TEST CASE DOCUMENTATION AND TESTING RESULTS

TEST CASE ID AWG-CI-2

Joints_Fasteners Shear Loading

Tested with LS-DYNA® R14.1.1 Revision 8-g2ef819c24f

Tuesday 11th March, 2025

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Contents

1 Introduction

1.1 Purpose of this Document

This document specifies the test case AWG-CI-2. 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	Joints_Fasteners Shear Loading
Test Case ID	AWG-CI-2
Test Case Status	active
Test Case Classification	Example
Test Case Source	The Boeing Company
Tested Keyword	*ELEMENT_SOLID, *ELEMENT_BEAM
Member of Test Suite	AWG CI SUITE
Metadata	AWG CI

Table 1: Test Case Summary

3 Test Case Specification

3.1 Test Case Purpose

The purpose of Test Case ID AWG-CI-2 is the comparison of results from different cpu architectures for the single shear joint models using 3D solid element or 1D beam element. The reliability and consistency of LS-DYNA® as a finite element solver for this test cases is evaluated by performing analyses on different cpu architecture platforms.

3.2 Test Case Description

This test case is a comparison between a 3D solid element and 1D beam element representation of a single shear joint subjected to shear loading and preload.

3.3 Model Description

Two aluminum (2024-T351) plates (5.0 in x 0.75 in x 0.75 in) are connected together through steel alloy (4340) fasteners. Fasteners assembly includes bolt head, bolt shank, washers, and nut. Bolt diameter is 0.25 in. The cross section side view shows two plates attached with fasteners defined as 3D solid elements (Sub Test Case 1) or as 1D beam elements (Sub Test Case 2), please see figure 1.

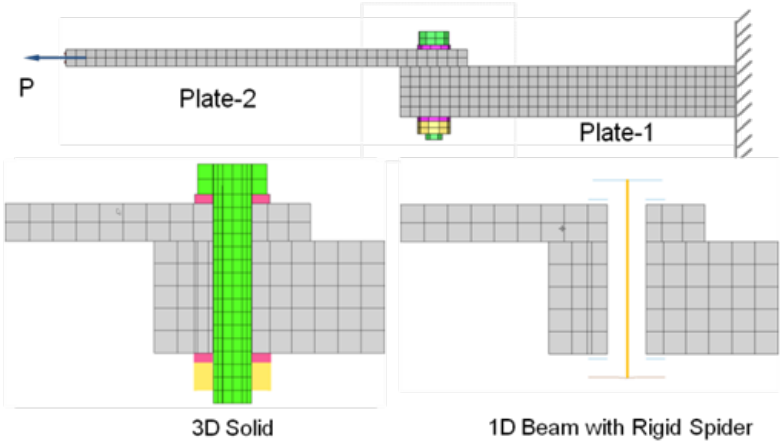

Figure 1: Joint_Fasteners Shear Loading Model

The model specifications can be found in table 2. The material definitions and their parameters can be found in the input deck. The input deck names of the two sub test cases are listed in table 3.

FEA Model information		
Sub Test Case ID [1]	1	2
Nodes	2522	2146
Solid elements	1579	1267
Shell elements	0	78
Beam elements	0	83
Material type list	MAT_1, MAT_24	MAT_1, MAT_24, MAT_5
Parts	6	8
Units	in (length), s (time), lbf-s^2/in (mass), lbf (force)	

[1] Sub Test Case ID refers to the ID's in table 3

Table 2: FEA Model Information

Sub Test ID	Fastener Element Type	Input Deck Name
1	Solid element	bolt_solid.key
2	beam element	bolt_spider.key

Table 3: Specification of sub test cases

4 Test Specifications

4.1 Test Case Targets

Table 4 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. The test case targets of the two sub test cases are the resultant displacement of a node at the tip of the upper plate (Plate-2 in figure 1) representing the maximum resultant displacement, and the Von Mises stress of an element around the bolt hole at the bottom face of the upper plate representing the maximum Von Mises stress on the upper plate.

Test Case Targets					
Target number	Sub Test Case ID	output	component type	components id	retrieved from
1	1	nodout	Resultant Displacement	71874	binout/nodout file
2	1	elout	Von Mises Stress	65559	binout/elout file
3	2	nodout	Resultant Displacement	75022	binout/nodout file
4	2	elout	Von Mises Stress	66872	binout/elout file

Table 4: Test Case targets for Test Case ID AWG-CI-2

4.2 Pass/Fail Criteria

These are the Pass/Fail criteria used for the Test Case ID AWG-CI-2.

The test case passes if the test case target data falls within the corridor bounds. Otherwise the test fails.

