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Dynamic Analysis of Flat Slab and Grid Slab System in a Multistorey Building

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Abstract: *Civil engineers are facing a great challenge in structural designing. The design must fulfill various parameters which include economical 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. Nowadays every designing organization is using these Software but there is a question mark to which software we must go for designing. The parent organizations which have developed these designing tools promote their Software by showing all the positive points. In addition to this they are trying to fill all the loop holes which they found in their products but it will never happen that another developing company will put the points in light what the negative points are there in existing products. They keep on improving to deliver their best. In this project work I will present the difference for future users to which tool you must go through to acquire your needs. I am not saying that some products are not ok at all. I have designed a residential building with proper loading which is being designed on both ETABS. Manual calculations make it crystal clear the difference between the Software. The main purpose of this study is to show detailed difference between well-known simulation Software STAAD Profaned 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 Performa difficult task. It is found that ETABS is good for building design and 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 noted sign result while using STTAD Pro.*

Keywords: STTAD Pro

I. INTRODUCTION

An RCC framed structure is basically an assembly of slabs ,beams, columns and foundation inter-connected to each other as a unit. The load transfer, in such a structure takes place from the slabs to the beams, from the beams to the columns and then to the lower columns and finally to the foundation which in turn transfers it to the soil. The floor area of arc framed structure building is 10 to 12 percent more than that of a load bearing walled building. Monolithic construction is possible with r.c.c framed structures and they can resist vibrations, earthquakes and shocks more effectively than load bearing walled buildings. Reinforced concrete is a composite material in which concrete's relatively low tensile strength and ductility are counteracted by the inclusion of reinforcement having higher tensile strength and ductility. there in for cement is usually embedded passively in the concrete before the concrete sets.

The reinforcement needs to have the following properties at least for the strong and durable construction:

- High toleration of tensile strain.
- Good bond to the concrete, irrespective of pH, moisture, and similar factor.
- Thermal compatibility, not causing unacceptable stresses in response to changing temperatures.

Design needs to have good hand on numerical problem, to counter different challenges while getting twisted in a design. After complete knowledge of analysis and design one can design any structure but it is not possible for a single

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person to go through all fields. It is necessary to get a full knowledge in a particular field. Building analysis and design needs complete knowledge of IS Codes and numerical analysis. One must be well versed about loading which are considered in a building. Building can be of various types and can be residential, commercial, industrial and institutional. So, while performing a design we need to go through different design codes. Some of the codes are given below with their description of loading.

- IS-875(Part 1)– Design Code for Dead Loads.
- IS-875(Part 2)– Design Code for Live Loads.
- IS-875(Part3)–Wind Load Design Code. IS- 1893

In addition to above codes we have other codes too to take proper loading and to follow the steps as per standard code recommendation. Engineers which are dealing with Analysis and Design of Structures are known as Structural Design Engineers. They are professional in design both by manual process and by software means. But there is a question that which method we must choose while designing nowadays. It is not as easy as it looks to design a problem it needs mathematical calculation and practice in that field. With this specialization one must have good hand on numerical calculation and must have good experience as well.

OBJECTIVE OF THE RESEARCH

The main approach of this research is to test the basic assumptions that others in the field have used. It is quite possible for an assumption to become accepted fact simply because several authors have stated or cited the same idea, even though it has never been systematically tested or proven. I got the opportunity to find such an untested assumption and can think of away to test it, then my work can be of great value to the field (provided it is well executed) Technology is growing now a days with an alarming rate. It is necessary for every individual to get know about latest technologies as they make life easier from time to time. Great scientist's and creative work force are involved in the process of making changes in technologies and to make complex things easy as much as possible. With this research I will get to know about latest technologies and will compare some results how much difference is being acquired and how much accurate is the result given by technologies used in our field. The points which will be taken into consideration while going through the research are listed below:

- Modeling and analysis of G+14 R.C. framed structure by the use of ETABS and to detail the process using various design code algorithms for concrete member selection.
- To assign a suitable cross section which will resist load as well as fulfill some design requirements such as economy and serviceability.
- Comparison of results obtained in terms of storey drift, displacement, base shear, stresses and deflection in the portion of building with flat slab and the portion of building with grid slab and finally verifying the results

