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Comparative Study and Behavior of Seismic Performance of Conventional Slab, Flat Slab and Grid Slab for Seismic Zone IV and V

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Abstract – *Urbanization is rapidly increasing nowadays therefore effect of earthquake also play an important role to analysis and design of structure. The principal purpose of this work is to analyses and design of G+10 commercial building for seismic zone IV & V with different slab arrangements, i.e., Conventional slab, Flat slab with drop panels, Grid/ Waffle slab. There are several parameters which affect the performance of structure from which storey drift, base shear and storey displacement play a crucial role in finding the behavior of structure against the seismic loads. An evaluation of this seismic parameter has been analysis by ETAB 2016 software. The analysis and design are done by the IS 456:2000 and IS 1893:2016 by using the M30 grade of concrete and FE 500 grade of steel.*

***Key Words*: Conventional slab, Flat slab, Grid slab, storey displacement, storey shear, base shear, storey drift, storey stiffness etc**

1.INTRODUCTION

The earthquake may additionally harm the structural factors such as slab, beam, column. The sort of slab type i.e., Convectional slab, flat slab and grid slab also play a crucial role in the seismic parameters of multi-storey building. Building with Conventional slab is the slab resting on regular beam and columns. In conventional slab, load transfers of the slab on columns, the columns to the beams and from beams to foundation. Flat slab is a concrete slab that is supported at once by columns without usage of beams. Flat slab with drop panel is stronger than the flat slab without drop panel. Flat slab is easy to construct and requires less scaffolding work. Grid/ Waffle/ Two-way ribbed slab is the reinforced concrete slab which consists of beams in two directions. Grid slab is widely used for industrial and commercial buildings. It is used for that place where column spacing is more and can be constructed rapidly as compared with conventional slab. Seismic load is the important factor for collapse of many high-rise structures. Seismic zone plays a significant role in the design of building structures for earthquake resistant. Base Shear, Storey displacement, Storey drift, and Lateral forces acting on a structure plays a vital role in checking the building's stability against seismic load. Design seismic load at each floor height is termed as storey shear. Summation of storey shear is base shear. Storey displacement is overall displacement of the storey. Storey drift is depicted as ratio of displacement of two successive floors to altitude of that floor. It is very important to determine the Storey drift for earthquake analysis of buildings.

2. Literature Survey

The following are the literatures are referred for the present work-

Swaroop and Jogi [1] have compared the behaviour of convectional slab, flat slab, grid slab and building with load bearing wall for earthquake and the wind load for load combination of 1.2(DL + LL + EQ) and 1.5(DL + LL + WL) is taken. There are several parameters which affect the stability of structure out of which storey drift, base shear and storey displacement play a important role in finding the behaviour of structure against the wind and seismic loads. They have examined that store y displacement, base shear, storey drift, concrete quantity and wind load capacity for different type of slab. Load bearing wall is safe against wind and earthquake loads. But, considering cost as a crucial factor Grid slab is economical and safer when compared with other building slab arrangements.

Alraie and Manoranjan [2] explained that grid slab is a type of floor system consisting of beams running in both directions. It is commonly used for architectural reasons in large halls such as auditoriums, restaurants, theatres and other halls where column-free space is required. In this literature studding about this type of slabs. Some international codes i.e., the Syrian code gives the value for response reduction factor for this type of slab, but only for simply supported slab. These values are not valid for the case where continuity exists. Hence this paper attempts the study about effect of continuity on the reduction factors of bending moments and shear forces of grid beams, and obtain the reduction factors for various cases of continuity.

Lago, Salem and Pravia [3] investigating the dynamic characteristics of slabs, meeting economic needs and architectural requirement, have been built lighter with longer open spans, and became useful for the phenomena of vibration. Therefore, considering the important parameters of vibration at time of the design of structure, i.e., natural frequencies and damping, reduce the vibrations problems in the future.

