

Optimized Design of Multi-Storey R.C.C Building in ETABS

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Abstract— ETABS is computer software which provides a variety of modelling, analysing, designing practice processes for civil engineering infrastructure & nowadays ETABS is widely used in India to analyse & design various types of frame structures. In this regards, this paper presents to provide the simplest way to analyse & design a frame structure in ETABS & to provide an economical section which will get by design which reduces the cost of construction of the R.C.C. Building & it is mainly achieving by the use of computer software rather than manual conventional designing methods so, that it is important to aware the engineers use designing software which helps them to model, analyse & design the structure in the easiest way with optimization. The present work was carried out on G+12 Storey residential building. modelling, analysis & design of the frame structure with a shear wall is done by using software package ETABS, for the design of structure dead loads, live loads, wind loads & earthquake loads are considered & limit state method is adopting for the analysis, here the design is in confirmation with IS 456:2000. The principal objective of this paper is to aware Civil-Structural Engineers to adopt the simplest way to design a residential or a commercial building in ETABS.

Keywords: ETABS, Analysis & Design, Multi-Storey Building

I. INTRODUCTION

As our country is the fastest growing country in terms of the population across the world so the need for the shelter is the prime need of every people, whereas the population of all the cities is growing at a higher rate than the rural areas is because of the people are moves towards city from rural areas but for accommodation in city due to increase in population horizontal expansion is not possible due to unavailability of space, so the only solution for this is achieved by vertical expansion & it is possible when multi-storey buildings are to be constructed. Shear wall is more efficient & also economical in construction of tall & multi-storey building structure. As a Civil Engineer is it our responsibility to provide efficient housing accommodation to the society which is also safe in a structural point of view. In today's era, the design of multi-storey the building is done by using software & there are various software packages which are available in the market like ETABS, STAAD.Pro, MIDAS, SAP, RISA, STRUDL, RAM, etc.

The term building in Civil Engineering is a structure having various components like foundation, plinth, slabs, walls, columns, beams, staircases, lifts, doors, windows, etc. so to provide all the components in good aesthetics with providing structural safety our design should resist all the loads comes over the structure during its intended life of the structure so that our final design of the structure must be serviceable for its intended function over its design life period.

Optimization means the action of making the best or the most effective use of resource thus, the structural optimization is the making assemblage of materials sustains different types of loads in the best way, the goal of optimization is to find the best solution among a set of solutions using an efficient quantitative method. In this framework, a residential building with G+12 Storey is taken for analysis & design.

II. IMPORTANCE OF CORRECT DESIGN STEPS

While designing the structure it is very important to follow the correct steps to get the correct results

- 1) In any structural design software, it is important to follow certain steps in order to reach the correct results.
- 2) If by mistake any step is miss out of these steps, they may get any results which may or may not be correct.
- 3) Always follow the steps. Tweak the individual steps by own but don't change the sequence or remove any of these steps.

III. OBJECTIVES

- 1) The main objective of this study is to analysed & design G+12 R.C.C. multi-storey building using ETABS software.
- 2) To understand the basic principles of building structures by using Indian Standard Codes

IV. SCOPE OF THE STUDY

The scope of the study is to provide appropriate designing steps for building frame structure in ETABS software which will minimize the time required for designing structure if compare with designing the structure by manual method.

V. METHODOLOGY

A. STEP 1: Prepare Beam-Column Plan with Centreline

Once prepared the architectural plan start placing the columns at the desired location with respect to its orientation for better aesthetic view by following the column placement rules; In Fig. 1 shows the Beam Layout Plan.



Fig. 1: Beam Layout Plan

B. STEP 2: Model Initialization Set-Up

For following Standard specifications of Steel Design Code - IS 800: 2007 & Concrete Design Code - IS 456:2000 & feasibility for display units this setup is required to fill at an initial time. Fig. 2 shows Model Initialization.

