FINITE ELEMENT TECHNIQUES(FALL 2018)

Final Project

Damacharla,vishnu Vardhan

vxd180005@utdallas.edu

Objective: -Q4 and Q8 element implementation for a cantilever beam with end load in MATLAB for different mesh sizes under plane stress state and comparing stresses and deflection with Ansys results.

Implementation in MATLAB: -

1) Plane stress analysis of solid using linear Q4 elements

Variable descriptions

k = element matrix

f = element vector

kk = system matrix

ff = system vector

displ = system nodal displacement vector

eldisp = element nodal displacement vector

gcoord = coordinate values of each node

nodes = nodal connectivity of each element

index = a vector containing system dofs associated with each element

bcdof = a vector containing dofs associated with boundary conditions

bcval = a vector containing boundary condition values associated with

the dofs in 'bcdof'

q=shear stress equation

ForceNodes=nodes on which load is acting

ShapFun=Shape functions matrix;

DiffMatr=Differentiation matrix

Jacobian=jacobian matrix

TransMatrx=Transformation matrix

Bmtx2=’B’ matrix

DisplX=Displacement along X,DisplX=Displcement along Y

NodeStrain=Nodal strains

NodeStress=nodal stresses

ElemeStrains=Element strains

ElemeStresses=Element stresses

eleStrain.m file consists of element strain calculation.

Input data:-D=1; Load=10000, E=2e11, Length=5, Poisson ratio-0.3

Procedure: -

Meshing with Element sizes of 0.3,0.4,0.7

1) Initializing all the input variables like number of elements, number of nodes, number of degrees of freedom etc.

2) Importing the nodal coordinates, mesh data and force nodes from Ansys through excel File named ‘Data.xlsx’. Then we have find the loads on the nodes using the shear stress and shape functions matrix.

3)Ux, Uy equations are used for specifying the displacement boundary conditions.

4) Calculating a Constitutive matrix for plain stress analysis.

Here in command window you are prompted to enter Desired gaussian quadrature points

1,2 or 3

5)finding Jacobean, transformation matrix, differentiation matrix and B matrix

6) Then Calculating element stiffness matrix using 2X2 ,3,1-point gaussian quadrature;

7) Assembling of the elements.

8) Finding the system matrix.

9) Then finding out stress at different nodes and elements.

Ansys for **very fine Mesh-Q4 element**

Preprocessing

Step 1. Define Element Type

ANSYS Main Menu: Preprocessor → Element Type → Add/Edit/Delete
In the pop-up window (Element Types), select Add. Then in the new window (Library of Element Types), select Structural Mass → Solid, Quad 4 node 182. OK to close.
In options, element behavior, pick 'plane stress'.

Step 2. Define Material Type

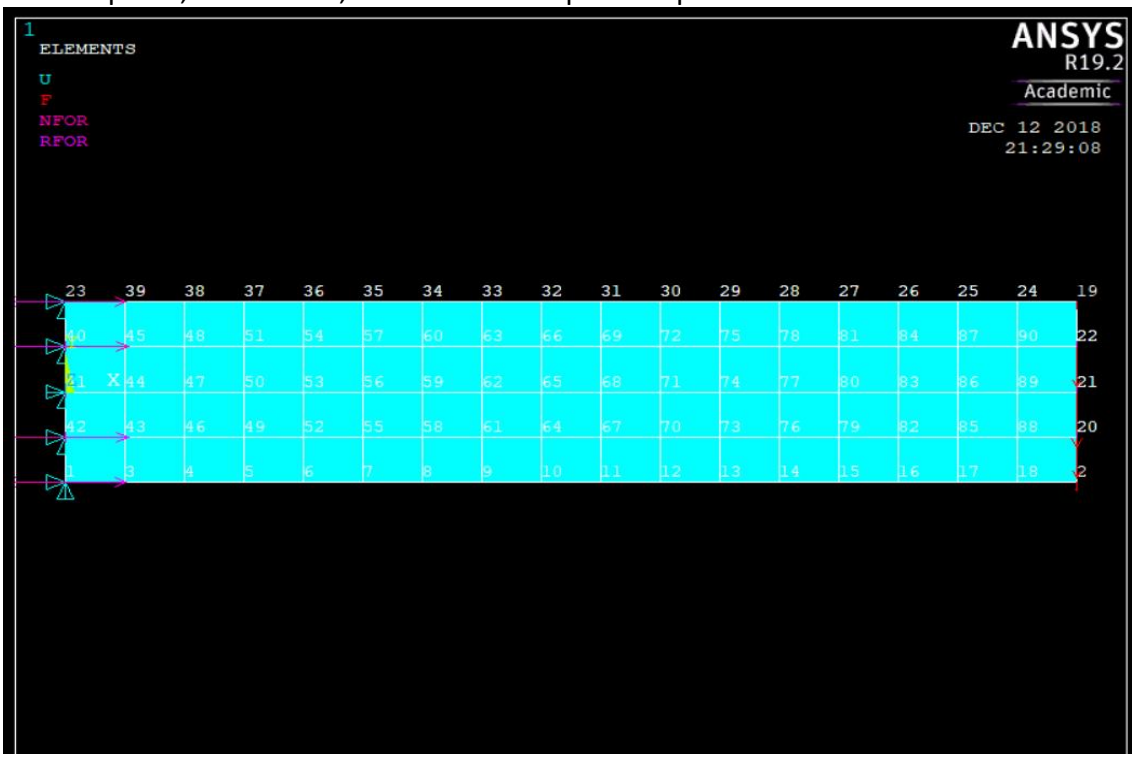
(1) ANSYS Main Menu: Preprocessor → Material Props → Material Models → Structural (double click) → Linear → Elastic → Isotropic
Input Mat'l Properties {EX=Young's '2. e11'; PRXY=0.3; OK}

Step3.Define Geometry

(1) Ansys Main Menu: Preprocessor → Modeling → Create → Areas → Rectangle → By 2 Corners
Enter X = 0; WP Y = -0.5; Width = 5; Height = 1, Click Apply to create rectangle.

Step 4. Create Mesh

Ansys Main Menu: Preprocessor → Meshing → Mesh Tool
A new "Mesh Tool" Window opens. Select Global.
In Size Controls panel, set global element SIZE as 0.3.
In Mesh panel, select Area, click Mesh. And pick the plate area to mesh



Solving

Step 6. Apply Displacement Constraints:

Solve->Define Loads->Apply->Functions>
First define the displacement equations of UX, UY given and save the file.
Then Read the files UY.fun, UY.fun and names as DisplX and DisplY correspondingly.
Ansys Main Menu: Solution → Define Loads → Apply → Structural → Displacement → On nodes

Pick the left edge, select UX->instead of 'Constant value' use 'Existing Table'->then select 'DisplX'. Repeat the same for UY also.

Step 7. Apply Loads

For Loads first find the individual nodal in MATLAB by using sigma-xy and shape functions
Ansys Main Menu: Solution → Define Loads → Apply → Structural → Force/Moment→ On nodes ->pick->top node and give Fy=-468.8, similarly for bottom node Fy=-468.8. node-22=-2500,node-21=-3437.5,Node-20=-2500

Step 8. Solve

Ansys Main Menu: Solution → Solve → Current LS
Close Solution Done Window.

Postprocessing

Step 9. Plot Deformed Shape

ANSYS Main Menu: General Postproc → Plot Results → Deformed Shape

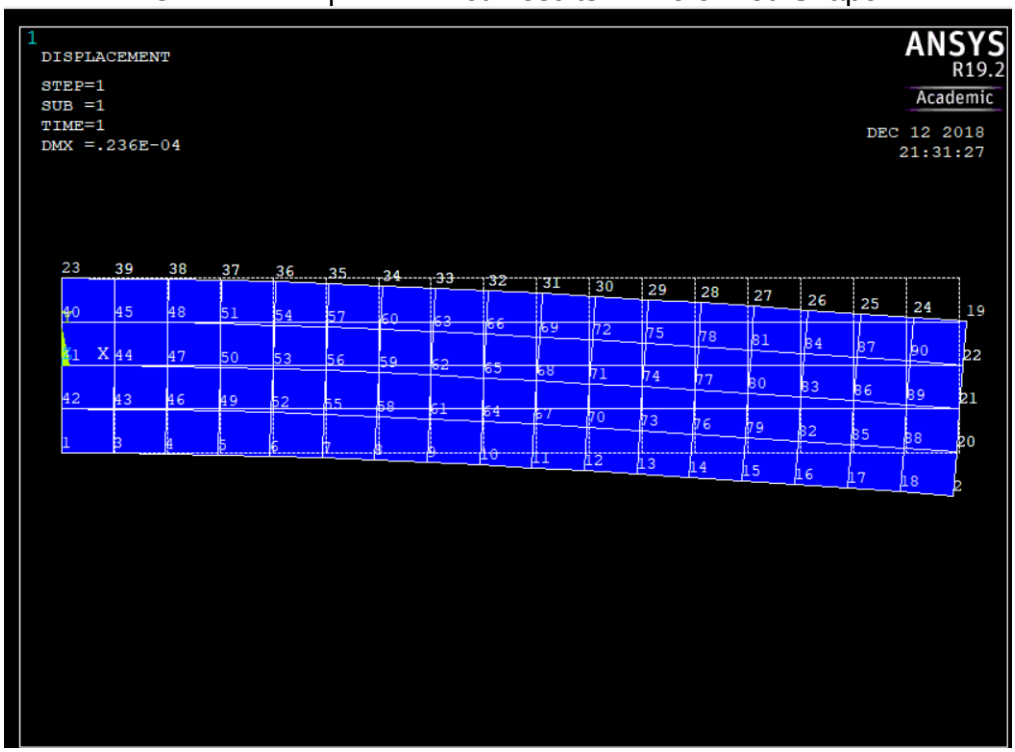
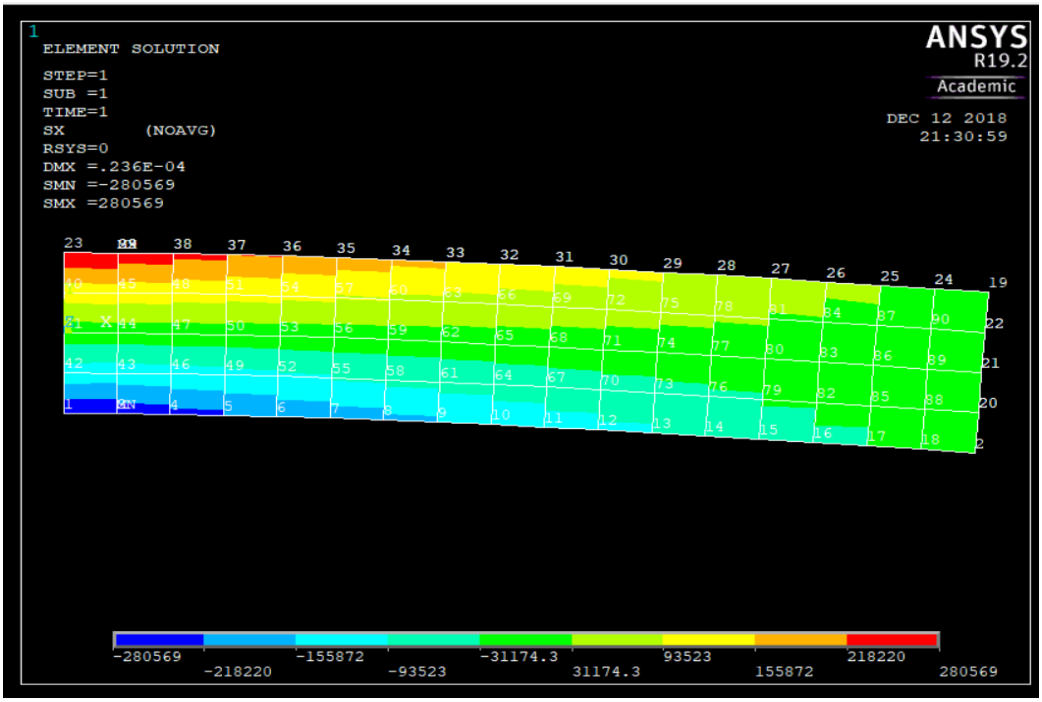


