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Analysis of RC Framed Post Tensioned Slab Structure to Evaluate the Performance of Floating Column with and without Shear Wall using ETABS

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Abstract: This research aims to develop analytical study of post tensioned slab with floating column. In present scenario buildings with floating columns are of typical feature within the fashionable multi storey construction practices in urban India. Such sorts of constructions are highly undesirable in building inbuilt seismically active areas. For this buildings are given floating columns at one or more storey. These floating columns are highly disadvantageous during a building inbuilt seismically active area. The earthquake forces that are developed at different floor levels during a building got to be carried down along the peak to the bottom by the shortest path. Deviation or discontinuity during this load transfer path leads to poor performance of the building. In this paper, analytical study of post tensioned slab to evaluate the performance of floating column at ground level or at alternative story for G + 10 story building without shear wall, shear wall at corner, shear wall at center, shear wall at external middle and combined shear wall are provided for regular building is taken for study. The response of building like storey drift, storey displacement and storey shear has been wont to evaluate the results obtained using ETABS software.
Keywords: Floating Column, ETABS, Post Tensioned Slab, Shear Wall, RC Frame, Storey Displacement, Storey Drift, Regular Building.

I. INTRODUCTION

The floating column is a vertical member which rest on a beam but doesn't transfer the load directly to the foundation. The floating column acts as a point load on the beam and this beam transfers the load to the columns below it. The column may start off on the first or second or any other intermediate floor while resting on a beam. Usually columns rest on the foundation to transfer load from slabs and beams. But the floating column rests on the beam. This means that the beam which supports the column acts as a foundation. That beam is called as a transfer beam. This is widely used in high storied buildings for both commercial and residential purpose. This helps to alter the plan of the top floors to our convenience. The transfer beam which supports the floating column, transfers the loads up to foundation. Hence this has to be designed with more reinforcement.

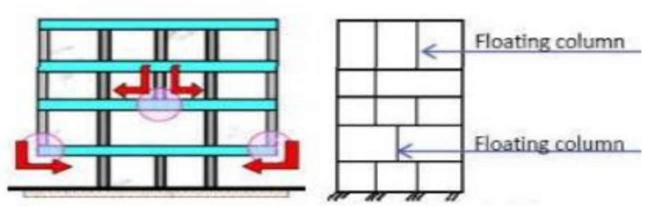

Fig. 1 Floating column at various position

Absence of column at any level changes the load path and transfers the floating column load through horizontal beams below it, also mentioned as transfer girders. Therefore when floating column is to be necessarily provided special care should tend to the transfer girders and column below the floating column. In this present study, post tension slabs are used to evaluate the performance of floating column at ground level or alternative stories of regular building with and without shear wall under earthquake. Now a day multi-storey buildings constructed for the purpose of residential, commercial, industrial etc., with an open ground storey has become a common feature. For the sake of parking, the ground storey is kept free without any constructions, except for the columns which transfer the building weight to the ground. For a hotel or commercial building, where the lower floors contain banquet halls, conference rooms, lobbies, show rooms or parking areas, large interrupted space is required for the movement of people or vehicles. The columns which are closely spaced in the upper floors are not advisable in the lower floors. So to avoid this problem, floating column concept has come into existence.

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A. Framed Structure

Framed structures can be considered as an assemblage of one dimensional and two-dimensional member. The length of a one-dimensional member of a structure is large compared to its other dimensions whereas the thickness of a two-dimensional member is smaller than its other two dimensions. A structure made of line members joined together is referred to as framed structure. In general, framed structures have three dimensional configurations. While transferring loads acting on structures, the members of the structure are subjected to internal forces like axial forces, shearing forces, bending and torsion moments. Structural Analysis deals with analysing these internal forces in the members of the structures. The process of analysis commences with planning of a structure, primarily to meet the functional requirement of the user. Planning a structure involves the selection of the most suitable type of structure and the choice of its general layout and overall dimension based on economic, aesthetic, functional and other criteria. Designing a structure entails determining the disturbances to which it is expected to be exposed during its life time and then choosing the dimensions of its members as well as the details of their connections.

