SASSI to ESSI conversion: distorted SASSI elements

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1 Introduction

SASSI, a System for Analysis of Soil-Structure Interaction developed by Ostadan (2007), consists of a number of interrelated computer program modules which can be used to solve a wide range of dynamic soil-structure interaction problems in two or three dimensions. A lot of geometric finite element models has been developed based on SASSI.

While RealESSI (Realistic Earthquake-Soil-Structure Interaction) Simulator is a software, hardware and documentation system for high fidelity, high performance, time domain, nonlinear/inelastic, deterministic or probabilistic, 3D, finite element modeling and simulation of earthquake-soil/rock-structure interaction of Infrastructure Objects (Nuclear Facilities, Dams, Bridges, Buildings, &c.), It will be very useful if these original SASSI geometric models can be transfered into RealESSI models and conduct nonlinear Soil Structure Interaction (SSI) analysis.

A very handy mesh conversion tool **SASSI_converter** has been developed for this purpose. With **SASSI_converter**, most of SASSI geometric entities (points, elements, fixities, etc) can be directly converted into corresponding ESSI entities. However, there are three types of distorted SASSI 8 node brick element (figure 1) needed to be handled with special attention.

Since in SASSI, there are only 7, 6 and 5 nodes (node IDs) consisting of corresponding eight node brick element, respectively. But in RealESSI, the 8 node brick element must contain 8 different node IDs. The nodes with two different IDs can share the same location. Therefore, the conversion strategy adopted here is to reproduce some new nodes with different node IDs but has the same coordinates as these distorted nodes. Then with these reproduced nodes, ESSI 8 node brick element is formed.

Rigorous numerical tests have been done to confirm the feasibility and validity of this strategy, shown in section 2.

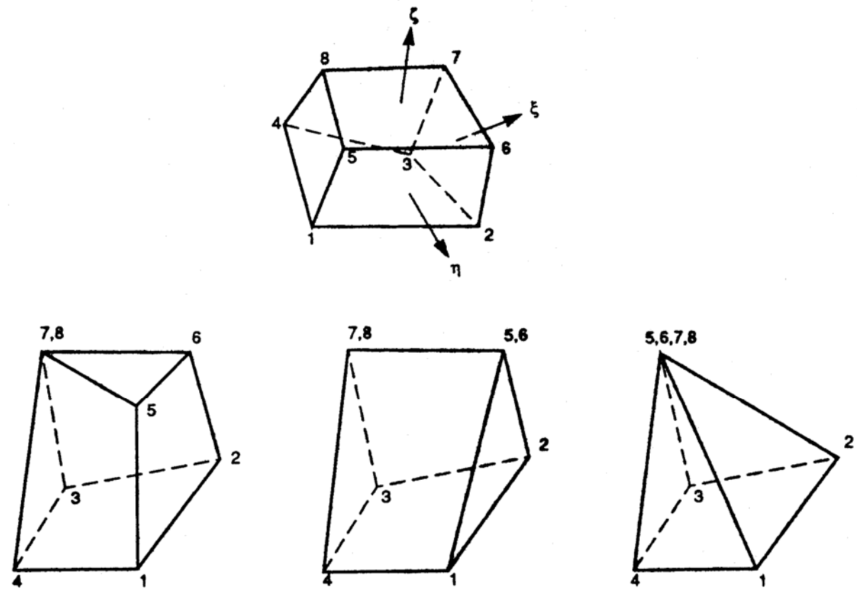

Figure 1: Three types of distorted elements in SASSI

2 Numerical test

2.1 Test procedure

The test procedure is following:

- A standard solution is given by simple confine-shearing-unloading-reloading simulation on a single normal 8 node brick element. The cyclic shearing force is applied on four nodes of top layer, while four nodes on bottom layer are totally fixed. Simple elastic material is adopted here with Young's modulus E taken as 125 MPa and Poisson's ratio μ as 0.25. The setup of standard test is shown in figure 2.

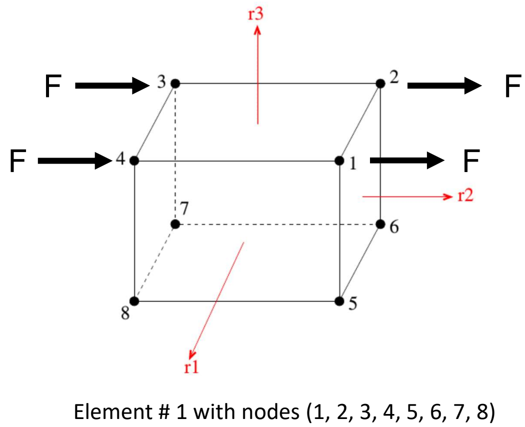

Figure 2: Setup of standard 8-node element

- Build the same geometric model with distorted 8 node brick elements and conduct numerical simulation under the same loading and boundary conditions as first step.

