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Dynamic Behaviour Comparison of an Irregular Edifice with Different Locations of Floating Column and Shear Wall

Varun Mahajan[1], Prof. Rupali Gaud[2]
[1]M. Tech. (SE) Scholar, [2]Assistant Professor, Civil Engineering Department, SVITS, SVVV, Indore

Abstract: Architects nowadays develop attractive edifices, and floating columns are widely employed in this process. Floating columns are used not only to provide a magnificent perspective but also when a vast open area is necessary. Edifices with irregular configurations are more vulnerable to earthquakes and hence, suitable shear wall placement is required to ensure the edifice's stability.

Many multi-storey edifices collapsed in seconds after the Bhuj Earthquake (Jan 26, 2001), due to the presence of soft stories, floating columns, and mass anomalies. As a result, knowing the seismic reactions of these buildings are vital for constructing earthquake-resistant assemblies.

The relevance of a Floating Column and the existence of a shear wall in an irregular multistorey building is highlighted in this study. Dynamic seismic behaviour of a G+18 irregular edifice with different locations of the floating column and different positions of the shear wall is explored in this research. The edifice is analysed and compared with the model without shear walls and floating columns to examine the alterations.

The dynamic analysis is carried out using Response Spectrum Analysis and storey drift, storey displacement and base shear are calculated and finally, software compression is computed for different zones. The analysis is carried out by Indian standardized codes IS 1893:2016 and IS 456:2000 which are the codes specified by the Bureau of Indian Standards for earthquake resistance edifice design and plain and reinforcement concrete design respectively.

Keywords: Floating Column, Shear Wall, Irregular Edifice, Seismic behaviour, Response Spectrum Analysis, storey drift, storey displacement, base shear.

I. INTRODUCTION

A. Floating Column

A vertical section that rests on the beam and does not convey loads to the foundation directly is known as a floating column. The general behaviour of transfer of load is from beam to column and finally to footings. A column originates at the top of the edifice and ends at a lower level, generally the ground floor. A floating column may start on any midway floor, and it is fixed on a beam. The beams on which the floating columns are sitting are known as transfer beams.

B. Shear Walls

A shear wall is an erect component of a structure built to withstand lateral stresses like wind and earthquakes. Shear walls are a vital component in skyscrapers, as well as constructions in high-wind and seismic-prone areas. Shear walls are often constructed with concrete or masonry. Because the shear wall functions as a single element, lateral forces tend to create a rotational force on the shear wall, causing compression at one corner and tension at the other.

C. Response Spectrum Analysis

Reaction spectra are graphs that indicate the link between an SDOF system's highest response and the amount of time it was engaged in a specific “ground motion.” The response spectrum is the plotted graph of the peak values of a single degree of freedom system for a particular damping ratio. Response spectra help determine the peak structural behaviour within a linear region, which may subsequently be used to compute the lateral forces generated in edifices because of earthquakes, making earthquake-resistant building design smoother. This method is used to compute “maximum storey displacement”, “maximum storey shear”, and “storey drift.”

II. LITERATURE REVIEW

Badgire Udhav S., et al. (2015) have researched on the existing G+10 edifice is considered and drawn into three different models according to the location of the floating column and compared for seismic analysis with the equivalent static method using STAAD PRO. The findings of this paper were that the probability of failure of edifice because of the floating column is more for the edifice with a floating column on a longer side than the edifice with a floating column on a shorter side. In both cases, the orientation of the column plays a great role which changing the value of column shear significantly.

Jiji Thomas, et al. (2015) have researched the dynamic analysis is executed for a six-storey building with and without floating column and the performance of the building is witnessed under altered soil conditions and seismic zones. The results are drawn from the graphics by examining storey drift and storey shear. The findings of this paper were that the storey drift and shear increase with soil type from I to III and with the increment of seismic zones. the storey shear in the top storey of a building with the floating column is more than shear in a building without a floating column. A rapid descent of storey drift is observed on the third floor in both models.

