TEST CASE DOCUMENTATION
AND TESTING RESULTS

TEST CASE ID EM-VER-2.1

Coaxial cable inductance

Tested with LS-DYNA® v980 Revision Beta

Friday 1st June, 2012

Document Information	
Confidentiality	**external use**
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1 Introduction

1.1 Purpose of this Document

This document specifies the test case EM-VER-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	Coaxial cable: Calculation of the inductance in a Coaxial cable
Test Case ID	EM-VER-2.1
Test Case Status	Under consideration
Test Case Classification	Verification
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 study the resulting inductance in a coaxial cable using the eddy current solver.

3.2 Test Case Description

Coaxial cable, or coax, is an electrical cable with an inner conductor surrounded by a flexible, tubular insulating layer (Dielectric), surrounded by a outer conductor. The term coaxial comes from the inner conductor and the outer shield sharing the same geometric axis. Coaxial cable was invented by English engineer and mathematician Oliver Heaviside, who first patented the design in 1880. Its main characteristic is that the electromagnetic field carrying the signal exists only in the space between the inner and outer conductors (in the Dielectric). This makes it particularly suitable for feedlines connecting radio transmitters and receivers with their antennas, computer network (Internet) connections, and distributing cable television signals.

In this test case, the inductance caused by the magnetic field generated in the dielectric by the electric currents will be studied. It can be shown [1] that for a coaxial cable, the theoretical value of the inductance is written :

$$L = \frac{\mu_0 l}{2\pi} ln(\frac{R_2}{R_1}) \tag{1}$$

where μ_0 is the permeability of free space,l the length of the coaxial cable and R_2,R_1 the radius of the inner and outer conductors (see Figure (1)).

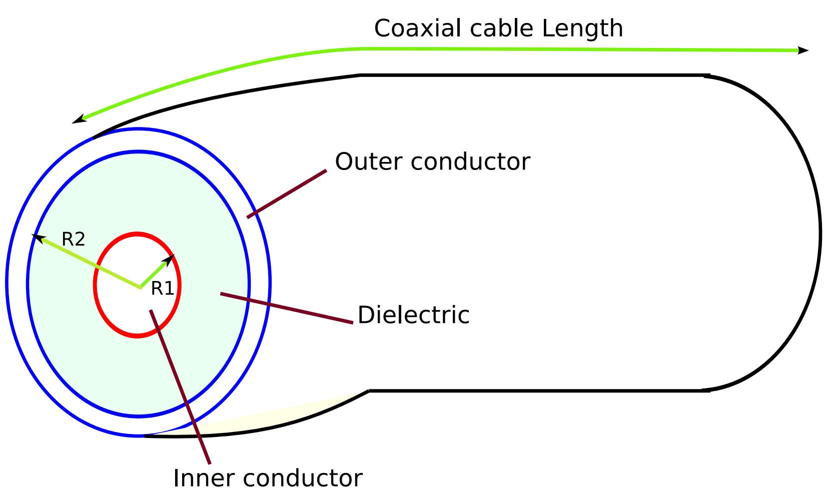

Figure 1: Test Case Sketch

3.3 Model Description

The two conductors will be represented by two cylinders linked at the end of the cable by a circular plane (see Figure (2)). The exterior boundary of the outer conductor will be excluded from the BEM calculation to better represent the physical cable and to reduce the BEM system. Table 2 offers some information on the mesh used while Table 3 gives the physical parameters used.

