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Dynamic Analysis of Multistory Building with and Without Floating Column Using ETABS

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ABSTRACT: Floating columns are those that support the beam without a foundation. They are frequently seen in multi-story structures with the intention of housing ground floor parking or higher levels with open halls. This column shows a discontinuity in the load transfer path. They are therefore made to withstand gravity loads. However, these buildings aren't made to withstand seismic loads. In the current situation, floating column architectures can be typical in Indian cities. However in tectonic areas, this type of structure is not preferred due to discontinuity of load transfer path i.e. whole earthquake load on the structure is shared by the shear walls without any loads on the floating columns. In present scenario buildings with floating column is a typical feature in the modern multistory construction in India. Such features are highly undesirable in building built in seismically active areas. In the unavoidable circumstance floating columns are adopted in building. This paper review the nature of a multi-storey building under quake forces with and without of floating columns. This analysis focus the importance of specially identifying the presence of the floating column within the study of the struture, establish its correlation with the building without a floating column using designing software Extended three dimensional analysis of building systems (ETABS). This paper also discusses the performance of structure having floating column in seismically active areas. Besides these various parameter such as maximum displacement, effect on number of storey on drift, base shear are also studied.

KEY WORDS: *Floating column, stiffness balance, FEM codes, earthquake excitation, time history, roof displacement, Inter storey drift, base shear, column axial force.*

I.INTRODUCTION

Today, an open first story is an inevitable element of many urban multistorey buildings in India. The main purpose of this is to make room for first-story parking or reception lobbies. While a building's natural period determines the total seismic base shear it experiences during an earthquake, the seismic force distribution depends on the mass and stiffness distribution along the height. In addition to how the earthquake forces are transmitted to the ground, a building's overall design, size, and geometry all influence how it will behave during an earthquake. A building's performance suffers from any deviation or discontinuity in the load transfer path, which is necessary to bring the earthquake forces generated at different floor levels down along the height to the ground. At the level of discontinuity, buildings with vertical setbacks—such as hotel buildings that are a few stories wider than the others—cause an abrupt increase in seismic pressures. Structures with an exceptionally high storey or fewer columns or walls in that level are more likely to sustain damage or collapse, which starts in that storey. During Gujarat's 2001 Bhuj earthquake, numerous structures with an open ground floor meant for parking either collapsed or suffered significant damage. There are discontinuities in the load transmission path in buildings with columns that hang or float on beams at an intermediate story and do not extend all the way to the foundation.

Strength and stiffness requirements are the foundation for the construction of traditional civil engineering structures. The ultimate limit state, which guarantees that the forces generated in the structure stay within the elastic range, is connected to strength. Stiffness and serviceability limit states are connected, ensuring that the structural displacement stays within acceptable bounds. Ductility is required in the event of seismic forces. A building that needs to react to powerful ground vibrations must have ductility. Ductility is the structure's capacity to deform or distort without breaking or failing, which causes energy to be lost. More ductility and energy dissipation derive from a structure's ability

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to bend plastically without collapsing. As a result, the effective seismic forces are reduced. The columns of the soft storeys diffuse the majority of the energy generated by an earthquake. This method turns the soft story into a mechanism by creating plastic hinges at the ends of the columns. The collapse is inevitable in such a situation. As a result, additional attention should be given to the study and design of soft stories.
The objective of the present work is to study the behavior of multistory buildings with and without floating columns under earthquake excitations. RC Frames of different stiffness on floor wise and height of building are considered. The base of the building frame is assumed to be fixed. The time history analysis of these RC Frames has been done by subjecting the whole system to BHUJ earthquake ground motion, using FEM Package SAP2000 and ETABS Packages.

Need of floating column:

Now a days multi-storey building construction for residential, industrial or commercial purpose has become a common feature. These multi-storey building need ample of parking or open spaces below.
In multi-storey residential building to accommodate for the number of parking places and the turning radius, some of the columns from the floors above create a problem. In these cases, these columns are designed as floating columns.
Even in commercial building there might be a need for conference hall or banquet hall on the lower floors. For these purposes we prefer to have a clear open space rather than having columns in between. This is where floating columns come into the picture. Floating columns gives the liberty to alter the floor plans above.

Advantages and Disadvantages of floating column:

The floating column is undesirable in building construction. Some of the reasons are:

1. Increased storey displacement in buildings
2. Attract seismic forces extensively
3. There is no continuity with the above and below floors making it vulnerable

Still floating column is used due to following advantages

1. The plan can be varied on each floor
2. Construction of Soft-storeys
3. Architectural Importance

In areas where the floating column cannot be ignored, they are designed carefully by the structural engineers. The supporting girders must also be designed with higher shear capacity or as deep beams.

Load transfer in floating columns and non-floating columns:

The load transfer is directly done by the non-floating column where it is safely transferred to the foundation. In case of floating column, the load is taken by the below beam. The column is arranged as a point load over the beam. The load is equally distributed to the beam.

Objective of the study:

- To study behavior of multi-storey building with floating column under earthquake excitation.
- To analysis R.C.C. frame building with floating column and without floating column using ETABS.
- To compare analysis for base shear storey drift and displacement between floating column and without floating column.
- To analysis story drift, displacement, shear, storey stiffness on different floor.

