

Architectural Planning and Different Loads Analysis of a School Building Using Revit and Staad Pro

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Abstract: Educational buildings such as school structures require careful architectural planning and detailed structural analysis due to their high occupancy, long service life, and importance to public safety. This journal presents an integrated study on the architectural planning and structural load analysis of a reinforced concrete school building using Autodesk Revit and STAAD.Pro. Revit is utilized as a Building Information Modelling (BIM) tool to develop architectural layouts, floor plans, elevations, sections, and three-dimensional views, ensuring proper space utilization, ventilation, and functional efficiency. STAAD.Pro is employed for structural modelling, load calculation, and analysis of the building under various loading conditions. Dead loads, live loads, wind loads, and seismic loads are calculated in accordance with Indian Standard codes such as IS 456:2000, IS 875 (Part 1–3), and IS 1893 (Part 1). Appropriate load combinations are generated to verify both strength and serviceability criteria. The analysis results indicate that the proposed school building is structurally stable and satisfies all codal requirements. The study also briefly incorporates the concept of a Zero Energy Building by emphasizing energy-efficient architectural planning, optimal daylight utilization, natural ventilation, and the potential use of rooftop solar photovoltaic systems to offset the building's energy consumption. The integration of BIM tools with structural analysis software thus improves design accuracy, coordination, structural safety, and sustainability in modern educational building projects.

Keywords: School Building; Architectural Planning; Structural Analysis; Autodesk Revit; STAAD.Pro; Dead Load; Live Load; Indian Standard Codes; Load Combinations; Reinforced Concrete Structure; Educational Buildings; Zero Energy Building (ZEB).

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I. INTRODUCTION

School buildings are one of the most important public infrastructure facilities, as they serve as centers for education and social development. These buildings accommodate a large number of students, teachers, and staff for extended periods, making safety, comfort, and durability essential design considerations. Any structural failure or improper planning in such buildings can result in serious consequences, including loss of life and disruption of educational activities.

Traditionally, architectural planning and structural analysis were performed manually, which was time-consuming and prone to human errors. With the advancement of computer-aided design and analysis tools, modern software such as Autodesk Revit and STAAD.Pro has revolutionized the construction industry. Revit allows the creation of intelligent BIM models that integrate

architectural, structural, and functional information, while STAAD.Pro provides powerful capabilities for analyzing reinforced concrete structures under various loading conditions.

Several previous studies have focused on residential and commercial buildings using software-based analysis. However, school buildings have unique functional requirements and load considerations due to high occupancy and importance factor. This journal aims to present a comprehensive methodology for architectural planning and load analysis of a school building using Revit and STAAD.Pro, ensuring compliance with Indian Standard codes and structural safety requirements.

➤ Objectives of the Project:

The main objective of this project is to develop an efficient and safe design for a school building by integrating

architectural planning with structural load analysis using modern engineering software tools. The specific objectives are:

- To prepare a detailed architectural plan of a school building considering functional requirements such as classrooms, corridors, ventilation, lighting, and circulation.
- To model the building structurally and analyze it under different types of loads including dead load, live load, wind load, and seismic load.
- To evaluate structural behavior such as displacement, bending moment, shear force, and stability using analysis software.
- To ensure the design satisfies safety, serviceability, and code requirements.
- To incorporate Zero Energy Building concepts by applying energy-efficient planning strategies and renewable energy integration.
- To understand the workflow between architectural modeling and structural analysis platforms for practical engineering applications.

II. LITERATURE REVIEW

A study published in the International Research Journal of Engineering and Technology by A. V. Deepanchakaravarthi, S. Nivetha, and S. Rajalakshmi (2021) presented the structural analysis and design of a two-storey reinforced concrete primary school building designed for 500 students with a built-up area of 6000 m². The building included classrooms, laboratories, library, staff rooms, and sanitation facilities. Structural components such as slabs, beams, columns, staircases, and isolated footings were designed according to Indian Standard codes, and analysis was performed using structural software. Manual calculations were also carried out for slabs, beams, columns under axial and biaxial loads, and foundations. The results confirmed that all elements satisfied requirements for bending, shear, deflection, and punching shear, demonstrating that software-assisted analysis produces safe and economical designs for institutional buildings. Similarly, research published in the International Journal of Innovative Research in Technology by Babitha Rani H. and Nagendra Babu (2018) analyzed a G+4 reinforced concrete building using structural analysis software. The structure was modeled as a three-dimensional frame subjected to dead, live, wind, and seismic loads calculated according to Indian standards. The study adopted the Limit State Method with M25 concrete and Fe415 steel and verified software-generated loads through codal calculations. The findings demonstrated that digital structural analysis tools improve accuracy, efficiency, and reliability in multi-storey building design. Earlier works by Dinesh Ranjan and Aishwarya Lakshmi (2017) highlighted the importance of systematic load distribution and detailing practices in institutional structures, while Natasha Khalil (2015) validated the effectiveness of software-based RCC building analysis. Research by Arjun Sahu and co-authors further emphasized that computer-based methods are essential for analyzing

complex framed structures compared with conventional analytical approaches. Standard design references such as books by N. Krishna Raju published by CBS Publishers and B. C. Punima published by Laxmi Publications provide fundamental theory and procedures for reinforced concrete design, supporting analytical and software-based approaches. Together, these studies establish that integrating codal provisions, manual verification, and advanced structural software ensures safe, efficient, and practical design of school and institutional buildings, forming the basis for the methodology adopted in the present project. If you want, I can also condense this into a short literature review paragraph version suitable for strict page-limit reports.

