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Seismic analysis of G+6 buildings with floating column using Staad pro

1. Shiphali Dubey,
2. Mr. Himanshu Shrivastav

Department of Civil Engineering, SSIMPT, Raipur, (Chhatisgharh), India

Received- 23.02.2022, Revised- 27.02.2022, Accepted - 01.03.2022 E-mail: sarika2417@gmail.com

Abstract: ***In present work we have tried to show various cases of floating column structures and compared their various properties and tried to present an analysis based on various structural and geometrical parameters. The main objectives of this study are to evaluate the performance of floating column building. In order to do that we have studied the behaviour of mid-rise structure with floating columns under various conditions. We have tried to understand the effect of earthquake on these floating columns. To analyse we have used staad.pro software.***

Key Words: structures, properties, various structural, geometrical parameters, evaluate, performance.

From the last several centuries, some of the cities are periodically struck with severe earthquake tremors. The distinction among harm and destruction depends on the size of the seismic tremor, yet additionally on confined topography and on building strategies. The world we live in is growing day by day in terms of number of humans present in it. And as we know necessity is mother of novel approaches and that resulted in building where hundreds of families could live together. A quest to optimize spaces in these buildings and structures is ongoing and have a great deal of importance for civil engineers. One such approach is using floating columns in these buildings (figure 1). Research to find out the pros and cons of these floating columns is quite essential. One interesting scenario is to observe how floating columns are performing in the event of earthquake. When earthquake occurs each floor of the building or structure is affected and we should build these structures in such a way that waves produced in buildings must go down from upper part to ground in least problematic manner. All exercise done must leave no breakage in structures, for a case of successful design. The question here is what should be our point of focus to make a successful design. We, firsthand can say shape and size of the structures are very important if we talk about seismic activities happening in the area. Tragedy happened in Bhuj is one the failure examples of the open structure in ground floor and make us careful in our choices (1-10).

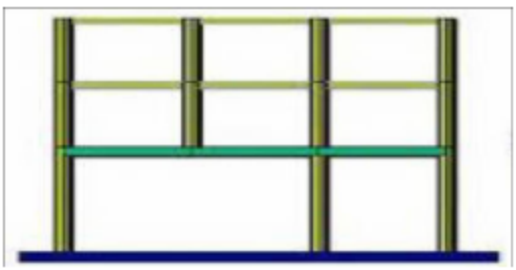

Figure 1- Floating Columns

There are numerous undertakings wherein coasting sections are embraced, particularly over the ground floor, where move braces are utilized, so increasingly open space is accessible on the ground floor. These open spaces might be required for a lobby or stopping reason. The exchange supports must be structured and detailed appropriately, particularly in seismic tremor zones. The segment is a focused burden on the shaft which underpins it. Most definitely, the segment is regularly accepted stuck at the base and is in this manner taken as a point load on the exchange pillar. Looking forward, obviously, one will keep on making structures fascinating as opposed to dreary. In any case, this need not be done at the expense of helpless conduct and the quake security of

Corresponding Author / Joint Authors

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Figure 2: (A) Floating column used on Structure in construction, (B) Palestra in London, United Kingdom

A B structures. Compositional highlights that are averse to the tremor reaction of structures ought to be kept away from. If not, they should be limited. At the point when sporadic highlights are remembered for structures, an impressively more elevated level of designing exertion is required in the basic plan but then the structure may not be comparable to one with straightforward building highlights. Henceforth, the structures previously made with these sorts of spasmodic individuals are jeopardized in seismic locales. Yet, those structures can't be obliterated, rather study should be possible to reinforce the structure or some healing highlights can be recommended. The segments of the principal story can be made more grounded, the firmness of these sections can be expanded by retrofitting or these might be furnished with supporting to diminish the lateral deformation (5-14).

Figure 2 (A) and (B) show live examples of floating column. Such floating columns come along with a disadvantage in such structures constructed in seismically active areas. The seismic tremor that is formed at various floor levels in a structure should be conveyed down along the stature to the ground by the most limited way. Deviation or brokenness in this shift in load brings the poor performance of the structure. The conduct of a structure during seismic forces relies fundamentally upon its general shape, size and geometry, notwithstanding how the forces of the earthquake are conveyed to the ground. Numerous structures with an open ground storey were seriously damaged in Gujarat during the 2001 Bhuj tremor (10-16).

