Impact Factor (SJIF): 3.632

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 3, Issue 4, April-2016

EFFECT OF VARIOUS POSITIONS OF FLOATING COLUMNS ON A BUILDING WITH AND WITHOUT PROVISION OF INFILL WALLS

Krutarth S. Patel[1], Sumant B. Patel[1], Snehal V. Mevada[1]

[1]*Structural Engineering Department, Birla Vishwakarma Mahavidhyalaya*

Abstract- In today's world building with floating columns if a typical feature in multi-storey buildings. Due need of column free space, aesthetical and functional requirements floating columns are provided at one or more storey at various positions. These types of provisions are highly disadvantage in seismic active areas. This paper aims to investigate the behavior of low rise building when provided with floating columns according to center of stiffness at different floor. Also each model has been analysed with and without effect of infill walls with soft storey. The response of building obtained in form of horizontal and vertical displacements using SAP 2000 version 14.

Keywords : Floating columns, Centre of stiffness, Infill walls Soft storey, Displacements.

1. INTRODUCTION

Structural engineer's greatest challenge in today's world is to design earthquake resistance structure. Due to various requirements of clients and architecture many uncertainties involve in structure, make the structure unstable during earthquakes. Bhuj earthquake is recent example.

General uncertainties involves in structure are vertical irregularities, unsymmetrical planning, unsymmetrical loading, provision of soft or weak storey etc. Today many multi-storey building in urban India have open ground storey as unavoidable feature. This is primarily being adopted to accommodate parking or reception lobbies in the ground storey. Whereas the total seismic base shear as experienced by a building during an earthquake is dependent on its natural period, the seismic force distribution is dependent on the distribution of stiffness and mass along the height.

The behaviour of a building during earthquakes depends on its shape, size and geometry, in addition to how the earthquake forces are carried to the ground. The earthquake forces developed at different floor levels in a building need to be brought down along the height to the ground by the shortest path; any discontinuity in this load transfer results in poor performance of the building.[9]

Buildings with vertical setbacks (like the hotel buildings with a few storey wider than the rest) cause a sudden jump in earthquake forces at the level of discontinuity. Buildings that have weaker columns or walls in a particular storey or with unusually tall storey tend to damage or collapse which is initiated in that storey. Many buildings with an open ground storey intended for parking collapsed or were severely damaged during the 2001 Bhuj earthquake. Damaged buildings in Ahmedabad are typical examples of it.

Buildings with columns that hang or float on transfer beams at an intermediate storey and do not go all the way to the foundation, have discontinuities in the load transfer path.[9]

Discontinuity in load transfer mechanism leads to concentration of loads at a junction which increases the stresses and if structural element is not design for such provisions than it will cause damage.

Detail information and definition of floating / hanging column is given below.

2. FLOATING COLUMN

Figure 2.1 Building with floating columns

A column is a vertical load carrying member which starts from foundation to the top of building, and transfer load to the ground through foundation.
Floating or hanging column is also a vertical load carrying member, but discontinues at some level and rest on beam below it, known as a transfer beam.
There are many projects in which floating columns are adopted, especially above the ground floor, where transfer beams are provided, so that more space is available in the ground floor.
These open spaces may be required for assembly hall or parking or reception purpose. The transfer beams should have to be designed and detailed properly, especially in earth quake zones.
The column is a concentrated load on the beam which supports it. In analysis, the column is assumed pinned at the base and is therefore taken as a point load on the transfer beam. STAAD Pro / ETABS / SAP2000 can be used to do the analysis of this type of structures. Floating columns are enough to carry gravity loading but transfer girder must be of adequate Stiffness with very minimal deflection.[9]

3. METHODOLOGY

In all research papers authors analysed and compare, normal building and floating column building (made from providing floating columns in same normal column building) without revising design after provision of floating columns. At some extent such type of comparison is not gives satisfactory results, as they were not make the structure safe after providing floating columns and compare various parameters. Hence it is require to make the structure safe after such provisions, because in actual design work no one is submitting such work without revision of design. Hence in this work , design of building has been modifying by increasing the dimensions of failed members and describe the results and conclusions based on those safe designs. That's why comparing to the research papers, the values of displacements are quite less but shows practical and satisfactory results.

