TEST CASE DOCUMENTATION AND TESTING RESULTS

TEST CASE ID AWG-MAT_213-185

*MAT_213 Test Case 185: Single Solid Element - Uncoupled Damage with Monotonic Loading

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

This document specifies the test case AWG-MAT_213-185. 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_213 Test Case 185: Single Solid Element - Uncoupled Damage with Monotonic Loading
Test Case ID	AWG-MAT_213-185
Test Case Status	In Development
Test Case Classification	Verification
Test Case Source	Arizona State University
Tested Keyword	*MAT_213 *BOUNDARY_PRESCRIBED_MOTION_SET *BOUNDARY_SPC_SET
Member of Test Suite	AWG MAT_213 SUITE
Metadata	AWG MAT_213

Table 1: Test Case Summary

3 Test Case Specification

3.1 Test Case Purpose

The purpose of Test Case ID AWG-MAT_213-185 is verification of the *MAT_213 T800/F3900 input for solid elements with cyclic loading.

3.2 Test Case Description

This test case is a single solid element model for T800/F3900 with cyclic 2-direction compression (C2) loading with only C2 uncoupled damage input. It uses the corrected plastic strain approach for damage tracking. The test case details include:

- Displacement controlled
- Deformation and damage
- Visco-plastic assumption (VEVP=0)

3.3 Model Description

A single solid element test case using *MAT_213 with displacement control; deformation and damage; and visco-plastic assumption (VEVP=0).

Model information	
Nodes	8
Solid Elements	1
Parts	1
Materials	1
Unit System	inch (length), second (time), lbf-s^2/in (mass), pound (force), psi (stress), Celsius (temperature)

Table 2: FEA Model Information

Model information	
Test Case ID	Input Deck Name
1	185_Single_Solid_Element_Uncoupled_Damage_with_Cycling_Loading_.k

Table 3: Specification of sub test cases

4 Test Specifications

4.1 Test Case Targets

Test Case Targets					
Target number	Output	Integration pt.	Component type	Component id	Retrieved from
1	Stress xx	1	Element	1	binout/elout
2	Stress yy	1	Element	1	binout/elout
3	Stress zz	1	Element	1	binout/elout
4	Stress xy	1	Element	1	binout/elout
5	Stress yz	1	Element	1	binout/elout
6	Stress zx	1	Element	1	binout/elout
7	Strain xx	1	Element	1	binout/elout
8	plastic strain C2 (Hist #52)	1	Element	1	binout/elout
9	Internal Energy				binout/glstat
10	Kinetic Energy				binout/glstat
11	Hourglass Energy				binout/glstat

Table 4: Test Case Targets

4.2 Pass/Fail Criteria

These are the Pass/Fail criteria used for the Validation of the Test Case ID AWG-MAT_213-185.

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. They were defined based on the test target data obtained with LS-DYNA® R14.0 Revision 331 binaries by the following process:

- For a specific test case target, interpolate the data from different platform and executable (R14.0 Revision 331) 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 (R14.0 Revision 331) 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	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-MAT_213-185 completed with all combinations of software and hardware defined in section 5.1 (1 * 2 * 4 total calculation runs).
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-MAT_213-185

5.3 Result Details

The following subsections contain detailed results for the Test Case ID AWG-MAT_213-185 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.

5.3.1 Test Target 1: Solid Element Stress xx

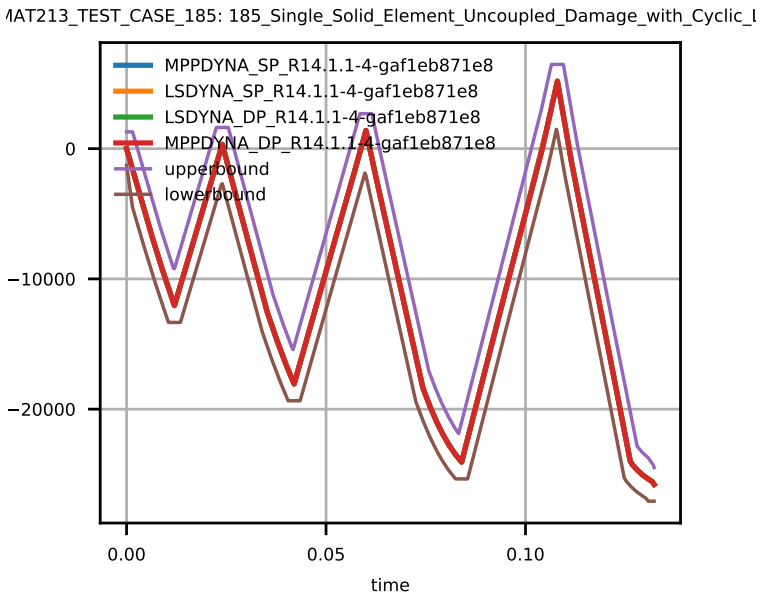

Figure 1: Solid Element Stress xx.

