"Comparative study on conventional beam slab and flat slab under various seismic zones and soil conditions"

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Abstract - *Commonly, Flat slab buildings are used for the construction because use of flat slab building provides many advantages over conventional beam slab building. The objective of the present work is to compare the behaviour of multi-storey commercial buildings having flat slabs with drop and peripheral beams and beam slab. Present work provides good source information on the parameters base shear, lateral displacement and storey drift. The analysis is carried out by ETABS V9.7.4 software.*

Key Words: RC frame building, flat slab, base shear, displacement, storey drift, ETABS.

1. INTRODUCTION

The reinforced concrete frame buildings are commonly used in construction. Flat slabs are one of the most popular floor systems used in residential buildings, car parks and many other structures. Flat slab are favored by both architects and clients because of their aesthetic appeal and economic purpose. The flat slab system is a special structural form of reinforced concrete construction that possesses major advantages over the conventional beam column frame. The flat slab system provides easier formwork, architectural flexibility, unobstructed space, lower building height and shorter construction time.

A flat slab floor system is often the choice when it comes to heavier loads such as multi-storey car parking, libraries and multi-storey buildings where larger spans of free space are also required. Common practice of design and construction is like to support the slabs by beams and next support the beams by columns. This may called as beam slab construction. In normal frame construction uses columns, slabs and beams, however it ought to be potential to undertake construction without using beams, in this case the frame system would comprises of slab and column without beams. These types of buildings are called as flat slabs. The slab directly rests on column and load from the slab is directly transferred to the columns and then to be foundation.

2. LITERATURE REVIEW

Prof. Naveen kumar B M, Priyanka S (2015) "Comparative study of flat slabs and conventional RC slabs in high seismic zone" The present study covers the behavior of multistory buildings having conventional RC frame building, flat slabs and to study the effect of height of the building on the performance of these types of buildings under seismic forces. It gives good source information on the parameters storey drift, lateral displacement, natural time period and seismic base shear.

Ms. Navyashree K and Sahana T. S (2014) "Use of flat slabs in multi-storey commercial building situated in high seismic zones" In this work six number of conventional RC frame and Flat slab buildings of G+3,G+8,G+12 storey building models are considered. The performance of flat slab and vulnerability of frame and flat slab models under different load conditions were studied and for the analysis, seismic zone IV is considered. The analysis is done with using ETABS software. The object of this work is to compare the behavior of multi-storey commercial buildings having flat slabs and conventional RC frame with that of having two way slabs with beams and to study the effect of height of the building on the performance of these two types of buildings under seismic forces. It gives a good source of information on the parameters lateral displacement, storey drift, storey shear, column moments axial forces and time period.

Mr. Kiran S. Patil and N. G. Gore. P .J. Salunke (2014) "Minimum Cost Design OF Reinforced Concrete Flat Slab" Sequential unconstrained minimization technique (SUMT) is used for the solution of a comprehensive minimum cost design problem formulation. The formulation, based on Indian standard codes of practice (IS 456-2000), Solutions of the nonlinear programming problem are obtained with an appropriate computer program. This is used for solving a wide range of typical flat slab designs with varying span-to-depth ratios, live and dead loads, different grades of concrete and steel. A related sensitivity study shows the comparison of optimal and standard solutions. The different conditions of flat slabs are analyzes and design by using MATLAB software.

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Dr. Uttamasha Gupta, ShurtiRatnaparkhe, Padma Gome (2012) "Seismic Behavior of Buildings Having Flat Slabs with Drops" The main object of this paper is to compare the behavior of multi-storey buildings having flat slabs with drops with that having two way slabs with beams and to study the effect of part shear wall on the performance of these types of buildings under seismic forces. Present work provides a good source of information on the parameters lateral displacement and storey drift.

Prof. K S Sable, Er. V.A. Ghodechor, Prof. S. B.Kandekar (2012) " Comparative Study of Seismic Behavior of Multi-storey Flat slab and Conventional Reinforced Concrete Framed Structures" Tall commercial buildings are primarily response to the demand by business activities to be as close to each other, and to the city centre as possible, thereby putting intense pressure on the available land space. Structures with a large degree of indeterminacy is superior to one with less indeterminacy, because of more members are monolithically connected to each other and if yielding takes place in anyone of them, then a redistribution of forces takes place. Therefore it is necessary to analyze seismic behavior of building for different heights to see what changes are going to occur if the height of conventional building and flat slab building changes.

