

DESIGN OF A TWO-STOREY PRIMARY SCHOOL BUILDING AT SAVAR, DHAKA

Submitted by

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A Capstone Project Submitted in Partial Fulfillment of the Requirements for the Award
of a Degree of
Bachelor of Science in Civil Engineering



Department of Civil Engineering

Faculty of Engineering

DAFFODIL INTERNATIONAL UNIVERSITY

November 2025

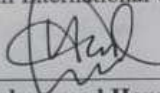
This certifies that the student shown below completed the Capstone Project titled "Design of a two-storey primary school building at Savar, Dhaka" under my supervision, as part of the requirements for the Bachelor of Science in Civil Engineering degree. The presentation of the work was successfully held on 15 November 2025.

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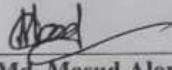
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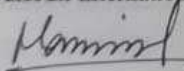
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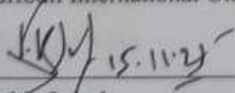
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DECLARATION

The dissertation, entitled "Design of a Two-Storey Primary School Building with Structural Completion and Environmental Considerations," was overseen by Mr. Abu Hasan, Assistant Professor, Department of Civil Engineering, Daffodil International University, Dhaka, Bangladesh, and was sanctioned in partial fulfillment pertaining to the capstone project component of the Bachelor of Science in Civil Engineering.



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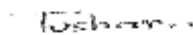
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TABLE OF CONTENTS

BOARD OF EXAMINERS	ii
DECLARATION	iii
ACKNOWLEDGEMENTS	iv
TABLE OF CONTENT	v
OUTLINE OF CAPSTONE PROJECT	viii
LIST OF FIGURES	ix
LIST OF TABLES	x
Chapter 1 INTRODUCTION	1
1.1 Background of the Project	1
1.2 Objectives of the Project	1
1.3 Outline of the project report	2
Chapter 2 PLAN AND STRUCTURAL SPECIFICATIONS	3
2.1 Objective	3
2.2 Proposed Structure	3
2.3 Basic Information	3
2.4 Design code	4
2.5 Foundation and soil	4
2.6 Lapping Zone of Beam	6
2.7 Corner reinforcement	6
2.8 Material strength	7
2.9 Development length	7
2.10 Concrete Clear Cover for Reinforcing Bars	8
2.11 According infrastructure plan and planning guideline	9
2.12 Summary	9
Chapter 3 STRUCTURAL ANALYSIS AND OUTPUT	10
3.1 Introduction	10

3.2 Load consideration	11
3.1 Design of Slab and detailing	11
3.3 Design of Beam and Detailing	12
3.4 Lap Location	13
3.4 Design of Column and detailing.	16
3.5 Design of Foundation and Detailing.	17
3.6 Design of Stairs and Detailing.	20
3.7 Summary	21
Chapter 4 COST ESTIMATION AND PROJECT DURATION	22
4.1 Introduction	22
4.2 Construction BOQ (Bill of Quantities) Estimation	22
4.2.1 Slabs	22
4.2.2 Beams	23
4.2.3 Columns	24
4.2.4 Isolated Footings	25
4.2.5 Staircase	26
4.2.6 Summary of BOQ Estimation	27
4.3 Project Duration	27
Chapter 5 DESIGN AND CONSIDERATION OF SEPTIC TANK	29
5.1 Introduction	29
5.2 Component of Septic Tank	29
5.3 Design Considerations of Septic Tank	29
5.4 Design of Septic Tank.	30
5.5 Summary	33
Chapter 6 CONCLUSION AND RECOMMENDATION	34
6.1 Conclusion	34
6.2 Recommendation	35

Reference	37
APPENDIX	38
DESIGN OF SEPTIC TANK	38
A.1 Slab Design	40
A.2 Beam Design	42
A.3 Column Design	45
A.4 Footing Design	47
List of Deliverables	50

OUTLINE OF CAPSTONE PROJECT

Chapter 1: Introduction to the capstone project

Chapter 2: Codes and materials to be used in this project

Chapter 3: Design of structural elements and output

Chapter 4: Cost estimation of the project and the timeline of the project

Chapter 5: Design and consideration of septic tank

Chapter 6: Conclusion of the project and recommendations

LIST OF FIGURES

Fig. 2.1: First Floor Plan	5
Fig. 2.2: Second Floor Plan	5
Fig. 2.3: Corner Reinforcement.....	6
Fig. 3.1: Top and Bottom Reinforcement of Slab	12
Fig. 3.2: Finite Element Design.....	12
Fig. 3.3: Longitudinal Reinforcement Area of 1st Floor Beam	14
Fig. 3.4: Longitudinal Reinforcement Area of 2nd Floor Beam.....	14
Fig. 3.5: Bending Moment Diagram.....	15
Fig. 3.6: Lap Position	15
Fig. 3.7: Longitudinal Area Reinforcement of Column	17
Fig. 3.8: Footing Load.....	18
Fig. 3.9: Stair View from ETABS.....	20
Fig. 4.1: Gantt Chart.....	28
Fig. 5.1: Section View of Septic Tank.....	32
Fig. 5.2: Plan of Septic Tank.....	32

LIST OF TABLES

Table 2.1: Basic Information of the Building	4
Table 2.2: Material Strength.....	7
Table 2.3: Concrete Clear Cover.....	8
Table 3.1: Beam Details	13
Table 3.2: Details of Ground to Roof Column.....	16
Table 3.3: Final Detailing of Footing.....	19
Table 4.1: Quantity Takeoff (Slabs).....	23
Table 4.2: Quantity Takeoff (Beams).....	24
Table 4.3: Quantity Takeoff (Columns).....	25
Table 4.4: Quantity Takeoff (Footings)	26
Table 4.5: Summary of BOQ	27
Table 4.6: Project Timeline	28

Chapter 1

INTRODUCTION

1.1 Background of the Project

One of the most important things for a developing country is education. School buildings that are safe and well-designed are a key part of that future. As places like Savar, Dhaka grow, the need for good schools is growing swiftly. To address this need, school buildings need to be strong, long-lasting, and good for the environment.

The goal of this project, "Design of a Two-Storey Primary School Building at Savar, Dhaka," is to implement what students learn in the classroom in the actual world.

1.2 Objectives of the Project

1. For structural analysis, use modern civil engineering software like ETABS, and for clear, accurate drawings, use AutoCAD.
2. Use Excel to create a complete Bill of Quantities (BOQ) and cost estimate so that you can properly plan your budget and resources.
3. To develop a working septic tank system that maintains the school clean and safe for the environment.
4. To get real-world experience by using what you've learned in school to plan and build engineering projects.

Chapter 2

PLAN AND STRUCTURAL SPECIFICATIONS

2.1 Objective

The goal of following a design code is to set minimum standards for the design, construction, material integrity, use and occupancy, positioning, and maintenance of all buildings in Bangladesh to protect life, health, property, and the public's health and safety, within reasonable limits. Rules are also put in place to reach the same goal. This includes how to install and utilise certain tools, services, and extras that are related to or associated to these buildings. We used (BNBC, 2020) a lot to look for the criteria and coefficients that should be used in the structural design of this building. ETABS 2020 was analysed subsequent to (BNBC, 2020).

2.2 Proposed Structure

The plan is to build the two-story elementary school entirely out of RCC with separate foundations. The building is about 140 feet long, 32 feet wide, and 12 feet tall. It has nine classrooms, a storage room, a teachers' room, and a head teacher's room. Figures 2.1 and 2.2 show a layout plan.

2.3 Basic Information

This project uses an Intermediate Moment Resisting Frame (IMRF) structural system to build a two-story reinforced concrete (RC) school building, as shown in Table 1.1. The foundation has separate footings to handle the stresses, while the flooring system has slabs that are supported by the edges. Emphasising structural integrity, the structure will be evaluated and built to enable the designated functionality. Check the weights on the floor and make sure they follow all important rules for gravity and lateral force.

Table 2.1: Basic information of the building

Building Usage Type	Educational building
Structural System	RC Beam-Column frame (Intermediate Moment Resisting)
Floor System	Edge-supported Slab
No. of Stories	2-storey Building
Floor Load	Mentioned in Load Plan
Foundation Type	Isolated footing

2.4 Design code

- All structural drawings must be read along with the appropriate architectural drawings.
- The Bangladesh National Building Code (BNBC, 2020) has been used for analysis and design.
- For any specifications or structural needs that aren't shown in the drawings or this design report, see (BNBC, 2020).

2.5 Foundation and soil

- A footing foundation has been suggested as the base.
- A minimum clear cover of 3.0 inches is suggested.
- The depth of the foundation should match the sketch.
- The qualities of the material.

Minimum $f'c$ (28-day cylinder crushing strength)

Foundation and Column = 4000 psi with Mix Ratio = 1:1.5:3

Beams and Slabs = 4000 psi with Mix Ratio = 1:1.5:3

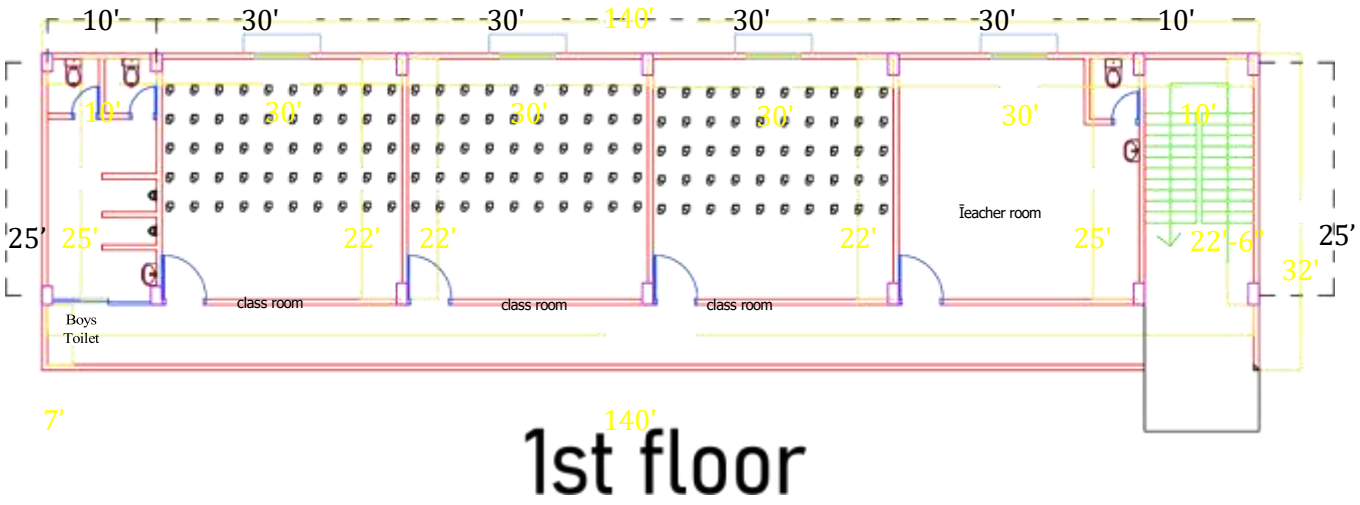


Fig. 2.1: First Floor Plan

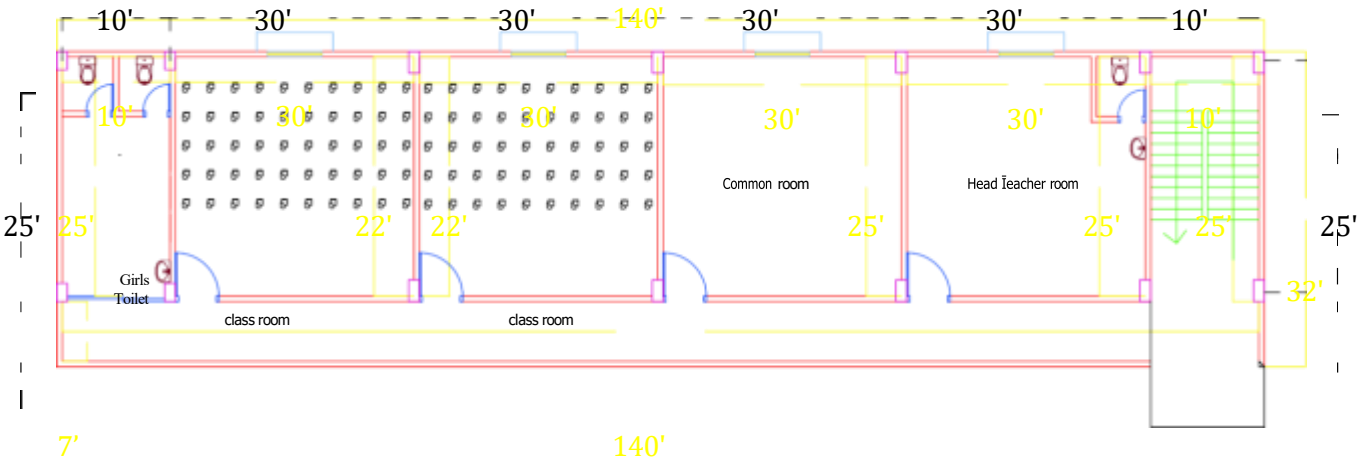


Fig. 2.2: Second Floor Plan

2.6 Lapping Zone of Beam

The grade of concrete, the diameter of the reinforcement bars, and where they are placed (in tension or compression zones) all affect the minimum lap length that (BNBC, 2020) says is needed. The lap length is usually a number that is the same as the bar's diameter (for example, $40D$, where D is the bar's diameter). The lap length of the bar should be 1: For Tension = $40D$, and 2: For Compression = $30D$. D is the size of the bar N . B: The column lap is the same as the tension lap.