5.3.2 Test Target 2: Solid Element Stress yy

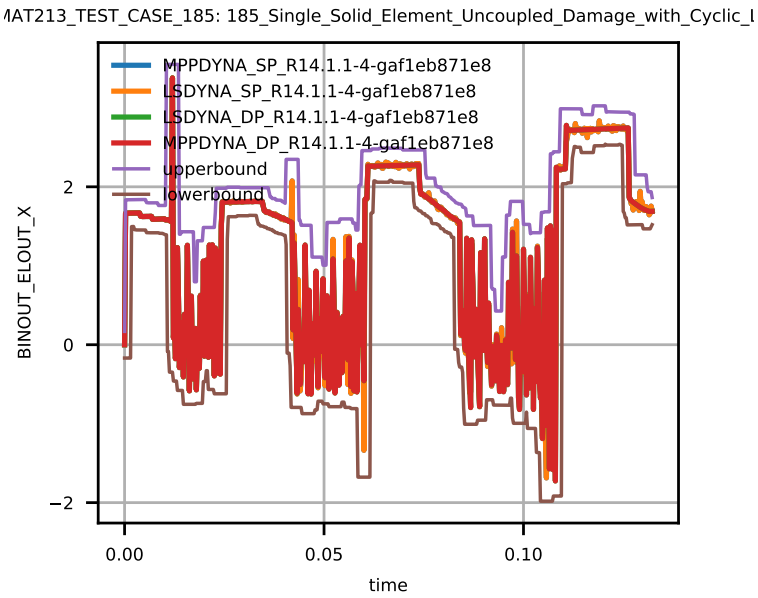

Figure 2: Solid Element Stress yy.

5.3.3 Test Target 3: Solid Element Stress zz

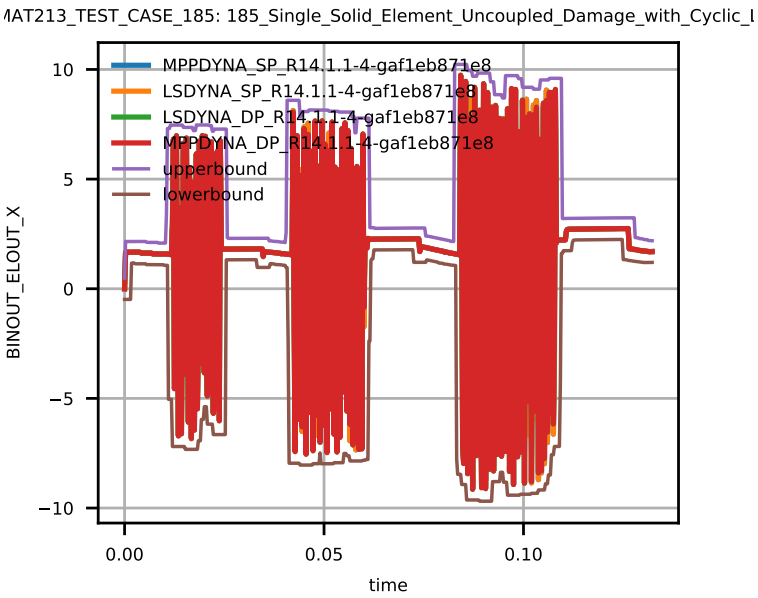

Figure 3: Solid Element Stress zz.

