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EXTENDED ABSTRACT

Numerical Investigation on the Behavior of Castelated Plate Girders

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Castellated Beams, Cellular Beams, Design Variables, Plate Girder, Finite element method.

1. Introduction

In the Civil Engineering field, we have to search a structure with lower weight and cost, to reach minimal energy and materials. Since using of Cellular and Castellated Beams can provide higher bending strength and stiffness without increasing the weight of the structure, therefore, in the recent years, they have lionized by most researchers. In some structures like bridges, in order to large stiffness and high strength, we have to use special beams with large dimensions and height. On the other hand, to solve this necessity, it is not possible to use hot-rolled Castellated Beams. So Castellated plate girders can be used. In this paper, it is denoted that castellated plate girders can be used in long spans as a convenient choice.

2. Methodology

2.1. Design criteria

Before starting numerical investigation on the behavior of these beams, we have to introduce a practical way to cut the W-sections and produce them. The proposed method of cutting and producting cellular and castellated beams has been shown in the article.

For designing of these beams, it is necessary to consider their strength and serviceability. So the geometrical parameters of cellular and castellated beams like length between the holes and number of them, the interaction of flexure and shear effects, vertical and horizontal shear, compression stress on the web, local buckling effect and displacement limitations have to be considered. The design procedure given here is taken from (AISC-ASD).

2.2. FEM model of numerical example

The FEM-based software, Abaques, is used for the numerical modeling and analysis. In this process, the behavior of castellated plate girders will be investigated. So, castellated web plate with circular and hexagonal holes, length of 8 m, and pinned joints at its two ends which are respectively subjected to distributed loads of 8.5 kg/cm^2, 12.75 kg/cm^2 and 22 kg / cm^2, is used. All of restrictions are applied in accordance with the AISC-ASD. Results of analysis are summarized and presented in Tables 1 and 2.

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Table 1. Numerical results of castellated plate girders

Loading (kg/cm^2)	maximum deflection (cm)	Maximum of stress (kg/cm^2)
8.5	0.652	2400
12.75	1.07	2400
22.5	3.22	2400

Table 2. Numerical results of castellated plate girders

Loading (kg/cm^2)	maximum deflection (cm)	Maximum of stress (kg/cm^2)
8.5	0.356	2400
12.75	0.786	2400
22	2.94	2400

3. Results and discussion

Considering the results under the effects of distributed loads, it is seen that by increasing the loading rate, the maximum deformation also enhances, and the maximum deflections occurs at the middle part of the beam. In addition, the deformation rate in cellular beams is lower than castellated one's. By investigation of stress contour, it can be concluded that near supports areas are failure candidates.

4. Conclusions

By investigation of this type of beams. It can be seen that in the castellated beams, the sharp corners of near supports holes are failure candidates. Also, a focus of stress and yielding can be noticed. In addition, results observe that under the larger load in a castellated beam, due to the presence of a hole, a mutation of deformation values was created. The reduction of the cross section inertia can be afforded mentioned phenomena. It should be noted that, in the cellular beams, deformations are lower than castellated one's, and more appropriate cross-sectional shape can provide that the smaller part of the cross sections reaches to yield stress.

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