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A Literature Review on Seismic Response of FloatingColumn Building

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Abstract: ***Floating column building is a new fascination for engineers. As floating column buildings provides more space and good aesthetics to the building. But have high structural challenges, when a floating column is provided in a multi-story building in a high seismic zone. This paper reviews several studies conducted on the floating column building and its behavior under seismic loads. This paper studies that floating column building are vulnerable to the high seismic zones. The risk of damage also depends on the shape and size of the buildings. The ductile detailing of the joints is the promising solution for immediate failure of such buildings.***

Keywords: ***Floating Column, Response spectrum analysis. Vulnerable, damage, multi-story***

I. INTRODUCTION

Multi-story buildings in urban cities have been required to have column-free spaces due to lack of space, population density, and also aesthetic and functional requirements. For this, the buildings have floating columns on one or more floors. These floating columns are very disadvantageous in a building that is constructed in seismically active areas. The seismic forces that arise in the different floors of a building must be carried by the shortest possible path over the height to the ground. Any deviation or discontinuity in this load transfer route will result in poor building performance.

The behavior of a building in the event of an earthquake depends fundamentally on its general shape, size, and geometry, as well as on the transfer of earthquake forces to the ground. Many open buildings intended for parking collapsed or were severely damaged in Gujarat during the 2001 Bhuj earthquake. In the case of tall buildings, the column is interrupted on the ground floor and the first floorto allow a greater opening on the ground floor. Low to facilitate access to the public area at the base.

In the 1950's and 1960s, some Eastern European scholars suggested the soft base level to reach the large openings at the lower level. A-frame is built on the lower level to support the upper structure in this type of structure. This type of structure is believed to work best in earthquakes, but current experience has shown the concept to be wrong. In 1978, many buildings of this type collapsed during the earthquake in Romania. A column is intended to be a vertical element that starts from the foundation level and transfers the load to the ground. The term suspension column is also a vertical element that ends at the lower level (end level) of the building. Due to architectural requirements and its support on beams. The beams in turn transfer the load to other columns below. In practice, true piers below final grade [generally stilt grade] are not constructed carefully and are more prone to errors. Larger openings on the ground floor are now achieved by using transfer beams to absorb vertical and lateral loads from the high-rise building component and distribute them to widely spaced supports. This research focuses on literature studies of the behavior of floating columns under buildings in a high seismic zone.

II. REVIEW

Prerna nautiyal et. al. (1997) In the paper "The effect of a floating column under earthquake excitation for various soil conditions", This paper focuses for safe and economical design of a building having floating columns. Linear Dynamic Analysis is done for 2D multi storey frames with and without floating columns. For that purpose created the model G+4 and G+6 building, changing the position of the floating column. After that response spectrum analysis is done for both buildings. Dynamic response parameters such as base shear and moment for hard and medium soil condition are obtained for both building models.

T.raja sekhar et. al. (2001) In the paper "The behavior of building frames with and without floating columns is studied under static load, free vibration and forced vibration conditions". The results are plotted for both the frames with and without floating column by comparing each other's time history of floor displacement, base shear. The equivalent static analysis is carried out on the entire project mathematical 3D model using the software STAAD Pro V8i and the comparison of these models are presented. This will help us to find the various analytical properties of the structure and we may also have a very systematic and economical design for the structure.

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Behela S (2009), In paper "The behaviour of multi-storey buildings with floating columns under the action of seismic excitations". Finite element analysis is used to perform calculations and equations under various seismic loads with varying frequency components. A linear time history analysis of the building is performed. The Newmark integrated approach is used to advance the solution in a timely manner. Research conclude as the column rises near the ground, the displacement between floors and the different displacements of the floor, the overturning moment and shear force of the column also vary depending on the dimensions of the column.

Poonam, et al (2012), in paper "The response of structurally asymmetrical buildings performed the seismic analysis of building frames considering several irregularities like mass irregularity and stiffness irregularities". They derived conclusions about the effectsof such irregularities on storey shear forces, storey drifts and deflection of girders. This paper concludes that irregularities are catastrophic to the structure, but when provided, they must be detailed and well-designed and the joints must be ductile.

Malaviya P, Saurav (2014), In paper "The comparative learning of effects of floating columns on the overall cost investigation of a building". Designed on STADD PROV8i. Various models were created and analyzed. This paper concludes that in a frame structure without floating column, node displacement is minimal and stress is evenly distributed across all column and beams.

