Some numerical verification examples for plane stress elasto-viscoplasticity

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ABSTRACT

In many engineering practical applications useful simplifications can be conveniently assumed. For example, either axisymmetric, plane strain or plane stress assumptions are often assumed leading to a reduced number of variables. Plane stress conditions can be adopted in specific engineering situations in which the out-of-plane stress components are assumed to be null, e.g. thin membranes, load-free surfaces, etc. Particularly, a straightforward formulation can be obtained when isotropic linear elasticity is employed. In this simple case, conditions satisfying null out-of-plane stress components are readily imposed both on analytical and numerical frameworks. In contrast, imposing the corresponding plane stress conditions in inelastic formulations is more complex from both analytical and numerical points of views. This paper focus on development of verification examples which can be applied especially for code verification involving viscoplasticity and elasto-viscoplasticity problems. First, focus is given in some simple, but very important, verification examples in which numerical results are confronted against with analytical and semi-analytical rigid viscoplastic solutions. Secondly, a more sophisticated plane stress example is considered, serving as reference solutions. In this paper the enforcement of the plane stress viscoplastic flow is given by a version of stress-project algorithm. The viscoplastic formulation is given in terms of an overstress function which couples viscid and inviscid flow. It is shown that to employ the so-called stress-projected procedure some terms must arise in order to assure the correct evolution of the plane stress state along the viscoplastic flow. The elasto-viscoplastic model considered in this paper is equipped with an internal variable that accounts for the strain-rate hardening, which removed the strain-rate dependence can represent a Voce type of hardening. The proposed verification tests were employed for the numerical verification of an in-house implementation presenting the required reproduction fidelity.

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