Staad output – Member 15
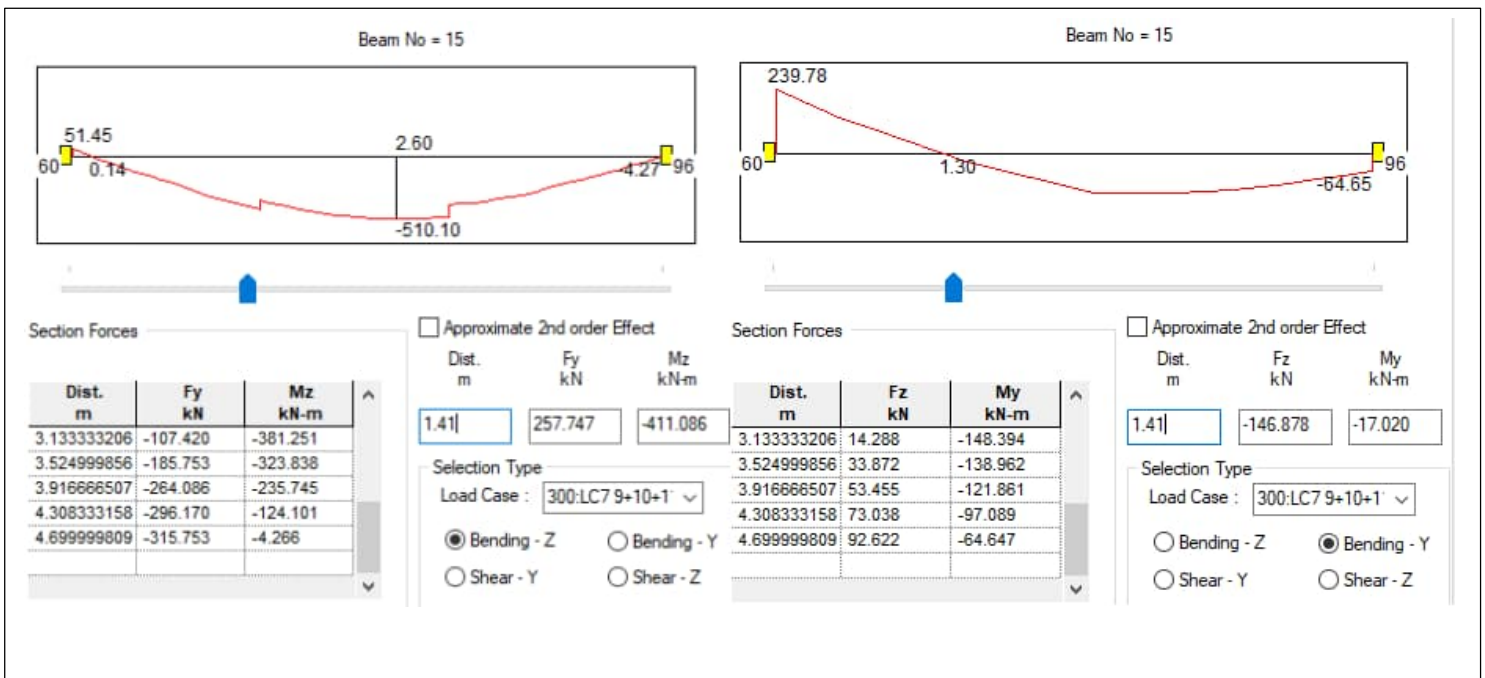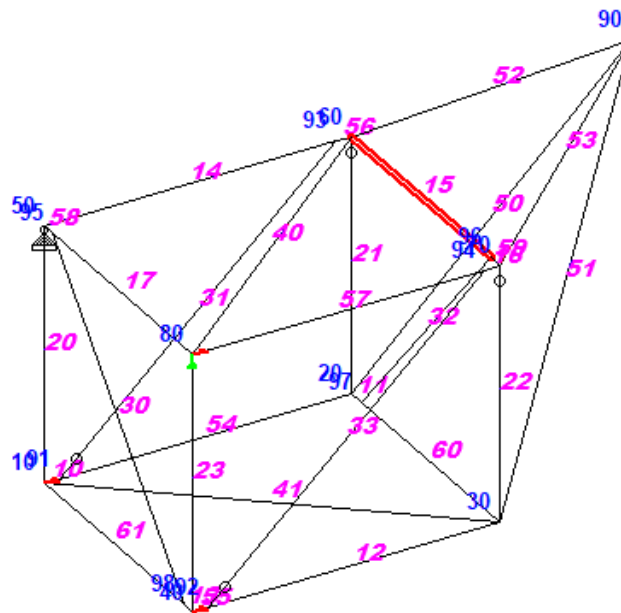

