POLITECNICO DI TORINO
SECOND SCHOOL OF ARCHITECTURE
Master of Science in Sustainable Architecture
Honors theses

GEOPOLYMERIC BINDERS: INNOVATIVE MATERIALS FOR ENVIROMENTAL SUSTAINABILITY IN ARCHITECTURE

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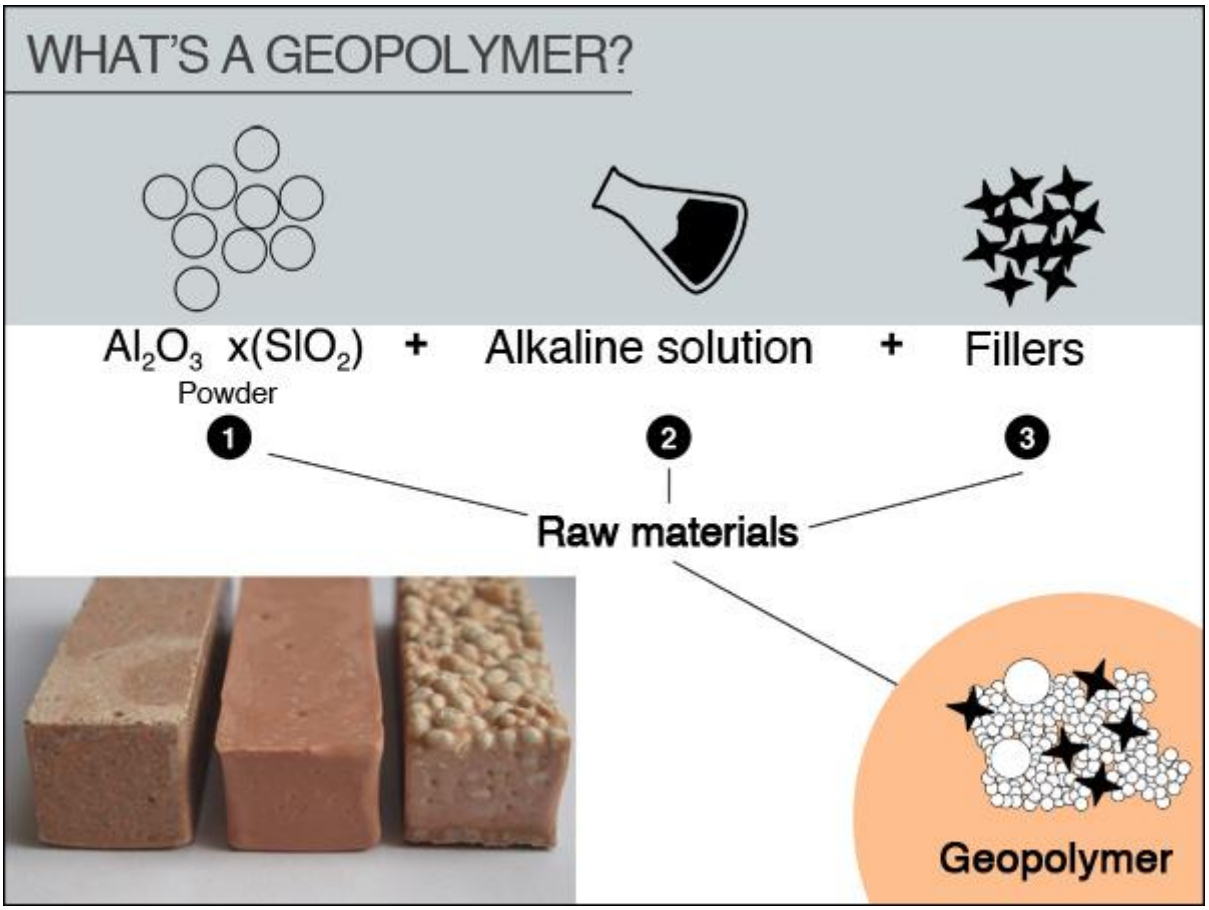
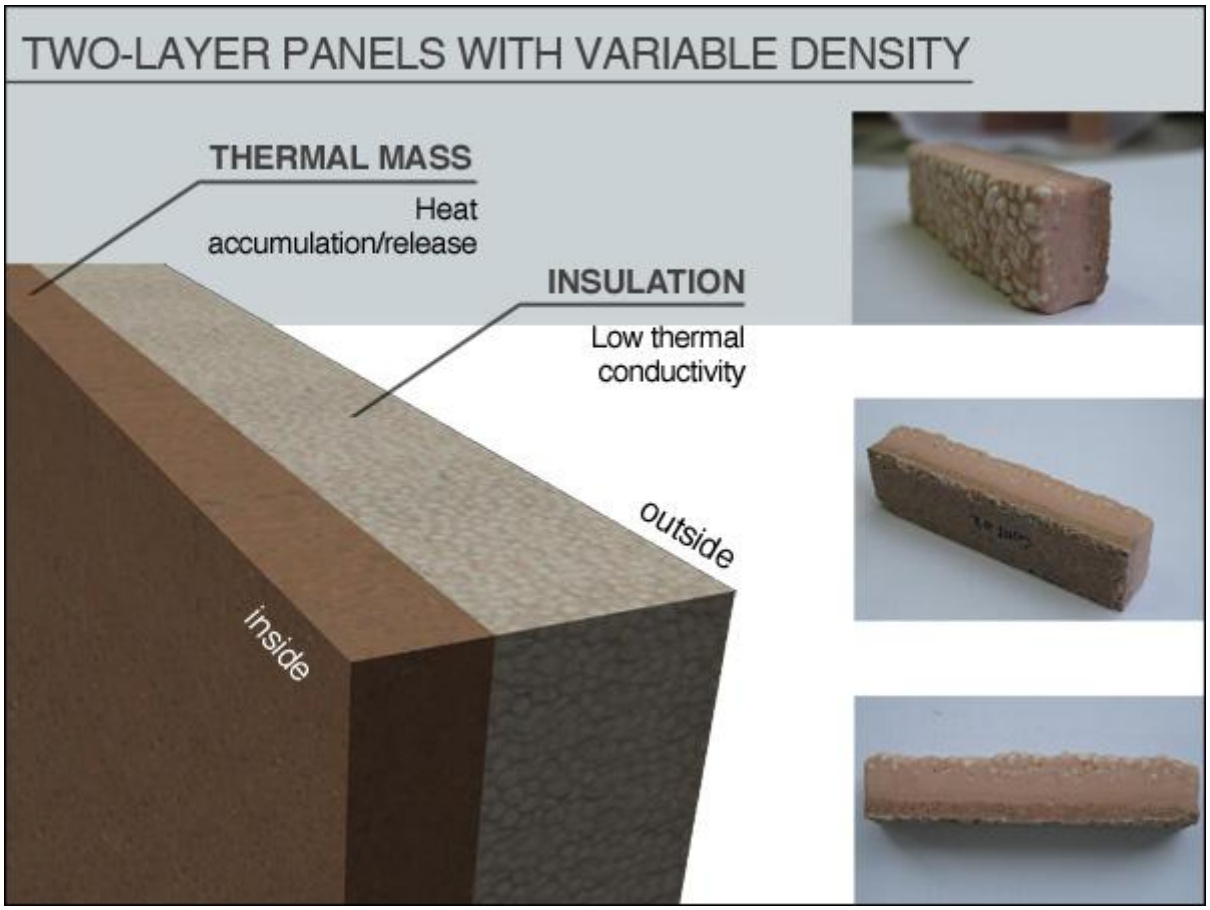
In the context of environmentally sustainable Architecture it is necessary to carry out a multidisciplinary approach involving a large number of sectors: from the energy saving and emissions control, to the recycling and reuse of materials.
In this perspective, this research suggests a possible way to make more sustainable one of the most imposing, energy-intensive and impactful sector of the world: the cement industry. In fact, although many strengths are associated with Portland, the continuous increase in demand for clinker, mainly linked to the needs of Emerging Countries, will not be anymore sustainable in the future.
Geopolymeric cements are among the many strategies, in part already implemented, to a more sustainable production of Portland cement: In effect, they enable a reduction of CO_2 emissions for values between 40% and 80%, depending on the composition of the dough, with equal performance as Portland; in addition to this substantial characteristic, these materials bring also great benefits in terms of reuse of raw materials, simplification of the production process and characteristics of strength and durability, proving to be highly competitive, in particular regarding to fire resistance. Geopolymeric binders are therefore presented as a viable alternative to Portland cement, to be understood in terms of possibility in coming up as back up or, in case, as an effective replace.
Geopolymers can be defined as a new class of inorganic materials characterized by an extreme variety in composition and, thus, in their performances. Geopolymers result from the union of an aqueous solution, strongly basic, with a reactive powder rich in silica and alumina; fillers or aggregates can be added to the mixture too.
Geopolymers are already been widely used in many fields. For example: the automotive and the aerospace industry, the plastic and ceramics one, and the art trade, as well as the decoration and restoration of Cultural Heritage.



