

EGU21-9638

<https://doi.org/10.5194/egusphere-egu21-9638>

EGU General Assembly 2021

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New sustainable mortars for stone restoration in the context of climate change

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Restoration mortars are a designated group of products made to repair damaged masonry. They must be compatible with the former support of stones and bricks, and protect original materials from environmental agents; aesthetical and historic aspects must not be neglected.

To improve the ecological footprint of the restoration mortars while keeping their efficiency, we have tested several combinations of lime with aggregates and additives. Recycled and natural materials were used as additives such as pinecone resin, semi-milled cones of pine, milled glass waste, brick production residue.

For research purposes different physical properties have been measured in prepared mortars: porosity, density, capillarity absorption, moisture absorption, water vapour permeability. We have also tested the mechanical properties and the P and S waves velocities (from which dynamic Young's modulus and Poisson's ratio were inferred). The durability of mortars has been estimated by salt crystallization and frost/thaw cycles.

The life cycle analysis (LCA) of such mortars allows us to understand the carbon footprint of each manufacturing process. Considering this we selected the raw materials, from an environmental and commercial point of view, to produce mortars fulfilling sustainability requirements. As a result, the developed mortars are compatible with aged stones, minimize environmental impact, and use minimum natural resources.

Twenty mortar formulations with three different types of limes (NHL5, NHL3.5, CL90) and two different aggregates (siliceous and calcareous) have been studied using the LCA. Currently, five new formulations are being selected to be tested on Euville limestone. Adhesive strength (James Bond test), and physical properties will be measured on these mortars.