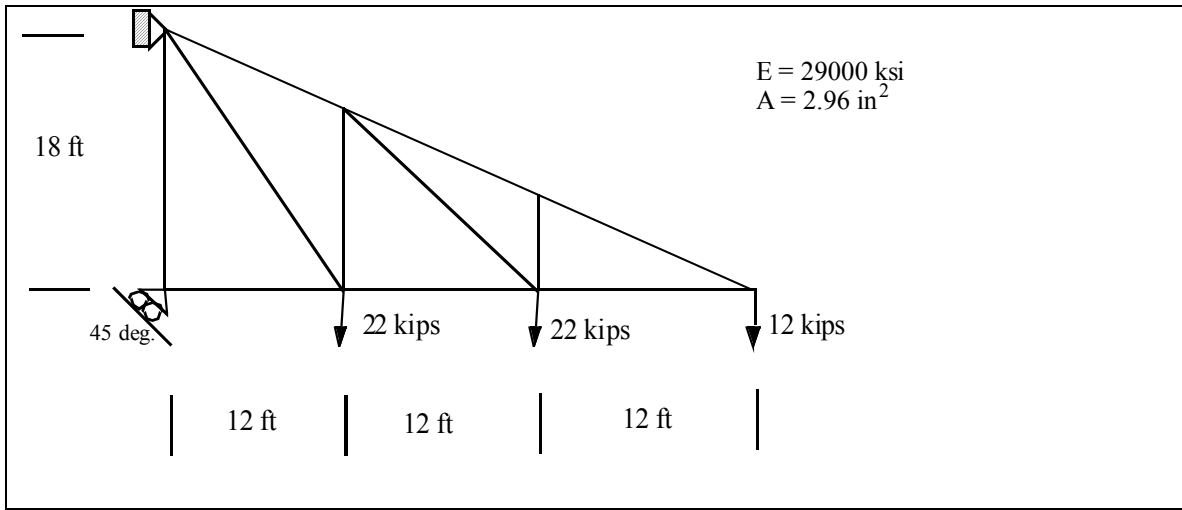
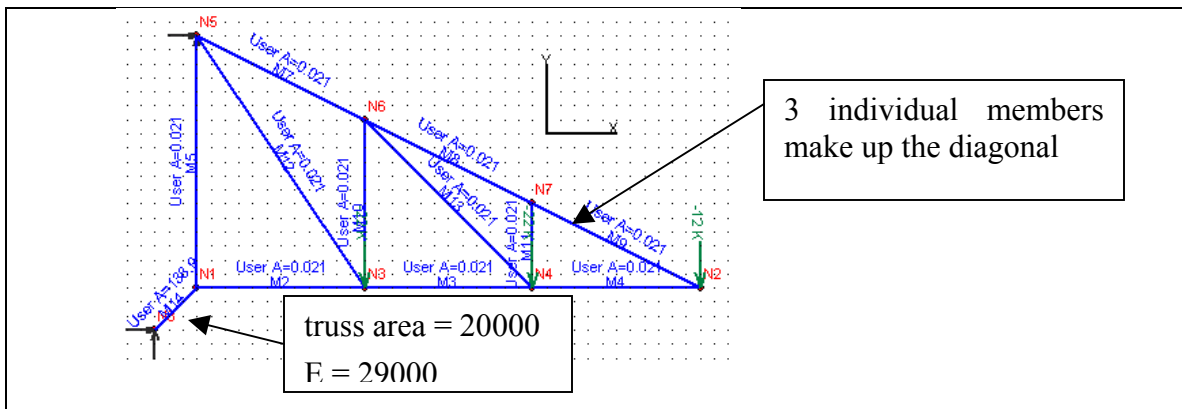


