A mixed isogeometric plane stress and plane strain formulation with different continuities for the alleviation of locking

Lisa Stammen* and Wolfgang Dornisch

Chair of Structural Analysis and Dynamics
Brandenburg University of Technology Cottbus-Senftenberg
Cottbus, Germany
e-mail: {lisa.stammen,wolfgang.dornisch}@b-tu.de

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ABSTRACT

Isogeometric analysis was founded by Hughes et al. [1] and tries to unify computer aided design (CAD) and finite element analysis (FEA) by using the same model for geometry representation and analysis. Therefore, non-uniform rational B-splines (NURBS) and other kinds of splines are used as shape functions of the finite elements. Due to the exact representation of the geometry, analysis results can be improved [1, 2]. Furthermore, many fast and numerically stable algorithms have been developed that exhibit favourable mathematical properties [3].

In mixed formulations stresses and/or strains or pressures are approximated independently and in addition to the usual displacement approximation. Using such methods is more robust and offers more accurate results. Hence, mixed formulations are employed to solve incompressible elasticity problems for instance [4].

Recent investigations have already combined isogeometric analysis and mixed formulations in order to benefit from the advantages of both methods [5].

In this contribution, a mixed isogeometric method is proposed in order to improve the analysis results and to counteract different types of locking. Therefore, spline basis functions are used and the displacement shape functions of a two-dimensional isogeometric element are supplemented by independent stress shape functions. These additional stress shape functions are chosen to be of one order lower compared to the displacement shape functions, but with adapted continuity.

Evaluating the errors for two examples, it is shown that the proposed mixed method leads to an improved accuracy of results compared to a standard isogeometric formulation and is able to counteract locking. Furthermore, the influence of the continuity of stress shape functions is shown.

REFERENCES