The test case corridors are upper and lower bounds for the test case targets. They were defined based on the test target data obtained with LS-DYNA® R9 Revision 118235 binaries by the following process:

- For a specific test case target, interpolate the data from different platform and executable (R9 Revision 118235) combinations, so that the time domain is the same.
- Calculate the upper and lower bounds by:

$$bound_{up}(i) = max(i) + 0.2 \times [max(i) - min(i)] + 0.05 \times peak$$
$$bound_{low}(i) = min(i) - 0.2 \times [max(i) - min(i)] - 0.05 \times peak$$

  where $max(i)$, $min(i)$ are the maximum and minimum values at the i_{th} time step across all platforms and executable (R9 Revision 118235) combinations the test case was calculated with, $peak$ is the maximum absolute y value across the whole time domain, $bound_{up}(i)$ and $bound_{low}(i)$ are the upper and lower bounds for the i_{th} time step.

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 5 and the results are calculated with software versions defined in table 6.

Platform Name	Operating system	CPU type	MPI-Protocol	Number of cpu's [1]
cdcvdce7mbu01	CentOS 7.9	Intel® Xeon® Gold 6238R @ 2.20GHz	Platform MPI 08.3.0.2	4

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

Table 5: Used Platforms and CPU Type's

Product	Version	Release	Revision	Parallel type [1]	Precision [2]	executable
LS-DYNA®	971	R14.1.1	8-g2ef819c24f	SMP	SP	ls971.8-g2ef819c24f.R14.1.1
LS-DYNA®	971	R14.1.1	8-g2ef819c24f	SMP	DP	ld971.8-g2ef819c24f.R14.1.1
LS-DYNA®	971	R14.1.1	8-g2ef819c24f	MPP	SP	mpp971.8-g2ef819c24f.R14.1.1
LS-DYNA®	971	R14.1.1	8-g2ef819c24f	MPP	DP	mpd971.8-g2ef819c24f.R14.1.1

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

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

Table 6: Tested LS-DYNA® version

5.2 Results Summary

Table 7 contains the results of the Test Case ID AWG-CI-2 completed with all combinations of software and hardware defined in section 5.1 (4 * 2 total cases).
Details on the test results can be found in the section 5.3.

The table 7 validation 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.

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

Table 7: Results summary for Test Case ID AWG-CI-2

5.3 Result Details

The following subsections contain detailed results for the Test Case ID AWG-CI-2 for LS-DYNA® R14.1.1 Revision 8-g2ef819c24f.

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 test case ID and the name of input deck.

Example for title:

Title:
'AWG_CI_TEST_CASE_2: bolt_solid_.key' states the test case ID 2 and name of the input deck.

5.3.1 Sub Test Case ID 1-Test Target 1

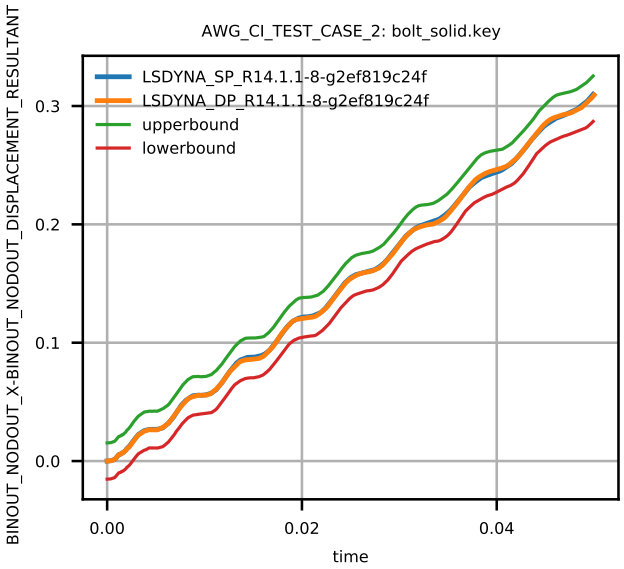

Figure 2: Cross platform results, nodal resultant displacement node 71874, sub test case ID 1

5.3.2 Sub Test Case ID 1-Test Target 2

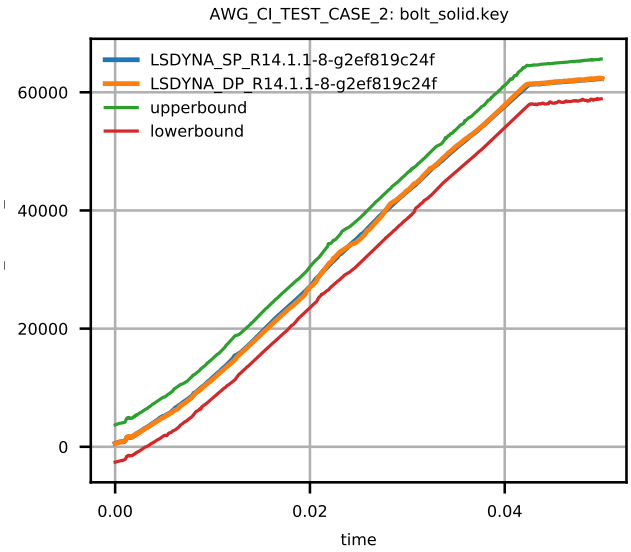

Figure 3: Cross platform results, Von Mises stress of element 65559, sub test case ID 1

