Part #1:

Fill in the tables

Predicted Beam Deflection (mm)

Element Type	Mesh Size		
	1x6	2x12	4x12
CPS4	2.242E-3	1.049E-2	1.758E-2
CPS8	3.541E-2	5.979E-2	1.077E-1
CPS4R	6.356E-1	4.735E-2	6.330E-2
CPS8R	3.556E-2	5.991E-2	1.080E-1

Predicted Maximum Normal Stress (MPa)

Element Type	Mesh Size		
	1x6	2x12	4x12
CPS4	1.880E3	9.139E3	1.529E4
CPS8	2.943E4	5.176E4	9.410E4
CPS4R	1.125E-9	1.893E4	3.796E4
CPS8R	3.000E4	5.099E4	9.187E4

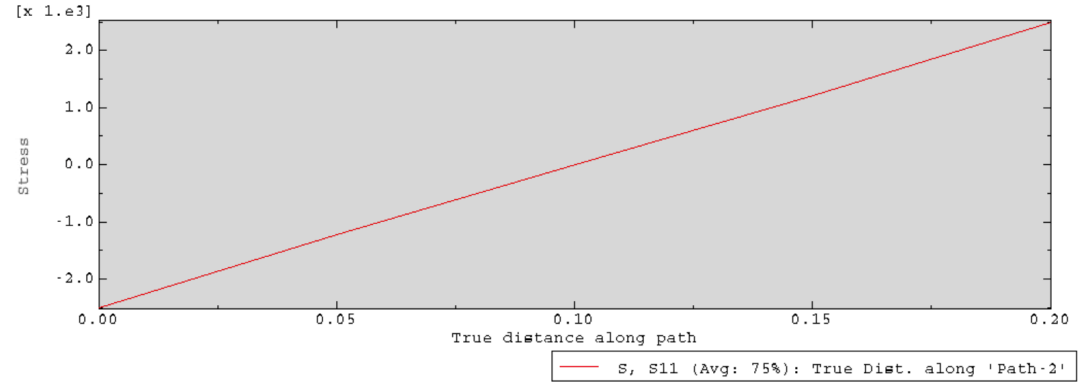
Predicted Maximum Shear Stress (MPa)

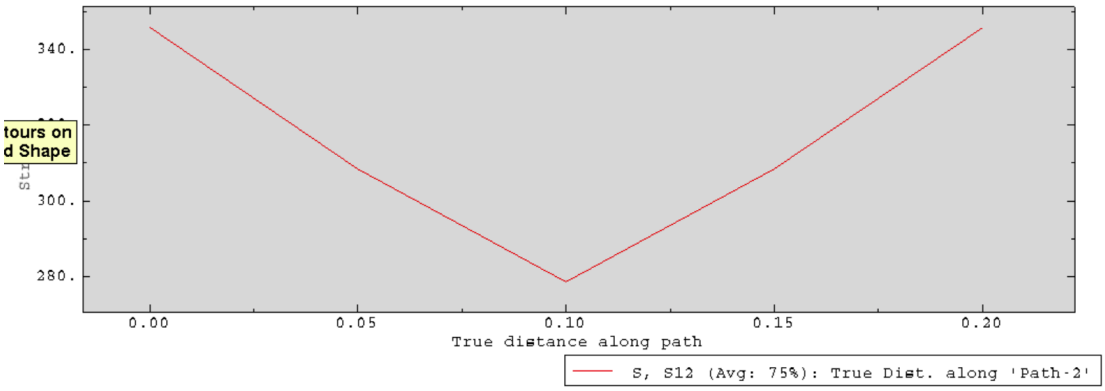
Element Type	Mesh Size		
	1x6	2x12	4x12
CPS4	3.179E3	7.890E3	1.321E4
CPS8	2.304E2	6.387E2	6.977E2
CPS4R	-1.111E2	-1.667E-2	-9.126E-1
CPS8R	-1.667E-2	1.207E3	2.791E3

