TEST CASE DOCUMENTATION AND TESTING RESULTS

ANSYS-QA-LS-DYNA-AWG-ERIF-16-14

TEST CASE ID AWG-ERIF-16

*MAT_264 / *MAT_TABULATED_JOHNSON_COOK_ORTHO_PLASTICITY

Tested with LS-DYNA® R14.1.1 Revision 4-gaf1eb871e8

Friday 5th July, 2024

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Contents

1 Introduction

1.1 Purpose of this Document

The purpose of this test case is the demonstration of the *MAT_264 feature in LS-DYNA® . The reliability and consistency of LS-DYNA® as a finite element solver for this test case is evaluated by performing analyses on different cpu architecture platforms.

2 Test Case Information

Test Case Summary	
Confidentiality	external use
Test Case Name	*MAT_264 / *MAT_TABULATED_JOHNSON_COOK_ORTHO_PLASTICITY
Test Case ID	AWG-ERIF-16
Test Case Status	active
Test Case Classification	Example
Test Case Source	ANSYS
Tested Keyword	*MAT_264 / *MAT_TABULATED_JOHNSON_COOK_ORTHO_PLASTICITY
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-16 is to verify that *MAT_264 gives the same results as *MAT_224_GYS for an isotropic material.

3.2 Test Case Description

This test case compares *MAT_264 and *MAT_224_GYS in the isotropic limit, but with different yield stresses in tension, compression, and shear for the five load conditions bi-axial tension, uni-axial tension, pure shear, uni-axial compression, and bi-axial compression (See Figure 1)

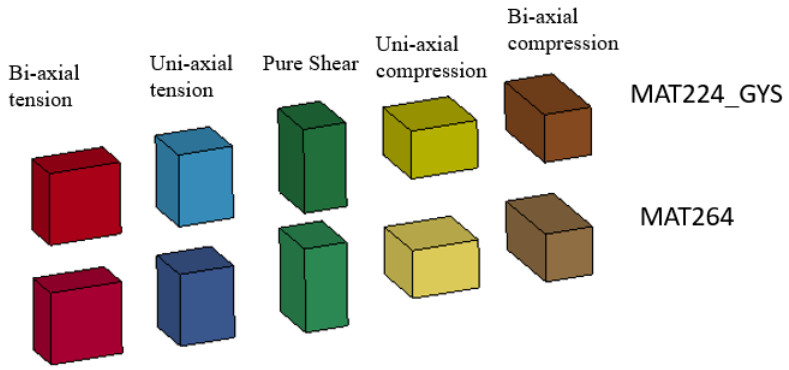

Figure 1: Elements, loads, and materials for Set 1

3.3 Model Description

The models consists of a set of ten single constant stress solid elements (type 1) that are evaluated for five distinct load cases. Material models for *MAT_264 and *MAT_224_GYS are compared in the isotropic limit with different yield stresses in tension, compression, and shear. Von Mises and z-stress components are compared to verify correct implementation of *MAT_264. The material definitions and their parameters can be found in the input deck. A summary of the sub test cases can be found in Table 3.

FEA Model information	
Nodes	88
Solid Elements	10
Materials	2
Parts	10
Units	mm (length), ms (time), kg (mass), kn (force), GPa (stress), degrees K (temperature))

Table 2: FEA Model Information

Specification of sub test cases	
Test Case ID	Input Deck Name
1	mat224_GYS_vs_mat264.k

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 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	Sub Test Case ID	output	component type	components id	retrieved from
1	1	elout	z-component Stress	1-5,11-15	binout/elout file
2	1	elout	Von Mises Stress	1-5,11-15	binout/elout file

Table 4: Test Case targets for Test Case ID AWG-ERIF-16

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-16.

The sub 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. The corridors were updated to LS-DYNA® R11.0 Revision 130010 binaries after the BUG 13652 was fixed. They were defined by the following process:

- For a specific test case target, interpolate the data from different platform and executable (R11.0 Revision 130010) 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 (R11.0 Revision 130010) 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]	Memory Option
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	4-gaf1eb871e8	SMP	SP	ls971.4-gaf1eb871e8.R14.1.1
LS-DYNA®	971	R14.1.1	4-gaf1eb871e8	SMP	DP	ld971.4-gaf1eb871e8.R14.1.1
LS-DYNA®	971	R14.1.1	4-gaf1eb871e8	MPP	SP	mpp971.4-gaf1eb871e8.R14.1.1
LS-DYNA®	971	R14.1.1	4-gaf1eb871e8	MPP	DP	mpd971.4-gaf1eb871e8.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-ERIF-16 completed with all combinations of software and hardware defined in section 5.1.
Details on the test results can be found in the section 5.3.

