

PLANNING, DESIGNING & ANALYSIS OF NEW BLOCK AT MATTANNUR HIGH SCHOOL

Ms. Jean Mary Jacob

Assistant Professor

Department of Civil Engineering

St. Thomas College of Engineering & Technology

Kannur, Kerala

jeanmaryjacob@stthomaskannur.ac.in

Ahmed K P

Department of Civil Engineering

St. Thomas College of Engineering &

Technology Kannur, Kerala

ahmedannu111@gmail.com

Sangeeth P

Department of Civil Engineering

St. Thomas College of Engineering &

Technology Kannur, Kerala

sangeethpalliath6@gmail.com

Sreerag M

Department of Civil Engineering

St. Thomas College of

Engineering & Technology

Kannur, Kerala

msreerag006@gmail.com

Sreya V

Department of Civil Engineering

St. Thomas College of

Engineering & Technology

Kannur, Kerala

sreyav2019@gmail.com

Abstract --This project presents the planning, designing and structural analysis of new block at Mattannur Higher Secondary School Building. The objective of the project is to design a safe, functional, economical, and durable educational building by following the guidelines of relevant Indian Standard (IS) codes. The planning of the school building is carried out by considering important aspects such as site conditions, orientation, ventilation, natural lighting, safety, accessibility, and future expansion. Proper space planning is done to provide comfortable and efficient accommodation for classrooms, laboratories, staff rooms, administrative offices, corridors, staircases, and sanitary facilities. Special importance is given to smooth circulation of students and staff and compliance with safety requirements. The structural design of the building is carried out using the limit state method as per IS 456:2000. Structural components such as slabs, beams, columns, staircases, and foundations are designed to safely resist applied

loads. Dead loads, live loads, and wind loads are calculated in accordance with IS 875. The type of foundation is selected based on the soil bearing capacity and site conditions. Structural analysis is performed to ensure adequate strength, stability, and serviceability of the building. Checks for bending, shear and deflection are carried out for all major structural elements. Economy in material usage, structural safety and long-term durability are considered throughout the design process. The results of the analysis show that the proposed school building is structurally safe, stable, and economical, and fully suitable for educational purposes. This project demonstrates the practical application of civil engineering principles in the planning and design of a public building.

Keywords: *Planning and Design, School Building, Structural Analysis, Limit State Method, IS Codes, Load Calculation, Reinforced Concrete Structure, Safety and Serviceability, Foundation Design, Educational Building*

structural analysis of a new academic block at Mattannur Higher Secondary School, including architectural planning, load calculations, and RCC structural design. The project emphasizes safety, material optimization, and economic feasibility to ensure long-term performance and sustainability.

I. INTRODUCTION

Rapid urbanization and population growth have increased the demand for improved educational infrastructure. Many existing school buildings suffer from inadequate classroom space, poor ventilation, structural deterioration, and lack of modern facilities.

To provide a safe and comfortable learning environment, new educational buildings must be planned and designed to meet functional requirements and structural safety standards. Proper planning and structural analysis are essential to achieve durability, serviceability, and cost-effectiveness. School building design must consider site conditions, soil characteristics, climatic factors, lighting, ventilation, circulation, and accessibility, along with resistance to dead, live, wind, and seismic loads as per Indian Standard codes. This study focuses on the planning, design, and

II. METHODOLOGY

A) Literature review

The literature review highlights that effective building projects require proper planning, accurate structural design, and detailed analysis. Previous studies emphasize the importance of systematic space planning and functional layouts to ensure efficient utilization of space and resources. In terms of design, research stresses adherence to standard codes such as IS 456:2000 and IS 875 to ensure safety, serviceability, and economy, using both manual calculations and software-based methods. For analysis, the literature

underlines the need to evaluate structures under dead, live, wind, and seismic loads to assess displacement, drift, bending moments, and shear forces, while also verifying results through manual methods. Overall, proper planning, code-based design, and thorough structural analysis enhance safety, stability, and overall performance of multi-storey buildings.

B) Site surveying

The proposed site for this project is located at Mattannur Higher Secondary School, near Mattannur Town in Kannur District, Kerala. The total plot area is 903.87 m² (54.45 m × 16.6 m). The site is rectangular in shape.

