International Journal of
Advances in Scientific Research and Engineering (ijasre)
E-ISSN : 2454-8006
DOI: http://dx.doi.org/10.7324/IJASRE.2017.32569
Vol.3 (11) December-2017

STUDY ON THE STABILITY ANALYSIS OF RC FRAME BUILDINGS

Naveen Kumar D T[1] Jagadish G Kori [2]

P G Student [1] and Professor[2]

Department of Civil Engineering

Govt. Engineering College

Haveri, Karnataka

India

ABSTRACT

Buckling is instability of column under compression, any axial member that supports compressive load. In most of the buckling analysis applied loads, structural properties and material properties are considered certain. The buckling load factor (BLF) or effective length factor (K-factor) is one of important parameters in design of column or beam-column members in framed structures and the stability design method based on this effective length is quite commonly used by practicing engineers for many years. The present study mainly deals with BLF that may affect critical buckling load. It is concluded that buckling of structure is a major factor in stability analysis and we need to study factors that may affect the buckling during design of structure. From the analysis, it is interred that as the loads on buildings increases the most critical value of BLF, as height of building increases the most critical value.

Key Words: *Stability, Buckling, Buckling Load Factor.*

---

1. INTRODUCTION

Stability of the structure is a very important criterion for tall buildings. The capacity to recover equilibrium is known as structural stability. Structural stability is essential to ensure the safety of structures against collapse. The theory of stability is of critical importance for several engineering fields like structural, offshore, ocean, aerospace and nuclear engineering. The history of structural collapse due to neglecting the effect of stability or improper understanding of stability aspects of design highlights the importance of the subject. Structural evaluation process involves checking buckling-limit load capacities of structural elements as well as stability calculations. A critical aspect in structural design is stability calculations and a significant damage to column members can result from miscalculations. A major criteria to a building's safety is the limiting loads for columns. Hence, careful evaluation of the critical load limits must be carried out by the designer. Buckling is instability of column under compression. A thin long wooden strip bends considerably when subjected to compressive forces. If similar bending was to occur in the columns, it would lead to the collapse of the building. The collapse of a structure due to buckling of column is catastrophic as well as sudden. The uncertainty in material properties, structural properties and applied loads is not taken into consideration in most buckling analysis. An important parameter to be taken into account in the design of column and beam-column members in framed structure is the effective length factor or K-factor. Practising engineers have been using the effective length based stability design method for several years now.

1.1 Buckling phenomenon

The instability of a structure due to compressive loads or stresses is known as buckling phenomenon. The loads that cause buckling of components or structures are far smaller than those that produce material strength failure. More often than not buckling is a catastrophic failure. The stiffness of a structure or component, governs the buckling load rather than the strength of its material. Buckling is usually independent of material strength and it refers to the instability of a structure. The loss of stability in a structural member usually occurs within elastic limit. Theoretically, different differential equations govern the buckling phenomenon A finite element eigenvalue-eigenvector solution is used for modelling and analysis of buckling failure due to loss of structural stiffness and the usual linear finite element analysis is not used. The eigenvalue-eigenvector solution is represented by the equation

$$|Ke + \lambda m \, KgF| \, \delta m = 0,$$

Where λm is the buckling load factor BLF for the mth mode, Ke is the elastic stiffness, Kg is geometric stiffness due to the stresses caused by the axial loading, F is applied axial force and λm is the associated buckling displacement shape for the mth mode. A multiplier (BLF) from the buckling analysis that scales the magnitude of the load (up or down) to that required to cause buckling.

1.2 Buckling load factor

An indicator of the factor of safety against buckling is the buckling load factor BLF given by the ratio of buckling load to the applied axial load. Linear buckling analysis is used to calculate the mode shapes and corresponding buckling load factors of a structure under loading. The analysis is based on the assumption that all element stresses change proportionally with load factor just before the point where the primary and secondary loading paths intersect.

