RE-SKIN

D5.3 – Manufacturing design of the multifunctional façade cladding III

Funded by the European Union

Deliverable Information Sheet

Version	1.0
Grant Agreement Number	101079957
Project Acronym	RESKIN
Project Title	Renewable and Environmental-Sustainable Kit for building Integration
Project Call	HORIZON-CL5-2021-D4-02-02
Project Duration	42
Deliverable Number	D5.3
Contractual Delivery Date	31/07/2024
Actual Delivery Date	31/07/2024
Deliverable Title	Manufacturing design of the multifunctional façade cladding III
Deliverable Type	R
Deliverable Dissemination Level	PU
Work Package	5
Lead Partner	GAR
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History of changes

Version	Date	Comments	Main Authors
0.1	21/06/2024	First draft, establishing document structure	S. García, J. García, Á. Llamas, R. Menor, F. Gabaldón, A. Saráchaga
0.2	11/07/2024	First version, incorporating input from all participants	Á. Llamas, A. Saráchaga, P. Outón
0.3	25/07/2024	Quality review	L. Vanhoutteghem
1.0	29/07/2024	Final version addressing all further comments	J. García, Á. Llamas, A. Saráchaga

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Disclaimer

1. Executive summary

This document constitutes the third iteration of the report detailing the manufacturing design of the multifunctional façade cladding. The content presented herein represents an advancement from the previous releases: D5.1 Manufacturing Design of the Multifunctional Façade Cladding I and D5.2 Manufacturing Design of the Multifunctional Façade Cladding II.

The document outlines the enhancements made to the multifunctional façade cladding since its initial development by GAR for the preceding EU-funded HEART project. These enhancements were undertaken to ensure alignment with the specific requirements of the RE-SKIN project.

The innovations in the façade solution developed in RE-SKIN include replacing conventional sandwich panel insulation with a bio-based alternative and integrating sustainable steel for the outer layers/casing. Additionally, the mounting structure has been enhanced by integrating recycled materials and optimizing the installation process to reduce installation time.

Chapter 2 presents an overview of the façade system and its key components, whereas Chapter 3 focuses on the design of these components. Chapter 4 offers a general description of the installation process, covering transportation of materials, necessary preparatory work, and installation of the components. Finally, Chapter 5 explains the operational mode of the façade ventilation solution.

The optimisation of façade components will continue throughout the project's development, with updates provided as new information becomes available. An additional version of this report (D5.4) is scheduled for release in month 27. This subsequent deliverable D5.4, marking the final installment in the Manufacturing Design of the Multifunctional Façade Cladding series, will incorporate additional specifications or modifications based on project progress and testing results. It will cover aspects such as usage, maintenance, end-of-life approach, as well as detailed descriptions of the manufacturing process and production monitoring. Supporting documents and certificates will also be included.

2. General description

The RE-SKIN façade system builds upon the façade system developed by GAR for the previous H2020 HEART project, aligning with RE-SKIN's objectives to develop multi-technology, low-impact renovation solutions for energy retrofitting buildings in critical contexts.
The HEART system consisted of self-supporting thermal insulation sandwich panels with a 0.7 mm galvanized steel outer layer, PIR foam core, and a 0.4 mm inner layer, joined by tongue-and-groove joints and attached to walls via a substructure.
The RE-SKIN façade system aims to reduce energy consumption and environmental impact while promoting life cycle sustainability and circular economy. To achieve this, the new sandwich panels incorporate bio-based PUR (bioPUR) foam provided by INDRES and GreenCoat BT sustainable steel from Swedish steel manufacturer SSAB, which uses rapeseed oil and recycled scrap metal, reducing environmental impact. The mounting structure has also been improved by using recycled aluminium profiles manufactured by EXLABESA. Additionally, the assembly process of the entire system has been optimised to reduce retrofit work time and costs.
The RE-SKIN solution is suitable for installation on brickwork and concrete block façades, concrete load-bearing walls, and wooden structures. Prior to installation, a dynamometric test (Pull-out Test) is conducted to assess the tensile strength of the walls and the load capacity of the fixings. For a description of this test, see Chapter 4.3 of this deliverable. 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.

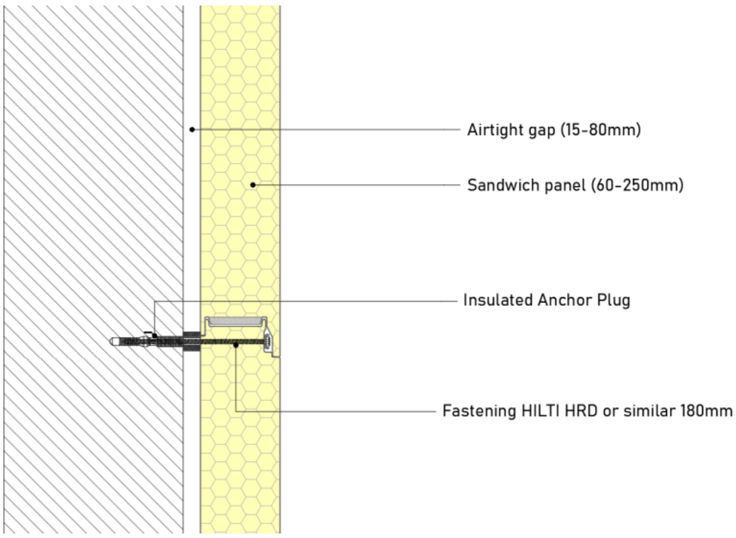


Figure 1. Panel detail (vertical) [drawing created using AutoCAD]

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 with fixings and plugs. The upright structural profiles are then fixed to the brackets using self-drilling screws. Finally, the panels are affixed directly to the walls using structural fasteners. The upright profiles serve as guides for installing all the panels in a perfectly vertical position.

The adaptable sealed chamber between the insulation panels and the existing wall structure is designed to facilitate air circulation in warmer seasons, thereby preventing moisture and heat accumulation. During the cold season, it can be sealed to function as thermal resistance. However, complimentary to the system, the air chamber is equipped with manually adjustable ventilation grilles. Depending on the season, the internal chamber can be fully sealed to act provide thermal resistance during cold weather, or the ventilation grilles can be manually adjusted to facilitate enhance airflow in warmer weather. Further details on this component can be found in chapter 6

The project involves testing the entire façade system. A testing mock-up, integrating all system elements, is currently in the design phase through a collaboration between GAR and DTI, and installation instructions will be produced. The mock-up components will be dispatched to DTI for thorough testing, verification, and demonstration of the long-term reliability of the novel façade system. Test results will be included in D3.6 Lab Testing Report II and D3.7 Lab Testing report III. A test method is outlined in D3.1 Methodology to test the reliability of subsystem and will be further developed in parallel with ongoing testing.

3. System components

As described in the previous chapter, the multifunctional prefabricated thermal insulating façade system within the RE-SKIN project is a self-supporting structure primarily composed of sandwich panels and a substructure, designed to enhance energy performance and decrease environmental impact. This chapter provides an overview of the design process and key features of the three main subcomponents: the sandwich panel, the recycled aluminium mounting structure, and the finishing elements. Additionally, it explores the materials and technologies used in each subsystem to create a façade aligned with sustainability and circular economy principles defined in the RE-SKIN project.

3.1. Sandwich panel

As previously introduced, the multifunctional façade system comprises sandwich panels and a substructure. The sandwich panels, being a key component of the system, consist of an outer layer made of GreenCoat sustainable steel from SSAB, a novel bio-sourced polyurethane (bioPUR) foam core from natural oils by INDRES, and an inner steel layer also sourced from SSAB. These panels are interconnected through a tongue-and-groove joint and are attached directly to the existing walls using structural fasteners, following the upright profiles to ensure the panels are installed vertically. The manufacturing of sandwich panels can be continuous or discontinuous. The discontinuous process uses a closed mould to produce standard-sized panels, while the continuous process creates larger panels that are later cut to size. For RE-SKIN, a continuous process is used due to its efficiency and cost-effectiveness for large-scale façade applications. During production, metal sheets are spaced apart by supports to allow foam injection, forming the insulating core. The finishing phase includes cutting, welding, laminating, and applying a protective film. A detailed description of the manufacturing process can be found in deliverable D5.2.

The manufacturable thickness of the panels ranges from 60 to 250 mm. The specific panel thickness for each demonstration in the RE-SKIN project will be determined based on project calculations. The typical thickness range is expected to be between 80 to 100 mm. For the Milan demonstration, a panel thickness of 100 mm has been established. 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 to project requirements. The manufacturable length ranges from 250 to 6000 mm. While panels can be manufactured up to 6000 mm in length, it is recommended that panels be cut to a maximum length of 4000 mm for façade installation. This avoids issues related to expansion, dimensional stability, and potentially strength. Strength testing and other assessments, such as those performed at Lattonedil, ensure the panels meet necessary standards for impact resistance and overall performance.

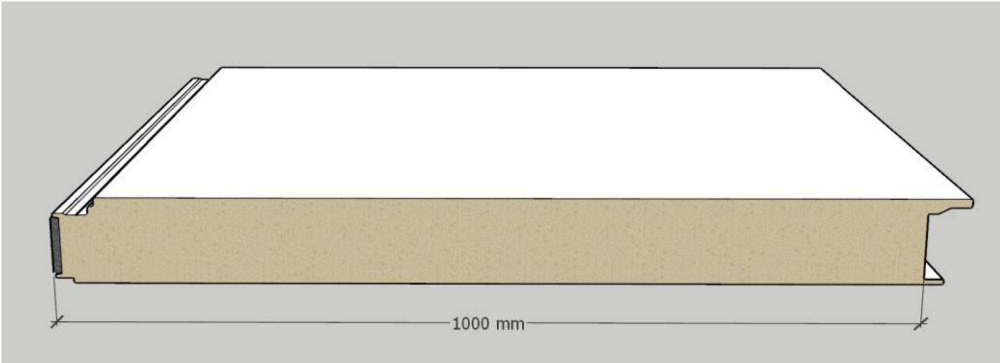
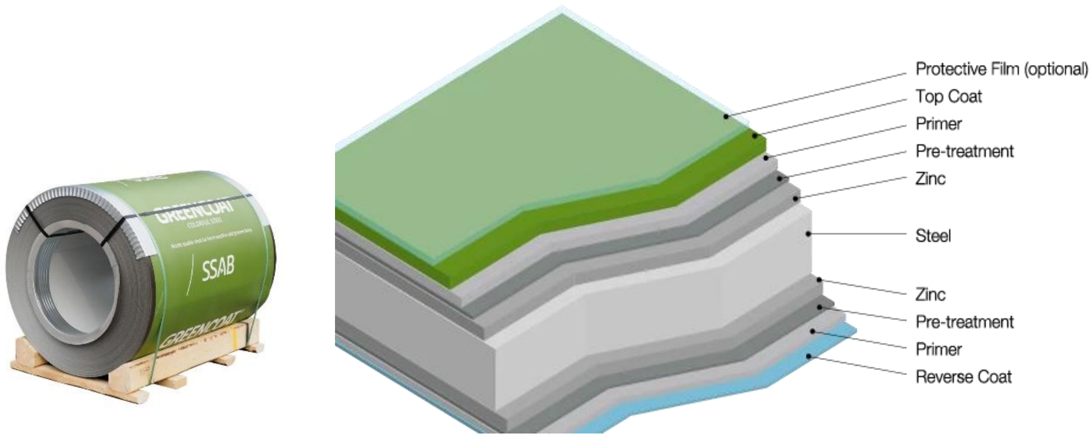


Figure 2. Sandwich panel with bioPUR and GreenCoat metallic sheet [drawing created using SketchUp]

3.1.1. External layers

Outer layer

The outer layer steel coating in the sandwich panels is a critical element for building construction, providing protection and enhancing aesthetics. In response to the demand for sustainable materials, SSAB has developed an innovative, eco-friendly coating technology. GreenCoat colour coated steel products feature a patented Bio-based Technology (BT) that incorporates Swedish rapeseed oil as a natural alternative to fossil oil. Introduced in 2012, this chromate-free coating reduces the environmental footprint compared to traditional coatings that use chromates, which are toxic and environmentally harmful. At the same time, it ensures long-lasting performance[1] without emitting harmful substances. Compliant with EU REACH ('Registration, Evaluation and Authorisation of Chemicals') regulations, it is suitable for both indoor and outdoor use. For the RE-SKIN project, the specified material thicknesses are as follows: 0.7 mm GreenCoat with Pural BT top coating for the external layer and 0.45 mm GreenCoat with a polyester coating for the internal layer.



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

Figure 3. 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	$R_{UV}5$	$R_{UV}4$	$R_{UV}4$-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]

The team overseeing architectural decisions for the RE-SKIN demonstration projects, in collaboration with pilot owners and local regulations, has finalized the colour selection for the façade sandwich panels to be used in all pilot buildings. As a result, the purchase order for the steel coils has been submitted to SSAB.

The specifications for the steel coils ordered for the outer layer are as follows:

Product	GreenCoat	**Gloss coating**	Regular
Specification top	S280GD Z275 / Pural BT G40	**Tolerance width**	-0/+6 mm
Specification reverse	Epoxy 018 Reverse Side Grey	**Tolerance thickness**	NEN-EN 10143

Colour	**Dimensions**	**Pcs**	**m2**	**kg**

[2] https://www.ssab.com/en/brands-and-products/greencoat/products/pural-bt

30 Almond Brown	1.155,0x0,70	3	2.001,82	11.000

Table 2. Specifications of the steel coil for the outer layer (SSAB)

Inner layer

The sandwich panel's inner layer is also composed of steel sourced from SSAB. Since this layer is not exposed to external environmental conditions, the manufacturer only applies a primer to ensure galvanic neutrality and adhesion. The thickness of the inner steel layer in the sandwich panel measures 0.45 mm.

In the table below are the specifications for the steel coils ordered for the inner layer:

Product	GreenCoat		**Gloss coating**	Regular
Specification top	S280GD Z275 / Polyester G35		**Tolerance width**	-0/+6 mm
Specification reverse	Epoxy 018 Reverse Side Grey		**Tolerance thickness**	NEN-EN 10143
Colour	**Dimensions**	**Pcs**	**m2**	**kg**
1L4 White	1.085,0x0,45	3	2.830,85	10.000

Table 3. Specifications of the steel coil for the inner layer (SSAB)

3.1.2. Thermal insulation

The insulation used in the sandwich panels is a bio-based polyurethane foam (BioPUR) developed by INDRES, currently at TR 6-7. The raw materials (polyols) for production of the foam are commercially available and derived from natural oils, making them more environmentally friendly compared to traditional polyurethane (PUR) materials. At the end of their life cycle, these products are managed through circular methods, including mechanical and chemical recycling, see also deliverable D5.2. Integrating these products into the RE-SKIN project represents an important step towards achieving a more sustainable and environmentally friendly approach to insulation, this both with regards to traditional PUR solutions, but also other types of insulation materials. Typically, plastic-based foams have a higher carbon footprint than natural and mineral materials. However, BioPUR insulation material has an estimated carbon footprint value that is lower than many other types of insulation materials. For additional details on this subject, refer to deliverable D5.2.

