



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 12, December 2022

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.118

 9940 572 462

 6381 907 438

 ijirset@gmail.com

 www.ijirset.com



Seismic Analysis of Large Span Structure for Commercial Building by Various Types of Slab: A Review

Mr. Pradeep Karnawat, Prof. Rahul Sharma

PG Student, Department of Civil Engineering, Prashanti Institute of Technology & Science, Ujjain (M.P), India
Assistant Professor & Head, Department of Civil Engineering, Prashanti Institute of Technology & Science, Ujjain (M.P), India

ABSTRACT: The demand for multi-storey buildings is increasing day by day. The residential and commercial building is mainly used for the needs of a large span. Large spans are required for flat slabs, waffle slabs and ribbed slabs as an excellent option for architects when larger spans in a building must be covered with the least possible number of columns. The use of different types of slabs is developing as a new trend and becoming a great challenge for civil engineers. Therefore, it is necessary to study its structural behavior. The project deals with the behavior of different types of plates such as flat plate, wafer and ribbed plate. The article reviews various research papers based on the use of different types of plates such as flat plate, waffle plate, ribbed plate concept by various researchers. The review paper concluded that for longer span it required to advance types of slab used for the multistorey building as commercial building concept. The use of waffle and ribbed can also be used with high rise & tall structure construction due to more resisting moment capacity of the slabs. The use of secondary beam is adopted for large span requirement.

KEYWORDS: Large Span, Flat Slab, Waffle Slabs, Ribbed Slab, Multistorey Building,

I. INTRODUCTION

The demand for construction is high due to the development of various cities of India. The Madhya Pradesh is one of the states in it. The most common types of long-term structures are trusses, folded plates, shell structures, frames, and tent structures or structures. For Large span RCC slab is also used under different methods used to build them. A waffle slab is made of reinforced concrete with concrete joists running in parallel directions perpendicular to its bottom. Because of the grid arrangement created by R.C. waffle ribs. It is also known as two-way joist slab. It is mainly used when the span is greater than 12 m. It is stronger than other types of slab. The slab has two parts. The first part is at the top on the flat side and the second part at the bottom has joists to create a grid like structure. The grid is visible when the molds are removed from it. It is also used when heavy loads are forming a shape. Under the influence of stiffness this type of Slab is used where buildings require less vibration, such as laboratory use, manufacturing facilities.

Ribbed Slab are the types of slabs cast in full with a series of closely spaced joists which are supported by a set of beams. The main advantage of the rib bottom is the reduction in weight achieved by removing part of the concrete below the neutral axis. This creates this type of floor economy for buildings with long spans and light or moderate loads. Ribbed slabs are cast slabs connected by a series of closely spaced joists that are supported by a set of beams. The main advantage of the rib bottom is the reduction in weight achieved by removing the part of the concrete below the neutral axis. This makes this type of floor more economical for buildings with long light periods or moderate loads. A Flat Slab is a concrete slab supported directly by concrete columns without the use of beams. These types include different systems of elements such as beams, column head, perimeter beam etc. as well as flat slab. These types of buildings use column headers and column strips as substitutes for beams to provide larger column dimensions. Whole slab rests on the column heads and column lines and looks like a dicer. These structures are vulnerable to earthquake forces so a seismic analysis should be done before constructing these structures in earthquake prone areas.



a) Waffle Slab



b) Ribbed Slab



c) Flat Slab

Fig. 1 Various Types of slab used in Multistorey Buildings.

II. REVIEW OF LITRATURE

The following research papers are studied under the study of analysis of a Structure containing the different slabs such as Flat Slab, Waffle Slab, and Ribbed. The summarized reports of different researchers are as follows:

K. Pandey, R. Singh (2021) The project is carried out in earthquake zone III with G+9 floor building earthquake analysis. For this study, four types of large span slab structures were modeled in the form of C (Horizontal Setback Building) which has 10 floors which is a G+9 storey building with a height of 3.50 meters for each storey to be modelled and analyzed. The plan area of all four buildings is the same, which is 2859 square meters (49.50 m x 82.50 m). The building is designed in compliance with the Indian Code of Practice for earthquake resistant design of buildings. The foundation of the building remains. Box sections are used for structural elements. The height of the building is assumed to be constant throughout the structure. The building was modelled using ETABS.

