An-Najah National University

Faculty of Engineering and Information Technology

Building Engineering Department

Course: Graduation Project 2

Integrative redesign of bank institution in Nablus

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Dedication:

We dedicate this dissertation (our graduation project) to the faculty of engineering in An-Najah university, specifically the building engineering department for its limited resources of educational related knowledge, providing comfortable studying areas, and plenty of technologies and equipment's which helped us majorly during our studying phase. Moreover, this dedication includes our beloved doctors who had the patience and dedication to teach us and provide us with all the information and knowledge needed to be successful in our lives. Also, a special dedication to our graduation project supervisor Dr. Fadi Fatayer, not only for aiding us throughout the project, but for being eager on us to be the best and work the hardest in order to achieve the ultimate goal.

Acknowledgement

Similar to any major project like graduation project, which requires years of hard work and dedication with the intention of accomplishing it, would not be achievable without the help and love of the surrounding people around us. Therefore, we would like firstly to praise God for giving us the insight and blessings throughout our work. Second, a sincere thank you to our parents and siblings for unlimited amount of love and support was given in times were such act of believe and encouragement is needed for us to rise above this difficult challenge. Last but not least, we would like to express our gratitude to our doctors for being true and honest to their jobs by teaching us with heart and effort with intention that us students become supreme at what we implement in our fields of work. Additionally, a special gratitude to Dr, Fadi Fatayer for being the greatest supervisor that anyone could hope for.

Disclaimer

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Table of content

List of figures

Nomenclature /List of symbols:

%: percentage

ϕ : soil friction angle

≤: less or equal

° N: north degree

°E: east degree

Kg: kilo gram

kN: kilo newton

L.L: live load

Dfu : fixture unit

dB: Decibel

KW: Kilo Watt

Abstract

A bank is an institution that mainly deals with money related activities and provides plenty of financial services. Also, a place with high security standards for people to deposit their money safely. Banks deals with checks and gives out loans for aiding people in need. As a result of that, banks are considered one of highest value buildings in any city/town. To understand the functions of a bank and how it operates thoughtfully, you have to acknowledge how every space included in the bank functions. Examples of the spaces in a bank, a conference room, meeting room, employee offices, safe rooms, etc...

Most banks do not follow the guidelines and standards of an integrated design, that requires certain international standards and regulations to achieve. Exceptionally high Security measures should be applied to the bank, considering that banks are high value buildings. However, unfortunately banks generally don't implement high security measures in design, which leads to higher risks of thievery and robbery. Other issues related to bank designs, space proportions/distribution, parking spaces, and waiting areas, etc....

the main objective in this project:

- To design integrally taking into consideration, architectural, environmental, structural, economical, and safety aspects of the building.

In order to achieve such goal a certain methodology had been followed. At the beginning, site analysis and literature review are performed gathering all information related to bank institutions, by reading educational books and articles, conducting a number of surveys to receive expertise advice. After gathering all the information needed. The procedure of achieving a fully integrated designs have been divided into a variety of steps. First of all, the architectural aspect has been improved including space dimension, distribution, and orientation using AutoCad programme.

Consequently, the environmental aspect has been analyzed, by revising the topography of the building, buildings nearby to calculate shading and to achieve maximum comfort (checked by Revit programme/design builder). After that, structural checks and analysis have been performed to ensure stability throughout programs like SAAP and Etabs. Mechanical systems like HVAC, water supply and pipe distributions, have been taken into consideration to avoid any conflict with other systems, and achieve fully integral design. Then, electrical systems have been proposed including cabling and lighting distribution, power systems, and control panels which is achievable by using the DIALUX program. Last but not least, safety measurements like fire exits, firefighting systems, escape routes, and alarm systems are included in the aspect of safety design.

In conclusion, an integrated design had been achieved following the standard of a regular bank, using various designing applications:

- AutoCAD, is used to design the building in 2D to confirm if the standards and regulations are met.
- Revit. is used to view the building in 3D which gives a different perspective of the design. Also used in some environmental checks.
- SAAP, ETABS, SAFE, will be used to check if the building is structurally stable.
- DIALUX, is used for lighting distribution and coverage.
- ECOTYCT,INSUL,EASE, is used to design for acoustical comfort.

Chapter 1: Introducto

1.1. Introduction:

As known around the globe, each country has many different sectors included in the developing of the country. Each sector plays an important role in the enhancing of society quality of living, for instance, construction, commerce, agriculture, etc.... Economical sector which includes the banking sector is one of the most important sectors for communities to consider boosting. In order for people to strengthen the banking sector, they should have a fully understanding idea on how the economical aspect operate. (Manthos D.Delis,2011)

Banking sector nowadays is becoming way more complex and sophisticated than it was in the past. Moreover, is one of the fastest growing sectors, due to plenty of applications that accompanied the technology era. For example, the e commerce, digital currencies and online banking, etc.… However, in order for societies to be successful at that, an improved understanding of the banks basic function should be implemented in people's minds. The main objectives that decide the scope of work are: designing an architectural that meets the standards of spaces inside a bank, taking into consideration the orientation of them. Checking if the building is environmentally compatible by using several simulation applications. (Manthos D.Delis,2011)

Are banks safer? A question asked frequently since bank institution are relatively new especially in Palestine, people are used to old methods of depositing money. Banks are much safer than old methods, considering the fact that, money is electronically deposited removes the risk of thievery. Also, physical money is vulnerable to humidity and weather condition, which may lead money to ware out and torn apart. As a result, depositing money through banks is much safer, although is may have some disadvantages, but the advantages out weight the disadvantages. (Polizzi, S., Scannella, E., & Suárez, N. (2020))

1.2. Planning considerations:

This bank was designed using AutoCAD application. The bank consists of 9 floors. Exterior design is specified as a traditional style bank. the first two floors are about the same area in size. However, the other five floors are different in sizes, and one basement floor used as a garage for employees.

- Basement floors are around 6140 m2
- Ground and 1st floor are around 880 m2 individually
- 2nd floor is around 482 m2
- Floors from 3 to 8 are around 334 m2 in area for each space
- Outside space

So total area of the project is 10080 m2.

1.3. problems:

Studies were conducted and feedback were taken, to avoid any problems located in previous bank structures. Banks structures should be design integrally accommodating the architectural, structural, and environmental aspects of the building. Here is a list of some issues regarding bank structures.

- Space proportions standards are not met in most buildings.
- Having difficulty forming a good entrance for the building
- Not taking into consideration the hazard situations for example, fire exits, escape routes, etc...
- Capacity of people is usually larger than expected, including parking spaces.
- Elevators not enough for costumers.

1.4. objectives:

The main objectives to be considered while working on this project.

1. To perform analytical studies about bank standards and regulations.
2. To apply the standards and regulations on our unmodified plans or project.
3. To make sure all standards are being applied on the new project to redesign it into a better enhanced version.
4. While redesigning take into consideration the environmental aspects to insure maximum comfort.
5. Design the structural skeleton integrally with the new design to avoid any conflicts between architectural and the structural aspects of the building.
6. Design for electromechanical aspect, including HVAC , water and drainage distribution, and acoustical comfort.
7. Take into consideration the economical values of materials, to form a well-rounded bill of quantity that satisfy the costumer.

1.5. methodology:

The graduation project is mainly divided into two categories, graduation project 1 and graduation project 2 during two full semesters in 2022/2023, in this report graduation 1and 2 will be discussed. Graduation project 1 went through a methodology with a verity of steps to reach completeness. In the first step, literature review of the site and building had been conducted, to fully understand the functionality of the structure for better understanding of the design approach, and the issues that might occur during execution and post occupancy phases of the building. Literature review which is mainly studying the standards and regulation of site topography orientation for sun path, and spaces within the institution can be conducted by studying existed similar buildings which help to avoid any further setbacks, feedback from experts and end users (Occupants). in the second stage, the execution of the studies that were conducted by making comparisons before modification and after modification for the architecture design and for environmental analysis after that, check if the modifications are met to standards and regulation through programs like Auto-CAD for 2D modeling and Revit for 3D modeling. and. Last but not least, check if the building is structurally stable using programs like SAAP and ETABS, additionally check if the building is economically friendly and will satisfy the customer. Graduation project 2, included a wider and more detailed checks by including seismic analysis in the structural aspect, also more accurate environmental check by using design builder program. Furthermore, for electro-mechanical aspect, first of all hot cold-water distribution and calculations then, pipe and floor trap distribution (including drainage). After that, lighting calculation and distribution using DAILUX program. Power designing for wiring and distribution boards in the structure. Last but not least, a fully detailed bill of quantity (BOQ) to sum up all the approximated expenses.

1.6. limitations

Limitations and constrains are usually required to specify the field of work and to remove any confusion during designs, some of the constrains related to a bank structure are:

- Land constrains issued by the municipality.
- Building location and orientation.
- Environmental constrains

1.7. Codes and standards

Redesigning like architecture, site and checks like environmental, structure are all done according to internationally certified codes mentioned below:

Structural codes:

- ACSE: (American Society of Civil Engineers) for load distribution and combination
- ACI: (American Concrete institute) for concrete design and reinforcement

Architectural standards:

- Nuefort 3RD edition for room standards and orientation
- Nuefort 4th edition for room standards and orientation
- Metric for room standards and orientation

1.8. Earlier Coursework

This project knowledge is based on previous courses in building engineering department that are mandatory to complete for achievement of all studies and checks in this project, examples are shown below:

1. Architectural design: Computer Aided Building Design, Integration of Building Systems
2. Environmental analysis: Environmental Systems Design I - Lighting, Environmental Systems Design II Thermal, Building Core Systems,
3. Structural Design: Concrete Design 1, Concrete Design 2
4. Economic Studies: Construction Bids & Contracts Administration, Building Economics, Quantity Surveying and Cost Estimate
5. Building construction 1, Building construction 2.
6. Acoustic simulation, thermal simulation, lighting simulation.

Chapter2: ENVIRONMENTAL ARCHITECTURAL ASPECTS

2.1. Literature Review

2.1.1. Introduction

This chapter is containing the requirement spaces in bank and the relationship between them, Bank contain several spaces, entrance, manager office, meeting room, banking hall, cash counter, service room such as toilet etc.… and storage room

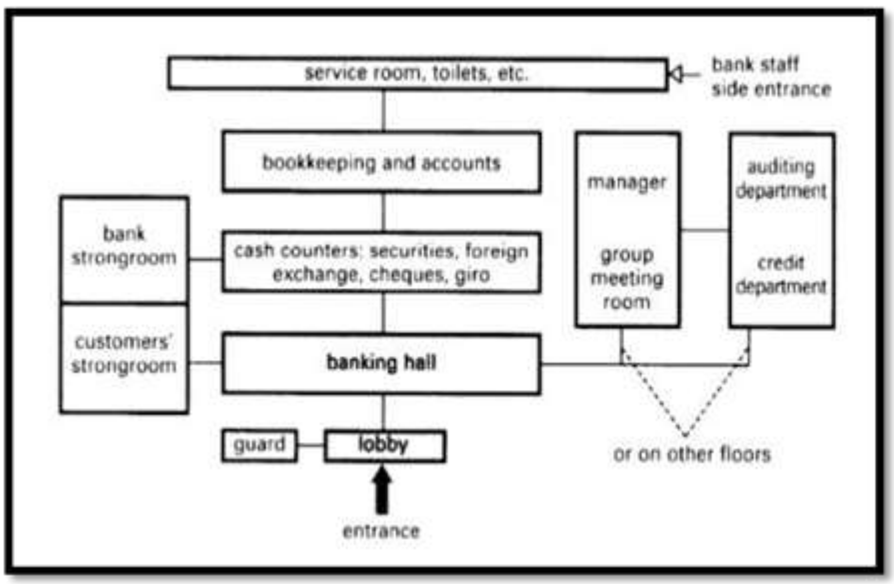


Figure 1- Bank Room relationships (Nuefort,2014)

Globally, banks usually require an entrance from the main street, then from the entrance to the banking lobby. banking lobby ordinarily includes chairs for clients to be seated for waiting.

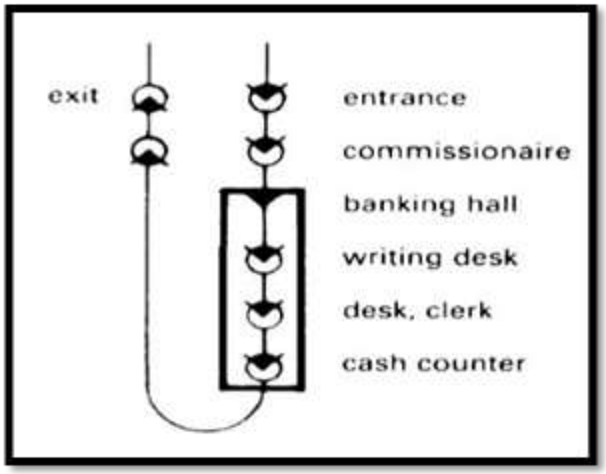


Figure 2- Bank Room relationships (Nuefort,2014)

2.1.2. Spaces and Standards:

Exterior design of Banks:

There are various exterior banks designs that can be implemented to give a distinctive and fancy exterior appearance, most commonly used designs are, traditional design and modern design Traditional design is a regular concrete construction, with a classical exterior appearance. Modern design is uniquely shaped, with high usage of glass for exterior coverage

Figure 3 - Traditional Exterior Design

Figure 4 - Modern Exterior Design

Interior design of Banks

as known around society banks are one of the highest-value buildings in the country due to, having plenty amount of money-related activities. also, large quantities of clients are expected to be present at the same time, as a result of that, the interior design should include high security and large areas to fit all client’s interior.

designs of typical banks should include:

Lobby:

it's a space that holds great importance. the lobby is a space that includes a banking hall seating for customers to wait, reception, and cashier counters.

cashier counters and dealers have different orientations depending on their location of them.

if it's aligned with a wall the angle should be greater than 180 degrees.

if the counter is curved, it should be curved towards the staff.

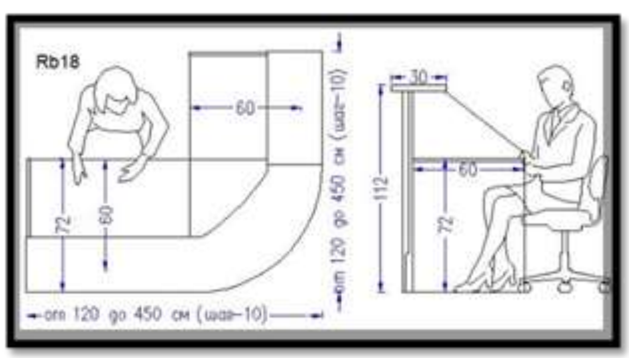


Figure 5 - Reception Desk Dimensions (Nuefort,2014)

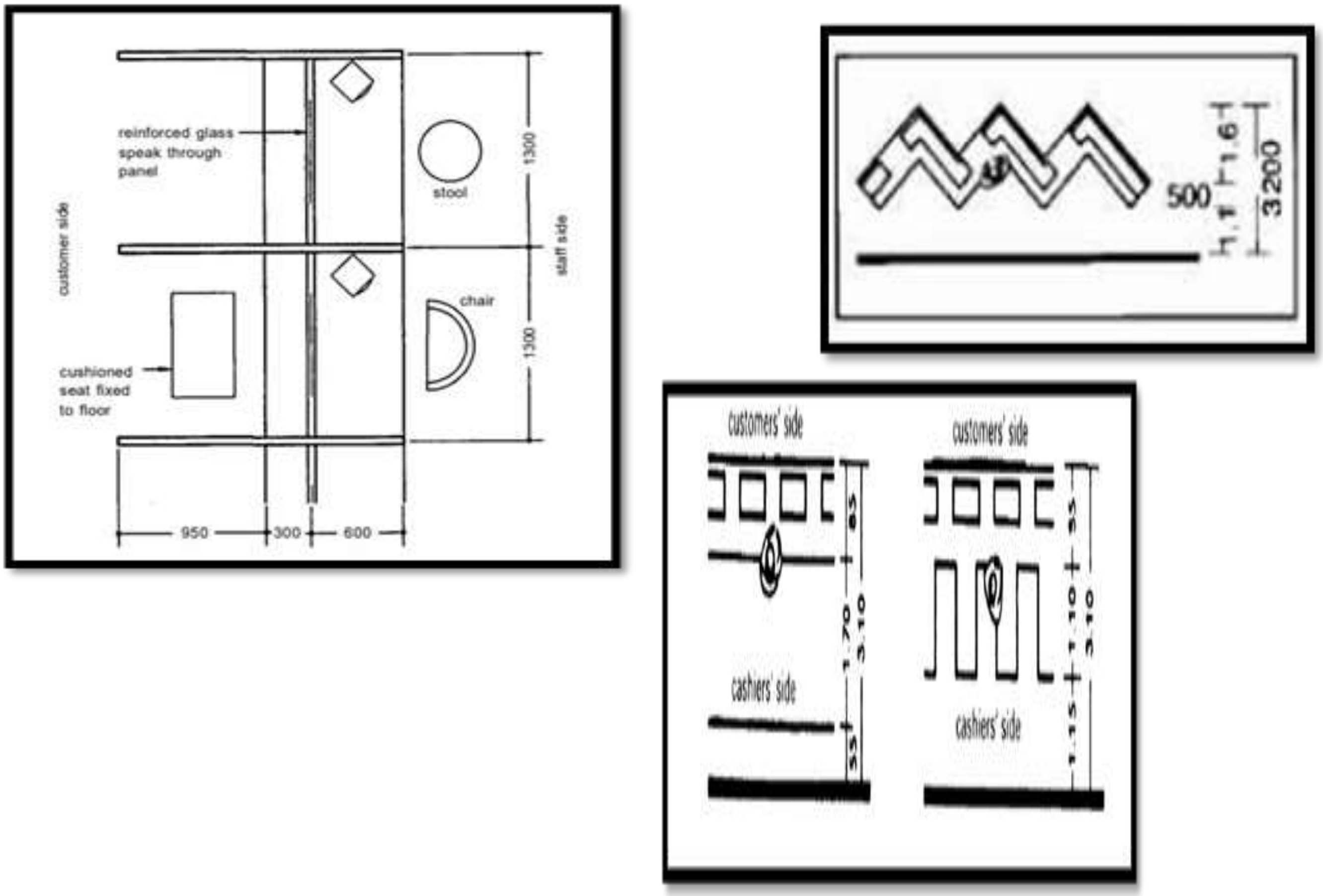


Figure 6 - Cashier Desk Dimensions

The waiting area:

waiting areas are included in the lobby, with enough seats for customers to sit and wait for their turns. Additionally, the location of seats should not block the flow of movement in the lobby regular seat dimensions are 1.2 x 0.75 and 1.4 x 0.8 for disabled customers with wheelchairs

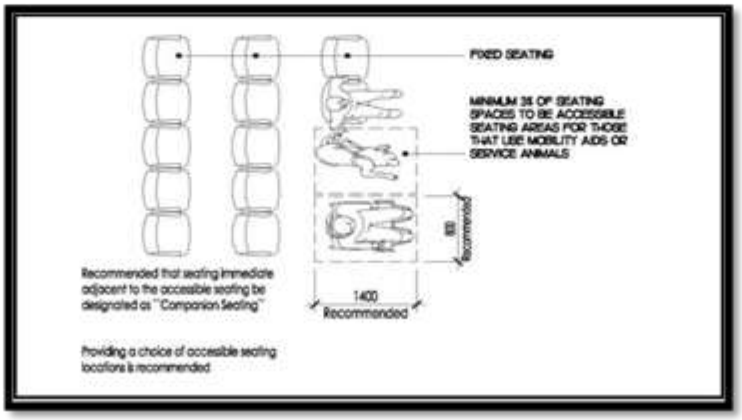


Figure 7 - Waiting Area (nuefort,2014)

Staff zone:

includes multiple division

Offices Spaces

that consists of desks for employees, each office area has a standard dimension depending on the number of employees per office, shown in the figure.

Table 1 - Staff Offices dimensions (Nuefort,2014)

Workgroup Space Footprint Calculation Chart				
Number of Staff	Current Space Utilization (staff per useable space)		Proposed Space Utilization (staff per useable space)	
	m²	ft²	m²	ft²
1 to 5	22.9	246.5	**22.0**	236.8
6 to 10	20.5	220.7	**20.0**	215.3
11 to 20	18.9	203.4	**18.6**	200.3
21 to 40	18.0	193.8	**18.6**	200.3
40 plus	18.0	193.0	**18.0**	193.8

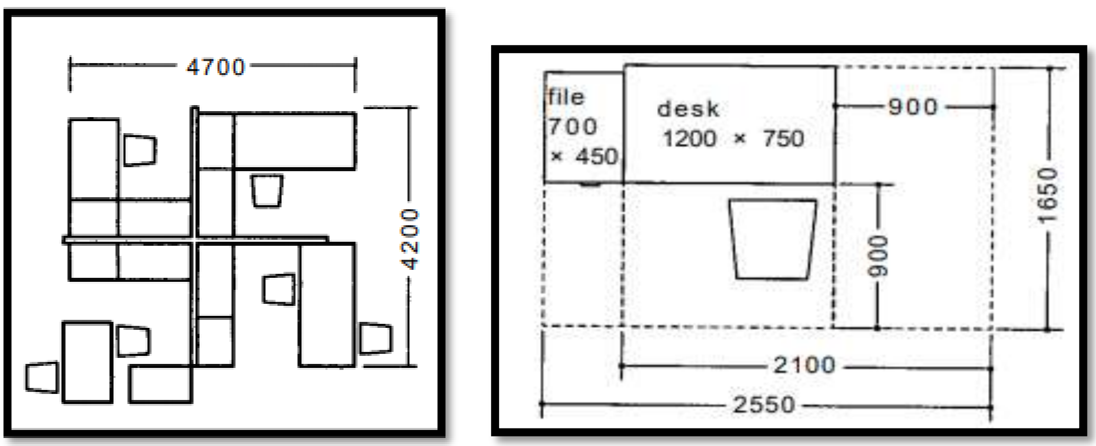


Figure 8 - Staff Office Dimension (Nuefort,2014)

Administration Department

consists of manager's office, deputy manager's office, conference and meeting rooms, and a secretarial.

The manager rooms

a bank manager is responsible for supervising almost all activities in the bank. room dimensions should be between 20 to 30 m^2.

The deputy manager room

a deputy manager is responsible for supervising in the absence of the manager.

The secretary room

is the closest office to the manager's room and responsible for organizing and keeping everything in order for the manager

Table 2 - Managerial Office Dimension

Type of office	Function	Area per person
Private office	Senior manager/director	20-30 m^2
Private office	Manager/department head	15-20 m^2
Private office	Manager/professional	10-15 m^2
Private office	Manager/professional	10-15 m^2
Small group room	Professional	10 m^2
Large group room	Professional	9 m^2
Open plan	Professional	9 m^2
Open plan	Secretarial/administration	9 m^2
Open plan	Clerical	7-9 m^2
Group room/open plan	Dealer	6-9 m^2

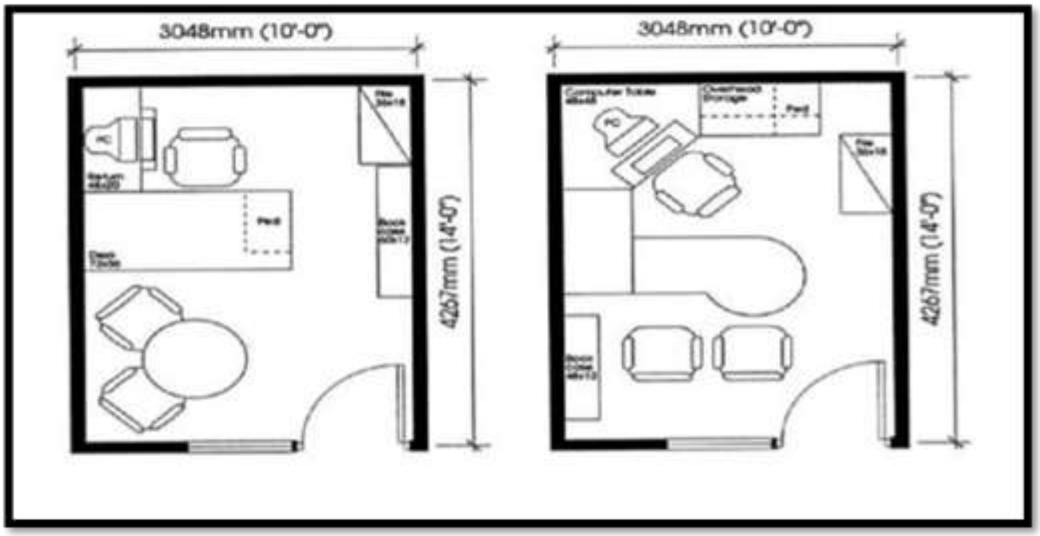


Figure 9 - Managerial Office Dimention (David,2016)

Conference room

a conference room is important as plenty of meeting among the staff are being held, in order to discuss key ideas and plans. Moreover, the conference room should be centrally oriented to be close to all staff offices with dimensions between 50 to 100 m^2.

Records dep

called the archive room, it must be safe and easily accessible due to, it containing private information for client and for the bank.

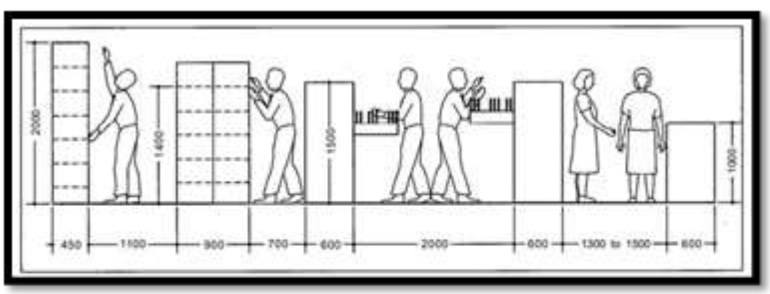


Figure 10 - Record Department Dimensions (David,2016)

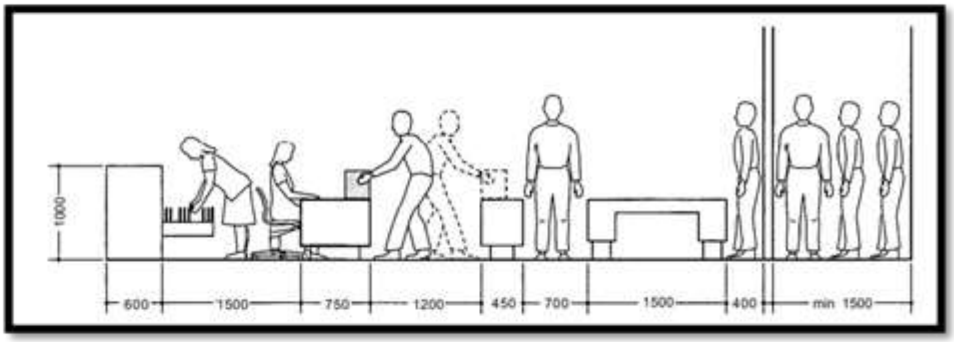


Figure 11 - Record Department Circulation (David,2016)

Bank vault

the bank vault is the most important room in the bank, because, all the bank deposits and money are stored there. therefore, it is designed of hard solid reinforced concrete with a thickness ranging from 20 to 30 cm, also a special door is attached to the vault for the armored truck to transfer money from or to the bank.

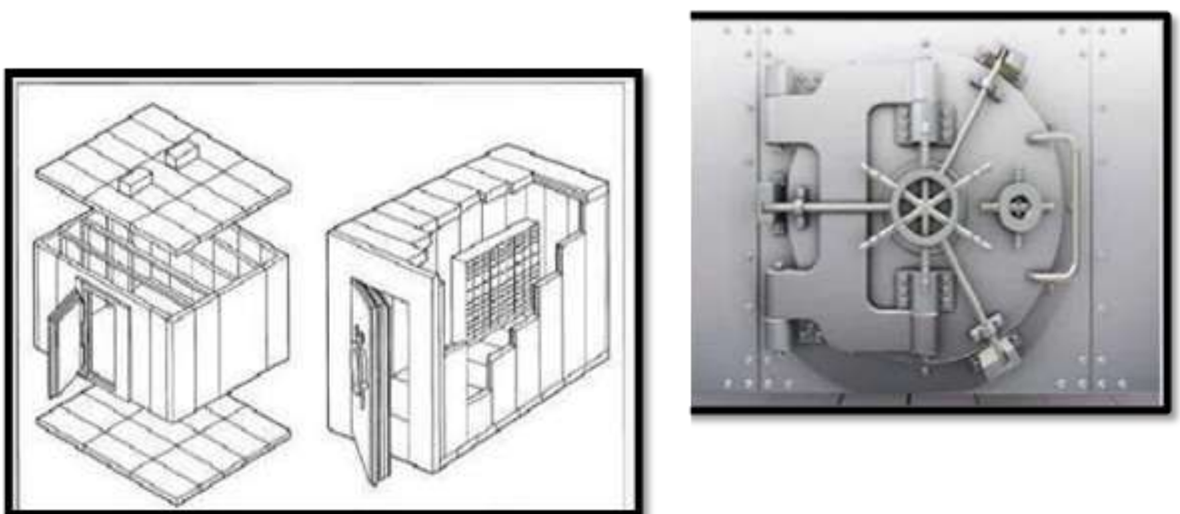
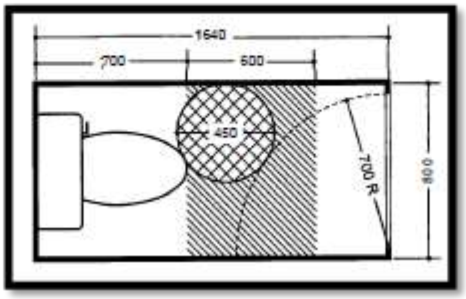


Figure 12 - Bank Vault (David,2016)

***Services**

Bath rooms

bathrooms are exclusive to employees in the bank for security purposes, the number of bathrooms varies depending on the number of employees.



Number of persons at work	Number of WCs	Number of washing stations
1 to 5	1	1
6 to 25	2	2
26 to 50	3	3
51 to 75	4	4
76 to 100	5	5
Above 100	One additional WC and washing station for every unit or fraction of a unit of 25 persons	

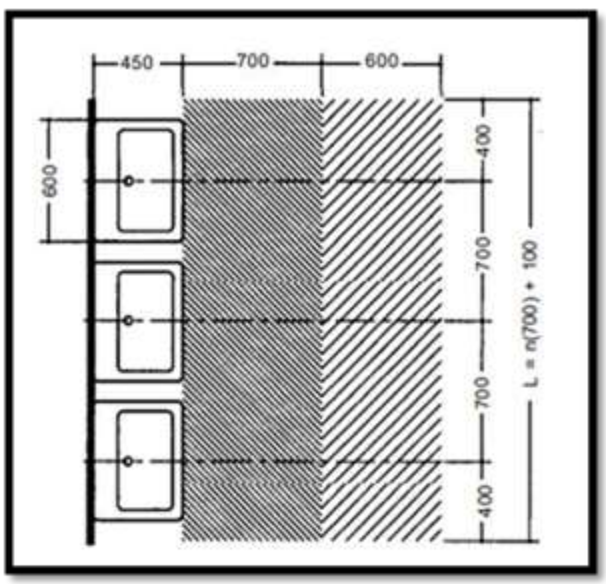


Figure 13 - WC Dimensions and Circulation (David,2016)

Elevators

It’s used to transport people vertically between different floor

Number of elevators depend on type of building.

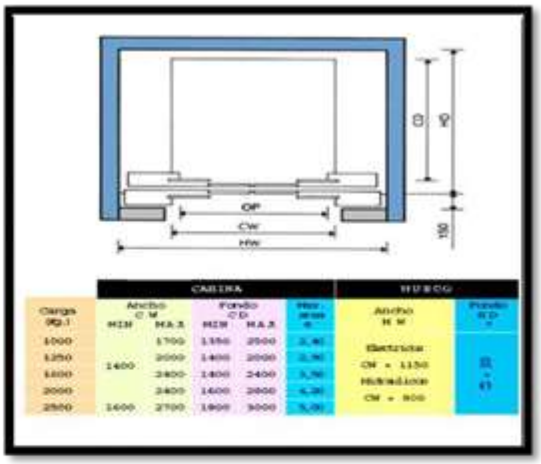


Figure 14 - Elevator Dimensions and Standards (David,2016)

Stairs

stairs are a key element in the bank which provides a simple method of moving between floors. width of the flight should be 1.5 m

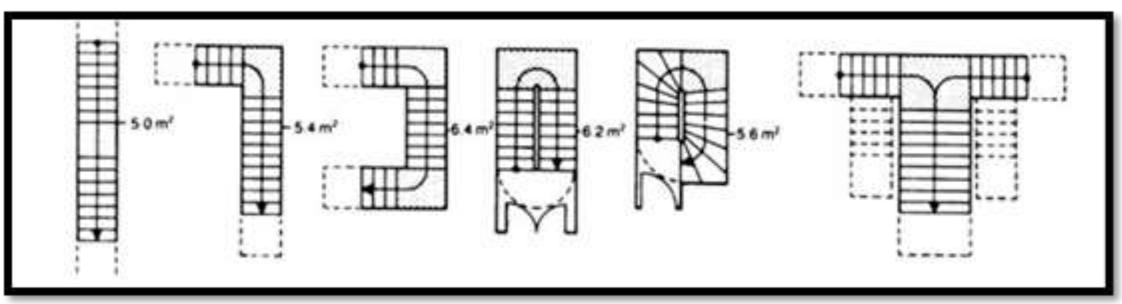


Figure 15 - Staircase Shapes and dimensions (Nuefort,2014)

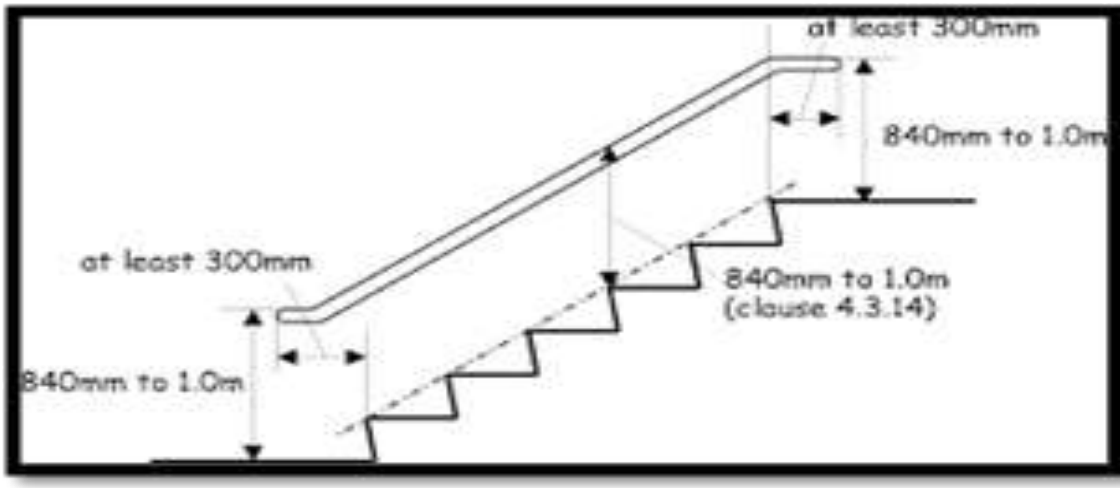


Figure 16 - Staircase Elevation Dimension (Nuefort,2014)

Corridors

corridors are essential because they connect all the parts of the building. the corridor should at least fit two people walking the opposite way. duo to that, the width range between 1.2 - 1.4 m

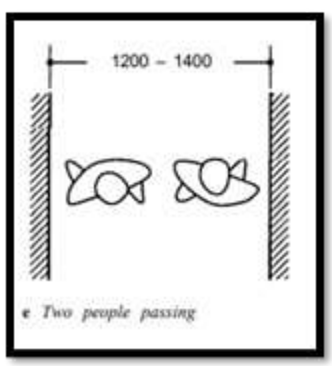


Figure 17 - Corridor Dimension With two People Walking in Different Directions (David,2016)

Kitchen

In these types of building kitchen is used by the staff and must be far away from areas where staff and customers meet

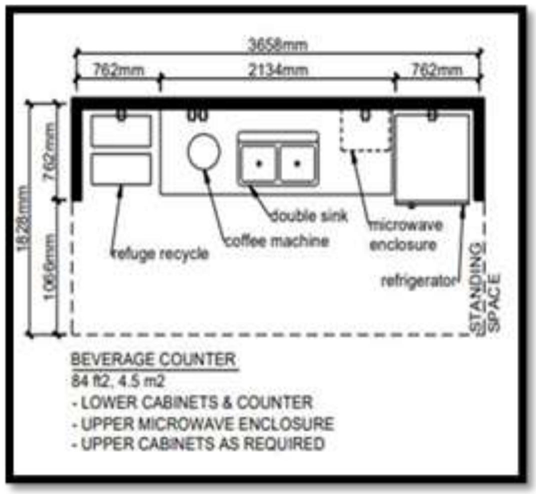


Figure 18 - Kitchen/Cafeteria Dimension and Circulation (David,2016)

Parking

the parking spaces are usually divided into two types, underground parking and above-ground on the street.

underground parking in the basement floor is limited to employees due to security reasons. however, parking's on the street are restricted only to customers

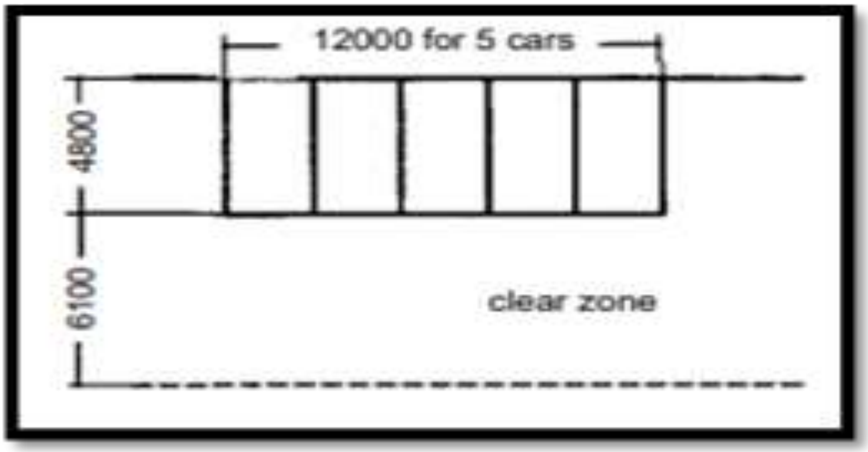


Figure 19 - Parking at 90 Degree Dimensions (Nuefort,2014)

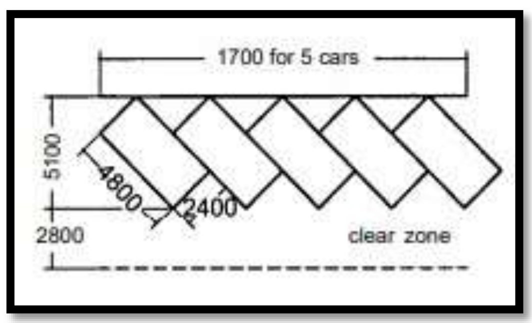


Figure 20 - 45 Degree echelon Parking Dimension (Nuefort,2014)

as shown in the figures dimension for parking that consists of 5 cars are 12 x 4.8 m and 17 x 5.1 for 45-degree parking (echelo

Fire stair

Fire escape stairs shall be to examine for structural ability and safety, it can be reinforced or steel. Minimum number of fire exit is two and it depend on the number of employees and size of the building. The minimum standard width of stairs is 1.1 m

ATM

ATM are initials for automated teller machine, which is a machine that makes it easier for customers to withdraw or deposit money, without the need of waiting inside the bank.

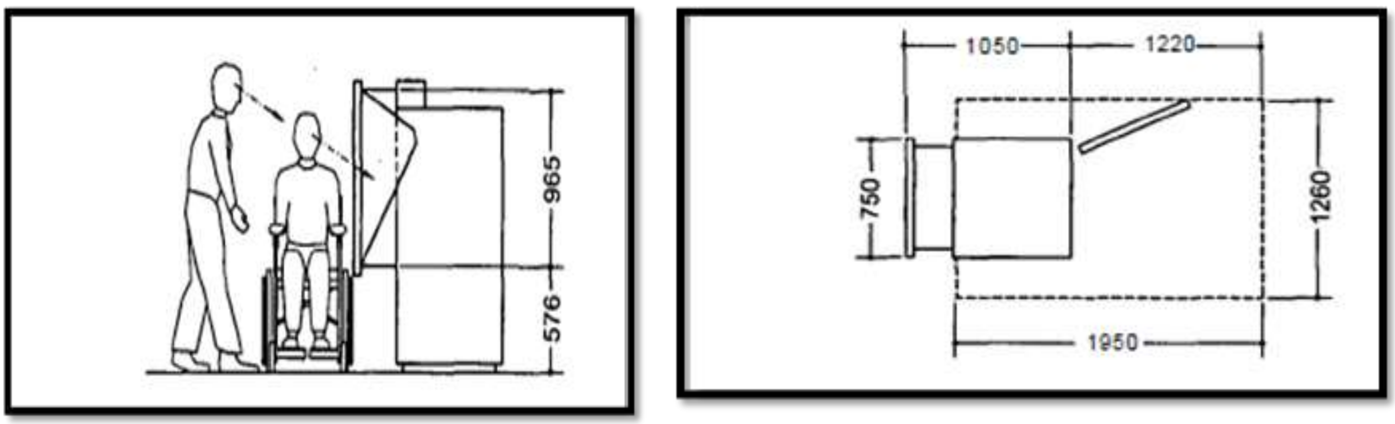


Figure 21 - ATM (Automated Teller Machine) Dimensions considering Handicapped people (David,2016)

Armored bank truck

armored truck is a way of transferring money from and off the bank. they are manufactured to be bulletproof, explosive proof, to defend against any theft attempts.

Figure 22 - Armored Truck

2.2. Case study

Building name: Bank of Palestine

Location: Nablus, Palestine

Founders: Haj Hisham atta shawa, Dr, Hani shawa

2.1.1. Project:

According to bank of Palestine website, bank of Palestine was established in 1960, in purpose of improving the financial services in Palestine. Also, is one of the most widespread bank institutions in the country with all its branches and automated teller machines. Including their expert staff and employees, bank of Palestine serves over 850,000 customers. Regulations and international law were compiled into the institution, as it's required by the Palestinian monetary authority.

2.1.2. Project location:

Bank of Palestine has multiple branches throughout the country. However, the main branch is located near the old downtown in Nablus city at Sufian St.It is considered one of the biggest banks in terms of size.

2.1.3. Project concept:

As the main branch structure was established near 2008, the building was designed as a traditional building, back in the days environmental designing was minimal considering the lack of studies towards that subject, the building was poorly designed in terms of environmental aspect. However, later was modified environmentally and architecturally due to the awareness of companies on the importance to the comfort of people within the institution.

2.1.4. project modifications:

As mentioned before, the designing of the institution didn't consider the importance of environmental analysis and comfort then later was modified to meet the standards. The main modifications that was implemented into the institution was, modifying exterior curtain walls by adding either skin facade (CNC treatment) to minimize heat gain(Direct sun) through glass, or by changing the glass type to low E glass. Furthermore, adjusting room sizes to meet global standards also, create more corridor areas for the movement to become as linear as possible and for escaping routes to avoid collision during emergencies.

2.1.5. Case study Benefits:

This particular case study was used since it was the same institution as our project which is a bank institution. Also, in the same same city (Nablus) as they have similar weather conditions, sun path, and solar gain. Benefits of this case study was giving us ideas on how to solve issues facing us environmentally and architecturally, aiding us on how to avoid future issues and solving them in early stages of designing (Feedback)

2.3. Site Analysis:

2.3.1. Site Location:

The site is located in Nablus city in sofian st. at longitude 32.224168, and latitude 35.259151 and approximately 550 m above sea level, site is around 550 m away from city center (martyrs square roundabout) , the site main entrance from Faisal st. is directed to north.

Figure 23 - Site mapping and specific location (Google Maps)

Figure 24 - Close up look to site location

2.3.2. Site Climatic Analysis:

2.3.2.1.Annual Temperature:

As shown in figure 25 and in table 3, temperature annually averages around 29℃ in summer days (hot days), and 6℃-8℃ in winter days (cold days) ,

According to Weatherspark website "The hot season lasts for 4.4 months, from May 30 to October 10, with an average daily high temperature above 26°C. The hottest month of the year in Nablus is August, with an average high of 29°C and low of 20°C.

The cool season lasts for 3.1 months, from December 8 to March 13, with an average daily high temperature below 16°C. The coldest month of the year in Nablus is January, with an average low of 6°C and high of 13°C."

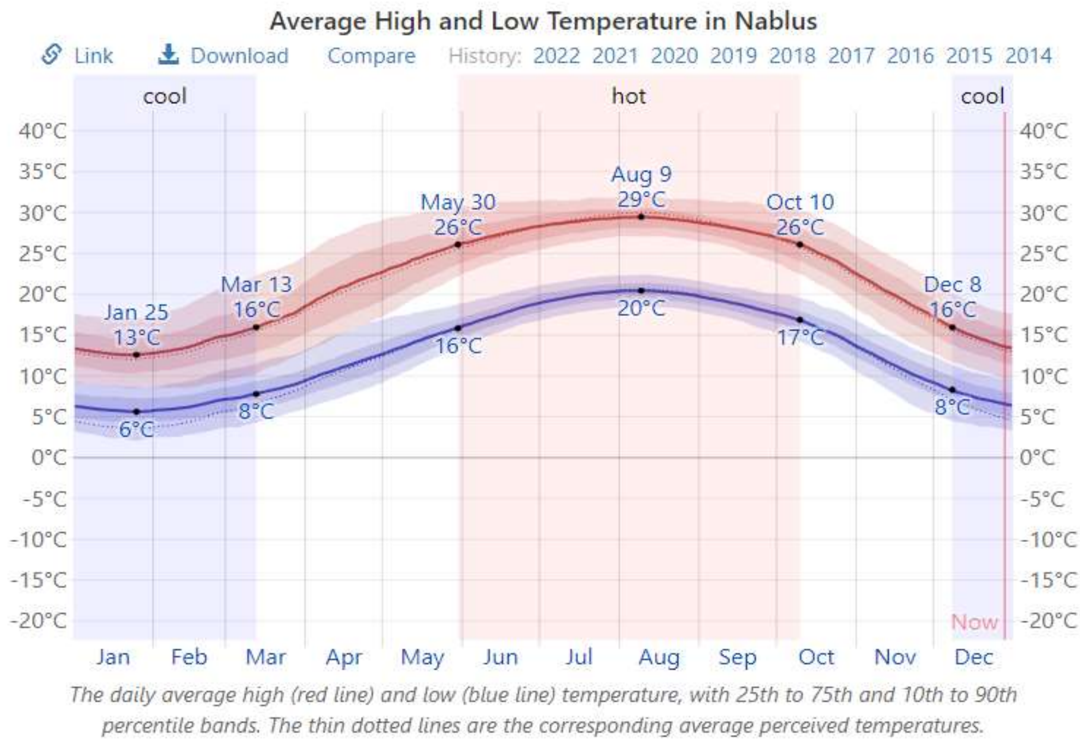


Figure 25 - Average annual temperature in Nablus city (Weather Spark,2022)

Table 3 - Average Annual High and Low Temperatures in Nablus city (Weather Spark,2022)

Average	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High	13°C	14°C	17°C	21°C	25°C	27°C	29°C	29°C	28°C	25°C	20°C	15°C
Temp.	9°C	10°C	12°C	16°C	20°C	22°C	24°C	25°C	23°C	20°C	15°C	11°C
Low	6°C	6°C	8°C	11°C	15°C	18°C	20°C	20°C	19°C	16°C	11°C	7°C

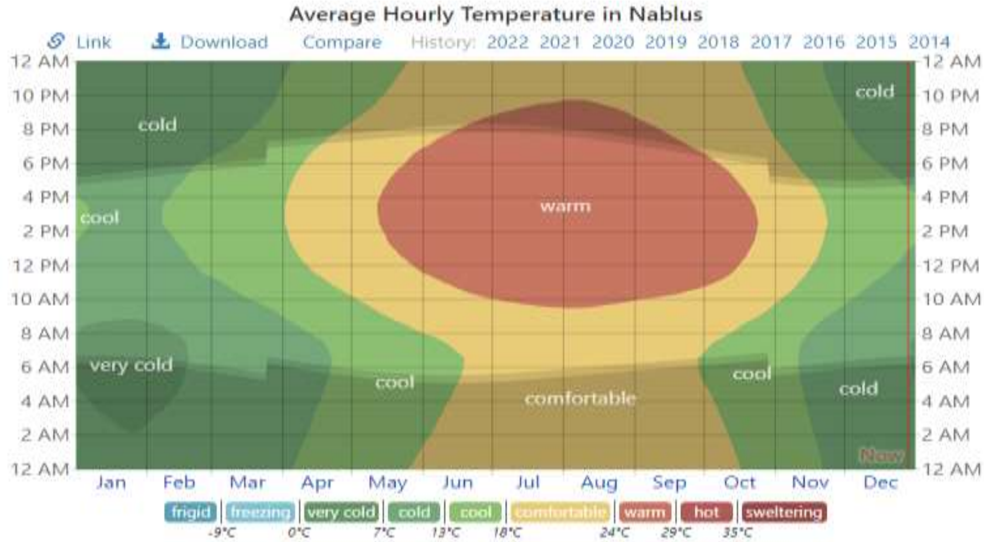


Figure 26 - Average Hourly temperature during the year(Weather Spark,2022)

2.3.2.2. Site Clouds and Precipitation Analysis:

According to weather spark website, the clearest sky month of the year is august and the cloudiest month of the year is December , these statistics effect on the rainy days during the year.

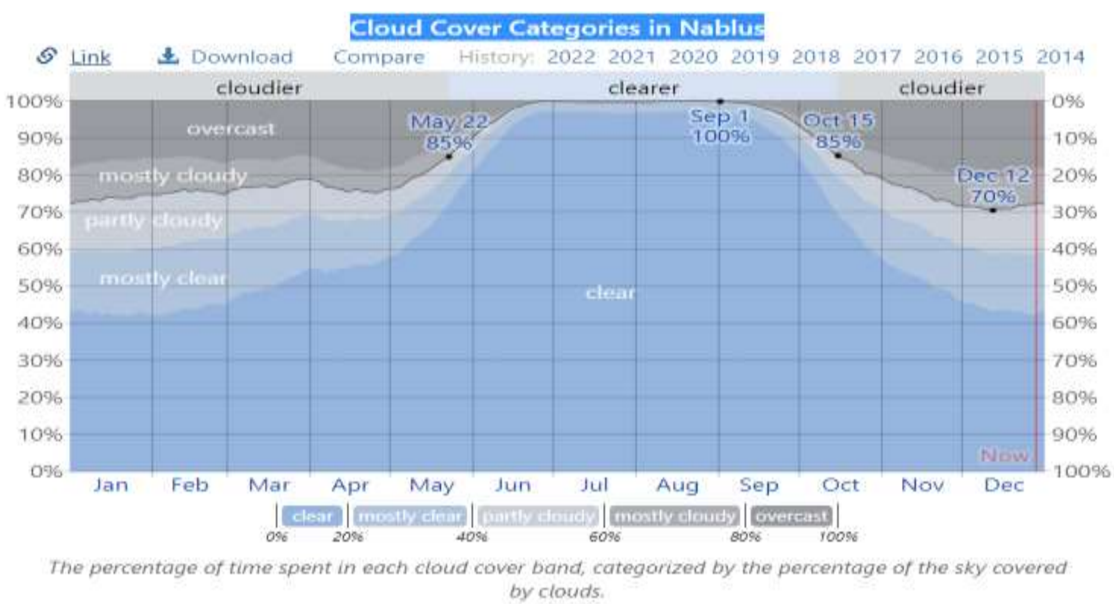
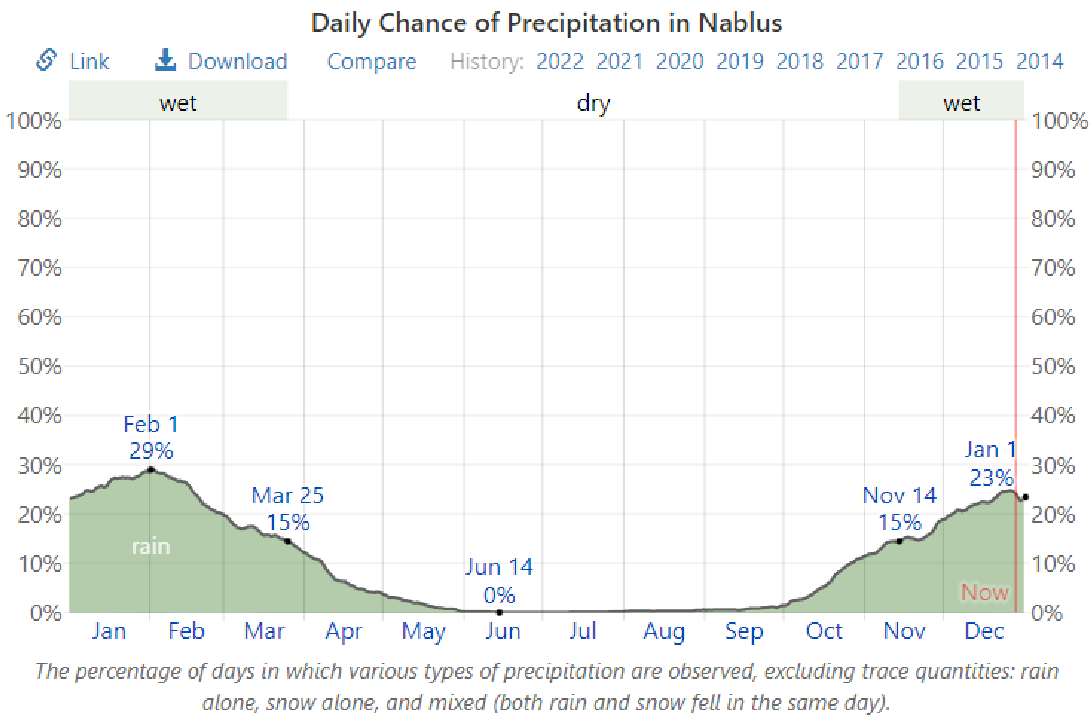


Figure 27 - Cloud coverage percentage during the year (Weather Spark,2022)

Table 4 - Cloud coverage percentage during the year (Weather Spark,2022)

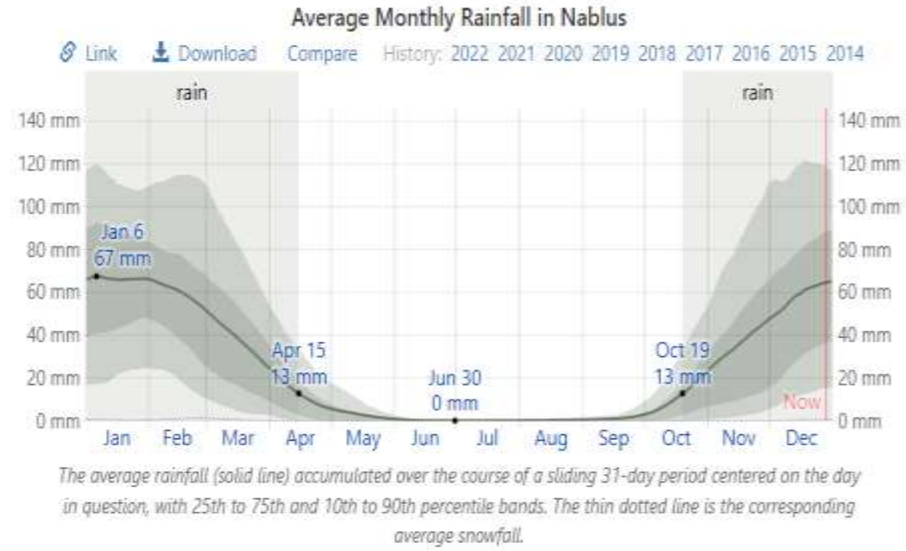
Fraction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cloudier	26%	25%	23%	24%	17%	3%	0%	0%	2%	15%	25%	29%
Clearer	74%	75%	77%	76%	83%	97%	100%	100%	98%	85%	75%	71%

Figures 28 and 29 below show the precipitation (the amount of rain) during the year, with approximately the number of rain days each month.



