An energy equivalent d^+/d^- damage model with extended MCR capabilities

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ABSTRACT

The present contribution is addressed to the formulation of a consistent orthotropic damage model for quasi-brittle materials. The starting point of this study is the rate-independent d^+/d^- constitutive law proposed in [1] for the modelling of concrete, based on an independent treatment of tensile and compressive regimes and on the hypothesis of strain-equivalence.

First, a drawback of the original formulation is identified in the inadequate consideration of the Poisson's effect on the representation of the damage-induced anisotropy, which translates in the lack of major symmetry of the secant stiffness tensor. In view of this, an orthotropic model, ruled by a symmetric secant operator, is here developed, resorting to an energy-equivalence assumption. This allows describing an essential feature of orthotropic damage models, i.e. the modification of the Poisson's ratio throughout the damage process.

Secondly, another shortcoming of the d^+/d^- formulation is represented by its unsatisfactory modelling of the micro-crack closure reopening (MCR) effects in presence of generic cyclic loadings, due to the impossibility of preserving memory of the damage orientation. An approach to enhance the stiffness recovery capabilities of the model is here proposed. It consists in saving during the analysis two damage values for tension and two for compression, which differ for the principal strain directions which have generated them, and in choosing the active values d^+ and d^- on the base of the current maximum and minimum principal directions.

Finally, some structural applications are studied to discuss the performance of the new model compared with the original one.

REFERENCES

[1] R. Faria, J. Oliver ad M. Cervera, *A strain-based plastic viscous-damage model for massive concrete structures*, *Int. J. Solids Struct.*, **35** (14), 1533-1588 (1998).