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Analysis and Design of G+5) Residential Building Using BIM

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ABSTRACT

Building Information Modeling (BIM) has revolutionized the way we approach building and infrastructure projects. By allowing users to create virtual models of a project from start to finish, BIM has transformed the way we plan, design, construct, and manage buildings and other structures.

One of the most popular BIM software tools on the market is Autodesk Revit. This powerful software is designed specifically for architects, structural engineers, MEP engineers, and contractors, and allows users to create highly detailed 3D models of a building's components. With Revit, users can annotate their models with 2D drafting elements, access important building information from the model's database, and make informed decisions that support sustainable design, construction planning, analysis, documentation, estimation, clash detection, fabrication installation.

In this project, we will be using Autodesk Revit to design and analyze a residential building with a ground floor and four additional floors. Each floor will contain two flats, with a staircase located between them. Our goal is to create a detailed 3D model of the building that considers all relevant factors, including sustainability, construction feasibility, and clash detection.

With BIM, we can accomplish this project more effectively and affordably than ever before. The result will be a highly detailed, accurate, and comprehensive model of the residential building that can be used throughout its entire life cycle.

Keywords: Building Information Modelling (BIM), Autodesk Revit, Robot Structural Analysis.

CHAPTER-1 INTRODUCTION

A residential building is more than just a structure that provides a place to sleep. It is a place where people create memories and build their lives. Our project goes beyond traditional architectural design and aims to create a living space that not only meets the basic needs of its occupants but also enhances their quality of life. Using advanced BIM technology, we can able to design and analyze a G+3 residential building that is not only aesthetically pleasing but also sustainable, costeffective, and efficient. We will also conduct a thorough structural analysis using Robot structural analysis to ensure the safety and stability of the building. Our project's objective is to create a residential building that not only meets the needs of its occupants but also contributes positively to the environment and the community.

1.1 RESEARCH OBJECTIVES

The Main Objectives of this Study is

- Creating a comprehensive 3D model of the residential building using Revit software
- Analyzing and designing a (G+5) residential building, considering structural, architectural, and using BIM tools and techniques.
  Conducting a structural analysis of the building using Robot software to ensure its safety, stability, and durability.
- Identifying and addressing potential challenges and obstacles in implementing BIM throughout the building's life cycle and exploring how informed building design decisions can improve sustainability, cost-effectiveness, and construction efficiency.
- Developing detailed documentation, estimates, and clash detection reports to facilitate fabrication, installation, and project management.

1.2 BIM

BIM (Building Information Modeling) is a workflow technique used to create and manage information for a constructed asset. BIM combines structured, multidisciplinary data to create an intelligent 3D digital model of a project that spans its entire life cycle.

BIM is a game-changing digital technology and methodology that is redefining the Architecture, Engineering, and Construction (AEC) business. BIM is used in the design, building, and operations processes to create and manage data. BIM combines data from several disciplines to build precise digital representations that are controlled in an open cloud platform for real-time collaboration.

Using BIM on AEC projects provides improved insight, better decision-making, more sustainable solutions, and cost savings. The power of BIM is that it enables architects, engineers, and contractors to cooperate on synchronized models, providing everyone a competitive advantage.

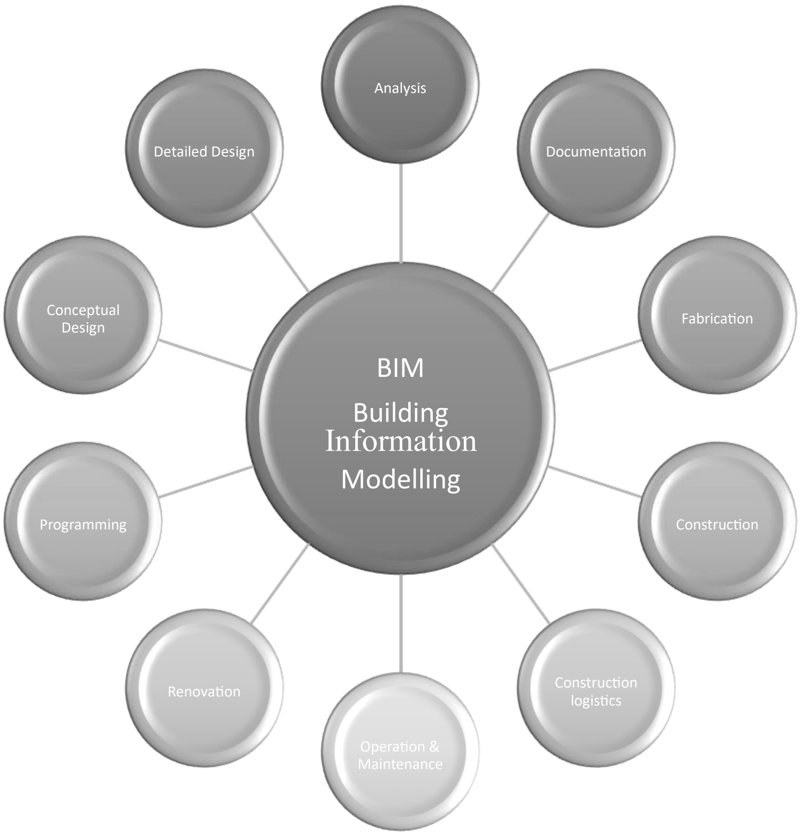


Fig.1 Workflow Process of BIM

1.3 REVIT

Revit software has revolutionized the architectural, engineering, and construction industries with its advanced capabilities in building information modelling. It enables architects, engineers, and construction professionals to collaborate seamlessly, reducing the likelihood of errors, conflicts, and delays. With Revit, the entire project team can access the same model and its associated information, enabling them to make informed decisions quickly and efficiently.

Revit's ability to create detailed 3D models with explant elevation, detailing diagrams, and schedules for each structural element, coupled with V-ray rendering software, provides a realistic view of the project with high efficiency. This level of detail enables the team to visualize the building and identify any design or construction issues early on, minimizing the risk of costly changes later in the project.

Furthermore, Revit architecture allows for the collection of comprehensive information about each structural element, such as material, thickness, and height. This data can then be used to generate schedules that provide valuable insights into cost, type of family, and the number of bricks, doors, and windows required. All of these views and details can be viewed on a single page, simplifying the communication of design intent across the project team.

Revit Structure offers advanced testing and analysis capabilities to ensure the stability of the building structure. It can also schedule reinforcements where necessary, further reducing the likelihood of errors or delays during construction. Finally, Revit MEP provides system modelling capabilities within the building and can perform energy analyses to optimize the building's energy efficiency.

Overall, Revit software is an essential tool for building information modelling that streamlines project design, construction, and management processes. It is powerful software that enables the project team to collaborate effectively and make informed decisions, resulting in a high-quality building project that meets the client's requirements.

1.4 ROBOT STRUCTURAL ANALYSIS

Robot Structural Analysis is a structural analysis software tool used by engineers and architects to analyze and design structures. It is developed by Autodesk and is used for advanced analysis of structures, including complex building structures and other types of infrastructure.

The software provides a comprehensive range of analysis tools that allow users to perform linear and nonlinear analyses, static and dynamic analyses, and perform time history analyses. It can also be used for advanced analysis such as seismic analysis and wind analysis.

Robot Structural Analysis has a user-friendly interface that allows users to quickly create and analyze structural models. The software supports multiple input formats, including AutoCAD drawings and Revit models.

The program can also export analysis results to various formats for further processing or sharing with other applications.

Overall, Robot Structural Analysis is a powerful tool for engineers and architects who need to design and analyze complex structures. Its range of analysis tools, ease of use, and ability to import and export various formats make it a popular choice for professionals in the field.

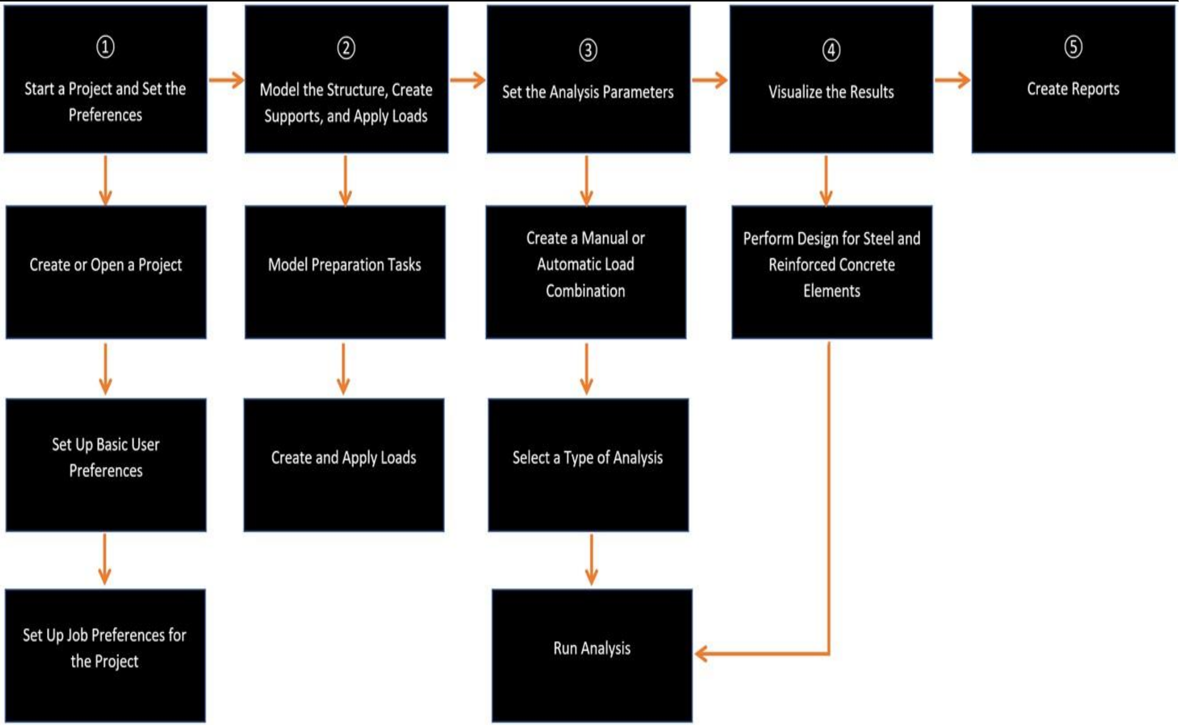


Fig.2 Workflow Process of Robot Structural Analysis

1.5 DETAILS OF BUILDING

Type of Building: Residential Building

Plot Area: 1632 sq ft (181.3 sq yds)

No of floors: Ground floor and three floors(G+5)

Height of each floor:10.5 ft

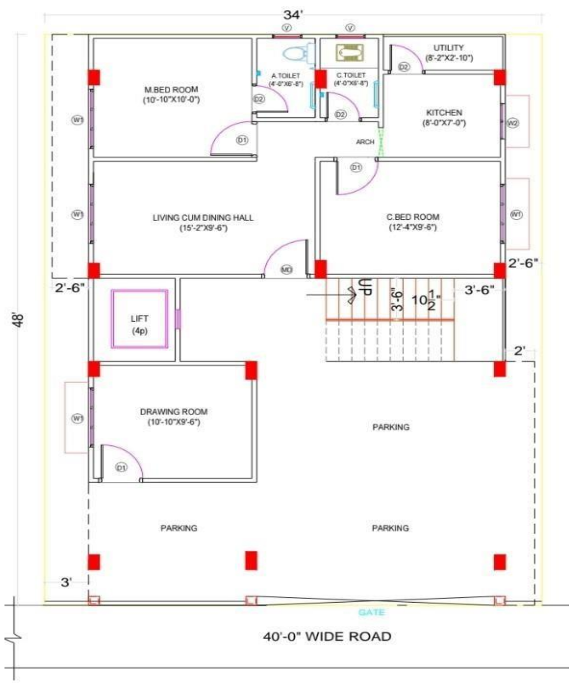


Fig.2 Ground Floor Plan

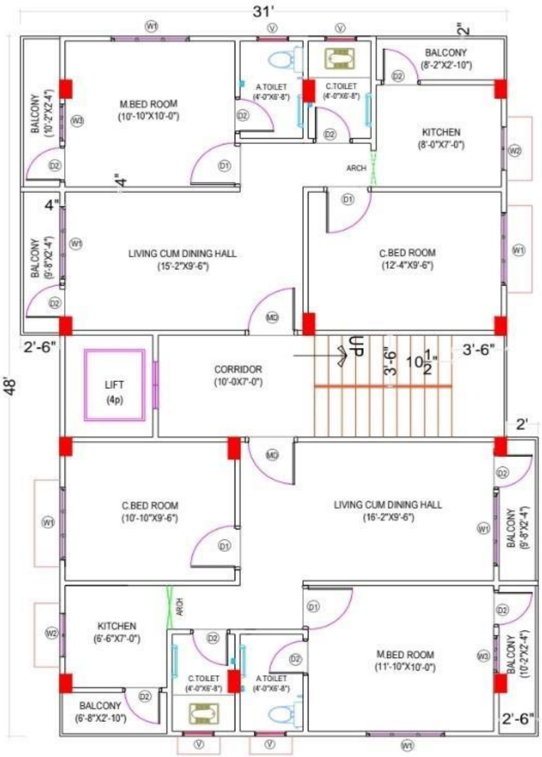


Fig.3 Typical Floor Plan

CHAPTER 2
LITERATURE REVIEW

- Manoj U. Deosarkar, et.al (2021). concluded in their study that BIM is an innovative way to virtually design and manage project. Predictability of building performance and operation is greatly improved.
- R. S. Bute, et al. (2018), – Stated the uses of scheduling and cost estimating in Autodesk Revit and provided a case study to show how Autodesk Revit can work for Architects, Engineers, and contractors. As well as comparing Autodesk Revit Estimate values with Manual Estimate values.
- Matarneh et.al (2017). concluded that BIM covers the entire lifecycle of a building, and it can create, coordinate, document, manage and update information about the building.
- François Denis (2015). Concluded in his study that BIM process a more efficient for design and construction process, and a virtual prototype of the building can be developed.
- Hexu Liu et al., (2014): - Stated detailed cost estimation and construction project scheduling using an integrated framework based by developing a product model using Autodesk Revit software.
- Emad Elbeltagi Et al (2014): - Presented a model in Revit and AutoCAD which provides data to the construction practitioner for visualizing the cost and comparing it with the budget at various stages along with the appropriate corrective actions in case of any deviation from the budget.
- S. S. Pimplikar et al (2012): - Introduced various Revit software to increase the sustainability of the building. The comparison showed how the building consumed resources, environment impact and its performances.
- Eastman Et al. (2011). Studied and discussed the strength and weakness of the available BIM packages like: Revit, Bentley systems, ArchiCAD, Digital Project, Vector works, Tekla Structures, Profiler and AutoCAD-based applications. Accordingly, Revit was found to be the best-known and the market leader for BIM implementation in architecture.

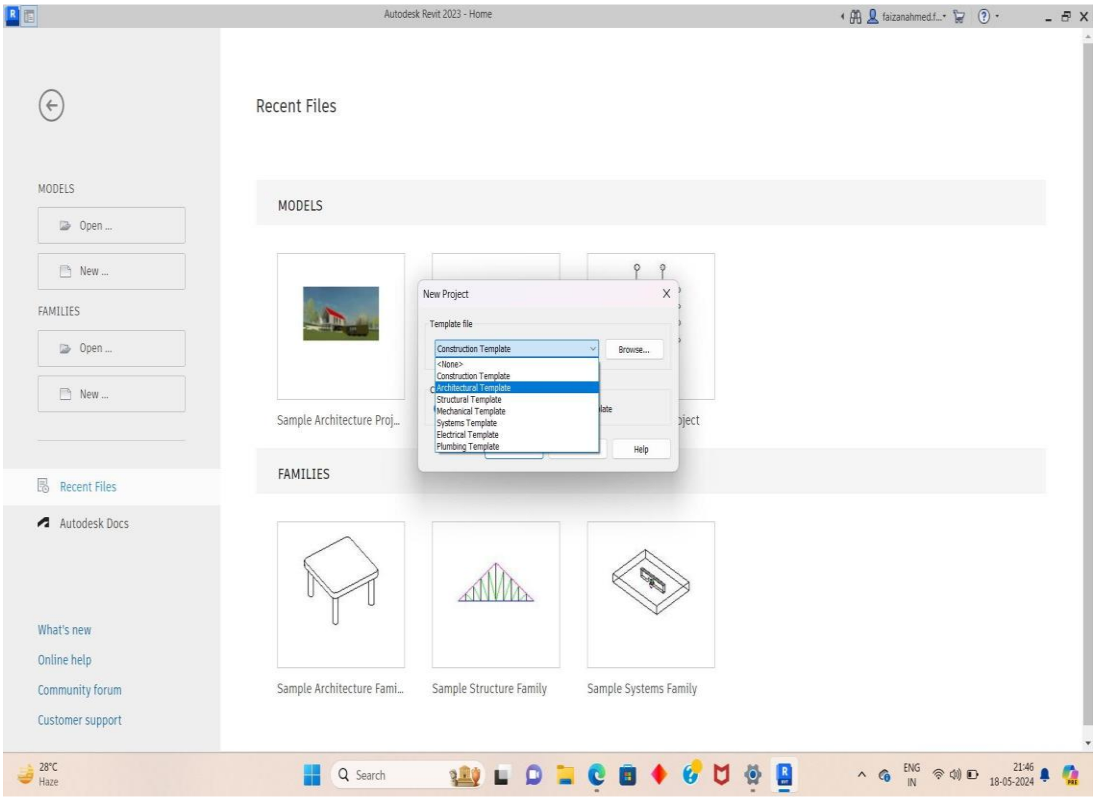
- Singh, Gu (2011). Stated While CAD technology is limited to geometric data, parametric design is at the core of BIM models that allows to design or provide both the geometrical and non-geometrical data.

