EFFECT OF FLOATING COLUMNS ON SEISMIC RESPONSE OF MULTISTORY BUILDING

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Abstract – *Soft storey building and Mass irregular building with Floating column are the typical features in the modern multistory constructions in India. These are highly undesirable in building built in seismically active areas. In this study the effect of Floating columns which are adopted in soft story and mass irregular building in Zone5 are revealed. To achieve this objective six G+15stories rc bare frame structures which are having 3mt and 4mt column height regular structure are considered. These structures are analyzed, and compared the base shear and displacement with the base shear and displacement of soft story and also mass irregular structure using ETABS 9.7.4.*

Key Words: *Floating column, Equivalent Static Analysis, Response spectrum Analysis, soft story, Displacement, Story Shear, Story Drift*

1. INTRODUCTION

1.1 General

The configuration of tall structures with Floating column basically includes a theoretical outline, clear investigation, preparatory outline and advancement, to securely convey gravity and lateral loads. The outline criteria are strength, serviceability, stability and human comfort.

Presently a day's framed Structure are extremely mainstream in India, and column assumes an essential part in these Structural working with Floating column. This is a common place element in the present day multi-storey building development in India. Such components are profoundly undesirable in seismically active ranges. In basic Engineering a column should be a vertical part beginning from establishment level and exchange the auxiliary burden to the ground through establishment, the term Floating column is additionally a vertical component which closes at its lower load level lies on a beam which is horizontal member and exchange the load of the structure through column to beam. The beam in term transfers the load to other columns below it. Such column where the heap was considered as point load hypothetically such structure investigated and designed. In urban region multi-storey structures have open first story as an unavoidable component, this open space might be required for get together corridor or stopping reason. These are highly undesirable in building built in seismically active areas usually the civil engineering infra structures are subjected to two classes of loads, static and dynamic loads. The static loads such as dead load, live load are independent with respect to time In case of dynamic loads, loads are changing with respect to time. Most of the cases the structures are designed with the assumptions that all the loads applied are static. Generally the dynamic loads i.e. earthquake loads are not taking an account in the design because the buildings are not regularly subjected to earthquakes, and also it takes more time to solve these parameters in the analysis and also its more difficult to solve the solution.

1.2 Floating column

In Structural engineering, a column is supposed to be a vertical member starting from foundation level and transfer the load to the ground through foundation is called as regular columns

The term floating column is also a vertical element which ends at its rests on a beam which is a horizontal member and transfer the load of the structure through column to beam.

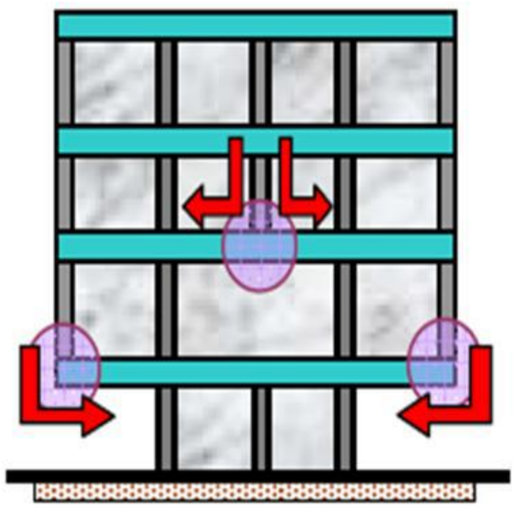
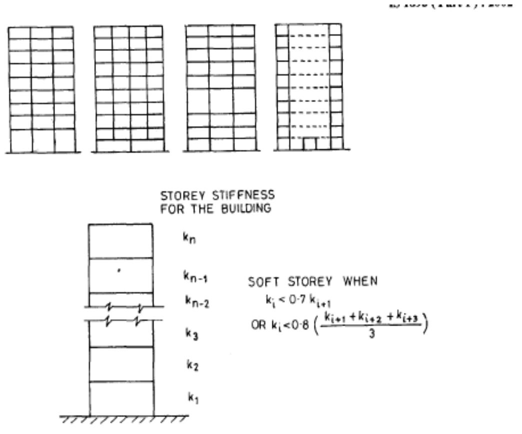


