Comparative Study of Sinusoidal Opening Different Fillet Radius of Castellated Beam

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Abstract - The castellated beam manufactured from its parent solid I beam by cutting it in zigzag pattern and again joining it by welding, therefore the depth of the beam increases. Hence, due to increase in depth of beam load carrying capacity of the parent I section is increased with same quantity of material. The increase in depth of castellated beam leads to web post buckling and lateral torsional buckling failure.

In this study the IS 800:2007 is used for the designing of castellated beam by using parent section ISMB150 with different openings with same length . The Experimental investigation on castellated beam is done with different opening under two point loading. The comparative study is done for the sections this castellated beam are tested for two point loading under universal testing machine.

The deflection at Centre of beam and various failure patterns are studied. Castellated beams with Sinusoidal web opening, 1/8th Sinusoidal web opening offer more load carrying capacity. The openings considered in the experimental study are standard Sinusoidal shapes like Sinusoidal web opening angle of opening with filleted radius 1/4th ,1/6th and 1/8th. Castellated beams are by and large furnished with Sinusoidal l openings in the web portion. In any case, in structural applications, suitable size and shape of openings in web are constantly a significant issue of concern.

Keywords: I Section ISMB150, Sinusoidal Castellated beam, IS code.

I. INTRODUCTION

A beam with a perforated web is called castellated beam. It is an open web beam but made up of single rolled wide flange beam section and is formed by flame cutting the beam section in the predetermined pattern and re-joining the segment by welding to produce a regular pattern of holes in web. The beam section obtained in such way can be even 50% dipper than the original section. By increasing the depth, the section modulus is increased by about 2.25 times the section modulus of the original beam section. A beam with various ordinary openings in its web is known as a castellated beam. Castellated beams have been utilized in a wide variety of uses, for example, rooftop bars and rafters in both straight forward range and cantilever development, floor beams of unbending casings, pipe spans, girts and other extraordinary applications. They likewise show the interesting appearance and the utilization of the web holes. Indeed, even the expanded profundity is on occasion worth while as on account of spandrels or other exceptional design highlights. The economy of castellated beam is one of their most important advantages. Be that as it may, the effectiveness and economy of castellated beam has been well set up and, for beams on most spans carrying medium to heavy loads, their utilization merits thought.

The exhibition of such beam has been viewed as just for vertical loads. Hot rolled steel light ISMB 150 with openings in the web were tested to failure. The beams were at the ends simply supported and subjected to a concentrated load applied at the mid-span. The openings considered in the experimental study are standard and non-standard hexagonal shapes. In any case, in structural applications, suitable size and shape of openings in web are constantly a significant issue of concern. Research work completed in advancing sizes of castellated beam, with Sinusoidal openings have detailed that castellated beam flop principally by near by disappointment modes and stress focuses at opening edges.

Castellated beams are fabricated by cutting flange of a hot rolled steel I beam along its centre line and then welding two halves so that the overall beam depth gets increased for more efficient structural performance against bending. Castellated beams with Sinusoidal openings have found widespread use, primarily in

buildings, because of great savings in materials and construction costs. The research studies report that, use of beams with hexagonal openings require smaller amount of steel material and it is also superior to cellular beams from the cost point of view.

II. PROCEDURE

Types of castellated beam -

Castellated beams are generally classified on the basis of type or shape of perforations made in the web of beam. Based on the shape of the opening the various types of castellated beams are shown figure.

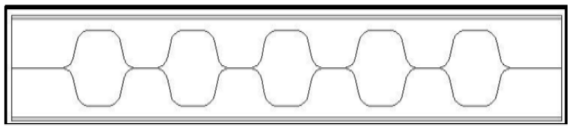

Figure No.1 Castellated Beam with Sinusoidal Shaped Opening

METHODOLOGY

[Analysis and Design of Castellated Beam as Per IS 800:2007]

This chapter describes the methodology of this project the main topics included in this chapter are study of material, selection of suitable section, section properties, fabrication of test specimens, testing of specimens .

