner or inside the plastic protector so the protective mesh settles properly.
- Install the plastic protector on the corner, and by resting the straightedge longitudinally on its edge, press softly to leave it straight.
- Remove the excess material from the plastic protector.
- Wait until the holding mortar reaches a suitable level of hardening, depending on the type between 2 and 24 hours, to avoid the plastic protector from moving when applying the one-coat mortar over it.
- Finally, apply the one-coat mortar up to the edge marked by the edge of the plastic protector.
- All other parts shall be taken into consideration when applying the product in order to obtain the perfect flatness possible.

Recommendations regarding its installation:

- Respect the substrate type and conditions included in sections 7.1 and 7.2.
- The length of the baton must be the same size as the edge to protect, so no weak areas are left in the event of an impact.
- The wall must present a suitable flatness in the area of adhesion of the plastic protector so the thickness of the mortar finish is appropriate.
- In joints of two edges - for example, in doors and windows, it is advisable that the plastic protectors are finished in a 45° cutting so they overlap in a suitable fashion.

8. YIELD

The theoretical yield per square metre by 1 mm of thickness is 1.4 kg ± 0.1 kg. The effective yield of material applied on a straight substrate with a thickness of 13 to 15 mm is 19-24 kg/m².

9. REFERENCES

Up to the date of application of the Technical Approval Document and according to the references of the manufacturer, aprox.5 millions of square metres of façade surface have been covered. The most important works have been performed at the following sites:

- 130 detached houses. C/ Mónaco. Loeches, Madrid. 25.000 m². 2004
- DIA center. C/ Ordesa. Alovera, Guadalajara 3.500 m². 2005.
- Residential building. C/ Europa. Azuqueca de

- Henares, Madrid. 20.000 m². 2005.
- Residential building C/ Reino de España, Roquetas de Mar. 7.000 m². 2002.
- Residential building C/ Estional Balerna. 12.000 m². 2002.
- Residential building C/ Principio Indaliano El parador. 10.000 m². 2007
- Instituto el pinillo en Torremolinos (Málaga). 3000 m². 2006.
- Detached houses C/ Xoriguer en Comarruga. 38.000 m². 2006.
- Residential building, Avda Barcelona 87-89 en Segur de Calafell. 1.000 m². 2006.
- Residential building. C/Lluis Companys esquina Bellavista, Sant Celoni.Barcelona. 5.000m². 2009.
- Singlefamily house. Avda. La Pau s/n, Deltebre. Tarragona. 1500 m². 2010.
- Residential building Avda.Pau Casals esq. c/ Montserrat. Tarragona. 3.000 m². 2011
- Residential building C/ Amadeu Vives, nº11. La Pineda. Tarragona. 2.500 m². 2011
- Pareados. C/ Cornella del Moro s/n, Urb. Rodolat del Moro, Tarragona. 7.000 m². 2012.
- Residential building. Bloque Argentina. Sant Perei Sant Pau, Tarragona. 2.400 m². 2012.
- Residential building. C/ Virgen de la Salut, bloque 19, Badalona, Barcelona. 1.400 m². 2012.
- Residential building. C/ Frigiliana, Málaga. 3000 m². 2012.
- Residential building. C/ Puerto, Málaga. 1000m². 2012.
- Residential building en Playa de Puçol (Valencia), Avda. Grau Vell, s/n. 1.000 m². 2012.
- Residential building. C/ Che Guevara s/n. Ciudad cooperativa nº 42. Sant Boi de Llobregat. Barcelona. 2.000 m². 2012.
- Residential building. C/ Pompeu fabra s/n. L'Hospitalet de Llobregat. Barcelona. 9.000 m². 2012.
- Residential building. C/ Pi i Maragall nº 54-56. Barcelona. 1.200 m². 2012.
- Residential building. C/ Virgen de la Salut, blouqe 19. Badalona. 1.500 m². 2012.

Some of the aforementioned sites have been visited by IETcc technicians. A survey has also been carried out on the users of the material regarding its performance and the results were satisfactory.