III. LITERATURE SURVEY

- **Seismic Analysis & Design of Multistory Building Using Etabs** by Rinkesh R Bhandarkar et al (2017) E-tabs are mostly used to analyze concrete& steel structure, low& high rise buildings, skyscrapers& portal frames.

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- **Design Optimization and Analysis of Shear Wall in High Rise Buildings Using ETABS** by Umamaheshwara.B et al (2016) the shear wall is a structural element which is used to resist earthquake forces. These wall will consumptives shear forces & will prevent changing location-position of construction & consequently destruction. On other hand, shear wall arrangement must be absolutely accurate, if not, we will find negative effect instead. For example if the shear walls make an increase distance between mass centre and hardness centre, we cannot expect a good tensional behavior from the structure. In case of mass centre and hardness centre coincide with each other, at that time the distance of shear wall from the mass centre also plays an important role in the shear contribution of the shear wall. The bending moment, shear force, torsion, axial force contribution by rest of the structural element and the ultimate design of all the structural components also affected by that. A study has been carried out to determine the optimum Structural configuration of a multistory building by changing the shear wall locations. Three different cases of shear wall position for a 15 storey residential building with keeping zero eccentricity between mass centre and hardness centre have been analyzed and designed as a space frame system by computer application software, subjected to lateral and gravity loading in accordance with IS provisions.
- **Study on High-rise Structure with Oblique Columns by ETABS, SAP2000, MIDAS/GEN and SATWE** by Kai Hu et al (2012) Facing a large number of new-type complex structural system and progressively consummate earthquake-resistant theories, the conventional software can no longer meet the needs of calculation and analysis. Meanwhile, some international finite element programs, such as ETABS, SAP2000, MIDAS/gen and SATWE, were updating themselves but remained respective limitations. In this paper, response spectrum, time history and linking slab in-plan stresses analysis were executed combined with a practical project by these programs, which were also compared following the analysis results.
- **Analysis of G+30 High-rise Buildings by Using Etabs for Various Frame Sections in Zone IV& Zone V** By A. Pavan Kumar Reddy et al (2017) from the ancient time we know earthquake is a disaster causing occasion. Up to date days constructions are fitting increasingly narrow and extra inclined to sway and consequently detrimental within the earthquake. Researchers and engineers have worked out within the past to make the constructions as earthquake resistant. After many functional reports it has proven that use of lateral load resisting methods in the constructing configuration has drastically increased the performance of the structure in earthquake by using ETABS 9.7.4, the work has been carried out for the distinctive instances utilizing shear wall and bracings for the exceptional heights, and maximum top regarded for the reward gain knowledge of is 93.5m. The modeling is completed to examine the outcome of special circumstances along with specific heights on seismic parameters like base shear, lateral displacements and lateral drifts. The gain knowledge of has been implemented for the Zone IV and Zone V in Soil Type II (medium soils) as targeted in IS 1893-2002.
- **The Effect Of Shear Wall Locations In Rc Multis-torey Building With Floating Column Subjected To Seismic Load** by Israa H. Nayel et al (2018) The architectural designer likely tends to provide more space for one or more storey inside the multi-storey building by means of many methods; one of them by using floating columns, which means the end of any vertical element rest on a beam that leads to discontinuity of columns in such type of multi-storey buildings. So it has been used shear wall in their direction of orientation that provides additional strength and stiffness to the buildings. As a result of the increase of seismic activities recently, there is a necessity for considering the effect of the seismic loading on the structural analysis of the constructions. So this paper concerns with analyzing 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 analyzed, discussed and the best location of the shear wall is stated.
- **Seismic Analysis of Multi-Storey Building with Floating Columns Using ETABS** by Pradeep D. et al (2017) Now a day multi-storey buildings are constructed for the purpose of residential, commercial etc., with open ground storey is becoming common feature. For the purpose of parking all, usually the ground storey is kept free without any construction except columns. Buildings which have discontinuity of columns and building having columns which transfer load to the beams in lateral direction are called as floating column building. A column is meant to be an upright member ranging from footing level and conveying the load to the lowest. The

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term floating-column is additionally anupright member that ends (due to subject field design/ web site situation) at its lower level (termination Level) rests on a beam that may be a horizontal member. The beams successively transfer the load to alternative columns below it. Such columns in structures will be analyzed and designed. Results are compared in the form of Storey displacements, Storey Shear with & without columns. Also the Zone wise results are compared using tables & graph to find out the most optimized solution. ETABS 2015 has been utilized for analyzing the above building Structure.