Fig 1.1 Floating columns

1.3 Soft storey structure

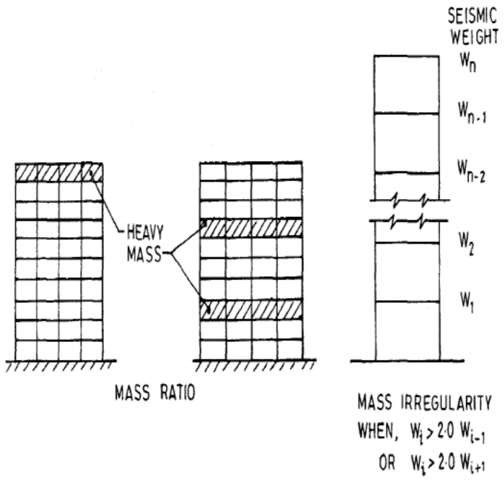
Buildings with first story not filled with masonry walls, which has done in upper stories, suffered extensive damage during earthquake. Stiffness is lesser than 50% when compare to first storey to upper storey, this building is called as soft storeys.



4 A Stiffness Irregularity

1.4 Mass irregular structure

It shall be considered that seismic weight of the any storey is more than 200% of that of its adjacent storey's



4 B Mass Irregularity

2. METHODOLOGY

To determine seismic behaviour of the Buildings with and without floating columns for zone V the basic components like inter storey drift, lateral displacement analysis has been carried using the software ETABS 9.7.4. For the analysis purpose Equivalent static method, and Response spectrum methods are adopted.

A) Assumptions

The following are the assumptions made, Plan of the building is regular, soft storey and Mass irregular building 24mX24m has considered and each storey height is 3m, situated at zone 5 with medium soil condition,4m story height is also considered for Analysis of the building.

C) Group properties

Beam	:	0.3x0.45m
Column	:	0.45x0.45m
Slab	:	0.150m
Concrete Grade	:	M25
Steel Grade	:	Fe500

D) Loading

Gravity loading: Member load and floor load is calculated as per IS 456 part1 and Live load on the floor is taken as 3 Kn/m^2. And the live load at the terrace is taken as 1.5 Kn/m^2.

E) Plans and models

Plans and 3D models considered for the analysis purpose, Floating columns at different locations in the building also considered.

