

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 9, September 2018

Reliability Analysis of Multi-Storey Building with Floating Column for Long Span

Kuldeep Dubey¹, Dr. Rakesh Patel²

M.Tech Scholar, Department of Structural Engineering, Sagar Institute of Research, Technology & Science,
Bhopal, India¹

Asst. Professor, Department of Civil Engineering, Sagar Institute of Research, Technology & Science, Bhopal, India²

ABSTRACT: In today life it is very difficult to make a building with floating column in urban India. This technology is highly undesirable in building built in earthquake active areas. This study provide knowledge about the importance of presence of the floating column in the analysis of building. This study is about stiffness balance of the first storey and the storey above, and are proposed to reduce the irregularity introduced by the floating columns. This study is related to floating column placed on long span transfer beam.

For the study of buildings with floating column we used FEM codes for 2D multistory frames to study the responses of the structure under different earthquake excitation having different frequency content keeping the time duration factor constant. The time history of floor displacement, inter storey drift, base shear, overturning moment are computed for the frames with floating column.

KEYWORDS: Floating column, Earthquake active area, Irregularities remove, Stability for long span, Transfer beam.

I. INTRODUCTION

A vertical member which is start from the foundation level is known as column. Floating Column is also a vertical member which is started from the horizontal member called beam. i.e. floating column is not started from the ground. it is footing less vertical member. The beam which is act as foundation is called as transfer beam this is widely used in above open storey in building.

Why Floating Column

1. This helps to alter the plan of top floors to our convenience, the transfer beam that support floating columns will be designed with more reinforcement.
2. And transfer the load of above storey of building at specific column safely.

Objective Of Work

1. The objective of present work is to study the behaviour of multi-storey building with floating column under earthquake excitation.
2. Remove ir-regularity in multi-storey building.
3. Calculation of base shear, overturning, drift on the multi-storey building.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 9, September 2018

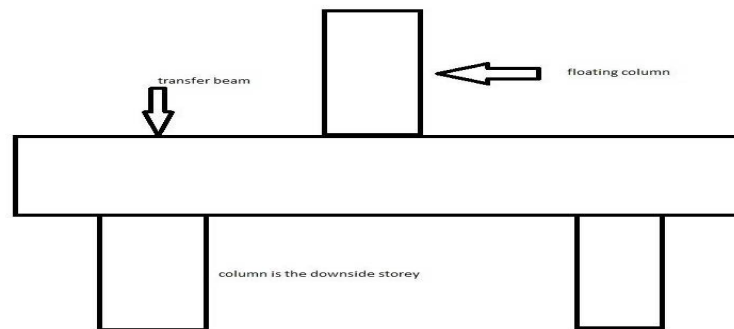


fig. no.1:- line diagram

In fig. 1, two vertical column which is start from ground is known as column and the column which start from transfer beam is known as floating column.

II. RELATED WORK

There are some research which is related to our work. Research are as follows-

1. **Tamner and Talikoti [2016]**- It gives the strength to the building when the horizontal beam designed safely, it gives 46.17% more strength.
2. **Ashfi rahman(2015)** – In this paper static and dynamic analysis is done with response spectrum method for a multi-storey with and without floating column. This analysis is done by using STAAD pro v8i software in this research floating column position is changed in a floor and the floating column is changed in a storey results are based on the fundamental time period, spectral acceleration, base shear, storey drift and storey displacement.
3. **Sekhar and Prasad(2014)** – in this paper the behavior of building structure with floating column and without floating column is studied under static load, forced and free vibration condition and the results are plotted for both the frames by comparing time history of floor displacement and base shear the static analysis of building frame is done by software STADD pro v8i and comparison of these models are presented. So that this study help us to find the analytical properties of the structure and we can constructed the building structure with systematic and economical type.
4. **Ozyigit (2009)** performed free and forced in-plane and out-of-plane vibrations of frames are investigated. The beam has a straight and a curved part and is of circular cross section. A concentrated mass is also located at different points of the frame with different mass ratios. FEM is used to analyze the problem.
5. **Maison and Ventura (1991)**, Members of asce computed dynamic properties and response behaviours of thirteen-story building and this result are compared to the true values as determined from the recorded motions in the building during two actual earthquakes and shown that state-of-practice design type analytical models can predict the actual dynamic properties.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 9, September 2018

III. METHODOLOGY AND DISCUSSION

Analysis By STAAD ProV8i SOFTWARE.

