جامعة بوليتكنك فلسطين
Palestine Polytechnic University

College of Engineering and Technology

Civil Engineering Department

Graduation Project

"Structural design of Khalet Mana' Basic School for Girls"

Project Team:

Bayan Sameer Azbak Alafghani **Haider Hussein Abusheikha**

Supervisor:

Dr.Belal Almassri

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This project we submitted to the College of Engineering in partial fulfillment of the requirements for the degree of bachelor's degree in civil engineering Branch of Building Engineering.

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Signature of Project Supervisor	**Signature of Department Chairman**
Name……………………………	**Name ……………………………..**

الاهداء

إلهي لا يطيب الليل إلا بشكرك و لا يطيب النهار إلا بطاعتك ... ولا تطيب الجنة إلا برؤيتك جل جلالك..

إلى من بلغ الرسالة و أدى الأمانة ونصح الأمة إلى نبي الرحمة و نور العالمين

"سيدنا محمد صلى الله عليه وسلم"

إلى مشاعل العطاء و فيض الحنان و بسمة الحياة ...إلى من تطلب الجنة تحت اقدامهن امهاتنا الغاليات

إلى من أحمل إسمه بكل فخر و من قدم لنا وضحى من أجلنا وسهر على راحتنا وبذل كل جهد لنصل إلى مؤهلات التخرج و ميدان العمل آبائنا الكرام.

إلى من شاركنا افراحنا واتراحنا ونتقاسم معهم حلاوة الحياة ومرها ...إخوتنا وأخواتنا

إلى من هم افضل منا جميعا الذين رووا بدمائهم ثرى فلسطين ... الشهداء

إلى من عشقوا الحرية وخاضوا المعارك من أجلنا ... الأسرى

إلى جميع الأساتذة في جامعة بوليتكنك فلسطين الذين دعمونا في طريق دراستنا و كانوا عونا لنا في مشروع تخرج.

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We also extend our thanks to our dear colleagues who, without their presence, would not have felt the pleasure of research, nor the sweetness of positive competition.

In conclusion, we would like to thank our fathers, mothers, and brothers who had the greatest role in reaching what we have reached, and perhaps we will fulfill their right by achieving their satisfaction.

ABSTRACT

The idea of the project is to prepare the complete structural design of Khalet Mana' Basic Girls School, in the south of Hebron City "Dura". In such a way as to cover all the construction elements of foundations, walls, columns, and slabs, so that the operational plans are prepared to enable the project to be fully implemented.

According to the plans, the proposed study building is a school that has a total area of 2067 m^2. Consisting of four floors divided into a basement floor, ground floor, first floor, second floor, and staircase. The structural design of this building will be by the American code. The project contains the distribution of columns in the building in a manner that does not contradict the architectural design of the project and works to define the construction system of each slab with the design of all construction elements of slabs, beams, columns, walls, foundations, and staircase. While maintaining safety and economic standards.

The results of this work have resulted in a structural design that meets the standards.

ACI 318 Structural Design.

الملخص

تتلخص فكرة المشروع في إعداد التصميم الانشائي الكامل لمدرسة خلة مناع الأساسية للبنات في جنوب مدينة الخليل "دورا" بشكل يهدف و يشمل كافة العناصر الانشائية من أساسات وجدران وأعمدة وعقدات، بحيث يتم إعداد المخططات التنفيذية تمكن من تنفيذ المشروع بشكل كامل.

ويظهر من خلال المخططات أن المبنى المقترح دراسته هو مدرسة بمساحة اجمالية 2067 م2 يتكون من اربع طوابق مقسمة إلى طابق قبو والطابق الأرضي والطابق الأول والطابق الثاني و بيت الدرج، وهذا المبنى سيتم تصميمه إنشائيا وفقا للكود الأمريكي، حيث يحتوي المشروع على توزيع الاعمدة في المبنى بما لا يتناقض مع التصميم المعماري للمشروع و يعمل على تحديد النظام الانشائي لكل عقدة مع تصميم كافة العناصر الانشائية من عقدات وجسور واعمدة وجدران واساسات و ادراج مع الحفاظ على معايير الأمان والاقتصاد .

ومن المتوقع ان تكون نتائج هذا العمل تفي بالمعايير.

بناء على كود التصميم الانشائي ACI 318.

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- Ac = area of concrete section resisting shear transfer.
- As = area of non-prestressed tension reinforcement.
- As`= area of non-prestressed compression reinforcement.
- Ag = gross area of the section.
- Av = area of shear reinforcement within a distance (S).
- At = area of one leg of a closed stirrup resisting tension within a (S).
- b = width of compression face of member.
- bw = web width or diameter of circular section.
- Cc = compression resultant of the concrete section.
- Cs = compression resultant of compression steel.
- DL = dead loads.
- d = distance from extreme compression fiber to centroid of tension reinforcement.
- Ec = modulus of elasticity of concrete.
- fc` = compression strength of concrete.
- fy = specified yield strength of non-prestressed reinforcement.
- h = overall thickness of the member.
- Ln = length of clear span in the long direction of two-way construction measured face-to-face of supports in slabs without beams and face-to-face of a beam or other supports in other cases.
- LL = live loads.
- Lw = length of the wall.
- M = bending moment.
- Mu = factored moment at section.
- Mn = nominal moment.
- Pn = nominal axial load.
- Pu = factored axial load
- S = Spacing of shear in a direction parallel to longitudinal reinforcement.
- Vc = nominal shear strength provided by concrete.
- Vn = nominal shear stress.
- Vs = nominal shear strength provided by shear reinforcement.
- Vu = factored shear force at section.
- Wc = weight of concrete.
- W = width of beam or rib.
- Wu = factored load per unit area.
- Φ = strength reduction factor.
- εc = compression strain of concrete = 0.003.
- εs = strain of tension steel.
- έs = strain of compression steel.
- ρ = ratio of steel area.

Chapter 1 : " INTRODUCTION"

1.1 Introduction.

1.2 Project Objectives.

1.3 Project Problem.

1.4 Work Procedure.

1.5 Project Scope.

1.6 Time Line.

1.7 Programs Used In the Project.

1.1 Introduction

Engineering is the best way to harness natural resources to serve humanity.

The art of applying scientific principles and life experiences to our lives to improve the things we use or the facilities we live in. In general, the body combines the available technical tools, activities, and knowledge. A professional activity uses imagination, wisdom, and intelligence in applying science, technology, mathematics, and practical experience to design, produce, and manage processes that suit the needs of people.

Civil engineering affects many of our daily activities: the buildings we live in and work in, the transportation facilities we use, the water we drink, and the drainage and sewage systems that are necessary for our health and well-being, so civil engineering, in general, the only way to make the world a more suitable and suitable place to live in.

Building engineering is a professional discipline that focuses on providing housing with specific specifications and quality to individuals in a community. It deals with designing, constructing, and maintaining the physical and naturally built environment, including public works such as roads, bridges, canals, dams, airports, sewage systems, pipelines, and building components. [1]

1.2 Project Objectives.

After completing this project, we hope to achieve the following objectives:

- Obtaining experience in solving the problems of each project in particular.
- Boosting the capacity to choose the proper structural system for the project and distribute its structural elements in the plans, considering the architectural style.
- Gaining experience in reaching the best safe and economical design.
- Using structural design programs and comparing them with theoretical solutions.

1.3 Project Problem

The problem with this project is the analysis and structural design of all the construction components of the building. In this field, we analyzed each construction element such as slabs, ribs, columns, beams... etc.

By identifying, the loads located on it and thus determining its dimensions and the design of the reinforcement required for it, taking into account the safety factor of the origin, the executive plans of the structural elements that we designed were prepared to bring this project out of the proposal into force. [2]

1.4 Work Procedure

To achieve the objectives of the project, the following steps we taken:

- The architectural study involved the site, building plans, and floor heights.
- The structural planning of the building, in which we selected the type of slab and determined the location of columns, beams, and shear walls, took into account the architectural design.
- We continued a structural study that identified all the structural members and showed the different loads; we appreciate it.
- Analysis and design of the elements according to the ACI code using software and theoretical solutions.
- Preparing construction drawings for all the elements in the building.
- Writing a project where all these stages we presented in detail.

1.5 Project Scope

This Project contains the following chapters:

CHAPTER 1: Introduction.

CHAPTER 2: Architectural description of the project.

CHAPTER 3: General description of the structural elements.

CHAPTER 4: Structural analysis and design of all structural elements.

CHAPTER 5: Results and Recommendations.

CHAPTER 6: References

1.6 Time Line

Table 1-1: Timeline

Introduction to Graduation Project																
Active in Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Project selection	■	■	■	■												
Study for architectural plans.					■	■										
Study of building structurally							■	■								
Column distribution									■							
Distribution of the project's construction system										■						
Structural analysis and design											■	■				
Completing the preparation of construction plans													■	■		
Complete project writing															■	
Project presentation																■
Introduction to Graduation Project																
Active in Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Completing to Structural analysis and design	■	■	■	■												
Completing the preparation of construction plans					■	■	■									
Complete project writing								■	■	■						
Project presentation										■						

1.7 Programs Used In the Project.

- Using analysis and structural design programs such as (Atir18, CSI Safe, and CSI Etabs).
- Other programs such as Microsoft Office Word, PowerPoint, and Excel.
- AutoCAD and Revit.

Chapter 2 : " ARCHITECTURAL DESCRIPTION OF THE PROJECT"

2.1 Introduction.

2.2 General Description of the Project.

2.3 General Site Description.

2.4 Floors Description.

2.5 Elevations Description.

2.6 Sections.

2.1 Introduction

The architectural description of any building that needed a diamond for its success.

The design of any facility or building is done through several stages until it is fully completed, starting with the architectural design phase. Initial installation of facilities, realization of the required spaces and dimensions, the lighting process, ventilation, movement, mobility, and other functional requirements are also studied.

Architectural designs should be easy to use and understand for different events and other important matters. That gives a clear view of the project, and therefore, it will be possible to locate the columns and other structural elements in the structural design process; the goal is to determine the dimensions and characteristics of the structural elements depending on the different loads on which they are placed. They are transmitted through these elements to the foundations and then to the soil. [3]

2.2 General description of the project

The proposed project is the study and structural design of Khalet Mana' Basic Girls School. The safe structural design of the school consists of four floors: the basement floor has a total area = 480.79 m^2, the ground floor has a total area = 486.51 m^2, the first floor has a total area = 532.61 m^2, the second floor has a total area = 532.61 m^2 and a total project area = 2058.46 m^2.

The school consists of 12 classrooms, a management section, a multi-purpose auditorium, scientific laboratories, cultivated green areas, squares, and facilities. It serves students from grades 1-4 and girls from grades 5-9, accommodating approximately 480 students.

2.3 General Site Description

The project is in:

- Governorate: Hebron
- City: Dura
- Location: Khalet Mana'
- Basin: 5
- Neighborhood: 38/30
- Area: 3034 m^2

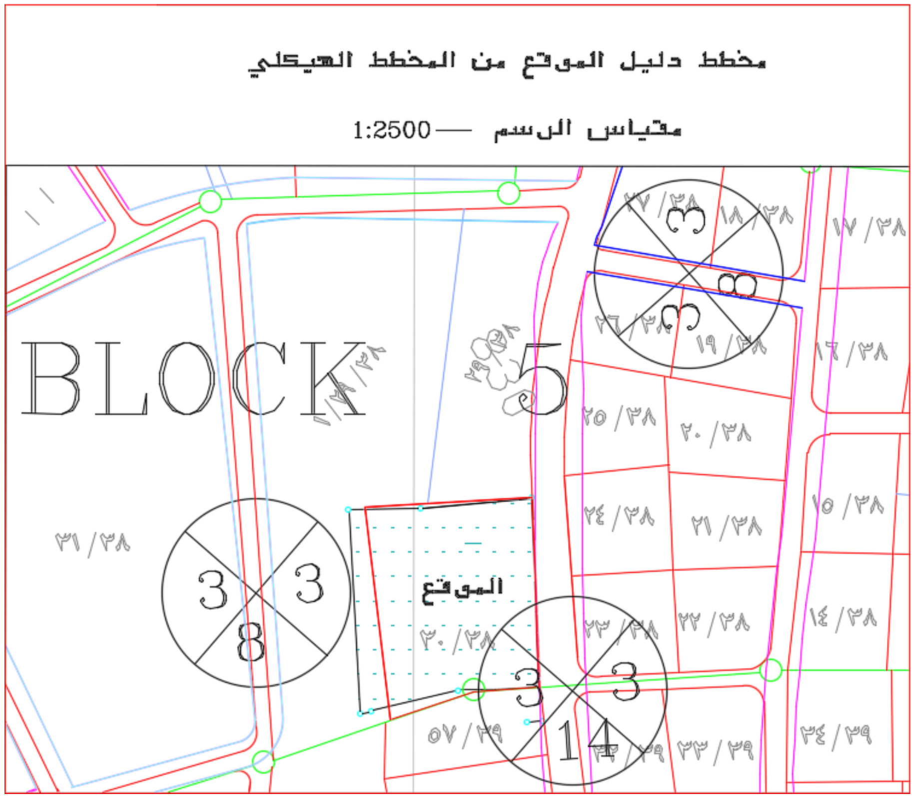


Figure 2-1:The project local site

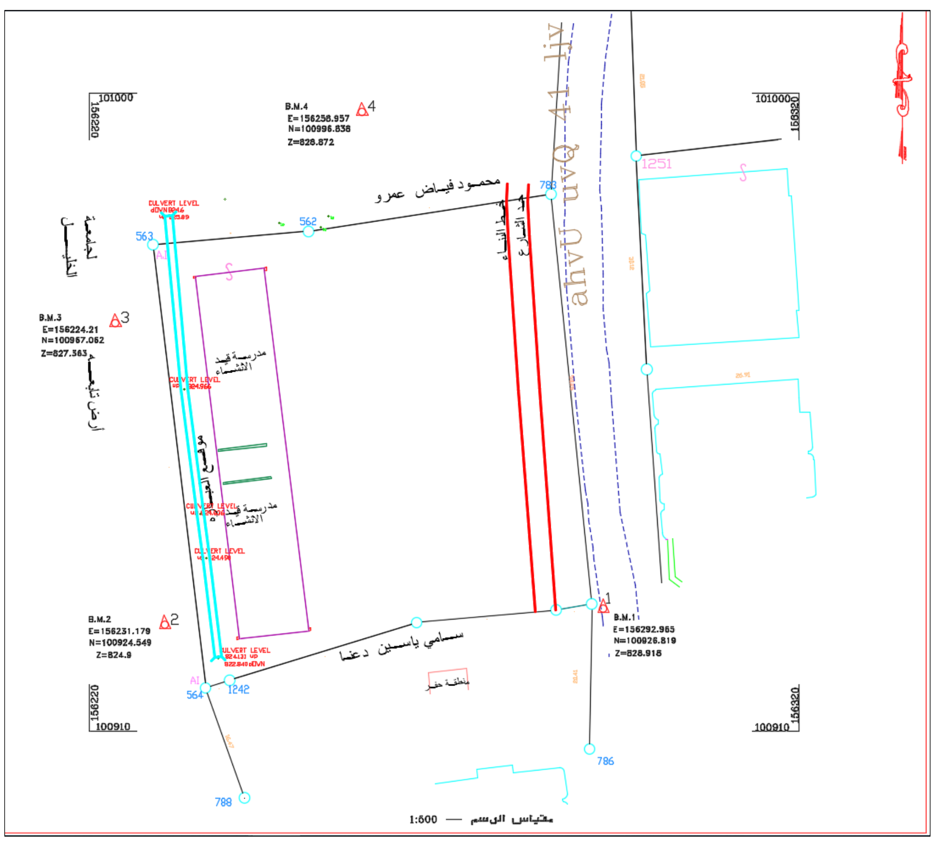


Figure 2-2:The project area plan

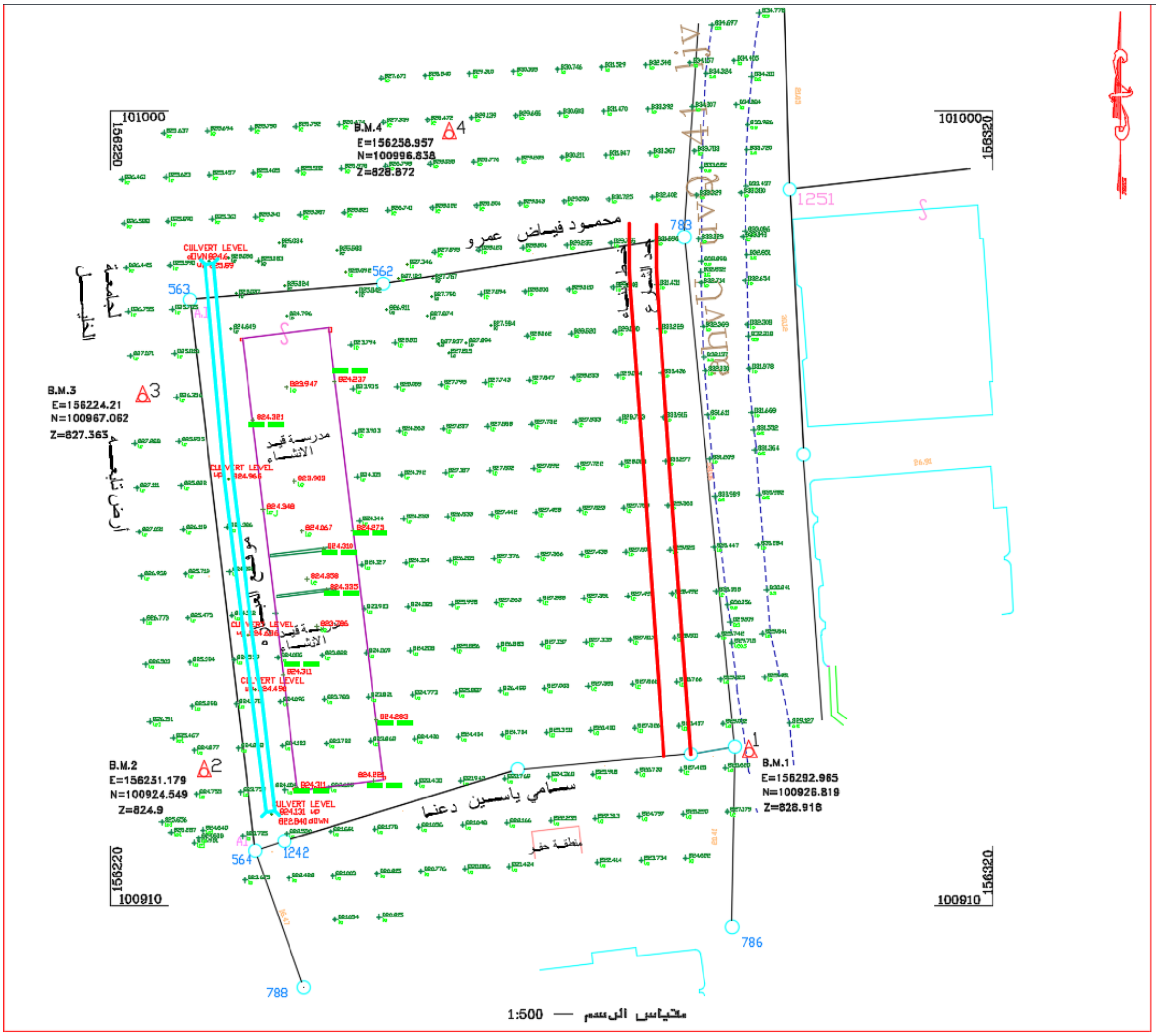


Figure 2-3:The project shape and area

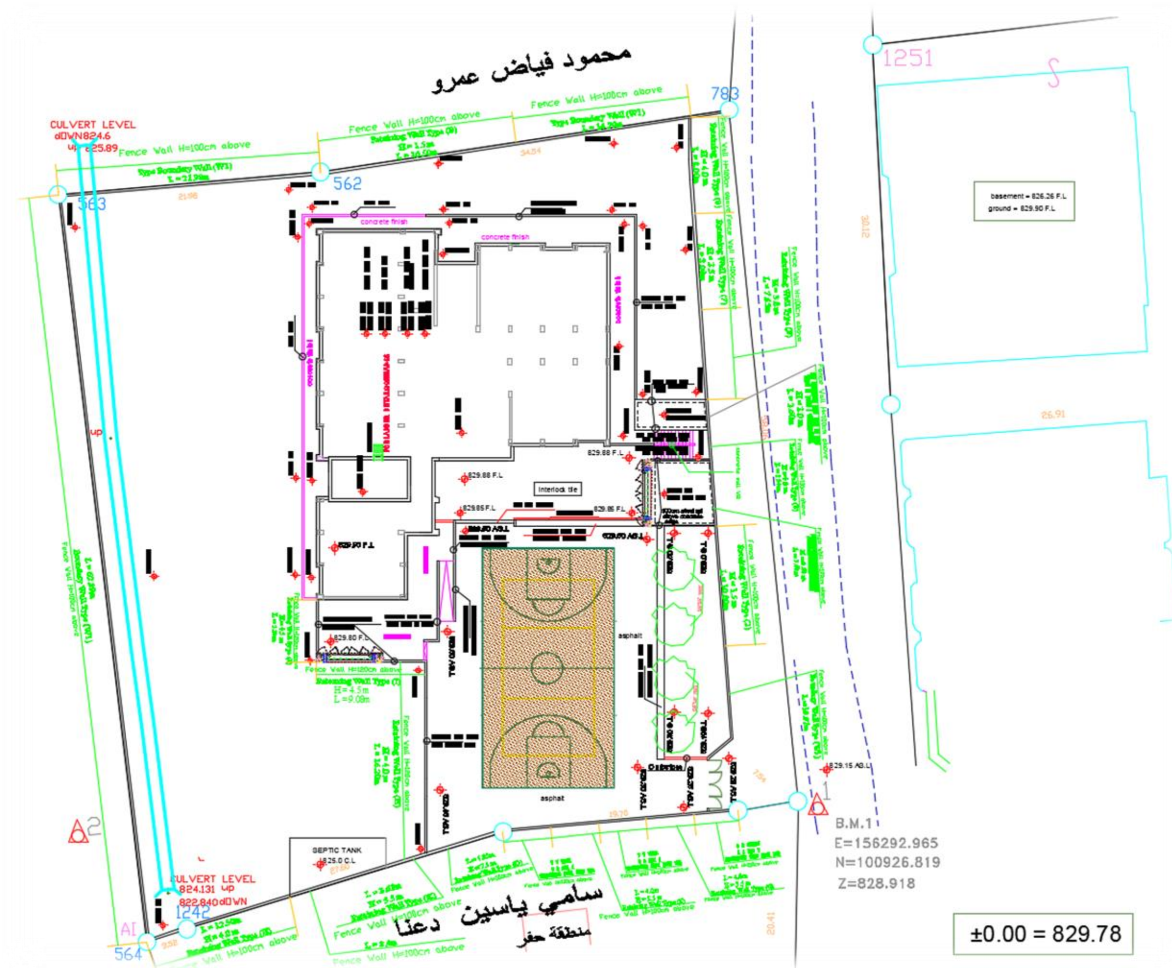


Figure 2-4:The project site plan

2.4 Floors Description

2.4.1 Basement Floor:

(Level: S.F.L– 3.38 m) with an area of 480.79 m^2 .

