Design and Analysis of Perforated "I" Section Beam

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Abstract – *The main aim of perforated beam is to increase the depth of the section so it will automatically increase the moment of inertia. A perforated beam is a type of I section beam which is longitudinal cut along its web post and it is divided in two parts and rejoin. The perforated beam is having only three shapes which is Circular, Hexagonal, Square shape and We are generating a new shape which is Pentalpha, Monogram, Pinnacle, Pixshark. We have to increase a depth of the section without increasing the weight of beam. Stress concentration occurs near the perforation and the shearing capacity is reduced, then we have to reduced stress by forming a perforation near the neutral axis then the stresses are negligible.*

Key Words: **Pentalpha, Monogram, Pinnacle, Pixshark**

1.INTRODUCTION

The perforated beam is concept which increased the depth and also strength of the section with its original weight. It also increase the moment of inertia parameter. Now a days due to advancement in cutting technology and welding equipment it is possible to create a maximum number of depths and spans. This perforated beam is suitable for light and heavy loading condition. In a past days cutting angle for perforated beams is taken in ranged between 45^0 to 70^0 but now a days 60^0 angle is become standard cutting angle. These beam having not only higher bending moment capacity but also suitable for passing the service wires, pipes, ventilating ducts through opening. The perforated beams is also improve the load carrying capacity.

2. METHODOLOGY

2.1 Fabrication of Perforated Beam

Fabrication of castellated beam is comparatively common operations when capable handling and controlling equipment is used. For these fabrication oxy-acetylene gas cutter machine is used, following are the steps of fabrication:

i. In a market only 12m and 6m I-section beams are available.

ii. In the beginning we have cut the I-section into number of pieces we should required.

iii. Then we have marked the cutting alignment to the web portion of the section.

iv. By using gas cutter we have to cut the I -beam in pre-determined patterns.

v. Then we have to weld the two separated I-section face to face.

vi. Then we have observed all the un-alignment corner parts.

vii. Then we filled the un-alignment parts by welding plates at the corner to make stability.

viii. Then test the prepared beams on the UTM machine to gain strengths.

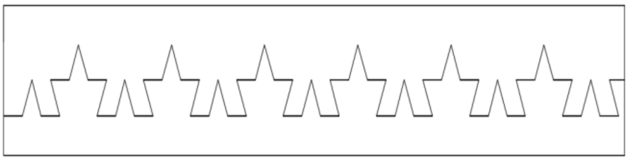


Fig 2.1.1 Marking Pentalpha Perforated beam

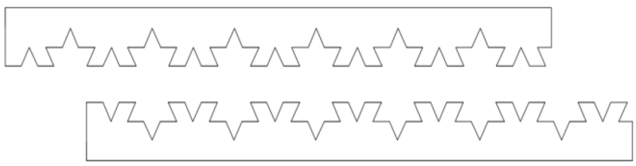


Fig 2.1.2 Cutting Pentalpha Perforated Beam

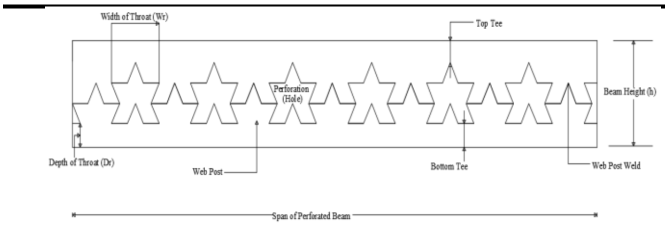


Fig 2.1.3 Final Pentalpha Perforated Beam

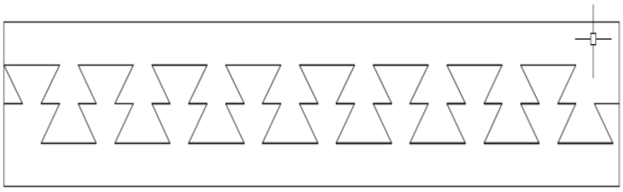
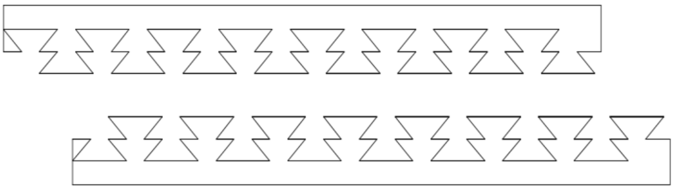