The table 7 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**

Table 7: Results summary for Test Case ID AWG-ERIF-16

5.3 Result Details

The following subsections contain detailed results for the Test Case ID AWG-ERIF-16 for LS-DYNA® R14.1.1 Revision 4-gaf1eb871e8.

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. The legend contains the type, branch and the revision of the executable.

Example for title:

Title:
'AWG_ERIF_TEST_CASE_16: mat224_GYS_vs_mat264.k' states the test case ID 16 and name of the input deck for sub test case 1.

5.3.1 Sub Test Case ID 1 - Test Target 1

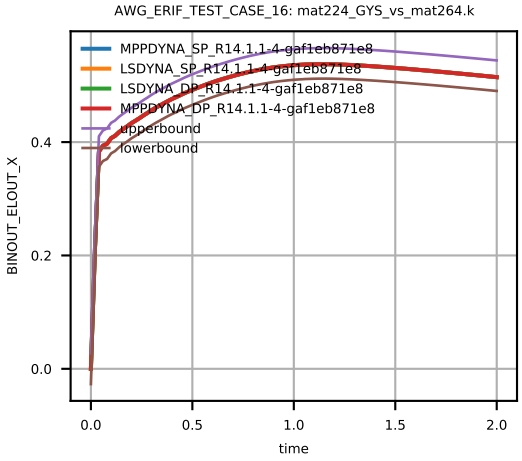

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Figure 2: Cross platform results, z-component Stress, element ID 1, sub test case ID 1

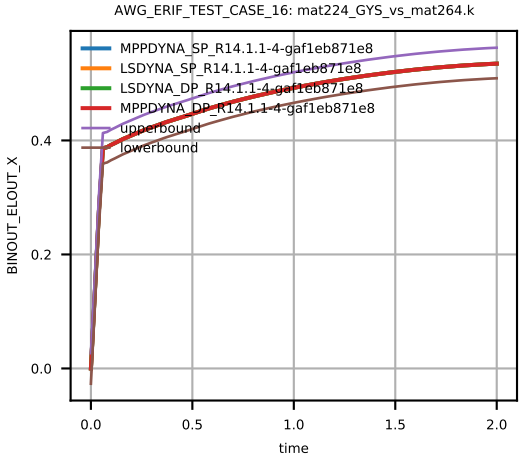

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Figure 3: Cross platform results, z-component Stress, element ID 2, sub test case ID 1

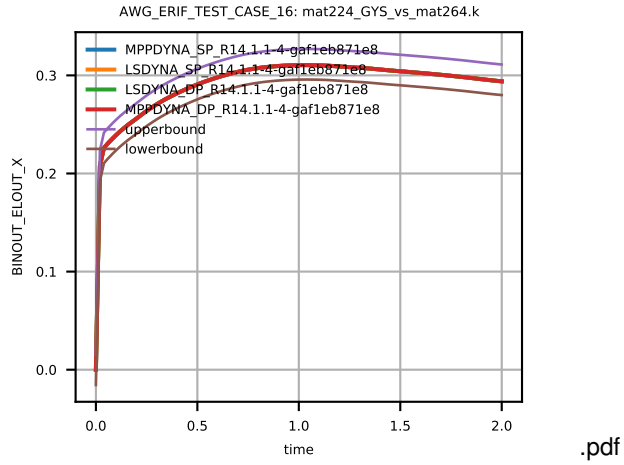

Figure 4: Cross platform results, z-component Stress, element ID 3, sub test case ID 1

