ANALYTICAL STUDY OF POST TENSIONED SLAB TO EVALUATE THE PERFORMANCE OF FLOATING COLUMN IN MULTI STORIED BUILDING 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 areas. 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, the critical position of floating column in vertically irregular buildings has been discussed for G+11 buildings for zone II. Also the effect of size of beams and columns carrying the load of floating column has been assessed with tendons. The response of building like storey drift, storey displacement and storey shear has been wont to evaluate the results obtained using ETABS software.*

Key Words: Floating column, Irregular building, Post tensioned slab, Etabs, Response Spectrum Analysis, Storey displacement, Storey drift, Torsional Performance.

1. INTRODUCTION

Often primarily being adopted to accommodate parking or reception lobbies within the primary storey, whereas the whole seismic base shear as experienced by a building duringanearthquake.

There should be a transparent load path available for the load to realize the inspiration level. 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.

1.1 Floating Column

A column is meant to be a vertical member ranging from foundation level and transferring the load to the bottom. Floating columns are implemented, especially above the bottom floor, in order that added open space is accessible for auditorium or parking purpose. The term floating column may be additionally a vertical element which at its lower level rests on a beam which is a horizontal member. The beams in turn transfer the load to neighbor columns or the columns below it which ultimately increase the load on remaining columns.

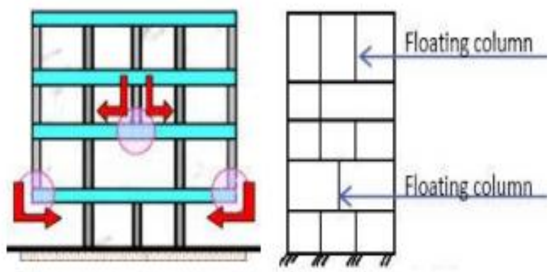

Fig-1: Floating or hanging columns at various positions

1.2 Post tensioning Systems

Post tensioning system is probably the latest discovery in man's continuing search for new construction materials and methods. It is defined as the application of compressive stresses to concrete members. Those zones of the member ultimately required to hold tensile stresses under working load conditions are given an initial compressive stress before the appliance of working loads . In post-tensioning systems, the ducts for the tendons (or strands) are placed alongside the reinforcement before the casting of concrete.

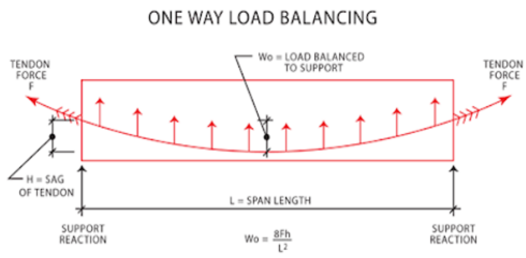

Fig-2: Post tensioning concept

1.3 Method of seismic analysis

In this thesis, the project topic was finalized after the detailed literature survey.Etabs 2017 software was used for this entire study. After that, validation successfully carried out. 20 models were created, out of this 8 were selected for the further study. Those 8 models were carefully studied in all aspects. And how to improve the stability are discussed. Finally, the results were tabulated and plotted graphically for better and easier understanding.

1.4 Response spectrum Analysis

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.

2. MODELLING DETAILS

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. The importance factor and response reduction factor are used as 1 and 5 respectively within the analysis. Earthquake has been considered in X direction only. Various loads working on all the models et al. parameters are shown in table 1.

Table -1: Input Parameters

Storey height	Slab thickness	Dead load	Live load
m	mm	kN / m2	kN / m2
3	180	2	5

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, storey shear, time period is compared for these models. Response spectrum analysis is carried out for the study.

