

A Review Paper on Design and Structural Analysis of Simply Supported Gantry Crane Beam for Eccentric Loading

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Abstract - *The study incorporates an examination of the accordion effects such as stresses, deflection, shear limit and lateral-torsional buckling presence in regular I section simply supported gantry crane beam subjected to a consistently uniform distributed (self-weight) and an aggregated load at the intermediate section of the beam. The lateral torsional buckling and bending are the main failure mode that controls the design of a beam. Diverse states of simply supported beam is proposed in this study with distinctive cross area, web shapes and materials. Structural analysis and test study are completed on both sorts for customary and proposed beam to ascertain and approve results. An enhancement system is utilized to advance the arrangement over regular I section beam. FEA software is the most efficient tool to carry out structural analysis is done to examine the influence of the section dimension due to point load at middle span and uniformly distributed load on beam. Using the study it is observed that not only the web thickness, but also the shape of web and cross section of beam influences the resistance accordion effects.*

Key Words: *Gantry crane beam¹, lateral torsion buckling², structural analysis³, etc...*

1. INTRODUCTION

Beams are basic components produced using steel material, while extremely proficient as far as the auxiliary quality and firmness to weight proportions can be powerless to profoundly complex shakiness marvels. Presently days in industry to conveying high ton limit of burden different types of material handling equipments like cranes are use which comprises of lifting system slides over the crane beam. The expansive overwhelming burden directed by beam causes accordion impacts because of which trolley conveying a heap stuck up at the focal point of a crane. To defeat these major issues joined

arrangement is required to diminish these impacts. A few arrangements must be fused to take out the above issues, for example, to receive propelled outline way to deal with increase enough quality to lessen accordion impacts produce in beam amid conveying a substantial load.

The basic steel beam must have adequate strength to oppose the clasping, unreasonable diversion, vibration and crumbling of weakness quality. Regularly numerous stiffeners are altered with I-channel beam to expand the strength and solidness of the structural steel beam which additionally build the expense of creation and support. Thus, to conquer the constraint different sorts of steel beam need to create and analysed experimentally and numerically to evaluate their auxiliary execution. I segment beam stiffeners are utilized is replaced by tapered with trapezoidal web I channel which build the quality and diminish the avoidance and clasping of the structure.

Accordingly the study displays the progressed altered outline approaches by investigating and creating tapered with trapezoidal corrugated web steel beam. There is an expanding enthusiasm for the steel beam with the ridged web is subjected to unpredictable stacking is enhanced stability as contrast with the customary standard web I channel beam.

When uniformly distributed load and load with self load of beam both combine applied over the long length of the beam shear, bending and different types of stresses is induced, loads are applied over the long span of the simply supported I section beam which causes Failure in beam.

1.1 Failures occurs in simply supported beam

A. Lateral Torsion Buckling

At the point when a connected load causes both lateral displacement and twisting a member lateral torsional buckling has occurred. The relocations and revolutions portray the disfigurement of the beam axis, and the

displacements in the cross-segment are immediate identified with the twisting of the beam axis.

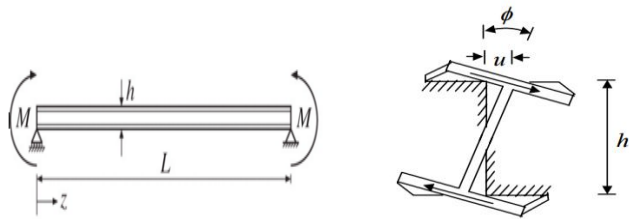


Fig -1: Laterally buckled I section

At the point when consistently concentrated load and uniform distributed load (self weight) both act over the beam are stacked in twisting about their solid axis, instability can happen because of clasping of the top some portion of the beam that is under pressure. Since the base part is in strain, it will offer some imperviousness to the parallel developments of the compacted upper part. This results in a combined lateral and torsional movement of the beam. This phenomenon is known as lateral-torsional buckling. Lateral torsional buckling is one of the important failure modes for crane beams.

B. Lateral Bending and Deflection

The bending force impelled into the material of the beam as a result of the external loads, span, own weight, and external to these loads is called a bending moment. Beam hypothesis demonstrates that I sectional area is an exceptionally effective structure for conveying both bending and shears loads into the plane of the web.

