TEST CASE DOCUMENTATION
AND TESTING RESULTS

TEST CASE ID EM-VAL-2.1

Induced current on a plate

Tested with LS-DYNA® v980 Revision Beta

Friday 1st June, 2012

LSTC
Livermore Software
Technology Corp.

Document Information	
Confidentiality	**external use**
Document Identifier	LSTC-QA-LS-DYNA-EM-VAL-2.1-1
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Number of pages	8
Date created	Friday 1st June, 2012
Distribution	External

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Contents

1 Introduction

1.1 Purpose of this Document

This document specifies the test case EM-VAL-2.1. 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	Induced current on a plate: Experimental, numerical comparison
Test Case ID	EM-VAL-2.1
Test Case Status	Under consideration
Test Case Classification	Validation
Metadata	INDUSTRIAL/ACADEMIC TEST CASE

Table 1: Test Case Summary

3 Test Case Specification

3.1 Test Case Purpose

The purpose of this test case is to validate the solver's capability to induce current in a work piece that is not in contact with the source current coil.

3.2 Test Case Description

One of the main industrial applications of the present solver is magnetic pulse welding (MPW). A very high current is passed through a conductive coil near a target plate electrically conductive. An intense magnetic field is locally produced that generates Lorentz forces that will move or deform the plate. Usually a stationary material is positioned in the trajectory of the target thus producing an impact which causes a solid state weld.

Figure 1 offers a sketch of the test case. The main objective of the test case is to see if the induced currents due to the coil source currents are correctly calculated in the target plate. For measurement and accuracy purposes, the currents were chosen small enough so as to prevent the plate from moving due to the Lorentz forces. The experimental results were provided by the Ohio State University.

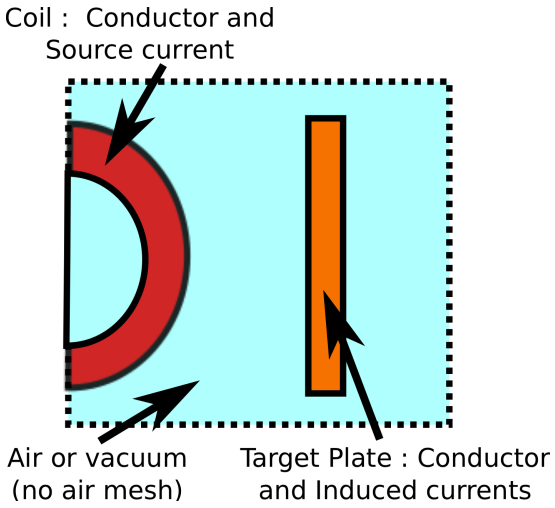

Figure 1: Test case sketch

3.3 Model Description

A view the model's geometry and mesh can be observed in figure 2. The plate consists of a solid box of dimensions $50 \times 50 \times 0.6$ millimeters. A hole of dimension 25.4×25.4 millimeters is located at its center is order to let the Rogowsky coil go through and measure the induced current. Table 2 offers some information on the mesh while Table 3 gives the physical parameters used.

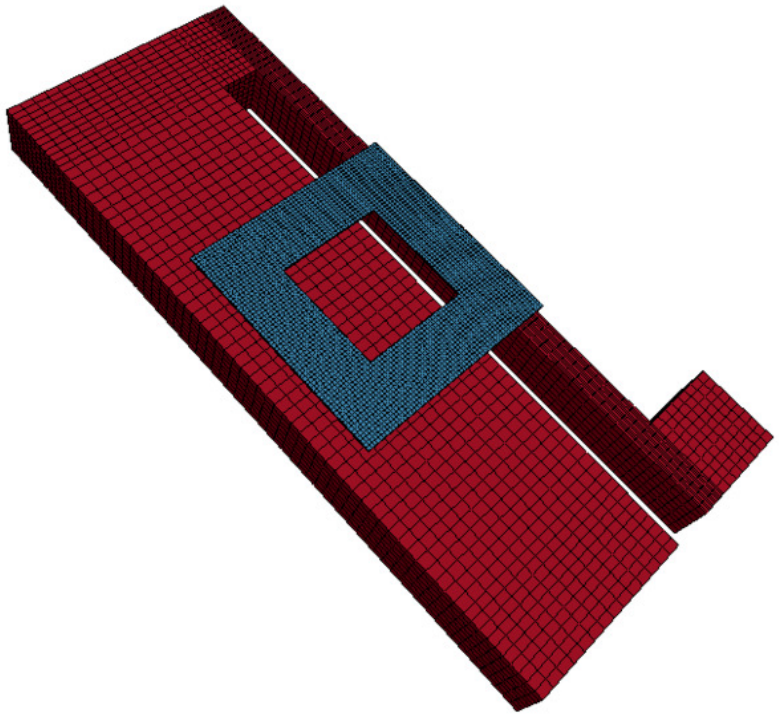

Figure 2: Test case Geometry and Mesh for the coil (in Red) and the plate (in Blue)

