International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 08 | Aug 2023 www.irjet.net p-ISSN: 2395-0072

Analysis and design of multistorey commercial building using Etabs

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Abstract— Civil Engineers are facing a great challenge in structural designing. The design must fulfil various parameters which include economical structure, durability and serviceability. But taking these points in mind it becomes very difficult for an Engineer to fulfil all these requirements at a time when a design is performed manually. This dissertation presents 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 for commercial building.

Nowadays every designing organisation is using these Software but there is a question mark to which software we must go for designing. The parent organisations 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.

Key word: Etabs Software, structural design, commercial building.

1. Introduction

In civil engineering, a structure with several parts, such as a foundation, walls, columns, floors, roofs, doors, windows, ventilators, stairlifts, various types of surface coatings, etc., is referred to as a "building." A structure is created using structural analysis and design such that it can withstand all applied loads without failing for the duration of its planned life. Geotechnical investigation must be used to gather the relevant data regarding the supporting soil before any structure's study and design. The process of gathering data and assessing the site's conditions in order to plan and build a structure's foundation is known as a geotechnical site investigation. In order to ensure that the final design of a building and the building can be used for its intended function over the course of its design life, structural engineers must balance the need for the most accurate, efficient, and inexpensive design. STAADPRO, ETABS, SAP, and other software programmes are now available on the market for nearly all types of structural analysis and design.

AUTOCAD:

A popular commercial drafting and computer-aided design (CAD) programme is AutoCAD. AutoCAD, created and marketed by Autodesk, was first made available as a desktop application for microcomputers with built-in graphics controllers in December 1982. Prior to the release of AutoCAD, the majority of commercial CAD programmes were run on mainframe or minicomputers, with each CAD operator (user) utilising a different graphics terminal. Additionally, there are mobile and online apps for AutoCAD.

ETABS:

Engineering software called ETABS is used to analyse and design multi-story buildings. The grid-like geometry specific to this form of construction is taken into account via modelling tools and templates, code-based load prescriptions, analysis techniques, and solution approaches. ETABS can be used to analyse simple or complex systems under static or dynamic conditions. Modal and direct-integration time-history analyses may be coupled with P-Delta and Large Displacement effects for a sophisticated evaluation of seismic performance. Under monotonic or hysteretic behaviour, nonlinear linkages and concentrated PMM or fibre hinges may capture material nonlinearity. It is possible to develop applications of any complexity thanks to intuitive and integrated features. ETABS is a coordinated and effective solution for designs ranging from straightforward 2D frames to intricate modern high-rises thanks to interoperability with a variety of design and documentation systems.

2. Literature Review

1) **Mounika. Pallapolu et.al (2017)** this project presented the plan, examined and outlined a vertical general office building of G+4 storey and explored its execution under different loading conditions. The purpose of the building was commercial which is in the shape of rectangular having G+4 stories with a depth of foundation of 1.5m by using brick wall. The area of construction was Hyderabad. The project was taken in rainy season in the month of August. The approximate temperature during construction was 30 degrees centigrade, having humidity up to 25 -27%. Soil condition during the time of construction was medium stiff. The entire design was done by the code arrangement IS: 456:2000. The load that followed up on the structure was taken from the code arrangement IS: 875 part1,2,3.

2) **Rohitkumar.B. R et.al (2017)** The analysis and design of a multi-story residential building of (G+2) employing the most cost-effective beam to column approach are the subjects of this work. With its additional capabilities, ETABS outperformed its predecessors with its data sharing while applying the dead load and live loads and designing for beams, columns, and footing. Their main goal was to finish the multi-story building, ensuring that it is safe and inexpensive under gravity loading conditions, and perform the function for which it was designed. Both the dead load and the live load were taken into account when designing the construction. Utilising the software programme ETABS, the structure's study and design were completed. There are multiple stories in this project. The design adhered to IS 456-2000 guidelines. The analysis' findings were utilised to confirm that the structure was fit for usage. For the calculation of forces, bending moments, stress, strain, and deformation or deflection for a complicated structural system, computer software is also utilised. This project's main goal was to compare ETABS 2009's design and analysis of multistory buildings (G+2) to manual calculations. They had a fantastic opportunity to get involved in the planning and design of a multistory hostel building during the project's preparation. This project has provided an opportunity to recall and coordinate the different engineering principles and design methodologies we learned in our lower levels. ETABS software was used for the design, which was then successfully manually checked in accordance with IS 456-2000. Using ETABS, the analysis and design work were finished in the allotted amount of time. When compared to calculations and designs done by hand, software-assisted analysis and design outcomes were secure.

