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Abstract

We propose a simple and efficient scheme based on adaptive finite elements over conforming quadtree meshes for collapse plastic analysis of structures. Our main interest in kinematic limit analysis is concerned with both purely cohesive-frictional and cohesive materials. It is shown that the most computational efficiency for collapse plastic problems is to employ an adaptive mesh strategy on quadtree meshes. However, a major difficulty in finite element formulations is the appearance of hanging nodes during adaptive process. This can be resolved by a definition of conforming quadtree meshes in the context of polygonal elements. Piecewise-linear shape functions in barycentric coordinates are used to approximate the velocity field. Numerical results prove the reliability and benefit of the present approach.

Keywords: Plasticity; incompressibility; limit analysis; adaptive; quadtree meshes

1. Introduction

Limit analysis has been known as a power tool to directly obtain the ultimate load bearing capacity and plastic collapse path of structures without any requirement of iterative or incremental analysis. The iteratively elastic-plastic analysis that might be undertaken with numerical methods is capable of providing a collapse load factor. However, the computational cost and convergence of the nonlinear solution is still questionable for large-scale structures. As an alternative methodology, limit analysis allows to show the most important features of the limit state of structures in the plastic regime. Until now, the slip-line field (SLF) theory is an analytical approach for evaluating the load bearing capacity of structures [1–3]. Practically, SLF is well suited to the given problem with simple geometry and loading conditions [4]. The extensive development of different numerical methods has become more attractive beyond analytical approaches. Various numerical methods basically rely on the Koiters kinematic (upper bound) theorem [5] or the Melans static (or

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