IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 22, Issue 4 Ser. II (July - August 2025), PP 29-42
www.iosrjournals.org

Performance Study On Seismic Analysis Of Conventional Slab, Flat Slab And Grid Slab System For R.C Framed Structures In Etabs

Shri. Shreehari R. Gudi, Prof. Sameer Chitnis
(Dep.Civil Engineering, Sdm Colege Of Engineering And Technology, Dharwad-580002, / Vtu Belgaum, India)

Abstract:
This study presents in recent years, seismic safety has become a critical design consideration in the construction of multi-storey reinforced concrete (R.C) structures.
Background: The type of slab system adopted plays a significant role in influencing the structural behavior under seismic loads, especially in terms of stiffness, mass distribution, and load transfer mechanisms. This study focuses on a detailed seismic performance analysis of three distinct slab systems—conventional slab (beam-slab system), flat slab, and grid slab (waffle slab)—commonly used in R.C framed buildings.
The primary objective is to analyze how different slab configurations affect key seismic response parameters such as storey displacement, storey drift, base shear, and Time period. For this purpose, a set of building models with identical plan geometry, number of storeys, and loading conditions were developed using ETABS, a widely used structural analysis and design software. The models were designed in compliance with IS 456:2000 for structural detailing and IS 1893 (Part 1): 2016 for seismic loading.
A Response Spectrum Method was adopted for seismic analysis, with the buildings assumed to be located in a high seismic Zone V, resting on medium soil conditions. Each model was carefully evaluated to understand the influence of slab type on the lateral load-resisting behavior of the structure.
Results of the study reveal that:
Conventional slabs, which include beams and slabs, offer higher lateral stiffness and better resistance to seismic loads. They show lower values of storey drift and displacement due to the effective beam-column frame action.
Flat slabs, characterized by the absence of beams, provide architectural advantages such as flexible planning and reduced floor heights. However, they exhibit greater lateral displacement and longer natural periods, making them more flexible and less efficient in resisting seismic forces unless supplemented with lateral load-resisting elements like shear walls.
Grid slabs provide high structural efficiency due to their ribbed configuration, distributing loads more evenly and increasing torsional rigidity. These systems demonstrated intermediate performance, showing better results than flat slabs but slightly less stiffness compared to conventional slabs, while being complex in construction and detailing.
The analysis also highlighted that base shear is significantly influenced by the slab system, with conventional slabs attracting the highest base shear due to their higher stiffness, while flat slabs showed reduced base shear but with higher drift.
In conclusion, the study provides valuable insights into the seismic performance of different slab systems. While conventional slabs are structurally more reliable under seismic loading, flat slabs require additional design measures to enhance lateral load resistance. Grid slabs, though effective, demand intricate design and are best suited for buildings requiring both structural strength and architectural flexibility.
This research contributes to improved decision-making in slab system selection during the preliminary design stages of seismic-resistant R.C buildings, especially in earthquake-prone regions.

Date of Submission: 07-08-2025 Date of Acceptance: 17-08-2025

I. Introduction

Shelter is a very important in the basic need of the human being since the early civilization. Varieties of structural forms are constructed for the purpose of better living.

In structural engineering, the slab systems plays a vital role in distributing loads and enhancing structural performance. The increasing need for taller and more complex buildings has made it essential to understand that how the different slab configurations respond to dynamic loading like earthquakes.

Research are been carried out to make the building comfortable, safe and economical. Presently, there is an increase in requirement of construction of tall structures at urban areas to accommodate the population which is growing exponentially. Problem faced by the designers in the vertical growth of the cities is efficiently handling the seismic forces which are haphazard in nature & unpredictable. Hence, earthquake modeling is to be done carefully. Because the Seismic forces cause different vibrations at a different areas and the damage caused is also a different. Factors like intensity of vibration, duration etc, are very important to understand the effect of seismic force. Hence, it is important to know the earthquake behavior of structure such as lateral displacements, story drift, storey shear and Time period.

To determine the seismic response of structure, seismic analysis is done using various methods i.e. Response Spectrum Method and Time History method. Failure of structure occurs at the point where it is week during earthquake. Earthquake appears due to the Geotechnical aspect of the Earth bed, it is unpredictable, if it occurs in populated areas, it causes heavy loss to both life and properties. Many a times damage caused by the earth quake is enormous.

In this study the focus is on the performance of flat slab RCC structure with all types of slabs with perimeter beams which engage its actions to earthquake situation with column. As it is very much obvious from earlier literature so as to the slab arrangement is not stable in seismic force, so we are going to analytically investigate the outcome of slab normally with concrete encased and in different earthquake zones. The method considering for the analysis are Response spectrum analysis method, linear static analysis method as per the Indian Standard codal provisions and by using ETABS software.

II. System Of Resisting Lateral Loads

Lateral loads, especially from earthquakes and wind, induce horizontal forces on structures. These forces must be efficiently resisted and transferred to the foundation to prevent structural damage or collapse. The slab type influences the effectiveness of the Lateral Load Resisting System (LLRS) because it contributes to overall structural stiffness and mass distribution.

The lateral load resisting system in your ETABS models is primarily the moment-resisting frame.

The type of slab system directly influences the stiffness, mass, and diaphragm action, which in turn affects seismic performance indicators like base shear, time period, and drift.

Grid slabs show the best performance due to their inherent structural stiffness.

