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RE-SKIN

D5.2 – Manufacturing design of the multifunctional façade cladding II

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Disclaimer

1. Executive summary

This document outlines the enhancements made to the multifunctional façade cladding that was previously developed by GAR for the EU-funded HEART project to align with the requirements of the RE-SKIN project. The content presented in this document represents an advancement from the content found in D5.1 Manufacturing design of the multifunctional façade cladding I.

Since its inception for the HEART project, the façade has undergone significant changes, including the replacement of the conventional sandwich panel insulation with a bio-based alternative, and the incorporation of sustainable steel for the outer layers. Moreover, the mounting structure is further improved by incorporating recycled materials and optimising the installation process to reduce installation time.

Chapter 2 provides an overview of the façade system and its key components, the survey of the pilot cases, and the work carried out to implement the façade cladding system on these cases. Chapter 3 includes the design of these components, preliminary testing conducted by the manufacturer of the sandwich panel, and the preparation of testing mock-ups for testing at partner DTI's facilities. Subsequent releases of this deliverable will detail aspects related to use, maintenance, end-of-life treatment, as well as a definition of the manufacturing process and production control. Supporting documents and certificates will also be included.

It must be noted that some testing activities regarding the façade cladding and the definition of its detailed configuration on the second case study have been slightly delayed from what was initially planned due to the change of the first 3 case studies of the project, as detailed in the first technical report. However, results of preliminary testing and the first definition of the technical configuration of the Burgas case study have been included in the present document.

The optimisation process of façade components will remain ongoing throughout the project's development, with continuous updates as new information becomes available. Two additional versions of this report are scheduled for release in months 19 and 27, respectively. These subsequent deliverables will incorporate further specifications and/or modifications based on the project's progress and testing results.

2. General description

The RE-SKIN façade's solution is suitable for installation on brickwork and concrete block façades, concrete load-bearing walls, and wooden structures. The new façade cladding's structure is securely anchored to the supporting vertical surfaces. All external surfaces that are not part of the supporting elements must be removed. Prior to installation, a dynamometric test (Pull-off Test) is conducted to assess the tensile strength of the walls and the load capacity of the fixings. The selection of the appropriate anchoring method, whether mechanical or chemical, is based on the results of this test.

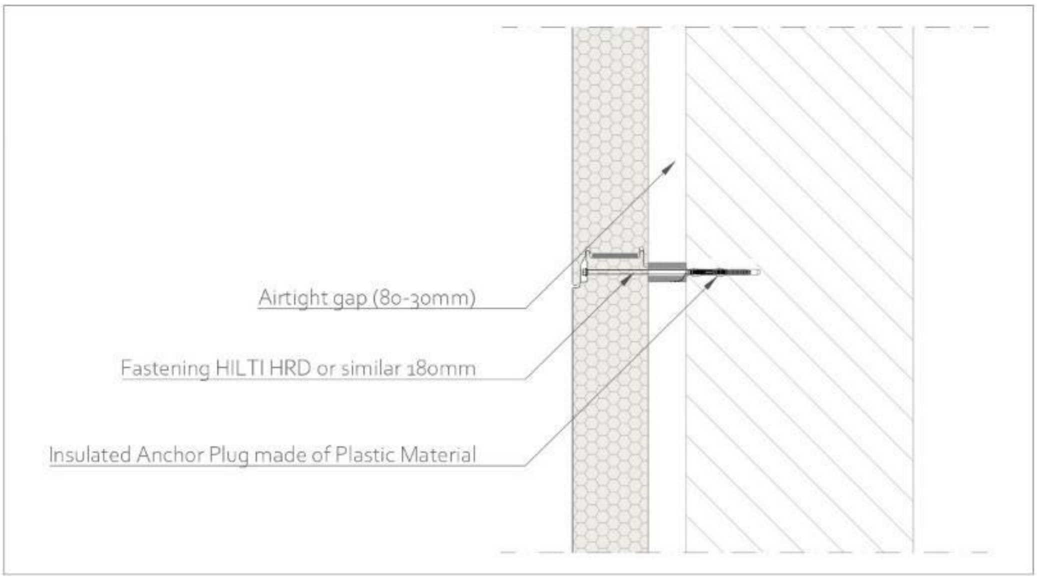


Figure 1. Panel detail (vertical) [drawing created using AutoCAD]

The substructure, which features anti-corrosion properties and galvanic protection, is assembled using supporting brackets that are attached to the pre-existing walls of the façade employing mechanical fixings and plugs. The upright structural profiles are then fixed to the brackets using self-drilling screws. The system is completely sealed, forming an airtight cavity between the panel and the pre-existing wall. Complimentary to the system is the integration of an adaptable sealed chamber equipped with manually adjustable ventilation grilles. Depending on the seasons, the internal chamber can be fully sealed to act as thermal resistance during cold weather, or ventilation grilles can be manually adjusted to facilitate ventilation in warmer weather.

The project focuses on developing multi-technology and low-impact renovation solutions for the energy retrofit of buildings in critical contexts. The primary objective is to reduce the energy consumption and environmental impact of existing residential, public, and commercial buildings while adhering to the principles of life cycle sustainability and the circular economy.

Therefore, many of the materials and components used in producing the façade system will be recycled, recyclable, reused or repurposed.

To develop a sustainable and circular economy-oriented façade system, the new sandwich panels replace the conventional thermal-insulation foam core with an innovative bio-based PUR (bioPUR) foam provided by INDRES. Furthermore, the conventional metal sheet outer layer of the sandwich panels is superseded with GreenCoat BT steel from SSAB, a subcontractor of GAR. This coating incorporates a significant amount of rapeseed oil, replacing fossil oil, making it more sustainable compared to regular steel coatings. Moreover, SSAB's steel production process utilizes about 45% recycled scrap metal, further reducing the environmental impact of the material.

The mounting structure is also improved by using recycled aluminium profiles manufactured by EXLABESA. Furthermore, the assembling process is optimised to reduce retrofit work time and costs.

The initial phases of the project involve testing the façade system. A testing mock-up, integrating all system elements, will be assembled at GAR facilities and dispatched to DTI for thorough testing, verification, and demonstration of the long-term reliability of the novel façade system. However, such tests have been postponed due to delays in the production of steel coils for the sandwich panels and metal sheets for the finishings.

The delays were caused by two main factors: firstly, a strike in Finland, where SSAB operates its production facilities, which delayed the start of steel coil production, and secondly, issues in the production of raw materials for the coils, which further delayed their delivery to the sandwich panel manufacturing plant. As a result, the production of the sandwich panels was delayed.

The postponed tests will be reported in D5.4 and D3.7. Since month 19, work on these tests has been ongoing. GAR and DTI have collaborated on developing the mock-up model for façade testing at DTI's facilities. GAR has created a 3D model of the testing mock-up, detailing the sandwich panel layout, anchoring, finishings, and auxiliary components for jambs and lintels.

Initial laboratory testing was conducted by DTI on mock-ups of the BIPVT roof system, which comprised refurbished PV modules and sandwich panels with a bioPUR encased in steel, similar to the façade system. Both were mounted in recycled aluminium mullion profiles attached to the underlying slab or roof framework. The test aimed to assess watertightness under simulated driving rain conditions, including pulsating air pressure. For the full test report, refer to D3.5.

2.1. Case studies

Since the start of the project, efforts have been focused on analysing the documentation derived from the survey of the pilot cases (see deliverables D8.1, D8.2 and D8.5). This documentation includes floor plans, elevations, and sections of both the existing and proposed renovated states, alongside the results of pull-out tests conducted on the façades.

These assessments aim to determine the optimal layout of the sandwich panels and substructure, identify critical points requiring bespoke solutions, plan the installation process, specify necessary finishings, and integrate pre-existing elements, among other technical considerations.

At the time of writing this deliverable update, the assessment of the Milan demonstration case has been completed, while work on the second case, the Burgas demonstration, is ongoing.

2.1.1. Milan case study

Upon receiving the initial survey of the building in its pre-retrofit state, which included and energy audit and a comprehensive assessment of its architectural and technical systems, work began on creating a 3D model of the building.

Figure 2. South-West view of the building

Collaboration between ZH and GAR led to the design of the optimal façade layout, in consultation with CDM, the building owner.

A pull-out test was performed on the façades to assess the tensile strength of the supporting walls, which is key to determining the anchoring of the system. For the full report on the pull-out tests conducted on the Milan case study, refer to Annex I of this deliverable.

Subsequently, work focused on addressing the various building connections, including those at windows, corners, the starting of the system, as well as determining the layout of the substructure, façade finishings, sandwich panel dimensions, and other relevant details.

Once the design for the Milan case study façade cladding was finalised, the specifications for the sandwich panels, metal sheets, and substructure components were sent to the respective manufacturers for production. Additionally, an installation manual for the substructure was shared with the general contractor.

2.1.2. Burgas case study

In month 19, work began on developing the 3D model for the second demonstration case in Burgas, based on the initial architectural survey provided by BURGAS and ZH.

Figure 3. South view of the building

To properly assess the façade, determine the tensile strength of the building's supporting walls, and decide whether mechanical or chemical anchors would be more appropriate, pull-out tests were conducted following EOTA TR 051 guidelines. The full report detailing the pull-out test results is available in Annex II of this deliverable.

The results showed relatively low kN values, suggesting that standard mechanical anchoring would not be sufficient. As a result, further testing using brackets with chemical anchoring have been required. These tests are still pending.

3. System/component design

The RE-SKIN project's multifunctional façade is a self-supporting system made of sandwich panels and a substructure, designed to improve energy performance and reduce environmental impact. This chapter covers the design and key features of its three subcomponents: the sandwich panels, the recycled aluminium mounting structure, and the finishing elements.

3.1. Sandwich panel

The sandwich panels consist of an outer layer of GreenCoat sustainable steel from SSAB, a bio-sourced polyurethane (bioPUR) foam core, and an inner steel layer, also from SSAB. These panels are interconnected through a tongue-and-groove joint and are attached to the pre-existing wall via the substructure.

Sandwich panel production can be either continuous or discontinuous. For RE-SKIN, a continuous manufacturing process is employed, producing larger panels that are cut to size for the façade. This process is more efficient and cost-effective for large-scale façade applications. During production, the steel sheets are spaced apart by lateral supports to allow for the injection of foam to fill the gap between them and create the insulating core. The use of steel in sandwich panels enhances their durability and strength, compared to other materials.

After manufacturing, the panels undergo processes such as cutting, welding, and laminating. followed by the application of a protective film is applied to prevent scratches and dirt accumulation.

The manufacturable thickness ranges from 60 to 250 mm, with the typical thickness for RE-SKIN falling between 80 to 100 mm. The panel width has been standardised at 1000 mm to align with the standard width of the steel coil for the metal sheets. However, the panel length can be adjusted based on project requirements and is expected to fall within the range of 250 to 6000 mm.

Following the initial trial manufacturing of the RE-SKIN sandwich panel at Lattonedil, the manufacturer conducted preliminary tests. The results confirmed that panels within the recommended length exhibited stable mechanical properties, including tensile strength, thermal conductivity, and dimensional stability, confirming their suitability for façade application. Refer to Annex III for the full test report.

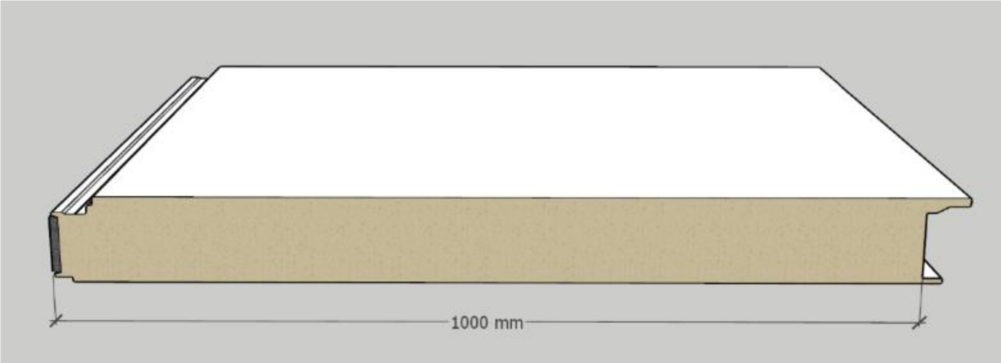


Figure 4. Sandwich panel with bioPUR and Greencoat metallic sheet [drawing created using SketchUp]

3.1.1. Outer layer

The outer layer steel coating with GreenCoat colour in the sandwich panels offer a sustainable coating solution for the building industry. GreenCoat Bio-based Technology (BT) coating, introduced in 2012, incorporates a significant amount of rapeseed oil, a natural alternative to fossil oil, it contributes to a reduced environmental footprint compared to conventional coatings
This patented BT coating not only offers environmental advantages but also improved efficiency for an extended product life, ensuring long-lasting performance for buildings over several decades.[1]

In RE-SKIN, the specified thickness of the material to be used is 0.7 mm for the external layer and 0.55 mm for the internal layer.
In subsequent deliverables, additional specifications, such as steel grade, topcoat, dimensions, and colours, for the steel coils used in panel manufacturing will be finalised once the responsible team determines the finishing colours for all demonstration projects. Subsequently, the order for the steel coils will be placed with SSAB, who will provide the detailed specifications for the steel coils.

[1] https://www.environdec.com/library/epd1922

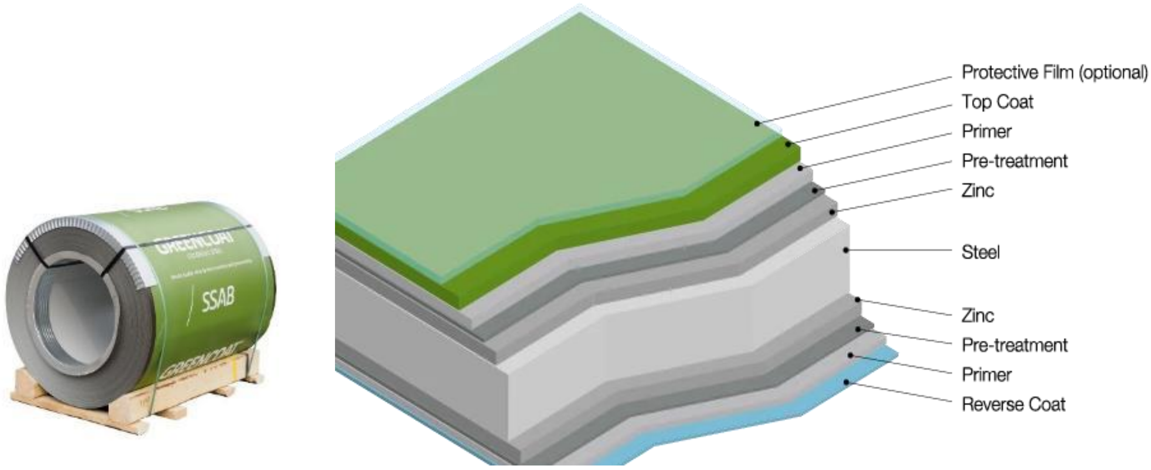


Figure 5. GreenCoat® components

Technical Properties	Matt	Regular	Satin
Gloss	< 5	40	20
Minimum inner bending radius	1 x sheet thickness	1 x sheet thickness	1 x sheet thickness
Scratch resistance	40 N	40 N	40 N
Lowest forming temperature	-15 °C	-15 °C	-15 °C
UV radiation resistance	RUV5	RUV4	RUV4-5
Corrosion resistance	RC5+	RC5+	RC5+
Stain resistance	Very good	Very good	Very good
Highest operating temperature	100 °C	100 °C	100 °C
Fire classification, EN 13501-1	A1 s1 d0	A1 s1 d0	A1 s1 d0
Coating thickness, nominal (primer + topcoat)	50 µm	50 µm	50 µm
Coating structure	Structured and wrinkled	Structured	Structured
Zinc coating	S280GD, S320GD, S350GD	S280GD, S320GD, S350GD	S280GD, S320GD, S350GD
Min steel thickness	275 g/m^2	275 g/m^2	275 g/m^2
Steel width	1000 – 1500 mm	1000 – 1500 mm	1000 – 1420 mm

Table 1. Technical Properties of GreenCoat Pural BT (SSAB)[2]

3.1.2. Thermal-insulation

BioPUR foam has been selected as the insulation layer for the sandwich panel

Specifically designed for the residential sector, BioPUR foam is primarily used for energy renovation, insulation, and waterproofing in renovation activities.

As previously mentioned, the foam in the insulation panels is based on a bio-Polyurethane foam developed by INDRES. Currently at TR 6-7, it has a density of 40-50 kg/m3, and an estimated thermal conductivity value of 0.03-0.04 W/mK. The raw materials (polyols) used are commercially available and they are derived from natural oils, making them more environmentally friendly. Furthermore, at the end-of-life, these products are approached through a circular use methodology, employing both mechanical and chemical recycling methods, see Figure 4 and 5.

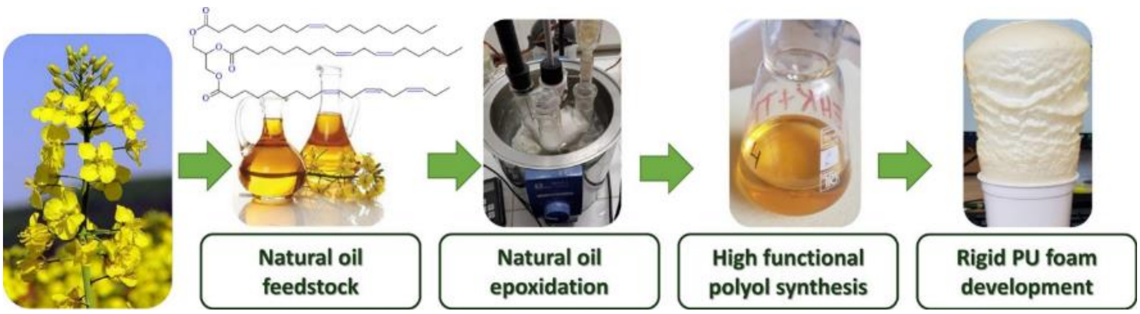


Figure 6. Process for the utilisation of natural oil-derived raw materials in BioPUR foams [3]

In general, plastic foams exhibit a higher carbon footprint compared to natural and mineral materials. BioPUR insulation has a lower carbon footprint compared to many other types of insulation materials.

[2] https://www.ssab.com/en/brands-and-products/greencoat/products/pural-bt
[3] https://www.sciencedirect.com/science/article/abs/pii/S0926669018305508

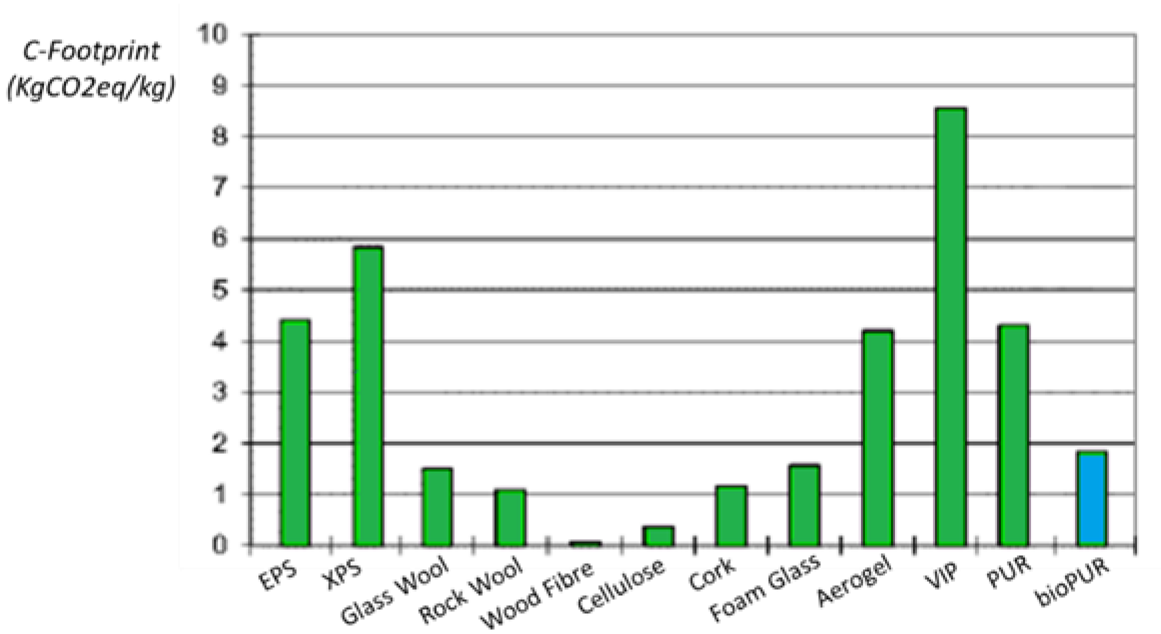


Figure 7. Comparative values of C-Footprint of insulating materials [4]

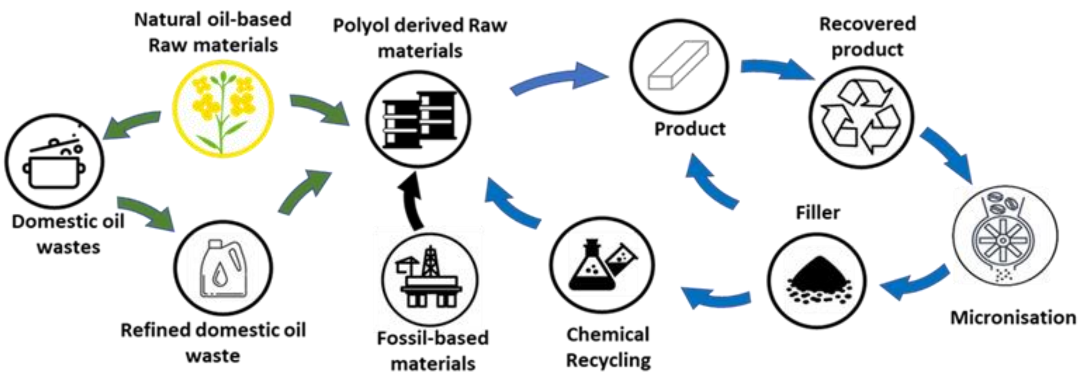


Figure 8. Schematic representation of circular approach of BioPUR materials (Source: INDRESMAT)

[4] https://www.researchgate.net/figure/Carbon-footprint-of-different-thermal-insulation-materials-per-kilogramme-mass-of-the_fig2_317934578

Figure 9. Mechanical and chemical recycling methods for Polyurethanes (Source: INDRESMAT)

BioPUR technical features for sandwich panels in RE-SKIN:

The BioPUR used in the RE-SKIN project is expected to have mechanical and thermal properties similar to conventional PUR. A Currently at TRL 6-7, these values will be verified through additional testing during the project. The thermal properties are more reliant on the microstructure of the foam (density, homogeneity, distribution of cell size, open/close cell ratio, etc.) than on the origin of the raw materials (bio-based or fossil-based). In this regard, INDRES has developed a foaming process for BioPUR equivalent to conventional PUR, ensuring that the microstructure and properties of the foam are suitable for insulation in buildings.