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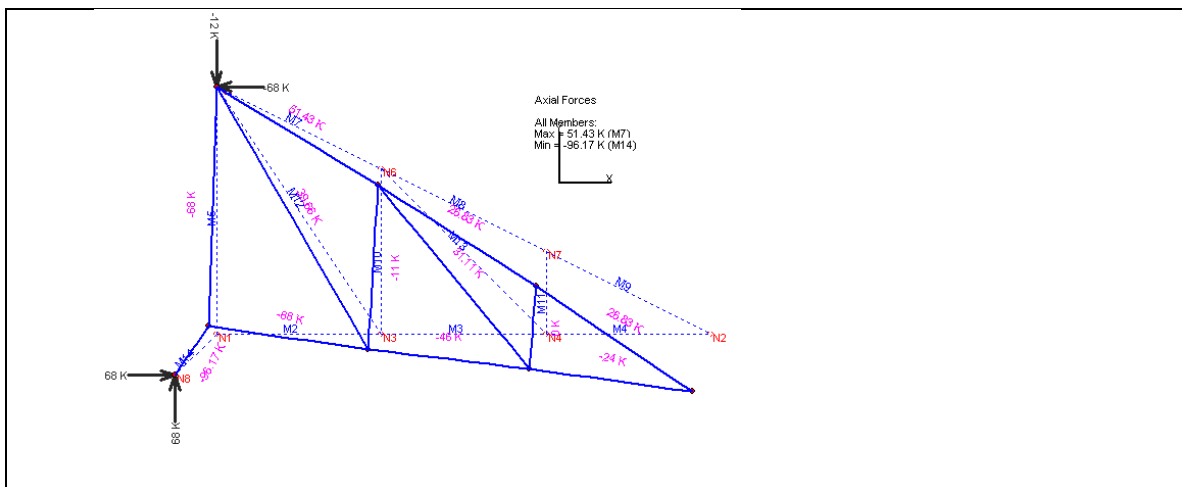
Problem #1



Problem Statement



Visual Analysis model



Displaced shape and axial forces.

Nodal Displacements

Node	Load Case	DX ft	DY ft
N1	Service Case 4	-0.014260083	0.014259087

Note that N1 moves at the desired 45 degree angle, so our model of a stiff truss works to replace the roller. If the magnitudes of displacement in x- and y were not equal, I would stiffen the truss further.

N2	"	-0.033551788	-0.103833025
N3	"	-0.023766140	-0.027856997
N4	"	-0.030196709	-0.062579870
N5	"	0.000000001	0.000000000
N6	"	-0.005710378	-0.029394742
N7	"	-0.017614076	-0.062579870
N8	"	-0.000000001	-0.000000001