Flat slabs may require supplemental systems like shear walls or drop panels to compensate for lateral resistance deficiency.

Types of Slabs:

CONVENTIONAL SLAB:

A conventional slab refers to a cast-in-situ reinforced concrete slab that is supported by beams and columns. This is the most traditional and widely used method of constructing floors and roofs in buildings.

It is typically part of a beam-slab-column system, where the slab transfers loads to the supporting beams, which then carry the loads to the columns and eventually to the foundation.

FLAT SLAB:

A Flat Slab is a reinforced concrete slab that rests directly on columns, without the use of beams. The slab transfers loads directly to the columns, and the underside (soffit) of the slab is flat—making it easier to construct and more aesthetically pleasing.

GRID SLAB:

A grid slab, also known as a waffle slab, is a reinforced concrete slab system consisting of a thin slab cast monolithically over a grid of intersecting beams (ribs), spaced at regular intervals in two directions. This creates a grid-like or waffle-shaped pattern when viewed from below.

It is used where large spans and heavy loads are required, offering strength with reduced weight.

Fig. 1.1 FLAT SLAB

Fig. 1.2 GRID SLAB

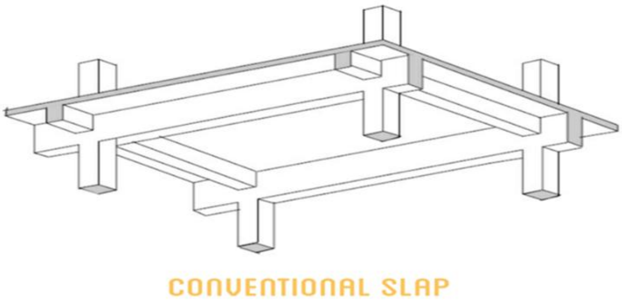


Fig. 1.3 CONVENTIONAL SLAB

III. Literature Survey

The seismic behavior of reinforced concrete (R.C.) structures is significantly influenced by the type of slab system employed. Different slab systems—Conventional Slab, Flat Slab, and Grid Slab—alter the stiffness, mass distribution, and dynamic characteristics of buildings, impacting their response to lateral loads. This literature survey highlights key findings from previous research related to the seismic performance of these slab systems, specifically focusing on studies that utilize analytical tools such as ETABS and STAAD.Pro.

Kareem & Raikar (2018)
Title: Seismic Performance of RC Building with Flat Slab and Beam-Slab Systems
Source: International Journal of Engineering Research & Technology (IJERT)

Kareem and Raikar conducted a comparative study of R.C. buildings using flat slabs and conventional beam-slab systems under seismic loading. Their analysis revealed that buildings with flat slabs exhibited higher displacements and fundamental time periods, indicating lower stiffness and greater flexibility. Although flat slabs reduced the overall seismic weight and base shear, they were found to be less efficient in resisting lateral loads. The study recommended the use of shear walls when adopting flat slabs in seismic zones.

Jadhav & Patil (2016)
Title: Comparative Study of Multistorey RC Framed Structures with Flat Slab and Conventional Slab Systems
Source: International Research Journal of Engineering and Technology (IRJET)

This study analyzed a G+10 R.C. framed structure in ETABS with two slab configurations. Results showed that conventional slab systems had lower storey drift and displacement due to better frame action provided by beams. Flat slab systems, while reducing floor height and construction material, were found to be less stable under lateral loads. The authors concluded that while flat slabs offer architectural advantages, they may not be suitable for high seismic zones without additional strengthening measures.

Khadke & Kulkarni (2015)
Title: Analysis of Grid Slab System for Multistorey Building Using STAAD.Pro
Source: International Journal of Civil Engineering and Technology (IJCIET)

Khadke and Kulkarni examined the structural behavior of grid (waffle) slabs under seismic and gravity loading. Their research highlighted that grid slabs reduce dead load and improve lateral load distribution due to their ribbed structure. The grid slab system demonstrated better stiffness-to-weight ratio and lower storey drift compared to solid slab systems, making them suitable for medium to high seismic zones.

IS 1893 (Part 1):2016
Title: Criteria for Earthquake Resistant Design of Structures
Issued by: Bureau of Indian Standards (BIS)

This standard outlines guidelines for the seismic analysis of buildings in India. It emphasizes the importance of considering building regularity, mass distribution, and lateral stiffness in design. It also recommends using dynamic analysis methods, such as Response Spectrum Analysis, for medium to high-rise buildings. This standard is essential for evaluating the performance of different slab systems under seismic loading in compliance with national codes.

Pattar & Rathi (2017)
Title: Comparative Study of Grid Slab, Flat Slab and Solid Slab in Multistorey RC Buildings
Source: International Journal of Engineering Sciences and Research Technology

This research compared grid, flat, and solid slabs in terms of seismic performance, weight, and material usage. Grid slabs showed a significant reduction in dead load and provided adequate stiffness for seismic resistance. Flat slabs, while faster and cheaper to construct, were found to be vulnerable under lateral forces. The authors recommended grid slabs for long-span and seismic-prone constructions.

