D5.2 – Installation at demo sites

WP5

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Executive Summary

The present document constitutes Deliverable 5.2 “Installation at demo sites” in the framework of EENSULATE project and includes particular steps for the installation of EENSULATE solutions on the following demo buildings, located in different climatic areas in Europe, to validate the products:

- Polish School, Dzierżoniów
- Polish Museum, Dzierżoniów
- Italian San Giovanni public library, Pesaro

This deliverable is strictly related to the implementation of EENSULATE products developed in WP4 “Detailed design, prototyping and lab characterisation of EENSULATE façade modules”, preceded by its manufacturing process, preparatory works and constructive design for particular demo building in Task 5.1 “Retrofit process application at the individual testing sites” and it was based on installation guidelines prepared within Task 5.5 “Development of installation, commissioning and maintenance guidelines”.
In order to facilitate explanation of different steps, photos from the installation of Eesulate solutions from demonstration activities are included.

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Abbreviations and Acronyms

D - Deliverable

VIG – Vacuum Insulated Glass

BCF – bicomponent foam

WP – Work Package

DGU –Double Glazed Unit

TGU - Triple Glazed Unit

1 Introduction

The aim of this deliverable is to present the particular steps of installation of the developed EENSULATE solutions on the project real scale demo buildings.

The EENSULATE products (façade modules, foam and vacuum glazing) are integrated into both curtain wall and windows systems.

The EENSULATE façade module is the part of the curtain wall system which integrates VIG (transparent part) and BCF (opaque part) into façade solutions, in combination with a customized profile.

The EENSULATE VIG is a light and thin Vacuum glazing suitable for new, existing and historical windows.

There are two installation approaches to be followed, in general, during EENSULATE demonstration:

1. **Façade installation** with building preparatory works, supporting system fixing and modules installation, taking into consideration all connections, sealing and finishing.
2. **Substitution of existing glazing** with vacuum glass only by window sash dismountling.

In order to test the installation process of the EENSULATE products into real façade and windows system, three different demo buildings representing different building types have been selected: Polish Primary School, Museum City of Dzierżoniow and San Giovanni Public Library.

In the following sections, the installation steps for each particular demo case are presented.

2 EENSULATE demonstration cases

The three EENSULATE demonstration cases are:

1. **Polish Primary School** – Tertiary Building in Dzierżoniów, Poland where **EENSULATE façade modules** have been installed.

Figure 1 School in Dzierzoniow, Poland.

Demonstrator	Location	Total area	Type of intervention	Note
School	Dzierżoniów, Poland	115,5m2	facade system, VIG modules	1 facade with VIG and TGU

Table 1 Dzierzoniow school- scope of intervention.

2. **Museum City of Dzierżoniow** – Historical building in Dzierżoniów, Poland where the installation of the **EENSULATE VIG** to renovate the original old windows was performed.

Figure 2 Museum building.

Demonstrator	Location	Total area	Type of intervention	Note
Museum	Dzierżoniów, Poland	3,25m2	windows	3 windows, substitution of old single glass with VIG

Table 2 Dzierzoniow Museum – scope of intervention.

3. **San Giovanni Public Library** – Historical building renovated in 2002, Pesaro, Italy where the intervention is aimed to substitute standard double glazing units with **EENSULATE VIG** in a selected door.

Figure 3 Pesaro Library building.

Demonstrator	Location	Total area	Type of intervention	Note
Public Library	Pesaro, Italy	2,20m2	door	1 door, substitution of DGU with VIG

Table 3 Pesaro Library – scope of intervention.

3 EENSULATE retrofitting installation process approach

The following retrofitting scenarios were defined in order to demonstrate the applicability of EENSULATE components in different building retrofitting case.

Curtain Wall Façade (façade replacement):

EENSULATE module replacing existing Curtain Wall Façade (Polish Primary School case); the module is the part of the curtain wall system which integrates VIG and bicomponent foam to fill the spandrel volume in combination with a customized profile. This lightweight solution contributes to reduce the weight on the load bearing structure of the building and to increase its energy performance.

Figure 4 Façade modules scheme and demo building photo.

Windows:

EENSULATE VIG it is a light and thin Vacuum glazing suitable for historical and existing windows:

- **Historical window** – VIG for replacement of old single glass with improvement of energy transmittance without affecting the overall view of the window.
- **Contemporary window** – VIG for the replacement of standard DGU/TGU in existing window with improvement of performance without affecting the overall configuration of the window.

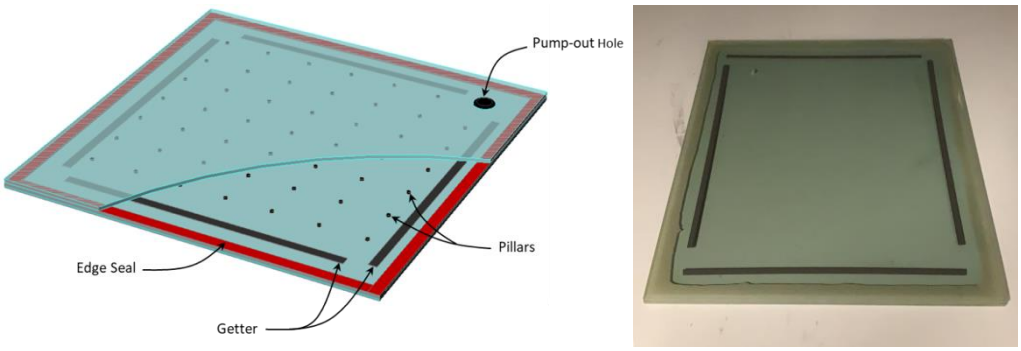

Figure 5 EENSULATE VIG scheme and the sample.

In the next chapters installation steps for retrofitting of curtain wall (for the Primary School case) and window retroffiting (for the Museum and Library case) will be presented.

Installation activities were preceded by preparatory works and the procedures include activities as detailed design, computer calculations of the systems, assessment of connections methods between particular elements and the building, as described in D5.5.

3.1 DEMO 1 Primary School in Dzierzoniow - Curtain wall

The EENSULATE demonstration building with biggest scope of intervention is a Primary School in Dzierzoniow.

The building has been built in 80's and it has a total curtain wall façade area of around 500 sqm.

One of the three existing façades with surface of around 115 square meters was dismounted and the new EENSULATE one was installed.

Figure 6 School façade before intervention– external view.

Figure 7 School façade before intervention – internal view.

The requirement of the building responsibles was to keep the same appearance in regards to shape, divisions and colors as existing aluminium façade, to be compliant with the two other façades.

