3D MODELLING ANALYSIS AND DESIGN OF COLLEGE BUILDING USING BIM SOFTWARE

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ABSTRACT

This project focuses on the design and rendering of the KLM college using advanced Building Information Modelling (BIM) software, including Autodesk Revit and AutoCAD. The primary objective is to create a comprehensive, detailed, and realistic model of the KLM College, incorporating schedules, architectural, structural, and MEP (Mechanical, Electrical, and Plumbing) elements. For visualization and rendering, Enscape software will be used to produce high-quality, photorealistic images and animations. The project aims to demonstrate the efficiency and effectiveness of BIM tools in enhancing design accuracy, collaboration, and overall project management in construction. The project covers the Architecture, structure Lighting and preparing of schedules by using our institutional plan. And doing rendering in Enscape.The STAADPRO software is used for analysis and design of the college building using Indian standard codebooks and applying Loads for the building.

Key words: Revit, Architecture, Structure, Staadpro, Rendering.

I. INTRODUCTION

This project focuses on the integration of three industry-standard software tools—AutoCAD, Revit, and STAAD.Pro—to perform comprehensive 3D modeling, structural analysis, and design of civil engineering structures. The objective is to leverage these technologies to demonstrate how modern digital tools can enhance the precision, efficiency, and quality of engineering designs while aligning with current industry practices and standards.

The use of AutoCAD Civil 2D plays a foundational role in generating accurate and detailed 2D drafts essential for infrastructure planning and development. It is particularly useful for site layout, road alignment, and utility design. Its tools for dynamic blocks, annotation scaling, and advanced layer management improve productivity and communication among stakeholders. The ability to produce clear, professional construction documentation makes it a critical component in the early phases of design and coordination.

Revit Architecture, a Building Information Modeling (BIM) tool by Autodesk, extends the capabilities of design beyond simple drafting by enabling intelligent 3D modeling. Revit's parametric design environment ensures that changes in one part of the model are automatically reflected throughout the project, thereby reducing errors and rework. It allows integration of various building systems—architectural, structural, mechanical, electrical, and plumbing—within a single environment, supporting real-time collaboration among project teams. Revit also includes tools for construction documentation, cost estimation, scheduling, and even energy and structural performance analysis, contributing to a more sustainable and efficient design approach.

STAAD.Pro, developed by Bentley Systems, is employed for structural analysis and design. It allows engineers to simulate real-world conditions and assess the safety, stability, and compliance of the proposed structures. The software supports a wide variety of materials, including concrete, steel, and timber, and includes extensive libraries of international design codes. Its advanced analysis features, such as finite element analysis (FEA), dynamic and seismic analysis, and load combination evaluations, enable the creation of structurally sound and economically optimized designs.

Together, these tools form a powerful workflow that bridges theoretical knowledge with practical implementation. The project not only highlights each software's individual strengths but also their interoperability in supporting complex civil

engineering tasks. From visualization and drafting to real-time simulation and performance evaluation, this integrated approach enhances both the technical output and the understanding of holistic, technology-driven engineering processes.

This project aims to develop both technical competence and a broader perspective on the role of software in shaping modern civil infrastructure. By simulating real-world challenges and applying professional tools to solve them, it serves as a preparatory foundation for future careers in engineering design and construction.

II. LITRERATURE REVIEW

Several studies and academic projects have demonstrated the utility and efficiency of modern engineering software tools in the design and analysis of civil engineering structures. Vipul Gupta and Abhiroop Goswami (2016) showcased 3D modeling of Amity University using BIM and GIS technologies. Their work emphasized how 3D modeling facilitates effective urban planning and facility management, highlighting the benefits of integrating modern tools for a comprehensive representation of built environments.

Sreeshna K.S (2016) conducted a structural analysis and design of a B+G+4 apartment using STAAD.Pro, supported by IS codes such as IS 875 for load calculation. The work followed a structured methodology encompassing modeling, analysis, and detailing of structural elements such as slabs, beams, columns, and foundations.

Borugadda Raju et al. (2015) analyzed a G+30 building using STAAD.Pro with the limit state method. Their study focused on designing reinforced concrete frames and applying various load combinations in both 2D and 3D environments. Similarly, SK Saleem (2017) validated STAAD.Pro's utility for manual load calculation and structural analysis under different loading conditions for multi-storey buildings.

