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DETECTION AND SIZING CRACKS IN METALLIC AND NONMETALLIC PLATES USING TOFD METHOD : NUMERICAL SIMULTIONS AND EXPERIMENTAL RESULTS

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Abstract : One major deterioration source in metallic and non-metallic structural elements is initiation and growth of fatigue cracks. Undetected active fatigue cracks in structural elements under service loads are possible and could result in unstable fracture and catastrophic final failure of the structure under consideration. Conventional ultrasonic technique uses the pulse transit time to locate and the echo amplitude to size the flaw. For accurate flaw sizing, the amplitude of the back reflected wave may not always be sufficient, since the amplitude of the reflected pulse may be influenced by many parameters other than the size of the reflector. Such parameters include the surface roughness, transparency and orientation of the defect. In order to ensure a more reliable defect sizing ultrasonic NDE technique, the ultrasonic TimeOf Flight Diffraction (TOFD) method was developed [1]. In this paper, the interaction between cracks and an ultrasonic pulse as an incident wave is simulated by using Elastodynamic Finite Integration Technique (EFIT) [2, 3], the reflected wave is stored and analyzed in time domain to image crack like defects in metallic and nonmetallic plates. One advantage of modeling using the EFIT method is that complex structures with defects of various configurations can be handled easilywhere it would be difficult to conduct experiments. Arbitrary shape crack like defects have been considered for the simulation. The crack dimensions can be determinedfrom the characteristic of reflected wave. Experiments studies were also performed on metallic (Aluminum) and non-metallic (Cement paste) plates with defect tip closer to the surface of a flat plate sample to illustrate the utility of the TOFD technique and validate the resultsof the simulation. An increase in the flaw sizing accuracy, by using the longitudinal wave-diffracted echoes from the tip and through the application of a signal processing technique using embedded signal identification technique (ESIT) [4], was demonstrated

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