4. PROBLEM FORMULATION

The entire work consists of 20 models and these models were modeled and analysed by SAP 2000. They analysed for local zone III (Vidhyanagar) , medium soil condition, and results are tabulated for horizontal and vertical displacements.
Table given below shows the information about different models and their specifications:

Model No.	Specification
All 1-10 models are analysed without infills and 11-20 are analysed with infills	
1	Normal building without floating columns
2	Corner floating columns @ G.F
3	Internal floating columns @ G.F
4	Centre floating column @ G.F
5	Corner floating columns @ F.F
6	Internal floating columns @ F.F
7	Centre floating column @ F.F
8	Corner floating columns @ S.F
9	Internal floating columns @ S.F
10	Centre floating column @ S.F
11-20	Similar as model 1-10 but with infill walls

- Followings are data which used for design and analysis of model
  - Plan dimensions : 14m X 14m (bay width 3m , 1m projection beyond columns)
  - Floor height : 12m (3m for each)
  - Base column : 0.550 X 0.550 m
  - Other columns : 0.450 X 0.450 m
  - Beam : 0.350 X 0.450 m
  - Slab thickness : 0.125 m
  - Live load (for model 1 to 11) : 2 kn/m^2
  - Importance factor : 1
  - Response reduction factor : 5
  - Zone : III
  - Soil type : Medium
  - Size of infill wall : 0.230 m

Followings are pictures showing plan, sectional elevation and 3-dimentional representation of various designed models:

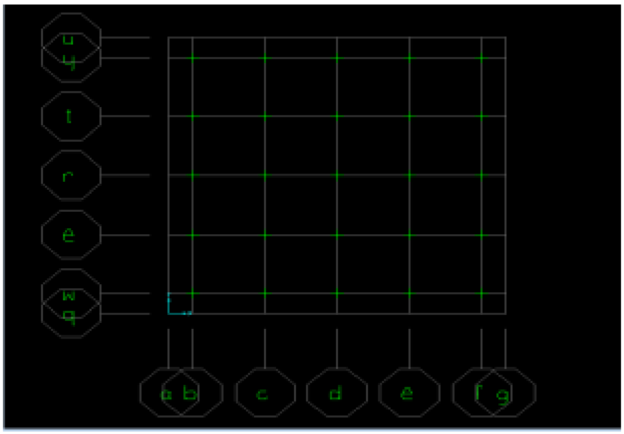

Figure 4.1 Plan of building

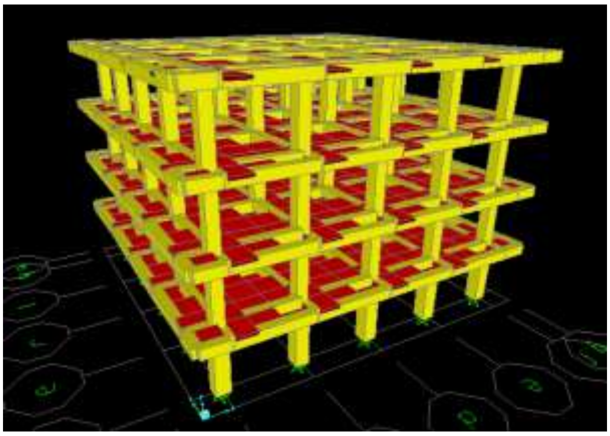

Figure 4.2 3-D model

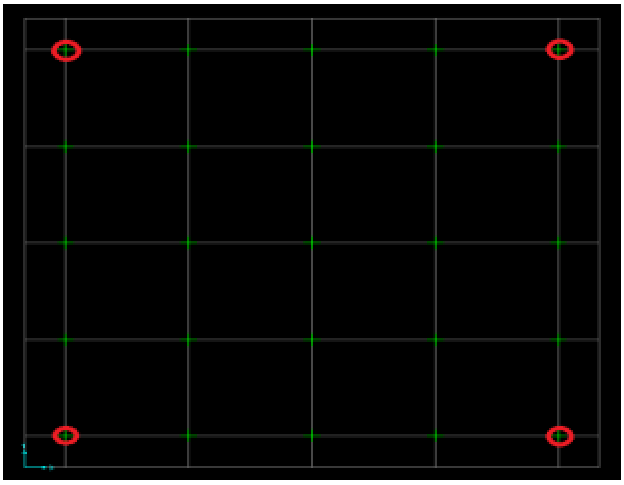

Figure 4.3 Corner position of F.C

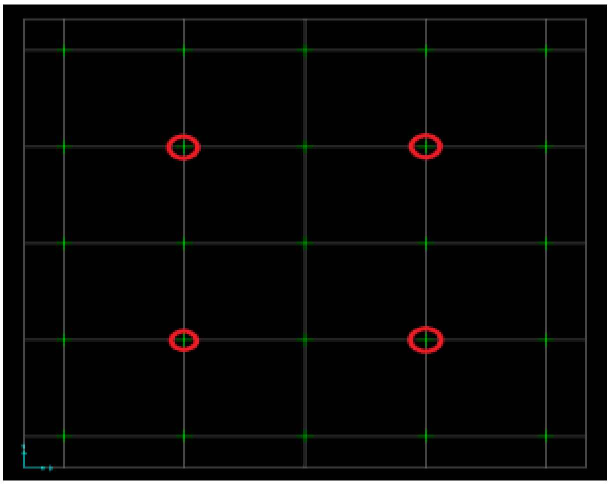

Figure 4.4 Internal position of F.C

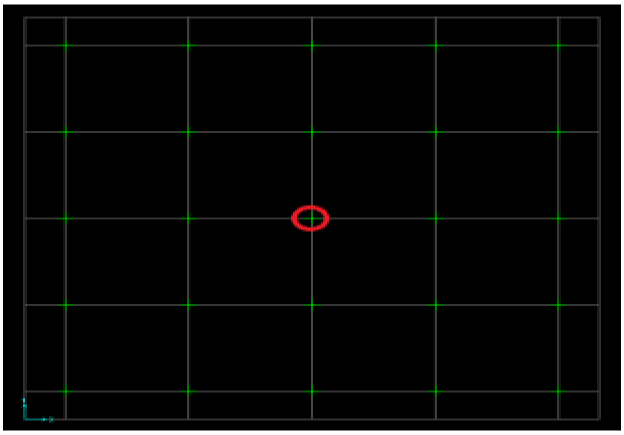

Figure 4.5 Central position of F.C

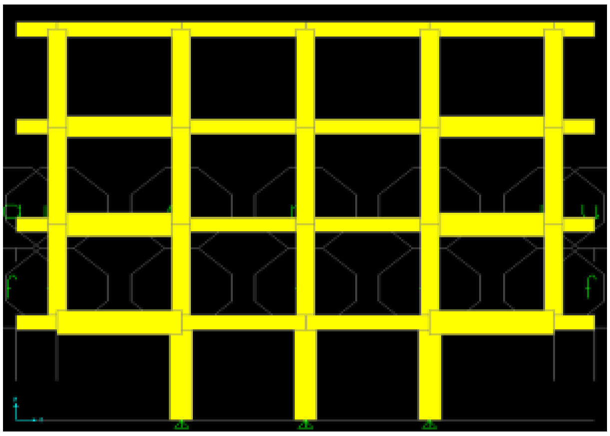

Figure 4.5 F.C at G.F corners

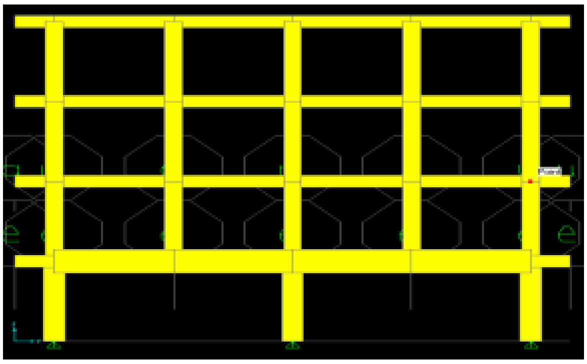

Figure 4.6 F.C at G.F internal side

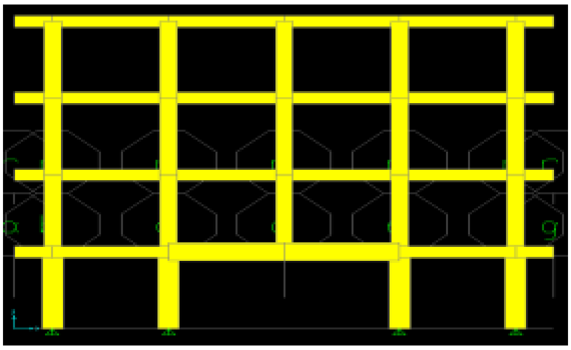

Figure 4.7 F.C at G.F centre

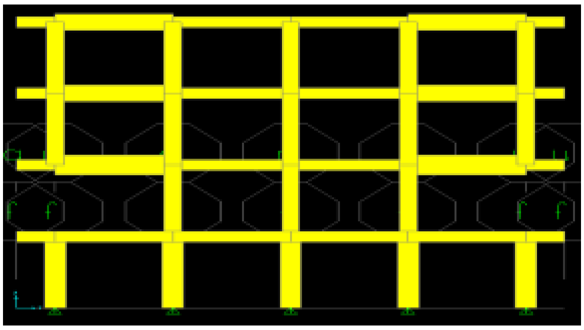

Figure 4.8 F.C at F.F corners

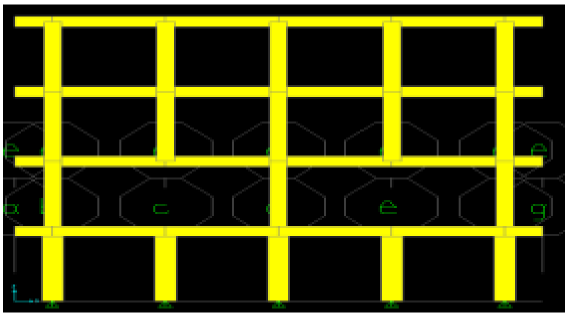

Figure 4.9 F.C at F.F internal site

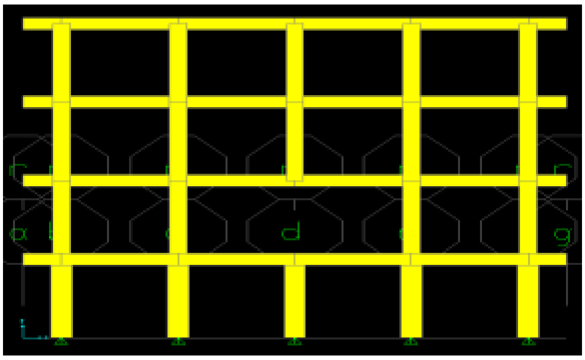

Figure 4.10 F.C at F.F centre

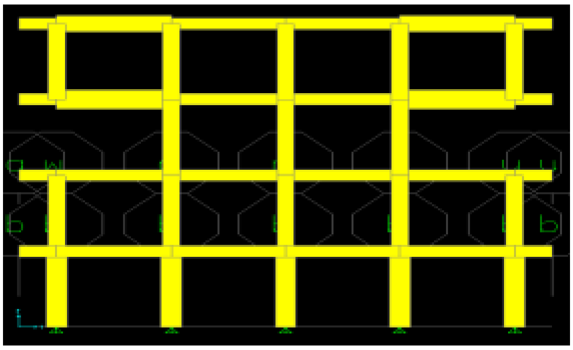

Figure 4.11 F.C at S.F corners