II. METHODOLOGY

The research consists of various values which are considered to know the fact which I was searching for. The methodology must be well known and should be of practically applicable. So, in this research I found it suitable to select ETABS for my fact-finding process as they are widely used nowadays. Experts are available in case there is any need of assistance while having some technical issue. The brief history of these two Software is given below:

In structural design and analysis various types of software uses like:-

- STAADPRO
- ETABS
- SAP
- SAFE
- ANSYS
- STAADPRO FOUNDATION
- STAADPRO RCDC

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Many design alternatives run in parallel with the cloud services of STAAD PRO and view the results in clear side-by-side graphical comparisons. Design for high-seismic regions or everyday conditions, using Finite Element analysis. Optimize BIM concrete and steel workflows with full physical and surface integration.

III. 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 analyzed 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,STAADPRO,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 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.

IV. 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.

ROLES AND RESPONSIBILITIES OF STRUCTURAL DESIGN ENGINEERS IN CONSTRUCTION

A strong knowledge of physics, creative problem solving and three-dimensional conceptual skill must be gained by a structural engineer. Other than these, the roles and the responsibilities of the structural engineer includes:

- Structural Designing
- Site and Work Investigations
- Communication

Adequate Training is required for a Structural Engineer to make him technically sound so that he can solve complex problems, find solutions of various problems and can make efforts to rectify errors as much as possible. The structural model is composed of framed structure, with beam sand columns being monolithically considered.

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V. 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 a teach level. Flat slab is being used at front portion of building to make beam less area for a esthetic purpose where as 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:

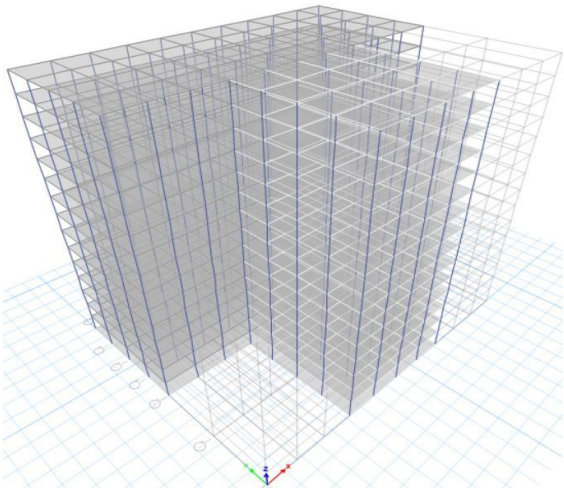

Fig1: Isometric view of structure

No. of Floors = G+14
Height of each Floor = 3m
Beam Size = 300 mm X 250 mm
Column Size's taken = 500mm X 400mm, 350mm X 300mm, 450mm X 350mm and 550mm X 500mm.
Flat Slab Thickness = 150 mm
Grid Slab Thickness (Waffle Slab) = 450(Overall) Live load on each floor = 3 KN/M2
Load due to Floor Finish = 0.75KN/M2 Type of Soil = Medium
Zone=III
Grade of Concrete used = M25 Grade of Steel = Fe-415

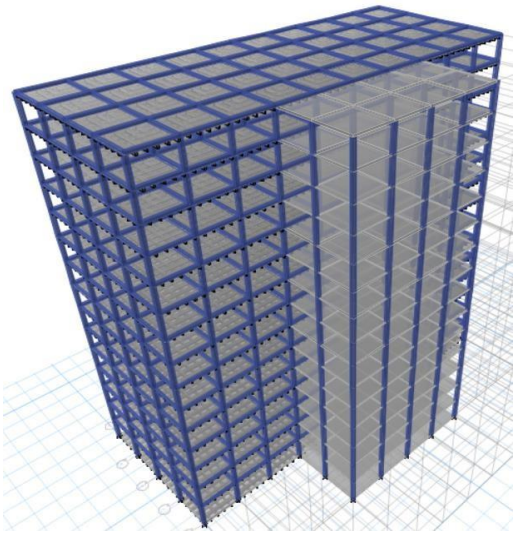

Fig 2: D Rendered view of building

The structure composes of both flat and grid slabs. Above diagram makes it clear by showing rendered view of structure. When slabs are used without beams, they are called flat slabs. That means load coming on slab is resisted by slabs itself but not transferred to beams. In case of flat slab load is directly transferred from slab to columns. In this