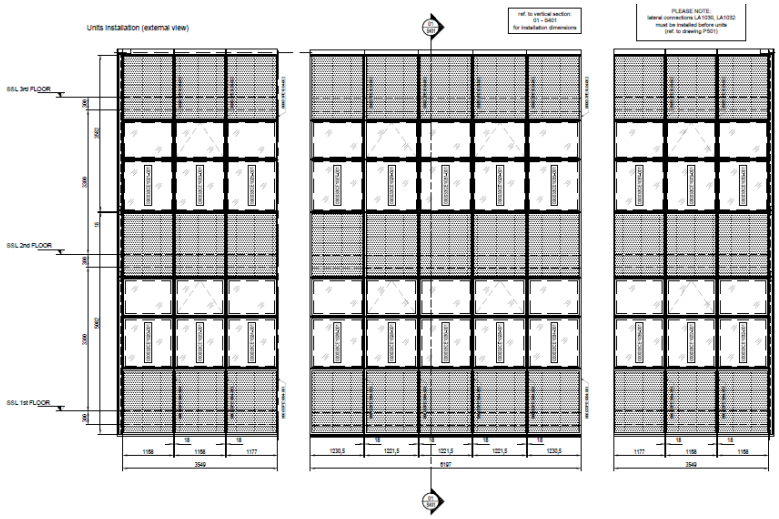

Figure 8 Façade units location.

The installation works started in December 2020, and ended in February 2021.

3.1.1 Overview – scope of intervention

The scope of intervention covered the substitution of two existing curtain wall façade floors, with an area of 115 m^2, by means of EENSULATE VIG developed and manufactured within the project and standard TGU units, enabling the comparison of performance between the two solutions.

The first action performed was the dismountling of the existing façade elements starting with glass, aluminium profiles through fastening elements removal.

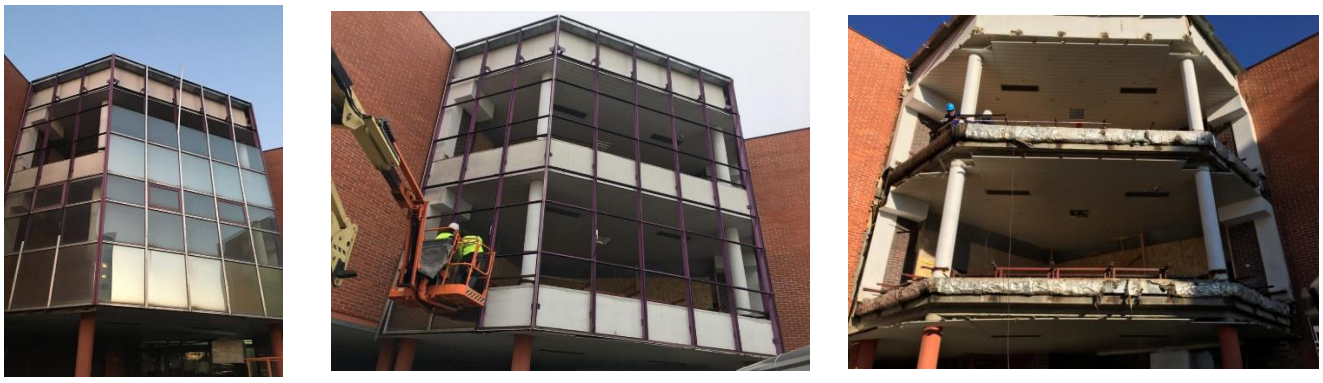

Figure 9 Dismantling of existing facade

Then, after building surface preparation with the support of previously prepared drawings and installation guidelines, the new EENSULATE façade was mounted.

Curtain Wall Façade retroffiting installation process:

Work flow - Façade
Demo 1 case - Polish Primary School – Tertiary Building in Dzierżoniów, Poland.

In the next sections, the focus will be put on the installation of supporting system and modules installation.

3.1.2 Installation steps - documentation

The installation required the following particular steps

- Brackets installation
- Lifting system positioning and use
- Unit installation
- Slab edge details

3.1.2.1 Brackets installation

Installation process begun with proper positioning of the brackets located on the front of the floor slabs. Location of the anchors at the building interface was conducted according to the position signed on the drawing.

Proper brackets installation is crucial for undisturbed units mounting.

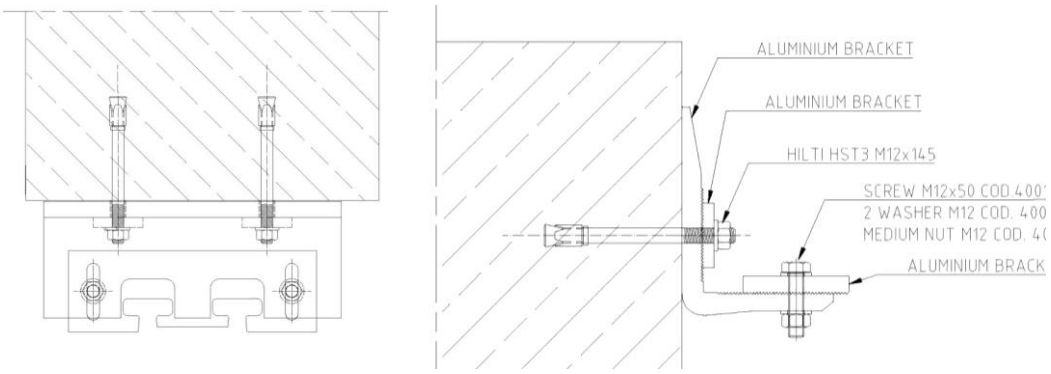

Figure 10 Drawing of the brackets fastening.

Figure 11 Bracket.

The fixing of supporting elements for façade units installation is documented by the following pictures.

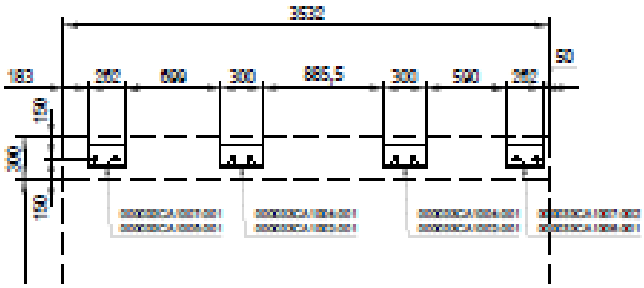

Figure 12 Position of the brackets – drawing.

Figure 13 Fixing elements installation – brackets.

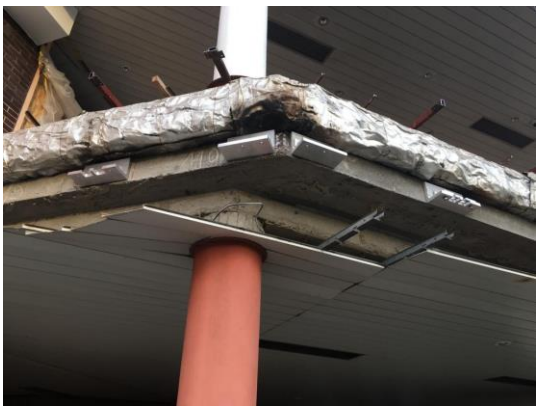

Figure 14 Brakets fixed to the slab – corner.

Once the above steps have been properly performed, the façade units could be fastened to the brackets installed to the building slab.

