Failure of Network Materials: from Stochastic Damage to Fracture

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Abstract

Many materials have a stochastic network of fibers as their main structural component and are referred to collectively as 'network materials.' This includes all biological connective tissue, the extracellular matrix, the cytoskeleton, paper and cellulose networks, nonwoven textiles and various molecular networks. Failure is critical in many applications involving such materials. However, interpreting and quantifying failure is less straightforward than in continua due to the discrete nature of the structure, its intrinsic stochasticity and the coupling of length scales of the fracture process with that of the network. This talk reviews results related to this topic including the relationship between strength and toughness and network parameters, the effect of preferential fiber alignment on stiffness, strength and toughness, the competition between diffuse damage and localized, fracture-like damage. Non-dimensional structural parameters are used to distinguish between types of behavior, leading to a classification of network materials in view of their failure characteristics.

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