CHAPTER 3

METHODOLOGY

- **Architectural Modelling**

▪ Creating a Project

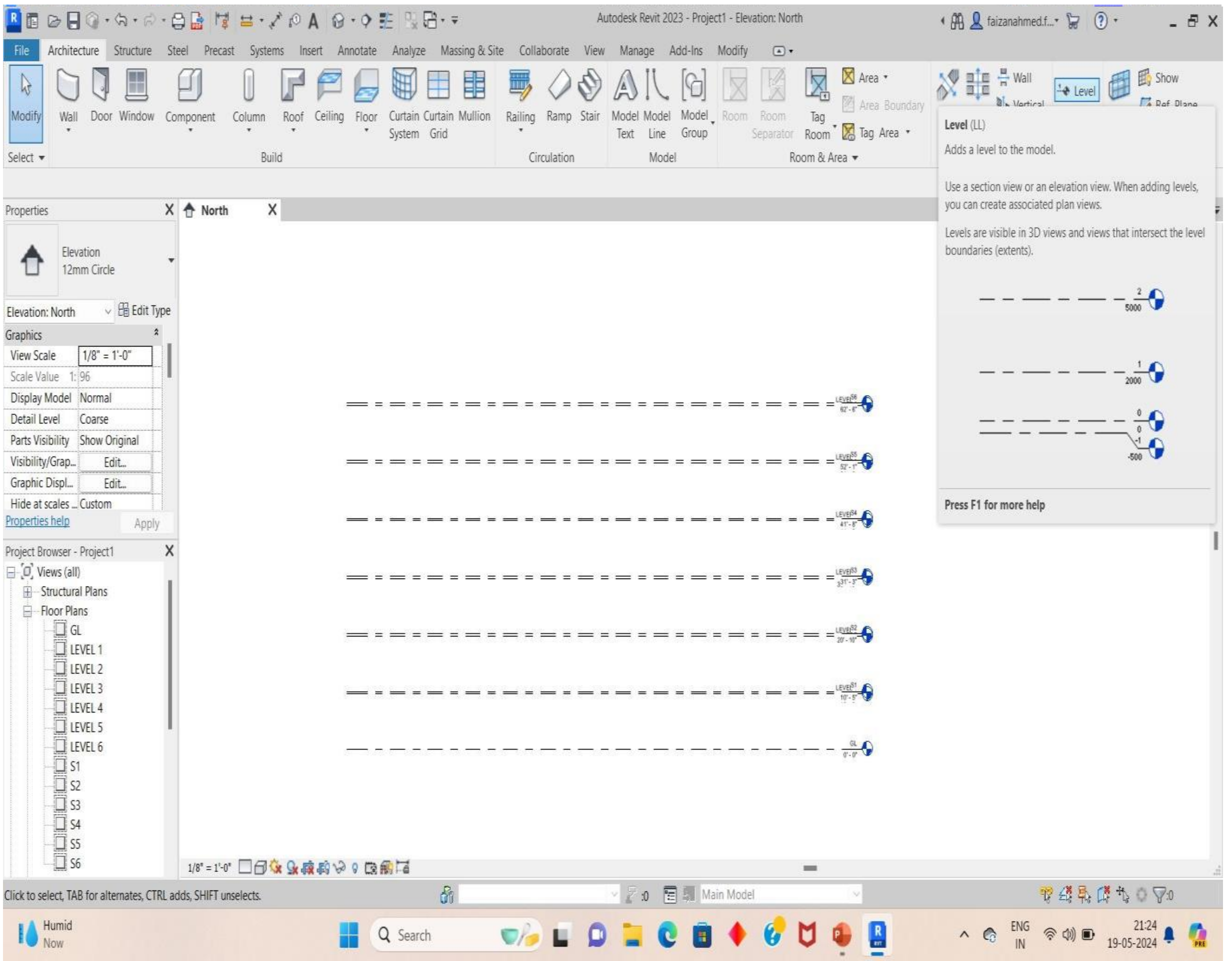


➢ Open Revit Software

➢ Click on Create a new project

➢ Select the architectural template

Creating Levels



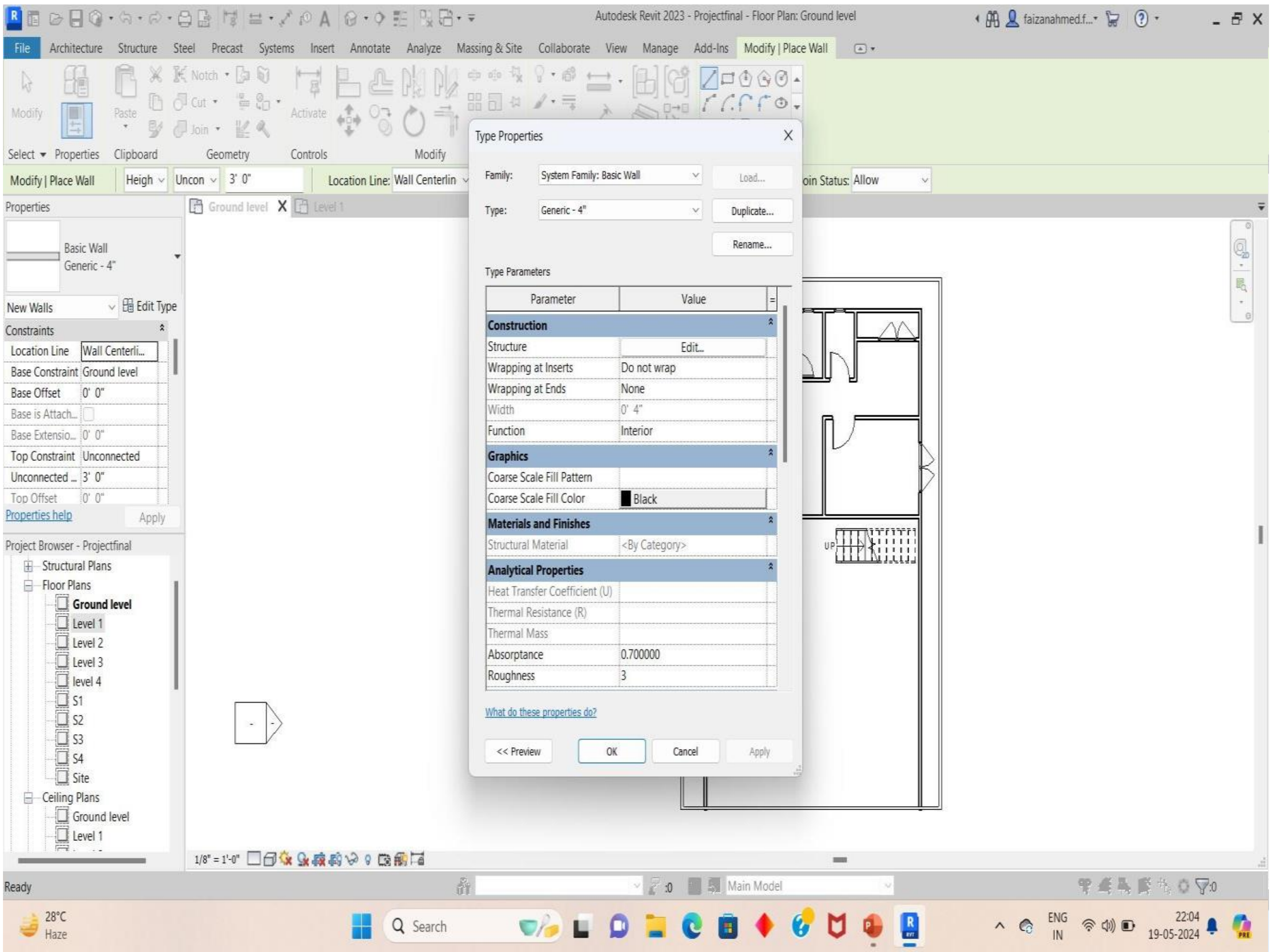
➢ Open Architecture tab

➢ Click on levels

➢ Create levels

We can create the levels as per the requirements, in this project we have created a total of five levels.

▪ Adding Walls



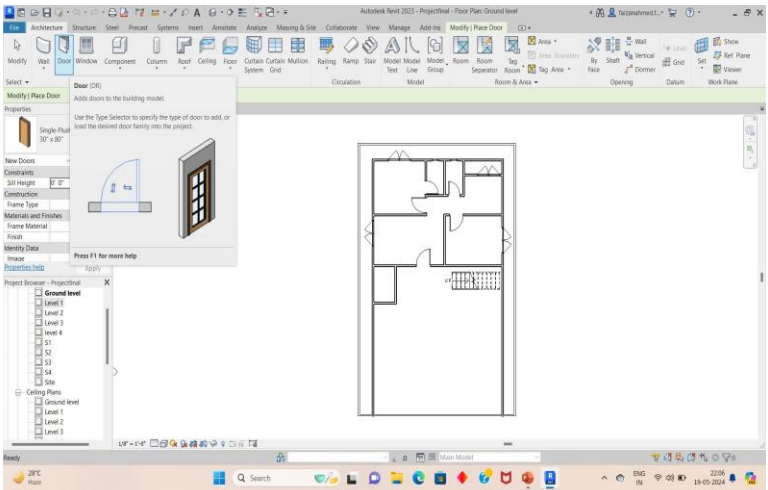
➢ Open Architecture tab

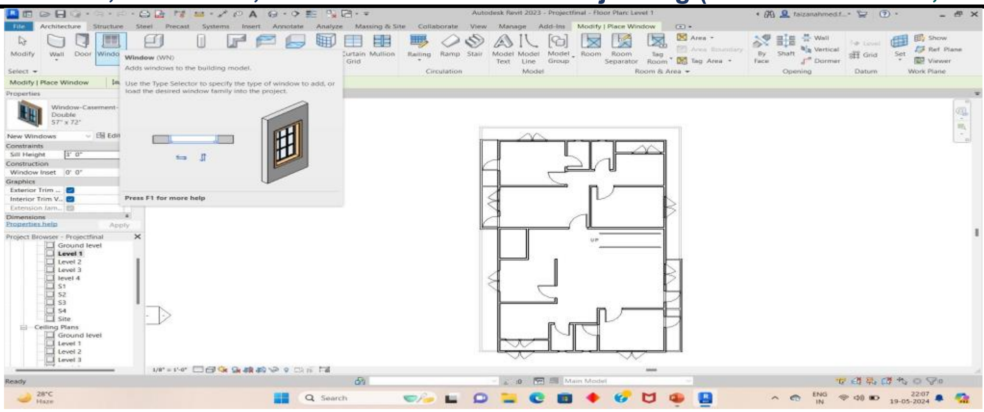
➢ Click on Walls

➢ Choose the walls as per the requirements from properties.

In this we have selected 9-inch thickness for outer walls and 4-inch thickness for inner walls.

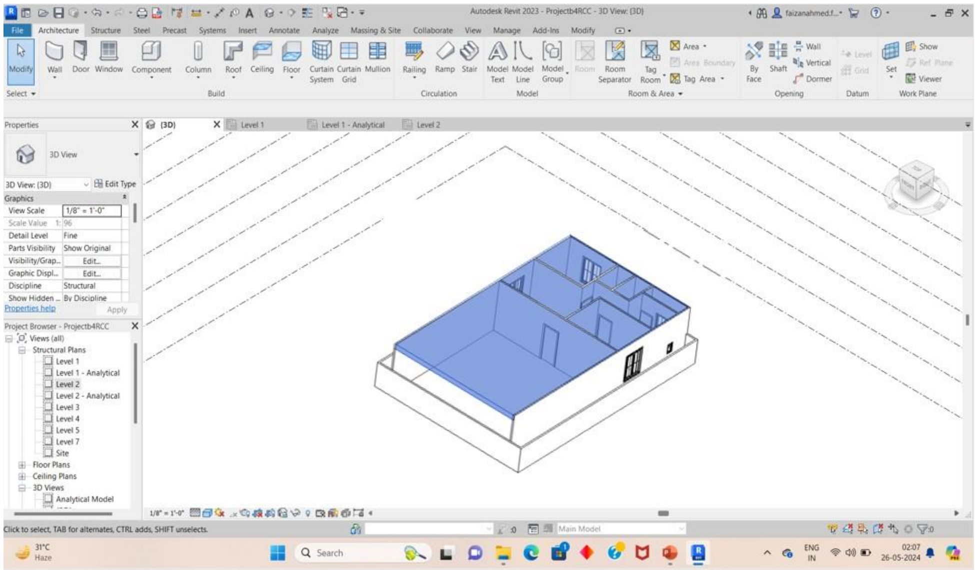
Adding Doors, Windows, and other Components

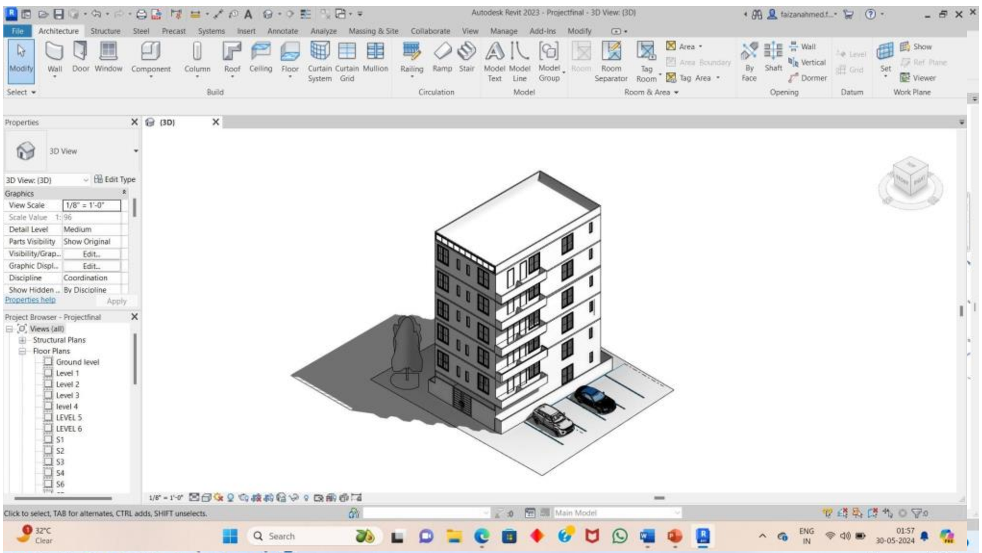




- Open Architecture tab
- For placing the doors and windows we must select form the load families.
- Click on doors and windows and select and place the doors and windows as per size requirements from properties
- Click on stairs and place the stairs in required position