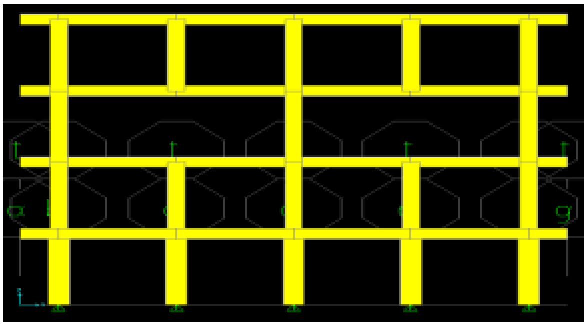

Figure 4.12 F.C at S.F internal side

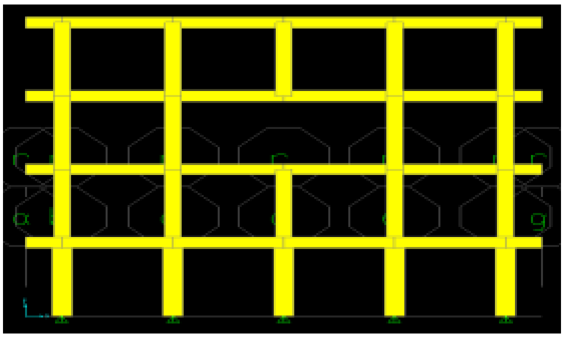

Figure 4.13 F.C at S.F centre

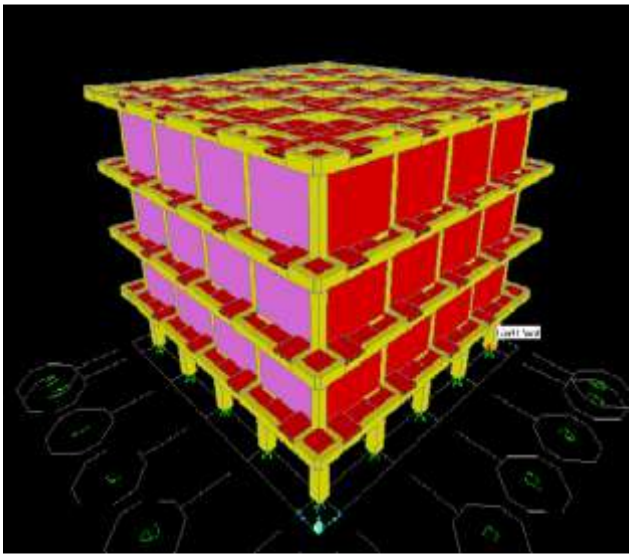

Figure 4.13 3-D model with infill walls

The software used for the present study is SAP 2000 version 14, used for analysing general structures including bridges, stadium, tower, industrial plants, off shore structure, buildings, dams, soils, etc. It is fully integrated programme that allows model creation, modification, execution of analysis, design optimization, and result review from within a single interface. SAP 2000 is finite element based structural programme for analyse and design of civil structures.

5. RESULTS AND DISCUSSIONS

Various models listed above were analysed using SAP 2000. Results were obtained in form of maximum horizontal and vertical displacements of typical floor for each case. To obtain the worst condition, results were taken by applying ENVELOP load combination. Which includes all the load cases at a time (dl+ll+eqx+eqy) and gives the idea about max. possible displacements.

Results includes the comparison of various models with each other according to the position of floating columns, storey wise comparison , and comparative study for building with and without effect of infills.

5.1 Tabular and graphical comparison :

Here in the table , data shows the obtained values of horizontal displacements for both with and without infills for the critical case – 2 :

Design	Storey	Horizontal disp. With infill(mm)	Horizontal disp.without infill(mm)	% Comparison
2	1	1.12	0.8	-28.57142857
	2	1.47	1.4	-4.761904762
	3	1.73	1.9	9.826589595
	4	1.89	2.39	26.45502646

Table 5.1 Comparative % Horizontal displacements for critical case no 2 building

And here is the graphical comparison :