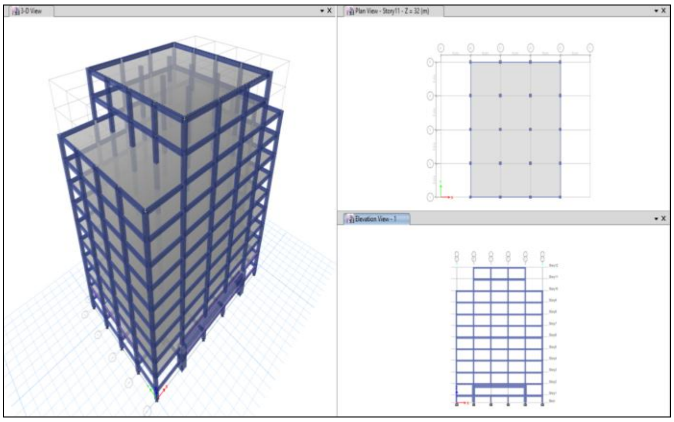

Fig -3: G+11 PT model-1

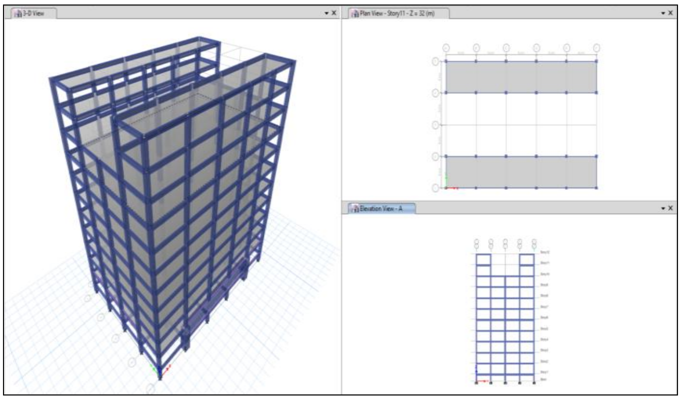

Fig -4: G+11 PT model-2

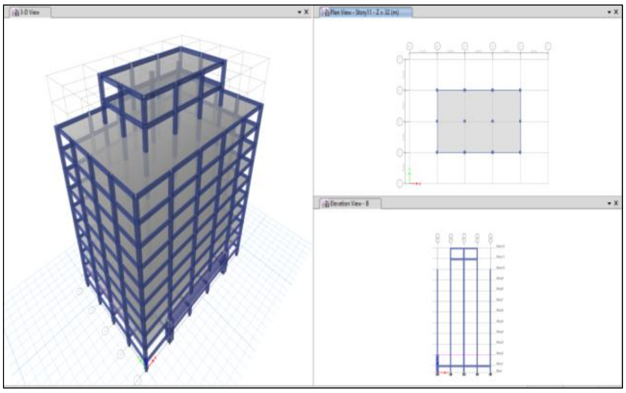

Fig -5: G+11 PT model-3

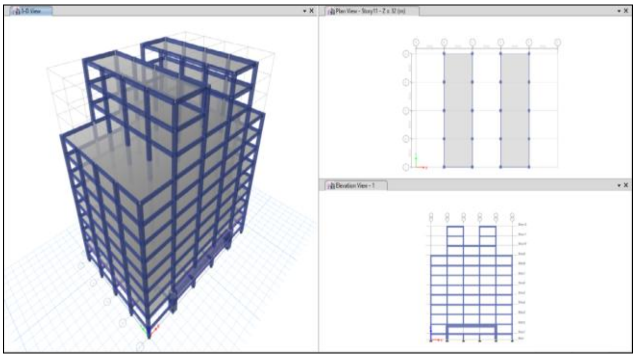

Fig -6: G+11 PT model-4

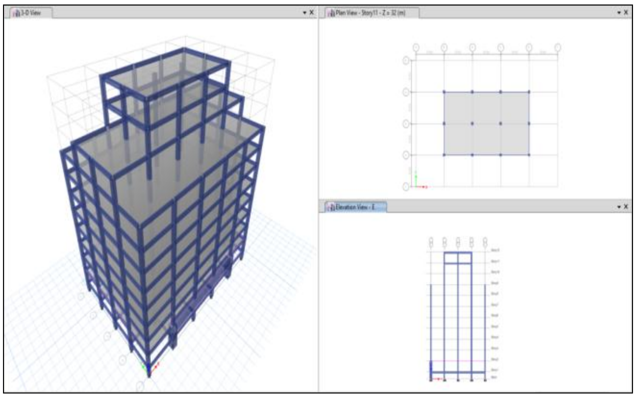

Fig -7: G+11 PT model-5

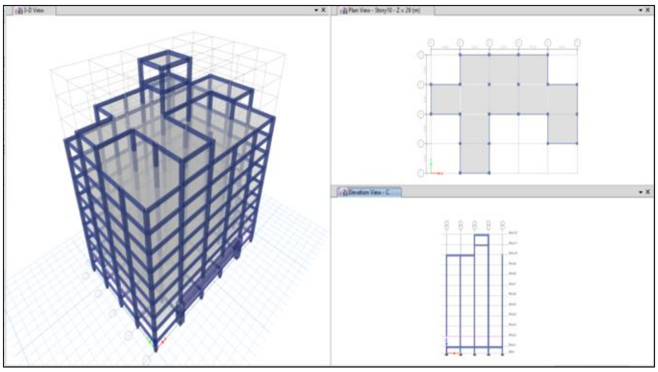

Fig -8: G+11 PT model-6

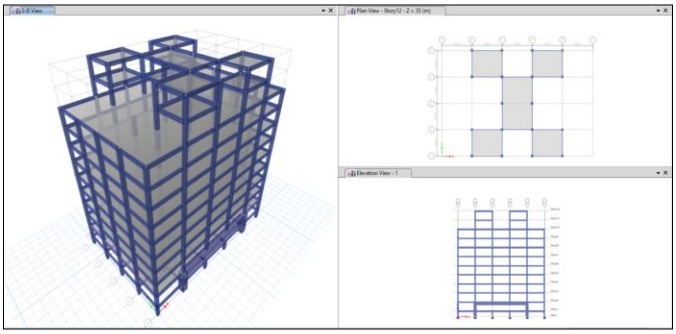

Fig -9: G+11 PT model-7

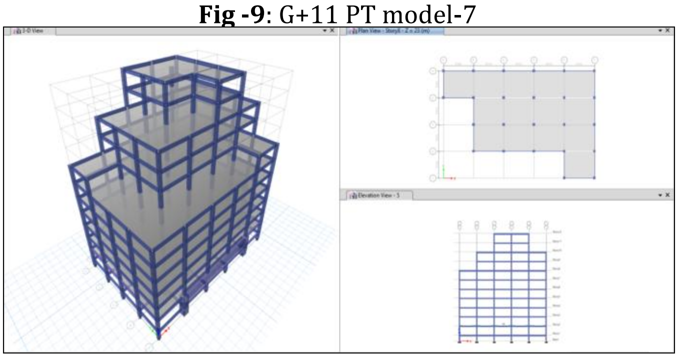

Fig -10: G+11 PT model-8

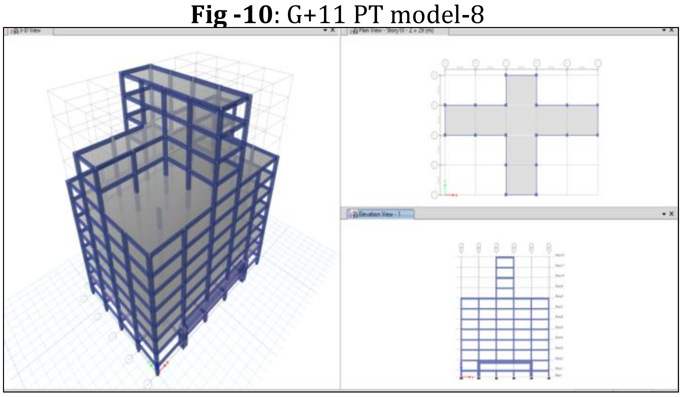

Fig -11: G+11 PT model-9

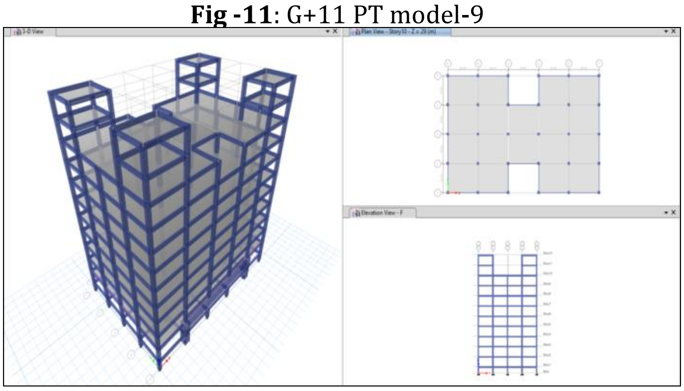

Fig -12: G+11 PT model-10

For irregular building frame of type 1, floating column have been taken. The discontinuity has been provided at the bottom floor only because it has already been observed in previous