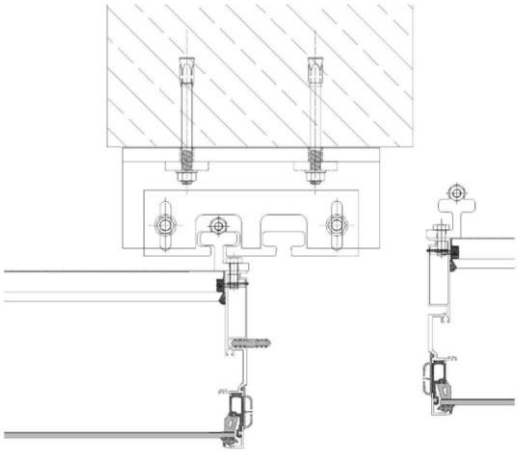

Figure 15 Fastening the units to the brackets.

3.1.2.2 Lifting system

In order to put the modules in position, a crane provided with a standard lifting device (hook) for units until 550 Kg was used.

Figure 16 Crane used to lift facade modules

During the lifting process, the standard lifting device was fixed to both side of the superior transom of each unit, as showed in

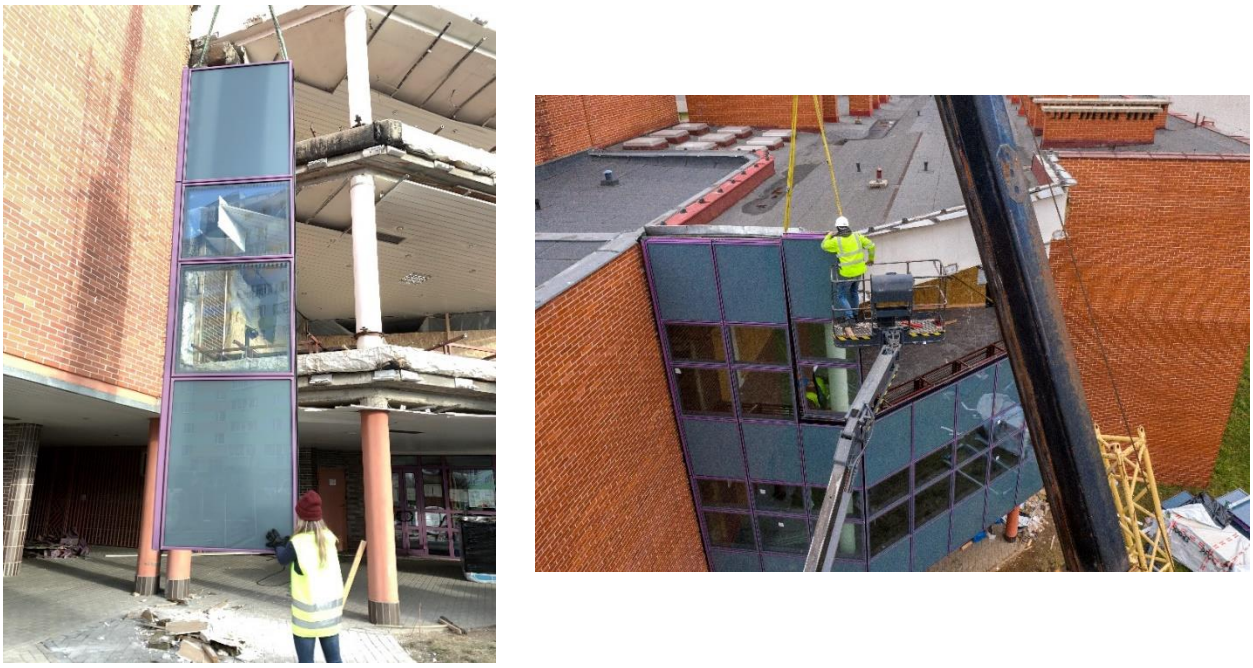

Figure 17.

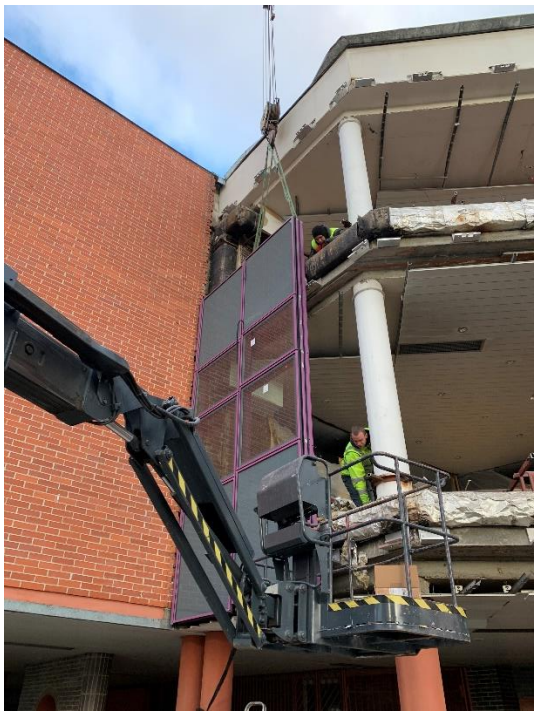

Figure 17 Lifting of a facade modules

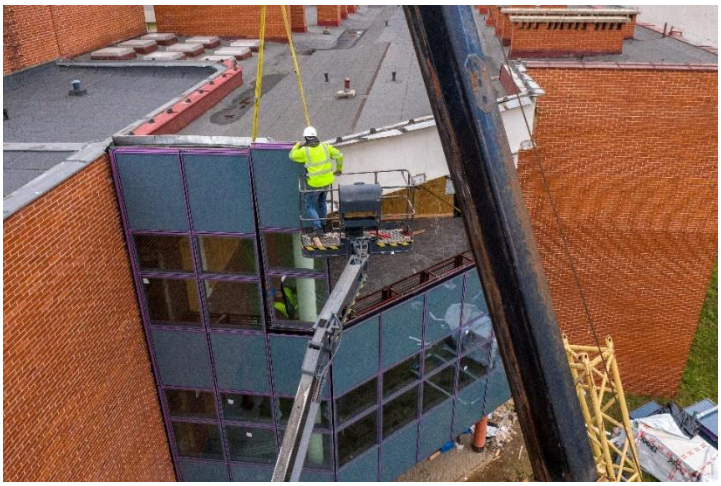

Figure 18 Lifting the units – photo.

3.1.2.3 Unit installation

The key procedure for the installation of the units is illustrated in the following.

Installation of the EENSULATE façade modules was performed from left to the right and from bottom to the top.

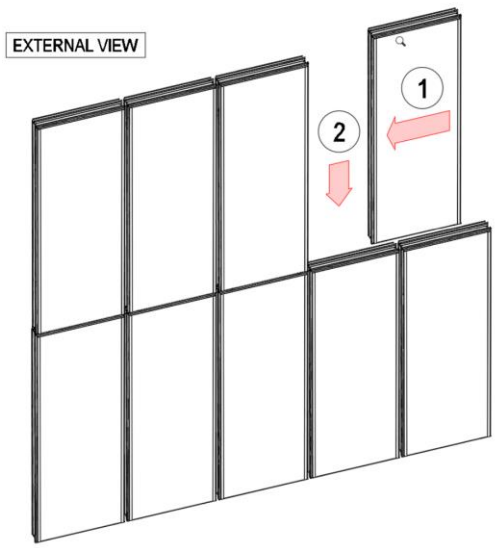

Figure 19 Installation direction.

