Transient amplitude analysis of Lamb waves generated by a low-frequency EMAT

Kyogo Sato[1], Farrukhbek Karimov[2], Hirokazu Enomoto[3], Kenji Kitamura[4], Toshihiko Sugiura[4]

[1]Mechanical Engineering, Keio University, Japan, [1]Department of mechanical Engineering , Keio University, Japan, [1]Department of mechanical Engineering, Keio University, Japan, [1]Mechanical engineering, Keio University, Japan

The electromagnetic acoustic transducers (EMATs) with meander coils are guided wave transducers that can excite a specific mode to some extent selectively by adjusting the coil pitch to the wavelength of the guided wave mode to be excited. However, even these EMATs actually excite not only a specific mode, but also different modes. For highly accurate inspection, it is necessary to theoretically obtain the amplitude of each guided wave mode generated by EMATs. This study analyzes transient processes in which Lamb waves generated by a transducer grow in the early stage of propagation. The excitation force term of each mode can be obtained by separating the excitation force into components corresponding to the symmetric mode and the antisymmetric mode and performing Fourier transform. For the governing equation, as an inhomogeneous partial differential equation, of elastic vibration of each mode under each excitation force term, the analysis using the method of multiple scales is performed on the assumption that each mode amplitude of the solution gradually increases with propagation. The amplitude ratio of each mode was determined from the degree of amplitude increase. In general, guided waves are often used in low-frequency range where there are few types of propagation modes. In the low-frequency range, the skin depth of eddy currents in a sample plate cannot be ignored with respect to the plate thickness. Therefore, the Lorentz force generated on the sample by an EMAT may need to be treated as a body force, not a surface force. Therefore, in this study, the Lorentz force generated by an EMAT was obtained as a body force by electromagnetic field analysis, and the transient analysis of ultrasonic guided waves stated above was performed.