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Seismic Response of Multistorey Building with Floating Column: A Review

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A B S T R A C T

The use of large span as a parking or for commercial purpose is increased now a days. Many high-rise buildings are built with floating columns in order to give maximum free spaces as possible for movement. By Introducing floating column in building we also need to analyze the building under seismic behavior for safety. The paper consists of summary report on different research papers based on floating column concept by different researchers. The different researcher used the different location of FC in the building. The basic objective of the worked by the different researchers is compare to building under with and without floating column. The analysis is carried to check the building is belonging to safer side or not under lateral effect. The paper concluded that the floating concept is used for requirement of structure mostly for commercial buildings. The excess amount of floating column affects the structure and also damages the building components

Keywords:Floating Column, Commercial buildings Building, Seismic Zone.

1. Introduction

Floating columns are a typical feature in modern multi-storey construction in urban India and are highly undesirable in buildings constructed in seismically active areas. The effect of earthquake is amplified in improperly designed irregular structures. Floating columns provided in a multi-storey building form an irregular building. A multi-storey framed building with floating columns in one or more positions is in danger of collapsing in the event of strong earthquakes. But lately, due to aesthetic and functional requirements, column-free space is required for buildings in urban cities. The forces generated during the earthquake at different levels of the building must be dissipated by the shortest path. The floating column results in interruptions in this load transfer path, resulting in poor performance of the building. Floating Column is designed with proper care to make sure that the final design can withstand loading and will be durable and serviceable for its lifetime to withstand external loading. Conventional building structures are designed based on criteria of strength and rigidity. In the case of seismic forces, ductility is required. The greater the ability of the structure to deform plastically without collapsing, than the greater the ductility and energy dissipation. This causes a reduction in the effective forces of the earthquake. The behavior of a building during an earthquake depends mainly on the overall shape, size and geometry, in addition to the way the earthquake forces are transmitted to the ground. The seismic forces developed at different floor levels in a building must be reduced in height by the shortest path; any deviation or discontinuity in this load transfer path results in poor building performance.

Floating column

A floating column is a vertical member that rests on a beam and has no foundation. The floating post acts as a point load on the beam and this beam transfers the load to the columns below it. But such a column cannot be easily applied to a practical construction, because true columns below the end level are not constructed carefully and therefore ultimately cause failure. Fig. 1, 2 and fig.3 had shown the floating column through line diagram and a typical building with floating in it.

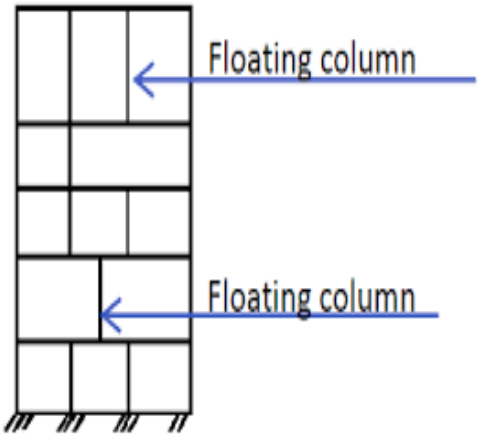

Fig.1 floating column in structural frame

Fig.2 Typical Example of floating column

Fig. 3: Hanoi Museum in Vietnam consist of FC

2. Literature Review

The following research papers are studied under the study of floating column concept of a Structure containing the different position of placing FC (floating column) & use of different types of method of earthquake analysis. The summarized reports of different researchers are as follows:

Sreadha A R, C. Pany (2020) This article provides an overview of the nature of the construction of buildings under the influence of earthquake forces with and without floating columns. This analysis focuses on the importance of specifying the presence of a floating column in a structural study, determining its correlation with a building without a floating column using Advanced Three-Dimensional Analysis of Building Systems (ETABS) design software. This article also discusses the characteristics of a floating column structure in seismically active areas. In addition to the effects of these various parameters such as maximum displacement, number of floors in sediment, soil displacement, are also investigated. It can be concluded that the seismic zone, a building with a floating support, has a higher floor settlement and larger displacements compared to a building without a floating support. A floating column structure shows the maximum offset relative to a non-floating column structure.

Mo Farhan (2019) these articles presented the behavior of a floating column in a building, its load distribution, and structural continuity. It was observed that the floating columns do not carry as much load as those columns that are connected to the foundation. The conclusions of the bases analysis and the result conclude that if the structure has a smaller number of floating columns, it does not have a significant impact on the building if the building is no more than three storey's high. If the building is earthquake resistant, the floating column should be disregarded. In open spaces and car parks, a sloping roof should be preferred to floating columns, as they transfer loads directly to the columns and only compressive forces occur. Floating columns are suitable if the columns are closer to each other so that they can distribute loads normally and will not have a significant effect on adjacent beams.