2. AIM AND SCOPE OF STUDY

The aim of the study is to carry out the buckling analysis of a 3D RCC FRAME structure and to determine the buckling factor for the study of stability of structure.

After going through the literature and based on the current trend of increasing number of tall structures, the scope of the present work was framed broadly as follows:

- To study the stability of column members in multi-storey buildings.
- To study the effect of geometric properties on the critical buckling load.
- To study behaviour of structure under the action of gravity, seismic and wind loads.

3. METHODOLOGY

A brief overview of buckling analysis, seismic analysis (linear static) and wind analysis models considered for analysis and assumptions are made during the analysis.

Table -1: Summary of Models considered for analysis

Sl. No.	Model	Description of Model
1.	Model – 1	3 bay 10 storeys RC building subjected to gravity loading with earthquake and wind loads.
2.	Model – 2	3 bay 10 storey RC building considering different column cross sections subjected to gravity loading. ➢ 450*450 mm ➢ 450*600 mm ➢ 600*600 mm ➢ 300*300 mm
3.	Model – 3	3 bay RC building for different story height subjected to gravity loading ➢ 10 Storey ➢ 20 Storey ➢ 30 Storey

4. RESULTANTS AND DISCUSSIONS

The Buckling analysis of RC structures for different considerations modelled in the Etabs has been performed. From the analysis the buckling load factor, displacements, story drift, story shear and base shear values are extracted for each case, compared and the results are discussed.

4.1 Buckling load factor

We must evaluate buckling for each set of loads and first buckling mode found will be the most critical for the structure. Higher value of buckling load is not critical one, lower value or value nearer to the applied load is a critical buckling load. To observe the difference in the behaviour of the structures a comparative study is carried out in this section.