III. METHODOLOGY

The project methodology follows a systematic process integrating architectural planning, structural analysis, and sustainable design principles. First, basic data such as building requirements, site conditions, and design standards are collected. The architectural model of the school building is then created in Revit, where floor plans, elevations, sections, and a 3D model are developed with proper orientation for natural lighting and ventilation. Structural elements such as beams, columns, slabs, and foundations are also defined within the model. Next, the structural model is exported from Revit to STAAD Pro through compatible file formats. In STAAD Pro, material properties, support conditions, and structural parameters are assigned. Different loads including dead load, live load, wind load, and seismic load are calculated and applied, and load combinations are generated according to design standards. The structure is analyzed to obtain results such as bending moments, shear forces, axial forces, and displacements. Based on the analysis results, member sizes are checked and modified if necessary to ensure safety, stability, and serviceability. Finally, zero energy building concepts such as passive planning, daylight utilization, natural ventilation, and provision for renewable energy systems are incorporated to enhance energy efficiency and sustainability.

➤ *Planning with AUTOCAD:*

The methodology involves preparing accurate two-dimensional architectural drawings of a G+3 school building using AutoCAD based on site conditions, building regulations, and functional requirements. Space planning is carried out for classrooms, laboratories, administrative rooms, corridors, staircases, and sanitation facilities, ensuring proper circulation and safety. The ground floor plan is drafted first, followed by plans for the upper three floors while maintaining structural alignment. Elevations, sections, staircase details, and door-window layouts are then developed with proper dimensions, layers, and annotations. Essential safety features such as adequate corridor width, emergency exits, and accessibility provisions are incorporated. The finalized AutoCAD drawings provide precise geometrical information that serves as the basis for subsequent structural modeling and load analysis of the G+3 school building.