Forces and stresses extracted from output listing at 1.41m (0.334 x 4.7m = 1.41m)

MEMB	LOAD	SEC	AXIAL	SHEAR-Y	SHEAR-Z	MOM-Y	MOM-Z
15	300	0.334	-244.80	234.20	-139.03	-39.46	-374.70

MEMB	LD	SECT	AXIAL	BEND-Y	BEND-Z	COMBINED	SHEAR-Y	SHEAR-Z
15	300	0.334	26.9 T	152.7	509.4	689.0	122.2	29.5

Properties as extracted from output

Physical Properties (Unit: m)

Ax	0.0091	Ix	7.66e-007
Ay	0.00209	Iy	2.843e-005
Az	0.00469333	Iz	8.091e-005
D	0.22	W	0.22

MEMB	PROFILE	AX	IZ	IY	IX
		AY	AZ	SZ	SY
15 ST	HE220B	91.0	8091.0	2843.0	76.60
		20.90	46.93	735.55	258.45

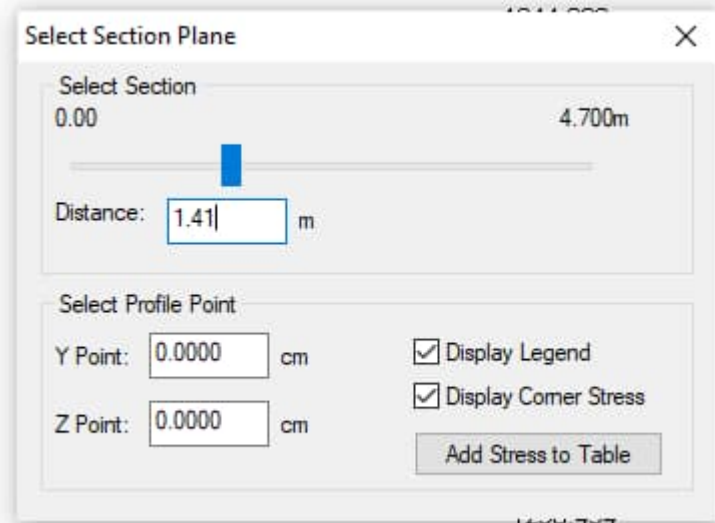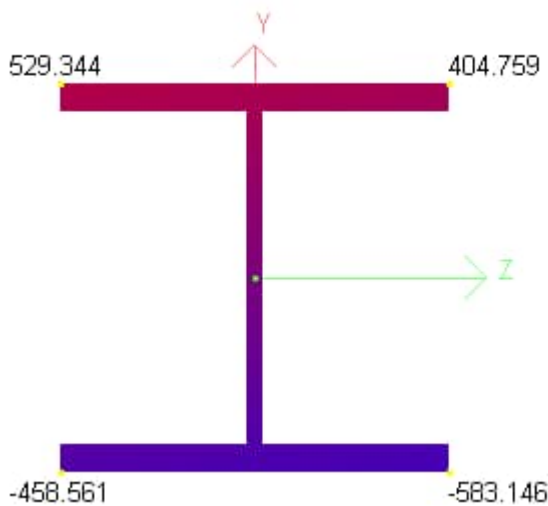## Verification of tabulated axial and bending stresses (ignoring sign)

$$\sigma x := \frac{244.5 \cdot 10^3}{91 \cdot 10^2} = 26.868 \qquad \sigma by := \frac{39.46 \cdot 10^6}{258.45 \cdot 10^3} = 152.679 \qquad \sigma bz := \frac{374.7 \cdot 10^6}{735.55 \cdot 10^3} = 509.415$$

$$\sigma x + \sigma by + \sigma bz = 689$$

Considering all combinations of axial and bending stress (considering sign)

$$\sigma x + \sigma by + \sigma bz = 689 \qquad \sigma x - \sigma by + \sigma bz = 384 \qquad \sigma x + \sigma by - \sigma bz = -330 \qquad \sigma x - \sigma by - \sigma bz = -635$$

$$-\sigma x + \sigma by + \sigma bz = 635 \qquad -\sigma x - \sigma by + \sigma bz = 330 \qquad -\sigma x + \sigma by - \sigma bz = -384 \qquad -\sigma x - \sigma by - \sigma bz = -689$$

