# Structural Analysis of Castellated Beam in Cantilever & Fixed Action

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***Abstract*** **– The majority of existing literature on castellated beam is focused on Simply supported analysis, but this paper provides new analytical solution for calculation critical buckling load by the cantilever action. In Simply supported castellated beam the maximum deflection occurs at the mid span of the Beam, but in cantilever castellated beam maximum deflection on the free end. By experimentally it was found that the value of web shear deformation on the critical buckling load of castellated beam increase with the increase in crass sectional area of the tee section and depth of web opening, but decrease with the length and web thickness. The experimental study of the castellated beam is tested on the cantilever action in the castellated beam the buckling capacity of the web post with fillet corner hexagonal web opening are compared with the web opening are compared with circular opening by this opening service pipe can also have passed through this. Comparison Between Castellated Beam and Cellular Beam is carried out by different test. A concentrated load or reaction point applied directly over a web-post cause this failure mode, such a failure mode could be prevented if adequate web reinforcing stiffeners are provided.in castellated beam we have to use hexagonal, Square opening and cellular has to kept circular web.**

**Use of Castellated beam for various structure rapidly gaining appeal. This is due to increased depth of section without any addition of weight, high strength to weight ratio, their lower maintenance and painting cost. A castellated beam has some limitation also Stress concentration occurs near the perforation and the shear carrying capacity is reduced. Stress concentration may be reduced by making perforation near the neutral axis where the stresses are small and making the cut in zig-zag manner.**

***Key Words:*** **Buckling, Perforation, castellated beam, FEA.**

## I. INTRODUCTION

The beam section obtained in such away can be even 50% deeper than the original section by increasing the depth, the section modulus is increased by about 2.25 times the section modulus of original beam section. A predetermined pattern is cut on section webs and the rolled section is cut into two halves. The two halves are joined together by welding and the high points of the web pattern are connected together to form a castellated beam The theory behind the castellated beam is to increase the beam's depth and strength without adding additional material. The resistance of castellated beams is frequently controlled by shearing forces. These forces may cause excessive stresses in the tee-sections above and below the hole's excessive stresses at mid-depth of the web post between holes or web-buckling involving the web-post. The primary advantage of castellated beams is the improved strength due to the increased depth of the section without any additional weight. However, one consequence of the increased depth of the section is the development of stability problems during erection. To fully utilize the engineering advantage of castellated beams, erection stability must be considered.

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## II.CASTELLATED BEAM

### A) Terminology

Throughout this paper various terms will be used to discuss castellated beam components and testing results. This section introduces the reader to the definition of these terms and Figure 1.4 illustrates the terms.

- Web Post: The cross-section of the castellated beam where the section is assumed to be a solid cross-section.
- Castellation: The area of the castellated beam where the web has been expanded (hole).
- Throat Width: The length of the horizontal cut on the root beam. The length of the portion of the web that is included with the flanges.
- Throat Depth: The height of the portion of the web that connects to the flanges to form the tee section.

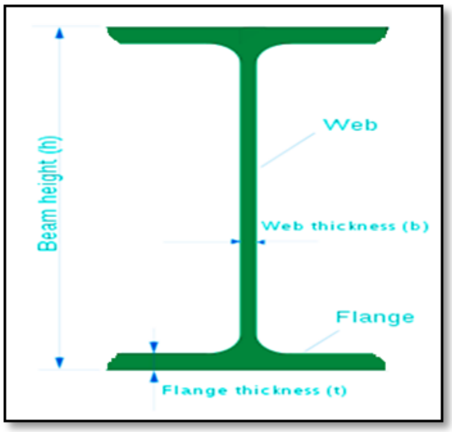


Fig – 1: Terminology

B) Fabrication of Castellated Beam and Cellular Beam

Fabrication of castellated beams is a comparatively simple series of operations when adequate handling and controlling equipment is used. Structural Steel by burning two or more at. a time, depending upon their depth. Splitting is performed by using a component of the oxy-acetylene gas cutter equipment shown in fig.5.1 This is an electrically propelled buggy which runs on a fixed track. The buggy has building burning patterns that can be adjusted to any one of live standard longitudinal "module" dimensions and to any hall-opening height.

