Pushover Analysis of Reinforced Concrete Building with and without Floating Column

Abdul Azeem Shaikh[1], Dr. A.P. Wadekar [2], Dr. D.N Kakade[3]

[1]*P.G. Student, Civil Engineering Department, PES College, Aurangabad, Maharashtra, India.*
[2]*Principal, PES College, Aurangabad, Maharashtra, India.*
[3]*Prof, Civil Engineering Department, PES College, Aurangabad, Maharashtra, India.*

---***---

Abstract - *One of the emerging fields in seismic design of structures is the Performance Based Design. In this study Push over analysis is adopted because this analysis will yield performance level of building for design capacity (displacement) carried out up to failure, it helps in determination of collapse load and ductility capacity of the structure. Two RC buildings are considered one without floating column and another with floating column which are being analyzed by using ETABS 2015 software. Finally the results of pushover analysis for both the building are compared in terms of roof displacement, base shear and the force and moment carrying capacities.*

***Key Words*: Capacity curve, E-tabs, Floating column, Seismic performance**

1. INTRODUCTION

Earthquakes have the potential for causing the greatest damages, amongst the other natural hazards. They are perhaps the most unpredictable and devasting of all natural disasters. Hence concern about seismic hazards has led to an increasing awareness and demand for structures designed to withstand seismic forces. Traditional earthquake resistant design is based on force strength approach. This method aims to achieve only one performance objective life safety. Such a method is inadequate to predict the damage mechanism correctly. Hence, performance based seismic design with the consideration of both structural and non-structural damage, multiple performance objectives, specific quantification of performance criteria and explicit consideration of inelastic deformation of the structures are required to achieve the seismic design methodology. Therefore, for this reason nonlinear static pushover analysis is carried out for the present work

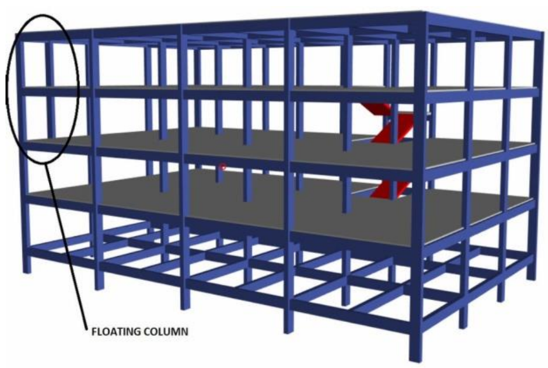
1.1 Pushover Analysis

Nonlinear static analysis, or pushover analysis, has been developed over the past twenty years and has become the preferred analysis procedure for design and seismic performance evaluation purposes as the procedure is relatively simple and considers post elastic behaviour. However, the procedure involves certain approximations and simplifications that some amount of variation is always expected to exist in seismic demand prediction of pushover analysis.

1.2 Floating column

Floating column is also called as hanging column or stub column, which unlike regular column rest over the beam element of the structure. The regular column is designed to transfer the load to the foundation or to the column below and then to foundations. But a floating column will not be involved in the direct transmission of the load. The floating column may be positioned on the first floor or top floors or any of the intermediate floors based on the requirements in the architectural design of the respective structure.

The arrangement of a hanging column is in such a way that it simply floats or is being hung over a base (beam or slab) with no fixed support below with the foundation. This gives the vertical column the name floating or hanging column as shown in the image below.



2. SYSTEM DEVELOPMENT

Two soft storied reinforced concrete frame building with and without Floating column situated in zone V with subsoil Type medium - I were analyzed in ETAB software. For the analysis of these models various methods of seismic analysis are available but for present work linear and non linear static methods are used.