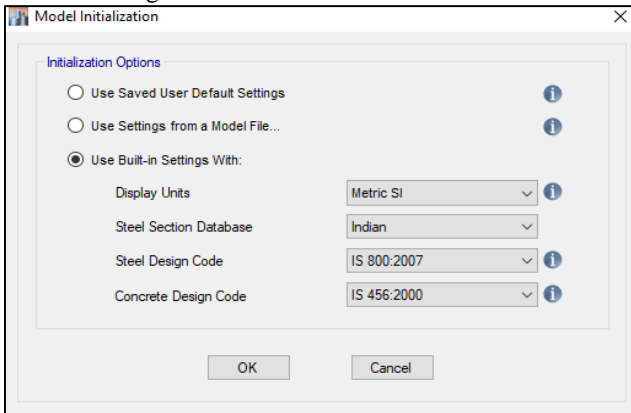


Fig. 2: Model Initialization

C. STEP 3: Enter Grid Spacing

In ETABS i.e.; Centreline Spacing of Beams This step is a really important step, model the structure is very easy & quick process by using quick draw tools compare to other software, Fig. 3 shows the Grid of the plan. Without Grid Lines, you will not be able to place beams and columns precisely to its location.

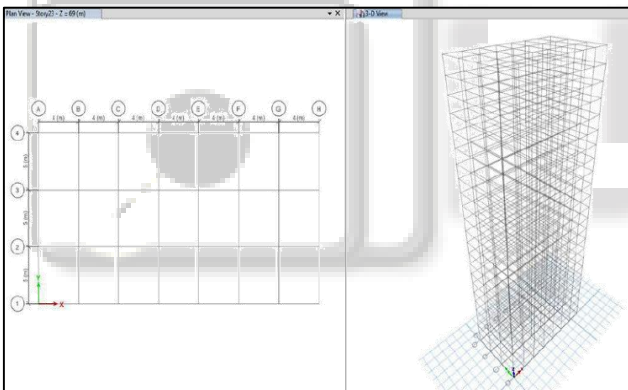


Fig. 3: Grid

D. STEP 4: Enter Concrete, Rebar Properties & Beam, Column, Slab Sizes

Once you have entered the referenced grids and entered into the ETABS you need to provide Material properties as per your project demands. Prominently these are Concrete (fck) & Steel (fy, fu) Once the material properties are entered, define Beam, Column, Slab sizes as shown in Fig. 4; in the Frame section list option.

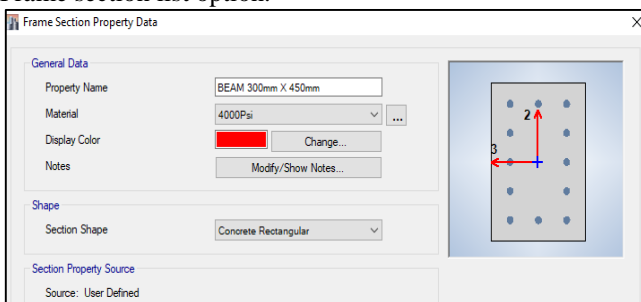


Fig. 4: Defining Frame Section Property Data

E. STEP 5: Provide: Shear Wall

Drawing shear wall by Wall Stack tool from Draw option & locate it on exact place in the plan.

F. STEP 6: Model the structure

Drawn the reference grids correctly as mentioned in Step 2 then modelling the structure is an easy by using Draw Beam/Column tool to draw Beam & Column at their respective location, Draw Rectangular Floor tool for providing slab & Draw Floor for non-rectangular slab & for staircase slab & in this way model will be created as shown Fig.5.

