International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 04 | Apr 2020 www.irjet.net p-ISSN: 2395-0072

SEISMIC RESPONSE OF R. C. BUILDING AT DIFFERENRT RISE WITH FLOATING COLUMN AND SOFT STOREY

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Abstract – Now a days in Construction scenario floating column is growing as a new and improved feature for the reinforced concrete framed buildings in urban areas of India. Buildings with floating columns have discontinuities in the load transfer path. Closely spaced columns are not desirable at the lower level floors. These buildings are designed for gravity loads but not for earthquake loads. This paper studies the analysis of a G+5,G+10,G+15 storey normal building and a G+5,G+10,G+15 storey floating column building with soft Storey and comparison of these models are been presented. The analysis is done by the use of Etabs 2015 and structure was assumed to be situated in earthquake Zone III. The seismic performance of building with floating columns are presented in terms of various parameters such as time and Frequency, Storey displacement, storey drift, El Centro Ground Motion etc

***Key Words*: floating column, Soft storey, time and frequency, storey displacement, storey Drift, El Centro ground**

1. Introduction

The shortage of space is a growing issue nowadays in urban cities due to increase in population. For this there is a need of having column free space. Many urban multi-storey buildings in India today have open first storey as an unavoidable feature. The modern construction techniques in which main concern is given to the structural and architectural needs is shaping out, most high-rise buildings have open ground storey space for parking area, lobbies, receptions and for other aesthetic requirements. There are many projects in which floating columns are adopted, especially above the ground floor, so that more open space is available in the ground floor. Structure with floating column construction has grown rapidly and caught everyone's attention in structural engineering.

1.1 Floating Columns

The columns which are supported on a beam instead of rigid foundation are called as floating columns. The floating column acts as a point load on the beam and this beam transfers the load to the columns below it. The column may start off on the first or second or any other intermediate floor while resting on a beam. Usually columns rest on the foundation to transfer load from slabs and beams. But the floating column rests on the beam [1].

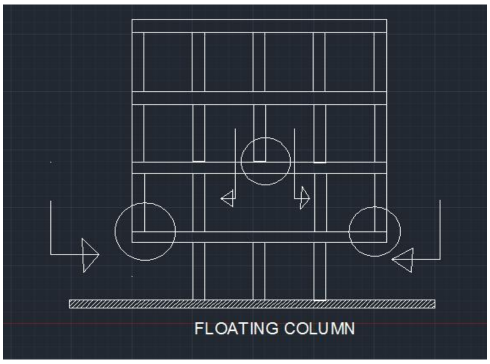


Fig -1: Floating Column in a Building

1.2 Objective of Study

The aim of this work is to compare the response of RC frame buildings with floating columns and soft storey building under earthquake loading and under normal loading [6].

1.The primary aim of this work is the comparative study of seismic behavior of floating columns and non floating columns at low Mid and Highrise R.C.Building.
2. Determination of seismic response of the models by using response spectrum an analysis in ETABS15 software.
3. To study the effect of internal and external floating columns on the building under earthquake loading for seismic zone.
4. Finding out effects on various parameters of RC building under seismic events due to presence of floating columns.
5. To check the seismic response of any existing structure with floating columns.
6. To determine which structure is superior to an other in higher earthquake zones.

2. Previous Work

Malaviya et al. 2014 has analysed the RC frame of 15m X 20m, G+1 symmetrical frame with and without floating column to study the effect of cost on RC frames of floating columns. Conclusion of this study is found in favour of RC frame without floating column explaining that the cost is being reduced because in RC frame with floating column heavier weight of concrete and steel is provided in columns and beams; however, it is also concluded that after changing the position of floating columns, the quantity of steel and concrete is also getting changed. [2].

Yeruvakota sanjeeva reddy In this thesis the seismic performance of building with floating columns are presented in terms of various parameters such as displacement, storey drift, maximum column forces, time period of vibration etc. The building having various locations of floating columns ie floating columns starting from different stories are considered for the study. The building is modeled by using finite element software ETABS. Equivalent static analysis and response spectra dynamic analysis are performed on the various buildings and their seismic performance is evaluated[3].

Ms.Waykule .S.B and Dr.C.P.Pise In this Investigation A five storied building with floating column at 1st floor and building with floating column at 2nd floor and building without floating column located in zone v of india as per code IS 1893(Part1):2002 were taken for the investigation. linear static analysis of buildings were done under gravity loads and seismic loads. Then compare base shear and storey displacement of each building. Modeling and analysis was carried out in sap 2000v17[4].

PremaNautiyal(2013) discussed about seismic response of RC framed building with floating column for different soil conditions[5].

3. Methodology

Methodology of this project consists of analysis of two type of structure floating column structure and without floating column structure i.e. Regular structure by using the software ETABS. They are explained in details below.

