D4.2 – Prototypes for testing in relevant environment

WP4

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Project Acronym	Eensulate
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Executive Summary

The present deliverable demonstrates the activities conducted in Task 4.2 “Manufacturing of the prototype for testing in relevant environment” to manufacture the prototypes for the final tests of EENSULATE façade module. The deliverable objectives are:

- To demonstrate the manufacturability of EENSULATE façade module based on the facade system design;
- To demonstrate the integrability of EENSULATE components (VIG and Foam) in Eensulate façade module;
- To demonstrate the scalability of the EENSULATE façade module towards the industrialization.

The deliverable reports the positive achievements of the EENSULATE façade module prototyping in line with project developments and expectations. In particular, the following report presents the assembly activities of the EENSULATE façade module protypes manufactured for testing activities to be conducted in T4.4 “Testing and monitoring activities”.

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1 Introduction

The aim of the Task 4.2 “Manufacturing of the prototype for testing in relevant environment” is to demonstrates the scalability of EENSULATE façade module towards industrial needs duly justifying availability of the proposed materials for potential further massive use and wide replication both in new built and renovation across Europe. Within the task activities, the EENSULATE façade module prototype was designed based on in EENSULATE façade system design and it was manufactured according to specifications.

The deliverable D4.2 “Prototypes for testing in relevant environment” shows the manufacturing phases for the unit prototypes manufacturing based on the EENSULATE module designed within the T4.1 “Design optimization and development of the façade module”.
The activities were conducted in Focchi facility integrating the EENSULATE components (EENSULATE bi-component foam (Selena) and EENSULATE VIG (BGTEC)) in the EENSULATE façade module. The prototypes were manufactured on the base of protypes to be assembly for the tests to be conducted in T4.4 “Testing and monitoring activities”:

- Acoustic Mock-Up (AMU) to be conducted in line with UNI EN ISO 16283-3:2016/EC 1-2016/EC 2-2016 and UNI EN ISO 717-1:2013;
- Performance Mock-Up (PMU) to be conducted with EN ISO 13830:2005 Curtain Wall Façade;
- Fire Mock-Up (FMU) to be conducted in medium furnace in Ulster facility.

The above-mentioned mock-ups have been manufactured in the T4.2 “Manufacturing of the prototype for testing in relevant environment” and the activities are reported in this document.

2 Prototype Eensulate façade module manufacturing

The EENSULATE façade module has been manufactured on the base of the EENSULATE façade system design and the detail designs for the mock-ups. Operative Instruction for manufacturing has been defined to support the production line operations and the demonstration of the industrialization of the process. The main operations for EENSULATE façade module manufacturing are here listed:

1. **Eensulate frame assembly**
   1.1. **Profile preparation** – In this phase, EENSULATE profiles (mullions and transoms) are preassembled. In particular, the aluminium profiles are filled with sponge and silicone 5 mm back in comparison to the external edge. This operation allows to have watertight profiles.
   1.2. **Frame assembly** – In general a unit frame is composed by two mullions, one upper transom and one lower transom; in addition, the number of intermediate transom depends by the unit dimension and typology. In this phase the prepared profiles are assembled through mechanical connections. The connections which are made by self-tapping screws are always filled by grey sealant to guarantee the water tightness and fill all the slot between the profiles.
2. **Manufacturing of spandrel part**
   2.1 **Metal sheet positioning** – Once the unit frame is assembled, in the spandrel part is located a metal sheet since it allows to stiffen the aluminium frame and to host the insulated foam. The connection is made in the inner part of the profile through self-tapping screws which are filled by grey sealant for the water tightness.
   2.2 **Sealant for tightness** – The metal sheet in the spandrel part is carefully sealed for the water tightness.
   2.3 **Plasterboard positioning** – A plasterboard is located in the spandrel part in order to guarantee acoustic performance. The plasterboard is fixed to the metal sheet by sealant.
   2.4 **Heating pre-foaming –** The unit components need to be heated over 50 C° to correctly react with the foam. Therefore, 15 minutes before the foaming process, a heating lamp was located over the unit. Difficulties to heat all the components due to the direction of the lamp heating.
   2.5 **Foaming** – The foaming process involved the use of a specific foaming machine. The critical part was to calculate the right amount of foam and the time for distribute evenly in the unit. Once distribute the liquid foam a steel template is located on the cells and locked with several clamps in order to block the spreading of the foam out of the units. The steel template is lifted after 4 minutes the foaming activities. The foam is expanded and hardened.
   2.6 **Glazing** – This phase involved the use of the lifting crane in order to bear the weight of the glass components and positioned in the unit.

