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ANALYSIS AND DESIGN OF MULTISTORY BUILDING WITH DIFFERENT SLAB ARRANGEMENTS USING ETABS

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Abstract - *In the prevailing era, earthquakes play a maximum probably position internal factor the evaluation and designing of systems. Therefore, it is far crucial to research the seismic conduct of buildings. In modern day creation, RC systems are normally used for creation. Here evaluation and layout of a Conventional Slab, Flat Slab and Waffle Slab is carried out using ETABS. The assessment is the technique of identifying the behavior of the form beneath heath unique load combinations. Design is the process, which requires the ideal specification of the form. Using software program application utility evaluation and layout device is carried out easily.*

This paper analyzes of multistory building with wonderful slab arrangements the use of etabs like as conventional slab, flat slab and waffle slab. We have modelled a 10 storey building in ETAB software program application. Total 12 Models have been prepared with wonderful shape of slabs in wonderful earthquake zone. The object of the prevailing artwork is to study the behavior of building in several seismic zones to study the Story Displacement, Story drift, and Shear force, for building thru the use of ETABS. Most premier prolonged span slab based completely on this study is Building with Waffle Slab.

***Key Words*: Slab Arrangement, Symmetric Asymmetric, Plain and Sloping Ground Seismic analysis, ETAB.**

1. INTRODUCTION

Due to the shortage of space, vertical creation has advanced in city areas, which include low-rise, medium-rise, and high-rise homes. These sorts of homes make use of body systems, which include conventional RC body systems or flat slab body systems. A traditional slab is used for the development that accomplishes a machine in which a beam helps the slab and the beam is supported via way of means of a column. This can be referred to as the Beam–Slab Load Transfer method; away this is not unusual place exercise everywhere in the world. The different shape of body shape is referred to as a "flat slab," in which the slab immediately rests at the column. This is likewise referred to as a beam without a slab, as there might be no beams on this body shape.

1.1 SLAB ARRANGEMENT

1. Flat slab

The flat slab is an R.C.C concrete slab supported directly via way of means of concrete columns or caps. A flat slab does now no longer have beams so it is also referred to as a beam-much less slab. They are supported on columns themselves. Loads are without delay transferred to columns.

There are four unique kinds of concrete Flat Slabs:

[1] Slab without drop and column without column head.

[2] Slab with drop and column without column head.

[3] Slab without drop and column with column head.

[4] Slab with drop and column with column head.

Fig -1: Flat Slab

2. Conventional Slab

The slab that is supported on Beams and columns is called a conventional slab. The thickness of the slab is small whereas the depth of the beam is large and load is transferred to beams and then to columns. It requires more formwork when compared with the flat slab.

Conventional Slab is classified into two types:

[1] One-Way Slab

[2] Two-Way Slab

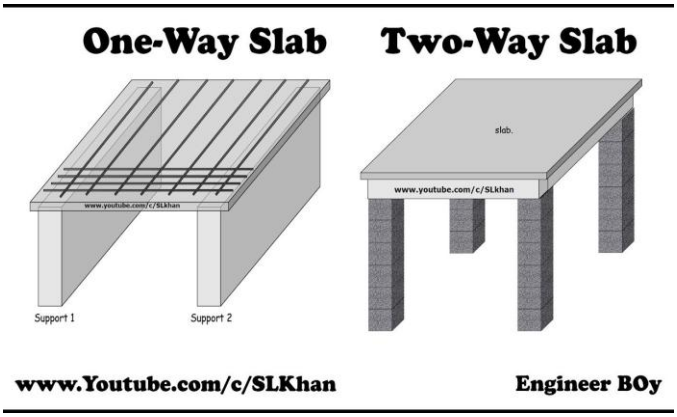

Fig -2: Conventional Slab

3. Waffle Slab

Waffle slab is a reinforced concrete roof or floor containing square grids with deep sides and it is called as grid slabs. This kind of slab is majorly used at the entrance of hotels, Malls, Restaurants for good pictorial view. It is usually used where large spans are required (e.g. auditorium, cinema halls) to avoid many columns interfering with space.

