DETERMINATION OF STRESS INTENSITY FACTORS USING MIXED ELEMENTS

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SUMMARY

Stress Intensity Factors (SIF) have been determined by many authors using finite elements based on displacement and hybrid formulations. The major problem in the application of these techniques is the region around the crack tip which involves a singularity. With displacement formulations, a very large number of elements have to be used for describing the area neighbouring the crack tip for an accurate determination of SIF. Further, an accurate satisfaction of boundary conditions on crack surface is also not possible. Some authors have tried to overcome this difficulty by adopting a hybrid system of primary element around the crack tip and conventional elements away from the tip. The primary element description requires a knowledge of the nature of singularity at the tip. This knowledge may not always be possible and further it reduces the versatility of the finite element method.

With a view to avoid some of the above disadvantages, a study on the application of mixed finite element formulation to fracture mechanics is undertaken and some of the results are reported in this paper. A number of mixed plane stress and plane strain elements based upon Hellinger-Reissner's variational theorem have been utilised in the study. None of these elements includes any special terms representing theoretical singularities. Linear and quadratic isoparametric mixed elements have been developed for the purpose. Some of the problems solved are: centrally cracked isotropic and orthotropic tension plates; isotropic and orthotropic double-edge cracked tension specimens; a three point bend problem; and a mode II problem for an edge notched plate. The estimated stress intensity factors are in error by 1 to 5 percent from the true values. These values are obtained with relatively coarse meshes.

From this it can be concluded that reasonably accurate values of stress intensity factors can be obtained with the help of mixed finite element formulations without resorting to any special crack tip elements.