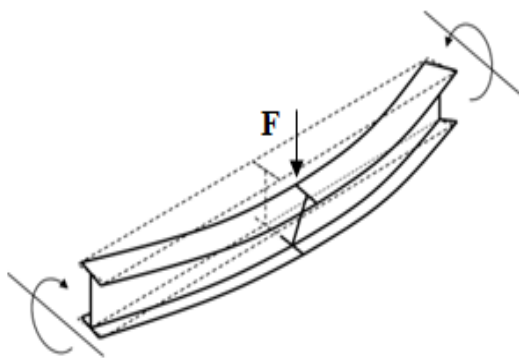


Fig -2: Lateral bending in I section

Bending of beams when a beam experiences a bending moment it will change its shape and internal stresses will be developed. The applied vertical load results in compression and tension in the flanges of the section. The compression flange tries to deflect laterally away from its original position, whereas the tension flange tries to keep the member straight. Due to combine concentrated and uniform distributed load (self weight) applied over the span of the simply supported I section beam, the beam

changes its equilibrium position and permanent deformation occurs at the middle span of the beam which is known as deflection.

C. Shear centre and warping

Shear Centre is defined as the point in the cross-section through which the lateral (or transverse) loads must pass to produce bending without twisting. It is also the centre of rotation, when only pure torque is applied. It is assumed that plane cross section remain plane during twisting of circular bars subjected to torsion. However when member with cross section like solid I channel are subjected to torsion, the warping of cross section take place. Warping means the out of plane disfigurement of cross area when a part is subjected to torsion.

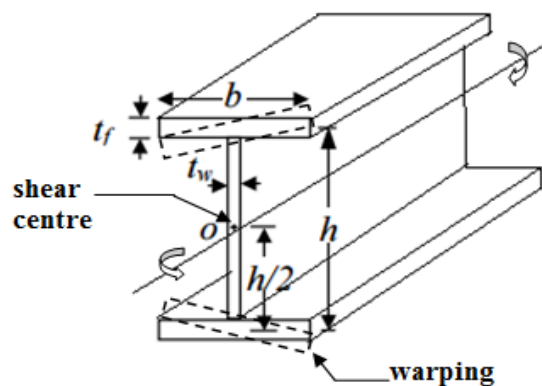


Fig -3: Warping occurs in I section beam

If warping is allowed at both ends, no longitudinal stresses are developed in member. warping may be anticipated at one or both the finishes making the closure assembled in or inflexibility associated with a supportive member like a column.

1.2 Advanced design solution to reduce the accordion effects

It is necessary to built up the advanced design model to overcome the failures occur in regular I section beam.

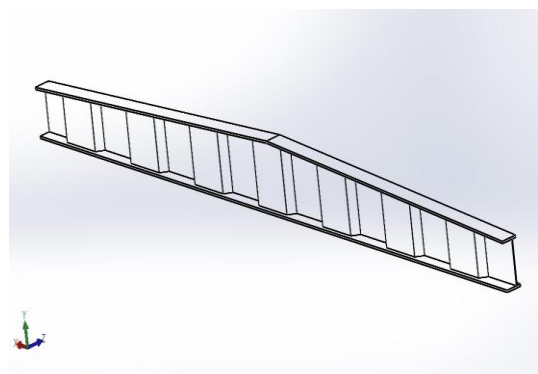


Fig. 1. Solid model of tapered with trapezoidal web beam

The proposed system of design with varying cross sectional shape with trapezoidal web is shown in figure. New modified design must have sufficient strength and Capability to reduce the accordion effect. Hence structural analysis will be perform by developing solid model on CATIA and FEA software. Suitable cases can be considered and manufactured for experimental analysis. The final results will be validated through FEA and experimental analysis.

2. LITERATURE REVIEW

A. Bending and torsion of hollow flange channel beams, Hong-Xia Wan et al. Mahendran (2015)

This paper has presented the details of an investigation into the combined bending and torsion behaviour of a hollow flange channel beam known as Lite Steel beam using experiments and finite element analyses. Experimental study included three LSB sections tested to failure under a mid-span eccentric load. Simple boundary conditions were accurately simulated by suitable test supports in a special test rig that was used to simulate different loading eccentricities. Finite element models of tested LSBs were developed using ANSYS, and their ultimate strengths, failure modes, load, displacement curves were obtained and compared with corresponding test results. The results from FEA and tests agreed well and thus validated the developed finite element models. Parametric studies were also conducted using the validated finite element models of LSB to investigate the effects of the location and eccentricity of the applied load, and spans. The results showed that the bending moment capacity reduces significantly as the loading eccentricity increases. This paper presents the details of the tests, finite element analyses, and parametric study of LSBs subject to combined bending and torsion, and the results.

