An-Najah National University
Faculty of Engineering and Information Technology
Building Engineering Department

- Graduation Project II-

Redesign of the Palestinian child institute in Nablus city

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الاهداء:

الحمد لله قولا وفعلا وشكرا ورضا .. نهدي مشروع تخرجنا هذا وتعب السنوات التي مضت الى اباءنا وامهاتنا

الذين وقفوا بجانبنا ودعمونا في كل الاوقات, لم نكن لنصل الى هذا اليوم لولا وجودهم حفظهم الله , كما نهدى

هذا الانجاز الى اساتذة كلية الهندسة ونخص بالذكر مشرفنا المهندس هيثم صوالحه جزاه الله كل خير,

والى شهداء الوطن شهداء فلسطين الحبيبة. .

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Disclaimer statement

This report was written by Musab Abdoh, Hussein Bashir, and Muhammad Shreh in the Department of Building Engineering at the Faculty of Engineering and Information Technology at An-Najah National University (Nablus).

The report's opinions, findings, and recommendations are ours as students only. An-Najah National University does not bear any responsibility or liability for the use of this report in a place other than the place where he worked.

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List of Abbreviation

- KM: Kilo Meter.
- M2: Meter square.
- Ft: Foot.
- C: Celsius.
- Hrs: Hours.
- M: Meter.
- 1st: First
- h: Thickness
- GF: Ground Floor.
- F1: First Floor.
- F2: Second Floor
- F3: Third Floor.
- M: Moment.
- Cm: Centimeter.
- SID: Super Imposed Dead
- L.L: Live Load.
- D.L: Dead Load
- C: Column
- Wu: Ultimate Load.
- Pu: Ultimate load
- Ps: Service load.
- Mu: Moment Ultimate.
- Vu: Shear ultimate.
- $: Dollar.
- CBS: Cost Breakdown Structure
- L/S: Letter per Second
- WxD: Width x Depth.
- VRF: Variable Refrigerate Flow
- PVC: Polyvinyl chloride.
- “: Inch.
- Gpm: Gallon per meter.
- DB: Distribution Board.
- CB: Circuit Breaker.
- V: Volt
- W: Watt
- R: Resistan

Abstract:

One of the most important stages in a person's life is the childhood stage and the establishment of subsequent impacts in his life. Considering the high percentage of children in Palestine affected by autism, hearing, speech, and psychological problems, this requires the existence of centers and institutes specialized in these children, taking care of them and preparing them to integrate into Palestinian society.

The most important of these diseases that need to be treated is autism, and according to the American Autism Association, the number of people with autism is estimated at 6000-8000 most of whom are children, due to the lack of centers and institutes that are technically and environmentally prepared to receive such cases, the need has arisen to create the necessary architectural designs to structurally and environmentally reach the highest necessary standards.

After studying the project and obtaining the architectural plans and comparing them with the architectural standards, and submitting appropriate construction proposals for this building, taking into account the appropriate environmental treatments for the building in general, the building was designed architecturally according to the standards, then the building was designed structurally according to the code, environmentally and electromechanically, and calculating the quantities and costs for the building.

During the analysis and design, several engineering programs were used:

-AUTOCADE

- REVIT

- DESIGN BUILDE

-DAIALUX

-INSUL

-EASE

Chapter 1: Introduction

The Palestinian Institute for Childhood was founded in 2014 as a programmatic reaction to the large number of children suffering from various developmental disabilities, including autism spectrum disorders. At the start of the institute's work period, diagnostic and rehabilitation services within a multidisciplinary team were the main focus of the institute's work, but as demand for services grew, so did the phenomena related to early childhood, and the expansion of partnerships with institutions working in this field led to the expansion of programs to include awareness programs, early detection, diagnosis, and rehabilitation, as well as integrating.

The Palestinian Institute for Childhood presently has several departments and programs dedicated to the concept of childhood, there are also several centers in Nablus from (4-to 5) similar centers and a limited number of Palestinian centers from (15-20) centers throughout the country.

The objectives of this project in general are the integrated design of the building from all aspects of engineering, architectural, structural and electromechanical, and to provide an account of the costs related to the building.

As the design takes into account the creation of a comfortable and safe environment for the building.

1.1 Definition of the building.

The building studied in this project was constructed and located in Nablus, on Al-Junaid Street, behind An-Najah National University. The building consists of five floors, a parking area of 584 square meters, a ground floor of 625 square meters, a first floor of 584 square meters, a second floor of 584 square meters, and a third floor of 584 square meters. The total area is 2961 sqm. On site there is a car park for 15 cars.

The building has a main staircase on the north side of the building, an elevator to the side and an emergency staircase

The ground floor contains classrooms, bathrooms, clinics, and a reception hall. The floor height is 3.6 meters.

The first, second and third floors contain classrooms, bathrooms, meeting room, secretarial, Manager room, clinics, kitchenettes, administration rooms and an antechamber. The height of each floor is 3.6meters.

1.2 Project Problem:

. In this project, the "Children's Institute Building" was redesigned in the best architectural, structural, functional and environmental ways to provide a comfortable and good environment for children so that they can benefit from the center with the best efficiency.

Some of the issues we encountered in building design include:

- There are not enough parking spaces.
- The building needs to move the bathrooms from the middle.
- Energy efficiency and environmental challenge
- Limited natural light and discomfort
- The number of all internal relationships is limited and needs to be increased

1.3 OBJECTIVES.

The main objective of this project is to create a design that meets and contributes to creating a nurturing environment for children in Palestine with the highest possible quality, where all problems related to the building have been studied and resolved, and this will focus on the concept of designing this type of building very carefully. Especially if the building is multi-purpose and will be of interest to different people. The proposed design includes all matters related to architectural aspects, structural design, environmental design, general analysis of the site and fire escape methods. It is designed in the best possible way to create a space that meets the needs of the children within the building and those who work in that building and to make the desired place safe and comfortable for all.

1.4METHODOLOGY.

This project was implemented using several research methods, including data collection, survey, statistics, graphs and numbers, evaluation of the current site, and study of the building architecturally, environmentally and structurally, and all systems of this building were analyzed using simulation programs,

This project includes several stages: The first stage: is an environmental analysis of the construction site, through which the environmental aspect of the building is evaluated, taking into account the general building location, climate, wind movement, solar radiation during the day, lighting, acoustic and thermal comfort in proportion to the sound and noise in the building.

The second stage: Is the architectural re-design of the building, and this stage includes comparing the spaces in the building with the codes and standards and re-designing the building to meet the needs of this constructor perfectly. use the REVIT program to draw environmental and architectural plans.

The third stage is a structural design of the building using the ETABS program to do the inclusion of checks (compatibility, strength, balance). Data will be collected through approved websites, newspapers, books, articles, online scientific journals, statistics, and academic materials, in addition to the use of building personnel.

1.5 Limitations and constraints.

Aside from the design limits discussed previously, there was an architectural constraint in signing the building without affecting the original layout.

One of the problems was to treat the entire glass façade of the building without compromising the architectural concept.

In fact, the significant limitation of the project is that it's a local building with a special needed function

that used for, it had limited standards for spaces, and in addition that there weren't enough recommended spaces to be checked or added for the project. Moreover, the main building boarders were on the land rebounds

1.6 Codes and standards.

- Structural codes:

The following books were used for the structural standards in this project:

- ACI 14 Building Code Requirements for Structural Concrete and Commentary
- ASCE 7-16 Minimum design loads for buildings and other structures

- Architectural standards:

1. Neu fort Architect's data 3rd edition.
2. Neu fort Architect's data 4th edition.
3. Time-saver standards for building types.
4. Time-saver standards for Interior Design and Spacing planning (1).
5. The Metric Handbook Planning and Design Data.

Chapter two: Architectural Aspects.

2.1 literature review:

When you look at the quality of the buildings that have overcome the functional aspects of the architectural design note lasting conflict in the mind of the architect of function and beauty and the ratios required to achieve both of them in an external form and internal relationship with formations each.

1) Entrance

This should be large enough to handle a huge crowd, such as before a meeting. Because many people may be unfamiliar with the structure, the signage should be clean. It should allow for bulk deliveries of food and drink, display material, and equipment unless there is a separate goods entrance. Take into account the door layout, the durability of the surfaces, and easy access to both the kitchen and the hall.

2) Entrance lobbies:

In many ways, having a lobby space at a building's entry makes sense. It can reduce heat loss and draughts by controlling uncontrolled air flow. It can also be used to shed rainfall and create transitional lighting levels, avoiding the accompanying slide hazard farther inside the building.

Size: The lobby should be large enough for a wheelchair user (assisted) or a parent pushing a stroller to navigate the doors at either end, clear of the other door's opening arc. This means adding 1570 mm to the space generated by the arcs for a lobby length. It is 300 mm wider than the effective clear door width to facilitate wheelchair access to the operating system.

Surfaces: Floor surfaces in lobbies should be level and free of any irregularities that could provide a trip hazard. They should also aid in the disposal of rainfall while allowing pushchairs and wheelchairs to move freely.

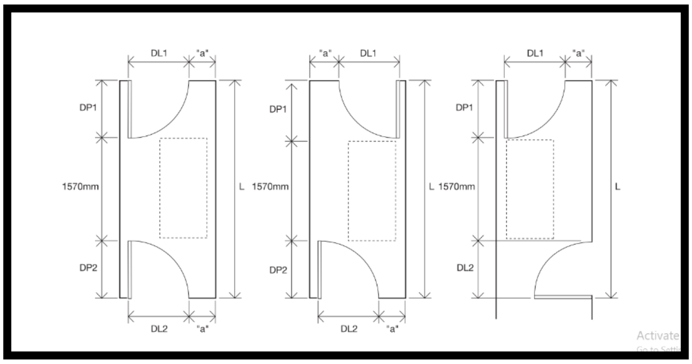


Figure 1:standard door

3)Meeting rooms:

Make them varied sizes if there are more than one. Alternatively, use sliding folding doors to split a single space, albeit some of them may not provide appropriate sound insulation. There should be at least one meeting room with direct access to the hall.

Table I Minimum floor areas for various activities

Function	Area per person (m^2)	
Main hall:		
Closely seated audience	0.46 (based on movable seats, usually armless, 450 mm centre to centre; with fixed seating 500 mm centre to centre will increase to 0.6 m^2)	
Dances	0.55 to 0.9	
Dining	0.9 to 1.1	
Crèche, day nursery or pre-school playgroup	0-2 years	3.75
	2-3	3
	3-5	2.5
Children 5–8 years (out of school and holiday schemes, open access projects)	2.5	
Meeting rooms	2.25	up to 4 people
	2	6 people
	1.55	8–12 people
	1.25	20 people

4) Kitchen

More than a domestic kitchen should not be required. Provide space for setup and final preparations if catered events are planned.

There are three different 'working heights' in kitchen design. The ideal height, according to the weighted conclusions, is 100 mm below elbow height. This gives a number of 905 mm for women and 990 mm for males for the 50th percentile of British people.

However, the range from the 5%ile women to the 95%ile men goes from 830 to 1005 mm. The dimensions recommended here assume that the data will be used to design for a wide range of the British population but aimed specifically to accommodate 95 percent of the elderly whose strength, reach, etc., is most likely to be limited. For more specific populations where heights can be individualized as in specific workplaces,

please refer to specialist literature e.g., British Health & Safety (HSE). Accessing storage at work. The ideal layout of storage space and its accessibility bears a strong .

link between the weights, the frequency of use, and the number of individuals involved Once again, we look to the domestic kitchen for storage zone options. Dishes and pots lifted into and out of ovens are the heaviest and undoubtedly the riskiest things to use and store. According to research (Noble 1982).

95 percent of the senior population can use shelves that are 300 mm deep and 1400 mm high (reduced to 1350 mm when reaching over an obstruction). Deep shelves should be kept above 500 mm for this group since they are more likely to have trouble kneeling and bending. It's worth mentioning that the best storage height also happens to be the best worktop height, resulting in the most demand for space in this area.

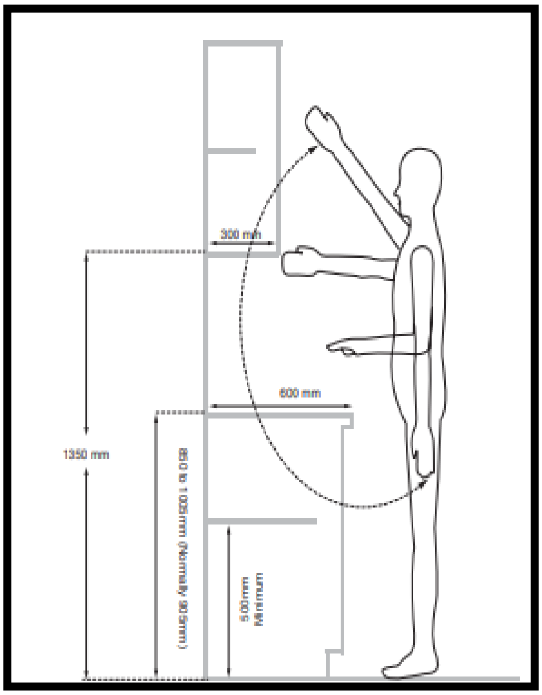


Figure 2: standard kitchen

5) Stairs:

× Width: Access steps must be at least 1.2 meters wide (reduced to 0.9 m for domestic situations). x Treads: Treads should be consistent throughout the flight, rising between 150 and 170 mm and descending between 280 and 450 mm (reduced to between 75 mm and 150 mm rise with a minimum going of 280 mm in domestic situations). No open risers are permitted.

Landings: For every 12 risers with a going of less than 350 mm or 18 risers with a going of more than 350 mm, landings should be supplied that are at least 1.2 m wide (total of 1.8 m rise in domestic situations). At the foot and top of the stair, there should be at least a 1.2 m level approach, with 1.2 m intermediate landings (reduced to 0.9 m for domestic situations). x Handrails: On both sides, handrails should be supplied. Additional stair access is required if it is wider than the minimum.

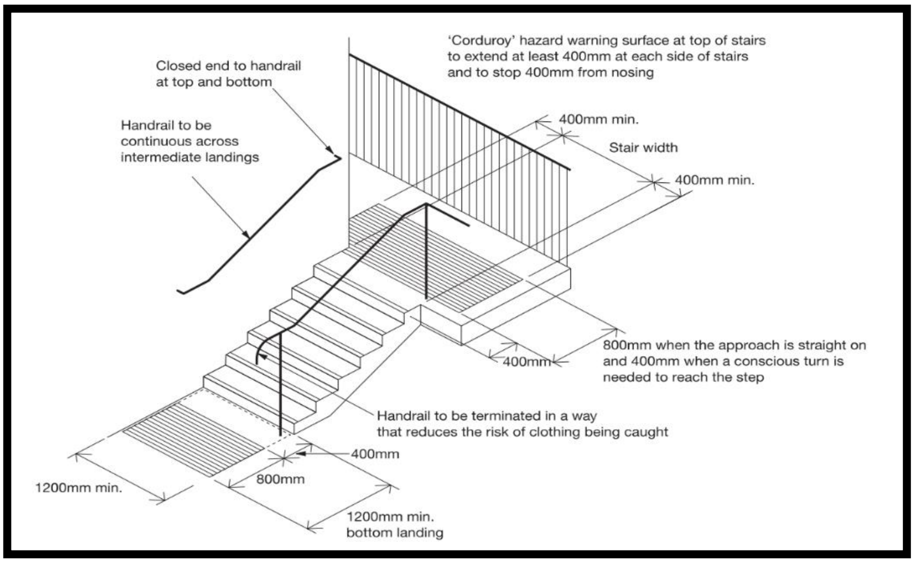


Figure 3: standard stairs

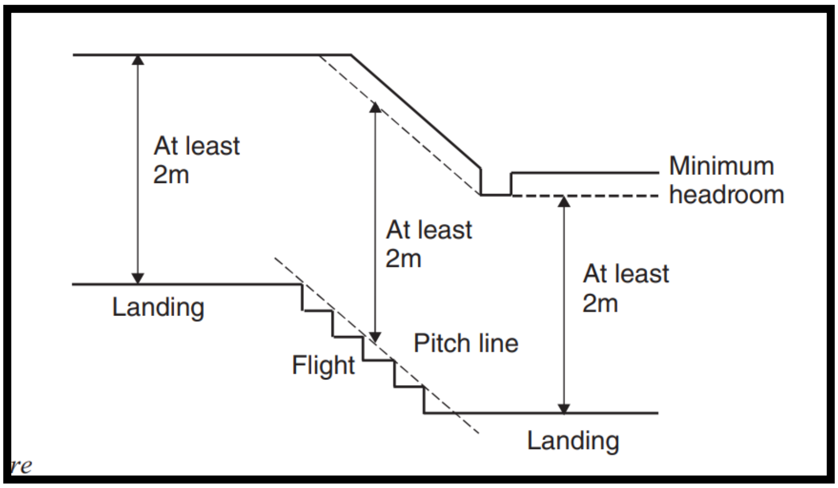


Figure 4: standard stairs

Table I Rise and going

The range of permissible design dimensions for common stairs.

	Rise (mm)		Going (mm)	
	Minimum	Maximum	Minimum	Maximum
Private stairs	150	220	220	300
Utility stairs	150	190	250	400
General access stairs	150	170	250	400

Source: Part K

Figure 5: standard stairs

6)Storage

Each principal usage should have its own storage area.

a) kitchen

The weights involved, the frequency of use, and the number of individuals engaged all influence the best storage space layout and accessibility.

Storage zone recommendations. Dishes and pots lifted into and out of ovens are the heaviest and undoubtedly the riskiest things to use and store. According to research (Noble 1982), 95 percent of the older population can use shelves that are 300 mm deep and 1400 mm high (reduced to 1350 mm when reaching over an impediment). Deep shelves should be kept above 500 mm for this group since they are more likely to have trouble kneeling and bending. It's worth noting that the best storage height is also the best worktop height, resulting in the least amount of space demand in this zone.

b) seating and other furniture

c)crèche/kindergarten

The kitchen store should be accessible directly from the kitchen, while the others should be accessible from the hall. Storage should be as extensive as space and money permit.

7) Corridors:

Within structures, corridors will be designed to meet a variety of purposes. Minimum sizes and surface material conditions for usually horizontal movement around a structure should be required to satisfy inclusive design principles. A more ergonomic strategy can be used for other, non-standard access.

Width: The corridor should be wide enough for wheelchair users (who must be accompanied) or a parent pushing a pushchair to go about freely. Local izednarrowing is permissible as long as the fundamental idea is not jeopardized. A minimum unobstructed width of 1200 mm is required, with passing spaces of 1800 mm square at intervals.

Surfaces: Corridor floor surfaces should be flat and non-slip, with no patterns that could be misinterpreted for stairs. To help those with vision impairments, there should be enough contrast between the floor, wall, and ceiling, as well as adequate lighting levels.

Number of People	Women		Men			Barrier-free WC cubicle
	WC	WB	UR	WC	WB	
medium level of simultaneous use						
25	1	1	1	1	1	1W 2M
50	2	2	2	1	1	
100	3	3	3	1	2	
300	5	3	5	2	3	
500	6	4	6	3	4	
700	7	5	7	4	5	
1000	9	6	9	5	7	
1500	11	8	11	7	9	2W 2M
2000	13	10	13	9	11	
3000	17	14	17	12	14	
4000	21	18	21	15	18	3W 3M
5000	24	21	24	18	21	
6000	26	23	26	20	23	

Corridor handling capacity (C_c) in people per minute can be calculated using:

$$C_c = 60\,v\,D\,W$$

where: v is the average pedestrian speed (m/s)
D is the average pedestrian density (people per m^2)
W is the corridor width (m)

Free flow design: D = 0.3 people per m^2 and v = 1.0 to 1.3 m/s

Full flow design: D = 1.4 people per m^2 and v = 0.6 to 0.8 m/s

Figure 6:Standard of corridor

8) reception and waiting:

It is common practice to provide a single point of entry for all users of the building, students, staff, and visitors alike. Therefore, a key requirement is to be able to receive high volumes of people efficiently and effectively while providing a pleasant environment that will engage visitors in the work. This involves detailed design of reception spaces, and the ability for the reception to have a direct connection with other parts of the building.

9) Toilets:

Separate bathrooms will be required for males, women, and those with disabilities. Smaller toilets may also be required for small children.

Unisex baby-changing stations should be available.

Sanitary and services

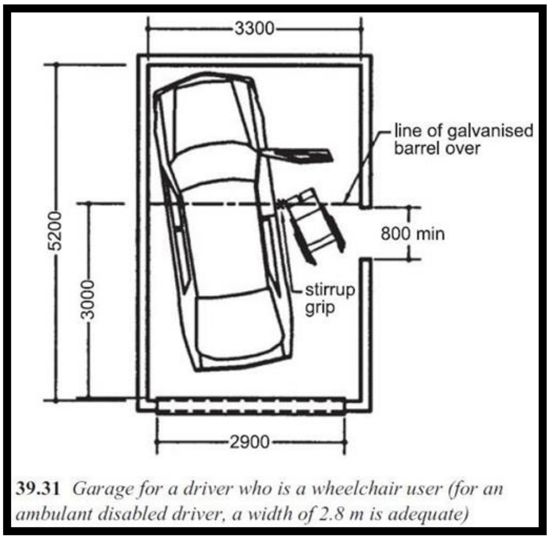
Sanitary units are required in every structure. As a result, the following table was used to determine the number of sanitary units necessary in the building:

10)Disabled parking design

Parking for impaired or handicapped individuals is one of the most crucial things to study and consider.

Disabled people have distinct demands and modes of transportation than

healthy people



39.31 *Garage for a driver who is a wheelchair user (for an ambulant disabled driver, a width of 2.8 m is adequate)*

Figure 7:standard of parking

11) Ramps

Because of the different levels of topography on the site, separate ramps were created for cars and disabled people.

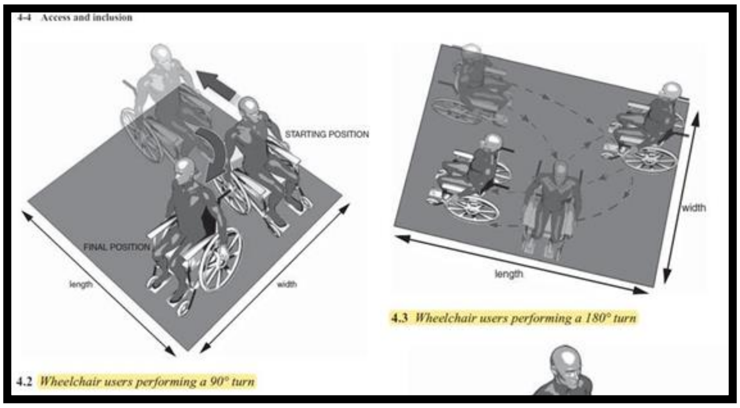


Figure 8:standard of ramp.

Table V Space required for users of self-propelled wheelchairs to turn through 90° (Figure 4.2)

Chair type	Space required Length (mm)	Width (mm)
Manual wheelchair	1345*	1450*
Attendant propelled	1200–1800	1500–1800
Electric wheelchair	1600*	1625*
Electric scooter	1400–2500	1300–2500

*90% of users.

Table VI Space required for users of self-propelled wheelchairs to turn through 180° (Figure 4.3)

Chair type	Space required Length (mm)	Width (mm)
Manual wheelchair	1950*	1500*
Attendant propelled	1600–2000	1500–1800
Electric wheelchair	2275*	1625*
Electric scooter	2000–2800	1300–2200

*90% of users

Disabled persons should be handled differently than regular people. Typically, the maximum slope is 8%. To make movement easier for those with impairments, straight ramps are preferred rather than curved ramps

4-6 Access and inclusion

Table VIII Maximum ramp length between landings

Gradient	Length of ramp between level landings (m)
1:20	10
1:19	9
1:18	8
1:17	7
1:16	6
1:15	5
1:14	4
1:13	3
1:12	2

Figure 9: Standard for ramp length

12) Elevators

Stairs calculations are based on a variety of factors, including the building's floor area and type, population, and working hours.

The MEEB guide for elevator design provided all of the tables and references in this section (Walter).

TABLE 32.9 Elevator Equipment Recommendations

Building Type	Car Capacity[a] lb	Car Capacity[a] kg	Rise ft	Rise m	Minimum[a] Car Speed fpm	Minimum[a] Car Speed m/s
Office building	2500	1250	0–125	0–40	350–400	2.0
	3000	1250	126–225	41–70	500–600	2.5
	3500	1600	226–275	71–85	700	3.15
			276–375	86–115	800	4.0
			Above 375	>115	1000	5.0
Hotel	2500	1250	As above		As above	
	3000	1250				
Hospital	3500	1600	0–60	0–20	150	0.63
	4000	2000	61–100	21–30	200–250	1.0
			101–125	31–40	250–300	1.6
			126–175	41–55	350–400	2.0
			176–250	56–75	500–600	3.15
			>250	>75	700	4.0
Apartments	2000	1000	0–75	0–25	100	0.63
	2500	1250	76–125	26–40	200	1.0
			126–200	41–60	250–300	1.6
			>200	>60	350–400	2.0
Stores	3500	1600	0–100	0–30	200	1.0
	4000	2000	101–150	31–45	250–300	1.6
	5000	2500	151–200	46–60	350–400	2.0
			>200	>60	500	2.5

Figure 10: Standard for elevator

<u>Elevator:</u>

Population of the building: 128 persons

Capacity= 2500 lb. (1200 kg)

Rise 20m

Speed: = 350 fpm

Handling capacity = 20.48 persons/5min

TABLE 32.5 Car Passenger Capacity (*p*)

Elevator Capacity lb (kg)	Maximum Passenger Capacity	Normal Passenger[a] Load per Trip
2000 (907)	12	10
2500 (1134)	17	13
3000 (1361)	20	16
3500 (1588)	23	19
4000 (1814)	28	22

Figure 11:Standard for elevator capacity.

2.2 Project Description:

The Palestinian Institute for Childhood was established in 2014 in the city of Nablus, located on the western side of the city, within the walls of An-Najah National University, as a programmatic response to the phenomenon of the high number of children suffering from various developmental difficulties, specifically in the autism spectrum. Diagnostic and rehabilitation services within a multidisciplinary team formed the main focus of the institute's work at the beginning of its work period, but the increase in demand for services expanded and multiplied the phenomena related to early childhood, and also the expansion of partnerships with institutions working in this field led to the expansion of programs to include awareness programs early detection, diagnosis, and rehabilitation as well as integrating children into an appropriate educational environment.

The Palestinian Institute for Childhood now includes several departments and programs that focus on the concept of early childhood in a broad framework.

The Palestinian Institute for Childhood:

1. The institute consists of four floors

The institute consists of three floors and a basement.

2. Administrative departments

The administration room is one of the most important rooms in the institute, and those responsible for the administration of the institute are responsible for carrying out the various functions of the administration of the institute that it supervises.

3. Clinics Department:

The clinic's section is distinguished by the services that it provides to parents who file a specific complaint about their child, where the child's condition is diagnosed through tests and diagnoses that help parents know the strengths and weaknesses of their child who needs to develop them, where multi-experienced specialists meet to discuss the child's situation to Come up with the best plan and share it with the parents.

The clinic's department consists of:

- Diagnostic and Psychotherapy Unit.

Treatment is provided for children suffering from childhood disorders, and internationally approved and Arabic-translated diagnoses are used in line with the reality of the Palestinian child.

-special education unit:

It is a unit that works on detecting those with special educational needs, discovering and investing the child's talents and abilities, and using special educational means to develop children's abilities and capabilities, as well as developing and training the senses to benefit from them in acquiring diverse experiences and different knowledge.

- Pronunciation and language unit:

Through which work is done with cases of speech disorders that suffer from a defect in the use of verbal, linguistic, and vocal skills, and communication skills with others, where several assessments are made according to the child’s need: language assessment, pronunciation assessment, assessment of stuttering and speech

- occupational therapy unit.

It is one of the methods of assessment and treatment that cares for children with special needs who have physical, sensory, motor, intellectual, mental, psychological, or social disorders.

- Family Care Unit.

It was established based on the needs that emerged through continuous meetings with parents, as it provides the parents of children with rehabilitation classes (father and mother) through individual and group counseling sessions.

4- Qualification Programs:

- qualifying classes.

It is a division of the Palestinian Institute for Childhood and specializes in rehabilitating children with an autism spectrum disorder.

- Montessori Kindergarten:

The kindergarten was established based on the Montessori principles, which take into account the individual capabilities and idiosyncrasies of each child and provide the means of self-education in the child's environment so that nature is required to be able to arouse the child's interest.

5- reception and waiting.

6- bathrooms:

This includes bathrooms for children and private bathrooms for staff.

7- kitchens:

It includes a kitchen for children and a kitchen for staff.

8- Conference and multipurpose halls:

When it comes to the angle of vision from the audience and the artist on stage, auditoriums or halls should be regarded with caution.

One of the most important aspects of a well-functioning auditorium is the audience's visual comfort, which is achieved by considering the audience's range of vision as well as the height of the seats and stage.

The field of vision that the human eye can adjust to is limited; the following graphics depict the field of vision and stage positioning recommendations.

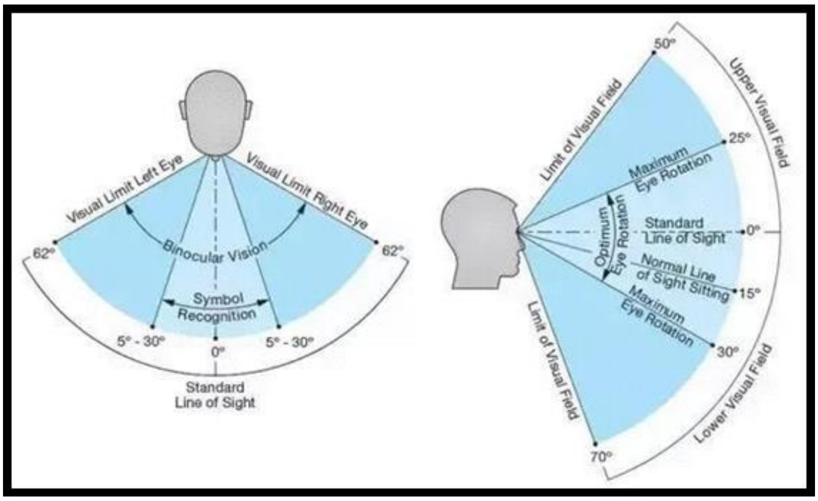


Figure 12:illstration of human sight field

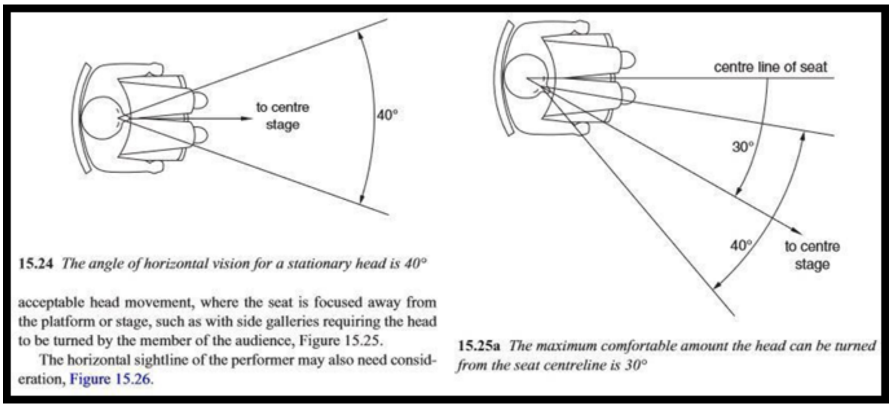


Figure 13: maximum horizontal vision angle for stationary head and turning head:

Standard:

1) design:

Because upkeep budgets are usually limited, it is worthwhile to plan for minimum maintenance in self-contained community centers, and to provide appropriate floor areas for various functions and activities.

2) Safety:

A community center's patrons span from little toddlers to the elderly and disabled. All floors, ramps, and steps should be non-slip, and finishes should be chosen with safety in mind. Angles, projections, and sharp corners should all be avoided.

3) Cleaning:

Community facilities are heavily used, and operating finances are limited. The structure should be simple to clean.

4)Means of escape:

It is extremely vital to prepare and indicate the ways of escape in the event of a fire because:

a) The users, such as meeting attendees, will be unfamiliar with the layout of the structure.

b) A crèche or daycare center is likely to have tiny children.

c) The center is open to the elderly and crippled.

d) People with learning disabilities may use the facilities.

5) Licensing:

Certain usage will necessitate a license, which will almost always come with constraints.

6) Noise:

A community center is more likely to generate noise than to be subjected to it. and are frequently found in residential areas. As a result, they must be constructed to minimize annoyance. Sound separation will be required where multiple usage occur at the same time.

The basic principles of acoustic design should be applied:

a) orientation, such as the placement of entrances, exits, and windows with relation to neighboring structures.

b) layout.

c) shape of rooms.

d) Only in conjunction with mechanical ventilation is double glazing feasible.

e) sound-absorbing coatings that balance durability and clean ability requirements.

g) To reduce external noise, use landscaping, including trees.

Noise-making spaces should not be positioned next to calm spaces unless absolutely necessary. Absorbent surfaces may need to be concentrated at the ceiling or offered through drapes and wall hangings. Management can play an important role in noise management, and this should be discussed with the customer early on.

7) security:

Because they are not continually occupied, are visited by a large number of people, contain expensive equipment, and are secluded, community centers are more prone to break-ins and vandalism than most other buildings.

from other structures Because security requirements may conflict with need for means of escape, it is critical to confer with specialists and local authorities.

8) Disabled people:

Accessibility for disabled individuals is governed by legislation. These rules apply not only to wheelchair users, but also to those with vision and hearing problems and those who use other sorts of mobility assistance. All of them have difficulty with steps and changes of direction, and entrances, circulation spaces, and restrooms should be designed to accommodate this.

9) Legislation:

The local government will provide information on the most recent requirements. If the public will be charged for admission, it is especially crucial to ensure complete compliance.

2.3 Case study:

2.3.1 Overview:

The Center for Childhood Institute is located in the city of Nablus, which is located on the northern West Bank, about 30 miles away.

North Jerusalem. Nablus is located at an altitude of 569 m above sea level.

The site is located in the Al-Junaid area at 32.22 degrees north latitude and 35.25 degrees east longitude

Next to An-Najah National University, the western entrance to the city.

Figure 14: location of the palestinian child institute

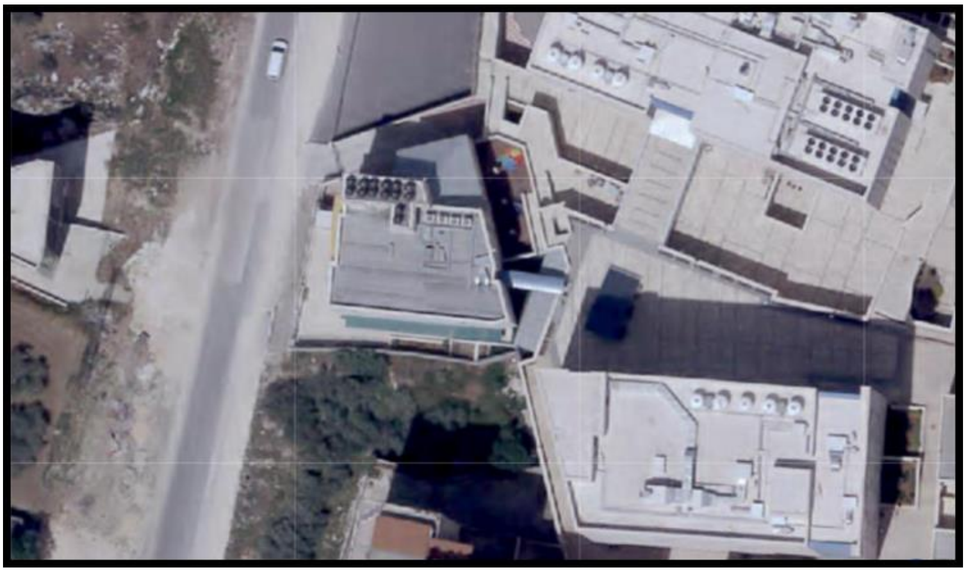


Figure 15: location of the Palestinian child Institute

Figure 16: Model of the Palestinian child institute

Figure 17: Model of the Palestinian child institute

The Figures below show the plan for the Palestinian child institute:

Figure 18:Autocad plan for basement floor.

1- Parking
2- Electrical room
3- Water room
4- Storage
5- Elevator
6- Stair

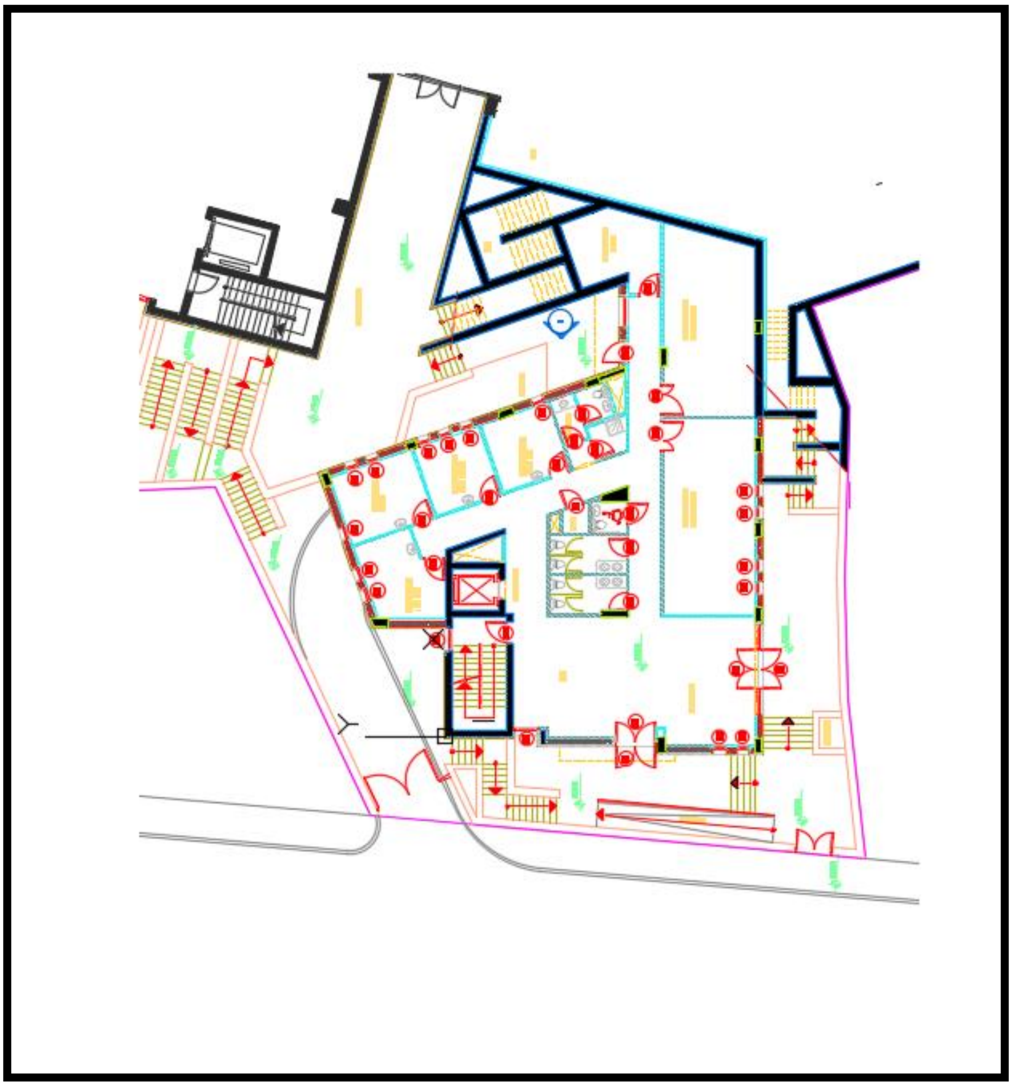


Figure 19: AutoCAD plan for ground floor

1- Reception
2- Waiting room
3- Clinics
4- Bathrooms for staff
5- Bathrooms for child
6- Class room
7- Storage
8- Kitchen
9- Children’s game rooms
10- Stair
11- Elevator
12- Outer yard

Figure 20: AutoCad plan for the first floor

1- Stair
2- Elevator
3- Bathrooms for child
4- Bathrooms for staff
5- Class rooms
6- Library
7- Kitchen
8- Manager room

Figure 21: AutoCad plan for the second floor .

1- Stair
2- Elevator
3- Class rooms
4- Bathrooms for child
5- Library
6- Kitchen
7- Closed yard
8- Resource room
9- Bathrooms for staff
10- Staff room

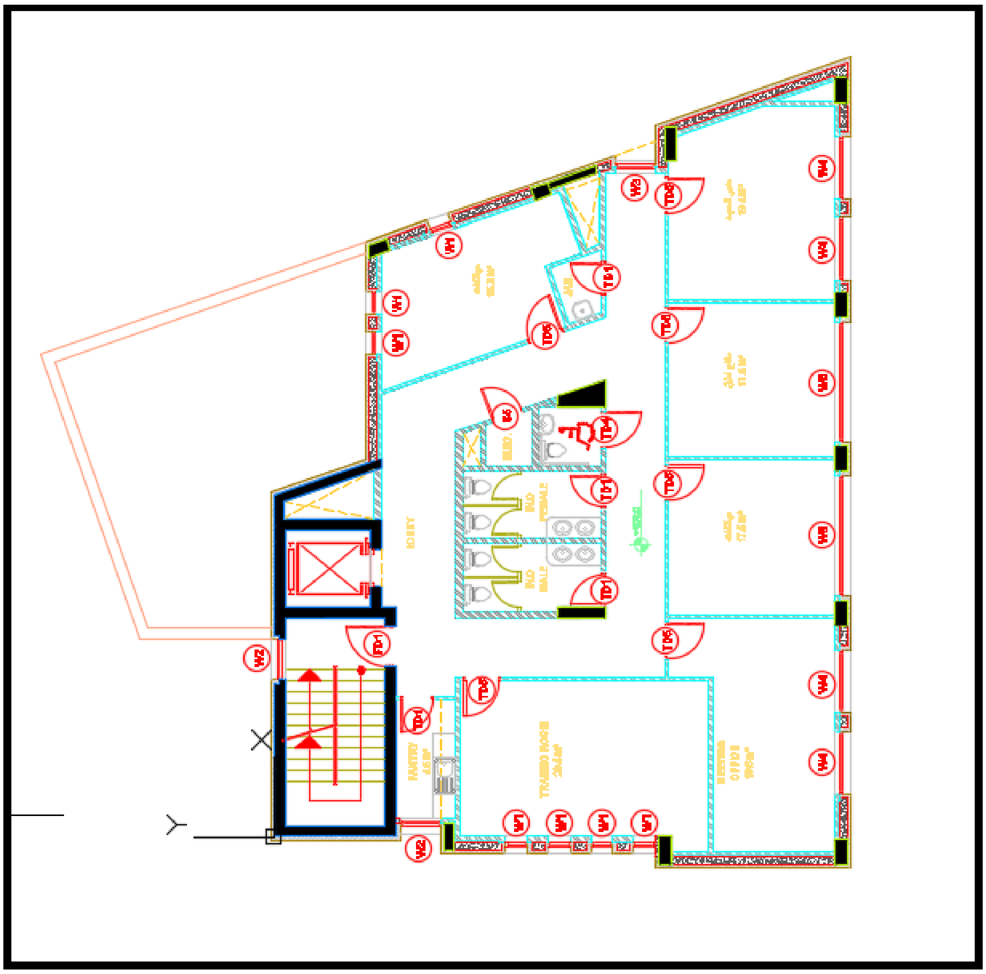


Figure 22: AutoCad plan for thr third floor.

1- Manager room
2- Clinics directors room
3- Stair
4- Elevator
5- Class room
6- Meeting room
7- Training hall
8- Research department
9- Bathrooms

The functional relationships between facilities:

The bubble diagram shows the relationships of rooms with the corridor, with the stairs, with the courtyards and bathrooms, the corridor connecting everyone, and that the classrooms should be quiet and the administration as well.

And that the bathrooms have an appropriate relationship with the rooms.

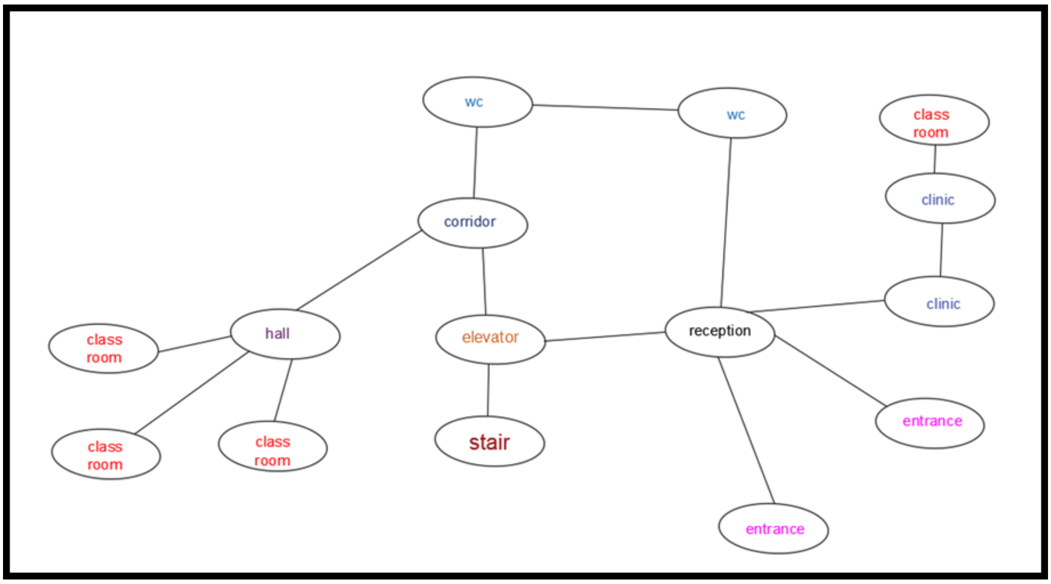


Figure 23: bubble diagram for the Ground Floor

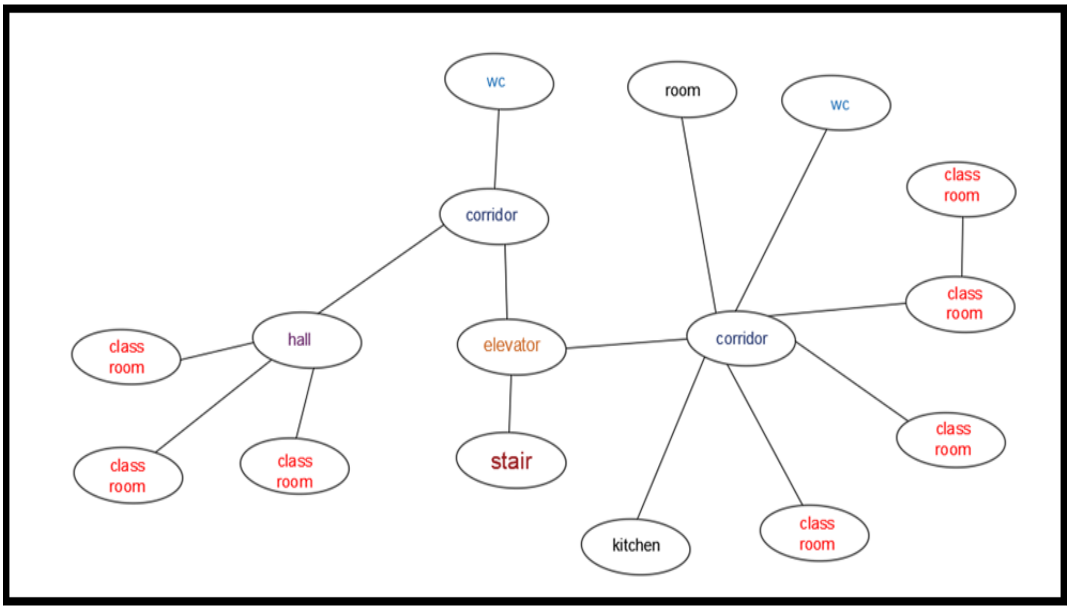


Figure 24: bubble diagram for the First Floor

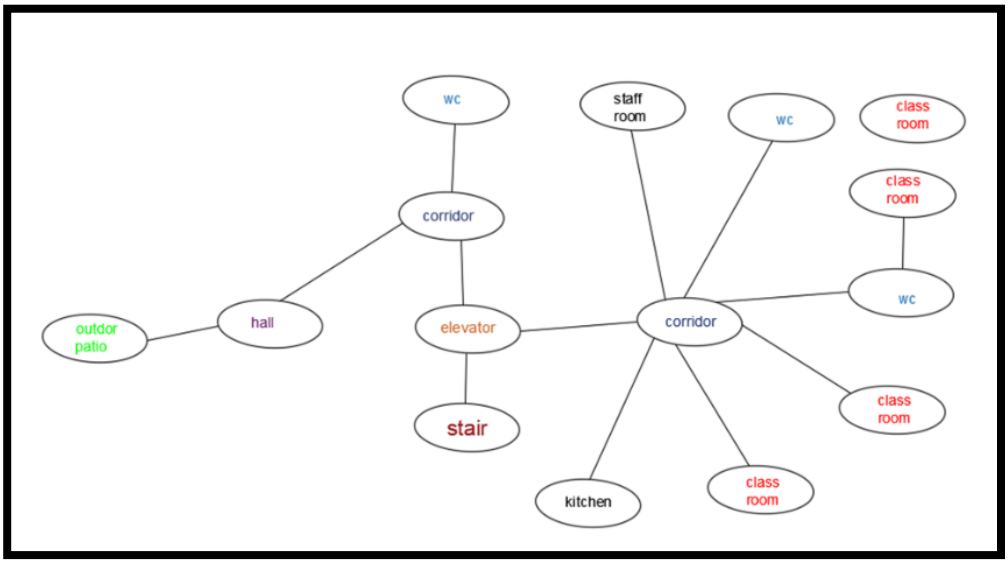


Figure 25: bubble diagram for the Second Floor.

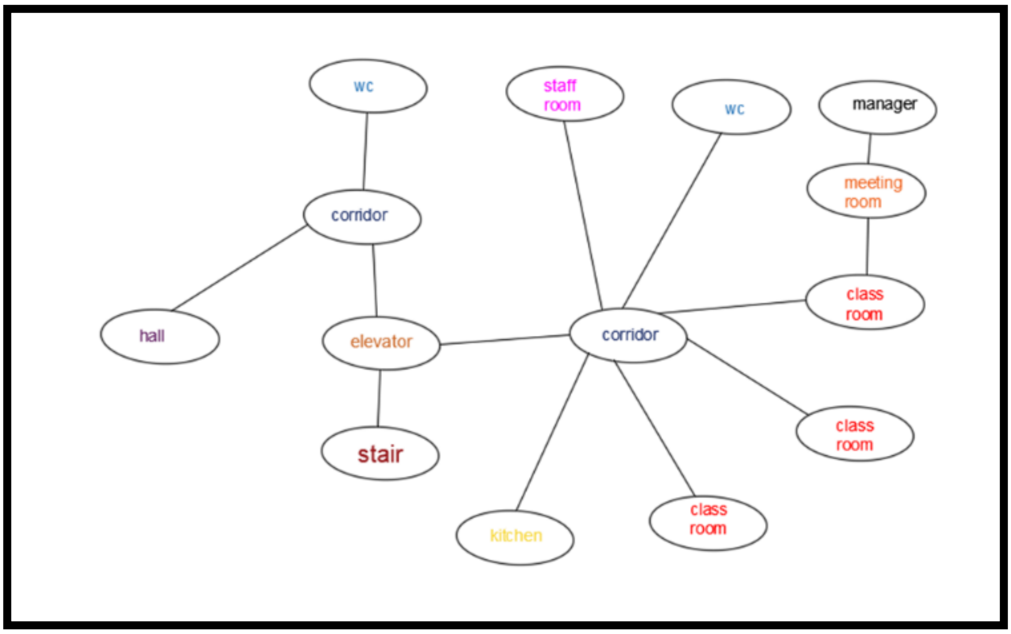


Figure 26: bubble diagram for the Third Floor.

The Figures Below show the Elevation for the Palestinian child institute.

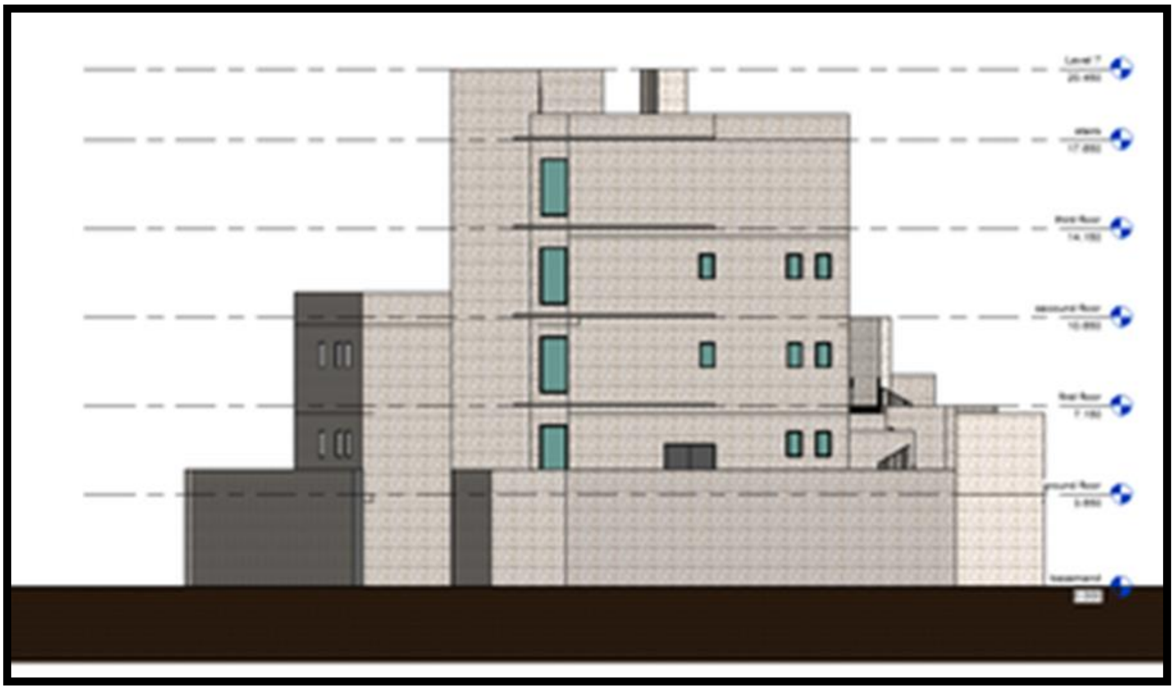


Figure 27: AutoCAD plan for West elevation.

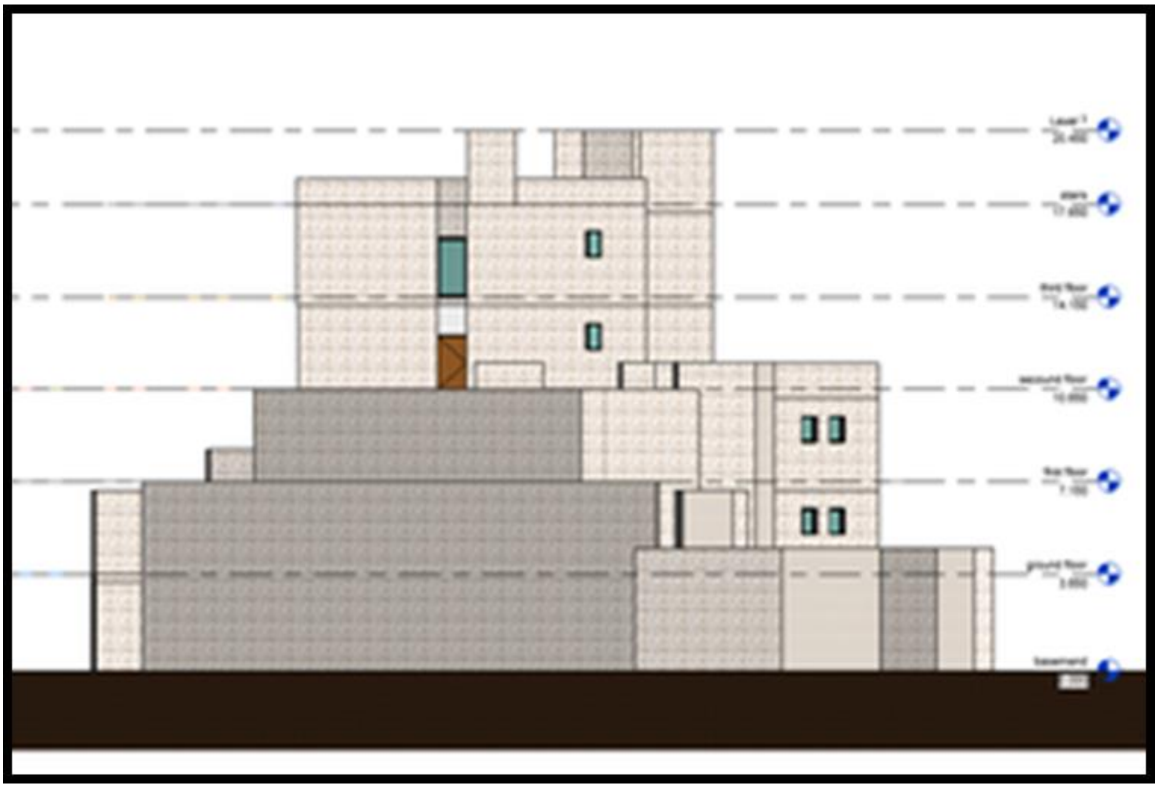


Figure 28: AutoCAD plan for east elevation.

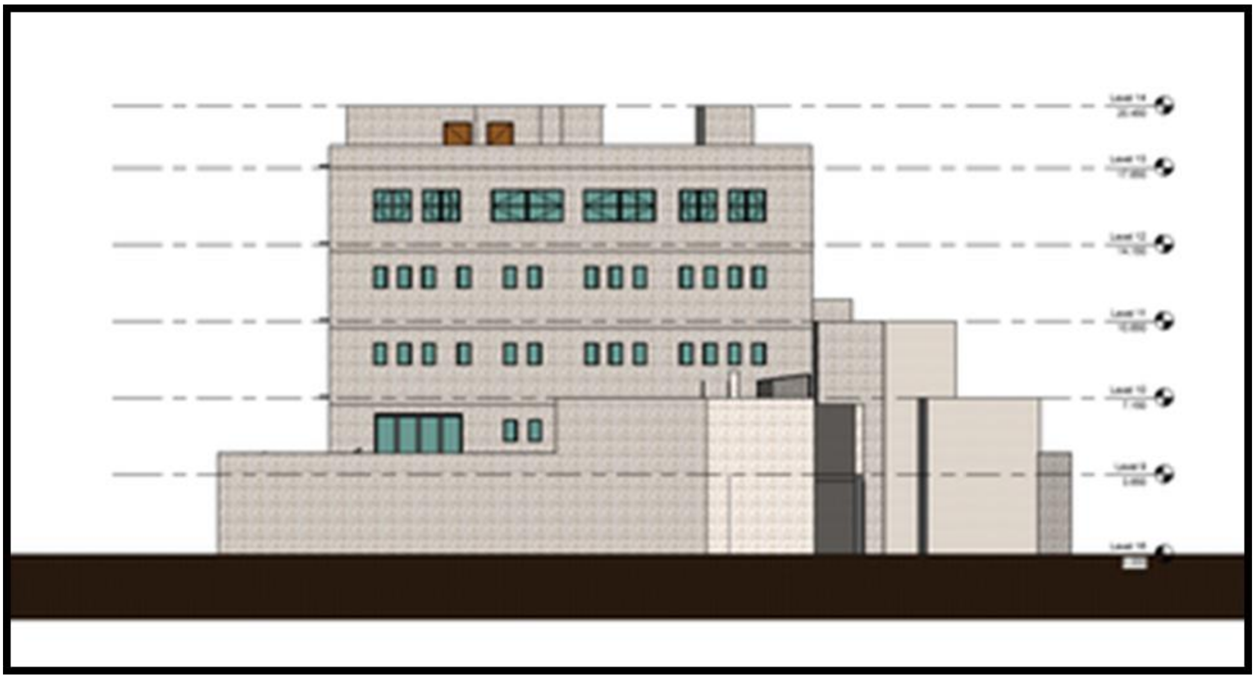


Figure 29: AutoCAD plan for south elevation.

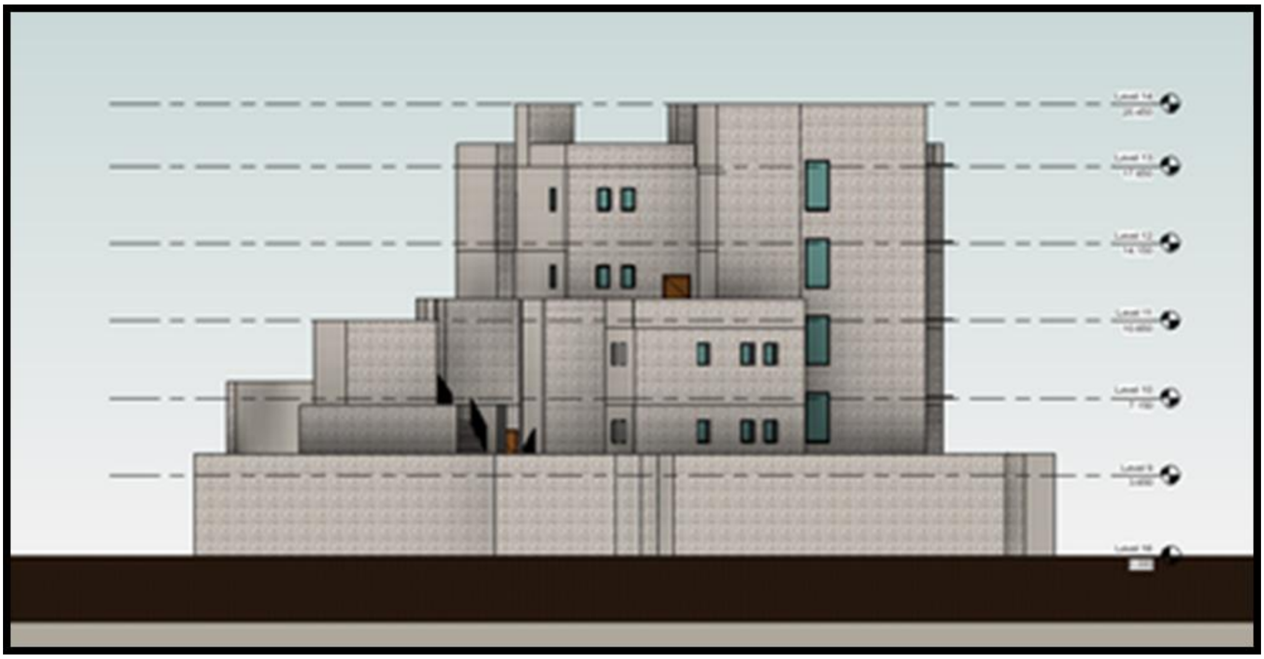


Figure 30: AutoCAD plan for north elevation.