The basement floor consists of three classrooms, a teachers' room, a services unit, a source room, a social property room, and two staircases.

Figure 2-5:Basement floor plan

2.4.2 Ground Floor:

(Level: S.F.L ± 0.00 m) with an area of 486.51 m^2.

The ground floor is the main floor, consisting of the management department, art hall, and classroom and service unit, including teachers, students, disabled, lobby, and canteen.

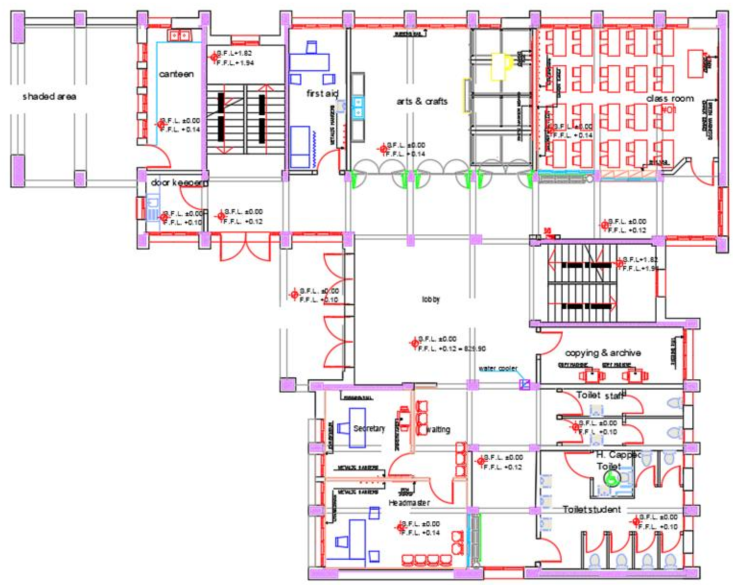


Figure 2-6:Ground floor plan

2.4.3 First Floor:

(Level: S.F.L+3.64 m) with an area of $532.61\, m^2$.

The first floor consists of four classrooms, a technology lab, a store and two staircase.

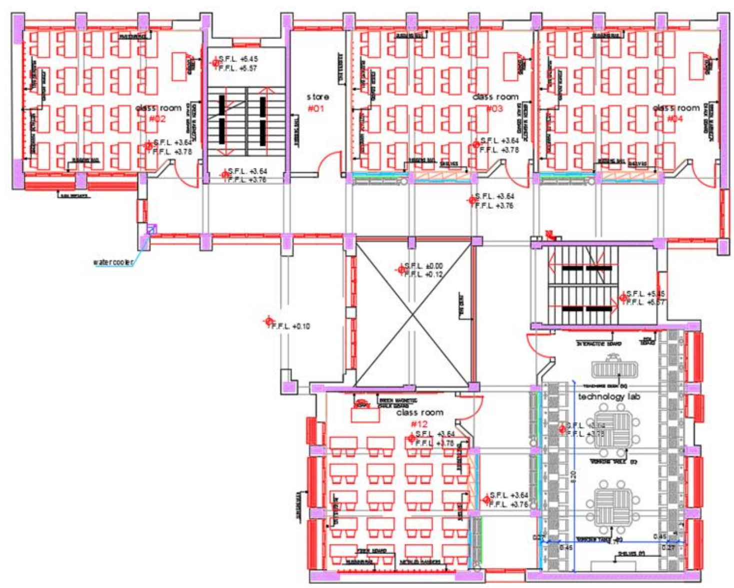


Figure 2-7:First floor plan

2.4.4 Second Floor:

(Level: S.F.L+7.28 m) with an area of 532.61 m^2 .

The second floor consists of four classrooms, a library, a science lab, a store, and two staircases.

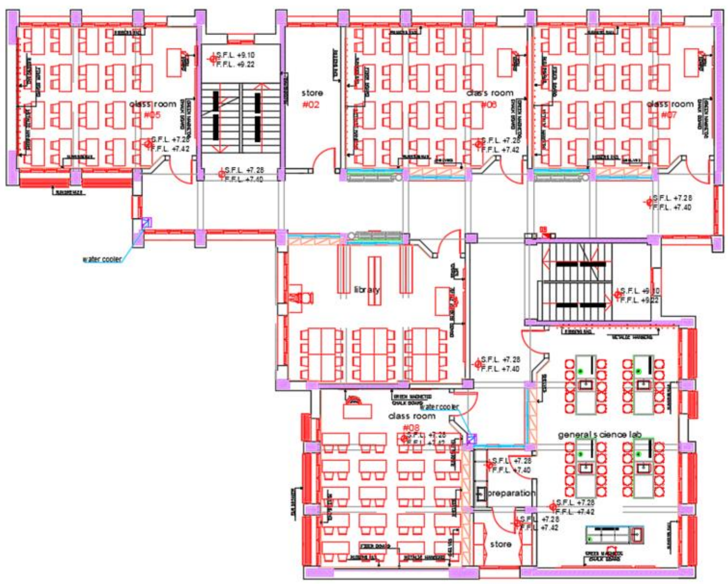


Figure 2-8:Second floor plan

2.5 Elevations Description

The following is a description of the different elements and components of the project elevations:

2.5.1 Northern Elevation:

The northern elevation is simple to form on one level and shows one type of stone with varied windows.

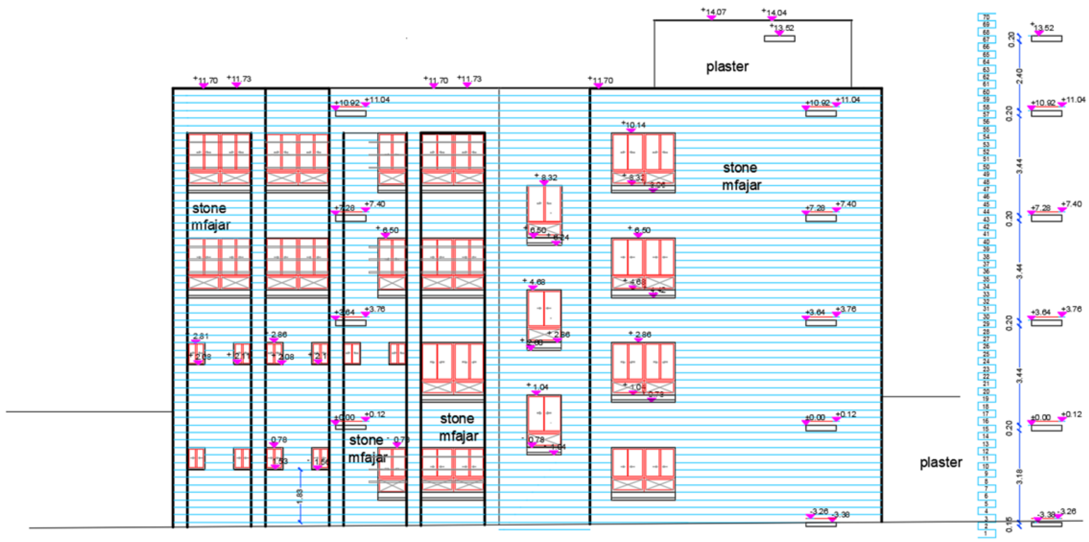


Figure 2-9:Northern Elevation

2.5.2 Southern Elevation:

This is elevation considered the main elevation of the school, and this elevation includes two entrances, with several types of stone, different shapes of windows, and different levels.

Figure 2-10:Southern Elevation

2.5.3 Eastern Elevation:

In the elevation, and there is no change in slope, and only one types of stone and there are several windows.

Figure 2-11:Eastern Elevation

2.5.4 Western Elevation:

This elevation includes three entrances, with several types of stone, different shapes for windows, and different levels.

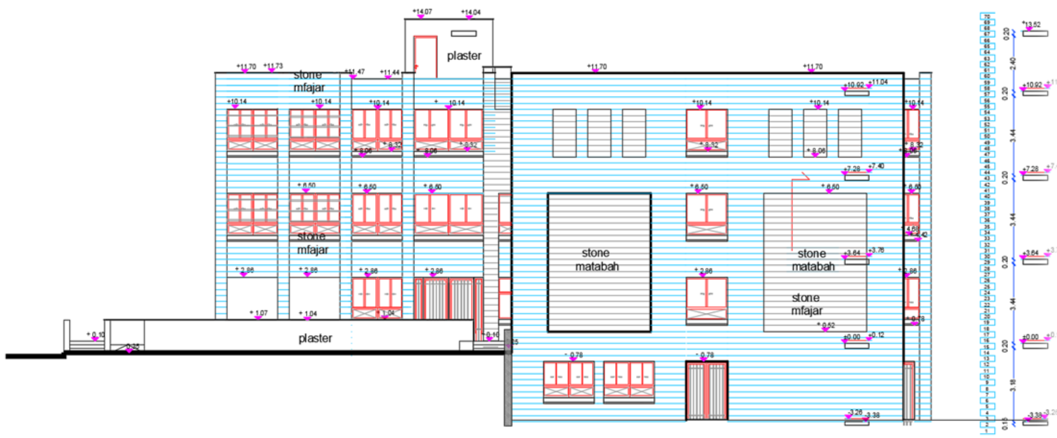


Figure 2-12: Western Elevation

2.6 Sections

2.6.1 Section A-A

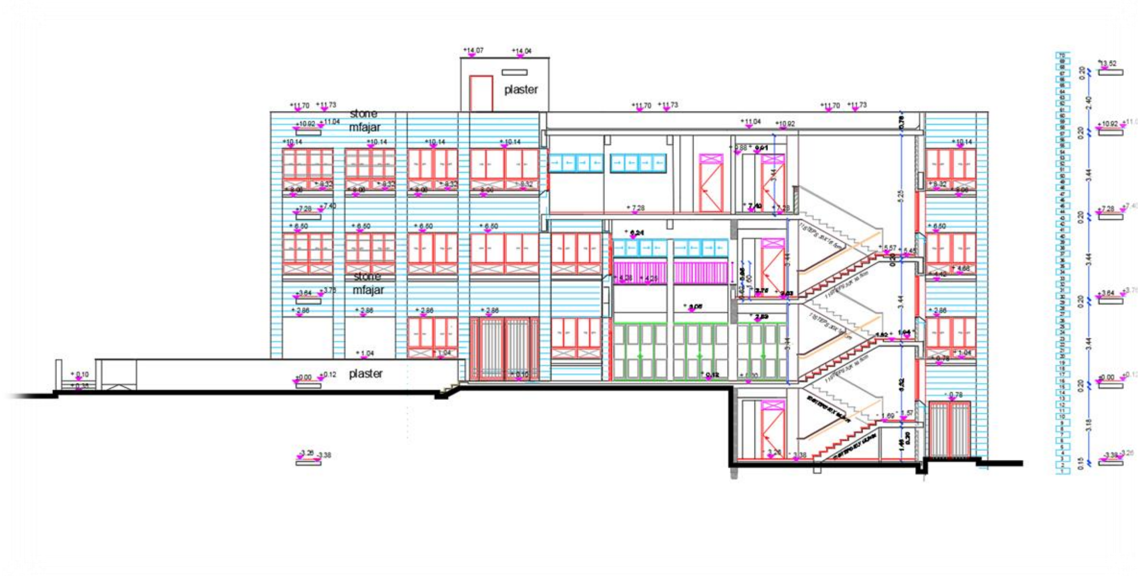


Figure 2-13:Section A-A

2.6.2 Section B-B

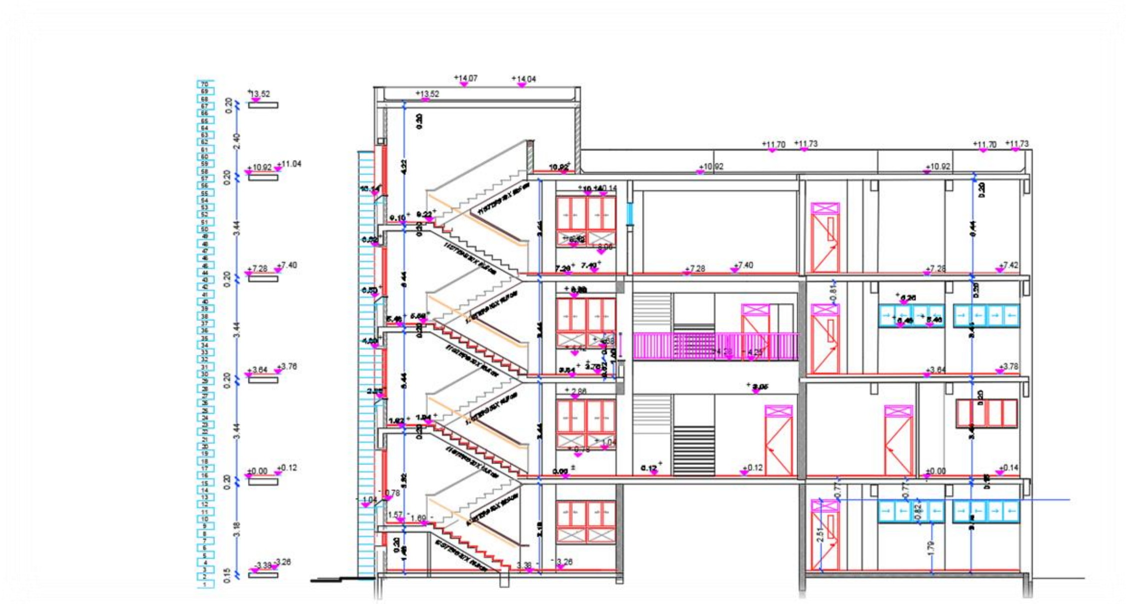


Figure 2-14:Section B-B

Chapter 3 : "GENERAL DESCRIPTION OF THE STRUCTURAL ELEMENTS"

3.1 Introduction.

3.2 The Aim of the Structural Design.

3.3 Stages of Structural Design.

3.4 Loads Acting on the Building.

3.5 Scientific Tests.

3.6 Structural Elements of the Building.

3.1 Introduction

After studying the project in architectural terms, necessary to move to the construction side to study the construction elements and describe them carefully. The nature of the loads on the building and how to deal with, then we studied to come out with a structural design that meets all safety requirements and takes into account the economic aspect of the project.

The purpose of the facility design process is to ensure that the necessary operating advantages exist, with the construction elements containing more economically appropriate dimensions, in addition to providing an important factor of safety.

Therefore, necessary to identify the structural system included in the project in order to choose the most appropriate elements to make comparisons between the different types of elements to achieve the requirements in addition to not conflicting with the architectural plans. This requires a comprehensive description of the construction components of the project, which we will dealt with and subsequently designed in the terms of this project in order to reach a complete construction design.

In this chapter, the construction components of the project will describe. [4]

3.2 The Aim of the Structural Design

The following aims must take into consideration:

- Ensure structural safety, which implies providing adequate stiffness and reinforcements to prevent deflections and cracks.
- Durability: Achieve the shelf life of the structural
- Produce a structure that can resist all applied loads without failure during its service life.
- Obtain the economic dimensions of structural members. As any engineer can always design a massive structure that has more than adequate stability, strength, and serviceability, but the resulting cost of the structure may be exorbitant.
- Stability to stop overturning, slipping, or buckling of the frame, or sections thereof, under load motion.
- Investigate the strength and rigidity of structures.

(Safety, Economic, Strong)

3.3 Stages of Structural Design

Structural design stages can divide into two main stages:

3.3.1 The First Stage:

It is the preliminary study of the project in terms of the nature and size of the project, in addition to understanding the project from all its various aspects, determining the building materials that will approve for the project, then making the basic structural analyzes of this system, and the expected preliminary dimensions of it.

3.3.2 The Second Stage:

It represented in the structural design of each part of the structure, in a detailed and accurate manner, according to the structural system that chosen and the necessary structural details for it in terms of drawing horizontal projections, vertical sectors, and details of the reinforcing steel. [5]

3.4 Loads Acting on the Building

The building subjected to different types of loads, which are as follows:

3.4.1 Dead Loads:

The dead loads are the weights of the main components of the structure, such as tiles, cement mortar, and reinforced concrete, as well as additional parts like internal partitions and permanent mechanical works or additions. These loads are permanent and fixed, and can calculate by determining the dimensions of the structural element and the densities of its constituent materials. Table 1-3 provides specific densities of the materials used in the project.

Table 3-1: Specific Density

Item No	**Material**	Specific Weight (KN/m^3)
1	Tile	23
2	Mortar	22
3	Sand	17
4	Hollow Block	10
5	Reinforced Concrete	25
6	Plaster	22
7	Backfill	18

In addition to the dead load resulting from the breakers (Partition load) = 2.5 KN/m^2

3.4.2 Live loads:

The continually changing loads in quantity and location include people, furniture, appliances, equipment, and operational loads such as lumber and equipment. The value of these loads depends on the nature of the facility's use.

The live loads in the project were determined according to Jordanian code: $5KN/m^2$. [6]

3.4.3 Environmental loads:

The loads that affect a structure include those resulting from natural changes such as snow, wind, heavy loads, earthquakes, and soil pressure. These loads vary in magnitude and direction from one region to another.

3.4.3.1Wind loads:

The wind exerts different pressures on the facades of a building depending on factors such as its height, shape, wind speed, and location relative to other buildings. Wind loads calculated based on the maximum wind speed, which varies with height above the ground. The force of the wind determined by its maximum speed, considering the area's topography and the building's position in relation to neighboring structures.

To obtain wind force values, ACI code will employ.

3.4.3.2 Earthquake loads:

Earthquakes occur due to horizontal and vertical vibrations caused by the movement of the earth's rock layers. This movement creates shear forces that can affect buildings. When designing structures, it is important to consider these forces to ensure the building can withstand earthquakes and minimize potential damage. This project will incorporate shear walls distributed throughout the building, based on structural calculations, to mitigate the effects of earthquakes. [7]

3.4.3.3 Snow Loads:

The load caused by snow on different surfaces depends on the elevation above sea level and the angle of the snow-covered surfaces. Snow loads can be calculated using the Jordanian code.

3.5 Scientific Tests.

The construction study of any building begins with geotechnical studies of the site. This involves exploring the site, studying the soil, rocks, and groundwater, analyzing the information, and predicting how the soil will behave when a building is construct on it. The structural engineer is primarily concerned with determining the soil-bearing strength needed to design the building's foundations. This information is crucial for approving the type of foundation to use for the building.

The bearing capacity of the soil in the project implementation area has according to the soil test; the allowable bearing capacity is 2.3 kg/cm2 for strip footing & 2.9 kg/cm2 for single footing.

3.6 Structural Elements of the Building

Buildings typically consist of various structural elements that intersect to withstand the loads placed upon them. These elements include slabs, beams, columns, stairs, and foundations. The diagram illustrates some of the structural elements found in a building. [8]

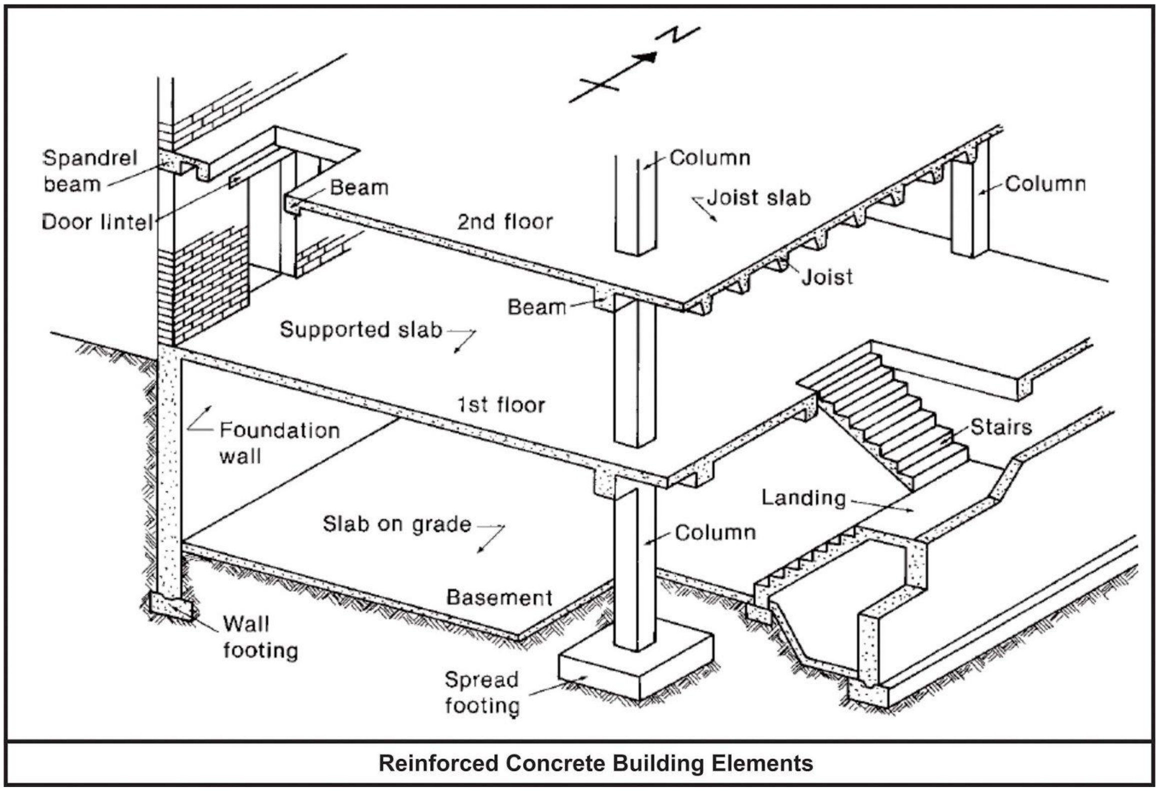


Figure 3-1:Structural element

3.6.1 Slabs:

These are structural elements designed to transfer vertical forces from the loads they bear to the load-bearing structural elements in the building, such as beams, columns, walls, staircase, and foundations, without causing deformations. The following types of slabs:

3.6.1.1 Ribbed Slabs:

These are divided into:

- One-way ribbed slab.
- Two-way ribbed slabs.

Only one-way has used in the project is building design.

3.6.1.1.1 One-way ribbed slabs:

One of the most commonly used methods for designing slabs in these countries is a technique that involves a row of bricks followed by ribs, with reinforcement in one direction. This method is known for its lightweight and effectiveness, and it is widely used in Palestine and our project, as shown in the figure.

Figure 3-2:One-way ribbed slab

3.6.1.1.2 Two-way ribbed slabs:

The structure is similar to the previous one in terms of components, but it differs in that the reinforcement is in two directions, the load is distributed in all directions, and the weight of two blocks and a beam are taken into account when calculating their load in both directions, as shown in the figure.

Figure 3-3:Two-way ribbed slab

3.6.1.2 Solid slabs:

These are divided into:

- One-way solid slab.
- Two-way solid slab.

The only one-way used in the project is building design.

3.6.1.2.1 One-way solid slabs:

Due to their low thickness, they are used in areas that are frequently subjected to dynamic loads to avoid vibration. They are usually used in stair slabs, as shown in the figure.

