

# Finite Element Modeling of a Pulsed Spiral Coil Electromagnetic Acoustic Transducer (EMAT) for the Testing of Plates

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## Abstract

This paper presents numerical simulation of plate wave modes in thin stainless steel plates using a racetrack spiral coil electromagnetic acoustic transducer (EMAT), which works under the principle of acousto-elastic effect, called Lorentz force mechanism. EMATs are useful for non-contact ultrasonic nondestructive testing (NDT) of metallic materials for detection of defects and for measurement of thickness.

A 2D finite element model of the spiral coil EMAT is developed to calculate the induced eddy current and subsequently, the Lorentz force density inside the steel plate. The calculated Lorentz force density values are used for simulating the transient ultrasonic plate wave generation within the stainless steel plate. The governing equations are implemented using the commercial finite element package COMSOL Multiphysics®. This multiphysics model includes simulation of the electromagnetic field coupled to the elastic field through appropriate constitutive equations. This model is used to predict the performance of a spiral coil EMAT that generates plate waves. The predicted results are compared with experimental data for validation of the model and also to get insight on the transduction process. This numerical simulation is also extended to analyze the interaction of plate wave modes with defects.