BioPUR technical features for sandwich panels in RE-SKIN:

The BioPUR used in the RE-SKIN project is estimated to demonstrate mechanical and thermal properties similar to conventional PUR. As the product is currently at TRL 6-7, these properties will be verified through additional testing throughout the RE-SKIN project. To date, the manufacturer

Lattonedil has conducted tests on the RE-SKIN roof panels, which also include SSAB GreenCoat outer layers and BioPUR insulation. These tests have resulted in a measured thermal conductivity value of 0.022 W/mK. (See Fig. 5)

Technical properties of BioPUR used in RE-SKIN:

- Thermal conductivity (0.022 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)

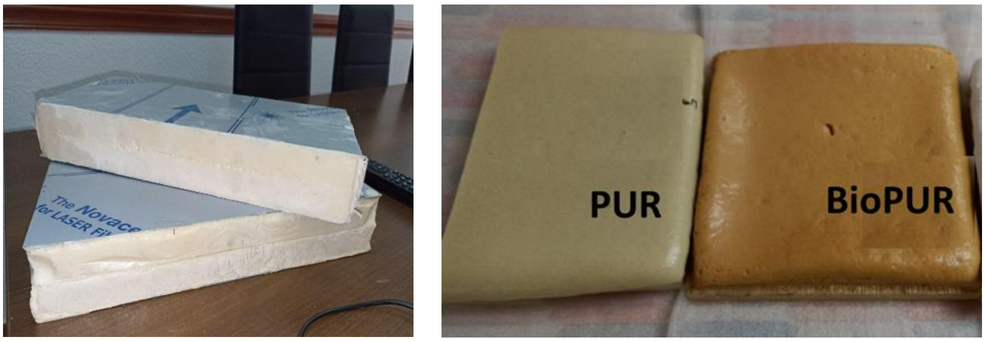


Figure 4. Demo sandwich panels made from bioPUR (left). Different varieties of PUR materials from INDRES (right).

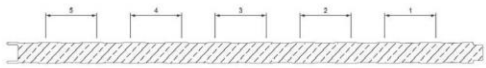
M 06-11 Rev 6 Protocollo di prova

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:	$[Kg/m^3]$	A.8	44,77	43,96	44,22	43,87	43,71	≥ 36	44,10
Res. Trazione:	$[N/mm^2]$	A.1	0,103	0,077	0,080	0,110	0,072	> 0,084	0,088
Mod. Trazione:	$[N/mm^2]$	A.1	2,56	2,18	2,24	2,57	2,49	> 1,62	2,41
Res. Compressione:	$[N/mm^2]$	A.2	0,090	0,089	0,096	0,093	0,091	> 0,110	0,092
Mod. Compressione:	$[N/mm^2]$	A.2	2,13	2,13	2,41	2,40	2,17	> 1,25	2,25
Res. Taglio:	$[N/mm^2]$	A.3	0,090	0,129	0,128	0,124	0,122	> 0,086	0,119
Mod. Taglio:	$[N/mm^2]$	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

Figure 5. Summary of tests and results conducted at Lattonedil (Source: Lattonedil)

Flammability Test

Lattonedil conducted internal fire tests (Piccola Fiamma test) on the manufactured RE-SKIN roof panels, which have the same composition as the façade panels, with the only difference being the thickness and the tongue-and-groove joint. These tests were not conducted under a specific standard. However, they can be correlated with the UL94 Standard for the Flammability of Plastic Materials for Parts in Devices and Appliances testing, specifically regarding the foam used in the panels. In this case, vertical burn tests were performed. It is important to note that this is not a certified test by product regulations but rather a self-check of the product.

The results of Lattonedil's Piccola Fiamma tests follow this classification for the BioPUR foam:

- *The sample catches fire and self-sustains without extinguishing itself, corresponding to UL 94 V-2.*
- *The flame height is approximately 110-140 mm with medium intensity dark grey smoke, corresponding to UL 94 V-1.*
- *The flame height is approximately 60-80 mm with low-intensity light grey smoke, also corresponding to UL 94 V-0.*

In the case of the RE-SKIN panel, the sandwich panel self-extinguishes in a few seconds, and the flame goes out, corresponding to UL 94 V-0.

The formulations for the BioPUR foam are not yet finalised, and these tests are for characterisation purposes, not certification. Once the façade panels are manufactured with a higher amount of fire retardant, they should be tested under standard norms, and a classification of B-s1-d0 in the Euroclass System is expected.

After internal testing at Lattonedil on the roof sandwich panel, additional flammability tests were conducted on the BioPUR foam at INDRES facilities, adhering to the UL94 standard. These tests achieved a V-0 classification.

The fire reaction test for the panel has not been conducted yet, pending testing during the next manufacturing run.

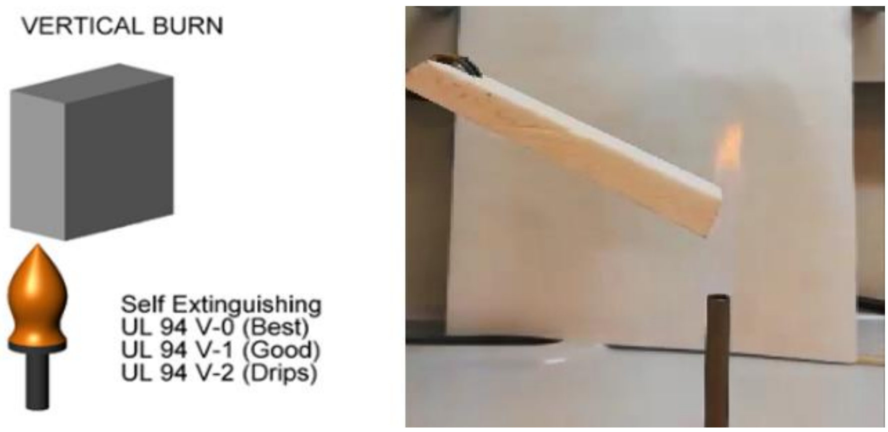


Figure 6. UL94 Flammability Test – Vertical burn method

3.2. Recycled aluminium mounting structure and fixings

The substructure of the RE-SKIN façade system is designed for both sustainability, due to the selection of recycled aluminium, and efficient installation. Furthermore, the substructure is engineered to compensate for uneven surfaces, ensuring a level installation.

First, all **brackets** are securely fastened to the façade, providing foundational support for the entire substructure and allowing for tolerances in the case of uneven surfaces. This setup ensures that the upright profiles are firmly anchored, and the panels are aligned correctly.

Figure 7. Substructure elements [image created using SketchUp]

Vertical profiles are fixed on the brackets after they have been secured. (See Fig. 8)

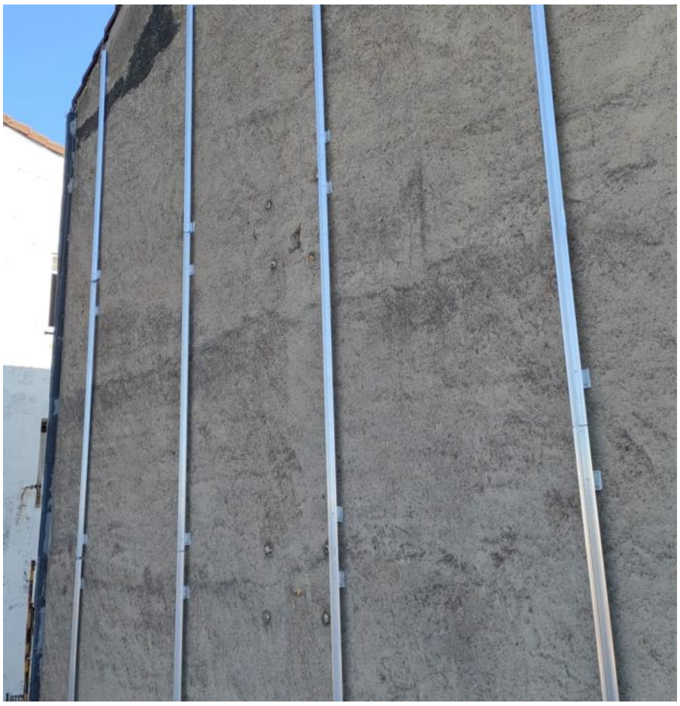


Figure 8. Façade with brackets and vertical profiles installed

To begin installing the system, the horizontal starting profiles are anchored to the vertical ones to support the first row of panels that will initiate the complete façade system, see Figure 9.

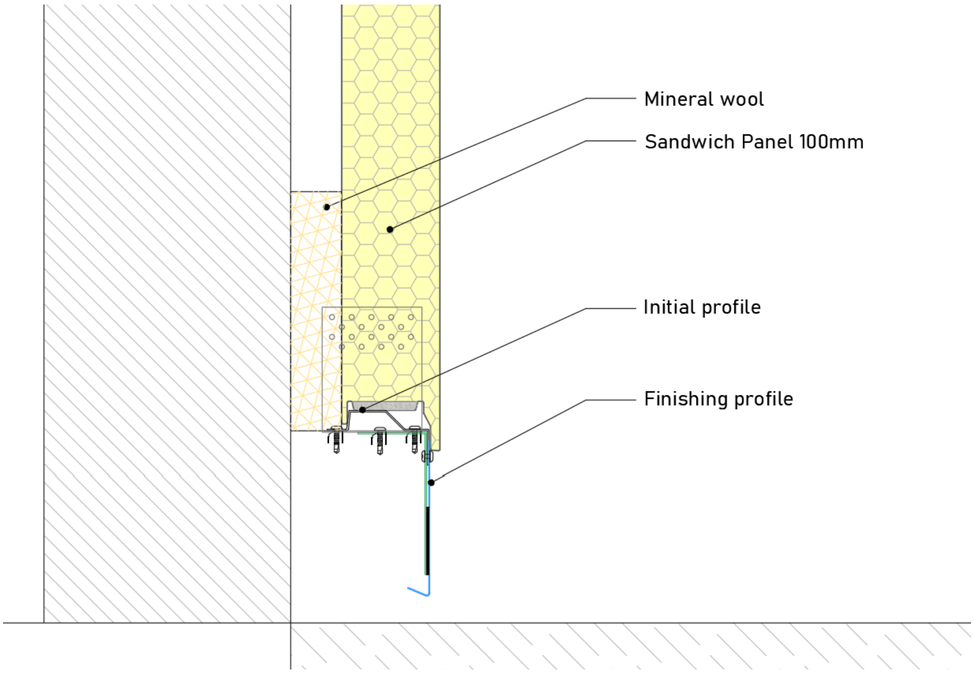


Figure 9. Start of the façade system.

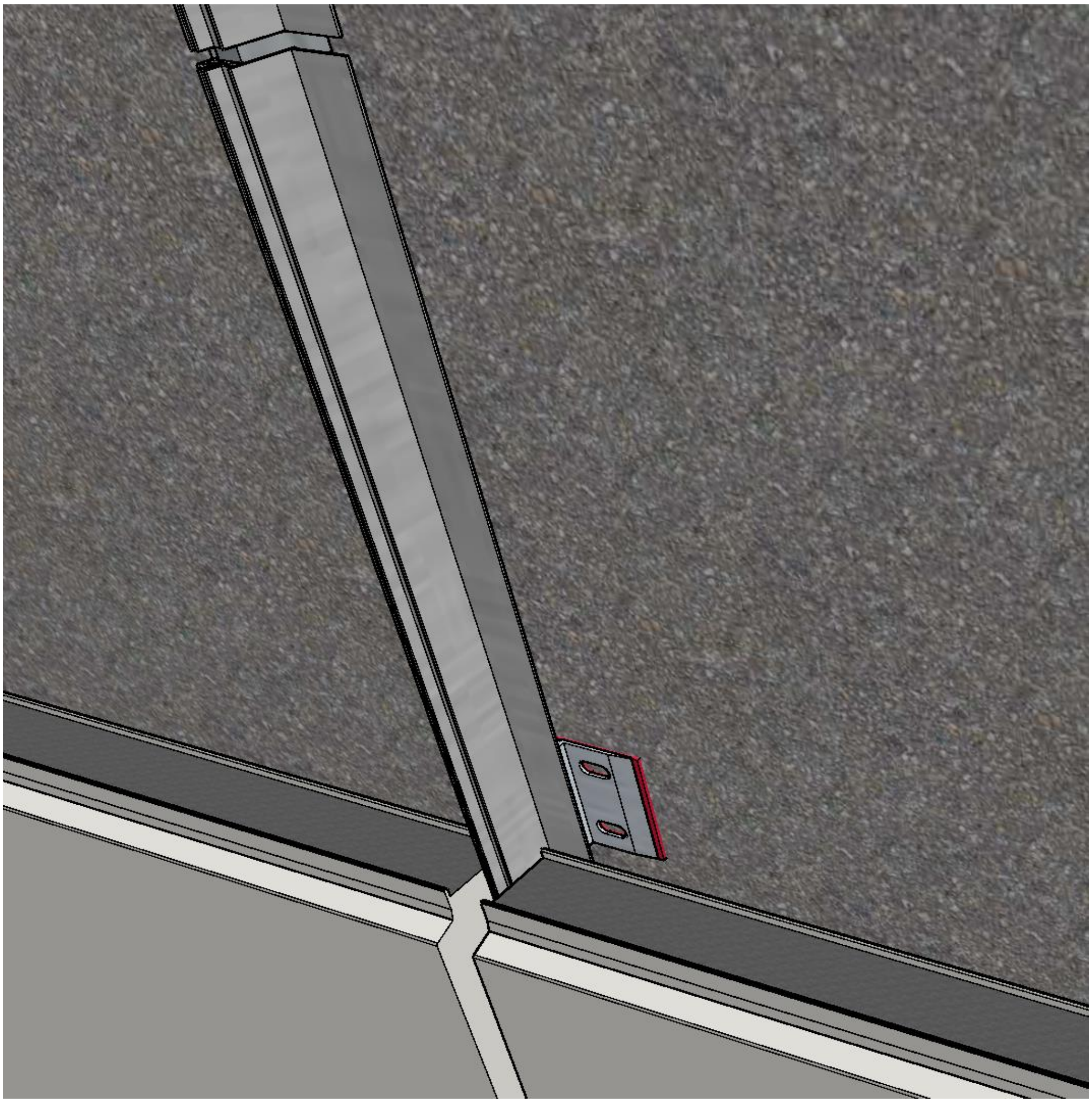


Figure 10. Sandwich panel and existing façade [image created using SketchUp]

The upright **profiles**, made by EXLABESA from recycled AA 6063 aluminium with 98% recycled content, are subsequently attached to the brackets. The use of recycled aluminum profiles significantly reduces the carbon footprint compared to traditional profiles, aligning with RE-SKIN's sustainability goals. Further details will be available in the deliverable D7.1 Circular economy evaluation procedure/tool, which is scheduled for submission in Month 20.

A specific extrusion die (see Fig. 11) has been developed to enable the subsequent production of the profiles for the RE-SKIN façade system, using recycled aluminium.

Figure 11. Extrusion dies for profile manufacturing as developed by EXLABESA for the RE-SKIN façade system.

