International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 11, November-2016

Effect of Imperfections on Stability of Column and Frame

J. N. S. Suryanarayana Raju[1st]
Assistant Professor,
Department of Civil Engineering
S. R. K. R. Engineering College
Bhimavaram-534202, A.P, INDIA

M. Venkata Rao [2nd]
Assistant Professor,
Department of Civil Engineering
S. R. K. R. Engineering College
Bhimavaram-534202, A.P, INDIA

G. Sabarish[3rd]
Assistant Professor,
Department of Civil Engineering
S. R. K. R. Engineering College
Bhimavaram-534202, A.P, INDIA

P. Venkateswara Rao [4th]
Assistant Professor,
Department of Civil Engineering
S. R. K. R. Engineering College
Bhimavaram-534202, A.P, INDIA

Abstract- **In this paper the buckling behavior of an imperfect columns and frames is studied by considering a member whose axis is initially bent and subjected to axial and lateral loads. The influence of imperfection in the design of long and short column and frame is studied. Analysis with and without imperfections is done using ANSYS software. The short and long columns are known by using the slenderness ratio. The imperfection value is calculated and induced in columns and frames.**

Keywords: ANSYS, Axial and lateral loads, Buckling behavior, Columns and Frames, Hot rolled steel, Imperfections.

I. INTRODUCTION

Steel is mainly used material in the current construction scenario. Steel can be used in two ways: As in the construction of steel frames or structures and as a composite with any other material as concrete. The steel construction is gaining its popularity not only because of its strength but also due to its good ductility, easy fabrication.

In a framed structure the stability mainly depends on the columns. The buckling of column can lead to sudden and dramatic failure as a result, special attention must be given to design of column so that they can safely support the loads. The buckling for a column occurs at mid section mostly, while buckling of columns the tendency of the axial compressive force is to increase the lateral displacement. Consideration of critical load is important in design of columns and frames. Critical load is that load at which the transition occurs from stable to unstable conditions i.e., where the buckling starts. Critical load is the only load for which the structure will be in equilibrium even in the disturbed position. But the columns may fail even before reaching the critical load because of imperfection. Due to imperfections no column is really straight. A column can either fail due to the material yielding or because of the column buckling. It is of interest to the engineer to determine when this point of transition occurs.

The buckling is a more common mode of failure in slender columns. As long as the load on such a member is relatively small, increase in the load result only in an axial shortening of the member. However, once a certain critical load is reached, the member suddenly bows out sideways. This bending gives rise to large deformations, which in turn cause the member to collapse. The load at which buckling occurs is thus a design criterion for compression members.

The quality or condition of being imperfect is known as imperfection. These imperfections are classified as geometric imperfections, that refer to the deviation of the geometry from the perfect to the imperfect shape of the member, the thickness imperfections that refer to the changes from the nominal thickness the so-called material imperfections that refer to the deviation of the material parameters and boundary imperfections that refer to imperfections in support and loading conditions. Finally the critical load of a column can also be less because of residual stress.

II. LITERATURE REVIEW

Nishino and Hartono in 1989 studied the effect of the mode of geometric imperfection on the carrying capacity of an elastic discretized structure [1]. Masarira in 2002 described about the influence of joint construction on the lateral-torsional behaviour of steel frames [2]. Veerman in his report described, calculation methods and results for several stability problems [3]. Bourezane in 2012 had done the buckling analysis of frames, derived the geometric stiffness from the governing equation of the second order for bending with axial force, resulting in stability functions that yield the exact solution for constant flexural stiffness and constant axial force [4].

III. METHODOLOGY

Fig. 1. Shows the steps followed for both columns and frames in achieving the objectives.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 11, November-2016

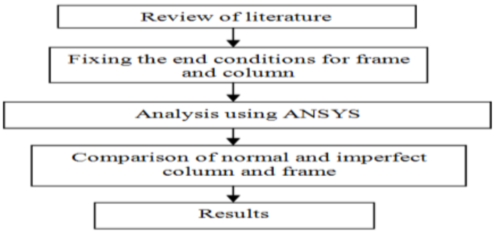

Fig. 1 Flow chart showing methodology

IV. CALCULATION OF IMPERFECTIONS

The member is assumed to be perfectly straight and the loading is assumed to be concentric at every cross section. These idealizations are made to simplify the problem. However, perfect members do not exist in actual engineering structures. Both minor imperfections of shape and small eccentricities of loading are present in all real structures. Let the initial deformation of the member be given by Yo and the additional deformation due to bending by y. The initial deformation assumed to be of the form

$$Yo = \delta_0 \sin(\pi x/L)$$

where δ_0 = amplitude (5 to 7 mm is allowable)