- A Response Spectrum Analysis (RSA) will be done utilizing ETABS15programming.
- ETABS15 is a completely incorporated program that permits display creation, alteration, execution of examination, outline improvement, and results survey from inside a solitary interface.
- ETABS15 is an independent limited component based auxiliary program for theexamination and plan of common structures.
- Two (2) number of issues will be brought with and without floating sections toconcentrate seismic conduct.
- The yield results will be communicated as far as Time and Frequency, Storey displacement, storey drift, Elcentro Ground Motion.

A.Modeling of the structure

Modeling of this project consists of analysis of two type of structure floating column structure and without floating column structure i.e. Regular structure with different Storeys i.e.G+5, G+10, G+15. They are explained in details below.

- There are 6 types of structures floating column structure with soft storey and without floating column structure i.e. Regular structure analysized in this work, these are G+5, G+10, G+15 under seismic zone III.
- At Ground level we remove columns at corners and also we make floor soft storey and combined effect is studied in case of floating column structure.
- All Structures are analysized design for Dead load, Live load, Earthquake Load and wind in seismic III.
- Considering Different hight of structure how the seismic response effect is changed is studied.
- Findingouteffectsonvariousparametersof RCbuilding underseismiceventsduetopresenceoffloatingcolumns.

B. Structure and its Details

A G+5, G+10, G+15 structure used for analysis. A plan as case study is used for the analysis of floating column. In this building, the ground floor is made for the purpose of parking. First, second, third floor plans are made typical. Following figure shows the plan of the building-