The settling of the modular curtain wall units into position and securing to the brackets installed on the slabs were performed from the outside of the building. The units were lifted from a placement area on the ground near to the façade.

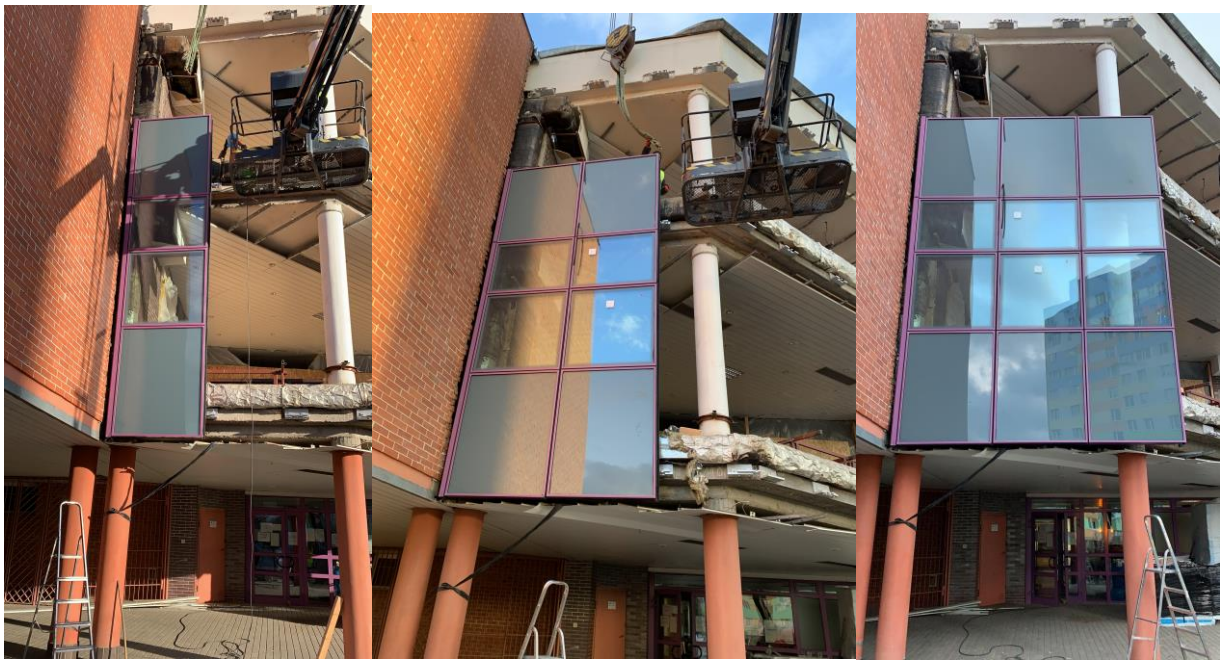

Figure 20 Unit installation direction.

The modules were lifted and directed to the appropriate location by means of the crane and then guided and hosted into position by the crew in order to be secured to the preinstalled anchors.

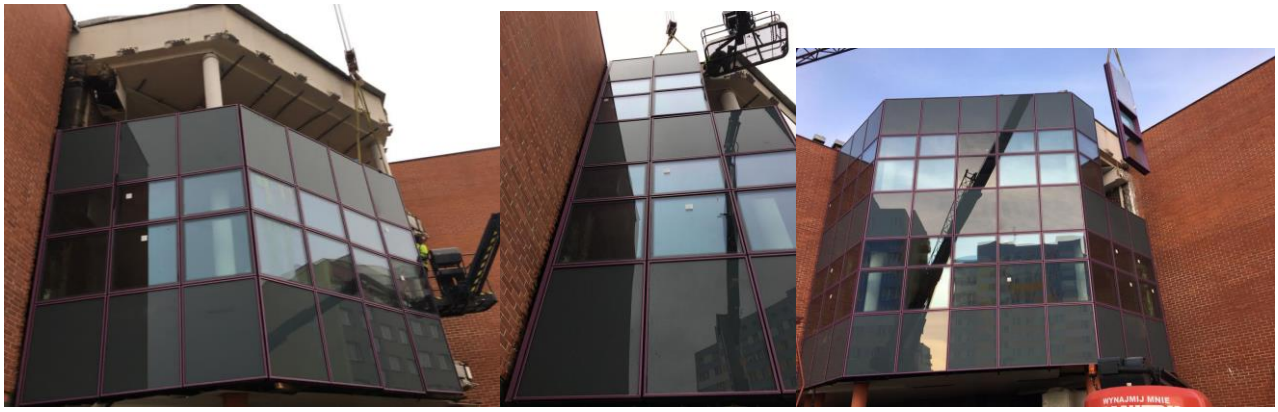

Figure 21 Unit installation progress.

Modules were attached sequentially following instruction marked on the prepared documentation (reported in D5.5). It is necessary to install a unit after the previous one up to complete the whole level.

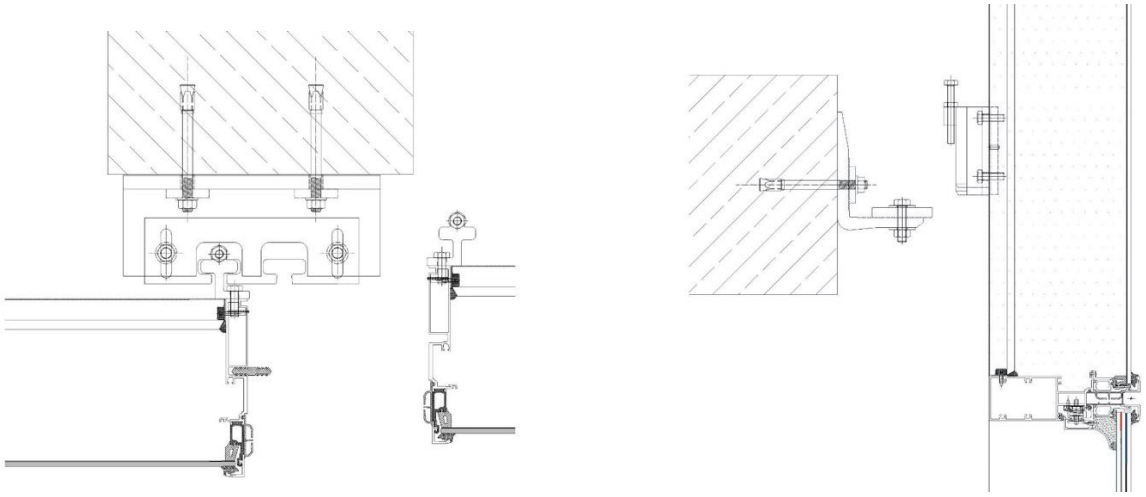

Figure 22 Units connection – plan and side view.

