TEST CASE DOCUMENTATION AND TESTING RESULTS

LSTC-QA-LS-DYNA-AWG-ERIF-10-6

TEST CASE ID AWG-ERIF-10

MAT_224
Dynamic Punch Test Aluminium 2024

Tested with LS-DYNA® R8.0.0 Revision 96167

Tuesday 10th March, 2015

LSTC
Livermore Software Technology Corp.

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1 Introduction

1.1 Purpose of this Document

This document specifies the test case AWG-ERIF-10. 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. The test case specifications also state the target measures for testing and the expected results, as well as their pass and fail criteria.
Testing results are provided in section 5 for the therein mentioned LS-DYNA® version and platforms.

2 Test Case Information

Test Case Summary	
Confidentiality	external use
Test Case Name	MAT_224 Dynamic Punch Test Aluminium 2024
Test Case ID	AWG-ERIF-10
Test Case Status	active
Test Case Classification	Example
Test Case Source	NCAC/GWU
Tested Keyword	*MAT_TABULATED_JOHNSON_COOK
Member of Test Suite	AWG ERIF SUITE
Metadata	AWG ERIF

Table 1: Test Case Summary

3 Test Case Specification

3.1 Test Case Purpose

The purpose of Test Case ID AWG-ERIF-10 is the comparison of results from different cpu architectures for punch tests of Aluminium 2024.
The reliability and consistency of LS-DYNA® as a finite element solver for this punch test simulation is evaluated by performing analyses on different cpu architecture platforms.

3.2 Test Case Description

This Test Case contains punch tests (see figure 1) performed on a Split Hopkinson Bar (SHB) which are used to examine the failure of Aluminium 2024.

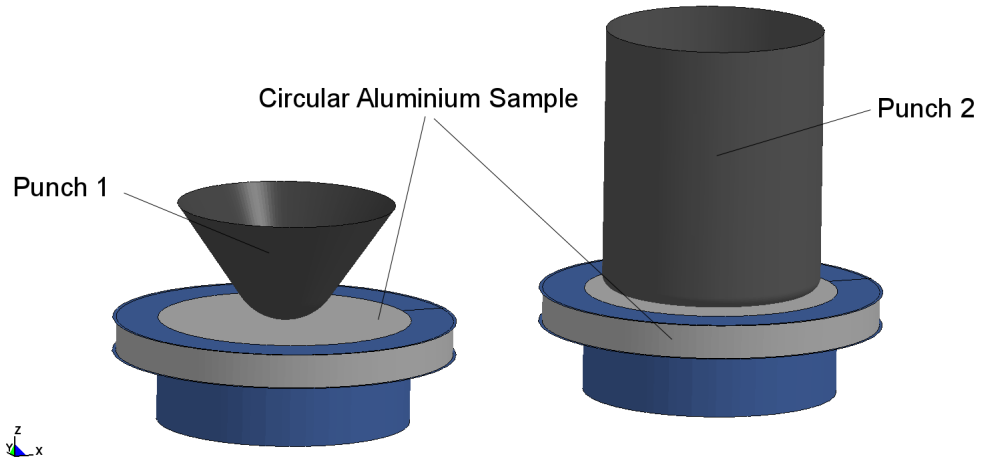

Figure 1: Model sketch: Punch test on circular Aluminium samples with two different punch shapes

Table 2 contains a short summary of the physical model set up.

Physical Model Information	
circular sample geometry	diameter = 14.56 mm, thickness = 1.456 mm
sample material	Aluminium 2024
punch velocity	20 m/sec

Table 2: Model set-up data

3.3 Model Description

The model geometry is discretized with solid elements for the circular Aluminium 2024 sample and shell elements for the punch geometry (see figure 2).
The model specifications can be found in table 3, and table 4 defines the sub test case specification.
The material definitions and their parameters can be found in the input decks.

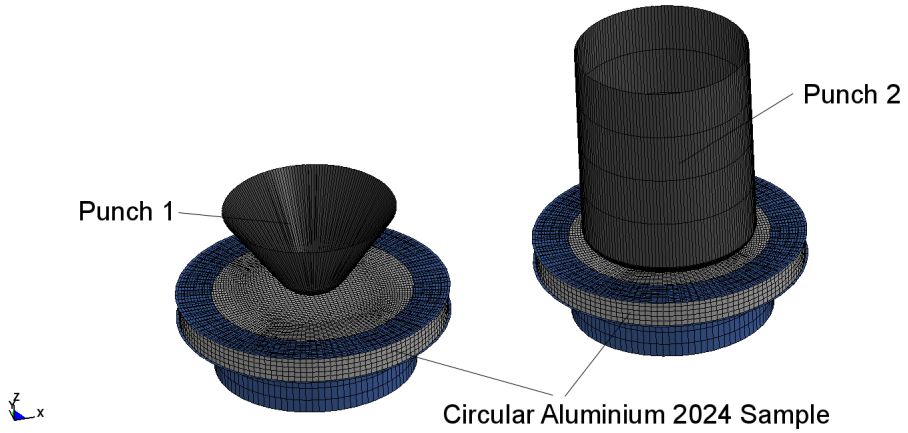

Figure 2: FEA model: Punch test on circular Aluminium samples with two different punch shapes

