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Damage Acquired Anisotropy in Elastic-Plastic Materials

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A thermodynamically consistent framework for elasto-plasticity coupled with damage is discussed based on existing state and dissipation coupling models. Weak dissipation coupling, based on the concept of existence of multiple dissipation potentials, expressed in the space of thermodynamic forces associated with plasticity and damage variables, is focused. Unilateral damage response to reverse loading cycles is addressed by the use of generalised projection operators that extend the Hansen and Schreyer concept. The elastic-plastic-damage constitutive equations derived in a total form and calibrated for spheroidized graphite cast iron by Hayakawa and Murakami are adopted. They are based on the assumption of existence of the Gibbs state potential and two dissipation potentials, plasticity and damage. Only isotropic plasticity and damage hardening are included to thermodynamic forces conjugated to the fluxes. In what follows the incremental elastic-damage and plastic-damage equations are developed in a matrix form derived in Bielski, Kuna-Ciskał and Skrzypek to finally yield the local elastic-plastic compliance (or stiffness) matrix. Crack opening/closing effect is controlled by the modified stress tensor, in an analogous way as in Kuna-Ciskał and Skrzypek. The effective plane stress equations are implemented to ABAQUS finite element code via the user-supplied procedure. The predictor-corrector approach is applied with doubly-passive predictor used at each iteration step.

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