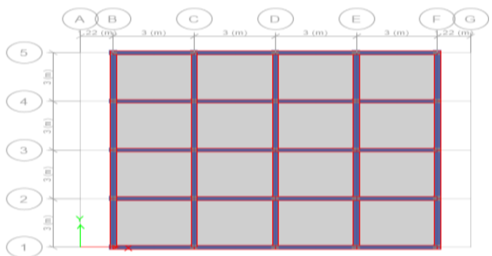


Fig 2: Regular Structure Plan for G + 5

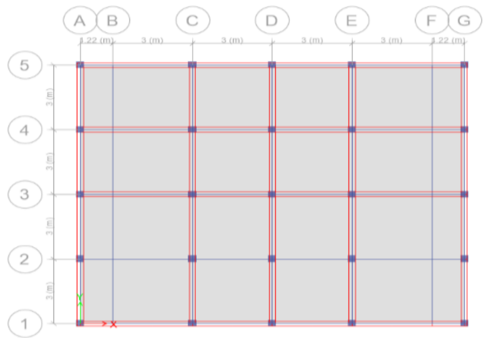


Fig 3: Soft Storey cum Floating Column (SSFC) Structure Plan for G + 5

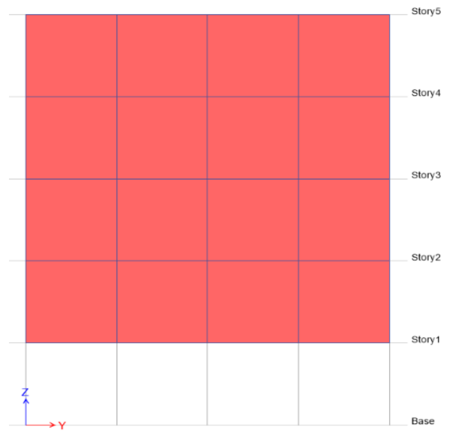


Fig 4: Regular Structure Elevation for G + 5

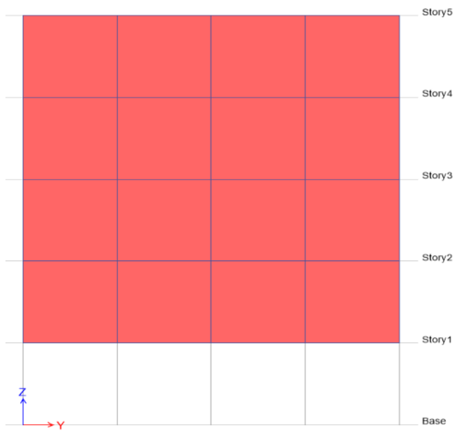


Fig 5: Soft Storey cum Floating Column (SSFC) Structure Elevation for G + 5

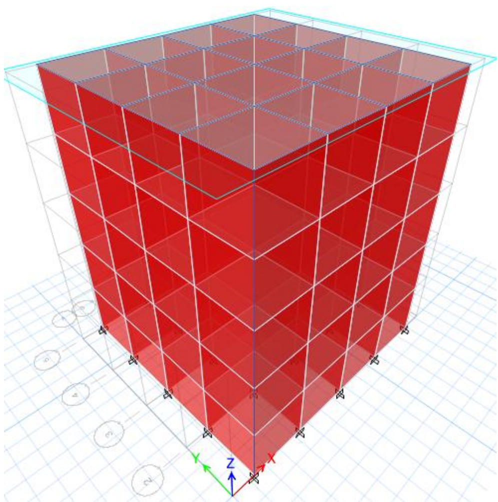


Fig 6: Regular Structure Three Dimentional view for G + 5

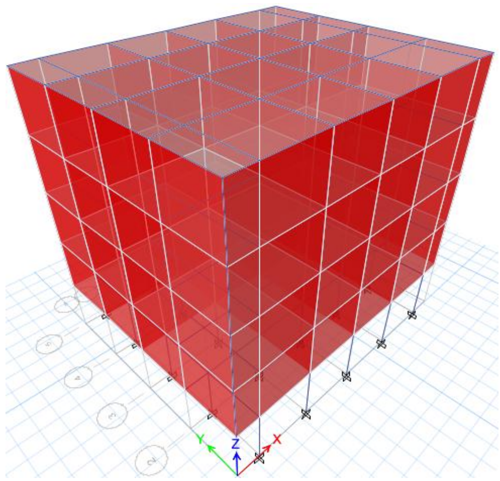


Fig 7: Soft Storey cum Floating Column (SSFC) Structure Three Dimentional View for G + 5

C.Sizes of beams and columns and slabs used for analysis

All the sizes of beams and columns used for analysis are kept same for both type of structure.

The column sizes are –

- For G+5 = 300 mm X 300 mm
- For G+10 = 450 mm X 450 mm
- For G+15 = 600 mm X 600 mm

The beam sizes are–

- For G+5 = 300 mm X 230 mm
- For G+10 = 300 mm X 230 mm
- For G+15 = 300 mm X 230 mm

The slab thicknesses are taken as per the plan Slab that is S=100 mm.

D.Details of parameters for seismic analysis

Analysis is carried out as per IS 1893 following parameters are considered:

- Zone factor as zone III
- Soil type is taken as II
- Reduction factor is taken as 5
- Importance factor is taken as 1

E.General considerations of the structure

- Reference Code is IS 456-2000, IS 875-1987, IS 2911(part III).
- Grade of concrete M:25.
- Grade of steel to be Fe415 confining to IS 1786-1985 except 6mm bar which Fe250 grade confining to IS 432-1982 (part I).
- Clear cover to the main reinforcement of column should be 40 mm.
- Clear cover to footing should be 50 mm from all the sides.

- Clear cover to beam must be 25 mm and
- For the slab cover should be 15 mm.

Use of vibrator is mandatory.

F.Loading