CH. Lokesh Nishanth a, Y. Sai Swaroop a, & et. al. (2020) A commercial building is one in which at least 50 percent of its floor space is used for commercial purposes. The influence of seismic and wind forces on buildings with different slab arrangements were analyzed using ETABS software. Analysis and design are carried out as per IS 456-2000 code book. M30 grade concrete and Fe-500 steel are adopted. Load combinations are taken as per code book of IS: 875-part 5 (2015). Live loads are assumed as per IS 875-part 1. Wind speed of 55 m/s and earthquake zone 5 is assumed for analysis. There are several concerns affecting the performance of a building since floor deflection, foundation shear and floor displacement play a crucial role in determining the behavior of a building to wind and seismic loads. The results are conveyed in the form of tables, bar charts. Storey displacement increases with storey height. The results show that construction with grid slab is robust and economical, in contrast to all other slab arrangements used in building evaluations for wind and seismic loads.

Imran S. M., K. R. Raghunandan & et. al. (2020) an optimized calculation of reinforced concrete (RC) slabs of ribbed and waffle slabs was performed. The purpose of these articles is the total cost of reinforcement, concrete and formwork, which sums up the cost of a ribbed slab. The structure is analyzed by the direct design method. The objective function is developed after a detailed study of the ribbed plate. The optimization process is carried out for different grades of concrete. Comparative results for different grades of concrete are numbered and presented in the form of a table. The optimization of a ribbed slab made of reinforced concrete and cement concrete is illustrated, and the results of the optimal and conventional calculation are compared. An optimization problem is a constrained nonlinear programming problem. The mathematical model is analyzed using mathematical software. As a result of the analysis, it was found that savings of up to 25 percent can be obtained by optimizing the reinforced concrete ribbed slab.

Zekirija Idrizi and Isak Idrizi (2017) compared solid and waffle plate system. A typical 14-story RC building structure is selected as an example for this study. The first part of this study is aimed at finding the optimal solution for a system of solid and waffle slabs, which are subsequently considered as integral parts of all floors of a 14-storey building. In the second part, the influence of both floor systems on the model of a 14-story building is considered. This

study aims to highlight the benefits of mid-rise buildings made up of a wafer slab system compared to buildings characterized by solid slabs in terms of economy, structural safety and productivity.

Archana Shaga, Satyanarayana Polisetty (2016) presented work RCC flat slab structure and conventional slab structures are considered for comparative study of 6 storey building which is situated in earthquake zone-II and for earthquake loading, the provisions of IS: 1893 (Part1)-2002 is considered. A three dimensional modeling and analysis of the structure are carried out with the help of E-tabs 2015 software. Linear Static Method of Analysis and Response spectrum analysis method are used for the analysis of both Flat slab structure and Conventional slab structure. The forces and all the relative displacements, storey shears and overturning moments that are developed in each of the structure are analyzed. The results that are obtained from the analysis are discussed. Further these results have been used for understanding the performance of flat slab structure and conventional slab structure under the effects of lateral loads and earthquake. The results are compared and found that flat slab structure perform well in earth quake condition than the conventional slab structure.

Anuj Bansal, Aditi Patidar (2016) presented work is to compare the behaviour analysis, we can know the weak zones in the of multi-storey buildings having flat slab with that of having grid structure and then slab and to study the effect of base shear, storey drift and whether the particular part is retrofitted or maximum displacement purpose three cases of multi-story buildings are considered with under seismic forces. For this rehabilitated as per requirement. area 20 m x 20 m having 4 storey, 8 storey and 12 storey with 3.6 m storey height considered. All the three cases are considered having flat slab and grid slab, and also analyzed by using software SAP2000. Observation shows that pushover analysis is a simple way to explore the nonlinear behaviour of building. Analysis is an approximation method based on static loading. It “Seismic Performance Of Different RC Slab may not accurately represent dynamic phenomena. Performance points for flat slab are larger than in grid slab models. Resultant Systems For Tall Building”, investigated displacements for flat slab are quite larger than in grid slab analytically different types of RC slab taken as an models and also base shear in both types of slabs is almost example and performed the various analytical similar. Present work provides a good source of information on the parameters of pushover analysis of multi-story buildings.

