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VARIATIONAL MODELING OF MICRO-CRACKING AND FAILURE IN FIBER-REINFORCED CONCRETES

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The mechanical properties of standard concrete significantly improve with the use of fibers dispersed within. In particular, such fibers contribute to sustain tensile loadings and to diffuse stresses [1], thus largely increasing the ultimate strength and ductility in FRC (Fiber Reinforced Concretes). Focusing on the tensile behavior, for which significant mechanical enhancements are achieved, FRC typically experiences a non-linear stress-hardening phase of diffuse micro-cracking, followed by a process of stress-softening, corresponding to strain localization and macro-crack opening.

In this work, the great potentialities of FRCs are explored both from a modeling point of view, by developing a variational micro-mechanical model, and from an applicative viewpoint, by presenting a preliminary study for the realization of a table prototype totally made of FRC.

As the model is concerned, the mechanics of the cementitious matrix and fibers is described by two material phases, which account for brittle and ductile elasto-plastic responses. The evolution problem is formulated as an incremental energy minimum problem, where the unknowns are a damage and a plastic strain fields (corresponding to the internal variables associate to the two phases). Analytical estimates and numerical solutions are determined in the one-dimensional setting, which clearly show the model capability of describing the different stages observed experimentally. The problem is reformulated in the two-dimensional setting and implemented in a finite element code, which is used to simulate the behaviour of real FRC structural elements.

Then, attention is turned to applications. In particular, the idea of realizing a table totally made of fiber-reinforced concrete is explored in [2]. Starting from the design of the table, and going on with the mechanical characterization of a purpose-made high-performance fiber-reinforced concrete via experimental testing, all the stages of the study are presented, focusing on the modeling analysis and the discussion of numerical results.

REFERENCES

[1] G. Lancioni, V. Corinaldesi, Variational modelling of diffused and localized damage with applications to fiber-reinforced concretes. *Meccanica* on-line, DOI 10.1007/s11012-017-0709-y, 2017.

[2] E. Baioni, R. Alessi, V. Corinaldesi, G. Lancioni, R. Rizzini, Feasibility Study of a Table Prototype Made of High-Performance Fiber-Reinforced Concrete. *Technologies*, Vol. **5**(41), pp. 1–13, 2017.