Scaling Laws for Damage Evolution in Disordered Media[1]

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Abstract

Scaling laws derived from mesoscopic discrete lattice models are typically used for coupling the mesoscopic damage evolution with the continuum damage response and in determining the size effects on the constitutive response of materials. This study develops the scaling laws based on the Renormalization Group (RG) methodology for the number of bonds broken in a discrete lattice before the macroscopic fracture occurs. The developed scaling laws imply the existence of a finite critical fracture threshold, defined as a fraction of number of broken bonds to the total number of bonds, below which macroscopic fracture of an infinite system does not occur. This result is in contrast with earlier results based on power law curve fit expressions, wherein the critical threshold approaches zero in the limit of an infinite system. However, the existence of a finite critical fracture threshold can be associated with a critical crack size, below which macroscopic fracture of a specimen does not occur. Further, the finite size scaling law based on the RG methodology remains accurate *with increasing system size* and also avoids certain inconsistencies associated with conventional power law type expressions reported in the literature. Numerical simulations based on two-dimensional triangular and diamond lattice networks substantiate the proposed scaling laws and are used to estimate the critical thresholds and the scaling exponents.

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