TEST CASE DOCUMENTATION AND TESTING RESULTS

TEST CASE ID AWG-MAT_213-183

*MAT_213 Test Case 183: 12 Single Solid Elements - Linear Material

Tested with LS-DYNA® R16.0 Revision 563-g2adec5a053

Wednesday 16th April, 2025

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Document Information	
Confidentiality	**external use**
Document Identifier	
Author(s)	Prepared by LS-DYNA® Aerospace Working Group
Number of pages	40
Date created	Wednesday 16th April, 2025
Distribution	LS-DYNA® Aerospace Working Group / internal ANSYS QA

Contents

1 Introduction

1.1 Purpose of this Document

This document specifies the test case AWG-MAT_213-183. 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 183: 12 Single Solid Elements - Linear Material
Test Case ID	AWG-MAT_213-183
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_213-183 is verification of the *MAT_213 synthetic linear material properties for solid elements.

3.2 Test Case Description

This test case has twelve single solid element models with synthetic linear material properties. This linear MAT_213 model has twelve solid elements representing each of the twelve components. The input is based on the fiber material property that is completely linear. In this test case, MAT_213 will automatically detect that the material is rate-temperature independent and it is linear. The twelve load tests are:

- 1-direction tension test
- 1-direction compression test
- 2-direction tension test
- 2-direction compression test
- 3-direction tension test
- 3 direction compression test
- 1-2 shear test
- 2-3 shear test
- 1-3 shear test
- 45 degrees 1-2 plane tension test
- 45 degrees 2-3 plane compressino test
- 45 degrees 1-3 plane compression test

The test case details include:

- Displacement controlled except for cases 7 and 8 in the list above
- Deformation only
- Visco-plastic assumption (VEVP=0)

3.3 Model Description

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

Model information	
Nodes	96
Solid Elements	12
Parts	12
Materials	7
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	183_12_Single_Solid_Elements_Linear_Material_.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 xx	1	Element	2	binout/elout
3	Stress xx	1	Element	3	binout/elout
4	Stress xx	1	Element	4	binout/elout
5	Stress xx	1	Element	5	binout/elout
6	Stress xx	1	Element	6	binout/elout
7	Stress xx	1	Element	7	binout/elout
8	Stress xy	1	Element	8	binout/elout
9	Stress xx	1	Element	9	binout/elout
10	Stress xx	1	Element	10	binout/elout
11	Stress xx	1	Element	11	binout/elout
12	Stress xx	1	Element	12	binout/elout
13	Strain xx	1	Element	1	binout/elout
14	Strain xx	1	Element	2	binout/elout
15	Strain xx	1	Element	3	binout/elout
16	Strain xx	1	Element	4	binout/elout
17	Strain xx	1	Element	5	binout/elout
18	Strain xx	1	Element	6	binout/elout
19	Strain xx	1	Element	7	binout/elout
20	Strain xy	1	Element	8	binout/elout
21	Strain xx	1	Element	9	binout/elout
22	Strain xx	1	Element	10	binout/elout
23	Strain xx	1	Element	11	binout/elout
24	Strain xx	1	Element	12	binout/elout
25	Internal Energy				binout/glstat
26	Kinetic Energy				binout/glstat
27	Hourglass Energy				binout/glstat
28	CPU Time				d3hsp file

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_213-183.

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.

For CPU Time target, it holds:

$$bound_{up}^{CPU\,Time} = 2 \times Max + 1$$
$$bound_{low}^{CPU\,Time} = 0$$

where Max is the maximum CPU Time (in seconds) across all platforms and executable (R14.0 Revision 331) combinations the test case was calculated with and $bound_{up}^{CPU\,Time}$ and $bound_{low}^{CPU\,Time}$ are the upper and lower bounds.

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	R16.0	563-g2adec5a053	SMP	SP	ls971.563-g2adec5a053.R16.0
LS-DYNA®	971	R16.0	563-g2adec5a053	SMP	DP	ld971.563-g2adec5a053.R16.0
LS-DYNA®	971	R16.0	563-g2adec5a053	MPP	SP	mpp971.563-g2adec5a053.R16.0
LS-DYNA®	971	R16.0	563-g2adec5a053	MPP	DP	mpd971.563-g2adec5a053.R16.0

[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_213-183 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_213-183

5.3 Result Details

The following subsections contain detailed results for the Test Case ID AWG-MAT_213-183 for LS-DYNA® R16.0 Revision 563-g2adec5a053.

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: Stress xx of Solid Element 1

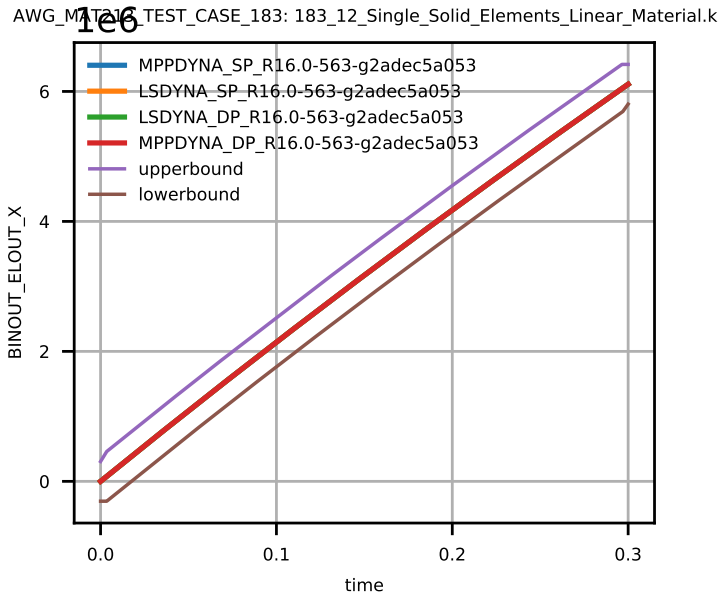

Figure 1: Stress xx of Solid Element 1.