Days of	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rain	8.1d	6.9d	4.9d	2.0d	0.5d	0.0d	0.0d	0.1d	0.3d	2.0d	4.5d	6.9d

Figure 28 - Precipitation annual graph (Weather Spark,2022)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall	65.8mm	61.3mm	38.6mm	12.5mm	2.7mm	0.1mm	0.1mm	0.3mm	0.9mm	10.5mm	35.2mm	59.7mm

Figure 29 - Average monthly Rainfall (Weather Spark,2022)

2.3.2.3. Wind Analysis (Direction and Speed):

Wind in Palestine is mainly fixed during the year with an average anomaly of 0.2 m/s between the highest and lowed wind speed. The highest wind speed recorded is around 3.1 m/s , while the lowest is around 2.7 m/s . also shown in the figures below. The direction of the wind as shown in figure 31 is mainly western wind and western north , with a small amount of eastern wind during the summer season

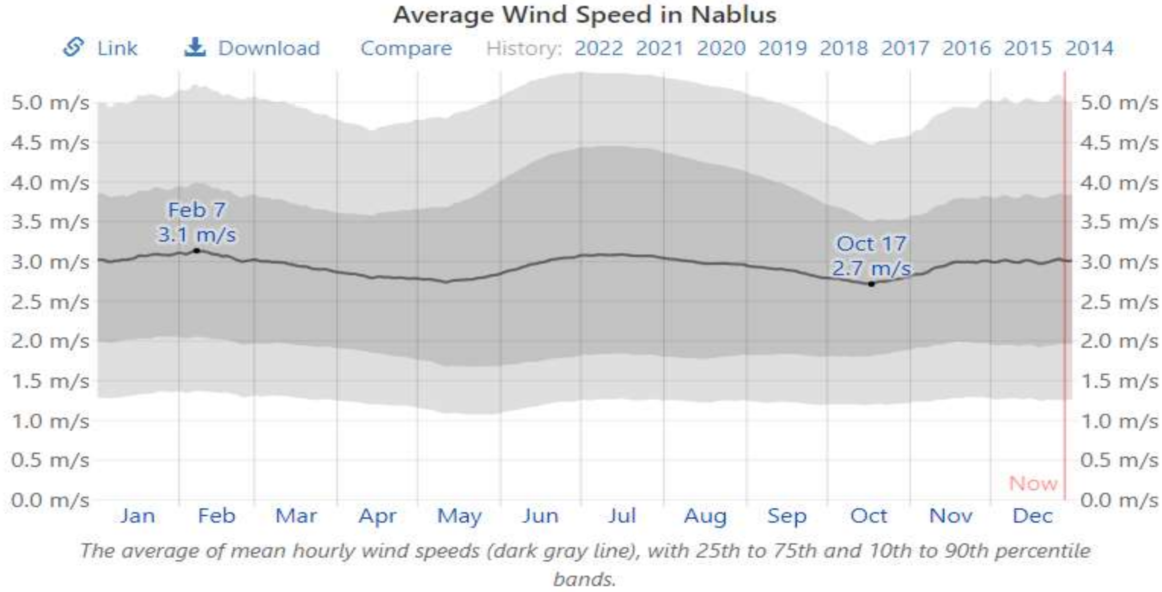


Figure 30 - Average Annual Wind Speed (Weather Spark,2022)

Table 5 - Average monthly Wind Speed (Weather Spark,2022)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind Speed (m/s)	3.1	3.1	2.9	2.8	2.8	3.0	3.1	3.0	2.9	2.8	2.9	3.0

Wind direction during the year is mainly western wind as shown in figure 31

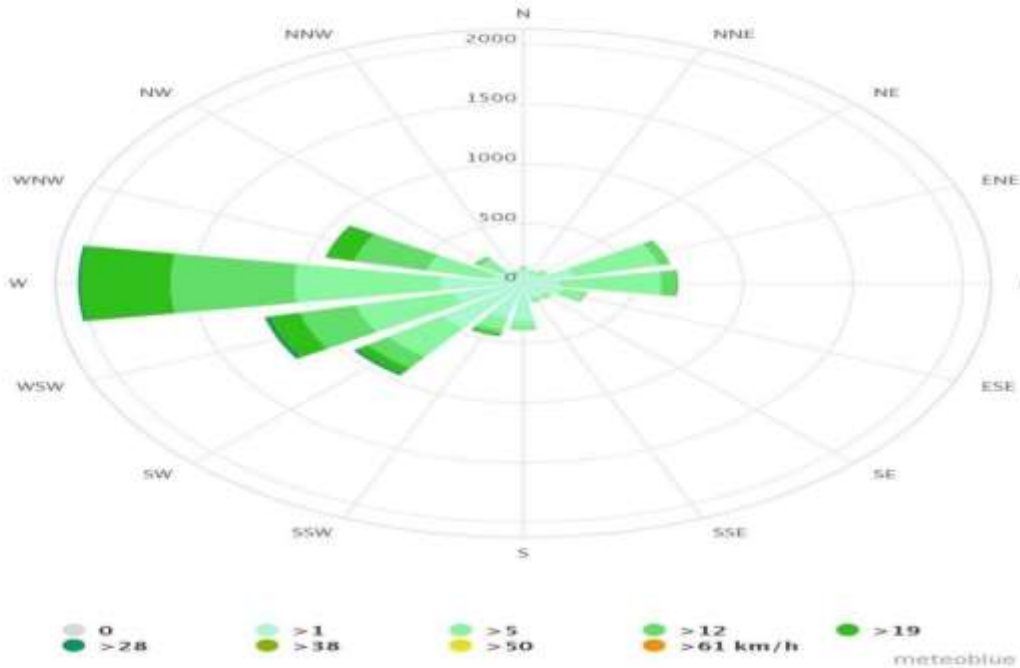


Figure 31 - Wind direction and speed (Metoeblue,2019)

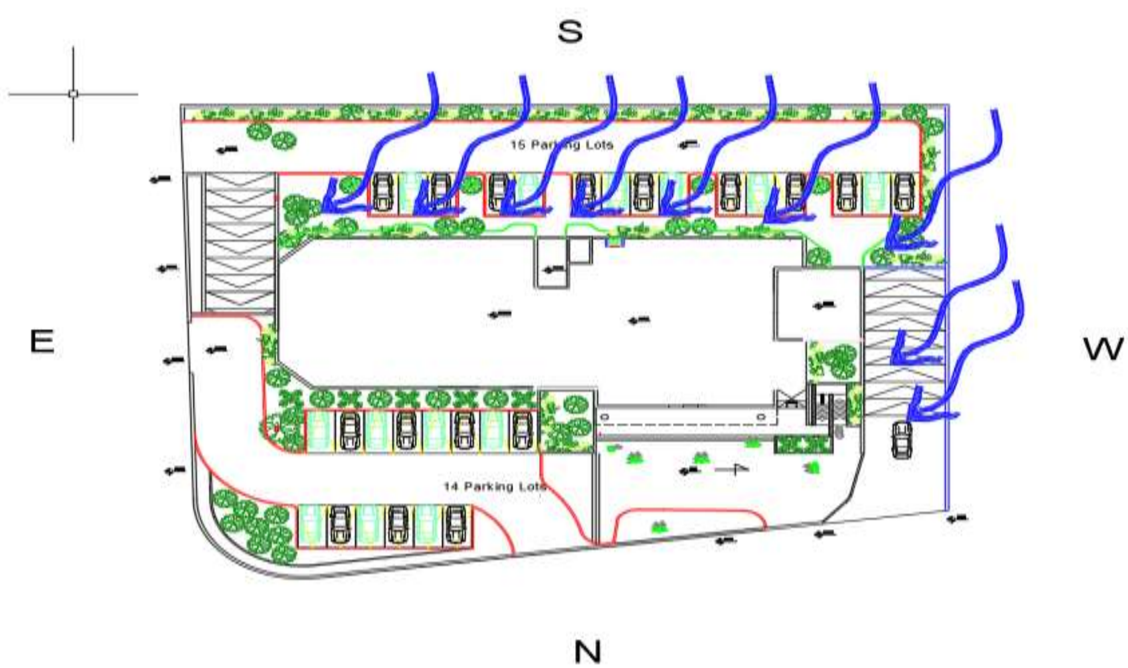


Figure 32 - Wind Direction on Bank

2.3.2.4. Solar energy:

the amount of incident energy per meter square in Nablus city, Taking into consideration the seasonal variation of day length and atmospheric absorption from clouds. Also the direct sun light and the diffused with the ultraviolet radiation.

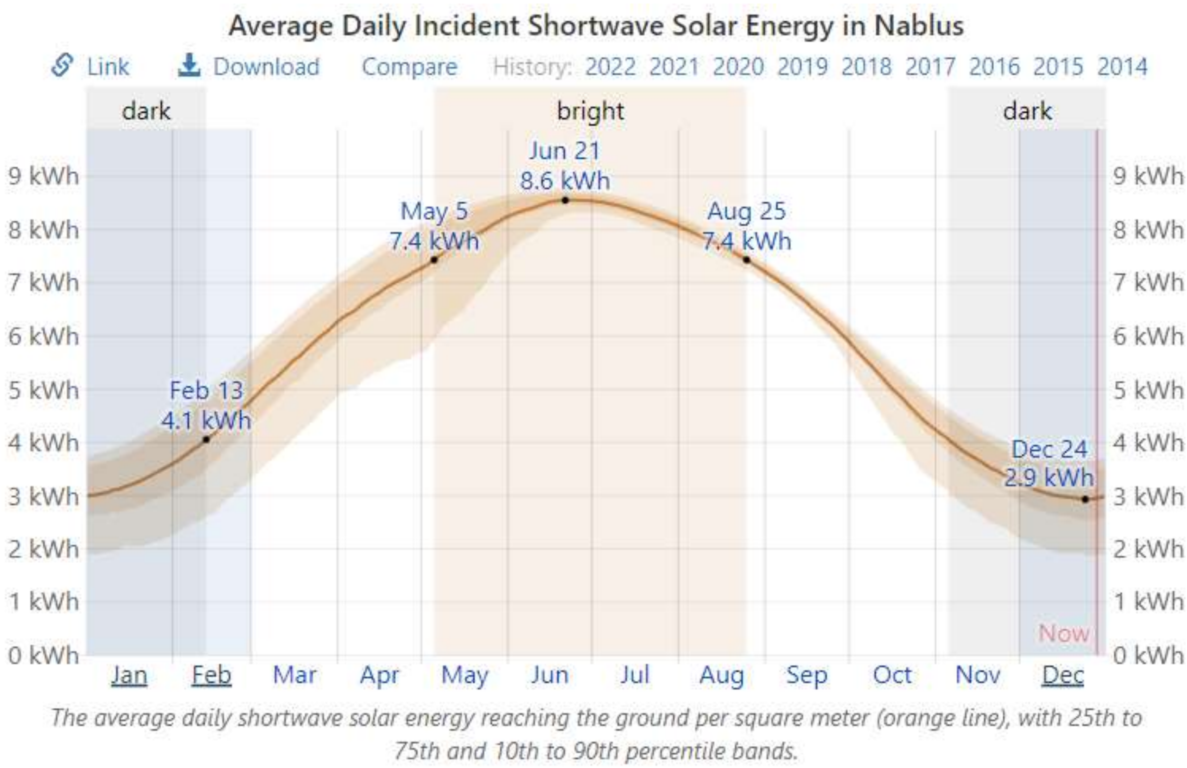


Figure 33 - Daily Solar incident energy in KWh (Weather Spark,2022)

Table 6 - Monthly average Solar Energy in KWh (Weather Spark,2022)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Solar Energy (kWh)	3.2	4.2	5.6	6.8	7.8	8.5	8.3	7.6	6.6	5.0	3.7	3.0

2.3.3. Sun Path Analysis:

In Palestine sun incident angle at 12pm in summer is almost perpendicular with around 81° from the surface and path is longer which lead to more daytime and sun time, However in winter season the sun path lowers to around 34° from the surface and much shorter path than in summer and less day time.

\

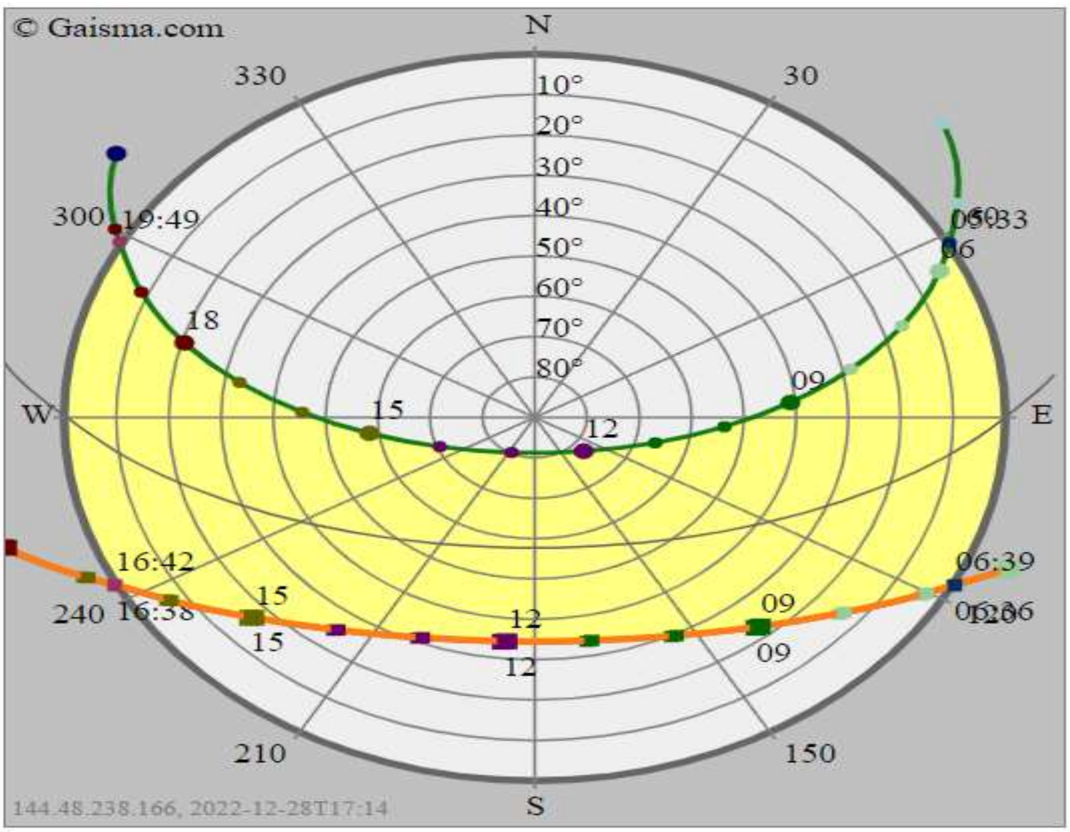


Figure 34 - Sun path during Summer and Winter times (gaisma,2022)

2.3.4. Noise analysis:

Acoustical comfort is one of the most important factor to consider during the designing phase. In addition, acquiring the sources of noises around the building could help in insulating wall/windows in order to achieve acoustical comfort for clients inside the institution.

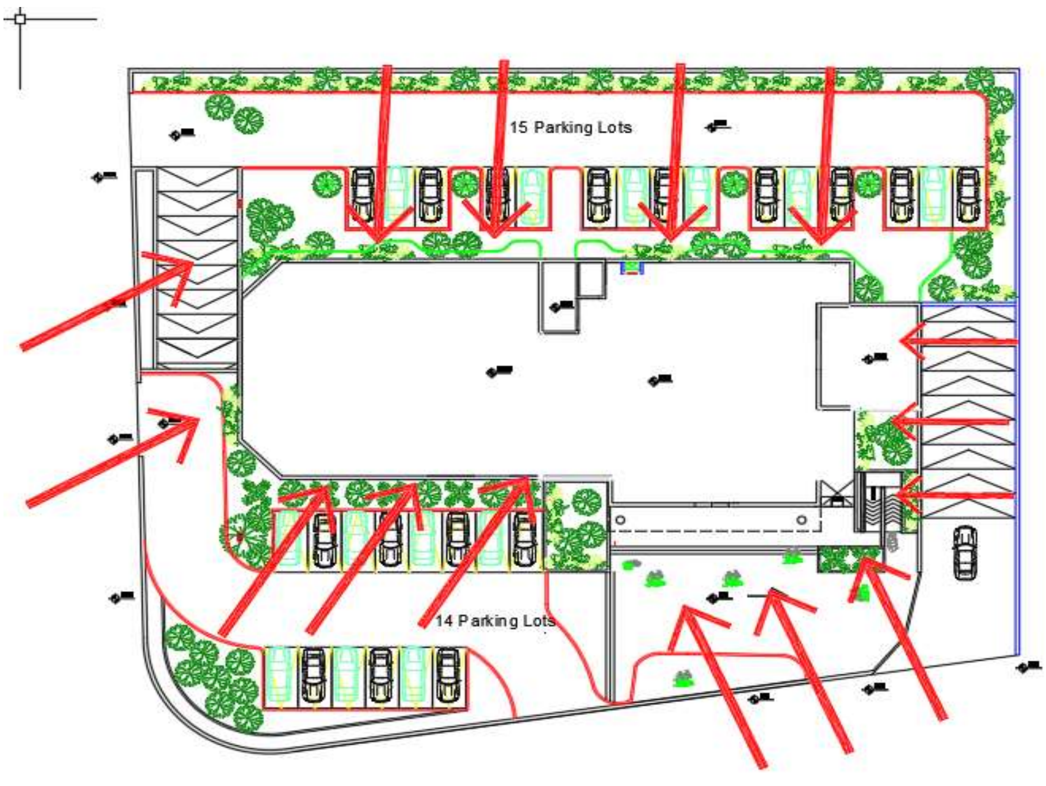


Figure 35 - Noise Directions on Bank

According to figure 35 above, Noise is Mainly from Parking areas and Streets surrounding the building

2.4. Architectural Aspect:

2.4.1. Building contents:

Building contents includes the envelope (Walls, floor and roof), windows and doors

- Envelope: with wall of 30 cm of manufactured stones and concrete masonry units with concrete in between as joining agent and 3 cm polyethylene foam as a thermal insulator.
- Windows: are regular windows with no treatment against heat gain or loss
- Door: regular door with no extra safety considering this is a bank institution and it should be strictly secured

All elements mentioned above will be treated during modification phase later in the report, and will be done according to standards and regulation for secure bank institutions. Moreover, bank designing main concern is safety, so it will be majorly taken into consideration during architectural and environmental modification.

2.4.3. Floor comparisons before modification and after modification:

After going through standards and regulation for the bank, each floor was edited and redesigned to meet the standards. Aalso, a couple of basement floors were added to have enough parking space for clients and employees. Figures below shows each floor of the institution before and after the architectural modification.

1: Basement Levels:

Basement was added after modification, due to not having enough parking spaces for clients and employees, as stated in the codes that, in main branch banks every employee should have 1 parking spot and every 4 clients should have 1 parking spot, Moreover, the main bank safety box was added in the basement level surrounded and separated with fully reinforced steel walls from the parking areas, for safety reasons.

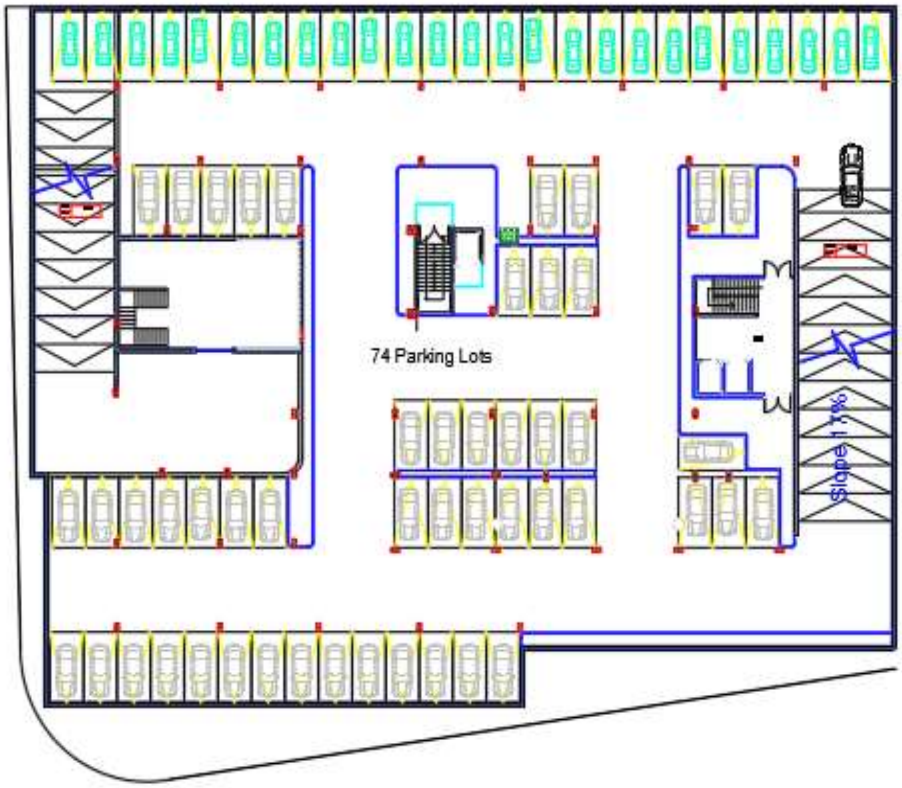


Figure 36 - Basement Level 1

Figure 37 -Basement level 2

General comment:

The parking spaces was calculated based on how many employees the bank have and how people/clients enter the bank per hour. the bank basements have about 154 parking spaces, due to having around 100 employees and 25-30 clients entering the bank per hour

2- Ground Floor: (Before and After Modification)

After **Before**

Figure 38 - GF Architectural Improvements

3- 1st Floor: (Before and After Modification)

After | Before

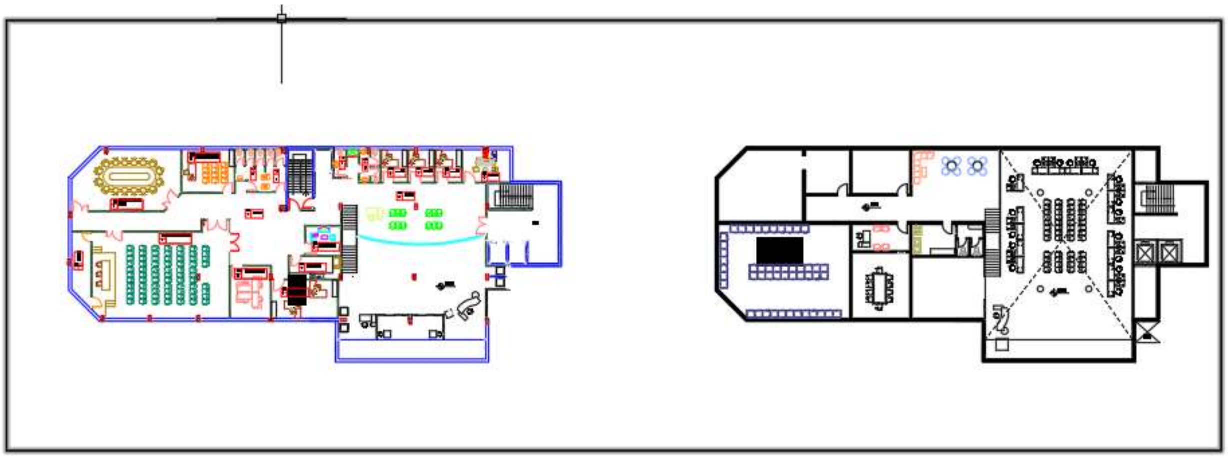


Figure 39 - 1st Floor Architectural Improvement

4- 2nd Floor: (Before and After Modification)

After | Before

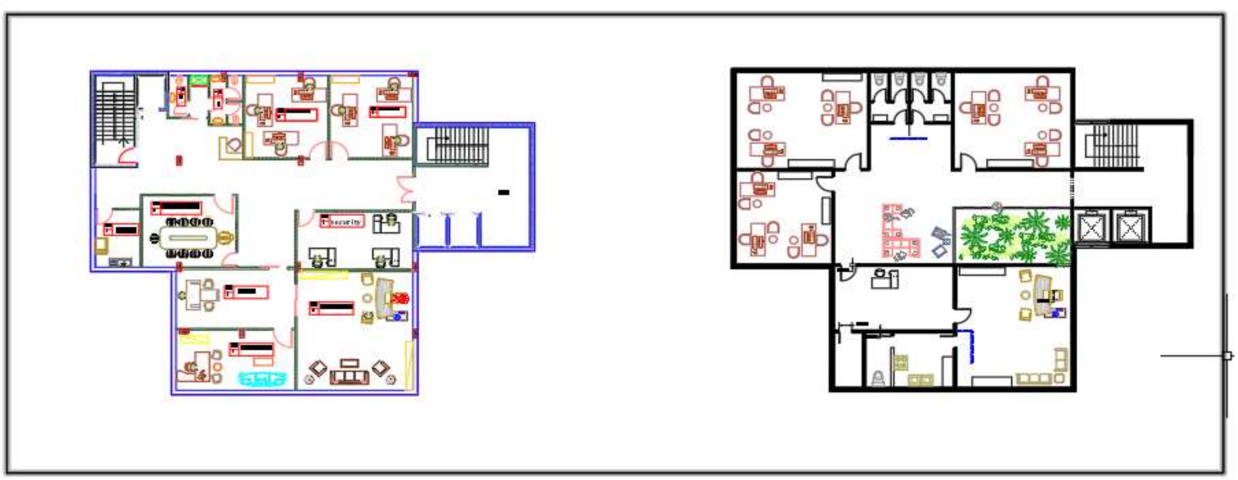


Figure 40 - 2nd Floor Architectural Improvements

5- 3RD Floor: (Before and After Modification)

After **Before**

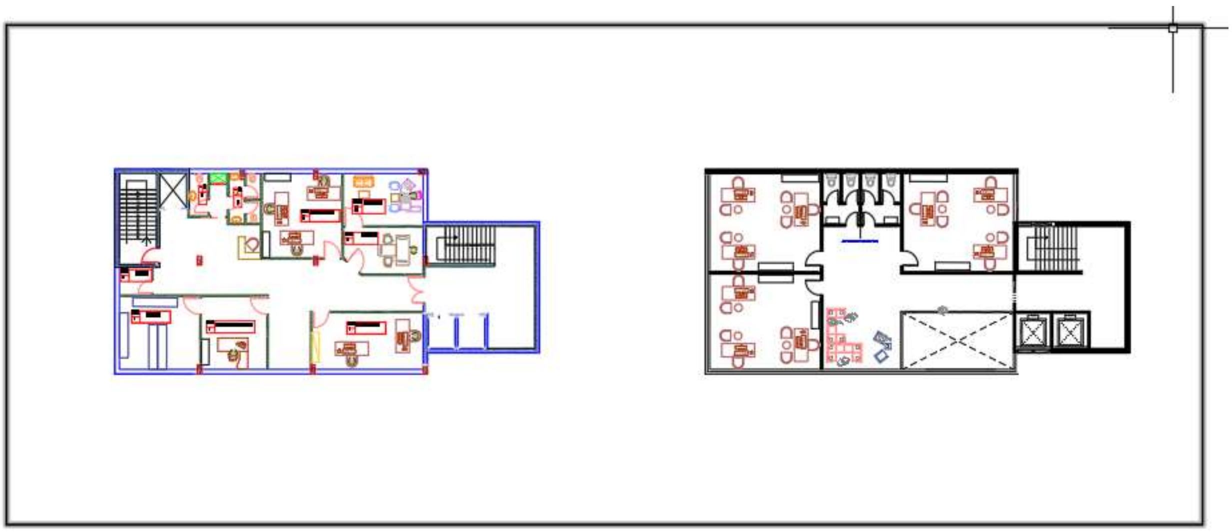


Figure 41 - 3rd Floor Architectural Improvements

6- 4th Floor: (Before and After Modification)

After **Before**

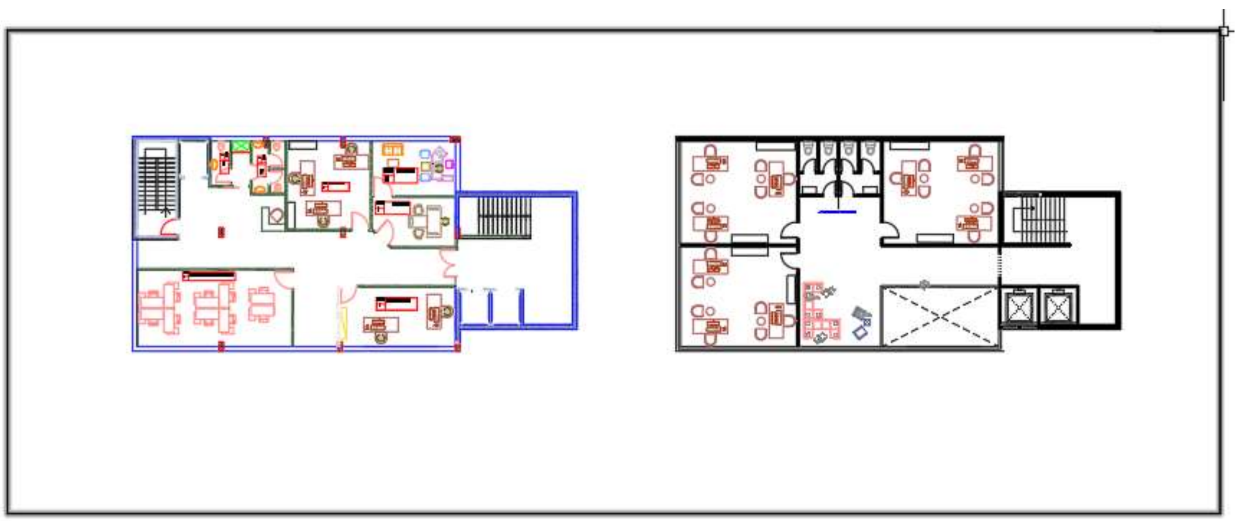


Figure 42 - 4th Floor Architectural Improvements

7- 5th Floor: (Before and After Modification)

After **Before**

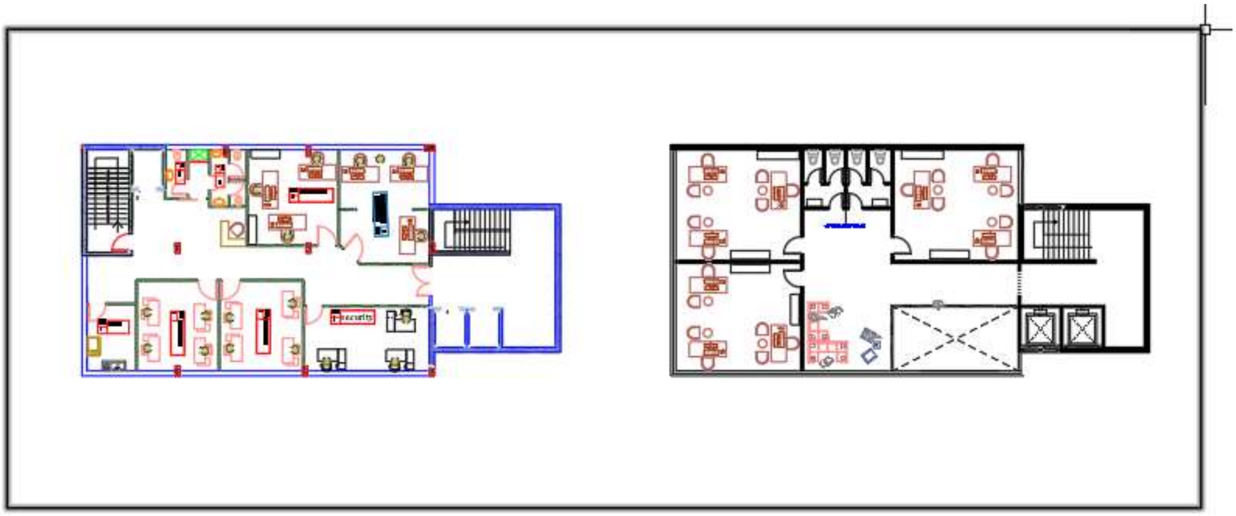


Figure 43 - 5th Floor Architectural Improvements

8- 6th Floor: (Before and After Modification)

After **Before**

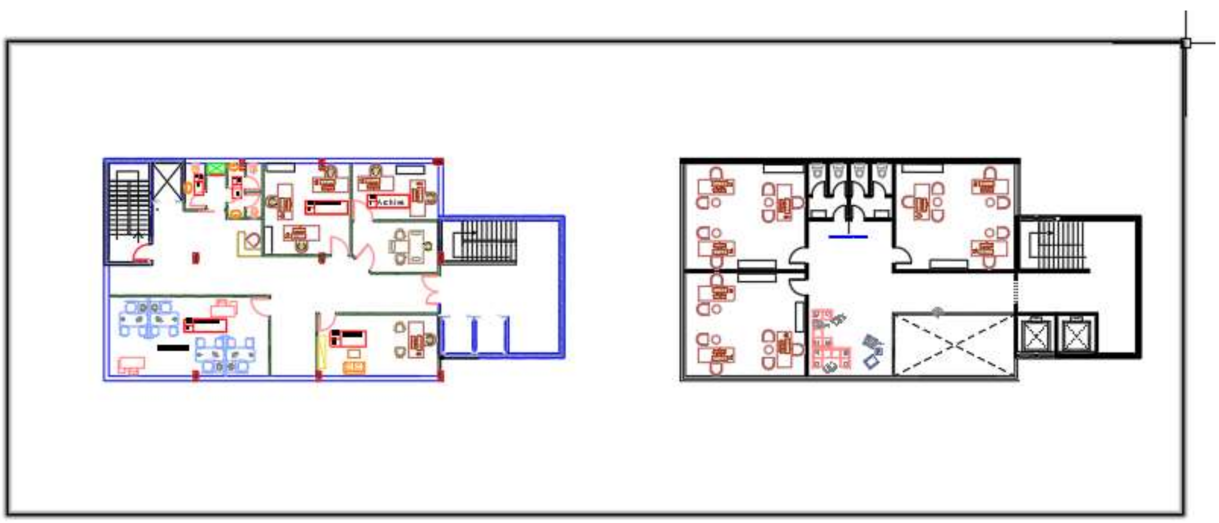


Figure 44 - 6th Floor Architectural Improvements

9- 7th Floor: (Before and After Modification)

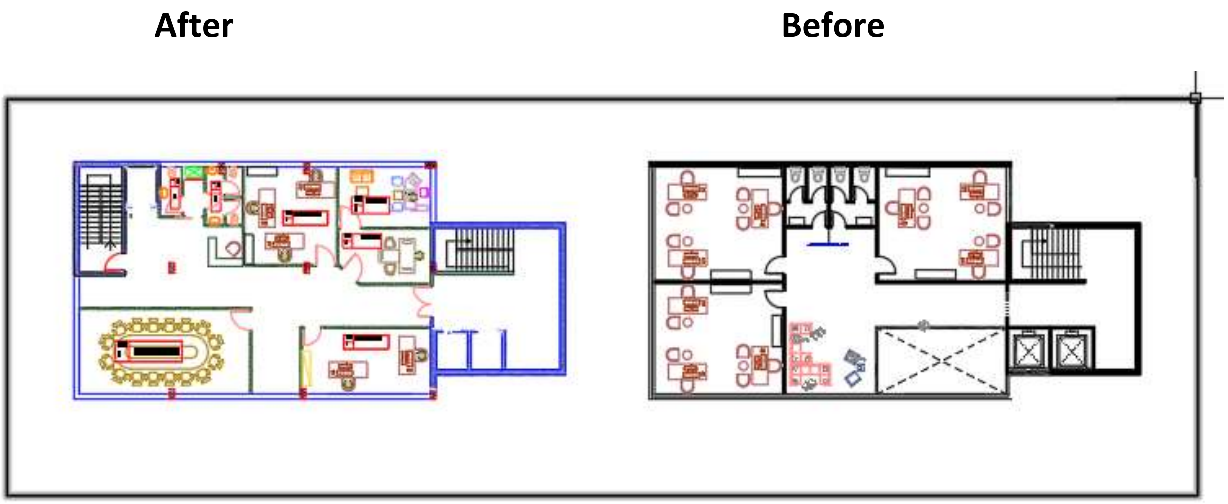


Figure 45 - 7th Floor Architectural Improvements

2.4.4. Escape Plans:

As safety measurement studies are part of the integral designing of the institution, the study of escape routes should be analysed. One of the improvements done on the bank was to make the movement in the floor as linear as possible, for easier evacuation during emergencies. In addition, an extra emergency staircase was added to shorten the travel time from any point in the building to safety. Figures 45- below will show the escape routes in each floor

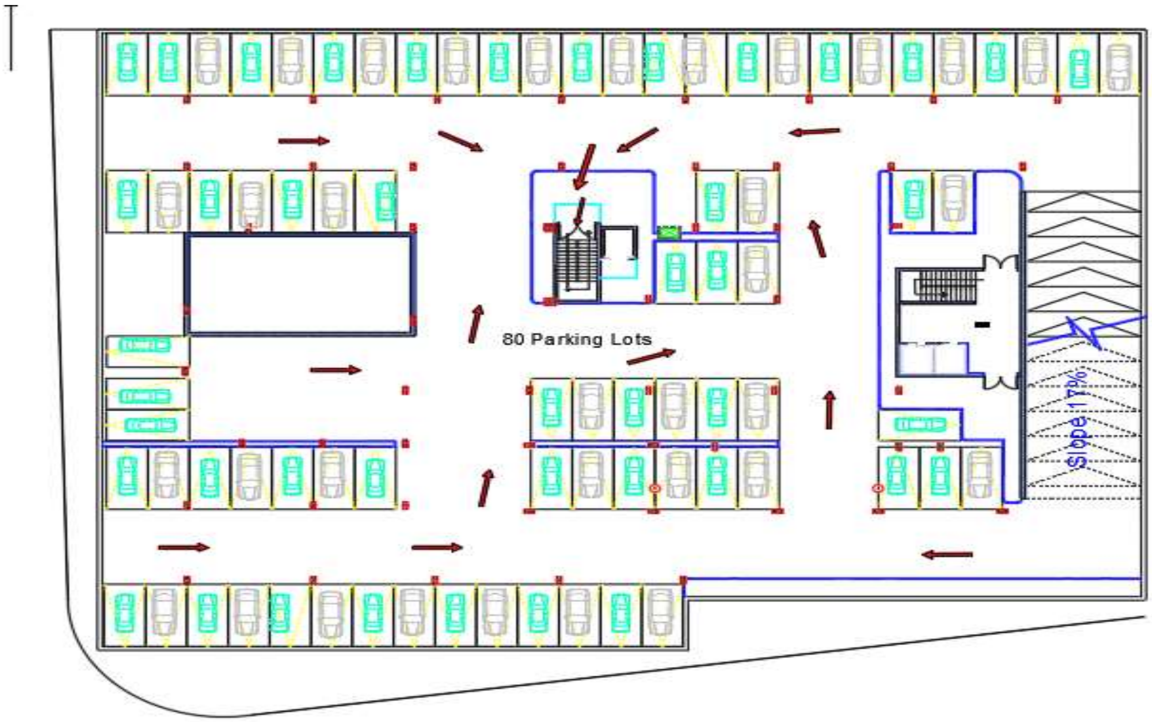


Figure 46 - Escape routes in Basement Level 2

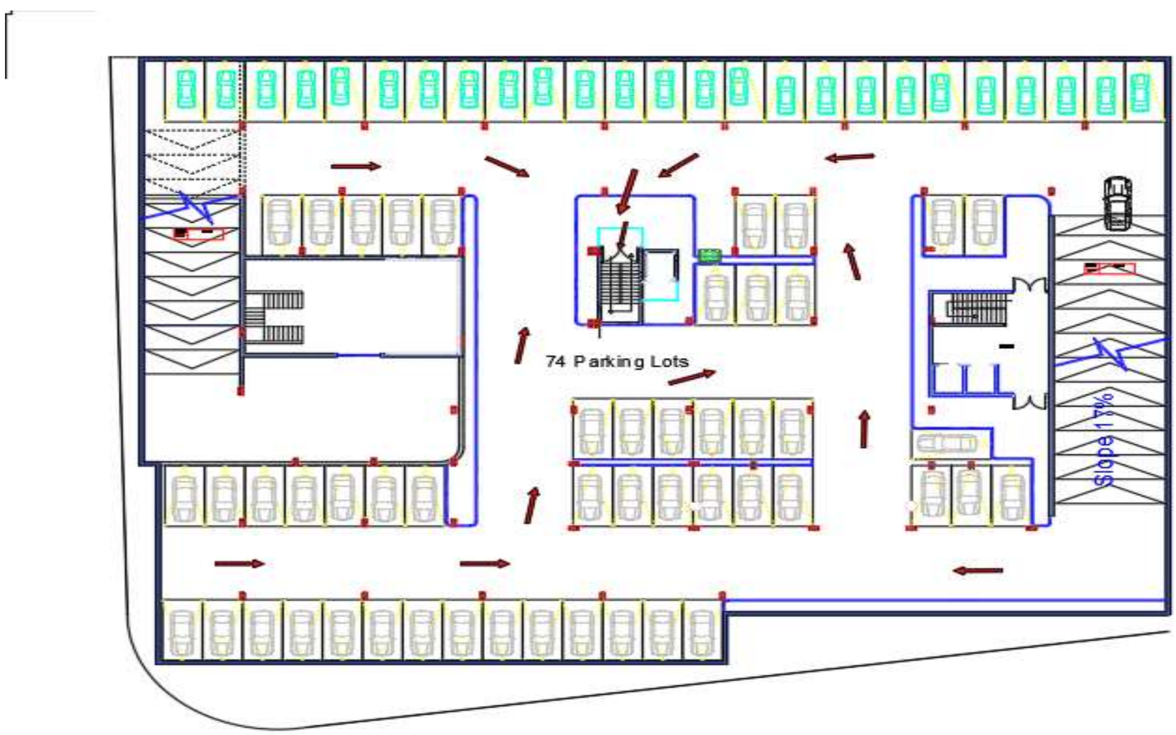


Figure 47 - Escape routes in Basement Level 1

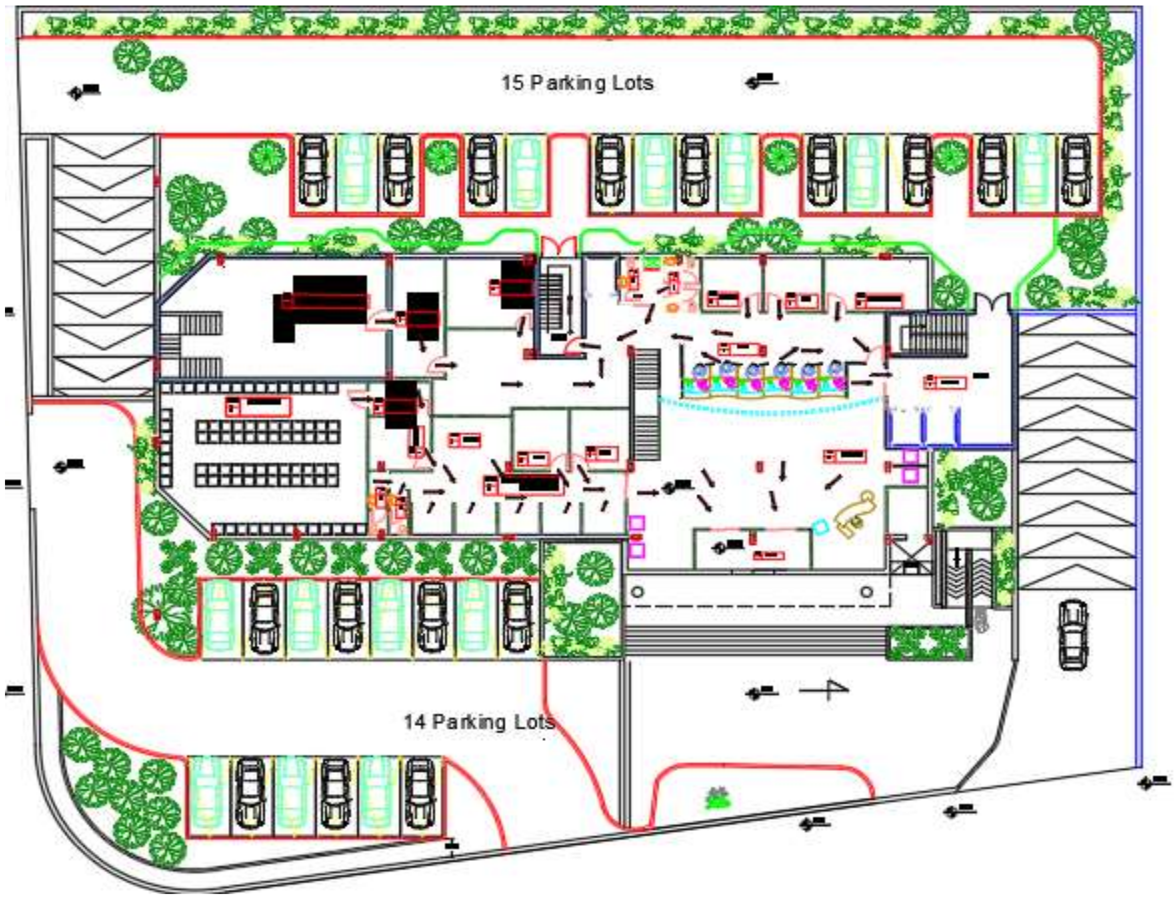


Figure 48 - Escape routes in GF Level

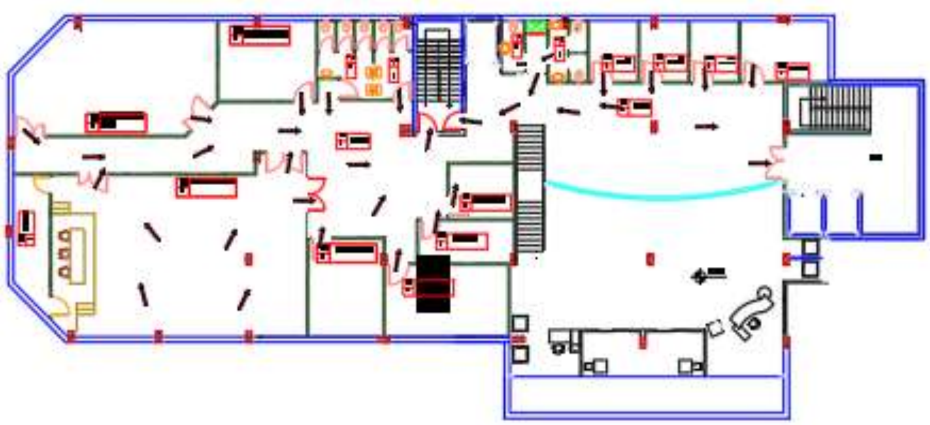


Figure 49 - Escape routes in 1ST Floor Level

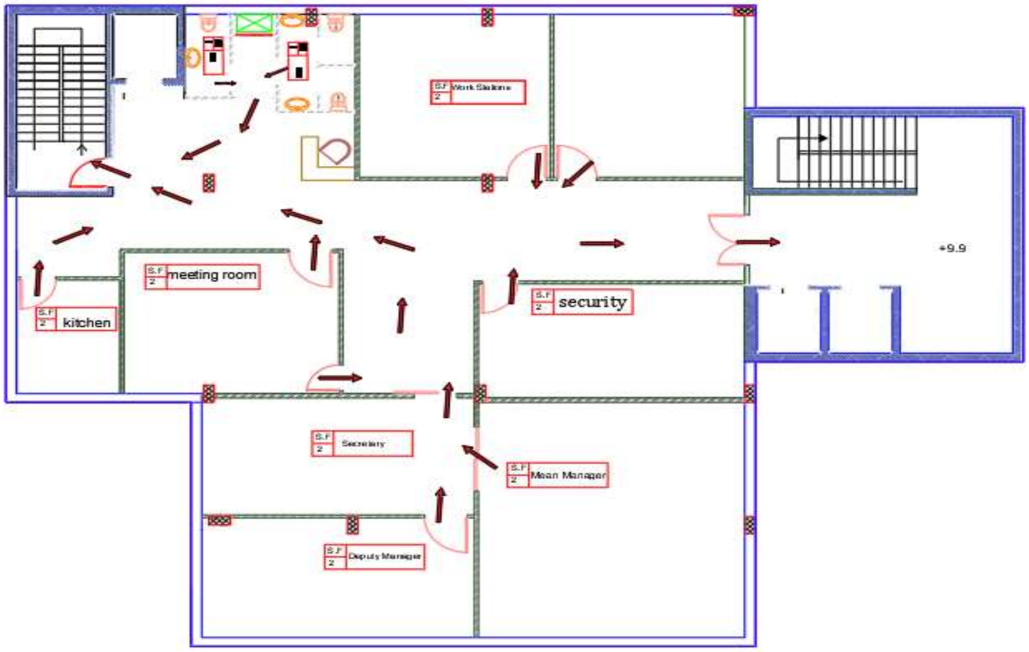


Figure 50 - Escape routes in 2nd Floor Level

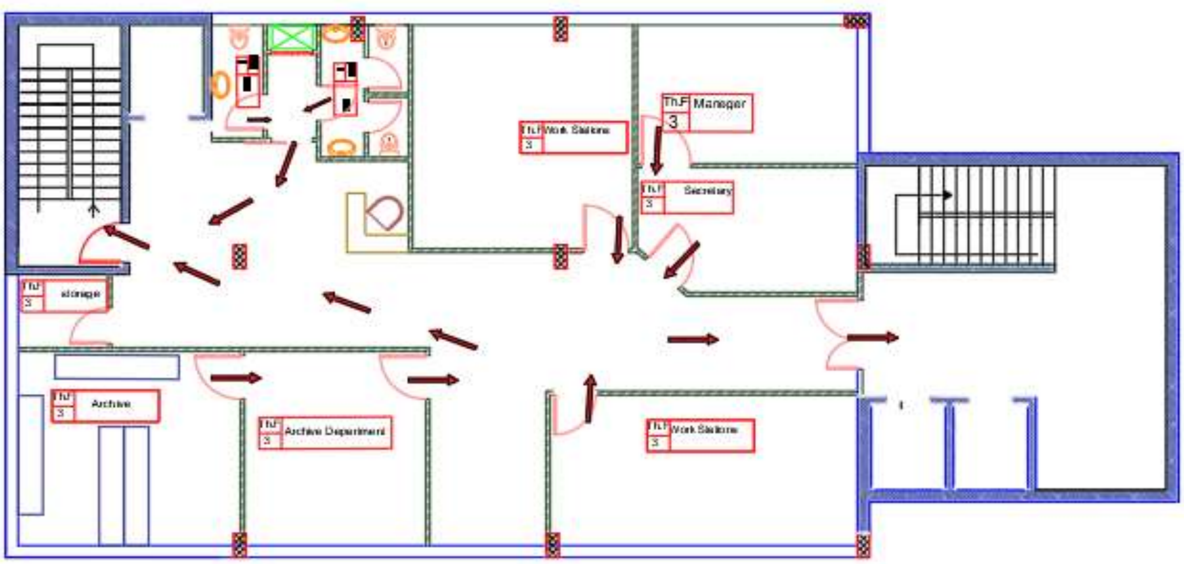


Figure 51 - Escape routes in 3rd Floor Level

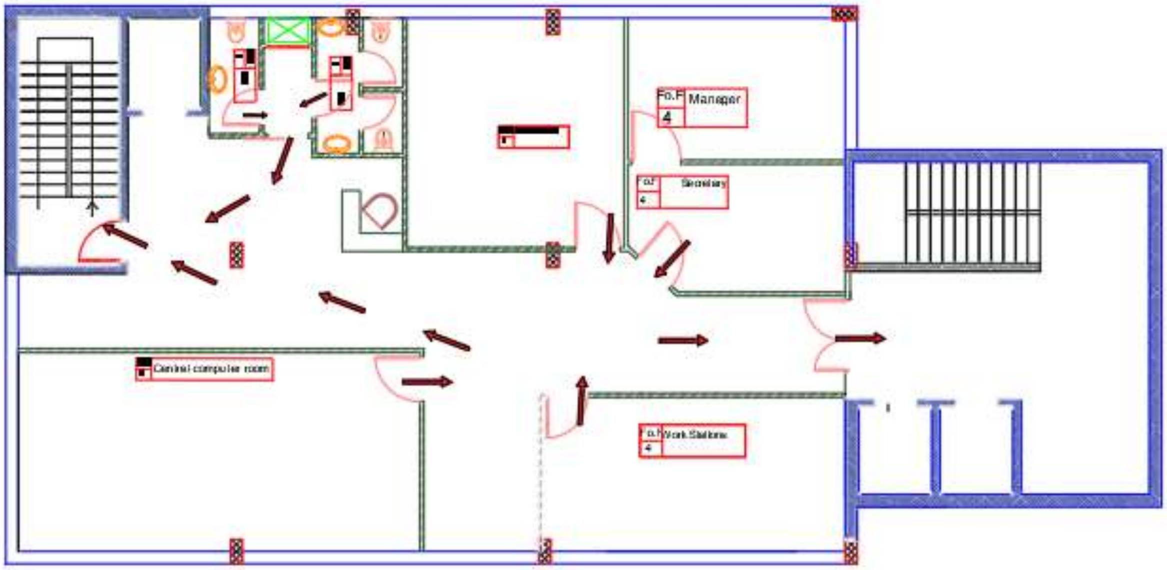


Figure 52 - Escape routes in 4th Floor Level

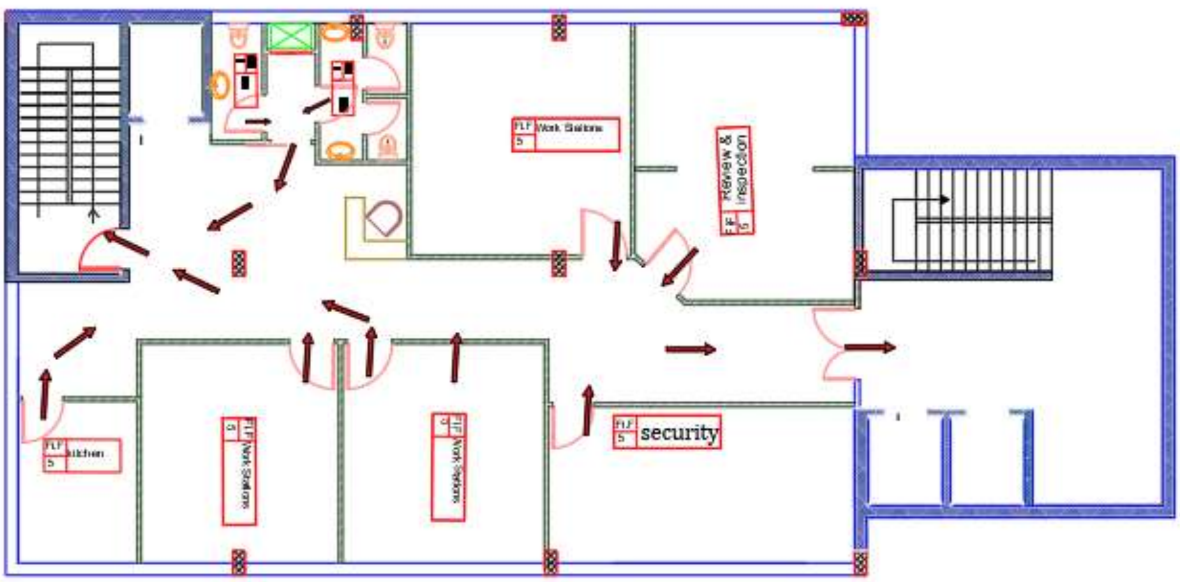


Figure 53 - Escape routes in 5th Floor Level

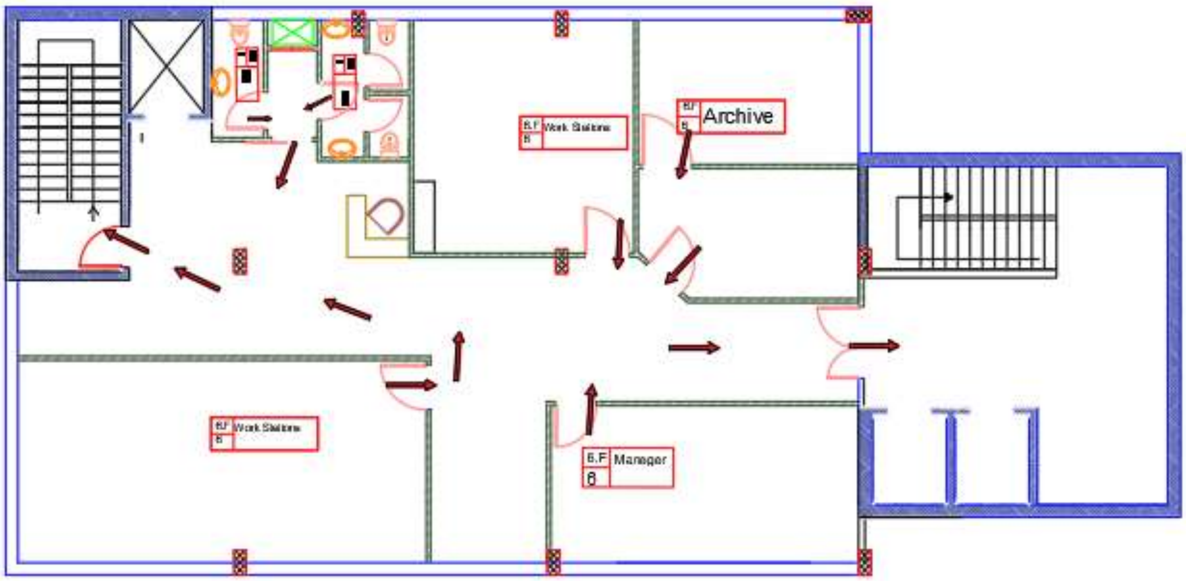


Figure 54 - Escape routes in 6th Floor Level

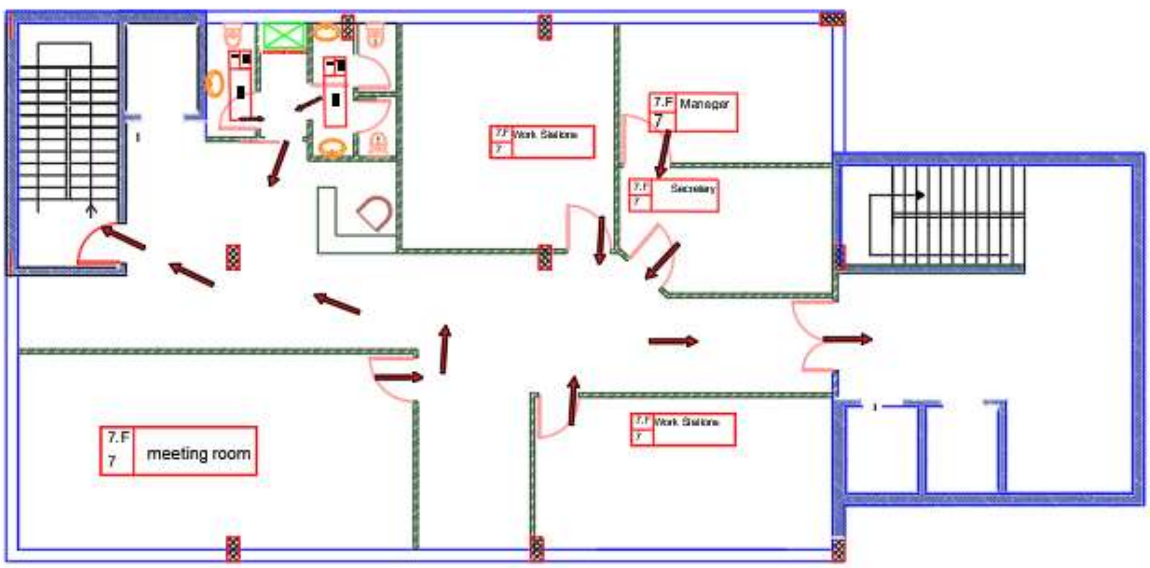


Figure 55 - Escape routes in 7th Floor Level

2.5. Environmental Aspect:

2.5.1. Introduction:

Environmental analysis is essential in every building design, as it gives a better understanding of the end- user comfort. This section of this chapter is divided into multiple categories all working together to achieve maximum comfort for people, categories are :

- **Daylight Factor Analysis** : making use of the natural daylight, but not over use it to avoid mainly glare and. That will also include a percentage of the day light entering each space (in office buildings should be between 2%-7%).

- **Solar radiation analysis**: the sun direct light, could be helpful in reducing cooling loads, that will include the sun direct light on each elevation with two seasons (Summer,Winter) and three different times (8AM,12PM,4PM).

- **Shadowing and overshadowing analysis**: to consider the neighboring buildings as they make shadowing on different parts of the building, and the building can shadow itself too. Also, will contain different views of the building (from all four elevations) that explains which parts of the building is shadowed and which part is not.

- **Heating and cooling load analysis**: understanding the cooling and heating load can help in minimizing the usage of mechanical ventilation. This will also include, the summation of heating and cooling loads needed for this building to be thermally comfortable.

This project building consists of 7 floors above ground, 5 of them have mainly curtain exterior walls for the view, but will be enhanced and treated, to achieve the finest environmental design.

2.5.2. Daylight factor (Before and after treatment)

the day light factor is an indicator that describes the ratio of inside each room at certain time (Ei) over the illuminance for the outside sky at clear sky condition (Eo). This analysis should be included to acknowledge which side of the building must be treated.

$$DF = (Ei/Eo) \times 100\%$$

According to standards, the DF in office building should not be below 2% and over 7% , all analysis and treatments will be done in Revit programme and will be shown in the figures below.

