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A Rate-Dependent Damage Model and its Application to Uniaxial Strain MARTIN N. RAFTENBERG, MICHAEL A. GRINFELD, U.S. Army Research Laboratory — Our analysis is based on a damage model discussed in [1] in which the internal energy density W depends on strain $\mathbf{E}$ and damage κ : $W(\mathbf{E},\kappa) = \phi(\kappa)\ \mu\ \left(\frac{\nu}{1-2\nu}E_{kk}E_{ll} + E_{ij}E_{ij}\right)$; μ is elastic shear modulus, ν is Poisson's ratio. The factor $\phi(\kappa) = 1 - (1-\phi_{\min})\frac{\kappa}{\kappa_{\max}}$ describes degradation of elastic modulus due to damage; ϕ_{min} and $\kappa_{max}$are material constants. The system of evolution includes

$$\rho\frac{\partial^2 u}{\partial t^2} = \nabla\frac{\partial W}{\partial \mathbf{E}}, \qquad \frac{\partial \kappa}{\partial t} = -K\frac{\partial W}{\partial \kappa}$$

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 $\Pi = \frac{\rho_0}{2}\sqrt{\frac{(1-2\nu)\rho_0}{2\ (1-\nu)\mu}} \cdot \frac{(1-\phi_{\min})K}{\kappa_{\max}^2} \cdot L \cdot \dot{u}_0^2$, where ρ_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 Π 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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