Technical properties of BioPUR used in RESKIN:

- Thermal conductivity (0.03-0.04 W/mK)
- Biobased content (60-70 %)
- Carbon footprint (1.8-3 KgCO2/kg)
- Viscosity (600-3000 cPs)
- Reactivity range (10–50 s)
- Density range (40-60 kg/m3)

Figure 10. Demo sandwich panels made from bioPUR (left). Different varieties of PUR materials from INDRES (right).

Lattonedil conducted internal fire tests (Piccola Fiamma) on the RE-SKIN roof panels, not under a specific standard but correlating with the UL94 flammability test. The RE-SKIN panels self-extinguish shortly after ignition, corresponding to UL 94 V-0.
These tests are for characterisation purposes and are not intended for certification. The sandwich panels will undergo testing under standard norms to determine their classification in the Euroclass System.

3.2. Recycled aluminium mounting structure and fixing elements

The façade system utilises a recycled aluminium mounting structure to attach the sandwich panels to the existing façade. This approach supports RE-SKIN's goal of promoting sustainability (more information can be found on deliverables from WP7 Circular-economy support) using environmentally friendly materials during construction.

EXLABESA RE-local – Recycled low carbon aluminium
Aluminium is a highly versatile material that can be recycled indefinitely without losing its quality or properties. This makes it an essential material for sustainable development. The façade profiles used in RESKIN are made with recycled aluminium, with a recycled aluminium content rate of 98%.
The recycling process includes collection, smelting, and the extrusion of new profiles. The production process generates a carbon footprint of only 2.95 kg of CO_2 per kg of aluminium produced, achieving a substantial reduction of up to 95% in energy consumption compared to the production of primary aluminium.

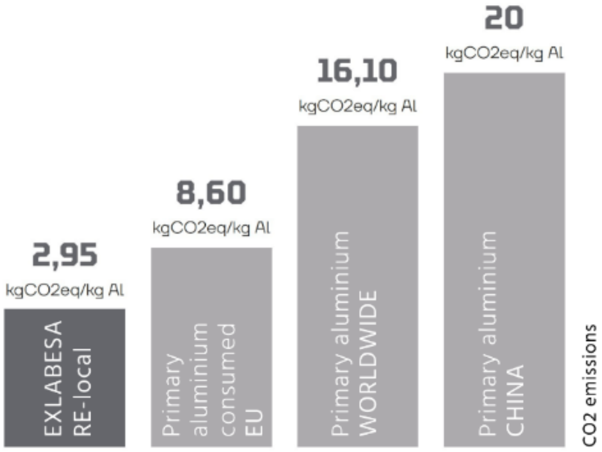


Figure 11. Aluminium Carbon Footprint (EXLABESA)[5]

Structural Profile properties and composition

In the RE-SKIN project, aluminium extrusion profiles made from AA 6063 are employed. This alloy contains magnesium and silicon as alloying elements, and its composition is regulated by The Aluminium Association. This alloy exhibits excellent mechanical properties, is heat-treatable, and can be welded. It is the most commonly used alloy for aluminium extrusion due to its capability to create complex shapes with smooth surfaces suitable for anodising.

Constituent element	Minimum (% by weight)	Maximum (% by weight)
Aluminium (Al)	97.5%	99.35%
Magnesium (Mg)	0.45%	0.90%
Silicon (Si)	0.20%	0.60%
Iron (Fe)	0	0.35%

Property	6063-T5
Tensile Strength	186 MPa | 27000 psi
Yield Strength	145 MPa | 21000 psi
Modulus of Elasticity	68.9 GPa | 10000 ksi

Figure 12. Aluminium Composition of AA 6063

The panels are affixed to the existing walls via the structural profiles, secured by self-drilling screws, the profiles are attached to the supporting brackets that are anchored to the façade. Before installation, a dynamometric test (Pull-off Test) is conducted to assess the tensile strength of the walls and load capacity of the fixings. Based on the test results, the appropriate anchoring method—either mechanical or chemical—will be determined.

[5] https://exlabesa.com/en/arquitectura/re-local-recycled-aluminium

Façade system

The system is designed in a modular and detachable way, which makes it possible to inspect specific areas when needed. To detach the panels, we first need to dismantle the vertical finishing profiles on the sides. Then, we can proceed to remove the panels one by one in the same column, starting from the top and moving downwards, until we reach the desired area that needs to be inspected.

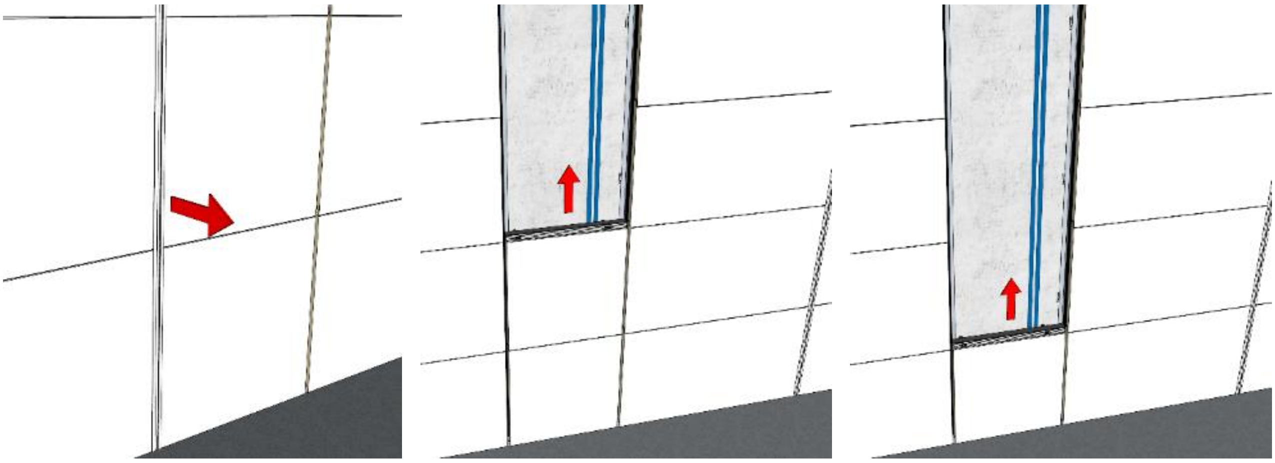


Figure 13. 3D images illustrating the sequence of panel dismantling for installation inspection [drawing created using SketchUp]

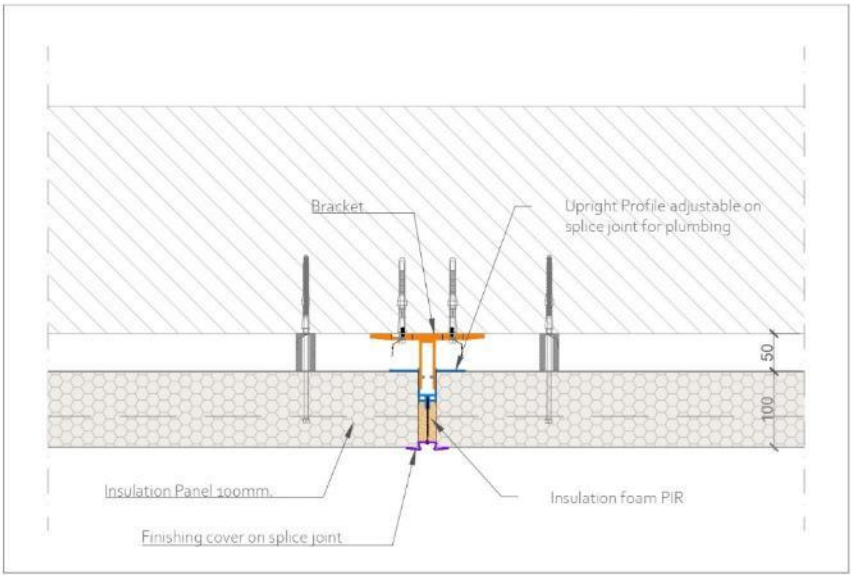


Figure 14. Detail drawing of the vertical panel connection for standard air gap (<6cm, approximately.) [drawing created using AutoCAD]

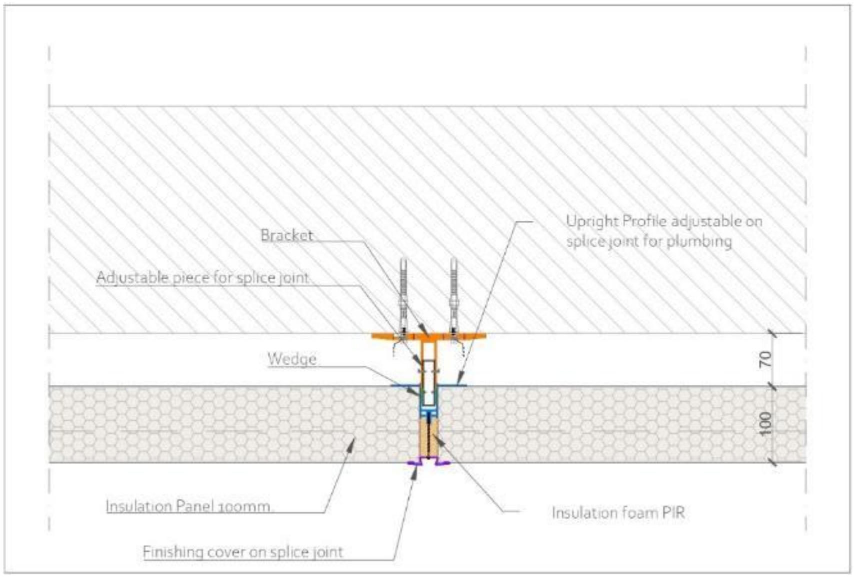


Figure 15. Detail drawing of the vertical panel connection for larger air gap (>6cm, approximately.) [drawing created using AutoCAD]

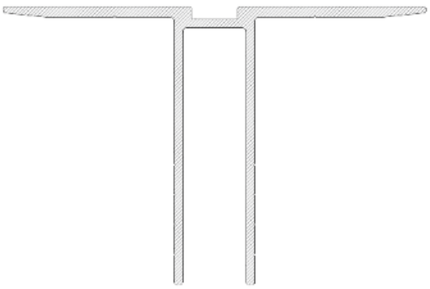


Figure 16. Detail drawing of the façade system's bracket [drawing created using AutoCAD]

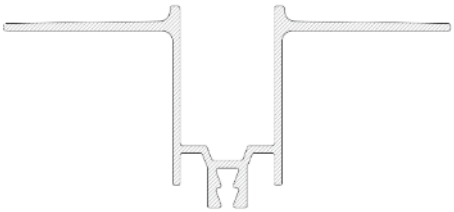


Figure 17. Detail drawing of the façade system's profile [drawing created using AutoCAD]

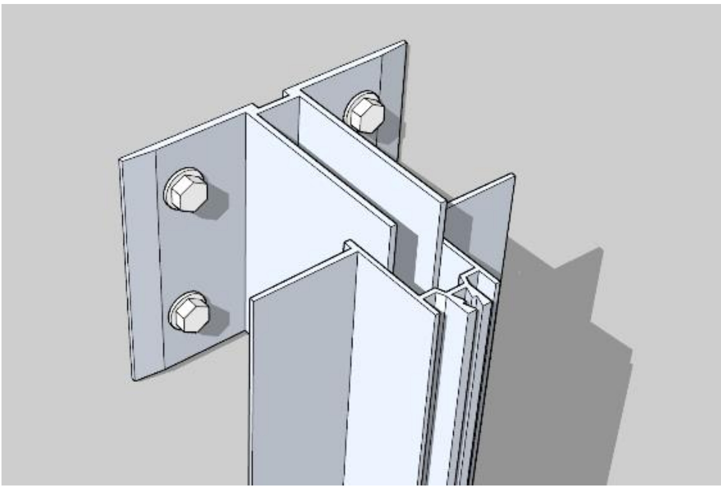
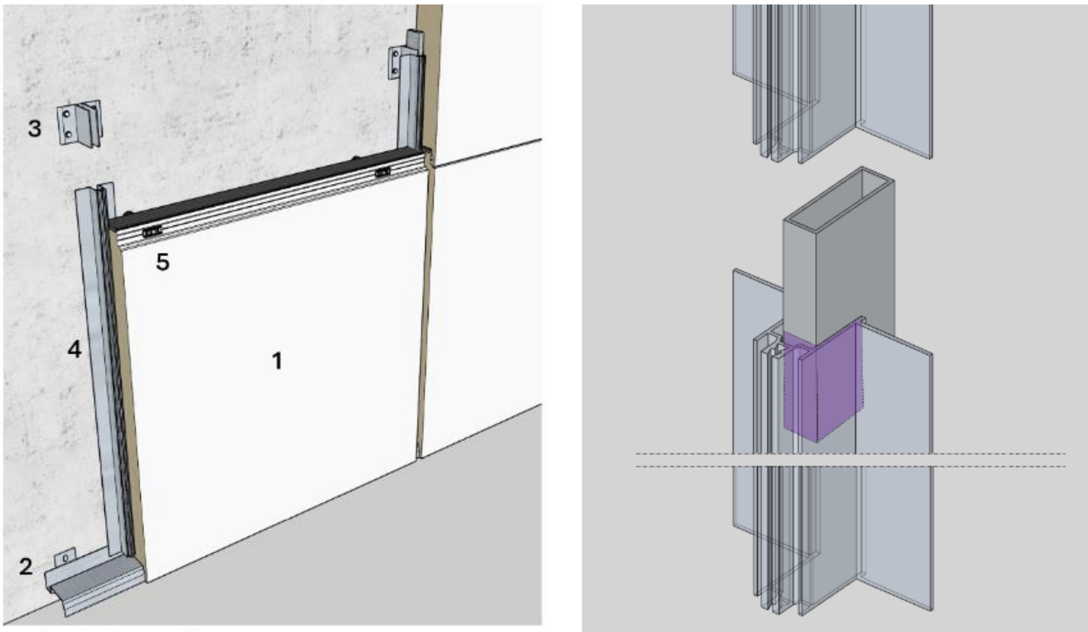


Figure 18. 3D view of the joint connection

A dedicated extrusion die has been developed to enable the subsequent production of the profiles using recycled aluminium.

Figure 19. Extrusion dies for profile manufacturing as developed by EXLABESA for the RE-SKIN façade system.



1. Insulating panel
2. System start section for internal chamber regulation
3. Vertical profile fixing bracket
4. Vertical planimetry profile
5. Insulating panel direct fixings

Detail of the planimetry profile union of the system. In purple, the fixed part of the connector to the profile. The sliding part protrudes to absorb system expansions.

Figure 20. Façade system elements

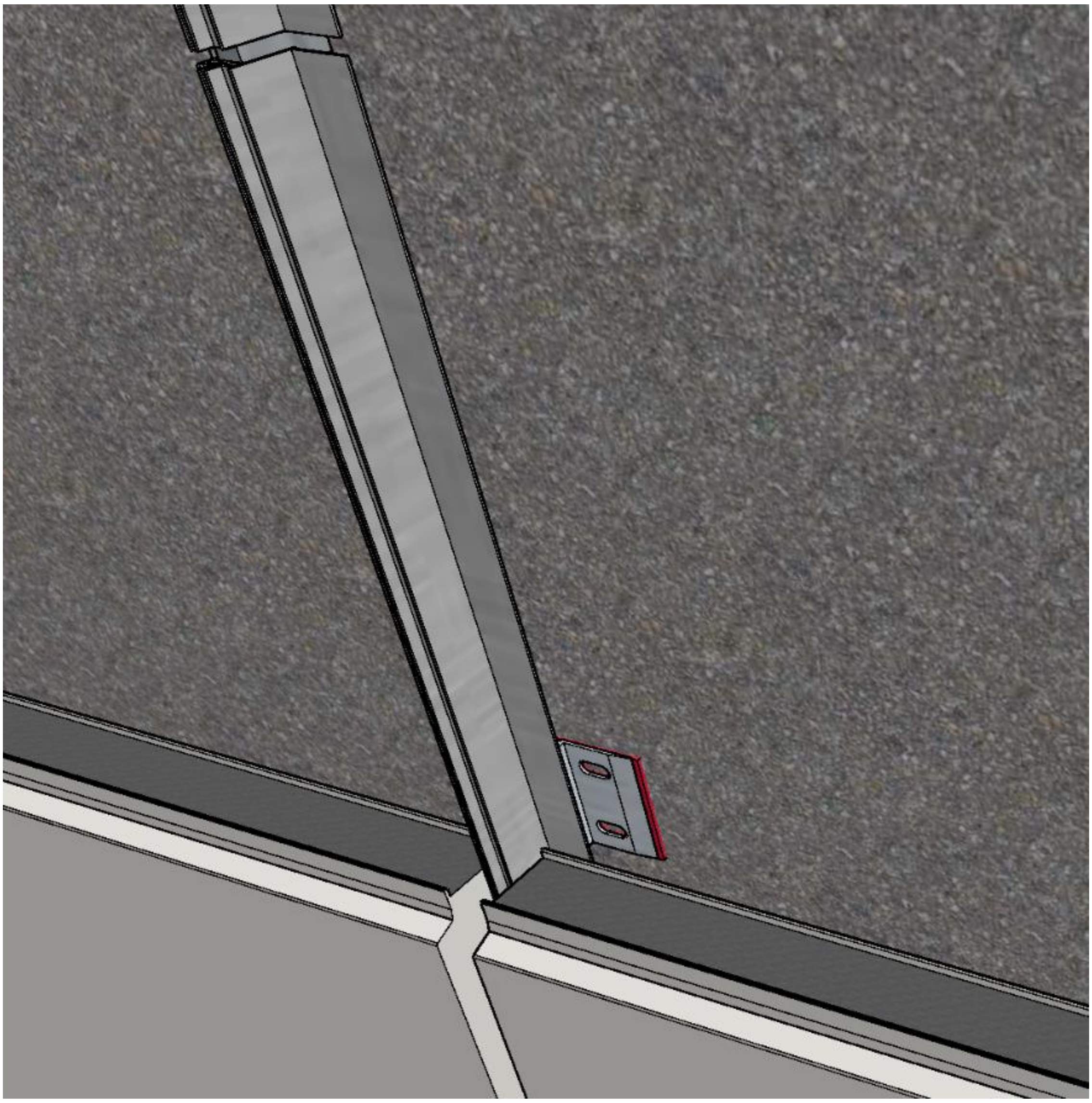


Figure 21. Sandwich panel and existing façade [image created using SketchUp]

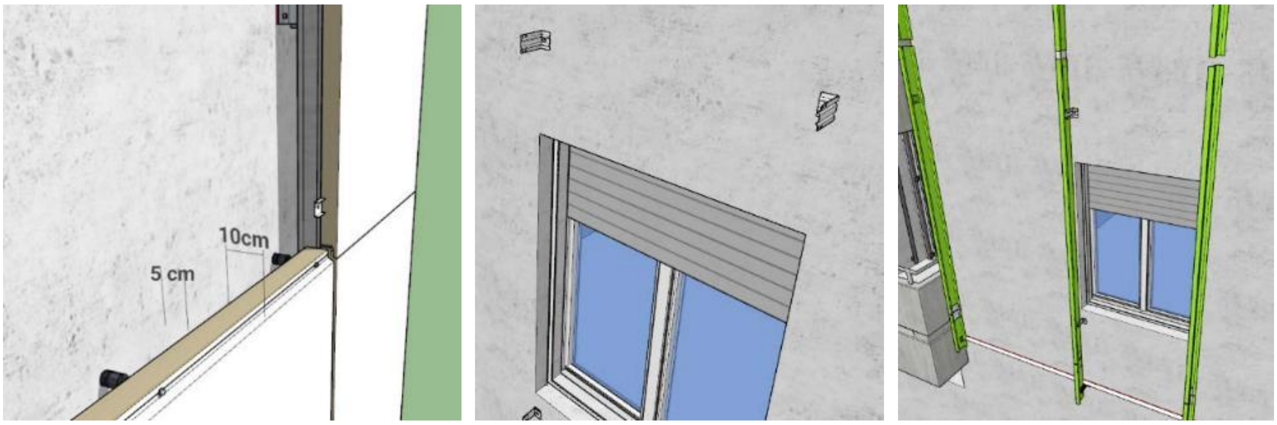


Figure 22. Substructure elements [image created using SketchUp]

The façade system is engineered to compensate for uneven surfaces, ensuring a level installation even on non-vertical building façades. To account for these irregularities, a thorough measurement of the façade's unevenness is necessary prior to installation.

