Engineering Failure Analysis 18 (2011) 75–87

Contents lists available at ScienceDirect

Engineering Failure Analysis

journal homepage: www.elsevier.com/locate/engfailanal

Improving the fatigue strength of a multiple hole specimen by applying additional holes or notches

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ARTICLE INFO

Article history:
Received 29 March 2010
Accepted 13 August 2010
Available online 16 August 2010

Keywords:
Fatigue
Failure life
Crack initiation life
Multiple hole
Additional holes

ABSTRACT

A series of tests were conducted in aluminum alloy 2024-T3 to investigate the effect of additional holes and notches on the fatigue behavior of double hole specimens. Also, circular pins were inserted into the additional holes, but not removed before testing in some cases. Basic specimen has dual holes and their cracks interacted with the specimen edge. Within the present study conditions, the longest fatigue life was observed where dual holes had a shorter distance between their edges and a longer distance from specimen edge to holes. The shortest fatigue life was observed where there was a longer distance between the hole edges. This paper describes how the improvement of fatigue life in the shorter life case of a basic specimen was examined by applying additional holes or notches. The crack initiation and growth behavior was observed and the mechanism of the extension of the fatigue life was investigated. The finite element method (FEM) was used to analyze the stress concentration around the basic dual holes, additional holes and notches in the present specimens. Then it was discussed how the reduction of stress concentration around the basic dual holes affected the fatigue life of the double holed specimens. A method of enhancement of fatigue life of notched material is discussed in the present study.

1. Introduction

Metal damage must be taken into consideration during machine design and maintenance [1,2]. For example, the aerospace industry demands a lot from the materials it uses. Demands include improved toughness, lower weight, increased resistance to fatigue and corrosion. The boundaries of material properties are being constantly extended as manufacturers strive to give the next generation of aircraft improved performance while making them more efficient. Over the last three decades, a variety of experimental and computational methods have been developed in order to improve the life of machine components under fatigue [1–5]. Aluminum is one of the key materials facing these challenges. Aluminum alloy plate is used in a large number of aerospace applications, ranging in complexity and performance requirements from simple components through to primary load bearing structures in aircraft. Over the past several years extensive research has been done in the area of fatigue life enhancement of aluminum alloy on aerospace materials. With the development of high strength aluminum alloys, further emphasis has been placed on this research. So many fracture accidents have originated in fatigue cracks which initiate at notched sites, that the method of arresting such fatigue cracks was investigated [3–5].

In this study, the effects of additional holes and notches on the crack growth behavior of double hole specimens was examined to achieve the improvement of fatigue life in aluminum alloy. The result of this study shows that crack initiation

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doi:10.1016/j.engfailanal.2010.08.007