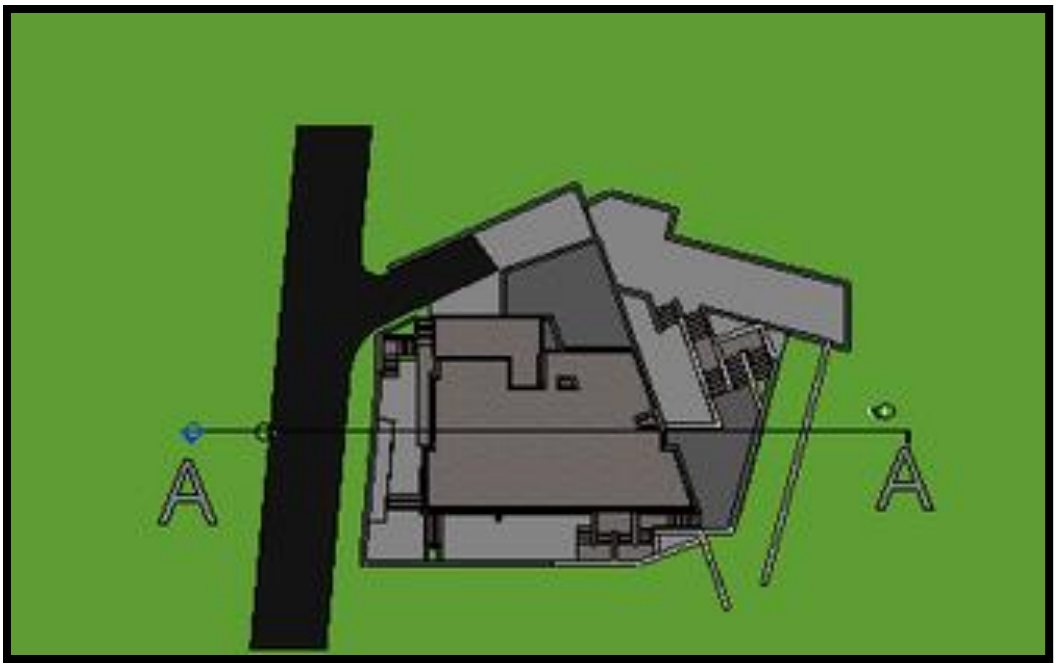


Figure 31: site plan

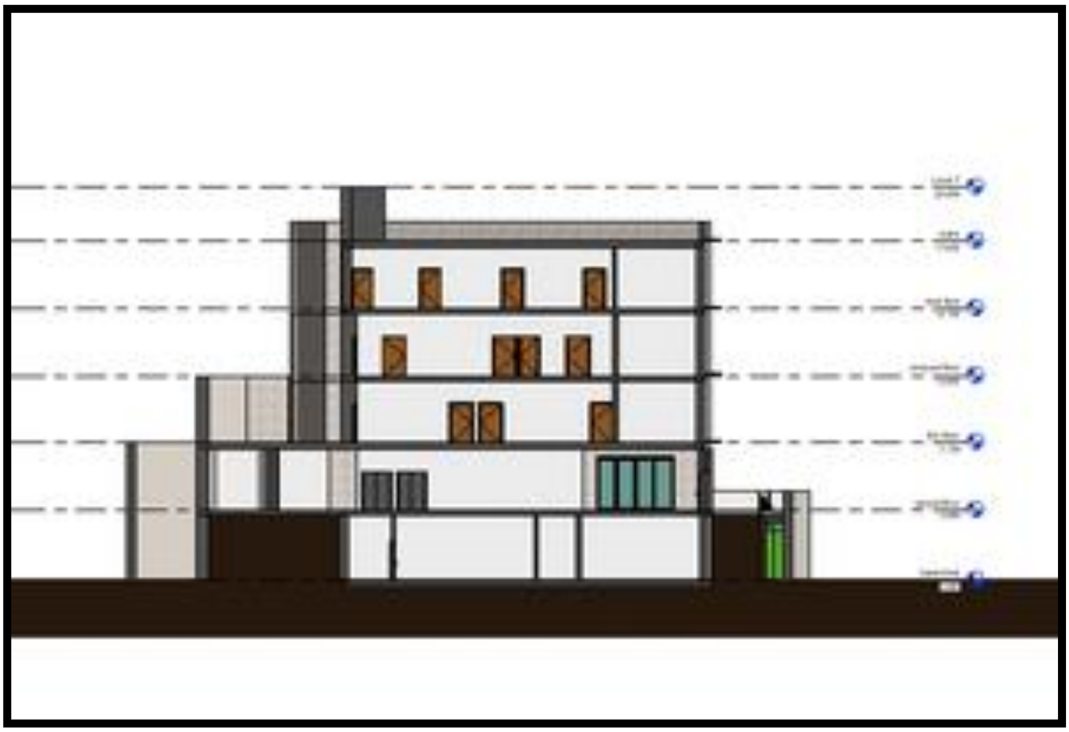


Figure 32: Section A-A

The Figure Below show the Sun Path of the Palestinian child institute.

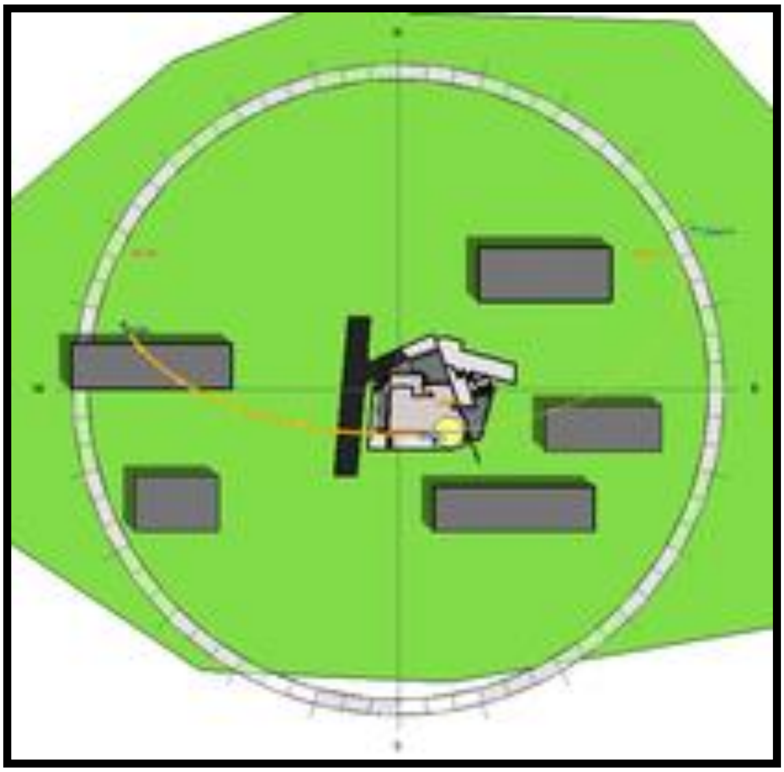


Figure 33: Sun path In summer.

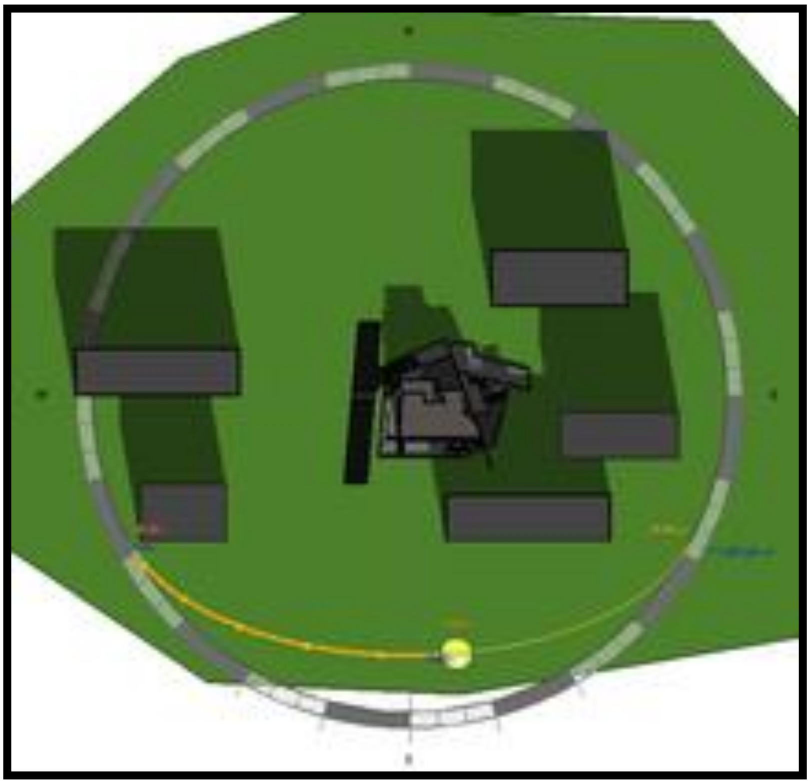


Figure 34: Sun path in winter.

2.4 Site Analysis:

2.4.1 Overview

Architectural design lies in a logical, technical, and scientific process capable of defining forms, organizations, and processes that create spaces dedicated to the human being to carry out specific activities; Like living, working, relaxing, and healing

Site analysis is the first basic benchmark to start with before analyzing the functional spaces of any building. The childhood institute building was designed on this land as part of a development strategic plan for the city within the upcoming years

The architectural design reflects, interprets, and solves both the aesthetic and technical aspects of housing in its broad sense

2.4.2 Website location

The center of the Childhood Institute is located in the city of Nablus, which is located in the north of the West Bank, about 30 miles away

North Jerusalem. Nablus is located at an altitude of 569 m above sea level.

The site is located in Al-Junaid at 32.22 degrees north latitude and 35.25 degrees east longitude

Next to An-Najah National University, the western entrance to the city.

Figure 35: the Location of of the Palestinian child institute and the surrounding

2.4.3 Climatic condition.

Because it is located inside the Mediterranean region at latitude 32.13, the city of Nablus has a Mediterranean climate typified by a dry summer season that lasts for more than five months of the year and a short chilly, rainy winter that lasts for no more than three months in most circumstances.

2.4.3.1: temperature.

The climate of Nablus is classified as a Mediterranean climate, with hot and dry summers

It is cold and rainy in winter. The average temperature reaches 28°C in the summer months and 16°C in the summer months.

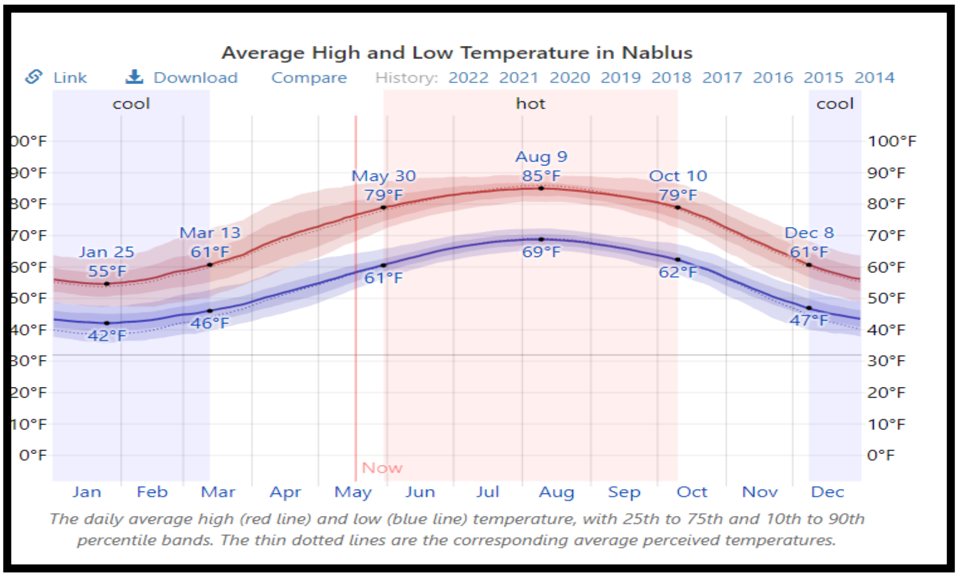


Figure 36:temperatur

2.4.3.2 wind direction and speed.

The winds in Palestine are from the west and northwest, and this will be factored into the facility's natural ventilation.

Describe the wind speed and direction in Palestine, accordingly. In the city of Nablus, the wind speed varies.

The average wind speed changed throughout the year, from the lowest in December to the greatest in June.

The speed is 3.5 meters per second. The prevalent wind directions in the Nablus region are northwest, with an annual average wind speed of (10) km/h.

2.4.3.3 Precipitation Amounts

As for the rain, it is like in the rest of Palestine, the rainfall is limited to the winter and spring seasons, specifically in the period between October and May, when the annual amount of rain reaches about 1660 mm, of which falls 80% in the period between December and March. Source: (Palestinian Meteorology, 2010).

2.4.3.4 Sun’s path

On every given day, the sun follows the same path as the stars through our sky. It rises over the eastern horizon and sets over the western horizon. If you dwell in the mid-north latitudes, the midday sun will always be visible somewhere in the southern sky (most of North America, Europe, Asia, and North Africa).

However, as the weeks and months pass, you will see that the sun's movement is not dissimilar to that of any other star. For one thing, the sun takes 24 hours to complete a full round around the celestial sphere, rather than the usual 23 hours and 56 minutes. We base our days on the movement of the sun for obvious reasons, not the stars

2.4.3.5 Relative humidity

As for the relative humidity in the Nablus governorate, the annual general rate is 61%. (World weather online)

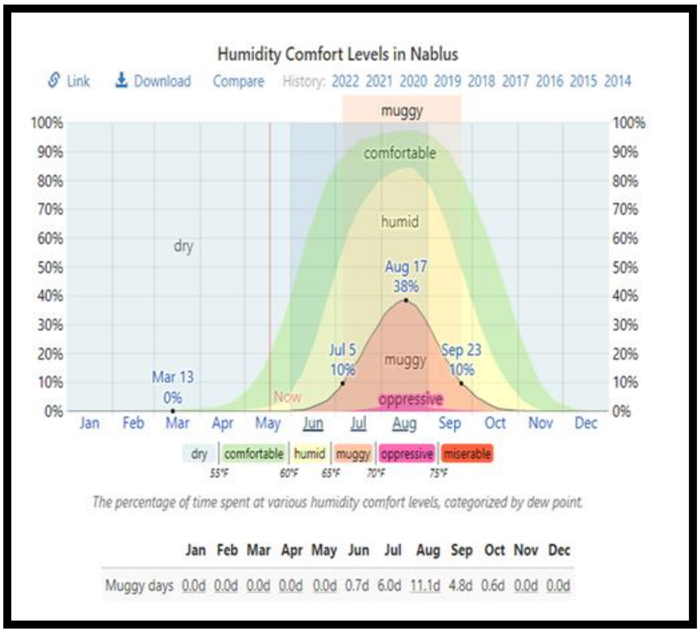


Figure 37:relative humidity

2.5 Architectural modifications:

The Architectural plan before and After Modification:

a) Basement

In this project, the number of people in the building was not taken into account, Therefore, we found a great shortage in the number of parking spaces, and there was a plot of land for the institute next to it on the north side, so we worked on expanding the building to accommodate a larger number of cars.

Figure 38:Basement before modification.

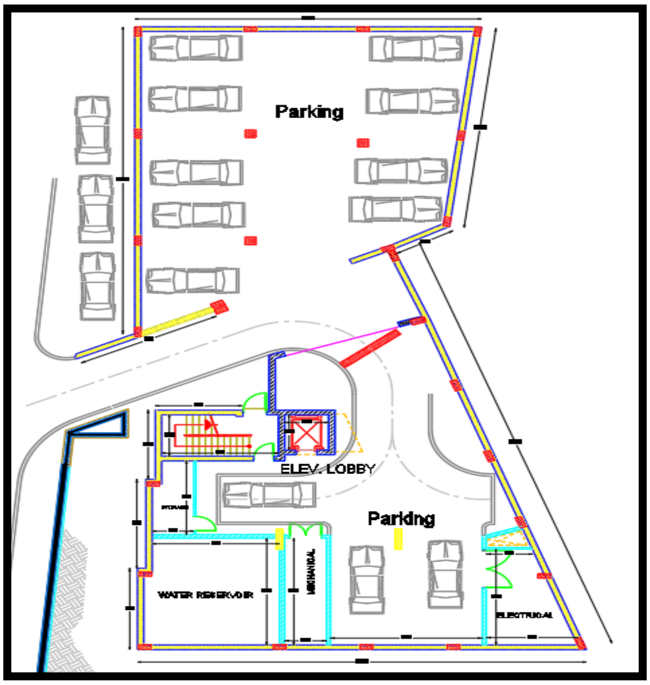


Figure 39:Basement after modification.

b) Ground floor

On the first floor there were several problems, the most important of which was the problem of the bathrooms located in the middle, and the classrooms also had their areas not as required by the standard, through the expansion of the building we worked on removing the bathrooms on the eastern facade, and we worked on adding classrooms and expanding the old ones as well.

Figure 40:Ground floor before modification.

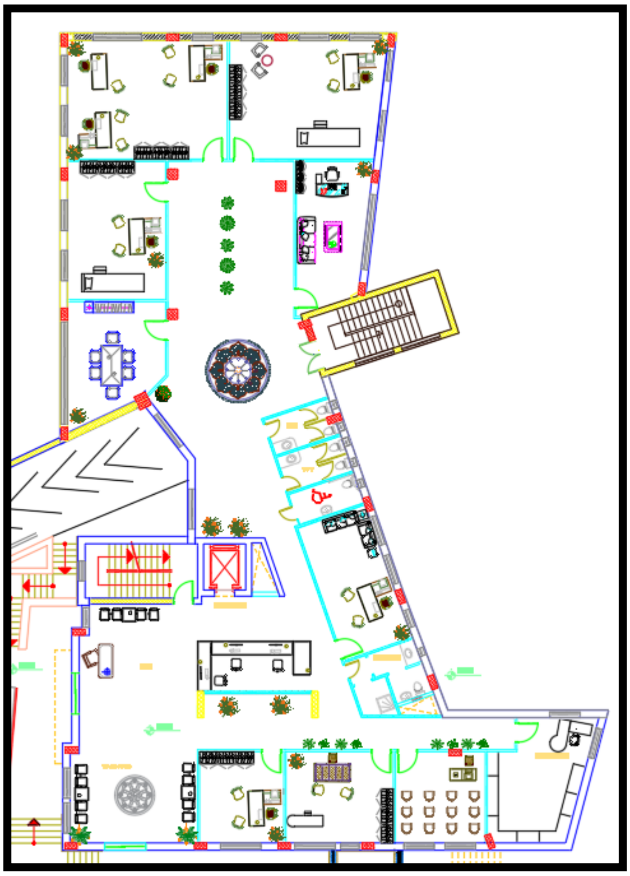


Figure 41:Ground floor after modification.

c) 1 st floor

On the first floor, similar to the ground floor, waiting and rest rooms were added in the middle, and classrooms were added and expanded. The first floor contained 4 classrooms, so we added 3 additional rows, and made a meeting room.

Figure 42:First floor before modification.

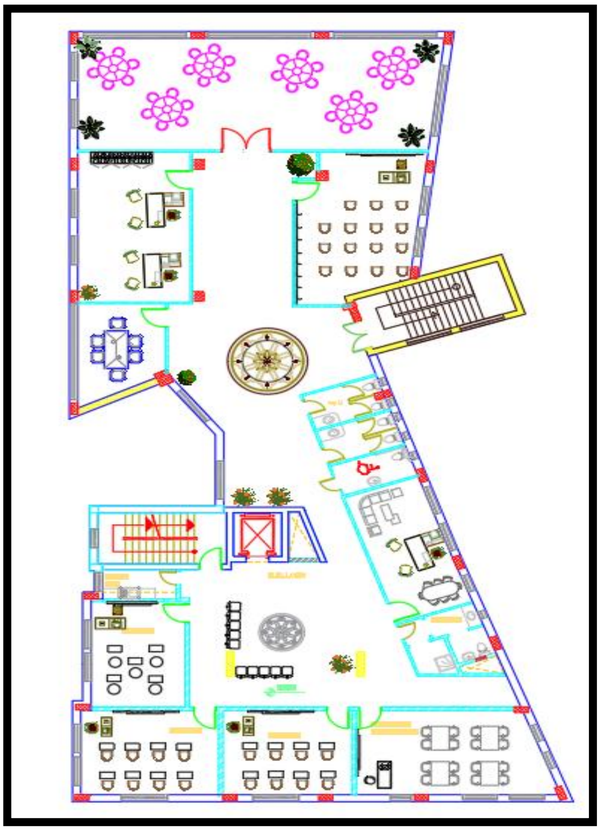


Figure 43:First floor after modification.

d) 2nd floor

On the second floor, we worked on making an additional closed outdoor yard for the old building for students.

Figure 44:Second floor before modification.

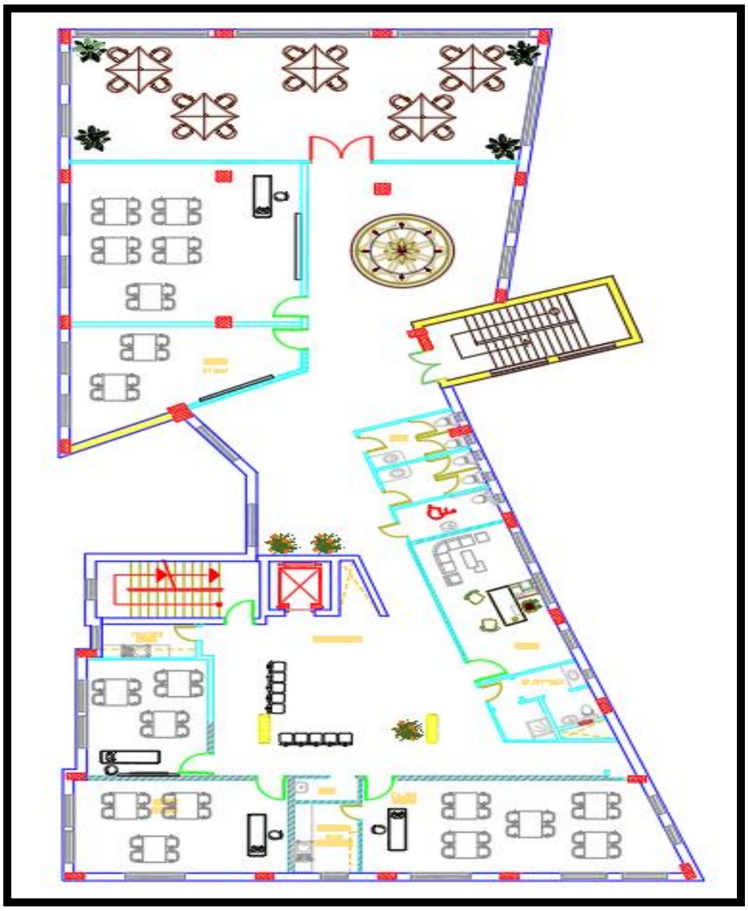


Figure 45:Second floor after modification.

e) 3rd floor

The third floor works on rooms for the administration and runs the institute, the director of clinics, the training halls, the meeting room, the research department, and we worked as before, bathrooms and an outside patio that employees benefit from in helping to access natural lighting.

Figure 46:Third floor before modification.

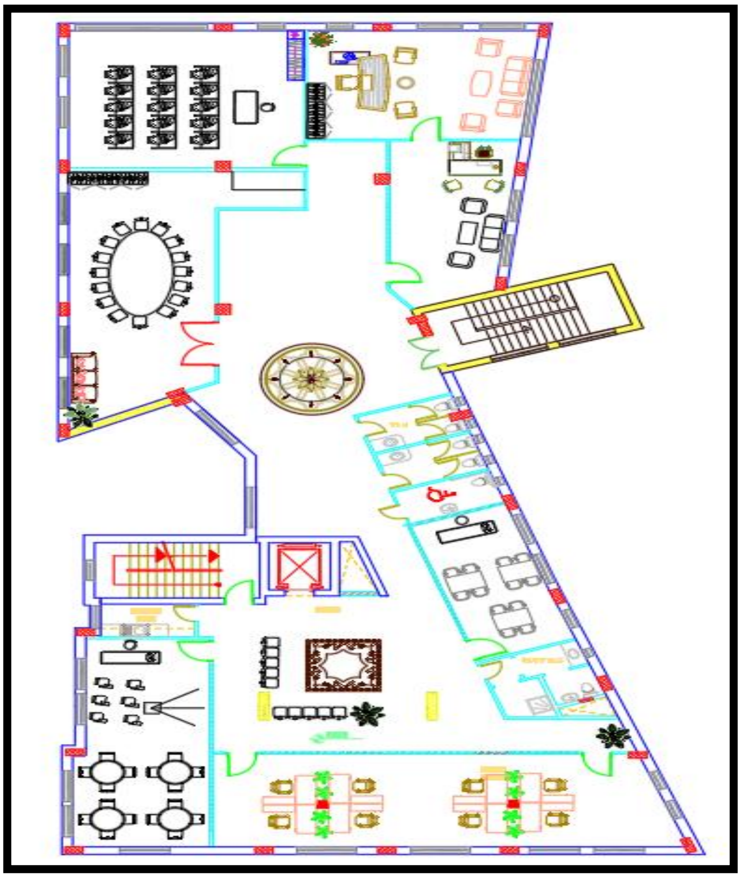


Figure 47:Third floor after modification.

2.6 Elevations:

Housing by enlarging the dimensions of the windows to suit the building's environmental requirements.

The figure below shows the elevations before & after modification:

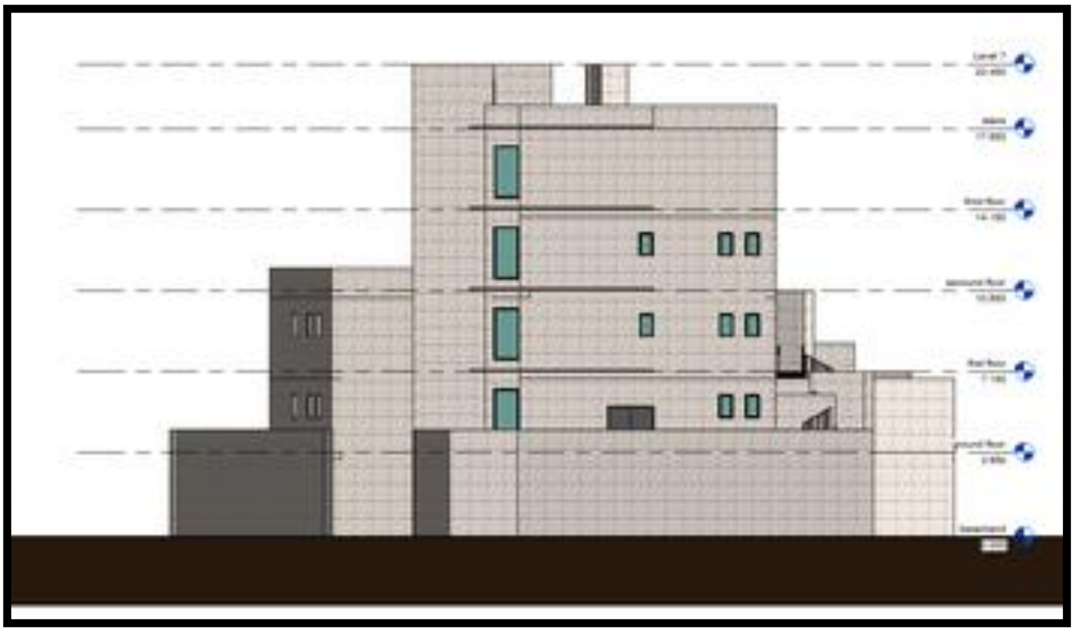


Figure 48: West elevation before modification

Figure 49: West elevation after modification

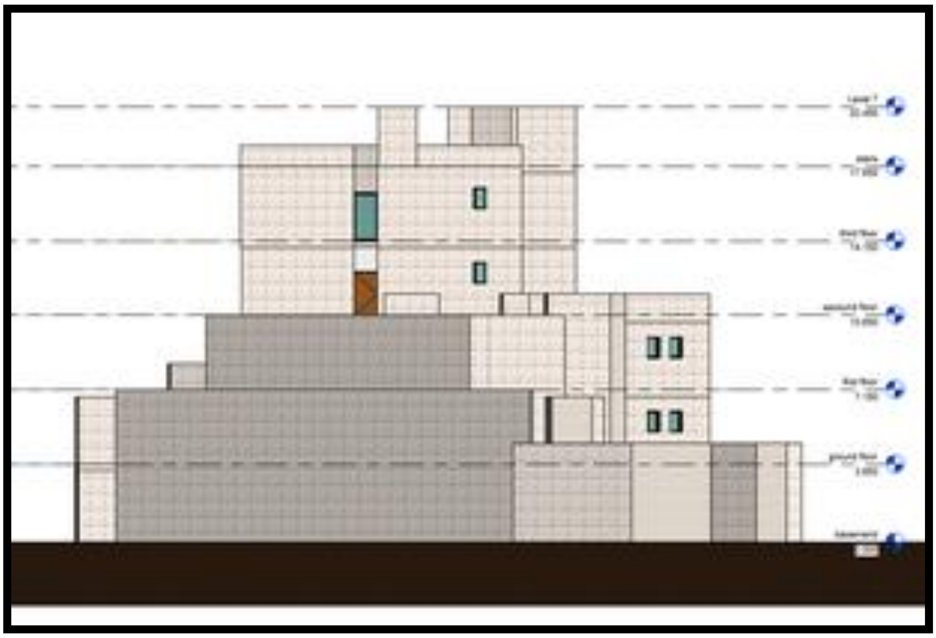


Figure 50: East elevation before modification .

Figure 51: East elevation after modification

.

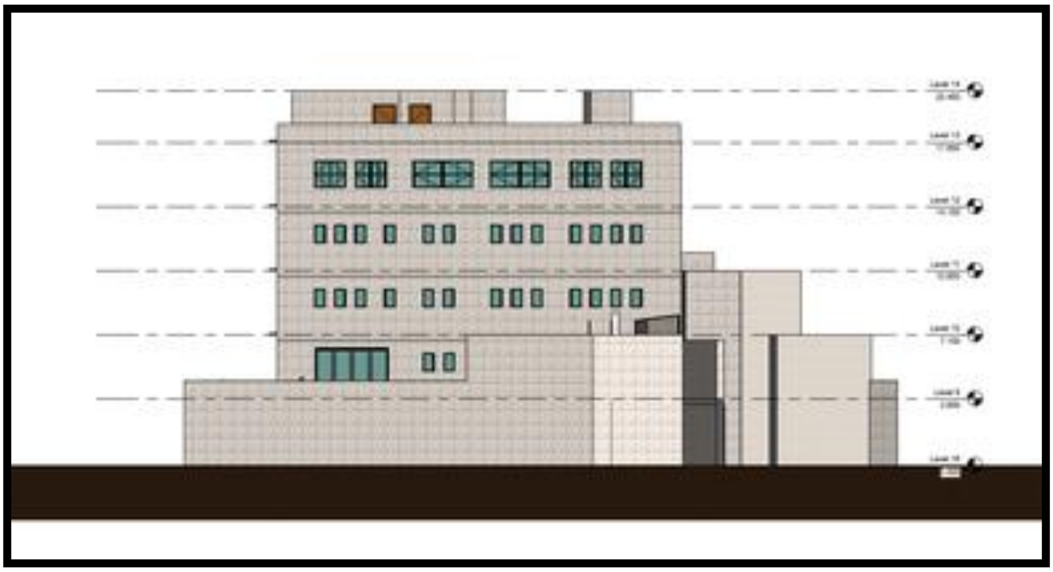


Figure 52: South elevation before modification

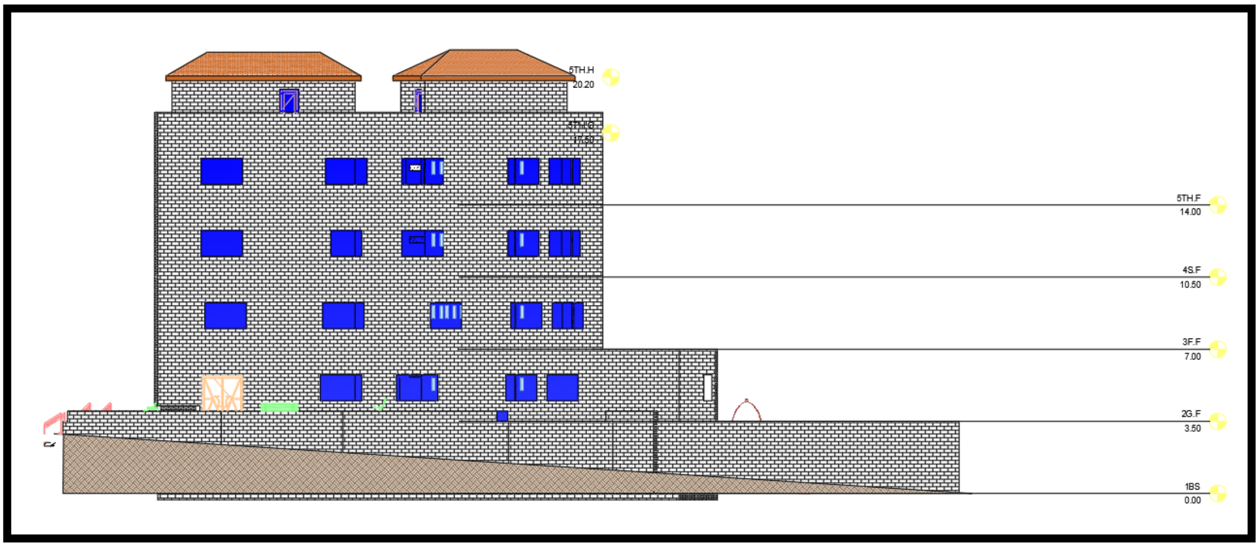


Figure 53: South elevation after modification

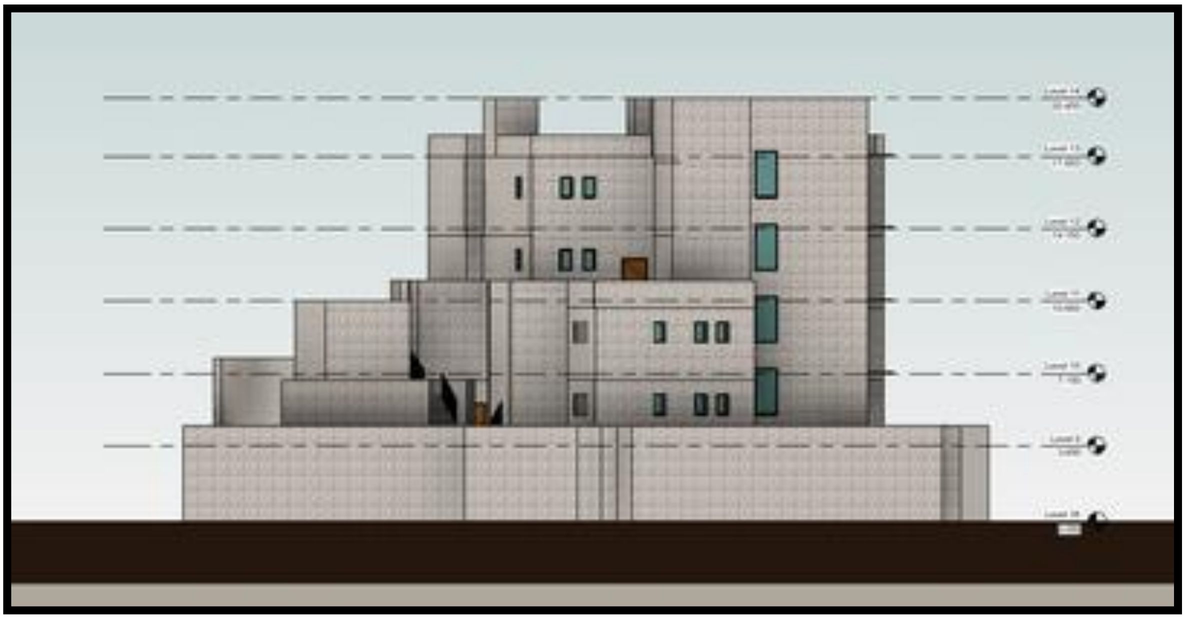


Figure 54: North elevation before modification

Figure 55: North elevation after modification.

2.6 Environmental Aspects:

2.6.1 Introduction:

The environmental aspect of buildings is an essential thing in our time, and environmental pollution is increasing with time, global warming, and the lack of some energy sources. From this point of view, the environmental aspect has been made essential to reduce this pollution and reduce the use of non-renewable energy sources and replace them with renewable energy sources. The environmental aspect provides comfort to the human being in all respects such as; lighting, sound, and heat.

Design Builder:

With the use of this program, we were able to construct the structure in accordance with the required requirements, taking into account the building's sensitivity and its intended functions as well as the sensitivity of its tenants and visitors—whether they be youngsters or their parents.

2.6.1.1Properties of the material used

Layers of the exterior walls from DESIGHN BUILDER:

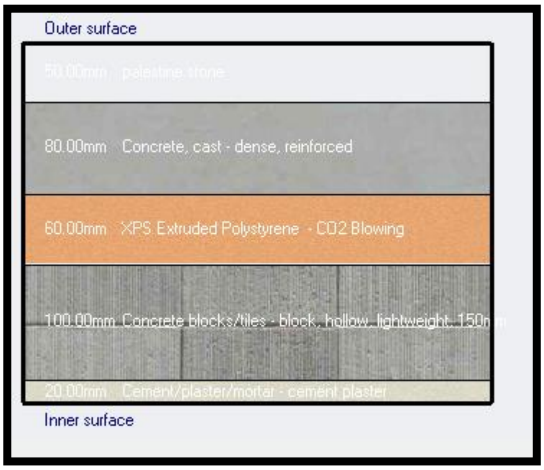


Figure 56: Wall layers

The exterior wall is composed of five layers: the outer layer is made of stone and is 5 cm thick; the second layer is made of concrete and is 8 cm thick; the third layer is made of polystyrene and is 6 cm thick; the fourth layer is made of bricks and is 10 cm thick; and the final layer is made of gypsum and is 2 cm thick.

Roof layers from DESIGHN BUILDER:

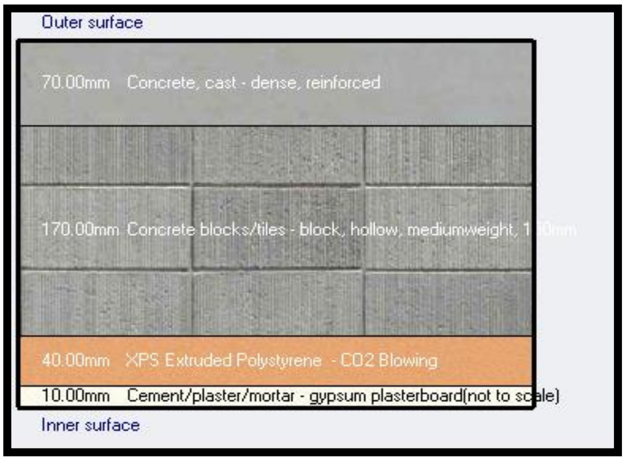


Figure 57: roof layers

The roof has four layers: an outside layer of concrete that is 7 cm thick, a second layer of hollow blocks that is 17 cm thick, a third layer of polystyrene that is 4 cm thick, and a fourth layer of plaster that is 1 cm thick.

Internal floor layers:

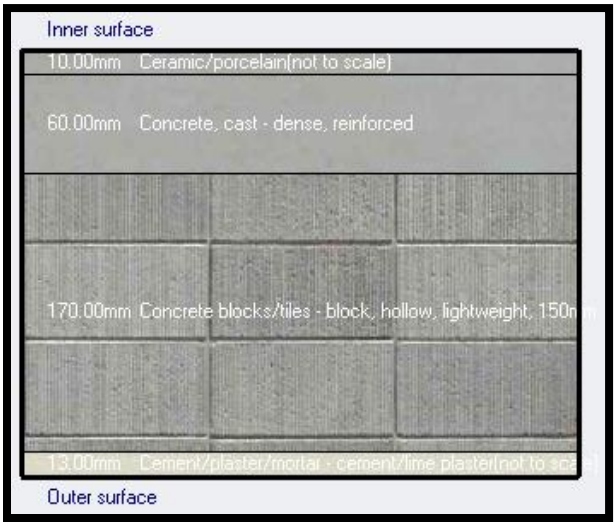


Figure 58: internal floor layers

The internal floor is made up of four layers: an inner layer of ceramics that is 1 cm thick, a second layer of concrete that is 6 cm thick, a third layer of hollow bricks that is 17 cm thick, and a fourth layer of plaster that is 1.3 cm thick.

Partition layers:

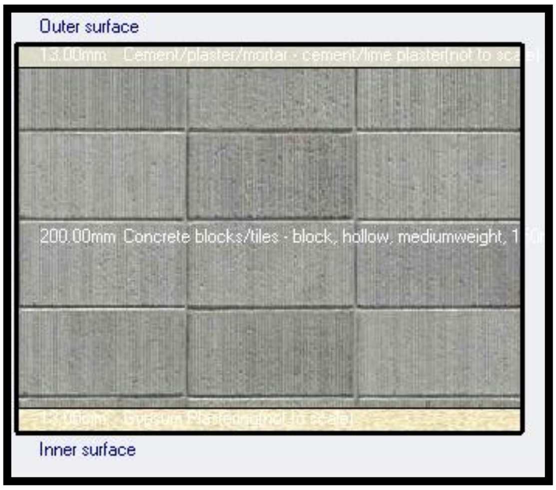


Figure 59: Partition layers

Three layers make up the wall: the first is plaster, which is 1.3 cm thick; the second is hollow bricks, which are 17 cm thick; and the third is plaster, which is 1.3 cm thick.

2.6.1.2 Summary of U-value:

A building element's total thermal resistance across all of its layers, such as those on its roof, wall, or floor, is calculated as the element's U-value. Additionally, it includes corrections for any fixes or air gaps.

The ability of an element to transfer heat from a warm space to a cold place in a structure, and vice versa, is indicated by a U-value value, which is expressed in units of W/m2K. The building part is better insulated the lower the U-value as can be shown in table below.

The table below shows the u-value of the elements inside the building in units (W/m2K) .

Table 1: Elements U-value

Element	U-value(W/m2K)
Exterior walls	0.44
Interior floors	1.21
Roof	0.65
Partitions	1.58
Doors	2.30
Windows	1.38

2.6.2 Daylight factor:

The "Daylight Factor" is a unit used to assess how well daylight performs as a light source. For comfort and to prevent glare, the ideal range of daylight factor is between (2%-6%). (Daylight Factor | Daylighting Pattern Guide, 2020)

2.6.2.1Daylight factor before Modifying using design builder program

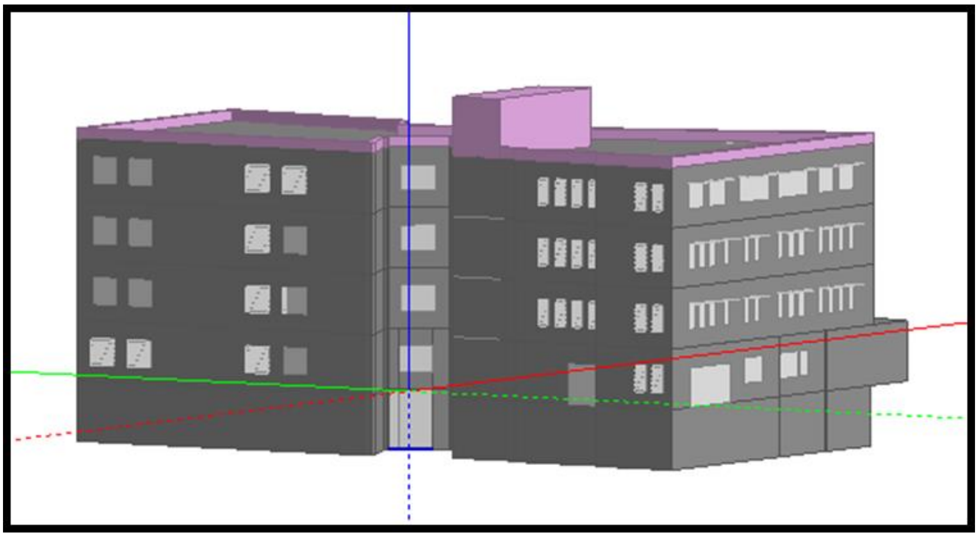


Figure 60: 3D model before Modifying using design builder program

Figure 61: 3D model after Modifying using design builder program.

- Ground floor:

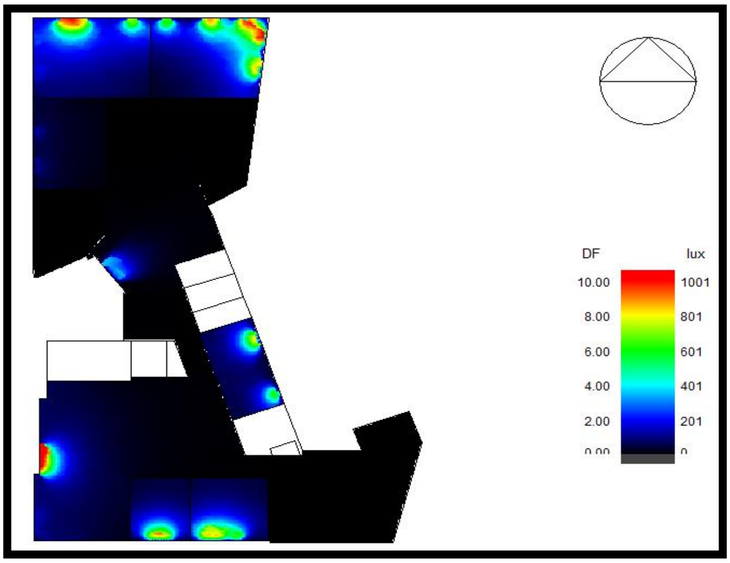


Figure 62:Daylight factor for ground floor before modification.

Daylight factor is not within the standards. On the ground floor, the size of the ground floor windows will be modified.

- First floor:

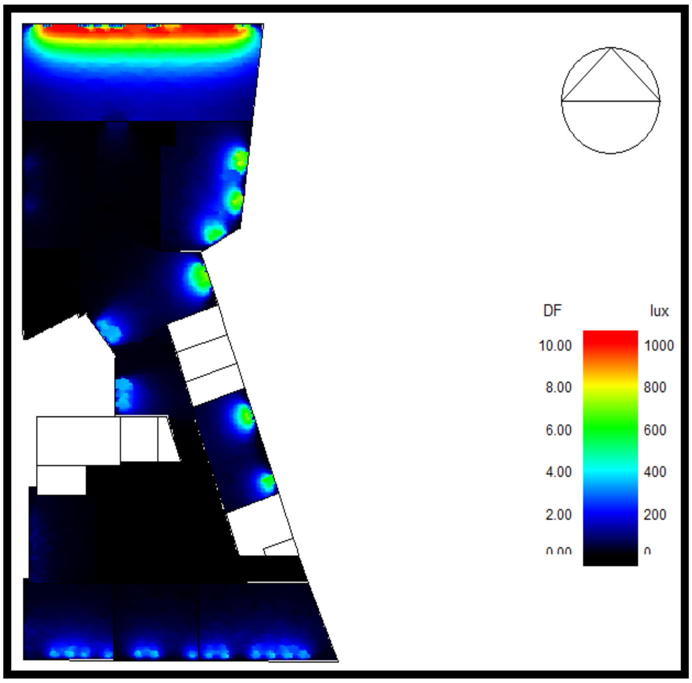


Figure 63: Daylight factor for first floor before modification..

Daylight factor is not within the standards. On the first floor, the size of the ground floor windows will be modified.

- Second floor:

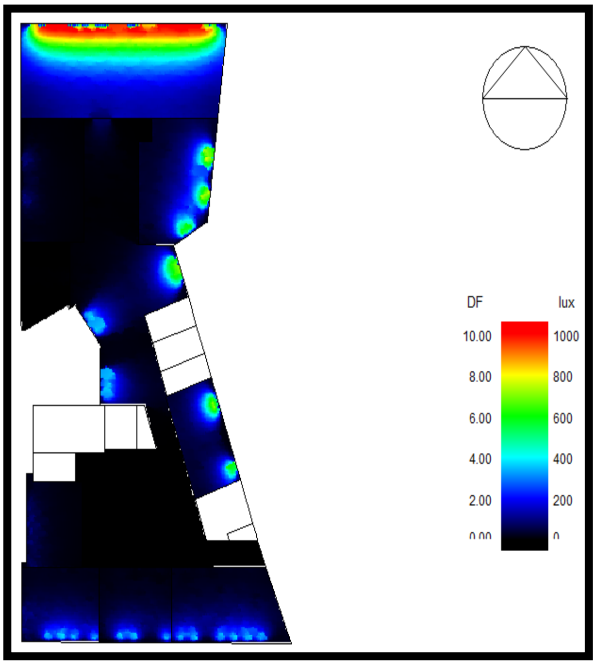


Figure 64: Daylight factor for second floor before modification..

Daylight factor is not within the standards. On the floor, the size of the Second floor windows will be modified .

- Third floor:

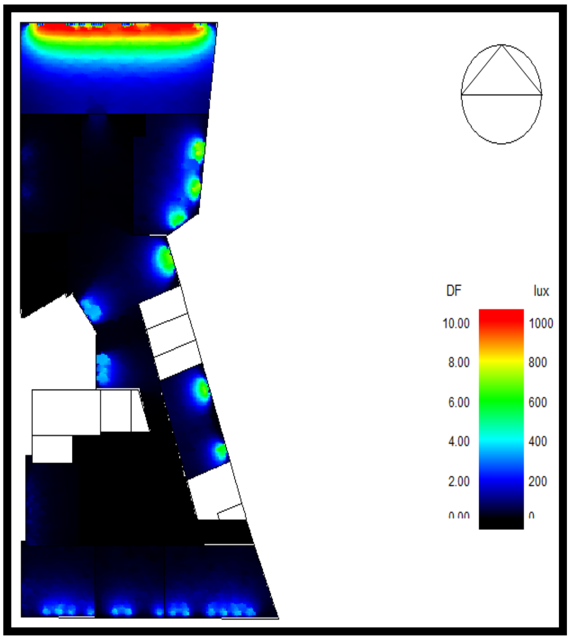


Figure 65: Daylight factor for third floor before modification..

Daylight factor is not within the standards. On the floor, the size of the Third floor windows will be modified .

2.6.2.2 Daylight factor after Modifying using design builder program

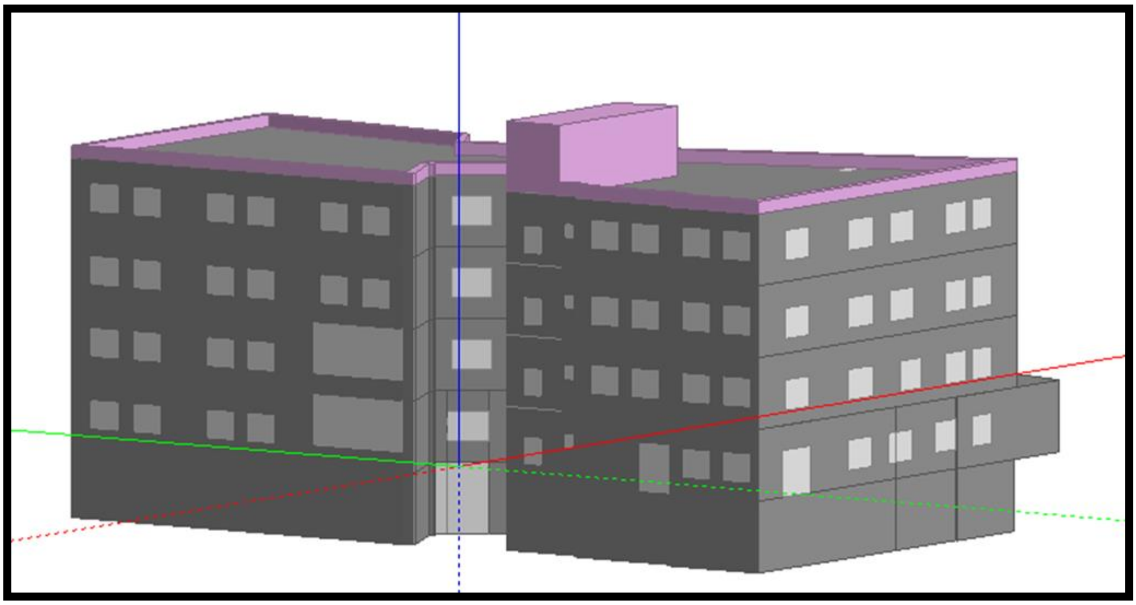


Figure 66 : 3D model after Modifying using design builder program:

Figure 67: 3D model after Modifying using design builder program

- Ground floor:

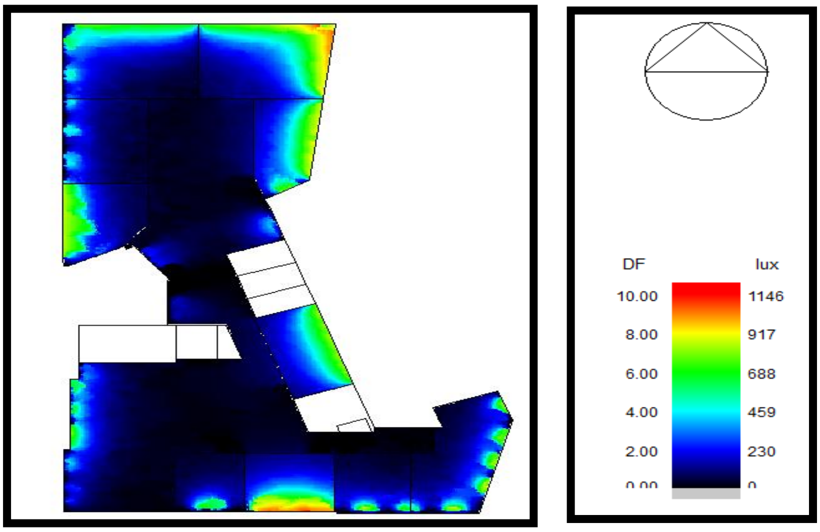


Figure 68: Daylight factor in ground floor

The majority of the ground floor's daylight factor complies with norms, with the exception of a few spots near windows, particularly in the northeastern direction, and spots in the middle of the floor where artificial lighting will be employed.

- First floor:

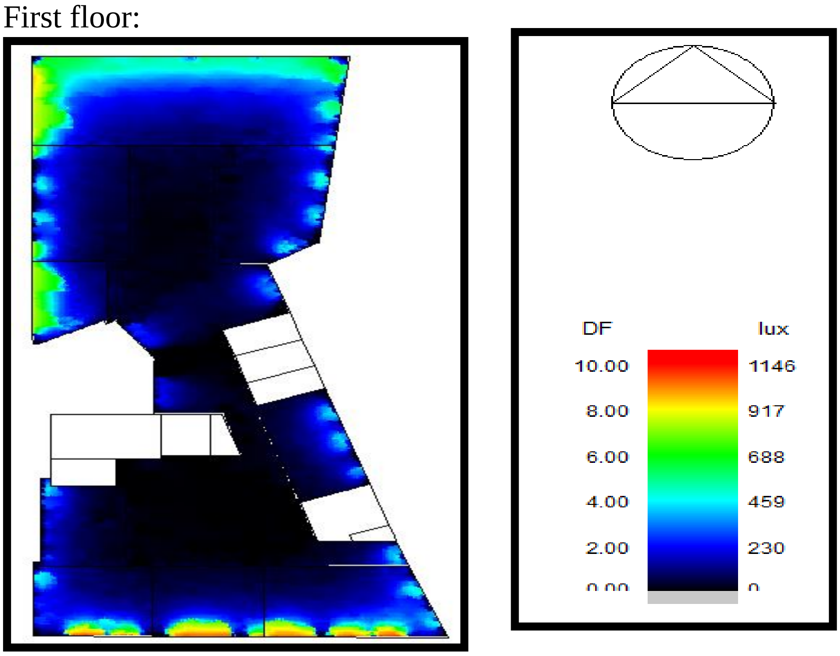


Figure 69: Daylight factor in first floor

The majority of the first floor's daylight factor complies with norms, with the exception of a few spots near windows, particularly in the west direction, and spots in the middle of the floor where artificial lighting will be employed.

Second floor:

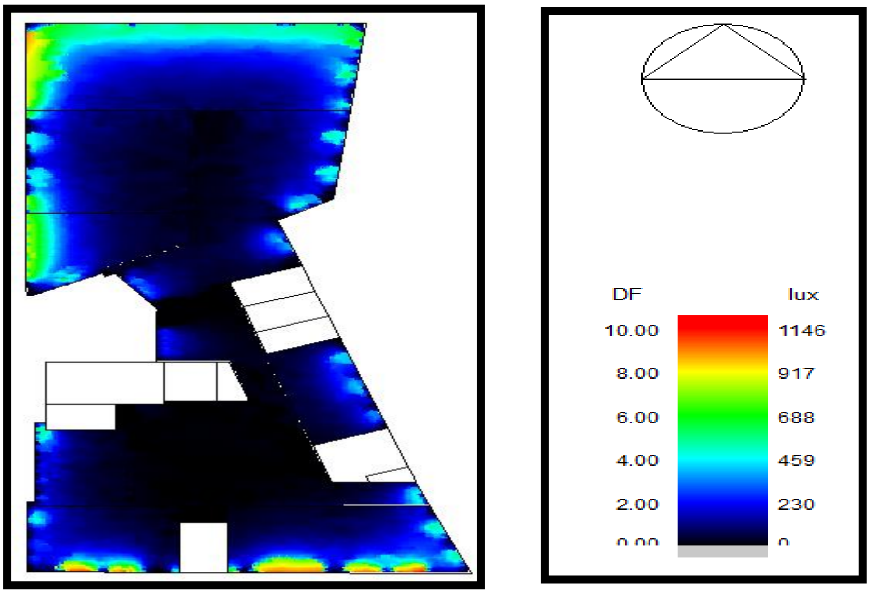


Figure 70: Daylight factor in second floor.

The majority of the second floor's daylight factor complies with norms, with the exception of a few spots near windows, particularly in the west direction, and spots in the middle of the floor where artificial lighting will be employed.

- Third floor:

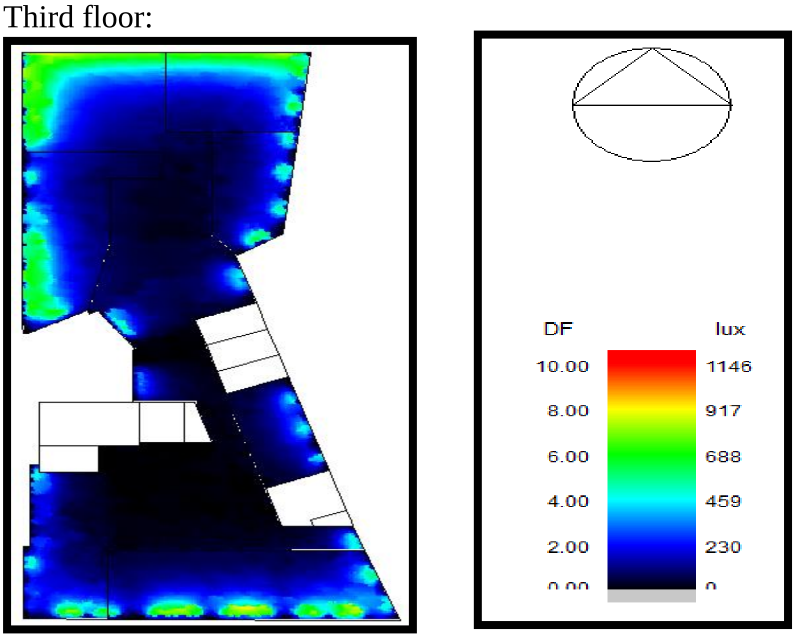


Figure 71: Daylight factor in third floor.

The majority of the third floor's daylight factor complies with norms, with the exception of a few spots near windows, particularly in the west direction, and spots in the middle of the floor where artificial lighting will be employed. Daylight Factor/ Daylighting Pattern Guide. (2020).

2.6.3 Thermal Comfort:

2.6.3.1 Introduction:

Thermal comfort is a critical concept in temperature control systems and other applications , When does one feel comfortable, when does one feel uncomfortable, and when do become dangerous? Thermal comfort is defined as a state of mind expressing satisfaction with one's thermal conditions , One of the most important design concepts is thermal comfort design systems in the building which impact on the people that located inside the facility ,There are numerous programs used in the field of determining the necessary thermal comfort, but the Design Builder software is the most significant and precise one, so we will use it to determine the necessary thermal comfort for building occupants.

2.6.3.2 PMV chart:

The results of the simulations provide useful data on annual energy use, enabling us to estimate the cost to the energy company. The data can also be used to calculate hours and other alarming outcomes. As shown in the figure below, the building reached rest when the PMV ranged from -0.7 to 0.7 excluding the winter and summer solstices, according to the Pierce PMV group.

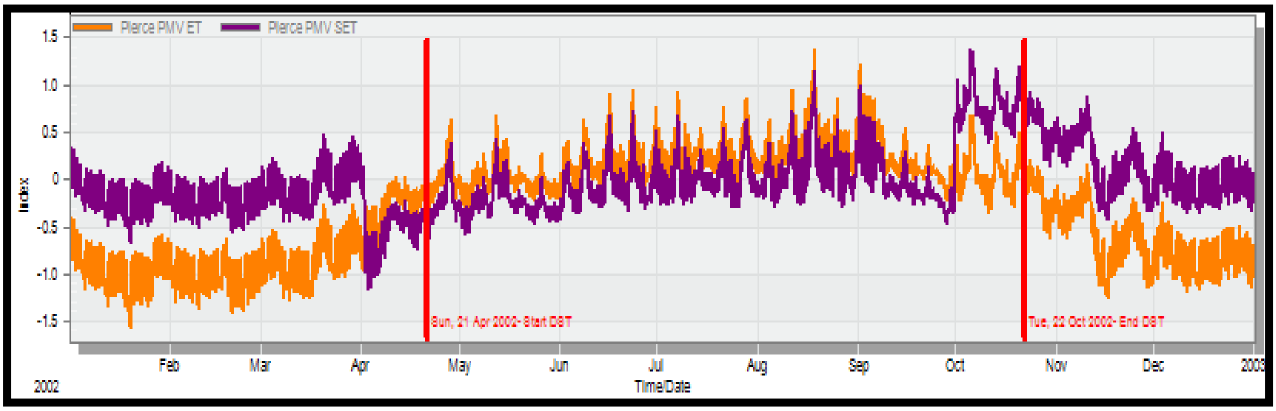


Figure 72: Predict mean vote chart

As shown in the figure, the PMV is between -0.7 and 0.7 in most months which is ok .

2.6.3.3 Discomfort hours

The total number of hours that cannot be managed in terms of thermal comfort is the number of hours of discomfort. The majority of these hours fall on the summer and winter solstices.

The Comfort and Set point Not Met Summary is shown in the table below:

Table 2: Discomfort hours

Comfort and Setpoint Not Met Summary

	Facility [Hours]
Time Setpoint Not Met During Occupied Heating	10.83
Time Setpoint Not Met During Occupied Cooling	0.00
Time Not Comfortable Based on Simple ASHRAE 55-2004	1171.33

The total discomfort hours are 1171 which is ok.

- Building Consumption

The projected Site and Source Energy results from the design builder are displayed in the table below.

Table 3: Building consumption

Site and Source Energy

	Total Energy [kWh]	Energy Per Total Building Area [kWh/m2]	Energy Per Conditioned Building Area [kWh/m2]
Total Site Energy	143748.68	63.13	63.13
Net Site Energy	143748.68	63.13	63.13
Total Source Energy	455252.06	199.95	199.95
Net Source Energy	455252.06	199.95	199.95

The net site energy = 63.13 kwh/m2 and the net source energy is 199.95 kwh/m2 , so the total site energy in the building is good.

2.6.4 Heating & cooling analysis:

2.6.4.1 Heating load:

This table displays the overall heating load required to heat the entire building as well as the individual heating load values for each room within the building as can be shown in table 2.

Table 4: Heating load

Floor	Zone	Design Capacity (kW)	Design Capacity (W/m2)
0,G.F	Office 2	2.28	43.98
0,G.F	Office 3	2.24	45.27
0,G.F	Office 1	1.46	39.78
0,G.F	Waiting area	10.29	37.34
0,G.F	terrace2	1.18	41.45
0,G.F	terrace1	1.25	42.48
0,G.F	Filing room	2.63	60.71
0,G.F	Clinic	1.17	42.04
0,G.F	Office 4	0.86	40.71
0,G.F	Office 5	1.10	41.47
0,G.F	Class	0.93	40.26
1, First floor	Elev.lobby	6.49	34.05
1, First floor	Clinic	1.16	41.62
1, First floor	office2	1.63	39.16
1, First floor	Class	1.83	40.61
1, First floor	terrace2	0.93	46.51
1, First floor	Class	1.43	46.29
1, First floor	Class	1.14	39.60
1, First floor	Staff room	1.89	44.30
1, First floor	Class	1.09	42.74
1, First floor	terrace	4.69	46.20
2, Second floor	EIEV.lobby	7.42	37.15
2, Second floor	Clinic	1.20	43.00
2, Second floor	Class	1.14	44.44
2, Second floor	Class	1.70	46.07
2, Second floor	JAN.	0.11	39.15
2, Second floor	Class	2.41	44.58
2, Second floor	Kitchen for children	0.42	48.34
2, Second floor	Class	2.31	38.00
2, Second floor	Class	1.38	41.54
2, Second floor	terrace	4.90	46.78
3, Third floor	Elev.lobby	12.71	50.30
3, Third floor	Clinic	1.55	55.77
3, Third floor	Training Room	2.95	59.41
3, Third floor	Staff	4.50	57.39
3, Third floor	Manager office	2.69	59.30
3, Third floor	Secretary office	2.10	57.31
3, Third floor	Meeting office	3.35	52.47

Total Heating load = 100.51 K

2.6.4.2 Cooling load:

The Design builder's temperature, sensible and latent cooling, heat gain, relative humidity, ventilation, and infiltration are depicted in the table. As can be seen, the air temperature and operating temperature values are nearly equal, which suggests that good insulation was used in the exterior wall as can be shown in table 3.