5.3.2 Test Target 2: Stress xx of Solid Element 2

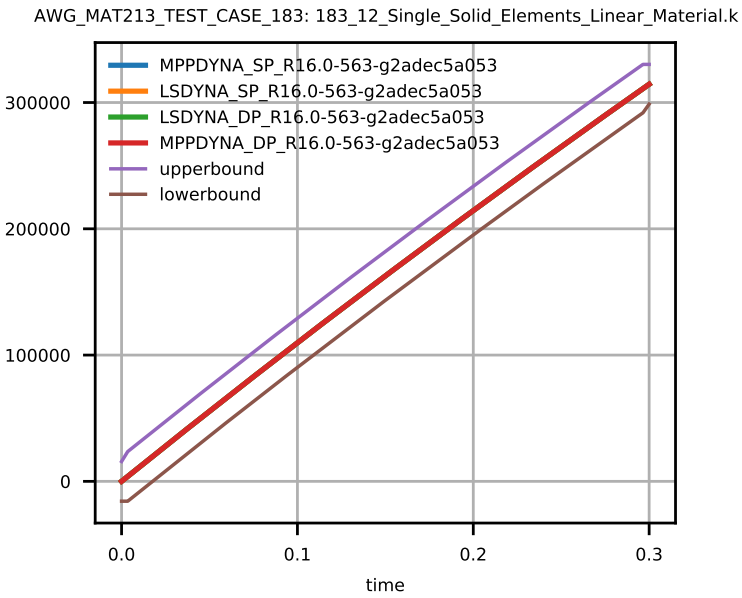

Figure 2: Stress xx of Solid Element 2.

5.3.3 Test Target 3: Stress xx of Solid Element 3

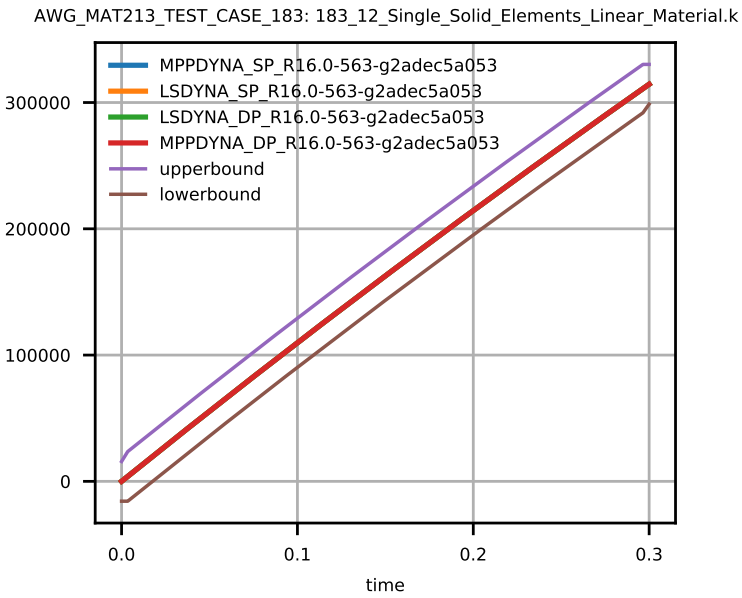

Figure 3: Stress xx of Solid Element 3.

5.3.4 Test Target 4: Stress xx of Solid Element 4

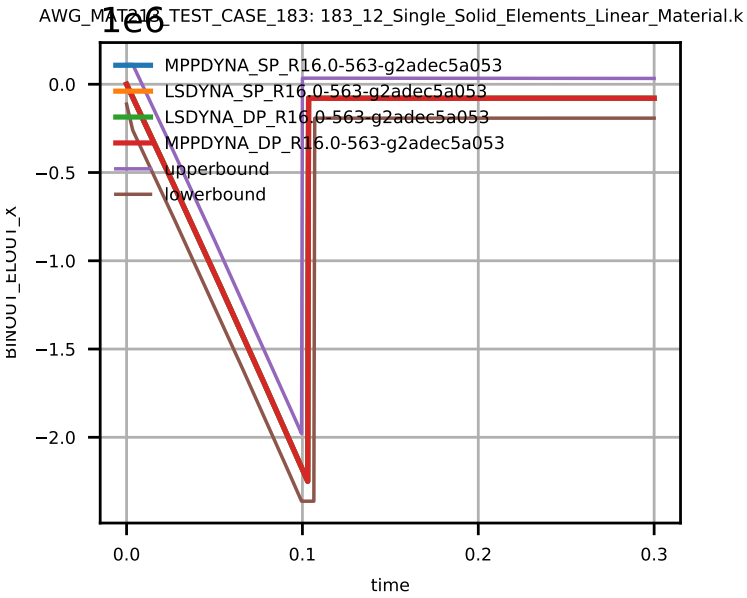

Figure 4: Stress xx of Solid Element 4.

5.3.5 Test Target 5: Stress xx of Solid Element 5

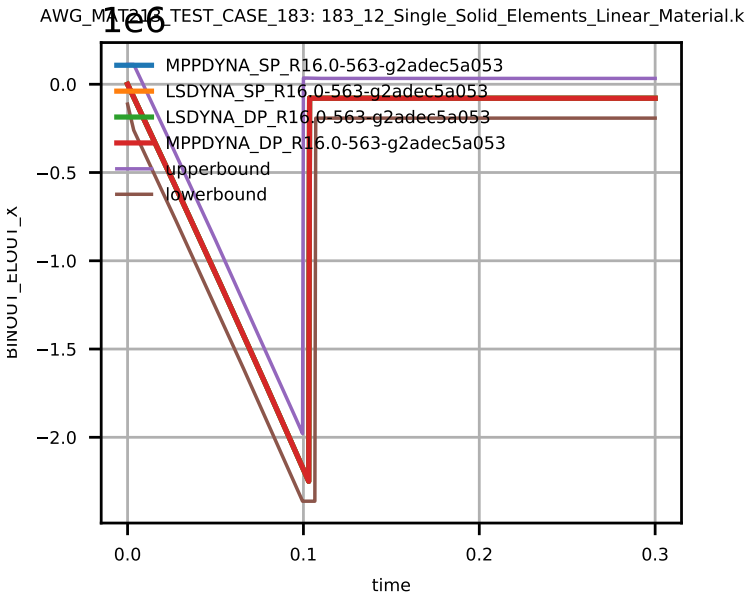

Figure 5: Stress xx of Solid Element 5.