Sen and Singh [4] they explained the behaviour of flat slab buildings designed as per existing code, under the earthquake loading. Buildings is designed as per the Indian code, ACI code, Eurocode and New Zealand code. Nonlinear static analysis method is used for the calculate the performance of these buildings with and without considering the continuity of slab and bottom reinforcement through column cages.

Jain and Khan [5] In Present work highlight about study of comparative analysis of flat slab system and wide beam system in reinforced concrete buildings. The comparison is done by considering conventional moment resisting frame. The main purpose of this study is to analyse three different type of model in two different RCC building – G+3 and G+9. The models are analysed for gravity load and seismic load. The building models are analysed for gravity load with and without consideration of seismic load. The gravity load analysis gives results of this models without consideration of earthquake. The result is analysed by SAP2000 software.

Beth and Bai [6] an explained the seismic damage of reinforced concrete (RC) frame structure of 1980s construction in the Central United States. The results of the un-retrofitted structure are represented in terms of fragility structure that is relate the probability of increasing a performance level for the earthquake intensity. seismic fragility relationships were more developed for the retrofitted structure based on retrofitted techniques and several performance levels.

Torabian and Isufito [7] In this present work study about the thin reinforced concrete (RC) slabs under concentrated loads as well as to find out the application of Critical Shear Crack Theory (CSCT) for this slab. For this study, four square 100-mm-thick slabs is cast for the concentrated punching monotonic loading. The experimental parameters such as the flexural reinforcement ratio, 0.38% and 1.00%, and the presence or absence of shear headed study's reinforcement.

Sandiford and Moresi [8] To find out the relationship between intra slab seismicity and the dynamics of subduction is very important. Uncertainty surrounds the extent to which the stress regime associated with slab earthquakes reflects the driving/resisting forces of subduction, or more localized processes such as metamorphic or thermo-elastic volume change, and the relative contribution of uniform (stretching/shortening) and flexural (bending/buckling) deformation modes in slabs.

Sridevi and Shivaraj [9] Design of a building is very much important for seismic performance of buildings. The important parameters that affect seismic performance of a building are overall geometry and structural system. This parameter is change for the performances of building in flat slab and conventional slab. In the present Work, G + 6 multi-storey RC-frame structure is considered for the analysis. Storey height of building is 3.2 m considered. To study the dynamic characteristics of RC frame structure with conventional slab system and flat slab system, two models have been prepared in ETABS software and result is analyse by response spectrum method.

Raju and Shereef [10] the performnce of the structure during seismic and wind loads has play important role not only structure point of view, but also safety of humans living in the structure. It is major challenge to study the impact and performance of tall structures under seismic and wind loading. In this paper the response of tall building under wind and seismic load as per IS code of practice is studied. Seismic analysis with response spectrum method and wind load analysis with gust factor method are used for analysis of a G+40 storey building.

3. Proposed Work

3.1 Objective

1. To analyze the comparative study between the conventional slab, flat slab and grid slab.

2. To perform the analysis and design of slab for seismic resistant structure.

3. Design the structure for the various seismic zones (IV & V) and analysis of convectional slab, flat slab and grid slab.

4. To find the effectiveness and strength of convectional slab, flat slab and grid slab for various seismic zones (IV & V)

5. To find out the seismic characteristics of structure like storey drift, storey shear, base shear.

3.2 Methodology

1. Prepare the software model on ETABs of G+10 RCC symmetrical building.
2. Analysis and design of building for convectional slab, flat slab and grid slab
3. Analysis and design of building for convectional slab, flat slab and grid slab for seismic zones IV and V using Etabs.
4. Compare the results analytically by using Etabs.