There were three types of loading consideration taken into account while analyzing both the type of the structure that is floating column structure and without floating column structure.

- Dead load
- Live load
- Seismic load
- Wind load

4. Results and Discussion

Response spectrum and static analysis was done for both the models of G+5, G+10, G+15 building models of floating column structure, and without floating column structure. The Time & frequency, storey displacement, storey drifts, El centro Ground motion, in the members are studied. Following are the result of analysis.

I. Time and Frequency

The Frequency of earthquake on building is determined by Cycles per seconds. The movement of structure per second under earthquake is calculated by the frequency. Calculated Frequency is shown below.

Table -1: For G+ 5 Structure

Mode Number	5 Storey			
	Regular		SSFC	
	Time (sec)	Frequency (Cycles/sec)	Time	Frequency
Modal 1	0.006	179.355	0.556	1.799
Modal 2	0.006	181.605	0.552	1.812
Modal 3	0.006	181.605	0.536	1.866
Modal 4	0.004	242.958	0.052	19.243
Modal 5	0.004	266.098	0.05	20.149
Modal 6	0.004	266.098	0.014	70.323
Modal 7	0.003	304.154	0.013	77.879
Modal 8	0.003	314.676	0.011	90.915
Modal 9	0.003	335.153	0.009	110.222
Modal 10	0.003	335.153	0.007	136.944
Modal 11	0.002	454.643	0.006	168.262
Modal 12	0.002	454.643	0.006	168.405

Table -2: For G+ 10 Structure

Mode Number	10 Storey			
	Regular		SSFC	
	Time (sec)	Frequency (Cycles/sec)	Time	Frequency
Modal 1	0.016	62.052	0.431	2.318
Modal 2	0.016	62.052	0.425	2.353
Modal 3	0.011	94.869	0.376	2.657
Modal 4	0.008	126.137	0.097	10.262
Modal 5	0.006	164.965	0.094	10.662
Modal 6	0.006	164.965	0.015	67.028
Modal 7	0.005	206.645	0.014	71.805
Modal 8	0.005	215.836	0.012	86.192
Modal 9	0.004	233.601	0.009	105.43
Modal 10	0.004	239.593	0.008	130.343
Modal 11	0.004	239.593	0.007	152.84
Modal 12	0.004	249.878	0.006	160.376

