Guided Wave Propagation in a Repaired Aircraft Wing Panel under Variable Temperature Condition

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ABSTRACT

The aim of the study is to explore the ultrasonic guided wave propagation phenomenon in a carbon-fibre-reinforced patch-repaired stiffened composite panel of a real-life aircraft wing. In order to understand the guided wave propagation phenomenon in such complex multi-layered repaired structure, a coordinated theoretical dispersion analysis, finite element based three-dimensional (3D) numerical simulation and experimental investigation have been carried out using piezoelectric transducers [1,2]. The dispersion curves for a similar healthy structure are theoretically obtained by using a global matrix method based fast and efficient 2D semi-analytical model described in [3], in order to study the dispersion characteristics of the propagating guided waves at the high-frequency (>100 kHz) range. An extensive 3D simulation of guided wave propagation in the repaired sample structure is then carried out in ABAQUS for a range of operating frequency and ambient temperature conditions, and the simulation results are successfully validated with selected laboratory experiments. Various wave modes in the numerical and experimental signals are effectively identified based on the theoretically obtained dispersion curves. It is observed that the presence of a localized patch repair region in the structure significantly influences the amplitudes and propagation velocities of certain wave modes in the recorded sensor signals. A pseudo-experimental parametric study is also carried out, in order to understand the influence of excitation frequency and the temperature variation influence on the propagating wave modes in the structure.

Keywords: Dispersion, guided wave, piezoelectric transducer, patch-repair, stiffened composite panel, structural health monitoring

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