S.B. Waykule, et al. (2016). have researched two models that are considered a G+5 building. One includes a floating column and the other lacks a floating column. The seismic analysis is performed under a highly seismic zone which is zone V. In this paper the observation was made that the building with floating columns has more time period, storey drift and displacement compared to the building without floating columns. The base shear is fewer for structures containing floating columns. The dynamic analysis shows that the analysis depends upon the different locations of the floating columns.

Sampath Kumar M.P., et al. (2016). have researched a total of six models that are considered with different combinations of height, soft storey concept and mass irregularity and analysed with the adoption of equivalent static method and response spectrum analysis. The findings of this paper were that the lateral displacement is more for building with floating columns and mass irregularity than that of normal buildings and the rise of height results in the growth of displacement. The drift reduces at the base because of stiffness. The base shear is more for mass irregularity and less for the floating column as compared to the regular edifice.

Kandukuri Sunitha, et al. (2017). This paper gives a brief about the floating column in the modern era of high-rise buildings. The compression of normal buildings is done with buildings with a floating column for external lateral forces on ETABS. The time historic analysis is performed in this research paper. Total seven models are considered with varying combinations of the shear wall, bracings, and floating columns with different locations. Each modal is then analysed for G+4, G+9 and G+14 stories. This study can be summarised as the maximum displacement and the story drift increases for floating columns and increment of height, the axial forces increased in regular columns because it bears the load of floating columns, shear wall installation in the small building will not be economical so not recommended rather bracing system should be used and bending moment is also observed and upper columns show the larger bending moment whereas the lower column shows lesser bending moment.

Priya Prasannan, et al. (2017). It deals with the seismic analysis of the G+14 multistorey edifice with different locations of the floating column not only floor wise but also on different levels such as on the ground, fifth, tenth and fifteenth floor and five models are considered for the floor level changes to obtain the best configuration. The findings of this paper were that the time period and base shear are more in the case where floating columns are provided on the ground and the storey drift and storey displacement are more in the case where the floating columns are provided on the fifth floor. Model 4 having the maximum number of external columns resisted better against the lateral forces. The best way to oppose the lateral force is to provide a shear wall at diagonal corners.

Chethana, et al. (2018). It deals with the response spectrum analysis is performed on G+24 multistorey buildings with the different locations of shear walls on regular as well as irregular edifices and storey drift, displacement, and base shear are observed. Model A and Model B are the two models available. Model A has a bay size of 4.35m x 4.35m for standard construction. Model B has a bay size of 5m X 5m and is designed for irregular edifices. Both variants have the same surface area. These two models are employed differently by the shear wall. each model is created in ETABS. The findings of this paper were that the maximum reduction in storey drift, storey displacement and time period was observed in model four (M4) for both regular and irregular edifices and the value of base shear also increased by the implementation of shear wall in both regular and irregular edifices.

Kirankumar Gaddad, et al. (2018). It deals with the compression of the G+20 multistorey edifice between shear wall, floating column, and normal edifice. The static analysis, as well as dynamic analysis, is performed for earthquake zone 5. For this study, four models are considered: the first is a normal or braced frame edifice, the second includes floating columns, the third includes a vertical shear wall, and the fourth includes a combination of shear wall and floating column. The findings of this paper were that the storey drift and displacement in models with only floating columns are observed highest among the four models.

The time period is greater in edifice with only floating columns. storey shear is decreased in a similar model as above. the functioning of the model utilising the shear wall was best.

Mr. Gaurav Pandey, et al. (2018). It deals with a G+14 high rise edifice is considered, and response spectrum analysis is performed with the different location of floating columns on prereferral position for seismic zone V. The findings of this paper in the case of storey drift and shear force the models with floating columns only at corners and periphery of G+9 and G+12 was more efficient among all the others. Nodal displacement is observed minimum for models only with floating columns at the corner and periphery of G+12. Bending moment at the model with the floating column at the periphery of G+9 was optimum.

Israa H. Nayel, et al. (2018). It deals with the multistorey edifice is considered with a floating column at the bottom and four different models are considered with different locations of the shear wall, i.e., at the corner, at the centre, and the centre of the faces of the building, and the best spot for the shear wall is witnessed.