2.7 Corner reinforcement

The Bangladesh National Building Code (BNBC, 2020) stipulates that corners need to be strengthened so they don't bend when they are under stress, especially in places that are likely to have earthquakes. To deal with shear and torsional forces, (BNBC, 2020) suggests to add more diagonal bars, stirrups that are close together, and ties to connect beams, slabs, and columns. Figure 2.1 shows that bars at corners need to be correctly anchored and have minimum lap lengths to keep them from slipping when they are loaded.

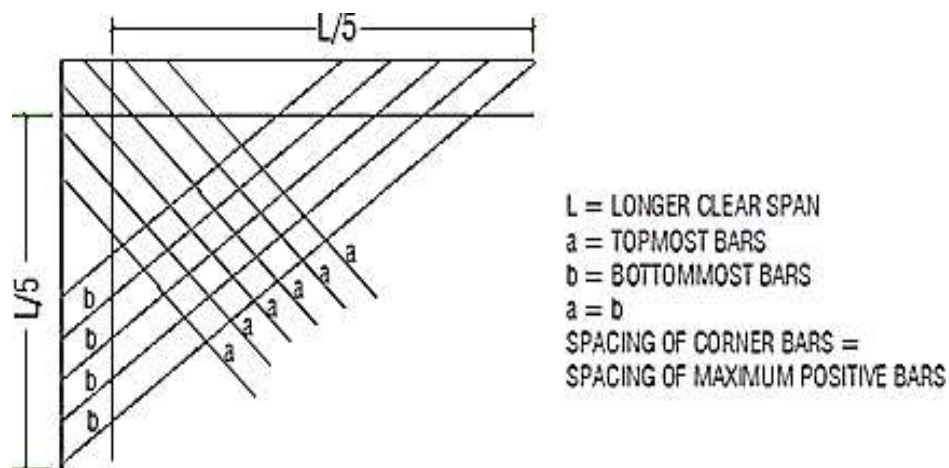


Fig. 2.3: Corner reinforcement

2.8 Strength of materials

The plan says that the concrete strength ($f'c$) for all structural pieces, like the foundation, pedestal columns, grade beams, columns, beams, and slabs, must be more than 5000 pounds per square inch. Table 2.1 shows that the yield strength (fy) of the reinforcing steel is 60,000 psi. This makes sure that each structural element is consistent and follows the design criteria that have already been set.

Table 2.2: Material Strength

	Concrete, f'_c (psi)	Rebar Strength, f_y (psi)
Foundation	4000	60000
Pedestal Column	4000	60000
Grade Beams	4000	60000
Column	4000	60000
Beams and Slabs	4000	60000

2.9 Length of development

The development length (Ld) is the shortest length needed for strengthening beams and slabs. According to the Bangladesh National Building Code (BNBC, 2020), the minimum amount of rebar that needs to be put in concrete to protect it from slipping and make sure the construction is entirely solid. The formula used to find the answer is $Ld = \phi \times fy / 4 \times T_b$. The diameter of the bar is represented by ϕ , the yield strength of the steel is represented by fy , and the bond strength of the concrete is represented by b . Depending on the type of rebar, how strong the concrete is, and where it is, this strength vary. Beams often need to be longer than slabs because they can hold more weight. The BNBC (2020) says that development periods require adjustment variables for various things, such as the type of reinforcement bar and the position of the top reinforcement. These standards make sure that concrete buildings are stable and safe by defining the right anchoring lengths for different load scenarios.

2.10 Concrete Clear Cover for Reinforcing Bars

The clear concrete cover is necessary to keep the reinforcing steel bars safe from fire. The main reason for the spacing between them is to protect them from corrosion and other damage from the environment. and the top of the concrete. The clear cover for columns is usually 1.5 inches thick. provides enough protection and long-lastingness. Usually, internal beams are 1 inch thick. Still, the conditions under which it is exposed may help it develop. The usual thickness of slabs is between 0.75 and 1 inch. Clear cover, depending on how thick they are and how much they are exposed to the elements. The standard translucent cover for staircases is 0.75 inches thick, which protects the stairs without weakening their structure, as shown in Table 2.2. A good translucent cover makes a structure last longer and more reliable by making it more fire-resistant, protecting the reinforcement from moisture and chemicals, and making sure the construction lasts.

Table 2.3: Concrete clear cover

Member	Location or Combination	Thickness of Cover
Column	Not in contact with ground or water	1.5"
	In contact with the ground or water	2.5"
Beam	Indoors face: Top. Side & Bottom	1.5"
	Outdoors face: Top, Side &Bottom	1.5"
Slab and Stair	Bottom	1"
	Top	3/4"

2.11 According infrastructure plan and planning guideline

1. The school's open area should be at least 50% of the school's total area. The open space might be used for a playground, laying things out, and so on.
2. There should be at least four wash blocks for the classroom, and they should be distinct for boys and girls.
3. The size of the classroom should be the same (Education, 2018)
4. The school must provide at least one room for the teacher and one separate HT room for every 600 kids.
5. The classroom should be 16 feet by 19 feet, and the stairs should be 10 feet by 19 feet.

2.12 Summary

The building design follows BNBC 2020 to make sure that it is safe and meets all building, material, and service standards.

Chapter 3

STRUCTURAL ANALYSIS AND OUTPUT

3.1 Introduction

To help you understand the photographs better, we have added labels and symbols. By combining the analytical results, we used ETABS for structural analysis, together with detailed drawings in AutoCAD, to make sure the designs were sound.

Both physically strong and easy for the construction workers to understand, which gives them confidence that the project can be built successfully.

3.2 Load consideration

When making a model in ETABS, loads are split into three groups. The structure of a primary school that meets BNBC (2020) standards has a dead load and a live load. Load and floor finish load. The dead load is the total weight of the building's permanent structures, such as ceilings and walls, as well as any permanent structural elements, such as flooring, walls, beams, and columns. The weight of the materials (such steel, brick, or concrete) is what makes up this burden. The live load includes the people who live in the building, the furniture, and other things that can be moved. Based on normal use and occupancy, primary schools should set a live load of between 42 to 84 psf in classrooms. Raise the Live Load to 84 to 105 psf to make room for more people walking around in crowded places like assembly rooms and hallways. The last thing to think about is the load on the floor finish, which is normally between 21 and 30 psf. This is how much the flooring materials, such tiles or carpets, weigh. The BNBC 2020 stipulates that these loads must be combined in ETABS for correct modeling after that.

3.1 Design of Slab and detailing

There are several important things to think about when building a slab in ETABS. Things to think about while designing a slab to make sure it is structurally sound and meets building codes. The software looks at the slab's shape, thickness, material qualities, types of loads (dead, live, and environmental), and boundary conditions. It looks at the stresses, deflections, and needs for reinforcement. Using finite element analysis on the slab. ETABS looks at how the slab works with different load combinations, load distribution, support conditions, and boundary conditions (such simply supported, fixed, or continuous). It also includes safety features and design rules that are unique to each region, which lets engineers check their work. Table 3.1:

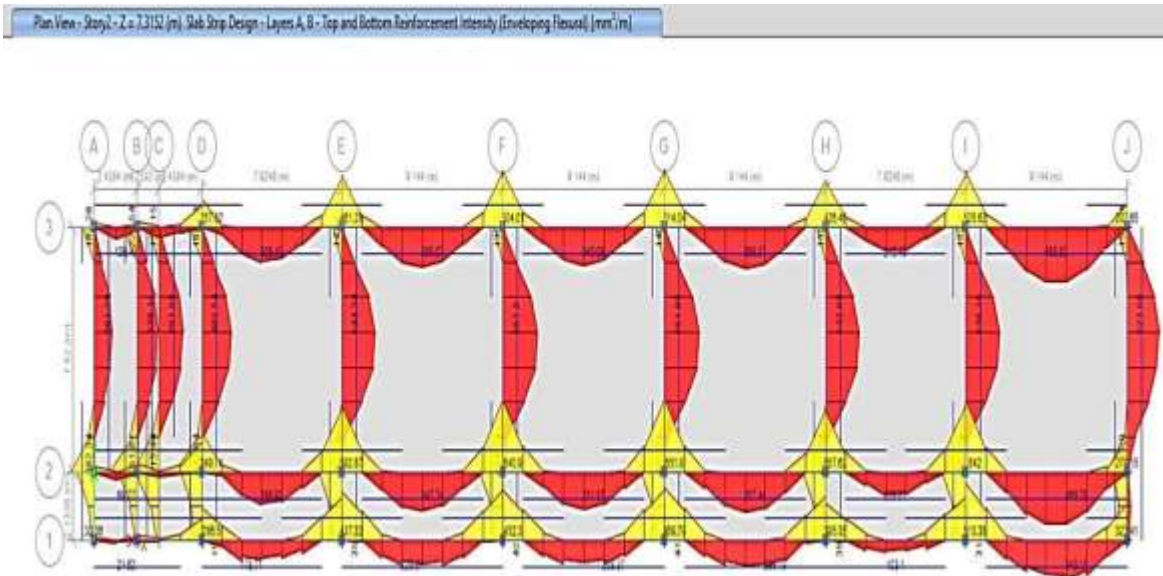


Fig. 3.1: Top and Bottom Reinforcement of Slab

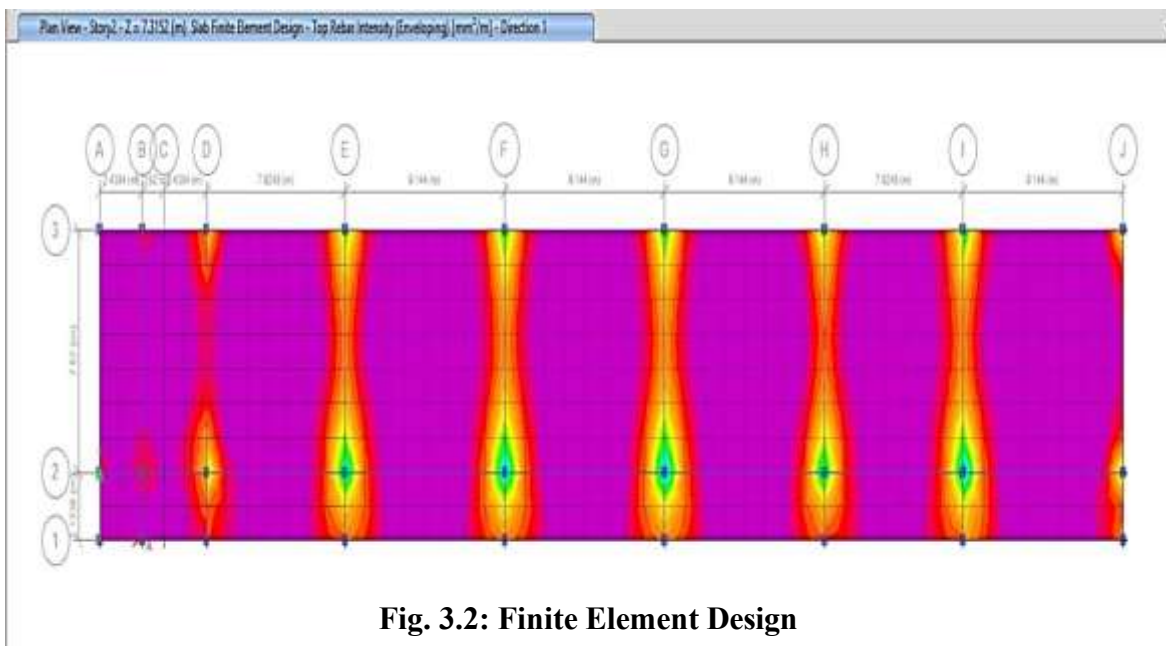


Fig. 3.2: Finite Element Design

3.3 Design of Beam and Detailing

For the G+1 building's ETABS beam design procedure, the beam's size and the loading conditions, like dead and live loads, must be set according to the rules. We utilized ETABS to look at the beams for shear forces and bending moments once we had built up the model, as shown in Fig. 3. The software made sure the beams met structural

