A STUDY ON CONTROL OF BUCKLING IN SLENDER STEEL COLUMNS

Submitted by

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IN

STRUCTURE ENGINEERING

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DECLARATION

I hereby declare that the dissertation report titled "A Study on The Control of Buckling Effect in Slender Steel Columns" is an authentic record of my own research work carried out as a requirement for the preparation of M-Tech dissertation for the award of Masters of Technology Degree in structure Engineering from Lovely Professional University, Phagwara, Punjab, under the guidance of MrAshfaq Malik, during. All the information furnished in this report is based upon my intensive work and is completely genuine to the best of my knowledge. And no part of the uncited work in this report has ever been published before in any journal or presented for the award of any degree or honor

Date: **Syed Shahbaz Sikender**

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CERTIFCATE

Certified that this project report entitled **"A Study on the Control of Buckling Effect in Slender Steel Columns"** submitted individually by Syed Shahbaz Sikender student of school Of Civil Engineering, Lovely Professional University, Phagwara carried out the work under my supervision for award of degree. This report has not been submitted to any other university or institution for the award of any degree

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ABSTRACT

Steel members are used in construction industry over years as beams, columns and other structural members. Under normal loading conditions these members perform well, but under large loading conditions these basic building members are subjected to deflections. This deflection phenomenon called as buckling in case of columns is the prime mode of failure. Slender steel columns ratio of length and least lateral dimension have lesser load carrying capacity than short columns, hence fail to respond the large loads as their load carrying capacity is less than normal columns .This project work is about to overcome this problem regarding the problem with slender columns .It is suggested in this report that geometry of column is equally responsible for the buckling Most of the slender columns show maximum buckling effect in middle portion or about middle portion. Therefore it is suggested to increase the area of middle portion of the column, so that the response of middle section increases. In other words strength of middle section of column increases. To reduce the perpendicular buckling of slender column it is suggested that the area of response in perpendicular direction is increased. In case of designed geometry columns. The response of perpendicular buckling comes only from the area on perpendicular direction to the load axis

Slender I section column when tested for vertical loads under software (stadd pro),it was seen that buckling of a test section (I Section) gets reduced and thereby increases the performance of column , when the cross section of middle portion was increased and also by increasing the perpendicular direction dimensions of column which is done by increasing the with of flanges in z direction of column

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Chapter 1

INTRODUCTION

Vertical members used in construction of buildings or any other structures are called as columns. Columns are the members that transmit the whole loads of building including both live load and dead load to the soil. These columns transmit the loads in axial direction only. No other loads are taken by the columns, hence are designed for axial loads only. This load transferring capacity of a column depends on its cross sectional area and also the geometry. As per the conditions a structural engineer or a designer chooses different cross sections and different geometries for the column so that it can transfer maximum loads to the ground. Over various years of research steel columns have been found effective the field of construction. Steel members have been used in construction because their installation is relatively easy, have long life span if maintained properly, have high scrap and salvage value. Based on the dimensions of a steel column, steel columns are categorized into two main types

Long column: - Ratio of effective length to the least lateral dimension of column is greater than 12.

Short column:- Ratio of effective length to the least lateral dimension is generally less than 12

Both short and long columns fail when imposed loads exceed the bearing capacity. Short column fails directly by crushing while as long column fails first by buckling also the load carrying capacity of a short column is greater than the load carrying capacity of a long column

To carry the higher loads long columns require to large cross section, which in turn increases the dead weight of column and as has higher surface area. In order to overcome this problem, this research work has been carried out. This research work is about the method that is to be utilized in designing a slender column with higher load carrying capacity and which shows lesser over all buckling at higher loads than the normal section slender column. The designed column proves to be more economical than the braced slender column.

Chapter 2

SCOPE OF STUDY

The study is about the buckling control of slender steel columns. These are the columns having ratio of length and least lateral dimension less than 12.As previously revealed in this report that the slender columns fail by buckling hence have lesser load carrying capacity than normal columns and methods to increase the load carrying capacity of such columns have also been illustrated. The illustrated methods are purely based on experimental analysis of long column done by using analysis software. The reduction in overall buckling of the designed column enriches the current study in finding its scope in following areas

- Long columns are used in construction of via ducts were the length of columns is mostly more than 30 meters. For such structures it is necessary that the load capacity of the column should be excellent. By applying the concept of current study in this area columns with higher efficiency can be constructed and the number of underneath columns can be reduced which will result in economy of the entire project.
- Long columns are used in industrial buildings to support the gantry girders. In such cases there are very large loads and higher impact loads, hence it is necessary for supporting columns that the load resistance should be higher. In such cases the current study finds its use so that excellent load carrying columns can be manufactured
- Long columns are used in construction of railway bridges at higher altitudes, were there are large moving loads. When such bridges are constructed over a water channel large dimensions for supporting columns are required which decreases the clear water way between two consecutive supports. To overcome this problem modified slender columns with modification discussed in this report can be used