5.3.4 Test Target 4: Solid Element Stress xy

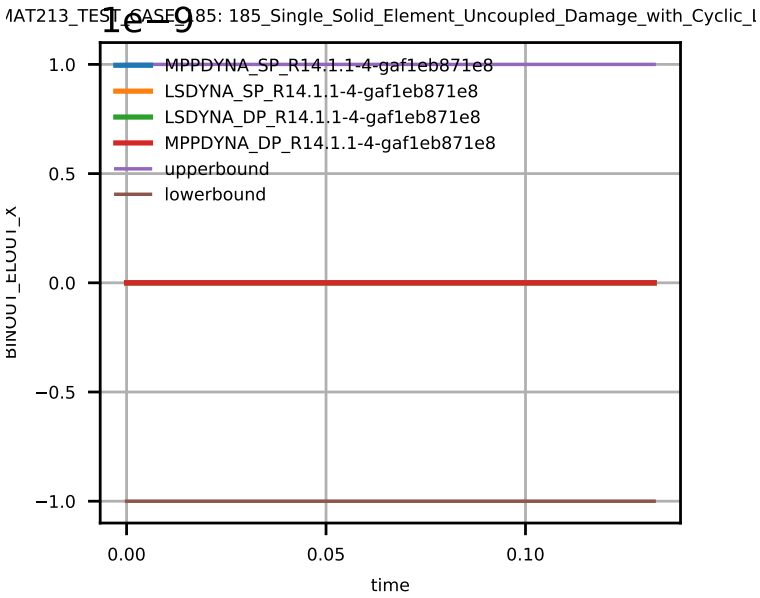

Figure 4: Solid Element Stress xy.

5.3.5 Test Target 5: Solid Element Stress yz

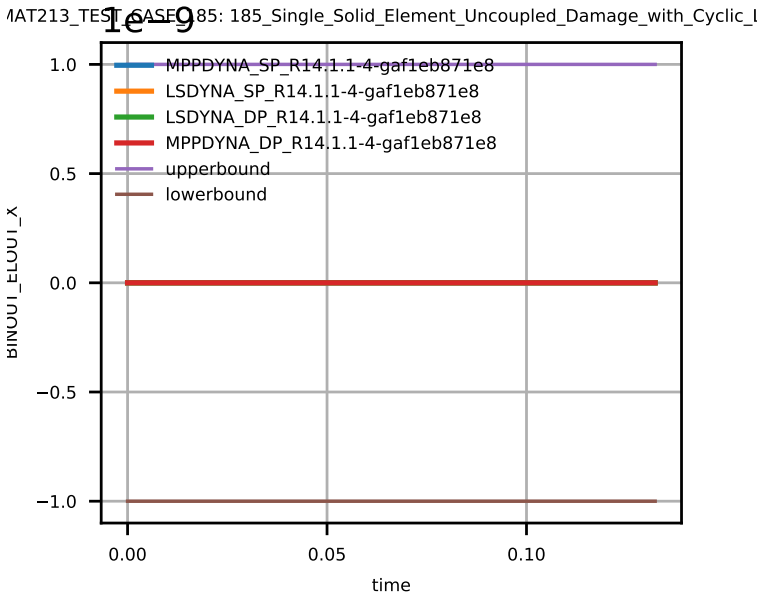

Figure 5: Solid Element Stress yz.

5.3.6 Test Target 6: Solid Element Stress zx

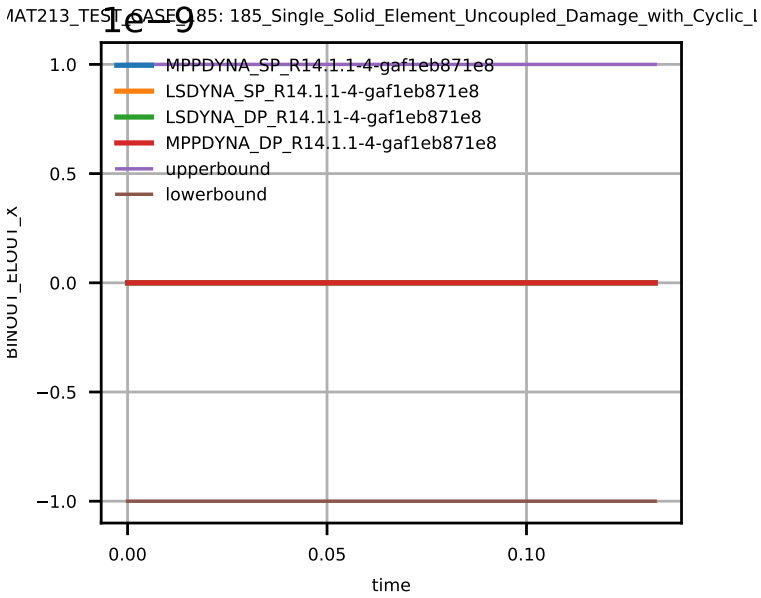

Figure 6: Solid Element Stress zx.