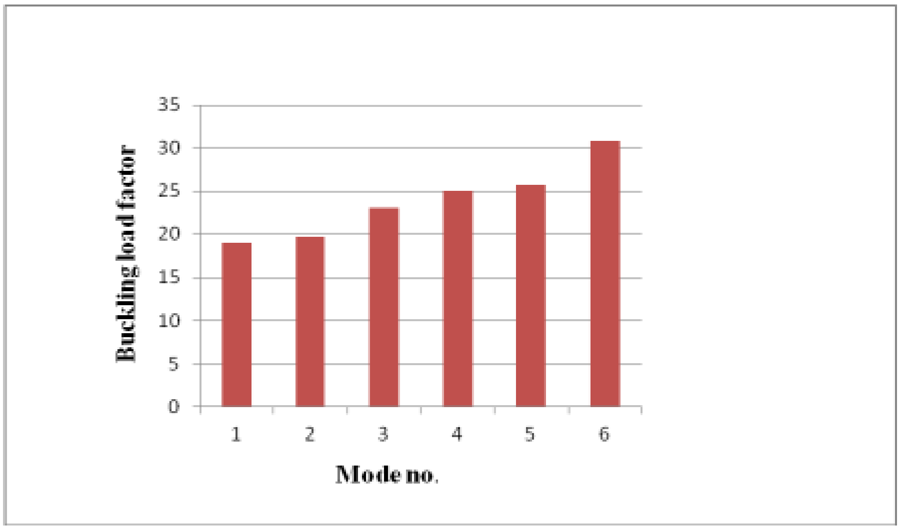

Chart -1: Buckling load factor for 3bay 10 story building

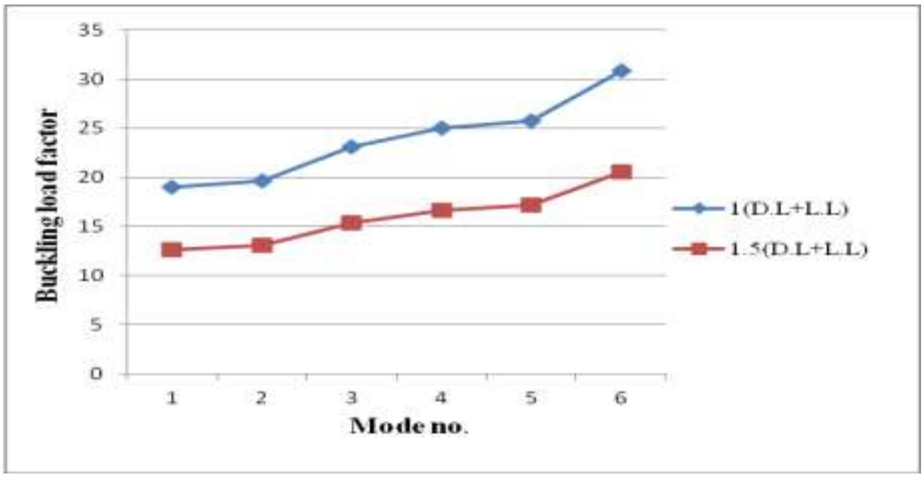

Chart -2: Buckling load factor of 3bay 10 story building for 2 load combinations

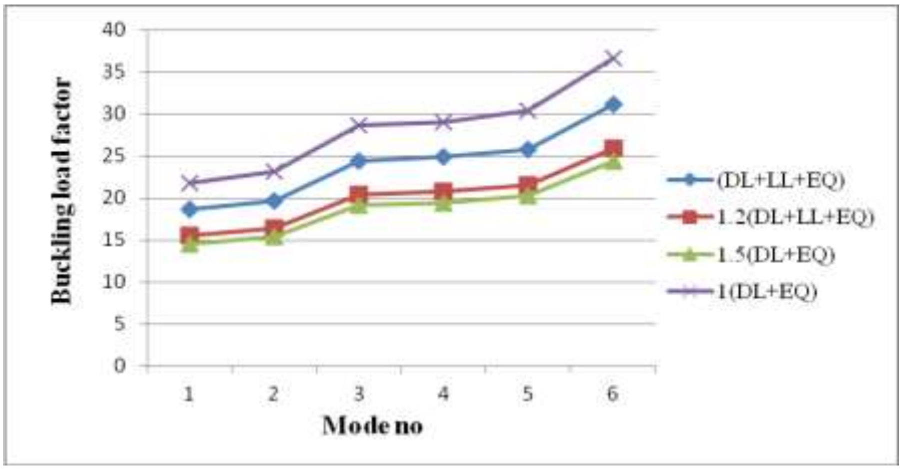

Chart -3: Buckling load factor for 3bay 10 story building for different earthquake load combinations

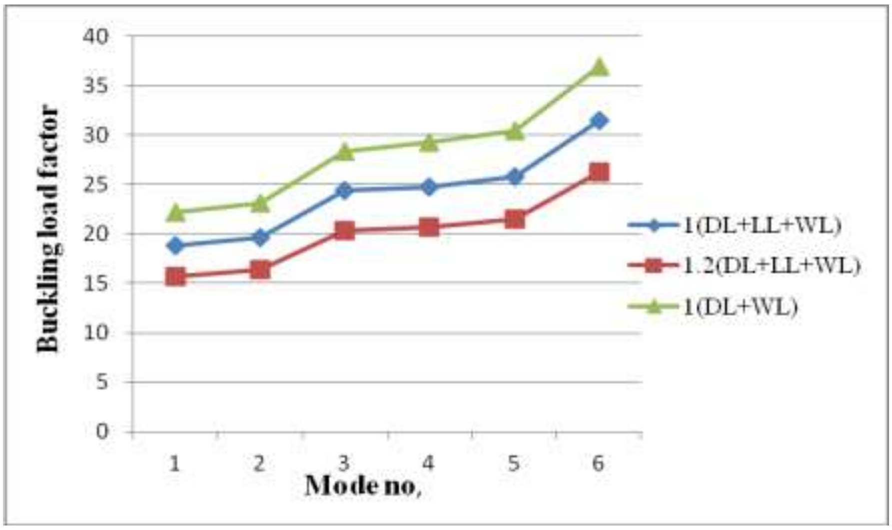

Chart -4: Buckling load factor for 3bay 10 story building for different wind load combinations

