INTERNATIONAL JOURNAL
FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Review Paper on Studying the Behavior and Comparison of Flat Slab and Waffle Slab System in Same Building under Seismic Condition

Mrunal Lonare[1], Dr. Prashant Nagarnaik[2]

[1]M.Tech. student Dep. of Civil Eng. G. H. Raisoni Institute of Engineering and Technology Nagpur, India
[2]HOD Dep. of Civil Eng. G. H. Raisoni Institute of Engineering and Technology Nagpur, India

Abstract: There has been an associated increasing demand for the construction of tall buildings thanks to associate ever-increasing urbanization and increase in population. The modeling of such earthquake and wind masses has to be done, therefore evaluating the behavior of the structure with a transparent perspective of the injury that's expected. to research the structure for numerous earthquake and wind intensities and so perform checks for numerous criteria at every level has become vital apply for the last few decades. The principal objective of this project is to research flat blocks and waffle slab victimization ETABS, to urge the optimum style. The look involves load calculations and analyzing the full structure by ETABS. the look strategies utilized in ETABS analysis square measure Limit State style orthodox to Indian customary Code of apply. ETABS options have a state-of-the-art computer program, mental image tools, powerful analysis and style engines with advanced finite component and dynamic analysis capabilities
Keywords: Flat slab, Waffle slab, Seismic condition, Flat slab with a drop, flat slab without a drop, ETABS.

I. INTRODUCTION

There has been Associate in Nursing increasing demand for the construction of tall buildings due to Associate in Nursing's ever-increasing urbanization and the increase in population. Earthquake and wind load is the curse of such tall structures. as a result of the earthquake forces unit of measurement being risky, we tend to would like to correct engineering tools for analyzing structures below the action of these forces. Thus, careful modeling of such earthquake and wind tons got to be done, so on appraise the behavior of the structure with a clear perspective of the injury that is expected. to analyze the structure for varied earthquake and wind intensities so performing checks for varied criteria at each level has become extremely important follow for the last style of decades. Earthquake causes completely different shaking intensities at different locations than the injury-induced in buildings at these locations is besides different. Thus, it is necessary to construct a structure that's earthquake-resistant at a selected level of intensity of shaking and assimilate the impact of the earthquake.[1]

Even though the same magnitudes of earthquakes unit of measurement occur because of their varied intensity, it results in dissimilar damaging effects in several regions. Hence, it is necessary to look at the unstable behavior of multi-storied RC framed building for varied unstable intensities in terms of varied responses like lateral displacements, story drift, and base shear. that the unstable behavior of buildings having similar layout got to be below all entirely utterly completely different intensities of wind and earthquake. For determination of unstable responses, it is a necessity to hold out unstable analysis of the structure victimization all entirely utterly completely different accessible ways in which it is necessary to look at the unstable behavior of multi-storied RC framed building for varied unstable intensities in terms of varied responses like lateral displacements, story drift, and base shear.[6]

The principal objective of this project is to analyze flat blocks and grid block victimization ETABS, to urge the optimum vogue. the design involves load calculations and analyzing the complete structure by ETABS. the design ways in which employed in ETABS analysis unit of measurement Limit State vogue orthodox to Indian customary Code of following. ETABS selections have a state-of-the-art interface, illustration tools, powerful analysis, and magnificence engines with advanced finite part and dynamic analysis capabilities. From model generation, analysis, and magnificence to illustration and result verification, ETABS is that the professional's different. ETABS decisions an extremely interactive computer code that allows the users to draw the frame and input the load values and dimensions. Then in step with the specified criteria assigned it analyses the structure and styles of the members with reinforcement details for RCC frames.

