A Rate-Dependent Damage Model and its Application to Uniaxial Strain

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\[
\rho \frac{\partial^2 \mathbf{u}}{\partial t^2} = \nabla \frac{\partial W}{\partial \mathbf{E}}, \quad \frac{\partial \kappa}{\partial t} = -K \frac{\partial W}{\partial \kappa}
\]

where $K$ is (for now) a material constant. The above model was installed into LS-DYNA using the User Material Interface. The model was applied to a finite-element simulation of a rod under uniaxial strain, with a prescribed-velocity boundary condition at one end and a stress-free condition at the other. The resulting initial-value boundary-value problem was scaled to reveal the presence of the dimensionless group

\[
\Pi = \frac{\rho_0}{2} \sqrt{\frac{(1-2\nu)\rho_0}{2(1-\nu)}} \frac{(1-\phi_{\text{min}})K}{\kappa_{\text{max}}^2} L \cdot \dot{u}_0^2,
\]

where $\rho_0$ is the material density, $L$ is the length of the rod, and $\dot{u}_0$ is the prescribed velocity. Solutions were obtained for a range of $\Pi$ values. The progression of contours of $\kappa(x,t)$ was observed. [1] Grinfeld, M.A., and Wright, T.W., Metallurgical and Materials Transactions A, Vol. 35A, 2651-2661, 2004.

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