C) Floor planning

The proposed new block at Mattannur High School is planned to meet the growing academic and infrastructural requirements. It is

designed as a multi-storeyed educational building with adequate load-resisting structural systems, functional planning, and full compliance with Indian Standard codes and Kerala Municipality Building Rules (KMBR), emphasizing safety, durability, and material efficiency. As per KMBR, classroom area is provided at 1 m² per student. Considering a maximum strength of 40 students, the required minimum classroom area is 40 m². The proposed classroom size of 6.6 m × 6.2 m provides an area of 40.92 m², satisfying the code requirement

Table 1: Specifications

Door, D1	1.20 × 2.1
Window, W1	1.5 × 1.5
Rise	15cm
Thread	30cm
Width	1.7m

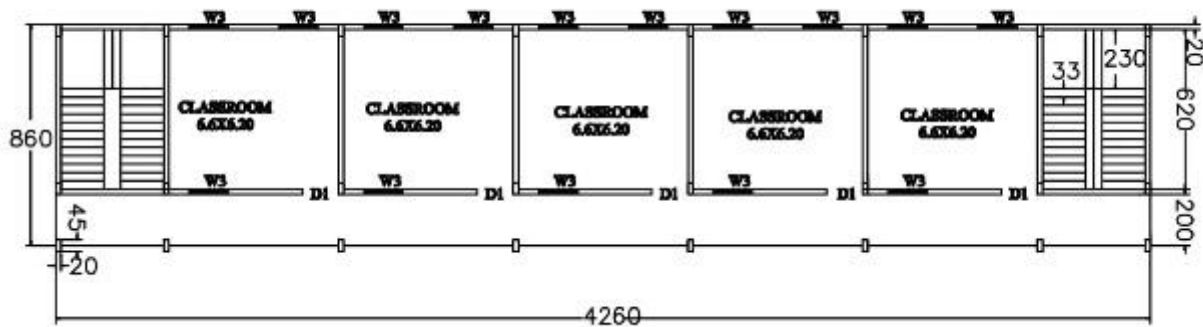


Fig 1: Ground floor plan

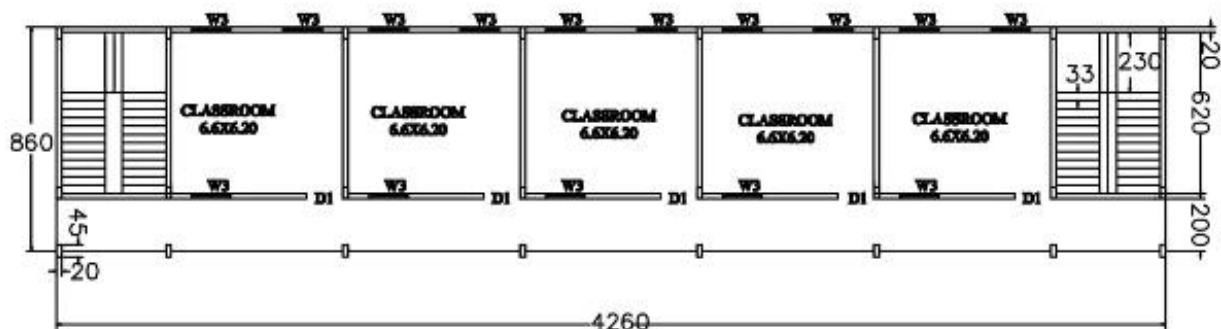


Fig 2: First floor plan

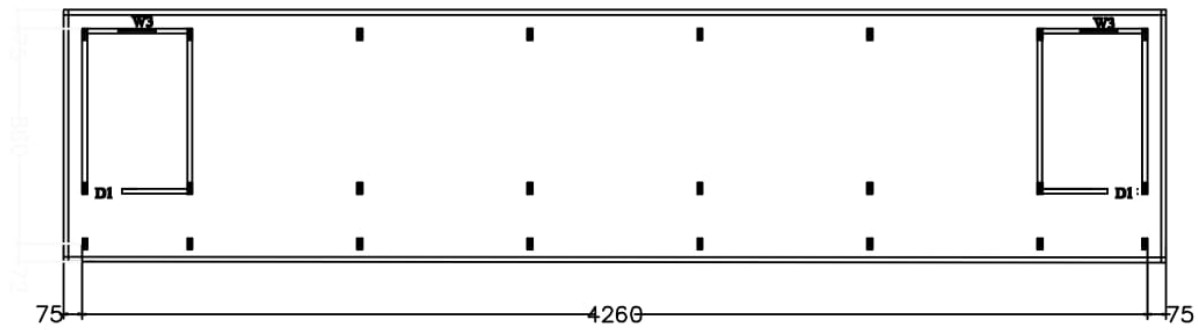


Fig 3: Terrace plan

D) Analysis of structure

The concrete grade adopted for the model is M25, which has a characteristic compressive strength of 25 N/mm².

