ANALYSIS OF FLAT SLAB STRUCTURE AND CONVENTIONAL SLAB STRUCTURE

Shital Borkar[1], Dr. Isha Khedikar[2], Dr. Kuldeep Dabhekar[3]

[1] PG Student, Structural Engineering, G H Raisoni College of Engineering, Nagpur, India

[2, 3]Assistant Professor, G H Raisoni College of Engineering, Nagpur, India

borkar_shital.mtechstr@ghrce.raisoni.net

isha.khedikar@raisoni.net

kuldeep.dabhekar@raisoni.net,

Abstract: For the design engineers, selection of the type of the structure for a particular purpose is very important, as multistory buildings are becoming necessary, as construction for living style with increases in demand for space. The feeble amount of space is forcing us to lift the high level of structures as much as possible to give space to greatest point number of people .Flat bit of material buildings are the ones in which slab is directly supported by columns for the advantage of reducing floor to floor height to make the structure cost effective and meet structural demands. This paper aims to work on seismic response of flat slab RCC structure for the various height and plan, also aims to compare behavior of flat slab building with old conventional 2 way slab system for different zones like zone II, zone III, zone IV, zone V in respect with maximum BM, story shear, base shear, and story drift, by the help of analysis soft wares like ETAB, STAAD PRO and SAP 2000 .[1,16]

***Keywords*: storey drift, storey shear, base shear, drop panel, column head.

I. INTRODUCTION

The increasing demand and space construction of multistoried building is becoming a necessary part of our living style. The lack of space is forcing us to raise the height of structures as much as possible to accommodate maximum number of people, and also in harmony with the architectural necessities. There are various structural system for the construction of multistoried building. Formed building and flat slab building are two of them generally slab is supported using beam and beam is supported using column
It is called as beam slab constructions, flat slab construction is made in which slab is supported using column. [2]

The practice of design and construction is to support the slabs using beams and support the beams using Columns. This may be called as beam-slab construction. The flat slab buildings in which slab is directly supported using columns, have been adopted in many buildings constructed in recent times due to advantage of reduced floor to floor heights to meet the cost- Effective and architectural demands .The beam decrease the obtainable net clear ceiling height.

Reinforced flat slab means a slab which is held with the help of column but there are no beam, this reinforced flat slab also known as beamless slab, a part of the slab rest on four sides by center line of column, this is also called as panel. This panel of flat slab gives strength in shear and it’s to reduce the amount of reinforced in support regions. The part below the slab is called as drop or drop panel.

1.1 History of adsorption of flat slab system**.**
Flat slabs have been accessible to structural engineers from the time when the start of reinforced concrete design. In Europe one of the founding father of flat slabs was Robert Millar, a design and building contractor. He carried out a series of full-scale tests on flat slabs on 1909. These slabs known as Millar’s slabs were usually used for industrial buildings and warehouses where column heads, of many various shapes and forms, were used.

The analysis of flat slab were solved with various loads tests on flat slabs, the design rules which have ensured are also empirical. This disparity between design and analysis procedures is particularly severe for flat slab buildings. Analysis of flat slab has slower to develop because it involves complex three dimensional behaviors, as compared with two dimensional behaviors of beam column frame.

1.2 Some terminologies involved in flat slab

1.2.1 Drop Panels:

Drop committee is a thick part of flat bit of material around column to oppose get cut at flat bit of material and column joint it is part of bit of material .It doesn't support any other structure member . [3]

Column head is a bracket on top of column or an enlarge cross section of column at its top on which other structure member can rest It provide additional base area which serves as a base to other structure member . [4]

1.2.2 Column Capital:

The column or column head provided at the top of a column, is intended mainly to increase the capacity of the slab to resist punching shear. The getting wider of the column at top is usually done such that the map geometry at the column head is similar to that of the column. The code restricts the structurally suitable portion of the column capital to that portion which lies whit in the large pyramid which has a apex of 90, and can be taken into consideration whit in the outline of the column and column head . [5]

II.OBJECTIVES

- To study the effect of seismic level over the intensities of various parameter like displacement, base shear etc.
- Observations of flat structure by having an effect equal to the input at rest careful way and move band careful way.
- A comparative study between various types of flat slabs in terms of parameters like base shear, story drift, story drift.
- Analysis of G+5 buildings for all zone factors and there comparative study for various parameters.
- The based on selected measure studies have among its parts of base get cut of structure. Maximum side moving developed and living-stage of story drift, axial forces in the column.

