Study and Analysis of Flat Slab System

Ms. Shruti Barbade, Student, Department of Civil Engineering, MGM's College of Engineering, Nanded, India, shrutibarbade92@gmail.com

Prof. Mr. Halbandge S.D. Assistant Professor, Department of Civil Engineering, MGM's College of Engineering, Nanded, India, halbandge_sd@mgmcen.ac.in

Abstract Civil Engineers are facing a great challenge in structural designing. The design must fulfill various parameters which include economic structure, durability and serviceability. But taking these points in mind it becomes very difficult for an Engineer to fulfill all these requirements at a time when a design is performed manually. This dissertation presents a research on digital tools used in civil engineering and comparing their results by taking in mind the requirements of the above points. In this research process a building is taken for analysis and design on well-known Software ETABS. Based on the results taken from the Software some comparison is done with manual analysis.

The main purpose of this study is to show detailed difference between well-known simulation Software STAAD Pro and ETABS used by structural design engineers nowadays. This study is focused on the advantages of digital tools in our life to make it easy and reliable for us to perform a difficult task. It is found that ETABS is good for building design and STAAD PRO on the whole deals with RCC Structures as well as Steel Structures but by survey I found STAAD Pro is mostly used to check analysis result. So, in this study I am going to check it out what is the reason, why Engineers are taking analysis result in case of RCC Design why not design result while using STTAD Pro.

Keywords — Flat slab, structural performance, innovation, high-performance concrete, reinforcement techniques, post-tensioning, sustainability

I. INTRODUCTION

The structure needs to be designed based on some priorities which can be achieved based on some facts and standard codes. The codes give us detailed knowledge about loading and some recommendations. The design performed which will not consider SI recommendation's will be considered dead end and will be not be considered as serviceable and durability. Some values are considered on the basis of different topography, site conditions and locations. Design codes are assigned according to the location. Every country has its own design codes. These codes are drafted based on knowledge collected from previous data.

This research considered all the values which must consider based on the functionality of the structure. The values are taken from design codes and then analysis is done. After completion of analysis design is prepared by making some assumptions.

The assumptions which are made are mentioned below:

- Material is homogenous all over the member.
- All the structural elements are considered monolithic.
- Concrete will resist compression force and steel will resist tension.
- Force applied is less than the load resisted by member.

Scope of project

- To ensure the safety and security of a building, employees, structure functionality, machinery and inventory. Essential to reduce hazard and losses from structural elements, predominantly concerned with structural improvement to reduce seismic hazard. Important buildings must be strengthened whose services are assumed to be essential just after an earthquake like hospitals.

II. LITERATURE SURVEY

Uttam V Chothani et.al (2016) Analysed that the flat slab with drop is the most economical from the economic point of view when it is compared to the RCC grid slab and flat slab without drop. They considered the flat slab with drop and reinforced concrete flat slab, flat slab without drop. The thickness of reinforced concrete flat slab are 22% and 32% greater respectively and its cost are 25% and 27% greater respectively. The cost increases gradually if the panel sizes increases. The pure reinforced concrete flat slab structural system is more flexible for horizontal loads than the traditional RC frame structure which contributes to the increase of its exposure to seismic

 DOI : 10.35291/2454-9150.2024.0080

effects. Flat slab with drop is more economical than flat slab without drop and grid slab. Concluded that the Concrete required in grid slab is more as compared to flat slab without drop and flat slab with drop.[15]

Chintha Santhosh et.al (2016): Analysed a Multistory Building with Grid Slab by Using ETABS software. It is showed in the study that the maximum displacement is observed in flat slab with drop compare to grid slab without and with infills in both zones. Maximum Time period of grid slab is less in compare with flat slab without and with drop without and with infills structures in zone IV. Deflection is observed more in zone IV than zone III. Storey drift values of different types of buildings are within the permissible limit as per IS-1893-2002 code provision that is the 0.4% of height the floor. Structures having infills have less time period compare to structure without infills. Grid slab systems have maximum base shear in comparison with flat slab without and with drop in zone III and IV.[16]

