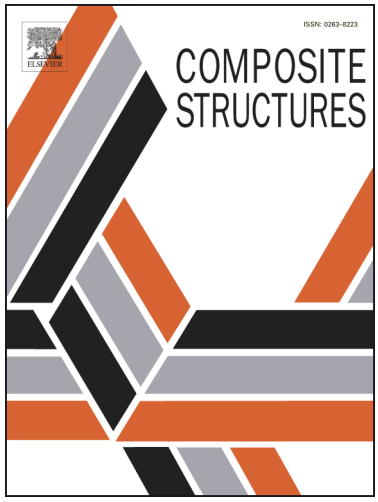

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Frequency Domain Finite Element Estimates of Viscoelastic Stiffness of Unidirectional Composites

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ABSTRACT

A general frequency domain finite element homogenization procedure is presented to estimate the viscoelastic moduli of heterogeneous materials on the basis of their representative multi-inclusion periodic unit cells. The procedure is used to obtain estimates of the effective viscoelastic moduli of unidirectional carbon/epoxy and glass/epoxy composites. Regular hexagonal and random Monte Carlo models with up to 800 fully aligned both identical and distributed diameter fibers are studied. It is shown that for common industrial unidirectional composites, the effect of fiber diameter distribution on the effective viscoelastic moduli is practically non-existent. It is found that classical three phase cylinder model gives accurate predictions for both storage and loss viscoelastic moduli of regular hexagonal microstructure unidirectional composites. However for random microstructures, the model's predictions are getting less accurate, in particular for glass/epoxy unidirectional composites. But nonetheless the model still captures well all the trends so it can be helpful in preliminary micromechanics design of the vibration damping performance of structural parts from unidirectional viscoelastic composites, as illustrated in this work for the case of cylindrical bending of orthotropic strips. However, for a quantitative analysis one can rather rely today on direct finite element viscoelastic predictions that have become practical, quick and convenient.

Keywords: viscoelastic; composite materials; finite element; design.

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