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Hyperelastic Modeling of Chain-Distributed Particle-Reinforced Composite in Finite Deformation

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A hyperelastic constitutive model is proposed to predict the mechanical behavior of chain-distributed particle-reinforced composite in this paper. The particle chain is first treated as a “virtual fiber” and its effective stiffness is obtained using the particle-reinforced composite model developed in (Guo et al. 2014). Then the overall composite is considered as a fiber reinforced composite and its mechanical behavior in finite deformation can be predicted by the composite-based model proposed in (Guo et al. 2006). To verify this theoretical model, cubic representative volume element (RVE) models with periodic structure are constructed to study the mechanical responses of the composites numerically. RVE models with 5%, 10%, 20% and 30% particle volume fractions are simulated using finite element methods (FEM). The number of identical spherical particles in a cubic RVE model ranges from 24 to 28 for different particle volume fractions. Both the particles and the matrix are modeled as incompressible neo-Hookean materials and the particles are 100 times stiffer than the matrix. Uniaxial deformation, simple shear, as well as general three-dimensional deformation of the RVE models are simulated and the results are compared with the predictions by the proposed theoretical model.

References

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