research studies that floating column caused adverse effects when discontinued at ground floor. The positions of floating column for the building frames have been shown in figures.

3. ANALYSIS OF RESULT

Each of the models was found to fail under response spectrum analysis, considering earthquake zone 2 and due to the introduction of stiffness irregularity, the maximum storey drift, displacement and time period values obtained were so high. So how to improve the stability became the matter of concern. The stability of high rise building can be well improved to a very greater extent by the introduction of shear walls. So 3 different cases of shear wall introduction were carefully studied for each of the models, that is,

- Case 1: Shear walls are provided at the corners.
- Case 2: Shear walls are provided at center.
- Case 3: Shear walls are provided at corner-center.

3.1 STOREY DISPLACEMENT

According to IS: 456:2000, maximum limit for displacement is Height/500. It is observed from Fig 13 to Fig 20 that, for all the models considered displacement values follow around similar gradually increasing straight path along storey height. In all the models displacement values are less for lower zones and it goes on increases for higher zones because the magnitude of intensity will be the more for higher zones. The displacement is more for floating column buildings because as the columns are removed the mass gets increased and hence displacement also increases. By providing shear wall displacement values reduces as compared to without shear wall models for all the zones. The maximum permissible limits just in case of without shear wall but it becomes safe in case of building models with shear wall.