Salman I Khan et.al (2015) analyse the seismic performance of multi-storied buildings having different floor heights and having different floor systems like Flat slabs, conventional solid slab- beam systems and Grid slabs. The storey drift in building with flat slab construction was significantly more as compared to conventional RCC building. The axial force in the intermediate columns are more in case of flat slabs than grid slabs. Buildings having the flat slab system are weaker in shear as compared to those with conventional or even grid slab systems. As a result, additional moments were developed. Therefore, the columns of such buildings should be designed by considering additional moments caused by the drift. The base shear of a multi-storey structure with grid slab is more as compared to flat slab.[17]

Mohana H.S et.al (2015) studied the Comparative Study of Conventional Slab and Flat Slab Structure Using ETABS for the Different Earthquake Zones of India. In this paper he observed that the storey shear of flat slab is 5% more than that of conventional grid-slab structure. The axial forces on flats slab building is nearly 6% more than conventional building. The difference in storey displacement of conventional building and flat building are about 4mm in each floor. Storey shear intensities, displacement, axial force are the parameters that increases with the increase of seismic level.[18]

Amit A. Sathawane et.al (2012) Analysed that the drops are important criteria in increasing the shear strength of the slab and increase resistance to punching failure at the junction of concrete slab and column. By introduction of heads in slab, rigidity of slab increases. Steel required in Flat slab without Drop is more as compared to Flat slab with Drop and Grid slab. Concrete required in Grid slab system is more when it is compared to the Flat slab with Drop and Flat slab without Drop. Flat slab with drop is more economical than flat slab without drop and grid slab. Rate of flat slab system with drop was found to be more economical than the flat slab without drop and grid slab [19]

R.Arvind et.al (2012): This paper deals with voided slabs using U-boot beton technology made by recycled polypropylene, the technology is designs for lightweight slabs in RCC. It is solution to build slabs of large spans with more bearing capacity. U-Boot its lightweight, stability, modularity, can be used to make structures without mechanical helps of equipment and it's also foundation rafters can be created with a low amount of concrete with big thickness. By using U-boot beton, it is easy to build raft foundations with a low quantity of concrete. It is used in high rise buildings to reduce the weight of the structure. It reduces the construction time and also requires less labours. It has high fire resistance and it's economical. Higher number of floors can be built. The u-boot beton is so economical, efficient, Fire resistance, and Eco friendly. Thus, the result gives a clear view of u-boot beton that is very useful for construction purpose.[20]

III. RESEARCH METHODOLOGY

A. STRUCTURAL DESIGNING

Structural engineers have proper technical knowledge for structural detailing and their analysis. So, they are more experienced to design structures. The structural designing procedures carried out by the structural engineers include calculating the loads and the stresses acting on the building, analysis results for the applied loading, design of sections of structures to sustain the loads, so that the structure designed will withstand the loads predicted safely. The structural engineers are also involved in the selection of materials best suited for the structure. This will hence ask for good knowledge about the different materials that are used in the construction at the current condition like their economic factors, strength factors and durability factors.

The quality factors of different building materials can be analysed by a structural engineer to finalize their suitability in the design of the beams, columns or the foundations.

Another skill of a structural designer is the analysis of structures. This is presently carried out by the software like ETABS, STAAD PRO, SAP, etc. As years pass new software are being developed for the analysis of structures at different conditions of loads like wind, earthquake etc.

Most of the structural engineers have to study and work with this software with a knowledge of both the technical details and the programming details. In some organizations, the analysis is carried out by a programmer who may not have the civil engineering graduation but is assisted by a structural engineer.

Whatever be the mode of analysis done, the structural engineer must have the ability to understand and interpret

 DOI : 10.35291/2454-9150.2024.0080

the results from the software to know the validity of the values provided as output.

Some organization won't completely rely on the computer results they conduct a separate man- made calculation for assurance.

Even though structural engineers are the ones that bring and develop the design ideas and detail, he can only see it happen on the site only if the structure is constructed as desired. For, this interpretation and ideas have to conveyed with the other members of the projects.

The structural engineer has to make coordination and consult other members like the site engineers, other design engineers, geotechnical engineers, landscape architects, architects, project managers etc. Proper knowledge helps in spreading correct information among the group avoiding confusion and errors.

B. WORKING TIME AND LOCATION OF A STRUCTURAL ENGINEER

When looking into the working time and the place spent by the structural engineers, most of the highly involved structural engineers will be working in office as well as on the construction sites.

