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Nguyen, K.; **Amores, Víctor Jesús**; **Sanz, Miguel A.**; **Montáns, Francisco J.**

Thermodynamically consistent nonlinear viscoplastic formulation with exact solution for the linear case and well-conditioned recovery of the inviscid one. (English) Zbl 1476.74013

Comput. Mech. 67, No. 5, 1349-1373 (2021).

This paper describes the development and application of a viscoplastic formulation (model) which is thermodynamically inspired and utilizes the continuum elastic corrector rate concept. The formulation circumvents the limitations of previous formulations but incorporates their beneficial attributes such as nonlinear viscosities and hardening. There are several other important characteristics of the formulation such as employing viscoplastic strain rate to distinguish between the conservative and dissipative behaviors for reverse loading, using an implicit integration algorithm, and exhibiting inviscid plasticity, viscoelasticity, and viscoplasticity as special cases. It is interesting to note that the formulation includes a well-conditioned recovery of the inviscid solution by simply setting the viscosity coefficient as zero. The paper presents a comprehensive description of the model via several sections titled as: Derivation of the model from thermodynamic principles, Incremental theory of J2-viscoplasticity with linear isotropic hardening, Comparison with classical models, Uniaxial numerical comparisons with classical models for linear viscoplasticiy, General discrete formulation: A simple backward-Euler integration algorithm for non-constant material parameters, Numerical examples, and finally conclusions. Each section contains several subsections that facilitate for the reader to follow the development of the model in a lucid manner. The authors do well to include an extensive list of references for collateral reading for an interested reader. The future extension of the model, currently developed for small strain case to the large strain (logarithmic strain) case is also indicated.

The reviewer believes that this interesting paper will be useful to the researchers working in the viscoplasticity and related areas.

Reviewer: Vinod K. Arya (Dallas)

MSC:

74C10 Small-strain, rate-dependent theories of plasticity (including theories of viscoplasticity)
74A15 Thermodynamics in solid mechanics
74S99 Numerical and other methods in solid mechanics

Keywords:

viscoplastic strain rate; Perzyna model; Duvaut-Lions model; backward Euler integration algorithm

Software:

HYPLAS

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