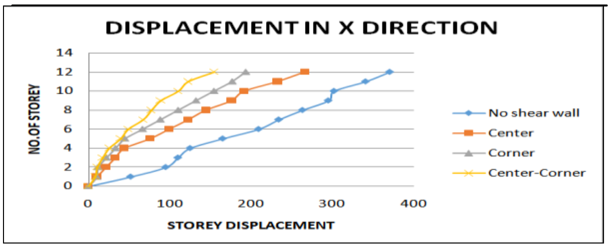

Fig -13: Displacement in X-Direction-Model 1

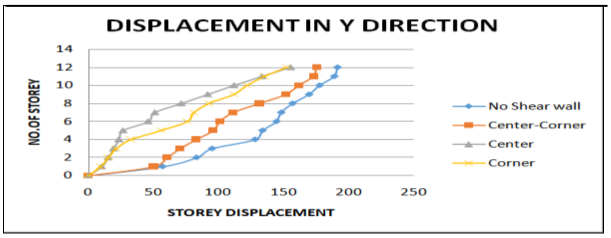

Fig -14: Displacement in Y-Direction-Model 1

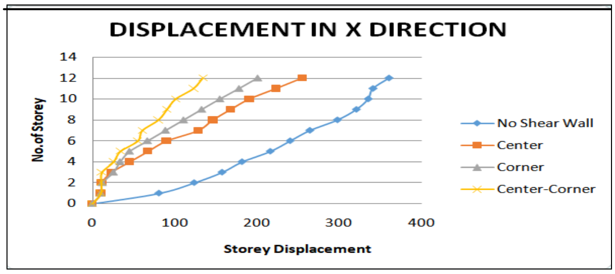

Fig -15: Displacement in X-Direction-Model 2

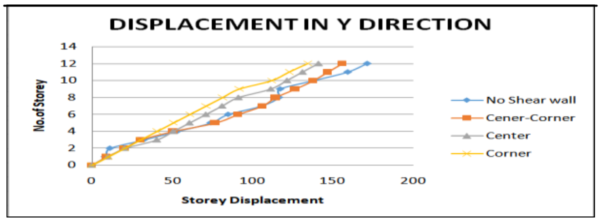

Fig -16: Displacement in Y-Direction-Model 2

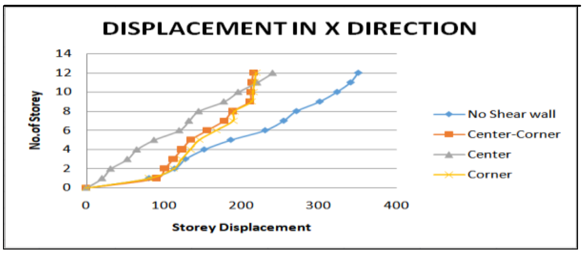

Fig -17: Displacement in X-Direction-Model 3

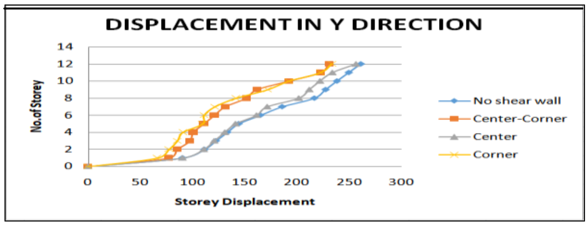

Fig -18: Displacement in Y-Direction-Model 3

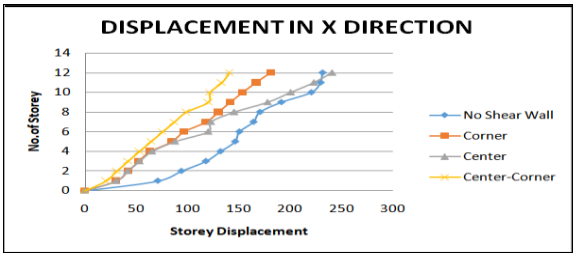

Fig -19: Displacement in X-Direction-Model 4

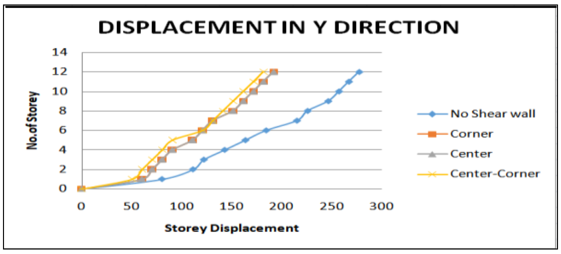

Fig -20: Displacement in Y-Direction-Model 5

The floating column provided at ground floor was most adverse as increase in storey displacement was maximum at ground floor for every position. There was not much effect of position of floating column in top floor, mass being very less on floating column. Storey displacement increased with increase in storey level for regular frames with floating column. The maximum percentage of increase in storey displacement has been observed for top storey level. Also, the storey displacement increased with increase in height of structure.

3.2 STOREY DRIFT

According to IS: 1893:2002 (part I), maximum limit for drift with partial load factor 1.0 is 0.004 times of height. Here, for 3 m height and load factor of 1.5, though maximum drift will be 18mm. It is observed from analysis results that for all the cases considered drift values follow around similar path along storey height with maximum value lying somewhere near about the middle storey. In all the models drift values are less for lower zones and it goes on increases. The storey drift is more for floating column buildings because as the columns are removed. The mass gets increased and hence drift also increases. By providing shear wall drift values reduces as compared to with shear wall models for all the zones. For all the models in all the zone drift values are safe within maximum permissible limits in with shear wall models.

