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Peridynamics Simulation of Inelasticity and Fracture in Pressure-Dependent Materials

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A pressure-dependent Drucker-Prager plasticity model is implemented in a computational peridynamics framework to simulate the failure of concrete during impact. Two approaches, one using a peridynamic state regularization of the classical Drucker-Prager model and the other using the equivalent peridynamic state relations of the Drucker-Prager model, are surveyed. The results of the two models are compared with results obtained from finite element simulations in the absence of fracture. A failure criterion based on the decomposition of the strain energy density into a deviatoric part and a volumetric part is implemented and used along with the criterion based on critical bond extension and the criterion based on critical strain energy density to explicitly model fracture in the material. The resulting crack velocities, fracture patterns, and distribution of fragment size are compared to those measured in experiments. The modeling framework is then used to quantify mesoscale energy dissipation in concrete during failure under dynamic loading.