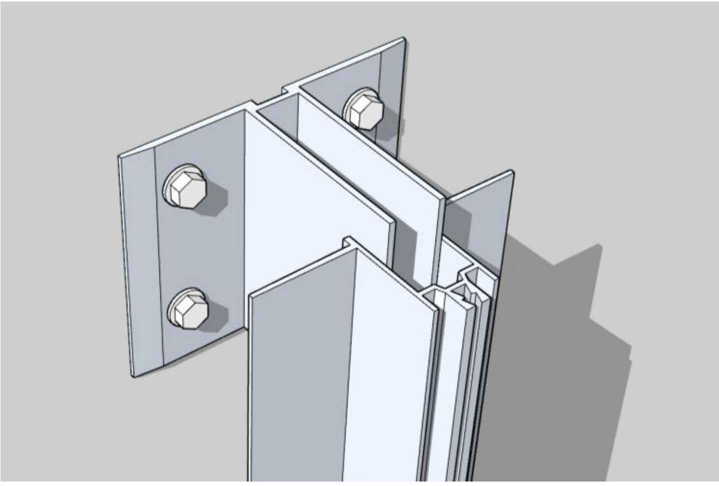


Figure 12. 3D view of the joint connection

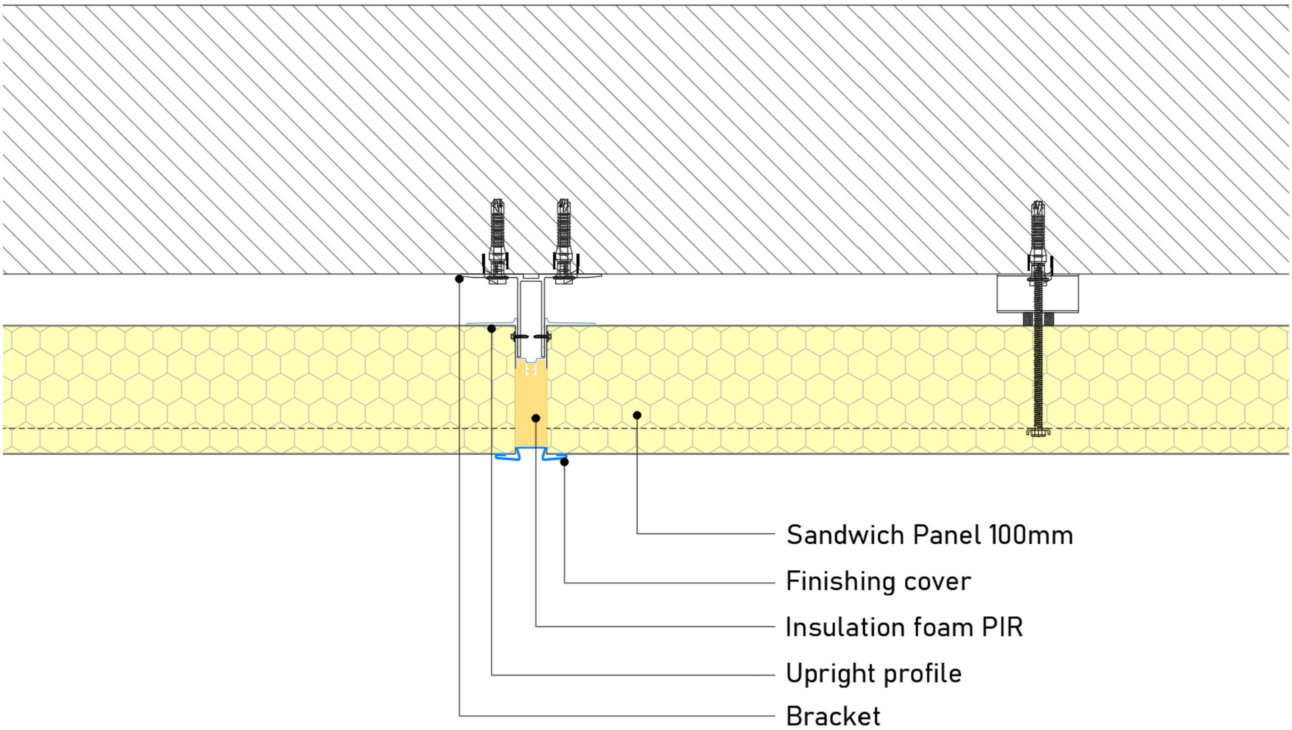


Figure 13. Detail drawing of the vertical panel connection for standard air gap (<5cm, approximately.) [drawing created using AutoCAD]

An **adjustable piece** is used to join the profiles, especially when the air gap exceeds 50mm. This ensures a seamless and stable connection between the profiles

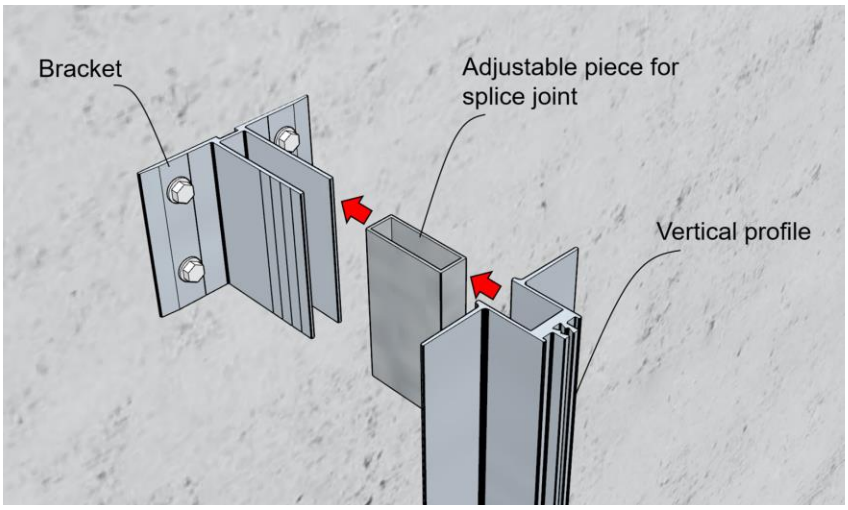


Figure 14. 3D view of the joint connection with splice joint

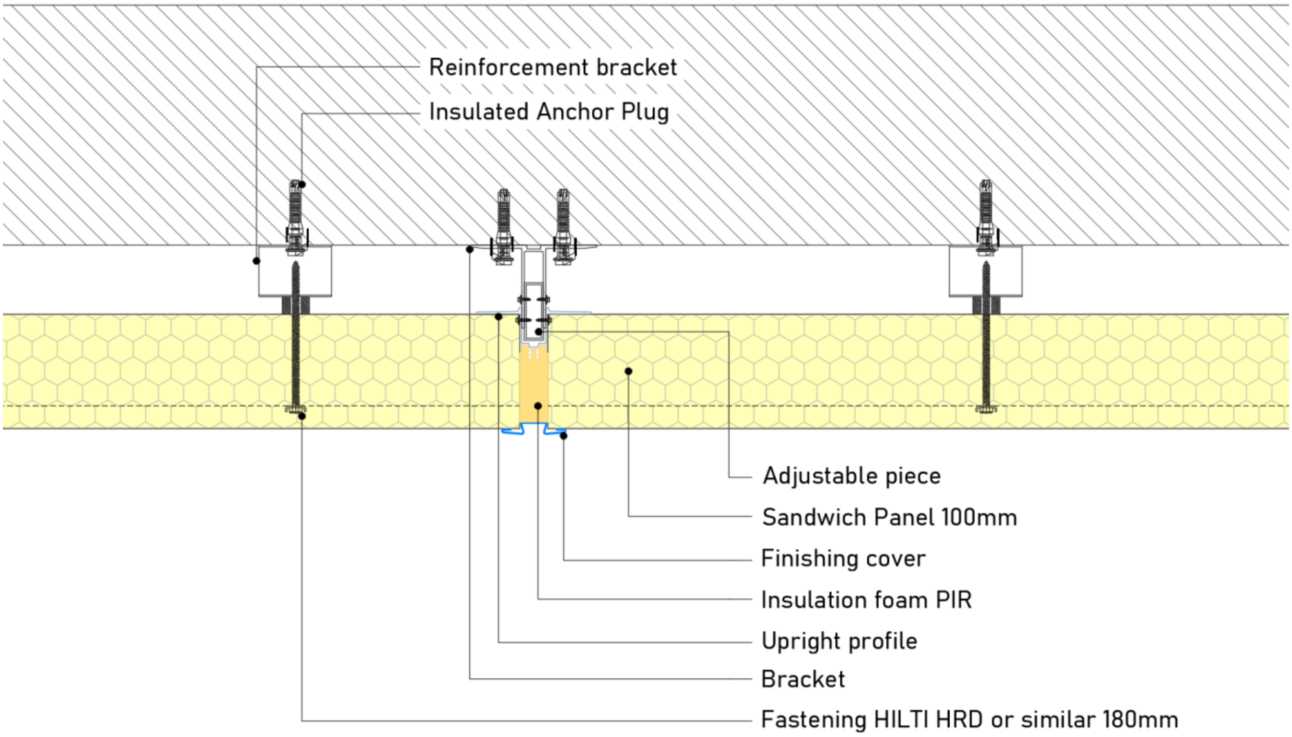


Figure 15. Detail drawing of the vertical panel connection for larger air gap (>5cm, approximately.) [drawing created using AutoCAD]

The sandwich panels experience their greatest thermal expansion perpendicular to their surface, primarily in the outer layer. Along their length the expansion is minimal, approximately 0.5 mm per 4 meters of panel. The vertical connections between panels have a spacing of 3 to 5 cm. Panels are installed within 15 cm of their edges. Typically, one fastening is installed every 70 cm, with a maximum spacing of 80 cm between fastenings. Detailed assembly instructions will be provided, based on 3D models for each demo building, specifying the exact positions of all anchors and façade components.

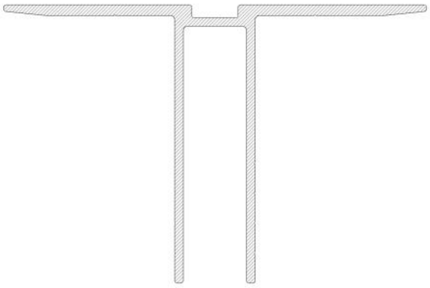


Figure 16. Detail drawing of the façade system's bracket [drawing created using AutoCAD]

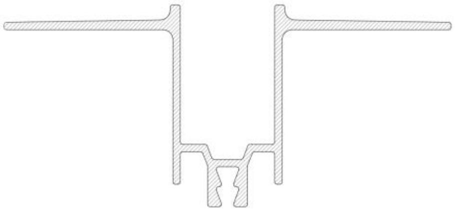
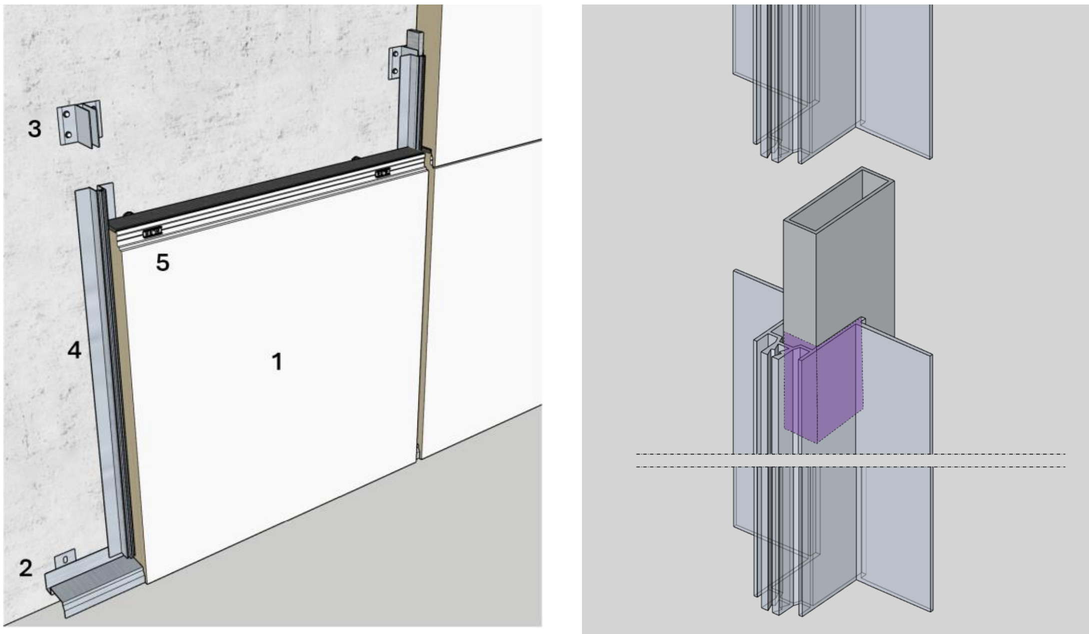


Figure 17. Detail drawing of the façade system's profile [drawing created using AutoCAD]

The sandwich panels are then fixed directly to the façade using **self-drilling screws** at the horizontal tongue-and-groove joint connections between panels (see Fig. 15), rendering them hidden. These screws are designed to securely hold the panels in place, contributing to the overall stability of the 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 18. Façade system elements

Depending on the width of the air gap or the stability of the system, **reinforcement brackets** (see Fig. 19) may be used to provide additional structural support. These brackets help distribute the load and reduce stress on the anchor screws, ensuring the façade remains secure and stable even under varying conditions.

The deviation of the façade and the integration within the interior chamber of wiring and ducts associated with technical components, such as the HVAC system and the MIMO power converter, which are part of the RE-SKIN retrofit package, 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.

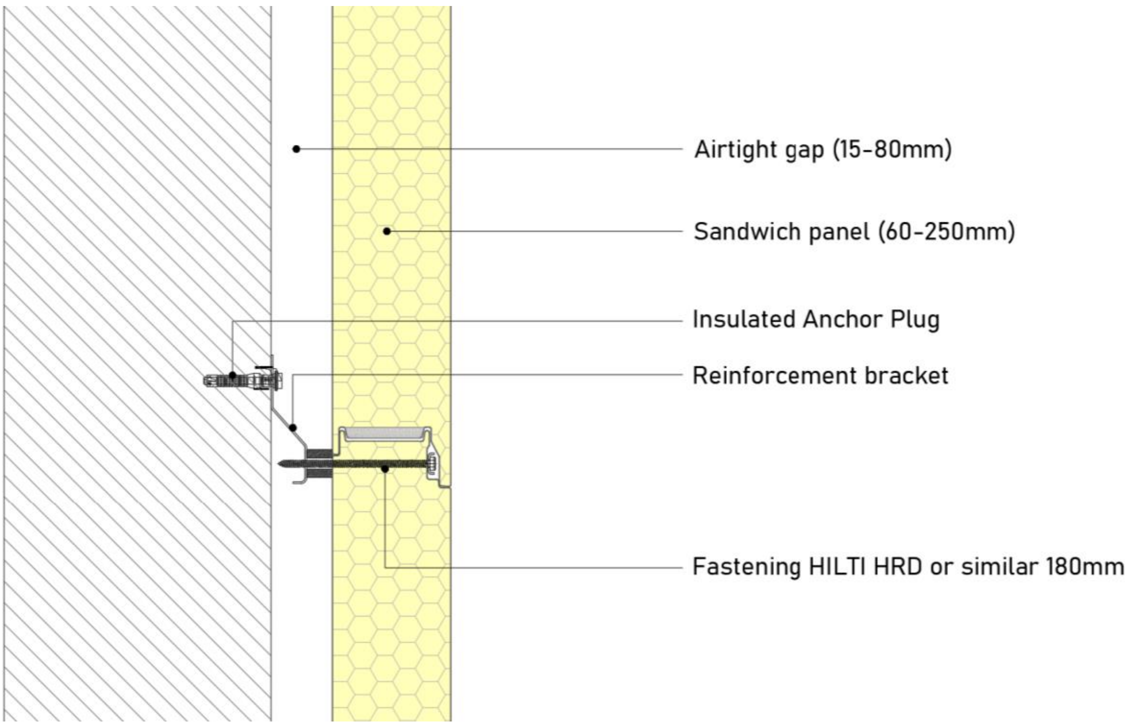


Figure 19. Reinforcement bracket for panel attachment (vertical) [drawing created using AutoCAD]

Before installation, a dynamometric test (Pull-Out Test) is performed to evaluate the tensile strength of the walls and the load capacity of the fixings. This test is critical for ensuring that the installation is securely anchored, adheres to safety standards, and maintains the long-term stability of the façade system. For the RE-SKIN project, mechanical fixings are specified as part of the standard solution. Should the pull-out tests reveal that mechanical fixings are inadequate, alternative methods, including chemical fixings, may be explored and assessed. More information can be found in Chapter *4.3. Preparation of walls that will support the new façade*.