They can work by splitting the time between both the contexts. The locations of work vary based on the working environments. Rural or metropolitan areas have different working schedules and environment.

The structural engineers may have to work for long hours sometimes similar to site engineers, which mainly depend on the size of the project and the size of the organization. If the structure of the organization is well defined and large, it will have sufficient members for the design team, planning team, execution team with a group of professionals, skilled as well as semi-skilled employees and workers. This will reduce some burden on the structural engineer.

C. DESCRIPTION OF MODEL TYPE

The model consists of RCC frame with concrete as a base material. This project mainly consists of Grid Slab and Flat slab in building at each level. Flat slab is being used at front portion of building to make beamless area for aesthetic purpose whereas inner side of building is having grid slab to resist loads easily and to increase rigidity of the structure. This consideration of both flat slab and grid slab helps us to minimize use of closely spaced columns. The various parameters taken for analysis and design process are mentioned below:

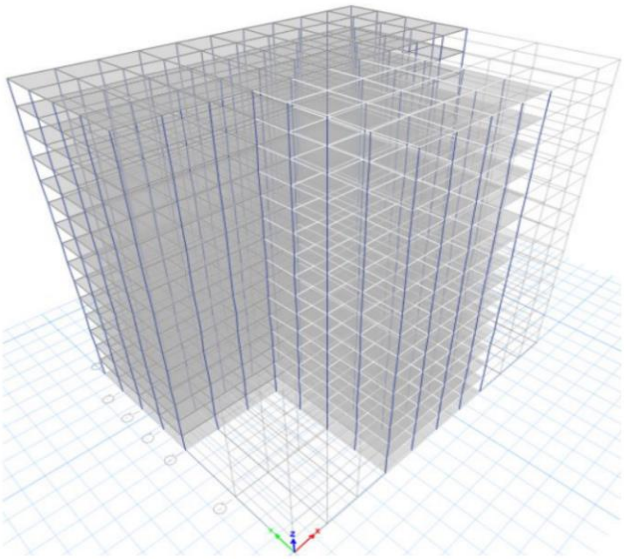

Fig. 1: Isometric view of structure.

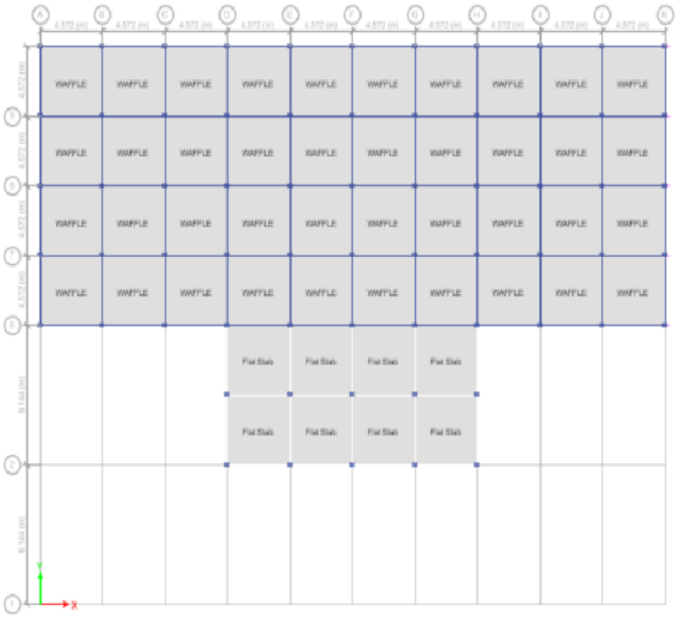

Fig. 2: PLAN of Structure

Above figure shows the plan view of structure labeled with waffle slab and flat slab.

Loads are the main parameters which we must consider while designing to make the final project such that it can resist all loading. The loads variety according to the function of the structure. The residential buildings are considered in general structures whereas institutional or commercial buildings are considered in important structures. The load distribution is same in case of residential and commercial structures as the building blocks are of same properties and mechanism but there is variation in amount of material used only. The loads are distributed from slab to beams. The slabs may distribute load in two ways that is either by one-way distribution or two-way distribution.

