Intrinsically Locking-free Shell Formulations and Their Performance on Unstructured Meshes

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ABSTRACT

Recently, two different versions of intrinsically locking-free shell formulations have been developed within the group of the authors. The first one relies on a *hierarchic parametrization* of shear-deformable shell models, exploiting the capability of spline-based discretizations to deal with the requirement of C^1-continuity [3], [4]. Due the particular parametrization, transverse shear locking (as well as curvature thickness locking in 3d shells) are avoided a priori. A similar idea, based on subdivision, has been proposed in [2].

The second version is based on a particularly constructed weak form that involves two independent fields of displacements and “displacement-like” quantities [1], therefore called *Mixed Displacement* (MD) method. It is theoretically related to the hierarchic concept and for the special case of transverse shear locking in beams its exact equivalence can be proven. However, it is more general, allows for C^0-continuity of the shape functions and can also be used to avoid membrane locking.

Apart from reviewing both concepts, two issues are discussed in the presentation that are crucial for both formulations. First, numerical evidence on locking-free behaviour is so far mostly restricted to academic benchmarks using structured grids or NURBS patches. The question arises, whether the excellent behaviour observed in these benchmarks – particularly in view of the quality of stress resultants – can be reproduced for unstructured grids. Secondly, a certain constraint conditions is needed in both the hierarchic and the MD method to avoid artificial instabilities. It does not pose any difficulty for structured discretizations, but it is non-trivial for general meshes. Several possibilities to solve this problem are presented and compared in view of their effectiveness and efficiency.

REFERENCES

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