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BOUNDARY ELEMENT FORMULATION FOR FRACTURED REINFORCED BODIES

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ABSTRACT

The Boundary Element Method (BEM) has been extended to deal with problems involving stress concentrations, strains localization and fracture propagation in the last decades. Nowadays, the BEM is recognized as a robust and accurate tool for numerical analysis of problems involving crack propagation, requiring reduced computational efforts when generation of new elements are necessary to capture crack growth.

This work presents a BEM formulation to simulate multiple cracks in reinforced brittle solids. This formulation is based on the dual version of the Boundary Element Method, in which integral equations of different types are employed along the opposite sides of the crack surface. Displacement integral equations are written for collocation points along one side, while traction integral equations are used for collocation points along the opposite side. This technique precludes singularities of the resulting algebraic system of equations, in spite of the fact that the material points coincide for the two opposite crack faces. The displacement correlation technique is applied to evaluate stress intensity factor.

Reinforcement is described by truss finite elements connected to the solid. The coupling between the Boundary Element Method and the Finite Element Method is provided by the least square method, giving rise to regularized solutions without the spurious oscillation that would be obtained by the classical BEM/FEM coupling, particularly for the interface forces between reinforcement and solid. This coupling procedure is efficient and allows for simulation of complex problems using low order elements.

The mechanical behavior of the fibers is described by an elastoplastic constitutive model with isotropic, kinematic or mixed hardening law. It is also presented a procedure to incorporate a bond-slip law between fibers and continuum, according to CEB-FIP (1990).

The concept of tangent consistent operator is used in order to obtain low number of iterations in the non-linear computations.

The methodology is first applied to solve linear elastic fracture problems and, then, after introducing the BEM/FEM coupling, it is extended to fracture analysis of reinforced structural members.

The preliminary results obtained in this paper show clearly the good performance of the proposed methodology, which constitutes a promising numerical tool in fracture mechanics.

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