Type of Structure	SMRF
Soil Type	Hard – 1

Response Reduction Factor	5
Importance Factor	1
Seismic Zone	V
Floor Height	3 m
Wall Thickness	230 mm
Live Load	3 KN/m2
Floor Finish	1 KN/m2
Concrete	M 20
Steel	Fe 415
Depth of Slab	150 mm
Poisson's Ratio	0.2
Self Weight Of RCC	25 KN / m3

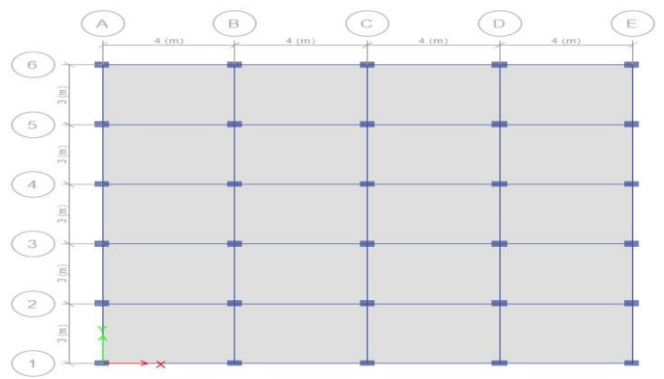


Fig. General Plan view

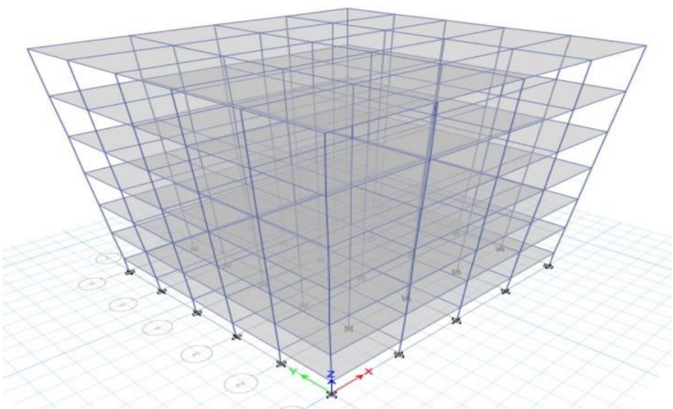


Fig. General 3D view

3. RESULTS

3.1 Capacity Curves

In pushover analysis, the behaviour of the structure is characterized by a capacity curve that represents the relationship between the base shear and the displacement of the roof.

(Model-1: RC building without floating column and Model-2: RC building with floating column)

