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Fatigue Crack Trajectory Analysis of Single-Side Repaired Thin Aluminum Panels with Various Composite Patch Lay-up Configurations

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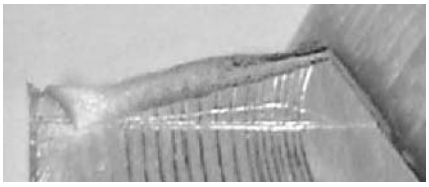
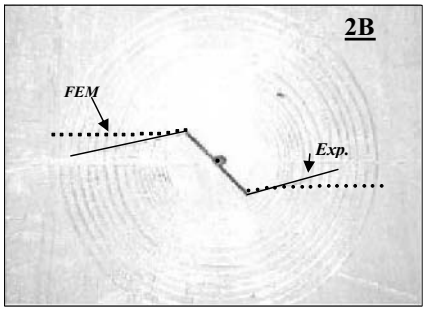
ABSTRACT

In this paper experimental and numerical finite elements fatigue crack propagation analysis of the single-side repaired thin aluminium panels containing an initial inclined flaw of 45^0 are studied. These panels are repaired with the 4 layers glass/epoxy composite materials with the lay-up configurations of $[90]_4$, $[105]_4$, $[-45]_4$, $[-45/+45]_2$, and $[90_2/0_2]$. In the performed three dimensional analyses it was assumed that the crack-front remains perpendicular to the panels' surfaces during its propagation. The effects of the patch lay-up configurations on the crack trajectories at patched and un-patched surfaces of the panels are presented. It will be shown that crack trajectories at patched surface is different from the un-patched surface and therefore leads to the existence of a three dimensional fatigue-fracture surface for all repaired panels. A typical fracture surface is shown in Figure 1-(a). Figure 1-(b) compare the typical crack trajectories of un-patched surface of the repaired panel with the patch lay-up of $[-45]_4$ obtained from experiment with that obtained from finite elements analyses. The finite elements results show a comparable agreement with those obtained from the experiments. The finite elements results also show that using various lay-up configurations may lead to various crack propagation orientation with 5^0 to 10^0 differences.



(a)



(b)

Figure 1. (a) Typical fracture surface; (b) Typical crack trajectories of un-patched surface of the repaired panel with the patch lay-up of $[-45]_4$ obtained from experiment and FEM