Fig -3: Waffle Slab

2. OBJECTIVE

1. The main objective of study is the analyze and design of a building with different slab arrangements like as , i.e., Conventional slab, Flat slab with drop panels and Grid/ Waffle slab.
2. To calculate the models for gravity loads and lateral loads Seismic and Wind with different load combinations as per Indian standards.
3. To calculate the design lateral forces for building by using ETABS.
4. To study the behavior of building in various seismic zones.
5. To study the Story Displacement, Story drift, Shear force, bending moment, Building Torsion for building by using ETABS.
6. Review of different slab results compare with different slab arrangements in a graphs and tables.

3. Literature Review

CH. Lokesh Nishanth, Y. Sai Swaroop, Durga Chaitanya Kumar Jagarapu, Pavan Kumar Jogi [1] The foremost functions of this paintings is to evaluation and layout a industrial constructing with specific slab preparations, i.e., Conventional slab, Flat slab with drop panels, Grid/ Waffle slab, and constructing with load bearing wall. An industrial constructing is one wherein at the least 50 percentage of its ground area is used for industrial activities. The impact of seismic and wind forces on homes with specific slab preparations were analyzed with the aid of using utilizing ETABS software program. ETABS is an engineering software program product, that's applied for evaluation and layout of structures. Analysis and layout are achieved as in keeping with IS 456-2000 codebook. M30 grade of concrete and Fe-500 metallic is followed. Load combos are taken as in keeping with IS 875-element five (2015) codebook. Live hundreds are taken as in keeping with IS 875-element 1. Wind velocity of fifty-five m/s and earthquake area five is followed for evaluation. Load combos of 1.2(DL + LL + EQ) and 1.five (DL + LL + WL) are considered.

After their research and analysis work, they conclude an overview on Storey displacement is maximum for Conventional slab and minimum for Load bearing wall type & increases with increase in storey height. Storey displacement for conventional slab is 92.6% more than the load-bearing wall Storey drift is maximum for conventional slab and minimum for Load bearing wall type. It is maximum at fourth storey of building. Base shear is minimum for Flat slab and maximum for Load bearing wall type in both the load combinations. Base shear for Load bearing wall type is 44.5% more than the flat slab type.

Latha M.S, Pratibha K [2] Grid slab includes ribs spaced at everyday c program language period in perpendicular directions, which might be monolithic with slab. These grid slabs are usually used for architectural motive for massive spans consisting of public meeting halls, display rooms, auditoriums, had been to keep away from inner columns with inside the shape. The rectangular voided sample is utilized in gift observe. In the existing, observe 12 tales shape of symmetric and uneven for every day, plan abnormal and vertical abnormal shape for each traditional slab and grid slab is considered. Conventional and grid slab shape as in keeping with IS code 1893:2002(Part 1). In addition, in comparison the consequences of traditional slab and grid slab for parameters of deflection, storey shear, displacement and storey stiffness.

After their research and analysis work, they conclude Deflection of slab of regular structure is maximum in conventional. In addition, in irregular structures grid slab is having maximum deflection. Story displacement is maximum in grid slab system and least in conventional slab for both regular & irregular structure. Story shear is maximum in conventional slab system and least in grid slab system for both regular & irregular structure. Finally concluded that, grid slab is better than conventional slab because grid slab is more economic than conventional slab.

P. Manjunath and Yogeendra R. Holebsgilu [3]

The homes are found in sloping floor are very specific from the ones in simple floor, in sloping floor the homes are very abnormal and unsymmetrical in horizontal and vertical planes. The homes in sloping floor reasons greater harm at some point of earthquake, due to the fact in sloping floor the shape is built with specific column heights. In this observe three-D analytical version of 10-storied constructing, the plan of every configuration consists of four bays in Y route and six bays in X route that is saved identical for all configurations of constructing frame, the slope selected in among zero to 30 degrees. The constructing is positioned on seismic quarter V, with specific soil type; the fashions are analyzed and designed with the aid of using ETABS 2015 software. Seismic evaluation executed with the aid of using linear dynamic evaluation (RSA).

After their research and analysis work, they conclude the slope of the base increases; it results in decrease in seismic weight. Base shear will be very less in sloping ground compared to that on level ground. Storey drift is more in on the plain ground compared to that on the sloping ground this is due to increase in fixity and reduces in number of stories. Effect of soil is more important on the earthquake performance of structure. The study also possesses that in static linear method and response spectrum analysis the performance of the building on sloping ground has more danger to earthquake than that of building present in plain ground.