3. DESCRIPTION OF SAMPLE BUILDING

In the study symmetric building models has been taken for all the cases.

- Beam slab Building.
- Flat Slab with Drop and Peripheral Beams.

A 3D RC frames with 4 bay by 4 bay for 11 (G+10) stories of dimension 28mx28m has been taken for seismic analysis. Effect of RC slab and flat slab with drop and peripheral beams using soil conditions as hard soil, and Soft soil. And seismic zones II, III, IV and V as per IS 1893 (part I):2002.

4. DESIGN DATA

Table- 1: Geometric Property

Parameter	Values
Number of storeys	G+11
No. of bays in X direction	4
No. of bays in Y direction	4
Bay width in X direction	7m
Bay width in Y direction	7m
Storey height	3m
Slab thickness	0.225m
Drop thickness	0.3m
Main Beam size	0.3mx0.6m
Secondary Beam size	0.2mx0.6m

Table -2: Material Properties of concrete

Property	Values
Grade of concrete	M25
Modulus of elasticity	Ec = (5000√fck)
Poisson's ratio of concrete	0.2
Density of concrete	25kN/m³

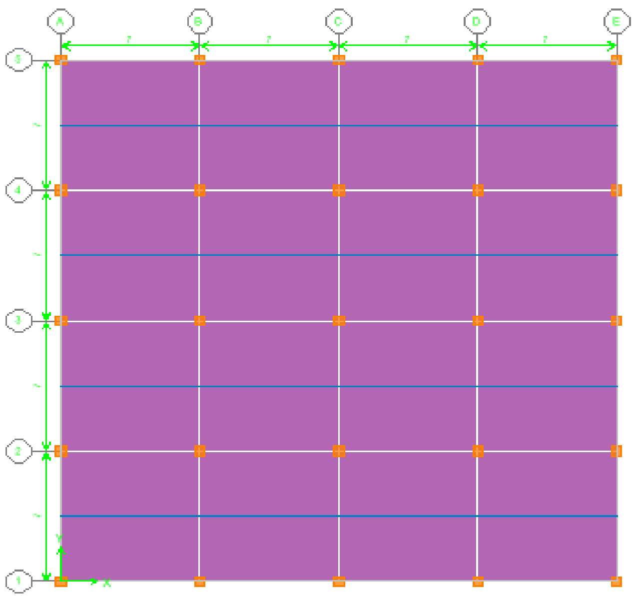

Fig.1: Building plan for conventional beam slab building

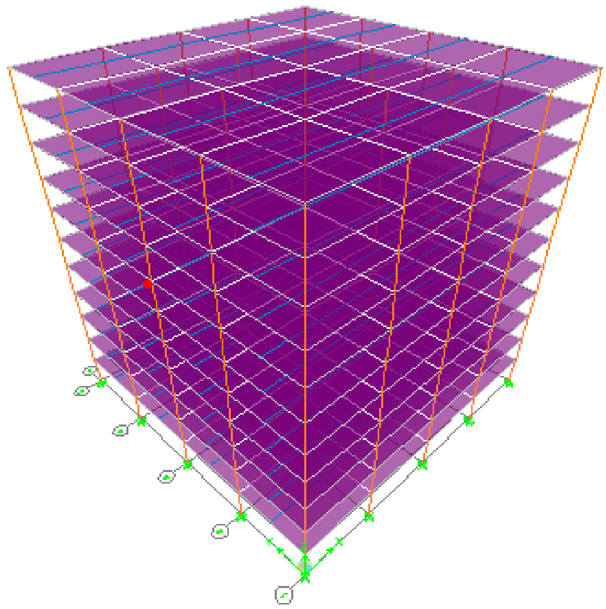

Fig 2: 3D View of conventional beam slab building