safety rules by automatically figuring out how much reinforcement was needed for both positive and negative moments. To make sure that the calculated deflections were within the limits for serviceability, check that the reinforcement layout fulfilled the minimum code requirements and could handle the loads that were put on it after looking at the analysis results. Taking everything into account.

3.4 Lap Location

- a. The beam bottom bar lap shouldn't be in the middle third zone of the span.
- b. The beam top bar lap may be put in the middle third of the span. (See Fig. 3.6).
- c. There should not be more than 50% of the bars spliced at one area.

Table 3.1: Beam details

Beam of Roof				
Beam No	Dimension	Bottom Rebar	Top Rebar	Stirrups
B1	18" x 10"	2 Nos 20mm Dia	2 Nos 20mm Dia St. 1 Nos 16mm Dia ext.	10mm @ 8" c/c

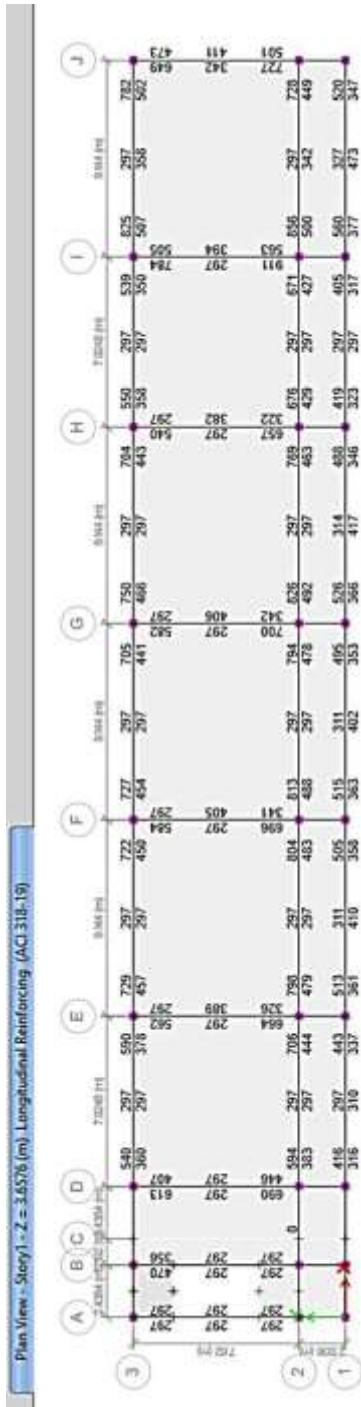


Fig. 3.3: Longitudinal Reinforcement Area of 1st floor beam

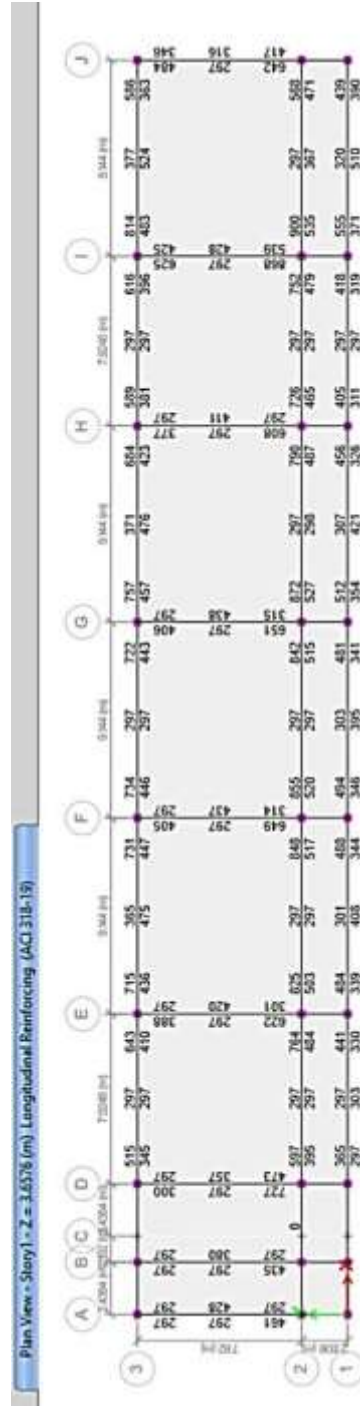


Fig. 3.4: Longitudinal Reinforcement Area of 2nd floor beam

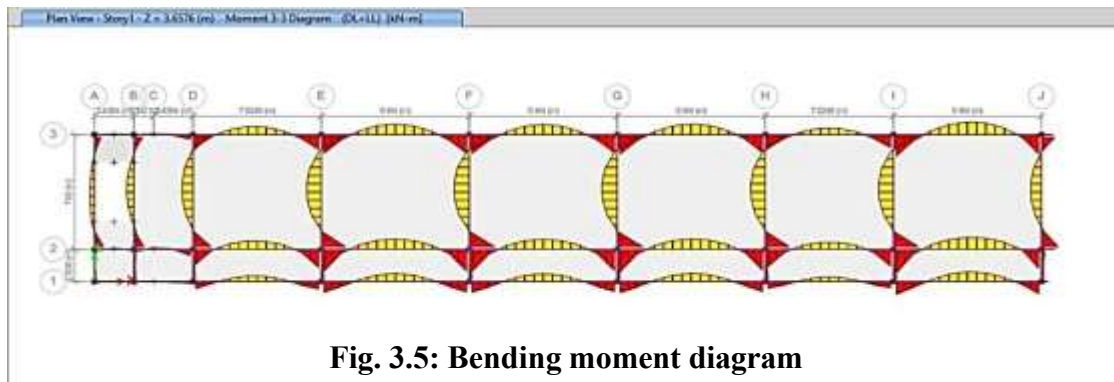


Fig. 3.5: Bending moment diagram

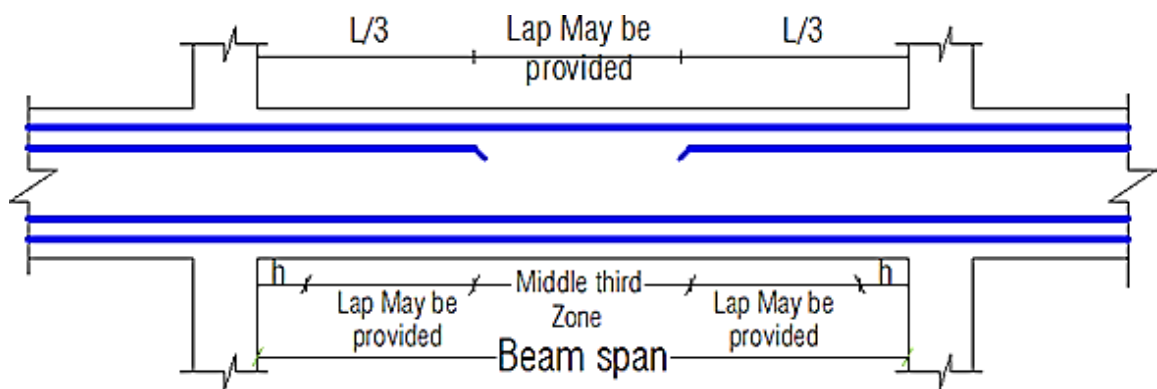


Fig. 3.6: Lap position

3.4 Design of Column and detailing.

ETABS takes into account a number of important elements while designing columns in a structural model. It starts by looking at the axial loads and moments on the columns, which are very important for figuring out how strong and stable they are. ETABS looks at both dead loads and live loads when it does its evaluations. Find out what they do to the column's performance. The algorithm also takes into account the cross-sectional area, the characteristics that make the column stronger, the column's rigidity, and its ability to resist buckling.

Table 3.2: Details of Ground to Roof Column

Columns from Basement to Ground Floor			
Column No.	Size of Column	Main Reinforcement	Lateral Ties
C1	14"x14"	10 Nos of 16mm dia	10mm @ 8"c/c

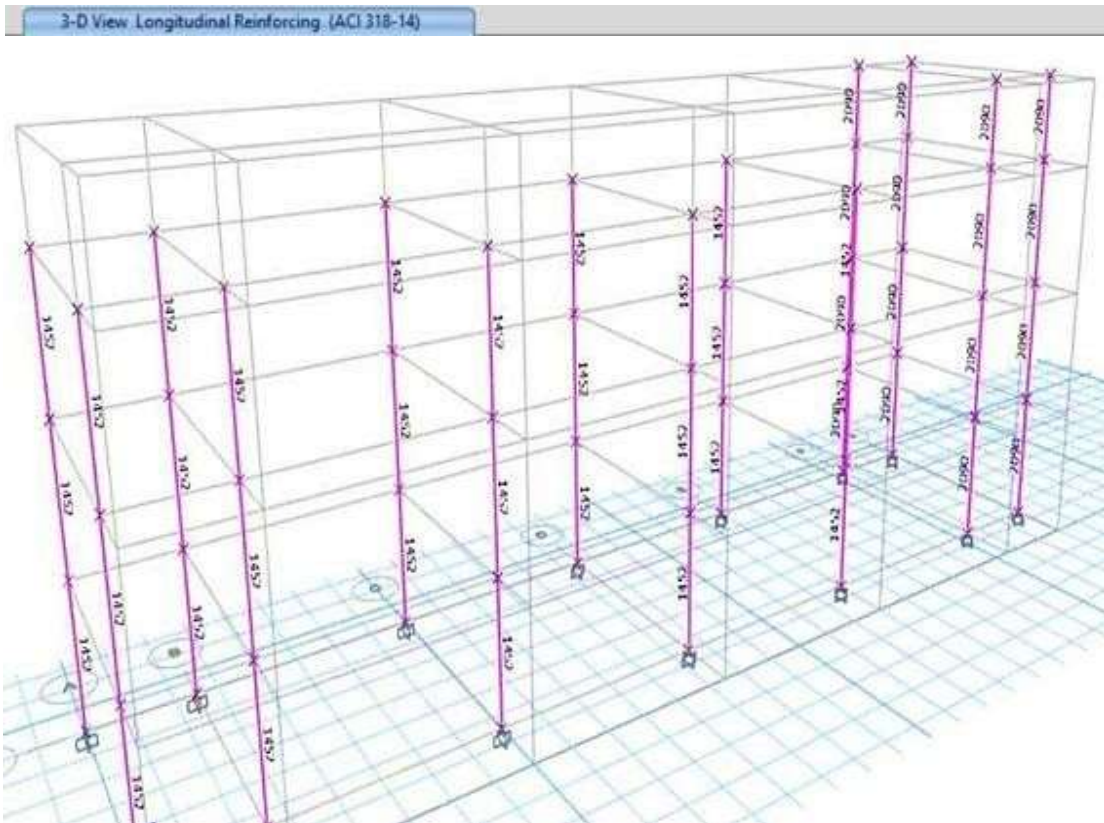


Fig. 3.7: Longitudinal Reinforcement Area of Column

3.5 Design of Foundation and Detailing.

It also looks at the shear pressures and moments at the base, especially when compared to the requirements for bending and punching shear. The computer checks the depth of the footing and the strength of the reinforcement to make sure that the settlement stays within reasonable limits. The design is optimized, and compliance with local construction rules and safety laws is ensured by taking into account parameters such as concrete strength, footing shape, and dimensions, and all detailing mentioned in Fig. 3.8 and Table 3.3.

