Seismic Analysis of High Rise Building with Floating Column in Bracing System

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Abstract- In Reinforced Cement Concrete structures lateral loads are first which will grow proportionally with growth in floor height of the structure as a result of which lateral loads more effective in the top story in contrast to the bottom story due to which the structures are likely to react as cantilever and that forces develop high stresses, produce sway movement leads to serious damages and hence at last results in failure of the structure. Each of these causes form the study of the effect of lateral loads very dominant. Column is the most critical member in the building subjected to earthquake loading because failure of a column can affect the stability of the whole building. Column may fails due to lack of ductility, strength and weak beam column joint. A model of a 10 storey structure is made on ETABS Software and analysis of reinforced concrete framed structure under earthquake excitation has been carried using the linear static analysis methods as per the guidelines provided in IS1893:2016 codes to simulate seismic analysis. In order to study the effect seismic force in zone IV of India a multi-storey hotel building of G+9 of rectangular Shape configuration is taken in zone IV with and without having Floating column at different location is analysed using linear static method. Based on results and comparing the parameters of different cases with and without Floating column & Bracings System the conclusion can be made.

Index Terms- Bracing System, Earthquake Engineering, ETABS software, Floating Column,Linear static method

I. INTRODUCTION

Now-a-days the demand of area for construction is going on increasing everywhere. The shortage of place in different regions has guided to the evolution of vertical growth restoring from low-rise to average-rise and high-rise or tall structures. For High-rise structures Reinforced Cement Concrete is preferred. R.C.C. structures are always subjected to gravity loads (i.e. vertical loads) and lateral loads (i.e. horizontal loads), gravity loads consider live load, dead load, superimposed load, and lateral loads consider earthquake load and wind load. Previously structures were designed and drafted for only gravity loads that may not have protection against lateral or horizontal loads due to low height of structure.

The floating column is a vertical member which rest on a beam and doesn't have a foundation. The floating column act as a point load on the beam and this beam transfers the load to the columns below it. It belongs to a vertical member that is laid on a beam and it doesn't deliver the load directly to the foundation.[AllacheruvuRaghavendra 2016] The arrangement of a hanging column is in such a way that it simply floats or is being hung over a base (beam or slab) with no fixed support below with the foundation. This gives the vertical column the name floating or hanging column. There are many projects in which floating columns are adopted, especially above the ground floor, where transfer girders are employed, so that more open space is available on the ground floor. These open spaces may be required for an assembly hall or parking purpose [Snehal Ashok Bhayar 2016].

Commonly the building with the bracing system has more lateral stability as compared to normal moment-resisting framed buildings. But the floating column structure has less lateral stability as compared to simple moment-resisting framed structure the behavior floating column structure with the bracing system will be studied in this study:

II. LITERATURE REVIEW

- AlirezaKianmehr (2021) Simple bracing frames can be divided into two types in terms of concentric or eccentric. Concentric bracing frames are frames that intersect with other structural members at one point in the structure along the bracing members. Otherwise, the braced frame will be eccentric. It is said empirically that due to this type of shaping, eccentric bracing frames exhibit more ductile behavior and concentric bracing frames exhibit more stiff behavior. This behavioral difference caused this study to be numerically computing for five frames, including unique concentric and eccentric bracing frames of 5 and 10 stories and an ordinary 5-story concentric bracing frame. Their tensions and drift ratios should be acceptable for the use of residential buildings. Using the primary two steps of the new PEER probabilistic framework, namely, probabilistic seismic hazard analysis and structural analysis, which leads to the drawing of fragility curves, the probability of collapse is obtained to compare the safety capability of these frames.

- Neha Pawar et.al. (2021) In the present study, A G+8 high rise structure with special moment resisting frame is considered. Various configuration of building is analyzed using FEM based software ETabs. The inputs are Geometry of frames which includes dimensions of building, storey height, Beams and columns sizes, Thickness of slabs, Loading conditions, Modulus of elasticity, Response spectrum data, damping ratio and earthquake data. The structural response of all configurations is compared in the form of Maximum Storey displacement, Storey drifts, Base Shear and Overturning moments. In order to validate the results, the calculation of seismic weight and base shear of regular structure is done by manual calculation as per IS 1893:2016 part 1. Analysis concluded that interior placement of floating columns reduces the seismic hazard of structure as compared to outer periphery floating columns. There was not any significant improvement in structural behavior of the structure SI-1 and SI-8.But after increasing the diameter of the column the displacement is reduced. It is also concluding that the displacement in FC building decreases as the upper story height increases but the overturning moments are increased abruptly. In modern trends, the architectural requirements are designed so as to provide more space with less obstruction. Hence Incorporating Floating columns with the combination of various irregularity can be adopted not only to fulfil Architectural requirements but also the Structural requirements .

