TEST CASE DOCUMENTATION
AND TESTING RESULTS

TEST CASE ID EM-VAL-1.1

TEAM Workshop Problem 28

Tested with LS-DYNA® v980 Revision Beta

Friday 23rd March, 2012

Document Information	
Confidentiality	**external use**
Document Identifier	LSTC-QA-LS-DYNA-EM-VAL-1.1-1
Author(s)	Iñaki Çaldichoury, Pierre L' Eplattenier
Number of pages	8
Date created	Friday 23rd March, 2012
Distribution	LS-DYNA® QA and Support Department

Disclaimer:

Contents

1 Introduction

1.1 Purpose of this Document

This document specifies the test case EM-VAL-1.1. 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 28: An Electrodynamic Levitation Device
Test Case ID	EM-VAL-1.1
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 axisymetric capabilities as well the coupling between the electromagnetism solver and the structural solver.

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 28 problem presents an electrodynamic levitation device which consists of a conducting plate over two exciting coils. The aim is to determine the dynamic characteristics of the levitating plate (after some damped oscillations, the plate attains a stationary levitation height). A coupled solution of the electromagnetic and the mechanical problem is necessary for that (See [1] for model complete description). Several work groups have tackled this problem (see [3], [2]). Figure (1) shows a picture of the mentioned electrodynamic levitation device while Figure (2) shows a sketch of the problem.

Figure 1: TEAM Workshop problem 28: An electrodynamic levitation device

The test case's objective is to study the dynamic response of the levitating plate and to focus on the frequency of its oscillating.

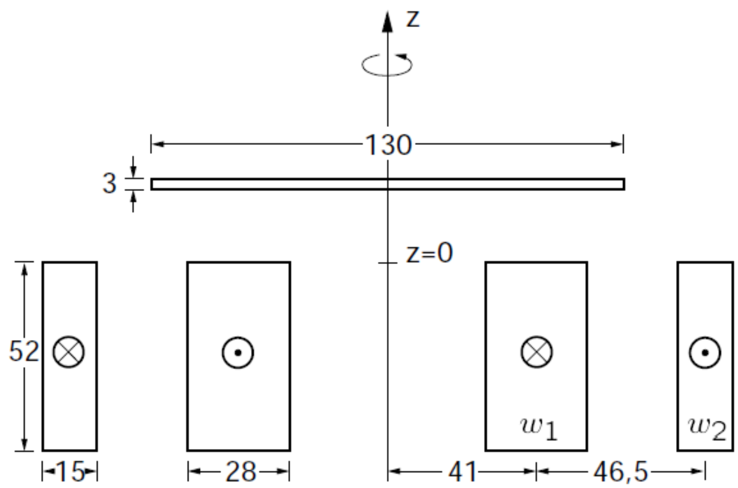

Figure 2: Test case dimmensions (in mm) of the electrodynamic levitation device

3.3 Model Description

This test case will be modelled using the axisymetric features of the solver. In order to avoid divergences occuring when $R = 0$, the plate will have a small hole at its center. It is believed that this hole won't affect the results. In order to reproduce the test case described in [1], a uniform current will be imposed on the coils (No Eddy-Current will be calculated and thus no BEM-mesh will be computed). Figure (3) offers a view of the resulting model while Table (2) offers some information on the mesh. Finally Table (3) gives the physical parameters used as described in [1] (the values are given in the following unit system :g,mm,s). Sinusoidal currents $i(t)$ flow in the coils in opposite directions.

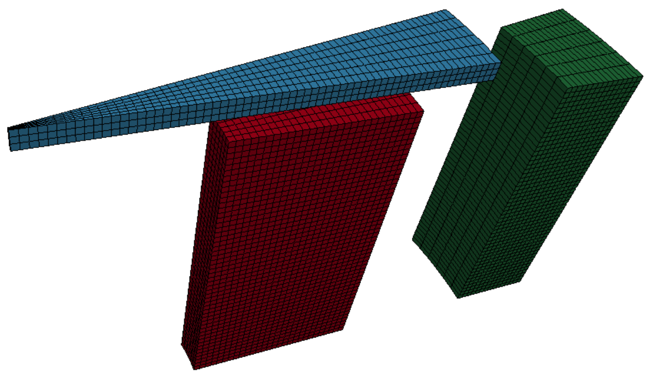

Figure 3: Test case Geometry and Mesh

Model information	
Nodes	18543
Solid elements	14586
Surface element size (in z direction)	1