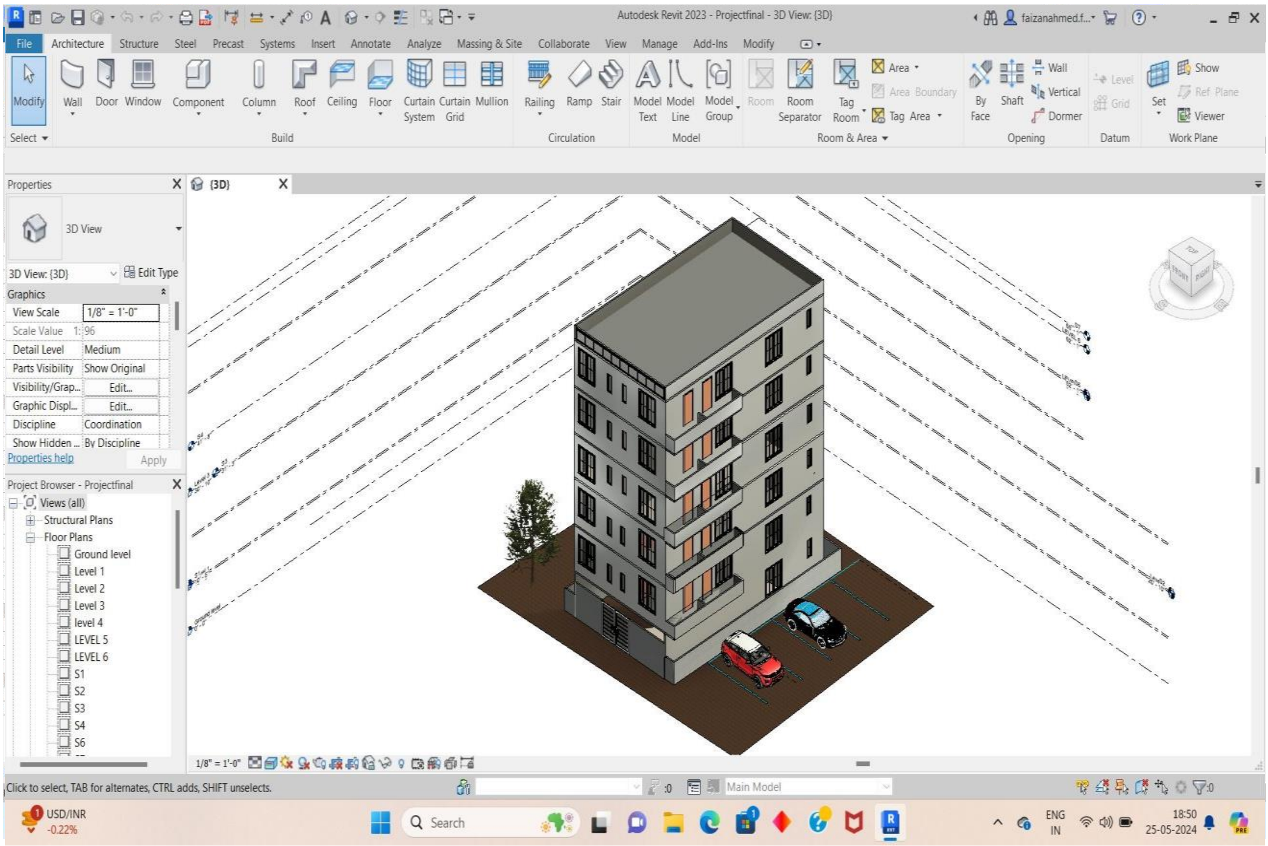
Adding Floors





- Open Architecture tab
- Click on Floor
- Add floor to each level

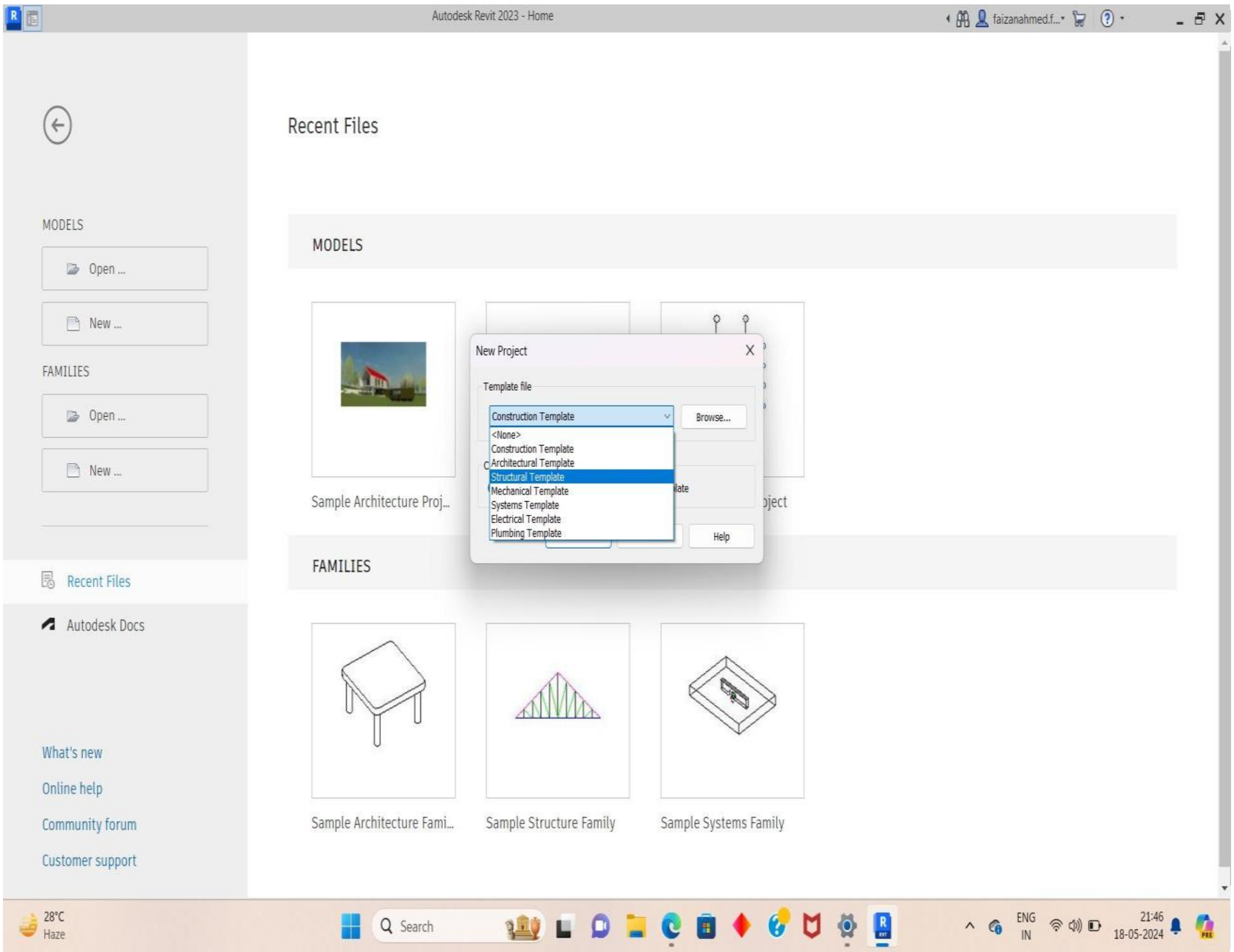
Adding Paint



- Open Modify tab
- Click on paint
- Add paint as per the choice from the paint properties