B. Post Tensioned Slab

We all know that concrete has a high compressive strength and steel has a high tensile strength, and when their combination is used to bear loads, the efficiency increases manifold. When a heavy live load is brought upon a structure, its concrete slab undergoes tension, which leads to the formation of cracks and ultimately deformation occurs. To mitigate this problem, post tensioned steel tendons are inserted at the time of concreting and tensioned after concreting with conventional rebar. When these post tensioned steel tendons are stressed, the concrete is squeezed, in other terms, the concrete is compacted which increases the compressive strength of the concrete and at the same time the steel tendons that are pulled increase the tensile strength. The overall strength of the concrete increases. In post-tensioning systems, the ducts for the tendons (or strands) are placed alongside the reinforcement before the casting of concrete. Post tension slab is a combination of conventional slab reinforcement and additional protruding high-strength steel tendons, which are consequently subjected to tension after the concrete, has set. This hybridization helps achieve the formation of a much thinner slab with a longer span devoid of any column-free spaces.

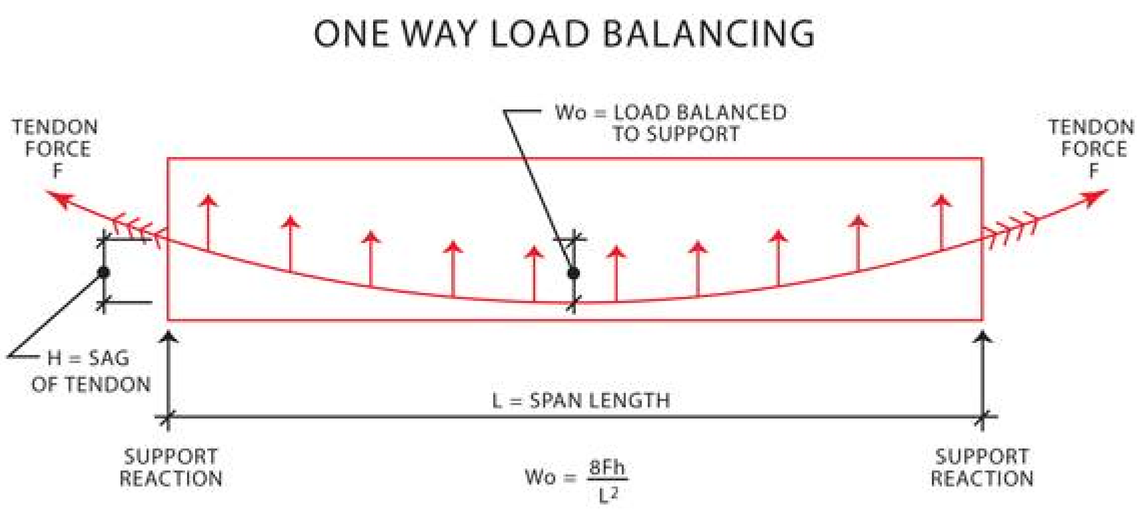


Fig. 2 Post tensioning concept

II. MODELLING

A G+11 story building is taken for analysis with floating column in lower stories and a PT transfer Girder is additionally designed to know better the effect of varied seismic parameters just in case of high rise building. The analysis is completed for seismic zone II to see the utmost value of result parameters. The effect of change dimensions of beams & columns supporting floating column was also studied. Medium soil conditions were used for analysis. Model consists 5 m spacing in X direction and 6m spacing in Y direction. Several models are created, by deleting 90 floors and the associated columns from the base building that is keeping the mass of the building constant. Thus stiffness irregularities are introduced into the building and also floating column is introduced. And the storey displacement, storey drift, story shear, time period is compared for these models. Response spectrum analysis is carried out for the study. The plan and elevation are shown in Fig 3 and Fig 4 generated using ETABS

