

Detailed Design, 3D Modelling & Costing of Multi-Storey R.C.C Building

Mohammad Khalil Khan¹, Lokesh Vardhan D², Faizan Aslam Khan³, T M Hasibur Rahaman⁴, Bishal shah⁵, Sahil Jaggi⁶

^{1,2,3,4,5} UG Students, Department of civil engineering, Lovely Professional University, Phagwara, Punjab

⁶ Assistant Professor, Department of civil engineering, Lovely Professional University, Phagwara, Punjab

Abstract— There has been a significant growth in technology and advancement in designing a building. Designing is a sophisticated task and can get tedious at times where there are too many elements to design. Designing a building has different objectives to achieve based on the type of building. With time, it became a necessity for every designer to master their skills in computer software rather than traditional methods. It is equally crucial for a structure engineer to save time in order to participate in the fast-growing competitive market. So, the major goal of this project is to use computer-based software, such as ETABS, to design and assess a multi-story building. We receive more accurate results if we use computer-based software such as ETABS, AutoCAD, Google Sketch-Up, and so on. Because the software provides an easy-to-use and accurate platform for analysing a multi-story structure, the building study was dependable and efficient. The project is designed in accordance with Indian Standard Code.

Index Terms: Etabs-2019, Software, Building, analyze and design, RCC, Load, pH, Beam, Column, pedestal, clear cover, Indian standard code, dead load, live load, slab load, wall load.

1. INTRODUCTION

RCC refers to Reinforced Cement Concrete, a plain cement concrete reinforced with steel bars (a combination of cement, fine aggregate, and coarse aggregate). The major basic components of an RCC structure, including slabs, beams, columns, and foundations, are formed using reinforced cement concrete. The primary reason for reinforcing concrete with steel is to increase its strength, especially where the member would be exposed to tensile stresses, as concrete is a brittle material that has a low capacity for absorbing tensile stresses.

Designing an RCC building using computer software like ETABS gives a precise idea to the user about the flaws of the design and also provides simulations, animations, graphs, and calculations about the different kinds of loads and conditions that the building will have to go through after the construction.

The detailed views of reinforcement can be taken from CSI Detailing which is an attachment for CSIETABS. Using ETABS and Detail one can make minor to no errors in designing a building.

Softwares like Google SketchUp provide the user with aesthetic looks and drawing which takes care of the building's exterior and interior aspects. V-ray add-on to Google SketchUp provides realistic elements to the model and also works according to the lighting conditions by providing artificial lighting. AutoCAD provides a clean and easy-to-use interface to visualize and draw all kinds of views of the building.

All of the Standard codes are preinstalled in the design software and the structural designer can pick the codes depending upon his/her choice.

2. THE CURRENT STUDY

The current building is a G+7 storey which has been analyzed and designed by Etabs-2019, detailed by CSI detailing and architecture drawing has been done by using AutoCAD-2022, the building location is in Amritsar which has G+7 stories. The design is accompanied with abundant parking space and garden area to give the aesthetical appearance in the real world.

The architectural drawing was done on AutoCAD for a built-up area of 3171 m² that has sixteen flats in

each story, each flat has two bedrooms, a storeroom, kitchen, main hall and three bathrooms.

The building drawings are made in autocade 2D plan of each building with all the specifications and details such as four elevations, sections, details of all the elements, all the results of analysis design of the buildings are discussed. Each flat has a main hall of dimension (6.0 x 6.2) m². The main bathroom dimensions are (1.8 x 3.0) m² and (1.8 x 2) m² for the rest two. Both the bedrooms are of size 13.5m².