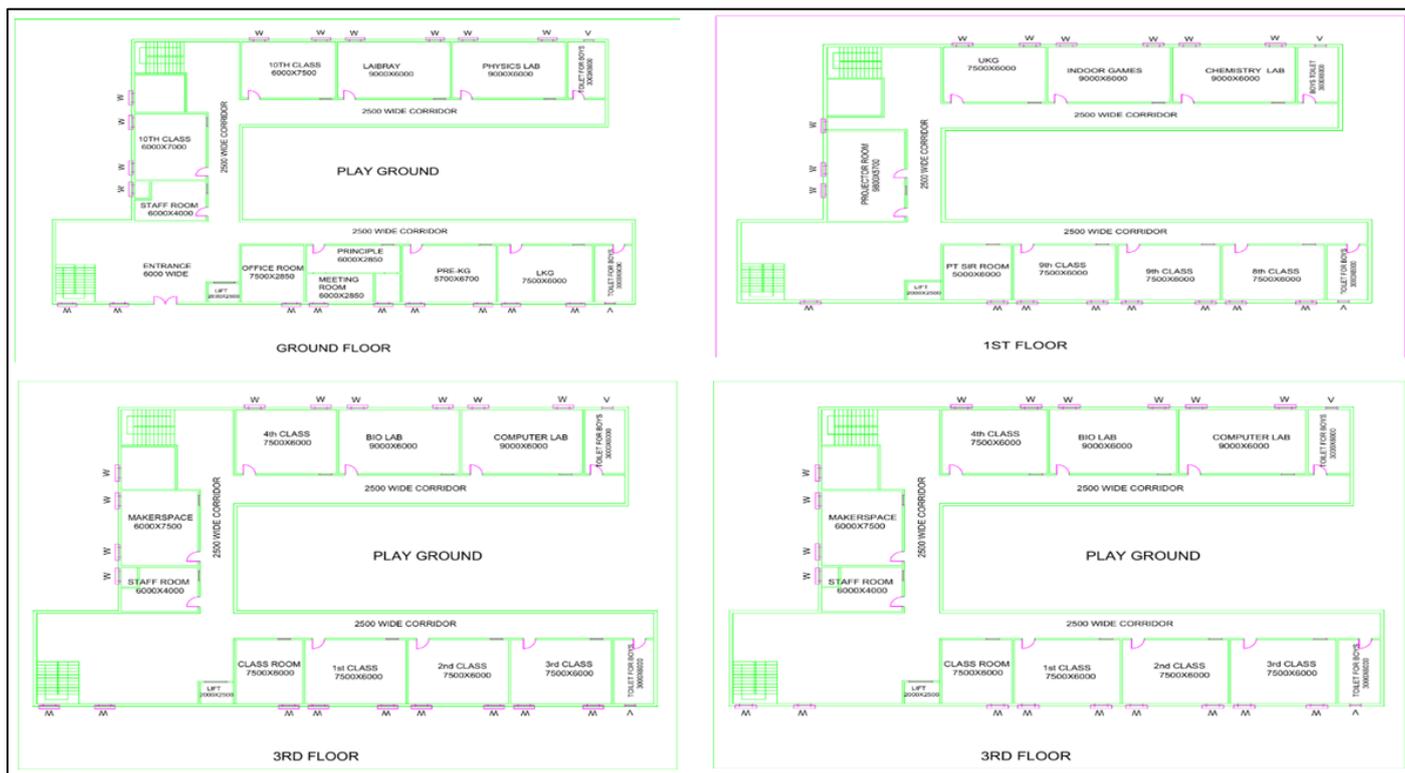


Fig 1 Plans of Whole G+3 School Building

➤ *Architecture Planning with BIM (Revit):*

The architectural planning of the school building is performed using Autodesk Revit. The building layout includes classrooms, corridors, laboratories, administrative offices, staff rooms, staircases, and sanitation facilities. Adequate attention is given to ventilation, natural lighting, circulation, and safety.

Revit enables the preparation of floor plans, elevations, sections, and 3D views from a single BIM model. Building components such as walls, slabs, doors, windows, and staircases are modeled with accurate dimensions and material properties. The BIM environment helps in detecting clashes and improving coordination among different building elements at the planning stage itself.

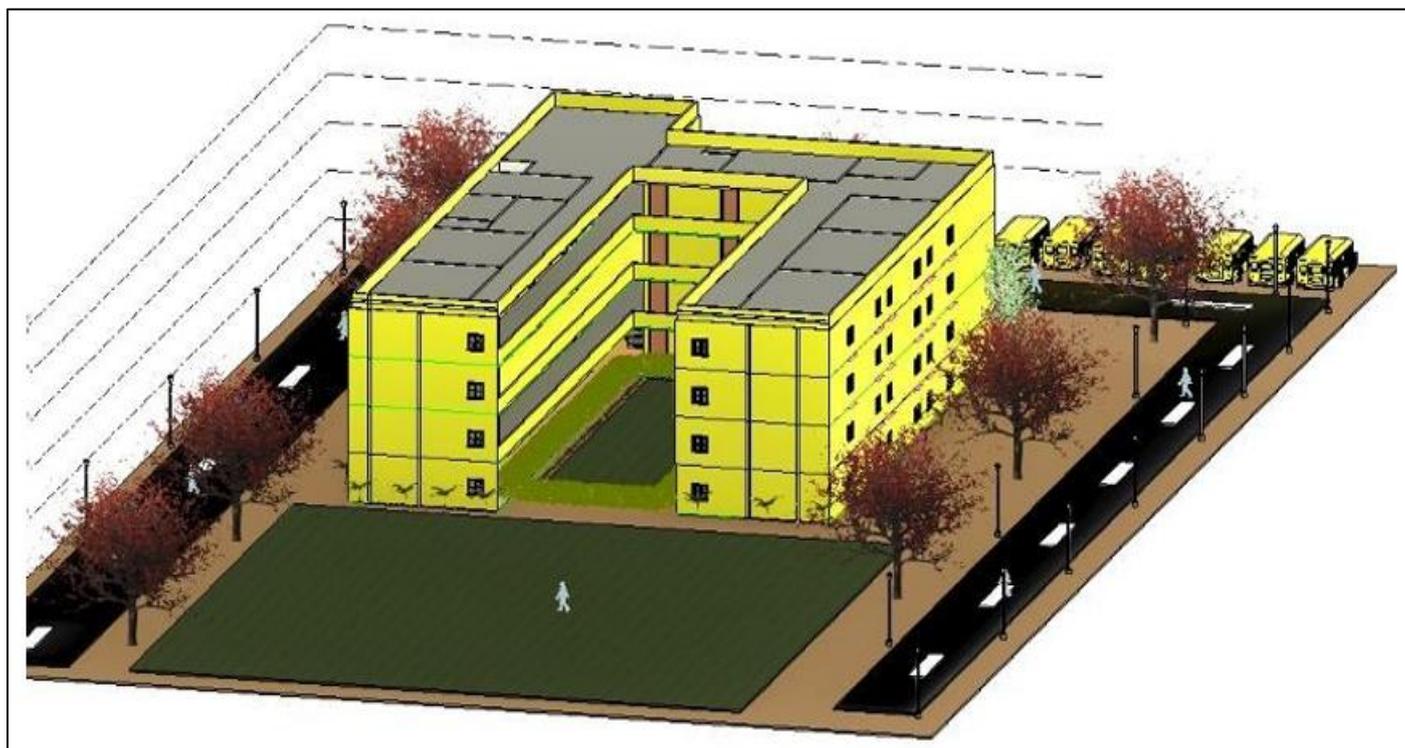


Fig 2 Structure Modelling

➤ *Structural Modelling in STAAD. Pro and Load Analysis:*

Based on the architectural drawings, the structural model of the school building is developed in STAAD.Pro. The structure is modeled as a reinforced concrete framed system consisting of beams, columns, slabs, and foundations. A grid system is defined, and member connectivity is established according to the architectural layout. Material

properties such as grade of concrete and reinforcement steel are assigned as per Indian Standards. Support conditions are assumed to be fixed at the foundation level. STAAD.Pro automatically considers the self-weight of structural members, reducing manual calculation errors and improving accuracy.

