

TEST CASE DOCUMENTATION AND TESTING RESULTS

LSTC-QA-LS-DYNA-AWG-ERIF-15-11

TEST CASE ID AWG-ERIF-15

*MAT_224_GYS

Tested with LS-DYNA® R12.0 Revision 148708

Tuesday 15th December, 2020

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1 Introduction

1.1 Purpose of this Document

The purpose of this test case is the demonstration of the *MAT_224.GYS and *MAT_224 features 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_224_GYS
Test Case ID	AWG-ERIF-15
Test Case Status	active
Test Case Classification	Example
Test Case Source	LSTC
Tested Keyword	*MAT_224_GYS
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-15 is to verify that *MAT_224_GYS and *MAT_224 give the same results for symmetric materials (tensile yield=compressive yield). A total of ten subcases as described in Section 3.2 make up the test case.

3.2 Test Case Description

This test case contains three sets of models (Set 1, Set 2, and Set 3) each with subcases for evaluating and comparing various features in *MAT_224 and *MAT_224_GYS. Set 1 (Figure 1) compares the compressive and shear yield stress as a function of plastic strain (IFLAG=0) and as a function of effective plastic strain (IFLAG=1) for the five load conditions bi-axial tension, uni-axial tension, pure shear, uni-axial compression, and bi-axial compression. Set 2 (Figure 2) compares the four loading patterns step-down, step-up, confined tension, and uni-axial tension for two different fractions of plastic work converted into heat (BETA equal and not equal to 1). Set 3 (Figure 3) contains seven verification test cases with a different yield ratios (compressive yield/tensile yield).

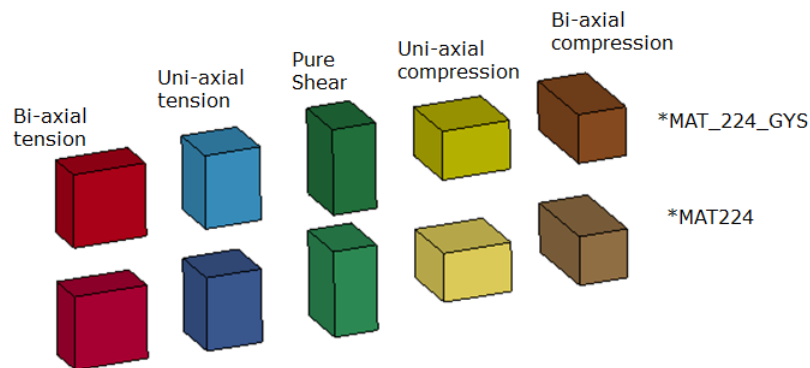


Figure 1: Elements, loads, and materials for Set 1

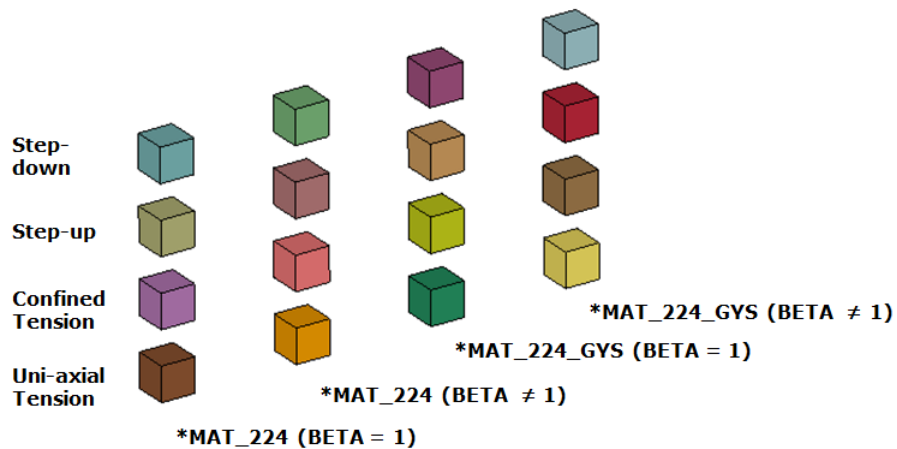


Figure 2: Elements, loads, and materials for Set 2

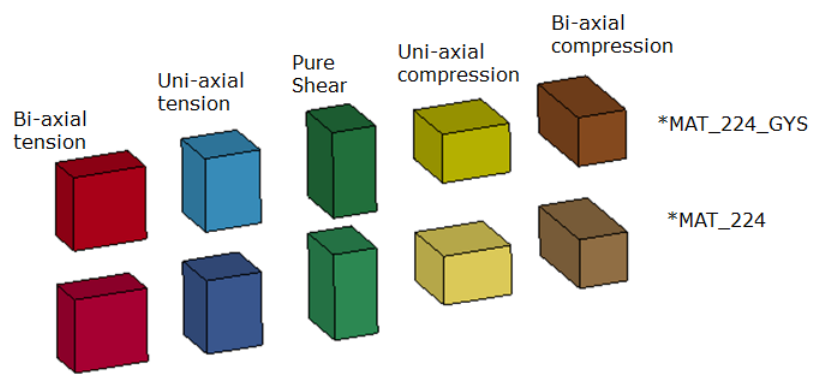


Figure 3: Figure 3: Elements, loads, and materials for Set 3

3.3 Model Description

The models consists of ten subcases with three different sets of single elements using MAT_224 or MAT_224_GYS for various loads. The models were used as verification test cases for the implementation of MAT_224_GYS. 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	Set 1: 80, Set 2: 108, Set 3: 80
Solid Elements	Set 1: 10, Set 2: 16, Set 3: 10
Materials	Set 1: 2, Set 2: 2, Set 3: 2
Parts	Set 1: 10, Set 2: 16, Set 3: 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_QA_SET1_IFLAG0.k
2	MAT224_GYS_QA_SET1_IFLAG1.k
3	MAT224_GYS_QA_SET2.k
4	MAT224_GYS_QA_SET3_case2.k
5	MAT224_GYS_QA_SET3_case3.k
6	MAT224_GYS_QA_SET3_case4.k
7	MAT224_GYS_QA_SET3_case5.k
8	MAT224_GYS_QA_SET3_case6.k
9	MAT224_GYS_QA_SET3_case7.k
10	MAT224_GYS_QA_SET3_case8.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	1-10	binout/elout file
2	1	elout	Von Mises Stress	1-10	binout/elout file
3	2	elout	z-component Stress	1-10	binout/elout file
4	2	elout	Von Mises Stress	1-10	binout/elout file
5	3	elout	z-component Stress	9-24	binout/elout file
6	3	elout	Von Mises Stress	9-24	binout/elout file
7	4	elout	z-component Stress	2,4,12,14	binout/elout file
8	4	elout	Von Mises Stress	2,4,12,14	binout/elout file
9	5	elout	z-component Stress	2,4,12,14	binout/elout file
10	5	elout	Von Mises Stress	2,4,12,14	binout/elout file
11	6	elout	z-component Stress	2-4,12-14	binout/elout file
12	6	elout	Von Mises Stress	2-4,12-14	binout/elout file
13	7	elout	z-component Stress	2-4,12-14	binout/elout file
14	7	elout	Von Mises Stress	2-4,12-14	binout/elout file
15	8	elout	z-component Stress	2-4,12-14	binout/elout file
16	8	elout	Von Mises Stress	2-4,12-14	binout/elout file
17	9	elout	z-component Stress	2-4,12-14	binout/elout file
18	9	elout	Von Mises Stress	2-4,12-14	binout/elout file
19	10	elout	z-component Stress	2-4,12-14	binout/elout file
20	10	elout	Von Mises Stress	2-4,12-14	binout/elout file

Table 4: Test Case targets for Test Case ID AWG-ERIF-15

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-15.

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® R9.1 Revision 113467 binaries by the following process:

- For a specific test case target, interpolate the data from different platform and executable (R9.1 Revision 113467) 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 (R9.1 Revision 113467) 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
mars	CentOS 6.5	Intel [®] Xeon [®] E5- 2640 @ 2.50GHz	Platform MPI 8.2.0.0	4
dinar3b	SUSE LES 11	AMD [®] Opteron [®] 6276 @ 2300MHz	Platform MPI 8.2.0.0	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	R12.0	148708	SMP	SP	ls971.148708.R12.0
LS-DYNA [®]	971	R12.0	148708	SMP	DP	ld971.148708.R12.0
LS-DYNA [®]	971	R12.0	148708	MPP	SP	mpp971.148708.R12.0
LS-DYNA [®]	971	R12.0	148708	MPP	DP	mpd971.148708.R12.0

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-ERIF-15 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
2	PASS
3	PASS
4	PASS
5	PASS
6	PASS
7	PASS
8	PASS
9	PASS
10	PASS

Table 7: Results summary for Test Case ID AWG-ERIF-15

5.3 Result Details

The following subsections contain detailed results for the Test Case ID AWG-ERIF-15 for LS-DYNA® R12.0 Revision 148708.

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 result file name, output, platform, executable and number of cpu's separated by comma. A minus sign before the number of cpu's refers to the compatibility option for SMP calculations (see [1] for details on this option).

Example for title and legend:

Title:

'AWG_ERIF_TEST_CASE_15: MAT224_GYS_QA_SET1_IFLAG0.k' states the test case ID 15 and name of the input deck for sub test case 1.

Legend:

'elout_effsg_1_1_1,mars,ls971.148708.R12.0,4' states that the graph shows the Von Mises Stress (effective stress) of element ID 1 derived from the 'elout' output file for an input deck which was calculated on the 'mars' platform with a LS-DYNA® R12.0 Revision 148708 binary (SMP, single precision) on four processors.

5.3.1 Sub Test Case ID 1 - Test Target 1

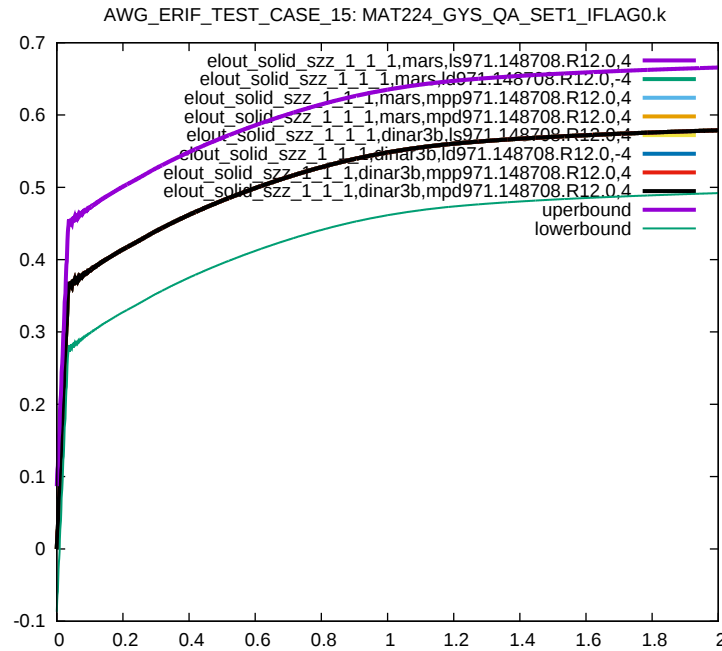


Figure 4: Cross platform results, z-component Stress, element ID 1, sub test case ID 1

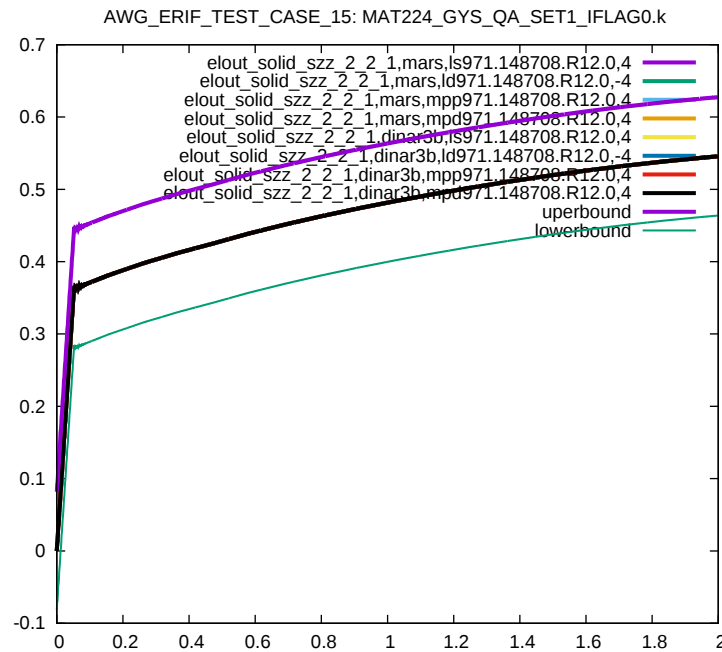


Figure 5: Cross platform results, z-component Stress, element ID 2, sub test case ID 1

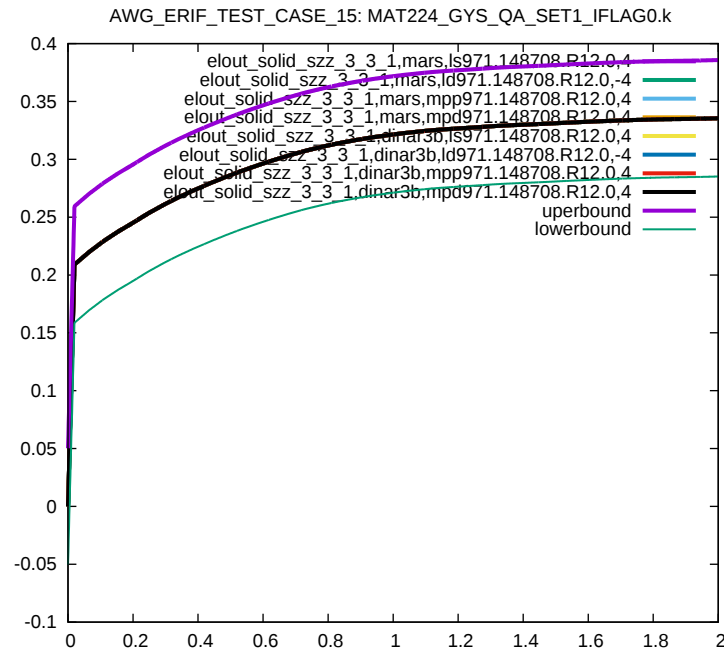


Figure 6: Cross platform results, z-component Stress, element ID 3, sub test case ID 1

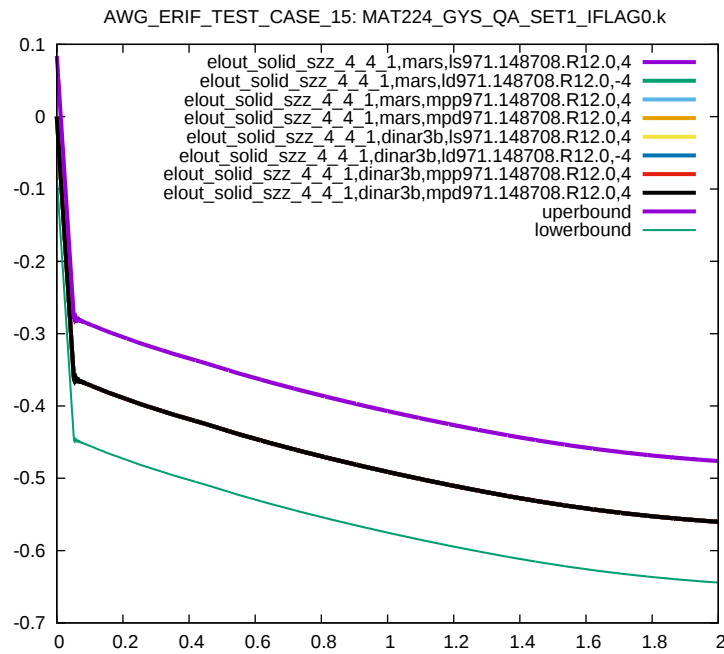


Figure 7: Cross platform results, z-component Stress, element ID 4, sub test case ID 1

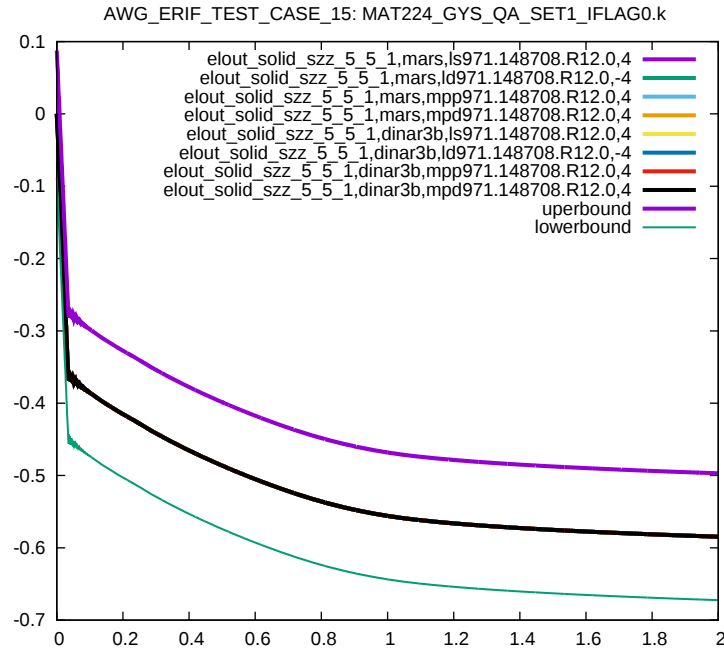


Figure 8: Cross platform results, z-component Stress, element ID 5, sub test case ID 1

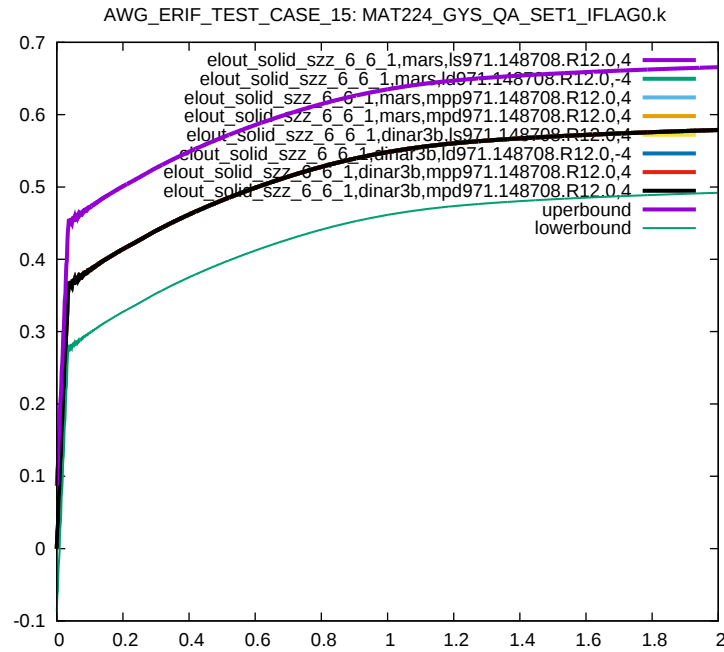


Figure 9: Cross platform results, z-component Stress, element ID 6, sub test case ID 1

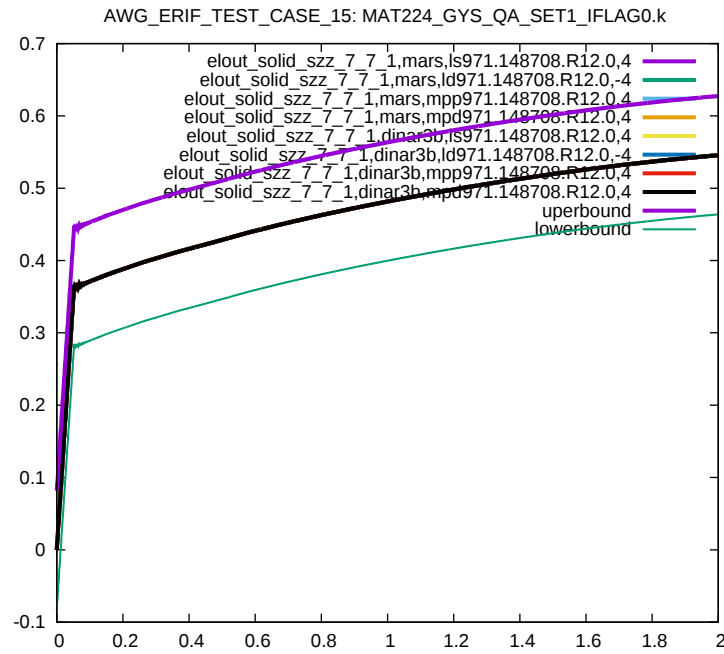


Figure 10: Cross platform results, z-component Stress, element ID 7, sub test case ID 1

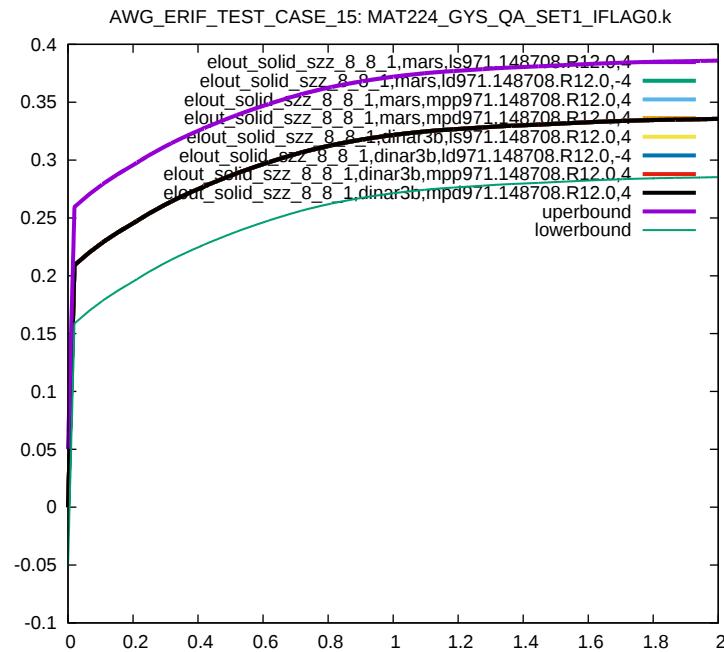


Figure 11: Cross platform results, z-component Stress, element ID 8, sub test case ID 1

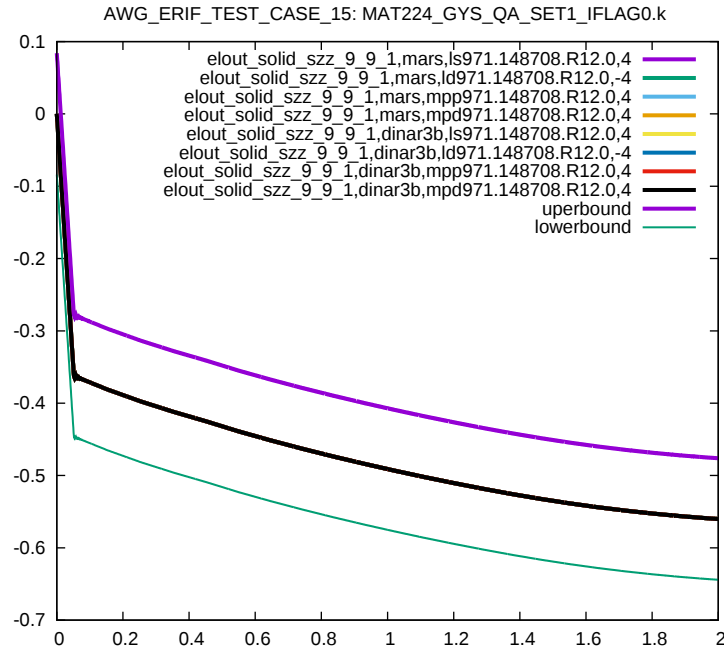


Figure 12: Cross platform results, z-component Stress, element ID 9, sub test case ID 1

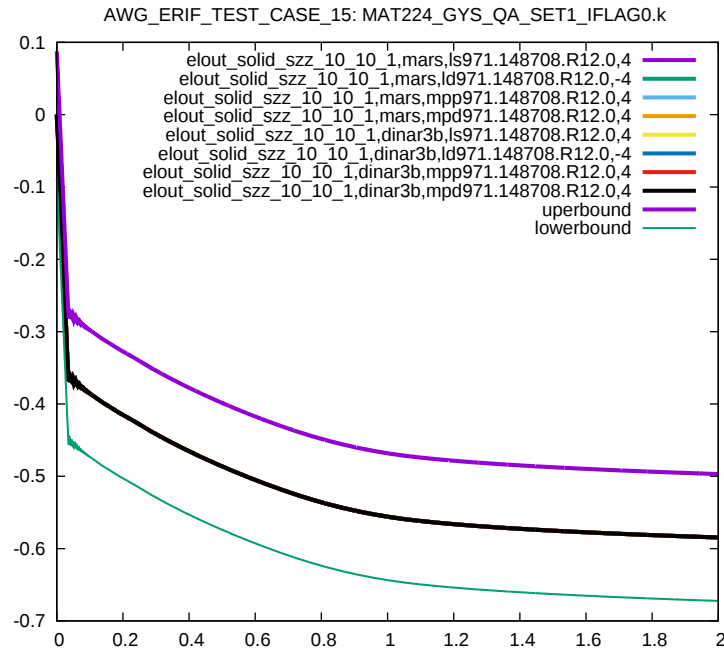


Figure 13: Cross platform results, z-component Stress, element ID 10, sub test case ID 1

5.3.2 Sub Test Case ID 1 - Test Target 2

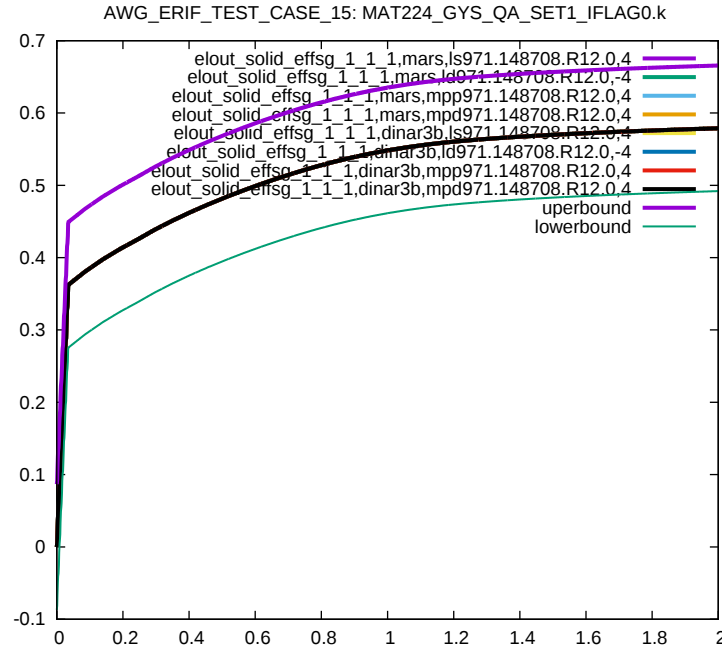


Figure 14: Cross platform results, Von Mises Stress, element ID 1, sub test case ID 1

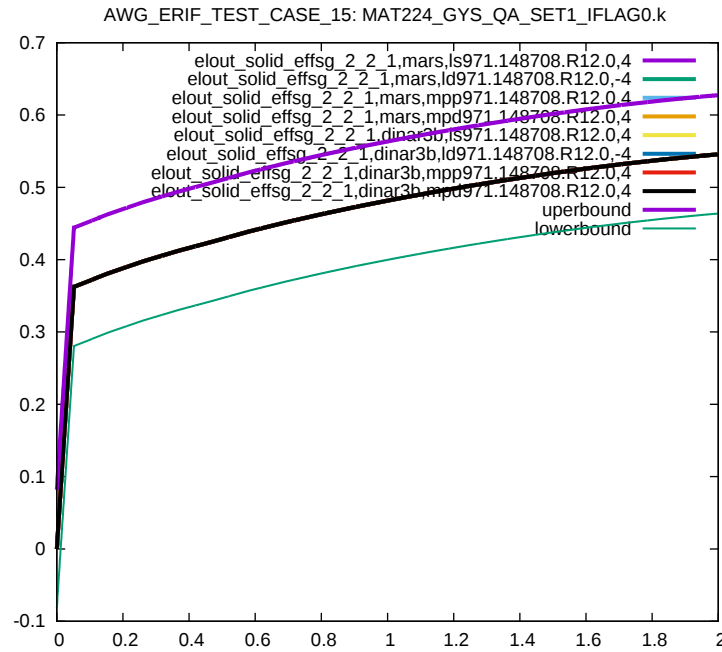


Figure 15: Cross platform results, Von Mises Stress, element ID 2, sub test case ID 1

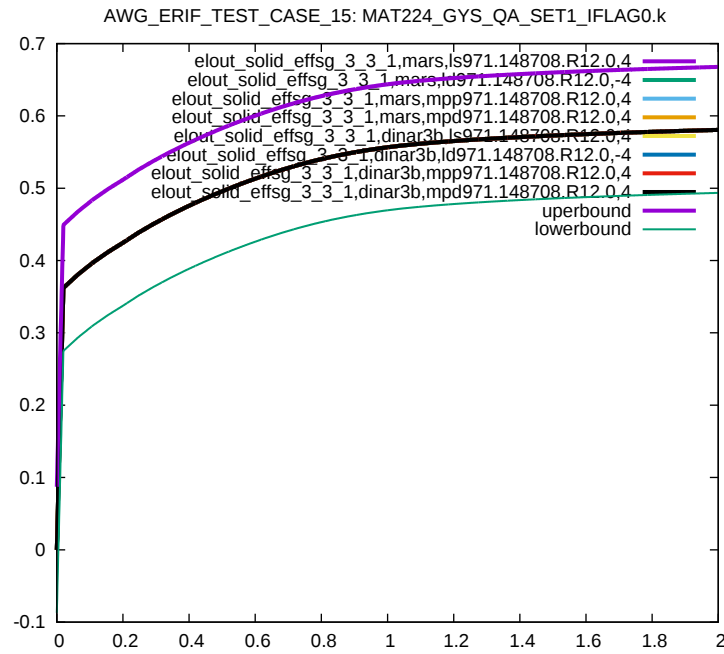


Figure 16: Cross platform results, Von Mises Stress, element ID 3, sub test case ID 1

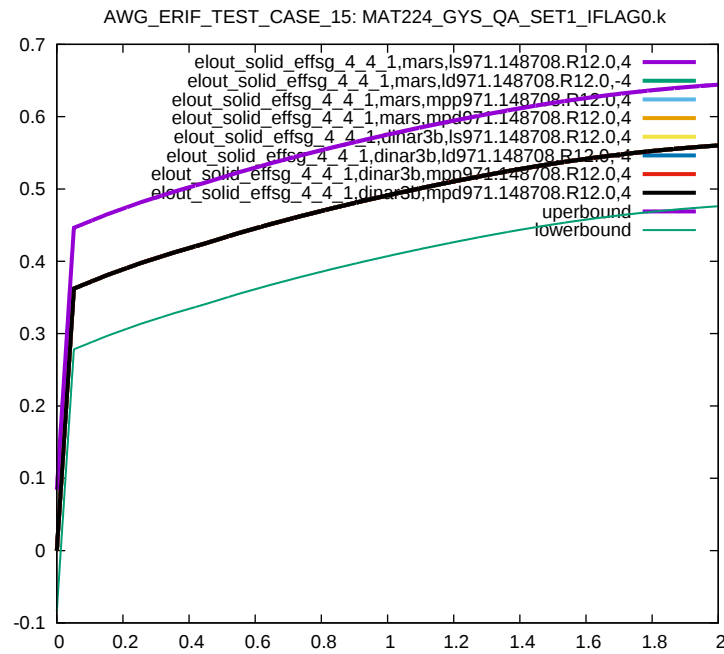


Figure 17: Cross platform results, Von Mises Stress, element ID 4, sub test case ID 1