The RE-SKIN façade system is detachable, facilitating installations and services' inspections in designated areas. The system's modular and detachable design facilitates straightforward **inspection and maintenance** procedures (see Fig. 20). Specific areas can be easily accessed as required. To inspect the interior, panels can be detached by first removing the vertical finishing profiles on the sides. Then, panels can be systematically removed one by one within the same column by unscrewing the screws in the horizontal tongue-and-groove connections between panels, starting from the top and moving downwards to the desired inspection area.

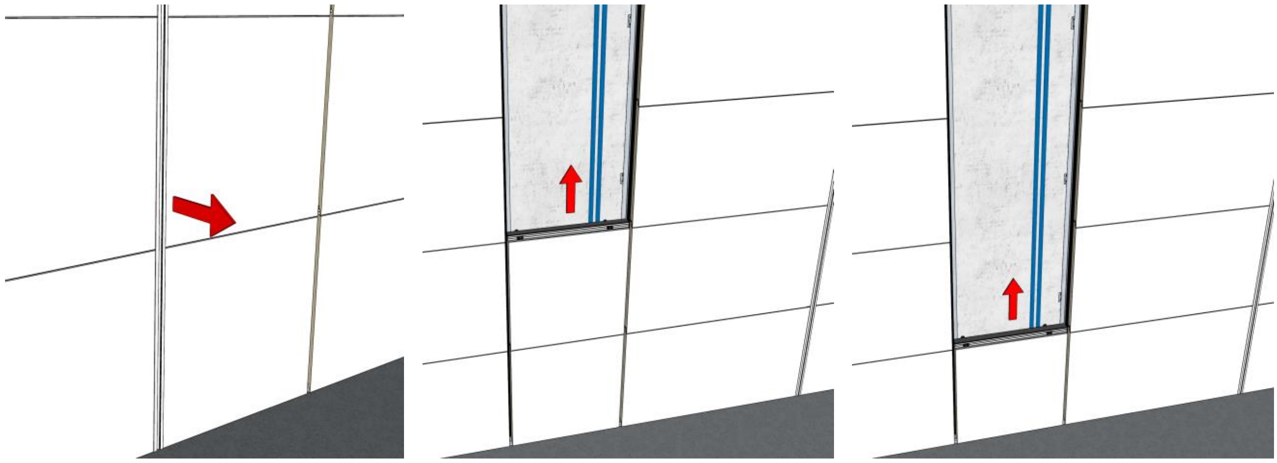


Figure 20. 3D images illustrating the sequence of panel dismantling for installation inspection [drawing created using SketchUp]

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.

3.3. Finishing elements

The versatility of the machinable façade system—meaning that the sandwich panels used in the system can be precisely cut and shaped to meet specific design requirements —allows for the customisation 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 façade can be utilized to incorporate various wiring and ducts associated with other technical components of the RE-SKIN energy retrofit

package. This includes, but it is not limited to, piping and wiring for smart DC fan-coils, earthquake sensors, and Fibre-To-The-Home (FTTH) connections.
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 and provide airtightness, insulation foam is used to fill the junction points (see *Insulation foam PIR* on Figures 13 and 15), and the overlapping of membranes and layers are also employed (see Figure 23).
The panels used in the façade system are manufactured with the maximum length allowed (6 m) 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 RE-SKIN 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. 21-26, 28-32 and 35-39]. This catalogue encompasses details for the installation of singular connection points at windows, doors, corners, air vents, as well as 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 connection points:

Windows

To achieve vertical alignment of window openings and ensure evenness between the window panels, substructure profiles are installed adjacent to the windows along the entire length of the façade, see Figure 21 and Figure 22.

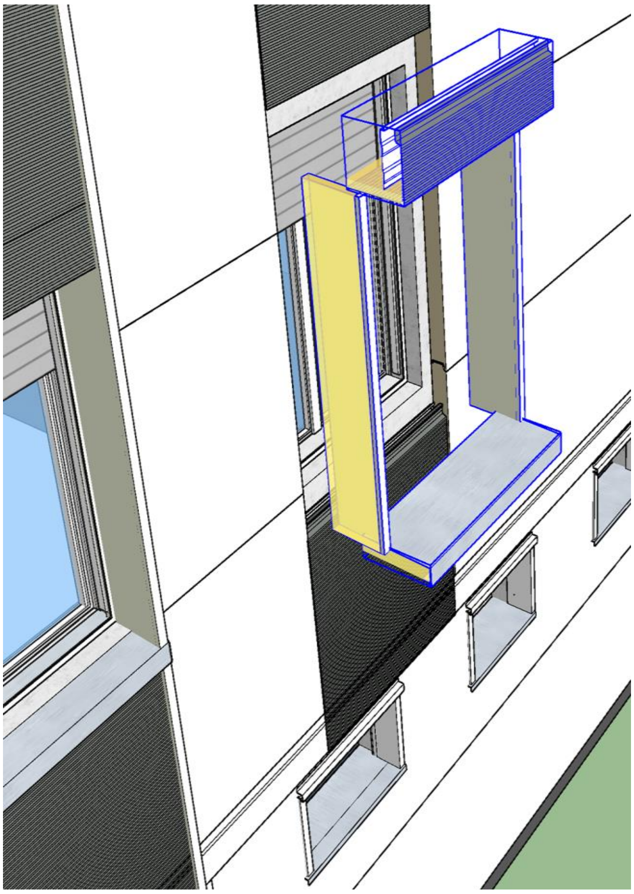


Figure 21. Finishing elements around windows [image created using SketchUp]

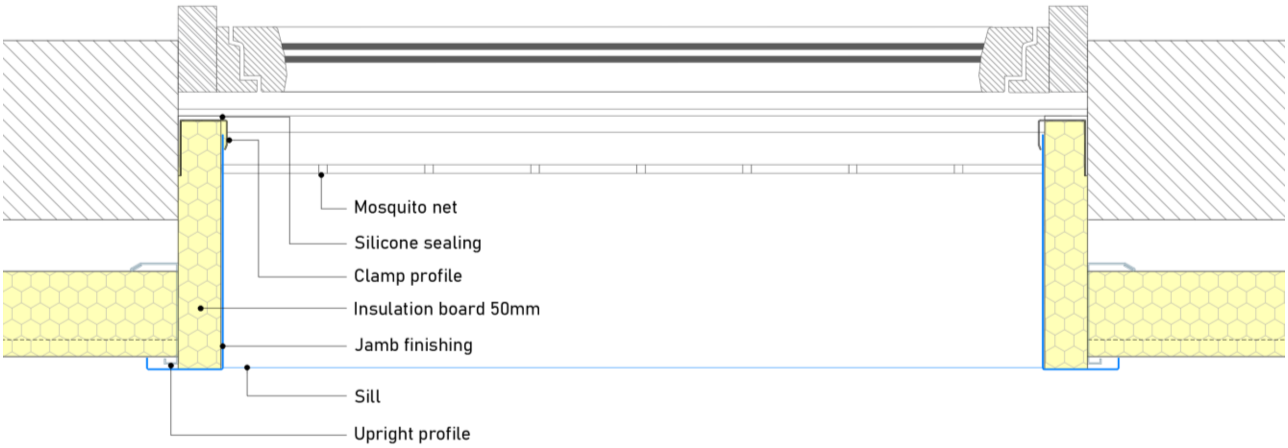


Figure 22. Window detail drawing (horizontal) [drawing created using AutoCAD]

The lintels, jambs, and windowsills are sealed using silicone and a rubber strip along the frame to create an airtight cavity (see Fig. 23). For insulating the jambs, lintels, and windowsills mineral wool insulation is used. 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, lintel, and windowsill.

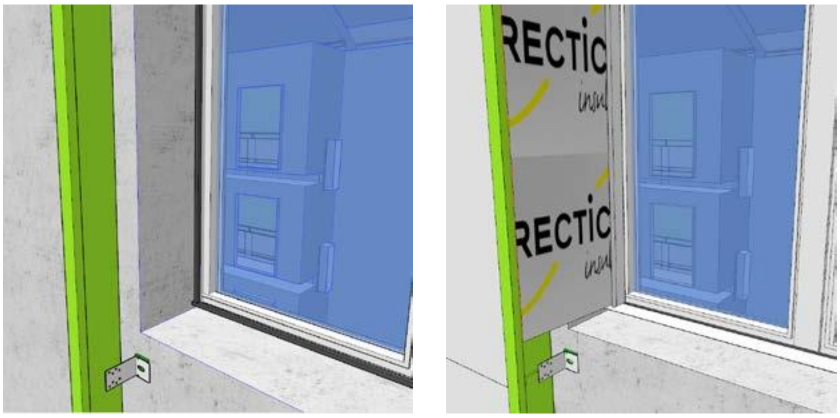


Figure 23. Window frame elements: rubber strip and insulation in jambs [images created using SketchUp]

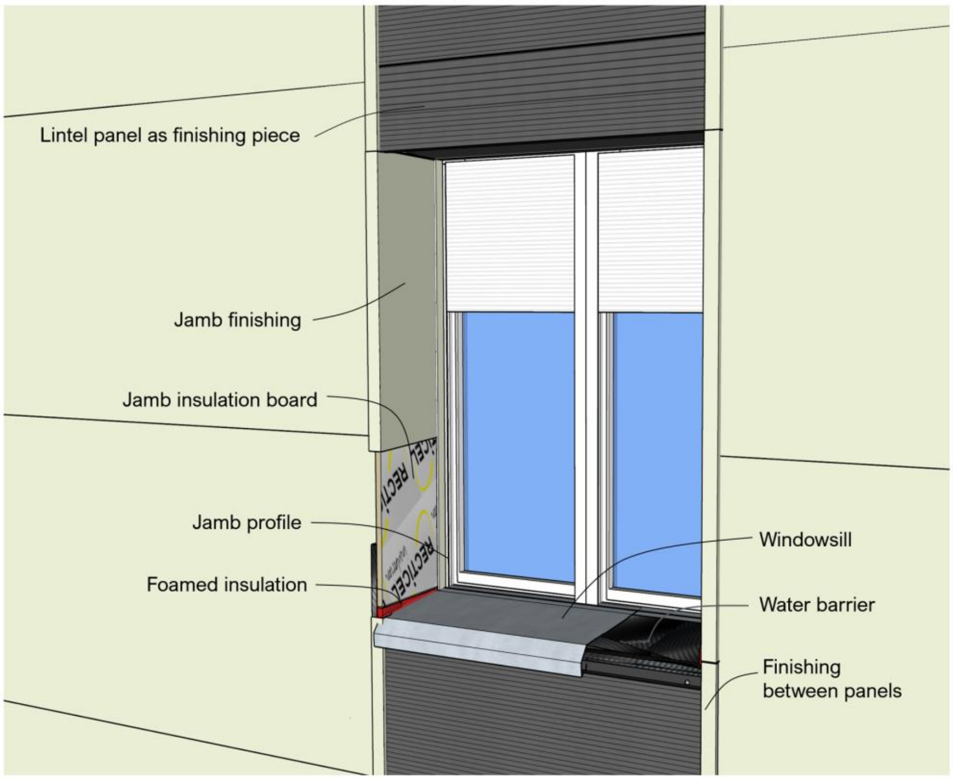


Figure 24. Components, membrane and window sealing [drawing created using SketchUp]

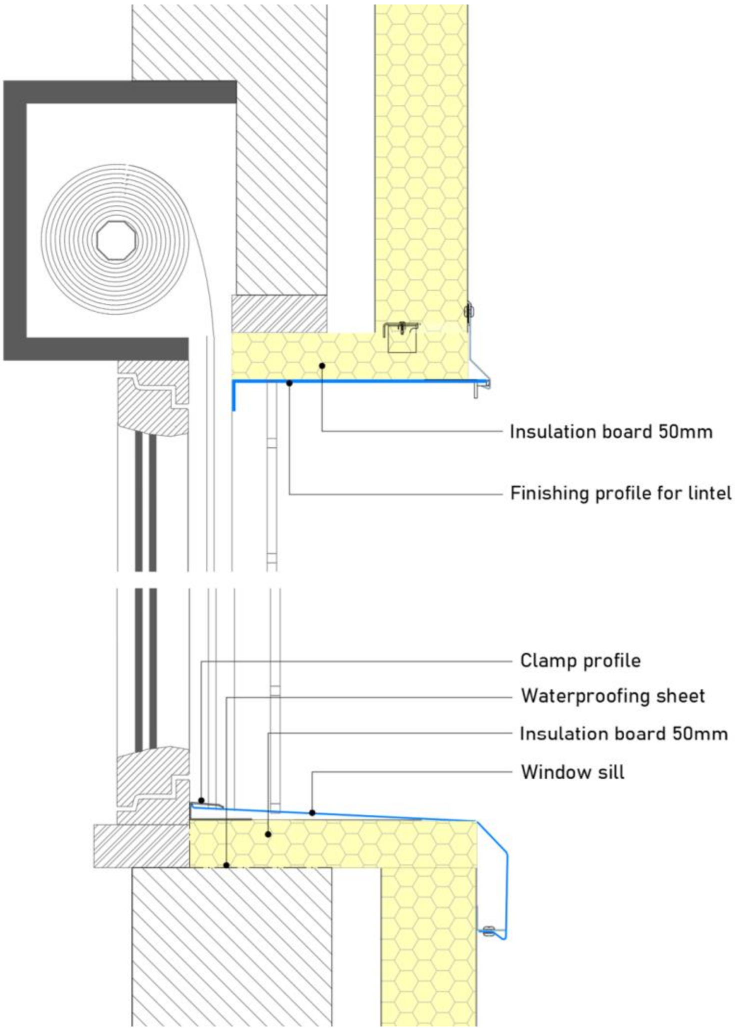


Figure 25. Window detail drawing (vertical) [drawing created using AutoCAD]

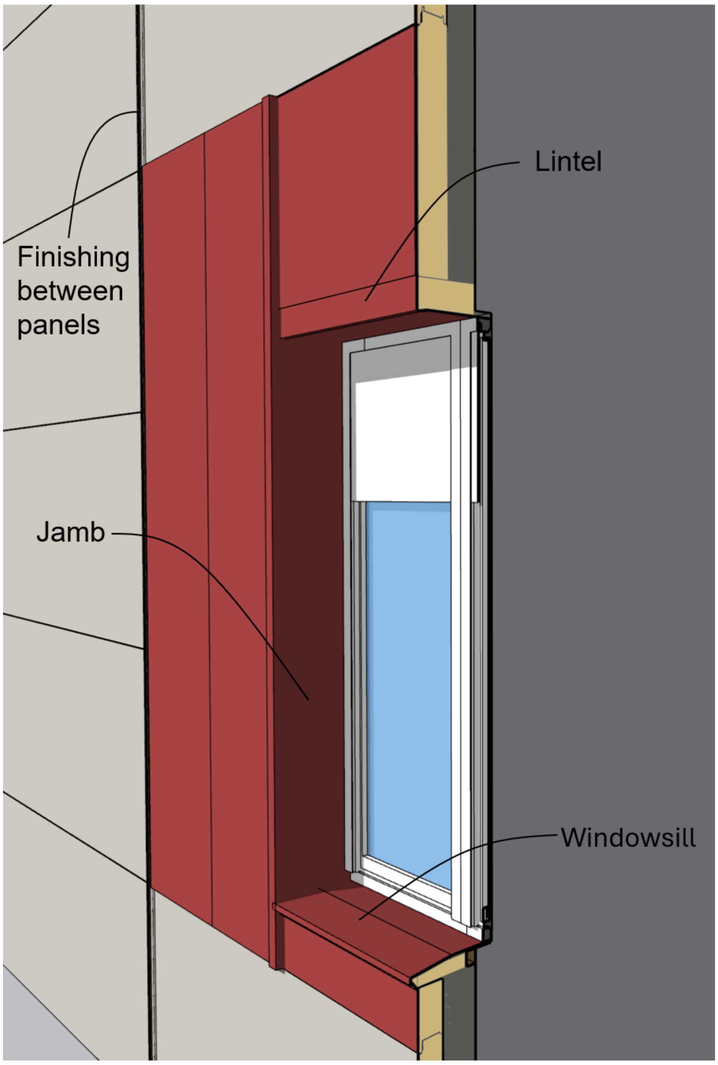


Figure 26. Façade section through window [drawing created using SketchUp]

The finishings at both lintel and windowsill 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.