Nodal Reactions

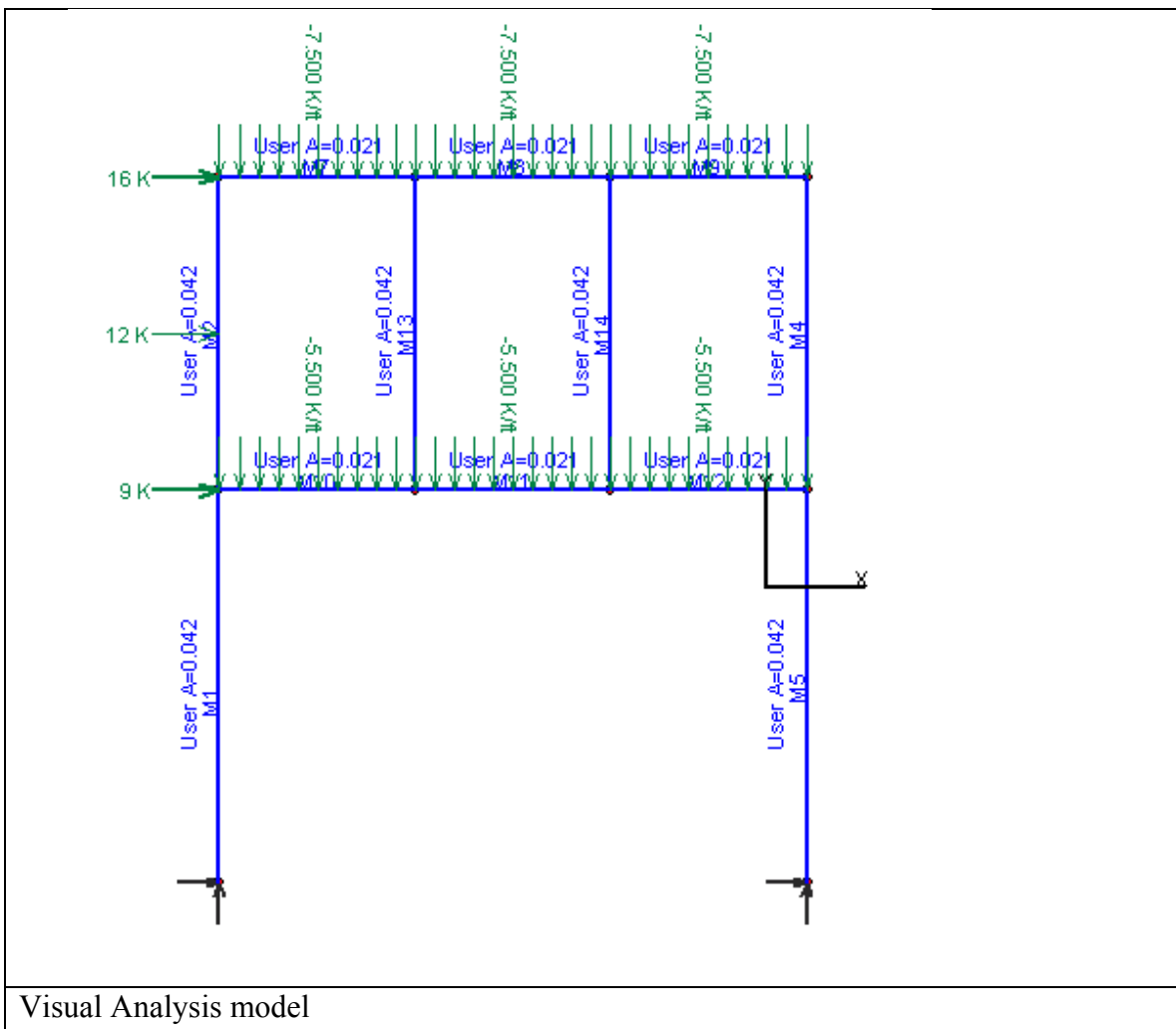
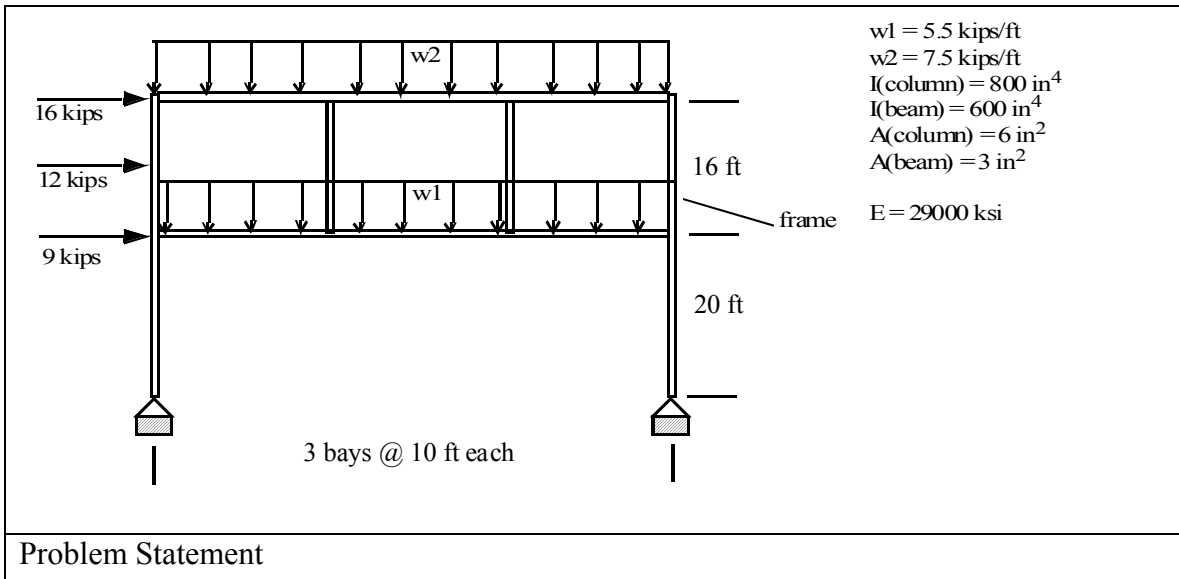
Node	Load Case	FX K	FY K
N5	Service Case 4	-68.00	-12.00
N8	"	68.000000000	68.000000000

