A Perturbation Technique for the Finite Element Modelling of Differential Probes in Nondestructive Eddy Current Testing

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Abstract

The present paper deals with a new finite element scheme for nondestructive eddy-current testing (ECT) problems involving differential probes and multiply connected test pieces. It concerns a perturbation technique applied to the magnetodynamic $\boldsymbol{h} - \phi$ formulation.

The unperturbed field (in the absence of the flaw) is conventionally computed in the complete domain taking advantage of any symmetry or analytical solution (if available). The source of the perturbation problem is then determined by the projection of the unperturbed field in a relatively small region around the defect, the size of which depends on the working frequency. The discretisation of this reduced domain is well adapted to the size of the defect. It is thus chosen independently of the dimensions of the excitation probe and the specimen under study. At a discrete level, the voltage change is efficiently computed by integrating only over the defect and a layer of elements in the reduced domain that touches its boundary.

The accuracy of the proposed perturbation model is evidenced by comparing the results obtained for different dimensions of the reduced domain to those achieved in the conventional way (two successive finite element computations without and with defect). The considered test case involves a differential probe scanning the outer surface of a metal tube for the detection of perforating cracks.

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