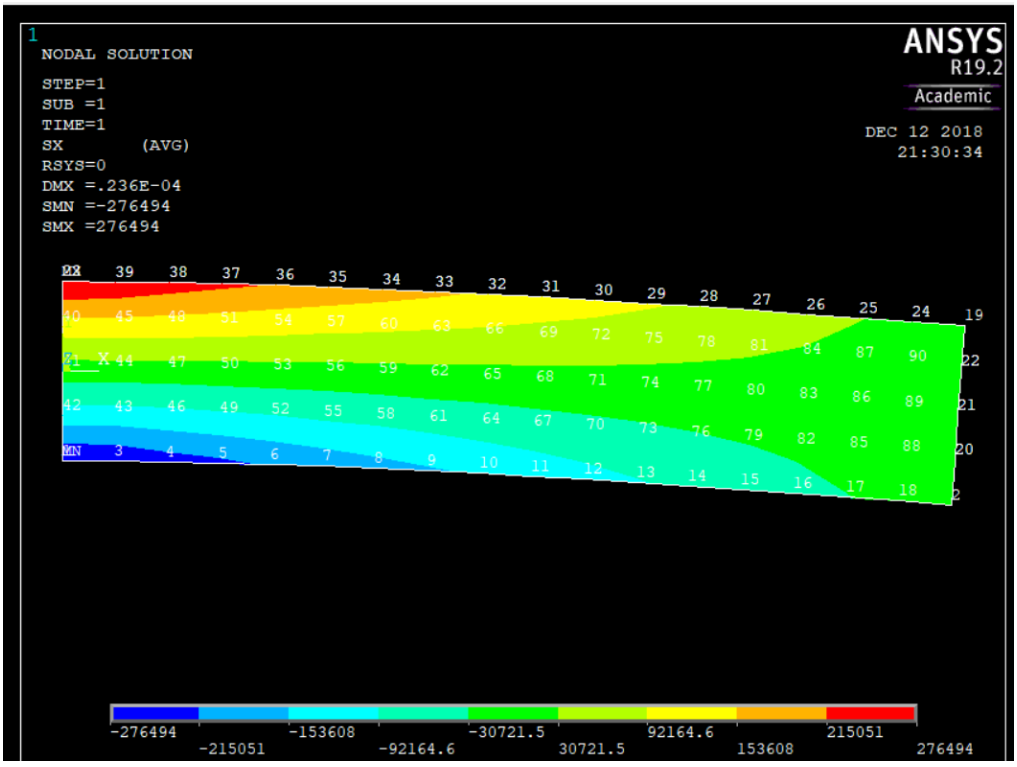
Fig.3 Deformed shape overlaid on outline of undeformed shape

Step 10. Contour Plots of Stresses ANSYS Main Menu: General Postproc → Plot Results → Contour Plot →Element Solu Select 'Element Solution', 'Stress', and 'X-Component of stress'. OK.

Element-Stresses

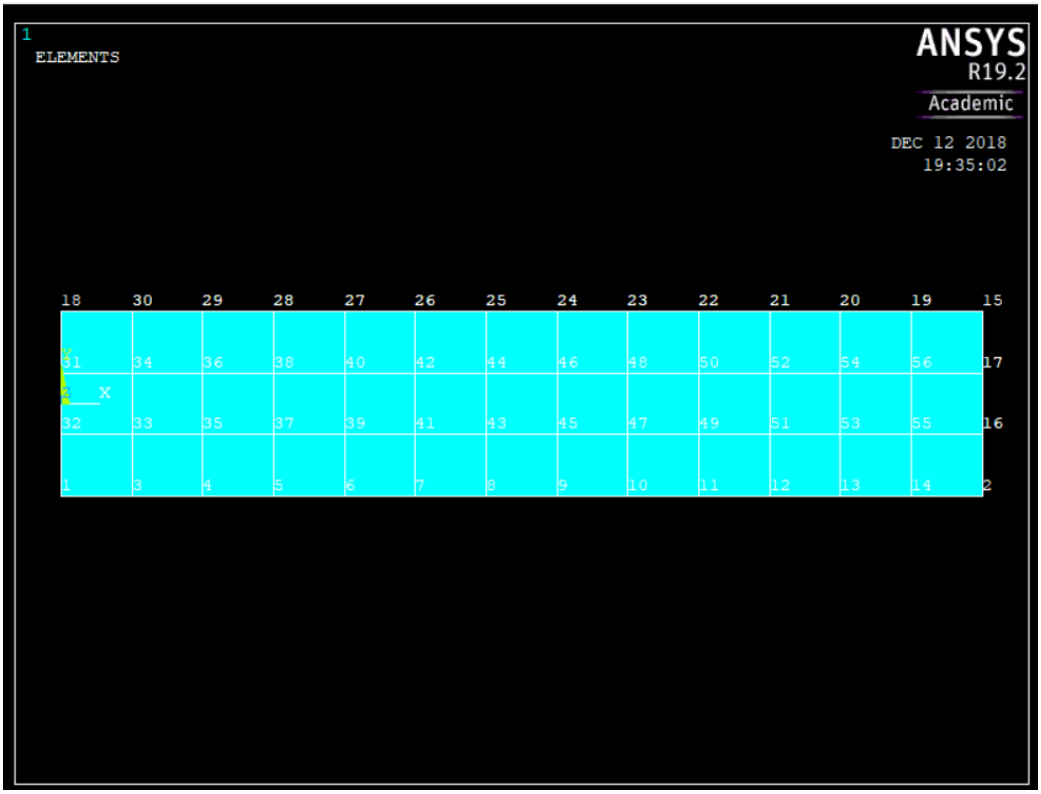


Nodal-Stresses



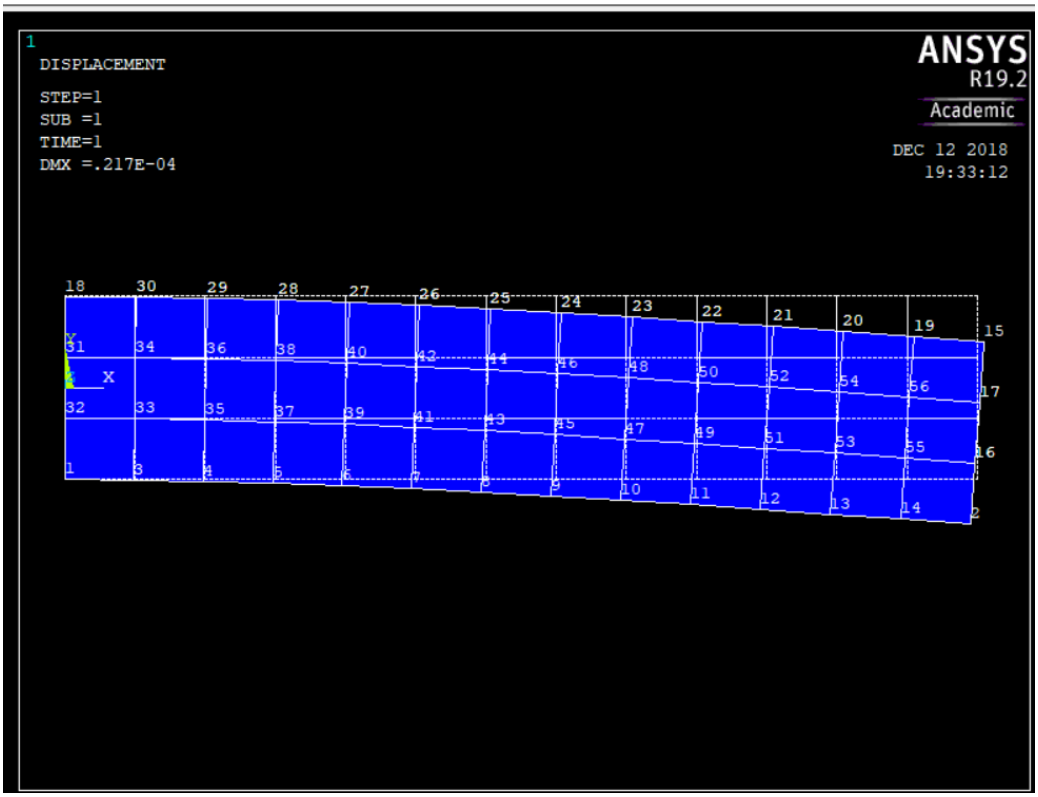
Ansys for fine Mesh:Follow the same procedure as of above

Mesh-size:0.5

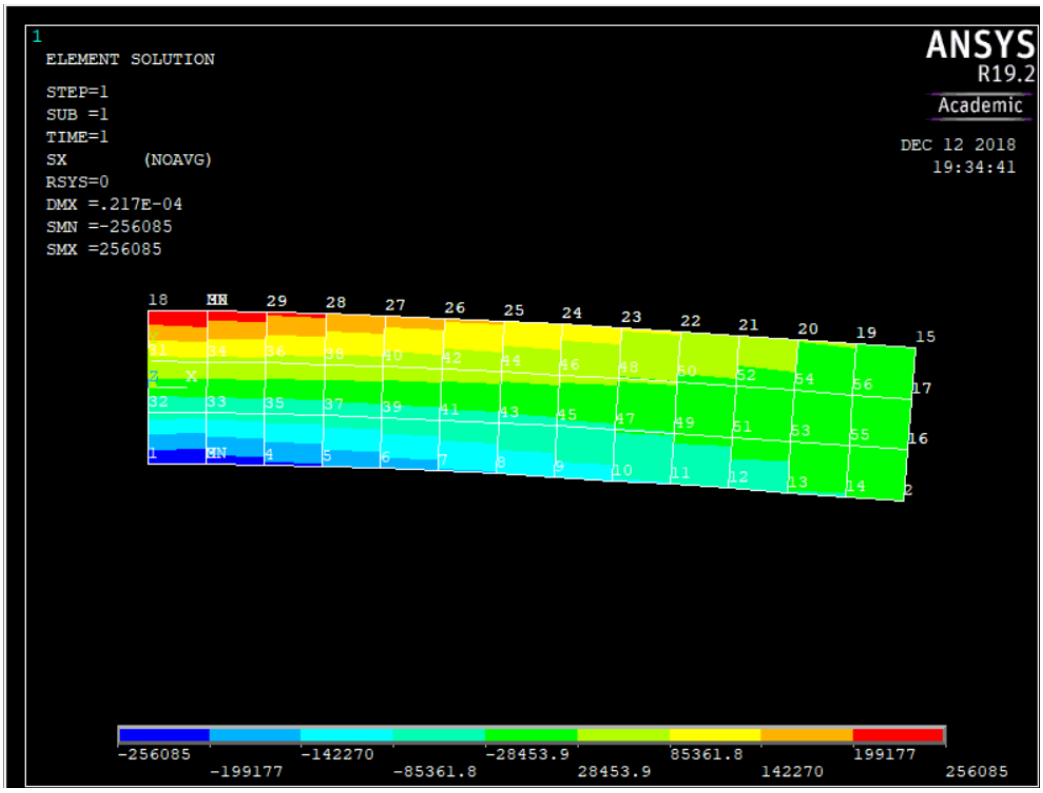


Nodal loads along y=node-15=-740.7,node 17=--3703.7,node 16=-3703.7,node-2=-740.7

