

Polytopal composite finite elements

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Abstract

In recent years, polygonal and polyhedral finite elements have gain much interest from researchers as an alternative approach for discretizing complicated computational domain. Findings to enhance their performance are still desirable to solve a broad class of mechanics problems. In this study, we propose a new formulation based on arbitrary polytopes, which we name as Polytopal Composite Finite Element (PCE). The key idea is to devise a polynomial projection of compatible strain fields through the least-squares approximation. For nearly incompressible problems, we design a pair of projection operators of volumetric and deviatoric strains resulting in stability of pressure solution. The present approach fulfills a patch test and satisfies the inf-sup stability. Through several numerical investigations, we show that the proposed method reaches the theoretical convergence rate and significantly improves the accuracy of polygonal element based solutions.

Keywords: Finite elements; polytope; elasticity; incompressibility; patch test; inf-sup