V. SHORT COLUMN

A. Model of Short Column

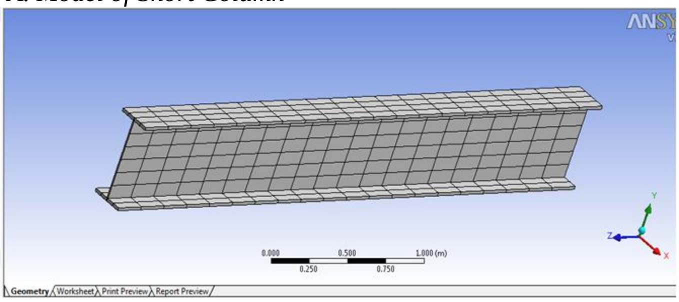

Fig.2 Model of short column

The section used for the column is ISLB 550 Length=4 m, Designed for load = 2000kN Slenderness ratio KL/r=91.93<180. The column modeled in ANSYS is as shown in Fig. 2.

B. Short Column Subjected to Axial and Lateral Loads with and without imperfections

Fig. 3 and Fig. 4 shows the short columns modeled in ANSYS subjected to both axial and lateral load with and without imperfection respectively.

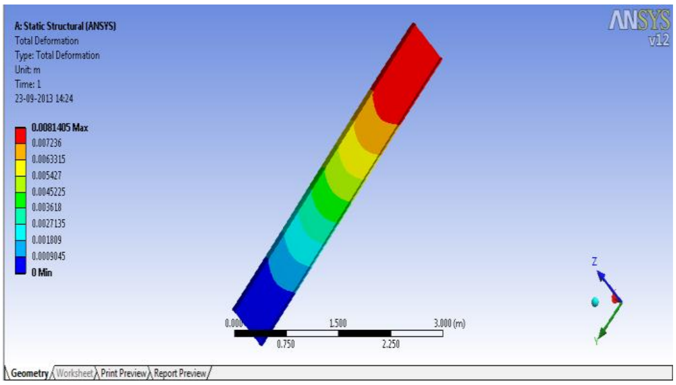

Fig.3 Short column subjected to axial load and lateral load

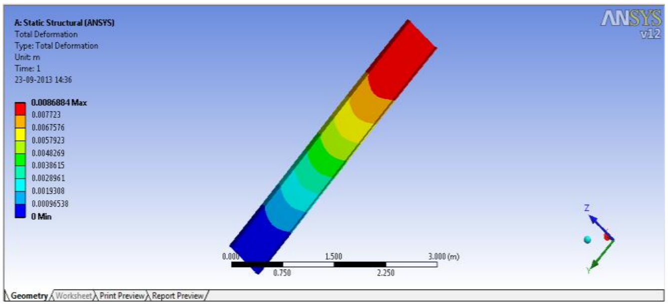

Fig.4 Short column subjected to axial, lateral loads and imperfections

The results of the above analysis are tabulated as shown below. It can be seen that the deformation is mainly in the axial direction and the influence of imperfection is minimal.

Table 1: Short column subjected to axial load and lateral load

Deformation	Imperfections	
	Without (mm)	With (mm)
Total	8.140	8.688
Axial	8.132	8.672
Lateral	0.008	0.016

Axial deformation > Lateral deformation so it is short column and fails by crushing.

VI. LONG COLUMN

A. Model of long Column

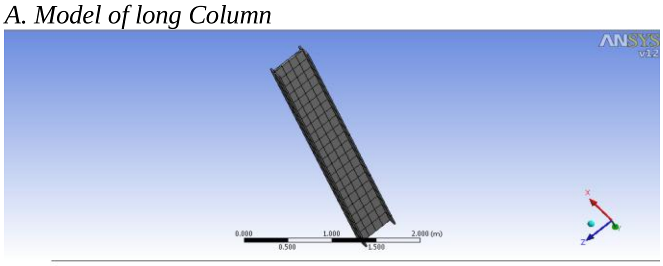

Fig.5 Model of long column

The section used for the column is ISMB 450
Length=8m,Design for load = 2000kN
Slenderness ratio KL/r=212.6>180. The column modeled in ANSYS is as shown in Fig.5.