Shivnarayan Malviya and Mr. Vipin Kumar Tiwari [4] Recent earthquakes wherein many concrete systems were significantly broken or collapsed, Have indicated the want for comparing the seismic adequacy of current homes. In order to Strengthen and face up to the homes for destiny earthquakes, a few techniques need to be adopted. The use of various form of slabs is evolving as a brand new fashion and is turning into a huge venture for Structural engineers. Therefore, it's far essential to examine approximately its structural conduct. This paper offers with the conduct of various form of slabs consisting of flat slab, waffle slab, ribbed Slab and slab with secondary beam. We have modelled a G+5 & G+9 storey constructing in ETAB Software having a plinth vicinity of 1600 m2. The reaction spectrum evaluation has been completed for the seismic, area III. It has been determined that for big span slabs the shape having secondary beams need to be prevented for higher seismic performance.

After their research and analysis work, they conclude Building having secondary beams structure shows highest value of maximum storey displacement. The lowest value of storey Building having waffle slab with respect to others cases of models.

Navyashree K, Sahana T.S [5] The shortage of area in city regions has caused the improvement of vertical growth including low-upward thrust, medium-upward thrust and tall homes. Generally, framed systems are used for those homes. They are subjected to each vertical and lateral hundreds. Lateral hundreds because of wind and earthquake governs the layout in place of the vertical hundreds. The homes designed for vertical load won't have the capability to face up to the lateral hundreds. Pure inflexible body device or body movement acquired via way of means of the interplay of slabs, beam and column isn't adequate. The body by myself fails to offer the desired lateral stiffness for homes taller than 15 to 20 (50m to 60m) stories.

After their research and analysis work, they conclude The moment is maximum at plinth, first and second level. After second level. Base shear of flat plate building is less than the conventional R.C.C building. The difference between the two varies from 8- 13percentage.The earthquake forces are more predominant than others load.

4. RESEARCH GAP

Literature survey is carried out to get more information for the methods of analysis for structure.

From the literature review, we can conclude that

The analysis and design a building with different slab arrangements will be more accurate results get and comparison with Conventional slab, Flat slab and Waffle slab will be more specified.

Which slab arrangement required less amount of steel quantity with same loads.

The structure can be compared with post-tensioned slab designed methods.

Slabs construction system is one in which the beams used in the study is limited to response spectrum analysis.

Use of recycled materials in concrete to form different slabs and analysis on the software.

5. METHODOLOGY:-

1. Compare with different slab arrangements like as, i.e., Conventional slab, Flat slab with drop panels and Waffle slab.
2. To calculate the models for gravity loads and lateral loads (Seismic) different load combinations as per Indian standards.
3. To calculate the design lateral forces for building by using ETABS.
4. To study the behavior of building in various seismic zones.
5. To study the Story Displacement, Story drift, Shear force, for building by using ETABS.
6. Review of different slab results compare with different slab arrangements in a graphs and tables.

6. DETAILS OF THE MODELS

In the present study, one building configurations are considered, which include buildings situated on plain ground. Plan layout of each configuration includes four bays across the X direction and six bays are considered along Y direction, which is kept same for all configurations of building frame with Conventional slab, Flat slab with drop panels and Waffle slab.

Table -1: General Data

DESCRIPTION		DATA
Dimension of plan	: -	18x25m
Number of Stories	: -	10
Floor Height	: -	3
Grade of Concrete (Beam)	: -	M25
Grade of Concrete (Column)	: -	M25
Grade of Concrete (Slab)	: -	M20
Grade of Steel (Beam & Column)	: -	Fe 500
Grade of Steel (Slab)	: -	Fe 500, Fe 415
Importance factors, I	: -	1.5
Response reduction factor	: -	5
Live load on floors	: -	2
Floor finish	: -	1.5

Table -2: Case 1 - Modal Data

Building having Two Way Slab	
Beam dimension	300 mm x 600 mm
Column dimension	600 mm x 600 mm
Slab thickness	125mm
Drop panel thickness	Nil