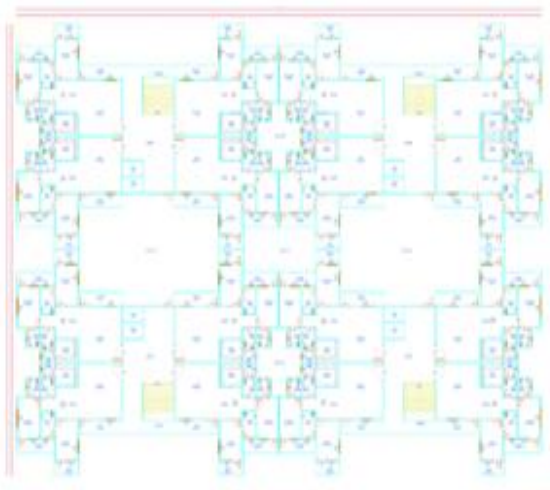


Fig. 1. Plan of the first to eighth floor

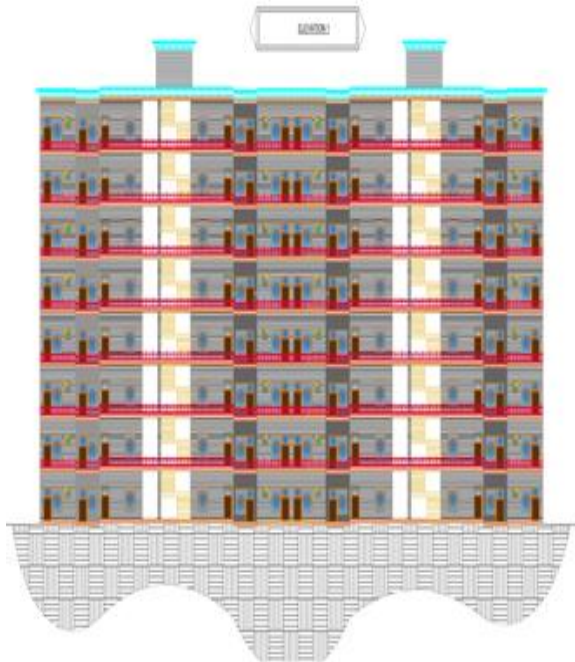


Fig. 2. Elevation of the front of the building



Fig. 3. Elevation of the side of the building

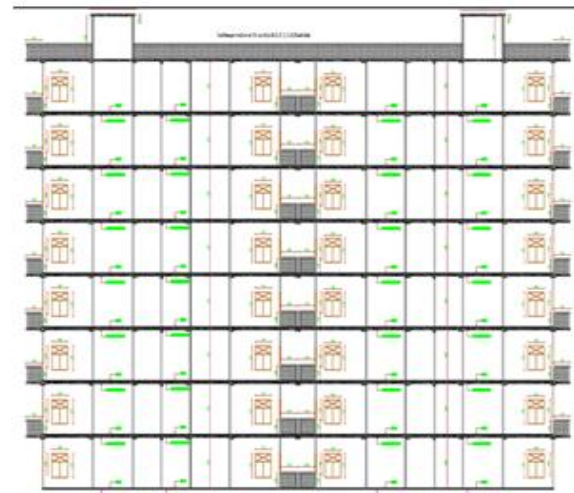


Fig. 4. Cut section of the building



Fig. 5. Cut section of the building

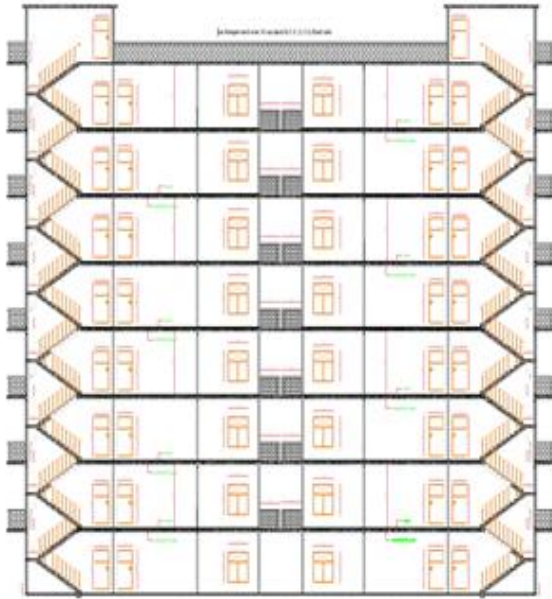


Fig. 6. Cut section of the building

3.1 MATERIALS

In the current project, software Architecture, modelling, analysis, design, and details for engineering is a broad field and is divided into subsections and parts, software are tools for maintenance of this project, it will be used as-is for these specific projects. AutoCAD 2022 is used in the first part Construction plan Architectural drawings like 2D planning, Height and section, better the project presentation is done with the help of SketchUp 2022, analytics, and 3-D modeling. Designed through ETABs 2019, and its details are CSI complete Details and quotes will be calculated With Excel 2019.



Fig. 7. 3-D view of the building



Fig. 8. 3-D view of the building



Fig. 9. 3-D view of the building

3.2. Analyze and design part:

3.2.1 LOAD CALCULATIONS

The dead load, live load, and seismic load are computed for the current building project, and the calculations, as well as combinations of the loads, are shown in the section below.

