A concept for the simulation of static and fatigue crack propagation in 3D shell structures.

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ABSTRACT

In this contribution an efficient and modular method is presented to simulate fatigue crack propagation within the framework of linear-elastic fracture mechanics. The FEM code ABAQUS/Standard is used to simulate the load/displacement history of the considered 3D shell structure using 6-node shell elements while the preprocessor ANSA is applied to employ remeshing. In addition, special purpose software modules have been created whose major purposes are (i) to achieve a continuous data transfer between ABAQUS and ANSA and (ii) to introduce the advancing crack tips into the finite element mesh. A governing shell script controls all software modules so that the crack propagation simulation runs automatically until all cracks arrest or unstable crack growth occurs.

In order to simulate efficiently fatigue crack propagation in large finite element models a submodel is extracted from the global model. The submodel is subjected to the kinematics given at the interface to the global model. The assignment of the kinematic boundary conditions to the interface nodes of the submodel is achieved by a special purpose program.

The stress intensity factor concept is applied. Stress intensity factors are calculated from the finite element mesh within an ABAQUS user subroutine using the displacement correlation technique. Variable amplitude loading is accounted for by using a special counting algorithm and an averaging procedure to calculate the crack extension direction. In order to calculate the number of load cycles various fatigue models have been implemented.

The focus of the present contribution is put on the applicability of the proposed concept. Various examples demonstrate the capabilities of the developed fatigue crack propagation simulation environment.

keywords: fatigue; crack propagation; fracture mechanics