10. TESTS

The following tests have been performed at the Building Science Institute "Eduardo Torroja". After the weathering accelerated tests carried out, the product did not present/display significant defects such as failures of adhesion, cracks or fissures, appreciable changes of colour, etc.

10.1 Identification characteristics

10.1.1 In powder form

	Almeria	Barcelona	Madrid	Malaga	Sevilla
Bulk density of powder (kg/m ³) (Procedure IETcc 2669-4)	1.300	1,250	1,350	1,400	1,320
Calcination residue 450 °C (%) (Procedure IETcc 2669-4)	99	99	99	99	99
Calcination residue 900 °C (%) (Procedure IETcc 2669-4)	65	67	65	60	64
Residue > 1 mm (%) (UNE-EN 1015-1)	20	11	16	16	19
Residue > 125 µm (%) (UNE-EN 1015-1)	61	60	64	64	63

10.1.2. Paste

	Almeria	Barcelona	Madrid	Malaga	Sevilla
Water retention (50 mm of Hg, 5 min) (%) (P. IETcc 2669-4)	96	95	95	95	95
- Bulk density (kg/m ³) (UNE-EN 1015-6) / Consistency (mm) (UNE-EN 1015-3)					
Sensitivity to the variations of water in the mix with 29% with 31% with 33 %	1.800 / 156	1.790 / 138	1.745 / 142	1.700 / 141	1.787 / 149
	1.750 / 162	1.694 / 153	1.700 / 152	1.634 / 152	1706 / 155
	1.713 / 180	1.616 / 162	1.767 / 163	1.577 / 161	1667 / 169
Sensitivity to the mix method slow speed for 30 s fast speed for 3 min	1.849 / 156 1.710 / 166	1.801 / 127 1.607 / 152	1.709 / 150 1.450 / 155	1.639 / 154 1.484 / 164	1.863 / 135 1.624 / 168
Stability of trapped air 0 min from the mix 15 min from the mix 30 min from the mix	1.680 / 166	1.718 / 150	1.644 / 155	1.593 / 159	1.701 / 153
	1.705 / 169	1.799 / 143	1.659 / 159	1.705 / 152	1.830 / 155
	1.724 / 169	1.849 / 141	1.792 / 158	1.775 / 153	1.920 / 155

10.1.3. Hardened product

	Almeria	Barcelona	Madrid	Malaga	Sevilla
Bulk density (kg/m ³) (UNE-EN 1015-10)	1,420	1,450	1,500	1,520	1,450
Compression strength 28 days (MPa) (UNE-EN 1015-11)	6	6,2	6,5	6	6.5
Flexural strength 28 days (MPa) (UNE-EN 1015-11)	2.5	3.2	2.8	2.5	2.8
Capillarity (kg/m ² min ^{1/2}) 28 days (UNE-EN 1015-18)	0.15	0.1	0.2	0.12	0.15
Shrinkage (mm/m), 28 days (UNE 80112)	1	1	0.9	0.9	0.8
Dynamic module of elasticity 28 days (MPa) (ASTM C 215)	6,000	7,500	6,600	6,000	6,200
Water vapour permeability, 28 d, 90% HR (UNE EN 1015-19) (g cm/m ² h mm Hg) / (gm/MNs) / (kg/m ² sPa)	0,7 / 15 x 10 ⁻³ / 1,6 x 10 ⁻⁹ / 12				

10.2 Characteristics of applied mortar

10.2.1 Adhesion test (perpendicular tensile stress) (MPa)

The following table includes the results obtained from the adhesion test (UNE-EN 1015-12) of samples before and after aging with a thickness of one-coat mortar of 15 mm (The aging test has been carried out taking into consideration Standard UNE-EN 1015-21, but conducting 20 cycles (10+10 cycles))

Type of test		Type of substrate	Almeria	Barcelona	Madrid	Malaga	Sevilla
Without treatment		Concrete slabs	0.6	0.7	0.5	0.5	0.5
		Concrete blocks	0.7	0.8	0.4	0.5	0.7
		Compact ceramic	0.6	0.6	0.5	0.5	0.5
Cycle	Freeze-thaw + Heat-freeze	Concrete slabs	0.7	0.7	0.6	0.4	0.8
		Concrete blocks	0.7	0.8	0.5	0.5	0.8
		Compact ceramic	0.7	0.6	0.6	0.5	0.6

The bonding detachment occurred in this test has been produced mainly in the mortar coating.