3.2.1.1 Dead load

Calculations for Dead Load The self-weight of structural parts, permanent partition walls, fixed permanent equipment, and the weights of various materials are the main sources of dead load. Loads are computed based on the unit weight of the materials utilised, as stated in (Part I) of IS 875 1987. Self-weight of brick wall = thickness of wall x unite weight x hight of wall – hight of beam

Heigh of each storey = 3.5 m

Beam size 1 750 x 700 mm

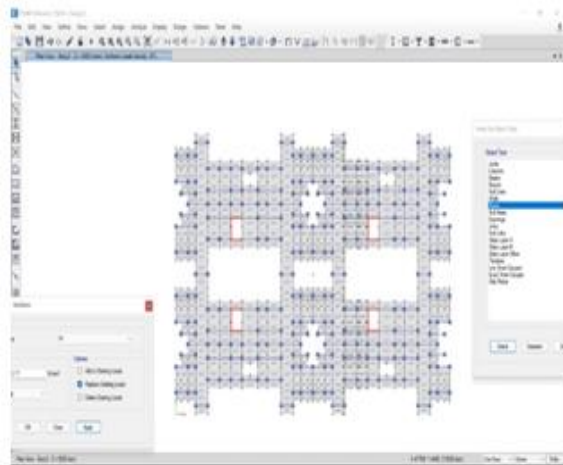
Beam size 2 700 x 550 mm

Beam size 3 800 x 650 mm

Beam size 4 900 x 600 mm

Column size 1 900 x 750 mm

Column size 2 750 x 900 mm



Self weight

Slab load kN/m² (127 mm)

$0.127 \times 25 = 3.17 \text{ kN/m}^2$

Wall load kN/m (228.6 mm)

$0.2286 \times (3 - 0.3) \times 19.1 = 11.789 \text{ kN/m}$

3.2.1.2 Live load

IS 875 1987 (Part 2) was used to calculate live loads.

Live load is 3 kN/m².

Seismic Load

ETABS was used to do the seismic analysis for our Capstone project.

- E.Q+x
- E.Q -x
- E.Q +y
- E.Q -y

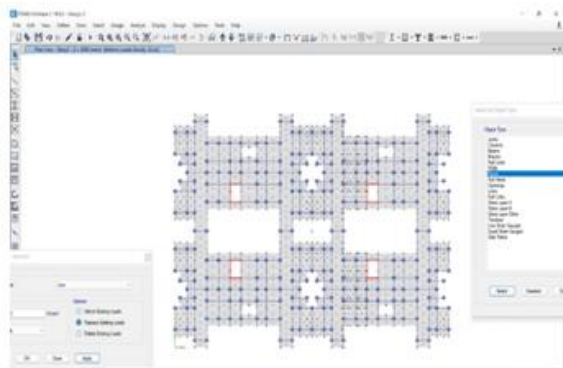


Fig. 11. Live load

City Ludhiana, City Centre

Z = Zone Factor

I = Importance Factor

R = Response Reduction Factor

Z IV, Z = 0.24

I = 1.2

R = 5

Time Period X = $0.09 \text{ h} / (d)^{1/2} = 0.09 \times 28 / (72.53)^{1/2} = 0.295$

Time Period Y = $0.09 \text{ h} / (d)^{1/2} = 0.09 \times 28 / (50.45)^{1/2} = 0.354$

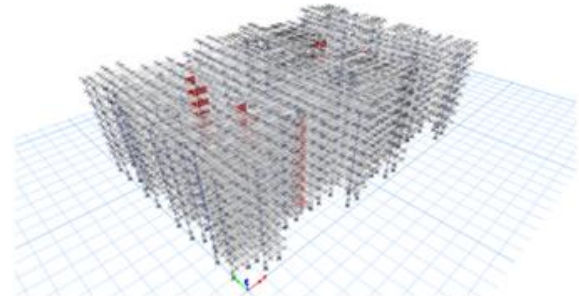


Fig. 12. After analysis

3.2.2 Load Combination

The combination of loads to be considered in the construction of structures is specified in IS 456:2000, IS 1893 (Part I): 2002, and IS 875 (Part 3). The following are the various load combinations that were used

1. 1.5 (D.L + L.L)

2. 1.2 (D.L + L.L + E.Q+x)

3. 1.2 (D.L + L.L + E.Q -x)

4. 1.2 (D.L + L.L + E.Q+y)

5. 1.2 (D.L + L.L + E.Q -y)

6. 0.9 D.L+ 1.5 E.Q +x

7. 0.9 D.L+ 1.5 E.Q -x

8. 0.9 D.L+ 1.5 E.Q +y

9. 0.9 D.L+ 1.5 E.Q -y

10. 1.5 (D.L + E.Q+x)

