Finite Elements and Fracture

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The finite element formulation of nonlinear material problems is briefly reviewed. Thereafter, incremental and iterative schemes for the solution of the nonlinear boundary value problems are discussed in regard to both, rate and range of convergence of different procedures.

This well established analytical tool is first applied to the solution of problems in linear fracture mechanics. Stress intensity factors are determined via three avenues. the COD-method, the compliance method and singularity elements and their respective results are compared in the light of known analytical solutions.

Then the lenear procedures are extendet to account for plasticity near the crack tip. To this end an elasto-Plastic analysis is carried out for a rectangular membrane with central crack, considering monotonic and cyclic loading conditions up to fracture. The results for different crack lengths are compared with relevant experimental data.

Thereafter, maximum stress fracture criteria are incorporated in teh finite element procedure to analyse two problems exhibiting cleavage and cracking:

A cylindrical mortar specimen subjected to triaxial conditions and a reinfroced concrete beam both of which are loaded up to failure. Again, comparisons with expermental results complete these examples.

In conclusion, an outlook is given how the finite element method, which is normaly used for stress analyses, can also serve to identify material properties, e.g. mathematical models to characterise nonlinear deformation behaviour and fracture phenomena.