TEST CASE DOCUMENTATION AND TESTING RESULTS

TEST CASE ID EM-VAL-5.1

TEAM Workshop Problem 7

Tested with LS-DYNA® v980 Revision Beta

Friday 1st June, 2012

LSTC
Livermore Software Technology Corp.

Document Information	
Confidentiality	**external use**
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Author(s)	Iñaki Çaldichoury, Pierre L' Eplattenier
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Contents

1 Introduction

1.1 Purpose of this Document

This document specifies the test case EM-VAL-5.1. It provides general test case information like name and ID as well as information to the confidentiality, status, and classification of the test case.

A detailed description of the test case is given, the purpose of the test case is defined, and the tested features are named. Results and observations are stated and discussed. Testing results are provided in section 4.1 for the therein mentioned LS-DYNA® version and platforms.

2 Test Case Information

Test Case Summary	
Confidentiality	external use
Test Case Name	TEAM Workshop Problem 7: Asymmetrical Conductor With a Hole
Test Case ID	EM-VAL-5.1
Test Case Status	Under consideration
Test Case Classification	Validation
Metadata	TEAM problem

Table 1: Test Case Summary

3 Test Case Specification

3.1 Test Case Purpose

The purpose of this test case is to analyse the EM solver's capabilities at simulating a uniform current (no eddy currents) circulating in a coil interacting with a conductor plate where the full Eddy Current problem is solved.

3.2 Test Case Description

TEAM (Testing Electromagnetic Analysis Methods) represents an open international working group aiming to compare electromagnetic analysis computer codes. TEAM Workshops are meetings of this group. A series of TEAM Workshops was started in 1986 and has been organized in two-year rounds, each comprising a series of "Regional" workshops and a "Final" Workshop, as a satellite event of the COMPUMAG Conference. The TEAM problems consist in a list of test-problems, with precisely defined dimensions, constitutive laws of materials, excitations, etc., and each backed by a real laboratory device, on which measurements can be made.

The TEAM 7 problem is very similar to the TEAM 3 problem but offers a little more challenge since the geometry is asymmetric(See Figure (1)). A thick aluminum plate with a hole, which is placed eccentrically, is set unsymmetrically in a non-uniform magnetic field. The field is produced by the exciting current which varies sinusoidally with time.

To examine the accuracy of the results, the z-components B_z of the flux densities along the line A1-B1 (y=72 mm, z=34 mm) and A2-B2 (y=144 mm, z=34 mm) are studied at $wt = 0$ (i.e when the coil's current value reaches its peak) and $wt = 90$ (i.e when the coil's current value is 0). The results will compared to the reference experimental results by [1].

