Study of Cracks Behavior in Riveted Joint Subjected to Fatigue Cycles with Acoustic Emission Approximate Entropy

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Most of the structural joints in metallic airframe are fabricated with riveted joints. Formation of fatigue cracks in riveted joints during service are very often encountered in aircraft industry. Wide spread fatigue damage, multi-site damages are consequence of initiation of clusters of fatigue cracks in riveted joints and threat in the structural integrity. Detection and understanding the initiation and growth behavior of fatigue cracks in riveted joints is extremely important to maintain the structural integrity of the airframe as well as for aging aircraft operating in extended life. The experimental research work projected here was carried out to understand the fatigue cracks behavior in riveted joints that are commonly employed in metallic airframes with quantifying complexity of acoustic emission signals acquired from riveted joints under cyclic loads.

Experiments were done on riveted single strap butt joint specimens fabricated with widely used in airframe construction material aluminium AA 2024 -T3 alloy. Specimens were subjected to load cycles with the magnitude of loads similar to the fuselage segment of transport aircraft encountering during pressurization cycles. Acoustic emissions radiated from the specimens under the fatigue loads were continuously acquired through broad band acoustic emission sensors installed in the specimens.

In the analysis, every fatigue load cycles were segmented as peak, transient, trough. Acoustic emissions received for these segments of load cycle were analyzed to determine the approximate entropy on various acoustic emission signal parameters such as hits, count, amplitude, and spectral features. Trend of determined approximate entropy magnitudes for the AE parameters with respect to exhaust of fatigue cycles were related to the stages of fatigue cracks. Increasing, decreasing trends, rate, slope and oscillating approximate entropy magnitudes are related to the crack growth behavior. Observed that the approximate entropy behavior is able to discriminate the various stages of fatigue cracks such as crack initiation, stable crack growth, development of multi-site damage, accelerated crack growth, coalescence of cracks etc.

From observation, approximate entropy analysis based approach found to be a very good candidate for evaluation fatigue cracks in riveted joints and can be further extend for efficient structural health monitoring of airframe.

Key Words: *Approximate Entropy, riveted joints, fatigue cracks, multi-site damage*