5.3.3 Sub Test Case ID 2-Test Target 3

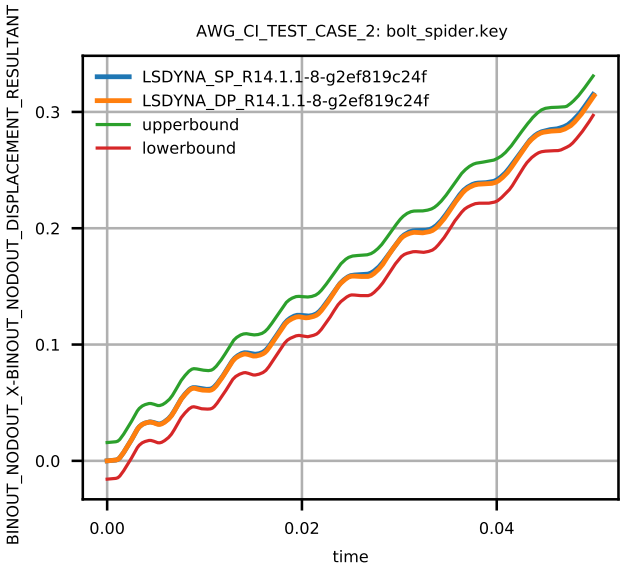

Figure 4: Cross platform results, nodal resultant displacement node 75022, sub test case ID 2

5.3.4 Sub Test Case ID 2-Test Target 4

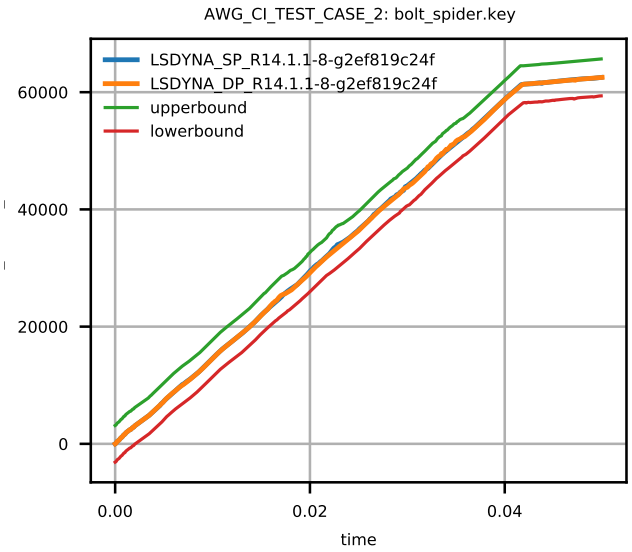

Figure 5: Cross platform results, Von Mises stress of element 66872, sub test case ID 2

5.3.5 Sub Test Case ID 1-CPU time

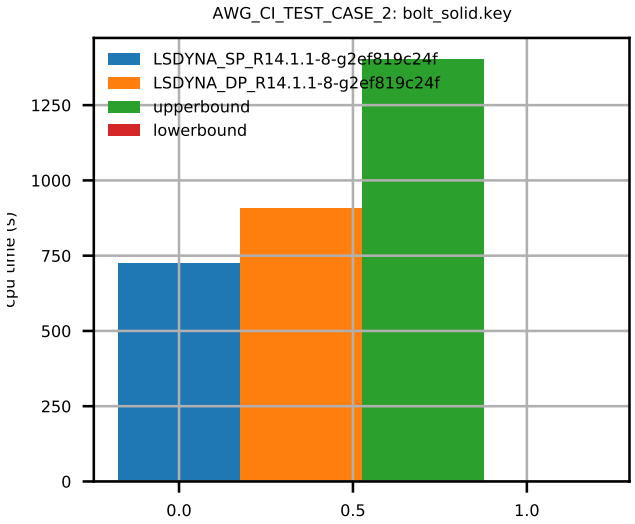

Figure 6: Cross platform results, CPU time

5.3.6 Sub Test Case ID 2-CPU time

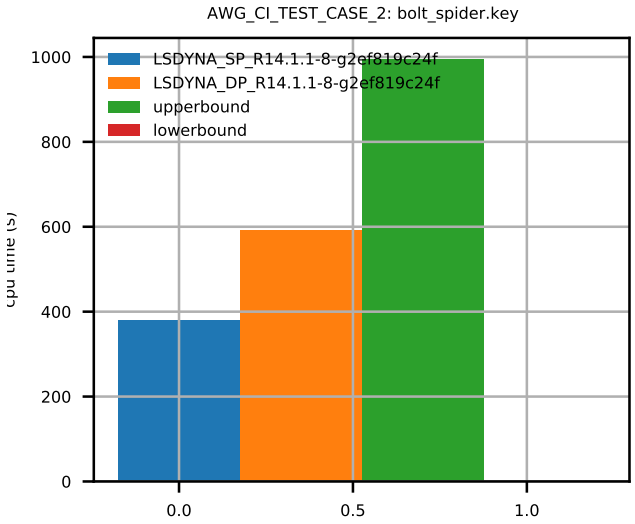

Figure 7: Cross platform results, CPU time (s)

References