Table 2: Test Case Mesh information

Model physical parameters	
Imposed current amplitude value (Coil ω_1)	20*960e3
Imposed current amplitude value (Coil ω_2)	20*576e3
Frequency of oscillations (Hz) (Coil ω_2 & ω_2)	50
Conductivity of the plate	34
Density of the plate	2687e-6

Table 3: Test Case Parameters

4 Test Case Results

4.1 Test Case observations

The results show a concentration of the Lorentz force on the center of the plaque (see Figure (4)). The dynamic behavior are similar to those obteined by [1] and agree well with the experimental results with an oscillation frequency of $6.27Hz$. The final height is approximately 11.4 mm. As explained in [1], the discrepancy of the maximum levitation height during the first half period might be traced back to the modelling of the coils.

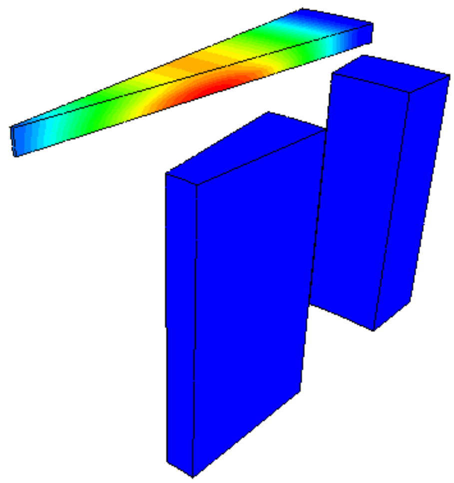

Figure 4: Test Case Lorentz force fringes

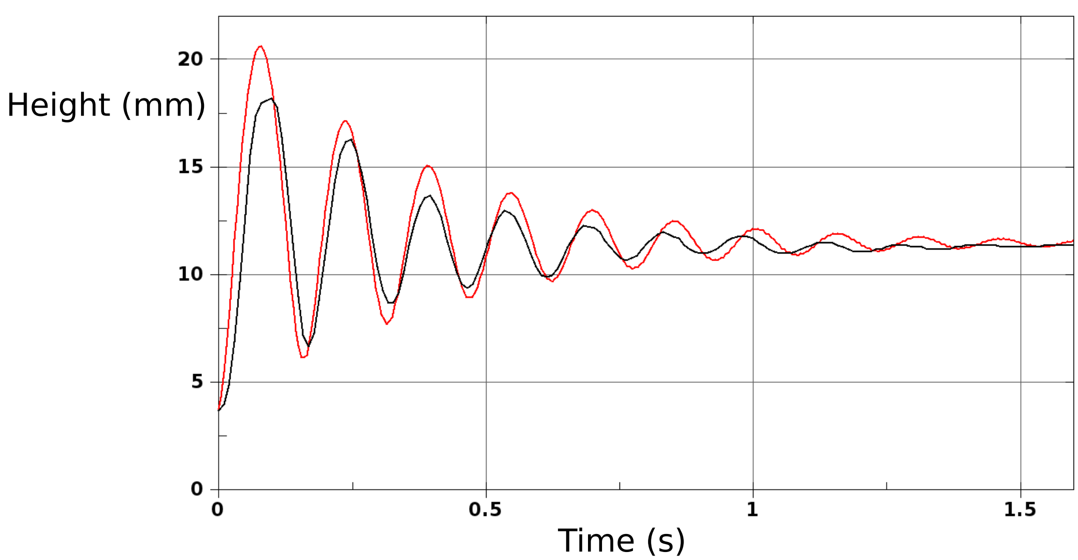

Figure 5: Comparison between the experimental and numerical levitation heights

References

[1] S. K. G. L. W. R. Hans Karl, Joachim Fetzer, *Description of team workshop problem 28: An electrodynamic levitation device*, Institut fur Theorie der Elektrotechnik, Universitat Stuttgart, Pfa enwaldring 47, 70550 Stuttgart, Germany.

[2] F. Rapetti, *An overlapping mortar element approach to coupled magneto-mechanical problems*, Mathematics and Computers in Simulation, (2008).

[3] J. F. Stefan Kurz and G. Lehner, *Threedimensional transient bem-fem coupled analysis of electrodynamic levitation problems*, IEEE TRANSACTIONS ON MAGNETICS, 32.