Fig 2.1.4 Marking Monogram Perforated Beam



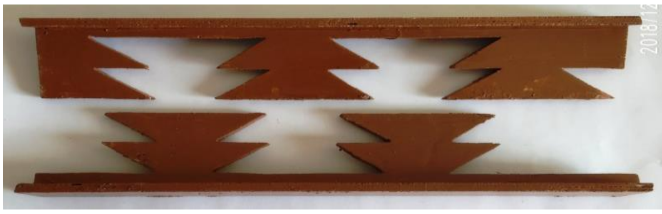


Fig 2.1.5 Cutting Monogram Perforated Beam

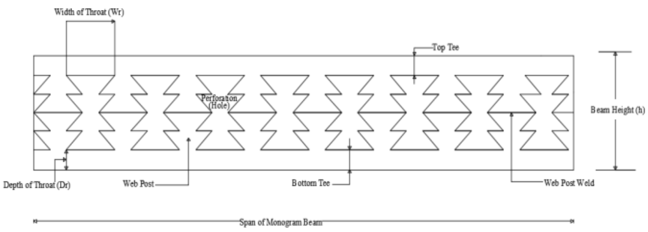


Fig 2.1.6 Final Monogram Perforated Beam

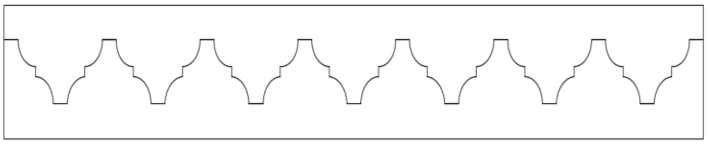


Fig 2.1.7 Marking Pinnacle Perforated Beam

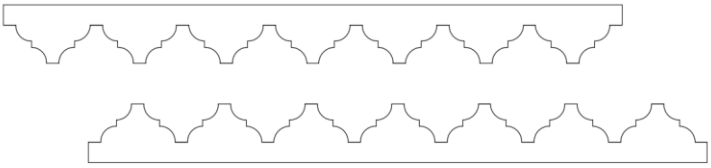


Fig 2.1.8 Cutting Pinnacle Perforated Beam

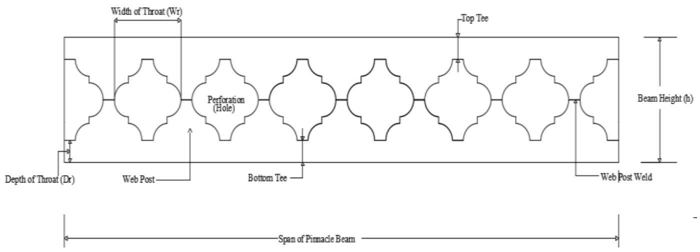


Fig 2.1.9 Final Pinnacle Perforated Beam

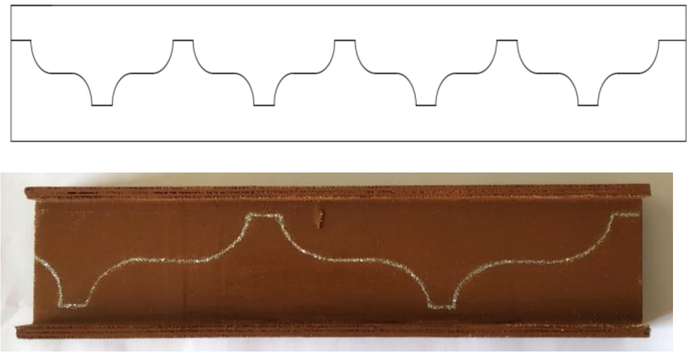


Fig 2.1.10 Marking Pixshark Perforated Beam

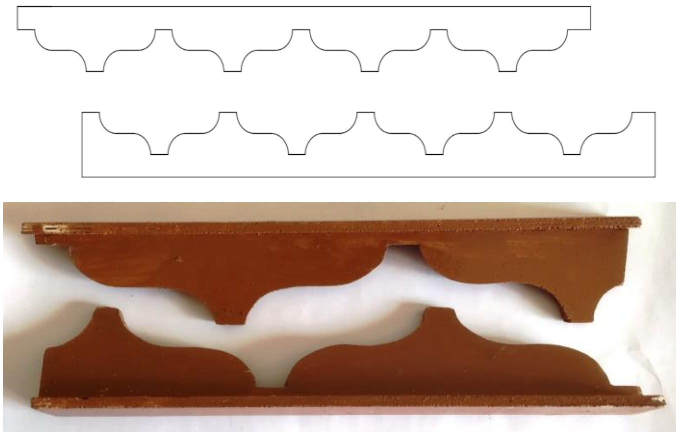


Fig 2.1.11. Cutting Pixshark Perforated Beam

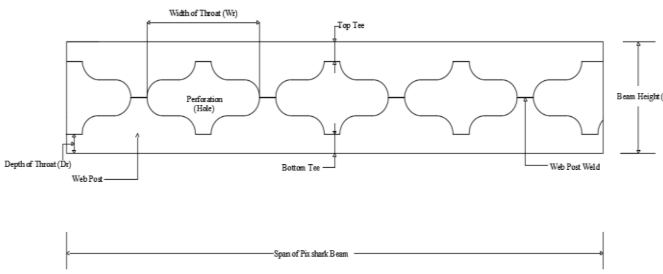


Fig 2.1.12. Final Pixshark Perforated Beam

2.2 Failure Modes in castellated Beams

2.2.1. Vierendeel or shear mechanism-

This modes are created with high shear force acting on beam of formation of plastic hinge at reentrant corner of holes deform Tee section above the opening in parallelogram shape. Beams with shorter span with shallow Tee section and larger weld length are susceptible to mode of failure. when a perforated beam is subjected to shear, the tee section above and below the opening must carry applied shear, as well as the primary and secondary moments. The primary moment is the conventional bending moment on the cross section of beam and the secondary moment, also known as vierendeel moment result from the action of shear forces in the Tee section over the horizontal length of opening, so the horizontal length of the opening decrease, magnitude of the secondary moment will decrease. Means in shortly this mode of failure is mainly occurs at the opening under the greatest length of opening. If flanges and webs of opening are sufficiently stocky, full yield occur in them, allowing a plastic vierendeel type of mechanism is develop.

2.2.2. Flexural mechanism-

The Tee section above and below the opening yield in tension and compression until they become fully plastic. yielding in tee sectors and below the opening of perforated beam is similar to the solid beam under pure bending forces, so the maximum in-plane carrying capacity of perforated beam under pure moment loading was determined to full section plastic modulus taken through the vertical centerline of hole.

2.2.3. Lateral-torsional buckling-