B. Lateral torsional buckling of I-girder with corrugated webs under uniform bending, Jiho Moon et al. (2009)

This paper presents the results of the theoretical and finite element analyses of the lateral-torsional buckling of I-girders with corrugated webs under uniform bending. In this paper, previous studies on the bending and torsional rigidities of the I-girder with corrugated webs are first discussed. Then, approximated methods for locating its shear center and calculating the warping constant are proposed. Using the proposed methods, the lateral-torsional buckling strength of I-girder with corrugated webs under uniform bending can be calculated easily. A series of finite element analyses are conducted and their results are compared with those of the proposed methods. Based on these comparisons, the proposed methods are successfully verified. Finally, the effects of the corrugation

profiles of the web on the lateral-torsional buckling strength of the I-girder with corrugated webs are further discussed. The effects of the corrugation profiles of the web on the lateral-torsional buckling strength of the I-girder with corrugated webs are also investigated in this study. From the results, it is found that the warping constant of the I-girder with corrugated webs is larger than that of the I-girder with flat webs, while the shear modulus of the corrugated plates is smaller than that of the flat plates.

C. The Study of Lateral Torsional Buckling Behavior of Beam with Trapezoid Web Steel Section By Experimental And Finite Element Analysis, Fatimah Denan et al. (2010)

This paper represents experimental and numerical study on lateral torsional buckling behaviour of steel section with trapezoid web. Comparison is made with conventional beams with flat web. In the experimental work, sections with nominal dimension 200 x 80 mm and 5 m length were loaded vertically while the lateral deflection were unrestrained to allow for the lateral torsional buckling. In the analytical study, eigen-value buckling analysis in the finite element method was used to determine the critical buckling load. Finite element can be used to determine the elastic lateral torsional buckling moment of the section. The result shows that corrugation thickness influences the resistance to lateral torsional buckling. From the experimental and analytical study on the lateral torsional buckling on trapezoid web section, it can be concluded that Steel beam with trapezoidally corrugated web section have higher resistance to lateral torsional buckling compared to that of section with flat web. Sections with thicker corrugation have higher resistance to lateral torsional buckling. Higher value of moment of inertia about minor axis for the section with thicker corrugation contributes to the higher resistance to lateral torsional buckling.

D. Main Girder Beam Design And Finite Element Analysis Of 2x160 Ton Gantry Crane, Ismail Gerdemeli et al. (2010)

In this study first of all, the main characteristics as the height of the crane, the distance between the rails, the lifting height, speed of the crane and speed of the trolley are determined. After that, the geometry of all parts, and the features of the power and transmission components are specified. The construction geometry is analyzed by Abaqus Software program. First, three dimensional geometry of the crane is built with a CAD program, then this geometry is modelled by using finite element method. The crane is tested under the effects of its self weight, the weight of the load, the hook and the trolley, and also the wind load and the dynamic loads occurring with the movement of the crane. The obtained stress values should

not exceed the safety stress of the material used. If any component has an unpermissible stress value, the thickness of the sheets should be increased or suitable supports should be added. In this study, the stress values on winkle supports which are employed for safety against wrinkle proves that they do not carry load and they do not provide strength for tension, compression and bending. Because of this, the strength of these parts can be decreased. For instance, the tower wrinkle supports, upper and middle sheet metal of the assembly box, middle sheet metal of the upper box of the leg, boggie upper sheet metal and upper sheet metal of bottom cross beam, the support sheet metals placed in the main beam are not under effect of high stress values.