S. N. Utane, H. B. Dahake (2016) examine the compare the various parameters like base shear, story displacement and story drift acting on flat slab and waffle slab system. With that behaviour of expansion joint which is provided between existing building and industrial structure in earthquake prone region is also checked. Analysis of the large industrial structures constructed using flat slab and waffle slab in square shape and rectangular shape layout will be done with the help of Etab software by using IS 456-2000 code Displacement of industrial structure constructed using flat slab system is more than the waffle slab system for both square and rectangular layout. Displacement of rectangular shape layout of industrial structure constructed using flat slab and waffle slab is more than the square shape layout structure. With the increase in height of structure displacement is also goes on increasing. Story shear of industrial structure constructed using flat slab system is more than the waffle slab system for both square and rectangular layout.

Ubani Obinna Uzodimma (2016) In this paper, a structure of dimensions 12 m x 20 m was designed without internal columns using Eurocode2. The floor system in this room was supported by the connection of the primary and secondary beams. The complete steps of load analysis, load transfer from secondary beams to primary beams, structural analysis, and detailed design of the structure were performed manually. After analysis and design, an area of 900 mm x 400 mm, and a reinforcement ratio of 1.786% were found to satisfy both the ultimate limit state and serviceability requirements limit state requirements) of primary beams. Finally he concluded that Primary and secondary beam relationships can be used as an alternative method in large span construction, provided adequate analysis, design, and specification of members are performed.

Gagankrishna R.R & Nethravathi S.M (2015) The analysis method adopted in this study is non-linear static or pushover analysis. Pushover analysis is usually of the displacement control type and is conducted as per ATC-40 and FEMA document guidelines. Analysis parameters related to structural performance and comparative studies on flat plate and flat slab of RC frames are considered. It has been shown that pushover analysis is a very convenient way to investigate the nonlinear behavior of structures. According to the result it is found that base shear is significantly higher in case of all structural systems with edge beam and shear wall compared to flat slab without shear wall. It is due to an increase in the lateral stiffness of structures. And also note that the displacement decreases with increasing lateral stiffness when adopting the shear axis and the edge beam for both the flat flat and the flat slab.

A. Sharma, C. J. Pushpa. D (2015) The researcher investigated the seismic effect of multi-storey construction on G+9, G+14 and G+19 floors with waffle slab and flat slab using ETABS 2013 software. It has been observed that waffle slabs are suitable for structure length less than 40m, while for structures higher than 40m it is advisable to go with thin slab. From the above results it can be observed that for a structure with a height of 40m, waffle slab and non-flat slab are recommended, whereas for structures with a height of 40m, a flat slab is recommended.

Jing Zhou, Wei Mao & et. al.(2015) A reinforced concrete (RC) frame system of a new type with diagonal braces has been introduced in the large-span sports educational building. In this paper, we study the nonlinear dynamic responses of long-span reinforced concrete frame structures with diagonal braces under vertical near-fault impulsive and non-impulsive soil movements. Ten ground movements during the earthquake in Chichi have been identified, which are divided into two groups. The flat, long-span design is simplified from practical engineering design and is used to perform dynamic history analysis. The vertical displacement of the middle part of the beam and the axial pressure at the base of the lower column of the structure are compared with vertical impulsive and vertical non-impulse soil movements, as well as the influence of the parameters of the structural system on the vertical average, the displacements of the beam are analyzed. This study shows that the vertical earthquake response of a long-span RCFB structure is significant, especially with ground impulsive movements, and that the structural system parameters and the ground impulsive effect exhibit a distinct associated effect on the vertical response. Optimizing the location of the haunch braces is very important when designing an RCFB structure.

Ilinca Moldovan, Aliz Mathe (2015) presented the aspects of a square shaped waffle slab calculation, supported punctually and having a two-way post tensioning reinforcement disposed parabolically. It is described the waffle slab system, its characteristics, preliminary design of composing elements, technological aspects regarding the manufacturing of precast panels, details regarding used materials, the reinforcement layout and the calculation of prestressing force. The work presented the design, calculation and layout, of prestressing reinforcement (TBP9 tendons) that are to be placed in the ribs of a waffle type slab. It is mentioned the sequence the tendons are stressed, the geometrical characteristics of their layout and is presented the computation of prestressing force in terms of maximum force applied to the TBP9 tendons and initial prestressing force at time $t=t_0$. It is to be mentioned that the angular change in tendon profile causes a transverse force on the member which 'balances' structural dead loads.