Deevi Krishna Chaitanya (2017) stressed the need for time-efficient structural design in a competitive market. His study explored several structural analysis methodologies and showcased STAAD.Pro as a time-saving solution for analyzing and designing beams, columns, and foundations with applied dead and live loads.

Aman et al. (2016) investigated the effect of dynamic loads such as wind and earthquakes using finite element analysis in STAAD.Pro. They emphasized safety and stability in structural modeling under various loading scenarios. K. Rama Raju et al. (2013) discussed challenges in tall building design, including conceptual and preliminary design aspects and the importance of strength and serviceability criteria under lateral loads.

Amar Hugar et al. (2016) highlighted the role of Computer-Aided Design (CAD) in structural analysis. Using STAAD.Pro, they compared manual design results with software-generated data, confirming the tool's efficiency and reliability in complying with IS:456-2000 standards.

Bandipati Anup et al. (2016) evaluated a G+2 multi-storey structure using STAAD.Pro. The study verified structural design through physical calculations and extended the work to higher storeys using various load combinations. Madhurivassavai et al. (2016) supported multi-storey construction as a solution to land scarcity due to population growth. Their study used AutoCAD and STAAD.Pro for efficient modeling and analysis, noting that software tools streamline otherwise time-consuming manual calculations.

Lastly, Mr. Suyog R. Jadhav et al. (2021) presented a holistic approach involving planning with AutoCAD, structural design as per IS codes, and detailed cost estimation for a residential building. Their work reinforced the importance of integrating planning, designing, and budgeting in civil engineering projects.

Collectively, these studies illustrate the growing reliance on digital tools like AutoCAD, Revit, and STAAD.Pro to ensure accuracy, safety, and efficiency in civil engineering practices.

III. OBJECTIVES OF STUDY

The primary objectives of this project are :

- To design and analyze a G+3 (Ground + 3 stories) commercial building using advanced software tools: AutoCAD, Revit, and STAAD Pro.
- To develop accurate 2D drawings and floor plans using AutoCAD.
- To create a comprehensive Building Information Model (BIM) incorporating architectural, structural, and MEP elements using Revit.
- To perform structural analysis and design using STAAD Pro to ensure safety, stability, and compliance with relevant building codes.

- To integrate all design components efficiently for improved coordination and clash detection.
- To optimize the building design for sustainability, energy efficiency, and cost-effectiveness.
- To equip students with practical, industry-relevant skills and experience in modern design and analysis tools.
- To document and present the design process, decisions, and outcomes in a professional format.
- To bridge the gap between theoretical knowledge and real-world civil engineering applications.

IV. METHODOLOGY

4.1 AutoCAD

In AutoCAD, the G+3 building design begins with setting up units and layers, followed by drafting 2D plans, elevations, and sections. Structural and utility details are added, ensuring precision using basic commands. The drawing is reviewed, annotated, and plotted for final use.

4.2 STAAD.Pro

STAAD.Pro is used to analyze and design the structure using the Response Spectrum Method. It evaluates the building's stability under seismic loads across different zones, ensuring safety and code compliance.

4.3 Revit

Revit modeling starts with importing CAD plans, setting grids and levels, and adding structural and architectural components. Interiors, MEP elements, and finishes are integrated. Renderings and detailed drawings are generated for complete project documentation.

V. PLANNING USING AUTOCAD

Classroom designs follow space utilization guidelines to ensure flexibility, functionality, and compliance with standards. Classrooms are categorized into seminar/collaborative rooms, traditional classrooms, and lecture halls, each designed for specific teaching methods and capacities.

5.1 Room Types

- Seminar/Collaborative Rooms: Movable furniture, <30 seats.
- Traditional Classrooms: 30–75 seats, flexible layout.
- Lecture Halls: 50–80 tiered seats, fixed or movable furniture.

5.2 Design Features

- Main Block: G+3 layout with admin, library, labs on lower floors, classrooms on upper floors.
- Classroom Design: Unobstructed views, proper spacing, appropriate ceiling heights, and acoustics.
- Hallways: Spacious, quiet, visually engaging, and allow smooth flow.

-Flooring & Ceilings: Durable, acoustic-friendly materials, and adequate access to services.

5.3 Special Areas

-Canteen: Double-height space for ~100 people with separate faculty seating.

-Hostel: Girls-only, G+3 with kitchen/dining on ground floor and rooms above.