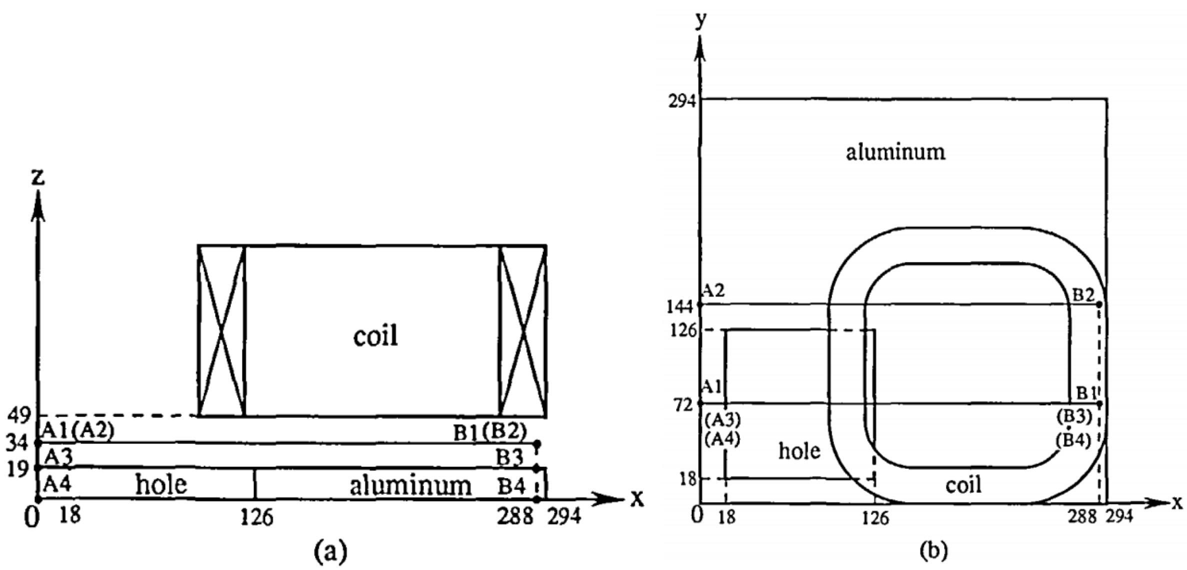

Figure 1: Test case sketch and dimensions

3.3 Model Description

The conductivity of the plate is $35.26e^6 S.m^{-1}$. Two different frequencies in the coil will be studied namely $50Hz$ and $200Hz$ respectively. The ampere turn of the coil is $2742AT$. Figure (2) and Table (2) give some information on the mesh.

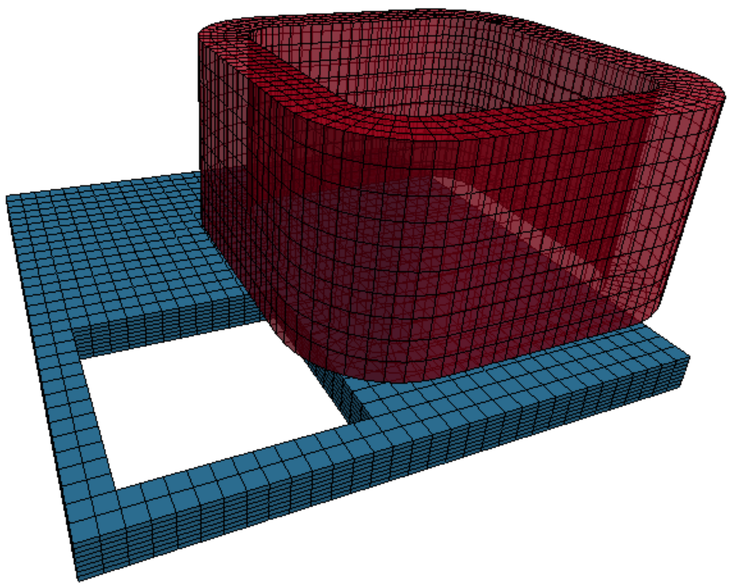

Figure 2: Test case Mesh

Model information	
Plate surface element size	9 (mm)
Number of elements in the thickness of the plate	10
Total number of Nodes (Coil and Plate)	14432
Total number of Solid elements (Coil and Plate)	11200

Table 2: Test Case Mesh information

4 Test Case Results

4.1 Test Case observations

On Figure (3), the current density vectors can be observed. The current can be seen rotating mainly just underneath the coil's location with a small portion flowing around the hole. Since the current is sinusoidal, the direction of the current flow gets periodically inverted. Figure (4) and Figure (5) show the results for the magnetic field B_z at $wt = 0$ and $wt = 90$ along the line A1-B1 and A2-B2 and offer a comparison with the measured results. For $wt = 0$, the results are in good agreement with the experimental results by [1]. For $wt = 90$, the results show some discrepancies especially for the $200Hz$ frequency case. However, these experimental results don't seem to be in accordance with the other curves and show a very unstable behavior that may be the result of bad measurements.

