Debonding detection of composite wing leading edge using ultrasonic guided wave

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Keywords: debonding, composite wing leading edge, ultrasonic guided wave Abstract: Composite wing leading edge is an important component to pertain the aerodynamic properties, ensure impact resistance and reduce weight of aircraft. The composite wing leading edge is a curved and sandwiched structure with variable thickness, which is composed of metal, glass fiber reinforced plastic and honeycomb layer and is prone to be debonding during manufacturing and service. Conventional non-destructive methods such as ultrasonic C-scan using bulk wave, cannot timely and effectively detect the debonding of composite wing leading edge. Therefore, it is necessary to develop a structural health monitoring method suitable for composite wing leading edge. In this study, two PZT sensor arrays, functioning as actuators and sensors, were implemented on a small section of a composite wing leading edge that was used in Chinese Plane. Hamming-window modulated three-cycle sinusoidal ultrasonic waves with middle frequency from 30 kHz to 300 kHz, as well as a chirp wave covering broadband, were excited and propagated in the structure. The performance of each PZT in the arrays was compared to analyzed to account for signal losses and then to eliminate differences from installation. The amplitude and arrival time of the detected signal along different paths were normalized based on the theoretical attenuation caused by the distances between each actuator-sensor pair. By comparing signals passing through debonding areas with those through the intact areas, a decrease in signal amplitude and a delay in arrival time can be observed in a specific set of data. The probability of damage was then evaluated by employing multiple parameters from the same path, which was later demonstrated by a traditional ultrasonic C-scan. Experimental results indicate that the ultrasonic guided wave, which is generated from PZT arrays and can propagate over a long distance, is highly effective in detecting debonding of composite wing leading edge. This approach provides an economical and practical structural health motoring method that can complement existing non-destructive technologies of composite wing leading edge.