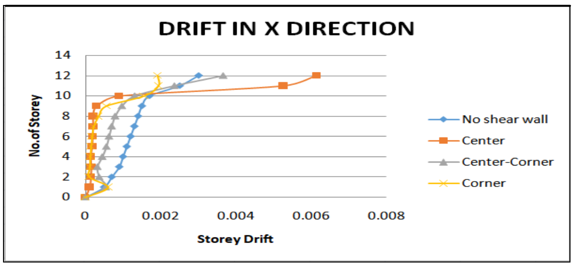

Fig -21: Drift in X-Direction-Model 1

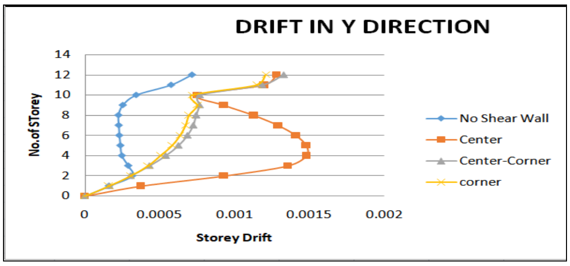

Fig -22: Drift in Y-Direction-Model 1

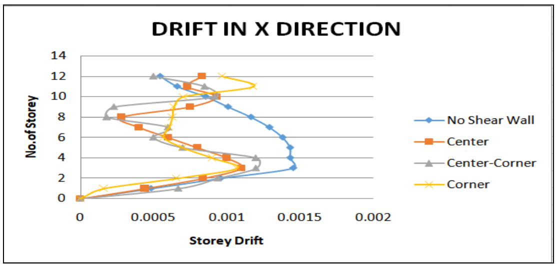

Fig -23: Drift in X-Direction-Model 2

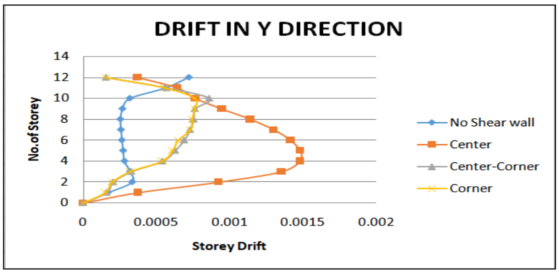

Fig -24: Drift in Y-Direction-Model 2

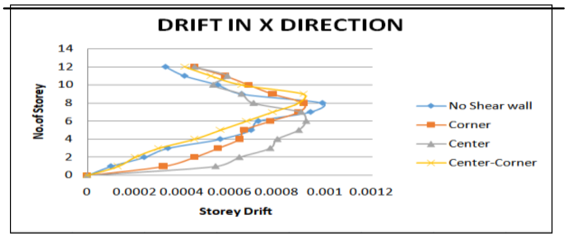

Fig -25: Drift in X-Direction-Model 3

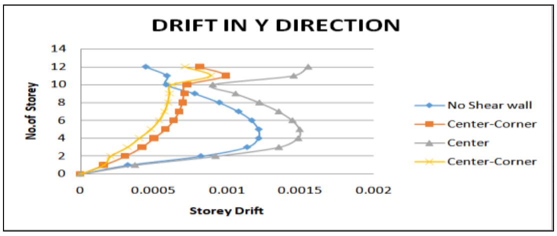

Fig -26: Drift in Y-Direction-Model 3

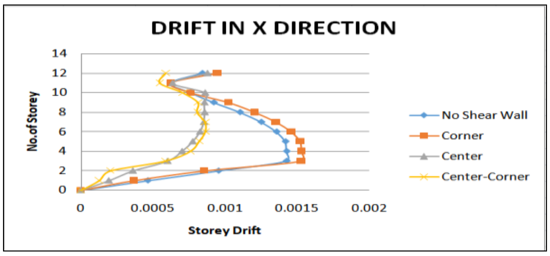

Fig -27: Drift in X-Direction-Model 4

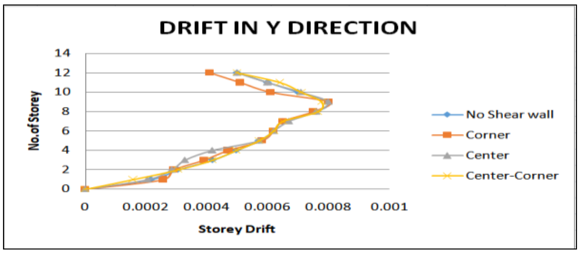

Fig -28: Drift in Y-Direction-Model 4

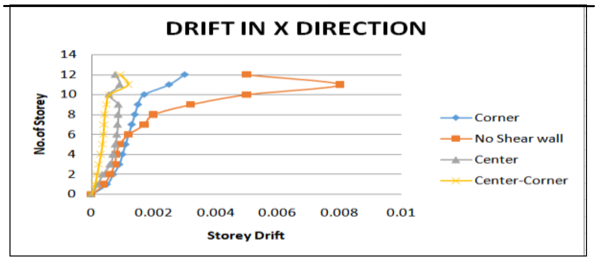

Fig -29: Drift in X-Direction-Model 5

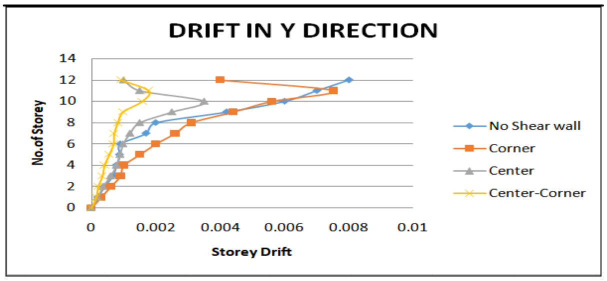

Fig -30: Drift in Y-Direction-Model 5

3.3 TIME PERIOD

The time period of the structure for particular mode shape is the time required to complete the oscillation for corresponding mode shape. After giving a unit displacement to the structure and when releasing the displacement suddenly the structure moves in back and forth motion having a while period which is named as fundamental time period of the structure.

