

# Behavior of Castellated Beam with Sinusoidal Openings

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**Abstract** - In this study analysis of castellated beam with sinusoidal opening has been done. Castellated beam has analyzed using Abaqus software as well as experimentally. Two-point load test has been conducted and the same loading has been given in the software. Deflection of beam has been found using software as well as experimental work and results are compared.

**Key Words:** castellated beam, sinusoidal opening, web opening, steel beam analysis

## 1. INTRODUCTION

Before castellated beams, I-beams were used in construction because they are strong and sturdy way of supporting houses and other industrial structures. Castellated beams were developed as structural channels to increase the beam's depth of parent I-beam and strength without adding additional material causing no change in weight.

Since the 1950, because of shortage of steel and increase in cost of steel castellated beams have been used in the construction. After study it was found that these beams save the cost and also give high strength to weight ratio.

Castellated beams have many advantages over parent I beam. Castellated beams are light in weight and cheap in construction. These beams can be easily assembled on site. Opening in beam gives many advantages. Some of the advantages are pipes and ducts can be easily passed through these opening. Secondary constructional element also can be passed or installed such as ceiling system. Another major advantage of castellated beams that they are aesthetically very good. Many architectures prefer the castellated beams at the position where the beams are clearly visible. For aesthetic beauty these beams are rated very high. There are different types of shapes of castellated beams that are available in the market. Different sections showing variations in the shape are as below.

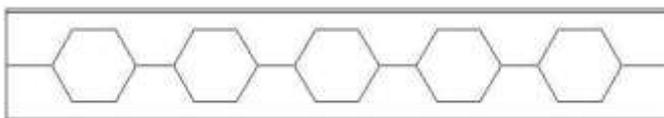


Fig- 1: Hexagonal Castellated Beam

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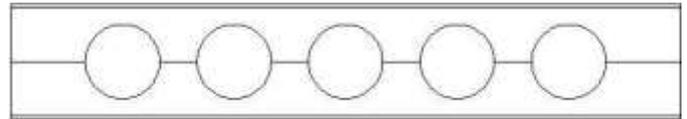


Fig -2: Cellular Beam

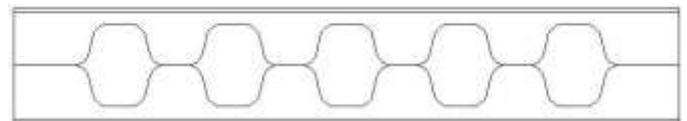


Fig-3: Sinusoidal Shape Castellated Beam

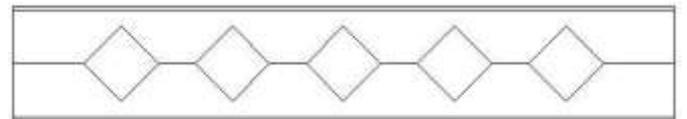


Fig-4: diamond shape castellated beam

## 2. MODELING OF CASTELLATED BEAM

Modeling of castellated beam has been done in Abaqus software. For modeling ISMB 100 Beam has been taken.

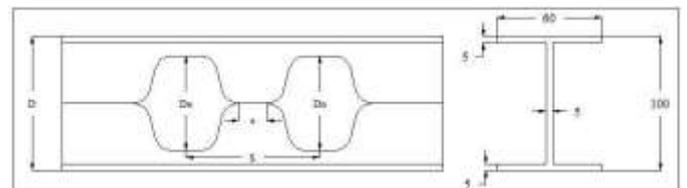


Fig-5: Typical Castellated Beam with its Cross Section.

Where,

Do= Depth of opening provided

D=Overall depth of the opening

S= Centre to Centre spacing between the two opening

e= Clear distance between two opening

b= Width of flange of I beam

tf= Thickness of flange of I beam

tw= Thickness of web of I beam

### 3. ANALYSIS

Analysis of castellated beam has been done by using abaqus software.

#### 3.1 ASSEMBLY OF MODEL

It is important to do the assembly of the model in case of complicated structure. In assembly module create instance by selecting dependent type. In next step module create step to fix analysis as static general which will perform bending analysis of structure.

#### 3.2 LOADING & BOUNDARY CONDITION

In load module concentrated load has been applied and boundary conditions have been applied by selecting proper edges. The model of castellated beam along with loading and boundary condition is shown in Fig 6

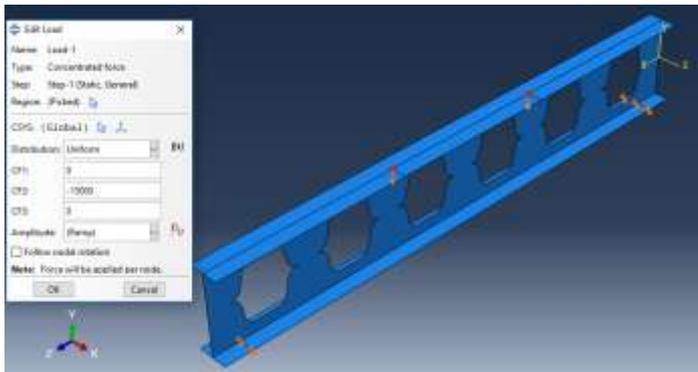


Fig- 6: loading and boundary conditions.

#### 3.3 MESHING OF MODEL

Meshing is the most important parameter in FEM in Abaqus, it is very important to select proper mesh size and type of element to get accurate results. In case of castellated beam select the Quad-dominated structured element. Which is S4R doubly curved shell element, which will give accurate results in case of castellated beam with sinusoidal perforations.

### 4. FABRICATION OF CASTELLATED BEAM

Castellated beam has been derived from the I beam having depth 100 mm. the sinusoidal pattern has been created by using machine i.e. profile cutter. For that first the detailed drawing has been made. In case of profile cutting, cutting profile has to draw on software with the real scale. The machine of profile cut is consisting of two sections. In the first section, cut profile is scanned by scanner of profile cut machine and in the second section, as per scanned profile of cut the simultaneous cutting is done on the other part of machine.



Fig- 7: Drawing of pattern

### 5. TEST SETUP

Two-point loading set up is prepared in the laboratory. Actual set up in the laboratory is shown in the Fig-8 for sinusoidal shaped castellated beam and to measure the deflection at central point, dial gauge is attached to lower flange. The loading is applied by 1000 KN universal testing machine (UTM).



Fig- 8: Test setup for castellated beam with sinusoidal opening.

### 6. RESULTS

Sr. No.	Deflection by Software Method in mm	deflection by Experimental method in mm	Difference in deflection in mm	% Error
1	1.170	1.172	0.002	0.18

1. Failure Load by Von- Misses Criteria=20000N
2. Stress by Von- Misses criteria =229 N/mm<sup>2</sup>

### 7. CONCLUSIONS

- From above analysis it is observed that, the deflection obtained from software result is 1.170 millimeter. While deflection from experimental result is 1.172 millimeter.
- Percentage variation in above case is almost negligible, that is 0.18 percent.
- It is observed that, software method can be applicable for analysis of castellated beams.

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