The deviation of the façade and the integration of ducts within the interior chamber influence the chamber's dimensions. If the chamber's thickness exceeds 5cm, support brackets are required to prevent anchor screws from bending excessively. These brackets effectively distribute the load, reducing screw stress.

Additionally, the system offers three types of brackets with varying dimensions, allowing for a wide range of interior chamber sizes. The appropriate bracket should be selected based on the required interior chamber size.

3.3. Finishing elements

The versatility of the machinable and modular façade system allows for the customisation of the design and configuration to meet the unique needs of a building, integrating seamlessly with new and existing elements like windows, corners, eaves and different types of ducts such as pipes, wiring, vents, or sensors. The gap required for the installation of the facade can be utilized to incorporate some of the ducts.

Moreover, the system is detachable, facilitating installations and services' inspections in designated areas.

Buildings vary in size and shape and often have different objects and facilities attached to them. To ensure that the joints between the different parts of the building are sealed with air-tightness, insulation foam is used to fill the junction points, and the overlapping of membranes and layers are also employed.

The panels used in the façade system are manufactured with the maximum lengths allowed to minimize the number of panel joints. However, connection points with other elements of the existing or new façade are inevitable. To address this issue, the RESKIN façade cladding system is designed to offer standardized solutions that can be used in various buildings, regardless of their shapes and sizes.

To ensure the proper installation of façade components, GAR has developed a catalogue of standardised technical details for constructive solutions [see Figs. 22-25, and 34-37]. This catalogue encompasses details for the installation of singular points such as windows, doors, corners, air vents, and horizontal and vertical panel connections. These technical details are necessary for the successful implementation of the façade system. By following these standardised details, the installation process can be conducted with greater efficiency and accuracy, reducing the risk of errors and ensuring the proper functioning of the façade.

Here are some examples of technical details for constructive solutions related to façade installation in singular points:

Windows

To achieve vertical alignment of window openings and ensure evenness between them, substructure profiles are installed adjacent to the windows along the entire length of the façade.

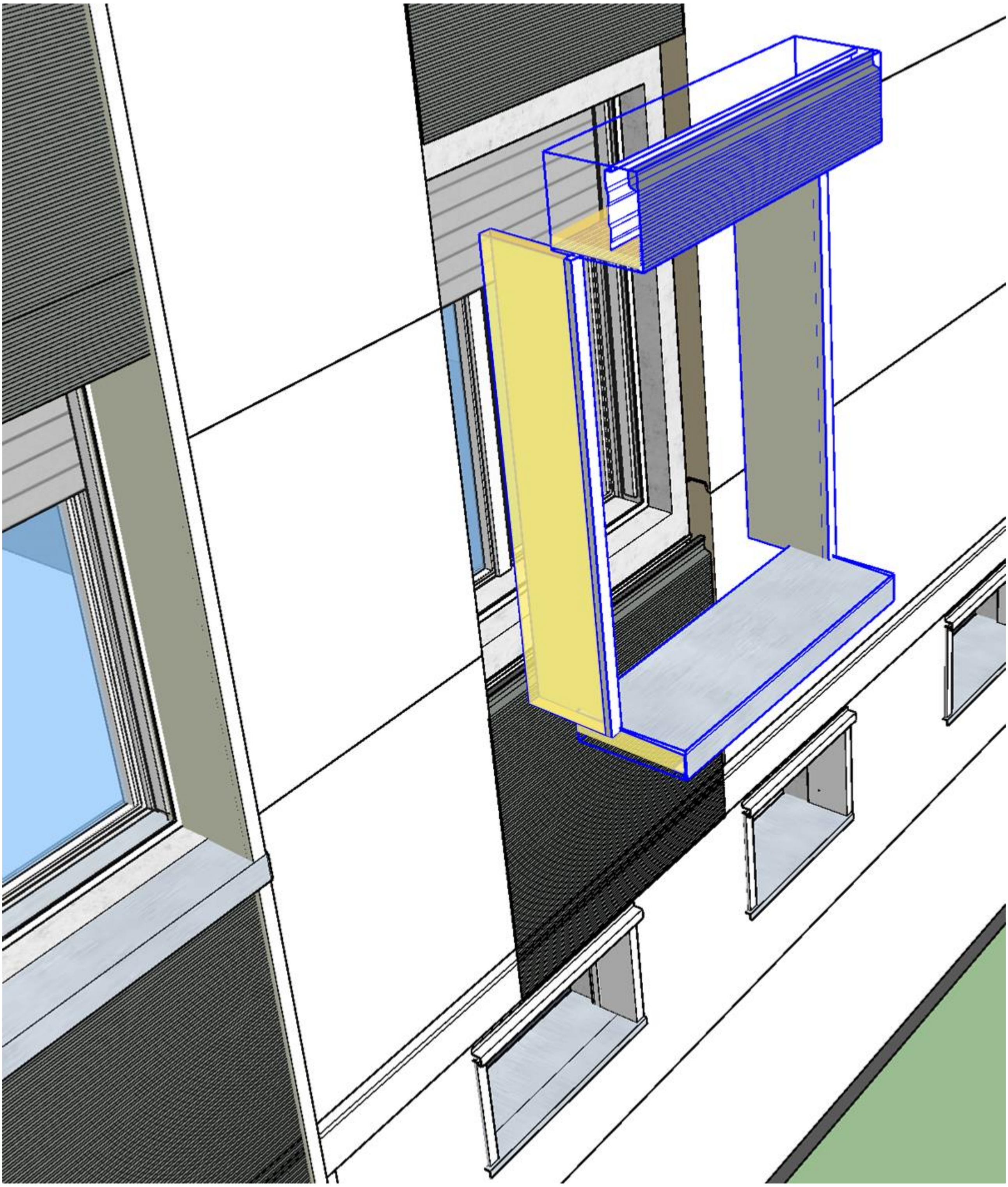


Figure 23. Finishing elements for insulated and sealed window frames [image created using SketchUp]

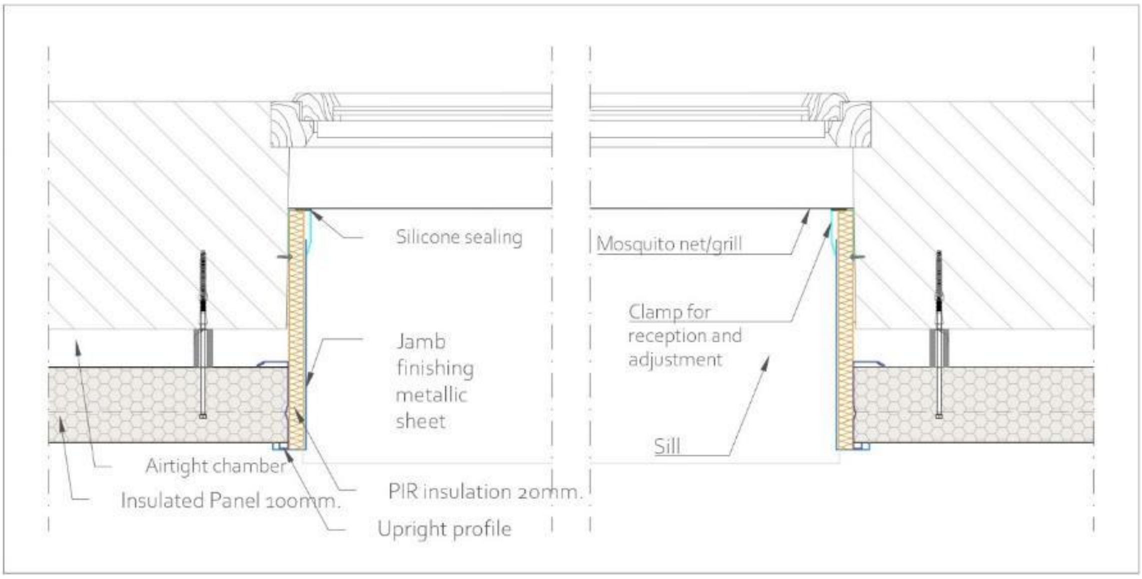


Figure 24. Window detail drawing (horizontal) [drawing created using AutoCAD]

The lintels, jambs, and windowsills are sealed using silicone and a rubber strip along the frame to create an airtight cavity. For insulating the jambs, BioPUR panel insulation is used, while the windowsills are insulated with PUR insulating foam. However, to avoid obstructing the visibility from indoors, it is essential to assess the dimensions of the window frame before determining the thickness of the insulation to be applied to the jambs and lintel.

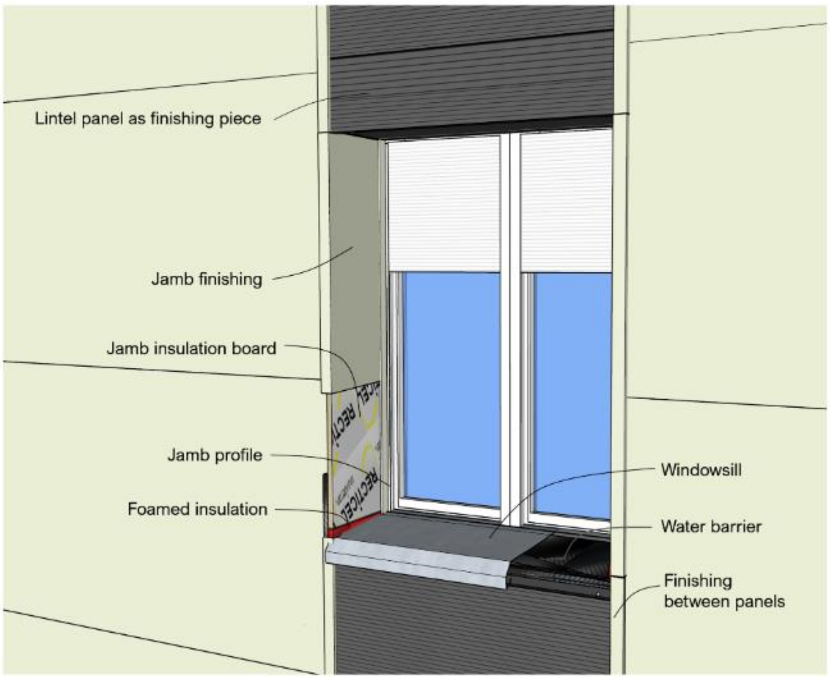


Figure 25. Components, membrane and window sealing [drawing created using SketchUp]

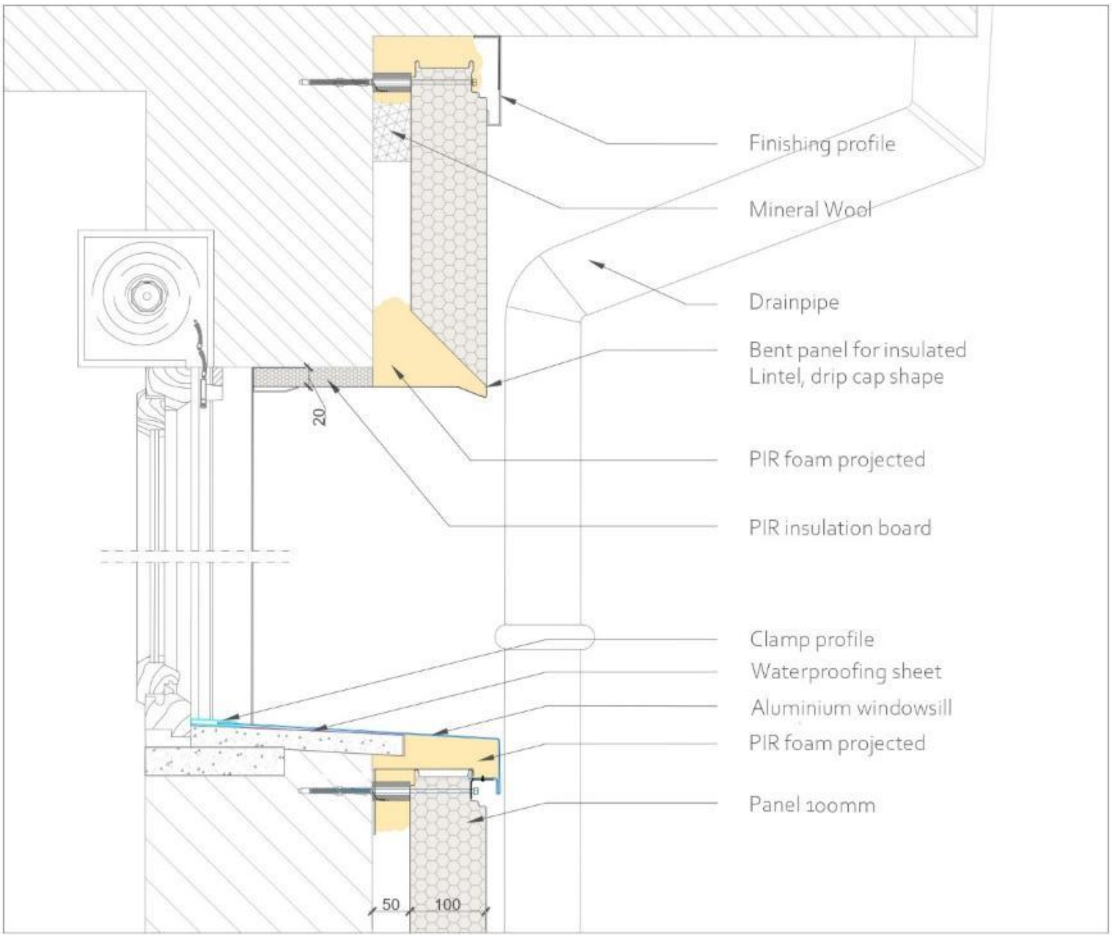


Figure 26. Window detail drawing (vertical) [drawing created using AutoCAD]

As illustrated in Figure 24, the panel used to cover both the façade and lintel is bent at a 90-degree angle to maintain airtightness and minimise thermal bridging. Additionally, the aluminium windowsill finishing must reach the window frame to avoid water penetration and ensure complete sealing. Finally, when insulating the windowsill, it is important to determine the dimensions of the window frame, as well as the location of the drainage points, to avoid obstructing them.

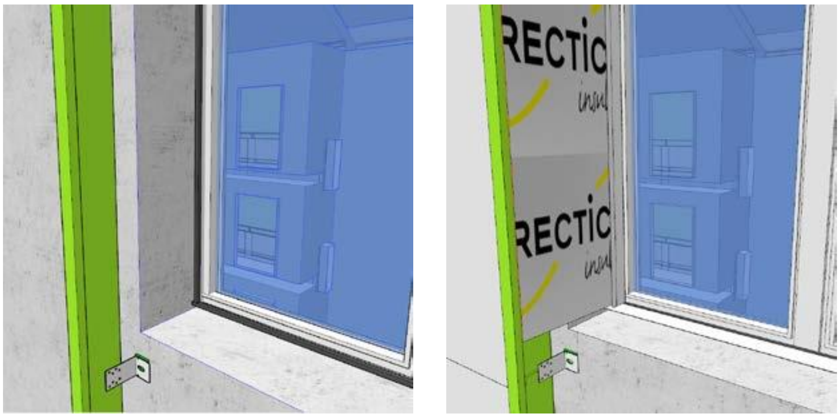


Figure 27. Window frame elements: rubber strip and insulation in jambs [images created using SketchUp]

Figure 28. Image depicting the current condition of the ground floor windows in the Milan demo case.

In the context of the Milan demonstration case (see Fig. 26), the existing stone sills and mouldings covering the jambs will be dismantled as they appear to be in poor condition and may not be securely attached to the wall. The deterioration of the sills and mouldings pose a risk to the proper attachment of new jambs. Removing these sills and mouldings will allow for the installation of thicker insulation, enhancing the efficiency of the insulation system, further reducing potential thermal bridges, see Figures 21-29.

However, it is paramount to avoid covering the drainage holes in the windows during this process. These openings are crucial for the proper functioning of the windows and ensuring effective drainage for the window frame.

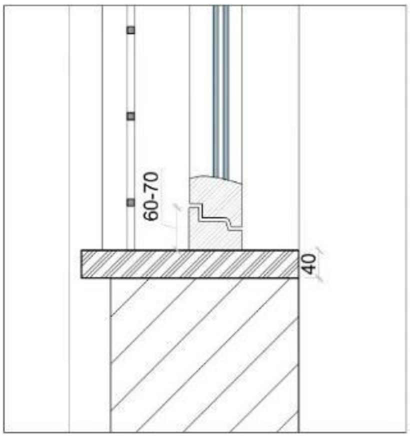


Figure 29. Vertical section of existing window detail

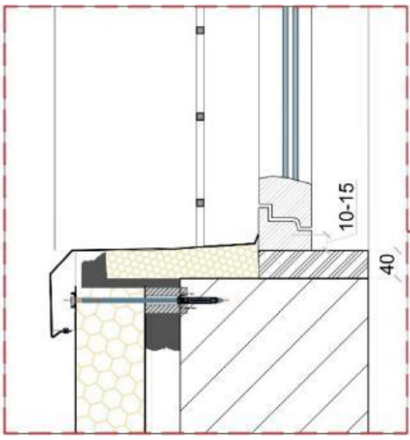


Figure 30. Vertical section of proposed windowsill design

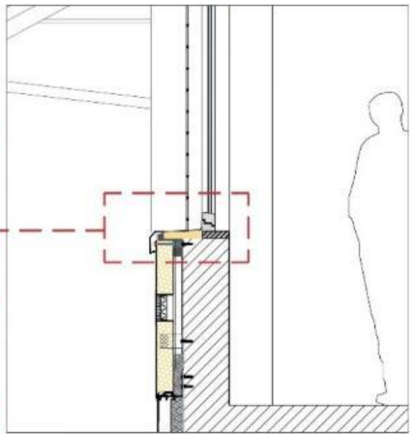


Figure 31. Vertical window detail section – Key plan

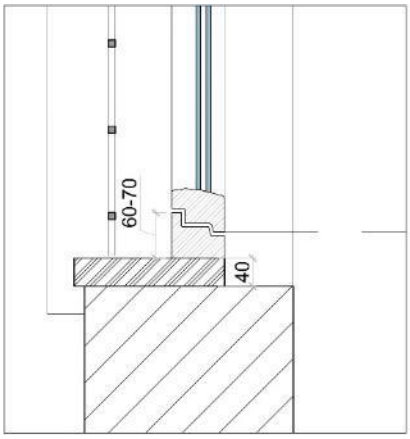


Figure 32. Horizontal section of existing window detail

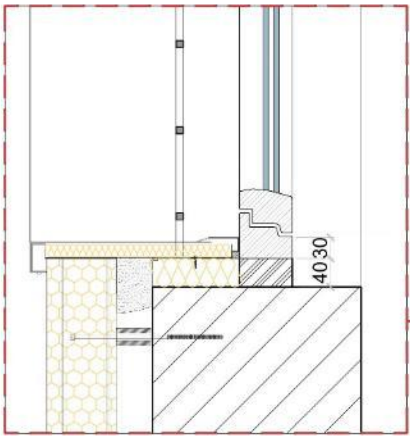


Figure 33. Horizontal section of proposed jamb design

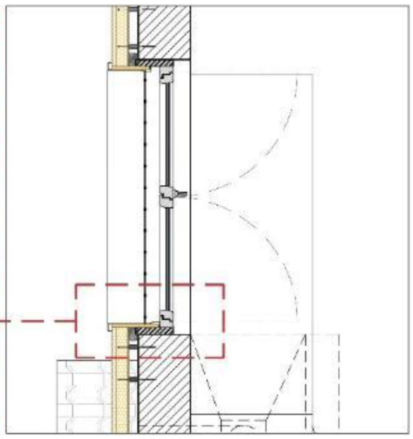


Figure 34. Horizontal window detail section – Key plan

When installing insulation in elements such as lintels and jambs, the presence of mosquito nets or window grills in the balcony windows should be considered.

For the Milan demonstration building, existing grilles and mosquito nets will be removed temporarily to allow for improved insulation and minimisation of thermal bridges. Subsequently, new mosquito nets and metal grates will be installed after the renovations.