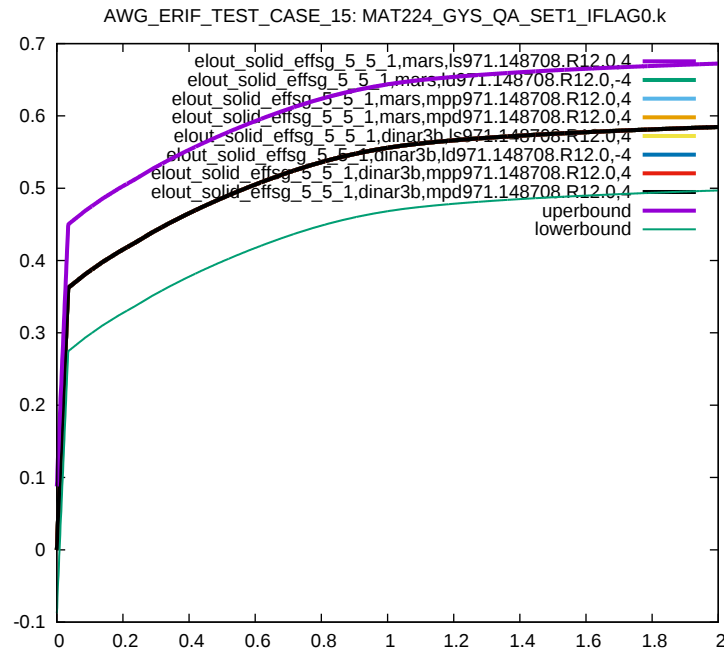


Figure 18: Cross platform results, Von Mises Stress, element ID 5, sub test case ID 1

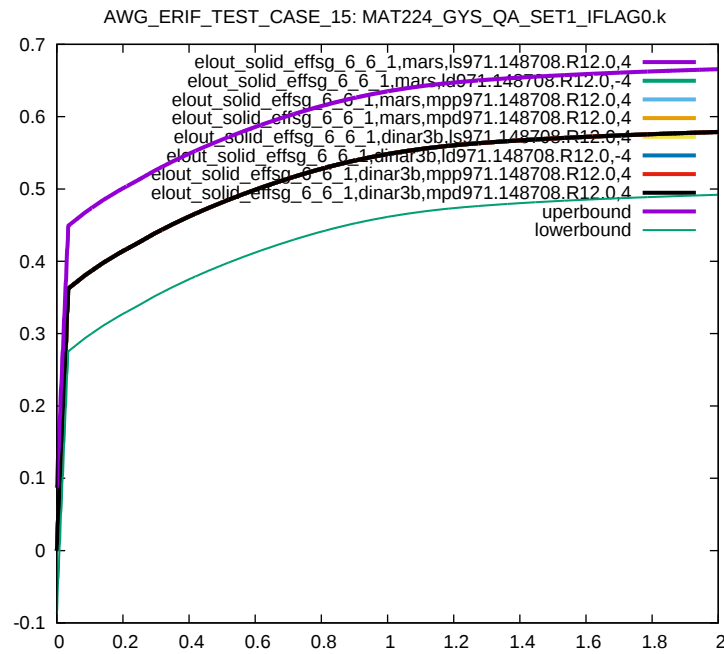


Figure 19: Cross platform results, Von Mises Stress, element ID 6, sub test case ID 1

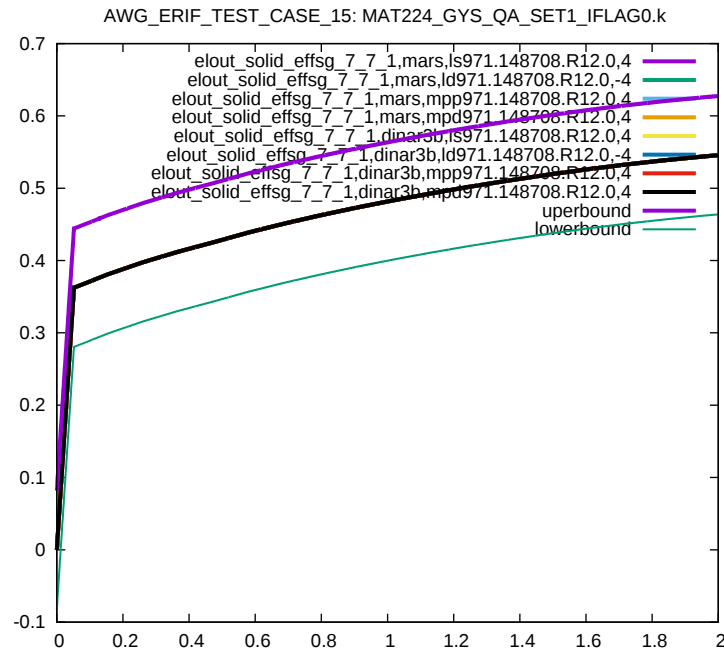


Figure 20: Cross platform results, Von Mises Stress, element ID 7, sub test case ID 1

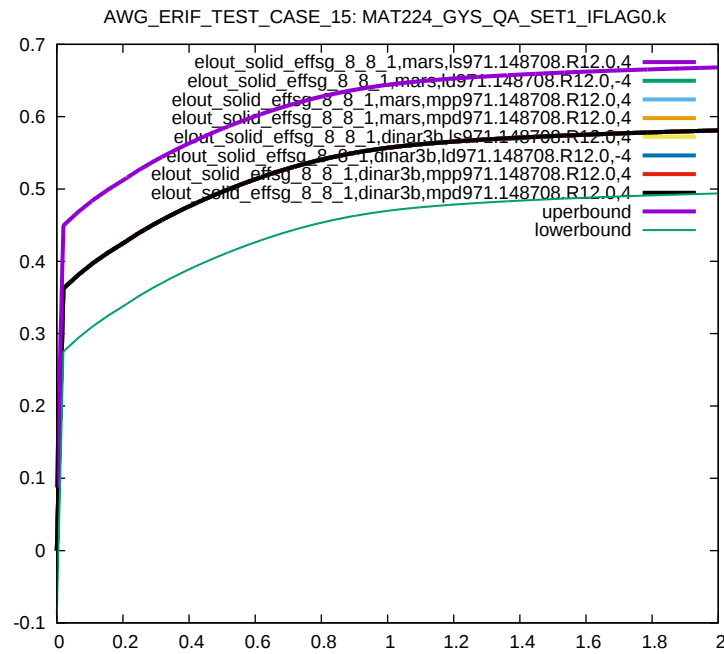


Figure 21: Cross platform results, Von Mises Stress, element ID 8, sub test case ID 1

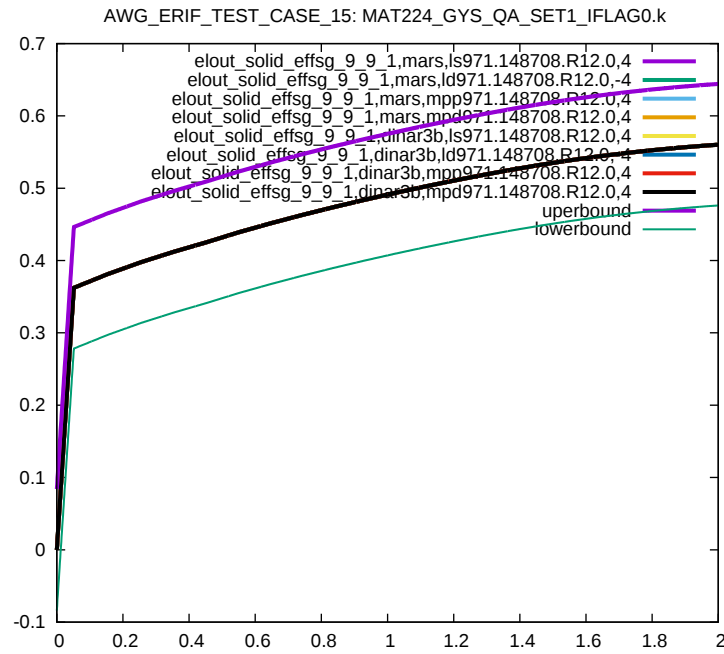


Figure 22: Cross platform results, Von Mises Stress, element ID 9, sub test case ID 1

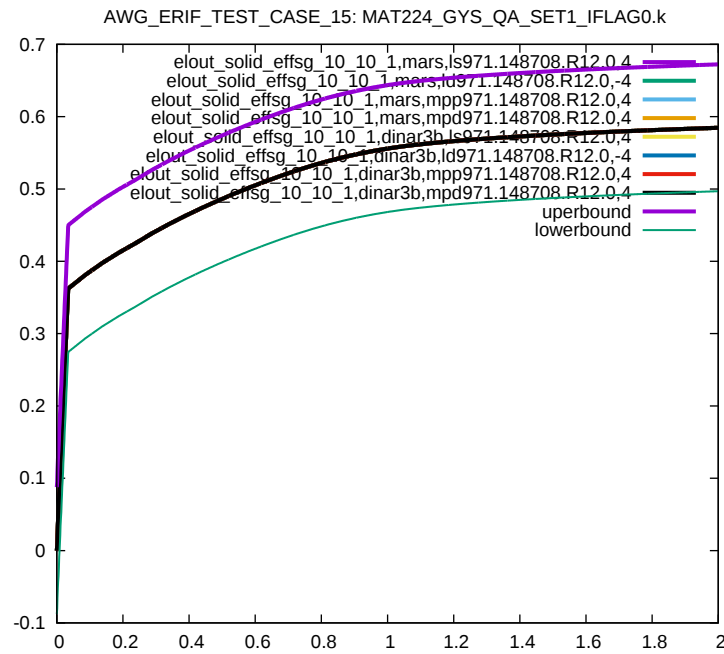


Figure 23: Cross platform results, Von Mises Stress, element ID 10, sub test case ID 1

5.3.3 Sub Test Case ID 2 - Test Target 3

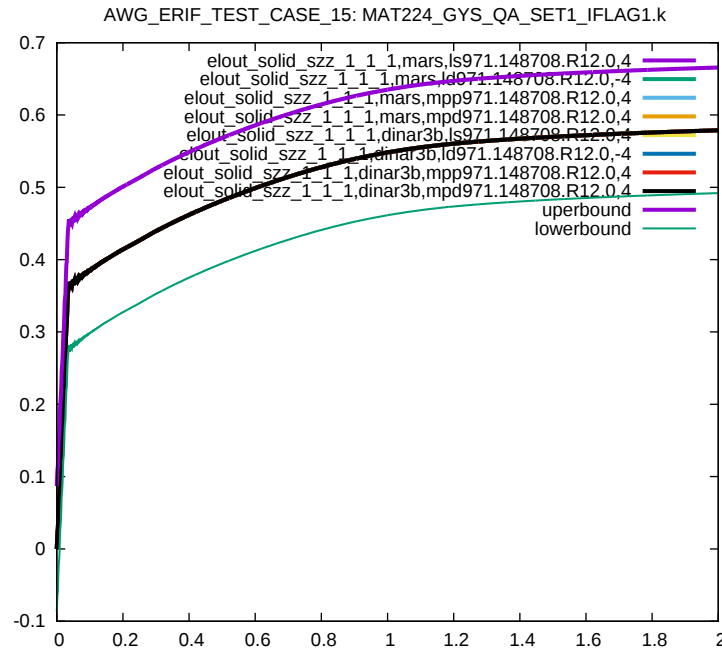


Figure 24: Cross platform results, z-component Stress, element ID 1, sub test case ID 2

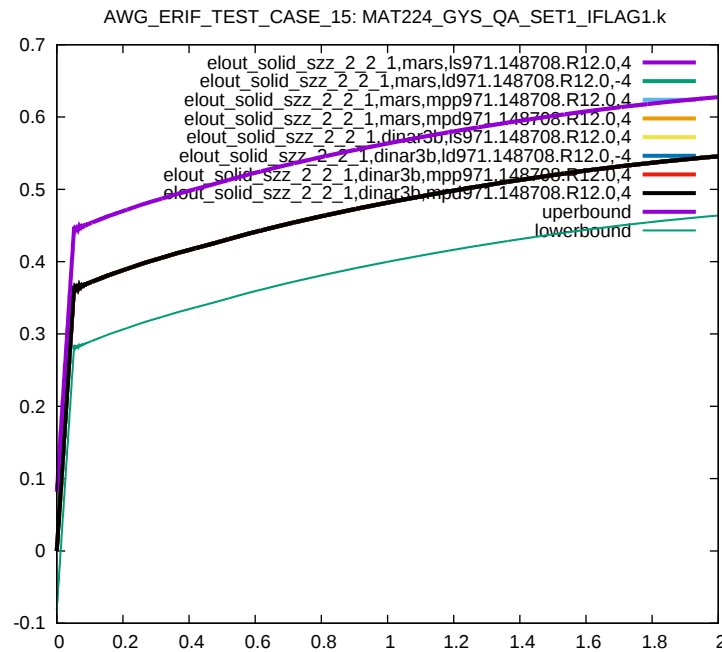


Figure 25: Cross platform results, z-component Stress, element ID 2, sub test case ID 2

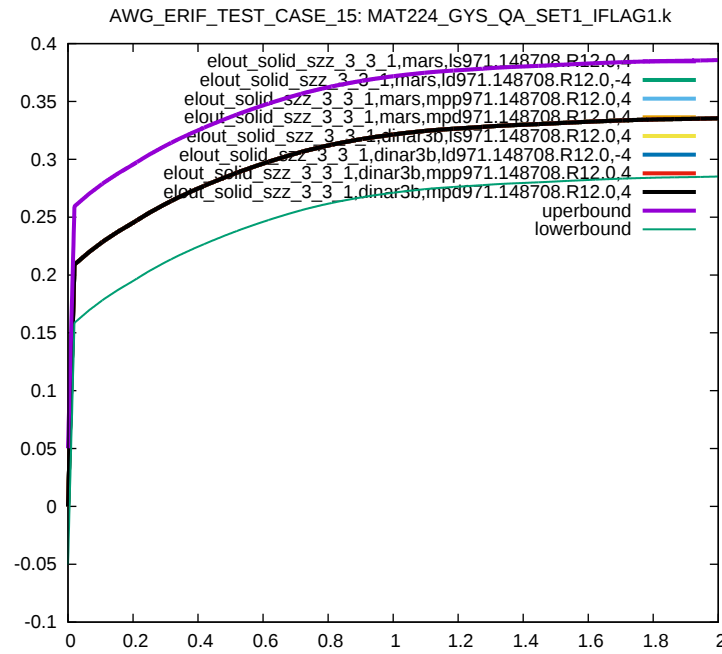


Figure 26: Cross platform results, z-component Stress, element ID 3, sub test case ID 2

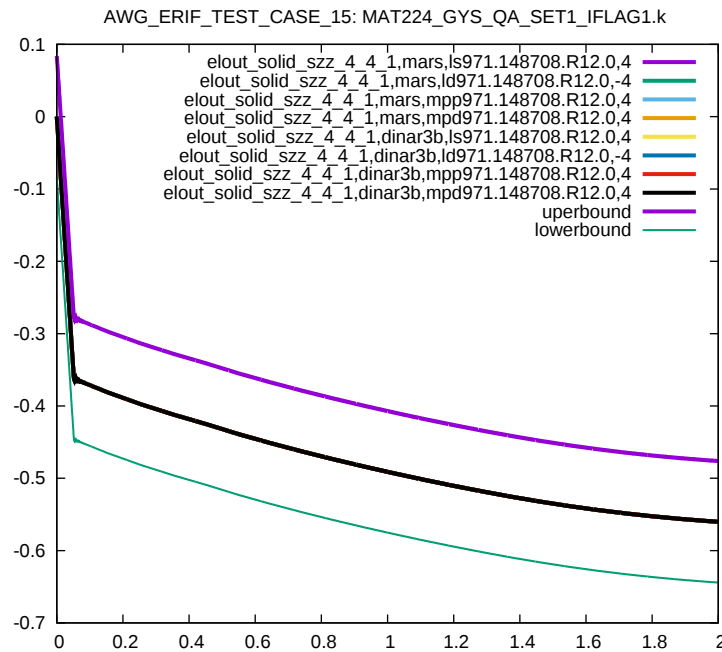


Figure 27: Cross platform results, z-component Stress, element ID 4, sub test case ID 2

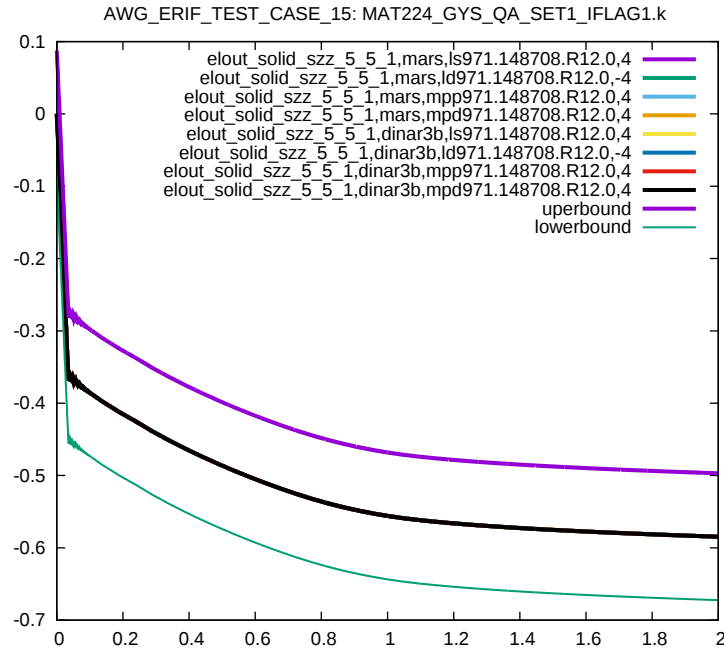


Figure 28: Cross platform results, z-component Stress, element ID 5, sub test case ID 2

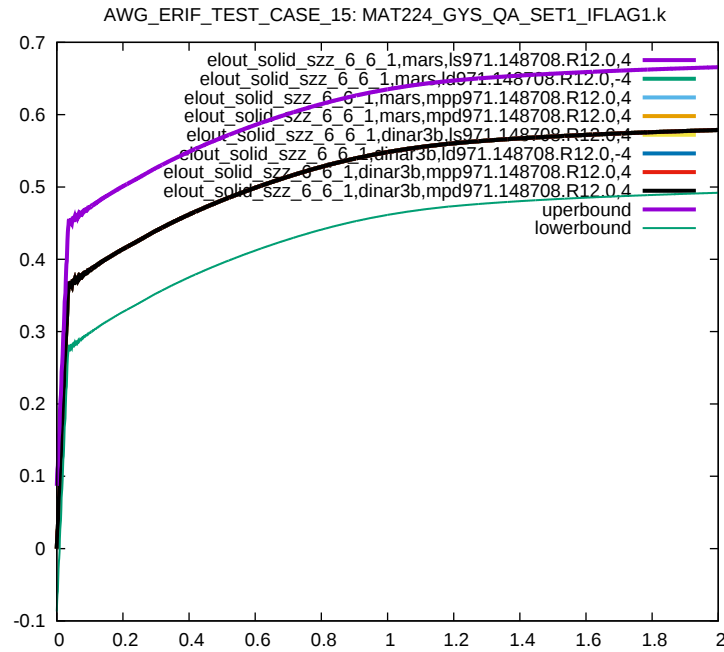


Figure 29: Cross platform results, z-component Stress, element ID 6, sub test case ID 2

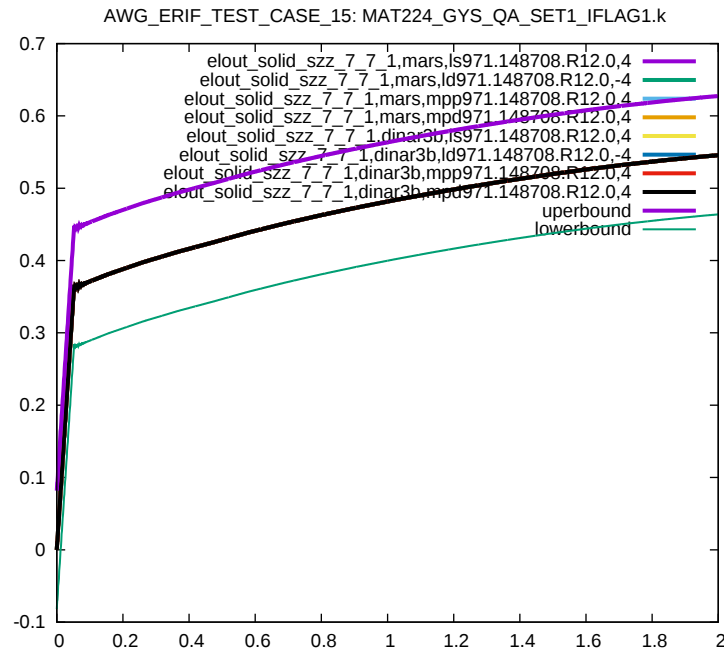


Figure 30: Cross platform results, z-component Stress, element ID 7, sub test case ID 2

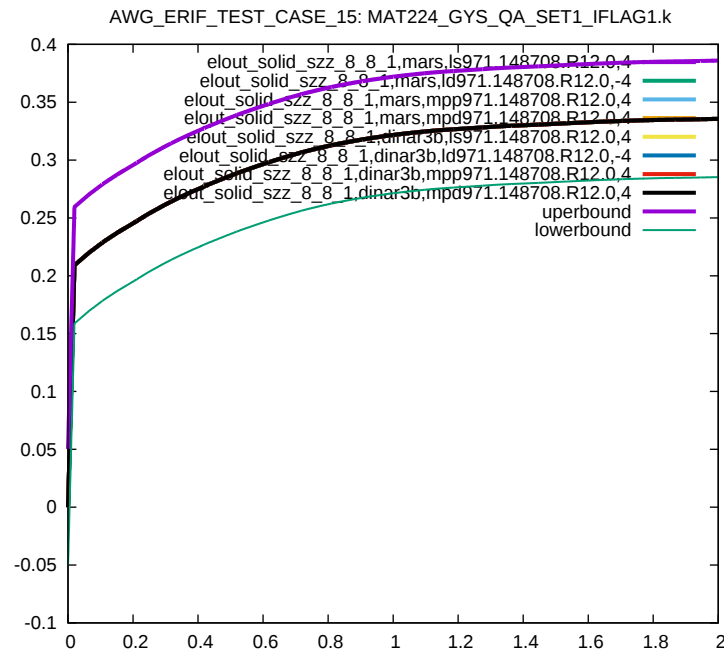


Figure 31: Cross platform results, z-component Stress, element ID 8, sub test case ID 2

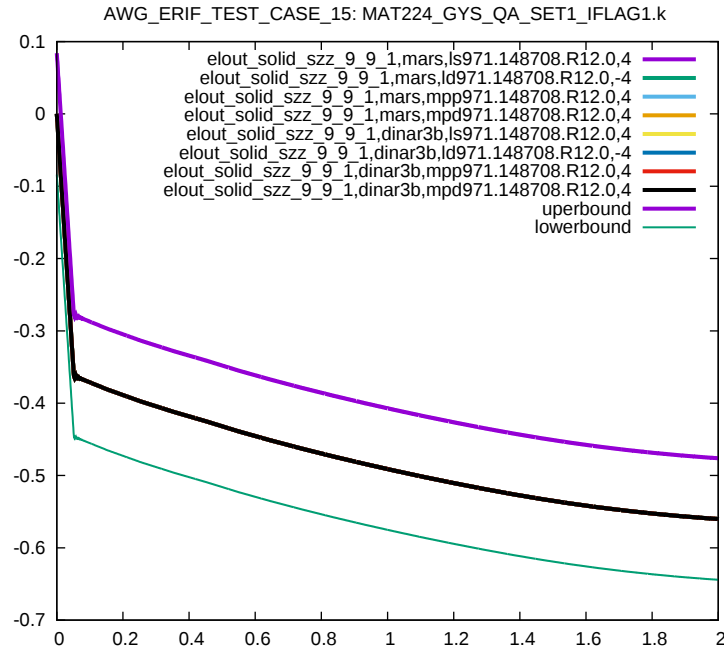


Figure 32: Cross platform results, z-component Stress, element ID 9, sub test case ID 2

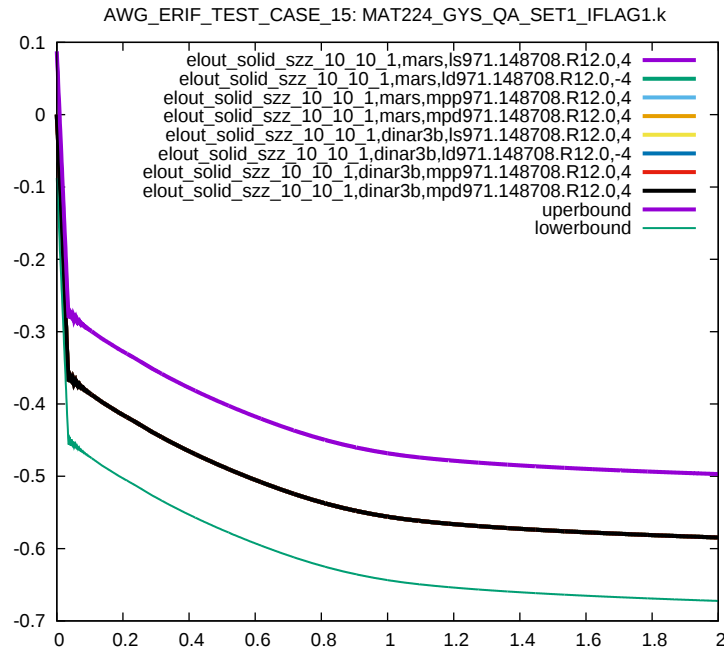


Figure 33: Cross platform results, z-component Stress, element ID 10, sub test case ID 2

5.3.4 Sub Test Case ID 2 - Test Target 4

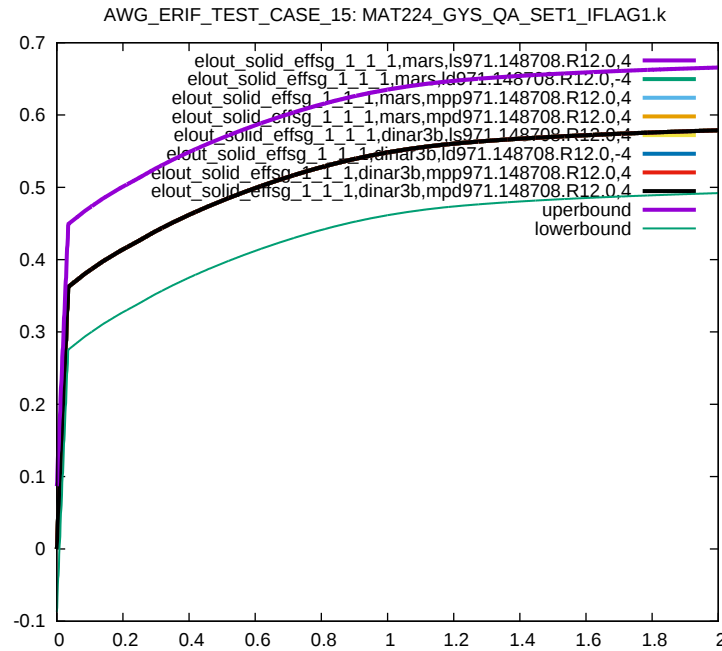


Figure 34: Cross platform results, Von Mises Stress, element ID 1, sub test case ID 2

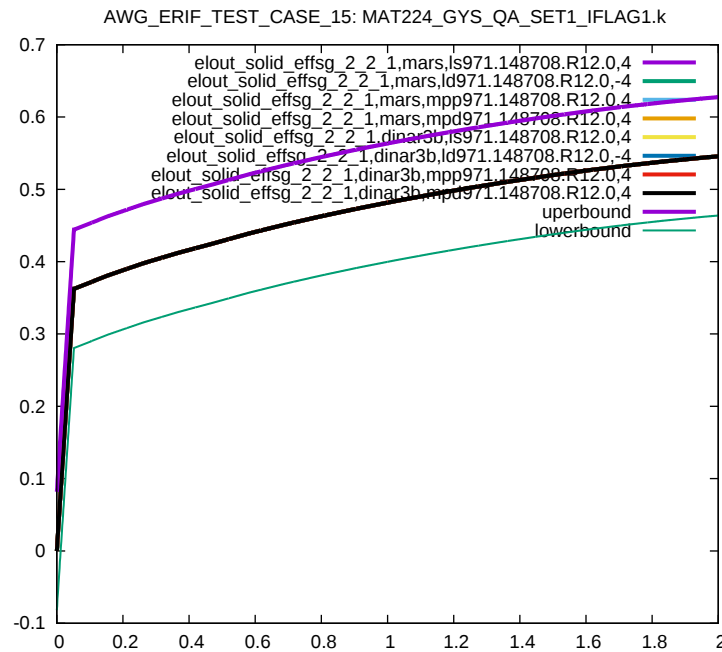


Figure 35: Cross platform results, Von Mises Stress, element ID 2, sub test case ID 2

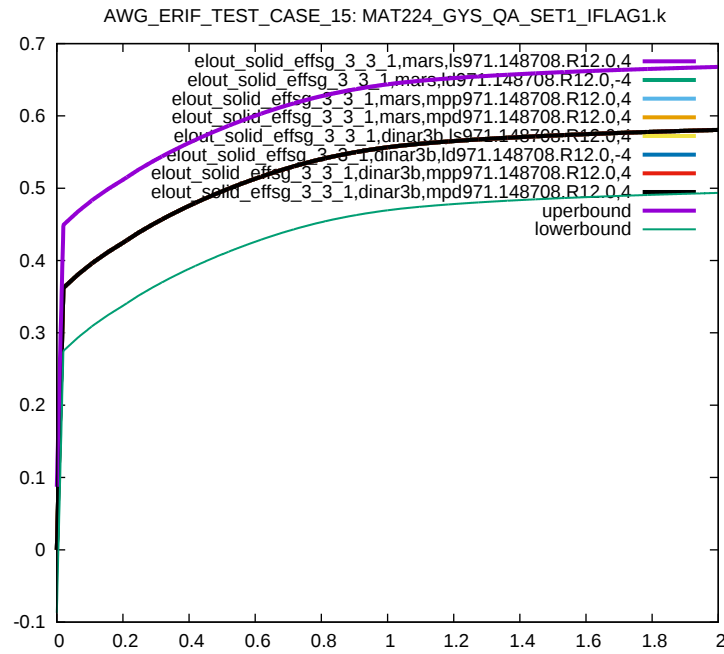


Figure 36: Cross platform results, Von Mises Stress, element ID 3, sub test case ID 2