3.3 Modelling

1. Plane RCC building
2. RCC building with conventional slab zone -IV
3. RCC building with flat slab zone -IV
4. RCC building with grid slab zone -IV
5. RCC building with conventional slab zone -V
6. RCC building with flat slab zone -V
7. RCC building with grid slab zone -V

Table 1: Structural Dimensions

Parameter	Conventional slab	Flat slab	Grid slab
No of	G+10	G+10	G+10

storey			
Plan Dimension	30m X 20m	30m X 20m	30m X 20m
Beam Dimension	230mm X 230mm	230mm X 230mm	230mm X 230mm
Column Dimensions	450mm X 600mm	450mm X 600mm	450mm X 600mm
Slab Thickness	150mm	150mm	150mm
Drop Panels Thickness	Nil	100mm	100mm

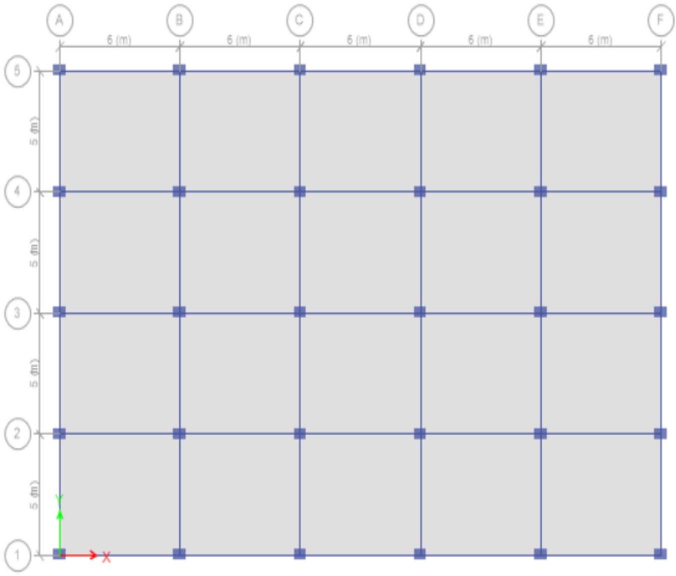

Fig 1: Plan of RCC building With Convectional Slab

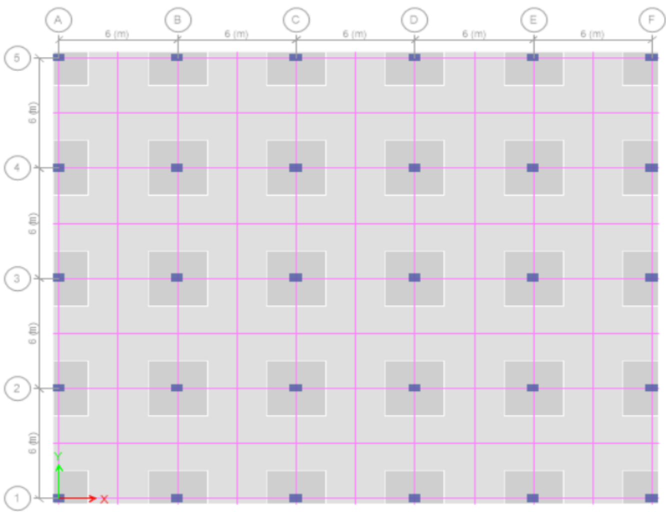

Fig 2: Plan of Rcc Building With Flat Slab

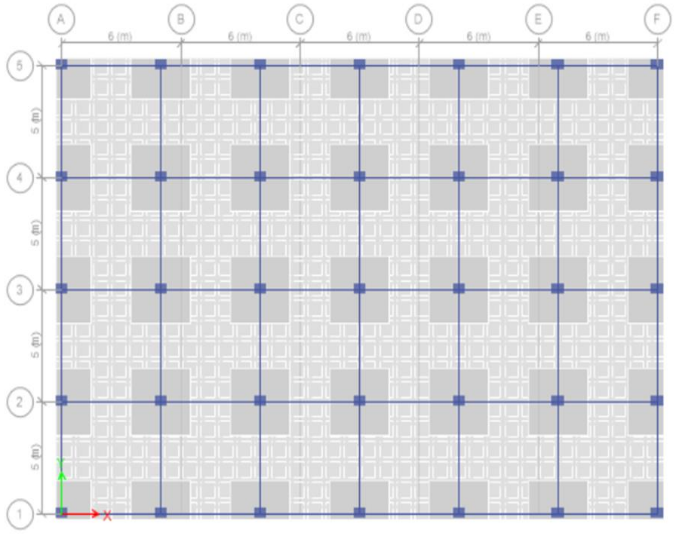

Fig 3: Plan of RCC building with Grid Slab

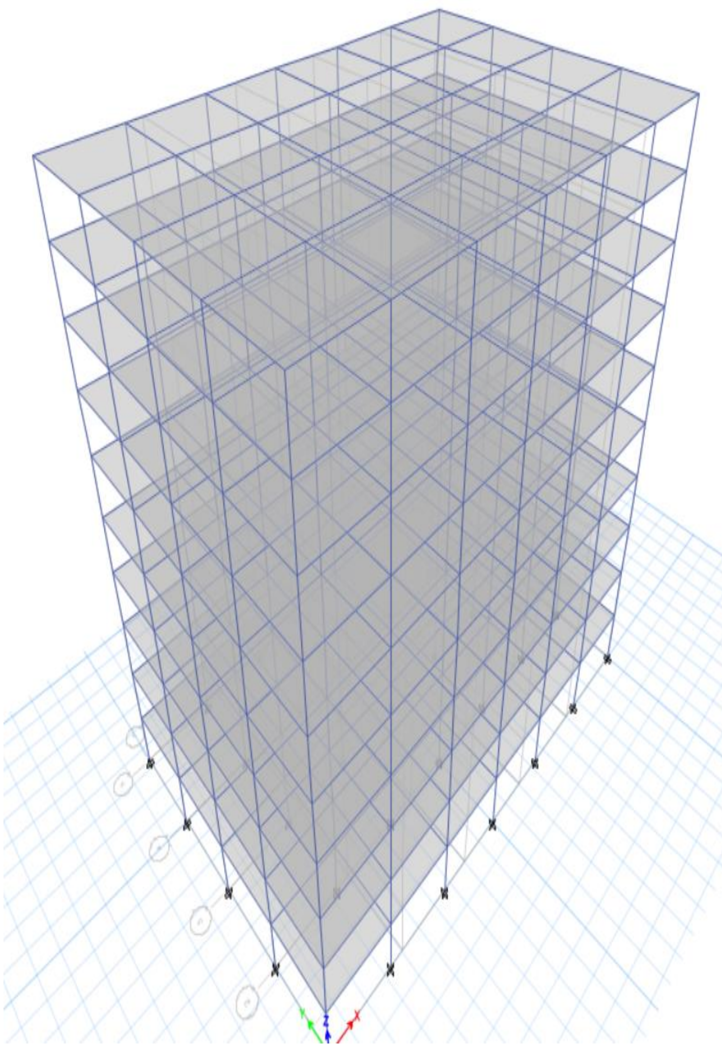

Fig 4: Elevation of RCC building with convectional slab

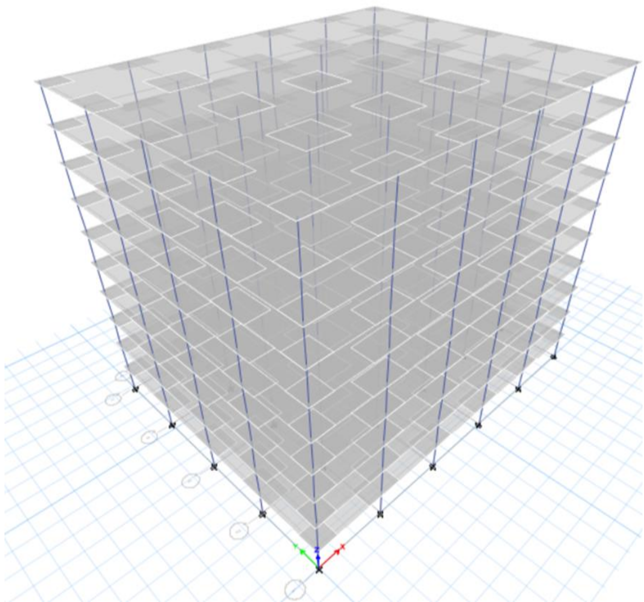

Fig 5: Elevation of RCC building with Flat slab

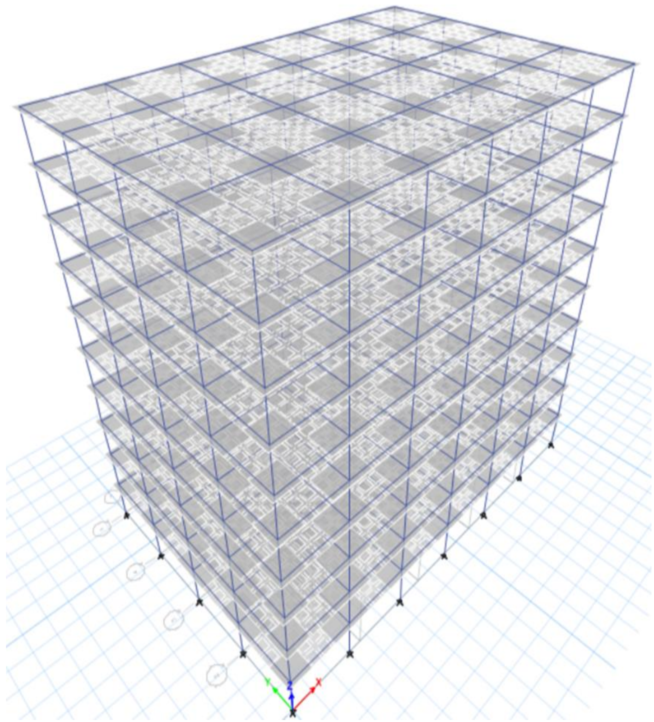

Fig 6: Elevation of RCC building with Grid slab

3.4 Load Calculations

Dead Load: Self wight of beams, column. slabs, drops
Live load: 4Kn/m²(As per the IS 875 Part 1)
Floor Finish Load: 1Kn/m²
Seismic Loads (IS 1893:2016)
Seismic Zones Z= 0.24 and 0.36
Response reduction Factor R=5
Importance Factor I= 1
Silt Type=2

4. Results

4.1 Storey Displacement

Storey displacement is the lateral displacement of the story with respect to the base. The lateral force-resisting system can limit the excessive lateral displacement of the building.

