LOSS-OF-ELLIPTICITYANALYSIS FOR A CRACK-BASED CONTINUUM DAMAGE CONSTITUTIVE EQUATION

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For a large number of situations, loss of stability and loss of ellipticity are identical criteria. Continuum damage is often reflected through alterations to the elasticity tensor as a method for reflecting the development of microcracks. Inevitably, there is the possibility of loss of ellipticity beyond which solutions to boundary-value problems under static loads become meaningless. Similarly, ellipticity may be lost in the strain-hardening regime of plasticity models that are not associative, and for all plasticity models with strain softening. Since ellipticity may be lost at an embarrassingly early stage for some strain paths the positive attributes of such constitutive equations can be rendered meaningless from a practical viewpoint. Therefore, a numerical procedure for routinely determining if ellipticity is lost should be a required part of the algorithm for any constitutive equation that falls in one of these categories. Furthermore, the stability properties of each constitutive equation should be part of the description of the model.

Presented here is a numerical procedure that is robust and may be sufficiently efficient to be used in large-scale applications. For a given path, the analysis provides the stress at which ellipticity is lost, the orientation of the plane of material failure and the initial mode of separation. As an example, the procedure is applied to a new constitutive equation developed by considering the stability of penny-shaped cracks under a general three-dimensional stress state [1]. Results are presented for typical paths such as uniaxial stress, uniaxial strain, triaxial compression and radial paths for plane stress.

Reference

[1] Zuo, Q.H., Dienes, J.K., 2005. On the stability of penny-shaped cracks with friction: the five types of brittle behavior. *International Journal of Solids and Structures*, **42**, 1309-1326.

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