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Numerical Modelling of Eddy Current Non-Destructive Evaluation in Material Defects Detection Studies

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This paper proposes an approach to evaluate the detection possibility and characteristics of material defects using numerical modelling, together with characterizing the capability and reliability of using eddy current non-invasive inspections.
Eddy-Current (EC) inspection represents an essential method for the electromagnetic non-destructive detection/evaluation (NDE) of cracks in conductive materials, with its main applications being found in the examination of aircraft, particle accelerators, and other engineering constructions. The method is based on the detection of the magnetic field produced by eddy currents induced in the specimen being tested. The presence of a crack disturbs the flow of the eddy currents, thus producing a magnetic field perturbation dependent on the position and shape of the defect itself. Variations in the electrical conductivity and magnetic permeability of the test object material, and the presence of defects in the object causes a change in eddy current and a corresponding change in phase and amplitude that can be detected by measuring the impedance changes in the magnetic field generating coil, which is a telltale sign of the presence of defects.

The NDE methods are characterized in a statistical manner by probability of detection (POD) assessments. The result will be different when evaluating different materials, geometries, defect types and also by the specified procedure settings.
The nature of the method is complex and there is therefore a need for deeper understanding that may be gained from mathematical models. Such models can have several objectives as for example procedure and equipment optimization or understanding of the method capability and reliability.

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