1. Study of material - Study of material is about the gaining of general ideas and knowledge about the materials using in the project. It also includes study of the terms involved in the project. It consists of the general study about steel, properties, advantages, applications and castellation techniques details etc

2. Selection of suitable section - The suitable section selection is nothing but identifying the most suitable section of beam required for the project from literature reviewed. The section is designed and analyzed by the limit state method. ISMB150 is selected as a parent section for fabricating castellated beam.

3. Process of fabrication of castellated beam -The fabrication of castellated beam is comparatively simple series of operations when adequate handling section on side only.

I) Cutting- This is the first step of process of fabrication. In this process of web of a rolled section is cut in Zigzag pattern, generally with advanced cutting systems in conjugation with CNC-controlled cutting heads. On small scale it is done with the help of Gas Cutter.

Figure No.2 Sinusoidal cutting of castellated beam

II) Welding- Lastly welding of the web post back together at the high points is carried out with an automated submerged arc welding process.

Figure No. 3 Welding of castellated beam

III) Grinding -

Grinding is used to finish work pieces that must show high surface quality (e.g., low surface roughness) and high accuracy of shape and dimension. As the accuracy in dimensions in grinding is of the order of 0.000025 mm, in most applications it tends to be a finishing operation and removes comparatively little metal, about 0.25 to 0.50 mm depth. However, there are some roughing applications in which grinding removes high volumes of metal quite rapidly.

Figure No.4 Grinding of castellated beam

IV) Colouring – It's last part of castellation of the entire beam because it is good finishing and attractive surface of this beam. It is also helping the easily naming on the beams with help of marker.

Figure No.5 Colouring of Sinusoidal castellated beam

4. Testing of specimen

1. Parent shape web openings having 1.7490m length of each specimen.
2. Sinusoidal shape web openings angle of opening with filleted radius 1/4th having 1.7490 m length.
3. Sinusoidal shape web openings angle of opening with filleted radius 1/6th having 1.7490 m length.
4. Sinusoidal shape web openings angle of opening with filleted radius 1/8th having 1.7490 m length.
5. Method of testing specimen

By two points loading in Universal Testing Machine

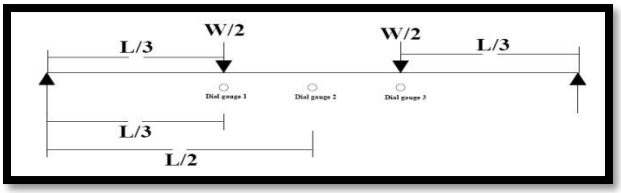

Figure No.6 Testing of the castellated beam

6. Experimental program

ISMB150 section chosen as the parent element for manufacturing castellated beam . The Castellated beams are fabricated such that the depth of the beam is 1.5 times the original depth 225mm. Thickness of flange is 8 mm, thickness of web is 5 mm, depth of opening is 150 mm, and Length of the beam is 1750 mm. Universal testing machine (UTM) is used for testing the castellated beam. below figures shows the schematic diagram of parent section, castellated steel Beam with Sinusoidal opening used for the analysis.

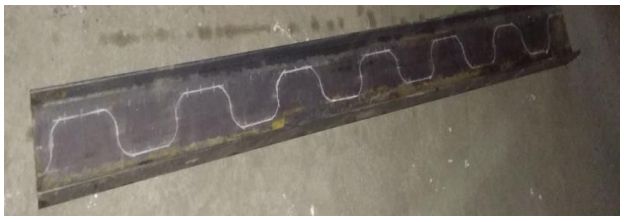

Figure No.7 Before Cutting Parent Section Marking Sinusoidal opening

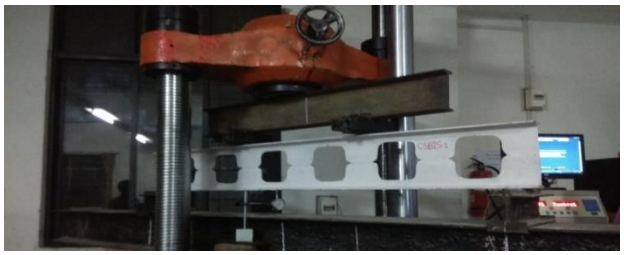

Figure No.8 Testing of 1/6th Sinusoidal Castellated Beam

III. EXPERIMENTAL RESULTS

Table No.1 Experimental Result obtained Parent section Length of Specimen= 1.7490 M

