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Review on Experimental study of Torsional effect on flat plate use in Built-up Column

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ABSTRACT

This paper present the experimental research on torsional behavior of flat plate used as lacing in built-up column. However the experimental research is carried out mostly and it has been limited to flexural buckling of column. It is not considerable for torsion but torsional moment because torsional moment becomes significantly large when the earthquake forces are predominant. In most of the steel structures column are only subjected to bending and not to torsion but situation do arises where the demands of practical construction result in eccentrically applied load. This paper focus on a review of all such works done by authors on the torsional behavior of Built-up column.

Keywords : Built-up column, Torsion, Flexural buckling, Earthquake Forces

I. INTRODUCTION

Nowadays Built – up column section is widely used steel structural member. In steel construction Built-up column is used when the length of buckling is larger than the compression force. They are composed of two or more parallel main components interconnected by lacing or battens plates. The lacing and battens are flat plate provided in built-up column for connection. The purpose of providing lacing is to resist shear forces. Producing in column and also prevent buckling of column. Built – up column commonly used in industrial building to support crane girders and steel water tank and supporting roof structures. The columns are capable of attending a high compressive load with minimum and effective use of materials. In most of steel- formed structures or members they are only subjected to bending but situation do arises where torsional effect are significantly typically where demand of practical construction result in eccentrically applied load . So that it is important to analyze the torsional behavior of steel member section. Because if there is an earthquake steel damages and analyze of that damages steel structures has proven that torsional moment occurs because of eccentric beam column joints and has greatly decreased the shear capacity of column. The torsional moment becomes significantly large when earthquake occurs so that analysis of torsional behavior is required. In order to understand the more significant behavior of torsion in the built up section various literatures are illustrated below.

II. LITERATURE REVIEW

1. Fatimah DE 'nan, Musnira Mustar (2012)

In this paper the authors explain that on steel beam sections with triangular web openings. A triangular web profile steel part is a built-up section. It is made up of two beam connected to a web plate of triangular profile. An analysis is carried out to study the effect of openings in the triangular web profile beam. The buckling resistance moment for TRIWP without web opening has a higher resistance in comparison with TRIWP with web opening. The diameter of the opening increased from 40 mm to 80 mm the buckling resistance moment ($M_{b, Rd}$) of the beam has decreased. Its length of the beam also affects the buckling resistance moment. Various studies have proved that the buckling resistance moment is affected by size of opening, the web of beam and the length of beam. The diameter of opening strikes the lateral torsional buckling behaviour of TRIWP steel section. Section with bigger size of opening has least buckling resistance compared with the smaller one and yet there was a minute difference between the sections without opening and the one with smaller size of opening.

2. M. Fortan, O. Zhao and B. Rossi:

In this paper the authors explain that the lateral torsional bending behaviour of welded lean duplex stainless steel beams using the finite element (FE) method. According to the different experiments, precision of EN 1993-1-4 and of Taras & Greiner (2010) are obtained. An analysis is made for three design methods: EN 1993-1-4, with imperfection factor 0.76 and 0.49, and Taras & Greiner (2010) by investigational and mathematical results. The investigation results with imperfection factor 0.49 is best to design stainless steel beams and mathematical results showed it would lead to unsafe predictions for various sections up to 12 %. The current design rules with imperfection factor0.76 are secured for almost all results (max 2% at risk). In order to optimize this method for stainless steel and avoid unsecure predictions, enhancement should be made in imperfection factor and plateau length.

3. S. Prabhakaran, and S. Kalaiselvi (2018):

In this paper Author study about the load carrying capacity of cold formed steel column. The columns were connected by providing bolted connection and load is applied on the column by flexural and flexural tension buckling. By this study author understand that closed built-up column carries more load that of open built-up section and if increase the thickness of section load carrying capacity is also increased.

4 Ajeet Sharma, S. Senthil Selvan, S. Suresh babu & D. ELango (2016):

In this research work author explain about the flexural and torsional behaviour of cold formed steel channel section which is connected back to back and four specimen of built-up I section which are formed by using symmetrical channel section connected back to back by the help of bolts. The sizes of sections are 230mmx100mmx3mm. The paper summarizes the theoretical & experimental investigation on cold formed steel members. The analytical investigation is carried out by FEM using ANSYS 14.5 & theoretical study is done by using Two different IS code i.e. (IS 801-1975 & BS 5950-5:1998). Experimental investigation includes flexural and torsion test. The experimental results were found to be precise with analytical results.

Specimen (mm)	IS-801:1975 (mm)	BS-5950:1998 (mm)	Analytic (mm)	Test Results (mm)
230x100x2	0.639	0.610	0.68	
230x100x25x2	0.627	0.670	0.70	0.60
180x50x1.6	0.296	0.273	0.41	0.35
180x50x20x1.6	0.273	0.260	0.36	0.30

Comparison of deflection values:

5. Anumour Sujith (2016):

This paper state the experimental and numerical analysis of cold formed open and close built-up column section. The column were connected using bolted connection. For finite element modelling ABAQUS 6.10 software was used and compare the results. The mechanical & geotechnical properties of the outer steel tube considerably influence. The contribution of the inner steel tube to the columns torsion capacity considerably increased with decrease in concrete shell thickness. As compare to the individual contribution, the combination of materials enhances 20% of the columns torsion capacity.

6. Martin vild and mirosluv Bazer (2016):

This paper present the experimental and numerical research into the strengthen of steel column under load using welded plates. Author focus on the local buckling and torsional, flexural buckling of column. The sets of three column were tested and the results obtained from the experiments and numerical simulations compared.

Result: Welding causes shrinkage & torsional stress near the weld.