3. **Manufacturing of the Vision part**
   3.1 **Internal curved cover cap positioning** – The curved cover cap profile is joined to the frame through mechanical connection.
   3.2 **EPS profile and gasket -** In this phase the gasket is located in dedicated notched and it is ready to host the glass components.

4. **Mechanical restraint**
   4.1 **Positioning** – The glass component is fixed to the frame through mechanical restraint.
   4.2 **Gasket positioning** –The gasket located with a resin hammer in order to fix it between the glass and the mechanical restraint.
   4.3 **Corner joint** – Finally, the mechanical restrains are fixed the 45° angled corner are sealed together.

Pictures regarding the chronological order of the manufacturing phase are reported below:

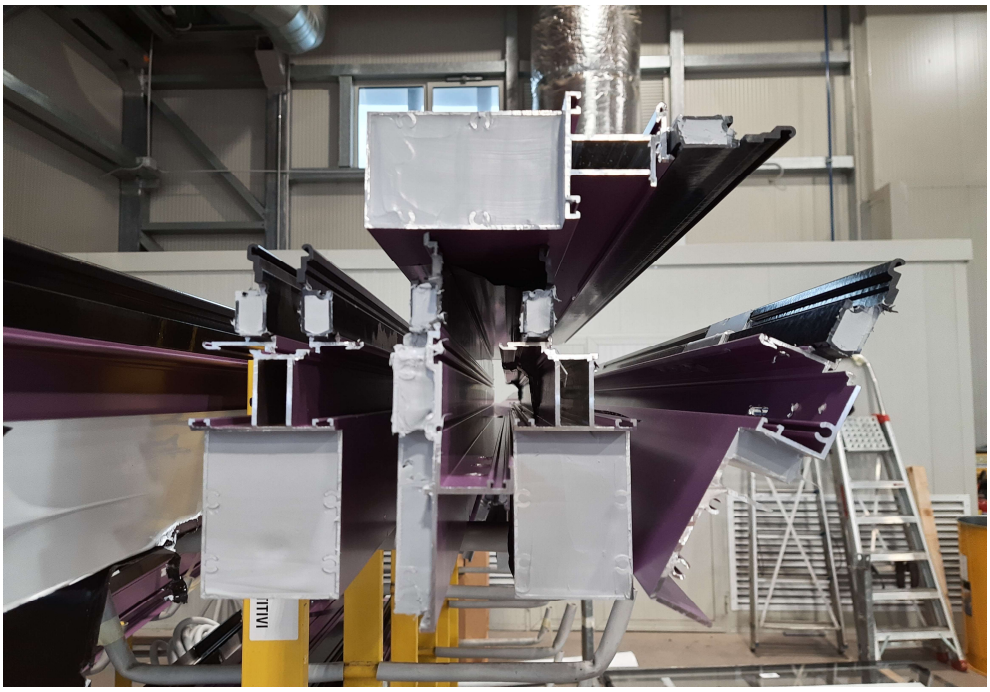

Figure 1 EENSULATE profiles preparation

Figure 2 EENSULATE frame assembly

Figure 3 EENSULATE frame assembled

Figure 4 Spandrel part – metal sheet positioning