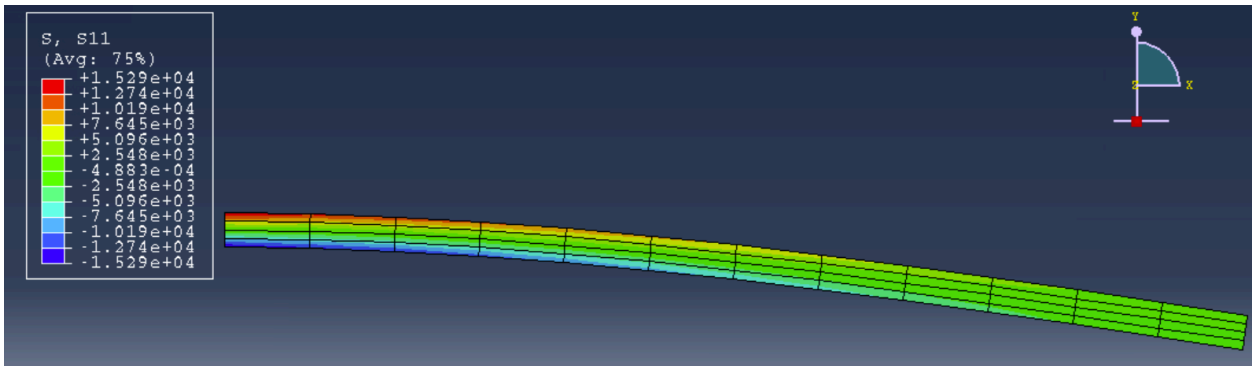
Part #2

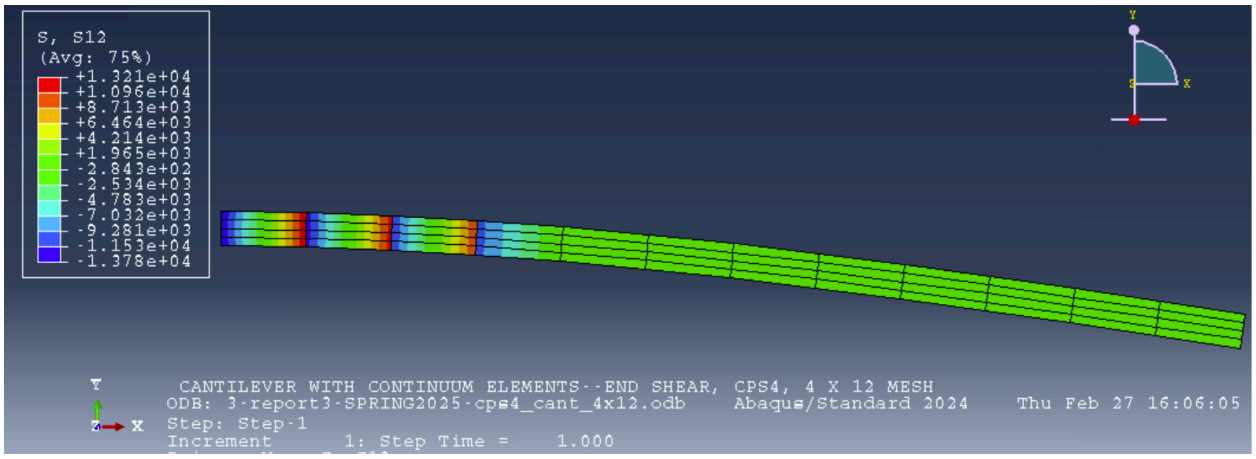
For the meshes 4x12 and all four element types, extract the normal and shear stress distribution across the beam height at the location x=L/6 from the free end of the beam, and provide respective contour plots of S11 and S12.

