Scaling of Fracture Strength in Disordered Quasi-Brittle Materials[1]

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Abstract

For materials with *broadly distributed* microscopic heterogneities, the fracture strength distribution corresponding to the peak load of the material response does not follow the commonly used Weibull and (modified) Gumbel distributions. Instead, a *lognormal* distribution represents the fracture strength of the macroscopic system more adequately than the conventional Weibull and (modified) Gumbel distributions. Lognormal distribution arises naturally as a consequence of multiplicative breaking process, in which large number of random distributions that represent the individual conditional probabilities of breaking of bonds leading up to the peak load, are multiplied to give the failure probability of the lattice system. Numerical simulations based on two-dimensional triangular and diamond lattice topologies with increasing system sizes substantiate that a *lognormal* distribution represents an excellent fit for the fracture strength distribution at the peak load. The second significant result of the present study is that, the mean fracture strength decreases with increasing lattice system size as an affine transformation of $1/L$, and approaches a constant threshold value, as the lattice system size, L approaches infinity. This result is in agreement with the finite size scaling laws derived using the renormalization group (RG) methodology as the system approaches critical behavior. The critical fracture threshold, below which macroscopic fracture of an infinite system does not occur may be associated with the driving force necessary for macroscopic crack propagation that ultimately leads to the failure of the lattice system.

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