In case of one-way distribution, the load is transferred to longer span beams and shorter span beams experience

 DOI : 10.35291/2454-9150.2024.0080

minimum loading which is neglected in calculation process. A slab is said to be One-way slab when the ratio of longer span to shorter span is greater than 2 whereas a slab is said to be Two-Way when the ratio of longer span to shorter span is less or equal to 2.

After the transfer of loads from slab to adjacent beams, the load is transferred to columns and then finally to foundation.

IV. RESULT AND DISSCUSSION

A. DESIGN RESULTS

Design results are taken after completion of analysis process. Analysis gives idea of reaction of building members towards applied load and gives the values at different sections. Design in turn is the selection of member sections to resist load coming on it and the amount of reinforcement needed to counteract bending moment and shear force generated at a section. The main aim of all the process of loading and analysis is done to get an idea about selection of cross section and amount of reinforcement provided.

To get sections and reinforcement data is the final stage of design of a structure so that drawings can be created which is then implemented for construction. In this project there were some iterations to get best cross section for beams and columns so that they can resist loading without failure. It can be seen from pictures that there are some red lines which shows failed members. We know that as we go from top to bottom the section of columns goes on increasing because axial forces on columns increase as we go downwards. Similarly section of beams are found larger in interior beams as compared to outer beams.

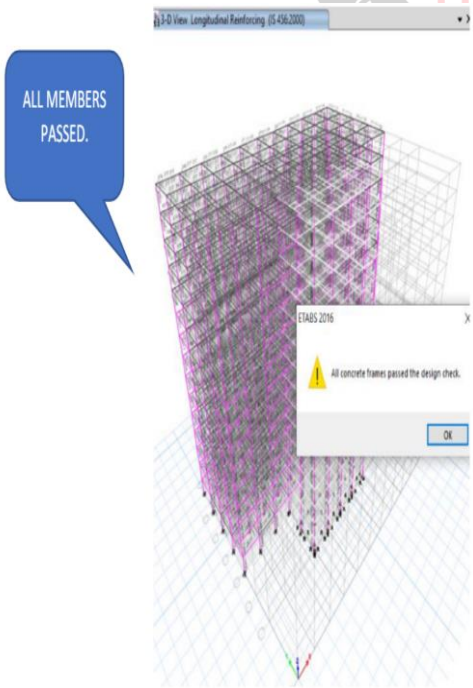

Fig. 3: Model analysis and all member passed

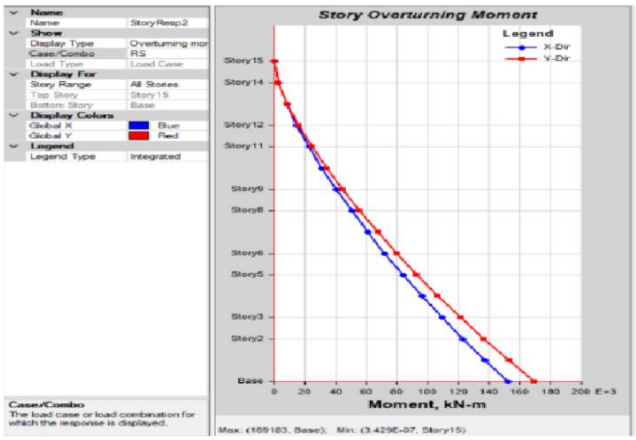

Fig. 4: Story Overturning Moment.

V. CONCLUSION

Although the approaches to check various results of different slabs in a single building is different but main focus is same, which is to check the effectiveness on their structural point of view. Static and dynamic analysis is being carried out to know the collective reaction of slab and beams to external loading. Economical section is being checked by many researches at different load conditions. Storey drift is minimized by provision of grid slabs. By going through all these papers, I came to know if we consider economical point of view then grid slab is not necessary. But if we are designing an important structure where there is need of large spaces Grid slabs plays a vital role at that place.

Designing the building with Flat Slab and Grid slab for long span building on ETABS, it is clear that ETAB gives best result for reinforcement data. This is the main reason which

I found while going through this research. Secondly ETABS gives the reinforcement detailing with drawing in the form of distinct tables, In case of ETABS failed members can be checked simply after design step. "Check failed members" in design section directly select those members and Design Engineer can change the section of those members by taking them in "view selected objects only". And then section is changed to those members to make them pass for the given loading. ETABS consists of multiple steps to complete a design by assigning each parameter of design that is why results were taken by use of this software.