3) **Mahesh Kumar C L et.al (2017)** developed "Seismic evaluation of multi-storey building using E-TABS" for Vol. 04 issue 08, August 2017. In this paper, G+10 floors were taken into account. the different loads placed on a building, such as seismic, live, and dead loads. Afterward, using the E-TABS programme, analyse the behaviour of the structure when it is subjected to a combination of loads. Considering the equivalent static approach for various zones and soil types when building irregularities. The lateral force caused by the wind earthquake action is felt by the tall building.

4) **Sayyed Firoz Sikandar et.al (2017)** Analysed and designed a G+10 story apartment building. The analysis was carried out with the aid of ETABS V15.2. An apartment building with (G+10) stories and a parking garage on the ground level was studied and developed. It is located in Latur, Maharashtra. Additionally offered were structural components such an RCC frame, a shear wall, and a retaining wall. The slab, staircase, and isolated footing were all painstakingly designed. The design processes involved performing manual load calculations and using ETABS to analyse the entire structure. To the greatest extent possible, the analysis and design were completed in accordance with standard requirements. It was also acknowledged that there were a variety of design challenges and limits that the structural engineer had to work within to design up to the architectural picture.

5) **Maruthi.T et.al (2019)** An attempt was made to analyse and design a commercial building using ETABS in this study, "Analysis and Design of Commercial Building Using ETABS software." Static analysis was used, and design was completed in accordance with IS456:2000 standards. Additionally, an effort has been made to manually design the structural components. Software called ETABS (9.7 version) is used for modelling. The first step towards achieving these goals was to create grid layouts. For these purposes the preliminary step was to prepare grid layouts. As their selected structure was (G+1) story, they prepared plinth beam layout, floor beam layout and roof beam layout and by using this layout they prepared grid system using ETABS. The next step was to define the materials properties, beam details, column details, slab details and the load combinations by referring to IS 456-2000

3. METHODOLOGY

KANI'S METHOD:

Analysis of continuous beams - including settlement of supports and single bay portal frames with and without side sway Kani's method, also called the Rotation Contribution Method, is an approximate calculation method for indeterminate structures, acicularly portal frames and multi-story frames with fixed connections. It is a much simpler and less time-consuming method compared to the Moment Distribution Method.

DESIGN METHODS:

a) Working Stress Method:

The working stress method is the oldest method to design structure. It is rarely used nowadays. The working stress method depends upon yield strength. In this method, all the structural material behaves as elastic. Stress increase in a linear way as the load applied to the structure. In this method, permissible stress kept below the strength of the material. Sufficient factors of safety are provided for the serviceability of the structure.

b) Limit State Method:

As we know Working Stress Method concern with serviceability. But Limit State takes care of both the safety and serviceability of the structure. So, we can say that Limit state method is the combination of the working stress method and the ultimate load method. Limit state methods solve the problem of both service abilities like large deflection in the structure and limit state of collapse like a fracture.

Assumptions

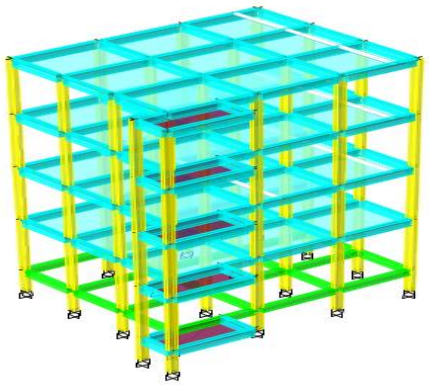
1. Type of structure: Framed
2. Form of structure: Slab-beam type
3. Type of material: Concrete
4. Grade of steel: Fe-500
5. Grade of concrete: M-25
6. Method of construction: RCC
7. Density of RCC: 25KN/m^3
8. Density of burnt brick masonry: 18.85KN/m^3
9. The lived for commercial building the slab is taken as 4KN/m^2
10. The wind load is considered as the height of building is exceeding the effective width as per [clause no. 4.3.4(a)] of IS 875-1987.

Dimensions

The dimensions of various elements are

1. Beam – 230*375mm
2. Column – 230*450mm
3. Slab thickness – 150mm
4. Wall thickness – 230mm
5. Parapet wall height – 1.5m

3D RENDERING OF COLUMNS AND BEAMS



4. CONCLUSIONS AND FUTURE SCOPE OF THE WORK

This chapter presents conclusions and scope of the work

1) Using E-TABS, deflection of entire structure can be calculated. But in case of manual design deflection of each member is calculated separately which is tedious time consuming.

2) Analysis and design of framed structure using E-TABS is easier when compared manual analysis and design.

3) In manual analysis methods, 2D frames are considered but in case of E-TABS the whole building is analyzed as 3D frame.

4) In case if any human errors occur during manual analysis and design, then whole procedure has to be completely repeated, but in case of E-TABS the errors can be suitably changed and new results can be obtained immediately.

5) Finally, it is concluded that E-TABS method of analysis and design of building frame is easier and quicker when compared to manual design.

6) Values of bending moment and shear forces obtained along by the permissible limits as per IS code

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