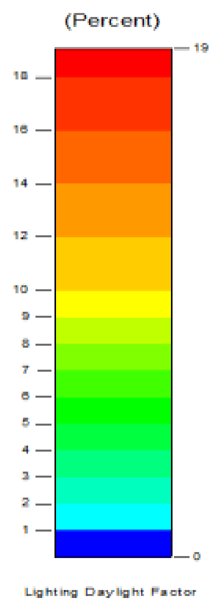


Figure 56 - Daylight Factor Scale

Ground Floor (DF analysis):

Before Treatment:

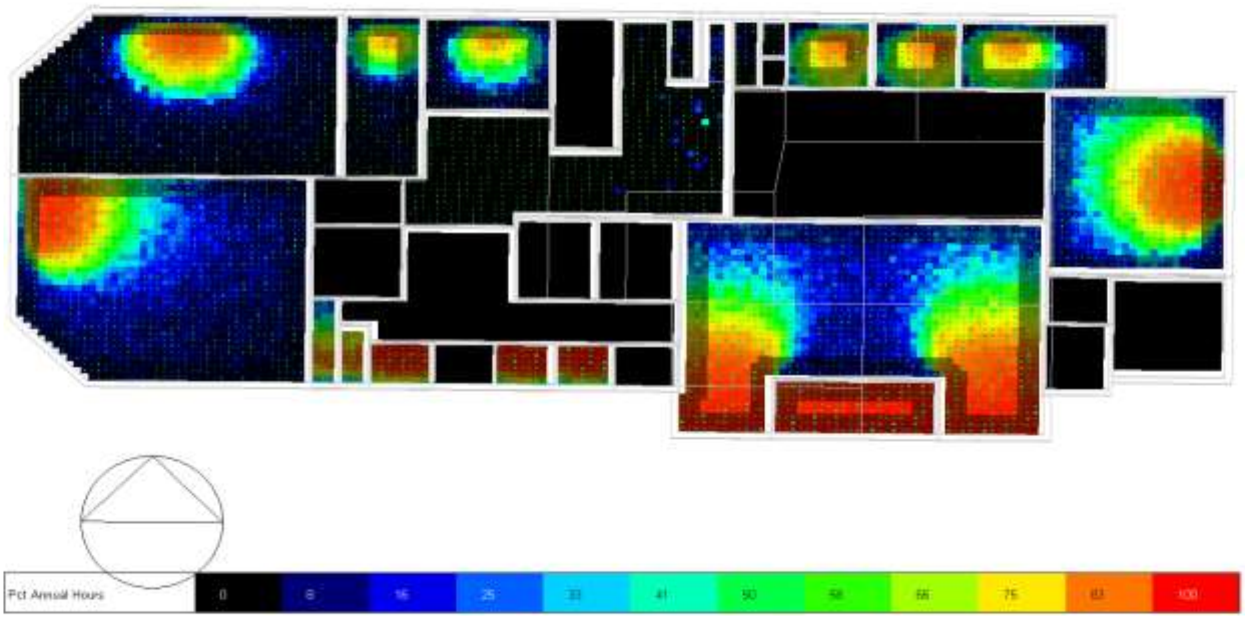


Figure 57 - DF Ground Floor Level (Before Treatment)

After Treatment:

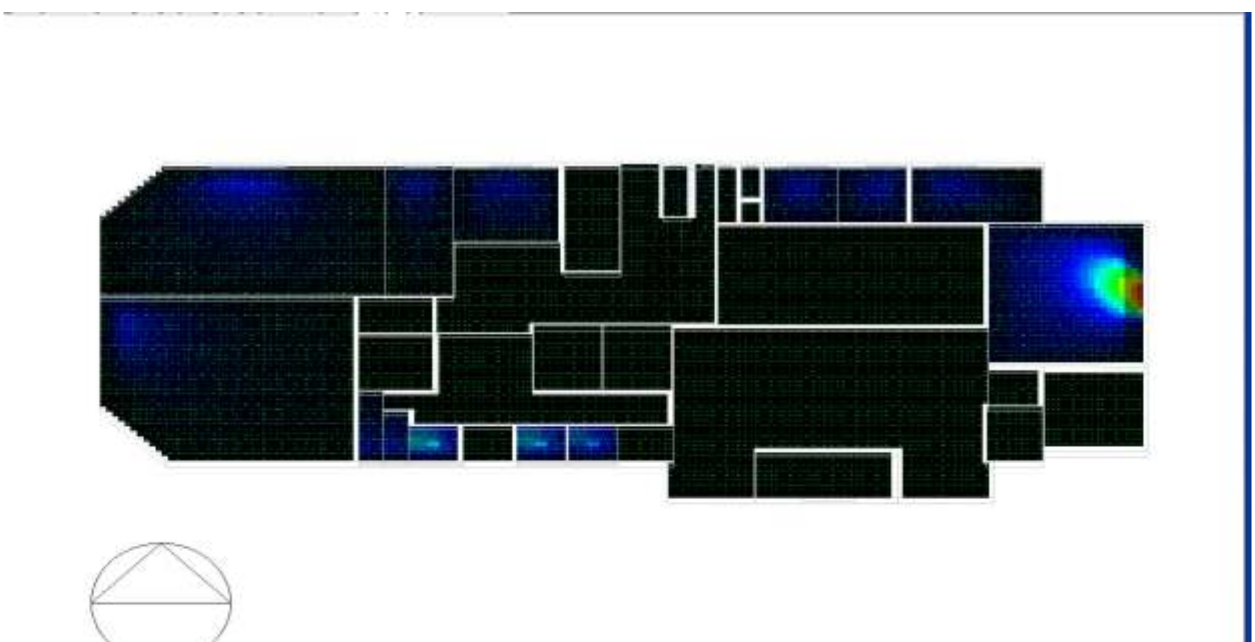


Figure 58 - DF Ground Floor Level (After treatment

1st Floor (DF analysis):

Before Treatment:

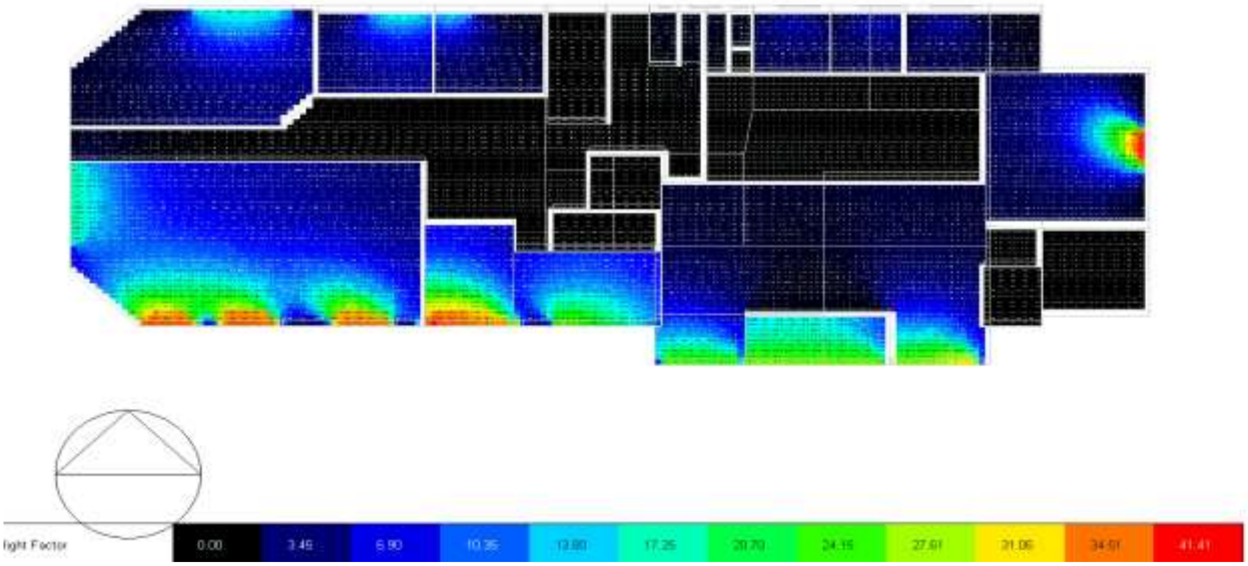


Figure 59 - 1st floor Level (Before Treatment)

After Treatment :

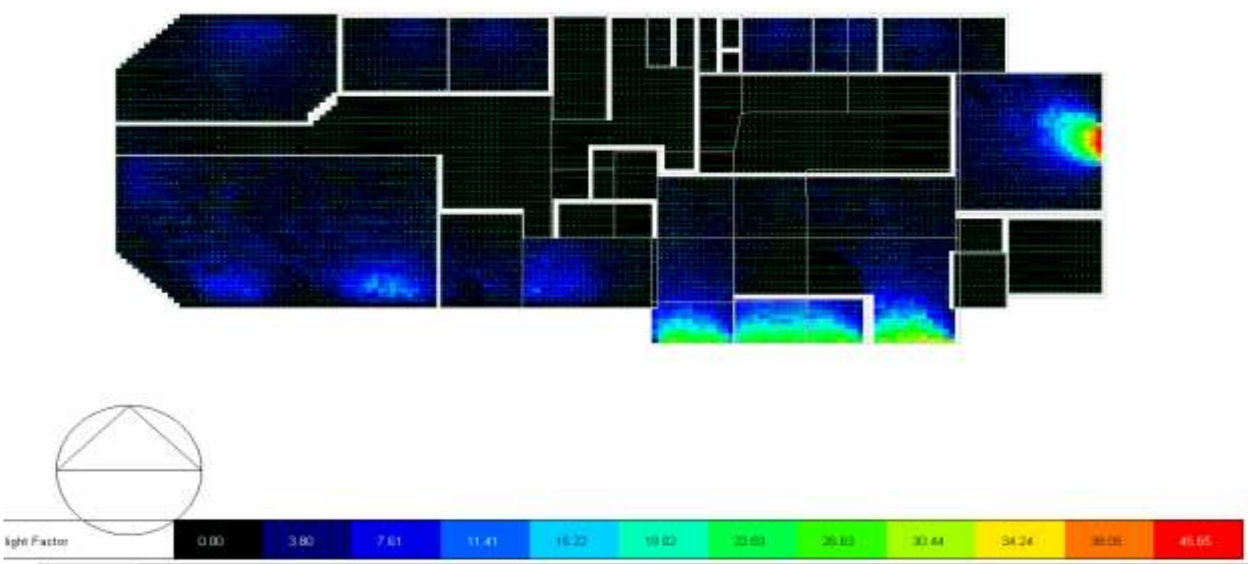


Figure 60 - DF 1st Floor Level (After Treatment)

2nd Floor (DF analysis):

Before Treatment:

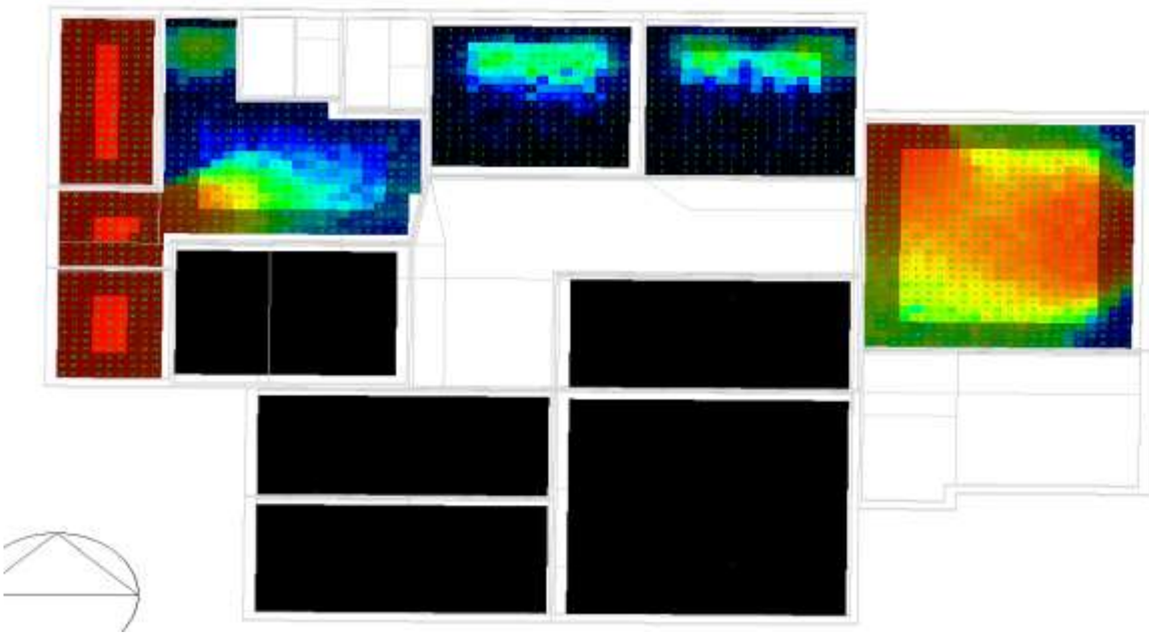


Figure 61 - 2nd floor Level (Before Treatment)

After Treatment:

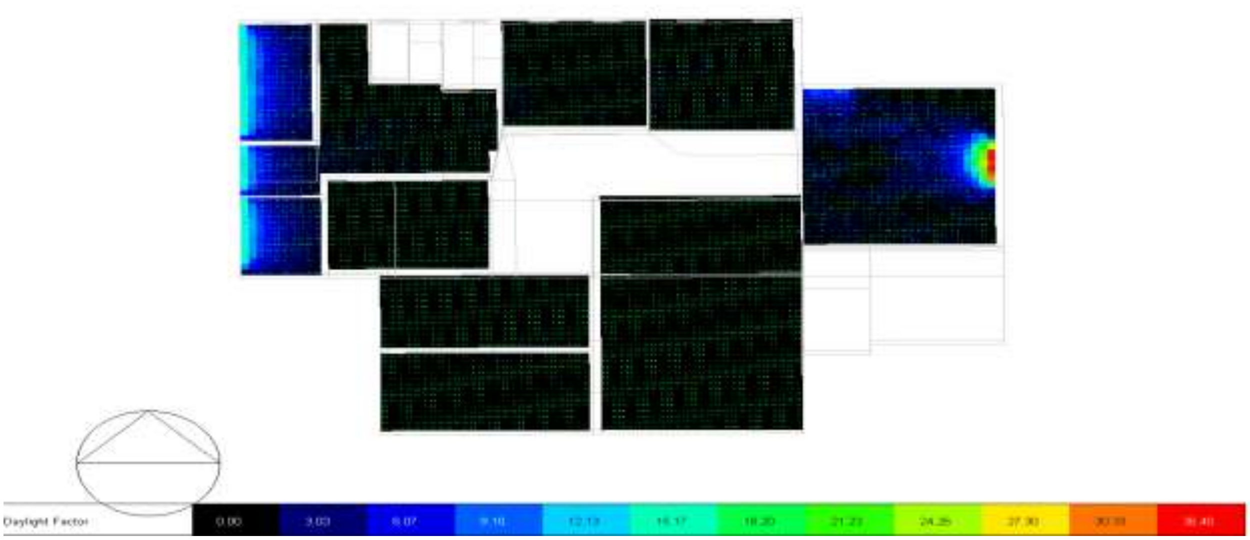


Figure 62 - DF 2nd Floor Level (After Treatment)

3rd Floor (DF analysis):

Before Treatment:

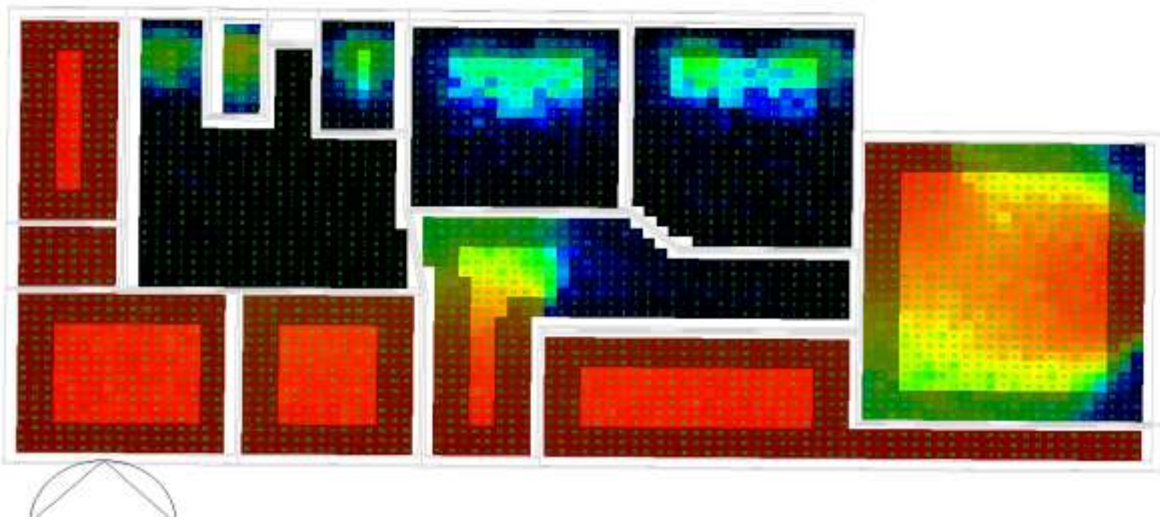


Figure 63 - 3rd floor Level (Before Treatment)

After Treatment:

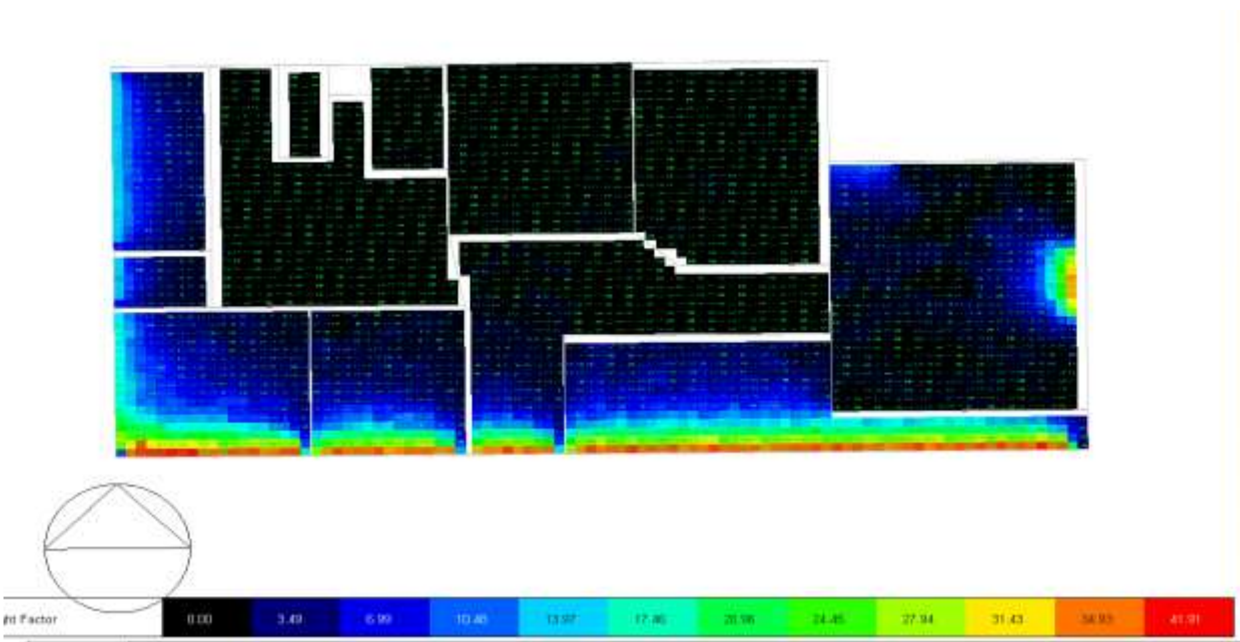


Figure 64 - 3rd floor Level (After Treatment)

4th Floor (DF analysis):

Before Treatment:

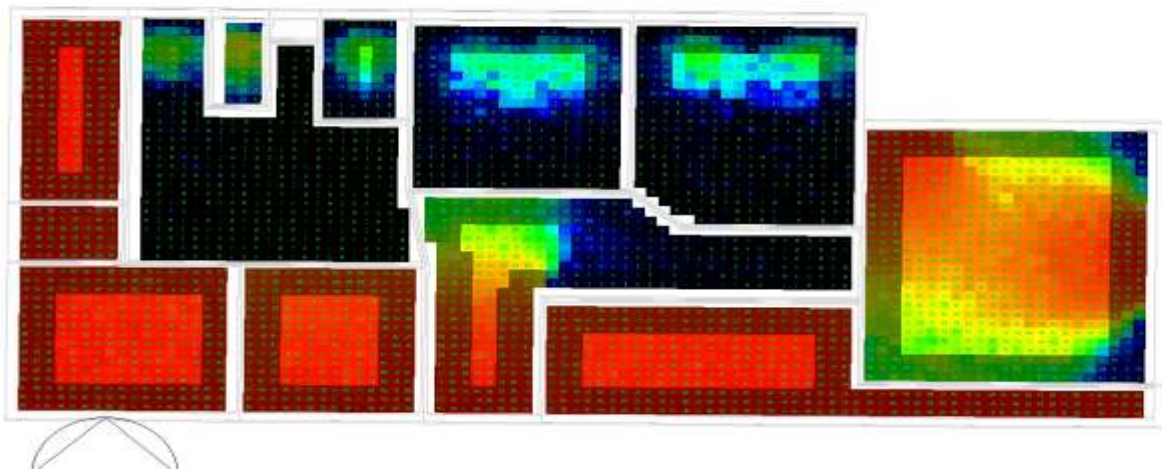


Figure 65 - 4th floor Level (Before Treatment)

After Treatment:

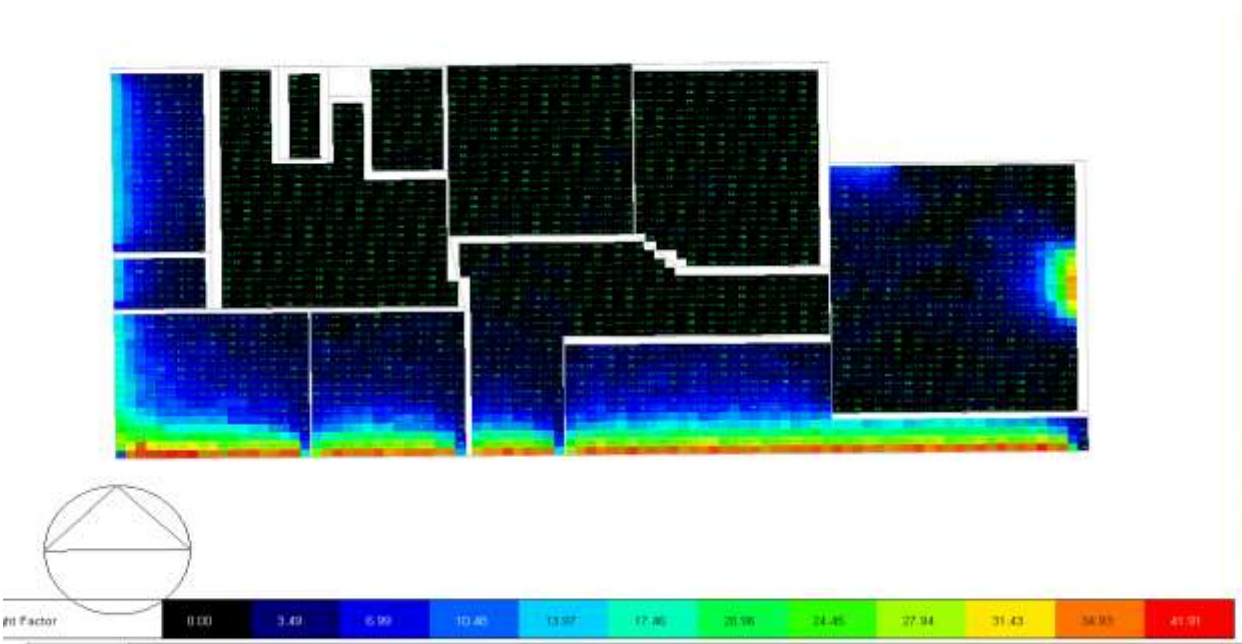


Figure 66 - 4th floor Level (After Treatment)

2.5.3. Solar Radiation:

Solar radiation which means the direct sun light or energy emitted from the sun on certain surfaces, used heavily in passive solar systems. Can be helpful to decrease heating loads if we add more window opening to the elevation with the most solar radiation per meter during winter. However, it can also increase cooling loads during summer. Due to that high solar radiation on any elevation during summer will be treated.

Using Revit program all elevation during winter and summer in three different times are analyzed and samples are shown below:

Figure 67 - Solar radiation during summer at 8am

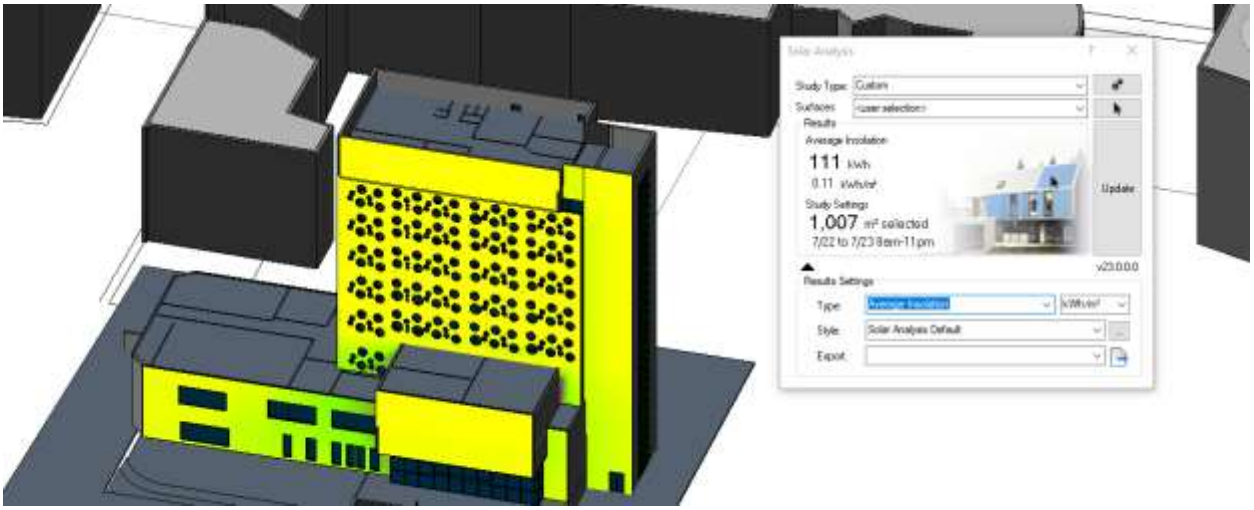


Figure 68 - North elevation Solar radiation during summer at 8am (treated)

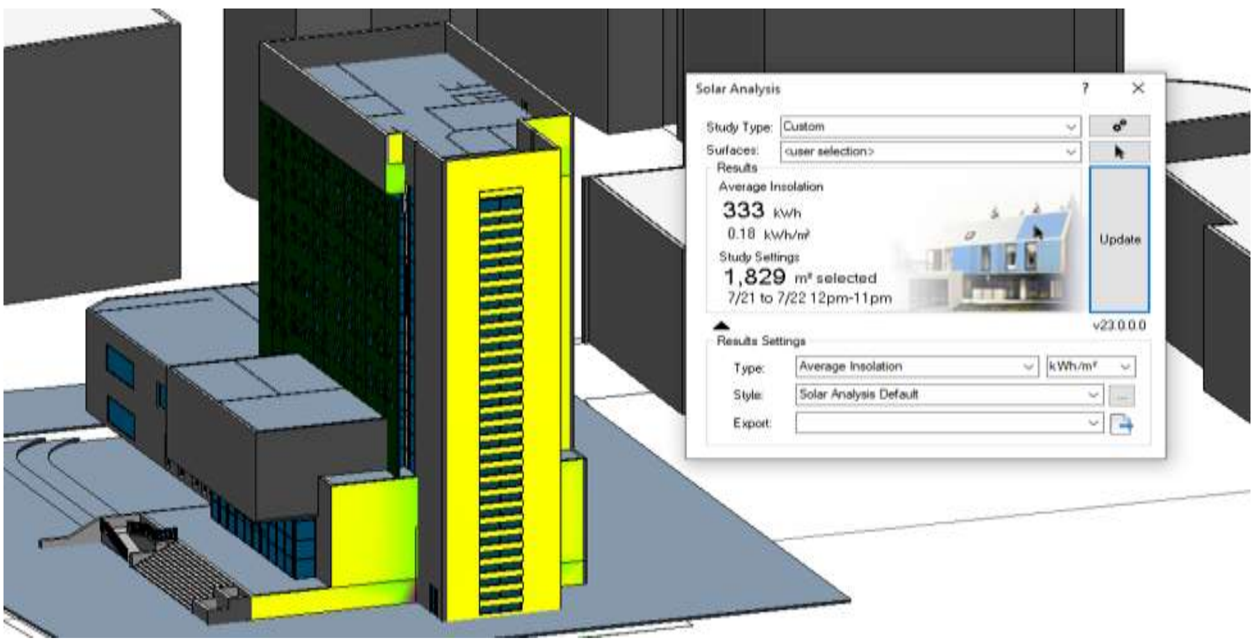


Figure 69 - West elevation Solar radiation during summer at 12pm (treated)

Figure 70 - West elevation Solar radiation during summer at 12pm (treated)

Summary table below shows solar radiation on every elevation before and after treatment:

Table 7 - Summary table showing solar radiation

Average Solar Radiation (KWh)		North Elevation			East elevation			South Elevation			West elevation		
Time		8am	12pm	4pm	8am	12pm	4pm	8am	12pm	4pm	8am	12pm	4pm
Winter	Before (kwh/m^2)	0.04	0.04	0.01	0.07	0.12	0.01	0.3	0.29	0.04	0.1	0.16	0.05
	After (kwh/m^2)	0.04	0.04	0.01	0.08	0.04	0.01	0.3	0.31	0.05	0.1	0.15	0.05
Summer	Before (kwh/m^2)	0.11	0.11	0.12	0.32	0.08	0.19	0.14	0.13	0.24	0.24	0.31	0.25
	After (kwh/m^2)	0.11	0.11	0.08	0.17	0.07	0.04	0.14	0.12	0.04	0.24	0.18	0.27

2.5.3.Shadowing and Overshadowing:

Is a study that considers neighbouring building and to analyze their shadow effect on the building, shadowing is helpful in summer , but not so much during the winter as sun light is needed to decrease heating loads.

Overshadowing In summer at 8pm:

As shown in figure below the building east elevation is fully exposed and not effected by surrounding building so it will be treated to reduce heat gain

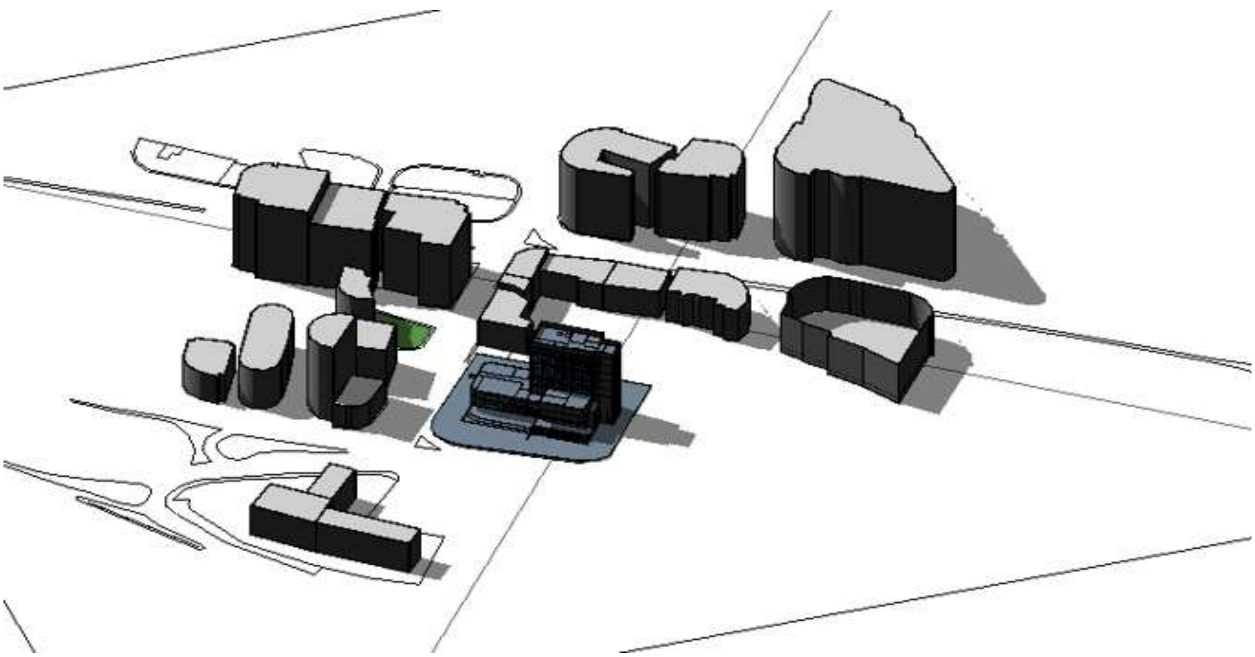


Figure 71 - Summer Overshadowing at 8AM

Overshadowing In summer at 12pm:

The south elevation as shown in figure 78 is fully exposed, But the sun angle in Palestine during summer at 12pm is around 81°. as a result of that, most of the sun light will be reflected, but smaller window opening will help in preventing direct sun light from entering the building.

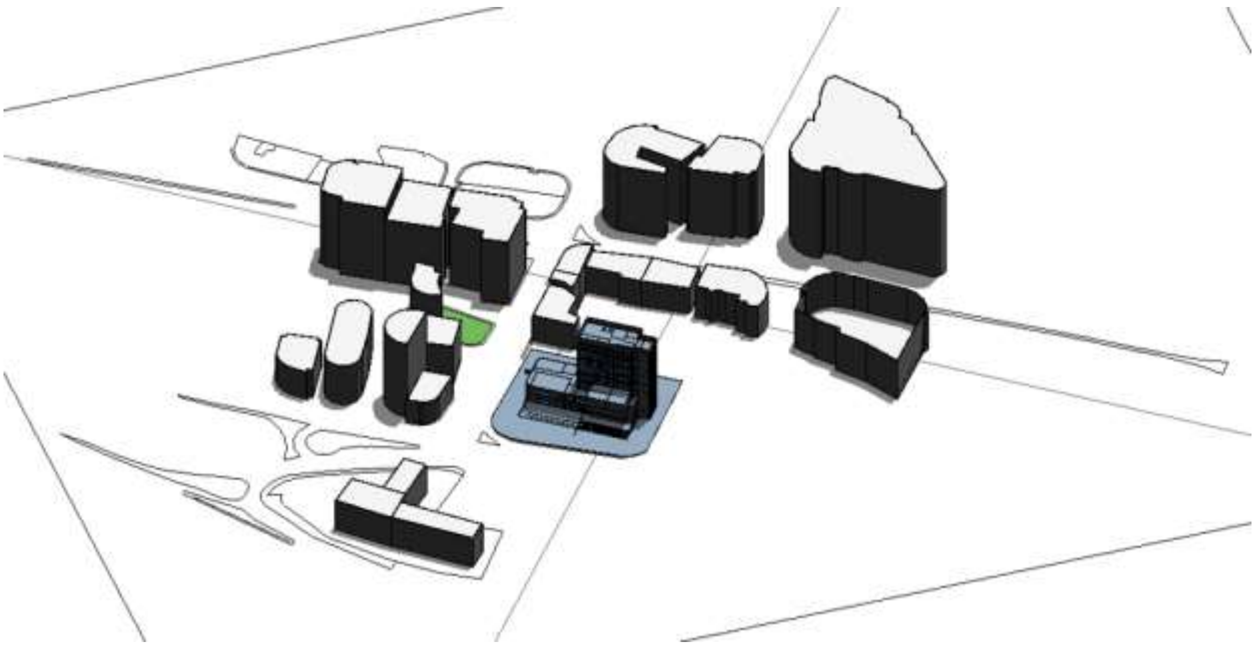


Figure 72 - Summer Overshadowing at 12PM

Overshadowing In summer at 4pm:

The west elevation as shown in figure 79 is fully exposed to a direct sun light during sunset, because of that horizontal louvers were added as a treatment to minimize the heat gain.

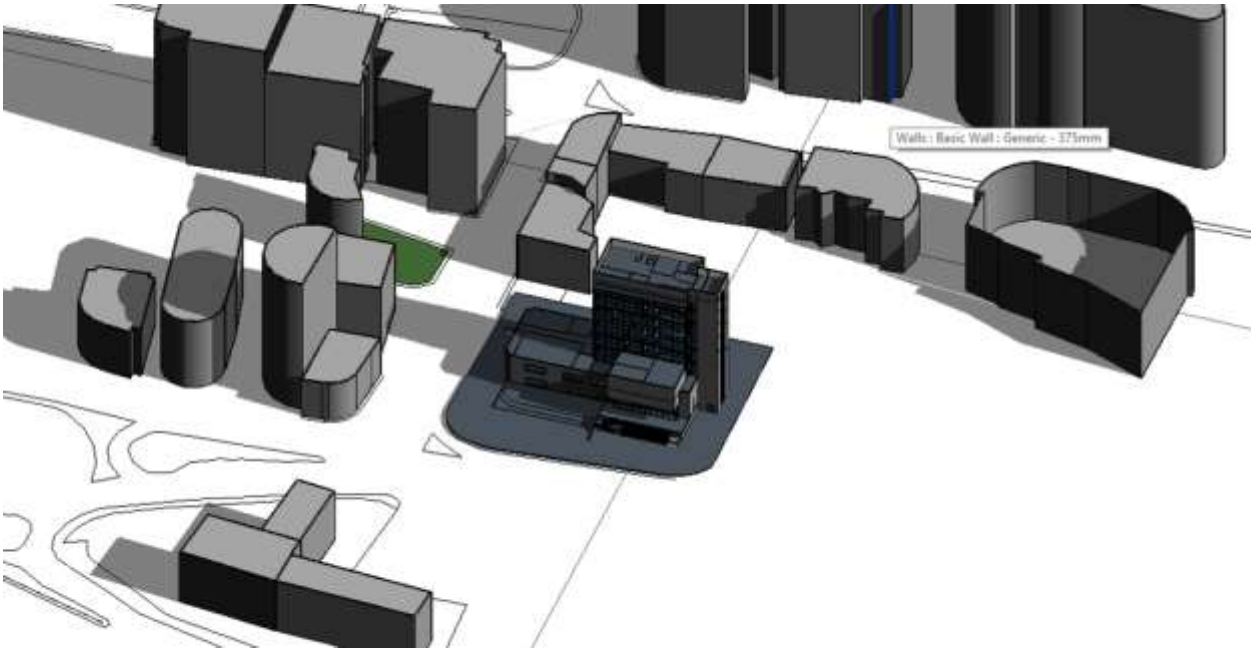


Figure 73 - Summer Overshadowing at 4PM

Overshadowing In Winter at 8am:

As shown in figure 80 the building is mostly shaded with no use of sun light

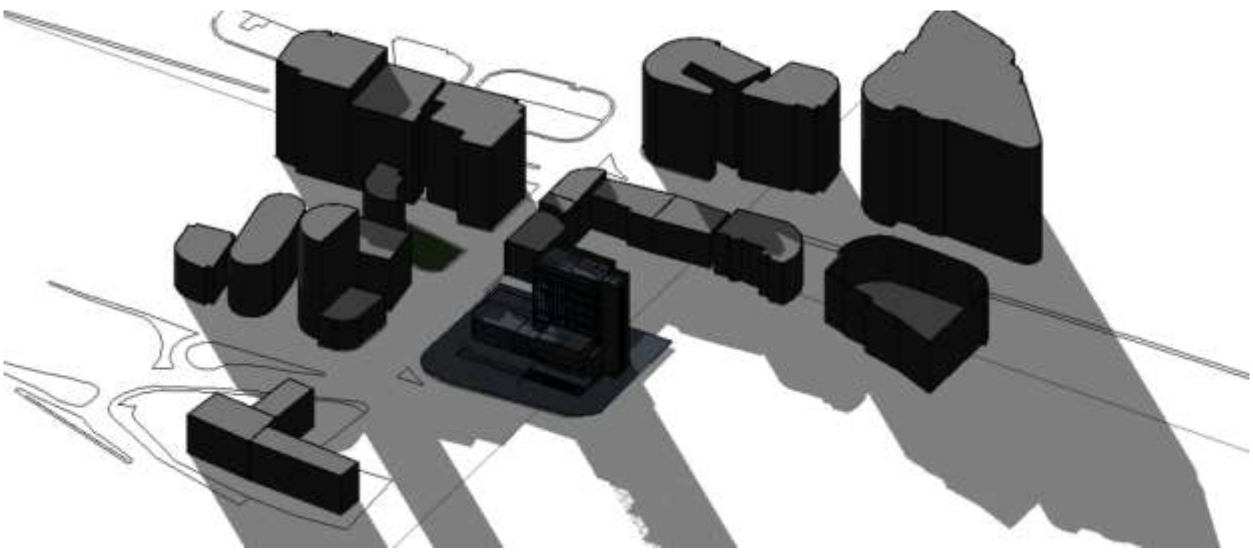


Figure 74 - Winter Overshadowing at 8AM

Overshadowing In Winter at 12pm:

The figure 81 shows that the south elevation is fully exposed to sunlight which we can use to lower the heating load during winter, so the south elevation was treated by adding more window openings.

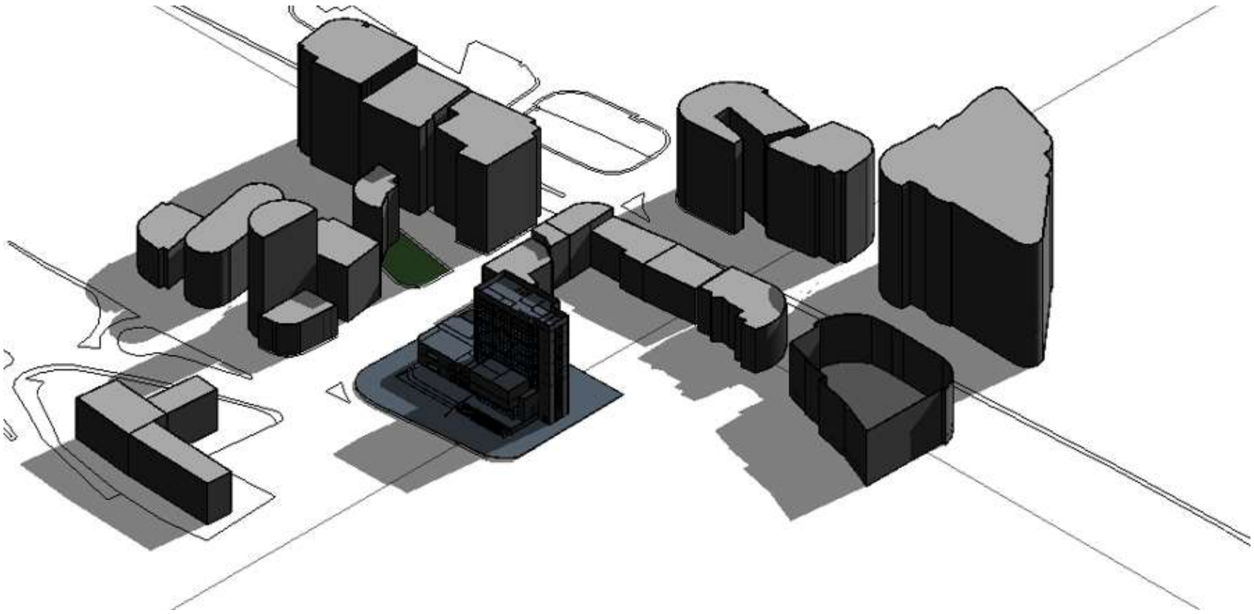


Figure 75 -Winter Overshadowing at 12PM

Overshadowing In Winter at 4pm:

The upper side of the building in the west elevation as shown in figure 82 is semi-exposed, so curtain wall was added to take advantage of direct sunlight during winter.

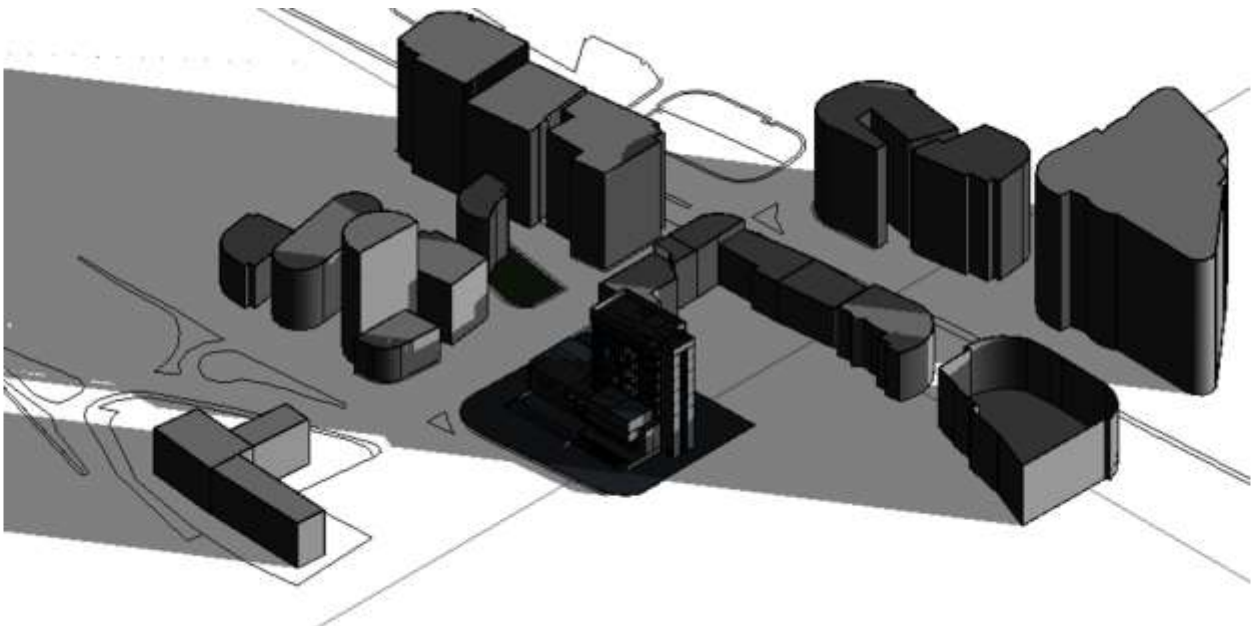


Figure 76 - Winter Overshadowing at 4PM

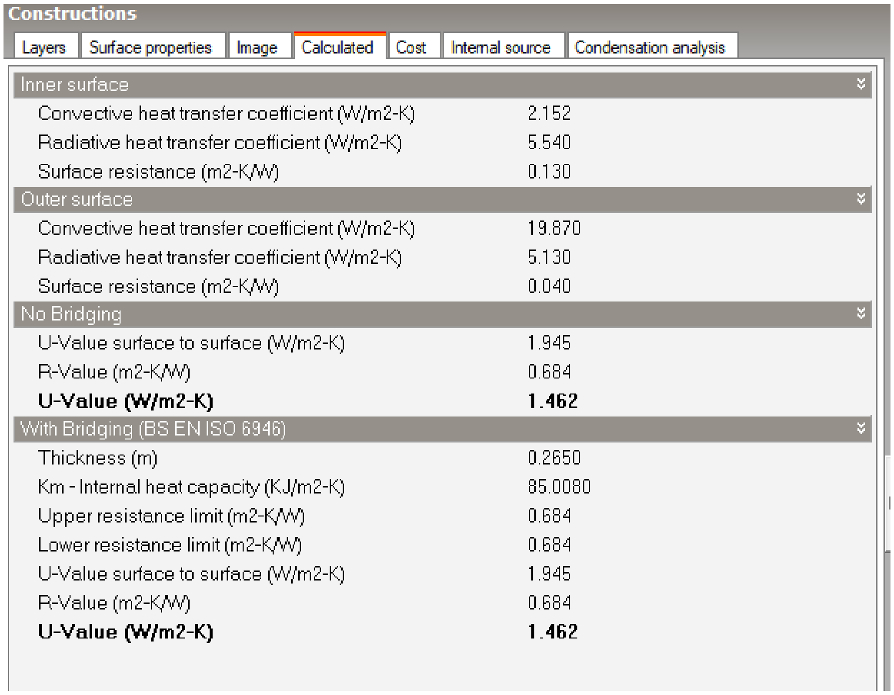
2.5.4. Passive design:

Design builder program is used to achieve maximum thermal comfort for any structure. The main objectives are:

- Calculate heating and cooling load
- Energy consumption of the building

The figures below show the layers and U-Value of external wall and floors before insulation.

Figure 77 - external wall layers (Before Modification)



Constructions

Layers | Surface properties | Image | Calculated | Cost | Internal source | Condensation analysis

Inner surface	
Convective heat transfer coefficient (W/m2-K)	2.152
Radiative heat transfer coefficient (W/m2-K)	5.540
Surface resistance (m2-K/W)	0.130
Outer surface	
Convective heat transfer coefficient (W/m2-K)	19.870
Radiative heat transfer coefficient (W/m2-K)	5.130
Surface resistance (m2-K/W)	0.040
No Bridging	
U-Value surface to surface (W/m2-K)	1.945
R-Value (m2-K/W)	0.684
U-Value (W/m2-K)	**1.462**
With Bridging (BS EN ISO 6946)	
Thickness (m)	0.2650
Km - Internal heat capacity (KJ/m2-K)	85.0080
Upper resistance limit (m2-K/W)	0.684
Lower resistance limit (m2-K/W)	0.684
U-Value surface to surface (W/m2-K)	1.945
R-Value (m2-K/W)	0.684
U-Value (W/m2-K)	**1.462**

Figure 78 - external wall U-value (Before Modification)

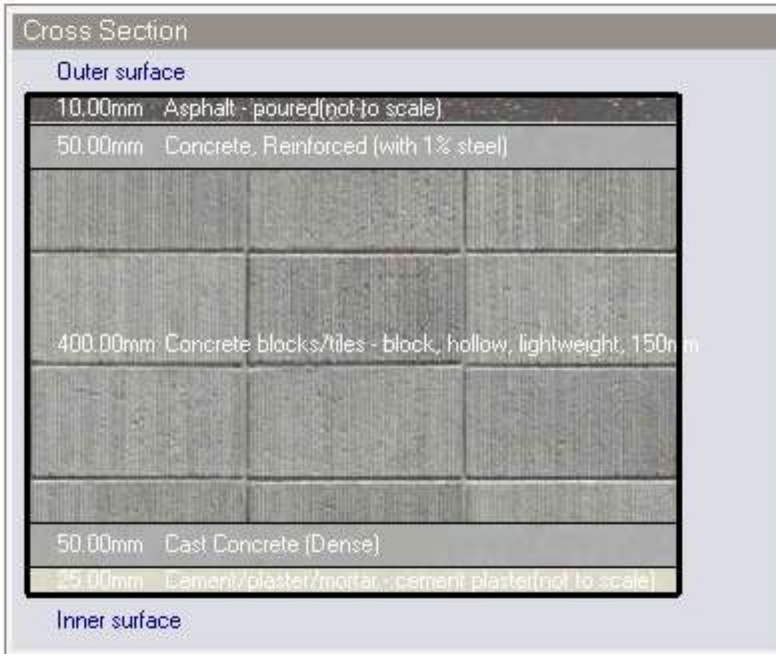
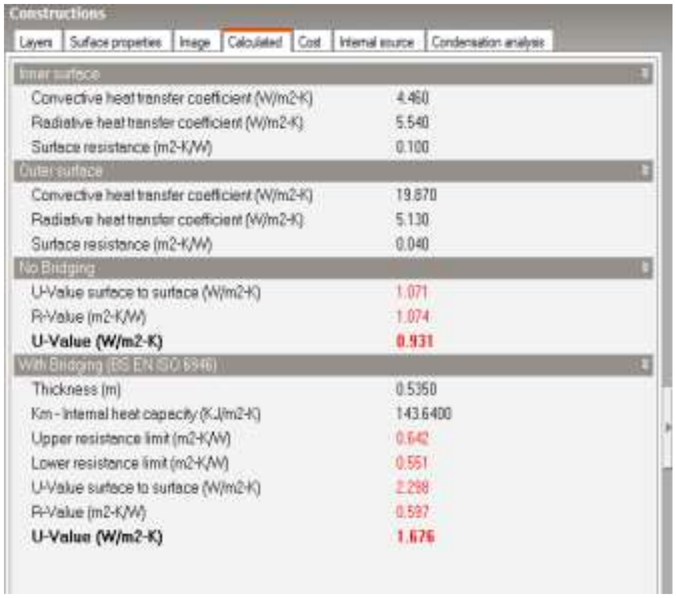


Figure 79 - Roof layers (Before Modification)



Constructions

Layers | Surface properties | Image | Calculated | Cost | Internal source | Condensation analysis

Inner surface	
Convective heat transfer coefficient (W/m2-K)	4.460
Radiative heat transfer coefficient (W/m2-K)	5.540
Surface resistance (m2-K/W)	0.100
Outer surface	
Convective heat transfer coefficient (W/m2-K)	19.870
Radiative heat transfer coefficient (W/m2-K)	5.130
Surface resistance (m2-K/W)	0.040
No Bridging	
U-Value surface to surface (W/m2-K)	1.071
R-Value (m2-K/W)	1.074
U-Value (W/m2-K)	**0.931**
With Bridging (BS EN ISO 6946)	
Thickness (m)	0.5350
Km - Internal heat capacity (KJ/m2-K)	143.6400
Upper resistance limit (m2-K/W)	0.642
Lower resistance limit (m2-K/W)	0.551
U-Value surface to surface (W/m2-K)	2.298
R-Value (m2-K/W)	0.597
U-Value (W/m2-K)	**1.676**

Figure 80 - Roof U-value (Before Modification)

The figures below show the layers and U-Value of external wall and floors after insulation

Figure 81 - external wall layers (after Modification)

Inner surface	
Convective heat transfer coefficient (W/m2-K)	2.152
Radiative heat transfer coefficient (W/m2-K)	5.540
Surface resistance (m2-K/W)	0.130
Outer surface	
Convective heat transfer coefficient (W/m2-K)	19.870
Radiative heat transfer coefficient (W/m2-K)	5.130
Surface resistance (m2-K/W)	0.040
No Bridging	
U-Value surface to surface (W/m2-K)	0.970
R-Value (m2-K/W)	1.192
U-Value (W/m2-K)	**0.839**
With Bridging (BS EN ISO 6946)	
Thickness (m)	0.3000
Km - Internal heat capacity (KJ/m2-K)	85.0080
Upper resistance limit (m2-K/W)	1.192
Lower resistance limit (m2-K/W)	1.192
U-Value surface to surface (W/m2-K)	0.970
R-Value (m2-K/W)	1.192
U-Value (W/m2-K)	**0.839**

Figure 82 - external wall U-value (After Modification)

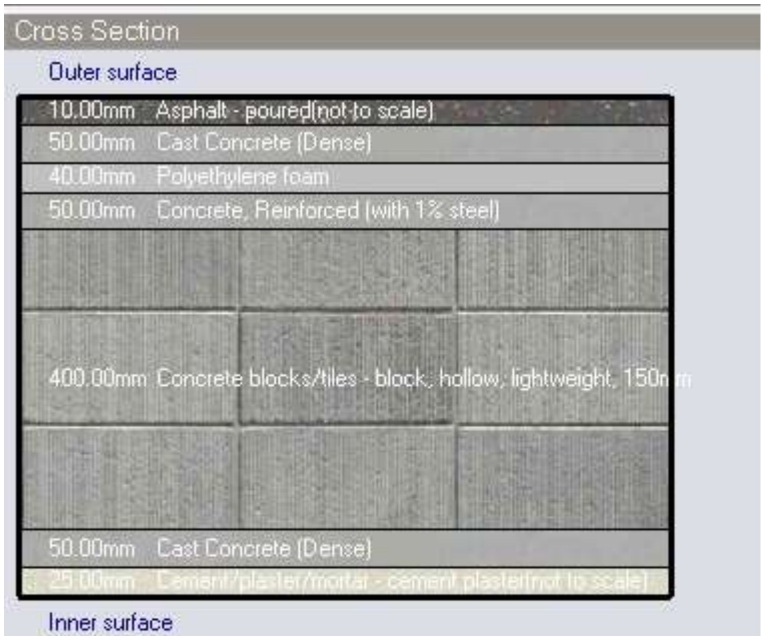
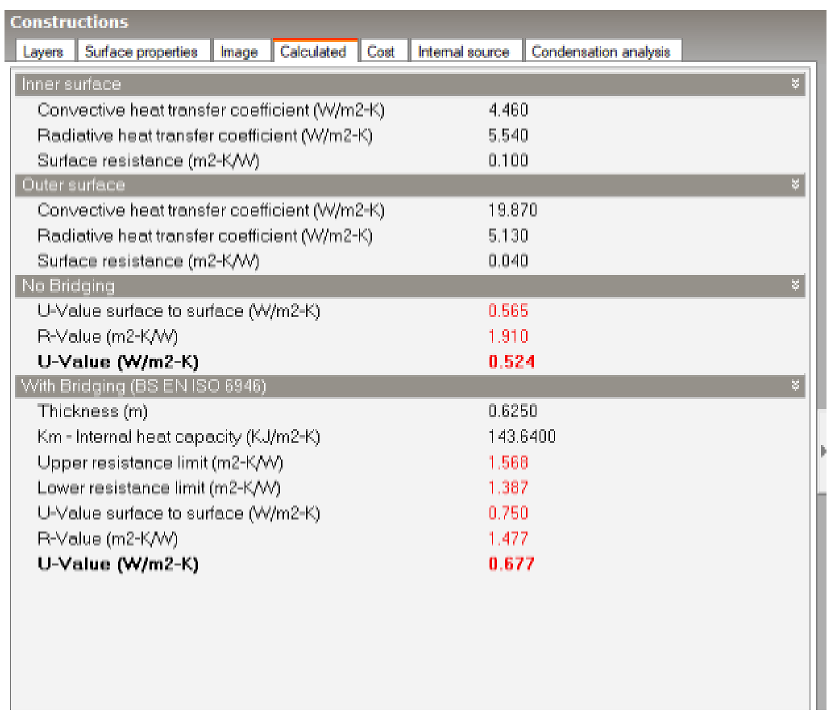


Figure 83 - Roof layers (after Modification)



Constructions

Layers | Surface properties | Image | Calculated | Cost | Internal source | Condensation analysis

Inner surface	
Convective heat transfer coefficient (W/m2-K)	4.460
Radiative heat transfer coefficient (W/m2-K)	5.540
Surface resistance (m2-K/W)	0.100
Outer surface	
Convective heat transfer coefficient (W/m2-K)	19.870
Radiative heat transfer coefficient (W/m2-K)	5.130
Surface resistance (m2-K/W)	0.040
No Bridging	
U-Value surface to surface (W/m2-K)	0.565
R-Value (m2-K/W)	1.910
U-Value (W/m2-K)	**0.524**
With Bridging (BS EN ISO 6946)	
Thickness (m)	0.6250
Km - Internal heat capacity (KJ/m2-K)	143.6400
Upper resistance limit (m2-K/W)	1.568
Lower resistance limit (m2-K/W)	1.387
U-Value surface to surface (W/m2-K)	0.750
R-Value (m2-K/W)	1.477
U-Value (W/m2-K)	**0.677**

Figure 84 - Roof U-value (After Modification)

2.5.4.1. Simulation and energy savings

The figure below shows the PMV which it should be between (-0.5 – 0.5) to insure thermal comfort

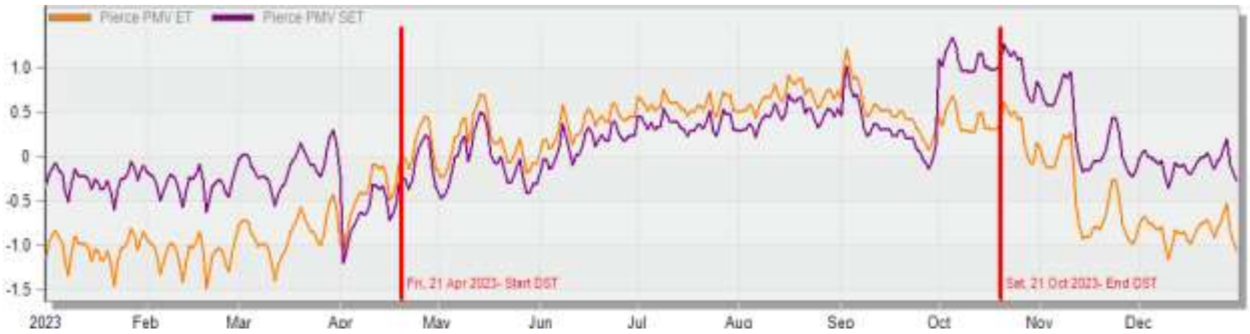


Figure 85 - PMV Graph

Net site energy and Net source energy is listed in the table below which is around 104 KWh/m^2