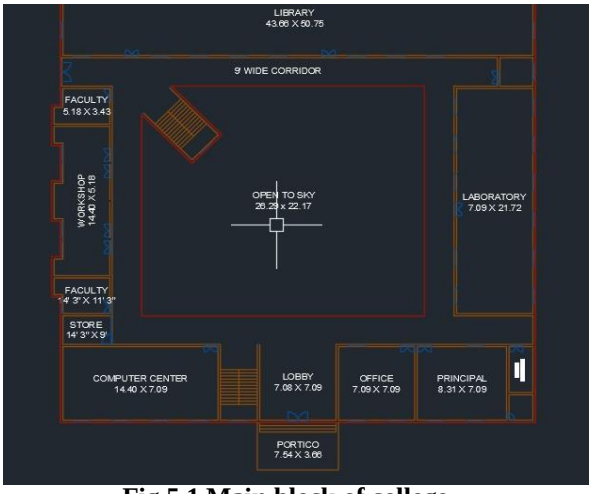


Fig 5.1 Main block of college

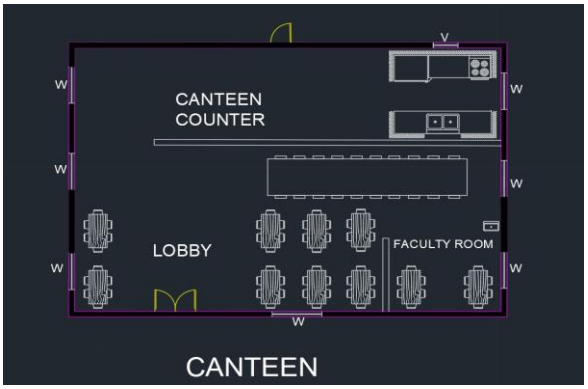


Fig 5.2 Canteen

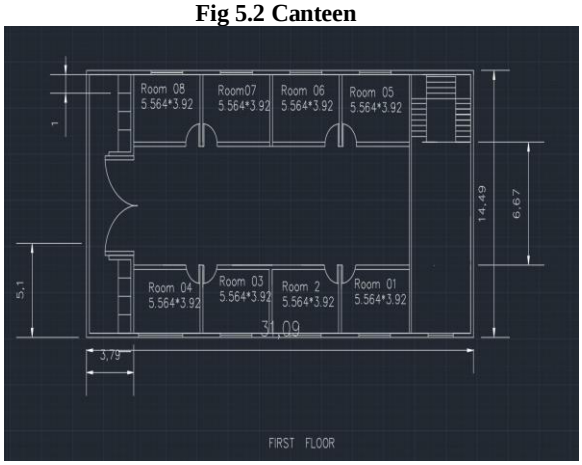


Fig 5.3 College Hostel

VI. STRUCTURAL DESIGN USING STAAD.PRO

This chapter outlines the structural design results, focusing on the main structural elements—columns, beams, and footings. The design adheres to the IS 456:2000 and IS 13920:2016 codes, using STAAD Pro for analysis and manual verification for critical components.

6.1 DESIGN OF MAIN BUILDING COLUMN

Design Code: IS 456 : 2000 + IS 13920 : 2016

Load Combinations :

L/C No Analysis No Load Definition

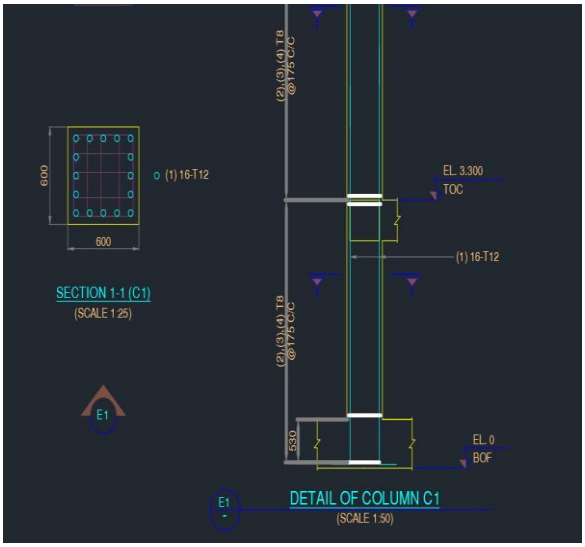
1 3 1.5 (LOAD 1: DEAD LOAD) +1.5 (LOAD 2: LIVE LOAD)

