Abstract

Ahmed Y Elroubi

Automating XFEM Technique for Crack Onset of Composites

The eXtended Finite Element Method (XFEM) is one of the most versatile methods for solving crack propagation problems [1]. XFEM works by enriching the critical region(s) with special shape functions to account for crack propagation [2]. A noteworthy contribution for XFEM applications was done by its coupling with Level Sets Method (LSM) making it possible to predict the crack location and propagation direction [3, 4]. This method is currently implemented in finite element commercial code ABAQUS. Meanwhile, XFEM predictions for crack onset and propagation rely on the stress field of finite elements simulations. It is well known that stress fields tend to converge at a slower rate than that of displacements, making it difficult to accurately capture the crack behavior. Furthermore, identifying the critical region(s) rely mainly on skills of an expert user. In the presented work, a new approach is developed to automate identification process of potential crack onset region(s), eliminating the need for an expert user and minimizing the problem complexity. Hence, it allows non-expert users to precisely model crack problems in ABAQUS. Also it results in enriching critical region(s) only instead of enriching the entire model enhancing cost effectiveness. Moreover, the new approach is capable of Selecting the optimized mesh size for simulations. Both features have a significant effect on computational efficiency and accuracy of predicted results. For this purpose a python script is developed into ABAQUS scripting interface implementing an iterative algorithm based on material-specific failure criterion. The developed technique is to capture the behavior of cracks in brittle materials such as matrix resins of composite materials. Hence, a brittle material failure criterion was used for crack onset. For the purpose of initial validation of the developed algorithm, a set of six concrete specimens are tested under four point bending loading. The predicted critical loads corresponding to crack onset showed an excellent agreement with measurements.