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EFFECT OF PATCH REPAIR ON FATIGUE BEHAVIOR

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Abstract: *In this paper, effect of patch repair on fatigue crack growth was investigated. In additional loading parameters associated with patch repair was studied in order to shown theirs influence on fatigue life and fatigue crack growth rate.*

Keywords: ***Composite patch repair, aluminum alloy, fatigue crack, stress ratio.***

1. Introduction

Fatigue problems become an important topic in the maintenance of aircrafts structures. Efficient repair technique, called composite patch repair, was used to reinforce the damaged structures and extend the service life of structures. In the investigation of Sabelkin et al. (2007), experimental and analytical investigation was conducted on 7075 T6 Al-alloy panel repaired by one sided adhesively bonded composite patch. In this study, crack growth rate was primarily dominated by SIF of the repaired panel near the bonded patch. In the investigation of Hosseini-Toudeshky (2006), it is experimentally and numerically shown that the crack grow non-uniformly from its initial position along the thickness of a single-side repaired panel and the crack-front shape were an important parameter influencing the stress intensity factor and FCGR. Fatigue behavior of patched aluminum alloys 2024 T3 and 7075 T6 were investigated by Duquesnay et al. (2005). An increasing in maximum shear stress was shown in increasing of stress ratio for the both aluminum alloys. In recent work (Pastor et al., 2009), lifetime extension of the reinforced specimens is significant assuming the same load level for patched and unpatched specimens. In this study, effect of composite patch repair of M(T) specimen on FCG was studied and compared to the unrepaired specimen.

Materials used in this study are 2024 T351 aluminum alloy obtained on rolled plates in L-T orientation (see Afgrow database). Simulation of fatigue crack growth in mode I used thin middle tensile plate M(T) subjected to uniform tensile cyclic load and patched by graphite/epoxy. NASGRO Model was used in order to evaluate fatigue behavior (fatigue life and FCGRs)

2. Results & discussions

Patched and unpatched M(T) specimen in L-T orientation were subjected to a constant cyclic loading under variation of stress ratio. Fig.1 showed respectively the effect of stress ratio on fatigue life for unpatched and patched specimen. For two configuration specimens, stress ratio presents the same effects. It is noticed that an increasing in stress ratio, fatigue life was increasing. In all stress ratios, fatigue life ratio "patched/unpatched" for both specimens is about twice for crack length greater than 10 mm.

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The fatigue crack growth rates for different stress ratio R (ratio of minimum on maximum of applied cyclic loading) on patched specimens are shown in Fig. 2. Curves illustrate a general increase in da/dN with increasing of stress ratio R. It is noticed that at same stress ratio, FCGRs for patched and unpatched specimen have the same slope and threshold stress intensity factor is influenced by patch repair (Fig. 2). Fig. 3 shows the comparison of predicted fatigue crack growth between patched specimen repaired by Graphite/Epoxy and unpatched specimen. It is clearly that patch repair retard crack growth.

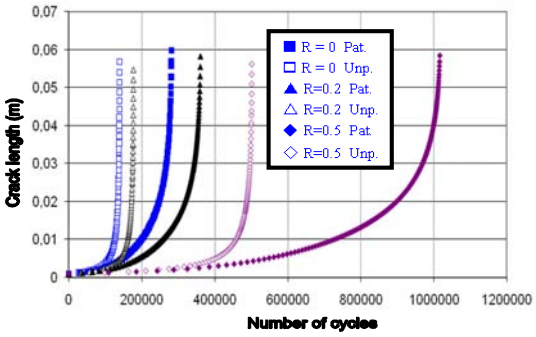

Fig. 1: Effect of stress ratio "R" on fatigue life for patched and unpatched M(T) specimen

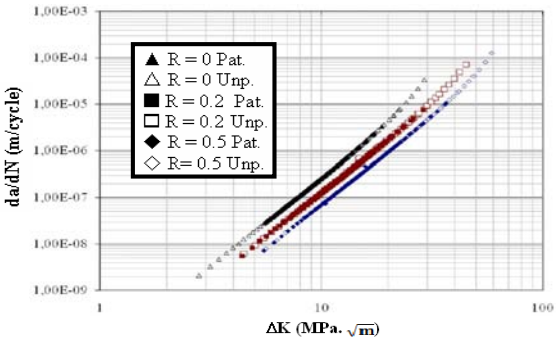

Fig. 2: Effect of stress ratio "R" on FCGRs for patched and unpatched M(T) specimen

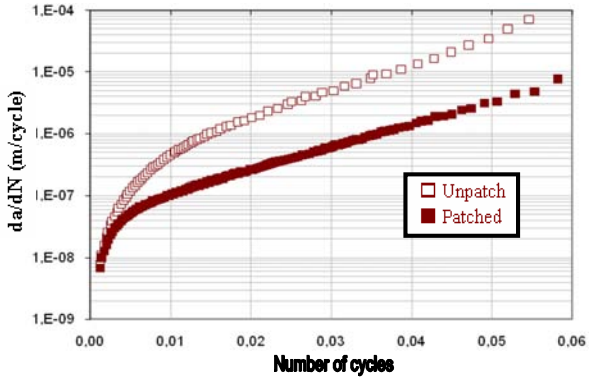

Fig. 3: Effect of patched and unpatched specimen on FCGRs performed on 2024 T351 Al-alloy M(T) specimen

3. Conclusions

This study involve fatigue behavior of 3 mm thin specimens "center crack M(T)" in unrepaired and repaired (graphite/epoxy) case. In this study fatigue crack growth and fatigue life of thin plate were evaluated. Fatigue life for repaired and unrepaired specimen was affected by stress ratio. Fatigue crack growth rate (FCGR) increased by increasing of stress ratio. Fatigue crack growth rate for repaired and unrepaired specimen was compared. Results shown beneficial effect of composite patch repair when service life of damaged structures will be extended.

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