The findings of this paper show that the lateral displacement and drift are greater for the model without a shear wall than for the model with a shear wall. And these quantities are also higher for higher stories and lower for lower stories. Stiffness in the first storey is more for models with shear walls in corners. For lower shear walls, it is not advisable.

Mohd Khadeer Ahamed, et al. (2020). It helps us study seismic effects on the uneven building; different locations of floating columns are calculated and compared with the edifice without floating columns with the help of ETABS.

The findings of this paper show that storey drift and displacements are better in the model that has floating columns in the centre modes for all the models that are under permissible limits. The most optimal models can be models 5 and 6, with floating columns in the centre.

Sreadha A R, et al. (2020). have researched the three models without floating columns and those with different locations of floating columns are compared, and the seismic zone IV is considered. Research is done to observe the performance of edifices in seismic prone zones. The findings of this paper show that an edifice with a floating column shows higher storey drift, displacement, and base shear as compared to an edifice without a floating column. The lateral storey drift rises as the floating column is moved above the edifice.

T Minu Sree, et al. (2021). In this the response spectrum analysis is performed on the typical building plan of G+10 storey building with a shear wall of two different dimensions i.e., 150 mm and 200 mm. The findings of this paper show that the torsion, shear force, bending moment and displacement is better for the model with a shear wall of 200 mm but a model with a shear wall of 150 mm is economical.

Prit B Sathwara, et al. (2021). In this study, the response spectrum analysis of vertically irregular edifices such as setback frames and stepped frames is performed with different locations of shear walls, i.e., at the core and periphery. The findings of this paper show that the step frame edifice shows maximum venerability against the seismic analysis, and the edifices with basements perform better, but the regular frame edifice with the basement showed the maximum value of the time period.

Rohan Duduskar, et al. (2021). In this study, four models are considered for the G+20 edifice: one with a shear wall, one with a floating column, and one with both, and they are compared on ETABS based on storey drift, storey displacement, storey shear, and time period. When the findings from every model are examined, the buildings with shear walls have lower displacements and storey drifts than the floating column models. When compared to all other models, the shear wall construction provides higher performance and strength. Apart from floating columns without shear walls, the rigidity of the shear wall in the corner (L shape) increases.

Nikhil Pandey (2021). In this paper, the geometrical irregular multi-storey building is taken under consideration with different locations and different patterns of shear wall. Total 8 models are taken with the same plane and different locations for the shear wall. It gives the outcome of the ideal location of the shear wall.

It can be observed that maximum stiffness, minimum storey drift and displacement, and minimum overturning moments can be observed in the edifice where shear walls are in corners or I-shaped at the centre. So, as per the results, the best location for shear walls is at the corners and then at the centre, I-section shaped.

Kuldeep Singh Bhadoriya, et al. (2021). In this paper, they considered a G+10 edifice with and without floating column and shear wall is analysed under seismic forces with the help of STAAD PRO software. It was observed that the forces and stresses are more in normal R.C.C edifice and edifice with the shear wall than that in floating columns edifices but the moment are more in floating column edifice than that in normal R.C.C. edifice with shear walls.

III.CONCLUSIONS

The literature review can be concluded as follows:

1) All the above research deals with the edifice having shear walls and floating columns in different locations and conditions, and we can observe that the edifice with floating columns has increased values of storey drift and displacement as compared to the edifice without floating columns.
2) The displacement of the storey enhances with the rise in height of the building.
3) It was also observed that the analysis was affected by the orientation of columns and the different locations of floating columns.
4) The edifices with floating columns in the centre performed well in the seismic analysis as compared to the edifice with floating columns on the periphery.
5) The storey drift was increasing as the floating column's location was shifted above the edifice.
6) The edifice with floating columns and a shear wall performed well in seismic analysis.
7) The edifice having a shear wall in all the corners, or I-shaped at the centre, performed well and shows maximum stiffness, least storey drift, displacement, and overturning moments compared to buildings with all the other locations of shear wall.
8) The shear wall, when provided at the diagonal region structure performed well.
9) Shear wall is not advisable for an edifice with fewer heights because if it is provided, the edifice will not be economical
10) When the edifice was observed under different soil conditions, the zones, it was observed that the storey drift increased with the increment of the soil type from I to III type soil and from zone II to zone V.
11) Every study was done with the help of software like STAAD PRO and ETABS. So, the comparison of software performance will be observed and with different seismic.

