

## COSSERAT HOMOGENIZATION OF ELASTIC PERIODIC BLOCKY MASONRY

\* L. Gambarotta<sup>1</sup> and A. Bacigalupo<sup>1</sup>

<sup>3</sup> DICAT- University of Genova  
Via Montallegro, 1 – 16145 Genova, Italy  
gambarotta@dicat.unige.it – www.dicat.unige.it

**Key Words:** *Homogenization, Masonry, Micropolar elasticity, Multiscale models.*

### ABSTRACT

In continuum modelling masonry structures the current consensus is that a higher-order theory is necessary to include geometric and material length scales to appreciate the influence of block size and high stress and strain gradients and to prevent pathological localizations arising from the assumption of strain-softening constitutive equations due to the quasi brittle components of the masonry.

Elastic micropolar continuum models for 2D periodic masonry have been derived through an integral equivalence procedure starting from the description of a Lagrangian system of rigid bodies interacting through linear elastic interfaces (see for reference [1-2]). From this approach the validity limits of the Cauchy models can be quantitatively obtained, and turn out to be remarkable in cases of load or geometrical discontinuities and when the block size is not small with respect to the structure size. However, an evaluation of the Cosserat continuum model would require to consider the block deformability, which in some cases is comparable to the mortar one's.

General approaches to the micropolar homogenisation of periodic heterogeneous materials have been proposed in [3,4]. A micropolar homogenization of 2D periodic masonry with elastic brick/blocks and mortar joints has been proposed in [5], where the rotational dof of the homogenised continuum has been assumed through a heuristic evaluation of the mean local rotation of the block.

In this work a two-dimensional Cosserat homogenization is developed for periodic masonry made up of elastic brick/block units and mortar joints. According to [3], the homogenization of the representative periodic masonry element is obtained by prescribing the macroscopic dofs and generalized strain measures through a corresponding displacement field including a periodic perturbation. The orthotropic moduli of the homogenized micropolar continuum are obtained for realistic values of the elastic moduli of the components and compared to the corresponding orthotropic moduli of the Cauchy continuum. Finally, a sensitivity analysis is carried out for varying geometric and constitutive parameters.

## REFERENCES

- [1] P. Trovalusci, R. Masiani, “A multifield model for block materials based on multiscale description”, *Int. J. Solids and Structures*, **42**, 5778-5794, (2005).
- [2] J. Sulem, H.B. Mühlhaus, “A continuum model for periodic two-dimensional block structures”, *Mech. Cohesive-frictional Materials*, **2**, 31-46, (1997).
- [3] S. Forest, K. Sab, “Cosserat overall modeling of heterogeneous materials”, *Mech. Res. Comm.*, **25**, 449-454, (1998).
- [4] F. Bouyge, I. Jasiuk, M. Ostoja-Starzewski, “A micromechanically based couple-stress model of an elastic two-phase composite”, *Int. J. Solids and Structures*, **38**, 1721-1735, (2001).
- [5] S. Casolo, “Microscopic modelling of structured materials: Relationship between orthotropic Cosserat continuum and rigid elements”, *Int. J. Solids and Structures*, **43**, 475-496, (2006).