Did you know that using insulation foams and panels in building saves 2.400 million tons of greenhouse gases in the world, but doesn't work without adhesives?

"Heating causes around 14% of the greenhouse gas emissions in the EU. Up to 75%of the heat inside a building escapes through its exterior walls. An efficient insulation can reduce energy costs by as much as 60%. Using chemical products provides better insulation, saves energy and reduces greenhouse gas emissions. In Europe, the no heating cost house is a reality" *(Cefic - Data from EU Commission, Cefic and ICCA)*

Not only heating costs, but also air conditioning/cooling costs can be dramatically reduced by a proper ETICS (External Thermal Insulation Composite System).

ETICS is a system usually including an adhesive, a leveling mortar, an insulation panel, an alkali-resistant reinforcement grid, a primer and a finishing coat, as well as sealants and accessory materials for the installation (Figure 1). Being ETICS a multi-component system, the compatibility among the components is a key factor in order to obtain the performances of the overall system as well as its durability.

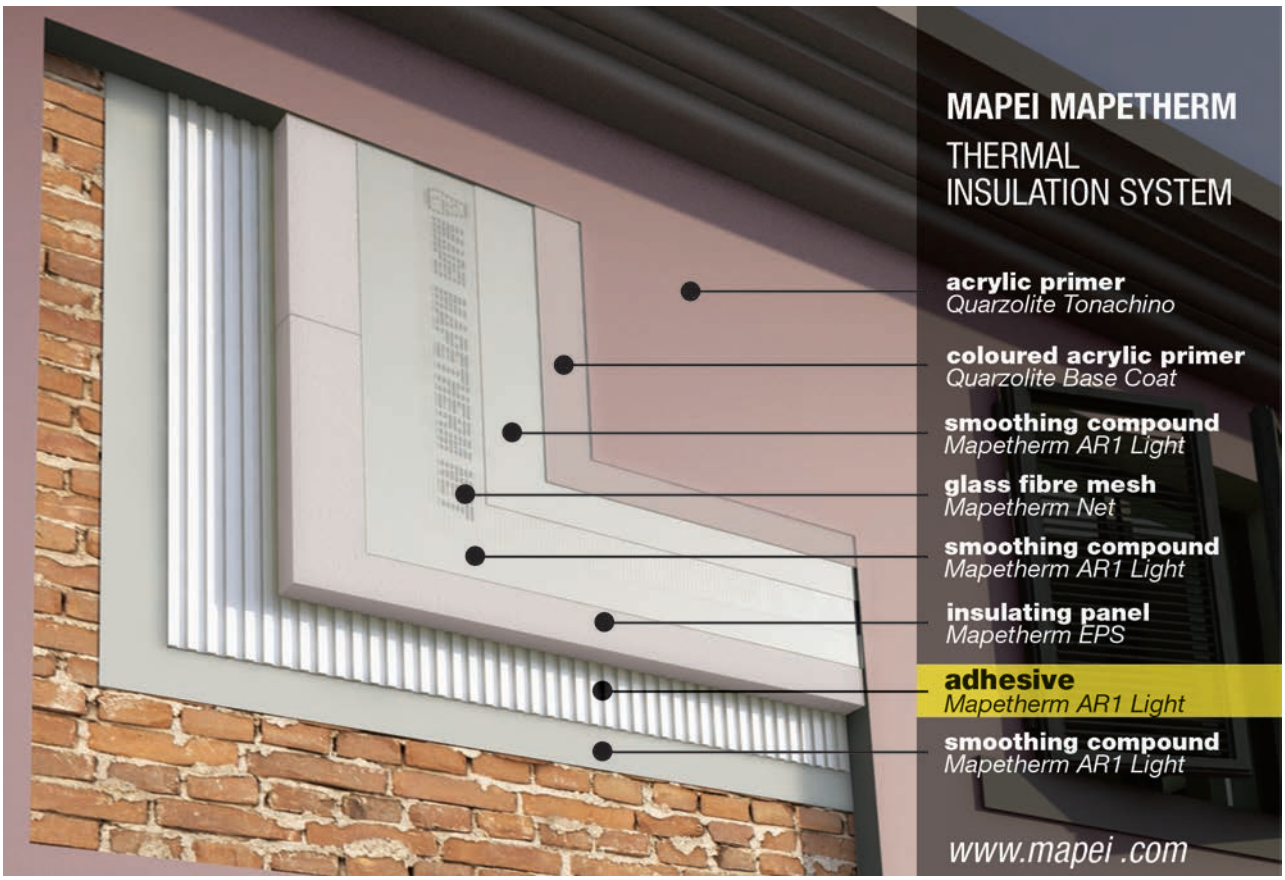


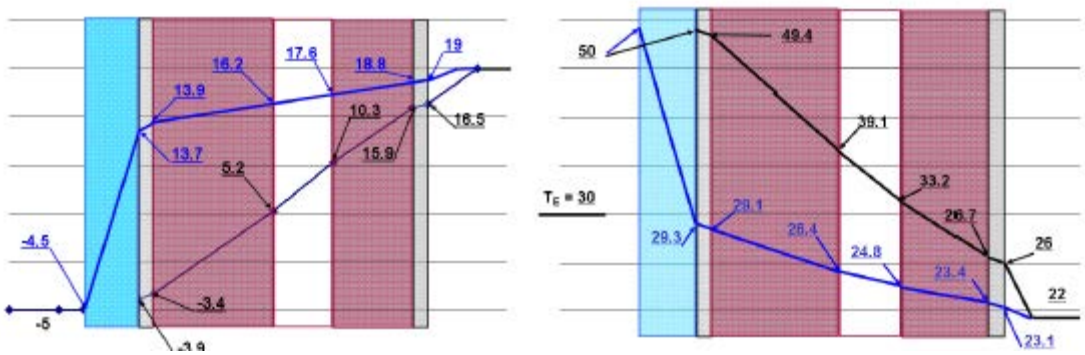
Figure 1: ETICS stratigraphy

It shall be emphasized that the effects of the ETICS installation are not limited to energy saving and comfort, but include the protection of the building structure from the stresses caused by temperature differences. The stress is transferred into the ETICS System, in particular into the adhesive which links the insulation panel to the plaster of the external masonry.

To fully understand the essential role of the adhesive and its quality in ETICS, a detailed analysis of the peel and shear stress condition of the adhesive, generated by the restrained differential thermal elongations of the insulation panel, should be necessary [(1)]. We will try to avoid mathematics and simplify the matter.

Energy saving

We report graphically the heat flux through a wall of a room maintained at 20°C in winter (ext. -5°C) and 22°C in summer season (ext 30°C) with and without the presence of an insulating panel 80 mm thick. The temperature profiles for both cases are reported in figures 2a and 2b.



a) Wintertime b) Summertime

Figure 2: Temperature profiles (blue line with ETICS, black line without ETICS), in a two-walls masonry

The temperature profiles clearly show that the ETICS system allows the thermal gradients to be reduced inside the walls. The reduced thermal gradient, proportional to the heat flux, highlights the beneficial effect of the ETICS on the energy saving.

This reduction leads also to mechanical benefits in terms of structural stresses in the masonry, but care must be taken on the stress on the panel and on the performance of the adhesive to fix the panel.

What happens to the panel?

The installation of the ETICS System reduces the temperature gradients in the masonry, because the main temperature gradient lies inside the insulating panel

The thermal difference anyway causes a thermal distortion in the panel both in winter and in summer weather conditions. (Figure 3)