10.2.2 Impact test (cm) (Procedure IETcc 2669-4) one-coat mortar thickness of 15 mm:

Type of test		Type of substrate	Almeria	Barcelona	Madrid	Malaga	Sevilla
Without treatment		Concrete slabs	2	2	2.2	2.2	2
		Concrete blocks	2	2	2.1	2.2	2.2
		Compact ceramic	2	1.8	2	2.2	2
Cycle	Freeze-thaw + Heat-freeze	Concrete slabs	1.9	1.9	2	2.2	2
		Concrete blocks	1.9	2	2	2	2
		Compact ceramic	1.9	2.1	2	2.3	2

11. TECHNICAL ASSESSMENT

11.1 Compliance with national regulation

Fire safety. The Building Technical Code (CTE) establishes a fire resistance of B-s3 d2 for the exterior finish of façades whose detachment can affect the public whether from an exterior wall or from a roof, as well as the entire façade whose height exceeds 18 m.

One-coat mortar MORCEMDUR P contains mineral products in a proportion higher than 99%, that is, it has an organic content lower than 1%; therefore, its degree of combustion is A1 classification, according to the European Standard EN 13501-1, which is a higher value than required by the Spanish Regulation.

Energy saving, thermal insulation and noise protection. The Building Technical Code does not establish acoustic or thermal requirements for rendering materials for façades. These requirements must be justified with the design of the entire enclosure.

One-coat mortar MORCEMDUR R does not contribute significantly to the insulation of buildings, although for the calculation of thermal insulation in an enclosure, a thermal conductivity $\lambda = 0.76$ W/mK can be used, according to the contents established in Standard EN 1745:2002 Table A.12; for acoustic insulation, a density of $1,700$ kg/m³ can be used.

Health, safety and environment. The Building Technical Code establishes a classification for the resistance to leakage of the continuous exterior coating applied on façades according to a series of parameters:

Sufficient watertightness so leakage of water does not come into contact with the enclosure located immediately underneath. The degree of capillarity of one-coat mortar MORCEMDUR R: W2 (inferior to traditional render)⁽¹²⁾, implies a resistance of the material to the penetration of water. This characteristic of the material guarantees the required watertightness of the product.

Sufficient adhesion to the substrate in order to guarantee its stability. The adhesion of mortar MORCEMDUR R is sufficient to ensure a good grip of the finish material to the aforementioned

⁽¹²⁾ Regarding resistance to water penetration by capillarity one-coat renders may be classified, according to Standard UNE-EN 998:1, in the following way:

Classification of the render	Capillarity (kg/m ² min ^{1/2})
W2	≤ 0.2
W1	≤ 0.4

brickwork substrate, taking into account that the minimum adhesion required to a render is 0.3 MPa.

Sufficient water vapour permeability in order to avoid its deterioration as a consequence of an accumulation of vapour between it and the main wall. The permeability of MORCEMDUR P normally allows hygrometric exchanges between the brickwork substrate and the weather conditions, thus limiting the risk of condensation on the substrate.

Adaptation to the movements of the substrate and very good performance against cracking; cracks are not produced in the render due to mechanical stresses caused by structure movement, thermal stresses caused by the weather or the alternation of night-day, or the shrinkage of its contents. MORCEMDUR R mortar presents an average shrinking value⁽¹³⁾ and a low modulus of elasticity, which evidences the deformability of the product and allows a small movement of the substrate. Following the tests carried out no cracks have appeared after the sample has been applied at the work site or aged by acceleration.

Stability against physical, chemical and biological attacks avoiding the degradation of its mass. The durability of MORCEMDUR R and its performance in presence of dirt and chemical attacks (pollution, etc) can be considered the same as those of a traditional render. The performance of its colouring is equivalent to that of coloured concrete. These appreciations are made from the data available from examining the material both on the building site and after the accelerated ageing tests it has undergone, as well as taking into consideration the age (25 years) of the inspected buildings.