B. Long Column Subjected to Axial Load and Lateral Load

Fig. 6 and Fig. 7 shows the long columns modeled in ANSYS subjected to both axial and lateral load with and without imperfection respectively.

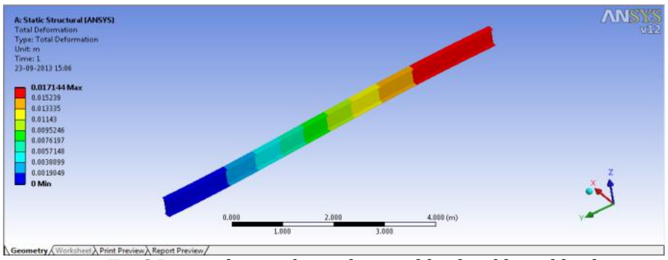

Fig.6 Long column subjected to axial load and lateral load

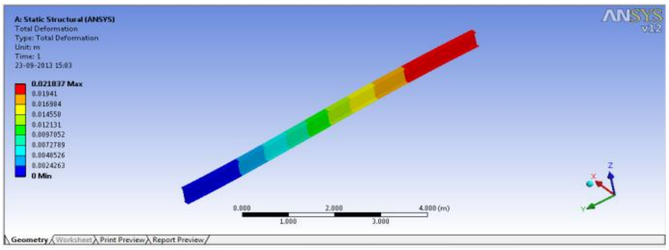

Fig.7 Long column subjected to axial, lateral loads and imperfections

The results of the above analysis are tabulated as shown below. It can be seen that the deformation is mainly in the lateral direction and the influence of imperfection is observed.

Table 2:Long column subjected to axial load and lateral load

Deformation	Imperfections	
	Without (mm)	With (mm)
Total	17.144	21.837
Axial	0.036	0.091
Lateral	17.108	21.746

Axial deformation < Lateral deformation so it is long column and fails by buckling.

VII. FRAME WITH SHORT COLUMNS

A. Model of Frame with Short Columns

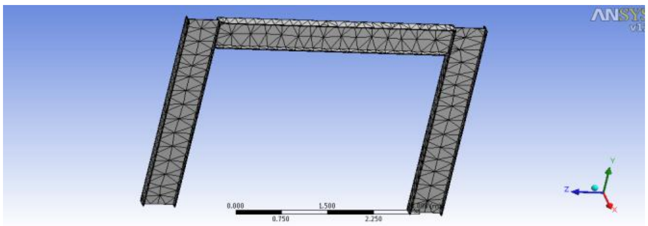

Fig8 Model of frame with short columns

The section used for frame is ISLB 550
Length of beam= 6
Height of column= 4 m ,The frame modeled in ANSYS is as shown in Fig. 8.

B. Short Column Frame Subjected To Axial, Lateral Loads with and without imperfections

Fig. 9 and Fig. 10 shows the short frames modeled in ANSYS subjected to both axial and lateral load with and without imperfection respectively.

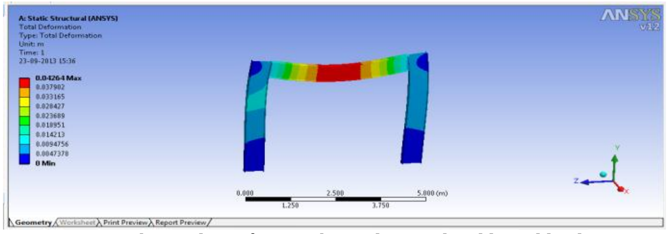

Fig.9 Short column frame subjected to axial and lateral loads

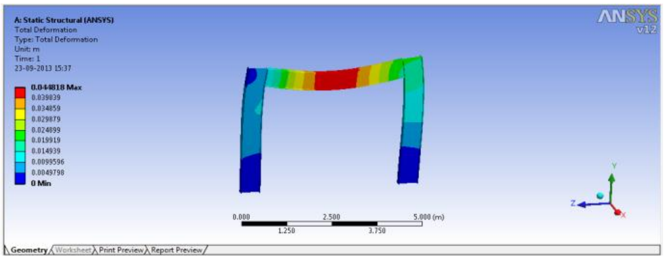

Fig.10 Short column frame subjected to axial, lateral loads and imperfections

The results of the above analysis are tabulated as shown below. It can be seen that the deformation is mainly in the axial direction and the influence of imperfection is minimal.

