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Determination of Stress and Deflection of Cantilever Beam for Various Cross-Sections

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ABSTRACT

A Cantilever beam is one, which is anchored at only end. A beam is a structural element that is capable of withstanding load primarily by resisting bending. There are different types of beams, like cantilever beam, simply supported beam and in that there will be different types of cross-sections, like rectangular, circular etc. In this present work we have taken a cantilever beam and three cross-sections are selected (Rectangular, circular, and T) and analysis was done and the stress and deflection of all the three cross-sections were found and tabulated. For carrying out the analysis Ansys workbench software was chosen.

Keywords : Cantilever Beam, Ansys, Stress, Deflection, Rectangular, Circular, T Cross Section.

I. INTRODUCTION

A beam is a structural element that is capable of withstanding load primarily by resisting bending. In the concept of beams we come across the major classification of beams as statically determinate and statically indeterminate beams. If the equilibrium conditions are sufficient to compute the reactions then it is called as statically determinate beams. And if Deflections along with equilibrium conditions are sufficient to find reactions then it is called as statically indeterminate beams.

Beams are traditionally descriptions of building or civil structural elements, but smaller structures such as truck or automobile frames etc. contain beam structures that are designed and analysed in a similar fashion. Basically in general terms, a cantilever beam is a beam which is fixed at one end. The beam carries the load to the support where it is forced against by a moment and shear stress. Cantilever construction allows for overhanging structures without external bracing. Cantilevers are widely found in construction, notably in cantilever bridges and balconies.

II. METHODS AND MATERIAL

Modelling and Analysis

In this present work the modelling and analysis was carried out in Ansys software. By following certain set of steps a cantilever beam of rectangular cross section is drawn in Ansys as shown in fig.1.

Rectangular Cross-section

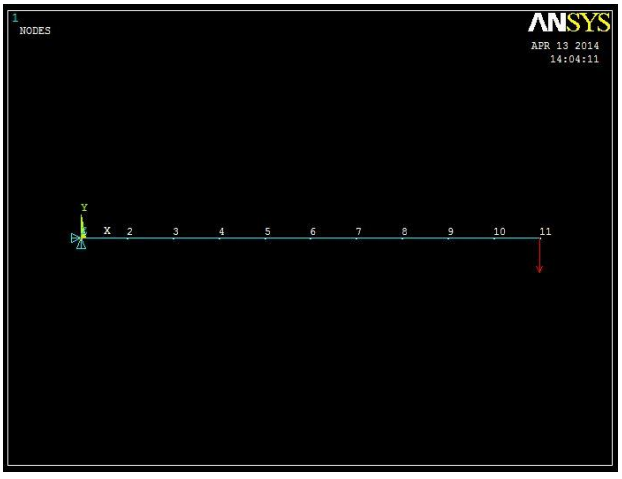

Figure 1. Rectangular Cross-section of Cantilever Beam

For finding out the deflection:

******POST1 NODAL DEGREE OF FREEDOM LISTING******
LOAD STEP= 1
SUBSTEP = 1
TIME= 1.0000
LOAD CASE= 0

The following degree of freedom results are in Global Coordinates:

Node	UY
1	0.0000
2	-181.25
3	-700.00
4	-1518.8
5	-2600.0
6	-3906.3
7	-5400.0
8	-7043.8
9	-8800.0
10	-10631
11	-12500

The maximum absolute value is at node 11 and is equal to -12500, since we get the maximum deflection at the end of the cantilever beam.

Fig.2 shows the deflection of cantilever beam for a rectangular cross-section.

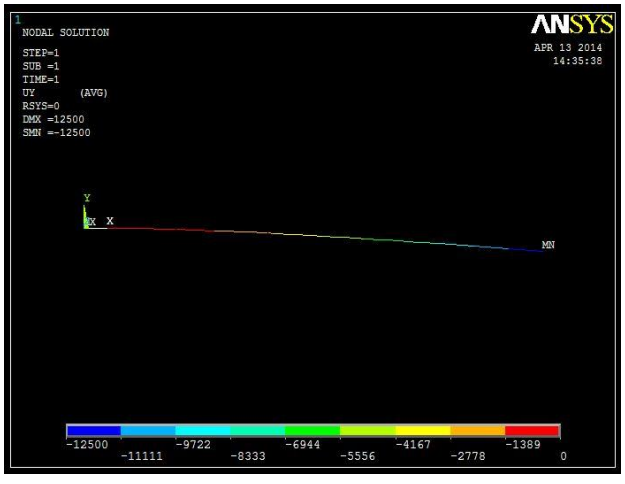

Figure 2. Deflection of cantilever beam (Rectangular)

