

Elastic-plastic analysis of the J integral for repaired cracks in plates

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Abstract. In this paper, three-dimensional finite element method is used to analyze the J integral for repaired cracks in plates with bonded composite patch and stiffeners. For elastic the effect of cracks, the thickness of the patch (e_p) and properties of the patch are presented for calculating the J integral. For elastic-plastic a several calculations have been realized to extract the plasticized elements around the crack tip of repaired and un-repaired crack. The obtained results show that the presence of the composite patch and stiffener reduces considerably the size of the plastic zone ahead of the crack. The effects of crack size and the inter-distance of repaired cracks were analysed.

Keywords: composite; finite element method; crack; J integral; fracture mechanic; elastic-plastic

1. Introduction

The cracks can occur in many structural components of plates form They are the cause of premature damage in structures such as bolts, pins and reinforcements of aircraft. Most of the previously performed studies on bonded composite patch repair have involved plane aluminum panels without considering stiffeners.

The stress intensity factor can be taken as an essential parameter to analyze crack (Shen *et al.* 2010, Shouetsu 2009, Sapora *et al.* 2014). To estimate repair performance, SIF can also be utilized as an important measuring parameter (Gu *et al.* 2011, Lam *et al.* 2010).

A considerable amount of research has been conducted on extending the service life of cracked engineering structures with the emphasis on the life extension of aging aircraft structures using various repair techniques (Oudad *et al.* 2009). Analytical models have been developed for analysis of adhesively bonded joints, numerical solutions have been used in the past to predict the strength and stress distributions of adhesively bonded composite joints (Costa Mattas *et al.* 2012, Sayman *et al.* 2013). Bonded composite repair has been recognized as an efficient and economical method to extend the fatigue life of cracked aluminium components, several authors (Liu *et al.* 2009, Shen *et al.* 2011, Hosseini-Toudeshky *et al.* 2011) analysed fatigue crack growth rate of cracked

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