Chapter 3

OBJECTIVE OF STUDY

- To design a column section that has better control over buckling and thereby increases critical load carrying capacity

Chapter 4

LITERATURE REVIEW

- Jindal doshi(2009):-"Buckling Of Steel Columns Can Be Prevented By Varying Geometry ,And Increasing Moment Of Inertia Of Column". Long and slender steel columns when subjected to heavy loads undergo geometric deformations. Sometimes the deformations occurred are permanent. To overcome this problem author has suggested that columns with increased cross sectional area can be used to reduce the individual deflection, and to increase the load capacity of individual column.
- T.usami and A.Kasai (2008):-"Euler Type Buckling Can Be Prevented By Providing Restrains And Bracings". Long columns when follow the modes of buckling as per Euler theory, such a buckling is called as Euler buckling. The lowest load on which buckling occurs critical load of buckling. To increase this load for slender columns authors have suggested that the end restrains and web bracing result effectively. Therefore it may concluded that the load bearing capacity of a slender column depends on conditions through which restraining supports transfer the load to the column. Simply it can be said that response of a slender column towards loads depends upon end conditions.
- Andrew A. Berlin (1994):-"Intelligent Buckling Control By Using Piezo-Ceramic Actuators To Counter Act Buckling And Use Of Control Forces Through Tendons To Control Buckling". Long columns mostly buckle on the section which is unsupported. If the unsupported length is higher, higher will be the length of buckled section. Most of the columns buckle near middle section. To avoid this problem regarding large unsupported length columns, authors have suggested the use of external forces applied on the section which is expected to buckle .The forces are applied through tendons to counteract the deflection or buckling of a particular section of column. By this it can be concluded that buckling of section of column depends on the direction of resultant force acting upon that section of column
- A.Shaat and A.Fam(2007):-"Investigative experimental studies reveal that 16% increase in load carrying capacity can be achieved by providing C F R P plates which reduces buckling of square column". C F R P plates have higher density and higher weight which when

attached to a section of column increase the dead weight of modified section, which in turn increases the load bearing capacity of that section. This method is most appropriate when plates with higher density are provided near middle section

- DR B.c punmia and S.K Duggal (2010):-“limit state design of steel members”, “design of steel structures”. These are the two published books of the said authors in which both the authors reveal that the buckling about any axis of the column depends upon the moment generated by the acting loads along that axis of the column. The deflection about an axis can be controlled by increasing the stiffness of the column which can be done by providing high strength stiffeners

Chapter 5

TEST SECTION AND SOFTWARE USED

I section steel column was chosen as test section with modified geometry such that the cross section area in the middle of the column is more. This geometry can be achieved by tapering tout he column along both flanges towards the middle section from both the ends

The designed column is subjected for buckling analysis in structure analysis software's like stadd pro and e tabs. The detailed results of both the software's are compared and are found to be fruitful

Figure 5.1

Chapter 6

RESEARCH METHODOLOGY

- I section steel column is chosen as test specimen with relatively increased cross section at center and with changed end connections.
- Provision of high strength steel members on the web area at center which will act as web stiffeners.
- Analyzing the designed section and comparing its load carrying capacity in designing software's like Ansys and etabs.
- Comparing the buckling of standard rolled I sec with the designed section under steel compression testing rig.
- First trial of analysis was done on stadd pro in which a tapered I section was selected with start end dimensions same as ISHB 200 and the web modification was done in center of column by increasing web section from 200mm to 300 mm, and the column with 10 meter height was designed. The analysis performed on the column shows reduced buckling when compared to the buckling of ISHB 200

Chapter 7

EXPECTED OUTCOMES

- The designed section is expected to carry 5 % to 15% more load than rolled I section, while being economical and aesthetical.
- Buckling is expected to be lesser than standard section
- The expected reduction in buckling is about 15% than normal rolled section slender column

Chapter 8

CONCLUSION

The designed geometry of the column Reduces the buckling more than 20% as compared to normal rolled I section. At the same time the load carrying capacity of the designed column is also increased up to 15%.At the same end dimensions as that of standard section, the designed column shows higher load carrying capacity with lesser overall buckling. With the achieved results it can be concluded that the resistance of the buckling mostly depends upon the resistance of unsupported section of the column. If the column is made enough stiff in its middle portion, the overall load resistance of the column increases

Chapter 9

REFERENCES

- Overall buckling preventions conditions of steel columns (T Usami and A.Kasai)
- Article on buckling control of steel columns by jindal doshi (founder of structural madness)
- Control of overall buckling of columns using cfrp plates by A.Shaat and A.Fam
- Active control of buckling in columns by Andrew A. Berlin
- Euler buckling theory or Prevention of buckling by DR.Bc.Punmia and S.K Duggal