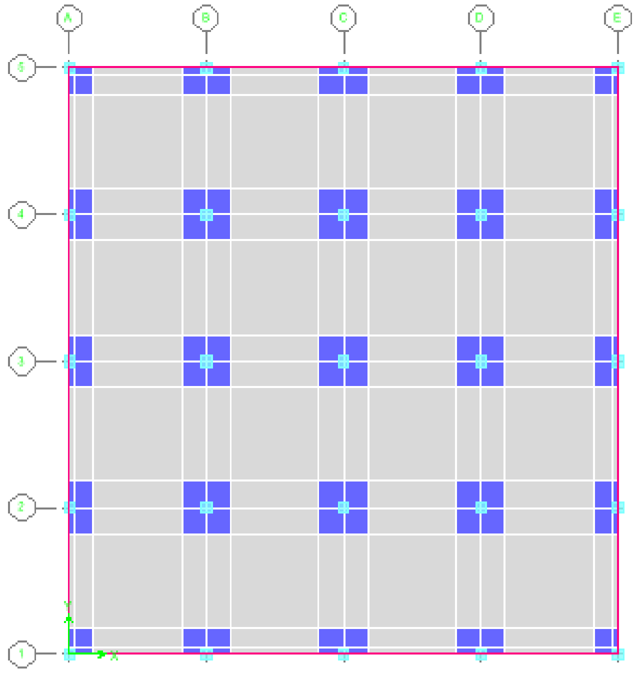

Fig.4: Building plan for Flat slab building

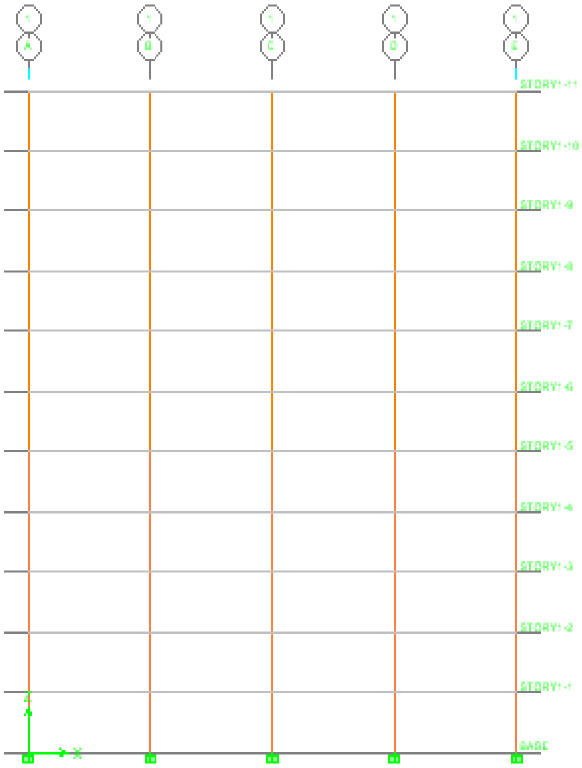

Fig 3: Model elevation of conventional beam slab building

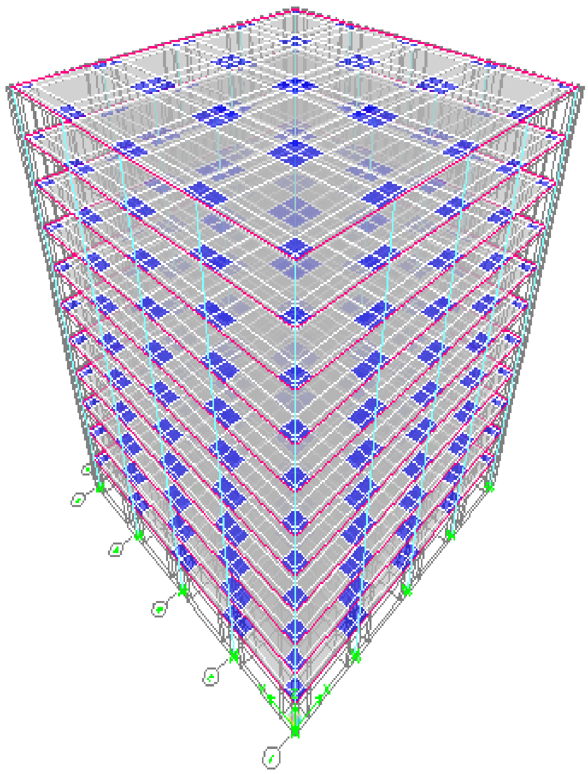

Fig.5: 3D view of flat slab building

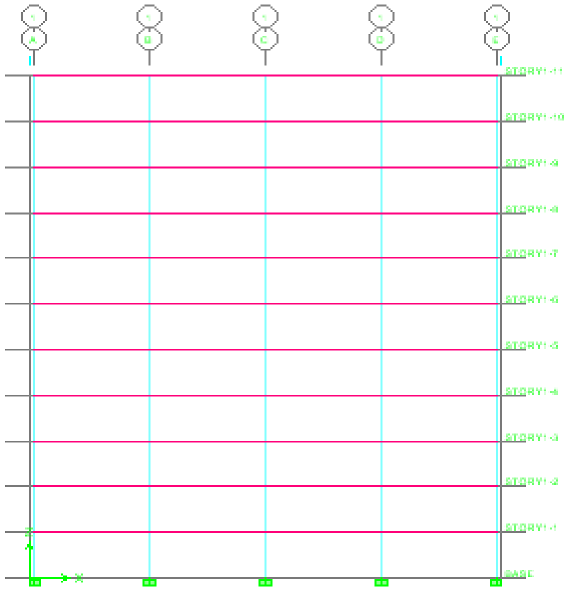

Fig.6: Model Elevation of Flat slab building

5. RESULTS AND DISCUSSION

The following work carried to study the behavior of beam slab building and Flat slab building. The study also includes various parameters which are studied such as base shear, displacement and storey drift. The overall study is conducted by applying the all four seismic zones and different soil conditions are Hard or Rock soil and Soft soil. The seismic analysis for the study has been carried by equivalent static method of analysis.

5.1 Base Shear

Table- 3: Comparison of base shear along X directions for different models for rock soil.

ZONES	BEAM SLAB	FLAT SLAB
	Vx (kN)	Vx (kN)
II	1132.65	1358.02
III	1631.01	1955.55
IV	1812.24	2172.83
V	2446.52	2933.33

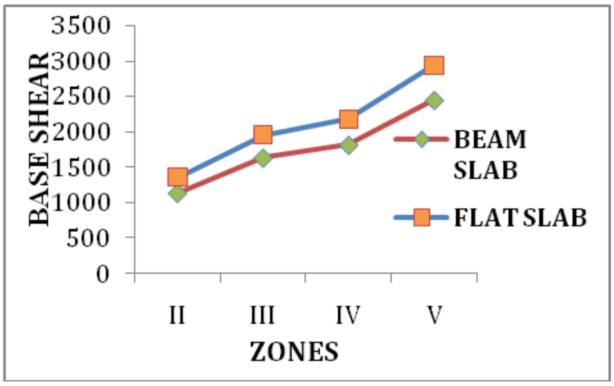

Fig-7: comparison of base shear along X direction for rock soil