Sr. No.	Load (kN)	Deflection(mm)	Remark
1	0	0	
2	10	1.2	
3	20	2.5	
4	30	3.4	
5	40	4.0	
6	50	5.5	
7	60	6.7	
8	70	7.3	
9	75.6	8.5	Failure

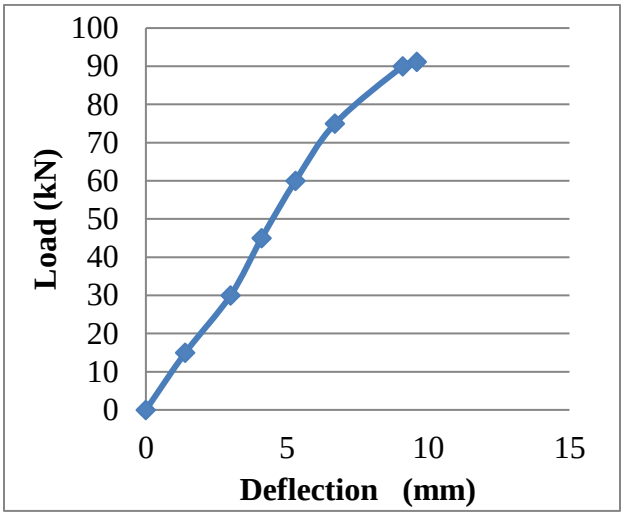

Figure No. 9 Load Vs Deflection for Parent section

From Fig. 9 and table no.1 it is concluded that the parent section takes maximum load of 75.6 kN and the deflection at this load is 8.5 mm. For this load and deflection beam fails.

Table No.2 Experimental Result Obtained Section with Sinusoidal web opening angle of opening with filleted radius 1/4th

Length of Specimen= 1.7490 M

Sr. No.	Load (kN)	Deflection(mm)	Remark
1	0	0	
2	10	0.3	
3	20	1.6	
4	30	2.3	
5	40	3.0	
6	50	3.7	
7	60	4.4	
8	70	5.4	
9	80	6.7	
10	90	9.3	Failure

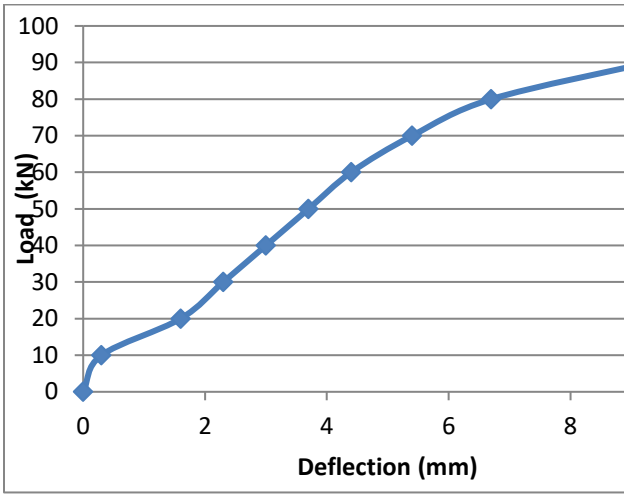

Figure No. 10 Load Vs Deflection for with Sinusoidal web opening angle of opening with filleted radius 1/4th From Fig.10 and table no.2 it is concluded that the Sinusoidal 1/4th section takes maximum load of 90 kN and the deflection at this load is 9.3 mm. For this load and deflection beam fails.