Khalid et al. (2020)
Title: Dynamic Analysis of RC Building with Different Floor Slab Configurations
Source: International Journal of Structural Engineering and Technology (IJSET)

Khalid and co-authors modeled a G+12 building in ETABS with three slab types: flat slab, solid slab, and waffle (grid) slab. Their findings revealed that flat slabs had the highest displacement and lowest base shear, confirming their flexible behavior. Waffle slabs offered a balance between rigidity and reduced mass, while solid slabs were the most rigid but also the heaviest. The study concluded that slab configuration has a direct influence on seismic performance.

Outcome of Literature Review

In conclusion, the outcome of the literature review clearly shows that conventional slab systems are structurally superior in seismic performance, flat slabs offer economic and architectural advantages but require caution in seismic design, and grid slabs present a balanced option with promising seismic behavior. This study is intended to fill the existing research gap by conducting a comparative seismic analysis of all three slab systems using ETABS, based on uniform loading, geometry, and design criteria as per IS codes. The goal is to provide practical insights for engineers and designers to choose the most appropriate slab system depending on seismic zone classification, building functionality, and performance requirements.

Objectives

The primary objective of this study is to evaluate and study the seismic performance of reinforced concrete (R.C.) framed structures incorporating three different slab systems—Conventional Slab, Flat Slab, and Grid (Waffle) Slab—using the structural analysis software ETABS, in compliance with IS 1893 (Part 1):2016 and IS 456:2000.

The specific objectives are as follows:
- To model R.C. framed structures with Conventional Slab, Flat Slab, and Grid Slab systems using ETABS under identical geometry, loading, and boundary conditions.
- To perform seismic analysis of each structural model using the Response Spectrum Method as per the Indian Standard Code IS 1893 (Part 1):2016.
- To compare the dynamic behavior of the three slab systems based on critical seismic response parameters, such as:
  - Natural time period
  - Base shear
  - Storey drift
  - Storey displacement
  - Lateral stiffness
- To evaluate the influence of slab type on the seismic performance of buildings in various seismic zones and assess their suitability based on structural safety and performance criteria.
- To identify the most effective slab system in terms of both structural performance and practicality for use in earthquake-prone regions.
- To provide design recommendations for selecting appropriate slab systems in R.C. framed structures based on the outcomes of seismic analysis.

IV. Methodology

A plan of commercial building is considered which is an asymmetric. A 10-storey building of dimension 42m in X direction and 30m, in Y direction (7bays in X direction and 5 bays in Y direction) having each storey height 3m is taken into account for the investigation.

Model 1: Model represents G+10 building with Flat Slab.
Model 2: Model represents G+10 building with Conventional Slab.
Model 3: Model represents G+10 building with Grid Slab.

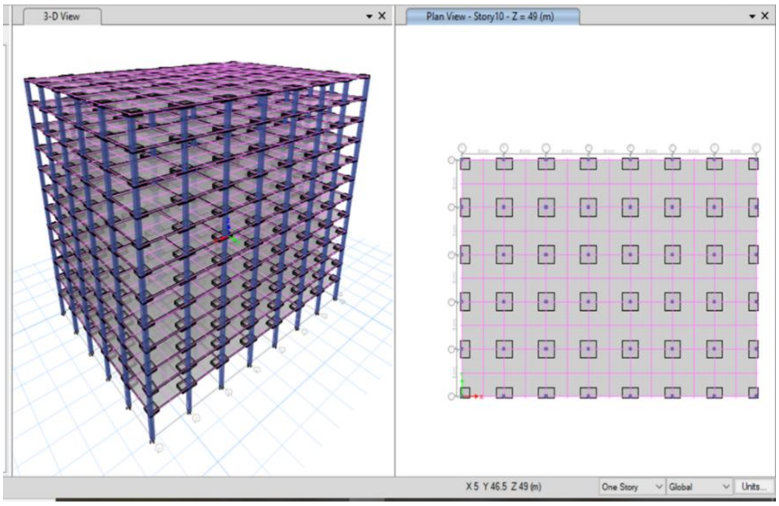


Fig. Model 1: Model represents G+10 building with Flat Slab .

