A P1/P1 finite element for the elasto-plastic analysis of structures

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ABSTRACT

Solid metals undergoing large elasto-plastic deformations associated with the von Mises criterion exhibit a nearly incompressible behavior. Indeed, in this case, the plastic strain rate being deviatoric, the volume change only results from the elastic part of the strain rate which becomes very small compared to the deviatoric part when large strains are involved. It is generally admitted that such a behavior needs treatments similar to those of incompressible materials. Unfortunately, the finite element method faces a numerical difficulty in modeling the incompressible material flow. The discretization of the kinematic must be chosen in a sensible way to avoid volumetric locking phenomena [1-6]. The finite element P1/P1 has a very interesting feature because it is not sensitive to volumetric locking phenomena. Unfortunately, numerical experiments exhibit pressure oscillations which have to be addressed in order to achieve satisfactory solutions [7].

The aim of this communication is to propose a new stabilized finite element P1/P1 without introducing new degrees of freedom or stabilization parameters to calibrate. Examples show that a first order accuracy can be obtained for the pressure and the approach developed is well suited for cyclic loadings.

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