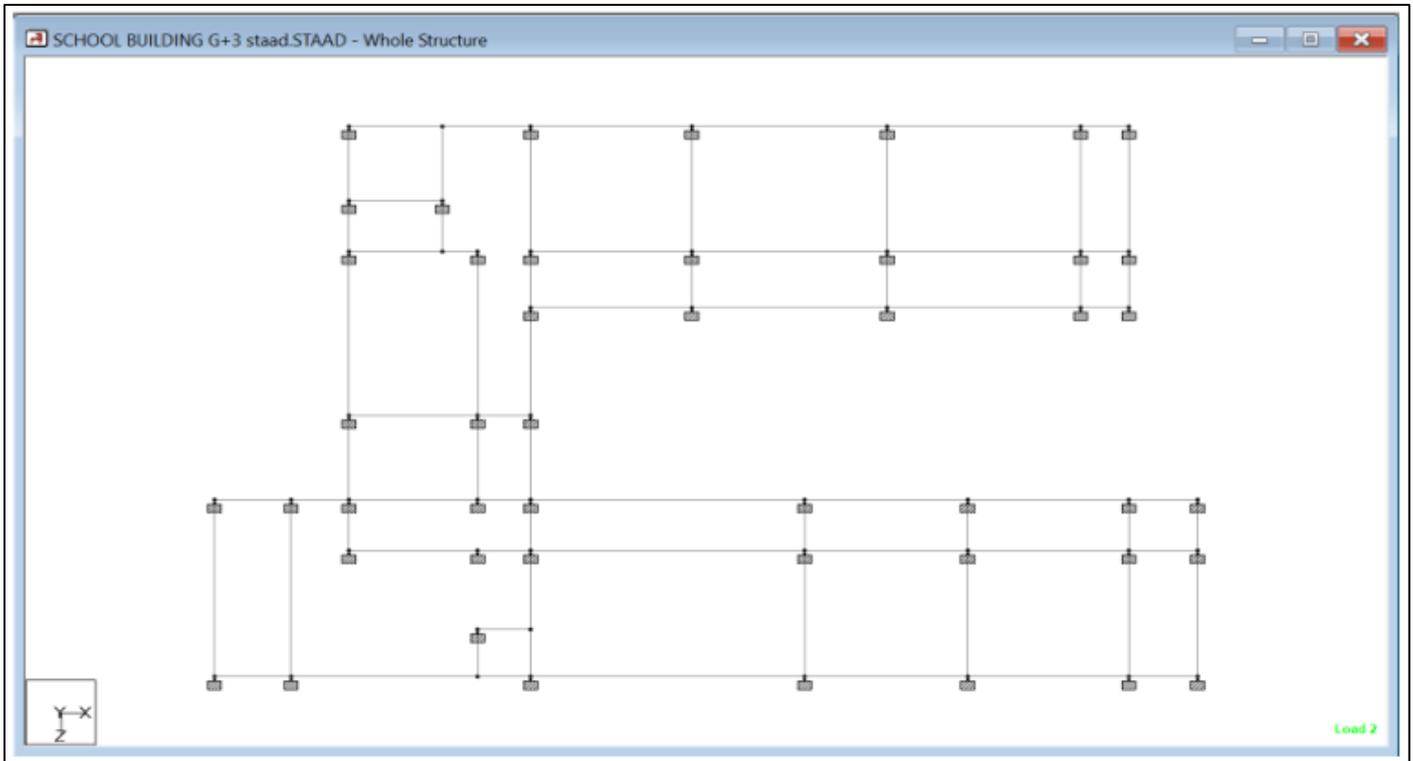


Fig 3 Line Diagram in Staad Pro

Load analysis is a critical step in structural design. In this study, dead loads and live loads are calculated and applied as per Indian Standard codes.

- Dead loads include the self-weight of slabs, beams, columns, walls, and floor finishes. Live loads represent the loads due to occupants, furniture, and movable equipment and are considered as per IS 875 (Part 2) for school buildings.