FEA Model information		
Sub Test Case ID [1]	1	2
Nodes	32882	34544
Solid elements	23625	23625
Solid materials	1	1
Shell elements	3910	5598
Shell materials	3	3
Parts	4	4
Units	mm (length), s (time), tonne (mass), N/mm^2 (stress), Nmm (energy)	

[1] Sub Test Case ID refers to the ID's in table 4

Table 3: FEA Model Information

Sub Test ID	Punch Type	Input Deck Name
1	Punch 1	pch1_mod.k
2	Punch 2	pch6_mod.k

Table 4: Specification of sub test cases

4 Test Specifications

4.1 Test Case Targets

Table 5 displays the test case targets. The test case targets specify values or a series of values taken from the finite element analysis solution of the test case and they are used in a comparison of analysis results on different cpu architectures. They are chosen in a way that they are representative of the numerical model.

Test Case Targets				
Target number	output	component type	component id	retrieved from
1	resultant interface force	z	2	binout/rcforc file

Table 5: Test Case targets for Test Case ID AWG-ERIF-10

Test case targets are used to evaluate the cross cpu architecture consistency (see section 4.2).

4.2 Pass/Fail Criteria

These are the Pass/Fail criteria used for the cross cpu architecture consistency test of the Test Case ID AWG-ERIF-10.

The sub test case passes if all of the following criteria are reached:

- For a specific test case target, the maximum distance between an x-y pair of a slope of one cpu architecture/software version combination to at least one x-y pair of all other tested cpu architecture/software version combinations is 15% of the maximum slope value.

Otherwise the cross cpu architecture consistency test fails.

5 Test Case Results

5.1 Software and Hardware Specifications

In order to ensure cross-platform consistency, the herein mentioned sub test cases are run on platforms specified in table 6 and the results are calculated with software versions defined in table 7.

Platform Name	Operating system	CPU type	MPI-Protocol	Number of cpu's [1]
sandwich	SUSE LES 11.1	Intel® Xeon® E7- 8837 @ 2.67GHz	Platform MPI 8.2.0.0	4
ham	CentOS 5.4	AMD® Opteron ® 8435 @ 800MHz	Platform MPI 8.1.0.0	4
sgi64d	SUSE LES 9.4 [2]	Intel® Itanium® 2 @ 1.6GHz	SGI MPT 1.13	4

[1] Number of cpu's used for calculation of the test case

[2] SGI PROPACK 4

Table 6: Used Platforms and CPU Type's

Product	Version	Release	Revision	Parallel type [1]	Precision [2]	executable
LS-DYNA®	971	R8.0.0	96167	SMP	SP	ls971.96167.R8.0.0
LS-DYNA®	971	R8.0.0	96167	SMP	DP	ld971.96167.R8.0.0
LS-DYNA®	971	R8.0.0	96167	MPP	SP	mpp971.96167.R8.0.0
LS-DYNA®	971	R8.0.0	96167	MPP	DP	mpd971.96167.R8.0.0

[1] MPP = Massively Parallel Processing, SMP = Symmetric Multiprocessing

[2] SP = single precision, DP = double precision

Table 7: Tested LS-DYNA® version

5.2 Results Summary

Table 8 contains the results of the Test Case ID AWG-ERIF-10 completed with all combinations of software and hardware defined in section 5.1 (2 * 3 * 4 total calculation runs).
Details on the test results can be found in the section 5.3.

The table 8 cross cpu architecture consistency summary is:

- **PASS** - Pass criteria in section 4.2 is attained.
- **FAILED** - Pass criteria in section 4.2 is not attained.
- **ERROR** - sub test case terminates due to error.
- **N/A** - sub test case was not calculated.

Sub Test Case ID	PASS/FAILED
1	**PASS**
2	**PASS**

Table 8: Results summary for Test Case ID AWG-ERIF-10

5.3 Result Details

The following subsections contain detailed results for the Test Case ID AWG-ERIF-10 for LS-DYNA® R8.0.0 Revision 96167.

For each sub test case defined in section 3.3 there is a graph displaying the time history of the result target defined in section 4.1 for the platform and software version combinations defined in section 5.1.