5.3.6 Test Target 6: Stress xx of Solid Element 6

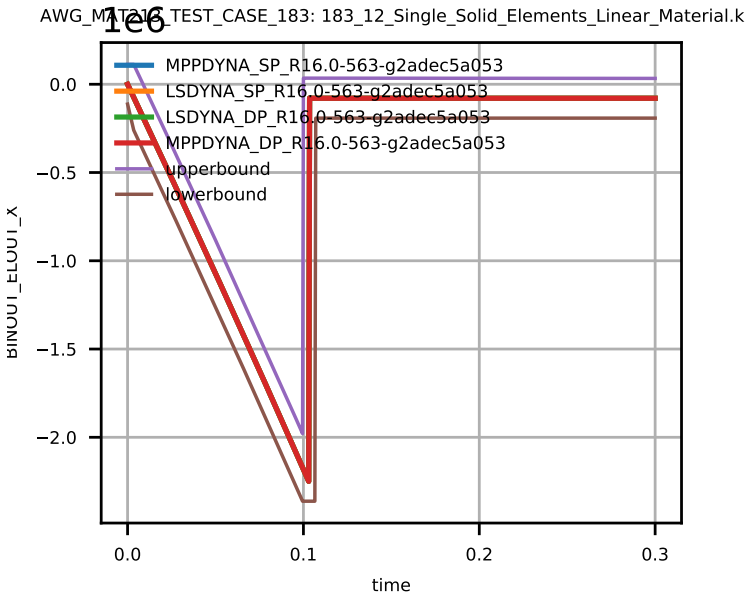

Figure 6: Stress xx of Solid Element 6.

5.3.7 Test Target 7: Stress xx of Solid Element 7

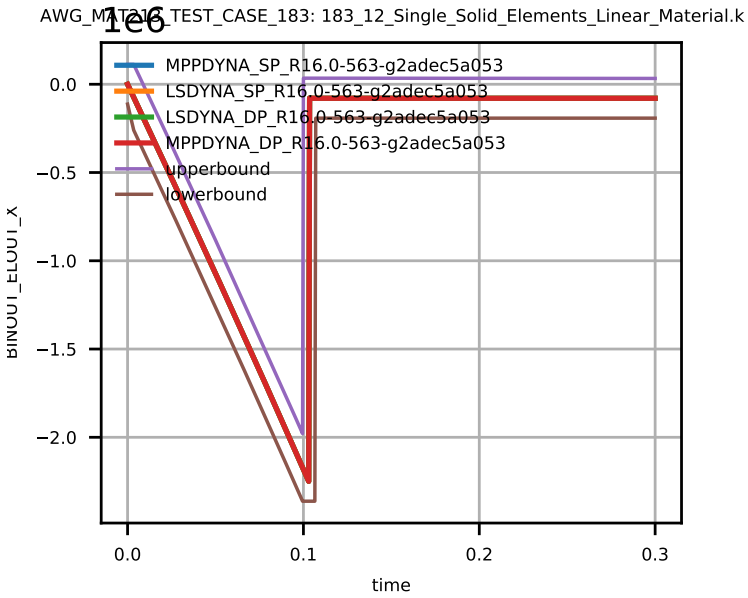

Figure 7: Stress xx of Solid Element 7.

5.3.8 Test Target 8: Stress xy of Solid Element 8

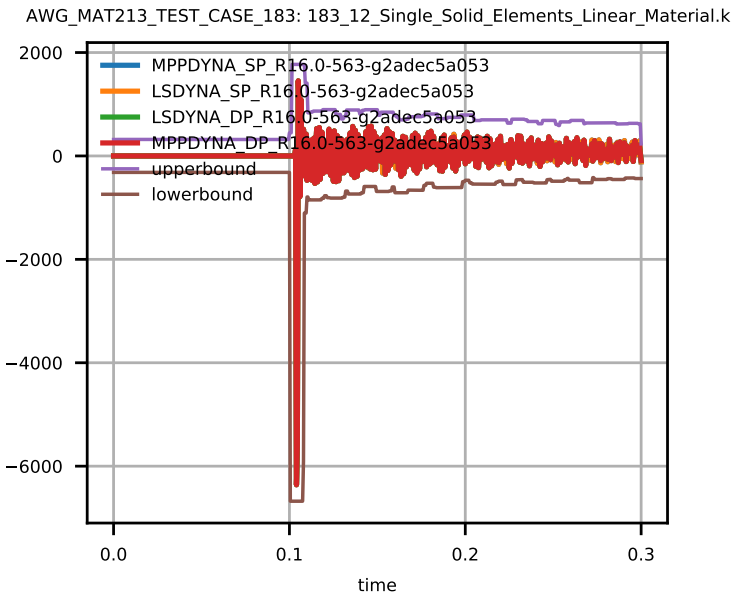

Figure 8: Stress xy of Solid Element 8.

5.3.9 Test Target 9: Stress xx of Solid Element 9

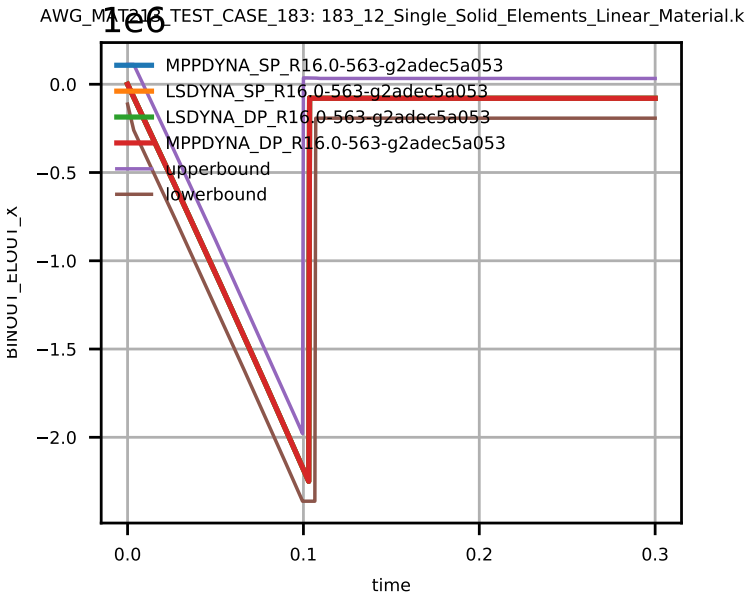

Figure 9: Stress xx of Solid Element 9.