Sekhar TR, Prasad PV (2014), In paper "The behaviour of seismic analysis of multi storied building with and without floating column" .Taken static loads, free vibrations and forced vibrations into account. The conclusions of the study were graphed for buildings with and without suspended columns by associating floor thrust with the time course of floor displacement. He uses STAAD Pro V8i to perform equivalent static analysis and evaluations of these prepared models are available. This paper concludes as that increasing the base floor column would reduce extreme movement and that different sizes of column would cause base shear to fluctuate.

Mundada AP and Sawdatkar SG (2014), In paper "The comparative seismic analysis of multi-storey building having floating columns at various heights with the building doesn't having any floating column". This research focuses on existing residential structure. The load distribution of the floating column and the many properties resulting from it, as well as the reputation and things due to the application of force are taken into account. Equivalent static studies have been approved for the entire 3D model project using software. Test results show that the probability of failure of a building with a float is much higher than that of a building without a float, and the use of struts in a building with a float significantly minimizes lateral deflection.

Nanabala SG, et al. (2014), In paper, "The seismic investigation of a standard conventional building and hanging (floating) column building". The objective of this research is to discover that whether the structure is unsafe or safe with floating column when constructed in earthquake prone zones and similarly to discover whether floating column structure is cost-effective or not. Intensities of the previous year's earthquakes 9 were applied to both the normal and floating column building and displacement time history results are compared.

Nautiyal P. (2014), In paper "Seismic response evaluation of RC frame building with floating column considering different-different soil conditions". Linear Dynamic analysis is performed for 2D multi-storey frame and responses are calculated and analysed for safe and economical design of RC building under different earthquake accelerations. According to the results, the base shear requirements from response spectrum study for RC frames without floating column are found to be slightly higher than that of RC frames having floating column.

Banerjee S. and Sanjaya K Patro (2015), In paper "The approximation of damage catalogue for building with infill wall considering floating column".This paper concluded as that the infill wall considering the floating columns provides seismic reinforcement of the structure with the floating columns, and the embankment effect has a slightly higher damage index but helps reduce the formation of high-rise cracks. The infill wall increases the rigidity of the structure, resulting in higher base shear.

Sudheer KV (2015), In paper "The behaviour of G+15 multi storey building with and without floating column". Performed 3 - D Analysis of Building Systems (ETABS) software was used for designing and analysis purposes. The analysis of the multi-storey buildings with & without hanging columns is completed and various results are compared. This research conclude as the floating column building is going to experience very risky storey displacement or drift when compared with conventional one and storey shearis also high due to the use of additional amount of materials than a conventional building.

Roy S, de Danda G (2016) analysed the various building models considering floating columns. Comparisons is done in between these structural models on the basis of bending moments and shear forces. It is concluded that, with the orientation and alignment of the column and condition, the column shear varies and bending moment's at all single floors rises and shearing force also rises but it is identical for each and every floor column.

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Rohilla I, Gupta SM, Saini B (2016) The seismic response of multi-story irregular buildings has been investigated the dangerous location of floating columns in vertically uneven or asymmetrical buildings for G + 7 and G + 5 concrete structures in various seismic sectors. Building behaviors such as displacement, floor drift, and shear on specific floors were used to evaluate the final results obtained with ETABS. As beam and column sizes increase, floor displacement tends to decrease, but floor shear tends to increase. The presence of floating columns in the structure increases the drift of certain floors.

Bhensdadia H. (2018) studied pushover analysis of frames with floating column and soft storey in various earthquake areas. Push-over analysis will reflect the performance level of buildings, for designed capacity approved till the occurrence of failure. ETABS, a finite element method based structural database is used for analysis and design purposes. Results advocates that push over analysis is precise and well organized method of analysis, and also the drift and movement of building starts increasing from minor quake prone regions to major quake prone regions.

Udhav B, et al (2018) in paper "The analysis of multi-storey building with floating column" studied the behaviour of G+10 residential building. Various building models were created using STAAD Pro software and analysis was done using static method. The systematic building models comprises of all the modules which effect the mass, deformability, stiffness and finally the strength of structure. The structural building system consists of a column, wall, beam, elevator, staircase, slab, footing and retaining wall. The results shows that the column shear changes in accordance with the condition and location of column, also the curvature at every single floor or storey rises and shear force gradually rises but it is almost equivalent at every floor for respective columns.

Rahman A. (2018) in paper "Effect of floating columns on seismic response of multi-storeyed RC framed buildings" explores the effects of disjointedness column in a building exposed to seismic forces. Dynamic and static analysis using response-spectrum method were performed for a high-rise G+6 storey building by fluctuating the location of floating columns floor-wise. It has been noted that by introducing a floating column in a RC building the time period increases and this is generally due to the decrease in the stiffness. It also decreases the base reaction and spectral acceleration.