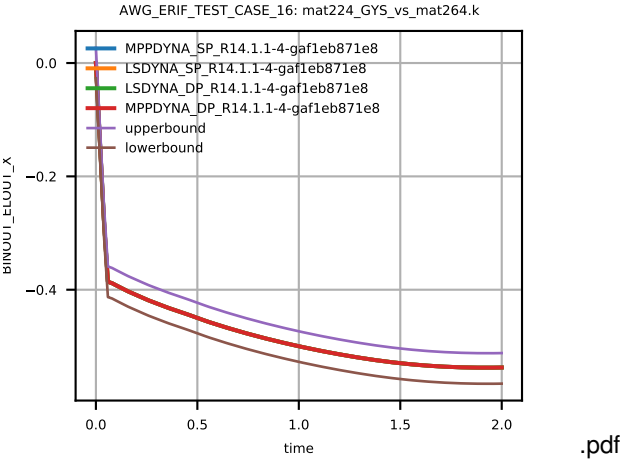

Figure 5: Cross platform results, z-component Stress, element ID 4, sub test case ID 1

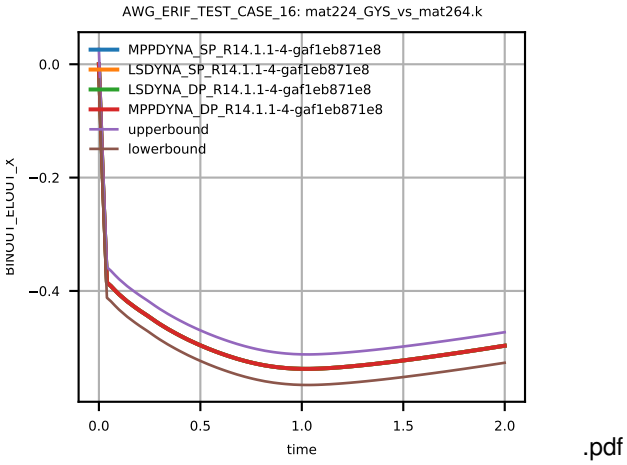

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Figure 6: Cross platform results, z-component Stress, element ID 5, sub test case ID 1

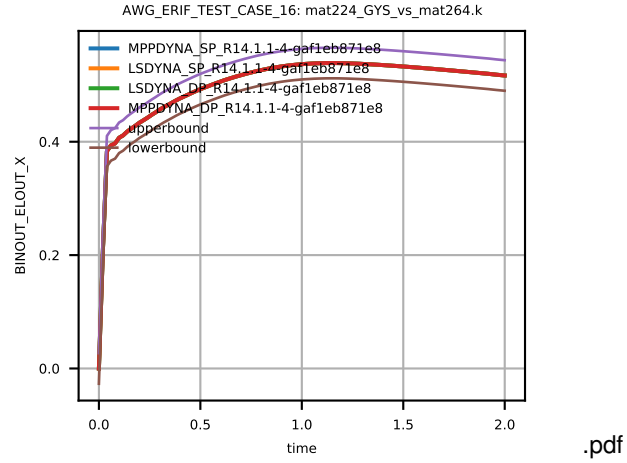

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Figure 7: Cross platform results, z-component Stress, element ID 11, sub test case ID 1

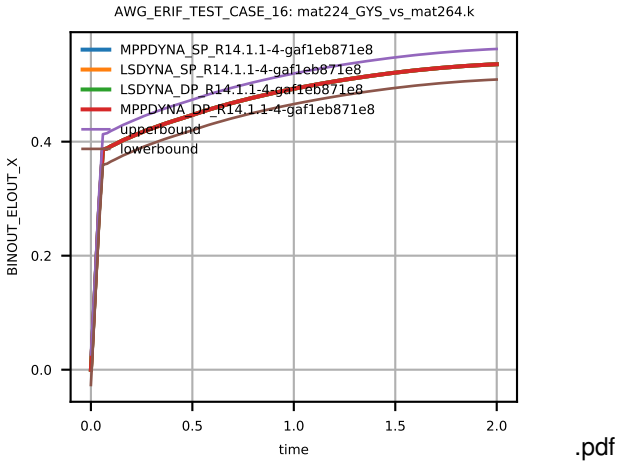

Figure 8: Cross platform results, z-component Stress, element ID 12, sub test case ID 1

