ON THE IMPLEMENTATION OF SYMMETRIC GALERKIN BEM FOR DOMAINS CONNECTED BY COHESIVE INTERFACES

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This note concerns the problem of N homogeneous bodies made of different materials, connected each other by M non linear cohesive interfaces, subjected to quasi-static external actions. The problems of N domains with M traction-free cracks or rigid connections are to be taken as particular instances of the proposed cohesive formulation.
The problem under investigations has deep motivations in the scientific as well as in the industrial community: the interface between two different materials is in fact one of the most important regions governing the strength and stability of structures, the properties of biomechanical systems, the initiation and propagation of fractures in polymer, ceramics, and composites.
The problem is formulated via boundary integral equations and the solution is approximated by boundary element methods: this numerical technique is indeed very attractive for the problem under consideration because all non linearities are localized on the boundary of linear elastic domains.
In the presence of non linear elastic interface laws with symmetric tangent stiffness matrix, a symmetric incremental boundary integral formulation of the problem considered has already been carried out in [1]. In the presence of negative definite tangent stiffness matrices, the Galerkin approximation ensures uniqueness, stability and convergence of the approximation in a suitable functional space. Symmetry of the integral operator with respect to a suitable bilinear form allows the problem to have a variational formulation, the problem solution being the saddle point of a suitable functional. The present note is the natural continuation of [1] and is mainly devoted to the implementation of the aforesaid formulation in an object oriented code. Integration of singularities and hyper-singularities has been carried out following recently proposed integration strategies. Galerkin as well as collocation approaches have been considered.
In the numerical analysis of the problem, topological connections require special care in the choice of the discrete approximation. Compatibility and equilibrium conditions along interfaces, when two or more domains interact, lead to the "star of interfaces" and "berth of interfaces" topological concept. Using such structures, the discretized problem has a sound formulation and its operator maintains symmetry and structure properties, like sparsity.
Two and three-dimensional examples show the capability of the proposed technique. Engineering applications and test are presented, together with discussions of computational issues like multiplicity of solutions and numerical instabilities. Comparisons with the recent literature on the subject [2] are also proposed.

References

[1] Salvadori, A., "Symmetric Galerkin BEM for domains connected by cohesive interfaces", *in press on Computational Mechanics*, 2003
[2] Gray, L.J., and Paulino, G.H., "Symmetric Galerkin boundary integral formulation for interface and multizone problems", *International Journal for Numerical Methods in Engineering*, v. 40, p. 3085-3101, 1997