POLITECNICO DI TORINO

Honors thesis

COURSE OF ARCHITECTURE FOR THE SUSTAINABILITY DESIGN

Abstract

Advanced thermal insulating plasters. Theoretical and experimental analysis of the in-situ and laboratory thermal performance.

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by

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The Italian building stock was composed by many ancient constructions and over the 50% was built before the ‘70s. These buildings were made during a period without any energy saving law, therefore are affected by large energy loss through the envelope so high energy demands. The energy refurbishment of the building stock seems an achievable way to reduce energy loss, also in order to reach the European objective of reduction of energy demands. The European Union, through the project Horizon 2020, encourages the development of new technologies for energy consumption reduction in buildings. In the framework of this program, it’s also included the Wall-ACE project that has the objective of realized a series of new building products improved with aerogel characterized by high thermal performances; this nanomaterial has a low thermal conductivity, about 50% lower than insulating material like EPS.

The objective of this Master thesis is to realize, through an optimization process, an innovative series of thermal plaster and thermal coating formulations improved with aerogel with high thermal performances. Part of the results shows in this work fall within the Wall-ACE project. Thermal insulating plasters were made up by lightweight aggregates that improved thermal performances of the final product, allowing their use both for energy refurbishment and new building construction.

The work, carried out in collaboration with Politecnico of Turin and Vimark, was developed in three different steps. In the first part a literature and market survey, related to thermal plasters, were carried on. Results show a significant growth both in the scientific and market sector, proving an increasing interest in these materials.

Next, a series of new thermal coating and thermal plaster were developed starting from plaster formulation improved with only perlite. An increasing aerogel content was gradually added to the mixture, replacing perlite. The formulations were submitted to different tests (mechanical and hygrometric), in accordance with UNI EN 998-1. Through a Heat Flux Meter was determine the thermal conductivity of the different mixtures. Results show a correlation between the decrease of conductivity and the increase of aerogel content. The minimum conductivity value obtained was about 30% less than the value obtained from mineral thermal plaster, in addition, mechanical and hygrometric properties were acceptable.

Besides laboratory tests, a measurements campaign was carried on in a real case study refurbished by thermal insulating plaster with perlite. Through the monitoring period a series of data were collected that allow to determine the thermal transmittance reduction of the envelope due to the presence of thermal plaster and how does it work under real operating conditions. The analysis of the data has brought to determine that 5 cm of thermal plaster reduce thermal transmittance of about 50%.

Data collected were also used to validate a heat and moisture simulation model realized with WUFI ® Pro. An opaque partition consistent with that monitored in-field was simulated, so it was possible to determine the conductivity variations of the aerogel thermal plasters.

The increase of thermal conductivity was assessed at 50%, but the final λ value was considered acceptable.
Finally, it's possible to assert that using aerogel to improve the thermal performances of plasters can lead to low thermal conductivities, without significant reduction of mechanical and hygrothermal performances. Further development of the materials consists in the formulation of other thermal plaster and coating to reach lower thermal conductivity values and also both the materials will be applied to a real case study building and monitored, to determine behavioral changes under real operational conditions.

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