- **STRUCTURAL MODELLING**

- Creating a Project

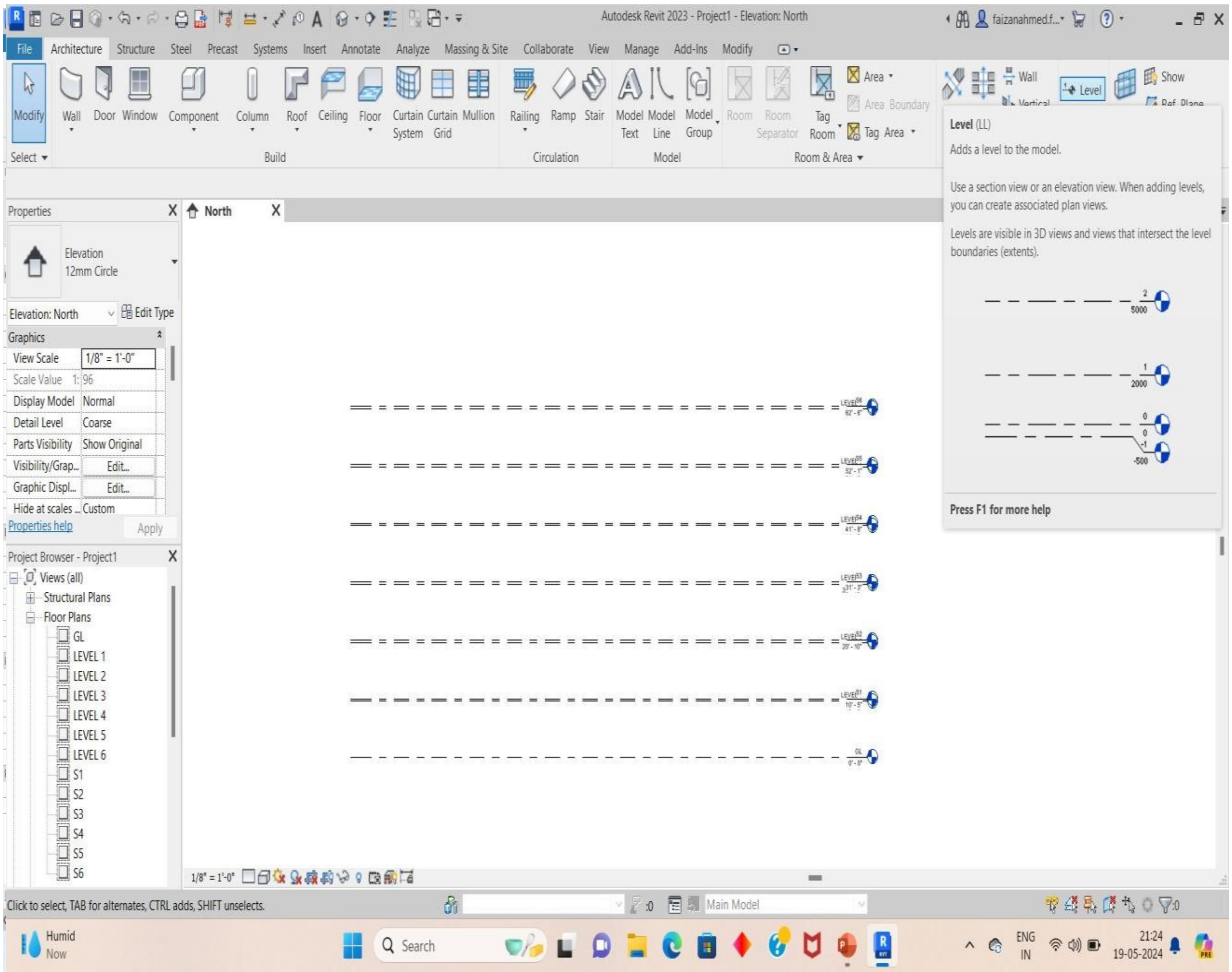


➢ Open Revit software

➢ Click on new project

➢ Select structural template

• Creating Levels

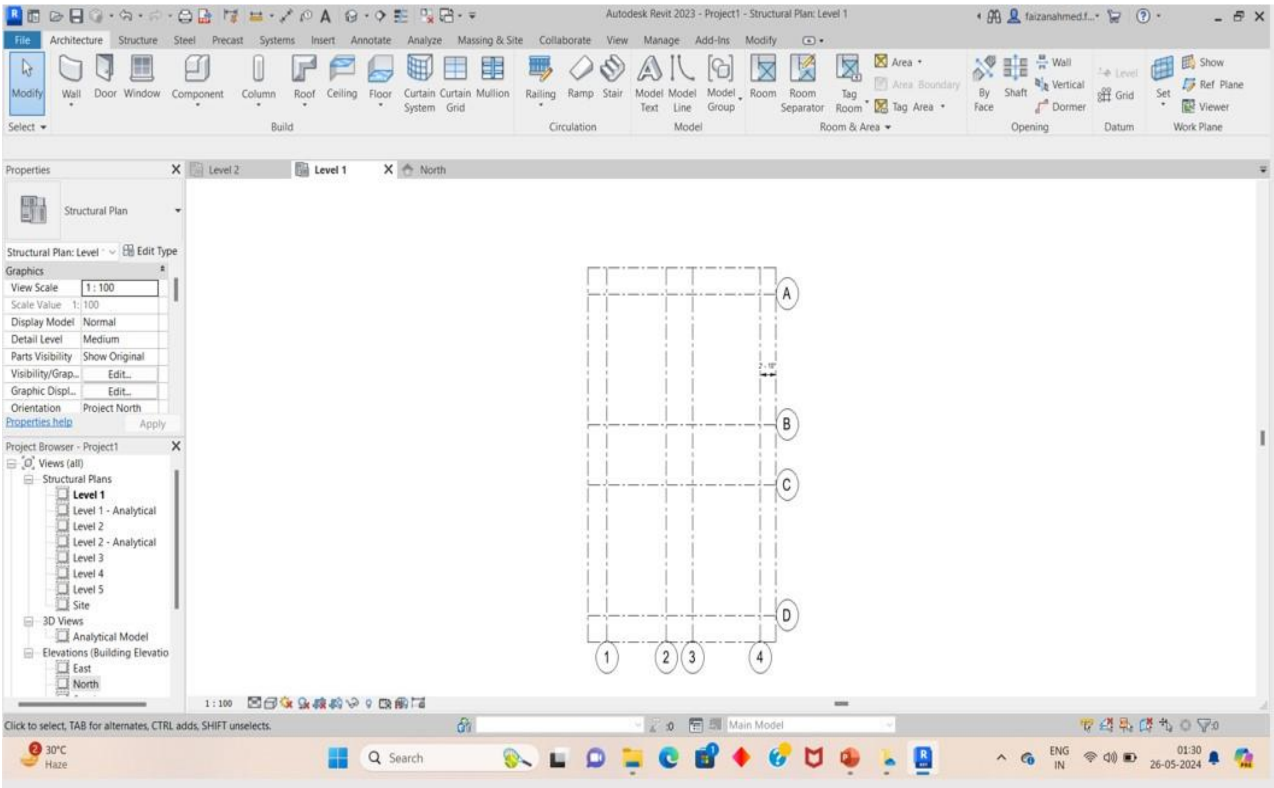


➢ Open architecture tab

➢ Click on levels

➢ Create levels as per requirements

• Creating Grids

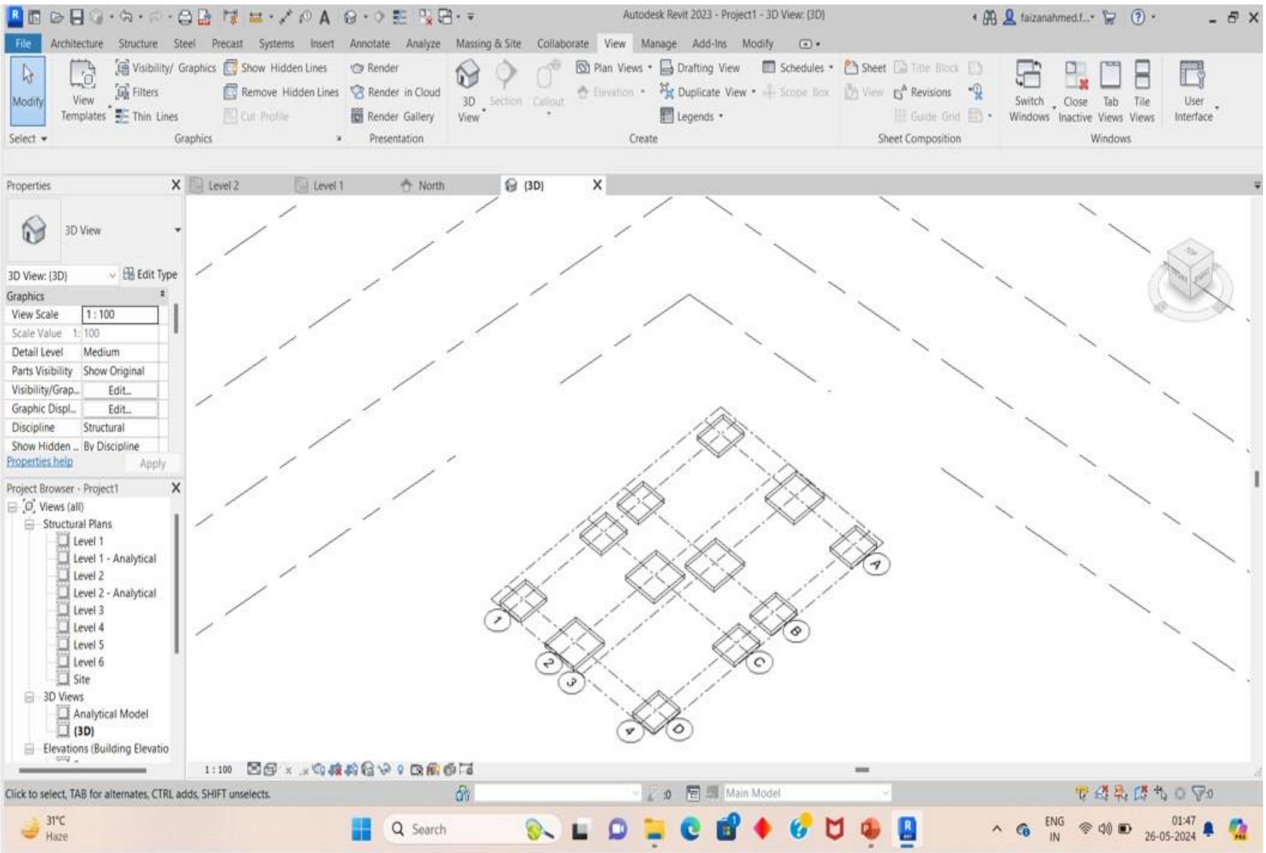


➢ Go to Architecture tab

➢ Click on Grid

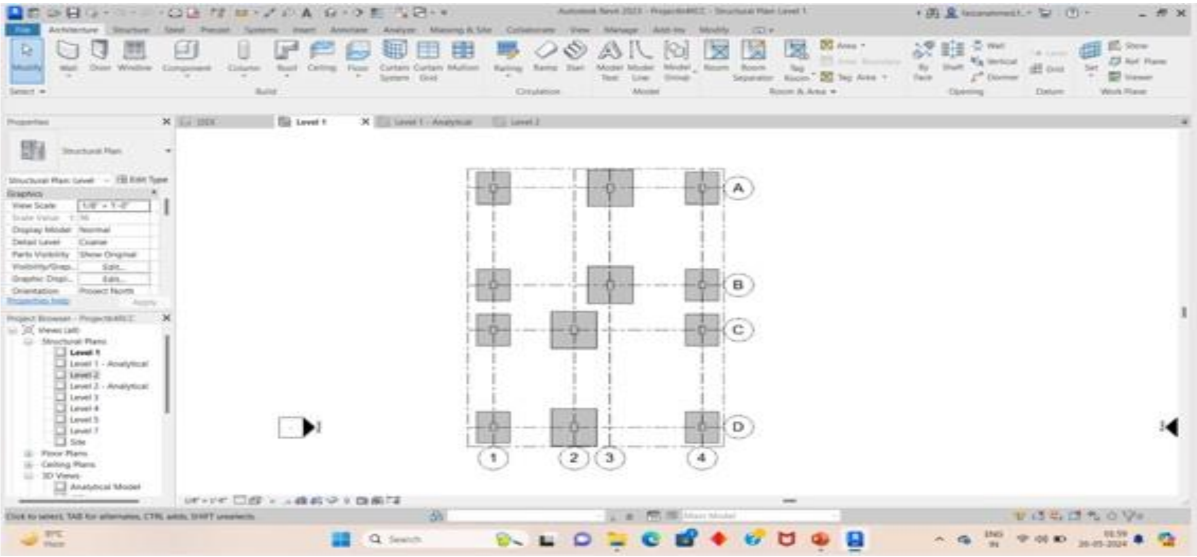
➢ Create horizontal and vertical grids as per the plan

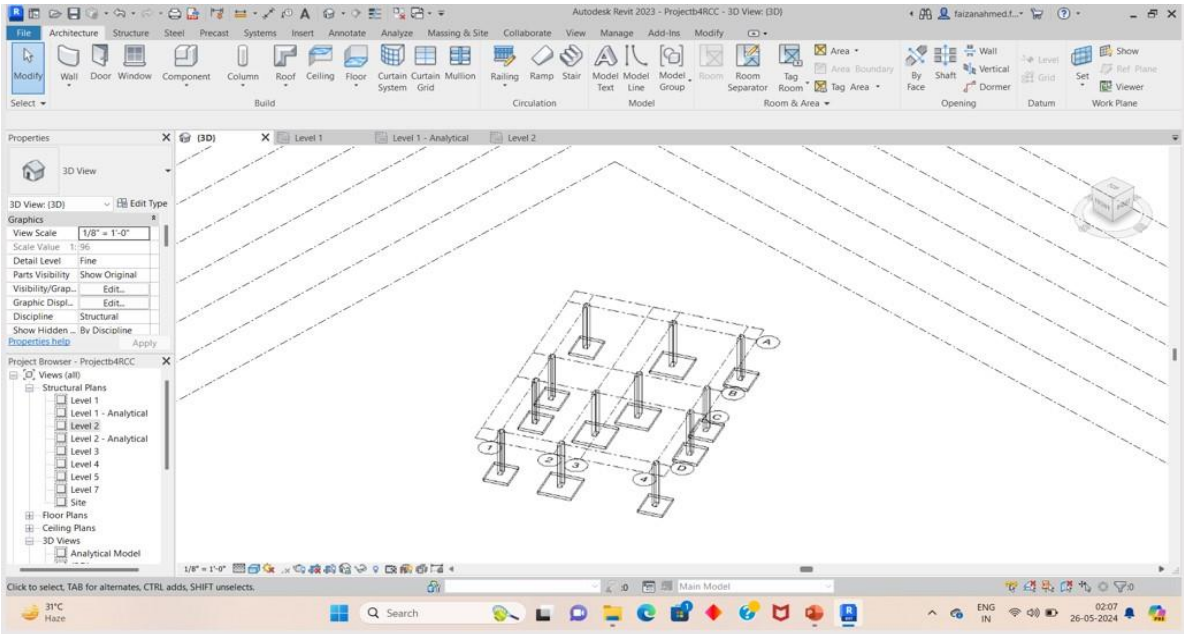
● Placing of Foundation



- Go to Structure tab
- Click on structural foundation
- Select the size of footing from properties
- Place the footing as per the plan requirements

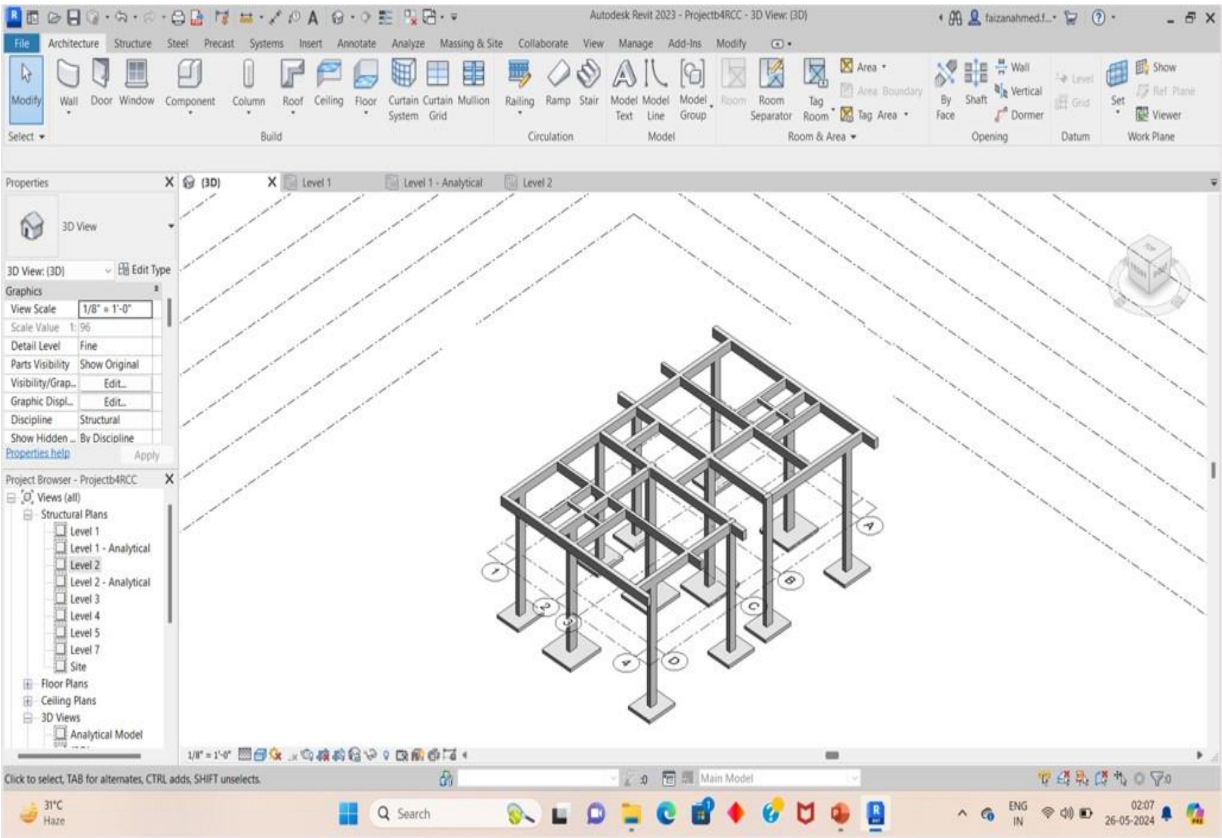
● Placing of Columns





- Go to Structure tab
- Click on Structural Column
- Select the shape and size of the column from the properties
- Place the column on the footings

- Adding Beams



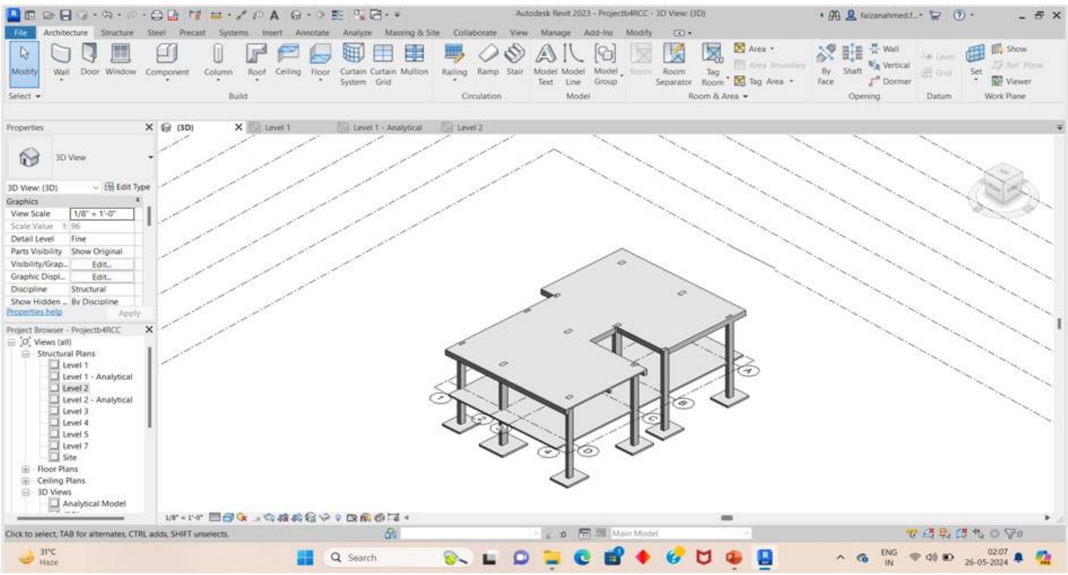
➢ Go to Structure tab

➢ Click on Beam

➢ Select the size and shape of beam from properties

➢ Place the beam as per the plan requirements

- Adding Slab



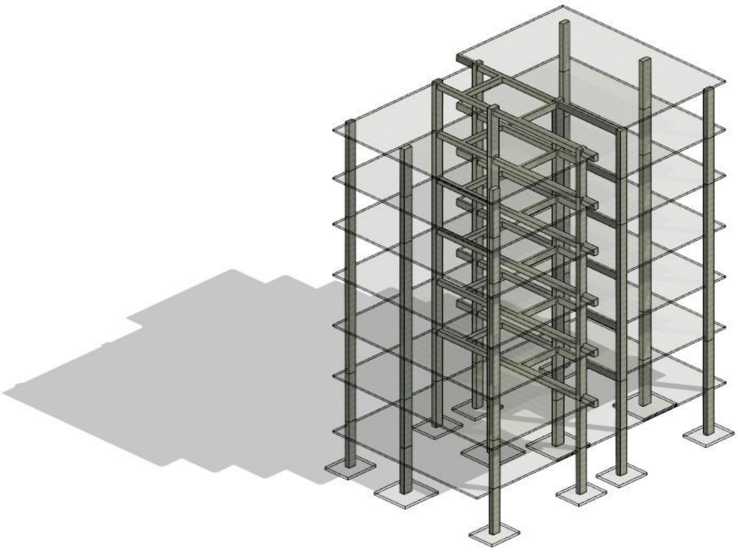
➢ Go to Structure tab

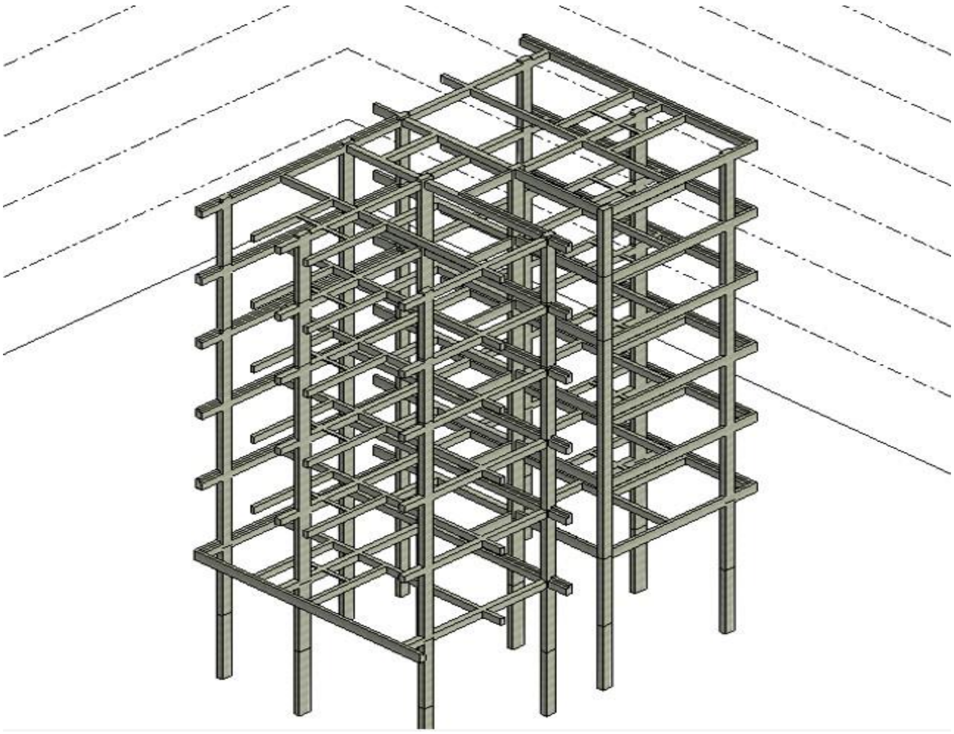
➢ Click on Slab

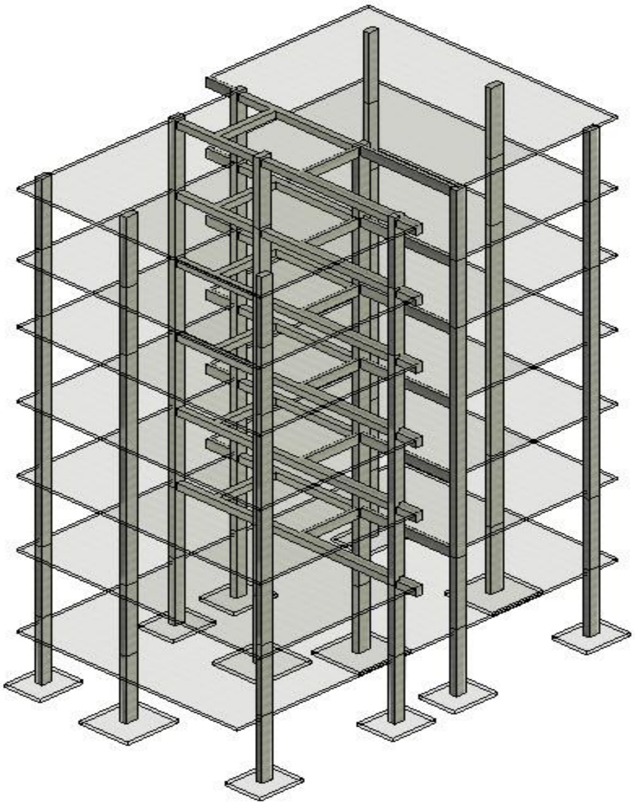
➢ Select the thickness of slab from properties

➢ Place the slab on the level by selecting the area of slab

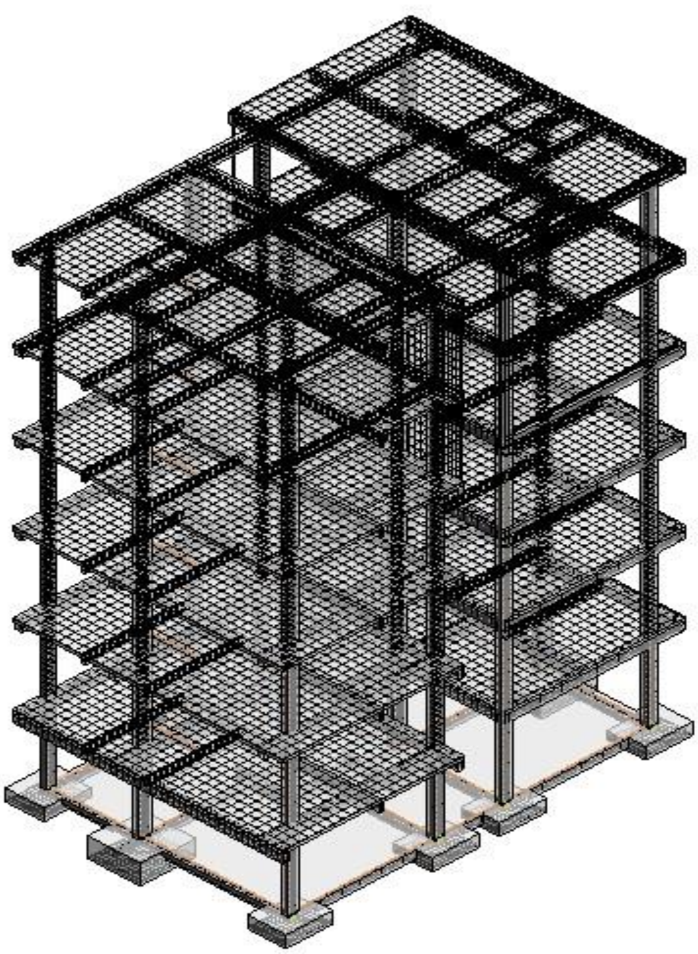
In this model we have taken 4.5-inch thickness of slab ○ As of this procedure complete the slabs for other three levels.







