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A unified phase-field model of fracture in rate-dependent materials

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For materials with rate-dependent mechanical behaviour, loading velocity can significantly influence critical load and deformation until failure. When modelling such failure mechanisms in these materials exhibiting viscous effects, it is crucial to properly account for the coupling between dissipative mechanisms present in the bulk material, possibly rate-dependent fracture toughness and crack growth.

Within the phase-field fracture approach, a unified phase-field model for fracture of viscoelastic materials has been presented in the small strain regime in [1] recently. Herein, this model is extended to the finite viscoelasticity setting [2]. Moreover, a strain rate-dependent fracture toughness is introduced. The proposed model enables flexibility in modelling the coupling between crack phase-field and viscous mechanisms. Depending on its parameters, the model allows describing the specific behaviour of different materials. Particularly, it enables to capture quantitatively and qualitatively differing responses that are experimentally observed for varied materials, e.g. regarding the change of critical stress and deformation with rate of deformation.

Several numerical examples, including monotonic loads and creep, are studied to analyse the coupling between rate effects and crack phase-field for different materials. The predictions of the model are qualitatively and quantitatively compared with experimental data.

REFERENCES

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