For finding out the stress:

****** POST1 ELEMENT TABLE LISTING ******

Element	Stress
1	-15000
2	-13500
3	-12000
4	-10500
5	-9000
6	-7500
7	-6000
8	-4500
9	-3000
10	-1500

The minimum value of stress obtained is -15000 and the maximum value is -1500and is shown in fig.3

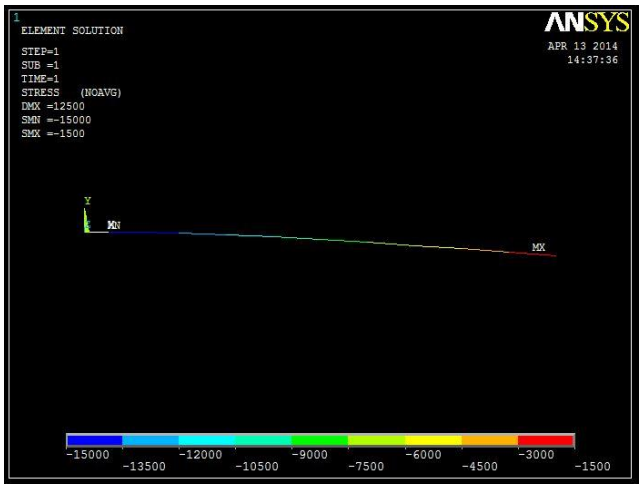

Figure 3. Stress plot of the beam (Rectangular)

III. RESULTS AND DISCUSSION

Circular Cross-section:

Let us find the deflection of the beam for circular type of cross section.

****** POST1 NODAL DEGREE OF FREEDOM LISTING ******

LOAD STEP= 1
SUBSTEP= 1
TIME= 1.0000
LOAD CASE= 0

The following degree of freedom results are in global coordinates:

Node	UY
1	0.0000
2	-30.386
3	-117.35
4	-254.62
5	-435.88
6	-654.88
7	-905.30
8	-1180.9
9	-1475.3
10	-1782.3
11	-2095.6

The maximum absolute value of deflection obtained is -2095.6 at node-11, since we get the maximum deflection at the end of the cantilever beam shown in fig.4

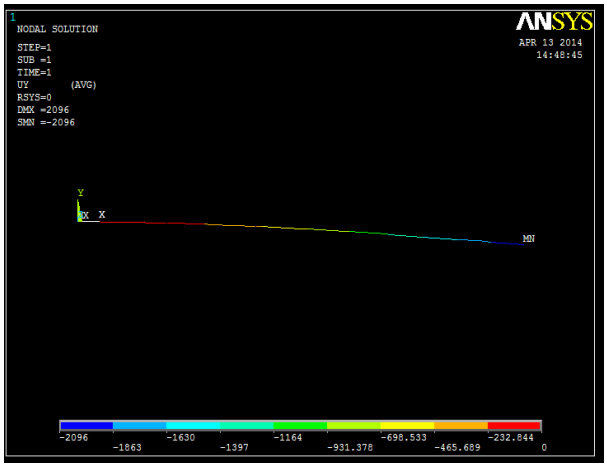

Figure 4. Deflection of Cantileverbeam (Circular)

For finding out the stresses:

****** POST1 ELEMENT TABLE LISTING ******

Element	Stress
1	-7096.5
2	-6386.9
3	-5677.2
4	-4967.6
5	-4257.9
6	-3548.3
7	-2838.6
8	-2129.0
9	-1419.3
10	-709.65

The minimum value of stress is -7096.5 and the maximum value is -709.65 as shown in the fig.5