Levels :

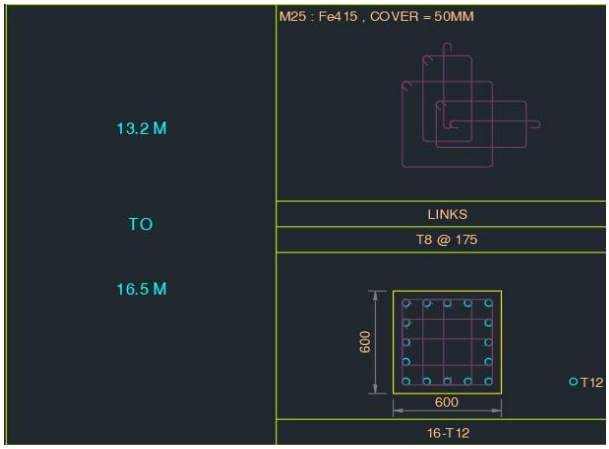
1. FOUNDATION
2. 3.3 m
3. 6.6 m
4. 9.9 m
5. 13.2 m
6. 16.5 m

Column/Wall : C1

Frame Type : Non-Ductile



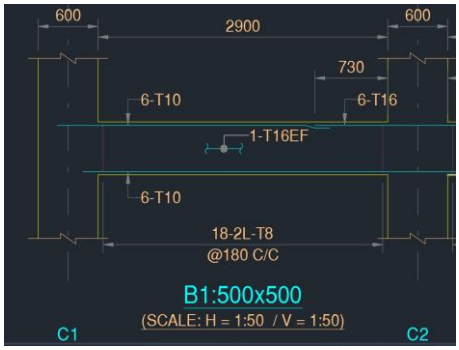
Level	Size (mm)	Material	LC	Analysis LC No	P (KN)	Mx (KN/m)	My (KN/m)	Pt (%)	Interaction Ratio	Main Reinforcement
1 TO 2	600 X 600	M25	1	3	3850.03	19.32	123.21	0.5	0.94	16-T12
2 TO 3	600 X 600	M25	1	3	3096.2	-26.55	158.03	0.5	0.63	16-T12
3 TO 4	600X 600	M25	1	3	2261.73	20.44	153.43	0.5	0.46	16-T12
4 TO 5	600 X 600	M25	1	3	1515.09	19.11	154.35	0.5	0.42	16-T12
5 TO 6	600 X 600	M25	1	3	687.27	9.11	220.2	0.5	0.72	16-T12

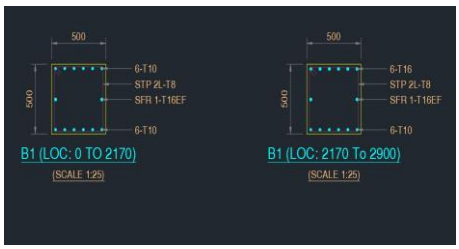


6.2 DESIGN OF MAIN BUILDING BEAM

Beam No : B1
Group No : G1
Analysis Reference(Member) 3.3 m : 1264
Analysis Reference(Member) 6.6 m : 1344
Analysis Reference(Member) 9.9 m : 1424
Analysis Reference(Member) 13.2 m : 1504
Analysis Reference(Member) 16.5 m : 1584
Breadth : 500 mm
Depth : 500 mm
Concrete Grade : M25 N/sqmm
Grade Of Steel (Main) : Fe415 N/sqmm
Grade Of Steel (Shear) : Fe415 N/sqmm
Top/Bottom Clear Cover : 25 mm
Side Clear Cover : 25 mm
Design Code : IS 456 : 2000 + IS 13920 : 2016
Beam Type : Regular Beam

	Beam Bottom			Beam Top		
	Left	Mid	Right	Left	Mid	Right
Mjud (kNm)	43.98	49.4	2.62	44.38	19.24	128.85
PtClc (%)	0.205	0.205	0.2	0.205	0.205	0.385
AstCalc (sqmm)	455.72	455.72	445	455.72	455.72	857.06
Ast Prv (sqmm)	471.25	471.24	471.24	471.24	471.24	1206.36
Reinforcement	6-T10	6-T10	6-T10	6-T10	6-T10	6-T10