- **Seismic Analysis of Multi-Storied Building with Shear Walls Using ETABS** by N. Janardhana Reddy et al (2013) Shear walls are structural members used to elongate the strength of R.C.C. structures. These shear walls will be construct in each level of the structure, to form an effective box structure. Equal length shear walls are placed symmetrically on opposite sides of outer walls of the building. Shear walls are added to the building interior to provide more strength and stiffness to the building when the exterior walls cannot provide sufficient strength and stiffness. It is necessary to provide these shear walls when the tolerable span-width ratio for the floor or roof diaphragm is exceeded. The present work deals with a study on the improvement location of shear walls in symmetrical high rise building. Position of shear walls in symmetrical buildings has due considerations. In symmetrical buildings, the centre bright b of gravity and center of rigidity coincide, so that the shear walls are placed symmetrically over the outer edges or inner edges (like box shape). So, it is very necessary to find the efficient and ideal location of shear walls in symmetrical buildings to minimize the torsion effect. In this work a high rise building with different places of shear walls is considered for analysis. The multi storey building with 14 storeys is analysed for its displacement, strength and stability using ETABS-2013 software. For the analysis of the building for seismic loading with two different Zones (Zone-II & Zone-V) is considered with a soil I & soil III types. The analysis of the building is done by using equivalent static method and dynamic method. The results from the analysis obtained from both the methods are presented in tabular form and the results are compared using graphical form.
- **Study of shear walls in multi-storeyed buildings with different thickness and reinforcement percentage for all seismic zones in India** by sanjay sengupta et al (2014) this paper investigates the effect of different thickness and corresponding reinforcement percentages required for shear walls on multi storied buildings. Building models with shear walls are developed using ETABS. The location of the shear walls are kept same and a comparative study is done for different thickness of the shear wall for different height of building (5 storied, 10 storied and 15 storied) in each of cases corresponding reinforcement percentages required are found out. It is observed that for a constant thickness of shear wall, reinforcement percentages increases of both seismicity and number of stories.it is also observed that for all zones, the reinforcement percentages increases if the shear wall thickness increases for a certain range of thickness and then decreases for a certain range of thickness. Thus the results indicates that increases of shear wall thickness is not always effective for earthquake resistant design.
- **Mr. Abhayguleria** has done the work on this paper; Etabs is commonly used to analyse: skyscrapers, parking garages, steel & concrete structures, low and high rise building, and portal frame structures. The case study in this paper mainly emphasizes on structural behaviour of multi-storey building for different plan configurations like rectangular, c, and I shape. Modelling of 15- storey R.C.C framed building is done on the ETABS software for analysis. Post analysis of the structure, maximum shear forces bending moments, and maximum storey displacement are computed and then compared for all the analysed cases.
- **Mr. Raghunandan M H & Mrs. Suma Devi** has done the work on this paper. In this study they used ETABS nonlinear software for simulation of adjacent multi-storey R.C. frame buildings of 15 storey and 10 storey, the provisions that may reduce the effects of pounding like the separation distance, addition of shear walls, lateral bracing and variation in storey height of the buildings have been considered for analysis and the responses by considering both fixed base and base isolated are arrived.
- **Prof. Kishore Chandra Biswal & Prof. Avasha** has done the work on it. Now a day's building with floating column is a typical feature in construction in urban India. This study light on the storey above, are proposed to reduce the irregularity introduced by the floating column. Fem codes are developed for 2d multi-storey frames with and without floating column to study the responses of the structure under different earthquake excitation having different frequency content keeping the page and time duration factor constant. The time history of floor displacement, drift, base shear, and overturning moment is computed for both the frames with and without floating column by using ETABS.
- **Dynamic analysis of RCC frames structure with floating column** by Sharma R. K. In urban India floating column building is a typical feature in Morden multi storey construction. Floating column buildings are adopted

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either for architecture aspect or when more free space is required in the ground floor. Such features are highly undesirable in seismically active area. 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 Colum is carried out. The analysis is done by using staad pro V8i software by using response spectrum analysis. The paper deals with the results variation in displacement of structure, base shear, seismic weight calculation of 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 is carried out to find whether the floating column structures are safe or unsafe when built in seismically prone area, and also out commercial aspects of flooding column building either it is economical or uneconomical.

IV. METHODOLOGY

- The existing work is to examine the behavior of multi-storey buildings having floating columns with and without seismic forces.

Model-1 G+23 structure without floating column
Model-2 floating column at ground floor
Model-3 floating column at 5th and 10th floor
Model-4 floating column at 8th and 16th floor
Model-5 floating column from 18th floor to terrace
Model-6 floating column at 5th, 10th , 15th , 20th floor
Model-7 floating column at 8th, 11th , 13th , 17th floor
Model-8 floating column at 9th ,10th ,16th ,17th floor
Model-9 floating column at gf,1st ,2nd ,3rd floor
Model-10 floating column at 6th ,12th ,18th floor