In order to guarantee that the façade units are properly in position, it was necessary to perform some steps on the gaskets, as illustrated below.

The general procedure for all facades is the following:

1. To position the first Unit correctly;
2. The vertical gasket has to be already installed on the unit, following the positioning rule from left to right the gasket is positioned on the right (external view)
3. Check if the gasket is properly fixed on the unit side.

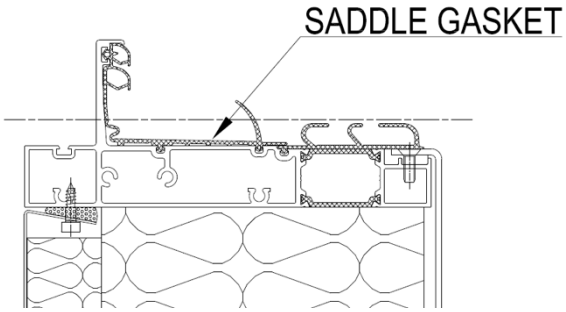

Figure 23 Saddle gasket position.

4. Lubricate the free-side of the vertical gasket of the unit already installed and the relative cavity on mullion (vertical element) of the unit to be installed. Do not use the lubricant on the upper/bottom 200mm of the gasket (in order to avoid lubricant near the upper sealing).

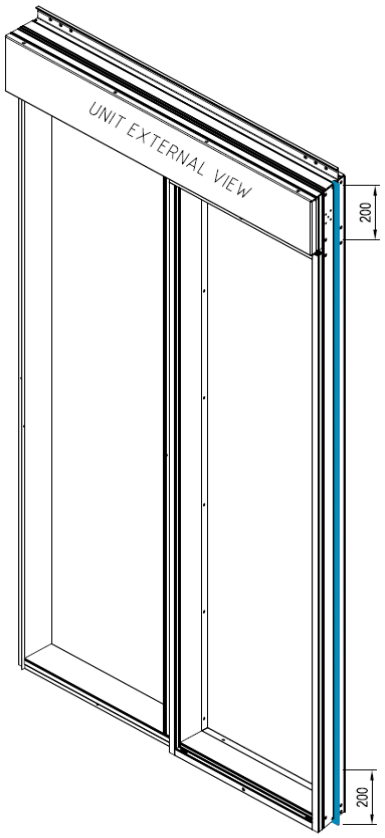

Figure 24 Unit external view.

The correct protrude length of the vertical gasket is 15 mm.

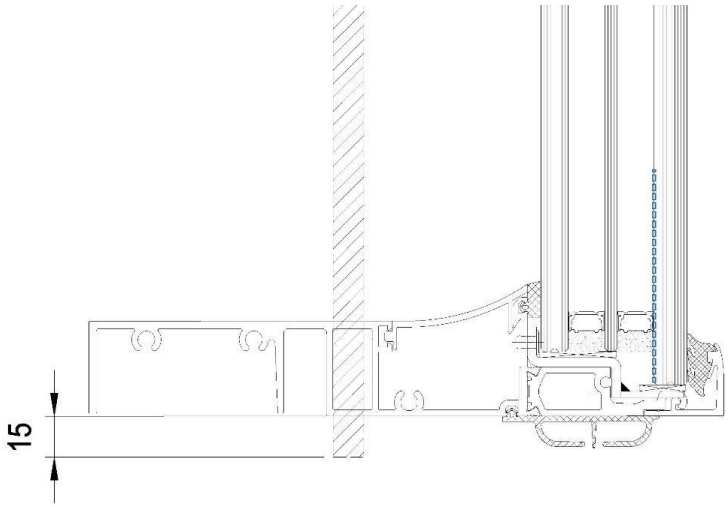

Figure 25 Vertical gasket lenght.

The aim is to achieve the touch between vertical and saddle gasket

5. On the top joint, clean with Cleaner Sika Glass&Metal, apply Sika Aktivator-205 and then, SikaBond TF Plus N Black on the top of the vertical gasket and the snaps of saddle gasket for 30mm length.

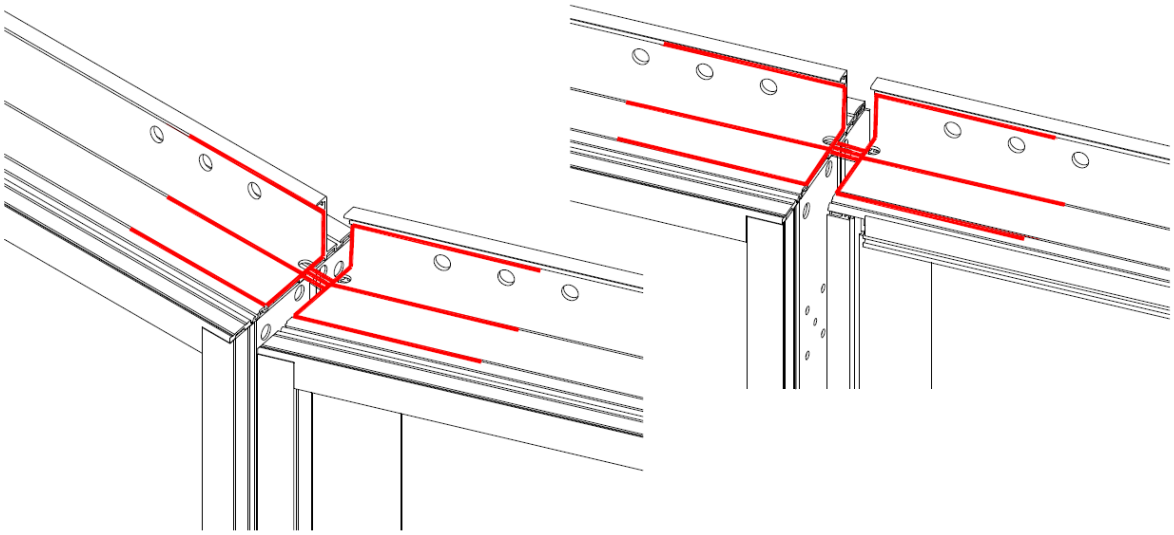

Figure 26 Sealing the units - scheme.

Façade components like gaskets, sealants and joints should be properly applied for preserving permability of the façade wall.

6. Saddle gasket overlapping

Where the saddle gasket should be overlapped, clean the alluminium transom and the gaskets in the joint corrispondance using Glass & Metal, apply Sika Aktivator-205.

Then put Sikabond TF Plus N Black on the joint of the two horizontal gaskets for about 30mm length.

Cut the flipper of the saddle gasket in front of the two lateral cuts of the vulcanized gasket.

