

Damage detection on invisible reverse side of planar steel using disturbance measurement of magnetic flux

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Many steel pipes are used at oil and gas plants and they easily corrode because of the work of fluid and the anode cathode effect by surrounding chemicals. These defects or corruptions are likely to arise on the invisible reverse side of the material and are difficult to detect by conventional electromagnetic methods such as eddy current testing. In this research, we propose a new non-destructive testing method using magnetic field to detect the rear defect on the steel materials, e.g. steel pipes or plates. Recently we showed that we could find the defect on the rear side of steel material by measuring the change of the amplitude of magnetic flux around the defect when applying magnetic field to the material. Furthermore, we verified the magnetic flux leakage is caused by the circumvention of magnetic flux around the defect. However, it is not clear whether the features of defects (e.g. shape, width, depth) can be estimated or not. We hypothesize that the magnetic flux leakage includes information about the features of defects. To validate our hypothesis, we conduct numerical experiments using the finite-difference method in the fictitious domain. Our numerical model includes a yoke and a target steel plate with a rear defect, which has different widths. We found that the amplitude of magnetic flux leakage has linear relationship with the width of the defect. Although the absolute value of the amplitude is small compared with that of a surface defect, FWHM (Full Width at Half Maximum) of magnetic flux are independent from the amplitude, i.e., no energetic dissipation, and the change in the phase is usable. As a result, we showed that the phase of x component is shifted slightly over the defect and y component is changed by π [rad] at the center of the defect although in the case of the surface defect, both components are altered by π [rad]. We conclude that we could detect the position of the defect by measuring the change of the phase even if the amplitude is small.

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