Mesh-objective description of isotropic/anisotropic damage with crack-closure and irreversible strains

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ABSTRACT

The overall goal of our work is the development of an anisotropic damage model including crack-closure and irreversible strains, guaranteeing 'strictly increasing damage' and mesh objectivity.

We start with an isotropic damage model accounting for crack-closure effects and irreversible strains by means of an initial strain tensor (cf. e.g. Chaboche et al. (1995) [1]). Mesh objectivity is achieved by utilizing a micromorphic approach according to the work of Forest (2009) [2]. In the case of isotropic damage, one micromorphic variable, namely the micromorphic damage variable is defined which carries the gradient effects and acts as an additional degree-of-freedom on the global level.

For the anisotropic case (second order damage tensor) also only one scalar micromorphic variable is introduced (accumulated micromorphic damage). In order to guarantee equivalence between the local damage and the micromorphic damage a penalty term is incorporated into the free energy function. Moreover, the free energy is constructed in such a way that 'strictly increasing damage' is ensured. Here 'strictly increasing damage' is understood that additional damage does not lead to stiffening in any direction (for a more detailed explanation see Wulfinghoff et al. (2017) [3]).

For the isotropic and anisotropic model several parameter studies on Gauss point level are shown. In the end, some numerical examples are presented in which the features of the models are illustrated.

REFERENCES

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[3] S. Wulfinghoff, M. Fassin and S. Reese, "A damage growth criterion for phenomenological damage models motivated from micromechanics" (2017) submitted.