This project presents the "comparative study of flat and grid variety of block for multi-storied building below unstable condition". This work includes the analysis of flat block and grid blocks. This study aims to grasp the characteristics, the maneuver of study, then the design of the flat block and grid block; and to seem out that the block system with positive parameters is superior to utterly completely different. A block is besides a flat a strive of a dimensional two-dimensional structural part having thickness very little compared to its utterly completely different a strive of dimensions. It provides an operative flat surface or a covering shelter in buildings. It primarily transfers the load by bending in one or a strive of directions. concrete slabs unit of measurement employed in floors, roofs, and walls of buildings and since the decks of bridges. rock bottom system of a structure can take many forms like Insitu solid block, ribbed block, or pre-cast units. Slabs may even be supported on monolithic concrete beams, steel beams, walls, or directly over the columns. Concrete blocks behave primarily as flexural members then the design is analogous thereto of beams. The advantage of a grid over different types of floors is that the flat roof or floor is obtained. By victimization commonplace concrete construction and by increasing vary of beams, the depth of the beam is shortened. Thus, a larger clearance is obtained. The structure is monolithic and these forms of floors have no stiffness. the maintenance value of these floors is to boot negligible than that of steel-girders and pre-stressed concrete. one in each of the constraints of Grid floors is the preventative event value. The Aims and main objectives of this project is to vogue a flat and grid block system in the multi-storied building below unstable condition and to match the ETAB results of flat and grid block system in the multi-storied building below unstable condition with the help of IS 1893:2002 and IS 875.

II. OBJECTIVE

A. Objective of The Study

The primary objectives of this plan can be shortening as follows:

1) Study of earthquake design methods for flat slab and waffle slab as per Indian standard building code (IS code 1893-2002)
2) Flat slabs will be designed using the direct design method.
3) Waffle slab will be designed using the approximate method.
4) To compare the ETABS result for flat slab and waffle slab by considering a dimension.
5) To critically study the provision of IS: 875 part 3
6) To understand the difficulties faced in the design of high rise structure
7) To understand the performance of the realistic building under the different designs of seismic load and permeability in the development of forces in the typical column.
8) To explore the possibility of investigating the dynamic seismic effect on the building along with seismic and across seismic analyses.

III. LITERATURE REVIEW

A brief review of previous studies on the comparative analysis of the Flat slabs and waffle slab structure. This literature review is on recent contribution related to Comparative Analysis of waffle slab & flat slabs with and without a drop and past efforts most closely related to aspects of present work.

Ibrahim. S. Vepari, Dr. H.S Patel, (13-14 May 2011), In their paper presented that to aim economical aspects of long-span slabs between flat slab and grid slab is presented in this paper. The flat slab with drop and column head is modeled and analyzed using the direct design method and the grid slab is modeled and analyzed using the plate theory method.

Amit A. Sathawane, R.S. Deotale (2015), In the paper presented this project aimed to determine the most economical slab between flat slab with a drop, and grid slab. Analysis of the flat slab and grid slab has been done both manually by IS 456-2000 and by using software also. The flat slab and Grid slab has been analyzed by STAAD PRO. Drops are important criteria in increasing the shear strength of the slab. It enhances resistance to punching failure at the junction of concrete slab & column.

Akshay S. Raut, Riyaz Sameer Sha, (2016), In this paper, presents a comparative study of R.C.C. Waffle slab and Prestressed Waffle slab. When a large space within a building needs to be covered without hindrance and supports, architects often deploy waffle slabs to construct floor and ceiling. Waffle slabs are generally used for heavy loads. The work includes the analysis and design of R.C.C. Waffle slab and Prestressed Waffle slab for small span, medium span, and long-span ranging from 10m to 40m. For analysis purposes ETAB 15 (Integrated Analysis, Design, and Drafting of Building System) and SAFE 14 (Integrated Design of Slabs, Mat, and Footing) software results will be taken into consideration for R.C.C. Waffle slab and Prestressed waffle slab and manual calculation will be carried out for both.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue I Jan 2022- Available at www.ijraset.com