- Israa H. Nayel et.al. (2018) this paper concerns with analysing the effect of different locations of the shear wall on a multistory specific building (contains10 stories) with floating columns which is subjected to earthquake force zone. The first model taken without shear wall, while the others three models include a shear wall in the centre, core and at the centre of the building to study the best location. The effect of shear wall locations on some important parameters like displacement in the two directions, time periods and also the base shear in the two directions are discussed. The present analysis was done by using the software ETABS-2015, because of there is large difficulties to do that experimentally. The responses of these structures are analysed, discussed and the best location of the shear wall is stated. This study covers the performance of multisory floating column building with and without shear wall in various positions and according to the earthquake excitation. The analysis of response spectrum is achieved, and it has been concluded that the maximum storey drift values and shifts are becoming larger for the floating column.

- Amir Fateh et.al. (2017) This paper presents a new bracing system with variable stiffness springs; this adaptive structural control system is designed to protect buildings against severe vibration and ground movement. The developed variable stiffness bracing (VSB) system comprises four nonlinear steel leaf springs that provide nonlinear and variable stiffness capacity at different frame displacements. The inelastic actions of the VSB system's nonlinear leaf springs keep the energy dissipation characteristics and ductility of moment-resisting frames. At large vibration amplitudes, the VSB device restrains unallowably story drift. Therefore, frames display ductile performance. they developed a mathematical model to simulate the mechanical behavior of the system, including the stiffness nonlinearity of the springs. Moreover, theyevaluated the efficiency of the VSB implementation in a single-degree-of-freedom system by dynamically analyzing different models: a moment-resisting frame, a conventional braced frame, and a frame using the VSB system. This article discusses and proves the effectiveness of the proposed system through numerical analysis.

- K. K. Pathak et. al. (2016), studied and analyzed G+9 steel frames with a different typeof bracing pattern and different combination of soft-story using software STAAD Pro. Effectof these different bracings on the soft story is studied for different parameters like column displacement, maximum deflection, story drift, maximum bending moment, maximum axial force and maximum shear force.

- Nitin Bhojkar and Mahesh Bagade (2015), studied the seismic evaluation of high-rise structure by using steel bracing system. For the seismically inadequate reinforced concrete frames, the use of steel bracing systems is done for strengthening. In this study, different types of bracing systems are used and seismic analysis is done for seismic zone III as per IS1893:2002. Lateral displacement, story drift, axial force, and base shear are the main parameters which are studied. It was seen that the structural stiffness was contributed by the X type of steel bracing and maximum inter-story drift of the frames also gets reduced. The bracing system gives best results in lateral stiffness, strength capacity as well as in displacement capacity. They conclude that a reduction in lateral displacement of the structure occurs up to 65% by the use of Xtype of bracing system. Story drift gets reduced in X type of bracing system. Therewas an increase in axial force for X bracing system up to 22%.

- Snehal Ashok Bhayar (2017) had done a comparative study of the behavior of building with and without floating column for the regular and irregular plan, subjected to seismic loading for equivalent static analysis by using ETABS Software. The areas of study were Base Shear, Lateral story Displacement and Storey Drift in seismic zone IV. He found that the probability of failure of building with a floating column is more.

- Kapil Dev Mishra (2018), studied a multi-storied Plaza building of different heights (G+2+3, G+2+4, G+2+5) having different position of floating columns (4 columns of mid ordinate axis or 4 columns of diagonal axis) at different height of building (at the level above second floor) at two different zones (Zone III and Zone IV) are considered for analysis and STAAD PRO. Software is used for the analysis. The plan area of building up to the second floor is 30m×30m

and above this floor area is reduced to 20m×20m. The comparisons were done on the basis of results from the software andare based on following parameters such as Maximum displacement at joint, Support reaction at the base, Maximum moment at the joint and Base shear.

III. METHODOLOGY

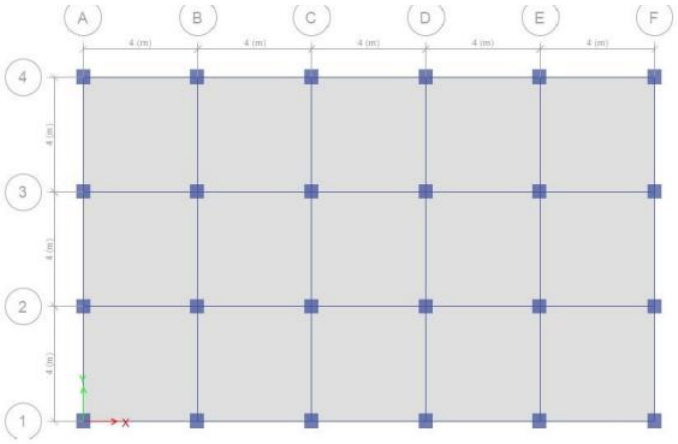
The study on the topic of "Seismic Analysis of High Rise Building with Floating Column in Bracing system" is performed. In order to study the R.C.C. framed structure having floating columns (without bracing) and floating columns with bracing system seismic zone 4 are considered of India.

Table 1: general details under consideration

Software used	Configuration of Building	Model Dimensions	Story	Seismic Zone
ETABS	Rectangular	20 m x 12 m	10	IV as per IS: 1893:2016.