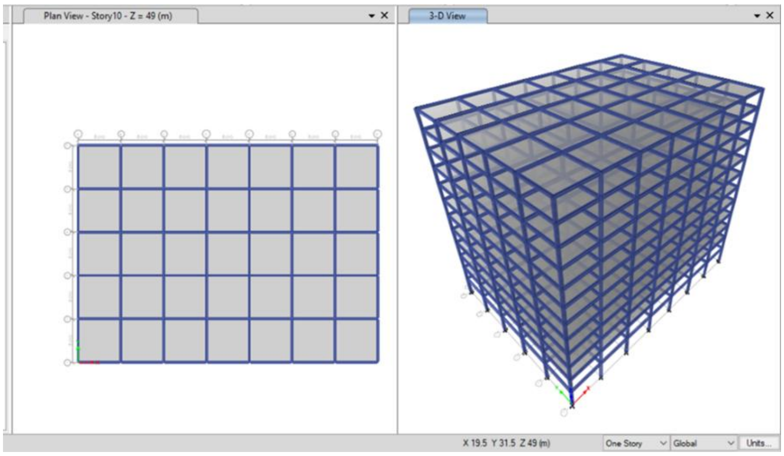


Fig. Model 2: represents G+10 building with Conventional Slab

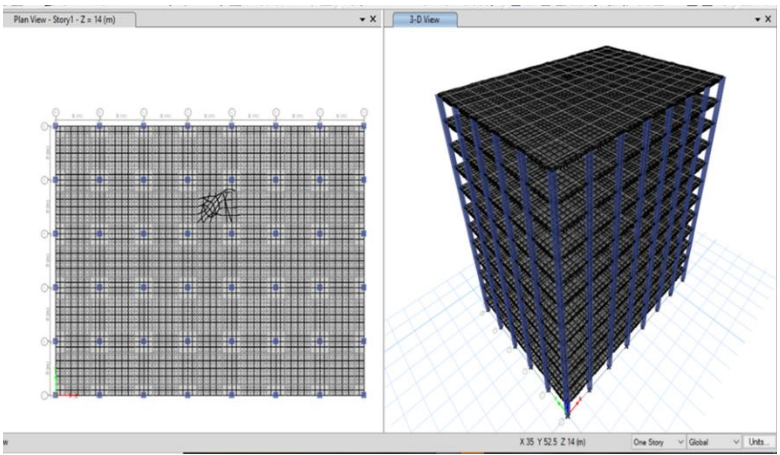


Fig. Model 3: represents G+10 building with Grid Slab

V. Modeling Of Multistoried Building (G+10) In ETABS

The Modeling a G+10 (Ground + 10 floors) multistoried reinforced concrete building in ETABS involves a structured sequence of steps, beginning with setting up the grid and story data to reflect the architectural and structural layout. The user starts by launching ETABS and creating a new model, where units such as kN-m are selected. A regular grid is created by specifying the number of bays along both X and Y directions and the spacing between them, according to the building plan. The total number of stories is set to 11, including the ground floor, with a typical floor height of around 3.0 meters and possibly a taller plinth or ground floor at 3.5 meters.

Using plan and 3D views, the structural elements are modeled by drawing columns, connecting them with beams, and adding floor slabs at each level. If required, shear walls or core walls are added to resist lateral forces. The base of the structure is assigned fixed supports to simulate foundation conditions. Load patterns are then defined for dead load, live load, seismic load (EQX, EQY), and wind load (WX, WY), following relevant Indian standards such as IS 875 for loading and IS 1893:2016 for seismic forces. Load assignments include live loads on slabs and lateral loads on diaphragms or frames. Load combinations are generated automatically in ETABS as per IS 456:2000, ensuring that all critical design scenarios are covered.

After defining the geometry and loads, a model check is performed to detect any errors, followed by structural analysis. The software calculates internal forces, moments, shear, displacements, base shear, and story drifts. These results are reviewed against code-prescribed limits—for example, checking that story drift does not exceed 0.004 times the story height. Once the behavior is verified, the design module in ETABS is used to design concrete elements as per IS 456. ETABS provides reinforcement detailing and capacity checks for beams and columns. The final step includes extracting results in tabular or graphical format and generating reports. If necessary, the model can be exported to other tools such as SAFE for foundation design. Through this systematic process, ETABS provides a powerful platform for the efficient and accurate modeling, analysis, and design of G+10 multistoried RC buildings.

Material properties of building

Grade of Concrete: M25
Grade od Steel: Fe500
Modulus of Elasticity of Concrete, Ec : 29580.4 MPa
Modulus of Elasticity of steel, Es: 200000 MPa
Density of Reinforced Concrete : 25 kN/m3
Density of Brick Masonry: 20 kN/m3

Material properties of building

Size of Building : 42m X 30m
Number of storeys :10
Storey Height :3 m
Column Size :350mm X 550 mm
Beam size :300mm X 450mm
Footing size :2.6m X 2.6m, 2m X 2m
Slab Thickness :150mm
Wall Thickness :230mm

Loads

Dead Load
Floor Finish= 1.5 kN/m2
Live load on Roof and Floor= 3 kN/m2
External wall load= 14 kN/m
Parapet wall load= 3 kN/m

Seismic Load (As per IS 1893 (part-1)2016)

Seismic Zone=V
Zone Factor Z= 0.36
Importance Factor= 1
Response Reduction Factor R= 5
Soil Type= III and II

Wind Load (As per IS 875 part 3)

Wind Speed, Vb= 33 m/sec

Terrain Category= 4
Structure Class= B
Risk Coefficient, k1= 1
Topography, k3= 1

Load Combinations

In the seismic performance analysis of reinforced concrete (R.C.) framed structures using different slab systems—namely conventional slab, flat slab, and grid slab—appropriate load combinations play a vital role in accurately assessing structural behavior under various loading scenarios. The load combinations used in this study are formulated based on the guidelines provided in IS 456:2000 for structural design and IS 1893 (Part 1): 2016 for seismic analysis.

The basic load cases considered in the analysis include Dead Load (DL), Live Load (LL), and Earthquake Loads in both the X (EQX) and Y (EQY) directions, with positive and negative directions taken into account to capture the worst-case seismic response. These loads were applied consistently across all three slab systems to maintain a uniform basis for comparison.