Table 1: Results of parametric study: load resistance $N_{b,R}$, deflection in the direction of axis z caused by the fillet weld at longer flange $W_{z,T}$ and at shorter flange $W_{z,I}$

Column	Temperature load	$N_{b,R}$ (kN)	$W_{z,T}$ (mm)	$W_{z,I}$ (mm)
D	0.67 x exp exp 1.33 x exp	134 138 140	6.3 8.5 10.3	
E	0.67 X exp Exp 1.33 x exp	420 399 387	6.3 8.5 10.	-7.2 -9.9 -12.2
F	0.67 X exp Exp 1.33 x exp	405 383 374	6.3 8.5 10.	-7.4 -10.5 -13.4

7. Vila Real, Catelli, Silva, Santigo, Piloto:

In this paper the authors describes the effects of residual stresses in the lateral – torsional buckling of steel I-beams at elevated temperature. According to this paper the Young's modules defoliates faster than the yield strength when the temperature raises and the stress –strain relationship at elevated temperature is not the same as the room temperature. It is shown that the buckling resistance of the beam is less sensitive to the residual stresses when temperature increases.

8. Powel Lorkowski, Bronislaw Gosowki (2017):

In this paper authors studied to evaluate the uniform torsion of the two-chord steel laced member's

equivalent 2nd moment of area. These members are mostly used as steel columns of framed buildings and as poles of railway traction network gates also. This kind of a columns allows the stiffness of uniform torsion to the investigate the critical loads of the spatial suitability. The experimental studied have been carried out on a single span members with rotation arrested at their ends and torque applied at the mid span. The between torque and angle of rotation of the considered cross section has been investigated.

Results: The more beneficial effect of equivalent 2nd moment of area of the uniform torsion is reached. If when the binding area executed of square bars. The member which is analysed by square tubes is @ 15% larger than the tube laced flat.

9. Belarbi and Suriya Prakash (2012):

In this paper RC bridges column could be subjected to combined flexural axial shear torsional load during earthquake. The seismic behaviour of circular and square column is significantly different under combined loading due to the transverse reinforcement configurations.

Result: The results for a column under bending pure torsion & shear & combined bending shear torsion were presented. If aspect ratio is increased so the bending & torsional strength is also increased.

10. Kumaran V., Sureshbabu S. (2016):

The purpose of this research work is to find out torsional behaviour of light gauge steel section. Cold form steel structures are used for multipurpose in construction industries, in these research work authors has been made an attempt in this study to check the torsional behaviour of cold form steel. In the last decades studies on the structural behaviour of cold formed steel beams are increasingly popular. The behaviour of light gauge channel section of load carrying capacity subjected to torsional buckling is studied. For a span of 1.25m a built-up cold formed steel beam has been adopted & it is verified with FEM analysis by using ABAQUS Software. Theoretical & experimental results comparison is presented y these research work authors understand that angle of twist obtained from theoretical investigation is 8.34% more than that of experimental values.

Sr. No.	Description	Twist (kNm)	Torque (rad/m)
1	Theoretical results	0.00085	15.5
2	Experimental	0.00075	14.4
3	Analytical results	0.00070	13.7

TABLE 1

Sr. No.	Tittle of Paper	Name of Author	Year of Publication	Focused Area
1.	The effect of web opening on lateral torsional behaviour of triangular web profile steel beam section	Fatimah DE ‘nan, Musnira mustar	2012	Focused on steel beam sections with triangular web openings. A triangular web profile steel part is a built-up section lateral torsional buckling.

2.	Lateral torsional buckling behaviour of welded lean duplex stainless steel I-section beams	M. Fortan ,o. Zhao and B. Rossi	2013	Focused on the lateral torsional bending behavior of welded lean duplex stainless steel beams using the finite element (FE) method.
3.	Experimental study on load carrying capacity of cold formed steel Built-up column	S.Prabhakaran, S. Kabiselvi	2018	The load carrying capacity of cold formed steel column. Flexural buckling of column.
4.	Experimental study on the Flexural – Torsional Behaviour of cold-formed steel channel section connected Back to Back	Ajeet sharma , Senthil selvan suresh babu and D.Elango	2016	Focused on the flexural and torsional behavior of cold formed steel channel section which is connected back to back and four specimen of built-up I section.
5.	Behaviour of hollow – cone Composite Column under loading	Sujith Anumolu	2016	Torsional behavior of hollow core FRP concrete steel column.
6.	Strengthening of steel columns under load: Torsional-Flexural Buckling	Martin vild and Miroslav Bazer	2016	The strengthen of steel column under load using welded plates. Focused on the local buckling and torsional, flexural buckling of column.
7.	The effect of Residual stresses in the lateral – Torsional Buckling of steel I-beam at elevated Temperature	Vila Real , R.Cazeli P.Piloto	2003	Focused on the effects of residual stresses in the lateral – torsional buckling of steel I-beams at elevated temperature
8.	Investigation on torsion of the two –chords single laced members	Pawel Lorkowski, Bronislaw Gosowki	2017	Focused on the uniform torsion of the two-chord steel laced member's equivalent 2nd moment of area
9.	Seismic Performance of circular RC columns subjected to axial force bending , and torsion with low and moderate shear"	Belarbi and Suriya Prakash	2010	RC bridges column could be subjected to combined flexural axial shear torsional load during earthquake.
10.	Experimental study on Torsional Behaviour of Lightgause steel sections"	Kumaran V. Sureshbabu.S	2016	Focused on the torsional behavior of cold form steel & light gauge steel section

III. CONCLUSION

- Based on the review of various papers it can be concluded that, when closed built-up column were used then it has been seen that it carries more load than the open built-up section.
- Finite element is a useful tool in the study of the lateral torsional buckling behaviour of section
- Torsional test on steel section indicates the importance of the end boundary conditions on the torsional response.

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