MORCEMDUR R mortar is compatible with the substrates tested. The resistance to extreme temperatures and to the impact of solid objects is satisfactory.

In terms of performance, MORCEMDUR R meets the requirements demanded by the CTE and it may be considered a continuous render for façades with an R3 classification in leakage resistance, according to the CTE, if it fulfils all the requirements established in this document.

The manufacturer GRUPO PUMA S.L. states that MORCEMDUR R does not contain or release any

⁽¹³⁾ The classification established by IETcc Procedures based on Cahiers for one-coat mortar is as follows:

Classification	Dynamic Modulus of Elasticity, MPa	Shrinkage, mm/m
Low	lower than 7,000	lower than 0.7
Medium	between 7,000-12,000	between 0.7-1.2
High	greater than 12,000	greater than 1.2

hazardous substances, according to the data from the EU.

11.2 On-site application and limitations of use

Product use. One-coating mortar MORCEMDUR R presents a high degree of water retention that allows it to be applied on-site comfortably. Nevertheless, it is necessary to dampen the surface before its application in hot, dry or very windy weather. It must also be dampened 24 hours after its application in the conditions mentioned above.

The time for scraping is only provided as a mere reference. It should be thus determined by the applicator according to the consistency of the material under the corresponding weather conditions and the absorption of the substrate.

Limitations of use. This technical evaluation only covers substrates mentioned in section 7.1. Besides the limitations enclosed in the Technological Standard NTE-RPE, the one-coat mortar should not be applied on surfaces where water may remain logged, or on sloped surfaces exposed to direct rainfall. It should not be applied on walls where water may filter through leaks due to capillarity or in areas where the render may be subjected to immersion in water.

According to the CTE *“When the façade is comprised by a porous material or has a porous render, to protect it from splashes, a baseboard made with a material whose absorption coefficient is lower than 3% with over 30 cm above exterior ground level shall be placed covering the wall's waterproofing or the waterproofing system installed between the wall and the façade; the meeting point between the baseboard and the façade shall be sealed at the top, or another solution shall be adopted that achieves a similar result.”*

Therefore, the render shall be protected from detaching due to capillarity by placing a baseboard at the bottom of the wall; it is advisable, as an extra measure, to cut the render on the upper side of the baseboard or skirting.

The non-installation of baseboards when water is present may result in the formation of shading due to capillary absorption of the material, carbonation, growth of microorganisms, etc.

In the event that the render is used on façades of buildings exposed to frequent rainfalls, necessary constructive elements (eaves, throats, intermediate imposts, gutters, etc) must be installed in order to avoid water flowing onto the render. If this measure is not carried out, on a mid-term basis the render may present differential carbonation with colour changes between the different areas exposed to

different conditions (partly protected or too exposed).

These constructive elements must meet the requirements established in the CTE:

- *Meeting of the façade and metalwork or woodwork. When the metalwork/woodwork is set back from the exterior wall of the façade, the window sill shall be finished off with a drip cap that evacuates the rainwater and avoids it from reaching the section of the façade immediately below; a throat shall be installed on the lintel so as to avoid the rainwater flowing down the lower part of the lintel towards the metalwork/woodwork, or another solution shall be adopted that achieves a similar result.*

The drip cap shall have a minimum outward slope of 10° and be waterproof, or be installed on a waterproof barrier fixed to the enclosure or wall that extends towards the back and both sides of the drip cap, as well as featuring a minimum outward slope of 10°. The drip cap must include a throat on the lower side of the projection and be separated at least 2 cm from the exterior wall of the façade. It shall be embedded in the jamb at least 2 cm.

The joints of pieces with gutters must have the same shape so a bridge is not created towards the façade.

