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*Abstract*

# ALMOND SHELLS AS NATURAL AGGREGATES IN THERMAL PLASTER
## Product development and theoretical-experimental analysis of the energy-environmental performance


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This study proposes an experimental use of almond shell with added value in buildings sector (an agricultural waste generated by processing of the fruit to get the edible seeds, often incinerated or disposed without control). The research aim is to recycle this product as natural aggregate in the composition of a thermal plaster, for sustainable use and economic benefits, providing a second plantation income for farmers as well. For this purpose we have investigated the chemical and physical performance characteristics of almond shells (Prunus Amygdalus L.), provided from a Sicilian farm, located in Mazzarino, (CL), Italy.

The tests conducted in the laboratory have been housed at the laboratories of the Polytechnic of Turin, Department of Energy (DENERG) and also in the company Vimark S.r.l. located in Peveragno, (CN), Italy. The experimental phase of the research involved the formulation of mortar test prepared in accordance with the European standard UNI EN 1015-2, considering as basic recipe Thermocalce's formulation. It consists of a natural mineral plaster dry premixed with high heat-insulating capacity, prepared within the Vimark S.r.l., composed by natural hydraulic lime Wasselonne NHL2, expanded mineral aggregates (perlite), natural fibers (paper fiber ) and specific additives (ex. cellulose and starch).

The new formulation's study has foreseen the development of three variants of thermal plaster identified with the name "Thermalmond", employing almond shells as a natural aggregate charge, present in each of these variants with different weight percentages for this experimental activity were used almond shells with particle size between 2-3 cm long and 1.5-4 cm in diameter. The increase of almond shells in the compound has corresponded to the reduction of two components: natural hydraulic lime and perlite. In relation to the percentage of almond shells used: 16.7%, 13.16% and 9.14% each formulation was named respectively as THM_16, THM_13 and THM_9.

We proceeded with the test phase according to the UNI EN 998-1: 2010, establishing the compliance of physical-mechanical performance values of the new plaster mortars tested compared with standard parameters. The experimental analysis allowed the calculation of Thermalmond's thermal conductivity (dry samples), according to the UNI EN 12664. The average thermal conductivity results to be, respectively: $\lambda_{THM\_9}$ = 0.121 [W/mK]; $\lambda_{THM\_13}$ = 0.109 [W/mK] and $\lambda_{THM\_16}$ = 0.113 [W/mK].
Comparing thermal conductivity values of the three new formulations with that of Thermocalce ($\lambda_{THM\_CALCE}$ = 0.136 W/mK), these turn out to be more performing, confirming as the increase of almond shells to compound has had a positive influence on the thermal conductivity. Moreover, it is observed a slight decrease of mechanical resistance and even a modest increase of the density of the hardened product as compared to Thermocalce, due to the presence of almond shells inside the compound. However, these differences do not generate any disadvantages.
To the value of $\lambda_{THM\_13}$ appeared lower than $\lambda_{THM\_16}$, is attributed a measurement error of 3%, probably caused by the content of residual water present in the analyzed sample or to its surface not perfectly coplanar and also the possible inhomogeneity of almond shells distribution within the mixture. To minimize this uncertainty, one solution should be to use

almond shells with lower particle size to achieve both a greater cohesion between the components and the dough that better flexural/compression resistance.

Concluding, it is possible to affirm as the almond shell applied within the composition of thermal plaster plays a role addressed to increasing the building's energy efficiency, limiting both dispersions and reducing the outer casing's transmittance, and also improving indoor comfort.

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