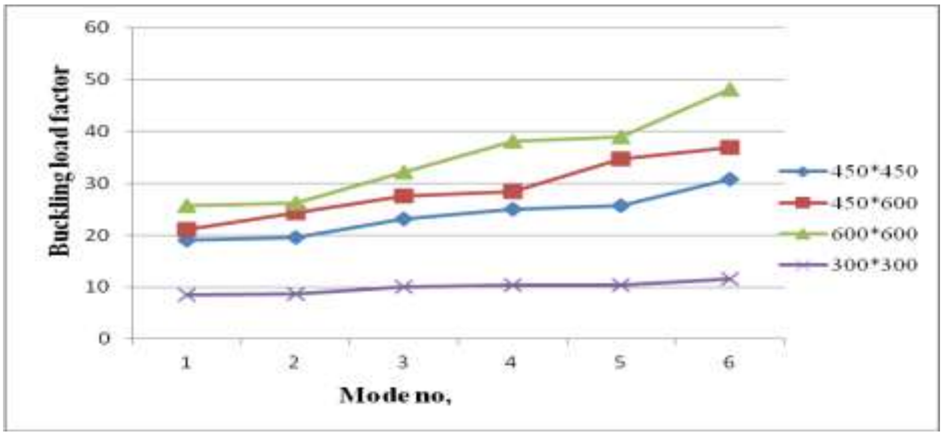

Chart -5: Buckling load factor for 3bay 10 story building with different column cross sections

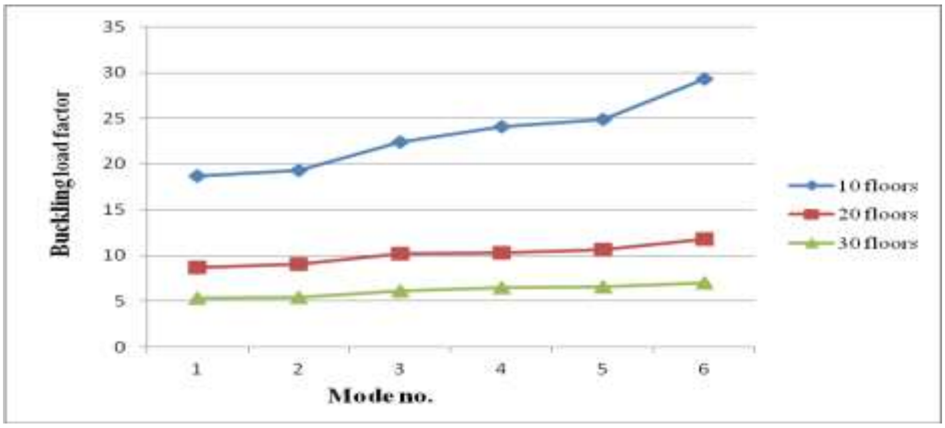

Chart -6: Buckling load factor for 3bay 10, 20, 30 story building.

4.2 Story Drift

Drift is the lateral displacement and it can be defined as the displacement of one level of multi-story building relative to the other level above or below it. If, greater the drift, greater the likelihood of damage. As per Indian code, story drift in any story level shall not exceed 0.004 times the story height.

