International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 04 | April - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Assessment of Large Span Multistory Building Using Various Slab Under Earthquake Response

Prakash Chamelka **[*1], *Ms. Anjali shirke*** **[2] & Dr. *Chaitanya Mishra*** **[3]**
[*1]Department Of Civil Engineering, **Oriental University, Indore**.
[2]Assistant Prof. Department Of Civil Engineering, **Oriental University, Indore**
[3]Head Of Department Civil Engineering, **Oriental University, Indore**

ABSTRACT

With the growing need for multistory buildings in a variety of industries, the need for novel structural solutions has become critical. This research looks at the structural behaviour of wide span structures, with an emphasis on the use of various slab forms to meet the problems provided by growing architectural trends. The study undertakes a detailed literature analysis, looking into the use of Grid Slabs, Flat Slabs, Waffle Slabs, and Ribbed Slabs alongside regular slabs to improve stiffness and load-carrying capability in large-span buildings.

Architects are challenged to accommodate bigger spans while minimising the number of columns, which has led to the introduction of novel slab layouts. Grid Slabs, which have unique grid patterns, and well-established Flat Slabs are popular alternatives. The analysis of the literature reveals an increasing trend among academics who have effectively used various slab designs to meet the issues given by long spans. The findings provide architects, structural engineers, and construction industry stakeholders significant insights into the performance features and advantages associated with each slab type.

This study adds to the continuing discussion about optimising structural designs for large-span structures to meet the changing demands of current construction practises. The complete analysis is a helpful resource for professionals involved in multistory building design and construction, assisting in informed decision-making and supporting developments in the field.

1. INTRODUCTION:

The rising demand for multistory structures in a variety of industries has heralded a new age of architectural and structural problems. As organisations grow and diversify, the demand for large, open, and adaptable facilities grows. In response to this need, architects and engineers are pushing the boundaries of traditional design by investigating new structural solutions that enable wide spans with low column interference.

The use of various types of slabs is an important part of this developing structural landscape. Slabs, as essential parts of building construction, play an important role in defining a structure's efficiency, stability, and aesthetic appeal. Architects and structural engineers have used a variety of slab designs to cover bigger spans while retaining structural integrity.

Types of Slabs:

1. **Grid Slabs:**

Grid slabs are distinguished by their distinct structural grid pattern. This arrangement allows for the strategic placement of load-bearing parts, giving strength as well as flexibility in allowing bigger spans. The grid's geometric arrangement provides architects with a blank canvas for artistic expression while retaining structural strength.

2. Flat Slabs:

Flat slabs are a well-known option for long spans. Flat slabs reduce the load flow by removing beams and utilising a flat, horizontal surface, making design and construction easier. Because the absence of beams allows for greater freedom in interior space planning, flat slabs are a common choice in modern architectural designs.

3. Waffle Slabs:

Waffle slabs have an undersurface grid-like arrangement of ribs that resembles a waffle. This novel design considerably improves the load-bearing capacity and rigidity of the slab while reducing total structural weight. Waffle slabs are suited for a variety of architectural styles because they find a balance between structural efficiency and aesthetic appeal.

4. Ribbed Slabs:

Ribbed slabs have a row of closely spaced, parallel ribs running along the underside of the slab. These ribs contribute to greater rigidity and load bearing capability. Ribbed slabs are especially successful in large-span constructions where both utility and structural performance are important.

2. Literature Review:

Comparison of Slab Types in Building Structures:

The selection of slab types in building structures plays a pivotal role in determining structural behavior, seismic performance, and overall stability. Several research studies have investigated and compared the characteristics of different slabs, shedding light on their implications for storey displacement, shear at the base, deflection, and seismic response.

Storey Displacement and Shear at the Base:

The study conducted by **Latha M.S. and Pratibha K** emphasizes that storey displacement is greatest for conventional slabs and smallest for load-bearing wall structures. Additionally, the research findings suggest that, for all possible load configurations, the shear at the base is lowest for flat slabs and highest for load-bearing walls. The base shear of load-bearing walls is reported to be 44.5% higher than that of flat slabs, revealing significant variations in seismic behavior.