The primary objective of this current work is to study of the earthquake response of multi-storey Buildings using performance based design. The effect of seismic response on G+9 storey building with the help of ETABS software 16.2.1 version, for seismic zone IV has been investigated. The main objectives of the present thesis are as follows;

1) To design a G+9 storey, reinforced concrete frame building using ETABS
2) To calculate the base shear, story shear, story displacement, Story drift to regular G+9 building.
3) To calculate the base shear, story shear, story displacement, Story drift of regular G+9 building with floating column.
4) To calculate the base shear, story shear, story displacement, Story drift of regular G+9 building with floating column in Bracing system.
5) To explore possibility of utilization of Bracing system in floating column structure for increasing its effectiveness under of ground motion.



IV. RESULTS

1. Base Reaction in X Direction

It can be observed from the above graph that the value of maximum base shearincreases asthe weight of the structure is increased

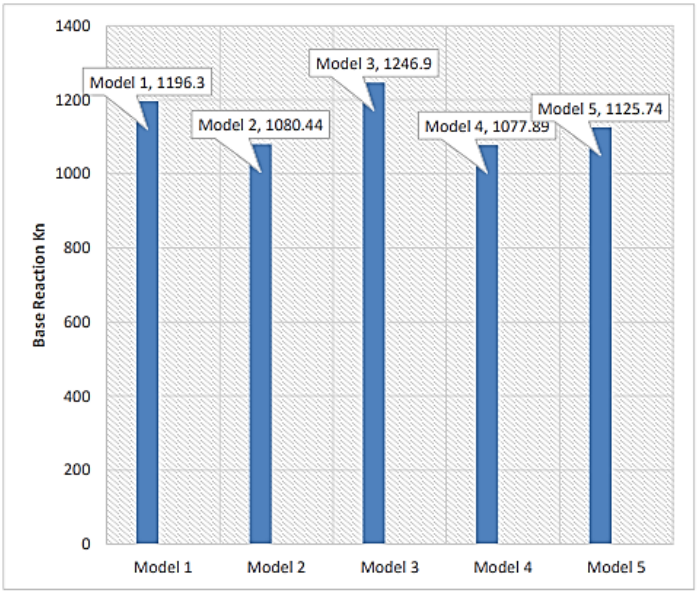


Figure 2: Figure showing Maximum Base Reaction in X direction

2. Base Reaction in Y Direction

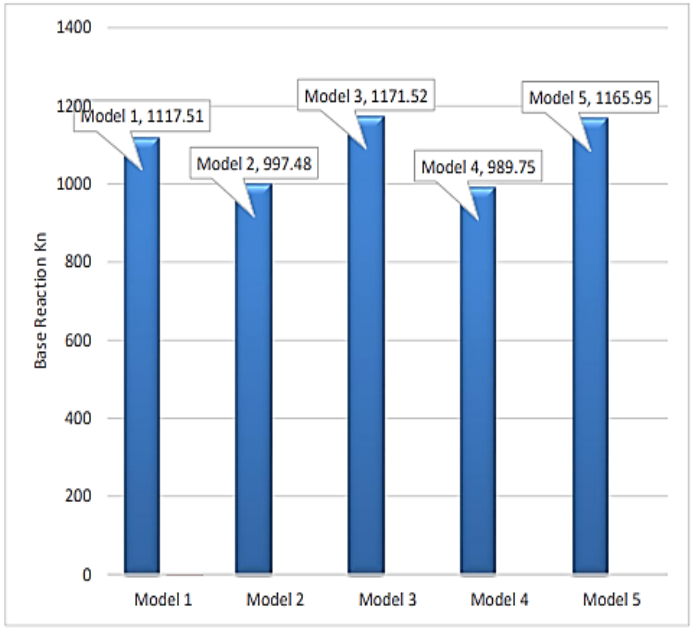


Figure 3: Figure showing Maximum Base Reaction in Y direction

3. Determination of storey drift for different cases

Table 2: Comparison of storey drift

STORY	Maximum Story drift		
	MODEL 1 (Regular column structure)	MODEL 2 (Floating column structure without bracing)	MODEL 3 (Floating column structure with bracing)
Story10	0.001454	0.001587	0.001328
Story9	0.001512	0.001660	0.001614
Story8	0.00155	0.001676	0.001346
Story7	0.001568	0.001707	0.001626
Story6	0.001568	0.001681	0.001285
Story5	0.001553	0.001676	0.001556
Story4	0.001519	0.001611	0.001148
Story3	0.001443	0.001539	0.00141
Story2	0.001162	0.001219	0.000807
Story1	0.000362	0.000386	0.000319
Base	0	0	0

V. CONCLUSION

Maximum Story Displacements in floating column structures are higher than regular column structure and it reduces by providing bracing in floating column structure. Values of Maximum Story Displacement is maximum in Model 4 (10 Story Floating Column Structure with Floating Columns at edges. Load on the foundation increases with the implementation of bracing in a floating column structure. Load on the foundation for the floating columns structures are less than the regular column structure. Value of maximum base reaction in vertical direction in maximum in Model 1 (G+9 story regular column structure.

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