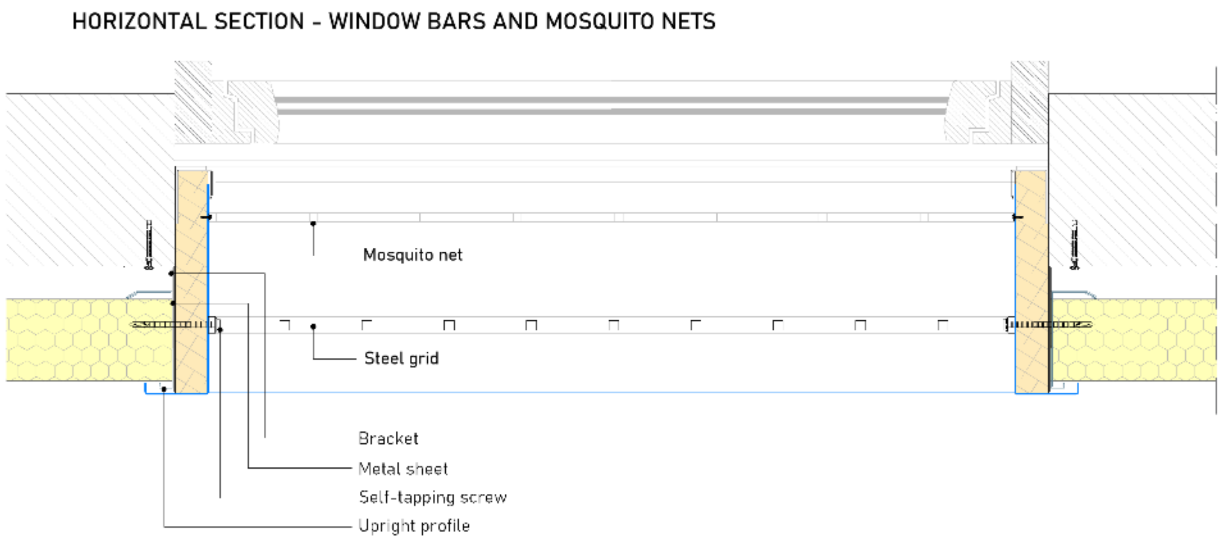


Figure 35. Detail drawing (horizontal) of the mosquito nets and steel grids in the Milan case study [drawing created using AutoCAD]

Figure 36. Image showcasing the specific case of the first-floor windows in the Milan demo, featuring blinds and a mosquito net

On the first floor, all windows feature vertical shutters with a recessed vertical rail in the wall. The insulation will extend up to the shutter track in the jambs, given the presence of the vertical rail.

The existing shutter rail is closely positioned to the window frame. As a result, the new jamb will terminate at the rails without covering them.

Balconies

Residential buildings frequently encounter space constraints in certain areas that need to be insulated. This is the case for balconies, which require a different construction approach compared to the rest of the building due to space limitations. The solution for balcony insulation involves incorporating a Bio-based PUR foam and a finishing layer of aluminium composite panel affixed using brackets and profiles.

In the areas where installing the sandwich panel is not feasible, an alternative BIO-based material will be used for the 50 mm insulating layer.

The construction solution for insulating the balconies aims to minimise thermal bridges while using the balcony space efficiently. Lintel and jambs are insulated wherever feasible, similar to window frames.

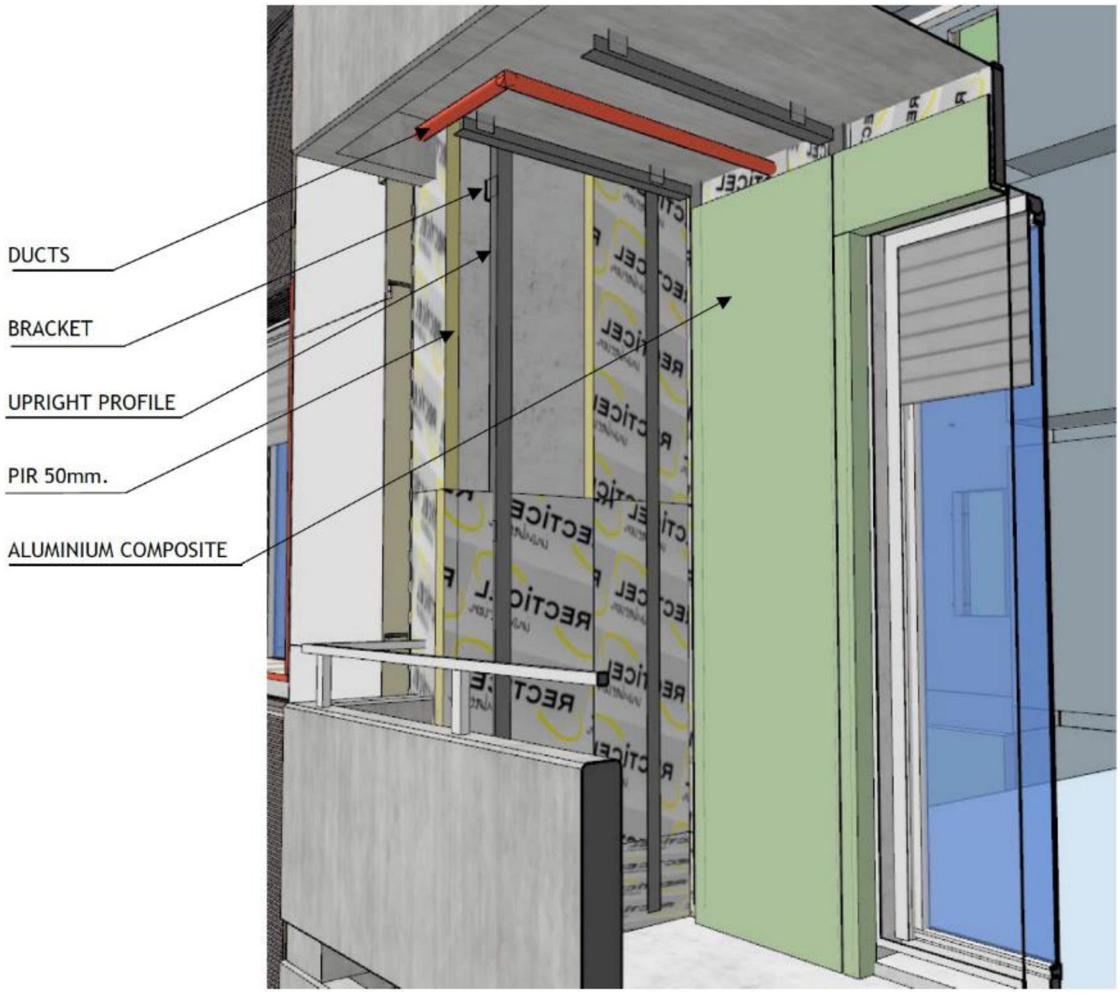


Figure 37. Balcony 3D [image created using SketchUp]

When the balconies are open, the balcony ceiling does not require insulation; therefore, the gap between the ceiling and the composite panel attached to the balcony's façade is used to accommodate different ducts and wires. Thermal bridges at the connection with the facade are minimised using insulation boards or foam for sealing points.

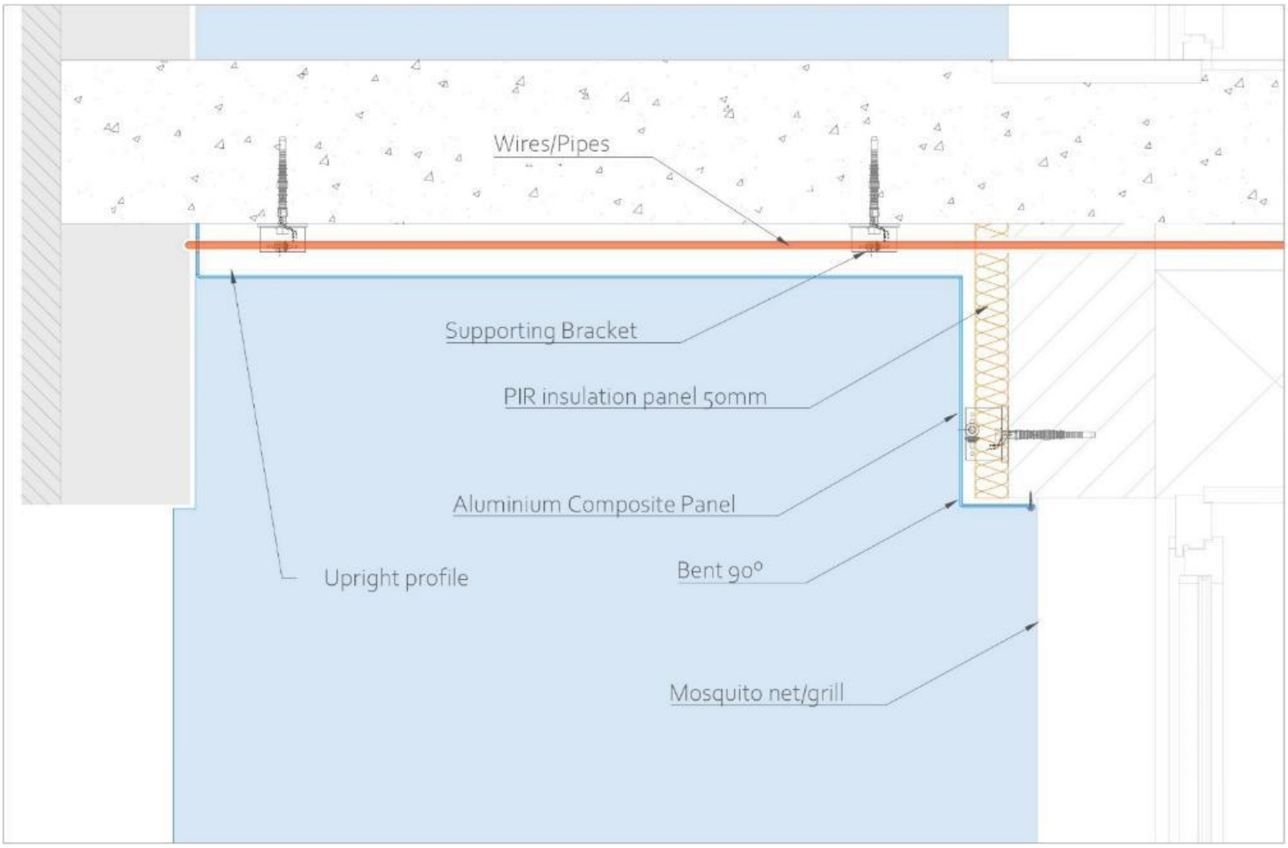


Figure 38. Balcony detail (Vertical) [drawing created using AutoCAD]

Integration of utility elements

Other elements found in existing residential buildings that require specific design solutions to adapt to the new façade system are gas metres, drainpipes, vents, and gas pipes. Drainpipes will remain on the exterior of the new façade, and before the installation of the new façade, require dismantling to allow the fitting of the substructure and panels. Once the new building envelope is in place, the drainpipes will be assembled again, readjusting the pipe elbows to adapt to the new façade's width. Gas pipes and meters remain in their original locations, and the insulation of the façade is briefly interrupted when its application overlaps with these elements. The composite panels will be modified to facilitate inspections of gas meters and pipes.

Adaptations for air vents involve removing the outside grid and connecting a new ventilation duct to the existing one, ensuring compatibility with the new façade system, see Figure 30.

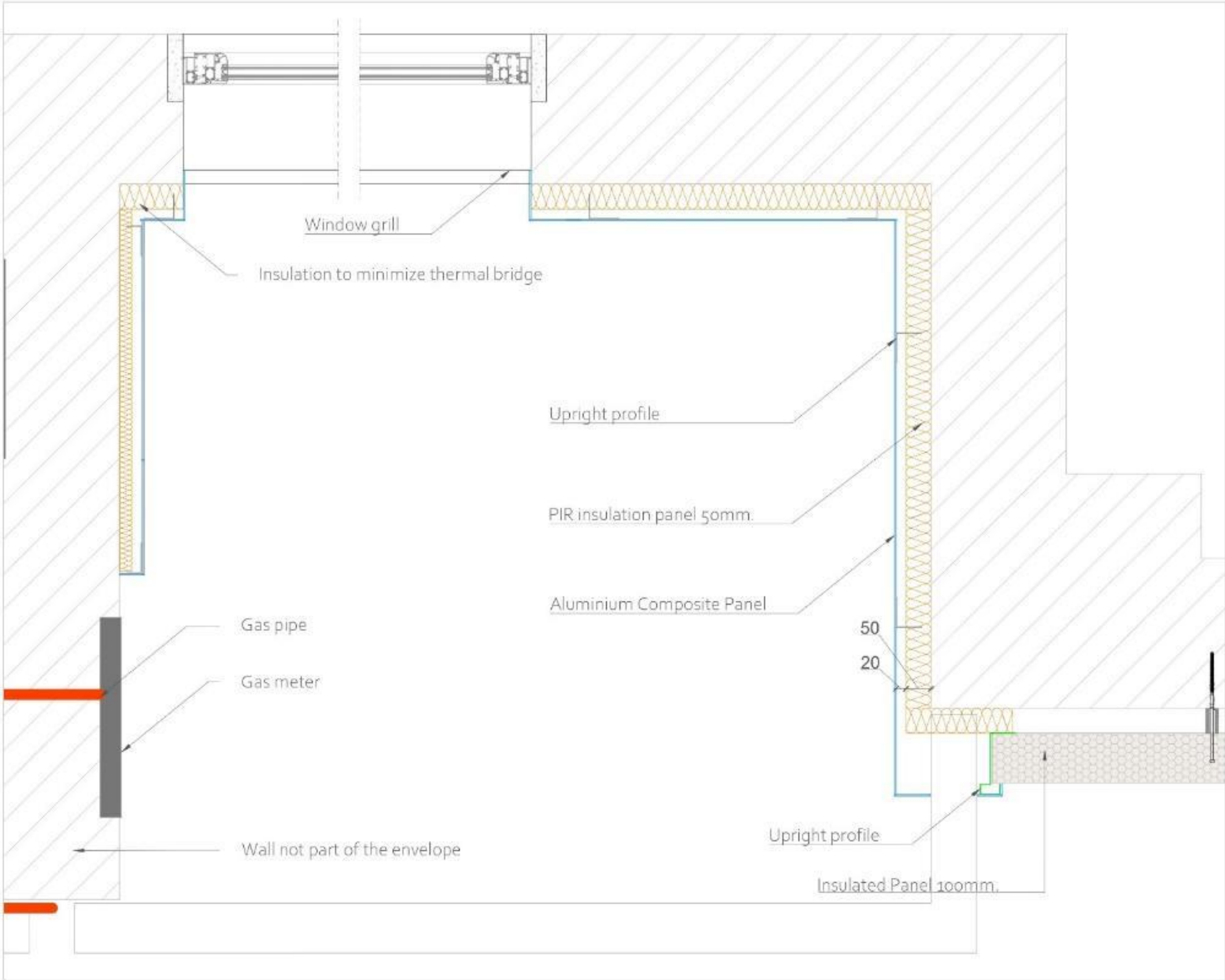


Figure 39. Balcony section (Horizontal) [drawing created using AutoCAD]

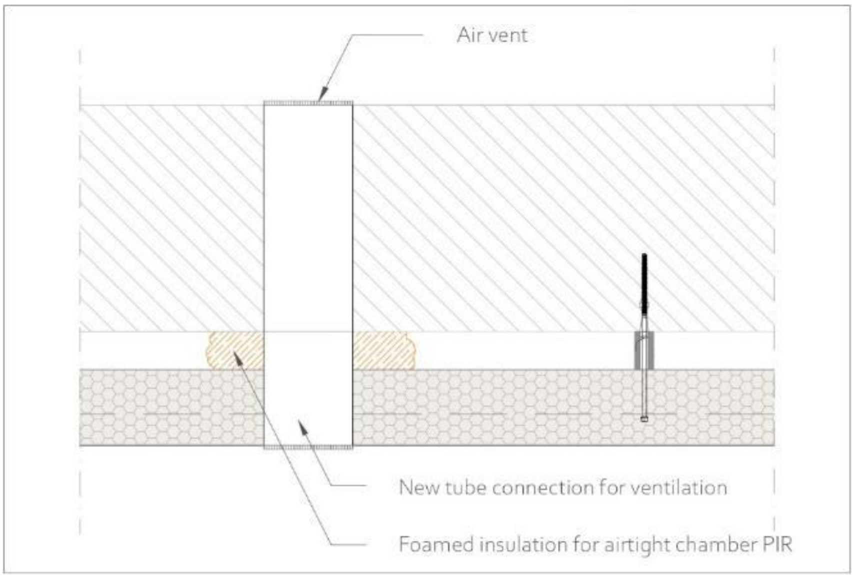


Figure 40. Air vent detail [drawing created using AutoCAD]

A valuable addition to the system involves incorporating an adaptable sealed chamber equipped with manually adjustable ventilation grilles (see Fig. 37). Depending on the seasons, the internal chamber can be completely sealed to provide thermal resistance in cold weather. Alternatively, ventilation grilles can be manually adjusted to enhance ventilation in warmer weather.

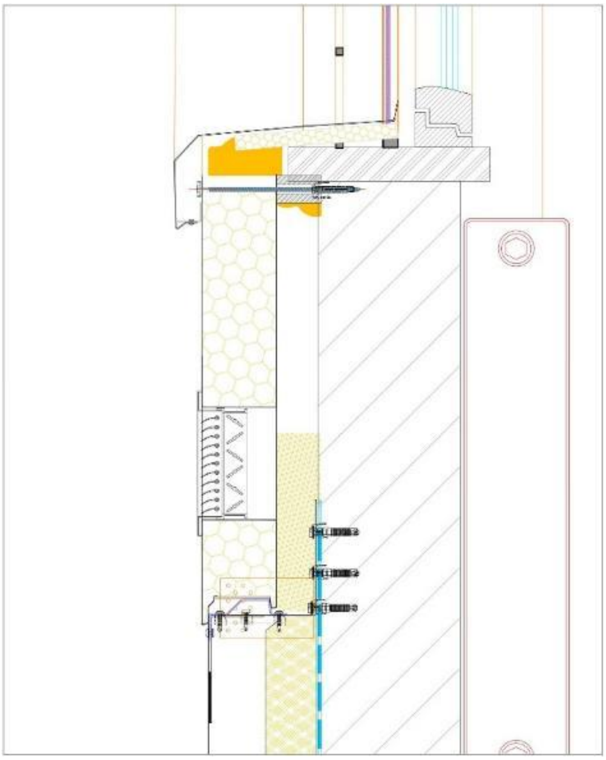


Figure 41. Preliminary design of ventilation grilles dependent on the final manufactured façade panel.

4. Installation

4.1. Transportation and storage

The material is transported in batches of pallets. The pallet dimensions are approximately (6x1x1.3) m, weighing each one about one ton. These figures vary depending on the building itself (square meters of façade, morphology, etc.) as the material and dimensions are defined when all areas of the building have been analysed and resolved. The material is sent on a truck. A pallet jack is necessary on-site to unload the material.

Regarding the storage, the material should be kept indoors, to avoid any type of degradation. It is recommended to use fencing material and regular construction site safety measures.

Figure 42. Transport and unloading of materials on-site for the HEART project. (Source: GarcíaRama)

4.2. Selection of auxiliary equipment

The selection of an installation system by the installer depends on the complexity of the façade and the existing accessibility conditions. For instance, in the case of a highly intricate façade, the installer may opt for general scaffolding systems, while crane platform installation systems may be employed in less complicated situations due to the versatility of the machinable and modular façade system. The RE-SKIN facade system allows for the use of crane platforms, thereby reducing installation time, labour requirements, and eliminating the need for scaffolding.

In the case of the Milan demonstration building, given that it is a two-storey building, using a compact lifting platform in such a structure facilitates the installation of larger panels while minimising the risks associated with their handling. This approach allows for the maximisation of panel length, leading to a substantial reduction in installation time due to the decreased number of panels requiring placement. Therefore, employing a lifting platform in a two-storey building is the optimal choice for enhancing the efficiency of the installation process.

Figure 43. Crane platform and scaffolding installation system

4.3. Preparation of walls that will support the new façade

To ensure the strength and endurance of the existing wall structure supporting the façade system, conducting multiple test samples using a dynamometer is essential. GAR has developed a Pull-Off Test Guide (dynamometric test) with comprehensive instructions and indications to identify the appropriate type of anchoring needed. The Pull-Off Test Guide can be found as Annex II in this deliverable.

The objective of the test is to ascertain whether mechanical anchoring alone is adequate or if chemical anchoring is required, especially in instances where the façade walls exhibit weaknesses, deterioration, or poor construction. This process guarantees the stability and safety of the façade system.

Figure 44. Dynamometric test (Pull-Off Test Guide in Annex)

4.4. Substructure installation

The installation of the façade system requires the coordination of at least two operators working simultaneously. These workers are tasked with the layout and distribution of components, aided by laser measuring and guiding equipment. The installation process begins by fixing the brackets, followed by the lower base profiles. Subsequently, the remaining substructure is installed, using the appropriate fixings depending on the condition of the existing wall.

Step 1: Using a laser and measuring tools, holes are made for the brackets that will support the starting point of the façade.

Step 2: The brackets are then screwed onto the façade.

Step 3: The starting profile is placed, anchored to the brackets. This starting profile will guide the panels that will later be screwed onto the façade.

Step 4: The laser assists in ensuring the profiles are perfectly vertically aligned, even if the façade is not flat and exhibits irregularities and slopes.

Figure 45. Demonstration of substructure installation

4.5. Insulating panel installation

The façade panel is attached to the substructure and subsequently to the wall using screws, which are concealed due to the tongue-and-groove system.