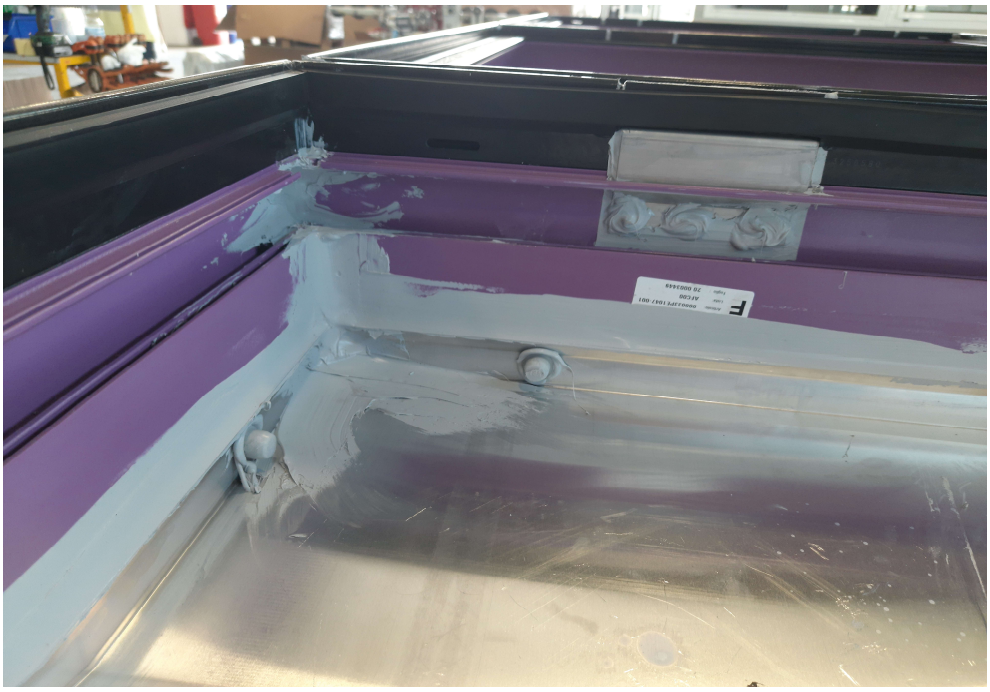

Figure 5 Spandrel part – sealant for tightness

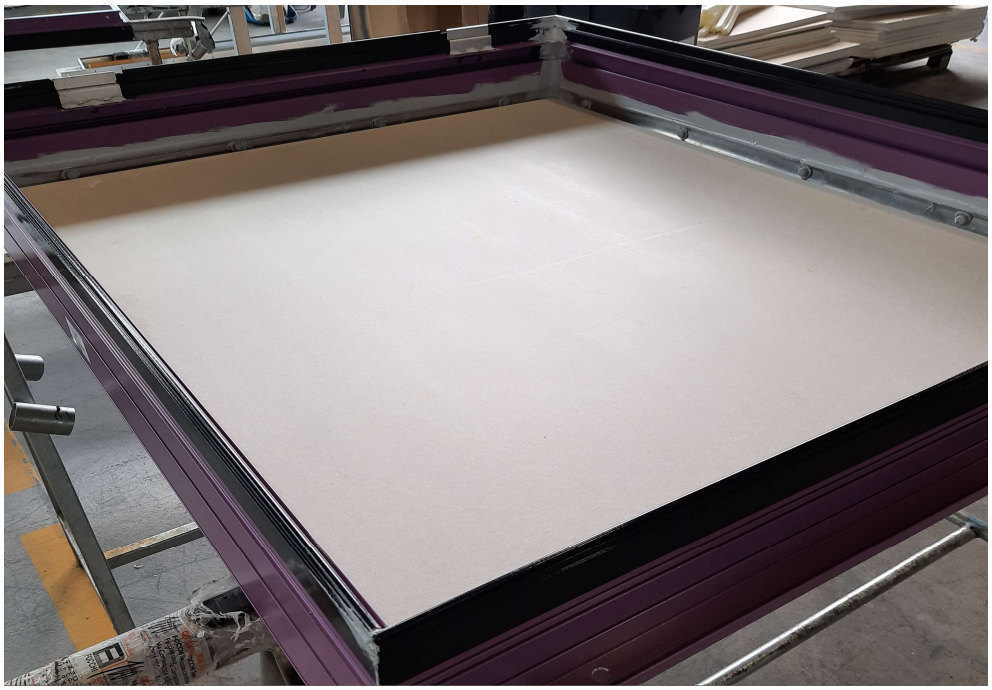

Figure 6 Spandrel part – Plasterboard positioning

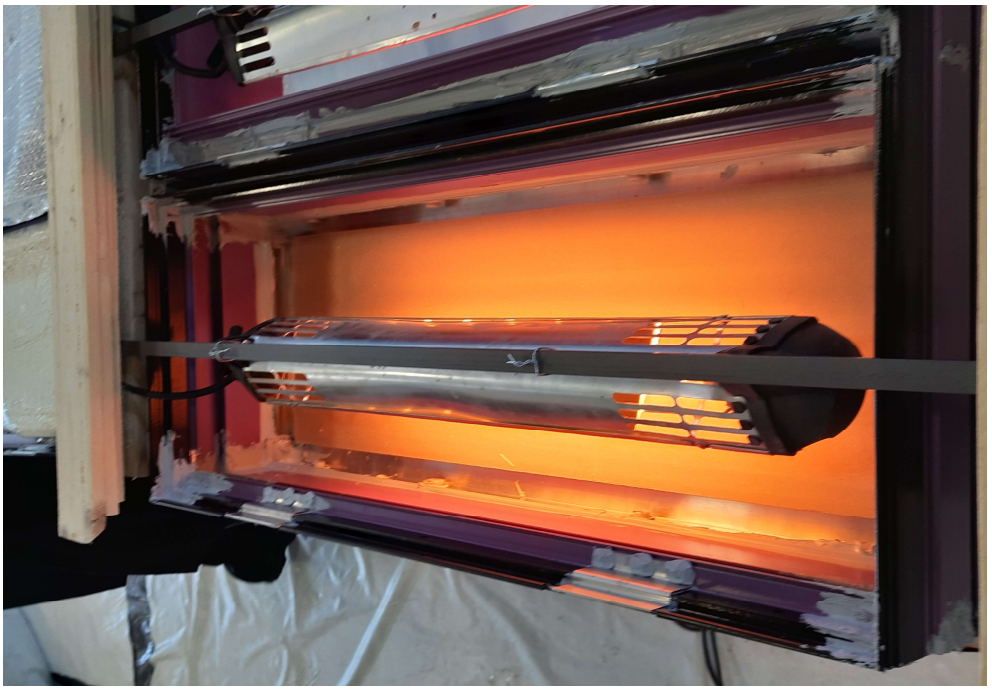

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Figure 10 EENSULATE spandrel part ready to be glazed

Figure 11 Spandrel part - glazing

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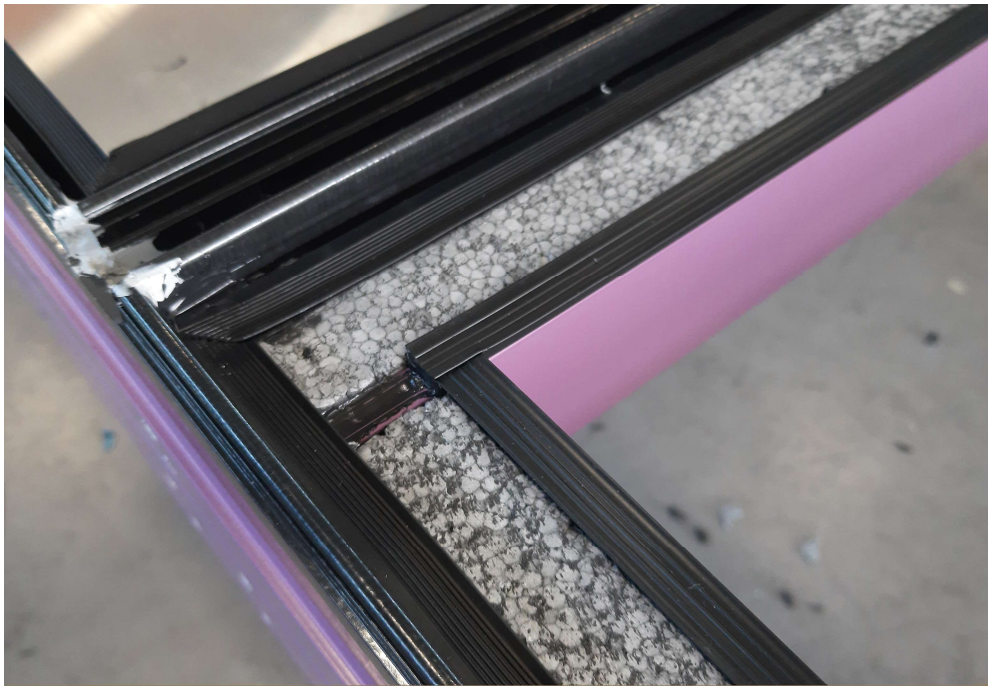