Model of the raw materials composing the geopolymeric dough and samples produced during the lab activity

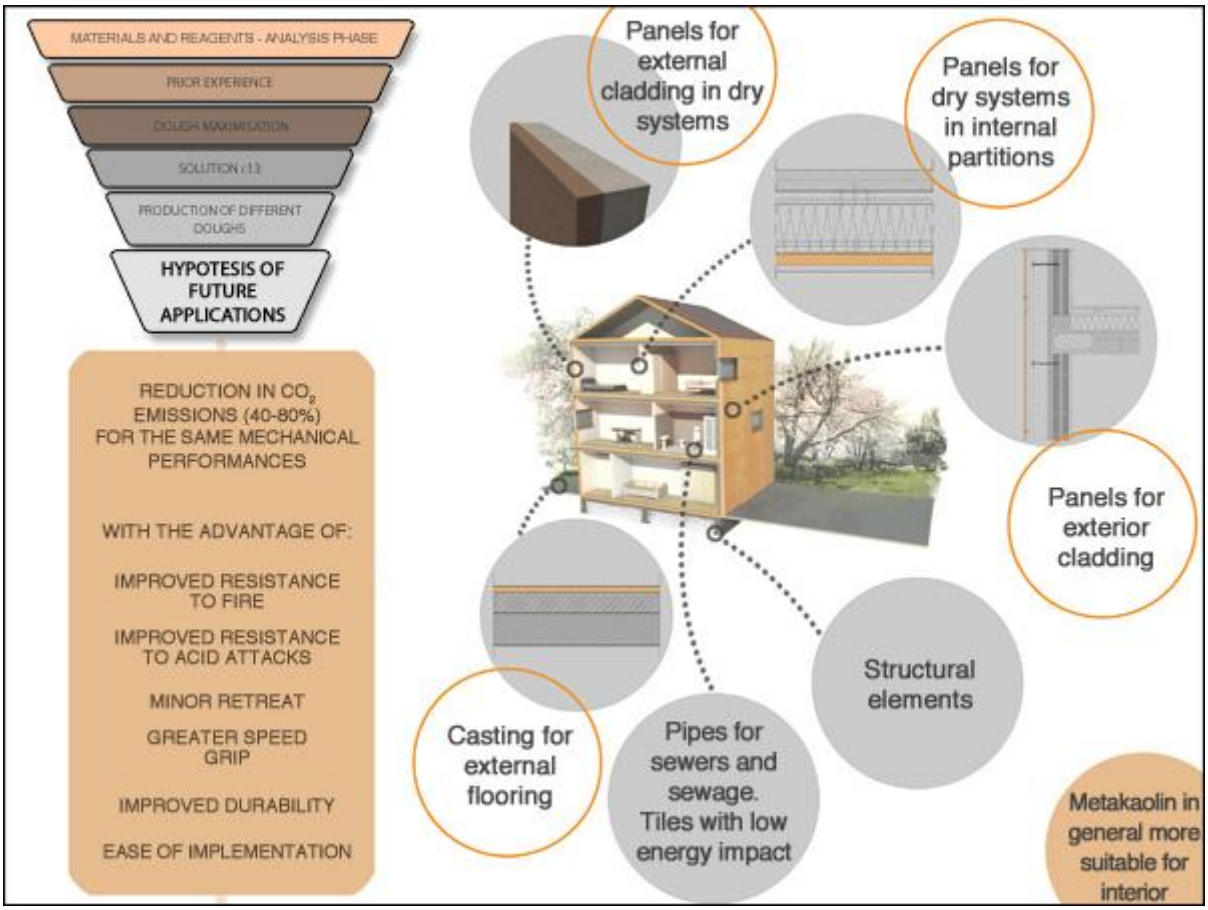
The experimental phase, based on the literature review, has allowed us to lay the groundwork for a long period of research at DISAT. The lab activity enabled the direct realization of some geopolymeric samples based on metakaolin, which differ from each other in certain composition characteristics (pastes, mortars and lightened mixture), and some other Portland cement samples. The work has been developed as a progressive mixture evolution and optimization oriented to the research of the most suitable composition, for the purpose of future application possibilities for the realization of architectural components.
The produced samples were tested in the main mechanical, physical and chemical properties through the specific analysis methods. The resulting data were finally compared: overall, they reported similar values to those presented by literature, moreover they were comparable with Portland cement performances.

In the final phase, tests were carried out for the production of samples made by composite geopolymeric mixtures. These experiments, based on the lessons learned from an article published by J.R.Mackechnie and T.Saevarsdottir from the University of Canterbury in New Zealand, are aimed to the possible and future production of two-layer panels with variable density and want to be a first approach to the practical step of realization. These elements have to combine the performance of heat storage and release with the ones of thermal insulation within a single component. The specimens, and therefore the panels, are, indeed, an outer massive layer connected to another lightened internal one.



Brief outline of the two-layer panel operation

In addition, based on the lessons learned, assumptions and intentions of future studies have been developed; they are aimed to delineate features for optimized mixtures oriented to the production of various building components. It is now clear that, depending on the specific needs, it is necessary to use a precise mixture, reporting the correct characteristics.



Summary of the future possible fields of application in construction

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