The load combinations that we have used in our study are, From IS 456:2000 table 18 and from IS 1893:2016 Clause 6.3.2.2

Seismic Analysis

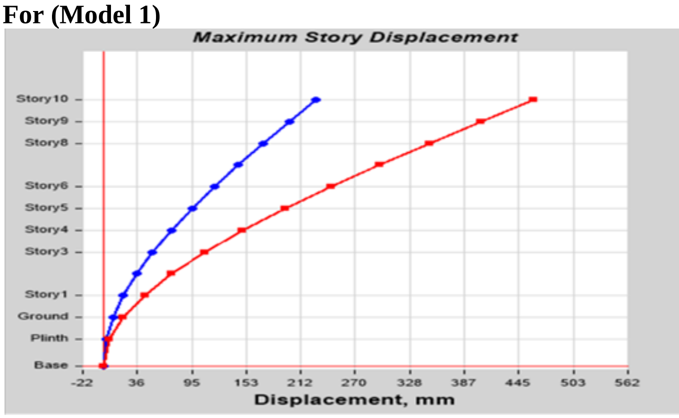
Seismic analysis of the building

Seismic analysis of the proposed R.C. framed building was carried out using ETABS software in accordance with IS 1893 (Part 1):2016. Three structural models were developed one each for the conventional slab with beams, flat slab, and grid (waffle) slab system with identical plan configurations and material properties to ensure uniformity in comparison. The seismic forces were applied as per the Response Spectrum Method, considering a medium soil type (Type II) and seismic zone III/IV, depending on the selected location. The analysis involved the application of dead loads, live loads, and lateral earthquake loads in both X and Y directions. The importance factor, response reduction factor, and damping ratio were assigned based on the building usage and structural system as per code provisions. Modal analysis was conducted to determine the natural frequencies and mode shapes of each model. The seismic performance was assessed by comparing key parameters such as base shear, storey displacement, storey drift, fundamental time period, and torsional irregularities. Special attention was given to how each slab system influenced the overall stiffness, mass distribution, and dynamic behavior of the building under lateral seismic excitations.

VI. Results And Discussions

This section presents the comparative analysis of three slab systems — Conventional Slab (Model A), Flat Slab (Model B), and Grid Slab (Model C) — in a reinforced concrete (R.C.) framed structure, using ETABS. The models were analyzed under seismic loading conditions (Response Spectrum Method as per IS 1893:2016). The performance was evaluated based on the following parameters:

1.**Story Displacements For (Model 1)**



Storey Displacement: In a reinforced concrete (R.C.) framed structure, storey displacement refers to the lateral movement of each storey relative to the base of the structure when subjected to lateral forces such as those induced by earthquakes.

In the case of a flat slab system, where slabs rest directly on columns without the presence of deep beams, the overall lateral stiffness of the structure is significantly reduced compared to conventional beam-slab systems.

This reduction in stiffness leads to larger lateral displacements under seismic loading. The displacement is crucial in structural engineering because excessive movement can lead to damage or structural failure. To manage storey displacement, engineers design buildings with specific materials, structural systems.

Storey displacements have been analyzed for various buildings, These displacements indicate how much each storey shifts under applied loads or environmental conditions, providing valuable information on the structural behavior and integrity of the buildings.

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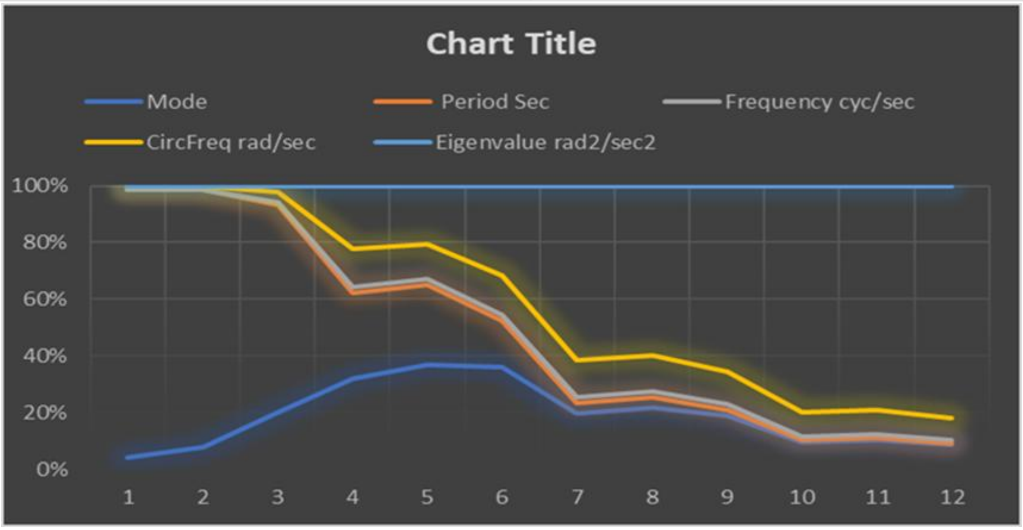
2. Time Period

Mode	Period Sec	Frequency cyc/sec	CircFreq rad/sec	Eigenvalue rad2/sec2
1	23.577	0.042	0.2665	0.071
2	23.577	0.042	0.2665	0.071
3	10.933	0.091	0.5747	0.3303
4	3.761	0.266	1.6707	2.7912
5	3.761	0.266	1.6707	2.7912
6	2.734	0.366	2.2978	5.2797
7	1.343	0.745	4.679	21.893
8	1.343	0.745	4.679	21.8935
9	1.12	0.893	5.6121	31.4958
10	0.685	1.459	9.1672	84.0382
11	0.685	1.459	9.1676	84.0455
12	0.593	1.686	10.5939	112.2316