Gulchaman Khan, MayurSingi (2019) The articles examine the effect of shear wall along with provide the FC in the multi-storey building. The work consists of with three different storey multi-storey buildings. The storey is 8, 12 & 16-storey. Under all 3 cases suspended columns are equipped with and without shear partitions and analyze the use of ETABS 2016 software for zone V. The analysis shows that the supply of suspended columns is good in the increasing FSI of the building. The lateral displacement of the construction and the storey wave will swing from decrease to better zones, as the significance of the depth may be greater for higher zones. With use of shear wall, lateral forces will be reduced in all cases models. This analytical work is a beneficial aid in conjunction with lateral displacement and the stem inside the floor and multi-storey buildings. The final finding is that the building is safe in the IV and zone V.

Ullas, Gopal. D. J, B. P. Annapurna (2019) This study attempts to investigate the behavior of a high-rise frame with floating columns. For this 2 and 3-storey building considered. The work consist a frame with a floating column with and without filler on csi-etabs software. Different types of frames are considered such as bare frame with floating column (BFFL), filled frame with partial soft floor under floating column (SIFFL) and filled frames with floating column (IFFL). The results show that, the lateral and vertical deformation is reduced compared to the bare frame when the filler is applied to the bare frame. When a floating column is introduced at various locations, the lateral and vertical deformation increases in most cases compared to frames without a floating column. In all types of filled frames (SIFFL and IFFL), the compressive stress in the filler is higher compared to the tensile stress. The introduction of a floating column in both cases increases both the compressive and tensile stresses. The paper concluded that the compressive and tensile stresses increase in the filled frame, whose partial soft height is below the floating columns compared to the filled frames.

Radha Krishna Amritraj, MohitSheode& et.al. (2018) In this study, an equivalent static analysis (ESA) was performed on the 3D building frames. A 7-story G + building with floating columns and soft ground effects. A total of 73 cases were considered in which 8 cases have central floating columns on a floor, while another 64 have floating columns on a given floor, and the soft floor extends from the floor to the floor (G) and up to G + 7 floors. The cases also consist of a simple case arises where both floor is not soft and no column is floating. Nine load combinations were considered. Soft floors were created by changing the height of the floor. Staad.Pro software was used for analytical purposes. The conclusion was that the presence of floating columns on the upper floor increases the maximum node displacement that occurs in a non-soft two-story building. The maximum bending moment increases 2.54 times as the floating columns reach the ground level relative to a normal building under the same load but without floating columns.

YS Reddy, Y. Sunny babu (2017) these articles presented the seismic performance of a building with floating columns. The building is examined under various parameters such as displacement, storey drift, maximum column forces, and vibration time. The building is modeled using ETABS finite element software. The seismic method is adopted in it is Equivalent static analysis and response spectrum-dynamic analysis for different buildings and their seismic performance is evaluated. The final conclusion is that it is only worthwhile to build a floating column in buildings if there is a proper purpose and functional requirement for them. If they are to be secured, due care must be taken in the design of the structure.

RupaliGoud (2017) This researchers analyzed the RC Building having with and without floating columns. The articles consist of comparative study of both modes. Two buildings with floating columns and buildings without floating columns were analyzed for seismic loading. The building chosen was a 16 m high building with 4 model cases. The seismic response is performed by response spectrum analysis. The result shows that short natural period structures suffer greater acceleration. Thus, increasing the duration of the insulated-based structure ensures that the structure is completely safe from the earthquake resonance range. The building with floating columns sheared at a higher level than the normal building. This increases the size of the structural members. So a floating column building is as uneconomical as a normal building. Lateral displacements are in time history analysis rather than

the other two methods of analysis. The maximum displacement increases in the floating column model compared to the floating column model.

Pradeep D., Chethan V R, &et. al. (2017) These articles are based on comparative study of a building without a floating column and a building with a floating column on different floor levels. Seismic analysis is performed by linear static and linear dynamic methods using ET ABS. As per the results obtained, the floor shear force proved to be maximum on the first floor and decreased to a minimum on the upper floor. The results obtained showed that buildings located in medium soils experience 25% more base shear than buildings located in hard soils. A building with a column floating on the lower floor experiences the same base shear, but drift between floors is greater compared to a building with a column floating on the edge of the building. Buildings in hard soil show less displacement and drift than buildings in medium soil. A building without floating columns shows 35% less displacement compared to buildings with floating columns.

AllacheruvuRaghavendra, T. Appa Reddy & et.al. (2016) The articles deal with use of floating column in multilevel buildings along with use of Bracings system into the building. The project consists of four models with named assigned as model 1 to model 4. Model 1 G + 9 normal RC building, Model 2 G + 9 RC floating column building), Model 3 G + 9 RC floating column building with corner braces and Model 4 the floating column building G + 9 RC, with reinforcements in the middle. Earthquake analysis is performed using the equivalent static method (esa) and a response spectrum method (rsa). The two seismic zones is consider i.e. III and V. The comparative study is taken with the help of different results. The results consist maximum displacement, duration, and base shear for all 4 models. The results of Model 4 produce better results compared to other models, its performance is reviewed by means of thrust analysis, and performance levels are discussed comparing Model 4 and Model 3. 2002. The final conclusion was that the Building with Medium Reinforcement (Model 4) performs well compared to all models.