Ms. Waykule S.B, et al (2019) in their study of performance of floating column for seismic analysis of multistorey concrete building performed the analysis and evaluation of building with and without floating column in highly seismic prone zone v. 4-models were created by changing the place of floating column. Linear static and time history is performed.

Prerna. (2019) in recent times, multi-storey buildings in urban cities were required to have column free space due to shortage of space, population and also for aesthetic and functional requirements. For this, buildings were provided with floating columns at one or more storey. These floating columns were highly disadvantageous in a building built in seismically active areas. The earthquake forces that were developed at different floor levels in a building need to be carried down along the height to the ground by the shortest path. Deviation or discontinuity in that load transfer path results in poor performance of the building. The behaviour of a building during earthquakes depends critically on its overall shape, size and geometry, in addition to how the earthquake forces were carried to the ground. Many buildings with an open ground storey intended for parking collapsed or were severely damaged in Gujarat during the 2001 Bhuj earthquake.

Priyanka D. Motghare (2019) this paper pertains of analytical studies carried out to evaluate the performance of RCC frame under different position of floating columns. Building with a column that hangs or floats on beams at an intermediate storey and do not go all the way to the foundation, have discontinuities in the load transfer.

Sharma R. K. (June 2019) - studied that in urban India floating column building was a typical feature in the modern multistorey construction. Buildings with floating column were adopted either for architectural aspect or when more free space was required in the ground floor. Such features were highly undesirable in seismically active areas. In the project studies the analysis of G+5, G+7, G+9, G+11 and G+13 storey building with floating column and without floating was carried out. The analysis has been done by using Staad Pro V8i software by using Response spectrum analysis. The paper deals with the variation in results in displacement of structure, base shear, Seismic weight calculation of the building from manual calculation and Staad pro V8i. For building with floating column and building without floating column, finding the variation between the response parameters of earthquake and describe what happens when variation may be high or low. The study was carried out to find whether the floating column structures were safe or unsafe when built in seismically prone areas, and has also found out commercial aspects of floating column building either it was economical or uneconomical.

Mandwale S. et al. (2020) have done Response spectrum analysis of G+5 using ETABS 2016 software. The author has compared Normal Building and Building with FC. Columns were eliminated at outer edge on ground floor. Various Load combinations were taken as per Indian standard 456:2000.This Study concluded that the value of storey drift and time period were more in case of FC column building.

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Pundir A et al. (2020) have modeled G+15 and G+20 Steel structures with eight different cases. He has introduced Mass irregularity on the alternate floor of different models and compared their results. After placing the heavy mass, there was 7% decrease in maximum displacement was observed on the 13th floor as compared to the building having no mass. The bending moment was also increased by 15.8% on the 13th floor. He has also mentioned the increase in steel quantity due to the increment in mass. Similarly, he also calculated these parameters by placing heavy mass on the second and seventh floor. Hence this study concludes that an increase in the total weight of a building increases its lateral stability.

Sreadha A R et. al (2020) carried out an equivalent static analysis of G+5 storey structure using ETABS 2016 software. The author has also compared it with response spectrum analysis. Three models were considered for analysis. Model -1 was the conventional model, Model-2 was introduced with FC at the outer edge of the first floor and in Model-3 FC were placed at the 5th floor at the outer edge. The results were taken for Zone 4 with medium soil conditions.

Chand D et al. 2021 have done a comparative analysis of regular column structure with a floating column structure using ETABS software. Two models were modeled and three different cases were considered in each model. Some columns were floated at the corner and in another model it was floated at the edge. The Author calculated Maximum Reactions, Maximum Story Displacement, maximum base shear, and Maximum Story Drift using Response Spectrum Analysis. The present research concluded that maximum storey displacement in the lateral direction was maximum in the case of the model which had floating columns on their edges. Also, the value of vertical reaction was increased with an increase in story height.

Pundir A et al. (2021) have modeled G+15 and G+20 Steel structures with eight different cases. He has introduced Mass irregularity on the alternate floor of different models and compared their results. After placing the heavy mass, there was 7% decrease in maximum displacement was observed on the 13th floor as compared to the building having no mass. The bending moment was also increased by 15.8% on the 13th floor. He has also mentioned the increase in steel quantity due to the increment in mass. Similarly, he also calculated these parameters by placing heavy mass on the second and seventh floor. Hence this study concludes that an increase in the total weight of a building increases its lateral stability.

Yamini et al. (2021) have done a literature survey on floating column buildings. Further Author concluded that FC affects the building parameter due to irregularity of structure. Maximum researchers in this Review have adopted shear walls to compensate for the effect of FC. It was also observed that Shear walls were effective below G+10 storey. She also concluded that FC creates more damage in ZONE IV& V. The effects were satisfactory in Zone III if extra techniques are used.