Staad stress plot at location 1.41m

529.344   404.759

-458.561   -583.146

Select Section Plane

Select Section
0.00   4.700m

Distance: 1.41 m

Select Profile Point

Y Point: 0.0000 cm   ☑ Display Legend
                          ☑ Display Corner Stress
Z Point: 0.0000 cm
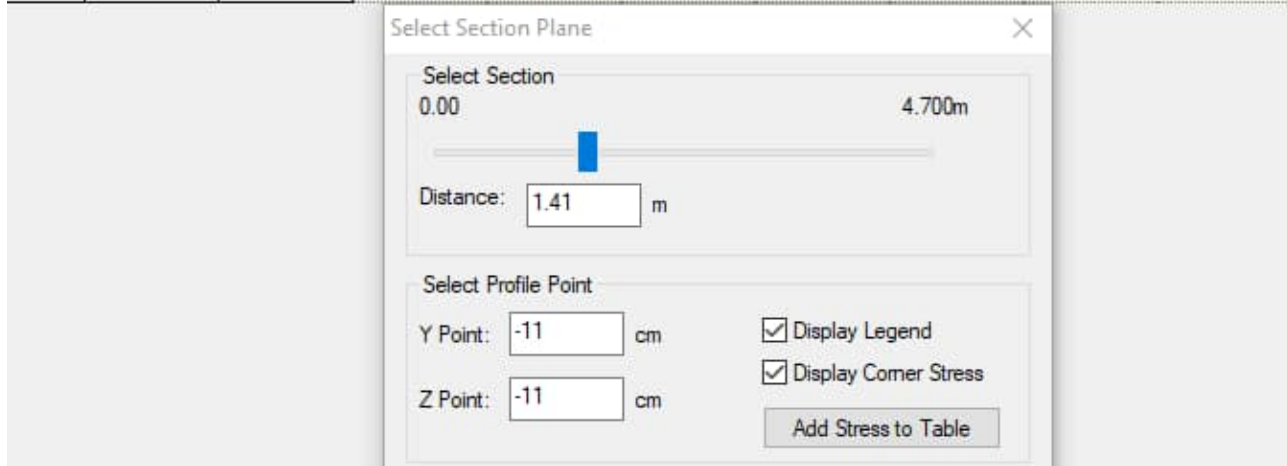   Add Stress to Table

Noting that not one of the above calculated stress combinations equals any of the 4 corner stresses on the diagram ???

The following are the extracted stresses for the four corner positions on the diagram. Note the Fx, My and Mz forces used for the following calculations.

| | Beam | L/C | Location | | | Fx | My | Mz | Stress |
			Dist m	Stress Pt(Y)	Stress Pt(Z)	kN	kN-m	kN-m	N/mm2
1	15	300	1.410	0.000	0.000	-244.798	-16.100	-363.324	-26.901
2	15	300	1.410	11.000	-11.000	-244.798	-16.100	-363.324	529.344
3	15	300	1.410	11.000	11.000	-244.798	-16.100	-363.324	404.759
4	15	300	1.410	-11.000	11.000	-244.798	-16.100	-363.324	-583.146
5	15	300	1.410	-11.000	-11.000	-244.798	-16.100	-363.324	-458.561

Select Section Plane ✕

Select Section
0.00   4.700m

Distance: 1.41   m

Select Profile Point

Y Point: -11   cm   ☑ Display Legend
                         ☑ Display Corner Stress
Z Point: -11   cm
                         Add Stress to Table

Using the above forces to verify calculated stresses

$$\sigma x := \frac{244.5 \cdot 10^3}{91 \cdot 10^2} = 26.868 \qquad \sigma by := \frac{16.1 \cdot 10^6}{258.45 \cdot 10^3} = 62.294 \qquad \sigma bz := \frac{363.324 \cdot 10^6}{735.55 \cdot 10^3} = 493.949$$

$$\sigma x + \sigma by + \sigma bz = 583.1$$

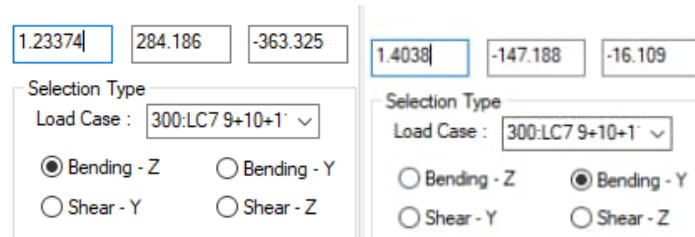$\sigma x + \sigma by + \sigma bz = 583.1 \qquad \sigma x - \sigma by + \sigma bz = 458.5 \qquad \sigma x + \sigma by - \sigma bz = -404.8 \qquad \sigma x - \sigma by - \sigma bz = -529.4$