5.3.10 Test Target 10: Stress xx of Solid Element 10

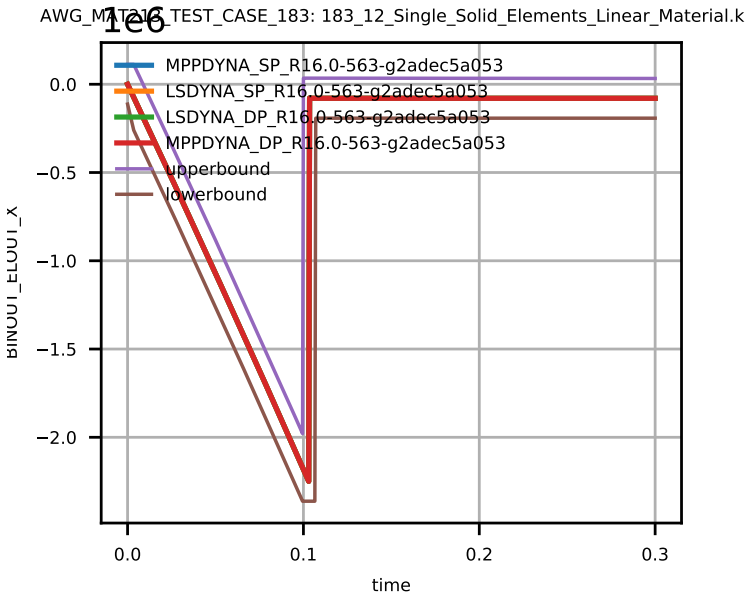

Figure 10: Stress xx of Solid Element 10.

5.3.11 Test Target 11: Stress xx of Solid Element 11

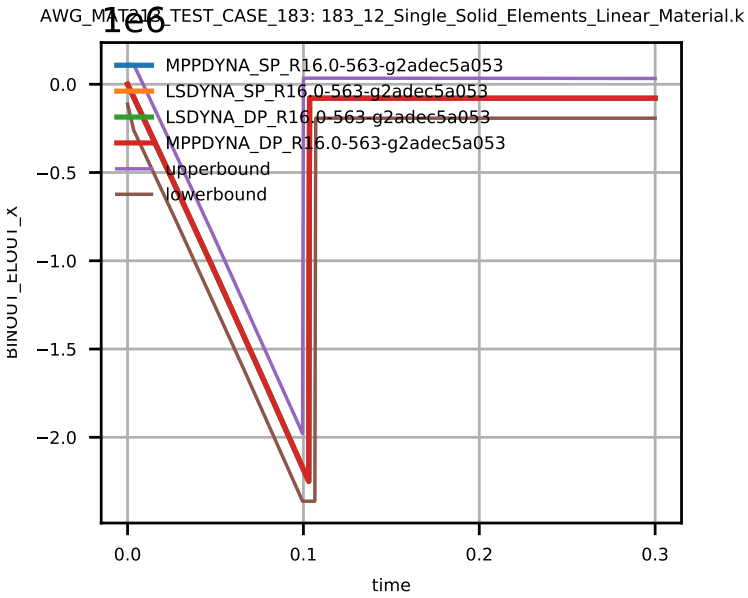

Figure 11: Stress xx of Solid Element 11.

5.3.12 Test Target 12: Stress xx of Solid Element 12

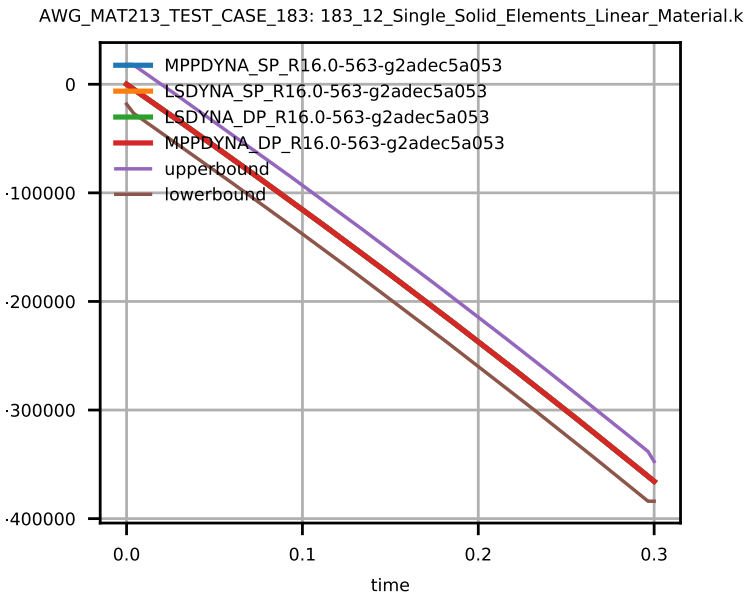

Figure 12: Stress xx of Solid Element 12.

5.3.13 Test Target 13: Strain xx of Solid Element 1

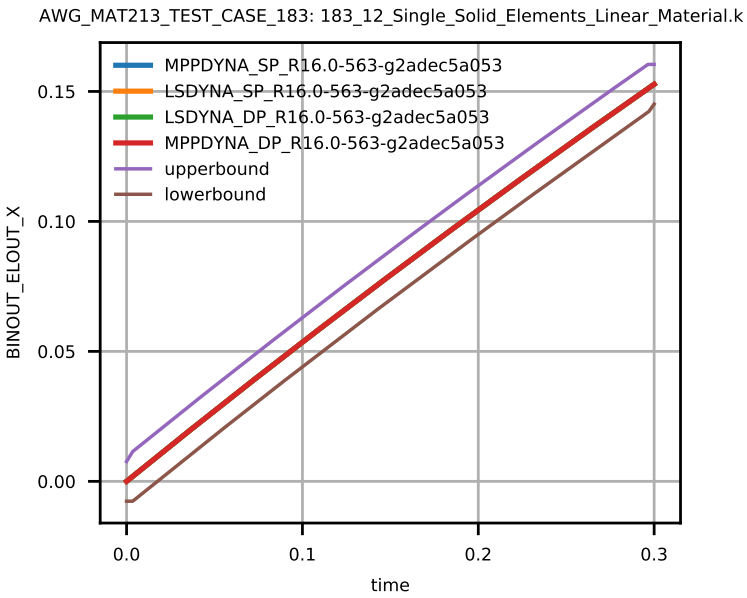

Figure 13: Strain xx of Solid Element 1.