In this study we are analysing a G+6 structure with mixed use of land i.e lower floors for commercial and rest above are residential. Utilizing Ground and first floor for parking and commercial use respectively. For this we need large span and location of column should be such that it does not obstruct the above floor requirement. But under some circumstances there is a need to terminate the column at certain floor and make new column from beam to support the above structure. The main objectives of this study is to evaluate the performance of floating column building.

Literature Survey- In 2017 Sunitha et al presented their research work using ETABS software. They have tried to study lateral forces applied externally. Magnitude of seismic tremor has been varied to test the safety of the building. Safety test has been performed under earthquake waves in normal and floating column conditions. Cost effectiveness of these columns were also targeted. It was observed by the group that the values of maximum displacement in floating column is more compare to other types. Similar response was observed for the storey drift also. Aspects of G+2+3 building was carried out by Mishra and Jain in 2018. Building was chosen with floating column placed at various situations along with different seismic zones. Building is planned is such a way that floor with more heights have reduced area compare to the area size of the second and lesser floors. This made floors with and below second to be used in commercial activities and also used in parking lot if needed. One important remark is that zone iv is more dangerous than zone iii, if floating column is placed in structures. In 2017 Waykule has presented his work, which contain comparison between columns having floating and non-floating type. Many buildings were studied by his group with the varied situations of floating columns. SAP 2000 software was used to analyze the work and to propose a working model. It was found out that base shear value of the Ist floor was

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reduced in those cases where floating column was used. Research group of Patel have investigated and developed an understanding of the G+3 multi storey buildings using unconventional floating columns. Group used as much as 29 models to get a clear picture of G+3 multi storey buildings with floating column. Software used in this work was SAP 2000, which successfully analyzed zone iii in Surat. One very interesting outcome of this study is that if floating columns were used at room corners of the buildings, then results are not as satisfactorily as it was expected. In other scenario the position of the columns was changed from corner of the rooms to the center of the rooms. It was viewed that the value of the eccentricity has been significantly increased while carrying out this work. Safety against earthquake was modified when infill wall was used in addition to the floating columns. In this case displacement in horizontal direction was reduced close to 200 percent and 140 percent in the vertical direction when this structure is put under seismic conditions. Columns based on reinforced cement concrete along with floating columns for the different buildings G+3, G+5, G+10 were studied by Roy and Danda recently. Various comparison of variables was made using plots and other techniques. Staad pro was also used for detailed analysis to study bending moments of the building. Shear force was also studied by Roy and Danda in 2015. Results drawn were enough to say that above mentioned structures with floating columns have higher bending moment compare to others. Shear forces also got higher value in this case. Placing of the columns were proved very crucial for the value of the shear of the columns. Value of shear and bending moment increases at each floor but remain same for the same floor. Shear force was analyzed and it was found out that buildings with G+10 style is having maximum shear force. While studying G+3 buildings we find that value of the shear force was reduced by 4.368KN in floating column case compare to the conventional case. Under similar conditions value is reduced by 7.133 KN while studying G+5 buildings and 13.793KN for G+10 buildings.

Research work was carried out in 2016 by A Paridhi and others on how floating columns are affected by the tremor caused by earthquake. Value of column forces and its maximum value is something of the importance while studying these behaviors. Study for the different places of floating columns is performed. Study of nodes with various degrees of freedom (in present case 6) were top notch of this study and beams along with columns were treated for modelling. The basic aim of A Paridhi groups work is to evaluate the above-mentioned parameters for floating columns and observe the change to the conventional methods. A research work was carried outing to analyze G+10 type structure having floating columns by Udhav et al in 2015. Two perpendicular directions were modelled using Staad pro software for frames which resisted moments in the building. These buildings are in the area of the standard zone iii of the seismic active area. Possibility of damages in case of seismic tremor is compared in both cases i.e. with floating column and without floating column and it was found out that floating column structures were better.

Another work performed by waykule group on G+5 buildings in 2016 to the zone v. Models were simultaneously analyzed temporal response and the static response was also analyzed linearly. Results of various parameters such as drift, shear, displacements and time period of vibrations due to the waves rises after earthquake. Displacement and drift of the building was enhanced when floating column was considered.

