Fig. 1: Tagliolo Monferatto Castle

Effective use of internal insulation

Retrofitting an ancient palace in a medieval village in Piedmont, Italy

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This article describes retrofitting activities of an apartment on the first floor of a 400 year old building unoccupied for years with a lot of perimeter walling below street level. Retrofitting included an energetic upgrade that the owner family desired with the aim of achieving a maximum level of comfort with minimum investments. This task, a kind of project that surely will not be encountered every day, was mastered within a period of 10 months of planning to execution directed by ing. Marco Arata.

Ing. Marco Arata Graduate in Genoa University. Since 2009 he is KlimaHaus Energy consultant and PassivHaus Designer since 2015. Marco Arata is founder of Arata EcoBuilding a workshop specializing in project of Low Energy Building and refurbishment of historical palaces in Italy.

Dry or hygroscopic interior insulation, a fundamental decision to be made

The wall on the eastern side of the building comes below street level. A second wall on the northern side borders a garden on the northern side with partial lateral contact of the basement to adjacent soil and is unprotected from rainwater by any roof eaves (fig. 2). For these reasons, most of the building's perimeter is affected by moisture infiltration.

Fig. 2:
(a) Northern façade
(b) northeast corner by interior

The project posed a great challenge and a tempting opportunity to experiment with new thermal insulation techniques that the PassivHaus Designer ing. Marco Arata decided to implement for this historical structure. The three-storey building, located in the historic centre of a small village in the Monferrato area just a stone's throw from a medieval castle (fig. 1), had a natural stone façade of substantial value that did not permit the application of any type of external insulating layer (fig. 8c). The only possible choice for any type of thermal insulation for the perimeter walls was then to approach the task from inside.

As a consequence, the only possible choice was a hygroscopic insulation system. Hence, for the entire apartment perimeter, Multipor type calcium silicate panels from Xella with a thickness of 140 mm were considered appropriate. The chosen thickness constitutes the minimum to be sufficient for achieving an appropriate thermal transmittance of the finished wall, i. e., below 0.27 W/m²K, and at the same time a value representing the limit for enjoying the tax deduction granted by the Italian government for this purpose (fig. 3).

Fig. 3: MultiPOR panels thickness of 140 mm

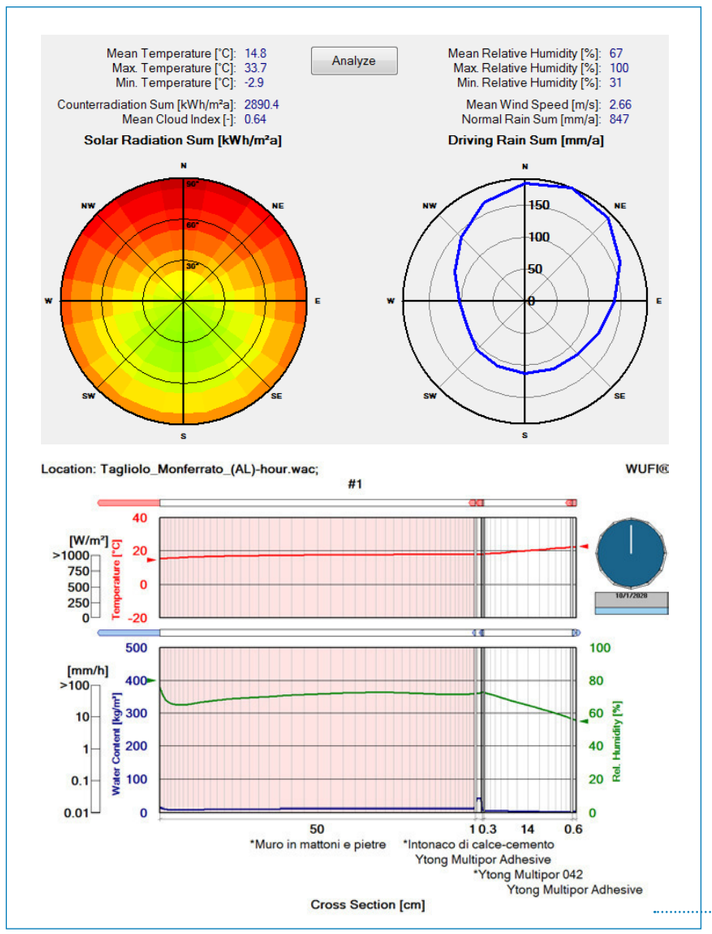

Fig. 4: WUFI-Software report

Moreover, in the northeastern corner of the building, architectural planning envisaged a bathroom. Hence, a greater degree of internal moisture with corresponding levels of continuing infiltration from the outside into the wall could be expected. Moreover, the desired type of wall covering required the installation of tiles onto the Multipor panels. This, however, could not be carried out if the waterproofing layer with Volteco's osmotic mortar was not pierced or damaged in any other way.
Using WUFI-Software, it was possible to verify the presence and accumulation of moisture in the wall over a period of three years, with the design stratigraphy rendering highly satisfactory theoretical results (fig. 4).