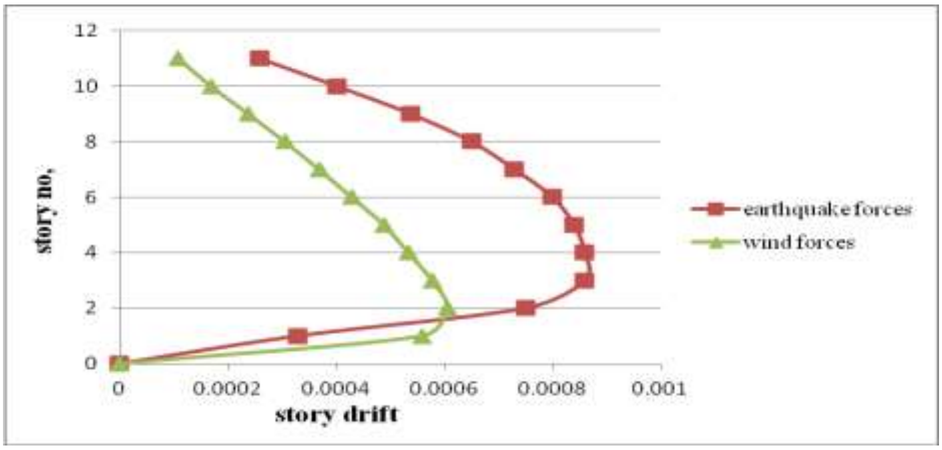

Chart 7: story drift of 3bay 10 story building due to earthquake and wind load

4.3 Story Displacement

Maximum story displacement or lateral displacements are recorded for each story in X- directions, results are tabulated for earthquake and wind load.

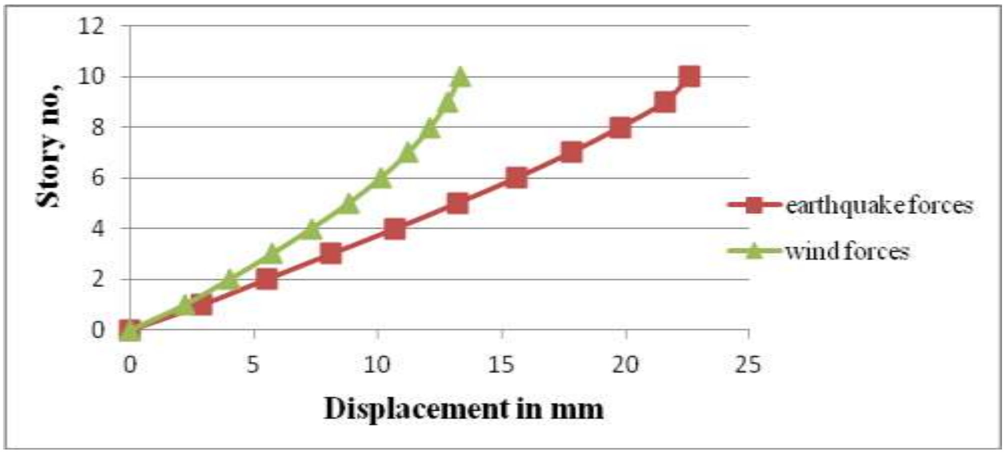

Chart 8: Displacement of 3bay 10 story building due to earthquake and wind load

4.4 Story Displacement

It is the summation of design lateral forces at all floors above the story under considerations.