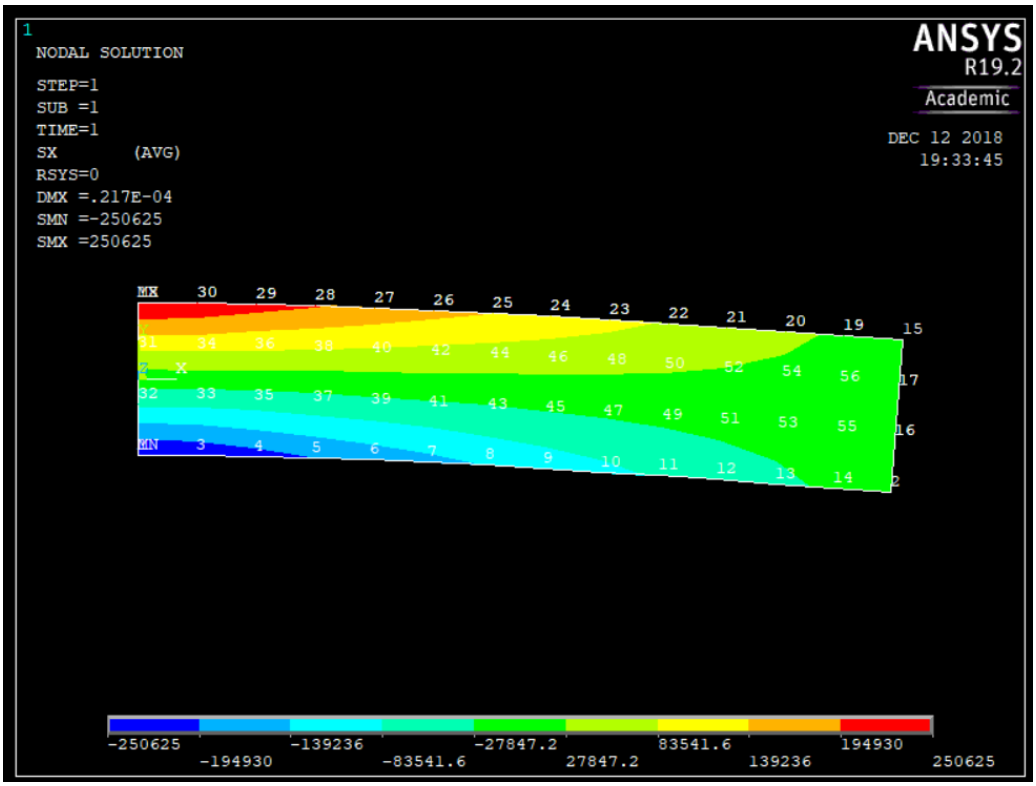
Deformed Shape



Element-Stress-X

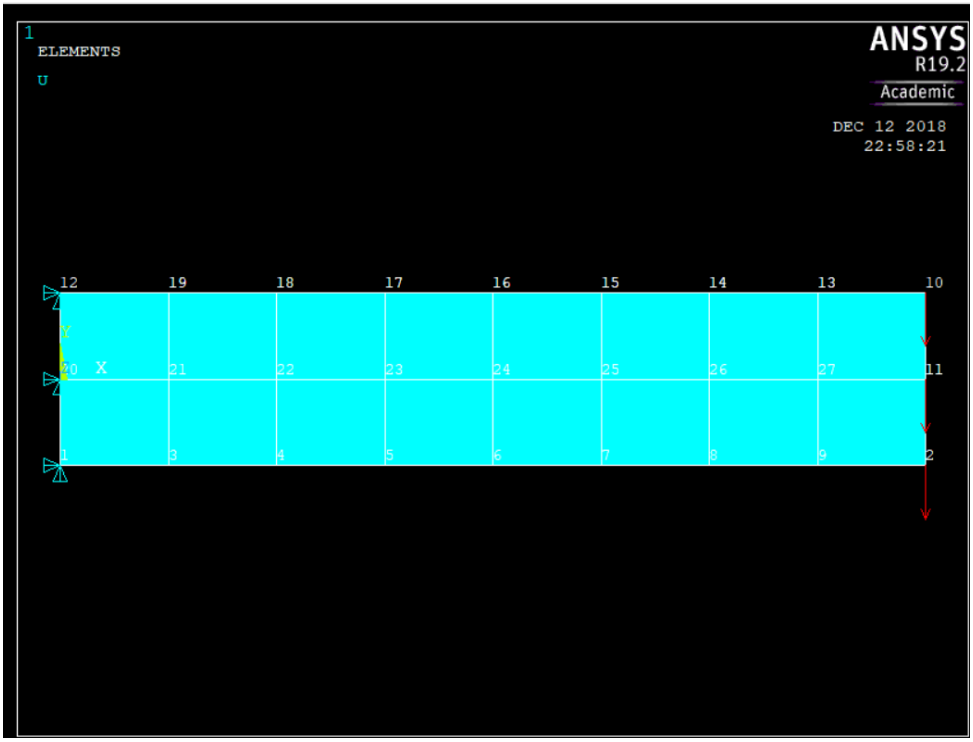


Nodal-Stress



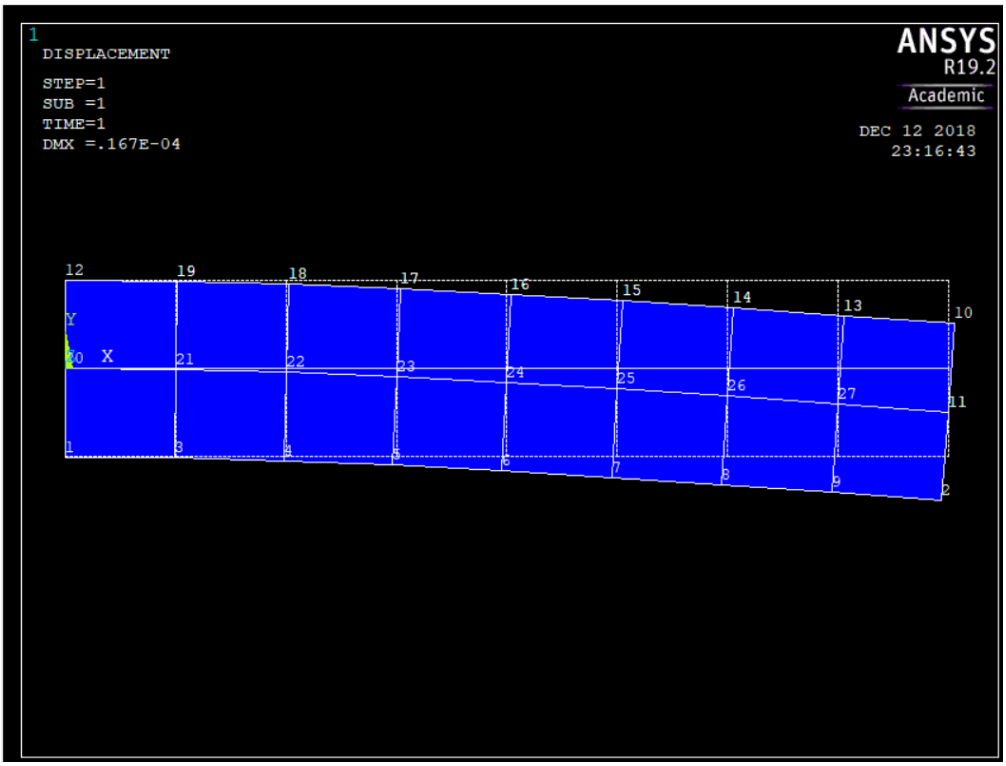
Ansys for coarse Mesh:-

Mesh-size-0.7

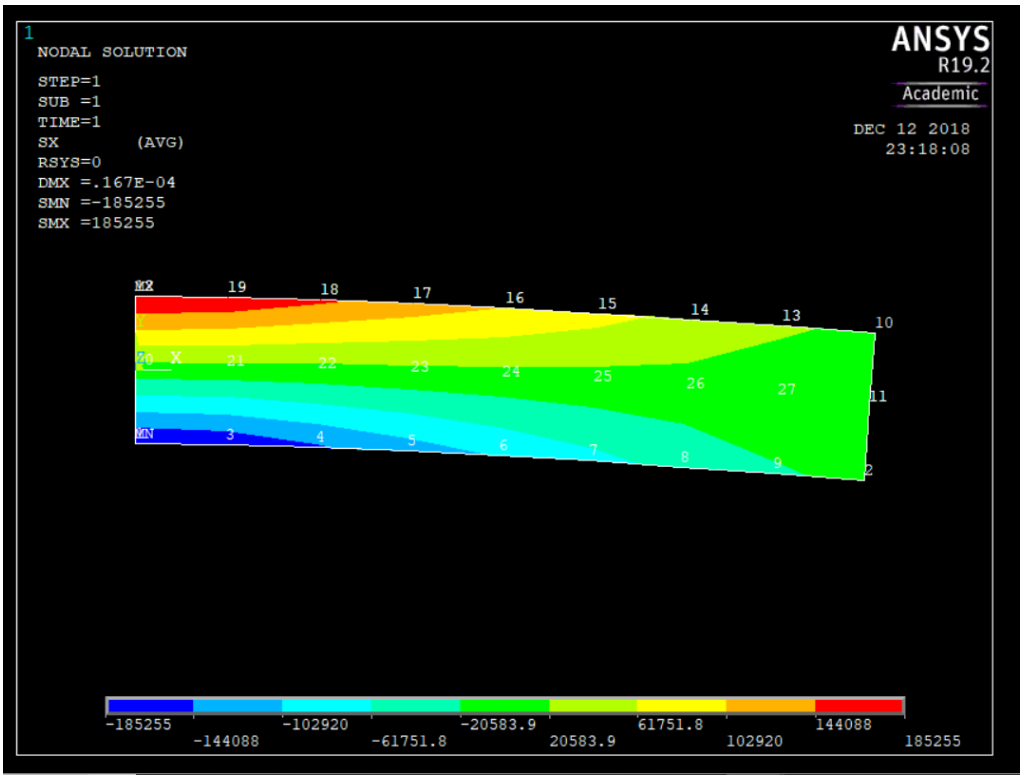


Deformed shape

Nodal-loads->node-10=-1250,node-11=-5000,node-2=-1250



Element-Stress



Observations from three types of mesh:-

1)As we make the mesh more fine then a very good convergence of the values can be seen.

2)As we decrease the mesh size the nodal loads at the end become more covergent to the applied load.

Ansys for Q8 element-Very fine mesh(0.3)

Preprocessing

Step 1. Define Element Type

ANSYS Main Menu: Preprocessor → Element Type → Add/Edit/Delete
In the pop-up window (Element Types), select Add. Then in the new window (Library of Element Types), select Structural Mass → Solid, Quad 8 node 183. OK to close.
In options, element behavior, pick 'plane stress'.