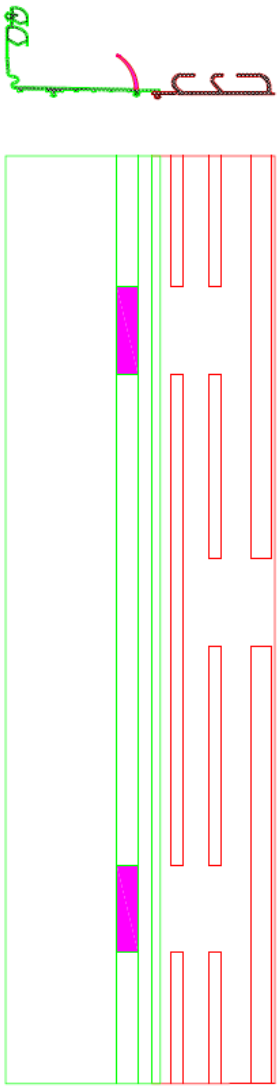

Figure 27 Saddle gasket cutting – scheme.

Figure 28 Saddle gasket cutting – photo.

Clean the vertical gasket at the bottom and the saddle gasket with cleaner R40; then seal with Black DC 791 silicone as shown in figures below.

Lubricate the rest of the saddle gasket seat (except for the part with silicone).

7. Insert the vertical profile where necessary following the installation drawings.

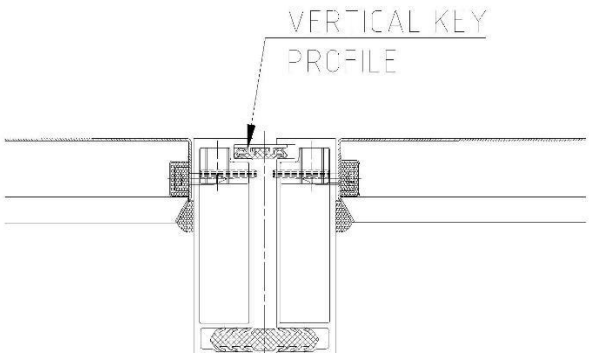

Figure 29 Inserting the vertical profile.

The new EENSULATE façade presents the same divisions as the old ones in order to be in line with existing facades.

Figure 30 Façade view - before intervention

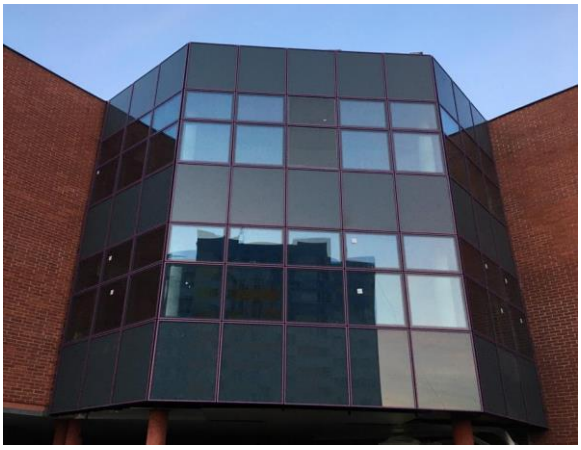

Figure 31 Façade view - after intervention

3.1.2.4 Slab edge details

The following procedure explain how the slab details have been installed.

A 1,5mm galvanized steel sheet was put from the level below in the right position and sealed to the internal side of the unit and to the concrete. Where the galvanized steel sheet crossd the mullions junction, the junction was sealed (if necessary, it is possible to use a pipe to seal through the cavity) and the two sealings joint.

From the top level, the cavity between the slab and the Unit was filled with mineral wood insulation.

3.1.3 Conclusions – curtain wall retroffiting

The installation process of the EENSULATE façade system is similar to the installation procedure used for traditional façade retrofitting.

Thanks to the EENSULATE system it is possible to retrofit the building providing better thermal performance and inside comfort using lighter and thinner constructions. This contributes to the facilitated installation

process due to the weight of construction and influences the logistic because of reduced storage and transportation place needed due to the thinner glazing units.

On the basis of school demo it was proved that the EENSULATE solution is suitable for retroffiting of existing buildings where preserving the same appearance is crucial but it can be also applied to new constructions.

Standard double or triple glazing can be also replaced by EENSULATE Vacuum glass just by adjusting aluminium glazing bead.

Glass façade systems have big influence on the general building behaviour due to the big transparent surface that can influence thermal building performance if not properly selected. For that reason, planning and proper installation procedures are important.

3.2 DEMO 2 Dzierżoniow City Museum – Window retroffiting

The second demo is an historical building built in 1897 hosting City Museum. As in case of historical objects, the building has its limitations concerning any changes to be introduced and recommendation of keeping the same windows appearance during its retrofitting.

Thanks to EENSULATE VIG it is possible to substitute existing poor performing single old glass with high thermal Vacuum Insulating Glazing, keeping the same construction of the windows thanks to reduced thickness and lightweight of the Vacuum glass.

EENSULATE activities in this demo includes substitution of three glazing panes with Vacuum glazing in windows located in one room on the ground floor.

Figure 32 Museum -External windows view.

Figure 33 Museum -Internal view of the windows.

3.2.1 Installation steps

Due to the historical character of the building, the scope of activities was limited to works connected with substituting existing old single glass with EENSULATE VIGs, by dismantling the window sash and without affecting window construction and its appearance.

In case of VIGs application to existing windows, the approach below is followed.

Window retroffiting:

Work flow – Windows
Demo 2 case - Museum City of Dzierzoniow – Historical building, Dzierżoniów, Poland
Demo 3 case – San Giovanni Public Library – Historical building, Pesaro, Italy

Existing windows are old box windows with double sash opening to the inside, filled with a single glass.

The scope of intervention is to replace old single glass with EENSULATE VIG of thickness 10,2mm (6+0.2+4mm), by dismounting the window sash.

As the windows constructions are deteriorated, in order to be able to insert the new glass, each sash was renewed by sealing, painting, using the most similar materials as existing ones and performing all necessary works required for its proper functioning.

As a first installation step, the window sash was removed carefully in order to perform renovation works.

Figure 34 Window sash dismounted.

The old glass has been removed and the wooden sash elements was cleaned and renovated.

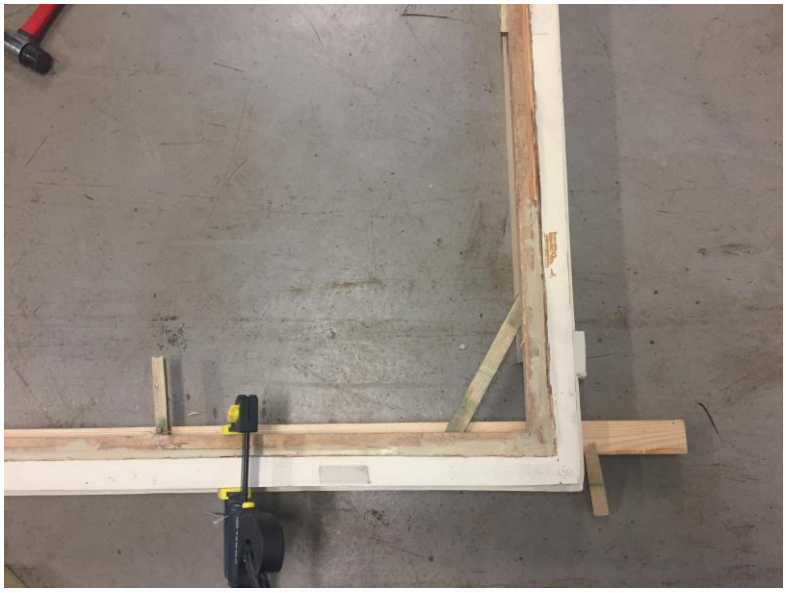

Figure 35 Old sash before renovation.