Figure 13 Vision part – EPS profile and gasket

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Figure 14 Mechanical restraint – preparation

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Figure 16 Mechanical restraint – gasket positioning

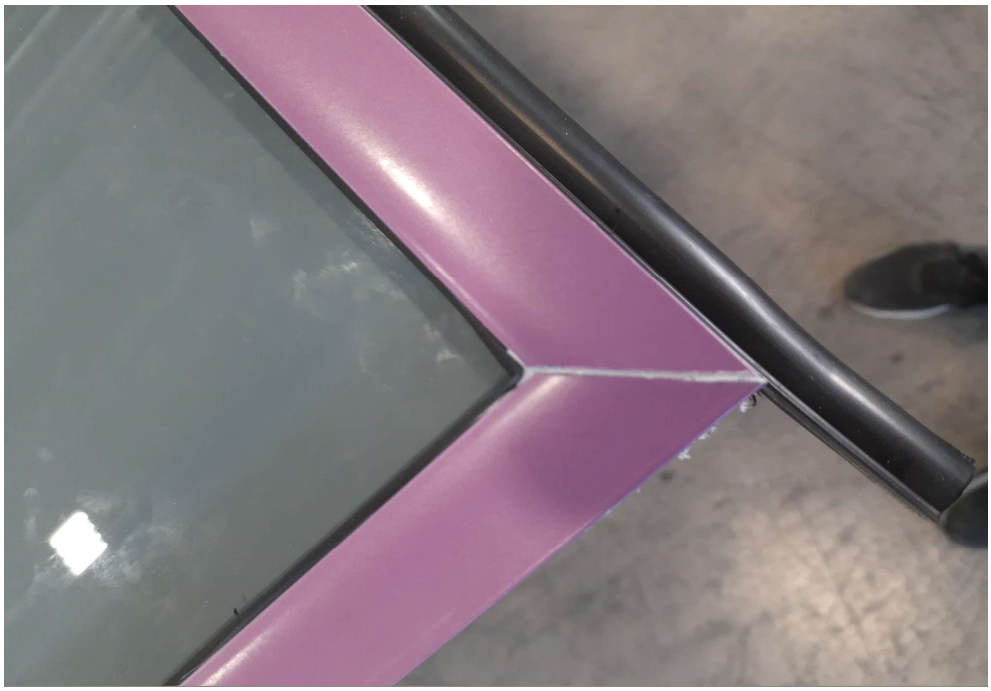

Figure 17 Mechanical restrain – corner joint

Figure 18 EENSULATE façade module prototypes

3 Conclusion

The EENSULATE façade module prototyping demonstrate the effectiveness of the EENSULATE façade system design and its manufacturability. In particular:

- The foaming of EENSULATE foam in the spandrel has been positive achieved. After the development of foam and the preliminary tests conducted for foaming the spandrel during WP2, the optimization of foam formulation and foaming process have demonstrated its effectiveness. The main issues emerged in WP2 were:
    - Heating of the spandrel to have right foam expansion;
    - Shrinkage of the foaming;
    - Ruining of gaskets and profile dirties due to foam expansion.

  During the prototyping of EENSULATE façade module, all these issues have been successfully faced. The result is a relevant reduction of the shrinkage due to an homogenous mixed of the foaming and a correct heating of the spandrel; the foam expansion was conducted with a metal sheet under pressure, allowing the distribution of the foam and to not have any issues on the profiles and related gaskets.
- The EENSULATE VIG has been installed on the Eensulate profile specifically designed for the integration. The profile-gasket system is in line with the façade design.

The EENSULATE façade module manufacturing is in line with the expected design, demonstrating the manufacturability of the façade. The test and monitoring activities included in T4.4 “Testing and monitoring activities” and in WP5 “Validation of performance, sustainability and replicability” will demonstrate the effectiveness of the EENSULATE façade module.