Model information	
Plate surface element size (Length and width directions)	0.8 mm
Plate surface element size (Thickness direction)	0.08 mm
Total model number of Nodes	48645
Total model number of Elements	40352

Table 2: Test Case Mesh information

Model physical parameters	
Plate Conductivity	24.6e6 $\Omega^{-1}m^{-1}$
Coil Conductivity	50e6 $\Omega^{-1}m^{-1}$

Table 3: Test Case Parameters

4 Test Case Results

4.1 Test Case observations

Figure 3 offers a view of the resulting current density vectors that can be seen circulating around the plate. Figure 4 offers a comparison between the experimental and numerical source and induced currents. The numerical source current of the coil matches exactly the experimental curve. This was expected as the experimental current was exactly imposed to the coil when setting up the problem. However, it can be observed that the resulting induced current in the plate is also in good agreement with the experimental results.

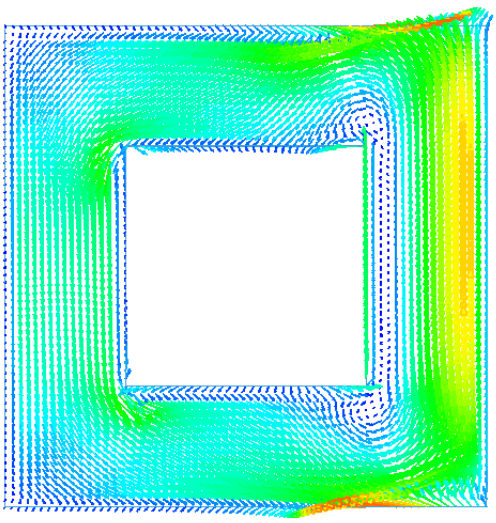

Figure 3: Test Case Current Density vectors

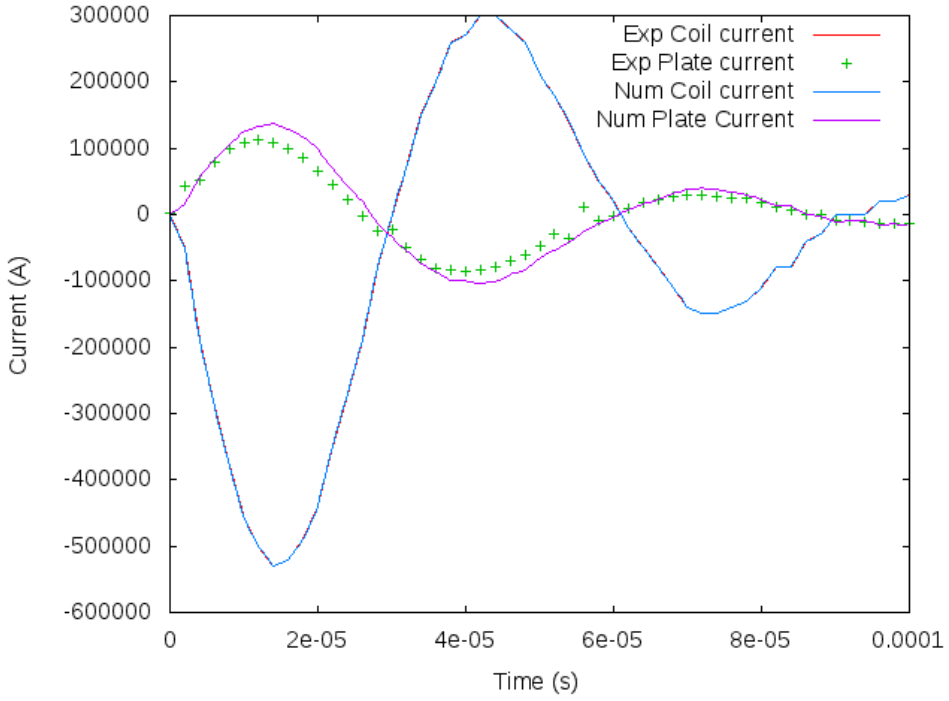

Figure 4: Comparison between numerical and experimental results for the source currents and the induced currents