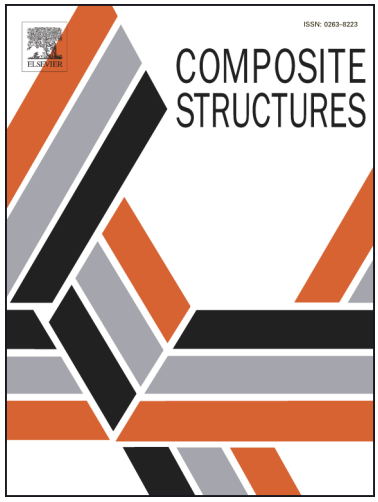

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Construction of second gradient continuum models for random fibrous networks and analysis of size effects

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Abstract

In this work we develop anisotropic first and second order displacement gradient linear elastic continuum models for two-dimensional random fiber networks. The continuum constitutive parameters are evaluated based on the response of the explicit representation of the network in which each fiber is a beam and the fibers are connected at crossing points with welded joints. The scaling of the first and second order moduli with the network parameters, such as the network density and the ratio of the fiber bending to axial stiffness, is determined. We observe that the dependence of the second gradient moduli on these two parameters is similar to the dependence of the classical moduli on the same parameters. The internal length scales associated with the gradient terms of the constitutive equation are also defined in terms of the network parameters. The influence of the model size on the elastic constants is discussed. We observe that if the model size is large enough for the classical moduli to be size effect free. However, there is still a strong size dependency of the computed internal lengths associated to second order gradient effects.

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