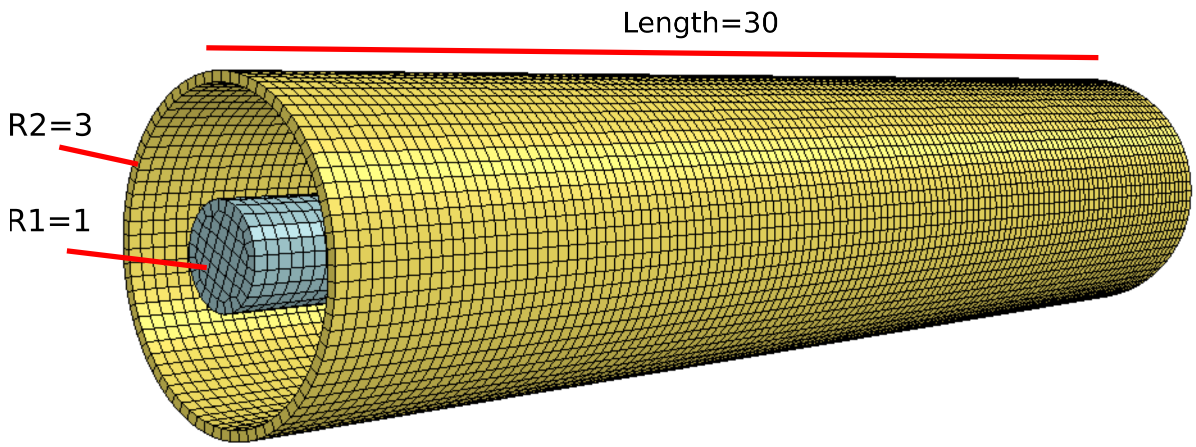

Figure 2: Test Case Geometry

Model information	
Nodes	26937
Solid elements	15989
Parts	1

Table 2: Test Case Mesh information

Model physical parameters	
Conductivity	1e6
Imposed tension value	1

Table 3: Test Case Parameters

4 Test Case Results

4.1 Test Case observations

As expected, the scalar potential follows a linear behavior with values going from 1 to 0 between the two conductors (See Figure (3)). Figure 4 also shows the current density vectors coming from the inner conductor spreading in the back face of the cable before flowing back in the opposite direction in the outer conductor. The numerical result for the inductance (0.6445) is in good agreement with the analytical result (0.6477) with an error of less then 1%.

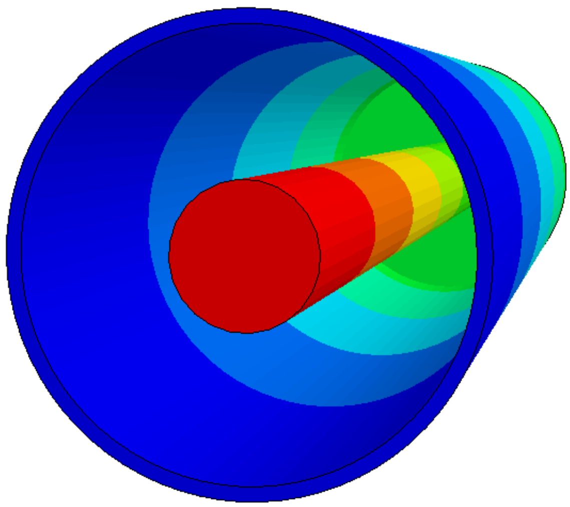

Figure 3: Test Case potential

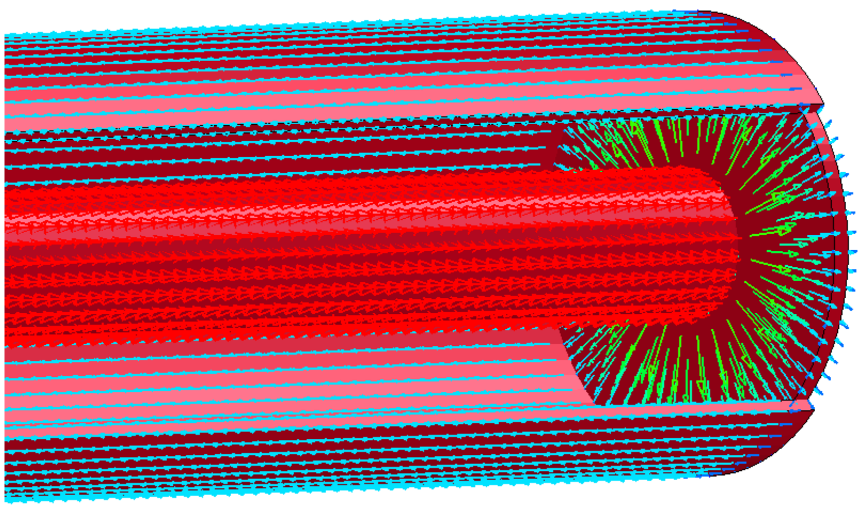

Figure 4: Test Case Current density vectors

References

[1] O. Heaviside, *Electrical papers*, February 1986.