Programming in EXCEL will be done to obtain the results for various spans for different elements of the waffle slab. The rectitude of the program was checked by first designing the manually designed slabs comparing the results. The idea is to reach a definite conclusion regarding the superiority of the two techniques over one another. Results reveal that an RCC Waffle Slab is cheaper than a Prestressed Waffle Slab for smaller spans but vice versa is true for larger spans

Aradhna A. Ganvir, Prof. V. S. Singhade, (2016), In the paper a reinforced concrete flat-plate floor system is widely used in various types of building structures including condominiums, parking garages, and office buildings. This floor system is advantageous in terms of simpler formwork, shorter construction period, reduced story height, flexible room arrangement, more headroom, better air circulation, and better light penetration. Despite the advantages, the system has its problems, one of which is the possibility of punching shear failure in the vicinity of the slab-column connections. The present aim of this study is to check the suitability of flat slabs with openings of different locations & sizes. In this study, an analysis of flat slabs is proposed. Firstly a comparative study is carried out between experimental & analytical design of 500x500x110mm & 700x700x110mm slab panels. The analytical study has been done by using SAFE 12.2.0 4 for 500x500 & 700x700 mm panels with and without openings. The behavior of flat pates then compared w.r.t to maximum deflection, Failure load & first crack load.

Anghan Jaimis, Mitan Kathrotiya, Neel Vagadia, Mulani, (2016), In the paper study the current work is focused on the Comparative Study of the flat slab and conventional slab. The configuration involves the conventional frame structures which act on different loading circumstances. The conventional R.C. and flat slab have different conditions in the framework so, they are performing different ways on different loading circumstances. Components of the flat slab and conventional R.C. slab are dissimilar so the performance was studied in terms of, lateral displacement, period, base shear, story drift, base shear, in linear analysis using code-IS 1893:2002(part-1): The complete modeling, analysis, and design were put into execution by the mean of SAP 2000 software.

Dr. N. Krishna Raju, (2017), In chapter 14 of this book analysis and design of grid floor using approximate method is given. According to IS 456: 2000, the ribbed slab system can be analyzed as a solid slab, if the following requirements regarding spacing of beams, the thickness of the slab, and edge beam are satisfied: The spacing of ribs should not be greater than 1.5m and it should not be greater than 12 times the flange thickness. In situ ribs should not be less than 65mm wide. The bending moment in the other ribs can also be determined in direct proportions to their distance from the center. The ribs are designed as a flanged section to resist the moment and shear.

Lalit Balhar, Dr. J.N. Vyas, (2017), In recent times, Flat slab buildings are generally used for the construction because the use of flat slab building provides many advantages above conventional RC Frame building in terms of economy, make use of space, easier formwork, architectural flexibility and mostly shorter construction time. The structural effects of the Flat slab construction are mainly difficult by its meager performance under earthquake loading. It is essential to analyze the seismic behavior of buildings to observe what are changes are going to arise for the conventional RC frame building, flat slab building with and without shear wall respectively. The analysis is done with STAAD.PRO V8i software. The characteristics seismic behavior of conventional RC frame building, flat slab buildings imply that supplementary measures for guiding the formation and design of these structures in seismic regions are desirable and to increase the performance of building having conventional RC building, flat slabs under seismic loading. The object of the present study covers the behavior of multi-story buildings having conventional RC slab building, flat slabs and to study the performance of these types of buildings under seismic forces. The current study covers information on the parameters story drift, lateral displacement, seismic base shear, story shear.

IV. METHODOLOGY

A. General

The building considered in the present report is the G+14 Conventional Frame structure, complete analysis is carried out for dead load, live load & seismic load using ETABS software. All combinations are Considered as per IS 1893:2002.

B. Method of Analysis

In this study method of analysis is done by using the Dynamic analysis method (only response spectrum method) for seismic loads acting on the structure.

1) Seismic analysis is the calculation of the building response of the structure to earthquake and is a relevant part of structural design where earthquakes are prevalent.
2) The seismic analysis of a structure involves the evaluation of the earthquake forces acting at various levels of the structure during an earthquake and the effectiveness of such forces on the behavior of the overall structure

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue I Jan 2022- Available at www.ijraset.com

3) In the process of structural analysis system the analysis is carried out to predict its behaviors by using mathematical equations and physical laws.