Table 8 - Site and Source energy

Site and Source Energy

	Total Energy [kWh]	Energy Per Total Building Area [kWh/m2]	Energy Per Conditioned Building Area [kWh/m2]
Total Site Energy	290480.73	104.46	104.46
Net Site Energy	290480.73	104.46	104.46
Total Source Energy	761531.18	273.86	273.86
Net Source Energy	761531.18	273.86	273.86

Saving from building and how much was saved (Annually) in comparison with the baseline building (ASHRAE 2016)

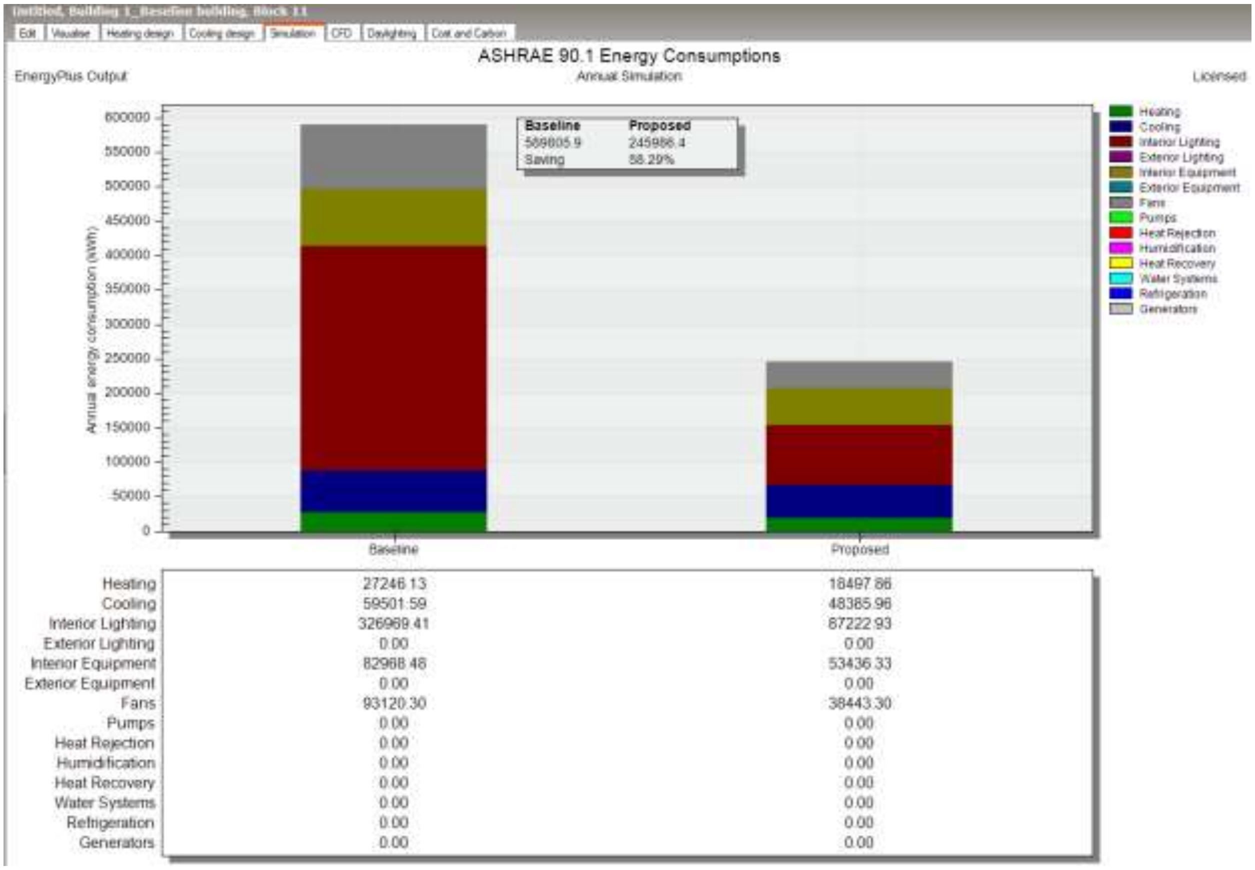
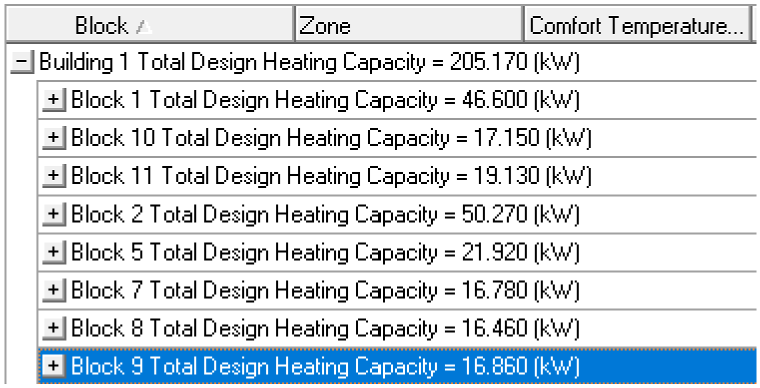


Figure 86 - Energy Saving Simulation

2.5.4.2. Heating and Cooling loads using Design builder:

Heating and Cooling loads are very important factors to be considered to maintain the thermal comfort of people inside any institution, analyses and studied in both summer and winter to make sure people are thermally comfortable during the year. As heating load is the load needed to heat the building during winter. On the other hand, cooling load is the load needed to cool the building during summer

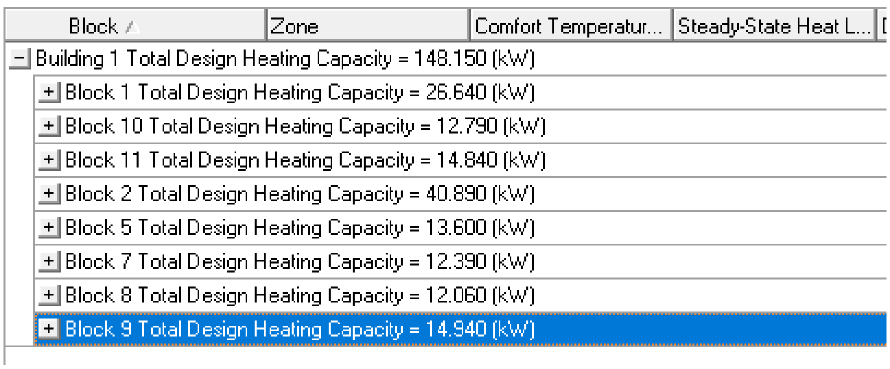
Total heating load of the bank before treatment is = 205 KW



Block	Zone	Comfort Temperature...
Building 1 Total Design Heating Capacity = 205.170 (kW)		
Block 1 Total Design Heating Capacity = 46.600 (kW)		
Block 10 Total Design Heating Capacity = 17.150 (kW)		
Block 11 Total Design Heating Capacity = 19.130 (kW)		
Block 2 Total Design Heating Capacity = 50.270 (kW)		
Block 5 Total Design Heating Capacity = 21.920 (kW)		
Block 7 Total Design Heating Capacity = 16.780 (kW)		
Block 8 Total Design Heating Capacity = 16.460 (kW)		
Block 9 Total Design Heating Capacity = 16.860 (kW)		

Figure 87 - Total Heating Capacity Before treatment

Total heating load of the bank After treatment is = 148 KW



Block	Zone	Comfort Temperatur...	Steady-State Heat L...
Building 1 Total Design Heating Capacity = 148.150 (kW)			
Block 1 Total Design Heating Capacity = 26.640 (kW)			
Block 10 Total Design Heating Capacity = 12.790 (kW)			
Block 11 Total Design Heating Capacity = 14.840 (kW)			
Block 2 Total Design Heating Capacity = 40.890 (kW)			
Block 5 Total Design Heating Capacity = 13.600 (kW)			
Block 7 Total Design Heating Capacity = 12.390 (kW)			
Block 8 Total Design Heating Capacity = 12.060 (kW)			
Block 9 Total Design Heating Capacity = 14.940 (kW)			

Figure 88 - total Heating Capacity After treatment

Total cooling load of the bank before treatment is = 226 KW

office	Block 11	6.03	0.389	5.24	5.24	0.00	26.00	35.6	Sep 1
office 4	Block 11	3.03	0.196	2.64	2.64	0.00	26.00	35.3	Sep 1
office 3	Block 11	9.36	0.604	8.14	8.14	0.00	26.00	34.9	Sep 1
office 2	Block 11	2.25	0.136	1.96	1.83	0.12	26.00	43.4	Jul 14
office 1	Block 11	1.83	0.111	1.59	1.49	0.10	26.00	43.5	Jul 14
hall	Block 11	4.10	0.210	3.57	2.83	0.74	26.00	49.3	Aug 1
storage	Block 10	1.66	0.134	1.45	1.42	0.03	23.00	50.2	Aug 1
office	Block 10	5.87	0.379	5.10	5.10	0.00	26.00	35.7	Sep 1
office 4	Block 10	2.87	0.186	2.50	2.50	0.00	26.00	35.5	Sep 1
office 3	Block 10	9.09	0.587	7.90	7.90	0.00	26.00	35.8	Sep 1
office 2	Block 10	1.93	0.116	1.68	1.57	0.12	26.00	43.7	Jul 14
office 1	Block 10	1.56	0.094	1.35	1.26	0.10	26.00	43.7	Jul 14
hall	Block 10	3.71	0.188	3.22	2.53	0.69	26.00	50.2	Aug 1
entrance	Block 1	1.39	0.105	1.21	1.21	0.00	24.00	42.1	Sep 1
auto Casher	Block 1	0.26	0.015	0.23	0.20	0.03	26.00	45.2	Aug 1
office	Block 1	1.00	0.060	0.87	0.80	0.06	26.00	43.8	Jul 14
office	Block 1	0.57	0.034	0.49	0.46	0.04	26.00	43.8	Jul 14
office	Block 1	0.57	0.034	0.49	0.46	0.04	26.00	43.8	Jul 14
green	Block 1	1.10	0.062	0.95	0.83	0.12	26.00	45.1	Aug 1
ATMroom	Block 1	0.39	0.022	0.34	0.30	0.04	26.00	45.1	Aug 1
office	Block 1	0.25	0.014	0.22	0.19	0.03	26.00	45.0	Aug 1
office	Block 1	0.49	0.032	0.43	0.43	0.00	26.00	35.6	Sep 1
office	Block 1	0.53	0.035	0.46	0.46	0.00	26.00	35.6	Sep 1
office	Block 1	0.25	0.014	0.22	0.19	0.03	26.00	44.8	Aug 1
office	Block 1	0.58	0.037	0.50	0.50	0.00	26.00	35.5	Sep 1
waiting room	Block 1	5.38	0.280	4.68	3.77	0.91	26.00	49.0	Aug 1
office	Block 1	0.48	0.026	0.42	0.36	0.06	26.00	45.9	Aug 1
office	Block 1	0.79	0.051	0.68	0.59	0.09	24.00	50.5	Aug 1
waiting room	Block 1	1.66	0.086	1.44	1.16	0.28	26.00	49.0	Aug 1
office	Block 1	0.81	0.053	0.70	0.61	0.09	24.00	50.3	Aug 1
office	Block 1	0.34	0.019	0.29	0.25	0.04	26.00	45.5	Aug 1
sales Room	Block 1	5.63	0.316	4.90	4.25	0.65	26.00	45.1	Aug 1
cashiers	Block 1	3.03	0.166	2.63	2.23	0.40	26.00	46.0	Aug 1
coridor	Block 1	1.49	0.093	1.30	1.25	0.05	26.00	42.6	Jul 14
office	Block 1	1.03	0.061	0.89	0.82	0.07	26.00	44.0	Jul 14
office	Block 1	1.15	0.069	1.00	0.92	0.07	26.00	43.9	Jul 14
Vault Room	Block 1	4.52	0.270	3.93	3.64	0.30	26.00	44.0	Jul 14
Totals	-	226.50	13.823	196.95	183.30	13.66	25.92	44.0	N/A

Figure 89 - Total Cooling load before treatment

Total cooling load of the bank After treatment is = 159 KW

Edit | Visualise | Heating design | Cooling design | Simulation | CFD | Daylighting | Cost and Carbon

Zone	Block	Design Capacity (kW)	Design Flow Rate (m3/s)	Total Cooling Load (kW)	Sensible (kW)	Latent (kW)	Air Temperature (°C)	Humidity (%)	Time of Max Cool...	Max Op Temp in Day ('
office 5	Block 2	0.85	0.062	0.74	0.73	0.02	24.00	40.4	Jun 14:30	27.34
office 6	Block 2	0.53	0.034	0.46	0.45	0.01	26.00	42.8	Jun 14:00	28.51
office 2	Block 11	2.15	0.134	1.87	1.81	0.06	26.00	43.2	Jun 14:00	31.38
office 1	Block 11	1.68	0.105	1.46	1.41	0.04	26.00	43.2	Jun 11:00	30.78
hall	Block 11	3.74	0.208	3.25	2.80	0.45	26.00	49.3	Jun 13:00	30.97
office 3	Block 11	3.90	0.246	3.39	3.32	0.08	26.00	42.6	Jun 13:30	31.36
storage	Block 11	1.11	0.091	0.97	0.97	0.00	23.00	49.8	Jun 17:00	30.18
office	Block 11	3.30	0.209	2.87	2.82	0.05	26.00	42.4	Jun 17:00	32.22
office 4	Block 11	1.68	0.105	1.46	1.42	0.04	26.00	42.9	Jun 13:00	31.01
office 2	Block 10	1.85	0.115	1.60	1.55	0.05	26.00	43.4	Jun 14:00	30.39
office 1	Block 10	1.40	0.087	1.21	1.17	0.04	26.00	43.5	Jun 13:00	29.79
hall	Block 10	3.28	0.182	2.86	2.45	0.40	26.00	50.6	Jun 14:00	30.10
office 3	Block 10	3.56	0.224	3.10	3.02	0.08	26.00	42.7	Jun 13:30	30.77
storage	Block 10	1.04	0.085	0.90	0.90	0.00	23.00	50.0	Jun 17:00	29.76
office	Block 10	3.08	0.195	2.68	2.62	0.05	26.00	42.5	Jun 17:00	31.91
office 4	Block 10	1.48	0.092	1.29	1.24	0.04	26.00	43.0	Jun 13:00	30.18
corridor	Block 1	1.04	0.067	0.90	0.90	0.00	26.00	39.2	Jun 13:00	27.73
cashiers	Block 1	2.33	0.145	2.03	1.96	0.07	26.00	44.5	Jun 14:00	28.98
office	Block 1	0.94	0.059	0.82	0.79	0.03	26.00	43.9	Jun 14:00	29.16
Vault Room	Block 1	3.86	0.240	3.35	3.23	0.12	26.00	43.9	Jun 14:00	30.64
office	Block 1	1.01	0.063	0.87	0.84	0.03	26.00	43.8	Jun 14:00	29.10
ATMroom	Block 1	0.35	0.022	0.31	0.30	0.01	26.00	43.8	Jun 15:00	28.83
green	Block 1	1.12	0.070	0.98	0.94	0.03	26.00	43.5	Jun 16:30	30.24
office	Block 1	0.29	0.018	0.26	0.25	0.01	26.00	43.2	Jun 15:00	28.58
office	Block 1	0.23	0.014	0.20	0.19	0.01	26.00	43.8	Jun 17:00	28.59
office	Block 1	0.53	0.033	0.46	0.45	0.02	26.00	43.6	Jun 14:00	28.95
auto Cashier	Block 1	0.24	0.015	0.21	0.20	0.01	26.00	43.6	Jun 11:00	28.27
entrance	Block 1	1.09	0.077	0.95	0.88	0.05	24.00	49.3	Jun 15:30	27.89
office	Block 1	0.54	0.034	0.47	0.45	0.02	26.00	43.6	Jun 15:30	29.03
office	Block 1	1.08	0.067	0.94	0.91	0.03	26.00	43.4	Jun 15:00	30.04
office	Block 1	0.31	0.019	0.27	0.26	0.01	26.00	43.2	Jun 14:00	28.62
office	Block 1	0.67	0.048	0.58	0.55	0.03	24.00	49.4	Jun 11:00	26.96
waiting room	Block 1	1.26	0.074	1.09	1.00	0.09	26.00	49.2	Jun 14:00	27.98
sales Room	Block 1	4.23	0.263	3.67	3.54	0.13	26.00	44.0	Jun 14:00	30.62
office	Block 1	0.29	0.018	0.25	0.25	0.01	26.00	44.0	Jun 13:00	28.12
office	Block 1	0.64	0.045	0.56	0.52	0.03	24.00	49.7	Jun 14:30	26.62
office	Block 1	0.32	0.020	0.29	0.27	0.01	26.00	43.2	Jun 15:00	28.64
office	Block 1	0.23	0.014	0.20	0.19	0.01	26.00	43.7	Jun 17:00	28.70
office	Block 1	0.38	0.024	0.33	0.32	0.01	26.00	44.5	Jun 14:00	28.01
waiting room	Block 1	4.08	0.241	3.55	3.24	0.30	26.00	49.1	Jun 15:00	28.98
Totals	-	**159.74**	**10.044**	**138.91**	**133.17**	**5.74**	**25.91**	**44.3**	**N/A**	**32.22**

Figure 90 - Figure 89 - Total Cooling load After treatment

2.5.6. Building 3D views regular and treated:

North Elevation regular:

The issue was high heating gain and high percentage of daylight that causes thermal discomfort and glare, due to having an excessive glass area (curtain wall)

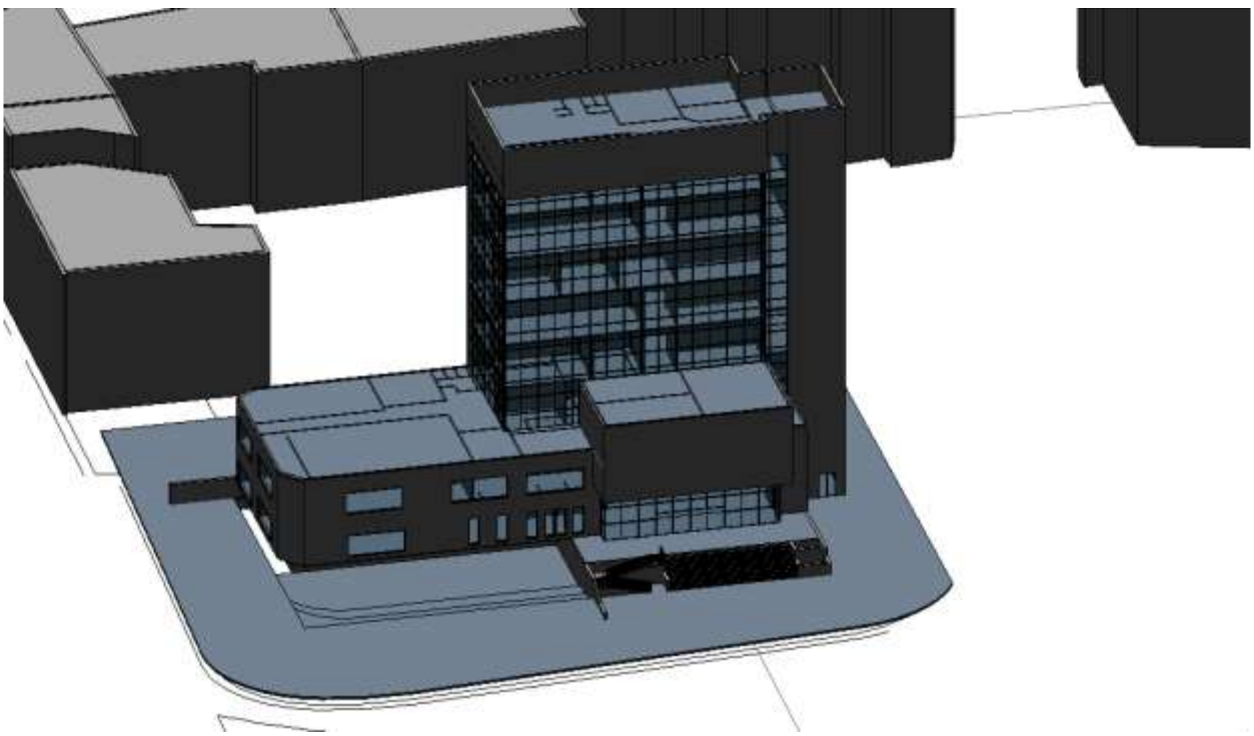


Figure 91 - North Elevation Before Treatment

North Elevation After treatment:

The treatment made was adding an extra thin CNC aluminum wall with 30% porosity, to maintain the view and to decrease the direct light and energy from the sun. In addition, a heat trap door was added to the entrance glass wall. Furthermore, double glazing with low E (0.2) was added to window openings.

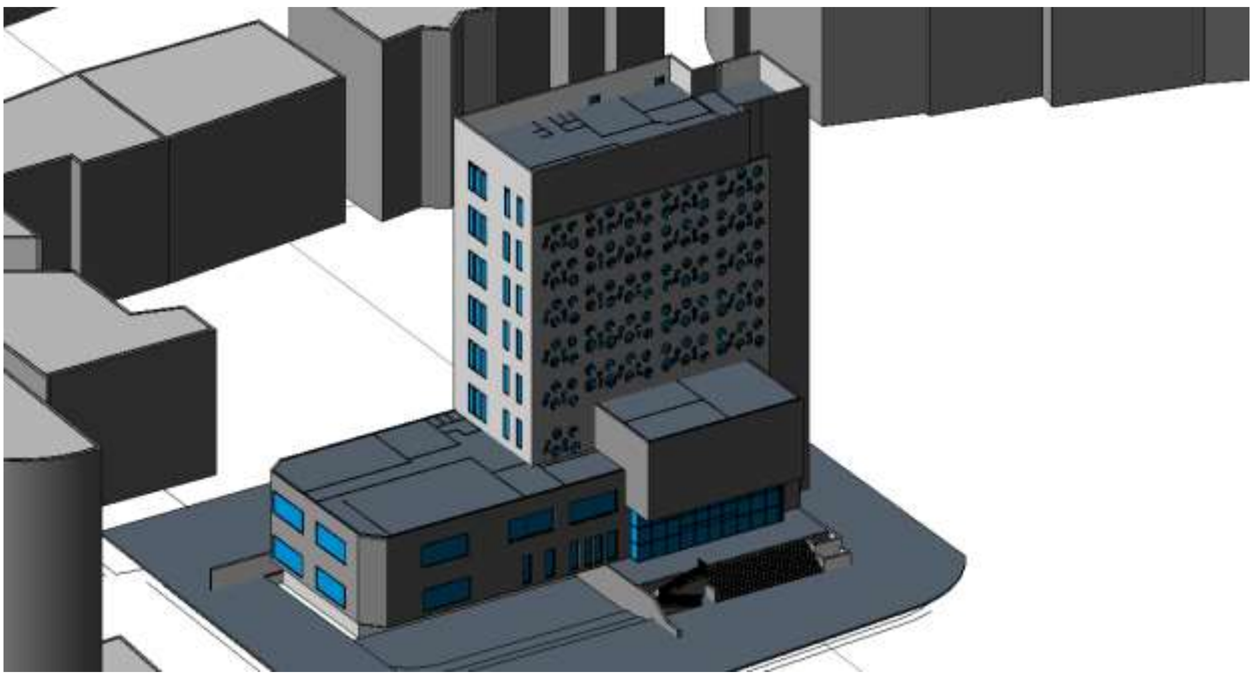


Figure 92 - North Elevation After Treatment

East Elevation regular:

As presented in figure 86 a full curtain wall from 2nd floor to 7th floor, which can be problematic in terms of thermal comfort and safety.

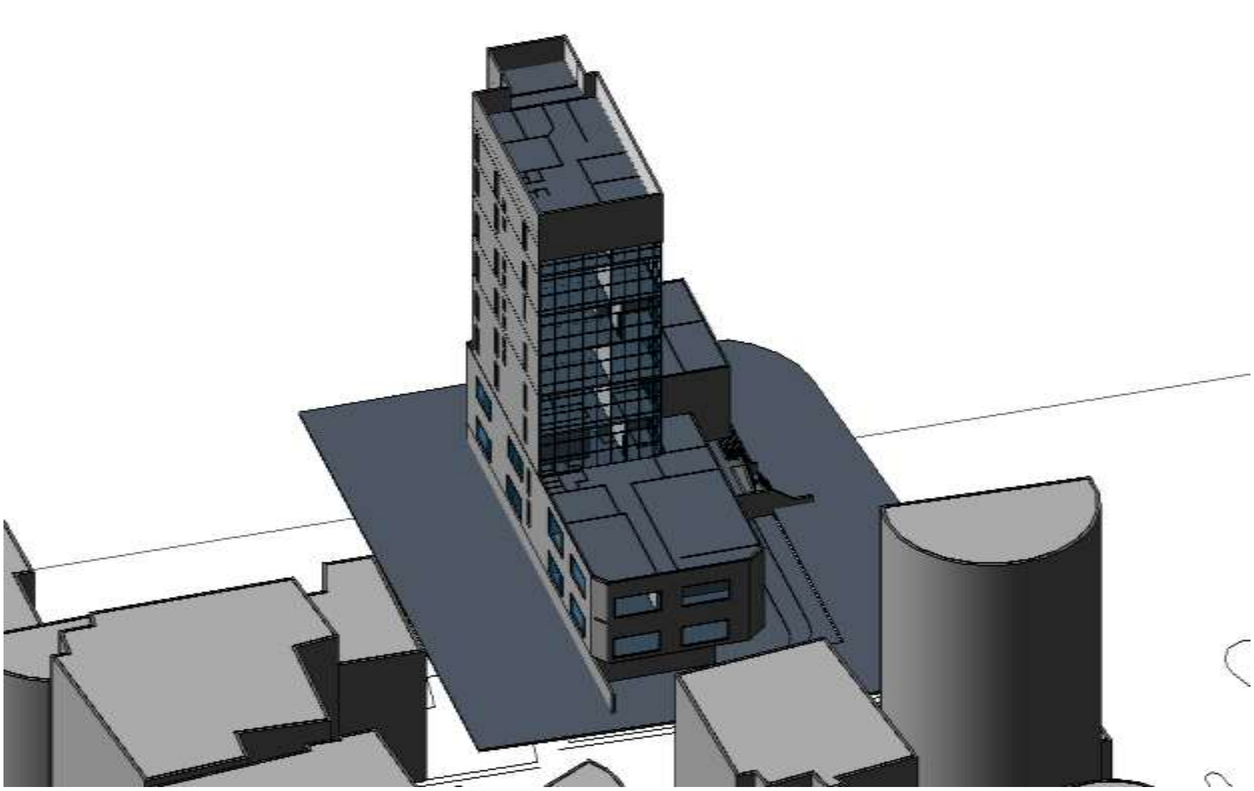


Figure 93 - East Elevation Before Treatment

East Elevation After treatment:

This problem was solved by entirely removing the curtain wall, and adding small window openings to maintain the natural cross ventilation in the building also, to maintain safety. In addition, window openings in the first two floors were treated by adding double glazing tow minimize heat gain.

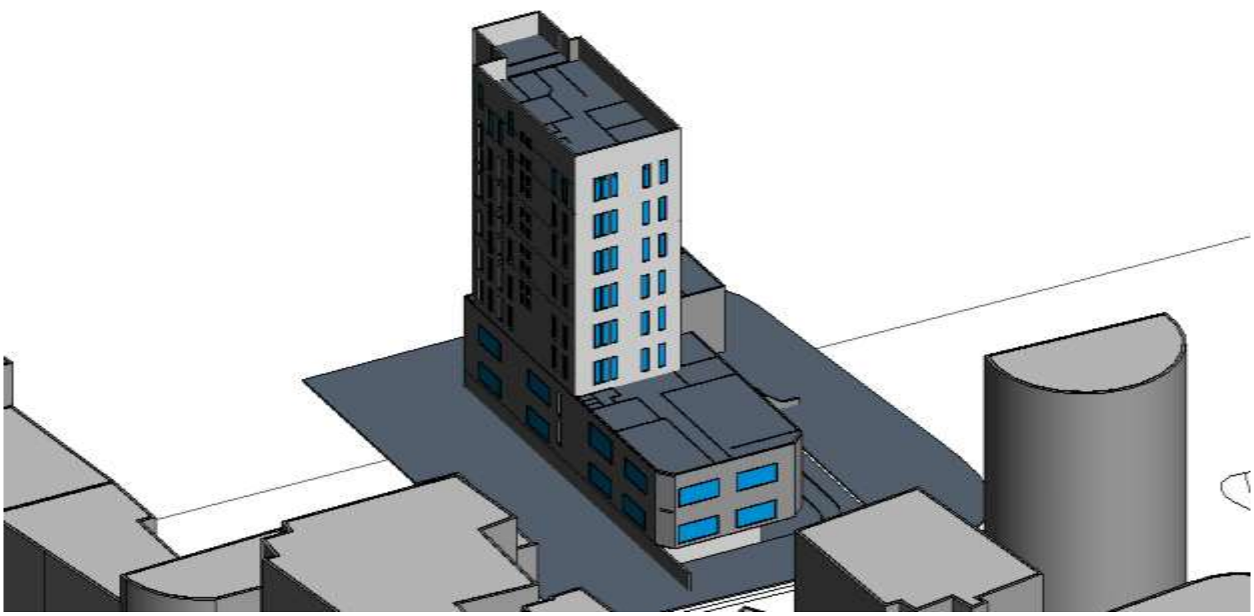


Figure 94 - East Elevation After Treatment

South Elevation regular:

This elevation is the only elevation that is not overshadowed during winter, helpful to minimizing the use of mechanical ventilation, and decrease heating loads during winter.

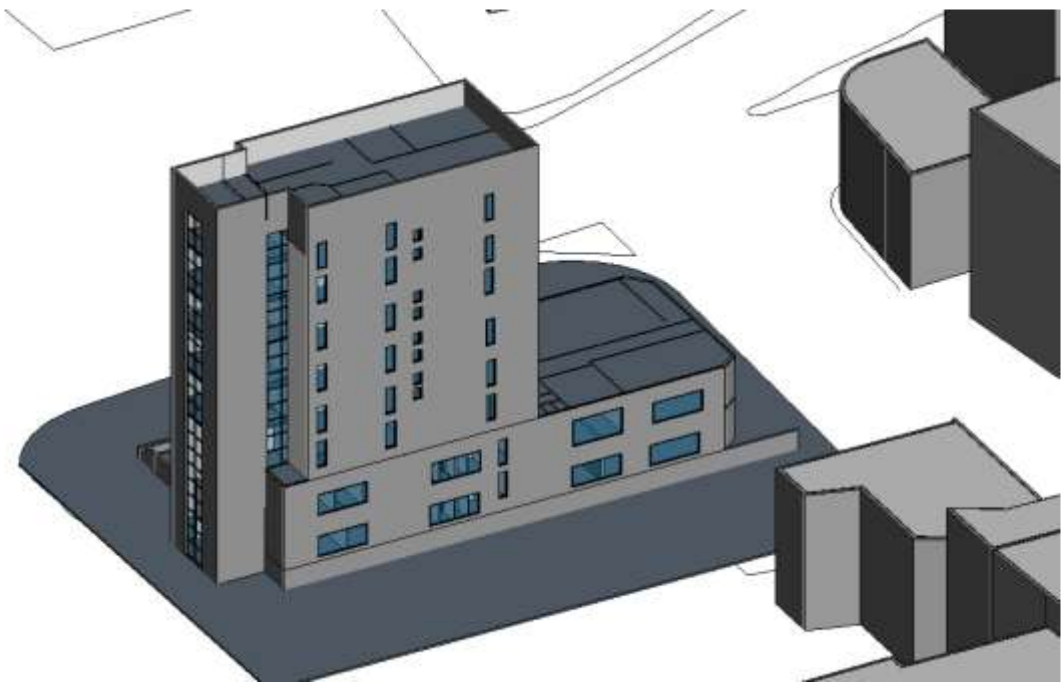


Figure 95 - South Elevation Before Treatment

South Elevation After treatment :

This elevation was taken advantage of the direct sun during winter, by adding more glass areas to increase heat gain. However, horizontal louvers were added to the curtain wall to control over heating and natural lighting.

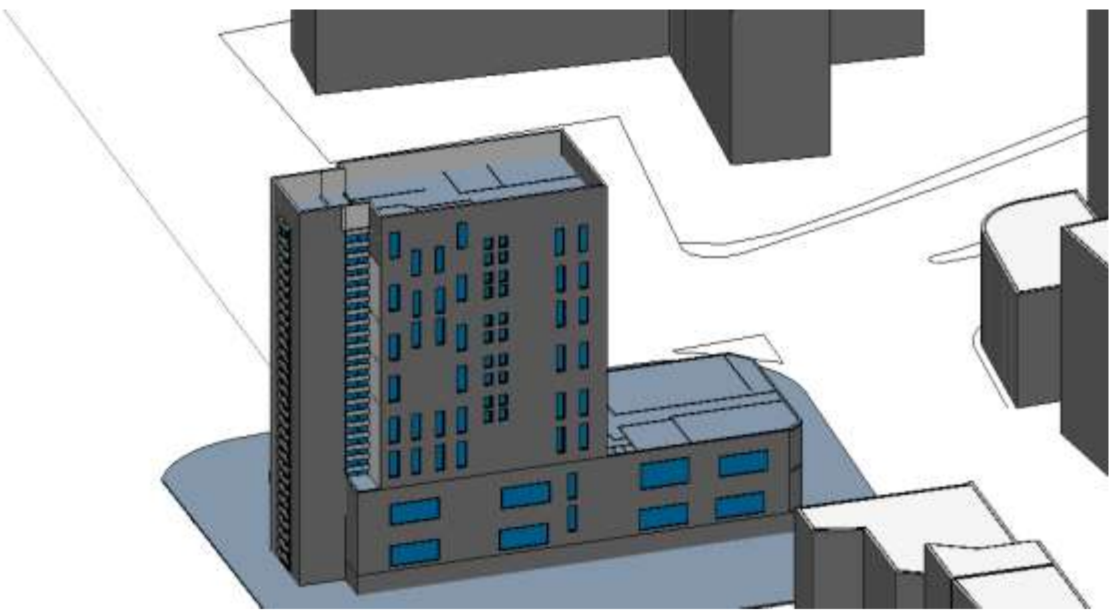


Figure 96 - South Elevation After Treatment

West Elevation regular:

In this elevation there is only one curtain wall located on the staircase exterior wall, which has an increment effect on heating and direct energy from the sun

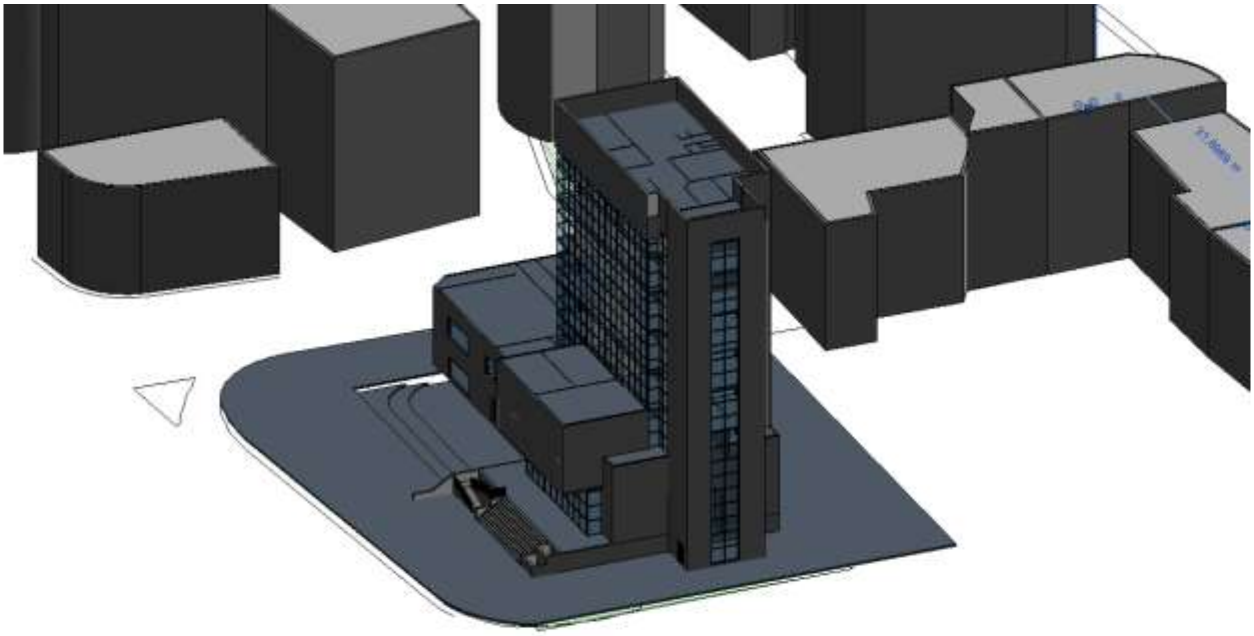


Figure 97 - West Elevation Before Treatment

West Elevation After treatment:

As shown in figure 91, the solution of excessive heat gain and energy from the sun was treated by adding horizontal louvers on the curtain wall.

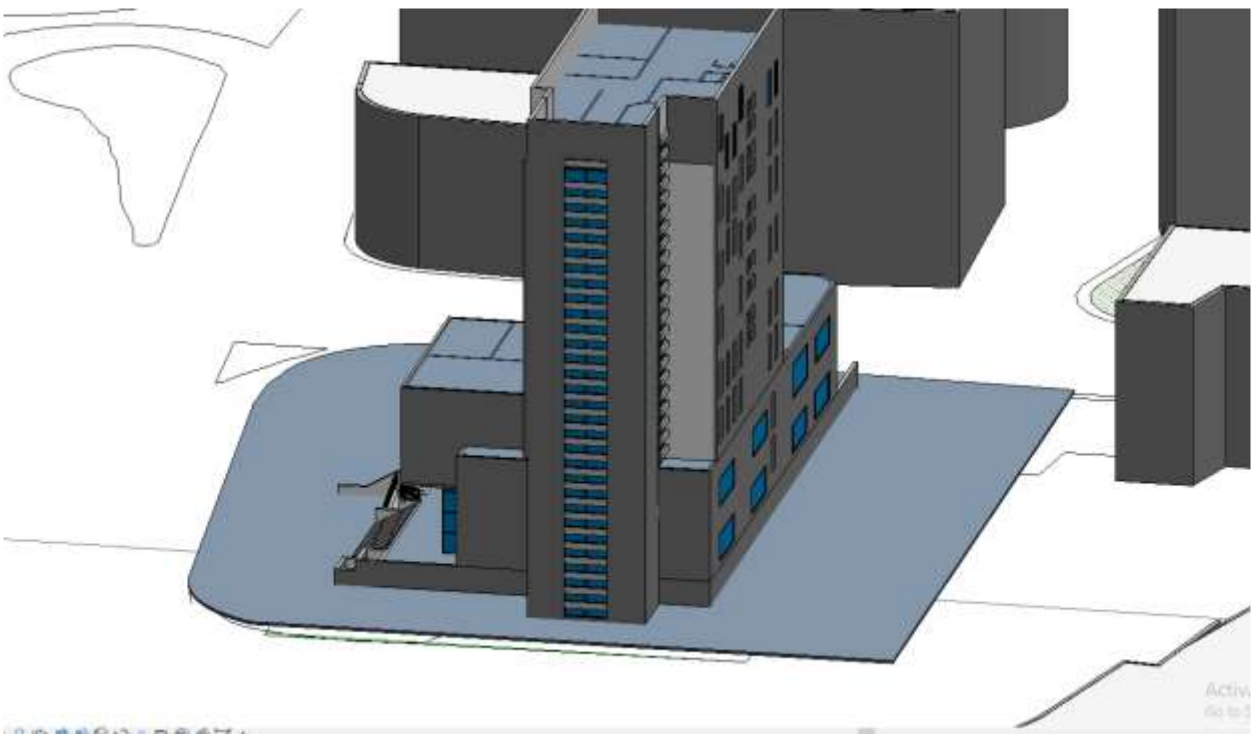


Figure 98 - West Elevation After Treatment

Treatment summary:

All treatment solutions added to the building are:

- thin CNC aluminum wall with 30% porosity
- Horizontal louvers
- Double glazing with low E (0.2)

CHAPTER 3: Structural Aspect

3.1. Introduction:

Structural aspect presents the design of a concrete structure for a bank building. The project involved analyzing the loads and forces that the building will be subjected to during its service life, and designing a concrete structure that can withstand these loads while meeting the required safety and serviceability criteria.

The report covers the design process and calculations for various components of the structure, including the foundation, columns, and slabs. It also includes drawings and specifications for the structural components.

We will used Etabs program to do structural design.

Codes and standers:

ACI-318

ASCE 7-16

3.1.1. Material:

1- Concrete: used concrete with strength f'_c = 28 MPa
2- Steel rebar used steel yield strength f_y = 420 MPa

3.1.2. Load:

1- Live load: 3 KN/m2
2- Live load for parking: 5.5KN/m2
3- Live load for Bank store: 10KN/m2
4- Super imposed load =4 KN/m2

3.1.3. Load combination:

Load combination	Equation	Primary load
$U = 1.4D$	(5.3.1a)	D
$U = 1.2D + 1.6L + 0.5(L_r \text{ or } S \text{ or } R)$	(5.3.1b)	L
$U = 1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (1.0L \text{ or } 0.5W)$	(5.3.1c)	L_r or S or R
$U = 1.2D + 1.0W + 1.0L + 0.5(L_r \text{ or } S \text{ or } R)$	(5.3.1d)	W
$U = 1.2D + 1.0E + 1.0L + 0.2S$	(5.3.1e)	E
$U = 0.9D + 1.0W$	(5.3.1f)	W
$U = 0.9D + 1.0E$	(5.3.1g)	E

Slab thickness calculate:

We will use flat plat slab because max span so after calculation slab thickness based on ACI318 cod the slab thickness is 500mm

Slab wight is 8.29KN/m2.

Table 9 – U-boot Catalog

Square mesh clearance	Thickness of the proposed slab with overload 500 Kg/m²	S1	H U-Boot	S2	Lightened slab inertia*	Full slab inertia	Equivalent percentage loss of height	Lightened slab weight	Full slab weight	Weight savings
		cm	cm	cm	cm^4 /m	^{4}cm /m	%	Kg/m	Kg/m²	%
7	26	5	16	5	122.364	146.467	5,85	482,6	650,0	26
8	30	7	16	7	200.897	225.000	3,73	582,6	750,0	22
9	34	5	24	5	246.063	327.533	9,12	596,2	850,0	30
10	36	10	16	10	364.697	388.800	2,14	732,6	900,0	19
11	38	7	24	7	375.796	457.267	6,36	696,2	950,0	27
12	42	5	32	5	429.513	617.400	11,43	715,2	1050,0	32
12	44	10	24	10	628.396	709.867	4,02	846,2	1100,0	23
12	46	7	32	7	623.247	811.133	8,44	815,2	1150,0	29
13	50	5	40	5	673.542	1.041.667	13,56	828,8	1250,0	34
14	52	10	32	10	983.847	1.171.733	5,70	965,2	1300,0	26
14	54	7	40	7	944.075	1.312.200	10,43	928,8	1350,0	31
15	58	5	48	5	989.345	1.625.933	15,30	942,4	1450,0	35
15	60	10	40	10	1.431.875	1.800.000	7,38	1.078,8	1500,0	28
16	62	7	48	7	1.349.478	1.986.067	12,13	1.042,4	1550,0	33
18	68	10	48	10	1.983.678	2.620.267	8,90	1.192,4	1700,0	30

3.2. Checks:

ETABS modal:

For part 1:

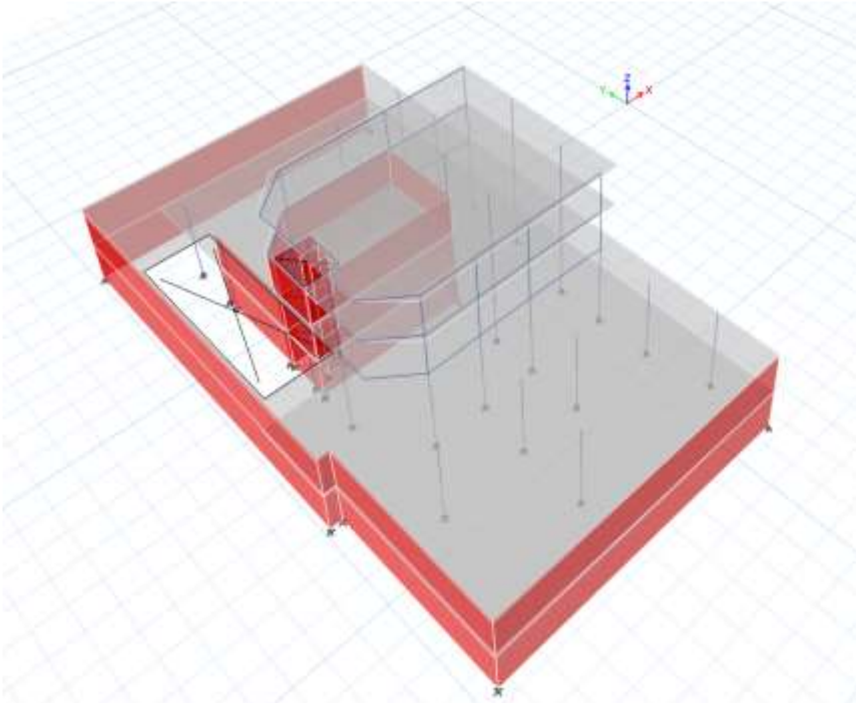


Figure 99 ETABS Model

Figure 100:ETABS modal

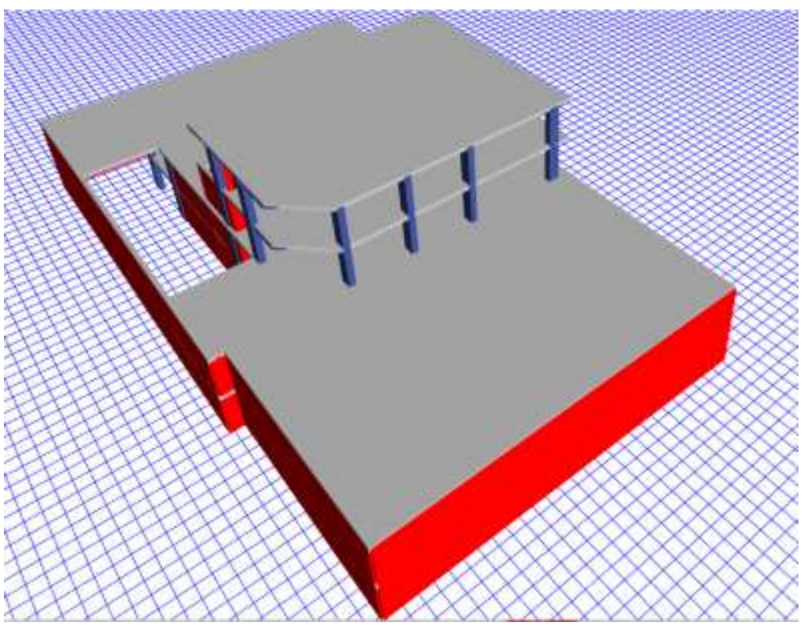


Figure 101:ETABS modal

For part 2:

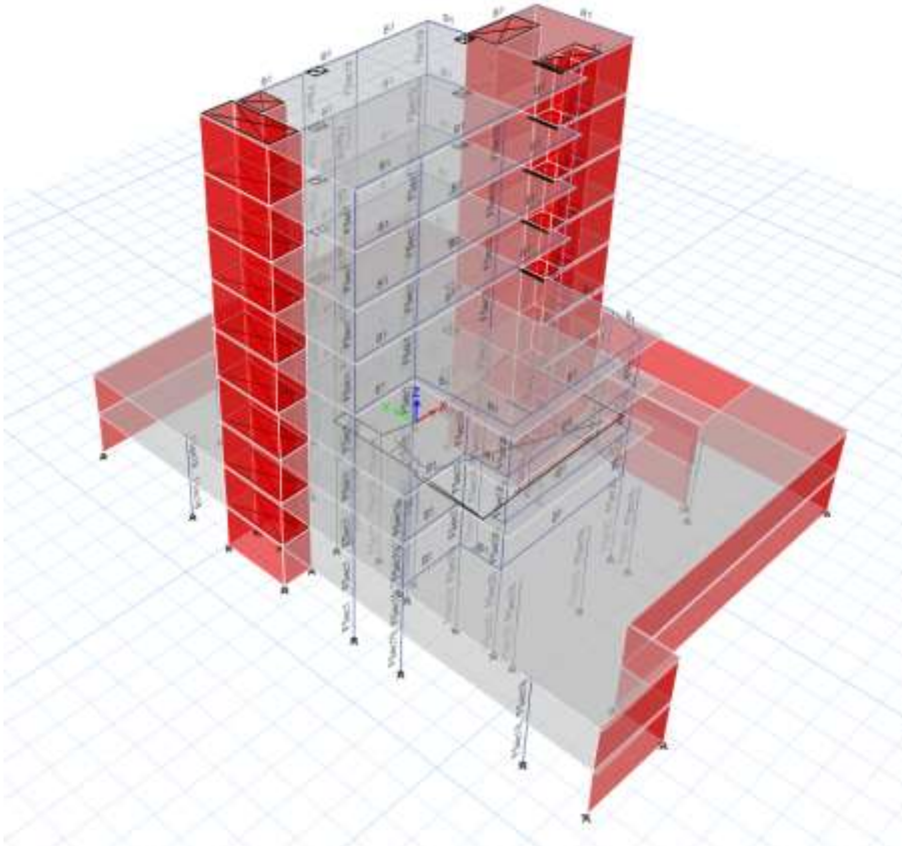


Figure 102:ETABS modal

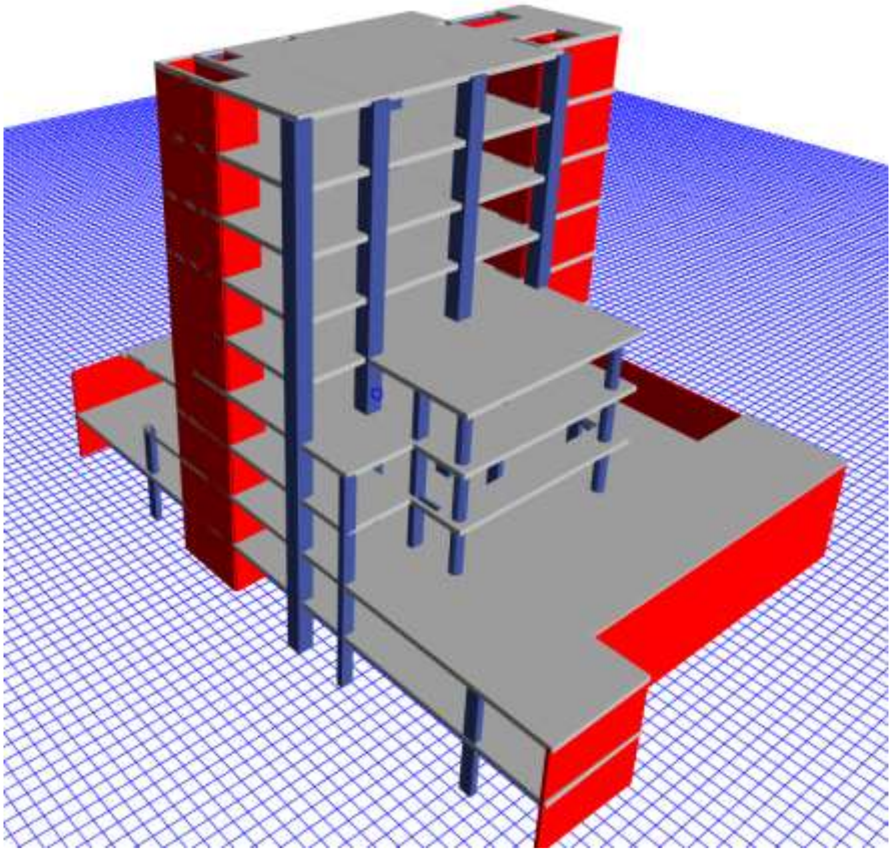


Figure 103:ETABS modal

3.2.1. Model modifiers:

1-slab:

Figure 104:Model modifiers

2-column:

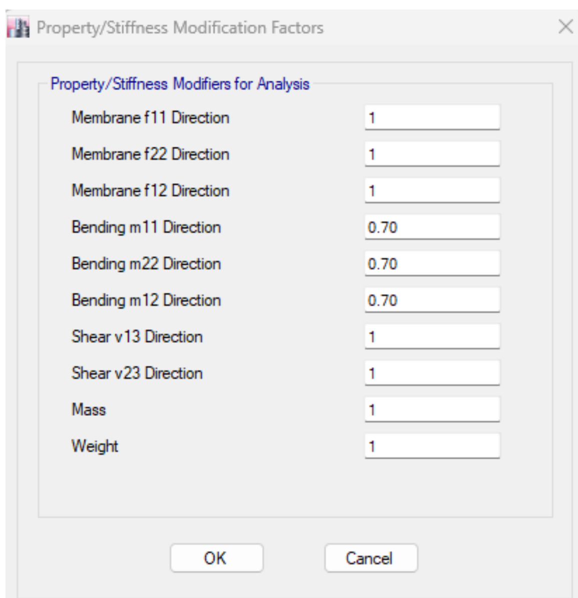


Figure 105:Model modifiers

3-shear wall:

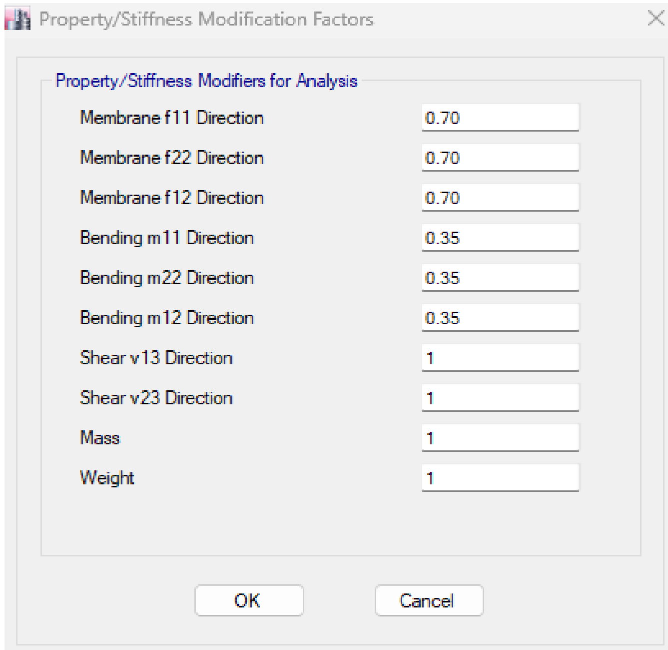


Figure 106:Model modifiers

3.2.2. Compatibility check:

For part 1:

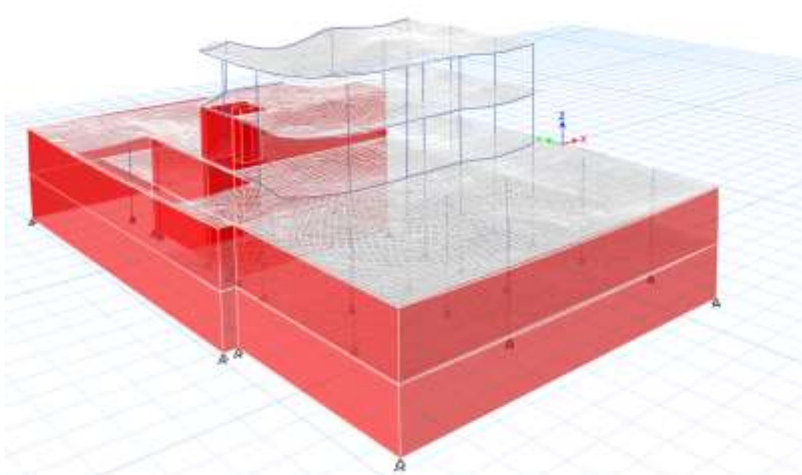


Figure 107:Compatiblility check.

All elements are moving together since they are compatible.

For Part 2:

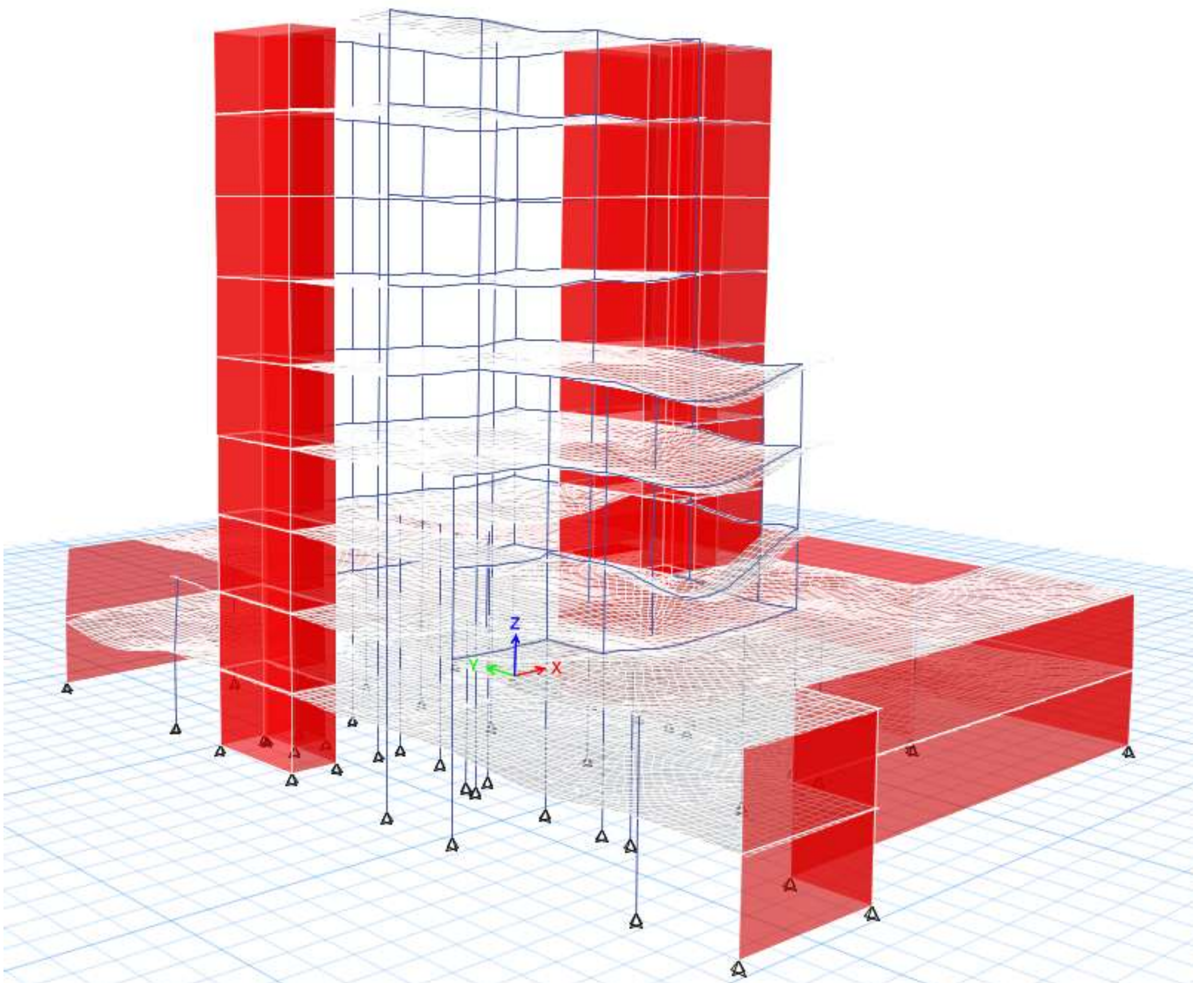


Figure 108:Compatiblility check

All elements are moving together since they are compatible.