Fig 1.1 Floating column in a Building

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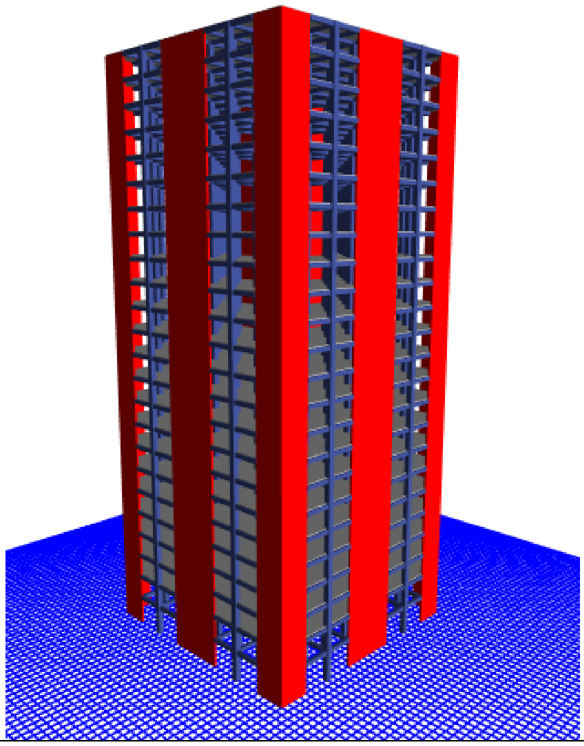	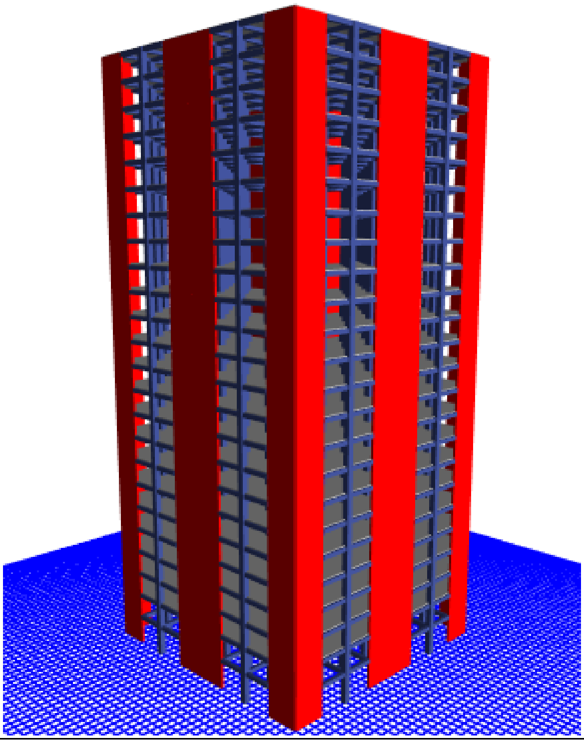
Fig 1.1 G+ 23 structure without floating column	Fig 1.2 floating column at ground floor
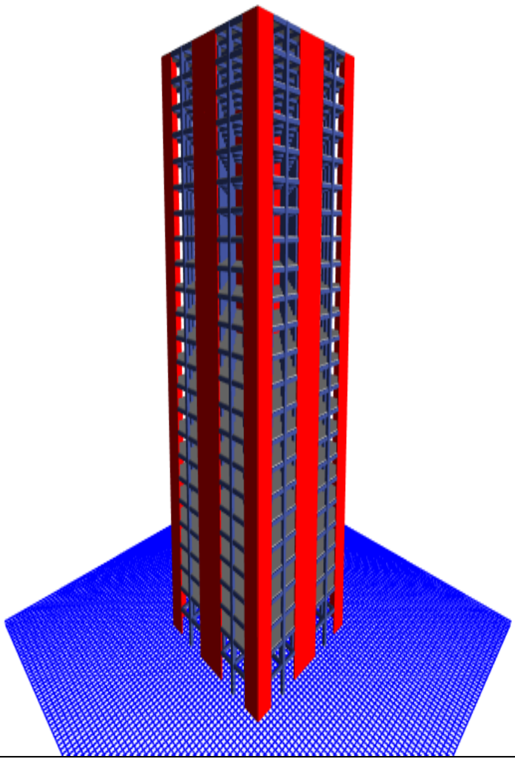	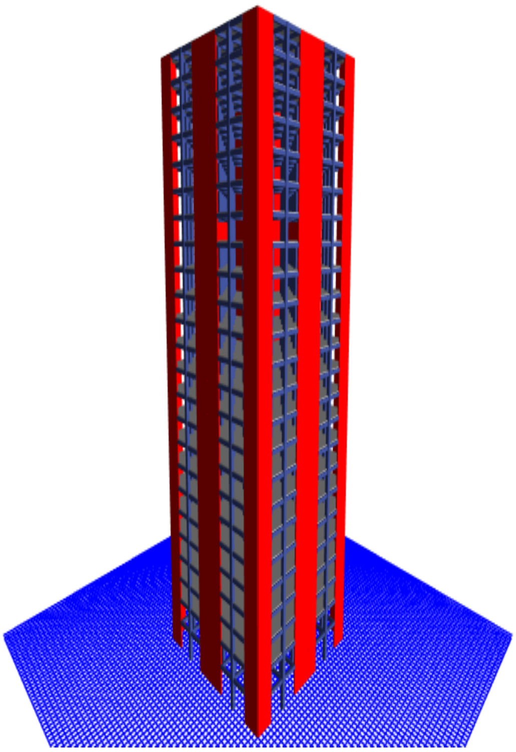
Fig 1.3 floating column at 5th and 10th floor	Fig 1.4 floating column at 8th and 16th floor