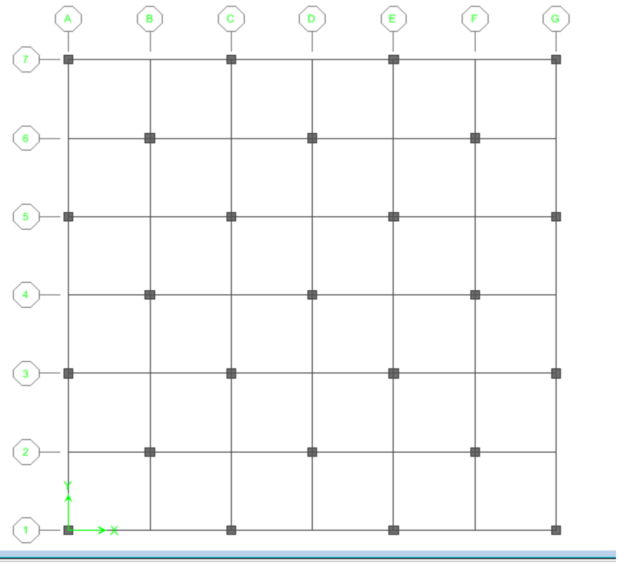


Fig 2.1 plan of the soft story building

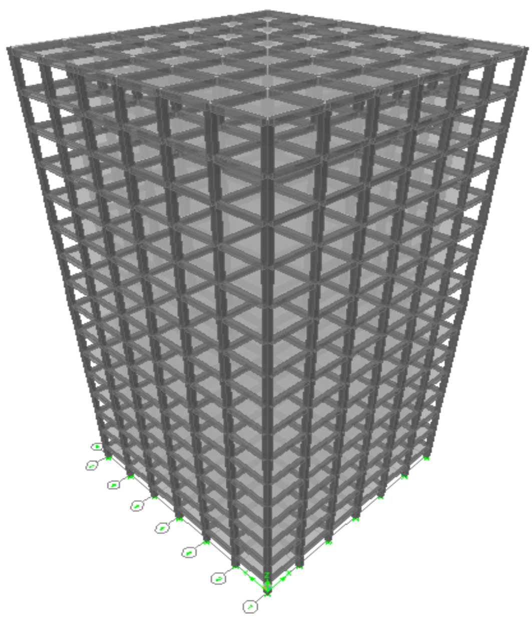


Fig 2.2 Framed building

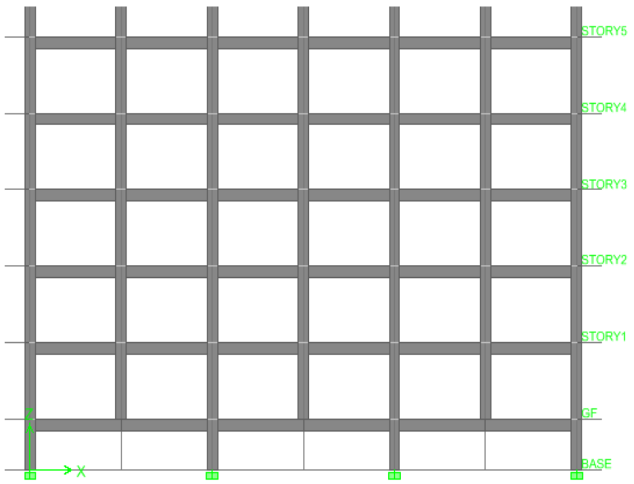


Fig 2.3 Floating coloumns in the building

F) Load combinations considered for the building analysis

The following are the load combinations are adopted for the analysis & design of building as per IS 1893(Part1):2002, as shown in table

Sl. No	Load Combination	Load Factors
1	Gravity analysis	1.5(DL+LL)
2	Equivalent static analysis	a) 1.2 (DL+LL±EQX) b) 1.2 (DL+LL±EQY) c)1.5 (DL+LL± EQX) d)1.5 (DL+LL± EQY) e) 0.9 (DL+LL±EQX) f) 0.9 (DL+LL± EQY)
3	Response spectrum analysis	a) 1.2 (DL+LL±RSX) b) 1.2 (DL+LL±RSY) c) 1.5 (DL+LL±RSX) d) 1.5 (DL+LL±RSY) e)0.9 (DL+LL±RSX) f)0.9 (DL+LL±RSY)

Table 4.4: Load combinations as per IS: 1893(Part1):2002

Where ,

DL= Dead load.

LL = Live load.

EQX, EQY=Earthquake load in the X &Y directions respectively.

RSX, RSY=Earthquake loadSpectrum in the X &Ydirections respectively

3. RESULTS AND DISCUSSIONS

3.1Equivalent Static Analysis

3.1.1 Lateral Displacements.

Lateral displacement profile for building models obtained from the equivalent static and response spectrum methods are shown in figures

Displacement in mm

STOREY	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6
15	141.4	153.9	166.57	300.98	335.95	362.33
14	138.4	150.28	161.79	294.68	328.16	352.19
13	133.9	145.09	155.37	285.17	317.18	338.74
12	127.8	138.37	147.52	272.6	303.16	322.44
11	120.5	130.35	138.44	257.47	286.51	303.69
10	112	121.21	128.3	240.07	267.64	282.89
9	102.6	111.15	117.4	220.84	246.91	260.38
8	92.5	100.35	105.78	200.12	224.69	236.49
7	81.8	88.97	93.63	178.23	201.29	211.54
6	70.67	77.15	81.09	155.47	177.02	185.79
5	59.2	65.03	68.29	132.12	152.12	159.5
4	47.6	52.72	55.32	108.4	126.85	132.89
3	35.96	40.33	42.29	84.5	101.4	106.17
2	24.32	27.95	29.3	60.72	75.97	79.4
1	12.93	15.79	16.54	37.18	50.7	53.09
0	2.9	4.73	4.96	14.78	26.35	27.53