Castellated steel beams fabricated from standard hot-rolled I-sections have many advantages including greater bending rigidity, larger section modulus, optimum self-weight–depth ratio, economic construction, ease of services through the web openings and aesthetic architectural appearance. However, the castellation of the beams results in distinctive failure modes depending on geometry of the beams, size of web openings, web slenderness, type of loading, quality of welding and lateral restraint conditions. The failure modes comprise shear, flexural, lateral torsional buckling, rupture of welded joints and web post-buckling failure modes. [2]

C) Fabrication of Fixed Support assembly

1) In this project work we have prepared a two Fixed Support assembly

2) Bottom Jaw of a Fixed Support assembly is of size 165mm x 230mm & It works of fixing to movable cross head of a Universal Testing Machine.

3) Upper Jaw of a Fixed Support assembly is of size 165mm x 170mm and it performs load distribution to the castellated beam.

4) Now by excluding distance 30mm from both side and mark it and drilled the holes of 16.5mm diameter at the center.

4) after that these two Blocks fixed such that the upper Block's comes at the middle of the Lower one.

6) Now mark the upper block at the four corner.

5) after that we drilled former holes on the Both blocks of the Fixed Support assembly.

6) Then we took found foundation Bolt of length 800 mm and gave threads to them at the top and bottom.

7) Now fixed the foundation bolt at corner holes by using threads.

8) Then we passed a steel plate through foundation bolt and tight it by using rubber pad.

9) Then lock the castellated I-Section by steel plates and rubber pad using four bolts.




D) Manufacturing

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1) In the beginning we cut the I-section into 12 pieces of 1m each.
2) Then we marked the cutting alignment to each three section of hexagonal, square, circular Resp.
3) By using gas cutter, we cut the each nine I-Beam in pre-determined pattern.
4) Then we welded the two Separated I-section face-to-face.
5) Then we observed all the un-Alignment corner parts.
6) Then we filled the un-Alignment parts by welding plates at the corner to make the stability.
7) Then test these prepared Beams on the UTM machine to gain its strengths.

III. Test setup and equipment-

1) In the beginning we performed all the initial adjustment.

2) remove all the fixtures on the lower – cross head of UTM.

3)then put cantilever fixture on the lower-cross head of UTM.

4) after that, fixed the Fixed Support assembly by using Nut-Bolt available at both side of Block.

5) Then fixed cantilever I-section between upper Block & steel plate using Nut-Bolts.

6) Then loading Assembly is fixed on the movable cross head of UTM with the I-Section.

7) put the extensometer Below the castellated I-section.

8) Then start loading taking loading assembly in the middle of cantilever beam.

9) Then noted down the result of Load & deflection.

10) Then, apply all the above step for the hexagonal, circular, square & plane castellated Beam and Note down the Result of Load and deflection.

**Analysis of fixed Beam**

Fig. Lateral torsional buckling on NPI-125 (Hexagonal)

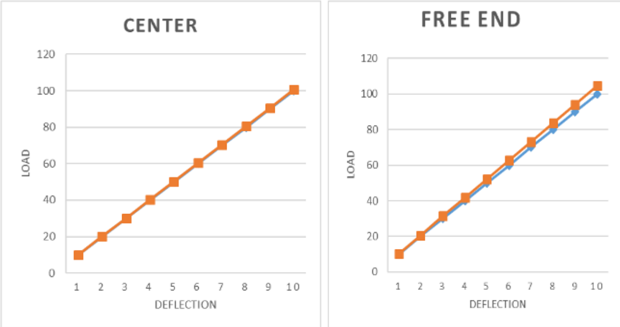


Fig. Load vs Deflection Graphics for NPI-125 (Hexagonal)

Fig. Lateral torsional buckling on NPI-125 (Circular)

