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APPLICATION OF ADAPTIVE MESH REFINEMENT FOR LIQUEFACTION ANALYSIS CONSIDERING LARGE DEFORMATION

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1. INTRODUCTION

Adaptive mesh refinement (AMR) is a promising method to refine the approximation successively in order to reach predetermined standard accuracy and to increase the efficiency of finite element code. AMR includes error estimates and mesh refinement.

In this research, AMR was applied in liquefaction analysis of saturated soil considering large deformation. A cyclic elasto plastic model was used as constitutive model, and Updated Lagrange method was used in FEM. An error criterion based on an L2-projection of strain was developed and fission procedure was adopted in mesh refinement. Examples of compression of saturated sand caused by a stepwise loading and flow of liquefied sand problems were given.

2. THE MODEL PROBLEM

In order to describe the material nonlinearity of liquefible saturated soil, a cyclic elasto plastic model was used. It bases on the Biot's two phase mixed theory and kinematic hardening rule. The problem that elements distort heavily was prevented effectively.

For the geometrical nonlinearity of soil, Updated Lagrange method was used in FEM equations. By this method the configuration at time t+?t refers to the configuration at time t. It deal with large deformation problem caused by liquefaction successly.

3. ERROR ESTIMATION

The numerical approximation of FEM causes error. Decreasing the size of elements can lower error, but with heavy burden of calculation. The better way is to refine the mesh according to error.

A simple error estimation method was developed here. The error of element i was proposed as a L2 norm projection of strain:

$$e_i = \left[\int_{\Omega_i} (e^* - e^h)^T (e^* - e^h) d\Omega / \Omega_i \right]^{1/2}$$

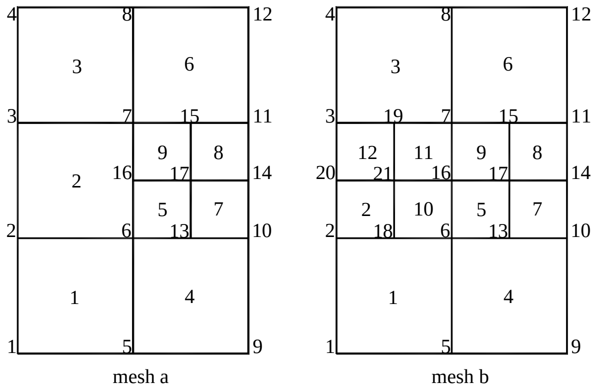
where e^h is approximate solution of FEM, e^* is exact value, and assumed that it can be interpolated from node value $\bar{e}^*$ by the same shape function used for the displacement: $e^* = N^* \bar{e}^*$

The node value of strian $\bar{e}^*$ is defined by:

$$\bar{e}^* = A^{-1} \int_{\Omega_i} N^{*T} e^h d\Omega \quad \text{and} \quad A = \int_{\Omega_i} N^{*T} N^* d\Omega$$

4. MESH REFINEMENT

We use an h-adaptive technique here. First, an error limit should be given, if the error of an element exceeds the limit, the element will be fissioned into four elements. The process is shown in the figure below. When an element is fissioned next to an unfissioned element, slave nodes are created. The motion of a slave node should be governed by the constraint of compatibility.



Fission process