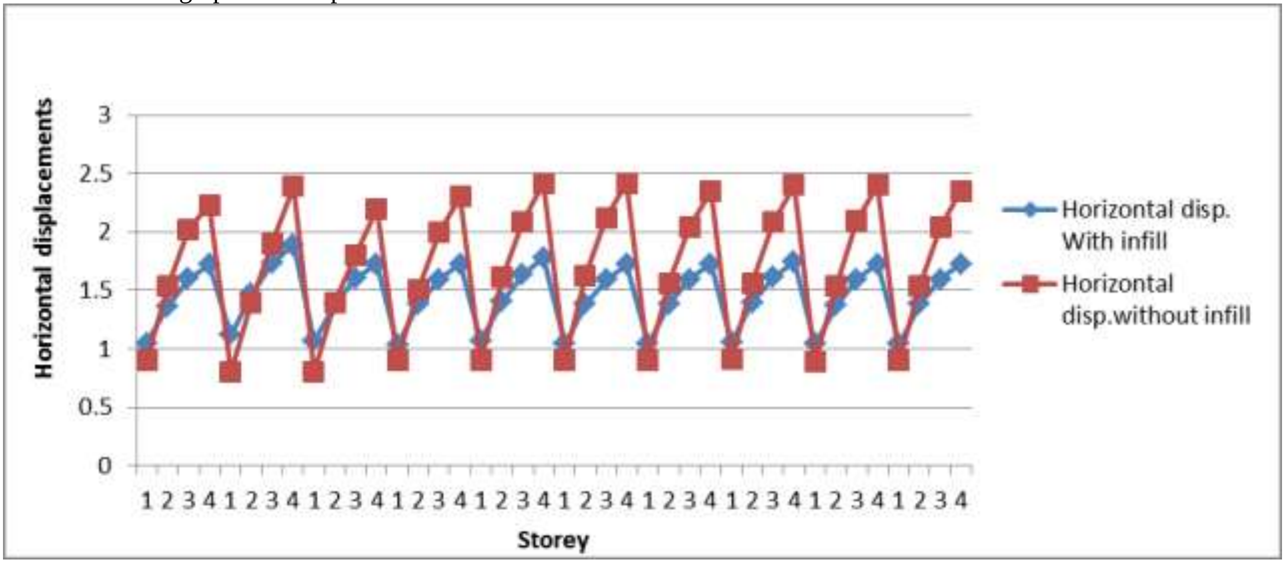

Figure 5.1 Comparison of storey wise horizontal displacements between model 1-10 and 11-20

And here's for the vertical displacements :

Design	Storey	vertical displ. With infill	verical disp. Without infill	Comparative %
1	1	0.211	0.229	8.530805687
	2	0.1	0.28	180
	3	0.12	0.3	150
	4	0.24	0.36	50
2	1	0.393	0.84	113.740458
	2	0.34	0.76	123.5294118
	3	0.33	0.755	128.7878788
	4	0.45	0.79	75.55555556

Table 5.2 Comparative % Vertical displacements for normal building and critical case no 2 building