Grid Slabs vs. Conventional Slabs:

Authors: Chintha Santhosh September 2016 "Analysis and Design of Multistory Building with Grid Slab Using ETABS"

This study looks at the structural performance of grid floor systems in a G+5 building, which is a monolithic slab construction with regularly spaced beams. Mostly used for architectural purposes in areas that need large, column-free interiors, such as showrooms and auditoriums, these systems provide benefits including discrete areas for architectural lighting that is hidden. A thorough study and design for seismic (earthquake) and wind forces, as well as gravity and lateral stresses, are included in the research. The feasibility and effectiveness of the grid floor system are evaluated through comparisons with a flat slab configuration, offering important information to architects and engineers working on the design and construction of multi-story buildings with an emphasis on structural integrity and architectural freedom.

Effect of Sloping Floors on Seismic Performance:

P. Manjunath and Yogeendra R. Holebsgilu explore the seismic performance of buildings on sloping floors. Their findings indicate that as the slope of the base increases, seismic weight decreases, resulting in lower base shear. Moreover, storey displacement is higher on level ground compared to sloping floors, attributed to increased fixity and reduced number of stories. The study underscores the significant impact of soil conditions on the earthquake performance of structures.

Framed Systems and Lateral Load Considerations:

Sahana T.S. and Navyashree K. **Aug-2014** address space constraints in urban areas, leading to the development of low-rise, medium-rise, and tall dwellings utilizing framed systems. The review emphasizes that buildings reliant solely on vertical support are susceptible to collapse under lateral loads, underscoring the importance of lateral stability. For taller structures, the interaction of slabs, beams, and columns becomes crucial in providing the required lateral rigidity.

Comparison of Flat Plate and Conventional R.C.C Construction:

Authors: Sampson Agudze August 2018 "Comparative Study of RCC Flat Slab and RCC Beam-and-Slab Floor Systems"

With a particular focus on the underutilization of RCC flat slabs in Ghana, this research compares reinforced concrete flat slabs with RCC beam-and-slab floor systems. The latter is frequently preferred by designers in the area, despite its alleged advantages. The research analyses and designs two floor systems for an office building using structural design software and manual techniques that follow BS 8110 requirements. The most financially feasible solution is the RCC flat slab system, which delivers cost savings of +6.07% for floor construction and +2.42% for column building, according to the results. The main reason for this savings is the large decrease in formwork expenses.

In conclusion, the literature reviewed underscores the importance of thoughtful slab selection in achieving desired structural performance, considering factors such as seismic behavior, storey displacement, and cost implications. The findings provide valuable insights for architects, structural engineers, and researchers engaged in optimizing building designs for various applications and constraints.

3. Objective:

- Building Structural Models:

Using ETABS software, create a comprehensive 3D model of the multi-story grid slab structure to guarantee an idealisation that is accurate for seismic analysis. This involves representing a realistic building layout by including the structural and architectural features.

- Methods of Seismic Evaluation:

Use the Response Spectrum approach to examine and assess the grid slab structure's seismic performance in compliance with IS: 1893-2000. In order to evaluate the structure's reaction to seismic forces, this phase entails taking into account its dynamic properties.

- Multi-Storied Building Seismic Analysis (G+8):

Conduct a thorough seismic investigation of the eight-story (G+8) multi-story skyscraper. Use the Response Spectrum approach to assess important seismic characteristics such as story drift, displacements, story shear, and auto lateral loads. Perform this study in order to comprehend the variance in structural behaviour under varied seismic intensities throughout the seismic zones 2, 3, 4, and 5.

4. Methodological Approaches:

i. **Problem Definition and Scope:**

- Clearly define the scope of the analysis, outlining the specific objectives, structural characteristics, and loading conditions of the G+8 building. Identify the seismic considerations and the importance of adopting the Response Spectrum method for the analysis.

ii. **Literature Review:**

- Conduct an extensive literature review to understand the behavior of structures under seismic loads, the principles of the Response Spectrum method, and the advantages of using grid slabs in seismic-resistant designs. Identify key findings from previous studies to inform the present project.

iii. **Structural Modeling:**

- Utilize advanced structural analysis software, such as ETABS, to create a detailed 3D structural model of the G+8 building. Ensure accurate representation of the building's geometry, material properties, and structural components, with specific focus on the chosen grid slab system.

iv. **Loading Conditions:**

- Apply realistic loading conditions to the structural model, including gravity loads and seismic loads as per IS 456:2000 and 1893:2000. Consider the medium soil condition for a more accurate representation of real-world scenarios.