3.2.3. Period check:

For part 1:

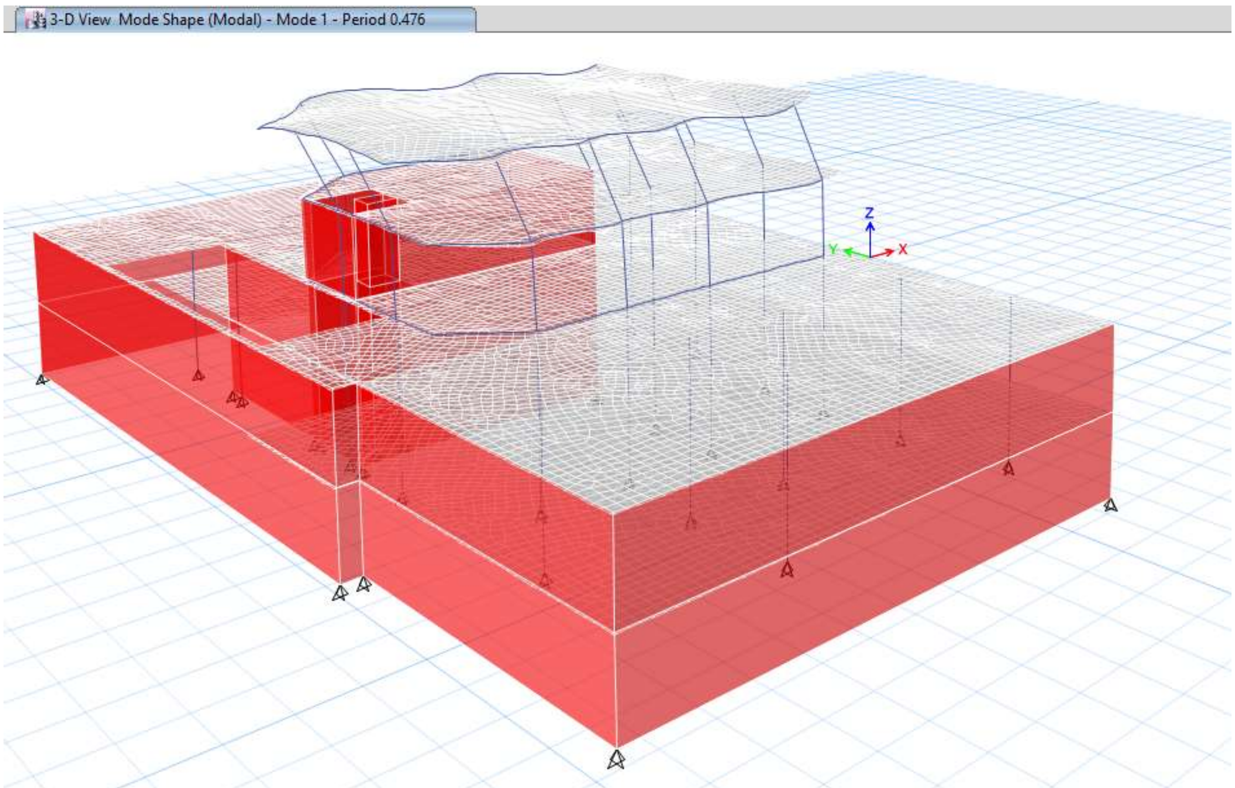


Figure 109:Period check

Period less than 1 which is ok

For part 2:

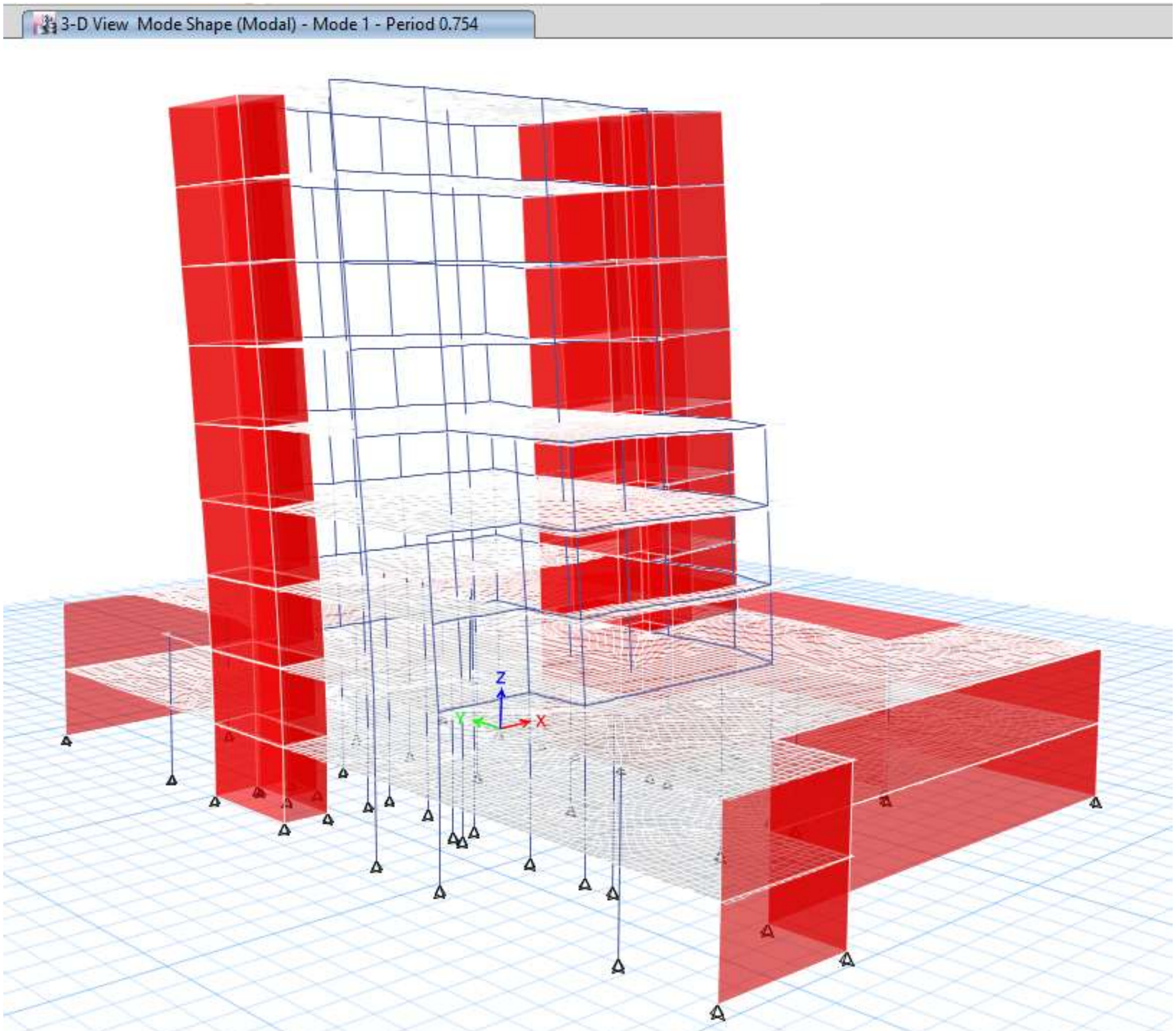


Figure 110:Period check.

Period less than 1 which is ok

3.2.4. Equilibrium check:

For part 1:

Table 10:load from ETABS.

Load Case/Combo	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m
Dead	0	0	44168.5321	-416272.0663	1528588.3224
Live	0	0	16549.7017	-163163.1775	557372.9245
SID	0	0	14958.3104	-149671.5192	502865.8161

Table 11:Equilibrium check.

	Etabs	Manual	%Error	Case
Live	16549.7	16357.7	1.16%	<5%-->ok
SID	14958.3	14784.8	1.16%	<5%-->ok

Table 12:Equilibrium check

<table>
<tr><td rowspan="3">Dead</td><td rowspan="3">44168.5</td><td>columns</td><td>3922.41</td><td rowspan="6"><5%-->ok</td></tr>
<tr><td>Slabs</td><td>32715.65</td></tr>
<tr><td>Shear walls</td><td>5812.31</td></tr>
<tr><td colspan="3">Total manual dead load</td><td>42450.37</td></tr>
<tr><td colspan="3">ETABS dead load</td><td>44168.53</td></tr>
<tr><td colspan="3">%Error</td><td>-3.89%</td></tr>
</table>

For part 2:

From ETABS:

Table 13:load from ETABS

Load Case/Combo	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m
Dead	0	-8.017E-06	97807.5312	-813773.8881	512249.0444	0.0002
Live	0	-4.398E-06	24031.1938	-199407.9241	121241.6171	0.0001
SID	0	-3.196E-06	22024.8772	-184375.1459	124364.5882	0.0001

Table 14:Equilibrium check.

	Etabs	Manual	%Error	Case
Live	24031.2	23759.6	1.13%	<5%-->ok
SID	22024.9	21776	1.13%	<5%-->ok

Table 15:Equilibrium check

<table>
<tr><td rowspan="3">Dead</td><td rowspan="3">97807.5</td><td>columns</td><td>12258.74</td><td rowspan="6"><5%-->ok</td></tr>
<tr><td>Slabs</td><td>82282.70</td></tr>
<tr><td>Shear walls</td><td>7614.72</td></tr>
<tr><td colspan="3">Total manual dead load</td><td>102156.16</td></tr>
<tr><td colspan="3">ETABS dead load</td><td>97807.53</td></tr>
<tr><td colspan="3">%Error</td><td>4.44%</td></tr>
</table>

3.2.5. Deflection check:

For part 1:

From live load:

Limit =13.8/360= 38.33mm

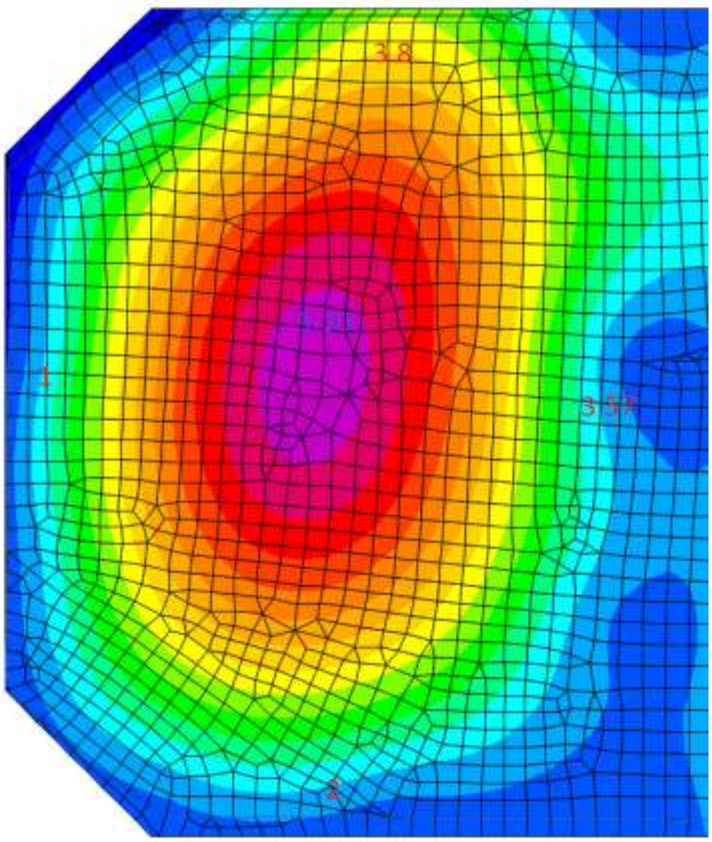


Figure 111:Deflection check

Etabs deflection = 6.70mm<<<38.33mm………is ok

From serves load:

Limit =13.8/240= 57.5mm.

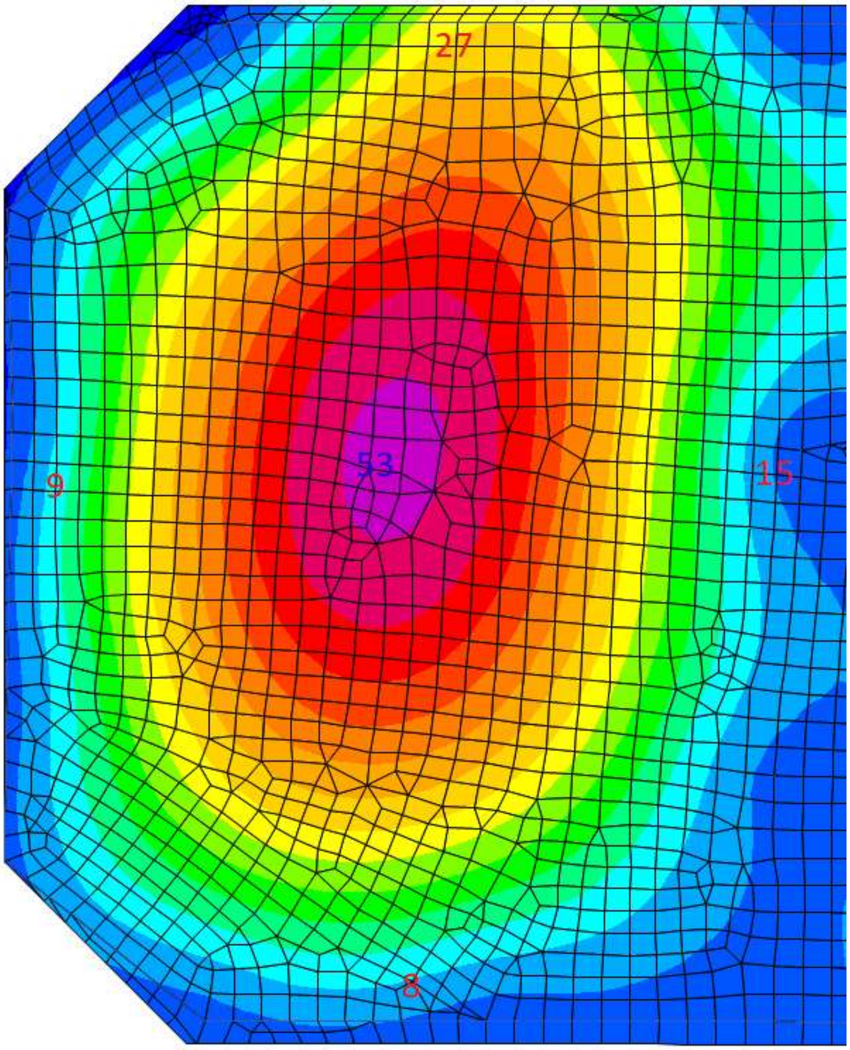


Figure 112:Deflection check

Etabs deflection = 38.25mm<<<57.50mm………is ok

For part 2:

From live load:

Limet =13.5/360= 37.50mm

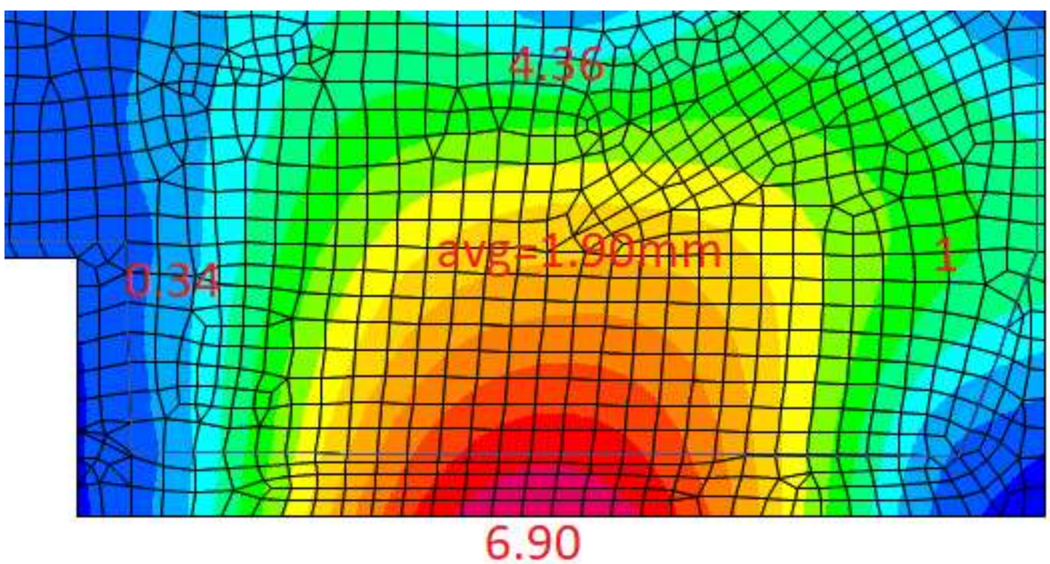


Figure 113:Deflection check

Etabs deflection = 1.90 mm<<<37.50mm………is ok

From SID load :

Limit =13.5/240=56.2mm

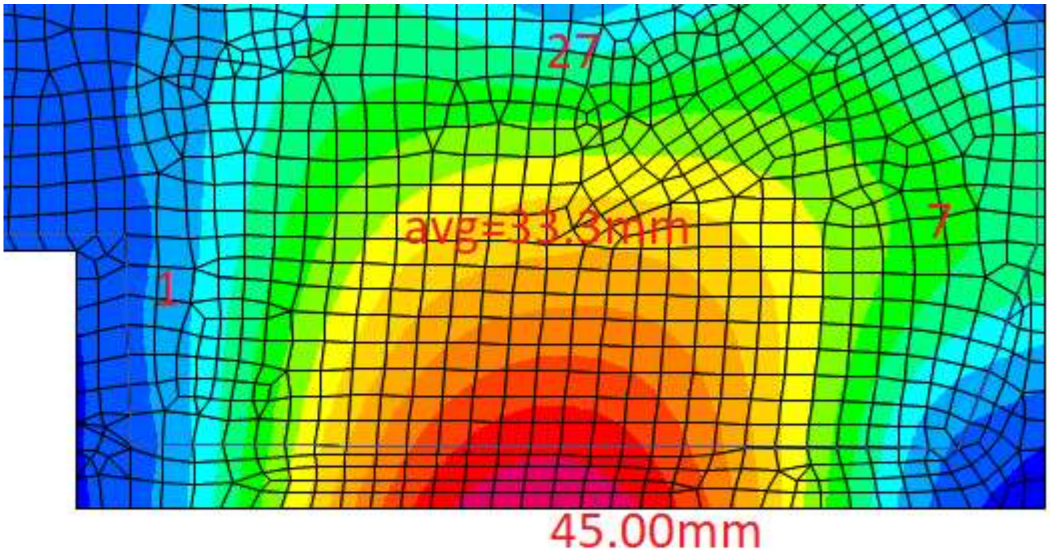


Figure 114:Deflection check

Etabs deflection=33.33mm<56.20mm…………..is ok

3.2.6. Shear check:

$\Phi Vc = \frac{0.75}{6} * \sqrt{fc} * b * d = \frac{0.75}{6} * \sqrt{28} * 1000 * 340/1000$ =224.88KN

For part 1:

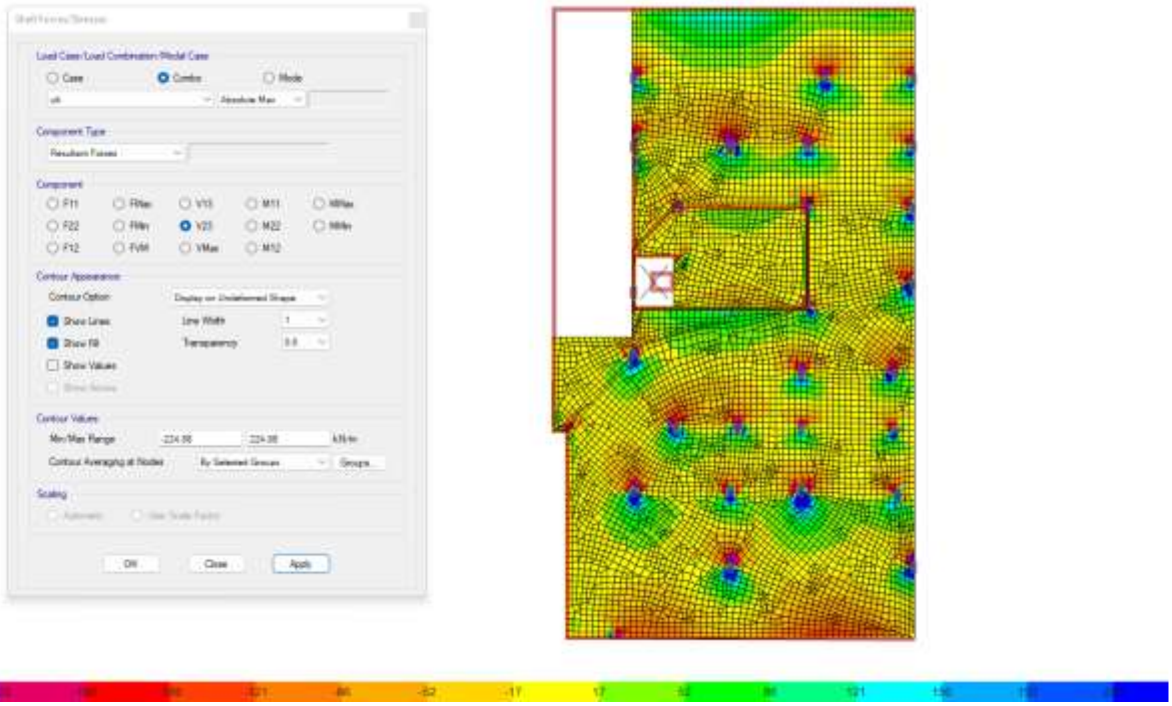


Figure 115:Shear check

Vu< ΦVc ok after d/2

For part 2:

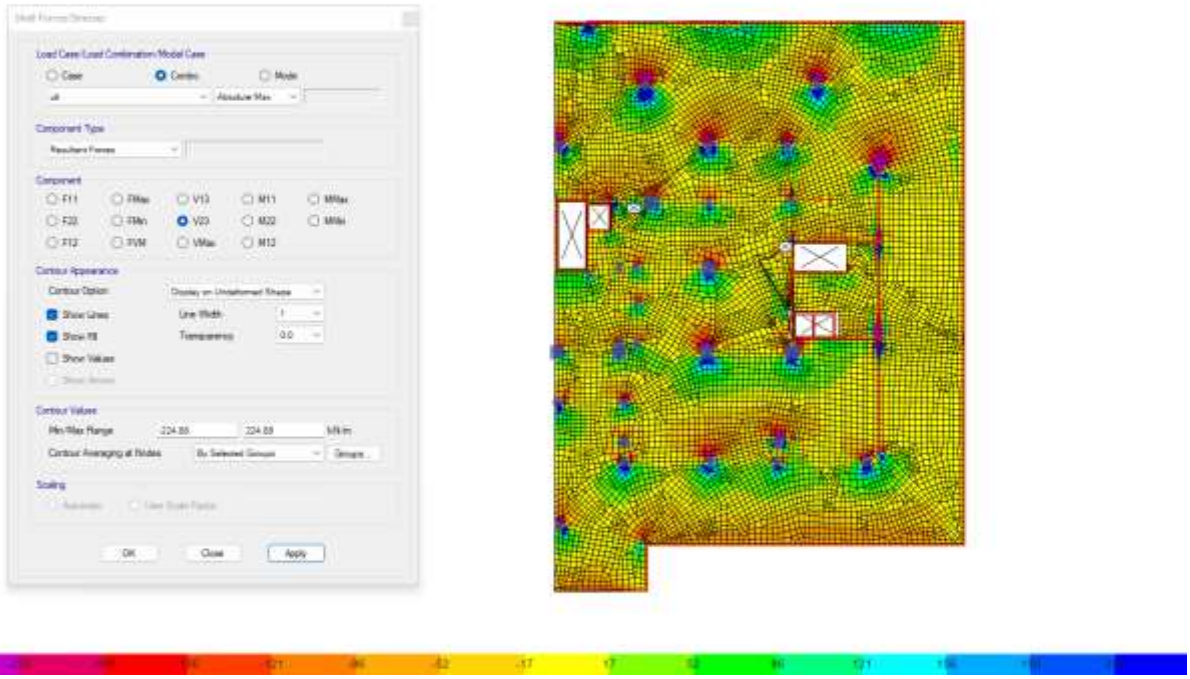


Figure 116:Shear check

Vu< ΦVc ok after d/2

3.2.7. Punching shear check:

For part 1:

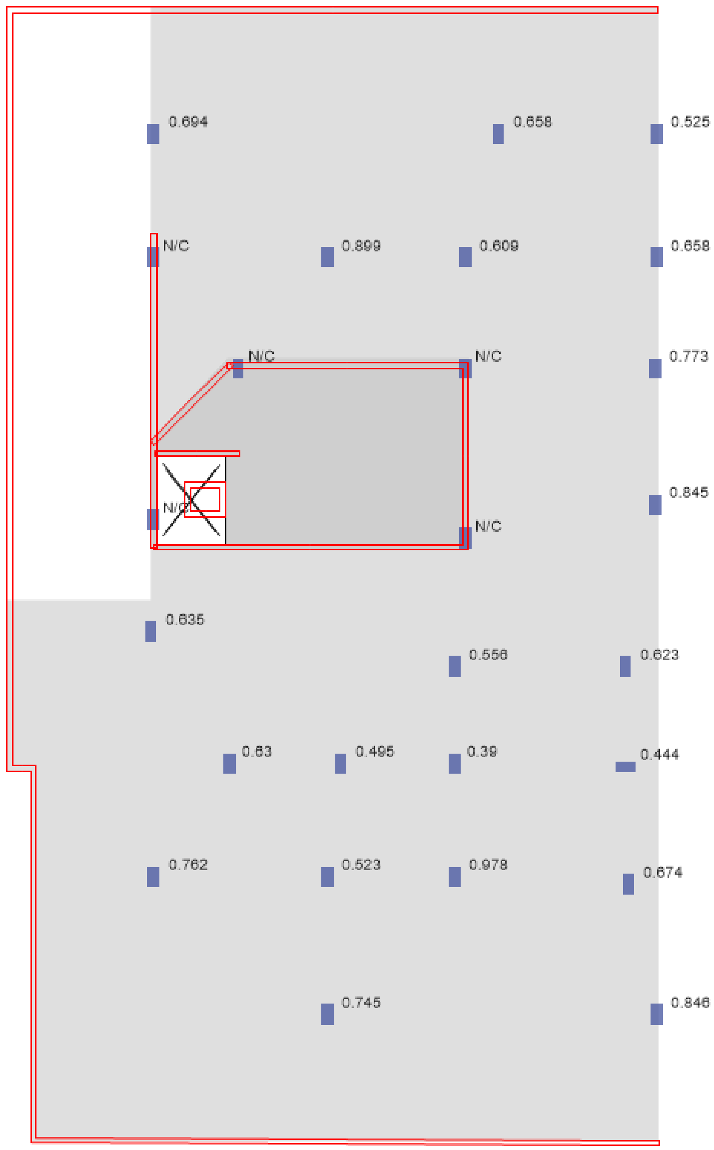


Figure 117:Punching shear check

Punching shear is ok.

For part 2:

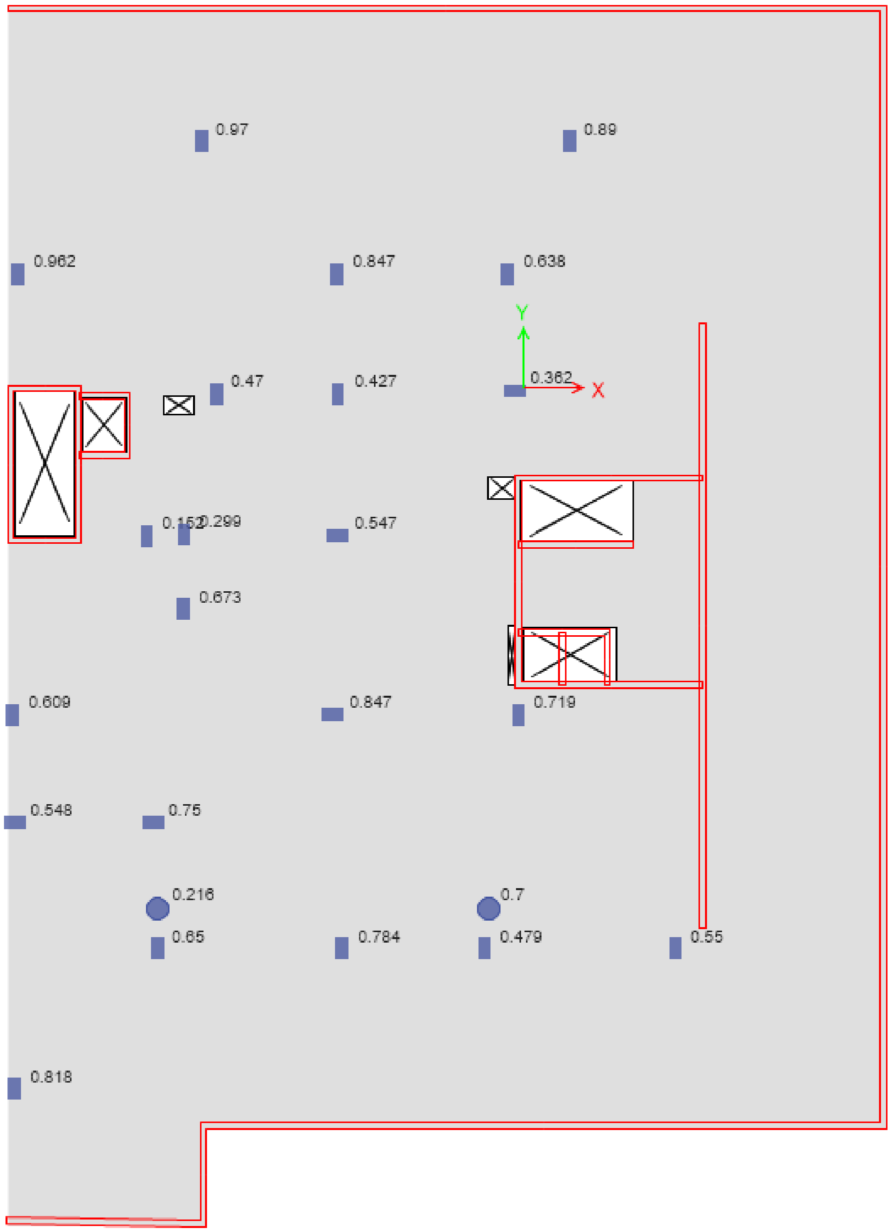


Figure 118:Punching shear check

Punching shear is ok.

3.2.8. Design check:

For part 1:

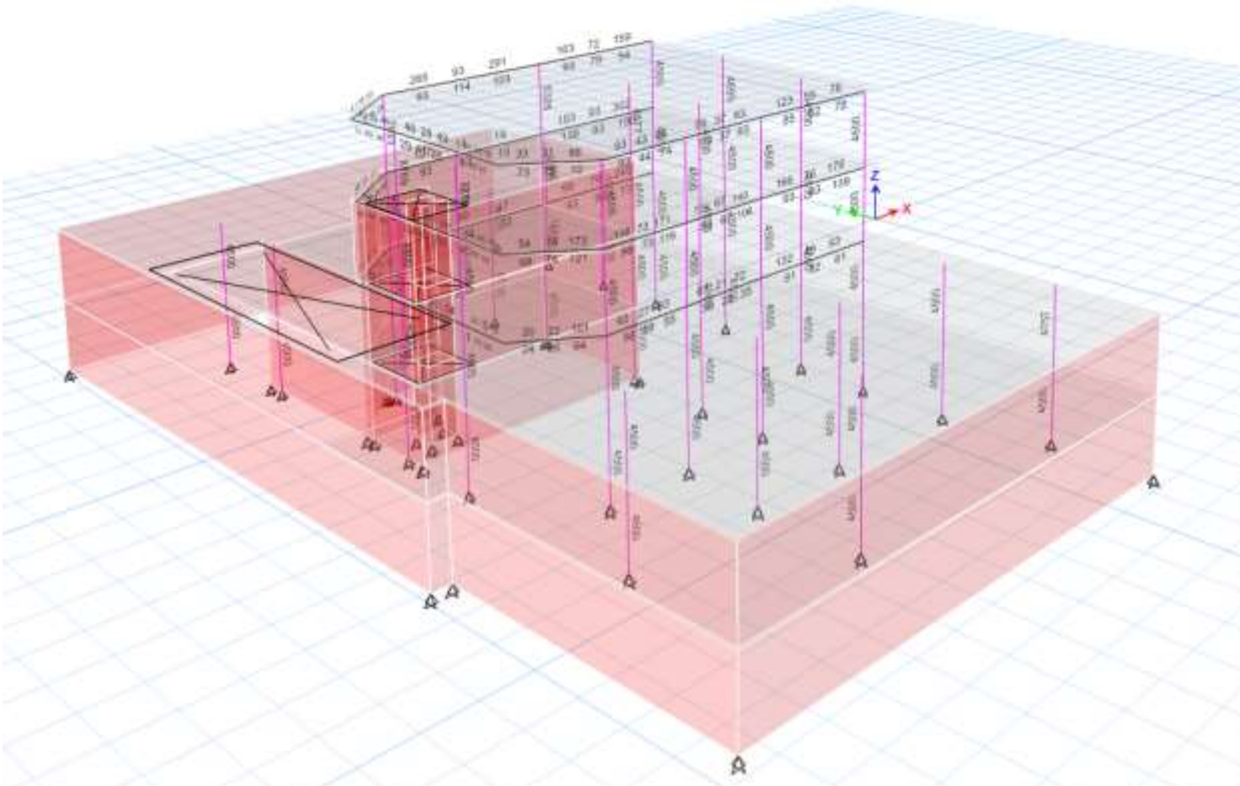


Figure 119:Design check

Design Check is ok

For part 2

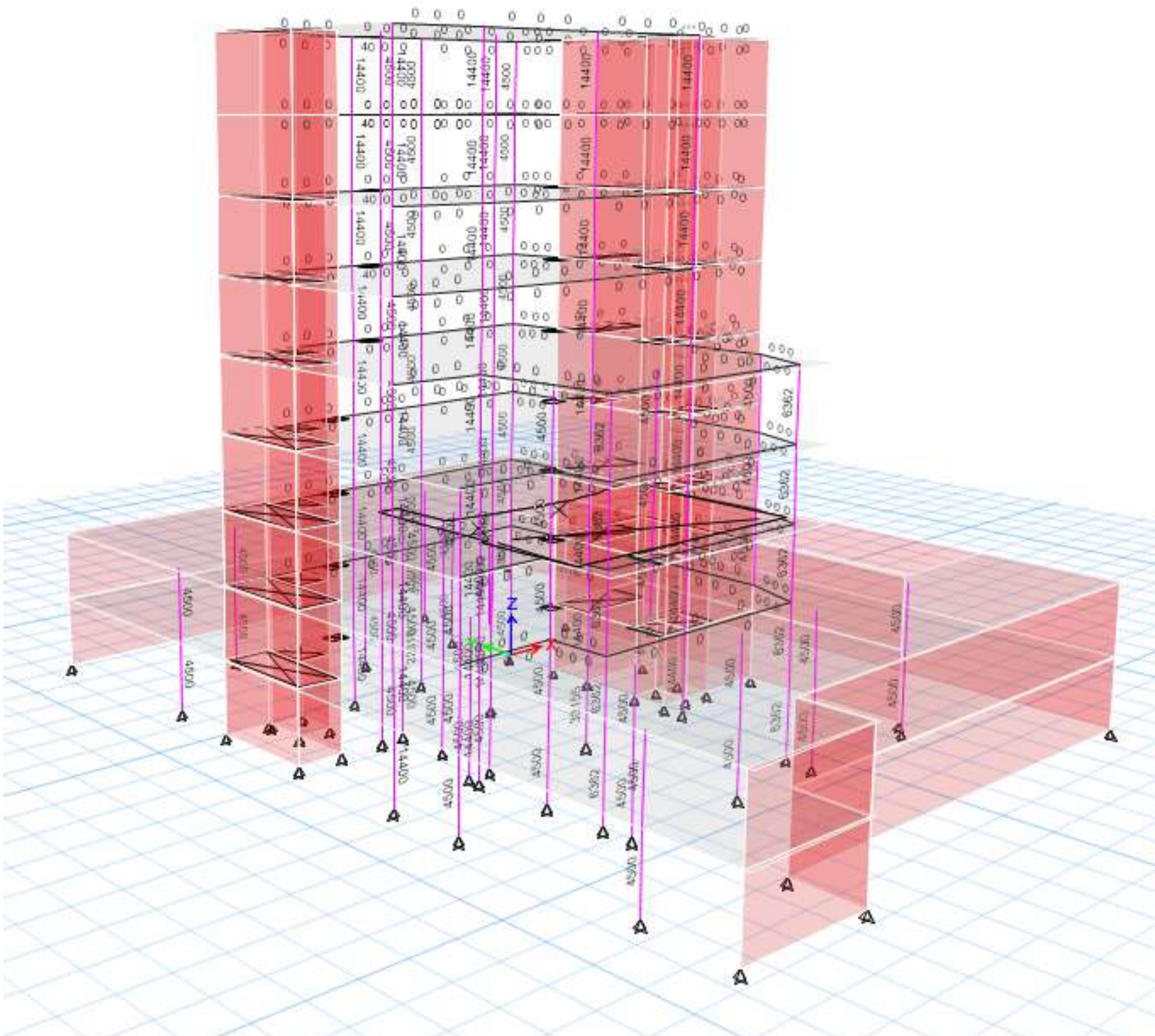


Figure 120:Design check

Design Check is ok

3.2.8. Internal force check:

for part 1:

check for column:

From Live loads:

1- Interior column:
2-

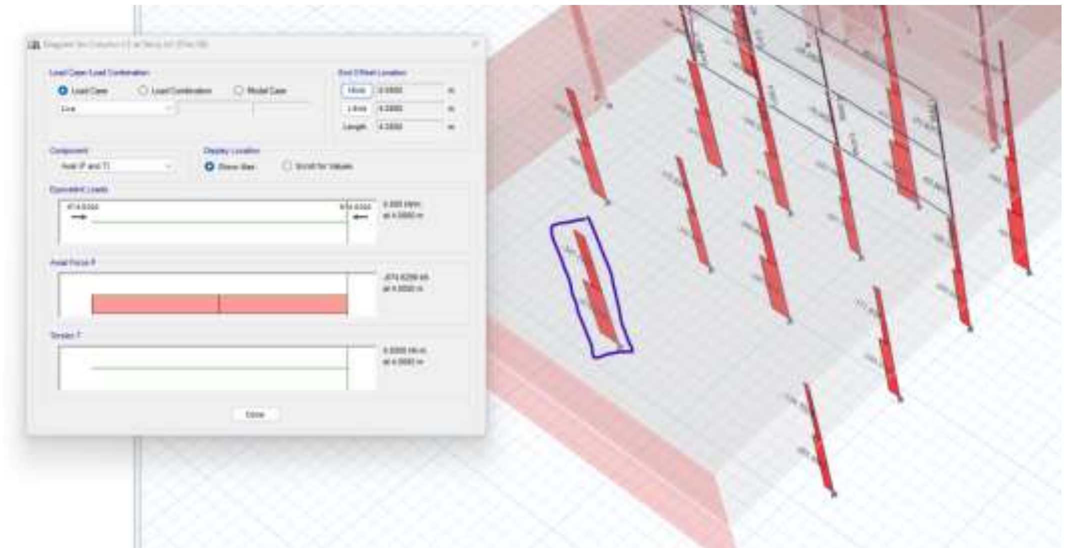


Figure 121:Internal force check for column.

From etabs =674.62 kN

From manual =682kN

% error = 1.1%

Check is ok

3- corner column:

Figure 122:Internal force check for column.

From etabs =295.92 kN

From manual =298.3kN

% error = 3.3%

Check is OK

4-   edge column:

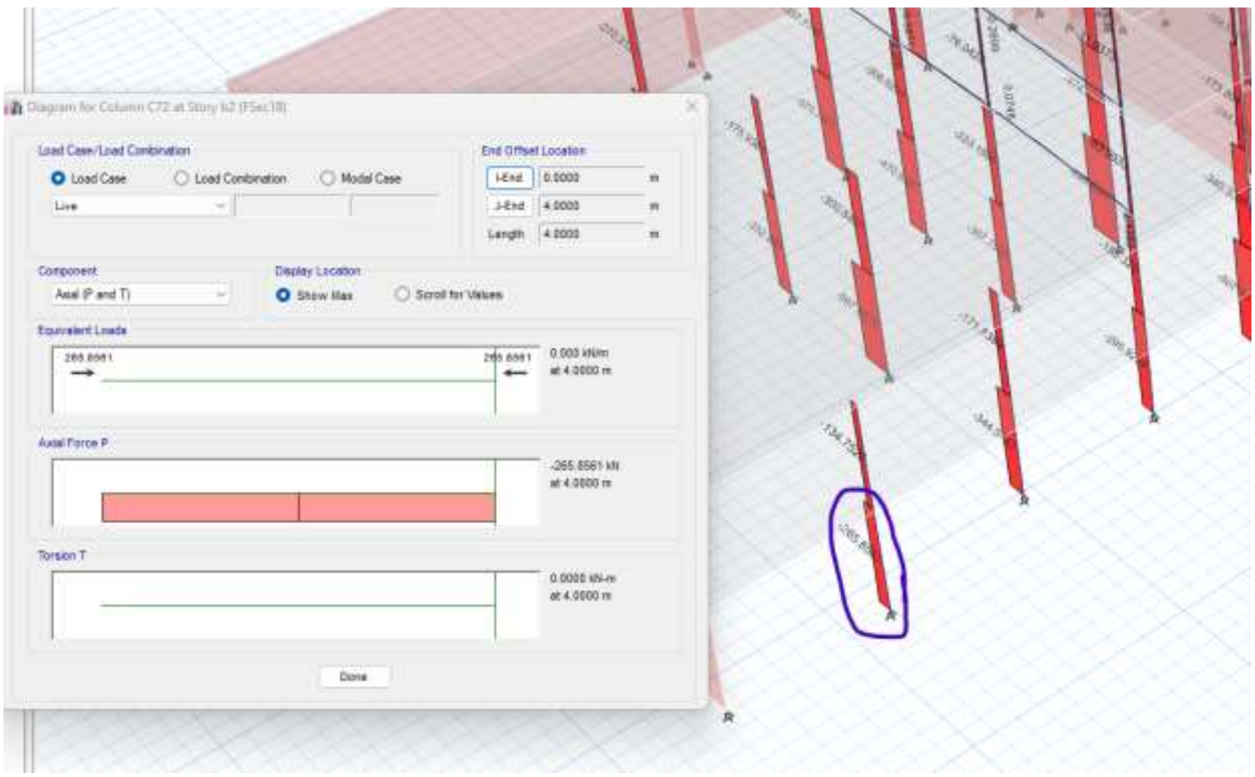


Figure 123:Internal force check for column.

From etabs =265.8 kN

From manual =270.50kN

% error = 4.73%

Check is ok..

3.2.9. Slab check:

From live load:

Panel type: internal panel

From etabs =23.45 kn.m

From manual =24 kN.m

% error = 2.34%

for part 2

check for column:

From Live loads:

1- Interior column:

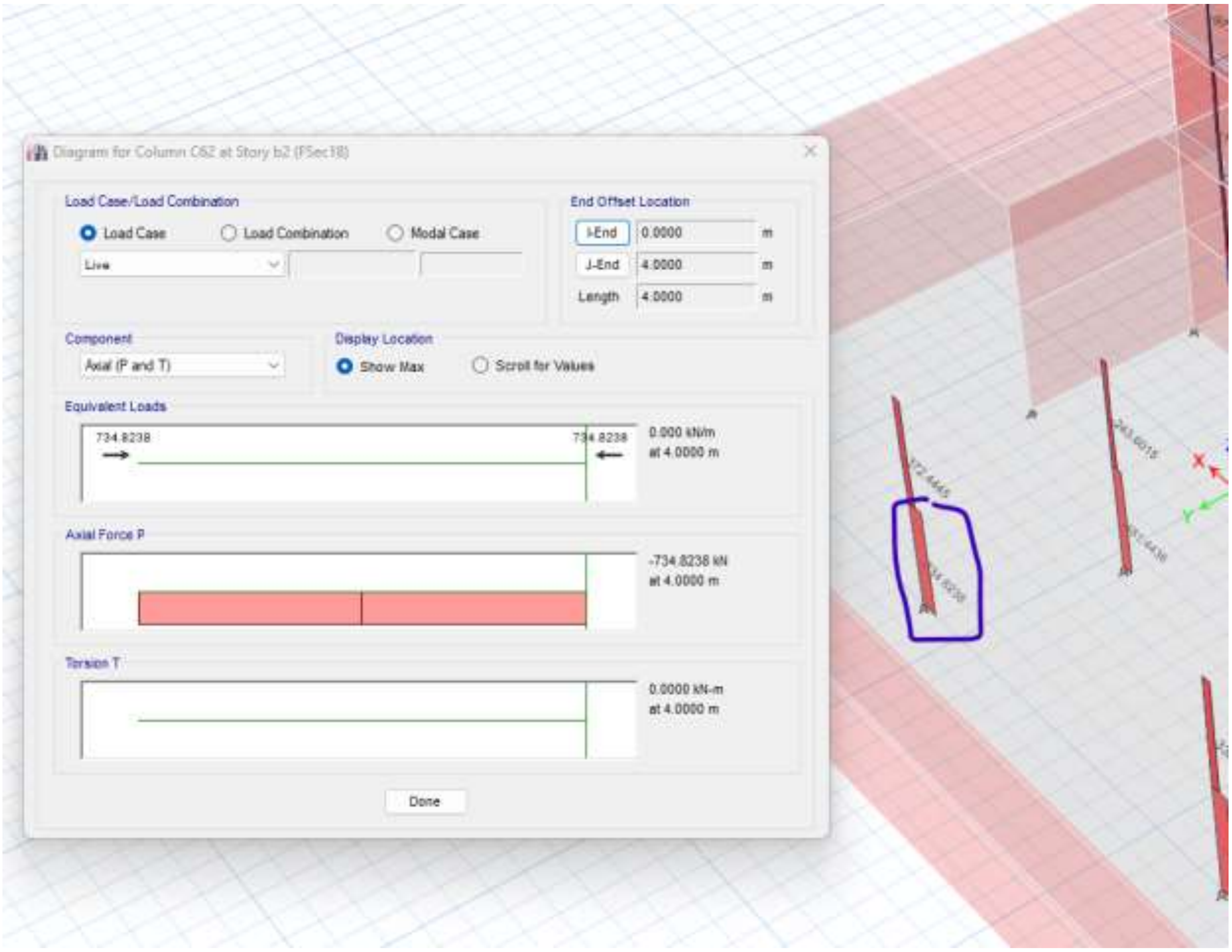


Figure 124::Internal force check for column.

From etabs =734.82 kN

From manual =770.3kN

% error = 4.83%

Check is ok

2- corner column:

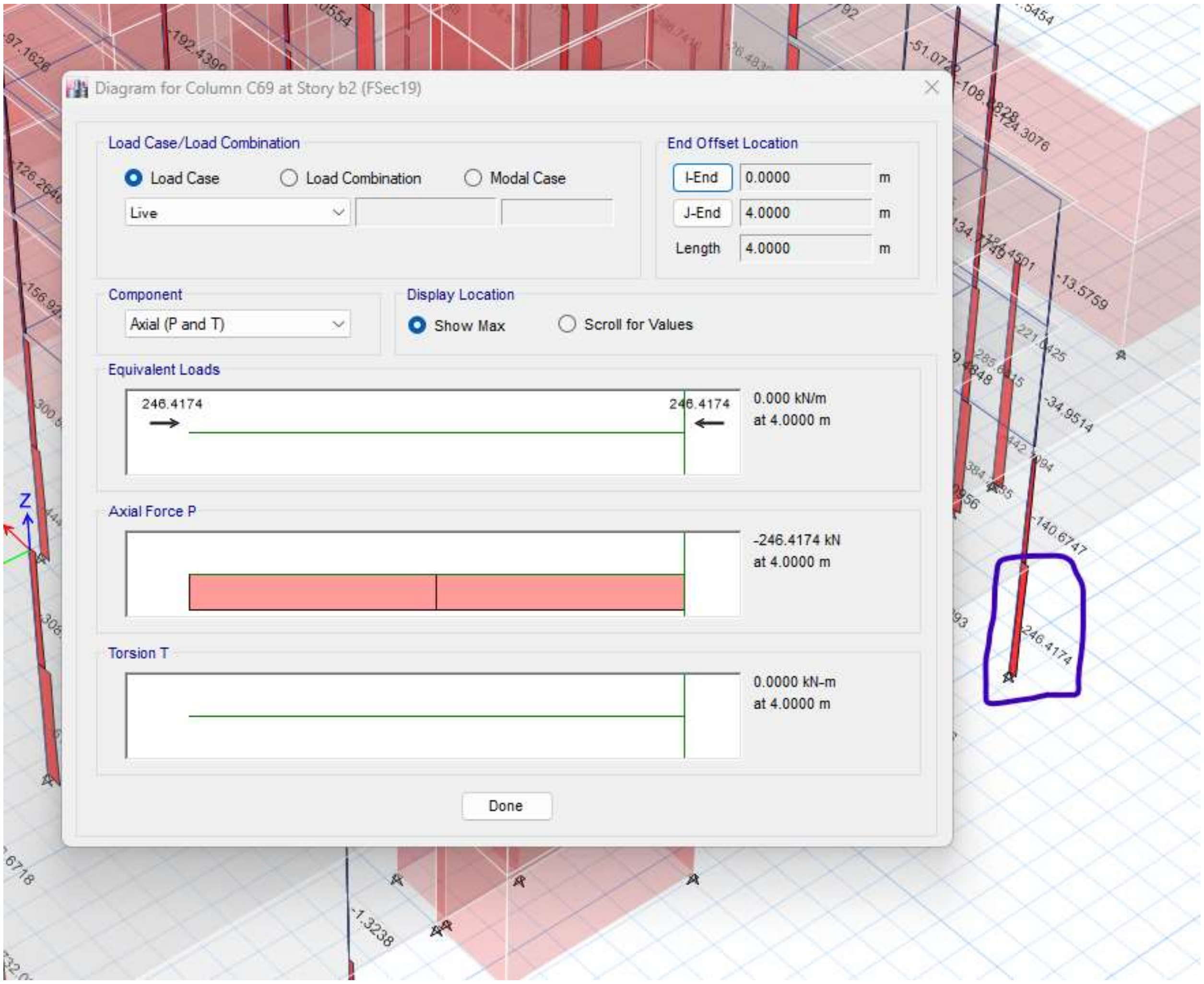


Figure 125::Internal force check for column.

From etabs =246.41 kN

From manual =254.34kN

% error = 3.22%

Check is ok

3- edge column:

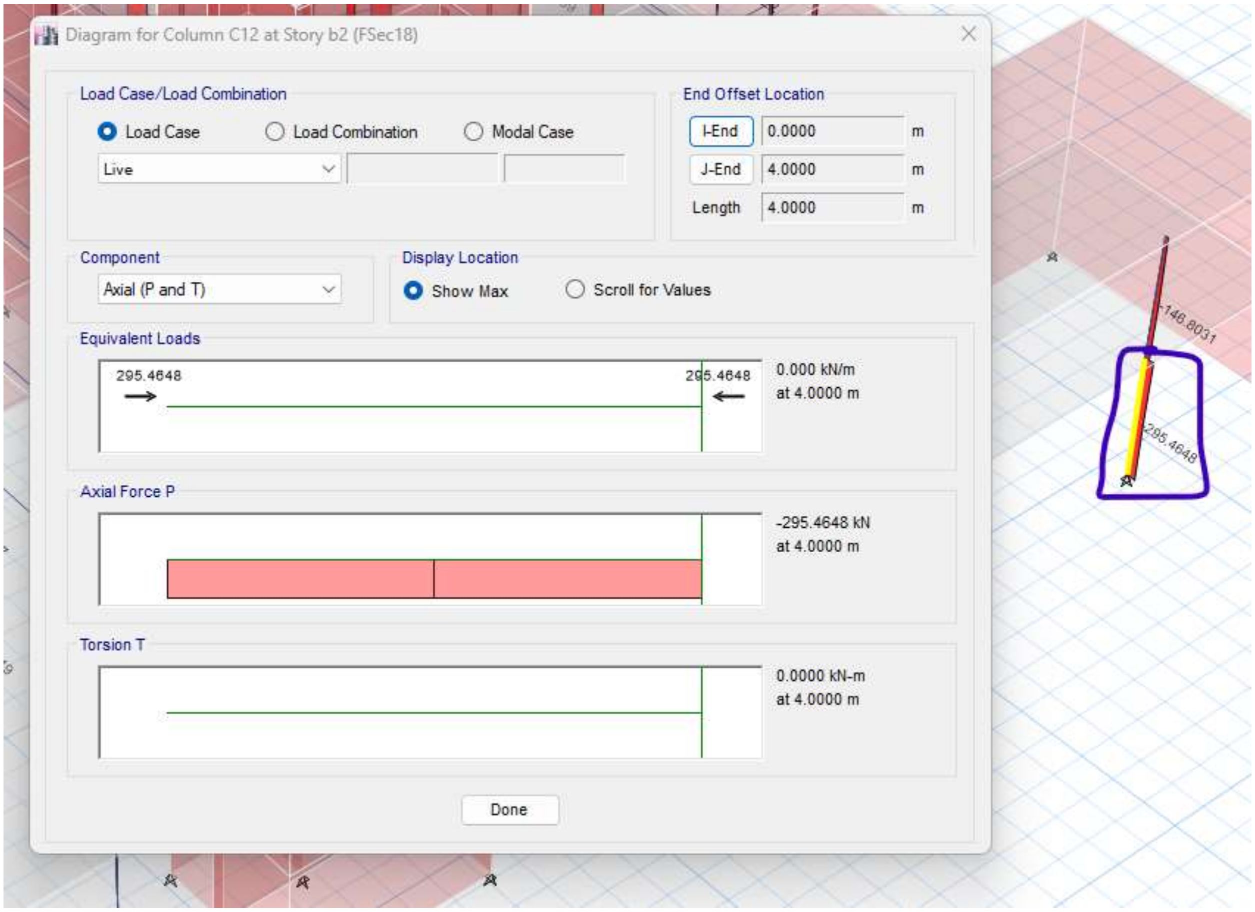


Figure 126::Internal force check for column.

From etabs =295.46 kN

From manual =300.92kN

% error = 1.85%

Check is ok.