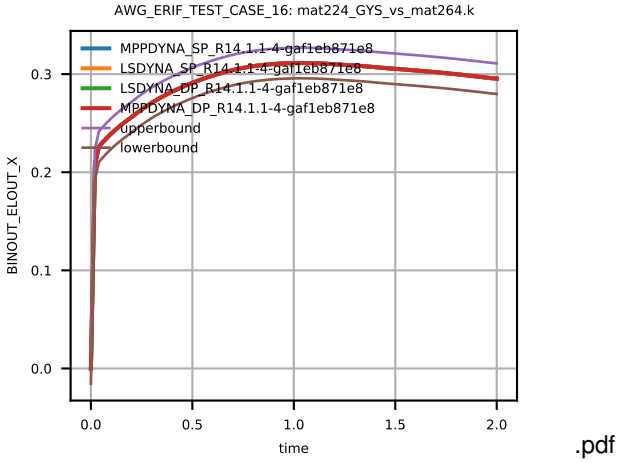

Figure 9: Cross platform results, z-component Stress, element ID 13, sub test case ID 1

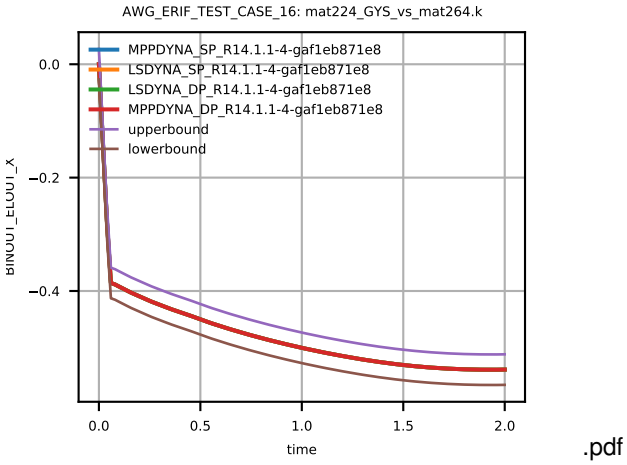

Figure 10: Cross platform results, z-component Stress, element ID 14, sub test case ID 1

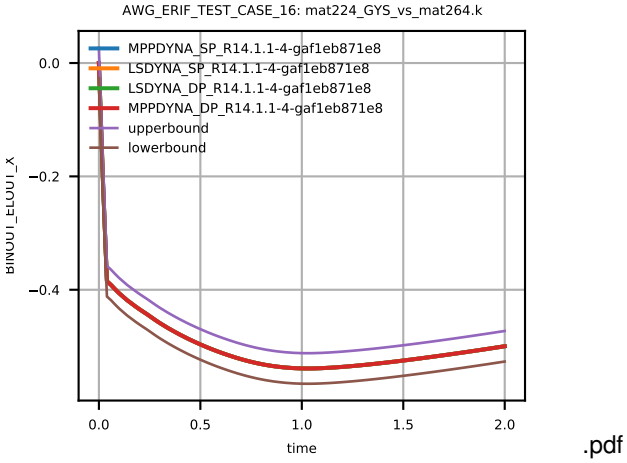

Figure 11: Cross platform results, z-component Stress, element ID 10, sub test case ID 1

5.3.2 Sub Test Case ID 1 - Test Target 2

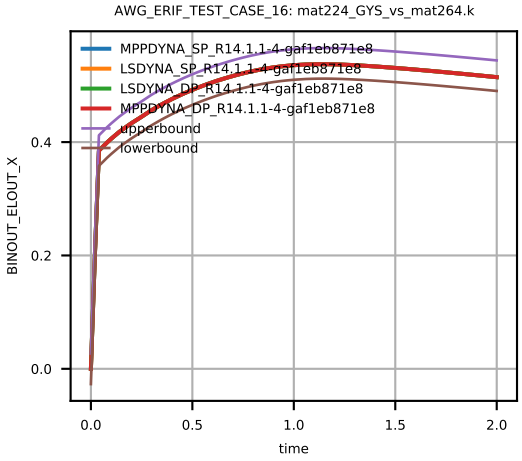

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Figure 12: Cross platform results, Von Mises Stress, element ID 1, sub test case ID 1

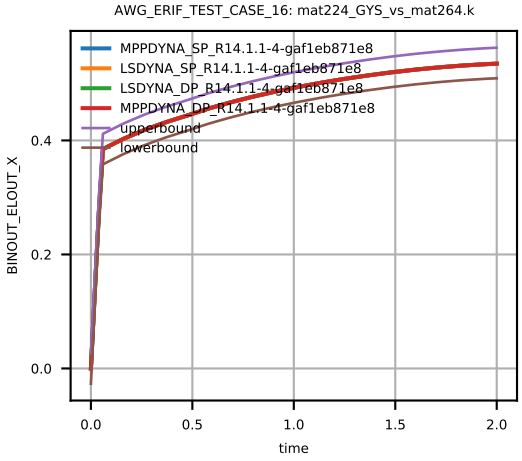

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Figure 13: Cross platform results, Von Mises Stress, element ID 2, sub test case ID 1