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configuration of slabs, load is not distributed in one way or two way phenomenon. Drop panels were used to prevent the structure from punching failure

VI. 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.

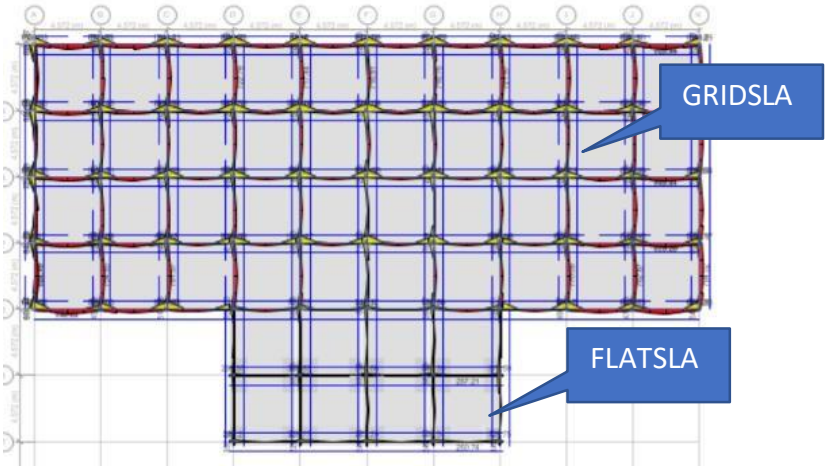

Fig3: Diagrammatic representation of reinforcement of top slab

Table 1: Area of Reinforcement at mid span of slab.

0 535.4mm^2	0 524.48 mm^2	0 523.22mm^2	0 529.95mm^2
0 499.56mm^2	6.73 mm^2 498.22mm^2	6.54 mm^2 506.25mm^2	0 539.9mm^2
0 403.23mm^2	0 348.12mm^2	0 352.8mm^2	0 412.95mm^2
0 257.35mm^2	0 163.18mm^2	0 162.94mm^2	0 258.37mm^2

GRID SLAB

FLAT SLAB

Above table shows reinforcement consisting of data from four panels of flat slab and four panels of grid slab. Reinforcement data is taken at mid span of edges of each panel to make comparison with flat and Grid slab on the basis of reinforcement. It can be clearly figured out that area of reinforcement needed for Grid slabs is more than Flat slabs.

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VII. 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. Some structural Engineers recommend to provide floating columns in parking lots, open spaces etc but in return that needs extra reinforcement for nearby beams and columns which bypass the loading which is transferred by that column.

To know the inter-relation between grid slab and flat slab and their dependency on adjacent beams and to check the effect on reinforcement, section detailing. By going through some of the researches done previously I came to conclusion by this research that:

1. Flat slab makes it best for design purpose instead of grid slab if we take economic point of view.
2. Reinforcement provided for flat slabs is minimum as compared to grid slabs.
3. Grid slabs help to minimize provision of number of columns as they are rigid and can be used for longer spans. But flat slabs cannot resist that much amount of load as they are not supported by beams.
4. Stress is found to be maximum on flat slab as compared to grid slab.So,chances of cracks will be more in flat slabs.
5. As found in analysis result stress is minimum at column joints in both the cases but in case of flat slab drop panels are used to minimize stress on columns. Drop panels transfer loading uniformly from all sides.
6. Deflection is always found more in case of flat slabs as they are not supported by beams whereas grid slabs show good resistance for deflection.
7. By this research work I came to conclusion that if it is any important building like public building then it is necessary to use grid slabs to make frame as rigid as possible. On the other hand, it will cost more but will be durable and safe as compared to flat slabs. Flat slabs are mostly used in the cases where we prioritize aesthetic look of building and where we want to provide any different architectural look in building.

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 the min “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.

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