Table -3: For G+ 15 Structure

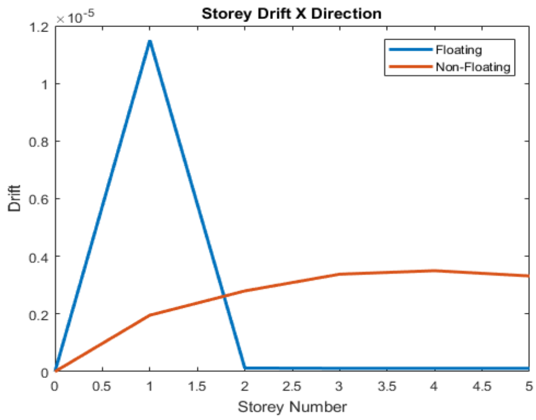
Mode Number	15 Storey			
	Regular		SSFC	
	Time (sec)	Frequency (Cycles/sec)	Time	Frequency
Modal 1	0.034	28.999	0.429	2.33
Modal 2	0.034	28.999	0.415	2.412
Modal 3	0.012	80.541	0.287	3.489
Modal 4	0.012	81.064	0.11	9.126
Modal 5	0.008	132.118	0.108	9.283
Modal 6	0.008	132.118	0.016	63.816
Modal 7	0.007	135.547	0.015	67.221
Modal 8	0.007	135.547	0.012	81.505

Modal 9	0.007	135.887	0.01	100.49
Modal 10	0.006	176.344	0.008	123.445
Modal 11	0.005	190.439	0.008	129.434
Modal 12	0.004	222.622	0.007	142.298

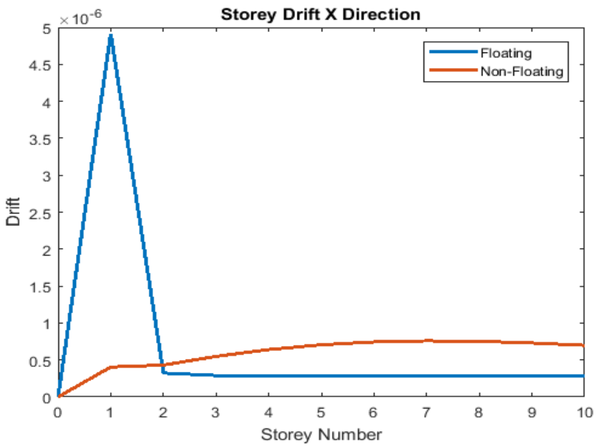
II. Storey Drift

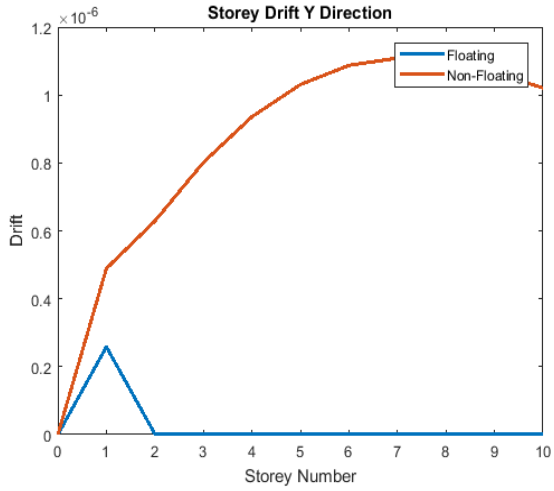
Storey drifts is usually interpreted as inter-storey drifts, the lateral displacement of one level relative to the other level above or below prescribes the limitation on storey drift. It is the ratio of two consecutive floor to height of that floor. Following figure shows the maximum story drifts of the structures

