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Time of Flight Diffraction (TOFD) Technique for Accurate Sizing of Surface Breaking Cracks

Sony Baby[1], T. Balasubramanian[1], R. J. Pardikar[2], M. Palaniappan[3] and R. Subbaratnam[3]

[1]Department of Physics, Regional Engineering College, Tiruchirappalli
[2] NDTL, BHEL, Tiruchirappalli, Tamil Nadu, India
[3]Indira Gandhi Centre for Atomic Research, Kalpakam, Tamil Nadu, India

Abstract

The ultrasonic testing techniques are extensively employed for detection and characterisation of flaws during manufacturing and in-service inspection of critical engineering structures and systems. These techniques assure the integrity and reliability of the components. The recent developments in the ultrasonic inspection technology, based on the need for fitness for purpose has resulted in a reliable and accurate technique called a Time Of Flight Diffraction Technique (TOFD). This method uses the phenomena of ultrasonic diffraction rather than the traditional pulse echo technique, which uses reflective principles. The use of the phenomena of ultrasonic diffraction has distinct advantages in the sizing of defects, particularly the crack like planar defects. Diffracted wave fronts effectively originates at the crack tips. The difference in time of flight of wave fronts carry the information on the spatial relationship of the crack tips and hence, the extent of the crack. This technique is found to be substantially more accurate than conventional pulse echo techniques.

The authors have carried out an experimental study for evaluation of TOFD technique for determination of size of the surface breaking cracks. The study was confined to simulated cracks. The steel test blocks used for the study contained 0. 5mm wide vertical slits of various heights ranging from 0.91 mm to 30 mm. Another set of blocks contained inclined slits (10°, 15°) inclination of various heights ranging from 2.56 mm to 19.82 mm. Both the vertical and inclined slits were opened to the top surface.

TOFD equipment Model MICROPLUS of M/S AEA Technology, UK with manual scanner along with longitudinal angle beam probes of 45° - 4 MHz were used for the study. The blocks were scanned along the slits / defects and across the slits. The scanned images were analysed for the sizing. The results of the study indicated an average error of °0.15 for depth in vertical slits and °0.19 for inclined slits whereas the average error in length measured was *0.45 mm for vertical slits and *0.35 mm for inclined slits. However difficulty was experienced using TOFD to size defects extending less than about 2 mm depth. This is due to the presence of the lateral wave, which obscures the tip-diffracted signals from the defects close to the surface and also to the inherent lack of time resolution near the surface.