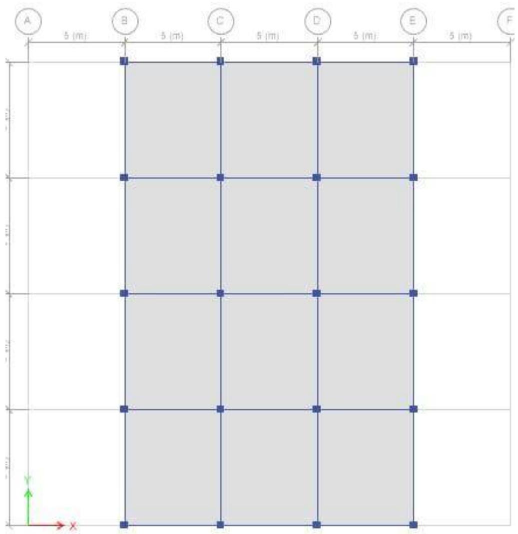


Fig. 3 Plan of G+10 PT model 1

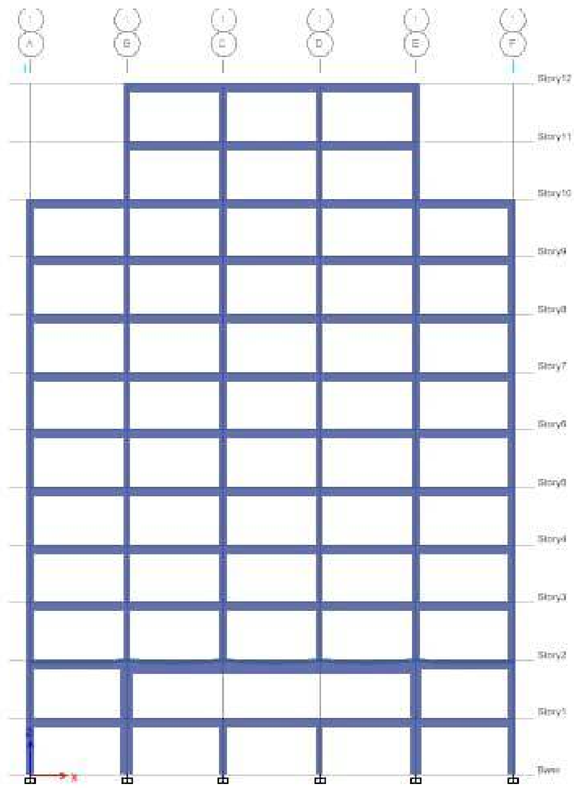


Fig. 4 Elevation of G+10 model 1

We are considered a storey height of 3m, slab thickness of 180 mm. dead load and live loads are 2 kN/mm^2 and 5 kN/mm^2 respectively. **Earthquake load:** Earthquake load for the building has been calculated as per IS 1893:2002

1) Zone (Z) = II
2) Response Reduction Factor (R) = 5
3) Importance factor (I) = 1
4) Rock and soil site factor (S) = 2
5) Type of Structures = 1
6) Scale factor = 1.962

The following combination of loads with approximate partial safety factor satisfying the Indian Standard code provision. i.e., IS 456:2000, table 18, clause 18.2.3.1 and IS 1893:2002, clause 6.3.2.1 are as follows.

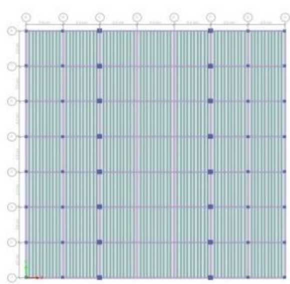
a) 1.5[DL + LL]
b) 1.2[DL + LL + EQX]
c) 1.2[DL + LL + EQY]
d) 1.2[DL + LL - EQX]
e) 1.2[DL + LL - EQY]
f) 1.5[DL + EQX]
g) 1.5[DL + EQY]
h) 1.5[DL - EQX]
i) 1.5[DL - EQY]
j) 0.9DL + 1.5EQX
k) 0.9DL + 1.5EQY
l) 0.9DL - 1.5EQX

Structural elements dimensions in ETABS

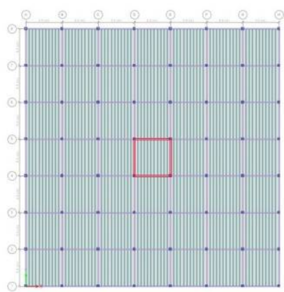
TABLE I
STRUCTURAL ELEMENTS DIMENSIONS

Element	Dimension (mm)
Common beam (bxd)	350x500
Transfer beam (bxd)	350x750
Common column (bxd)	450x450
Column below transfer beam (bxd)	750x750
Slab thickness (t)	200
Shear wall (t)	250

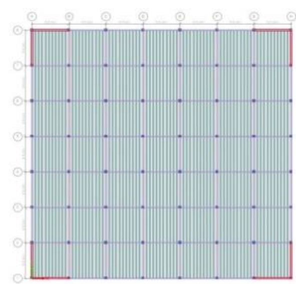
The plan of the twin tower buildings with and without structural linking for regular plan building generated by ETABS are shown in Fig.5