III CONCLUSION

The following points are concluded from the literature review –

1) The building with floating column has more time period as compared to building without floating columns.
2) The building with floating column has less base shear as compared to building without floating column
3) Floating column building has more displacement as compared to without floating column building.
4) Building with floating column has more storey drift as compared to building without floating column.
5) Floating column at different location results into variation in dynamic response.
6) Building with floating column are more vulnerable in high seismic zone than buildings without floating column.
7) Building without floating column are more economical than building with floating column.
8) Hard soil type is more feasible to construct buildings with floating column.
9) Soft and loamy soil is not at all safe for the floating column buildings.
10) The joints must be designed with ductile detailing as per IS 13920.
11) Buildings with irregularity and floating column are more vulnerable to the earthquake rather than regular buildings.

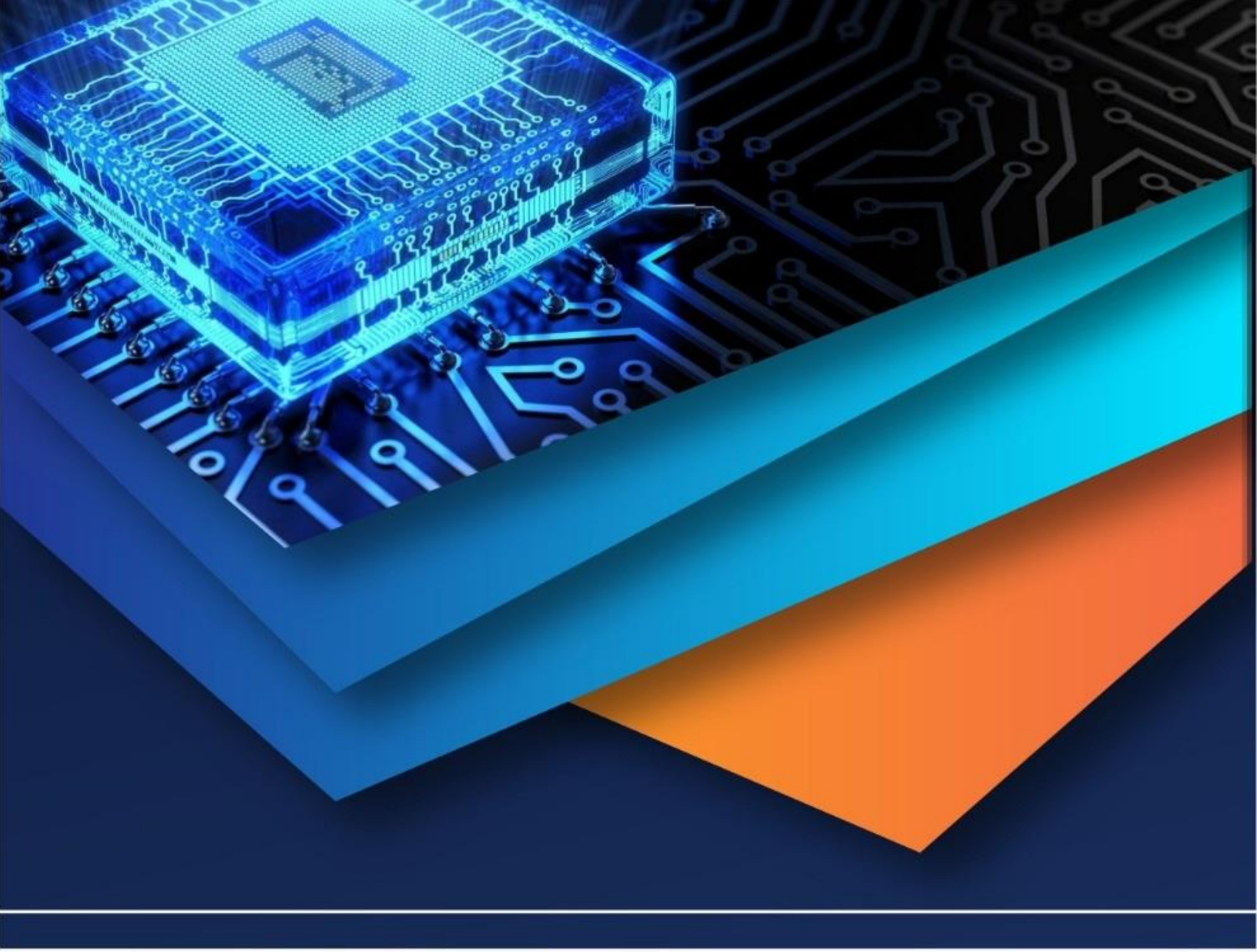
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