Micro-scale numerical modelling of FRCM tensile behaviour

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ABSTRACT

In the last decade, fibre-reinforced cementitious composites (FRCM), have drawn the attention of the scientific community as strengthening material of existing masonry structures. As a matter of fact, such material, made with a fibre mesh embedded into inorganic matrix, has shown good properties in terms of mechanical response. Furthermore, it is easy to install on the support, resulting also as a masonry-compatible material. Indeed, this strengthening material can be applied on the substrate without using polymeric resin and exhibiting a good vapour permeability.

Differently from the most known FRP (Fibre Reinforced Polymers), that exhibit a brittle linear elastic tensile law, FRCM tensile behaviour is characterized by an inelastic law that involves the mortar matrix cracking and the slippage of the longitudinal fibres along the load direction. Many experimental campaigns have been carried out in order to evaluate a constitutive tensile stress-strain law. A tri-linear curve has been identified, characterized by three different stage: i) linear elastic behaviour up to the matrix cracking, ii) second branch characterized by mortar cracks spreading and by longitudinal fibres sliding, iii) third branch influenced by the fibres strength up to failure. The complexity of such constitutive law, due to different micro-mechanical phenomena, that involves the mortar and the fibre-mortar interfaces damaging [1], needs to a specific numerical modelling.

In this context, aim of this work is to model the FRCM tensile behaviour, accounting for these effects. A micro-scale finite element numerical modelling is herein proposed, based on an incremental displacement-based approach and on a plane-strain bi-dimensional formulation. The utilized numerical procedure takes into account the mortar matrix damage and the fibre-matrix detachment through interfaces modelling [2]. In particular, for the mortar a nonlocal damage model is adopted. Furthermore, the progressive damage evolution of the material is evaluated through the stress analysis. The numerical models have been validated with available benchmarking experimental results [3]. Good agreement of the proposed modelling has been highlighted by the comparisons of the experimental and numerical tensile stress-strain curves.

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