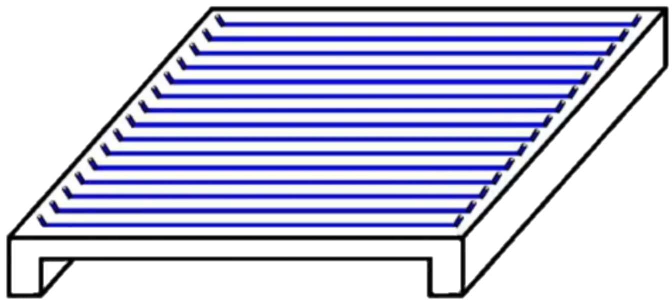


Figure 3-4:One-way soild slab

3.6.1.2.2 Two-way solid slabs:

If the effective loads and the distances between the beams are significant, it is advisable to consider using this type of slab design. This design can better withstand heavier loads, as the main reinforcement is distributed in two directions. as shown in the figure.

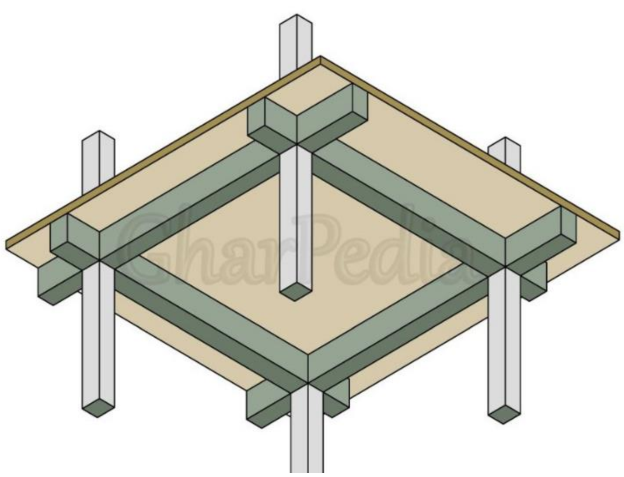


Figure 3-5:Two-way solid slab

3.6.2 Beams:

Beams are essential to a building's structure as they transfer loads to the columns. There are two main types of beams:

1. Hidden beams: These have the same height as the slab.

2. Dropped beams: They have a greater height than the slab, and the additional part of the beam extends either upwards or downwards.

The reinforcement for these beams consists of horizontal steel bars to withstand bending moments and stirrups to resist shear forces. as shown in the figure.

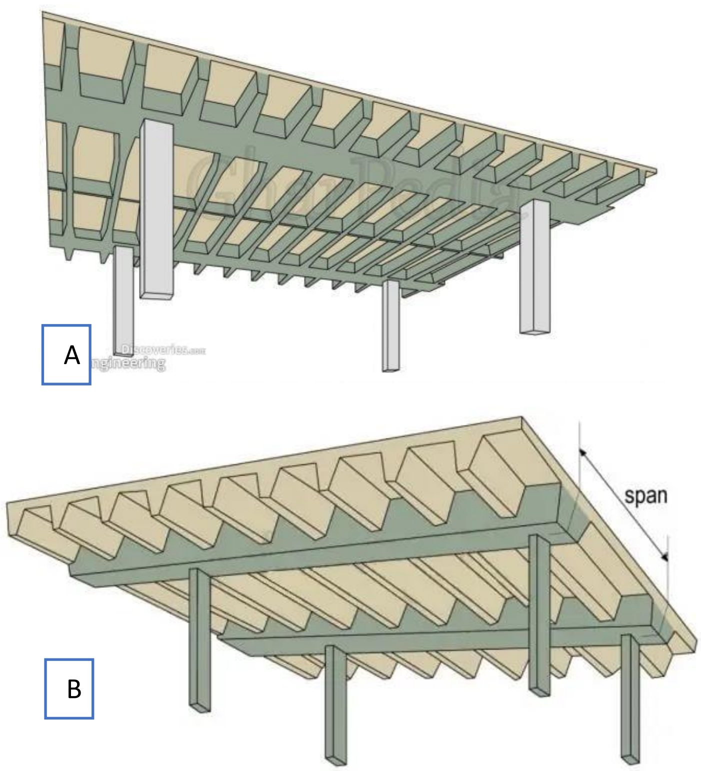


Figure 3-6:A.hidden beam B.dropped beam

The only hidden beams and dropped beams used in the project are building design.

3.6.3 Columns:

Columns are basic and major structural elements in a building. They transfer loads from the slab to the beams and then to the columns and foundations. They must be carefully designed to distribute these loads.

In structural design, columns are categorized as short or long.

There are three types of columns: rectangular and circular. as shown in the figure.

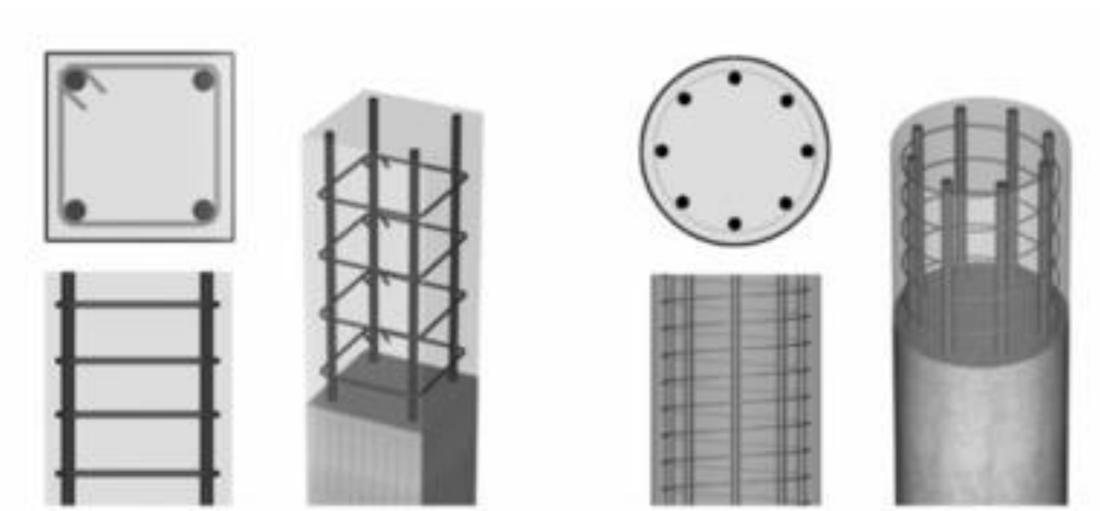


Figure 3-7:Types of Columns

The only rectangular columns used in the project are building designs.

3.6.4 Foundations:

The foundations are the first thing to be implemented when building. Still, they are designed after all the basic elements in the building, as the foundation transfers loads from columns and shear walls to the soil in the form of strength. As shown in the figure.

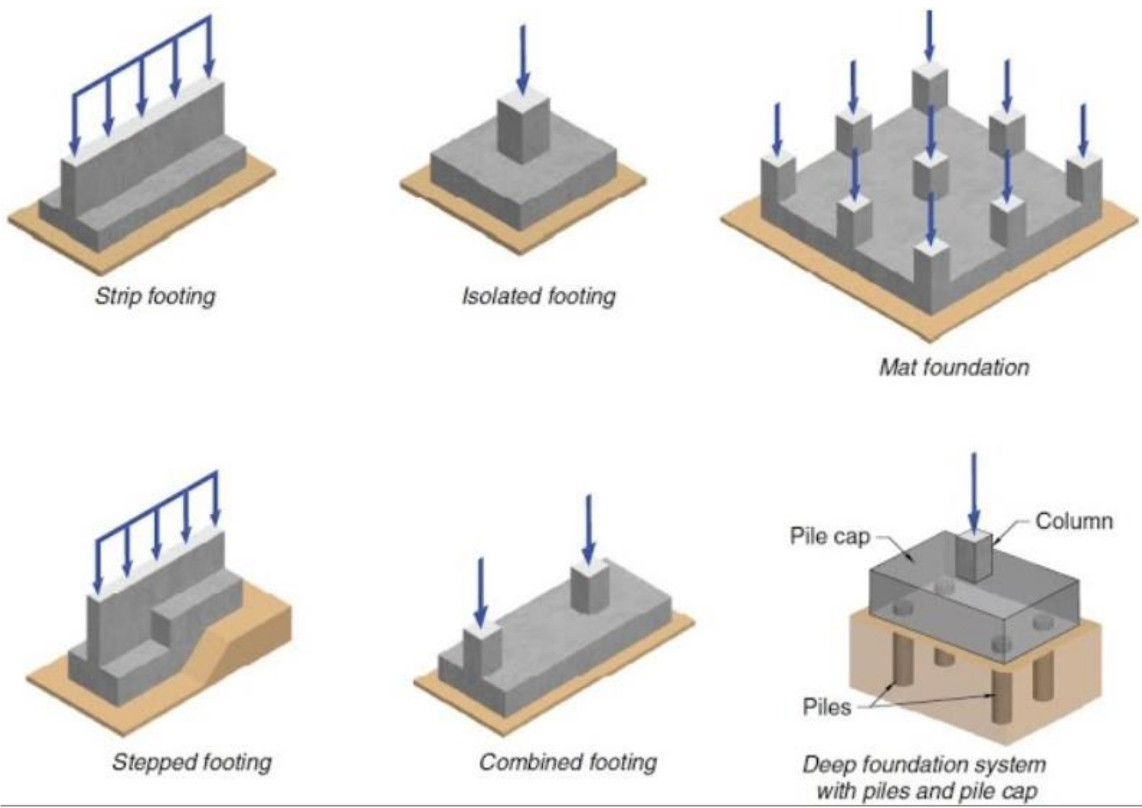


Figure 3-8:Foundations

3.6.5 Shear Walls:

Shear walls resist horizontal forces such as wind and earthquakes, and they are found in the walls of the stairwell and the basement floor walls.

In our project, we used a continuous shear wall in the staircase. As shown in the figure.

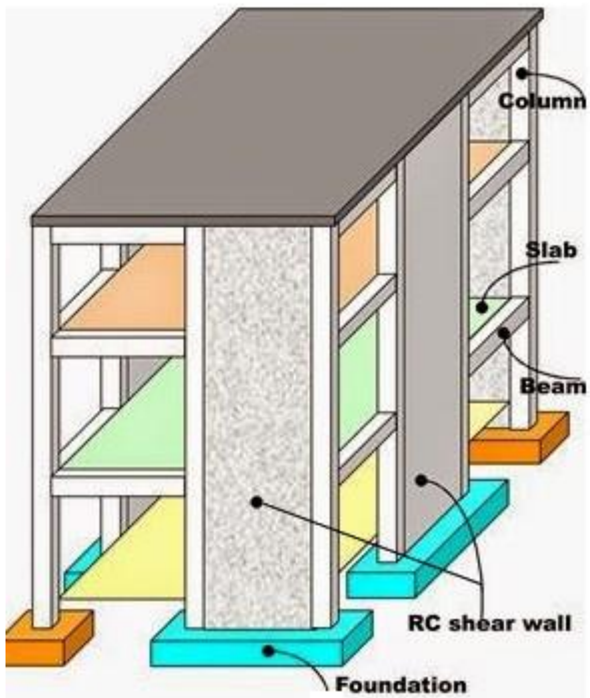


Figure 3-9:shear wall

3.6.6 Stairs:

Stairs are structures designed to connect lower and higher levels by dividing a considerable vertical distance into smaller steps.

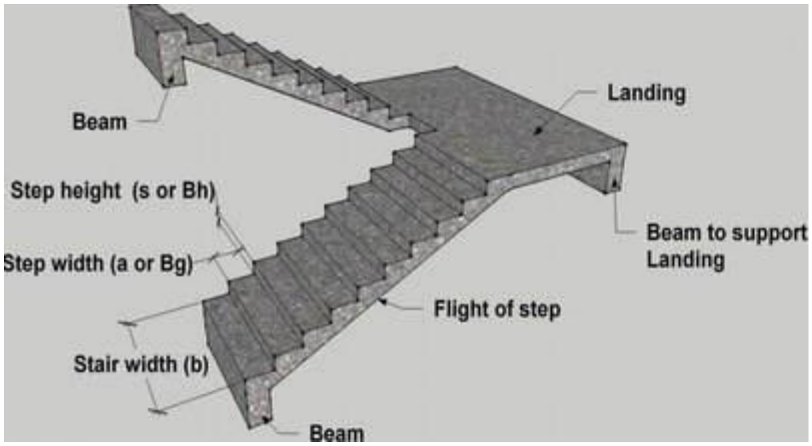


Figure 3-10:Stair

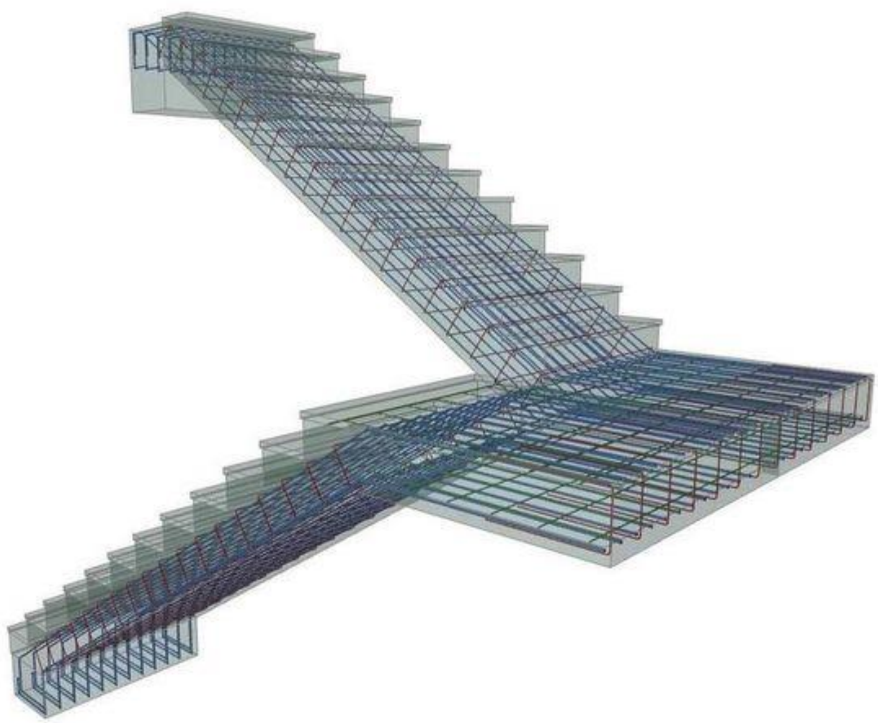


Figure 3-11: Stair reinforcement

Chapter 4 : "STRUCTURAL ANALYSIS AND DESIGN"

4.1 Introduction.

4.2 Design method and requirements.

4.3 Check of Minimum Thickness of Structural Member.

4.4 Design of Topping.

4.5 Design of One-Way Rib Slab (R1).

4.6 Design of Beam (B.1).

4.7 Design of Stair.

4.8 Design of Column C2.

4.9 Design of Basement wall.

4.10 Seismic Design.

4.1 Introduction

Regular plain concrete can handle compressive stress but is ineffective against tensile stresses, such as those caused by wind or earthquakes. In contrast, reinforced concrete includes steel within the concrete to complement each other, allowing it to resist forces like tensile, shear, and compressive stress in the concrete structure.

In this project, various slabs, such as "one-way ribbed slabs", will be analyzed and designed using the finite element design method. This will be accomplished with a computer program called "Atir Beam D-Software, CSI Safe, and CSI Etabs" to determine the internal forces, deflections, and moments for ribbed slabs, beams, columns, and foundations. Subsequently, calculations will be performed to determine the required steel for all members.

4.2 Design method and requirements

A member's design strength, connections to other members, and cross sections in terms of flexure, load, shear, and torsion are taken as the nominal strength calculated by the requirements and assumptions of the ACI-318-14 code.

4.2.1 Strength design method:

In the ultimate strength design method, the service loads have increased by factors to obtain the load at which failure occurs.

This load is called a factored load or factored service load. The structure or structural element is then proportioned such that the strength is reached when the factored load is acting. The computation of this strength considers the nonlinear stress-strain behavior of concrete.

The strength design method is expressed by the following:

Strength provided ≥ Strength required to carry factored loads.

- ## Material:

Reinforced Concrete: B300, fc′ = 24 N/mm^2 (Mpa).

Reinforcement Rebar: Fy = 420 N/mm^2 (Mpa).

4.2.2 Strength reduction factors (Ø):

According to ACI a reduction factor for structural elements must be included in the calculation of concrete sections, these factors are less than 1.0 for safety purposes, 0.9 for tension-controlled sections, 0.75 (Spiral) or 0.65 (Stirrups) for compression-controlled sections, 0.75 in shear calculation and 0.6 for plain concrete sections. The strength factor (Ø) changes with a net tensile strain of the cross-section as illustrated in the following figure:

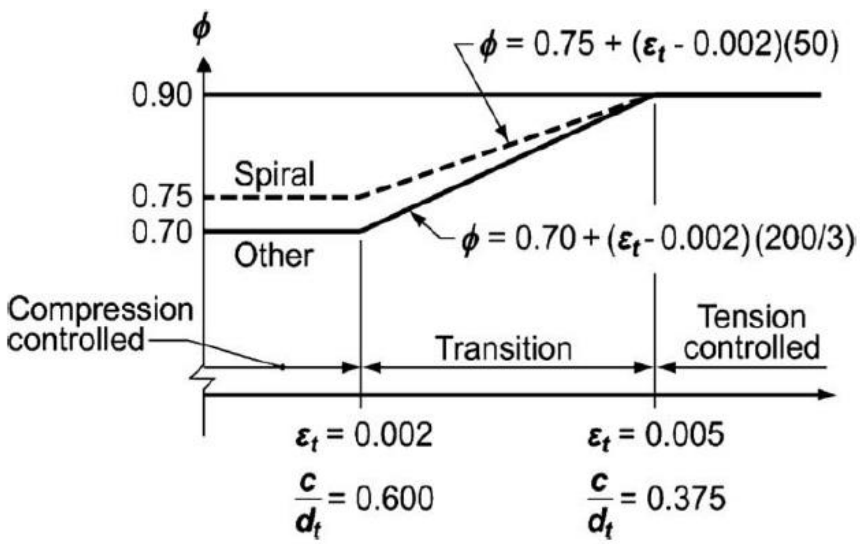


Figure 4-1:Variation of Ø factor with net tensile strain

4.2.3 Factored loads:

The factored loads used in the structural analysis and design according to ACI-318-14(9.2) eq.

It is determined as follows:

$$U = 1.2D_L + 1.6L_L \quad (1.1)$$

Where:

U : Ultimate Load (KN)

D_L : Dead Load (KN)

L_L : Live Load (KN)

4.3 Check of Minimum Thickness of Structural Member

Minimum thickness of non-prestressed beams or one-way ribbed slabs unless deflections are calculated. (ACI 318M-14).

Table 4-1:Determination of minimum thickness of structural member

	Minimum Thickness, h			
Member	Simply Supported	One-end continuous	Two-ends continuous	Cantilever
Ribbed slabs &Beams One Way	Span(L)/16	Span(L)/18.5	Span(L)/21	Span(L)/8
Solid slabs One Way	Span(L)/20	Span(L)/24	Span(L)/28	Span(L)/10

For both end continuous L= 2.7m and L=3.5 m then:

$$h_{\min} = \frac{L}{21} = \frac{270}{21} = 12.86cm$$

$$h_{\min} = \frac{L}{18.5} = \frac{270}{18.5} = 14.6cm$$

$$h_{\min} = \frac{L}{21} = \frac{350}{21} = 16.67cm$$

In addition, this value is considered an initial value and is not relied on definitively.

Select h = 20cm.

14 cm block + 6 cm topping = 20cm

4.4 Design of Topping

Topping in One- way ribbed slab can be considered as a strip of 1-meter width and span of hollow block length with both ends fixed in the ribs.

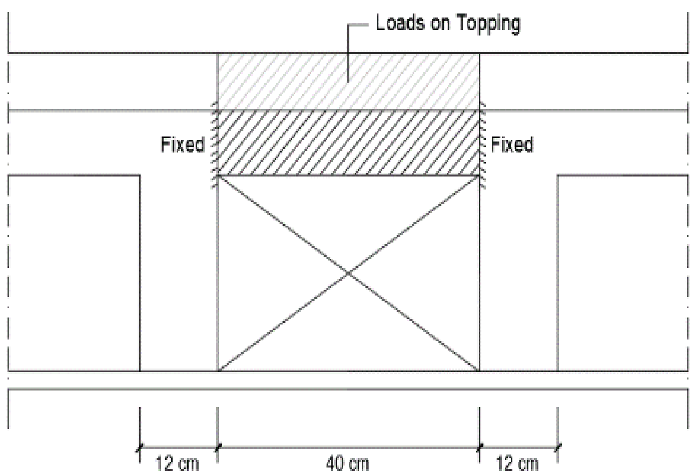


Figure 4-2:System of Topping

4.4.1 Calculation of Loads on Topping:

Dead loads that act on Topping can be calculated as shown in the following table:

Dead Load For 1m strip:

Table 4-2-:Dead Load Calculation for Topping

No.	Material	Quality Density KN/m^3	DL (KN/m)
1	Topping	25	0.06×25 ×1= 1.5
2	Coarse Sand	17	0.07×17×1 = 1.19
3	Mortar	22	0.03×22×1 =0.66
4	Tile	23	0.03×23×1 =0.69
5	Interior partition	2.5*1=2.5 KN/m	
∑ =	6.54KN/m		

Pu = 1.2 DL + 1.6 LL

= 1.2 * 6.54 + 1.6 * 5 = 15.848 KN/m^2. (Total Factored Load)

$$M_u = \frac{W_u * l^2}{12} = \frac{15.848 \; * \; 0.4^2}{12} = \; 0.211 \; KN.m/m$$

4.4.2 Moment Design Strength

For the Plain concrete section with “b = 1 m & h = 6 cm”.

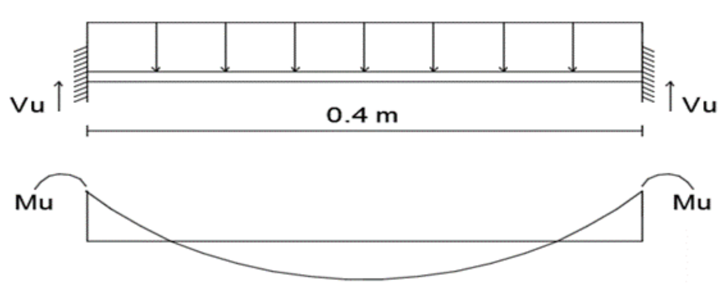


Figure 4-3:Moment Shape for Topping

Consider the Topping as a strip of (1m) width and span of mold length with both ends fixed in the ribs.
Check the strength condition for plain concrete:

$\emptyset Mn \geq Mu$, where $\emptyset = 0.55$

$Mn = 0.42\ \lambda \sqrt{fc'}Sm$.... (ACI 22.5.1, equation 22-2)

$$\emptyset M_n = 0.55 * 0.42 * \sqrt{fc`} * b * \frac{h^2}{6}$$

$$\emptyset M_n = 0.55 * 0.42 * \sqrt{24} * 1000 * 60^2/6 = 1.2\ KN.m$$

$$\emptyset M_n(plane\ concrete\ ) = 1.2KN.m > M_u\ max = 0.152\ KN.m$$

No structural reinforcement is needed.