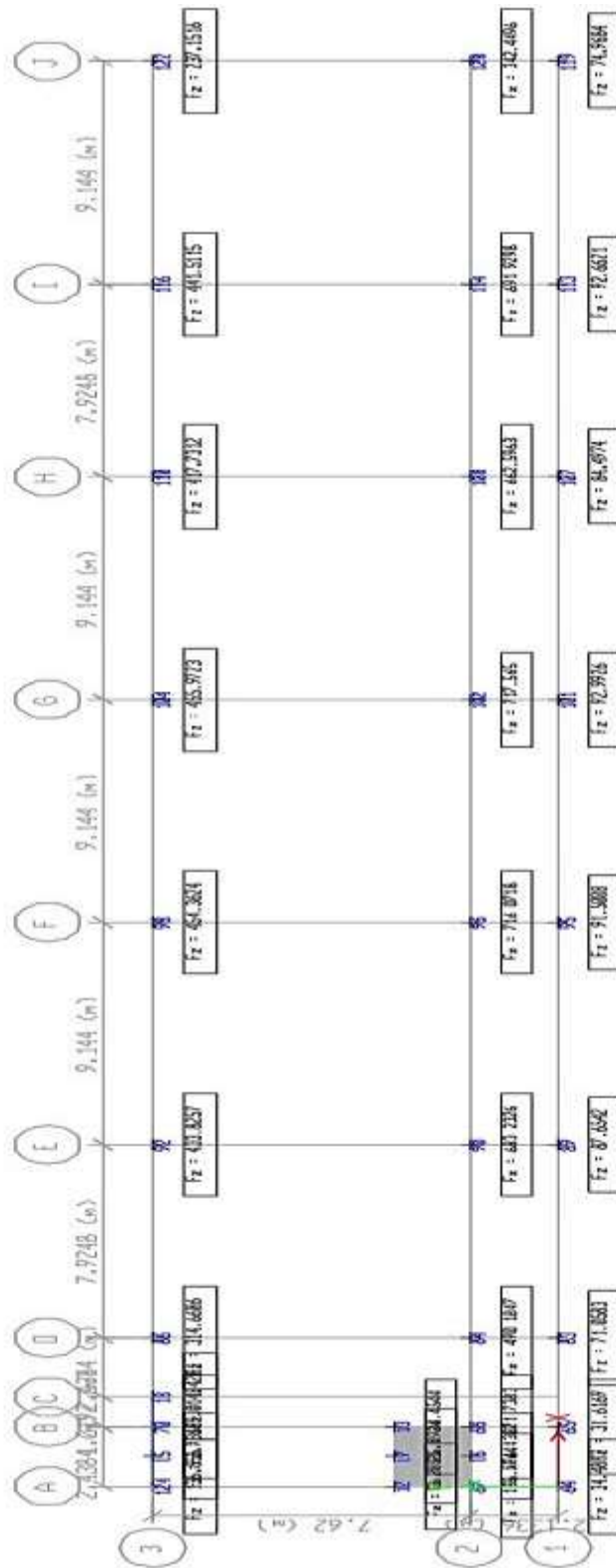


Fig. 3.8: Footing load

Table 3.3: Final detailing of footing

NO. OF FOOTING	TDL (KIP)	TLL (KIP)	QA (KSF)	Square Column Size (Inch)	Final Detailing
9	98.371	20.459	3	14	Footing Size 6.5' x 6.5' x 18" and both direction #7 @ 9inch C/C
4	121.227	51.055	3	14	Footing Size 6.5' x 6.5' x 20" and both direction #7 @ 8inch C/C
2	125.305	39.328	3	14	Footing Size 6' x 6' x 16" and both direction #7 @ 7inch C/C
2	118.204	49.587	3	14	Footing Size 5.5' x 5.5' x 18" and both direction #7 @ 4.5inch C/C
2	47.818	9.937	3	14	Footing Size 5' x 5' x 12" and both direction #7 @ 7inch C/C
2	33.114	3.701	3	14	Footing Size 4' x 4' x 12" and both direction #7 @ 6inch C/C
2	98.672	37.821	3	14	Footing Size 5' x 5' x 15" and both direction #7 @ 6inch C/C
2	68.307	16.503	3	14	Footing Size 6' x 6' x 14" and both direction #7 @ 5.5inch C/C
2	62.338	7.012	3	14	Footing Size 6' x 6' x 14" and both direction #7 @ 9inch C/C

3.6 Design of Stairs and Detailing.

When making a staircase in ETABS, you need to think about a few structural and load issues to make sure it is safe and works. To meet architectural standards, ETABS will look at the rise and run of the staircase's geometry. the overall slope. It looks at the materials' strength and rigidity, such steel or concrete, to figure out how they will hold up. To follow architectural rules, load considerations must include both dead loads. Include the weight of the building itself and the living loads, such as the weight of people and moving things on the steps, no matter if the stairs are cantilevered or supported at both ends.

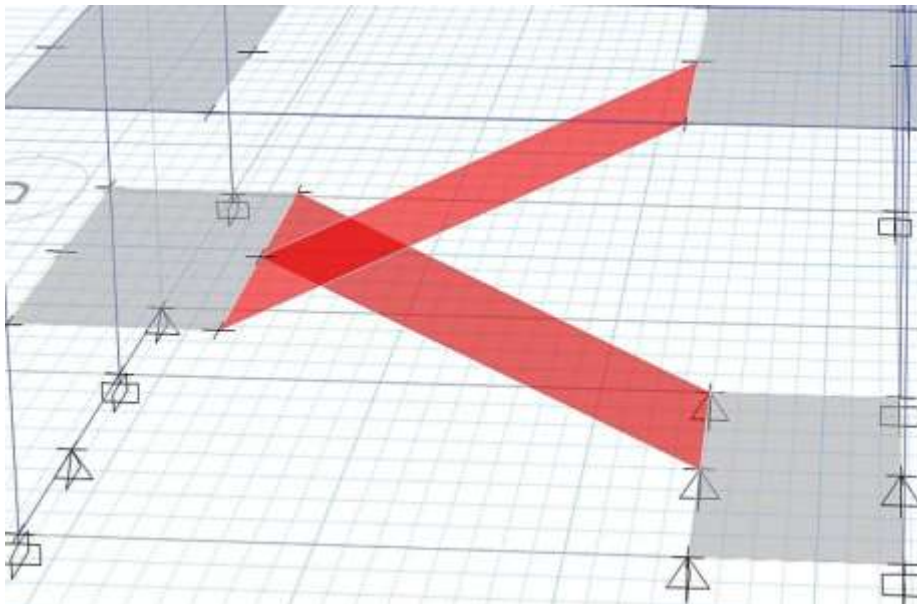


Fig. 3.9: Stair view from ETABS

3.7 Summary

Using ETABS, this project involved designing the structural parts of a G+1 , such as footings, slabs, columns, beams, and staircases. The safety and usefulness. After that, AutoCAD gave clear and accurate drawings of the designs, complete with notes, reinforcement layouts, and dimensions. This all-encompassing approach made sure that the design was safe for real-world use. It was confirmed that the structure was stable and met code criteria.

Chapter 4

COST ESTIMATION AND PROJECT DURATION

4.1 Introduction

A Bill of Quantities (BOQ) is very important in construction since it lists all the materials and resources needed for each part of the structure. The BOQ has the specifications for concrete and reinforcement for every major structural stairway, isolated footings, beams, columns, and component slabs that are taken apart in a ground floor plus one (G+1) structure. This difference makes sure that the structure is safe by making it possible to see the budget and making sure that the materials meet the design criteria. This is a full study of each part of the concrete standards that are covered by the BOQ in table... reinforcement and a summary of the building's anticipated cost. The stairs, footing, beam, column, and slab, as well as all the parts listed in Table 4.1, are all included.

4.2 Construction BOQ (Bill of Quantities) Estimation

4.2.1 Slabs

Slabs, which are horizontal parts, carry loads to beams and columns to support the floor and roof. The slab BOQ specifies the amount of concrete needed in cubic meters, depending on the thickness and area of the slab. Most of the time, BOQ calls for M20 grade concrete, which is a good mix between cost and strength. The volume of slab is found as 2854 cft.

Calculation:

$$\text{Total reinforcement weight} = 26978 \text{ ft} \times 0.188 \text{ kg/ft} = 5071 \text{ kg}$$

$$\text{Total cost} = 5071 \text{ kg} \times \text{rate} = 456466 \text{ tk}$$

Table 4.1: Quantity Takeoff (Slabs)

Material	Quantity	Rate (Taka)	Amount (Taka)
Cement required	412 bags (515cft)	500 per bag	206000
Sand required	772 cft	50 per cft	38600
Aggregate required	1544 cft	90 per cft	138960
Reinforcement (10mm dia)	5071 kg	88 per kg	456466
TOTAL COST FOR SLABS			840026

4.2.2 Beams

Beams are very important for handling since they transport weights from slabs to columns. bending and shear forces. The BOQ tells you how much concrete you need based on the beam's length and cross-sectional area, like A beam at 1st.

Reinforcement Calculation:

Total main reinforcement bar weight = $2598 \text{ ft} \times 0.48 \text{ kg/ft} = 1247 \text{ kg}$ (102 nos)

Total cost for main bars = $1247 \text{ kg} \times 170 \text{ tk per kg} = 211975 \text{ tk}$

Total tie bars = $50 \text{ nos/beam} \times 10 \text{ beams} = 500 \text{ nos}$

Total weight = $2167 \text{ ft} \times 0.188 \text{ kg/ft} = 407 \text{ kg}$

Total cost = $407 \text{ kg} \times 140\text{tk per kg} = 56660 \text{ tk}$

Table 4.2: Quantity Takeoff (Beams)

Material	Quantity	Rate (Taka)	Amount (Taka)
Cement	40 bags	500 per bag	20000
Sand	70 cft	50 per cft	3500
Crushed Material	140 cft	90 per cft	12600
Reinforcement (main bar)	1247	90 per kg	211975
Reinforcement (tie bar)	407 kg	88 per kg	56660
TOTAL COST FOR BEAMS			420991

4.2.3 Columns

Vertical structural elements that carry loads from the upper levels to the foundation and are made to handle both compressive and lateral stresses.

Materials Specification

Grade of Concrete: M30

Reinforcement: ETABS says that the weight of the column reinforcement is 1.493 tons, which is the same as 1493 kg. So, the total cost of reinforcing the columns is $1107 \times 170 = 188,223$ BDT for the main bars and $386 \times 140 = 54,110$ BDT for the tie bars. This includes all the vertical bars, ties, and laps that are needed for both the ground and first-floor columns.

Size of the column: 14 in \times 14 in

Table 4.3: Quantity Takeoff (Columns)

Material	Quantity	Rate (Taka)	Amount (Taka)
Cement	70 bags	500 per bag	35000
Sand	112 cft	50 per cft	5600
Crushed Material	224 cft	90 per cft	20160
Reinforcement (main bar)	1107	90 per kg	188223
Reinforcement (tie bar)	386 kg	88 per kg	54110
TOTAL COST FOR COLUMNS			409733

Notes:

- The main reinforcing bar used has a diameter of 16 mm.
- There are ties with a diameter of 10 mm every 150 mm.

