

## NON LINEAR HOMOGENIZATION TECHNIQUES TO SOLVE MASONRY STRUCTURES PROBLEMS

Ricardo D. Quinteros<sup>\*</sup>, Sergio Oller<sup>†</sup> and Liz G. Nallim<sup>\*</sup>

<sup>\*</sup> Facultad de Ingeniería, ICMASa, INIQUI (CONICET)

Universidad Nacional de Salta (UNSa)

Avenida Bolivia, 5150 - 4400 Salta, Argentina

e-mail: rdquinteros@conicet.gov.ar, web page: <http://www.unsa.edu.ar>, <http://www.conicet.edu.ar>

<sup>†</sup> CIMNE. Internacional Center for Numerical Method in Engineering.

e-mail: oller@cimne.upc.edu, web page: <http://www.cimne.com>

UPC. Technical University of Catalonia (Barcelona Tech)

Edif. C1, Campus Nord, Jordi Girona 1-3, 08034 Barcelona, Spain.

e-mail: sergio.oller@upc.edu, web page: <http://www.upc.edu>

**Key words:** Composite structures, homogenization techniques, masonry, constitutive models.

**Abstract.** *The behaviour of masonry material subjected to different in-plane loading combination is studied in this work. The masonry is considered as a periodic composite material composed by a regular distribution of brick and mortar and it is analysed using a homogenization technique. The mechanical properties of the masonry, as an orthotropic homogeneous material, depend on the geometrical and mechanical properties of the components based on the study of the equilibrium and compatibility of a basic cell. The masonry is a frictional material and its behaviour depends on the loading direction, for these reasons, a unilateral damage model is chosen for the analysis. This model describes the behaviour of brittle materials subjected to tensile-compressive cyclic loads based on the introduction of two damage variables and it assumes that the damage is due to the beginning and growth of cracks only in the mortar joints. It is considered that the bricks have a linear elastic constitutive relationship. Numerical applications are performed with a non-linear finite element code in order to test the proposed procedure by comparing the results with those available in the literature and also with experimental data.*