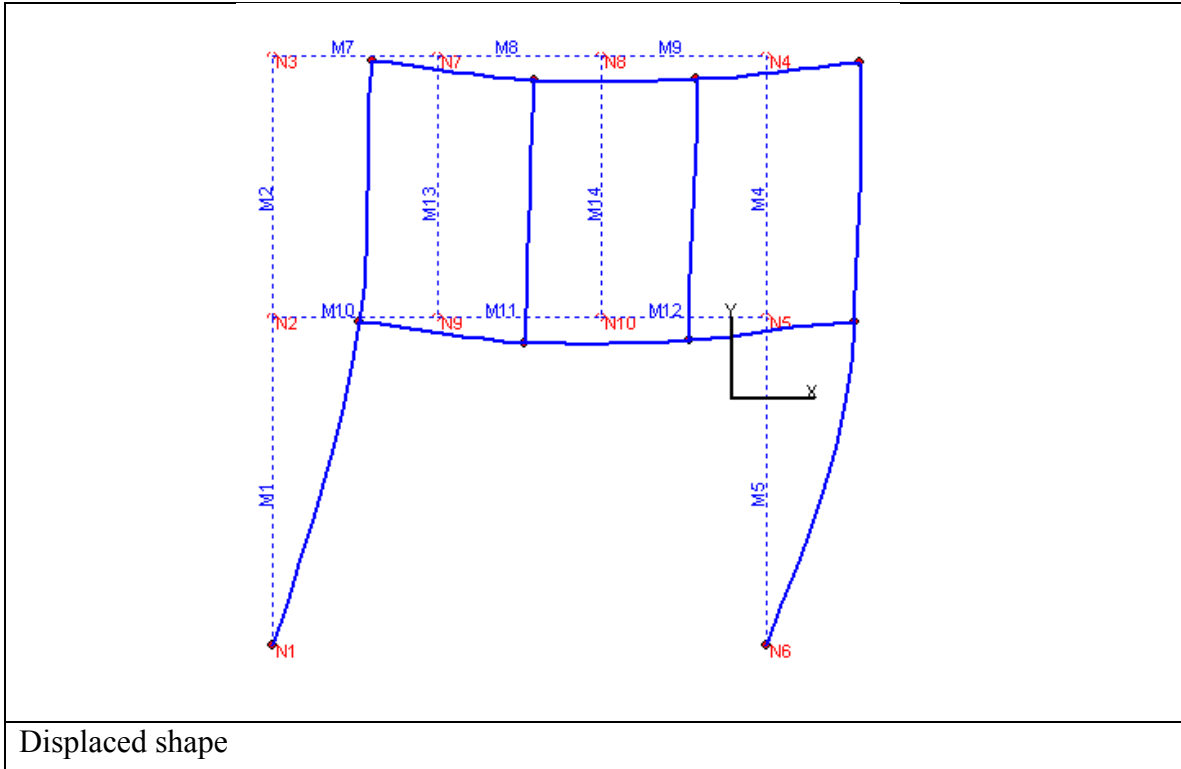
Member Internal Forces

Member	Load Case	Offset ft	Axial K
M2	Service Case 4	0.000000000	-68.00
M3	"	0.000000000	-46.00
M4	"	0.000000000	-24.00
M5	"	0.000000000	-68.00
M7	"	0.000000000	51.429563482
M8	"	0.000000000	26.832815730
M9	"	0.000000000	26.832815730
M10	"	0.000000000	-11.00
M11	"	0.000000000	-0.000000000
M12	"	0.000000000	39.661064030
M13	"	0.000000000	31.112698372
M14	"	0.000000000	-96.17

Problem #2

Run once using linear analysis, and once using frame instability P-DELTA





Displaced shape

Linear Analysis and P-DELTA Results side by side

Highlighted numbers to be compared with P-DELTA case

Nodal Displacements - Linear

Node	Load Case	DX ft	DY ft	RZ rad
N1	Service Case 1	0.000000	-0.000000	-0.026986
N2	"	0.441181	-0.018230	-0.012205
N3	"	0.504223	-0.026941	-0.007188
N4	"	0.484295	-0.035470	0.005920
N5	"	0.452456	-0.026598	-0.001856
N6	"	0.000000	-0.000000	-0.033006
N7	"	0.496697	-0.126941	-0.004918
N8	"	0.487786	-0.120397	0.002930
N9	"	0.445823	-0.127505	-0.004634
N10	"	0.451849	-0.116727	0.005066

Nodal Displacements – P-DELTA

Node	Load Case	DX ft	DY ft	RZ rad
N1	Service Case 1	0.000000	-0.000000	-0.037318
N2	"	0.590640	-0.017290	-0.014264
N3	"	0.662920	-0.026065	-0.007249
N4	"	0.642864	-0.036309	0.005935
N5	"	0.602516	-0.027538	-0.003706
N6	"	0.000000	-0.000000	-0.043723
N7	"	0.654940	-0.128508	-0.005149
N8	"	0.645985	-0.119931	0.002766
N9	"	0.595894	-0.129662	-0.004484
N10	"	0.602122	-0.115634	0.005237

Displacement Notes: Significant differences are seen

Nodal Reactions - Linear

Node	Load Case	FX K	FY K	MZ K-ft
N1	Service Case 1	-11.91	158.60	-NA-
N6	"	-25.09	231.40	-NA-