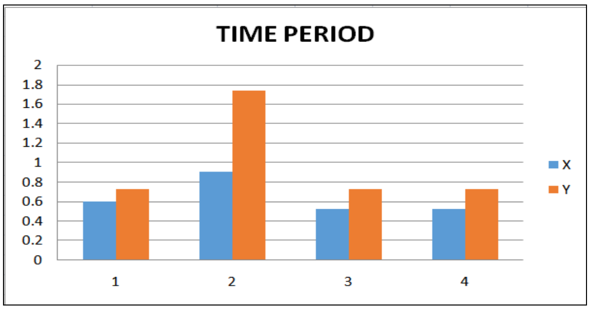

Fig -31: Maximum Time Period for Model-1

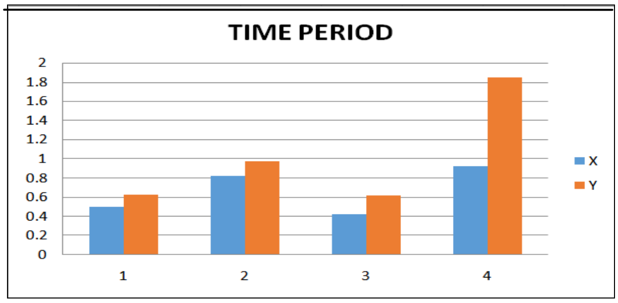

Fig -32: Maximum Time Period for Model-2

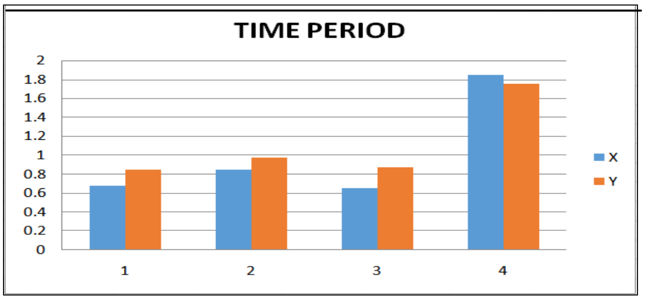

Fig -33: Maximum Time Period for Model-3

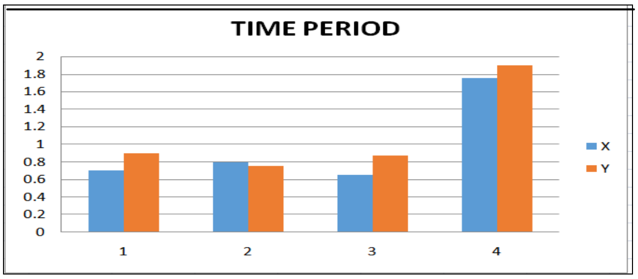

Fig -34: Maximum Time Period for Model-4

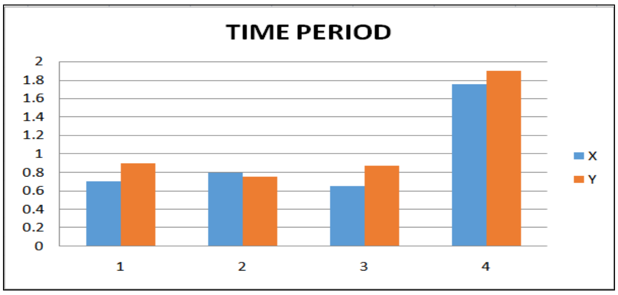

Fig -35: Maximum Time Period for Model-5

For most cases the No shear wall exhibits the maximum Time period and Center-Corner exhibits minimum Time Period.

3.4 BASE SHEAR

Base shear is that the horizontal reaction at the bottom against horizontal earthquake load. This base shear is working at the bottom or supports of the structure or wherever structure is fixed. The variation in base shear thanks to different location of floating column floor wise are tabulated in table 2

Table -2: Calculation of Base Shear

Sl No	Floor	Wi	hi	hi2	wihi2	wihi2/Σwihi2	VB	Qi
1	Storey-1	5623.75	3	9	50613.8	0.002083497	7844.85	16.3447
2	Storey-2	5623.75	6	36	202455	0.008333989	7844.85	65.3789
3	Storey-3	5623.75	9	81	455524	0.018751476	7844.85	147.103
4	Storey-4	5623.75	12	144	809820	0.033335958	7844.85	261.516
5	Storey-5	5623.75	15	225	1265344	0.052087434	7844.85	408.618
6	Storey-6	5623.75	18	324	1822095	0.075005905	7844.85	588.41
7	Storey-7	5623.75	21	441	2480074	0.10209137	7844.85	800.891
8	Storey-8	3748.75	24	576	2159280	0.088886007	7844.85	697.297
9	Storey-9	3748.75	27	729	2732839	0.112496353	7844.85	882.517
10	Storey-10	3748.75	30	900	3373875	0.138884387	7844.85	1089.53
11	Storey-11	3748.75	33	1089	4082389	0.168050108	7844.85	1318.33
12	Storey-12	3748.75	36	1296	4858380	0.199993517	7844.85	1568.92

3.5 TORSIONAL IRREGULARITY

According to IS 1893:2002, if Umax / Uavg is greater than 1.2 torsional irregularity exist in the building and if Umax / Uavg is greater than 1.4 extreme torsional irregularity exist.