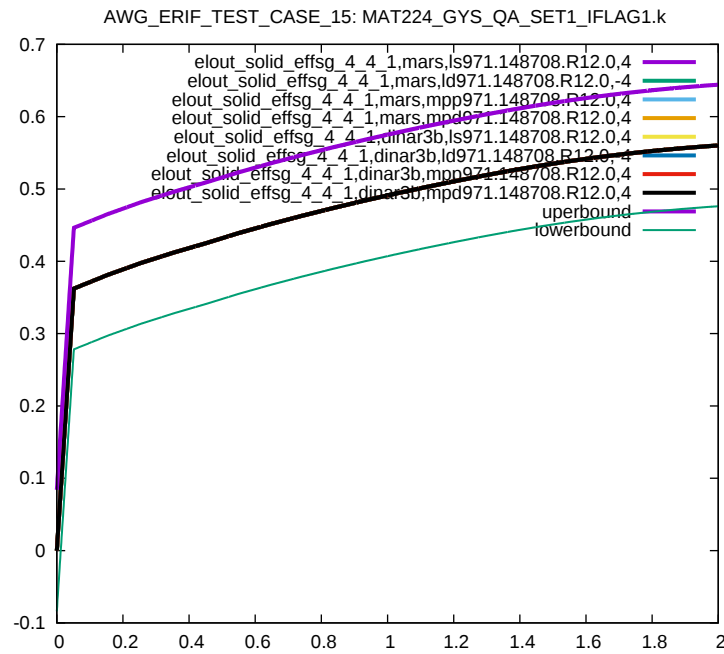


Figure 37: Cross platform results, Von Mises Stress, element ID 4, sub test case ID 2

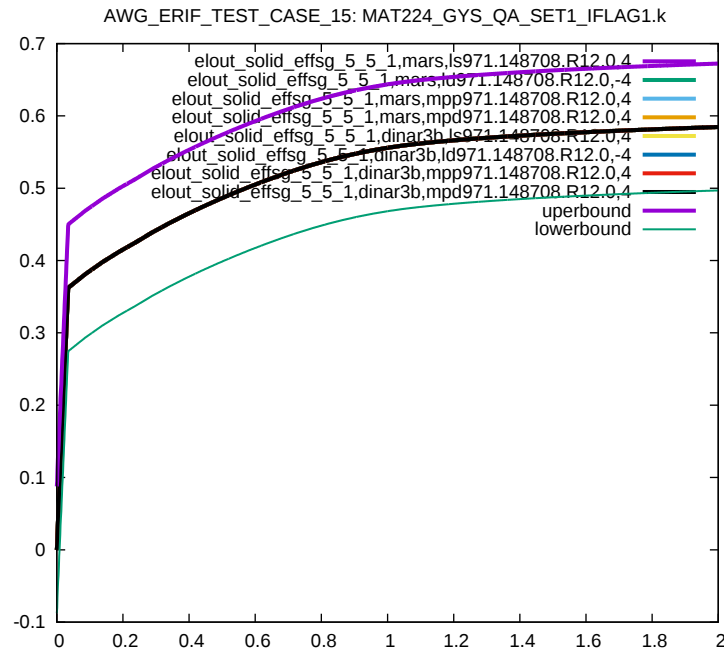


Figure 38: Cross platform results, Von Mises Stress, element ID 5, sub test case ID 2

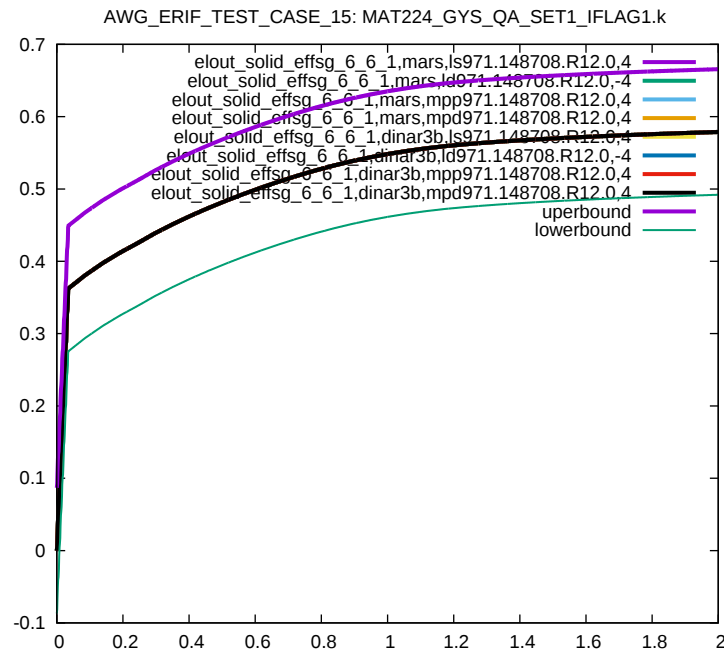


Figure 39: Cross platform results, Von Mises Stress, element ID 6, sub test case ID 2

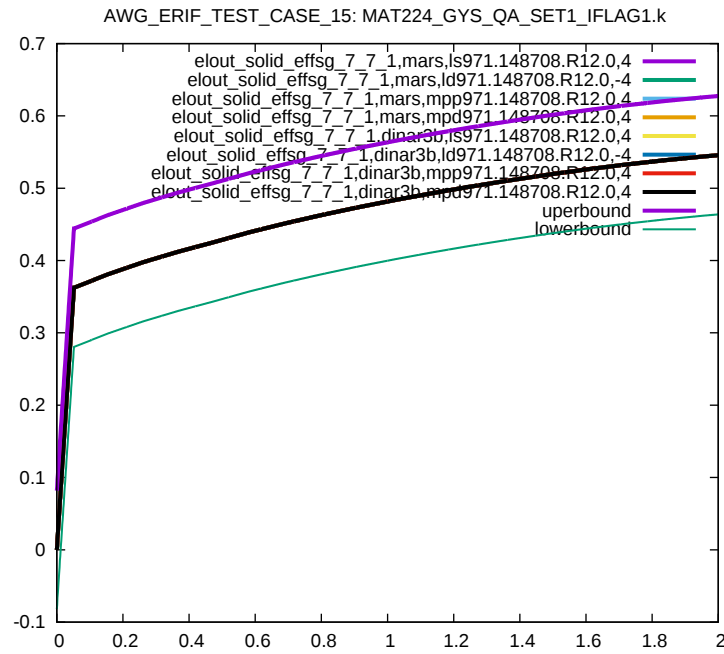


Figure 40: Cross platform results, Von Mises Stress, element ID 7, sub test case ID 2

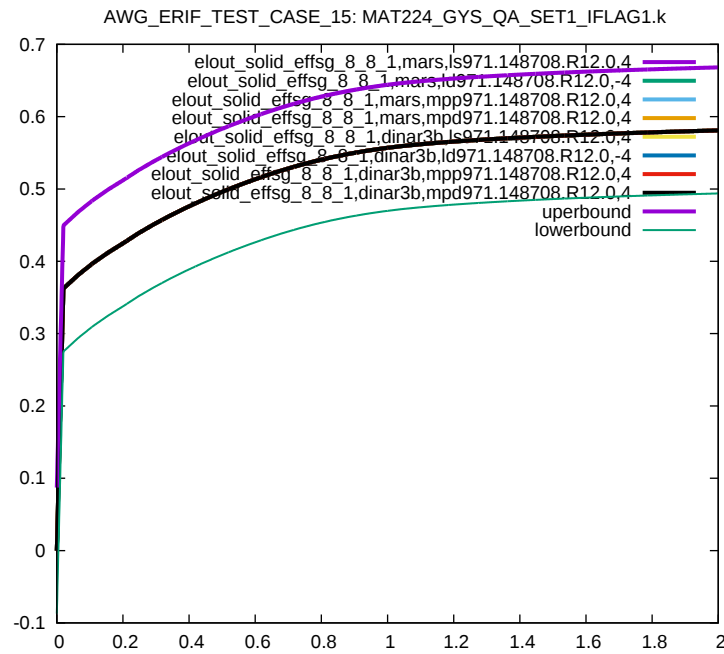


Figure 41: Cross platform results, Von Mises Stress, element ID 8, sub test case ID 2

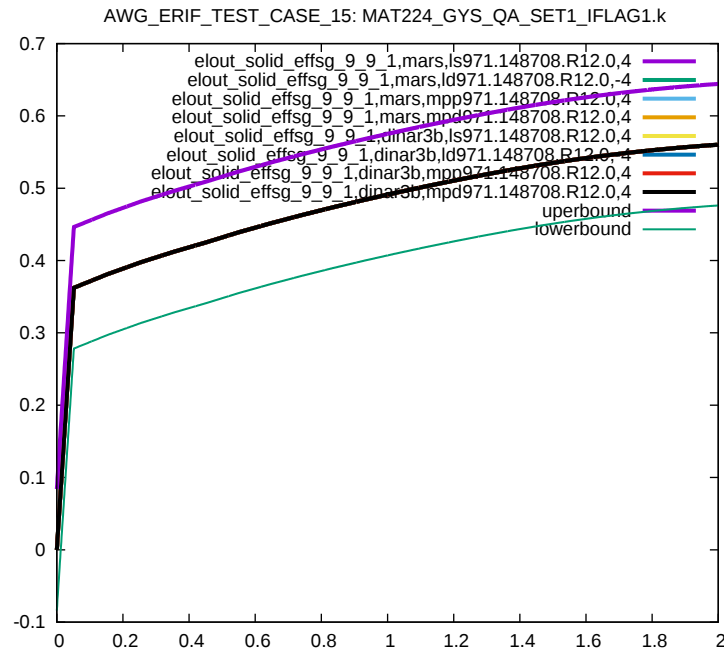


Figure 42: Cross platform results, Von Mises Stress, element ID 9, sub test case ID 2

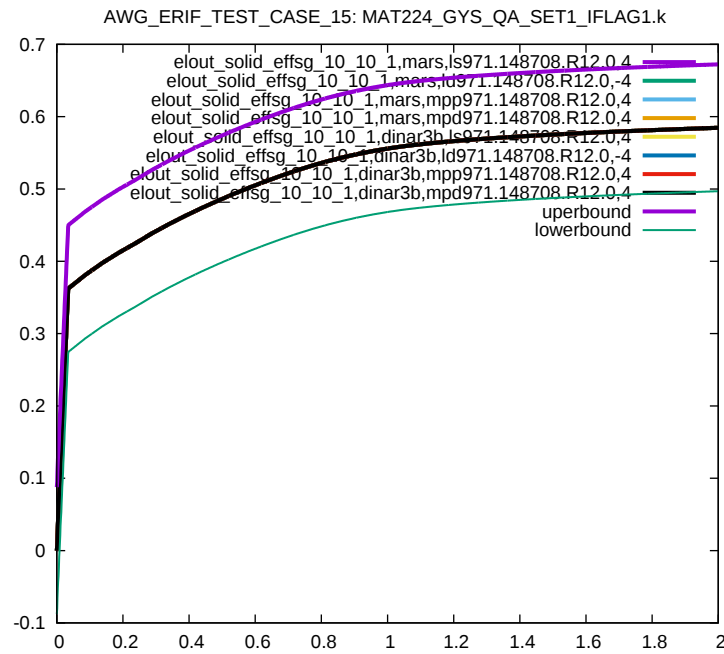


Figure 43: Cross platform results, Von Mises Stress, element ID 10, sub test case ID 2

5.3.5 Sub Test Case ID 3 - Test Target 5

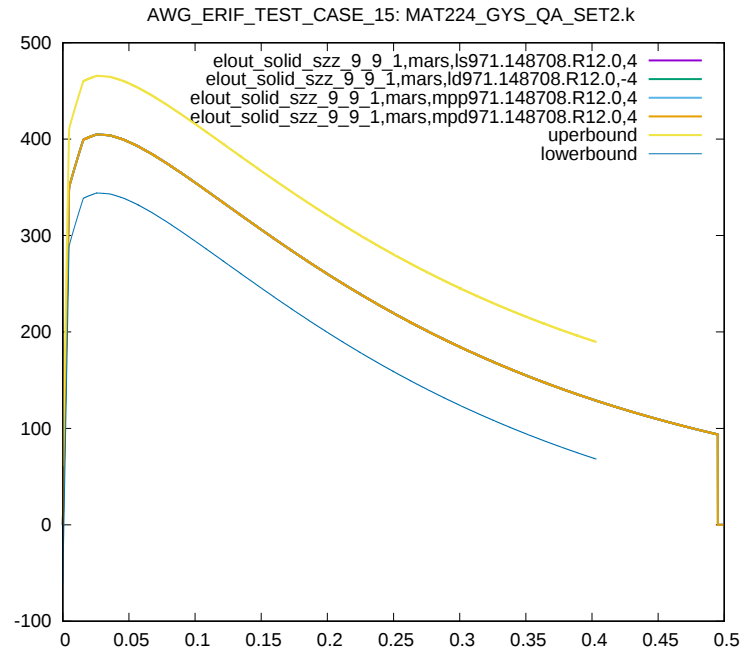


Figure 44: Cross platform results, z-component Stress, element ID 9, sub test case ID 3

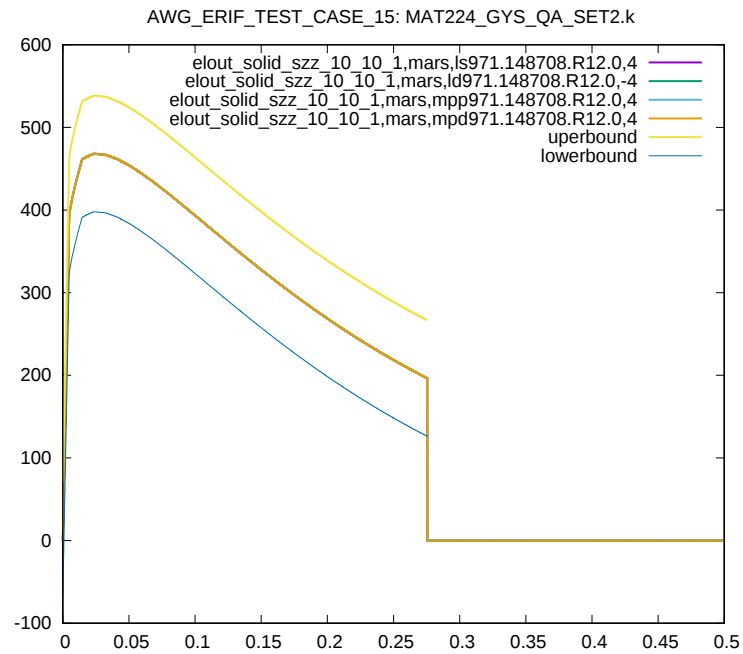


Figure 45: Cross platform results, z-component Stress, element ID 10, sub test case ID 3

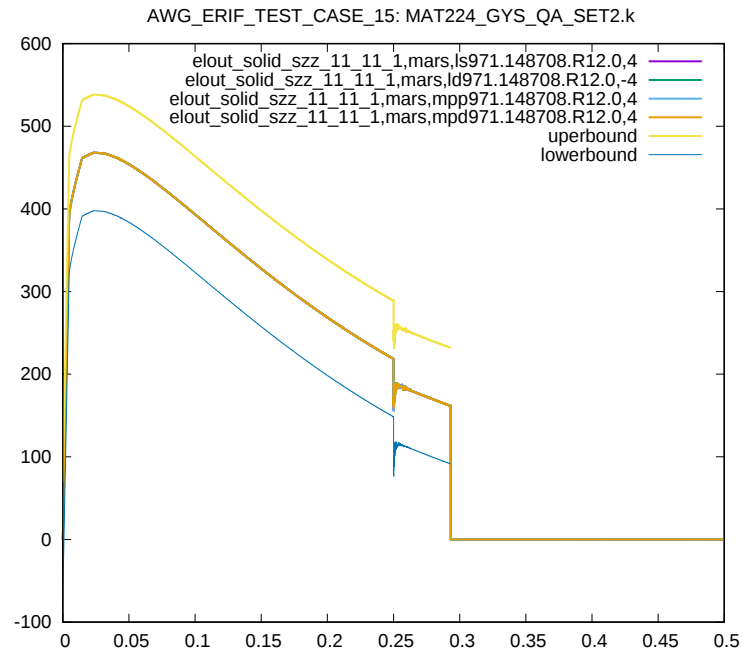


Figure 46: Cross platform results, z-component Stress, element ID 11, sub test case ID 3

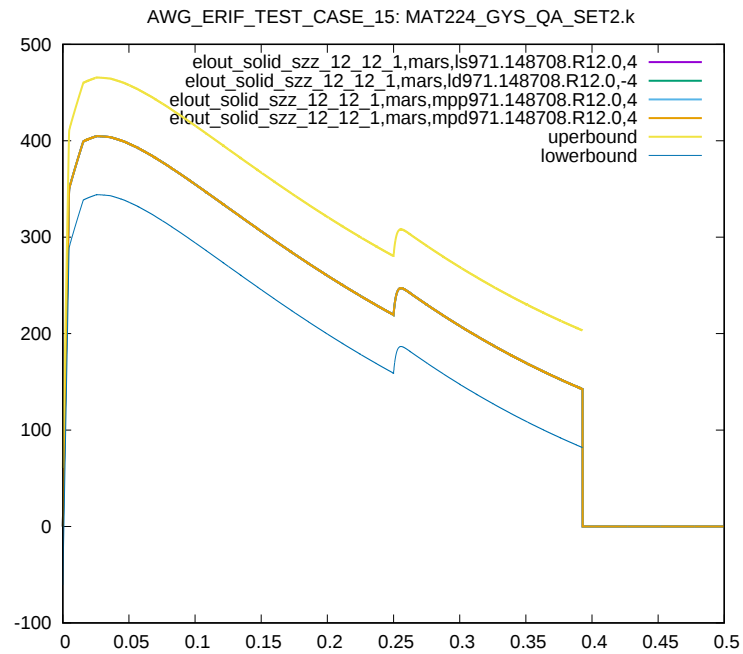


Figure 47: Cross platform results, z-component Stress, element ID 12, sub test case ID 3

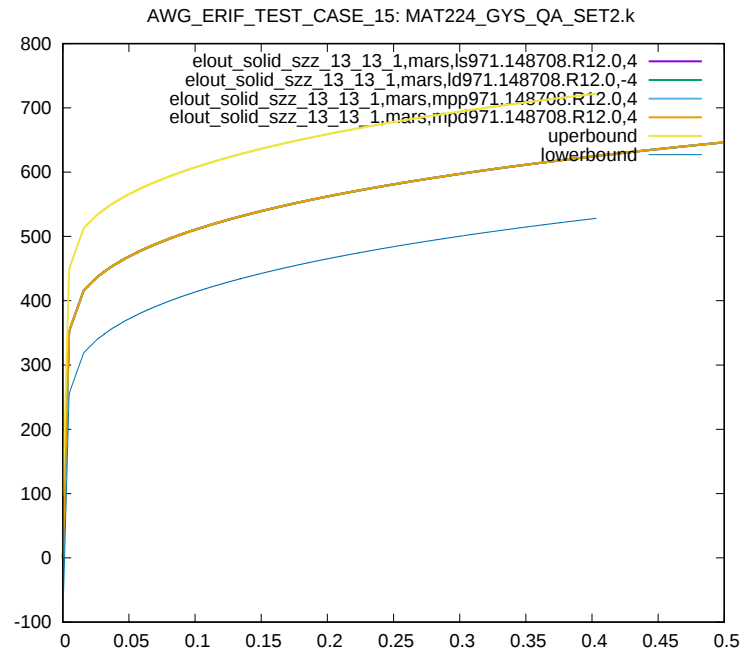


Figure 48: Cross platform results, z-component Stress, element ID 13, sub test case ID 3

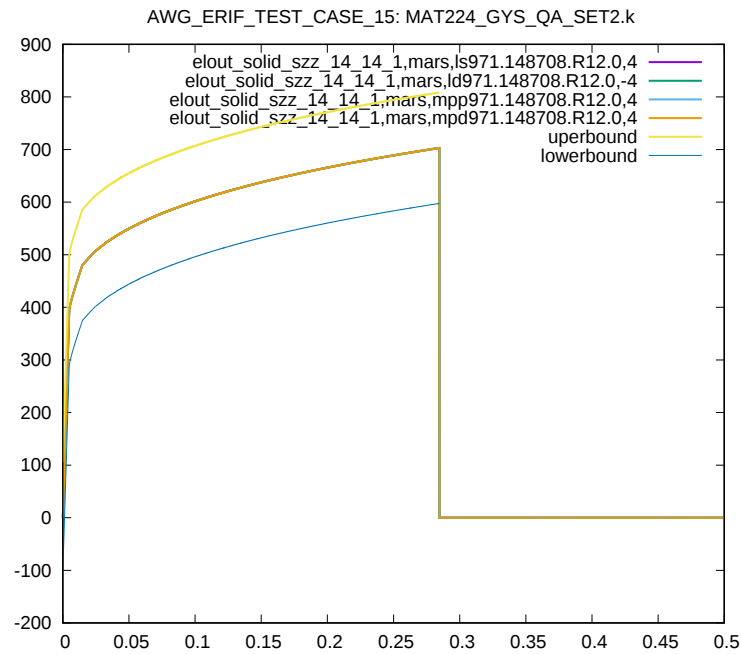


Figure 49: Cross platform results, z-component Stress, element ID 14, sub test case ID 3

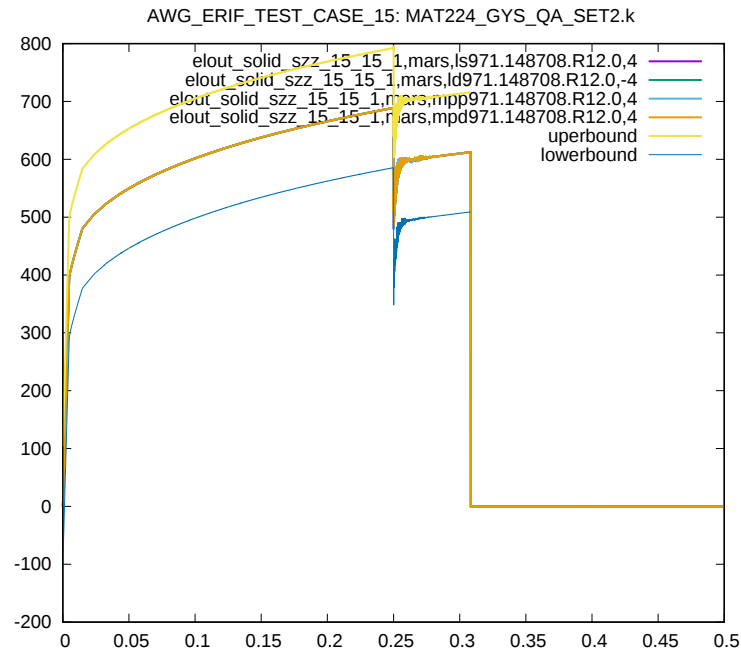


Figure 50: Cross platform results, z-component Stress, element ID 15, sub test case ID 3

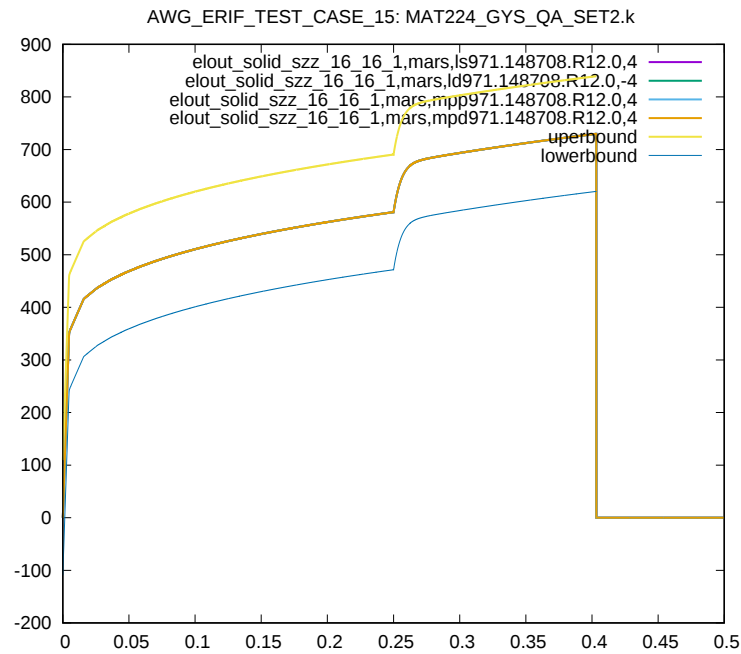


Figure 51: Cross platform results, z-component Stress, element ID 16, sub test case ID 3

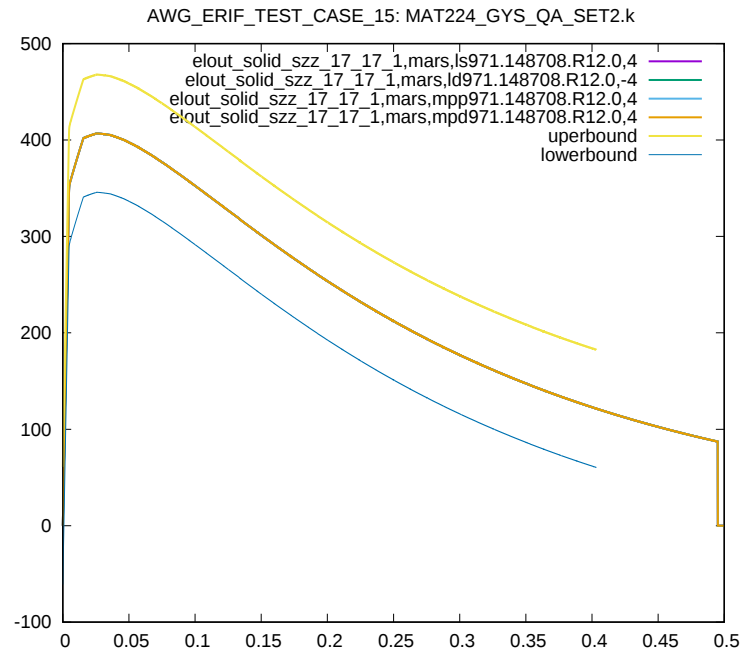


Figure 52: Cross platform results, z-component Stress, element ID 17, sub test case ID 3

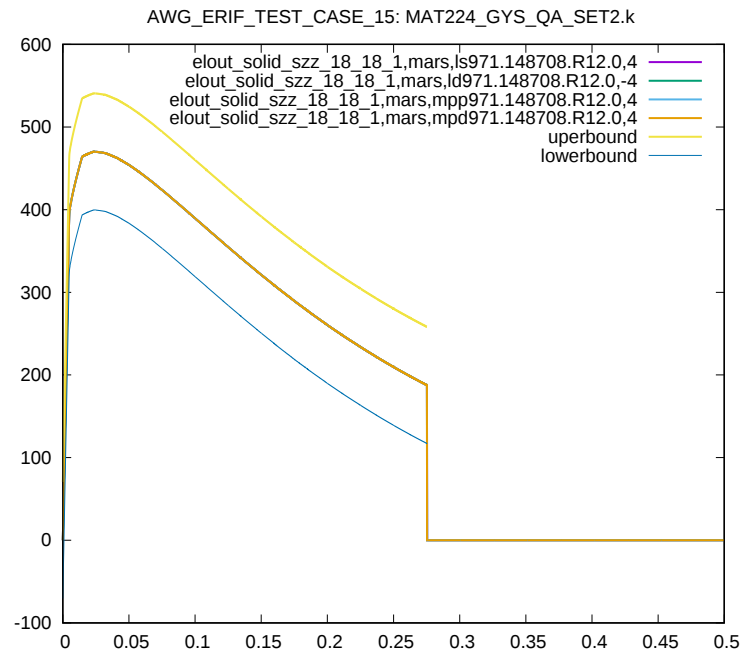


Figure 53: Cross platform results, z-component Stress, element ID 18, sub test case ID 3

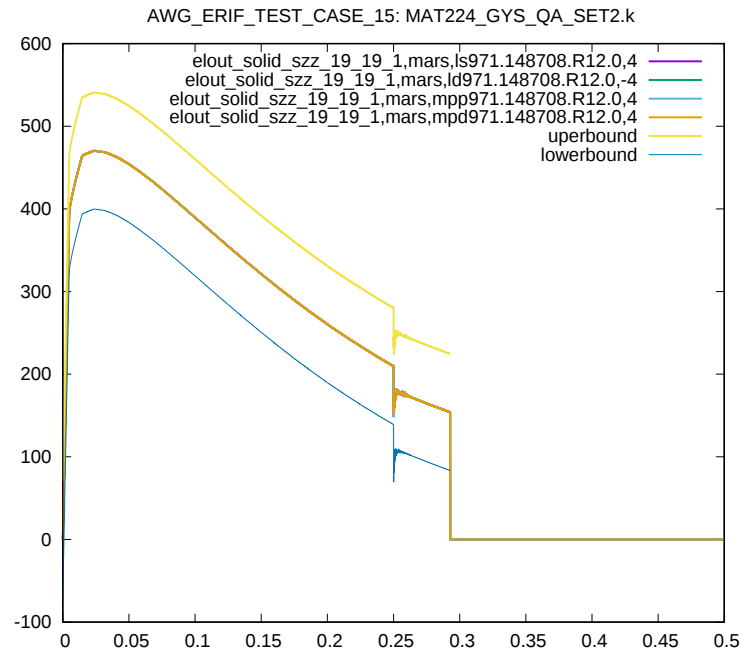


Figure 54: Cross platform results, z-component Stress, element ID 19, sub test case ID 3

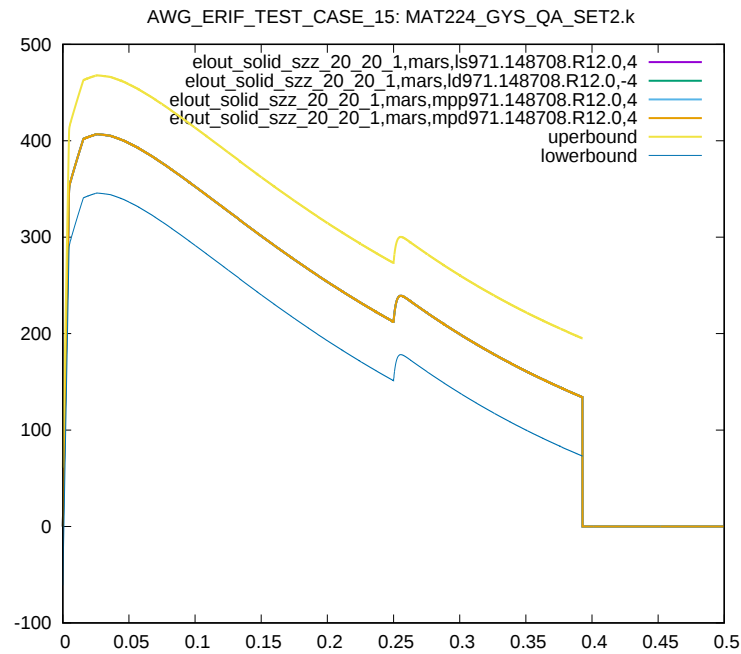


Figure 55: Cross platform results, z-component Stress, element ID 20, sub test case ID 3

