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An Analysis Approach toward FAA Certification for Damage Tolerance of Aircraft Components

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ABSTRACT

This paper presents a novel analysis approach by considering multiple crack interaction in achieving FAA certification for durability and damage tolerance of exterior attachment installations on an aircraft fuselage according to FAA policy on Certification by Analysis-Supported-by-Test (CAST). Durability and damage tolerance evaluation of an aircraft component requires assessment of damage initiation and fatigue crack propagations under service loading, which consists of complex loading types, paths and variable amplitudes. Both simulation and service experience showed that multiple cracks developed in the fuselage skin and doublers that are made of wrought aluminum alloys. Progressive failure analysis (PFA) tool was used to simulate the fatigue damage initiation life using a scale-down stress-life property. A virtual crack closure technique (VCCT) was implemented to evaluate fatigue crack growth with interactions between cracks from different parts in a component, which preserves conservativeness. The fatigue crack growth data is obtained uniquely from an analytical extension of fatigue crack growth data of thin aluminum sheet. Fatigue crack growth analysis showed that only a few initiated cracks propagated steadily before a crack became visible under inspection, which was validated by comparison to service history. Eventually one crack became dominate in the fracturing process thereby setting an inspection time. Analysis also showed that fatigue damage state in the components at the design operational life will not exceed the static safety requirements. Therefore, FAA accepted the damage tolerance analysis and the aircraft retained certification with no need for repair.

***KEYWORD**: 1) Multi-site crack initiation; 2) Progressive failure analysis; 3) Fatigue crack growth; 4) VCCT; 5) Spectrum loading; 6) FAA certification; 7) Conservativeness; 8) Structural safety*