Slab check:

From live load:

Panel type: internal panel

From etabs =9.23 kn.m

From manual =9.66 kN.m

% error = 4.72%

3.3. Seismic design:

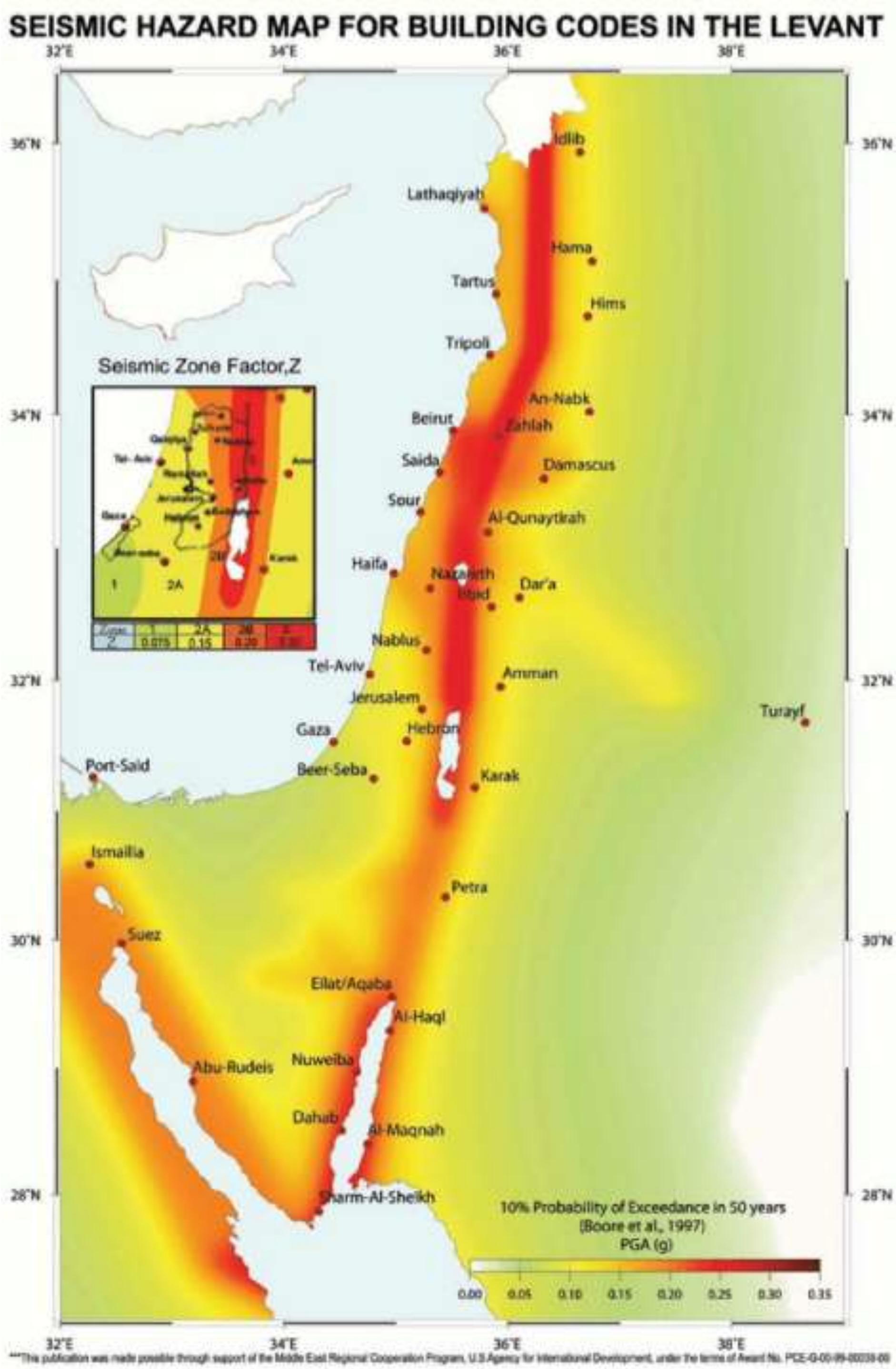


Figure 127:zone factor

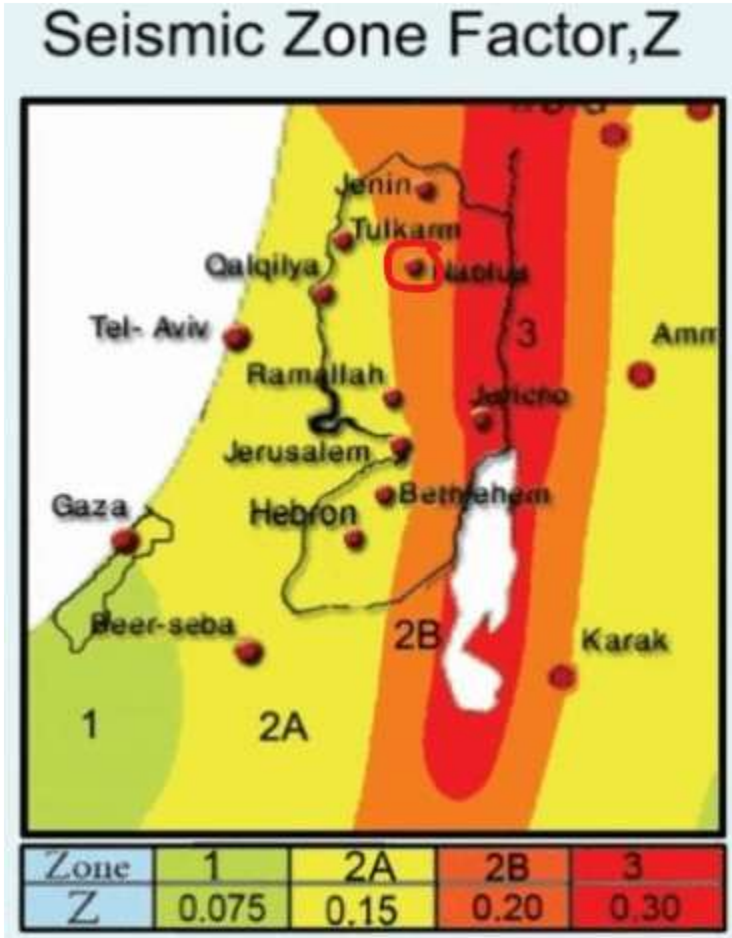


Figure 128:zone factor

The site of building in Nablus, so zone factor is =0.20

3.3.1. Assumptions:

1. Soil profile is SC
2. I=1
3. R=5.5
4. Ca=0.24
5. Cv=0.32

3.3.2. Model participant mass ratio check:

Part 1:

Table 16: participant mass ratio check

Modal Participating Mass Ratios

1 of 40 Reload Apply

Case	Mode	Period sec	UX	UY	UZ	Sum UX	Sum UY
Modal	1	0.476	0.1371	0.0004	0	0.1371	0.0004
Modal	2	0.376	0.0001	0.1772	0	0.1371	0.1776
Modal	3	0.351	0.0022	0.001	0	0.1393	0.1786
Modal	4	0.164	0	0.004	0	0.1393	0.1827
Modal	5	0.14	0.004	0	0	0.1434	0.1827
Modal	6	0.135	0.0014	0.6057	0	0.1448	0.7884
Modal	7	0.118	0.4678	0.0157	0	0.6126	0.8041
Modal	8	0.093	0.0006	0.0016	0	0.6131	0.8057
Modal	9	0.085	0.1541	0.0533	0	0.7673	0.859
Modal	10	0.077	0.0595	0.0254	0	0.8267	0.8844
Modal	11	0.072	0.0021	0.0067	0	0.8288	0.8911
Modal	12	0.067	0.0006	0.0006	0	0.8294	0.8918
Modal	13	0.061	0.0139	0.0049	0	0.8432	0.8967
Modal	14	0.058	0.0402	0.0005	0	0.8834	0.8972
Modal	15	0.051	0.0135	1.517E-05	0	0.8969	0.8972
Modal	16	0.051	0.0007	0.0001	0	0.8976	0.8973
Modal	17	0.05	0.0381	0.0005	0	0.9357	0.8978
Modal	18	0.048	0.0218	0.0092	0	0.9576	0.907
Modal	19	0.047	0.0005	0.0283	0	0.958	0.9353
Modal	20	0.044	0.0064	0.0078	0	0.9644	0.9431
Modal	21	0.042	0.0006	0.0011	0	0.965	0.9441
Modal	22	0.041	0.0001	0.0025	0	0.9651	0.9466
Modal	23	0.038	0.0001	0.0001	0	0.9652	0.9468
Modal	24	0.037	1.197E-05	0.0048	0	0.9652	0.9516
Modal	25	0.036	0.0006	0.0078	0	0.9658	0.9594

Sum UX and Sum UY> 0.9---->ok

Part 2:

Table 17:participant mass ratio check

Modal Participating Mass Ratios

1 of 40 Reload Apply

Case	Mode	Period sec	UX	UY	UZ	Sum UX	Sum UY
Modal	1	0.754	0.423	0.0248	0	0.423	0.0248
Modal	2	0.613	0.0258	0.3994	0	0.4488	0.4243
Modal	3	0.322	0.0008	0.0253	0	0.4495	0.4496
Modal	4	0.229	0.0003	0.0078	0	0.4498	0.4574
Modal	5	0.175	0.1292	0.055	0	0.5791	0.5124
Modal	6	0.159	0.0223	0.072	0	0.6014	0.5844
Modal	7	0.157	0.0396	0.1059	0	0.6409	0.6903
Modal	8	0.15	2.254E-05	0.0004	0	0.641	0.6907
Modal	9	0.134	2.771E-05	0.0001	0	0.641	0.6907
Modal	10	0.131	3.055E-06	2.121E-05	0	0.641	0.6907
Modal	11	0.13	0.006	0.0001	0	0.647	0.6909
Modal	12	0.119	0.0013	8.322E-06	0	0.6483	0.6909
Modal	13	0.118	0.0001	0.0008	0	0.6483	0.6917
Modal	14	0.107	0.0302	0.0547	0	0.6785	0.7464
Modal	15	0.105	0.0005	0.0029	0	0.679	0.7493
Modal	16	0.094	0.0037	0.1142	0	0.6828	0.8635
Modal	17	0.092	0.0045	0.0048	0	0.6873	0.8683
Modal	18	0.088	0.1279	0.0008	0	0.8152	0.8691
Modal	19	0.081	5.717E-06	1.838E-05	0	0.8152	0.8691
Modal	20	0.081	2.688E-05	0.0034	0	0.8152	0.8725
Modal	21	0.073	0.0576	0.0029	0	0.8728	0.8754
Modal	22	0.072	0.0028	0.0086	0	0.8756	0.884
Modal	23	0.072	0.0015	0.0073	0	0.8771	0.8913
Modal	24	0.07	0.018	0.0014	0	0.8951	0.8927
Modal	25	0.068	4.336E-05	0.0004	0	0.8952	0.8931
Modal	26	0.066	0.0016	0.002	0	0.8968	0.8951
Modal	27	0.063	2.445E-05	0.0012	0	0.8968	0.8964
Modal	28	0.062	0.0053	0.0035	0	0.9022	0.8998
Modal	29	0.06	0.0001	0.0099	0	0.9023	0.9098
Modal	30	0.059	0.0235	0.0009	0	0.9258	0.9106
Modal	31	0.057	0.0016	0.0019	0	0.9274	0.9125
Modal	32	0.055	5.168E-06	0.0073	0	0.9274	0.9198

Sum UX and Sum UY> 0.9---->ok

3.3.3Period check:

For part 1:

From etabs:

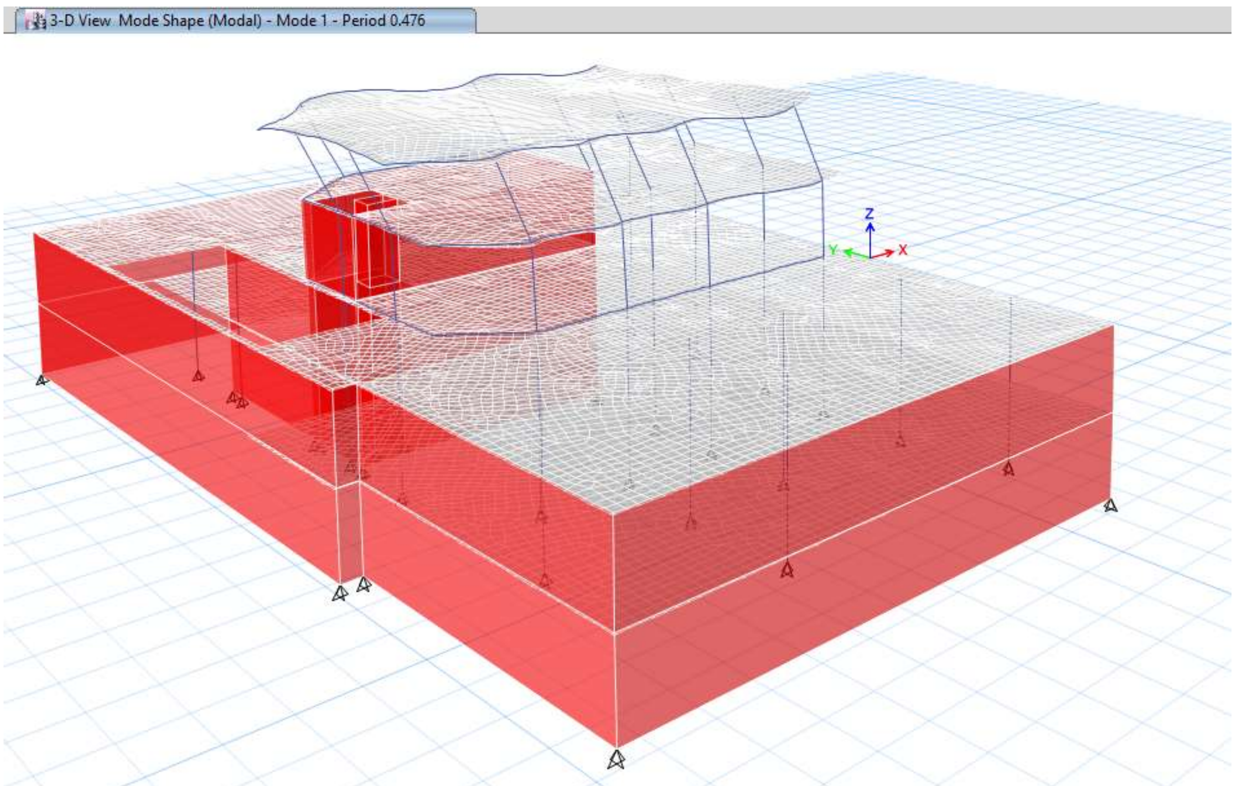


Figure 129:Period check

T (method A) = Ct*($hn^{3/4}$)

Table 18: assumptions

Ct	0.0731
hn	16.00
T(method A)	0.58
1.40*T(method A)	0.82

t period from etabs =0.476 < 1.4 * T (method A)= 0.82 ………….. is ok

For part 2:

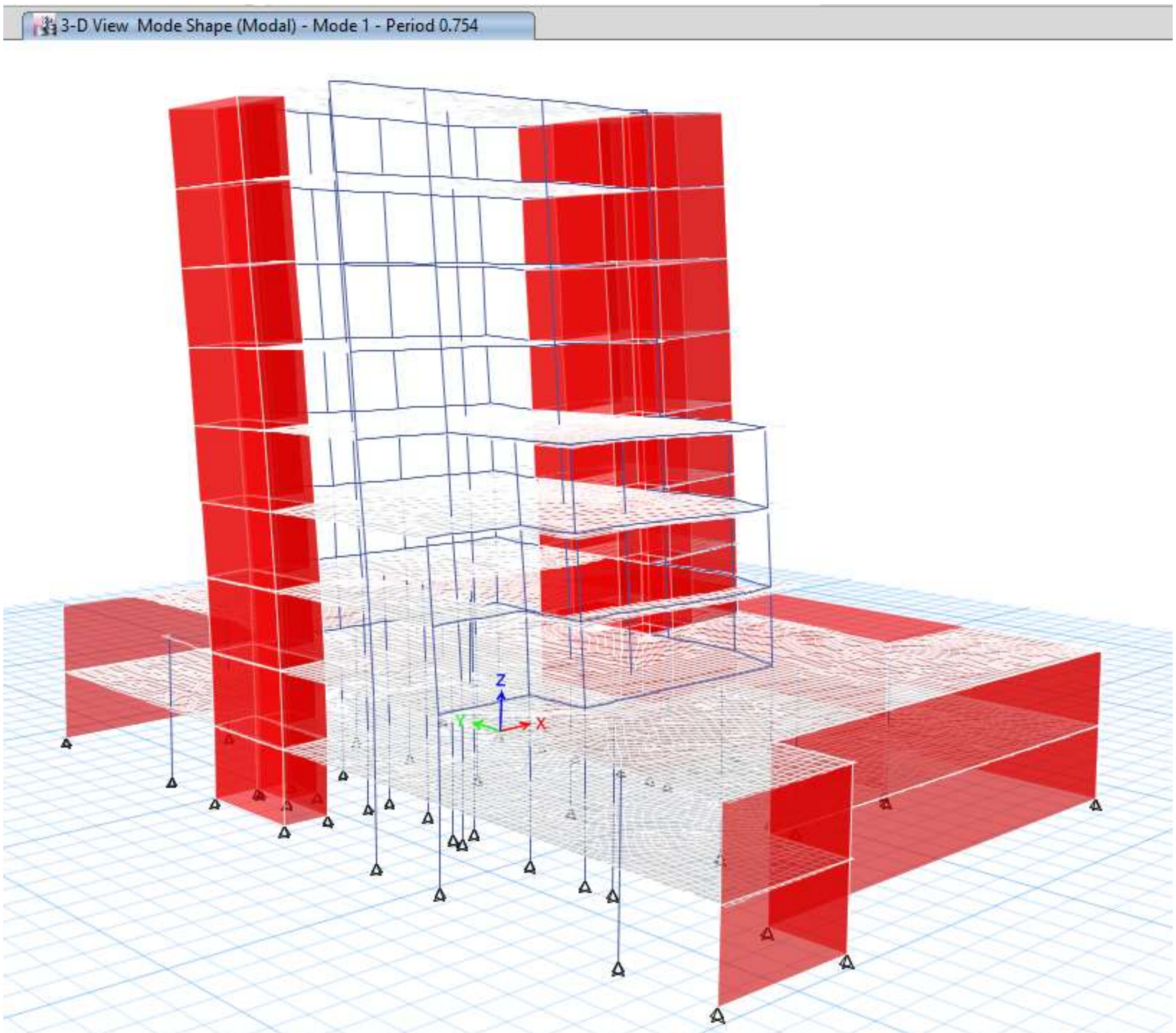


Figure 130:Period check.

T (method A)= Ct*($hn^{3/4}$)

Table 19:assumptions

Ct	0.0731

hn	36.00
T(method A)	1.07
1.40*T(method A)	1.50

t period from etabs =0.75 < 1.4 * T (method A)= 1.50 ………….. is ok

3.3.4. Draft check:

For part 1:

Table 20:Draft check

story	H	DIS X	DIS Y	DRIFT X	DRIFT Y	DELTA X	DELTA Y	LIMITATION	
0		0	0						
1	4000.00	0.30	0.39	0.30	0.30	1.16	1.16	100.00	ok
2	4000.00	0.68	0.52	0.38	0.13	1.46	0.50	100.00	ok
3	4000.00	2.06	1.78	1.38	1.26	5.31	4.85	100.00	ok
4	4000.00	15.10	6.40	13.04	4.62	50.20	17.79	100.00	ok

For part 2:

Table 21:Draft check

story	H	DIS X	DIS Y	DRIFT X	DRIFT Y	DELTA X	DELTA Y	LIMITATION	
0		0	0						
1	4000.00	0.75	0.39	0.75	0.75	2.89	2.89	100.00	ok
2	4000.00	1.30	9.38	0.55	8.99	2.12	34.61	100.00	ok
3	4000.00	3.44	10.50	2.14	1.12	8.24	4.31	100.00	ok
4	4000.00	6.00	11.19	2.56	0.69	9.86	2.66	100.00	ok
5	4000.00	18.60	12.24	12.60	1.05	48.51	4.04	100.00	ok
6	4000.00	23.00	14.00	4.40	1.76	16.94	6.78	100.00	ok
7	4000.00	30.00	16.00	7.00	2.00	26.95	7.70	100.00	ok
8	4000.00	36.00	18.00	6.00	2.00	23.10	7.70	100.00	ok
9	4000.00	42.00	27.00	6.00	9.00	23.10	34.65	100.00	ok

3.3.5. Base shear check:

Part 1:

$$V = \min\left(\frac{2.5*Ca*W*I}{R}, \frac{Cv*W*I}{R*T}\right)$$

Table 22:Base shear check

EQ max from etabs	9792.87
W =D.L+SID +0.3 *L.L	127041.73
ca	0.24
cv	0.32
I	1
R	5.5
T	0.754
V	9803.08
error%	0.01%

………………ok

Part 2:

$$V = \min\left(\frac{2.5*Ca*W*I}{R}, \frac{Cv*W*I}{R*T}\right)$$

Table 23:Base shear check .

EQ max from etabs	45447.35
W =D.L+SID +0.3 *L.L	614892.521
ca	0.24
cv	0.32
I	1
R	5.5
T	0.754

V	47447.70
error%	4.40%

…………ok

3.4. Ramp design:

Figure 131:Ramp design.

We will use flat plat solid slab because span so after calculation slab thickness based on ACI318 cod the slab thickness is 250mm.

Slab wight is 6.25KN/m2.

3.4.1. Deflection check for ramp:

From live load:

Limit =7.00/360= 19.44mm.

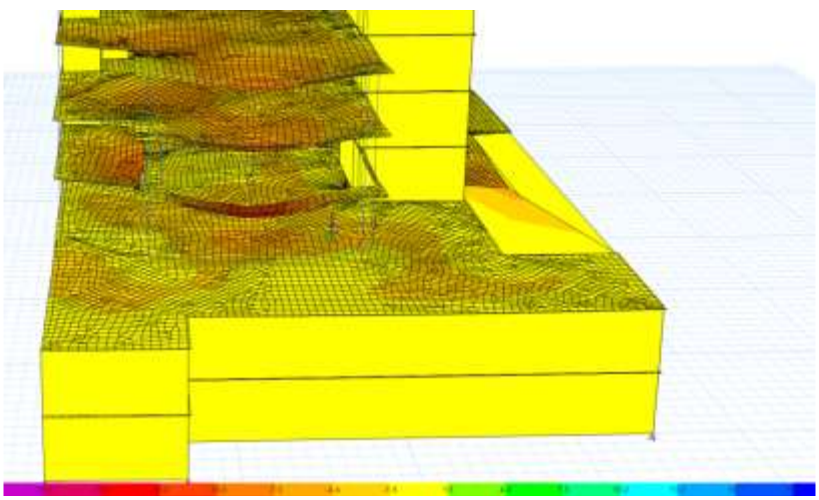


Figure 132:Ramp design

Figure 133:Deflection check

Etabs deflection less than 19.44 mm………is ok

From serves load:

Limit =7.00/240=49.16mm

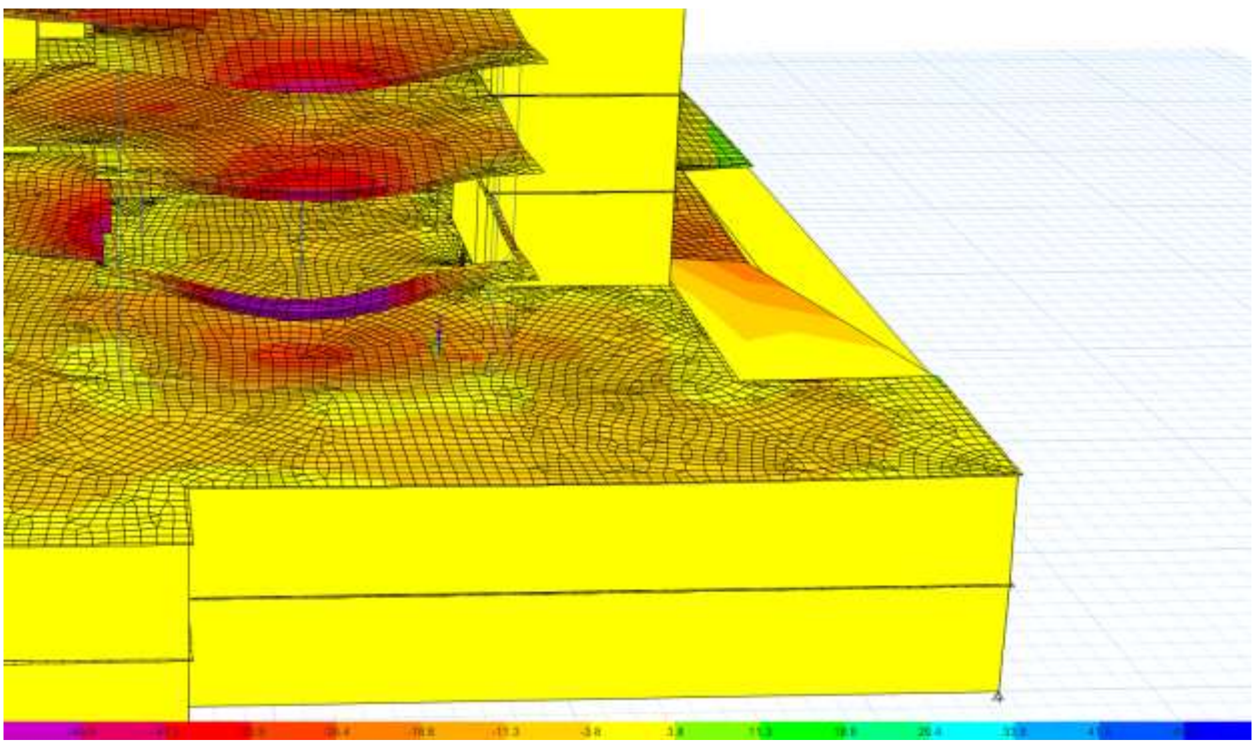


Figure 134:Deflection check

Etabs deflection less than 49.16 mm………is ok.

3.4.2. Shear check:

$$\Phi Vc = \frac{0.75}{6} * \sqrt{fc} * b * d = \frac{0.75}{6} * \sqrt{28} * 1000 * 190/1000 = 125.60 \text{KN}$$

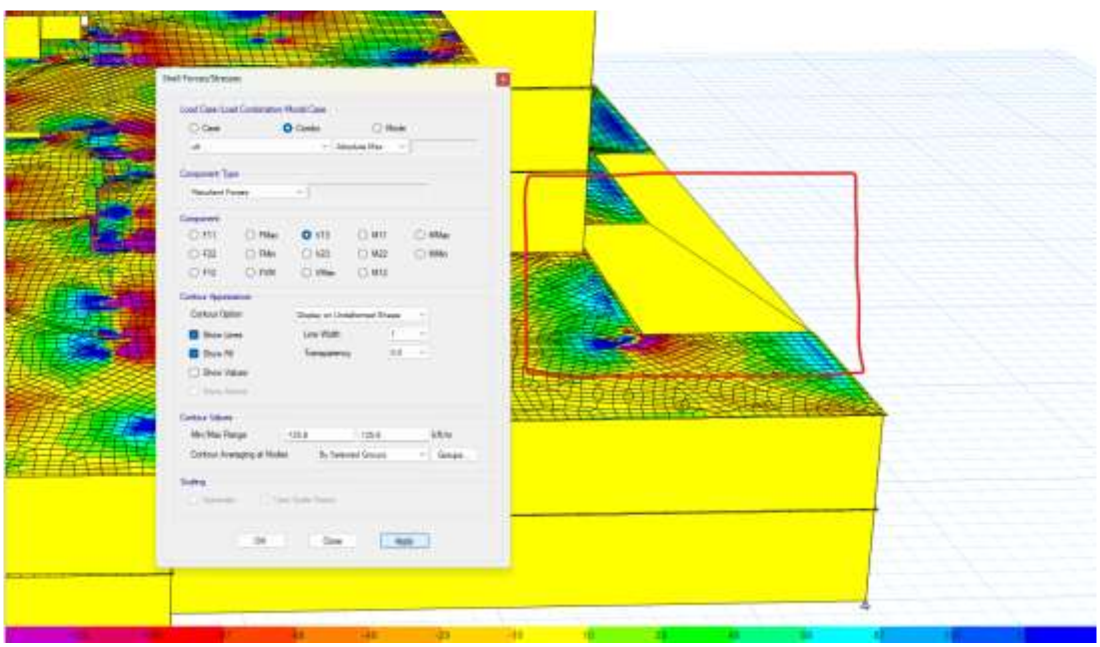


Figure 135:Shear check

Vu< ΦVc ok after d/2

3.5. Design:

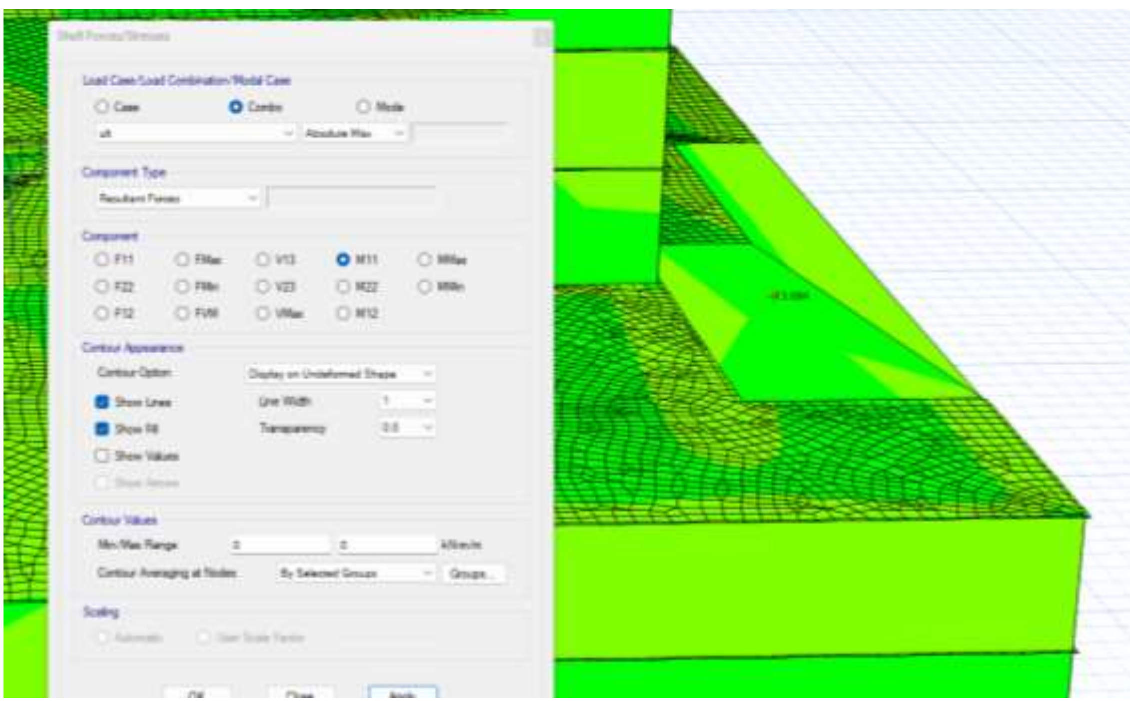


Figure 136:Design

Max moment =13.60 KN.m

$$\rho = \frac{0.85 * fc}{Fy}\left(1 - \sqrt{1 - \left(\frac{2.61 * 10^6 * Mu}{fc * b * d^2}\right)}\right) = 0.001003$$

ρ min = 1.4/ fy = 1.4 /420 = 0.003

so, use AS min

As min = 0.003 * 1000 * 250 = 750 mm^2 use 5 Ø14/ m

3.5.1. Ramp detailing:

Figure 137:Ramp detailing.

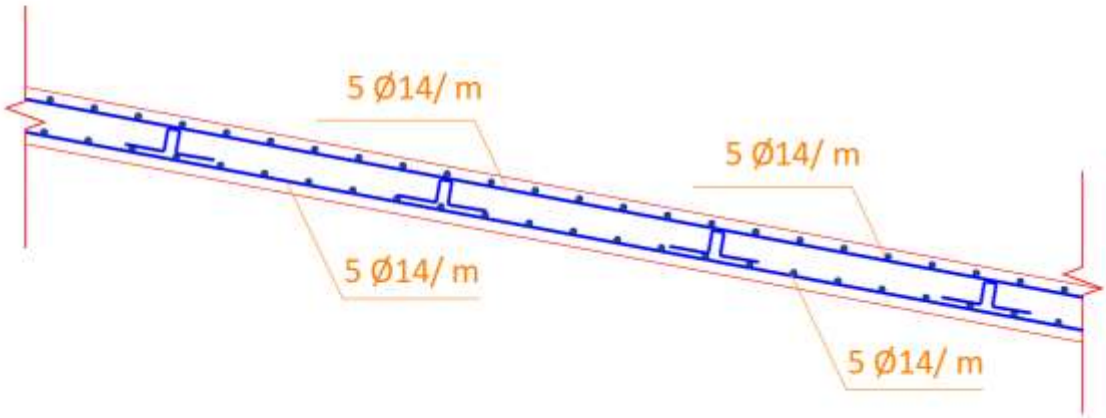


Figure 138:Ramp detailing.

3.5.2. Manual design for column:

Column design:

Figure 139:Column dimension.

Column dimension :500mmx900mm=450000mm2.

The area of steel is = $\frac{\pi}{4}\times18^2\times18$=4580.45 mm^2---> Ratio of steel $= \frac{4580.45}{450000} = 1.02\%$

Check for ratio of steel.

Should be Pu ≤ ΦPn.

Pu=3507 KN

Φ=0.65 for tied columns.

Pn = 0.80× (0.85×fc`×AC+ fy×Ast).

fc` = 28 Mpa.

Fy = 420 Mpa.

AC = Total area – Steel area = 450000– 4580.45 = 445419.55mm^2.

As = 4580.45 mm^2.

---> Pn = 0.80× ((0.85×28×445419.55+ 420×4580.45)× 10^{-3}) = 10646.006KN.

---> ΦPn = 0.65×10646.006 = 6919.90 KN > Pu ----> Ok.

Check for long column:

Column height =4 m

$$\frac{K \times L}{r} \leq 34$$

K = 0.80, L = 4.00 m

In X-direction:

rx = 0.30 × 0.90 = 0.27

$$\frac{K \times L}{r} = \frac{0.80 \times 4.00}{0.27} = 11.85 < 34 --->\ short\ column.$$

In Y-direction:

ry = 0.30 × 0.50 = 0.15

$$\frac{K \times L}{r} = \frac{0.80 \times 4.00}{0.15} = 21 < 34 ---> Short\ column.$$

$$EI\ eff = \frac{0.40 \times EC \times Ig}{1 + \beta d}$$

EC = $4700 \times \sqrt{fc} = 4700 \times \sqrt{28} = 24870.00$

$$\beta d = \frac{Wu\ sustained}{Wu} = \frac{1.20 \times (8.29 + 4.50) + 1.60 \times (25\% \times 5)}{1.20 \times (8.29 + 4.5) + 1.60 \times 5.00} = 0.74$$

In X-direction:

$$Ig\ X = \frac{1}{12} \times 500 \times 900^3 = 3.04 \times 10^{10}\ mm^4.$$

$$EI\ eff\ X = \frac{0.40 \times 24870 \times 30.4 \times 10^9 \times 10^{-9}}{1 + 0.74} = 176804.13\ KN.m^2.$$

In Y-direction:

$$Ig\ Y = \frac{1}{12} \times 900 \times 500^3 = 9.38 \times 10^9\ mm^4.$$

$$EI\ eff\ X = \frac{0.40 \times 24870 \times 9.38 \times 10^9 \times 10^{-9}}{1 + 0.74} = 53627.72 KN.m^2.$$

$$Pc = \frac{\pi^2 \times EIeff}{(KL)^2}$$

In X-direction:

$$Pc\ x = \frac{\pi^2 \times 176804.13}{(0.8 \times 4.00)^2} = 170236.132$$

In Y-direction:

$$Pc\ y = \frac{\pi^2 \times 53627.72}{(0.8 \times 4.00)^2} = 51635.53$$

$$\delta ns = \frac{1}{1 - \frac{Pu}{0.75 \times Pc}}$$

In X-direction:

$$\delta nsx = \frac{1}{1 - \frac{3507}{0.75 \times 170236.13}} = 1.03 > 1 - -\!-\!> Ok.$$

M max = Pu×emin

emin =0.03+0.015×h.

M max = 3507× (0.015+0.03×0.90) = 147.29.

-->Mux = 1.03×147.29 = 151.71KN.m.

In Y-direction:

$$\delta nsy = \frac{1}{1 - \frac{3507}{0.75 \times 51635.53}} = 1.10 > 1 ---> Ok.$$

M max = 4516.28× (0.015+0.03×0.50) = 135.50

-->Mux = 1.10×135.5 = 149.03 KN.m.

Interaction diagram data:

$$\frac{Pu}{Ag \times fc} = \frac{3507}{500 \times 900 \times 28} = 0.27.$$

$$\frac{Mux}{Ag \times h \times fc} = \frac{151.71}{500 \times 900 \times 500 \times 28} = 0.024.$$

$$\frac{Muy}{Ag \times h \times fc} = \frac{149.03}{500 \times 900 \times 900 \times 28} = 0.014.$$

In x-direction:

$$\gamma\ x = \frac{900 - (2 * 60)}{900} = 0.87$$

Use chart Interaction diagram of 0.80 ------------- ratio of steel =0.01…………..ok

In y-direction:

$$\gamma\, y = \frac{500 - (2 * 60)}{500} = 0.76$$

Use chart Interaction diagram of 0.80------------- ratio of steel =0.01………………ok

3.6. Shear wall design:

For part 1:

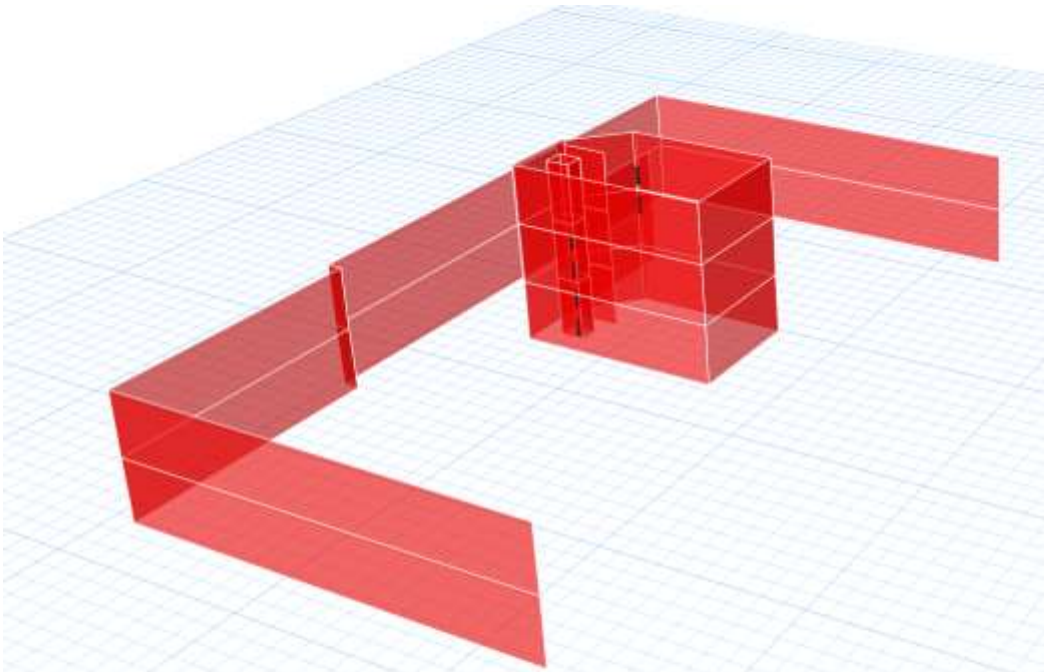


Figure 140:Shear wall design

3.6.1. Shear check for shear wall:

Table 24:Shear check for shear wall

Shear Design

Station Location	ID	Rebar mm²/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	ΦV_c kN	ΦV_n kN
Top	Leg 1	625	DWal3	5145.5784	12482.8669	1372.7271	6744.1352	11004.0343
Top	Leg 2	625	DWal4	4255.1242	11009.6969	1226.3682	6815.0477	11220.798
Top	Leg 3	625	DWal4	1052.411	86.073	115.1603	968.0202	1545.8871
Top	Leg 4	625	DWal6	831.1071	931.5742	440.6279	1191.6556	1952.7139
Top	Leg 5	625	DWal8	2938.5256	3286.2375	1750.275	3416.1855	5538.4727
Top	Leg 6	625	DWal6	2148.1286	-1391.4593	1767.568	3318.0302	5454.8712
Top	Leg 7	625	DWal3	4266.9454	1343.1809	1356.3208	2917.4123	4541.8068
Top	Leg 8	625	DWal6	4628.472	-595.2678	1043.8793	1571.7443	2804.9411
Top	Leg 9	625	DWal6	3999.9866	4581.8527	1382.7529	4146.3652	6675.905
Top	Leg 10	625	DWal4	172.4416	487.9245	237.1412	113.2763	274.7783
Top	Leg 11	625	DWal5	3147.4084	5074.3403	2301.4409	7702.4835	12859.7369
Top	Leg 12	625	DWal3	100.7489	-1.7303	11.9539	204.3109	444.7656
Top	Leg 13	625	DWal5	81.2511	-6.5501	9.9025	164.7668	358.6819
Top	Leg 14	625	DWal4	100.7489	1.7303	11.9539	204.3109	444.7656
Top	Leg 15	625	DWal6	81.2511	6.5501	9.9025	164.7668	358.6819
Bottom	Leg 1	625	DWal3	6038.0227	17973.7754	1372.7271	6878.0018	11137.901
Bottom	Leg 2	625	DWal4	5178.1242	6104.2241	1226.3682	6953.4977	11359.248
Bottom	Leg 3	625	DWal4	1173.4735	-374.5684	115.1603	986.1795	1564.0464
Bottom	Leg 4	625	DWal6	990.548	-830.9375	440.6279	1215.5717	1976.6301
Bottom	Leg 5	625	DWal8	3212.136	-3714.8626	1750.275	3457.2271	5579.5142
Bottom	Leg 6	625	DWal6	2595.7945	-8461.7313	1767.568	3385.1801	5522.0211
Bottom	Leg 7	625	DWal3	4607.2543	6768.464	1356.3208	2968.4587	4592.8531
Bottom	Leg 8	625	DWal6	4886.8254	-4770.785	1043.8793	1571.7443	2804.9411
Bottom	Leg 9	625	DWal6	4529.9225	-949.1589	1382.7529	4225.8556	6755.3954
Bottom	Leg 10	625	DWal4	206.2761	-460.6403	237.1412	122.0835	283.5855
Bottom	Leg 11	625	DWal5	4227.8475	14280.1038	2301.4409	7864.5494	13021.8027
Bottom	Leg 12	625	DWal3	151.1239	46.0852	11.9539	134.6753	375.13
Bottom	Leg 13	625	DWal5	121.8761	33.0599	9.9025	103.6049	297.52
Bottom	Leg 14	625	DWal4	151.1239	-46.0852	11.9539	134.6753	375.13
Bottom	Leg 15	625	DWal10	75.0007	-33.0599	9.9025	101.0137	294.9288

Vu< Ø VC in all shear wall in building ……..check is ok.

3.6.2. Design for shear wall:

Table 25:Design shear wall.

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm²
Top	104098	0.0025	0.0083	DWal10	18102.2827	-53138.5322	-32246.4827	41639250
Bottom	104098	0.0025	0.0083	DWal10	21433.4226	-52849.9532	-48352.391	41639250

Steel ratio in all shear wall in building =0.0025.

Steel /1m in shear wall =0.0025*300*1000 …..use 5 Ø14 /1m.

3.6.3. Shear wall detailing:

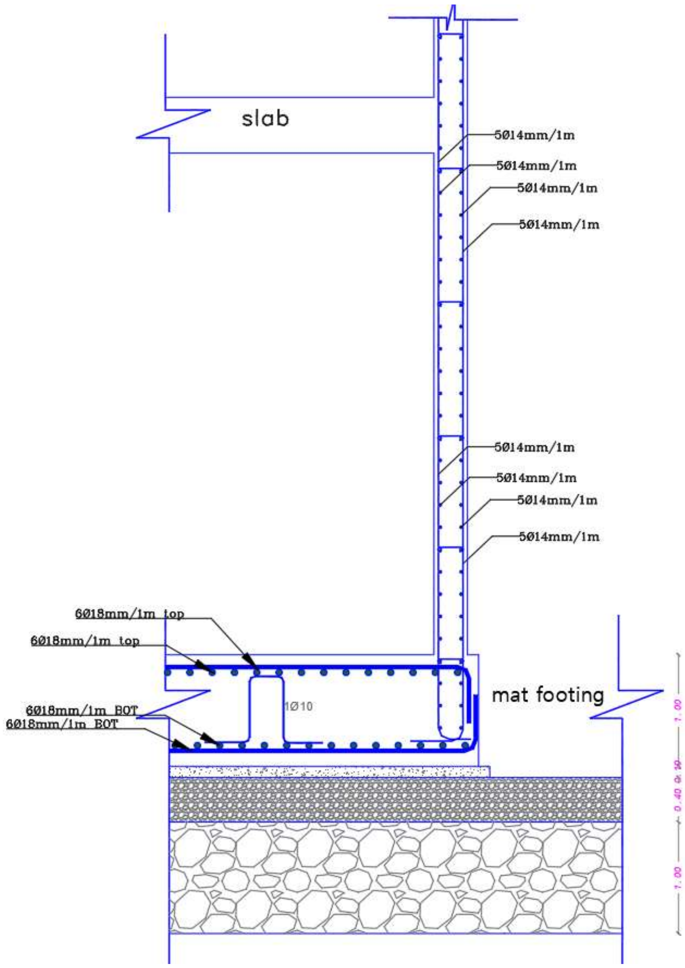


Figure 141:Shear wall detailing

For part 2:

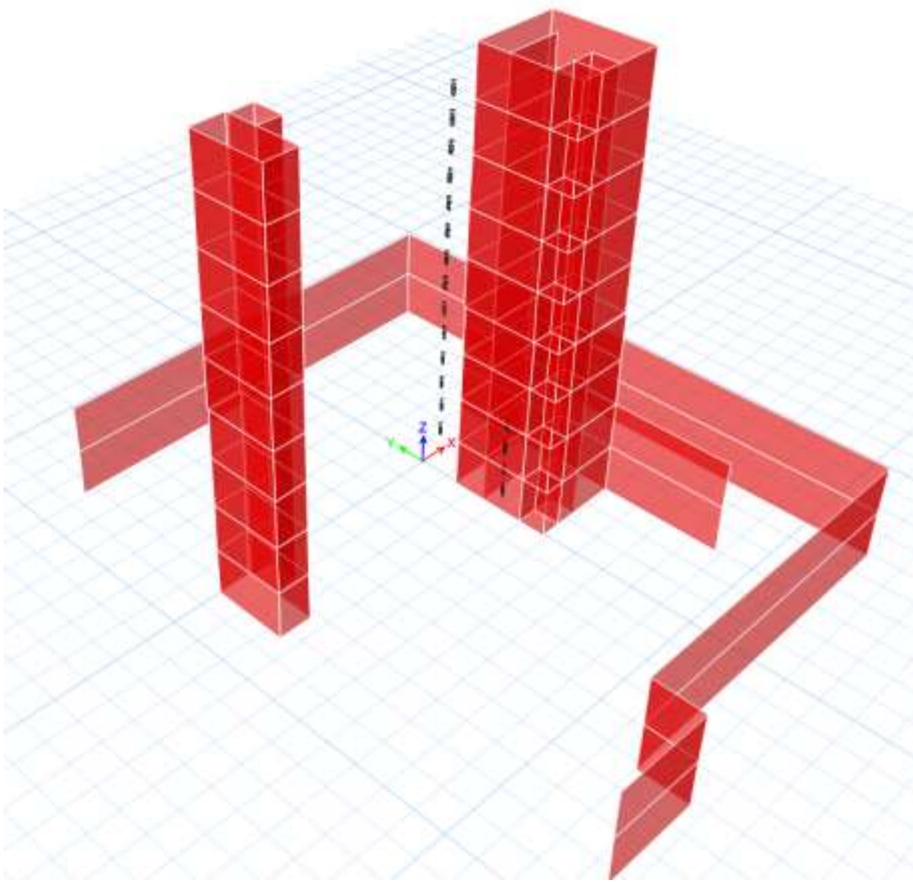


Figure 142:Shear wall design.

3.6.4. Shear check for shear wall:

Table 26:Shear check for shear wall

Shear Design

Station Location	ID	Rebar mm²/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	ΦV_c kN	ΦV_n kN
Top	Leg 1	625	DWal3	4880.6134	10901.0285	5361.0545	8491.1269	14025.4629
Top	Leg 2	625	DWal4	1228.5291	1535.3629	606.6237	1924.2171	3165.2735
Top	Leg 3	625	DWal5	5785.3762	-325.5089	154.2813	924.3419	1649.5843
Top	Leg 4	625	DWal9	311.4006	-72.7527	91.7611	330.8518	667.4884
Top	Leg 5	625	DWal5	2484.138	279.761	99.0163	711.7927	1270.2681
Top	Leg 6	625	DWal6	2743.0831	212.5279	167.1883	330.8518	667.4884
Top	Leg 7	625	DWal1	1354.7554	47.4995	18.2845	488.8204	799.0844
Top	Leg 8	625	DWal6	-178.0665	254.675	107.4253	288.3197	598.5837
Top	Leg 9	625	DWal6	796.3232	-230.8891	51.4006	309.8347	682.9321
Top	Leg 10	625	DWal6	1394.3719	1094.851	800.2108	1079.2584	1699.882
Top	Leg 11	625	DWal3	5141.731	-13435.4674	5629.786	6794.0768	11090.0097
Top	Leg 12	625	DWal5	6574.2397	37604.5754	3090.3631	10891.2478	17956.3296
Top	Leg 13	625	DWal6	6491.9968	-28441.7772	3638.1271	6329.8626	10150.2157
Top	Leg 14	625	DWal5	5398.5776	7215.5072	989.8688	1482.7221	2646.0717
Top	Leg 15	625	DWal6	4104.7077	7780.4201	954.8826	1482.7221	2646.0717
Top	Leg 16	625	DWal6	5525.5821	-7344.0971	706.8688	2197.2505	3508.1163
Top	Leg 17	625	DWal6	-968.197	492.5273	180.09	331.9396	758.5529
Top	Leg 18	625	DWal5	3948.6379	4091.3625	266.8656	744.2753	1706.094
Top	Leg 19	625	DWal4	2928.5924	-480.5034	107.816	624.5203	1051.1335
Top	Leg 20	625	DWal5	3370.4908	3626.4435	482.1556	1528.6068	2490.4255
Bottom	Leg 1	625	DWal3	6040.0509	32345.2466	5361.0545	8665.0426	14199.3785
Bottom	Leg 2	625	DWal4	1488.5291	-891.1319	606.6237	1963.2171	3204.2735
Bottom	Leg 3	625	DWal5	5937.3137	291.6162	154.2813	924.3419	1649.5843
Bottom	Leg 4	625	DWal9	354.8006	294.2918	91.7611	312.1495	648.786

Vu< Ø VC in all shear wall in building ……. check is ok.

Design for shear wall:

Table 27:Design for shear wall.

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm²
Top	128690	0.0025	0.0103	DWal10	41502.4602	89313.2059	-108897.4756	51476194
Bottom	128690	0.0025	0.0103	DWal10	45620.5555	89101.7399	-140420.8864	51476194

Steel ratio in all shear wall in building =0.0025.

Steel /1m in shear wall =0.0025*300*1000 …..use 5 Ø14 /1m.

3.6.5. Shear wall detailing:

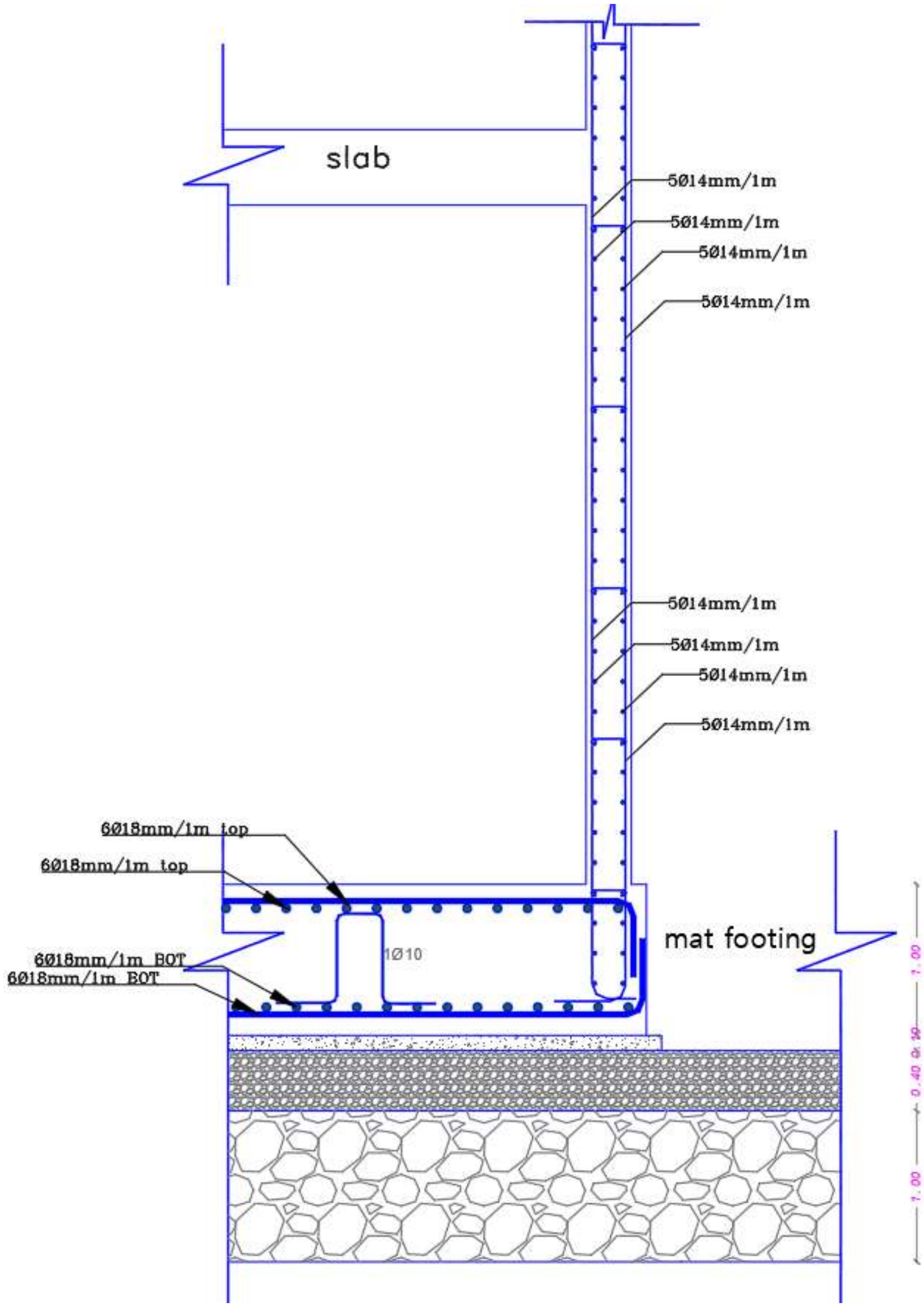


Figure 143:Shear wall detailing.

3.6.6. Column detailing:

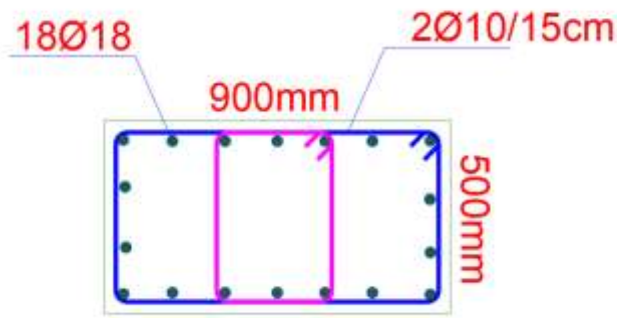


Figure 144:Column detailing

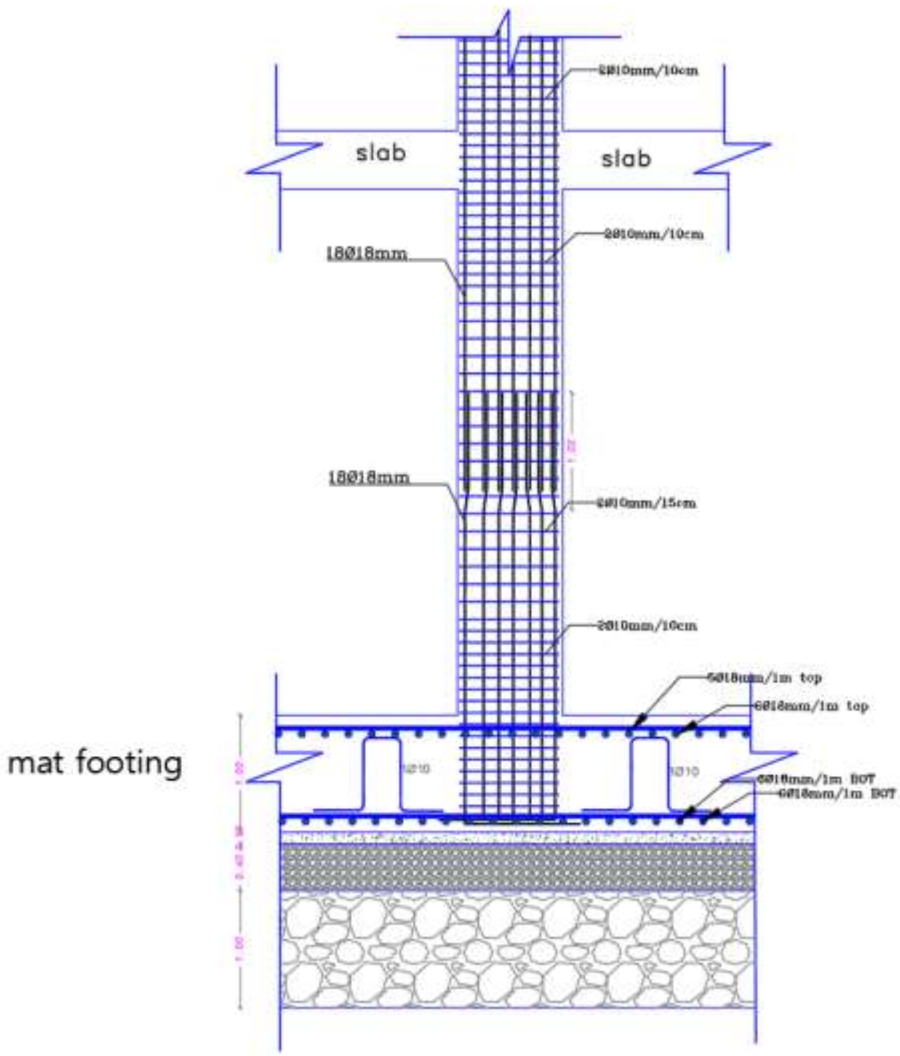


Figure 145:Column detailing

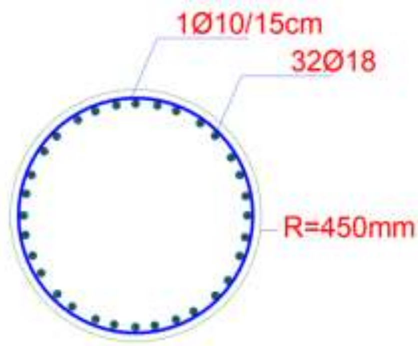


Figure 146:Column detailing

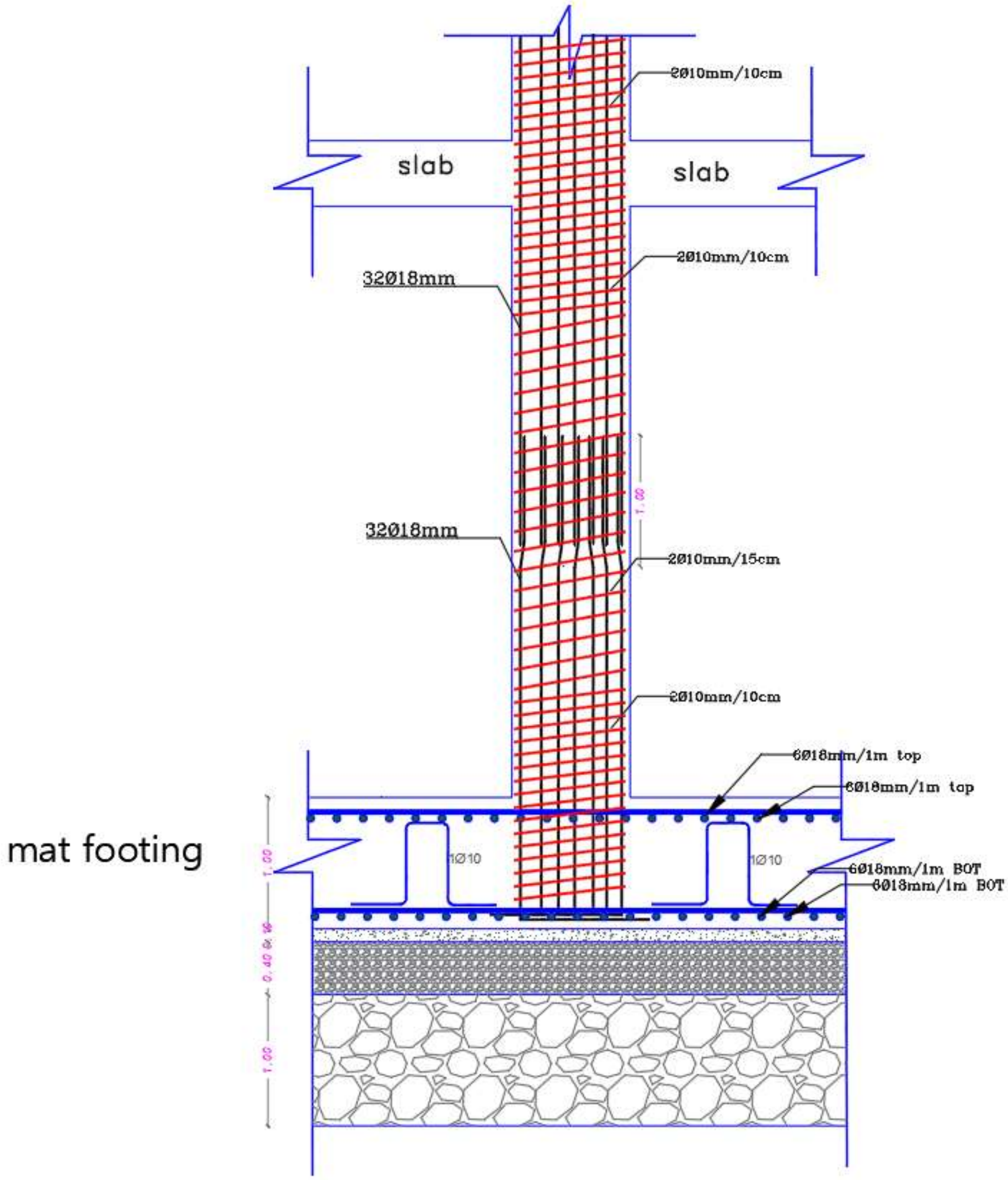


Figure 147:Column detailing

3.6.7. Slab detailing:

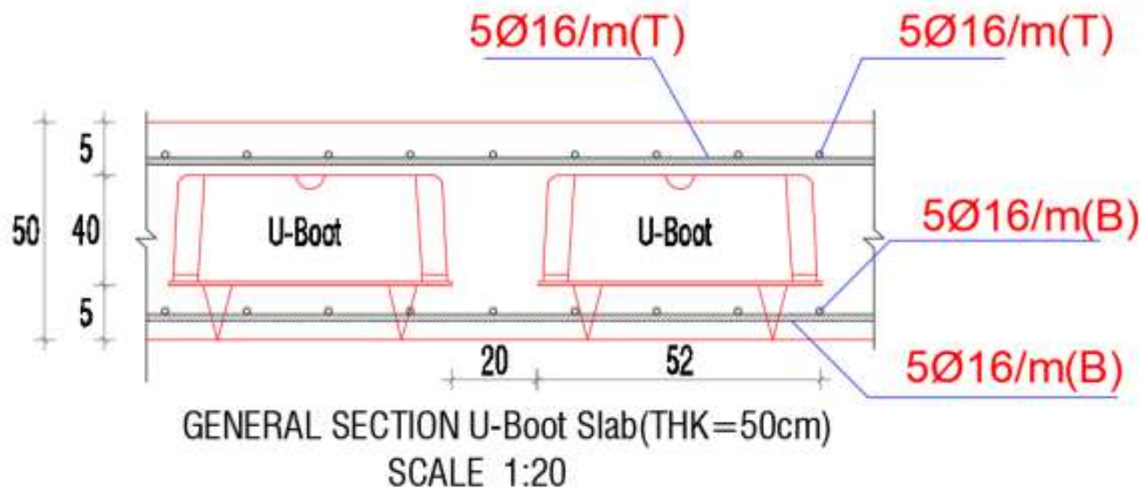


Figure 148:Slab detailing

Slab detailing for b2:

Figure 149::Slab detailing

Slab detailing for b1:

Figure 150:Slab detailing

Slab detailing for gf:

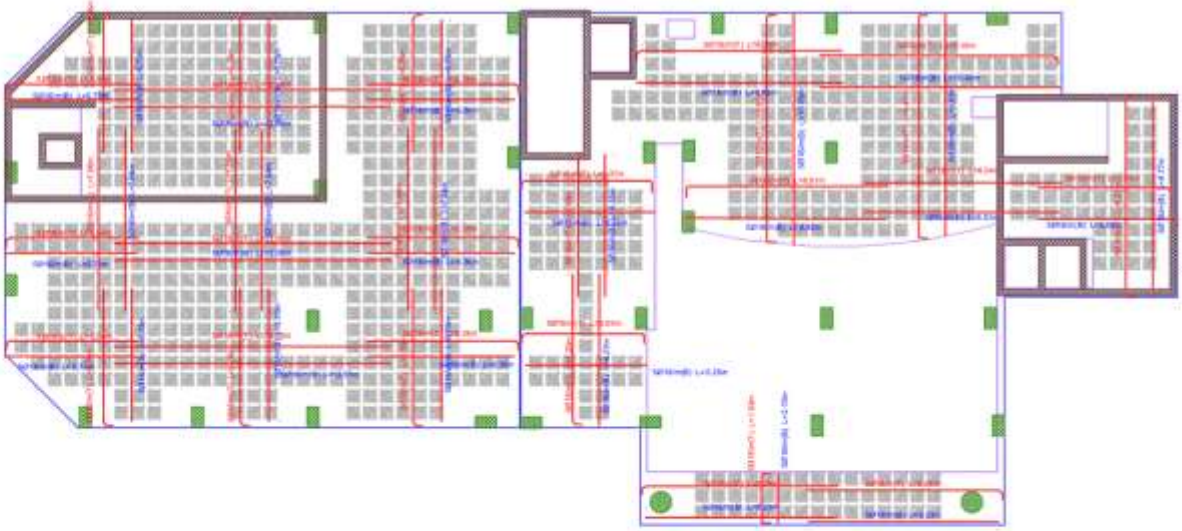


Figure 151:Slab detailing

Slab detailing for f1:

Figure 152:Slab detailing

Slab detailing for f2:

Figure 153::Slab detailing .