11. 1.5 (D.L+ E.Q -x)

12. 1.5 (D.L + E.Q +y)

13. 1.5 (D.L+ E.Q -y)

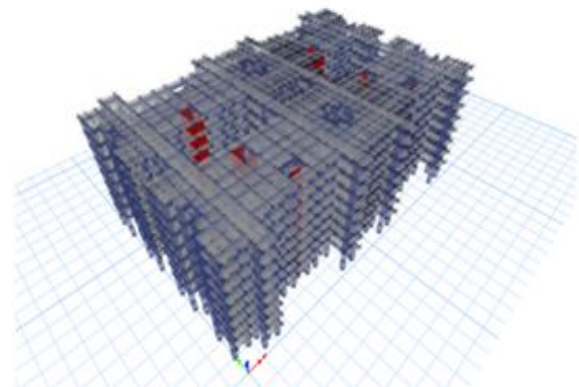
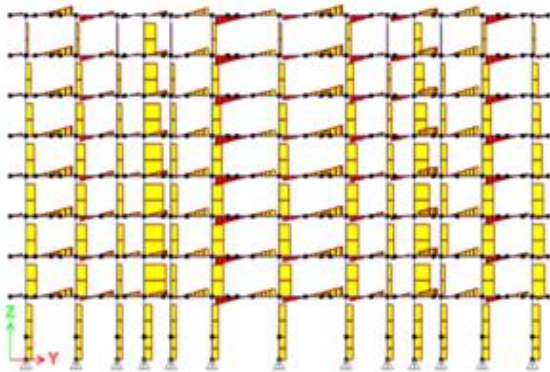


Fig. 13. isometric view



14. Shear force diagram

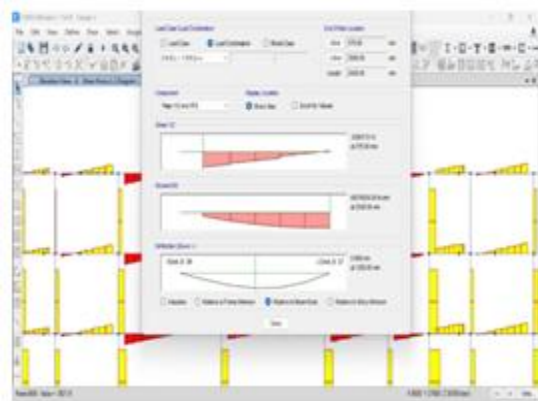


Fig. 15. Shear force diagram

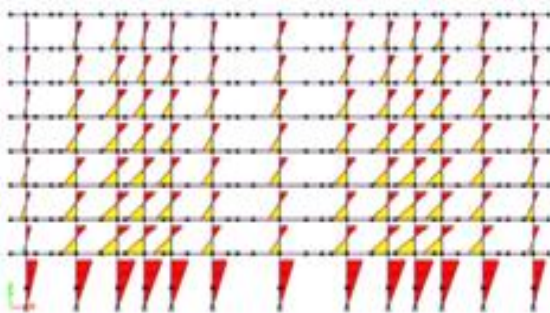


Fig. 16. Bending moment diagram

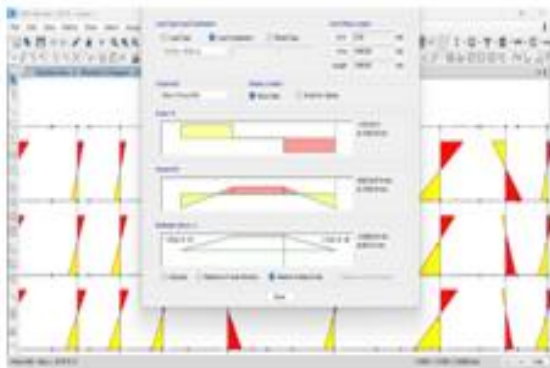


Fig. 17. Bending moment diagram

3.2.3 Result and discussion

The analyze and designed of the building that are done by ETAB software, the results of all the forces on building are given below.

4. DETAILING OF STRUCTURAL ELEMENTS

Detailing is the most important part of reinforced concrete design; the sections of the elements are detailed by CSI detailing software and the sections are shown in bellow.