1. Static Analysis
 - Plane Frame Element
2. Dynamic Analysis
 - Time History Analysis
 - New mark's Method

STATIC ANALYSIS:- This analysis is done by plane frame element.

PLANE FRAME ELEMENT:-

1. Plane frame element is a finite element method in this method stiffness matrix is used to solve the problem.
2. This is 2-D finite element method with two co-ordinate namely local and global.
3. Plane frame element having area(A), length(L), elasticity(E) and moment of inertia(I).
4. In this method each element has two nodes.
5. In this method each node have 2 displacement and 1 rotation are available. So plane frame element has degree of freedom. i.e. 6 no
6. So stiffness matrix generally 6X6 matrix.

DYNAMIC ANALYSIS:-

1. Dynamic analysis of any building structure is a branch of structural engineering in which we study the behaviour of flexible building due to dynamic loading. This dynamic load changes according to time.
2. Dynamic load include earthquake, wind and live load etc.
3. In comparison with static analysis, displacement and stresses are much higher. This is find by following method-

TIME HISTORY ANALYSIS:-

1. Time history analysis is a finite element method. This method use to calculate the response at discrete time, but this method required more calculation effort.
2. This method is used to calculate the mode shape of the building structure according to load condition by using some numerical calculation.
3. This method is used for break the coupled equation into uncoupled equation. This make solution easy.
$$[M]\{X''\}+[C]\{X'\}+[K]\{X\} = X''g(t)[M]\{I\}$$
----- (coupled equation)
$$[M]\{q''\}+[C]\{q'\}+[K]\{q\} = \{Peff.(t)\}$$
----- (uncoupled equation)
4. After all the calculation we can get the participation factor of building according to mode shape.
$$\{Peff.(t)\} = (-X''g(t)[\emptyset]^T[M]\{I\})$$
5. This participation factor further solve by numerical method. That is new mark's method.

NEWMARK'S METHOD:-

Using boundary condition on displacement and initial velocity condition, we get the solution of new mark's equation. By the help of this equation we can easily solve the time history analysis equation and get the participation factor, by the help of this factor mode shape of the building is determine.

Data of building structure are as follows-

In this analysis we consider a residential as well as commercial building in mandideep, Bhopal {m.p.}. Building having zone factor 0.10. This is G+2 storey building, Total height of this building is 9.760M, Ground floor height 3.660M, 1ST and 2nd floor height is 3.050M. Base dimension of building is 18.520X31.210M, Length of each beam is

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 9, September 2018

varies according to span condition, Size of beam and column is depend on the condition of load. This is ordinary moment resisting frame, Depth of foundation is 2M in Medium soil condition.

INPUT DATA OF LOADING:-

- | Type of load (dead) | Intensity(KN/M) |
|--|-----------------|
| 1. Member load(outer wall of ground floor) | = 14.4 |
| 2. Member load(inner wall of ground floor) | = 7.21 |
| 3. Member load(inner wall 1 st and 2 nd floor) | = 11.88 |
| 4. Member load(outer wall 1 st and 2 nd floor) | = 5.94 |
| 5. Member load(top parapet wall) | = 1.8 |
| 6. Floor weight (KN/M ²) | = 3 |
- In terms of floor load live load is acting this is 3 KN/M²

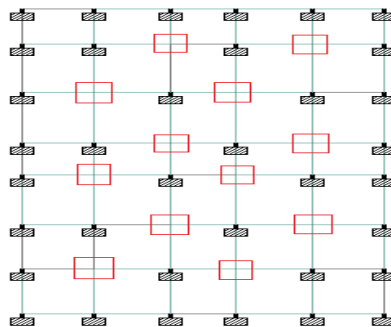


fig. no. 2:- plan of building with fc

fig.2 shows structure dimension with fc and without fc. Red in colour is fc; start from 1st storey.