- Adding Reinforcement



- Go to the Structure tab
- Click on Rebar
- Then choose the shape and properties of the rebar and place the rebar in the structural members.

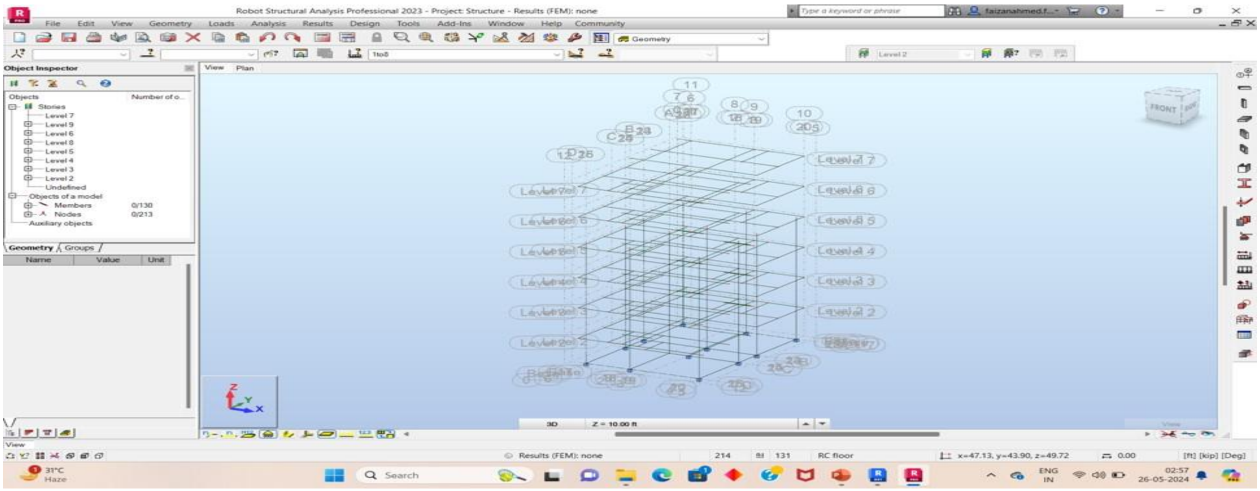
  - The reinforcement is added to the structural model of the building, and details of the reinforcement can be viewed in the documentation.

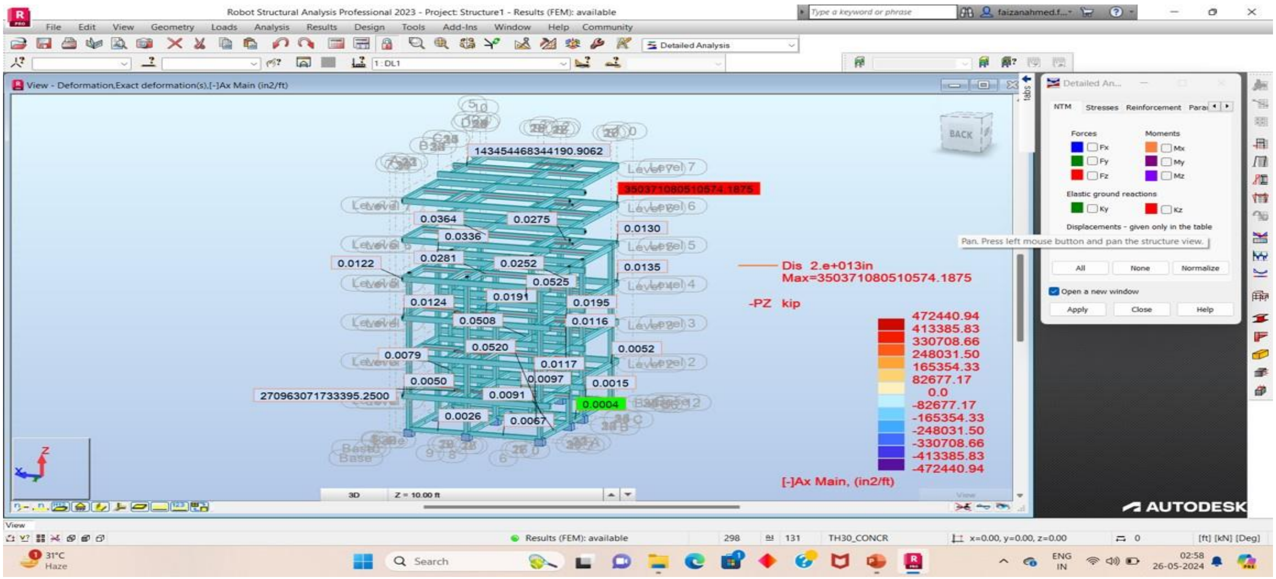
CHAPTER 4

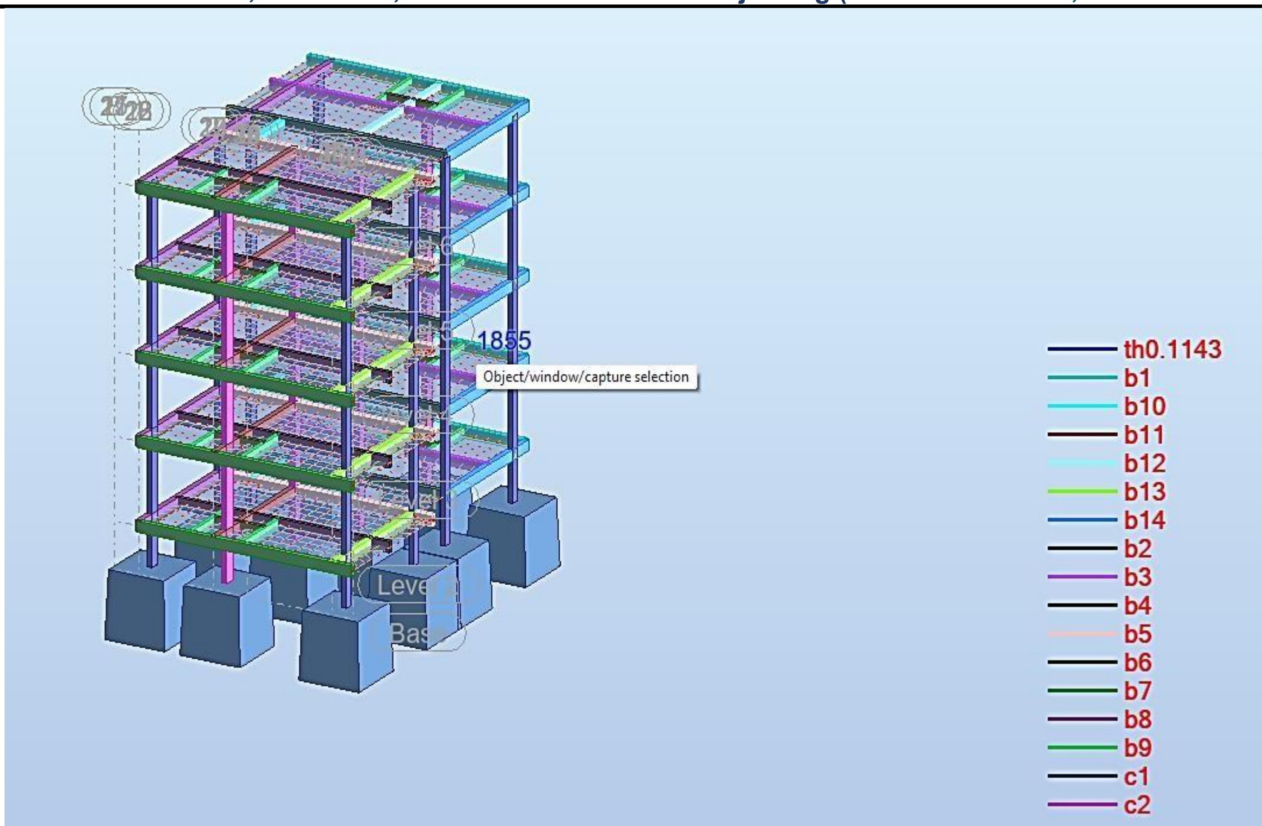
ANALYSIS

4.1 ANALYSIS USING ROBOT STRUCTURAL ANALYSIS TOOL

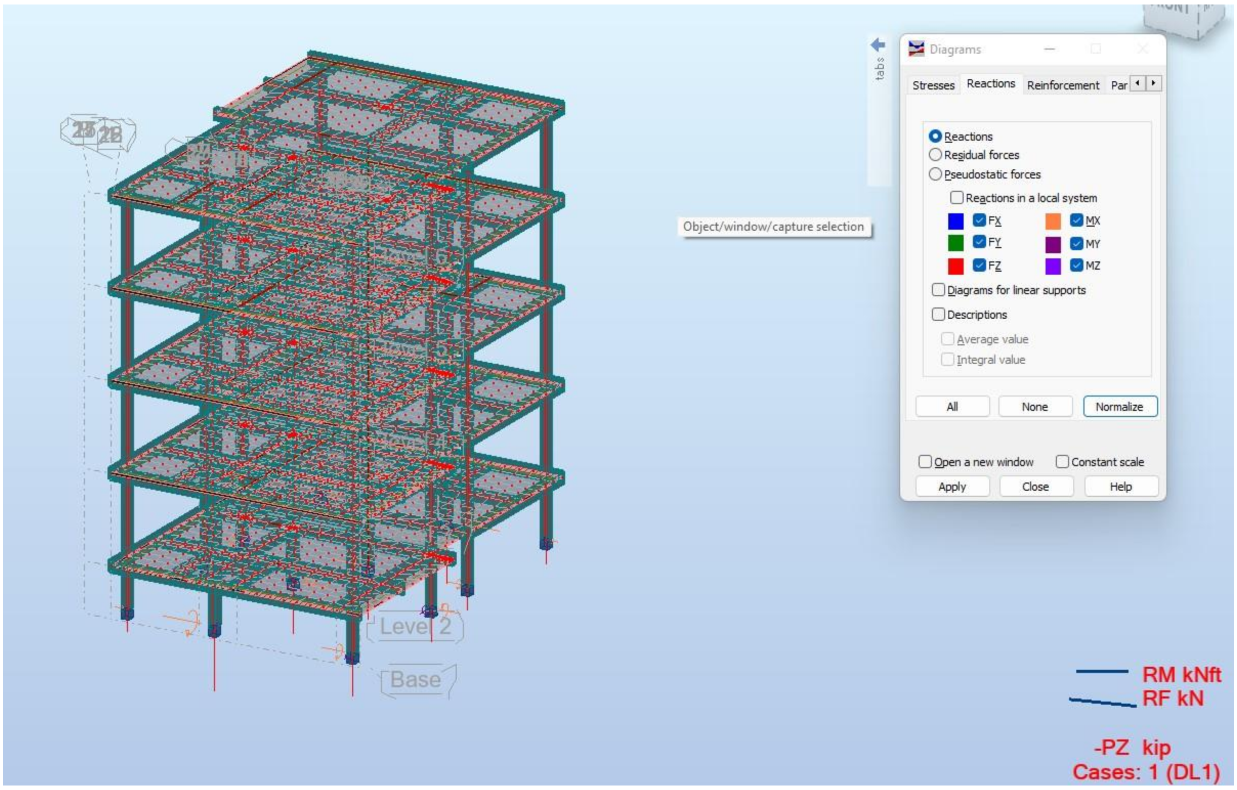
- The analytical model from the Revit Software is sent to Robot Structural Analysis to analyze the structural model of the residential building.