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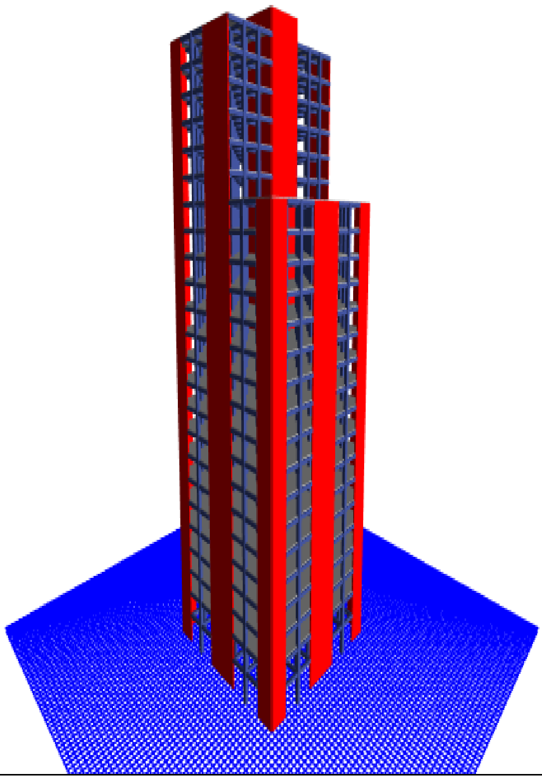	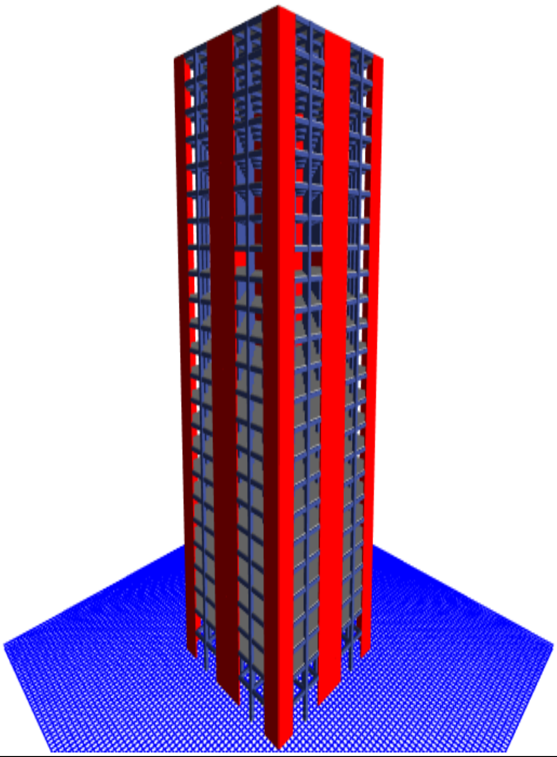
Fig 1.5 floating column at 5th, 10th , 15th , 20th floor	Fig 1.6 floating column at 5th, 10th , 15th , 20th floor
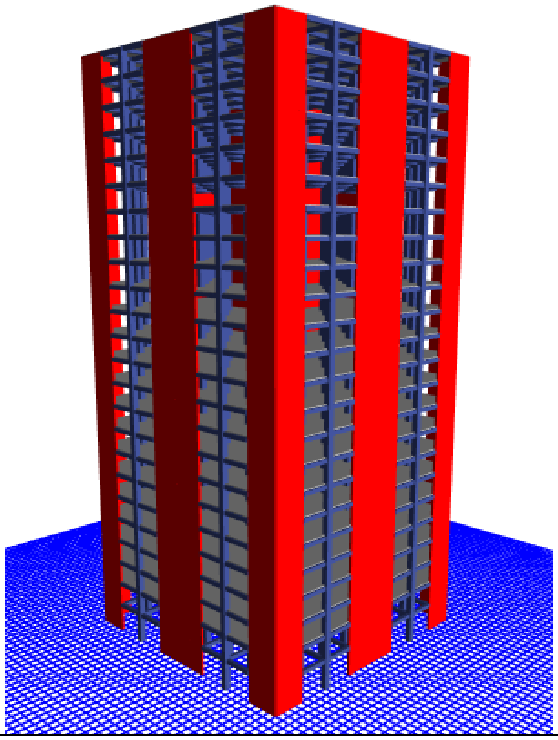	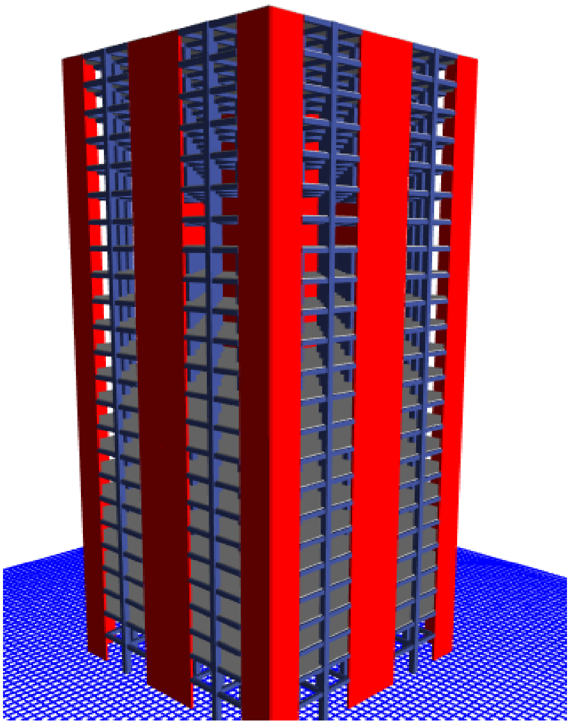
Fig 1.7 floating column at 8th, 11th , 13th , 17th floor	Fig 1.8 floating column at 9th ,10th ,16th ,17th