Step 2. Define Material Type

(1) ANSYS Main Menu: Preprocessor → Material Props → Material Models → Structural (double click) → Linear → Elastic → Isotropic
Input Mat'l Properties {EX=Young's '2. e11'; PRXY=0.3; OK}

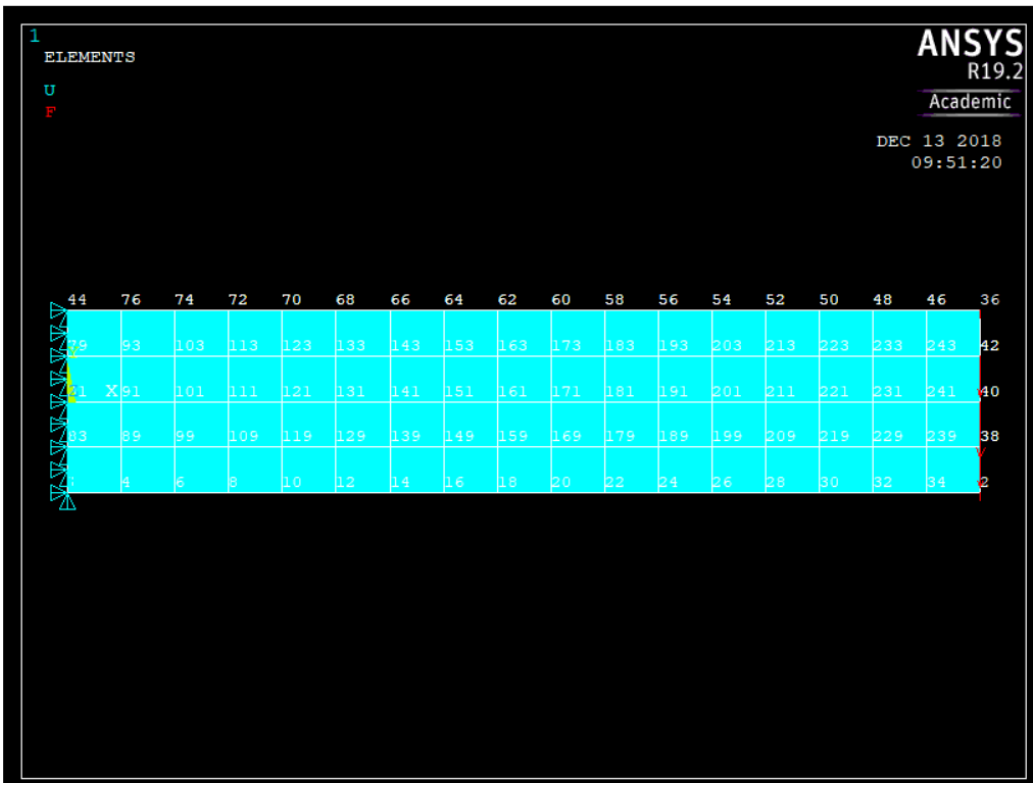
Step3.Define Geometry

(1) Ansys Main Menu: Preprocessor → Modeling → Create → Areas → Rectangle → By 2 Corners
Enter X = 0; WP Y = -0.5; Width = 5; Height = 1, Click Apply to create rectangle.

Step 4. Create Mesh

Ansys Main Menu: Preprocessor → Meshing → Mesh Tool
A new "Mesh Tool" Window opens. Select Global.
In Size Controls panel, set global element SIZE as 0.3.
In Mesh panel, select Area, click Mesh. And pick the plate area to mesh

Mesh



Solving

Step 6. Apply Displacement Constraints:

Solve->Define Loads->Apply->Functions>
First define the displacement equations of UX, UY given and save the file.
Then Read the files UY.fun, UY.fun and names as DisplX and DisplY correspondingly.
Ansys Main Menu: Solution → Define Loads → Apply → Structural → Displacement → On nodes
Pick the left edge, select UX->instead of 'Constant value' use 'Existing Table'->then select 'DisplX'. Repeat the same for UY also.

Step 7. Apply Loads

For Loads first find the individual nodal in MATLAB by using sigma-xy and shape functions
Ansys Main Menu: Solution → Define Loads → Apply → Structural → Force/Moment→ On nodes
->pick->top node and give Fy=-468.8, similarly for bottom node-2 Fy=-468.8. node-42=-2500, node-40=-3437.5,Node-38=-2500

Step 8. Solve

Ansys Main Menu: Solution → Solve → Current LS
Close Solution Done Window.

Postprocessing

Step 9. Plot Deformed Shape

ANSYS Main Menu: General Postproc → Plot Results → Deformed Shape

Deformed Shape

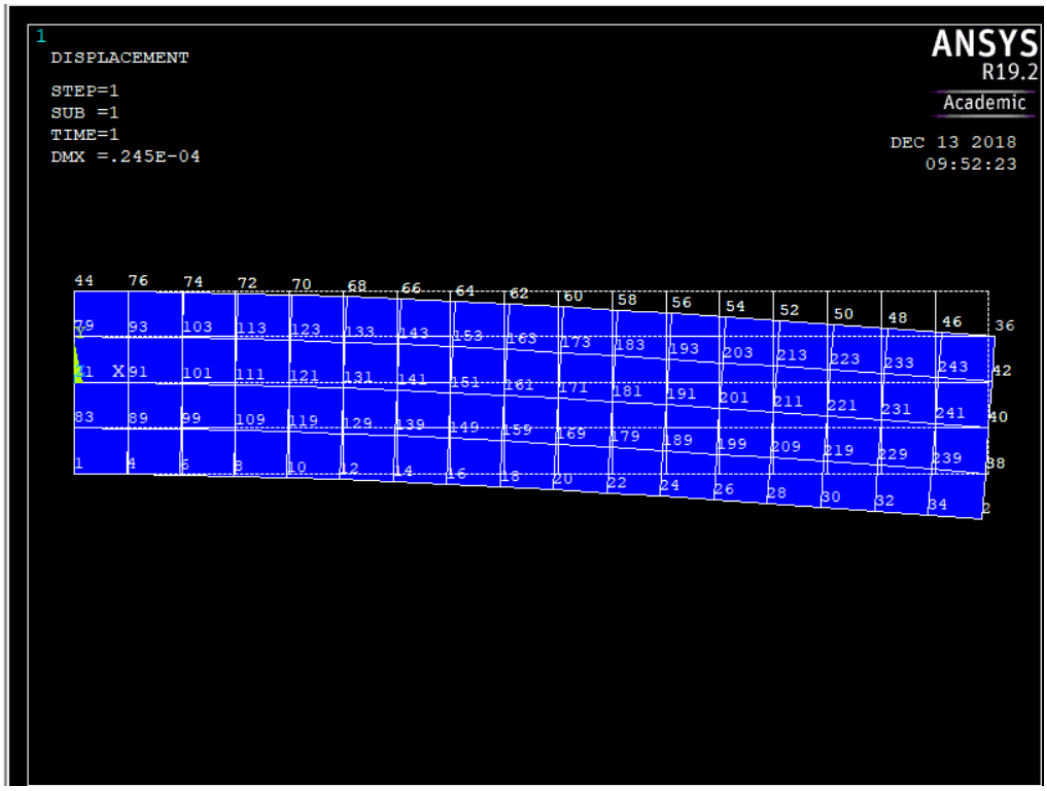
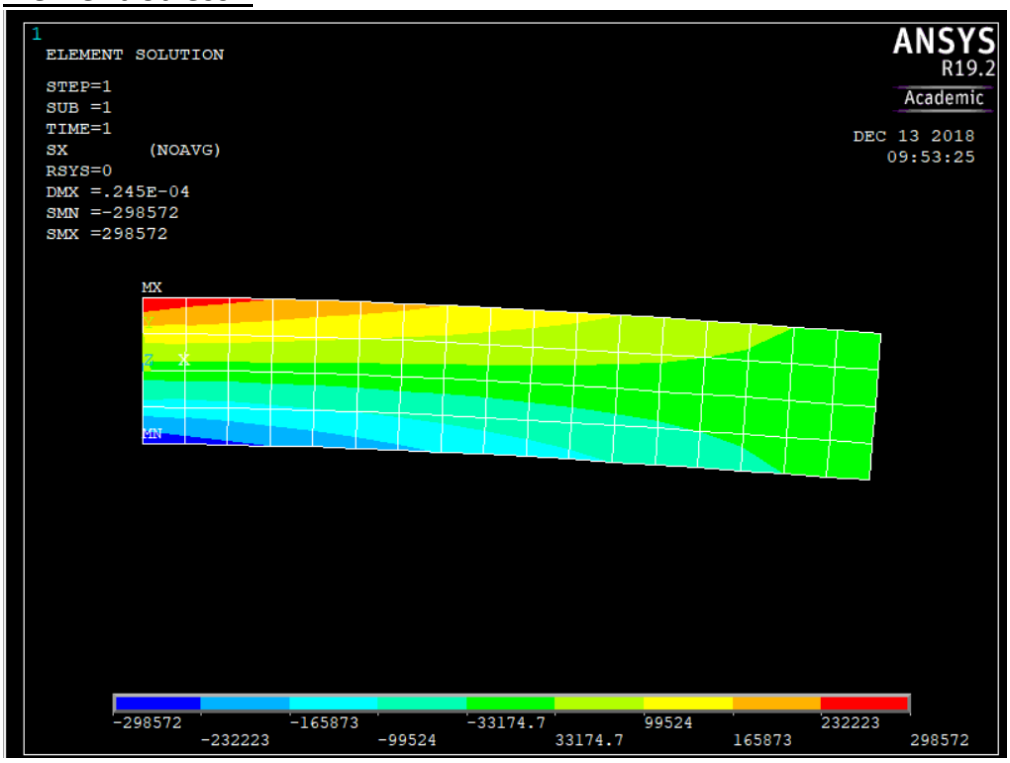


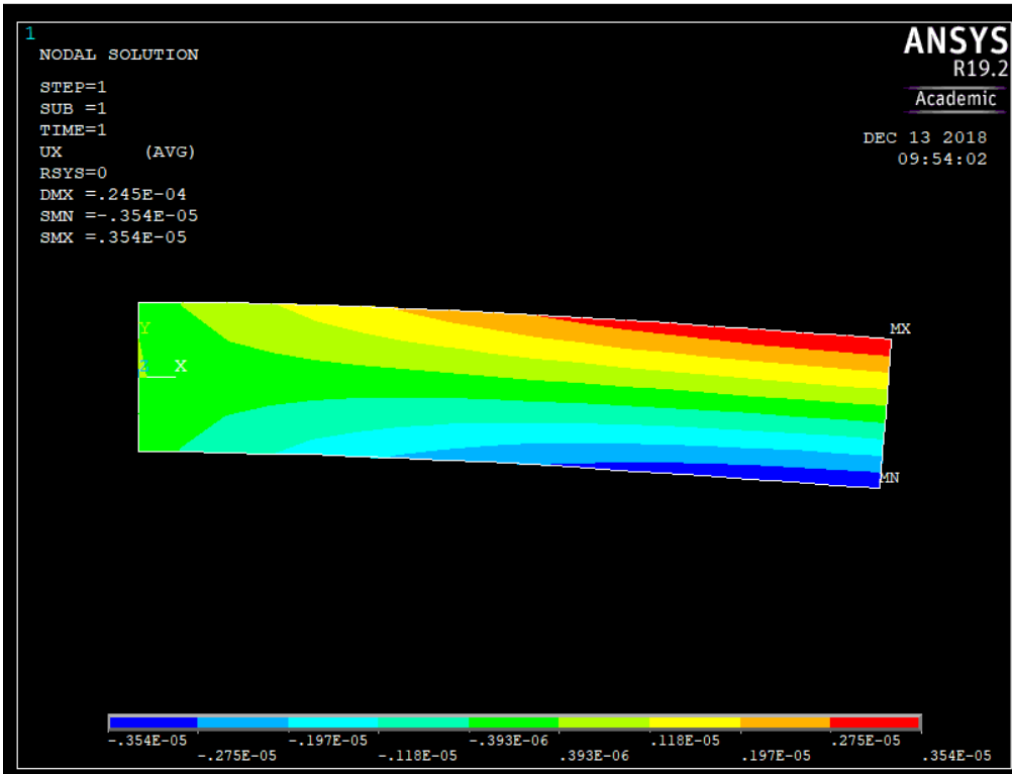
Fig.3 Deformed shape overlaid on outline of undeformed shape

Step 10. Contour Plots of Stresses ANSYS Main Menu: General Postproc → Plot Results → Contour Plot →Element Solu Select 'Element Solution', 'Stress', and 'X-Component of stress'. OK.