III.METHODOLOGY

3.1 Methods and procedure adopted [11,12]

- Selections of 5 different types of slab models are considered (conventional slab, flat slab, flat slab with drops, flat slab with column heads and combination of drops and column heads).
- Seismic analysis is carried out by both methods (linear static analysis and linear dynamic analysis) for different seismic zone factor.
- The 5 slab models are examined for different zone factors.
- Analysis is conducted using ETABS 2015 software.

3.2 Plan and elevation view of models

A plan is designed and is used same for all types of models i.e. conventional structure, flat slab, flat slab with drop, flat slab with column head, flat slab with drop and column head. It consists of slab, columns and beams for conventional building on the other hand consist of slab with drop, slab with column head and columns for flat slab building. [8,9,10]

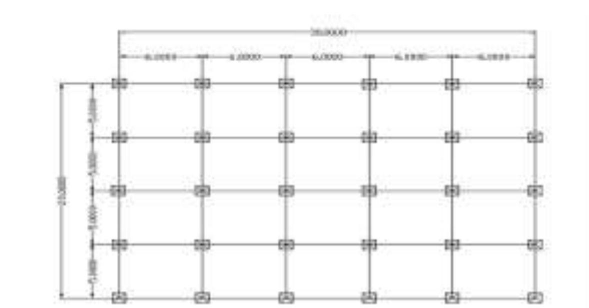

Figure 3: Plan

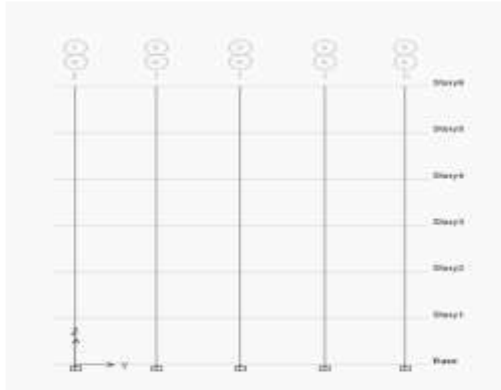

Figure 4: Elevation (total height= 24m)

Table: Analysis data (Preliminary Data and Seismic Data)

Preliminary Data	Seismic data
No of stories = G+5	Seismic loading = as per IS1893 part1
plan dimension = 30 x 20 m	Type of soil = medium
Type of structure = commercial building	Seismic Zone II = 0.10
Floor to floor height = 4 m	Zone III= 0.16
Total height = 24 m	Zone IV= 0.24
Column = 400 x 400 mm	Zone V = 0.36
Beam = 300 x 300 mm	Importance factor = 1
Live load = 4 KN/m2 (IS 875 part2)	Response reduction factor = 3
Floor finish = 0.75 KN/m2	----
Roof live = 1.5 KN/m2	----
M25, Fe415	----

- Calculation of parameters for flat slab

This section includes calculation of data that are used in the project and their properties like density. A detailed explanation about behavior of structure under lateral load and calculation is done by Indian standard code IS 456-2000. In IS 456-2000, there is a provision for flat slab structure, from this we can know the various terminology used in flat slab structure. For the modeling purpose we are calculating the thickness of slab from given data.

