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Numerical simulations of dynamic fragmentation in brittle materials RAMESH RAGHUPATHY, FENGHUA ZHOU, Johns Hopkins University, GEORGE GAZONAS, U.S. Army Research Laboratory, JEAN-FRANCOIS MOLINARI, Johns Hopkins University — The problem of fragmentation of a contiguous body subjected to intense loading has been under strong scientific scrutiny over the past few decades. Variations in fragment size have important implications in ballistic impact, crash performance, explosive drilling, and even the clustering of galaxies resulting from the big bang theory. In ceramic materials under high stress loads, cracks will initiate at flaws, and potentially propagate catastrophically to cause large-scale fragmentation. Multiple cracks will initiate at seemingly random locations and material failure will occur through a complex stress-wave communication process. In this presentation, a numerical approach relying on the cohesive element approach to cracking is advocated. The proposed model naturally accounts for stress-wave communication and other non-instantaneous cracking processes. The robustness of various cohesive element models in accurately predicting fragment size is discussed at length. In particular, a cohesive zone length scale, which is made explicitly dependent on the loading rate, is proposed to capture the correct amount of energy dissipated during fragmentation. Numerical evidence shows that this new formalism provides a simple and robust replacement of quasi-static predictions of the cohesive zone size. Illustrative examples are given for ceramic materials with various defect populations.

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