Therefore, shrinkage and temperature reinforcement must be provided.

For the shrinkage and temperature reinforcement:

$$\rho_{min} = 0.0018$$

$$A_s = \rho * b * h = 0.0018 * 1000 * 60 = 108\ mm^2.$$

Step (s) is the smallest of:

1. S =3h = 3×60 =180 mm … control

2. S=450 mm.

3. $S = 380\left(\frac{280}{f_s}\right) - 2.5c_c = 380\left(\frac{280}{\frac{2}{3}\times 420}\right) - 2.5\times 20 = 330$ =330mm

Take Ø8 @ 150 mm in both direction, S = 150 mm <*Smax*= 180 mm … OK

4.5 Design of One-Way Rib Slab (R1)

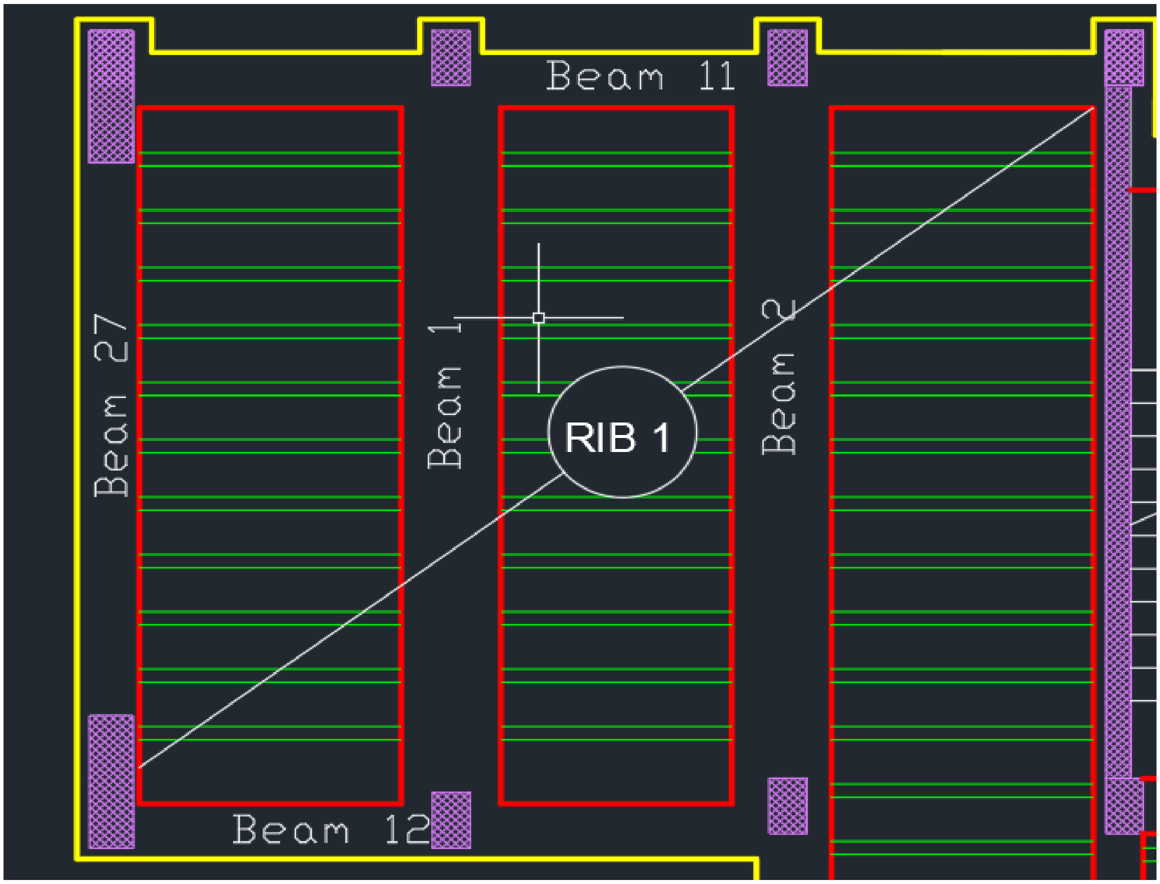


Figure 4-4: Rib 1 from Project

From the Geometry of T-Section:

$b_w = 120mm$

$h = 200mm$

$t = h_f = 60mm$

4.5.1 Loads Calculation for Rib (R1):

Table 4-3-:Dead Load Calculation for Rib1

No	Material	Quality Density KN/m^3	DL (KN/m)
1	Topping	25	0.06×25 ×0.52= 0.78
2	Coarse Sand	17	0.07×17×0.52 = 0.619
3	RC Rib	25	0.14×25×0.12 = 0.42
4	Mortar	22	0.03×22×0.52 =0.3432
5	Hollow block	10	0.14×10×0.4 = 0.56
6	Tile	23	0.03×23×0.52 =0.359
7	Plaster	22	0.03×22×0.52 = 0.3432
8	interior partition	2.5*0.52=1.3	
∑ =	4.73	KN/m/Rib	

Dead Load for 1 Ribbed =4.73 KN/m

Live Load for 1 Ribbed = 5*0.52=2.6 KN/m.

Structural Analysis of Rib 1. The envelope shear and moment diagrams (for all load combinations).
Using the structural analysis and design programs, we obtain the Envelope Moment diagram for Rib1.

4.5.2 Rib Geometry:

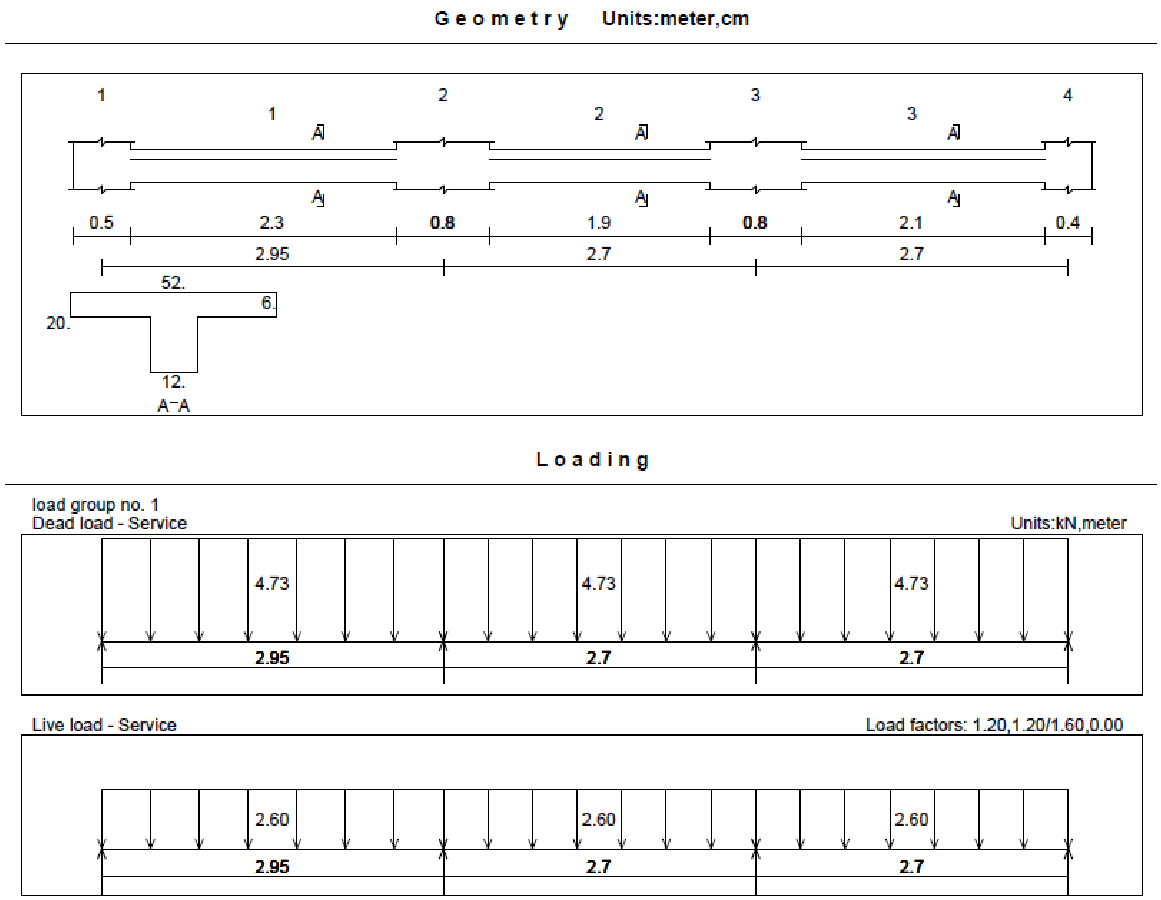


Figure 4-5:Geomery and loading for rib1

Requirements for Ribbed Slab (T-Beam Consideration According to ACI) are as follows:

- bw $\geq$ 10cm $\rightarrow$ select bw = 12 cm.
- h $\leq$ 3.5 bw = 3.5 × 12 = 42 cm $\rightarrow$ select h =20 cm.
- Tf $\geq \frac{Ln}{12} \geq$ 50 mm $\rightarrow$ select Tf = 6 cm.

4.5.3 Analysis:

The figure shows the shear and Moment envelope of the rib (R1) on the Ground Floor obtained from Atir:

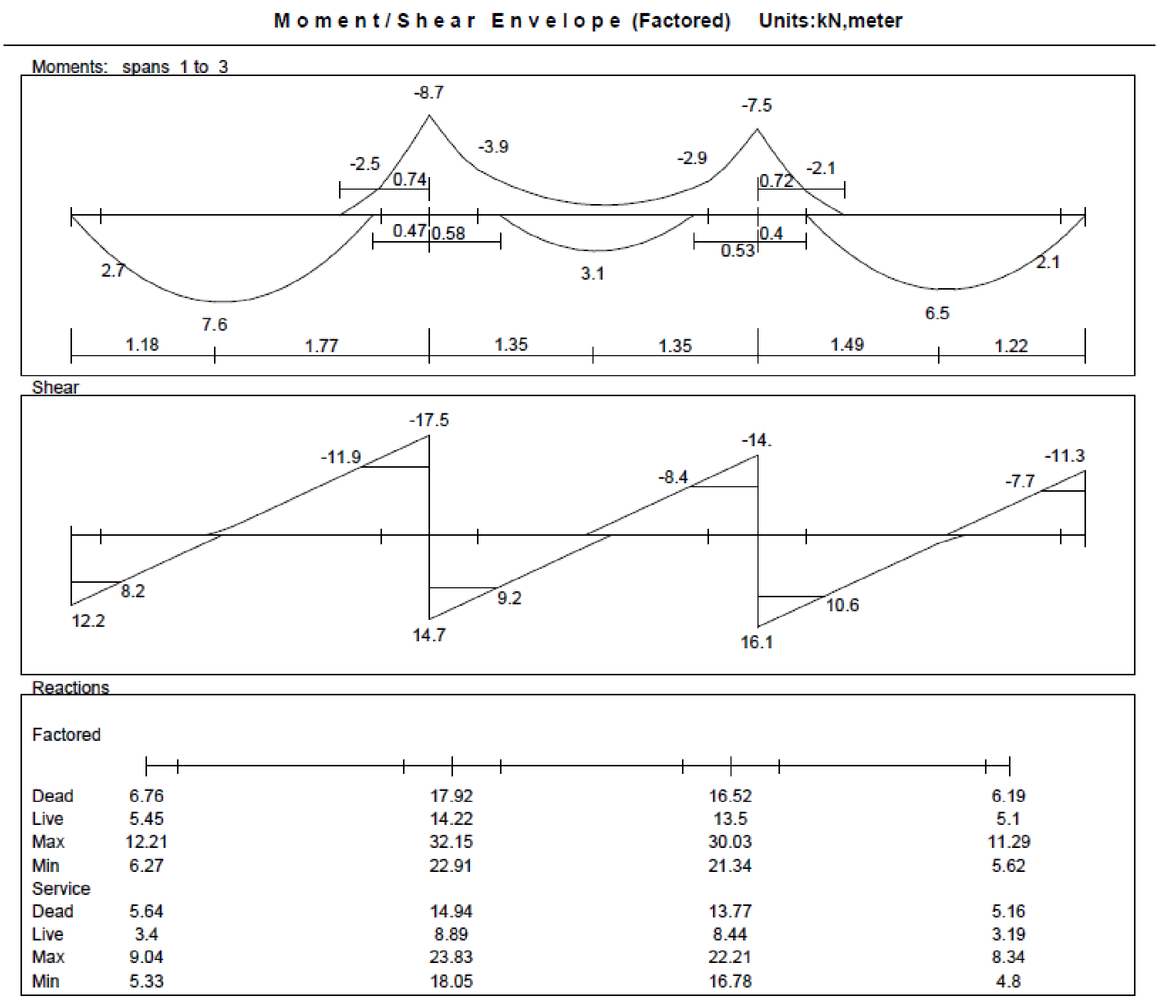


Figure 4-6:Moments and Shear Envelope (Factored) for rib 1

4.5.4 Design of flexure:

4.5.4.1 Design of Positive moment of rib (R1):

Maximum Positive moment Mu (+) = +7.6 KN.m.

Check whether the rib acts as rectangular or T-section:

For a= Tf =6cm

Assume a bar diameter of $\phi 12$ for main reinforcement.

Assume a bar diameter of $\phi 10$ for stirrups.

Check if $a > hf$:

$$d = h - cover - d_s - \frac{d_b}{2}$$

$$d = 200 - 20 - 10 - \frac{12}{2} = 164mm$$

$$M_n = \frac{M_u}{\phi} = \frac{7.6}{0.9} = 8.444KN.M$$

$$M_{nf} = 0.85 * fc' * b_e * h_f \left(d - \frac{h_f}{2}\right)$$

$$M_{nf} = 0.85 * 24 * 520 * 60 * \left(164 - \frac{60}{2}\right) * 10^{-6} = 85.3KN/m$$

$$M_{nf} = 85.3KN/m > M_n req = 8.444KN.m$$

Design as a rectangular section.

$$R_n = \frac{M_n}{b*d^2} = \frac{8.444*10^6}{520*164^2} = 0.603Mpa$$

$$m = \frac{fy}{0.85*fc'} = \frac{420}{0.85*24} = 20.59$$

$$\rho = \frac{1}{m}(1-\sqrt{1-\frac{2*m*R_n}{fy}})$$

$$\rho = \frac{1}{20.59}(1-\sqrt{1-\frac{2*0.603*20.59}{420}}) = 1.46*10^{-3}$$

$$A_{s.req} = \rho.b.d = 1.46*10^{-3}*520*164 = 124.51mm^2$$

$$A_{s.\min} = \frac{\sqrt{fc'}}{4f_y}.b_w.d \geq \frac{1.4}{f_y}.b_w.d$$

$$A_{s.\min} = \frac{\sqrt{24}}{4*420}*120*164 \geq \frac{1.4}{420}*120*164$$
$$= 57.4mm^2 < 65.6mm^2$$

$$A_{s.\min} = 65.6mm^2$$

$$A_{s.req} = 124.51mm^2 > A_{s.min} = 65.6\ mm^2$$

$so\ select\ 2\ \phi\ 10 with\ A_{s.prov} = 157\,mm^2 > 124.51mm^2$

Check for strain $\left(\varepsilon_s \geq 0.005\right)$:

$$a = \frac{A_s \times f_y}{0.85 \times f_{c'} \times b}$$

$$a = \frac{157 \times 420}{0.85 \times 24 \times 520} = 6.22mm$$

$$c = \frac{a}{\beta} = \frac{6.22}{0.85} = 7.32$$

$$\varepsilon_s = 0.003\left(\frac{d - c}{c}\right) = 0.003\left(\frac{164 - 7.32}{7.32}\right) = 0.064 >> 0.005..ok$$

$$\therefore \phi = 0.9$$

4.5.4.2 Design of negative moment of rib (R1):

Maximum negative moment Mu (-) = -8.7 KN.m.

$$d = h - \text{cover} - d_s - \frac{d_b}{2}$$

$$d = 200 - 20 - 10 - \frac{12}{2} = 164mm$$

$$M_u = 8.7KN.m$$

$$M_n = \frac{M_u}{\phi} = \frac{8.7}{0.9} = 9.7KN.m$$

$$R_n = \frac{M_n}{b_w * d^2} = \frac{9.7*10^6}{120*164^2} = 3Mpa$$

$$m = \frac{fy}{0.85*fc'} = \frac{420}{0.85*24} = 20.59$$

$$\rho = \frac{1}{m}(1 - \sqrt{1 - \frac{2*m*R_n}{fy}})$$

$$\rho = \frac{1}{20.59}(1 - \sqrt{1 - \frac{2*3*20.59}{420}}) = 7.8*10^{-3}$$

$$A_{s.req} = \rho b_w.d = 7.8*10^{-3}*120*164 = 152.8mm^2$$

$$A_{s.\min} = \frac{\sqrt{fc'}}{4f_y} .b_w .d \geq \frac{1.4}{f_y} .b_w .d$$

$$A_{s.\min} = \frac{\sqrt{24}}{4*420} *120*164 \geq \frac{1.4}{420} *120*164$$
$$= 57.4mm^2 < 65.6mm^2$$

$$A_{s.\min} = 65.6mm^2$$

$$A_{s.req} = 152.8mm^2 > A_{s.min} = 65.6\ mm^2$$

$$so\ select\ 2\ \phi\ 10 with\ A_{s.prov} = 157mm^2 > 152.8mm^2$$

Check for strain $(\varepsilon_s \geq 0.005)$:

$$a = \frac{A_s \times f_y}{0.85 \times f_{c'} \times b}$$

$$a = \frac{157 \times 420}{0.85 \times 24 \times 520} = 6.22mm$$

$$c = \frac{a}{\beta} = \frac{6.22}{0.85} = 7.32$$

$$\varepsilon_s = 0.003\left(\frac{d - c}{c}\right) = 0.003\left(\frac{164 - 7.32}{7.32}\right) = 0.064 >> 0.005.ok$$
$$\therefore \phi = 0.9$$

4.5.5 Design of Shear:

Vu max = -11.9 KN

$$d = 164mm$$

$$V_n = \frac{V_u}{\phi} = \frac{11.9}{0.75} = 15.9KN$$

$$V_C = 1.1 * \frac{1}{6} * \sqrt{fc'} * b_w * d$$

$$V_C = 1.1 * \frac{1}{6} * \sqrt{24} * 120 * 164 * 10^{-3} = 17.675KN$$

$$\phi V_C = 0.75 * 17.675 = 13.27KN$$

$$\frac{1}{2}\phi V_C < V_u < \phi V_C$$

$$6.635 < 11.9 < 13.27$$

Minimum shear reinforcement is required except for concrete joist construction. So, No shear reinforcement is provided.

