

## FRACTURE ENERGY AND HOMOGENIZATION OF MASONRY STRUCTURES

\* N. Cavalagli, F. Cluni and V. Gusella

Department of Civil and Environmental Engineering, University of Perugia  
Via G. Duranti, 93 - 06125 Perugia - IT  
Corresponding author: cavalagli@strutture.unipg.it

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### ABSTRACT

The masonry material can be considered as a heterogeneous material with inclusions (stones or bricks) in a matrix (mortar). The definition of the overall response beyond the elastic range is very complex because of the variety of the texture and the uncertainties related to the quasi-brittle nature of the phases.

This paper presents a new approach to the evaluation of macroscopic parameters of the heterogeneous material, with the aim to estimate the RVE and its mechanical characteristics beyond the elastic range, that is to determine the inelastic response of the homogenized continuum. The main aspect of this work is to consider the fracture energy obtained in essential conditions [1, 2] as a homogenization parameter.

Using a FEM micromechanical model, the RVE is estimated through the test-windows method [3, 4]. The analyses are performed in the generalised plane strain and a concrete smeared crack model is used for each phase. Moreover, a Mohr-Coulomb interaction law between the contact surfaces of the inclusions and the matrix is defined. The model is compared to the experimental results obtained by Dhanasekar et al. [5].

The procedure permits to analyse non-periodic masonries, with different mechanical characteristics of the phases and several textures, and proposes an RVE estimation criteria.

### REFERENCES

- [1] J. Zeman and M. Šejnoha. "From random microstructures to representative volume elements". *Modelling and Simulation in Materials Science and Engineering*, Vol. **15** (4) 325–335, 2007.
- [2] J. Šejnoha, M. Šejnoha, J. Zeman, J. Vorel and J. Šykora. "A Mesoscopic Study on Historic Masonry". *Computers & Structures*, (Preprint: [http://cml.cvut.cz/~zemanj/preprints/cs\\_07\\_sejnoha.pdf](http://cml.cvut.cz/~zemanj/preprints/cs_07_sejnoha.pdf)).
- [3] F. Cluni and V. Gusella. "Homogenization of non-periodic masonry structures". *International Journal of Solids and Structures*, Vol. **41** 1911–1923, 2004.
- [4] N. Cavalagli, F. Cluni and V. Gusella. "Computational evaluation of random masonry yield surface". *Proceedings, 9th U.S National Congress on Computational Mechanics*, San Francisco, CA, USA, 2237–2242, 2007.
- [5] M. Dhanasekar, A. W. Page and P. Kleeman. "The failure of brick masonry under biaxial stresses". *Proceeding of the Institution of Civil Engineers London, Part 2*, Vol. **79** 195–313, 1985.