Table- 4: Comparison of base shear along X directions for different models for soft soil.

ZONES	BEAM SLAB	FLAT SLAB
	Vx (kN)	Vx (kN)
II	1891.52	2267.9
III	2723.79	3265.77
IV	3026.44	3628.23
V	4085.69	4898.65

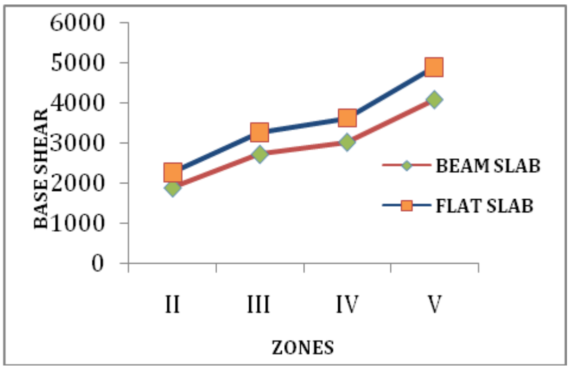

Fig-8: comparison of base shear along X direction for soft soil

Above table shows the base shear values for various seismic zones and soil conditions as hard soil and Soft soil for different models, from the above results it can be seen that base shear values are increasing in flat slab system compared to the beam slab system.

5.2 Displacement

Table- 5: Comparison of Displacement (mm) along X direction for all models for Rock soil

No. of storeys	RC slab and Flat slab		RC slab and Flat slab		RC slab and Flat slab		RC slab and Flat slab	
	Zone 2		Zone 3		Zone 4		Zone 5	
1	10	10	10	10	10	10	10	10
2	10	10	10	20	10	20	10	20
3	10	20	10	30	20	30	20	30
4	10	20	20	40	20	40	30	40
5	10	20	20	50	20	50	30	50
6	20	30	20	50	20	60	40	50
7	20	30	30	60	30	60	40	60
8	20	40	30	60	30	70	40	80
9	20	40	30	70	30	70	40	90
10	20	40	30	70	30	70	40	100
11	20	40	30	70	30	70	40	110

