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A finite-strain solid–shell using local Löwdin frames and least-squares strains

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Highlights

- Finite strain solid–shell element with good distortion insensitivity.
- Shell benchmarking and comparison with established techniques.
- Motion of anisotropic axes by use of Lowdin frames.
- Constitutive framework based on a consistent updated-Lagrangian formulation with smoothed complementarity condition.
- Combination with standard 3D elements avoids additional tasks.

Abstract

A finite-strain solid–shell element is proposed. It is based on least-squares in-plane assumed strains, assumed natural transverse shear and normal strains. The singular value decomposition (SVD) is used to define local (integration-point) orthogonal frames-of-reference solely from the Jacobian matrix. The complete finite-strain formulation is derived and tested. Assumed strains obtained from least-squares fitting are *an alternative* to the enhanced-assumed-strain (EAS) formulations and, in contrast with these, the result is an element satisfying the Patch test. There are no additional degrees-of-freedom, as it is the case with the enhanced-assumed-strain case, even by means of static condensation. Least-squares fitting produces invariant finite strain elements which are shear-locking free and amenable to be incorporated in large-scale codes. With that goal, we use automatically generated code produced by AceGen and Mathematica. All benchmarks show excellent results, similar to the best available shell and hybrid solid elements with significantly lower computational cost.

Keywords: Finite-strain solid–shell; Least-squares; Assumed-strains; Singular value decomposition

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