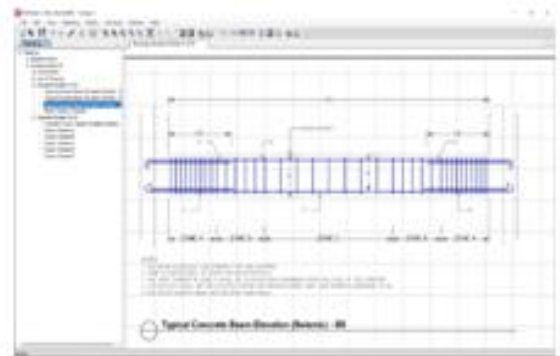


Fig. 18. Concrete beam elevation

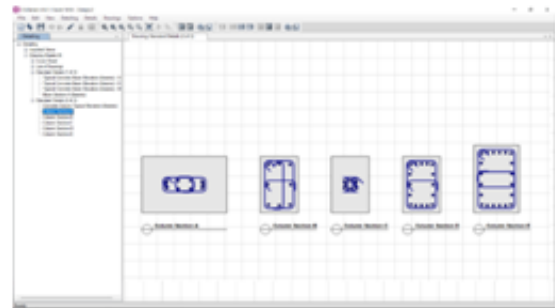


Fig. 19. Column section elevation

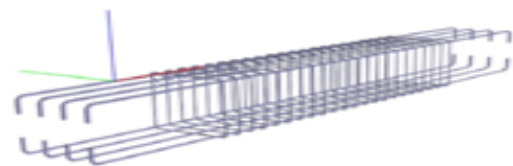


Fig. 20. Reinforcement details

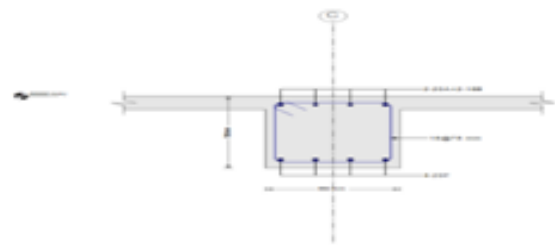


Fig. 20. Elevation & section

5. CONCLUSION

The paper presented complete design details and load calculations including the dimensions and grades of the structural components. In the paper, the design procedures for columns under concentric loads as per IS 800:2007 are reviewed and applied for different of steel sections to obtain safe loads for the sections in both major buckling axis and minor buckling axis. The beams in the far lower storeys need thicker and deeper beams to withstand the loads. The lower storeys include 2nd, and 3rd storeys. Pedestals are to be provided much thicker than that of the columns. In the analysis stage, forces such as bending moments, shear forces, and axial forces reactions are determined. The planned component is done according to IS 456 2000, the design has been done for the critical forces, after all the maximum forces are found with the findings of the forces.

All members, including beams, columns, slabs, stairwells, foundations, and footings, are intended to carry a high load capacity. Furthermore, according to IS 1893 part one, buildings are built to withstand seismic loads. and the detailing of designed members has been done with CSI detailing software and presented in detail. Throughout the current project, we have encountered a variety of problems and challenges that civil engineers confront, and we have learned a lot and gained practical knowledge in the field of civil engineering. We can now analyse and design a building as a group. Furthermore, working as a team with our Mentor, Mr. Sahil Jaggi, who mentored us so effectively, was a fantastic experience. We could not have finished this job without his assistance and the efforts of our entire team. As a result, in addition to learning how to analyse and design a building, we also learnt how to collaborate as a group.

REFERENCE

- [1] IS Code of Practice for Design Loads (other than earthquake) for Buildings and Structures," IS:875(Part –III)-2015, B.I.S
- [2] Indian Standard- Criteria for Earthquake Resistant Design of Structures (IS:1893 (Part-I)-2002)" B.I.S
- [3] Limit state design of RCC structures", New Delhi, Laxmi publications PVT Ltd., 2003.

- [4] IS:875 (Part-I)-1987, Bureau of Indian Standards, "Indian Standard Code of Practice for Design Loads (other than earthquake) for Buildings and Structures."
- [5] Websites like c for-civil, The Constructor, and others.
- [6] Reinforced Concrete" is a term used to describe concrete that has been strengthened IBH and Oxford Publishing Company published Mallik S.K's book.
- [7] IS 456: 2000 Indian Standard, "Plain and Reinforced Concrete – Code of Practice," B.I.S, New Delhi, 2007.
- [8] Prentice-Hall of India Private Ltd.'s "Advanced Reinforced Concrete Design" P.C. Varghese's contribution
- [9] Varghese. P.C, "Advanced Reinforced Concrete Design", Prentice – Hall of India Private Limited, New Delhi 2008