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PHASE-FIELD FRACTURE MODEL WITH NEW HYBRID SPECTRAL-DIRECTIONAL ENERGY SPLIT BASED ON GRADIENT SMOOTHING TECQNIQUE

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In the last decade, the phase-field modelling of fracture gained significant popularity, as it is an elegant and versatile numerical tool capable of accurately capturing experimentally observed crack patterns. However, basic brittle fracture models are neither perfect nor universal, their flaws often stemming from the adopted energy decomposition. Models that use spectral splits [1] are sometimes prone to the transmission of shear stress through a crack, while the spherical-deviatoric decomposition [2] can be prone to cracking in compression and to the artificial loss of compressive stiffness. To solve those problems, different models based on directional splits have been proposed, such as in [3].

In this contribution, we propose a new approach for decomposing the strain energy, where both the spectral and directional energy split are used, depending on the intensity of the damage in material. Thereby, the spectral-based energy decomposition is dominant for small phase-field values, while at high phase-field values the directional-based energy split becomes more relevant. As a result, material behaviour shortly after the crack initiation is defined by the spectral energy split, while the behaviour preceding the complete material failure is determined by the directional split. The definition of the crack driving force is inspired by the Rankine criterion. The calculation of crack direction is performed as a 'postprocessing' of the phase-field, where the smoothing of the phase-field gradient is utilized. To speed up computation, a simple adaptive refinement procedure is utilised.

Preliminary results of simple standard benchmark examples as well as problems with complex geometry show that the method results in physically meaningful stress distributions, as the model is capable of simulating crack closure, i.e., the contact between crack surfaces, without producing any spurious stresses.

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