

Diagnostic study of lime mortar samples from historical buildings in Catania (Sicily) through an experimental approach

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INTRODUCTION AND AIMS

The reconstruction of the historical city center of Catania after the devastating earthquake of 1693 has been characterized by the use of volcanic materials both as building blocks and as aggregates in lime mortars. In the latter, two different materials peculiar of the Etna territory can be found, namely *azolo* and *ghiara*.

Azolo, now obtained from the fine grinding of basalts, in its ancient meaning was an incoherent pyroclastic rock with dark-gray color; *ghiara* is a reddish material deriving from the thermal transformation induced by lava flows of paleo-soils originally rich in organic matter.

In situ surveys of the two types of mortars in the historic built heritage of Catania show intense degradation phenomena. The weathering forms commonly observed include salt efflorescence, chromatic alteration, disaggregation and detachment.

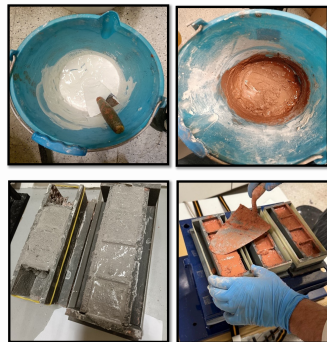
In this contribution, an experimental approach is used to study the durability of the two mortars for conservation/restoration purposes through their reproduction in laboratory.



Examples of ghiara (upper photos) and azolo (lower photos) mortars in historical edifices of Catania city center.

REPRODUCTION IN LABORATORY OF HISTORICAL MORTARS

- Mixing aggregate with aerial lime in a 3:1 aggregate/binder ratio, according to the ancient recipes
- Pouring the mixture into 4x4x4 cm molds and then on a vibrating table to remove air bubbles
- Curing at room temperature for 28 days by keeping the relative humidity level around 80–85 %



Mortar type	Mixture ID	Grain size of aggregate	Aggregate/binder vol. ratio	
			Aggregate	binder
Ghiara-based mortars	MG1	$\phi \leq 2 \text{ mm}$	3	1
	MG2	$2 \text{ mm} \leq \phi \leq 63 \mu\text{m}$	3	1
Azolo-based mortars	MC1	$\phi \leq 2 \text{ mm}$	3	1
	MC2	$2 \text{ mm} \leq \phi \leq 63 \mu\text{m}$	3	1

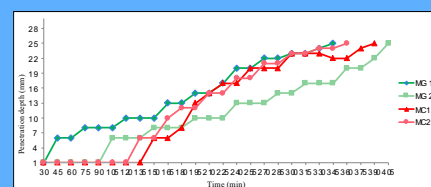


DATA COLLECTION

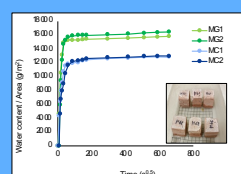
- Mineralogical-petrographic analysis by means of XRD and polarized optical microscopy
- Colorimetric analysis (PCE-XXM 30 colorimeter);
- Hydric tests: water absorption by capillarity (UNI EN 1295:2000) and by total immersion (UNI EN 16535:2019)
- Vicat Needle Test (ASTM C191)
- Mechanical tests: a) compressive strength (UNI EN 1926:2007); b) perforation resistance test
- Accelerated aging test by salt crystallization (UNI EN 12370:2020)

RESULTS

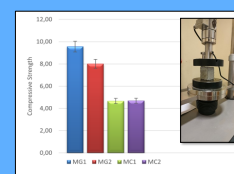
- The water absorption test shows that ghiara mortars absorb more water and more quickly than azolo ones.
- Ghiara mortars exhibit higher mechanical resistance (to both compression and perforation) than azolo ones.
- The Vicat needle test shows that ghiara mortars start and complete the hardening process earlier than azolo ones.
- In terms of salt crystallization resistance, all specimens show a slight mass increase up to the 8th cycle, after which they break.
- The presence of the fine-grained fraction ($< 63 \mu\text{m}$) in ghiara mortars enhances packing and compactness, thus reducing open porosity and water absorption and increasing both compressive and perforation resistance. It also promotes the hardening processes of mortars.



Vicat Needle Test (ASTM C191)



Water absorption by capillarity (UNI EN 1295:2000)



Uniaxial compressive strength (MPa)



Salt crystallization test (UNI EN 12370:2020)