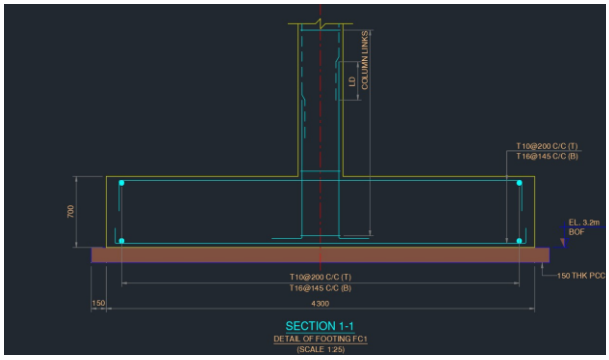




6.3 DESIGN OF HOSTEL FOOTING

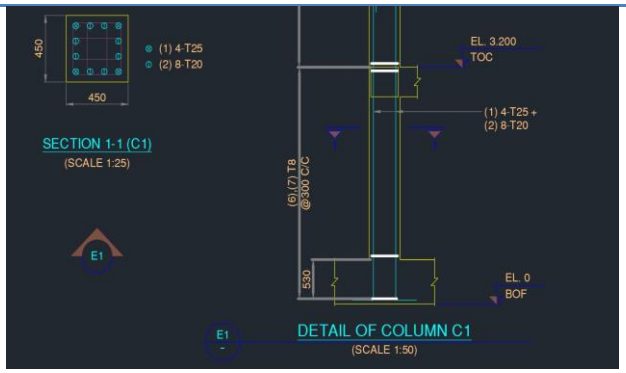
Design Code : IS 456 : 2000 + IS 13920 : 2016
Footing No: FC1
Column No: C1 (450 mm X 450 mm)
Footing Type: Pad
Concrete Grade: M25
Steel Grade: Fe415

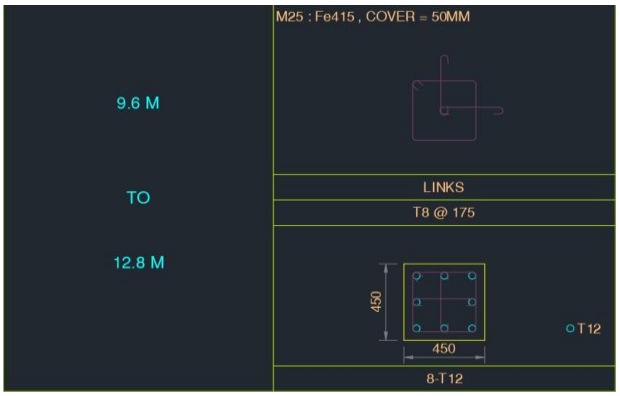
Size (LxBxD)	Bot @ L	Bot @ B	Top @ L	Top @ B	Shear @ L	Shear @ B	SFR
4300x4300x700	31-T16 @ 145	31-T16 @ 145	23-T10 @ 200	23-T10 @ 200	-	-	-



6.4 DESIGN OF HOSTEL COLUMN

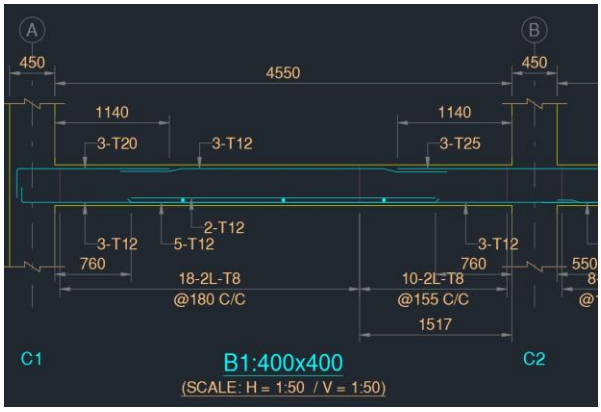
	Required			Provided	
	Normal Design	Shear Design	Ductile Design	Normal Zone	Ductile Zone
Link Dia	8	---	---	8	---
Spacing	300	---	---	300	---

