

## **Investigation of the microstructural characteristics of matured hydraulic grouts and durability in sodium sulphate crystallization**

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Natural Hydraulic Lime (NHL) and Cement–Pozzolan–Lime based grouts, prepared for the consolidation of three-leaf historic masonry as well as mosaic bearing mortars, are being examined in order to study the morphological and chemical variations induced by ultrasonic vs. mechanical mixing, the addition of superplasticizer and pozzolan. All of the examined grouts have been produced with fixed water to binder ratio of 0.8 and have matured for a period between eight to nine years in a sealed high RH container.

A systematic study of the samples that enables to assort the induced variations has been conducted using different analytical methods. Polished grout samples have been examined by means of Backscattered Scanning Electron Microscopy (SEM) coupled with Energy Dispersive Spectroscopy (EDS) and by Optical Microscopy (OM) in brightfield and under polarized light in order to distinguish and characterize the different phases present. Fractured samples have been examined by Secondary emission SEM in order to study morphology. Furthermore, the grouts open porosity has been measured by capillary absorption of water. XRD spectra have been used in order to identify crystalline phases.

At a next step, samples of the grouts, have been subjected to cycles of  $\text{Na}_2\text{SO}_4$  crystallisation in order to assess their durability to water soluble salt crystallization. The use of sodium sulphate has been chosen, since its presence is quite abundant (particularly when Portland cement has been used in previous restoration works) and its anhydrous and hydrated morphs can cause severe damage to porous materials.

Macroscale properties, such as mechanical strength and durability in water soluble salts crystallization or freezing and thawing, are affected by microstructural characteristics, such as porosity, morphology and size distribution of porous, crystalline and amorphous phases, bonding at the interface of different phases. This work aims to a better understanding of the impact of superplasticizer and pozzolan addition, as well as mixing methods, on the grouts microstructural characteristics. Designing of hydraulic grouts, tailored for the specific needs of a monument with regard to the authentic materials and the environmental conditions, can benefit from such knowledge.