Analytical solution to the 1D Lemaitre's isotropic damage model and plane stress projected implicit integration procedure - DTU Orbit (08/11/2017)

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In the present paper, for the first time in literature an exact analytical solution to Lemaitre's isotropic damage model is developed for the special case of uniaxial tensile testing. This is achieved by taking advantage of a convenient formulation of the isotropic hardening function, which allows obtaining an integral relationship between total strain and effective stress. By means of the generalized binomial theorem, an expression in terms of infinite series is subsequently derived. The solution is found to simplify considerably existing techniques for material parameters identification based on optimization, as all issues associated with classical numerical solution procedures of the constitutive equations are eliminated. In addition, an implicit implementation of the plane stress projected version of Lemaitre's model is discussed, showing that the resulting algebraic system can be reduced to a single non-linear equation. The accuracy of the proposed integration scheme is then verified by means of the presented 1D analytical solution. Finally, a closed-form expression for the consistent tangent modulus taking damage evolution into account is given, and its impact on the convergence rate is analyzed.

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