4.2.4 Isolated Footings

Isolated footings, which are also called isolated footings, are used to hold up independent columns and spread the weight over the ground. The BOQ for concrete and reinforcing details for isolated footings needs to be based on the size of the footing and the load on the column. It is meant to help.

The volume of concrete is 89 cft, and it is grade M30. A 20 mm bar diameter is utilized for reinforcement. It is important to reinforce the footing so that it can handle shear pressures and bending moments, especially at the top and bottom parts of the footing.

The BOQ regions of the footing would list the following reinforcements. The BOQ would list reinforcement like this:

Table 4.4: Quantity Takeoff (Footings)

Material	Quantity	Rate (Taka)	Amount (Taka)
Cement	280 bags	500 per bag	140000
Sand	518 cft	50 per cft	25900
Crushed Material	1050 cft	90 per cft	94500
Reinforcement (main bar)	2790 kg	90 per kg	474220
TOTAL COST FOR FOOTINGS			734620

4.2.5 Staircase

Stairs carry loads by letting people move up and down and passing them on to structural parts like beams and columns. The BOQ figures out how much concrete is needed based on the size of the stairs, including the flight, tread, landing, and riser. For instance, a flight of stairs that is 6 m wide, 0.15 m high, and 0.3 m deep needs around 1.8 m³ of concrete. People employ M30 grade concrete because it can hold up under heavy loads.

The BOQ says that the main bars (12 mm in diameter) should run down the span and the distribution bars (8 mm in diameter) should be arranged at right angles to the main bars with a space of 200 mm between them.

4.2.6 Summary of BOQ Estimation

Table 4.5: Summary of BOQ

S.L.	Description	Estimated Amount (Taka)
A	Estimation of Foundation and Footing	834,620.00
B	Estimation of Column	819,466.00
D	Estimation of Floor Beam	841,980.00
E	Estimation of Slab	840,028.00
F	Estimation of Stair	287,038.00
G	Estimation of Labor	960,000.00
H	Estimation of Brick masonry, Plaster, & Painting work	850,260.00
I	Estimation of the Septic Tank	231,320.00
Grand Total		5,664,712.00

4.3 Project Duration

For organizing our G+1 school building project, a Gantt chart is a highly significant tool. It helps engineers, construction workers, and project managers plan and coordinate tasks like digging, putting up footings, casting columns, and creating slabs. This plan helps to speed up work, stay within budgets, and finish projects on schedule in Table 4.2. It does this by cutting down on delays and making the best use of resources.

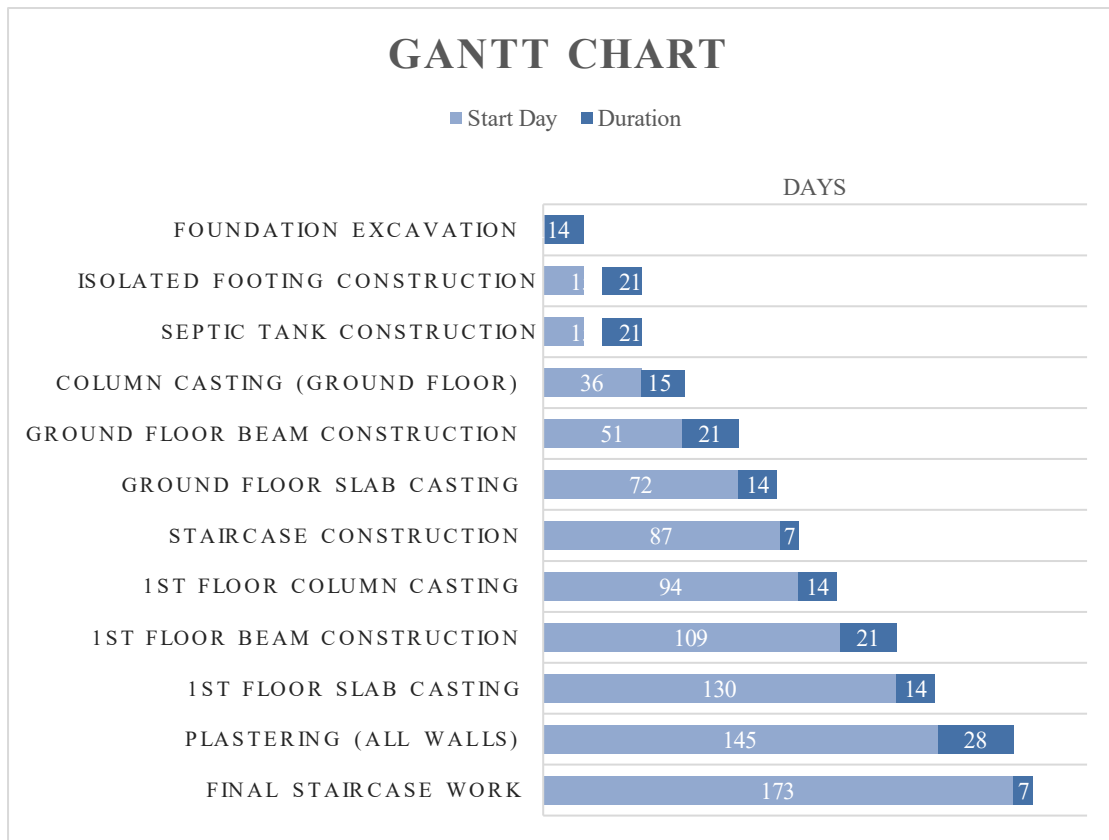


Fig.4.1: Gantt chart

Table 4.6: Project timeline

Task No.	Task Description	Duration	Start Date	End Date
1	Foundation Excavation	2 weeks	Day 1	Day 14
2	Isolated Footing Construction	3 weeks	Day 15	Day 35
3	Septic Tank Construction	3 weeks	Day 15	Day 35
4	Column Casting (Ground Floor)	2 weeks	Day 36	Day 50
5	Ground Floor Beam Construction	3 weeks	Day 51	Day 71
6	Ground Floor Slab Casting	2 weeks	Day 72	Day 86
7	Staircase Construction	1 week	Day 87	Day 93
8	1st Floor Column Casting	2 weeks	Day 94	Day 108
9	1st Floor Beam Construction	3 weeks	Day 109	Day 129
10	1st Floor Slab Casting	2 weeks	Day 130	Day 144
11	Plastering (All Walls)	4 weeks	Day 145	Day 172
12	Final Staircase Work	1 week	Day 173	Day 179

Chapter 5

DESIGN AND CONSIDERATION OF SEPTIC TANK

5.1 Introduction

An underground septic tank cleans up dirty water. Commonly used in areas without a central sewage system. Anaerobic bacteria can break down organic materials and items that are inside a sealed chamber, which is commonly built of concrete, fiberglass, or plastic, and separates solids from liquids. The tanks only clean up part of the liquid, which is called effluent. After that, it proceeds to a drain field, where it goes through dirt to be cleaned even further. A good design includes picking durable materials, calculating out how big the tank has to be depending on how much water the family consumes, and making sure the tank is far enough away from water sources to keep them clean. It's a good idea to check and pump regularly. Every two to five years, maintenance is quite vital. Local regulations say that certain things must be done before, during, and after arrangements are made to protect public health and the purity of groundwater.

5.2 Component of Septic Tank

A septic tank comprises a lot of vital pieces that work together to clean up dirty water from residences. An entrance line brings dirty water into the tank, where the particles and liquids start to separate.

5.3 Design Considerations of Septic Tank

Here is a step-by-step guide on how to figure out the size and features of the septic tank design: The tank's size should depend on how much water the family uses every day. It should be able to store effluent for one to two days so that the particles can settle and break down. Concrete, fiberglass, and plastic are strong, waterproof materials that should be used to make tanks so they don't leak and stay safe. Barriers or partitions commonly split underground water tanks into two halves to make cleaning easier. The exit pipe needs to be a bit lower so that the wastewater can flow correctly. The input and output pipes also need to be set up such that fittings make it easy to control the flow. To let gas out, get rid of unwanted smells, and make bacteria work better, there needs to be good ventilation. The

(BNBC, 2020) also recommends that there should be access points, or risers, so that pumping and checking can place regularly. To keep pollution out, they need to be tightly sealed. The drain field, which is where the tank's effluent goes, should be set up such that it is safe from water sources, buildings, and wells. It should also take into account how well the soil can absorb water. To avoid freezing problems, the septic tank must be buried deep enough and far enough away from buildings and bodies of water. Regular maintenance is necessary to make sure the tank works well and protects public health. This includes getting rid of solids every two to five years. And the picture that is shown in Fig. 5.1 and Fig. 5.2.

5.4 Design of Septic Tank.

Population, $P = 300$ persons

Length, $L = 29.90 \text{ ft} \approx 30 \text{ ft}$

Per capita water use, $q = 25 \text{ lpcd}$

Width, $W = 9.30 \text{ ft} \approx 10 \text{ ft}$

Design life, $N = 5$ years

Liquid depth, $H = 11.25 \text{ ft}$

Design temp, $T = 25^\circ\text{C}$

Solids accumulation rate, $C = 0.04 \text{ m}^3/\text{person}/\text{year}$

$= 1.413 \text{ ft}^3/\text{person}/\text{year}$

Scum zone:

$$V_{sc} = 847.55 \text{ ft}^3$$

$$d_{sc} = 2.66 \text{ ft}$$

Sedimentation zone:

$$t_h = 0.337 \text{ days}$$

$$d_h = 1.23 \text{ ft}$$

$$V_h = 89.38 \text{ ft}^3$$

Digestion zone:

$$T = 42.3 \text{ days}$$

$$d_d = 0.705 \text{ ft}$$

$$V_d = 224.18 \text{ ft}^3$$

Sludge zone:

$$V_{sl} = 2118.88 \text{ ft}^3$$

$$d_{sl} = 1238.651 \text{ ft}$$

Total:

$$V = 3282.75 \text{ ft}^3$$

$$d = 11.247 \text{ ft}$$

$$a = 3$$

$$b = 1$$

$$c = 1$$

$$A = 318.61 \text{ ft}^3 \approx 320 \text{ ft}^3$$

Detailed specs and design criteria for the septic tank are presented in the Appendix for comprehensive.

