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Extended finite elements in eddy current devices

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ABSTRACT

Eddy current testing is one of the most popular techniques in the field of non destructive evaluation. It is widely used in science and industry to detect cracks and other defects in metallic structures such as tubes or aircraft fuselage. There are essentially two strategies to compute eddy currents numerically: on the one hand, semi-analytic methods which are based on integral equations and need the explicit knowledge of a Green's function. On the other, completely numerical methods based on finite elements which aim to compute the eddy currents in the whole conductor [2]. The method that we present in this talk, enters within the second class.

We consider the two dimensional configuration of a circular conductor surrounded by a coil at a small distance η. In the presence of an emerging crack in the conductor, the induced eddy currents are diverted since no current passes through the crack. The eddy current model derives from Maxwell's equations by neglecting the displacement currents $\partial_t(\varepsilon\mathbf{E})$. Its formulation implies the splitting of the electric field $\mathbf{E}$ which is at the origin of the eddy currents into a vector potential $\mathbf{A}$ and a scalar potential ψ.

Standard XFEM are based on the enrichment of classical Lagrange finite elements where the degrees of freedom are associated with the *nodes* of the mesh. In the context of Maxwell equations, extended *edge* elements have been introduced in [3]. In this talk, we present a new extended finite element method which couples nodal and edge enrichment through the mixed formulation of the eddy current problem in terms of scalar and vector potentials.

We address some theoretical properties of the coupling of nodal and edge extended finite elements and show numerical results in order to illustrate its performance. Finally, we will discuss the resolution of crack identification problems in combination with meta-heuristic methods [1].

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