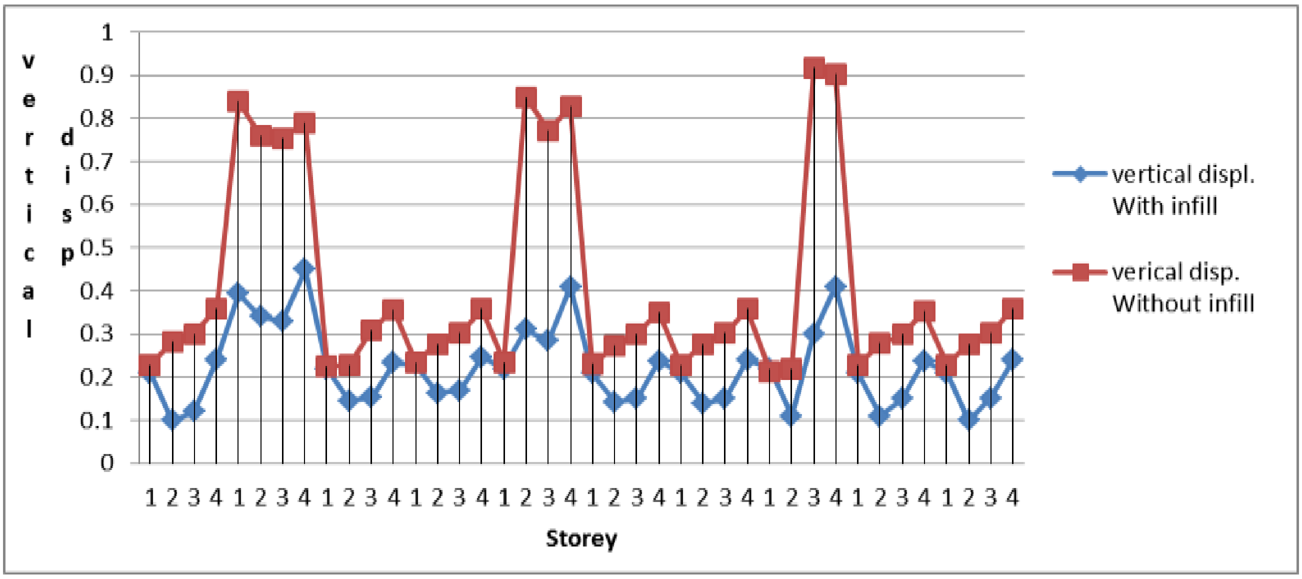

Figure 5.2 Comparison of storey wise vertical displacements between model 1-10 and 21-30

6. CONCLUSIONS

i. Results from all graphs shows that, buildings with provisions of floating columns at corners, on any floor, shows the poor performance compare to other cases. Hence corner provisions of floating columns should be considered as critical case.
ii. As the position of floating columns changes from corner to the centre of stiffness of typical floor, there is decrement in value of displacements. Higher decrement can be seen in vertical displacements, comparison to the horizontal one.
iii. Infill walls provide seismic strengthening of the floating column building. It also helps to reduce seismic response of the building.
iv. An analytical result shows that, a horizontal displacement reduces by 26.5% (max) and a vertical displacement reduces by 128.78% (max) after infill provisions.
v. A graphical comparison shows that in cases without infiills, there is sudden increment in value of displacements compare to the cases with infills.

7. REFERENCES

1) Dubal R.A , Vasanvala S.A , Modhera C.D, " *Application of performance based seismic design method to column discontinued rc frames*" vol – 119, ijca, june 2015.
2) Hardik Bhensdadia, Siddharth Shah *''Pushover analysis of rc frame structure with floating column and soft story in different earthquake zones*'', vol-4 ijret , 2015.
3) Isha Rohilla, S.M. Gupta, Babita Saini, '*Seismic response of multi-storey irregular building with floating column*'', vol-4 ijret , 2015.
4) Nikhil Bandwal, Anant Pande, Vaishali Mendhe, Amruta Yadav '' *To study seismic behaviour of rc building with floating columns* '', vol-3 ijsetr, p: 1593-1596,2014.
5) Poonam, Anil Kumar And Ashok K. Gupta'' *Study of response of structurally irregular building frames to seismic excitations* '', vol-2 ijcseierd,,2012.
6) Srikanth.M.K, Yogeendra.R.Holebagilu, *''Seismic response of complex buildings with floating column for zone ii and zone v''*, vol-2 ijoer,2014.
7) Susanta Banerjee, Sanjaya Kumar Patro' ''*Estimation of the park-ang damage index for floating column building with infill wall*'', vol-8 issri , 2014.
8) Kabade P.P, Shinde D.N, "*Effect of column discontinuity on base shear and displacement of structure*" vol – 1, ijaetmas, july-2014a
9) Behra Sukumar, "*Seismic analysis of multistorey building with floating column*", thesis work in nit, rourkela, may 2012.
10) SAP 2000 14 manuals, Structural Analysis Program,(2010). Computers and Structures Inc. , Berkeley CA.
11) Murty C.V.R, " *Earthquake tips*" , IIT ,Kanpur.
12) Agrawal P., Shrikhande M., "Earthquake resistance design of structure" , PHI learning private limited, New Delhi.
13) Krishna Raju, R.N.Pranesh, "Reinforced concrete design IS 456-2000 Principles and practice"
14) Criteria for earthquake resistance design of structures, Part : 1 General provisions and buildings, IS 1893:2002. Bureau of Indian Standards, New Delhi.
15) Plain and reinforced concrete – code of practice , IS 456-2000, Bureau of Indian Standard, New Delhi.
16) http://www.selfindia.com/forum/viewtopic.php
17) http://www.jknanda.wordpress.com/2010/20/10/floatingcolumn.html
18) http://www.wikipedia.com/hangingcolumns.html