4.6 Design of Beam (Beam1)

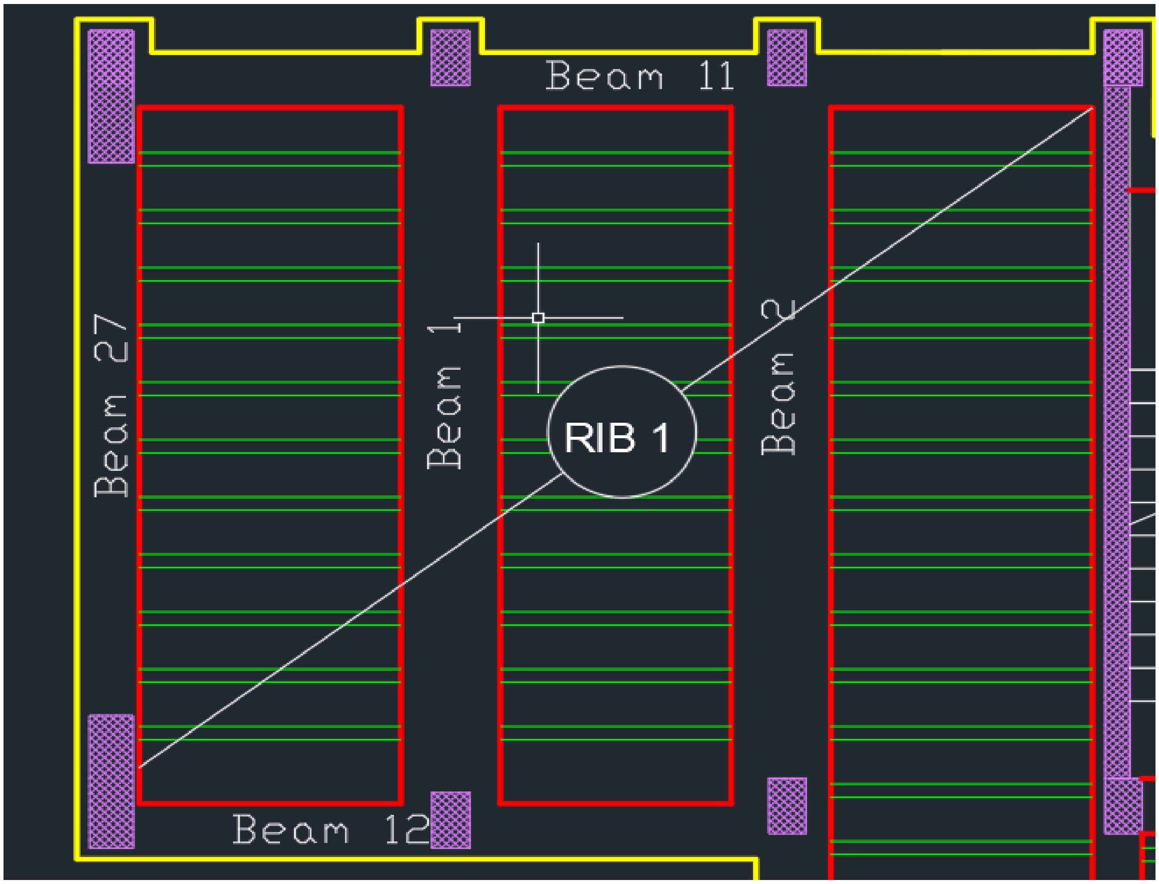


Figure 4-7:Beam 1 from Project

4.6.1 Section details and load:

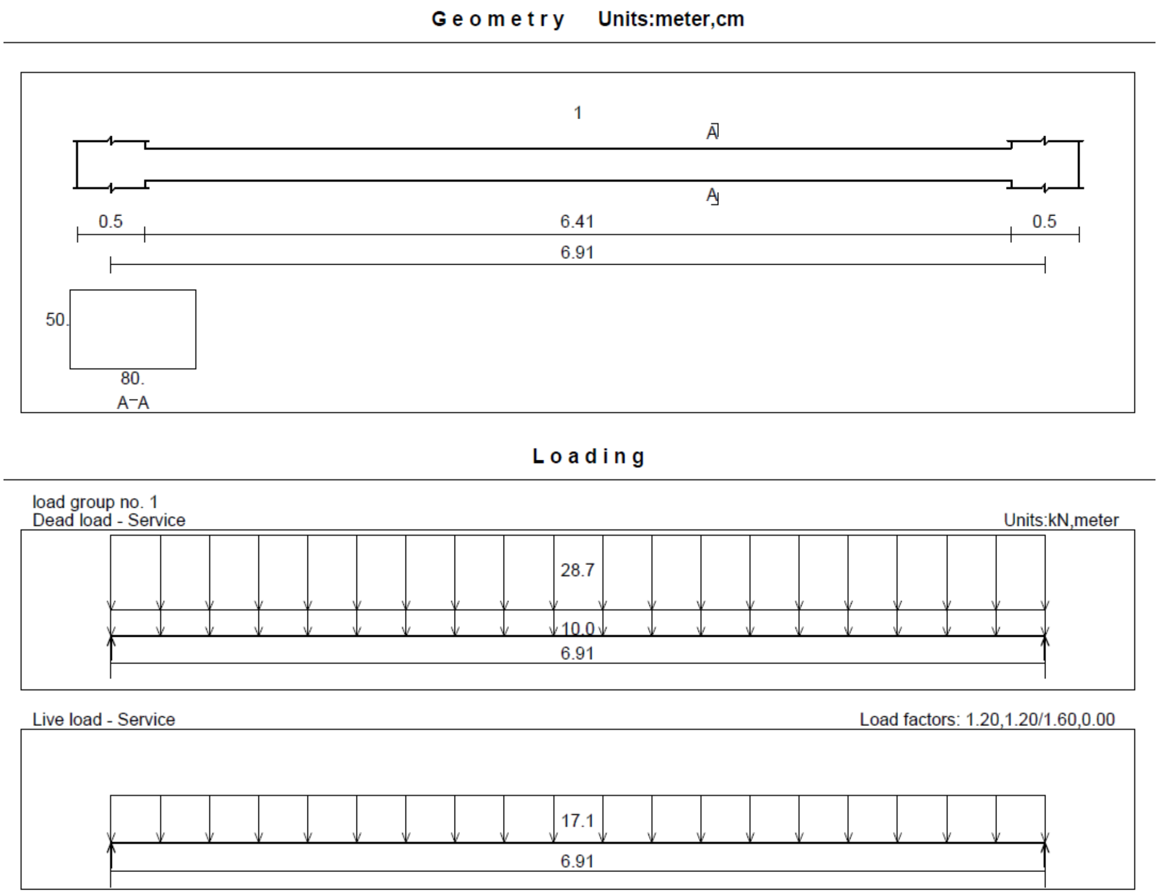


Figure 4-8:Geometry and loading for beam1

4.6.2 Design of flexure:

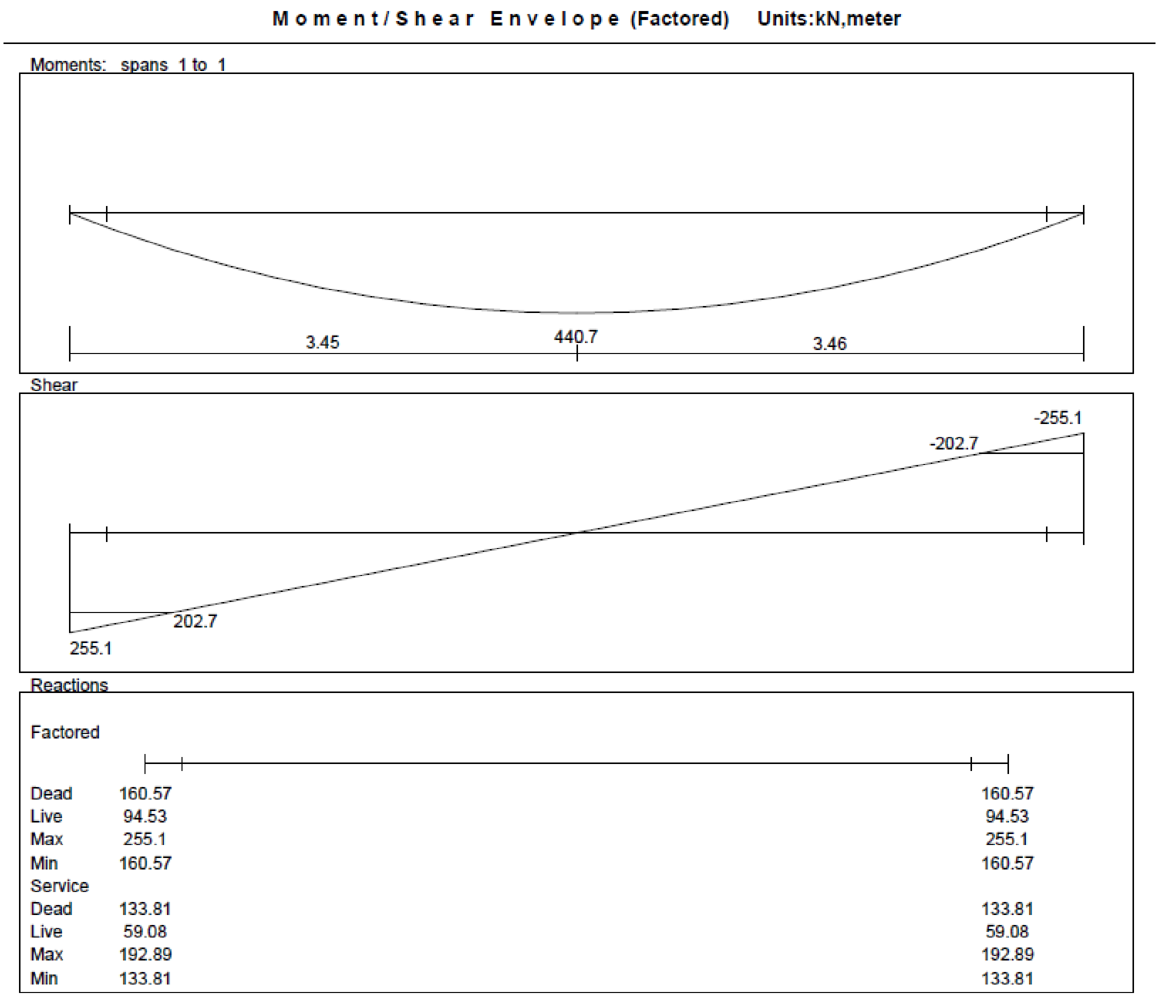


Figure 4-9:Moment and Shear Envelope (factored) for Beam1

b =80 cm

h =50cm(choose h=50cm, for deflection requirement's L/240)

According to ACI-Code-318,

the minimum thickness of no prestressed beams or one-way slabs unless deflections are computed as follows:

h_{min} for simple end = L/16

$= 678/16 = 42.375 cm.$

h_{min} for one end cont. = L/18.5

$= 678 \ /18.5 \ = 35.65 cm.$

$= 270/18.5 = 14.6 cm$

h_{min} for both end cont. = L/21

$= 360 \ / 21 \ = \ 17.14 \ cm.$

$= 270/21 = 12.86 cm.$

Select the Total depth of beam h= 50cm.

Loads acts on beam Beam1:

Reactions from (rib 1):

Factored:

D.L = 17.92/0.52 = 34.5 KN/m

L.L = 14.22/0.52 = 27.35 KN/m

Service:

D.L = 14.94/0.52 = 28.73KN/m

L.L = 8.89/0.52 = 17.1 KN/m

4.6.2.1 Design of Maximum Positive Moment:

Mu max = 440.7 KN.m

Assume a bar diameter of Ø**20** for main reinforcement.
Assume a bar diameter of Ø**10** for stirrups.

b = 80 cm.   h = 50 cm.

$$d = h - \text{cover} - d_s - \frac{d_b}{2}$$

$$d = 500 - 40 - 10 - \frac{20}{2} = 440mm$$

$$C_{\max} = \frac{3}{7} * d = \frac{3}{7} * 440 = 188.6mm$$

$$fc' = 24Mpa < 28Mpa \rightarrow \beta_1 = 0.85$$

$$a_{\max} = \beta_1 * C_{\max} = 0.85 * 188.6 = 160.29mm$$

**Note :*

$$M_{n.\max} = 0.85 * fc' * b * a * (d - \frac{a}{2})$$

$$M_{n.\max} = 0.85 * 24 * 0.8 * 0.1603 * (0.44 - \frac{0.1603}{2}) = 941.4KN.m$$

$$\varepsilon = 0.003 \left(\frac{d - c}{c}\right) = 0.003\left(\frac{440 - 188.6}{188.6}\right) = 0.004$$

$$\phi = 0.650 + \frac{250}{3} * \left(0.004 - 0.002\right) = 0.82$$

$$\rightarrow \phi M_{n.\max} = 0.82 * 941.4 = 772KN.m$$

$$\rightarrow M_u = 440.7\ KN.m < \phi M_{n.\max} = 772\ KN.m$$

$\therefore$ **Singly reinforced concrete section**.

Maximum positive moment Mu (+) = 440.7 KN.m

$$M_u = 440.7 KN.m$$

$$M_n = \frac{M_u}{\phi} = \frac{440.7}{0.9} = 489.67 KN.m$$

$$R_n = \frac{M_n}{b*d^2} = \frac{489.67*10^6}{800*440^2} = 3.16 Mpa$$

$$m = \frac{fy}{0.85*fc'} = \frac{420}{0.85*24} = 20.59$$

$$\rho = \frac{1}{m}(1-\sqrt{1-\frac{2*m*R_n}{fy}})$$

$$\rho = \frac{1}{20.59}(1-\sqrt{1-\frac{2*3.16*20.59}{420}}) = 0.00822$$

$$A_{s.req} = \rho.b.d = 0.00822*800*440 = 2893.2 mm^2$$

$$A_{s.\min} = \frac{\sqrt{fc'}}{4fy}.b_w.d \geq \frac{1.4}{fy}.b_w.d$$

$$A_{s.\min} = \frac{\sqrt{24}}{4*420}*800*440 \geq \frac{1.4}{420}*800*440$$

$$= 1026.5mm^2 < 1174mm^2$$

$$A_{s.\min} = 1174mm^2$$

$$A_{s.req} = 2893.2mm^2 > A_{s.min} = 1174mm^2$$

$$A_{s.req} = 2893.2mm^2$$

$$\therefore Use.\phi 20 \rightarrow A_S = 314.2mm^2$$

$$\therefore Use.\phi 14 \rightarrow A_S = 153mm^2$$

$$\#botom.of\ .bars = (3142) = 10\phi 20.bar$$

$$\#Top.of\ .bars = (612) = 4\phi 14.bar$$

$$\rightarrow A_{s.prov} = 3142mm^2 > 2893.2mm^2$$

Check for strain $\left(\varepsilon_s \geq 0.005\right)$:

$$a = \frac{A_s \times f_y}{0.85 \times f_{c'} \times b}$$

$$a = \frac{3142 \times 420}{0.85 \times 24 \times 800} = 80.86mm$$

$$f_{c'} = 24MPa < 28MPa \rightarrow \beta_1 = 0.85$$

$$c = \frac{a}{\beta} = \frac{80.86}{0.85} = 95.13mm$$

$$\varepsilon_s = 0.003\left(\frac{d - c}{c}\right) = 0.003\left(\frac{440 - 95.13}{95.13}\right) = 0.011 >> 0.005..ok$$

$$\therefore \phi = 0.9$$

4.6.2 Design of Shear:

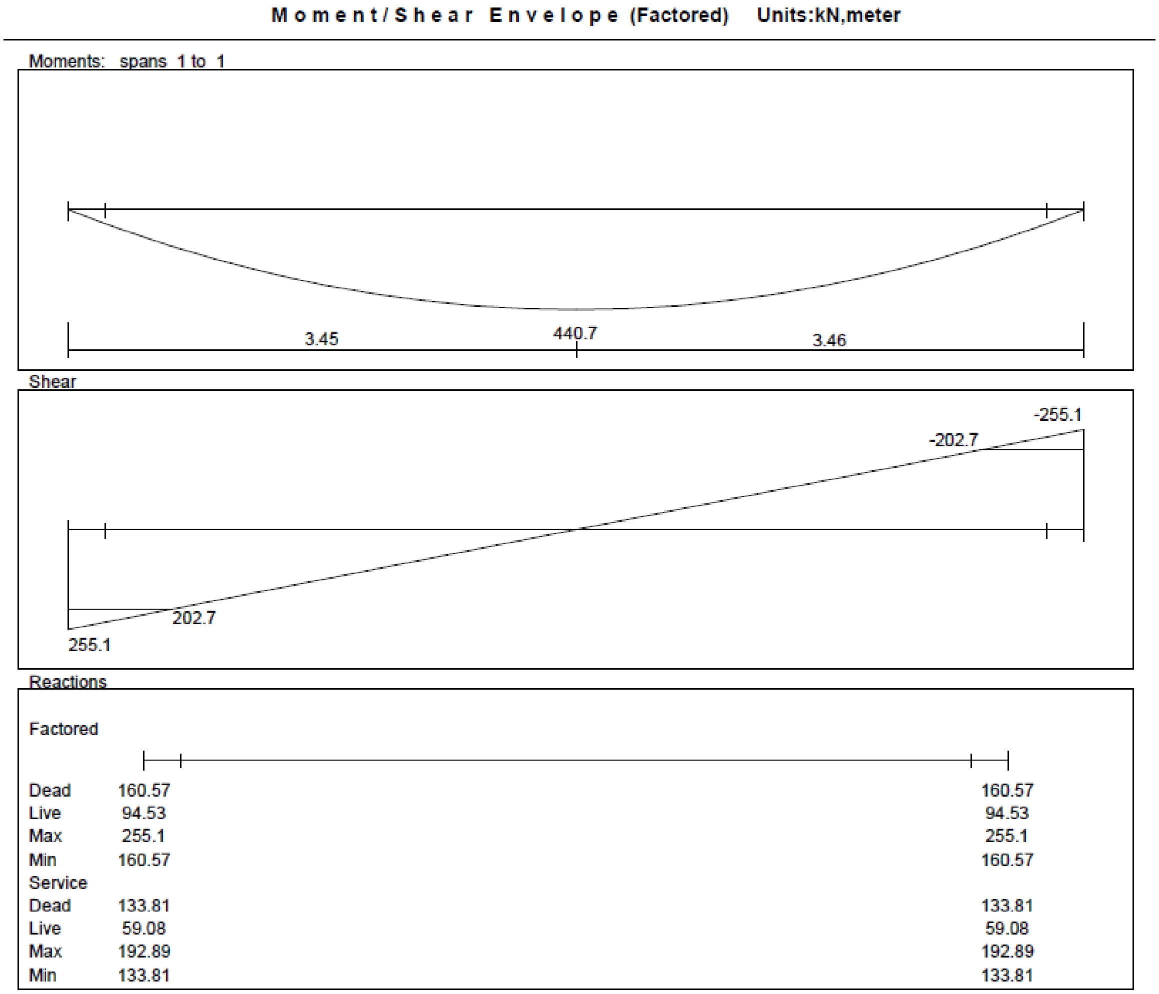


Figure 4-10: Moment and Shear Envelope (Factored) for Beam1

- **Vu = 202.7KN.**

$$\phi V_C = \phi * \frac{\sqrt{fc'}}{6} * b * d$$

$$\phi V_C = 0.75 * \frac{\sqrt{24}}{6} * 800 * 440 * 10^{-3} = 195.96KN \ .$$

Check for Cases:

1- **Case1 :**

$$V_u \le \frac{\phi V_c}{2} \ .$$

$$V_u \ge \frac{195.96}{2} = 97.98KN$$

∴ **Case (1) is NOT satisfied**.

2- **Case2 :**

$$\frac{\phi V_c}{2} < V_u \le \phi V_c \ .$$

$$97.98 < 202.7 \le 195.96$$

∴ **Case (2) is NOT satisfied**.

3- <u>Case3 :</u>

$$\phi V_C < V_u \le \phi\left(V_C + V_{S.\min}\right)$$

$$\phi V_{S.\min} = \phi \frac{1}{16}\sqrt{f_{c'}} * b_w * d$$

$$\phi V_{S.\min} = 0.75 \frac{1}{16}\sqrt{24} * 800 * 440 * 10^{-3} = 80.84 KN$$

And

$$\phi V_{S.\min} = \phi \frac{1}{3} * b_w * d = 0.75 * \frac{1}{3} * 800 * 440 * 10^{-3} = 88 KN \ldots Control$$

$$\phi V_C < V_u \le \phi\left(V_C + V_{S.\min}\right)$$

$$195.96 < 202.7 \le 283.96$$

$$\frac{A_{V.\min}}{S} = \frac{V_{S.\min}}{f_{yt}.d} \rightarrow S = \frac{A_{V.\min} * f_{yt} * d}{V_{S.\min}}$$

$$Try\ \ \phi 10\ with\ four\ legs\ = 4 * 78.5 = 314\ mm^2.$$

$$S = \frac{314 * 420 * 440}{88} = 659.4 mm$$

$$S_{\max} \le \frac{d}{2} = \frac{440}{2} = 220 mm \ldots Control$$

$$S_{\max} \le 600 mm$$

$$\therefore Use\ \ \phi 10\ @\ 200\ mm.$$

4.7 Design of Stair

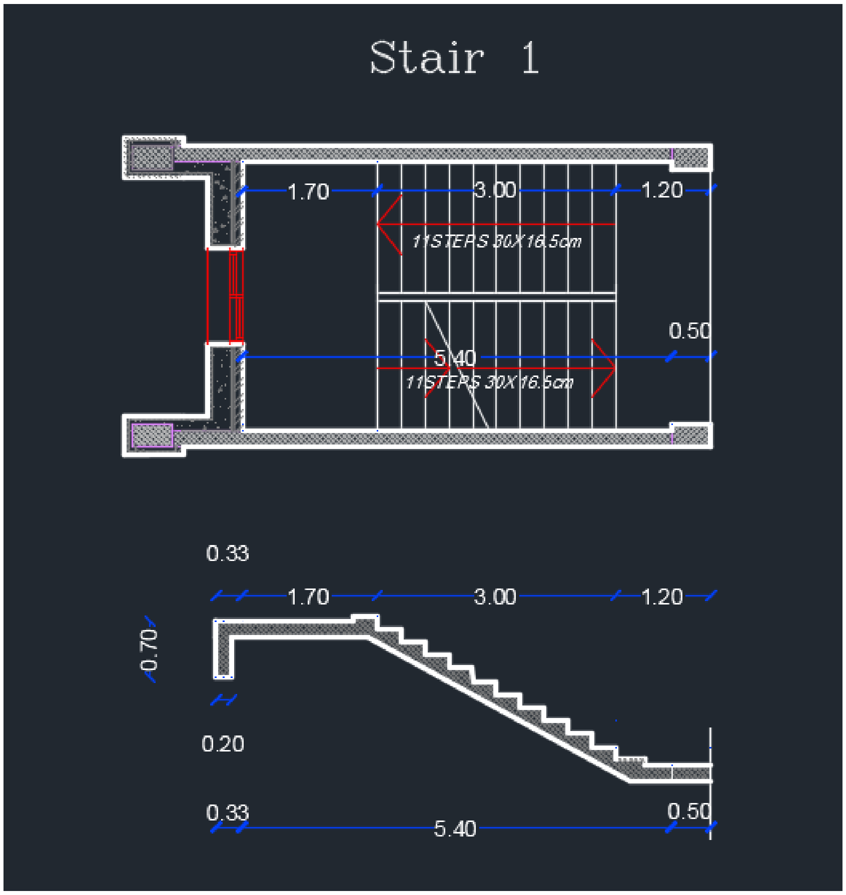


Figure 4-11: Stairs from Project

4.7.1 Design of Flight:

The minimum slab thickness for deflection is (for a simply supported one-way solid slab)

$$h_{\min} = \frac{L}{20} = \frac{5.4}{20} = 0.27m$$

In the case presented here, where the slab ends are cast with the supporting beams and additional negative reinforcement is provided, minimum thickness can be assumed to be

$$h_{\min} = \frac{L}{20} = \frac{5.4}{28} = 0.193m$$

Take h_{min} =20cm.