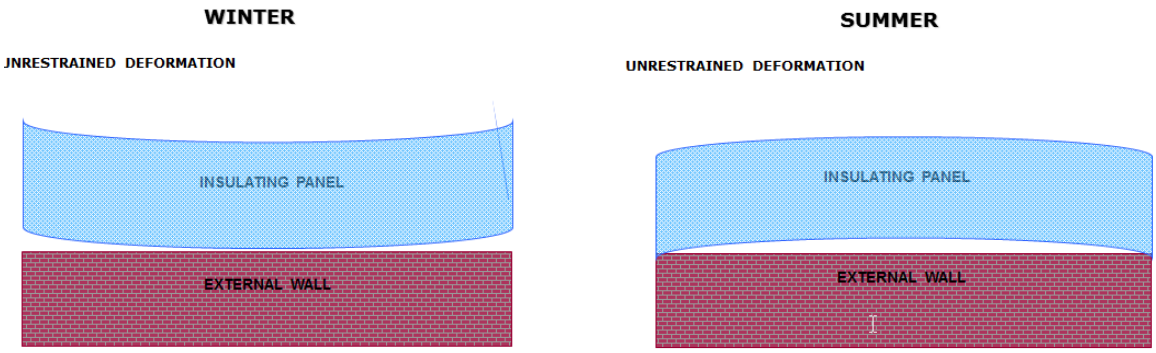


Figure 3: Stress in the panel due to thermal distortion

This distortion is the main reason for the stresses in the fixing system of the panels to the masonry either mechanical anchors or adhesive. But…

…in the case of mechanical fixing (typically a five anchors fixing system - Figure 4), the stress is distributed among the anchors, concentrated on the shank of the anchors, and solicits the panel with tensions often exceeding the acceptable limits for the panel integrity.

Serious damaging of the panel is very likely.

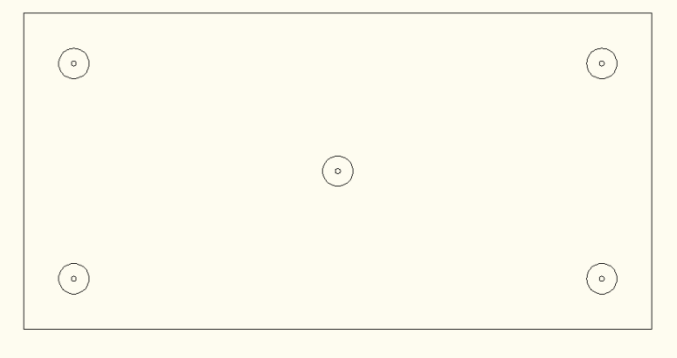


Figure 4: five anchors mechanical fixing system

When a layer of adhesive covering the whole surface of the panel is used instead of mechanical fixing, the adhesive bears all the stresses - peeling, compression and shear stresses -, caused by the panel deformation

-The peeling stress in the adhesive is due to the restrained thermal inflection caused by the temperature gradient within the panel thickness. The most solicited portions of the adhesive are close to the panel edges, the maximum tensile stresses are relatively high and can be held only by high quality adhesives.

- Even though the peeling stress in summer season seems to be lower than in winter, the restrained expansion of the panel yields to compression stress relevant if compared to the low critical stress due to the high slenderness of the panels. The stability is more and more crucial for lower thicknesses of the panel. The application of the adhesive in a continuous layer and the care of planarity of the panel are the only ways to overcome these stability issues.

- The linear thermal deformation of the panel leads also to shear stresses in the adhesive. Shear stresses are generally high.

The risk of bond failure exists and can be overcome only by the mandatory use of a high quality adhesive specifically developed for this application in order to guarantee the performance of the system.

Conclusions

ETICS is a great tool to achieve energy saving and increase the durability of the building, but performing only by the use of a great adhesive.

Mechanical fixing is not an advisable alternative to adhesive, even joining the five anchor system and the adhesive, because the already described problem related to the stress on anchors and possible panel damaging remains also in the presence of adhesive.

To be on the safe side, the bond panel may be fixed also with one only anchor in the middle of it, where the thermal distortions are absent for symmetrical reasons

References

(1) Collina, A., Lignola, G.P. *The External Thermal Insulation Composite System (ETICS). More than comfort and energy saving* - 3rd Portuguese Congress on Construction Mortars (APFAC), Lisboa, Portugal, 2010

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