4) Under various load effects, the main objective of structural analysis is to determine internal forces, stresses, and deformation of structures.

C. Dynamic Analysis

It should be performed to get the design seismic force and its allotment to different levels along with the height of the building and different lateral load resisting elements. Though in both methods, the planning base shear (Vb) should be compared with a base shear (vb) calculated employing a basic period Ta. When (Vb) is a smaller amount than (vb) 3 all the response quantities shall be multiplied by Vb /vb. The values of damping for a building may be taken as 2 and 5 percent of the critical, for dynamic analysis of steel and reinforced concrete buildings, respectively.

D. Response Spectrum Analysis

Response spectrum is a useful tool of earthquake engineering. The height response of the building is often estimated by reading the worth from the bottom response spectrum for the appropriate frequency if you'll determine the natural frequency of the structure. A response spectrum may be a plot of the utmost response amplitude (displacement, velocity, or acceleration) versus the period of the many linear single degrees of freedom oscillators to a given component of ground motion.

The resulting plot is often wont to select the response of any linear SDOF oscillator, given its natural frequency of oscillation. Response spectroscopy (RSA) is an elastic method of study and lies in between the equivalent force method of study and nonlinear analysis methods in terms of complexity.

RSA is predicated on the theory of structural dynamics and may be derived from the essential principles (e.g. Equation of motion). Damping of the structures is inherently taken under consideration by employing a design (or response) spectrum with a predefined damping level. The maximum response of every mode is a particular solution. The sole approximation utilized in RSA is the combination of modal responses.

RCC Frames with G+14 have been considered in the study. The fundamental period of vibration of the frame with fixed support using the modal formula in IS 1893(Part I):2002 and model analysis has been evaluated. To understand the resistance effect of earthquake and stability of structure has been modeled as response spectrum method by using ETABS.

Response spectra method of analysis of the models are performed using ETABS Effects waffle slab on different parameters are studied i.e. story drift, displacement, Shear force and bending moment

E. Structural Modeling

General 14 storied buildings are modeled using flat slabs & waffle slabs respectively. These buildings were given rectangular geometry.

These are then analyzed using the response spectrum method for earthquake zone II of India. The details of the modeled building are listed below. Modal damping of 5% is considered with SMRF and Importance Factor (I) =1. The isometric 3D view and elevation of the building model are shown below.

F. Structure Data:

1) *Site Properties*

a) Details of building:: G+14

b) Dimension:: 40m x 46m

c) Length in X- direction:: 40m

d) Length in Z- direction:: 46m

e) Total height of Building:: 46.5m

f) Soil Type:: Hard

g) Spacing:: 6m

h) Base story height:: 5m

i) Floor height::3.2 m

2) Seismic Properties
a) Seismic zone:: II
b) Zone factor:: 0.16
c) Importance factor:: 1
d) Response Reduction factor R:: 5

3) Material Properties:
a) Grade of concrete:: M40
b) Grade of Steel:: Fe500

4) Loading on structure:
a) Dead load :: self-weight of structure +1kN/m2
b) Live load::   4kN/m2
c) Wind load:: Not considered
d) Seismic load:: Seismic Zone II

5) Optimized Sizes of members
6) Flat slab Design parameters
a) Column:: 700mm x 700mm
b) Flat Slab thickness:: 250mm
c) Drop:: 1.5m
d) Drop thickness:: 350mm

7) Waffle slab Design parameters
a) Column:: 700mm x 700mm
b) Beam:: 400mm x 500mm
c) Slab thickness:: 250mm
d) Grid Size :: 1m

H. Models to be considered for the study are:
1) Model 1- Flat Slab with Drop by the effect of Diaphragm for zone II.
2) Model 2- Waffle slab by the effect of Diaphragm II.
The above types of slabs are analyzed for the seismic zone by the Response Spectrum Method.

