Synopsis

Thesis Title : Fatigue and Fracture Analysis of Cracked Stiffened Panels using Extended Finite Element Method

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Extended Finite Element Method, also known as XFEM, is a numerical method used to handle discontinuity problems in structural mechanics. Unlike Finite Element Method (FEM), XFEM can represent the geometry of discontinuity such as cracks, voids, bi-material interface etc., independent of the finite element mesh without conforming to the meshes and no remeshing is required as the discontinuity propagates.

In this work, XFEM methodologies have been implemented and integrated along with fracture mechanics concepts to predict crack growth of unstiffened and stiffened cracked panels. XFEM formulations such as concept of partition of unity, enrichment functions, element stiffness matrix formulation, numerical integration and level set method of crack representation have been addressed in detail. For stiffened panels, stiffeners have been modeled using truss element such that nodes of the panel and nodes of the stiffeners coincide. XFEM formulations have been implemented in MATLAB software. Solutions of XFEM have been used to compute mixed mode stress intensity factors using domain form of interaction integral. Maximum hoop stress criterion has been used to predict the crack growth direction and Paris crack growth law has been used to estimate the fatigue life cycles. The fatigue crack growth curves that are generated for stiffened and un-stiffened cracked panels using XFEM as framework is first of its kind and variety of numerical examples have been solved to demonstrate the efficacy of the methodologies developed for XFEM. A Good correlation is observed between predicted and the corresponding value available in literature. Therefore the developed methodologies especially for stiffened panels are found to be robust and effective