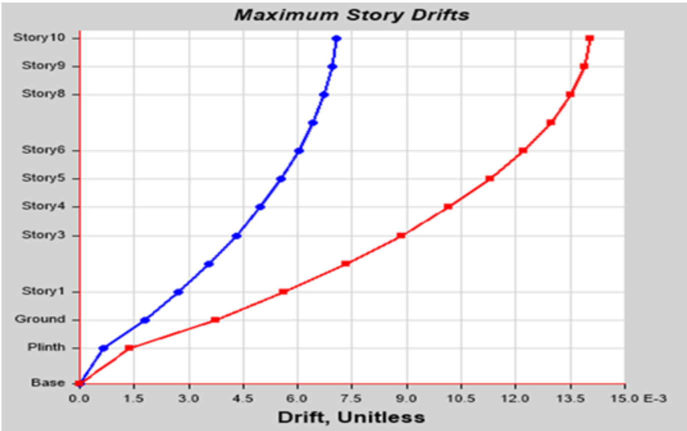
3. Story Drift

Storey drift is defined as the relative lateral storeys of a structure during lateral loading, such as during an earthquake.

It is a crucial parameter in seismic design as it directly correlates to the building's deformation and the potential for damage to both structural and non-structural components. In a flat slab system, where the slab directly rests on columns without the use of beams, the lateral stiffness of the structure is significantly reduced compared to conventional beam-slab systems. This reduced stiffness leads to increased flexibility, resulting in higher storey drifts under seismic excitation.

In the ETABS seismic analysis of the RC framed structure using a flat slab system, it was observed that the storey drift values were relatively higher compared to those in conventional slab-beam systems. This is attributed to the lack of beams in flat slab construction, which significantly reduces the lateral stiffness of the structure. The building exhibited increasing drift values up to the mid-height, after which the drift started decreasing towards the top, forming a parabolic distribution typical in earthquake response. The maximum storey drift occurred between the 8th and 9th floors, reaching approximately 14 mm, which slightly exceeds the permissible limit of 12 mm as per IS 1893 (Part 1): 2016, considering a typical storey height of 3.0 meters. This indicates that the flat slab system, in its basic form, may not fully satisfy seismic drift requirements in mid to high-rise buildings without additional stiffness-enhancing elements. The results suggest that while flat slab systems offer structural efficiency and architectural flexibility, they require supplementary measures such as shear walls, drop panels, or edge beams to control drift and meet seismic safety standards.

4. Base Shear



Base shear is the total lateral force at the base of a structure due to seismic activity. It represents the summation of all lateral inertial forces acting on the structure's mass during an earthquake and is a key parameter in seismic design. In a flat slab system, the base shear is influenced primarily by the seismic weight of the structure and the dynamic characteristics, such as the fundamental time period.

1. Story Displacements For (Model 2)

Storey displacement is the lateral movement of a particular floor level with respect to the building's base due to lateral seismic forces. In a conventional slab system, the slab is supported by beams, which in turn are connected to columns.

This configuration forms a moment-resisting frame that provides significant lateral stiffness to the structure. Compared to flat slab systems, conventional slab-beam systems are stiffer due to the presence of deep beams, which enhance the structure's ability to resist lateral loads.

Reduced displacement improves the serviceability and performance of the structure during and after an earthquake, and also helps keep storey drift within permissible limits.

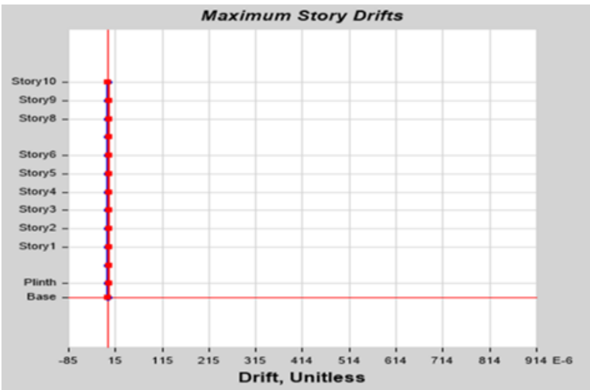
2. Time Period

Mode	Period Sec	Frequency cyc/sec	CircFreq rad/sec	Eigenvalue rad2/sec2
1	2.985	0.335	2.1049	4.4307
2	2.807	0.356	2.2381	5.0091
3	2.638	0.379	2.3822	5.6747
4	0.98	1.02	6.4101	41.0893
5	0.92	1.087	6.8276	46.6159
6	0.867	1.153	7.2474	52.5251
7	0.57	1.753	11.0148	121.3261
8	0.534	1.872	11.7628	138.3634
9	0.506	1.976	12.4135	154.0949
10	0.394	2.538	15.9444	254.2231
11	0.367	2.725	17.1203	293.1062
12	0.349	2.862	17.981	323.3161

The fundamental time period of a structure is the time it takes to complete one full cycle of vibration in its first natural mode. It is a key dynamic property that determines how the structure will respond to seismic forces.

In a conventional slab system, the structural frame comprises beams and columns, which provide significant lateral stiffness. This increased stiffness results in a shorter time period compared to flat slab systems of the same height and mass.

