TEST CASE DOCUMENTATION
AND TESTING RESULTS

TEST CASE ID ICFD-VAL-5.1

Cylinder Slamming

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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1 Introduction

1.1 Purpose of this Document

This document specifies the test case ICFD-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	Slamming: Impact between a cylinder and the water
Test Case ID	ICFD-VAL-5.1
Test Case Status	Under consideration
Test Case Classification	VALIDATION
Metadata	FREE SURFACE

Table 1: Test Case Summary

3 Test Case Specification

3.1 Test Case Purpose

The purpose of this test case is to study the impact of a cylinder impacting the water with a prescribed velocity resulting in a one way fluid-structure coupling problem with the solid transmitting displacements to the fluid.

3.2 Test Case Description

The slamming effect occurs during impact between a blunt body and the water. It is therefore one the great issues that have to be addressed by the research community in hydrodynamics ([1]). In this test case, this test case will consist of a 2d cylinder impacting the water. The experimental results performed by [2] were extracted thanks to [3]. The main objective will be to study the slamming coefficient defined by :

$$Cs = \frac{F_{impact}}{\rho R V^2} \tag{1}$$

with F_{impact} the total vertical hydrodynamic force , R the radius of the circular cylinder and V the entry velocity.

3.3 Model Description

Figure (1), Figure (2) and Table (2) provide some information on the mesh. Table (3) gives the physical parameters that will be used. The model consists of two phases, the liquid column and the air or vaccum. Therefore the physical parameters given correspond to the fluid's parameters.

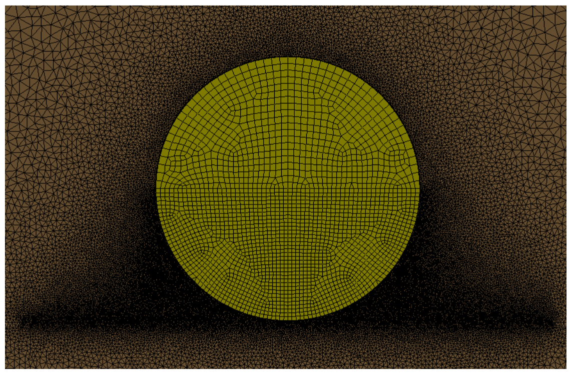

Figure 1: Test Case Mesh

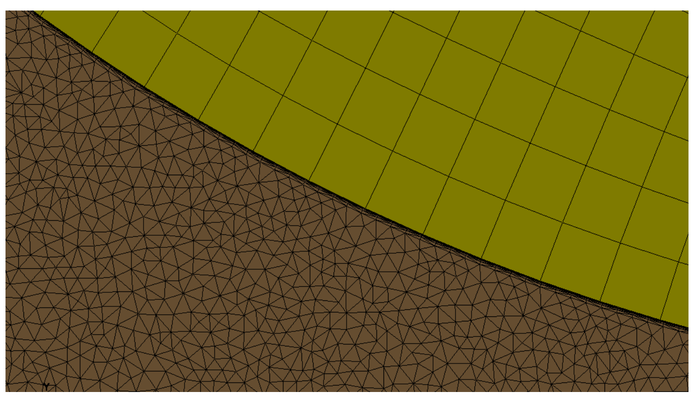

Figure 2: Zoom on the mesh around the wedge

Model information	
Cylinder Radius	0.25
Surface Cylinder Element size (Approx)	0.002
Volume Nodes (Approx)	80000
Volume Elements (Approx)	80000
Elements added to the cylinder boundary layer	4

Table 2: Test Case Mesh Information

Model physical parameters	
Cylinder velocity	$5m.s^{-1}$
Fluid density	$1000kg.m^{-3}$
Fluid viscosity	$0.001m^2.s$

Table 3: Test Case Parameters

4 Test Case Results

4.1 Test Case observations

Figure (3) offers a view of the pressure distribution along the jet flow ”running” up the cylinder at a given instant. Figure (4) shows the results for the slamming coefficient. The initial force results showed some oscillations, therefore a four point filter has been applied. The comparison between the experiments of [2] and the simulations is relatively good. It can be seen that the slamming coefficient is over predicted during the first stages of the simulation but agrees better at a later stage.

