Parallel multilevel solution of nonlinear shell structures

Abstract:
The analysis of large-scale nonlinear shell problems asks for parallel simulation approaches. One crucial part of efficient and well scalable parallel FE-simulations is the solver for the system of equations. Due to the inherent suitability for parallelization one is very much directed towards preconditioned iterative solvers. However thin-walled-structures discretized by finite elements lead to ill-conditioned system matrices and therefore performance of iterative solvers is generally poor. This situation further deteriorates when the thickness change of the shell is taken into account. A preconditioner for this challenging class of problems is presented combining two approaches in a parallel framework. The first approach is a mechanically motivated improvement called scaled director conditioning (SDC) and is able to remove the extra-ill conditioning that appears with three-dimensional shell formulations as compared to formulations that neglect thickness change of the shell. It is introduced at the element level and harmonizes well with the second approach utilizing a multilevel algorithm. Here a hierarchy of coarse grids is generated in a semi-algebraic sense using an aggregation concept. Thereby the
complicated and expensive explicit generation of course triangulations can be avoided. The formulation of this combined preconditioning approach is given and the effects on the performance of iterative solvers is demonstrated via numerical examples.

**Stichworte:**
Three-dimensional shell; Structural dynamics; Multilevel preconditioning; Algebraic multigrid; Iterative solvers

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