Investigations on the use of adapted approximation orders for a convective IGA formulation

Lisa Stammen[1], Wolfgang Dornisch[1]

[1] *Chair of Structural Analysis and Dynamics, Brandenburg University of Technology Cottbus - Senftenberg, Cottbus, Germany*

E-mail: lisa.stammen@b-tu.de, wolfgang.dornisch@b-tu.de

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In isogeometric analysis (IGA), which was founded by Hughes et al. [1], the geometry representation is used for the analysis as well. Hence, due to the exact description of the geometry, analysis results can be improved [1, 2]. Therefore, different kinds of splines, like non-uniform rational B-splines (NURBS) [3], are used as shape functions for the discretizations. In linear elasticity problems, for standard formulations, shear locking phenomena can occur due to the different orders of the derivatives in the unbalanced strain-displacement relation. This effect can be reduced using shape functions of higher order, causing an increased computational effort. For low-order formulations, the degrees of shape functions can be adapted accordingly in order to counteract this effect. For an isogeometric displacement-stress mixed Reissner-Mindlin shell formulation such adapted approximation spaces were investigated in [4], for instance. In [5], additionally to a proper choice of shape function spaces, convective coordinates are employed in the derivation of isogeometric shell formulations.

In this contribution, a convective displacement-based isogeometric formulation is introduced, wherein the displacements in the different surface directions are approximated independently using appropriate approximation orders. Therefore, two different meshes are generated from the NURBS-described geometry representation, employing order elevation solely for one of the two surface directions. Thus, the order is elevated in opposite directions for these two meshes. The two different possibilities of order elevation are investigated. Furthermore, the use of different convective basis systems is studied. This comprises convective basis systems in each control point, computed according to [6], as well as convective basis systems determined from the local geometry direction in each integration point. The achieved results are compared to whose of a two-dimensional displacement-stress mixed formulation presented in [7].

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