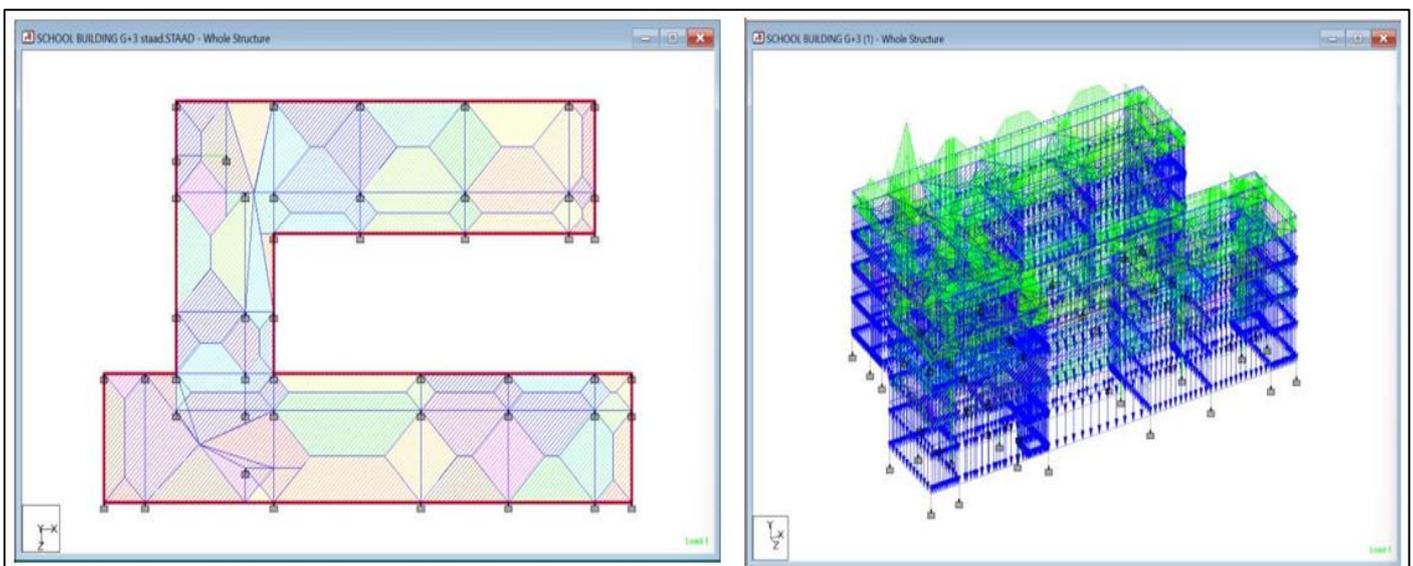


Fig 4 Dead Load for External Walls

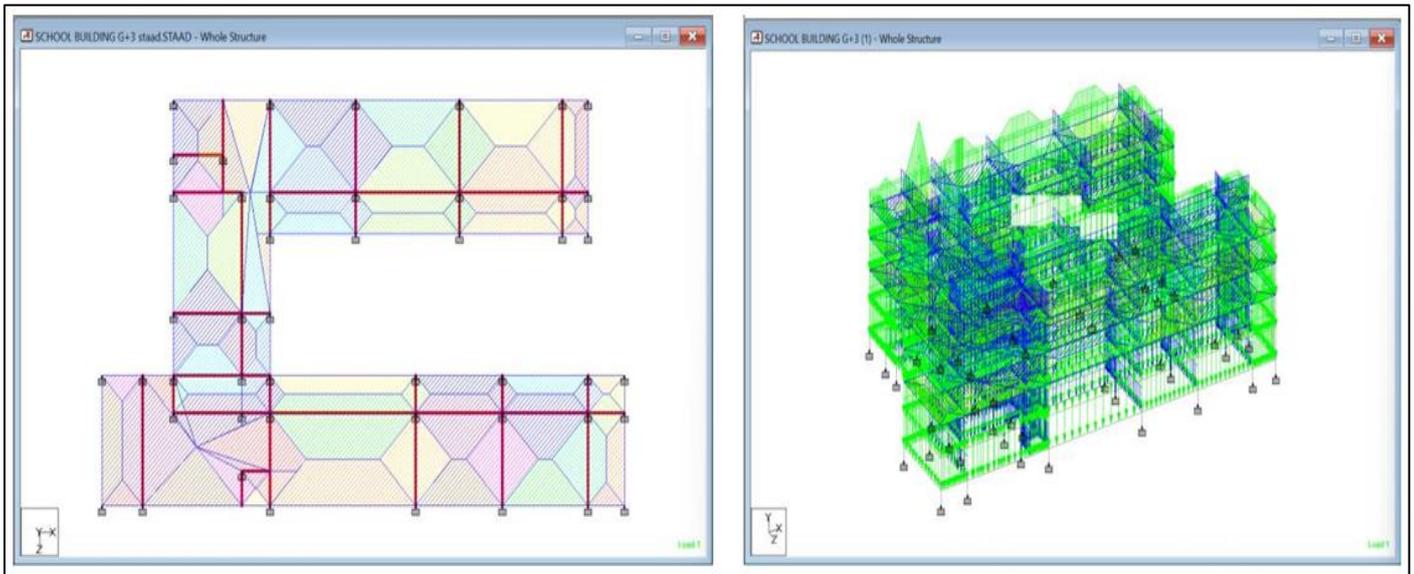


Fig 5 Dead Load for Internal Walls

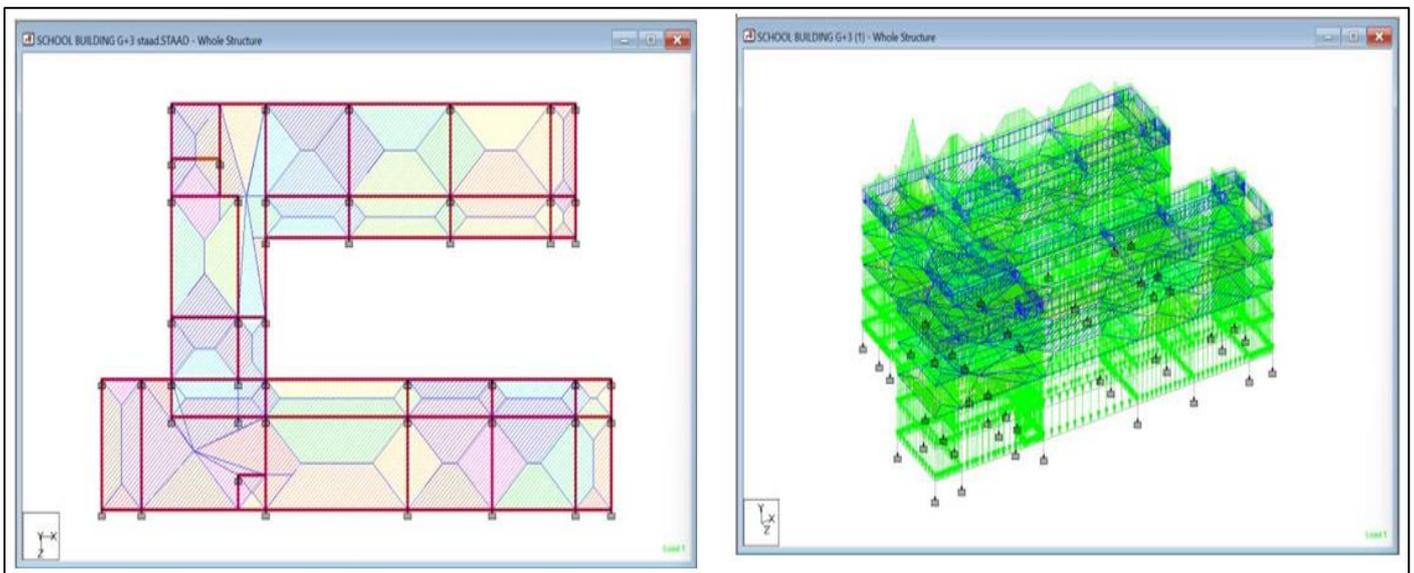


Fig 6 Dead Load for Parapet Wall

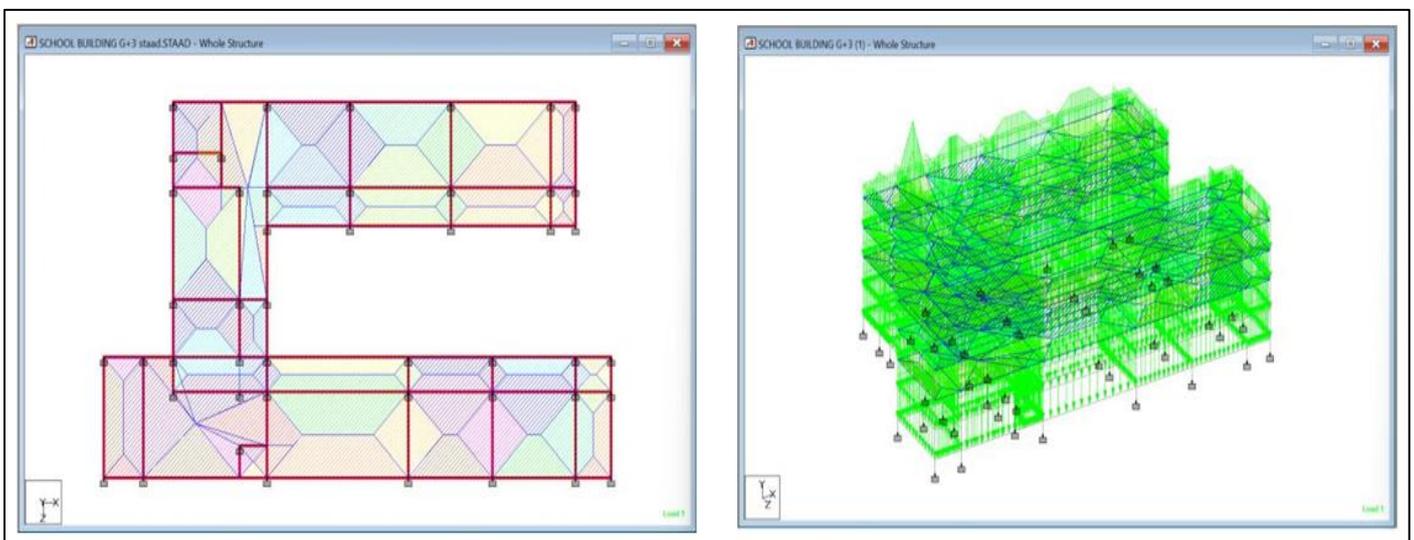


Fig 7 Dead Load in Self Weight

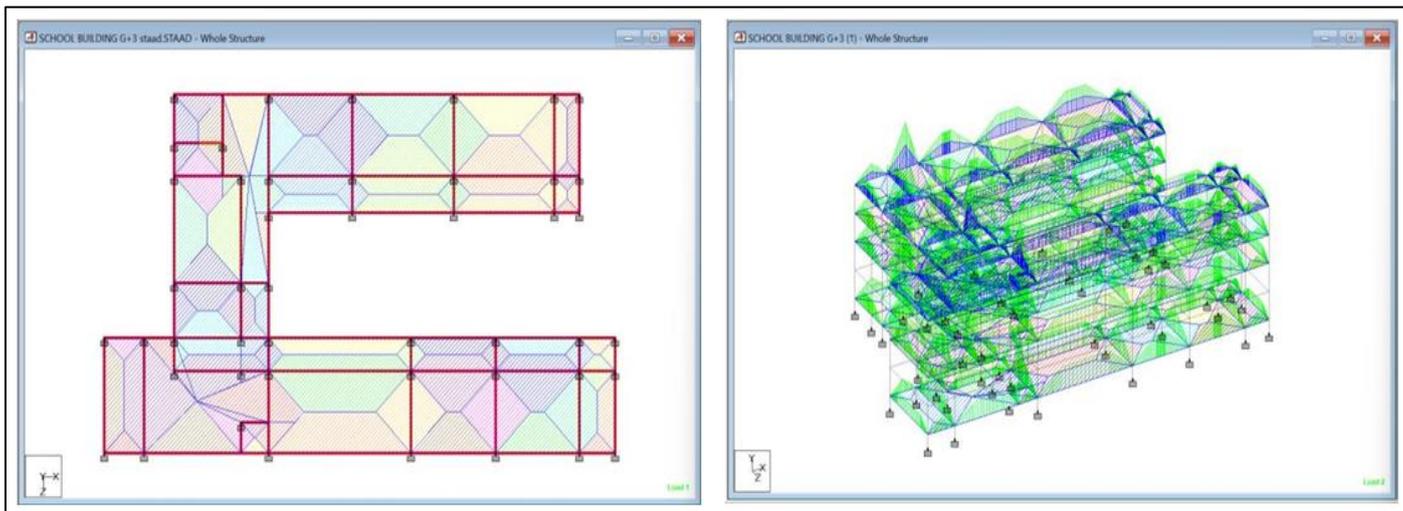


Fig 8 Live Load for Roof

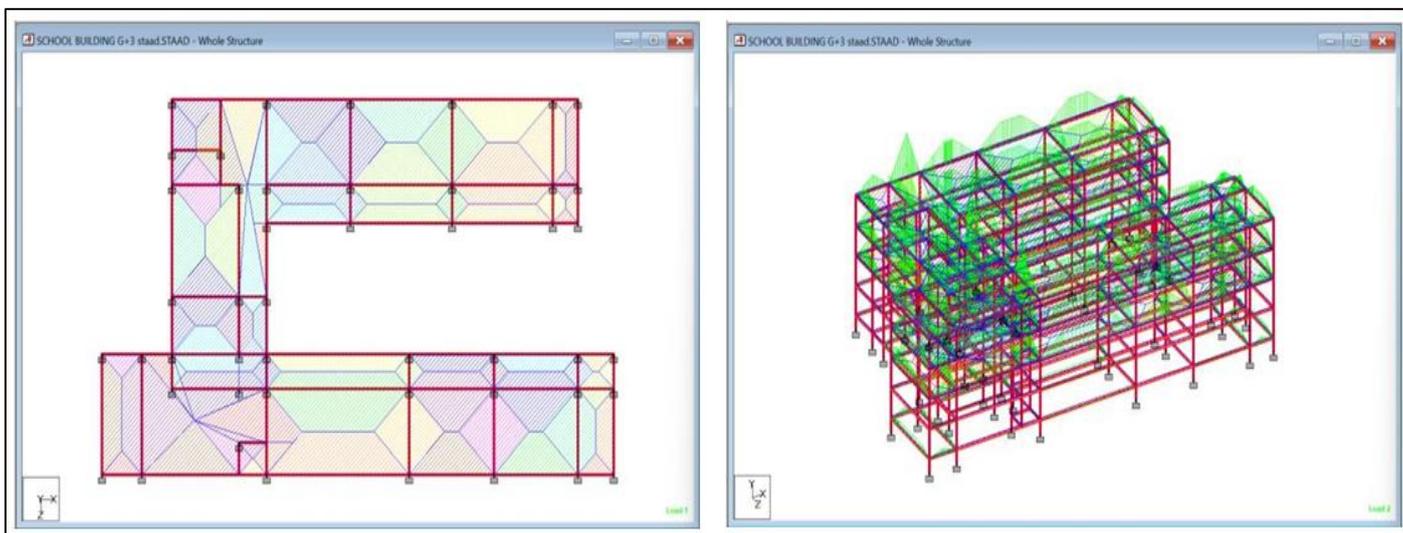


Fig 9 Live Load for Whole Structure

To ensure safety under different loading conditions, load combinations are generated as per IS 456:2000. Both strength and serviceability load combinations are considered. These combinations include various permutations of dead

load, live load, wind load, and earthquake load. The structure is analyzed for all combinations to identify critical forces in structural members.

