XV International Conference on Durability of Building Materials and Components
DBMC 2020, Barcelona
C. Serrat, J.R. Casas and V. Gibert (Eds)

Laboratory Vs Field Performance of Innovative Thermal Insulating Plasters

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Keywords: *Plaster, Render, Aerogel, Retrofit, Historical Buildings.*

1 Introduction

In the last years the energy demand reduction, and hence, the reduction of greenhouse gas emission has become a crucial global strategy. Building sector can play a key role in this process. Since the largest part of the EU existing buildings is old and thus weak from the thermal point of view, retrofit strategies should be adopted for improving the thermal insulations level. Nevertheless, a big challenge is to identify suitable insulating solutions able to guarantee the proper compatibility with the existing masonries, considering that ~39% of the EU residential buildings were built before the 1960'. Among all the different solutions for the energy retrofit, one of the most promising is represented by the thermal insulating plasters and renders. These materials are similar to the traditional plasters, but the sand is replaced by lightweight thermal insulating aggregates (LWA) to reduce density and thermal conductivity. Key-features of these materials is the ease of application on an irregular surface, the higher hygrothermal compatibility, the minimum space reduction (indoor application) and the good thermal performance improvement.

Nevertheless, despite the interesting potentials of thermal insulating plasters, some aspects are currently under investigation. Actually, during their service life, these materials might be exposed to variable boundary conditions *e.g.* temperature and relative humidity variations, that can strongly affect the expected thermal performance. It seems evident that, in addition to the laboratory nominal thermal conductivity measurements, an in-field monitoring activity can be useful.

The aim of this paper is to present a comparison between the laboratory performance and the actual in-field monitored performance, in real case studies. For this sake, an overview of the latest Authors researches that involve the monitoring of three different historical case study buildings in northern Italy in which three different thermal insulating plasters containing different LWA were applied (vegetal, mineral and aerogel) is here presented.

For each developed plaster, the nominal thermal conductivity in dry state was measured according to EN 12667:2001 by using the heat flow meter method. The laboratory tests have confirmed, as expected, a decrease of the thermal conductivity due to the addition of lightweight (vegetal, perlite and aerogel) aggregates in the formulations. Thermal conductivity values between 0.09 W/mK to 0.027 W/mK were achieved; as expected the lower is the thermal conductivity of the LWA adopted, the lower is the final thermal conductivity of the plaster.

The monitoring campaigns were carried out by performing temperature and heat flux measurements adopting the ISO 9869-1:2014 standard, in order to estimate the thermal transmittance reduction. The in-situ measurements performed for the vegetal based plaster (~60 mm thick layer) have shown a decreasing of the U-value of about 30% respect to the non-retrofitted wall. The perlite-based plaster shows a reduction of about 45% (~50 mm thick layer). As expected, the plasters with a lower thermal conductivity (aerogel-based) allowed the achievement of the higher thermal transmittance reduction, up to 60% with a thinner layer (~45 mm). Comparing the nominal thermal conductivity values measured in the laboratory with the actual equivalent thermal conductivity determined through the monitoring campaign, an increment between 10% and 30% were highlighted. This performance decrease was mainly due to different moisture content and different temperature at which the plasters were exposed.

From these analyses, it is possible to underline that the characterization of the thermal conductivity at different temperatures and moisture content are necessary to properly evaluate the actual thermal performance and allow more conscious evaluation among different retrofit alternatives.

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