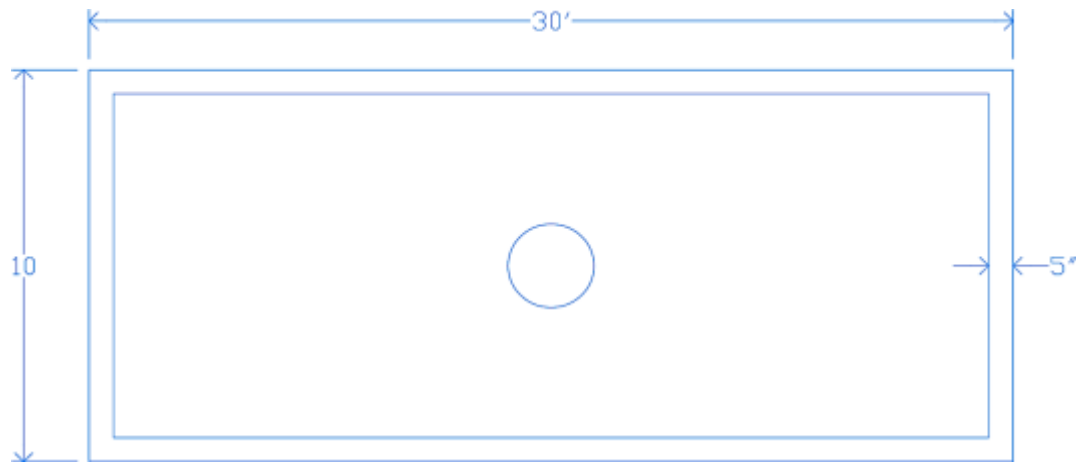


Fig. 5.1: Section view of septic tank

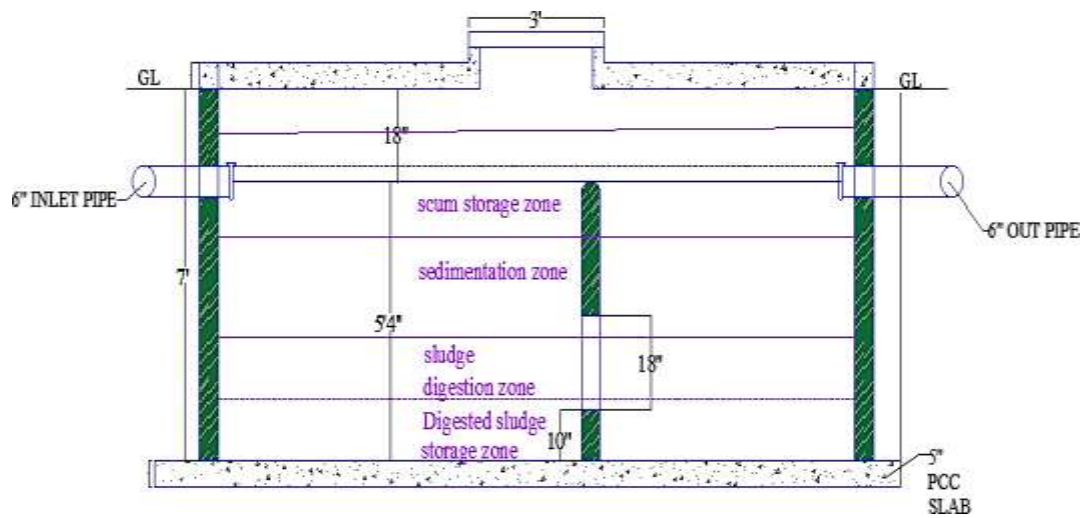


Fig. 5.2: Plan of septic tank

5.5 Summary

In places where there are no sewers, a septic tank is used to treat wastewater. It divides trash into three groups: effluent (processed liquid), sludge (dense particles), and scum (lipids and fats). The Effluent gets more filtering once it goes through a drainage field.

Chapter 6

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The main goal of this capstone project was to do a lot of research that combines the structural, environmental, and economic aspects of civil engineering by designing a two-story primary school in Savar, Dhaka. This project was more than just a way to learn something new. It had students employ real-world design processes in a real-world situation, taking into account both technical and social issues. The initiative was aimed to aid with the expanding need for schools in Bangladesh that are safe, long-lasting, and friendly.

We employed the Bangladesh National Building Code (BNBC 2020) and ACI 318-19 to make sure the building was as safe, sturdy, and usable as feasible. We used ETABS 2021 software to model and look at the structure of major sections such beams, columns, slabs, foundations, and staircases. We paid close attention to how to deal with the heaviest live and dead loads and how to resist both vertical and lateral strains. Because the site is in an area where earthquakes are likely to happen, stress limits, deflection control, and ductility were all taken into account.

It is a good and adaptable way to establish schools in Bangladesh and other areas like it in the future. It also showed how important civil engineers are in building infrastructure that helps communities, education, and national development goals. The student team has obtained the technical and professional preparation they need for future duties in the field and for further lifelong learning as civil engineers through this capstone project.

6.2 Recommendation

- Keep using ETABS for future structural design projects because it is a solid tool for analyzing and designing structural elements.
- Use AutoCAD to make sure that structural and architectural plans work better together. This will make the detailing process easier.

- Use AutoCAD's skills in architectural layout and visualization to make designs that are more realistic and detailed.

- Excel is good for estimating costs, but you might want to transition to more advanced methods, including combining cost estimation with software, to get more accurate results and save time.
- Keeping a consistent workflow between ETABS and AutoCAD is vital for lowering mistakes and raising the quality of the design.
- Staying up to date on building codes (such as NBC 2020) and getting regular training on software should be a top priority to make sure you follow the rules and get the best results on future projects.

Reference

BNBC. (2020). *Bangladesh National Building Code*. HBRI.

Education, D. of P. (2018). *Infrastructure Plan and Planning Guidelines for Primary School (Part A)*. Directorate of Primary Education.

B. Gazette, "Government of the People's Republic of Bangladesh Ministry of Housing and Public Works BANGLADESH NATIONAL BUILDING CODE 2020," 2021.

ACI Committee 318, 319 and American Concrete Institute., Building code requirements for structural concrete (ACI 318-11) and commentary. American Concrete Institute, 2011.

APPENDIX

DESIGN OF SEPTIC TANK

Design of a septic tank to serve a primary school of 300 persons who produce 25 lpcd of wastewater and the tank is to be cleaned every 5 years.

Solution:

$$P = 300 \text{ persons}$$

$$N = 5 \text{ years}$$

$$C = 0.04 \text{ m}^3/\text{person}/\text{yr.}$$

$$T = 25 \text{ }^\circ\text{C}$$

$$q = 25 \text{ lpcd.}$$

Volume calculation (m^3)

Sedimentation zone v_h

$$T_h = 1.5 - 0.3 \log(Pq)$$

$$= 1.5 - 0.3 \log(300 * 25) = 0.361 \text{ days}$$

The volume required by the sedimentation zone

$$v_h = 10^{-3}(Pq) * t_h$$

$$= 10^{-3} \times (300 \times 25) \times 0.361 = 2.258 \text{ m}^3$$

Sludge Digestion Zone: Assuming a design temperature of 25°C

$$T_d = 30(1.035)^{35-T} = 30(1.035)^{35-25} = 42.3 \text{ days}$$

$$v_d = 0.5 * 10^{-3} * P * t_d = 0.5 \times 10^{-3} \times 250 \times 42.3 = 5.290 \text{ m}^3$$

Sludge Zone

$$v_{s_l} = CPN = 0.04 \times 300 \times 5 = 50 \text{ m}^3$$

Scum Zone (v_{sc})

$$v_{sc} = 0.4V_{s_l} = 0.4 \times 50 = 20 \text{ m}^3$$

$$\text{Total Volume } V = v_{sc} + v_h + v_d + v_{s_l}$$

$$V = 20 + 2.258 + 5.290 + 50 = 77.5 \text{ m}^3$$

Depth Calculation

$$\text{Cross-sectional area } A = 26.2 \text{ m}^2$$

$$\text{The maximum depth of sludge } d_{sl} = v_{s_l}/A = 50/26.2 = 1.906 \text{ m}$$

$$\text{The maximum submerged scum } d_{sc} = 0.4 \times v_{s_l}/A = 0.4 \times 50/26.2 = .763 \text{ m}$$

Sludge clear depth = 0.3 m is adopted

$$\text{Total clear space} = 0.3 + 0.075 = 0.375 \text{ m}$$

C = Sludge accumulation constant
 $= 0.04 \text{ m}^3/\text{person}/\text{year}$
 (Part VIII, Chapter 6, 6.9.12.10
 BNBC 2020)

Depth of digestion zone $d_d = v_d/A = 5.290/26.4 = 0.202$ m

Depth required for sedimentation $= v_h/A = .375/26.4 = 0.014$ m < 0.375 m

$d_h = 0.375$ m is adopted

Total effective depth $= 1.906 + 0.763 + 0.202 + 0.375 = 3.46$ m

The suitable overall internal dimension of the septic tank can be chosen as

$= 9.144\text{m} \times 3.048\text{m} \times 3.46\text{m}$

$\approx 30\text{ft} \times 10\text{ft} \times 11.25\text{ft}$

$$V = L * W * H$$

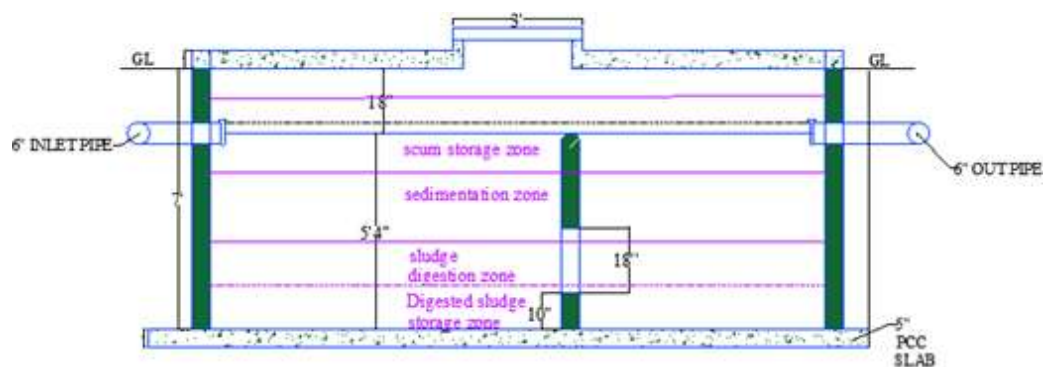
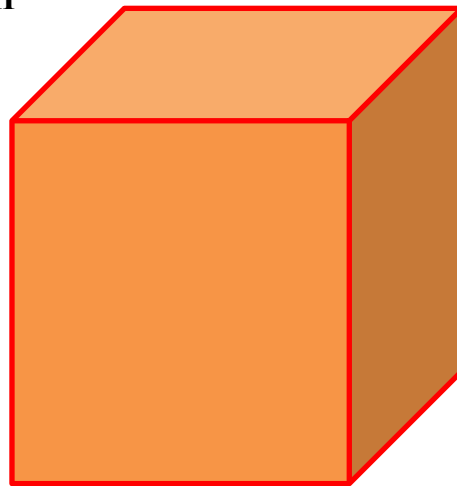
$$X = \sqrt{v/abc}$$

$$A = abx^2$$

$$W = bx$$

$$H = cx$$

$$L = ax$$



Septic tank

A.1 Slab Design

Step 1:

$$t_{min} = \text{perimeter}/180 \geq 3.5$$

$$t = \frac{2(30+25) \times 12}{180} = 7.33 \approx 7.5" \geq 3.5 \text{ (ok)}$$

take $t = 7.5$ in

$$d = t - 1 = (7.5 - 1) = 6.5 \text{ in}$$

Step 2: Calculation of factored load

Dead load:

$$s_w = 150 \times \frac{t}{12} = 150 \times \frac{7.5}{12} = 93.75 \text{ psf}$$

Floor finish (FF) = 25 psf

Partition wall (pw) = 55 psf

Total dead load = $93.75 + 25 + 55 = 173.75$ psf

Live load

Live load = 55 psf

$$w_u = 1.2 \text{ DL} + 1.6 \text{ LL} = 1.2 \times 173.75 + 1.6 \times 75 = 328 \text{ psf} = 0.328 \text{ ksf}$$

$$w_D = 1.2 \times 173.75 = 208.5 \text{ psf} = 0.208 \text{ ksf}$$

$$w_L = (1.6 \times 55) = 88 \text{ psf} = 0.088 \text{ ksf}$$

Step 3: Determination of moment coefficient

$$m = \frac{l_a}{l_b} = 25/30 = 0.833$$

$C_a \text{ neg} = 0.062$

$C_b \text{ neg} = 0.0289$

$$C_a \text{ dl} = 0.02468$$

$$C_b \text{ dl} = 0.0113$$

$$C_a \text{ ll} = 0.03836$$

$$C_b \text{ ll} = 0.9832$$

Step 4: Calculation of moment

Middle strip moment

$$\text{Positive moment: } M_a(+ve) = C_A \cdot DLW_D l a^2 + C_{aLL} \times w_L l a^2$$

$$= 0.02468 \times 0.208 \times 25^2 + 0.03836 \times 0.088 \times (25^2)$$

$$= 5.31 \text{ k-ft/ft}$$

$$M_b(+ve) = C_B \cdot DLW_D L b^2 + C_{bLL} \times W_L L b^2$$

$$= 0.0113 \times 0.208 \times 30^2 + 0.01832 \times 0.088 \times 30^2$$

$$= 3.56 \text{ k-ft/ft}$$

Negative Moment:

$$M_a(-ve) = C_a(\text{neg}) \times w_L l a^2 = 0.062 \times 0.328 \times 25^2 = 12.71 \text{ k-ft/ft}$$

$$M_b(-ve) = C_b(\text{neg}) \times w_L l b^2 = 0.0289 \times 0.328 \times 30^2 = 8.53 \text{ k-ft/ft}$$