5.3.14 Test Target 14: Strain xx of Solid Element 2

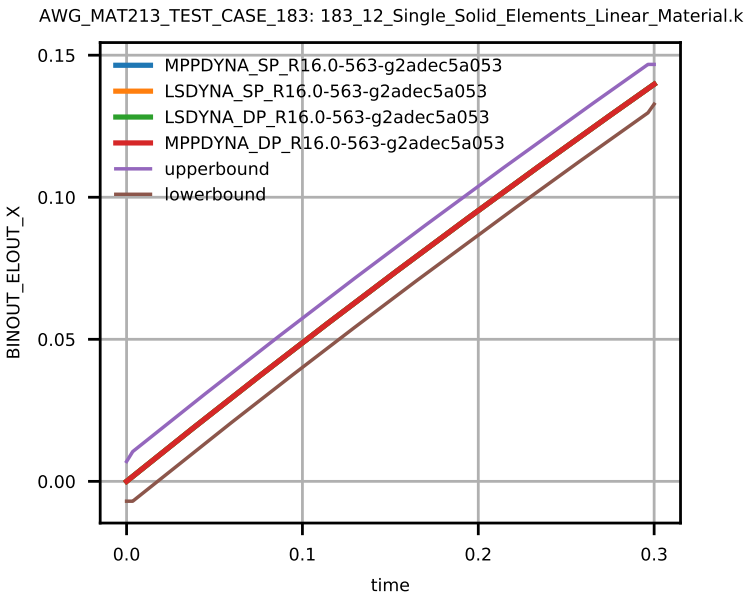

Figure 14: Strain xx of Solid Element 2.

5.3.15 Test Target 15: Strain xx of Solid Element 3

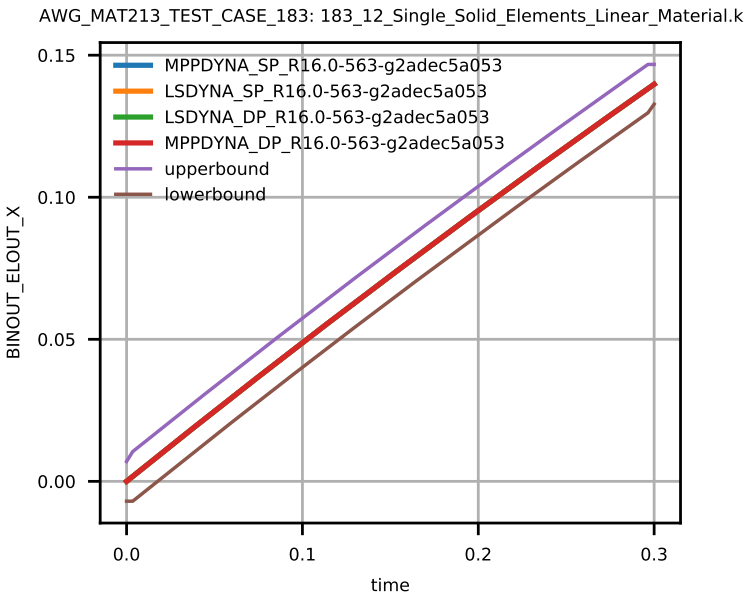

Figure 15: Strain xx of Solid Element 3.

5.3.16 Test Target 16: Strain xx of Solid Element 4

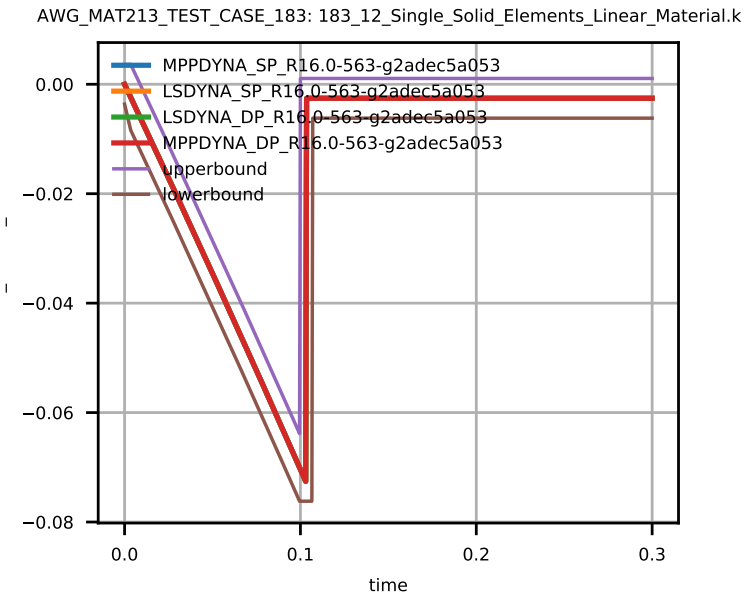

Figure 16: Strain xx of Solid Element 4.