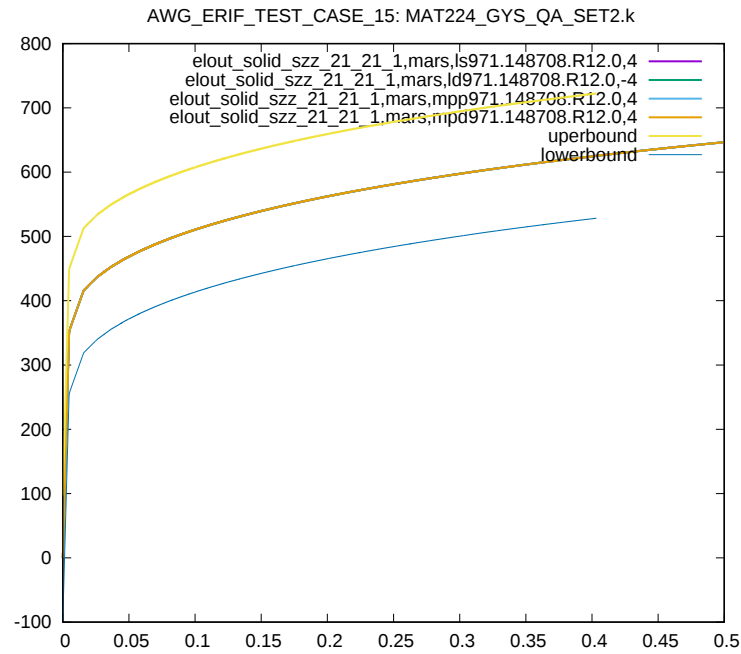


Figure 56: Cross platform results, z-component Stress, element ID 21, sub test case ID 3

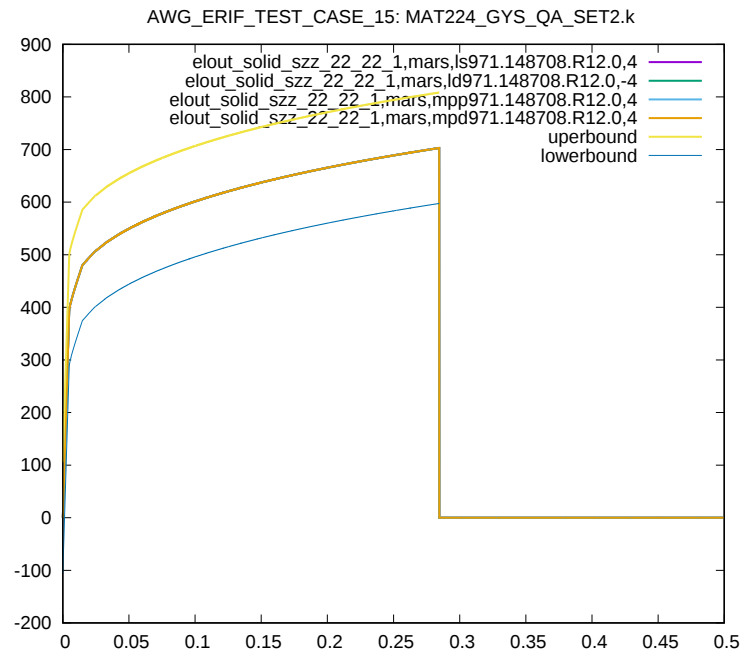


Figure 57: Cross platform results, z-component Stress, element ID 22, sub test case ID 3

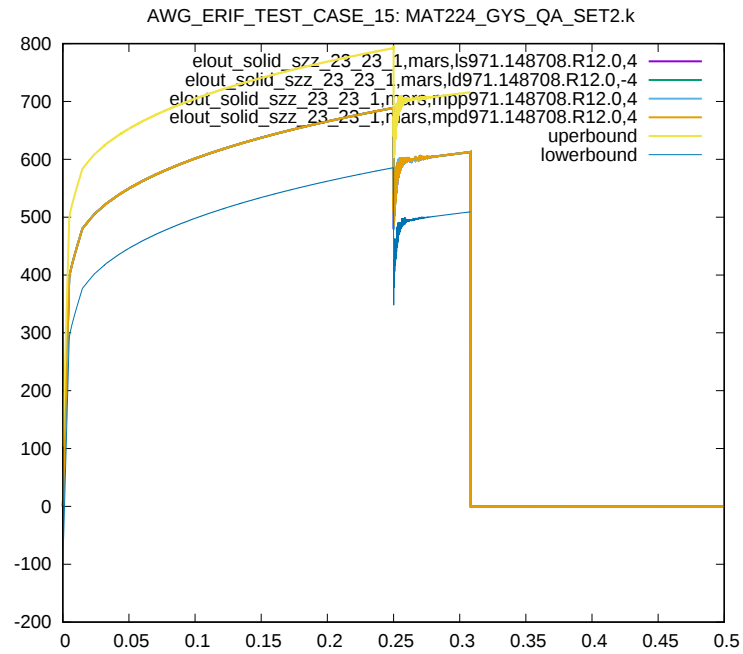


Figure 58: Cross platform results, z-component Stress, element ID 23, sub test case ID 3

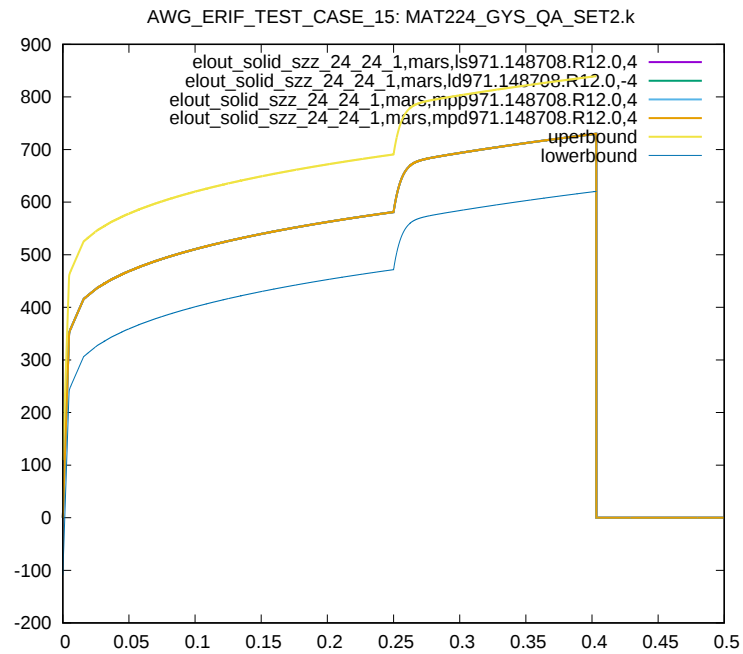


Figure 59: Cross platform results, z-component Stress, element ID 24, sub test case ID 3

5.3.6 Sub Test Case ID 3 - Test Target 6

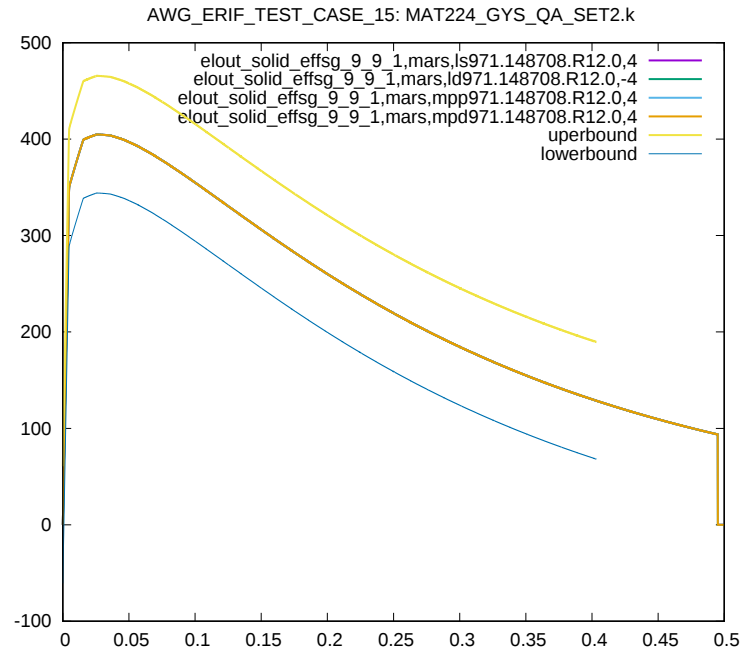


Figure 60: Cross platform results, Von Mises Stress, element ID 9, sub test case ID 3

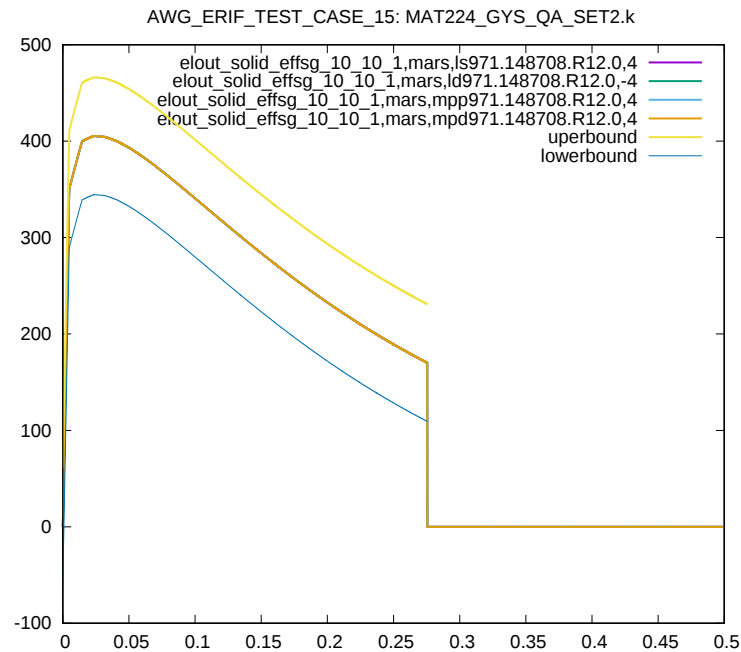


Figure 61: Cross platform results, Von Mises Stress, element ID 10, sub test case ID 3

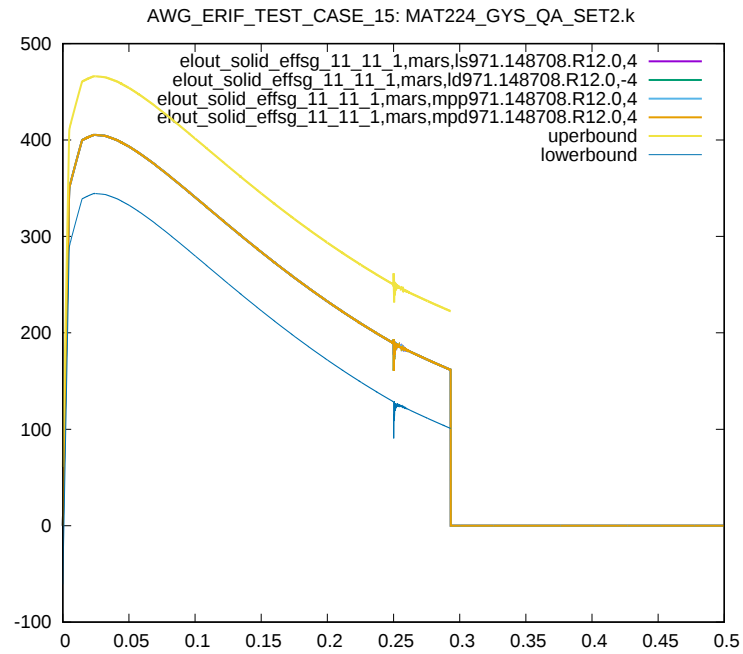


Figure 62: Cross platform results, Von Mises Stress, element ID 11, sub test case ID 3

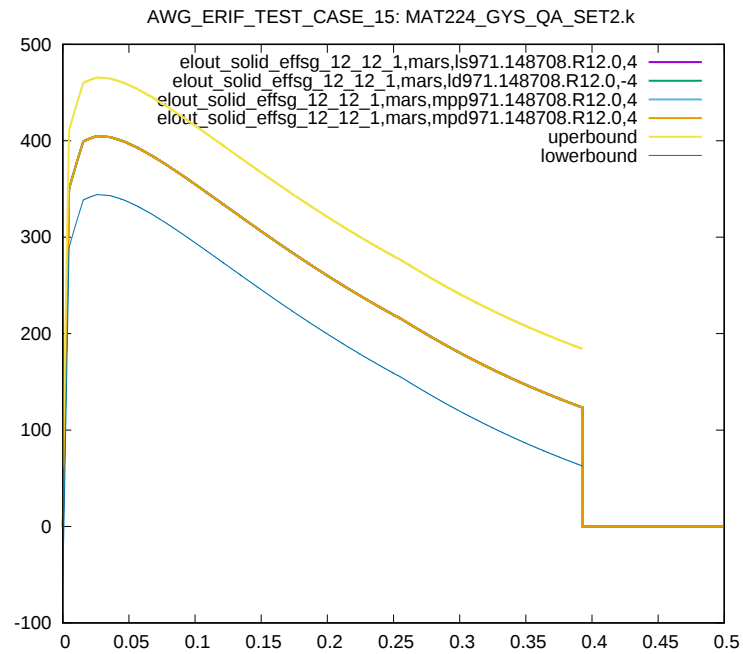


Figure 63: Cross platform results, Von Mises Stress, element ID 12, sub test case ID 3

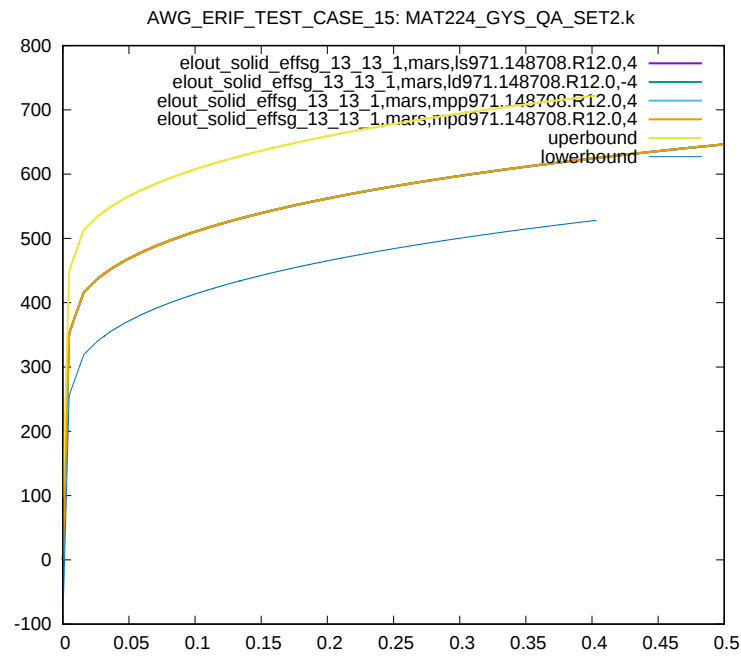


Figure 64: Cross platform results, Von Mises Stress, element ID 13, sub test case ID 3

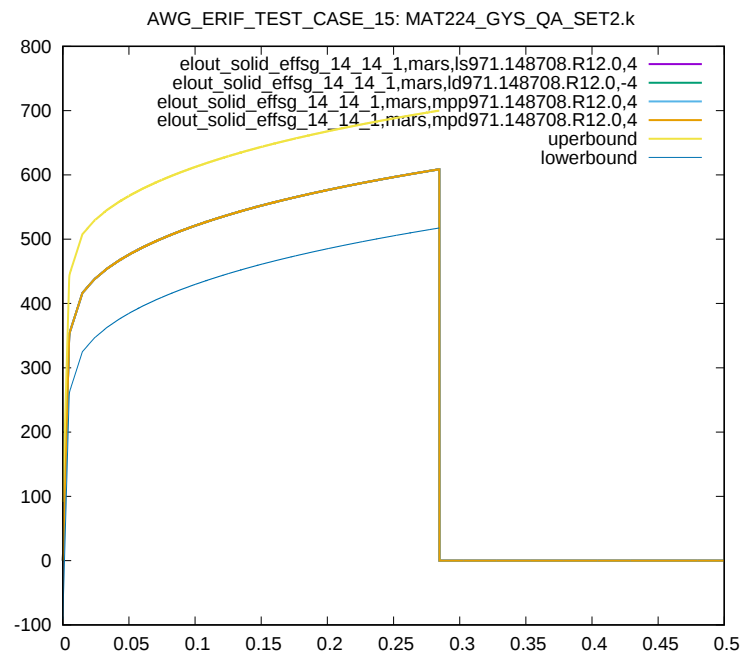


Figure 65: Cross platform results, Von Mises Stress, element ID 14, sub test case ID 3

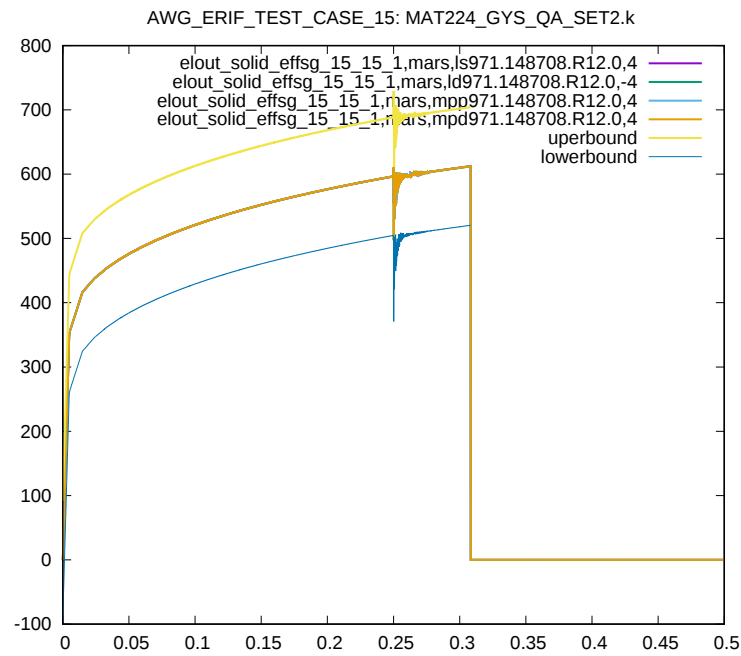


Figure 66: Cross platform results, Von Mises Stress, element ID 15, sub test case ID 3

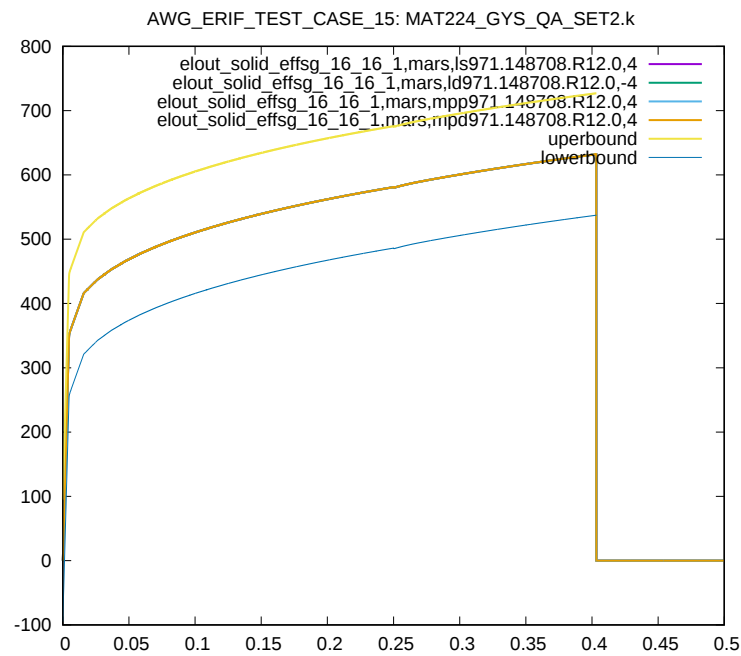


Figure 67: Cross platform results, Von Mises Stress, element ID 16, sub test case ID 3

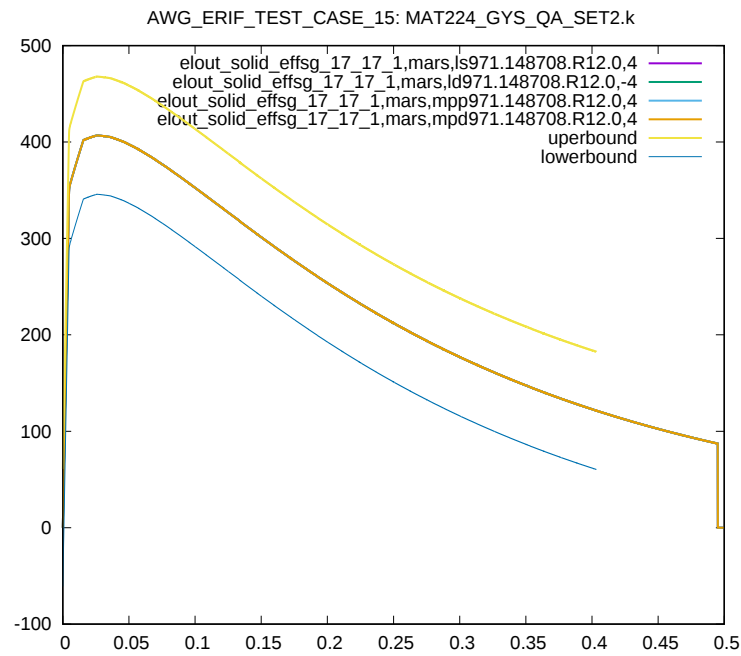


Figure 68: Cross platform results, Von Mises Stress, element ID 17, sub test case ID 3

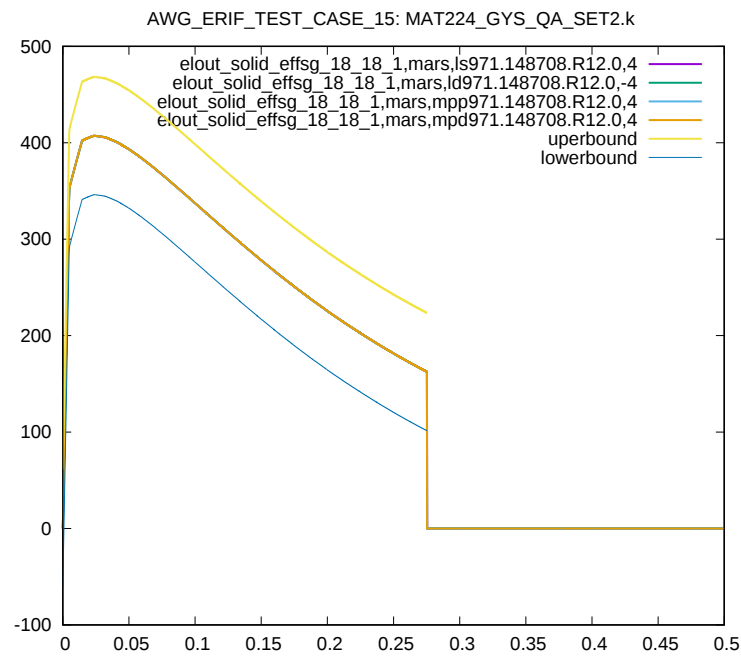


Figure 69: Cross platform results, Von Mises Stress, element ID 18, sub test case ID 3

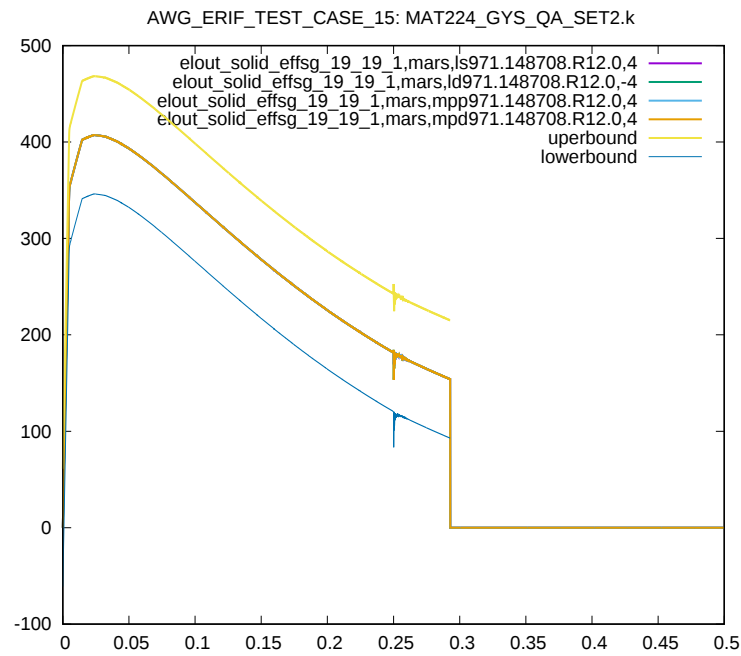


Figure 70: Cross platform results, Von Mises Stress, element ID 19, sub test case ID 3

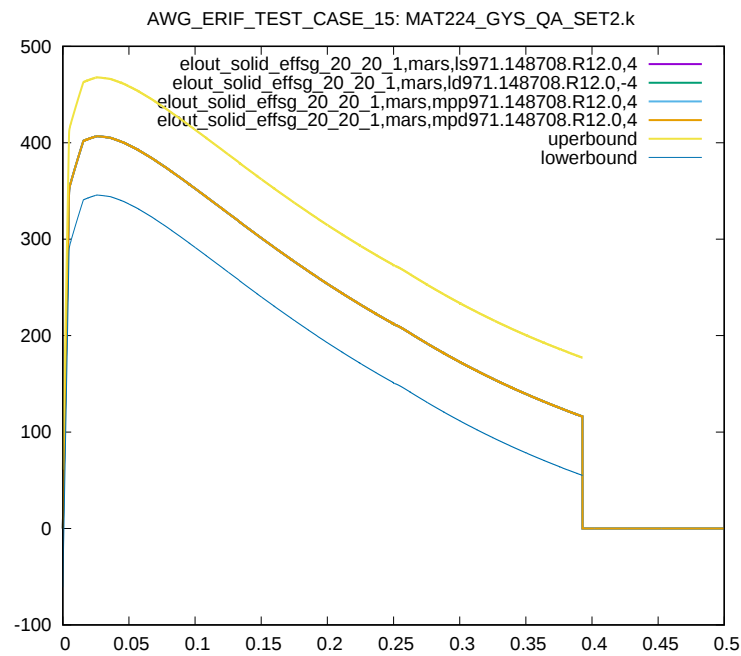


Figure 71: Cross platform results, Von Mises Stress, element ID 20, sub test case ID 3

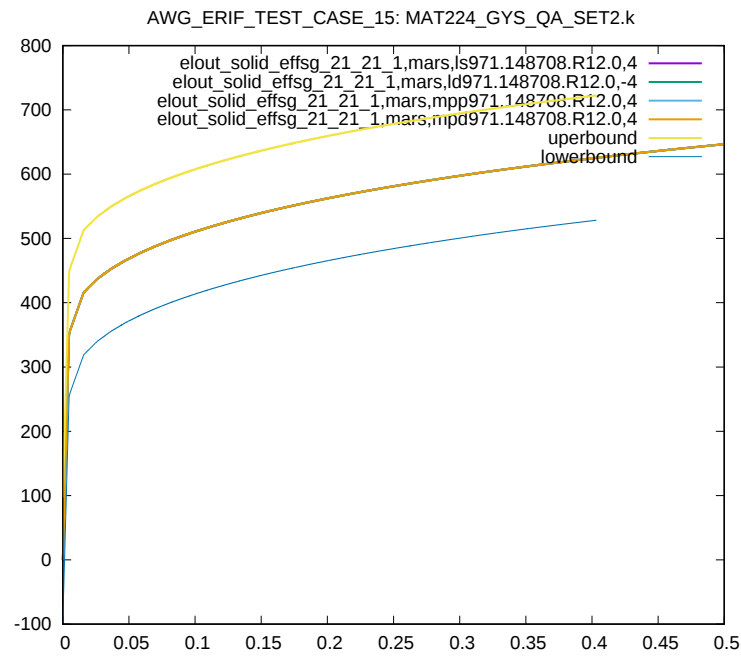


Figure 72: Cross platform results, Von Mises Stress, element ID 21, sub test case ID 3

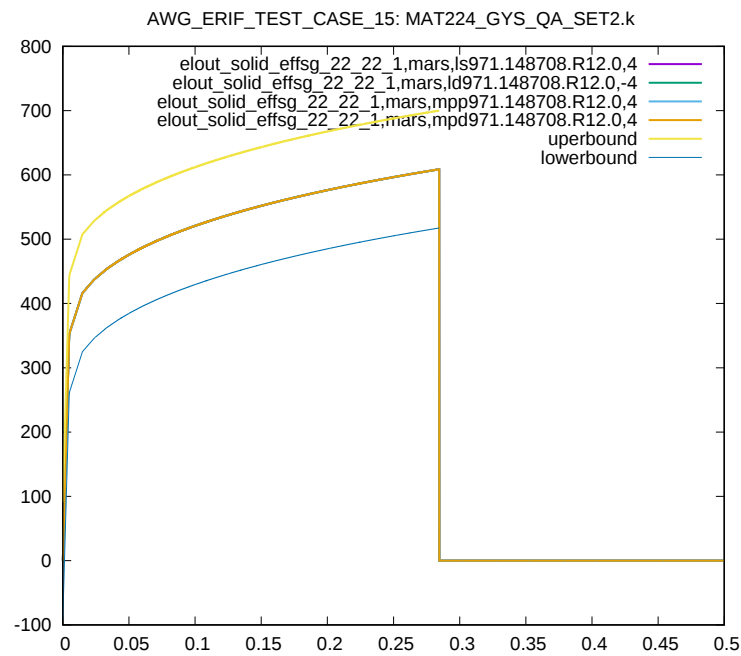


Figure 73: Cross platform results, Von Mises Stress, element ID 22, sub test case ID 3

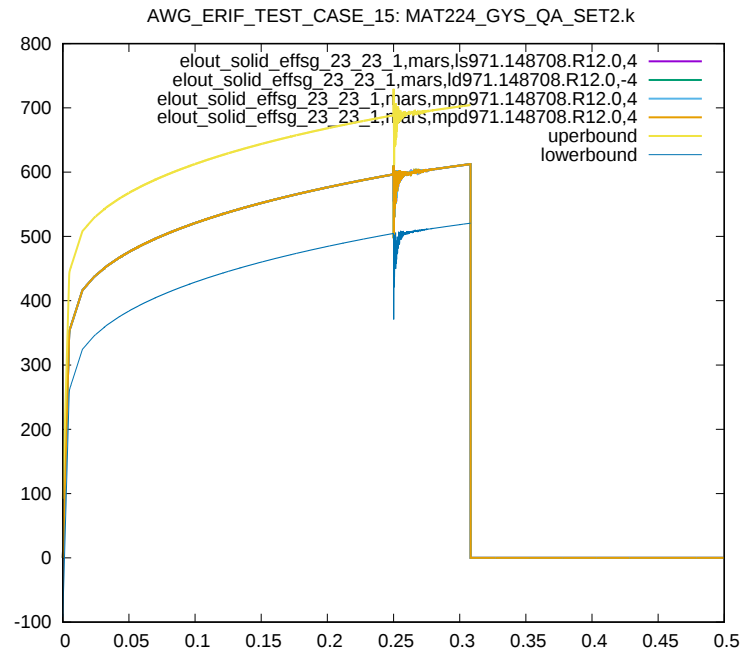


Figure 74: Cross platform results, z-component Stress, element ID 23, sub test case ID 3

