International Conference on Extended Finite Element Methods – XFEM 2013
September 11 – 13, 2013, Lyon, France
A. Gravouil, Y. Renard and A. Combescure

A SOLUTION PROCEDURE FOR CONTACT PROBLEMS BY XFEM

HU Zhiqiang
School of Hydraulic Engineering, Dalian University of Technology,
No.2 Linggong Road, Ganjingzi District, Dalian, China, 116024, huzhq@dlut.edu.cn

FAN Yingfang
Institute of Road and Bridge Engineering, Dalian Maritime University,
No.1 Linghai Road, Ganjingzi District, Dalian, China, 116026, fanyf72@yahoo.com.cn

Key Words: *extended finite element method, frictional contact, B-differential equation.*

ABSTRACT

Frictional contact is often observed in the problems with the presence of crack surface or crack propagation. In this paper, firstly, we proposed solution procedure for thet static frictional contact problems resulting from presence of crack surfaces by combining the eXtended Finite Element Method (XFEM) [1] and B-Differentiable Equation Method (BDEM)[2]. XFEM is used to model the discontinuities of displacement fields in the interior of the elements without the need for the remeshing of the domain. In BDEM, the normal and tangential Coulomb frictional contact conditions are formulated as B-differentiable equations and satisfied accurately. Therefore the total governing equations consist of the equilibrium equations and contact equations. The B-differentiable Newton solution strategy which has the good convergence performance with high accuracy is employed for the solution of the governing equations. Next, the dynamic solution procedure[3] with implicit and explicit time integration schemes are presented.

In the frame work of XFEM, the crack surfaces are embedded in the finite element meshes. Therefore, under the assumptions of small displacement and small strain, the node-to node contact pairs are easily to be identified at the intersections between the crack surface and the edges of elements. The relative displacements and the contact forces at these contact pairs are used to formulate the contact equations. Where, the relative displacements are computed according to the enriched displacement field, the contact forces are taken as unknowns. Because the contact forces are not acting at the nodes, the corresponding equivalent nodal loads will be obtained according to the equivalence principle of virtually work. Finally, the equilibrium equations and contact equations are solved by B-differentiable Newton methods. In the explicit scheme, it requires that the quadrilateral (2D) or hexhedral (3D) elements are cut by the crack into two parts which are also quadrilateral (2D) or hexhedral (3D) elements. And making use of the local property of contact conditions, i.e., the contact conditions expressed by B-differential equations are only related to the two end nodes of the edge cut by the crack surfce, the high computational efficiency and accuracy to satisfy the contact frictional conditions can be obtained in the explicit algorithm.

The Numerical examples including 2D and 3D static and dynamic contact frictional problems are given to demonstrate the effectiveness and accuracy of the presented solution procedure.

REFERENCES

[1]. N. Moës, J. Dolbow and T. Belytschko. A finite element method for crack growth without remeshing. Int. J. Numer. Meth. Engng., Vol. **46**, 135–150, 1999.
[2]. P. Christensen, A. Klarbring, J. Pang and N. Stromberg. Formulation and comparison of algorithm for frictional contact problems. Int. J. Numer. Methods Eng., Vol.**42**, 145-173,1998
[3]. Z.Q. Hu, G. Lin, Dynamic solution algorithms for elastic dynamic contact problems based on B-differentiable equations method, 6th European Congress on Computational Methods in Applied Sciences and Engineering, ECCOMAS2012, Sep.10-14, 2012, Vienna, Austria