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A new driving force parameter for fatigue growth of multiple cracks

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Abstract

In this paper, the 2060 Al-Li alloy specimens containing a single crack and multiple cracks were tested under fatigue load. The experimental results showed that the fatigue crack growth rates for multiple cracks deviated from the single crack when there is no interaction between multiple cracks. The results cannot be interpreted by the conventional Paris law using the crack tip stress intensity factor range ΔK calculated with the external applied nominal stress $\Delta\sigma$. At a given ΔK, the fatigue crack growth rates (da/dN) of different cracks for the same homogeneous material should be same based on the Paris law. Therefore, a new mechanical driving force parameter ΔK_n that was calculated using the net section stress range $\Delta\sigma_n$ was proposed to describe the single crack and collinear multiple cracks growth behavior under fatigue load. All da/dN vs ΔK_n curves for collinear cracks of equal and unequal crack sizes were overlapped, and also overlapped with the single crack curve when no interaction occurred, showing that the ΔK_n can be considered as a proper parameter to address the fatigue behavior of materials containing multi-cracks.

Keywords: Collinear multiple cracks; Fatigue crack growth; Crack driving force; Interacting cracks.

1. Introduction

Material defects, shallow notches and rivet holes in structural components are potential locations from which fatigue multiple cracks may initiate and grow under cyclic loading [1, 2]. Fatigue multi-cracks growth analysis represents a very important and challenging problem for aircraft structural integrity [3]. Several small and closely spaced cracks could cause sudden failure even if each crack is smaller than a critical size. Firstly, fatigue multiple cracks are growing as isolated from each other under

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