XL CILAMCE
IBERO-LATIN AMERICAN CONGRESS ON COMPUTATIONAL METHODS IN ENGINEERING
NOVEMBER 11-14, 2019
Praiamar Natal Hotel & Convention
Natal, RN-BRAZIL

A NUMERICAL FORMULATION FOR TWO-DIMENSIONAL ANALYSIS OF ELASTO-VISCO-PLASTIC SOLIDS AT LARGE STRAINS

Péricles R. P. Carvalho
Giovane Avancini
Humberto B. Coda
Rodolfo A. K. Sanches
periclescarvalho@usp.br
giavancini@usp.br
hbcoda@usp.br
rodolfo.sanches@usp.br
Department of Structural Engineering, São Carlos School of Engineering, University of São Paulo
Av. Trab. São Carlense, 13566-590, São Carlos, São Paulo, Brazil

Abstract. Several commonly used materials, like metals, exhibit rate-dependent plastic strains. In order to properly simulate such behavior, in this paper we present a large strain elasto-visco-plastic constitutive model and its numerical implementation. The formulation is thermodynamically based and derived from a total Lagrangian description, with the second law of thermodynamics written in the form of Clausius-Duhem inequality. In order to account for large strains, we apply the multiplicative decomposition of the deformation gradient into elastic and visco-plastic part. A neo-Hookean constitutive law is addopted for the elastic part, while for the visco-plastic part we apply a Perzyna-type model together with Norton's Law for the overstress function. Yield is defined by von Mises criterion, and a kinematic hardening of Armstrong-Frederick type is considered. The time integration of the evolution laws is performed via backward Euler method. Both plane strain and plane stress approximations are considered for two-dimensional applications, where the latter is solved numerically by a local Newton-Raphson procedure. To solve the solid mechanics problem, we employ a position based finite element formulation, which differs from traditional ones by using positions instead of displacements as nodal parameters. This approach naturally includes geometric non-linearity, being applicable to large displacements problems. Finally, we select numerical examples in order to show the characteristics of the model and its response considering different strain rates and material parameters. The obtained results show that the presented constitutive model behaves as expected and, therefore, is applicable to numerical analysis of elasto-visco-plastic materials.

Keywords: Elasto-visco-plasticity, Positional FEM, Large Strain, Perzyna Model