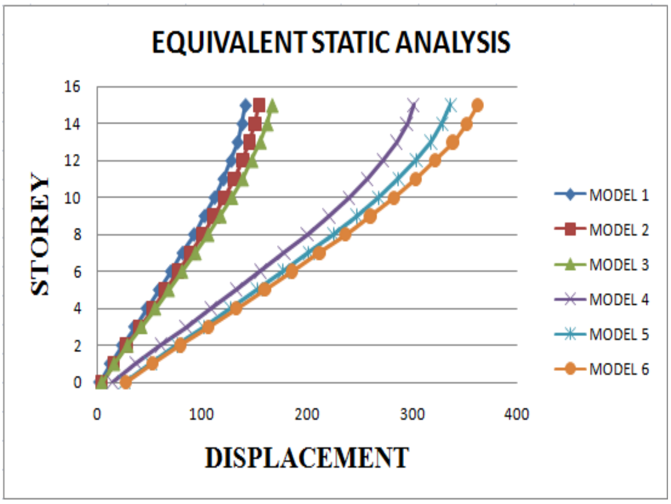


Fig 3.1 Displacement graph in MM

Model 1 - G+15 Regular building, 3m column

Model 2 - G+15 Soft storey building, 3m column

Model 3 – G+15 Mass irregular building, 3m column

Model 4 - G+15 Regular building, 4m column

Model 5 - G+15 Soft storey building, 4M column

Model 6 – G+15 Mass irregular building, 4M column

1)From the figure it's clearly shows that Displacement varies with respect to stiffness of the building , Displacement greater in the soft storey building in which we used floating column and also displacement increased in Mass irregular building due to load variation.

2) It is observed from figure that the displacement increases as the storey height increases, this is due to the fact that , as the storey height increases ,lateral instability increase when compared to lesser storey height .

3) Mass irregular buildings should be naturally lateralled instable irrespective of the height and storey.

3.1.2 Storey drift

	STOREY DRIFT -EQX					
STOREY	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6
15	0.00098	0.00120	0.00159	0.00175	0.00194	0.00253
14	0.00151	0.00173	0.00214	0.00237	0.00274	0.00336
13	0.00201	0.00223	0.00261	0.00313	0.00350	0.00407
12	0.00245	0.00267	0.00302	0.00379	0.00416	0.00468
11	0.00282	0.00304	0.00336	0.00434	0.00471	0.00520
10	0.00312	0.00335	0.00364	0.00480	0.00518	0.00562
9	0.00337	0.003	0.00387	0.00518	0.00555	0.00597
8	0.00356	0.00379	0.0040	0.00547	0.00584	0.00623
7	0.003709	0.00393	0.0041	0.00568	0.0060	0.00643
6	0.00380	0.0040	0.00426	0.00583	0.00622	0.00657
5	0.00386	0.00410	0.00432	0.00592	0.00631	0.00665
4	0.00389	0.00413	0.00434	0.00596	0.00636	0.00668
3	0.0038	0.00412	0.00433	0.00595	0.00635	0.00666
2	0.00379	0.00405	0.00425	0.00588	0.006	0.00659
1	0.00331	0.00368	0.00386	0.00559	0.00615	0.0063
0	0.00145	0.0023	0.00248	0.00369	0.00458	0.00488

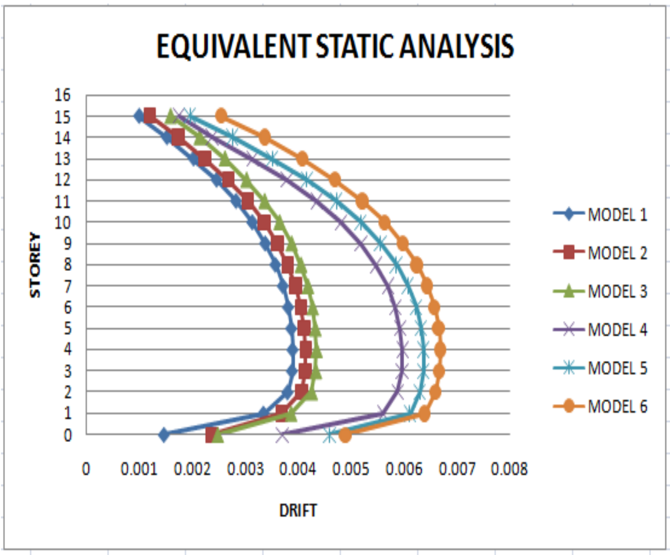


Fig 3.2 Displacement graph in MM

Storey Drift variation in percentage
Regular building – soft storey building drift varies 18%
Regular building – Mass irregular building drift varies 38%
Regular building 3mt column – Regular building 4mt column 43%
In this combination it is observed that the lateral drift of the building is more compared to the regular building. Storey drift increases due to presence of floating columns.