Table 5: cooling load

Block	Zone	Design Capacity (kW)	Design Flow Rate (m3/s)	Design Cooling Load Per Floor Area(W/m2)
0,G.F	Office2	2.54	0.21	49.00
0,G.F	Office3	2.81	0.23	56.60
0,G.F	Office1	1.89	0.15	51.30
0,G.F	Waiting Area	11.91	0.97	43.20
0,G.F	Terrace2	1.45	0.12	50.90
0,G.F	Terrace1	1.45	0.12	49.40
0,G.F	Filing Room	2.31	0.19	53.30
0,G.F	Clinic	1.79	0.15	64.40
0,G.F	Office4	1.00	0.08	47.60
0,G.F	Office5	1.25	0.10	47.40
0,G.F	0XGXF:Class	1.09	0.09	46.90
1, First floor	ElevXlobby	8.83	0.72	46.30
1, First floor	Clinic	1.81	0.15	65.10
1, First floor	Office2	2.15	0.17	51.60
1, First floor	Class	2.69	0.22	59.70
1, First floor	Terrace2	1.07	0.09	53.90
1, First floor	ClassQ1	1.56	0.13	50.50
1, First floor	ClassQ2	1.33	0.11	46.10
1, First floor	Staffroom	2.01	0.16	47.00
1, First floor	ClassQ3	1.38	0.11	54.10
1, First floor	Terrace	5.31	0.43	52.40
2, Second floor	ElEVXlobby	9.86	0.80	49.30
2, Second floor	Clinic	1.88	0.15	67.60
2, Second floor	Class	1.44	0.12	56.50
2, Second floor	ClassQ1	1.85	0.15	50.30
2, Second floor	:JANX	0.20	0.02	68.20
2, Second floor	ClassQ2	2.58	0.21	47.80
2, Second floor	KitchenForChildren	0.51	0.04	59.00
2, Second floor	ClassQ3	3.08	0.25	50.70
2, Second floor	ClassQ4	1.77	0.14	53.10
2, Second floor	Terrace	5.62	0.46	53.70
3, Third floor	ElevXlobby	16.04	1.31	63.50
3, Third floor	Clinic	2.16	0.18	77.70
3, Third floor	Training Room	2.93	0.24	59.00
3, Third floor	Staff	4.22	0.34	53.80
3, Third floor	Manager Office	3.19	0.26	70.30
3, Third floor	Secretary Office	2.86	0.24	78.20
3, Third floor	Meeting Office	3.34	0.27	52.40

Total Cooling load = 121.16 KW.

Chapter three: Structural aspect:

3.1 General Introduction

Reinforced concrete structures are the most common type of structures in Palestine. Design of it will be done by hands and by using CSI Etabs program, and make a structural detail using AutoCAD program.

3.2 Materials:

The materials that used to construct the building and it is important to specify the properties of these materials in order to achieve needed design of the structure so that it gives the required safety.

3.2.1 Structural materials:

Concrete and Reinforcement Steel they give the structure strength.

Table 6: Concrete Properties.

Uses	Compressive Strength of **Concrete** (fc)	**Modulus of Elasticity (Ec)**	**Unit Weight of Plain Concrete**	**Unit Weight of Reinforced Concrete**
For all element	28 MPa	24870.06 MPa	23 KN/m^3	25 KN/m^3

*Where: E concrete = $4700\sqrt{fc'}$

Table 7: Reinforcement Steel rebar Properties.

Reinforcement Steel Gr (60) Type A615	
Yield strength (fy)	**420 MPa**
Modulus of elasticity (Es)	**200 GPa**
Unit weight (Ɣ)	**77 KN/m^3**

3.2.2 Non-Structural Materials:

The material that not give the structure strength and have a self-weight on structural element.

Table 8: Non-Structural Materials Unit Weight

Material	ɣ Kn/m³
Blocks	12
Filling Materials	13
Tiles	26
Plaster	23
Aggregate	13
Concrete Mortar	23
Glass	26
Masonry Stone	26

3.3 Load Types and Its Calculations:

1. **Dead Loads:** structure element self-weight
2. **live Loads:** weight of people, and any movable objects in the structure. The value of live load depends on the type of the structure. In this project, the live load from ASCE code as shown in table below.

Table below shows minimum values of live load depending on the building use, according to ASCE.

Table 9: Minimum Uniformly Distributed Live Loads and Minimum Concreted Live Load (ASCE7-16)

Occupancy or Use	Uniform psf (kN/m^2)	Conc. lbs (kN)
Apartments (see residential)		
Access floor systems		
Office use	50 (2.4)	2000 (8.9)
Computer use	100 (4.79)	2000 (8.9)
Armories and drill rooms	150 (7.18)	
Assembly areas and theaters		
Fixed seats (fastened to floor)	60 (2.87)	
Lobbies	100 (4.79)	
Movable seats	100 (4.79)	
Platforms (assembly)	100 (4.79)	
Stage floors	150 (7.18)	
Balconies (exterior)	100 (4.79)	
On one- and two-family residences only, and not exceeding 100 $ft.^2$ (9.3 m^2)	60 (2.87)	
Bowling alleys, poolrooms, and similar recreational areas	75 (3.59)	
Catwalks for maintenance access	40 (1.92)	300 (1.33)
Corridors		
First floor	100 (4.79)	
Other floors, same as occupancy served except as indicated		
Dance halls and ballrooms	100 (4.79)	
Decks (patio and roof)		
Same as area served, or for the type of occupancy accommodated		
Dining rooms and restaurants	100 (4.79)	
Dwellings (see residential)		
Elevator machine room grating (on area of 4 $in.^2$ (2580 mm^2))		300 (1.33)
Finish light floor plate construction (on area of 1 $in.^2$ (645 mm^2))		200 (0.89)
Fire escapes	100 (4.79)	
On single-family dwellings only	40 (1.92)	
Fixed ladders		See Section 4.4
Garages (passenger vehicles only)	40 (1.92)	Note (1)
Trucks and buses	Note (2)	

Table 10: live load from ASCE

Occupancy or Use	Uniform psf (kN/m^2)	Conc. lbs (kN)
Grandstands (see stadium and arena bleachers)		
Gymnasiums, main floors, and balconies	100 (4.79) Note (4)	
Handrails, guardrails, and grab bars	See Section 4.4	
Hospitals		
Operating rooms, laboratories	60 (2.87)	1000 (4.45)
Private rooms	40 (1.92)	1000 (4.45)
Wards	40 (1.92)	1000 (4.45)
Corridors above first floor	80 (3.83)	1000 (4.45)
Hotels (see residential)		
Libraries		
Reading rooms	60 (2.87)	1000 (4.45)
Stack rooms	150 (7.18) Note (3)	1000 (4.45)
Corridors above first floor	80 (3.83)	1000 (4.45)
Manufacturing		
Light	125 (6.00)	2000 (8.90)
Heavy	250 (11.97)	3000 (13.40)
Marquees and canopies	75 (3.59)	
Office buildings		
File and computer rooms shall be designed for heavier loads based on anticipated occupancy		
Lobbies and first floor corridors	100 (4.79)	2000 (8.90)
Offices	50 (2.40)	2000 (8.90)
Corridors above first floor	80 (3.83)	2000 (8.90)
Penal institutions		
Cell blocks	40 (1.92)	
Corridors	100 (4.79)	
Residential		
Dwellings (one- and two-family)		
Uninhabitable attics without storage	10 (0.48)	
Uninhabitable attics with storage	20 (0.96)	
Habitable attics and sleeping areas	30 (1.44)	
All other areas except stairs and balconies	40 (1.92)	
Hotels and multifamily houses		
Private rooms and corridors serving them	40 (1.92)	
Public rooms and corridors serving them	100 (4.79)	
Reviewing stands, grandstands, and bleachers	100 (4.79) Note (4)	
Roofs	See Sections 4.3 and 4.9	

The building is mostly composed of offices so the live load equal 4.8 KN/m^2

3- Super imposed load: is the weight of non-structural material.

*** Floor superimposed dead load:**

Figure below shows the elements that make the floor superimposed dead load from tiles and it's filling and concrete materials:

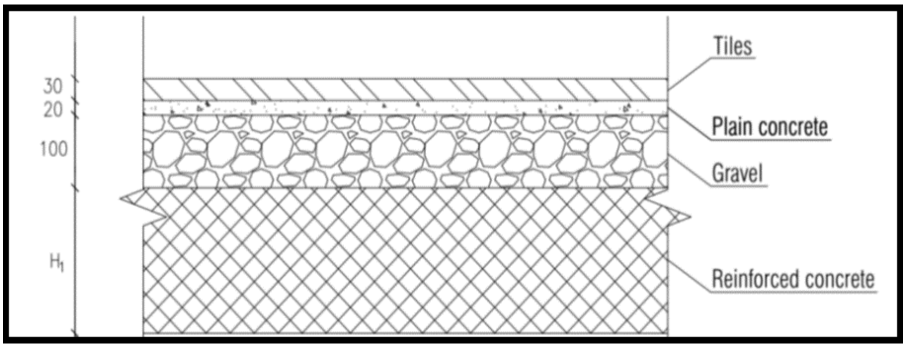


Figure 73: Figure: Superimposed Dead Load Material in the Slab.

Table below shows the thickness and specific weight for the materials in figure above:

Table 11 Thickness and Unit Weight of the Material in Figure above:

Material type	Gravel Fill	Plain Concrete	Tiles
Thickness (mm)	100	20	30
ɣ(kN/m²)	13	23	26

WSD $(KN/m2)$ = W Tile + W Mortar + W Gravel

= 0.03 × 26 + 0.02 × 23 + 0.1 × 13

= 2.54 KN/$m2$

Figure below shows the section of a partition wall with plastering:

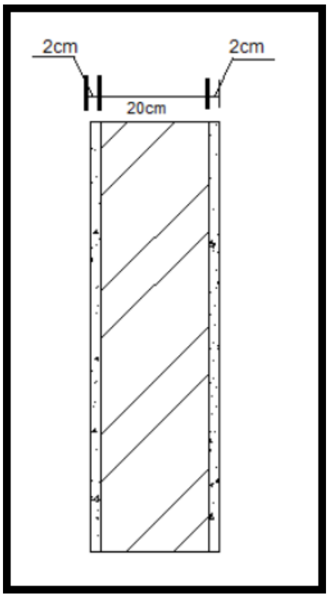


Figure 74: Cross Section of Partition Wall

WSD =floor height *(2*(ɣ plaster*plaster thickness)+(ɣ blocks *block thickness))

=3.6 (2*(23*0.02)+(13*.1))= 8 KN/m

W_{SD}= 1.77 KN/m^2

so, this number is taken to be in safe side if there is any change in the future.

WSD = 2.54 + 1.77= 4.3177KN/m^2

3- seismic load (dynamic load): loads from vibration from earthquake

*it will be calculate in section 7 in these chapter.

3.4 PRELIMINARY DESIGEN

3.4.1 Preliminary Design for Slabs:

Slab: Is the horizontal structural element that is covered the entire structure, and it is the first vertical load receiver.

A concrete slab is the most common structural element of modern building, horizontal steel reinforced concreate slab, typically between 10 and 50 centimeters thickness,

3.4.1.1 preliminary design of slab for block 1

The slab system is decided to be one way ribbed slab with light weight ribs block ($6Kn/m^3$ unit weight) ; because of these slabs are easier in construction and mostly economical .

Slab Thickness:

The critical clear length 5m in the exterior span (one end continuous) and 6 m in the interior span (tow end continuous).

Determine the thickness of slabs using the direct design method's equations. At aci318-14 table 9.5(a)

$$Hmin = \begin{Bmatrix} \frac{ln}{18.5} & for\ one\ end\ continuous \\ \frac{ln}{21} & for\ two\ end\ continuous \end{Bmatrix}$$

Where:

H: Minimum slab thickness.

Ln: Clear span length.

$Hmin = .28m$

Take it300mm

Check slap for shear

slab Own weight (o.w) =

(Ɣconc * (Bf * Hf + BW * Hw) + Ɣblock * (bBblok * Hblok))/rib width

$=(25x(0.52x0.06+0.12x0.24) +6*(0.4x0.24))/.52=3.2\ KN/m^2$

Figure below shows a section in the slap

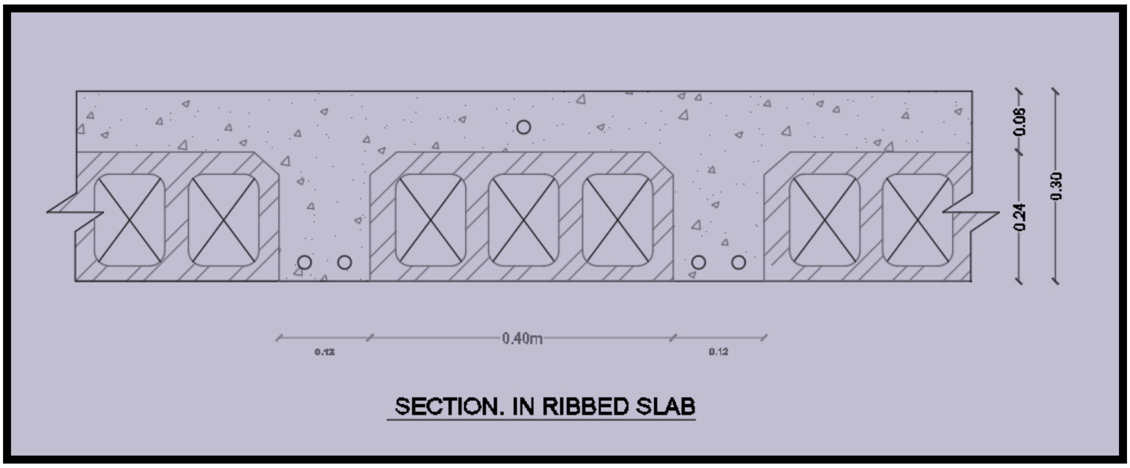


Figure 75: section in slab

Superimposed dead load = 4.3117kN/m^2

Total Dead = o.w + super imposed DL

Live load = 4.8 KN/m^2

<u>Total ultimate load (Wu)</u> = 1.2 (3.2 + 4.311) + 1.6 (4.8) = 16.6KN/m^2=8.6KN/rib

$$\Phi Vc = 1.1 * .75 * \frac{1}{6} * \sqrt{Fc`} * bw * d$$

ΦVc =1.1*0.75(1/6) ×√28×120× (300 -20) = 24.5KN

$$\text{Vu at face} = \left(\frac{1.15Wu*Ln}{2}\right)$$

$$Vu = \left(\frac{1.15 * 8.6 * 5}{2}\right) = 24.7KN$$

$$Vu = \left(\frac{8.6 * 6}{2}\right) = 25.8KN$$

$$\text{Vu at d} = \text{Vu at face } - Wu * d$$

$\max Vu = 23.3$ KN   Since ΦVc > Vu, ribs not need shear reinforcement.

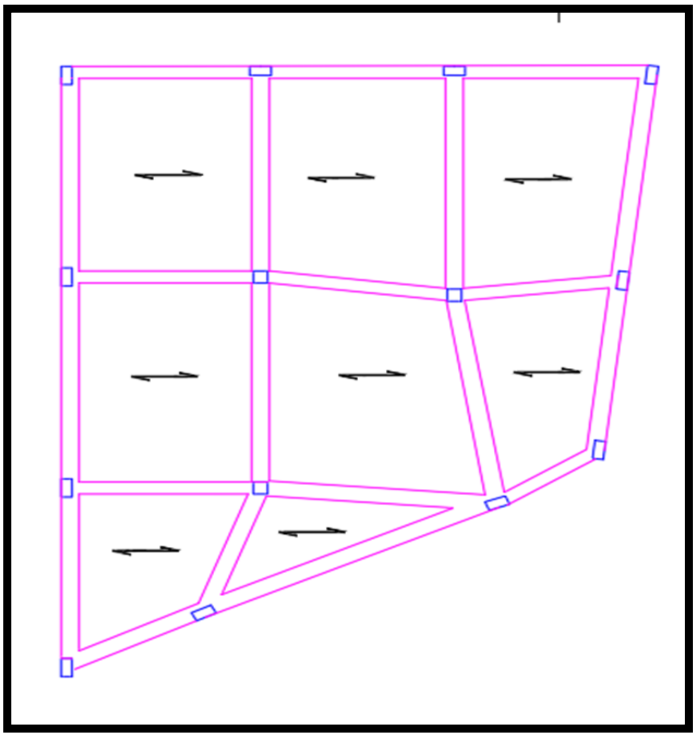


Figure 76: slab direction

3.4.1.2 preliminary design of slab for block 2

The slab system is decided to be one way ribbed slab; because of these slabs are easier in construction and mostly economical.

Slab Thickness:

The critical clear length 3.6m in the exterior span (one end continuous) and 4.6 m in the interior span (tow end continuous).

Determine the thickness of slabs using the direct design method's equations. At aci318-14 table 9.5(a)

$$Hmin = \begin{Bmatrix} \frac{ln}{18.5} \; for\ one\ end\ continuous \\ \frac{ln}{21} for\ two\ end\ continuous \end{Bmatrix}$$

Where:

H: Minimum slab thickness.

Ln: Clear span length.

1.1.1.1.1.1 $Hmin = .22m$

Take it250mm

Check slap for shear

Total Load on slabs: Own weight(o.w) =

(Ɣconc*(Bf*Hf+BW*Hw)+Ɣblock*(bBblok*Hblok))/rib width

=(25x(0.52x0.08+0.12x0.17)+12*(0.4x0.17))/.52=4.55 KN/m^2

Figure below shows a section in the slap

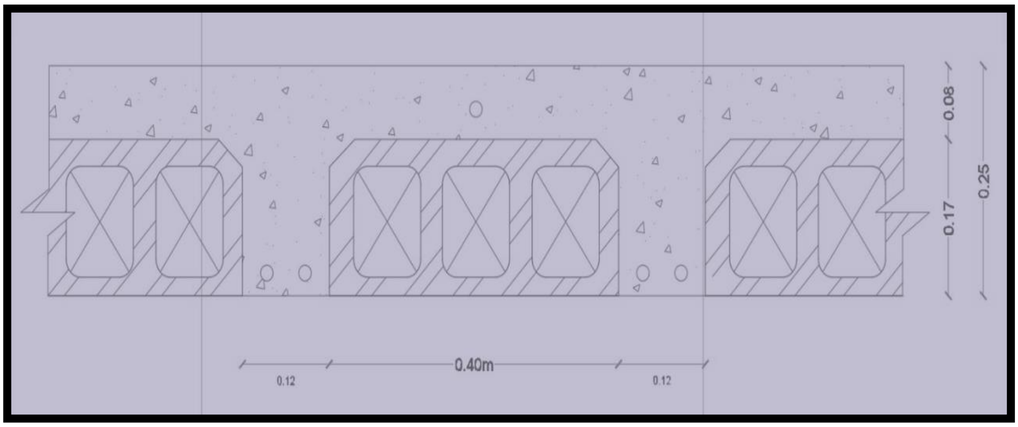


Figure 77: section in slab

Superimposed dead load = 4.3117kN/m^2

Total Dead = o.w + super imposed DL

Live load = 4.8 KN/m^2

<u>Total ultimate load (Wu)</u> = 1.2 (4.55 + 4.311) + 1.6 (4.8) = 18.3KN/m^2=9.5KN/rib

$$\Phi Vc = 1.1 * .75 * \frac{1}{6} * \sqrt{Fc`} * bw * d$$

ΦVc =1.1*0.75(1/6) ×√28×120× (250 -20) = 20.1KN

$\text{Vu at face} = \left(\frac{1.15Wu*Ln}{2}\right)$

$$Vu = \left(\frac{1.15 * 9.5 * 3.6}{2}\right) = 19.6KN$$

$$Vu = \left(\frac{9.5 \ * 4.6}{2}\right) = 21.8KN$$

$\text{Vu at d} = \text{Vu at face} - Wu * d$ = 21.8 – 9.5 x 0.23 = 19.65 Kn

$maxVu = 19.65$ KN Since ΦVc > Vu, ribs not need shear reinforcement.

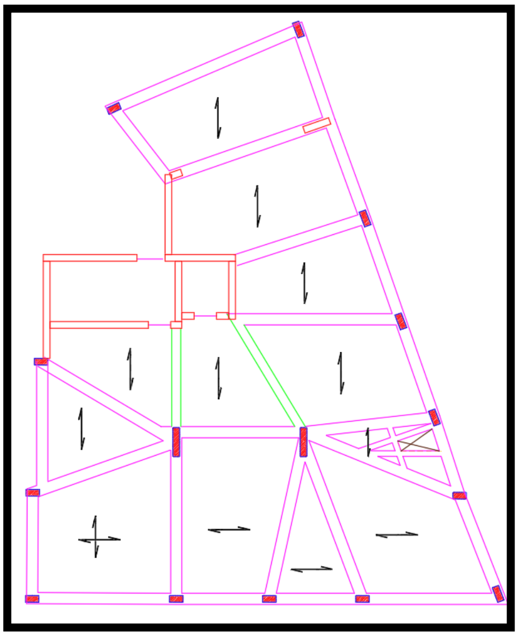


Figure 78: slab direction

3.4.2 Preliminary Design for Beams:

Beams: Is the structural element that holds the slab and transfers the loads to columns. and it consist of two type in one way slabs:

a) Main beams: is the beams that carry all slab loads.

b) Secondary beams: is the beams that carry portions and external wall loads.

The minimum depth of the beams shall be satisfying the limits in table 9.5 (a) in ACI 318-14. These limits are related to these requirements, to prevent the damage and failures.

The table below shows the minimum beam depth according to ACI 318-14:

Table 12: Minimum thickness requirement for beams

TABLE 9.5(a) — MINIMUM THICKNESS OF NONPRESTRESSED BEAMS OR ONE-WAY SLABS UNLESS DEFLECTIONS ARE CALCULATED

	Minimum thickness, *h*			
	Simply supported	One end continuous	Both ends continuous	Cantilever
Member	Members not supporting or attached to partitions or other construction likely to be damaged by large deflections			
Solid one-way slabs	**ℓ/20**	**ℓ/24**	**ℓ/28**	**ℓ/10**
Beams or ribbed one-way slabs	**ℓ/16**	**ℓ/18.5**	**ℓ/21**	**ℓ/8**

Notes:
Values given shall be used directly for members with normalweight concrete and Grade 60 reinforcement. For other conditions, the values shall be modified as follows:
a) For lightweight concrete having equilibrium density, w_c, in the range of 90 to 115 lb/ft^3, the values shall be multiplied by **(1.65 – 0.005w_c)** but not less than 1.09.
b) For f_y other than 60,000 psi, the values shall be multiplied by **(0.4 + f_y/100,000)**.

According to table 9.5 (a) in ACI318-14, the dimensions of beams shown in table below, and layout of beams shown in figure below.

Table 13 beams dimensions:

Beam Name	Depth(cm)	Width(cm)
Main beam B1	**40**	**50**
secoundary beam B2	**25**	**40**
Beam B3	**60**	**40**
cross beam CR	**25**	**20**

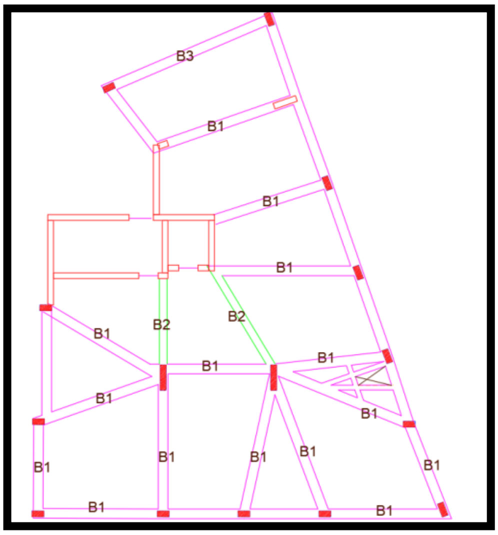


Figure 79: layout of beams for first block

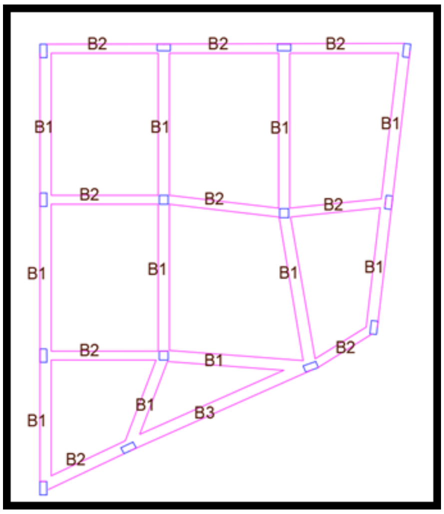


Figure 80: layout of beams for second block

3.4.3 Preliminary Design for Columns:

Column: the vertical structural element that hold all loads from beams, and transfer it to the footing., the dimension will be checked for load capacity.

All columns' dimensions were verified, using the following formula due to the axial force from the gravity loads only assuming 1% reinforced steel ratio. The column dimension will be checked by ETABS in design and modeling section.

Pu=Φʎ(0.85*fc`*(Ag-As) +As*fy)

Φ: strength reduction factor = 0.65

ʎ: factor to considered minimum eccentricity = 0.8

fc: concrete compressive strength = 28 MPa

fy: steel yielding strength =420 MPa

The columns which have max tributary area will be checked (maximum load manually, and by ETABS in checks later on.

<u>ultimate load on column (50 x 50 (cm)):</u>

load on column = weight on slab + beams weight +column weight

weight on slab= tributary area x ultimate load on slab

tributary area = (5.37-0.4) x (7.25-0.4)

=34.04 m^2(Where 0.4 m width of beams in X,Y-direction)

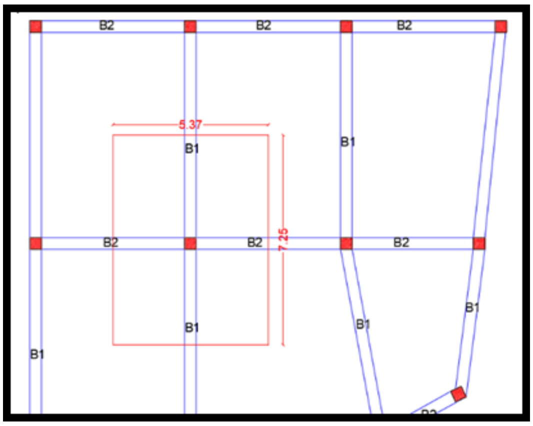


Figure 81: tributary area

Ultimate Weight on Slab = 34.04 x 16.6

= **565.064 KN**

Beam weight = length of beams X weight of beam per length unit.

= ((5.37-0.4)x(0.3x0.4) + 7.25(0.4x0.4)) x 25Kn/m^3

= 43.75 Kn

Beams live load = live load x surface area of beam

= 4.8 x (0.4 x (7.25+5.37))

= 24.23 Kn

Beams super dead load = SD x surface area of beam

= 4.317 x (0.4 x (7.25+5.37))

= 21.8 KN

Beam weight ultimate = 1.2x(43.75 + 21.8) + 1.6x(24.23)

= **117.42 KN**

Column weight = length of column x weight of column per unit length

Length of column = 3.5 m

Weight of column per unit length = (0.5 x 0.5 x 25)= 6.25

Column weight = 3.6 x 6.25 = 21.87KN

Column weight ultimate = 1.2 x 21.87

= **26.25 KN**

load on column from one story = **565.06 + 117.42 +26.25**

= **708.73KN**

Total Ultimate load on column = number of story x load from one story

= **3543.65 KN**

From equation Pu=$^{\phi}$ʎ(0.85*fc`*(Ag-As)+As*fy) assuming 1% AS :

Area of gross = 245469 mm^2 (**500 mm x 500 mm is OK)**

Column 500mm x 500mm capacity = 3610Kn

Column 600mm x 300mm capacity = 2590Kn

3.5 PROJECT MODLING

In this step, 3D model for building will be built up using ETABS Software, to analyze the structure for all vertical and horizontal loads, to determine the internal forces in all the structural members, then design all these elements.

3.5.1Models Layouts:

Defining the properties and sections for members.

The result as shown in figures below:

3.5.1.1 Block2 layout

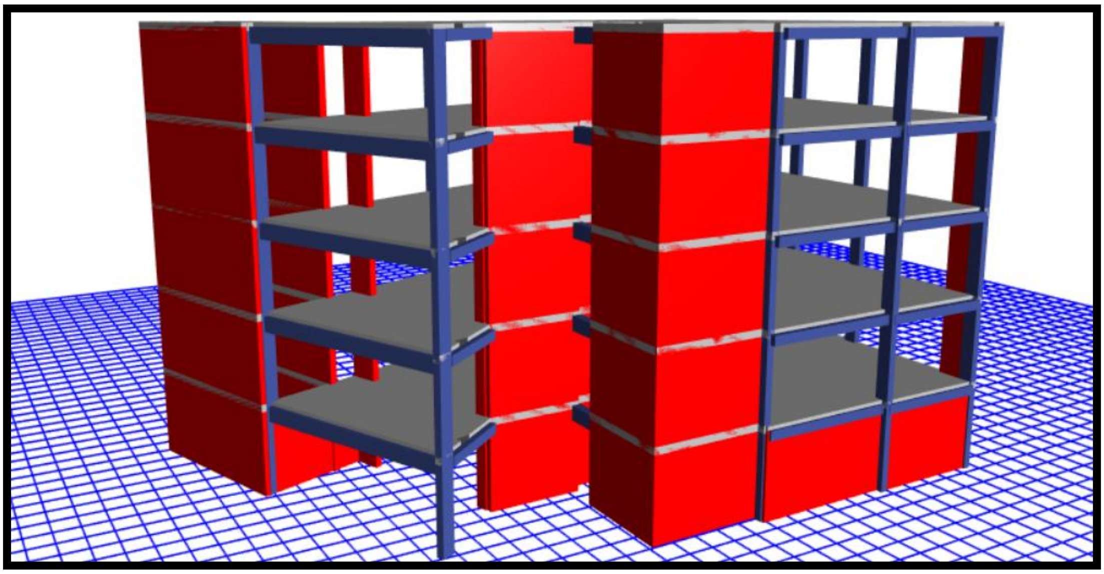


Figure 84: 3D modeling from ETABS for block 1

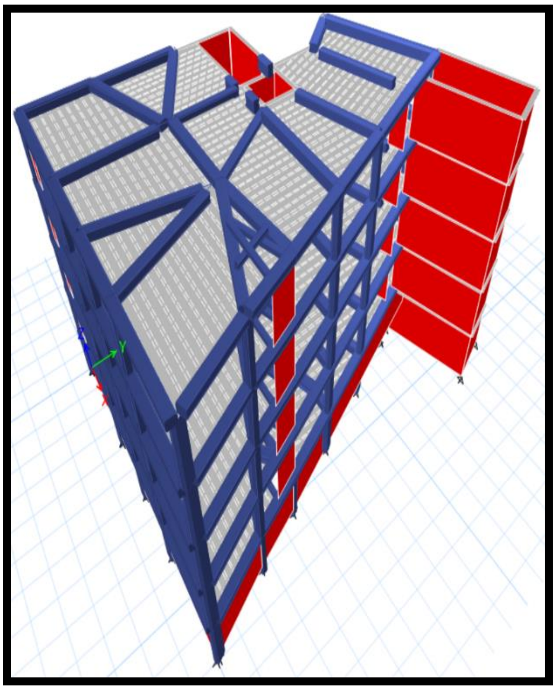


Figure 83: 3D modeling from ETABS for block 1

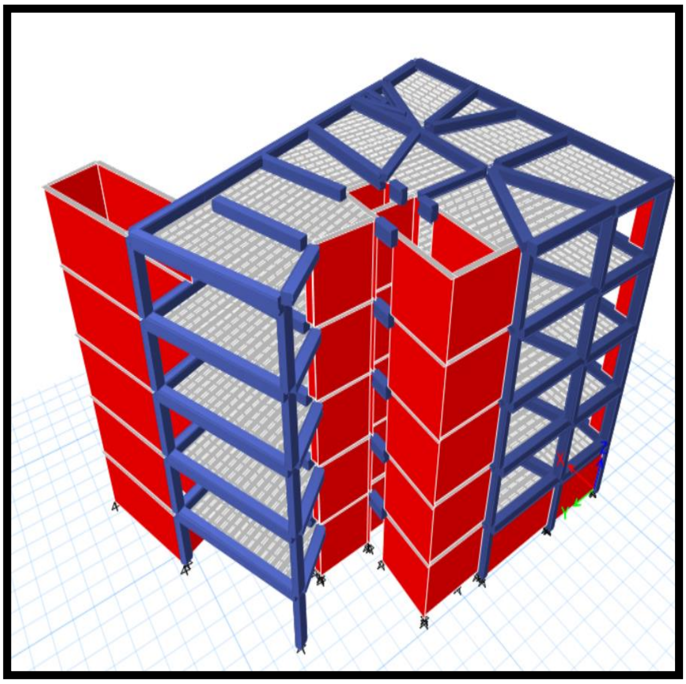


Figure 82: 3D modeling from ETABS for block 1

3.5.1.2Block1 layout

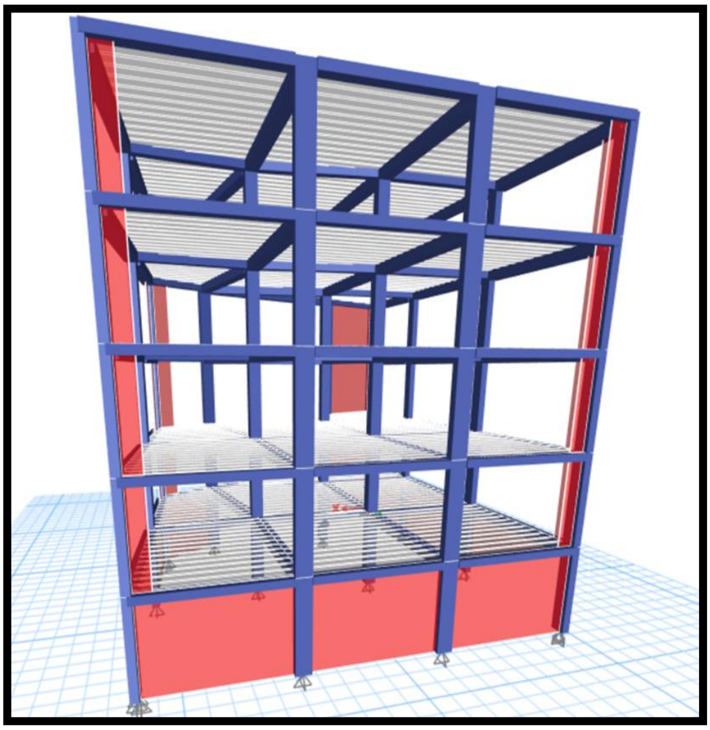


Figure 85: 3D modeling from ETABS for block 2

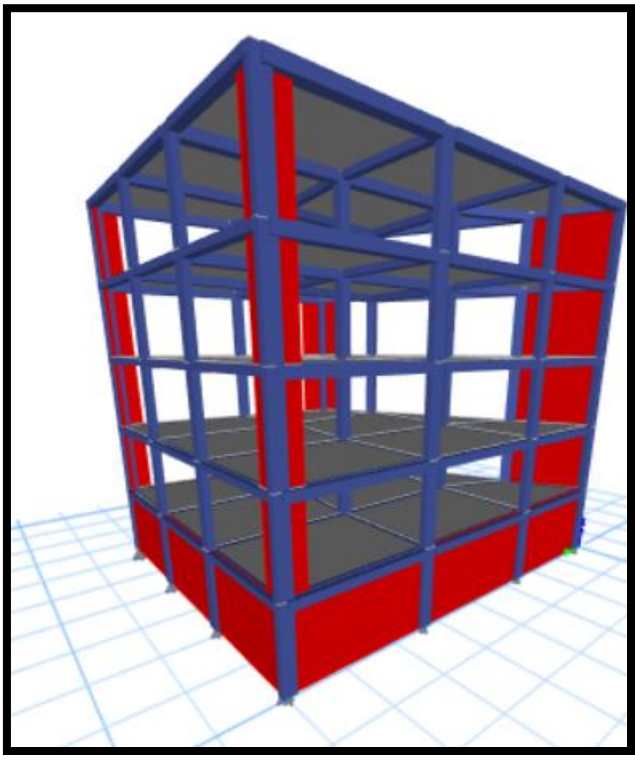


Figure 87: 3D modeling from ETABS for block 2

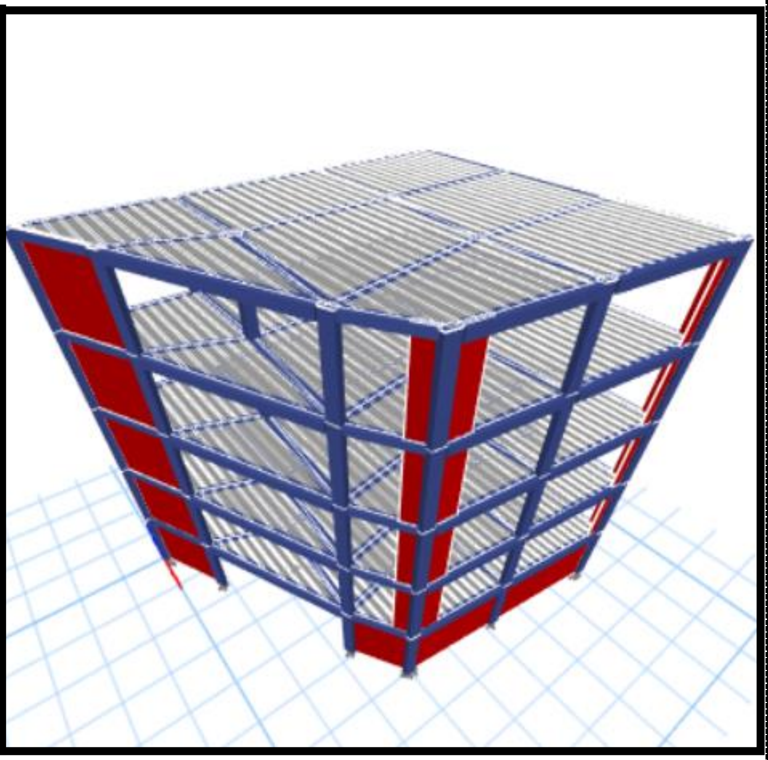


Figure 86: 3D modeling from ETABS for block 2

3.6 Material Definition:

The Materials that used in the building will have the following characteristics:

Structural Element	Material Type
Slabs	Concrete 28 Mpa
Beams	Concrete 28 Mpa
Columns & Shear Walls	Concrete 28 Mpa
Stair	Concrete 28 Mpa
Reinforcement Bar	A615Gr60 (420 Mpa)
Footing	Concrete 28 Mpa

3.6.1 Assumptions structural about project and design code:

The type of supports that defined is pin supports; because that the expected foundation is single foundation system, and the most representative type for this footing type is pin supports. ACI 318-14 code will be used in analyzing the structure.

3.6.2 MODEL CHECKS (gravity loads)

3.6.2.1Compatibility Check:

Check if the structure work as a one unit and all members are contacted.

3.6.2.1.1 compatibility check for Block 1:

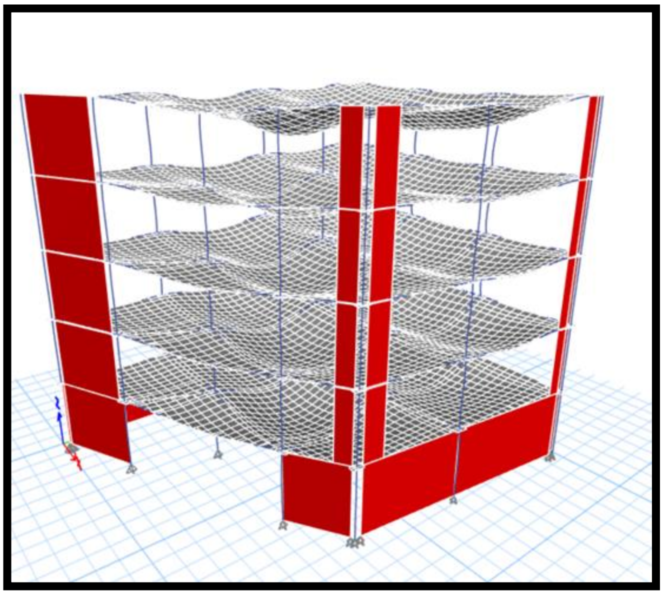


Figure 88: compatibility check result for block1

3.6.2.1.2 compatibility check for Block 2 :

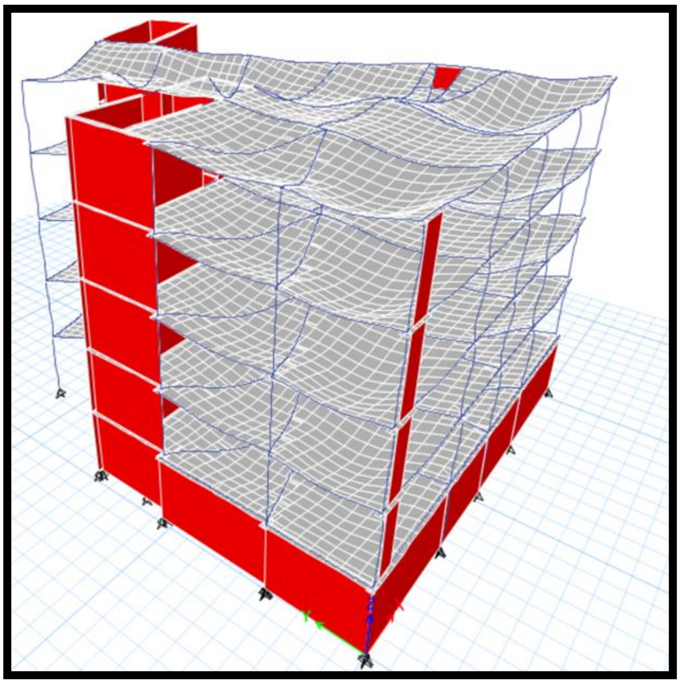


Figure 89: compatibility check result for block2

3.6.2.2 Equilibrium check:

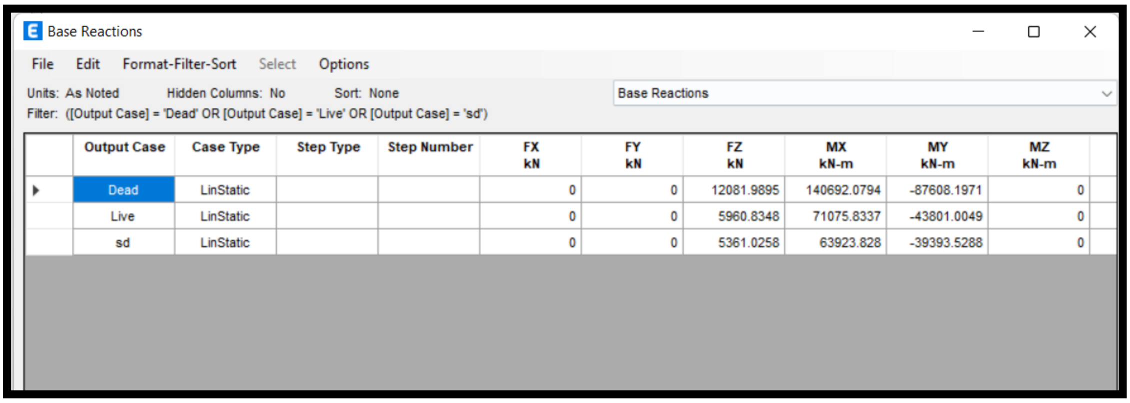
Calculate gravity load and compare with ETABS results.

3.6.2.2.1 equilibrium check for Block 1:

Total live load = $\sum area\ of\ story$ X live load per unit area

= 1250 X 4.8

= 6000 Kn



Output Case	Case Type	Step Type	Step Number	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m
Dead	LinStatic			0	0	12081.9895	140692.0794	-87608.1971	0
Live	LinStatic			0	0	5960.8348	71075.8337	-43801.0049	0
sd	LinStatic			0	0	5361.0258	63923.828	-39393.5288	0

Figure 90: Base Reaction from Etabs

For live load:

ETABS: live load = 5960.83KN

Manual: dead load = 6000 KN

ERROR $=\frac{6000-5960.83}{6000} = 0.65\% < 5\%\ OK$

3.6.2.2.2 equilibrium check for Block 2 :

Total dead load = weight of beams + weight of slab + weight of column + weight of walls

Weight of beam = length of beam x weight of beam per unit length

=(128.6365 * 0.5 * 0.4 *25) + (19.64 *0.6*0.4*25)

+ (11* 0.4*0.25*25)+(10.42 * 0.25 * 0.2)

=801.554Kn

Weight of slab = area of slab x weight of slab per unit area

= 321.13 *4.55 = 1560.55 Kn

Weight of column = number of column x weight of column

= 13*0.6*0.3*25*3.6 + 2*1.3*0.3*3.6*25

= 280.8Kn

Weight of shear walls in the barking = length of wall x weight of wall per unit length

= 16.1687 x 0.2 x 3.6 x 25

= 291.0365 Kn

Weight of shear walls in other stories = length of wall x weight of wall per unit length

= 30.5366 x 0.2 x 3.6 x 25

= 549.6588 Kn

Weight of retaining walls = length of wall x weight of wall per unit length

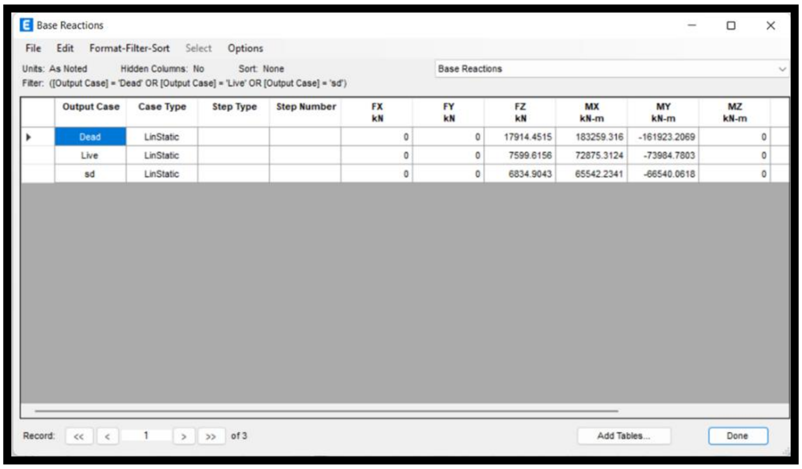
= 71.188 x 0.3 x 3.6 x25

= 1922.076Kn

Total dead load = $\sum weight\ of\ story$

= 17626.37 Kn

From ETABS:



Output Case	Case Type	Step Type	Step Number	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m
Dead	LinStatic			0	0	17914.4515	183259.316	-161923.2069	0
Live	LinStatic			0	0	7599.6156	72875.3124	-73984.7803	0
sd	LinStatic			0	0	6834.9043	65542.2341	-66540.0618	0

Figure 91: Base Reaction from Etabs.

For DEAD load

ETABS: dead load = 17914.45KN

Manual: dead load = 17626.37 KN

ERROR $=\frac{17626.37-17914.45}{17626.37} = 1.6\% < 5\% \; OK$

3.6.2.3 Internal force check:

manually calculation of forces in an element, and compare it with ETABS result.

.3.6.2.3.1 internal force checks for Block 1:

1- Making check for beam:

Beams B3:

For moment:

Check moment in beam, from SD load, Tributary area on beam = 1.73 x 7.33 m as shown :

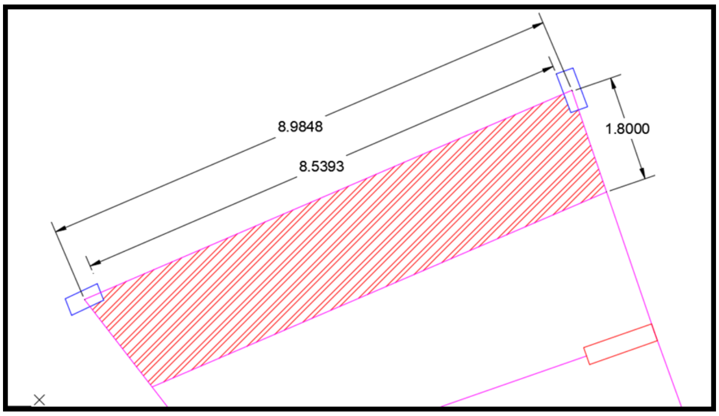


Figure 92: tributary area on beam B3

From manual calculations:

Super Dead load on beam= 4.317 x (1.8-.15) = 7.123 Kn/m

Moment = $\frac{WL^2}{8}$

So, moment = $\frac{7.123\ x(8.5393)2}{8}$ = **<u>64.33Kn.m</u>**

From Etabs:

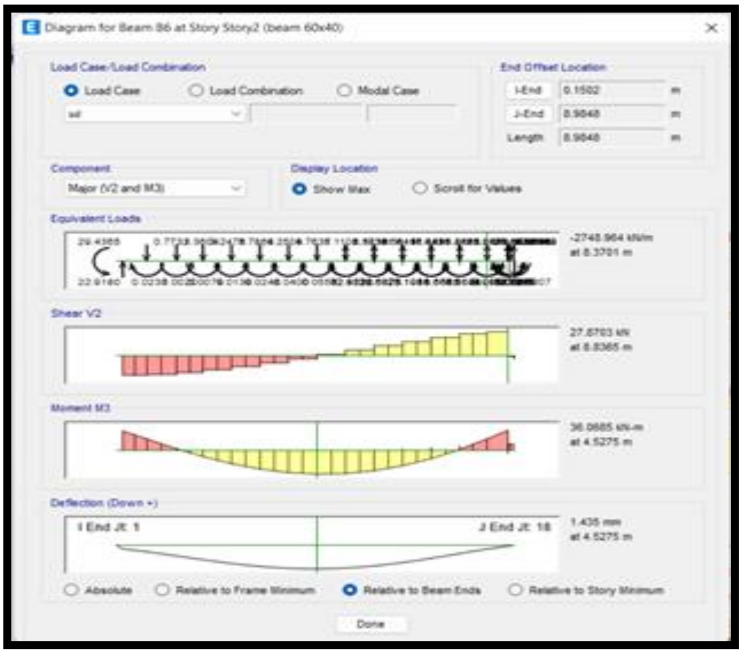


Figure 93: moment on beam from SD load

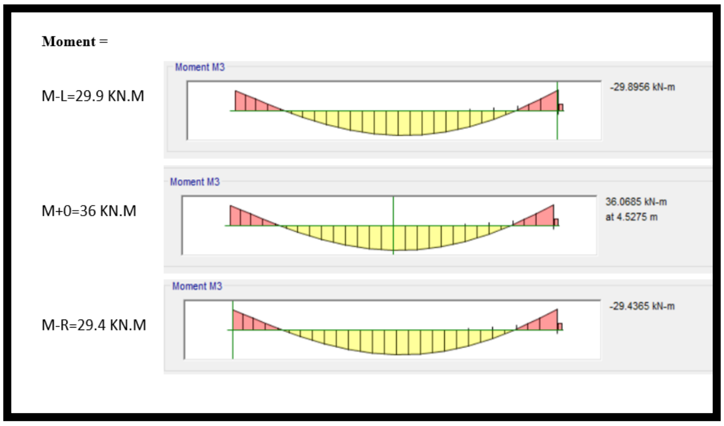


Figure 94: moment on center and edge of beam from SD load

$$Moment = \frac{(29.9 + 29.4)}{2} + 36 = \mathbf{65.65Kn.m}$$

Error <10%, its OK

2- Making check for column:

Load on column from SD load above basement:

Load on column = $SD\ x\ \sum\ area\ of\ tributary\ area\ from\ story$

= 4.317 x 4 x (5.017x3.122)

= 270.46 Kn.

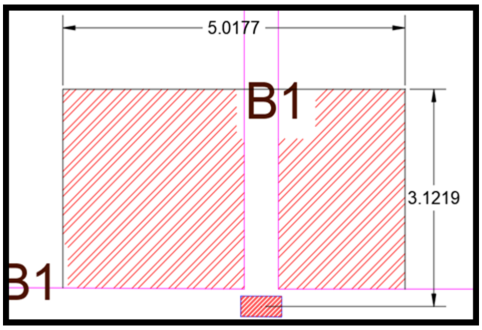


Figure 95: **Tributary area on column.**

Figure 96: **Axial load on column from SD load**

Error <10% its ok.

3- Making check for slab:

By making a strip with width equal 1 meter ; to show force result in slab in ETABS:

Check for moment from super dead load : Sd load = 4.317 Kn/m^2, For strip 1 meter width and length of strip = 5.4 meter .

$$M = \frac{wL^2}{8} = \frac{4.317*5.4^2}{8} = 15.6\ Kn.m$$

From Etabs:

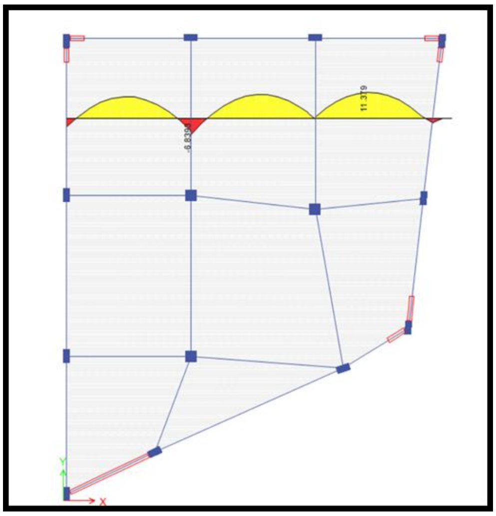


Figure 97: SD moment on strip in slab in block one

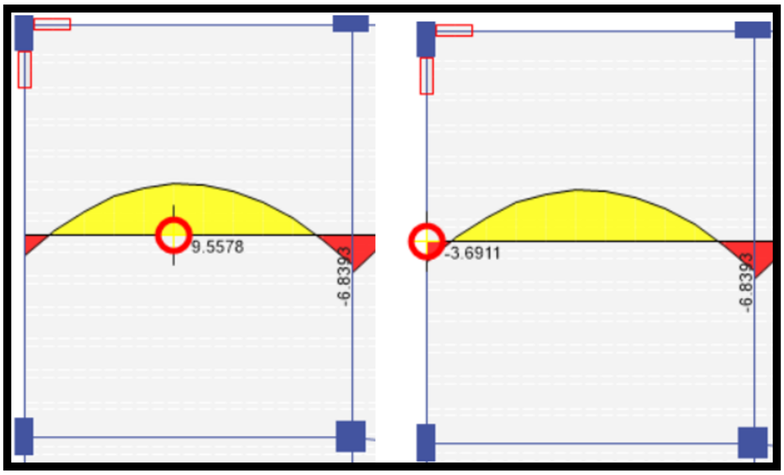


Figure 98: SD moment on strip in slab in block one

$$Moment = \frac{(6.84 + 3.69)}{2} + 9.55 = \mathbf{14.815 Kn.m}$$

Error <10%, its OK

3.6.2.3.2 internal force check for Block 2 :

1- Making check for beam:

Beams B1:

Beam dimensions = 50cm width, 40cm depth,

For moment:

Check moment in beam, from live load, Tributary area on beam = 5.343 x 6.37 m as shown:

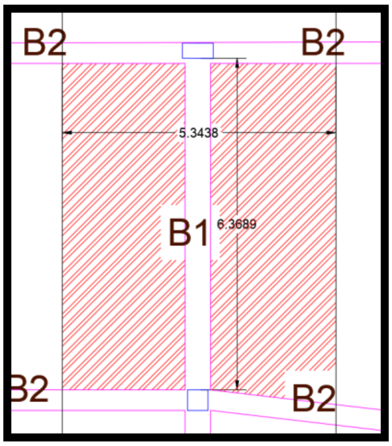


Figure 99: tributary area on beam B3

From manual calculations:

Live load on beam = 4.8 x (5.34) = 25.632Kn/m

Moment = $\frac{WL^2}{8}$

So, moment = $\frac{25.632\ x(6.37)2}{8}$ = **<u>130Kn.m</u>**

From Etabs:

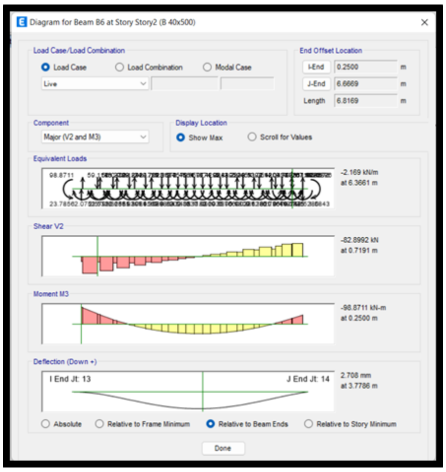


Figure 100: **moment on beam from live load**

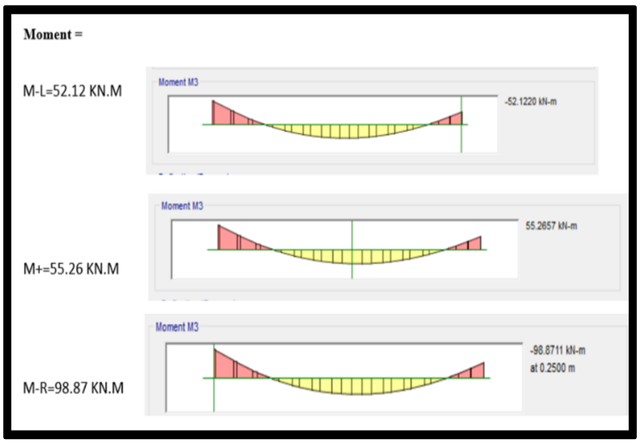


Figure 101: moment on center and edge of beam from live load

$$Moment = \frac{(52.12 + 98.87)}{2} + 55.26 = \mathbf{130.755 Kn.m}$$

Error <10%

its ok!

2- Making check for column:

Load on column from SD load:

Load on column = $SD\ x\ \sum\ area\ of\ tributary\ area\ from\ story$

= 4.317 x 5 x (5.6054 x 6.9285)

= 838.237 Kn.

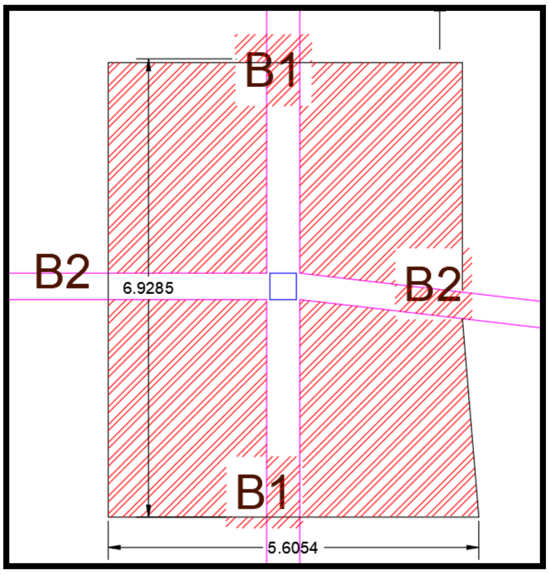


Figure 102: tributary area on column

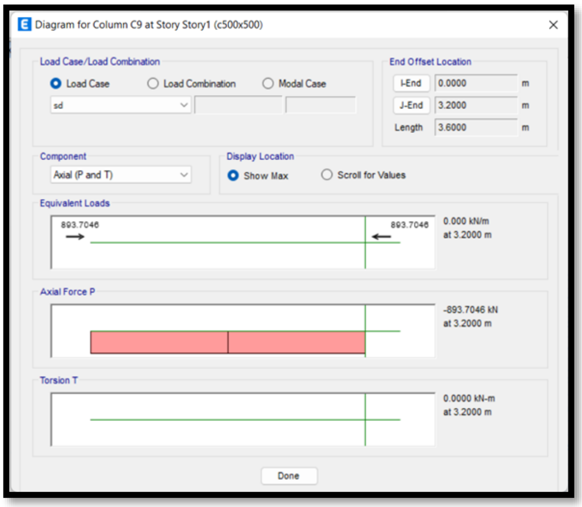


Figure 103: **Axial load on column from SD load**

Error <10%

its ok!

1- Making check for slab:

By making a strip with width equal 1 meter; to show force result in slab in ETABS:

Check for moment from live load : (live load = 4.317 Kn/m^2) , For strip 1 meter width and length of strip = 4.4 meter .

$$M = \frac{wL^2}{8} = \frac{4.8*4.4^2}{8} = 11.6\ Kn.m$$

From Etabs:

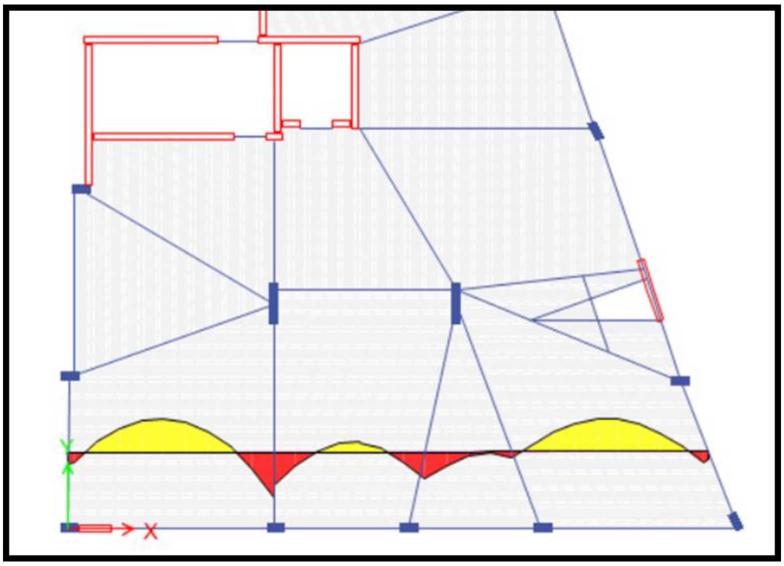


Figure 104: SD moment on strip in slab in block one

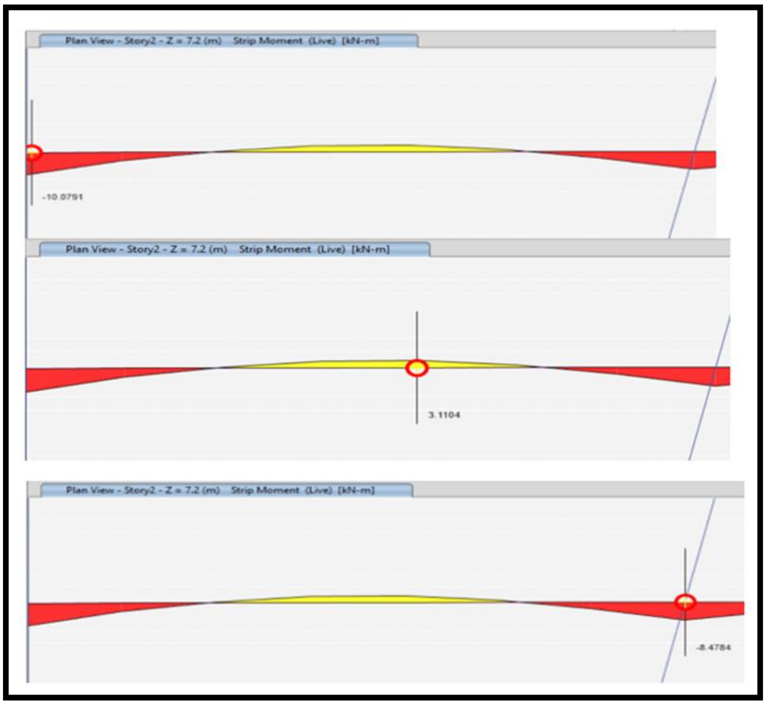


Figure 105: SD moment on strip in slab in block one

$$Moment = \frac{(10.08 + 8.47)}{2} + 3.11 = \mathbf{12.3 Kn.m}$$

Error <10%, its OK

3.7 Dynamic analysis

seismic location factors and values:

ASCE7-16 will be used for dynamic analysis to design the building under lateral forces.