For G+ 5 Structure

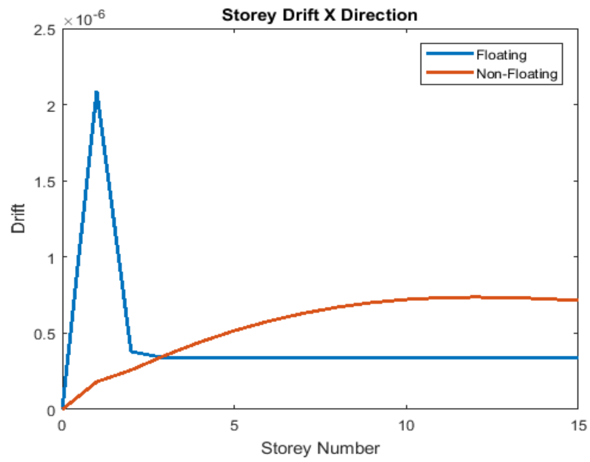


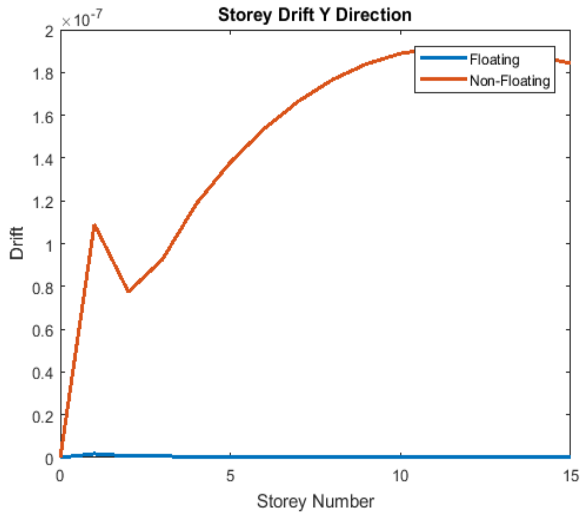
For G+ 10 Structure





For G+ 15 Structure

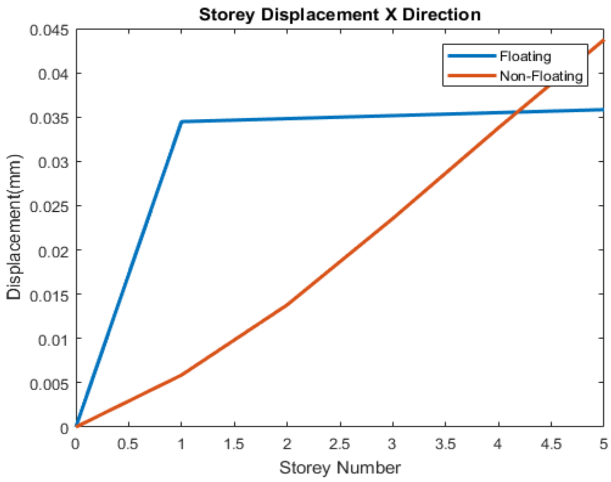


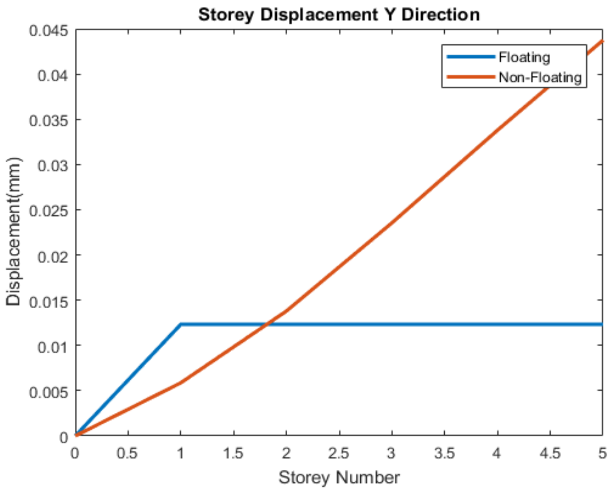


III. Storey Displacement

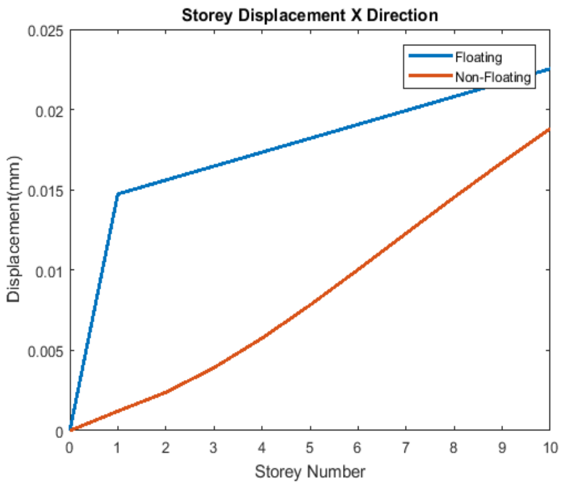
Storey displacement is the earthquake parameter in with on the account of an earthquake the relative displacement of each storey takes place. The storey displacement is found to be more on the top most storeys. Following is the figure shows the storey displacement of the floating column and without floating column structures