5.3.7 Test Target 7: Solid Element Strain xx

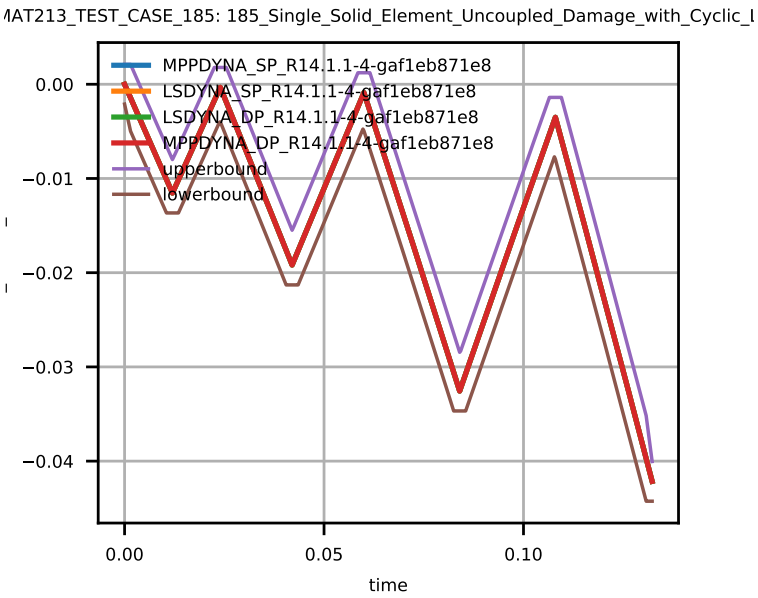

Figure 7: Solid Element Strain xx.

5.3.8 Test Target 13: Plastic Strain C2 (Hist #52)

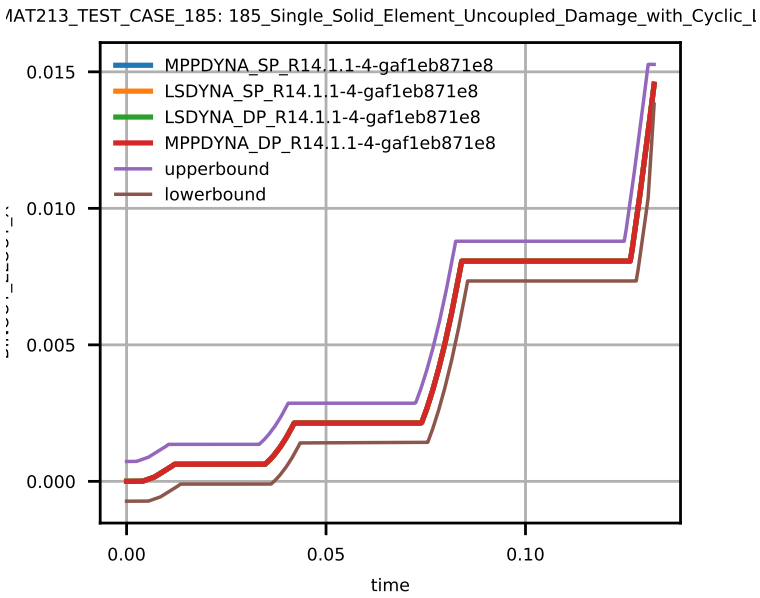

Figure 8: Solid Element Strain zx.