3. Story Drift

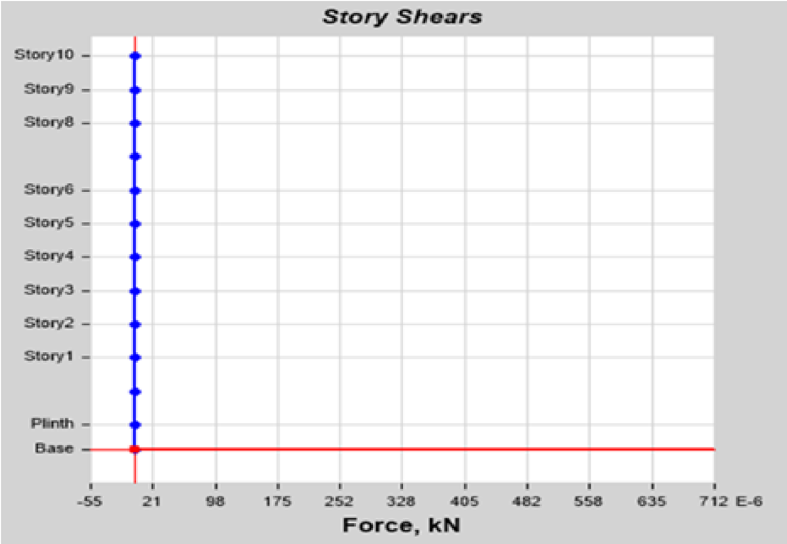


Storey drift is defined as the relative lateral displacement between the top and bottom of a storey during seismic motion.

It is a critical measure of a building's deformation under lateral loads and directly impacts the structural and non-structural integrity of the structure.

In a conventional slab system, the presence of beams integrated with slabs and columns forms a moment-resisting frame, which significantly enhances the lateral stiffness of the structure.

4. Base Shear

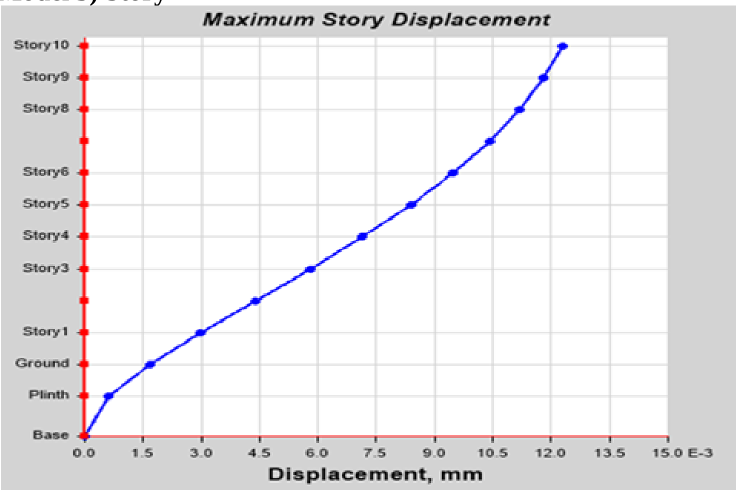


Base shear is the total horizontal force at the base of a structure generated by seismic ground motion. It reflects the structure's overall resistance to lateral loads and is a key input for designing members and connections in earthquake-prone areas.

For a conventional slab system, the slab is supported by beams, forming a moment-resisting frame with columns.

This configuration typically provides higher lateral stiffness than flat or grid slab systems, which affects both the fundamental time period and base shear.

Displacements For (Model 3) Story



The grid slab provides better load distribution and higher lateral stiffness than flat slabs—due to its ribbed structure—it results in reduced lateral displacements compared to flat slabs.

However, the stiffness is typically less than that of a conventional beam-slab system, so displacements may be slightly higher than in conventional slabs.

In seismic analysis, the grid slab's stiffness contribution helps control lateral movement and storey drifts, improving structural stability while maintaining architectural flexibility.

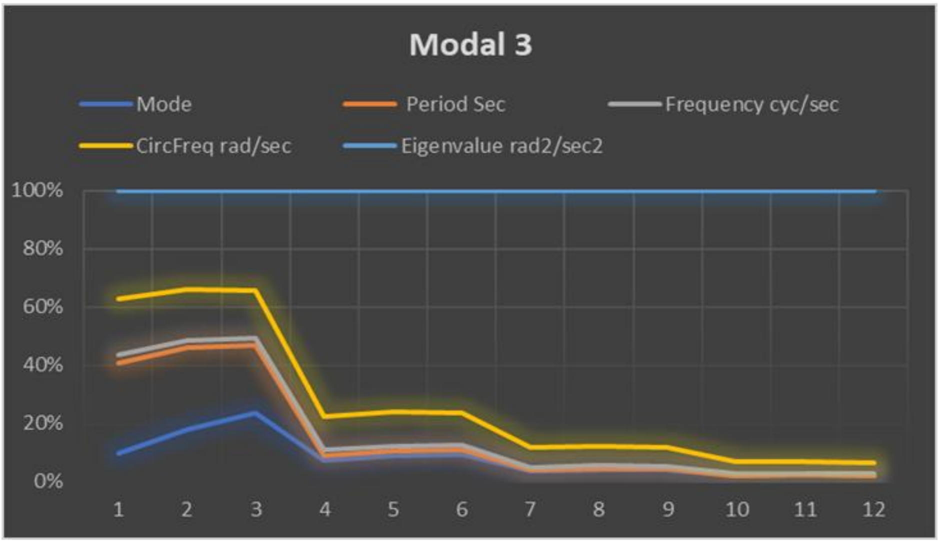
The slab thickness and rib dimensions are critical in achieving the desired stiffness and minimizing displacements.