- **Dead Load For Flight For 1m Strip:**

The Stair Slope by $\theta = \tan^{-1}\left(\frac{rise}{run}\right) = \tan^{-1}\left(\frac{165}{300}\right) = 28.8$

Table 4-4:Dead Load Calculation of Flight

No	Material	Quality Density	W (KN/m)
1	Tile	23	$23*0.03*1*\left(\frac{0.35+0.165}{0.3}\right) = 1.1845$
2	Mortar	22	$22*0.03*1*\left(\frac{0.35+0.165}{0.3}\right) = 1.023$
3	R.C	25	$\frac{25*0.20*1}{\cos(28.8)} = 5.706$
4	Plaster	22	$\frac{22*0.03*1}{\cos(28.8)} = 0.75$
5	Stair	25	$\frac{25}{0.3}*(0.5*0.3*0.165) = 2.1$
Total Dead Load. (KN/m)			10.76(KN/m)

- **Dead Load For Landing For 1m Strip :**

Table 4-5:Dead Load for Landing

No	Material	Quality Density	W (KN/m)
1	Tile	23	$23*0.03*1 = 0.69$
2	Mortar	22	$22*0.03*1 = 0.66$
3	R.C	25	$25*0.2*1 = 5$
4	Plaster	22	$22*0.03*1 = 0.66$
Total Dead Load. (KN/m)			7.01(KN/m)

- **Factored Load for Flight:**

$$W_u = (1.2 \times 10.76) + (1.6 \times 5) = 21KN\ /\ m$$

- **Factored Load for Landing :**

$$W_u = (1.2 \times 7.01) + (1.6 \times 5) = 16.4KN\ /\ m$$

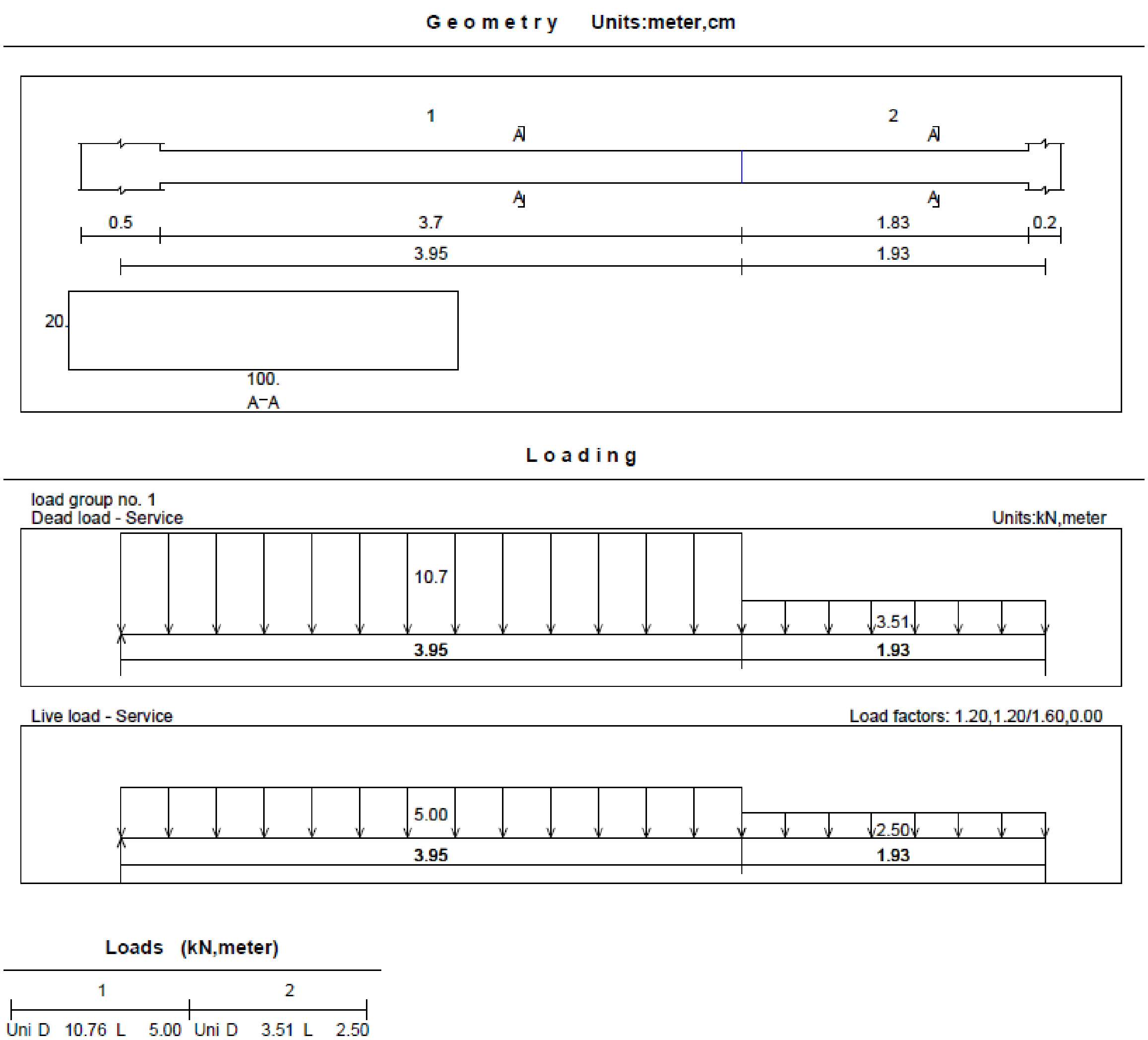
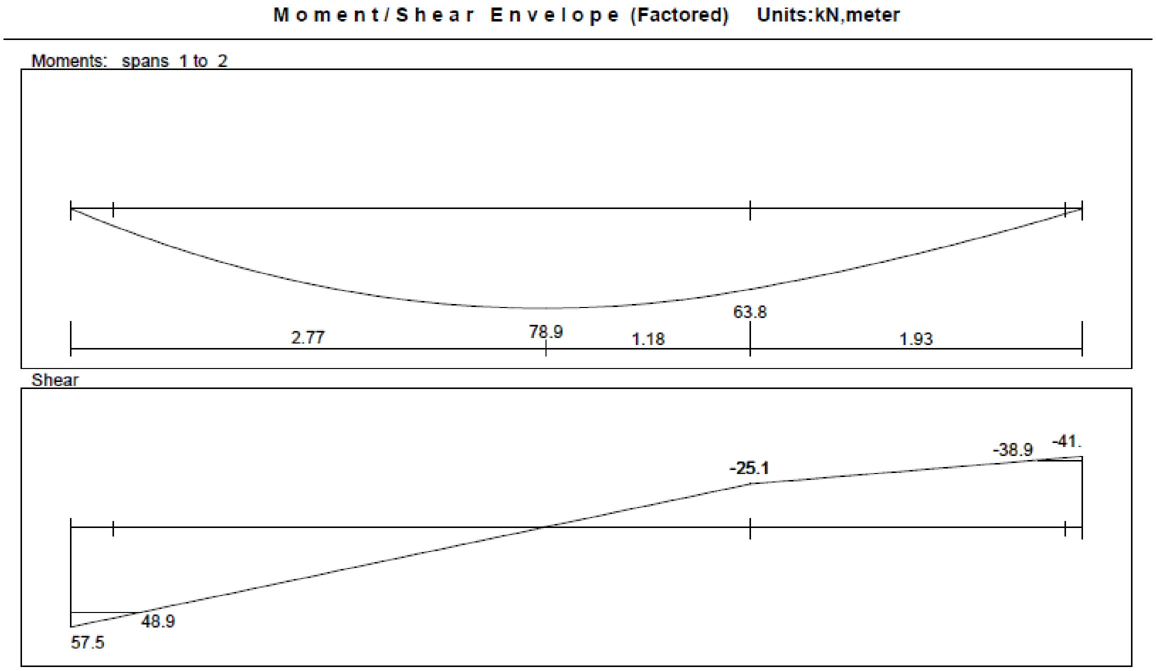


Figure 4-12:Load Envelope diagram for stair



Reactions

Factored		
Dead	35.21	23.93
Live	22.25	17.07
Max	57.46	40.99
Min	35.21	23.93
Service		
Dead	29.34	19.94
Live	13.91	10.67
Max	43.25	30.61
Min	29.34	19.94

Figure 4-13:Moment and Shear Envelope diagram for stair

- **Design of Shear: (Vu=-48.9KN)**

Assume bar diameter ø 14 for main reinforcement.

$$d = h - cover - \frac{d_b}{2} = 200 - 20 - \frac{14}{2} = 173mm$$

$$V_C = \frac{1}{6}\sqrt{f_{c'}} \bullet b_w \bullet d = \frac{1}{6}\sqrt{24} \bullet 1000 \bullet 173 = 141.25KN$$

$$\phi V_C = 0.75 \times 141.25 = 105.94KN > V_u = 48.9KN$$

$$\frac{\phi V_C}{2} = \frac{105.94}{2} = 52.97KN > V_u = 48.9KN$$

The thickness of the slab is adequate.

- **Design of Bending Moment: (Mu=78.9 KN.m)**

$$M_u = 78.9KN.m$$

$$M_n = \frac{M_u}{\phi} = \frac{78.9}{0.9} = 87.67KN.m$$

$$R_n = \frac{M_n}{b * d^2} = \frac{87.67 * 10^6}{1000 * 173^2} = 3Mpa$$

$$m = \frac{fy}{0.85 * fc'} = \frac{420}{0.85 * 24} = 20.59$$

$$\rho = \frac{1}{m}(1 - \sqrt{1 - \frac{2 * m * R_n}{fy}})$$

$$\rho = \frac{1}{20.59}(1 - \sqrt{1 - \frac{2 * 3 * 20.59}{420}}) = 0.0077$$

$$A_{s.req} = \rho b.d = 0.0077 * 1000 * 173 = 1332.1mm^2$$

$$A_{S.\min} = 0.0018 \bullet b \bullet h = 0.0018 \times 1000 \times 20 = 360 mm^2$$

$$A_{S.req} = 1332.1 mm^2 > A_{S.\min} = 360 mm^2$$

$$A_{S.req} = 1332.1 mm^2$$

$$n = \frac{A_{S.req}}{A_{S.b}} = \frac{1332.1}{153} = 8.71 \approx 9$$

$$S = \frac{1}{n} = \frac{1}{9} = 0.111 m \rightarrow 0.1 m$$

Step (S) is the smallest of:

1. $3h = 3 \times 200 = 600mm$

2. $450mm$

3. $S \le 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{\frac{2}{3}420}\right) = 300 mm - control$

$$S = 100 mm < S_{\max} = 300 mm - ok$$

$$Use\, \phi 14 @ 10 cm$$

$$A_{S.provid} = 1530 mm^2 / m > A_{S.req} = 1332.1 mm^2 / m - ok$$

- **Temperature and shrinkage reinforcement.**

$$A_S\left(\text{Shrinkage and Temperature}\right)=A_{S.\min}=360mm^2$$

$$n=\frac{A_S}{A_{S.b}}=\frac{360}{153}=2.35\approx 3$$

$$S=\frac{1}{n}=\frac{1}{3}=0.34m$$

$Take.3\phi 14/m$

$step$ (S-for Shrinkage and Temperature reinforcement) is the smallest of :

1. 5h = 5$\times$200=1000mm

2. 450mm _control.

$$S_{\max}=450mm>S=300mm$$

Use ϕ14@30cm

4.7.2 Design of Landing:

Take h_{min} =20cm.

- **Dead Load For Landing For 1m Strip :**

Table 4-6:Dead Load for Landing

No	Material	Quality Density	W (KN/m)
1	Tile	23	$23*0.03*1=0.69$
2	Mortar	22	$22*0.03*1=0.66$
3	R.C	25	$25*0.2*1=5$
4	Plaster	22	$22*0.03*1=0.66$
Total Dead Load. (KN/m)			7.01(KN/m)

- **Factored Load for Landing :**

$$W_u = (1.2\times 7.01)+(1.6\times 5)=16.4KN\ /\ m$$

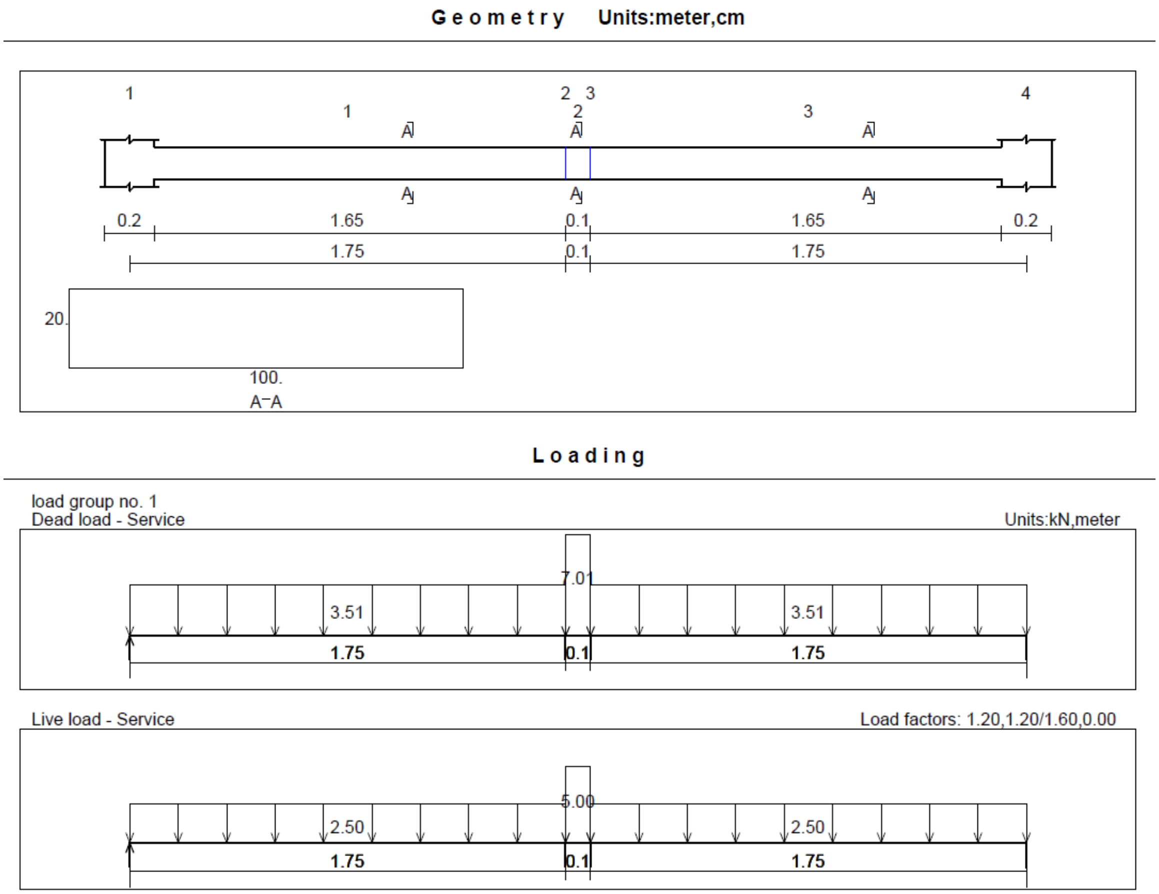
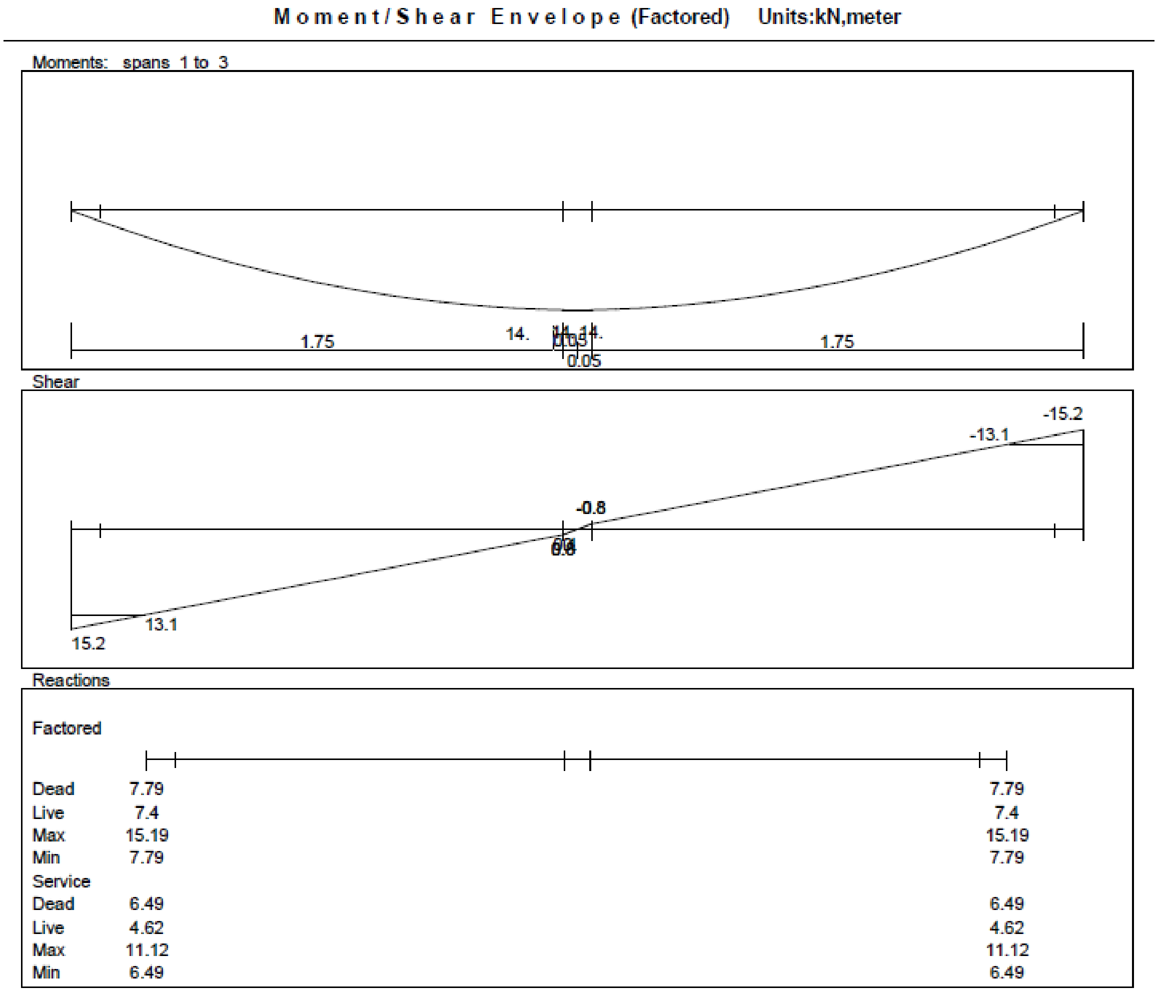


Figure 4-14:Geometry for Landing



Moment/Shear Envelope (Factored) Units:kN,meter

	1		2			3			4
		1			2			3	
Min M	0.0		7.2	7.2		7.2	7.2		0.0
Max M	0.0		14.0	14.0		14.0	14.0		0.0
MspMn	0.8		7.2	7.2		7.2	7.2		0.8
MspMx	1.5		14.0	14.0		14.0	14.0		1.5
M Max		14.0			14.0			14.0	
M Min		5.2			7.2			4.8	
Mmn=0 @	0.0		1.8	0.0		0.1	0.0		1.8
Mmx=0 @	0.0		1.8	0.0		0.1	0.0		1.8
mx -M @		0.0			0.0			0.0	
mx +M @		1.8			0.1			0.0	
V max	15.2		0.8	0.8		-0.4	-0.4		-7.8
V min	7.8		0.4	0.4		-0.8	-0.8		-15.2
DReac	7.8								7.8
LReac	7.4								7.4

Figure 4-15:Moment and Shear Envelope

- **Design of Bending Moment: (Mu=14 KN.m)**

$$M_u = 14KN.m$$
$$M_n = \frac{M_u}{\phi} = \frac{14}{0.9} = 15.56KN.m$$

$$R_n = \frac{M_n}{b*d^2} = \frac{15.56*10^6}{1000*173^2} = 0.52Mpa$$
$$m = \frac{fy}{0.85*fc'} = \frac{420}{0.85*24} = 20.59$$
$$\rho = \frac{1}{m}(1-\sqrt{1-\frac{2*m*R_n}{fy}})$$
$$\rho = \frac{1}{20.59}(1-\sqrt{1-\frac{2*0.52*20.59}{420}}) = 0.00125$$

$$A_{s.req} = \rho b.d = 0.00125*1000*173 = 216.25mm^2$$

$$A_{S.\min} = 0.0018 \bullet b \bullet h = 0.0018 \times 1000 \times 20 = 360mm^2$$
$$A_{S.req} = 216.25mm^2 < A_{S.\min} = 360mm^2$$
$$A_{S.req} = 360mm^2$$
$$n = \frac{A_{S.req}}{A_{S.b}} = \frac{360}{153} = 2.35 \approx 3 \rightarrow Take\ 3\phi 14/\text{m}$$
$$S = \frac{1}{n} = \frac{1}{3} = 0.34m \rightarrow 0.3m$$

Step (S) is the smallest of:

1. 3h=3$\times$200=600mm
2. 450mm
3. $S \le 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{\frac{2}{3}420}\right) = 300mm - control$

$$S = 300mm - ok$$
$$Use\ \phi 14 @ 30cm$$
$$A_{S.provid} = 459mm^2/m > A_{S.req} = 360mm^2/m - ok$$

- **Temperature and shrinkage reinforcement.**

$$A_S\left(\text{Shrinkage and Temperature}\right)=A_{S.\min}=360mm^2$$

$$n=\frac{A_S}{A_{S.b}}=\frac{360}{153}=2.35\approx 3$$

$$S=\frac{1}{n}=\frac{1}{3}=0.34m$$

$Take.3\phi 14/m$

$step$ (S-for Shrinkage and Temperature reinforcement) is the smallest of :

1. 5h = 5×200=1000mm

2. 450mm _control.

$$S_{\max}=450mm>S=300mm$$

Use ϕ14@30cm

4.8 Design of Column C2

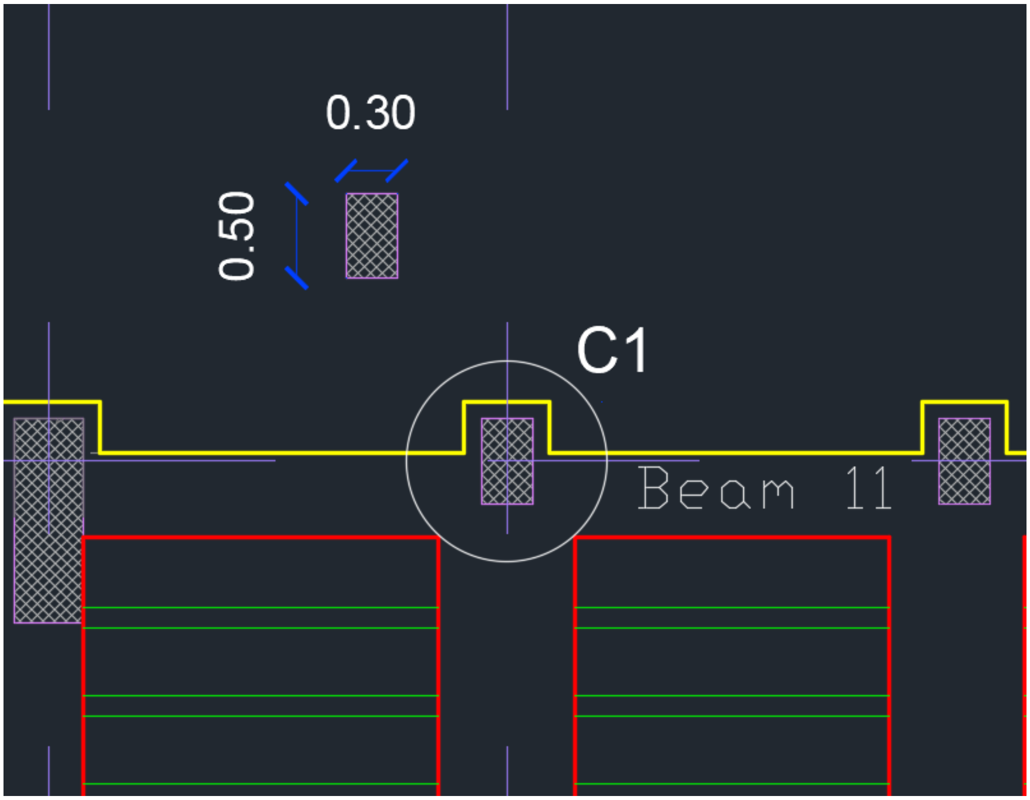


Figure 4-16:Column 1 from Project

4.8.1 Design of Column 2:

- **Load Calculation :**

Service Load:

Dead Load =133.81KN
Live Load =59.08KN

Factored Load:

U= 1.2 ×133.81+ 1.6×59.08=255.1KN

- **Check Slenderness Parameter:**

$$\frac{K \cdot L_u}{r} < 34 - 12\frac{M_1}{M_2} \leq 40$$

R: radius of gyration = $\sqrt{\frac{I}{A}} \approx 0.3$ h ………………. For rectangular section

Lu = 3.44 m
M1/M2 =1
K=1 for braced frame.

