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STUDY OF FLOATING COLUMN BUILDING UNDER SEISMIC FORCE: A REVIEW

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ABSTRACT

Engineers now find floating column construction to be fascinating. Buildings with floating columns offer additional space and a pleasing appearance. However, when a floating column is installed in a multi-story building in a high seismic zone, there are significant structural issues. This study examines a number of studies on the behaviour of floating column buildings under seismic stresses. This paper investigates how earthquake-prone areas affect buildings using floating columns. The size and shape of the buildings also affect the likelihood of destruction. The joints' ductile detailing is a promising defence against such structures failing instantly.

1. INTRODUCTION

Due to space constraints, population density, as well as aethetic and practical needs, multi-story structures in metropolitan areas have been mandated to include column-free spaces. The structures have floating columns on one or more floors for this purpose. A building built in a seismically active area suffers greatly from these floating columns. The shortest path over the height is required to carry the seismic forces generated in a building's various storeys to the ground. The performance of the building will suffer if this load transfer route deviates or is interrupted in any way.

Fundamentally, a building's response to an earthquake depends on its overall size, geometry, and shape as well as how successfully earthquake forces are transmitted to the ground. In Gujarat, numerous open structures meant for parking fell or sustained significant damage in the 2001 Bhuj earthquake. In towering buildings, the column is broken on the first and second floors to create a larger entrance on the bottom floor. Low to make it easier to access the base's public area. Some Eastern European scholars proposed the soft base level to access the huge openings at the lower level in the 1950s and 1960s. In this kind of structure, an A-frame is constructed on the lower level to support the upper structure. The idea that this kind of building performs well during earthquakes has been disproven by recent experience. Numerous structures of this sort fell during the Romanian earthquake in 1978. In order to convey the load to the ground, a column is designed to be a vertical component that begins at the foundation level. A vertical component with a termination at the lower level (end level) of the building is referred to as a suspension column. because of the structure's requirements and the beams that support it.

2. LITERATURE REVIEW

2.1.1 Prerna nautiyal et. al. (1997) The effect of a floating column under earthquake excitation for different soil conditions is the subject of the paper "The Effect of a Floating Column Under Earthquake Excitation for Different Soil Conditions". For 2D multi-story frames with and without floating columns, linear dynamic analysis is performed. Created the G+4 and G+6 model buildings with the floating column in a different place for that reason. After that, both buildings' response spectra are analysed. For both building models, dynamic reaction characteristics for hard and medium soil conditions, such as base shear and moment, are determined.

2.1.2 T.raja sekhar et. al. (2001) The behaviour of building frames with and without floating columns is examined in the paper under conditions of static load, free vibration, and forced vibration. By contrasting each other's time histories of floor displacement and base shear, the findings are presented for both the frames with and without floating columns. Using the programme STAAD Pro V8i, an equivalent static analysis is performed on the whole mathematical 3D model of the project, and a comparison of these models is then provided. This will assist us in identifying the structure's numerous analytical characteristics, and we might also have a highly methodical and cost-effective design.

2.1.3 Behela S (2009), The behaviour of multi-story buildings with floating columns under the influence of seismic excitations is discussed in the paper. Calculations and equations under varied earthquake loads with varying frequency components are performed using finite element analysis. The structure is subjected to a study of its linear time history. The solution is swiftly advanced using the Newmark integrated approach. 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.

2.1.4 Poonam, et al (2012), in the article "The Response of Structurally Asymmetries Buildings Performed the Seismic Analysis of Building Frames Considering Several Unevennesses Like Mass Unevenness and Stiffness Unevennesses" They came at conclusions regarding how these abnormalities affected storey shear forces, storey drifts, and girder deflection. This article comes to the conclusion that irregularities are disastrous to the structure, but that they must be provided when there occur, and that they must be detailed and well-designed, with ductile joints.

2.1.5 Malaviya P, Saurav (2014), The impacts of floating columns on a building's overall cost are compared in the paper "The Comparative Learning of Effects." created with STADD PROV8i. Different models were developed and examined. This study finds that node displacement is low and stress is equally distributed among all columns and beams in a frame system without floating columns..

2.1.10 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.

2.1.11 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 shear is also high due to the use of additional amount of materials than a conventional building.

2.1.12 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.

2.1.13 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.

2.1.16 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.

2.1.17 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.

2.1.20 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.

2.1.22 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.

2.1.23 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.

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2.1.27 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.

Research gap –

(1) Very few studies are carried out on comparison between Response spectrum analysis and Time history analysis has been done for building with floating column.
(2) Very few research is done on the floating column building under different soil condition.
(3) Very few research is done on design of floating column building with different country code of practice.
(4) Very few scientific studies we carried out on the mode of failure of the column.
(5) Very few research is carried out on performance of such building with base isolations under seismic loading condition.
(6) Very less comparative research is carried out on floating column building with and without bracings.

Research Objective –

Being having multiple research gap, this research/thesis focuses on comparative study of the behaviour of building with and without floating column and having base isolation. The response spectrum analysis is carried out to understand the behaviour of the above stated condition.

Design parameter –

F.C. / B.I.	G + 10	G + 15
Without F.C. / B.I.	Model - 1	Model – 2
Without F.C. / With B.I.	Model - 3	Model - 4
With F.C. / B.I.	Model - 5	Model - 6
With F.C. / Without B.I.	Model - 7	Model – 8

Site condition	Jammu and Kashmir
Seismic zone	IV
Frame	SMRF
Importance factor	1
Codes	IS:456 , IS:800 , IS-1893 (Part -1), IS 875 (Part 1 - 4)
Soil condition	Hard
Software used	STAAD pro

Loads	Dead load, Live load , Wind load, Seismic load
Analysis method	Response spectrum method

Methodology –

(1) Modelling of buildings are done in STAAD pro
(2) Calculated loads are assigned and analysis is done
(3) Comparative study is established to reach the conclusion.

3. 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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