Seismic ground motion values:

To find acceleration parameter SD1 and SDs, seismic zone factor (Z) and soil profile, it can be obtained from seismic zone factor maps. Which equal to **0.15** (NABLUS CITY).

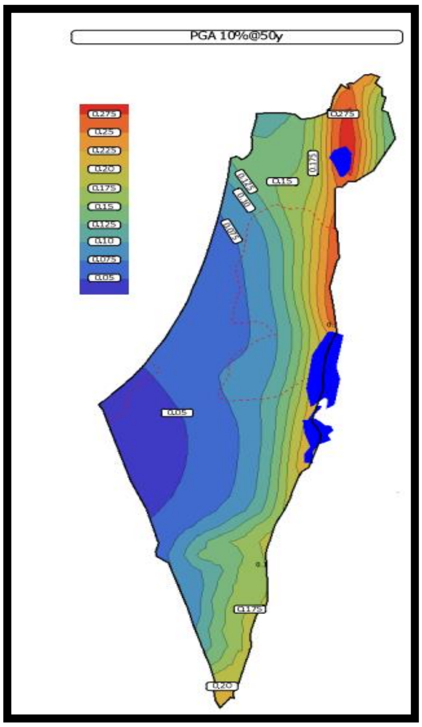


Figure 106: seismic zone factor map

Determine site soil classification:

from soil test report soil profile will be determinate and then according to ASCE7-16 code (Table 20.3-1 as shown) determine label of soil profile, it found to be (**SC**).

Table 14: soil profile

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	>2,000 psf
D. Stiff soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the following characteristics: —Plasticity index $PI > 20$, —Moisture content $w \geq 40\%$, —Undrained shear strength $\bar{s}_u < 500$ psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1 ft/s = 0.3048 m/s; 1 lb/ft² = 0.0479 kN/m².

Mapped Acceleration Parameters:

The parameters **S_1** and **S_S** determined from 1 sec and 0.2 sec spectral response accelerations shown on Figures below.

Where:

S_S = the mapped MCER spectral response acceleration parameter at short periods as determined in accordance with Section 11.4.1in ASCE,

S_1 = the mapped MCER spectral response acceleration parameter at a period of 1 s as determined in accordance with Section 11.4.1 in ASCE.

From maps:

S_s= 0.3 sec

S_1= 0.07 sec

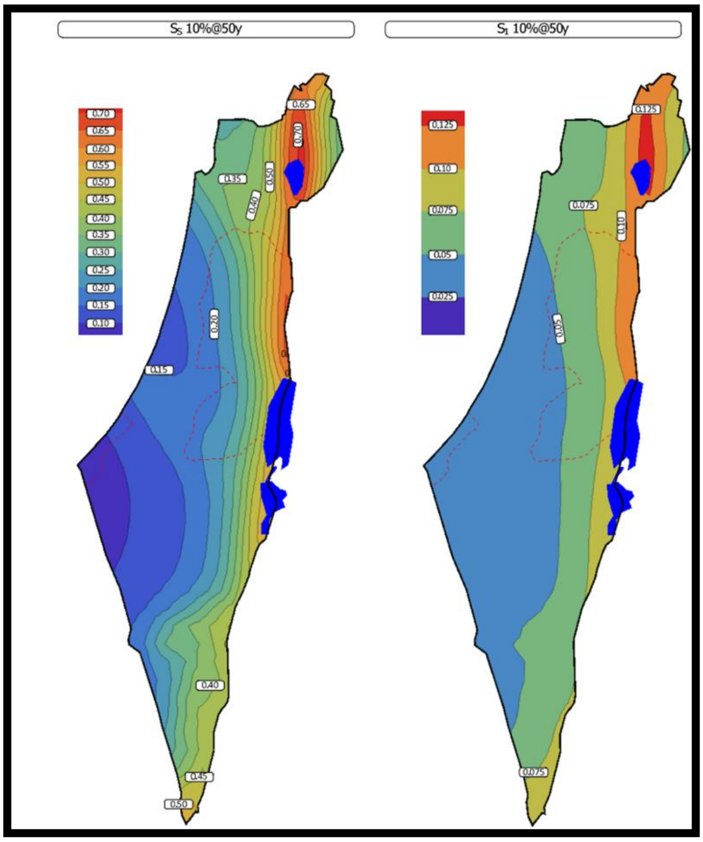


Figure 107: acceleration parameter map S_1 and Ss .

Site Coefficients and Risk-Targeted Maximum Considered Earthquake (MCER)

The MCER spectral response acceleration parameters for short periods (**S_{MS}**) and at 1 second (**S_{M1}**), adjusted for site class effects, shall be determined from ASCE7-16 EQs. (11.4-1) and (11.4-2), respectively:

$$S_{MS} = F_a S_S$$
$$S_{M1} = F_v S_1$$

Determine (Fa) and (Fv) based on site soil classification

Where

F_a = short-period site coefficient (at 0.2 s-period)

F_v= long-period site coefficient (at 1.0 s-period)

Site coefficients: **F_v = 1.7 and F_a = 1.2**

Table 15: Seismic coefficient Fa & Fv

Table 11.4-1 Site Coefficient, F_a

Site Class	Mapped Risk-Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameter at Short Period				
	$S_S \le 0.25$	$S_S = 0.5$	$S_S = 0.75$	$S_S = 1.0$	$S_S \ge 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7				

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

Table 11.4-2 Site Coefficient, F_v

Site Class	Mapped Risk-Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameter at 1-s Period				
	$S_1 \le 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 \ge 0.5$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7				

Note: Use straight-line interpolation for intermediate values of S_1.

site class = C

S_s= 0.3 sec

S_1= 0.07 sec

Fa = 1.2

Fv = 1.7

Design spectral acceleration:

SD_1 = the design spectral response acceleration parameter at a period of 1.0 s

SD_S = design spectral response acceleration parameter at short periods

SD_1 $=SM_1{}^{*} = F_v \text{ X } S_1 = 1.7 \text{ x } 0.07 = 0.119$

SD_s $= SM_s{}^{*} = F_a \text{ X } S_s = 1.2 \text{ x } 0.3 = 0.36$

* S_{Ds} in code equal $(\frac{2}{3} x \text{ SMs } x\ Fa)$ but because using 10% PGA $S_{Ds} = S_{MS}\ F_a$, and the same on S_{D1}

Determination of occupancy type:

From table 1.5-1 in ASCE7-16 Risk category **III**

Table 16: occupancy type

Table 1.5-1 Risk Category of Buildings and Other Structures for Flood, Wind, Snow, Earthquake, and Ice Loads

Use or Occupancy of Buildings and Structures	Risk Category
Buildings and other structures that represent a low risk to human life in the event of failure	I
All buildings and other structures except those listed in Risk Categories I, III, and IV	II
Buildings and other structures, the failure of which could pose a substantial risk to human life.	III
Buildings and other structures, not included in Risk Category IV, with potential to cause a substantial economic impact and/or mass disruption of day-to-day civilian life in the event of failure.	
Buildings and other structures not included in Risk Category IV (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing toxic or explosive substances where their quantity exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released.	
Buildings and other structures designated as essential facilities.	IV
Buildings and other structures, the failure of which could pose a substantial hazard to the community.	
Buildings and other structures (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, or hazardous waste) containing sufficient quantities of highly toxic substances where the quantity exceeds a threshold quantity established by the authority having jurisdiction to be dangerous to the public if released and is sufficient to pose a threat to the public if released.[a]	
Buildings and other structures required to maintain the functionality of other Risk Category IV structures.	

[a]Buildings and other structures containing toxic, highly toxic, or explosive substances shall be eligible for classification to a lower Risk Category if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.2 that a release of the substances is commensurate with the risk associated with that Risk Category.

Importance factor of the structure:

I = Importance Factor: From ASCE Code, depend on risk category:

I = 1.25

Table 17: Importance Factors table

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

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	1.25	1.00	1.25
IV	1.20	1.25	1.00	1.50

[a]The component importance factor, I_p, applicable to earthquake loads, is not included in this table because it is dependent 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.

Design risk category:

Table 18: **Seismic design category**

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

Value of S_{DS}	Risk Category I or II or III	Risk Category 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

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

Value of S_{D1}	Risk Category I or II or III	Risk Category 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

Seismic design category ((C)).

Determination of Lateral-force analysis Procedure:

methods of analysis and evaluate earthquake force:

1. Equivalent lateral force analysis (ELF method).
2. Modal response spectral analysis (MRS method).
3. Time history analysis.
4.

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; $T_s = S_{D1}/S_{DS}$.

The procedure will be ELF and to be confidence will use MRS method.

factors and design coefficients for seismic force resisting system:

The structure will design as shear wall resisting frame, and the amount of lateral force that taken by shear wall will be checked by ETABS.

Notice ASCE7 - 16 Code required the use of ordinary reinforced concrete shear walls system. from Table 12.2-1.

Table 12.2-1 *(Continued)*

Seismic Force-Resisting System	ASCE 7 Section Where Detailing Requirements Are Specified	Response Modification Coefficient, R^a	Overstrength Factor, Ω_0^g	Deflection Amplification Factor, C_d^b	Structural System Limitations Including Structural Height, h_n (ft) Limits[c] — Seismic Design Category: B	C	D[d]	E[d]	F[e]
4. Special reinforced concrete shear walls[l,m]	14.2	6	2½	5	NL	NL	160	160	100
5. Ordinary reinforced concrete shear walls[l]	14.2	5	2½	4½	NL	NL	NP	NP	NP
6. Detailed plain concrete shear walls[l]	14.2 and 14.2.2.8	2	2½	2	NL	NP	NP	NP	NP
7. Ordinary plain concrete shear walls[l]	14.2	1½	2½	1½	NL	NP	NP	NP	NP
8. Intermediate precast shear walls[l]	14.2	5	2½	4½	NL	NL	40[k]	40[k]	40[k]
9. Ordinary precast shear walls[l]	14.2	4	2½	4	NL	NP	NP	NP	NP
10. Steel and concrete composite eccentrically braced frames	14.3	8	2 ½	4	NL	NL	160	160	100
11. Steel and concrete composite special concentrically braced frames	14.3	5	2	4½	NL	NL	160	160	100
12. Steel and concrete composite ordinary braced frames	14.3	3	2	3	NL	NL	NP	NP	NP
13. Steel and concrete composite plate shear walls	14.3	6½	2½	5½	NL	NL	160	160	100
14. Steel and concrete composite special shear walls	14.3	6	2½	5	NL	NL	160	160	100
15. Steel and concrete composite ordinary shear walls	14.3	5	2½	4½	NL	NL	NP	NP	NP
16. Special reinforced masonry shear walls	14.4	5½	2½	4	NL	NL	160	160	100
17. Intermediate reinforced masonry shear walls	14.4	4	2½	4	NL	NL	NP	NP	NP
18. Ordinary reinforced masonry shear walls	14.4	2	2½	2	NL	160	NP	NP	NP
19. Detailed plain masonry shear walls	14.4	2	2½	2	NL	NP	NP	NP	NP
20. Ordinary plain masonry shear walls	14.4	1½	2½	1¼	NL	NP	NP	NP	NP

factors and design coefficients for seismic force resisting system:

Over strength factor **Ω = 2.5**

Deflection amplification factor **C_d =4.5**

Response modification factor **R = 5**

3.7.1block one calculation:

3.7.1.1 period calculation

The fundamental period, shall not be more than the product of the approximate period (Ta), determined in according with Section 12.8.2 in ASCE7-16. And coefficient of upper limit of period (Cu), from Table 12.8-1 in ASCE7-16.

Finding period manually, and then compare it with ETABS program.

- From ASCE7-16 code Section (12.8.2):

The approximately maximum period:

$$T \geq Ta \times Cu$$

Where:

: maximum period of the structure.

$$Ta = Ct \times hn^{x}$$

Ta: approximate fundamental period.

Cu: Coefficient for Upper Limit on Calculated Period.

hn: height of building.

Ct, X: building coefficient parameter for approximate period.

Table 19: Period of the structure

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

[a] Metric equivalents are shown in parentheses.

Ct= 0.0488 **X=0.75**

Then: **Ta = 0.36 second**

Determine the upper limit of period:

Table 20: Upper period limit coefficient C_u.

Table 12.8-1 Coefficient for Upper Limit on Calculated Period

Design Spectral Response Acceleration Parameter at 1 s, S_{D1}	Coefficient C_u
≥ 0.4	1.4
0.3	1.4
0.2	1.5
0.15	1.6
≤ 0.1	1.7

Cu = 1.66

$T \geq Ta \times Cu$

$Ta\ x\ Cu = 0.36\ x\ 1.66 = 0.6\ sec$

- ETABS:

The Value from ETABS must be smaller than (Ta x Cu = 0.6 sec)

X-direction: -

T = 0.48 Sec … OK

Y- direction: -

T = 0.57 Sec … OK

Modal Periods And Frequencies

File Edit Format-Filter-Sort Select Options

Units: As Noted Hidden Columns: No Sort: None Modal Perio

Filter: None

Case	Mode	Period sec	Frequency cyc/sec	CircFreq rad/sec	Eigenvalue rad^2/sec^2
Modal	1	0.569	1.759	11.0496	122.093
Modal	2	0.476	2.101	13.2032	174.3234
Modal	3	0.27	3.702	23.2581	540.9402
Modal	4	0.161	6.196	38.9298	1515.5325
Modal	5	0.132	7.558	47.4856	2254.8846
Modal	6	0.081	12.36	77.6609	6031.2134
Modal	7	0.067	14.966	94.0341	8842.4114
Modal	8	0.063	15.77	99.0836	9817.56
Modal	9	0.053	18.878	118.6136	14069.1762
Modal	10	0.043	23.463	147.4219	21733.2125
Modal	11	0.038	26.346	165.5388	27403.1005
Modal	12	0.034	29.014	182.302	33234.0031

Figure 108: Period of the structure

3.7.1.2 Equivalent static analysis:

Base shear reaction calculation

The total design base shear (V) shall be determined as follows:

The seismic base shear (V), can be determined in accordance with the following equation:

$$V = Cs\ W$$

Where:

W = the effective seismic weight.

Cs = seismic response coefficient.

Seismic response coefficient:

According to ASCE7-16, **Cs** determined in general by the following equation

$$Cs = \frac{SDS}{\frac{R}{Ie}}$$

But for T ≤ Ts:

$$Cs = \frac{SD1}{T\frac{R}{Ie}}$$

And for T > Ts:

$$Cs = \frac{SD1}{T^2\frac{R}{Ie}}$$

Cs shall not be less than

Cs =0.044S_{DS}Ie ≥ 0.01

Where:

Ie and R are as defined above and equal 1.25, 5 respectively

SDs = the design spectral response acceleration parameter at a period of 1.0 s, as determined equal 0.36;

SD1 = the design spectral response acceleration parameter at a period of 1.0 s, as determined equal 0.119.

T = the fundamental period of the structure(s) determined equal 0. 6 sec.

TL = long-period transition period(s) assumed equal 4 sec.

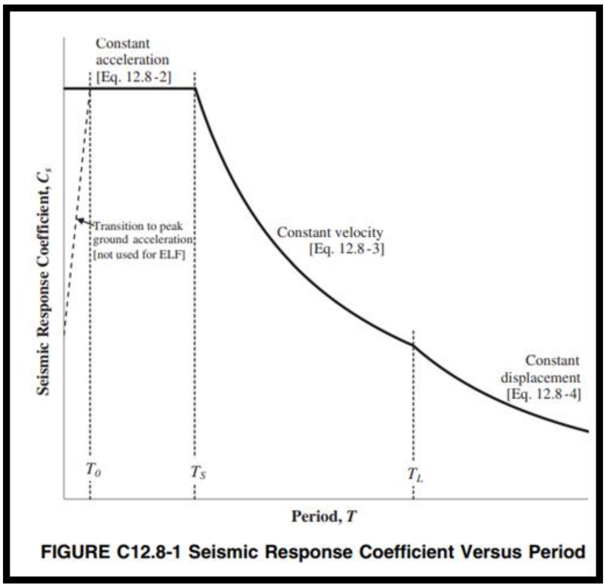


Figure 109:Seismic response coefficient versus period..

Where: Ω = 2.5 , C_d = 4.5 , R = 5 , T = 0.6 sec

$$Cs = min\ of \begin{bmatrix} \left(\frac{0.36}{\frac{5}{1.25}}\right) = 0.09 \\ \frac{0.119}{.6*\frac{5}{1.25}} = 0.05 \end{bmatrix}$$

So **Cs = 0.05** and its greater than (0.044 x .36 x 1.25 = 0.02)

Affective seismic weight (W): include all dead loads above the base and other loads in which:

1- In areas used for storage 25% of the live load shall be included according to ASCE7-16 section 12.7.2.
2- All super imposed dead load and partitions load in floor.

W = DL + SD + 0.25LL

= 7758.83+ 4279.16+0.25(4757.95)

= 13227.4775 KN

Base shear (V) = *Cs X W*   =*661.37 KN*

Define equivalent lateral static load on ETABS:

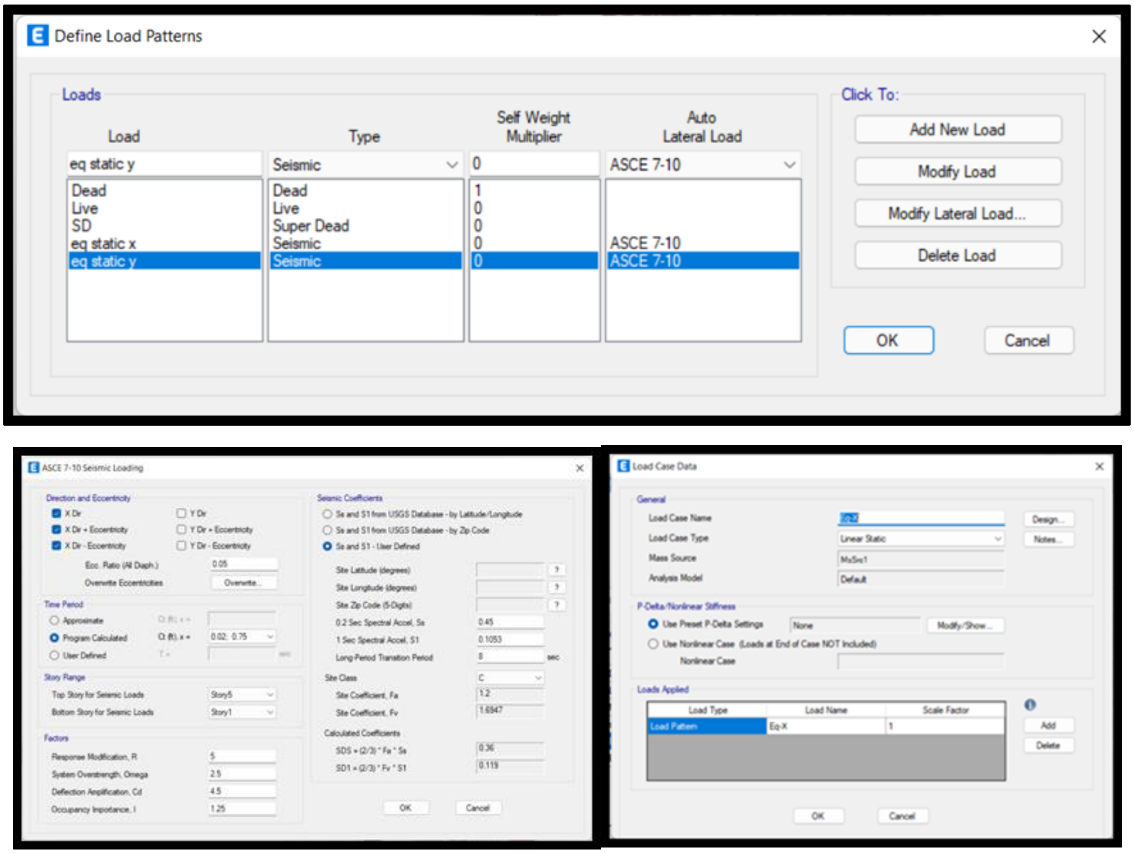


Figure 110: define lateral static force in etabs

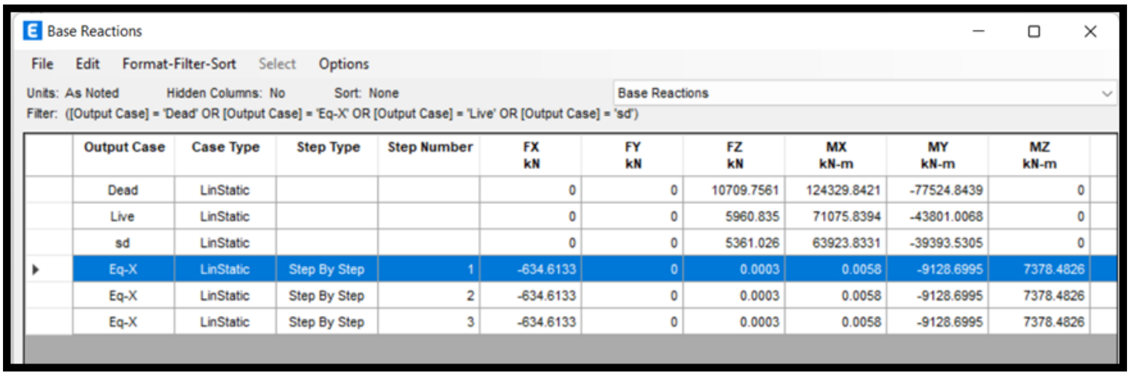
And then define mass source with dead factor = 1, and live factor=0.25.

3.7.1.2.1Equivalent Static shear check: -

V-x by ETABS = 634.61 KN

V-x by hand = 661.37 KN

Error < 5%, ok.



Base Reactions

File Edit Format-Filter-Sort Select Options

Units: As Noted Hidden Columns: No Sort: None Base Reactions

Filter: ([Output Case] = 'Dead' OR [Output Case] = 'Eq-X' OR [Output Case] = 'Live' OR [Output Case] = 'sd')

Output Case	Case Type	Step Type	Step Number	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m
Dead	LinStatic			0	0	10709.7561	124329.8421	-77524.8439	0
Live	LinStatic			0	0	5960.835	71075.8394	-43801.0068	0
sd	LinStatic			0	0	5361.026	63923.8331	-39393.5305	0
Eq-X	LinStatic	Step By Step	1	-634.6133	0	0.0003	0.0058	-9128.6995	7378.4826
Eq-X	LinStatic	Step By Step	2	-634.6133	0	0.0003	0.0058	-9128.6995	7378.4826
Eq-X	LinStatic	Step By Step	3	-634.6133	0	0.0003	0.0058	-9128.6995	7378.4826

Figure 111: Equivalent Static shear by ETABS

Response Spectrum Analysis by ETABS:

- **define a function**

  Define function with: SD1 = 0.119 SDs = 0.36

By Using response spectrum (ASCE7-16) to determine the design base shear:

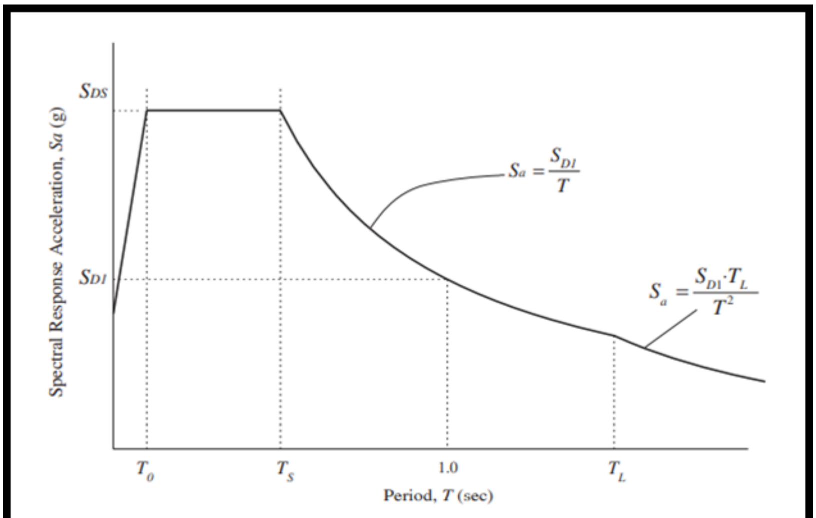


FIGURE 11.4-1 Design Response Spectrum

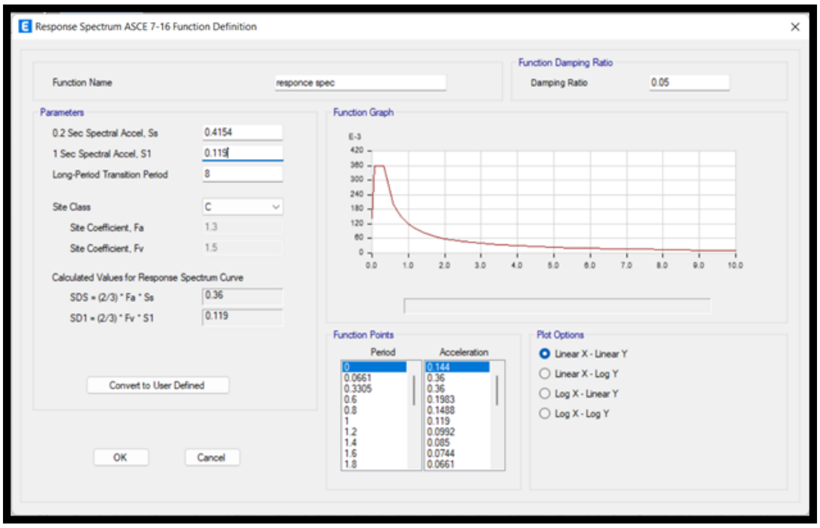


Figure 112: Definition of Response Spectrum Function

- **Define modal acceleration in X and Y.**

  Define modal acceleration in X, Y direction: by multiply response spectrum function by Scale factor.

  Where scale factor = g x I /R and that equal 2.4525.

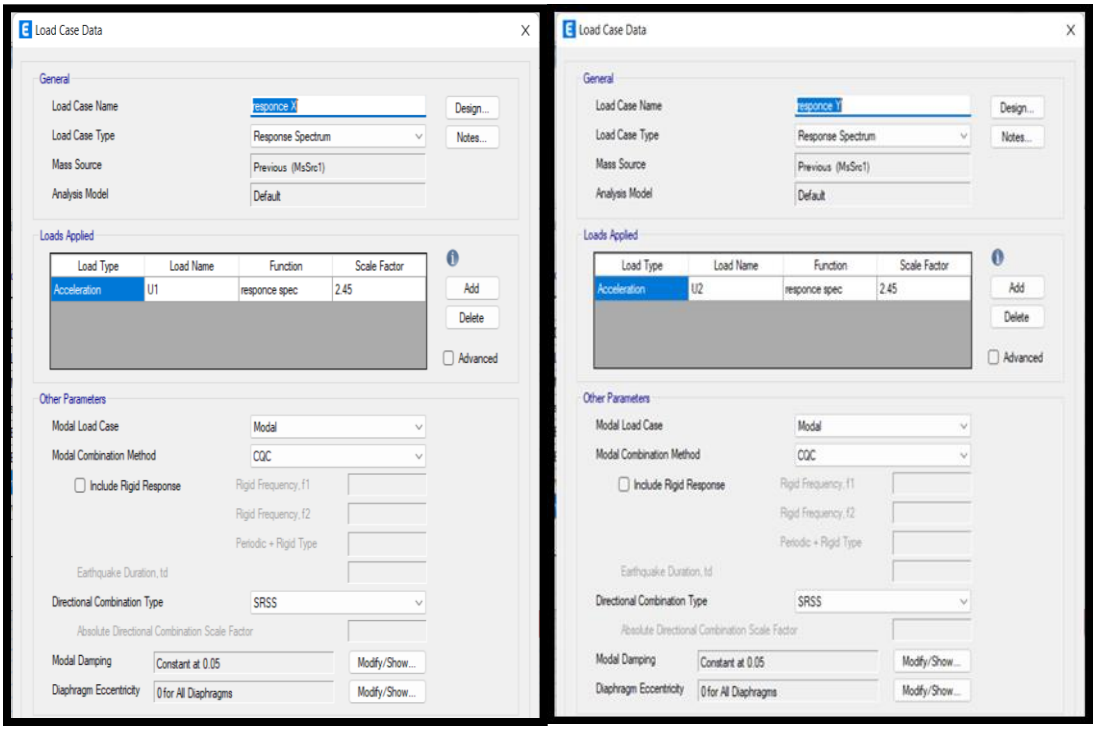
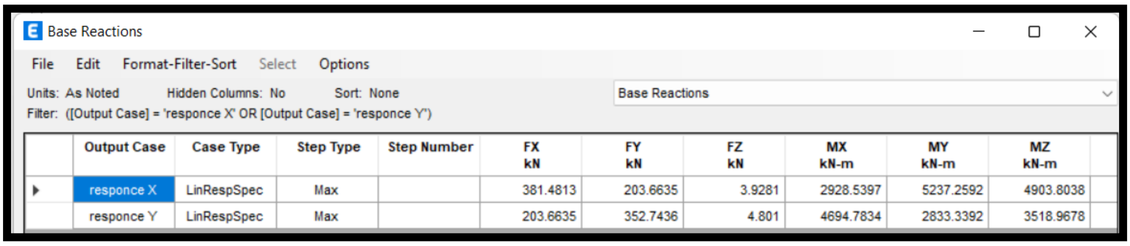


Figure 113: Definition of Response Spectrum load case in X&Y

response spectrum analysis in X & Y direction results:



Base Reactions

File Edit Format-Filter-Sort Select Options

Units: As Noted Hidden Columns: No Sort: None Base Reactions

Filter: ([Output Case] = 'responce X' OR [Output Case] = 'responce Y')

Output Case	Case Type	Step Type	Step Number	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m
responce X	LinRespSpec	Max		381.4813	203.6635	3.9281	2928.5397	5237.2592	4903.8038
responce Y	LinRespSpec	Max		203.6635	352.7436	4.801	4694.7834	2833.3392	3518.9678

Figure 114: Base shear from response spectrum

- The values of base shear for response spectrum analysis are less than the static values, so it is required to modify them to achieve the value of the 85% ELF analysis at least.
- increase scale factor of response spectrum analysis by multiply it by $\frac{VELF}{V_{RESPONCE}}$.

Base Reactions

File Edit Format-Filter-Sort Select Options

Units: As Noted Hidden Columns: No Sort: None — Base Reactions

Filter: ([Output Case] = 'Eq-X' OR [Output Case] = 'responce X')

Output Case	Case Type	Step Type	Step Number	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m
Eq-X	LinStatic	Step By Step	1	-634.6133	0	0.0003	0.0068	-9128.7002	7378.4826
Eq-X	LinStatic	Step By Step	2	-634.6133	0	0.0003	0.0068	-9128.7002	7378.4826
Eq-X	LinStatic	Step By Step	3	-634.6133	0	0.0003	0.0068	-9128.7002	7378.4826
responce X	LinRespSpec	Max		381.4813	203.6635	3.9281	2928.5397	5237.2592	4903.8038

Figure 115: Initial base shear

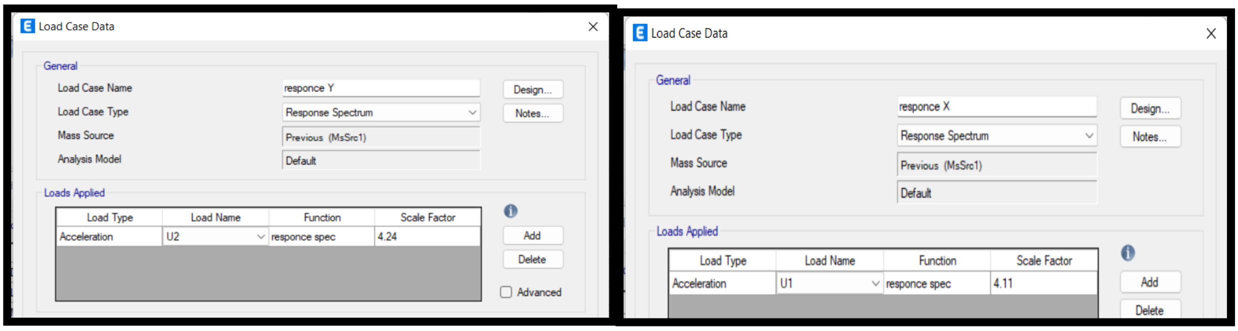


Figure 116: Modified scale factor for Y&X

- ➢ results of base shear from response spectrum after adjustment:

Base Reactions

File Edit Format-Filter-Sort Select Options

Units: As Noted Hidden Columns: No Sort: None — Base Reactions

Filter: ([Output Case] = 'responce X' OR [Output Case] = 'responce Y')

Output Case	Case Type	Step Type	Step Number	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m
responce X	LinRespSpec	Max		639.9242	341.6398	6.5891	4912.5466	8785.3554	8225.993
responce Y	LinRespSpec	Max		352.3108	610.1997	8.3051	8121.3618	4901.3018	6087.3488

Figure 117: Final base reaction

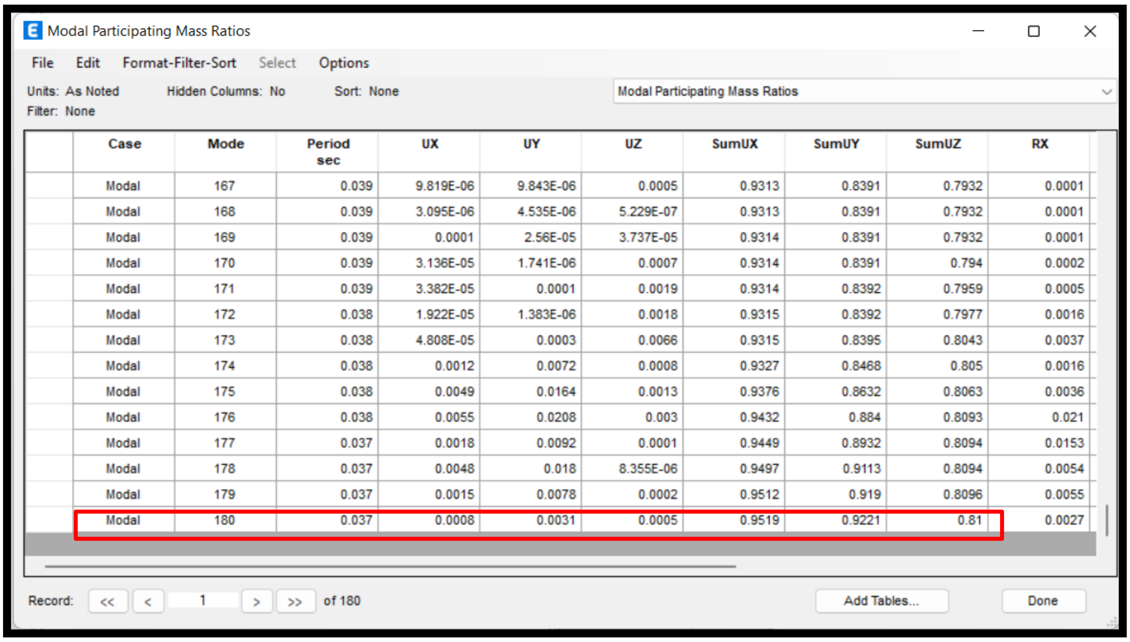
$V_{new\ response} > 0.85\ V_{ELF}$. Ok.

Modes and Periods

summation of the modal participation mass ratios in X and Y direction must be equal or more than 90% as the ASCE recommended.

The first two modes must be transition in (X or Y), and must Show if there is a torsional movement in the first two modes or not,

the summation of the modal participation mass ratio in X and Y more than 90% after 178Modes.



Modal Participating Mass Ratios

File Edit Format-Filter-Sort Select Options

Units: As Noted Hidden Columns: No Sort: None Modal Participating Mass Ratios

Filter: None

Case	Mode	Period sec	UX	UY	UZ	SumUX	SumUY	SumUZ	RX
Modal	167	0.039	9.819E-06	9.843E-06	0.0005	0.9313	0.8391	0.7932	0.0001
Modal	168	0.039	3.095E-06	4.535E-06	5.229E-07	0.9313	0.8391	0.7932	0.0001
Modal	169	0.039	0.0001	2.56E-05	3.737E-05	0.9314	0.8391	0.7932	0.0001
Modal	170	0.039	3.136E-05	1.741E-06	0.0007	0.9314	0.8391	0.794	0.0002
Modal	171	0.039	3.382E-05	0.0001	0.0019	0.9314	0.8392	0.7959	0.0005
Modal	172	0.038	1.922E-05	1.383E-06	0.0018	0.9315	0.8392	0.7977	0.0016
Modal	173	0.038	4.808E-05	0.0003	0.0066	0.9315	0.8395	0.8043	0.0037
Modal	174	0.038	0.0012	0.0072	0.0008	0.9327	0.8468	0.805	0.0016
Modal	175	0.038	0.0049	0.0164	0.0013	0.9376	0.8632	0.8063	0.0036
Modal	176	0.038	0.0055	0.0208	0.003	0.9432	0.884	0.8093	0.021
Modal	177	0.037	0.0018	0.0092	0.0001	0.9449	0.8932	0.8094	0.0153
Modal	178	0.037	0.0048	0.018	8.355E-06	0.9497	0.9113	0.8094	0.0054
Modal	179	0.037	0.0015	0.0078	0.0002	0.9512	0.919	0.8096	0.0055
Modal	180	0.037	0.0008	0.0031	0.0005	0.9519	0.9221	0.81	0.0027

Record: << < 1 > >> of 180 Add Tables... Done

Figure 118: Modal mass participation ratios (transition in x,Y,z)

- The torsional mode is not in the two first modes, and the percent of torsion in the first two modes is less than (10%).

3.7.2 block two calculation:

3.7.2.1 period calculation

The fundamental period, shall not be more than the product of the approximate period (Ta), determined in according with Section 12.8.2 in ASCE7-16. And coefficient of upper limit of period (Cu), from Table 12.8-1 in ASCE7-16.

Finding period manually, and then compare it with ETABS program.

- From ASCE7-16 code Section (12.8.2):

The approximately maximum period:

$$T \geq Ta \times Cu$$

Where:

T: maximum period of the structure.

$$Ta = Ct \times hn^{x}$$

Ta: approximate fundamental period.

Cu: Coefficient for Upper Limit on Calculated Period.

hn: height of building.

Ct, X: building coefficient parameter for approximate period.

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

[a]Metric equivalents are shown in parentheses.

Figure 119: Period of the structure

So:

Ct= 0.0488 , X=0.75

Then: **Ta = 0.36 second**

Determine the upper limit of period:

Table 21: Upper period limit coefficient C_u .

Table 12.8-1 Coefficient for Upper Limit on Calculated Period

Design Spectral Response Acceleration Parameter at 1 *s*, S_{D1}	Coefficient C_u
≥ 0.4	1.4
0.3	1.4
0.2	1.5
0.15	1.6
≤ 0.1	1.7

Cu = 1.66

$$T \geq Ta \times Cu$$

$$Ta\ x\ Cu = 0.36\ x\ 1.66 = 0.6\ sec$$

-ETABS:

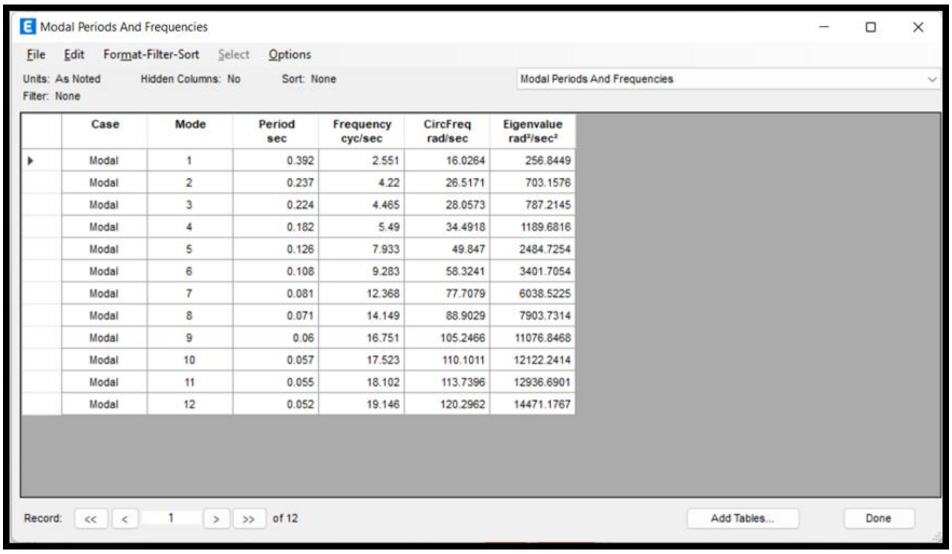
The Value from ETABS must be smaller than (Ta x Cu = 0.6 sec)

X-direction: -

T = 0.4 Sec … OK

Y- direction: -

T = 0.23Sec … OK



Modal Periods And Frequencies

File Edit Format-Filter-Sort Select Options

Units: As Noted Hidden Columns: No Sort: None Modal Periods And Frequencies

Filter: None

Case	Mode	Period sec	Frequency cyc/sec	CircFreq rad/sec	Eigenvalue rad²/sec²
Modal	1	0.392	2.551	16.0264	256.8449
Modal	2	0.237	4.22	26.5171	703.1576
Modal	3	0.224	4.465	28.0573	787.2145
Modal	4	0.182	5.49	34.4918	1189.6816
Modal	5	0.126	7.933	49.847	2484.7254
Modal	6	0.108	9.283	58.3241	3401.7054
Modal	7	0.081	12.368	77.7079	6038.5225
Modal	8	0.071	14.149	88.9029	7903.7314
Modal	9	0.06	16.751	105.2466	11076.8468
Modal	10	0.057	17.523	110.1011	12122.2414
Modal	11	0.055	18.102	113.7396	12936.6901
Modal	12	0.052	19.146	120.2962	14471.1767

Record: << < 1 > >> of 12 Add Tables... Done

Figure 120: Period of the structure

3.7.2.2 *Equivalent static analysis:*

Base shear reaction calculation

The total design base shear (V) shall be determined as follows:

The seismic base shear (V), can be determined in accordance with the following equation:

$$V = Cs\ W$$

Where:

W = the effective seismic weight.

Cs = seismic response coefficient.

Seismic response coefficient Cs:

Where: Ω = 2.5 , C_d = 4.5 , R = 5 , T = 0.6 sec

$$Cs = min\ of \begin{bmatrix} \left(\frac{0.36}{\frac{5}{1.25}}\right) = 0.09 \\ \frac{0.119}{.6*\frac{5}{1.25}} = 0.05 \end{bmatrix}$$

So **Cs = 0.05** and its greater than (0.044 x .36 x 1.25 = 0.02)

Affective seismic weight (W):

W = DL + SD + 0.25LL

= 13673.54+ 5465.24+0.25(6076.71)

= 20657.957 KN

Base shear (V) = ***Cs X W =1032.89 KN***

- Define equivalent lateral static load on ETABS:

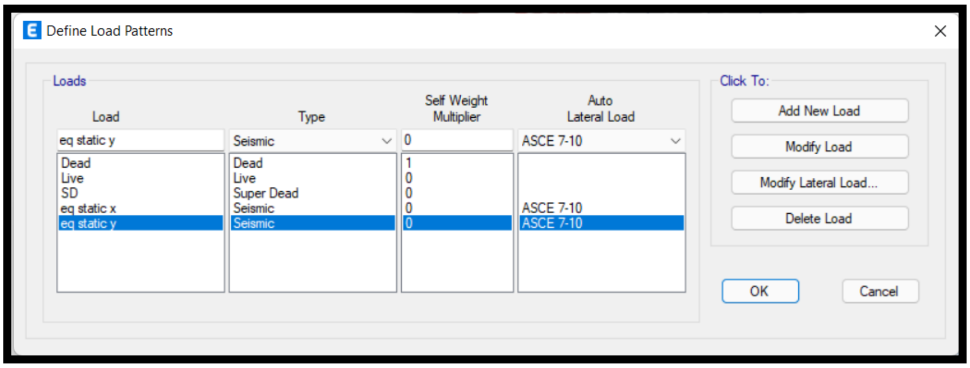


Figure 121: lateral static load

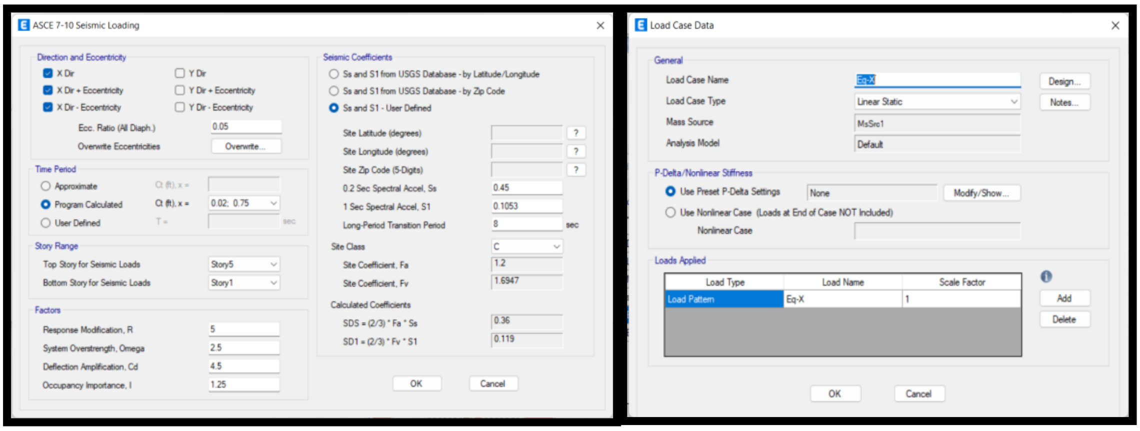


Figure 122: **lateral static load**

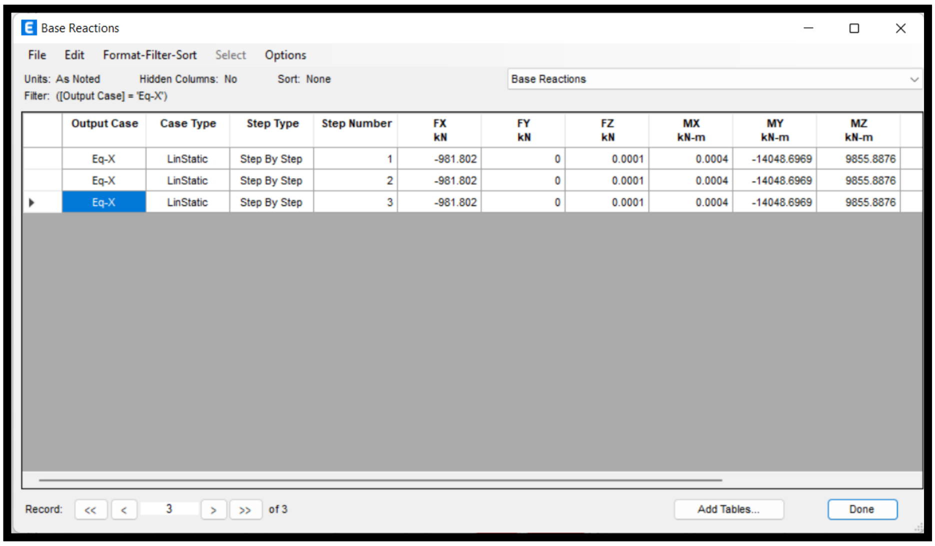
And then define mass source with dead factor = 1, and live factor=0.25.

3.7.2.2.1 Equivalent Static shear check: -

V-x by ETABS = 981.8 KN

V-x by hand = 1032.89 KN

Error < 5%, ok.



Output Case	Case Type	Step Type	Step Number	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m
Eq-X	LinStatic	Step By Step	1	-981.802	0	0.0001	0.0004	-14048.6969	9855.8876
Eq-X	LinStatic	Step By Step	2	-981.802	0	0.0001	0.0004	-14048.6969	9855.8876
Eq-X	LinStatic	Step By Step	3	-981.802	0	0.0001	0.0004	-14048.6969	9855.8876

Figure 123: Equivalent Static shear by ETABS

Response Spectrum Analysis by ETABS:

Define function with: SD1 = 0.119 SDs = 0.36

By Using response spectrum (ASCE7-16) to determine the design base shear:

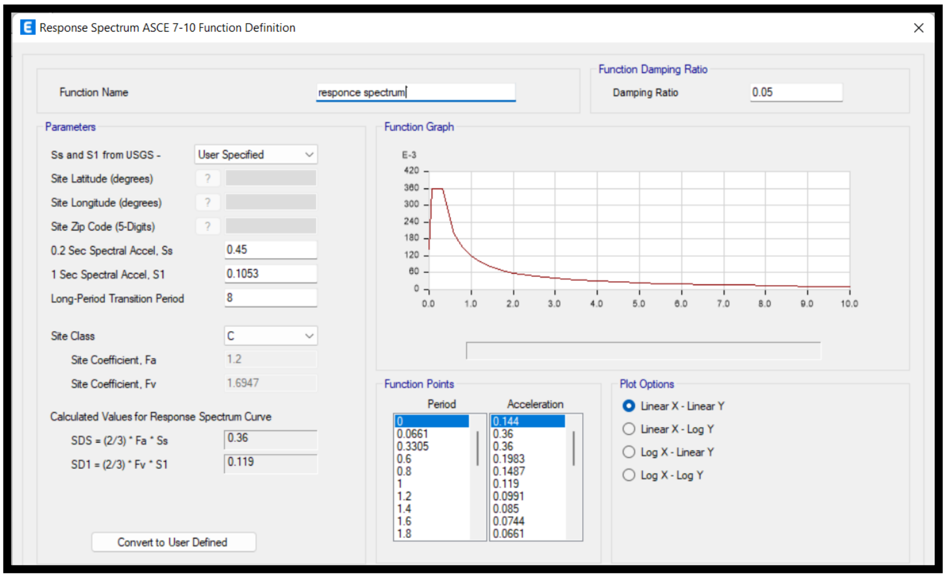


Figure 124: Definition of Response Spectrum Function

Define modal acceleration in X and Y.

Define modal acceleration in X, Y direction: by multiply response spectrum function by Scale factor.

Where scale factor = g x I /R and that equal 2.4525.

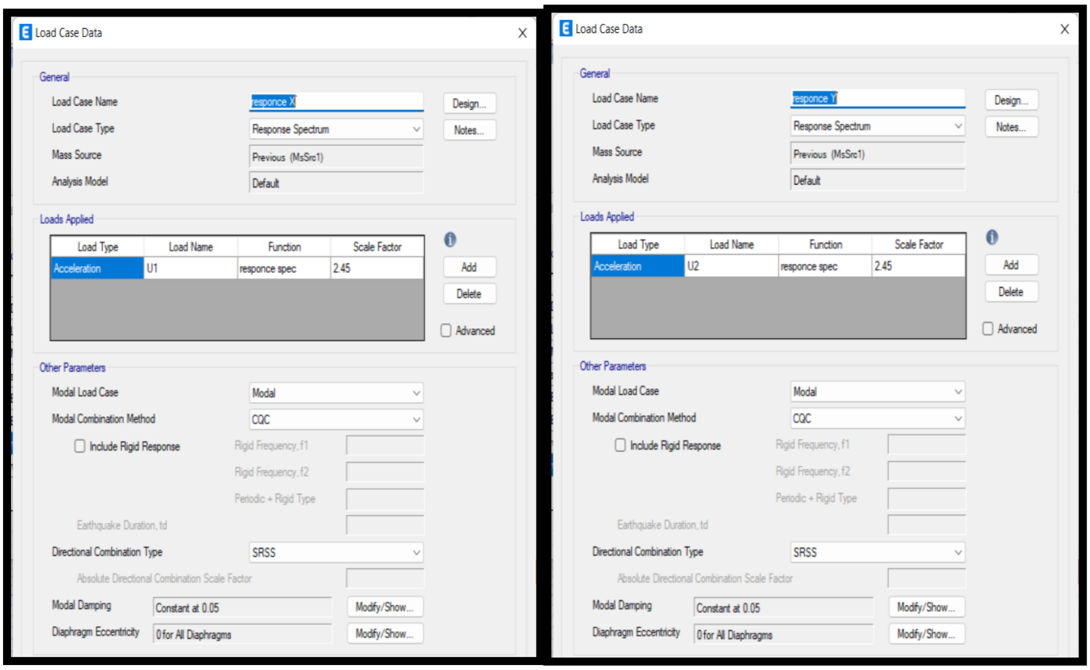
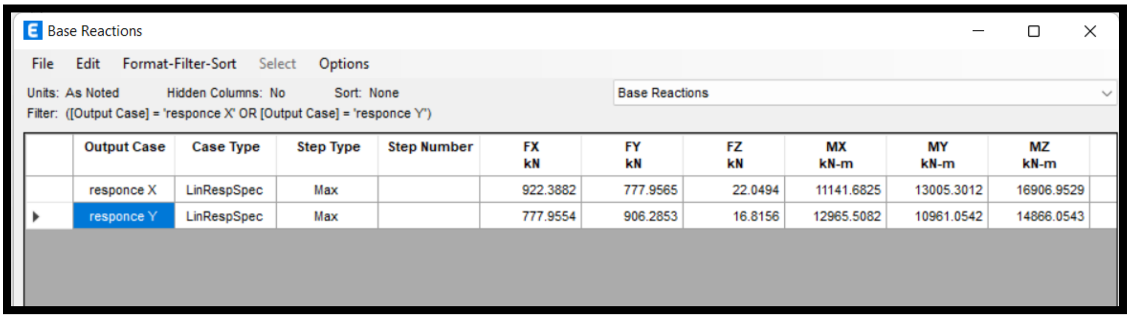


Figure 125: Definition of Response Spectrum load case in X & Y

response spectrum analysis in X & Y direction results:



Base Reactions

File Edit Format-Filter-Sort Select Options

Units: As Noted Hidden Columns: No Sort: None Base Reactions

Filter: ([Output Case] = 'responce X' OR [Output Case] = 'responce Y')

Output Case	Case Type	Step Type	Step Number	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m
responce X	LinRespSpec	Max		922.3882	777.9565	22.0494	11141.6825	13005.3012	16906.9529
responce Y	LinRespSpec	Max		777.9554	906.2853	16.8156	12965.5082	10961.0542	14866.0543

Figure 126: Base shear from response spectrum .

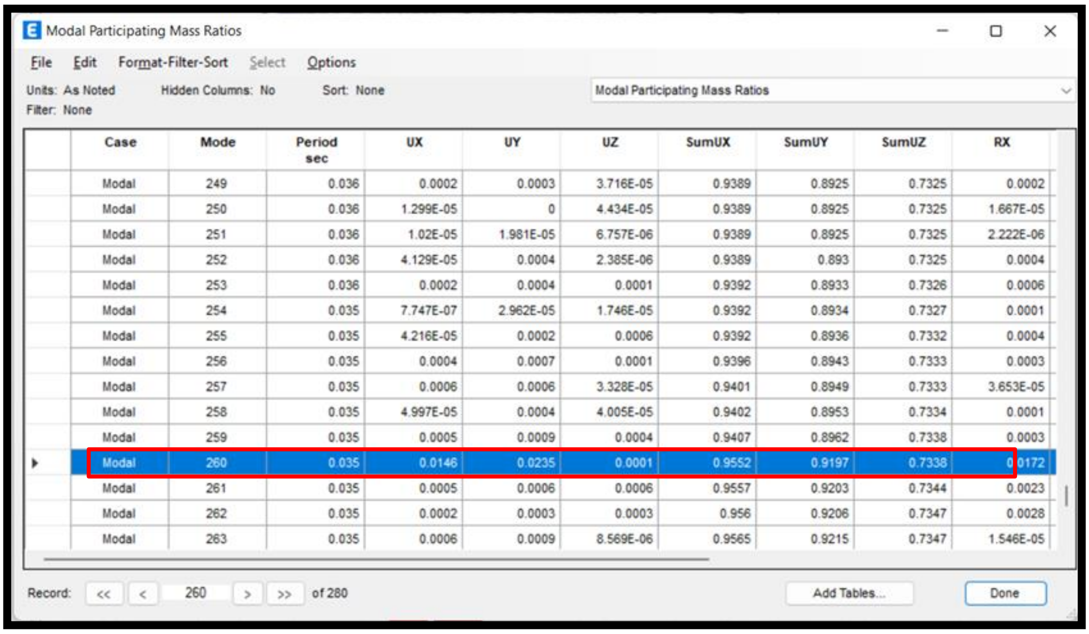
- The values of base shear for response spectrum analysis are more than 85% of static values ($V_{response} > 0.85\ V_{ELF}$), so it is Ok.

- **Modes and Periods**

summation of the modal participation mass ratios in X and Y direction must be equal or more than 90% as the ASCE recommended.

The first two modes must be transition in (X or Y), and must Show if there is a torsional movement in the first two modes or not,

the summation of the modal participation mass ratio in X and Y more than 90% after **260** Modes.



Modal Participating Mass Ratios

File Edit Format-Filter-Sort Select Options

Units: As Noted Hidden Columns: No Sort: None Modal Participating Mass Ratios

Filter: None

Case	Mode	Period sec	UX	UY	UZ	SumUX	SumUY	SumUZ	RX
Modal	249	0.036	0.0002	0.0003	3.716E-05	0.9389	0.8925	0.7325	0.0002
Modal	250	0.036	1.299E-05	0	4.434E-05	0.9389	0.8925	0.7325	1.667E-05
Modal	251	0.036	1.02E-05	1.981E-05	6.757E-06	0.9389	0.8925	0.7325	2.222E-06
Modal	252	0.036	4.129E-05	0.0004	2.385E-06	0.9389	0.893	0.7325	0.0004
Modal	253	0.036	0.0002	0.0004	0.0001	0.9392	0.8933	0.7326	0.0006
Modal	254	0.035	7.747E-07	2.962E-05	1.746E-05	0.9392	0.8934	0.7327	0.0001
Modal	255	0.035	4.216E-05	0.0002	0.0006	0.9392	0.8936	0.7332	0.0004
Modal	256	0.035	0.0004	0.0007	0.0001	0.9396	0.8943	0.7333	0.0003
Modal	257	0.035	0.0006	0.0006	3.328E-05	0.9401	0.8949	0.7333	3.653E-05
Modal	258	0.035	4.997E-05	0.0004	4.005E-05	0.9402	0.8953	0.7334	0.0001
Modal	259	0.035	0.0005	0.0009	0.0004	0.9407	0.8962	0.7338	0.0003
Modal	260	0.035	0.0146	0.0235	0.0001	0.9552	0.9197	0.7338	0.0172
Modal	261	0.035	0.0005	0.0006	0.0006	0.9557	0.9203	0.7344	0.0023
Modal	262	0.035	0.0002	0.0003	0.0003	0.956	0.9206	0.7347	0.0028
Modal	263	0.035	0.0006	0.0009	8.569E-06	0.9565	0.9215	0.7347	1.546E-05

Record: << < 260 > >> of 280 Add Tables... Done

Figure 127: The torsional mode is not in the two first modes, and the percent of torsion in the first two modes is less than (10%).

load combination

- **<u>Combination for strength design:</u>**

1.4 *D*
1.2 *D* +1.6 *L*
1.2 *D* +1.0 *E* +1.0 *L*
0.9 *D* + 1.0 *E*

- **<u>Combination for serviceability (allowability) design:</u>**

1.0 *D*
1.0 *D* +1.0*L*
1.0 *D* + 0.7 *E*
1.0 *D* + 0.525 *E* + 0.75 *L*
0.6 *D* + 0.7 *E*

Where:

E = seismic load effect,

Eh = effect of horizontal seismic forces

$$E_h = \rho Q_E$$

Ev = vertical seismic effect applied in the vertical downward direction. Ev shall be subject to reversal to the upward direction in accordance with the applicable load combinations.

$$E_v = 0.2 S_{DS} D = 0.072 \text{ take it } 0.1D$$

Q_E = effects of horizontal seismic forces from V, such effects shall result from application of horizontal forces simultaneously in two directions at right angles to each other)

ρ = redundancy factor, and its equal **1.0** because Risk category C

<u>Note:</u>

1- For use in load combination $1.2D + E_v + E_h + L$ in strength design, or $1.0D + 0.7E_v + 0.7E_h$, $1.0D + 0.525E_v + 0.525E_h + 0.75L$ in service design,

E shall be determined in accordance with ASCE. Eq. (12.4-1) as follows:

$$E = E_h + E_v$$

For another equation with earthquake affect (reversal to the upward direction).

$$E = E_h - E_v$$

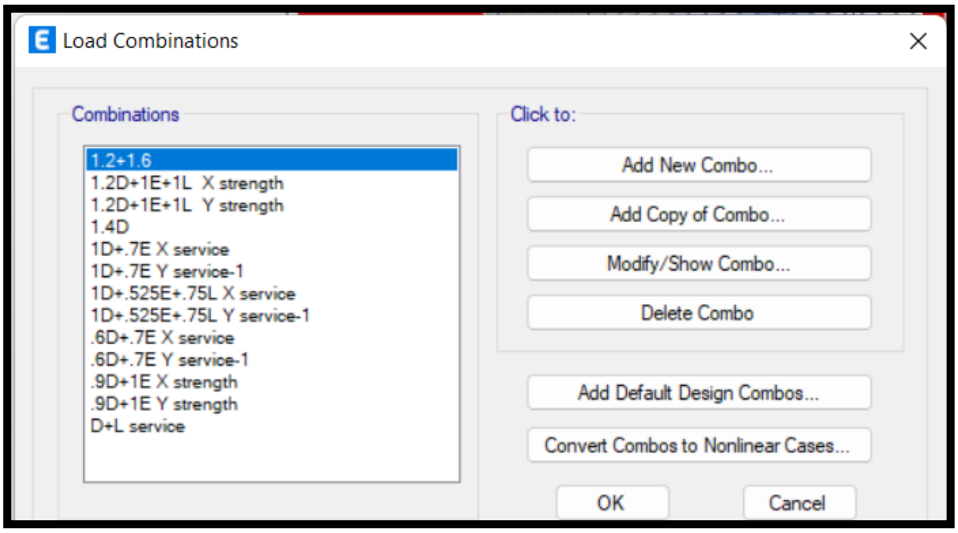


Figure 128: load combination

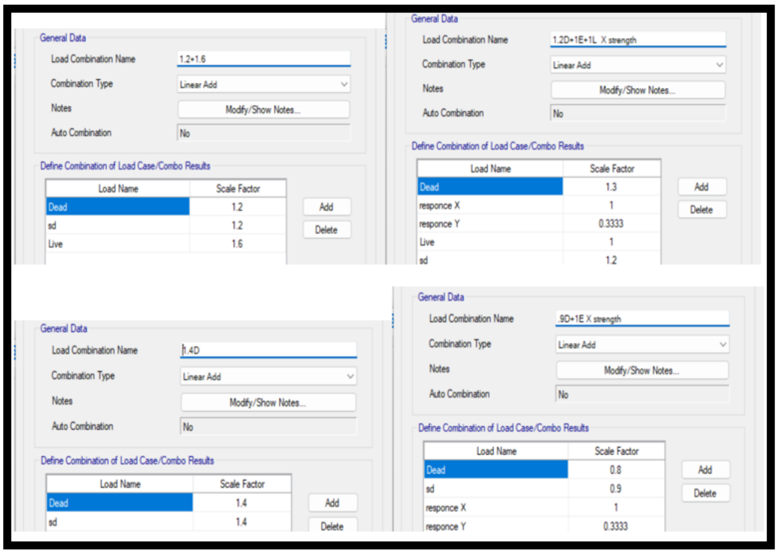


Figure 129: Strength load combination

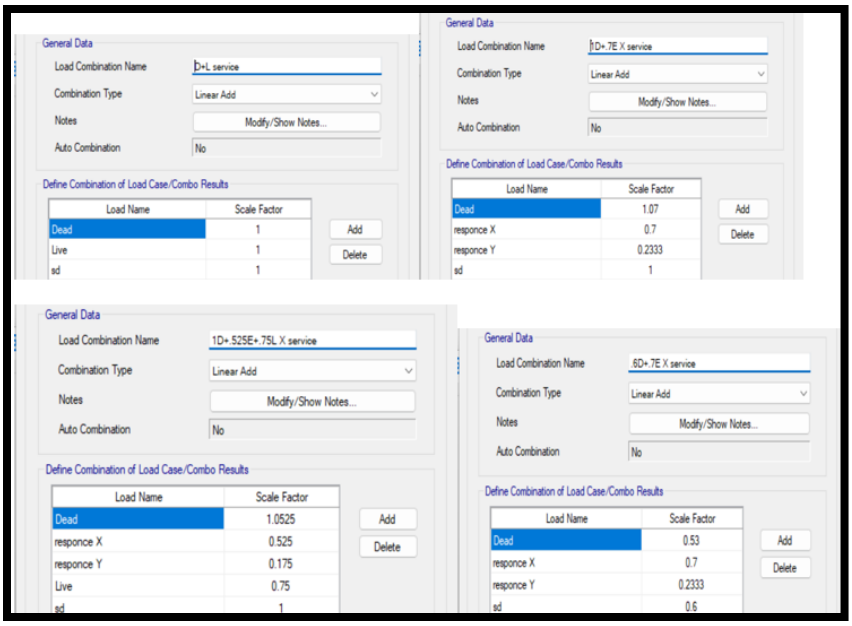


Figure 130: service load combination

3.8 design checks:

3.8.1 Drift check: -

The lateral displacement for every story in building and it make for serviceability. deflection shall not exceed the permissible value of deflection.