About Y-axis (b= 0.3 m)

r_x = 0.3h = 0.3 * 0.3 = 0.09

$$\frac{K \cdot L_u}{r} < 34 - 12\frac{M_1}{M_2} \leq 40$$

$$\frac{1 \times 3.44}{0.09} < 34 - 12 \times 1 \leq 40 \rightarrow 38.22 > 22 \rightarrow \text{Long Column}$$

About X-axis (h= 0.5 m)

r_y = 0.3h = 0.3 * 0.5 = 0.15

$$\frac{K \cdot L_u}{r} < 34 - 12\frac{M_1}{M_2} \leq 40$$

$$\frac{1 \times 3.44}{0.15} < 34 - 12 \times 1 \leq 40 \rightarrow 22.93 > 22 \rightarrow \text{Long Column}$$

$\therefore$ Long Column in both direction

- **calculated the minimum eccentricity:**

The minimum eccentricity $e_{\min} = 15 + 0.03h = 15 + 0.03 * 500 = 30mm$

$$M_{\min} = P_u(15 + 0.03h) = 255.1(15 + 0.03 * 500) * 10^{-3} = 7.653KN.m$$

- **calculated the EI:**

$$EI = \frac{0.4E_c I_g}{1 + \beta_{dns}}$$

$$E_C = 4700\sqrt{f_{c'}} = 4700\sqrt{24} = 23025.2MPa$$

$$I_g = \frac{bh^3}{12} = \frac{300 \times 500^3}{12} = 3.125 * 10^9 mm^4$$

$$\beta_{dns} = \frac{1.2D}{1.2D + 1.6L} = \frac{1.2 \times 133.8}{1.2 \times 133.81 + 1.6 \times 59.08} = 0.63$$

$$EI = \frac{0.4E_c I_g}{1 + \beta_{dns}} = \frac{0.4 \times 23025.2 \times 3.125}{1 + 0.63} = 17657.36KN.m^2$$

- **Determine the Euler buckling load, P_C:**

$$P_C = \frac{\pi^2 EI}{(K \cdot L_u)^2} = \frac{\pi^2 \times 17657.36}{(1 \times 3.44)^2} = 14726.81KN$$

- **Calculate the moment magnifier factor δ_{ns} :**

$$c_m = 0.6 + 0.4\frac{M_1}{M_2} = 0.6 + 0.4 \times 1 = 1$$

$$\delta_{ns} = \frac{c_m}{1 - \frac{P_u}{0.75P_C}} = \frac{1}{1 - \frac{255.1}{0.75 * 14726.81}} = 1.024 > 1 - ok.$$

- **The magnified eccentricity and moment:**

$$e = e_{\min} \bullet \delta_{ns} = 30 \times 1.024 = 30.72mm$$

$$M_2 = M_{\min} = 7.653KN.m$$

$$M_C = \delta_{ns} \bullet M_2 = 1.024 \times 7.653 = 7.84KN.m$$

- **Select the column reinforcement:**

-Compute the ratio $e \backslash h$:

$$\frac{e}{h} = \frac{30.72}{500} = 0.06144$$

-Compute the ratio γ:

Assume $\phi 25$ for bars

$$\gamma = \frac{d - d'}{h} = \frac{500 - 2*40 - 2*10 - 25}{500} = 0.750$$

Determine ρ_g **for the selected dimensions:** $h = 500mm, b = 300mm$

The interaction diagrams are entered with $\frac{\phi P_n}{A_g} = \frac{P_u}{A_g} = \frac{0.2551}{0.5*0.3} \times 0.145 = 0.25 \text{ ksi}$

$$\therefore \rho_g = 0.01$$

- **Select the reinforcement:**

$$A_{steel} = \rho_g A_g = 0.01*500*300 = 1500mm^2$$

$$\therefore Use\ \phi 16 \rightarrow \text{A}_{bar} = 201mm^2$$

$$n = \frac{A_s}{A_b} = \frac{1500}{201} = 7.46 \approx 8$$

- **Check for Spacing Between Bars:**

$Y\ -axis$

$$S = \frac{500-(40*2)-(2*10)-(3*16)}{2} = 176mm > 150mm \text{ use hook..}$$

$\text{X} \ -axis$

$$S = \frac{300-(40*2)-(2*10)-(3*16)}{2} = 76mm < 150mm \text{ no hook need..}$$

- **Spacing Between Strips:**

Step (S) is the smallest of:

$S = 48d_s = 48\times10 = 480mm$

$S = 16d_b = 16\times16 = 256mm$

$S = b = 300mm - Control$

select S=300mm

use 1 strips and 1 hook @300mm

4.9 Design of Basement wall

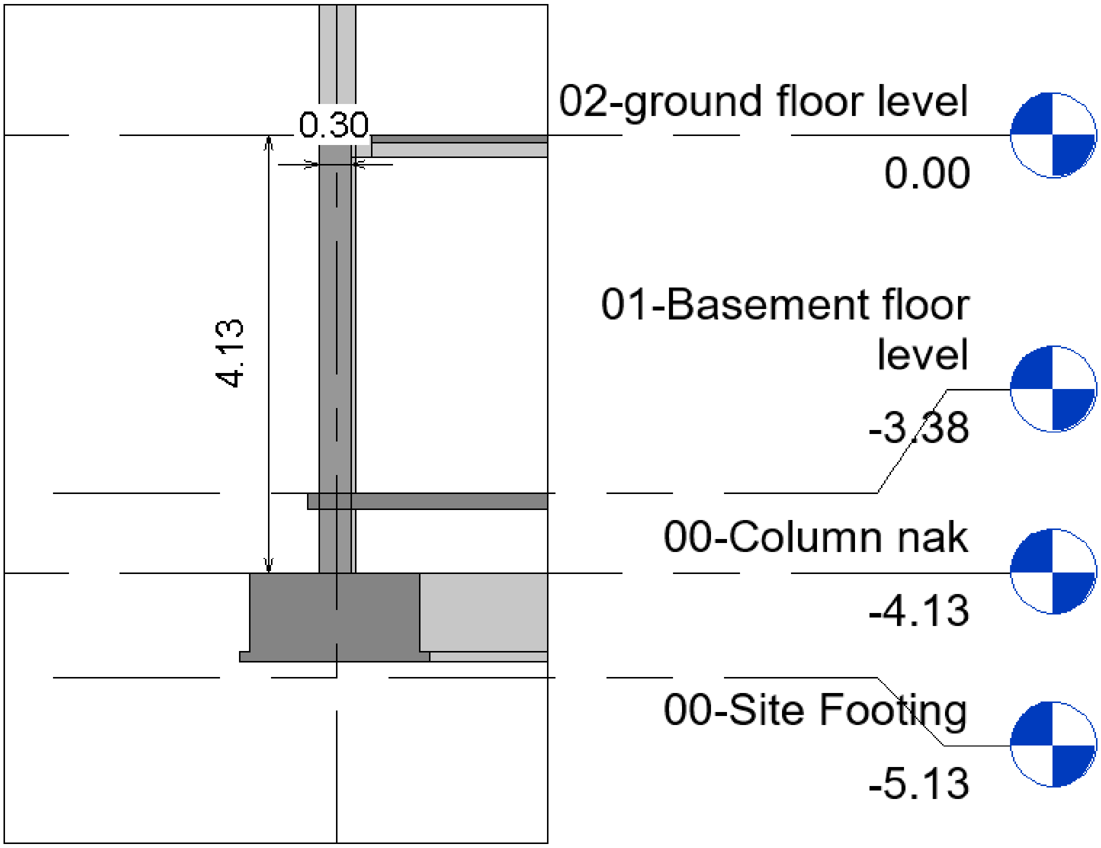


Figure 4-17:Basement wall for Project

4.9.1 Design of Basement Wall:

The different lateral pressures on a 1m length of the wall are calculated as follows:

$\gamma = 18KN\ /\ m^3$ (unit weight of dry backill)

angle of internal friction :$\phi = 30^{\circ}$

$H\ = 4.13m$. ($height$ of basement wall)

- **Load Calculation:**

$k_{\circ}=1-\sin\theta=1-\sin30^{\circ}=0.5$

Due to soil pressure at rest:

$P_{\circ}=k_{\circ}\gamma h=0.5\times18\times4.03=36.27KN/m^2$

$H_{\circ}=\frac{1}{2}P_{\circ}h=\frac{1}{2}\bullet36.27\bullet4.03=73.1KN.$

Due to surcharge:

$P_s=k_{\circ}h_s=0.5\times5=2.5KN/m^2$

$H_s=P_s h=2.5\times4.03=10.075KN$.

The following are shear and moment diagrams that obtained from Atir Software.

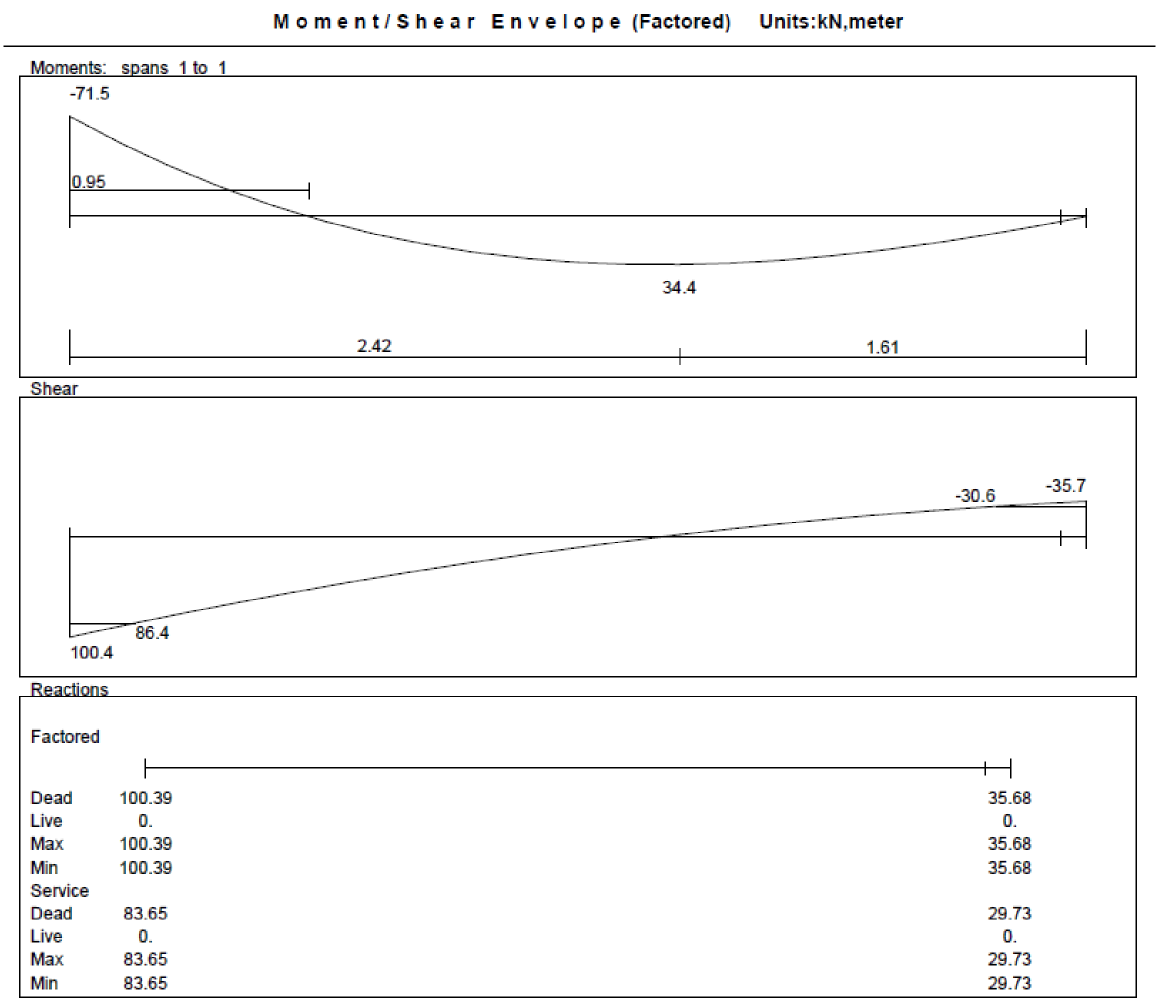


Figure 4-18: Moment and Shear for Basement Wall

4.9.2 Design of Moment:

- **Maximum negative moment Mu (-) = -71.5 KN.m.**

$$d = h - \text{cover} - \frac{d_b}{2}$$

$$d = 300 - 75 - \frac{16}{2} = 217mm$$

$$M_u = 71.5KN.m$$

$$M_n = \frac{M_u}{\phi} = \frac{71.5}{0.9} = 79.44KN.m$$

$$R_n = \frac{M_n}{b_w * d^2} = \frac{79.44*10^6}{1000*217^2} = 1.7Mpa$$

$$m = \frac{fy}{0.85*fc'} = \frac{420}{0.85*24} = 20.59$$

$$\rho = \frac{1}{m}(1 - \sqrt{1 - \frac{2*m*R_n}{fy}})$$

$$\rho = \frac{1}{20.59}(1 - \sqrt{1 - \frac{2*1.7*20.59}{420}}) = 4.23*10^{-3}$$

$$A_{s.req} = \rho.b_w.d = 4.23*10^{-3}*1000*217 = 918.34mm^2$$

The minimum vertical A_s according to the ACI Code, Section 14.3, is

Vertical, $A_{s.\min} = 0.0015bh = 0.0015 \times 1000 \times 300 = 450mm^2/m$

$$A_{s.\min}\left(\text{for flexure}\right) = \frac{\sqrt{fc'}}{4f_y}.b_w.d \geq \frac{1.4}{f_y}.b_w.d$$

$$A_{s.\min} = \frac{\sqrt{24}}{4*420}*1000*217 \geq \frac{1.4}{420}*1000*217$$

$$= 632.8mm^2 < 723.33mm^2$$

$$A_{s.\min} = 723.33mm^2$$

$$A_{s.req} = 918.34mm^2 > A_{s.min} = 723.33\ mm^2$$

$$use\,\phi 16 \rightarrow A_b = 201mm^2$$

$$\therefore n_b = \frac{A_{s.req}}{A_b} = \frac{918.34}{201} = 4.57 \approx 5\phi 16$$

$$so\ select\ 5\phi 16\ with\ A_{s.prov} = 1005mm^2 @1m$$

- **Maximum positive moment Mu (+) = 34.4 KN.m**

$$M_u = 34.4 KN.m$$

$$M_n = \frac{M_u}{\phi} = \frac{34.4}{0.9} = 38.22 KN.m$$

$$R_n = \frac{M_n}{b*d^2} = \frac{38.22*10^6}{1000*217^2} = 0.811 Mpa$$

$$m = \frac{fy}{0.85*fc'} = \frac{420}{0.85*24} = 20.59$$

$$\rho = \frac{1}{m}(1-\sqrt{1-\frac{2*m*R_n}{fy}})$$

$$\rho = \frac{1}{20.59}(1-\sqrt{1-\frac{2*0.811*20.59}{420}}) = 0.00197$$

$$A_{s.req} = \rho.b.d = 0.00197*1000*217 = 427.49 mm^2$$

The minimum vertical A_s according to the ACI Code, Section 14.3, is

$$\text{Vertical,}A_{s.\min} = 0.0012\text{bh} = 0.0012 \times 1000 \times 300 = 360 mm^2 / m.$$

$$A_{s.\min}(\text{for flexure}) = \frac{\sqrt{fc'}}{4f_y}.b_w.d \geq \frac{1.4}{f_y}.b_w.d$$

$$A_{s.\min} = \frac{\sqrt{24}}{4*420}*1000*217 \geq \frac{1.4}{420}*1000*217$$

$$= 632.8 mm^2 < 723.33 mm^2$$

$$A_{s.\min} = 723.33 mm^2$$

$$A_{s.req} = 427.49 mm^2 < A_{s.min} = 723.33 mm^2$$

$$use \phi 16 \rightarrow A_b = 201 mm^2$$

$$\therefore n_b = \frac{A_{s.req}}{A_b} = \frac{427.49}{201} = 2.13 \approx 3\phi 16$$

$$so\ select\ 3\phi 16\ with\ A_{s.prov} = 603 mm^2 @ 1m$$

4.9.3 Design of Shear:

Vu max (+) = 100.4 KN

$d = 217mm$

$\phi = 0.75$

$\phi V_C = \phi * \frac{1}{6} * \sqrt{fc'} * b_w * d$

$\phi V_C = 0.75 * \frac{1}{6} * \sqrt{24} * 1000 * 217 * 10^{-3} = 132.88 KN$

$\phi V_C = 132.88 > 100.4 KN$.

Longitudinal reinforcement: Use a minimum steel ratio of 0.0020 (ACI Code, Section 14.3), or $A_s = 0.0020bh = 0.0020 \times 1000 \times 300 = 600mm^2 / m$.

Use $\phi 12 @ 20cm$

4.10 Seismic Design

In this case, PGA, as well as S_1 and S_2, correspond to a 2% probability of exceedance within a 50-year period (maximum considered earthquake).

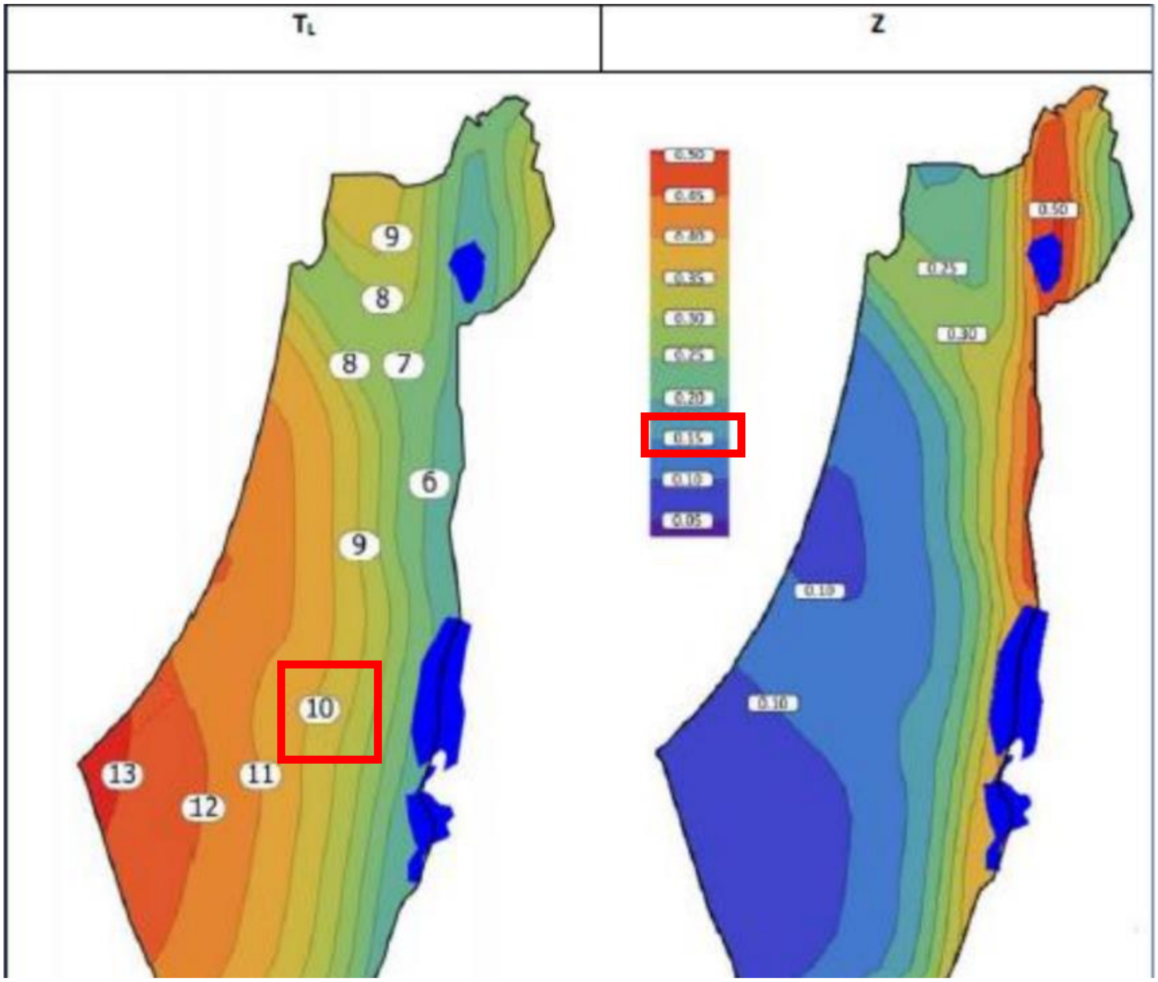


Figure 4-19:Seismic Hazard Map for Building Codein Palestine

So based on in these map Hebron .we selected Z=0.15, and T_L =10

S_S = 2.5 * Z = 2.5 * 0.15 = 0.375

S_1 = 1.25 * Z = 1.25 * 0.15 = 0.186

The Value on Etabs

S_S = 0.375 * 1.5 = 0.56

S_1 = 0.186 * 1.5 = 0.28

- ### Select Site Class

Table 4-7: Site Classification (Table 20.3-1 from ASCE 7-16)

Table 20.3-1 Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard rock	>5,000 ft/s	NA	NA
B. Rock	2,500 to 5,000 ft/s	NA	NA
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50 blows/ft	>2,000 lb/ft^2
D. Stiff soil	600 to 1,200 ft/s	15 to 50 blows/ft	1,000 to 2,000 lb/ft^2
E. Soft clay soil	<600 ft/s	<15 blows/ft	<1,000 lb/ft^2
	Any profile with more than 10 ft of soil that has the following characteristics: — Plasticity index $PI > 20$, — Moisture content $w \geq 40\%$, — Undrained shear strength $\bar{s}_u < 500$ lb/ft^2		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

Note: For SI: 1 ft = 0.3048 m; 1 ft/s = 0.3048 m/s; 1 lb/ft^2 = 0.0479 kN/m^2.

The Rook in Hebron is a Lame stone.
So the Velocity of Waves = 3000 m/s = 9800 ft/s
So Site Class A. Hard rock.