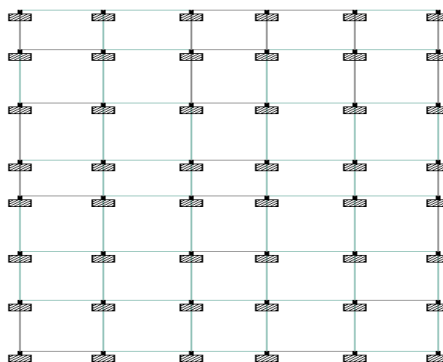


fig.no. 3:-plan of building without fc

fig.3 shows structure dimension without fc. All columns are normal column ; start from foundation level.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 9, September 2018

table no. 1:- input values in staad

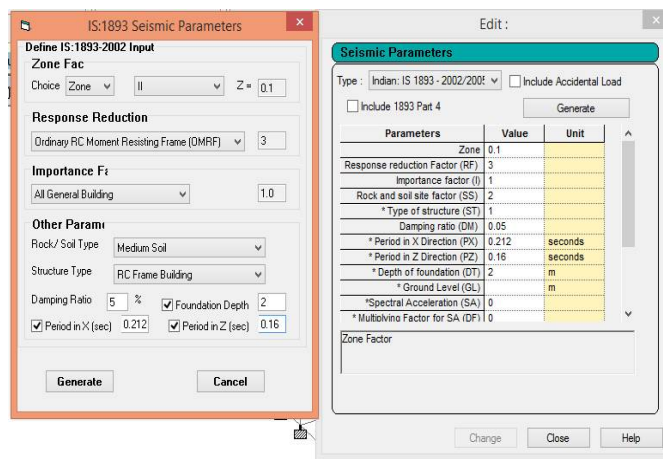


Table 1 shows input values of building with zone, type of frame etc. In staad pro.

IV. EXPERIMENTAL RESULTS

STATIC RESULTS:-

1. Maximum results of g+2 storey building on column:-

table no. 2:-values on columns

No.	Content	TYPE OF BUILDING	GROUND FLOOR	FIRST FLOOR	SECOND FLOOR
1.	DISPLACEMENT (mm)	WITH FC	4.779	13.481	13.845
		WITHOUT FC	3.860	6.7000	8.555
2.	BENDING MOMENT (kN-m)	WITH FC	59.656	80.529	59.608
		WITHOUT FC	19.116	17.440	15.156
3.	SHEAR FORCE (kN)	WITH FC	37.823	22.497	22.312
		WITHOUT FC	10.442	12.324	9.314
4.	AXIAL FORCE (kN)	WITH FC	1570	720.616	152.748
		WITHOUT FC	601.692	384.402	162.344

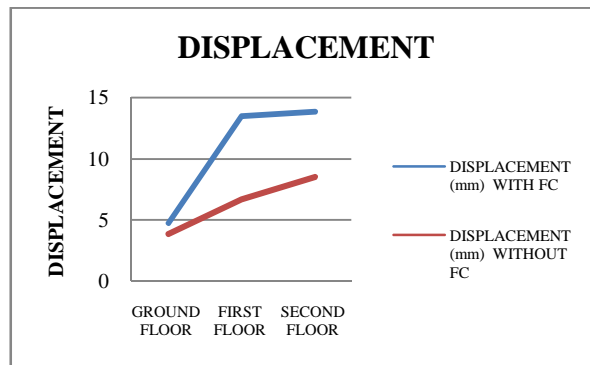
Table 2 shows the value on column for FC building and WFC building.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

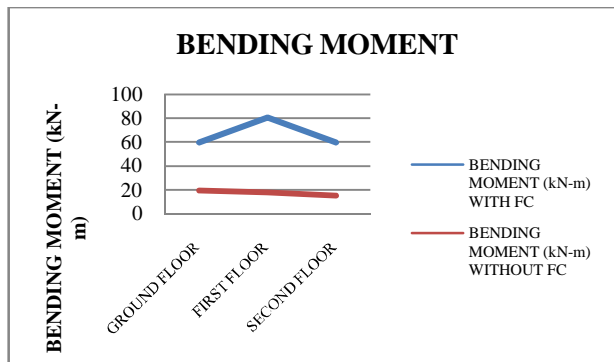
Visit: www.ijirset.com

Vol. 7, Issue 9, September 2018



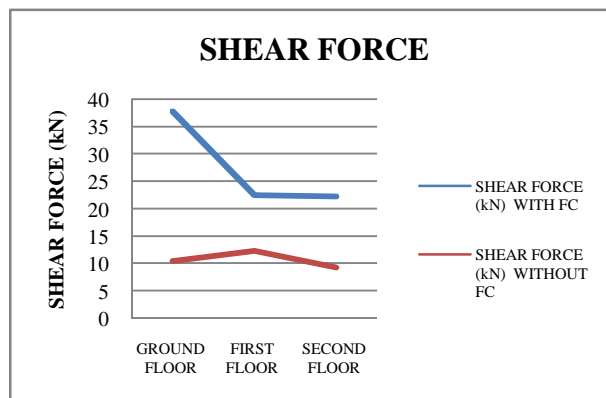
graph no.1:- displacement between fc and wfc buildings

in graph 1 displacement between fc and without fc building in columns due to horizontal as well as vertical load. By this load building gives the above value in displacement in staad software for maximum load combination.