VI. FUTURE-SCOPE

Using ETABS, the research of review document and journal discovered the different outcome and conclusion on the grounds of these results and the further work is evaluation of multi-storey construction (G+14) such as strengthening, shear force, bending moment etc. This research will help to select technology accordingly if project type is known to

 DOI : 10.35291/2454-9150.2024.0080

get better results. In next research processes this research can be used to know the best point of application of each technology to make some adjustments in case of slabs to get

best results. This process does not end here it is a vast field there is lot of research to know about strengthening process of structures by these results. Future projects can be analysed by using other materials on both slabs to get economical design and can be made various changes. This was for the purpose of education but this definitely gives us the practical idea of use of different slabs at various conditions.

Some researchers are still going there on types of slabs to be provided at different instances. This research will help other researchers to get idea and to put fore front its

results and then elaborate it with other techniques. There might be some flaws in this research which can be fulfilled onwards by engineers going for higher studies.

REFERENCES

[1] Uttam V Chothani, Jashmin Gadhiya, Hitesh K Dhameliya, "Comparative Study of Seismic Behaviour and Cost Comparison of Multi-Storey Flat Slab and Conventional Reinforced Concrete Framed Structure", IJSRSET | Volume 2 Issue 3 | Print ISSN: 2395-1990 | Online ISSN: 2394-4099

[2] Chintha Santhosh,"Analysis and Design of Multistory Building with Grid Slab Using ETABS", International Journal of Innovative Research in Science, Engineering and Technology Vol. 5, Issue 9, September 2016| ISSN(Online): 2319-8753

[3] Salman I Khan and Ashok R Mundhada, "Comparative Study of Seismic Performance of Multistoried RCC Building with Flat Slab and Grid Slab", International Journal of Current Engineering and Technology, Vol. 5, No. 3, June 2015, E-ISSN 2277-4106, P-ISSN 2347-5161, pp. 1666-1627.

[4] Mohana H. S and Kavan M. R, "Comparative Study of Flat Slab and Conventional Slab Structure using ETabs for different Earthquake Zones of India", International research Journal of Engineering and Technology (IRJET) Vol. 02, Issue 03, June 2015, e-ISSN 2395-0056, p-ISSN 2395-0072, pp. 1931-1936

[5] Sathawane, & Deotale, R. S. (2011). Analysis and design of flat slab and grid slab and their Cost comparison. International Journal of Engineering Research and Applications, 1(3), 837-848.

[6] S.V Mahamuni, Prof. Dr. S.A Halkude, "Comparison of Various Methods of Analysis of Grid Floor Frame", International Journal of Engineering Science Invention ISSN (Online): 2319 - 6734, ISSN (Print): 2319 - 6726.

[7] Sumit Sharma, Ashish Yadav and Mukesh Dubey, "Review Paper on RCC Structure with Flat Slab". International Journal of Advance Engineering and Research Development Volume 5, Issue 02, February - 2018

[8] R.S.More," Analytical Study of Different Types of Flat Slab Subjected to Dynamic Loading", International Journal of Science and Research (IJSR) Volume 4 Issue 7, July 2015 ISSN (Online): 2319-7064

[9] C.H.Rajkumar, Dr.D.Venkateswarlu, "Analysis and Design of Multi-storey Building with Grid Slab Using ETABS", International Journal of Professional Engineering Studies Volume VIII/Issue 5 / JUN 2017.

[10] Anitha.K, R.J Rinu Isah,"Design and Analysis of Grid Floor Slab", International Journal of Pure and Applied Mathematic Volume 116 No. 13 2017, 109-115 ISSN: 1311-8080 (printed version); ISSN: 1314-3395.

[11] Avinash Patel, And Seema Padamwar,"The Response Of Flat Slab and Grid Slab Systems in Conventional RCC Buildings". Indian J.Sci.Res. 14 (2): 516- 521, 2017 ISSN: 2250-0138.

 DOI : 10.35291/2454-9150.2024.0080