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	floor
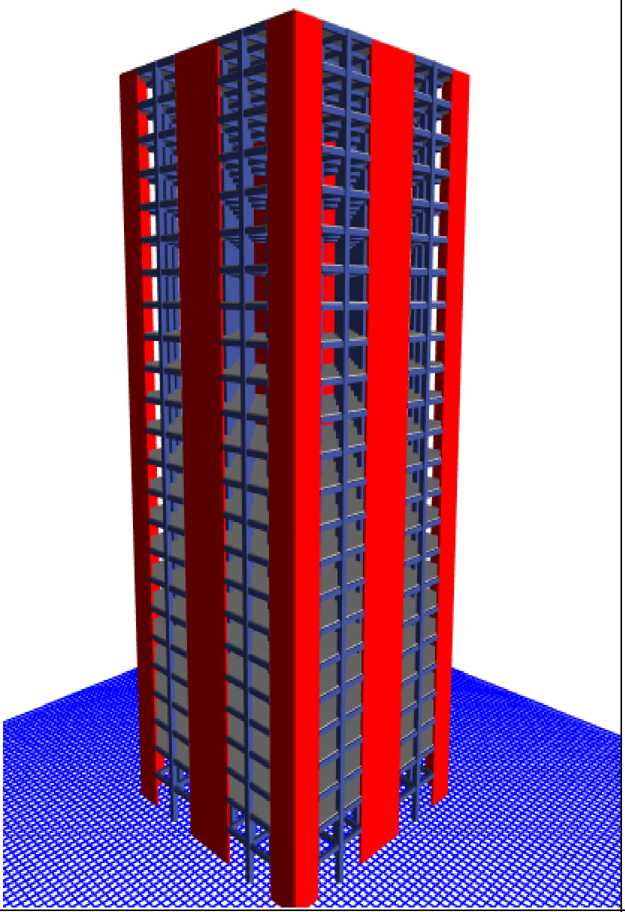	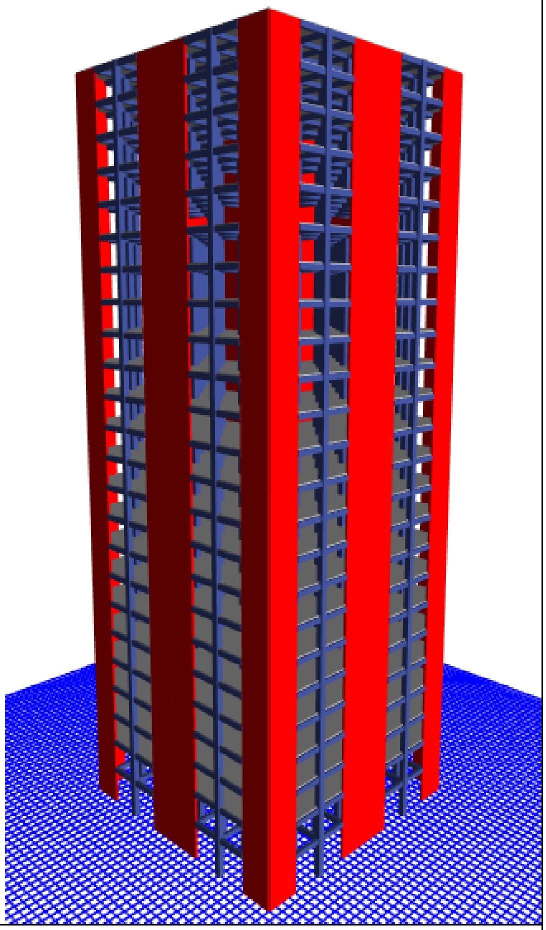
Fig 1.9 floating column at gf,1st ,2nd ,3rd floor	Fig 1.10 floating column at 6th ,12th ,18th floor

Table 1.1 General Parameters taken for the Analysis Purpose

Particulars	Dimensions
Length of building	32 (m)
Width of building	32 (m)
Height of building (G+23)	75 (m)
Bottom story height	4.5 (m)
Typical storey height	3 (m)
Live load on floor	2 KN / m²
Floor finishing	1 KN / m²
Thickness of slab	0.15 (m)
Zone -3	0.16
Beam	400*600 (mm)
Column	600*600 (mm)
Shear Wall Thickness	300 (mm)
Soil Type	Medium

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Load Combinations:

- 1.5 (DL + EQX)
- 1.5 (DL + EQY)
- 1.2 (DL + LL+ EQX)
- 0.9 DL + 1.5 EQX

Where,
DL = Dead Load
EQX = Earthquake Load on X-Axis
EQY = Earthquake Load on Y-Axis
LL = Live Load