Thickness of flat slab (by referring IS 456-2000, clause no- 31.2.1)
=6000/ (0. 5(20+26)1.6) = 163.04 mm
Total thickness= 163.04+15+16/2 = 186 mm
Drop size (IS 456-2000, clause no- 31.2.2)
= 1/3 * 6, 1/3* 5
= 2 m , 1.6 m
= 2*2 m
Thickness of drop = 1.25*186 = 233 mm

- Calculation of dead load

Slab thickness = 186mm
Concrete density = 25KN/m^2
Self-wt. of slab = 25*0.186
=4.63 KN/m^2 *30*20
= 2970 KN
Floor finish at floor level
=0.75 KN/^{m}
Total floor load =0.75*30*20
= 450KN
Load on beam = 3645 KN
Load on column = 2640KN

- Live load and roof live load calculation

Load intensity specified = 4KN/m^2

(50% load is considered)

L.L. = 4*0.5*30*20 = 1200KN

R.L. =1.5*0.5*30*20 = 450KN

- Seismic loading

Seismic load is calculated as mentioned in IS 1893-2002

Seismic parameters calculated as

T_a = 0.8132 s

Building is located on medium soil site,

Therefore, S_a/g = 1.6724

Design horizontal seismic coefficient

A_h=0.02787

Base shear, V_b= 871.63 KN

- 3-D Models

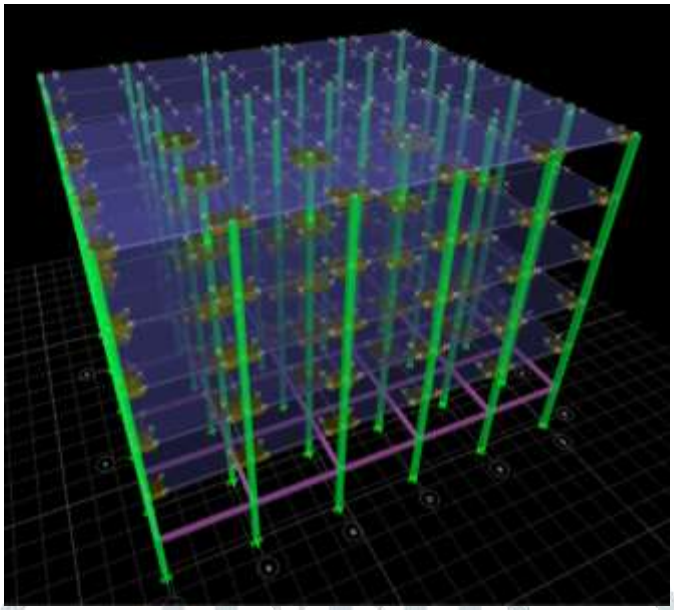

Figure 1.(a): Flat slab with drop cap

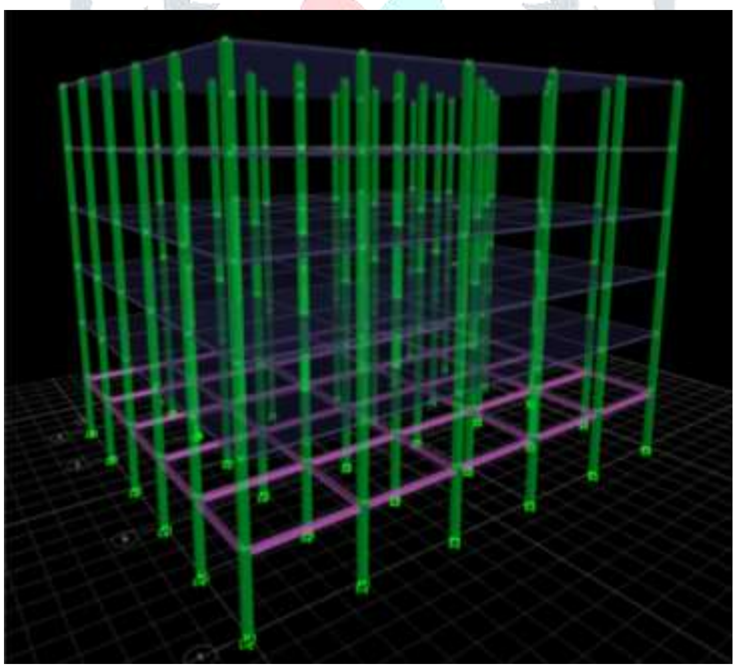

Figure2. (b): Flat slab without drop cap

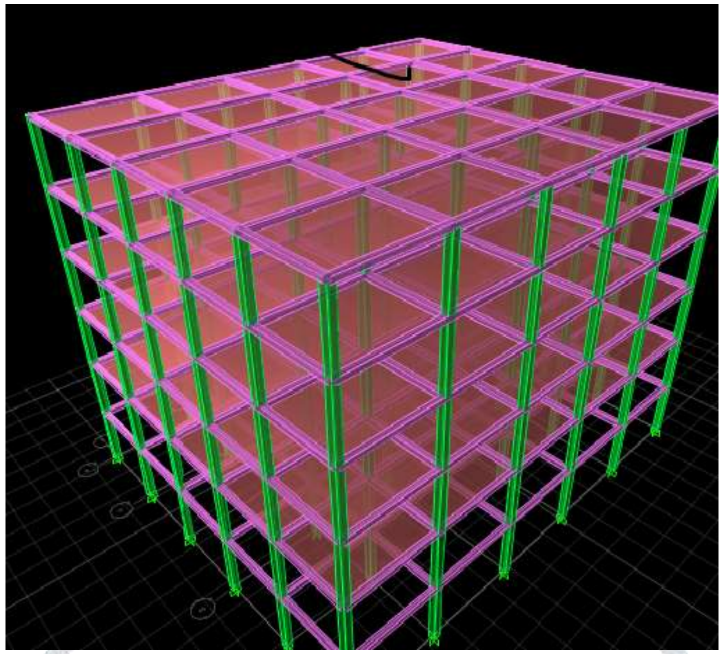

Figure 3.(c): conventional slab

IV. RESULTS AND DISCUSSIONS