- *Parapets and flashings of façades. Coping stones shall present a minimum slope of 10°, must include throats on the lower side of the projections towards which the water flows, separated from the parapet walls at least 2 cm, and must be waterproof or be installed on a waterproof barrier with a minimum outward slope of 10°. Expansion joints shall be installed every two pieces when prefabricated or made of stone, and 2 m when ceramic. Joints between coping stones shall be performed in such a way that they are waterproof and are properly sealed.*

- *Eaves and cornices. Continuous eaves and cornices must present an outward slope of at least 10° in order to evacuate the rainwater, and those that project more than 20 cm from the façade must:*

- a) *be waterproof or have its top face protected by a waterproof barrier in order to avoid water leakage;*
- b) *include prefabricated or manufactured in situ protection elements, where it meets the vertical wall, that extend upwards at least 15 cm and whose flashing is finished so leakage is avoided at the meeting point and the flashing;*
- c) *Include a gutter on the exterior edge of the lower side in order to avoid the evacuated rainwater from reaching the section of the façade immediately below.*

In the event that the aforementioned conditions are not met, another solution shall be adopted that achieves the same result.

The joints of pieces with gutters must have the same shape so a bridge is not created towards the façade.

One-coat layers with dark tones are more prone to evidence irregularities: i) due to the fact that the primitive colour could deteriorate as a consequence of lime formation; and ii) because the render absorbs a larger amount of sun radiation⁽¹⁴⁾, thus increasing thermal shrinkage. In addition, in hot weather or dry wind there is a bigger limitation when it comes to wetting a render with heavily pigmented one-coat mortars. If this wetting is omitted, the mechanical performance of the mortar could be reduced, as by not fulfilling these conditions a good setting will not be achieved (due to loss of part of the water of the mix).

Taking into account that the application of render is one of the most important aspects in its performance and appearance, this technical evaluation is limited to those where the manufacturer authorises the applicator.

Therefore, any other application carried out by an applicator not recognized by the manufacturer shall not be covered by this evaluation.

A suitable maintenance of the render just like in any other site jobs is recommended.

We recommend:

- Cleaning parapets and surfaces of cornices at least once a year.
- Cleaning the wall using pressurized water with neutral soap when the wall presents a significant degree of dirtiness due to pollution and the level of aesthetic deterioration advises it. In highly contaminated areas, this operation may be required every two to three years.

It is advisable to:

⁽¹⁴⁾

Colours of the render	Sun absorption factor
White	0.2 to 0.3
Yellow, orange, light red	0.3 to 0.5
Dark red, light green, light blue	0.5 to 0.6
Brown, dark green, deep blue, dark blue	0.7 to 0.9
Dark brown, black	0.9 to 1.0

- Inspect all walls every three years with the aim of evaluating the convenience of carrying out a general cleaning, as well as to detect any possible damages (cracks, air bags, or any other damages) and proceed with the required repair.

The formation of carbonation may be eliminated by means of three different procedures depending on the configuration of the façade, the age and intensity of the carbonation, and the colour of the render:

1. Using acid water. The procedure is as follows:
 - a. cover the areas with natural stone or metal perfectly so they are not damaged,
 - b. wet the area to clean with water,
 - c. clean the carbonated area homogeneously,
 - d. rinse the remains of acid water completely.

Allow to dry for 24 hours and repeat the process in areas where carbonation is still present.

The use of acid water to clean carbonation can be carried out by means of pressurized systems, although high-pressure systems must not be used.

2. Using colour equalizers (for low coverage paint, compatible with mortar and permeable to water vapour) that cover whitening without masking the mortar finish.

3. By means of applying a layer of one-coat mortar of 5-7 mm on the carbonated area.

In façades with several openings (balconies, windows...), cleaning with acid is complicated due to the amount of protective elements required.

In strong colours or very deep or old carbonation, the colour may be masked during cleaning, therefore the other two solutions are more appropriate.

11.4 Aspects related to appearance and aesthetics

To improve the behaviour of one-coat mortars and above all to avoid aesthetic problems (colour changes and stains), it is especially important to include all the constructive elements aforementioned in section 7.6 (eaves, throats, gutters) and protect the render from the rain.

The use of mesh in the areas mentioned in section 7.6.3., is also recommended.

