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A METHOD FOR CRACK SIMULATIONS OF HETEROGENEOUS SOLIDS USING NODAL-INTEGRATION FEM

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ABSTRACT

This study presents a simple FEM-based method for crack propagation analyses of heterogeneous solids. In order to develop a robust and simple algorithm for handling multiple crack growth and interfacial debonding involved in the fracture analysis of heterogeneous solids such as concrete materials, we incorporate the nodal-integration techniques and the mesh re-alignment techniques into the standard FEM. The cohesive crack model [1] is also introduced to the method to model the fracture process zone involving tension-softening behaviour and to reduce the mesh-size dependency in crack propagation analysis.

First, we present the problem formulation with standard 2-D triangular finite elements together with the penalty method by which the material continuity/discontinuity is introduced. Secondly, we apply the nodal-integration FEM [2] to the strategy for generation or propagation of fractured surface, and present a robust and simple algorithm for handling arbitrary discontinuities in conjunction with the reasonable mesh re-alignment techniques. Thirdly, the solution algorithm for the simulations of multiple cohesive crack growth is presented. Finally, after performance assessment of proposed method, benchmark problems, which are characterized by mixed-mode fracture, are solved to validate the proposed method and numerical examples demonstrate that the present procedure is robust, stable and effective even for the fracture analysis of two-phase composites including multiple cracks and interfacial debonding.

REFERENCES

[1] A. Hillerborg and M. Modeer, “Analysis of crack formation and crack growth in concrete by means of fracture mechanics and finite elements”, *Cem. Concr. Res.*, Vol. **6**, pp. 773–782, (1976).

[2] C.R. Dohrmann, M.W. Heinstein, J. Jung, S.W. Key and W.R. Witkowski, “Node-based uniform strain elements for three-node triangular and four-node tetrahedral meshes”, *Int. J. Numer. Meth. Engng.*, Vol. **47**, pp. 1549–1568, (2000).