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Simple triangular shell finite elements based on shell theory

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Abstract

In this work we introduce and analyze simple triangular finite elements for a variational formulation of a refined shallow shell model based on the linear theory of elasticity. The primal unknowns of the formulation are the three displacements of the shell mid-surface and two rotations of its normal. These are defined in terms of local curvilinear coordinate systems which are constructed using the nodal normal vectors assumed as input data. We develop linear elements and employ assumed membrane and transverse shear strain fields to alleviate the problems of membrane and shear locking which are encountered in bending-dominated deformations of shells. Unfortunately, the approach is not uniformly convergent for general shell geometries and mesh configurations but nevertheless leads to higher accuracy than conventional formulations based on flat elements and assumed shear strain fields. The efficiency of the proposed method is assessed numerically in problems involving linear static analysis. The numerical examples feature different shell geometries and the results are compared with analytical and numerical reference solutions and with commercial software solutions.

Key words: assumed strain approach, finite element method, membrane locking, shear locking

Mathematics subject classifications (1991): 65N30, 74S05, 74K25

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