In the design of the flexural members, the ratio to width to thickness of some beams does not meet the compression requirement. In addition lateral supports may not be placed in the appropriate intervals. most of the beams are constructed by thin plates cannot be considered as compact section since rolled steel I-section and perforated beams have been used. if the beam length between two supports can be exceed a given threshold, compression flange become unstable and tends to buckle laterally prior to reaching the maximum flexural strength, so the moment of inertia around the x-axis should be much greater then that of around the y-axis. Due to low moment of inertia around the y-axis in the beams with high distance between lateral supports can increase the lateral bending in compression flange and torsion in the tee section. It means if the compression flange is not properly braced laterally then the possibility of sudden failure of compression flange is increase, and this type of failure resulting from increase the increase compression stress flange due to the beam bending and lateral bending due to lack of laterally bracing is called lateral torsional buckling.

2.2.4. web-post buckling-

The horizontal shear force in web post associated with double curvature bending over the height of post.one inclined edge of the opening will be stresses in tension, and the opposite edge is the compression and buckling will cause the twisting effect over the web post along its height.

3. APPLICATIONS

i. The perforated beam is used for various applications like roof beams and rafters in both simple span and cantilever construction, floor beams and girders for heavy also light floor loads, tier building, rafter portion of rigid frames, pipe bridges, girts etc..

ii. The economy of perforated beam is one of their most significant advantages
iii. They also illustrate the interesting appearance and the functional use the web holes.
iv. There are several applications for which a smart beam can be economically used, they all have frequent characteristic. These use combined applications and longer than traditionally used spans.
v. The beam has better long span capacity and vibrations stability than other structural floor framing materials.
vi. It is light weight and eco-friendly structure
vii. Simple in design and simple trouble-shooting

4. CONCLUSIONS

The depth is the most important factor, the moment of inertia plays a very influential role. Due to the increase in depth without increasing its original weight the perforated beam is quick gaining appeal. The principle benefit of perforated beam is increase in vertical bending stiffness, comfort of service provision and pleasant appearance. To neglecting the vierendeel effect corners of the holes are to be rounded. Research on perforated beam with circular web opening is very restricted and is less developed than perforated beam which may be indication to the fact that cellular beam are more difficult to analyze due to their continuously changing section properties around the cell.

ACKNOWLEDGEMENT (Optional)

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