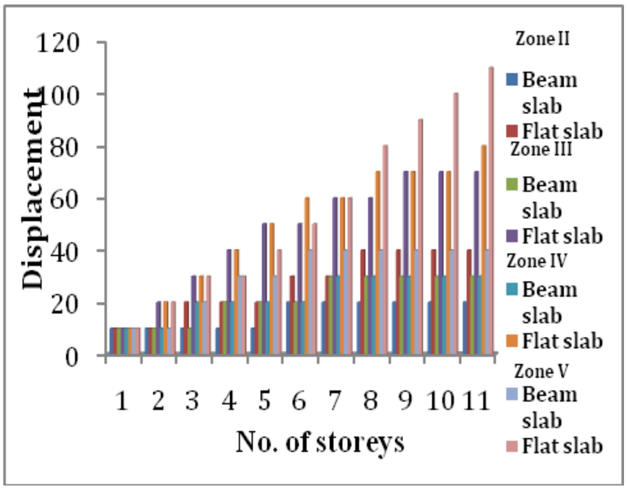

Fig-9: comparison of displacement along X direction for rock soil

Table -6: Comparison of Displacement (mm) along X direction for all models for soft soil

No. of storeys	RC slab and Flat slab		RC slab and Flat slab		RC slab and Flat slab		RC slab and Flat slab	
	Zone 2		Zone 3		Zone 4		Zone 5	
1	10	20	10	20	10	40	10	30
2	10	40	20	30	20	40	20	50
3	20	50	20	50	20	60	30	80
4	20	60	30	70	30	70	40	10
5	20	70	30	80	40	90	50	120
6	30	70	40	90	40	110	60	140
7	30	80	40	110	50	120	70	140
8	30	90	50	120	50	130	70	160
9	40	90	50	120	50	140	80	170
10	40	90	50	120	60	140	80	190
11	40	90	50	120	60	150	80	190

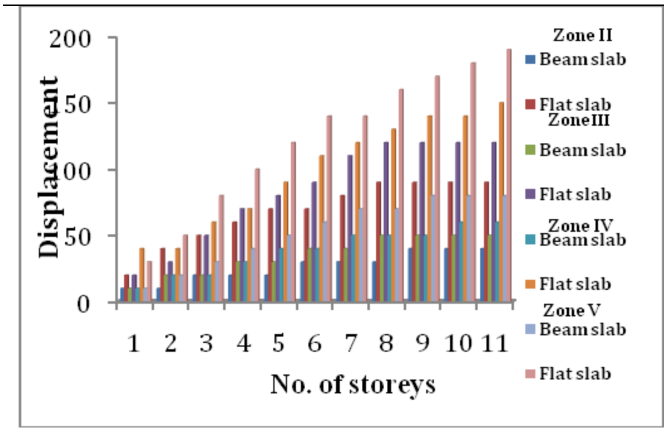

Fig-10: comparison of displacement along X direction for soft soil

From the above values it can be seen that displacement is more at top floors and it gradually decreasing to bottom floors, this is because stiffness participation factor is more in ground floor compared to the top floor for both beam slab and flat slab buildings.

5.3 Storey Drift

Table -7: Comparison of storey drift (m) along X direction for all models for Rock soil

Soil type I Hard or Rock soil								
	Zone II		Zone III		Zone IV		Zone V	
No. of Storey	Beam slab	Flat slab	Beam slab	Flat slab	Beam slab	Flat slab	Beam slab	Flat slab
1	0.000251	0.000362	0.000402	0.000682	0.000542	0.000982	0.000582	0.001473
2	0.000412	0.000591	0.000602	0.00132	0.000656	0.001486	0.000886	0.002229
3	0.000553	0.000796	0.000896	0.001377	0.000884	0.001983	0.001194	0.002975
4	0.000667	0.00096	0.00099	0.001664	0.001067	0.002396	0.00144	0.003594
5	0.000754	0.001086	0.001086	0.001886	0.001207	0.002716	0.001629	0.004074
6	0.000818	0.001178	0.001178	0.002044	0.001308	0.002944	0.001766	0.004415
7	0.000861	0.001239	0.001249	0.002166	0.001377	0.003047	0.001859	0.004571
8	0.000885	0.001274	0.001244	0.002157	0.001416	0.003106	0.001911	0.004659
9	0.000888	0.001278	0.001278	0.002112	0.00142	0.003042	0.001918	0.004562
10	0.000834	0.001202	0.001202	0.0011843	0.001335	0.002654	0.001802	0.003982
11	0.000508	0.000731	0.000777	0.000968	0.000812	0.001393	0.001097	0.00209