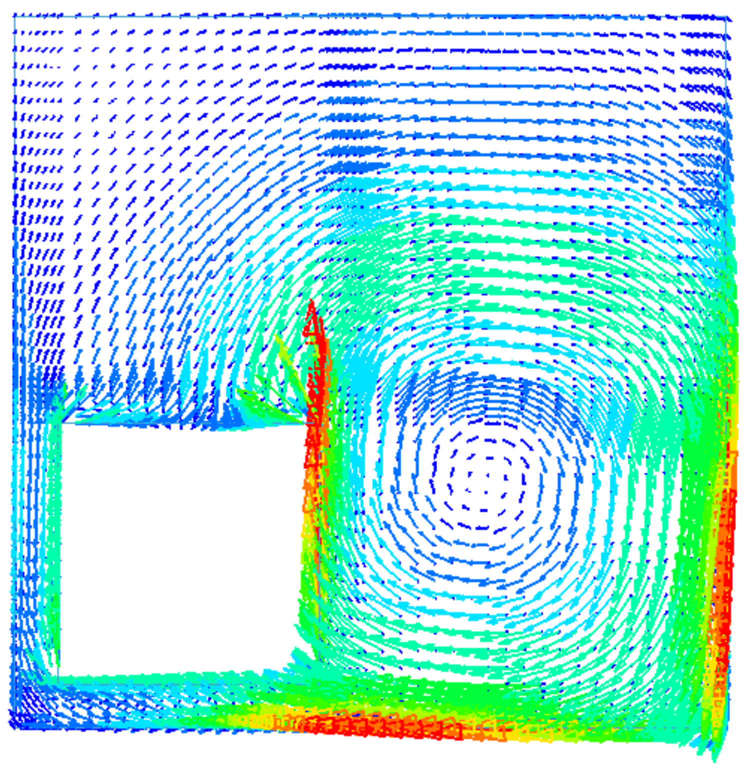

Figure 3: Test Case Density current vectors

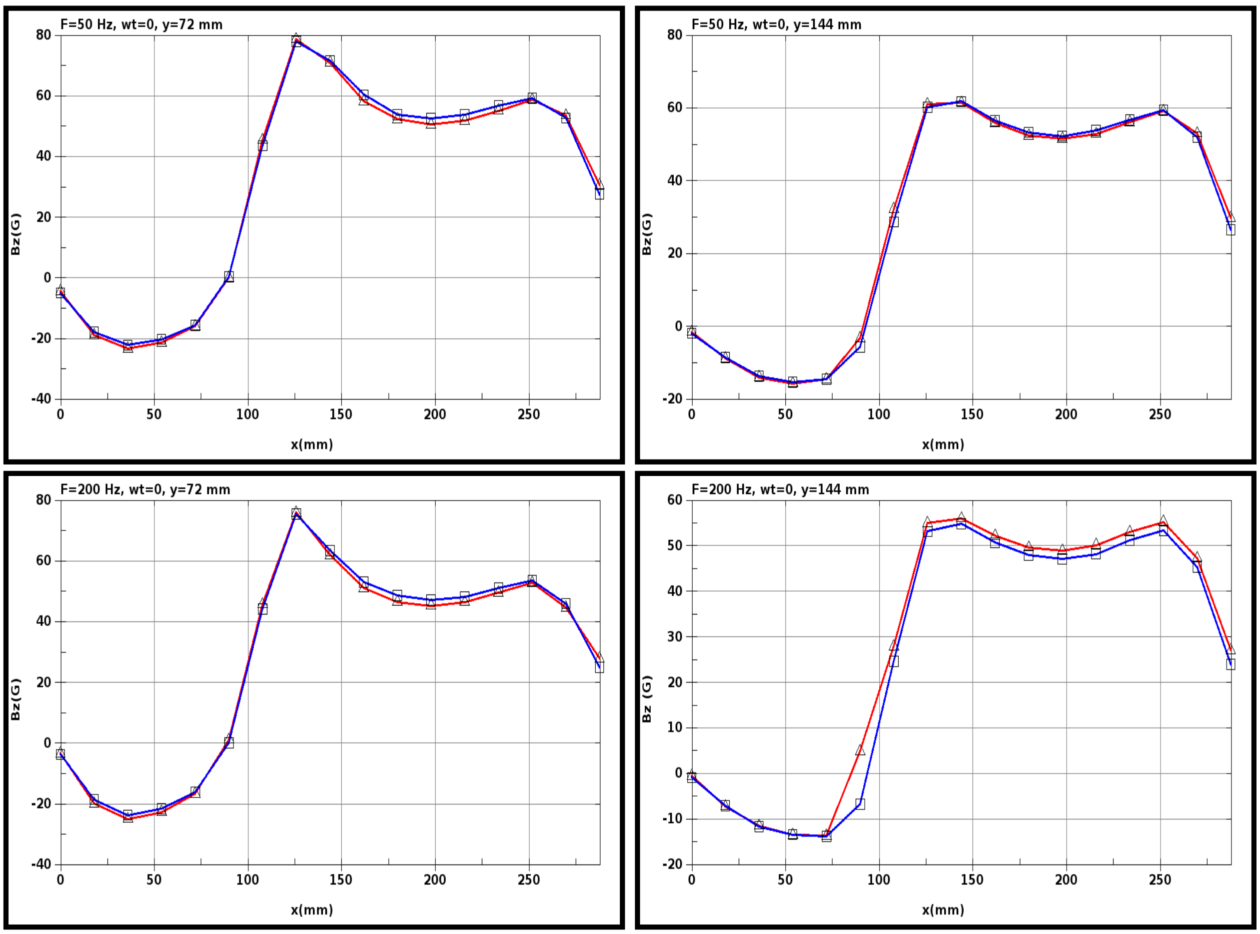

Figure 4: B_z variation at exiting current peak instant $wt = 0$ along the A1-B1 and A2-B2 lines. Comparison between numerical (in red) and reference experimental (in blue) values