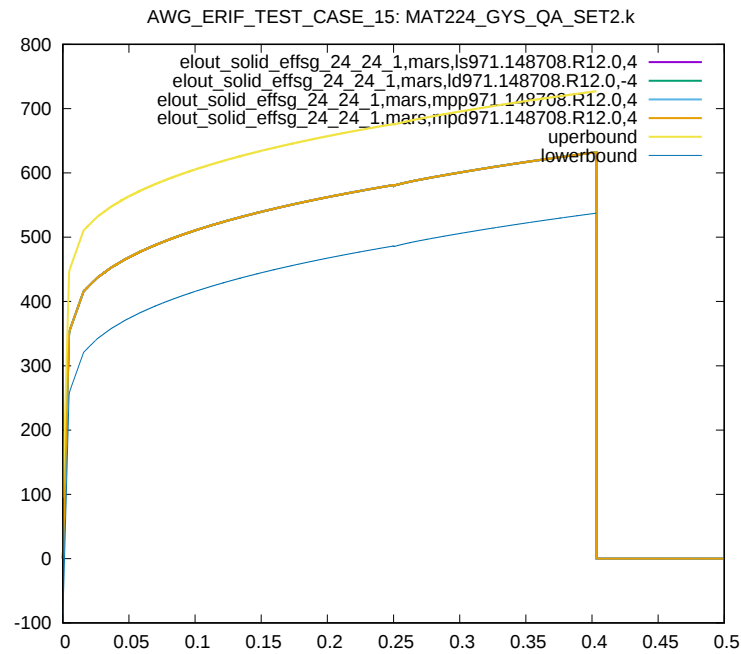


Figure 75: Cross platform results, Von Mises Stress, element ID 24, sub test case ID 3

5.3.7 Sub Test Case ID 4 - Test Target 7

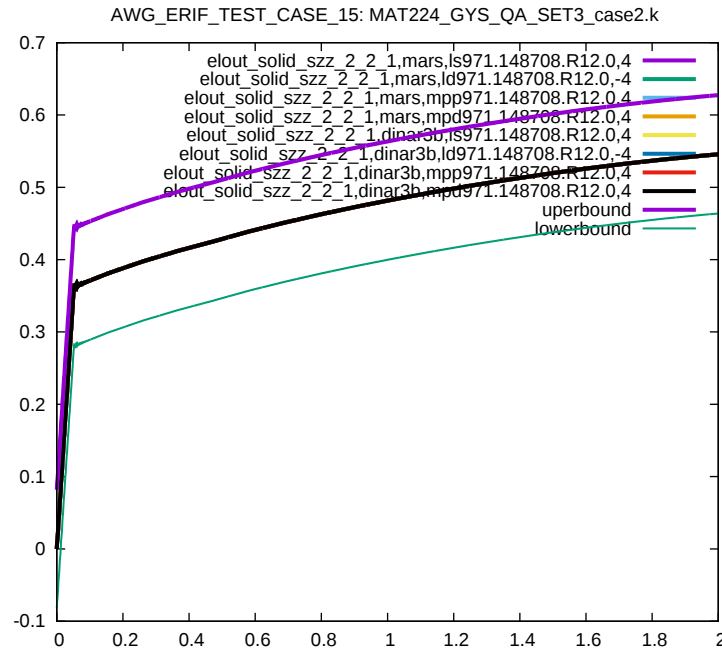


Figure 76: Cross platform results, z-component Stress, element ID 2, sub test case ID 4

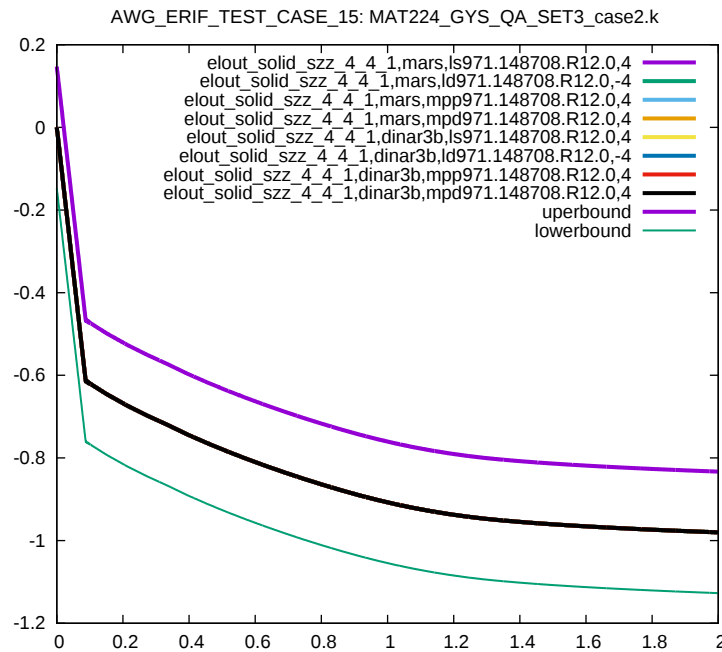


Figure 77: Cross platform results, z-component Stress, element ID 4, sub test case ID 4

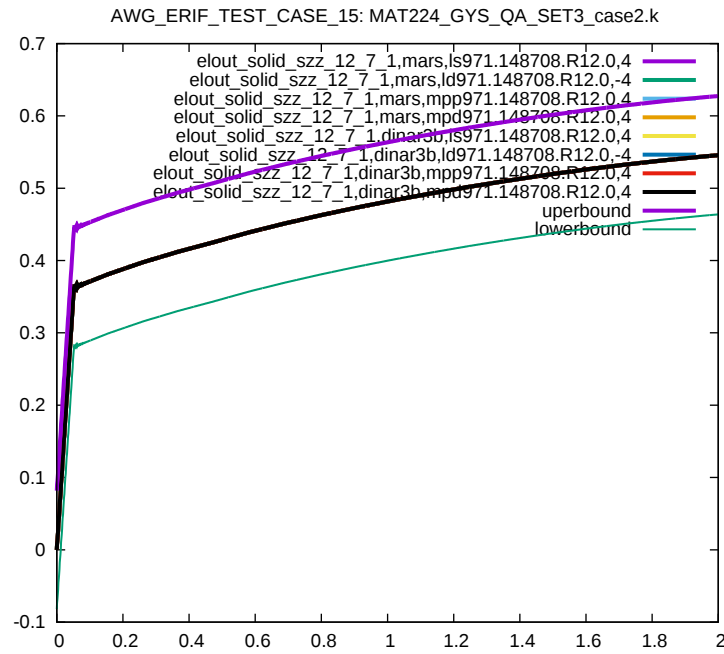


Figure 78: Cross platform results, z-component Stress, element ID 12, sub test case ID 4

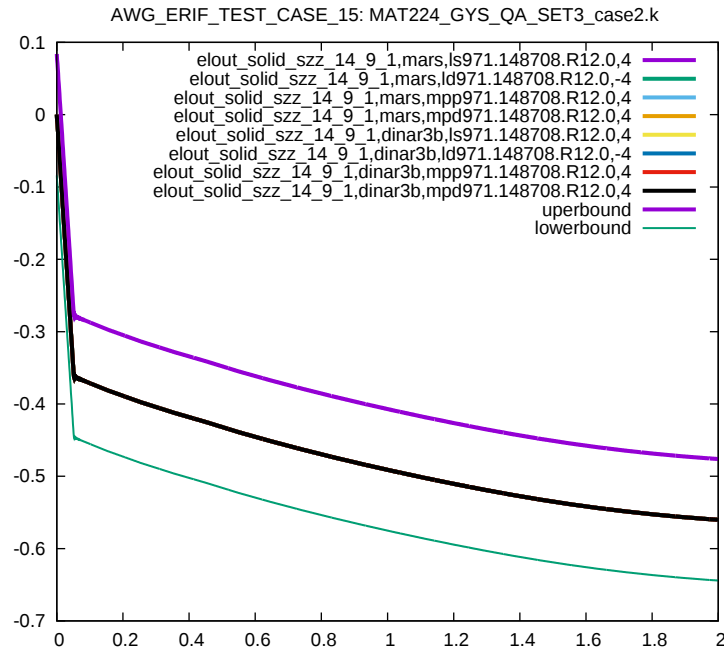


Figure 79: Cross platform results, z-component Stress, element ID 14, sub test case ID 4

5.3.8 Sub Test Case ID 4 - Test Target 8

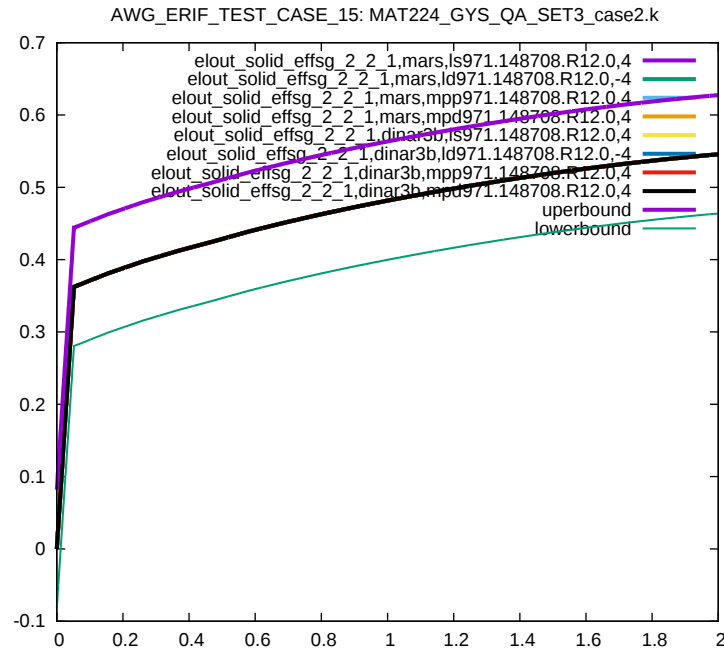


Figure 80: Cross platform results, Von Mises Stress, element ID 2, sub test case ID 4

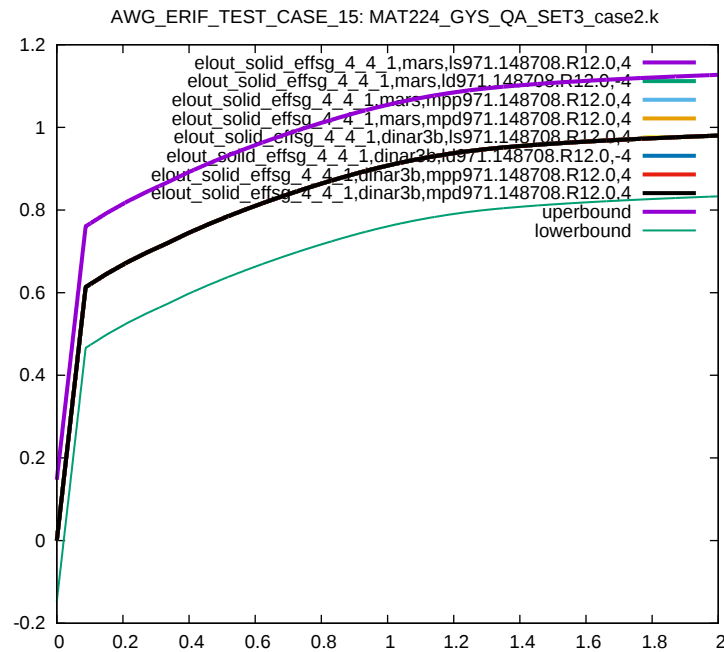


Figure 81: Cross platform results, Von Mises Stress, element ID 4, sub test case ID 4

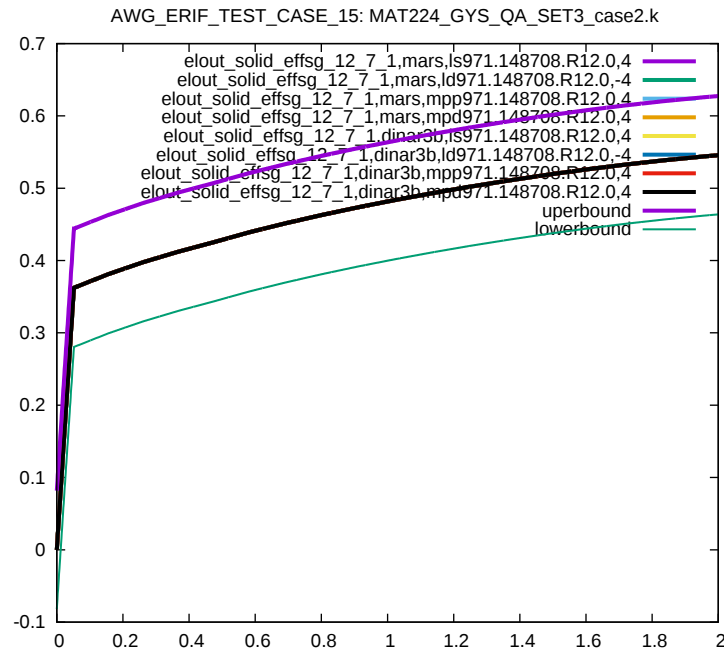


Figure 82: Cross platform results, Von Mises Stress, element ID 12, sub test case ID 4

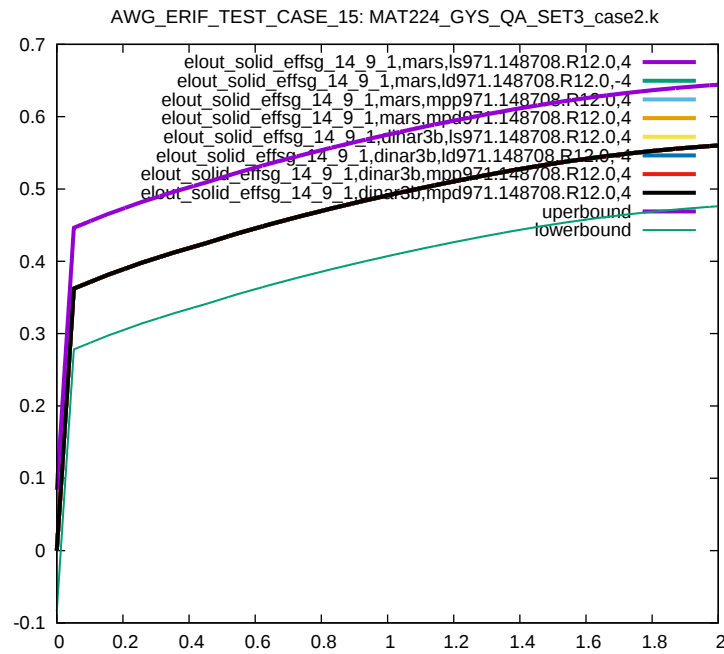


Figure 83: Cross platform results, Von Mises Stress, element ID 14, sub test case ID 4

5.3.9 Sub Test Case ID 5 - Test Target 9

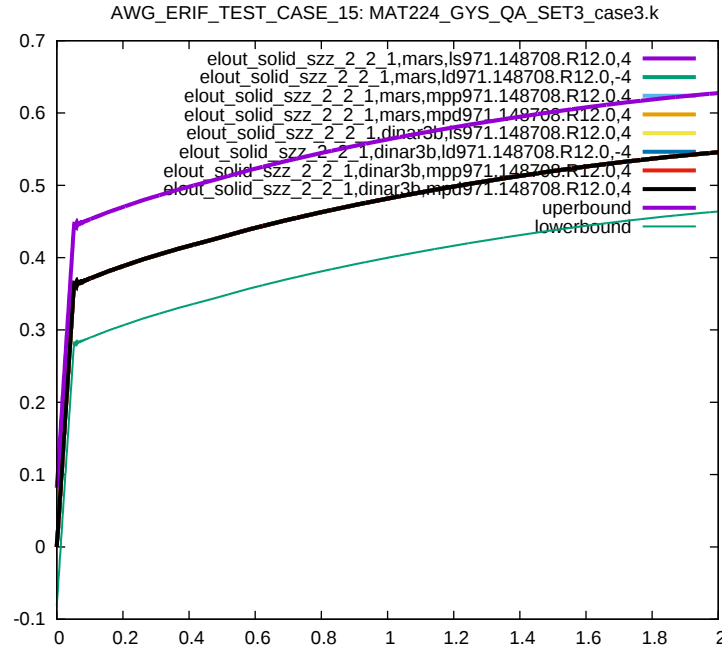


Figure 84: Cross platform results, z-component Stress, element ID 2, sub test case ID 5

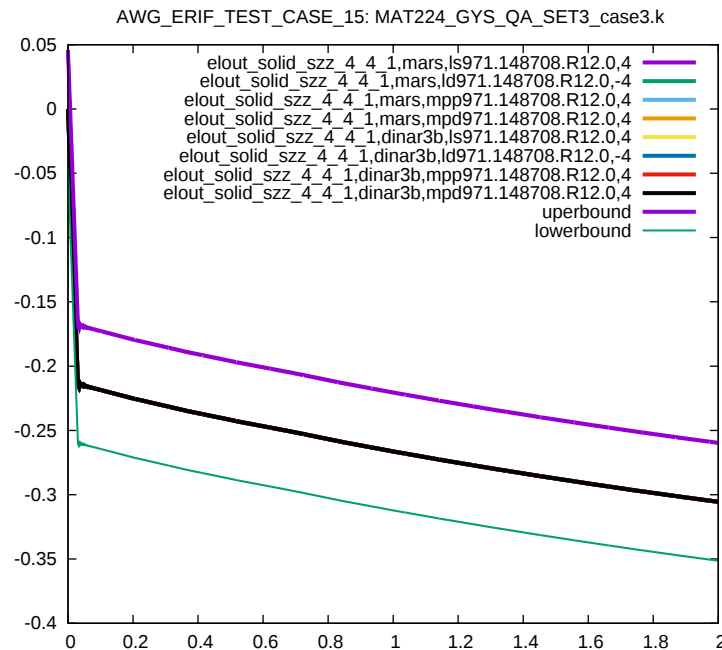


Figure 85: Cross platform results, z-component Stress, element ID 4, sub test case ID 5

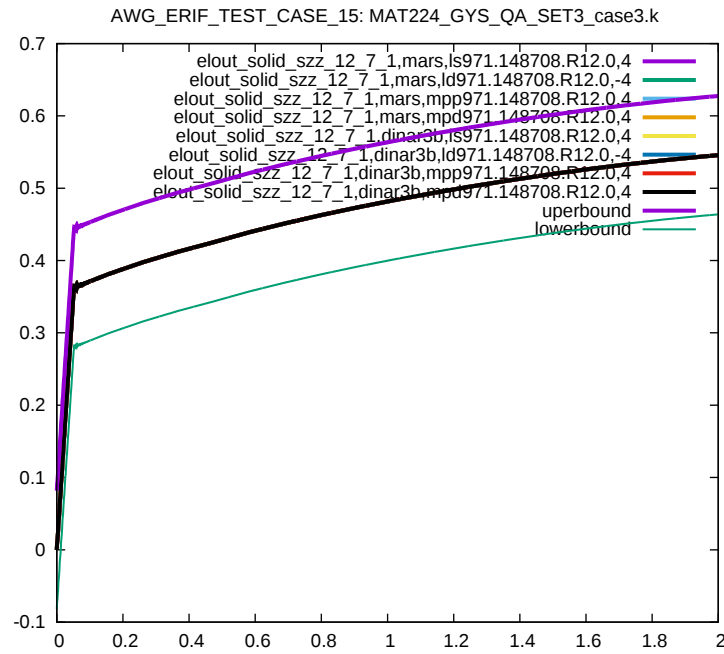


Figure 86: Cross platform results, z-component Stress, element ID 12, sub test case ID 5

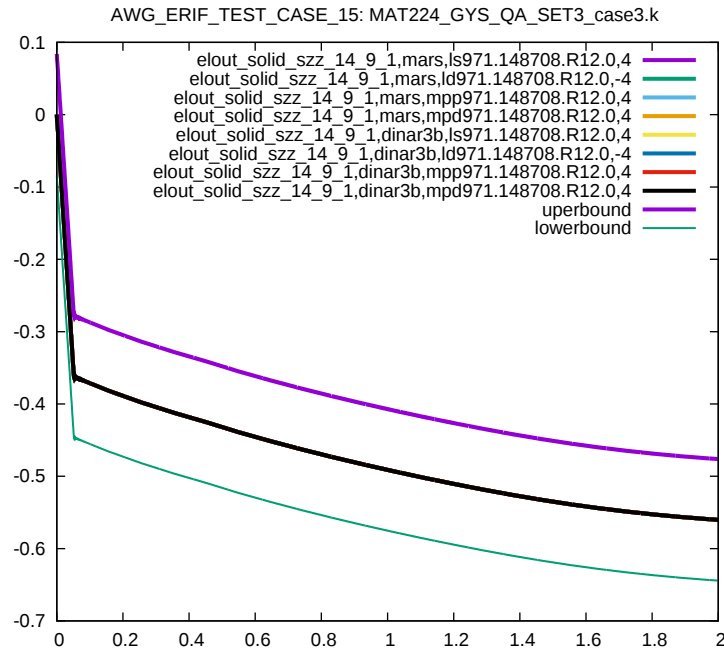


Figure 87: Cross platform results, z-component Stress, element ID 14, sub test case ID 5

5.3.10 Sub Test Case ID 5 - Test Target 10

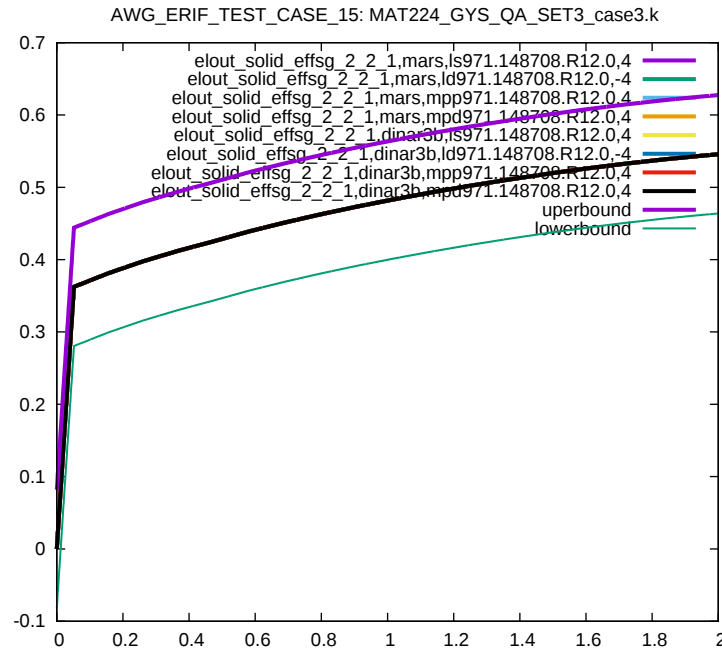


Figure 88: Cross platform results, Von Mises Stress, element ID 2, sub test case ID 5

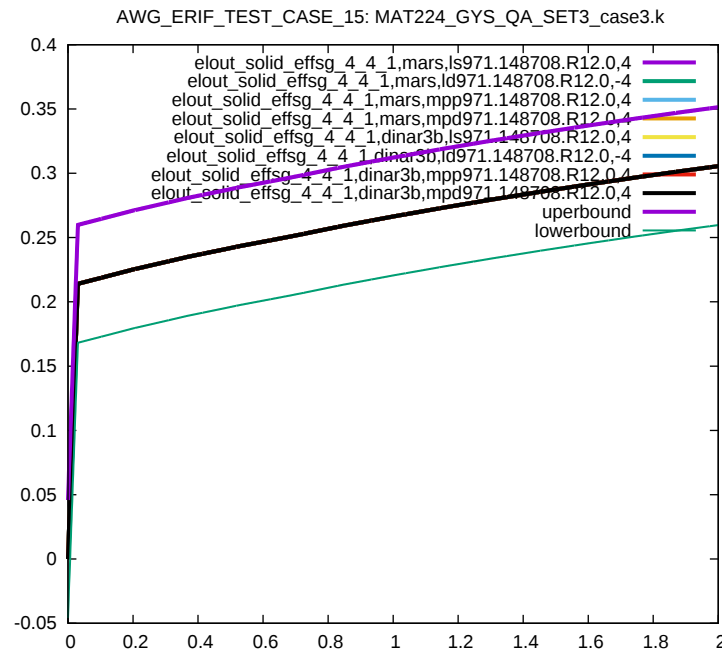


Figure 89: Cross platform results, Von Mises Stress, element ID 4, sub test case ID 5

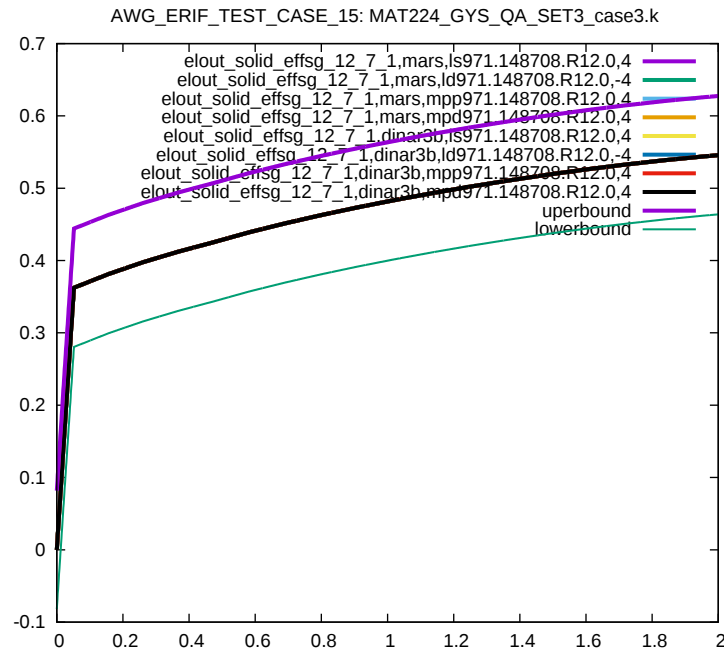


Figure 90: Cross platform results, Von Mises Stress, element ID 12, sub test case ID 5

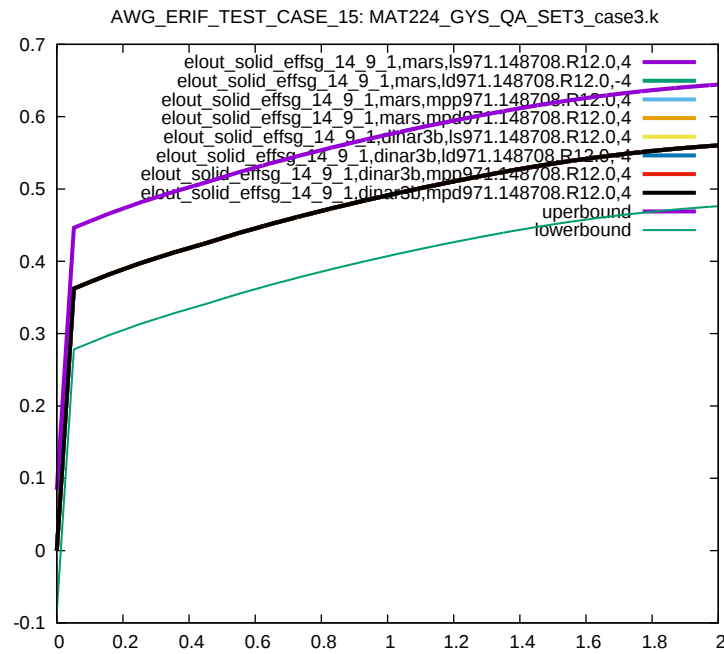


Figure 91: Cross platform results, Von Mises Stress, element ID 14, sub test case ID 5

5.3.11 Sub Test Case ID 6 - Test Target 11

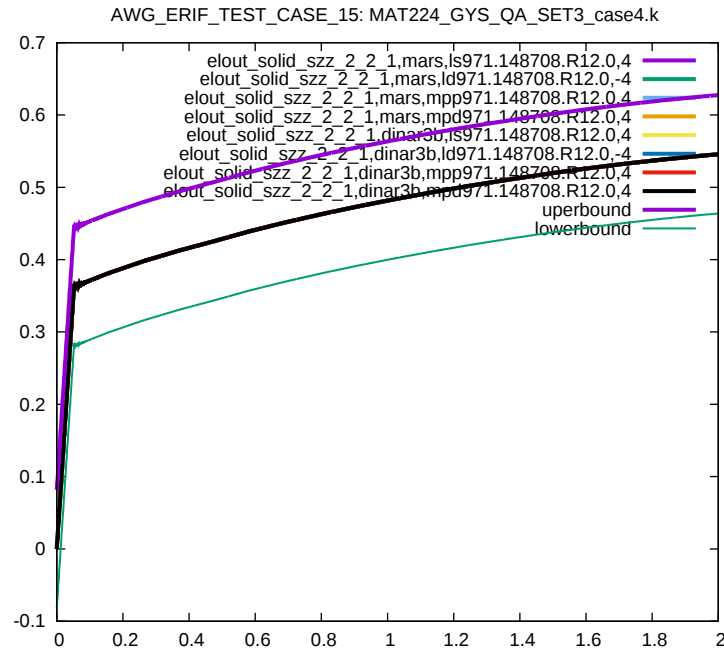


Figure 92: Cross platform results, z-component Stress, element ID 2, sub test case ID 6

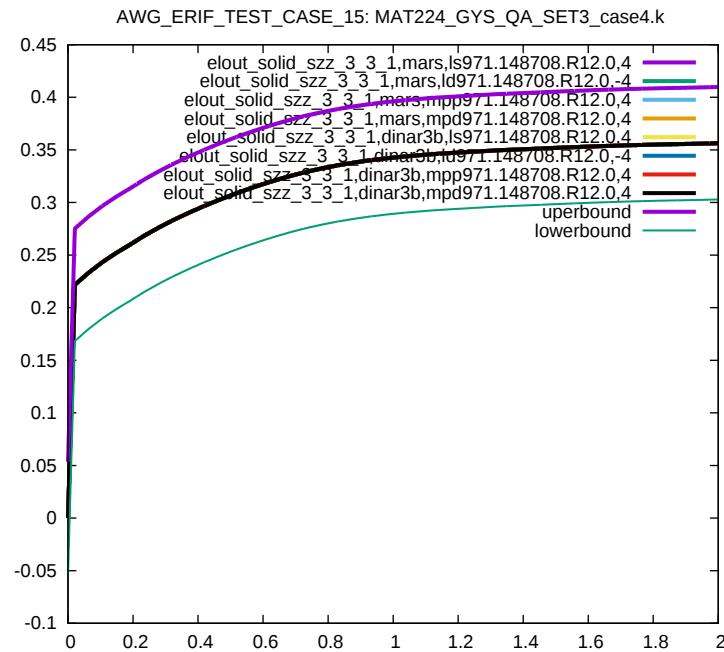


Figure 93: Cross platform results, z-component Stress, element ID 3, sub test case ID 6