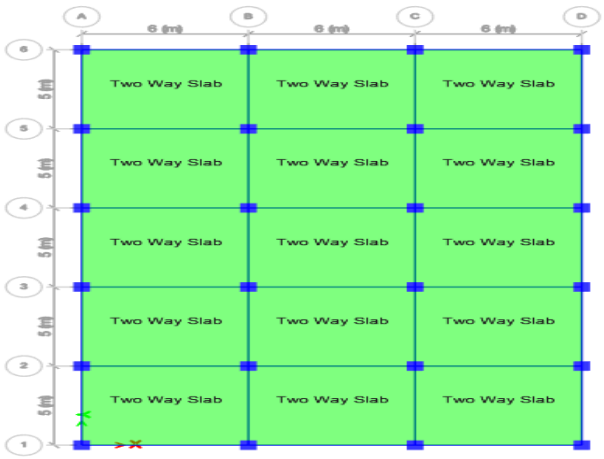

Fig -4: Plan View of One way Slab

Table -3: Case 2 - Modal Data

Building having One Way Slab	
Beam dimension	300 mm x 600 mm
Column dimension	600 mm x 600 mm
Slab thickness	125mm
Drop panel thickness	Nil

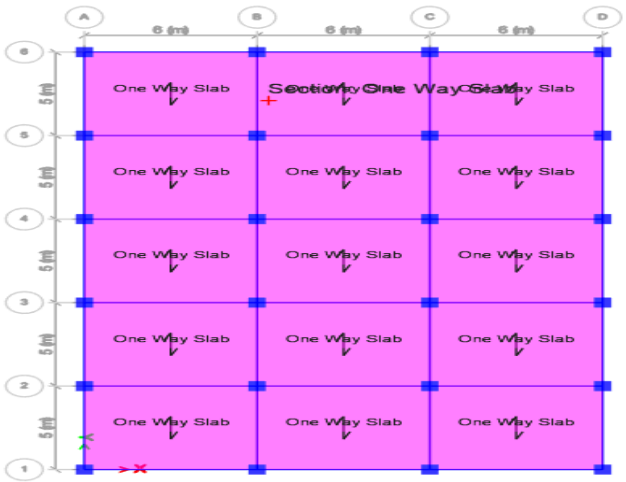

Fig -5: Plan View of Two way Slab

Table -4: Case 3 - Modal Data

Building having Flat Slab with Drop Panels	
Beam dimension	Nil
Column dimension	600 mm x 600 mm
Slab thickness	200mm
Drop panel thickness	400mm

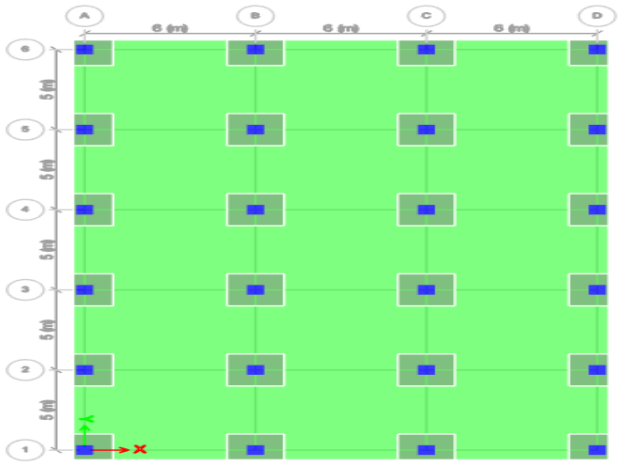

Fig -6: Plan View of Flat Slab

Table -5: Case 4 - Modal Data

Building having Waffle Slab	
Beam dimension	Nil
Column dimension	600 mm x 600 mm
Slab thickness	75mm
Drop panel thickness	450mm

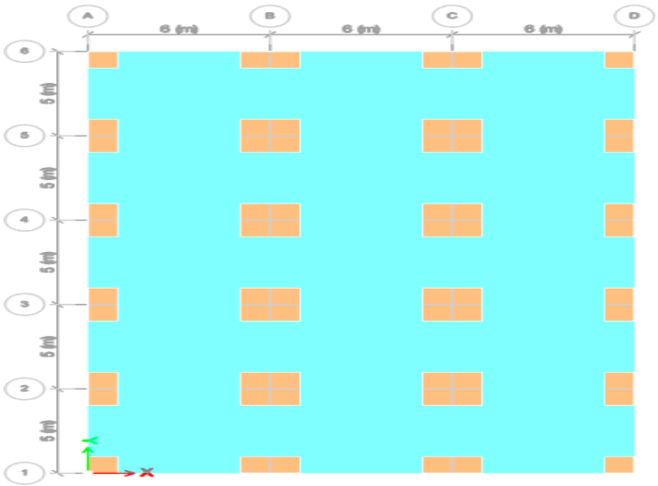

Fig -7: Plan View of Waffle Slab

7. Result:-

The results are seismic, story displacement; storey drift and concrete quantity are compared for all the four cases of the building. Moreover, load combination for all cases considered as 1.2(DL+LL+EQx/EQz).