v. **Response Spectrum Analysis:**

- Implement the Response Spectrum method for seismic analysis. Define the response spectrum compatible with the seismic zone and characteristics of the region. Utilize ETABS to perform linear dynamic analysis, plotting peak responses against undamped natural time for different damping values.

vi. **Grid Slab Analysis:**

- Focus on the grid slab structure within the G+8 building. Analyze the rectangular voided pattern grid slab using ETABS to assess its stiffness and response characteristics under seismic loading conditions.

vii. **Results and Interpretation:**

- Analyze and interpret the results obtained from the Response Spectrum analysis. Evaluate the maximum relative displacement and maximum relative velocity of the grid slab structure for different damping values. Consider the implications of these results on the overall seismic performance.

viii. **Comparison and Optimization:**

- Compare the seismic response characteristics of the grid slab structure with other slab types or configurations. Identify any optimization opportunities to enhance the seismic performance, considering factors such as material usage, cost-effectiveness, and structural integrity.

ix. **Code Compliance and Design Recommendations:**

- Verify the analysis results against relevant IS codes (IS 456:2000 and 1893:2000). Provide design recommendations based on the findings, ensuring that the grid slab structure complies with seismic design standards.

x. **Documentation and Reporting:**

- Compile a comprehensive report documenting the methodology, structural modeling details, loading conditions, analysis results, and recommendations. Clearly present the outcomes of the Response Spectrum analysis and the implications for the seismic performance of the G+8 building with a grid slab structure.

5. CONCLUSIONS

The literature evaluation carried out for this study highlights how crucial it is to carefully choose suitable slab systems, especially in areas where seismic activity is likely to occur. The study's emphasis on flat slab designs highlights these systems' remarkable adaptability, as shown by the analysis of the result parameters. This adaptability implies that flat slab arrangements might provide clear benefits in terms of efficiently reducing the effects of seismic loading. The research findings provide significant insights for professionals involved in the complex process of planning and building multi-story structures, including architects, structural engineers, and stakeholders. These insights are especially pertinent to areas with differing seismic hazard levels, underscoring the necessity of making well-informed decisions about structural design and construction methods.

REFERENCES

[1] IS 456:2000, "Indian Standard Code for Plain and Reinforced Concrete", Bureau of Indian Standards, New Delhi.M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[2] IS 800-2007, "Code of practice for General Construction in Steel".

[3] 1 Chintha Santhosh, 2 Venkatesh Wadki, 3 S. Madan Mohan, 4 S. Sreenatha Reddy, "Analysis and Design of Multi-story Building with Grid Slab using Etabs", IJIRSET Vol. 5, Issue 9, September 2016, ISSN : 2319-8753

[4] 1 S A Halkude, 2 C G Konapure, 3 S P Pasnur, "Effect of Depth of Periphery Beams on Behaviour of Grid Beams on Grid Floor", IJCET, Vol-2, E-ISSN 2277 – 4106.

[5] 1 Harish M K, 2 Ashwini B T, 3 Chetan V R, 4 Sharath M y, "Analysis and design of Grid slab in Building using Response Spectrum Method",2017 IJRTI, Volume 2, Issue 6, ISSN : 2456-3315

[6] 1 Maloth Naresh, 2 Posam Rukesh, "Analysis and Design of Multi-story Building with Grid Slab Using E-tabs", IJMTE, Volume 8, Issue XII, Dec-2018, ISSN NO-2249-7455

[7] 1 Priyanka H Chandanshive, 2 Sandeep R Gaikwad, " Comparative Analysis and Design of Flat slab and Grid Slab in Multi-storey Building under Seismic condition", 2019 JETIR April 2019, Volume 6, Issue 4, ISSN-2349-5162

[8] 1 B. Syam Prasad and 2 B. Syam, "Analysis and design of Multi-storey Building with Grid slab using ETABS", (Prasad, 6(7): July 2019) ISSN 2348-8034 DOI 10.5281/ zenodo.3345194

[9] 1 Umamaheshwari Rao Tallapalem, 2 Nurulla Shaik, 3 Gopi Pagidimarry, "Analysis of Multi-storey Building in Different Seismic Zones of India", IJRAT, Vol.7, No.5, May 2019 E-ISSN: 2321-9637