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Prediction of compression strength of ancient mortars through in situ drilling resistance technique

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HIGHLIGHTS

- Extensive in laboratory experimental campaign on low-strength mortars.
- Correlations among the DRMS mode and average values and the mortars' compressive strength.
- Definition of a stepwise process to apply to the mortar joints of existing buildings.
- Reliability of the proposed procedure proved by in situ applications.

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ABSTRACT

The paper presents the results of a research project carried out to determine the mechanical characteristics of mortar in historical masonry buildings by drilling resistance technique (DRMS).

A set of mortar mixtures have been produced in experimental campaigns covering different compressive strengths typical of historic mortars. The mortars have been obtained with different classes of binder and river sand with different grading curves. Specimens obtained were subjected both to flexural, compression and DRMS laboratory tests.

Considering the results of the drilling measurement distributions, both the mode and the average value, the latter obtained after a statistical treatment in which extreme outliers are deleted, have been taken as reference values for each test performed. Effective correlations between the mode and average values of DRMS tests and the compressive strengths of the mortars are provided.

Finally, a stepwise process to be followed for in situ use of DRMS is defined and applied to mortar joints of some existing masonry buildings in Tuscany (Italy).

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1. Introduction

Recent Italian seismic events have once again highlighted the vulnerability of the historical masonry building heritage. One of the causes of the high vulnerability is the poverty of materials especially the mortar used in buildings of the rural historical centres [1–3].

The structural evaluation of historic buildings has become a necessary step to be taken to prevent the seismic risk and to preserve the historical and artistic heritage (some examples in [4–8]). When analysing a historical construction, the evaluation of the mechanical characteristics of the materials is one of the major issues to be addressed. Although destructive in situ tests allow the direct estimation of the mechanical characteristics of the masonry types, they usually have to be excluded due to their high cost and impact on the monumental constructions [9]. Therefore, tests on the components – namely stones, blocks and mortar – have to be done, from which it is possible to derive the characteristics of the masonry. All national [10,11] and international [12] standards indeed, define the parameters of masonry types, such as the compression and shear strengths, depending

Abbreviations: CS, Case Study; CV, coefficient of variation; DRMS, Drilling Resistance Measurement System; DR, force measured by the DRMS test; DR_{av}, average of the DRMS values; DR_i, force measured by the DRMS test using a generic i-drill bit; DR_{mo}, mode of the DRMS values; MDT, Minor Destructive Testing; NC, Natural Cement (PROMPT type); NHL, Natural Hydraulic Lime; NDT, Non-Destructive Testing; PC 32.5, Portland Cement Type II/B-LL 32.5 R; R_C, compressive strength of the mortar; SK, Skewness; SL, slaked lime (CL 80-S); StD, standard deviation; ν, penetration rate; ω, revolution speed.

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