The team overseeing architectural decisions for the four RE-SKIN demonstration projects opted to enhance the façade's aesthetic appeal by using a contrasting colour for the window openings compared to the almond façade sandwich panel. For the Milan demonstration, a 100 mm BioPUR sandwich panel with a red steel outer layer, supplied by Lattonedil, will be installed around the windows (see Fig. 26). Additionally, red metal sheet finishes will be applied to the jambs, lintels, and windowsills over the installed insulation at these specific connection points.

In the context of the Milan demonstration case (see Fig. 27), 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 poses 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, while also reducing potential thermal bridges, see Figures 28-33.

Figure 27. Image depicting the current condition of the ground floor windows in the Milan demo case.

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.

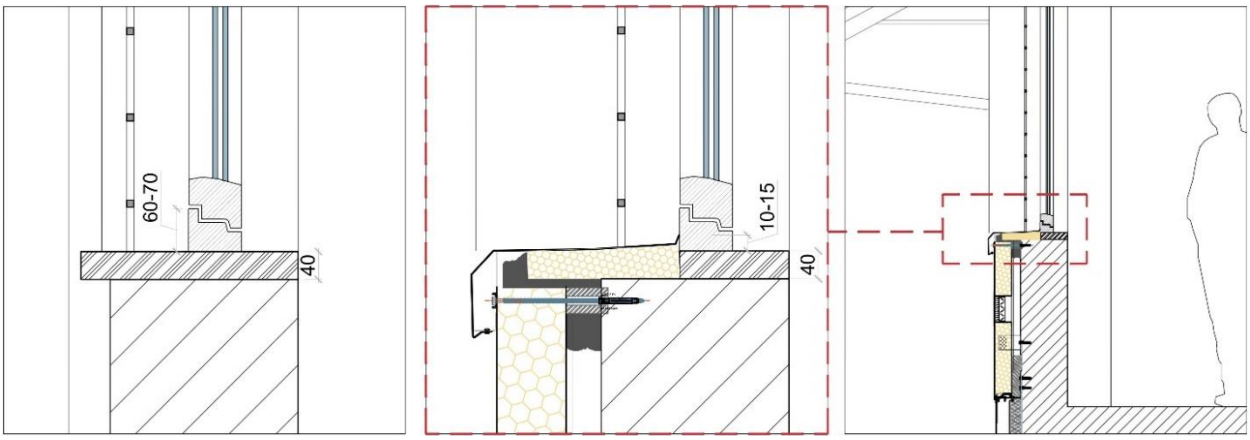
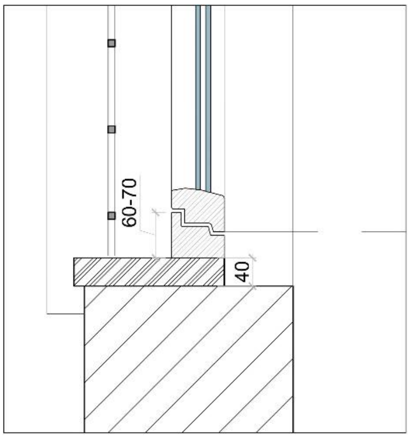
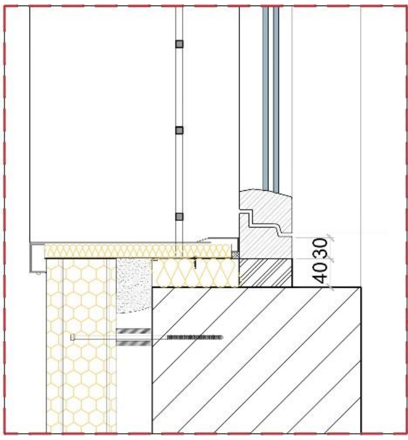


Figure 28. Vertical section of existing window detail

Figure 29. Vertical section of proposed windowsill design

Figure 30. Vertical window detail section – Key plan





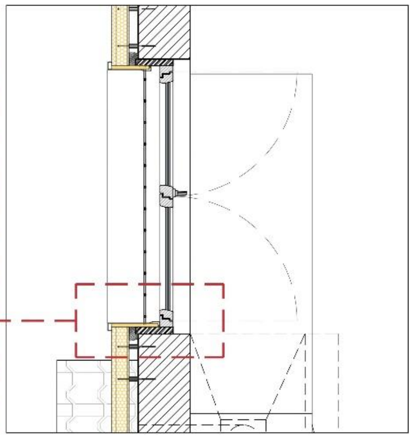


Figure 31. Horizontal section of existing window detail

Figure 32. Horizontal section of proposed jamb design

Figure 33. 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 34. Image showcasing the specific case of the first-floor windows in the Milan demo, featuring blinds and a mosquito net

On the first floor in the Milan demonstration building, 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.

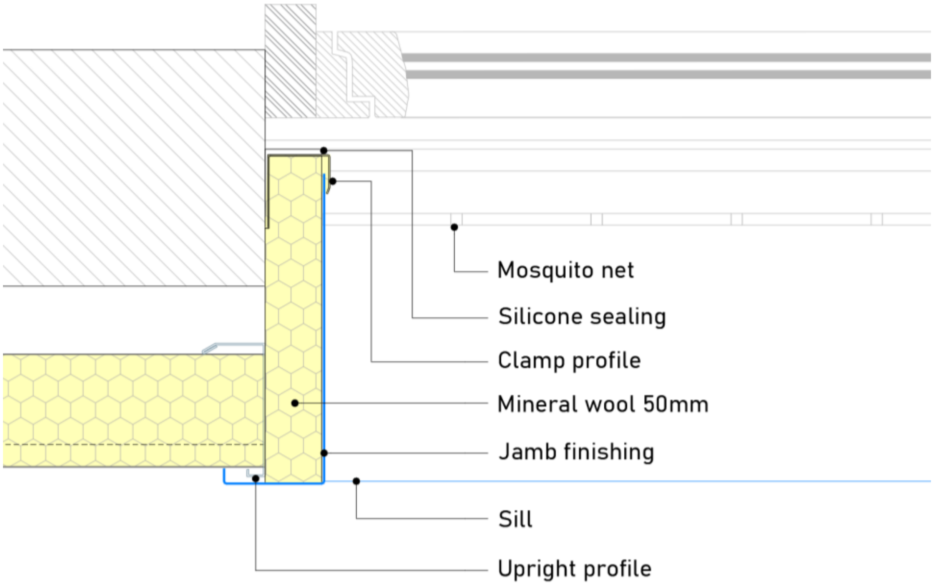


Figure 35. Detail of insulation on jambs

<u>Balconies</u>

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. To account for this, the RE-SKIN project includes a solution for balcony insulation which incorporates a sandwich panel with BioPUR foam insulation and a finishing layer of aluminium composite panel similar to the façade sandwich panels, 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, with a solution similar to the proposed solution around window frames.

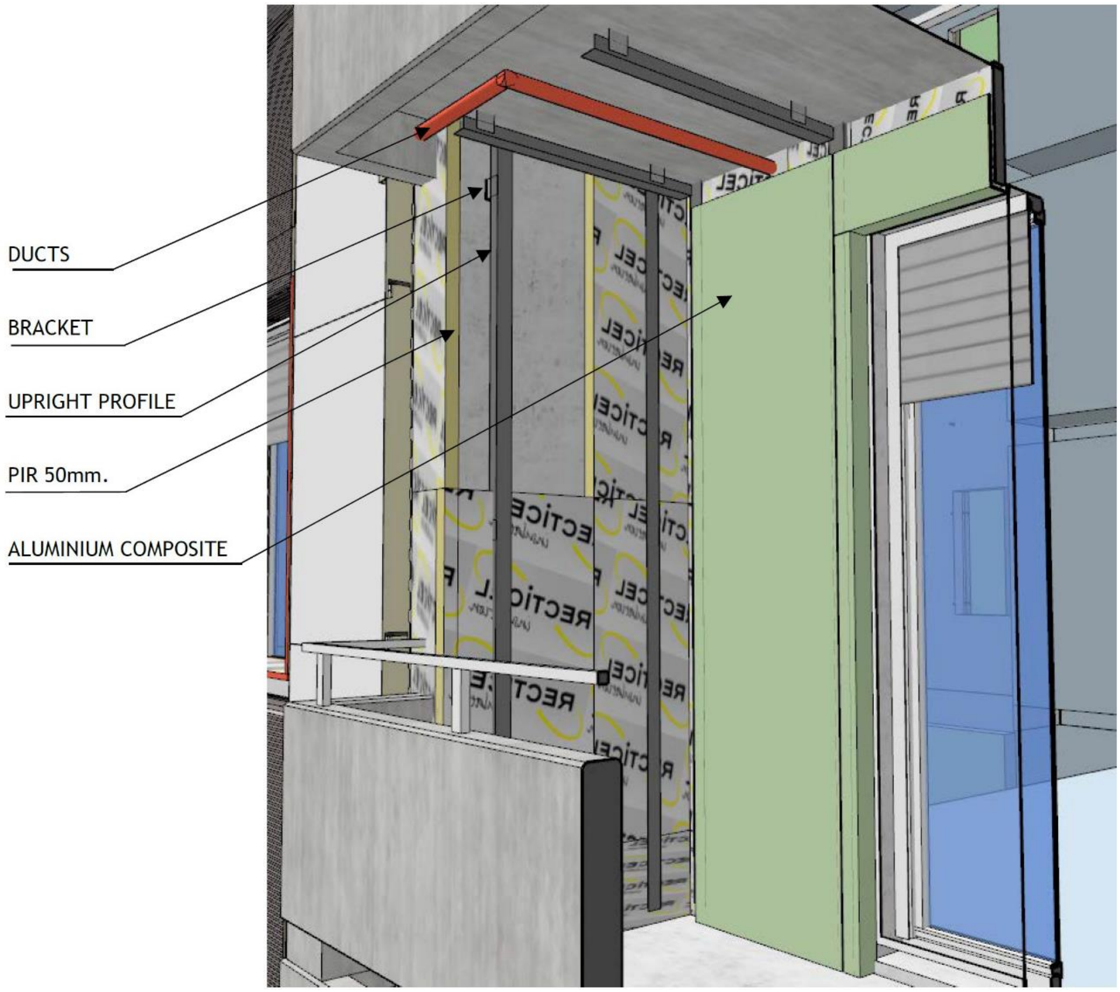


Figure 36. Balcony 3D [image created using SketchUp]

When the balconies are open, the balcony ceiling does not require insulation; therefore, the gap between the ceiling and the sandwich panel attached to the balcony's façade can be 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. (See Fig. 37)

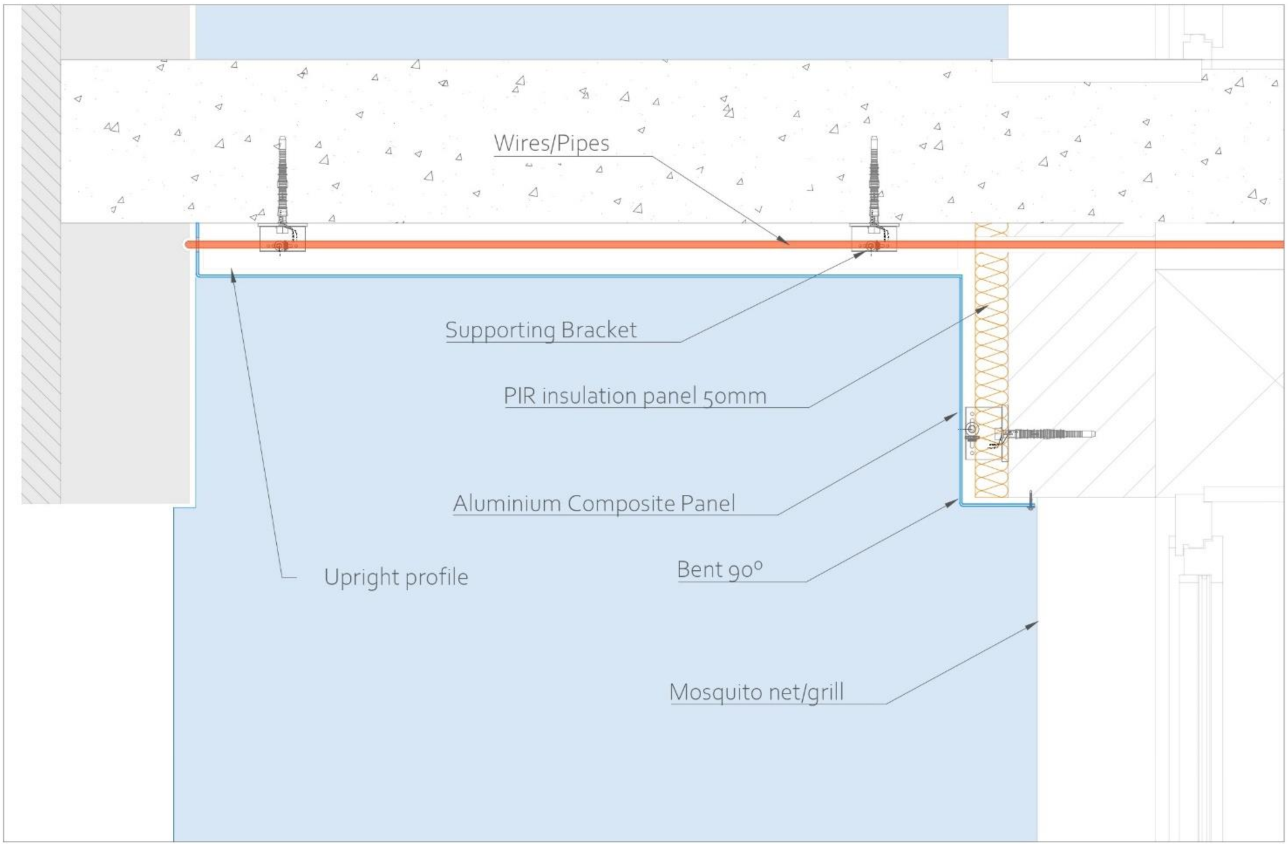


Figure 37. Balcony detail (Vertical) [drawing created using SketchUp]

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 façade sandwich 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 39.