Sharma and Shelke have presented their work on G+5, G+7, G+9, G+11 and G+13 type structures for floating columns and also for the conventional columns. Th Response spectrum behavior (RSB) and seismic weight calculation were analyzed using this software. Their work has shown variations in the results of various parameters such as displacement and base shear. Results of RSB showed that the displacement in the structure happened more in case of floating column compare to the that of conventional column structure. Maitra and Serker published their research work in 2018, in which they deduce static and dynamic processes with the help of the method of response spectrum. Study was carried out for multi storey buildings both for floating column and normal column. Situation of floating column were changed in the study and their corresponding analysis was done

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for different building with or without floating column. With the placing of floating column, size of the column was also changed simultaneously.

Study on G+5 structure was presented with and without using floating column in earthquake zone v by Wayeke et al in the year of 2016. Four cases were studied and subsequently modelled. In these cases, three were modelled using floating column and one without floating column. Observation was made that time period was bigger in case of floating column structure than the normal case. When floating column goes from the lower storey to the upper storey value of the base shear increases. Structures having floating column have lesser value of base shear when analyzed against the normal structure.

Behavioral analysis of buildings with RC frame having floating columns and without floating columns were studied extensively by R. Gaud in 2017. Response of these buildings was observed under seismic tremor and compared for cases with floating column and without floating column. Drift and displacement of the buildings storey were compared for both cases and the requirement of steel for better results was concluded in study. In 2017, Prasannan and Mathew presented their work on how placing of floating columns for different floors and within the same floor are affect during earthquake. Conclusion was drawn that though complexities of buildings providing more space and better look, it doesn't necessarily mean good for the safety of the buildings when facing seismic tremor. Work of Pradeep et al. in 2017, proposed two particular building models for floating columns placed at different levels and another with the conventional column. Software ETABS was used to analyze and model these conditions. Parameters representing seismic tremor like displacement, drift, base shear, time period etc were used in the software to provide generalize results. Shear force in the building had maximum for the very Ist floor and when we go up and up the value started decreasing continuously Bhoyar has presented his research work in 2017 presenting comparative analysis of a structural behavior with floating columns and with conventional type column. His work was especially on G+5 type regular and irregular type buildings, when put under earthquake conditions. It was observed that floating column structures for both irregular and regular cases were less secure in compare to the structures having normal column. Certainly, performances of the structures vary with the placement of floating column.

Methodology and Problem formulation In this study we are adopting followings steps to complete the study Step-1 In this step we reviewed publications and research works available on citations and in google scholar to review them briefly to prepare our study scope and boundary conditions. Step-2 In this step we started preparing geometry of all the three cases considered in this study where we are considering same geometry with different boundary and floating column support (Figure 3 A, B and C) conditions using structure wizard tool in staad.pro

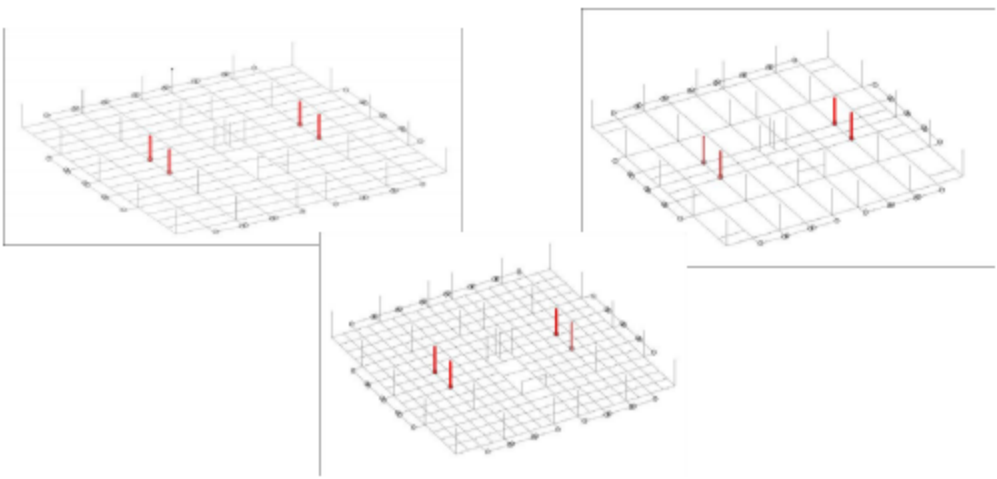

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Figure 3- (A) Case I (Floating column supported on beam at regular interval), (B) Case II (Floating column supported on beam at Perpendicular direction), (C) Case III (Floating column supported on Closely Supported beams in both directions) Step-3 Assigning material descriptions and member sizes to the structure using property wizard in staad.pro (Figure 4)