Table 3: Short column frame subjected to axial load and lateral load

Deformation	Imperfections	
	Without (mm)	With (mm)
Total	42.640	44.818
Axial	39.236	40.432
Lateral	3.404	4.386

Axial deformation > Lateral deformation so it is short column frame and fails by crushing.

VIII. FRAME WITH LONG COLUMNS

A. Model of Frame with Long Columns

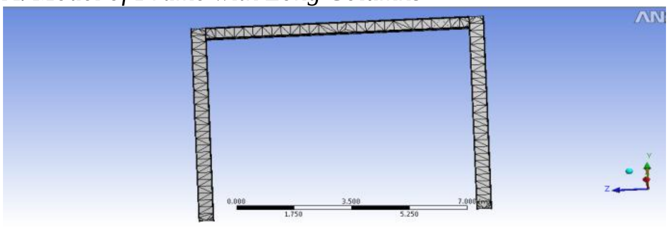

Fig.11 Model of frame with long columns

The section used for frame is ISMB 450
Height of column=8m
Width of beam=8m, The frame modeled in ANSYS is as shown in Fig. 11.

C. Long Column Frame Subjected To Axial, Lateral Loads with and without imperfections

Fig. 12 and Fig. 13 shows the long frames modeled in ANSYS subjected to both axial and lateral load with and without imperfection respectively.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 11, November-2016

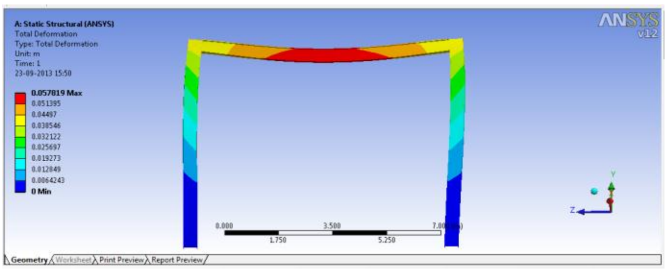

Fig.12 Long column frame subjected to axial and lateral loads

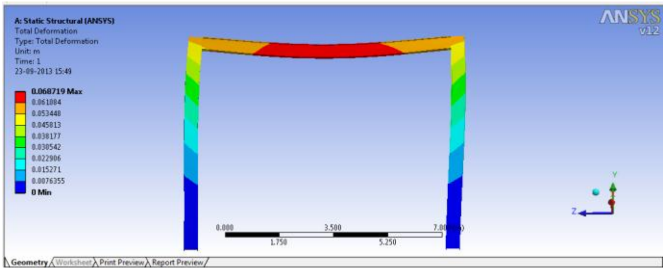

Fig.13 Long column frame subjected to axial, lateral loads and imperfections

The results of the above analysis are tabulated as shown below. It can be seen that the deformation is mainly in the lateral direction and the influence of imperfection is observed.

Table 4:Long column frame subjected to axial load and lateral load

Deformation	Imperfections	
	Without (mm)	With (mm)
Total	57.819	68.719
Axial	5.421	6.793
Lateral	52.398	61.926

Axial deformation < Lateral deformation so it is long column frame and fails by buckling.

IX. CONCLUSION

From the analytical results it can be see that the deformation observed in short column and frame is mainly axial and there is no influence of imperfection. In long column and frame the imperfection plays a major role in the deformation and lateral deformation is more compared to the axial deformation. Hence, the imperfections are to be considered in the design of long column.

REFERENCES

[1] Fumio Nishino and Wibisono Hartono ,“Influential Mode of Imperfection on Carrying Capacity of Structures”, *Journal of Engineering Mechanics*,1989, Vol. 115, No. 10.
[2] Alvin Masarira, “The Effect of Joints on the Stability Behaviour of Steel Frame Beams”, *Journal of Constructional Steel Research*, 2002, vol.58, pg.no: 1375–1390.
[3] R.P.Veerman, “Stability design for frame type structures”,Master thesis report,july 2009.
[4] Messaoud Bourezane,” Buckling Finite Element Analysis Of Beams and Frames”, *The World Congress on Engineering*, 2012, Vol 1.
[5] Analysis using ANSYS.