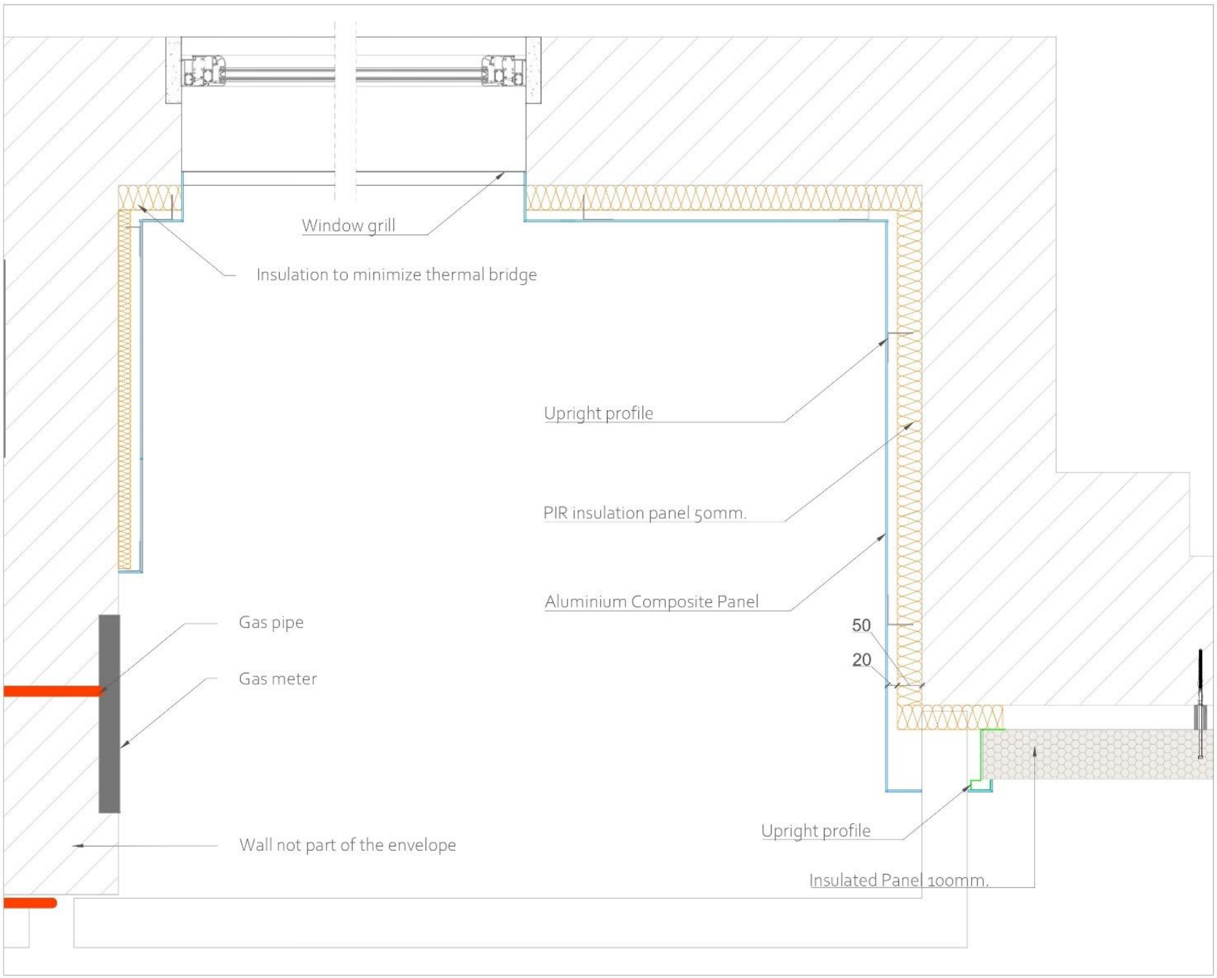


Figure 38. Balcony section (Horizontal) [drawing created using AutoCAD]

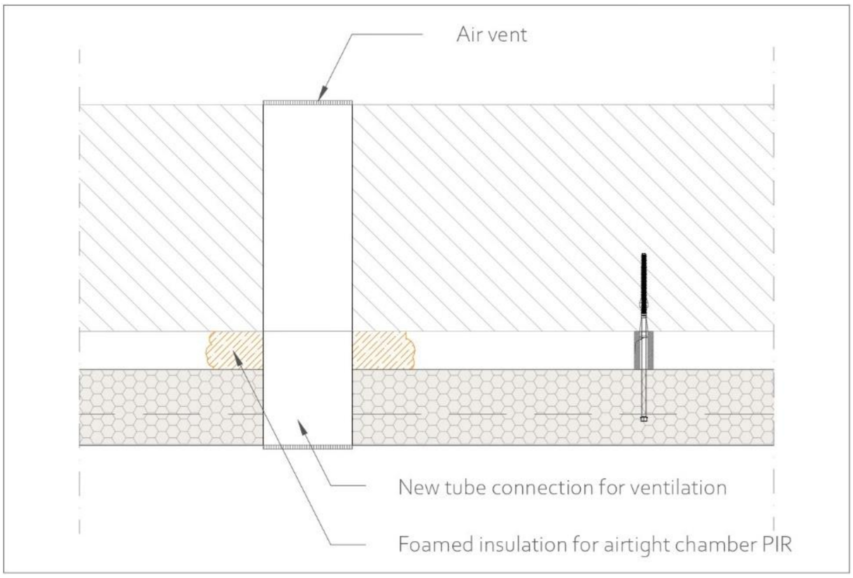


Figure 39. Air vent detail [drawing created using AutoCAD]

As mentioned, the airtight chamber can be modified to act as an adaptable sealed chamber, by equipping the façade with manually adjustable ventilation grilles. 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. For further details and drawings regarding this feature of the RE-SKIN façade system, please refer to Chapter 6.

4. Preparatory works

Before installing the substructure and façade panels, several preparatory tasks must be completed. These include preparing the site to receive the materials, assessing the façade to determine the necessary installation machinery, and selecting the appropriate anchoring by conducting pull-out tests.

4.1. Transportation and storage

The material is transported in batches of pallets. The pallet dimensions are approximately 6 m x 1 m x 1.3 m, with each pallet weighing about one ton. These figures may vary depending on the building's specifics (square meters of façade, morphology, etc.), as the material and dimensions are defined once all areas of the building have been analysed and resolved. The material is sent on a truck, and a pallet jack is necessary on-site to unload the material.

Regarding storage, the material should be kept indoors to avoid degradation from weather and environmental factors. If indoor storage is not feasible, the material should be stored under a ventilated cover to protect it from direct exposure to sunlight, rain, and other elements. It is recommended to use temporary barriers or fencing around the storage area and adhere to regular construction site safety measures to prevent unauthorized access and ensure safety.

It is advisable to implement just-in-time delivery to minimize the need for on-site storage. This approach ensures that the necessary elements arrive precisely when needed for immediate installation, reducing the risk of degradation and optimizing the workflow. However, just-in-time delivery can be challenging and requires careful coordination. Proper storage planning on-site is essential to manage the logistics and ensure the materials are handled and stored correctly until they are installed.

Figure 40. 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 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 41. 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. Specifically, a minimum of 15 pull-out tests should be performed in accordance with the European Technical Approval Guideline, ETAG 20. 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 I in this deliverable.

The objective of the test is to determine the adequacy of mechanical anchoring or the necessity for chemical anchoring, especially in instances where the façade walls exhibit weaknesses, deterioration, or poor construction. This process guarantees the stability and safety of the façade system.

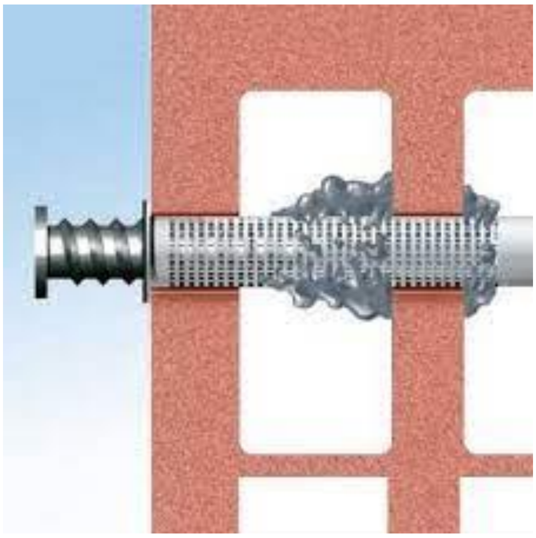


Figure 42. Illustration of Dynamometric Test (Pull-Off Test Guide in Annex)

A Pull-Off Test has been conducted for the Milan demonstration building. The test results indicate that the average pull-off strength for the plastic anchors in the tested perforated brick (Category ETA C) was found to be approximately 1.65 kN, with a characteristic value of 0.99 kN. The results for the anchors in lightweight concrete blocks (Category ETA D) showed an average pull-off strength of 0.84 kN, with a characteristic value of 0.50 kN. These values demonstrate that the anchors provide sufficient pull-off resistance for their façade installation.

The complete technical specifications of the tested parameters, the location of testing points, and the results can be found in Annex II of this deliverable.

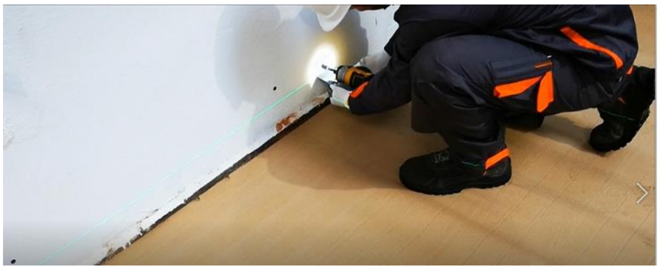
Figure 43. Dynamometric test performed in the Milan demonstration building

Preparations are currently underway to conduct a Pull-Off Test at the demonstration building in Burgas. This test is key for evaluating the structural integrity and performance of the building's materials, specifically to determine the optimal anchoring system solution for the RE-SKIN façade.

5. Installation

5.1. 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. Both the brackets and profiles work together to accommodate any irregularities and slopes in the façade, allowing for necessary tolerances.

Figure 44. Demonstration of substructure installation at GAR facilities.

5.2. 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.

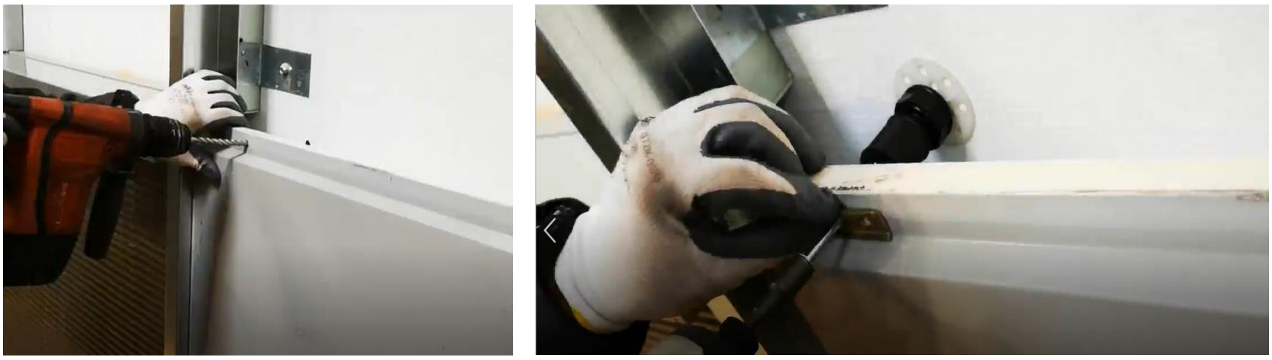


Figure 45. Demonstration of insulating panel installation

5.3. 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.

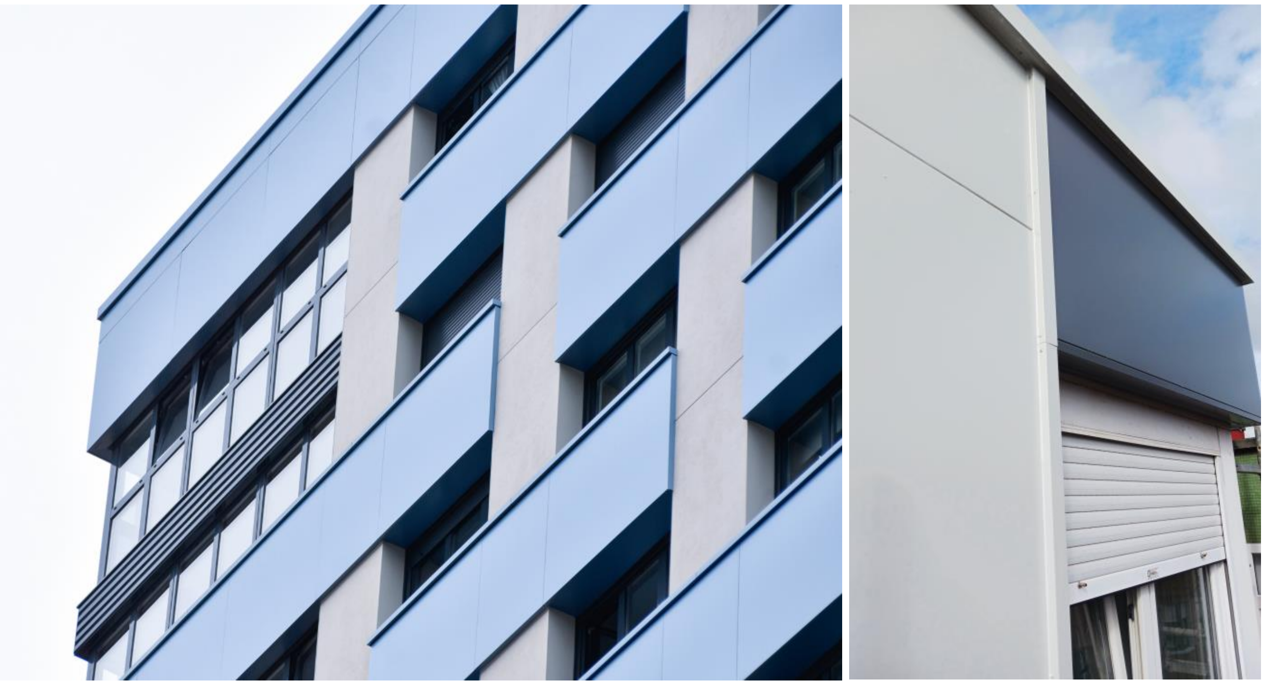


Figure 46. Finishings on completed façade installation by GarcíaRama (Image source: GarcíaRama)

6. Operation mode

6.1. Adaptable sealed chamber

The objective of the RE-SKIN façade system is to utilize the air chamber between the façade panels and the existing wall as an adaptable thermal barrier, incorporating manually operable ventilation grilles. The air chamber can be sealed to make the façade system airtight, or it can include ventilation grilles to allow for air circulation. It is important to note that incorporating grilles will not make the system completely airtight, as minor air leaks may occur even when the grilles are closed. By incorporating manually adjustable grilles, the air chamber is designed to function as a thermal resistance during the cold seasons. Although the chamber may not be entirely airtight, it should be sealed as effectively as possible to maximize thermal efficiency. In warmer seasons, the manual grilles can be opened to facilitate air circulation, thereby preventing the accumulation of moisture and heat. Strategically placed ventilation grilles enable the intake of fresh air and the exhaust of stale air, ensuring a continuous flow. These grilles are positioned at the base and top of the façade to optimize air intake and exhaust. Manufactured from stainless steel, these grilles will be sourced from existing market designs, ensuring they prevent the ingress of water and debris.

