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Large-deformation plasticity analysis using the edge-based smoothed finite element method

***J. Liu[1], Z.Q. Zhang[2]**

[1]Department of Mechanical Engineering, National University of Singapore, 117576, Singapore.
[2]Institute of High Performance Computing, Singapore.

*Corresponding author: nickliujun@gmail.com

An edge-based smoothed finite element method (ES-FEM) using 3-node triangular elements was recently proposed to improve the accuracy and convergence rate of the standard finite element method (FEM) for 2D elastic solid mechanics problems. In this research, ES-FEM is extended to the large-deformation plasticity analysis, and a selective edge-based / node-based smoothed finite element (selective ES/NS-FEM) model using 3-node triangular elements is used to handle the volumetric locking. Validity of ES-FEM for large-deformation plasticity problem is proved by benchmarks, and numerical examples demonstrate that, the proposed ES-FEM and selective ES/NS-FEM method possess (1) superior accuracy and convergence properties in the solutions of the strain energy comparing to the standard FEM procedure using 3-node triangular element (FEM-T3), (2) better computational efficiency than FEM-T3 and similar computational efficiency with FEM using 4-node quadrilateral elements and 6-node quadratic triangular elements, (3) a selective ES/NS-FEM method can successfully bear severe element distortion and solve the volumetric locking problem in the large-deformation plasticity analysis, under both static and dynamic loading.

Keywords: Large-deformation plasticity, Finite element method (FEM), Edge-based smoothed finite element method (ES-FEM), Node-based smoothed finite element method (NS-FEM), Volumetric Locking, Gradient smoothing