11.5 Superior performance than required in the DPC

The CE marking for one-coat mortars requires a level 4 certification of conformity, which only requires the manufacturer to carry out an initial type test and apply for declaration of conformity, without an Authorized Body intervening.

For the concession of this **DIT plus** the manufacturer has been subject to an inspection by the IETcc equivalent to level 1+ of the certification of conformity established by the CE, which entails:

- Initial test of product type (carried out by the IETcc)
- Initial inspection of the factory and production control.
- Yearly periodical inspections.
- Test of factory, warehouse and site samples.

Standard UNE EN 998-1 establishes the different categories for hardened one-coat mortar as included in table 1:

Properties	Categories	Values
Interval Compression strength 28 days	CS I	0.4 to 2.5 MPa
	CS II	1.5 to 5.0 MPa
	CS III	3.5 to 7.5 MPa
	CS IV	≥ 6 MPa
Water absorption due to capillarity	W 0	Not specified
	W 1	$c \leq 0.4 \text{ kg/m}^2 \cdot \text{min}^{0.5}$
	W 2	$c \leq 0.2 \text{ kg/m}^2 \cdot \text{min}^{0.5}$

One-coat mortar MORCEMDUR R always presents a compression strength greater than 5 MPa and a capillarity value lower than $0.2 \text{ kg/m}^2 \cdot \text{min}^{0.5}$.

These values are higher than the minimum requirements established by the IETcc for the concession of the **DIT plus**, according to contents in Page 2. The IETcc and the Commission of Experts in the evaluation of these products have established these values taking into consideration the experience acquired over the years.

Experts:

A. Blázquez Morales
Architect

J. Rivera Lozano
PhD Chemistry

12 OBSERVATIONS FROM THE COMMISSION OF EXPERTS ⁽¹⁵⁾.

The Commission of Experts, in addition, express the following observations:

On-site application. The one-coat mortar is a finishing coat for façades so it must be applied at the end of the constructive process, following the required previous applications and protections. Its application should be performed properly so no significant repairs or restoration work have to be performed as a result of any possible damages that may arise.

Waterproofing. This render collaborates with the substrate's waterproofing function to rainfall, since a render is considered suitable to fulfil this function when it absorbs a quantity of water small enough to be evaporated in between two successive rainfalls before soaking the entire render coating. However, this does not mean that it is completely watertight. The use of thicknesses smaller than 10mm reduces its waterproofing features, and depending on the size of aggregate to project 3-5, 5-9 or 9-12 mm, it will be necessary to fit the thickness of mortar, so that the thickness between the stone and the support never is inferior to 8 mm. The waterproofing properties that one-coat mortars provide to walls do not apply if the substrate cracks.

Substrate. Taking into consideration that the fitness of use of the System and its durability depend directly on the condition of the substrate, before its application, we recommend the adoption of additional precautions in order to meet the established requirements.

Storage. As cement is one of the main components of the render, and being under risk of deterioration in case of prolonged storage, both the manufacturer, before the material leaves the factory, and the user should check the expiry date. This expiry date may be significantly reduced and even its usage be invalidated if the required storage conditions are not maintained.

⁽¹⁶⁾ The Commission of Experts was formed by the representatives of the following Bodies and Institutions:

- High Council of the Professional Association of Architects of Spain.
- Technical Institute of Materials and Construction (INTEMAC).
- The Polytechnic University of Madrid (UPM).
- Laboratory of Engineers of the Army.
- NECSO, S.A.
- Association of manufacturers of mortar (AFAM)
- Technical Institute of Construction Industries (INTEINCO)
- FCC Construcción, S.A.
- SGS TECNOS, S.A.
- National Association of One-Coat Mortar Manufacturers (ANFAPA).
- Department of Housing.
- Building Science Institute Eduardo Torroja.