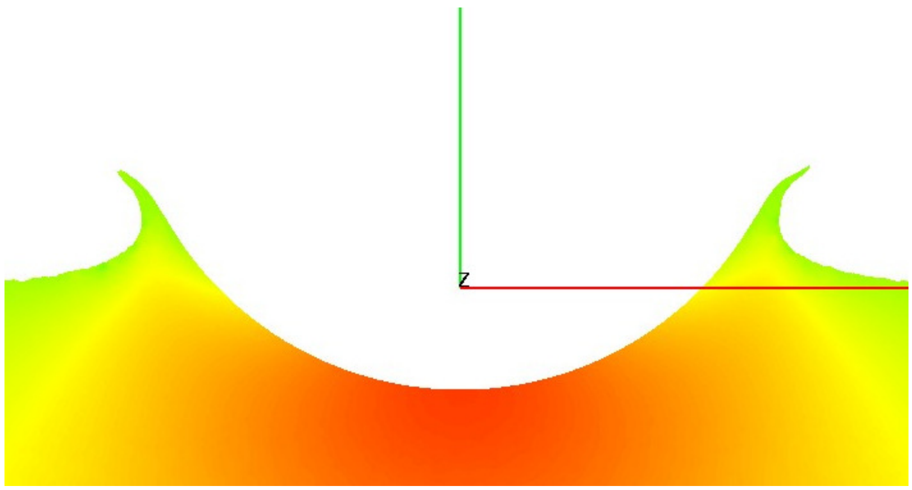

Figure 3: Pressure distribution and visualisation of the jet flow ”running” up the cylinder as it enters the water at a given instant

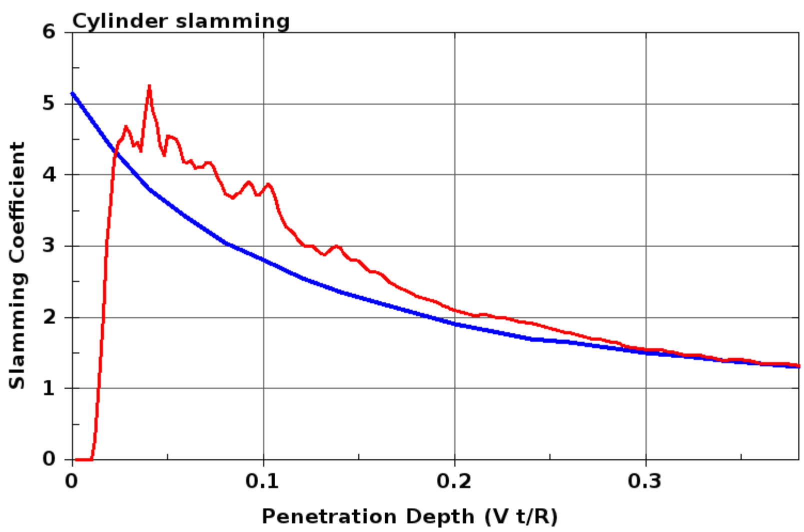

Figure 4: Slamming coefficient of the cylinder entering the water: numerical results (in Red) compared with experiment (in Blue) by [2]

References

[1] R. M. C. B. C. de Jouette N. Moirod L.Shen, *Validation of cfd codes for slamming*, European Conference on Computational Fluid Dynamics, (2010).

[2] P. W. I.M.C. Campbell, *Measurement of parameters affecting slamming*, Wolfson Unit of Marine Technology, 1980.

[3] K. K. G. F. A. veldman B.Iwanowski B. Buchner, *A volume of fluid based simulation method of wave impact problems*, Journal of Computational physics, 17 (2005).