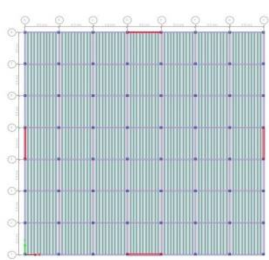
(a) Without shear wall



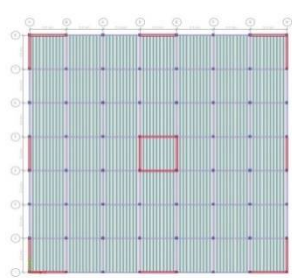
(b) shear wall at centre



(c) shear wall at corner



(d) Shear wall at external middle



(e) Combined Shear wall

Fig.5 Plan of regular building with and without shear wall

The elevation of the twin tower buildings with and without structural linking for regular plan building generated by ETABS are shown in Fig.6

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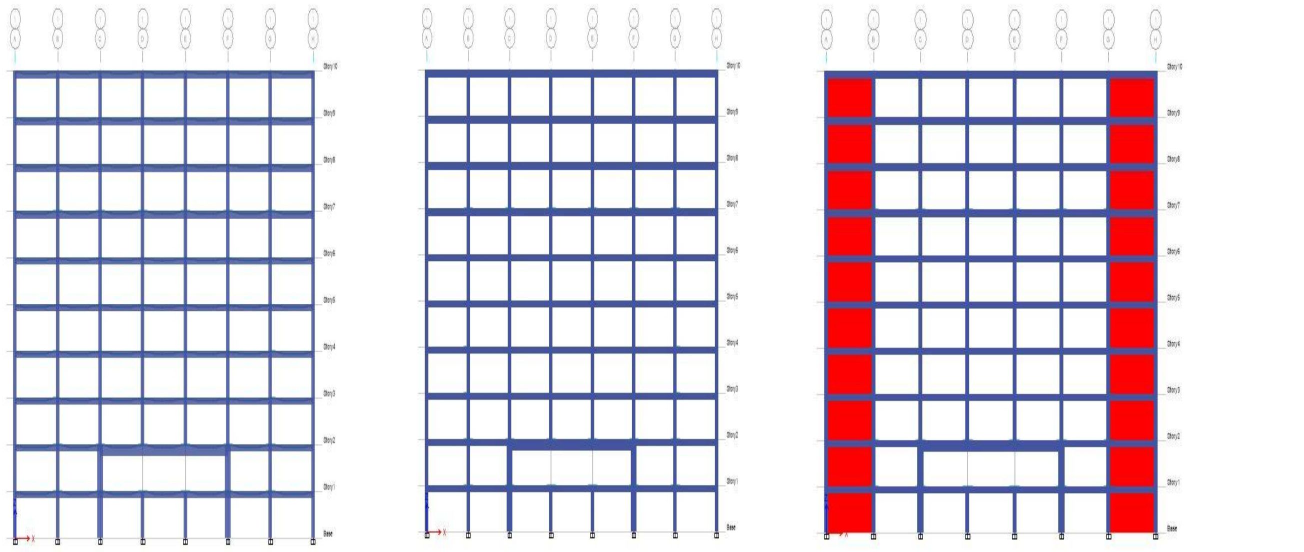
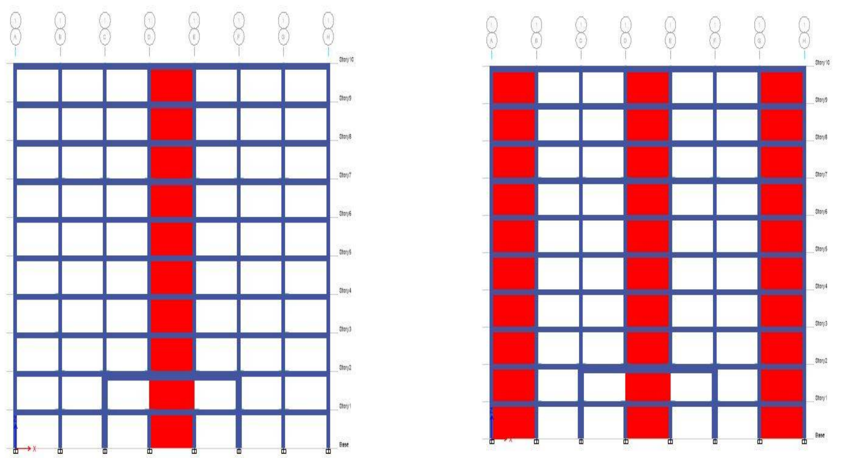