The title of the graph states the name of the input deck, the result file name, and the output separated by underscores. The legend contains the result file name, output, platform, and executable. The last number of the legend specifies the number of cpu's used to calculate the example. A leading minus sign refers to the compatibility option for SMP calculations (see [1] for details on this option).

Example for title and legend:

Title:
'pch1_mod.k: rcforc_slave_x_2' states that the input deck for sub test case 1 was used to calculate these results. The component displayed is the resultant force in x-direction derived from the 'rcforc' output file.

Legend:
'rcforc_slave_x_2_sandwich_ls971.96167.R8.0.0_4' states that the graph shows the resultant force in x-direction derived from the 'rcforc' output file for an input deck which was calculated on the 'sandwich' platform with a LS-DYNA® R8.0.0 Revision 96167 binary (SMP, single precision) on four processors.

5.3.1 Sub Test Case ID 1 - Test Target 1

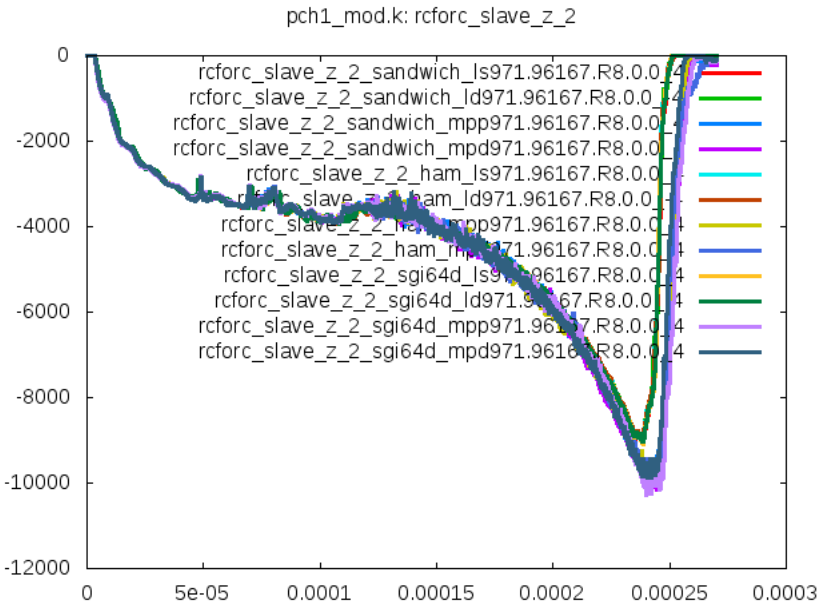

Figure 3: Cross platform results, resultant force in z-direction, sub test case ID 1

5.3.2 Sub Test Case ID 2 - Test Target 1

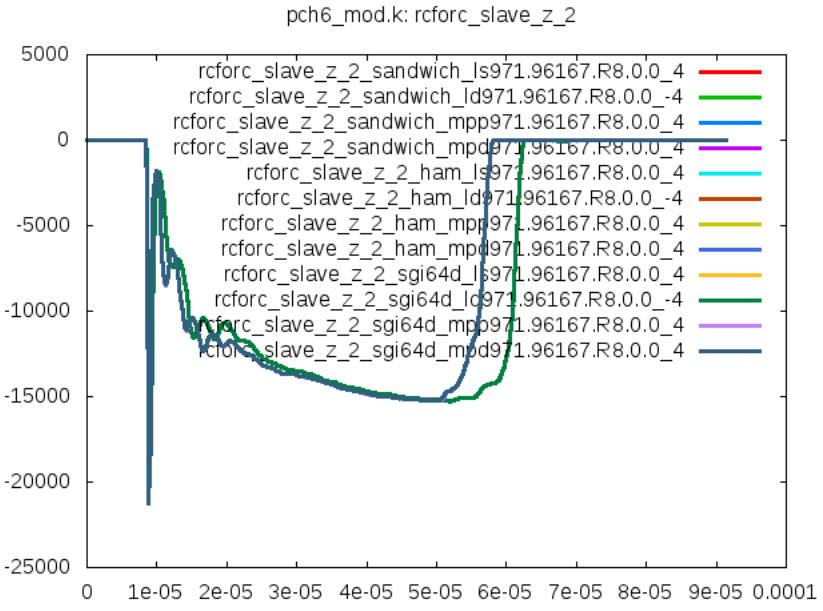

Figure 4: Cross platform results, resultant force in z-direction, sub test case ID 2

References

[1] LSTC, *LS-DYNA KEYWORD USER MANUAL*, 7374 Las Positas Road, Livermore, CA, 94551, USA, version 971 ed., May 2007.