

Development of a new calculation software for large deformation problems

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Abstract: This paper covers the development of a new stand-alone 3D finite element software package called “MSIM”, which allows large deformation calculations as it occurs in the field of manufacturing technology. Since existing commercial software packages do need a lot of time to solve the highly nonlinear system of equations and do not often incorporate suitable elements as it is common in several forming processes, a new calculation program was implemented to remedy this deficiencies.

The first part of this work describes the development and the object-oriented implementation of the finite element program MSIM in C++, which is highly superior to commercial software packages with respect to calculation time and storage capacities. The parallelization of the assembly algorithm and the implementation of the solution algorithm for the highly nonlinear system of equations is one of the core issues. The second part focuses on the development of a novel solid-shell element and treats the locking phenomenon resulting from low order interpolation functions. The customized solid-shell element formulation is embedded in a static implicit total Lagrange formulation, which is able to deal with large deformations in accordance with the finite strain theory. For the constitutive relation, a hyperelastic material law was used in preparation to a further extension to a hyperelastic-plastic material behavior. Therefore, the determination of the elastic predictor gained from the right Cauchy Green strains, turned out to be a crucial step in hyperelasto-plasticity.

Several benchmark tests were performed to evaluate the computing speed of the new calculation program MSIM and the accuracy of these solid-shell elements in comparison to the results attained by the FEM-package ANSYS[®].

The results obtained so far agrees satisfactorily by gaining a significantly reduced calculation time. The developed calculation program serves as an effective tool to predict the stress-distributions inside the material under large deformations. Furthermore, this calculation program provides the basis for further improvements and enhancements and thus serves as an effective tool for research and teaching.

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