The reinforcement used is HYSD Fe 415 steel, having a characteristic yield strength of 415 N/mm². These material specifications were considered in ETABS for accurate structural modelling and analysis of the building.

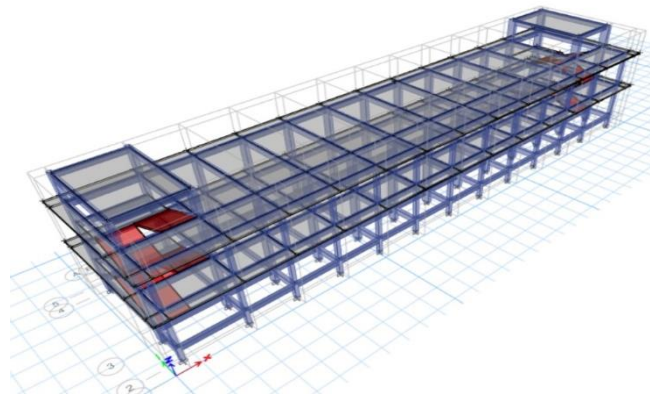


Fig 4: 3D View in ETABS

Loading details -The different load cases considered are dead loads, live loads, wind loads and earthquake loads. Dead load is primarily due to self-weight of structural members, permanent partition walls, fixed permanent equipment and weights of different materials. Loads shall be calculated based on unit weight of materials used and is specified in IS 875 (Part I) 1987 and Live loads were taken from IS 875: 1987(Part 2).

Table 2: Dead loads and live loads

SPECIFICATION		LOAD
Dead load		
A.A.C. Block wall	Floor Height = 3.9m	4.68 kN/m
Parapet	Height = 30cm	0.3 kN/m

Stair case	8.24 kN/m ²
Floor finish	1 kN/m ²
Live load	
Class room	3 kN/m ²
Roof with access	1.5 kN/m ²
Corridors	4 kN/m ²
Staircase	4 kN/m ²

Earthquake load details -As per IS 1893 (Part 1):2002, the earthquake load parameters considered for the structural analysis are defined to ensure safety against seismic forces. The structure is located in Seismic Zone III, with a zone factor (Z) of 0.16 as

specified in Table 2, representing the seismic intensity of the region. The importance factor (I) is taken as 1.0 according to Table 6, indicating that the building is categorized as a standard occupancy structure without special risk considerations. The response reduction factor (R) is adopted as 5 as per Table 7, which corresponds to a Special Moment Resisting Frame (SMRF) system, reflecting the building's ductile behaviour and energy dissipation capacity during earthquakes. Additionally, the site factor (SS) is considered as 0.5 based on Clause 5.3.3, accounting for the influence of soil conditions on seismic response. These parameters are incorporated in the calculation of design base shear and lateral forces, forming the basis for seismic analysis and ensuring structural stability and performance under earthquake loading.

Wind load details - Wind load details as per IS 875 (Part 3):1987, the wind load parameters adopted for the structure are defined to determine the design wind speed and corresponding wind forces. The basic wind speed (V_b) for the region is taken as 39 m/s as specified in Clause 6.2. The probability factor or risk coefficient (K_1), corresponding to a design life of 50 years, is considered as 1.0 in accordance with Clause 6.3.2. The terrain, height, and structure size factor (K_2) is taken as 1.0 based on Clause 6.3.3, considering the building height and surrounding terrain conditions. The topography factor (K_3) is assumed as 1.0 as per Clause 6.3.4, indicating no significant topographical features affecting wind flow. Additionally, the importance factor for cyclonic regions (K_4) is taken as 1.0 in accordance with Clause 6.3.4. These factors are used to compute the design wind speed and wind pressure acting on the building, ensuring stability and safety against wind loads.

