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NASLOV PREDAVANJA: **Numerical modelling of finite strain elastoplastic deformations**

SUMMARY

A constitutive model for isotropic and anisotropic elastoplasticity at finite strains together with its numerical implementation is developed. Accordingly, formulation is splitted into two parts.

In the isotropic material model, a free energy-based formulation incorporating the effect of kinematic hardening is proposed. The formulation is able to reproduce symmetric expressions for the back stress while incorporating the multiplicative decomposition of the deformation gradient. Kinematic hardening is combined with isotropic hardening where an associative flow rule and von Mises yield criterion are applied. It is shown that the symmetry of the back stress is strongly related to its treatment as a truly spatial tensor, where contraction operations are to be conducted using the current metric. The latter depends naturally on the deformation gradient itself. An accurate and trivial wise objective integration algorithm employing the exponential map is developed which preserves the plastic incompressibility condition. In order to ensure a high convergence rate in the global iteration approach, an algorithmic tangent operator is derived.

Second part of this work concerns anisotropic elastoplasticity at finite strains together with its numerical implementation. An anisotropic elastic constitutive law is described in an invariant setting by use of the structural tensors and the elastic strain measure $\mathbf{C}_e$. The elastic strain tensor as well as the structural tensors are assumed to be invariant with respect to a superimposed rigid body rotation. An anisotropic Hill-type yield criterion, described by a non-symmetric Eshelby-like stress tensor and further structural tensors, is developed, where use is made of representation theorems for functions with no-symmetric arguments. The model considers non-linear isotropic hardening as well. Explicit results for the specific case of orthotropic anisotropy are given. The associative flow rule is employed and the features of the inelastic flow rule are discussed in full. It is shown that the classical definition of the plastic material spin is meaningless in conjunction with the present formulation. As well as in isotropic material model the associative flow rule is integrated using the exponential map. The numerical treatment of the problem is fully developed and expressions related to the local iteration and the consistent tangent operator is considered in detail. It is shown that while the consistent linearisation of the model is quite complicated, it still can be achieved if various intriguing implicit dependencies are identified and correctly dealt with.

The computational algorithms are implemented and applied to a shell finite element which allows the use of complete three-dimensional constitutive laws. Various numerical examples of three-dimensional deformations of whole structural components are presented. Robustness and efficiency of the proposed algorithm are demonstrated by numerical examples.