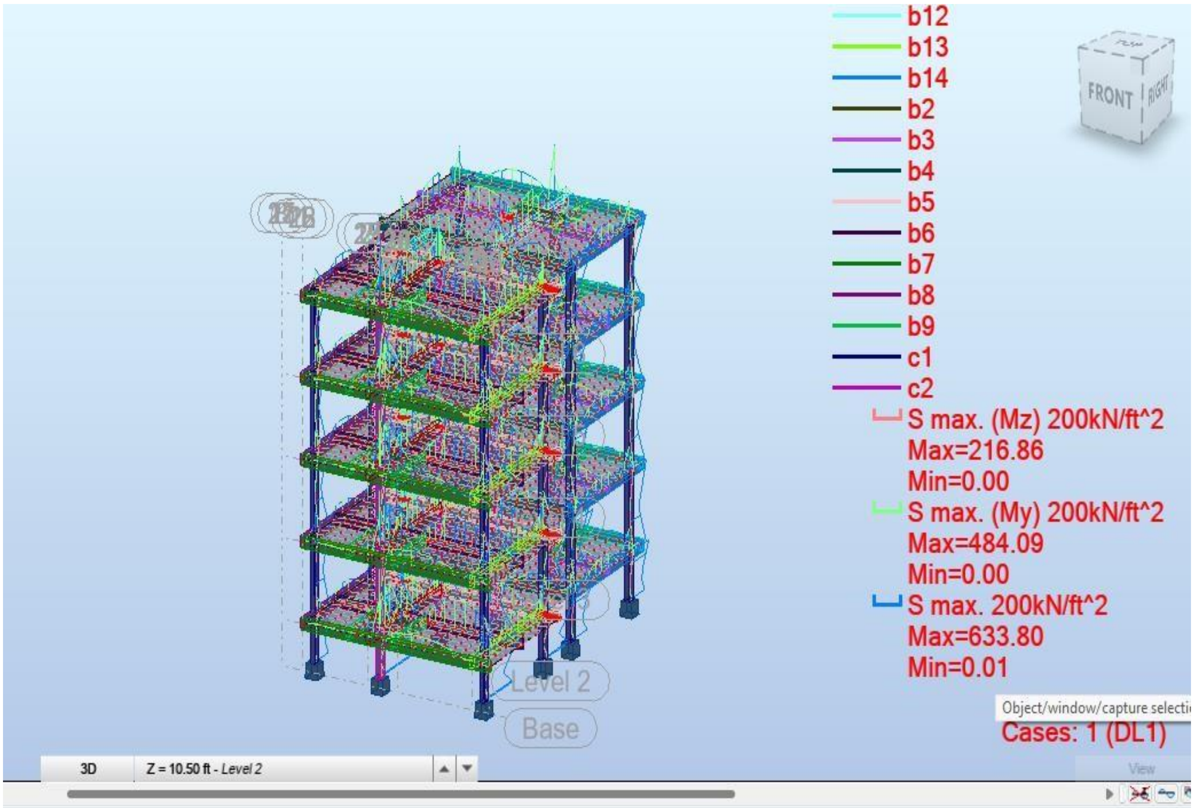


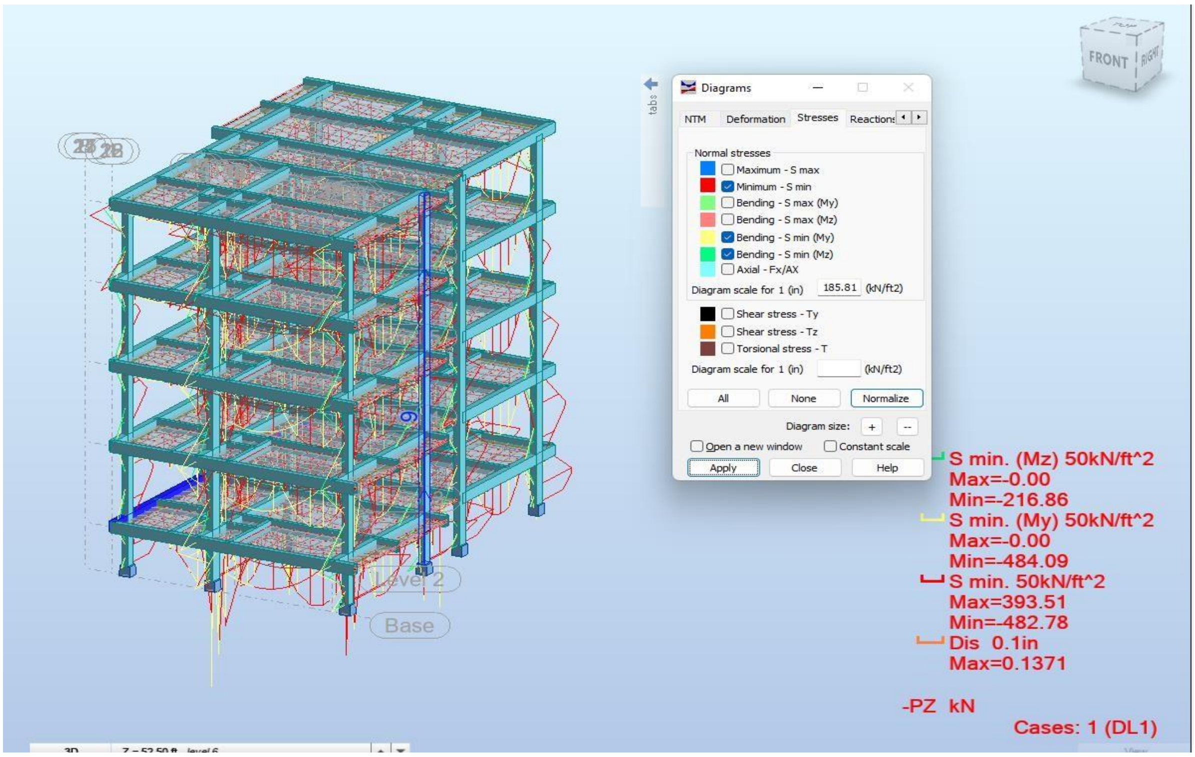


- Reaction Forces

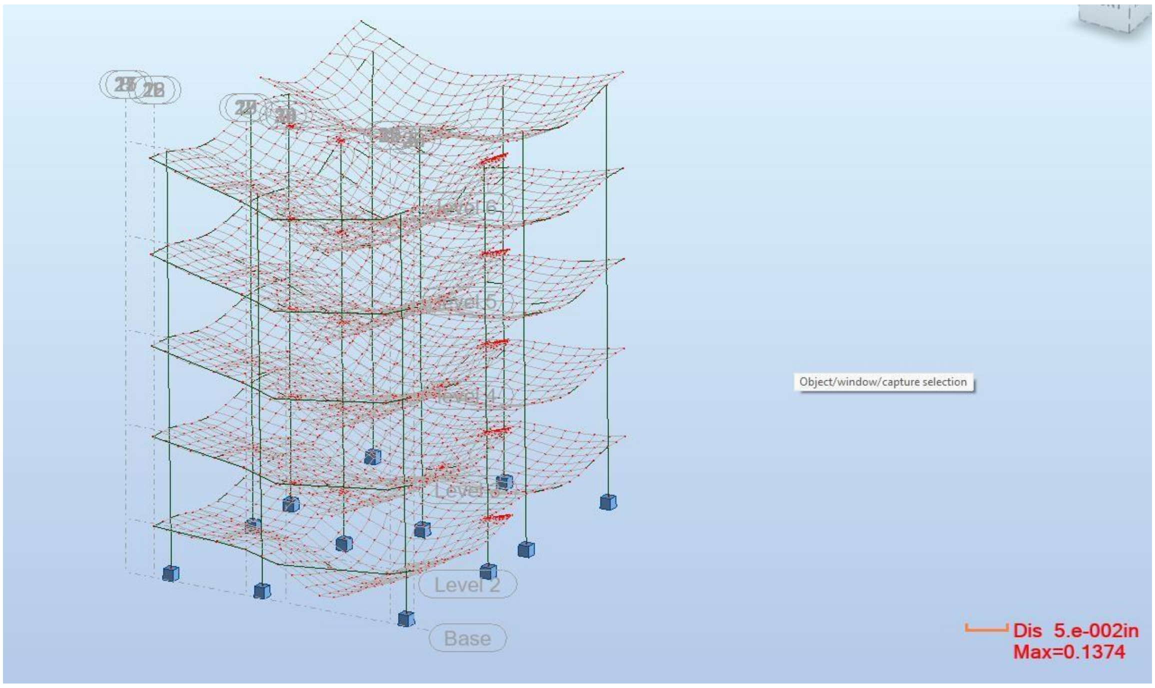


- Maximum Bending Moment and Minimum Bending Moment

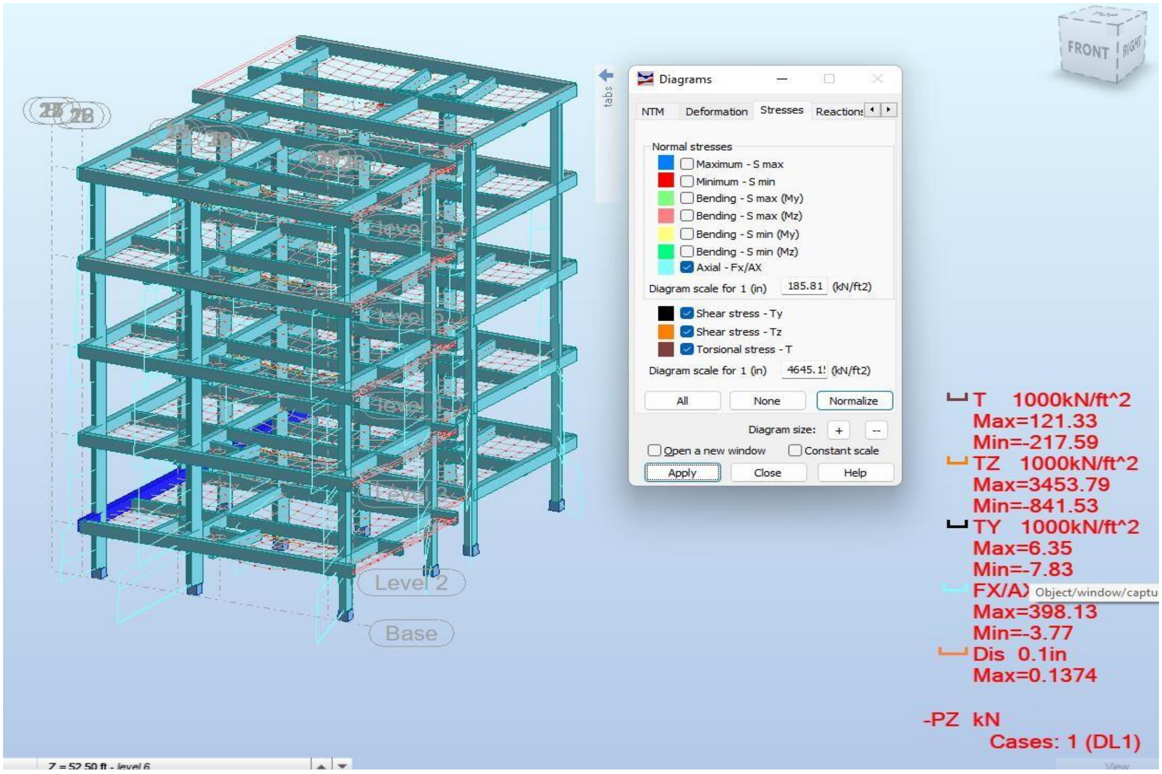




- Displacement



- Shear stress



CHAPTER 5

MANUAL CALCULATIONS

Design of Slab

We must Determine the load on the slab and select a suitable factor of safety.

Let's assume a live load of 2 kN/m^2 and a dead load of 1.5 kN/m^2.

Let's also assume a factor of safety of 1.5.

Let's assume a clear span of 4.5 meters (15 feet).

Now determine the design moment (M) for the slab. The design moment can be calculated using the formula, M = (wL^2)/8 where,

w = uniformly distributed load = live load + dead load = 2 + 1.5 = 3.5 kN/m^2

L = effective span = 4.5 m

M = (3.5 x 4.5^2)/8 = 8.85 kNm/m

Then determine the total area of steel required for the slab. The total area of steel required can be calculated using the formula,
Ast = (0.138 x fy x b x d)/(0.87 x fck) where, fy = yield strength of steel = 500 N/mm^2 b = width of the slab = 2.7432 m
d = effective depth of the slab = 4.5" - 0.5" (for mild steel bars) = 4"

Ast = (0.138 x 500 x 2.743 x 4)/(0.87 x 25) = 574.8 sqm

Now decide the spacing and diameter of reinforcement bars.

Let's use an 8 mm diameter bar, spaced at 7 inches c/c in both directions.

Then Check for deflection.

The deflection of the slab should be less than the permissible limit of L/250. Let's assume the permissible deflection limit as L/360.

The maximum deflection can be calculated using the formula, δmax = (5wL^4)/(384EI)
where, E = modulus of elasticity of concrete = 5000 √fck = 5000 x √25 = 12,500 N/mm^2

I = moment of inertia of the slab section = (bd^3)/12 I = (108 x 4^3)/12 = 1728 in^4
δmax = (5 x 4 x 4.5^4)/ (384 x 12,500 x 1728) = 2.52 mm The maximum deflection is within the permissible limit of L/360.
Therefore, a reinforced concrete slab of thickness 4.5 inches, using M25 grade concrete and Fe500 grade steel, with 8 mm diameter bar, spaced at 7 inches c/c in both directions, will be suitable for the given load and span.

Design of Beam

The load on the beam and select a suitable factor of safety. Let's assume a uniformly distributed load of 10 kN/m and a factor of safety of 1.5.

The effective span of the beam. Let's assume an effective span of 4 meters.

The bending moment (M) at the critical section of the beam. The critical section is the section where the bending moment is maximum. For a uniformly distributed load, the maximum bending moment occurs at mid-span. Therefore, M = (wL^2)/8

where, w = uniformly distributed load = 10 kN/m

L = effective span = 4 m

M = (10 x 4^2)/8 = 20 kNm

Determine the design moment (Mu) by applying the appropriate factor of safety. In this case, Mu = 1.5 x 20 = 30 kNm.
depth of the beam (d). According to Indian code, the depth of the beam should be at least L/16. Let's assume d = 450 mm.

width of the beam (b). According to Indian code, the width of the beam should be at least 1.5 times the effective depth of the beam.

Let's assume b = 675 mm.

Area of steel required (As). We can use the formula,

As = (Mu x 10^6)/(0.87 x fy x d) where, Mu = design moment = 30 kNm fy = yield strength of steel = 500 N/mm^2

As = (30 x 10^6)/(0.87 x 500 x 450) = 1263.2 mm^2

We can use 4 bars of 16 mm diameter and 4 bar of 12 mm diameter to provide the required area of steel.

Check for deflection. The deflection of the beam should be less than the permissible limit of L/250. Let's assume the permissible deflection limit as L/300. The maximum deflection can be calculated using the formula, δmax = (5wL^4)/(384EI)
where, E = modulus of elasticity of concrete = 5000 √fck = 5000 x √25 = 12,500 N/mm^2

I = moment of inertia of the beam section = (bd^3)/12 I = (675 x 450^3)/12 = 55,890,625 mm^4 δmax = (5 x 10 x 4^4)/(384 x 12,500 x 55,890,625) = 6.95 mm The maximum deflection is within the permissible limit of L/300.
Therefore, a reinforced concrete beam of size 9" x 16.5" using M25 grade concrete and Fe500 grade steel, with 4 bars of 16 mm diameter and 4 bars of 12 mm diameter, will be suitable for the given load and span.

Design of Column

Determine the size of the column based on architectural and structural requirements. In this case, the column size is given as 9" x 18".

Assuming the column is fixed at both ends, the effective height (Le) can be taken as the distance between the floor and the bottom of the beam above the column, which is 10 ft or 120 in.

The load on the column includes the dead load and live load. Assuming a dead load of 5 kN/m^3 for the concrete and 0.15 kN/m^2 for the floor finish, the total dead load on the column is:

DL = (5 x 0.15 x 1.5) + (5 x 0.09) = 0.975 kN/m^2

Assuming a live load of 2 kN/m^2, the total load on the column is:

LL = 2 kN/m^2

Total load on column (TL) = (DL + LL) x Ag where, Ag = cross-sectional area of the column Ag = 9" x 18" = 162 sq.in. = 0.1045 sq.m.
TL = (0.975 + 2) x 0.1045 = 0.312 kN

The bending moment (M) can be calculated using the formula:

M = TL x Le / 2

M = 0.312 x 120 / 2 = 18.72 kN-m

The design axial load (Pd) can be calculated using the formula:

Pd = TL x Φ x γf where, Φ = partial safety factor for loads = 1.5 (as per Indian code) γf = partial safety factor for materials = 1.5 (as per Indian code)
Pd = 0.312 x 1.5 x 1.5 = 0.702 kN

The moment of inertia (I) of the rectangular column can be calculated using the formula:

I = (bh^3) / 12

I = (9 x 18^3) / 12 = 8748 sq.in.

The section modulus (Z) can be calculated using the formula: Z = I / y
where, y = distance from the neutral axis to the extreme fiber y = h / 2 = 18 / 2 = 9 in.

Z = 8748 / 9 = 972 sq.in.

The slenderness ratio (λ) of the column can be calculated using the formula:

λ = Le / r where, r = radius of gyration r = √(I / Ag) = √(8748 / 162) = 14.96 in.
λ = 120 / 14.96 = 8.02

Since the calculated slenderness ratio (λ) is less than the permissible limit of 50, the section is safe against buckling.

The area of steel required for the column. The minimum percentage of longitudinal reinforcement for rectangular columns is 0.8% as per Indian code. The area of steel required (As The area of steel required (As) can be calculated using the formula:
As = (0.8 / 100) x Ag

As = (0.8 / 100) x 162 = 1.296 sq.in.

The number and spacing of longitudinal bars. The number of bars required can be determined using the formula:

n = As / (π/4 x d^2) where, d = diameter of the bar
Assuming 16 mm diameter bars, we have:

n = 1.296 / (π/4 x 16^2) = 3.2Therefore, we need 4 bars of 16 mm diameter.

The spacing of the bars should not exceed 3 times the effective depth of the column. Assuming the effective depth (d') as 15 inches (4.5 inches + 2 inches for the cover), the maximum spacing of the bars should not exceed:

3 x d' = 3 x 15 = 45 inches

Therefore, the spacing of the bars should not exceed 45 inches. We can take the spacing as 8 inches c/c.

Check for the development length of the bars. The development length of the bars should be checked to ensure that they are adequately anchored into the column. As per Indian code, the development length (Ld) for 16 mm diameter bars is:

Ld = 50 x dia = 50 x 16 = 800 mm = 31.5 inches

Therefore, the bars should be embedded into the column for a minimum of 31.5 inches.

Provide lateral ties. Lateral ties are required to prevent buckling of the longitudinal bars. The ties should be spaced at a maximum of 16 times the diameter of the longitudinal bars. Assuming 8 mm diameter ties, the maximum spacing of the ties should not exceed:

16 x 8 = 128 inches

Therefore, the spacing of the ties should not exceed 128 inches. We can take the spacing as 8 inches c/c.

Check for the maximum and minimum reinforcement ratios. The maximum reinforcement ratio for rectangular columns is 6% as per Indian code. The minimum reinforcement ratio for columns with 4 bars is 0.95% as per Indian code. The actual reinforcement ratio (ρ) can be calculated using the formula:

ρ = As / bd where, b = width of the column ρ = 1.296 / (9 x 18) = 0.0074
The calculated reinforcement ratio is less than the maximum limit of 6% and greater than the minimum limit of 0.95%.