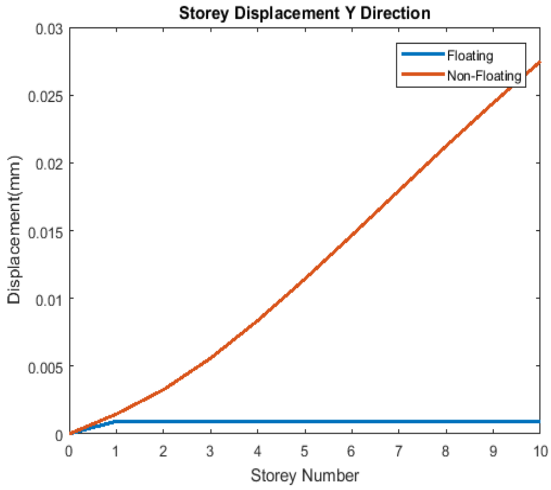
For G+ 5 Structure



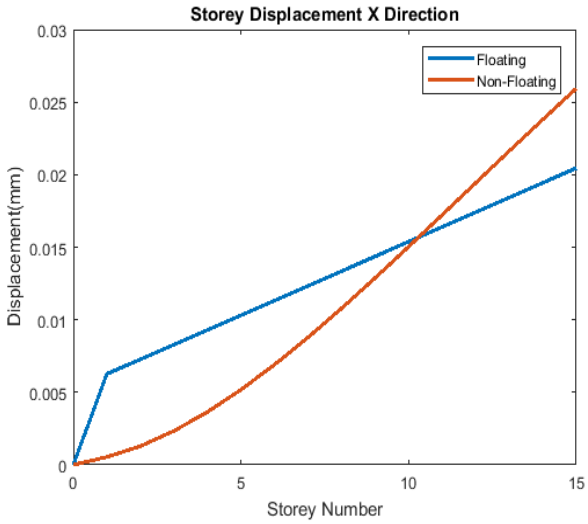


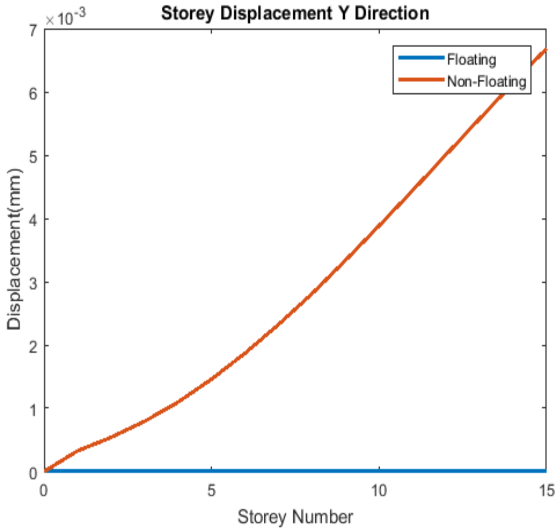
For G+ 10 Structure





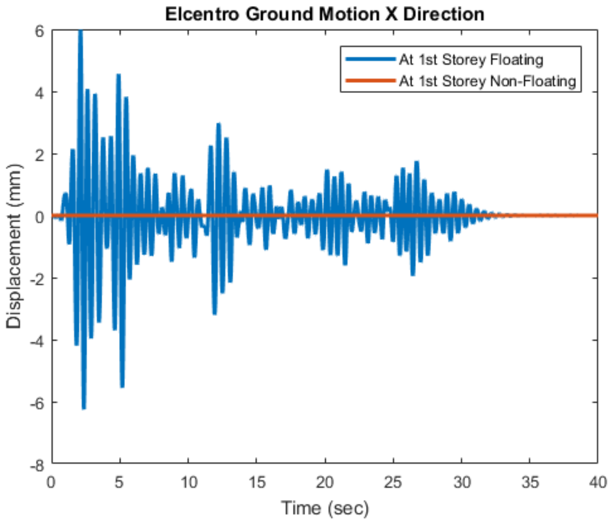
For G+ 15 Structure

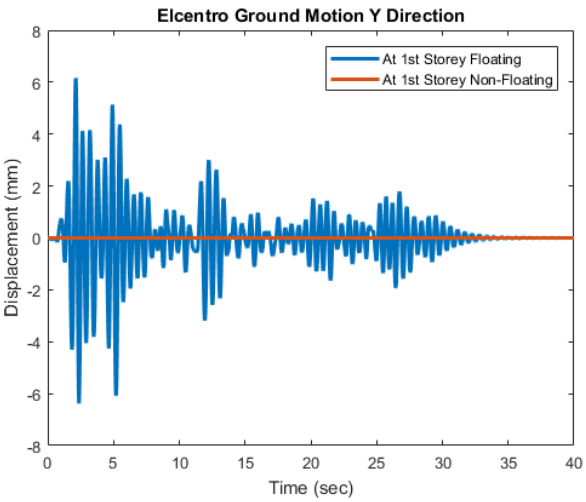


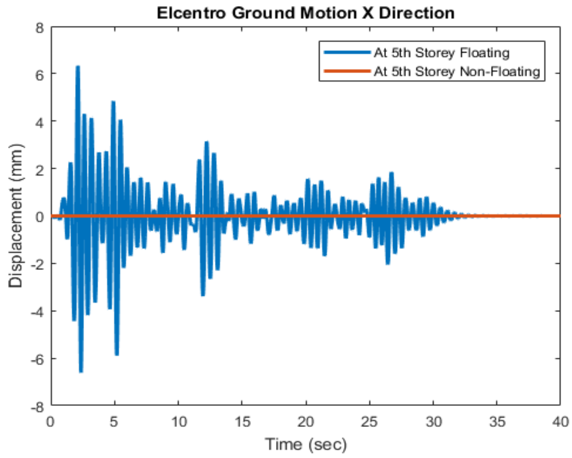


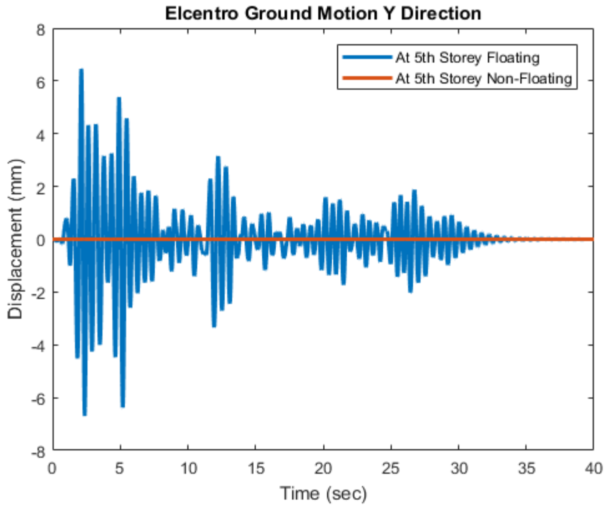
IV. El Centro Ground Motion

The El centro earthquake occurred at on May 18 1940 in the imperial Valley in southeastern southern California near the international border of United States and Mexico.It had a moment magnitude of 6.9 and a maximum perceived intensity of 6.9 and a maximum perceived intensity of X on the Mercalli intensity scale. In this work, we apply the El centro magnitude earthquake on the Structure and calculate its Displacements in X & Y Direction.