5.3.17 Test Target 17: Strain xx of Solid Element 5

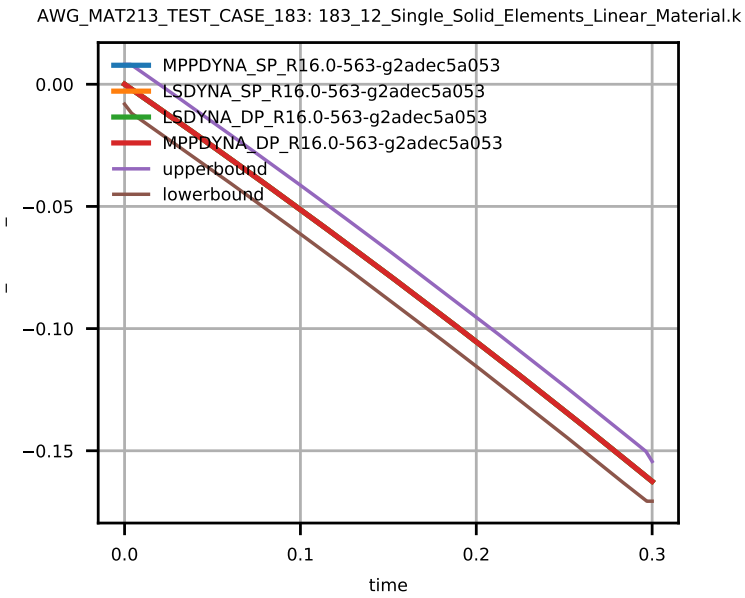

Figure 17: Strain xx of Solid Element 5.

5.3.18 Test Target 18: Strain xx of Solid Element 6

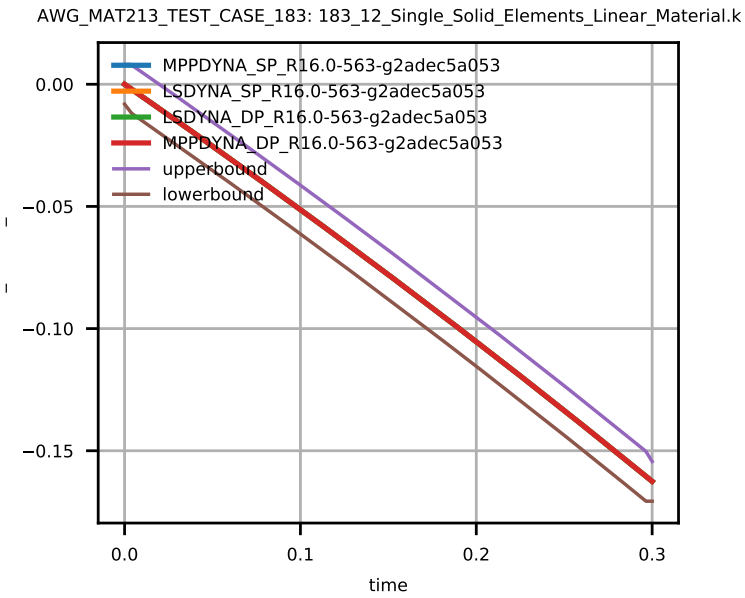

Figure 18: Strain xx of Solid Element 6.

5.3.19 Test Target 19: Strain xx of Solid Element 7

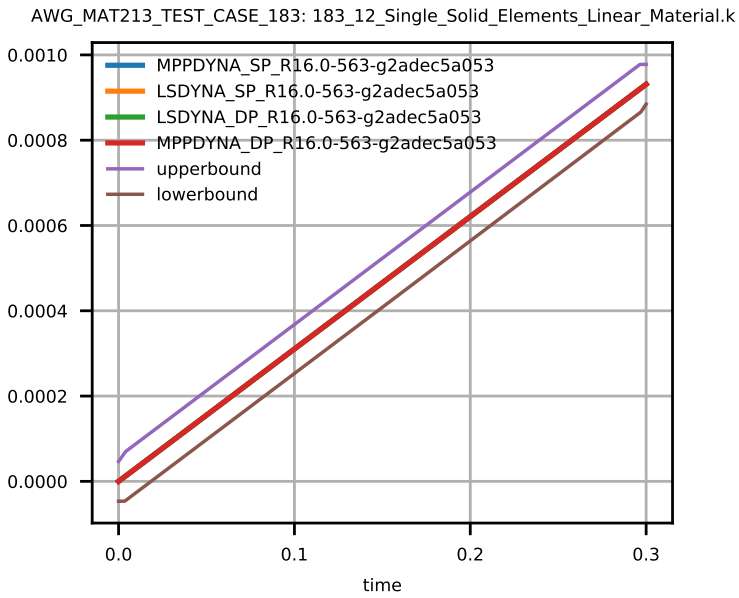

Figure 19: Strain xx of Solid Element 7.

5.3.20 Test Target 20: Strain xy of Solid Element 8

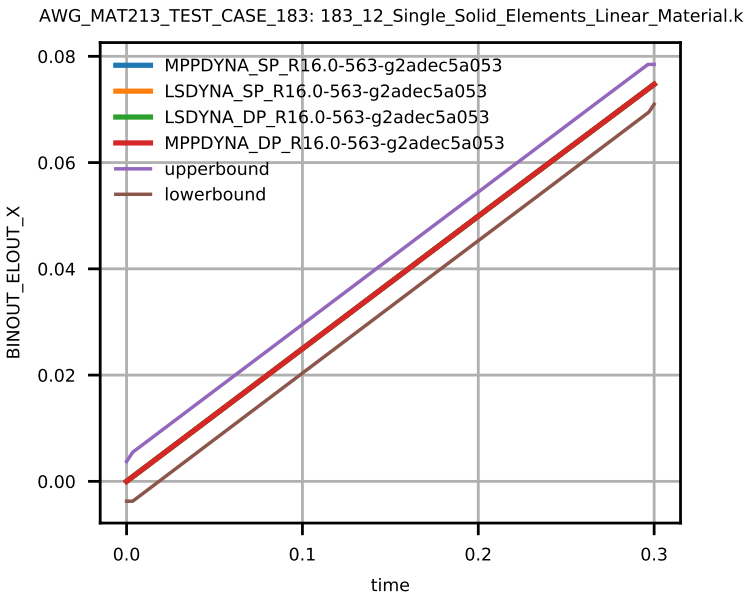

Figure 20: Strain xy of Solid Element 8.