Nodal Reactions – P-DELTA

Node	Load Case	FX K	FY K	MZ K-ft
N1	Service Case 1	-13.28	150.42	-NA-
N6	"	-23.72	239.58	-NA-

Note on Reactions: both systems are in equilibrium with the same load case, but P-DELTA is in equilibrium about the displaced shape

Member Internal Forces - Linear

Member	Load Case	Offset ft	Axial K	Vy K	Mz K-ft
M1	Service Case 1	0.000000	-158.60	11.906761	0.000000
"	"	20.000000	-158.60	11.906761	238.14
M2	"	0.000000	-94.74	-37.47	374.30
"	"	16.000000	-94.74	-49.47	-321.25
M4	"	0.000000	-96.48	30.373488	-321.29
"	"	16.000000	-96.48	30.373488	164.69
M5	"	0.000000	-231.40	25.093239	-501.86
"	"	20.000000	-231.40	25.093239	0.000000
M7	"	0.000000	-65.47	94.736791	-321.25
"	"	10.000000	-65.47	19.736791	251.11
M8	"	0.000000	-77.53	13.600471	151.82
"	"	10.000000	-77.53	-61.40	-87.17
M9	"	0.000000	-30.37	-21.48	268.55
"	"	10.000000	-30.37	-96.48	-321.29
M10	"	0.000000	40.379040	63.863209	-136.17
"	"	10.000000	40.379040	8.863209	227.46
M11	"	0.000000	52.434094	14.999529	133.88
"	"	10.000000	52.434094	-40.00	8.872641
M12	"	0.000000	5.280249	-79.92	407.61
"	"	10.000000	5.280249	-134.92	-666.55
M13	"	0.000000	6.136320	-12.06	99.293274
"	"	16.000000	6.136320	-12.06	-93.59
M14	"	0.000000	-39.92	47.153845	-355.72
"	"	16.000000	-39.92	47.153845	398.74

Member Internal Forces – P-DELTA

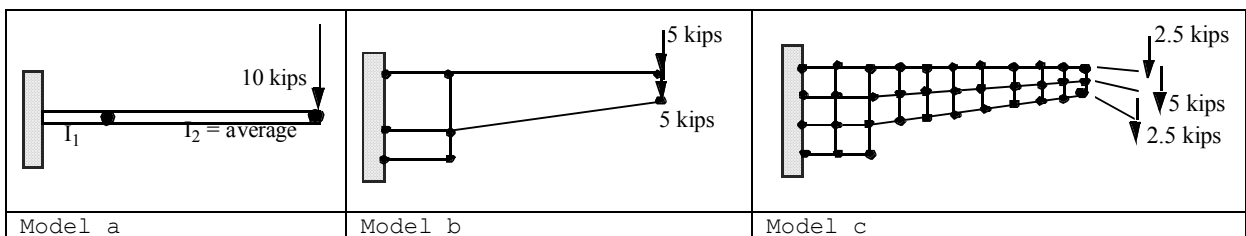
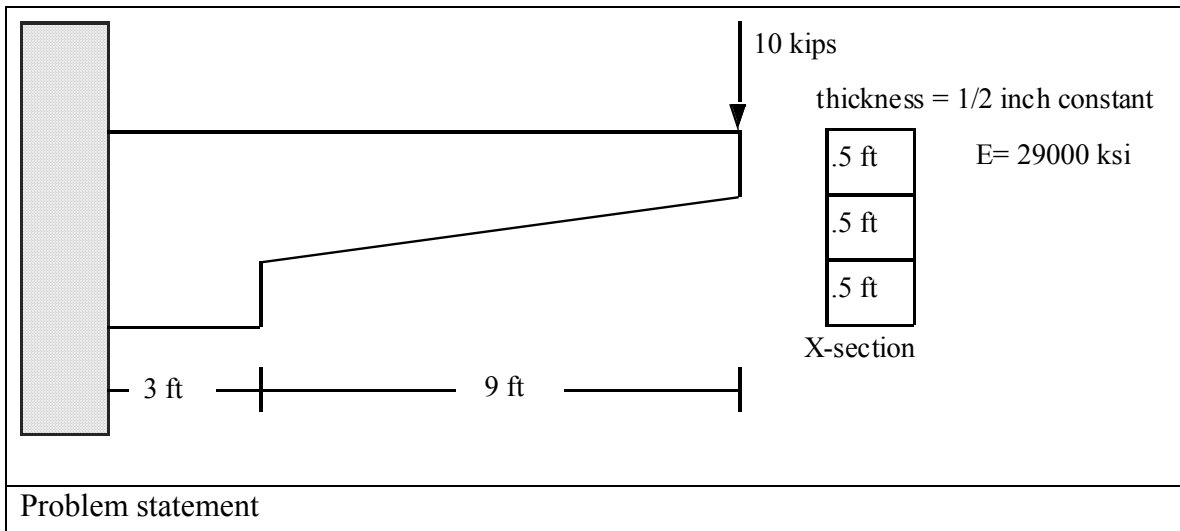
Member	Load Case	Offset ft	Axial K	Vy K	Mz K-ft
M1	Service Case 1	0.000000	-150.42	13.278497	0.000000
"	"	20.000000	-150.42	13.278497	354.41
M2	"	0.000000	-95.43	-41.43	421.75
"	"	16.000000	-95.43	-53.43	-330.20
M4	"	0.000000	-95.39	27.150280	-314.99
"	"	16.000000	-95.39	27.150280	123.26
M5	"	0.000000	-239.58	23.721503	-613.85
"	"	20.000000	-239.58	23.721503	4.928430
M7	"	0.000000	-69.43	95.432220	-330.25
"	"	10.000000	-69.43	20.432220	256.18
M8	"	0.000000	-77.91	7.884807	181.04

