An efficient blended mixed B-Spline formulation for avoiding membrane locking in non-polar thin structural models

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ABSTRACT

In the field of isogeometric analysis (IGA) of structural models, many efforts are devoted to devise efficient mixed formulations, extending to IGA methods well established within the FEM literature, like the $\bar{B}$ and /or ANS formulations, see [1, 2, 3]. In order to obtain the control variables for the assumed strain, it is necessary to invert a Gram matrix (or a collocation matrix) which defined at the patch level. Thus the resulting stiffness matrix is full (it is not a banded matrix) after the condensation step.

We present an efficient mixed formulation for removing membrane locking in B-Spline formulation of curved non-polar thin structural models: rods and shells, that differs from those already in use since the control variables are obtained by local projections at the element level (thus inverting small marices); then, adopting the efficient reconstruction algorithm proposed by Thomas et Al in [4], the assumed strain is reconstructed on the B-spline basis defined on the whole patch. In this way the global stiffness matrix presents an half bandwidth much smaller than the one found with the standard non local $\bar{B}$ method, even it is a little larger than the one presented by the displacement formulation.

The proposed algorithm, in addition to be very efficient, presents the optimal rate of convergence and almost the same accuracy as the full $\bar{B}$ algorithm. Numerical examples will be presented for comparing the performance of the method proposed with non local and local non reconstructed mixed formulations.

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