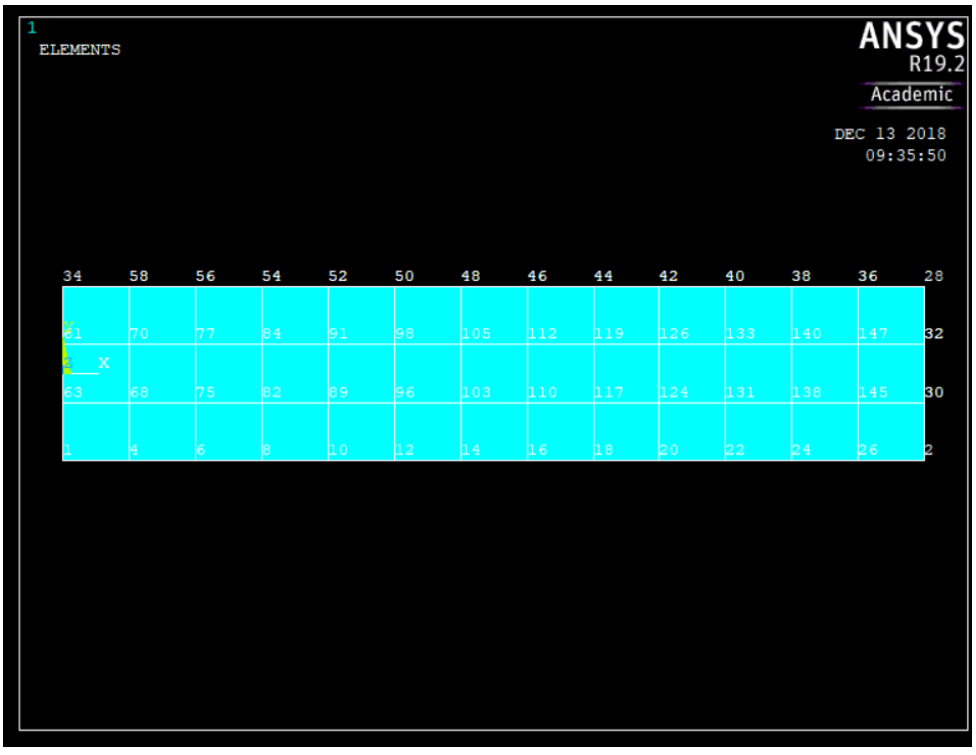
Element-Stress:-



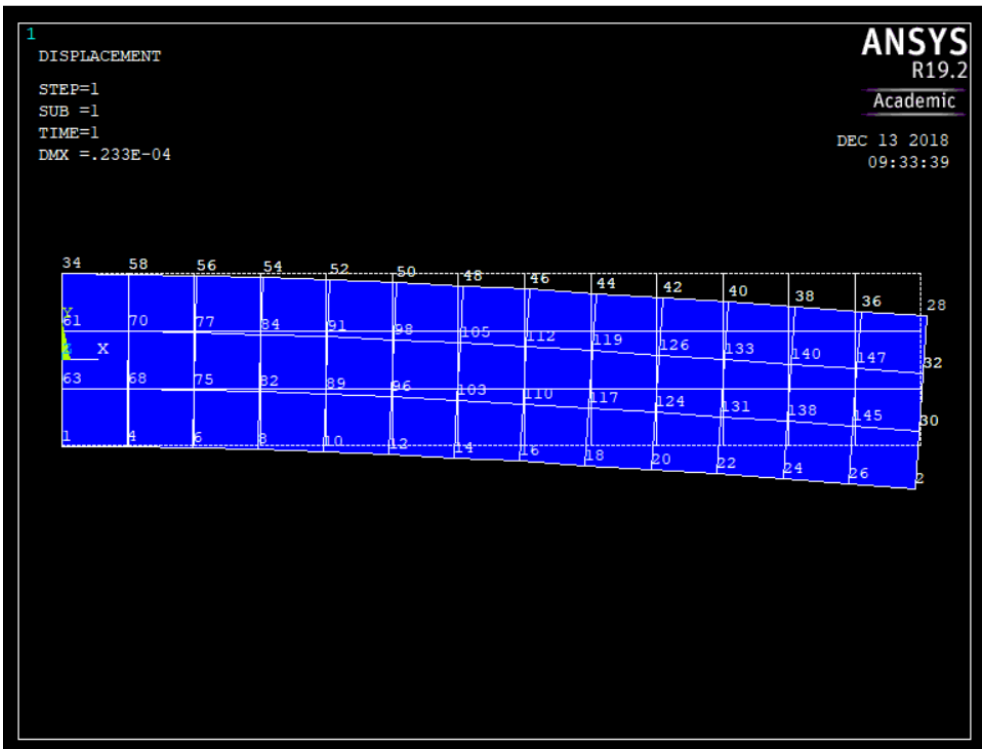
Displacement:



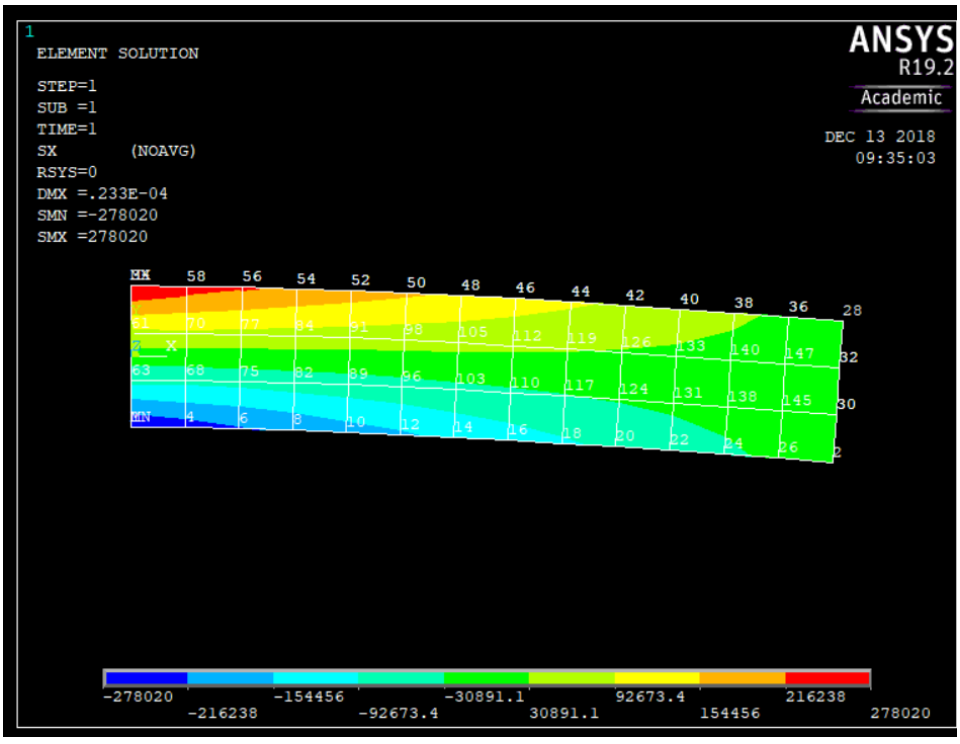
Similarly for **Fine Mesh-**



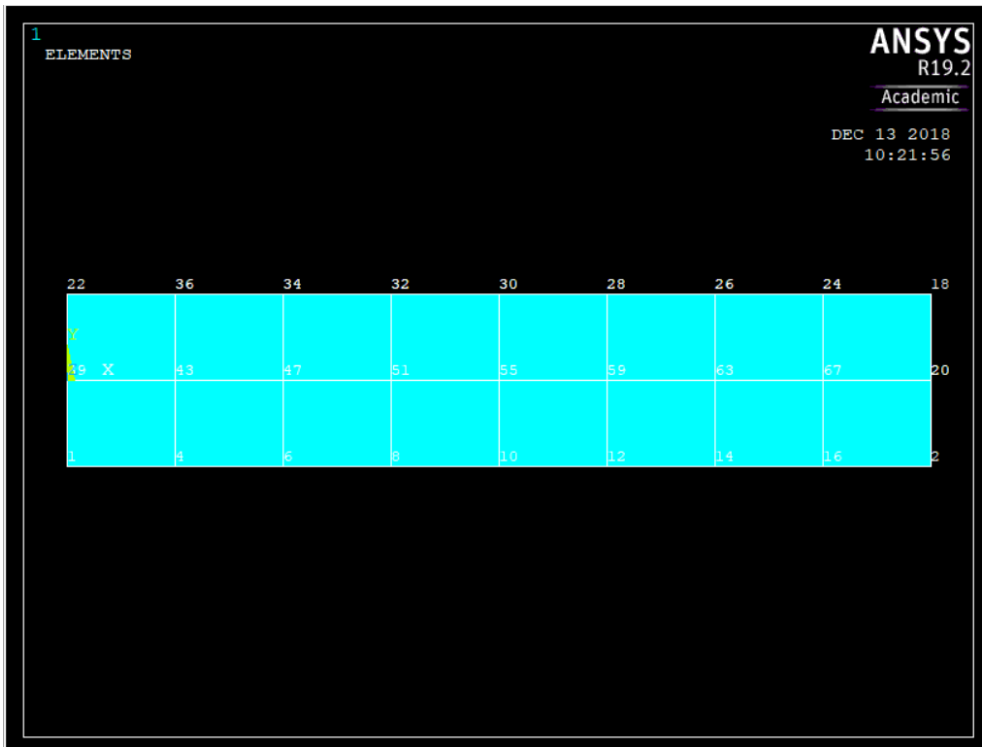
Deformed shape:-

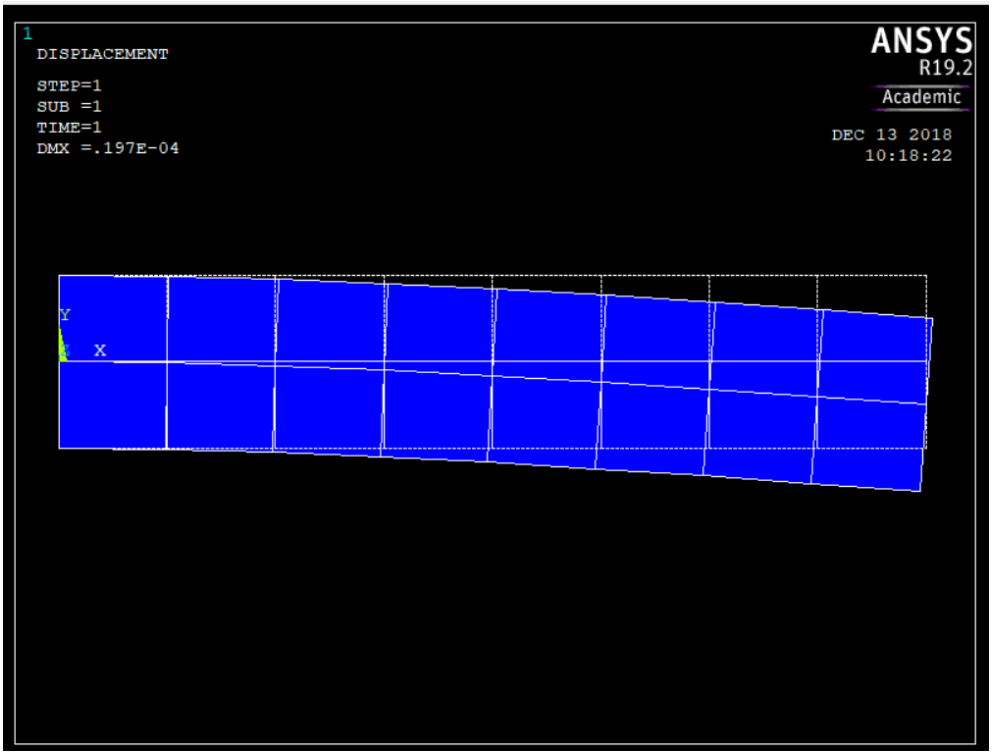


Stress-x

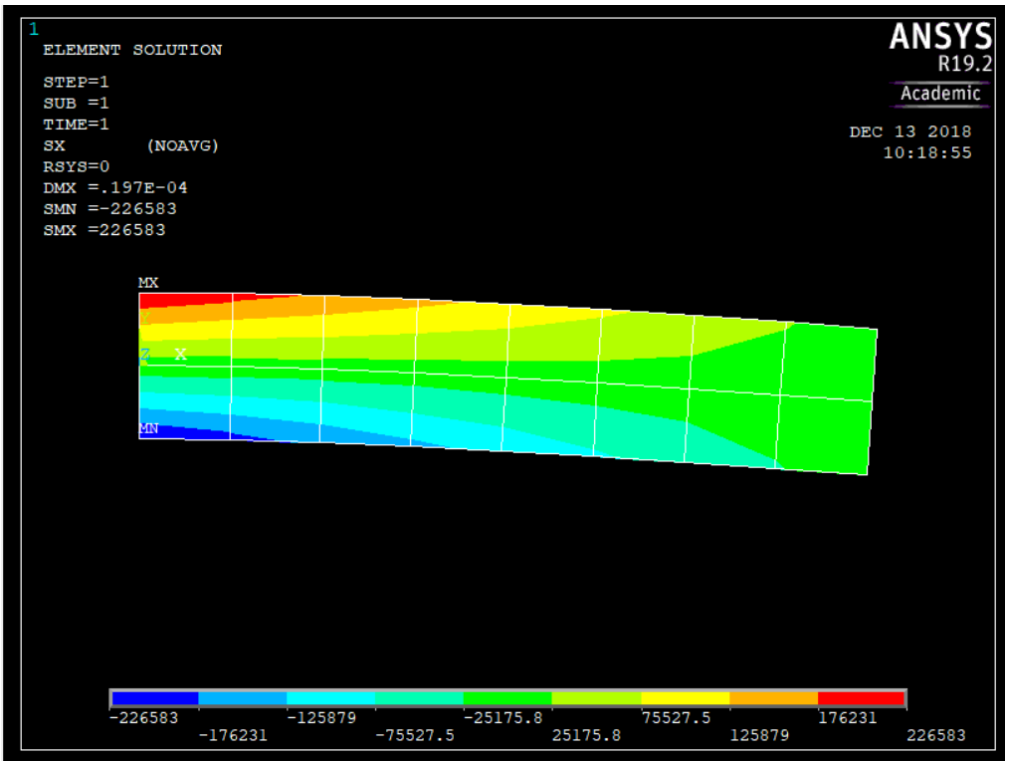


Q8 Coarse Mesh-(0.7)

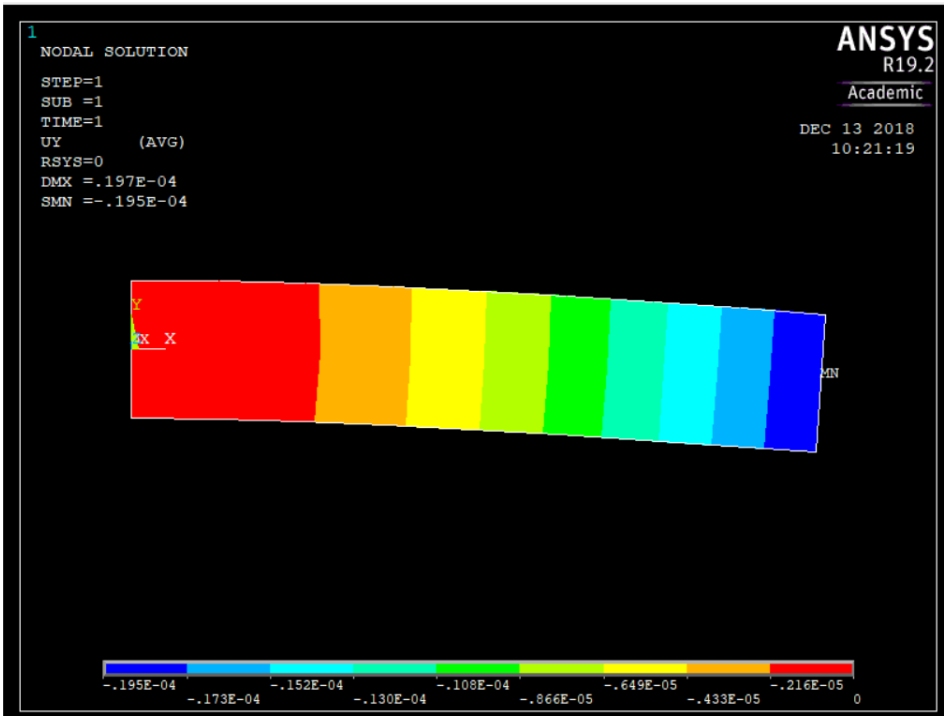




Stress-X



Displacement



Sigma-x comparisions for different meshes at x=L/2

Considering nodes at x=L/2

Stress at x=L/2-fine Mesh	
Nodes at x=L/2	
46	1.23E+05
113	9.31E+04
112	41025
111	-21025
110	-41025
103	-9.31E+04
1	-1.03E+05

Stress at x=L/2-very fine Mesh	
nodes at x=L/2	
62	1.49E+05
164	1.29E+05
163	74449
162	24563
161	1.33E-08
160	-24563
159	-74449
158	-1.22E+05
20	-1.32E+05

Stress at x=L/2-very fine	
Nodes at x=L.2	
18	-1.00E+05
19	-82641
20	-3.15E-05
21	82641
2	1.00E+05

Observations:

1)As mesh size increases the values are more convergent to analytical results.

2)The stress values for corresponding nodes on both the sides are almost same but with different signs

2)Comparision of Ansys and Matlab Results for **Very Fine Mesh**(90 nodes) of Q4 element

Ansys-Displacement-Y		Matlab-Displacement Y	
NODE	UY		
1	-1.13E-07	-1.13E-07	
2	-2.33E-05	-2.36E-05	
3	-2.53E-07	-2.23E-07	
4	-6.30E-07	-6.25E-07	
5	-1.21E-06	-1.23E-06	
6	-1.99E-06	-2.02E-06	
7	-2.94E-06	-2.99E-06	
8	-4.06E-06	-4.12E-06	
9	-5.33E-06	-5.41E-06	
10	-6.74E-06	-6.83E-06	
11	-8.27E-06	-8.38E-06	
12	-9.91E-06	-1.00E-05	
13	-1.16E-05	-1.18E-05	
14	-1.35E-05	-1.36E-05	
15	-1.54E-05	-1.55E-05	
16	-1.73E-05	-1.75E-05	
17	-1.93E-05	-1.95E-05	
18	-2.13E-05	-2.15E-05	
19	-2.33E-05	-2.36E-05	
20	-2.33E-05	-2.36E-05	
21	-2.33E-05	-2.36E-05	Maximum Value
22	-2.33E-05	-2.36E-05	
23	-1.13E-07	-1.12E-07	
24	-2.13E-05	-2.15E-05	
25	-1.93E-05	-1.95E-05	
26	-1.73E-05	-1.75E-05	
27	-1.54E-05	-1.55E-05	
28	-1.35E-05	-1.36E-05	
29	-1.16E-05	-1.18E-05	
30	-9.91E-06	-1.00E-05	
31	-8.27E-06	-8.38E-06	
32	-6.74E-06	-6.83E-06	
33	-5.33E-06	-5.41E-06	
34	-4.06E-06	-4.12E-06	

34	-4.06E-06			-4.12E-06	
35	-2.94E-06			-2.99E-06	
36	-1.99E-06			-2.02E-06	
37	-1.21E-06			-1.23E-06	
38	-6.30E-07			-6.30E-07	
39	-2.53E-07			-2.37E-07	
40	-2.81E-08			1.25E-10	
41	0			0	
42	-2.81E-08			2.61E-10	
43	-1.84E-07			-1.52E-07	
44	-1.63E-07			-1.47E-07	
45	-1.84E-07			-1.74E-07	
46	-5.63E-07			-5.59E-07	
47	-5.41E-07			-5.37E-07	
48	-5.63E-07			-5.61E-07	
49	-1.15E-06			-1.16E-06	
50	-1.13E-06			-1.14E-06	
51	-1.15E-06			-1.16E-06	
52	-1.93E-06			-1.96E-06	
53	-1.91E-06			-1.94E-06	
54	-1.93E-06			-1.96E-06	
55	-2.89E-06			-2.93E-06	
56	-2.87E-06			-2.91E-06	
57	-2.89E-06			-2.93E-06	
58	-4.01E-06			-4.07E-06	
59	-3.99E-06			-4.06E-06	
60	-4.01E-06			-4.07E-06	
61	-5.28E-06			-5.36E-06	
62	-5.27E-06			-5.35E-06	
63	-5.28E-06			-5.36E-06	
64	-6.69E-06			-6.79E-06	
65	-6.68E-06			-6.78E-06	
66	-6.69E-06			-6.79E-06	
67	-8.23E-06			-8.34E-06	
68	-8.22E-06			-8.33E-06	
69	-8.23E-06			-8.34E-06	
70	-9.88E-06			-1.00E-05	

76	73	-1.16E-05				-1.18E-05	
77	74	-1.16E-05				-1.18E-05	
78	75	-1.16E-05				-1.18E-05	
79	76	-1.34E-05				-1.36E-05	
80	77	-1.34E-05				-1.36E-05	
81	78	-1.34E-05				-1.36E-05	
82	79	-1.53E-05				-1.55E-05	
83	80	-1.53E-05				-1.55E-05	
84	81	-1.53E-05				-1.55E-05	
85	82	-1.73E-05				-1.75E-05	
86	83	-1.73E-05				-1.75E-05	
87	84	-1.73E-05				-1.75E-05	
88	85	-1.93E-05				-1.95E-05	
89	86	-1.93E-05				-1.95E-05	
90	87	-1.93E-05				-1.95E-05	
91	88	-2.13E-05				-2.15E-05	
92	89	-2.13E-05				-2.15E-05	
93	90	-2.13E-05				-2.15E-05	
94							
95	MAXIMUM	ABSOLUTE VALUES					
96	NODE	21					
97	VALUE -	2.33E-05					

Stress-X values Comparision at nodes:-

	Ansys-Nodal Stresses			
	NODE	SX	SY	SXY
Maxmimum	1	-2.76E+05	-15421	-39948
	2	-8850.7	-4130.2	-4236.1
	3	-2.67E+05	-25062	-4149.7
	4	-2.45E+05	-19954	-4726.1
	5	-2.28E+05	-18330	-4510.4
	6	-2.12E+05	-17044	-4505.7
	7	-1.96E+05	-15743	-4506.8
	8	-1.79E+05	-14430	-4507.3
	9	-1.63E+05	-13118	-4507.2
	10	-1.47E+05	-11806	-4507.2
	11	-1.30E+05	-10494	-4507.2
	12	-1.14E+05	-9182.5	-4507.2
	13	-97859	-7870.8	-4507.3
	14	-81549	-6558.7	-4507.1
	15	-65241	-5248.8	-4507.5
	16	-48929	-3932.1	-4506.8
	17	-32554	-2604.6	-4528.6
	18	-15992	-1024.7	-4380.6
	19	8850.7	4130.2	-4236.1
	20	-4694.2	-2491.7	-8783
	21	3.27E-06	7.20E-07	-12254
	22	4694.2	2491.7	-8783
	23	2.76E+05	15421	-39948
	24	15992	1024.7	-4380.6
	25	32554	2604.6	-4528.6
	26	48929	3932.1	-4506.8
	27	65241	5248.8	-4507.5
	28	81549	6558.7	-4507.1
	29	97859	7870.8	-4507.3
	30	1.14E+05	9182.5	-4507.2
	31	1.30E+05	10494	-4507.2
	32	1.47E+05	11806	-4507.2