Table: Capacity Curve for Model-1

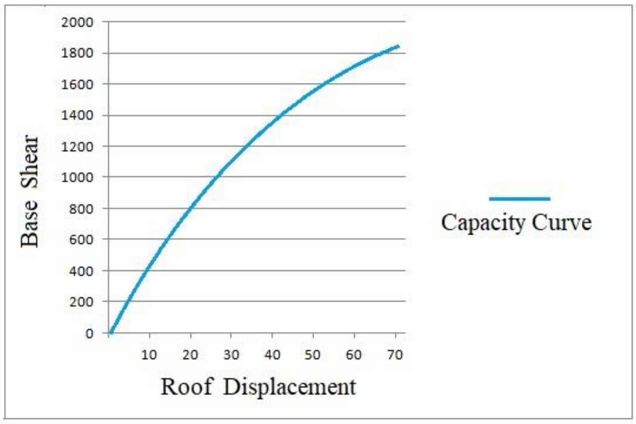


Table: Capacity Curve for Model-2

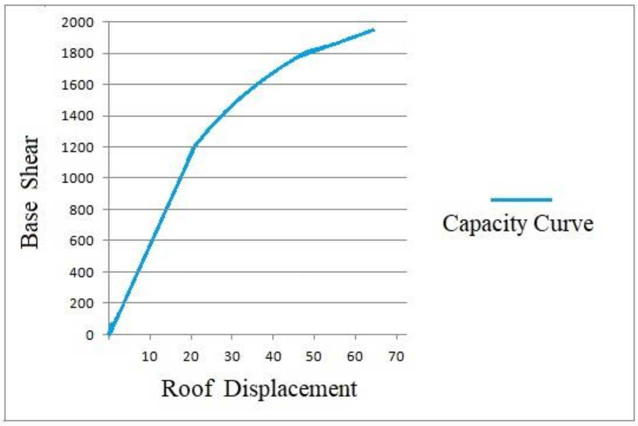


Table: Comparison of Roof Displacement

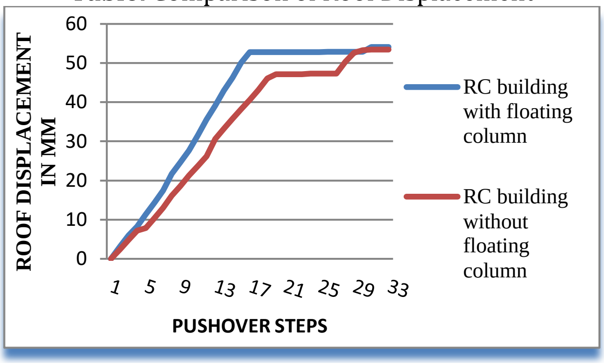
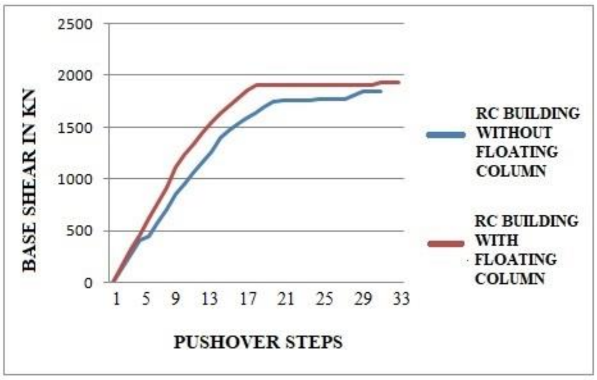


Table: Comparison of Base Shear



3.2 Comparison of Column Forces

The axial force in critical columns for RC building without floating column (Model-1) and RC building with floating column (Model-2) are shown in table below.

1. For Model -1-RC Building without Floating Column

Table : Critical column forces for RC building without floating column.

Story	Column	Load Case	P
Story1	C1	PUSHX	-56.3643
Story1	C9	PUSHX	-459.483
Story1	C13	PUSHX	-325.481
Story1	C14	PUSHX	-507.852

2. For Model-2-RC Building with floating column at Edge

Table : Critical column forces for RC building with floating column

Story	Column	Load Case	P
Story1	C1	PUSHX	-157.446
Story1	C9	PUSHX	-643.312
Story1	C13	PUSHX	-386.738
Story1	C14	PUSHX	-578.694

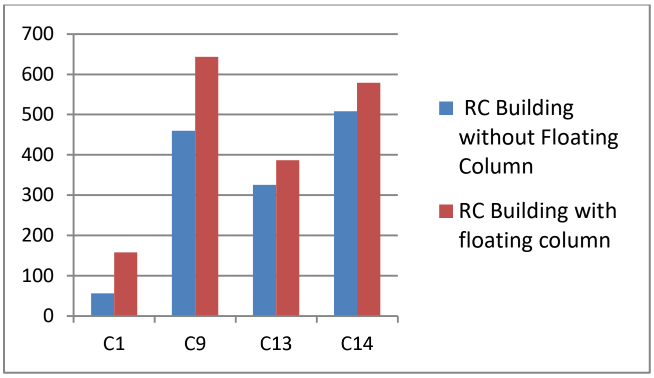


Fig. Comparison of Critical Column Forces of model-1 and model-2

3.3 Comparison of Induced Moments in Column

The critical bending moments in columns for RC building without floating column (Model-1) and RC building with floating column (Model-2) are shown in table below.

1. For Model -1-RC Building without Floating Column

Table : Critical bending moments for RC building without floating column.

Story	Column	Load Case	M3
Story1	C1	PUSHX	95.9836
Story1	C9	PUSHX	170.3263
Story1	C13	PUSHX	140.6791
Story1	C14	PUSHX	174.8923

2. For Model-2-RC Building with floating column at edge position

Table : Critical bending moments for RC building with floating column.