(a) Without shear wall (b) shear wall at centre (c) shear wall at corner



(d) Shear wall at external middle (e) Combined Shear wall

Fig.6 Elevation of regular building with and without shear wall

III.ANALYSIS RESULTS

The linear dynamic analysis method is also called as Response spectrum method. In this techniques the ultimate response of a building during a tremor is found specifically from the quake responses (or design) range. The representation of the max responses of ideal SDOF frameworks having notable period and damping, during seismic tremor ground motion, the max response is plotted against the un damped natural period and for different damping values, and can be communicated regarding most extreme relative displacement or most extreme relative speed.

A. Storey Displacement

It is observed that the lateral displacements increases as storey level increases. Maximum storey displacement is at the roof and minimum at ground floor. The displacements are decreased by the addition of structural links and the change in position of structural link also affects the lateral displacement. Maximum displacement for all cases for regular building with floating column at ground level and alternative storey are shown in table II and fig 7.

TABLE III

COMPARISON OF MAXIMUM DISPLACEMENT

Shear Wall Type	Maximum Displacement of Regular building	
	Floating Column at Ground Level	Floating Column at Alternative Storey
Case 1	18.125	17.489
Case 2	12.584	12.331
Case 3	13.528	12.823
Case 4	15.062	13.782
Case 5	10.037	8.807

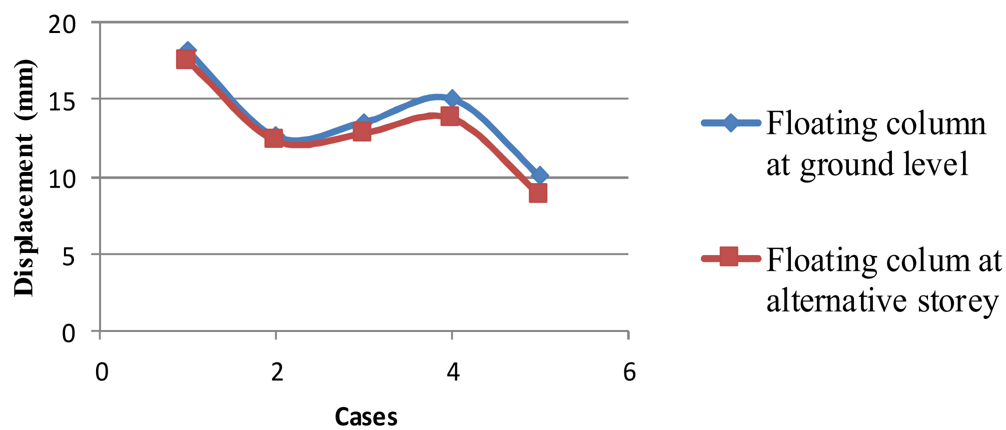


Fig 7 Comparison of maximum displacement

By comparing the maximum displacement values of regular building with floating column at ground level and floating column at alternate storey it can be seen that the maximum displacement is for case 1 building with floating column at ground level and minimum displacement value is for case 5 building with floating column at alternative storey. Maximum displacement and minimum displacement values are 18.125mm and 8.807mm.

B. Storey Drift

It is observed that storey drift increases as height of building increases up to middle of the building and then it decreases as height of the building increases. Maximum storey drift for all cases for regular building with floating column at ground level and at alternative storey are shown in table III and fig 8.

TABLE IIIII

comparison of maximum drift

Shear Wall Type	Maximum Drift of Regular building	
	Floating Column at Ground Level	Floating Column at Alternative Storey
Case 1	0.000942	0.00084
Case 2	0.000514	0.000517
Case 3	0.000548	0.000525
Case 4	0.00063	0.000585
Case 5	0.000413	0.00036