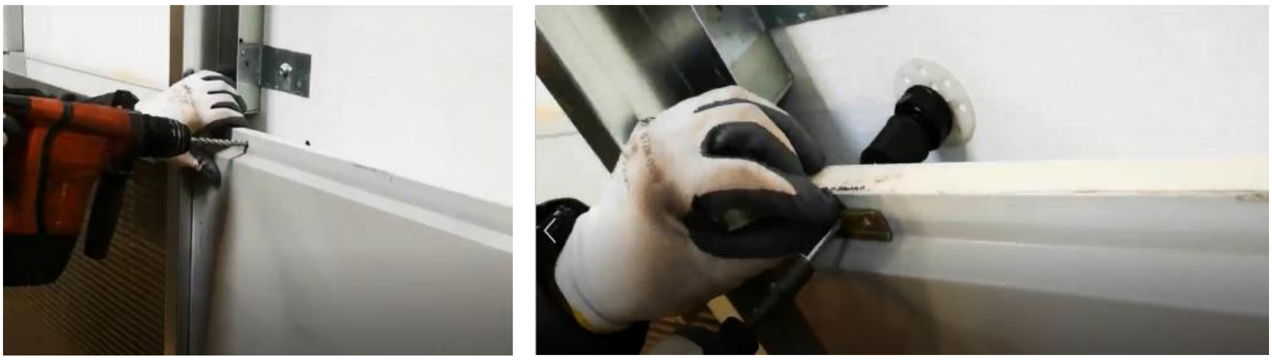


Figure 46. Demonstration of insulating panel installation

4.6. Installation of finishing elements

Similar to other façade cladding systems, such as ETICS (External Thermal Insulation Composite System) or ventilated façades, finishing elements are essential to complete singular elements like window frames, jambs, rain gutters, and gables. The use of aluminium sheet components is recommended for these purposes. Specifically, for window frames, it is advisable to incorporate an insulating sheet on the inner layer to prevent thermal bridging.

Figure 47. Completed façade installation by GarcíaRama (Image source: GarcíaRama)

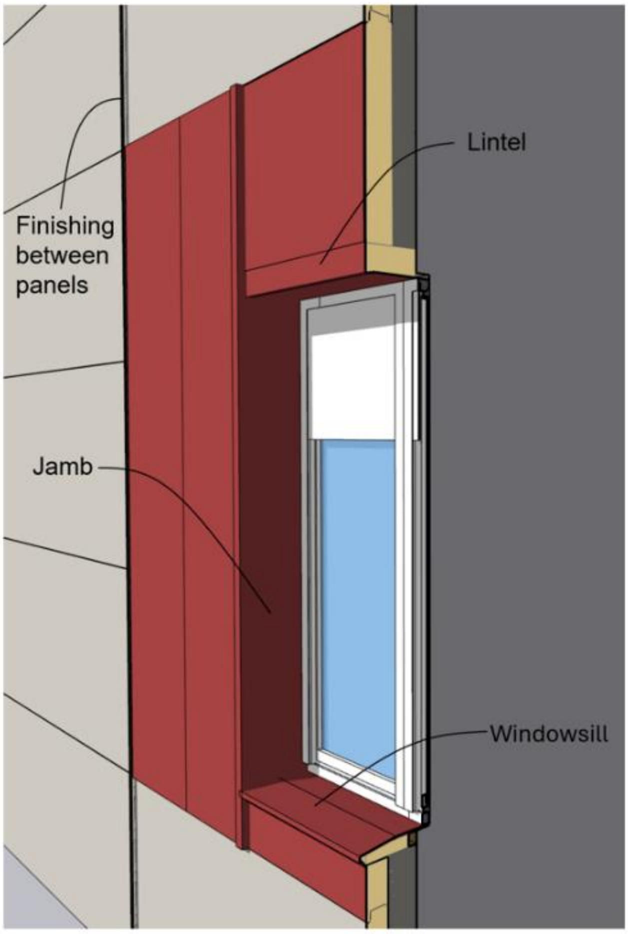


Figure 48. 3D view of finishings for the Milan demo (image created using SketchUp)

5. Operation mode

5.1. Adaptable sealed chamber

The objective of the installation system in RE-SKIN is to incorporate an adaptable sealed chamber with manually operable ventilation grilles. The internal chamber is devised to function as thermal resistance and can be created by sealing an airtight gap, offering an effective insulation solution during cold seasons. The transmissivity of the chamber can be manually adjusted using the ventilation grilles, allowing for ventilation in warmer seasons. This approach ensures energy efficiency, cost reduction, and easy adjustments in response to seasonal variations.

Depending on the climatic zone and the existing wall structure, the airtight seal during colder seasons helps maintain the internal temperature of the building. In warmer seasons, the cavity can be opened to facilitate air circulation, preventing moisture and heat accumulation. Strategically placed ventilation grilles enable fresh air intake and exhaust stale air, establishing a continuous flow. In this preliminary design stage, the grilles are positioned at the base and top of the façade to facilitate air intake and exhaust. These grilles, made from stainless steel or aluminium, will be sourced from existing market designs, ensuring they prevent water ingress and debris.

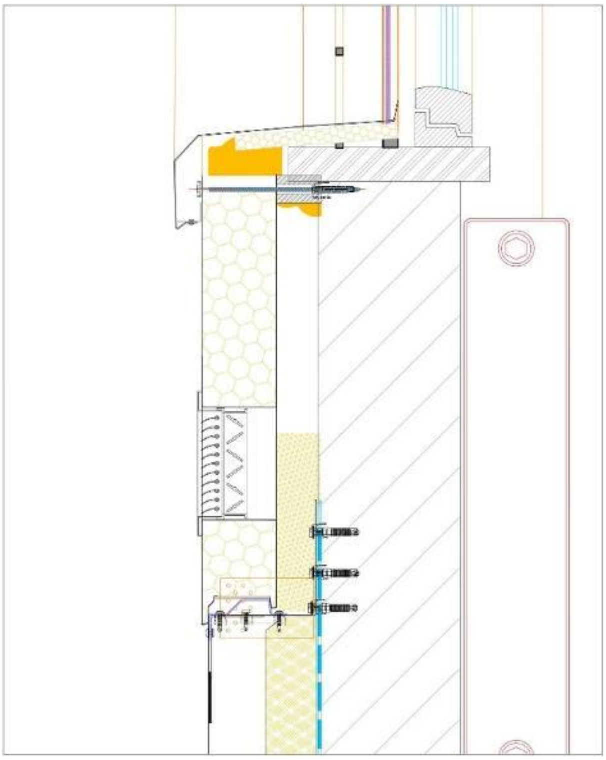


Figure 49. Preliminary design of ventilation grilles dependent on the final manufactured façade panel.

5.2. Maintenance

Regular cleaning and maintenance are essential to keep the Greencoat steel sandwich panel facade in good condition and extend their lifespan.

Cleaning

The most effective way to clean the facade is with a pressure washer. However, it is important to use the pressure washer carefully to avoid damaging the panels. The pressure should be set to a maximum of 20 bars.

The frequency of cleaning will depend on the location of the facade and the level of pollution in the environment. In general, it is recommended to clean the facade at least once every 5 years. If the facade is located in an urban area with heavy traffic, it is advisable to clean it more frequently.

It is important to use specific cleaning products. These products are designed to be gentle on the surface of the panels and will help to prevent damage.

Inspection

In addition to cleaning, it is also important to inspect the façade regularly for any signs of damage. This proactive approach helps to maintain the safety and integrity of the façade, extending its lifespan and reducing the risk of costly repairs or premature replacement.

Annex I: Milan Demonstration Building Pull-Out

DYNAMOMETRIC TEST RESULTS

Funded by
the European Union

PROTOCOLLO DI PROVA (secondo EOTA TR051: Job site tests for plastic anchors and screws)					
PROTOCOLLO NR.	2023-1112	REDATTO DA:	Martin Losso	DATA DOCUMENTO:	19/10/2023
		STRUMENTO NR.	3DAZG070808	DATA VERIFICA:	10/10/2023

RIFERIMENTI

Cliente: Weber-Saint Goban **Cod. Cliente:**

Referenti: Vittorio Benbanaste

Tecnico EJOT: Martin Losso *Tel:* +39 339 6637056

Mail: mlosso@ejot.com

Ubicazione cantiere:

Località: Milano *Prov:* MI *CAP:* 20100

Indirizzo: Via Amantea 3

DESCRIZIONE INTERVENTO

Tipo di intervento: Isolamento termico esterno (ETICS) con sistema weber.therm ROBUSTO

Tipo di edificio: Edificio pubblico

Stato dell'edificio: Riqualificazione edificio esistente

Posizioni di prova testate:

Pos. di prova	Cat. ETA	Tipologia di supporto	Note
1	C	Laterizio forato	
2	D	Blocchi in CLS alleggerito	

Tipologie di isolante:

Tipo	Sistema ETICS	Tipo	S [mm]	L [mm]	A [mm]
1	Resina fenolica	RHS	40	1200	600

Note particolari:

PROTOCOLLO DI PROVA (secondo EOTA TR051: Job site tests for plastic anchors and screws)

PROTOCOLLO NR.	2023-1112	REDATTO DA:	Martin Losso	DATA DOCUMENTO:	19/10/2023
		STRUMENTO NR.	3DAZG070808	DATA VERIFICA:	10/10/2023

FOTO

Vista cantiere

Vista prova di trazione

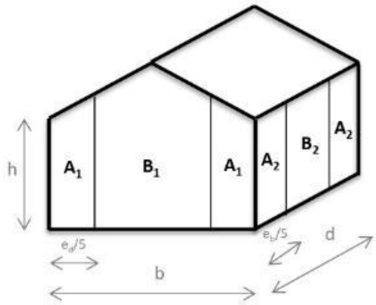
PROTOCOLLO DI PROVA (secondo EOTA TR051: Job site tests for plastic anchors and screws)					
PROTOCOLLO NR.	2023-1112	REDATTO DA:	Martin Losso	DATA DOCUMENTO:	19/10/2023
		STRUMENTO NR.	3DAZG070808	DATA VERIFICA:	10/10/2023

CALCOLO PRESSIONE CINETICA DEL VENTO (secondo NTC 2018)

Località: Milano
Provincia: MI **CAP** 20100
Indirizzo: Via Amantea 3

Topografia: B) Area urbana, suburbana o industriale con edifici di altezza media inferiore a 15 m
Altitudine: 12 m slm
Dist. dalla costa: >30 km
Zona ventosa: 1 (v_b= 25,00 m/s)
Cat. esposizione: IV

Pressione cinetica di riferimento (q_r): 390,63 N/m^2
Coefficiente di esposizione (c_e): 1,63
Coefficiente di pressione ($c_{p,A}$): -1,20
Coefficiente di pressione ($c_{p,B}$): -0,80
Coefficiente di topografia (c_t): 1,00
Coefficiente dinamico (c_d): 1,00



Altezza edificio	**(h)**	8 m	
Larghezza	**(b)**	10 m	
Lunghezza	**(d)**	22 m	
Angolo A1	**(e_d/5)**	3,2 m	(e_d= min tra d e 2h)
Angolo A2	**(e_b/5)**	2 m	(e_b= min tra b e 2h)

Pressione del vento:

Valori di calcolo	$p_{A,Rk}$	-0,766 kN/m^2	(in corrispondenza degli angoli dell'edificio)
	$p_{B,Rk}$	-0,511 kN/m^2	(in corrispondenza della parte centrale della facciata)
Valori di progetto	$p_{A,D}$	-1,149 kN/m^2	(in corrispondenza degli angoli dell'edificio)
	$p_{B,D}$	-0,766 kN/m^2	(in corrispondenza della parte centrale della facciata)
	γ_F	1,5	(coefficiente di sicurezza per le azioni)

NOTA

Il calcolo è da considerarsi puramente indicativo, in quanto eseguito considerando un edificio "semplificato" di base rettangolare e dimensioni simili a quelle dell'edificio reale considerato.

PROTOCOLLO DI PROVA (secondo EOTA TR051: Job site tests for plastic anchors and screws)					
PROTOCOLLO NR.	2023-1112	REDATTO DA:	Martin Losso	DATA DOCUMENTO:	19/10/2023
		STRUMENTO NR.	3DAZG070808	DATA VERIFICA:	10/10/2023

POSIZIONE DI PROVA 1

Laterizio forato (Cat. ETA C)

webertherm SRD ↔ *TA8*

Tassello universale ad avvitamento

DATI TECNICI

Certificazione:	ETA 15/0077
Cat. di utilizzo:	A B C D E
Azionamento:	Avvitamento T40
Ø piattello:	60 mm
Ø foratura:	8 mm
Prof. ancoraggio:	25 mm (A B C D)
	45 mm (E)

LEGENDA

Tipo foratura

ROT | Rotazione

PER | Percussione

Failure mode

S | Sfilamento

R | Rottura tassello

C | Cedimento supporto

Prova nr	Tipo foratura	Esito [kN]	Failure Mode
P1	ROT	2,67	R
P2 ↓	ROT	1,24	S
P3	ROT	1,98	S
P4	ROT	2,42	R
P5	ROT	1,86	S
P6	ROT	2,16	R
P7 ↓	ROT	1,82	S
P8 ↓	ROT	1,62	S
P9 ↓	ROT	1,82	S
P10 ↓	ROT	1,76	S
P11	ROT	2,08	S
P12			
P13			
P14			
P15			
N_1	1,65	Media minimi ↓	
N_{Rk}	0,99	Valore caratt.	
N	0,20	Classe di carico	

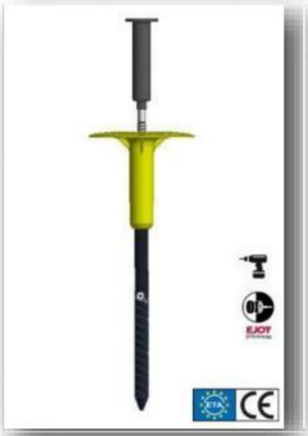
PROTOCOLLO DI PROVA (secondo EOTA TR051: Job site tests for plastic anchors and screws)					
PROTOCOLLO NR.	2023-1112	REDATTO DA:	Martin Losso	DATA DOCUMENTO:	19/10/2023
		STRUMENTO NR.	3DAZG070808	DATA VERIFICA:	10/10/2023

POSIZIONE DI PROVA 2

Blocchi in CLS alleggerito (Cat. ETA D)

webertherm SRD ↔ *TA8*

Tassello universale ad avvitamento



DATI TECNICI

Certificazione: ETA 15/0077
Cat. di utilizzo: A B C D E
Azionamento: Avvitamento T40
Ø piattello: 60 mm
Ø foratura: 8 mm
Prof. ancoraggio: 25 mm (A B C D)
45 mm (E)

LEGENDA

Tipo foratura
ROT | Rotazione
PER | Percussione

Failure mode
S | Sfilamento
R | Rottura tassello
C | Cedimento supporto

Prova nr	Tipo foratura	Esito [kN]	Failure Mode
P1 ↓	**ROT**	0,35	**R**
P2 ↓	**ROT**	1,10	**S**
P3 ↓	**ROT**	1,12	**S**
P4 ↓	**ROT**	0,78	**R**
P5			
P6			
P7			
P8			
P9			
P10			
P11			
P12			
P13			
P14			
P15			
N_1	**0,84**	Media minimi ↓	
N_{Rk}	**0,50**	Valore caratt.	
N	**0,20**	Classe di carico	

PROTOCOLLO DI PROVA (secondo EOTA TR051: Job site tests for plastic anchors and screws)					
PROTOCOLLO NR.	2023-1112	REDATTO DA:	Martin Losso	DATA DOCUMENTO:	19/10/2023
		STRUMENTO NR.	3DAZG070808	DATA VERIFICA:	10/10/2023

PARAMETRI DI CALCOLO (metodo analitico | risultati relativi al solo pull-out del tassello)

Coefficienti di sicurezza

Coefficiente di sicurezza per le azioni (γ_F): 1,5

Coeff. di sicurezza per il pull-out (γ_{M1}): 2

Pressione del vento	Valore di calcolo	Valore di progetto
Pressione vento in facciata ($p_{B,Rk}$):	-0,511 kN/m^2	-0,766 kN/m^2
Pressione vento in zona angolare ($p_{A,Rk}$):	-0,766 kN/m^2	-1,149 kN/m^2

Dati pannello isolante

Sistema ETICS — Resina fenolica | RHS (1200x600 mm)

TASSELLI CONSIGLIATI

In considerazione dei risultati delle prove di trazione, delle rilevazioni effettuate durante il sopralluogo in cantiere, e del tipo di intervento previsto, suggeriamo, per ciascuna posizione di prova, i seguenti tasselli:

Posizione di prova 1

Tipo di muratura:	Laterizio forato	Spessore isolante:	50 mm
Categoria ETA:	C	Spessore collante:	0 mm
		Spessore intonaco:	20 mm
		Altri spessori:	5 mm
		TOTALE DA FISSARE:	**75 mm**

Tasselli consigliati da EJOT (in numero pari a quanto indicato in tabella)		h_{ef} [mm]	h_{test} [mm]	N_D [kN]
webertherm SRD | TA8	**115 mm**	25	40	0,50
ejotherm® STR U 2G	**75 mm**	25		0,75

SCHEMA DI TASSELLATURA: *Rispettare le indicazioni tecniche riportate sul Manuale Tecnico Sistemi per l'isolamento esterno della facciata Saint Gobain Italia*

Posizione di prova 2

Tipo di muratura:	Blocchi in CLS alleggerito	Spessore isolante:	mm
Categoria ETA:	D	Spessore collante:	mm
		Spessore intonaco:	mm
		Altri spessori:	mm
		TOTALE DA FISSARE:	**0 mm**

Tasselli consigliati da EJOT (in numero pari a quanto indicato in tabella)		h_{ef} [mm]	h_{test} [mm]	N_D [kN]
ejotherm® STR U 2G	**0 mm**	25		#DIV/0!
#N/D	**0 mm**	#N/D		#DIV/0!

SCHEMA DI TASSELLATURA: *Rispettare le indicazioni tecniche riportate sul Manuale Tecnico Sistemi per l'isolamento esterno della facciata Saint Gobain Italia*

Posizione di prova 3

Tipo di muratura:	0	Spessore isolante:	mm

PROTOCOLLO DI PROVA (secondo EOTA TR051: Job site tests for plastic anchors and screws)					
PROTOCOLLO NR.	2023-1112	REDATTO DA:	Martin Losso	DATA DOCUMENTO:	19/10/2023
		STRUMENTO NR.	3DAZG070808	DATA VERIFICA:	10/10/2023

Categoria ETA: #N/D

Spessore collante: mm
Spessore intonaco: mm
Altri spessori: mm
TOTALE DA FISSARE: 0 mm

Tasselli consigliati da EJOT (in numero pari a quanto indicato in tabella)		h_{ef} [mm]	h_{test} [mm]	N_D [kN]
ejotherm® STR U 2G	**0 mm**	#N/D		#DIV/0!
ejotherm® H2	**0 mm**	#N/D		#DIV/0!

SCHEMA DI TASSELLATURA: *Rispettare le indicazioni tecniche riportate sul Manuale Tecnico Sistemi per l'isolamento esterno della facciata Saint Gobain Italia*

Posizione di prova 4

Tipo di muratura: 0
Categoria ETA: #N/D

Spessore isolante: mm
Spessore collante: mm
Spessore intonaco: mm
Altri spessori: mm
TOTALE DA FISSARE: 0 mm

Tasselli consigliati da EJOT (in numero pari a quanto indicato in tabella)		h_{ef} [mm]	h_{test} [mm]	N_D [kN]
ejotherm® STR U 2G	**0 mm**	#N/D		#DIV/0!
ejotherm® H2	**0 mm**	#N/D		#DIV/0!

SCHEMA DI TASSELLATURA: *Rispettare le indicazioni tecniche riportate sul Manuale Tecnico Sistemi per l'isolamento esterno della facciata Saint Gobain Italia*

LEGENDA

N_D = Resistenza di progetto del tassello = N_{Rk} / γ_{M1}
h_{ef} = Profondità di ancoraggio nominale del tassello
h_{test} = Profondità di ancoraggio testata in fase di prova
T_{centro} = Numero di tasselli consigliati nelle zone centrali dell'edificio
T_{angoli} = Numero di tasselli consigliati nelle zone angolari dell'edificio

NB: secondo la norma UNI/TR 11715:2018 la zona angolare non potrà mai essere inferiore ad 1 m e superiore a 2 m
EJOT consiglia comunque di attenersi alle dimensioni angolari calcolate seconto NTC 2018

INDICAZIONI DI POSA

1. In presenza di laterizio forato si raccomanda la foratura con il solo movimento di rotazione, e si consigliano punte specifiche
2. Per il montaggio del tassello ejotherm® STR U 2G, si consiglia il bit specifico ejotherm® STR-bit T30 x 90 mm.
3. I tasselli ejotherm® STR devono essere sempre abbinati al tamponcino, come previsto dalla certificazione ETA
4. Per il montaggio del tassello weber.therm SRD si consiglia il bit specifico weber.therm SSD Bit T40x127 mm.

#NUM!

#NUM!

