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Numerical electromagnetic simulation for high resolution eddy-current testing method

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The applicability and feasibility of eddy current detection method for the measurement of wall thinning and surface crack of steel structure have been practically confirmed by field and laboratory experiments. Recently, we could roughly understand the location and size of defects by this method. But the estimated size and shape are qualitative ones. For more accurate inspections, there has been a demand to quantitatively evaluate the defects. Therefore, we developed a numerical simulator to consider whether we could refine the high accuracy eddy current method.

In the eddy current method, we use the information of excitation and induced magnetic field.In order to calculate the induced magnetic field, we used 2.5 dimensional finite-difference frequency domain technique (2.5D-FDFD) to solve Maxwell's equations numerically. In this technique, we assumed the two-dimensional structure and the three-dimensional electromagnetic field. We used two-layer structure consisting of seawater and steel plate containing defects. To estimate characteristic of the induced magnetic field, we simulated for various defects and compared what effects appear.

As a result, we could confirm the effect of surface defects of steel plate on receiving magnetic field intensity. The induced magnetic field intensity increases near the edge of the defects and decays above the defects. The larger the defects length and width are, the more attenuation the magnetic field intensity becomes. Our simulation results indicated that we could calculate the response of magnetic field intensity whose detectable scale of defects is no smaller than mm order.

Keywords: Eddy current, Maxwell's equation, NDE, 2.5D-FDFD, Magnetic field