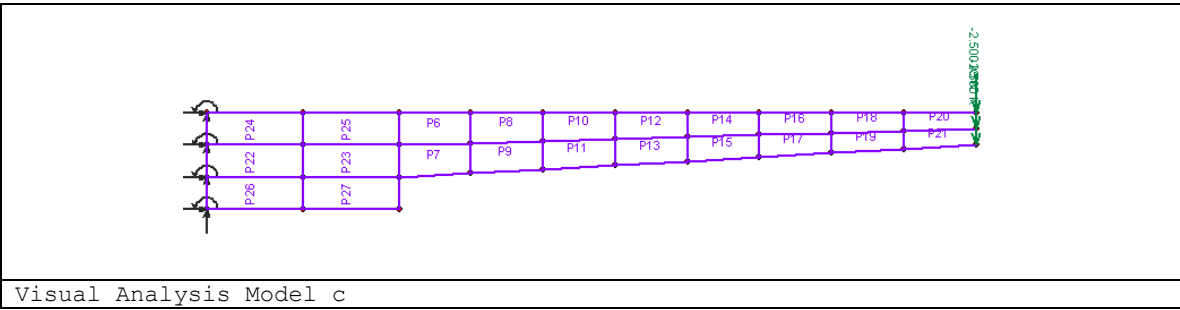
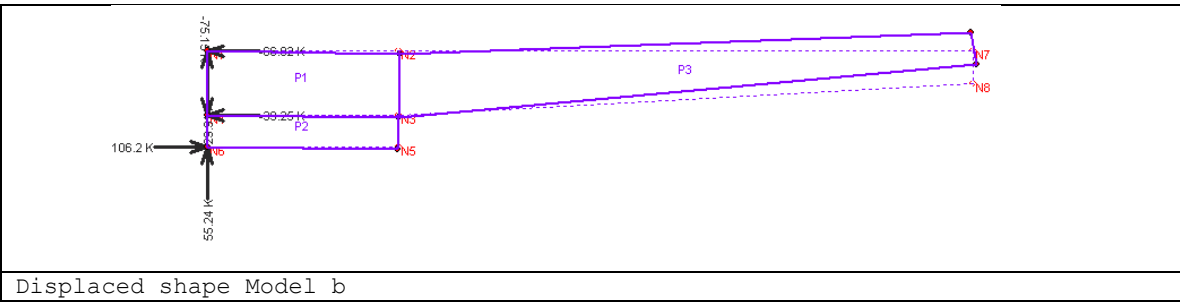
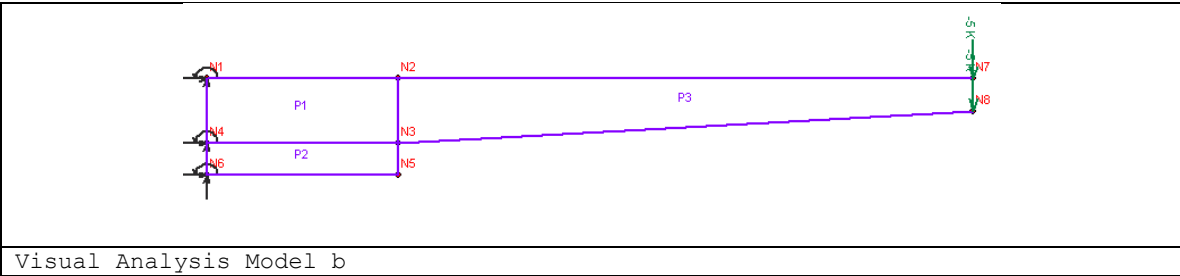
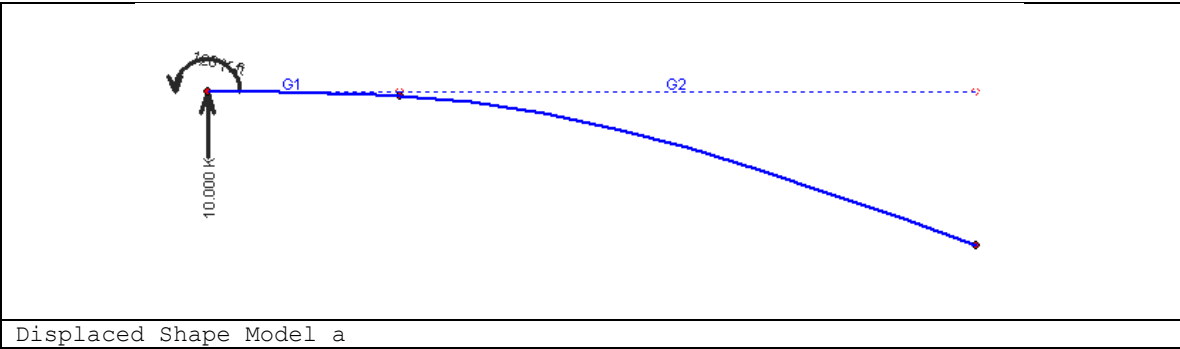
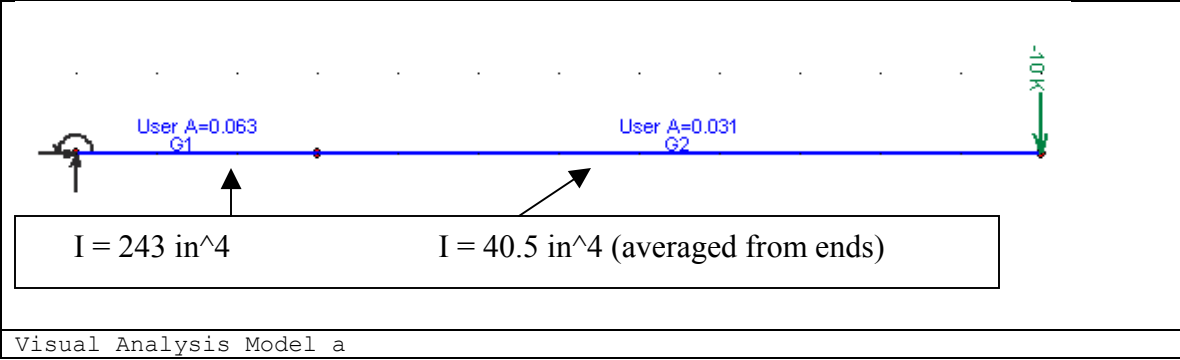
"	"	10.000000	-77.91	-67.12	-115.78
M9	"	0.000000	-27.15	-20.39	266.42
"	"	10.000000	-27.15	-95.39	-314.72
M10	"	0.000000	45.706214	54.988036	-62.50
"	"	10.000000	45.706214	-0.011964	207.24
M11	"	0.000000	54.188533	12.535450	146.51
"	"	10.000000	54.188533	-42.46	-2.379221
M12	"	0.000000	3.428777	-89.19	429.30
"	"	10.000000	3.428777	-144.19	-737.32
M13	"	0.000000	12.547413	-8.482320	74.742576
"	"	16.000000	12.547413	-8.482320	-61.72
M14	"	0.000000	-46.73	50.759757	-382.20
"	"	16.000000	-46.73	50.759757	432.00