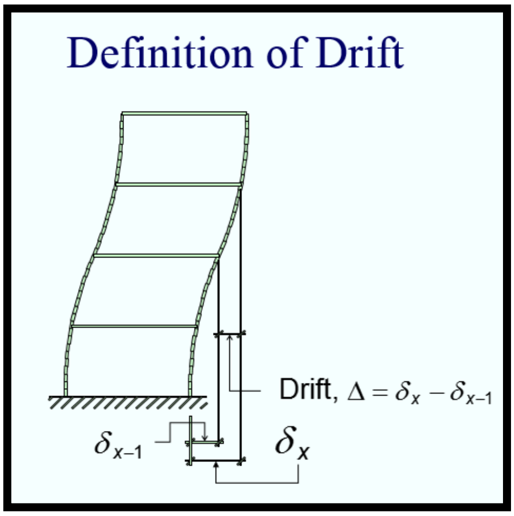


Figure 131:Definistin of drift.

Determination of the Inelastic Displacement:

The deflection of any level at center of the mass δ_M (mm) shall determine in according to ASCE7-16 from the following equation :

$$\delta_M = \frac{C_d \delta_{max}}{I_e}$$

where δ_{max} = maximum elastic displacement at the critical location.

where: I = 1.25 , Cd =4.5 .

Table 12.12-1 Allowable Story Drift, Δ_a[a,b]

Structure	Risk Category I or II	III	IV
Structures, other than masonry shear wall structures, four stories or less above the base as defined in Section 11.2, with interior walls, partitions, ceilings, and exterior wall systems that have been designed to accommodate the story drifts	$0.025h_{sx}$[c]	$0.020h_{sx}$	$0.015h_{sx}$
Masonry cantilever shear wall structures[d]	$0.010h_{sx}$	$0.010h_{sx}$	$0.010h_{sx}$
Other masonry shear wall structures	$0.007h_{sx}$	$0.007h_{sx}$	$0.007h_{sx}$
All other structures	$0.020h_{sx}$	$0.015h_{sx}$	$0.010h_{sx}$

[a]h_{sx} is the story height below level x.
[b]For seismic force-resisting systems solely comprising moment frames in Seismic Design Categories D, E, and F, the allowable story drift shall comply with the requirements of Section 12.12.1.1.
[c]There shall be no drift limit for single-story structures with interior walls, partitions, ceilings, and exterior wall systems that have been designed to accommodate the story drifts. The structure separation requirement of Section 12.12.3 is not waived.
[d]Structures in which the basic structural system consists of masonry shear walls designed as vertical elements cantilevered from their base or foundation support that are so constructed that moment transfer between shear walls (coupling) is negligible.

Figure 132: deflection limitation from ASCE7-16 Code

3.8.1.1 Block one drift check.

Story Drifts

File Edit Format-Filter-Sort Select Options

Units: As Noted Hidden Columns: No Sort: None Story Drifts

Filter: ([Output Case] = 'service X envelope') AND ([Step Type] = 'Max') AND ([Direction] = 'X')

Story	Output Case	Case Type	Step Type	Step Number	Direction	Drift	Label	X m	Y m
Story5	service X env...	Combination	Max		X	0.00173	103	0.0046	20.1799
Story4	service X env...	Combination	Max		X	0.002225	78	16.611	20.1791
Story3	service X env...	Combination	Max		X	0.002361	103	0.0046	20.1799
Story2	service X env...	Combination	Max		X	0.001326	15	10.9394	20.0299
Story1	service X env...	Combination	Max		X	0.000179	5	3.9685	2.1047

Figure 133:story drifts in x.

Table 22: story drift in X

		Cd	4.5	I	1.25	Δa = 0.015
Story	H(m)	Elastic Displacement(mm)	Amplified Displacement	Story Drift	Allowable	Check
		δ	Δm	Δi	Δa	
Story5	3.6	0.00173	0.006228	0.001782	0.054	Safe
Story4	3.6	0.002225	0.00801	0.0004896	0.054	Safe
Story3	3.6	0.002361	0.0084996	0.0132732	0.054	Safe
Story2	3.6	0.001326	0.0047736	0.005418	0.054	Safe
Story1	3.6	0.000179	0.0006444	0.0006444	0.054	Safe
BASE	0	0	0	0	0	Safe

Story Drifts

File Edit Format-Filter-Sort Select Options

Units: As Noted Hidden Columns: No Sort: None Story Drifts

Filter: ([Output Case] = 'service Y envelope') AND ([Step Type] = 'Max') AND ([Direction] = 'Y')

Story	Output Case	Case Type	Step Type	Step Number	Direction	Drift	Label	X m	Y m
Story5	service Y env...	Combination	Max		Y	0.002141	112	0.0015	-0.001
Story4	service Y env...	Combination	Max		Y	0.002689	103	0.0046	20.1799
Story3	service Y env...	Combination	Max		Y	0.002812	112	0.0015	-0.001
Story2	service Y env...	Combination	Max		Y	0.001816	112	0.0015	-0.001
Story1	service Y env...	Combination	Max		Y	5.1E-05	62	0.1546	19.8799

Figure 134: story drift in Y for block 1

Table 23: story drift in Y for block 1

		Cd	4.5	I	1.25	Δa = 0.015
Story	**H(m)**	**Elastic Displacement(mm)**	**Amplified Displacement**	**Story Drift**	**Allowable**	**Check**
		δ	**Δm**	**Δi**	**Δa**	
Story5	3.6	0.002141	0.0077076	0.0019728	0.054	Safe
Story4	3.6	0.002689	0.0096804	0.0004428	0.054	Safe
Story3	3.6	0.002812	0.0101232	0.0166608	0.054	Safe
Story2	3.6	0.001816	0.0065376	0.0067212	0.054	Safe
Story1	3.6	5.10E-05	0.0001836	0.0001836	0.054	Safe
BASE	0	0	0	0	0	Safe

From the calculations above, Drift check (inelastic Response displacement) is ok, and less than allowable limit.

3.8.1.2 Block two drift check.

Table 24: story drift in X for block 2.

Story Drifts

File Edit Format-Filter-Sort Select Options

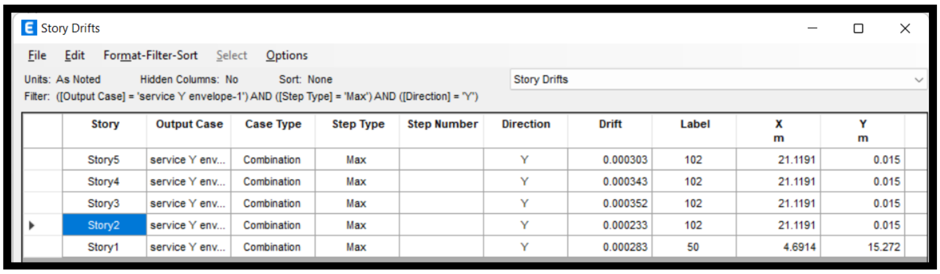
Units: As Noted Hidden Columns: No Sort: None Story Drifts

Filter: ([Output Case] = 'service X envelope') AND ([Step Type] = 'Max') AND ([Direction] = 'X')

Story	Output Case	Case Type	Step Type	Step Number	Direction	Drift	Label	X m	Y m
Story5	service X env...	Combination	Max		X	0.00038	112	-0.2258	-0.1499
Story4	service X env...	Combination	Max		X	0.000411	102	21.1191	0.015
Story3	service X env...	Combination	Max		X	0.000416	112	-0.2258	-0.1499
Story2	service X env...	Combination	Max		X	0.000293	102	21.1191	0.015
Story1	service X env...	Combination	Max		X	5.5E-05	38	5.1981	12.272

Table 25: story drift in X for block 2

		Cd	4.5	I	1.25	Δa = 0.015
Story	**H(m)**	**Elastic Displacement(mm)**	**Amplified Displacement**	**Story Drift**	**Allowable**	**Check**
		δ	**Δm**	**Δi**	**Δa**	
Story5	3.6	0.00038	0.001368	0.0001116	0.054	Safe
Story4	3.6	0.000411	0.0014796	0.000018	0.054	Safe
Story3	3.6	0.000416	0.0014976	0.0025524	0.054	Safe
Story2	3.6	0.000293	0.0010548	0.0012528	0.054	Safe
Story1	3.6	5.50E-05	0.000198	0.000198	0.054	Safe
BASE	0	0	0	0	0	Safe



Story Drifts

File Edit Format-Filter-Sort Select Options

Units: As Noted Hidden Columns: No Sort: None Story Drifts

Filter: ([Output Case] = 'service Y envelope-1') AND ([Step Type] = 'Max') AND ([Direction] = 'Y')

	Story	Output Case	Case Type	Step Type	Step Number	Direction	Drift	Label	X m	Y m
	Story5	service Y env...	Combination	Max		Y	0.000303	102	21.1191	0.015
	Story4	service Y env...	Combination	Max		Y	0.000343	102	21.1191	0.015
	Story3	service Y env...	Combination	Max		Y	0.000352	102	21.1191	0.015
▸	Story2	service Y env...	Combination	Max		Y	0.000233	102	21.1191	0.015
	Story1	service Y env...	Combination	Max		Y	0.000283	50	4.6914	15.272

Figure 135: story drift in Y for block 2

Table 26: story drift in Y for block 2

		Cd	4.5	I	1.25	Δa = 0.015
Story	H(m)	Elastic Displacement(mm)	Amplified Displacement	Story Drift	Allowable	Check
		δ	Δm	Δi	Δa	
Story5	3.6	0.000303	0.0010908	0.000144	0.054	Safe
Story4	3.6	0.000343	0.0012348	3.24E-05	0.054	Safe
Story3	3.6	0.000352	0.0012672	0.002106	0.054	Safe
Story2	3.6	0.000233	0.0008388	0.0018576	0.054	Safe
Story1	3.6	2.83E-04	0.0010188	0.0010188	0.054	Safe
BASE	0	0	0	0	0	Safe

From the calculations above, Drift check (inelastic Response displacement) is ok, and less than allowable limit.

delta affect:

P-delta effects is the moment and shears that resulting in members on story, and the story drifts from these effects aren't required to be considered where the stability coefficient (θ) that determined from the equation (12.8-16 from ASCE7-16) is less than, or equal 0.1 and not exceed θ max that determine from equation (12.8-17 in ASCE7-16) .

$$\theta = \frac{P_x \Delta I_e}{V_x h_{sx} C_d} \qquad \theta_{max} = \frac{0.5}{\beta C_d} \leq 0.25$$

Where:

Px = total vertical design load at and above level x (kN); where computing Px, no individual load factor need exceed 1.0 (gravity service load).

Δ = design story drift as defined in Section 12.8.6 occurring simultaneously with Vx (mm).

Vx = seismic shear force acting between levels x and x − 1 (kN).

Hsx = story height below level x (mm)

I e = Importance Factor that determined.

Cd = deflection amplification factor that determined.

β = the ratio of shear demand to shear capacity for the story between levels x and x − 1. This ratio is permitted to be conservatively taken as 1.0.

If the stability coefficient (θ) is greater than 10% but less than or equal to θ max, the incremental factor related to P-delta effects on displacements and member forces shall be determined by rational analysis. Alternatively, it is permitted to multiply displacements and member forces by $\frac{1}{1-\theta}$.

And if θ is greater than θ_{max}, the structure is unstable and shall be redesigned.

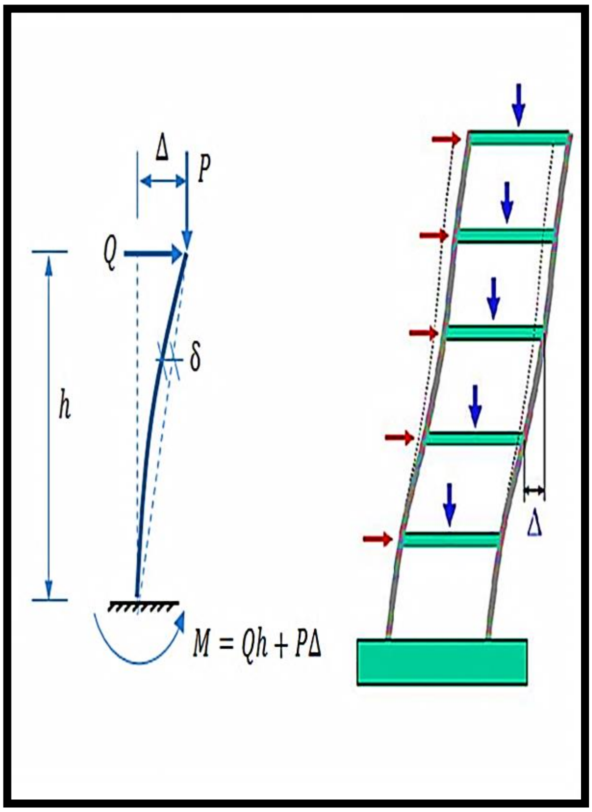


Figure 136: **delta affect**

- **Check in X-direction**

Story Forces

File Edit Format-Filter-Sort Select Options

Units: As Noted Hidden Columns: No Sort: None — Story Forces

Filter: ([Output Case] = 'service envelope') AND ([Step Type] = 'Max') AND ([Location] = 'Bottom')

Story	Output Case	Case Type	Step Type	Step Number	Location	P kN	VX kN	VY kN	T kN-m
Story5	service envelope	Combination	Max		Bottom	12818.2721	633.297	654.2682	9397.5389
Story4	service envelope	Combination	Max		Bottom	25620.759	1016.8557	970.0169	13897.9155
Story3	service envelope	Combination	Max		Bottom	38420.6792	1277.142	1211.998	17449.4181
Story2	service envelope	Combination	Max		Bottom	51212.2564	1487.6444	1416.2106	19874.0736
Story1	service envelope	Combination	Max		Bottom	68895.764	1637.2993	1512.9541	21623.6068

Figure 137: Story forces in x direction from ETABS

Story Forces

File Edit Format-Filter-Sort Select Options

Units: As Noted Hidden Columns: No Sort: None — Story Forces

Filter: ([Output Case] = 'responce X') AND ([Location] = 'Bottom')

Story	Output Case	Case Type	Step Type	Step Number	Location	P kN	VX kN	VY kN	T kN-m
Story5	responce X	LinRespSpec	Max		Bottom	10.771	276.4625	162.5876	3926.6405
Story4	responce X	LinRespSpec	Max		Bottom	15.2398	444.7636999...	261.0969	5821.3539
Story3	responce X	LinRespSpec	Max		Bottom	16.7556	559.5316	316.156	7307.1676
Story2	responce X	LinRespSpec	Max		Bottom	18.1455	653.6808	352.7601	8278.4353
Story1	responce X	LinRespSpec	Max		Bottom	16.6808	720.1773	379.277	9004.1638

Figure 138: Story forces in x direction from ETABS

Diaphragm Center Of Mass Displacements

File Edit Format-Filter-Sort Select Options

Units: As Noted Hidden Columns: No Sort: None — Diaphragm Center Of Mass Displacements

Filter: ([Output Case] = 'service X envelope') AND ([Step Type] = 'Min')

Story	Diaphragm	Output Case	Case Type	Step Type	Step Number	UX mm	UY mm	RZ rad	Point
Story5	D5	service X env...	Combination	Min		-20.168	-17.085	-0.001644	610
Story4	D4	service X env...	Combination	Min		-15.112	-13.495	-0.001275	611
Story3	D3	service X env...	Combination	Min		-9.492	-8.904	-0.000803	612
Story2	D2	service X env...	Combination	Min		-3.687	-3.705	-0.000301	613
Story1	D1	service X env...	Combination	Min		-0.299	-0.178	-1.6E-05	614

Figure 139:Diagram center of mass displacements

Table 27: **delta check**

			I	1.25	Cd	4.5		
Story	**H(mm)**	**P KN**	**Vx KN**	**Ux mm**	**Δx mm**	**θy 0.09**	**θmax 0.111**	**Check**
5	3600	12818.272	276.4625	20.168	18.2016	0.052094012		No p-delata
4	3600	25620.759	444.7637	15.112	20.232	0.071942655		No p-delata
3	3600	38420.679	559.5316	9.492	20.898	0.088578869		No p-delata
2	3600	51212.256	653.6808	3.687	12.1968	0.058984659		No p-delata
1	3600	68895.764	720.1773	0.299	1.0764	0.006356408		No p-delata
0								

No p-delta affect in x-direction.

- **Check in Y-direction**

Story Forces

File Edit Format-Filter-Sort Select Options

Units: As Noted Hidden Columns: No Sort: None — Story Forces

Filter: ([Output Case] = 'service envelope') AND ([Step Type] = 'Max') AND ([Location] = 'Bottom')

Story	Output Case	Case Type	Step Type	Step Number	Location	P kN	VX kN	VY kN	T kN-m
Story5	service envelope	Combination	Max		Bottom	12818.2721	633.297	654.2682	9397.5389
Story4	service envelope	Combination	Max		Bottom	25620.759	1016.8557	970.0169	13897.9155
Story3	service envelope	Combination	Max		Bottom	38420.6792	1277.142	1211.998	17449.4181
Story2	service envelope	Combination	Max		Bottom	51212.2564	1487.6444	1416.2106	19874.0736
Story1	service envelope	Combination	Max		Bottom	68895.764	1637.2993	1512.9541	21623.6068

Figure 140:story forces in y-direction.

Story Forces

File Edit Format-Filter-Sort Select Options

Units: As Noted Hidden Columns: No Sort: None — Story Forces

Filter: ([Output Case] = 'responce Y') AND ([Location] = 'Bottom')

Story	Output Case	Case Type	Step Type	Step Number	Location	P kN	VX kN	VY kN	T kN-m
Story5	responce Y	LinRespSpec	Max		Bottom	9.3612	157.5772	285.6894	2865.7425
Story4	responce Y	LinRespSpec	Max		Bottom	13.0315	250.4321	416.8816	4195.2455
Story3	responce Y	LinRespSpec	Max		Bottom	18.3577	311.7725	524.235	5272.6695
Story2	responce Y	LinRespSpec	Max		Bottom	17.4846	357.3829	618.1194	6137.5953
Story1	responce Y	LinRespSpec	Max		Bottom	18.9742	391.1238	659.5376	6686.9835

Figure 141: story forces in y-direction.

Diaphragm Center Of Mass Displacements

File Edit Format-Filter-Sort Select Options

Units: As Noted Hidden Columns: No Sort: None — Diaphragm Center Of Mass Displacements

Filter: ([Output Case] = 'service Y envelope') AND ([Step Type] = 'Max')

Story	Diaphragm	Output Case	Case Type	Step Type	Step Number	UX mm	UY mm	RZ rad	Point
Story5	D5	service Y env...	Combination	Max		14.175	27.014	0.001746	610
Story4	D4	service Y env...	Combination	Max		11.286	21.08	0.001341	611
Story3	D3	service Y env...	Combination	Max		7.247	13.345	0.000849	612
Story2	D2	service Y env...	Combination	Max		2.984	5.237	0.000347	613
Story1	D1	service Y env...	Combination	Max		0.275	0.108	1.3E-05	614

Table 28: delta check

Story	H(mm)	P	Vy	Uy	Δy	ϴy	ϴmax	Check
		KN	KN	mm	mm	0.11	0.111	
5	3600	12818.272	285.6894	27.014	21.3624	0.059165752		No p-delata
4	3600	25620.759	416.8816	21.08	27.846	0.105639678		No p-delata
3	3600	38420.679	524.235	13.345	23.6527	0.107005163		No p-delata
2	3600	51212.256	618.1194	5.237	18.4644	0.094432551		No p-delata
1	3600	68895.764	659.5376	0.108	0.3888	0.002507057		No p-delata
0								

No p-delta affect in Y-direction.

3.9 Check of Deflection:

The structure will be checked for the deflection, and then compare it with allowable deflection according to ACI314-19 (table24.2.2).

$$\Delta_{LT} = \Delta_L + \lambda_\infty \Delta_D + \lambda_t \Delta_{LS}$$

where:

Δ_L: immediate live load deflection.

Δ_D : immediate dead load deflection.

Δ_{LS} : immediate sustained live load deflection.

λ_Δ: multiplier for additional deflection due to long-term effects

$$\lambda_\Delta = \frac{\xi}{1 + 50\rho'}$$

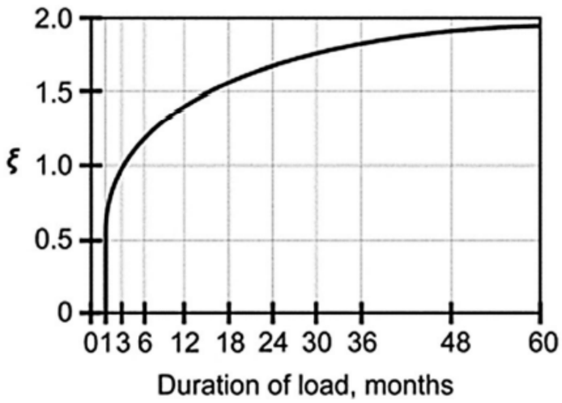
It shall be permitted to assume ξ, the time-dependent factor for sustained loads, to be equal to:

5 years or more 2.0

12 months............................ 1.4

6 months.............................. 1.2

3 months.............................. 1.0



Allowable deflection according to ACI318-19 code shown in figure below = L/240.

Table 29: allowable deflection in aci code

ACI 318-19 Table 24.2.2—Maximum permissible calculated deflections

Member	Condition		Deflection to be considered	Deflection limitation
Flat roofs	Not supporting or attached to nonstructural elements likely to be damaged by large deflections		Immediate deflection due to maximum of L_r, S, and R	$\ell/180$[1]
Floors	Immediate deflection due to L		$\ell/360$	
Roof or floors	Supporting or attached to nonstructural elements	Likely to be damaged by large deflections	That part of the total deflection occurring after attachment of nonstructural elements, which is the sum of the time- dependent deflection due to all sustained loads and the immediate deflection due to any additional live load [2]	$\ell/480$[3]
		Not likely to be damaged by large deflections		$\ell/240$[4]

[1] Limit not intended to safeguard against ponding. Ponding shall be checked by calculations of deflection, including added deflections due to ponded water, and considering time- dependent effects of sustained loads, camber, construction tolerances, and reliability of provisions for drainage.
[2] Time-dependent deflection shall be calculated in accordance with 24.2.4, but shall be permitted to be reduced by amount of deflection calculated to occur before attachment of nonstructural elements. This amount shall be calculated on basis of accepted engineering data relating to time-deflection characteristics of members similar to those being considered.
[3] Limit shall be permitted to be exceeded if measures are taken to prevent damage to supported or attached elements.
[4] Limit shall not exceed tolerance provided for nonstructural elements.

Long term combination load :2D+2SD+1.5L

Define long term deflection at Etabs:

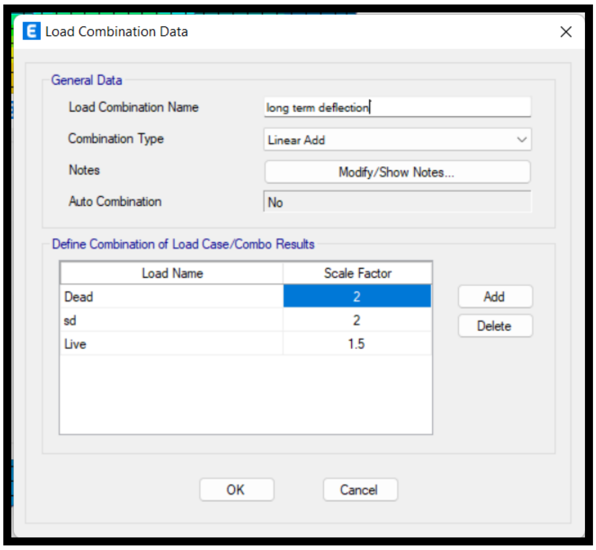


Figure 142: Define long term deflection at Etabs:

3.9.1Block one deflection check:

Max deflection at Max length = 7.4 meter

Allowable deflection = 30.8 mm

From ETABS using long term combination, max deflection = 30.64mm

As shown in figure below, So deflection check is OK.

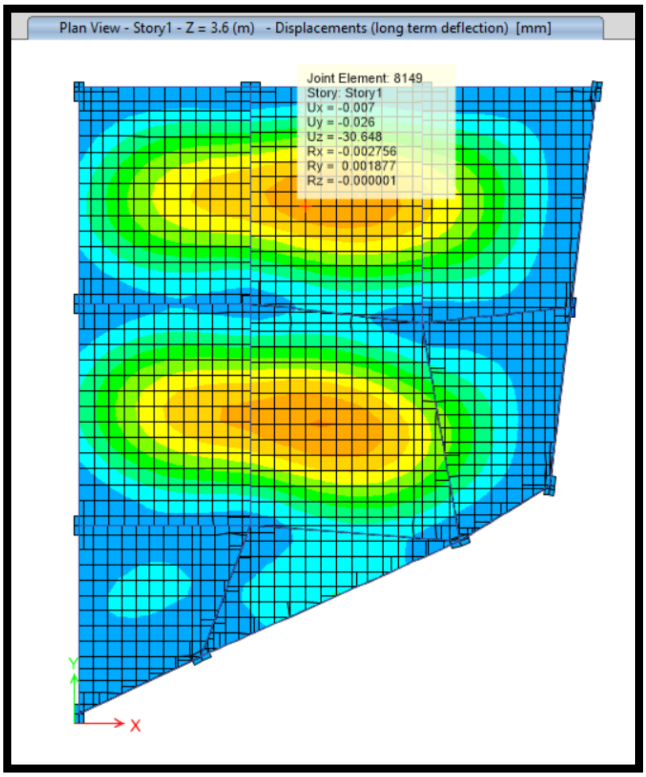


Figure 143: deflection in ETABS by long term

3.9.2 Block two deflection check:

Max deflection at Max length = 7 meter

Allowable deflection = 29.16 mm

From ETABS using long term combination, max deflection = 19mm

As shown in figure below, So deflection check is OK.

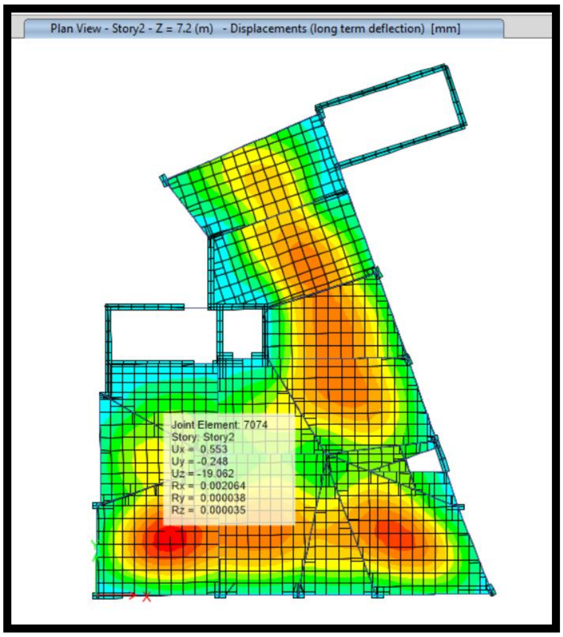
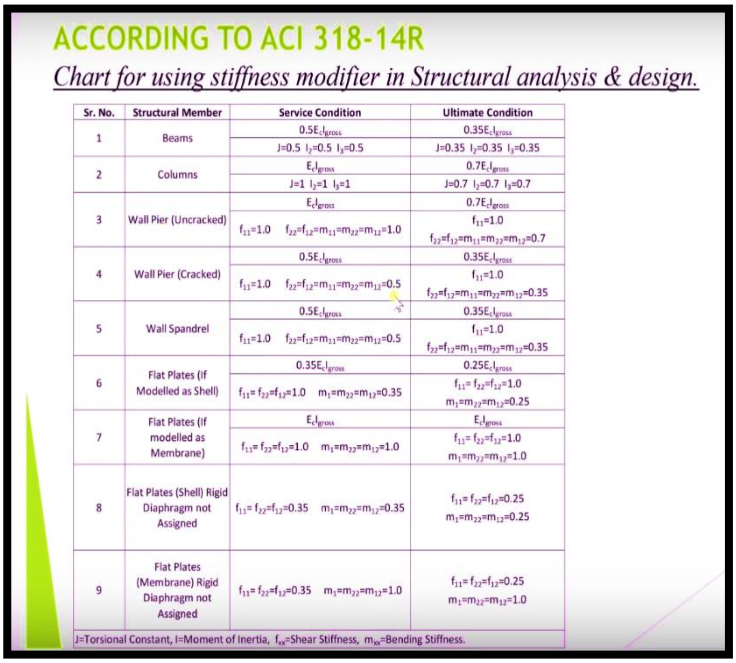


Figure 144: deflection in ETABS by long term

structural analysis values in ETABS program

Modifiers in structural analysis:



ACCORDING TO ACI 318-14R

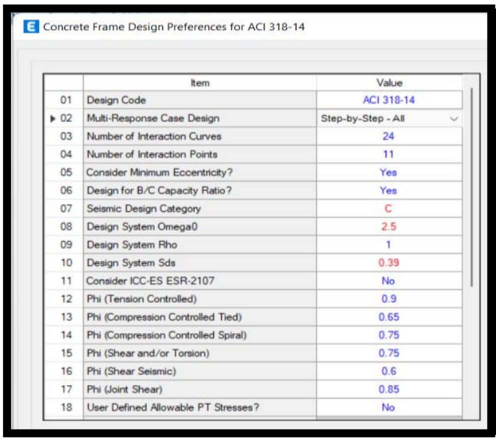
Chart for using stiffness modifier in Structural analysis & design.

Sr. No.	Structural Member	Service Condition	Ultimate Condition
1	Beams	$0.5E_cI_{gross}$	$0.35E_cI_{gross}$
		$J=0.5$ $I_2=0.5$ $I_3=0.5$	$J=0.35$ $I_2=0.35$ $I_3=0.35$
2	Columns	E_cI_{gross}	$0.7E_cI_{gross}$
		$J=1$ $I_2=1$ $I_3=1$	$J=0.7$ $I_2=0.7$ $I_3=0.7$
3	Wall Pier (Uncracked)	E_cI_{gross}	$0.7E_cI_{gross}$
		$f_{11}=1.0$ $f_{22}=f_{12}=m_{11}=m_{22}=m_{12}=1.0$	$f_{11}=1.0$ $f_{22}=f_{12}=m_{11}=m_{22}=m_{12}=0.7$
4	Wall Pier (Cracked)	$0.5E_cI_{gross}$	$0.35E_cI_{gross}$
		$f_{11}=1.0$ $f_{22}=f_{12}=m_{11}=m_{22}=m_{12}=0.5$	$f_{11}=1.0$ $f_{22}=f_{12}=m_{11}=m_{22}=m_{12}=0.35$
5	Wall Spandrel	$0.5E_cI_{gross}$	$0.35E_cI_{gross}$
		$f_{11}=1.0$ $f_{22}=f_{12}=m_{11}=m_{22}=m_{12}=0.5$	$f_{11}=1.0$ $f_{22}=f_{12}=m_{11}=m_{22}=m_{12}=0.35$
6	Flat Plates (If Modelled as Shell)	$0.35E_cI_{gross}$	$0.25E_cI_{gross}$
		$f_{11}=f_{22}=f_{12}=1.0$ $m_1=m_{22}=m_{12}=0.35$	$f_{11}=f_{22}=f_{12}=1.0$ $m_1=m_{22}=m_{12}=0.25$
7	Flat Plates (If modelled as Membrane)	E_cI_{gross}	E_cI_{gross}
		$f_{11}=f_{22}=f_{12}=1.0$ $m_1=m_{22}=m_{12}=1.0$	$f_{11}=f_{22}=f_{12}=1.0$ $m_1=m_{22}=m_{12}=1.0$
8	Flat Plates (Shell) Rigid Diaphragm not Assigned	$f_{11}=f_{22}=f_{12}=0.35$ $m_1=m_{22}=m_{12}=0.35$	$f_{11}=f_{22}=f_{12}=0.25$ $m_1=m_{22}=m_{12}=0.25$
9	Flat Plates (Membrane) Rigid Diaphragm not Assigned	$f_{11}=f_{22}=f_{12}=0.35$ $m_1=m_{22}=m_{12}=1.0$	$f_{11}=f_{22}=f_{12}=0.25$ $m_1=m_{22}=m_{12}=1.0$

J=Torsional Constant, I=Moment of Inertia, f_{xx}=Shear Stiffness, m_{xx}=Bending Stiffness.

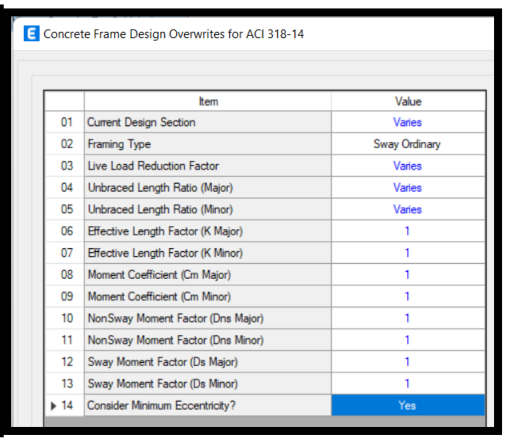
Figure 145: Modifiers in structural analysis

Design performances:



Concrete Frame Design Preferences for ACI 318-14

	Item	Value
01	Design Code	ACI 318-14
02	Multi-Response Case Design	Step-by-Step - All
03	Number of Interaction Curves	24
04	Number of Interaction Points	11
05	Consider Minimum Eccentricity?	Yes
06	Design for B/C Capacity Ratio?	Yes
07	Seismic Design Category	C
08	Design System Omega0	2.5
09	Design System Rho	1
10	Design System Sds	0.39
11	Consider ICC-ES ESR-2107	No
12	Phi (Tension Controlled)	0.9
13	Phi (Compression Controlled Tied)	0.65
14	Phi (Compression Controlled Spiral)	0.75
15	Phi (Shear and/or Torsion)	0.75
16	Phi (Shear Seismic)	0.6
17	Phi (Joint Shear)	0.85
18	User Defined Allowable PT Stresses?	No



Concrete Frame Design Overwrites for ACI 318-14

	Item	Value
01	Current Design Section	Varies
02	Framing Type	Sway Ordinary
03	Live Load Reduction Factor	Varies
04	Unbraced Length Ratio (Major)	Varies
05	Unbraced Length Ratio (Minor)	Varies
06	Effective Length Factor (K Major)	1
07	Effective Length Factor (K Minor)	1
08	Moment Coefficient (Cm Major)	1
09	Moment Coefficient (Cm Minor)	1
10	NonSway Moment Factor (Dns Major)	1
11	NonSway Moment Factor (Dns Minor)	1
12	Sway Moment Factor (Ds Major)	1
13	Sway Moment Factor (Ds Minor)	1
14	Consider Minimum Eccentricity?	Yes

Figure 146: design performance and overwrite .

3.10Design and Detailing

3.10.1 design of beams: -

3.10.1.1 block one beams:

The following figure shown all beams in floor and beams sections:

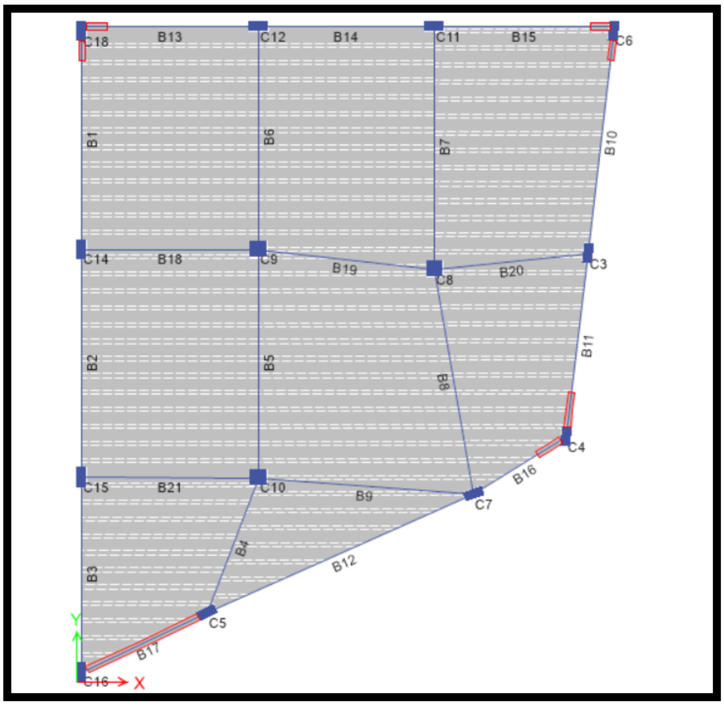


Figure 147: beams labels in block1

Beams B1:

Beam dimensions = 50 cm width, 40 cm depth ,and

d= 35 cm , $f_c' = 28MPa$, Fy = 420Mpa .

1- Design for axial load:

Check if the member behaves as beam or as beam column.

Beam column limit = 0.1 * Fc * Ag

= 560 Kn

Figure 148: axial load on beam envelope strength combination.

Axial load in beam = 137.24Kn , its not beam column .

All beams in block one act as beam not as beam column.

Design For moment:

Ultimate design strength moment on beam shown below:

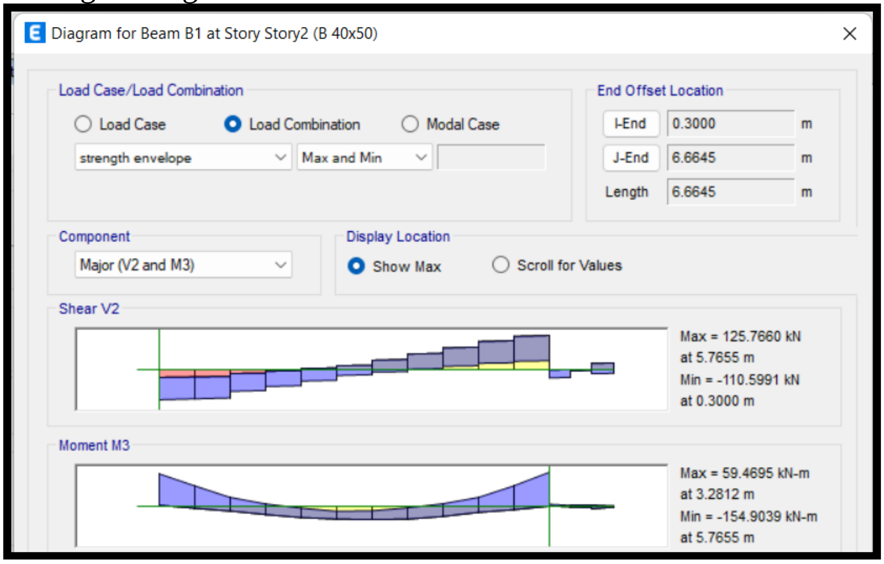


Figure 149: ultimate moment force in beam

Positive moment:

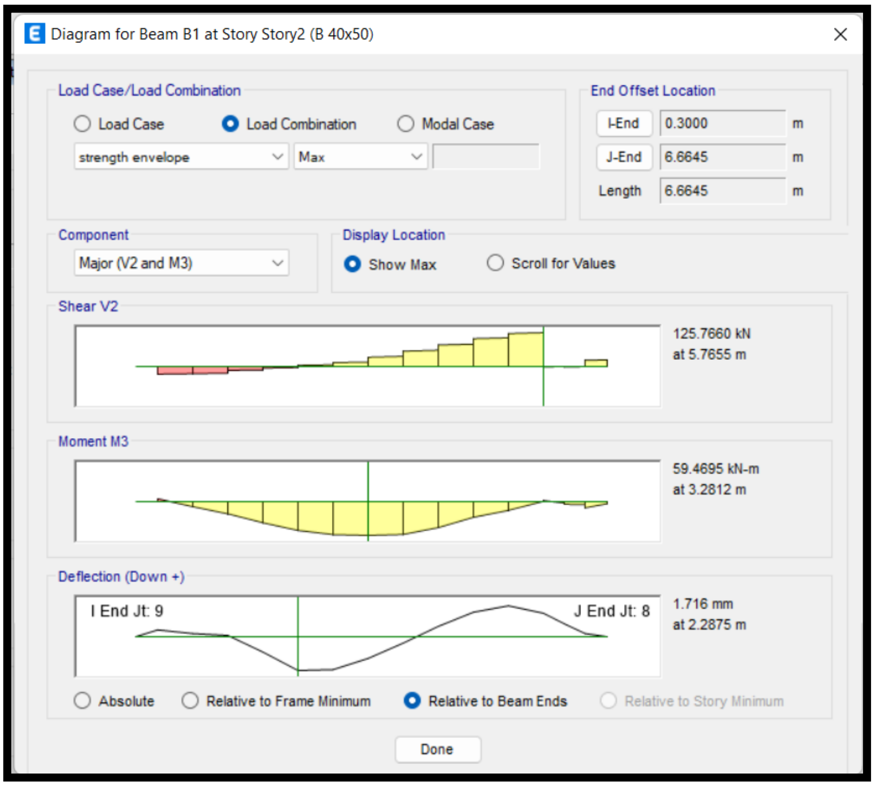


Figure 150: Max moment on center of beam

bottom steel:

Moment=59. 5Kn.m

$$\rho = \frac{0.85f'_c}{f_y}\left(1 - \sqrt{1 - \frac{2M_u}{0.85\emptyset bd^2 f'_c}}\right)$$

$$\rho_{max,singly} = 0.375\beta_1 \frac{0.85f'_c}{f_y} \quad \rho_{min} = max\left[\frac{1.4}{f_y}, \frac{0.25\sqrt{f'_c}}{f_y}\right]$$

0.0180625	ρ̇ max
0.003333333	ρ̇ min

ρ̇ =0.002 < ρ̇min

ρ̇= ρ̇min = 0.00333 , So

AS= 620.7 mm2 = 4ϕ16mm

Spacing = (500-2(30)-16*4) / (4-1) = 120mm

Spacing must be > $\begin{Bmatrix} diameter\ of\ bar\ (1.6)\ cm \\ 2.5\ cm \end{Bmatrix}$ so , OK.

Negative moment:

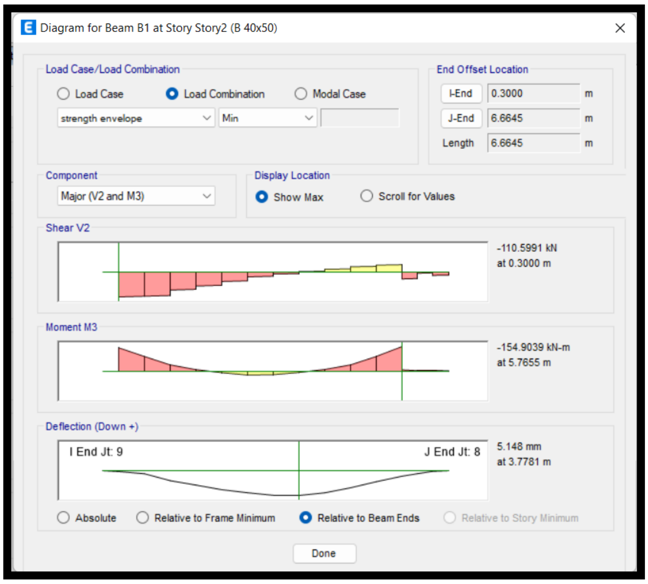


Figure 151: Max ultimate design strength moment on edge of beam

top steel:

moment = 154. 9kn.m

$$\rho = \frac{0.85f'_c}{f_y}\left(1 - \sqrt{1 - \frac{2M_u}{0.85\emptyset bd^2 f'_c}}\right)$$

$$\rho_{max,singly} = 0.375\beta_1 \frac{0.85f'_c}{f_y}$$

$$\rho_{min} = max\left[\frac{1.4}{f_y}, \frac{0.25\sqrt{f'_c}}{f_y}\right]$$

0.0180625	ṗ max
0.003333333	ṗ min

ṗ = .007 > ṗmin, So

AS= 1295 mm2 = 7ϕ16mm

Spacing = (500-2(30)-16*7) / (7-1) = 50mm

Spacing must be > $\begin{Bmatrix} diameter\ of\ bar\ (1.6)\ cm \\ 2.5\ cm \end{Bmatrix}$ so , OK.

Where:

ρ: steel ratio. $\rho = \frac{A_s}{bd}$

Mu: ultimate applied bending moment, N.mm

b: width of compression zone, width of section, mm

d= effective depth of section, mm

f'c: compressive strength of concrete, cylinder test, at 28 days, MPa

fy: yield strength of reinforcing steel, MPa

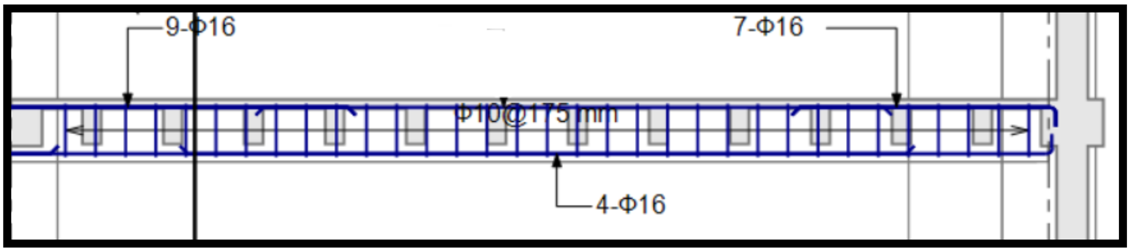


Figure 152: Section in beam.

Design for shear:

Figure 153: ultimate shear force in beam

Ultimate shear (V_u) = 125.76KN

$\frac{Vu}{\Phi} = Vc + Vs$ $\qquad$ $Vc = \frac{1}{6}\sqrt{fc}\, b\, d$

Vc = 163.15 Kn

$Vs = \frac{Vu}{\Phi} - Vc$ = 4.53Kn

$\frac{Av}{s} = \frac{Vs}{dfy}$ $\quad$ (use minimum shear reinforcement)

$$\frac{A_v}{s}\text{min.} = \text{max.}\left\{\begin{matrix} 0.062\sqrt{f_c'} * \frac{d}{F_y} \\ \frac{0.35 * d}{F_y} \end{matrix}\right\} = 0.3\ mm^2/mm$$

According to ACI318-19 code on table 9.7.6.2.2, as shown below.

S_{max}. = min. of { $\frac{d}{2}$ or 600 mm } = 370/2 =18.5cm

Choose Ø = 10mm, then $\frac{A_v}{s}$. = **0.3 =2(0.25*3.14*10^2)/s**

So s = 523.3mm = 52.33cm > S_{max}

So use S_{max} as spacing, evey 18.5 cm start after 5cm from support .

(**1 Ø10mm @ 18.5 cm** .)

Table 30: maximum space of stirrups in beams.

ACI 318-19 Table 9.7.6.2.2—Maximum spacing of shear reinforcement

Required Vs		**Maximum s, mm**			
		Nonprestressed beam		Prestressed beam	
		Along length	Across width	Along length	Across width
$\leq 0.33\sqrt{f_c'}\, b_w d$	Lesser of:	d/2	d	3h/4	3h/2
		600			
$> 0.33\sqrt{f_c'}\, b_w d$	Lesser of:	d/4	d/2	3h/8	3h/4
		300			

A_v: the area of vertical legs of stirrups (shear reinforcement), mm^2

S: spacing of stirrups, mm

f_{yt}: yield strength of stirrups reinforcing bars, MPa

d: effective depth of cross section, mm

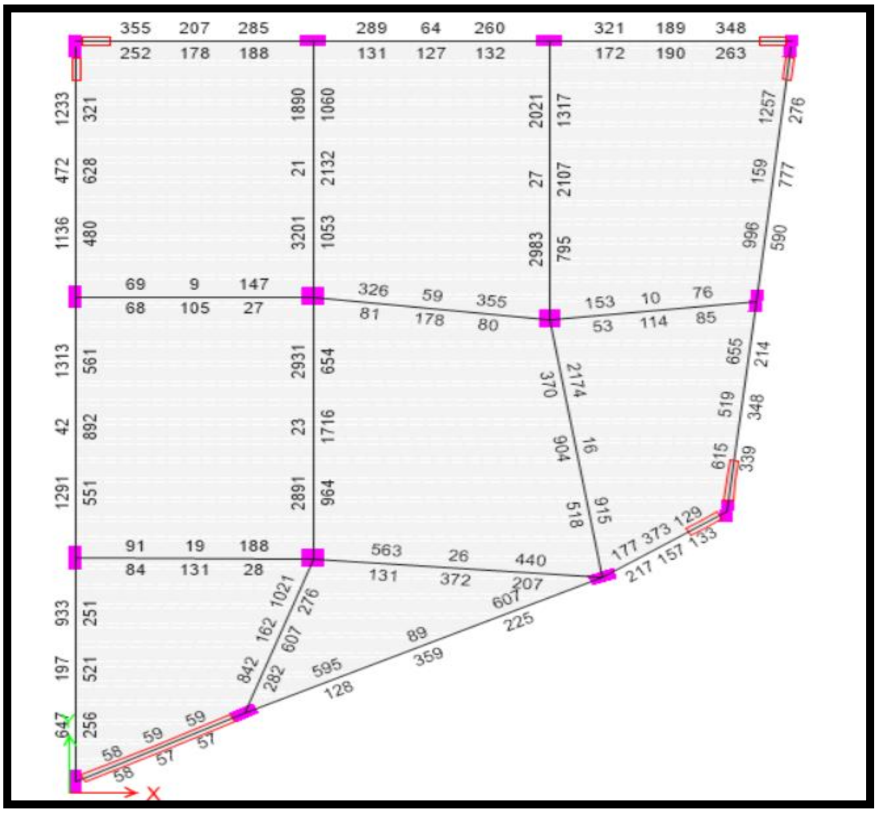


Figure 154: beams in block1 reinforcement steel needed

Beams Minimum requirements for ordinary frames: -

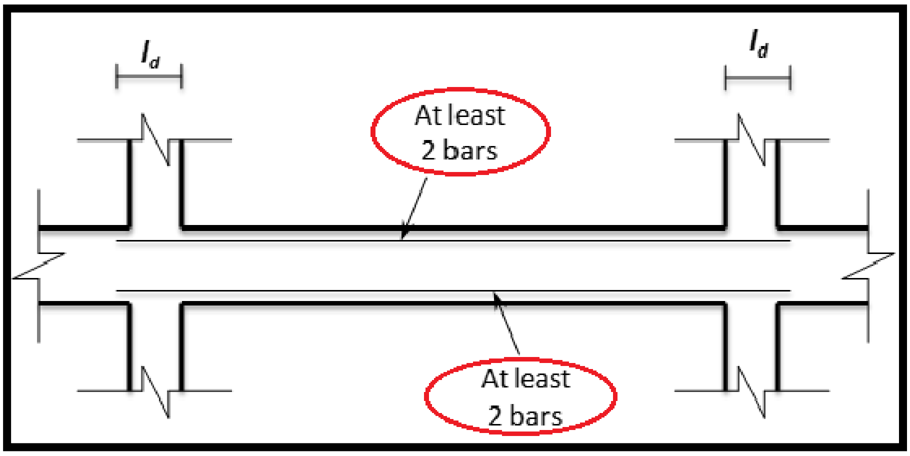


Figure 155: Minimum requirements for ordinary frame

<u>structural detailing and ordinary requirements:</u>

$$l_d = \frac{f_y d_b}{5.4\sqrt{f'c}} \geq max \begin{Bmatrix} 150\text{ mm} \\ 8d_b \end{Bmatrix} \quad \text{for hooked bars}$$

$$l_d = \frac{f_y d_b}{2.16\sqrt{f'c}} \geq max \begin{Bmatrix} 375\text{ mm} \\ 20d_b \end{Bmatrix} \quad \text{for straight bottom bars}$$

$$l_d = \frac{f_y d_b}{1.66\sqrt{f'c}} \geq max \begin{Bmatrix} 490\text{ mm} \\ 26d_b \end{Bmatrix} \quad \text{for straight top bars}$$

Figure 156: Minimum development length requirement

- For straight top bars:

$$ld = \frac{\text{fy } db}{1.66\sqrt{f'c}} = \frac{420 \times 16}{1.66\sqrt{28}} = 765mm > \max of \begin{Bmatrix} 490mm \\ 26 \times 16 = 420mm \end{Bmatrix}$$

- For straight bottom bars:

$$ld = \frac{\text{fy } db}{2.16\sqrt{f'c}} = \frac{420 \times 16}{2.16\sqrt{28}} = 587\ mm > max \begin{Bmatrix} 375mm \\ 20 \times 16 = 320mm \end{Bmatrix}$$

Column depth equal 300 mm, so it must use hooked bar

- For hooked bars:

$$ld = \frac{\text{fy } db}{5.4\sqrt{f'c}} = \frac{420 \times 16}{5.4\sqrt{28}} = 235mm > max \begin{Bmatrix} 150mm \\ 8 \times 16 = 128mm \end{Bmatrix}$$

& length of hook = 8d_{bar} = 8x16 = 128 take it 150mm

- All top and bottom steel are extended at all distance of beam , that have more than 2 bars extended in the columns so ordinary requirements are achieved.

Table 31: reinforcement of beams

Beam name	Dimension cm*cm	Top steel (Top)	Bottom steel (Bottom)	Stirrup steel
Beam B1S1	40*50	4ϕ16mm	5ϕ16mm	1ϕ10/18.5cm
Beam B1S2	40*50	7ϕ16mm	6ϕ16mm	1ϕ10/18.5cm
Beam B1S3	40*50	7ϕ16mm	4ϕ16mm	1ϕ10/18.5cm
Beam B2	40*50	5ϕ16mm	4ϕ16mm	1ϕ10/18.5cm
Beam B3S1	40*50	2ϕ16mm+8ϕ20mm	9ϕ16mm	1ϕ10/10cm
Beam B3S2	40*50	2ϕ16mm+10ϕ20mm	10ϕ16mm	1ϕ10/10cm
Beam B4	40*50	10ϕ20mm	7ϕ16mm	1ϕ10/10cm
Beam B5	40*50	11ϕ16mm	5ϕ16mm	1ϕ10/12.5cm
Beam B6	40*50	3ϕ16mm	3ϕ16mm	1ϕ10/18.5cm
Beam B7S1	40*50	4ϕ16mm	4ϕ16mm	1ϕ10/18.5cm
Beam B7S2	40*50	5ϕ16mm	5ϕ16mm	1ϕ10/18.5cm
Beam B8	20*50	5ϕ16mm	4ϕ16mm	1ϕ10/18.5cm
Beam B9S1	30*40	3ϕ16mm	3ϕ16mm	1ϕ8/12.5cm
Beam B9S2	30*40	3ϕ16mm	3ϕ16mm	1ϕ8/12.5cm
Beam B9S3	30*40	3ϕ16mm	3ϕ16mm	1ϕ8/12.5cm
Beam B10	30*40	3ϕ16mm	3ϕ16mm	1ϕ8/12.5cm
Beam B11	30*40	3ϕ16mm	3ϕ16mm	1ϕ8/12.5cm
Beam B12	30*40	3ϕ16mm	3ϕ16mm	1ϕ8/12.5cm

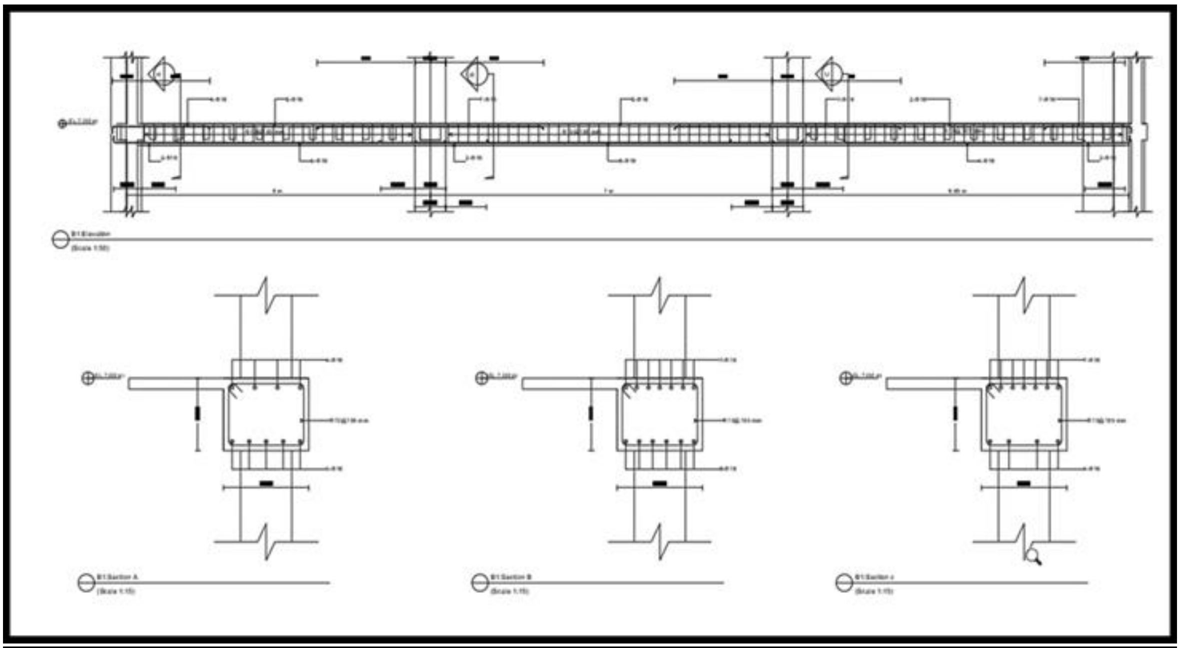


Figure 157: Section of beam1 in block 1

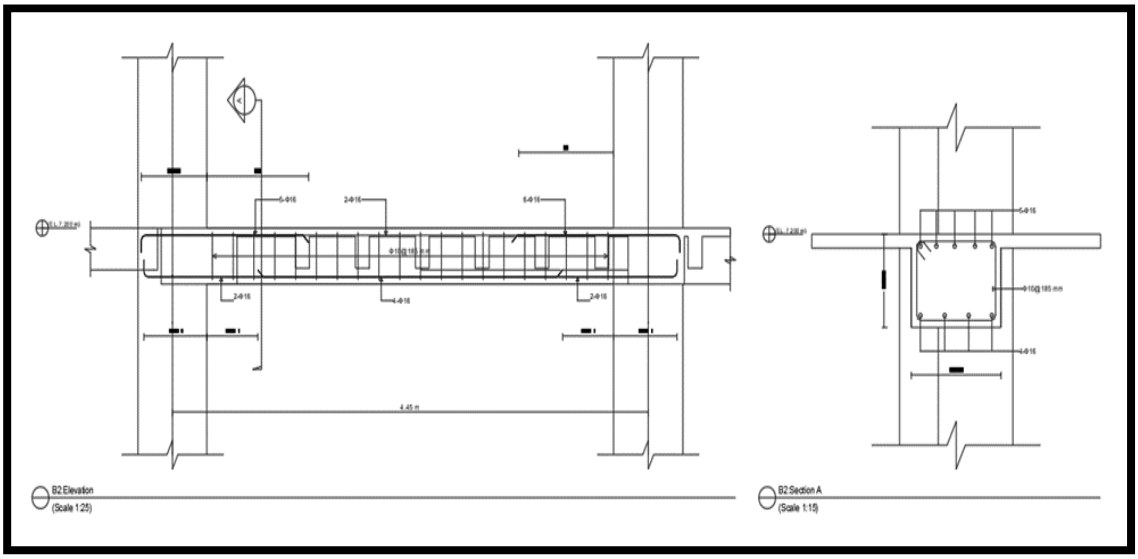


Figure 158: Section of beam2 in block 1

3.10.1.2 block two beams

The following figure shown all beams in floor and beams sections:

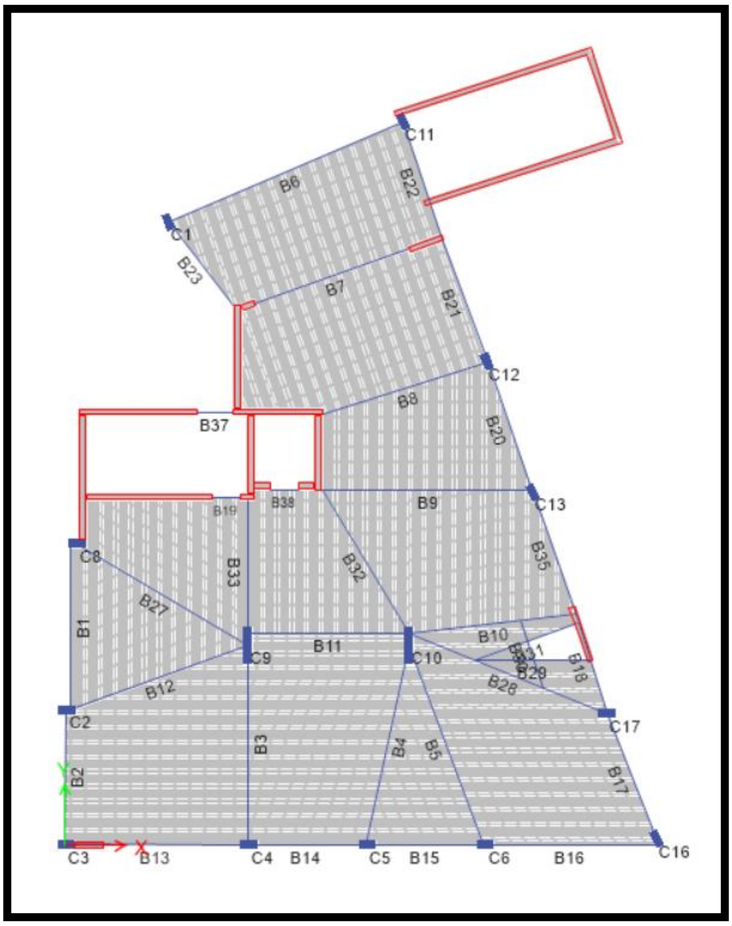


Figure 159: beams labels in block2

Beams B8:

Beam dimensions = 40 cm depth,50 cm width, and

d= 37 cm , $f_c' = 28MPa$, Fy = 420Mpa .

Design for axial load:

Check if the member behave as beam or as beam column.

