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A Dynamic Contact Solution Procedure in The Framework of XFEM

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ABSTRACT

Under the complex dynamic load environment, for the structure with the presence of discontinuous surfaces, such as crack surfaces or contact surfaces, the frictional contact between them is often observed. In this paper, a dynamic solution procedure for 3D frictional contact problems in the framework of eXtended Finite Element Method (XFEM)[1] is proposed. It is very convenient to make use of XFEM to model the discontinuities of displacement fields resulted from the discontinuous surfaces across the interior of the elements without the need for meshing the domain to make the boundary surface of the element coincide with those discontinuous surfaces. With the assumption of small displacement and small deformation, the intersection points by the discontinuity surface are easily formed as the contact pairs, hence the Point-to-Point contact model is used for implementing the contact constraints. On the other hand, for dynamic loading, the lumped mass matrix related to the enriched DOFs will be employed so that the explicit as well as implicit time integration scheme can be developed.

For the treatment of contact between discontinuous surfaces, the B-Differentiable Equations Method (BDEM)[2] is extended to the dynamic loading case. In BDEM, the contact conditions are formulated as B-differentiable equations and satisfied accurately. So, the 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.

In the context of XFEM, especially for 3D case, the geometry of section cut by discontinuous surfaces in every solid element may be complex, such as the polygon shown in Figure 1. Therefore it is difficult to assume the distribution of contact stresses on the section and interpolate the contact stress by the values at vertex of polygon. So contact forces acting at the points where the edges of the element intersects with the discontinuous surface will be used for expressing and implementing contact conditions. Then, the equivalent nodal forces resulted from the contact forces are needed to be computed according to the principle of virtual work.

The Numerical examples including the structures with discontinuous surface, such as contact surfaces and crack surfaces subjected to the dynamic loads will be presented to validate the applicability and accuracy of the proposed method.

The proposed method allows flexibly discretize the structures with discontinuous surfaces by XFEM. It also satisfies the non-smooth contact constraints more accurately and obtains the convergence solutions with high accuracy through BDEM. Moreover, the explicit time integration scheme using lumped mass technique has the potential to solve the large scale embedded contact problems.

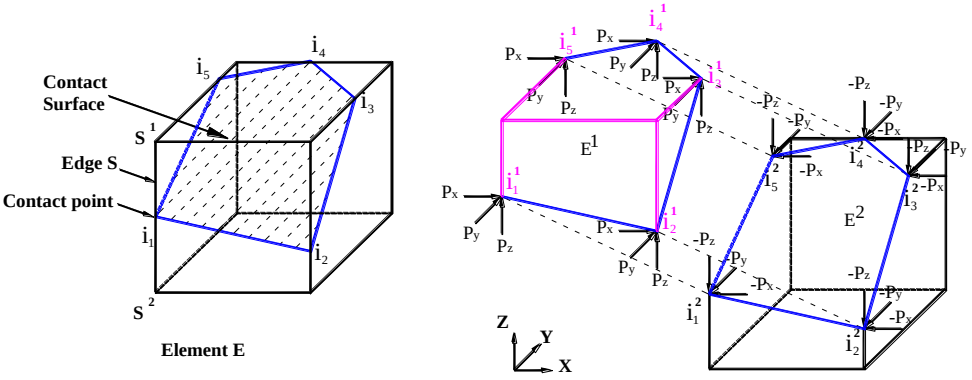

Figure 1: The element cut by contact surfaces and the contact forces

REFERENCES

[1] Moës N., Dolbow J. and Belytschko T. A finite element method for crack growth without remeshing. *Int. J. Numer. Meth. Engng* **46**: 135–150(1999)

[2] Christensen P., Klarbring A., Pang J. and Stromberg N. Formulation and comparison of algorithm for frictional contact problems. *Int. J. Numer. Meth. Engng* **42**:145-173 (1998)