Fig. 1. Solution for a structural joint

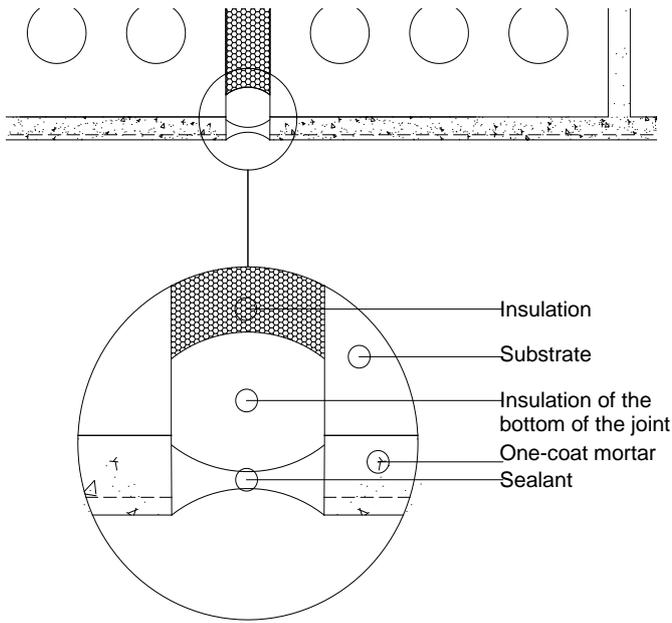
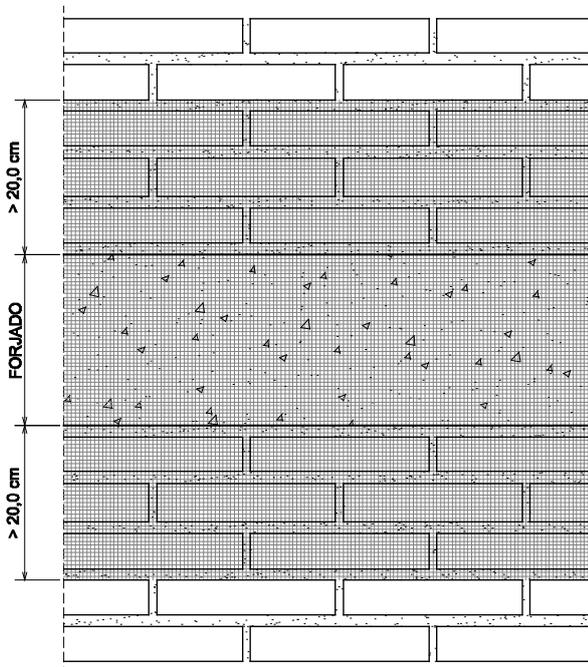


Fig. 2. Positioning of the mesh between different substrates (elevation)



Forjado = Framework

Fig. 3. Positioning of mesh in corners of openings

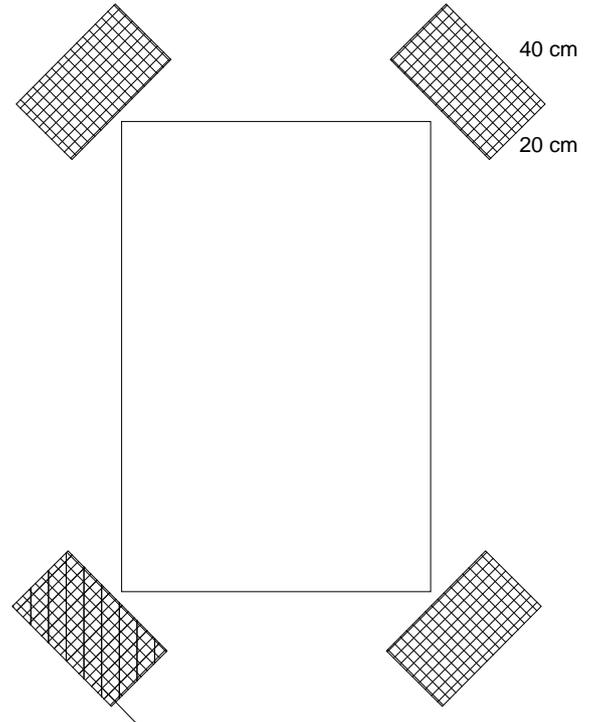


Fig. 4 Positioning of mesh (section)
Thickness of mortar in the constructive joint