Slab detailing for f3:

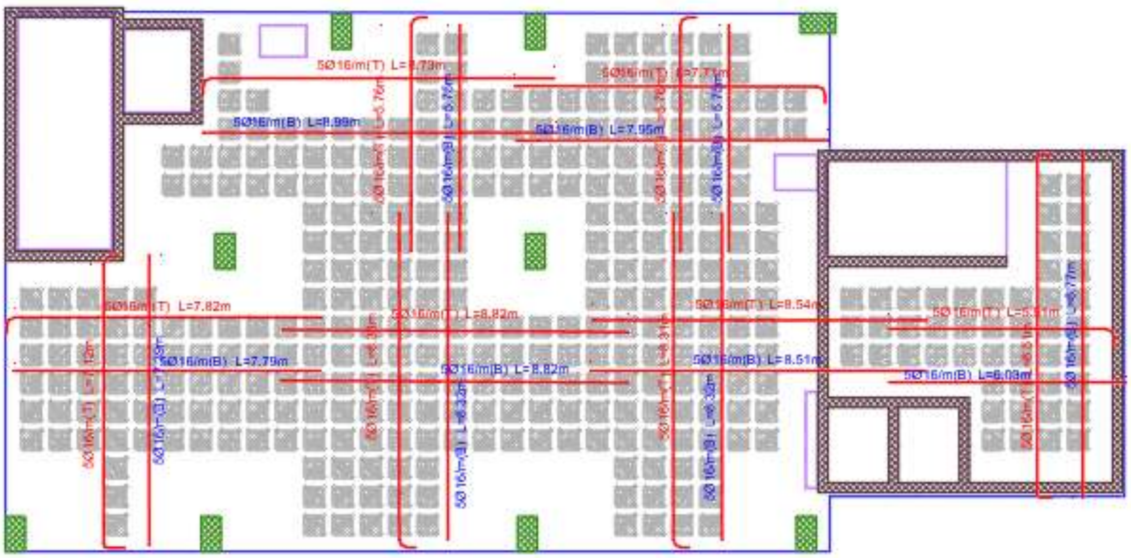


Figure 154::Slab detailing

Slab detailing for f4:

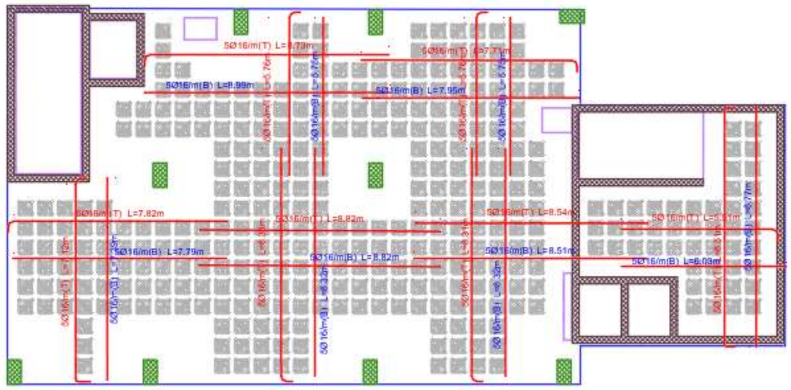


Figure 155:Slab detailing

Slab detailing for f5:

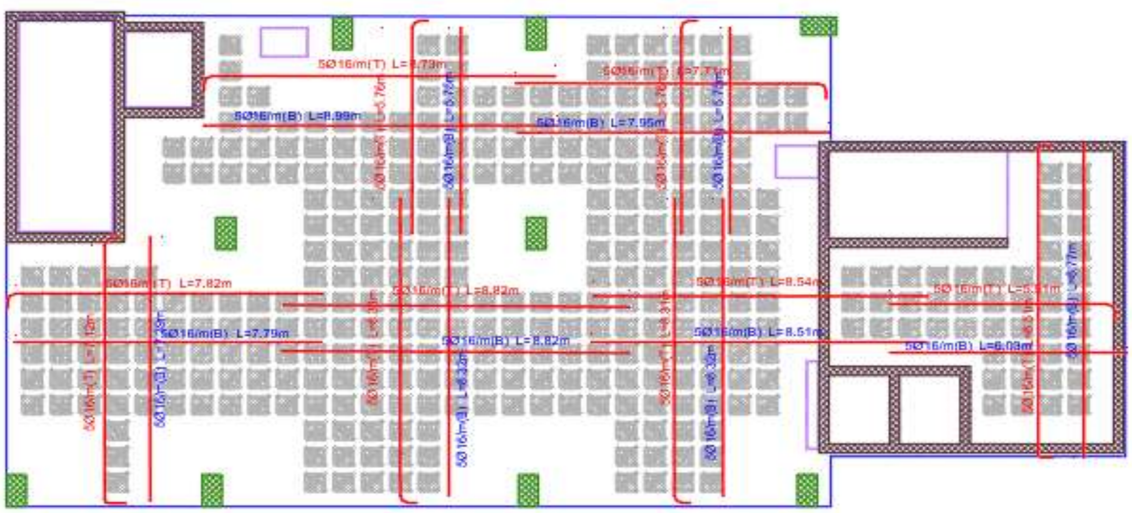


Figure 156:Slab detailing

Slab detailing for f6:

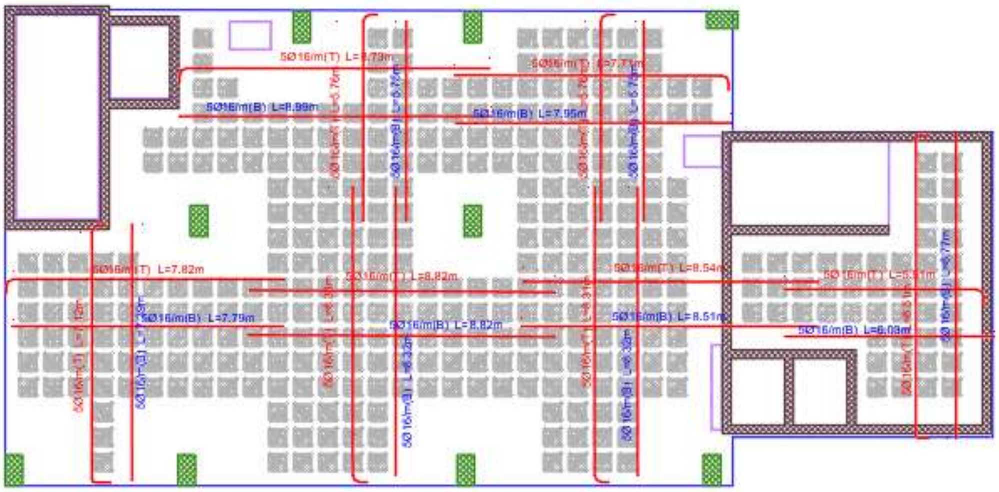


Figure 157:Slab detailing

Slab detailing for f7:

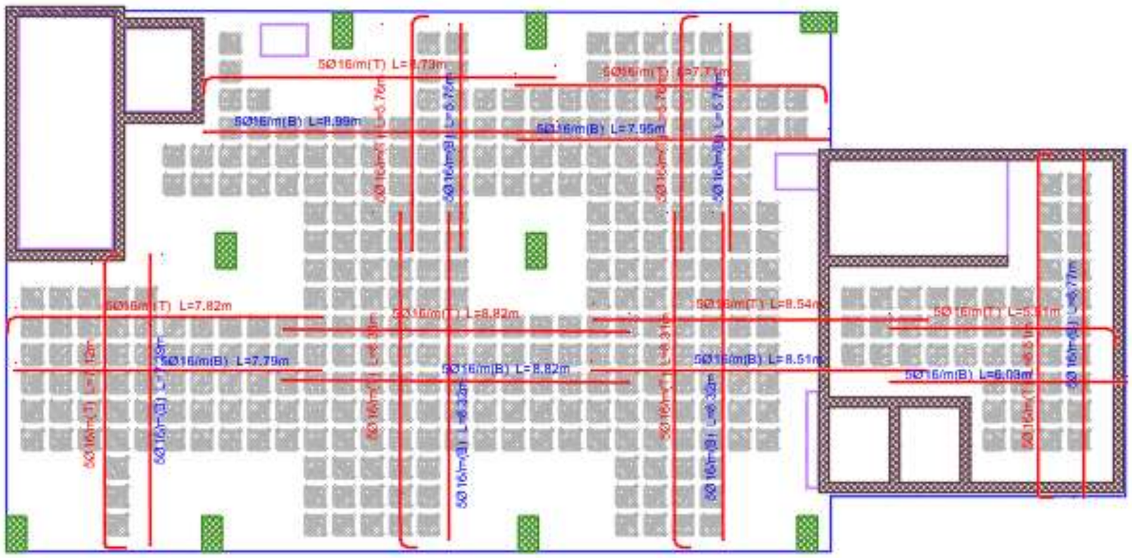


Figure 158:Slab detailing

3.7. footing design:

assumption for footing design:

1. allowable bearing capacity for soil = 200KN/m2
2. footing type is mat footing.
3. safe 2016 software used for design mat footing.

3.7.1. safe model:

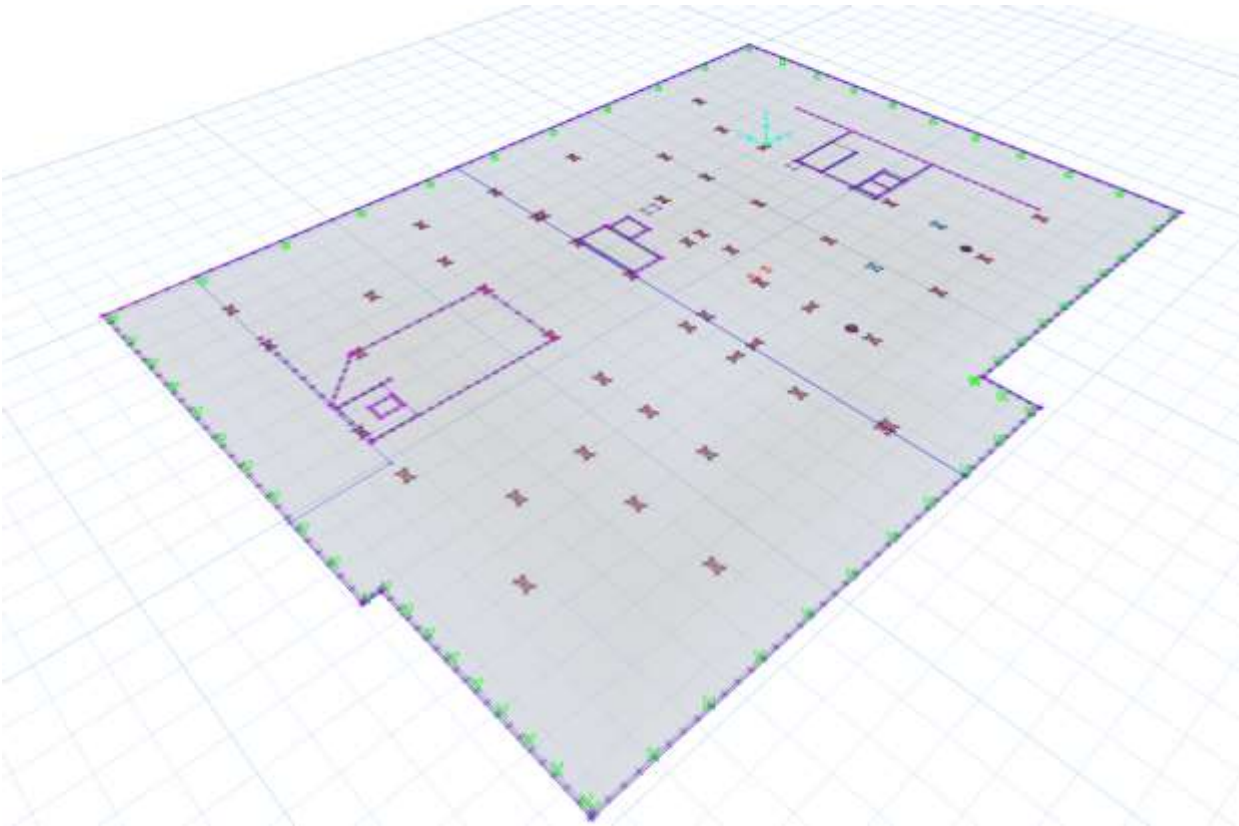


Figure 159:safe model

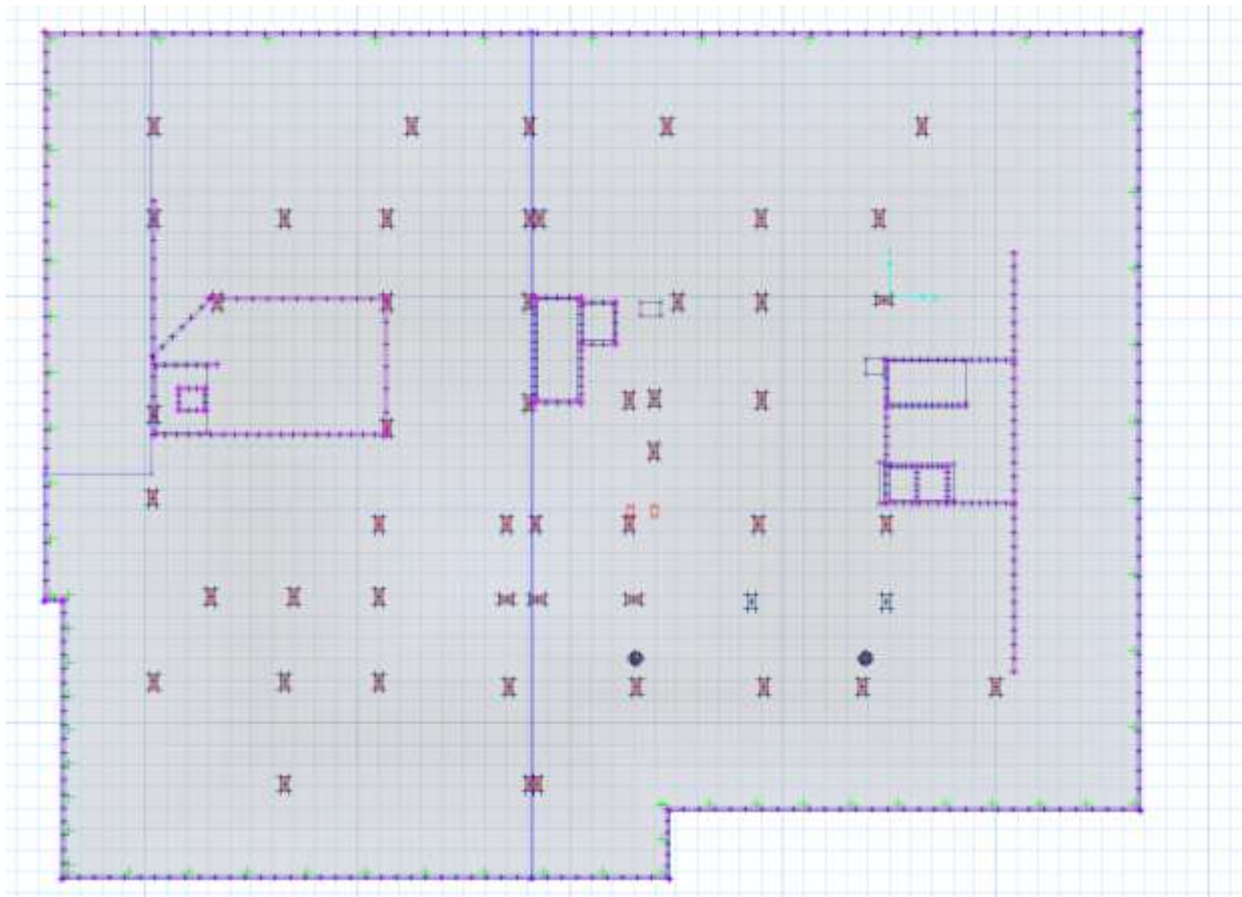


Figure 160: safe model

3.7.2. Model check:

Bearing capacity check from service load:

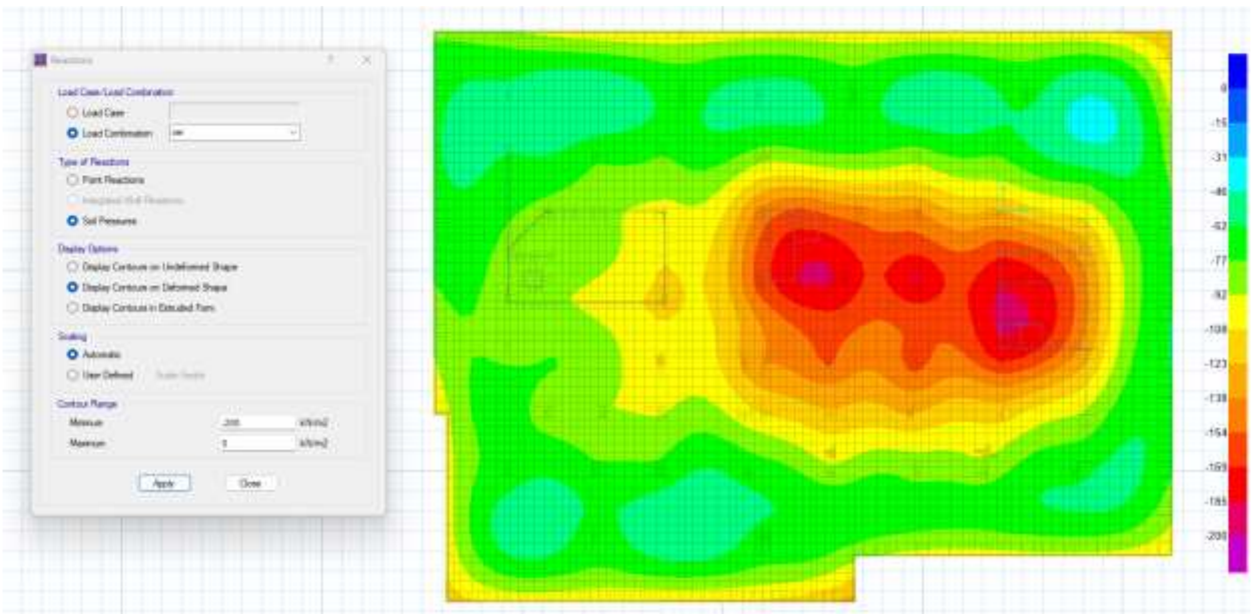


Figure 161:Bearing capacity check from service load

Allowable bearing capacity from safe >footing stresses ………check is ok.

punching shear check:

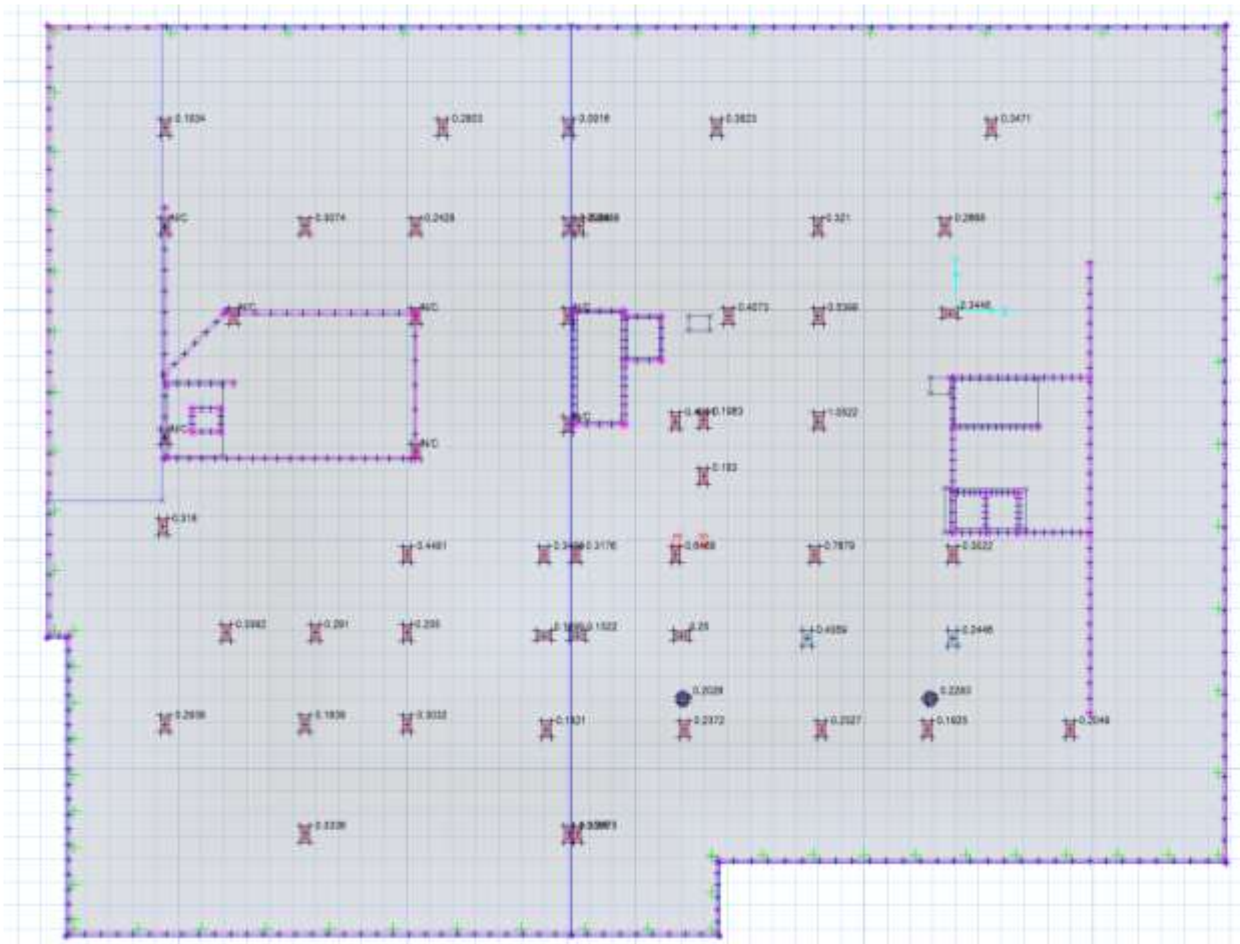


Figure 162:punching shear check

All result from safe modal less than 1 ……..check is ok.

Shear check:

$\Phi Vc = \frac{0.75}{6} * \sqrt{fc} * b * d = \frac{0.75}{6} * \sqrt{28} * 1000 * 910/1000$ =601.91 KN

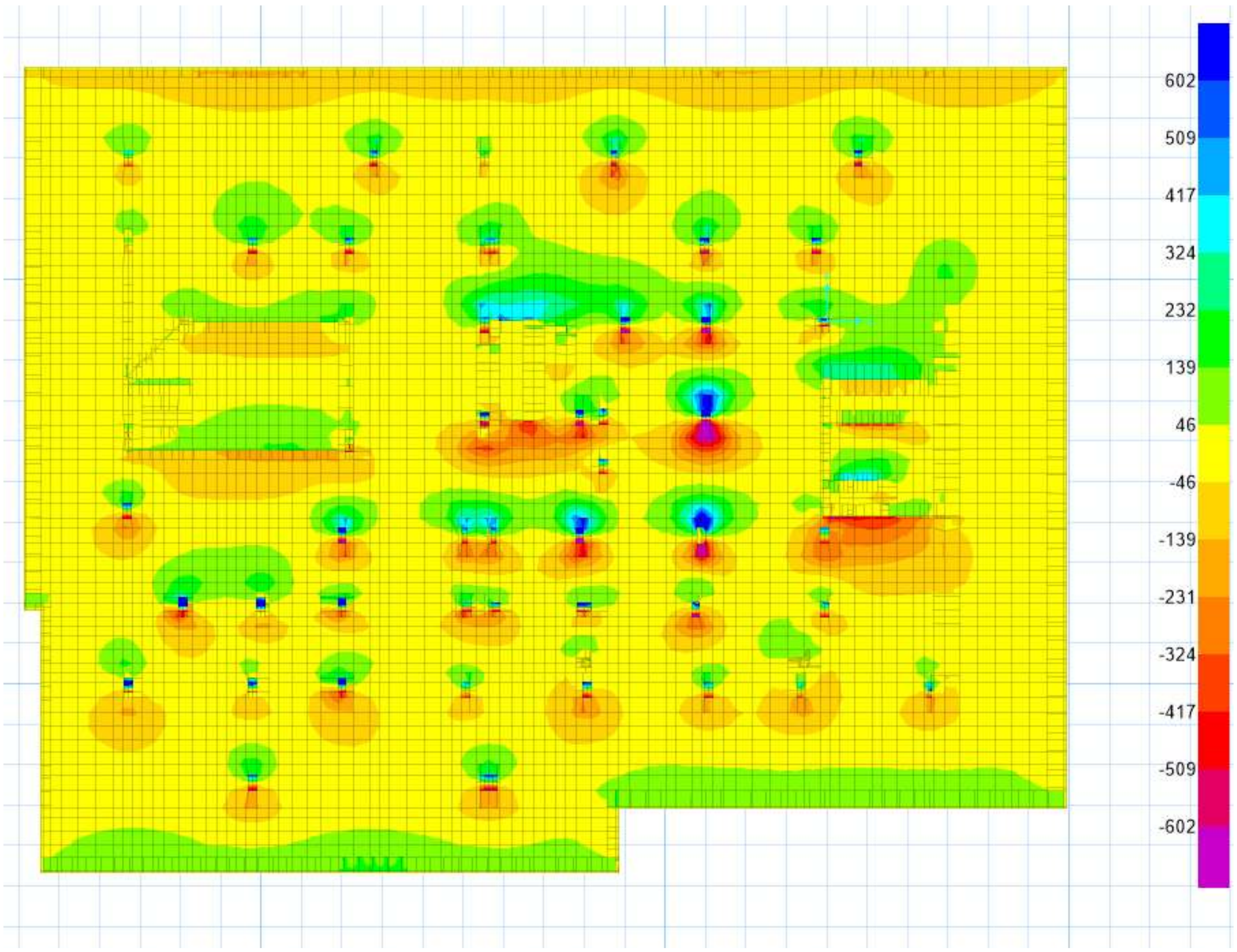


Figure 163:Shear check

Check is ok.

3.7.3. Footing detailing:

Figure 164:Footing detailing

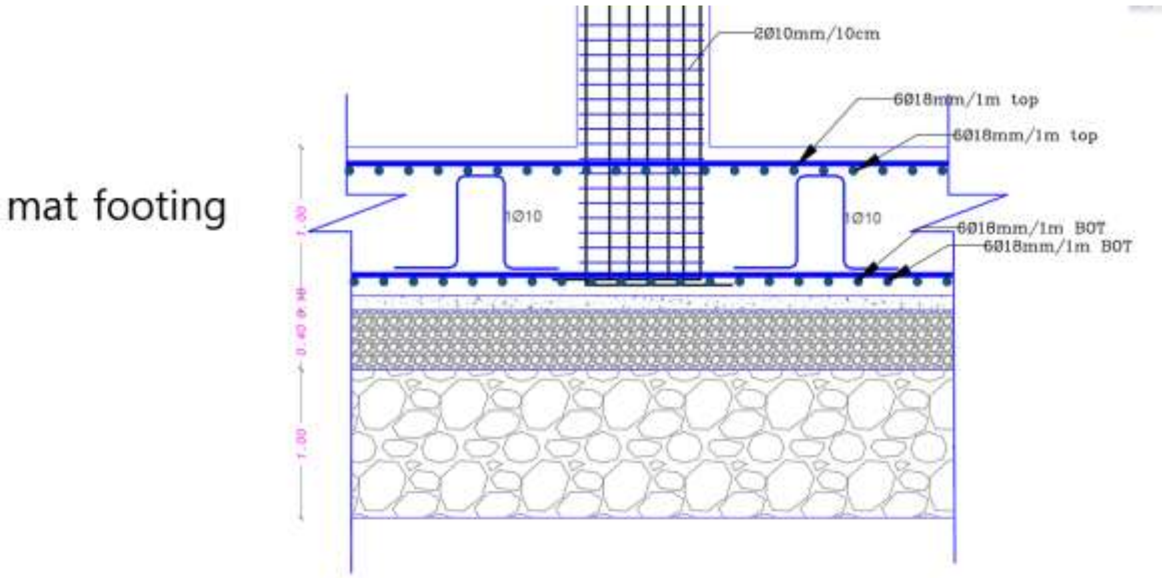


Figure 165:Footing detailing.

3.8. Sheet piles design:

Soli:

Unit weight=18 KN/m^3.

Stress state effective

Angle of internal fraction=30^o

Cohesion of soil 0.00 Kpa

Angle of fraction soil 30^o.

Saturated untie weight 22 KN

Height of water is 3 m from bottom.

Sheet pile dimension:

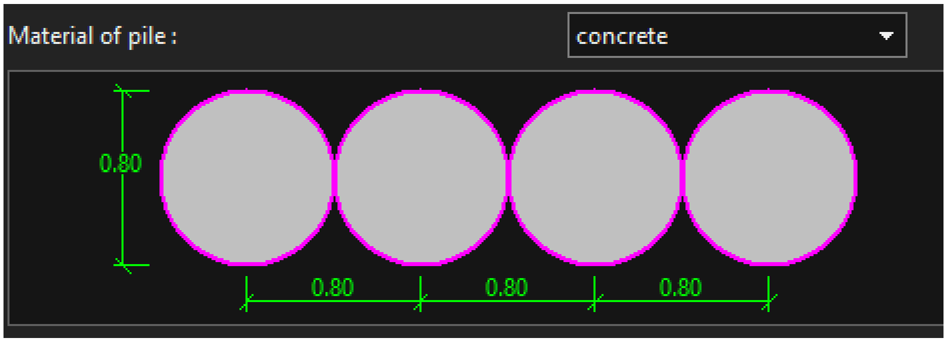


Figure 166:Sheet pile dimention

Sheet pile geometry:

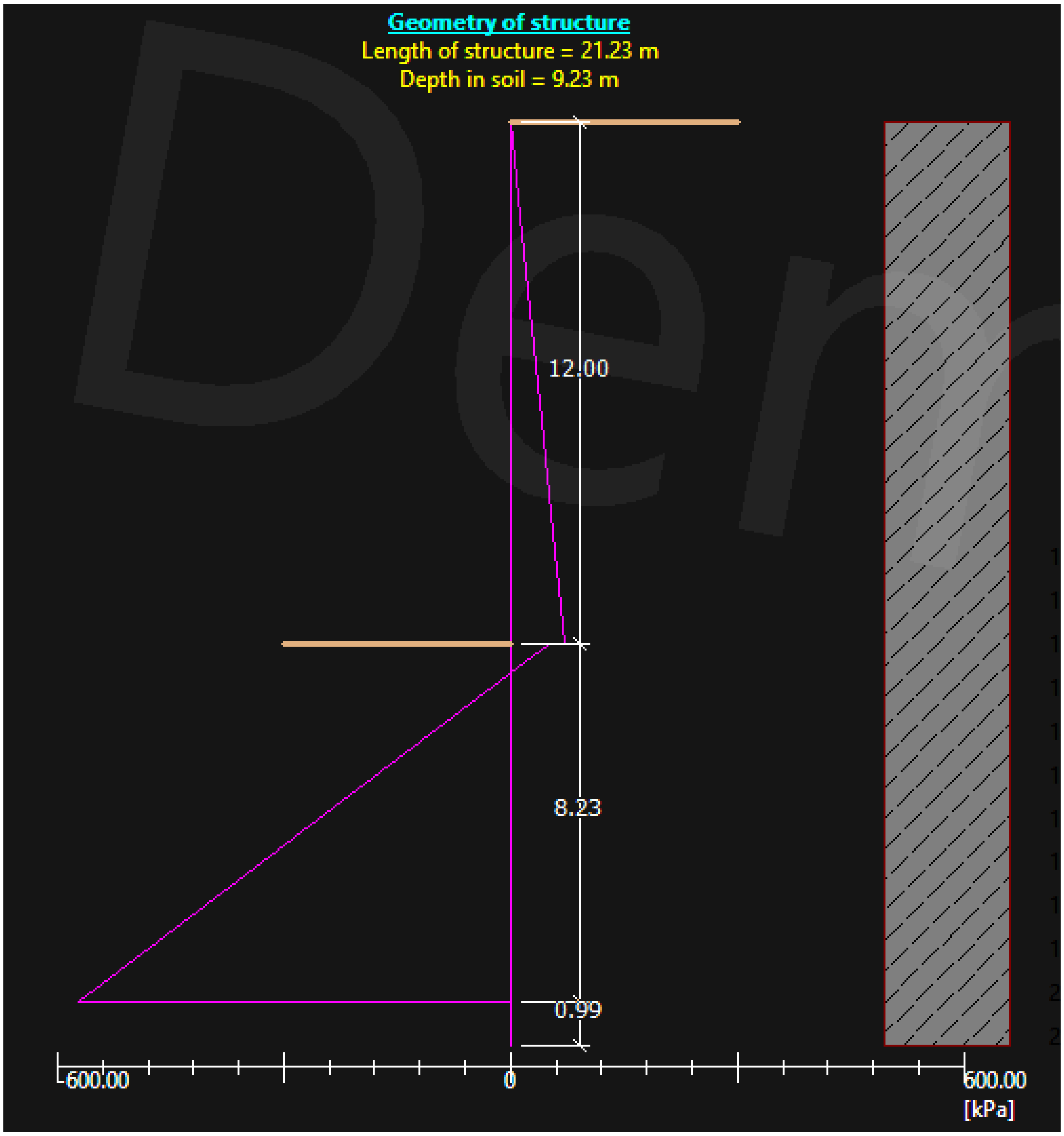


Figure 167:Sheet pile geometry

Bending moment and shear force:

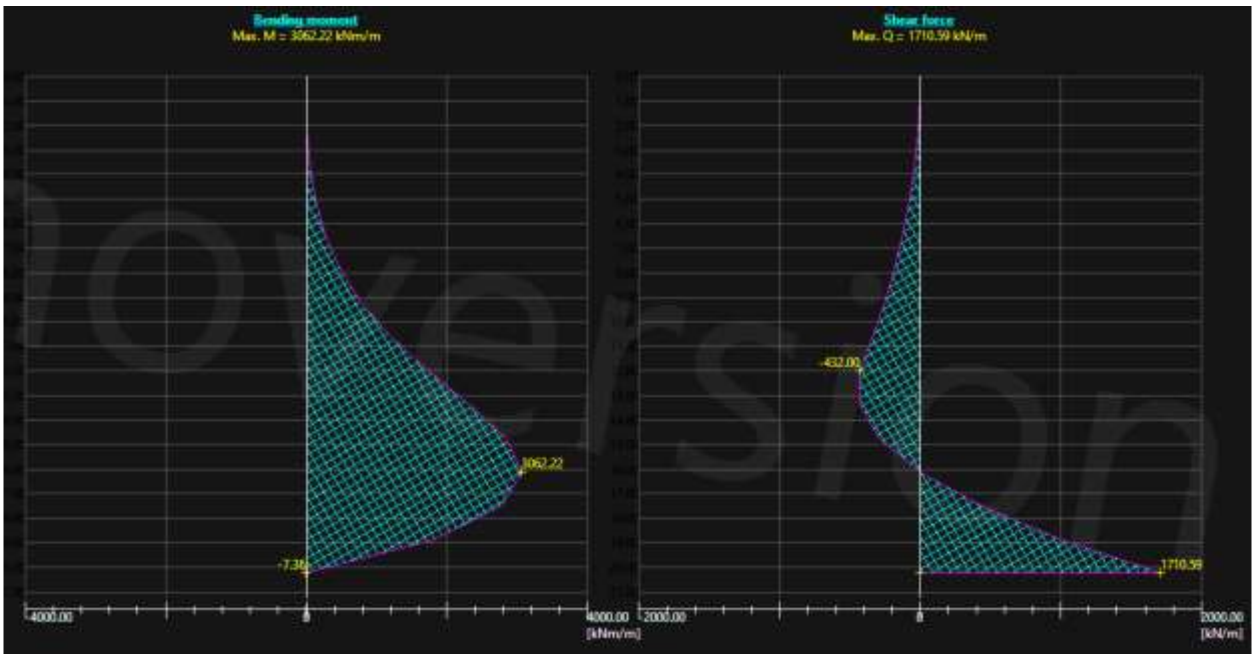


Figure 168:Bending moment and shear force.

Results :

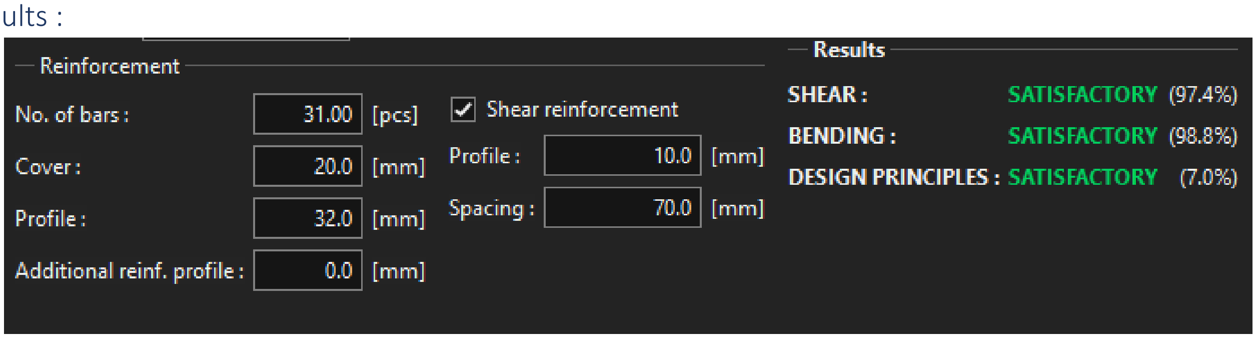


Figure 169:Results

Sheet pile detailing:

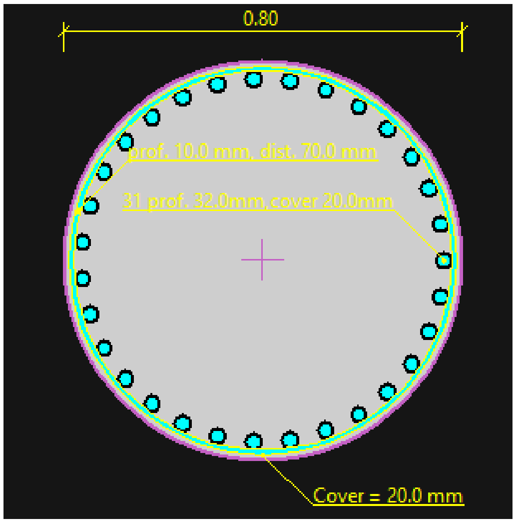


Figure 170Sheet pile detailing:

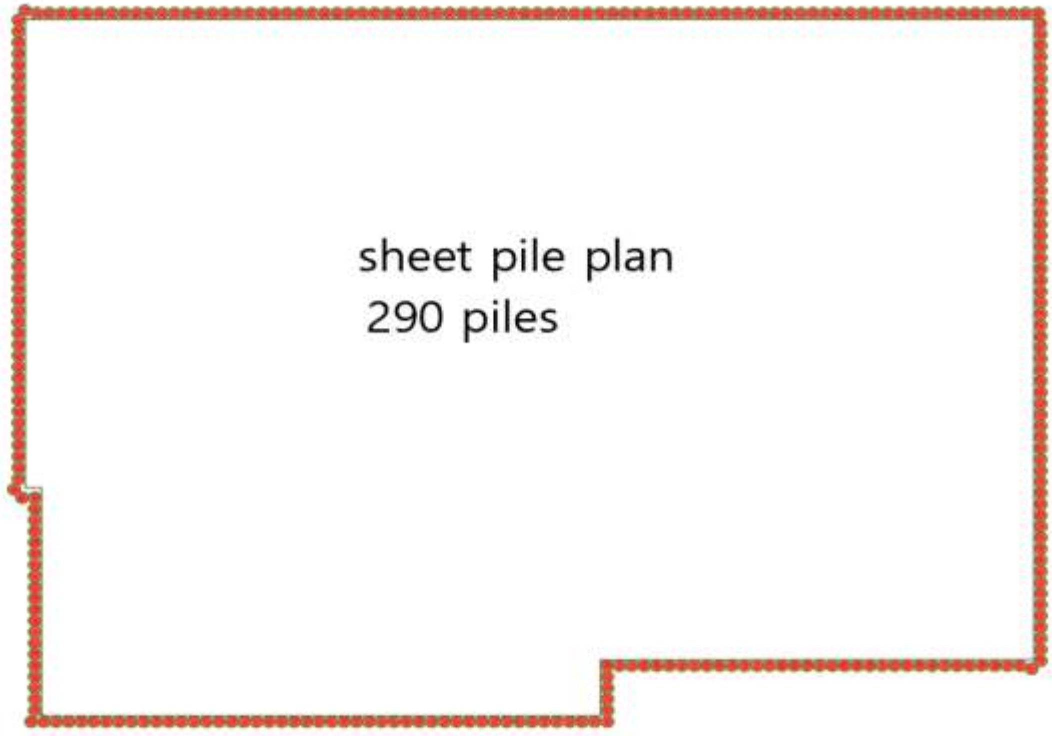


Figure 171:Sheet pile detailing

290 piles needed to cover the perimeter of the building

3.9. Stair design:

Stair plane:

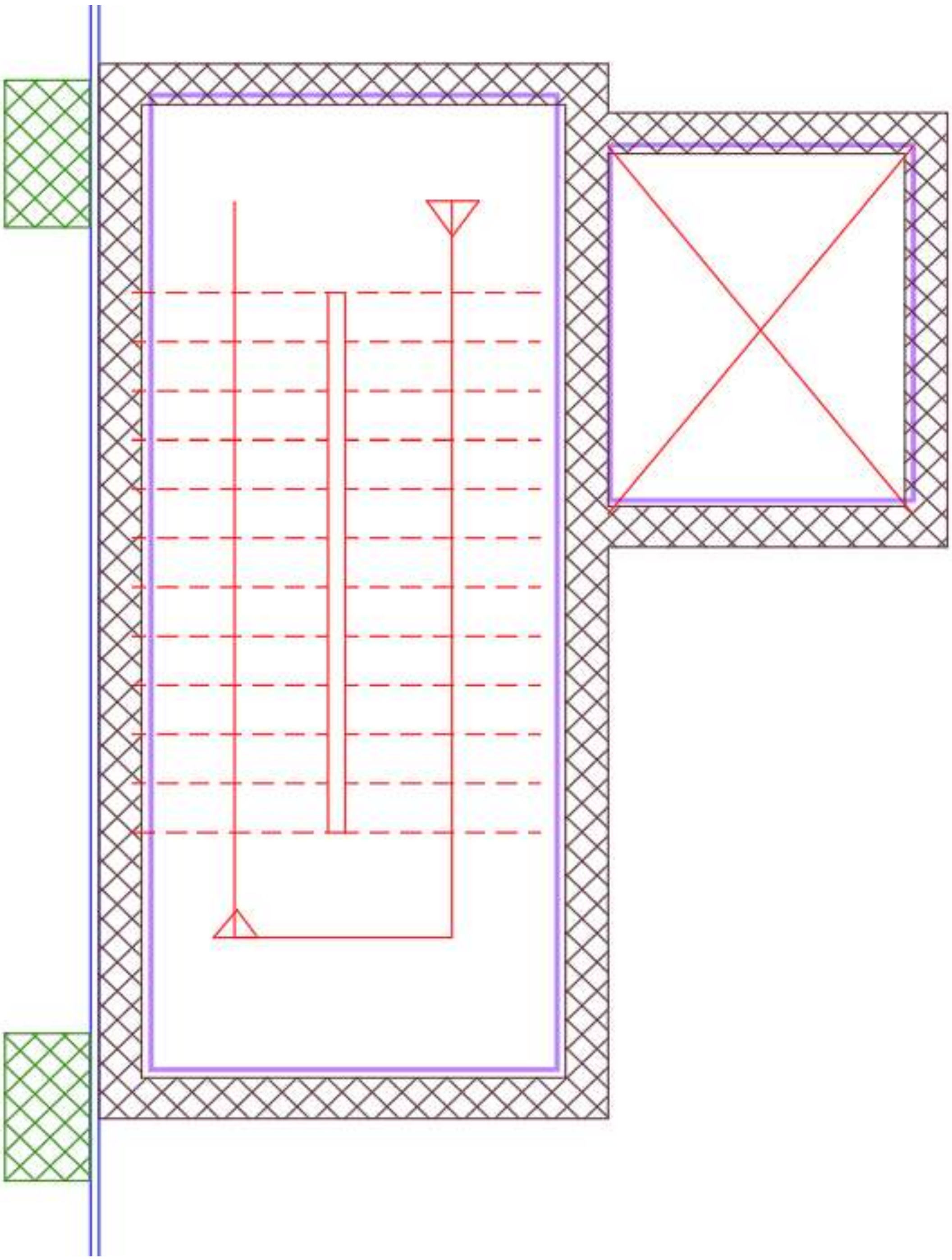


Figure 172:Stair plane.

Model ETABS:

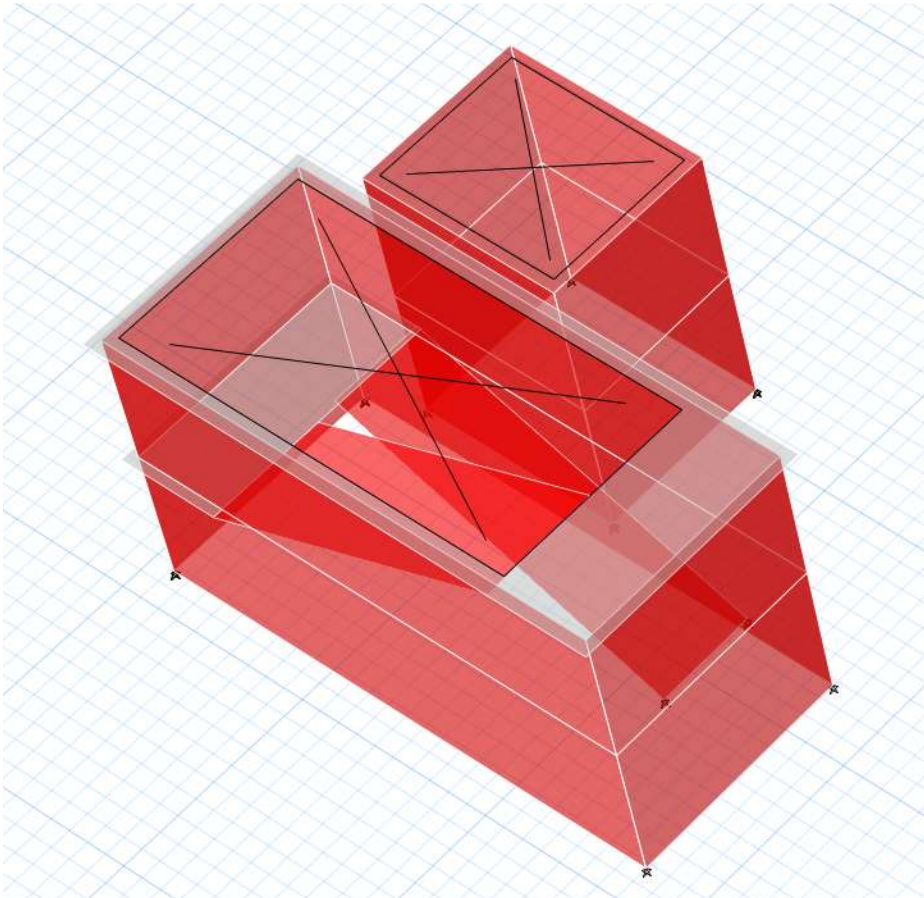


Figure 173:Modal etabs

3.9.1. Compatibly check:

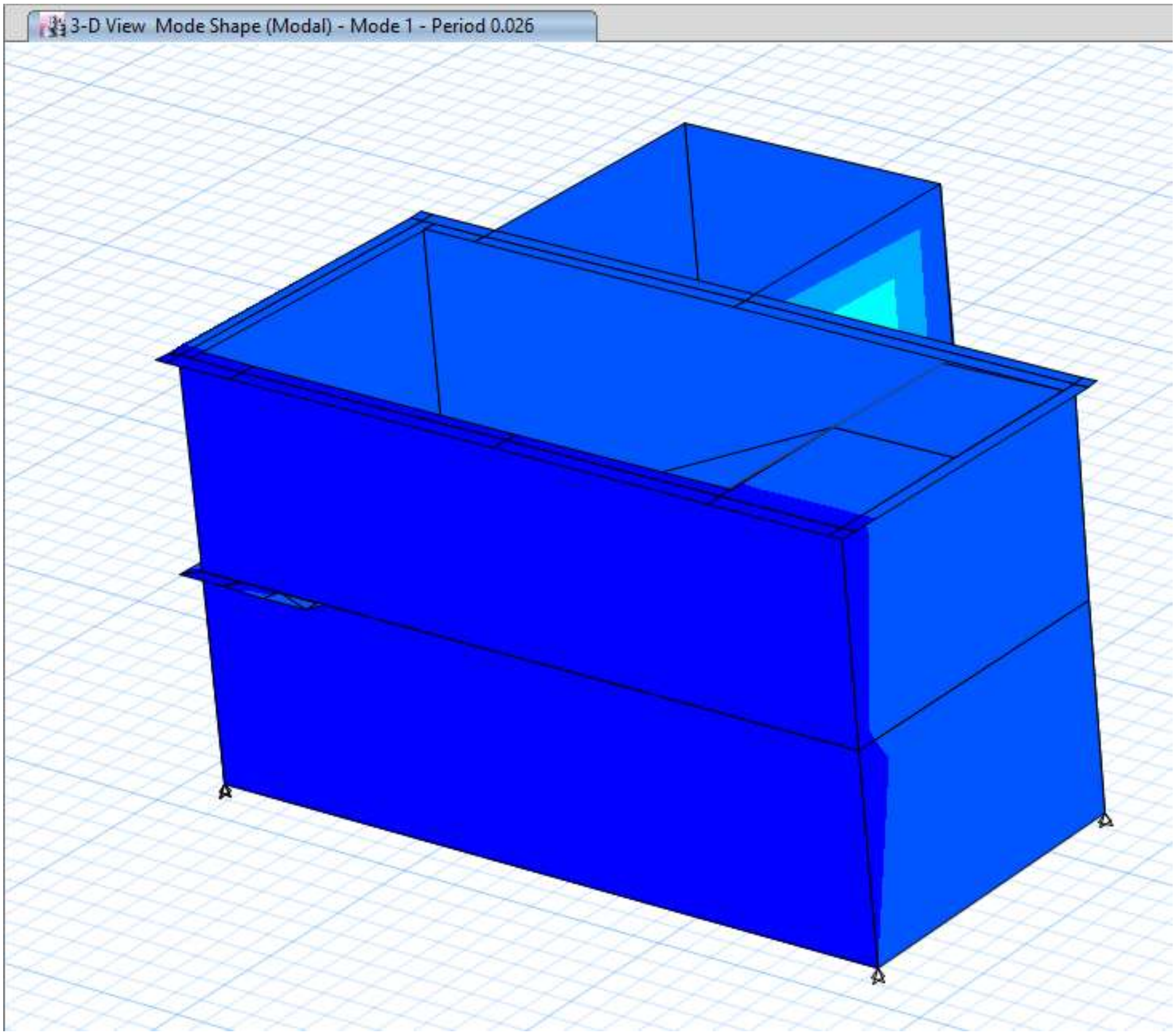


Figure 174:Compatibly check

the stair is compatible

3.9.2. shear check:

ΦVc=(0.75/6)((fc^2))*b*d

Fc=28mpa

.b=1m = 1000mm

.d=190mm

ΦVc = 125.67 kN

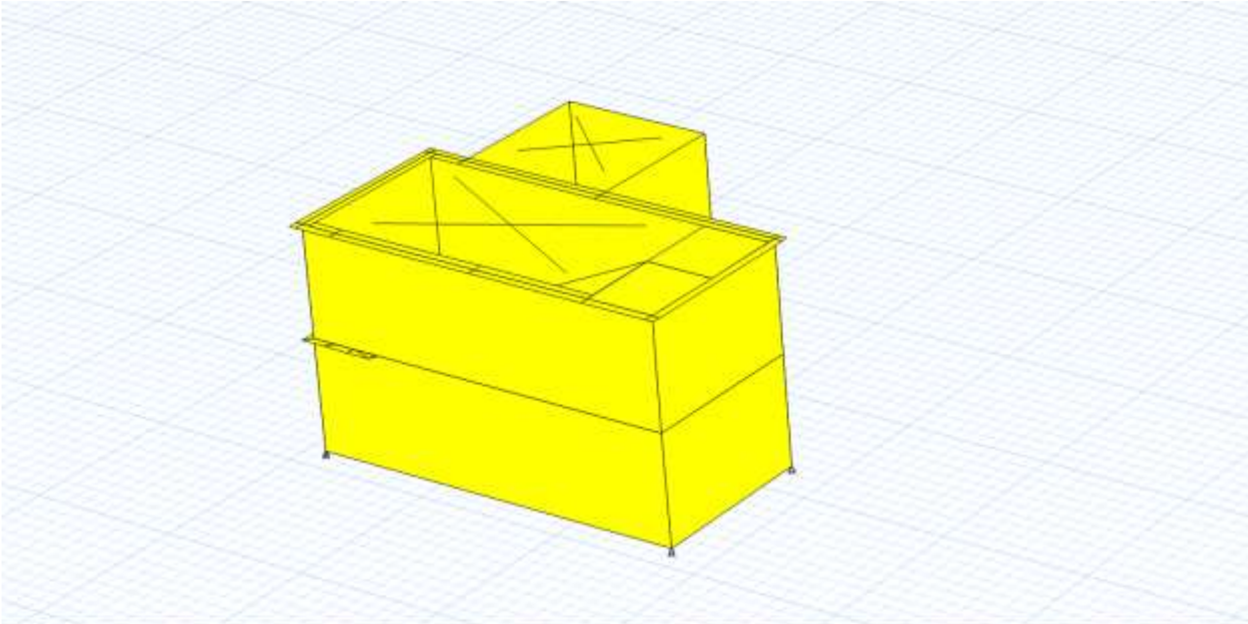


Figure 175:shear check

$\Phi Vc > Vu$ ….. check is ok.

