4.5.23. MULTI-DOMAIN INDUSTRIAL BENCHMARKS FOR EDDY CURRENT MODELLING: THE COFREND WORKING GROUP

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The use of simulation tools in non-destructive examination in general, and in eddy current testing in particular, has been dramatically increasing in the past decade and is now rather common in many industrial applications. Expected benefits of modelling are:

– a better comprehension of the involved physical phenomena and their influence on the results of the examination;

– a help to the qualification and performance demonstration of NDE applications through parametric studies, allowing a wider coverage of the influential parameters and a reduction of the number of mock-ups and experimental trials;

– a support to expertise in difficult testing situations. Nonetheless, before applying a modelling tool to an industrial NDE application, it is essential to know its ability to account correctly for the actual testing situation, and, thus, to validate it on specific representative cases.

Concerning eddy currents, a large number of simulation codes is now commercially available or under development. These codes are extremely variable in formulation and complexity: they can range from very simplified analytic to full-3D finite element formulations, with a considerable variety of intermediate combinations. It can then be difficult to make a first selection between codes to perform a full validation study, and a need for simpler test cases is expressed by the end-user. Benchmark problems from the literature have been used in a first step, but, being from an academic origin, they have proven in several occasions to be unfit to the representation of actual industrial situations.

The concern for defining benchmark problems focused on actual industrial issues is shared by the whole French NDE community and has led to the creation of a dedicated working group in the frame of COFREND (the French Confederation for Non-Destructive Examinations), gathering the main NDE-user industries (aerospace, nuclear, steelmaking), NDT vendors and instrument manufacturers, members of industrial and academic research centers and specialists of code development.

The COFREND Eddy Current Modelling Working Group has been now existing for more than 5 years, and has released several benchmark problems and has currently some other ones under development. Examples of COFREND benchmark problems are:

– Nickel-alloy thin plate with notches of various depths and lengths (proposed by EDF and CEA);

– Variable-shaped defects in a bore hole (proposed by Dassault Aviation and EADS);

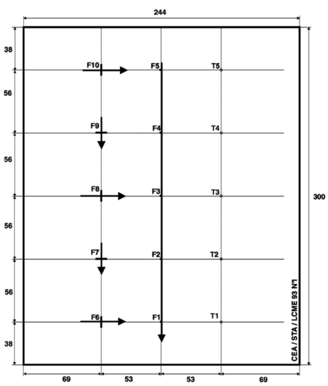
– Encircling probe around a stainless steel rod (proposed by Vallourec).

Other proposals include: inspection of ferromagnetic tubes by remote field eddy currents or detection of small defects in a plate with a pencil probe.

Resolutions for the existing benchmarks have been obtained with several codes, ranking from simplified semi-analytic formulation to 3D finite element formulation. The results, which will be presented and discussed in the paper, show that very useful information concerning code validation can be draught from this approach.

Now, the will of the Working Group is to open the resolution of COFREND test-problems to international codes and to look for exchanges worldwide with existing benchmarks with similar goals. To make this communication easier, the Working Group is currently building a dedicated Internet site, on which COFREND benchmarks description and existing resolutions will be made available.

Problem 2 : Thin plate with notches



Material : Inconel 600
Plate thickness : 1.55 mm

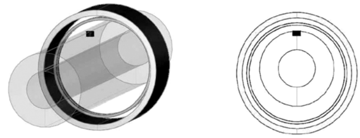
F1 to F5 :
notches l = 2 mm ; open. = 0.1 mm
p = 20% to 100%

F6 to F10 :
notches l = 10 mm ; open. = 0.3 mm
p = 20% to 100%

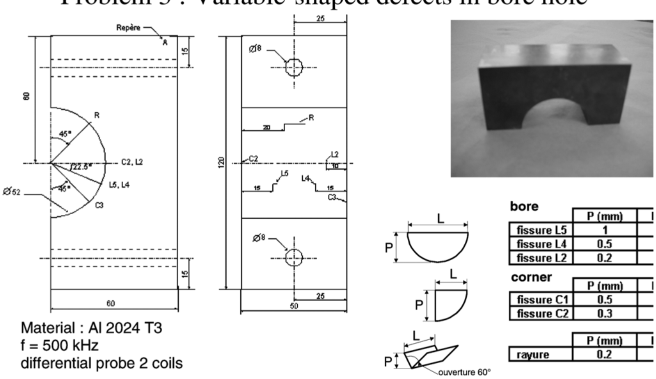
2 acquisitions by turning plate upside-dowr

2 "generic" probes
- absolute combined T/R
- absolute separate T/R
f = 100, 300, 500 kHz

Problem 6 : Ex-centered encircling probe around rod



Problem 3 : Variable-shaped defects in bore hole



Material : Al 2024 T3
f = 500 kHz
differential probe 2 coils

bore

	P (mm)
fissure L5	1
fissure L4	0.5
fissure L2	0.2

corner

	P (mm)
fissure C1	0.5
fissure C2	0.3

	P (mm)
rayure	0.2