LABORATORY TESTING OF MORTARS FOR A SUITABLE CONSERVATION OF MOSAICS IN ARCHAEOLOGICAL SITES.

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INTRODUCTION

The decay of mosaics in archaeological sites depends on different causes (physical, chemical and mechanical), and is due to environmental and micro-environmental conditions such as humidity changes, water and salts solutions capillary uptake, type of substrate, biological growth and so on.

A relevant role in the conservation of mosaics is related to the composition and structure of the mortars where the *tesserae* are embedded. These mortars, in fact, may contribute to the release and transport of soluble salts, transport of water and detachment of the *tesserae* themselves.

Original and repair mortars of the mosaic located in the archaeological site of the Roman *villa* in Castiglione della Pescaia -Paduline (Gr) (I-II century BC.) (Fig. 1), have been reproduced in laboratory in order to study their resistance to decay agents. New mortars with the same basic components of the original and repair one's, but added with polymers, have been also prepared in order to obtain materials with improved resistance against the same decay agents.

Fig. 1 - The mosaic floor of the archaeological site of Villa delle Paduline, Castiglion della Pescaia (Gr, Italy), after the restoration performed in Nineties (left) and today (right).

MATERIALS AND METHODS

Six different mortars have been prepared on the basis of petrographical observation performed on the original (MO) and repair (MR) mortars. The composition of the mixtures used for the preparation of the mortars are reported in Table 1.

The colour changes (determined by chromatic tests and expressed as ΔL*, Δa*, Δb*)[1], the water vapour permeability [2], the cohesion properties (determined by Drilling Resistance Measurement System) [3] were determined for all the mortar samples before and after the artificial ageing tests. The artificial ageing, carried out after 16 months from the realization of the mortars, consisted in maintaining the samples in water or salt solution (NaCl, 3.5 g/L) capillary uptake during thermo-hygrometric changes. The performed changes of temperature and relative humidity are reported in Fig. 3. 50 cycles of artificial ageing have been realized.

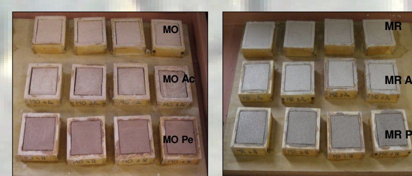

Fig. 2 – Samples of "original" (MO) (left) and "repair" (MR) (right) mortars

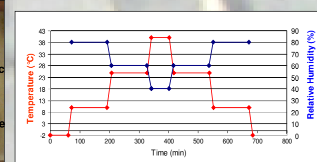

Fig. 3 – Thermo hygrometric changes corresponding to 1 cycle

MO	MO Ac	Mo Pe	MR	MrAc	MRPe
Original mortar realized with lime putty, *cocciopesto* (70%) and carbonatic aggregate (30%) (L/A=1/1)	MO+ acrylic resin (Acril 33; 3%)	MO+ poly(versatic ester-*co*-vinyl acetate) (Peoval 33; 3%)	Repair mortar realized with hydraulic lime, *cocciopesto* (10%), silicatic (70%) and carbonatic aggregate (20%) (L/A=1/3)	MR+ acrylic resin (Acril 33;3%)	MR+ poly(versatic ester-*co*-vinyl acetate) (Peoval 33; 3%)

Table 1.Composition of the mortar samples.

RESULTS AND DISCUSSION

The **mechanical properties** (drilling resistance values) of the MO and MR type mortars before and after 50 cycles of artificial ageing are reported in Table 2. A general trend is observed:

-The MO (realized with lime putty) shows a higher drilling resistance than MR (realized with hydraulic binder);

- Peoval 33 gives better hardness than acrylic polymer;

- The artificial ageing (both realized with water and salt) increases the drilling resistance.

The **permeability** values are in accordance with the drilling resistance data (Fig. 4): the decrease of permeability and increase of hardness are justified by salt crystallization and/or carbonation progression.

Color changes are not significant for all the mortar samples (Fig. 5).

Sample	Before ageing	Salt ageing	Water ageing
Original mortar (MO)	9.45 N	17.62 N	18.27 N
MO with acrylic resin	17.44 N	27.49 N	25.53 N
MO with Peoval resin	29.22 N	33.30 N	36.09 N
Repair mortar (MR)	6.80 N	18.21 N	17.33 N
MR with acrylic resin	2.84 N	7.58 N	8.74 N
MR with Peoval resin	11.51 N	16.18 N	15.83 N

Table 2. Drilling resistance of mortars before (after 16 months at room conditions) and after 50 cycles of ageing with salt and water uptake.

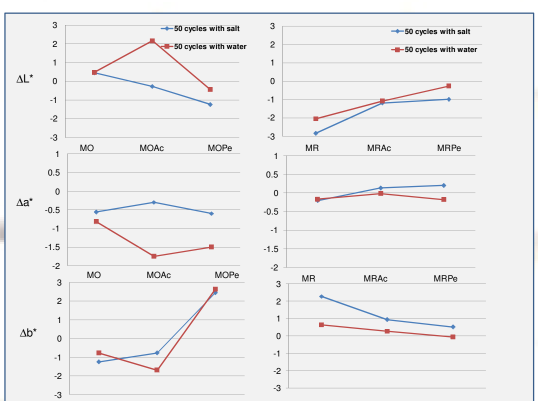

Fig. 5.- Colour changes of mortars after 50 cycles of ageing with salt and water uptake.

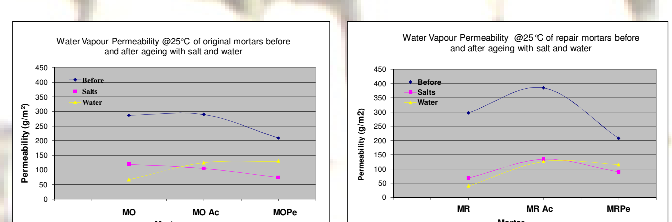

Fig. 4.- Water permeabilityof mortars before (after 16 months at room conditions) and after 50 cycles of ageing with salt and water uptake.

CONCLUSION

These preliminary results show that:

-the addition of Peoval 33 to mortars improves the properties of MO and MR;

- the addition of Acryl 33 improves only the properties of MO;

- MR Pe, in consequence of the lower changes of mechanical (drilling resistance) and physical (vapour permeability) properties, seems the best mortar to be used in restoration treatments.

[1] NORMAL UNI EN 15886:2010: Conservazione de Beni Culturali, Metodi per la misura del colore delle superfici.
[2] NORMAL 21/85: Permeabilità al vapor d'acqua, CNR-ICR, Comas Grafica ed., Roma 1986
[3] Tiano P., Filareto C., Ponticelli S., Ferrari M. & Valentini E. 2000. Drilling force measurement system, a new standardisable method to determine the stone cohesion: prototype design and validation. Int. J. for Restoration of Buildings and Monuments 6, 115-132.

Acknowledgment: the authors are grateful to dr. Leonardo Borgioli of C.T.S. (Altavilla Vicentina, Italy) for supplying Acryl 33 and Peoval 33.