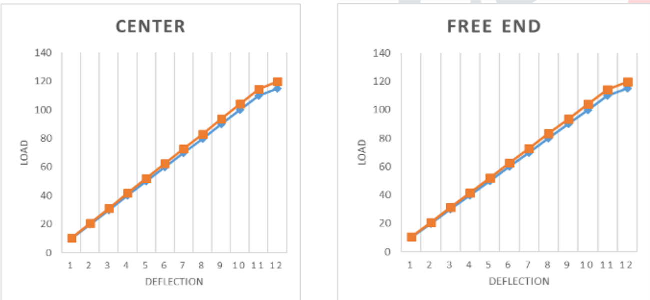


Fig. Load vs Deflection Graphics for NPI-125 (Circular)

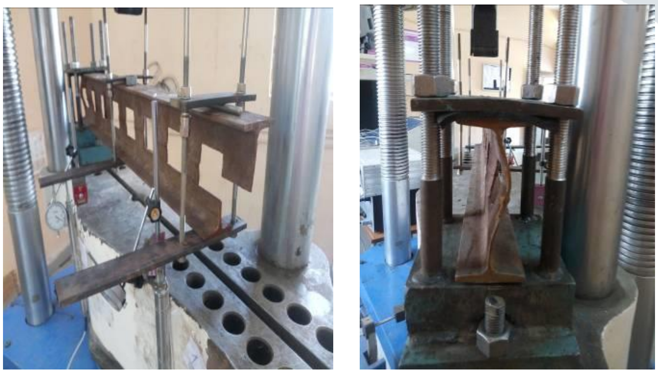

Fig. Lateral torsional buckling on NPI-125 (Square)

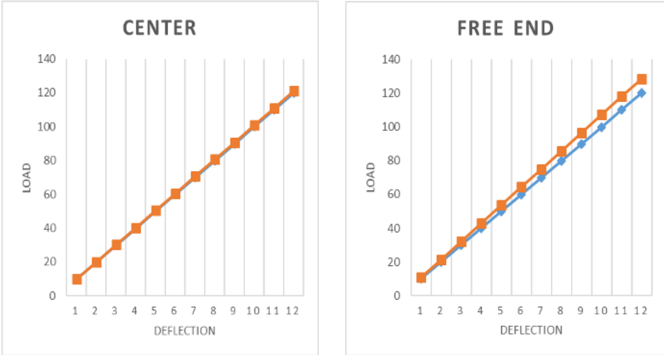


Fig. Load vs Deflection Graphics for NPI-125 (Square)

Fig. Lateral torsional buckling on NPI-125 (Plane)

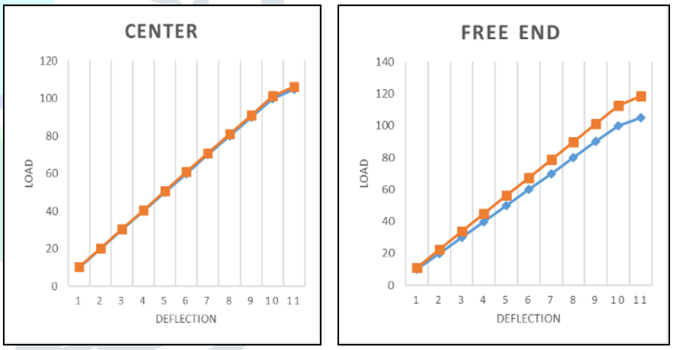


Fig. Load vs Deflection Graphics for NPI-125 (Plane)

**Analysis of fixed Beam**

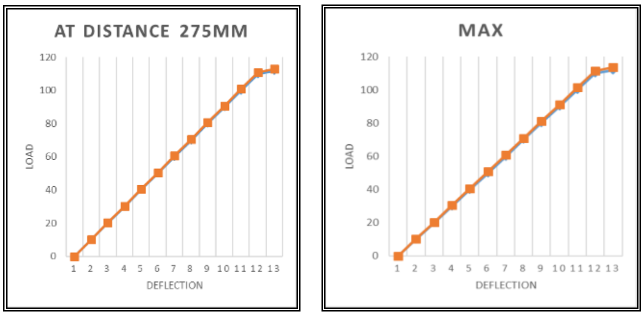


Fig. Load vs Deflection Graphics for NPI-125 (Hexagonal)

