POLITECNICO DI TORINO

Honors thesis

Course of

Degree in Master of Science in Architecture

(Rehabilitation and Revaluation)

Geopolymers based on quarrying muds: characterization and evaluation of dense and porous mortars

The geopolymers are by definition synthetic inorganic binders, made of chains of alluminosilicatica based polymers. Discovered in the seventies by the French chemist J. Davidovits, they are characterized by interesting mechanical and thermal properties and find application in several fields, representing an innovative solution for the recycling of waste materials. The raw material to be used to produce them does not require specific chemical-physical characteristics: it is sufficient that the matrix possesses a alluminosilicatica composition and texture of a powder; reacting with an alkaline solution of silicates and hydroxides, happens the polycondensation.

In the specific case of this thesis the choice of using the sawing sludge for the realization of geopolymers is linked to a recent research and is justified by the possibility of easily finding these wastes and reduce both the serious environmental impact that they produce and the cost of their disposal.

During the step of cutting and polishing of stone blocks, this are soaked and from this process derive the sludge: the fine fraction resulting from the mixture of water and powdered stone.

The research carried out in the course of this thesis is focused on the formulation and the behavior of geopolymerical materials, accomplished since the sawing mud but, as this is a very broad field, have been chosen and developed two specific surveys:

- The first is based on the production of dense mortars, perfecting the mechanical properties and optimizing the behavior in water.

- The second is linked to the evaluation of the mechanical properties and the response to various tests of durability of the porous mortar.

During the research we were produced a large number of samples in order to study the composition and evaluate the best formulation. The manufacturing procedure was repeated modifying each time the components and dosages, in order to provide for preparations with different properties.

Subsequently the samples produced were tested, compliant with the legislation, which made it possible to identify its characteristics.

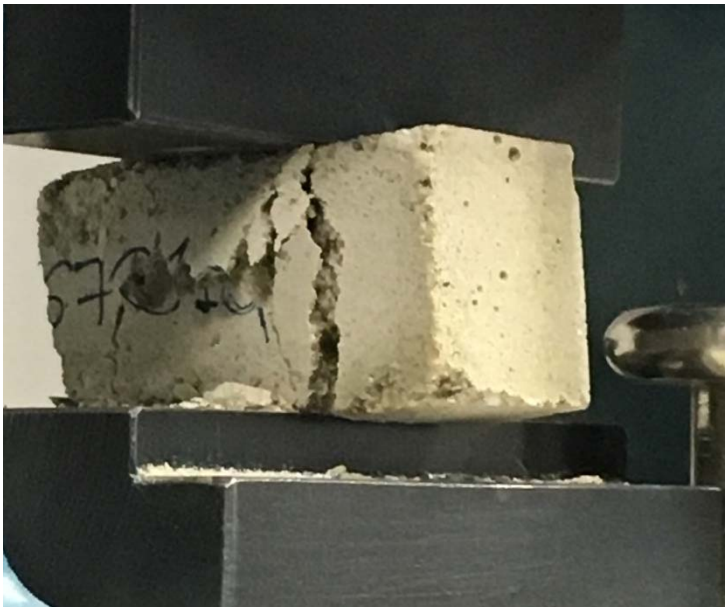

Figure 1 Compressive strength of a geopolymeric sample

Based on the results obtained and a comparison with the characteristics of traditional materials with equivalent destination, it was possible to select the composition that best meets the need for research.

Via the laboratory experimentation was established that the mechanical strength of mud base geopolymers are substantially impaired after prolonged immersion in water; the cause of this behavior stems from the fact that this material is poorly reactive and is unable to maintain sufficiently cohesion between the various components. The use of highly reactive powders combined with the muds, however, facilitate the development of the polycondensation reaction, limiting the problem and allowing a better maintenance of the properties of the material during the phase of immersion and also in later stages.

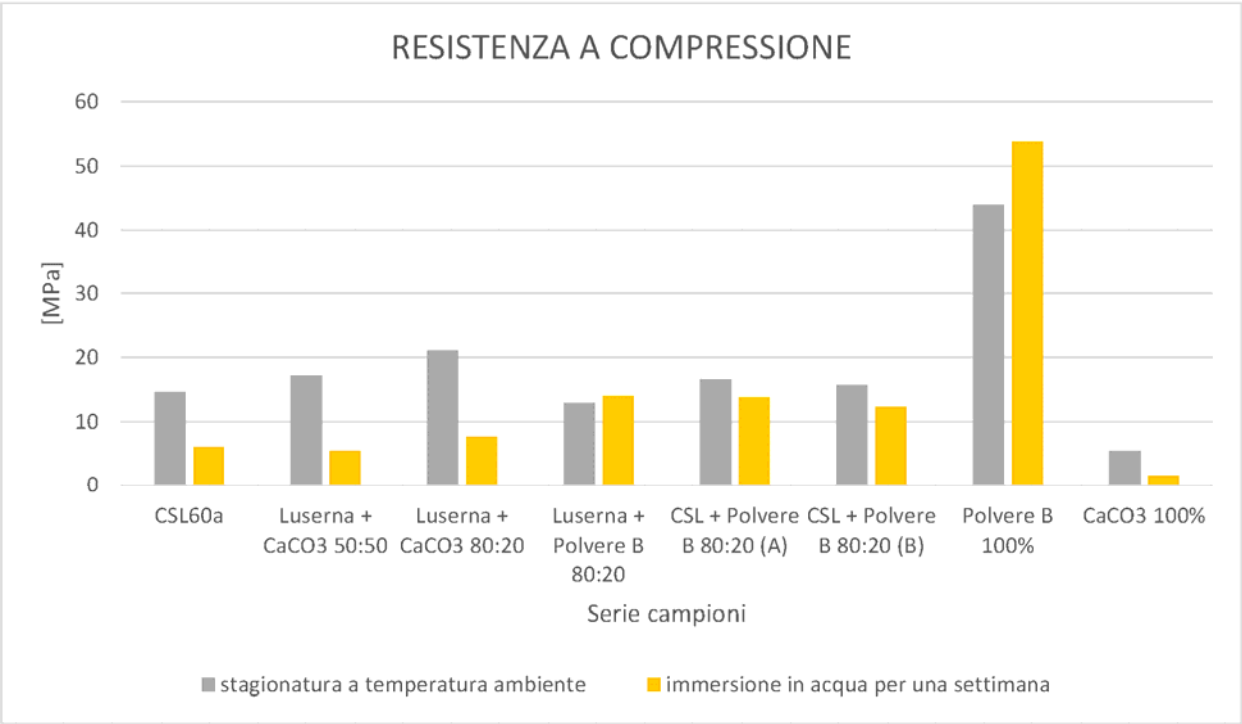

Table 1 Comparison of mechanical compressive strength of the different samples in the case of curing in air and immersion in water

Thanks to the interesting results, it was decided to apply the same formulation in the production of geompolymeric porous mortar which are proposed as a viable alternative to materials currently on the market, because of their characteristics of sustainability and environmental compatibility. Although the formulation parameters are not perfectly optimized, the relationship between the density of the material and the mechanical resistance is still satisfactory.

Furthermore, from the durability tests, it has been observed that the behavior of porous mortar doesn't differs much from the one of the autoclaved lightweight concrete blocks currently on the market.

In conclusion this thesis want to continue research on a little known material, which has great potential both in terms of features and cost both in ecological and environmental impact.

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