Beam column limit = 0.1 * Fc * Ag

= 560 Kn

Figure 160: axial load on beam envelope strength combination

<u>Axial load in beam = 75.3Kn, it's not beam column.</u>

<u>All beams in block two act as beam not as beam column.</u>

Design for moment:

Ultimate design strength moment on beam shown below:

Figure 161: ultimate moment force in beam

Positive moment:

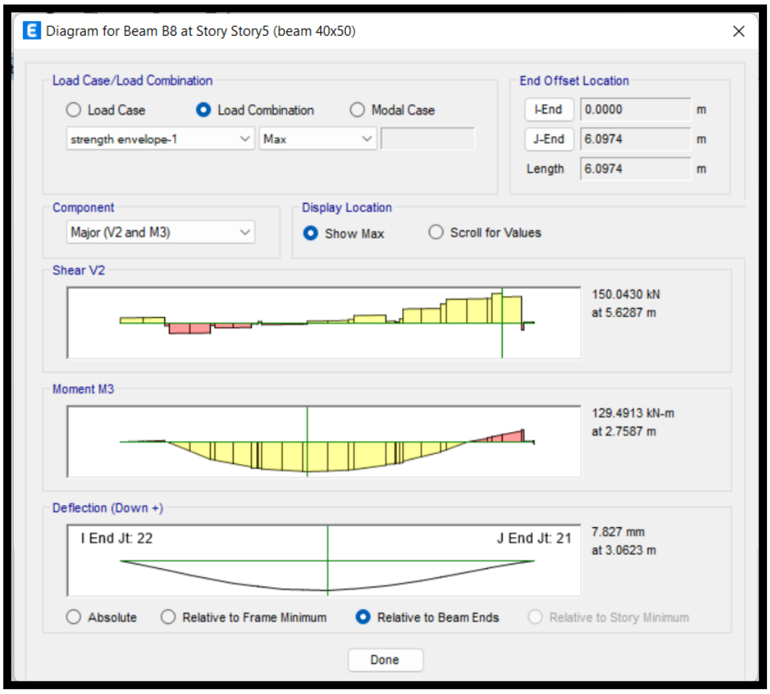


Figure 162: Max moment on center of beam

bottom steel:

Moment=129. 5Kn.m

$$\rho = \frac{0.85f'_c}{f_y}\left(1 - \sqrt{1 - \frac{2M_u}{0.85\emptyset bd^2 f'_c}}\right)$$

$$\rho_{max,singly} = 0.375\beta_1 \frac{0.85f'_c}{f_y} \qquad \rho_{min} = max\left[\frac{1.4}{f_y}, \frac{0.25\sqrt{f'_c}}{f_y}\right]$$

0.0180625	ῤ max
0.003333333	ῤ min

ῤ =0.0052 > ῤmin

ῤ= ῤmin = 0.00333, So

AS= 962 mm2 = 5ϕ16mm

Spacing = (500-2(30)-16*5) / (5-1) = 90mm

Spacing must be > $\begin{Bmatrix} diameter\ of\ bar\ (1.6)\ cm \\ 2.5\ cm \end{Bmatrix}$ so , OK.

Negative moment

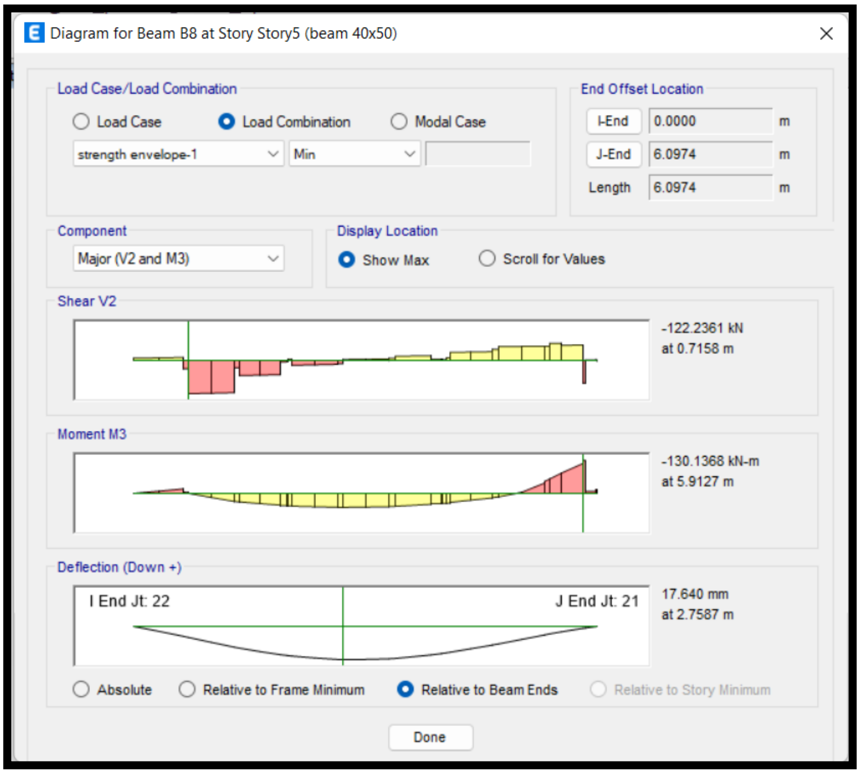


Figure 163: Max ultimate design strength moment on edge of beam

Top steel:

moment = 130. 13kn.m

$$\rho = \frac{0.85f'_c}{f_y}\left(1 - \sqrt{1 - \frac{2M_u}{0.85\emptyset bd^2 f'_c}}\right)$$

$$\rho_{max,singly} = 0.375\beta_1 \frac{0.85f'_c}{f_y}$$

$$\rho_{min} = max\left[\frac{1.4}{f_y}, \frac{0.25\sqrt{f'_c}}{f_y}\right]$$

0.0180625	ῤ max
0.003333333	ῤ min

ῤ = .00526 > ῤmin, So

AS= 973.1 mm2 = 5ϕ16mm

Spacing = (500-2(30)-16*5) / (5-1) = 90mm

Spacing must be > $\begin{Bmatrix} diameter\ of\ bar\ (1.6)\ cm \\ 2.5\ cm \end{Bmatrix}$ so , OK.

Where:

ρ: steel ratio. $\rho = \frac{A_s}{bd}$

Mu: ultimate applied bending moment, N.mm

b: width of compression zone, width of section, mm

d= effective depth of section, mm

f'c: compressive strength of concrete, cylinder test, at 28 days, MPa

fy: yield strength of reinforcing steel, MPa

Design for shear:

Shear design:

Figure 164: ultimate shear force in beam

Ultimate shear (Vu) = 150.04KN

$\frac{Vu}{\Phi} = Vc + Vs \qquad Vc = \frac{1}{6}\sqrt{fc}\, b\, d$

Vc = 163.15 Kn

$Vs = \frac{Vu}{\Phi} - Vc = 13.11Kn$

$\frac{Av}{s} = \frac{Vs}{dfy}$ (use minimum shear reinforcement)

$$\frac{A_v}{s}\text{min.} = \text{max.}\begin{Bmatrix} 0.062\sqrt{f_c'} * \frac{d}{F_y} \\ \frac{0.35 * d}{F_y} \end{Bmatrix} = 0.3\ \text{mm}^2/\text{mm}$$

According to ACI318-19 code on table 9.7.6.2.2, as shown below.

$S_{max.}$ = min. of { $\frac{d}{2}$ or 600 mm } = 370/2 =18.5cm

Choose Ø = 10mm, then $\frac{A_v}{s}$. = **0.3 =2(0.25*3.14*10^2)/s**

So s = 523.3mm = 52.33cm > S_{max}

So use S_{max} as spacing, evey 18.5 cm start after 5cm from support.

(**1 Ø10mm @ 18.5 cm**.)

ACI 318-19 Table 9.7.6.2.2—Maximum spacing of shear reinforcement

Required V_s		**Maximum s, mm**			
		Nonprestressed beam		Prestressed beam	
		Along length	Across width	Along length	Across width
$\le 0.33\sqrt{f_c'}\,b_w d$	Lesser of:	d/2	d	3h/4	3h/2
		600			
$> 0.33\sqrt{f_c'}\,b_w d$	Lesser of:	d/4	d/2	3h/8	3h/4
		300			

Figure 165: maximum space of stirrups in beams.

A_v: the area of vertical legs of stirrups (shear reinforcement), mm^2

S: spacing of stirrups, mm

f_{yt}: yield strength of stirrups reinforcing bars, MPa

d: effective depth of cross section, mm

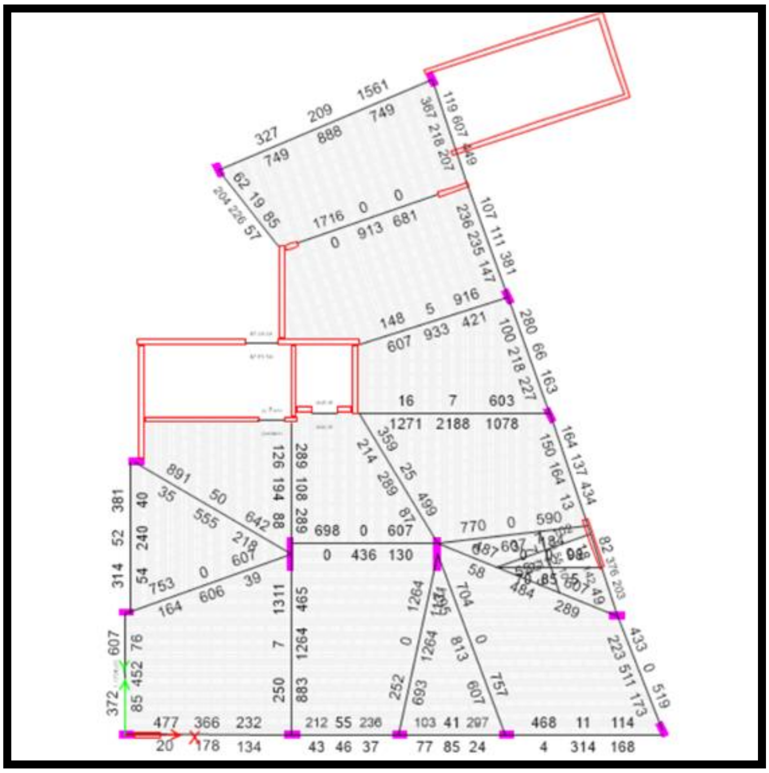
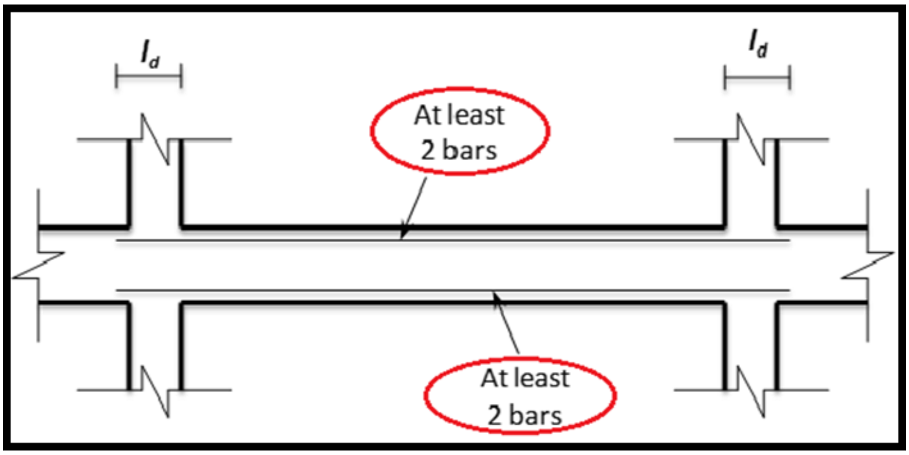


Figure 166: beams in block1 reinforcement steel needed

Beams Minimum requirements for ordinary frames: -



3.7.2.21.1 Figure 167: Minimum requirements for ordinary frame

<u>structural detailing and ordinary requirements:</u>

$$l_d = \frac{f_y d_b}{5.4\sqrt{f'c}} \geq max \begin{Bmatrix} 150 \text{ mm} \\ 8d_b \end{Bmatrix} \quad \text{for hooked bars}$$

$$l_d = \frac{f_y d_b}{2.16\sqrt{f'c}} \geq max \begin{Bmatrix} 375 \text{ mm} \\ 20d_b \end{Bmatrix} \quad \text{for straight bottom bars}$$

$$l_d = \frac{f_y d_b}{1.66\sqrt{f'c}} \geq max \begin{Bmatrix} 490 \text{ mm} \\ 26d_b \end{Bmatrix} \quad \text{for straight top bars}$$

Figure: Minimum development length requirement

- For straight top bars:

$$ld = \frac{\text{fy } db}{1.66\sqrt{f'c}} = \frac{420 \times 16}{1.66\sqrt{28}} = 765mm > \max of \begin{Bmatrix} 490mm \\ 26 \times 16 = 420mm \end{Bmatrix}$$

- For straight bottom bars:

$$ld = \frac{\text{fy } db}{2.16\sqrt{f'c}} = \frac{420 \times 16}{2.16\sqrt{28}} = 587\ mm > max \begin{Bmatrix} 375mm \\ 20 \times 16 = 320mm \end{Bmatrix}$$

Column depth equal 300 mm, so it must use hooked bar

- For hooked bars:

$$ld = \frac{\text{fy } db}{5.4\sqrt{f'c}} = \frac{420 \times 16}{5.4\sqrt{28}} = 235mm > max \begin{Bmatrix} 150mm \\ 8 \times 16 = 128mm \end{Bmatrix}$$

& length of hook = $8d_{bar}$ = 8x16 = 128 take it 150mm

- All top and bottom steel are extended at all distance of beam , that have more than 2 bars extended in the columns so ordinary requirements are achieved.

Table 32: reinforcement of beams

Beam name	**Dimension cm*cm**	**Top steel (Top)**	**Bottom steel (Bottom)**	**Stirrup steel**
Beam B1	40*50	3ϕ16mm	3ϕ16mm	1ϕ10/18.5cm
Beam B2	40*50	4ϕ16mm	4ϕ16mm	1ϕ10/18.5cm
Beam B3	80*50	7ϕ16mm	5ϕ16mm	2ϕ10/12cm
Beam B4	80*50	7ϕ16mm	5ϕ16mm	2ϕ10/12cm
Beam B5	40*50	4ϕ16mm	3ϕ16mm	1ϕ10/15cm
Beam B6	60*40	2ϕ16mm+4ϕ16mm	5ϕ16mm	2ϕ10/20cm
Beam B7	40*50	9ϕ16mm	5ϕ16mm	1ϕ10/18.5cm
Beam B8	40*50	3ϕ16mm	3ϕ16mm	1ϕ10/18.5cm
Beam B9	60*40	3ϕ16mm+2ϕ16mm	5ϕ16mm+5ϕ20mm	1ϕ10/150cm
Beam B10	40*50	4ϕ16mm	4ϕ16mm	1ϕ10/18.5cm
Beam B11	40*50	4ϕ16mm	3ϕ16mm	1ϕ10/18.5cm
Beam B12	40*50	4ϕ16mm	4ϕ16mm	1ϕ10/12cm
Beam B13	40*50	3ϕ16mm	3ϕ16mm	1ϕ10/18.5cm
Beam B14	40*50	3ϕ16mm	3ϕ16mm	1ϕ10/18.5cm
Beam B15	40*50	3ϕ16mm	3ϕ16mm	1ϕ10/18.5cm
Beam B16	40*50	3ϕ16mm	3ϕ16mm	1ϕ10/12.5cm
Beam B17	60*40	2ϕ16mm	2ϕ16mm	1ϕ10/25cm
Beam B20	40*50	5ϕ16mm	3ϕ16mm	1ϕ10/15cm
Beam B21	40*50	4ϕ16mm	3ϕ16mm	2ϕ10/12cm
CB	25*20	2ϕ14mm	3ϕ14mm	1ϕ6/12cm
Beam B25	25*30	3ϕ14mm	3ϕ14mm	1ϕ6/12cm
Beam B26	25*30	3ϕ14mm	3ϕ14mm	1ϕ6/12cm
Beam B27	40*50	3ϕ16mm	3ϕ16mm	1ϕ8/18.5cm

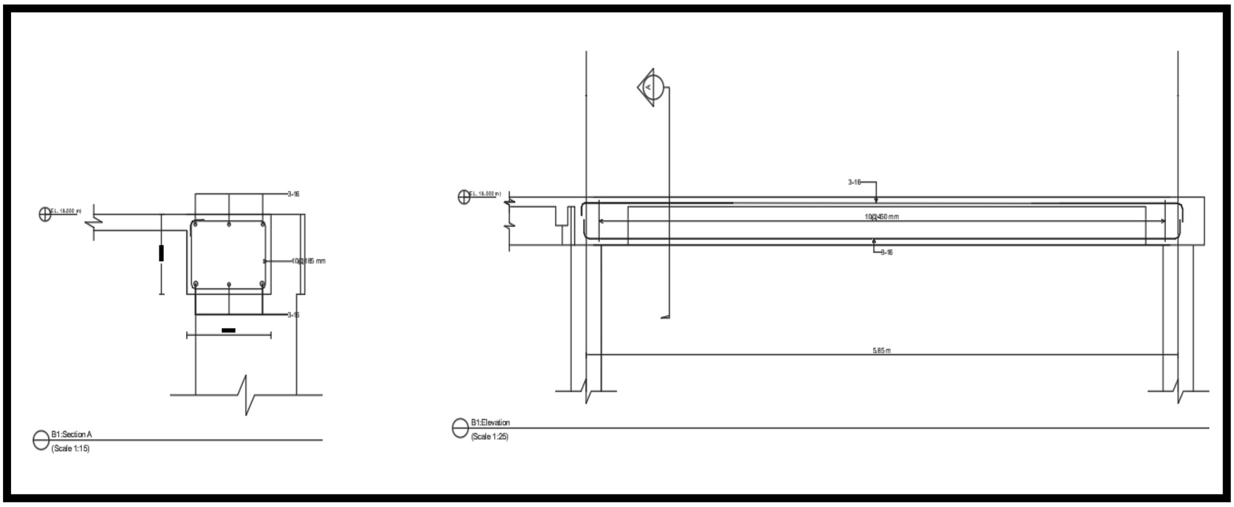


Figure 168:section of beam 1 in block 2

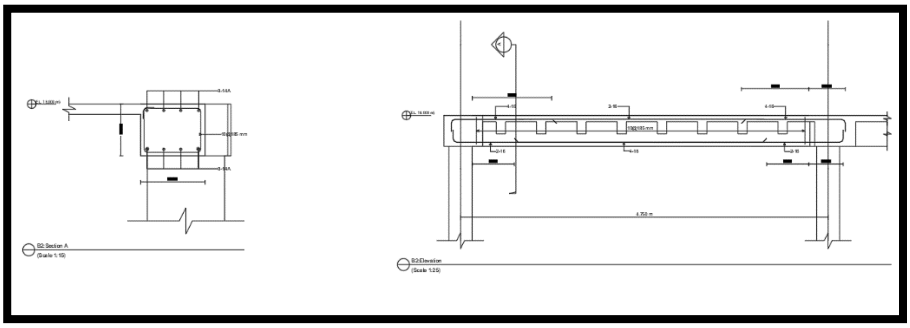


Figure 169:section of beam2 in block 2

design of columns

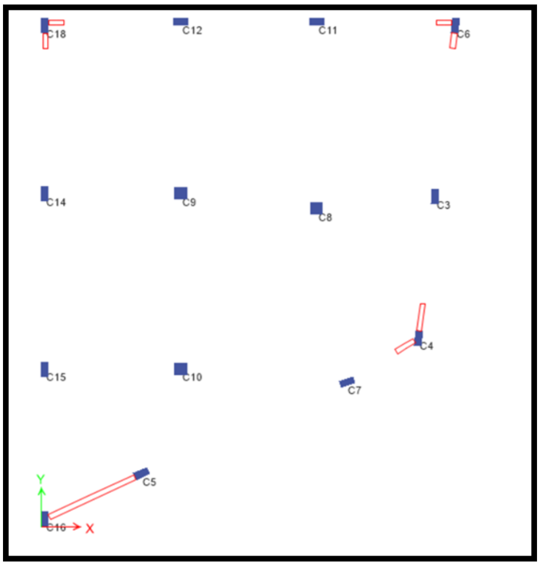


Figure 170:columns plan for block 1

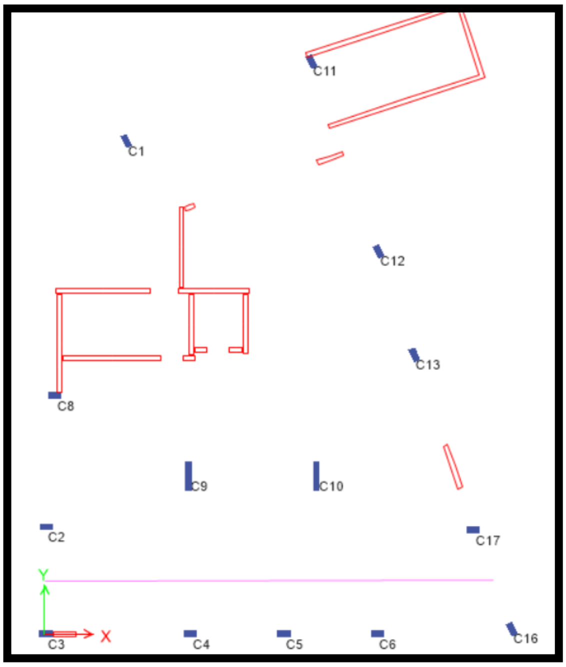


Figure 171:columns plan for block 2

- Column 1:

Column dimensions: - 0.5m * 0.5m

$f'_c = 28MPa$ Fy = 420MPa ، cover = 40mm

Longitudinal reinforcement: -

As = 2500mm^2 = **8** ϕ 20 mm^2

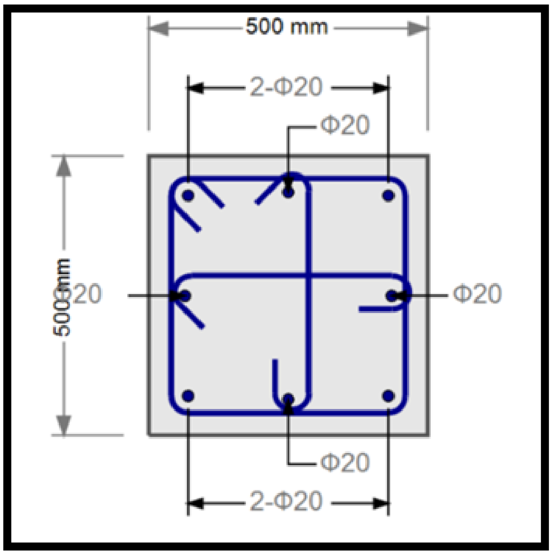


Figure 172:Section for column 1

- Column 2:

Column dimensions: - 0.6m * 0.3m

$f'_c = 28MPa$ Fy = 420MPa ، cover = 40mm

Longitudinal reinforcement: -

As = 1800mm^2 = **8** ϕ 18 mm^2 .

As = 2481mm^2 = **8** ϕ 20 mm^2 .

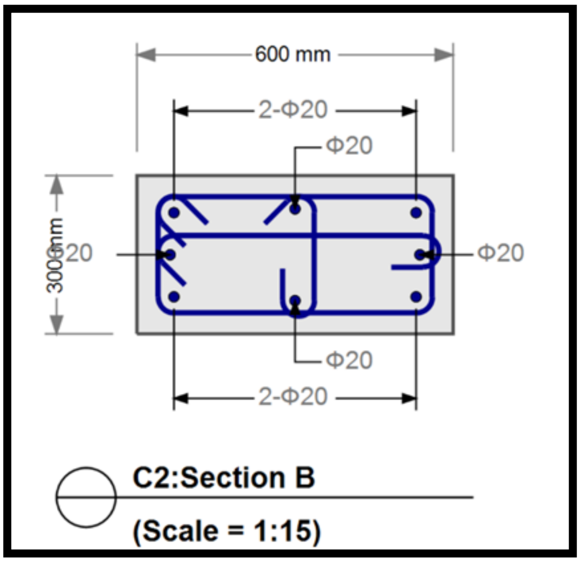


Figure 173:section for column 2

- Column 3

Column dimensions: - 1.3m * 0.3m

$f'_c = 28MPa$ Fy = 420MPa , cover = 40mm

As=3900mm^2 = 8Φ25mm

Check columns detailing for shear reinforcement:-

According to ASCE7-16, Column with value of (h/c_1< 5) shall be designed for shear as in intermediate frame.

Where:

h = clear column height

c_1 = maximum column cross sectional dimension

All stories height equals 3.6 m. And column have (50cm X 50cm), (60cmx30cm), (130cmx30cm).

. h/C1 for all column is more than **5** except column (130cm,30cm).

- Stirrups diameter and spacing shall be computed based on shear force (V_u) and spacing as shown in the figure below.
- Columns with H/c>5 will be designed as ordinary frames, and columns with h/c < 5 will be designed as intermediate frames.

ordinary column design:

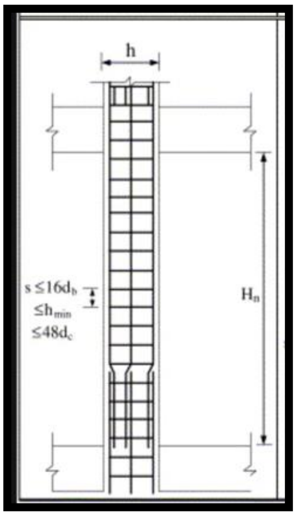


Figure 174: ordinary column spacing

Where:

$$S = Min\begin{Bmatrix} \text{least column dimension} \\ 16d_b \\ 48d_s \end{Bmatrix}$$

For Column 1: -

Column dimensions: - 50cm * 50cm

$$S = \text{Min}\begin{Bmatrix} 500 \\ 16*20 \\ 48*10 \end{Bmatrix} = \text{Min}\begin{Bmatrix} 500 \\ 320 \\ 480 \end{Bmatrix} mm = 320\text{ , } then\ use\ S_1 = 30cm$$

❖ **Check spacing between bars**

S= $\frac{500-2(30+10+10)}{2}$ = 200 mm > 150 mm

Every bar shall have stirrups corner.

Use splicing =1m.

For Column 2: -

Column dimensions: - 60cm * 30cm

$$S = \text{Min}\begin{Bmatrix} 600 \\ 16*16 \\ 48*10 \end{Bmatrix} = \text{Min}\begin{Bmatrix} 600 \\ 256 \\ 480 \end{Bmatrix} mm = 256\text{ , } then\ use\ S_1 = 25cm$$

❖ **Check spacing between bars**

Short direction: S= $\frac{300-2(30+10+8)}{2}$ = 102 mm < 150 mm

No need for another stirrup in that direction .

Long direction: S= $\frac{600-2(30+10+8)}{2}$ = 252 mm > 150 mm

Every bar shall have stirrups corner.

Use splicing =1m.

Intermediate column design:

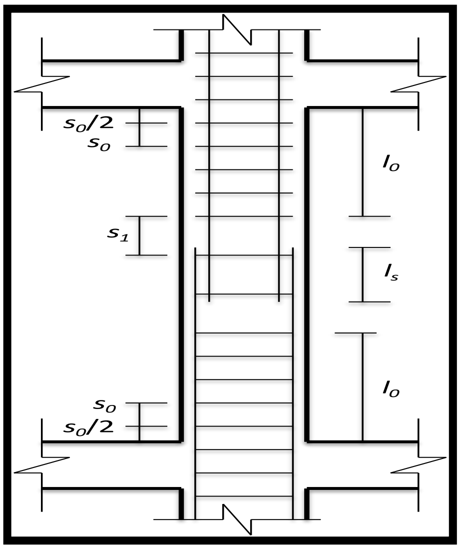


Figure 175: Intermediate column spacing

Where:

$$s_0 = Min \begin{Bmatrix} \text{least column dimension / 2} \\ 8d_b \\ 24d_s \\ \text{300 mm} \end{Bmatrix}$$

$$s_1 = Min \begin{Bmatrix} \text{least column dimension} \\ 16d_b \\ 48d_s \end{Bmatrix}$$

l_d = development length of the steel reinforcement in tension

$$l_0 = Max \begin{Bmatrix} \text{clear height of column/6} \\ \text{maximum column dimension} \\ \text{450 mm} \end{Bmatrix}$$

For Column 3: -

Column dimensions: - 130cm * 30cm

$$s_0 = \text{Min} \begin{Bmatrix} 300/2 \\ 8*16 \\ 24*10 \\ 300\text{ mm} \end{Bmatrix} = Min \begin{Bmatrix} 150 \\ 160 \\ 240 \\ 300 \end{Bmatrix} mm = 150, \text{then use } S_o = 150 \text{ mm}$$

$$s_1 = \text{Min} \begin{Bmatrix} 300 \\ 16*16 \\ 48*10 \end{Bmatrix} = \text{Min} \begin{Bmatrix} 300 \\ 256 \\ 480 \end{Bmatrix} mm = 256 \text{ , } then\ use\ S_1 = 250\ mm$$

$$l_0 = \text{Max} \begin{Bmatrix} 3600/6 \\ 1300 \\ 450\text{ mm} \end{Bmatrix} = \text{Max} \begin{Bmatrix} 600 \\ 1300 \\ 450 \end{Bmatrix} mm = 1300\ mm,$$

Use splicing =1m.

❖ **Check spacing between bars**

Short direction: S= $\frac{300-2(30+10+8)}{2}$ = 102 mm < 150 mm

No need for another stirrup in that direction .

Long direction: S= $\frac{1300-2(30+10+8)}{4}$ = 300 mm > 150 mm

Every bar shall have stirrups corner.

Use splicing =1m.

Table 33: column reinforcement

Column na	Dimensions (cm*cm)	Longitudinal reinforcement	Stirrups reinforcement
C1	50*50	8Ø20 mm	3Ø10mm/30cm
C2	60*30	8Ø18 mm	2Ø10mm/25cm
C3	130*30	8Ø25 mm	3Ø10mm/15cm for first for 1.3m below and then every 25cm

3.10.2 Slap design

3.10.2.1 Slap for Block one:

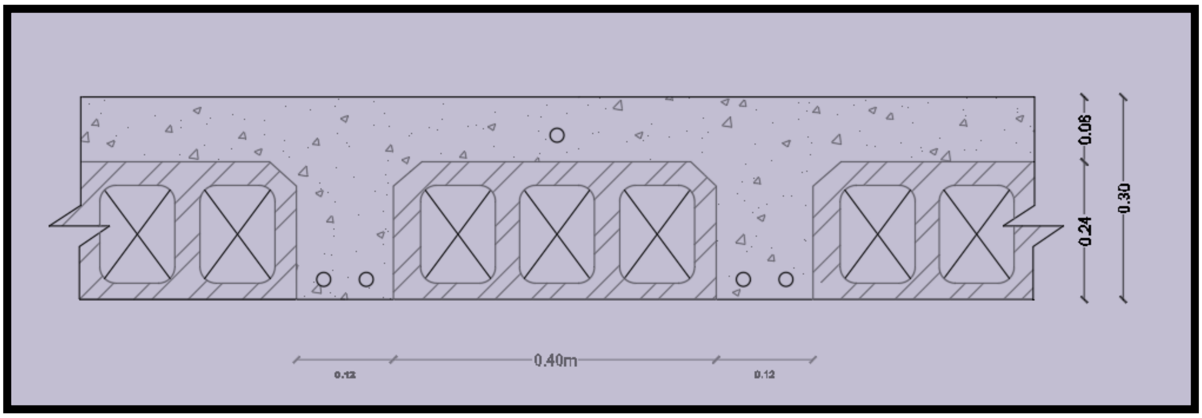


Figure 176: section in slap

Moment for a strip with width 1 meter:

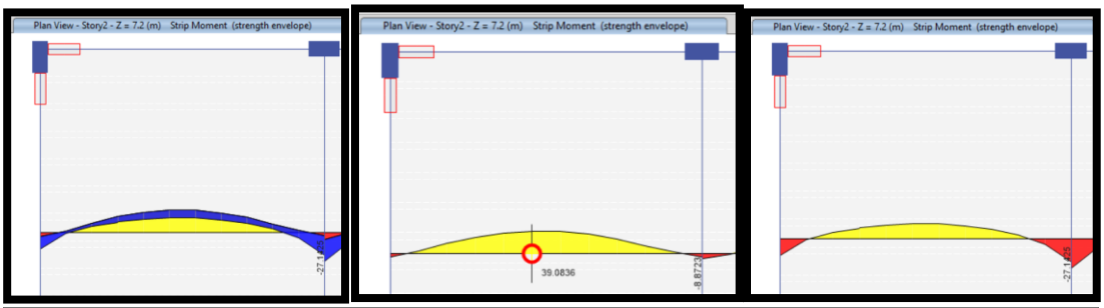


Figure 177: max positive & negative envelope Moment value for 1 meter width.

Mu (bottom) = 39$(Kn.m) * 0.52$ = 20.28KN.m/rib .

$$\rho = \frac{0.85f'_c}{f_y}\left(1-\sqrt{1-\frac{2M_u}{0.85\emptyset bd^2f'_c}}\right)$$ =.0064

Area of steel = 207mm² (2 Ø12 mm/rib)

Mu (Top) = 27.1KN.m=14.1KN.m/rib

$$\rho = \frac{0.85f'_c}{f_y}\left(1-\sqrt{1-\frac{2M_u}{0.85\emptyset bd^2f'_c}}\right)$$ -=*.0044.*

Area of steel = 142.56mm² (2 Ø12 mm/rib)

3.10.2.2 Slap for Block two:

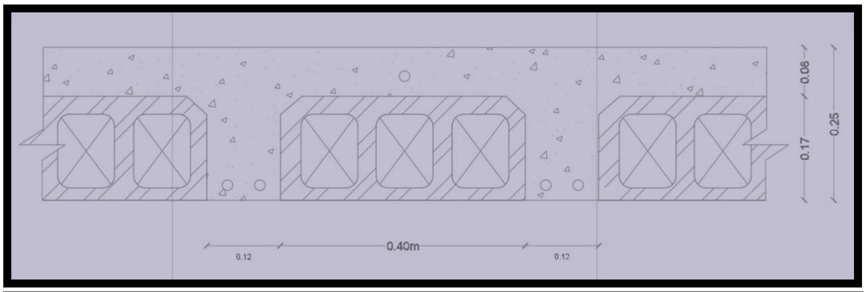


Figure 178: section in slap

Moment for a strip with width 1 meter :

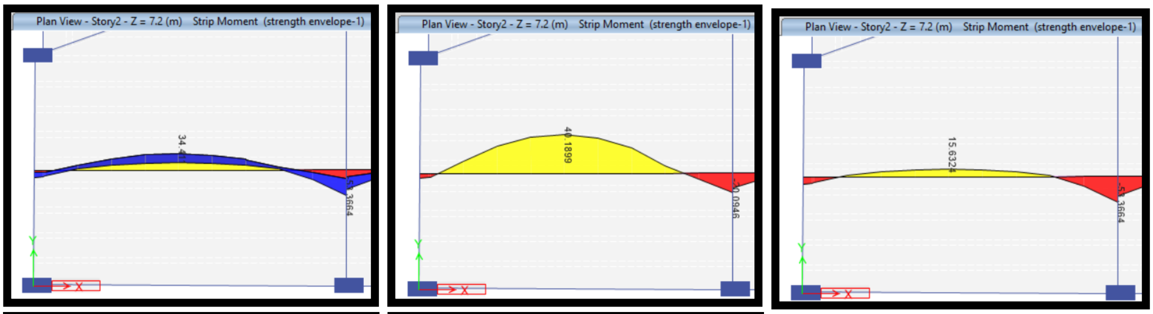


Figure 179: max positive & negative envelope Moment value for 1 meter width

Mu (bottom) = $40.18(Kn.m) * 0.52 = 20.8$KN.m/rib .

$$\rho = \frac{0.85f'_c}{f_y}\left(1 - \sqrt{1 - \frac{2M_u}{0.85\emptyset bd^2 f'_c}}\right)$$ =.009

Area of steel = 226mm² (2 Ø12 mm/rib)

Mu (Top) = 53.3KN.m=27.7KN.m/rib

$$\rho = \frac{0.85f'_c}{f_y}\left(1 - \sqrt{1 - \frac{2M_u}{0.85\emptyset bd^2 f'_c}}\right)$$ -=*.013.*

Area of steel = 327.6mm² (3 Ø12 mm/rib)

3.10.3 Footing design:

Footing are the element that transmit column or wall load reaction to the soil. That load develop a uniform stress on soil, that stress should be less than the bearing capacity of the soil which equal 290 Kn/m² in this location.

Service and ultimate load from building as shown in figure:

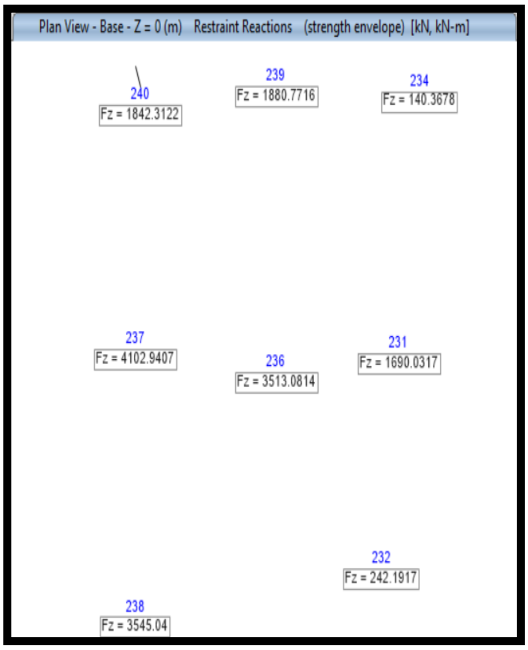


Figure 180: Service load from building

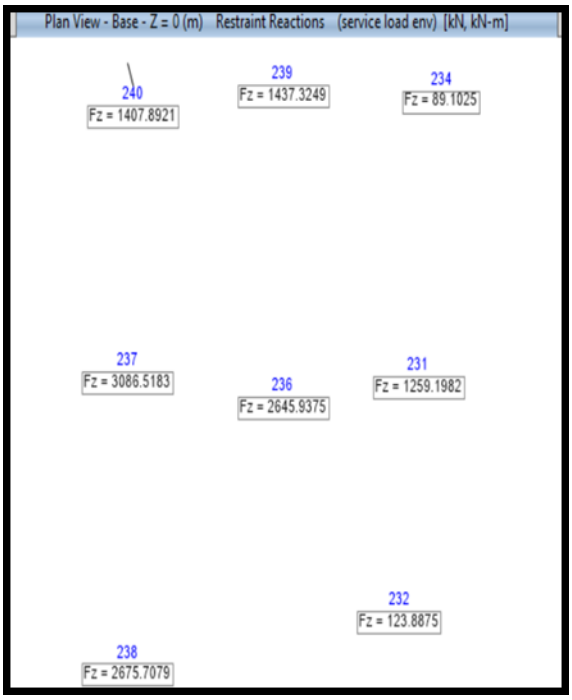


Figure 181: ultimate load on building

Sample calculation for critical column

$P_{service}$ = 3086.5 KN.

$P_{Ultimate}$ = 4102.95 KN.

$$\text{Area of footing} = \frac{Total\ service\ load\ (KN)}{Allowable\ soil\ bearing\ capacity\ (\frac{KN}{m2})}$$

$$= \frac{3086.5}{290} = 10.6\ m^2$$

Make the footing square with dimension 3.3 x 3.3 m.

ultimate pressure under footing (Q_u) = $\frac{Total\ ultimate\ load\ (KN)}{Area\ of\ the\ footing\ (m2)}$ = $\frac{4102.95}{3.3x3.3}$ = 376.76 $\left(\frac{KN}{m2}\right)$

3.10.3.1 footing thickness

$Q_u=\frac{pu}{Af}$= 376.76 KN/m^2

L = $\frac{3.3-0.5}{2} = 1.4\ m$

Vu=Q_u(L – **d**)

=376.76 * (1.4 – **d**) = 527.46 – 376.76**d**

ϕvc = Vu .

ϕvc=0.75*$\sqrt{28}$ *1000***d** /6 = 527.46 – 376.76**d**

solving equ

d= 0. 5 meter

take it 0.6 meter +blending concrete.

3.10.3.2 punching for footing

A1=(0.5+0.6)*(0.5+0.6)=2.2m^2

b_0=2*(1100)+2*(1100)=4400 mm

Vu punching =pu-A1qu=4102.95-(2.2*376.76)

= 3274 kN

Check vc where: β = 500/500 = 1 αs =40

$$\emptyset V_c \le \emptyset 0.33\lambda_s\lambda\sqrt{f'_c}b_o d$$

$$\emptyset V_c \le \emptyset 0.17\lambda_s\lambda\left(1+\frac{2}{\beta}\right)\sqrt{f'_c}b_o d$$

$$\emptyset V_c \le \emptyset 0.083\lambda_s\lambda\left(2+\frac{\alpha_s d}{b_o}\right)\sqrt{f'_c}b_o d$$

Minimum VC= 3457 KN

ϕvc > vu

thickness is OK .

3.10.3.3 Flexural reinforcement for footing

Mu=$\frac{qu*(L1)^2}{2}$ =$\frac{376.76*((1.4)^2}{2}$=369.2 kN/m

$$\rho = \frac{0.85f'_c}{f_y}\left(1-\sqrt{1-\frac{2M_u}{0.85\emptyset bd^2f'_c}}\right)$$

=0.0027 > P_{min} , where (P_{min}=$ps_{hrinkage}$=0.0018)

AS = 1620 mm^2 (8ϕ16mm / meter for both direction)

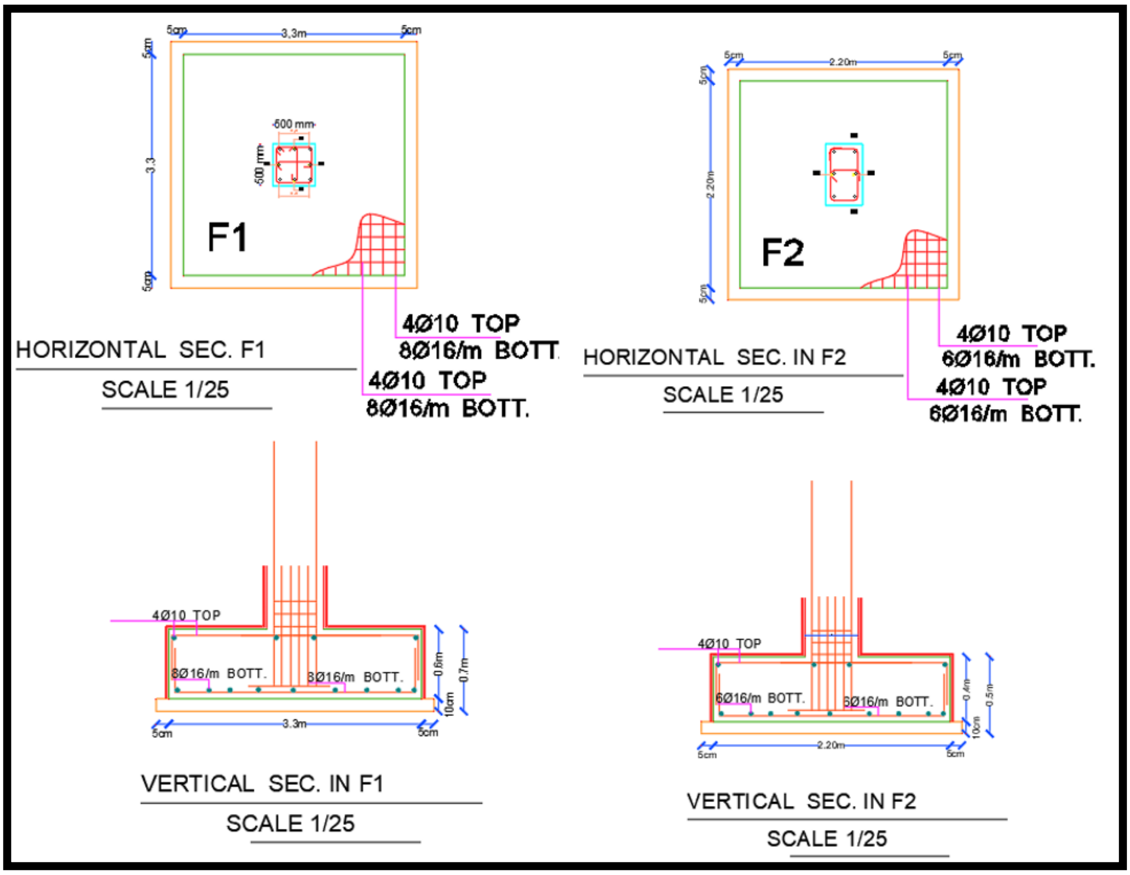


Figure 182: section of footing

3.10.3.4 wall footing

Service load on shear wall as shown in figure below:

Service Load = (734.8+533.84)

Altimate load = (1962.12 +757.33)

Length of shear wal = 4.22m

So, service load = 300.6 KN/m

altimate load = 637.3 KN/m

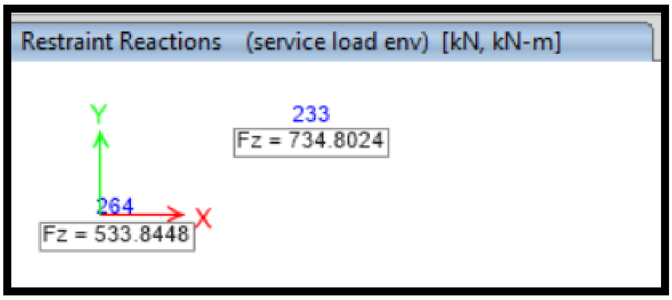


Figure 183: **service load**

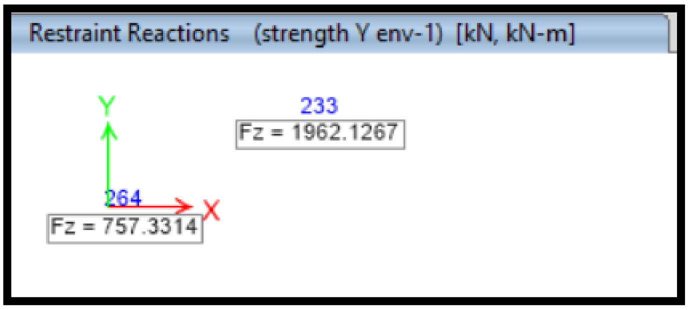


Figure 184: **Ultimate load**

width of wall footing *1meter = $\frac{Total\ service\ load\ (KN/m)}{Allowable\ soil\ bearing\ capacity\ (\frac{KN}{m2})}$

$= \frac{300.6}{290}$ = 1 m

Ultimate pressure under footing ($Q_{u)}$ = $\frac{Total\ ultimate\ load\ (KN)}{Area\ of\ the\ footing\ (m2)}$

$= \frac{637.3}{1*1} = 637.3\ \left(\frac{KN}{m2}\right).$

Vu=Qu(L – **d**)

=637.3 (0.35 – **d**) = 223 – 637.3**d**

ϕvc=0.75*$\sqrt{28}$ *1000***d** /6 = 223 – 637.3**d**

ϕvc=vu

solving equ : **d= 0.17 m**

take d = 300 mm and h = 350 mm

Flexural reinforcement for footing

Mu=$\frac{qu*(L1)^2}{2}$ =$\frac{637.3*((0.35))^2}{2}$=39.05 kN/m

$$\rho = \frac{0.85f'_c}{f_y}\left(1 - \sqrt{1 - \frac{2M_u}{0.85\emptyset bd^2 f'_c}}\right)$$ =0.0012 where (P_{min}=$\rho s_{hrinkage}$=0.0018)

AS = 630 mm^2 (6ϕ12mm / meter for both direction).

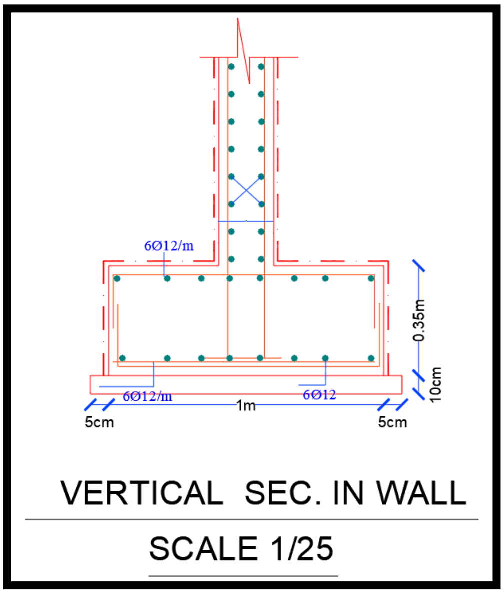


Figure 185: section of wall footing:

3.10.4 shear wall design:

Sample calculation for wall:

Moment in wall shown in figure:

Length of wall = 3.75m

Area of steel in wall shown in figure:

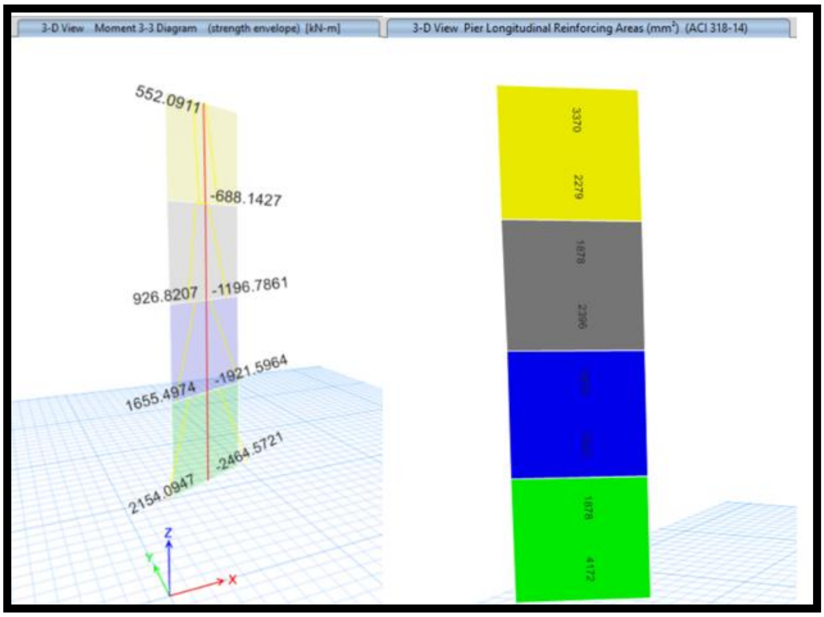


Figure 186: moment & area of steel in shear wall.

Area of steel in shear wall = 4172mm^2

So longitudinal steel for two face = 36 Φ12

So for every face 18 Φ12 ,

(3756/18 = 208mm)

So use 1 Φ 12 every 200mm for both faces.

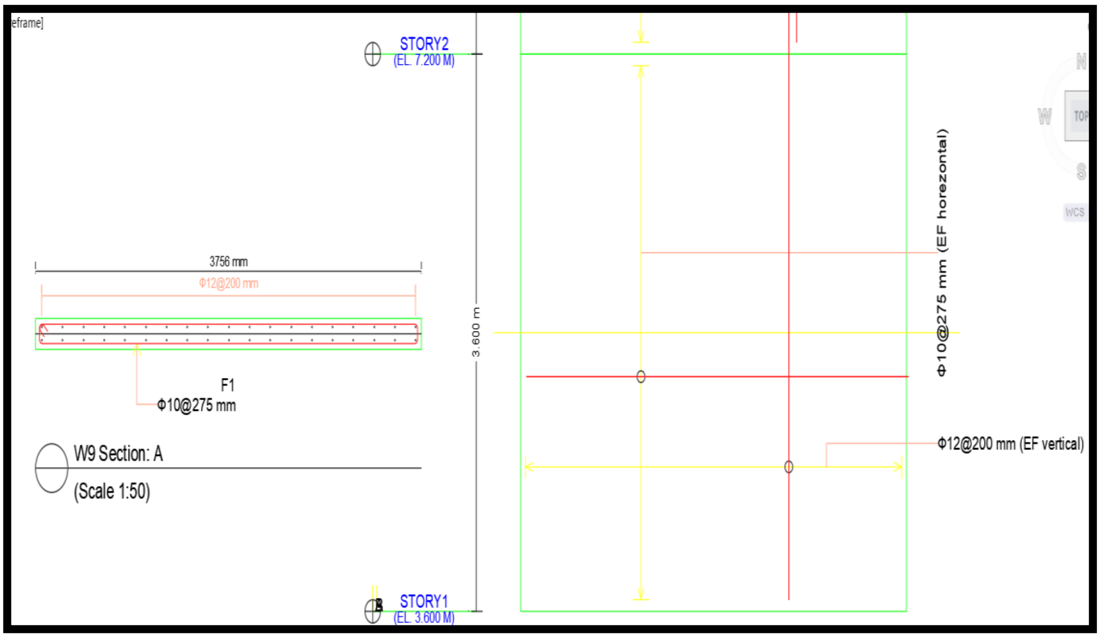


Figure 187: section in shear wall

3.10.5 Design of stairs:

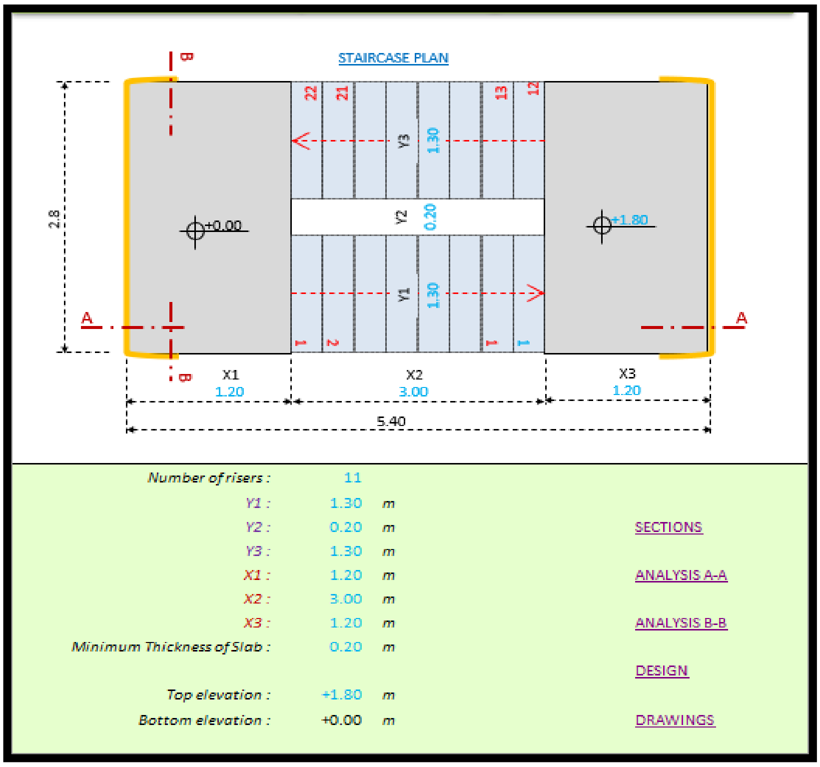


Figure 188: dimension of stairs

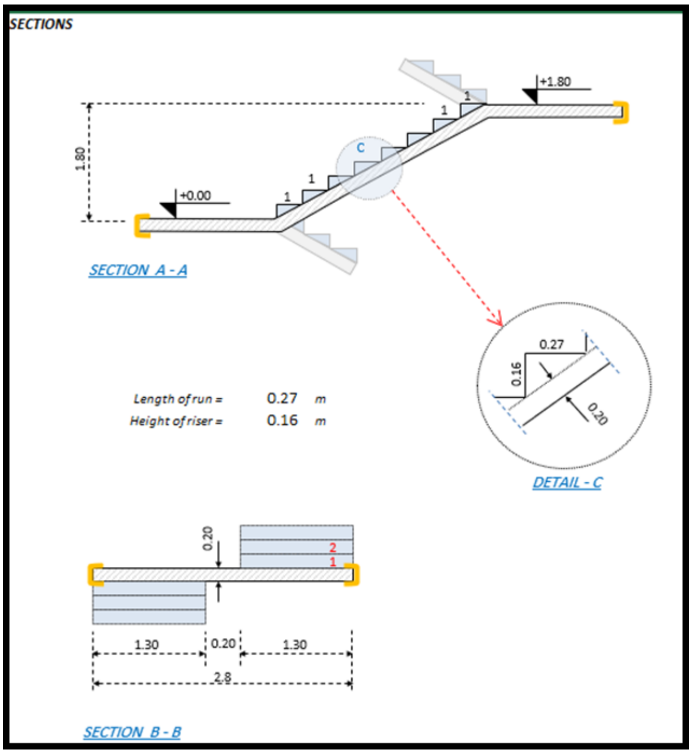


Figure 189: sections of stair

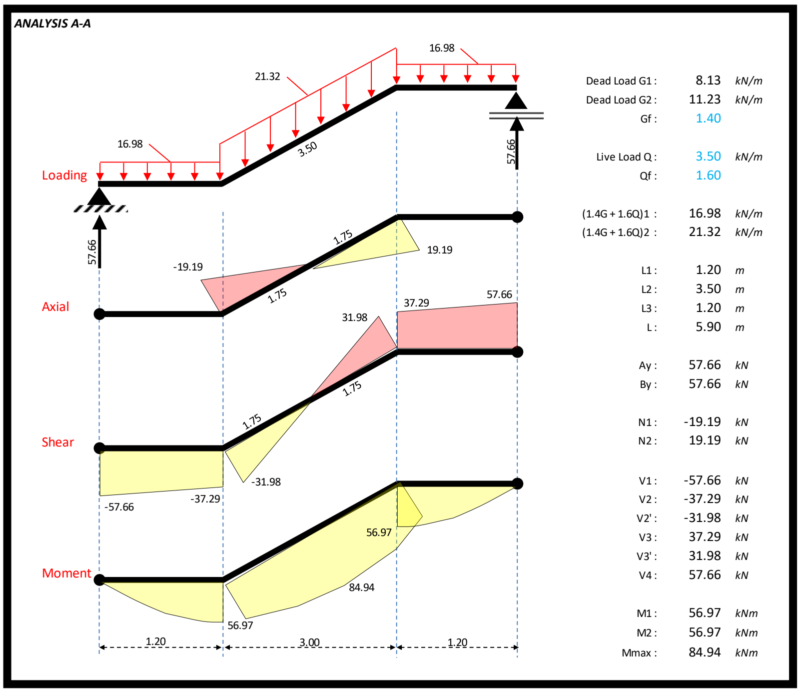


Figure 190: force in stair .

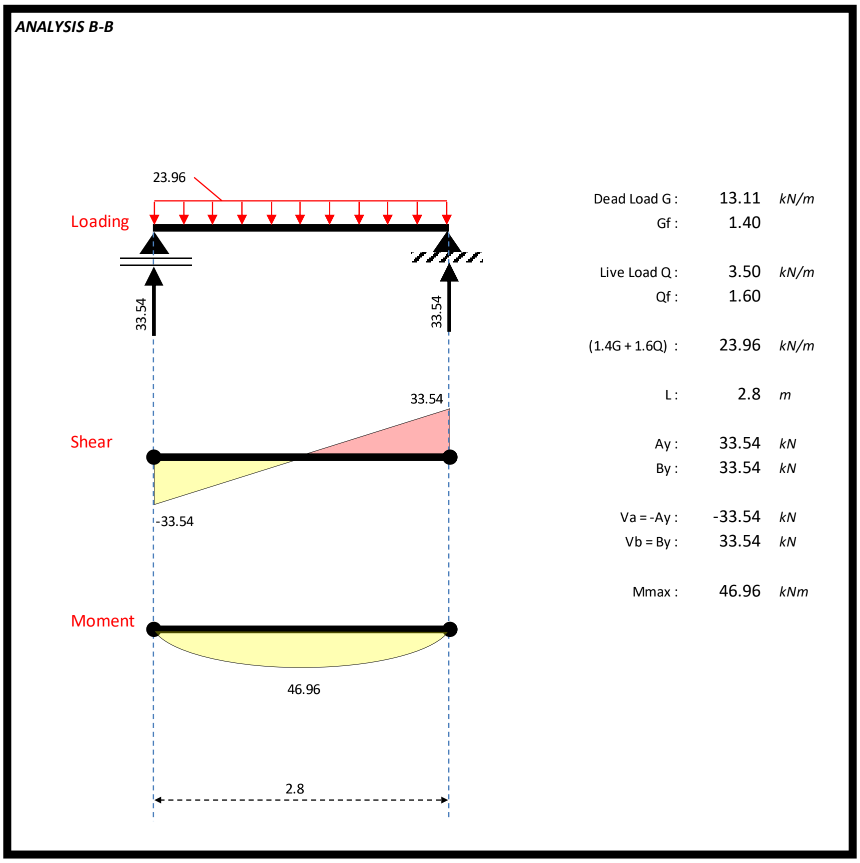


Figure 191: forces on stair landing

SECTION A - A				SECTION B - B			
f'c :	28.00	MPa		f'c :	28.00	MPa	
fy :	420.00	MPa		fy :	420.00	MPa	
cc :	25	mm		cc :	25.00	mm	
Mmax :	84.94	kNm		Mmax :	46.96	kNm	
d :	175	mm		d :	175	mm	
b :	1300	mm		b :	1200.00	mm	
K :	0.076		Ok	K :	0.046		Ok
z :	0.91		Ok	z :	0.95		Ok
calc As :	1328	mm2		calc As :	734	mm2	
Min As :	338	mm2		Min As :	312	mm2	
As :	1328	mm2		As :	734	mm2	
As.dist :	266	mm2					

Bars :

Diameter ①②③④ :	Φ16	mm	Diameter ⑥ :	Φ12	mm
Area :	201	mm2	Area :	113	mm2
Number :	6		Number :	6	
Spacing :	21	cm	Spacing :	20	cm
Length ① :	165	cm	Length ⑥ :	310	cm
Length ② :	500	cm			
Length ③ :	165	cm			
Length ④ :	150	cm			
Diameter ⑤ :	Φ10	mm			
Area :	79	mm2			
Number :	3				
Spacing :	33	cm			
Length ⑤ :	160	cm			

①	6Φ16/21 L = 165 cm.
②	6Φ16/21 L = 500 cm.
③	6Φ16/21 L = 165 cm.
④	6Φ16/21 L = 150 cm.
⑤	10Φ10/33 L = 160 cm.
⑥	6Φ12/20 L = 310 cm.

Figure 192: reinforcement of stair

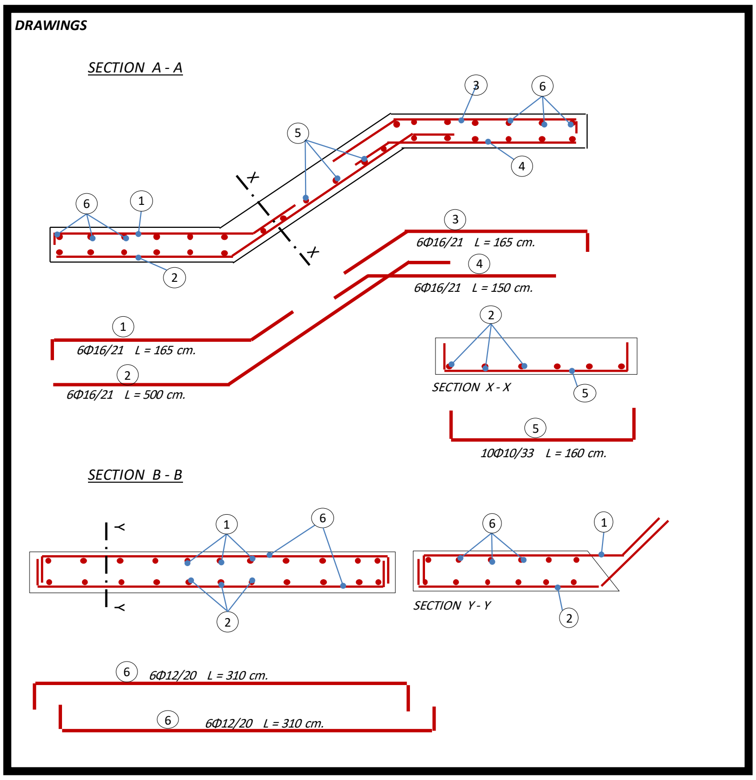


Figure 193: steel rebar of stair

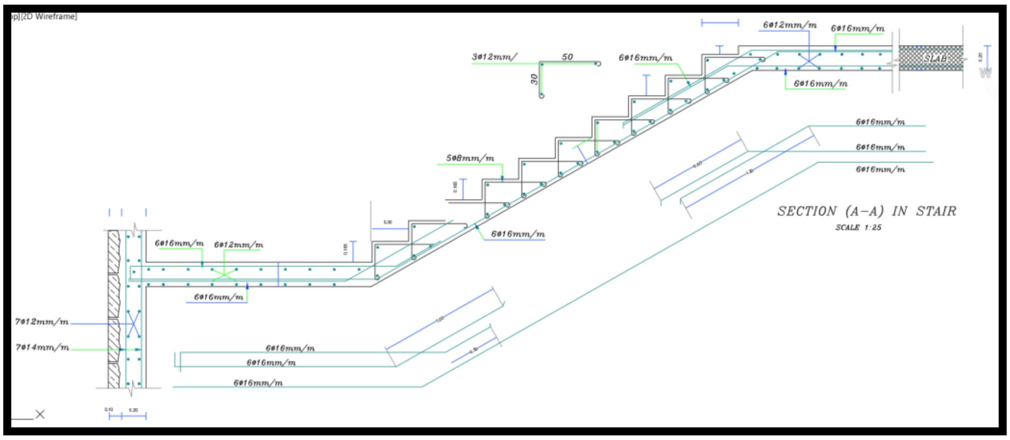


Figure 194: section on stair

Chapter four: Electro-mechanical Aspects

4.1 Artificial lighting

4.1.1Introduction

The concept of illumination describes how natural or artificial light is used to make an image clear. Lighting is indicated by light bulbs
"Artificial lighting." Where artificial light control is simple to produce
the required lighting effect in the space. The type of artificial light source is determined by the type of space (office, living room, bathroom, etc.), the quality and shape of the lighting necessary for space, appropriate power consumption of light.