$-\sigma x + \sigma by + \sigma bz = 529.4 \qquad -\sigma x - \sigma by + \sigma bz = 404.8 \qquad -\sigma x + \sigma by - \sigma bz = -458.5 \qquad -\sigma x - \sigma by - \sigma bz = -583.1$
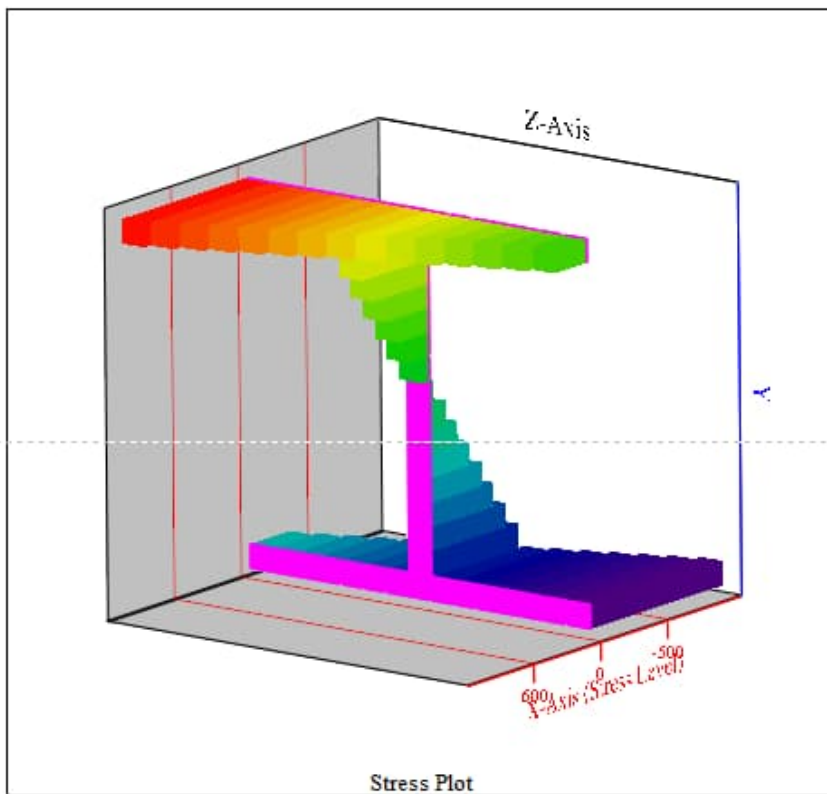
As can plainly be seen the above stresses are exactly the same as those on the stress plot, however........

Questions

1. Why are the tabulated (and correct) stresses, as listed in the output file, different from those shown on the graphics display ?
2. Since 0,0 is the centre of the beam (only axial stress present) which is correct, why don't all the corner stresses, as selected and tabulated, equal those on the plot ???
3. Why is the program, possibly, using moment forces at different locations ???

1.23374	284.186	-363.325

Selection Type
Load Case : 300:LC7 9+10+1' ⌄

◉ Bending - Z   ○ Bending - Y
○ Shear - Y   ○ Shear - Z

1.4038	-147.188	-16.109

Selection Type
Load Case : 300:LC7 9+10+1' ⌄

○ Bending - Z   ◉ Bending - Y
○ Shear - Y   ○ Shear - Z

Below is the output at the same section from MathCAD direct stiffeness program.
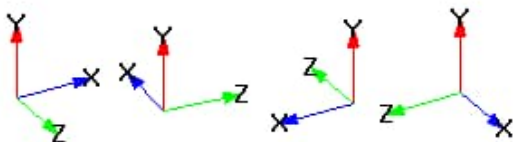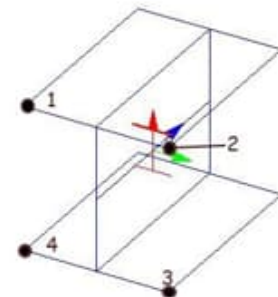