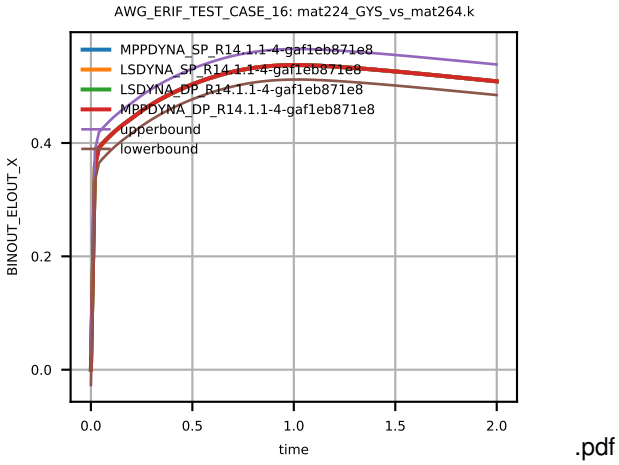

Figure 14: Cross platform results, Von Mises Stress, element ID 3, sub test case ID 1

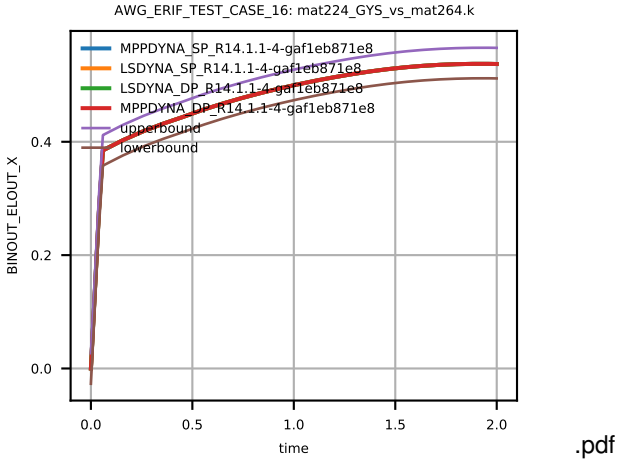

Figure 15: Cross platform results, Von Mises Stress, element ID 4, sub test case ID 1

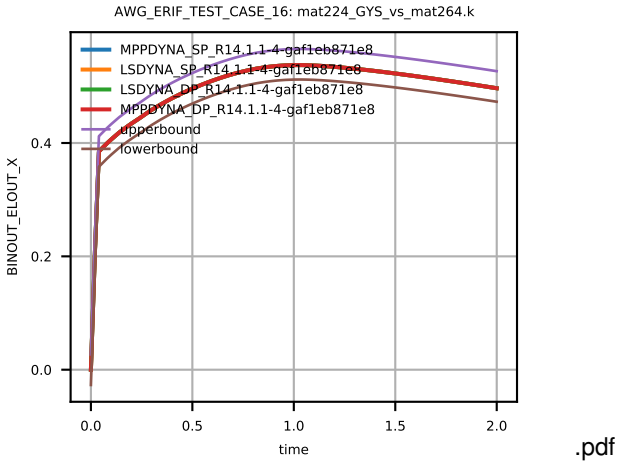

Figure 16: Cross platform results, Von Mises Stress, element ID 5, sub test case ID 1

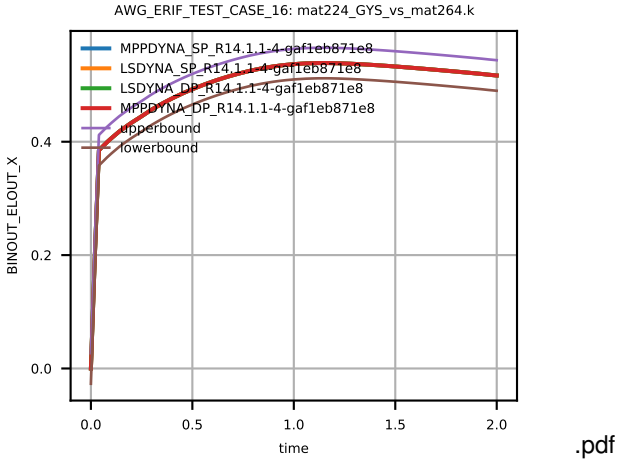

Figure 17: Cross platform results, Von Mises Stress, element ID 11, sub test case ID 1