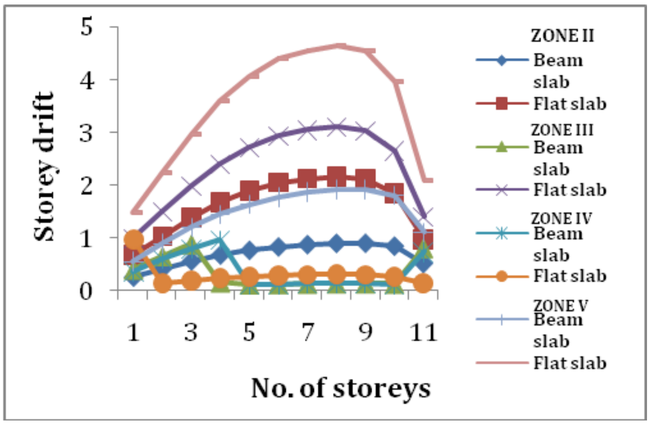

Fig-11: comparison of storey drift along X direction for rock soil

Table -8: Comparison of storey drift (m) along X direction for all models for soft soil

Soil type I Hard or Rock soil								
	Zone II		Zone III		Zone IV		Zone V	
No. of Storey	Beam slab	Flat slab	Beam slab	Flat slab	Beam slab	Flat slab	Beam slab	Flat slab
1	0.000419	0.001139	0.000604	0.00164	0.000671	0.00182	0.000906	0.00246
2	0.000685	0.001723	0.000986	0.002482	0.001096	0.002757	0.00148	0.003723
3	0.000923	0.0023	0.001329	0.003312	0.001476	0.00368	0.001993	0.004968
4	0.001114	0.002778	0.001604	0.004001	0.001782	0.004446	0.002405	0.006001
5	0.00126	0.003149	0.001814	0.004535	0.002015	0.005039	0.002721	0.006803
6	0.001366	0.003414	0.001966	0.004916	0.002185	0.005462	0.00295	0.007374
7	0.001437	0.003534	0.002069	0.005089	0.002299	0.005655	0.003104	0.007634
8	0.001478	0.003602	0.002128	0.005187	0.002365	0.005764	0.003192	0.007781
9	0.001483	0.003527	0.002135	0.00508	0.002372	0.005644	0.003202	0.007619
10	0.001393	0.003078	0.002007	0.004433	0.002229	0.004925	0.00301	0.006649
11	0.000848	0.001616	0.001221	0.002327	0.001357	0.00258	0.001831	0.00349

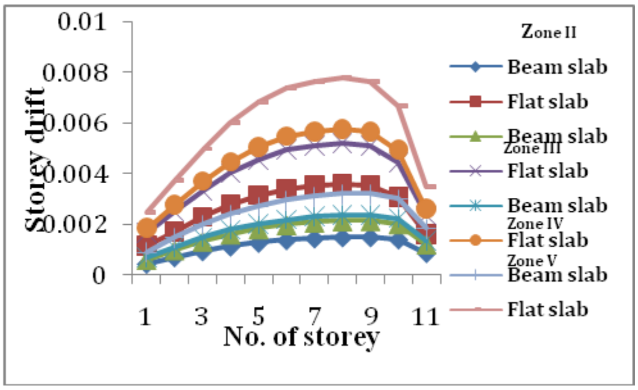

Fig-12: comparison of storey drift along X direction for soft soil

The results have been tabulated and represented in above figures. From the chart it can be observed that the storey drift is minimum at plinth level, increases at middle stories and decreases at terrace level for all types of buildings.

6 CONCLUSIONS

1) The base shear is maximum at plinth level. The base shear will increase drastically as the height increases. Base shear of conventional beam slab building is less than the flat slab building. .
2) The base shear is maximum in a soft soil compared to the rock soil. This shows that mass participation factor is high in flat slab compared to the conventional beam slab building.
3) The displacement of structures increased as the seismic zone increase in both conventional beam slab and flat slab building.
4) Displacement increases as the height increases for all the structure. Displacement of flat slab building is more than conventional beam slab building.
5) The displacement is maximum in soft soil compared to the rock soil.
6) Storey drift in buildings with flat slab construction is significantly more as compared to the conventional beam slab building.
7) The storey drift is maximum at soft soil compared to the rock soil.

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