PROTOCOLLO DI PROVA (secondo EOTA TR051: Job site tests for plastic anchors and screws)					
PROTOCOLLO NR.	2023-1112	REDATTO DA:	Martin Losso	DATA DOCUMENTO:	19/10/2023
		STRUMENTO NR.	3DAZG070808	DATA VERIFICA:	10/10/2023

#NUM!

NOTE:

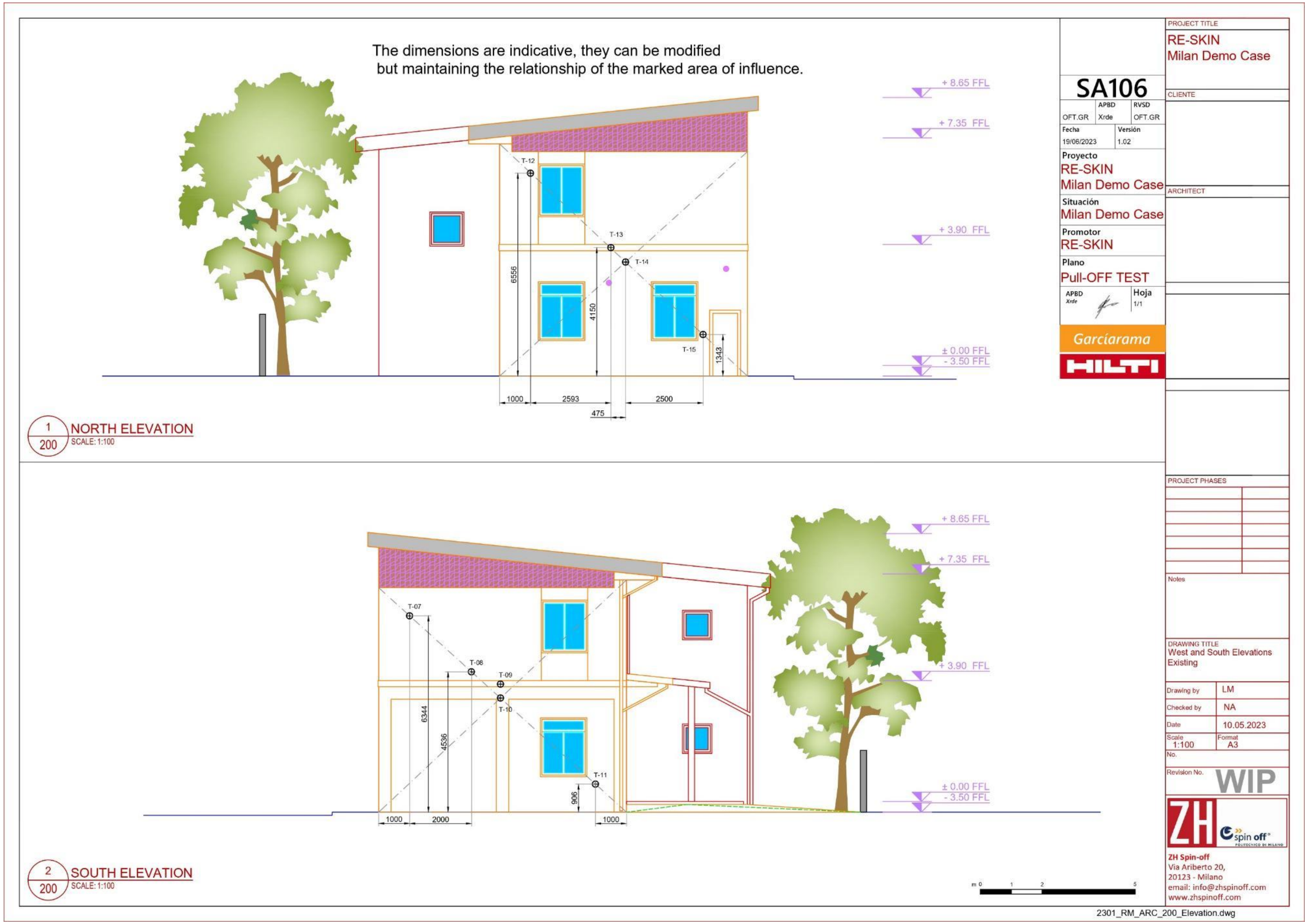
1. I valori di N_{Rk} riportati si riferiscono ad una applicazione eseguita "a regola d'arte" e conformemente alle indicazioni di posa EJOT.

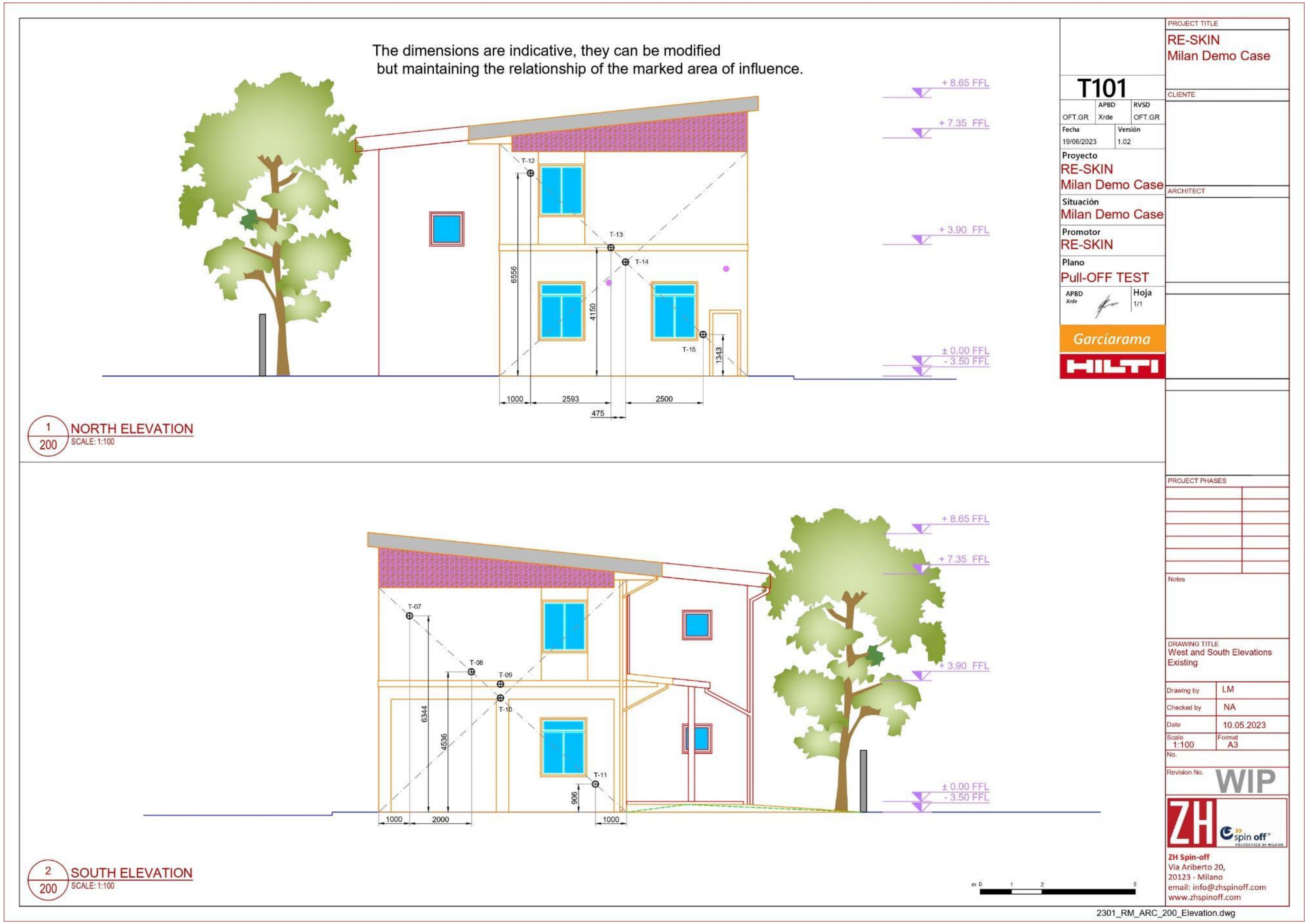
2. La presente relazione non rappresenta un calcolo statico e ha il solo scopo di definire la resistenza allo strappo dei prodotti testati, nelle stesse condizioni e nelle stesse posizioni di prova verificate in cantiere.

3. Qualora gli spessori indicati nel presente documento differissero da quelli effettivi al momento della posa, sarà necessario rivalutare il dimensionamento dei tasselli.

4. Il numero minimo di tasselli indicato è calcolato sul solo carico da vento (orizzontale), ed è calcolato sul solo valore di pull-out del tassello. Eventuali ulteriori carichi applicati al sistema non sono stati considerati.

DATA	FIRMA	TIMBRO
Campodarsego, 19 ottobre 2023	Losso Martin	EJOT S.A.S. di EJOT Tecnologie di fissaggio S.R.L. Via Marco Polo, 16 35011 Campodarsego (PD)


The dimensions are indicative, they can be modified
but maintaining the relationship of the marked area of influence.
+ 8.65 FFL
+ 7.35 FFL
+ 3.90 FFL
± 0.00 FFL
- 3.50 FFL
T-12
T-13
T-14
T-15
6556
4150
1343
1000
2593
2500
475
1 200 NORTH ELEVATION
SCALE: 1:100
T-07
T-08
T-09
T-10
T-11
6344
4536
906
1000
2000
1000
2 200 SOUTH ELEVATION
SCALE: 1:100
SA106
APBD RVSD
OFT.GR Xrde OFT.GR
Fecha 19/06/2023
Versión 1.02
Proyecto
RE-SKIN
Milan Demo Case
Situación
Milan Demo Case
Promotor
RE-SKIN
Plano
Pull-OFF TEST
APBD Xrde
Hoja 1/1
Garcíarama
HILTI
PROJECT TITLE
RE-SKIN
Milan Demo Case
CLIENTE
ARCHITECT
PROJECT PHASES
Notes
DRAWING TITLE
West and South Elevations
Existing
Drawing by LM
Checked by NA
Date 10.05.2023
Scale 1:100
Format A3
No.
Revision No.
WIP
ZH spin off
ZH Spin-off
Via Ariberto 20,
20123 - Milano
email: info@zhspinoff.com
www.zhspinoff.com
2301_RM_ARC_200_Elevation.dwg


The dimensions are indicative, they can be modified
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email: info@zhspinoff.com
www.zhspinoff.com
2301_RM_ARC_200_Elevation.dwg

The dimensions are indicative, they can be modified
but maintaining the relationship of the marked area of influence.
T102
OFT.GR APBD Xrde RVSD OFT.GR
Fecha 19/06/2023
Versión 1.02
Proyecto RE-SKIN Milan Demo Case
Situación Milan Demo Case
Promotor RE-SKIN
Plano Pull-OFF TEST
Hoja 1/1
Garciarama
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PROJECT TITLE
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Milan Demo Case
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ARCHITECT
PROJECT PHASES
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+ 8.65 FFL
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- 3.50 FFL
T-01
T-02
T-03
T-04
T-05
T-06
1041
2081
3122
4163
5203
6730
3000
3000
3000
3000
3000
1500
1
200
WEST ELEVATION
SCALE: 1:100
2
200
EAST ELEVATION
SCALE: 1:100
2301_RM_ARC_200_Elevation.dwg

Annex II: Burgas Demonstration Building Pull-Out

DYNAMOMETRIC TEST RESULTS

Funded by
the European Union

RE-SKIN	PLACE: Primary school „Ivan Vazov“
	8, Hadzhi Dimitar str., Banevo district Postal Code 8125 – Burgas, Bulgaria

WP5	**Pull-out Test guide**
DATE 03/09/2024	Construction works Metal Panel

		Anchors					
Nº TEST	Masonry (*a)	Ø	L (screw)	L (Plastic plug)	Crack	Pull-out	Results (KN)
1	BH	10	200	200	N	**N**	5,1 KN
2	BH	10	200	200	N	**N**	2,6 KN
3	BH	10	200	200	N	**N**	2,0 KN
4	BH	10	200	200	N	**N**	2,0 KN
5	BH	10	200	200	N	**N**	2,1 KN
6	BH	10	200	200	N	**N**	2,8 KN
7	BH	10	200	200	N	**N**	2,0 KN
8	BH	10	200	200	N	**N**	2,1 KN
9	BH	10	200	200	N	**N**	2,1 KN
10	BH	10	200	200	N	**N**	2,0 KN
11	BH	10	200	200	N	**N**	2,5 KN
12	BH	10	200	200	N	**N**	2,0 KN
13	BH	10	200	200	N	**N**	1,1 KN
14	BH	10	200	200	N	**N**	1,1 KN
15	BH	10	200	200	N	**N**	1,4 KN

(*a) 1. **C** *Concrete,* 2. **BH** *Brick (hole zone),* 3. **BM** *Brick (mortar zone).*

DRAFT

Заявка за обслужване — Скрепителни елементи за изпитване

Hilti BG Ltd 1766 София, Бизнес парк София, сграда No11A София
T 0800 123 98 F 974 01 23
W http://www.hilti.bg E bg-customer-service@hilti.co

Номер на поръчка за изпитване:	64325	**Дата на изпитване (yyyy-mm-dd):**	2024-09-03
PO n°:	**8000**		

Информация за клиента: Лице изисващо изпитване		**Инженерна информация:**	
Компания:	Община Бургас	Компания:	Община Бургас
Адрес:		Адрес:	
Пощенски код / Град:	8000 / Бургас	Пощенски код / Град:	8000 / Бургас
Държава:	България	Държава:	България
Номер на клиента:	000000	Номер на клиента:	000000
Контактно лице:	Камер Ахмедов	Контактно лице:	Камер Ахмедов
Телефон:	+359889740166	Телефон:	+359889740166
Емайл адрес:	k.ahmedov@burgas.bg	Емайл адрес:	k.ahmedov@burgas.bg

Информация за обекта	
Име на обекта: ОУ „Иван Вазов", гр. Бургас	Номер на обекта:
Адрес: ул.Хаджи Димитър 8, кв. Банево, гр. Бургас	Пощенски код / Град: 8125 / Бургас

Информация за анкера	
Основна група(семейство) на анкера: Пластмасов анкер	
Вид на анкера: HRD-C	Дълбочина на анкериране на анкера/пръта [mm]: 70
	Размер на анкер / шпилка [mm]: 10x230

Информация за основния материал "Нестардартно/и" показва, че анкера не разполга с валидно одобрение(сертификат) за съответния материал.	
Основен материал: Зидария (нестандартна)	
Зидария: Други	Дебелина на замазка [mm]: -
Размер на тухлата (LxWxH) [mm]: -	Якост на тухлата [N/mm2]: -
Материал на фуга: -	Дебелина на фуга (вертикални/вертикални фуги) [mm]: -/-

Информация за изпитването	
Посока на натоварване: Опън	
Цел на изпитването: Определяне на носимоспобност	
Вид изпитване: Pull-out (разрушение)	Продължителност на натоварване [min]: -
Брой анкери за изпитване: 20	Допустимо преместване [mm]: -
Опора на мост: без мостово натоварване	Опорно разстояние [mm]: -
HAT 30 => 300 mm; HAT 180 / 370 => 400 mm: Не	Измерване на натоварването в първото движение: Не
Резултатите от изпитването да бъдат оценени: Не	**Метод на изпитване: -**

DRAFT

Информация за монтаж	
Крепежът е монтиран от: Теодор Ганчев	Дата на монтаж (yyyy-mm-dd) и време (hh:mm): 2024-09-03
Диаметър на отвор [mm]: 10	Пробиване на отвор: Ударно пробиване
Дълбочина на отвор [mm]: 230	Почистване на отвор: Не почистен
Въртящ момент на затягане [Nm]: -	Състояние на отвор: Сух

Информация за изпитвателно оборудване	
Вид на изпитвателно оборудване: HAT-30	Тип на калибер: Цифров
Номер на оборудване: HT14715	Номер на калибер: MAN2414 30
Най-малко деление на измервателния уред [kN]: -	Последна калибрация на калибер (yyyy-mm-dd: 2024-07-25

Резултати от изпитване

Изпитване №	Натоварване [kN]	Преместване [mm]	Режим на разрушение	Коментари
1	5.1	-	Без разрушение	При достигане на стойност от 5,1 kN основата под крачетата на уреда за тестване започна сериозно да се компрометира. Тестът беше прекъснат.
2	2.6	-	Без разрушение	При достигане на стойност от 2,6 kN основата под крачетата на уреда за тестване започна да се компрометира. Тестът беше прекъснат, за да се избегне нарушаване целостта на положените топлоизолация и мазилка
3	2.0	-	Без разрушение	При достигане на стойност от 2 kN основата под крачетата на уреда за тестване започна да се компрометира. Тестът беше прекъснат, за да се избегне нарушаване целостта на положените топлоизолация и мазилка
4	2.0	-	Без разрушение	При достигане на стойност от 2 kN основата под крачетата на уреда за тестване започна да се компрометира. Тестът беше прекъснат, за да се избегне нарушаване целостта на положените топлоизолация и мазилка
5	2.1	-	Без разрушение	При достигане на стойност от 2,1 kN основата под крачетата на уреда за тестване започна да се компрометира. Тестът беше прекъснат, за да се избегне нарушаване целостта на положените топлоизолация и мазилка
6	2.8	-	Без разрушение	При достигане на стойност от 2,8 kN основата под крачетата на уреда за тестване започна да се компрометира. Тестът беше прекъснат, за да се избегне нарушаване целостта на положените топлоизолация и мазилка

7	2.0	-	Без разрушение	При достигане на стойност от 2,0 kN основата под крачетата на уреда за тестване започна да се компрометира. Тестът беше прекъснат, за да се избегне нарушаване целостта на положените топлоизолация и мазилка
8	2.1	-	Без разрушение	При достигане на стойност от 2,1 kN основата под крачетата на уреда за тестване започна да се компрометира. Тестът беше прекъснат, за да се избегне нарушаване целостта на положените топлоизолация и мазилка
9	2.1	-	Без разрушение	При достигане на стойност от 2,1 kN основата под крачетата на уреда за тестване започна да се компрометира. Тестът беше прекъснат, за да се избегне нарушаване целостта на положените топлоизолация и мазилка
10	2.0	-	Без разрушение	При достигане на стойност от 2 kN основата под крачетата на уреда за тестване започна да се компрометира. Тестът беше прекъснат, за да се избегне нарушаване целостта на положените топлоизолация и мазилка
11	2.5	-	Без разрушение	При достигане на стойност от 2,5 kN основата под крачетата на уреда за тестване започна да се компрометира. Тестът беше прекъснат, за да се избегне нарушаване целостта на положените топлоизолация и мазилка
12	2.0	-	Без разрушение	При достигане на стойност от 2 kN основата под крачетата на уреда за тестване започна да се компрометира. Тестът беше прекъснат, за да се избегне нарушаване целостта на положените топлоизолация и мазилка
13	1.1	-	Без разрушение	При достигане на стойност от 1,1 kN основата под крачетата на уреда за тестване започна да се компрометира. Тестът беше прекъснат, за да се избегне нарушаване целостта на положените топлоизолация и мазилка
14	1.1	-	Без разрушение	При достигане на стойност от 1,1 kN основата под крачетата на уреда за тестване започна да се компрометира. Тестът беше прекъснат, за да се избегне нарушаване целостта на положените топлоизолация и мазилка
15	1.4	-	Без разрушение	При достигане на стойност от 1,4 kN основата под крачетата на уреда за тестване започна да се компрометира. Тестът беше прекъснат, за да се избегне нарушаване целостта на положените топлоизолация и мазилка

Натоварване: "Натоварване за разрушение" се прилага в случай на изпитване за определяне на носимоспособнст; или "Максимално натоварване" се прилага в случай на изпитване за определяне на качеството.
Натоварване-1: "Натоварване при първо движение", по избор за изпитване за определяне на носимоспособнст съгласно BS 8539.
Преместване: Общо преместване под максимално натоварване се прилага, по избор за изпитване за определяне качеството в съответствие с BS8539.

Присъстващи лица: Представители на клиента и/или инжера изискват изпитвания

Компания	Контактно лице	Фукнция	Подпис
Община Бургас	Камер Ахмедов		

Изпитването се извършва от

Компания	Контактно лице	Подпис
Hilti BG Ltd	Ganchev, Teodor	

Информация за изпитването

Часове на изпитване: 5	Часове на пътуване: 1

Важна информация

Обща информация

Изпитването на място на крепежни елементи не: оценява дали оразмеряването на крепежния елемент е подходящо или адекватно; проверява правилното монтиране или съответствие с изискванията за одобрение; определя крайния капацитет на изпитваните крепежни елементи (освен ако не се изпитва до разрушение); или проверява технически характеристики на непреминалите изпитване крепежни елементи. Хилти извършва изпитване на място единствено на продукти с марка Hilti, като изпитването има за цел единствено да предоставя информация относно общата стабилност на основния материал и/или да помага при откриването на съществени грешки при монтаж на изпитваните крепежни елементи. С извършването на изпитване на място Хилти не изразява съгласие с или препоръка относно това, че изпитването или приложението на изпитваните крепежни елементи са подходящи или правилни. Изпитването на място не е предвидено да бъде използвано като средство за изпълнение на проектни или нормативни изисквания за извършване на контролна проверка на място.

