Structural Analysis and Design of Different types of Castellated Beam

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Abstract - *Castellated beams used as roof beams and rafters in both simple span, floor beams and girders for heavy and light floor loads, tier buildings, rafter portions of rigid frames, pipe bridges, girts and other special applications.*
The advantage of castellated beam is increased strength and the economy. They also demonstrate the interesting appearance and use of the web holes. The increased depth is at advantageous as in the case of spandrels or other special architectural features.

Use of Castellated beam for different structures rapidly getting acknowledment. The result due to increased depth of section without any addition of weight, strength to weight ratio, their maintenance and painting cost is low. Stress concentration due to occurs near the perforation as well as the shear carrying capacity is reduced is the limitation of castellated beam. Stress is reduced by making perforation near the neutral axis stresses are negligible

Key Words: Stress, Castellated beam, Girders, Strength, Rafter, Tier buildings, Preformation, Shear.

1. INTRODUCTION

A beam is increased depth without increasing weight and strength is called as castellated beam. It also increased moment of inertia of that section. Castellated beam is used in construction for many years. Today with the improvement of automated cutting and welding equipment, these beams are produced in a maximum number of depths and spans. These beams suitable for both light as well as heavy loading conditions. In the past the cutting angle of castellated beams ranged is 45° to 70° but the present 60°is become standard cutting angle. It should be consider these are approximate values. Actual angles will change slightly from other geometrical requirements. As roof and floor beams joints and purlins, these sections is change solid sections and truss members. Their attributes produce an attractive architectural design feature for workshops, colleges and public buildings. Castellated beams refer to the type of beams which include expanding a standard rolled steel section .The two halves are connected each other by welding or the high points of the web pattern are connected to form a castellated beam. The castellated beams were commonly used in roof beams and rafters in both simple span, floor beams and girders for heavy and light floor loads, tier buildings, rafter portions of rigid frames, pipe bridges, girts and other special applications.

1.1 Fabrication of Castellated beam

Fabrication of castellated beams is simple series of operations when handling as well as controlling equipment is used. Structural steel is made up by burning two or more section at a same time, depending upon their depth. By using a component of the oxy-acetylene gas cutter equipment, steel section is joined. This equipment is an operated electrically propelled buggy which runs on a fixed track. Castellated steel beams fabricated from standard I-sections have many advantages including self-weight–depth ratio, greater bending rigidity, economic construction and architectural appearance. However, the castellated beams results depending on quality of welding, geometry of the beams and the types of loading condition. Hence the behavior of normal and high strength castellated steel beams under combined buckling modes including web post buckling is also considered in this study.

Fig 1. Coloring on Wood

2. DESIGN OF CASTELLATED BEAM

1. The angle of cut is selected to be 45 for a good design the depth of stem of the t-section at the minimum beam cross-section should not be less than by 4 of the original beam section.
2. The load over the section from the roof is a curtained and the maximum bending moments are computed.
3. The cross sectional area of the t-section at the open

throat is calculated. Neutral axis of the section is determined and moment of inertia about the neutral axis is calculated.

4. The moment of resistance of the castellated beam which is the product of the resultant tensile or compressive a force and the distance between the centroid of T-section is calculated.

$$M.R = \sigma_{at} \times d$$

Where,

A = area of the T section at open throat

D = distance between the centroid of T section

The moment of resistance of the castellated beam should be more the maximum moment.

5. The spacing of castellated beam should not exceed the spacing determined by following equation

$$S = P/ W\times l$$

Where S= c/c distance between the castellated beam in meter.

P = net load carrying capacity in N

W = design load in N / m^2

l = span of the in meter

6. Stiffeners are designed at the supports and below the concentrated loads.

7. The beam is checked in shear. The average shear at ends is calculated from following equation

$$\tau_{va} = R/d \times t$$

$$< 0.4\ FY$$

Where, R = end reaction in N

d = depth of the stem of T section

t = thickness of stem

8. The maximum combined local bending stress and direct stress in T Segments is also workout and should be less than the permissible bending stress.

9. The maximum deflection of T Segment is calculated. This occurs at the mid span is due to the net load carrying capacity load capacity.

Let, δ_1 = deflection due to net load carrying capacity

δ_2 = deflection due to local effects

I = average moment of inertia of the section

I_T = moment of inertia of T section

P = number of perforation panels in half span

$$\delta_1 = \frac{5WL^3}{384EI}$$

$$\delta_2 = \frac{VavgP(m+n)^3}{24EI_T}$$

$$\delta = \delta_1 + \delta_2 < L/325$$

Fig 2. Cutting for Wooden Section

APPLICATIONS AND ECONOMY

Castellated beams is used in various types of applications such as girders and rafters in both simple construction and cantilever spans, roof beams and floors beam for heavy or light floor loads, tier buildings and workshops, low cost houses, pipe bridges, girts and other special architectural applications. These advantages of castellated beams are increased strength and the economy. They also demonstrate the good appearance and the functional use of the web holes. Even the increased depth is advantageous as in the case of spandrels and other special architectural features. The economy of castellated beams is one of their most important advantages. The savings affected depend on such factors as span, loading and depth requirements. Even the castellated beam is an ideal choice for many situations, it would be wrong to contend that it is the best solution for every case. There are some instances in which span are too small, the load too short and the depth to bring out the economy of castellated beams. The efficiency and economy of castellated beams have been well established for beams on most spans carrying by medium to heavy loads. The castellated Beam has long span capacities or vibration characteristics than other structural floor framing materials.

3. CONCLUSIONS

A beam is increased depth without increasing weight and strength is called as castellated beam. It also increased moment of inertia of that section. The depth is the most important parameter which depends on the property of the section. The moment of inertia plays very an important role and moment of inertia of I-section is directly proportional to the third power of the depth. Use of castellated beams for different structures rapidly gaining. This is due to increased depth of section without increasing weight, strength to weight ratio, their maintenance or painting cost is low. The principle of castellated beam is increase in vertical bending stiffness and the depth, ease of service provision and attractive appearance. In castellated beam to avoid stress concentration corners of the holes are to be rounded are concluded.

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