Sharma R. K, Shelke N. L. (2016) This paper aims to find out whether floating column structures are safe or unsafe when built in seismically prone areas. It also focused on the economic aspects of floating column construction, whether economical or uneconomical. The work consists of G+5, G+7, G+9, G+11 and G+13 storey buildings are performed with a floating column(fc) and without floating. The staad software is used to analysis with RSA. The work under the manual calculation of the structure displacement, the basic shear, the seismic mass calculation of the building and the change of the result of the Staad pro V8i. Based on result it concluded that the construction of a floating column should not be preferred in areas with severe seismic tendencies. By increasing the size of the beam and column, the structure provides greater displacement in floating column construction than in a normal building. Due to the increase in size, the cost of construction increases, so a building with floating columns becomes uneconomical. The work concluded that the construction of a floating column building should be avoided.

Waykule.S.B, Kadam.S.S,& et.al. (2016) In this study, the researchers presented an analysis of a G + 5 building with FC as well as without FC in a high seismic zone. The modeling consists of a total of four models, such as a floating column on the first, second and third floors, without a floating column. All four models are derived from static and temporal linear history.. It has been observed that a building with a floating pillar has a larger area than a building without a floating pillar. It was also noted that the movement of the floating column from the first floor to the upper level of the building increases the deposition of two-story buildings. Based on building response under dynamic impact, it was observed that the column floating in different places vary the results. A floating columnar building has several periods compared to a building without floating pillars.

Sk. ShamaBanu, G. ShaniPriyanka (2015) The researchers examine the seismic behavior of RC multi-storey buildings. The RC building is considered in two ways which is with and without a floating column. The work consists a G+3 storey buildings in zone IV using ETABS software. The analysis is based on Linear dynamic analysis i.e., responses (impact) and factors to the safe and economical design of the structure during different earthquake excitation. From the analysis, it was concluded that the natural duration depends on the configuration of the building. The lateral displacement increases along the height of the building. The displacement of floating column buildings increases to a greater extent than a conventional building. Drift between floors also increases as the number of floors increases. Floor drift is more relevant to floating column buildings because removing the columns increases the weight, hence the drift. Therefore, it can be concluded from the study that floating columns should be avoided as much as possible, especially in seismically prone areas.

Shiwli Roy, GargiDanda de (2015) This article presented the analysis of the floating column using the STAAD PRO V8i. For these three different storey level structures G+3, G+5, and G+10 are considered. The work on this project concerns the comparison of bending moment and lateral force between these structures. The results show that with increasing structure height, both the shear force and the bending moment increase. Compared to the study of the shear force G+3 in a conventional column, floating column (removed from the first floor).The value is increase is 57%, 56%, 3.42%, 6.67% in G+3 storey Building and approx. similar results are obtained for other two storey's. The finally conclude with introduced the floating column the enhance the value of shear force and bending moment.

H.R. Tavakoli, A. RashidiAlashti (2013) The researchers investigate the collapse potential in steel structure with moment resisting frame. The analysis is carried out to obtain the resist resistive collapse with damaged columns at in different locations under seismic loading. The result is taken as the displacement of 3-D and 2-D structures. For this two buildings 5 & 15-story buildings with 4 and 6 locations using the alternative load path method recommended in the UFC guidelines is considered. The floating concept can be introduced on the bottom storey at different locations. It was observed that when the first storey column for some reason improperly performed its load role, they were sufficiently reinforced to withstand gradual collapse and no plastic rotation exceeded the specified acceptance criteria. It was found that as the number of floors and spans increased the structure's ability to withstand progressive collapse under lateral load also increased because additional elements were included to resist progressive collapse. It has also been found that an increase in the number and history of bays results in higher strength values.

3. Conclusions

The following collusions are made based on the study and summarized report of the above literature reviews which are as follows:

- The study of the above literature papers of different researchers, the use of floating column are required for the use of structure such as parking slots, machine tool, equipments placing in large span, commercial purposes etc.
- This concept affects the buildings parameter due to irregularity of structure is generated by FC(Floating Column). So it is important necessarily to study about the floating concept and its behavior under the lateral loads.
- The researchers summarized the FC effect in different results forms such as base shear, shear force, bending movement, storey displacements etc. The show that resisting capacity will be reduces under seismic loads but the building are under safer modes.
- The basic structure rigid frame or rigid frame with shear wall is adopted by maximum researchers in her/him research. The use is accomplished with respect to multistory building. The use most effective below the G+10 Storey.
- The FC effect is satisfactory in ZONE III, and damaged and critical condition will be generated in ZONE IV& V. For that extra techniques will be required.
- For single modeling use of FC is best in base area as well as on single axis frame. More no of floating like 5 to 10 in a single model than the building are not in safer mode.

4. Summery and Comments

The review of different articles based on floating column uses in the building. The use of floating is carried out only when the more free space is required and its depends upon the purpose of the building. The placing of FC is done only in multi-storey building other than thesis like high rise, tall structure not be part in the building. The resisting effect can be evaluated under seismic analysis of the building due to irregularities will be developed due to FC. The effect of static and dynamic wind is not preferable and affected in the FC buildings. The irregularities are introduced in it. The future work can be carried out by taking FC positioning with respect to column and there arrangements. The method of analysis also carried out to compare the results.

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