A new Efficient Locking-free Mindlin–Reissner Plate Element

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The Mindlin–Reissner plate model is widely used for the elastic deformation simulation of moderately thick plates. Shear locking occurs in the case of thin plates, which means slow convergence with respect to the mesh size. The Kirchhoff plate model does not show locking effects, but is valid only for thin plates. One would like to have a method suitable for both thick and thin plates.

Several approaches are known to deal with the shear locking in the Mindlin–Reissner model. In addition to the well-known MITC elements and other approaches based on a mixed formulation, hierarchical methods have been developed in the recent years. A hierarchical deformation ansatz combining the Kirchhoff and Mindlin–Reissner models is given in [1]. An alternative rotation-free formulation for thick plates which is inherently locking-free was presented in [2]. A rotation-free isogeometric method for the original Mindlin–Reissner plate formulation was discussed in [3].

We present our new finite element formulation inspired by these references. The proposed element is not rotation-free, yet locking-free and performs very well in combination with a hierarchically preconditioned conjugate gradient method. Numerical comparisons between the mentioned elements are presented. A short outlook on an extension to Naghdi shells is also given.

References:

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