Characterization of Sub-millimeter Backside-Slit Defects on Galvanized Steel Plates using A Phase-Sensitive AMR Gradiometer and Low Excitation Frequency

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Abstract:
Backside inspection of metallic materials such as the widely used galvanized steels, is a challenging inspection in Non-Destructive Tests (NDTs) using eddy current (EC) and magnetic flux leakage (MFL) techniques. This is due to the propagation characteristic of electromagnetic waves is governed by the skin-depth effect in which a low frequency of the excitation field should be used to allow deeper penetration of electromagnetic waves in a high magnetic permeability material. In this study, to achieve a high sensitivity detection at a low frequency, we develop a magnetic probe consists of a planar gradiometer formed by sensitive Anisotropic Magnetoresistance (AMR) sensors (HMC1001, Honeywell) and two small 100-turn electromagnets. We evaluate the performance of the developed probe by characterizing artificial slit defects with different depth on a 2-mm galvanized steel plate. The width of the slits is laserengraved to be 1 mm and the depth is varied from 0.768 mm to 0.929 mm. The in-phase component exhibits a decrease in the differential output at the slit position and the out-of-phase component shows a characteristic where the slit position is located between peak and trough of the differential signal. The output difference between peak and trough in both components shows a fair correlation with the slit depth. It can be suggested that the in-phase component can be used to estimate the location of defects while the out-of-phase component can be used to provide rich information on the defect parameters such as depth. The developed probe can be used for assessing defects in both ferromagnetic and conductive materials by hybridizing EC and MFL techniques.

Keywords: Eddy current; Magnetic flux leakage.

ACKNOWLEDGMENT

This work was supported by the Research Management Center of Universiti Malaysia Pahang under grant number of RDU1903100 and Ministry of Higher Education of Malaysia under grant number of FRGS/1/2019/TK04/UMP/02/4 (RDU1901154)