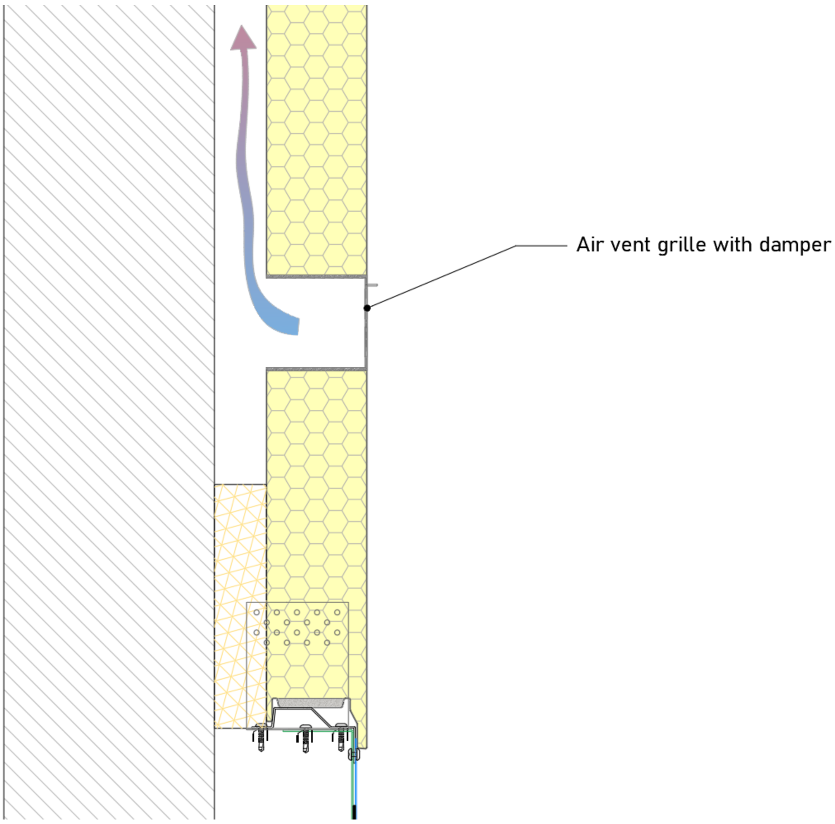


Figure 47. Bottom ventilation grille for air intake

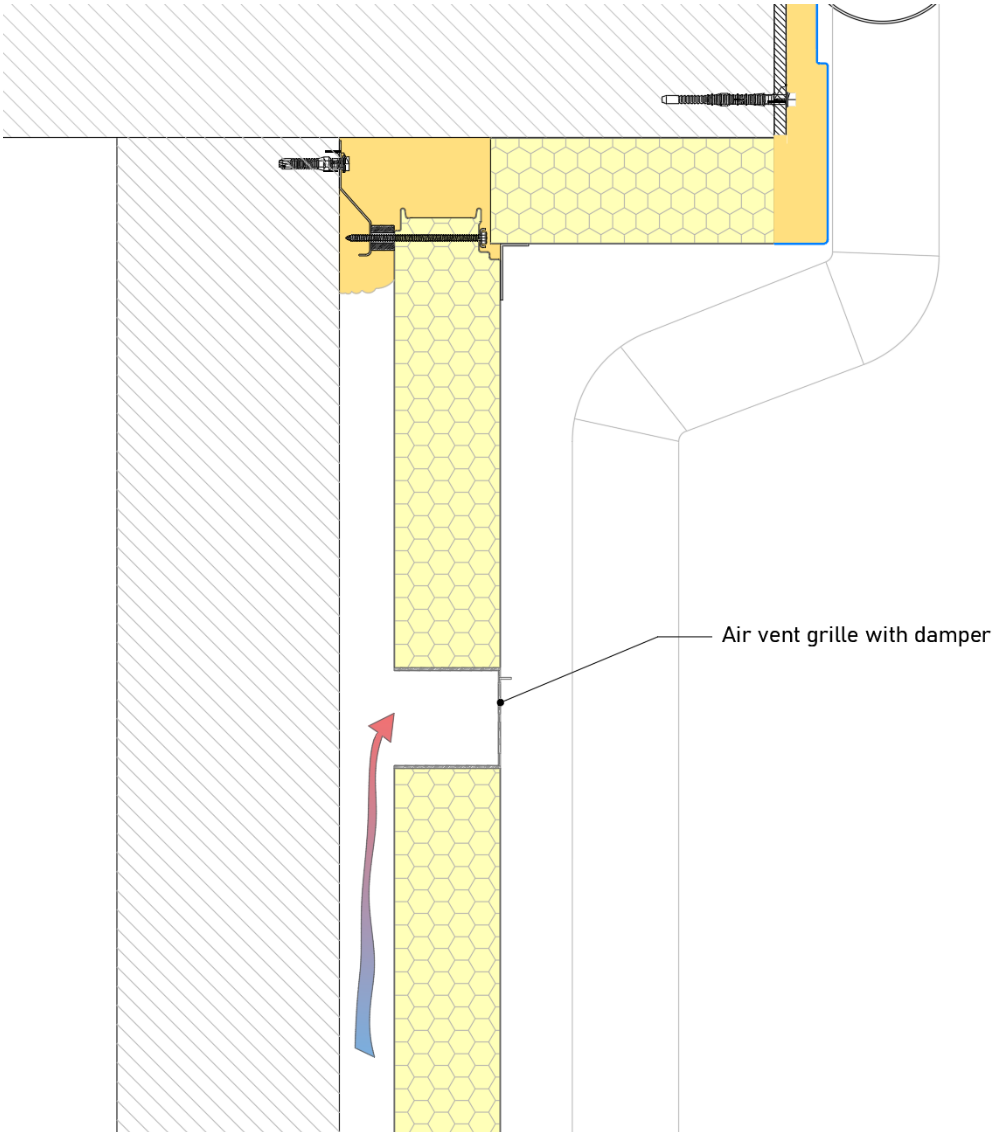


Figure 48. Top ventilation grille for air outtake

Figure 49. Stainless steel round Air Vent Grille with damper for facade ventilation

6.2. Maintenance

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

Cleaning

The most effective way to clean the façade 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 façade and the level of pollution in the environment. In general, it is recommended to clean the façade at least once every 5 years. If the façade 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. The panels will be optimized to resist various impacts, such as soft body impacts, flying debris, and other potential hazards like kids playing near the façade. These aspects will be thoroughly tested to ensure durability and safety.

Annex I: Pull-out Test Guide

DYNAMOMETRIC TEST

Funded by
the European Union

Table of Contents

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

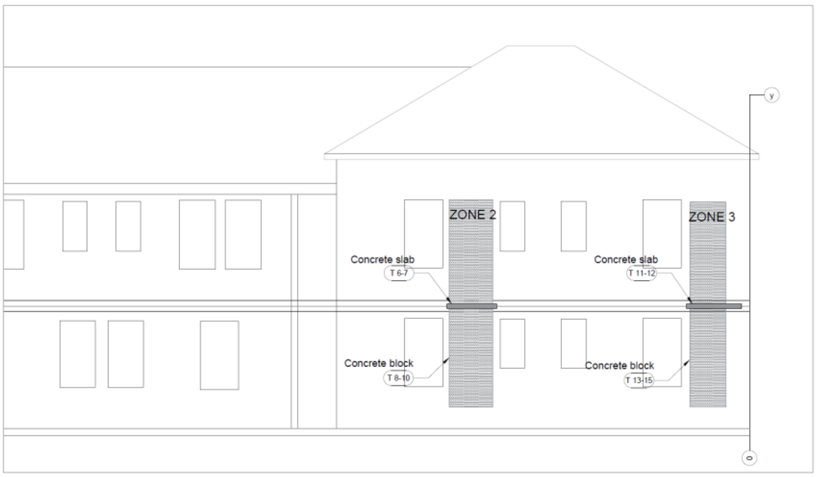
Specifically, in annex B:

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.*

Within the RE-SKIN project, 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 engineer may identify additional regions that require evaluation to improve the accuracy of the characterization process.



Example of elevation with areas for testing

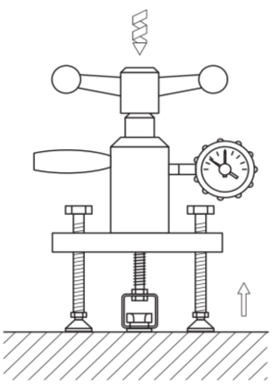
2. TEST EXECUTION

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 should be progressively increased to test the anchors to failure, either by destruction or by pull-out, which is the typical outcome.
This load must act perpendicular to the surface of the base material and be transmitted to the plastic anchor via a hinge. The reaction forces should be transmitted to the base material in a manner that does not restrict the potential breakout of the masonry. This condition is considered fulfilled if the support reaction forces are transmitted either to adjacent masonry units or at a distance of at least 150 mm from the plastic anchors.



RE-SKIN

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.

Below is a table with the recommended anchors (plugs). These recommendations are based on extensive testing and analysis of load capacities, wall construction types, and material compatibility. The recommendations are provided by GAR engineering team, who conducted these tests to ensure optimal performance and safety:

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

Based on GAR's experience with façade cladding installation and preliminary tests, several key points requiring attention have been identified. The following recommendations are provided:

- When testing on brick, we recommend searching for knots in two holes to allow the plug to achieve greater expansion inside the brick. This recommendation is based on preliminary tests that indicate improved stability and holding power when the plug expands adequately within the brick's internal structure.
- Preliminary tests and existing research indicate that using a longer plastic plug does not necessarily yield better results. The effectiveness of the plug is more dependent on its ability to expand properly within the material, rather than its length alone.

Plug on standard perforated clay 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)*

Annex II: 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

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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

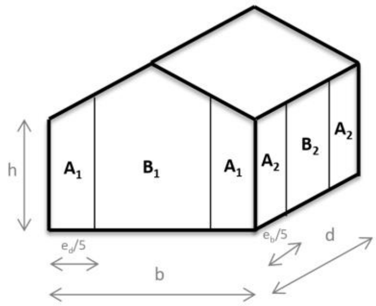
PROTOCOLLO DI PROVA (secondo EOTA TR051: Job site tests for plastic anchors and screws)					
PROTOCOLLO NR.	2023-1112	REDATTO DA:	Martin Losso	DATA DOCUMENTO:	19/10/2023
		STRUMENTO NR.	3DAZG070808	DATA VERIFICA:	10/10/2023

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.

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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	

weber SAINT-GOBAIN

EJOT

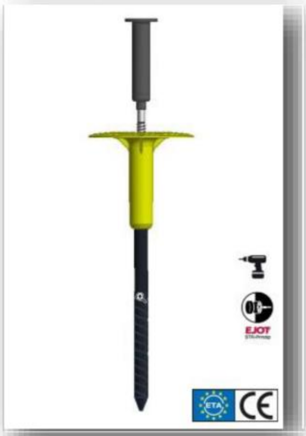
PROTOCOLLO DI PROVA (secondo EOTA TR051: Job site tests for plastic anchors and screws)					
PROTOCOLLO NR.	2023-1112	REDATTO DA:	Martin Losso	DATA DOCUMENTO:	19/10/2023
		STRUMENTO NR.	3DAZG070808	DATA VERIFICA:	10/10/2023

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)					
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		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

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		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)					
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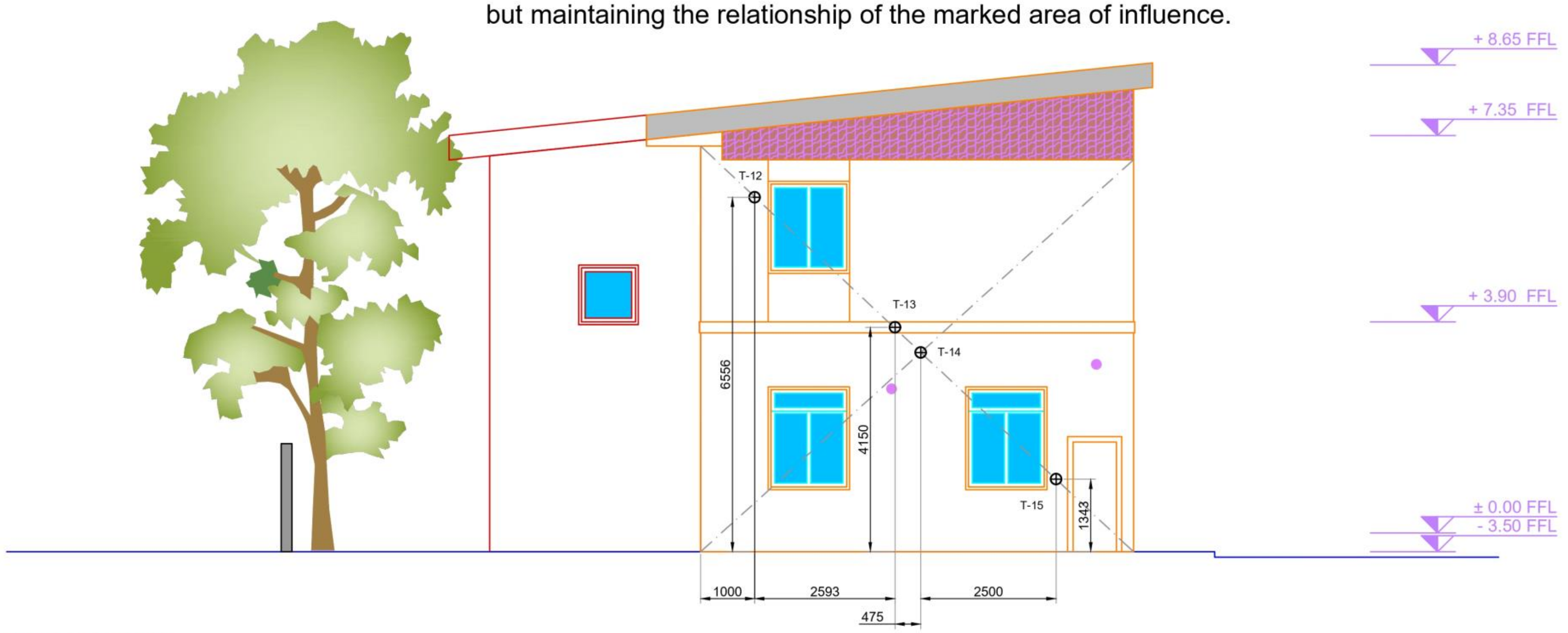
#NUM!

