

Chemo-mechanical degradation of monumental stones

F. Freddi*

*Dipartimento di Ingegneria e Architettura
Università di Parma, Parma, Italy
e-mail: francesco.freddi@unipr.it

ABSTRACT

The aim of this work is to study the degradation of monumental stones under the combination and the mutual interaction between mechanical actions and environment/pollution conditions. In particular the stone degradation has been estimated as a function of the environmental conditions and the prediction of damaging phenomena, which can compromise permanently the fruition and/or the stability of the monuments.

A macroscopic phenomenological model has been developed that couples the main aspects of the problem: the chemical reaction and the mechanical behavior of stones. In particular, the sulphation reaction and the diffusion of the pollutant agents will be described by suitable mathematical equations [1] that will be coupled to a variational formulation of the fracture mechanics [2]. The proposed model permits to evaluate how much aggressive atmospheric agents contribute to the decay of the mechanical properties of the stones as well as to establish the impact of the synergic chemical aggression and stress state. This latter will also be influenced by the chemical reaction and by the evolving mechanical properties of the material. The capability of the approach will be illustrated by specific numerical simulations.

REFERENCES

- [1] Giavarini C., Santarelli M.L., Natalini R., Freddi F., *A nonlinear model of sulphation of porous stones: numerical simulations and preliminary laboratory assessments*, Journal of Cultural Heritage, 9 (2008) 14-22.
- [2] Freddi F., Royer-Carfagni G., *Regularized Variational Theories of Fracture: a Unified Approach*, Journal of Mech. and Physics of Solids, 58 (2010) 1154-1174.