  Specifically, the geometric configure for 7-node distorted element is shown in figure 3, where the cubic consists of two 7-node distorted elements. A dummy node 11 is generated at the same location as node 2.

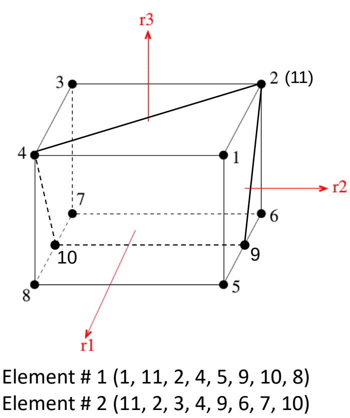

Figure 3: Geometric configuration of numerical test for 7-node distorted element

The geometric configuration for 6-node distorted element is shown in figure 4 . Again the cubic is composed of two 6-node distorted elements. Two dummy ESSI nodes 9 and 10 are generated at the same location with original node 1 and 2.

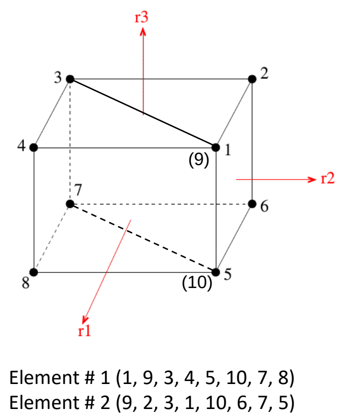

Figure 4: Geometric configuration of numerical test for 6-node distorted element

And figure 5 gives the geometric configuration of 5-node distorted element, where the cubic is divided into 3 5-node elements.

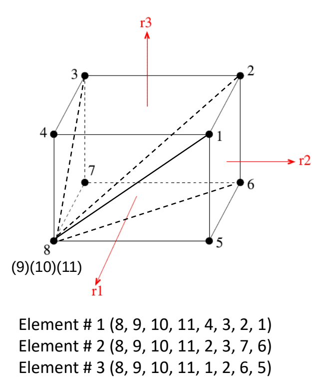

Figure 5: Geometric configuration of numerical test for 5-node distorted element

- Compare the response of models in step 1 and step 2. If the difference is small enough, the strategy described in section 1 is feasible and valid.

2.2 Test result

All the input files of numerical tests are placed at the website. The comparison result is shown in figure 6. It can be seen that the simulation results with these types of distorted element are close to result of standard 8 node brick element. The line of 6 node distorted element is almost overlap with the line of standard test. Distorted 7-node element and 5-node element experience certain decrease of accuracy. In this particular test, the maximum error happened at the beginning of reloading. The solutions of distorted 7-node element and 5-node element is 17% higher than that of standard 8-node element.

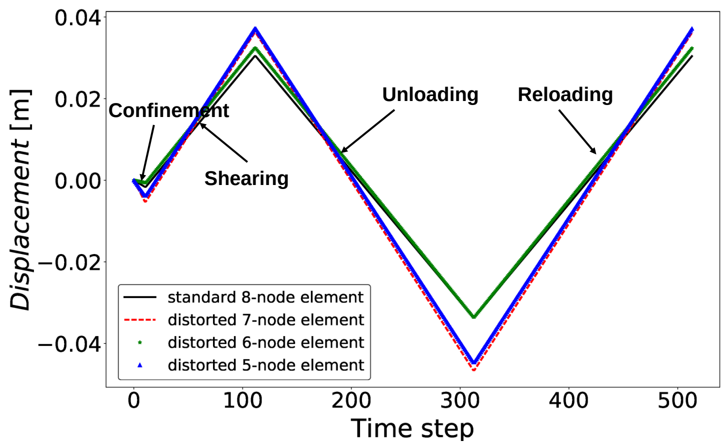

Figure 6: Comparison results of three types of distorted elements

3 Conclusion

SASSI_converter can conduct mesh conversion between SASSI and RealESSI. The strategy of creating dummy ESSI nodes at the same location with different IDs can well handle distorted 7-node, 6-node and 5-node SASSI element.

The accuracy of distorted 6-node element is good enough. For distorted 5-node element and 7-node element, when the external force is within certain limit, the error is also tolerable; The prediction error of displacement response grows with the increase of external force. Although ESSI can deal with these types of special element, as suggested by Ostadan (2007), the integration order of these elements should be increased and very distorted elements should be avoided as much as possible.

References

Ostadan, F. (2007), *SASSI 2000, A System for Analysis of Soil-Structure Interaction, User manual*, 3.0 edn, University of California, Berkeley.