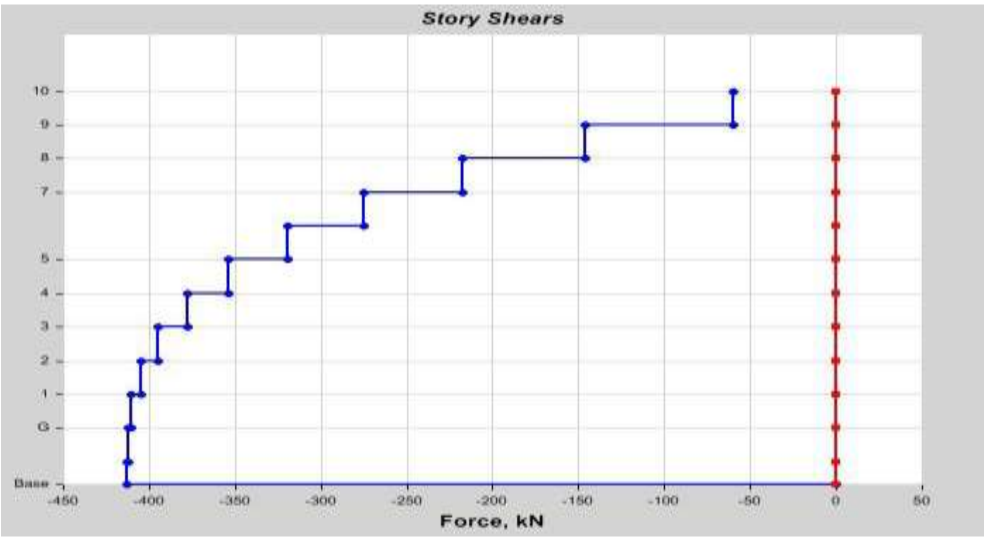

Chart 9: Displacement of 3bay 10 story building due to earthquake and wind load

5. CONCLUSIONS

In the present study the linear buckling analysis of multi-storied RC framed structures considering the different loads, load combinations, different stories, and different column cross-sections have been performed. Following conclusions were drawn based on the results obtained.

- Buckling load factor of 3 bay 10 story building was found to be critical in 1st mode.
- Buckling load factor of building with considering different loads was found and the earthquake load is predominant on structure compared to wind load and gravity load.
- Buckling load factor of building was found with considering different load combinations; the higher value of load combinations gives critical buckling load factor means when we combine the all loads for combination
- The use of basic cross section of column in building gives the critical value of buckling factor, means 300*300 mm column gives critical value compared to 450*450,600*450,600*600 mm column. Hence 300*300 mm column unstable than these column. The 600*600 mm column 66% more efficient than the 300*300 mm column.
- The height of building also affects the buckling load. We found that the 30 floors building get more critical value compared to 10, 20 floors buildings. Hence the 30 floor building unstable compared to 10, 20 floors buildings. The 10 story building is 64% more efficient or stable than the 30 story building.
- The story drift is increasing towards upper floors from base, but after ground floor it decreases drastically as we move further.

REFERENCES

[1] Hariton Xenidis (2004) ‘‘Critical Buckling loads of multi-storey RC buildings”, 13th world Conference on Earthquake Engineering Vancouver B.C., pp.21-25

[2] Syed Gousepak (2016) ‘‘A review on stability of a multi-storey building with underneath satellite bus stop having top soft story and floating column”, Volume: 03, Issue: 03, pp 985-991

[3] Zdeneik P (2000) ‘‘Structural stability’’, International Journal of Solids and Structures 37, pp 55-67

[4] Dong-ho choi (2015) ‘‘System buckling analysis for multi storey frames subjected to non conservative forces” International Journal of Steel Structures, 15(2); pp 285-297.

[5] Konuralp Girgin (2008) ‘‘Effective Lengths of Columns in Braced Multi-Storey Frames”, Teknik Dergi, Volume 19, pp: 4333-4346.

[6] Maheshraddy (2016) ‘‘A review on stability analysis of multi storey building with underneath satellite bus stop having service soft story and floating column”. International Journal for Scientific Research & Development| Volume 3, Issue 12, pp 705-709

[7] Shamshinar Salehuddin (2011) “Stability of a Six Storey Steel Frame Structure’’ International Journal of Civil & Environmental Engineering, Volume 13 Issue: 06, pp 1-7.

[8] Rekha M. Bhoi (2014) ‘‘Study of Buckling Behaviour of Beam and Column’’ IOSR Journal of Mechanical and Civil Engineering, Volume 11, Issue 4, PP 36-40

[9] L Shahsavar, (2013) ‘‘Sensitivity analysis of stability and behaviours of inhomogeneous concrete columns based on design codes”, International Journal of Civil & Environmental Engineering, Volume 13, Issue: 01, pp 13-22

[10] Y Y Chen (2015) ‘‘Modified approaches for calculation of effective length factor of frames” Advanced Steel Construction, Volume 11, Issue. 1, pp. 39-53.