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Rheological Models for Representing Rate Dependent Fracture of Concrete within Rigid-Body-Spring Networks

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As a rate dependent material, concrete exhibits the mechanical properties and fracture features varying with the strain rates. Rate effects on such macroscopic characteristics are related to microscopic mechanisms within the material composition. In this study, the dynamic fracture behavior of concrete is simulated using the rigid-body-spring networks. The volume of concrete is discretized by irregularly-shaped rigid particles interconnected lattice elements via the Delaunay–Voronoi tessellation. The rheological models are implemented within the lattice framework, in which the microscopic mechanisms of rate dependency are represented by the visco-elastic visco-plastic contributions. Numerical experiments are conducted for tension testing with the split-Hopkinson pressure bar setup at various strain rates. The increase of dynamic strengths resulting from the simulations is compared with the previous experimental results to calibrate the visco-elastic visco-plastic parameters. Crack patterns are also presented to validate the rheological models for simulating rate dependency over a wide range of strain rate.

Keywords: Dyanmic fracture, Rate dependency, Concrete, Rigid-body-spring networks, Visco-elastic visco-plastic models