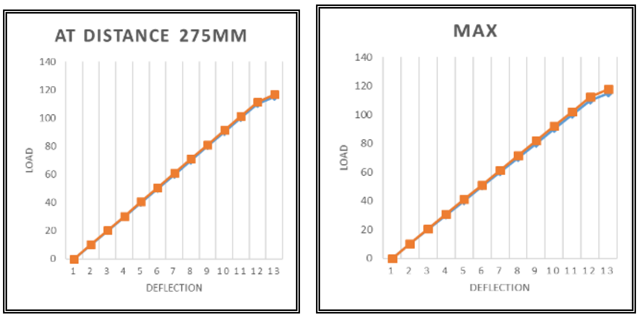


Fig. Load vs Deflection Graphics for NPI-125 (Circular)

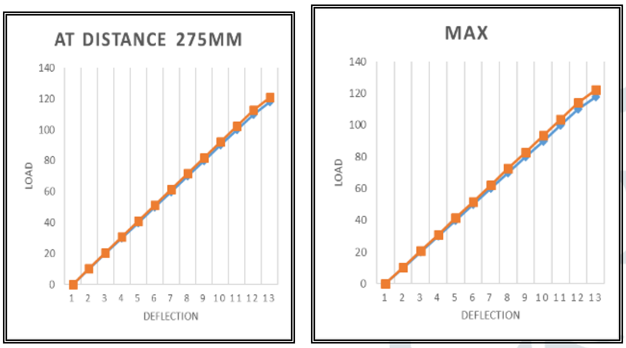


Fig. Load vs Deflection Graphics for NPI-125 (Square)

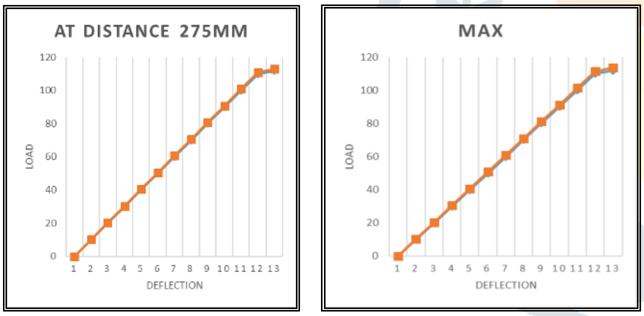


Fig. Lateral torsional buckling on NPI-125 (Plane)

## IV.CONCLUSIONS

Depth is the most important parameter which governs the sectional property of the section. For the serviceability moment of inertia plays very important role and moment of inertia of I-section is directly proportional to the third power of the depth Use of castellated beams and cellular beams for various structures rapidly gaining appeal. This is due to increased depth of section without any additional weight, high strength to weight ratio, their lower maintenance and painting cost, the principal advantage of castellated beam is increase in vertical bending stiffness, ease of service provision and attractive appearance Basically in castellated beam and cellular beam we increase the depth of the section as discussed earlier up to certain limit and under the consideration of the web shear In castellated beam to avoid local failure of beam provision of plate below concentrated load, to provide reinforcement at the weak sections of the beam, to avoid Vierendeel effect (to avoid stress concentration) corners of the holes are to be rounded are concluded. But there is not detailed study on above provisions Research on cellular beams with circular web openings is very limited and is less developed than castellated beams which may be attributed to the fact that cellular beams are more complicated to analyze due to their continuously changing section properties around the cell.

From the test analysis result of this Study the following Conclusion can be reasonably drawn-

1)The composite moment of inertia of the castellated beam section as found in catalogs.

2)The castellated beam section properties should be used to calculate the flexure strength of castellated beam.

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