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3D-FDFD simulation for high resolution eddy-current testing method

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The applicability and the feasibility of eddy-current testing method for the measurement of wall thinning and surface crack of steel structure have been practically confirmed by field and laboratory experiments. Where and how large the cracks would be are roughly understood by this method. However, it is difficult to estimate the exact size and shape of them. For more accurate inspections, there has been a growing demand to quantitatively evaluate the cracks. Therefore, we have developed a numerical simulator for the high accuracy eddy-current method. Eddy-current method measures excitation magnetic and induced magnetic fields, the latter of which is caused by the eddy-current in the inspecting material. In order to calculate induced magnetic field deformed by the cracks, we used three-dimensional finite-difference frequency domain technique to solve Maxwell's equations numerically. As a simulation model, two-layer structure consisting of seawater and steel plate including cracks is used. We simulated a variety of cracks to estimate characteristic of the induced magnetic field, and compared the results in terms of what kind of difference in the induced field would appear. As a result, the effect of surface cracks of steel plate on receiving magnetic field intensity was confirmed as follows: the induced magnetic field intensity increases near the edge of cracks and decays above the cracks with the distance to the edge. The deeper and wider cracks are, the more the magnetic field intensity becomes attenuated. Due to the limitation of our simulation schemes, the response of magnetic field intensity whose detectable scale of cracks was no smaller than mm order. We are introducing a method that could allow us to confirm much finer detectability.

Keywords: NDI, Maxwell's equations, Eddy Current, numerical simulation