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A Brief Introduction to Smoothed Finite Element Method (S-FEM)

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Extended Abstract

The smoothed finite element method (S-FEM) [1], a next-generation finite element method, has been studied and put into practical use in recent years. S-FEM is a type of strain smoothing technique, which includes node-based one (NS-FEM), cell-based one (CS-FEM), edge-based one (ES-FEM), and so on. A variety of S-FEM formulations have been developed to date, and the methods using 4-node tetrahedral (T4) meshes are particularly attracting attention as they are industrially important.

The edge-base S-FEM using T4 meshes (ES-FEM-T4) is the most successful formulation in classical S-FEMs and has been applied to various fields such as electrostatics [2] and solid mechanics. ES-FEM-T4 has advantages in analyses with complex geometries and has a good mesh convergence rate as fast as the 2nd-order element. Moreover, ES-FEM-T4 does not cause shear locking or nodal reaction force oscillations in solid mechanics. However, ES-FEM-T4 cannot suppress volumetric locking in nearly incompressible solids. Therefore, S-FEM formulations that can be applied to large deformation analysis of rubber-like materials are being actively studied.

Recently, an advanced S-FEM formulation called strain smoothing element (SSE) [3] was proposed. The classical S-FEMs generally perform strain smoothing only once, and then the strain distribution is piecewise constant within each smoothing domain. Meanwhile, SSEs perform strain smoothing two/three times so that the strain distribution is piecewise linear. The current best SSE formulation is the edge center-based SSE (EC-SSE) [4], which provides highly accurate solutions for compressible solids even with coarse T4 mesh.

In this talk, a brief of classical S-FEM formulations and our latest formulation (an extension of EC-SSE to nearly incompressible large deformation: EC-SSE-SRI-T4) is introduced.

References

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