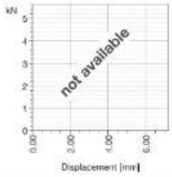
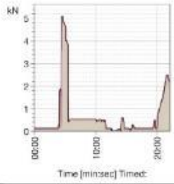
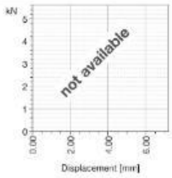
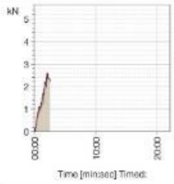
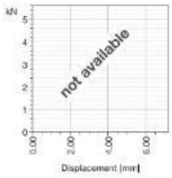
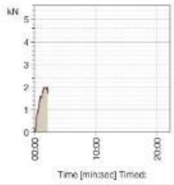
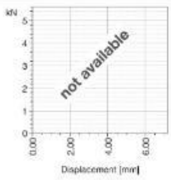
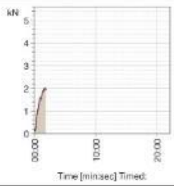
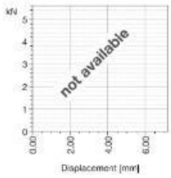
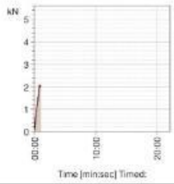
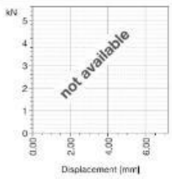
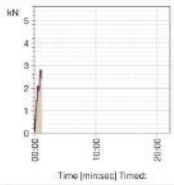
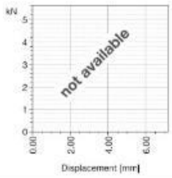
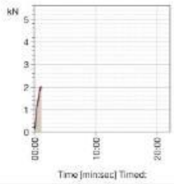
Направете справка с техническото ръководство за крепежните елементи на Хилти за информация относно оразмеряването и техническите характеристики. Правилното монтиране на крепежните елементи е изключително важно – при изискване се предлага обучение - свържете се с Хилти за информация

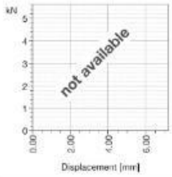
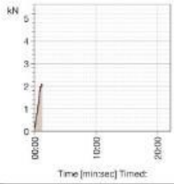
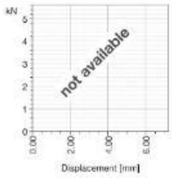
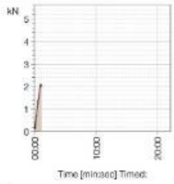
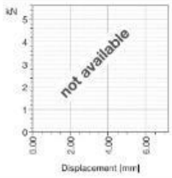
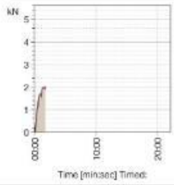
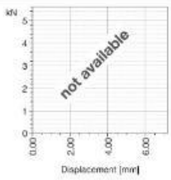
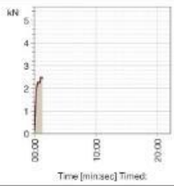
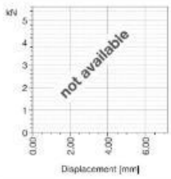
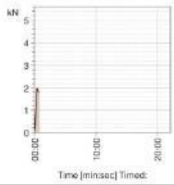
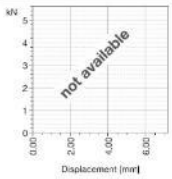
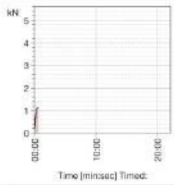
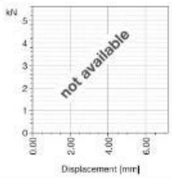
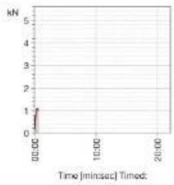
Извършване на изпитване на място

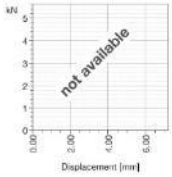
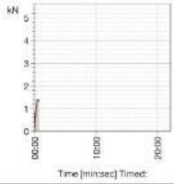
Резултатите от изпитването показват само, че изпитаните тестваните крепежни елементи са издържали на посоченото натоварване за времето на прилагането на съответното разрушаващо натоварване. Мястото и броя на изпитванията, както и параметрите на натоварване и крепежните елементи, подложени на изпитване, се извършват съгласно условията на изпитване, определени от клиента в съответния формуляр за заявка за обслужване. Hilti не извършва преценка дали тези условия на изпитване са подходящи за оценка. Поради различните характеристики на основния материал и различните ситуации на натоварване, резултатите от изпитването може да не се отнасят за целия строителен проект. Изпитването на място може да повреди конструкцията - Hilti не носи отговорност за повредите или за тяхното възстановяване.

Снимки от натоварване

Изпитване №	Натоварване при преместване	Натоварване във времето	Снимка

1	kN not available Displacement [mm]	kN Time [min:sec] Timed:		
2	kN not available Displacement [mm]	kN Time [min:sec] Timed:		
3	kN not available Displacement [mm]	kN Time [min:sec] Timed:		
4	kN not available Displacement [mm]	kN Time [min:sec] Timed:		
5	kN not available Displacement [mm]	kN Time [min:sec] Timed:		
6	kN not available Displacement [mm]	kN Time [min:sec] Timed:		
7	kN not available Displacement [mm]	kN Time [min:sec] Timed:		

8				
9				
10				
11				
12				
13				
14				

15	 kN not available Displacement [mm]	 kN Time [min:sec] Timed:		

HILTI

Inspection Service Certificate

Tester Type: ☐ Mark 5_01 ☐ HAT 28_01 ☒ HAT 30_01 ☐ HAT 50_01 ☐ HAT 3.3_01

Tester serial no. HT14715

Tester Type: ☐ HAT 180_01 ☐ HAT 20_01 ☐ HAT 370_01 ☐ HAT 41_01

Pump serial no. ______________

Cylinder serial no. ______________

Manometer serial no. ☐ analog ☒ digital 018221L

Master Test Gauge Ref. no. HYD35 M0014

Results obtained at inspection are as follows:

☒ kN ☐ lbf

Tester MANOMETER	5.0	10.0	15.0	20.0	25.0	30.0
READING from Master Test Gauge	5.4	10.5	15.6	20.7	25.5	30.4

We hereby certify that the product described has been tested before shipment and complied with the specifications as stated above.
The test equipment used is traceable to national standards or has been derived from accepted values of natural physical constants or has been derived by the ratio type of self-calibrating techniques. This is established by our Quality Management System.

Next inspection service is required in 12 months.

For re-inspection send the product to your local Hilti Tool Service Center.

Re-inspection due date: 25/07/2025

Inspection service date: 25/07/2024

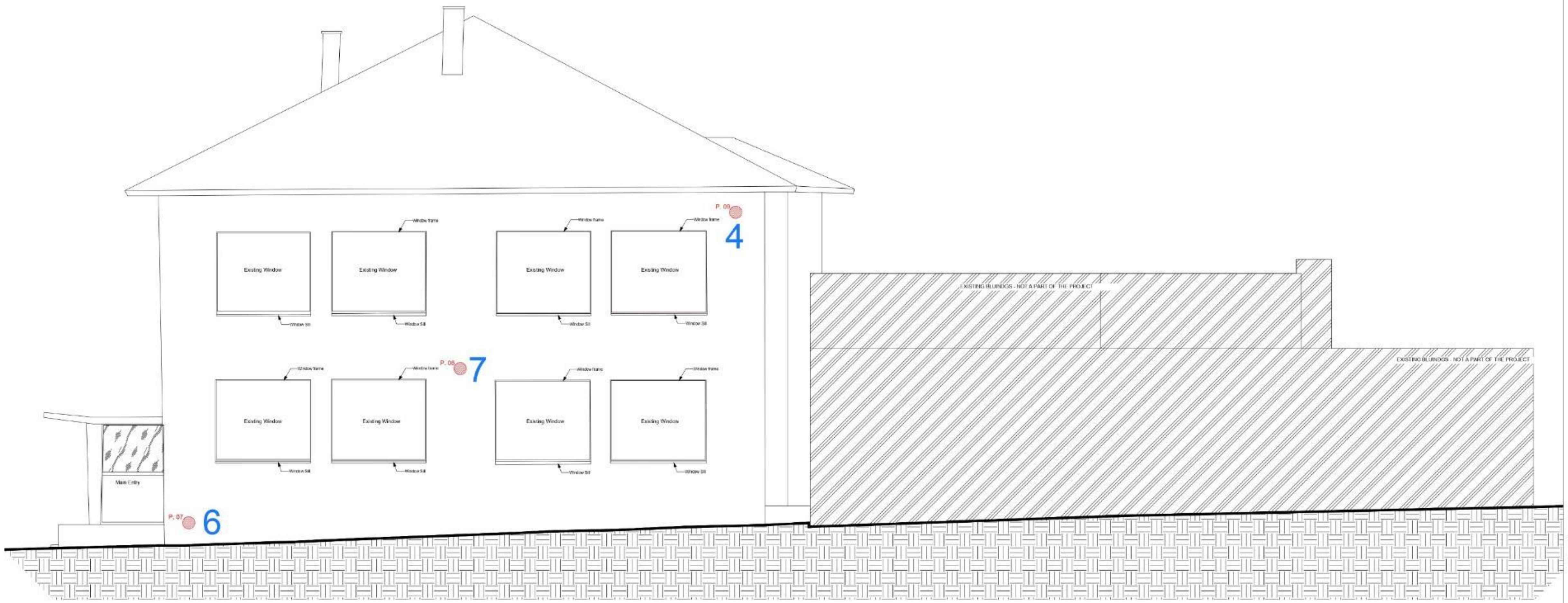
Tool Service Center: Carpiano

Technician's name: Malguzzi D.

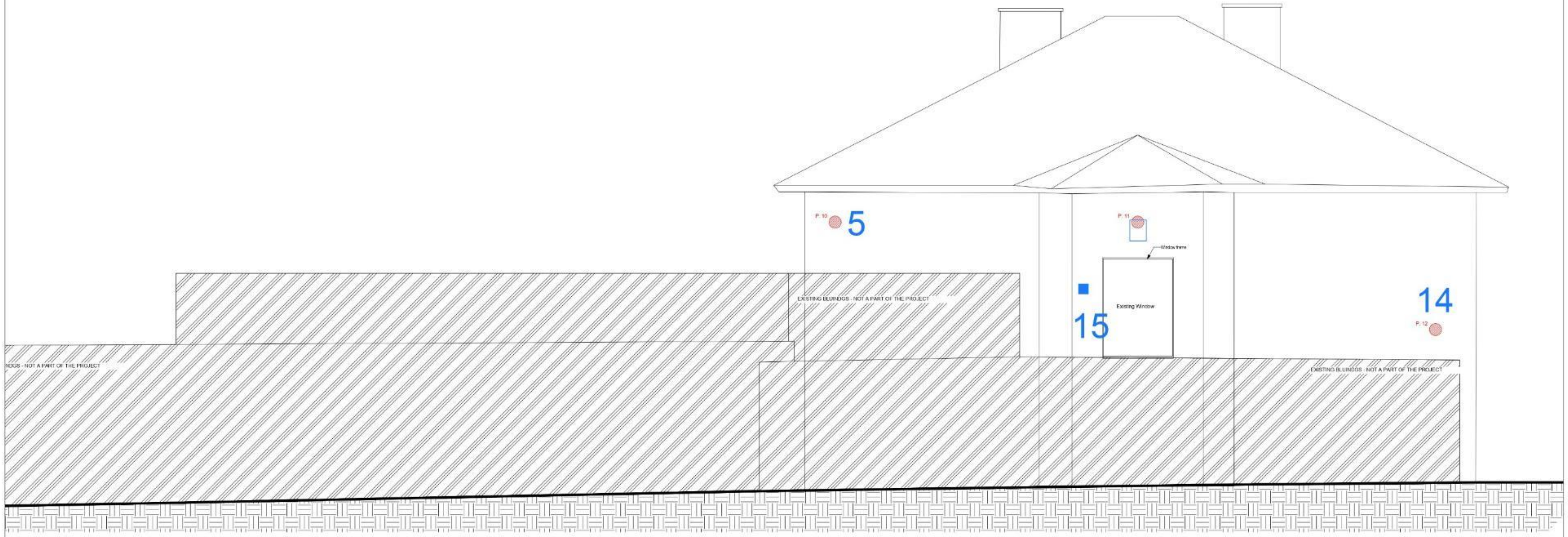
Signature:

Burgas Demo Building: East Elevation

P. 00 Dynamometric test points location proposal

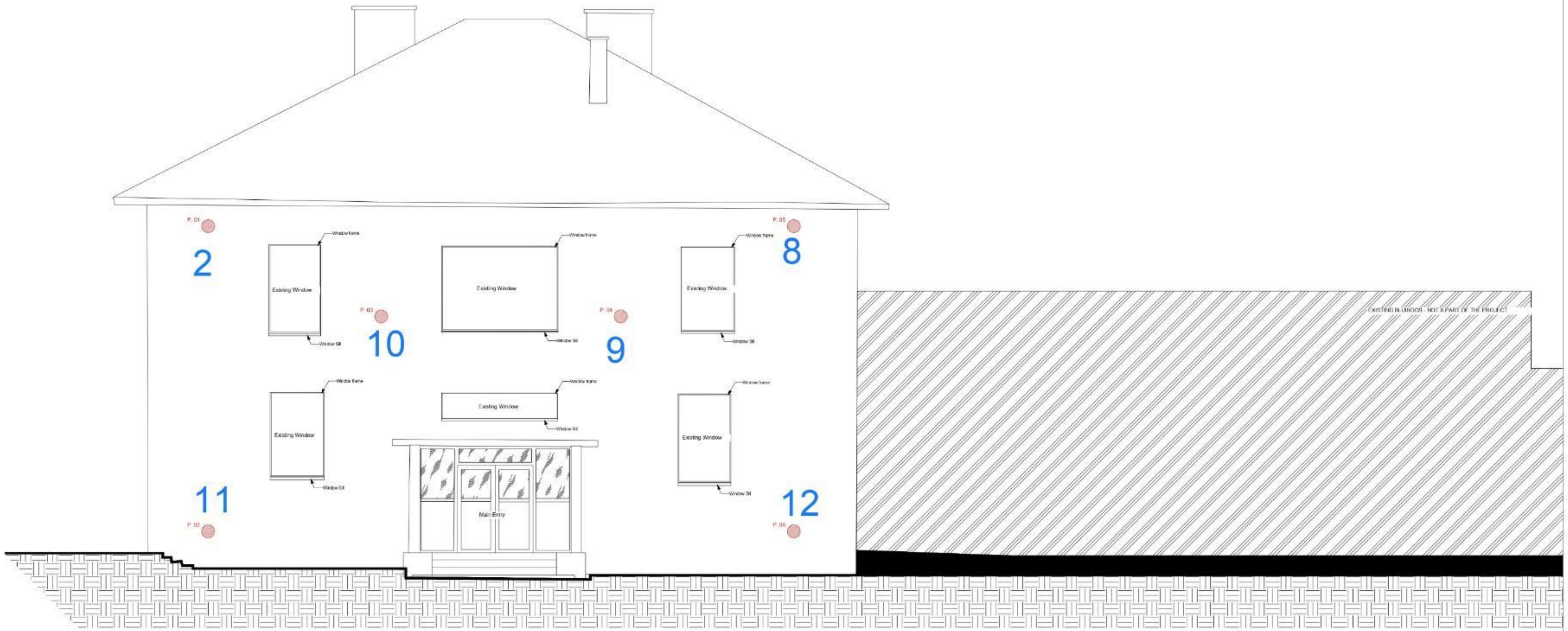


Burgas Demo Building: North Elevation	
P. 00	Dynamometric test points location proposal

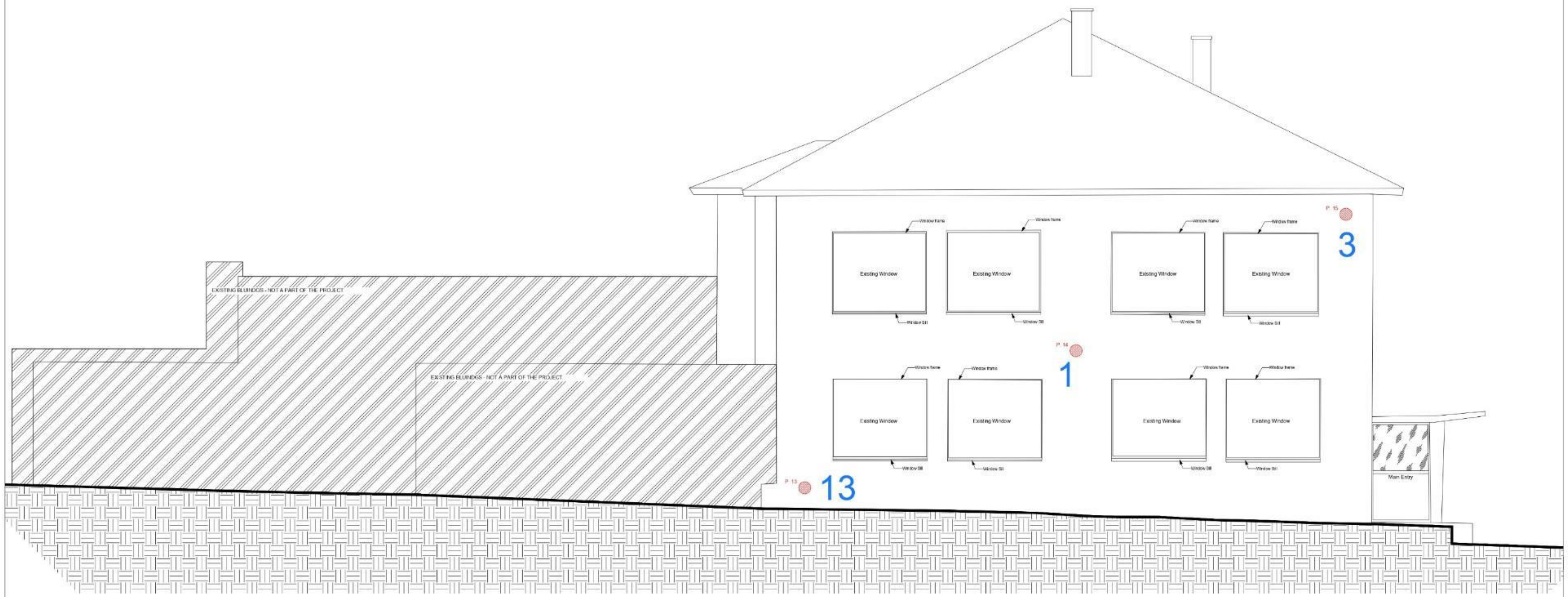


Burgas Demo Building: South Elevation

P. 00 Dynamometric test points location proposal



Burgas Demo Building: West Elevation	
P. 00	Dynamometric test points location proposal



Annex III: Test results on sandwich panel

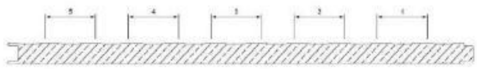
M 06-11 Rev 6 Protocollo di prova

LATTONEDIL

Protocollo di Prova

Tipo Pannello:	Isopar HP 80
Data produzione:	22/01/2024
Ora produzione:	12:00:00
Poliolo:	Indresmat
Linea di produzione:	Linea 2
Numero ordine:	Test

Sezione pannello Lattonedil Spa Milano
modello ISOPAR



	Unità di misura [SI]	Punti Norma UNI EN 14509	Posizione Provino Maschio 1	2	Centro 3	4	Femmina 5	Valori di riferimento	Valori medio
Densità:	[Kg/m³]	A.8	44,77	43,96	44,22	43,87	43,71	≥ 36	44,10
Res. Trazione:	[N/mm²]	A.1	0,103	0,077	0,080	0,110	0,072	> 0,084	0,088
Mod. Trazione:	[N/mm²]	A.1	2,56	2,18	2,24	2,57	2,49	> 1,62	2,41
Res. Compressione:	[N/mm²]	A.2	0,090	0,089	0,096	0,093	0,091	> 0,110	0,092
Mod. Compressione:	[N/mm²]	A.2	2,13	2,13	2,41	2,40	2,17	> 1,25	2,25
Res. Taglio:	[N/mm²]	A.3	0,090	0,129	0,128	0,124	0,122	> 0,086	0,119
Mod. Taglio:	[N/mm²]	A.3	2,380	2,354	2,339	2,156	2,337	> 2,209	2,313
Conducibilità Termica:	[W/MK]	A.10.2.1.1			0,02222			≤ 0,023	0,02222
Piccola Fiamma:	[mm]		170	165	175	180	170	< 150	172,0
Spessore:	[mm]	D.2.1	80,62	81,03	80,70	81,21	80,63	±2 ≤100;2%Sp>100	80,84

Rilievo dimensionale

Bm	Bf	ds1	p1	ds2	p2	ds3	p3	dc	Wp	W	Curv.
20,18	22,93							80,84	1002	1001	1

Rintracciabilità lamierati

Interno	N° Coil		Materiale	Acciaio	Ral	9006	Spessore	0,55	Fornitore	
Esterno				Acciaio		9006		0,70		

Firma Compilatore [signature]