The lower floor bordering the unheated rooms of the cellar turned out to be a structure composed of solid bricks with 360 mm thickness. This structure was insulated with a 100 mm thick panel of extruded expanded polystyrene (XPS).
After insulating the lower floor, Multipor panels with a thickness of 140 mm were installed. This made it possible to excavate the space needed for the electrical system sheaths and for positioning the power plugs. As can be seen in fig. 5, processing this material is very easy and can be carried out either by hand or with the help of electric equipment.

The upper floor bordering other heated apartments is made up of wooden beams with an ancient 30 mm plank. The owners decided to restore this architectural element so as not to lose this feature as its aesthetic appearance is of special value for their home. For this reason, any insulation measures were not desired. In order to achieve air tightness, a BG2 expanding tape was inserted in the spaces in between the internal silicate insulation (fig. 6).

Fig. 5: (a) Electrical system sheaths (b) shoulder pads of the windows

Fig. 6: Upper floor wooden beams

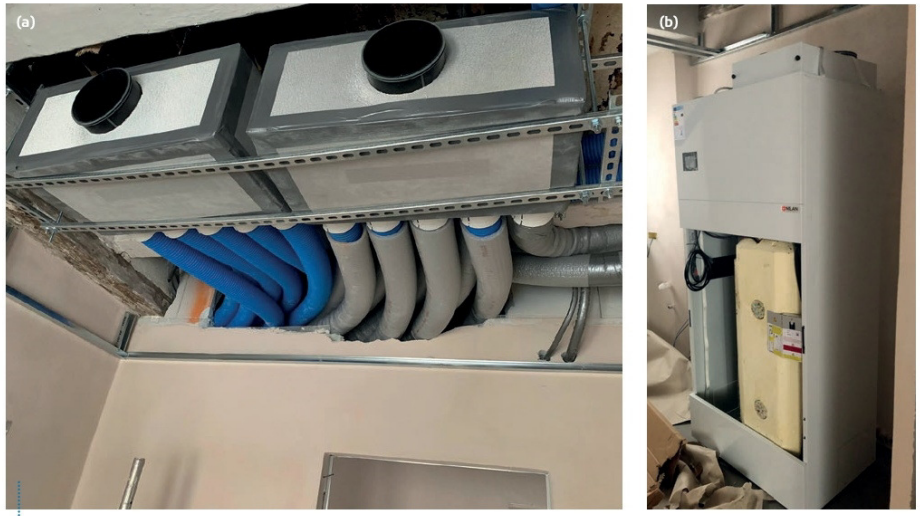

Fig. 7: (a) Exhaust and inlet air plenum (b) VPM machine

The counterframe was effected after wrapping the shoulder pads of the windows with a Multipor panel of only 50 mm thickness. In order to avoid a reduction in the illuminating surface, the fourth side in the French windows was connected with a vapour barrier placed over the insulation of the lower floor.

Before plastering the interior wall, a plasterable tape was placed between counterframe and internal insulation.

The internal insulation in the form of calcium silicate panels presented a problem for the installation of the false ceiling. This was solved by laying, one the one hand, a course of autoclaved concrete panels that are more resistant to any impacting load and, on the other hand, by systematically inserting wooden dowels for the installation of the curtains.

After applying an insulating shell for this level of the building, the maximum energy required for winter heating only amounts to 2 kW. This is achieved by an air system powered by an air-water heating pump and ducted with a mechanical air exchange system connected to a compact aggregate type Nilan CompactP (fig. 7).

Air tightness was verified by means of the Blower-Door-Test, during which leakages still present are detected to be sealed with suitable materials, such as, in the case of window frames, MS polymer, and in the case of system sheaths, EPDM plugs. After completion of this job, the result obtained turned out to be very satisfying, namely, 2.7 h^{-1} which is better than the required value of 3.0 h^{-1}.

The building is scheduled to be fully usable by the end of 2019. Remote monitoring has been planned to last for a period of three years to evaluate the performance and quality of this highly innovative construction work. This project constitutes a best practice example for the small village of Tagliolo Monferrato and beyond. The recovery of existing building stock is a challenging philosophy for an area with high tourist traffic capabilities, and it appears that the Multipor internal insulation solution best fits demands when it comes to ancient buildings (fig. 8).

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Fig. 8:
(a-b) Internal insulation finished
(c) East Facade