The analysis is done by using an analysis software named ETABS 2015 software individually and then comparison is done. The calculation of variations in base shear, effect of adsorption of drop, column head parameters are conducted and there trends with load variation is presented graphically and analyzed. The comparison of various performance parameters between conventional structure and flat slab structure was done. The results of above measured parameters are presented graphically and in tabular form and discussed below.

4.1 Effect of seismic load on base shear in KN

Base shear in X-dir.	Zone II	Zone III	Zone IV	Zone V
Convention structure	871.95	1395.13	2092.70	3139.05
Flat slab	768.80	1230.08	1845.13	2767.70
Flat slab with drop	875.70	1401.12	2101.69	3152.53
Flat slab with column head	799.56	1279.30	1918.95	2878.42
Flat slab with drop and column head	904.86	1447.77	2171.66	3257.49

Table 4.1(a): Base shear in x-dir.

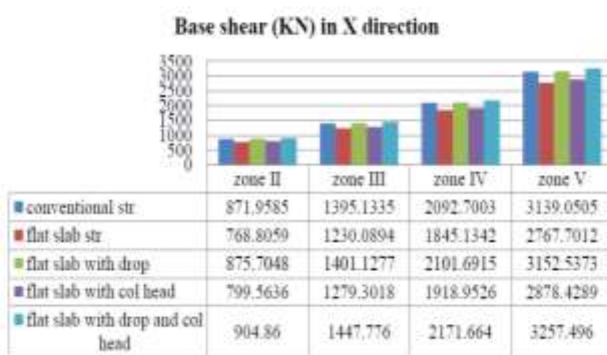

Figure 4.1(a): variation in base shear for diff. zone in x-dir.

Base shear in Y-dir.	Zone II	Zone III	Zone IV	Zone V
Convention structure	872.50	1396.00	2094.00	3141.00
Flat slab	764.34	1222.94	1834.42	2751.63
Flat slab with drop	874.49	1399.18	2098.77	3148.53
Flat slab with column head	799.56	1279.30	1918.95	2876.2
Flat slab with drop and column head	904.86	1447.77	2167.66	3250.49

Table 4.1(b): Base shear in Y-dir.

