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Dispersive homogenization model for fiber-reinforced composites

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The heterogeneity of the microstructure of composite material causes dispersion in wave propagation problems. For accurate prediction of the structural response, it is important to capture this microstructural effect. However, it is computationally not feasible to model the complete microstructure. To limit the computational cost, a homogenization method is needed.

In this study, the mathematical homogenization method that accounts for dispersion, which was first proposed by Fish et al. [1] and later explored by Karamnejad and Sluys [2] is investigated for complex random composite structures. In this method, asymptotic homogenization is utilized to introduce a coarse-scale and fine-scale formulation for the strong form of the problem. The fine scale problem of a representative volume element (RVE) is approximated with a quasi-static equilibrium equation while the effect of fine-scale wave dispersion is considered by an inertia-induced eigenstrain. The coarse-scale equation of motion is enriched with an acceleration gradient term scaled by a so-called "dispersion tensor", which is computed from solving the RVE problem. Our contribution includes: (1) testing the existence of a RVE for fiber-reinforced composites, a statistics study is therefore performed with different RVE sizes; (2) demonstrating the effect of the dispersive multiscale formulation on the wave propagation.

REFERENCES

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