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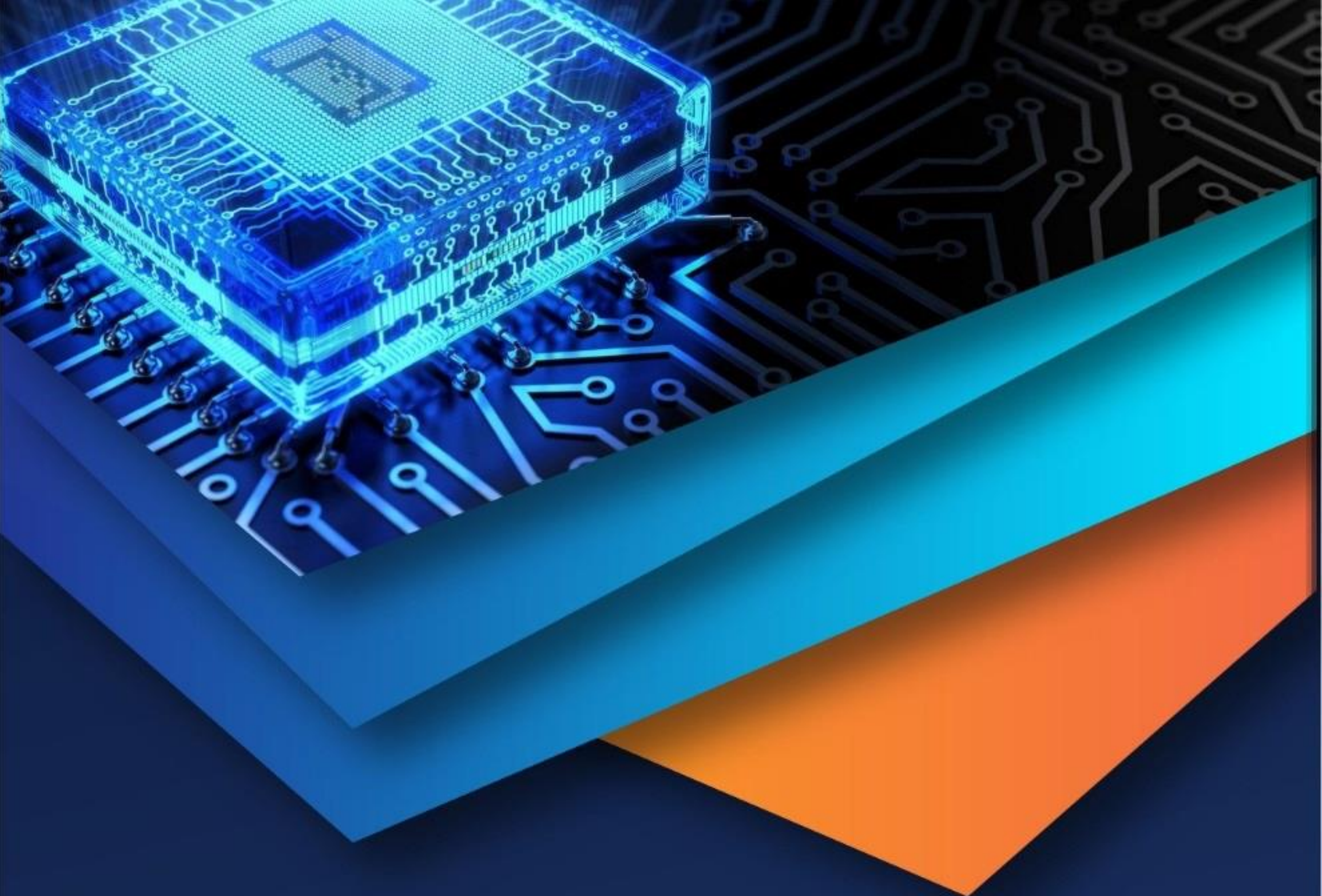

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