Therefore, the design of the RCC column with a size of 9" x 18", 4 bars of 16 mm diameter with lateral ties of 8 mm @ 8" c/c using Indian code and grade of concrete M25 and grade of steel Fe500 for a live load of 2 kN/sqm is completed.

CHAPTER 6 RESULTS

- Front View

- Back View

Fig.4 The front and back view of the residential building.

✦ Side Views

Fig.5 The side views of residential building.

▪ The Realistic 3d model of the building is generated using Rendering.

Fig.6 The realistic 3d model of the residential building.

▪ Quantities and Cost Estimation

<Wall Schedule 3>

A	B	C	D	E	F	G	H	I
Area	Length	Volume	Width	No. of Bricks	Cost of Brick	No. of Cement Bag	Cost of Cement	Quantity of Sand in
240 SF	47' - 10"	80.00 CF	0' - 4"	1133	9061.4	2.8	955.1	860.6
254 SF	50' - 10"	84.72 CF	0' - 4"	1200	9596.3	3.0	1011.4	911.4
1671 SF	48' - 0"	557.12 CF	0' - 4"	7888	63104.1	19.6	6651.2	5993.3
1667 SF	48' - 0"	555.43 CF	0' - 4"	7864	62912.2	19.5	6630.9	5975.1
317 SF	10' - 4"	105.58 CF	0' - 4"	1495	11959.1	3.7	1260.5	1135.8
447 SF	11' - 2"	148.96 CF	0' - 4"	2109	16872.1	5.2	1778.3	1602.4
265 SF	6' - 8"	88.24 CF	0' - 4"	1249	9994.8	3.1	1053.5	949.3
183 SF	8' - 0"	61.06 CF	0' - 4"	865	6916.7	2.1	729.0	656.9
275 SF	6' - 8"	91.67 CF	0' - 4"	1298	10382.8	3.2	1094.4	986.1
228 SF	8' - 4"	76.03 CF	0' - 4"	1076	8611.5	2.7	907.6	817.9
1058 SF	27' - 6"	352.54 CF	0' - 4"	4991	39931.5	12.4	4208.8	3792.5
392 SF	9' - 6"	130.63 CF	0' - 4"	1849	14795.6	4.6	1559.5	1405.2
436 SF	12' - 4"	145.17 CF	0' - 4"	2055	16442.6	5.1	1733.1	1561.6
964 SF	27' - 6"	321.32 CF	0' - 4"	4549	36395.0	11.3	3836.0	3456.6
167 SF	33' - 0"	55.56 CF	0' - 4"	787	6292.6	2.0	663.2	597.6
14 SF	3' - 0"	4.72 CF	0' - 4"	67	534.9	0.2	56.4	50.8
213 SF	7' - 0"	70.97 CF	0' - 4"	1005	8038.8	2.5	847.3	763.5
297 SF	9' - 6"	98.96 CF	0' - 4"	1401	11208.8	3.5	1181.4	1064.6
268 SF	10' - 0"	89.21 CF	0' - 4"	1263	10104.4	3.1	1065.0	959.7
210 SF	8' - 6"	70.01 CF	0' - 4"	991	7930.3	2.5	835.9	753.2
314 SF	11' - 0"	104.50 CF	0' - 4"	1480	11836.4	3.7	1247.6	1124.2
249 SF	9' - 8"	82.97 CF	0' - 4"	1175	9398.0	2.9	990.6	892.6
3 SF	6' - 4"	0.90 CF	0' - 4"	13	102.3	0.0	10.8	9.7
188 SF	6' - 4"	62.50 CF	0' - 4"	885	7079.2	2.2	746.1	672.3
217 SF	8' - 0"	72.22 CF	0' - 4"	1023	8180.4	2.5	862.2	776.9
188 SF	6' - 4"	62.50 CF	0' - 4"	885	7079.2	2.2	746.1	672.3
419 SF	27' - 6"	139.77 CF	0' - 4"	1979	15831.7	4.9	1668.7	1503.6
7 SF	2' - 7 7/8"	2.32 CF	0' - 4"	33	263.0	0.1	27.7	25.0
9 SF	2' - 11"	2.92 CF	0' - 4"	41	330.3	0.1	34.8	31.4
61 SF	20' - 2"	20.17 CF	0' - 4"	286	2284.2	0.7	240.8	216.9
8 SF	2' - 11"	2.58 CF	0' - 4"	37	292.5	0.1	30.8	27.8
7 SF	2' - 8"	2.33 CF	0' - 4"	33	264.3	0.1	27.9	25.1
8 SF	20' - 2"	2.79 CF	0' - 4"	39	315.9	0.1	33.3	30.0
8 SF	2' - 8"	2.81 CF	0' - 4"	40	318.3	0.1	33.5	30.2
61 SF	20' - 2"	20.17 CF	0' - 4"	286	2284.2	0.7	240.8	216.9
8 SF	2' - 7"	2.50 CF	0' - 4"	35	283.2	0.1	29.8	26.9
64 SF	21' - 2"	21.17 CF	0' - 4"	300	2397.5	0.7	252.7	227.7
7 SF	2' - 6"	2.17 CF	0' - 4"	31	245.4	0.1	25.9	23.3
8 SF	2' - 11"	2.58 CF	0' - 4"	37	292.5	0.1	30.8	27.8
7 SF	2' - 8"	2.33 CF	0' - 4"	33	264.3	0.1	27.9	25.1
7 SF	2' - 6"	2.17 CF	0' - 4"	31	245.4	0.1	25.9	23.3
63 SF	21' - 2"	21.00 CF	0' - 4"	297	2378.6	0.7	250.7	225.9
1 SF	1' - 6"	0.21 CF	0' - 4"	3	23.6	0.0	2.5	2.2
8 SF	20' - 0"	2.73 CF	0' - 4"	39	309.4	0.1	32.6	29.4
0 SF	1' - 6"	0.16 CF	0' - 4"	2	18.4	0.0	1.9	1.7

✦ Doors and Window Schedules

<Door Schedule>

A	B	C	D
Sill Height	Width	Type	Thickness
0' - 0"	3' - 0"	36" x 84"	0' - 2"
0' - 0"	2' - 10"	34" x 84"	0' - 2"
0' - 0"	2' - 10"	34" x 84"	0' - 2"
0' - 0"	2' - 10"	34" x 84"	0' - 2"
0' - 0"	2' - 10"	34" x 84"	0' - 2"
0' - 0"	2' - 6"	30" x 80"	0' - 2"
0' - 0"	2' - 6"	30" x 80"	0' - 2"
0' - 0"	2' - 6"	30" x 80"	0' - 2"
0' - 0"	2' - 6"	30" x 80"	0' - 2"
0' - 0"	2' - 6"	30" x 80"	0' - 2"
0' - 0"	2' - 6"	30" x 80"	0' - 2"
0' - 0"	3' - 0"	36" x 84"	0' - 2"
0' - 0"	2' - 10"	34" x 84"	0' - 2"
0' - 0"	2' - 10"	34" x 84"	0' - 2"
0' - 0"	3' - 0"	36" x 84"	0' - 2"
0' - 0"	2' - 10"	34" x 84"	0' - 2"
0' - 0"	2' - 10"	34" x 84"	0' - 2"
0' - 0"	2' - 10"	34" x 84"	0' - 2"
0' - 0"	2' - 10"	34" x 84"	0' - 2"
0' - 0"	2' - 6"	30" x 80"	0' - 2"
0' - 0"	2' - 6"	30" x 80"	0' - 2"
0' - 0"	2' - 6"	30" x 80"	0' - 2"
0' - 0"	2' - 6"	30" x 80"	0' - 2"
0' - 0"	2' - 6"	30" x 80"	0' - 2"
0' - 0"	2' - 6"	30" x 80"	0' - 2"
1' - 10"	2' - 6"	30" x 80"	0' - 2"
2' - 0 25/32"	2' - 6"	30" x 80"	0' - 2"
2' - 1 1/16"	2' - 6"	30" x 80"	0' - 2"
2' - 1"	2' - 6"	30" x 80"	0' - 2"
1' - 11 5/8"	2' - 6"	30" x 80"	0' - 2"
1' - 11 5/8"	2' - 6"	30" x 80"	0' - 2"
1' - 5 11/16"	2' - 6"	30" x 80"	0' - 2"
1' - 9 15/16"	2' - 6"	30" x 80"	0' - 2"
0' - 6 5/8"	2' - 6"	30" x 80"	0' - 2"
0' - 6 5/8"	2' - 6"	30" x 80"	0' - 2"
0' - 10 15/16"	2' - 6"	30" x 80"	0' - 2"
0' - 10 15/16"	2' - 6"	30" x 80"	0' - 2"

<Window Schedule>

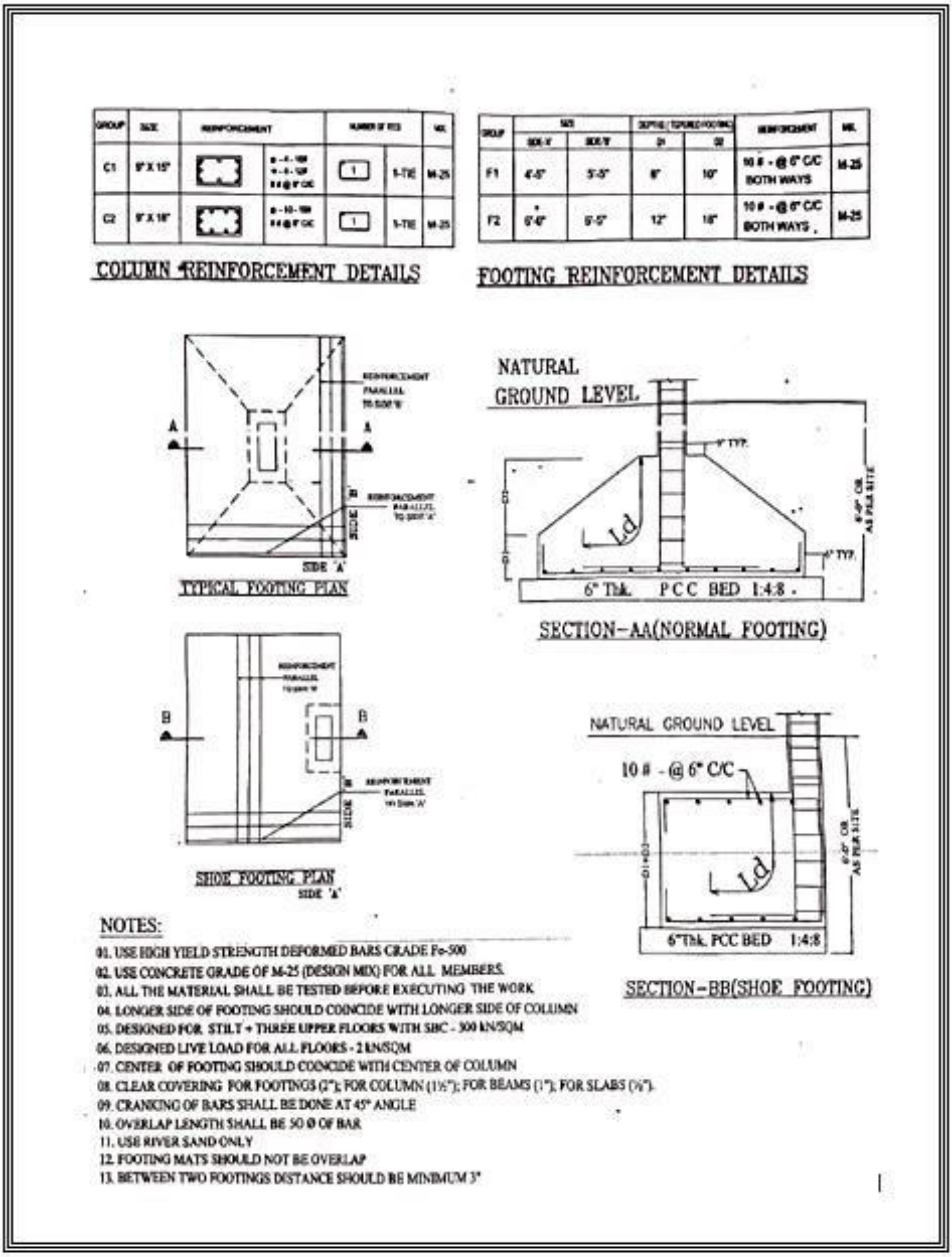
A	B	C
Width	Type	Height
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
1' - 4"	16" x 48"	4' - 0"
1' - 4"	16" x 48"	4' - 0"
1' - 4"	16" x 48"	4' - 0"
1' - 4"	16" x 48"	4' - 0"
1' - 4"	16" x 48"	4' - 0"
1' - 4"	16" x 48"	4' - 0"
1' - 4"	16" x 48"	4' - 0"
1' - 4"	16" x 48"	4' - 0"
1' - 4"	16" x 48"	4' - 0"
1' - 4"	16" x 48"	4' - 0"
1' - 4"	16" x 48"	4' - 0"
1' - 4"	16" x 48"	4' - 0"
1' - 4"	16" x 48"	4' - 0"
1' - 4"	16" x 48"	4' - 0"
1' - 4"	16" x 48"	4' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
1' - 4"	16" x 48"	4' - 0"
4' - 9"	57" x 72"	6' - 0"
1' - 4"	16" x 48"	4' - 0"
1' - 4"	16" x 48"	4' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
1' - 4"	16" x 48"	4' - 0"
4' - 9"	57" x 72"	6' - 0"
4' - 9"	57" x 72"	6' - 0"
1' - 4"	16" x 48"	4' - 0"
1' - 4"	16" x 48"	4' - 0"