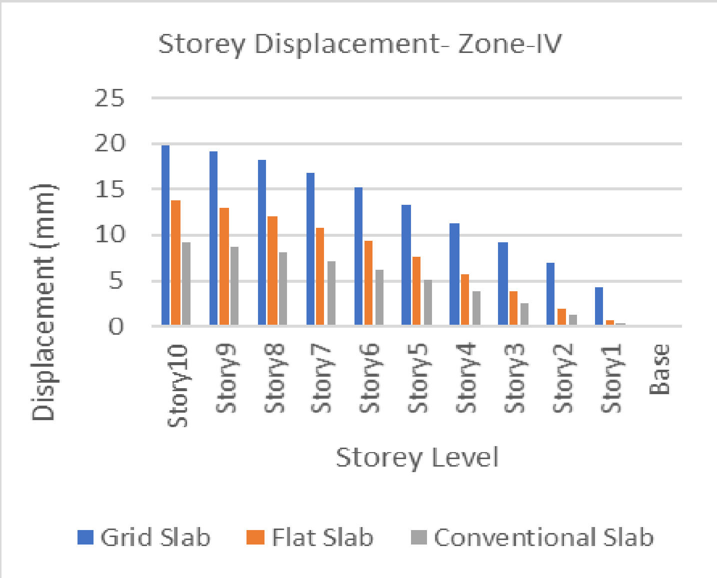

Chart 1: Maximum storey displacement for zone -IV

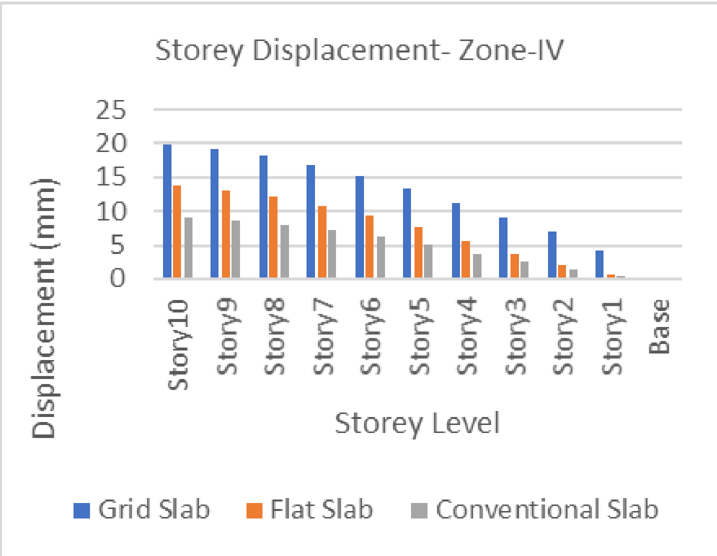

Chart 2: Maximum Storey displacement for Zone V

4.2 Storey Shear and base shear

Story shear is the graph showing how much lateral load, be it wind or seismic, is acting per story. The lower you go, the greater the shear become. Storey shear is the sum of the

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design lateral forces at all levels above the storey under consideration.

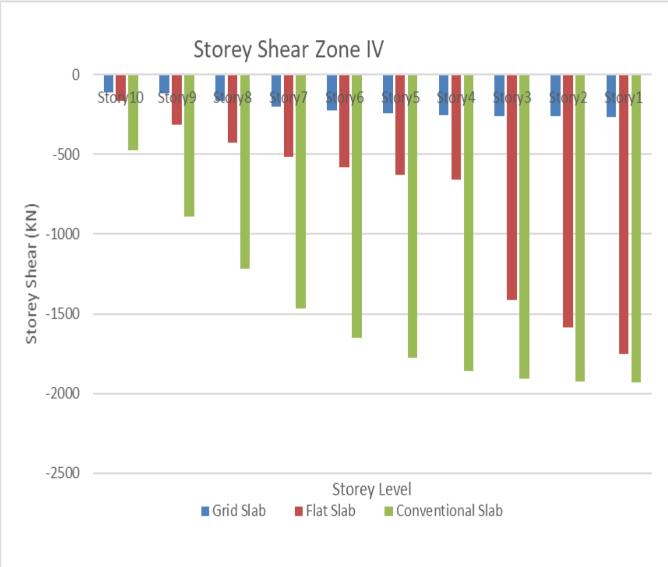

Chart 3 : Maximum Storey Shear for Zone IV

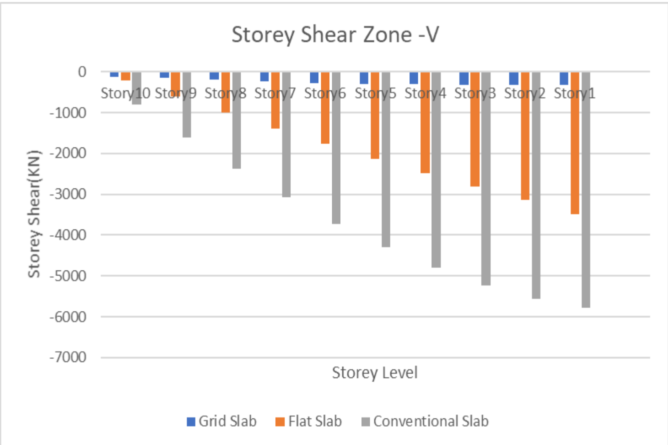

Chart 4 : Maximum Stroey Shear for Zone V

Chart 5 : Base shear for Zone IV and V

4.3 Storey drift

Storey drift is the lateral displacement of one storey level with respect to the level above or below. Storey drift ratio the story drift divided by the story height.