E. Finite Element Analysis of Castellated Steel Beam, M.R.Wakchaure et al. (2012)

In this paper steel I section was selected, castellated beams were fabricated with increase in depth of web openings. To analyze the behavior of castellated steel beams having an I-shaped cross-section, modeling is conducted using finite element software package ANSYS14. Analysis is carried out on beam with two point load and simply supported support condition. The deflection at centre of beam and study of various failure patterns are studied. The beams with increase in depth are then compared with each other and with parent section for various parameters and for serviceability criteria. From the finite element analysis results, it is concluded that, the Castellated steel beam behaves satisfactorily with regards to serviceability requirements up to a maximum web opening depth of 0.6h. Castellated beams have proved to be efficient for moderately loaded longer spans where the design is controlled by deflection. From the finite element analysis results, it is concluded that, the Castellated steel beam behaves satisfactorily with regards to serviceability requirements up to a maximum web opening depth of 0.6h. Castellated beams have holes in its web, which lead to local effects in the beams. The finite element analysis effectively captured the different failure modes of all the beams. The results also confirm that the flexural stiffness of castellated beams decrease as the depth of opening increases. It is conclude that the castellated beams are well accepted for industrial buildings, power plant and multistoried structures, where generally loads are less and spans are more with its economy and satisfactory serviceability performance.

F. Lateral Buckling Of Cold Formed Steel Beam with Trapezoidal Corrugated Web, R. Divahar et al. (2014)

The corrugated steel plate is a widely used structural element in many fields of application because of its numerous favorable properties. To increase the shear capacity of web of large steel plate girders, the web with different patterns such as tapered web, haunches,

corrugations of different shapes are used. This paper presents the results of the experimental study on load carrying capacity of cold-formed steel section with trapezoid web. A total of six cold-formed steel beams with plain webs and corrugated webs were tested. The load carrying capacity of cold-formed steel beam with plain web is studied and compared with the load carrying capacity of beam with trapezoidal corrugated web having 300 and 450 corrugations. The specimens were tested under two point loading for its pure flexural behaviour. From the study, it is found that the cold-formed steel beam with trapezoidally corrugated web having 300 corrugations has higher load carrying capacity compared to the beams having plain web and 450 corrugated web. The following observations and conclusions can be made on the basis of the experiments conducted on the six cold-formed steel beams with plain and trapezoidally 0corrugated web. The average load carrying capacity of cold-formed steel beams with 300 corrugated webs increases by 25% than the beam with plain web. But there is only a marginal increase in load carrying capacity of beam with 300 corrugated webs than that of beam with 450corrugated web. Beams with plain web showed shear buckling of web, but the failure due to shear in web could be eliminated by using corrugated web. The strain in the beams with corrugated web is more than that of the beams with plain web.

G. Design Optimization of Overhead EOT Crane Box Girder Using Finite Element Analysis Abhinay Suratkar et al. (2013)

In this paper the design optimization of double box girder has been done and a comparative study of results of finite element analysis of a crane with 10 ton capacity and 12 m span length has been conducted. It is not possible for the real experimental studies to take into consideration the influence of the connections between the main beams and the rest parts of the construction, the influence of the longitudinal and transverse ribbings as well as the influence of the supports on the overall stressed state of the construction. Moreover, the researches that use for the majority of the test cases different strain measurements turn out to be quite hard and expensive. All these problems could be solved successfully by the use of computer modeling procedures. The crane design was modelled with solids; material, Loads and boundary conditions were applied to solid model. Finite Element meshes were generated from the solid model. After a comparison of the finite element analyses, and the conventional calculations, the analysis was found to give the most realistic results. As a result of this study, a design optimization for an overhead crane box girder has been done. In this paper, the comparison between the analytical calculations and the finite element analysis results were investigated. Thus from the above results, we can state that the design optimization of EOT crane box girder has

been achieved without compromising the strength and rigidity. We have reduced the overall mass of the girder by 29%. As the overall mass of the girder has reduced, the initial cost for the structural building, civil work and electrical consumption for the crane has also reduced.

3. CONCLUSION

This study is mainly focusing on the most proficient method to diminish twisting and the sidelong torsion clasp impact of just upheld gantry crane beam by selecting suitable parameters and changing shape of existing design. This research can help to reduce the buckling effects usually face in material handling equipment industries. This paper explores a promising structure analysis of a beam. Another configuration methodology of beam shape is proposed to handle the issues of diversion, and sidelong torsional clasp of gantry crane beam because of stacking. Discussion of this paper demonstrate that when contrasted with normal I segment beam, the tapered with corrugated trapezoidal web shape beam is more equipped for opposing the accordion impact with high shear limit for a given load.

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