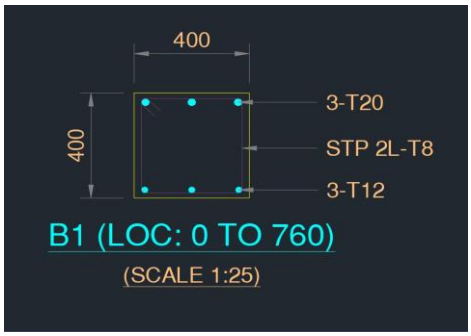




6.5 DESIGN OF HOSTEL COLUMN

	Beam Bottom			Beam Top		
	Left	Mid	Right	Left	Mid	Right
Mjud (kNm)	20.56	78.88	4.33	95.61	4.33	149.2
PtClc (%)	0.205	0.501	0.2	0.62	0.2	1.053
AstCalc (sqmm)	282.65	691.03	276	856.14	276	1453
Ast Prv (sqmm)	339.3	79.17	339.3	942.48	339.3	1472.61
Reinforcement	3-T12	5-T12	3-T12	3-T20	3-T12	3-T25





VII. REVIT ARCHITECTURE

Revit Architecture is a powerful Building Information Modeling (BIM) tool used for architectural design, documentation, visualization, and coordination. It allows creation of 2D plans, 3D models, elevations, sections, detailed drawings, schedules, and realistic renderings using Enscape.

Key Features:

- **BIM Integration**: Revit provides detailed information about project design, materials, quantities, costs, and phases.
- **All-in-One View**: 2D, 3D, sections, and elevations with details and schedules are available in a single project environment.
- **Material Info**: Revit stores data such as thickness, height, cost, family types, and quantities (e.g., bricks, doors, windows).

User Interface Components:

- **Quick Access Toolbar, Ribbon & Contextual Tabs** – Quick tool access.
- **Project Browser** – Navigate through views, families, and schedules.
- **Properties Palette** – Modify selected elements' parameters.
- **Drawing Area** – Visual workspace for model and views.

Project Workflow:

1. **Start with Revit Architecture Template**.
2. **Set Units**, Create Levels (Ground to Terrace).
3. **Create Grids & Line Diagrams** using drawing tools.
4. **Place Walls, Doors, Windows, Staircases**, and **Model Text**.
5. **Add Components** like furniture, beds, and railings from Revit library.
6. **Design Floors, Roofs**, and **Apply Materials** (using Paint tool or properties).

Model Details:

- **Main Block**: Classrooms, library, labs, lobby, faculty room, etc., with specified dimensions and furniture.
- **Hostel**: Dorm rooms, bathrooms, kitchen, dining, corridor, etc.
- **Canteen**: Dining space, kitchen area, staff seating, and tables.

Family Creation & Customization:

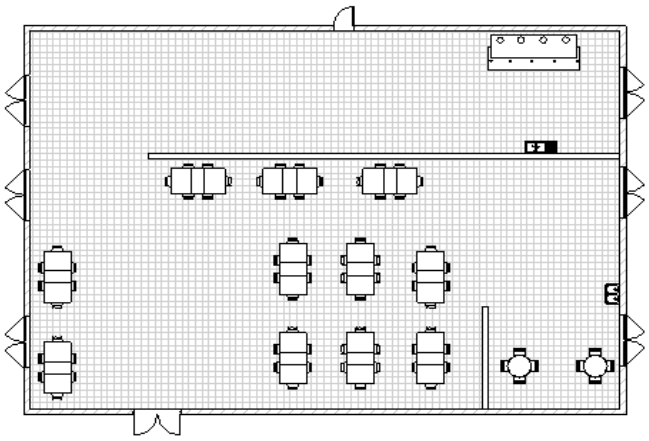
- Use **reference planes, extrusion, sweep, blend** tools.
- Create custom doors, windows, furniture and save them as families.
- Modify or import components easily as per project needs.

Visualization & Rendering:

- Use **Enscape** for realistic renderings.
- Apply **materials** to surfaces or elements for lifelike visuals.
- Use **Zoom tools & Navigation wheel** for clear model views.

