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STRESS-BASED GRADIENT-ENHANCED DAMAGE MODELS WITH TRANSIENT LENGTH SCALE

B. Vandoren[1,*] and A. Simone[2,3]

[1] Faculty of Engineering Technology, Hasselt University, Hasselt, Belgium,
bram.vandoren@uhasselt.be
[2] Department of Industrial Engineering, University of Padova, Padua, Italy
[3] Faculty of Civil Engineering and Geosciences, Delft University of Technology, Delft, The Netherlands,
angelo.simone@unipd.it

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While gradient-enhanced damage models show excellent regularization properties for avoiding mesh-dependency in strain localization, it is known that these models suffer from spurious spreading of damage and unphysical damage initiation [1,2]. To overcome these issues, we propose a class of anisotropic stress-based gradient-enhanced damage models in which the gradient activity vanishes when damage increases [3].

The first model is based on principal stresses and is directly inspired by the stress-based integral nonlocal model by Giry, Dufour and Mazars [4]. It will be shown that this model does not perform well in case of shear-dominated failure problems, leading to tortuous force-displacement curves caused by a mismatch between the evolving level of gradient activity and damage: nonlocal interactions are cancelled too soon with respect to damage. The second model solves this problem by employing a nonlocal equivalent stress-based gradient parameter, which is linked to the measure of the equivalent strain that drives damage evolution. Nonlocal averaging is thus more at pace with the evolving level of damage, similar to the recently proposed model by Poh and Sun [5] in which a damage-based parameter is used inspired by micromorphics.

It will be shown that both models lead to a correct location of damage initiation and significantly reduce the spreading issue. However, the models suffer from unphysical strain oscillations caused by a gradient parameter that becomes too small with respect to the mesh size, reintroducing some degree of mesh-dependency. It will be demonstrated that these oscillations can be cancelled by using an element-specific lower bound value of the gradient parameter. The performance of the proposed models is evaluated by means of shear and bending tests.

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