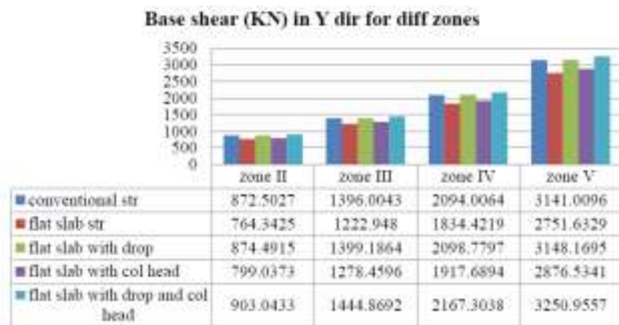

Figure 4.1(b): variation in base shear for diff. zone in y-dir.

Fig.4.1 (a) shows variations in base shear for diff zones in X dir. And Fig.4.1(b) shows variations in base shear for diff zones in Y dir. The base shear is an important parameters considered for evaluation of performance structural system. In structural system, dependency of these parameters on dead weight of building and Ah factor is observed. Increment in base shear of structure is noticed with increase in dead weight of building gas as well as with increase in zone factor. The occurrence of maximum base shear is obtained in flat slab with drop and column head..[14,15,16]

4.2 Effect of joint displacement

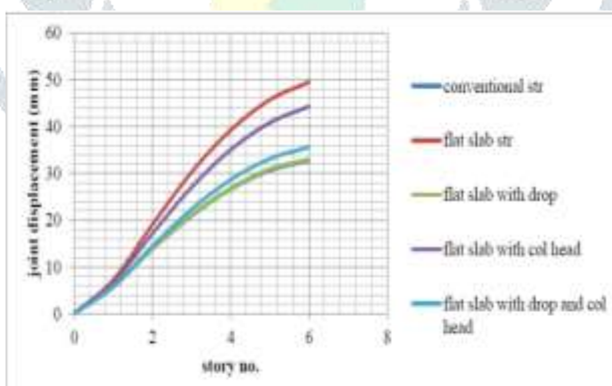

Figure 4.2 (a): joint displacement for zone II

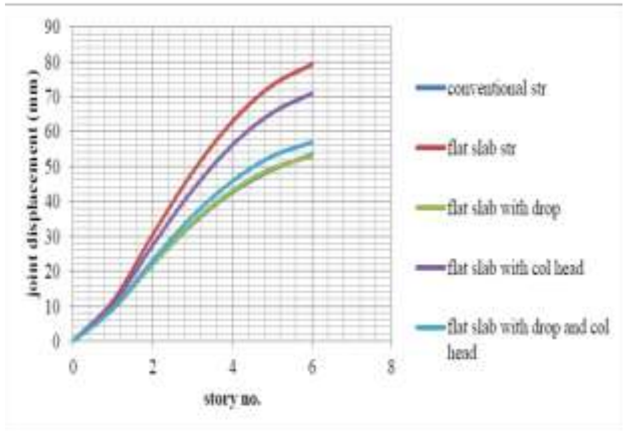

Figure 4.2 (b): joint displacement for zone III

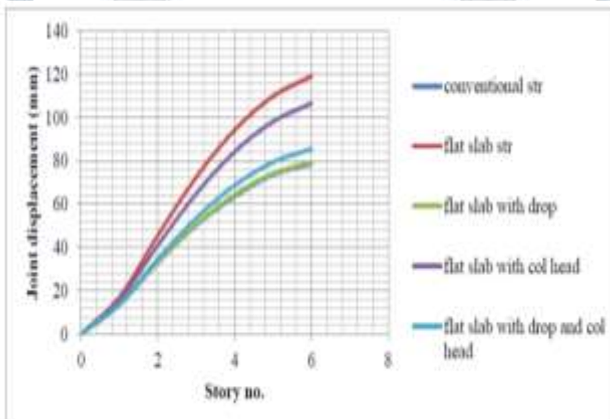

Figure 4.2 (c): joint displacement for zone IV

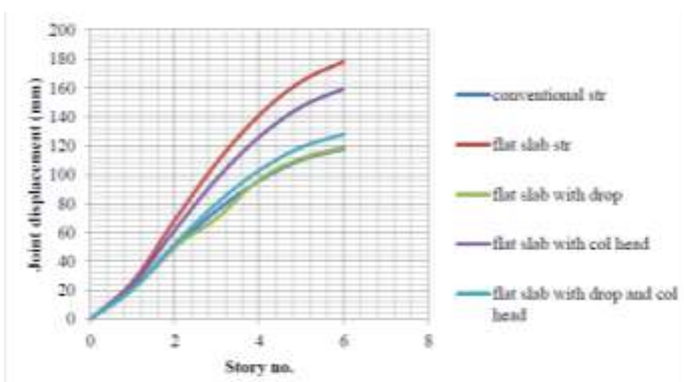

Figure 4.2 (d): joint displacement for zone V

The joint displacements as shown above with different zone factors and the obtain results appears as, with increase in the zone factor there will be increment in joint displacement also. This means that if the more seismic load acts on the structure, more displacement will takes place. If joints are highly stiff then the displacement is less thereby minimizing the effect of seismic load. In this case joint displacement for flat slab with drop is observed to be less.

