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BOUNDARY ELEMENT FORMULATIONS APPLIED TO ANALYSIS OF FRACTURE PROBLEMS IN VISCOELASTIC MATERIALS

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Abstract. This paper addresses the structural analysis of two dimensional linear viscoelastic bodies using Boundary Element Method (BEM). This type of analysis has major importance in engineering field, as materials widely used in this domain exhibit mechanical response depending on time, such as polymers and concrete. The mechanical behaviour of viscoelastic bodies subjected to complex geometries and boundary conditions is efficiently modelled by BEM. Moreover, its mesh reduction feature coupled to the intrinsic capability to represent high gradient fields and the automatic satisfaction of infinity boundary conditions make this method adequate to deal fracture mechanics problems and infinity domain problems. Traditional BEM formulations deal viscoelastic problems using a convolutional relation between stress and strain tensors, generally leading to a formal space transformation to be solved. However, this problem may be also solved using alternative techniques to derive the time-marching process. Viscoelastic approaches are based on differential constitutive equations resulting from different associations among springs and dashpots, which origin models such as Maxwell, Kelvin-Voigt and Boltzmann. In this paper, these models are applied to analysis of fracture mechanics problems. The numerical viscoelastic approach is based on an explicit time procedure, in which one step Euler method approximation for time derivatives is applied. It leads to a linear system of equations that has to be solved at each time step. This approach allows imposing time-dependent boundary conditions, which represent structural loading phase. In order to represent the mechanical structural behaviour along time of fractured solids, the Dual BEM is implemented, in which crack faces are discretised using displacement and traction integral representations. Three examples are analysed in order to validate the presented formulation. The results obtained by the presented formulation show good agreement to reported data as well as numerical stability.