graph no.2:- bending moment between fc and wfc buildings

in graph 2 BM between fc and without fc building in columns due to horizontal as well as vertical load. By this load building gives the above value in BM in staad software for maximum load combination.



graph no.3:- shear force between fc and wfc buildings

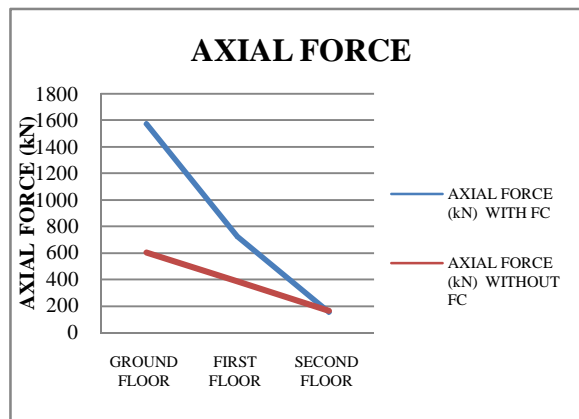
International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 9, September 2018

in graph 3 shear force between fc and without fc building in columns due to horizontal as well as vertical load. By this load building gives the above value in shear force in staad software for maximum load combination.



graph no.4:- axial force between fc and wfc buildings

in graph 4 axial force between fc and without fc building in columns due to horizontal as well as vertical load. By this load building gives the above value in axial force in staad software for maximum load combination.

2. Maximum results of g+2 storey building on beam :-

table no. 3:- maximum values on beam

No.	Content	TYPE OF BUILDING	GROUND FLOOR	FIRST FLOOR	SECOND FLOOR
1.	DISPLACEMENT (mm)	WITH FC	13.788	15.133	15.300
		WITHOUT FC	6.127	8.353	8.649
2.	BENDING MOMENT (kN-m)	WITH FC	344.718	77.007	57.881
		WITHOUT FC	54.544	47.340	6.440
3.	SHEAR FORCE (kN)	WITH FC	219.388	66.856	42.435
		WITHOUT FC	53.584	53.118	19.505
4.	AXIAL FORCE (kN)	WITH FC	4.884	2.589	2.334
		WITHOUT FC	1.449	0.482	0.322

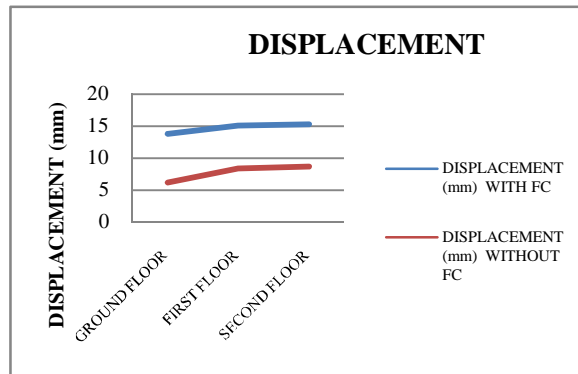
International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

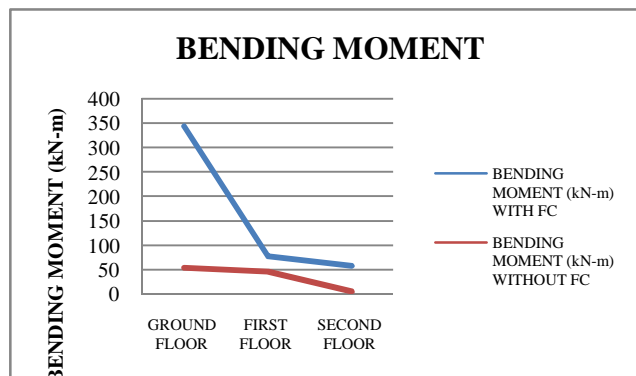
Vol. 7, Issue 9, September 2018

Table 3 shows different values of displacement, BM, SF, AF in beam of FC and WFC building.