Before glazing putty application, wooden elements parts were protected with tape.

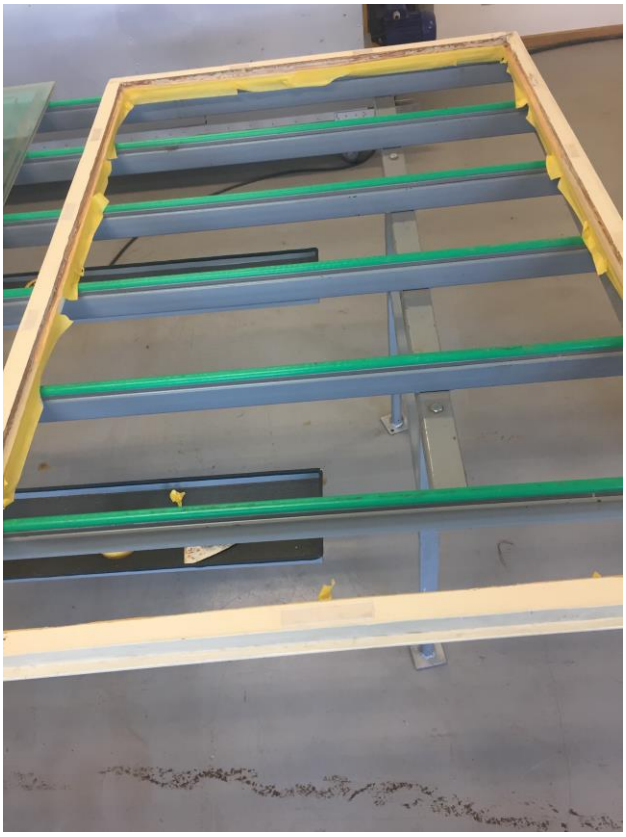

Figure 36 Window sash protected before glazing putty application.

After cleaning the area for inserting VIG, the new glazing putty was applied.

Figure 37 Application of the glazing putty.

The EENSULATE VIG was prepared with tailored dimensions for the particular window sash.

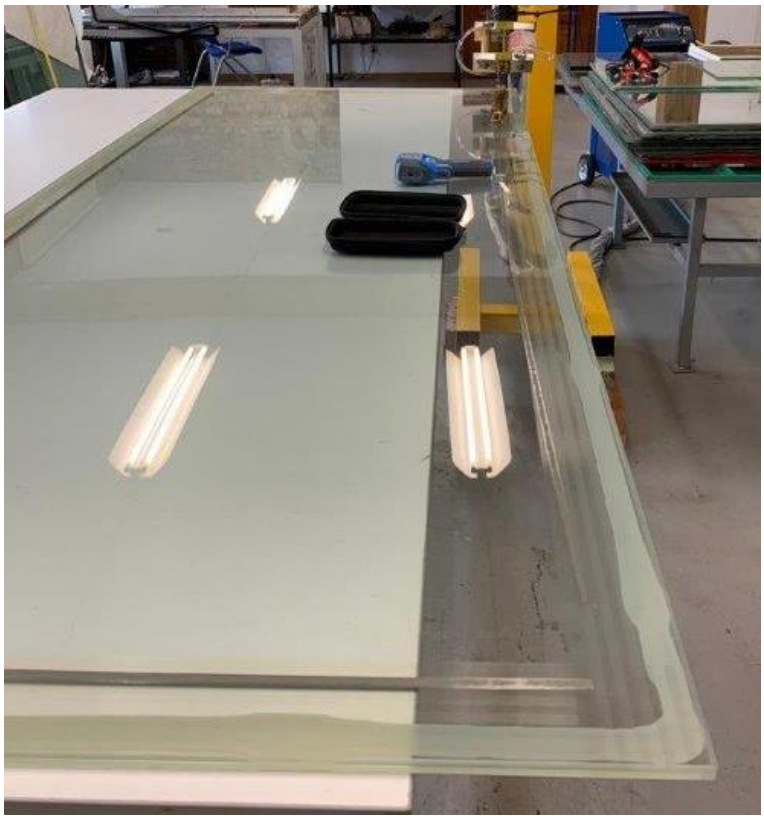

Figure 38 Vacuum glass preparation.

Figure 39 VIG glass to be inserted in the old sash.

Previously manufactured EENSULATE VIG was inserted into existing wooden window sash by means of vacuum holders.

Figure 40 VIG glass inserting.

In order to cover sealant and getter, the VIG edges was painted with special coating having the same color as window construction. Then, each window sash was repainted using exactly the same color as existing windows.

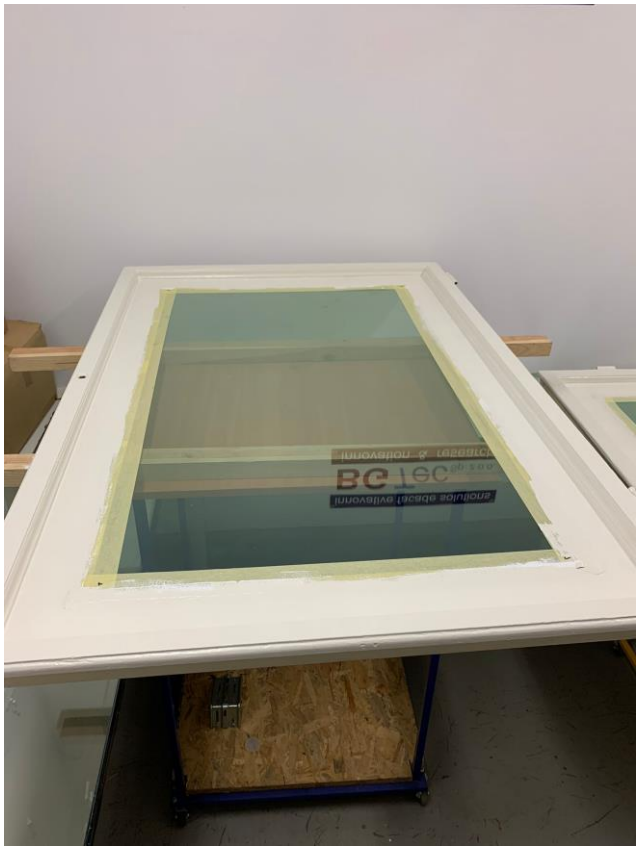

Figure 41 Window sash painted.

In order to preserve the existing details of the window, old accessories like handles were renewed and reinstalled in the same combination.

Figure 42 Existing window handle renovated.

Finally, the same sashes with EENSULATE Vacuum glass were installed in the existing frame on site.