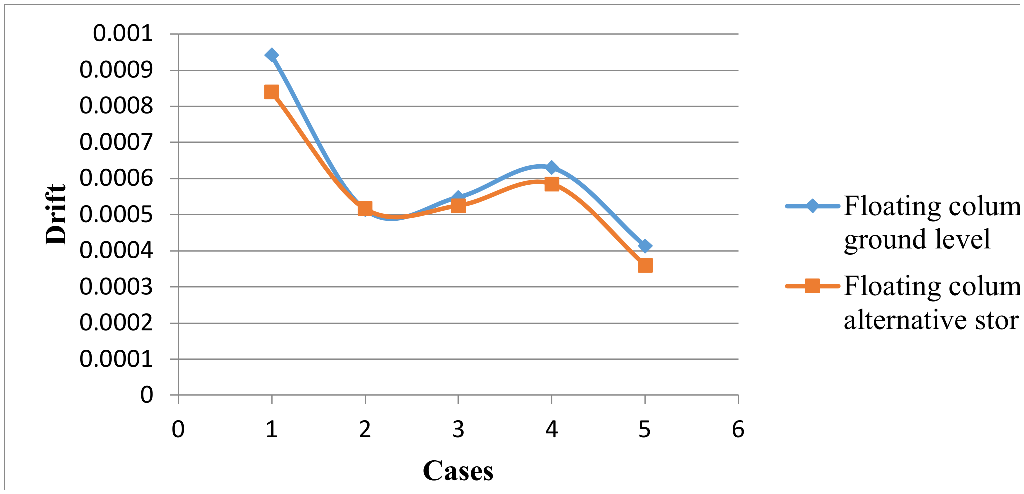


Fig 8 Comparison of maximum drift

By comparing the maximum storey drift values of regular building with floating column at ground level and floating column at alternate storey it can be seen that the maximum drift is for case 1 building with floating column at ground level and minimum drift value is for case 5 building with floating column at alternative storey. Maximum and minimum storey drift values are 0.000942 and 0.00036.

C. Time Period

Time period of regular building with floating column at ground story and alterative story are shown in fig 9

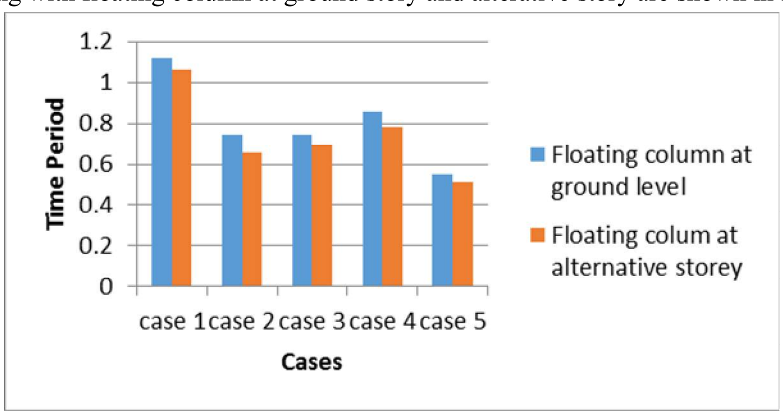


Fig 9 Time period of regular building with floating column

By comparing the time period values regular buildings with floating column at ground level and floating column at alternate storey it can be seen that the time period increases with increase in storey height.

D. Base Shear

Base shears of regular building with floating column at ground story and alterative story are shown in fig 10.

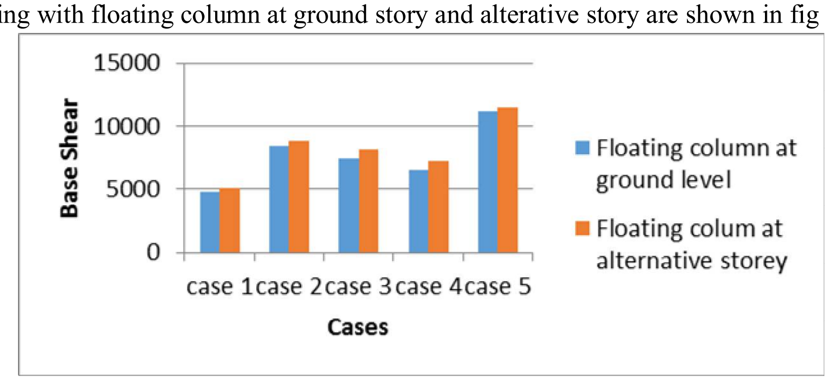


Fig 10 Base shear of regular building with floating column

By comparing the maximum base shear values regular building with floating column at ground level and floating column at alternate storey it can be seen that the base shear value is for case 5 is high.