✦ Rebar Schedule

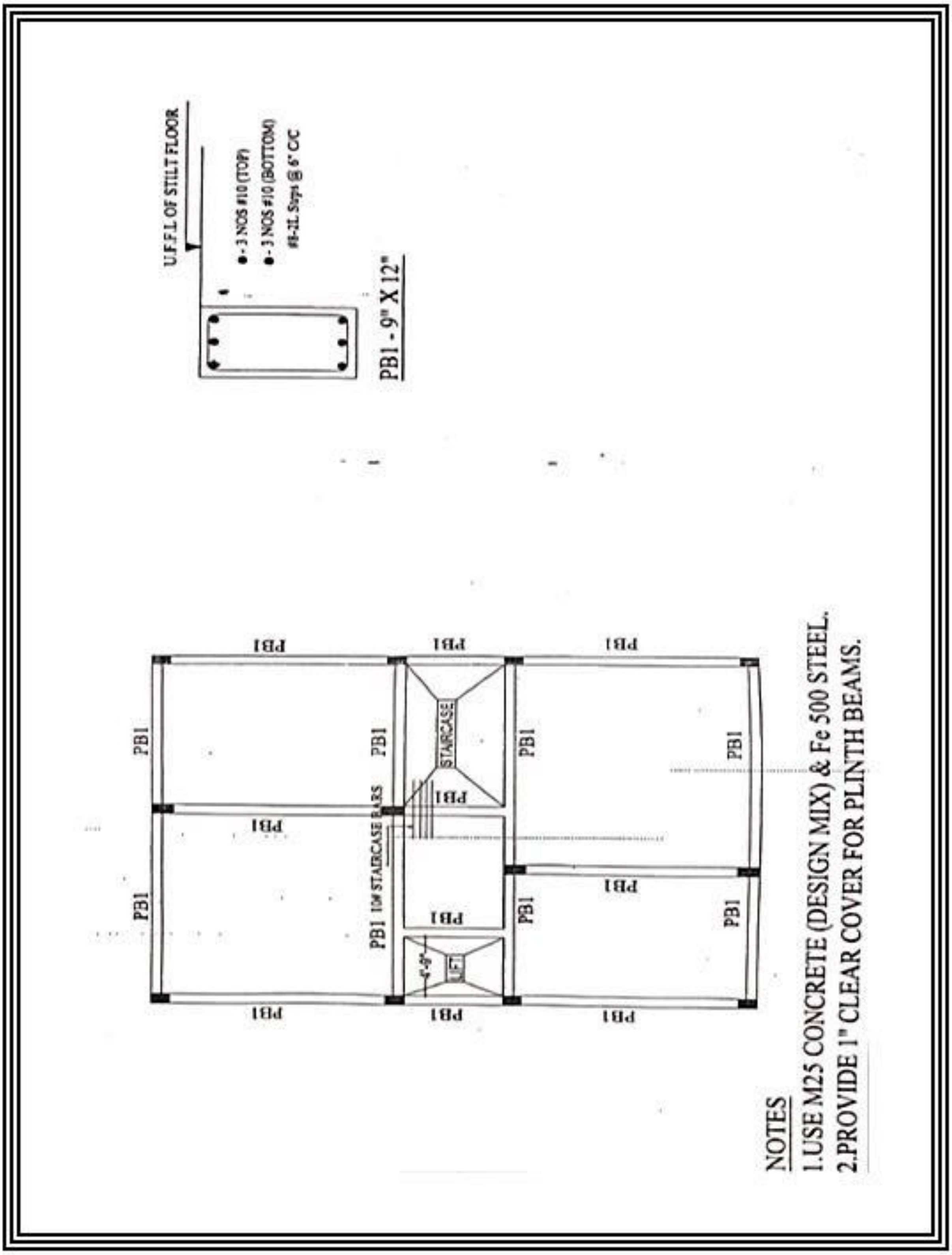
<Rebar Schedule>

A	B	C	D	E	F
Schedule Mark	Bar Diameter	Bar Length	Quantity	Total Bar Length	Image
2	0.50"	4' - 6"	12	54' - 0"	T1.PNG
2	0.50"	5' - 6"	10	55' - 0"	1.PNG
2	0.50"	4' - 7"	12	55' - 0"	17.PNG
2	0.50"	5' - 7"	10	55' - 10"	
2	0.50"	4' - 7"	12	55' - 0"	
2	0.50"	5' - 7"	10	55' - 10"	
2	0.50"	4' - 7"	12	55' - 0"	
2	0.50"	5' - 7"	10	55' - 10"	
2	0.50"	4' - 7"	12	55' - 0"	
2	0.50"	5' - 7"	10	55' - 10"	
2	0.50"	4' - 7"	12	55' - 0"	
2	0.50"	5' - 7"	10	55' - 10"	
2	0.50"	4' - 7"	12	55' - 0"	
2	0.50"	5' - 7"	10	55' - 10"	
2	0.50"	4' - 7"	12	55' - 0"	
2	0.50"	5' - 7"	10	55' - 10"	
3	0.50"	6' - 2"	14	86' - 4"	
3	0.50"	6' - 7"	13	85' - 7"	
3	0.50"	6' - 2"	14	86' - 4"	
3	0.50"	6' - 7"	13	85' - 7"	
3	0.50"	6' - 2"	14	86' - 4"	
3	0.50"	6' - 7"	13	85' - 7"	
3	0.50"	6' - 2"	14	86' - 4"	
3	0.50"	6' - 7"	13	85' - 7"	
6	0.47"	31' - 11"	3	95' - 9"	
6	0.47"	31' - 11"	3	95' - 9"	
6	0.31"	4' - 4"	47	203' - 8"	
5	0.50"	4' - 8"	1	4' - 8"	
5	0.50"	48' - 3"	1	48' - 3"	
8	0.63"	31' - 7"	2	63' - 2"	
8	0.47"	31' - 7"	2	63' - 2"	
9	0.47"	31' - 4"	3	94' - 0"	
9	0.47"	31' - 4"	3	94' - 0"	
9	0.50"	4' - 4"	47	203' - 8"	
8	0.31"	3' - 10"	47	180' - 2"	
10	0.50"	8' - 6"	3	25' - 6"	
10	0.39"	0' - 8"	3	2' - 0"	
10	0.39"	0' - 8"	3	2' - 0"	
10	0.50"	3' - 7"	58	207' - 10"	
10	0.39"	28' - 3"	3	84' - 9"	
10	0.39"	28' - 3"	3	84' - 9"	
10	0.50"	3' - 0"	58	174' - 0"	
10	0.39"	28' - 3"	3	84' - 9"	
10	0.39"	28' - 3"	3	84' - 9"	
10	0.50"	3' - 6"	58	203' - 0"	

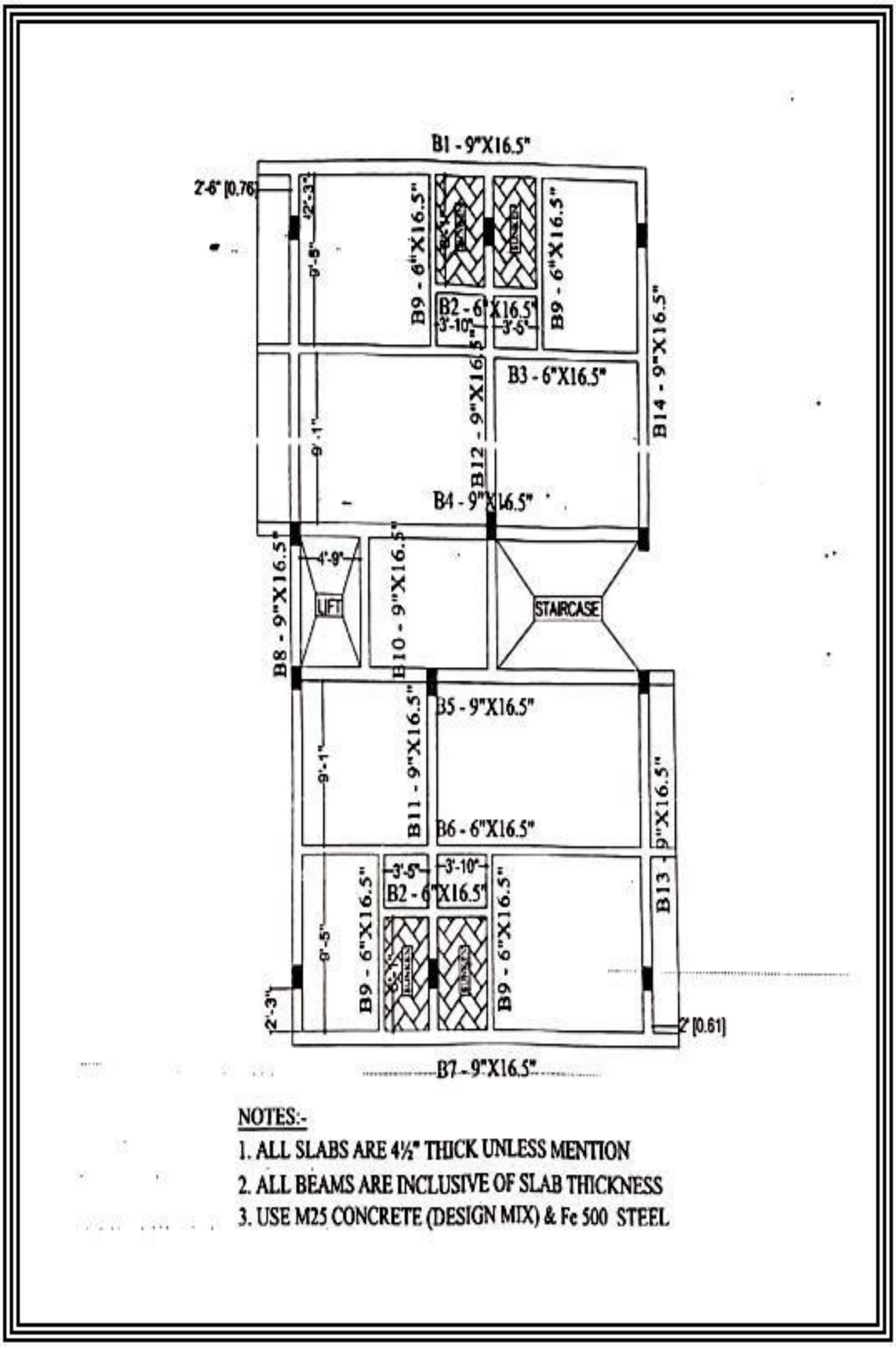
✦ Column and Footing Details



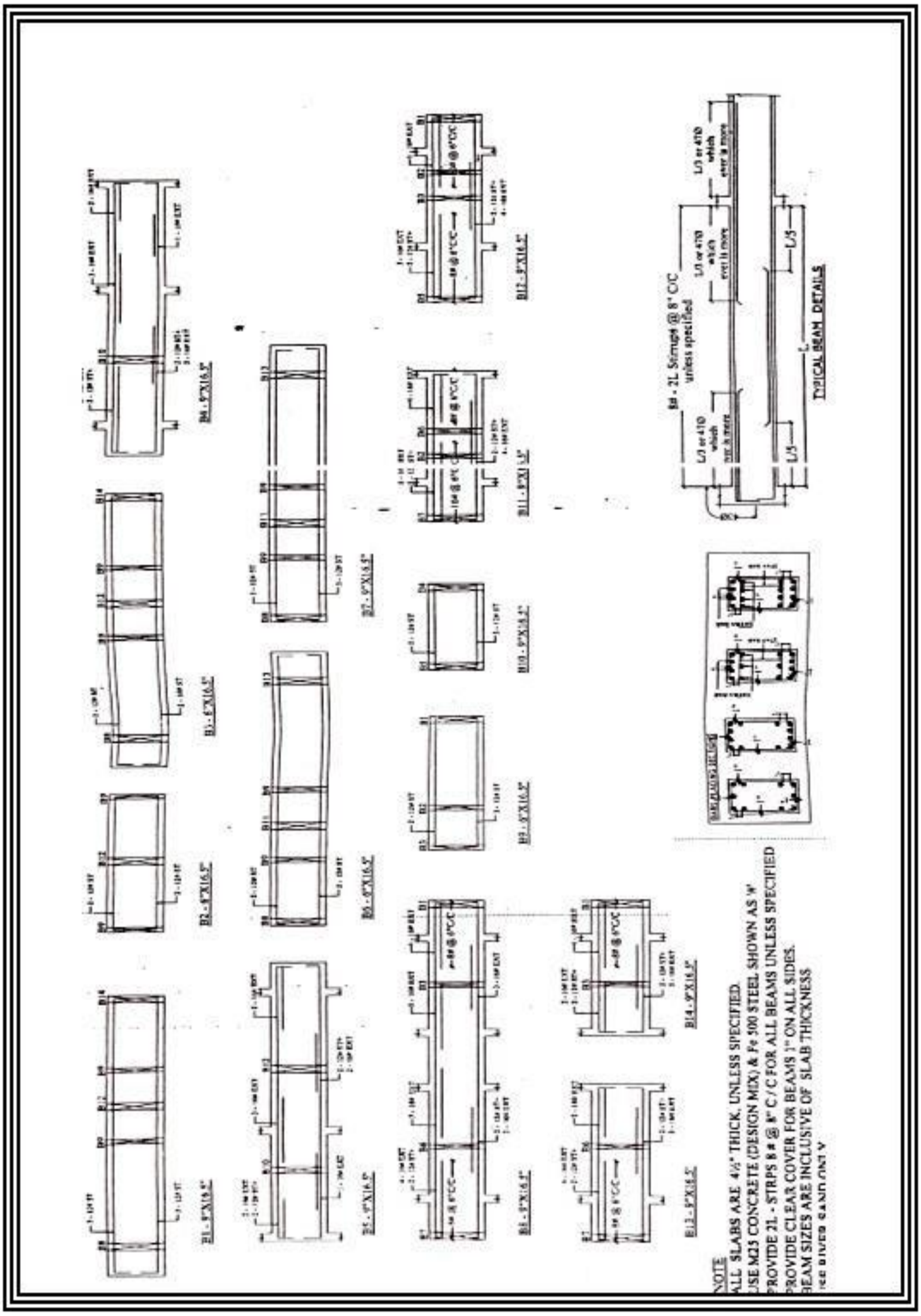
✦ Plinth Beam Details



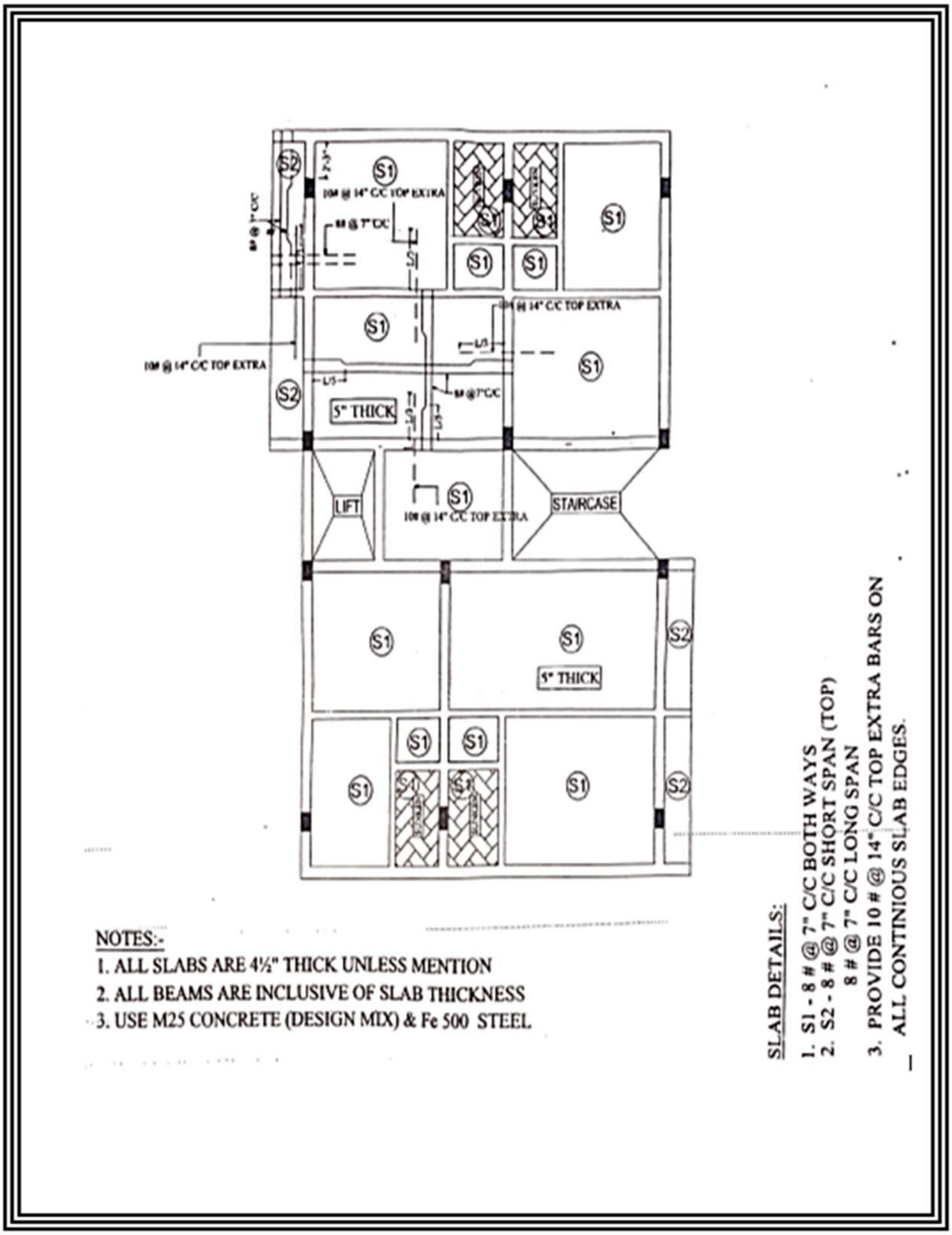
✦ Beam Layout


B1 - 9"X16.5"
2'-6" [0.76]
2'-3"
9'-8"
B9 - 6"X16.5"
B2 - 6"X16.5"
3'-10"
3'-5"
B9 - 6"X16.5"
B14 - 9"X16.5"
B3 - 6"X16.5"
9'-1"
B12 - 9"X16.5"
B4 - 9"X16.5"
4'-9"
LIFT
B8 - 9"X16.5"
B10 - 9"X16.5"
STAIRCASE
B5 - 9"X16.5"
9'-1"
B11 - 9"X16.5"
B6 - 6"X16.5"
3'-5"
3'-10"
B2 - 6"X16.5"
B13 - 9"X16.5"
8'-5"
B9 - 6"X16.5"
B9 - 6"X16.5"
2'-3"
2' [0.61]
B7 - 9"X16.5"
NOTES:-
1. ALL SLABS ARE 4½" THICK UNLESS MENTION
2. ALL BEAMS ARE INCLUSIVE OF SLAB THICKNESS
3. USE M25 CONCRETE (DESIGN MIX) & Fe 500 STEEL

Beams Details



Slab Layout



CHAPTER 7

CONCLUSIONS

The project's primary goal of obtaining skills in design, modelling, sketching, and analysis using software has been accomplished.

- The residential building's precise 3D model is analyzed.
- Rendering is used to give a realistic image of the building. ● The structural model of the residential structure is created.
- The loading conditions, Deflections, forces, Bending Moments of the structure analyzed by including the reinforcement in the structural members using the Robot structural analysis tool.

- The quantity and cost estimation for bricks, cement, sand, and schedules for doors, windows and rebar is completed.
- Documentation/ Sheets for planned and computed structural members is produced.
- The results of Revit software and manual results are compared.

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