CPS4:

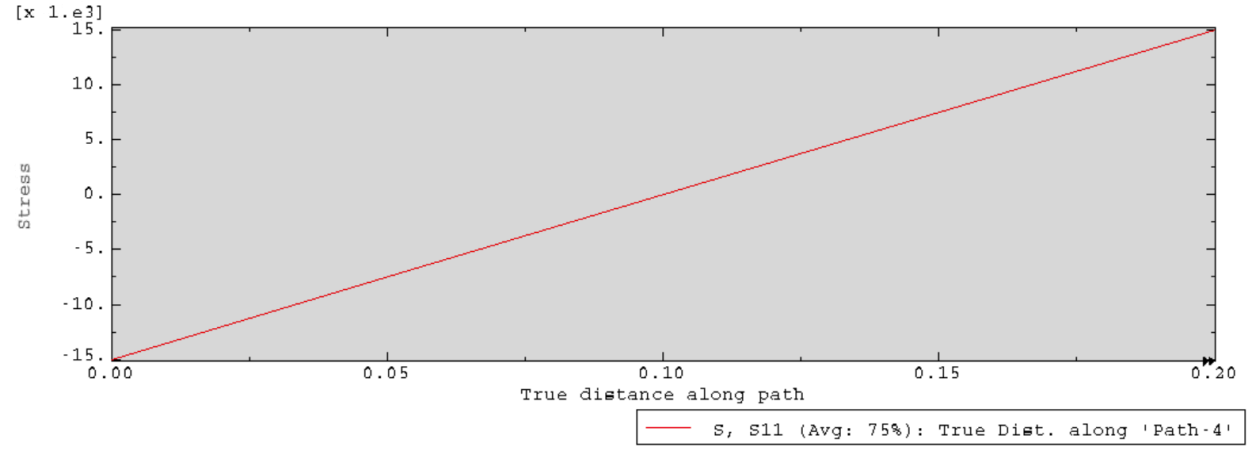

[x 1.e3]
2.0
1.0
0.0
-1.0
-2.0
Stress
0.00
0.05
0.10
0.15
0.20
True distance along path
S, S11 (Avg: 75%): True Dist. along 'Path-2'

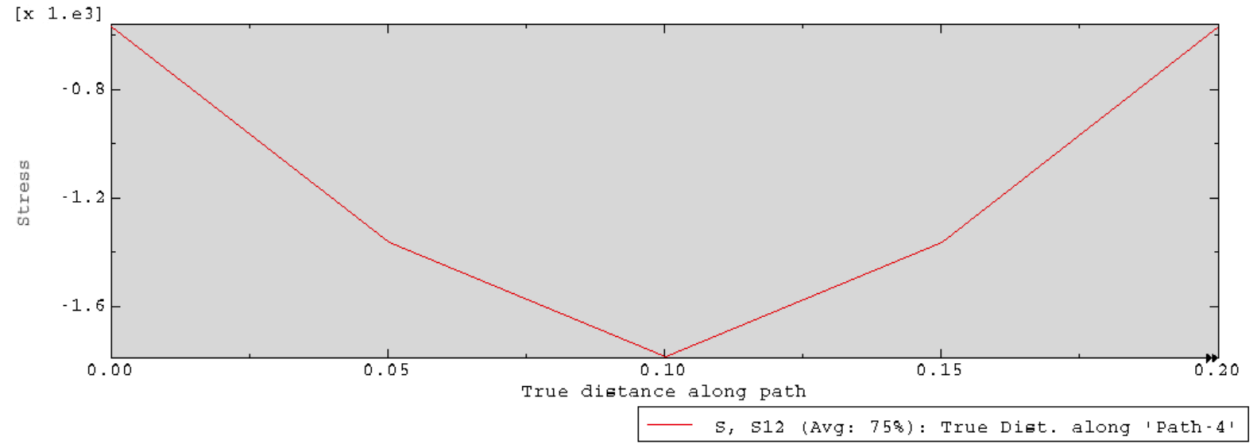

340.
300.
280.
0.00
0.05
0.10
0.15
0.20
True distance along path
S, S12 (Avg: 75%): True Dist. along 'Path-2'

