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Modelling the inelastic response and progressive failure of fibre-reinforced composites at finite strains

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ABSTRACT

Conventional constitutive models employed to predict the mechanical response of fibre-reinforced composites at the mesoscopic level, i.e. at the level of the unidirectional ply, are usually developed under the small strain assumption. Even though this assumption is adequate for materials exhibiting low plastic strain at failure, it may fail to accurately predict the inelastic and progressive damage response of composites that are more ductile, like fibre-reinforced thermoplastics.

A recently proposed invariant-based constitutive model can predict the finite strain response of uni-directional polymer composites, accounting for visco-elastic and visco-plastic effects [1]. Nevertheless, it does not account for damage mechanisms. Smeared crack approaches that include a cohesive law at locations where fracture criteria is verified and pursue an equilibrium between cohesive and bulk tractions can model transverse cracking [2]. The approach proposed in [2] is extended for a finite strain framework compatible with the visco-elasto-plastic model presented in [1]. It will be endowed with appropriate extrinsic mixed mode cohesive law that can deal with non-monotonic loading (load-unload-reload). This model is implemented in a user-defined Abaqus routine for finite element simulation. The Newton-Raphson method is employed to solve the highly non-linear equilibrium problem that arises due to the smeared crack approach. The accuracy of the numerical results is assessed by comparison with experimental data available in the literature, like stress-strain relationships observed in off-axis tests.

REFERENCES

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