Abstract

The present work is centred on two main research areas, namely the application of finite element techniques to modelling of the forming of glass components and of reinforced rubber shells. A parallel investigation is pursued on some mathematical aspects of the imposition of the incompressibility constraint in the Finite Element Method.

The finite element spatial discretization of the heat conduction equation and the structural equilibrium equations of solid mechanics are presented.

A Total Lagrangian formulation for geometrically nonlinear problems is described. Various iterative techniques to solve the resulting incremental nonlinear equations are presented.

Different methods of imposing the incompressibility constraint in the Finite Element Method are reviewed and discussed. A new explanation is given for the locking phenomenon in the Penalty Function Method.

The Finite Element Method is applied to reinforced rubber shells in which the material nonlinearity of rubber is modelled using the Mooney Rivlin law. Some changes are introduced to the traditional degenerated shell element to cater for large rotations. A discrete layered approach is adopted to represent varying material properties through the thickness. The computer code is assessed and some examples on how it can be employed in practice are given.

The Finite Element Method is also applied to the forming of glass components. The properties of glass are described and the equations governing the flow of molten glass are derived. Integration in time of the heat conduction equation is presented. The algorithm to solve simultaneously the heat conduction and flow problems is described. The computer code developed is assessed and some parametric studies are performed outlining the potential of the numerical method to model the practical process.