	MATLAB NODAL STRESSES												
	The Nodal Stresses are												
	1.0e+05 *												
	Columns 1 through 12												
Maxmimum SX	-2.76490	-0.0885	-2.5352	-2.3439	-2.1896	-2.0316	-1.8697	-1.7068	-1.5436	-1.3809	-1.2173	-1.0542	
SY	-1.0172	-0.0413	-0.1972	-0.1785	-0.1541	-0.1438	-0.1310	-0.1181	-0.1050	-0.0920	-0.0787	-0.0656	
SXY	-0.9291	-0.0424	-0.3570	-0.3088	-0.2933	-0.2782	-0.2610	-0.2432	-0.2251	-0.2085	-0.1891	-0.1711	
	Columns 13 through 24												
SX	-0.8911	-0.7280	-0.5650	-0.4019	-0.2375	-0.0712	0.0885	-0.0456	0.0023	0.0482	2.7239	0.0712	
SY	-0.0525	-0.0394	-0.0263	-0.0131	0.0004	0.0164	0.0413	-0.0206	0.0076	0.0292	-0.0828	-0.0164	
SXY	-0.1531	-0.1351	-0.1171	-0.1009	-0.0815	-0.0589	-0.0424	-0.1161	-0.1225	-0.0595	-0.3599	-0.0589	
	Columns 25 through 36												
SX	0.2375	0.4019	0.5650	0.7280	0.8911	1.0542	1.2173	1.3809	1.5435	1.7065	1.8697	2.0341	
SY	-0.0004	0.0131	0.0263	0.0394	0.0525	0.0656	0.0787	0.0920	0.1049	0.1181	0.1314	0.1449	
SXY	-0.0815	-0.1009	-0.1171	-0.1351	-0.1531	-0.1711	-0.1891	-0.2085	-0.2251	-0.2431	-0.2612	-0.2801	
	Columns 37 through 48												
SX	2.2018	2.3649	2.5589	1.0287	-0.1110	-0.8619	-1.3281	-0.0266	1.1536	-1.2158	-0.0699	1.0914	
SY	0.1586	0.1614	0.2635	-0.5914	-0.0308	-0.2622	-0.3586	-0.2255	-0.1580	-0.1892	-0.2103	-0.2207	
SXY	-0.3007	-0.3146	-0.3606	-0.4893	-0.3184	-0.0859	-0.4438	-0.3627	-0.3462	-0.3874	-0.3985	-0.3296	
	Columns 49 through 60												
SX	-1.1268	-0.0591	1.0143	-1.0415	-0.0522	0.9394	-0.9583	-0.0472	0.8641	-0.8749	-0.0432	0.7884	
SY	-0.1681	-0.1833	-0.1977	-0.1551	-0.1688	-0.1835	-0.1436	-0.1567	-0.1703	-0.1311	-0.1442	-0.1574	
SXY	-0.3674	-0.3753	-0.3126	-0.3495	-0.3552	-0.2918	-0.3324	-0.3366	-0.2729	-0.3147	-0.3185	-0.2548	

33	1.63E+05	13118	-4507.2		Columns 61 through 72																			
34	1.79E+05	14430	-4507.3																					
35	1.96E+05	15743	-4506.8	SX	-0.7914	-0.0393	0.7127	-0.7082	-0.0354	0.6373	-0.6244	-0.0315	0.5614	-0.5409	-0.0275	0.4858								
36	2.12E+05	17044	-4505.7	SY	-0.1181	-0.1312	-0.1443	-0.1050	-0.1181	-0.1311	-0.0918	-0.1049	-0.1181	-0.0787	-0.0918	-0.1049								
37	2.28E+05	18330	-4510.4	SXY	-0.2967	-0.3005	-0.2368	-0.2801	-0.2840	-0.2202	-0.2606	-0.2645	-0.2008	-0.2426	-0.2465	-0.1828								
38	2.45E+05	19954	-4726.1																					
39	2.67E+05	25062	-4149.7		Columns 73 through 84																			
40	1.22E+05	-8512.6	-40672																					
41	-7.19E-05	4.11E-04	-39226	SX	-0.4574	-0.0236	0.4102	-0.3739	-0.0197	0.3345	-0.2903	-0.0157	0.2588	-0.2070	-0.0118	0.1833								
42	-1.22E+05	8512.6	-40672	SY	-0.0656	-0.0787	-0.0918	-0.0525	-0.0656	-0.0787	-0.0393	-0.0525	-0.0656	-0.0263	-0.0393	-0.0525								
43	-1.23E+05	-985.81	-8394.6	SXY	-0.2246	-0.2285	-0.1648	-0.2066	-0.2105	-0.1468	-0.1886	-0.1926	-0.1288	-0.1725	-0.1762	-0.1126								
44	-0.36633E-004-	4.07E-05	-11150																					
45	1.23E+05	985.81	-8394.6		Columns 85 through 90																			
46	-1.18E+05	144.38	-8603.1																					
47	-1.12E-05	4.42E-05	-11665	SX	-0.1249	-0.0080	0.1092	-0.0392	-0.0042	0.0309														
48	1.18E+05	-144.38	-8603.1	SY	-0.0132	-0.0267	-0.0388	0.0009	-0.0139	-0.0284														
49	-1.11E+05	18.504	-8677.4	SXY	-0.1523	-0.1561	-0.0925	-0.1340	-0.1404	-0.0761														
50	-3.57E-05	2.07E-04	-12050																					
51	1.11E+05	-18.504	-8677.4																					
52	-1.03E+05	-1.5695	-8670.2																					
53	-5.41E-05	6.39E-05	-12059																					
54	1.03E+05	1.5691	-8670.2																					
55	-95498. -	0.35601	-8670.1																					
56	-2.39E-05	8.32E-05	-12052																					
57	95498	0.35634	-8670.1																					
58	-87540	1.98E-02	-8669.9																					
59	-0.50137E-004-	4.34E-06	-12052																					
60	-87540	1.97E-02	-8669.9																					
61	-79582	5.15E-03	-8670																					
62	2.66E-05	8.86E-05	-12052																					
63	-79582	5.20E-03	-8670																					
64	-71624	9.47E-05	-8670																					
65	-8.92E-06	1.09E-05	-12052																					
66	-71624	1.65E-04	-8670																					
67	-63665. -	3.60E-04	-8670																					

67	-63665. -	3.60E-04	-8670
68	-0.13377E-004-	8.53E-05	-12052
69	63665	2.71E-04	-8670
70	-55707	2.17E-06	-8670
71	-0.13418E-004-	8.54E-05	-12052
72	55707	2.16E-04	-8670
73	-47749. -	7.37E-04	-8670
74	-0.28827E-004-	5.54E-05	-12052
75	47749	8.34E-04	-8670
76	-39791	3.78E-02	-8670
77	-2.49E-06	3.24E-05	-12052
78	-39791	3.78E-02	-8670
79	-31831. -	1.54E-02	-8669.8
80	1.50E-05	5.00E-05	-12053
81	31831	1.55E-02	-8669.8
82	-23877	-1.8416	-8671.2
83	-8.69E-06	1.17E-05	-12049
84	23877	1.8415	-8671.2
85	-15997	-5.4264	-8659
86	1.27E-06	1.44E-05	-12027
87	15997	5.4264	-8659
88	-7980.9	125.08	-8687.4
89	-1.36E-06	5.38E-07	-12092
90	7980.9	-125.08	-8687.4
MINIMUM VALUES			
NODE	1	3	40
VALUE	-0.27649E+006	-25062.	-40672
MAXIMUM VALUES			
NODE	23	39	3
VALUE	2.76E+05	25062.	-4149.7

Comparision of Ansys and Matlab Results for **Fine-Mesh** of Q4 element

Ansys-Y-Displacement				Matlab Y-Displacement	
NODE	UY				
1	-1.13E-07			-1.13E-07	
2	-2.15E-05	Max		-2.13E-05	Max
3	-3.21E-07			-3.49E-07	
4	-8.92E-07			-8.80E-07	
5	-1.77E-06			-1.75E-06	
6	-2.94E-06			-2.90E-06	
7	-4.36E-06			-4.30E-06	
8	-6.00E-06			-5.94E-06	
9	-7.85E-06			-7.77E-06	
10	-9.87E-06			-9.77E-06	
11	-1.20E-05			-1.19E-05	
12	-1.43E-05			-1.42E-05	
13	-1.67E-05			-1.65E-05	
14	-1.91E-05			-1.89E-05	
15	-2.15E-05			-2.13E-05	
16	-2.15E-05			-2.13E-05	
17	-2.15E-05			-2.13E-05	
18	-1.13E-07			-1.13E-07	
19	-1.91E-05			-1.89E-05	
20	-1.67E-05			-1.65E-05	
21	-1.43E-05			-1.42E-05	
22	-1.20E-05			-1.19E-05	
23	-9.87E-06			-9.77E-06	
24	-7.85E-06			-7.77E-06	
25	-6.00E-06			-5.94E-06	
26	-4.36E-06			-4.30E-06	
27	-2.94E-06			-2.90E-06	
28	-1.77E-06			-1.75E-06	
29	-8.92E-07			-8.87E-07	
30	-3.21E-07			-3.27E-07	
31	-1.25E-08			-8.61E-09	
32	-1.25E-08			-1.13E-07	
33	-2.48E-07			-2.38E-07	
34	-2.48E-07			-2.61E-07	
35	-8.21E-07			-8.15E-07	
36	-8.21E-07			-8.12E-07	
37	-1.71E-06			-1.68E-06	
38	-1.71E-06			-1.69E-06	
39	-2.88E-06			-2.84E-06	
40	-2.88E-06			-2.84E-06	
41	-4.31E-06			-4.25E-06	
42	-4.31E-06			-4.25E-06	
43	-5.96E-06			-5.89E-06	
44	-5.96E-06			-5.89E-06	
45	-7.81E-06			-7.73E-06	
46	-7.81E-06			-7.73E-06	
47	-9.84E-06			-9.74E-06	
48	-9.84E-06			-9.74E-06	
49	-1.20E-05			-1.19E-05	
50	-1.20E-05			-1.19E-05	
51	-1.43E-05			-1.42E-05	
52	-1.43E-05			-1.42E-05	
53	-1.66E-05			-1.65E-05	
54	-1.66E-05			-1.65E-05	
55	-1.91E-05			-1.89E-05	
56	-1.91E-05			-1.89E-05	
MAXIMUM	ABSOLUTE VALUES				
NODE	16				
VALUE	-2.15E-05				

