Resumo

The finite element non-linear quasi-static and dynamic transient analysis of thin plates and arbitrary thin shells, is reported in this thesis.

The Semiloof shell element is used throughout the thesis for shell analysis and the Semiloof plate element is used for plate analysis.

To represent the material non-linear behaviour an elasto-viscoplastic model, based on Perzyna's type of material, is considered.

This model is described together with a finite element elasto-viscoplastic algorithm of solution for quasi-static analysis in terms of both the generalized stress vector (bending and twisting moments and in-plane membrane forces) and the corresponding generalized strain vector. A mixed numerical treatment, employing finite elements in space and finite differences in time of the quasi-static viscoplastic boundary value problem is considered.

Large displacement elasto-plastic analysis of thin plates and shells is performed, considering all incremental stiffness method and a Lagrangian formulation for the strain vector.

Approximate forms of the Von-Mises yield surface for shells are employed, the Iliouchine and modified Iliouchine (Criesfield) yield criteria being particularly considered.

The non-linear dynamic transient analysis of plates and shells is performed considering both material and geometric non-linear behaviour. The finite element method is considered for space discretization and a central difference scheme is considered for time integration of the equation of motion. The material non-linearity is represented through Perzyna's elasto-viscoplastic model. Both Lagrangian and updated formulations are considered to represent the strain and stress vectors. Only large in-plane displacements are admitted.

The central difference and the Euler schemes considered for the time integration of the equation of motion and of the viscoplastic strain rate respectively, are conditionally stable. The critical time step lengths of both schemes are defined in terms of the material and geometrical properties.

Application of dynamic transient finite element methods to the problem of dynamic crack propagation in pipelines is finally considered.