4.3 Effect of story drift in X and Y dir. For Zone II

Story No.	Conventional structure	flat slab structure	Flat slab with drop	flat slab with column head	Flat slab with drop and column head
6	0.00071	0.00125	0.00071	0.00113	0.000809
5	0.00123	0.00195	0.0012	0.00173	0.001333
4	0.001587	0.00249	0.0016	0.00221	0.00173
3	0.001861	0.00288	0.0018	0.00255	0.00202
2	0.002034	0.00297	0.002	0.00264	0.00217
1	0.001424	0.0017	0.0014	0.00164	0.001451

Table 4.3(a): Story drift in X dir. For zone II

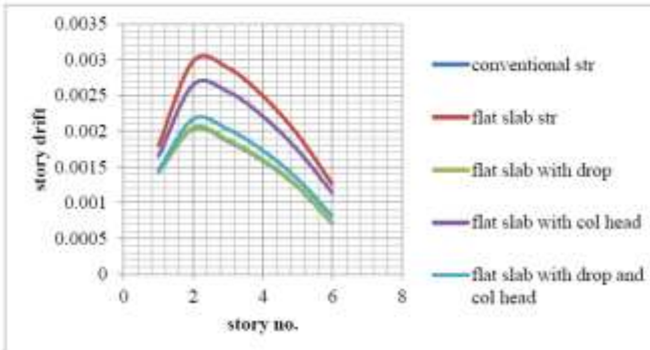

Figure 4.3(a): Story drift in X dir. For zone II

Story No.	Conventional structure	flat slab structure	Flat slab with drop	flat slab with col. head	Flat slab with drop and column head
6	0.00071	0.00125	0.00071	0.00113	0.000809
5	0.00123	0.00195	0.0012	0.00173	0.001333
4	0.001587	0.00249	0.0016	0.00221	0.00173
3	0.001861	0.00288	0.0018	0.00255	0.00202
2	0.002034	0.00297	0.002	0.00264	0.00217
1	0.001424	0.0017	0.0014	0.00164	0.001451

Table 4.3(b): Story drift in Y dir. For zone II

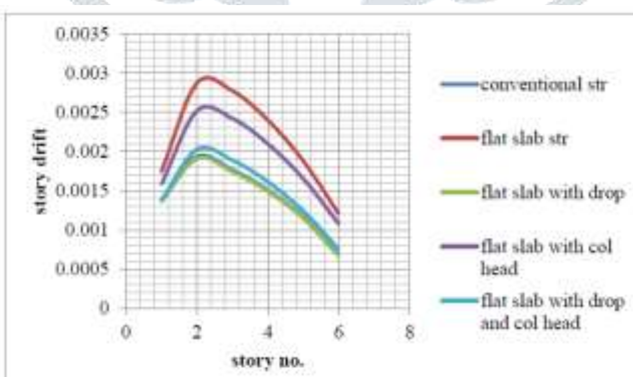

Figure 4.3(b): Story drift in Y dir. For zone II

4.4 Effect on torsional moment on bottom, z= 16m, on top for all diff zones

Bottom slab Torsion	Zone II	Zone III	Zone IV	Zone V
Convention structure	28.452	47.807	79.733	127.62
Flat slab	85.468	136.153	215.036	333.361
Flat slab with drop	37.057	66.383	108.428	170.84
Flat slab with column head	85.188	146.24	227.643	349.74
Flat slab with drop and column head	31.336	51.028	77.282	116.665