Table No. 3 Experimental Result Obtained Section with Sinusoidal web opening angle of opening with filleted radius 1/6th

Length of Specimen= 1.7490 M

Sr. No.	Load (kN)	Deflection(mm)	Remark
1	0	0	
2	10	0.9	
3	20	2.0	
4	30	2.7	
5	40	3.3	
6	50	4.0	
7	60	4.8	
8	70	5.7	
9	80	6.8	
10	90	8.8	
11	92.8	10.2	Failure

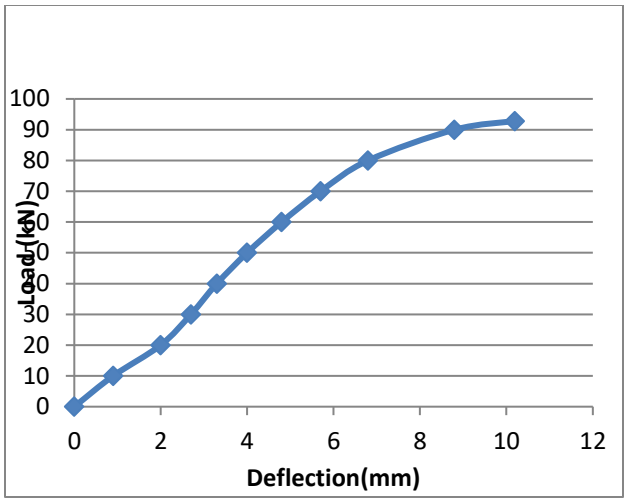

Figure No. 11 Load Vs Deflection for with Sinusoidal web opening angle of opening with filleted radius 1/6th From Fig.11 and table no.3 it is concluded that the Sinusoidal 1/6th section takes maximum load of 92.8 kN and the deflection at this load is 10.2 mm. For this load and deflection beam fails.

Table No. 4 Experimental Result Obtained Section with Sinusoidal web opening angle of opening with filleted radius 1/8th,

Length of Specimen= 1.7490M

Sr. No.	Load (kN)	Deflection(mm)	Remark
1	0	0	
2	10	0.5	
3	20	0.9	
4	30	2.0	
5	40	2.6	
6	50	3.3	
7	60	4.0	
8	70	4.8	
9	80	5.7	
10	90	7.1	
11	93.2	8.2	Failure

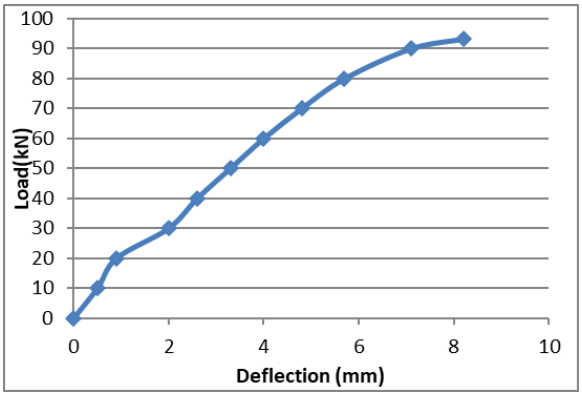

Figure No.12 Load Vs Deflection for with Sinusoidal web opening angle of opening with filleted radius 1/8th

From Fig. 12 and table no. 4 it is concluded that the Sinusoidal 1/8th section takes maximum load of 93.2 kN and the deflection at this load is 8.2 mm. For this load and deflection beam fails.

- Future Scope: This research is extended by considering the different lengths of opening, height of opening, changing depth of beam. By considering above dimensional variation, it can be possible to find optimum load carrying capacity of castellated beam. Comparative study of different shapes opening experimentally Result and Software Result.

IV. CONCLUSION & DISCUSSION

- Sinusoidal web opening angle of opening with filleted radius 1/4th ,1/6th and 1/8th shows a larger load carrying capacity as compared to a Parent element.
- Compare Sinusoidal web opening, 1/8th Sinusoidal web opening gain the more load carrying capacity as compared to Sinusoidal web opening angle of opening with filleted radius 1/4th ,1/6th.
- Experimentation shows that Sinusoidal web opening angle of opening with filleted radius 1/6th after failure mode more deflection other than to Sinusoidal web opening angle of opening with filleted radius 1/4th and 1/8th.
- Analytically after castellation more M.I and depth of beam than parent element ISMB150.

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