Time Period

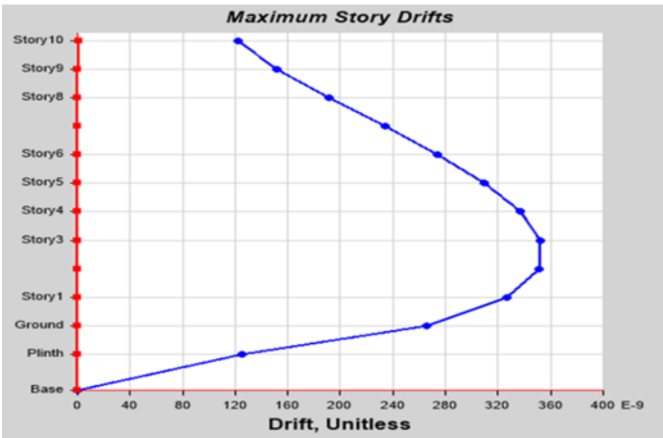
Mode	Period Sec	Frequency cyc/sec	CircFreq rad/sec	Eigenvalue rad2/sec2
1	3.195	0.313	1.9664	3.8667
2	3.193	0.313	1.9677	3.872
3	2.987	0.335	2.1033	4.4239
4	0.949	1.054	6.6204	43.8301
5	0.948	1.054	6.6255	43.8973
6	0.895	1.117	7.017	49.2388
7	0.475	2.107	13.237	175.2189
8	0.474	2.109	13.2483	175.5184
9	0.447	2.237	14.0564	197.5827
10	0.28	3.57	22.4334	503.2593
11	0.28	3.572	22.4457	503.8102
12	0.282	3.816	23.9906	575.5497

The fundamental time period of a structure is the duration of one complete cycle of its fundamental vibration mode, which strongly influences how seismic forces affect the building.

A grid slab system—which features slabs supported by a two-way grid of ribs—provides intermediate lateral stiffness compared to flat slabs (lowest stiffness) and conventional beam-slab systems (highest stiffness).



Story Drift



Storey drift is the relative lateral displacement between two consecutive storeys of a building when subjected to seismic forces.

It is a critical parameter for assessing structural deformation and potential damage to both structural and non-structural components.

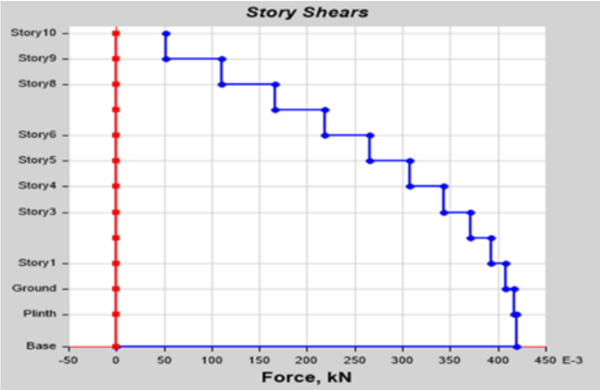
In a grid slab system, the presence of two-way ribs provides increased lateral stiffness compared to flat slab systems, but generally less stiffness than conventional beam-slab systems.

This intermediate stiffness results in storey drift values that lie between those of flat slab and conventional slab systems for the same building height and seismic load.

Base Shear

In a grid slab system, slabs are supported on a network of closely spaced ribs (beams) in two directions.

This configuration offers moderate lateral stiffness—greater than a flat slab system but typically less than a conventional beam-slab frame.



This influences the structure's fundamental time period, which in turn affects the spectral acceleration coefficient (Sa/g) and hence the base shear.

VII. Conclusion

The seismic performance study of RC framed structures with Conventional Slab, Flat Slab, and Grid Slab systems reveals significant differences in structural behavior under earthquake loading conditions. Using ETABS for modeling and analysis, key parameters such as base shear, storey displacement, drift, natural time period, and storey stiffness were compared.

The Conventional Slab System, with beams and columns, demonstrated the highest stiffness and resistance to lateral forces. It recorded the maximum base shear and minimum displacements, making it more stable under seismic loads. However, it also has the highest structural weight, which can increase seismic demand.

The Flat Slab System exhibited the lowest stiffness and maximum storey displacements due to the absence of beams, making it more flexible but less resistant to seismic forces. The system may be suitable in low seismic zones or when combined with shear walls or drop panels to improve lateral resistance.

The Grid Slab System provided an effective balance between stiffness and weight. Its seismic response was better than the flat slab and comparable to the conventional slab in some parameters. It also allowed for larger spans and reduced structural mass, making it a viable choice for seismically active zones when properly designed.

The choice of slab system significantly impacts the seismic performance of an RC structure.

- Conventional slabs are most seismically stable but heavier.
- Flat slabs need additional detailing or seismic-resistant features.
- Grid slabs offer a good compromise with effective load distribution and seismic performance.

For seismic-prone regions, careful consideration of slab type, structural system, and seismic detailing is essential. Where architectural flexibility is a priority, flat slabs may be used with additional seismic provisions. In contrast, for better seismic resistance, conventional or grid slab systems are more reliable.

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