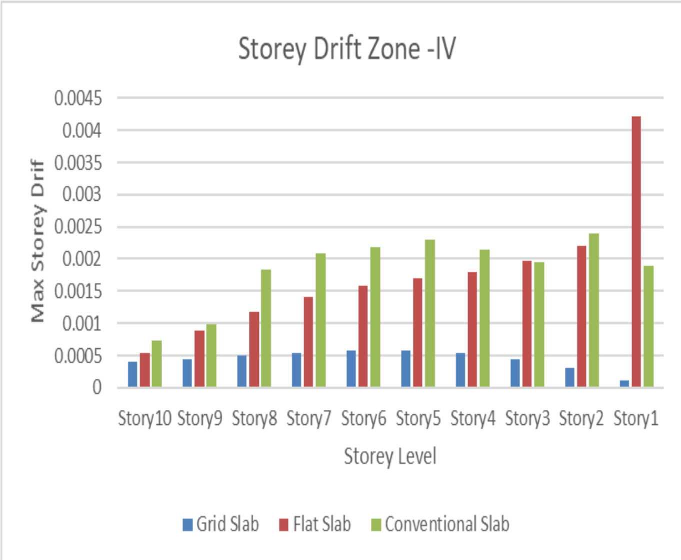

Chart 5: Maximum storey drift for Zone IV

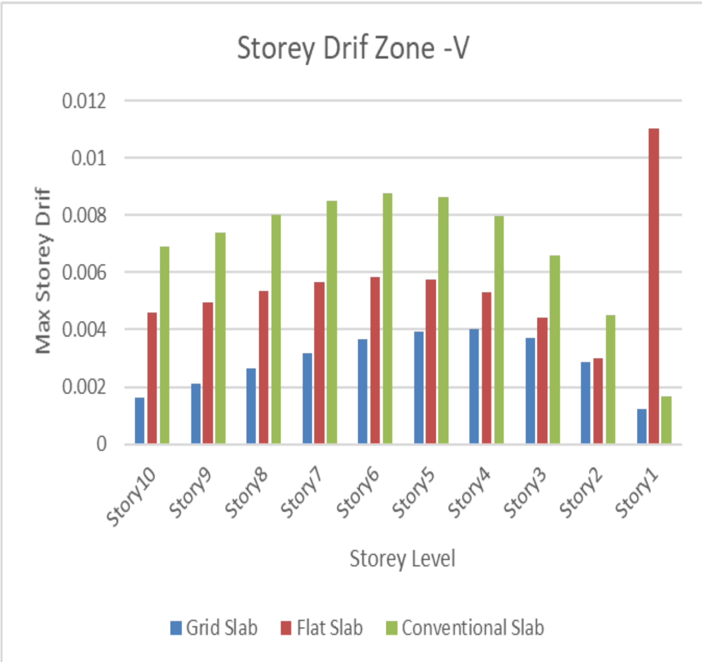

Chart 6: Maximum storey drift for Zone V

4.4 Storey Stiffness

storey stiffness is estimated as the lateral force producing unit translational lateral deformation in that storey, with the bottom of the storey restrained from moving laterally, i.e., only translational motion of the bottom of the storey is restrained while it is free to rotate.

