

An Interaction Between Electromagnetic Field And Materials: Characterization Of Mechanical Stress In Ferromagnetic Materials Using Eddy Currents Non-destructive Techniques

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Abstract

For more than thirty years the GeePs Laboratory has been working on the numerical simulation of electromagnetic systems through numerous research topics. During this conference, we propose to present a recent problem that has been addressed by the laboratory. This application concerns the use of Eddy Currents (EC) in non-destructive testing (NDT) to characterize the stress state of a ferromagnetic material. For this kind of material, the electromagnetic properties are modified under the effect of mechanical stresses. A "COMSOL Multiphysics" modeling was implemented to evaluate and to optimize the response of the sensor to EC signal according to a stress state. The modelling consists in including in a low frequency 3D electromagnetic finite element model a magnetomechanical constitutive law (here the multiscale model [Daniel and Galopin 2008], [Daniel 2013], [Dahia et al 2015]) by calling an external compiled C function. A nonlinear resolution is then necessary. The presence of regions with small skin thickness implies the use of a mix of different geometric elements in the 3D mesh.

Reference

[Daniel 2013] L. Daniel: An analytical model for the effect of multiaxial stress on the magnetic susceptibility of ferromagnetic materials, IEEE Transactions on Magnetics, 49(5):20372040 (2013).

[Dahia et al 2015] A. Dahia, E. Berthelot, Y. Le Bihan, L. Daniel: A model-based method for the characterisation of stress in magnetic materials using eddy current non-destructive evaluation, Journal of Physics D: Applied Physics, 48:195002 (2015).