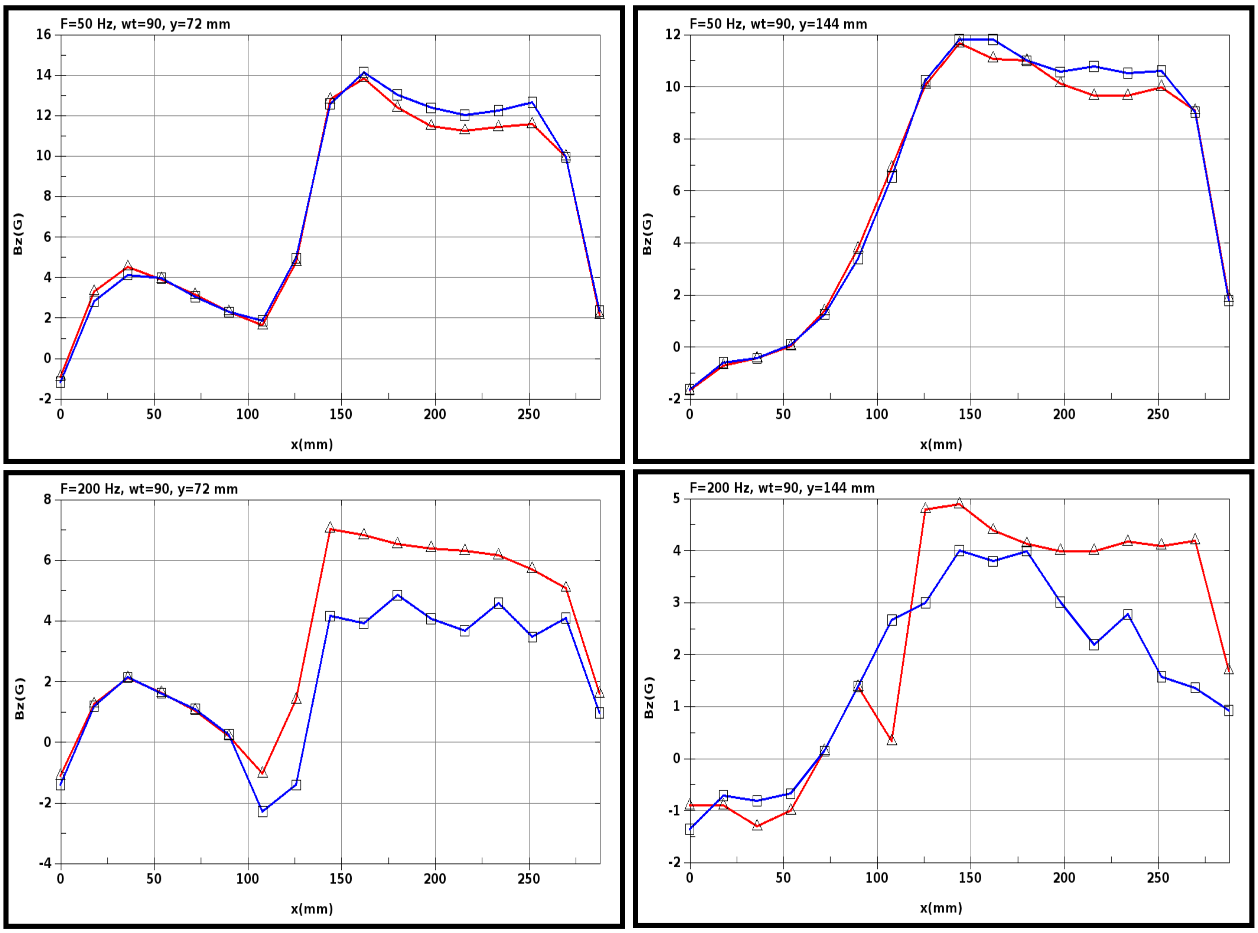

Figure 5: B_z variation at exiting current minimum instant $wt = 90$ along the A1-B1 and A2-B2 lines. Comparison between numerical (in red) and reference experimental (in blue) values

References

[1] K. FUJIWARA AND T. NAKATA, *Results for benchmark problem 7 (asymmetrical conductor with a hole)*, COMPEL-The International Journal for Computation and Mathematics in Electrical and Electronic Engineering, 9 (1990), pp. 17–154.