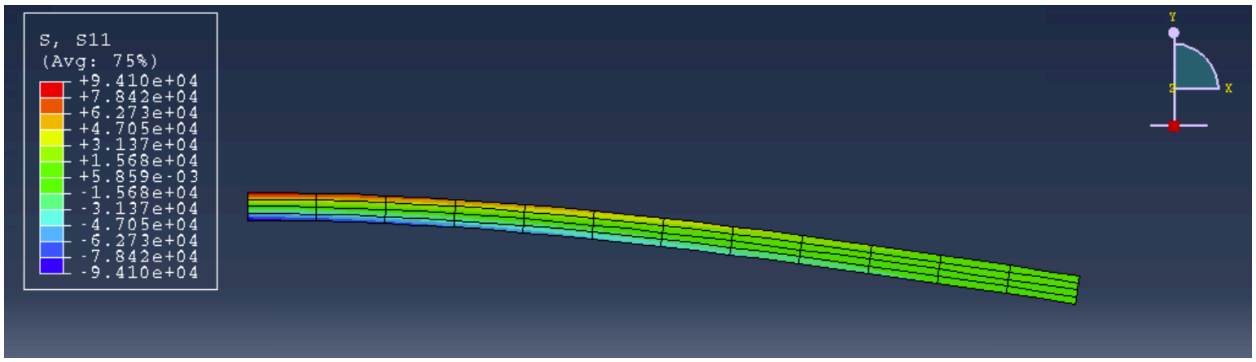

S, S11
(Avg: 75%)
+1.529e+04
+1.274e+04
+1.019e+04
+7.645e+03
+5.096e+03
+2.548e+03
-4.883e-04
-2.548e+03
-5.096e+03
-7.645e+03
-1.019e+04
-1.274e+04
-1.529e+04

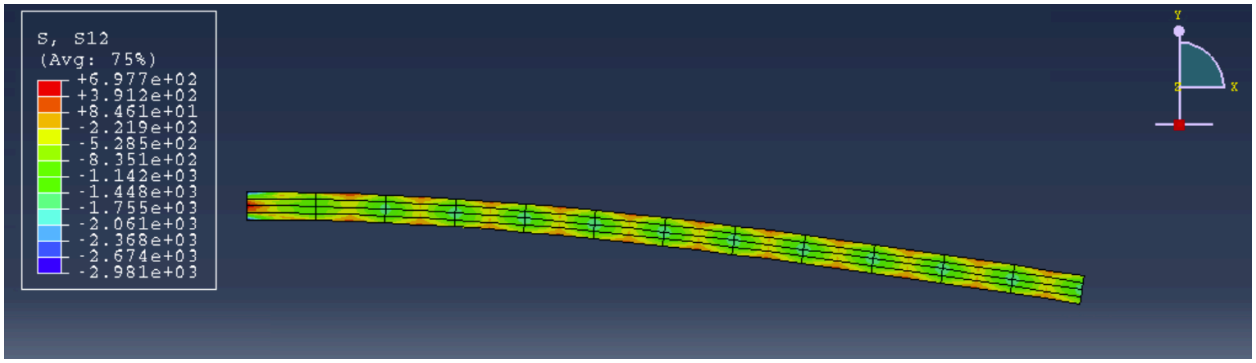

S, S12
(Avg: 75%)
+1.321e+04
+1.096e+04
+8.713e+03
+6.464e+03
+4.214e+03
+1.965e+03
-2.843e+02
-2.534e+03
-4.783e+03
-7.032e+03
-9.281e+03
-1.153e+04
-1.378e+04
CANTILEVER WITH CONTINUUM ELEMENTS--END SHEAR, CPS4, 4 X 12 MESH
ODB: 3-report3-SPRING2025-cps4_cant_4x12.odb Abaqus/Standard 2024 Thu Feb 27 16:06:05
Step: Step-1
Increment 1: Step Time = 1.000

CPS8:


[x 1.e3]
15.
10.
5.
0.
-5.
-10.
-15.
Stress
0.00
0.05
0.10
0.15
0.20
True distance along path
S, S11 (Avg: 75%): True Dist. along 'Path-4'