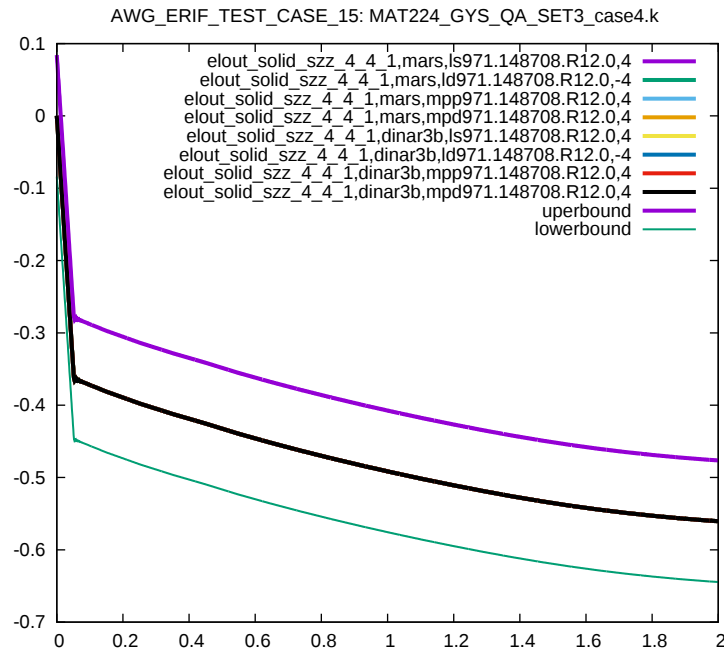


Figure 94: Cross platform results, z-component Stress, element ID 4, sub test case ID 6

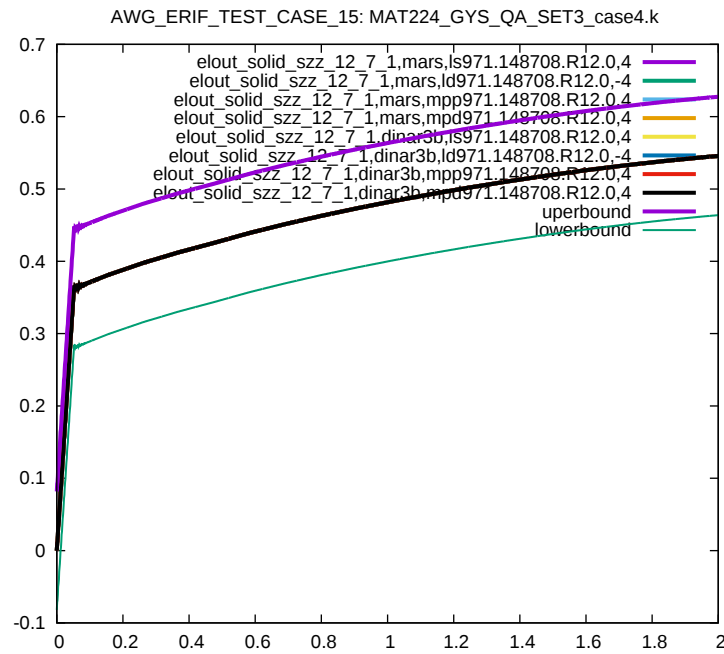


Figure 95: Cross platform results, z-component Stress, element ID 12, sub test case ID 6

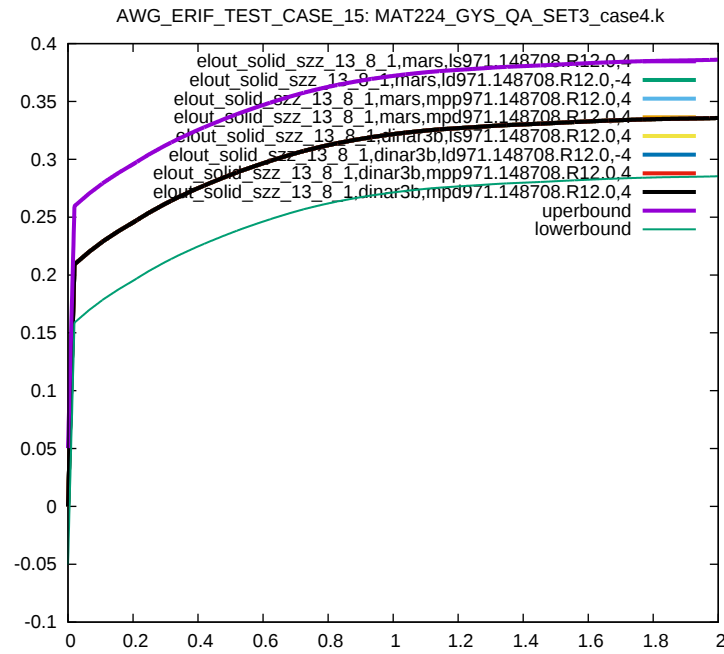


Figure 96: Cross platform results, z-component Stress, element ID 13, sub test case ID 6

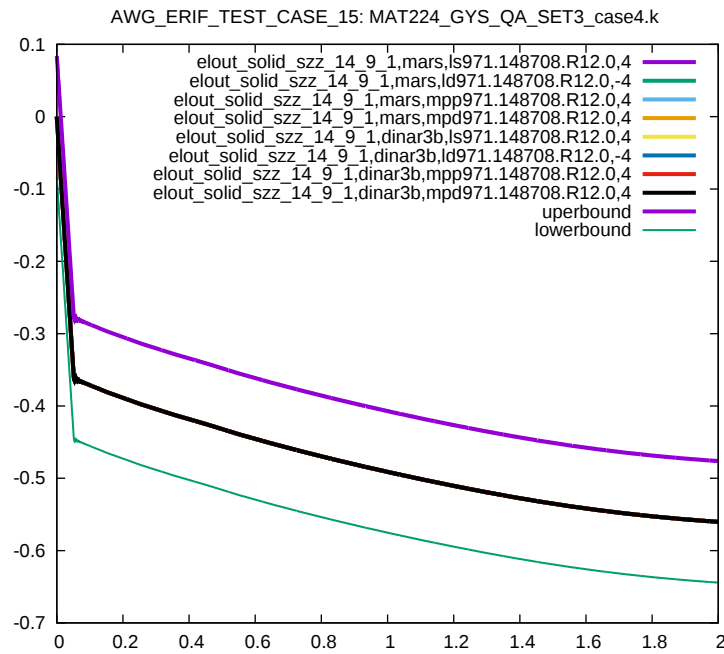


Figure 97: Cross platform results, z-component Stress, element ID 14, sub test case ID 6

5.3.12 Sub Test Case ID 6 - Test Target 12

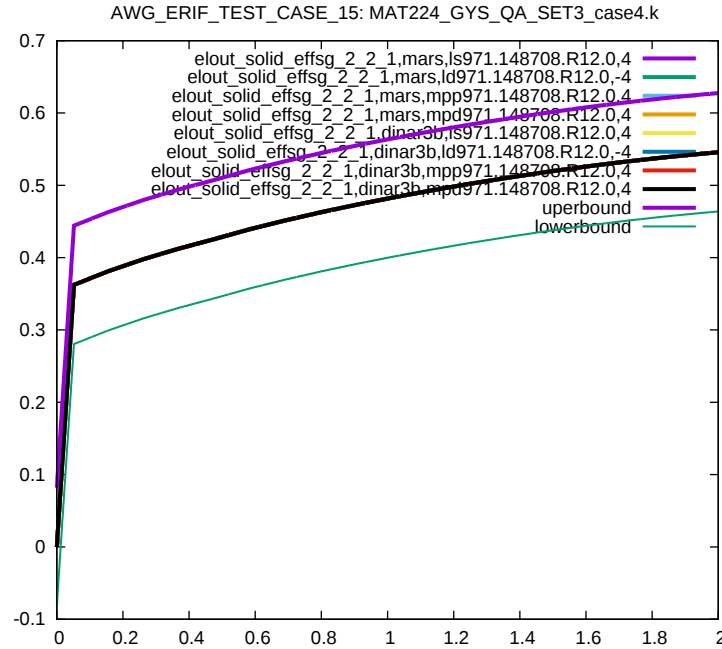


Figure 98: Cross platform results, Von Mises Stress, element ID 2, sub test case ID 6

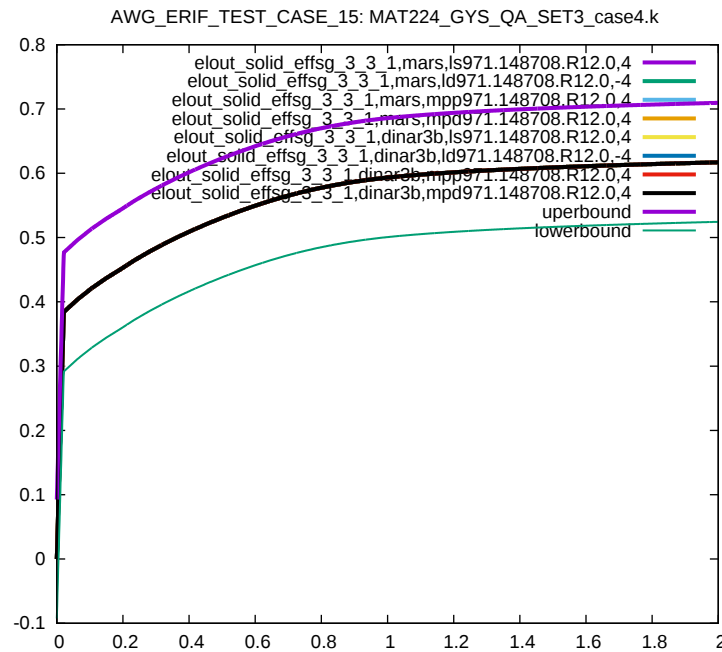


Figure 99: Cross platform results, Von Mises Stress, element ID 3, sub test case ID 6

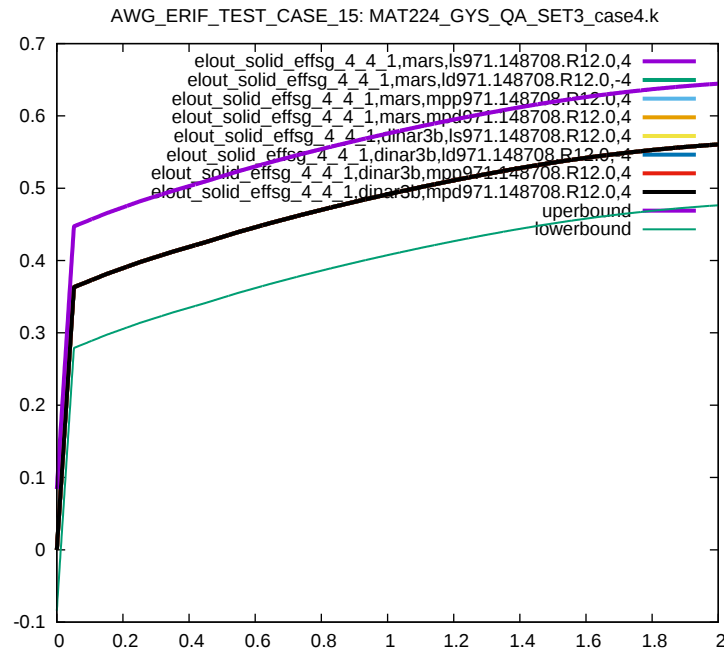


Figure 100: Cross platform results, Von Mises Stress, element ID 4, sub test case ID 6

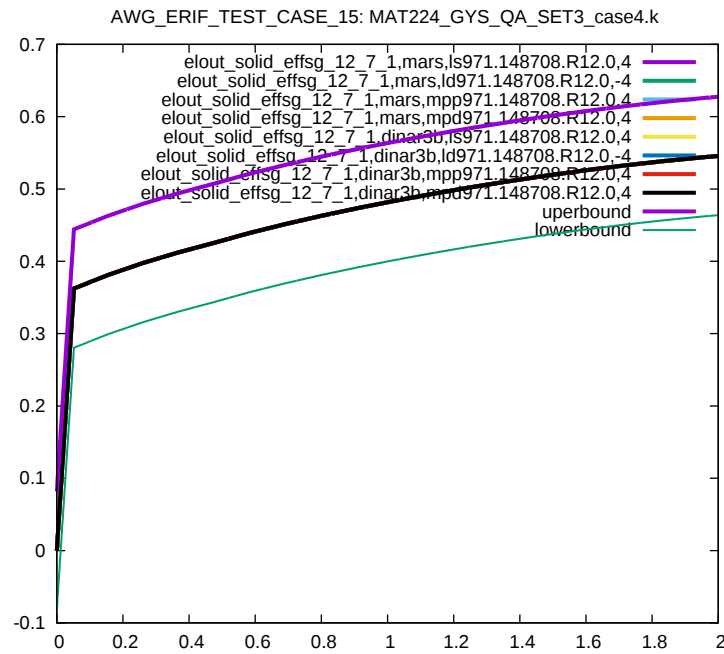


Figure 101: Cross platform results, Von Mises Stress, element ID 12, sub test case ID 6

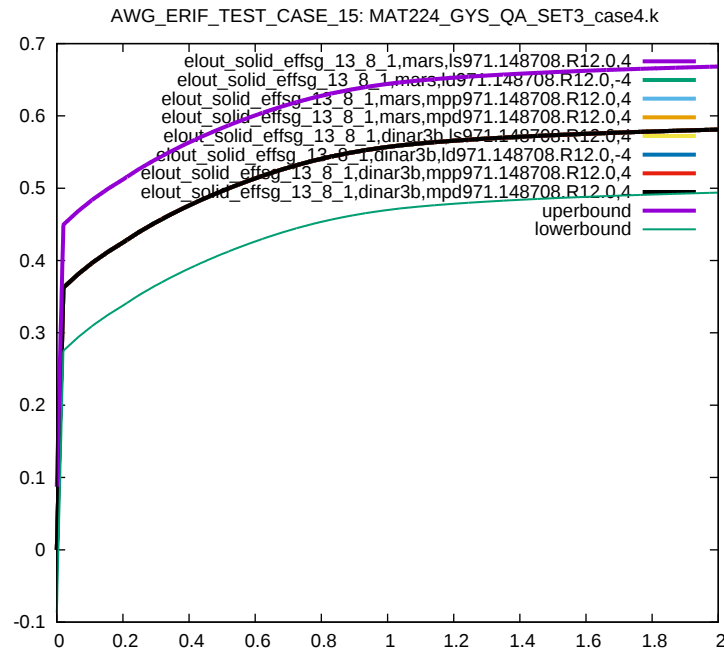


Figure 102: Cross platform results, Von Mises Stress, element ID 13, sub test case ID 6

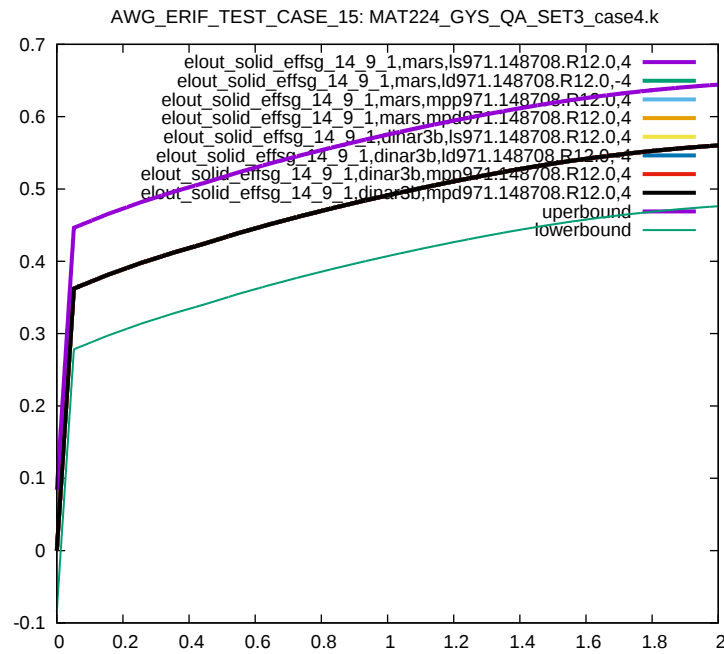


Figure 103: Cross platform results, Von Mises Stress, element ID 14, sub test case ID 6

5.3.13 Sub Test Case ID 7 - Test Target 13

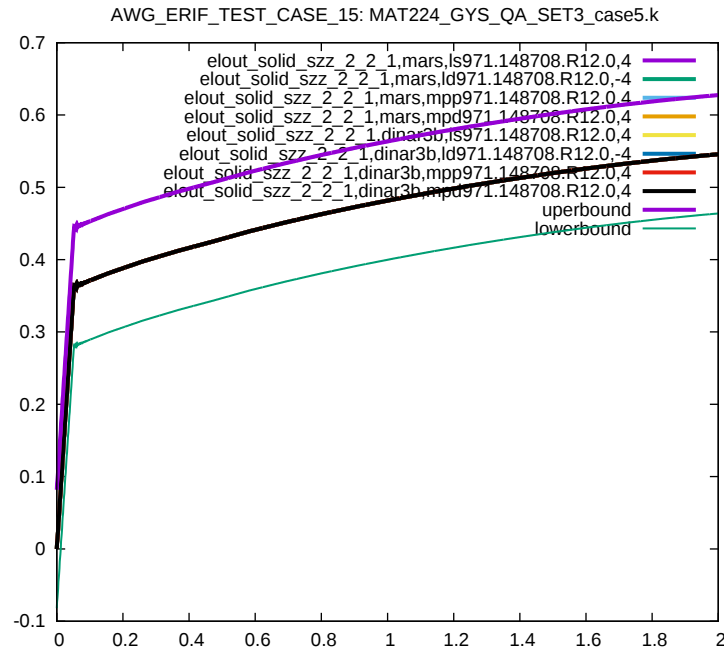


Figure 104: Cross platform results, z-component Stress, element ID 2, sub test case ID 7

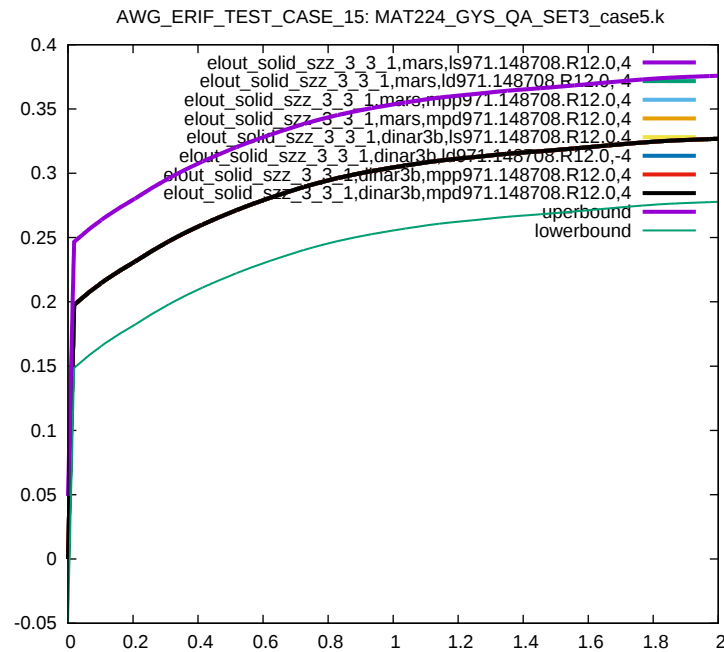


Figure 105: Cross platform results, z-component Stress, element ID 3, sub test case ID 7

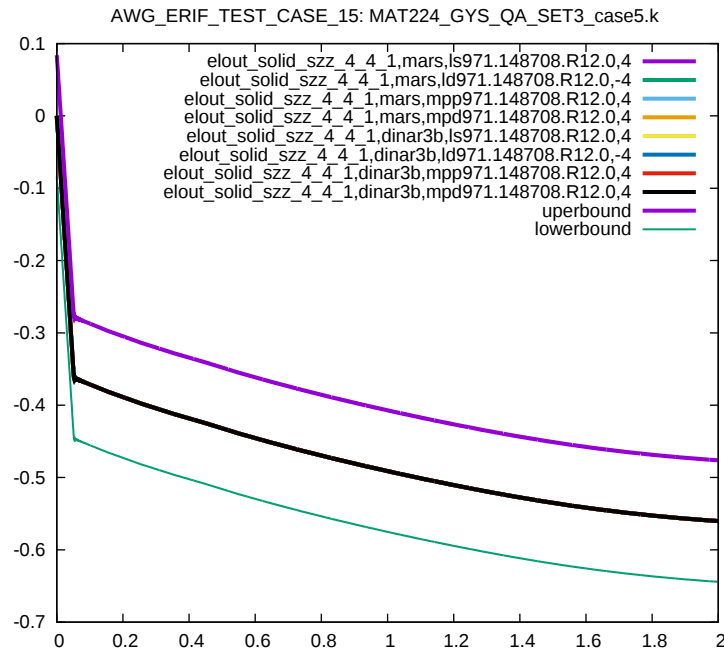


Figure 106: Cross platform results, z-component Stress, element ID 4, sub test case ID 7

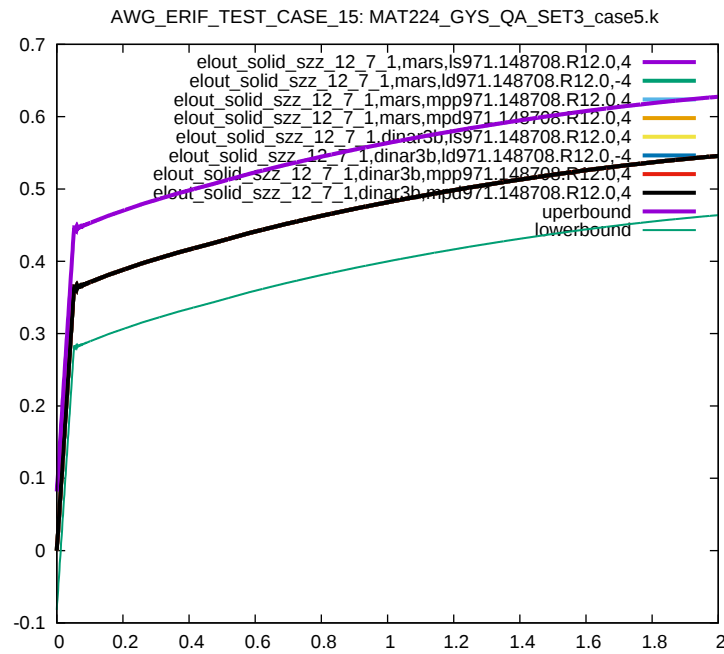


Figure 107: Cross platform results, z-component Stress, element ID 12, sub test case ID 7

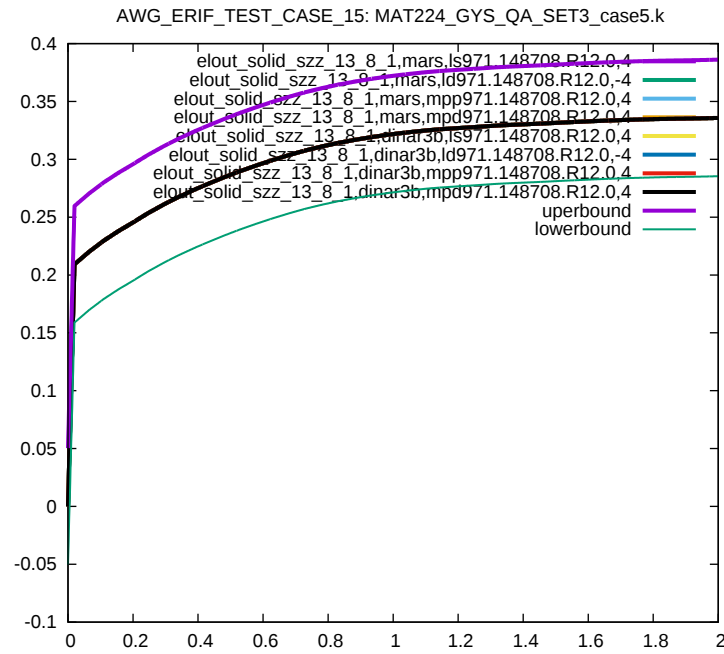


Figure 108: Cross platform results, z-component Stress, element ID 13, sub test case ID 7

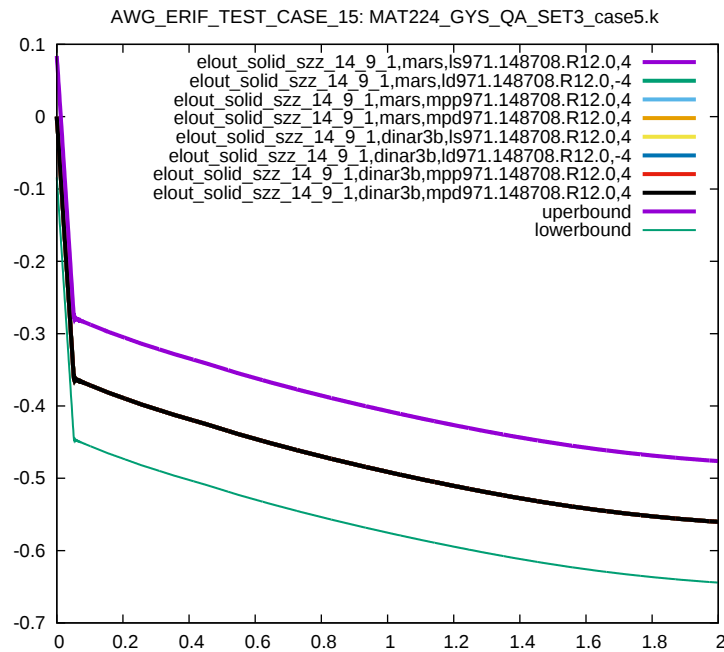


Figure 109: Cross platform results, z-component Stress, element ID 14, sub test case ID 7

5.3.14 Sub Test Case ID 7 - Test Target 14

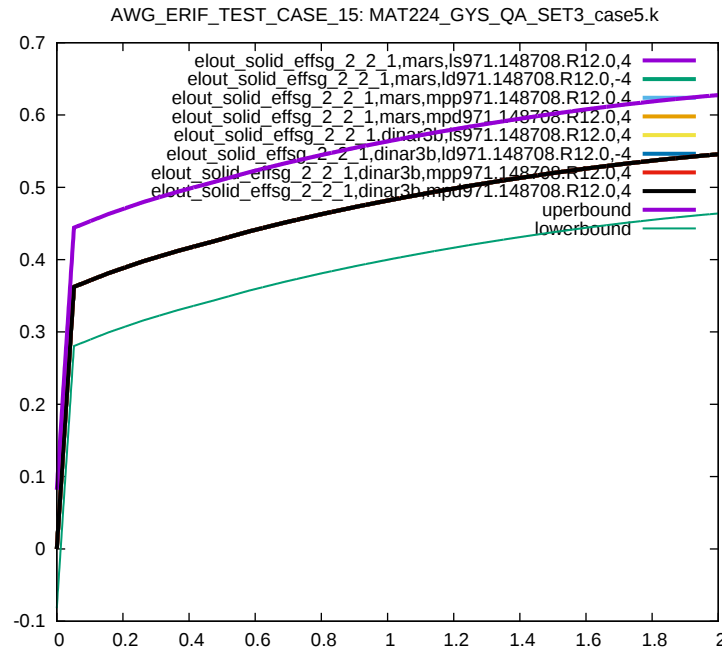


Figure 110: Cross platform results, Von Mises Stress, element ID 2, sub test case ID 7

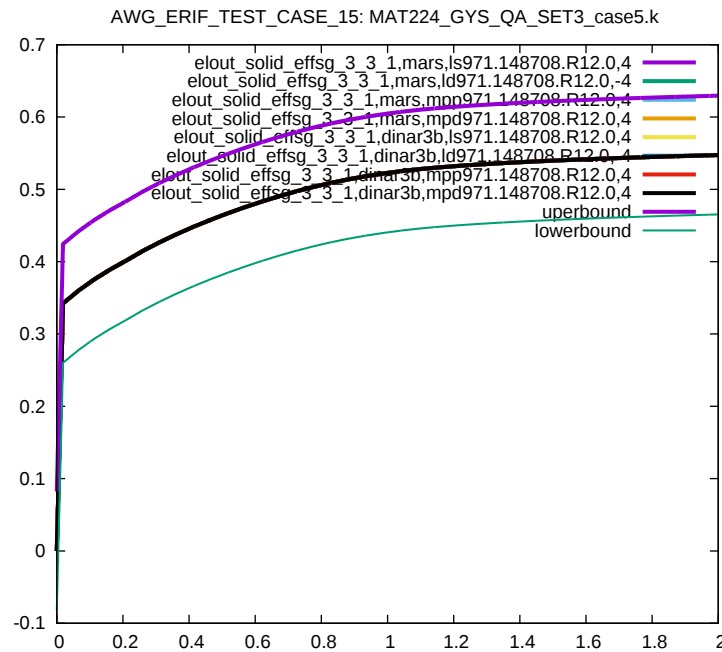


Figure 111: Cross platform results, Von Mises Stress, element ID 3, sub test case ID 7

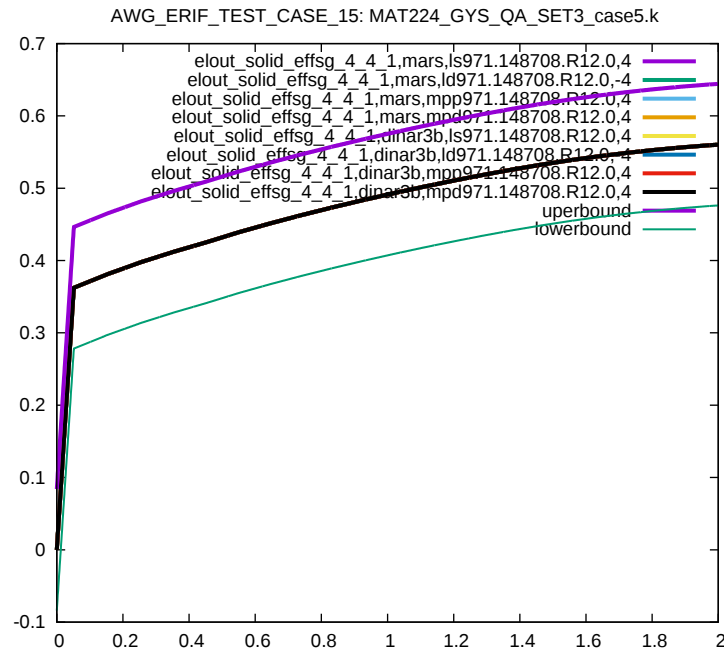


Figure 112: Cross platform results, Von Mises Stress, element ID 4, sub test case ID 7

