An isogeometric solid-shell formulation for geometrically nonlinear analysis

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ABSTRACT

In recent years an increasing amount of research has aimed at developing new efficient solid-shell finite elements [1] for nonlinear analysis of thin structures. This is due to the advantages of this kind of elements in comparison to classical shell ones. In particular, continuum strain measures employing translational degrees of freedom only [2] can be used, so avoiding to deal with finite rotations. These elements are usually based on low order interpolations and then exhibit poor convergence properties, especially for curved shells.

In this work, the solid-shell element proposed in [1] is extended to the framework of isogeometric analysis. A linear interpolation and an analytical pre-integration along the thickness direction is used in order to increase efficiency and to easily model composite multi-layered shells. In this way, the unknown fields as well as the geometry of the shell, functions of the mid-surface coordinates only, are interpolated using NURBS shape functions, just as in standard shell models.

The resulting formulation seems to be thickness, membrane and shear locking-free also using low order continuity shape functions [3]. In particular, the thickness locking is a priori avoided by a modified generalized constitutive matrix.

The proposal is compared to the original finite element showing the notable increase in accuracy.

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