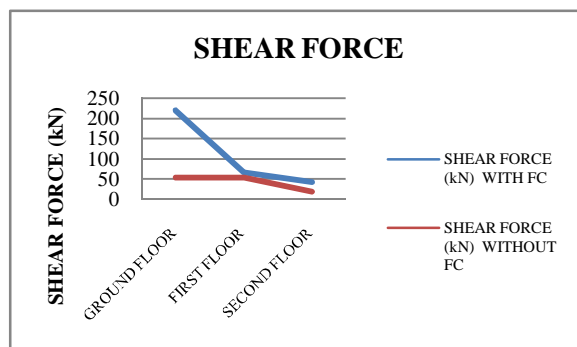
graph no.5:- displacement between fc and wfc buildings

in graph 5 displacement between fc and without fc building in beams due to horizontal as well as vertical load. By this load building gives the above value in displacement in staad software for maximum load combination.



graph no.6:- bending moment between fc and wfc buildings

in graph 6 BM between fc and without fc building in beams due to horizontal as well as vertical load. By this load building gives the above value in BM in staad software for maximum load combination.



graph no.7:- shear force between fc and wfc buildings

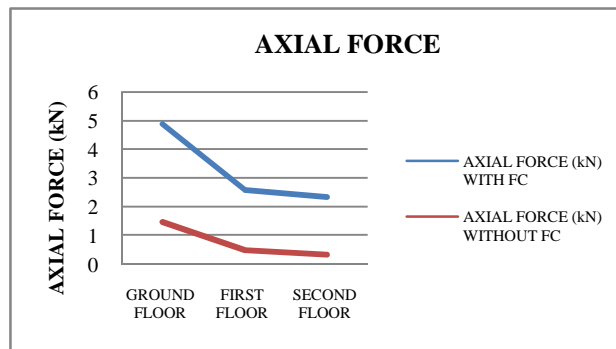
International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 9, September 2018

in graph 7 shear force between fc and without fc building in beams due to horizontal as well as vertical load. By this load building gives the above value in shear force in staad software for maximum load combination



graph no.8:- axial force between fc and wfc buildings

in graph 8 axial force between fc and without fc building in beams due to horizontal as well as vertical load. By this load building gives the above value in axial force in staad software for maximum load combination

DYNAMIC ANALYSIS:-

1.Mode shape of framework:-

table no. 4:- mode shape of building

MODE	TYPE OF BUILDING	FREQUENCY(CYCLE/SEC)	PERIOD(SEC)
1	WITH FC	1.211	0.82579
	WITHOUT FC	0.968	1.03272
2	WITH FC	1.227	0.81526
	WITHOUT FC	0.982	1.01796
3	WITH FC	1.388	0.72068
	WITHOUT FC	1.064	0.93989
4	WITH FC	3.362	0.29744
	WITHOUT FC	3.051	0.32774
5	WITH FC	3.398	0.29428
	WITHOUT FC	3.083	0.32435
6	WITH FC	3.787	0.26408
	WITHOUT FC	3.358	0.29778

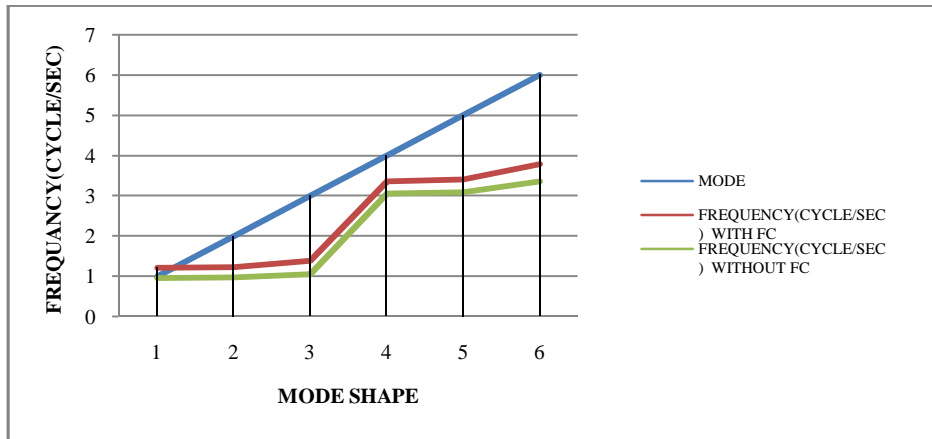
Table 4 shows the different mode shapes at different load combinations in building with FC and WFC building.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 9, September 2018



graph no.9:-mode shape of building

in graph 9 mode shapes between fc and without fc building due to horizontal as well as vertical load. By this load building gives the above value in mode shape in staad software for maximum load combination.