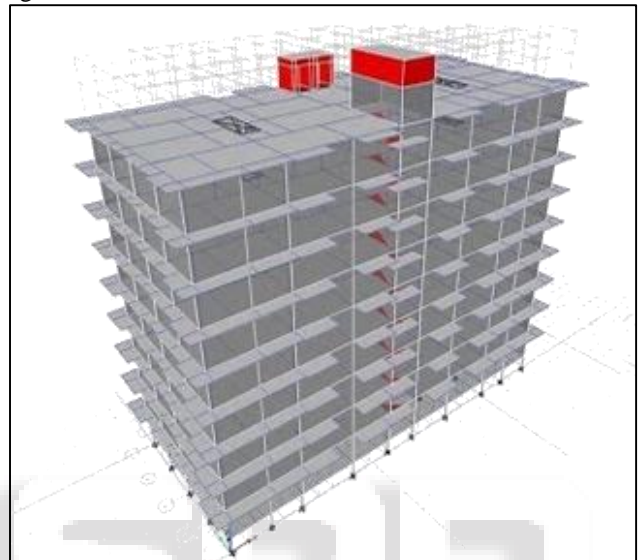


Fig. 5: Model of the Structure

G. STEP 7: Apply DL+LL+WL+EQ using IS Codes as per site conditions & Wall Load

Dead Loads are assigned as per IS 875-Part 1: 2013; Live Loads are assigned as per IS 875-Part 2: 2013; Wind Load are assigned as per IS 875- Part 3: 2015; Earthquake Loads are assigned as per IS 1893-Part 1: 2002. One cool thing about ETABS is that you don't have to apply self-weight onto beams, columns & slabs as ETABS automatically applies that for you because ETABS consider material property so through which it can calculate each member's self-weight.

H. STEP 8: Form load combinations & Assign Support Conditions

In Real life loads act in combination, so we need to analyse & design structures for load combination sets & before proceeding for analysis it is very important to assign the supports by keeping a selection of base of the structure for all columns.

I. STEP 9: Analyse the Structure & Apply Load + Deflection checks

Analysis results provide Bending Moment, Shear Force for all the members; Analysis will always come before Design. Post analysis checks are really important to be considered such as lateral deflection check, EQ deflection, WL deflection, beam & slab serviceability as per the IS 456 Code deflection rules.

J. STEP 10: Design the Structure & Apply Design Checks

By using Concrete Frame Design tool option Design, the structure for applied combinations of different loads & thereafter check for all the members for what they passed the design check or not. A member fails due to two reasons one is incorrect modelling and the other one is they have been given an inappropriate size.

K. STEP 11: Perform Automatic detailing

Because of designing the structure in ETABS software not need to Redraw Sheets in Auto-CAD, ETABS will provide Automatic detailing tools that can prepare floor framing plans for us & this is one of the best advantages of using ETABS. As the Floor Framing Plan is shown in Fig. 6. For the Reinforcement Details the ETABS File of the Project work is need to import in detailing software like Bentley Systems RCDC software to get Reinforcement Table which will further used for construction of that structure

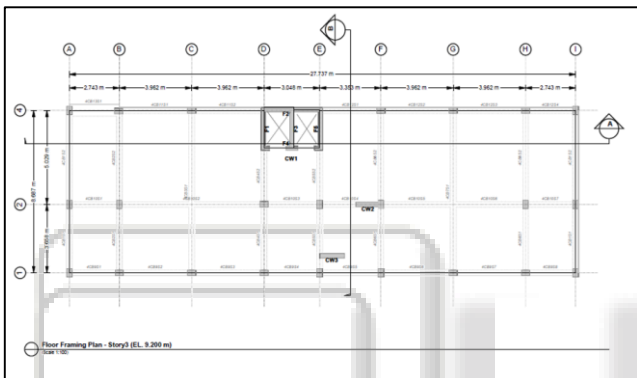


Fig. 6: Floor Framing Plan

VI. RESULT

Analysis & Design of residential building having G+12 storey is done by using software ETABS V15.0.0, which proved to be a premium of great potential in analysis & design of sections of the building structure. The design of RCC frame members like beam & column was done by using ETABS. The analysis & design was done according to the standard specification which is given by Indian Standard codes to the possible extent

VII. CONCLUSIONS

ETABS is an extremely powerful tool and can be adapted to specific needs in order to serve the intended purpose of any building project. By Performing Correct steps, you will not have to face any Model Error while Analysing for Error. The one useful thing is that ETABS will automatically provide the Structural Drawing of our project that is more helpful because drawing all the structural drawing in Auto-CAD or in Revit is a very difficult task.

From the analysis & design of the structure, the following conclusion has been made

- 1) The analysis was done by ETABS software & successfully verified manually as per IS 456:2000.
- 2) By usage of ETABS software for Analysis & Design, it minimizes required time.

- 3) ETABS software gives shear forces & bending moment along with the member so, it indicates how member resist loads.
- 4) To resist the seismic forces, beam & column dimensions are increased or shear wall should be provided to oppose the lateral forces instead of a masonry wall.

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