V. EXPERIMENTAL RESULTS

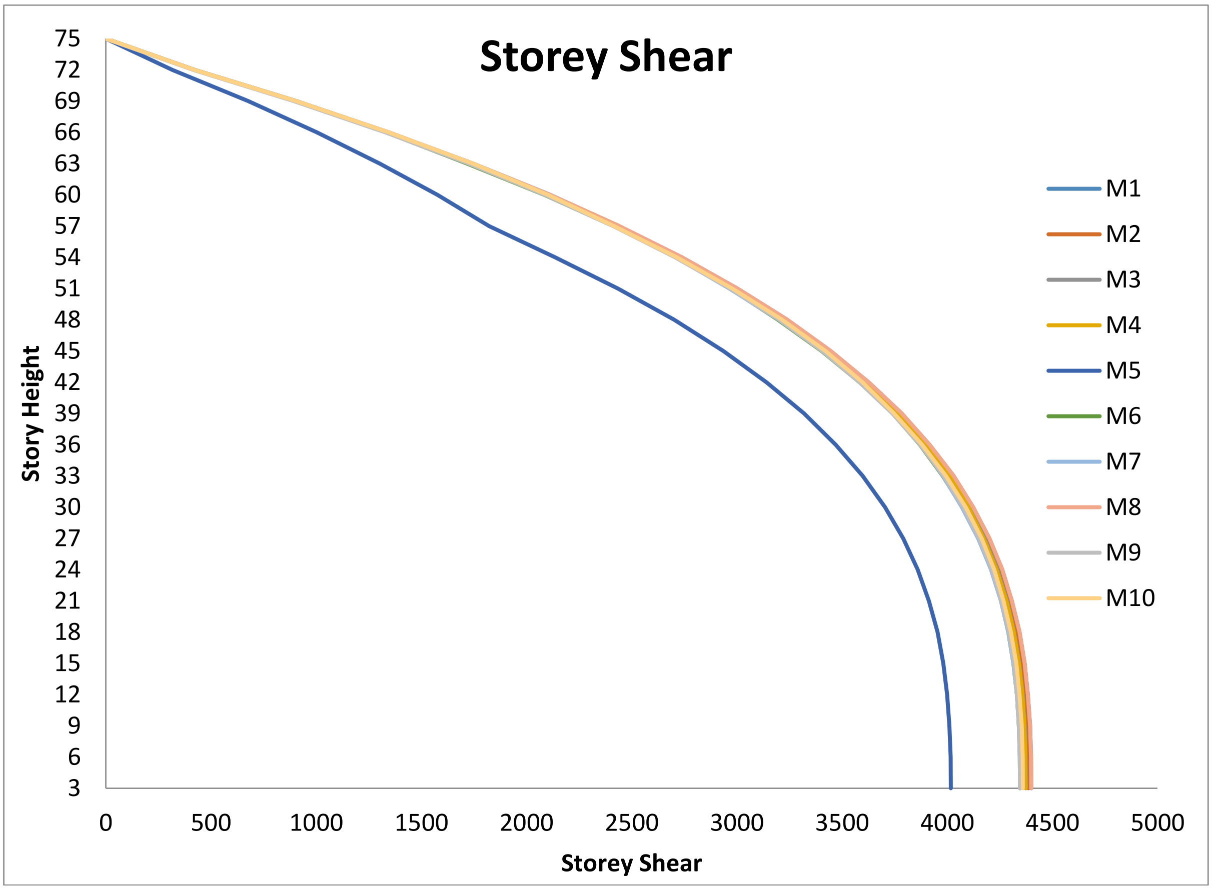

Fig 1.11 STOREY SHEAR TO STOREY HEIGHT

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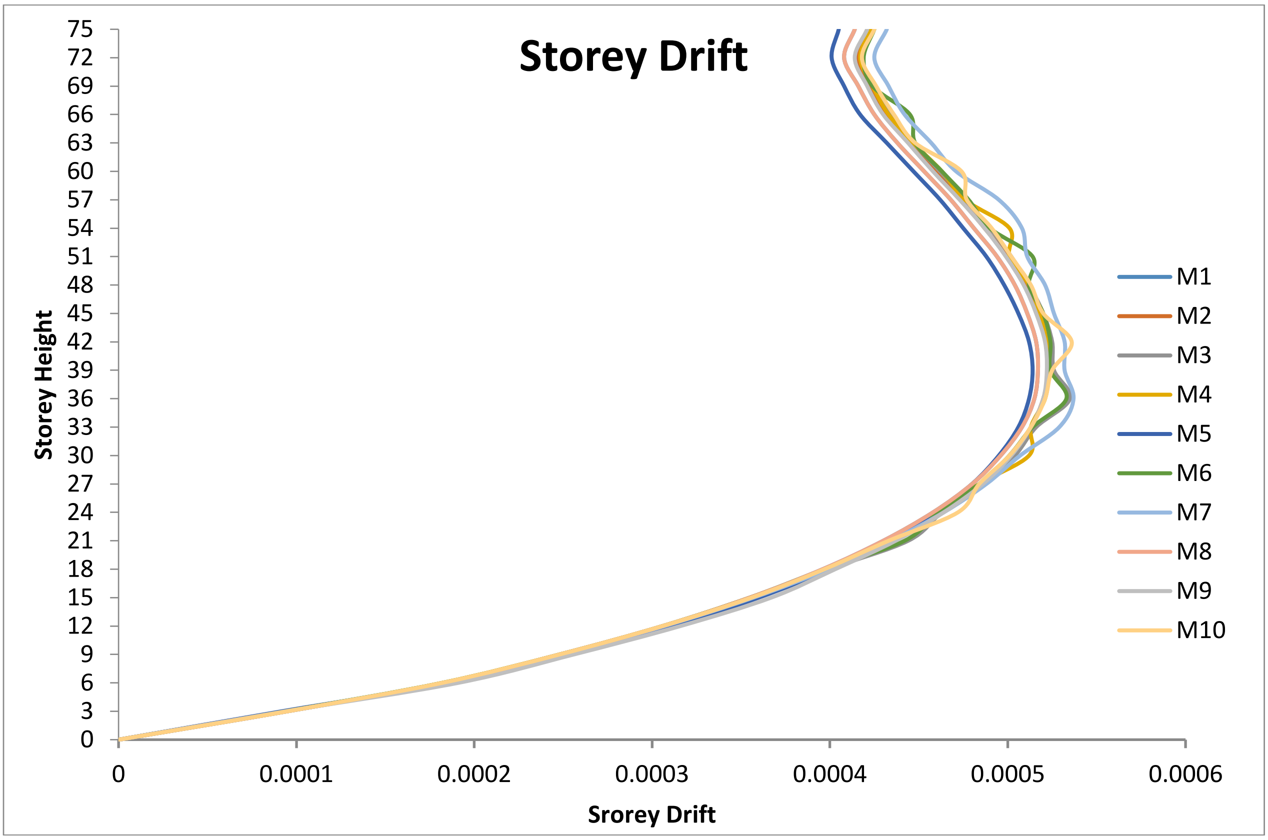