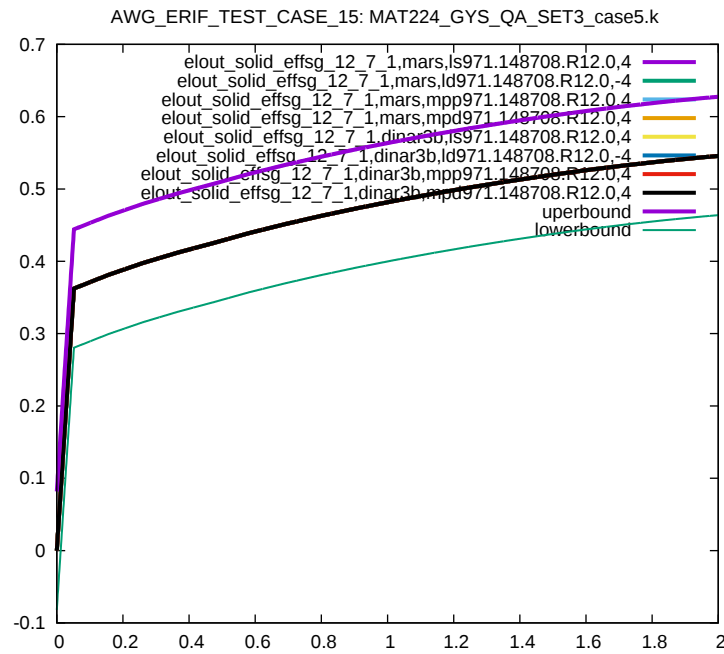


Figure 113: Cross platform results, Von Mises Stress, element ID 12, sub test case ID 7

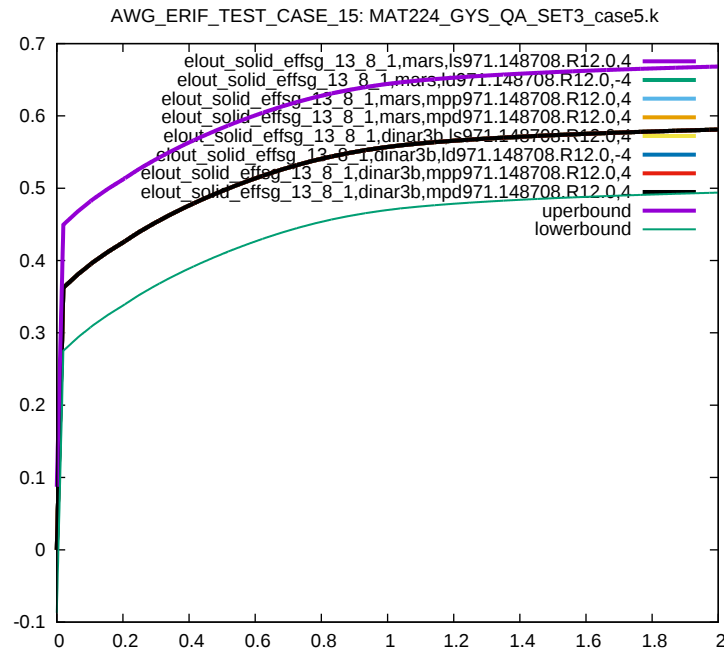


Figure 114: Cross platform results, Von Mises Stress, element ID 13, sub test case ID 7

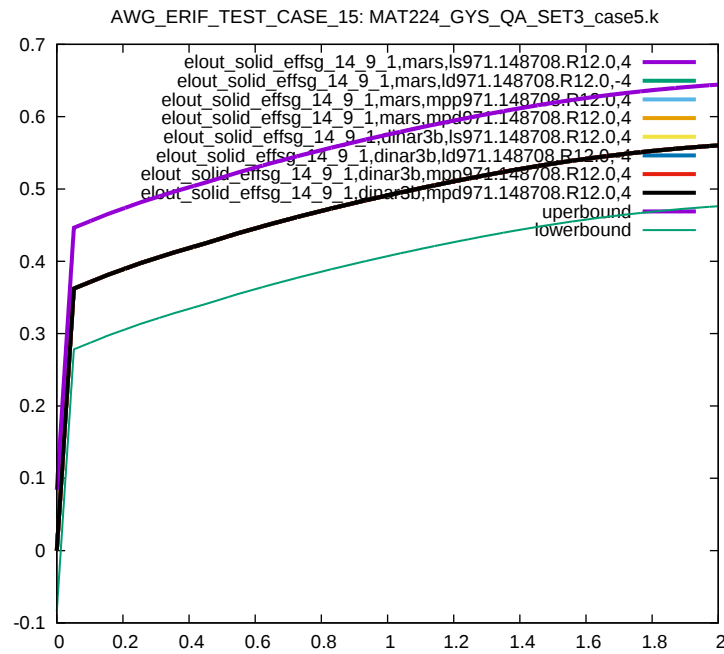


Figure 115: Cross platform results, Von Mises Stress, element ID 14, sub test case ID 7

5.3.15 Sub Test Case ID 8 - Test Target 15

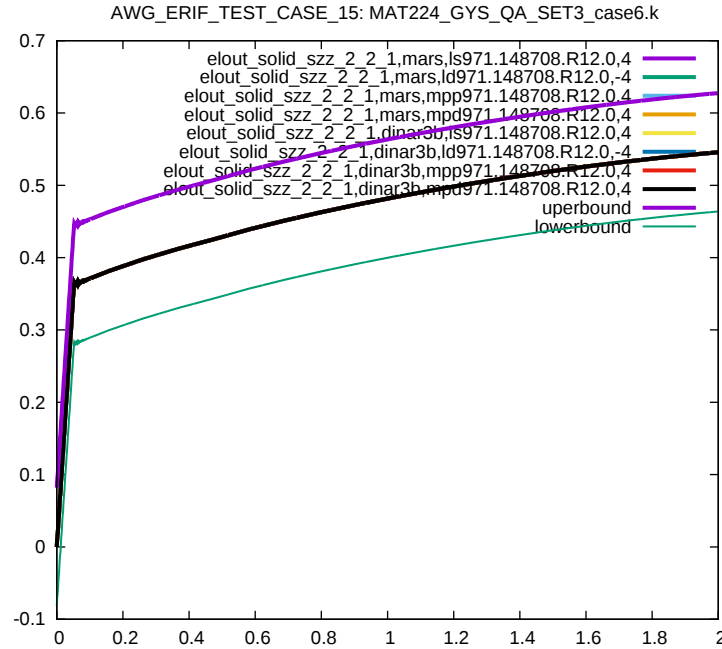


Figure 116: Cross platform results, z-component Stress, element ID 2, sub test case ID 8

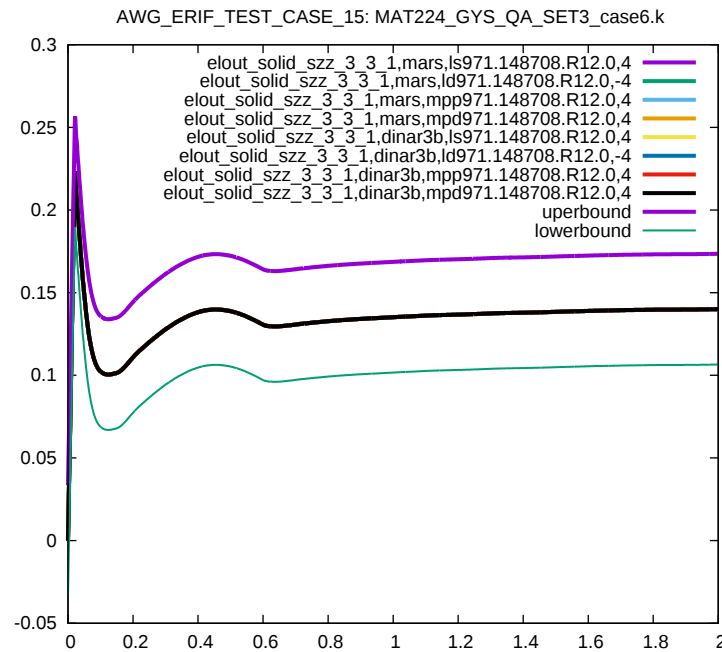


Figure 117: Cross platform results, z-component Stress, element ID 3, sub test case ID 8

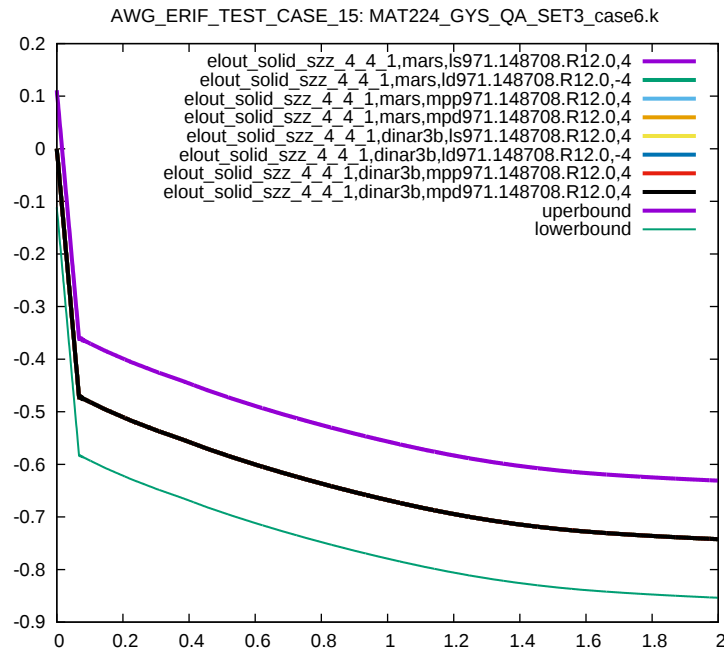


Figure 118: Cross platform results, z-component Stress, element ID 4, sub test case ID 8

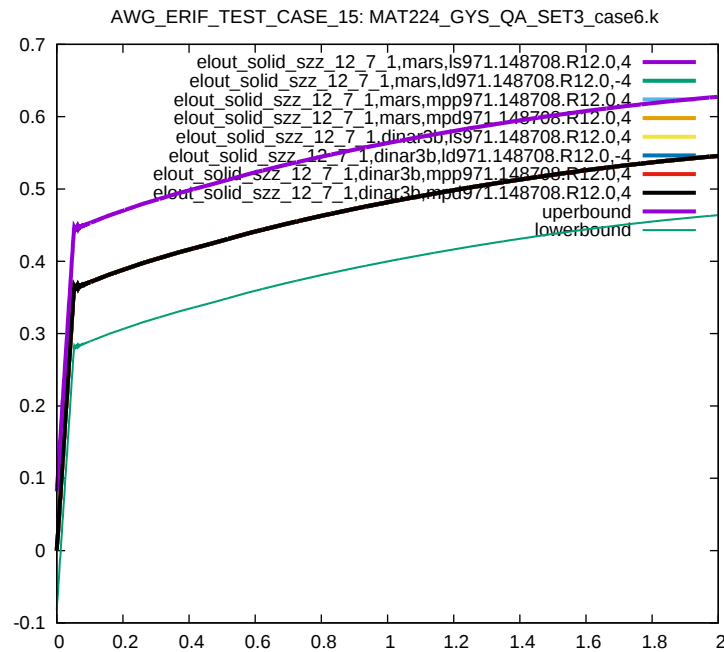


Figure 119: Cross platform results, z-component Stress, element ID 12, sub test case ID 8

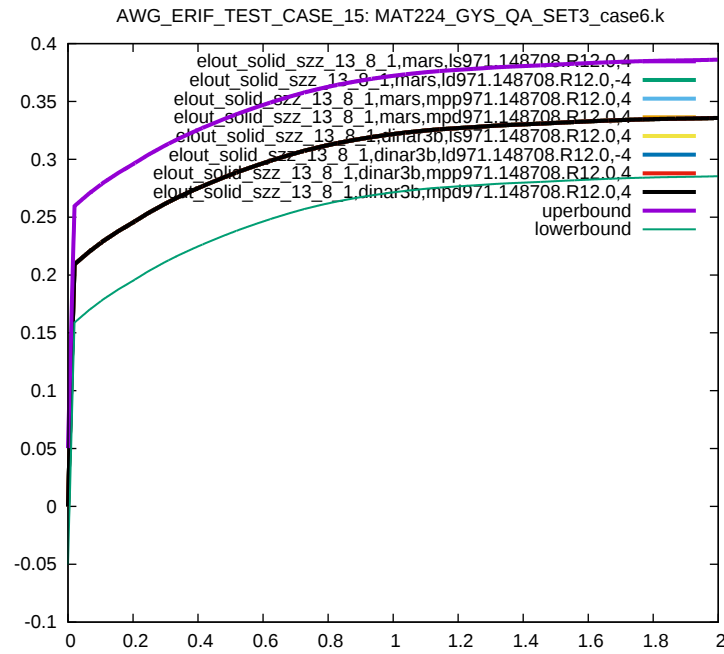


Figure 120: Cross platform results, z-component Stress, element ID 13, sub test case ID 8

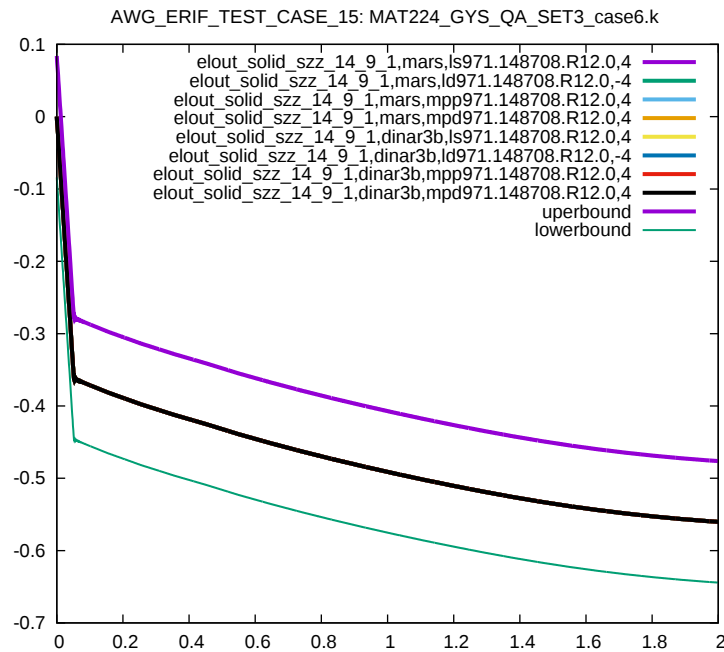


Figure 121: Cross platform results, z-component Stress, element ID 14, sub test case ID 8

5.3.16 Sub Test Case ID 8 - Test Target 16

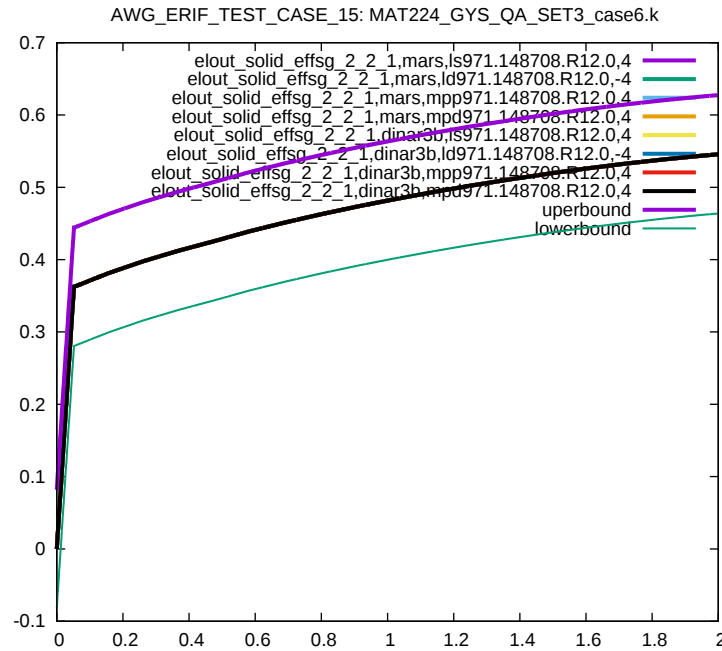


Figure 122: Cross platform results, Von Mises Stress, element ID 2, sub test case ID 8

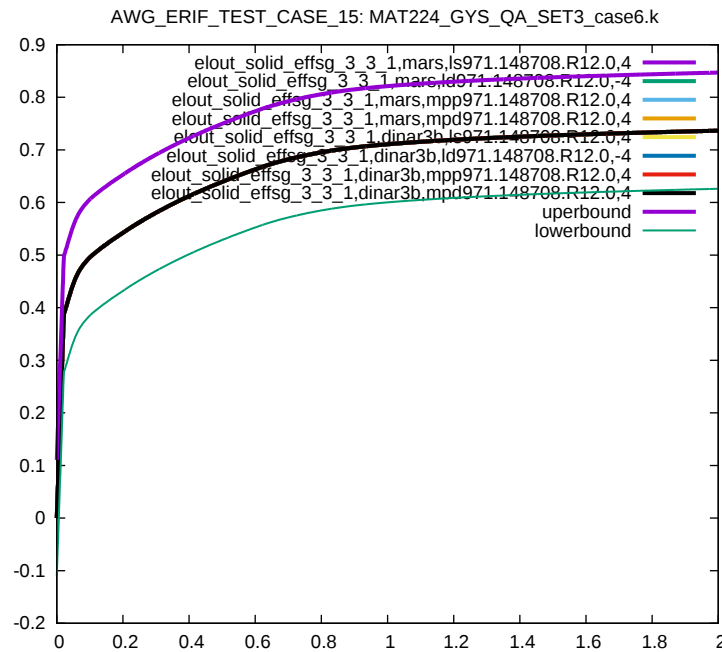


Figure 123: Cross platform results, Von Mises Stress, element ID 3, sub test case ID 8

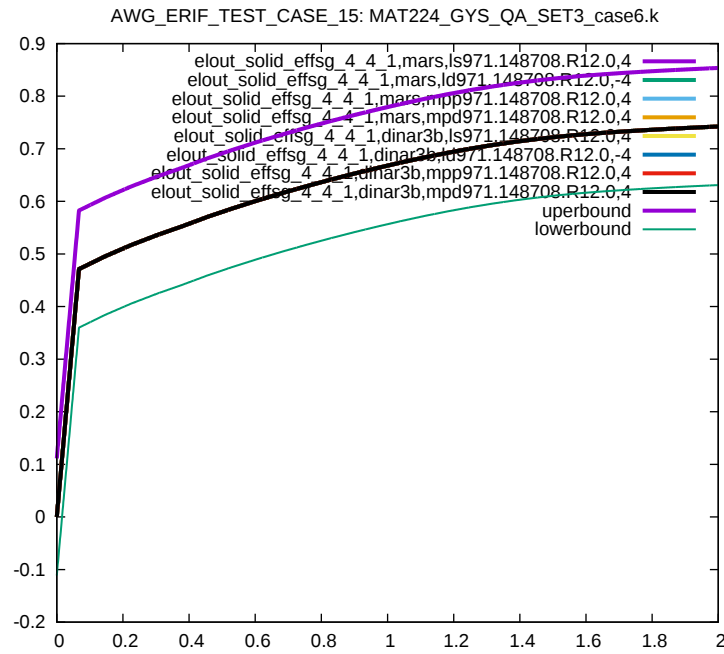


Figure 124: Cross platform results, Von Mises Stress, element ID 4, sub test case ID 8

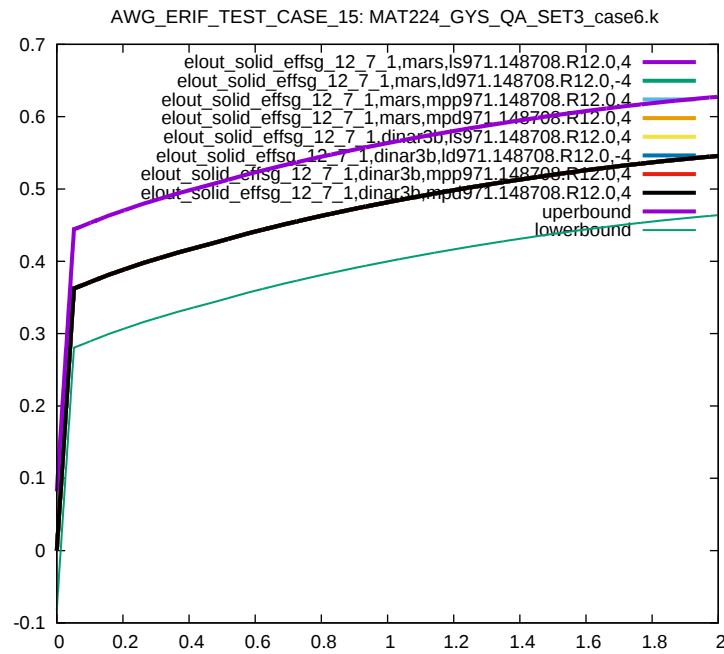


Figure 125: Cross platform results, Von Mises Stress, element ID 12, sub test case ID 8

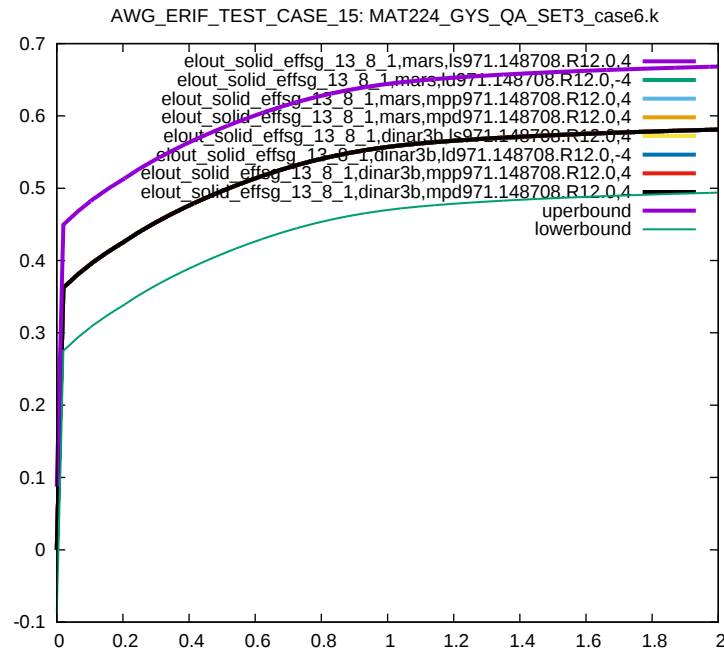


Figure 126: Cross platform results, Von Mises Stress, element ID 13, sub test case ID 8

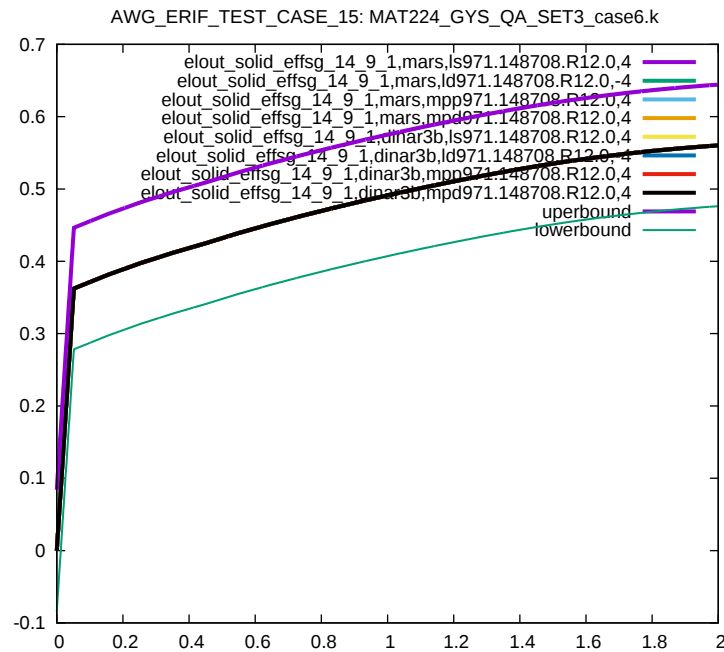


Figure 127: Cross platform results, Von Mises Stress, element ID 14, sub test case ID 8

5.3.17 Sub Test Case ID 9 - Test Target 17

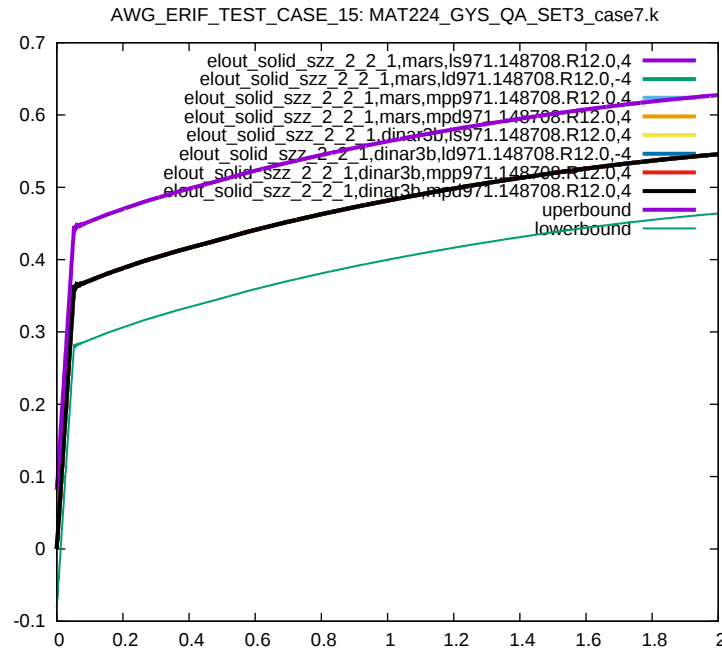


Figure 128: Cross platform results, z-component Stress, element ID 2, sub test case ID 9

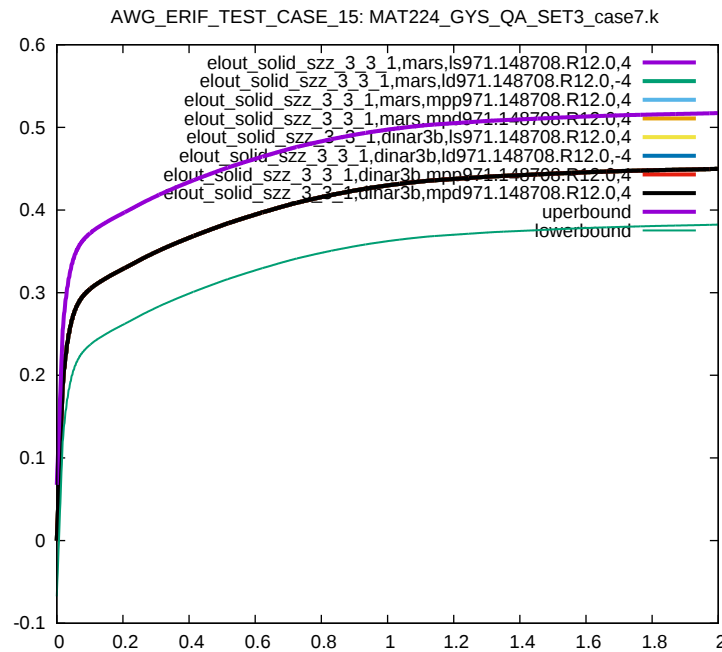


Figure 129: Cross platform results, z-component Stress, element ID 3, sub test case ID 9

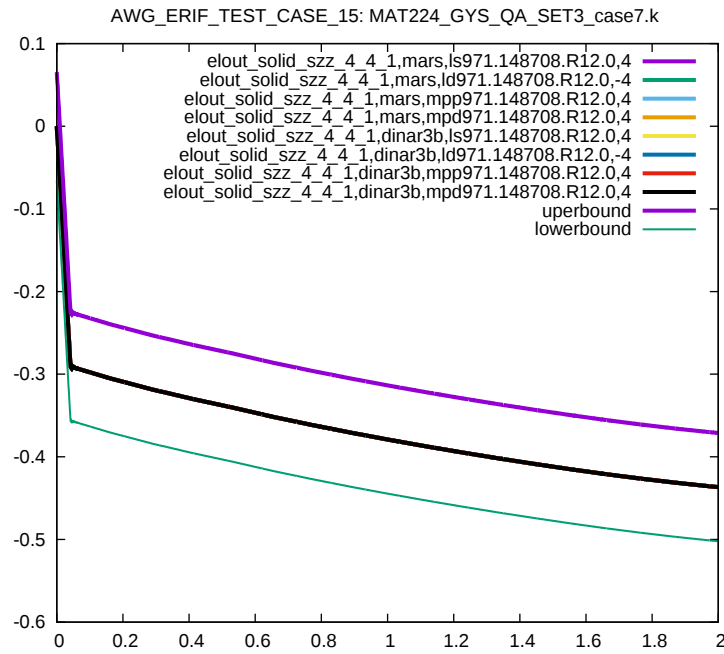


Figure 130: Cross platform results, z-component Stress, element ID 4, sub test case ID 9

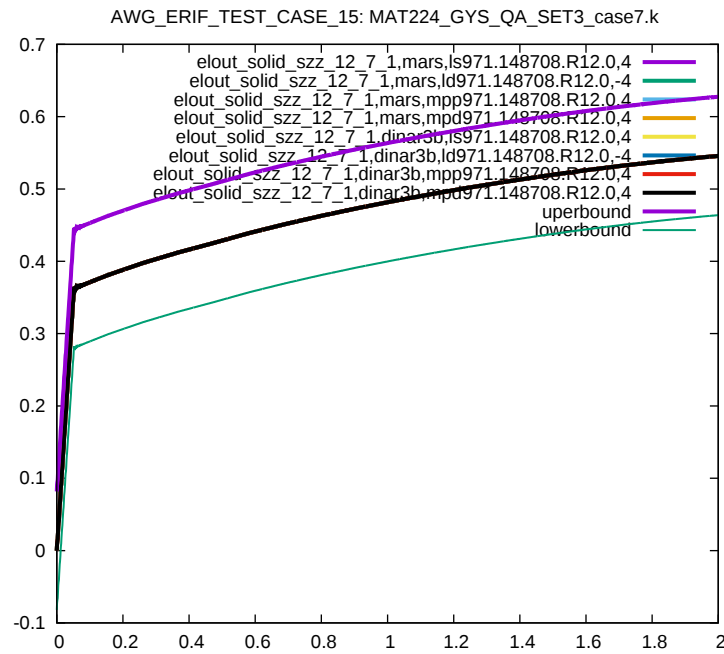


Figure 131: Cross platform results, z-component Stress, element ID 12, sub test case ID 9

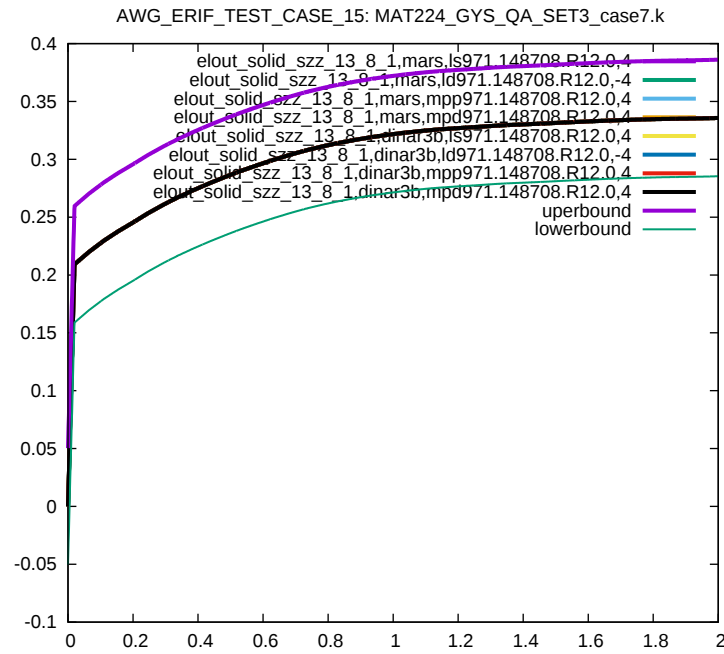


Figure 132: Cross platform results, z-component Stress, element ID 13, sub test case ID 9