3.1.3 Base shear

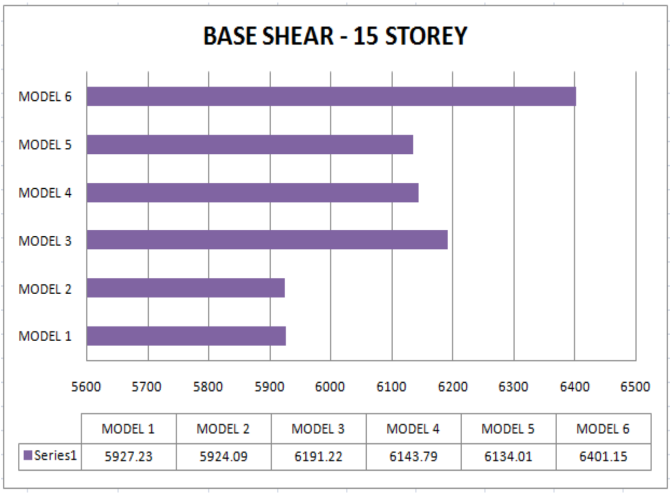


Fig 3.3 Base shear

1) Base shear reduces due to presence of floating column in building as the mass is less for building with floating column.
2) Base shear more for mass irregular structure

3.2 DYNAMIC ANALYSIS

3.2.1 LATERAL DISPLACEMENTS

Displacement in mm

	DISPLACEMENT -SPECX					
STOREY	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6
15	111.6768	120.1286	130.0845	238.9096	258.96	279.27
14	109.7057	117.6549	126.8146	234.6107	253.68	272.41
13	106.7212	114.1825	122.4967	228.263	246.4	263.51
12	102.7391	109.7261	117.2489	219.9476	237.28	252.82
11	97.8591	104.3875	111.1738	209.8715	226.43	240.51
10	92.1701	98.2563	104.347	198.1855	214.03	226.74
9	85.7439	91.4048	96.829	185.0127	200.2	211.59
8	78.6379	83.8897	88.6685	170.4704	185.08	195.20
7	70.8934	75.7507	79.9003	154.6595	168.73	177.63
6	62.5396	67.0135	70.5499	137.6612	151.25	158.96
5	53.6007	57.6983	60.6389	119.5586	132.69	139.24
4	44.0968	47.8211	50.1831	100.4299	113.13	118.51
3	34.044	37.3934	39.1897	80.2976	92.60	96.91
2	23.4927	26.45	27.6902	59.1237	71.09	74.30
1	12.6886	15.1957	15.8939	37.0067	48.6	50.79
0	2.8786	4.6405	4.8483	14.9547	25.87	26.97

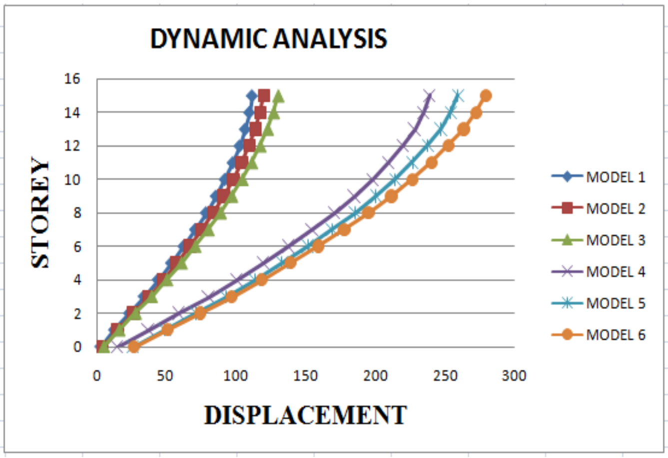


Fig 3.4 Displacement graph

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Displacement variation in percentage

Regular building – soft storey building displacement varies 7.0%

Regular building – Mass irregular building displacement varies 14.15%

Regular building 3mt column – Regular building 4mt column 40%

From the above values its clearly shows that in Dynamic analysis, Displacement is greater in the soft storey building in which we used floating column and also displacement increased in Mass irregular building due to load variation.

