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Investigation of custom-made metakaolin-based geopolymers for stone conservation: preliminary results on activation

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Geopolymers are an interesting material because they are inorganic and non-toxic, they are inexpensive because the raw materials are easy to obtain, and they also have high strength and are able to process and adjust. These properties make them an innovative alternative to restoration mortars, which carry out current restoration treatments of stone heritage, but which often cause more damage because they are not fully compatible with the original.

Geopolymers are stone-like materials placed between binders, such as cements and ceramics. Different types of geopolymers exist, depending on the raw materials and the system through which they are activated. In this research we focus on geopolymers with a base of metakaolin. Metakaolin based geopolymers improve the properties of the end product compared to geopolymers based on fly-ash and ground granulated blast furnace slag. For curing the geopolymer, certain requirements have been set that take into account the application of the geopolymer in the restoration sector in the future, like curing by room temperature and ambient relative humidity in less than 48 hours. A set of reactivity tests have been performed to determine the appropriate activator and to optimize their ideal molarity. These tests shows that calcium hydroxide give the best results in forming a matrix of geopolymer.

In the next phase of the research, the compatibility between the geopolymer and porous sedimentary building stones will be investigated. The properties that are important for technical compatibility include: porosity, pore size distribution, capillary water absorption, frost resistance, structure, texture, compressive and bending strength. Samples are made with standardized aggregates of marl flour (porous calcium carbonate flour), limestone flour (non-porous calcium carbonate flour) and relatively pure sand with various grain size distribution to evaluate the compatibility and to investigate the effects on reactivity. It is critical this test phase is carried out with pure products, so that any contamination cannot affect the results. In the following stage it is then possible to experiment with the effect of degraded and contaminated original material as aggregate.