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# NEW ASPECTS IN MATERIAL MODELLING AND FINITE ELEMENT TECHNOLOGY FOR FORMING SIMULATIONS

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## ABSTRACT

The development of shell theories which take the three-dimensional geometry correctly into account has been a topic of recent research in the field of finite element technology. The goal is to modify classical three-dimensional solid elements with only displacement degrees-of-freedom in such a way, that the undesired effects of locking are eliminated and only one element over the sheet thickness is sufficient for a physically correct result. From the viewpoint of industrial users two further aspects play an important role: the element has to be numerically efficient and robust in the case of large mesh distortions. That is why many solid-shell formulations are based on the eight-node hexahedral solid element.

One method to avoid locking in non-linear large deformation solid-shell formulations is the method of reduced integration, see e.g. [1-3]. The physically relevant deformation and stress response of the element is computed in Gauss points located on the shell director. To avoid the appearance of non-physical zero-energy modes an hourglass stabilization is necessary. The choice of these stabilization terms is still an object of research, in particular in the case of inelastic material behavior.

To approximate the hourglass stiffness we carry out a Taylor expansion of the first Piola-Kirchhoff stress tensor with respect to the shell director [2]. The present contribution aims at various procedures to make the element more robust and efficient for forming simulations. One aspect is the choice of the hourglass stabilization which should adapt automatically to the level of plastification. Secondly we seek to work with a variable number of EAS parameters in order to avoid hourglass instabilities in compressed regions of the structure. In the third place the number of Gauss points in thickness direction should be automatically adjusted to parameters such as the element geometry, the element distortion and the size of the accumulated plastic strain.

In the second part of the talk we will focus on the material modeling, in particular anisotropic plasticity. Introducing two families of structural tensors, elastic as well as plastic anisotropy can be modeled. The anisotropic behaviour should be also incorporated into the finite element formulation where a so-called anisotropic hourglass stabilization is introduced. The talk closes with several representative numerical examples.

**References**


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