A. E. Hassaballa , M. A. Ismaeil & et. al. (2014) deals with the a four-story residential existing reinforced concrete building in the city of Khartoum-Sudan, subjected to seismic hazard ,was analysed. Plastic hinge is used to represent the failure mode in the beams and columns when the member yields. The pushover analysis was performed on the building using SAP2000 software (Ver.14) and equivalent static method according to UBC 97. The principles of Performance Based Seismic Engineering are used to govern the analysis, where inelastic structural analysis is combined with the seismic hazard to calculate expected seismic performance of a structure. Base shear versus tip displacement curve of the structure, called pushover curve, is an essential outcomes of pushover analysis. The pushover analysis is carried out in both positive and negative x and y directions. Default hinge properties, available in some programs based on the FEMA -356 and Applied Technology Council (ATC-40) guidelines are used for each member. One case study has been chosen for this purpose. The evaluation has proved that the four-story residential building is not seismically safe.

Arman I. M. (2014) adopted the ACI direct design method is used as a manual or hand method of calculation and the solution will be compared with the analysis results of the three dimensional structural model done by the computer program Sap2000. The moments in beams, slab column strip and slab middle strip will be determined. It will be illustrated that the distribution of moments in two-way slabs with hidden beams likes the distribution of moments in slabs without beams as the stiffness of the hidden beams is small. It is recommended that the use of three dimensional modelling by computer software is the best solution for moment's determination and distribution.

R.S.More, V. S. Sawant, Y. R. Suryawanshi (2013) carried out by means of comparing the behaviour with that of conventional beam column framing. Grid slab system is selected for this purpose. To study the effect of drop panels on the behaviour of flat slab during lateral loads, flat plate system is also analyzed. Zone factor and soil conditions the other two important parameters which influence the behaviour of the structure, are also covered. Software ETABS is used for this purpose. In this study relation between the number of stories, zone and soil condition is developed.

III. CONCLUSIONS

The following conclusion is made based on the study and surmised report on review of literatures. The conclusions are as follows:

- The researcher carried flat slab analysis in India majorly other are less use in India so it is required to research on other slab also.
- Analysis is of rigid frame are major part of analysis, the other forms are if it used then it is stability of structure increases.
- Different researchers have used different slabs in the structure according to requirements, so flat slabs of multi-storey buildings are the best, and high-rise waffle and ribbed slabs can be adopted for large span structure.
- Scaffolding is simple in the apartment and otherwise necessary and tuff work in waffle and ribbed slabs and other aesthetic views of the building.
- Ribbed slab is more effective in resisting time by adjusting the effective depth and reinforcement section. It is used for a large span of slab and floor with a small number of columns.
- The waffle slab structure shows a load bearing capacity greater than other types of slab with savings on weight and materials. & Good vibration control ability. It also affects the Speed and speed of construction.

Overall it is concluded that In India demand of partition used large span structure is high so it is carried out to analysis these types of techniques under RCC & Steel structure.

IV. FUTURE SCOPE

The following work should be taken in future for research purpose.

- Optimized structure analysis for different types of slab in for a single optimized structure.
- Large span structural analysis for material based: Steel and RCC Structure.
- Codal Comparison for large span under various countries.
- Study based on Slabs with dampers or other vibration reduced techniques.
- Analysis of Industrial building under large span Structure.

ACKNOWLEDGEMENT

I extend my deepest gratitude to, Prof. Rahul Sharma, Assistant Professor & Head, Department of Civil Engineering, Prashanti Institute of Technology & Science, Ujjain (M.P), India for providing all the required data's related to the project, learning of software tools and guidance to do successful completion of this work