2. Is code time history:-

table no. 5:- time history

MODE	TYPE OF BUILDING	SPECTRAL ACCELERATION	DESIGN SEISMIC COEFFICIENT		
			X	Y	Z
1	WITH FC	1.64692	0.0593	0.0000	0.0593
	WITHOUT FC	1.31691	0.0474	0.0000	0.0474
2	WITH FC	1.66818	0.0601	0.0000	0.0601
	WITHOUT FC	1.33600	0.0481	0.0000	0.0481
3	WITH FC	1.88710	0.0679	0.0000	0.0679
	WITHOUT FC	1.44698	0.0521	0.0000	0.0521
4	WITH FC	2.50000	0.0900	0.0000	0.0900
	WITHOUT FC	2.50000	0.0900	0.0000	0.0900
5	WITH FC	2.50000	0.0900	0.0000	0.0900
	WITHOUT FC	2.50000	0.0900	0.0000	0.0900
6	WITH FC	2.50000	0.0900	0.0000	0.0900
	WITHOUT FC	2.50000	0.0900	0.0000	0.0900

Table 5 shows dynamic analysis of building with respect to time history analysis.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 9, September 2018

3. Storey drift v/s time response :-

table no. 6:- story drift in building

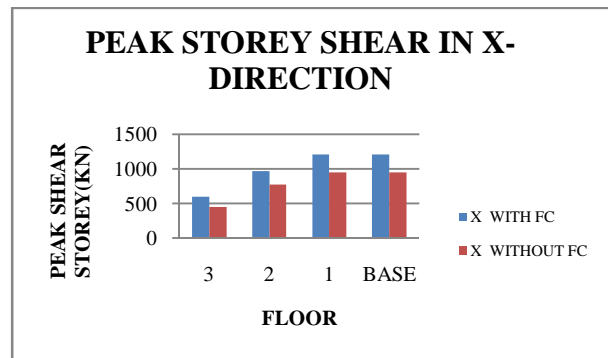
STOREY	HEIGHT	LOAD	TYPE OF BUILDING	AVG. DISPLACEMENT(CM)		DRIFT(CM)	
				X	Z	X	Z
BASE	0.00	----	WITH FC	----	----	----	----
			WITHOUT FC	----	----	----	----
1	0.00	1	WITH FC	0.0000	0.0000	0.0000	0.0000
			WITHOUT FC	0.0000	0.0000	0.0000	0.0000
2	3.66	1	WITH FC	-0.0043	-0.0042	0.0043	0.0042
			WITHOUT FC	0.0000	-0.0030	0.0000	0.0030
3	6.71	1	WITH FC	-0.0050	-0.0002	-0.0007	0.0040
			WITHOUT FC	0.0000	-0.0063	0.0000	0.0033
4	9.76	1	WITH FC	0.0017	0.0121	0.0067	0.01223
			WITHOUT FC	0.0000	-0.0106	0.0000	0.0042

Table 6 shows the value of displacement and drift value of building with FC and WFC.

4. Peak storey shear:-

table no. 7:- storey shear in building

STOREY	LEVEL(M)	TYPE OF BUILDING	PEAK STOREY SHEAR (KN)	
			X	Z
3	9.76	WITH FC	593.85	590.63
		WITHOUT FC	448.92	450.15
2	6.71	WITH FC	965.60	956.62
		WITHOUT FC	770.56	768.90
1	3.66	WITH FC	1203.67	1190.56
		WITHOUT FC	948.78	980.68
BASE	0.00	WITH FC	1203.67	1190.56
		WITHOUT FC	948.78	980.68