Table -6: Maximum Story Displacement of Various Slab

Building having Flat Slab with Drop Panels				
Story	**One Way Slab**	**Two Way Slab**	**Waffle Slab**	**Flat slab**
Story10	53.92	53.875	55.407	65.682
Story9	51.908	51.889	53.344	63.157
Story8	48.707	48.7	50.043	59.216
Story7	44.403	44.398	45.613	53.93
Story6	39.201	39.197	40.281	47.532
Story5	33.316	33.313	34.27	40.279
Story4	26.944	26.942	27.778	32.407
Story3	20.257	20.255	20.978	24.14
Story2	13.421	13.418	14.026	15.715
Story1	6.679	6.667	7.103	7.536
Base	0	0	0	0

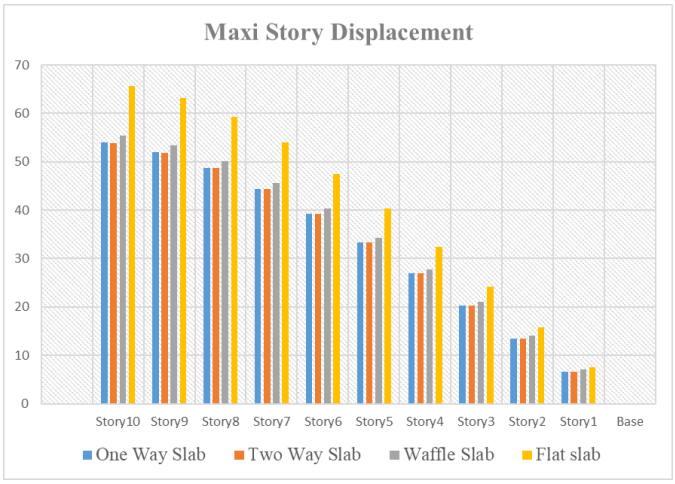

Chart -1: Graph of Maximum Story Displacement of various slab

Table -7: Maximum Story Drift in Various Slab

Building having Flat Slab with Drop Panels				
Story	**One Way Slab**	**Two Way Slab**	**Waffle Slab**	**Flat slab**
Story10	0.000679	0.000662	0.000688	0.000852
Story9	0.001068	0.001063	0.0011	0.001315
Story8	0.001435	0.001434	0.001477	0.001763
Story7	0.001734	0.001734	0.001777	0.002133
Story6	0.001962	0.001961	0.002004	0.002418
Story5	0.002124	0.002124	0.002164	0.002624
Story4	0.002229	0.002229	0.002267	0.002756
Story3	0.00228	0.002279	0.002317	0.002808
Story2	0.002258	0.00225	0.002308	0.002727
Story1	0.00167	0.001667	0.001776	0.001884
Base	0	0	0	0