Story	Column	Load Case	M3
Story1	C1	PUSHX	149.0264
Story1	C9	PUSHX	225.7181
Story1	C13	PUSHX	145.5479
Story1	C14	PUSHX	188.0346

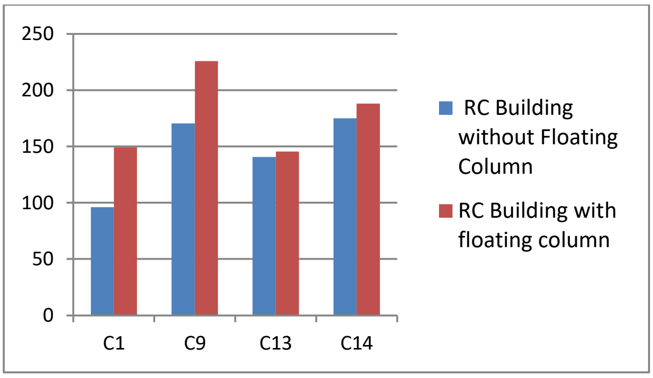


Fig. Comparison of Critical Bending Moments in Column of model-1 and model-2

4. CONCLUSIONS

The behavior of RC building with and without floating column is studied under earthquake excitation.

Structural models have been developed to study the dynamic behavior by using ETABS 2015 software. For this study two types of models are prepared 1st one is RC building without floating column and the 2nd one is RC building with floating column. Pushover analysis method is used to evaluate actual behavior of structure in earthquake excitation and results are obtained. After studying all the results following conclusions can be made:

1. There is significant increase in roof displacement for RC building with floating column as compared to RC building without floating column. That means incorporation of floating column in RC building leads to increase in roof displacement.
2. When base shear of both the buildings are taken into consideration it is observed that base shear in building with floating column increases slightly.
3. If column forces of columns C1, C9, C13, C14(columns below an around girder supporting floating column) are compared with column force in building without floating column ,it is seen that about minimum 50% of increase is observed in column forces with floating column than in building without floating column. The sections of these columns should be appropriately increased to with stand safely.
4. Moments in column C1, C9, C13, C14 are drastically increased in Building with floating column.

REFERENCES

[1] ATC, "Seismic evaluation and retrofit of concrete building", Applied Technical council Vol. 1, No. 40, Redwood City California, 1996.

[2] FEMA, "NEHRP Guidelines for Seismic Rehabilitation of Buildings", Developed by Building Seismic safety Council for Federal Emergency and Management Agency No. 273, Washington D.C.,1997.

[3] FEMA, "NEHRP Guidelines for Seismic Rehabilitation of Buildings", Developed by Building Seismic safety Council for Federal Emergency and Management Agency No. 356, Washington D.C.,2000.

[4] P Fajfar, "A Non Linear Analysis method for Performance Based Seismic Design", Earthquake Spectra, Vol. 16, No.3, p.p. 573-592, 2000.

[5] A Ghobarah, "Performance-based design in earthquake engineering: state of development", Engineering Structures, Elsevier Science Direct, vol. 23, pp. 878–884, 2001.

[6] A.K. Chopra and R.K. Goel, " A modal pushover analysis procedure for estimating seismic demands for buildings", Earthquake engineering and Structural dynamics, John Wiley, p.p. 561-582, 2001

[7] A.M. Mwafy, A.S. Elnashai, "Static pushover versus dynamic collapse analysis of RC buildings", Engineering Structures, Elsevier Science Direct, vol. 23, pp. 407–424, 2001.

[8] A.M. Chandler and Nelson T.K. Lam, "Performance based design in earthquake engineering: a multi-Disciplinary review", Engineering Structures, Elsevier Science Direct, p.p. 1525-1543, 2001.

[9] IS 1893 (Part 1):2016 Criteria for Earthquake Resistant Structures.

[10] Salonikios Karakostas Lekidis and Anthoine, "Comparative inelastic pushover analysis of masonry frames" Engineering Structures. , Elsevier Science Direct, vol. 25, p.p. 1515–1523, 2003.

[11] Triantafyllos K. Makarios, " Optimum definition of equivalent non-linear SDF system in pushover procedure of multistory r/c frames", Engineering Structures, Elsevier Science Direct, vol 27, pp. 814–825, 2004.

[12] C Chintanapakdee and A Chopra , "Seismic Response of Vertically irregular frames : Response history and Modal pushover analyses" Journal of structural engineering, ASCE, vol 130, p.p. 1177-1185, 2004.