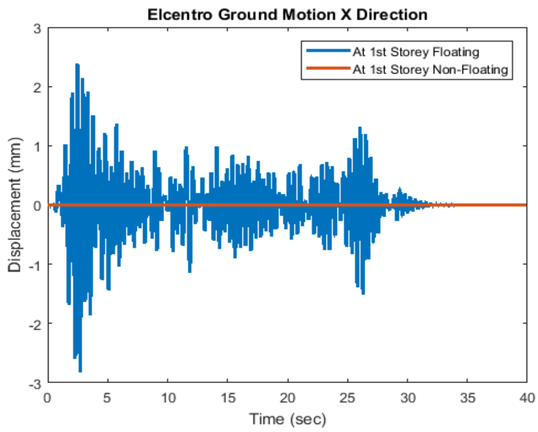


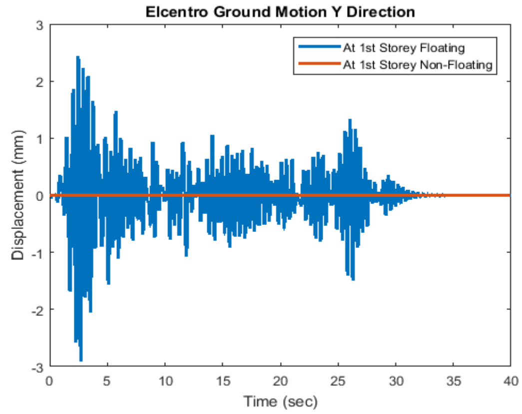


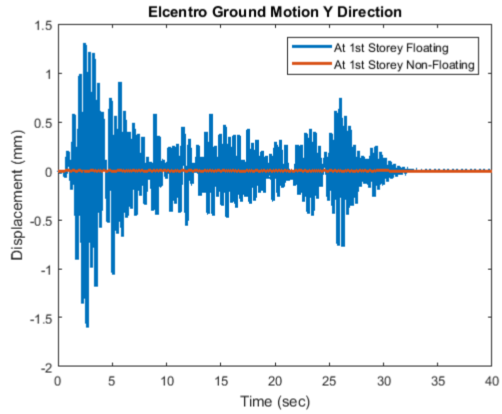


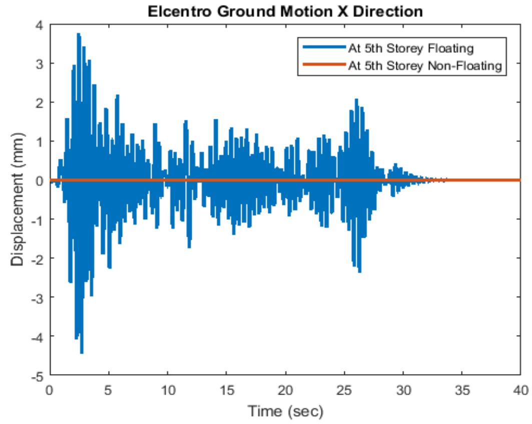


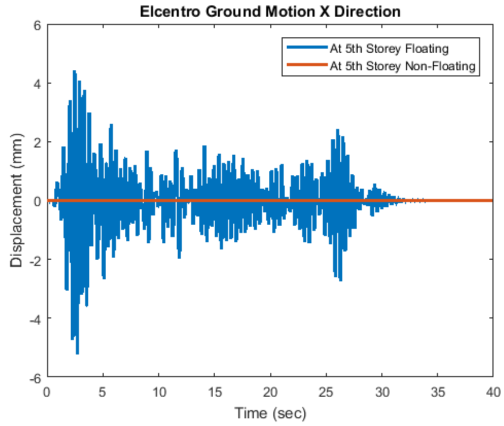
For G+ 10 Structure

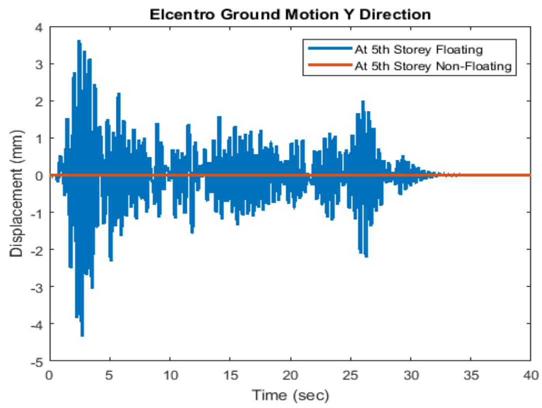


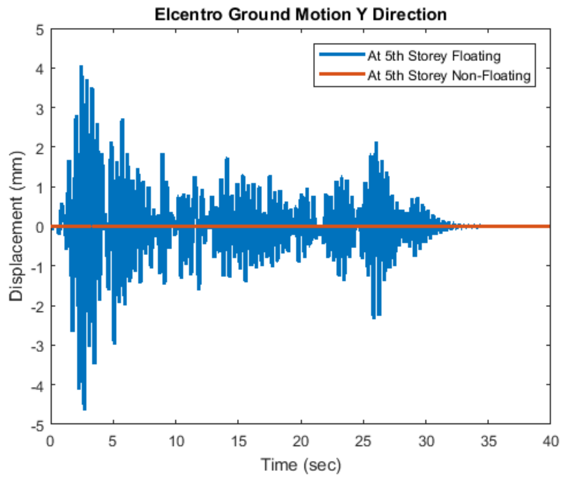




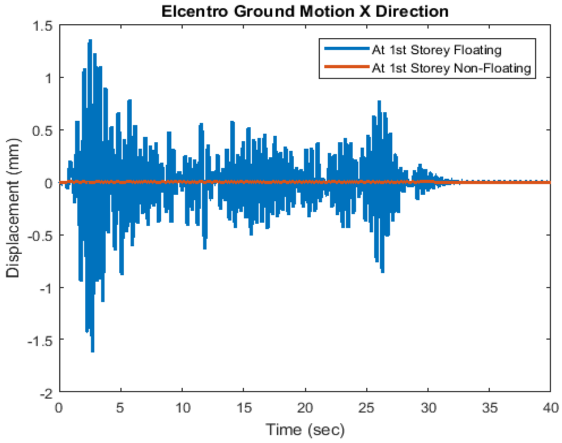








For G+ 15 Structure



5. CONCLUSIONS

On the basis of the result following conclusions are made:

- It was observed that in building with Soft Storey cum Floating Column Structure (SSFC) has less Frequency as compared to regular structure.
- It was observed that displacement in SSFC is more as compared to regular structure.
- The maximum storey drifts is more in the case of floating column structure than without floating column structure.

- It was observed that Elcentro ground motion displacement SSFC is less as compared to regular structure.

Acknowledgment

I am thankful to Mr .Durgesh .H. Tupe for his constant support and Guidance. I would also like to express my thanks to the department of Civil Engineering for providing facilities needed to carry out this study.

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