In this project, the industrial lighting was designed for the building consisting of five floors, taking into account the natural lighting entering the building, knowing that the operation of the building is during the day from eight in the morning until four in the evening. And the spaces that were designed by the DIALUX program

Table 34: spaces that were designed by the DIALUX

Meeting room
Class room
Office room
Bathroom
Parking

The table below shows the standard of the spaces in the building

Table 35: standard of the spaces in the building (DIALUX EVO)

Space	Lux	Uniformity	Glare
Reception	300	0.6	19
Waiting room	300	0.6	19
Classroom	300	0.6	19
Office room	500	0.6	19
Storage	150	0.4	22
Staff room	500	0.6	19
Bathroom	200	0.4	25
Meeting room	500	0.6	19
Library	500	0.6	19
Parking	100	0.4	0

The table below show the type of luminaire chosen in the design:

Table 36: Type of luminaire chosen in the design:

Manufacture	Article name	Luminous flux(lm)	CCT (k)	Efficacy (lm/w)	Light loss factor	Connected load(w)
ASTZ	Rastr HF	4800	3850	54.8	0.80	62
3F Filippi	3F HD100	2880	4000	99.3	0.80	29
SCHMTIZ	Tentec recessed	3200	4000	43.2	0.80	44
Delta light	DIM5	3200	4000	46.7	0.60	44

Spaces with lighting from AUTOCAD& DIALUX:

1- class room

The figure below shows the distribution of luminaires in class room.

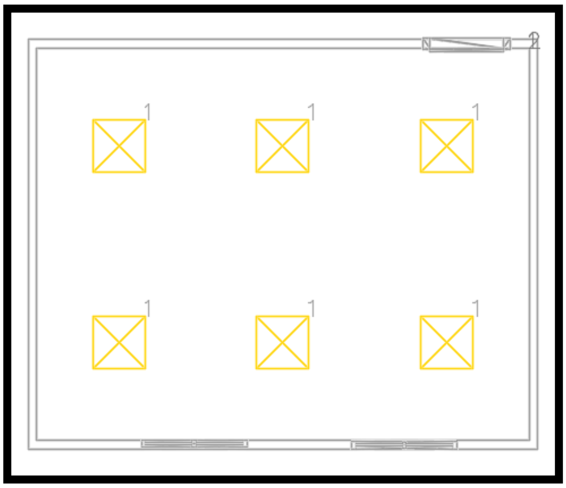


Figure 195:the distribution of luminaries in class room

The figure below shows the type of luminaire chosen to the class room.

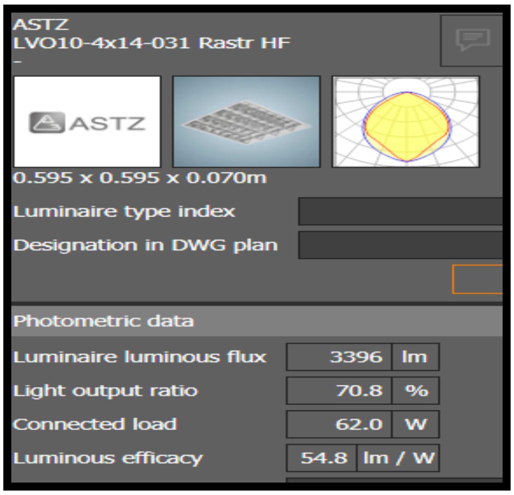


Figure 196: the type of luminaire chosen to the class room

- Results

The average illuminance in the classroom is 575 lux and the limit is 300 lux, the glare is13.5 and the limit is 19.

The figure below shows the result for classroom from DAILUX.

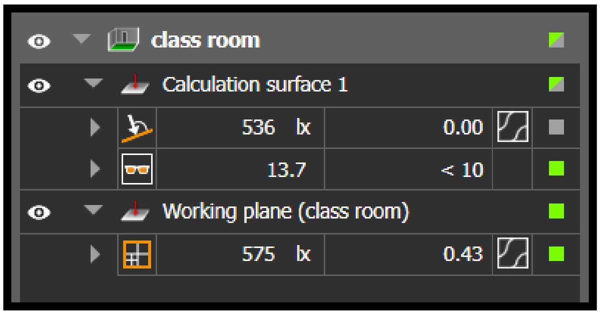


Figure 197: the result for classroom from DIALUX

2- office room

The figure below shows the distribution of luminaires in office.

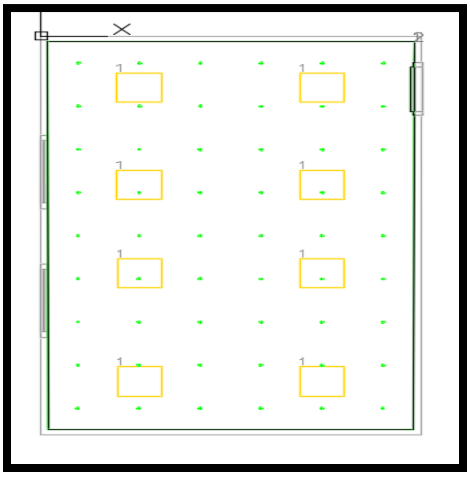


Figure 198: the distribution of luminaires in office

The figure below shows the type of luminaire chosen to the office room.

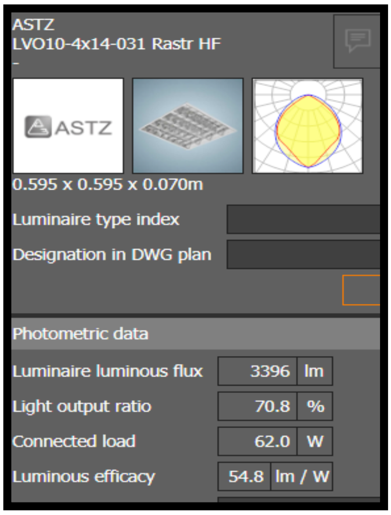


Figure 199: the type of luminaire chosen to the office room

- Results

The average illuminance in the office room is 510 lux and the limit is 500 lux, the glare is18 and the limit is 19.

The figure below shows the result for office from DAILUX.

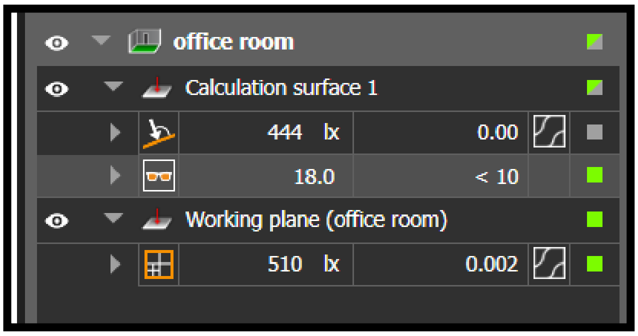


Figure 200: the result for office from DIALUX

3- bathroom

The figure below shows the distribution of luminaires in bathroom.

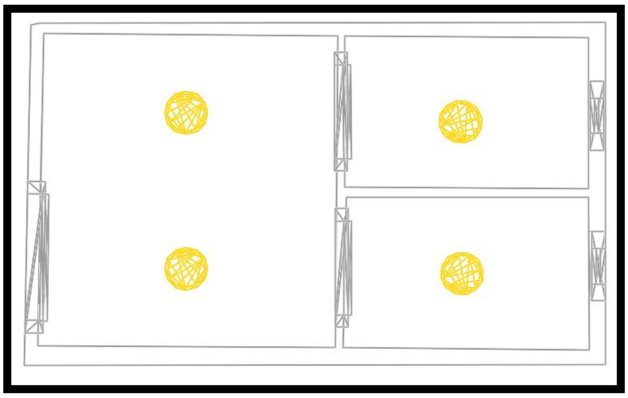


Figure 201: the distribution of luminaires in bathroom.

The figure below shows the type of luminaire chosen to the bathroom.

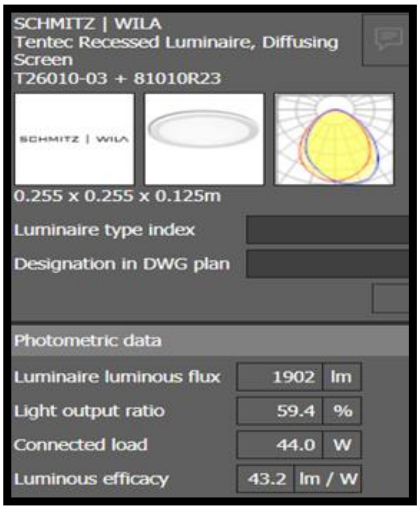


Figure 202: type of luminaire chosen to the bathroom.

- Results

The average illuminance in the bathroom is 294 lux and the limit is 200 lux.

The figure below shows the result for the bathroom from DAILUX

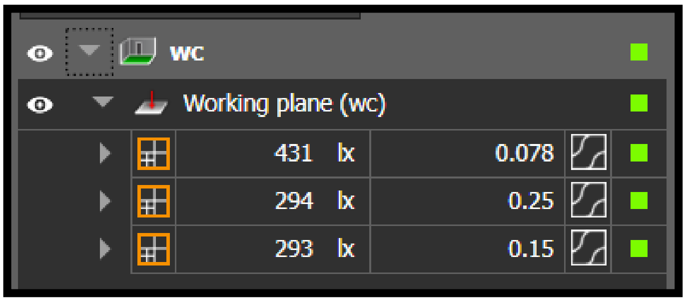


Figure 203: the result for the bathroom from DAILUX

4-parking

The figure below shows the distribution of luminaires in Parking

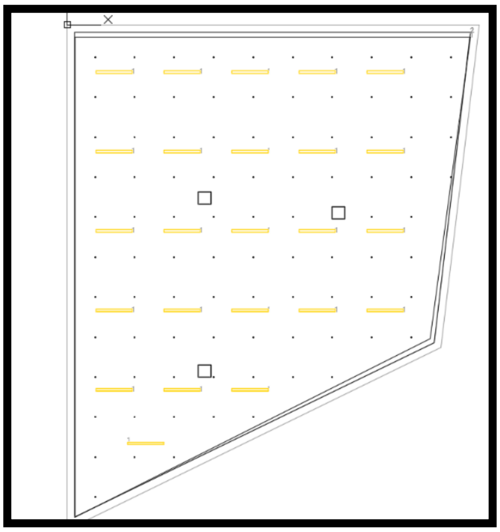


Figure 204: distribution of luminaires in Parking

The figure below shows the type of luminaire chosen to the parking.

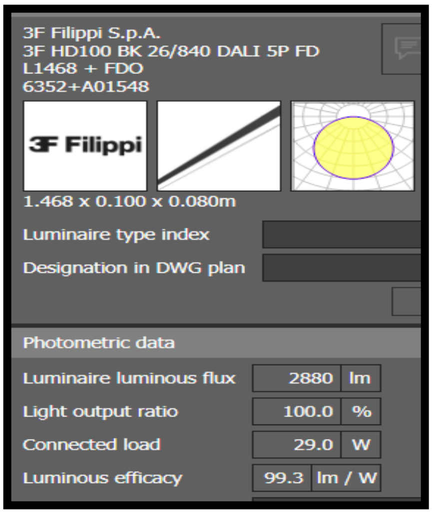


Figure 205: type of luminaire chosen to the parking

- Results

The average illuminance in the parking is 170 lux and the limit is 100 lux. The figure below shows the result for the parking from DAILUX.

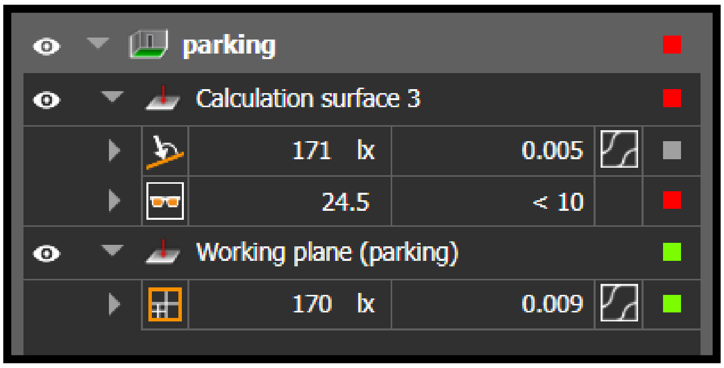


Figure 206: the result for the parking from DAILUX

The figures below show 3D views for building spaces from DIALUX program.

-parking

Figure 207:3D view for parking from DAILUX.

- Office room

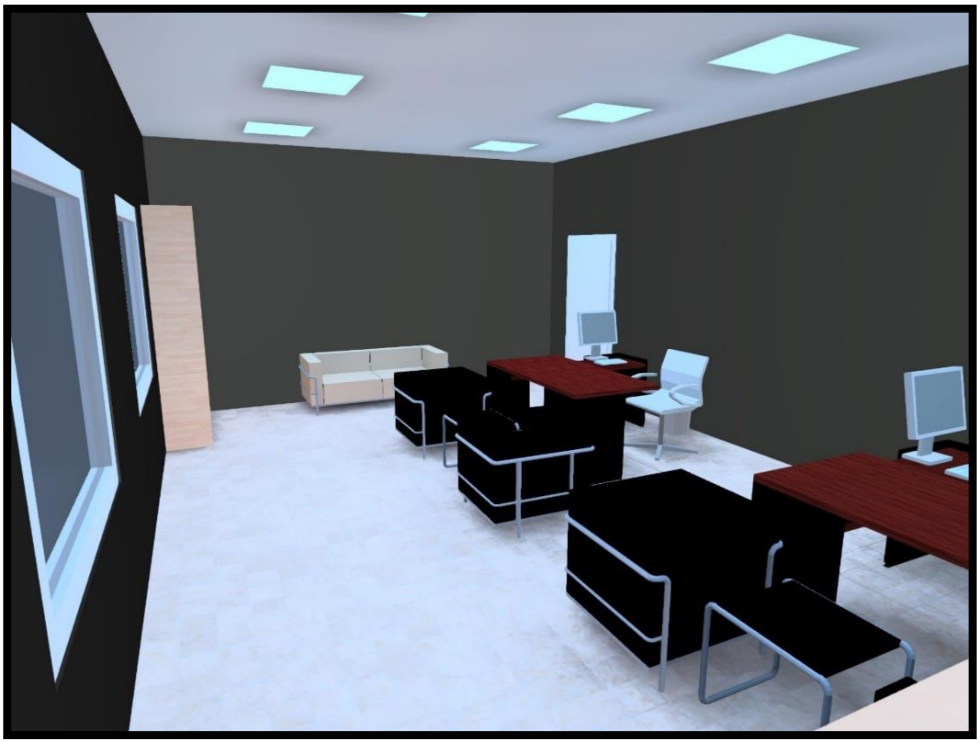


Figure 208: 3D view for office room from DAILUX.

-classroom

Figure 209: 3D view for classroom from DAILUX.

-Bathroom

Figure 210: 3D view for bathroom from DAILUX.

Figure 211: 3D view for bathroom from DAILUX

4.2HVAC System Design

The main goal of HVAC system is to provide comfort, acceptable indoor air quality, and thermal control within the room, these systems bring fresh air from outside to maintain a high level of indoor air quality by removing odors, dust, heat, there are a variety of HVAC system that can be used to achieve good functionality.

The following information is required to design HVAC system using Design Builder software:

1. Inside design temperature = 23˚C in Summer and 22˚C in Winter
2. Relative humidity between (30-60) %

The Result from **(**Design builder) simulation for heating and cooling as follow:

- Total design heating load = 202.08KW
- Total design cooling load= 274.54KW

Daikin company was selected for design.

Floor spaces: Ground floor:

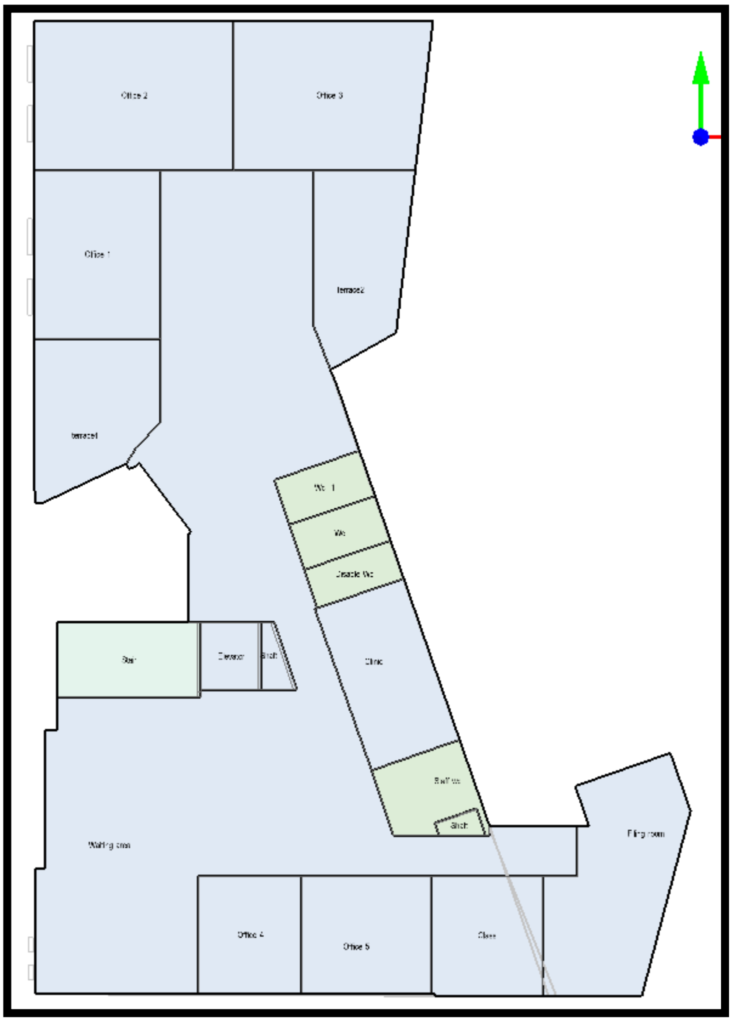


Figure 212: **Ground floor spaces**

Floors design data:

The table below show the design data for ground floor

Table 37: Ground floor design data.

Zone	Design Capacity (kW)	Design Flow Rate (m3/s)
Office2	2.54	0.2067
Office3	2.81	0.2307
Office1	1.89	0.1537
Waiting Area	11.91	0.9692
Terrace2	1.45	0.1183
Terrace1	1.45	0.1181
Filing Room	2.31	0.1879
Clinic	1.79	0.1472
Office4	1	0.0817
Office5	1.25	0.102
Class	1.09	0.0884

The table below show the design data for first floor

Table 38: First floor design data

Zone	Design Capacity (kW)	Design Flow Rate (m3/s)
Elev. lobby	8.83	0.7182
Clinic	1.81	0.1489
Office2	2.15	0.1749
Class	2.69	0.221
Terrace2	1.07	0.0874
ClassQ1	1.56	0.1272
ClassQ2	1.33	0.1078
Staff Room	2.01	0.1635
ClassQ3	1.38	0.1124
Terrace	5.31	0.4323

The table below show the design data for second floor

Table 39: Second floor design data.

Zone	Design Capacity (kW)	Design Flow Rate (m3/s)
Elev. lobby	9.86	0.8022
Clinic	1.88	0.1547
Class	1.44	0.1174
ClassQ1	1.85	0.1508
JANX	0.2	0.0163
ClassQ2	2.58	0.2098
Kitchen for Children	0.51	0.0417
ClassQ3	3.08	0.2505
ClassQ4	1.77	0.1436
Terrace	5.62	0.4577

The table below show the design data for third floor

Table 40: Third floor design data.

Zone	Design Capacity (kW)	Design Flow Rate (m3/s)
Elev. lobby	16.04	1.3052
Clinic	2.16	0.1777
Training Room	2.93	0.2382
Staff	4.22	0.3431
Manager Office	3.19	0.2624
Secretary Office	2.86	0.2352
Meeting Office	3.34	0.2721

Summary:

Table 41: Summary of floors cooling load.

Ground floor	29.49
Firs floor	28.14
Second floor	28.79
Third floor	34.74
Total	121.16

The total cooling load = 121.16 Kw = 34 Tons.

System used: VRV with cassette units.

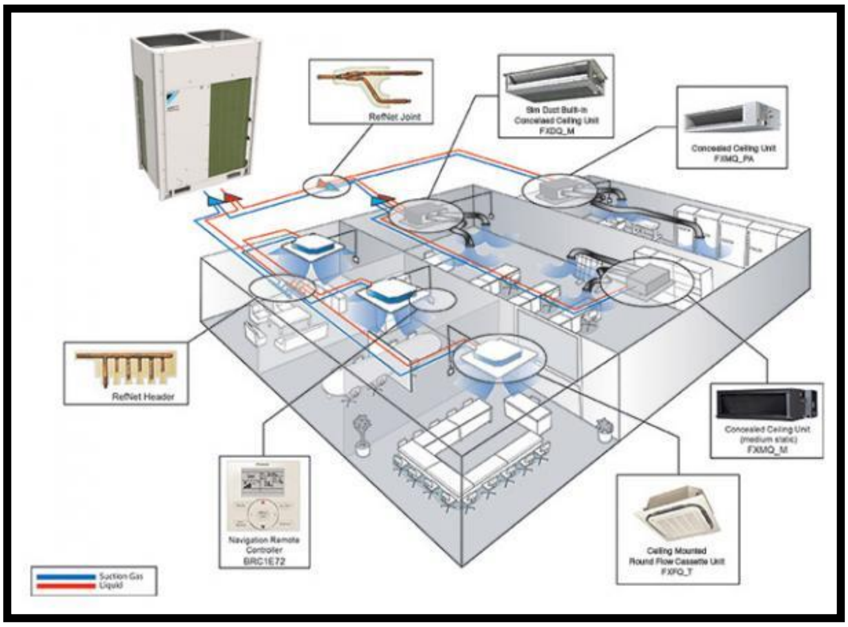


Figure 213: **VRV system concept.**

- Outdoor units:

PRODUCT NAME	CAPACITY (TONS)																				
	3	4	6	7	8	10	12	14	16	18	20	21	22	24	26	28	30	32	34	36	38
REYQ-T *VRV IV*			●		●	●	●	●													

Figure 214: Outdoor unit used. (DAIKIN, 2018)

The outdoor unit capacity = 10 tons ---->Number of units needed = 4 units.

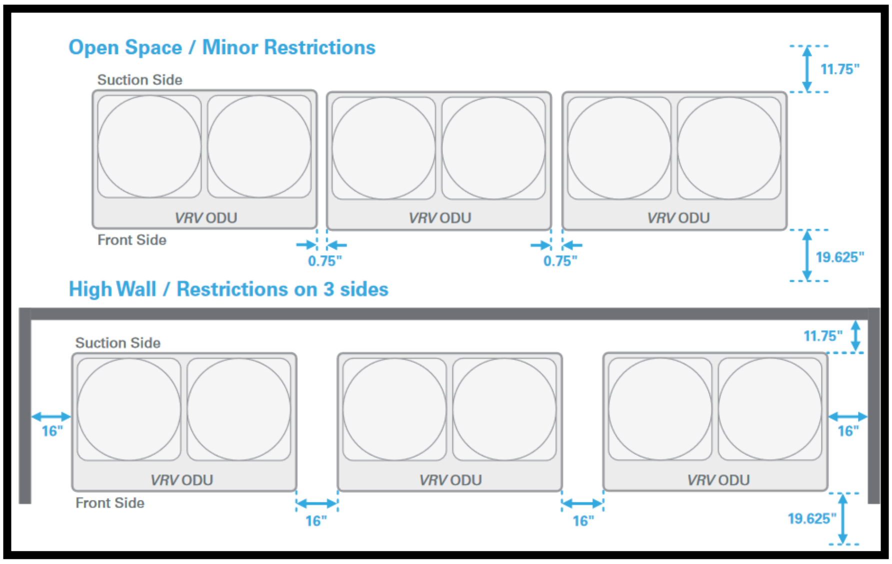


Figure 215: Outdoor units distribution restrictions. (Daikin, 2018)

- Cassette unit:

Figure 216: Cassette unit selected. (DAIKIN, 2018)

Table 42: Cassette unit selected specifications. (DAIKIN, 2018)

VRV Fully integrated solutions for medium to large commercial environments

Indoor unit			FXZQ	15A	20A
Cooling capacity	Nom.		kW	1.7	2.2
Heating capacity	Nom.		kW	1.9	2.5
Power input - 50Hz	Cooling	Nom.	kW		0.043
	Heating	Nom.	kW		0.036
Dimensions	Unit	Height	mm		
		Width	mm		

The selected cassette unit has cooling capacity of 1.7 kw and heating capacity of 1.9kw

Number of cassette unit = Space cooling load (Kw)/Cassette unit capacity from catalogue

- Fresh air

Because there exists sufficient number of windows in all spaces, fresh air or ventilation will be through windows.

Table 43: Design results for each space.

Floor	Zone	Design Capacity (kW)	Cassette unit capacity	Number of cassette unit
0, G. F	Office2	2.54	1.7	2
0, G. F	Office3	2.81	1.7	2
0, G. F	Office1	1.89	1.7	2
0, G. F	Waiting Area	11.91	1.7	8
0, G. F	Terrace2	1.45	1.7	1
0, G. F	Terrace1	1.45	1.7	1
0, G. F	Filing Room	2.31	1.7	2
0, G. F	Clinic	1.79	1.7	2
0, G. F	Office4	1	1.7	1
0, G. F	Office5	1.25	1.7	1
0, G. F	Class	1.09	1.7	1
1, First floor	Elev. lobby	8.83	1.7	6
1, First floor	Clinic	1.81	1.7	2
1, First floor	Office2	2.15	1.7	2
1, First floor	Class	2.69	1.7	2
1, First floor	Terrace2	1.07	1.7	1
1, First floor	ClassQ1	1.56	1.7	1
1, First floor	ClassQ2	1.33	1.7	1
1, First floor	Staff Room	2.01	1.7	2
1, First floor	ClassQ3	1.38	1.7	1
1, First floor	Terrace	5.31	1.7	4
2, Second floor	Elev. lobby	9.86	1.7	6
2, Second floor	Clinic	1.88	1.7	2
2, Second floor	Class	1.44	1.7	1
2, Second floor	ClassQ1	1.85	1.7	2
2, Second floor	JANX	0.2	1.7	1
2, Second floor	ClassQ2	2.58	1.7	2
2, Second floor	Kitchen for Children	0.51	1.7	1
2, Second floor	ClassQ3	3.08	1.7	2
2, Second floor	ClassQ4	1.77	1.7	2
2, Second floor	Terrace	5.62	1.7	4
3, Third floor	Elev. lobby	16.04	1.7	10
3, Third floor	Clinic	2.16	1.7	2
3, Third floor	Training Room	2.93	1.7	2
3, Third floor	Staff	4.22	1.7	3
3, Third floor	Manager Office	3.19	1.7	2
3, Third floor	Secretary Office	2.86	1.7	2
3, Third floor	Meeting Office	3.34	1.7	2

Drawings:

- Ground floor:

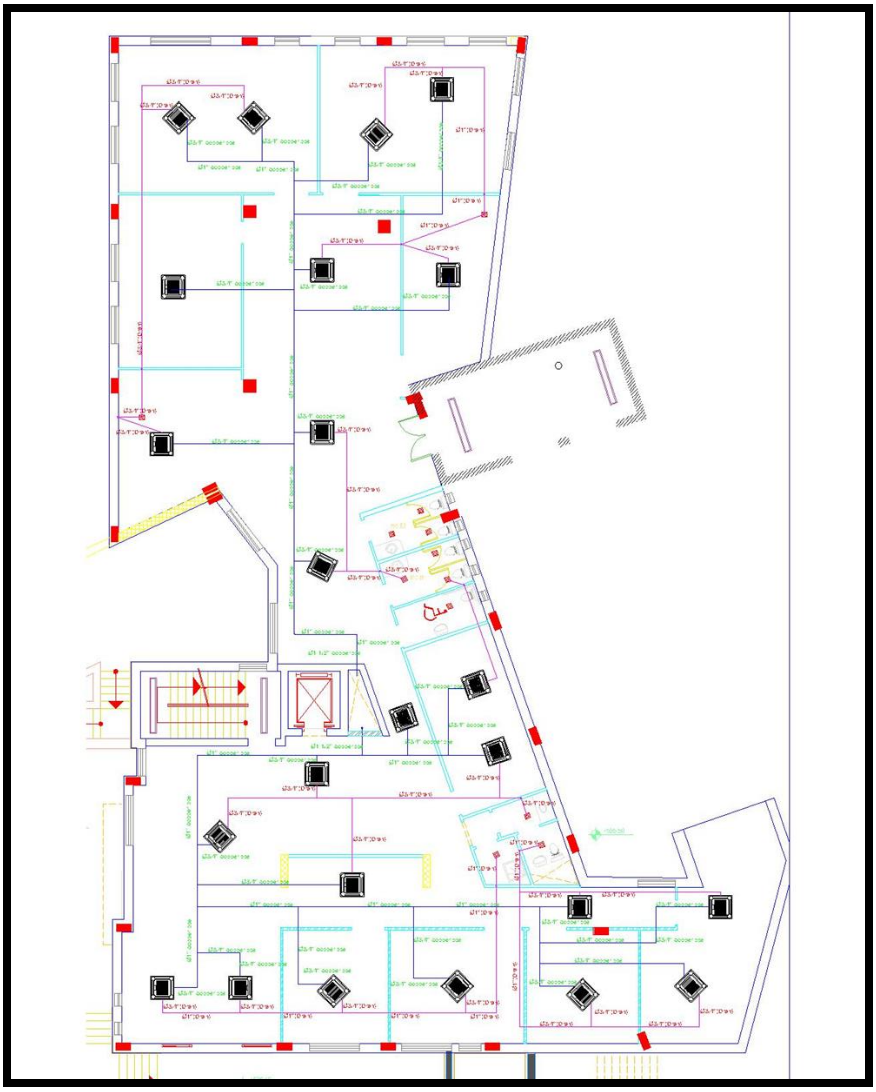


Figure 217: Ground floor HVAC system.

The materials used to connection in the system as shown:

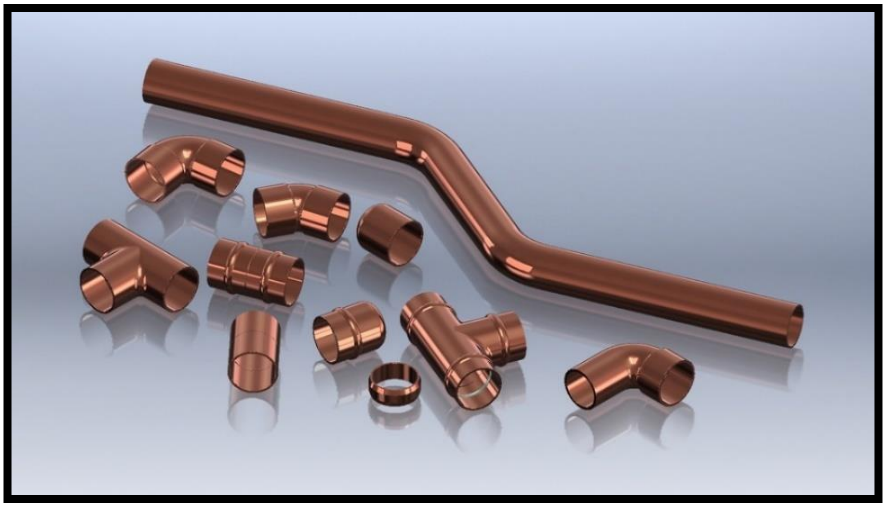


Figure 218: Copper pipes fittings.

Figure 219: Drain pipes fittings.

4.3Power design

In the electrical loads, we have separated the distributed board for each floor as we put two distribution boards in each floor and after that we collect them in one main distribution board to distribute the loads directed to it and to ensure the safety factor and the absence of pressure on it.

Procedure

Distribution board:

The power for the lights and sockets for each Distribution board:

- ❖ Parking Floor:

  DB1-P

- **Lighting**

Table 44:The power and number of lamp in parking

Power(w)	#of lamps
1*22	23
1*26	24
1*40	2

P light (1*22) = 1*22*23 = 506 W

P light (1*26) = 1*26*24 =624 W

P light (1*40) = 1*40*2 = 80 W

Demand factor for light = 0.8

Total power for light= power of light * demand factor

Total power for light= (1210)* (0.8) = 968W

- **Socket**

#of socket = 6

Demand factor for socket = 0.7

Power socket = 6 *250*0.7 = 1050W

✓ Total power = power light + power socket = 968 + 1050 = 2018W

Power factor = 0.92 lag for residential

I rated = 2018 / (230* 0.92) = 9.53 A

I c.b > 1.25 * 9.53A

I c.b > 11.92

So Ic.b = 3*20A

Cable = 3*4mm^2

- Ground floor:

DB2-GF1

Table 45: The power and number of lamp for DB2 in ground floor.

Power(w)	#of lamps
1*29	6
4*14	31
1*22	14
1*40	2

- **Lighting**

P light (1*29) = 1*29*6 = 174W

P light (4*14) = 4*14*31 =1736 W

P light (1*22) = 1*22*14 =308 W

P light (1*40) = 1*40*2 =80 W

Demand factor for light = 0.8

Total power for light= power of light * demand factor

Total power for light= (2300) * (0.8) = 1840W

- **Socket**

#of socket = 20

Demand factor for socket = 0.7

Power socket = 20 *250*0.7 = 3500W

- ✓ Total power = power light + power socket = 1840 + 3500 = 5340 W

Power factor = 0.92 lag for residential

I rated = 5340/ (230* 0.92) = 25.23 A

I c.b > 1.25 * 25.23A

I c.b > 31.54

So Ic.b = 3*20A

Cable = 3*6mm^2

DB3-GF1

Table 46: The power and number of lamp for DB3 in ground floor.

Power(w)	#of lamps
1*29	6
4*14	44
1*36	14
1*40	2
1*10	12

P light (1*29) =   1*29*6 = 174W

P light (4*14) =   4*14*44 =2464W

P light (1*36) = 1*36*14 =504W

P light (1*40) = 1*40*14 =560W

P light (1*10) = 1*10*14 =140W

Demand factor for light = 0.8

Total power for light= power of light * demand factor

Total power for light= (3842) * (0.8) = 3073W

#of socket = 31

Demand factor for socket = 0.7

Power socket = 31 *250*0.7 = 5425W

- ✓ Total power = power light + power socket = 3073 + 5425 = 8498 W

Power factor = 0.92 lag for residential

I rated = 8498/ (230* 0.92) = 40.1 A

I c.b > 1.25 * 40.1 A

I c.b > 50.2A

So Ic.b = 3*63A

Cable = 3*16mm^2

- ❖ First floor:

DB4-F1

- **Lighting**

Table 47: The power and number of lamp for DB4 in first floor.

Power(w)	#of lamps
1*29	4
4*14	28
1*22	9
1*40	2

P light (1*29) =   1*29*4 = 174W

P light (4*14) =   4*14*28 =2464W

P light (1*22) =   1*22*9 = 198W

P light (1*40) = 1*40*2 =80W

Demand factor for light = 0.8

Total power for light= power of light * demand factor

Total power for light= (2742) * (0.8) = 2193W

- **Socket**

#of socket = 24

Demand factor for socket = 0.7

Power socket = 24 *250*0.7 = 4200W

✓ Total power = power light + power socket = 2193 + 4200 = 6393 W

Power factor = 0.92 lag for residential

I rated = 6393/ (230* 0.92) = 30.21 A

I c.b > 1.25 * 30.21A

I c.b > 37.7A

So Ic.b = 3*40A

Cable = 3*10mm^2

DB5-F1

Table 48: The power and number of lamp for DB5 in first floor.

Power(w)	#of lamps
1*29	13
4*14	33
1*36	16
1*45	1
1*40	2

P light (1*29) = 1*29*13 = 377W

P light (4*14) = 4*14*33 =1848W

P light (1*36) = 1*36*16 =576W

P light (1*45) = 1*45*1 =45W

P light (1*40) = 1*40*2 =80W

Demand factor for light = 0.8

Total power for light= power of light * demand factor

Total power for light= (2926) * (0.8) = 2340W

The figure below shows the distribution of lighting in first floor:

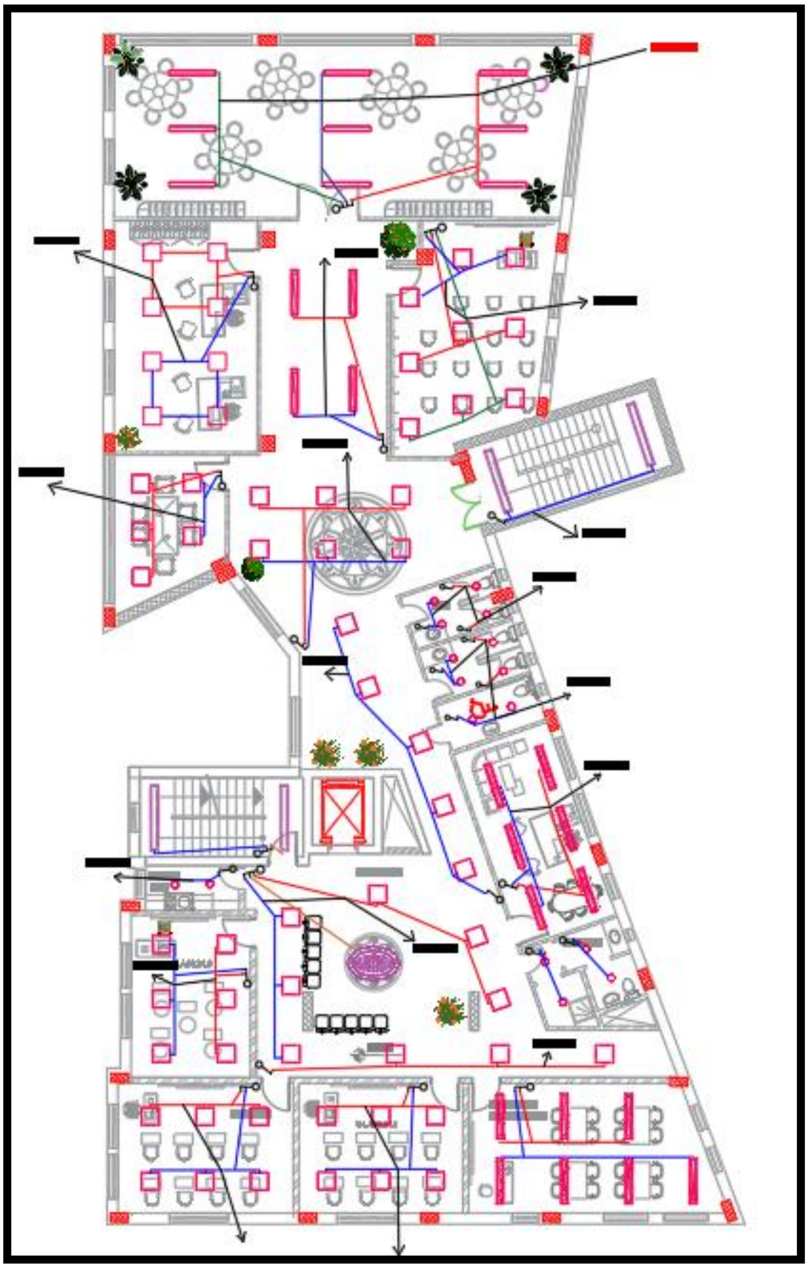


Figure 220: The distribution of lighting in first floor

#of socket = 28

Demand factor for socket = 0.7

Power socket = 28 *250*0.7 = 4900W

- ✓ Total power = power light + power socket = 2340 + 4900 = 7240 W
- ✓ Power factor = 0.92 lag for residential

I rated = 7240/ (230* 0.92) = 34.21 A

I c.b > 1.25 * 34.21 A

I c.b > 42.76A

So Ic.b = 3*63A

Cable = 3*16mm^2

The figure below shows the distribution of socket in first floor:

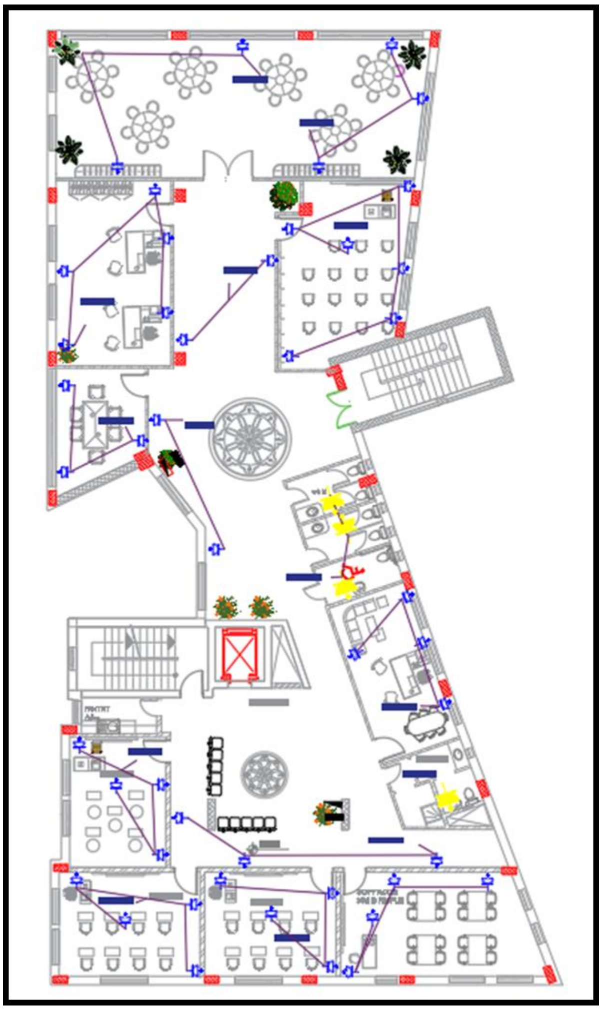


Figure 221: the distribution of socket in first floor

The figure below shows the distribution board in first floor:

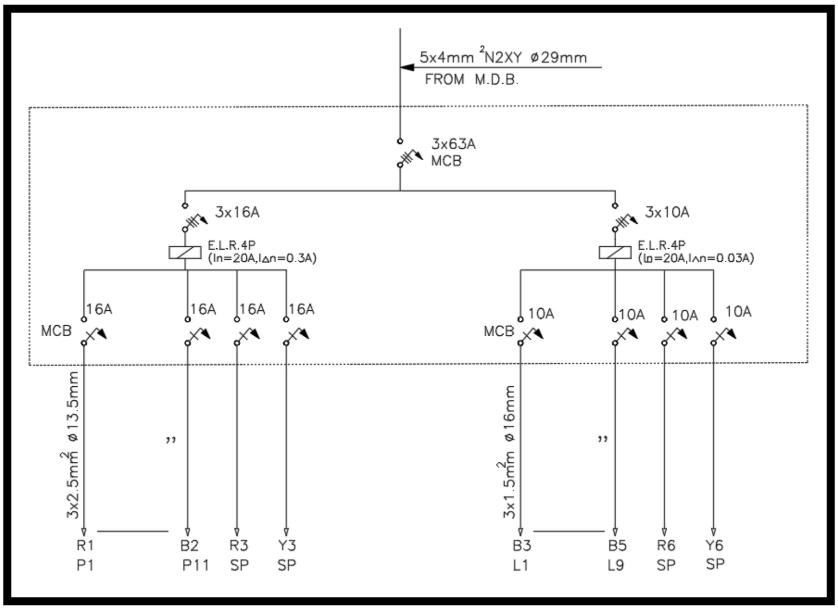


Figure 222: The distribution board in first floor

- ❖ Second floor:

DB6-F2

- **Lighting**

Table 49: The power and number of lamp for DB6 in second floor

Power(w)	#of lamps
1*29	9
4*14	10
2*36	7
1*22	9
1*40	2

P light (1*29) = 1*29*9 = 2661W

P light (4*14) = 4*14*10 =560W

P light (2*36) = 2*36*7 =504W

P light (1*22) = 1*22*9 = 198W

P light (1*40) = 1*40*2 =80W

Demand factor for light = 0.8

Total power for light= power of light * demand factor

Total power for light= (4003) * (0.8) = 3202W

- **Socket**

#of socket = 18

Demand factor for socket = 0.7

Power socket = 18 *250*0.7 = 3150W

- ✓ Total power = power light + power socket = 3202
- ✓ + 3150= 6352 W

Power factor = 0.92 lag for residential

I rated = 6352/ (230* 0.92) = 30.01 A

I c.b > 1.25 * 30.01 A

I c.b > 37.52

So Ic.b = 3*40A

Cable = 3*10mm^2

DB7-F2

Table 50: The power and number of lamp for DB7 in second floor

Power(w)	#of lamps
4*14	43
1*36	16
1*45	1
1*40	2

P light (4*14) = 4*14*43 =2408W

P light (1*36) = 1*36*16 = 576W

P light (1*45) = 1*45*1 = 45W

P light (1*40) = 1*40*2 =80W

Demand factor for light = 0.8

Total power for light= power of light * demand factor

Total power for light= (3109) * (0.8) = 2487W

#of socket = 26

Demand factor for socket = 0.7

Power socket = 26 *250*0.7 = 4550W

- ✓ Total power = power light + power socket = 2487
- ✓ + 4550= 7037 W

Power factor = 0.92 lag for residential

I rated = 7037/ (230* 0.92) = 33.25 A

I c.b > 1.25 * 33.25 A

I c.b > 41.57A

So Ic.b = 3*63A

Cable = 3*16mm^2

❖ Third floor:

DB8-F3

- **Lighting**

Table 51: The power and number of lamp for DB8 in third floor

Power(w)	#of lamps
4*14	32
2*36	12
1*45	1
1*22	5
1*40	2

P light (4*14) = 4*14*32 =1792W

P light (2*36) = 2*36*12 =864W

P light (1*45) = 1*45*1 = 45W

P light (1*22) = 1*22*5 = 110W

P light (1*40) = 1*40*2 =80W

Demand factor for light = 0.8

Total power for light= power of light * demand factor

Total power for light= (2891) * (0.8) = 2312W

- **Socket**

#of socket = 19

Demand factor for socket = 0.7

Power socket = 19 *250*0.7 = 3325W

✓ Total power = power light + power socket = 3325 + 2312= 5637 W

Power factor = 0.92 lag for residential

I rated = 5637/ (230* 0.92) = 26.63 A

I c.b > 1.25 * 26.63A

I c.b > 33.29A

So Ic.b = 3*40A

Cable = 3*10mm^2

DB9-F3

Table 52: The power and number of lamp for DB9 in third floor

Power(w)	#of lamps
1*29	15
4*14	24
1*36	16
1*45	1

P light (1*29) = 1*29*15 = 435W

P light (4*14) = 4*14*24 =1344W

P light (1*36) = 1*36*16 = 576W

P light (1*45) = 1*45*1 = 45W

Demand factor for light = 0.8

Total power for light= power of light * demand factor

Total power for light= (2400) * (0.8) = 1920W

#of socket = 26

Power socket = 26 *250*0.7 = 4550W

- ✓ Total power = power light + power socket = 1920 + 4550= 6470W

Power factor = 0.92 lag for residential

I rated = 6470/ (230* 0.92) = 30.57 A

I c.b > 1.25 * 30.57 A

I c.b > 38.22A

So Ic.b = 3*40A

Cable = 3*10mm^2

Main distribution board - :

Total power = total power DB1+ total power DB2+ total power DB3+ total power DB4+ total power DB5+

total power DB6+ total power DB7+ total power DB8+ total power DB9

Total power = 2018+5340+8495+6393+7240+6352+7037+5637+6470 +6700+121160=182842W …. Note (3phase system).

I rated = 182842/ (3^0.5 *400* 0.92) = 286.85 A

I c.b > 1.25 * 286.85 A

I c.b > 358.57 A

So Ic.b = 3*400A

Cable = 5*240mm^2

The power of elevator is = 6700 watt

I rated = 6700 / (3^0.5 *400 * 0.85) = 11.377A

I c.b > 1.25 * 11.377 A

I c.b >14.22A

Then **I**c.b = 3*15A

I Cable = 5*2.5mm^2

Chiller:

121.16kw

Now we will calculate the power of chiller:

I rated =121160/ (3^0.5 *400 *0.85) =205.74 A

I c.b > 1.25 *205.74 A

I c.b > 257.1755 A

Then Icb = 300A

Cable = 5*150 mm^2

The figure below shows the main distribution board:

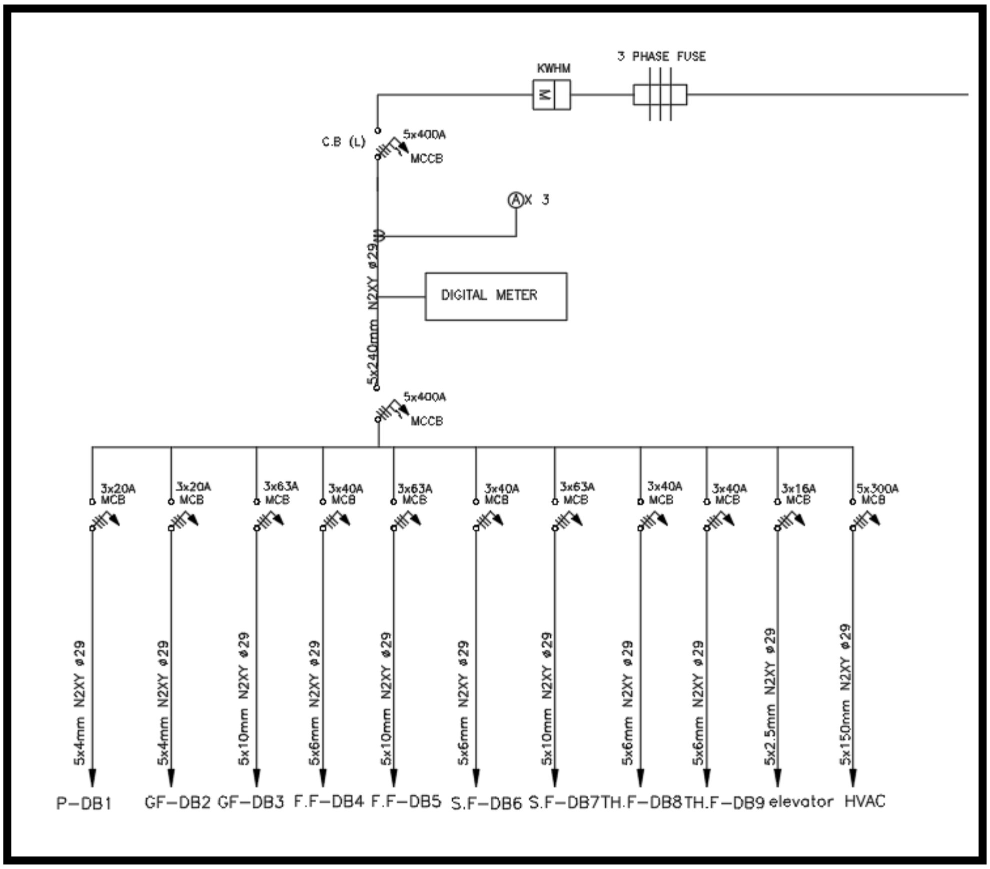


Figure 223: The main distribution board

4.4Acoustical design:

4.4.1Introduction:

In order to provide a comfortable environment inside the building, the acoustical design is very important phase.

Acoustical comfort inside the building is very important to enhance the productivity inside the facilities.

Room acoustics design:

The acoustical design will have divided into a three parts, the first one is reverberation time design, the second one is acoustical isolation, and the third one is electro acoustical design which contains loud speakers' distribution inside the building.

Selected spaces for design:

1. **Class room**

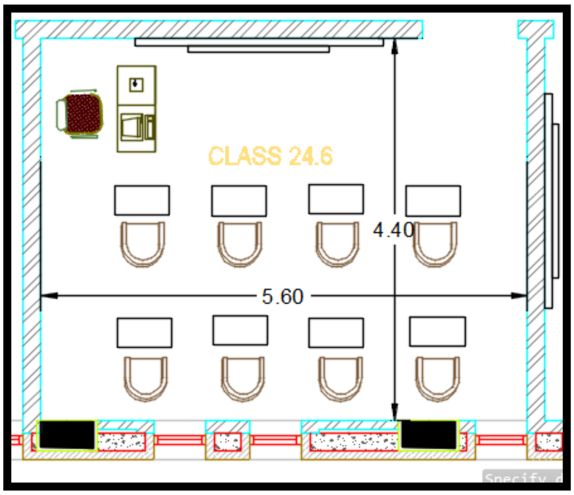


Figure 224: Class room plan

2. **Staff Room**

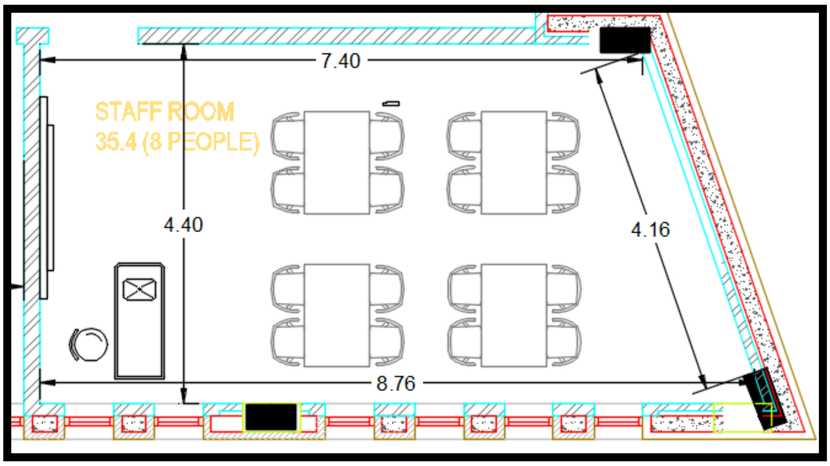


Figure 225: Staff room plan.

3. Office

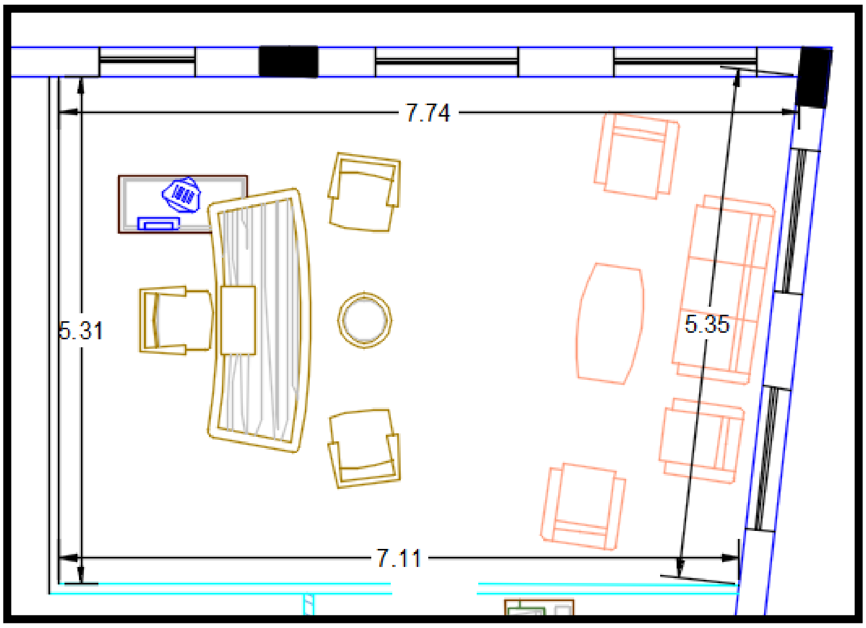


Figure 226: Office plan.

4. Training room

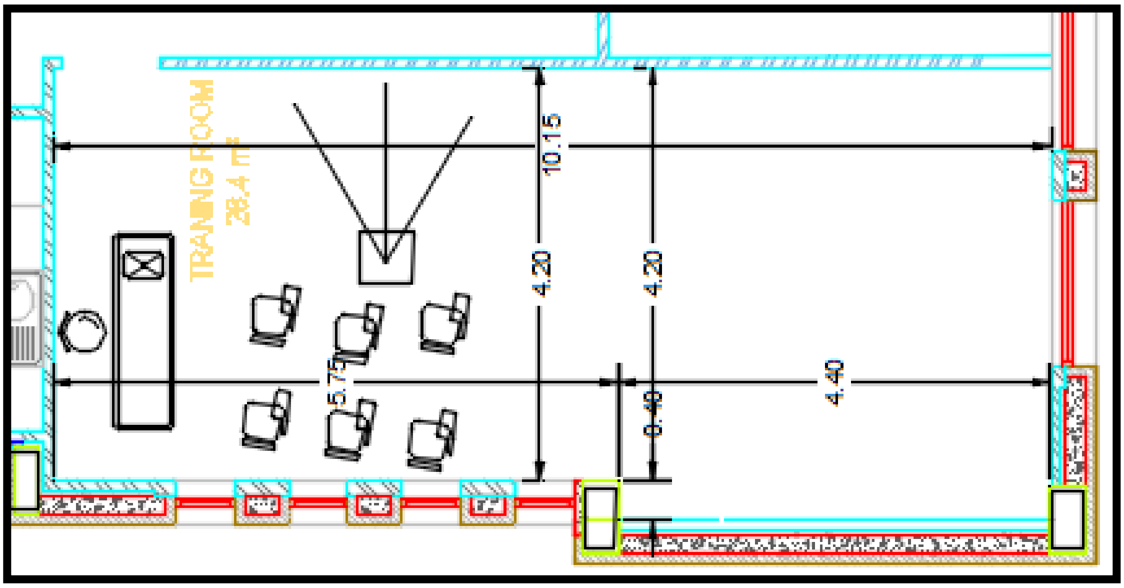


Figure 227: Training room plan

4.4.2 Recommended reverberation time:

Reverberation time is the amount of time it takes for a sound to "fade out" or "decay" in a closed area. In a space, sound can repeatedly reverberate off of surfaces including the floor, walls, roof, mirrors, and tables.

For class room: 0.40-0.80 sec (Dixon, 2022)

For offices and staff room: 0.40-0.70 sec (Recommended reverberation times for 7 key spaces, 2020)

For training room: 0.90-1.90 se(Dixon, 2022)c (Davis, 2022)

4.4.3 sound transmission class (STC):

Table 53: Required STC for spaces (commercial-acoustics, 2022)

Target STC		
Adjacencies		STC
Hotel Room	Hotel Room	55
	Corridor	50
Residence (Apartment or Condo)	Residence (Apartment or Condo)	50
	Corridor	50
Residence or Hotel	Retail	60
Retail	Retail	50
Standard Office	Standard Office	45
Executive Office	Executive Office	50
Conference Room	Conference Room	50
	Admin, Admissions	45
Office or Conference Room	Corridor	50
Mechanical Room	Occupied Area	60
Movie Theater	Movie Theater	65
Hospital Room	Hospital Room	45
Classroom	Classroom, Corridor, or Classroom	50
	Restroom	53
	Eletrical or Mechanical Room	60
Music Drama	Dining, Corridor	60
	Restroom	53
Entry	Teachers Support or Waiting Rooms	45

4.4.4impact insulation class(IIC)

IIC >50 dB(Acoustics.com: Codes & Testing - Impact Insulation Class (IIC), 2020)

- Articulation loss%

Table 54: Articulation loss categories(T. Grondzik, G. Kwok, Stein, & S.Reynolds, 2010)

AL	Category
>0.3	Bad
0.21–0.3	Minimal
0.06–0.2	Normal

0–0.05	Excellent

- Noise Criteria (NC) :

For offices and staff room: NC 30-35 dB(The Engineering toolbox, 2022)

For corridors: NC 35-40 dB(The Engineering toolbox, 2022)

For classrooms: NC 25-30 dB(The Engineering toolbox, 2022)

For training room: NC 25-30 dB(The Engineering toolbox, 2022)

- Speech Transmission Index (STI) :

Table 55: STI categories*(Stout, 2015)*

STI	Category
0.75 – 1.0	Excellent
0.6 – 0.75	Good
0.45 – 0.6	Fair
0.3 – 0.45	Poor
0 – 0.3	Bad

Design:

1. RT60 design:

Table 56: Materials sound absorption coefficient used.

Frequency / Category	125 HZ	250 HZ	500 HZ	1000 HZ	2000 HZ	4000 HZ
Walls	0.25	0.1	0.05	0.03	0.03	0.02
Floors	0.1	0.25	0.4	0.35	0.5	0.65
Windows	0.35	0.25	0.18	0.15	0.08	0.1
Doors	0.1	0.45	0.25	0.15	0.13	0.1
Ceilings	0.25	0.1	0.05	0.03	0.03	0.02

- Office

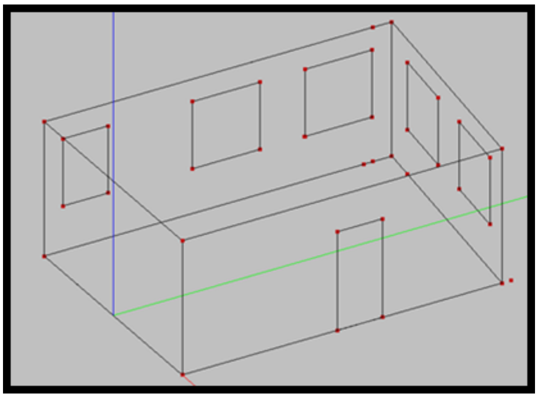


Figure 228: Office Ease model.

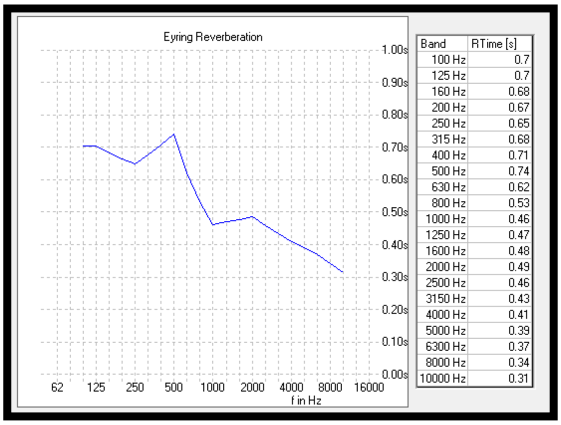


Figure 229: RT60 results for office.

The recommended RT60 for an office room is (0.4-0.7), and the preceding table shows that RT60 is equal to values between 0.41 - 0.70. Therefore, the room complies with the regulations.

- Staff room

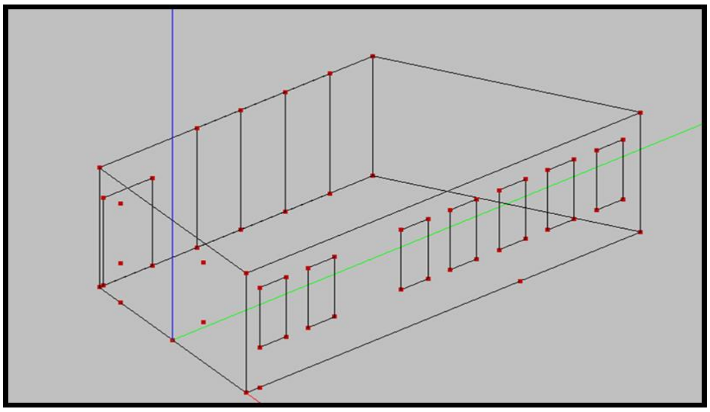


Figure 230: Staff room Ease model.

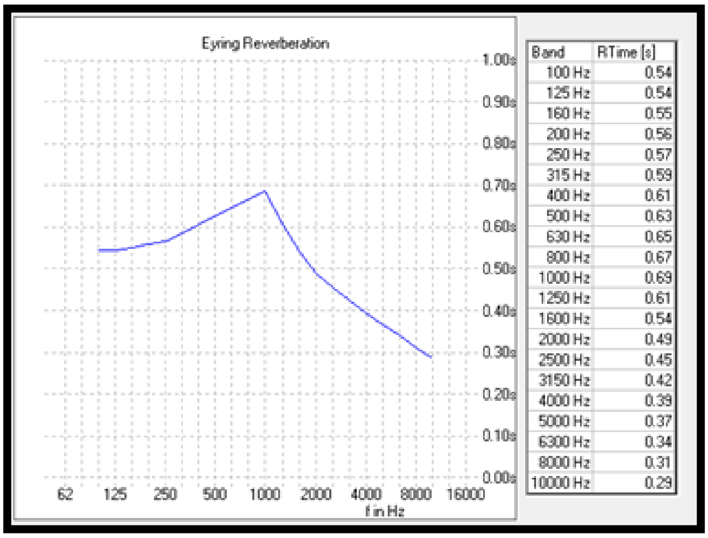


Figure 231: RT60 results for staff room.