Table 4.4(a): Torsional moment on bottom

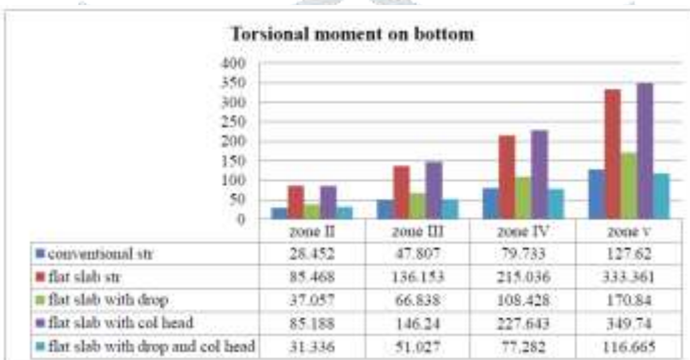

Figure 4.4(a): torsional moment at bottom

Z=16m Torsion	Zone II	Zone III	Zone IV	Zone V
Convention structure	24.531	36.849	55.274	83.954
Flat slab	81.819	108.909	173.283	269.845
Flat slab with drop	30.736	49.178	75.996	121.026
Flat slab with column head	70.142	119.456	186.618	287.36
Flat slab with drop and column head	20.063	36.547	56.048	85.299

Table 4.4(b): Torsional moment at Z=16m

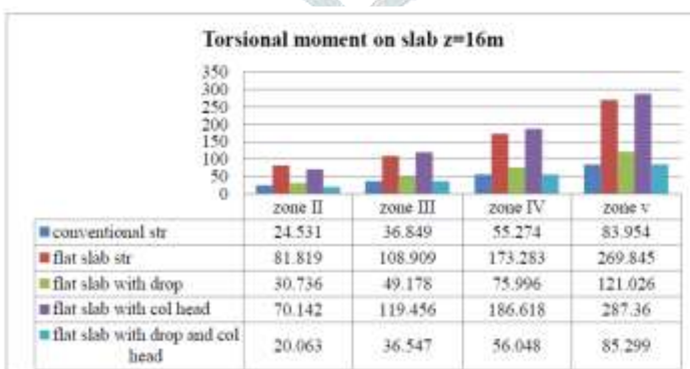

Figure 4.4(b): Torsional moment at z=16m

Top slab Torsion	Zone II	Zone III	Zone IV	Zone V
Convention structure	14.995	15.577	16.577	24.835
Flat slab	46.332	57.682	72.815	104.562
Flat slab with drop	15.345	17.627	20.688	30.082
Flat slab with column head	35.349	47.099	73.892	117.37
Flat slab with drop and column head	12.746	13.924	20.081	30.868

Table 4.4(c): Torsional moment on top

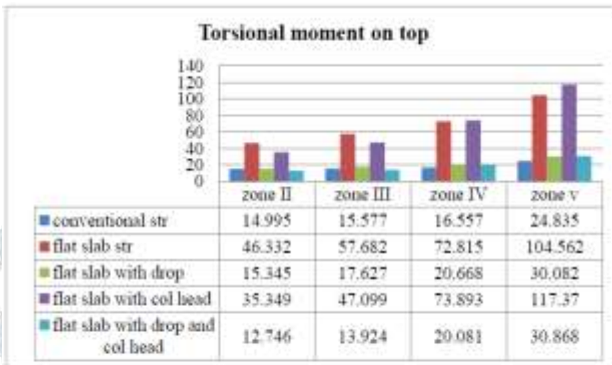

Figure 4.4(c): Torsional moment on top

Fig 4.4 On comparison between bottom, z=16m and at top, the value of torsional moment on bottom for all zones is more than z=16m and top. This result is because of gravitational load that shows torsional moment is more on bottom and as the zone factor increases the torsional shear increases.

