PNRPU Mechanics Bulletin 2013 N1, pages 82-93

Numerical algorithm of solving the problem of large elastic-plastic deformation by fem

Davydov R., Sultanov L.

Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

A numerical algorithm of the investigation of stress-strain state of the elastic-plastic solids with large deformations is described. The left Cauchy-Green tensor and velocity gradient tensor are used as the tensors describing the deformation and deformation rate. The potential of the elastic strain the specific strain energy, which depends on the left Cauchy-Green tensor is introduced. An isotropic material is considered. The state of stress is described by the Cauchy stress tensor. The linearized constitutive equations of elastic deformation are obtained as a function of the derivative of the Truesdell stress rate on the strain rate. The theory of flow and an additive representation of the total deformation rate are used. The von Mises yield criterion is applied. The research algorithm is based on the incremental method. The principle of virtual work in terms of the virtual velocity is used. After linearization the system of linear equations is obtained, where the unknown is the increment of displacement in the current state. The radial return method with an iterative refinement of the current mode of deformation, based on the introduction to the governing equations of additional power voltages is applied. As an example the potential of elastic deformation is considered. The von Mises yield criterion with isotropic hardening is used. The linearized constitutive relations is obtained. The numerical implementation is based on the finite element method. An 8-node brick element is used. Developed algorithm of investigation of large elastoplastic deformations is tested on the solution of the necking of circular bar problem. The results of solutions and comparison with results obtained by other authors is reduced. Also the deformation of a square plate under internal pressure is investigated.

Keywords

Finite deformation, Large deformation, Nonlinear elasticity, Plasticity