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A RECOVERY-BASED ADAPTIVE MESH REFINEMENT ALGORITHM WITH APPLICATION TO GEOMATERIALS

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Abstract. It has been recently highlighted that Adaptive Mesh Refinement (AMR) algorithms have not been fully exploited for applications in geomechanics [1]. This paper illustrates a simple AMR algorithm and demonstrates its performance by modelling standard soil test. The algorithm has been implemented for 6-noded triangular elements within the geotechnical finite element package PLAXIS 2D.

Localization is frequently observed in geomaterials, often as a precursor to failure. This phenomenon occurs in many situations ranging from biaxial tests to embankments and retaining walls. As loading on a body of soil increases, there comes a point when the strain field switches from being homogeneous in character to being inhomogeneous. High strains become concentrated in narrow zones known as shear bands. Either side of these bands, the material behaves almost as if it were a rigid body. To model such problems numerically is challenging. AMR presents itself as a natural solution because it provides an automated way of locating smaller elements where the high gradients are, and coarser elements elsewhere.

The algorithm described here is a recovery-based method (also referred to as "smoothing"). Nodal values are recovered from integration point values using Superconvergent Patch Recovery (SPR) [2]. The nodal values form a smoothed solution with which the finite element solution can be compared. An error in the finite element solution is then calculated based on this difference. Often the error estimator is based on incremental energy, but here, it is based on the second invariant of the incremental deviatoric strain [3]

as this would seem better suited to the localization problems studied here.

Instead of regenerating the mesh, elements whose error is larger than the target error are subdivided. The refinement algorithm combines regular refinement (splitting a triangle into 4 by joining the midpoints of its edges) [4] with longest edge refinement (Rivara's method, which limits the mesh degradation) [5]. Elements which are marked for refinement are regularly refined. At this stage the mesh is non-conforming, so neighbours of the refined elements must also be refined in order to have a conforming mesh. For this, Rivara's longest edge refinement is employed.

The combination of an error estimator well suited to detect localization and a simple remeshing scheme based on subdivision is shown to result in a stable and robust algorithm.

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