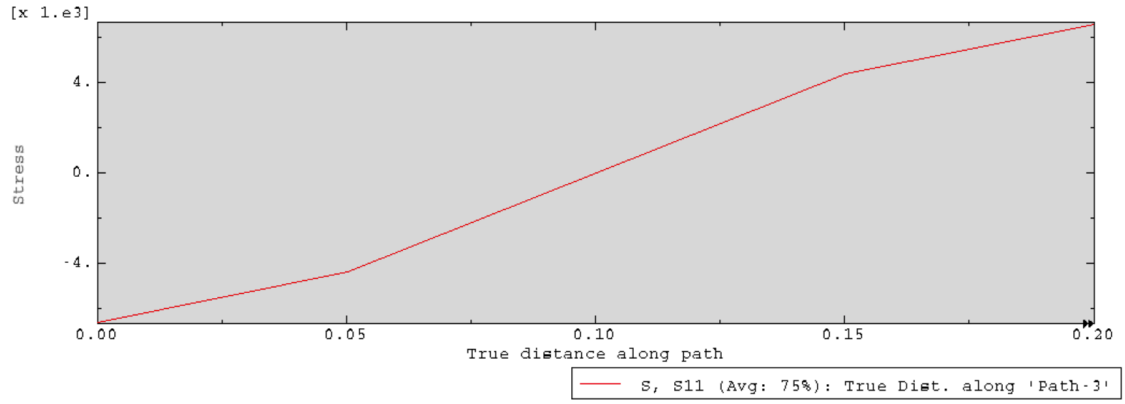

[x 1.e3]
-0.8
-1.2
-1.6
Stress
0.00
0.05
0.10
0.15
0.20
True distance along path
S, S12 (Avg: 75%): True Dist. along 'Path-4'

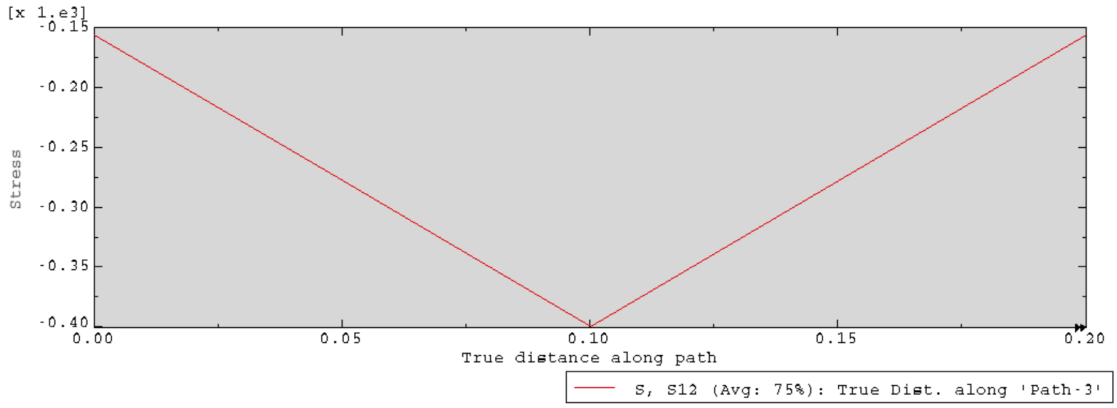

S, S11
(Avg: 75%)
+9.410e+04
+7.842e+04
+6.273e+04
+4.705e+04
+3.137e+04
+1.568e+04
+5.859e-03
-1.568e+04
-3.137e+04
-4.705e+04
-6.273e+04
-7.842e+04
-9.410e+04
Y
X

