Master project, 2025 - 26

– Local characterization of the electromagnetic properties of heterogeneous and weakly magnetic steels –

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Context and objective

Nuclear power plants are subject to severe operating constraints, requiring regular checks on the integrity of the equipment concerned, using non-destructive techniques to detect any defects that may arise. Non-destructive testing (NDT) techniques, such as those based on eddy currents (EC), are good candidates to detect, for example, sub-surface cracks.

Moreover, in order to correctly assess the signature of the NDT techniques in relation with the type of defect (shape, size, depth …), it is necessary to perform numerical simulations with calibrated defects. To that end, the knowledge of material properties (magnetic permeability, electrical conductivity) and their modelling is crucial for an efficient and reliable numerical implementation of NDT techniques. In addition to the weakly magnetic nature of these materials, their heterogeneous nature (at different scales, including that of the target defect size) poses a problem for reliably analysing the response of NDT probes.

- The objective of the master thesis is to propose and validate an experimental technique able to give satisfactory results in terms of material characterization from both above-mentioned criteria: spatial resolution (heterogeneity) and detection level (weak magnetic permeability).

This subject will lead to a thesis with EDF R&D in October 2026.

Work steps

- State of the art in characterisation techniques for weakly magnetic and heterogeneous materials
- Selection and implementation of a technique on steel samples
- Tests on homogeneous samples
  - Objective: validation of the technique on a simple/controlled case
- Tests on heterogeneous samples
  - Objective: generalisation of the technique.

Key words

Ferromagnetic steels, magnetic characterization, magnetic heterogeneity, NDT, weak permeability