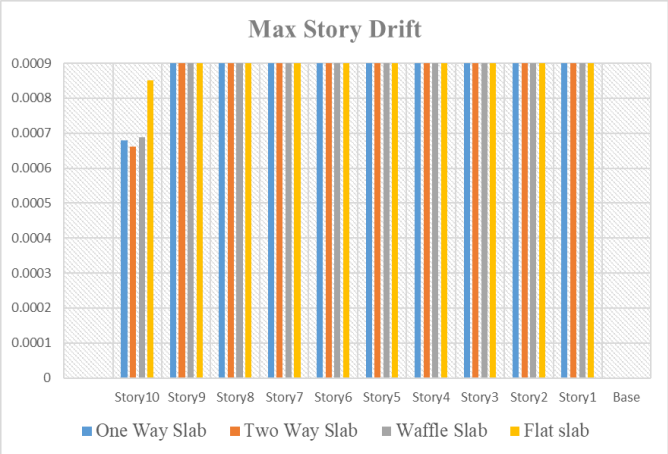

Chart -2: Graph of Maximum Story Drift of various slab

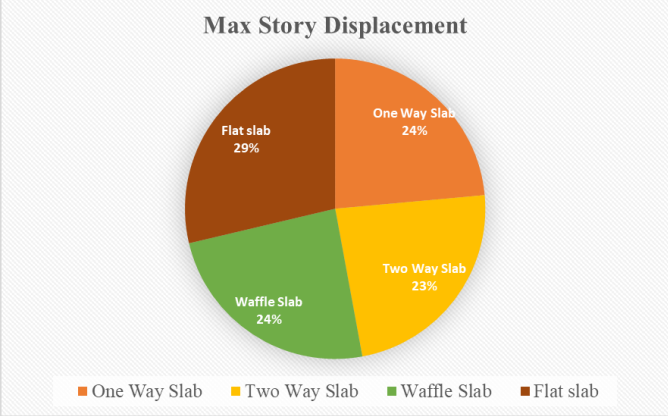

Chart -3: Percentage of Maximum Story Displacement of Various Slab

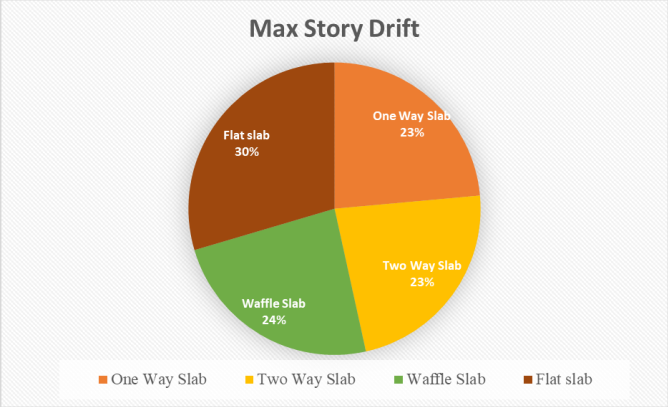

Chart -4: Percentage of Maximum Story Drift of Various Slab

Table -8: Total Quantity of Concrete for different slab

Types Of Slab	
ONE WAY	1187
TWO WAY	1187
FLAT SLAB	1588
WAFFLE SLAB	1384

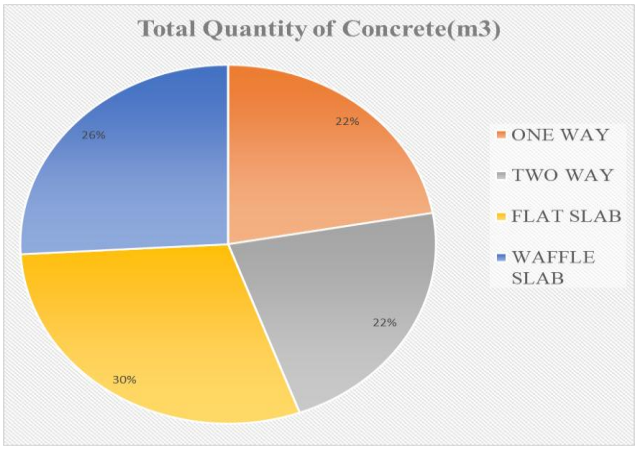

Chart -5: Graph of Total Quantity of Concrete in different slab

8. CONCLUSIONS

The following conclusions are obtained from the analysis and Results.

- Flat slab having greater story displacement and story drift while in comparison with the different slab.
- Flat slab constructions, on the other hand, increase the aesthetic perspective while allowing the

architect enormous flexibility of formwork, ease of placement of flexural reinforcement, ease of casting concrete, open space for water, and pipes, and the reduction of building height in multi-story structures by saving one story height. This makes the Flat slab more economical as compared to the conventional.

- Whereas the Conventional slab is more suitable for Residential and small span structures.
- Waffle Slab is more suitable for bigger span structures like big malls, halls, and auditoriums for the better elegant view of building.
- For the same span/grid size, the amount of concrete required for a Waffle slab multi-storey building is minimum and for a flat slab multi-story building is maximum.
- As per results, whenever increasing zone type story displacement and story drift increasing. So that, the study also posses that increasing earthquake zone has more danger to building for collapse.
- Storey displacement for Flat slab is 20% more than conventional slab.
- Storey drift for Flat slab is 23% more than conventional slab.

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