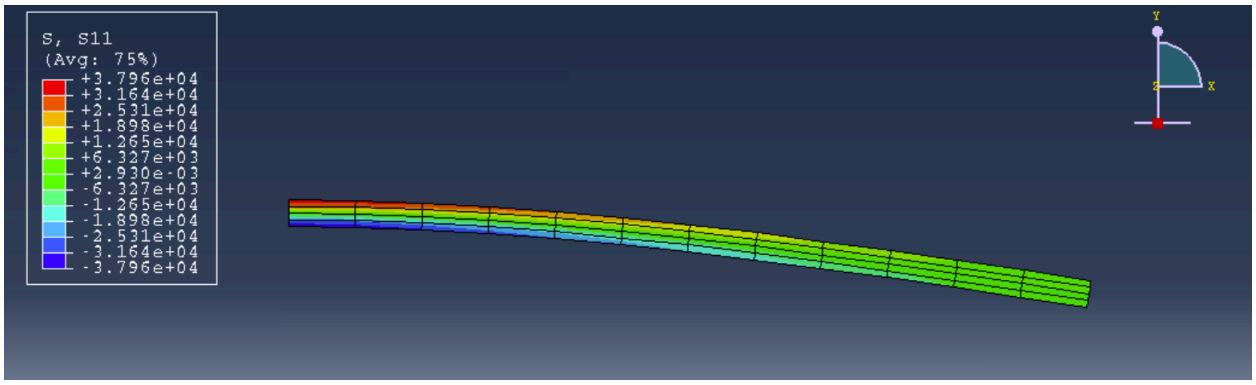

S, S12
(Avg: 75%)
+6.977e+02
+3.912e+02
+8.461e+01
-2.219e+02
-5.285e+02
-8.351e+02
-1.142e+03
-1.448e+03
-1.755e+03
-2.061e+03
-2.368e+03
-2.674e+03
-2.981e+03
Y
X

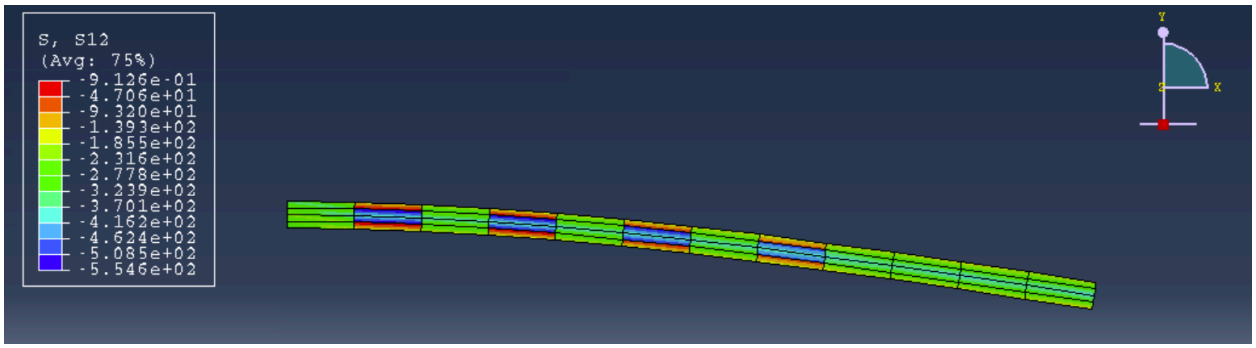
Heather Mello
02/28/2025

CPS4R:

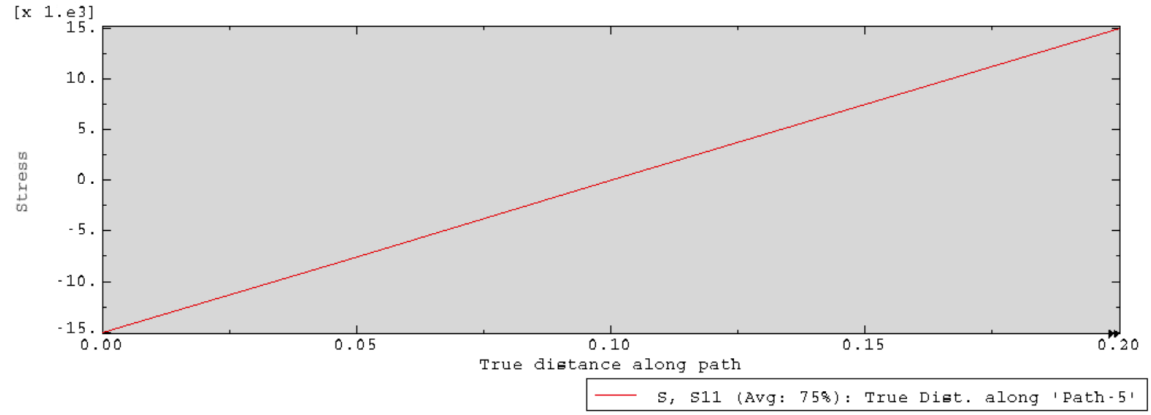


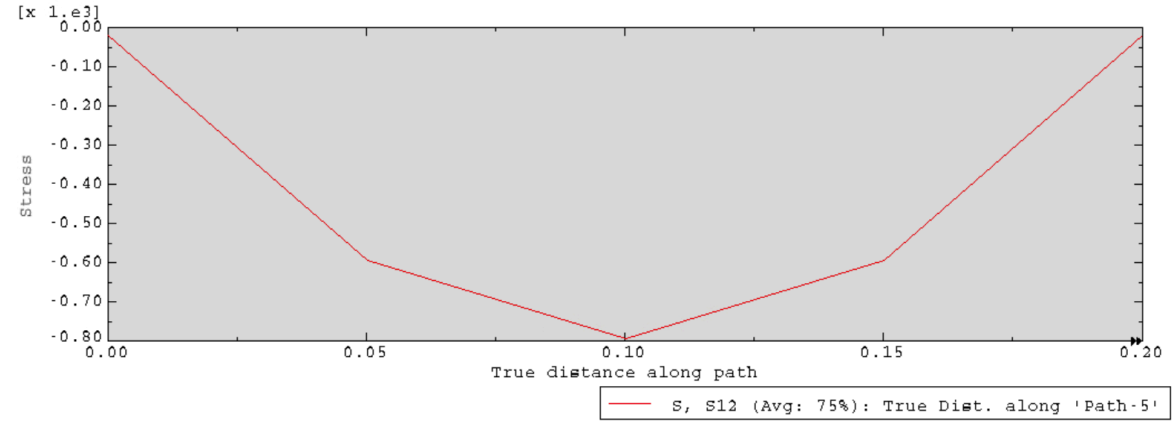


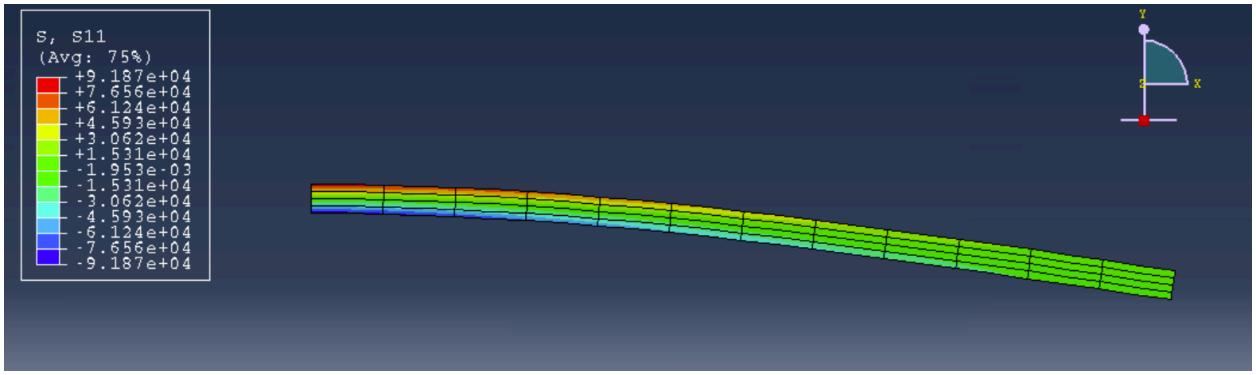


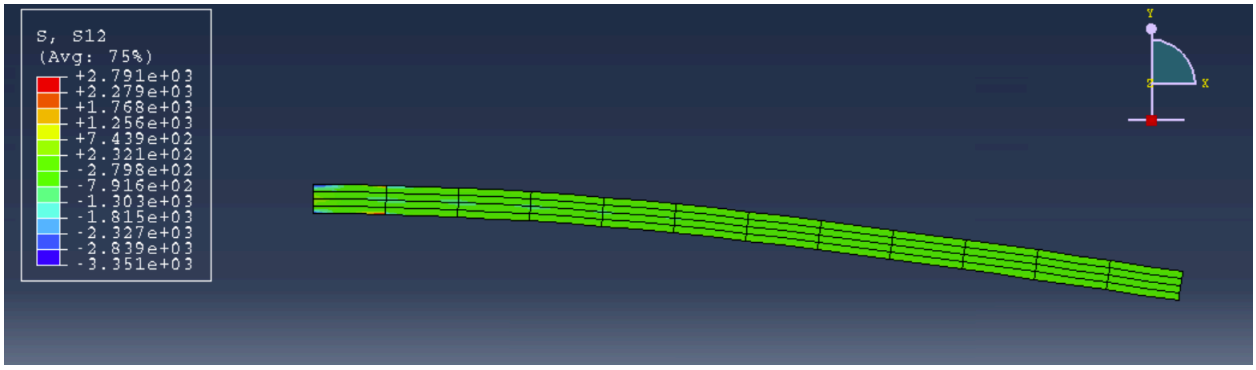


CPS8R:


[x 1.e3]
15.
10.
5.
0.
-5.
-10.
-15.
Stress
0.00
0.05
0.10
0.15
0.20
True distance along path
S, S11 (Avg: 75%): True Dist. along 'Path-5'


[x 1.e3]
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
Stress
0.00
0.05
0.10
0.15
0.20
True distance along path
S, S12 (Avg: 75%): True Dist. along 'Path-5'


S, S11
(Avg: 75%)
+9.187e+04
+7.656e+04
+6.124e+04
+4.593e+04
+3.062e+04
+1.531e+04
-1.953e-03
-1.531e+04
-3.062e+04
-4.593e+04
-6.124e+04
-7.656e+04
-9.187e+04
Y
X


S, S12
(Avg: 75%)
+2.791e+03
+2.279e+03
+1.768e+03
+1.256e+03
+7.439e+02
+2.321e+02
-2.798e+02
-7.916e+02
-1.303e+03
-1.815e+03
-2.327e+03
-2.839e+03
-3.351e+03
Y
X

Part #3

In a short paragraph (between ½ page and 1 page, typed 12 pt font, single spaced), summarize the results and observations you can make from this study.

This study analyzed the estimated deflection and stress values for a beam using different element types including: CPS4, CPS8, CPS4R, and CPS8R. The study also varied mesh sizes for each of these element types, with mesh sizes of 1x6, 2x12, and 4x12. The study proved that different mesh and element configurations can result in significant differences between simulations. From all of the results, it is immediately obvious that the CPS8 and CPS8R elements produced more consistent results compared to CPS4 and CPS4R. Because CPS8 and CPS8R are higher order elements, they are able to create more accurate and stable predictions. On the other hand, CPS4 and CPS4R are linear elements, so their accuracy can suffer due to reduced integration, as well as from a coarse mesh. Also based on the deflection results, it is evident that a finer mesh will result in more accurate results. Moving left to right on the table (from a coarse mesh to a fine mesh), the values for deflection at the end of the beam consistently get closer to the expected value 0.108 mm. The test for the 4x12 mesh on a CPS8R element resulted in the expected value, indicating that this is the most accurate model when considering deflection. This trend continues with the maximum normal stress and maximum shear stress, with the CPS8 and CPS8R tests providing more accurate results. Analyzing the results from just the CPS8 and CPS8R elements, it seems the reduced order quadratic elements were the closest. However, the results don't vary very much between the two elements, which is because quadratic elements are better at handling deformation, even with reduced integration. Therefore, the difference in results between CPS8 and CPS8R when compared to the difference between CPS4 and CPS4R is significantly less noticeable. Overall, this study highlights the importance of selecting appropriate element types and meshes when performing a finite element analysis. It also shows that quadratic elements will generally be better at predicting values for deformation, normal stress, and shear stress.