V. CONCLUSION

- Base shear of beam slab building is less when compared with both flat slab with drop building and flat slab with drop and column head. This is same for all types of zones.
- The seismic level increases all parameters like displacement, base shear intensities.
- Story displacement at roof is maximum than at the base level and story displacement of flat slab without drop is more than conventional slab structure, there is some amount of average displacement variation in different zones for all the type of structure.
- For all the zones and cases, drift value followed a parabolic path along story height with maximum value lying somewhere near the middle story level.
- Story drift in buildings with flat slab without drop is significantly high as compared to beam slab building. This happens because of the rigidity of the beam slab structure.
- Therefore some additional moment is developed and as a result columns of such structure should be designed by considering additional moments.
- As the height of a structure increases torsional stress decreases.

REFERENCES

[1] Hal Amrick, Tao Xu, Michal Gendreau, Collin Gordon, Associates, San Bruno, California USA 2004. "The role of buildings and slabs-on-grade in the suppression of low amplitude ambient ground vibration",

[2] W.P.Graf and mehrdad mehrain 1992. "Analysis and a testing of a flat slab concrete building''.

[3] R. A. Apostolska, G. S. Neceska-vetanovska, J. P. Cvetanovska and N. Niracle 2008."Seismic performance of flat-slab building structural system",

[4] Abhishek Lakshman Dhangar, Prof. S. B. Walke 3 May 2015. "A comparative study of seismic response of flat Slab structure and conventional structure", IJLTET, Vol.5.

[5] Sanjay P N, Mahesh Prabhu K 5, May – 2014. "Behavior of flat bit of material Rcc structure under earth shock adding weight, amount IJERT, Vol.3.

[6] Sumit Pahwa, Madhavi Prajapati 2, July 2014. "Comparative study of flat lab with old traditional two way slab", IJLTET, Vol. 4.

[7] Prof. K S Sable.3, june 2012**"**By comparison learning process of seismic behavior of multistory flat bit of material and common made stronger common building material framed structure", IJCTEE Volume 2
.

[8] Kalyan Chowdary Kodali 1, Feb 2015"By comparison learning process of seismic operation of high go higher 30storey building with long support bit of material, flat bit of material and first one, then the other flat long support bit of material system band, part V", IJRET, Vol. 4.

[9] Nalini Thakre, Mahesh Janbandhu, Dipak Mangrulkar 3, March 2015 **"**Flat slab dynamic analysis", IJCAT, Vol. 2.

[10] R. P. Apostolska1, G. S. Necevska-Cvetanovska 2008 "Seismic performance of flat slab building structural system", WCEE
.

[11] Ravindra B N, Mallikarjun S. Bhandiwad 4,july 2015 **"**Dynamic analysis of soft storey building with flat slab", IRJET, Vol. 2.

[12] Amit A. Sathwane and R. S. Deotale "Analysis and design of flat slab and grid slab and their Cost Comparison" International Journal of Engineering Research and Applications. Vol. 1, Issue 3, pp.837-848.

[13] IS 456: 2000- Plain and reinforced concrete – code of practice?

[14] IS 1893 (part1): 2002- Criteria for earthquake resistant design of structures

[15] Textbook on Reinforced Concrete Structure by B.C. Punmia.

[16] Textbook on Limit State Design by A.K. Jain.

[17] K. Navyashree and T. S Sahana, 2014 "Use of flat slabs in multistorey commercial building situated in high seismic zone" ,International Journal of Research in Engineering and Technology , Volume 03, pp. 2321-7308.

[18] S. Ravi and Lekshmi Sreedevi, 2015 "Effect of shape and plan configuration on seismic response of structure (zone II and V)", International Journal of Science and Research (IJSR), Volume 05, pp. 2319-7064.