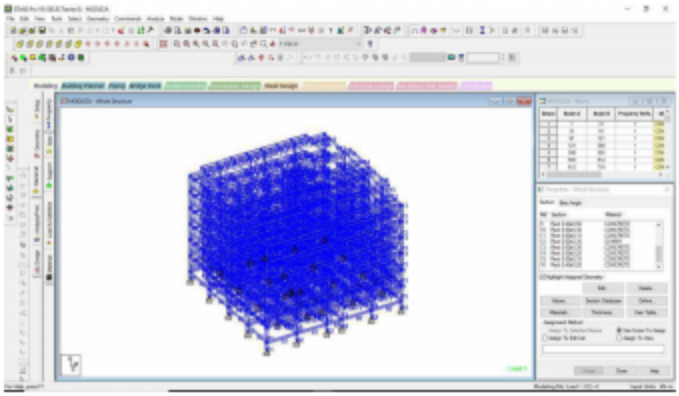

Figure 4- Material and size of structural members

(A) (B) (C) Step-4 Assigning fixed end & moment release support condition to the structure (Figure 5)

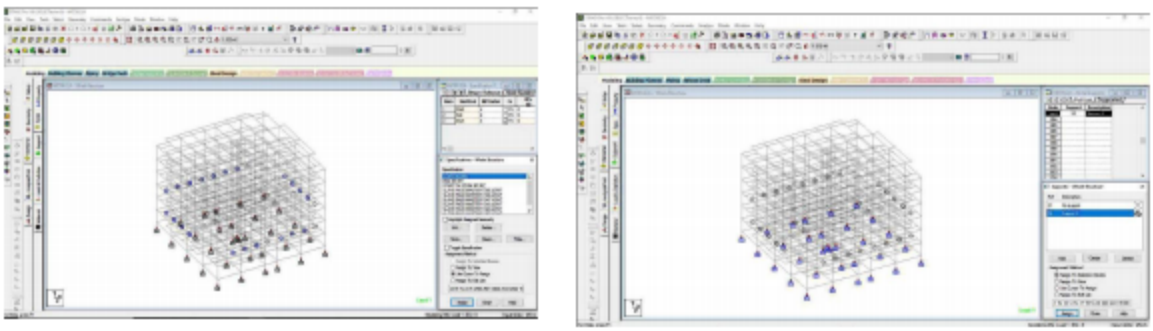

Figure 5 Support Condition (A) Moment Release at supported beams, (B) End Conditions (A) (B) Step-5 Defining Load conditions as per Indian Standards (Figure 6)

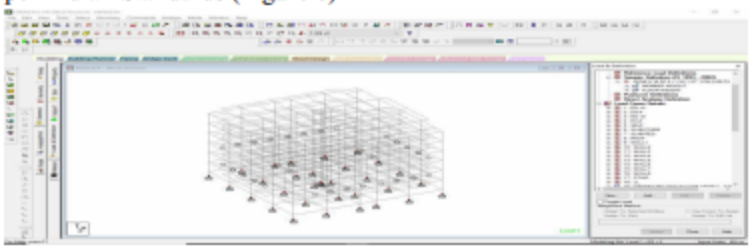

Figure 6- Defining Load conditions Step-6 Performing Analysis In this comparative analysis we have performed seismic analysis of structures considering seismic zones III and soft type of soil. In this study we are performing finite element analysis. Step-7 Analysing results in terms of forces, moment and displacement (Figure 7)

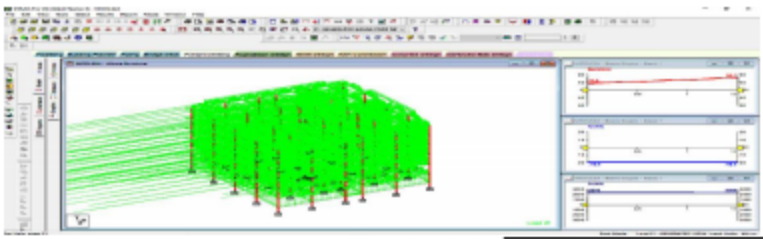

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Figure 7- Analysis output Figure 8 shows the flow chart of the work we are going to perform in this research work.