Step 5:

$$\rho_b = \alpha_B \frac{f'_c}{f_y} \times \frac{\Sigma U_C}{\Sigma U_C + \Sigma U_y} = (0.85 \times 0.85 \times 3) \times \frac{0.03}{60 \times 0.03 + 0.005} = 0.0135$$

$$\rho_{max} = 0.75 \times \rho_b = 0.75 \times 0.0135 = 0.01016$$

$$M = \phi \rho f_y d^2 b (1 - 0.59 \rho \frac{f_y}{f'_c}) \Rightarrow 11.47 \times 12 = 0.9 \times 0.01016 \times 60 \times 12 \times d^2 \times [1 - 0.59 \times 0.01016 \times \frac{60}{3}]$$

$$d = 4.88 < 6.5 \text{ in (ok)}$$

Step 6:

Rebar for short direction

$$+A_{SA} = \frac{M \times 12}{0.9 \times f_y (d - \frac{1}{2})} = \frac{5.31 \times 12}{0.9 \times 60 \times (6.5 - \frac{1}{2})} = 0.188 \text{ in}^2 \text{ (Assume, } a = 0.5)$$

And $a = \frac{Asf_y}{0.85 f'_c b} = \frac{0.188 \times 60}{0.85 \times 3 \times 12} = 0.37 \text{ in (ok)}$

$$A_{s, \min} = 0.00018, \quad b_t = 0.00018 \times 12 \times 7.5 = 0.162 \text{ in}^2/\text{ft}$$

Using $\phi 10\text{mm}$ bar

$$S = \frac{\text{Area of bar used} \times \text{Width of strip}}{\text{Required } A_s}$$

$$= \frac{0.121 \times 12}{0.2441} = 6.02'' \approx 6 \text{ in c/c at bottom along short direction}$$

$$-A_{s_A} = \frac{M \times 12}{0.9 \times f_y \times (d - \frac{2}{2})} = \frac{11.47 \times 12}{0.9 \times 60 \times (6.5 - \frac{2}{2})} = 0.428 \text{ in}^2/\text{ft}$$

$$a = \frac{0.428 \times 60}{0.85 \times 3 \times 12} = 0.85 \text{ in (ok)}$$

$$A_{m_n} = 0.0018 \times 12 \times 7.5 = 0.162 \text{ in}^2/\text{ft}$$

$$\text{Already provided } A_{s_1} = \frac{0.121 \times 12}{11} = 0.132 \text{ in}^2/\text{ft}$$

$$\text{Extra top required } A_{s_2} = (0.428 - 0.132) = 0.296 \text{ in}^2/\text{ft}$$

Using $\phi 10\text{mm}$ bar $s = 5.32 \approx 5''$ c/c extra top

Rebar bar long direction:

$$+A_{s_B} = \frac{3.56 \times 12}{0.9 \times 60 \times (6.5 - \frac{2}{2})} = 0.124 \text{ in}^2/\text{ft}$$

$$A_{m_n} = 0.0018 \times 12 \times 7.5 = 0.162 \text{ in}^2/\text{ft}$$

Using $\phi 10\text{mm}$ bar, $s = \frac{0.121 \times 12}{0.159} = 9.13 \approx 9''$ c/c at bottom along long direction crank

50% bar to negative zone.

$$-A_{s_B} = \frac{7.96 \times 12}{0.9 \times 60 \times (6.5 - \frac{2}{2})} = 0.29 \text{ in}^2/\text{ft}$$

$$\text{Already provide } A_{s_1} = \frac{0.121 \times 12}{15} = 0.0968 \text{ in}^2/\text{ft}$$

$$\text{Extra top required } A_{s_2} = (0.296 - 0.0968) = 0.20 \text{ in}^2/\text{ft}$$

Using 10mm bar @ = 6.38 $\approx 6''$ c/c extra top

A.2 Beam Design

Load Calculation

Load area = 156.25 ft^2

Beam length = 25 ft

Slab thickness, $t = 7.5$ in

Clear cover = 1.5"

$d = (25 - 1.5) = 23.5$ ft

Beam Size: 10"×18"

Now

Dead load from the slab

$$s_w = \frac{7.5}{12} \times 150 = 93.75 \text{ psf}$$

FF = 25 psf

PW = 55 psf

Dead load from slab = $93.75 + 25 + 55 = 173.75$ psf

1 ft^2 Dead load = 173.75 lb

Total Dead load = (173.75×156.25)

Total dead load = 27148.43 lb = 27.15 kip

Live load: LL=45 psf

Total LL = $(45 \times 156.25) = 7.031$ kip

$w_U = 1.2 \text{ DL} + 1.6 \text{ LL} = (1.2 \times 27.15 + 1.6 \times 7.031) = 43.82$ kip

$w_{UUDL} = \frac{49.96}{25} = 1.999 \approx 2$ kip/ft

Moment Calculation:

$$M(+ve) = \frac{1}{14} w_U L^2 = \frac{1}{14} \times 2 \times 25^2 = 89.28 \text{ kip-ft}$$

$$M(-ve) = \frac{1}{12} w_U L^2 = \frac{1}{12} \times 2 \times 25^2 = 104.16 \text{ kip-ft}$$

$f'_c = 3$ ksi $f_y = 60$ ksi

Now

$$\rho_p = aB \frac{f'_c}{f_y} \times \frac{\Sigma U}{\Sigma u + \Sigma y}$$

$$f'_c = 3 \text{ ksi}$$
$$c$$

$$= 0.85 \times 0.85 \times \frac{3}{60} \times \frac{0.003}{0.003 + 0.005}$$

$$f_y = 60 \text{ ksi}$$

$$= 0.0135$$

$$M = \phi \rho_f \frac{b d^2}{y} (1 - 0.59 \rho \frac{f_y}{f'_c})$$

$$104.16 \times 12 = 0.09 \times 0.0135 \times 60 \times 12 \times d^2 \times \left(1 - 0.59 \times 0.0135 \times \frac{60}{3}\right)$$

$$d_{req} = 13.03 \text{ in} < d \text{ (ok)}$$

Now

$$+A_s = \frac{M \times 12}{\phi f_y (d - \frac{a}{2})} = \frac{89.28 \times 12}{0.9 \times 60 \times (23.5 - \frac{a}{2})} \quad [\text{Assume, } a = 2]$$

$$a = \frac{A_s \times f_y}{0.85 f'_c b} = \frac{0.881 \times 60}{0.85 \times 3 \times 12} = 1.73 \text{ in (ok)}$$

$$-A_s = \frac{M \times 12}{\phi f_y (d - \frac{a}{2})} = \frac{104.16 \times 12}{0.9 \times 60 \times (23.5 - \frac{a}{2})} = 1.04 \text{ in}^2$$

$$a = \frac{1.04 \times 60}{0.85 \times 3 \times 12} = 2.03 \text{ in (ok)}$$

$$A_s \min = \frac{3 \sqrt{f'_c} b d}{f_y} \geq \frac{200}{f_y} b d$$

$$= \frac{3 \times \sqrt{3000}}{60000} \times 12 \times 23.5 \geq \frac{200}{60000} \times 12 \times 23.5$$

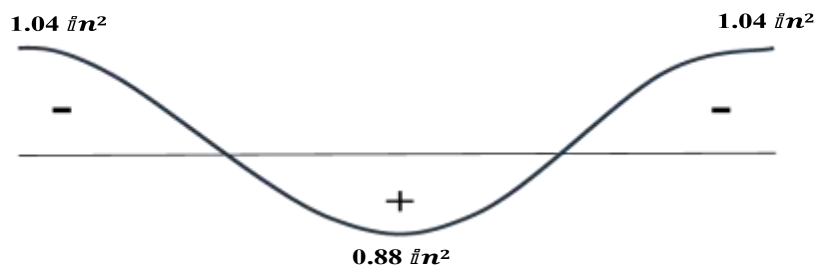
$$= 0.773 \leq 0.94 \text{ in}^2$$

$$\therefore A_s \min = 0.94 \text{ in}^2$$

Use 2#20mm St. (St. minimum 2 Nos)

$$\text{Area} = 2 \times 0.4869 \text{ in}^2$$

$$= 0.97 \text{ in}^2 > A_s \min$$





A.3 Column Design

$$\text{Total length} = (30+16) = 46 \text{ ft}$$

For Column:

$$\text{Area of supported slab} = (30' \times 16') = 480 \text{ ft}^2$$

$$\text{Slab thickness} = 7.5''$$

$$\text{Beam size} = 12'' \times 18''$$

$$\begin{aligned} \text{Dead load of beam} &= \left(\frac{18}{12} \times \frac{12}{12}\right) \times 150 \\ &= 225 \text{ psf} \end{aligned}$$

For other slab:

$$s_w = 150 \times \frac{7.5}{12} = 93.75 \text{ psf}$$

$$\text{FF} = 25 \text{ psf}$$

$$\text{Pw} = 55 \text{ psf}$$

$$\text{DL} = 173.75 \text{ psf}$$

$$\text{Dead load from slab} = (480 \times 173.75) / 1000 = 83.4 \text{ k}$$

$$\text{Live load from slab} = (480 \times 50) / 1000 = 24 \text{ k}$$

$$\text{Self-weight of Beam} = (46 \times 725) / 1000 = 10.35 \text{ k}$$

$$\begin{aligned} \therefore \text{Self weight of column} &= 10\% \text{ of (DL+LL+} s_w \text{ of Beam)} \\ &= 10\% \text{ of (83.4+24+10.35)} \\ &= 11.78 \text{ k} \end{aligned}$$

For one storied

$$\text{DL} = (83.4+10.35+11.78) = 105.52 \text{ k}$$

$$\text{LL} = 24 \text{ k}$$

$$\therefore P_U = 1.2 \text{ p DL} + 1.6 \text{ p LL} = (1.2 \times 105.52 + 1.6 \times 24) = 165.02 \text{ k}$$

$$\text{For 2-storeyed building } p_U = (165.02 \times 2) = 330.04 \text{ k}$$

For tied column:

$$P_U = 330 \text{ k}, \alpha = 0.8, \phi = 0.65, \rho_g = 2.5\% = 0.025$$

For tied $\alpha = 0.8$ $\phi = 0.65$

Now

$$P_U = \alpha \phi [0.85 f'_c (1 - \rho_g) + \rho_g f_y] \times A_g$$
$$\Rightarrow 330 = 0.8 \times 0.65 [0.85 \times 3 \times (1 - 0.025) + 0.025 \times 60] \times A_g$$
$$\text{So, } A_g = 159.20 \text{ in}^2$$