NOTE:

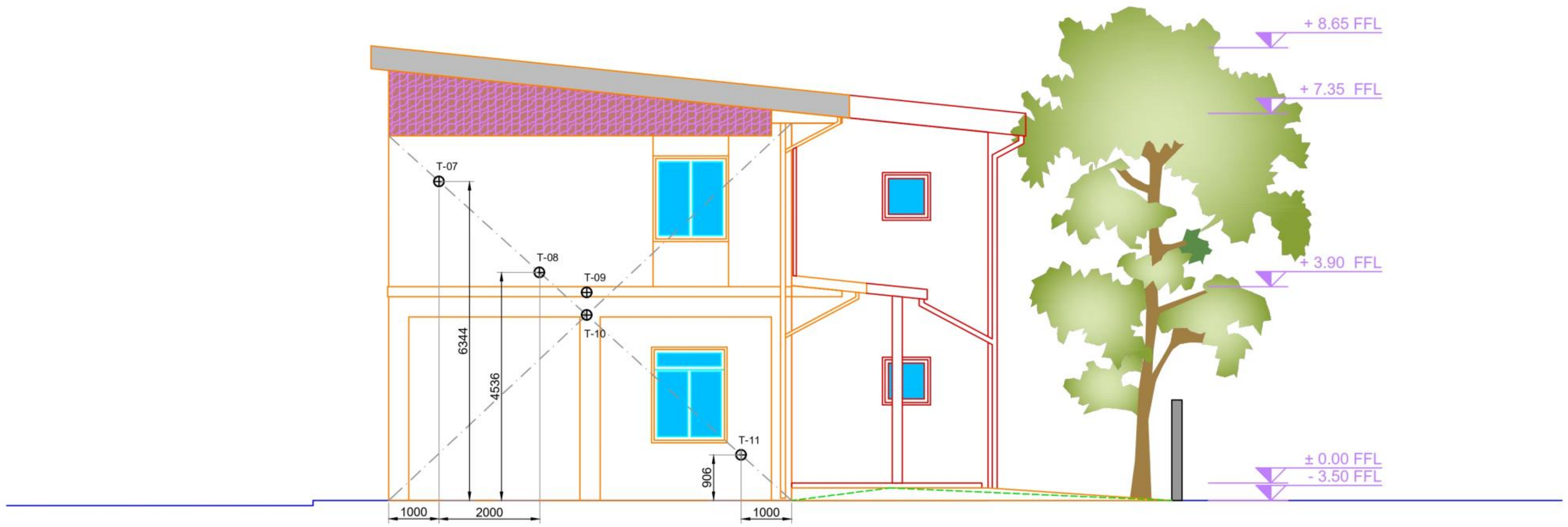
1. I valori di N_{Rk} riportati si riferiscono ad una applicazione eseguita "a regola d'arte" e conformemente alle indicazioni di posa EJOT.
2. La presente relazione non rappresenta un calcolo statico e ha il solo scopo di definire la resistenza allo strappo dei prodotti testati, nelle stesse condizioni 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 [signature]	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.



1
200
NORTH ELEVATION
SCALE: 1:100



2
200
SOUTH ELEVATION
SCALE: 1:100

m 0 1 2 5

SA106

APBD	RVSD
OFT.GR	Xrde	OFT.GR

Fecha	Versión
19/06/2023	1.02

Proyecto
RE-SKIN
Milan Demo Case

Situación
Milan Demo Case

Promotor
RE-SKIN

Plano
Pull-OFF TEST

APBD Xrde
Hoja 1/1

Garciarama
HILTI

PROJECT TITLE
RE-SKIN
Milan Demo Case

CLIENTE

ARCHITECT

PROJECT PHASES

Notes

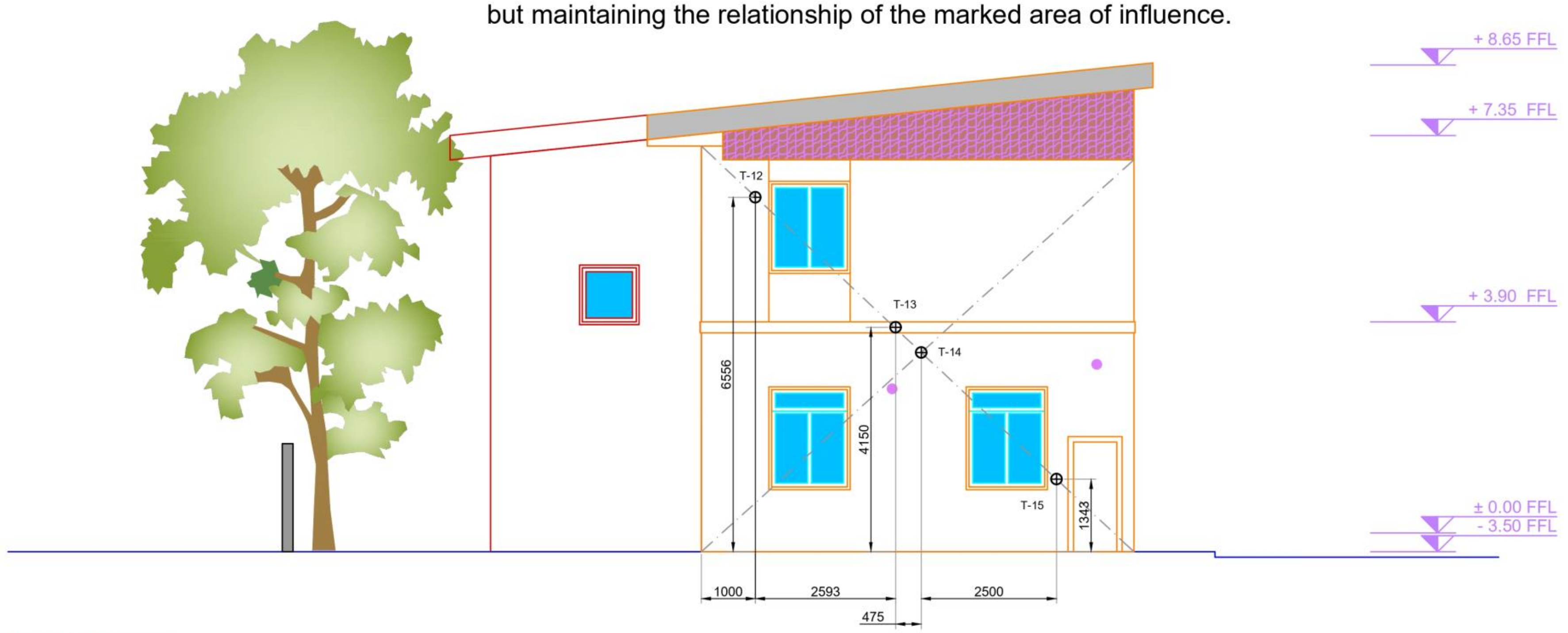
DRAWING TITLE
West and South Elevations
Existing

Drawing by	LM
Checked by	NA
Date	10.05.2023
Scale 1:100	Format A3
No.	
Revision No.	WIP

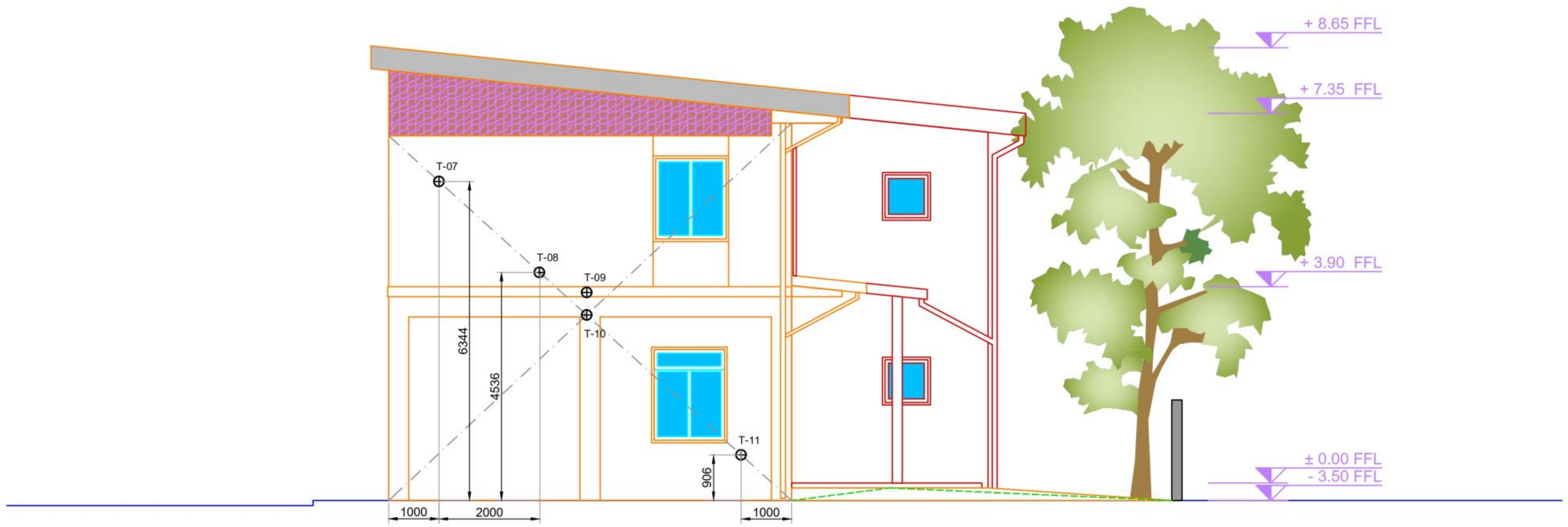
ZH Spin-off
Via Ariberto 20,
20123 - Milano
email: info@zhspinoff.com
www.zhspinoff.com

2301_RM_ARC_200_Elevation.dwg

The dimensions are indicative, they can be modified
but maintaining the relationship of the marked area of influence.



1/200 NORTH ELEVATION
SCALE: 1:100



2/200 SOUTH ELEVATION
SCALE: 1:100

m 0 1 2 5

T101	
APBD OFT.GR	RVSD 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

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West and South Elevations
Existing

Drawing by	LM
Checked by	NA
Date	10.05.2023
Scale 1:100	Format A3
No.	
Revision No.	WIP

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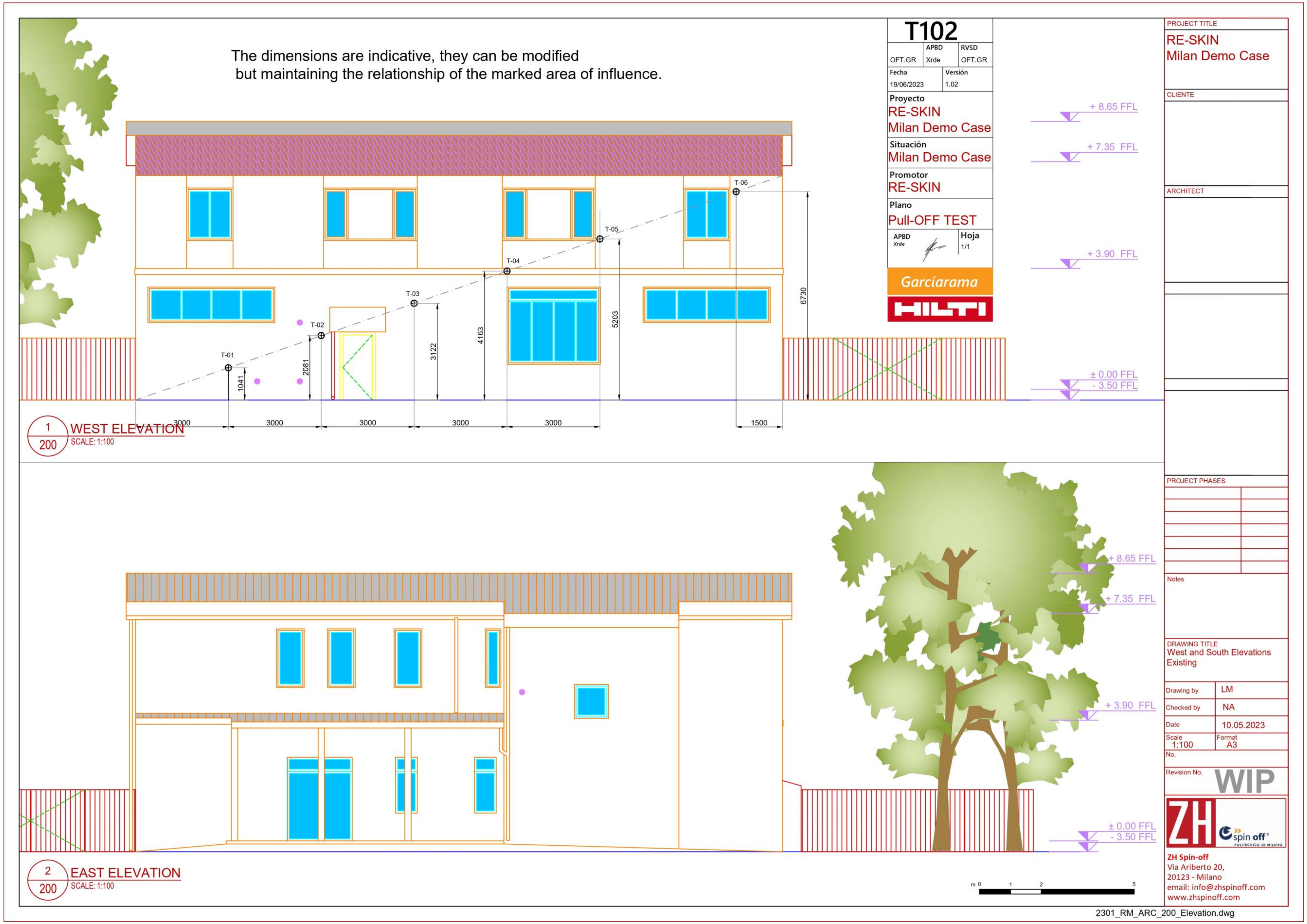
2301_RM_ARC_200_Elevation.dwg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T-01
T-02
T-03
T-04
T-05
T-06
1041
2081
3122
4163
5203
6730
3000
3000
3000
3000
3000
1500
+ 8.65 FFL
+ 7.35 FFL
+ 3.90 FFL
± 0.00 FFL
- 3.50 FFL
1
200
WEST ELEVATION
SCALE: 1:100
2
200
EAST ELEVATION
SCALE: 1:100
T102
APBD
RVSD
OFT.GR
Xrde
OFT.GR
Fecha
19/06/2023
Versión
1.02
Proyecto
RE-SKIN
Milan Demo Case
Situación
Milan Demo Case
Promotor
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Pull-OFF TEST
APBD
Xrde
Hoja
1/1
Garcíarama
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2301_RM_ARC_200_Elevation.dwg