G. Load combinations as per IS 1893:2016 (part 1)
By using IS 1893:2016 the analysis of the following load combinations is specified. The basic load combinations given by the code as per clause 6.3.4.1 are as follows:
1)   1.5 (D.L. + L.L.)
2)   2 (D.L. + L.L. ± EQ x)
3)   1.2 (D.L. + L.L. ± EQ y)
4)   1.5 (D.L. ± EQ x)
5)   1.5 (D.L. ± EQ y)
6)   0.9 (D.L.) ± 1.5 (EQ x)
7)   1 (D.L. + L.L. ± EQ x)
8)   1 (D.L. + L.L. ± EQ y)
9)   1 (D.L. ± EQ x)
10) 1 (D.L. ± EQ y)

H. IS 1893 2002 Auto Seismic Load Calculation
Direction and Eccentricity

Direction = Multiple

Eccentricity Ratio = 5% for all diaphragms

Structural Period

Period Calculation Method = Program Calculated

Factors and Coefficients

Response Reduction Factor, R[IS Table 7]:: R=5

Importance Factor, I [IS Table 6]:: I=1

Site Type [IS Table 1] = II

Seismic Response

Spectral Acceleration Coefficient, $\frac{Sa}{g} = \mathbf{0.34}$

Seismic Coefficient, Ah= $\frac{ZI\frac{Sa}{g}}{2R}$

REFERENCES

[1] Akshay S. Raut, Riyaz Sameer Shah," Comparative Study of R.C.C. Waffle Slab Vis-à Vis Prestressed Concrete Waffle Slab" International Journal of Innovative and Emerging Research in Engineering Special Issue 1, ICSTSD 2016 Volume 3.

[2] Ibrahim. S. Vepari, Dr. H.S Patel "Study On Economical Aspects of Long Span Slabs",   International Journal   of Engineering Research and Applications(IJERA), Vol2, May-2011

[3] Amit A. Sathawane & R.S. Deotale "Analysis and Design of Flat Slab and Grid Slab and Their Cost Comparison" © 2012 International Journal of Advanced Technology in Civil Engineering | Volume 1 | Issue 2 | 2012

[4] Aradhna A. Ganvir, "Comparative Study of Reinforced Concrete Flat Slabs with and without Openings using Finite Element Analysis" IJIRST –International Journal for Innovative Research in Science & Technology| Volume 3 | Issue 02 | July 2016 ISSN (online): 2349-6010

[5] Anghan Jaimis, Mitan Kathrotiya, Neel Vagadia & Sandip Mulani, "Comparative Study of Flat Slab and Conventional Slab using Software Aid" Journal of Engineering Sciences Assiut University Faculty of Engineering Vol. 42 No. 4 July 2014 Pages: 905-930 * Corresponding author. Email address: eng.tarek2011@gmail.com

[6] Akhila Lekshmi N H, Aswathy S. Kumar, "Dynamic Analysis of an Irregular RC Building with Different Bracing Systems" IJSR Volume 5 Issue 7, July 2016.

[7] Dr. N . Krishna Raju, "Advanced Reinforced Concrete Design", International Journal Of Civil And Structural Engineering Volume 3, No 3, 2013

[8] S.N Sinha, "Reinforced Concrete Design", Second Revised Edition, Tata Mc Graw Hill, New Delhi

[9] Durgesh Neve1, R. P.Patil 2, "Survey Paper on Analysis of Flat Slab Resting on shear walls" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 p-ISSN: 2395-0072. Volume: 03 Issue: 05 | May-2016 www.irjet.net

[10] Avinash Patela1 and Seema padamwarb, "Studying The Response Of Flat Slabs & Grid Slabs Systems In Conventional Rcc Buildings" ISSN: 2250-0138 (Online) Indian J.Sci.Res. 14 (2): 516-521,2017

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)