Development of an Unsaturated Differential Magnetic Probe for the Visualization of Back-side Slits with Different Directions on Carbon Steel Plate

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Abstract:
Magnetic Flux Leakage (MFL) and Eddy Current Testing (ECT) in Nondestructive Testing (NDT) are considered as commonly used techniques in the detection of cracks within metallic materials. MFL relies on the analysis of the flux leakages, while ECT relies on the analysis of eddy currents that resides within a metallic sample. The conventional MFL system, however, requires a strong magnetic field to be applied to a sample to achieve magnetic saturation so that strong flux leakages can be produced. In this work, an unsaturated differential magnetic probe which utilizes the highly sensitive AMR sensors is developed, which aims to eliminate the need for the sample saturation. Besides that, the ECT is rarely applied to ferromagnetic materials due to the large distribution of the magnetization signals compared to the eddy current signal. Thus, the phase-sensitive detection technique is proposed using a digital lock-in amplifier, which will allow the separation of both MFL and ECT signals. Besides that, a 2-mm carbon steel plate is used as the sample for this work. The surface of the plate is engraved with artificial slits with different directions, which are 0° (horizontal), 45°, and 90° (vertical). Then, a 2-D map measurement is conducted from the backside of the sample. From the results, the slits with the direction of 45° and 90° can be clearly observed for both real and imaginary components. However, the 0° slits are nowhere to be seen within the backside 2-D map for both real and imaginary components. Furthermore, the optimum frequency for the 2-D map measurement is concluded to be at 110 Hz for both MFL and ECT. Finally, by observing the intensity of the blue color region (for the real component) and red and blue region (for the imaginary component), the depth of the slits can be further estimated.

Keywords: Nondestructive Testing; NDT; Magnetic Flux Leakage; MFL; Eddy Current Testing; ECT; crack in steel; Anisotropy Magnetoresistance; AMR

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