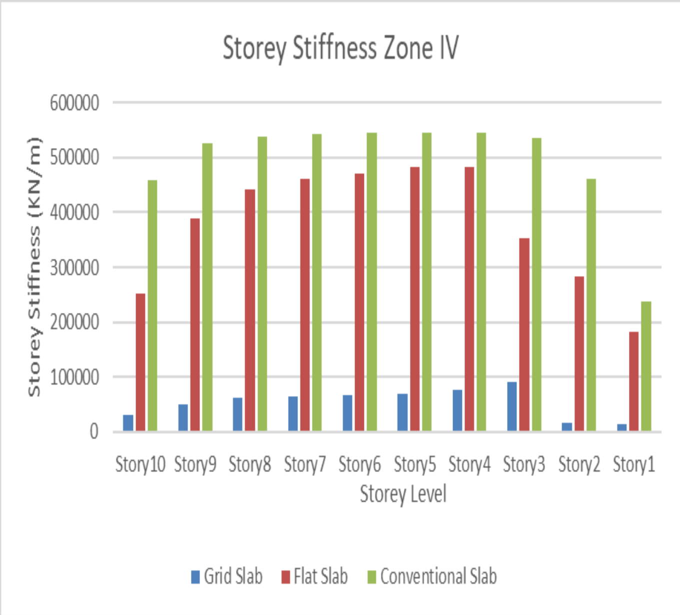

Chart 7: Maximum storey Stiffness for Zone IV

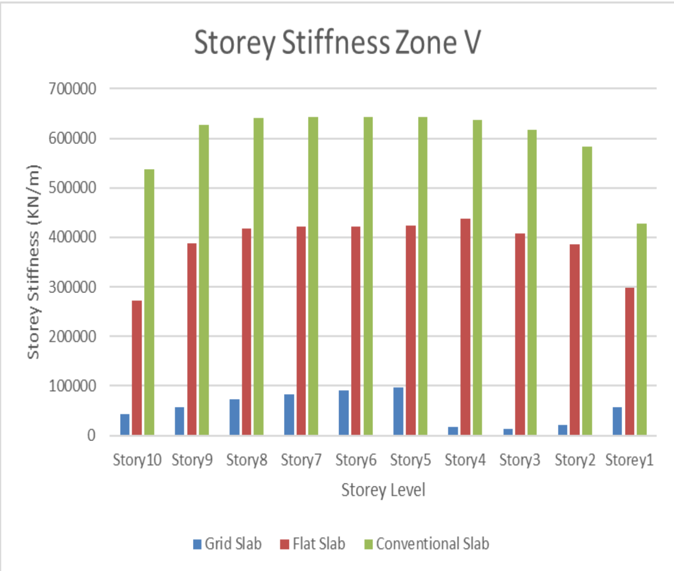

Chart 8: Maximum storey Stiffness for Zone V

5. CONCLUSIONS

1. storey displacement for grid slab is 90% more than the conventional slab. Storey displacement for grid slab is 70% more than the flat slab. Grid slab storey displacement is 30% maximum than the flat slab and 90% maximum than conventional slab.
2. The storey shear for the conventional slab is 6.6% is more than the value of grid slab for seismic zone IV and V. storey shear for flat slab is 0.67% more than the grid slab. The storey shear for conventional slab is 5.94% more than the flat slab.
3. Base shear is 1.3% minimum for the building design with the grid slab than the building design flat slab. The value of base shear for building design with the conventional slab 22.89% more than the building design with the flat slab.
4. Storey drift is maximum for the conventional slab and it is maximum for the storey 5. Flat slab has maximum displacement than grid slab. Grid slab have minimum displacement than the flat slab and conventional slab. storey drift for conventional slab and is 53.93% and 29.87% more than the grid slab
5. stiffness is minimum for the grid slab than flat slab and conventional slab. Building design with the conventional slab has 49.55% more than grid slab. Flat slab has 23.06% more than grid slab.

It is concluded that building design with grid slab is economical and safer when compared with other building slab arrangements. This increases the flexibility of the structure and increase the safety of the structure against earthquake.

5.1 Future Scope of work

1. Present work is comparison for conventional slab, flat slab and grid slab for seismic zones IV and V. This method can be studied for the building with large span.
2. This study is used for curved bridges, long span bridges, building design for the large utility of space.

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