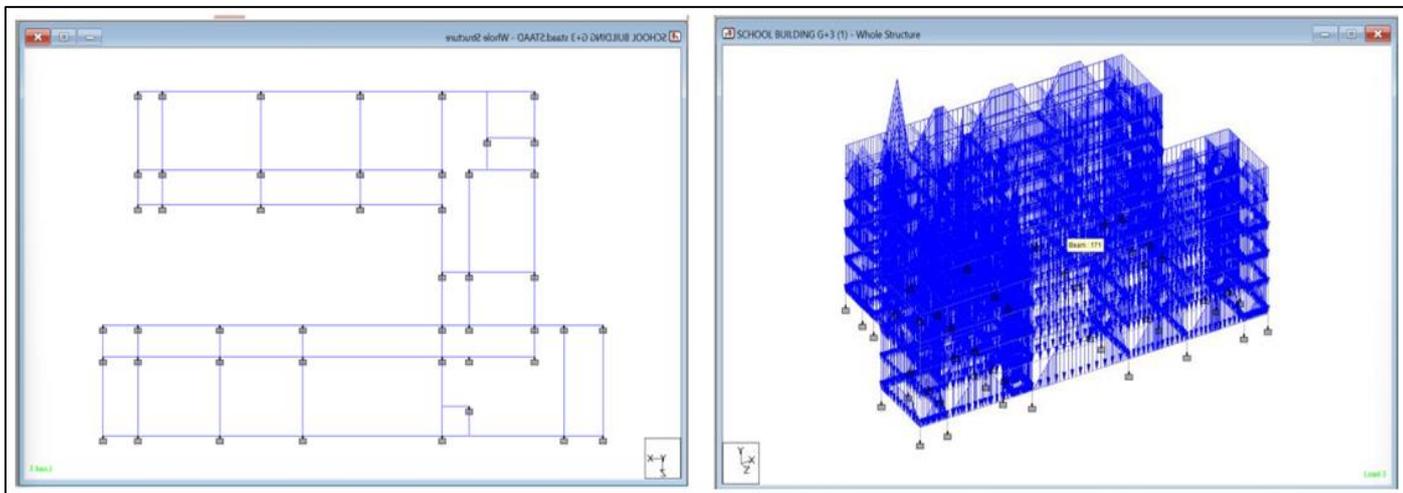


Fig 10 Load Combination for DL+LL

IV. RESULTS AND DISCUSSION

The analysis results obtained from STAAD.Pro include bending moments, shear forces, axial forces, and support reactions. Beams supporting classroom slabs experience higher bending moments due to higher live loads. Columns at lower floors carry higher axial loads due to cumulative effects. The lateral stability of the building under wind and seismic loads is found to be satisfactory.

The results indicate that all structural members are within permissible limits specified by Indian Standard codes. The use of STAAD.Pro provides accurate and reliable results while significantly reducing analysis time.

V. CONCLUSION

The study on architectural planning and load analysis of a school building using Revit and STAAD Pro demonstrates the effectiveness of integrating modern digital design tools with structural engineering principles. The architectural model developed in the planning stage enabled accurate visualization, space optimization, and functional layout suitable for educational infrastructure. By transferring the model into structural analysis software, various loads such as dead load, live load, wind load, and seismic load were systematically applied and analyzed, ensuring that the structure satisfies safety, stability, and serviceability requirements. The analytical results highlight the importance of software-based structural evaluation in predicting building behavior under different loading conditions and in optimizing member design for both strength and economy. This integrated workflow reduces manual errors, improves accuracy, and aligns with current professional engineering practices. Incorporating zero energy building concepts further enhances the project's significance by combining structural efficiency with environmental sustainability. Strategies such as proper orientation, passive design techniques, and renewable energy integration reduce energy demand and operational costs while improving indoor comfort for occupants. Overall, the project confirms that combining architectural planning, structural analysis, and sustainable design principles leads to safe, efficient, and environmentally responsible school buildings suitable for modern construction standards.

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