3.2.2 Storey Drift

Storey drift in mm

	STOREY DRIFT -SPECX					
STOREY	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6
15	0.000823	0.00097	0.001321	0.0011	0.0013	0.0017
14	0.001301	0.00144	0.001808	0.0017	0.0019	0.0024
13	0.00172	0.00186	0.002182	0.0023	0.0025	0.0029
12	0.002046	0.0021	0.002466	0.00272	0.0029	0.0032
11	0.002304	0.00245	0.002697	0.0030	0.0032	0.0035
10	0.002521	0.00267	0.002895	0.0033	0.003	0.0037
9	0.002706	0.00285	0.003066	0.0035	0.0037	0.0040
8	0.002866	0.00301	0.003218	0.003	0.0039	0.0042
7	0.003015	0.00315	0.00336	0.0039	0.00411	0.0044
6	0.003156	0.00329	0.003495	0.00414	0.004333	0.0045
5	0.00329	0.0034	0.003621	0.0042	0.00449	0.0047
4	0.003419	0.00355	0.003743	0.0044	0.00462	0.0048
3	0.003543	0.0036	0.003866	0.0045	0.0047	0.0050
2	0.003606	0.00375	0.00394	0.0046	0.0048	0.0051
1	0.00327	0.00351	0.003683	0.00418	0.00451	0.0047
0	0.001439	0.0023	0.002424	0.0014	0.0022	0.0023

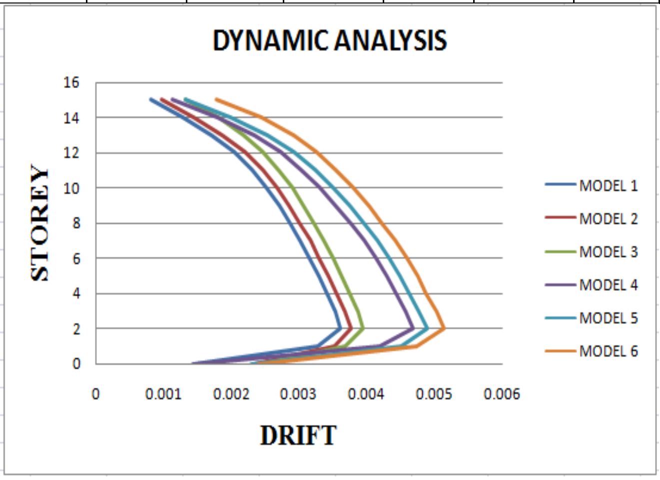

Fig 3.5 Story Drift

Storey Drift variation in percentage

Regular building – soft storey building displacement varies 15%

Regular building – Mass irregular building displacement varies 37%

Regular building 3mt column – Regular building 4mt column 26%

Storey drift increases due to presence of floating column

3.2.3 Base shear

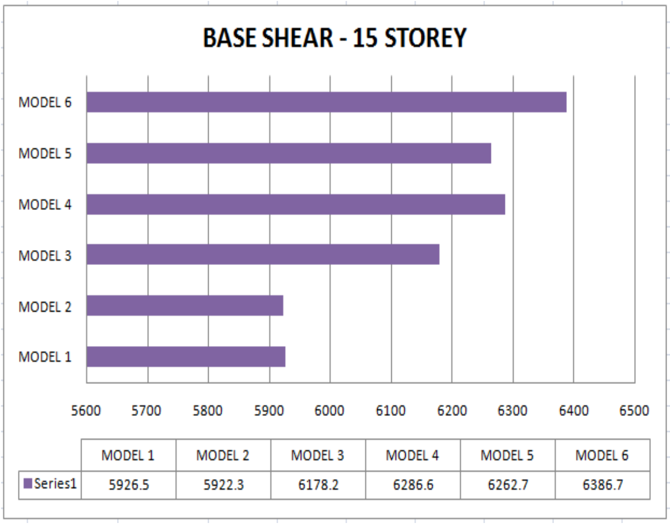

Fig 3.6 Base Shear

In dynamic Analysis Storey shear reduces due to presence of floating column in building as the mass is less for building with floating column.

4. CONCLUSIONS

Conclusions are made on the basis of present study,In this work, the effect of floating column on seismic response of multi-storied building are analysed for seismic and gravity condition . The seismic parameters such as lateral displacement, base shear, fundamental period and inter storey drift are studied

The conclusions are:

- Lateral displacement increases with the height of the building. Displacement is more for the floating column buildings compared with the regular building.
- Building with 4m column height displacement is more than that of building with 3m column height, displacement increases with the height of column.
- Mass irregular building displacement is higher than that of regular building and soft story building.
- The inter storey drift also increases from top up few storey , later the storey drift reduces due to stiffness near fixed end at base.
- As the mass and stiffness increases the base shear also increases. Therefore, the base shear is more for the Mass irregular building to the conventional building.
- Base shear lesser in the floating column building when compare to regular building due to decrease in column weight.
- Hence, from the study it can be concluded that as for as possible, the floating columns are to be avoided especially In the seismic prone areas.

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