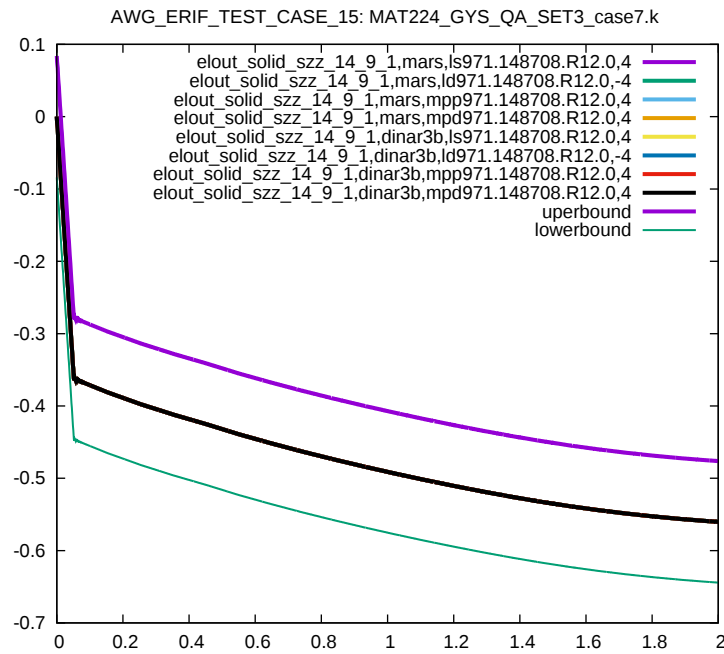


Figure 133: Cross platform results, z-component Stress, element ID 14, sub test case ID 9

5.3.18 Sub Test Case ID 9 - Test Target 18

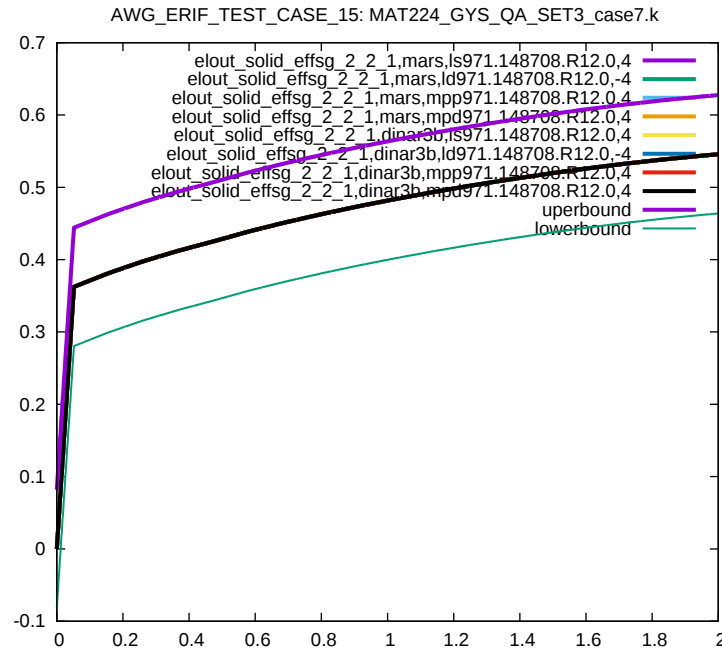


Figure 134: Cross platform results, Von Mises Stress, element ID 2, sub test case ID 9

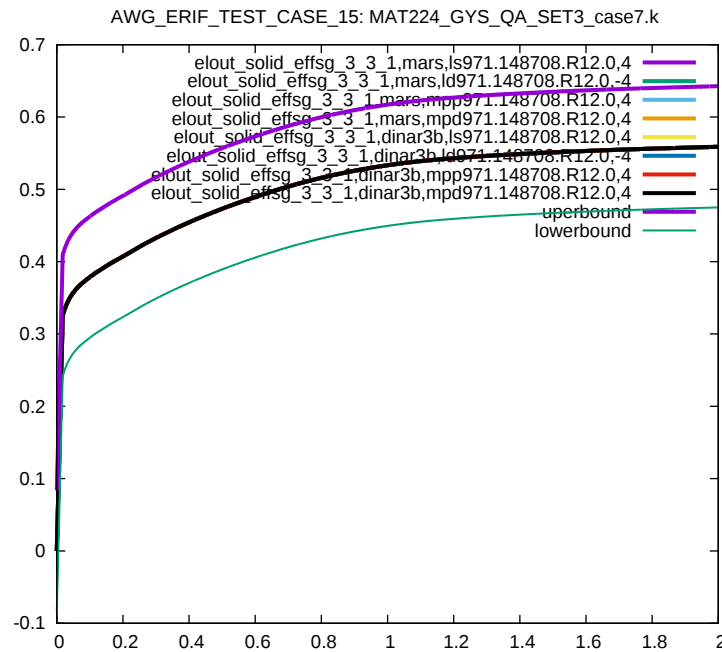


Figure 135: Cross platform results, Von Mises Stress, element ID 3, sub test case ID 9

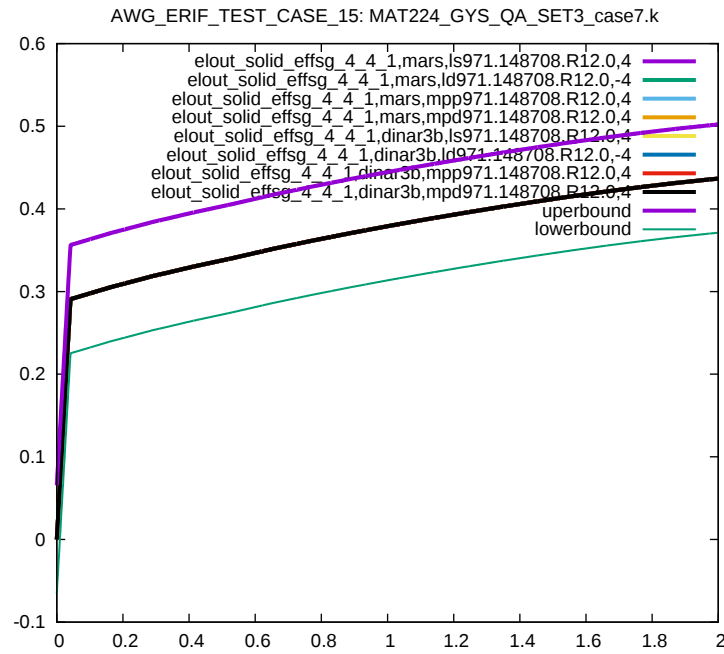


Figure 136: Cross platform results, Von Mises Stress, element ID 4, sub test case ID 9

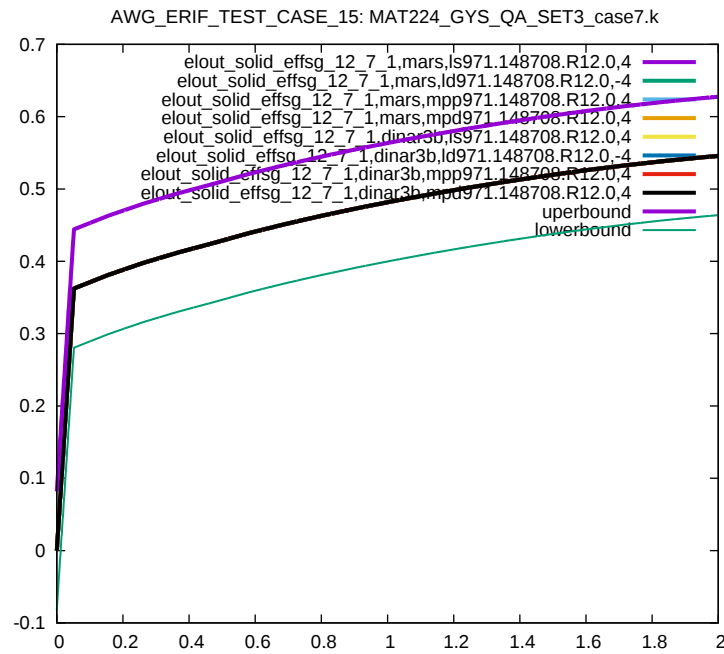


Figure 137: Cross platform results, Von Mises Stress, element ID 12, sub test case ID 9

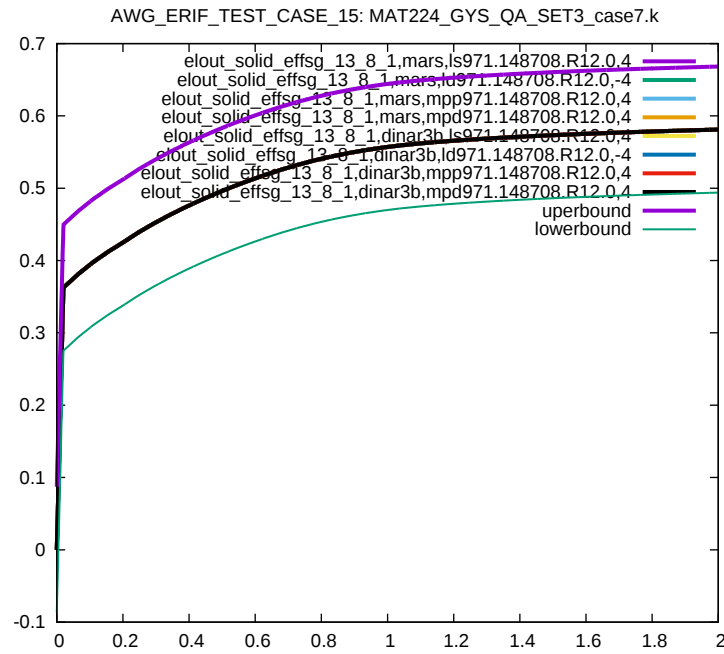


Figure 138: Cross platform results, Von Mises Stress, element ID 13, sub test case ID 9

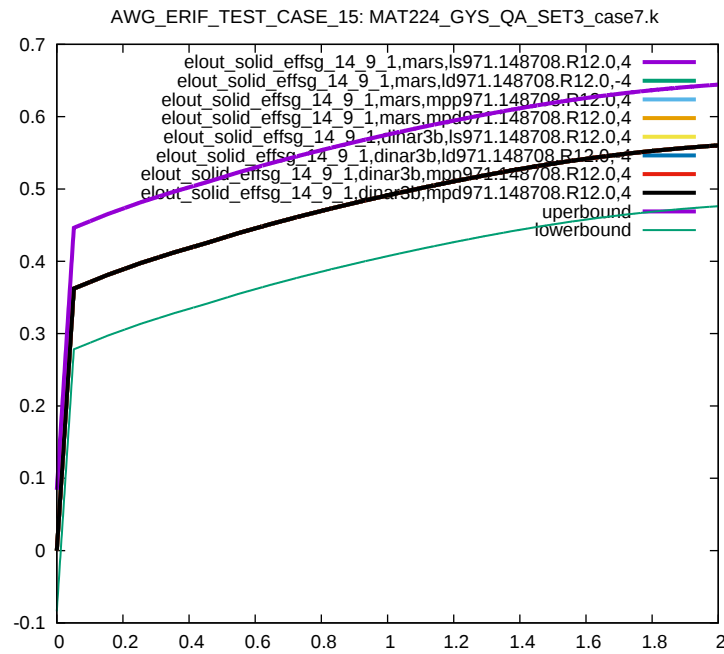


Figure 139: Cross platform results, Von Mises Stress, element ID 14, sub test case ID 9

5.3.19 Sub Test Case ID 10 - Test Target 19

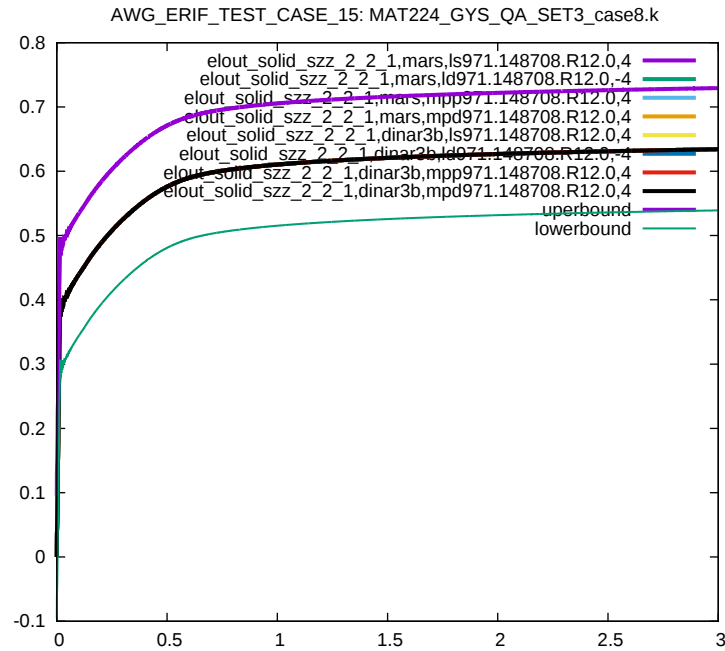


Figure 140: Cross platform results, z-component Stress, element ID 2, sub test case ID 10

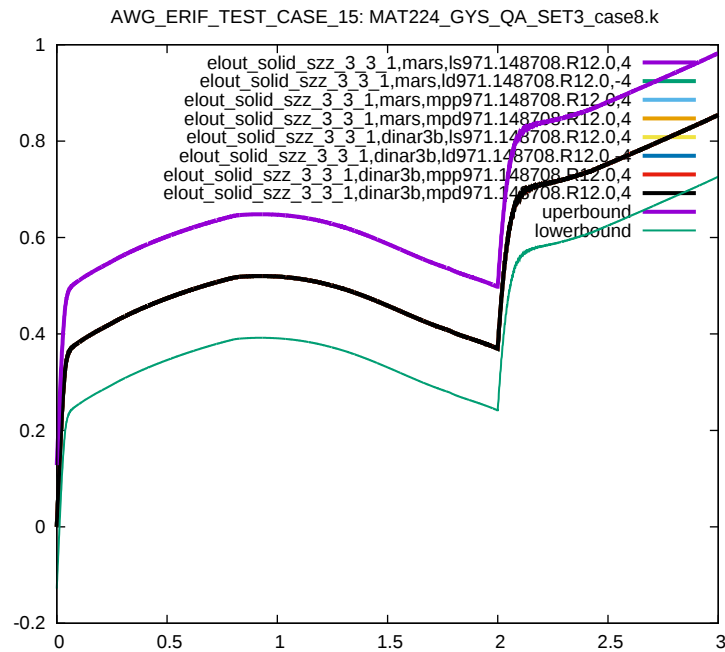


Figure 141: Cross platform results, z-component Stress, element ID 3, sub test case ID 10

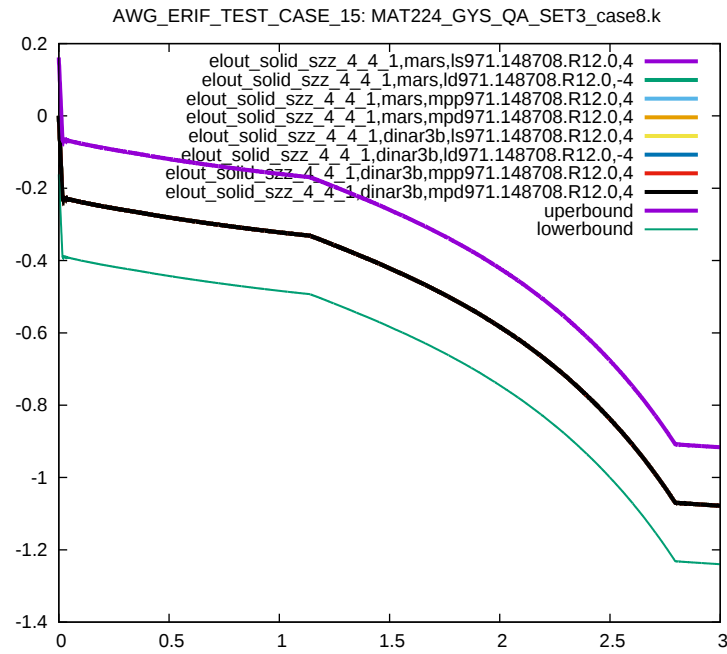


Figure 142: Cross platform results, z-component Stress, element ID 4, sub test case ID 10

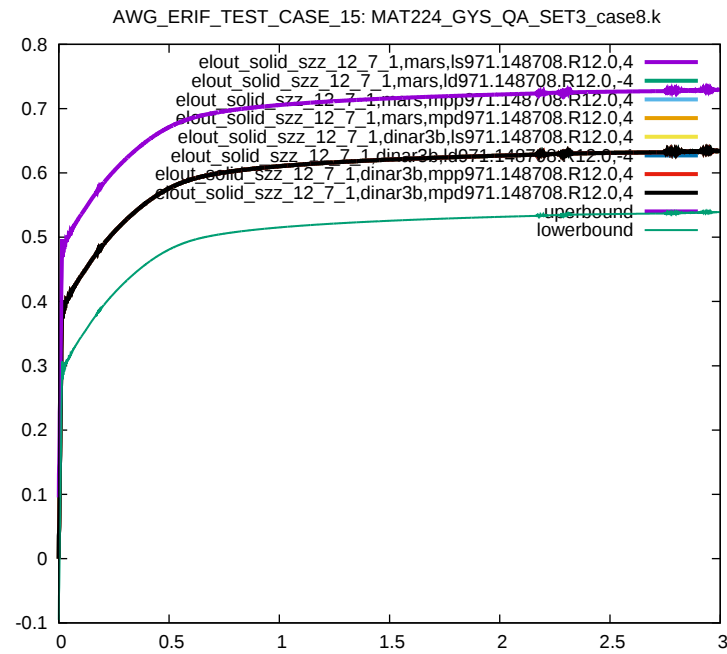


Figure 143: Cross platform results, z-component Stress, element ID 12, sub test case ID 10

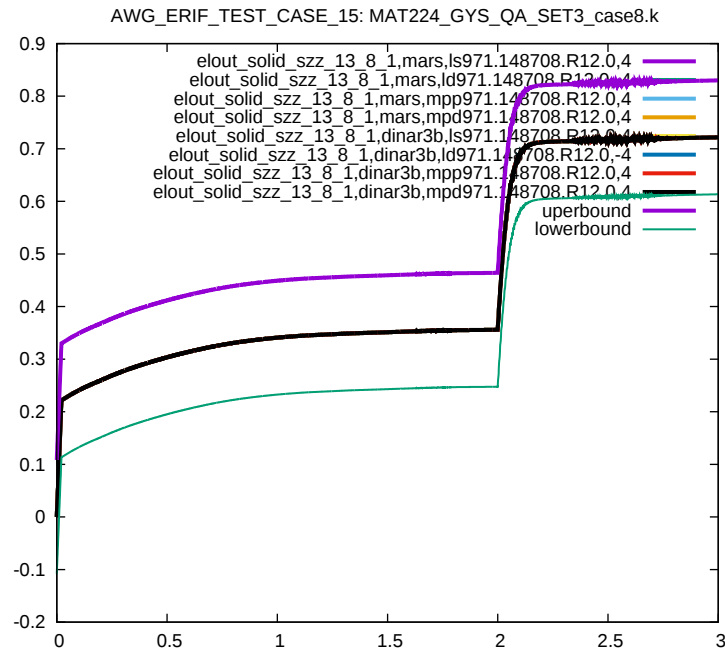


Figure 144: Cross platform results, z-component Stress, element ID 13, sub test case ID 10

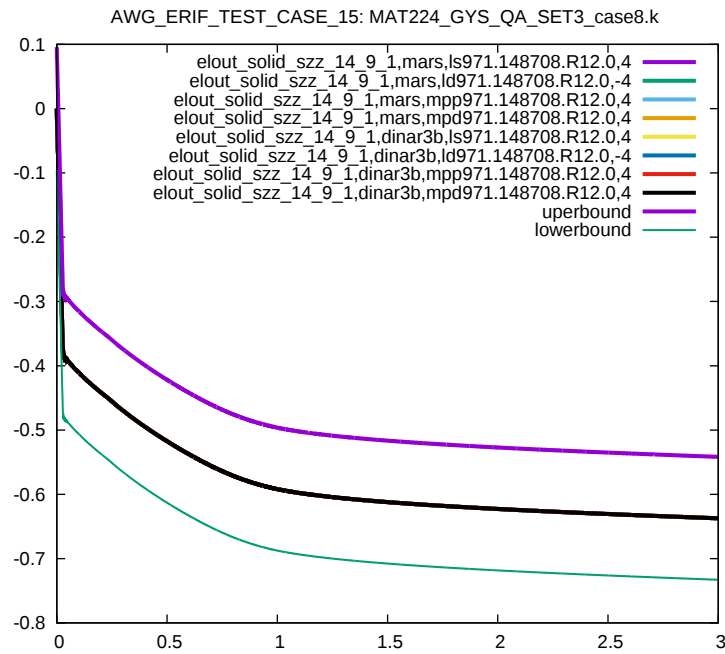


Figure 145: Cross platform results, z-component Stress, element ID 14, sub test case ID 10

5.3.20 Sub Test Case ID 10 - Test Target 20

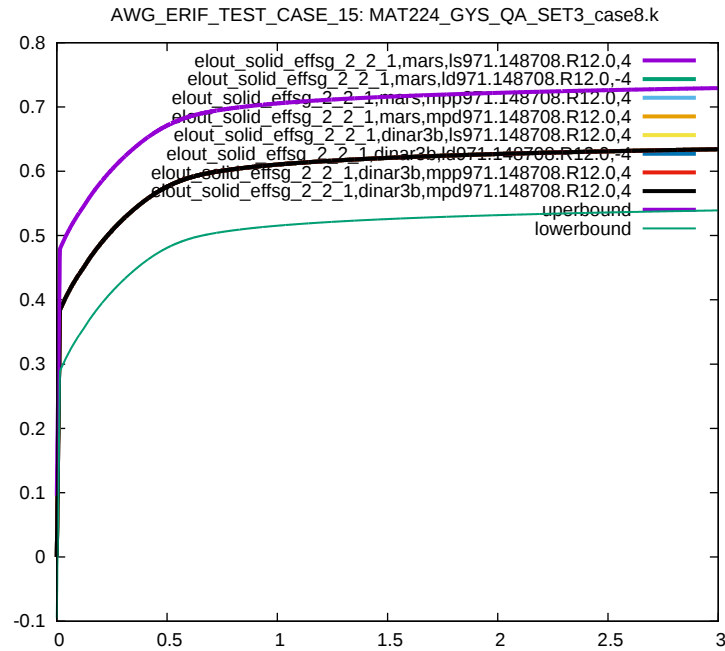


Figure 146: Cross platform results, Von Mises Stress, element ID 2, sub test case ID 10

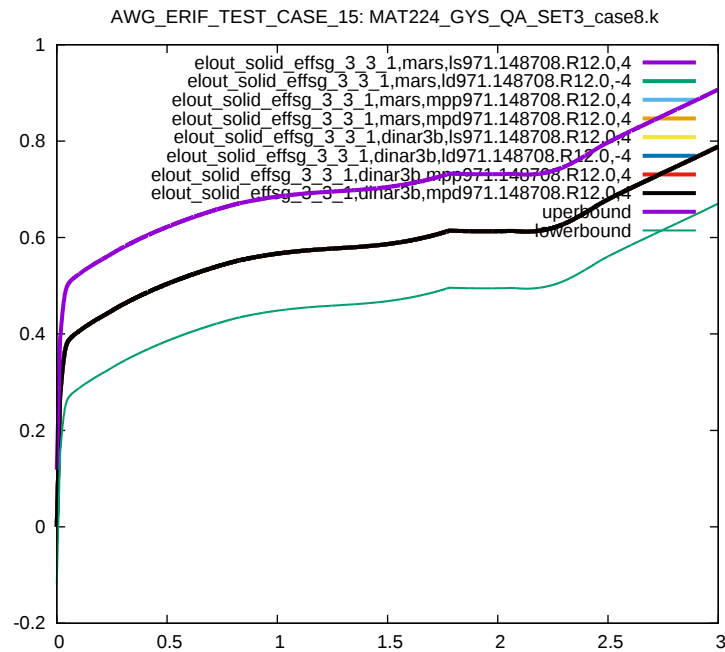


Figure 147: Cross platform results, Von Mises Stress, element ID 3, sub test case ID 10

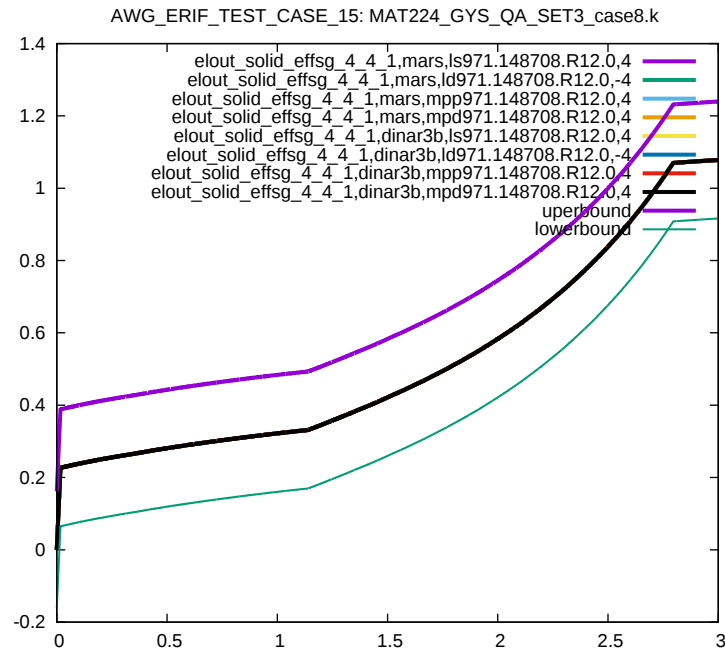


Figure 148: Cross platform results, Von Mises Stress, element ID 4, sub test case ID 10

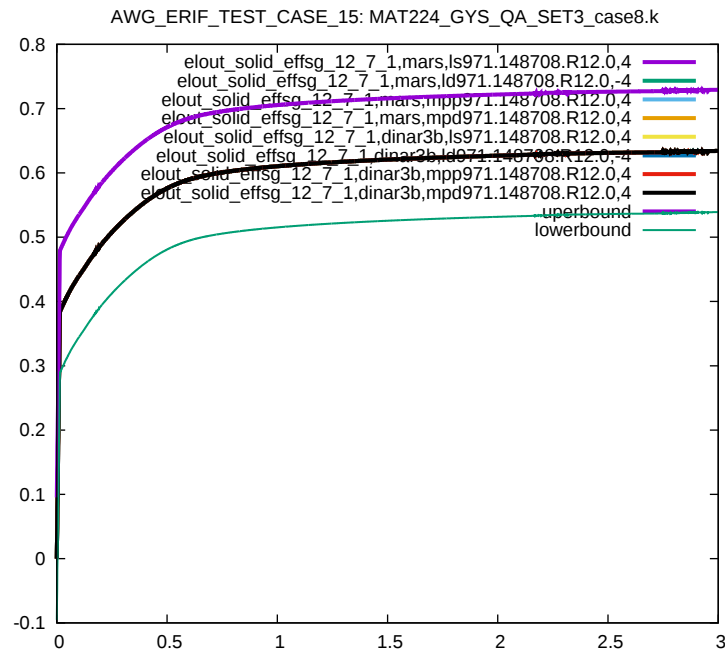


Figure 149: Cross platform results, Von Mises Stress, element ID 12, sub test case ID 10

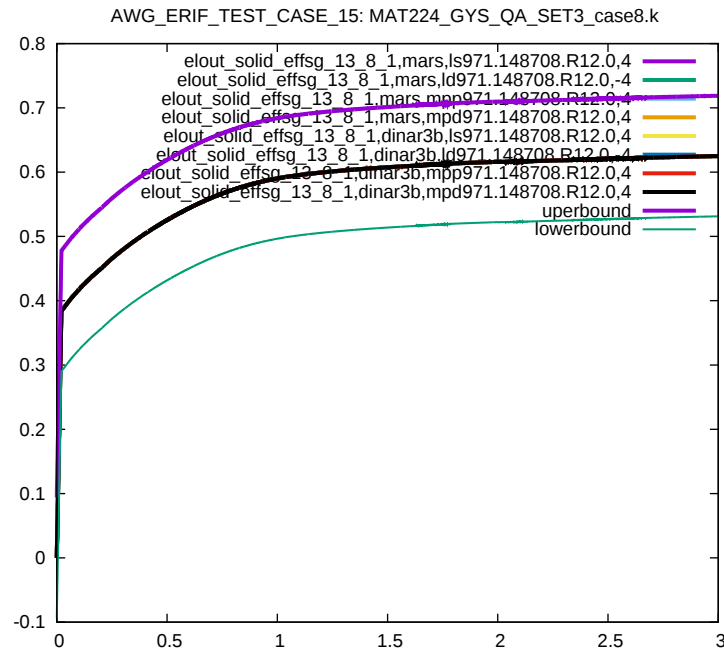


Figure 150: Cross platform results, Von Mises Stress, element ID 13, sub test case ID 10

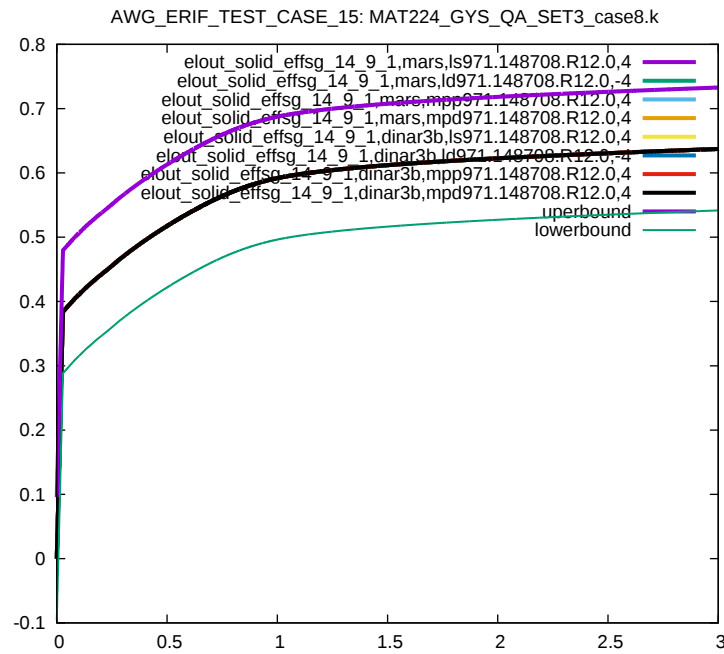


Figure 151: Cross platform results, Von Mises Stress, element ID 14, sub test case ID 10

References

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