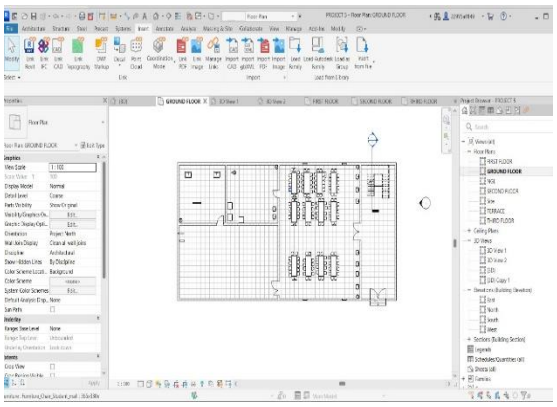
7.1 LINE DIAGRAMS

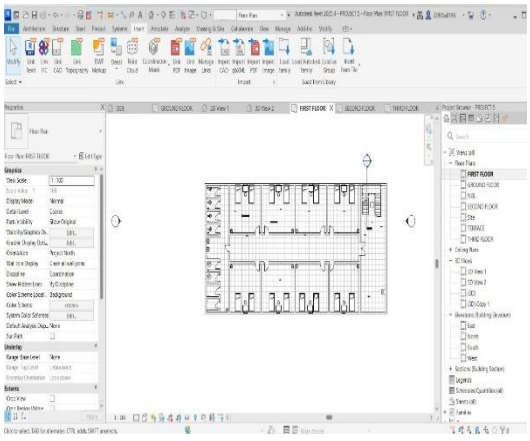
A. CANTEEN



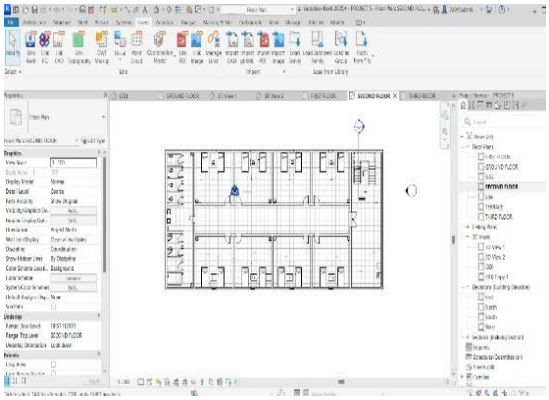
Ground floor

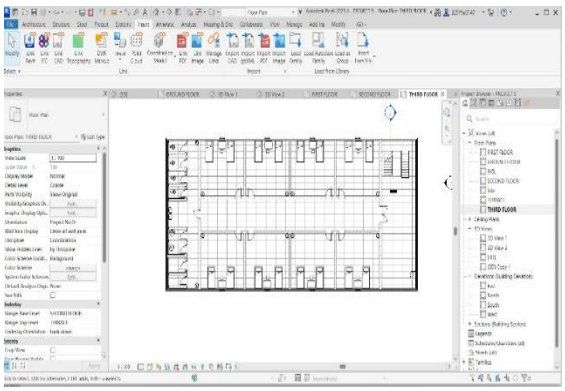
B.HOSTEL PLAN VIEWS



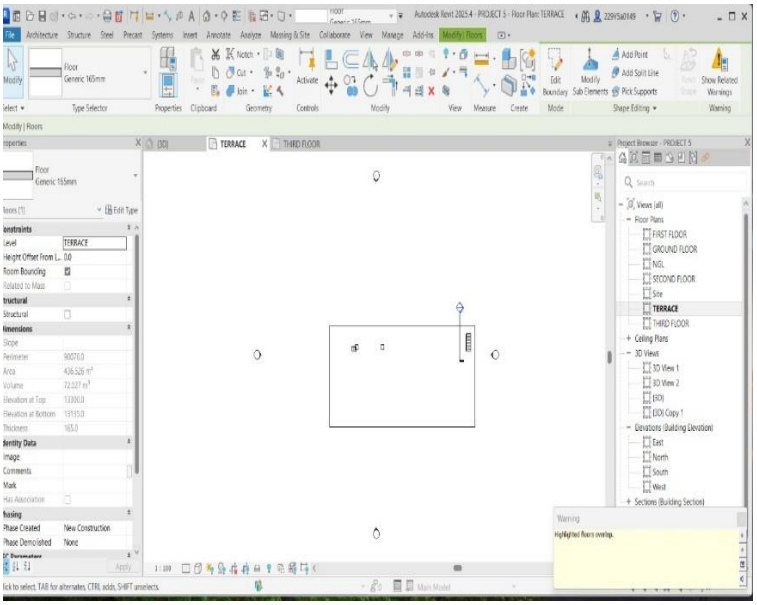


GROUND & FIRST FLOOR



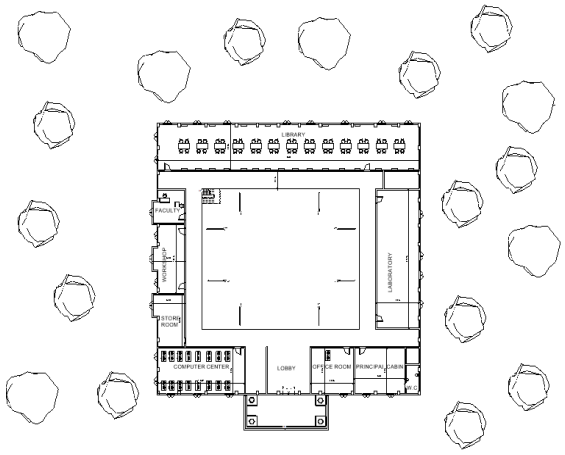


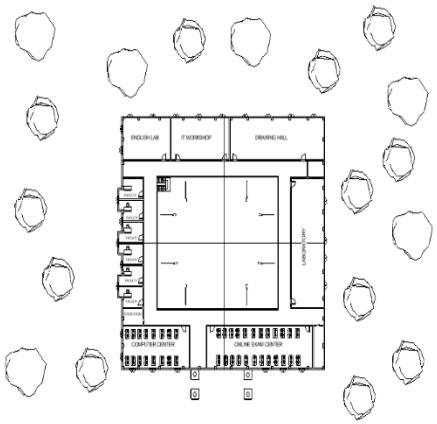
SECOND & THIRD FLOOR



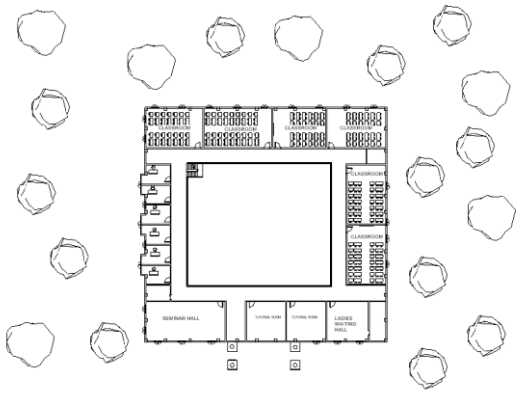
Terrace

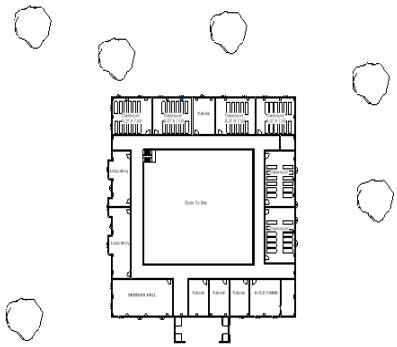
C. MAIN BLOCK PLAN VIEWS



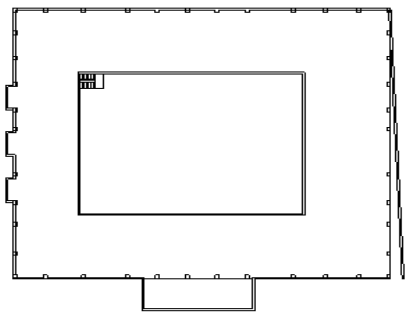


GROUND & FIRST FLOOR





SECOND & THIRD FLOOR



Terrace

VIII. ENSCAPE

Enscape is a real-time rendering tool that integrates seamlessly with design software like Revit, SketchUp, Rhino, and Archicad, enabling architects and designers to visualize their models instantly. It is user-friendly and eliminates the need for exporting files, as it works directly within the design environment. With its ability to produce high-quality, lifelike renderings, Enscape enhances collaboration by supporting virtual reality and advanced lighting options, making it easier to communicate design . Additionally, it offers customization options, allowing users to adjust materials, lighting, and other elements to refine the visual output to meet specific needs. Overall, Enscape streamlines workflows and elevates the quality of architectural presentations.

Fig 8.1 Main Block

Fig 8.2 Hostel

Fig 8.3 Canteen

IX. CONCLUSIONS

The aim of our project was planning, analysis and design of a college building, hostel building, canteen. We were able to complete the project in a successful and efficient manner by considering all the relevant features given as Eight chapters.

Planning of this building has been done based on the space requirements suggested by the prevailing rules stipulated in Building codes. The design is completely

based on relevant Indian Standard Codes. The modelling has been done by using Revit software. The analysis has been done with the help of STAAD Pro and the drawings have been made with the help of AutoCAD. The Rendering has been done by using Enscape software We have completed this project to the best of our knowledge and ability.

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