III. ANALYSIS RESULT AND DESIGN

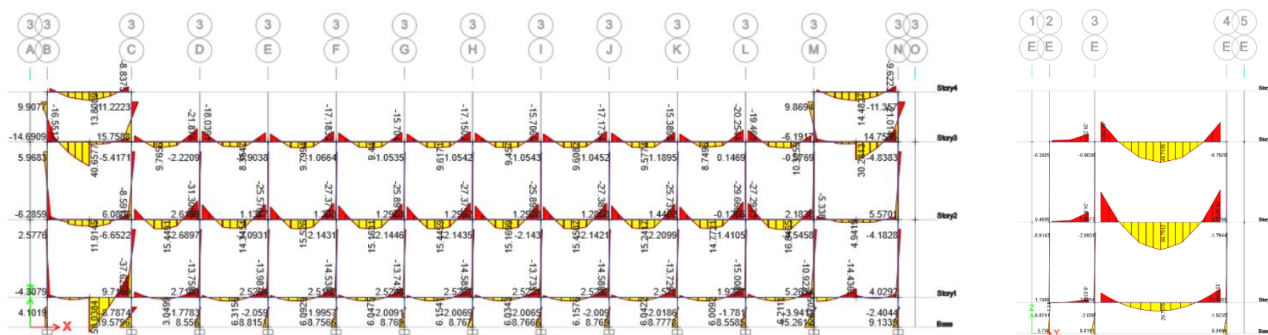


Fig 5. BMD (Bending Moment Diagram) of critical sections

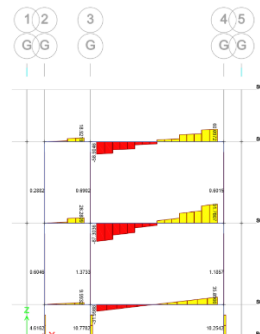
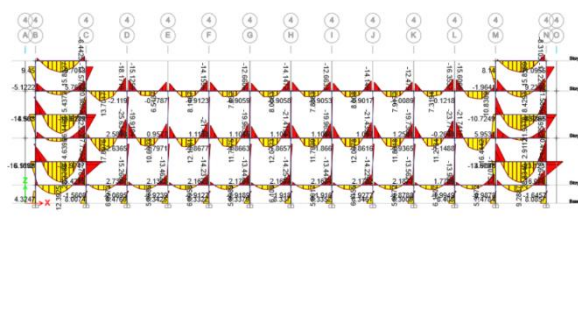


Fig 6: SFD (Shear Force Diagram) of critical sections

STRUCTURAL DESIGN

The structural components of the proposed school building were designed using the Limit State Method in accordance with IS 456:2000. Structural analysis was carried out using ETABS, and the reinforcement details were finalized based on the design forces obtained from the analysis. Concrete grade M25 and Fe415 HYSD reinforcement were used for all reinforced concrete members.

A. Slab Design

The slab panel was designed as a two-way slab since the aspect ratio was less than 2. The slab thickness and reinforcement satisfied the requirements for bending, shear, and serviceability.

Parameter	Value
Slab Type	Two-way slab

Overall Thickness	160 mm
Concrete Grade	M25
Steel Grade	Fe415
Main Reinforcement	8 mm Ø @ 125 mm c/c
Distribution Reinforcement	8 mm Ø @ 130 mm c/c

B. Beam Design

The beam was designed as a singly reinforced section based on the bending moment obtained from ETABS analysis. Shear reinforcement was provided in accordance with IS 456:2000.

Parameter	Value
Beam Size	250 × 500 mm
Concrete Grade	M25
Steel Grade	Fe415
Factored Moment	29.014 kNm
Bottom Reinforcement	2–16 mm Ø
Top Reinforcement	2–12 mm Ø
Stirrups	2-legged 8 mm Ø @ 300 mm c/c

C. Column Design

The column was designed as a short reinforced concrete column subjected to combined axial load and uniaxial bending. Reinforcement was selected using ETABS analysis results and IS 456:2000 provisions.

Parameter	Value
Column size	250 × 600 mm
Effective length	3.5 m
Concrete Grade	M25
Steel Grade	Fe415
Factored axial load	477.37 kN
Factored moment	150 kNm
Longitudinal reinforcement	4–25 mm Ø , 2–20 mm Ø
Lateral ties	8 mm Ø @ 300 mm c/c

D. Footing Design

An isolated footing was designed to safely transfer the column load to the soil while satisfying bending and punching shear requirements.

Parameter	Value
Footing type	Isolated Footing
Size	2.0 × 1.5 m
Column load	550 kN
Safe bearing capacity	200 kN/m ²
Reinforcement (Long Direction)	16 mm Ø @ 200 mm c/c
Reinforcement (Short Direction)	16 mm Ø @ 150 mm c/c

E. Staircase Design

The staircase was designed as a reinforced concrete waist slab with reinforcement provided to resist bending moments.

Parameter	Value
Stair type	RCC Waist Slab
Effective span	4.4 m
Waist thickness	220 mm
Main reinforcement	12 mm Ø @ 250 mm c/c
Distribution Reinforcement	10 mm Ø @ 300 mm c/c

The reinforcement provided for slabs, beams, columns, footings, and staircases satisfies the strength and serviceability requirements of IS 456:2000. The designed structural members are adequate to safely resist the applied loading conditions and ensure the stability and durability of the proposed school building.