LATTONEDIL

Trazione

24.01.2024

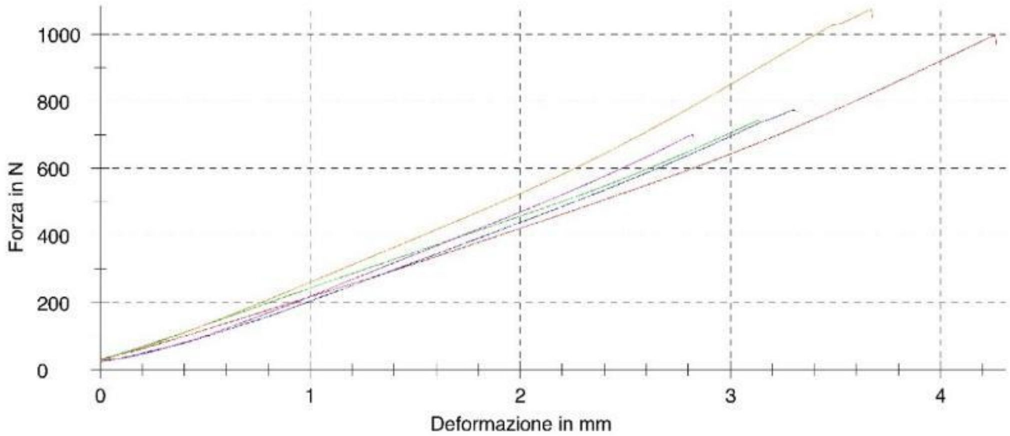
Tabella parametro:

Tipo di Pannello	:	Isopar HP 80	Data di Produzione	:	22/01/24
Tipo di Materiale	:	Indresmat	Ora di Produzione	:	12:00
Operatore:	:	Gastaldo	Data della Prova	:	24/01/24

Risultati:

No.	Larghezza mm	Lunghezza mm	Spessore mm	S_0 mm²	E_{mod} N/mm²	F_m N	R_m N/mm²	εF_{max} mm	W_u mm	Tipo di Rottura
1	97,51	99,35	81,23	9687,62	2,56	998	0,103	4,3	4,25	Interno 100%
2	97,45	99,79	81,5	9724,54	2,18	744	0,077	3,1	3,17	Interno 100%
3	97,75	99,38	81,94	9714,40	2,24	774	0,080	3,3	3,31	Interno 100%
4	98,27	99,3	82,2	9758,21	2,57	1070	0,110	3,7	3,82	Interno 100%
5	98,56	98,75	82,11	9732,80	2,49	701	0,072	2,8	2,83	Interno 100%

Grafico della serie:



Statistiche:

Series n = 5	Larghezza mm	Lunghezza mm	Spessore mm	S_0 mm²	E_{mod} N/mm²	F_m N	R_m N/mm²	εF_{max} mm	W_u mm
min	97,45	98,75	81,23	9687,62	2,18	701	0,072	2,8	2,83
$\bar{x}$	97,91	99,31	81,8	9723,51	2,41	858	0,088	3,4	3,48
max	98,56	99,79	82,2	9758,21	2,57	1070	0,110	4,3	4,25
s	0,4872	0,371	0,4155	25,80	0,184	167	0,017	0,6	0,56
ν [%]	0,50	0,37	0,51	0,27	7,66	19,43	19,39	16,07	16,20

Zwick Roell

Pagina1/1

LATTONEDIL

Compressione

24.01.2024

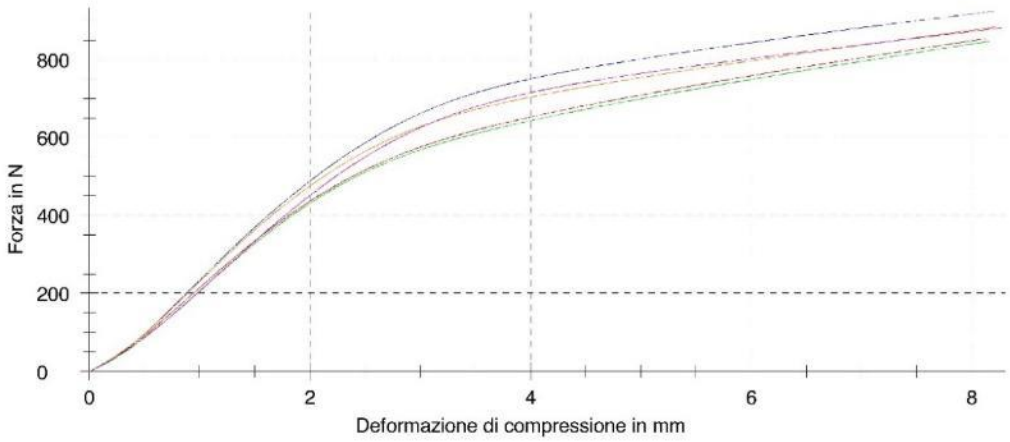
Tabella parametro:

Tipo di Pannello	:	Isopar HP 80	Data di Produzione	:	22/01/24
Tipo di Materiale	:	Indresmat	Ora di Produzione	:	12:00
Operatore:	:	Gastaldo	Data della Prova	:	24/01/24

Risultati:

No.	Lunghezza mm	Larghezza mm	Spessore mm	S_0 mm²	E_{mod} N/mm²	W_u mm	F_{max} N	R_{max} N/mm²
1	97,75	97,27	80,87	9508,14	2,13	3,56	854	0,090
2	97,43	97,79	81,15	9527,68	2,13	3,57	847	0,089
3	97,86	97,99	81,54	9589,30	2,41	3,44	924	0,096
4	97,8	97,52	81,74	9537,46	2,40	3,34	883	0,093
5	97,93	98,89	82,23	9684,30	2,17	3,64	882	0,091

Grafico della serie:



Statistiche:

Series n = 5	Lunghezza mm	Larghezza mm	Spessore mm	S_0 mm²	E_{mod} N/mm²	W_u mm	F_{max} N	R_{max} N/mm²
min	97,43	97,27	80,87	9508,14	2,13	3,34	847	0,089
$\bar{x}$	97,75	97,89	81,51	9569,38	2,25	3,51	878	0,092
max	97,93	98,89	82,23	9684,30	2,41	3,64	924	0,096
s	0,1932	0,6207	0,5271	70,91	0,144	0,12	30	0,003
ν [%]	0,20	0,63	0,65	0,74	6,42	3,47	3,47	3,20

Zwick/Roell

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RE-SKIN

LATTONEDIL

Flessione/Taglio 24.01.2024

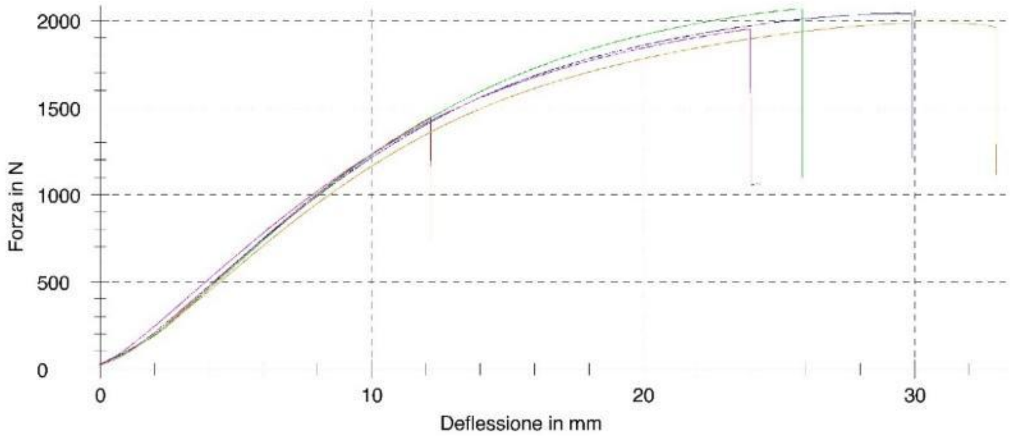
Tabella parametro:

Tipo di Pannello	:	Isopar HP 80	Data di Produzione	:	22/01/24
Tipo di Materiale	:	Indresmat	Ora di Produzione	:	12:00
Operatore:	:	Gastaldo	Data della Prova	:	24/01/24

Risultati:

No.	Spessore mm	Larghezza mm	$S_{0\,Sup}$ mm²	$S_{0\,Inf}$ mm²	$\Delta F/\Delta w$ N/mm	F_{max} N	εF_{max} mm	R_{taglio} N/mm²	G_c N/mm²	B_s Nm²
1	82,28	98,41	68,89	54,13	138,151	1440	12,17	0,090	2,380	42439,945
2	82,2	98,35	68,85	54,09	136,468	2070	25,86	0,129	2,354	42331,001
3	82,32	97,95	68,57	53,87	135,270	2040	29,28	0,128	2,339	42282,962
4	82,42	97,81	68,47	53,8	124,926	1990	30,68	0,124	2,156	42325,957
5	82,4	97,67	68,37	53,72	134,904	1950	23,95	0,122	2,337	42244,707

Grafico della serie:



Statistiche:

Series n = 5	Spessore mm	Larghezza mm	$S_{0\,Sup}$ mm²	$S_{0\,Inf}$ mm²	$\Delta F/\Delta w$ N/mm	F_{max} N	εF_{max} mm	R_{taglio} N/mm²	G_c N/mm²	B_s Nm²
min	82,2	97,67	68,37	53,72	124,926	1440	12,17	0,090	2,156	42244,707
$\bar{x}$	82,32	98,04	68,63	53,92	133,944	1900	24,39	0,119	2,313	42324,914
max	82,42	98,41	68,89	54,13	138,151	2070	30,68	0,129	2,380	42439,945
s	0,08989	0,3282	0,2297	0,1805	5,198	258	7,33	0,016	0,090	73,252
ν [%]	0,11	0,33	0,33	0,33	3,88	13,61	30,06	13,72	3,88	0,17

Zwick Roell Pagina1/1

M 01-11 Rev 5 Calcolo Densità

LATTONEDIL

CALCOLO DENSITÀ

Tipo Pannello : Isopar HP 80
Data produzione: 22/01/2024
Ora produzione: 12:00:00
Poliolo: Indresmat
Linea produzione: Linea 2
Ordine: 0,55+0,7
Data prova: 24/01/2024
Operatore: Gastaldo

Provino	D1	D2	D3	D4	D5	
Peso (grammi)	33,15	32,63	33,04	32,83	33,31	
Larghezza A (mm)	97,26	97,11	97,39	98,12	98,75	
Lunghezza B (mm)	99,27	99,29	99,28	99,14	99,39	
Larghezza C (mm)	97,06	97,16	96,81	97,22	98,70	
Lunghezza D (mm)	99,34	99,21	99,51	99,08	99,59	
Spessore A (mm)	76,62	77,22	77,60	77,55	77,95	
Spessore B (mm)	76,80	77,03	77,38	77,23	77,58	
Spessore C (mm)	76,65	76,63	77,27	77,24	77,39	
Spessore D (mm)	76,89	77,10	77,43	77,24	77,44	
Media Larghezza	97,16	97,14	97,10	97,67	98,73	
Media Lunghezza	99,31	99,25	99,40	99,11	99,49	
Media Spessore	76,74	77,00	77,42	77,32	77,59	Media Densità
Densità (Kg/m^3)	**44,77**	**43,96**	**44,22**	**43,87**	**43,71**	**44,10**

LATTONEDIL

M 12-11 Rev 0 Conducibilità termica

CONDUCIBILITA' TERMICA

Wednesday, January 24, 2024, Time 09:32

Wintherm32v3 Version 3.32.116 Uni
Instrument: F200
Instrument Program Version 296
Instrument Serial Number: 999

Sample Name: test1 1
Thickness: 29.01mm

Rear Left :	28.60 mm	Rear Right :	28.80 mm
Front Left:	29.21 mm	Front Right:	29.44 mm

[Isopar HP 80 22/01/24 12:00]
[Indresmat]
Thickness obtained : from instrument

TEST RUN

Calibration used : User Type
Calibration File Id: IMMR-440_Usertype_Calibration3

Number of transducers per plate: 1
Number of transducers used per plate: 1

Number of Setpoints: 1

Setpoint duration: 63 min

Block Averages for setpoint 1 in SI units

	Tupper [°C]	Tlower [°C]	Qupper [μV]	Qlower [μV]	Lambda [W/mK]
-se-	0.01	20.01	-684	712	0.02214
-se-	0.01	20.01	-685	713	0.02215
-se-	0.01	20.01	-685	713	0.02217
-se-	0.01	20.01	-685	713	0.02216
-se-	0.01	20.01	-685	715	0.02219
-se-	0.01	20.01	-686	715	0.02220
-se-	0.01	20.01	-686	715	0.02220
-se-	0.01	20.01	-685	717	0.02223
-se-	0.01	20.01	-688	714	0.02223
-se-	0.01	20.01	-689	713	0.02224

Wednesday, January 24, 2024, Time 10:36

Setpoint No.	1	
Setpoint Upper:	0.00	°C
Setpoint Lower:	20.00	°C
Temperature Upper:	0.01	°C
CalibFactor Upper:	0.022501	
Results Upper:	0.02242	W/mK
Temperature Lower:	20.01	°C
CalibFactor Lower:	0.021239	
Results Lower:	0.02202	W/mK
Percent Difference:	1.79%	

Thermal Equilibrium Criteria:

Temperature Equilibrium:	0.20
Between Block HFM Equil.:	40
HFM Percent Change:	0.00
Min Number of Blocks:	10
Calculation Blocks:	5

Results Table -- SI Units

Mean Temp	Upper Cond	Lower Cond	Average Cond
10.01	0.02242	0.02202	0.02222

M 03-11 Rev 5 Piccola Fiamma

LATTONEDIL

Piccola Fiamma

Tipo Pannello:	*Isopar HP 80*
Data Produzione:	*22/01/2024*
Ora Produzione:	*12:00:00*
Poliolo:	*Indresmat*
Linea produzione:	*Linea 2*
Ordine:	-
Data Prova:	*24/01/2024*
Operatore:	*Gastaldo*

MATERIALE	FORMULAZIONE
Isocianato	
Poliolo	
Pentano	
Catalizzatore	
Add. 1	
Add. 2	
Totale	**0**

N°	H Fiamma [mm]	Tempo [s]	Colore Fumi	Intesità Fumi
1	**170**	4	Grigio	Alta
2	**165**	4	Grigio	Alta
3	**175**	5	Grigio	Alta
4	**180**	5	Grigio	Alta
5	**170**	4	Grigio	Alta

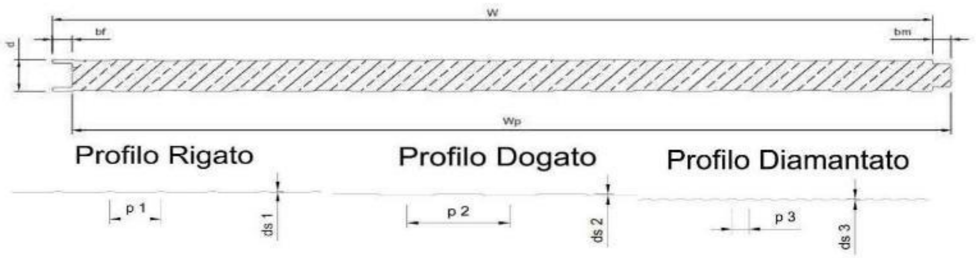
Note:	

LATTONEDIL

M 05-11 Rev 7 Verifica misure Pareti

Rilievo dimensionale

Sezione pannello Lattonedil Spa Milano
modello ISOPAR



DESCRIZIONE	DATO RILEVATO						VALORE (mm)	MEDIA
	LATO INTERNO			LATO ESTERNO				
PROFONDITA' LATO MASCHIO **bm**	19,82			20,53			20.0 ±1.0	20,18
PROFONDITA' LATO FEMMINA **bf**	22,71			23,15			22.5 ±1.0	22,93
PROFONDITA' RIGATO **ds1**							1.0 ±0.3	
PASSO RIGATO **p1**							47.5 ±1.0	
PROFONDITA' DOGATO **ds2**							0.9 ±0.27	
PASSO DOGATO **p2**							90.9 ±1.0	
PROFONDITA' DIAMANT. **ds3**							1.1 ±0.3	
PASSO DIAMANTATO **p3**							16.0 ±1.0	
SPESSORE PANNELLO **d**	80,63	81,21	80,70	81,03	80,62		±2 (d≤100); ±2%d (d>100)	80,84
PASSO POLIURETANO **Wp**	1002						1000 ±2	1002
LARGHEZZA UTILE **W**	1001			1001			1000 ±2	1001
CURVATURA	1,0						≤8.5	1

Operatore:	Battaglia		Linea di produzione:	2
Pannello:	Isopar HP		Spessore:	80
Data e ora produzione:	22/01/2024	12:00:00	Data Prova:	24/01/2024

Annex IV: Pull-out Test Guide

DYNAMOMETRIC TEST

Funded by
the European Union

Table of Contents

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2. TEST EXECUTION **3**

3. RESULTS REPORT **5**

1. GENERAL

This guide is made based on the recommendations included in the European Technical Approval Guideline, **ETAG 20**, in reference to:

PLASTIC ANCHORS FOR MULTIPLE USE IN CONCRETE AND MASONRY FOR NON-STRUCTURAL APPLICATIONS

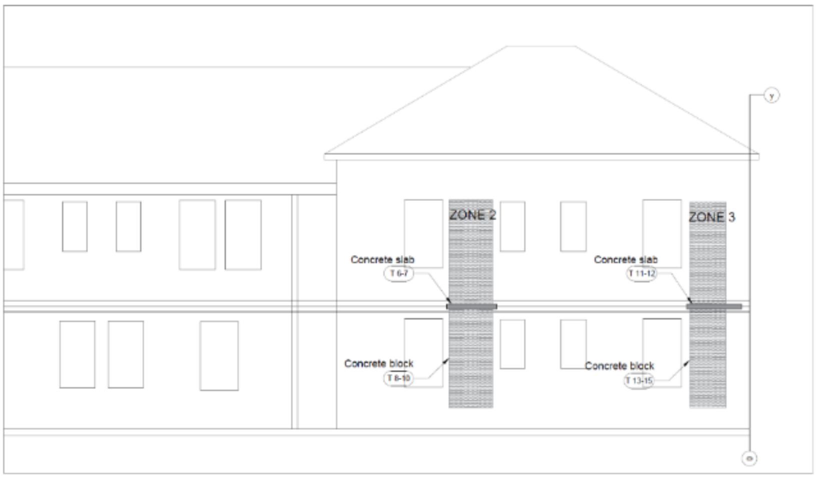
Specifically, in its annex B:

RECOMMENDATIONS FOR TESTS TO BE CARRIED OUT ON CONSTRUCTION WORKS

In the section for determination of resistance and according to the criteria of the ETAG:

*This characteristic resistance to be applied to a plastic anchor shall be determined by means of at least **15 pull-out** tests carried out on the construction works with a concentric tension load acting on the plastic anchor. These tests may also be performed in a laboratory under equivalent conditions as used on construction works.*

For each case study, a sampling plan is provided to guide the selection of representative areas for analysis. While the marked areas in the plan are considered to be critical due to their increased susceptibility to fatigue caused by expansion forces, the technician may identify additional regions that require evaluation to improve the accuracy of the characterization process.



Example of elevation with areas for testing

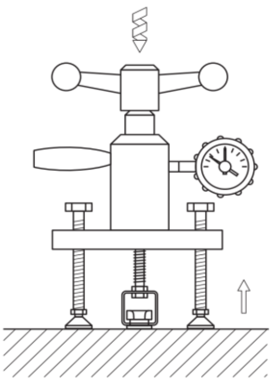
2. TEST EXECUTION

The test rig used for the pull-out tests shall allow a continuous slow increase of load recorded by a calibrated measuring equipment (dynamometer):

Tool recommended: HILTI AT 28 pull-out tester.

Pull-out tester

The load shall act perpendicular to the surface of the base material and be transmitted to the plastic anchor via a hinge. The reaction forces shall be transmitted to the base material such that the possible breakout of the masonry is not restricted. This condition is considered as fulfilled if the support reaction forces are transmitted either in adjacent masonry units or at a distance of at least 150mm from the plastic anchors.



The load shall be progressively increased so that the ultimate load is achieved after not less than about 1 minute. Recording of load is carried out when the ultimate load is achieved.

Recommended anchors:

IMAGE	ANCHOR NAME	SCREW LENGHT
	HRD-HR 10	Concrete: L >120 mm Brick: L 60 to 80 mm
	HUD-L 10 X 70	Brick: 100 mm
	Fischer plug UX 10 x 60 R	Brick: L 80-100 mm

Recommendations:

- When testing on brick, we will search for knot in two holes (for the plug to get more expansion inside the brick).
- A longer plastic plug does not necessarily give better results.

Plug on brick

3. RESULTS REPORT

RE-SKIN		PLACE					
		Street, number. Postal Code XXXXX - Region. Country					
WP5		**Pull-out Test guide**					
DATE	xx/xx/2024		Construction works Metal Panel				
		Anchors					
Nº TEST	Masonry (*a)	Ø	L (screw)	L (Plastic plug)	Crack	Pull-out	Results (KN)
1	C	8	120	120	Y/N	**Y/N**	18,7KN
2	BH	8	---	---	---	---	---
…	---	---	---	---	---	---	---
15							

(*a) 1. **C** *Concrete,* 2. **BH** *Brick (hole zone),* 3. **BM** *Brick (mortar zone).*