5.3.9 Test Target 14: Global Internal Energy

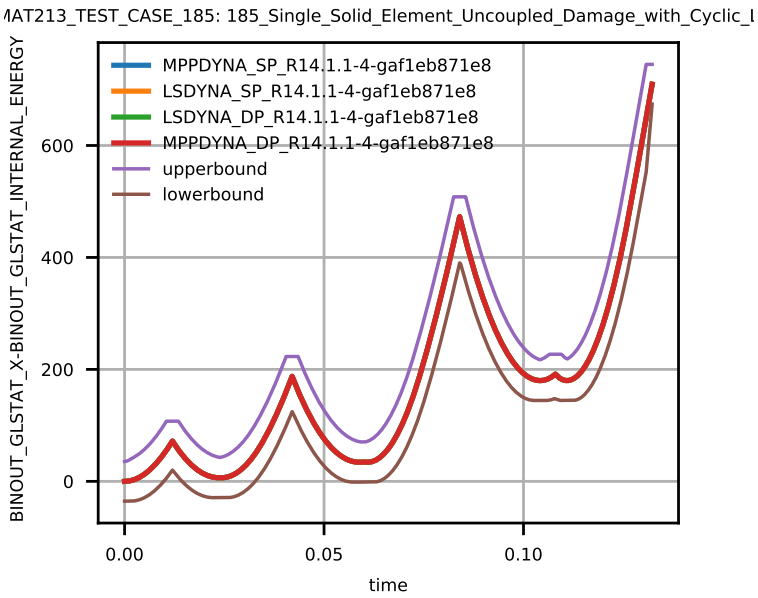

Figure 9: Global Internal Energy.

5.3.10 Test Target 15: Global Kinetic Energy

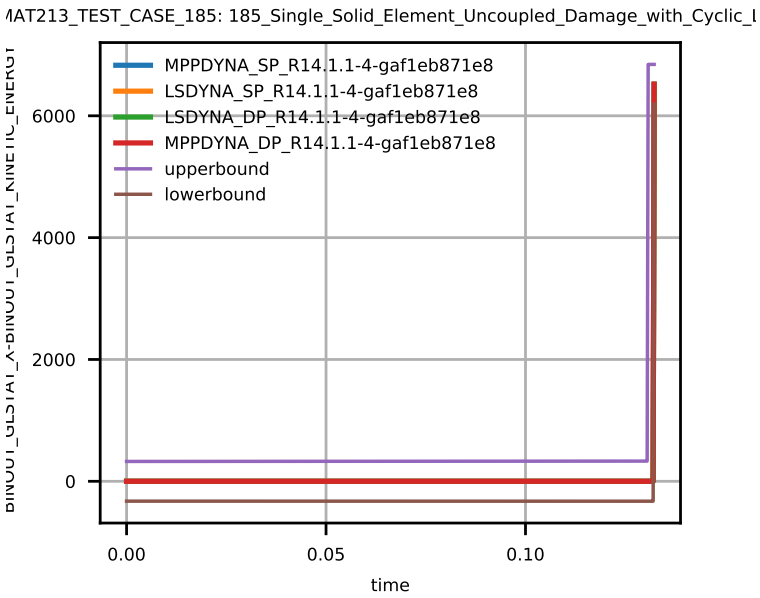

Figure 10: Global Kinetic Energy.

5.3.11 Test Target 16: Global Hourglass Energy

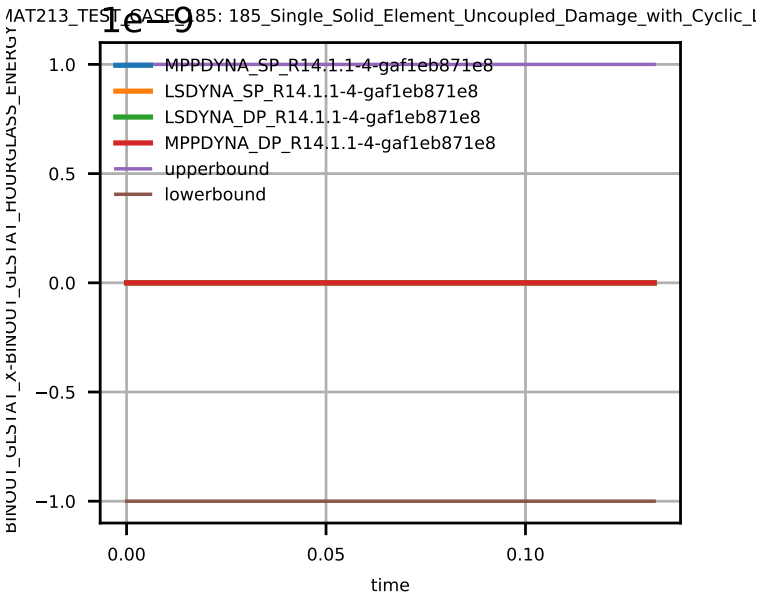

Figure 11: Global Hourglass Energy.