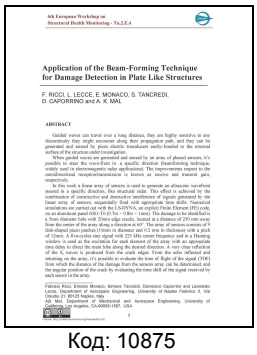

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Application of the Beam-Forming Technique for Damage Detection in Plate Like Structures

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Guided waves can travel over a long distance, they are highly sensitive to any discontinuity they might encounter along their propagation path, and they can be generated and sensed by piezo electric transducers easily bonded to the external surface of the structure under investigation.

When guided waves are generated and sensed by an array of phased sensors, it's possible to steer the wave-front in a specific direction (beamforming technique, widely used in electromagnetic radar applications). The improvements respect to the omnidirectional reception/transmission is known as receive and transmit gain, respectively.

In this work a linear array of sensors is used to generate an ultrasonic wavefront steered in a specific direction, like structural radar. This effect is achieved by the combination of constructive and destructive interference of signals generated by the linear array of sensors, sequentially fired with appropriate time shifts. Numerical simulations are carried out with the LS-DYNA, an explicit Finite Element (FE) code, on an aluminum panel 6061-T6 (0.7m x 0.8m x 1mm). The damage to be identified is a 5mm diameter hole with 20mm edge cracks, located at a distance of 250 mm away from the center of the array along a direction at 60°. The array of sensors consists of 9 disk-shaped piezo patches (10mm in diameter and 0.2 mm in thickness) with a pitch of 12mm. A five-cycles sine signal with 225 kHz center frequency and in a Hanning window is used as the excitation for each element of the array with an appropriate time delay to direct the main lobe along the desired direction. A very clear reflection of the S0 waves is produced from the crack edges. From the echo reflected and returning on the array, it's possible to evaluate the time of flight of the signal (TOF) from which the distance of the damage from the sensors array can be determined, and the angular position of the crack by evaluating the time shift of the signal received by each sensor in the array.

The experimental tests are carried out in a lm x lm xl mm aluminum panel with the same sensor array and edge cracked hole used in the simulation. The sources in the array are sequentially fired using the round-robin technique. A number of receivers located along the panel edges have been also used to detect the damage direction in pitch-catch mode.

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Ключевые слова:

Содержание