Let, Column width = 12"

$$\text{So, depth} = \frac{159.2}{12} = 13.3 \text{ in} \approx 14 \text{ in}$$

Let Column Size = 14"×14"

$$\text{Where } A_g = (14 \times 14) = 196 \text{ in}^2 \text{ (ok)}$$

$$\frac{\rho_u}{\alpha \phi} = \frac{0.85 f'_c (A_g - A_s) + A_s f_y}{c}$$

$$\Rightarrow \frac{330}{0.85 \times 0.65} = 0.85 \times 3 \times (196 - A_s) + A_s \times 60$$

$$\therefore A_s = 2.56 \text{ in}^2$$

A_s (min) = 1% of A_g

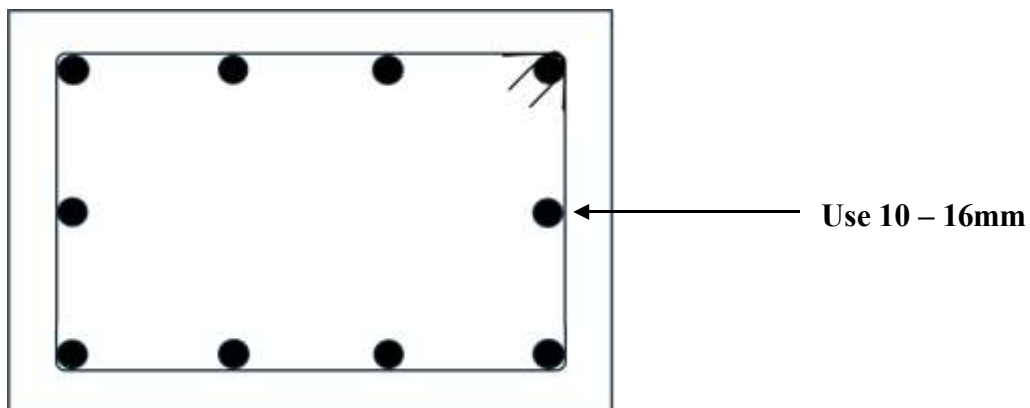
$$= (0.01 \times 196)$$

$$= 1.96 \text{ in}^2$$

So, Provide $A_s = 3 \text{ in}^2$

Use 10-16 mm bar

$$\text{Area} = 10 \times 0.31 = 3.1 \text{ in}^2 \text{ (ok)}$$



A.4 Footing Design

$$DL = (105.52 \text{ k} \times 2) = 213.4 \text{ k}$$

$$LL = 24 \text{ k} \times 2 = 48 \text{ k}$$

$$p_U = 330 \text{ k} \quad \text{Column size} = 14" \times 14"$$

$$f'_c = 3 \text{ ksi} \quad f_y = 60 \text{ ksi}$$

$$\text{Allowable Soil Pressure} = 3000 \text{ psf} = 3 \text{ ksf}$$

Calculation of footing

$$A = \frac{DL+LL}{q_a} = \frac{(105.52+24)}{3} = 43.17 \text{ ft}^2$$

Assume footing size is square $A = L^2$

$$L = \sqrt{A} = \sqrt{43.17}$$

$$\therefore L = 6.57 \text{ ft} \approx 6.5 \text{ ft}$$

Step 2: Check uplift pressure criteria $q_U > q_a$

$$q_U = \frac{p}{A}$$

$$q_U = \frac{1.4D}{A} = \frac{1.4 \times 105.52}{6.5^2} = 3.49 > q_a$$

$$q_U = \frac{1.2D+1.6L}{A} = \frac{1.2 \times 105.52 + 1.6 \times 24}{6.5^2} = 3.9 > q_a$$

So, Footing size is okay.

Step 3: One-way and two-way shear check

Effective depth $d = 150 \text{ mm} = 6" \rightarrow$ soil

300 mm = 12" \rightarrow pile

(BNBC 2020)

Here,

$$\begin{aligned} b_0 &= 2(a + b) \\ &= 2(C_1 + d + C_2 + d) \\ &= 2(C_1 + C_2 + 2d) \end{aligned}$$

$$v_{u1} = \left(\frac{L - c}{2} - d \right) b q = 2 \phi \sqrt{f' C} \quad b d$$

$$= \left(\frac{9.5 \times 12}{2} - \frac{1 \times 12}{2} - d \right) \times 9.5 \times 12 \times 3.68 \times 12 = 2 \times 0.75 \times \sqrt{3000} \times 10^{-3} \times d$$

$$d = 24''$$

$$v_{u2} = [A_f - (C_1 + d)(C_2 + d)] q_u = 4 \phi \sqrt{f' C} \quad b \cdot d$$

$$= [90.25 - (1 + d)(1.33 + d)] \times 3.68 = 4 \times 0.75 \times \sqrt{3000}$$

$$\times 10^{-3} \times 2(1 + 1.33 + 2d) \times d$$

$$\therefore d = 19.5 \text{ in}$$

Step 4: Flexural moment calculation:

$$M = \frac{q_u L}{2} \times \left(\frac{L}{2} - \frac{C}{2} \right)^2$$

$$= \frac{3.9 \times 6.5}{2} \times \frac{6.5}{2}^2 = 228.95 \text{ k-ft}$$

Step 5: Rebar Calculation:

$$A_s = \frac{M}{\phi f_y (d - \frac{a}{2})} \quad \text{----- (I)}$$

$$a = \frac{A_s f_y}{0.85 f' C b} \quad \text{----- (II)}$$

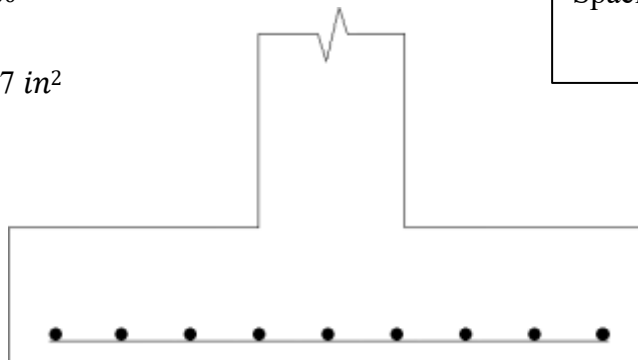
Trail between (I) and (II)

$$A_{s \min} = \frac{200}{f_y} b d$$

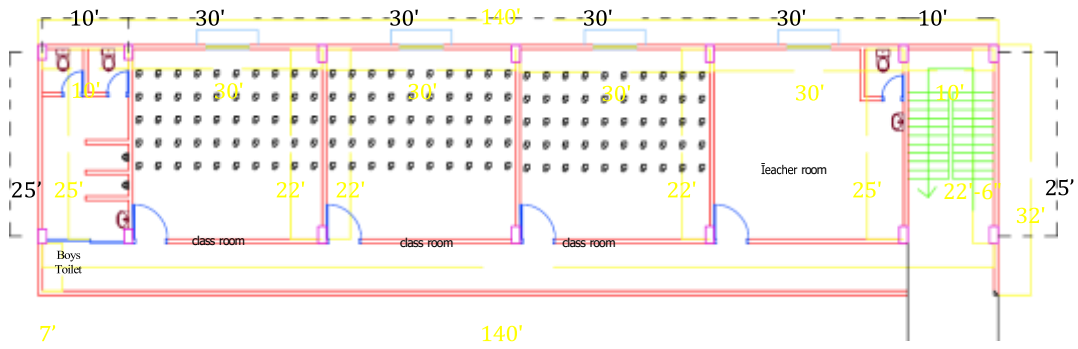
$$= \frac{200}{60000} (6.5 \times 12) \times 19.5$$

$$= 5.07 \text{ in}^2$$

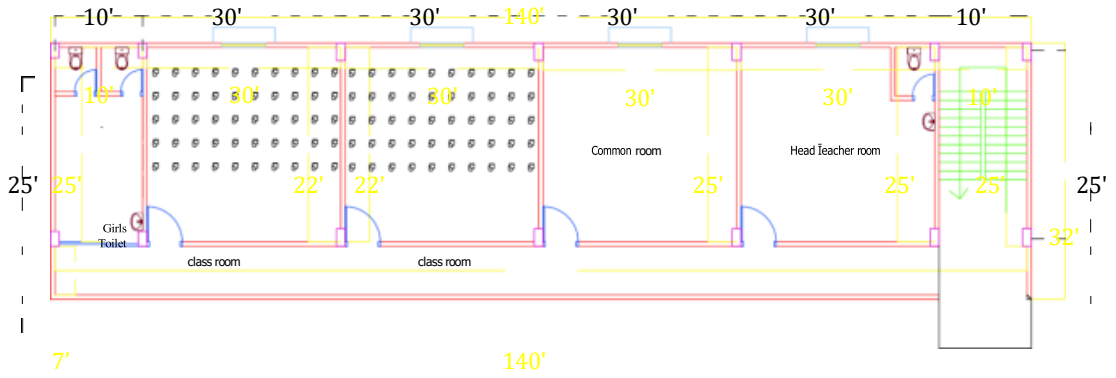
Spacing = $\frac{6.5 \times 12}{8} = 9'' \text{ c/c}$



∴ Provide 9 Nos #7 bars in each direction



1st Floor Plan



2nd Floor Plan

List of Deliverables

No.	Deliverable	Timeline	Format	Date of Submission
Level-4/Term-1				
1	Project Proposal	Week 1-3	Writeup	Not applicable.
2	Detail planning, methodology, data/survey requirement, stakeholder identification, and identification of external expert requirement, Gantt Chart	Week 4-5	Writeup, Presentation	18/08/2024
3	Data/survey Summary	Week 6-9	Writeup	20/08/2024
4	Preliminary Analysis and Design	Week 10-12	Writeup	28/08/2024
5	Analysis of Alternatives and preliminary cost estimation	Week 13	Writeup and Presentation	12/09/2024
6	Feasibility Study (Technical, Social, Environmental, Economic and Financial)	Week 14-15	Writeup and Presentation	18/09/2024
Level-4/Term-				
7	Analysis scheme for detail design	Week 1-2	Writeup	02/10/2024
8	Analysis output	Week 3-4	Writeup	05/10/2024

9	Detail Design Report	Week 5-9	Write-up, Drawings, and Presentation	2/11/2024
10	Final BOQ, and Cost Estimation	Week 10-11	Write-up and Presentation	20/11/2024
11	Tender Document, Implementation Schedule	Week 12-13	Write-up, Gantt Chart	Only the Gantt Chart was submitted on 20/11/2024

No.	Deliverable	Timeline	Format	Date of Submission
12	Final Report (Including Ethical aspects, lifelong learning)	Week 14	Write-up and Drawings	03/11/2025
13	Final Presentation	Week 15	Presentation	Presented to the supervisor twice a week and the final One presented to the examiner board on 15/11/2025

Self-assessment of COs with Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	Description	Criteria	Justification
CO1 (K6, P1, A1)	Application of modern engineering tools	Applied tools for design, drawings, etc.	Used CAD for design and ETABS for structural analysis, ensuring precision.
CO2 (K7)	Work on a Team	Attendance	<p>Collaborated effectively through regular meetings and task integration.</p> <p>Name: Saurov Mahanta (ID: 211-47-437)</p> <p>Name: Md. Al-Amin Hossen (ID: 211-47-443)</p> <p>Name: Md. Golam Sarowar Tushar (ID: 211-47-444)</p>
CO3 (K7, P2, A2)	Alternative analysis presented	Economic, environmental, social, ethical aspects, health and safety considered	Conducted alternative analysis, balancing cost, sustainability, and ethics.
CO4 (K7)	Societal and environmental benefit evaluation	Environmental, social and ethical obligation considered	Incorporated eco-friendly materials and energy-efficient designs. i.e., Fly Ash Concrete, Recycled Steel.
CO5 (K7)	Professional and ethical responsibility	Punctuality based on presentations in the specified weeks	Maintained punctuality, adhered to deadlines, and

COs	Description	Criteria	Justification
			upheld professionalism.
CO6 (P5, A3)	Lifelong learning	Demonstrate the ability to learn new skills (based on the statement in accordance with the lifelong learning in Final report)	Demonstrated the ability to learn new skills, i.e. , advanced skills in ETABS, Building Information Modeling (BIM) , and project management like Microsoft Project .
CO7 (A1)	Effective project management – time, financial	Prepared Tender Document	Due to time limitations, incomplete.
		Prepared BOQ	ensuring accurate financial and material planning for the project.
		Show Financial Assessment	Due to time limitations, incomplete
		Show time management skill	Used a Gantt chart to manage project timelines and ensure timely completion.

* K: Knowledge Profile, P: Complex Engineering Problem Solving and A: Complex Engineering Active.

COs	Description	Criteria	Justification
CO8 (K7)	Communication	Drawing	Created precise technical drawings in A3 paper for clear demonstration of detailing.
		Presentation	Presented the visibility of the project by showcasing its innovative design and functionality.
		Report	<ul style="list-style-type: none"> i. Design of Slab and detailing. ii. Design of Beam and detailing. iii. Design of Column and detailing. iv. Design of Footing and detailing. v. Design of Stairs and vi. detailing, vii. Design of Septic tank

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