Key :-

C +ve = Compression

T -ve = Tension

Direct

$x = 1410$

$$\begin{pmatrix} \sigma_{Cnr1} \\ \sigma_{Cnr2} \\ \sigma_{Cnr3} \\ \sigma_{Cnr4} \end{pmatrix} = \begin{pmatrix} 597.608 \\ 465.668 \\ -651.41 \\ -519.469 \end{pmatrix}$$

Shear

$$\begin{pmatrix} \tau_y \\ \tau_z \end{pmatrix} = \begin{pmatrix} 123.3 \\ -16.1 \end{pmatrix}$$

Stress Plot

Corner stresse using the Staad listed output results on page 1. Note how the calculated stress results are equal to those calculated and shown on the MathCAD stress plot.

$$\text{Staad} := \begin{pmatrix} \text{"SECT "} & \text{"AXIAL"} & \text{"BEND-Y"} & \text{" BEND-Z "} & \text{"COMB"} \\ 0 & -26.9 & 927.7 & 69.9 & 1024.6 \\ 0.3 & -26.9 & 65.9 & 558.9 & 651.6 \\ 0.5 & -26.9 & 514.6 & 686 & 1227.5 \\ 1 & -26.9 & 250.1 & 5.8 & 282.8 \end{pmatrix} \qquad 4700 \cdot 0.3 = 1410$$

$\sigma Sa := \text{Staad}_{3,2} = -27 \qquad \sigma Sby := \text{Staad}_{3,3} = 66 \qquad \sigma Sbz := \text{Staad}_{3,4} = 559$

$\sigma Sa + \sigma Sby + \sigma Sbz = 597.9$ $\sigma Sa - \sigma Sby + \sigma Sbz = 466.1$

$\sigma Sa + \sigma Sby - \sigma Sbz = -519.9$ $\sigma Sa - \sigma Sby - \sigma Sbz = -651.7$

Forces at relevant section as calculated by MathCAD program which are comparable to those shown on the Staad graphics output included on page 1 above.

At $x = 1410$
$$Fn\Delta = \begin{pmatrix} \text{"Fx"} & -244.795 \\ \text{"Fy-x"} & 257.747 \\ \text{"Fz-x"} & -146.878 \\ \text{"My-x"} & -17.02 \\ \text{"Mz-x"} & -411.085 \\ \text{"}\Delta\text{y-x"} & -52.222 \\ \text{"}\Delta\text{z-x"} & 23 \end{pmatrix}$$

The below are the 4 point stresses as calculated along the beam using MathCAD and comparing to the tabulated stress output from Staad.

As can be seen, the stresses are nearly the same with a very small % margiin error due to member properties round off.

Stresses at 4 corners along selected beam - Distance in mm's

	1	2	3	4	5
1	"DIST"	"Cnr-1"	"Cnr-2"	"Cnr-3"	"Cnr-4"
2	0	-1026.181	832.58	972.38	-886.381
3	392	-519.76	708.732	465.959	-762.533
4	783	-53.49	604.192	-0.311	-657.993
5	1175	370.548	516.879	-424.35	-570.68
6	1567	634.881	329.318	-688.682	-383.119
7	1958	940.122	242.125	-993.923	-295.926
8	2350	1174.18	143.206	-1227.981	-197.007
9	2742	1245.287	81.299	-1299.088	-135.1
10	3133	1066.269	-84.065	-1120.071	30.264
11	3525	951.707	-125.516	-1005.508	71.714
12	3917	765.729	-178.923	-819.53	125.121
13	4308	518.024	-234.598	-571.826	180.797
14	4700	229.462	-271.674	-283.263	217.872

$\sigma m_c =$

Beam	L/C	Dist m	Corner 1 N/mm2	Corner 2 N/mm2	Corner 3 N/mm2	Corner 4 N/mm2
15	300 LC7 9+1	0.000	-1024 590	830.906	970.788	-884.707
		0.392	-518 605	707.730	464.803	-761.531
		0.783	-52 725	603.803	-1.077	-657.604
		1.175	370 969	517.043	-424.770	-570.845
		1.567	634 928	329.903	-688.730	-383.705
		1.958	939 892	243.121	-993.693	-296.923
		2.350	1173 699	144.537	-1227.500	-198.339
		2.742	1244 692	82.749	-1298.494	-136.551
		3.133	1065 580	-82.734	-1119.382	28.932
		3.525	951 034	-124.297	-1004.836	70.496
		3.917	765 099	-177.895	-818.901	124.094
		4.308	517 470	-233.834	-571.272	180.032
		4.700	229 028	-271.231	-282.830	217.430