A High Order Cell-Based Smoothed Finite Element Method (CS-FEM) using Triangular and Quadrilateral Elements

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Abstract

The finite element method (FEM) is the most prevailing numerical method for engineering problems. Advanced FEM, such as the smoothed finite element method (S-FEM) has also been recently developed. In traditional FEM, the high-order elements can be used to improve the solution accuracy with less number of elements. However, high order S-FEM is not yet available. This paper presents a novel high-order CS-FEM using 6-noded triangular and 8-noded quadrangular elements. In the high-order CS-FEM, each element is divided into only one smoothing domain, and the high order strain field is constructed using Liu's pick-out theory. Both triangular and quadrangular second-order cell-based smoothed finite element method (T6/Q8 CS-FEM) are formulated in this paper. These new CS-FEM elements are implemented in ABAQUS using the user-element-library. The proficiency of the current method is demonstrated though numerical examples. Numerical results show that, as the mesh is distorted, the high-order CS-FEM has much better accuracy compared with traditional high-order FEM. In addition, the nodes on the edges of the high-order elements can be flexible.

Keywords: High-order CS-FEM; Strain field pick-up Theory; Smoothed strain; Mesh distortion; Stability

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