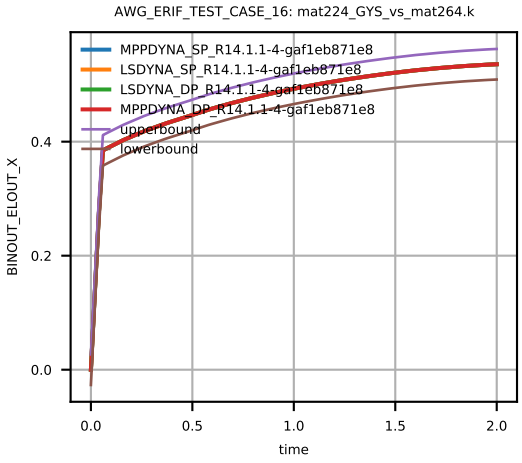

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Figure 18: Cross platform results, Von Mises Stress, element ID 12, sub test case ID 1

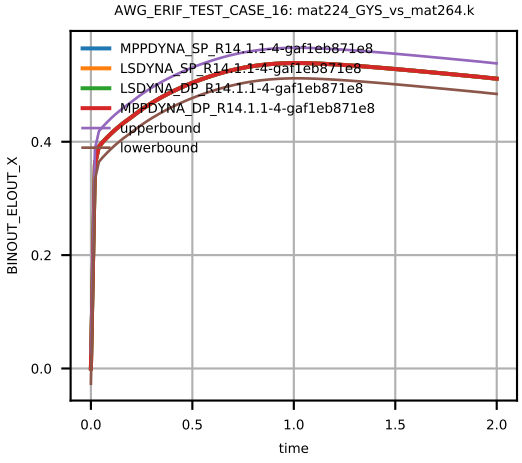

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Figure 19: Cross platform results, Von Mises Stress, element ID 13, sub test case ID 1

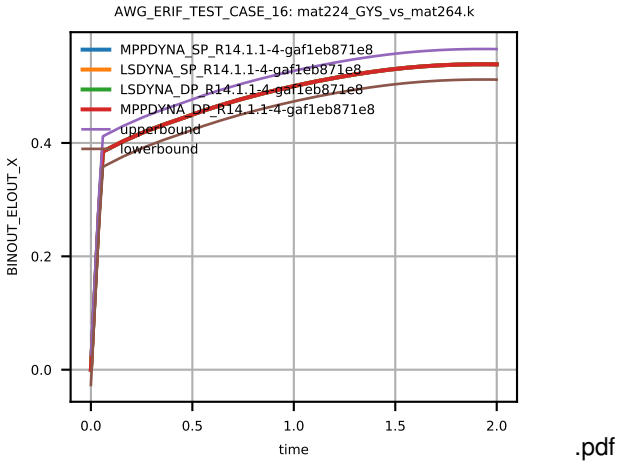

Figure 20: Cross platform results, Von Mises Stress, element ID 14, sub test case ID 1

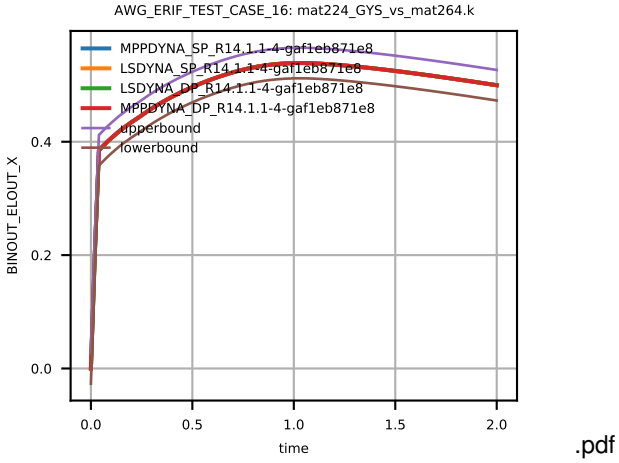

Figure 21: Cross platform results, Von Mises Stress, element ID 10, sub test case ID 1