Figure 43 Window frames with VIGs - Internal view.

Figure 44 Museum windows after renovation.

During this intervention, the window opening was protected against damaging and weather conditions while all operation were performed at BGTEC facilities.

3.2.2 Conclusions – window retroffiting

Regarding historical buildings, most interventions are reduced to minimum avoiding works that exceeds necessary renovation due to character of the building and respect of the historical heritage and appearance of the building construction.

Thanks to EENSULATE Vacuum glass there is no need to replace exisiting old windows for improving thermal performance, since this improvement can be obtained only by substituting of the glazing.

The renovation works has been carried out in accordance with existing appearance using materials as similar as possible to previously applied in existing windows.

Museum demo case allowed to monitor the process of replacing the glass in historical buildings without damaging existing windows and showed the possibility of adapting the solution to this demanding type of construction.

3.3 DEMO 3 San Giovanni Public Library – Contemporary door replacement

The third demo building case of EENSULATE retrofitting is San Giovanni Public Library located in Pesaro (Italy). This historical building has been object of a full renovation in 2000 while many contemporary elements have been introduced.

Figure 45 Pearo library building – internal.

In the Library, one of the door along the main corridor was retroffited. The wooden construction hosted double glazing. The retrofitting activities did not affect the aesthetic of the building and included the replacement of the existing DGU with EENSULATE VIG.

Figure 46 Library door external view- before intervention.

3.3.1 Installation approach

The scope of intervention in the library included one door as an example of VIG application in contemporary joinery frames. The retrofitting of the door consisted in maintaining the overall wooden frame and replacing only the DGU, with thickness of 28 mm, with the VIG, of thickness of 18 mm. The intervention was conducted by removing the internal aluminium profiles which restrained the existing double glazing, cleaning the area from the old sealant, placing the VIG, sealing the edge to create air and water tightness performance and repositioning the aluminium. All operations were performed on site with the sash mounted.

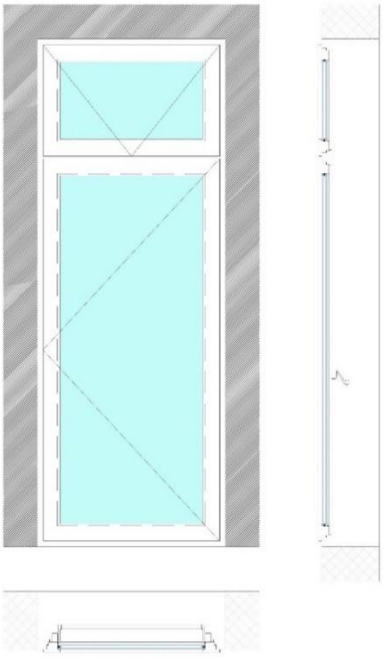

Figure 47 Library door- view and sections.

Particular installation steps are presented in the photos below.

Figure 48 Library door - internal view.

First of all, dismantling of existing glass was performed by means of vacuum holders, after removing aluminium elements.

Figure 49 Existing glass dismantling.

Figure 50 Old glass removing.

Before inserting the new glass, window sash was cleaned from existing sealant

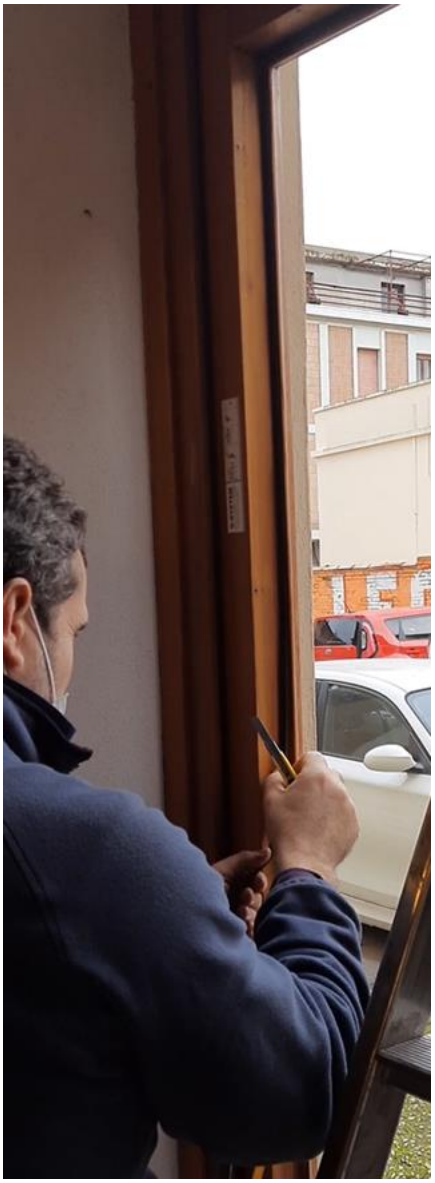

Figure 51 Cleaning the glazing area.

Then, the VIG was prepared and positioned into the existing frame.

Figure 52 Preparing the VIG for installation.

Figure 53 Placing the VIG.

After Vacuum glass placement, aluminium glazing bead was installed.

Figure 54 Glazing bead installed.

As the selected door is an emergency exit door, the anti-panic handle was reinstalled.

Figure 55 Handle installation.

EENSULATE VIG was also applied in the fixed upper part of the door.

Figure 56 Door after intervention – external view.

The museum door after replacing glass is presented on the photos below.

Figure 57 Museum door with VIG – internal view.

Figure 58 Door with VIG – external view.

Figure 59 EENSULATE label near library door.

3.3.2 Conclusions – door retroffiting

This small intervention shows applicability of EENSULATE VIG in different type of buildings. VIG glass can be applied in different configurations depending on the building requirements. Installation process does not differ from standard procedure of glass installation or replacement. The whole process went smoothly without any particular problems and was performed on site.

4 Conclusions

Acivities performed within the EENSULATE project led to the installation of developed solutions such as façade modules and Vacuum Insulated Glass (VIG) on real demonstration buildings. Despite the installations described reflect specific retroffiting cases of existing buildings, the developed products are suitable also for new constructions. Moreover they can be applied in such demanding constructions as historical buildings.

The EENSULATE ones are novel products but the installation process does not differ much from state-of–the-art façade and windows units installation and, thanks to the reduced thickness, handling on site is facilitated.

The EENSULATE VIG product is a lightweight solution with thin structure that can be easily hosted by existing construction of the windows made of different materials. Because of the reduced thickness, profiles of the new constructions can be further reduced, leading to facilitated installation process and logistic thanks to reduced weight and space occupation during the transport and storage. Moreover, the EENSULATE Vacuum glass can be adapted to different configuration depending of safety and thermal requirements of the building.

The activities performed confirmed future replication of EENSULATE products in different types of buildings.

Next activities within the EENSULATE project are focused on validation of the systems performance through analysis of the monitored results of each demonstration building.
Further activities for developed products should be concentrated on improvement of the visual aspect of the glass (minimalizing the sealant and getter margin on the edges) and on developing a more automatized process for products manufacturing.