B-scan Ultrasonic Testing of Rivets in Multilayer Structures Based on Short-Time Fourier Transform Analysis

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B-scan Ultrasonic Testing of Rivets in Multilayer Structures Based on Short-Time Fourier Transform Analysis

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Abstract:

This paper proposes an ultrasonic testing system for inspection of pitting corrosion cracks in rivets of multilayer structures. The inspection operates in B-scan mode with an ultrasonic probe passing over the rivet head. The ultrasonic signal is analyzed in the frequency domain using the short-time Fourier transform. To analyze and evaluate the effectiveness of the system, B-scan data obtained by scanning a rivet head within ±1 mm from the rivet head center will be used and an algorithm to evaluate the existence of cracks in the rivet using B-scan data will be proposed. To evaluate the performance of the system, its probability of detection (POD) is analyzed. With the data obtained at a scanning speed of 6 mm/s, the system could detect artificial pitting corrosion cracks with areas of 47.28% of the rivet body cross-section area with 90/95% POD.

Keywords: Ultrasonic testing, short-time Fourier transform, pitting corrosion crack, rivet, multilayer structures, aging aircraft.

1. Introduction

Rivets are used to assemble skins in aircraft fuselages. Corrosion and fatigue cracks in the rivet locations and in the rivets themselves can cause fractures by stress concentration and have to be inspected in detail, especially on aircraft multilayer structures. Far-side corrosion and fatigue cracks in rivet locations are typical results of salinity and moisture accumulation in the gaps between layers during