5.3.21 Test Target 21: Strain xx of Solid Element 9

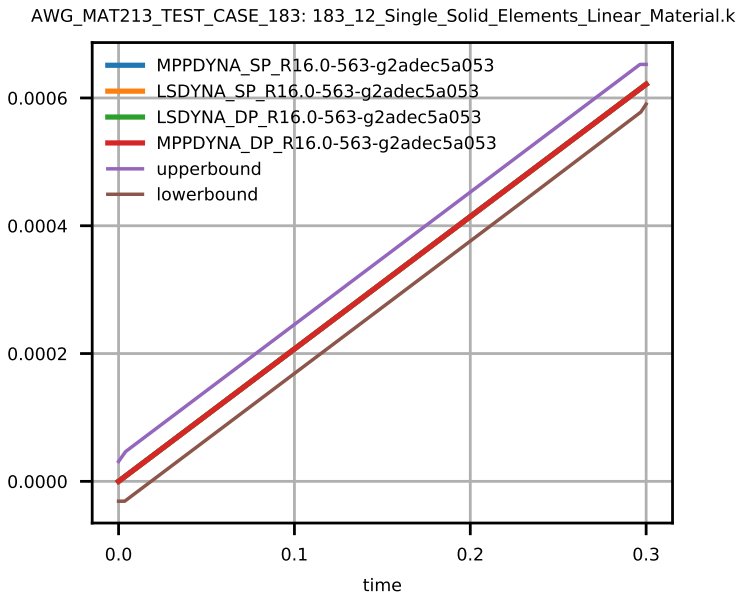

Figure 21: Strain xx of Solid Element 9.

5.3.22 Test Target 22: Strain xx of Solid Element 10

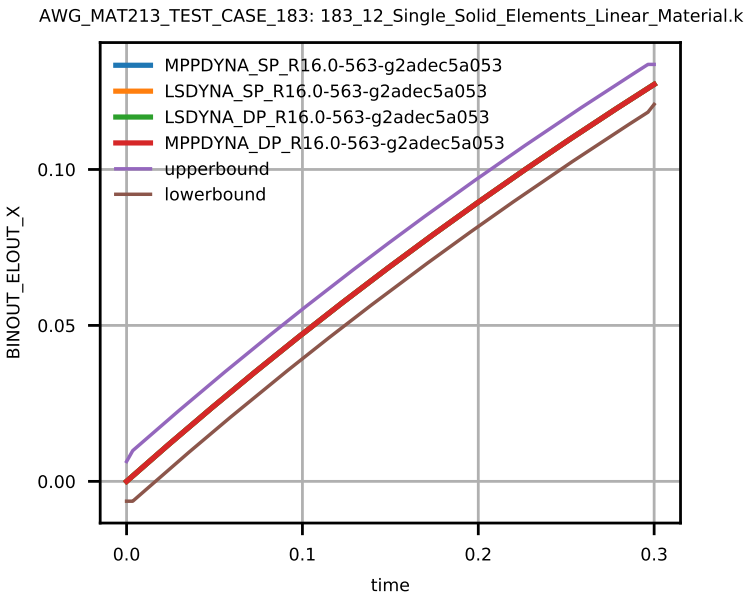

Figure 22: Strain xx of Solid Element 10.

5.3.23 Test Target 23: Strain xx of Solid Element 11

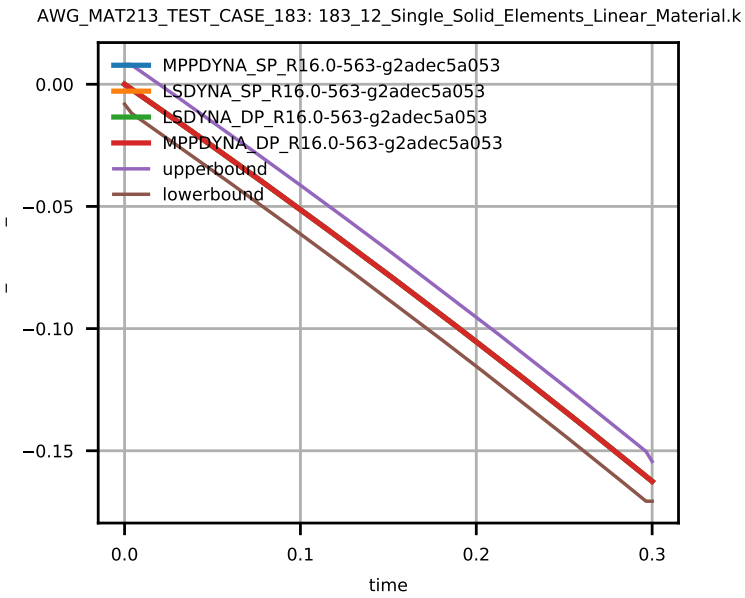

Figure 23: Strain xx of Solid Element 11.

5.3.24 Test Target 24: Strain xx of Solid Element 12

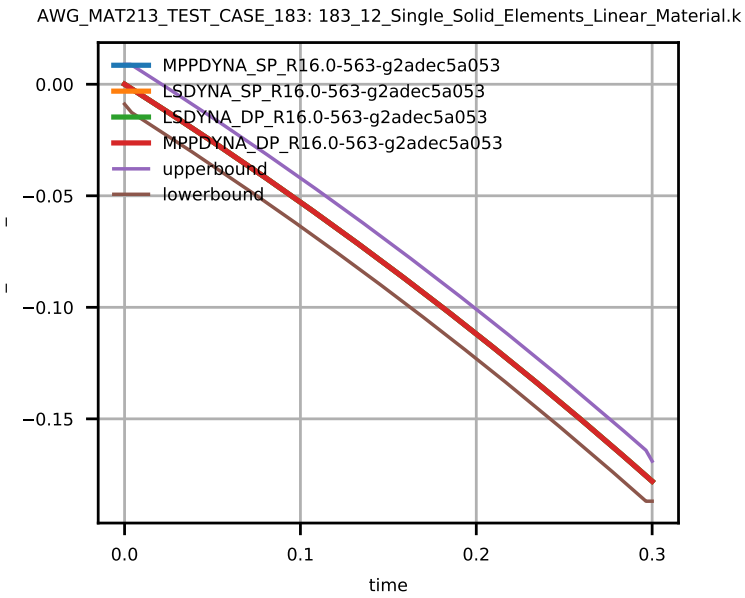

Figure 24: Strain xx of Solid Element 12.