E. Conclusions

Seismic behaviour of G +10 storey regular building with floating column either at ground level or at alternative story were analysed using ETABS. Ten cases were modelled with regular building for different shear at different positions. Buildings without shear wall, with shear wall at centre, corner, external middle and combine were taken for this study. The buildings are studied for different parameters like storey drift, storey displacement base shear and time period. Maximum displacement values case 1 building with floating column at ground level. Minimum displacement value is for case 5 building with floating column at alternative storey. Maximum drift is for case 1 building with floating column at ground level. Minimum drift value is for case 5 building with floating column at alternative storey.

IV. ACKNOWLEDGMENT

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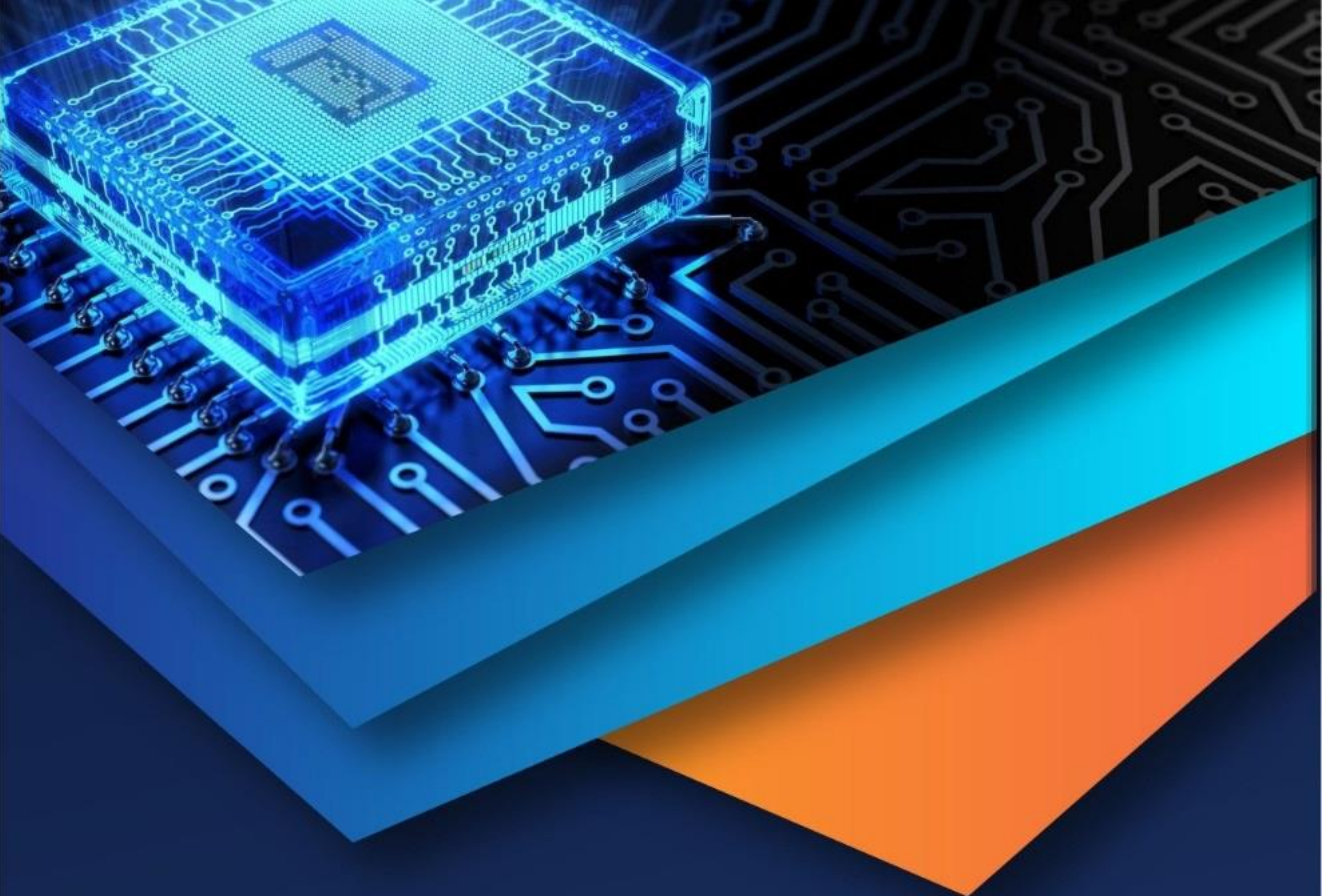

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