The recommended RT60 for a staff room is (0.4-0.7), and the preceding table shows that RT60 is equal to values between 0.39 - 0.54 Therefore, the room complies with the regulations.

- **Class room:**

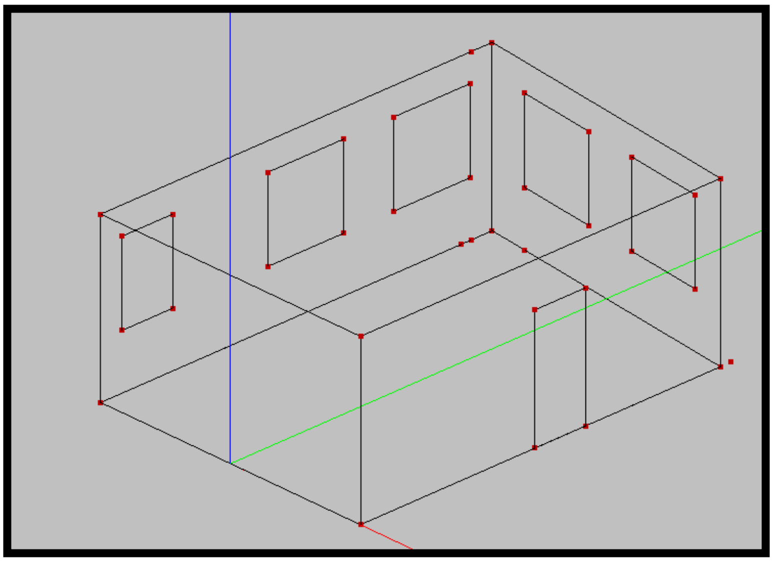
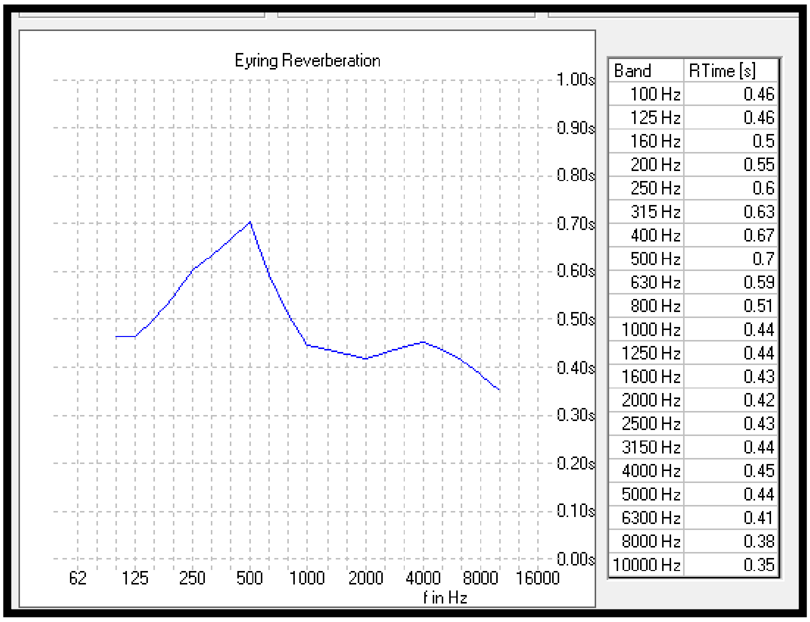


Figure 232: Class room Ease model.



Band	RTime [s]
100 Hz	0.46
125 Hz	0.46
160 Hz	0.5
200 Hz	0.55
250 Hz	0.6
315 Hz	0.63
400 Hz	0.67
500 Hz	0.7
630 Hz	0.59
800 Hz	0.51
1000 Hz	0.44
1250 Hz	0.44
1600 Hz	0.43
2000 Hz	0.42
2500 Hz	0.43
3150 Hz	0.44
4000 Hz	0.45
5000 Hz	0.44
6300 Hz	0.41
8000 Hz	0.38
10000 Hz	0.35

Figure 233: RT60 results for class room.

The recommended RT60 for a glass room is (0.4-0.8), and the preceding table shows that RT60 is equal to values between 0.42 - 0.7 Therefore, the room complies with the regulations.

Training room:

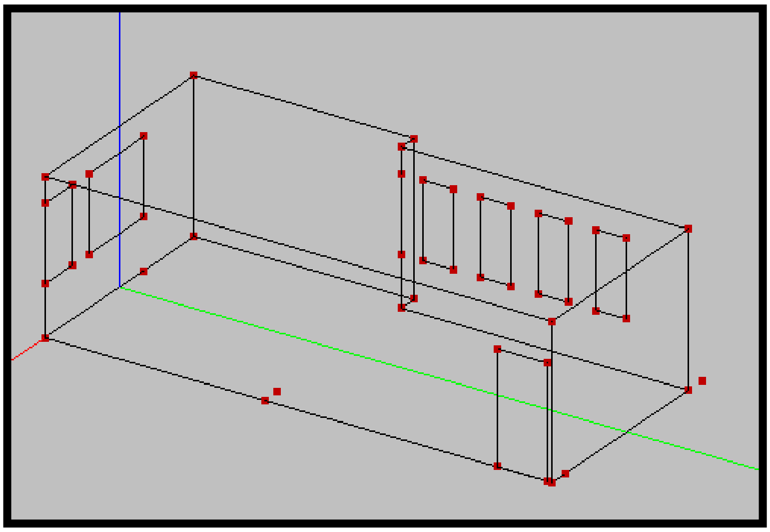


Figure 234: Training room Ease model.

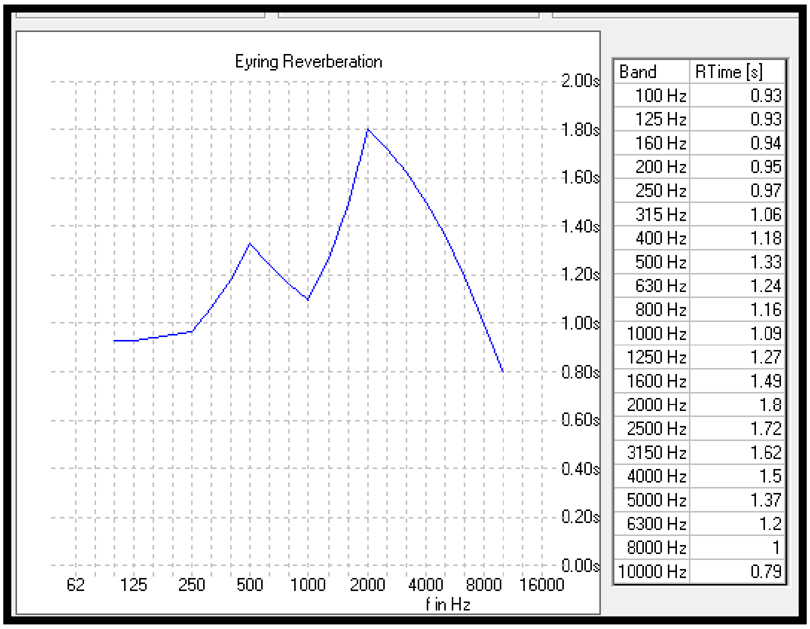


Figure 235: RT60 results for Training room.

The recommended RT60 for a training room is (0.9-1.9), and the preceding table shows that RT60 is equal to values between 0.93 – 1.8 Therefore, the room complies with the regulations.

Sound insulation design:

As for the partitions, the partitions will be designed for STC with a minimum of 50 dB using INSUL software.

Partition layers:

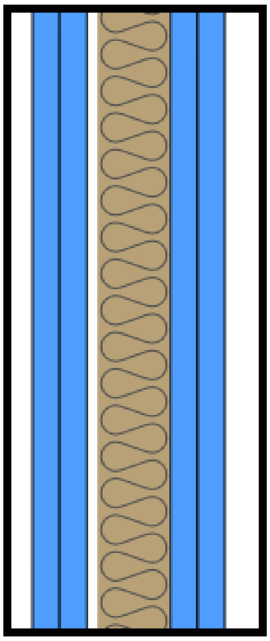


Figure 236: Partition layers

Left: + 2 x 13mm KNAUF 13mm SONAROCK + Ossature métallique simple (1.0-1.6mm) (40mm x 40mm) + 35mm R-2.6 HD glass wool 90mm wall piece + 2 x 13mm KNAUF 13 MM Sonarok.

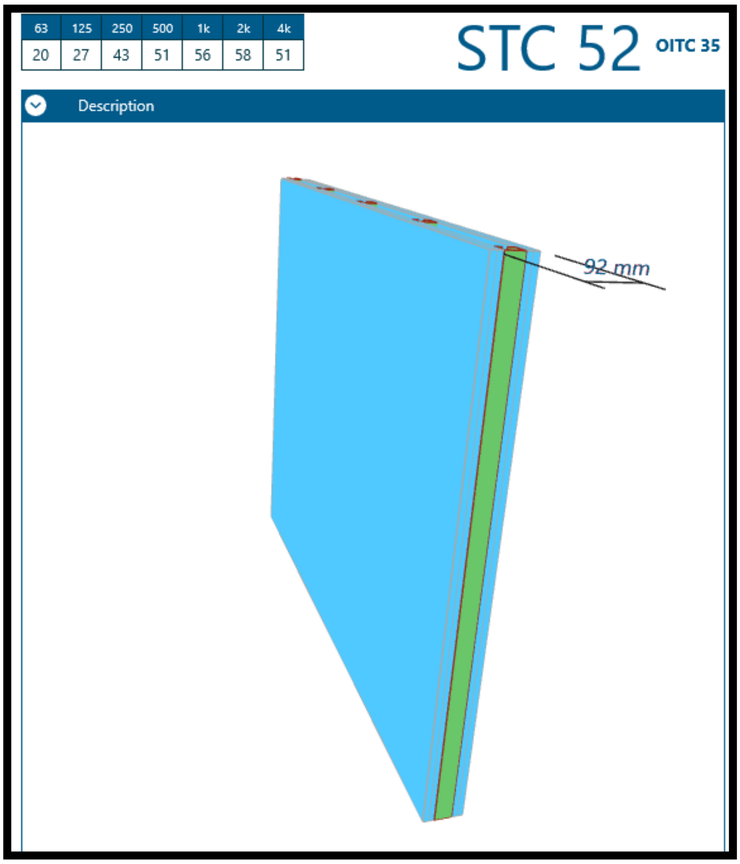


Figure 237: Partition design results.

The partition design is appropriate since the STC value in the partition must be larger than 50 dB; using the INSUL program, the result is displayed when it is STC equal to 52 dB, which is greater than 50 dB

Floor:

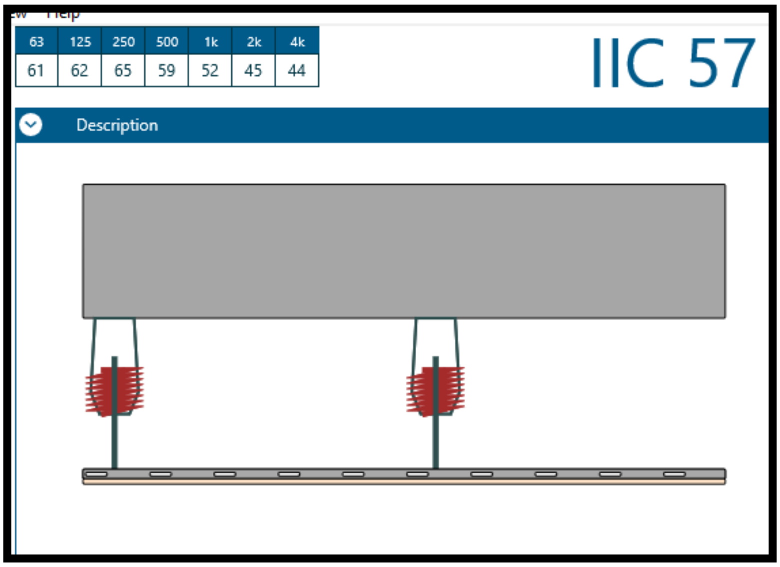


Figure 238: Floor IIC

The floor design is appropriate since the IIC value in the floor must be larger than 50 dB; using the INSUL program, the result is displayed when it is IIC equal to 57 dB, which is greater than 50 dB.

Electro Acoustics design:

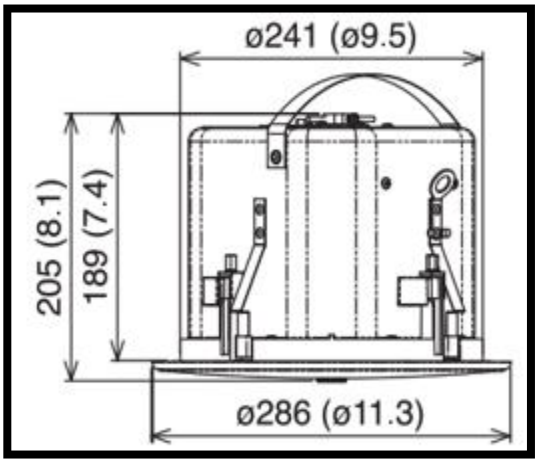


Figure 239: L oud speaker selected.

specification of the selected speaker are:

- Coverage angle: 110°
- Sound pressure level = 86dB SPL

4.4.5Load speaker

The loud speakers will be distributed in corridors.

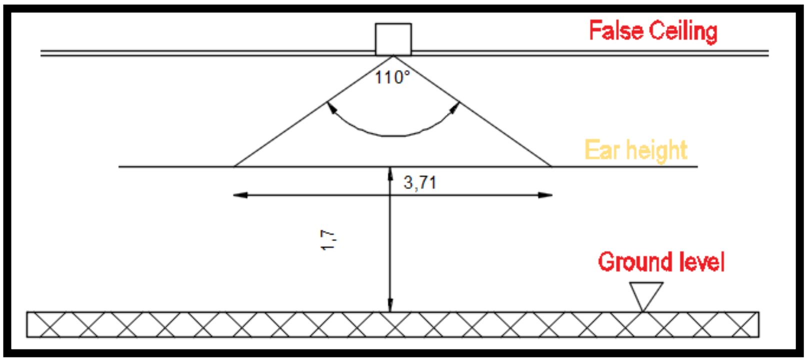


Figure 240: Loud speaker coverage

The listener is 13.7 square meters in size and 1.7 meters tall on average, with a degree of 110.

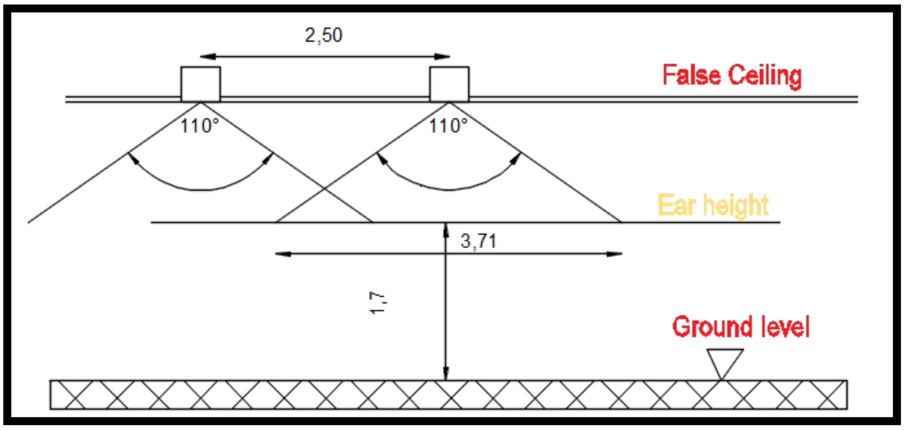


Figure 241: loud speakers distance.

The speaker every 2.5 meters because the area of the used speakers, which have a length of 3.7 meters and a width of 3.7 meters.

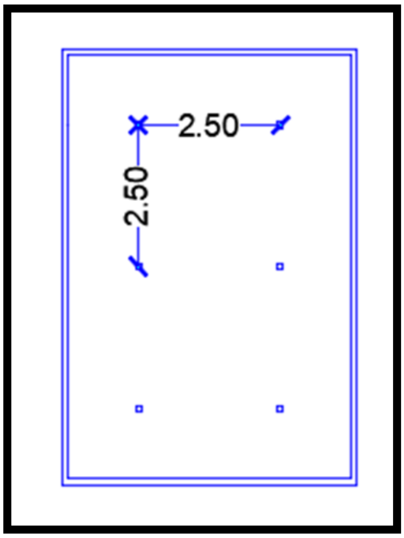


Figure 242: Distribution of speakers in the corridor

The speakers in the corridor every 2.5 meters and 1.25 meters away from the wall.

4.5 Mechanical design

4.5.1 Water supply design:

4.5.1.1 Introduction:

Water design is one of the most important designs needed for a building. All pipe diameters were calculated. Also, the amount of water required for the building was calculated, and as a result, the number of water tanks was calculated.

- **Tank sizing:**

The needed water 60liter /person.

Their size is roof thank= 24600 liter

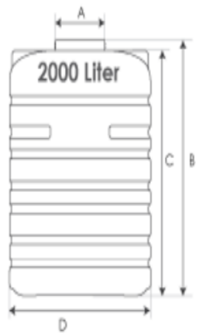
Table 57: tank sizing

Product Information

No.	Type	No. of Layers	Capacity	Outlet	Color
01-0334	Short	3	2000 Liters	3/4 '	White

Product Dimentions

Type	A	B	C	D
Short	400 mm	1650 mm	1580 mm	1350 mm



By the person in building 450 p

The use of water about 25 L/D

Number of roof tank = (450*25) /2000 = 6 tank.

- **Pipe design:**

Weight of the fixture units:

Table 58: weight of the fixture units

Fixture	Occupancy	Type of Supply Control	Load Values in WSFU Cold	Hot	Total
Bathroom group	Private	Flush tank	2.7	1.5	3.6
Bathroom group	Private	Flush valve	6	3	8
Bathtub	Private	Faucet	1	1	1.4
Bathtub	Public	Faucet	3	3	4
Bidet	Private	Faucet	1.5	1.5	2
Combination fixture	Private	Faucet	2.25	2.25	3
Dishwashing machine	Private	Automatic		1.4	1.4
Drinking fountain	Offices, etc.	⅜ in. (9.5 mm) valve	0.25		0.25
Kitchen sink	Private	Faucet	1	1	1.4
Kitchen sink	Hotel, restaurant	Faucet	3	3	4
Laundry trays (1 to 3)	Private	Faucet	1	1	1.4
Lavatory	Private	Faucet	0.5	0.5	0.7
Lavatory	Public	Faucet	1.5	1.5	2
Service sink	Offices, etc.	Faucet	2.25	2.25	3
Shower head	Public	Mixing valve	3	3	4
Shower head	Private	Mixing valve	1	1	1.4
Urinal	Public	1 in. (25 mm) flush valve	10		10
Urinal	Public	¾ in. (19 mm) flush valve	5		5
Urinal	Public	Flush tank	3		3
Washing machine, 8 lbs (3.6 kg)	Private	Automatic	1	1	1.4
Washing machine, 8 lbs (3.6 kg)	Public	Automatic	2.25	2.25	3
Washing machine, 15 lbs (6.8 kg)	Public	Automatic	3	3	4
Water closet	Private	Flush valve	6		6
Water closet	Private	Flush tank	2.2		2.2
Water closet	Public	Flush valve	10		10
Water closet	Public	Flush tank	5		5
Water closet	Public or private	Flushometer tank	2		2

The flow rate and pressure per fixture units:

Table 59:The flow rate and pressure

Fixture Served	Minimum Flow Rate gpm (L/s)[a]	Minimum Pressure psi (kPa)[b]	Maximum Flow Rate or Quantity
Bathtub	4 (0.25)	8 (55)	
Bidet	2 (0.13)	4 (28)	
Combination fixture	4 (0.25)	8 (55)	
Dishwasher, residential	2.75 (0.17)	8 (55)	
Drinking fountain	0.75 (0.05)	8 (55)	
Hose bibb	5 (0.32)	8 (55)	
Laundry tray	4 (0.25)	8 (55)	
Lavatory, private	2 (0.13)	8 (55)	2.5 gpm at 80 psi (0.16 L/s at 551 kPa)
Lavatory, public	2 (0.13)	8 (55)	0.5 gpm at 80 psi (0.03 L/s at 551 kPa)
Lavatory, public, metering or self-closing	2 (0.13)	8 (55)	0.25 gallon (0.95 L) per metering cycle
Shower head	3 (0.19)	8 (55)	2.5 gpm at 80 psi (0.16 L/s at 551 kPa)
Shower head, temperature controlled	3 (0.19)	20 (138)	2.5 gpm at 80 psi (0.16 L/s at 551 kPa)
Sink, residential	2.5 (0.16)	8 (55)	2.5 gpm at 60 psi (0.16 L/s at 414 kPa)
Sink, service	3 (0.19)	8 (55)	2.5 gpm at 60 psi (0.16 L/s at 414 kPa)
Urinal, valve	15 (0.95)	15 (103)	1.5 gallons (5.7 L) per flushing cycle[a] or 1.0 gallon (3.8 L) per flushing cycle
Water closet, blow out, flushometer valve	35 (2.21)	25 (172)	4 gallons (15 L) per flushing cycle
Water closet, siphonic, flushometer valve	25 (1.58)	15 (103)	4 gallons (15 L) per flushing cycle[a] or 1.6 gallons (6 L) per flushing cycle
Water closet, tank, close coupled	3 (0.19)	8 (55)	1.6 gallons (6 L) per flushing cycle
Water closet, tank, one piece	6 (0.38)	20 (138)	1.6 gallons (6 L) per flushing cycle

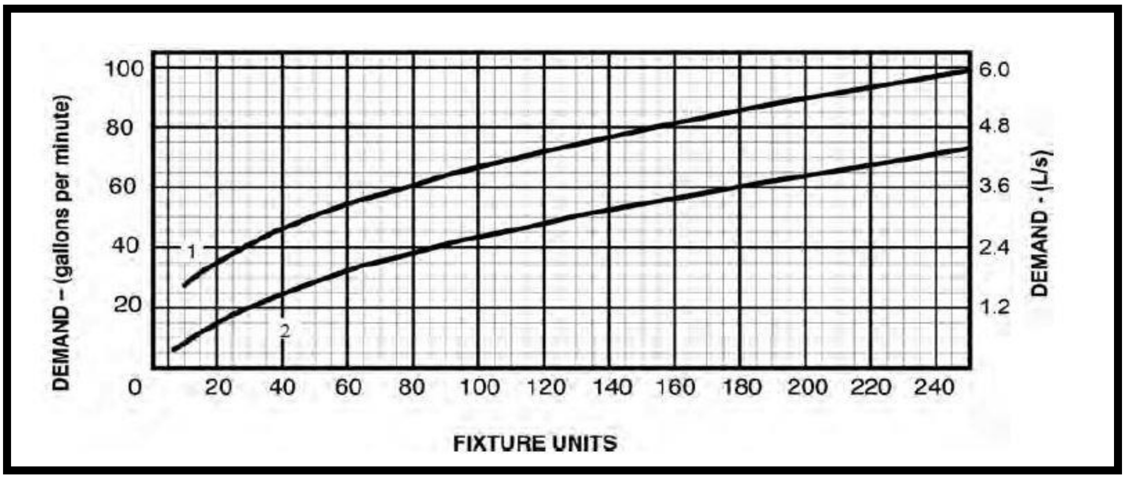


Figure 243: gallon per meter demand

Design pipes size:

The following table show weigh fixture unit for water sources:

Table 60: weight fixture unit

floor	water resources		demand weights of fixtures in fixture unit		weigh in fixture unit
	fixture	quantity	description	weight in fixture units	
GF	sink	5	lavatory	2	10
	shower	1	shower	12	12
	water closet	6	flush tank	5	30
F1	sink	6	lavatory	2	12
	shower	1	shower	12	12
	water closet	6	flush tank	5	30
f2	sink	6	lavatory	2	12
	shower	1	shower	12	12
	water closet	6	flush tank	5	30
f3	sink	6	lavatory	2	12
	shower	1	shower	12	12
	water closet	6	flush tank	5	30
total fixture unit					214

Pressure calculations for each floor:

P=0.433*h

H=the cumulative height of floors in feet.

Table 61: cumulative height tank

L(tank→vertical)	6	ft
h tank	8	ft
h tank from roof	10	ft
h floor	11.48	ft
total no. of floor	4	ft

Table 62: number of unit for each floor

no. of floor	P.	no.of unites
gf	24.21	52
f1	19.24	54
f2	14.27	54
f3	9.30	54

Design vertical pipes:

Table 63: vertical pipe design

vertical pipe	steel
total no. of unites	214
flow	65
actual length	61.92
eq. length	92.88

Table 64: losses for vertical pipes

Dim	3	2	1.5
loss/100"	0.4	4	12
loss/eq. length	0.37152	3.7152	11.1456

Design for horizontal pipes:

Table 65: design of horizontal pipes

horizontal pipe	pvc
total # of unites	54
flow	30
actual length	25
eq. length	30

Table 66: loses of horizontal pipes.

Dim	3	2.5	2	1.5	1.25	1
loss/100"	0.17	0.35	1	3.5	8	22
loss/eq. length	0.051	0.105	0.3	1.05	2.4	6.6

Design branch pipes:

Table 67: design of branch pipes.

shower critical	
branch pipe	pvc
total # of unites	4
flow	4
actual length	51.5
eq. length	61.8

Table 68: losses of branch design

Dim	1.5	1.25	1	0.75	0.5
loss/100"	0.6	0.25	0.7	2.4	13
loss/eq. length	0.3708	0.1545	0.4326	1.4832	8.034

Pipes size for all floors:

In the building, we used several diameters of pipes, each according to their distribution and uses.

Table 69: pipes size for all plane.

floor	vertical design		horizontal design		branch design		total loss	NACHRAL LOESS	actual pressure	check pump
	steel pipes dimeter	loss psi/100 ft	PVC pipes dimeter	loss psi/100 ft	PVC pipes dimeter	loss psi/100 ft				
GF	2	3.7	1.25	2.4	(3/4)	1.48	7.58	24.21	16.63	not need pump
f1	2	3.7	2	0.3	(3/4)	1.48	5.48	19.24	13.76	not need pump
f2	3	0.37	2	0.3	(3/4)	1.48	2.15	14.27	12.12	not need pump
f3	3	0.37	2.5	0.1	1	0.4	0.87	9.3	8.43	not need pump

The following figure show Water supply plan:

This plan shows the distribution of water to the points of the building from the source to the central one and then to the toilets, sinks and the kitchen from cold and hot pipes.

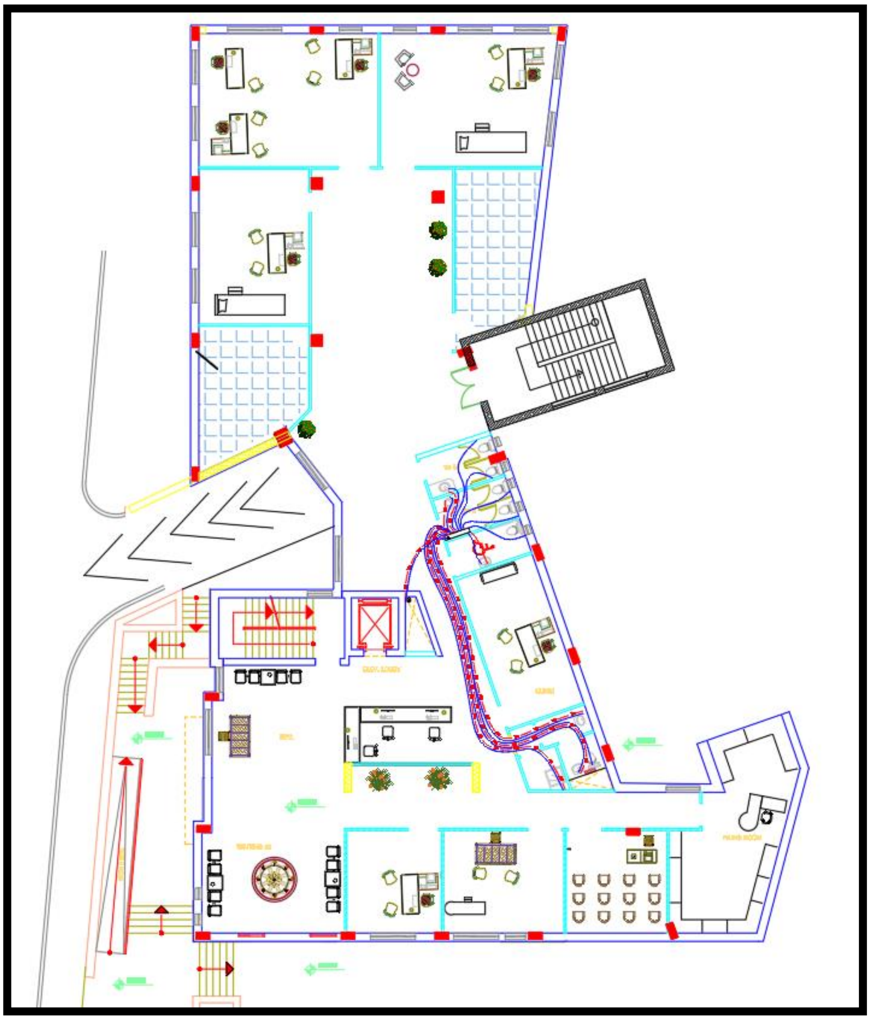


Figure 244: water supply plan.

4.6 Drainage system:

The drainage system is considered one of the most important mechanical systems in the building, and the main extensions to it are placed in the basic construction stages.

The main objective of the sewage system is to collect and dispose of liquid water in a correct manner and to have a safe environment.

After the completion of the distribution of sinks and toilets, the sewage system was established. will design a drainage system based on this; The sewage unit is calculated as follows.

The following table shows the pipe diameters used in the drainage system

Drainage fixture units:

Table 70: Drainage fixture unit.

Fixture(s)	Drainage Fixture Units (dfu)	Minimum Trap Size in.	Minimum Trap Size mm[a]
Automatic clothes washers: Commercial[b]	3	2	51
Residential	2	2	51
Bathroom group: Water closet (1.6 gpf [6 Lpf]), lavatory, and bathtub or shower; with or without a bidet and emergency floor drain	5	—	—
Bathroom group: Water closet (>1.6 gpf [6 Lpf]), lavatory, and bathtub or shower; with or without a bidet and emergency floor drain	6	—	—
Bathtub[c] (with or without overhead shower or whirlpool)	2	1½	38
Bidet	1	1¼	32
Combination sink and tray	2	1½	38
Dental lavatory	1	1¼	32
Dental unit or cuspidor	1	1¼	32
Dishwashing machine[d], domestic	2	1½	38
Drinking fountain	0.5	1¼	32
Emergency floor drain	0	2	51
Floor drains	2	2	51
Kitchen sink, domestic	2	1½	38
Kitchen sink, domestic, with food waste grinder and/or dishwasher	2	1½	38
Laundry tray (1 or 2 compartments)	2	1½	38
Lavatory	1	1¼	32
Shower	2	1½	38
Service sink	2	1½	38
Sink	2	1½	38
Urinal	4	[e]	
Urinal, 1 gal (3.8 L) per flush or less	2[f]	[e]	
Urinal, nonwater supplied	0.5	[e]	
Wash sink (circular or multiple) each set of faucets	2	1½	38
Water closet, flushometer tank, public or private	4[f]	[e]	
Water closet, private (1.6 gpf [6 Lpf])	3[f]	[e]	
Water closet, private (>1.6 gpf [6 Lpf])	4[f]	[e]	
Water closet, public (1.6 gpf [6 Lpf]),	4[f]	[e]	
Water closet, public (flushing >1.6 gpf [6 Lpf])	6[f]	[e]	

Max number of Drainage fixture units connected to building sewer:

Table 71:max number of drainage units

Diameter of Pipe (in.)	Diameter of Pipe (mm)[b]	Maximum Number of dfu Connected to Any Portion of the Building Drain or Building Sewer, Including Branches of the Building Drain[a] Fall, in. per ft (% slope) 1/16 (0.5%)	1/8 (1.04%)	1/4 (2.1%)	1/2 (4.2%)
2	51			21	26
2½	64			24	31
3	76		36	42	50
4	102		180	216	250
5	127		390	480	575
6	152		700	840	1000
8	203	1400	1600	1920	2300
10	254	2500	2900	3500	4200
12	305	3900	4600	5600	6700
15	381	7000	8300	10,000	12,000

Table 72: pipe diameters and slope

Type of pipe	Diameter	Slope
Vertical Vent	4″	0%
Vertical Stack	4″	0%
Horizontal Sewers	2″ , 4″	2% , 1%
Branches	1.5″ , 2″	2%
Horizontal Drain	4″ , 5″ , 6″	1%

Parking drainage:

As for the drainage of water entering the parking lots, PVC pipes with a diameter of 4 inches have been installed and drainage.

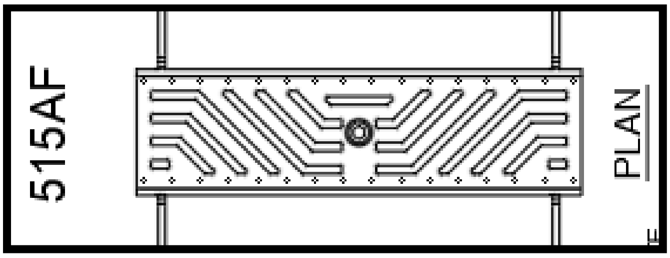


Figure 245: manhole used in parking

Sample of calculation:

Max dfu for 2 inch =21 dfu with slope 2%

Max dfu for 4 inch =180 dfu with slope 1%

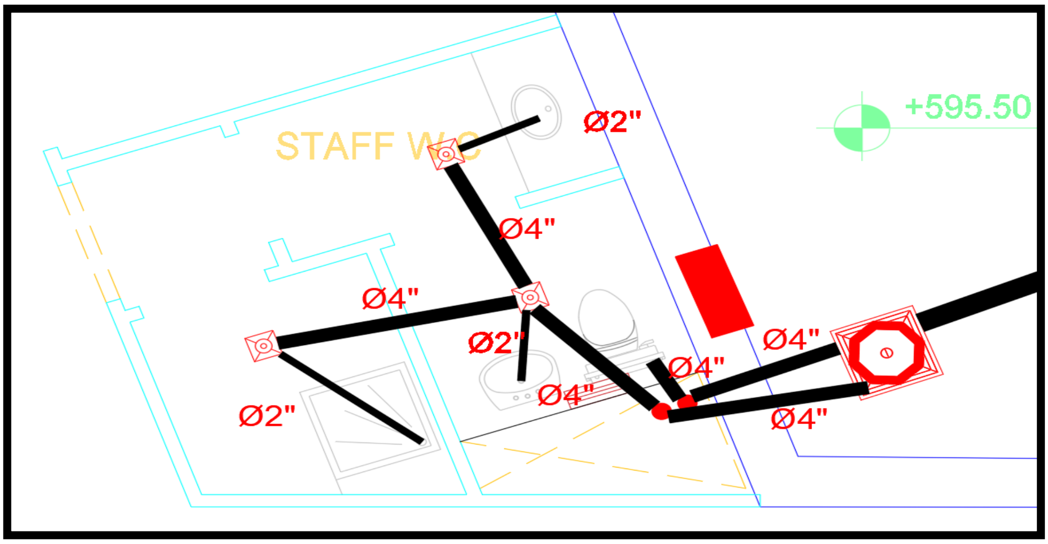


Figure 246: connection

The following shows the distribution of all points and then gives each pipe its diameter by dfu per unit:

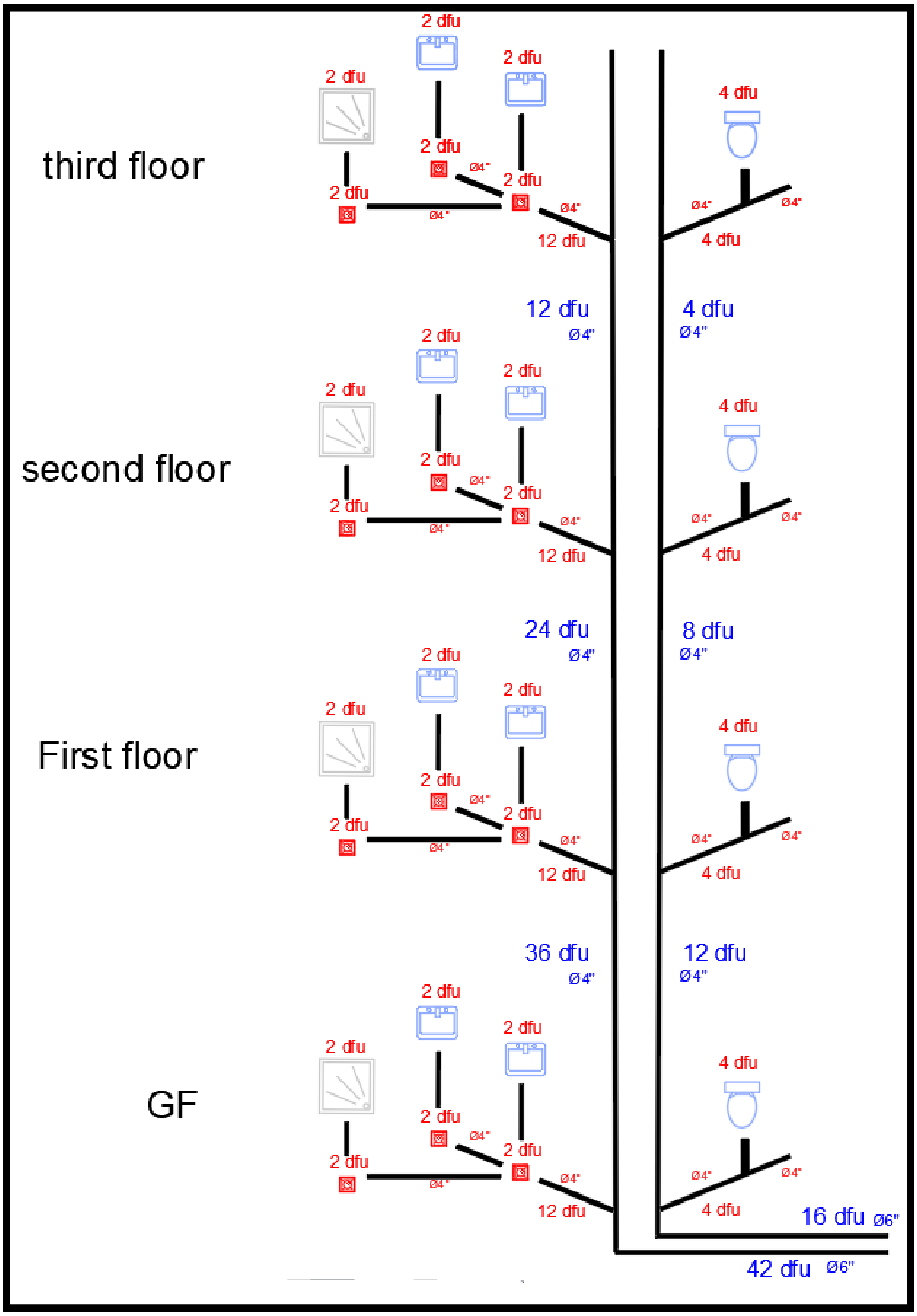


Figure 247: dfu per unit for building

The following figure show Water drain plan:

Ground floor distribution manholes and sewar

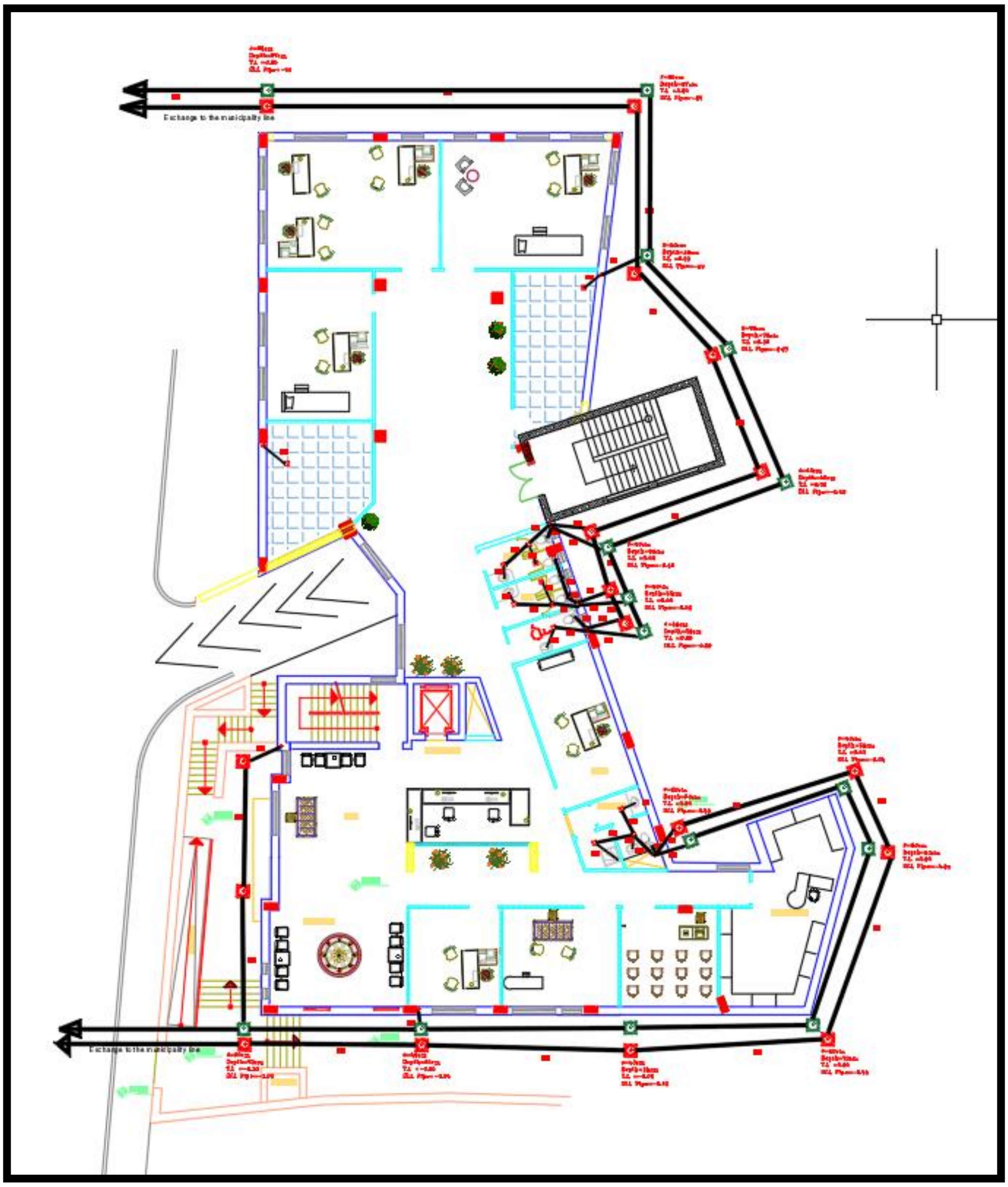


Figure 248: ground floor drainage

4.6 Fire Design

Fire design is the most important part inside any facility and should be taken into account to provide safety for all building's occupants, throughout this part, many firefighting systems will be used such that:

1- fire extinguishers inside class rooms, offices and corridors.
2- Fire hose stations in corridors.
3- Sprinkler system inside clinics, corridors and parking.

Also, the fire alarm system used for all spaces which contains: Smoke detectors, heat detectors (Inside kitchens only) and fire loudspeakers in addition a fire evacuation signs will be provided inside building. The fire alarm system contains a dialer which calls automatically to the responsible person and to the civil defense.

4.6.1Firefighting systems design

1) Water sprinklers system:

Water sprinklers system used only at the corridors, where corridors are considered as evacuation routes.

The Water sprinklers system consist of sprinklers unit,

1. Fire extinguishers

There are five classes for fire extinguishers depend on the materials(The Five Classes of Fires and the Fire Extinguishers that Stop Them | Strike First USA ,2021)

- "Class A: Ordinary combustibles (i.e., cloth, wood and paper)"
- "Class B: Flammable liquids."
- "Class C: Appliances, electrical."
- "Class D: Metals."
- "Class K: Cooking oil."

The selection of extinguisher type based on the fire class as shown in

Table 73: selection chart for fire extinguishers.

FIRE EXTINGUISHER SELECTION CHART

Class & Type of Fire / Type of Extinguisher	Colours	A: Wood, Paper, Plastic	B: Flammable & Combustible Liquids	C: Flammable Gases	D: Combustible Metals	(E): Electrically Energised Equipment	F: Cooking Oils and Fats	
Water		✓	✗	✗	✗	✗	✗	Dangerous if used on flammable liquid, energised electrical equipment and cooking oil/fat fires.
Carbon Dioxide (C02)		LIMITED	LIMITED	✗	✗	✓	✗	Not suitable for outdoor use or large class A fires.
Dry Chemical Powder (ABE/BE)		✓ AB(E) ✗ B(E)	✓	✓	✗	✓	✗ AB(E) ✓ B(E)	Look carefully at the extinguisher to determine if it is a BE or ABE unit.
Foam		✓	✓	✗	✗	✗	LIMITED	Dangerous if used on energised electrical equipment.
Wet Chemical		✓	✗	✗	✗	✗	✓	Dangerous if used on energised electrical equipment.
Fire Blanket		LIMITED	LIMITED	✗	✗	✗	✓	Fire Blankets effective for oil and fat fires within saucepans and are effective for extinguishing clothes that catch on fire. (Ensure you replace after every use).

FIRE & SAFETY AUSTRALIA — To obtain Fire Extinguisher or Warden Training please contact us on 1300 88 55 30 or www.fsaus.com.au

This information comes from Australian Standards AS 2444 & AS3745 – This standard requires that personnel who are trained in the use of portable fire extinguishers must refresh this training within a 2 year period

The used type is dry extinguishers that compatible with classes A, B, C and electrical fires and a one fire extinguisher will be used each 10 m distance inside the corridor.

Figure 249: Fire extinguisher

The fire extinguisher type used is dry and here are the specifications of it.

- Suitable for Class A, B, C & Electrical Fires
- Rechargeable
- Mounting Bracket
- Pressure Gauge
- Steel Construction
- 5 Year Manufacturer's Guarantee (T&Cs Apply)

2- Fire hose stations

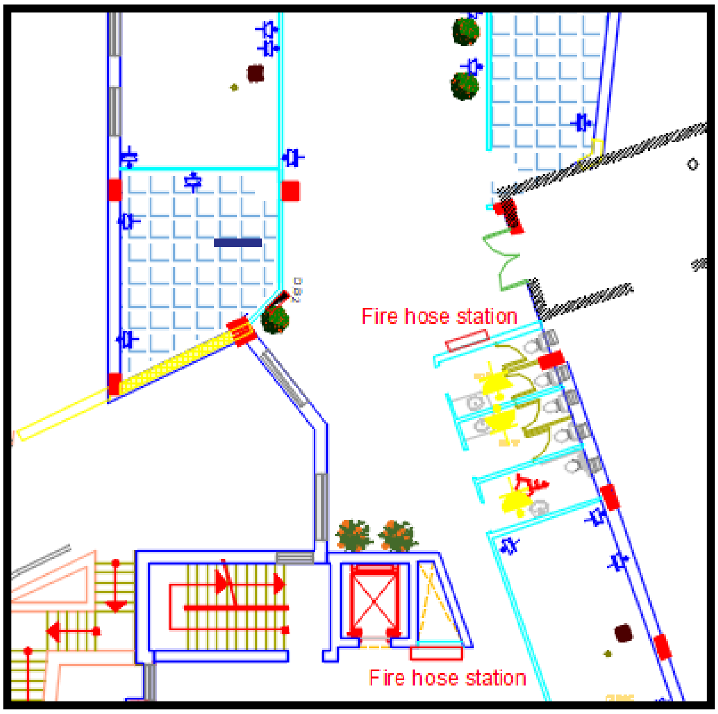


Figure 250: Fire hose stations location in corridors.

A two hose stations will be used in each corridor.

Figure 251: Fire hose station used.

3- Sprinkler system

Pendent and Recessed Pendent Sprinklers

5.6 (81) K-factor

VK600, Part No. 06778B
Technical datasheet F_080988

- Listed to 175 psi (12 bar)
- 1/2' NPT (15mm)
- Light Hazard
- Standard Response - 155°F/68°C, 175°F/79°C
- Quick Response - 135°F/57°C, 155°F/68°C, 175°F/79°C
- Standard Wrench - 21475M/B, Recessed Wrench - 13577W/B

Coverage Area ft (m)	Flow gpm (lpm)	Pressure psi (bar)
16 x 16[1] (4.9x4.9)	26 (98.4)	21.6 (1.49)
18 x 18[1] (5.5x5.5)	33 (124.9)	34.7 (2.39)
20 x 20[1,2,3] (6.1x6.1)	40 (151.4)	51.0 (3.52)

[1] cULus listed for quick response only. FM approved for quick response.
[2] cULus quick response listing available in 135°F/57°C only. FM quick response listing includes 135°F/57°C, 155°F/68°C, and 175°F/79°C.
[3] Standard response listing also available in 155°F/68°C and 175°F/79°C. See technical datasheet for expanded FM approval criteria.

Figure 252: The used sprinkler.

- The coverage area of sprinkler depends on the fire hazard classifications

Table 74: Fire hazard classifications. (NFPA Code, 2010)

Light Hazard Occupancies.	Ordinary Hazard Occupancies		Extra Hazard Occupancies	
	Group 1	Group 2	Group 1	Group 2
Churches	Automobile parking	Cereal mills	Aircraft hangars	Asphalt saturating
Clubs	Bakeries	Chemical plants — ordinary	Combustible hydraulic fluid use areas	Flammable liquids spraying
Eaves and overhangs,	Beverage manufacturing	Confectionery products	Die casting	Flow coating
Educational	Canneries	Distilleries	Metal extruding	Manufactured home
Hospitals	Dairy products	Dry cleaners	Plywood and particles	Open oil quenching
Institutional	Electronic plants	Feed mills	Printing	Plastics processing
Libraries,	glass products manufacturing	Horse stables	Rubber	Solvent cleaning
Museums	Laundries	Leather goods manufacturing	Saw mills	Varnish and paint dipping
Nursing or accommodation	Restaurant service areas	Libraries — large stack room areas	Textile All kind	
Offices,	showrooms	Machine shops	Upholstering with plastic foams	
Residential		Metal working		
Restaurant seating areas		Mercantile		

As shown in the previous table, the hazard is light hazard

Based on it, each sprinkler covers 18 m^2, as shown in **Error! Reference source not found.**.

- Pipes diameter:

Table 75: Pipes diameter

Steel pipes	
Diameter	Number of sprinklers
1 in.	2 sprinklers
1¼ in.	3 sprinklers
1½ in.	5 sprinklers
2 in.	10 sprinklers
2½ in.	30 sprinklers
3 in.	60 sprinklers
3½ in.	100 sprinklers
4 in.	See Section 8.2

Fire resistance is the number of minutes or hours that a material or component is likely to spread fire and smoke.

Fire resistant facades are used along the escape routes. Has glass partitions, metal doors (emergency doors) and concrete walls.

Table 76: Fire door openings. (Door, 2001)

Opening	Wall Rating	Door and Frame Rating	Description and Use
	4 Hour	3 Hour (180 minutes)	These openings are in walls that separate buildings or divide a single building into designated fire areas.
	2 Hour	1-1/2 Hour (90 minute)	Openings of this type are used in enclosures of vertical communication or egress through buildings. Examples of these types of openings include stairwells and elevator shafts.
	1 Hour	1 Hour (60 minute)	These door and frame assemblies divide occupancies in a building.
	1 Hour	3/4 Hour (45 minute)	For use where there are openings in corridors or room partitions.
	2 Hour	1-1/2 Hour (90 minute)	This opening is in a wall where there is the potential for severe fire exposure from the exterior of the building.
	1 Hour	3/4 Hour (45 minute)	This opening is in an exterior wall that has the potential to be exposed to moderate to light fire from the exterior of the building.
	1 Hour	1/3 Hour (20 minute)	These openings are in corridors where smoke and draft control is required. The minimum wall rating is 1 hour.

Our buildings needs wall with 1-hour rating and doors with 3/4-hour rating.

Emergency exists steel doors:

Figure 253: Steel Fire rated door used (Fire-Rated Commercial Steel Doors, 2021)

- Basic Fire Door Requirements. (Fire-Rated Commercial Steel Doors, 2021)

1.” A fire door must have a label attached”. (Fire-Rated Commercial Steel Doors, 2021)

2. “A fire door frame must have either an attached or an embossed label”. (Fire-Rated Commercial Steel Doors, 2021)

3. “A fire door must be self-latching”. (Fire-Rated Commercial Steel Doors, 2021)

4. “A fire door must be self-closing”. (Fire-Rated Commercial Steel Doors, 2021)

Fire alarm systems:

The used fire alarm system consists of:

1) Emergency signs:

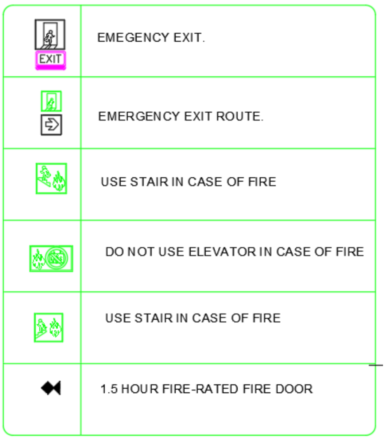


Figure 254: Emergency signs used

2)Smoke detectors and heat detectors:

- Smoke detectors will be used for all spaces except kitchens and parking
- The smoke detectors used at 4.00 m distance.
- Heat detectors are used for the kitchens and parking.

Figure 255: Smoke detector used(Smoke Alarms | Carbon Monoxide Detectors, 2021)

Heat Detectors:

Figure 256: Heat detectors. (Smoke Alarms | Carbon Monoxide Detectors, 2021)

2 Fire loud speakers:

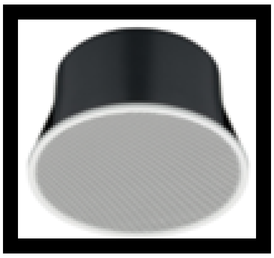


Figure 257: Fire loudspeakers speakers.

3 Fire alarm system

Figure 258: Fire alarm bell and manual call point.

Call point Parameter

1. Demension: 86*86*50mm
2. Working Voltage: DC 24V (8A)
3. Contact Resistance: ≤0.1Ω
4. Temperature Range :-10 to 50 degree
5. Relative humidity: ≤93RH±2%
6. State of the switch: Closed or Open
7. Glass: once/ Relocatable

Alarm bell Parameter

1.Operating voltage: DC24V
2.Operating current: ≤25mA
3.Alarm sound: ≥95dB
4.Waterproof type

Figure 259: Fire alarm bell and manual call point specifications

- Pump selected

The pump is for sprinkler system

Figure 260: Fire pump used. (Fire Extinguishers, 2021)

The fire pump will be installed in the mechanical room.

Chapter five: Quantity surveying & Cost Estimate

5.1 Introduction:

In this part of the graduation project, the quantities and costs are calculated in the smallest detail, according to current standards and prices.

One of the most important stages of the project is knowing the budget and value of the project when submitting any bid and being able to control the project through it

By using work break down structure as shown in the figure below

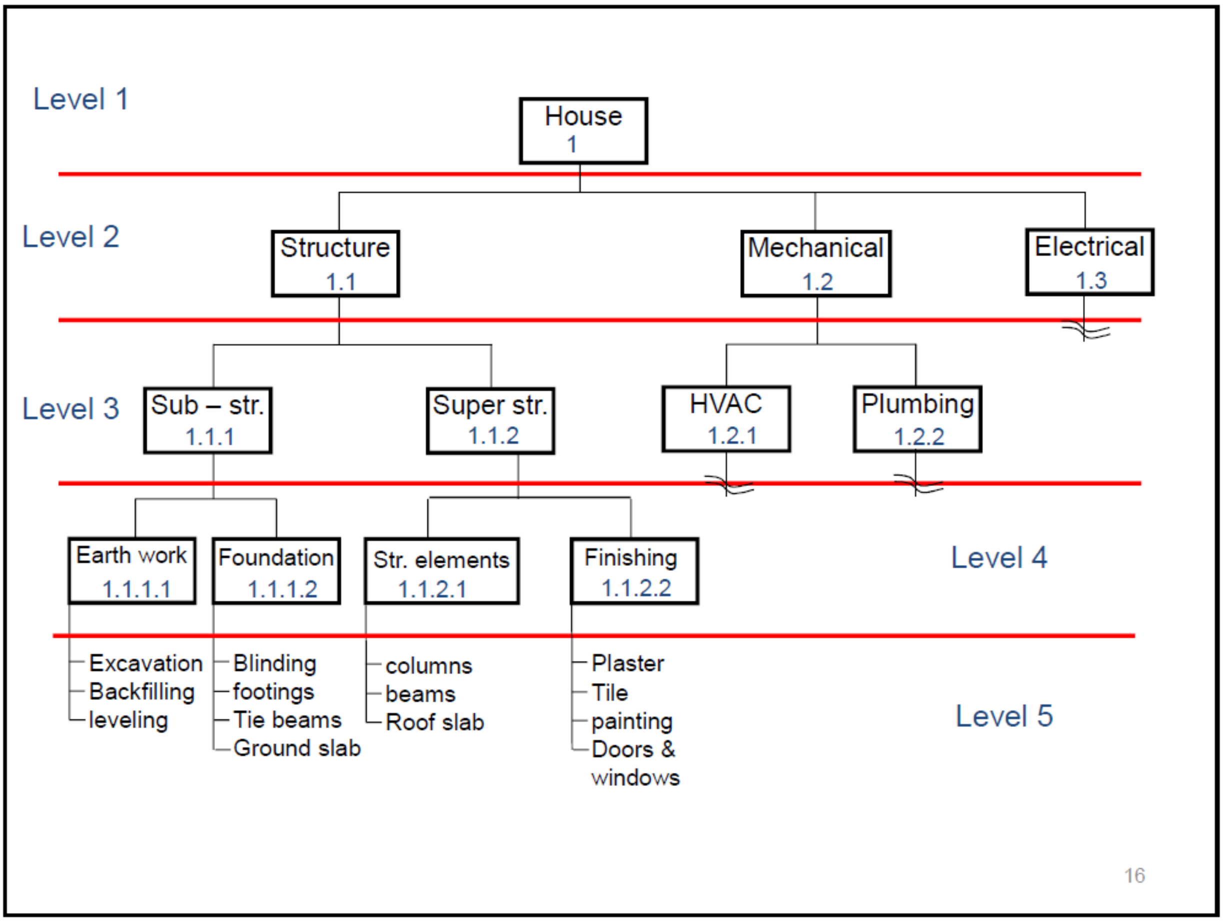


Figure 261: work break down structure

5.2 Methodology:

Project costs have been calculated using the "bottom-up estimation" method because it is considered more accurate than other methods used in costing.

5.3 Cost Project:

Table 77: cost estimation for project

1. Redesign Nablus childhood institute						
1.1 Structure						
1.1.1 Sub Structure						
1.1.1.1 Earthworks						
ID	**Items**	**unit**	**Quantity**	**Cost**		**total cost**
				Unit Cost	Total Cost for activity	NIS
Earth work	Excavation	CM	2280	50	141000	216090
	Backfilling	CM	623	50	31150	
	Disposal	CM	2197	20	43940	
1.1.1.2 Foundations						
FOOTING	Steel	Ton	22.47	4000	89880	157540
	concrete	CM	199	340	67660	
1.1.2 Super structure						
1.1.2.1 Structural Elements						
SLABS	steal	Ton	67.5	4000	270000	2626000
	concrete	CM	796	340	270667	
Columns	steal	Ton	10.5	4000	42000	
	concrete	CM	117.64	340	40000	
Shear wall (about stairs elevator)	steal	Ton	57	4000	228000	
	concrete	CM	258.26	340	87808	
Ex shear wall	steal	Ton	27	4000	102000	
	concrete	CM	170	340	57800	
Labor	Formwork	SM	3200	180	576000	
Walls (EX)	Gyp with	SM	1564	120	187680	
Walls (IN)	blocks	blocks	17680	1.5	26520	
	Stone	SM	3084	150	462600	
	Labor	SM	3084	45	138780	
	Polystyrene	CM	18.5	250	4625	
	Grout for stone	SM	3084	40	123360	
	Concrete	CM	24.67	340	8160	
1.1.2.2. Finishing						
plaster	Sand(clay) Volume	CM	325	90	29250	1542616

	Cement Bags (25Kg)	Bags	6250	12.5	78125	
	Area plaster w	SM	14603	25	365075	
Tile F	tiles area (helper +tile price)	SM	2325	80	186040	
	Cement Bags (25Kg)	Bags	1570	12.5	19500	
	Sand Volumes	CM	87	90	7830	
	STAIRS	Num	200	120	24000	
	Wall tile	SM	556	70	32920	
	Wall clay tile	Bags	952	13	12376	
	Filling	CM	348	45	15660	
window	window area	SM	216	600	129600	
False Ceiling	Area	SM	2268	120	272160	
Panting	Panting Area	SM	12328	20	246560	
	Base Coat (18L)	Bucket	171	70	11970	
	Finish Coat (18L)	**Bucket**	85	110	9350	
Door	Wood	Num	43	1100	47300	
	Aluminum	Num	29	900	26100	
	Steel	Num	9	3200	28800	
1.2. Mechanical						
HVAC	VRV	SM	170	2568	436560	657583
Water Supply	3" Water Steel Pipe	M	558	28	15624	
	2" Water Steel Pipe	M	267	18	4806	
	3/4" PVC Water Pipe	M	1835	8	14680	
	Collectors	Num	5	85	425	
	Water Meter	Num	5	250	1000	
	point	Num	214	40	8560	
Water Drain	WC cab	Num	24	150	3600	
	Lavatory	Num	25	140	3500	
	Kitchen sinks	Num	24	80	1920	
	Floor trap	Num	47	15	705	
	3/4" PVC Pipes	M	200	5	1000	
	1" PVC Pipes	M	212	5	1060	
	2" PVC Pipes	M	38	6	228	
	4" PVC Pipes	M	250	10	2500	
	6" PVC Pipes	M	237	15	3555	
	Manhole	Num	16	250	4000	
	labor	Num	322	30	9660	
Transportation	Elevators	#	1	140000	140000	
water tank	Tank (2000L)	Num	6	700	4200	
1.3. Electrical						
switches	single	#	45	20	900	528933
	double	#	38	26	988	
	vexel	#	21	30	630	
socket	single	Num	467	25	11675	

	Water proof	#	22	40	880	
Lamps	LED rectangular shape	#	20	40	800	
	Spot light	#	56	30	1680	
	Chandeliers	#	4	1000	4000	
	LED Square light	#	182	40	7280	
	Led lamp	#	208	50	10800	
	Labor	#	390	60	7800	
Fire Fighting	system	SM	3210	150	481500	
Total cost						5728762
Profit						286438.1
Price						6015200

After the process of calculating the quantities and costs for the requirements of the second graduation project for all construction and mechanical works and the cost of the elevator and electrical in the most accurate way.the final cost was calculated, amounting to 572762 NIS after adding 5% profits assume, the final cost amounted to 6015200 NIS

the unit total cost price for the building is (1880 NIS / m2).

Chapter six: Conclusion

This chapter explains what has been done in this project

- Environmental Architectural Aspects

In the beginning, the standards for all spaces in the building were collected and applied to the design to meet the needs of the building. The building was analyzed environmentally by the Design Builder program.

- Structural aspects:

  In this chapter, the building was designed seismically, where earthquake loads were added to the building, necessary checks were made, and all structural elements were designed using the ETAP program and details were drawn by the AutoCAD program.

- Electro-mechanical Aspects

  In this chapter the Artificial lighting, HVAC, power, acoustical, Fire alarm and Firefighting systems, Water supply and Drainage have been designed.

- Quantity surveying & Cost Estimate.

  In this chapter, the quantities and costs have been estimated in detail for the project.

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