REFERENCES

1. M, K. Pandey, R. Singh (2021) "Seismic Response of Large span slab in Horizontal Setback Building" International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429 Volume 9 Issue XI Nov 2021
2. CH. Lokesh Nishanth a, Y. Sai Swaroop a, & et. al. (2020) "Analysis and design of commercial building with different slab arrangements using ETABS" Materials Today: Proceedings 33 (2020) 700–704 <https://doi.org/10.1016/j.matpr.2020.05.823> 2214-7853/2019
3. Imran S. M., Raghunandan Kumar R., Arun Kumar (2020) "Optimum Design of a Reinforced Concrete Ribbed Slab" *Journal of Civil Engineering Research*, 10(1): Pp- 10-19, DOI: 10.5923/j.jce.20201001.02
4. Zekirija Idrizi and Isak Idrizi (2017) Comparative Study between Waffle and Solid Slab Systems in Terms of Economy and Seismic Performance of a Typical 14-Story RC Building *Journal of Civil Engineering and Architecture* 11 PP- 1068-1076 doi: 10.17265/1934-7359/2017.12.002



5. Archana Shaga, Satyanarayana Polisetty (2016) Seismic Performance Of Flat Slab With Drop And Conventional Slab Structure International Journal of Latest Engineering Research and Applications (IJLERA) ISSN: 2455-7137 Volume – 01, Issue – 09, , PP – 79-94.
6. Anuj Bansal, Aditi Patidar (2016) Pushover Analysis Of Multistorey Buildings Having Flat Slab And Grid Slab International Journal of Engineering Science Invention Research & Development; Vol. II Issue VII January 2016 e-ISSN: 2349-6185.
7. S. N. Utane, H. B. Dahake (2016) Effect of shape irregularity on flat slab and waffle slab industrial building under lateral loading ISSN: 2319-5967 ISO 9001:2008 Certified International Journal of Engineering Science and Innovative Technology (IJESIT), Volume 5, Issue 2, PP 43-50.
8. Ubani Obinna Uzodimma (2016) Analysis And Design Of A Network Of Interacting Primary And Secondary Beams As Alternatives In Large Span Construction Analysis of Primary and Secondary Beams in Large Span Construction.. Ubani Obinna U. (2016) Page 1-13.
9. Gagankrishna R.R, Nethravathi S.M (2015) Pushover Analysis Of Framed Structure With Flat Plate And Flat Slab For Different Structural Systems International Journal of Innovative Research and Creative Technology IJRCT , Volume 2, Issue 2, ISSN: 2454-5988, pp 54-59. IJRCT1601010
10. A. Sharma, C. J. Pushpa. D (2015) Analysis of Flat Slab and Waffle Slab in Multistorey Buildings using ETABS IJSRD - International Journal for Scientific Research & Development| Vol. 3, Issue 02, ISSN (online): 2321-0613, pp 2483-2488.
11. Jing Zhou, Wei Mao & et. al (2015) “Earthquake response of large-span reinforced concrete structures with haunch braces under vertical ground motions” Journal of Vibro Engineering Jve International Ltd. Journal Of Vibro Engineering, , Volume 17, ISSUE 2. ISSN 1392-8716
12. Ilinca Moldovana, Aliz Mathe (2015) A Study on a Two-Way Post-Tensioned Concrete Waffle Slab 9th International Conference Inter disciplinarily in Engineering, INTER-ENG 2015, 8-9, Tirgu-Mures, Romania Procedia Technology PP 227 – 234
13. Ibrahim Mohammad Arman (2014) Analysis of two- way ribbed and waffle slabs with hidden beams International Journal of Civil And Structural Engineering Volume 4, No 3, 2014 ISSN 0976 – 4399 pp 342-352.
14. R.S.More , V. S. Sawant, Y. R. Suryawanshi (2013) Analytical Study of Different Types of Flat Slab Subjected to Dynamic Loading *International Journal of Science and Research (IJSR)* ISSN (Online): 2319-7064 Index Copernicus Value : 6.14, Impact Factor : 4.438
15. A. E. Hassaballa, M. A. Ismaeil b, A. N. Alzeadc, Fathelrahman M. Adam (2014) Pushover Analysis of Existing 4 Storey RC Flat Slab Building *International Journal of Sciences: Basic and Applied Research (IJSBAR)* ISSN 2307-4531 (Print & Online) Volume 16, No 2, pp 242-257
16. (ref. Image taken <https://indianconstructioninfo.com>)
17. (Ref. Image taken <https://cordek.com>)
18. <https://housing.com>



INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 8.118



ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

9940 572 462 6381 907 438 ijirset@gmail.com



www.ijirset.com

Scan to save the contact details