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Sensitivity of mechanical masonry characteristics to the textures: FE micro-modelling and homogenization procedures

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ABSTRACT

The difficulty in masonry modelling lies both in the non-linear constitutive behaviour of its components and in its heterogeneous character, since it is composed by blocks jointed together by a thin layer of mortar, the stiffness of the blocks being much higher than that of the joints.

Furthermore, another relevant aspect to underline, connected to the non-linear behaviour of masonry, is the poor resistance to tensile stresses of the bond between the mortar and the blocks. This suggests to model the joints as interfaces completely cracked and justifies the success of the “no tension material” as a first step for a non-linear study.

Nevertheless, a linear elastic analysis is still significant under service loads to characterize the mechanical parameters as well as to perform the subsequently non linear analysis. Several papers have been presented in the technical literature for the in-plane case in the elastic range, see for instance [1], [2].

Two identification procedures are proposed, respectively based on standard homogenisation method and on direct identification method. In particular the homogenisation method here adopted is based on an analytical approach under the hypothesis of mortar joint modelled as interfaces of zero thickness, e.g. [3]. On the other hand the direct identification method is based on a finite element micro-modelling of a periodic masonry pattern subjected to homogeneous deformation state, e.g. [4]. As an example Figure 1 shows the finite element mesh of shear test for both stack and running masonry texture. It is worth noting that in this phase of the research the masonry system can be assumed as composed by rigid blocks interacting with elastic mortar joints.

The aim of this paper is to assess the accuracy and reliability of different identification approaches, with particular interest in comparison with explicit formulas obtained through an asymptotic model (Cecchi and Sab 2002). As well known, the homogenization approach is very difficult to be used in the non linear analysis, while the numerical model based on the homogenous deformation states at the boundary may be easily extended to non linear analyses. Hence the first step of this research is the

correct calibration of this latter numerical model by critical comparison with the analytical homogenization approach. In particular a detailed comparison with the constitutive functions obtained by different models is performed. Moreover, a critical analysis of the identification procedures to evaluate their accuracy by comparison with a F.E. model for some meaningful cases is carried out.

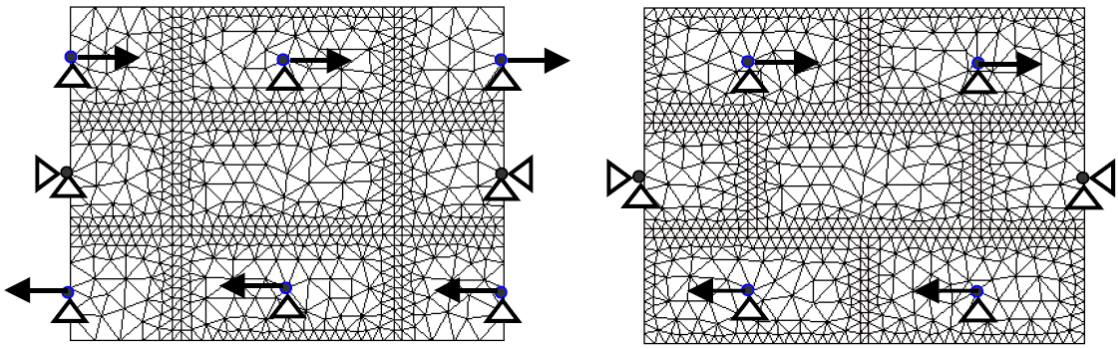

Figure 1 FE micromodelling: shear test for stack and running masonry texture

With reference to historical constructions, masonry typologies very different exist. From a structural point of view, two basic classes for masonry buildings may be distinguished: regular and irregular masonries. Masonries with regular texture in which brick or stone blocks are regularly shaped and characterized by a disposition of the units along horizontal lines belong to the first class. Two further sub-classes may be identified: periodic and quasi-periodic masonry, being the difference related to the possibility of identifying a REV, which generates panel as a whole by repetition. Masonry constituted by irregular stones belongs to the second class and is characterized by the presence of irregularly shaped and irregularly disposed stones with variable dimensions.

Here the attention will be focused on masonries with regular texture (e.g. stone masonry with disposition of the stones which follows sub-horizontal joints). In particular the case of stack bond and running bond are taken into account. This latter case may be obtained by half block translation of the pair courses. Also some intermediate cases (e.g. translation of a quarter of block) are considered and the sensitivity of the global constitutive function is analysed.

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