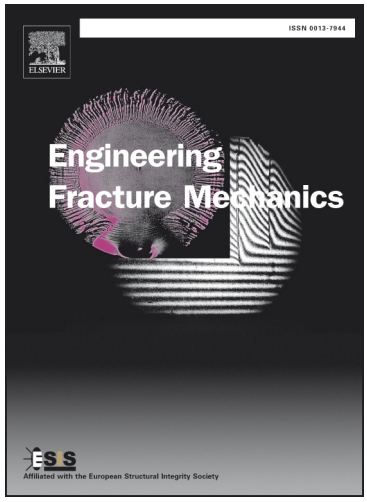

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ABSTRACT:

The residual strength of components can be abruptly reduced due to multiple site damage (MSD). In general, the fatigue and fracture performance of MSD contains a significant number of uncertainties. Major uncertainties can be characterized by initial flaw, material variability and crack growth rates, among other factors. To cope with uncertain random variables, some probabilistic methods can be considered. However, these seldom obtain efficient and reliable results because of the complexities included in computations of fatigue and fracture mechanics, and probabilistic approaches. To overcome these difficulties in the life-cycle reliability analysis of MSD, the Gaussian process (GP) response surface model has been assembled with one of the recent multiple crack analysis tools, XFEM, in this study. The assembled GP-XFEM method represents a convenient way to obtain the response surface and sensitivity factors of multiple crack propagation in a structure (or a component) under a complex environment with computational efficiency. The accuracy and advantages of the proposed method were verified by a number of experimental results and numerical examples.

Keywords: Multiple Crack Growth; Equivalent Initial Flaw; Probabilistic Fatigue; Monte Carlo Method; Extended Finite Element Method

1. Introduction

The multiple site damage (MSD) phenomenon has been widely studied since the Aloha Airlines accident of April 28, 1988 [1]. The Federal Aviation Administration (FAA) defined the procedures to assess structures on so-called Widespread Fatigue Damage (WFD). One of WFD forms is MSD in which it refers to the simultaneous presence of fatigue cracks in various locations of the same structural element [2]. In the MSD stage, cracks may link up to form a large crack which abruptly reduces the residual strength of the damaged structural member, resulting in a critical situation. Therefore, it is important to estimate the fatigue life before cracks linkup together if MSD occurs. In the traditional finite element methods,

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