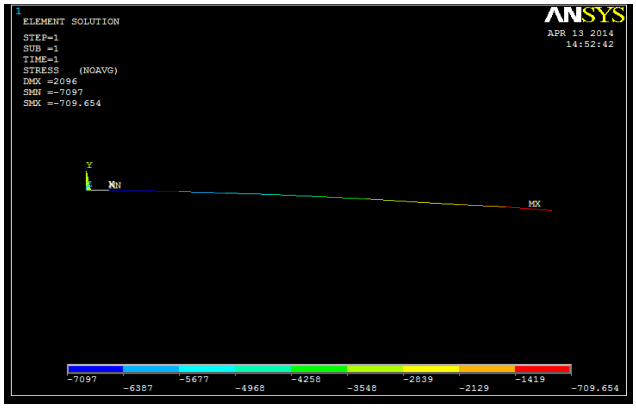

Figure 5. Stress plot of the beam (Circular)

T Cross-section:

****** POST1 NODAL DEGREE OF FREEDOM LISTING ******

LOAD STEP= 1
SUBSTEP= 1
TIME= 1.0000
LOAD CASE= 0

The following degree of freedom results are in global coordinates:

Node	UY
1	0.0000
2	-3.3672
3	-13.005
4	-28.215
5	-48.302
6	-72.570

7	-100.32
8	-130.86
9	-163.49
10	-197.51
11	-232.22

The maximum absolute value of deflection obtained is -232.22, since we get the maximum deflection at the end of the cantilever beam at node 11 as shown in the fig.6

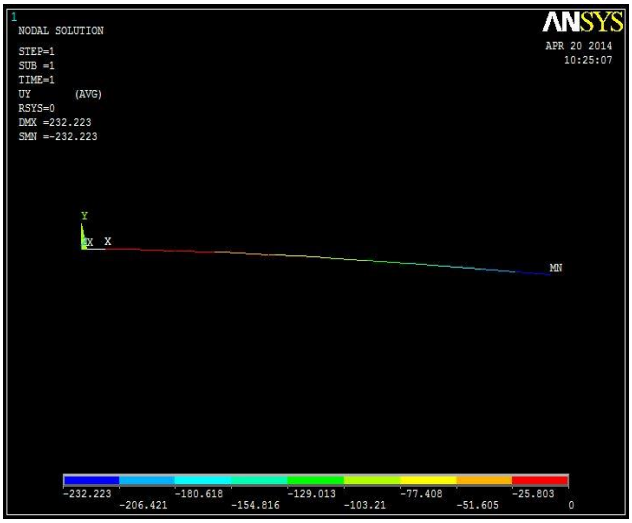

Figure 6. Deflection of cantilever beam (T Cross-section)

For finding out the stresses:
***** POST1 ELEMENT TABLE LISTING*****

Element	Stress
1	-1.6836
2	-8.1859
3	-20.610
4	-38.259
5	-60.436
6	-86.445
7	-115.59
8	-147.17
9	-180.50
10	-214.86

The minimum value of stress obtained is -214.86 and maximum value of stress obtained is -1.6836 as shown in fig.7

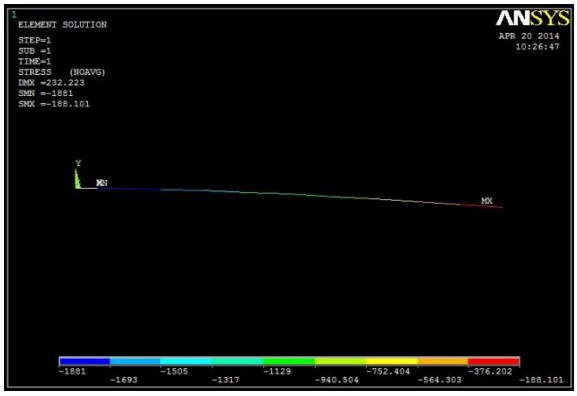

Figure 7. Stress plot of cantilever beam (T Cross-section)

IV. CONCLUSION

The deflection and stresses obtained for all the three cross-sections of cantilever beam are tabulated below.

Cross-Section	Deflection	Stress
Rectangular cross-section	12500	1500
Circular cross-section	2096	706.674
T Cross-section	232.223	188.101

Since T Cross-Section is having less deflection and less stress so it would be better to use T Cross-Section for cantilever beam. In addition, mainly the stress will be negative since the direction of bending will be in Y-direction. Therefore, we take it as positive in anti-clockwise direction.

V. REFERENCES

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