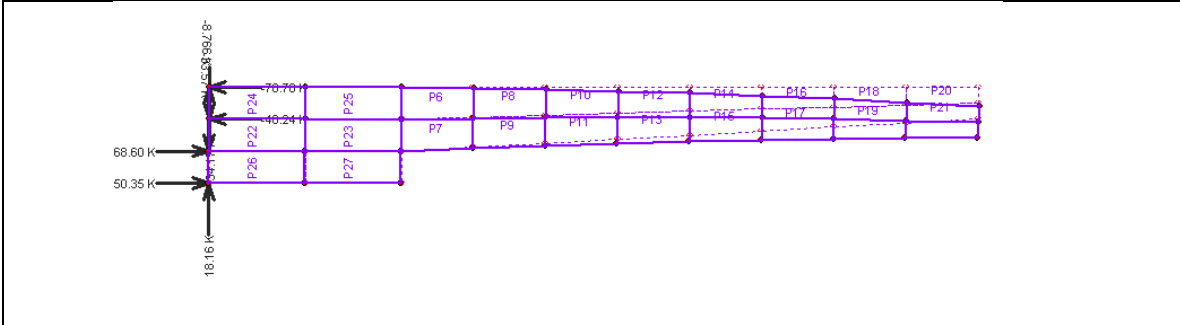
Member Internal Forces Notes: There are numerous differences showing that linear analysis is un-conservative. Even the location of the maximum positive moment shifts from member 12 to member 14. This can be significant.