Fig 1.12 STOREY DRIFT TO STOREY HEIGHT

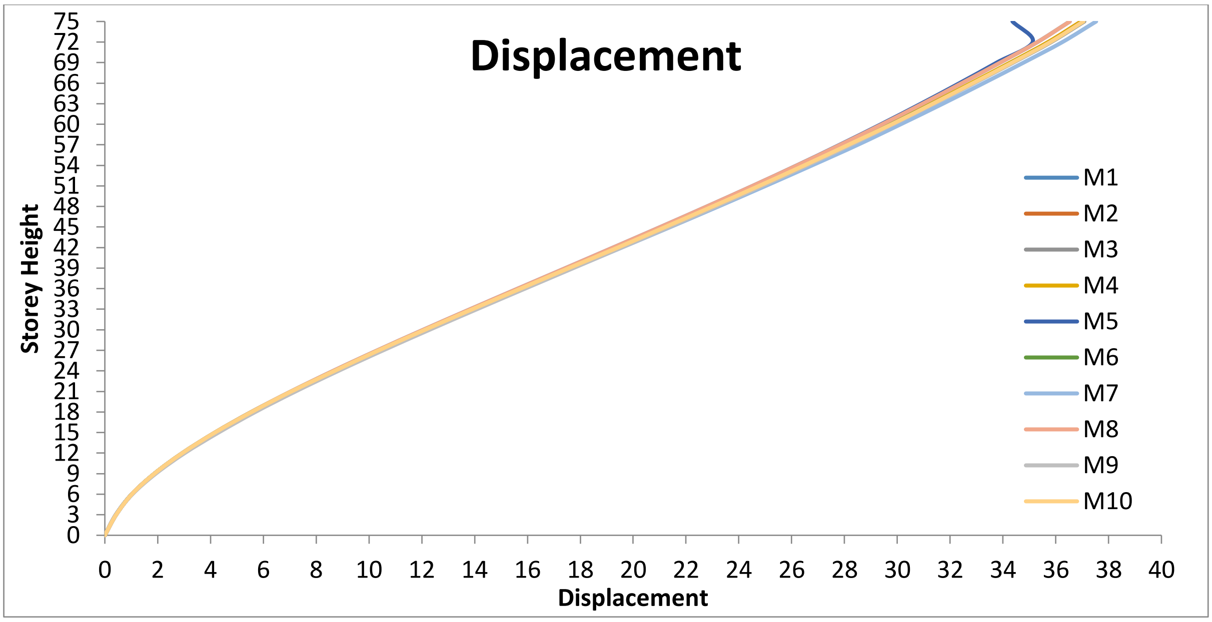

Fig 1.13 DISPLACEMENT TO STOREY HEIGHT

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VI. CONCLUSION AND FUTURE WORK

G+23 Building without and with different positions of floating column analysed in ETABS.

From above results for Base Shear:

Model 1 has a value of base shear compare to 0.30% Model-2, 0.59% Model 3, 0.60% Model-4, 8.69% Model-5, 1.21% Model-6, 1.21% Model-7, 0.00% Model-8, 1.21% Model-9 and 0.91% Model-10.

The base shear of without floating column had higher values, but the difference between the values was comparatively less.

From above results for Storey Drift:

The storey where floating columns were provided showed more lateral displacement between adjacent stories than non-floating columns. The stories where floating columns were not provided showed same storey drift.

From above results for Displacement:

Model 1 has value of displacement compare to -1.17% Model-2, -1.51% Model 3, -1.20% Model-4, 5.94% Model-5, -1.41% Model-6, -2.73% Model-7, 0.00% Model-8, -1.41% Model-9 and -1.41% Model-10.

There are more displacements of members in floating column buildings in seismic zones. The lateral displacement i.e., storey drift of floating column building is eventually more but does not affect stability of structure.

The behaviour of multistory building with and without floating column is studied under different earthquake excitation. The compatible time history and Bhuj earthquake data has been considered. The static and free vibration results obtained using present finite element code are validated. The dynamic analysis of frame is studied by varying column size dimension. It is concluded that by increasing the column size the maximum displacement and inter storey drift values are reducing.

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