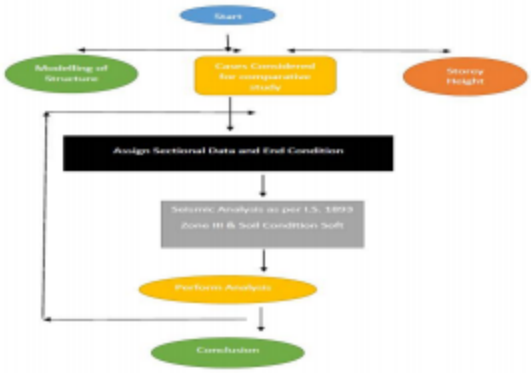

Figure 8- Flow chart of the study For problem formulation we are presenting description of geometry, material properties and description of loads assigned with their calculations as per Indian standard specifications. First, we present our three cases to be studied in this work. Case I: Floating column supported on beam at regular interval

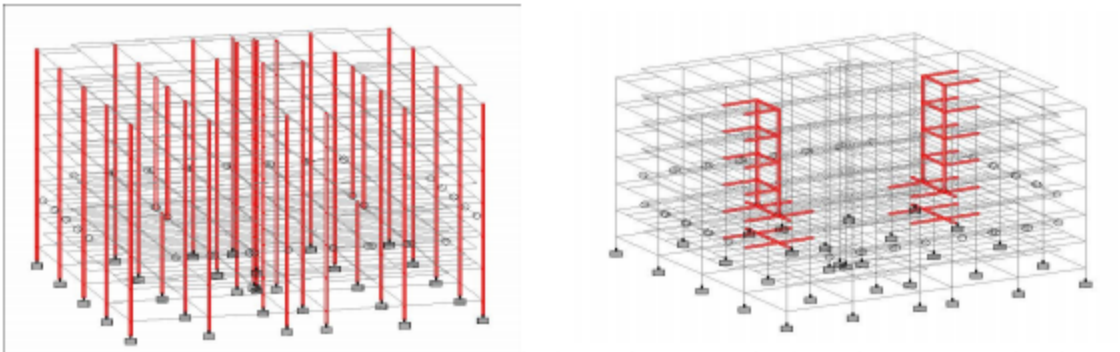

Figure 9- Floating column supported on beam at regular interval. Case II: Floating column supported on beam at Perpendicular direction (Figure 10) Figure 10- Floating column supported on beam at Perpendicular direction Case III: Floating column supported on Closely Supported beams in both directions (Figure 11) Figure

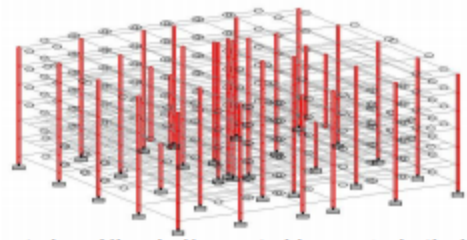

Figure 11- Floating column supported on Closely Supported beams in both directions The material properties of the structure are as follows Grade of concrete = M 25 Grade of Steel = Fe 415 Elasticity constant = 2.17 X 107KN/ ..2 Further . The dead load includes loads that are relatively constant over time, including the weight of the structure itself, and immovable fixtures such as walls, plasterboard or carpet, roof etc.

Conclusion- In present work we are comparing three different conditions of floating column where it is supported on different arrangements of beams.

(i) In this study we concluded that stability of structure with floating columns supported on regular interval beams are most suitable in comparison whereas case of floating column supported on beams on perpendicular direction second most suitable type whereas case floating column supported on both direction beams are showing worst results.

(ii) In terms of economy, we can conclude that case I is comparatively most economical one in comparison as

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bending moment observed in this case is comparatively less which results in less requirement of area of steel.

(iii) Here it is observed that all cases are under permissible limit of displacement as per I.S. 1893-I:2016 hence providing safety under seismic loading.

(iv) Unbalanced forces are observed 11.3% more in case III as compared to case I, thus resulting more stability to case I in comparison.

(v) In terms of vertical pressure case III is showing little more value in companion to other cases but variation is negligible.

In this study we can finally conclude that Case I is comparatively considered as best I terms of stability and costing whereas Case II is second best and Case III is observed as worst.

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