Problem #3

Analyze the following tapered beam using three different models







Displaced shape Model c

Nodal Displacements – Model a

Node	Load Case	DX ft	DY ft	RZ deg
N3	Service Case 1	0.000000	-0.365979	-3.213840

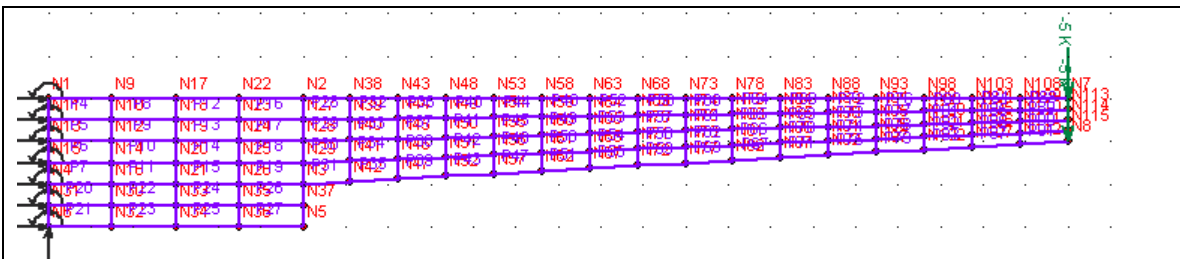
Nodal Displacements – Model b

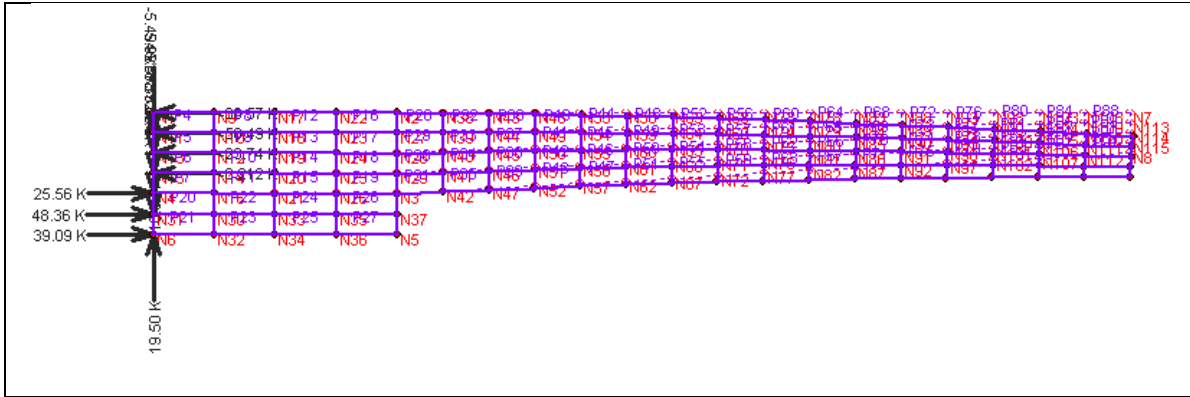
Node	Load Case	DX ft	DY ft	RZ rad
N8	Service Case 1	0.009449	0.070840	0.000000

Nodal Displacements – Model c

Node	Load Case	DX ft	DY ft	RZ rad
N8	Service Case 2	-0.004921	-0.350149	0.000000

The results show some disparities between displaced shapes. We would expect the plate models to be more accurate since they are used for members that are not well represented as 'thin', as is the case in this problem. Let's do one more model with more elements and see if we can get a refined answer. This time we will use 88 elements





Displaced shape Model d

Nodal Displacements

Node	Load Case	DX ft	DY ft	RZ rad
N8	Service Case 1	-0.004902	-0.355200	0.000000

This answer conforms very well with the 22 element model. Note also that we now have a better resolution of reactions at the wall.