Testing the hardened properties of mortars prepared according to the Wet Packing Method: is this model truly successful?

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Establishing the correct ratios during the preparation of lime mortars is a crucial point for the obtention of materials with good fresh and hardened performances.

1. The wet packing method [1]

$$\varphi = \frac{\frac{M}{V}}{\rho_w u_w + \rho_\alpha R_\alpha + \rho_\beta R_\beta + \rho_s R_s}$$

M/V = wet bulk density of the paste; α, β: two different cementitious materials; *s*: sand; ρ_w = density of the water; ρ_α, ρ_β, ρ_s = solid densities of α, β, and *s*; u_w = W/B ratio by volume; R_α, R_β, R_s = volumetric ratios to the granular material. In mortars where only a binder is present, ρ_β and ρ_β values are equal to zero.

By means of **this model**, it is possible to establish the optimum amount of water at which the packing density is achieved in mortars. This **allows preparing mortars with good workability**.

Porosity $\varepsilon = \frac{u}{1+u}$

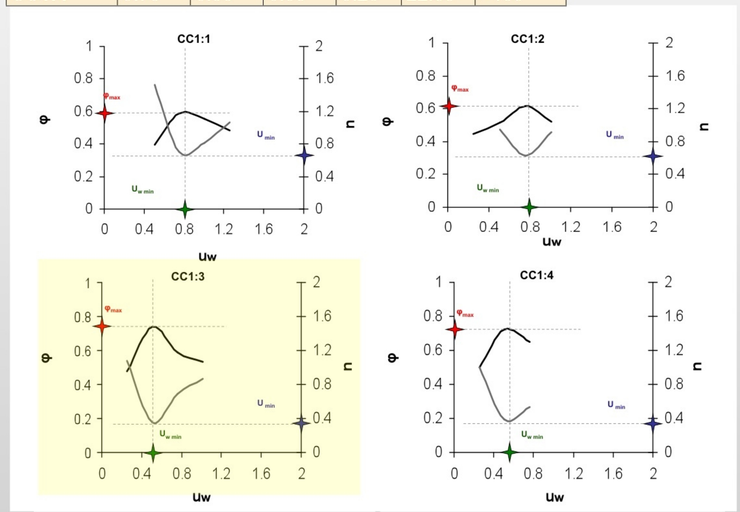
Solid concentration $\varphi = 1 - \varepsilon = \frac{1}{1+u}$

1.1. Application of the wet packing method to lime mortars [2]

Four types of mortars (**CC**) were prepared with **calcitic lime** (CL) and **calcitic aggregate** (CA) with different B/S proportions (by vol.).

Mortar name	φ_{max}	u_{min}	$u_{w\,min}$	u'_w	% water	Flow (mm)
CC1:1	0.59	0.67	0.81	0.14	32.30	172
CC1:2	0.62	0.63	0.81	0.18	31.94	>180
CC1:3	**0.74**	**0.36**	**0.49**	**0.13**	**20**	**143**
CC1:4	0.73	0.35	0.58	0.23	22.68	>180

Mortar CC1:1 and CC1:3 showed the best packing, the minimum amount of kneading water and the best workability of the fresh paste compared to other binder-to sand proportions.



2. AIM OF THE WORK

To verify the reliability of the WPM, i.e. to test out if CC1:1 and CC1:3 are still the best mortar when they harden, by studying their mineralogical, textural and mechanical properties.

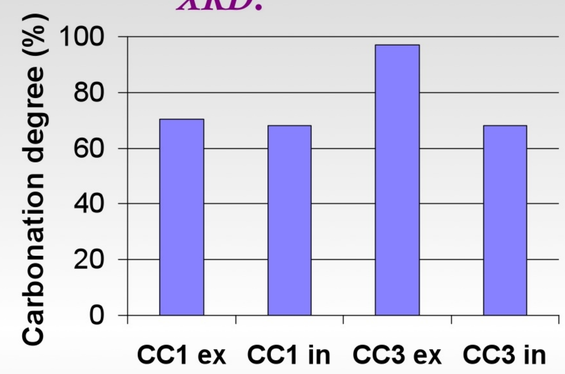
3. Analytical techniques

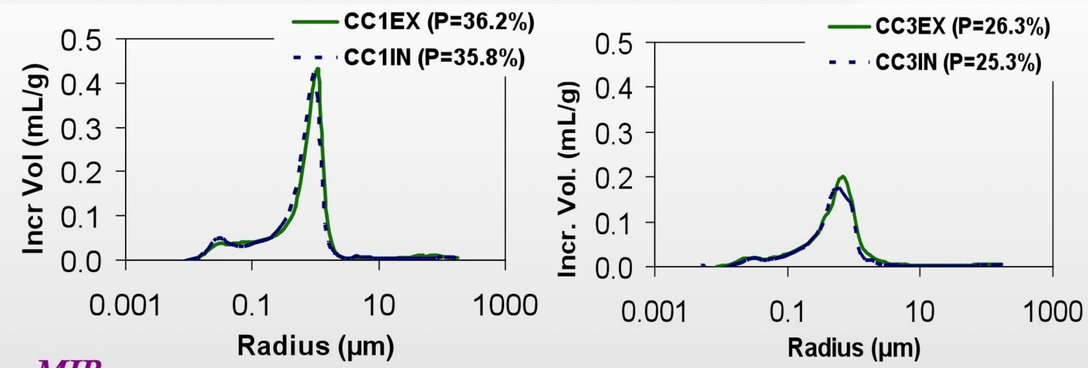
-***X-ray diffraction (XRD)***: for the determination of the carbonation degree, by means of a Philips PW-1710 diffractometer;

- ***Mercury injection porosimetry (MIP)***: for the characterisation of the pore system (open porosity, P in % and pores size distribution), by means of a Micromeritics Autopore III 9410 porosimeter.

-***Mechanical assays:*** for the evaluation of the compressive and flexural strength, by means of a hydraulic press INCOTECNIC-Matest

***XRD*:**





MIP

[1] Wong H.H.C., Kwan A.K.H. Packing density of cementitious materials: part 1-measurement using a wet packing method. Mater Struct: 10.16177s11527-007-9274-5 (2007).
[2] Arizzi A., Cultrone G. The comparison of different methods to determine the packing density of fresh mortars. Proceedings of the 2nd Historical Mortars Conference, Prague (2010).

4. CONCLUSIONS:

CC1:3 mortar presents a better carbonation degree and a lower porosity compared to CC1:1.
However, this mortar shows a lower strength than the expected considering the high dosage in aggregate.
On the basis of these results, we do not consider the WPM a satisfactory method to be adopted for the preparation of aerial lime mortars, if the mechanical resistance is one of the principal requirements (i.e. in structural mortars).

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