- ### Select Ct and X form Table:

Table 4-8: Value of Approximate Period Parameters C_t and x,(Table 12.8-2 from ASCE7-16)

Table 12.8-2 Values of Approximate Period Parameters C_t and x

Structure Type	C_t	x
Moment-resisting frame systems in which the frames resist 100% of the required seismic force and are not enclosed or adjoined by components that are more rigid and will prevent the frames from deflecting where subjected to seismic forces:		
Steel moment-resisting frames	0.028 (0.0724)[a]	0.8
Concrete moment-resisting frames	0.016 (0.0466)[a]	0.9
Steel eccentrically braced frames in accordance with Table 12.2-1 lines B1 or D1	0.03 (0.0731)[a]	0.75
Steel buckling-restrained braced frames	0.03 (0.0731)[a]	0.75
All other structural systems	0.02 (0.0488)[a]	0.75

So,

C_t = 0.02

x = 0.75

- **Select Fa in Table 11.4 – 1**

Table 4-9:Short-Period Site Coefficient Fa (Table 11.4-1 from ASCE 7-16)

Table 11.4-1 Short-Period Site Coefficient, F_a

Site Class	Mapped Risk-Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameter at Short Period					
	$S_S \le 0.25$	$S_S = 0.5$	$S_S = 0.75$	$S_S = 1.0$	$S_S = 1.25$	$S_S \ge 1.5$
A	0.8	0.8	0.8	0.8	0.8	0.8
B	0.9	0.9	0.9	0.9	0.9	0.9
C	1.3	1.3	1.2	1.2	1.2	1.2
D	1.6	1.4	1.2	1.1	1.0	1.0
E	2.4	1.7	1.3	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8
F	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8

Note: Use straight-line interpolation for intermediate values of S_s.

$$\text{In } S_S = 0.56 \rightarrow F_a = 0.8$$

- **Select Fv in Table 11.4-2**

Table 4-10:Long - Period Site Coefficient Fv (Table 11.4-2 from ASCE7-16)

Table 11.4-2 Long-Period Site Coefficient, F_v

Site Class	Mapped Risk-Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameter at 1-s Period					
	$S_1 \le 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 = 0.5$	$S_1 \ge 0.6$
A	0.8	0.8	0.8	0.8	0.8	0.8
B	0.8	0.8	0.8	0.8	0.8	0.8
C	1.5	1.5	1.5	1.5	1.5	1.4
D	2.4	2.2[a]	2.0[a]	1.9[a]	1.8[a]	1.7[a]
E	4.2	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8
F	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8

Note: Use straight-line interpolation for intermediate values of S_1.
[a]Also, see requirements for site-specific ground motions in Section 11.4.8.

$$\text{In } S_1 = 0.28 \rightarrow F_v = 0.8$$

Calculate S_{DS} , S_{D1}

$S_{DS} = F_a \ S_s = 0.8 * 0.56 = 0.448$

$S_{D1} = F_v \ S_1 = 0.8 * 0.28 = 0.224$

In Etabs.

$$S_{DS} = \frac{2}{3} * 0.448 = 0.298$$

$$S_{D1} = \frac{2}{3} * 0.224 = 0.149$$

- **Select Risk Category.**

Table 4-11:Table 1604.5 Risk Category of Buildings and other Structures

TABLE 1604.5
RISK CATEGORY OF BUILDINGS AND OTHER STRUCTURES

RISK CATEGORY	NATURE OF OCCUPANCY
I	Buildings and other structures that represent a low hazard to human life in the event of failure, including but not limited to: • Agricultural facilities. • Certain temporary facilities. • Minor storage facilities.
II	Buildings and other structures except those listed in Risk Categories I, III and IV.
III	Buildings and other structures that represent a substantial hazard to human life in the event of failure, including but not limited to: • Buildings and other structures whose primary occupancy is public assembly with an occupant load greater than 300. • Buildings and other structures containing Group E occupancies with an occupant load greater than 250. • Buildings and other structures containing educational occupancies for students above the 12th grade with an occupant load greater than 500. • Group I-2 occupancies with an occupant load of 50 or more resident care recipients but not having surgery or emergency treatment facilities. • Group I-3 occupancies. • Any other occupancy with an occupant load greater than 5,000.[a] • Power-generating stations, water treatment facilities for potable water, wastewater treatment facilities and other public utility facilities not included in Risk Category IV. • Buildings and other structures not included in Risk Category IV containing quantities of toxic or explosive materials that: Exceed maximum allowable quantities per control area as given in Table 307.1(1) or 307.1(2) or per outdoor control area in accordance with the *International Fire Code*; and Are sufficient to pose a threat to the public if released.[b]
IV	Buildings and other structures designated as essential facilities, including but not limited to: • Group I-2 occupancies having surgery or emergency treatment facilities. • Fire, rescue, ambulance and police stations and emergency vehicle garages. • Designated earthquake, hurricane or other emergency shelters. • Designated emergency preparedness, communications and operations centers and other facilities required for emergency response. • Power-generating stations and other public utility facilities required as emergency backup facilities for Risk Category IV structures. • Buildings and other structures containing quantities of highly toxic materials that: Exceed maximum allowable quantities per control area as given in Table 307.1(2) or per outdoor control area in accordance with the *International Fire Code*; and Are sufficient to pose a threat to the public if released.[b] • Aviation control towers, air traffic control centers and emergency aircraft hangars. • Buildings and other structures having critical national defense functions. • Water storage facilities and pump structures required to maintain water pressure for fire suppression.

- **Select Seismic Design Category.**

Table 4-12: Seismic Design Category Based on Short-Period (Table 11.6-5 from ASCE 7-16)

TABLE 11.6-1 Seismic Design Category Based on Short-Period Response Acceleration Parameter

	Risk Category	
Value of S_{DS}	I or II or III	IV
$S_{DS} < 0.167$	A	A
$0.167 \le S_{DS} < 0.33$	B	C
$0.33 \le S_{DS} < 0.50$	C	D
$0.50 \le S_{DS}$	D	D

In $S_{DS} = 0.3 \rightarrow$ Risk Category: B

Table 4-13:Seismic Design Category Based on 1-S Period Response Acceleration Parameter

TABLE 11.6-2 Seismic Design Category Based on 1-s Period Response Acceleration Parameter

	Risk Category	
Value of S_{D1}	I or II or III	IV
$S_{D1} < 0.067$	A	A
$0.067 \le S_{D1} < 0.133$	B	C
$0.133 \le S_{D1} < 0.20$	C	D
$0.20 \le S_{D1}$	D	D

In $S_{D1} = 0.15 \rightarrow$ Risk Category: C

Select Seismic Design Category worst case C

- **Select Seismic Importance Factor.**

Table 4-14:Seismic Importance Factor (Table 1.5-2 from ASCE 7-16)

Table 1.5-2 Importance Factors by Risk Category of Buildings and Other Structures for Snow, Ice, and Earthquake Loads

Risk Category from Table 1.5-1	Snow Importance Factor, I_s	Ice Importance Factor—Thickness, I_i	Ice Importance Factor—Wind, I_w	Seismic Importance Factor, I_e
I	0.80	0.80	1.00	1.00
II	1.00	1.00	1.00	1.00
III	1.10	1.15	1.00	1.25
IV	1.20	1.25	1.00	1.50

Note: The component importance factor, I_p, applicable to earthquake loads, is not included in this table because it depends on the importance of the individual component rather than that of the building as a whole, or its occupancy. Refer to Section 13.1.3.

Risk Category: $3 \rightarrow I_e = 1.25$

- **Select Seismic Force-Resisting System.**

Table 4-15:Design Coefficients and Factors for Seismic Force - Resisting System (Table 12.2-1 From ASCE 7-16)

Table 12.2-1 Design Coefficients and Factors for Seismic Force-Resisting Systems

Seismic Force-Resisting System	ASCE 7 Section Where Detailing Requirements Are Specified	Response Modification Coefficient, R^a	Overstrength Factor, Ω_0^b	Deflection Amplification Factor, C_d^c
B. BUILDING FRAME SYSTEMS				
1. Steel eccentrically braced frames	14.1	8	2	4
2. Steel special concentrically braced frames	14.1	6	2	5
3. Steel ordinary concentrically braced frames	14.1	3¼	2	3¼
4. Special reinforced concrete shear walls g,h	14.2	6	2½	5
5. Ordinary reinforced concrete shear walls g	14.2	5	2½	4½
6. Detailed plain concrete shear walls g	14.2 and 14.2.2.7	2	2½	2

Design coefficients & Factors for Seismic Force-Resisting System

In Our Region Ordinary reinforced concrete shear Wall,

Because in Hebron Not Active in Earthquake.

R= 5 $\Omega_0 = 2.5$ $C_d = 4.5$

- **Select Permitted Analytical Procedures:**

Table 4-16:Permitted Analytical Procedures (Table 12.6-1 from ASCE 7-16)

Table 12.6-1 Permitted Analytical Procedures

Seismic Design Category	Structural Characteristics	Equivalent Lateral Force Procedure, Section 12.8[a]	Modal Response Spectrum Analysis, Section 12.9.1, or Linear Response History Analysis, Section 12.9.2[a]	Nonlinear Response History Procedures, Chapter 16[a]
B, C	All structures	P	P	P
D, E, F	Risk Category I or II buildings not exceeding two stories above the base	P	P	P
	Structures of light-frame construction	P	P	P
	Structures with no structural irregularities and not exceeding 160 ft (48.8 m) in structural height	P	P	P
	Structures exceeding 160 ft (48.8 m) in structural height with no structural irregularities and with $T < 3.5T_s$	P	P	P
	Structures not exceeding 160 ft (48.8 m) in structural height and having only horizontal irregularities of Type 2, 3, 4, or 5 in Table 12.3-1 or vertical irregularities of Type 4, 5a, or 5b in Table 12.3-2	P	P	P
	All other structures	NP	P	P

[a]P: Permitted; NP: Not Permitted; $T_s = S_{D1}/S_{DS}$.

In Seismic Design Category (C) Equivalent Lateral Force Procedure.

- **Add The Value on Etabs.**

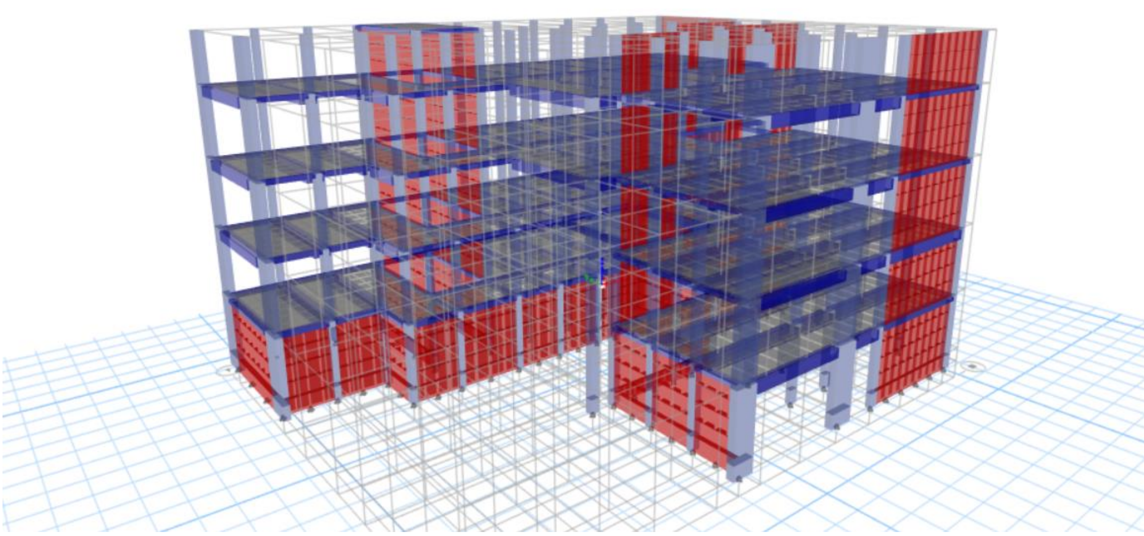


Figure 4-20:Project from Etabs

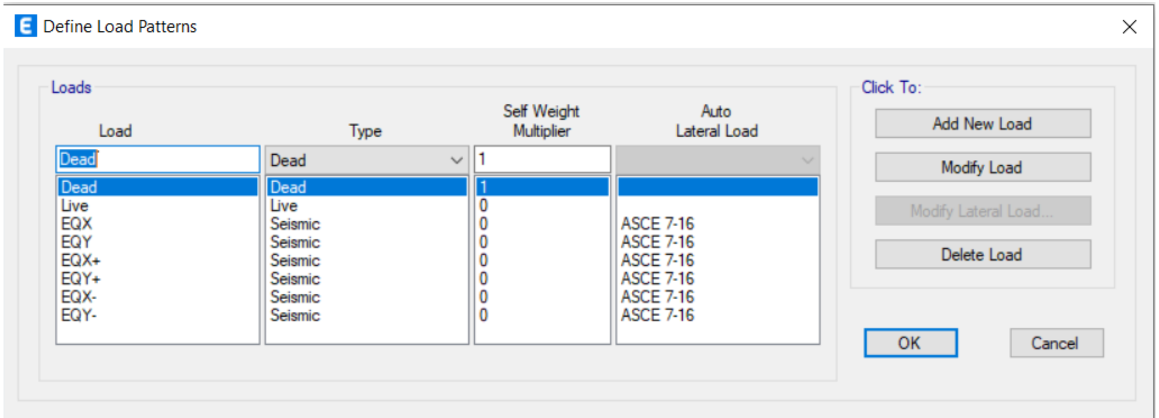


Figure 4-21:Load Patterns for Project in Etabs

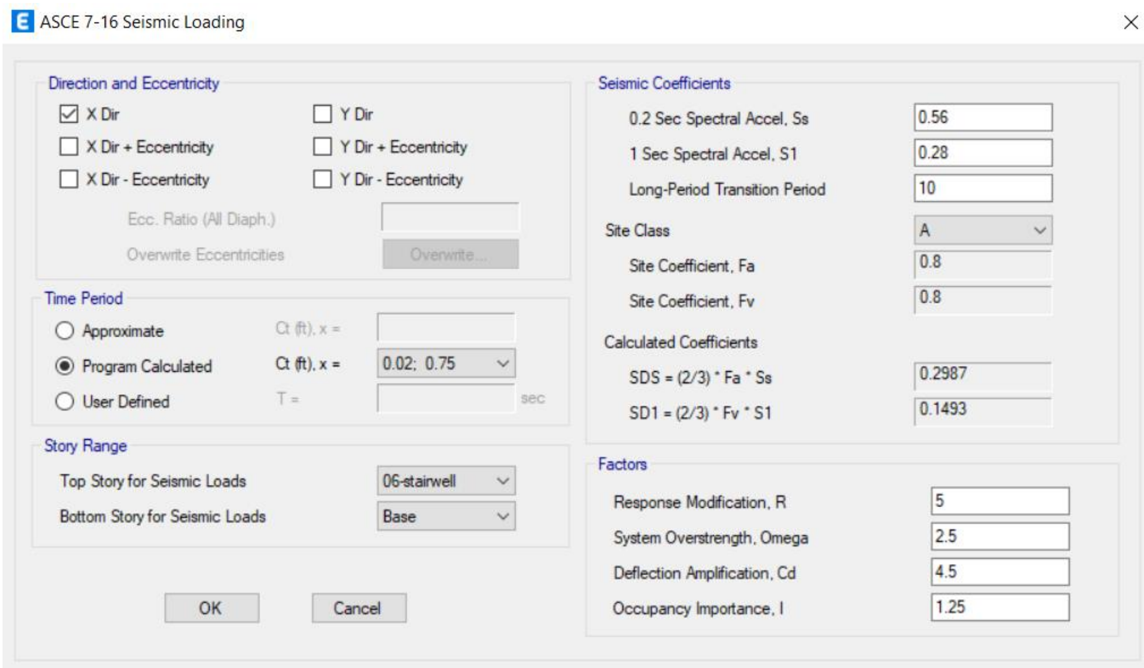


Figure 4-22:Define of Seismic Loading (EQx)

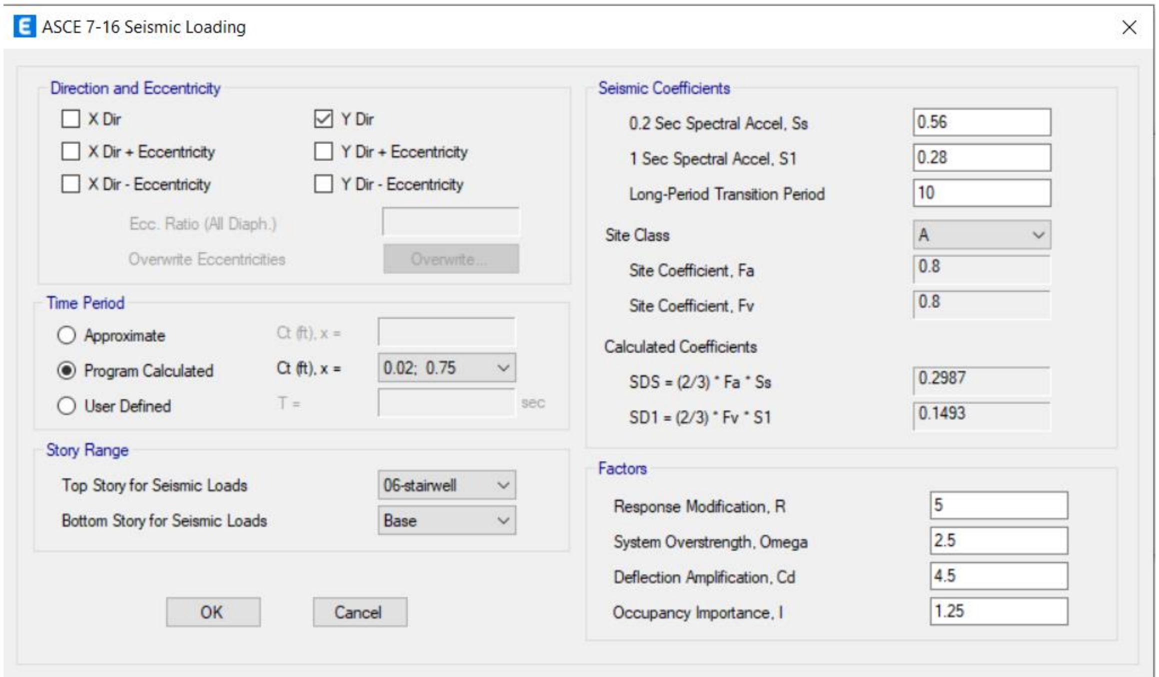


Figure 4-23:Define of eismic Loading (EQy)

- **Add The Value on Safe.**

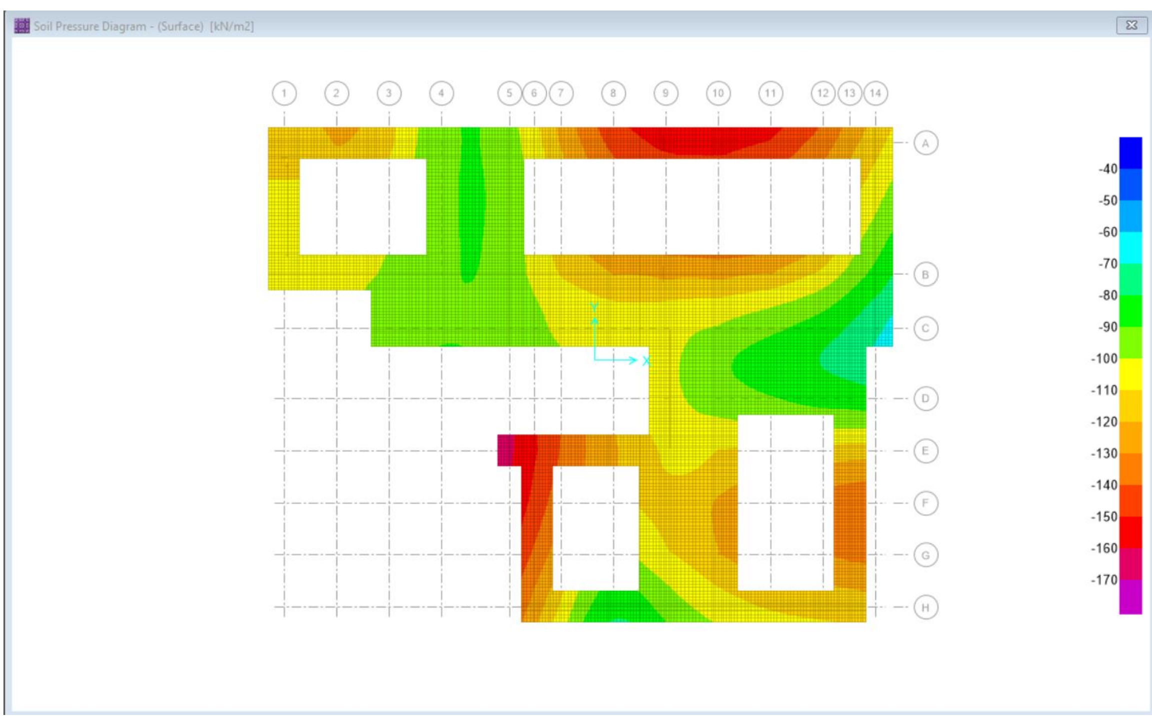


Figure 4-24:Soil Pressure Diagram For Foundation from Project

- **Add The Value on Revit.**

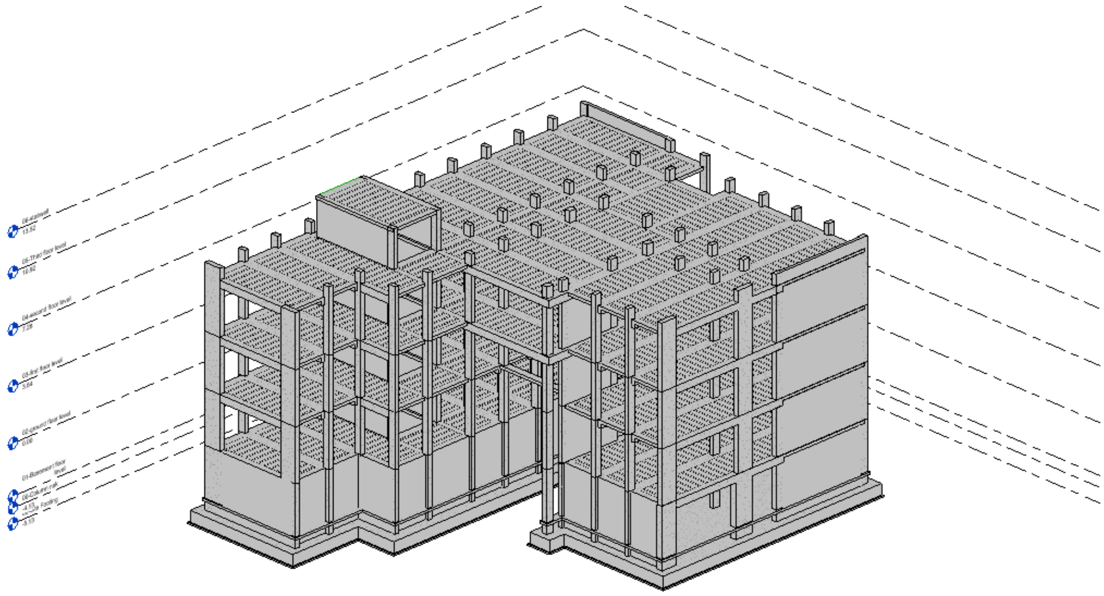


Figure 4-25:Revit Project Model

Chapter 5 : "Results and Recommendations."

5.1 Introduction

In this project, architectural plans were obtained from the Buildings Department of the Ministry of Education. After thoroughly studying these architectural plans, comprehensive structural designs were prepared for the project of **Khalet Mana' Basic Girls School** in Dura. These plans were executed with precision and clarity to facilitate the implementation of the project on the ground. This report provides a detailed explanation of all the steps involved in the structural design of the building, ensuring compliance with the required engineering and structural standards.

5.2 Results

1. A site study was conducted to determine and gather site information from the description and details of the soil report. One of the key pieces of information was the type of soil at the site, which is rock, with a bearing capacity of 230 kN/m^2.

2. One of the most important steps in structural design is determining how to connect the structural elements by identifying the structural system and defining the live loads based on the type and use of the building. Dead loads were calculated through a comprehensive understanding of the building, followed by the design of individual components in an interconnected manner, taking into account engineering specifications.

3. Clear and understandable execution plans were produced based on the American code using AutoCAD and Revit software. A 3D model was also created using ETABS and Revit, including columns, beams; shear walls, and slabs, followed by the transfer of the design loads from ETABS to SAFE. The foundations were then designed, input, and output using SAFE, BEAMD Atir software was also used to analyze certain structural elements. The report and presentation were prepared using Microsoft 365.

4. Gained experience, developed engineering skills, and acquired the most important trait, which is engineering intuition. This intuition gives engineers the ability to identify and solve problems before they occur in a well-considered and thoughtful manner.

5.3 Recommendations

1. Every student or structural designer should be capable of manual design to gain the necessary experience and knowledge for using structural design software effectively.

2. Factors that must be considered include the natural surroundings of the building, the nature of the site, and the impact of natural forces on the location.

3. Ensure the selection of an appropriate structural system for the building that is safe, economical, of high quality, feasible to implement, and meets the structural requirements, specifications, and durability.

Chapter 6 : " References"

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