Here the torsional performance in both x and y directions are studied for all the 10 models considering the 12th story, since maximum displacement for every model is found on 12th story.

Table -2: Calculation of Torsional Irregularity

MODEL-5					
Direction		No Shear wall	Shear wall at center	Shear wall at corner	Shear wall at Center-Corner
X	Ux	127.91	117.53	111.81	78.30
	Umax/Uavg	1.00	1.00	1.00	1.09
	Torsional irregularity	No	No	No	No
Y	Uy	120.151	119.945	79.487	79.687
	Umax/Uavg	1.00	1.00	1.00	1.00
	Torsional irregularity	No	No	No	No

4. CONCLUSIONS

Within the scope of present work following conclusions aredrawn:

1. For all the cases considered drift values follow similar path along height with maximum value lying near about thecenter storey.
2. For all the models considered displacement values follow around similar gradually increasing straight path alongstoreyheight.
3. Altogether the models storey drift and displacement values are less for lower zones and it goes on increases for higher zones because the magnitude of intensity are going to be the more for higher zones.
4. The storey drift and displacement is more for floating column buildings because as the columns are removed the mass gets increased and hence drift and displacement alsoincreases.
5. By providing shear wall drift and displacement values reduces as compared to without shear wall models for all thezones.
6. As drift values are safe within maximum permissible limits in without shear wall models so there's no necessity of providing shear walls from drift view point.
7. The variation in base shear due to different location of floating column floor wise also studied.

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