5.3.25 Test Target 25: Global Internal Energy

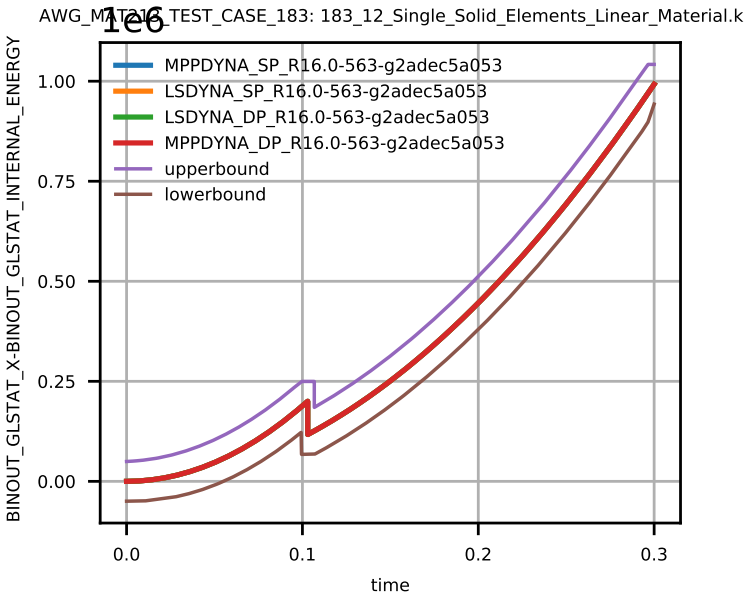

Figure 25: Global Internal Energy.

5.3.26 Test Target 26: Global Kinetic Energy

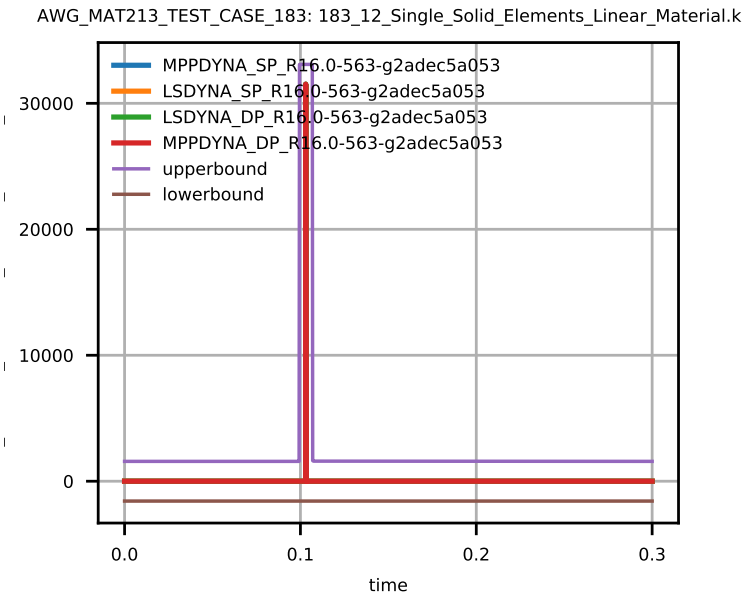

Figure 26: Global Kinetic Energy.

5.3.27 Test Target 27: Global Hourglass Energy

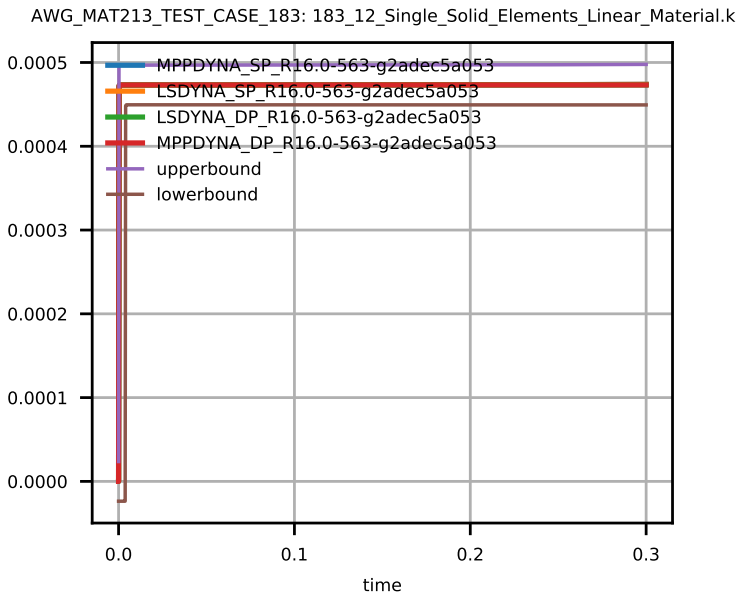

Figure 27: Global Hourglass Energy.

5.3.28 Test Target 28: CPU time

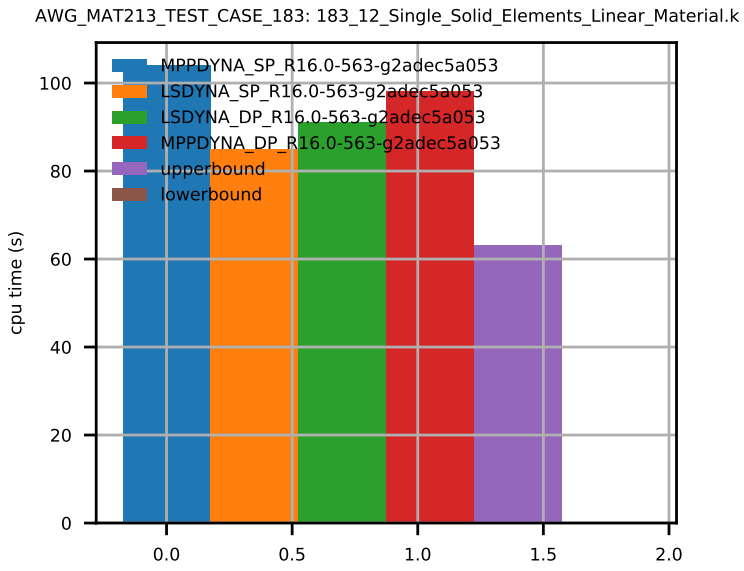

Figure 28: CPU Time.

References