graph no.10:- peak shear in x and z-direction between fc and wfc buildings

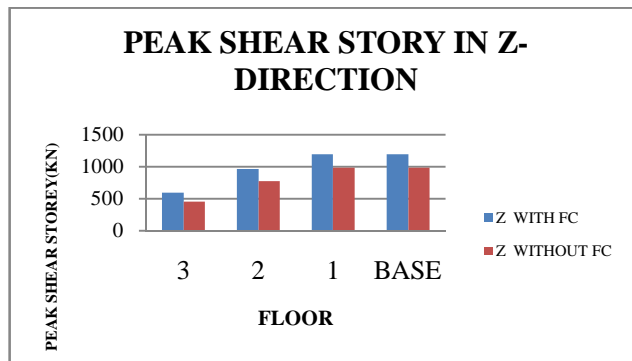
in graph 10 shear storey in X- direction between fc and without fc building due to horizontal as well as vertical load. By this load building gives the above value in storey shear in staad software for maximum load combination.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 9, September 2018



graph no.11:- peak shear in x and z-direction between fc and wfc buildings

in graph 11 mode shapes between fc and without fc building due to horizontal as well as vertical load. By this load building gives the above value in shear storey in Z- direction in staad software for maximum load combination

5. Cost /material quantity analysis:-

Table no. 8:- cost-material table

TYPES OF BUILDING	MATERIAL		RATE		TOTAL COST
	COCRETE(M3)	REINFORCEMENT(TONNE)	COCRETE/M3	R/F/TONNE	
WITH FC	175.90	174.152	3380	40000	7560622
WITHOUT FC	127.70	147.936	3380	40000	6349066

Table 8 shows cost analysis between reinforcement and concrete for FC and WFC building.

V. CONCLUSION

In this analysis we get the following conclusion-

1. When we applied static load on both buildings; then both buildings are found safe.
2. In dynamic load; with floating column structure is found unsafe. i.e. In earthquake this building found unsafe. So to make the structure safe beams and columns size are to be increased.
3. With the increase in size the quantity of concrete material is increased by 27.40%.
4. With the increase in displacement, bending moment, shear force and axial force in beams and columns in the structure reinforcement increased by 15.05%.
5. Increase in quantity of concrete and reinforcement building cost is increased by 16.02%.
6. After increasing size and providing reinforcement; building found safe in dynamic load in stadd pro analysis. Thickness of supporting beam is reduce upto 500mm.
7. In column at which supporting beam is rest, no. of reinforcement is find more. so reinforcement is increases and cross sectional area is increases.
8. By introducing floating column, irregularities are removed from the structure.
9. By applying floating column in structure building make serviceable for utilization purpose.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 9, September 2018

REFERENCES

1. **Agarwal Pankaj, Shrikhande Manish (2009)**, "Earthquake resistant design of structures", PHI learning private limited, New Delhi edition 1st-2009.
2. **Arlekar Jaswant N, Jain Sudhir K. and Murty C.V.R. (1997)**, "Seismic Response of RC Frame Buildings with Soft First Storey". Proceedings of the CBRI Golden Jubilee Conference on Natural Hazards in Urban Habitat, 1997, New Delhi.
3. **James L. Stratta**, Manual of seismic design, published by pearson education, first edition, ISBN 81-297-0180-4, 2003.
4. **B.c. Punmia, Ashok ku. Jain, at.el.** Theory of structure, Laxmi publication (p) LDT. 2013.
5. **Awkar J. C. and Lui E.M.**, "Seismic analysis and response of multistory semi-rigid frames", Journal of Engineering Structures, Volume 21, Issue 5, Page no: 425-442, 1997.
6. **Prasannan and matew(2017)**- seismic performance of rc floating column considering different configuration. IJERT, vol.6, issue 9, may 2017, pp. 100-107.
7. **Sukumar behera, NIT, ROURKELA(2012)**- report about floating column in seismic zone, dept. Of civil engineering, NIT, Rourkela,769008, may 2012.
8. **Waykule and pise (2016)**- study of behaviour of floating column for seismic analysis of multi-storey building.IJCIET, vol.7 issue 6, nov.-dec. 2016, pp. 676-685.
9. **Nanabala and ramancharla(2004)**- seismic analysis of a normal building and floating column building. IJERT, vol. 3, issue 9, sep. 2014, pp. 981-987.
10. **SOR PWD** for taking values of concrete and reinforcement rate. Addendum no. 05, chapter 13, w.e.f. 01-08-2014.
11. **IS456- 2000**, plain and reinforced concrete - code of practice, fourth revision, july 2000.
12. **IS1893-2002**, criteria for earthquake resistant design of structures, part 1, fifth revision, BIS 2002.