

Application of Node-Based Uniform Strain Elements to Mixed Limit Analysis

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ABSTRACT

The purpose of this study is to avoid the locking phenomenon in the mixed (upper and lower bound) limit analysis [1]. The locking phenomenon often arises in the finite element limit analysis when three node triangular elements (T3 element) are used. The problem is caused because the satisfaction of the flow rule at the centroid of each T3 element is required and the number of constraint conditions of the flow rule is large for degree of freedom. To solve the problem we use node-based elements [2]. When node-based elements are used, the flow rule holds at each node not at the centroid of each T3 element. Because the number of nodes is about half as large as that of T3 elements in general 2D mesh, the application of node-based elements reduces the number of constraint conditions by about half.

Besides, we apply adaptive method to calculate efficiently. In limit analysis there may be large undeformed domain where fine meshing is not required. Therefore, adaptive remeshing enables us to predict the collapse load accurately with less number of elements than uniformed meshing [3, 4]. We use an error estimator based on the recovery strain rate and a remeshing algorithm based on the advancing front technique.

Numerical analyses of two classical problems; namely a uniaxial strength of a slab with a circular cutout and a limit load of a direct extrusion, are demonstrated. Results of the proposed technique agree with the theoretical ones, and the validity of the proposed technique is confirmed.

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