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EDDY CURRENT TESTING OF Ferromagnetic
MATERIALS: MODELLING OF MULTIPLE FLAWS IN A
PLANAR STRATIFIED MEDIUM

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Abstract

Eddy current testing (ECT) is a standard technique in industry for the detection of surface breaking
flaws in ferromagnetic materials such as steels. In this context, simulation tools can be used to
improve the understanding of experimental signals, optimize the design of sensors or evaluate the
performance of ECT procedures. CEA has developed for many years semi-analytical models
embedded into the simulation platform CIVA [1] dedicated to non-destructive testing.

Following a previous work [2] carried out at the laboratory in the case of one flaw located in a
cylindrical ferromagnetic piece, the development presented herein address the case of multiple
interacting flaws located inside a planar, stratified [3] and ferromagnetic medium. Simulation
results are obtained through the application of the Volume Integral Method (VIM) [4]. This
approach has proved its efficiency when considering canonical geometries, mainly due to the fact
that an analytical expressions of dyadic Green operators are available in the spectral domain. While
only one integral equation, involving either the electric or the magnetic field, is needed to describe
the non-magnetic case completely, in the ferromagnetic case two coupled integral equations have to
be solved.

Therefore, when considering the ECT of a single flaw, a system of two differential equations is
derived from Maxwell equations. The numerical resolution of the system is carried out using the
classical Galerkin variant of the Method of Moments [4]. Finally, the probe response is calculated
by application of the Lorentz reciprocity theorem [6]. The resolution has been generalized to the
ECT simulation of \( N \) flaws located in a planar stratified medium. The theoretical approach will be
presented, as well as comparisons between simulation results and measured data obtained from the
literature, see [7] for example. Combined effects of ferromagnetic layers and interactions between
flaws will also be discussed.

References