3D VISUALIZATION USING REVIT

The complete building model was developed using Autodesk Revit, a Building Information Modelling (BIM) software used for architectural and structural modelling. The model included all major structural components such as beams, columns, slabs, staircases, and foundations, enabling integrated visualization and coordination of the project. Revit facilitated better understanding of the structural layout, detection of design conflicts, and effective presentation of the proposed building before construction. The 3D model also improved planning accuracy and coordination between architectural and structural components.

COST ESTIMATION

The cost estimation of the proposed school building was prepared using CPWD DSR rates based on detailed architectural and structural drawings. Quantity calculations and cost analysis were carried out using Microsoft Excel. The estimate included all major construction activities such as excavation, PCC, RCC works, reinforcement steel, AAC block masonry, flooring, plastering, doors and windows, painting, and finishing works.

Item	Quantity
Excavation	138.35m ³
PCC	71.80m ³
RCC Footing	56.75m ³
RCC Columns	58.45m ³
RCC Beams & Lintels	120.41m ³
RCC Slabs	113.25m ³
AAC Block Masonry	131.38m ³
Plastering	2050.30m ³
Ceiling Plastering	640.40m ³

Abstract of Cost

The abstract estimate was prepared by applying CPWD DSR unit rates to the calculated quantities. Additional provisions of 1% for architectural works, 5% each for water supply and sanitary works, and 6% for electrification were included, along with contingencies and unforeseen expenses. The estimated civil construction cost was approximately ₹5.18 crore, while the total project cost was approximately ₹6.26 crore. RCC work and reinforcement steel constituted the largest share of the project cost. The prepared estimate provides a reliable basis for budgeting, tendering, and project execution.

IV. CONCLUSION

The study presents the planning, design, and structural analysis of a new academic block at Mattannur High School, ensuring safety, functionality, and economy. The architectural layout was developed in accordance with the Kerala Municipality Building Rules (KMBR), providing adequate classroom space, ventilation, lighting, and proper circulation. Structural design was carried out as per IS 456:2000 and IS 875, considering all relevant loads. Analysis using ETABS confirmed that displacements, forces, and drifts are within permissible limits, ensuring structural stability and serviceability.

Overall, the proposed block is safe, efficient, and suitable for educational use.

REFERENCES

1. Manoj Chopdey, Dr. Rajeev Chandra (2023), Wind and Seismic Analysis of RCC Building using ETABS, International Journal of Engineering and Advanced Technology (IJEAT), Vol. 9, Issue 2.
2. E. Rakesh Reddy, S. Kaileshkumar (2019), Design and Modelling of G+5 Commercial Building by Autodesk Revit Architecture.
3. Manoj U. Deosarkar, Dhanashree R. Ballewar, Rutuja R. Chitte, Punam B. Swami, Nilima S. Shirasath (2021), Application of BIM through Revit for Design and Analysis of Multistoried Building.
4. Sham Dilip Chavan, Rohit Ashok Chilka, Devendra Revanasiddha Devare, Ravikiran Raju Mergu (2019), Manual Calculation, Analysis and Design of Multistorey (G+6) Residential Building, International Journal of Innovations in Engineering Research and Technology (IJIERT).
5. Amit Maurya, Paritosh Rawat, Ravinder Kumar, Mukul Kumar, Ujjwal Bhardwaj (2021), Sustainable Building Design: Energy Analysis of a Residential Building using Autodesk Revit, Proceedings of 2nd International Conference on Intelligent Engineering and Management (ICIEM), IEEE
6. E.U. Syed, K.M. Manzoor (2022), Analysis and Design of Buildings using Revit and ETABS Software, Materials Today: Proceedings, Vol. 65, pp. 1478–1485.
7. Lokesh Nishanth, C.H., Swaroop, Y. Sai, Jagarapu, Durga Chaitanya Kumar, Jogi, Pavan Kumar (2020), Analysis and Design of Commercial Building with Different Slab Arrangements Using ETABS, Materials Today: Proceedings, Issue 33, Pages 700–704.
8. Amresh A. Das, G.B. Bhaskar (2021), Static and Dynamic Analysis of Multistorey Building, International Research Journal of Engineering and Technology (IRJET), Vol. 08, Issue 06, pp. 3132–3136.
9. Pinar Usta, Basak Zengin (2021), Energy Assessment of Different Building Materials in Educational Buildings, Journal of Building Engineering.
10. Ashok R. Mundhada (2022), Analysis of an Educational Building in ETABS, International Journal of Engineering Research & Technology (IJERT), Vol. 11, Issue 05.