Stress-X values Comparision at nodes:-

Ansys Stress Results

	NODE	SX	SY	SXY
Maximum Stress	1	-2.51E+05	-15163	-43576
	2	-10773	-5139.6	-4647
	3	-2.42E+05	-29253	-3879.5
	4	-2.18E+05	-22967	-5188.1
	5	-1.98E+05	-21122	-4958.8
	6	-1.79E+05	-18997	-4979.5
	7	-1.59E+05	-16887	-4978
	8	-1.39E+05	-14776	-4978.1
	9	-1.19E+05	-12665	-4978.1
	10	-99211	-10554	-4978.1
	11	-79369	-8443.5	-4978.2
	12	-59529	-6331.4	-4976
	13	-39676	-4247.2	-5002.8
	14	-19512	-1695.3	-4803
	15	10773	5139.6	-4647
	16	-3818.2	-2099.3	-8961.6
	17	3818.2	2099.3	-8961.6
	18	2.51E+05	15163	-43576
	19	19512	1695.3	-4803
	20	39676	4247.2	-5002.8
	21	59529	6331.4	-4976
	22	79369	8443.5	-4978.2
	23	99211	10554	-4978.1
	24	1.19E+05	12665	-4978.1
	25	1.39E+05	14776	-4978.1
	26	1.59E+05	16887	-4978
	27	1.79E+05	18997	-4979.5
	28	1.98E+05	21122	-4958.8
	29	2.18E+05	22967	-5188.1
	30	2.42E+05	29253	-3879.5
	31	72356	-8305.1	-46148
	32	-72356	8305.1	-46148
	33	-73870	-430.75	-8626.3
	34	73870	430.75	-8626.3
	35	-69914	284.33	-8577.3
	36	69914	-284.33	-8577.3
	37	-64100	-30.233	-8728.8
	38	64100	30.232	-8728.8
	39	-57621	2.2853	-8712
	40	57621	-2.2854	-8712
	41	-51224.	0.13827	-8713.3
	42	51224	0.13887	-8713.3
	43	-44821	0.69305E-	-8713.2
	44	-44821	0.66073E-	-8713.2
	45	-38418.	-0.10975E-	-8713.2
	46	38418	0.75021E-	-8713.2
	47	-32015	0.13904E-	-8713.2
	48	-32015	0.13586E-	-8713.2
	49	-25613.	0.23881	-8713.1
	50	25613	0.23842	-8713.1
	51	-19201	3.3454	-8714.9
	52	19201	-3.3454	-8714.9
	53	-12876	-35.145	-8695.9
	54	12876	35.145	-8695.9
	55	-6417.6	153.83	-8763.6
	56	6417.6	-153.83	-8763.6
MINIMUM VALUES				
NODE		1	3	31
VALUE		-0.25062E+	29253	-46148
MAXIMUM VALUES				
NODE		18	30	3
VALUE		2.51E+05	29253	-3879.5

MATLAB RESULTS FOR STRESSES AT NODES

	NODES 1	TO	NODES 12									
	1.0e+05*											
SX	-2.7532	-0.1077	-2.2369	-2.0848	-1.8774	-1.6802	-1.4818	-1.2834	-1.0850	-0.8866	-0.6883	-0.4898
SY	-1.5016	-0.0514	-0.0085	-0.2381	-0.1734	-0.1594	-0.1369	-0.1161	-0.0950	-0.0739	-0.0528	-0.0317
SXY	-0.6979	-0.0465	-0.3489	-0.3707	-0.3331	-0.3055	-0.2770	-0.2487	-0.2203	-0.1919	-0.1646	-0.1350
	Columns 13 through 24											
SX	-0.2910	-0.0877	0.1077	-0.0350	0.0413	2.4782	0.0877	0.2910	0.4898	0.6883	0.8866	1.0850
SY	-0.0107	0.0153	0.0514	-0.0105	0.0315	0.1191	-0.0153	0.0107	0.0317	0.0528	0.0739	0.0950
SXY	-0.1072	-0.0733	-0.0465	-0.1124	-0.0667	-0.4492	-0.0733	-0.1072	-0.1350	-0.1646	-0.1919	-0.2203
	Columns 25 through 36											
SX	1.2834	1.4818	1.6803	1.8803	2.0756	2.2462	0.5693	-0.5560	-0.8767	0.7251	-0.7287	0.5883
SY	0.1160	0.1375	0.1573	0.1849	0.1762	0.2761	-0.4535	0.4571	-0.3989	-0.1802	-0.1994	-0.2699
SXY	-0.2487	-0.2771	-0.3055	-0.3356	-0.3597	-0.3682	-0.5247	-0.2311	-0.5135	-0.3519	-0.4165	-0.3822
	Columns 37 through 48											
SX	-0.6708	0.5436	-0.5978	0.4836	-0.5278	0.4265	-0.4573	0.3687	-0.3870	0.3110	-0.3166	0.2533
SY	-0.2063	-0.2161	-0.1781	-0.2017	-0.1585	-0.1791	-0.1372	-0.1584	-0.1161	-0.1372	-0.0950	-0.1161
SXY	-0.3977	-0.3464	-0.3671	-0.3187	-0.3389	-0.2898	-0.3105	-0.2615	-0.2821	-0.2331	-0.2536	-0.2047
	Columns 49 through 56											
SX	-0.2463	0.1957	-0.1757	0.1377	-0.1070	0.0818	-0.0350	0.0213				
SY	-0.0739	-0.0950	-0.0527	-0.0739	-0.0321	-0.0520	-0.0105	-0.0352				
SXY	-0.2264	-0.1774	-0.1968	-0.1479	-0.1681	-0.1189	-0.1407	-0.0935				

Comparisions between Ansys and Matlab for Coarse **Mesh(27 Nodes)**

Ansys Displacement-Y					MATLAB DISPLACEMENT-Y		
NODE	UY						
1	-1.13E-07				-1.13E-07		
2	-1.65E-05				-1.69E-05		
3	-5.00E-07				-5.52E-07		
4	-1.58E-06				-1.67E-06		
5	-3.21E-06				-3.36E-06		
6	-5.30E-06				-5.52E-06		
7	-7.78E-06				-8.05E-06		
8	-1.05E-05				-1.09E-05		
9	-1.35E-05				-1.39E-05		
10	-1.65E-05				-1.69E-05		
11	-1.65E-05				-1.68E-05		
12	-1.13E-07				-1.13E-07		
13	-1.35E-05				-1.39E-05		
14	-1.05E-05				-1.09E-05		
15	-7.78E-06				-8.05E-06		
16	-5.30E-06				-5.52E-06		
17	-3.21E-06				-3.36E-06		
18	-1.58E-06				-1.67E-06		
19	-5.00E-07				-5.31E-07		
20	0				2.15E-18		
21	-4.46E-07				-4.75E-07		
22	-1.52E-06				-1.61E-06		
23	-3.16E-06				-3.31E-06		
24	-5.27E-06				-5.48E-06		
25	-7.75E-06				-8.02E-06		
26	-1.05E-05				-1.08E-05		
27	-1.35E-05				-1.38E-05		
MAXIMUM ABSOLUTE VALUES							
NODE	11						
VALUE -	1.65E-05						
VALUE -0.16505E-004							

Ansys_Stress at nodes

	NODE	SX	SY	SZ	SXY	SYZ	SXZ
Maximum	1	-1.85E+05	-10559	0	-47696	0	0
	2	-13428	-5783.7	0	-3811.3	0	0
	3	-1.78E+05	-31640	0	-2499.1	0	0
	4	-1.50E+05	-22846	0	-4394.1	0	0
	5	-1.26E+05	-19898	0	-4003.7	0	0
	6	-1.00E+05	-15751	0	-4085.8	0	0
	7	-75356	-11826	0	-4060.6	0	0
	8	-50290	-7979	0	-4106	0	0
	9	-24881	-3512.7	0	-3901.2	0	0
	10	13428	5783.7	0	-3811.3	0	0
	11	2.10E-06	2.74E-05	0	-5567.3	0	0
	12	1.85E+05	10559	0	-47696	0	0
	13	24881	3512.7	0	-3901.2	0	0
	14	50290	7979	0	-4106	0	0
	15	75356	11826	0	-4060.6	0	0
	16	1.00E+05	15751	0	-4085.8	0	0
	17	1.26E+05	19898	0	-4003.7	0	0
	18	1.50E+05	22846	0	-4394.1	0	0
	19	1.78E+05	31640	0	-2499.1	0	0
	20	1.44E-04	-8.22E-04	0	-54846	0	0
	21	3.36E-05	-1.32E-04	0	-6004.4	0	0
	22	-1.38E-05	3.54E-05	0	-5004.7	0	0
	23	5.68E-05	-2.17E-04	0	-5210.6	0	0
	24	-3.15E-05	5.79E-05	0	-5167.4	0	0
	25	-2.31E-05	4.26E-06	0	-5180.6	0	0
	26	1.07E-05	-4.57E-05	0	-5156.7	0	0
	27	-4.00E-06	-1.33E-05	0	-5264.7	0	0
	MINIMUM VALUES						
	NODE	1	3	1	20	1	1
	VALUE	-1.85E+05	-31640	0	-54846	0	0
	MAXIMUM VALUES						
	NODE	12	19	1	3	1	1
	VALUE	1.85E+05	31640	0	-2499.1	0	0

MATLAB STRESS AT NODES

TThe Nodal Stresses are

Columns 1 through 12

1.0e+05 *	-1.8519	-0.1343	-1.5950	-1.3801	-1.1246	-0.8733	-0.6219	-0.3718	-0.1155	0.1343	0.0058	1.9239
	-0.5556	-0.0578	-0.1728	-0.2010	-0.1582	-0.1184	-0.0787	-0.0405	0.0049	0.0578	0.0193	0.1270
	-0.5057	-0.0381	-0.4123	-0.3896	-0.3286	-0.2708	-0.2132	-0.1566	-0.0943	-0.0381	-0.0557	-0.5147

Columns 13 through 24

SX	0.1155	0.3718	0.6219	0.8735	1.1242	1.3721	1.6548	-0.1981	-0.1034	-0.0658	-0.0595	-0.0474
SY	-0.0049	0.0405	0.0787	0.1187	0.1563	0.1991	0.2739	-0.5096	-0.2536	-0.2323	-0.1988	-0.1576
SXY	-0.0943	-0.1566	-0.2132	-0.2710	-0.3281	-0.3831	-0.4709	-0.5848	-0.4740	-0.3928	-0.3396	-0.2819

Columns 25 through 27

SX	-0.0356	-0.0234	-0.0130
SY	-0.1186	-0.0781	-0.0434
SXY	-0.2245	-0.1663	-0.1119

3) Sigma-X at x=L/2 for three types of mesh:

The nodes which are at x=L/2 are Considered

Sigma-X at x=L/2:Very **Fine Mesh**

Ansys_STRESS-X at x=L/2		MATLAB STRESS-X at X=L/2
Nodes at X=L/2		
32	1.47E+05	1.41E+05
66	71624	70624
65	8.92E-06	9.82E-06
64	1.19E+05	1.19E+05
10	-1.47E+05	-1.40E+05

Sigma-X at x=L/2:**Fine Mesh**

ANSYS Sigma X at x=L/2		MATLAB STRESS-X at X=L/2 2-Point
Nodes at x=L/2		
9	-1.19E+05	-1.25E+05
45	-38418	-45418
46	38418	45418
24	1.19E+05	1.25E+05

Sigma-X at x=L/2:**Coarse Mesh**

Ansys Stress at x=L/2		Matlab Stress at x=L/2 ---2point Gauss
Nodes at x=L/2		
6	-1.00E+05	-9.00E+04
24	-3.15E-05	-2.90E+05
16	1.00E+05	9.00E+04

3)Comparison of Stress(sigma-x) at 2-point,1-point,3-point Gauss Quadrature

ANSYS Sigma X at x=L/2		MATLAB STRESS-X at X=L/2 2-Point	MATLAB STRESS-X at X=L/2 1-Point	MATLAB STRESS-X at X=L/2 3-Point
Nodes at x=L/2				
9	-1.19E+05	-1.25E+05	3.10E+05	-1.09E+05
45	-38418	-45418	-68418	-38700
46	38418	45418	68418	38700
24	1.19E+05	1.25E+05	-309930.00	1.09E+05