Design :

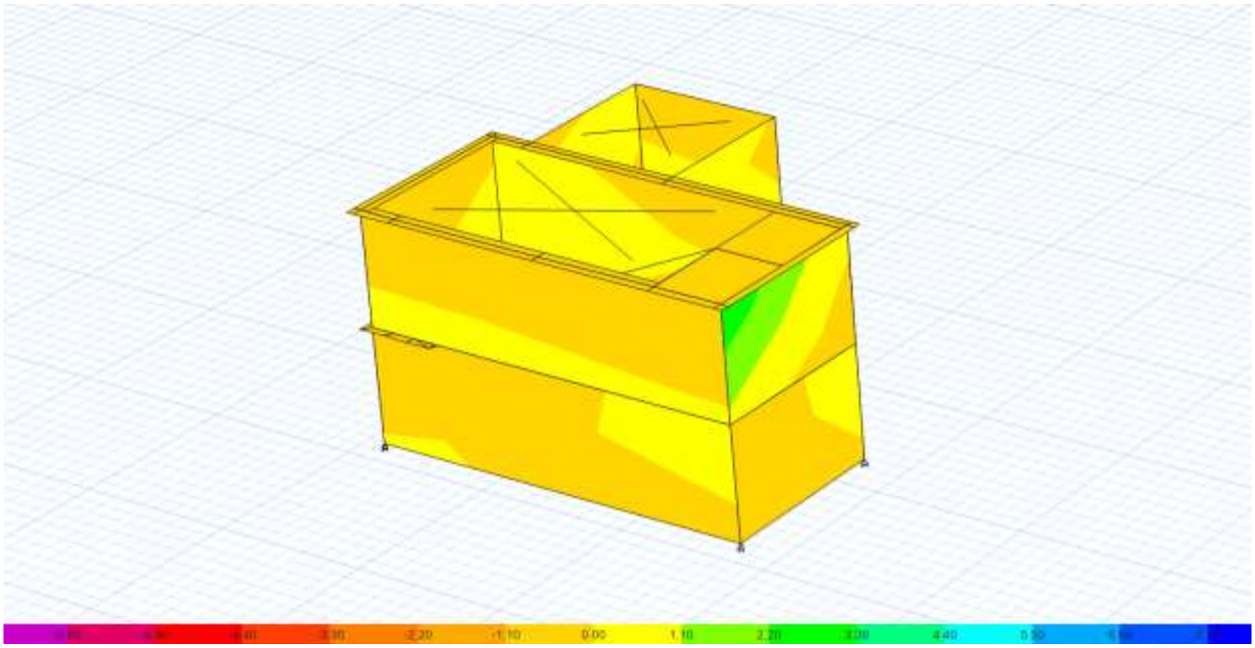


Figure 176:Design

Max moment from etabs =6.6kN.m

$$\rho=\frac{0.85*fc}{Fy}\left(1-\sqrt{1-\left(\frac{2.61*10^{6}*Mu}{fc*b*d^{2}}\right)}\right) = 0.000701$$

ρ min = 1.4/ fy = 1.4 /420 = 0.003

so, use AS min

As min = 0.003 * 1000 * 250 = 750 mm^2 use 5 Ø14/ m

3.9.3. Stair detailing:

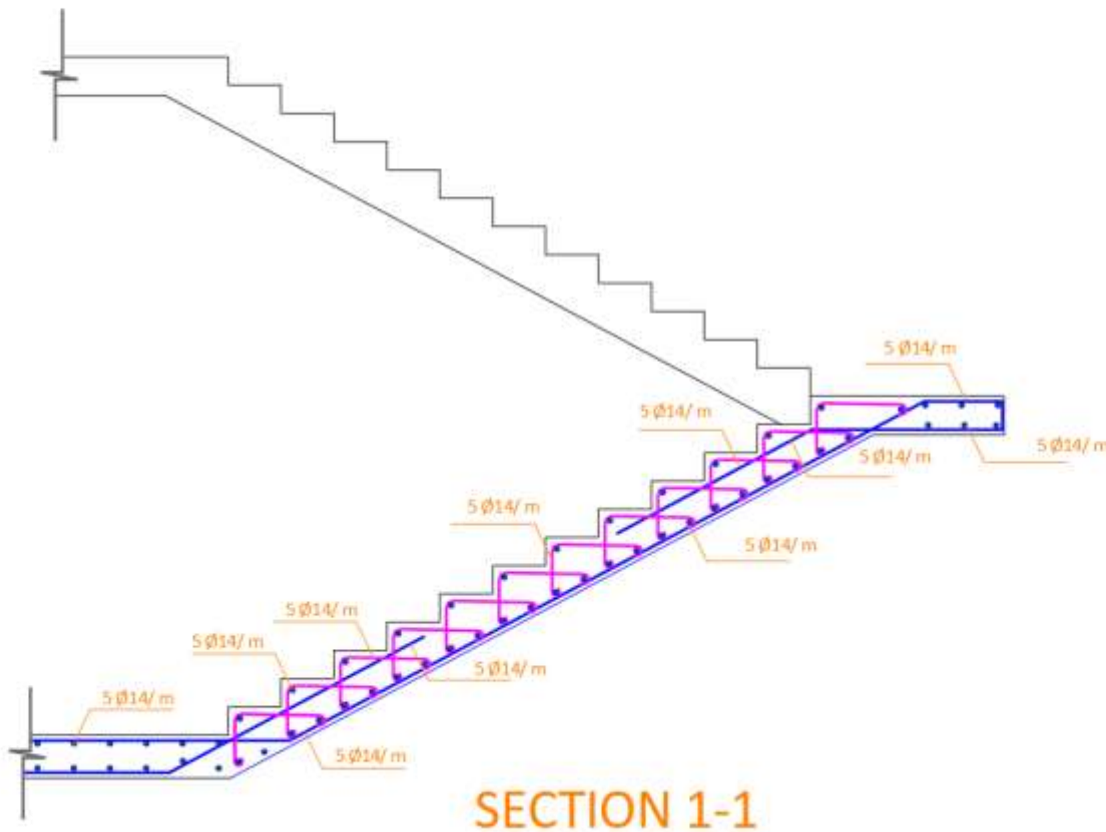


Figure 177:Stair detailing

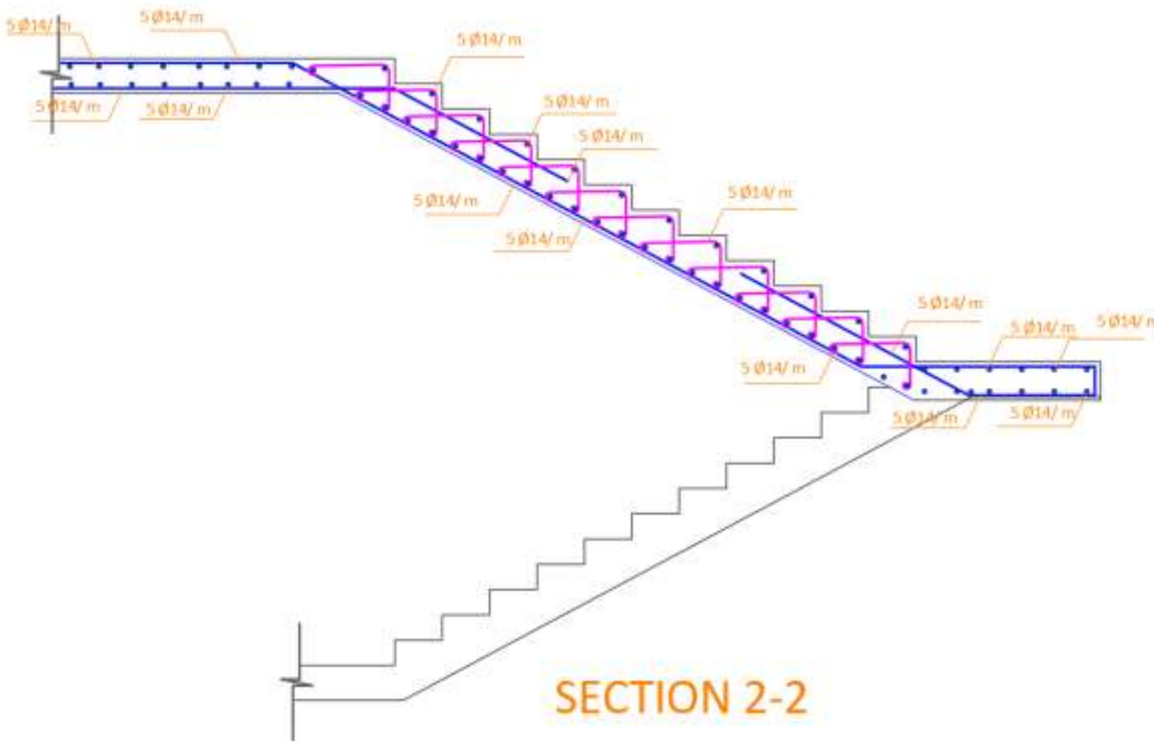


Figure 178:Stair detailing

3.10. Water tank design:

Designing a rectangular water tank involves careful considerations to ensure efficient storage and distribution of water. Rectangular tanks are commonly used in various applications, including residential, commercial, and industrial settings. They offer distinct advantages such as space utilization, ease of installation, and structural stability.

The primary objective of designing a rectangular water tank is to provide a reliable and sustainable water storage solution.

We will design water tank in basement floor (rectangular water tank 8.70m*7.70*4.00).

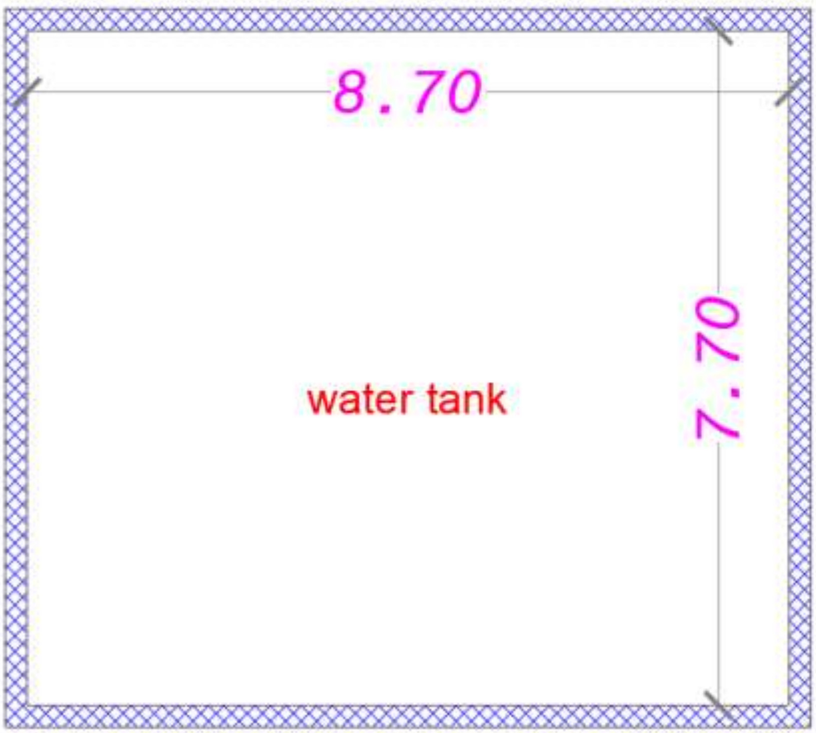


Figure 179:water tank plan.

Assumption:

Fc=28mpa.

Fy=240mpa.

Check type of tank:

L/H=8.70/4.00= 2.18>2

Is one way type of tank.

γw*(h water) =10*4.00=4.5 KN/m.

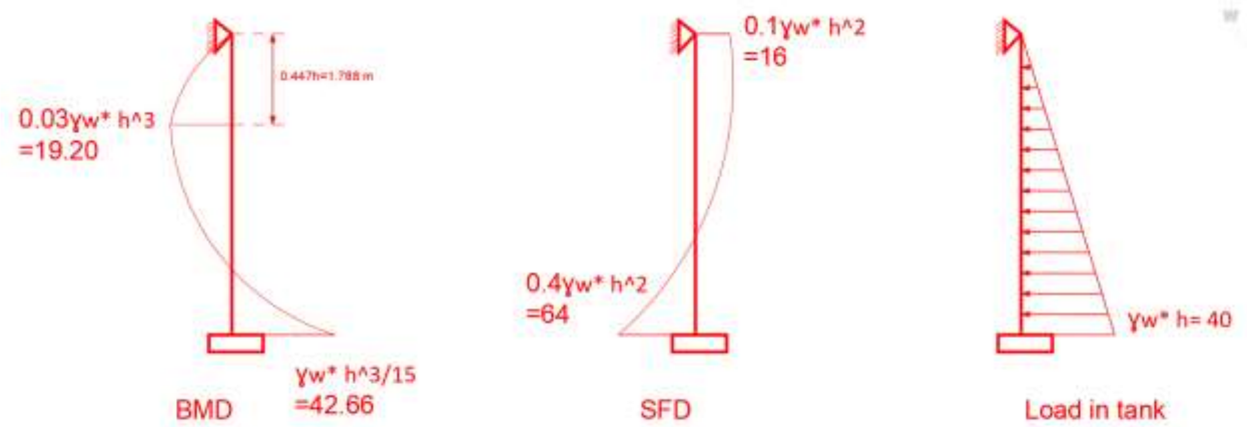


Figure 180:momant and shear load.

Horizontal tension = horizontal shear

$$V_H = T_H \approx \frac{\gamma_w H^2}{8} = \frac{10 \times 4^2}{8} = 20 \text{ kN/m}$$

Horizontal Moment:

$$M_H \approx \frac{\gamma_w H^3}{32} = \frac{10 \times 4^3}{32} = 20kN.m/m$$

Thickness of tank:

Vu =1.4 * 64 = 89.6 KN/m

$$\emptyset V_C = \frac{0.75}{6}\sqrt{28} \times 1000 \times d \times 10^{-3} = 0.662d$$

$\emptyset V_C = V_u$

$0.662d$ = 86.6

d = 135.4 mm

use h=300mm. ……… d=240mm.

check tension:

Tu=1.4 *20 = 28 KN/m

Table 28 - fs max

Internal force	Design internal force	f_{smax}
Tension	$T_{udesign} = S_d T_u$	138 MPa for normal conditions 119 MPa for severe conditions
Shear	$V_{sdesign} = S_d V_s$	165 MPa for normal conditions 138 MPa for severe conditions
Torsion	$T_{orudesign} = S_d T_{oru}$	165 MPa for normal conditions 138 MPa for severe conditions
Moment	$M_{udesign} = 1.06 S_d M_u$	From Figures

Normal condition so fs max=138 mpa.

$$S_d = \frac{\emptyset F_y}{\gamma f_{smax}} = \frac{0.9 \times 420}{1.4 \times 138} = 1.956$$

$$T_{udesign} = 1.956 * 28 = 54.76\frac{kN}{m}$$

$$A_s = \frac{T_{udesign}}{\emptyset F_y} = \frac{54.76 \times 1000}{0.9 \times 420} = 144.86\frac{mm^2}{m}$$

Check thickness for tension:

$$\frac{T + CE_s A_s}{A_g + nA_s} \leq \frac{1}{3}\sqrt{f_c'}$$

$$\frac{20000 + 0.0003 \times 200000 \times 144.86}{300000 + 8.04 \times 144.86} = 0.0952 \ \leq \frac{1}{3}\sqrt{28} = 1.76\ MPa$$

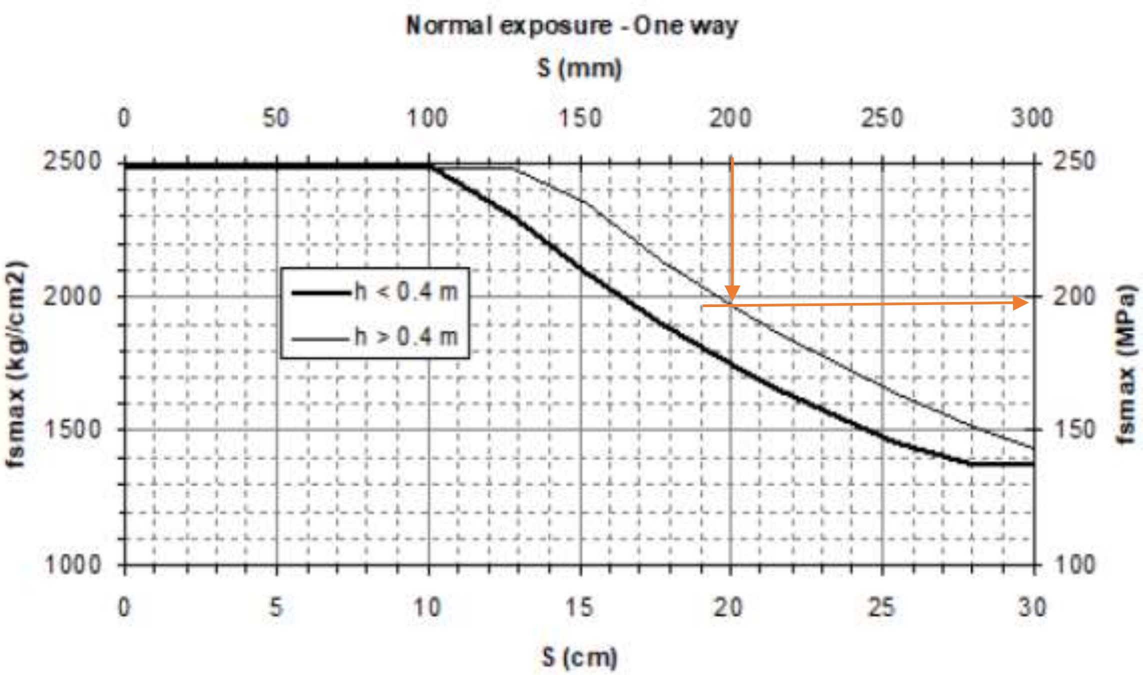
Thickness is ok.

VERTICAL reinforcement:

Mu=1.4*42.66=62.524 $kN.m/m$

Assume s = 200 mm

normal conditions, one way and h < 0.4 m.



f_{smax} = 197 Mpa

$$S_d = \frac{\emptyset F_y}{\gamma f_{smax}} = \frac{0.9 \times 420}{1.4 \times 197} = 1.37$$

$$M_{udesign} = 1.06 \times 1.37 \times 62.524 = 90.80 \frac{kN.m}{m}$$

$$\rho = \frac{0.85 \times 28}{420}\left(1 - \sqrt{1 - \frac{2.61 \times 10^6 \times 90.80}{28 \times 1000 \times 240^2}}\right) = 0.00433$$

$A_s = 0.00433 \times 1000 \times 240 = 1039.3\ mm^2/m$

$A_{smin} = 0.003bh$

$= 0.003 \times 1000 \times 300 = 900 mm^2/m$……..use AS

- on the outside surface:

$M_u = 1.4 \times 19.20 = 26.88\ kN.m/m$

Thickness $h = 300$mm

Assume s = 200 mm

➔ f_{smax} = 197 Mpa

$S_d = \frac{\emptyset F_y}{\gamma f_{smax}} = \frac{0.9 \times 420}{1.4 \times 197} = 1.37$

$M_{udesign} = 1.06 \times 1.37 \times 26.88 = 39.05 \frac{kN.m}{m}$

$$\rho = \frac{0.85 \times 28}{420}\left(1 - \sqrt{1 - \frac{2.61 \times 10^6 \times 39.035}{28 \times 1000 \times 240^2}}\right) = 0.00181$$

$A_s = 0.00181 \times 1000 \times 240 = 436.77\ mm^2/m$

$A_{smin} = 0.003bh = 0.003 \times 1000 \times 300 = 900\ mm^2/m$……use AS min

Horizontal Reinforcement

$M_u = 1.4 \times 20 = 28\ kN.m/m$

➔ f_{smax} = 197Mpa

$S_d = \frac{\emptyset F_y}{\gamma f_{smax}} = \frac{0.9 \times 420}{1.4 \times 197} = 1.37$

$M_{udesign} = 1.06 \times 1.37 \times 28 = 40.66\ \frac{kN.m}{m}$

$$\rho = \frac{0.85 \times 28}{420}\left(1 - \sqrt{1 - \frac{2.61 \times 10^6 \times 40.66}{28 \times 1000 \times 240^2}}\right) = 0.0033$$

$A_s = 0.0033 \times 1000 \times 240 = 797\ mm^2/m$

Assume distance between contraction joints =4 m

$A_{smin} = 0.003bh = 0.003 \times 1000 \times 300 = 900\ mm^2/m$ … use AS min

Type of steel	AS	Ø
Vertical Reinforcement (on the inside surface)	1039.3	1Ø16/15cm
Vertical Reinforcement (on the outside surface)	1039.3	1Ø16/15cm
Horizontal reinforcement nearby the corner (Outside)	450	1Ø12/20cm
Horizontal reinforcement nearby the corner (Inside)	450	1Ø12/20cm
Horizontal reinforcement Far from the corner (Outside)	450	1Ø12/20cm
Horizontal reinforcement Far from the corner(inside)	450	1Ø12/20cm

Table 29:steel reinforcement

Water tank detailing:

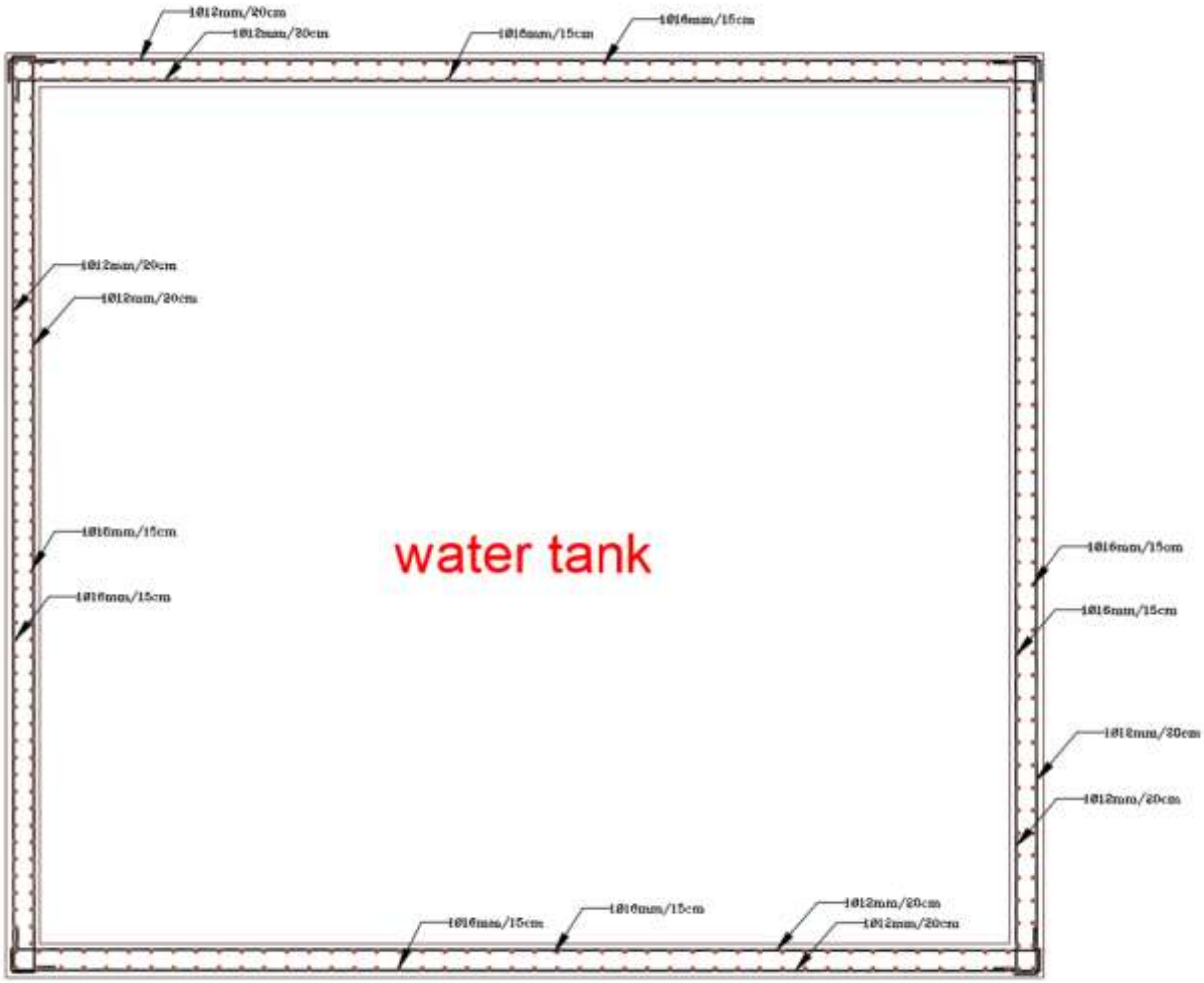


Figure 181:Water tank detailing

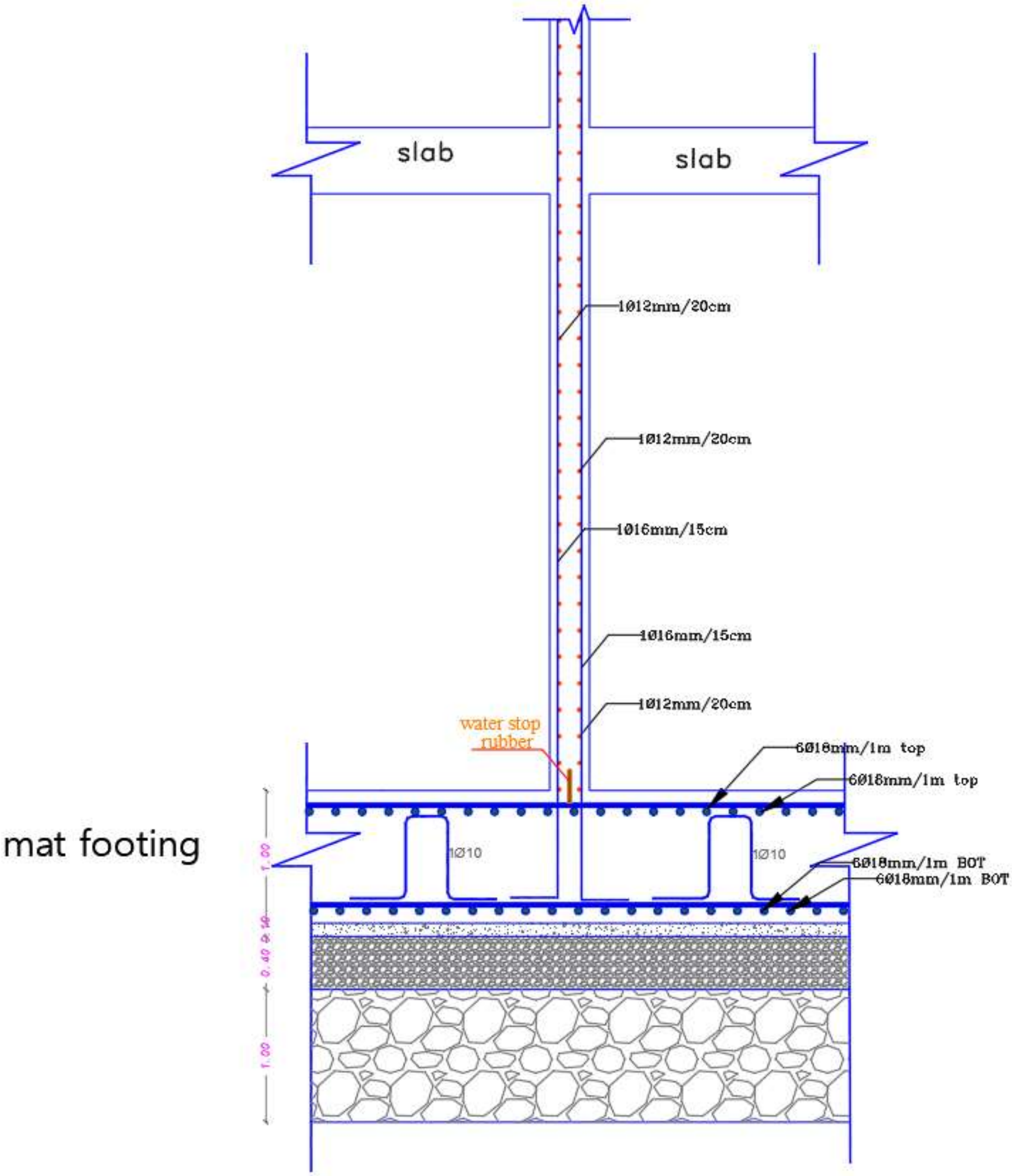


Figure 182:Water tank detailing

Chapter 4: Electra-Mechanical Aspect

4.1. Artificial Lighting Design:

The main goal of artificial lighting design:

Getting the amount and quality you want, the comfort of the occupants' eyesight Ensure safety in the hallways and lobbies. Many lighting systems based on uniformity and decoration are used in banks. The DIALux evo 8.2 program was used to design artificial lighting and demonstrates many parameters in this design.

Figure 183 - Artificial Lighting Design Process

Reflectance coefficients of finished materials used in the DIALux evo 8.2 program.

Table 30 - Reflector Factor

Surface	Finish material	Reflection Factor (%)
Wall	Paint (beige)	70%
Ceiling	white	70%
Floor	Tiles(white)	%30

Displays the list of luminaries used in the DIALux evo 8.2 program.

Table 31 - Luminaire List

Luminaire list (Building 1)								
Index	Manufacturer	Article name	Item number	Fitting	Luminous flux	Light loss factor	Connected load	Quantity
1	COLLINGWOOD	LSC43 2700K 4.8W 10cm Lengths	LSC432700	1x LSC43	34 lm	0.80	0.5 W	894
2	3F Filippi S.p.A.	3F Reno 200 WH 2000/930 UGR	30725	1x LED C COB Reno – 2000 – 930	2308 lm	0.80	24 W	4
3	Endo Lighting	Fixed Downlight	ERD6927B_RX360NA_RB574C	1x C150_LED_4000K_Ra83_SuperWide	1516 lm	0.80	13.4 W	26
4	COLLINGWOOD	LSC86 4000K IP65 41.6mm	LSC8640100	1x LSC86 4000K IP68 41.6mm	66 lm	0.80	0.7 W	354
5	Lightnet	Matric 38mm Lens Louver Recessed Frameless – M1	LM1LEE-840M-L953-FB	1x LED	2900 lm	0.80	33 W	16
6	LEDS C4 S.A.	Sla Standard 170 Square Trim Emergency	AH17-33X8W1D360	1x LED Blanco neutro – 4000K, 1x LED Blanco neutro 4000K	3646 lm	0.80	35 W	20
7	Lightnet	Ringo Star 60mm Surface – A3	RA3ASE-830M-D600-U	1x LED, 1x LED, 1x LED, 1x LED, 1x LED, 1x LED, 1x LED, 1x LED	2320 lm	0.80	24 W	7
8	Endo Lighting	Track Light	ERS4154WA_RAD727F	1x Lamp_JDR_4000K_SuperWide_non-Dim	590 lm	0.80	5.9 W	6
9	Delta Light	WANT-IT S 930 DIM8	275 12 82 93 ED8	1x 275 12 82 93 ED8 WANT-IT S 930 DIM8 gold [illegible]	309 lm	0.80	3.5 W	7
10	Delta Light	WANT-IT L 927 DIM8	275 13 82 92 ED8	1x 275 13 82 92 ED8 WANT-IT L 927 DIM8 gold mat version	297 lm	0.80	7 W	3
11	Molto Luce	DASH DC 2 TRACK TRACK SPOTLIGHT WITH 3 PH ADAPTER	676-002000424660v1	1x DASH DC 2 TRACK TRACK SPOTLIGHT WITH 3 PH ADAPTER, 1x DASH DC 2 TRACK TRACK SPOTLIGHT WITH 3 PH ADAPTER	2800 lm	0.80	25 W	1

All the rooms in the building are designed with artificial lighting.

Meeting room.

Conference room.

Tellers.

Offices.

Entrance.

Waiting area.

Credit Financial Department.

4.1.1. Ground Floor artificial lighting design.

The DIALux evo 8.2 program was used to create the ground floor's numerous lighting-related spaces, as may be seen in the example below.

The location of the luminaires for the bank's office is shown in the figure below

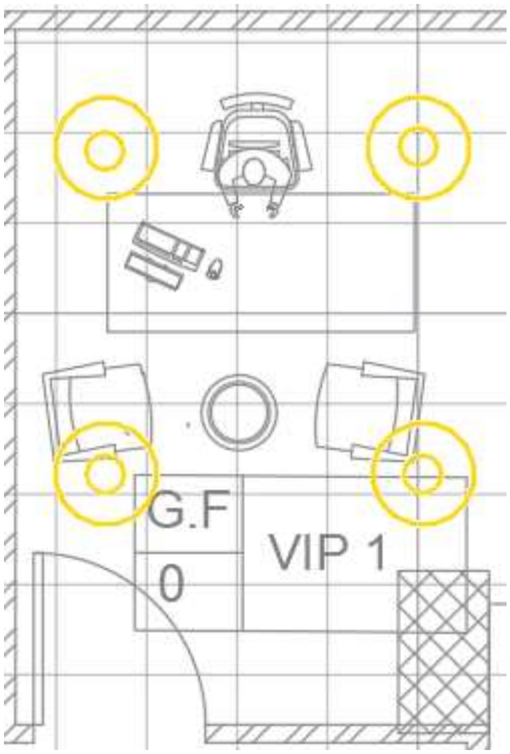


Figure 184 - Luminaire Distribution (office)

The lighting used in the office is shown in the figure below.

Figure 185 - Linear Unit

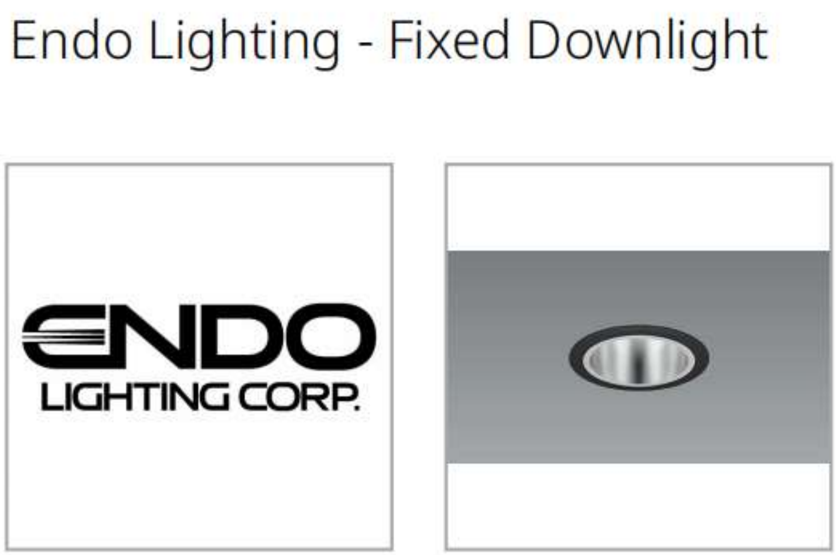


Figure 186 - Spot Unit

The DIALux evo 8.2 program's Europe standard code said that the desired illumination level should be 500 lux and that the glare level shouldn't be more than 20.

The figures below display the 3D office perspective from DIALux evo.

4.1.2. Conference room.

Figure 187 - Conference Room Lighting Distribution (DiaLUX)

Figure 188 - Conference Room Lighting Distribution (DiaLUX)

4.1.3. Credit Financial Department.

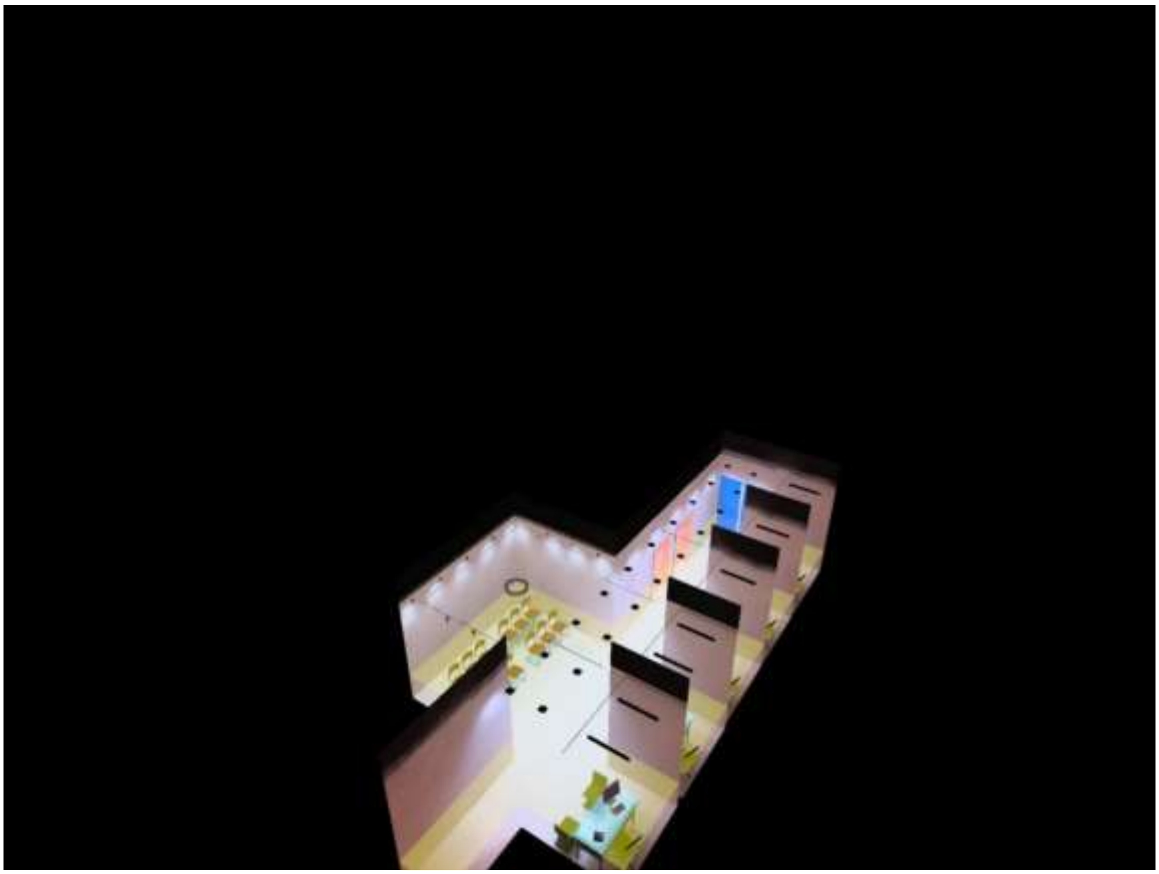


Figure 189 - Credit Financial Department Lighting Distribution (DiaLUX)

4.1.4. Meeting Room

Figure 190 - Meeting Room Lighting Distribution (DiaLUX)

Figure 191 - Meeting Room Lighting Distribution (DiaLUX)

4.1.5. Waiting area.

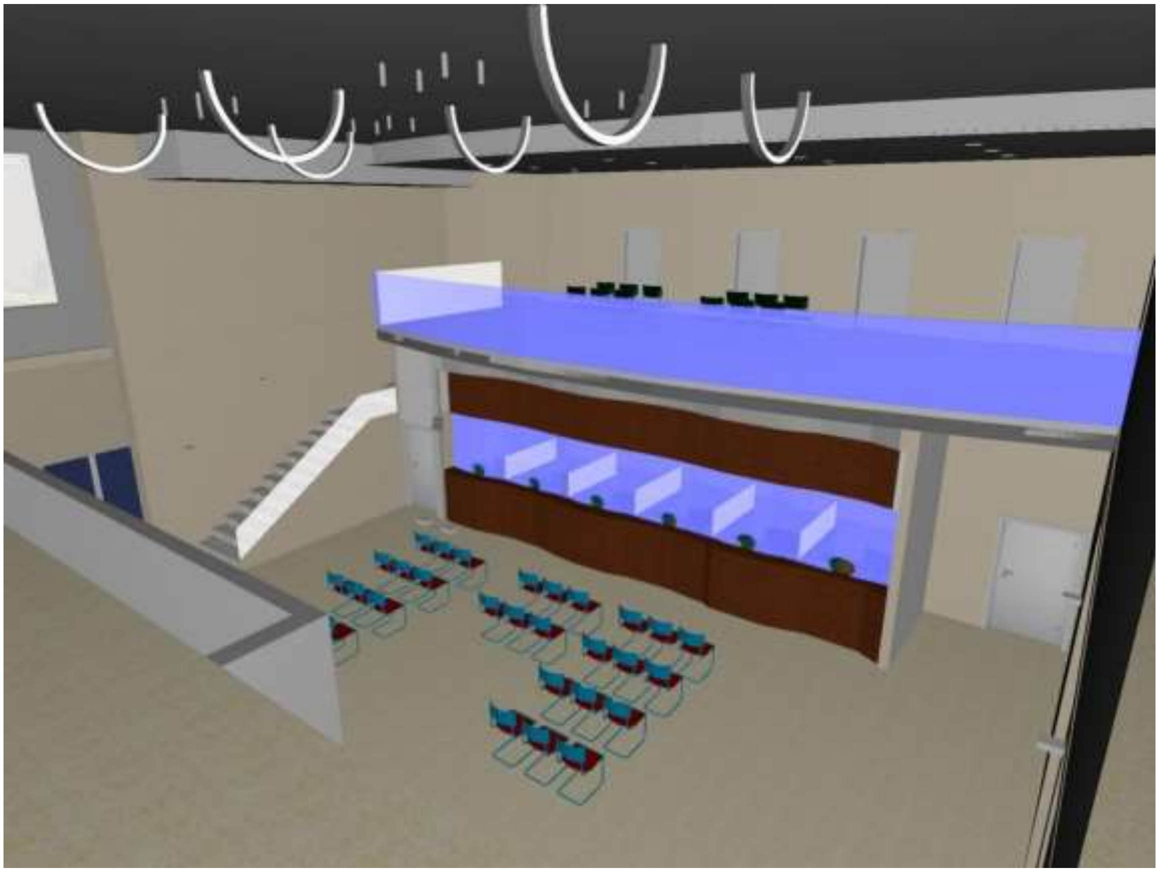


Figure 192 - Waiting Area Lighting Distribution (DiaLUX)

Figure 193 - Waiting Area Lighting Distribution (DiaLUX)

Figure 194 - Waiting Area Lighting Distribution (DiaLUX)

4.1.6. Tellers.

Figure 195 - Tellers Lighting Distribution (DiaLUX)

Figure 196 - Tellers Lighting Distribution (DiaLUX)

Figure 197 - Tellers Lighting Distribution (DiaLUX)

Figure 198 - Tellers Lighting Distribution (DiaLUX)

Figure 199 - Tellers Lighting Distribution (DiaLUX)

4.1.7. Offices.

Figure 200 - Office Lighting Distribution (DiaLUX)

4.1.8. Waiting area 2

Figure 201 - Waiting Area 2 Lighting Distribution (DiaLUX)

4.1.9. Corridor

Figure 202 - Corridor Lighting Distribution (DiaLUX)

Figure 203 - Corridor Lighting Distribution (DiaLUX)

DIALux output for each and every building space.

Table 32 - Room Output (DiaLUX)

Bank Different Spases						
space	Lux	Required Lux	UGR	Required UGR	Uniformity	Required Uniformity
Entrance	230	100	21	22	0.5	0.4
Meeting room	535	500	17.6	22	0.7	0.6
corridore	200	100	20.2	22	0.48	0.4
confence room	620	500	20	22	0.55	0.5
Teallers	515	500	17	19	0.61	0.5
offices	580	500	17.5	19	0.68	0.6
Credit Financial Department	550	500	18.1	19	0.63	0.6

4.2. HVAC Design:

Heating Ventilation and Air conditioning (HVAC) design is essential for the thermal comfort and indoor air quality for any structure. HVAC systems vary in operating systems, sizes and quality, however, they all serve the same purpose which is maintaining suitable room temperature and high indoor fresh air quality by exhausting odors, dust and excessive heat.

Given information (Design builder):

- Humidity ranges from (40% - 70%)
- Inside temperature design in winter = 22 ˚ C
- Inside temperature design in summer = 24 ˚ C
- Total heating load for structure = 140 KW
- Total cooling load for structure = 159 KW

The design will be on the cooling load, due to being more critical

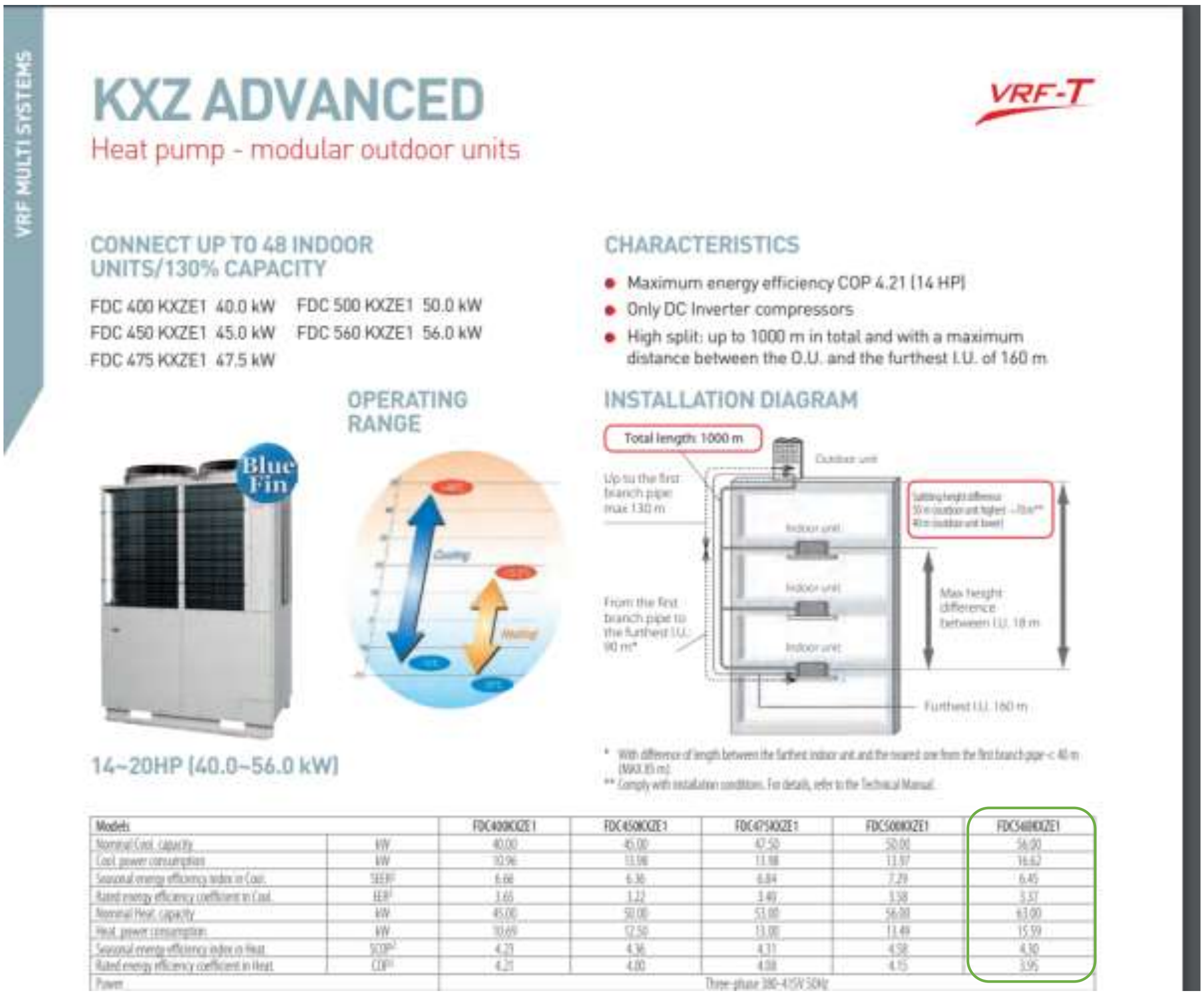
Mitsubishi Company is selected to design and choose suitable models from.

4.2.1. Model selection:

HVAC is divided into two types outdoor unit and indoor unit

From design builder, the design cooling load = 159 KW

Outdoor unit:



Models		FDC400KXZE1	FDC450KXZE1	FDC475KXZE1	FDC500KXZE1	FDC560KXZE1
Nominal Cool. capacity	kW	40.00	45.00	47.50	50.00	56.00
Cool. power consumption	kW	10.96	13.98	11.98	11.97	16.62
Seasonal energy efficiency index in Cool.	SEER[2]	6.68	6.36	6.84	7.29	6.45
Rated energy efficiency coefficient in Cool.	EER[1]	3.65	3.22	3.40	3.58	3.37
Nominal Heat. capacity	kW	45.00	50.00	53.00	56.00	63.00
Heat. power consumption	kW	10.69	12.50	13.00	11.49	15.59
Seasonal energy efficiency index in Heat.	SCOP[2]	4.23	4.36	4.31	4.58	4.30
Rated energy efficiency coefficient in Heat.	COP[1]	4.21	4.00	4.08	4.15	3.95
Power		Three-phase 380-415V 50Hz				

Figure 204 - Outdoor Unit (model FDCS560KXZE1)

Figure 205 - outdoor unit (model FDCS560KXZE1)

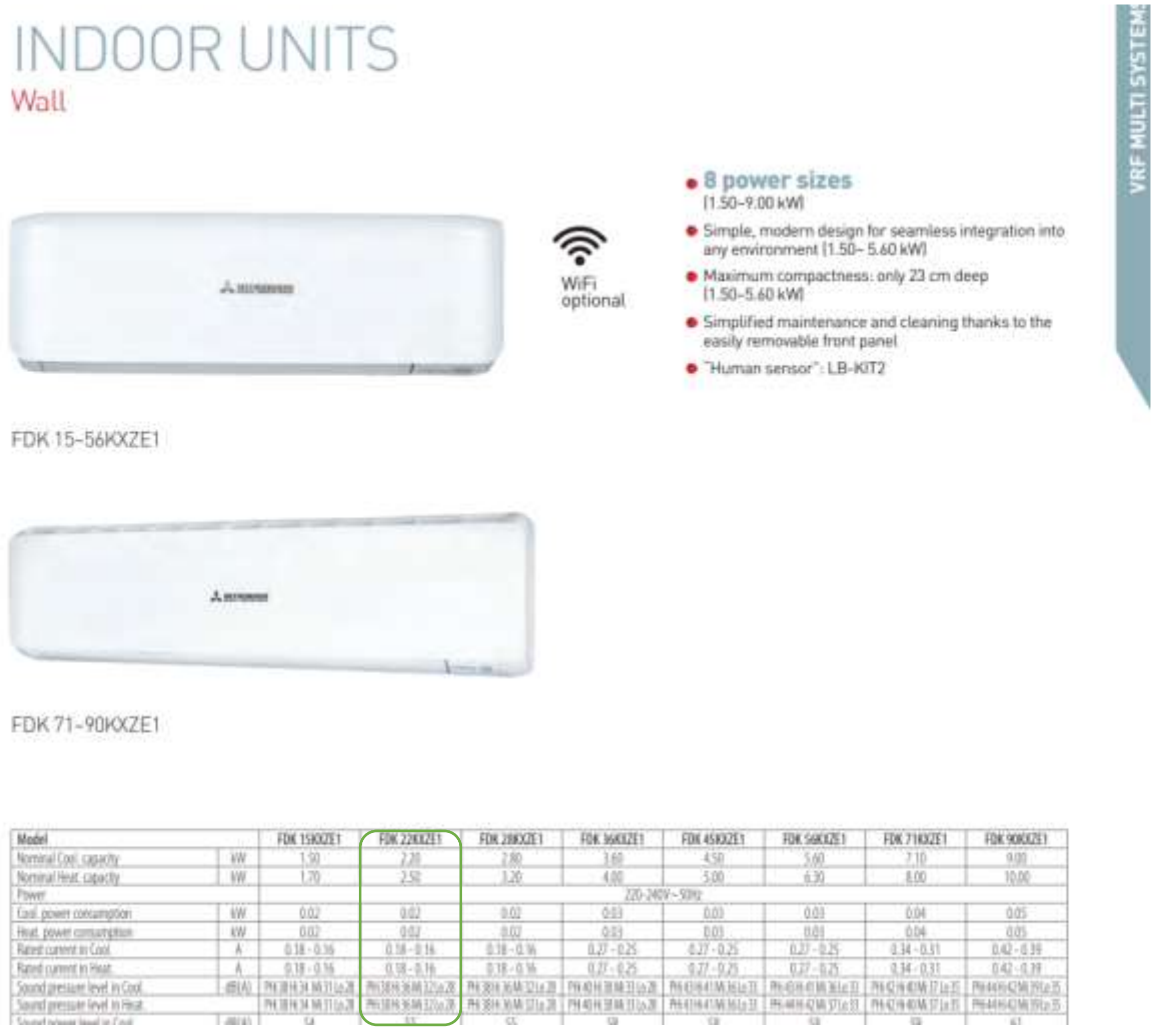
Model chosen is KXZ-FDC560KXZE1 (56 KW)

#of outdoor units needed = 159/56 = 3 units

Indoor unit selection:

For offices the wall mounted split indoor unit was chosen

For open areas ex. Waiting area ducted fan coil was chosen



Model		FDK 15KXZE1	FDK 22KXZE1	FDK 28KXZE1	FDK 36KXZE1	FDK 45KXZE1	FDK 56KXZE1	FDK 71KXZE1	FDK 90KXZE1
Nominal Cool. capacity	kW	1.50	2.20	2.80	3.60	4.50	5.60	7.10	9.00
Nominal Heat. capacity	kW	1.70	2.50	3.20	4.00	5.00	6.30	8.00	10.00
Power		220-240V~50Hz							
Cool. power consumption	kW	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.05
Heat. power consumption	kW	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.05
Rated current in Cool.	A	0.18 - 0.16	0.18 - 0.16	0.18 - 0.16	0.27 - 0.25	0.27 - 0.25	0.27 - 0.25	0.34 - 0.31	0.42 - 0.39
Rated current in Heat.	A	0.18 - 0.16	0.18 - 0.16	0.18 - 0.16	0.27 - 0.25	0.27 - 0.25	0.27 - 0.25	0.34 - 0.31	0.42 - 0.39
Sound pressure level in Cool.	dB(A)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sound pressure level in Heat.		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Figure 206 - indoor unit (model FDK22KXZE1)

Model FDK22KXZE1 was selected with 2.2 KW cooling load

INDOOR UNITS

Low head ducted

WiFi optional

- **7 power sizes**
  (1.50–7.10 kW)
- Ideal for applications in hotels, hospitals and small offices
- Optional filter kit: UT-FL1EF (FDUT 15–36); UT-FL2EF (FDUT 45–56); UT-FL3EF (FDUT 71)
- Ducting flange: UT-SAT1EF (FDUT 15–36); UT-SAT2EF (FDUT 45–56); UT-SAT3EF (FDUT 71)
- "Human sensor": LB-KIT2

FDUT 15–71KXE6F-E

COMPACT SIZE

200 mm

750 mm

500 mm

models FDUT 15, 22, 28, 36 KXE6F

200 mm

950 mm

500 mm

models FDUT 45, 56 KXE6F

VERY QUIET OPERATION

Extremely quiet: only 22 dB(A) for models from 1.50–2.80 kW.

Unit

1m

1m

2m

1.5m

1m

Model		FDUT 15KXE6F-E	FDUT 22KXE6F-E	FDUT 28KXE6F-E	FDUT 36KXE6F-E	FDUT 45KXE6F-E	FDUT 56KXE6F-E	FDUT 71KXE6F-E
		Rear recovery						
Nominal Cool capacity	kW	1.50	2.20	2.80	3.60	4.50	5.60	7.10
Nominal Heat capacity	kW	1.70	2.50	3.20	4.00	5.00	6.00	8.00
Power		220-240V~50Hz						
Cool. power consumption	kW	0.06 - 0.06	0.07 - 0.07	0.07 - 0.07	0.07 - 0.07	0.08 - 0.08	0.08 - 0.08	0.08 - 0.08
Heat. power consumption	kW	0.06 - 0.06	0.07 - 0.07	0.07 - 0.07	0.07 - 0.07	0.08 - 0.08	0.08 - 0.08	0.07 - 0.07
Rated current in Cool	A	0.27 - 0.27	0.28 - 0.25	0.28 - 0.25	0.32 - 0.29	0.36 - 0.33	0.38 - 0.35	0.42 - 0.42

Figure 207- Fan coil unit (model FDUT)

Model FDUT is used with a variety of cooling capacity depending on the room cooling design

Diffusers:

Used to pump out air from any direction, usually the shape is selected to match ceiling design

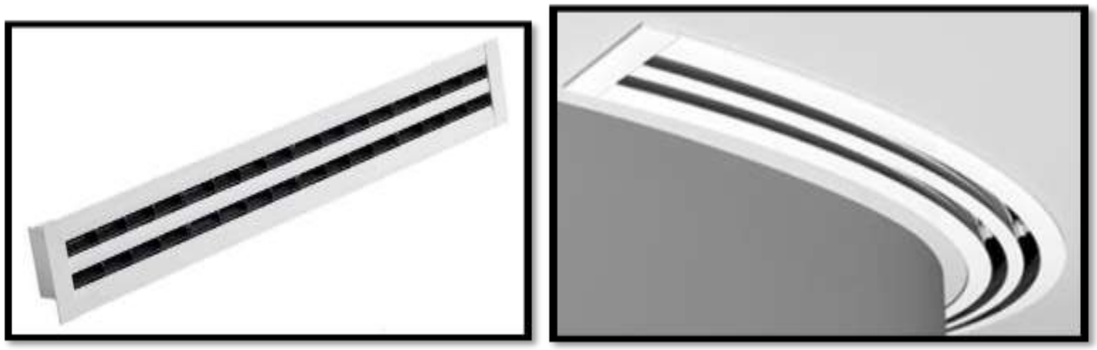


Figure 208 - Diffuser slots

Controller selection :

Used to distribute power intake for each indoor unit installed

Figure 209 - BC Collector

Technical specifications

MODEL (single)			CMB-P104V-J	CMB-P106V-J	CMB-P108V-J	CMBP1012V-J	CMBP1016V-J
Number of branch			4	6	8	12	16
Power source			1-phase 220-230-240 V				
Power input	kW 50Hz	Cooling	0.067/0.076/0.085	0.097/0.110/0.123	0.127/0.144/0.161	0.186/0.211/0.236	0.246/0.279/0.312
Power input	kW 50Hz	Heating	0.030/0.034/0.038	0.045/0.051/0.057	0.060/0.068/0.076	0.090/0.102/0.114	0.119/0.135/0.151
Indoor unit capacity connectable to 1 branch			Model P80 or smaller (Use optional joint pipe combing 2 branches when the total unit capacity exceeds P81.)				
Connectable outdoor/heat source unit capacity			P200 to P350	P200 to P350	P200 to P350	P200 to P350	P200 to P350
Height		mm	246	246	246	246	246
Width		mm	596	596	596	911	1,135
Depth		mm	495	495	495	639	639
Refrigerant piping diameter	To outdoor/heat source unit		Connectable unit capacity				
			P200		P250/P300	P350 *13	
	High press. pipe		15.88 (5/8) Brazed		19.05 (3/4) Brazed	19.05 (3/4) Brazed or 22.2 (7/8) Brazed	
	Low press. pipe		19.05 (3/4) Brazed		22.2 (7/8) Brazed	28.58 (1-1/8) Brazed	
	To indoor unit	Liquid pipe	Indoor unit Model 50 or smaller 6.35 (1/4) Brazed bigger than 50 9.52 (3/8) Brazed				
	To indoor unit	Gas pipe	Indoor unit Model 50 or smaller 12.7 (1/2) Brazed bigger than 50 15.88 (5/8) Brazed (19.05 (3/4), 22.2(7/8) with optional joint pipe used.)				
Drain pipe		mm (in.)	O.D. 32 (1-1/4)	O.D. 32 (1-1/4)	O.D. 32 (1-1/4)	O.D. 32 (1-1/4)	O.D. 32 (1-1/4)
Net weight		kg (lbs)	23 (51)	27 (60)	31 (69)	46 (102)	56 (124)

Figure 210 - Collector Technical specifications

4.2.1. HVAC Unit Distribution

Flow rate and cooling design for all spaces in GF:

Used to determine the number of indoor needed in each space

Table 33 - Flow rate and design capacity for each floor in GF

Floor	Zone	Design Flow Rate(m3/s)	Design cooling load (KW)
	Office	0.056	0.91
	Corridor	0.064	0.98
	Office	0.018	0.3
	Office	0.031	0.49
	Office	0.013	0.21
	Office	0.018	0.28

	Auto Cashier	0.014	0.22
GF	Waiting Room	0.073	2.22
	Office	0.013	0.21
	Office	0.019	0.31
	Office	0.023	0.37
	Office	0.045	0.63
	ATM Room	0.020	0.32
	Office	0.054	0.87
	Office	0.047	0.66
	Office	0.018	0.28
	Waiting Room	0.231	5.89
	Cashier	0.141	2.27
	Office	0.031	0.49
	Office	0.060	0.98
	Vault Room	0.231	3.70
	Safes Room	0.278	4.47

Flow rate and cooling design for all spaces in FF:

Table 34 - Flow rate and design capacity for each floor in 1st floor

Floor	Zone	Design Flow Rate(m3/s)	Design cooling load (KW)
	Office	0.026	0.4
	Corridor	0.115	1.78
	Office	0.019	0.3
	Security Room	1.12	0.071

FF	Office	0.019	0.3
	Server Room	0.84	0.061
	Meeting Room	0.207	2.82
	Waiting Room	0.340	5.6
	Kitchen	0.033	0.52
	Rest Room	0.037	0.58
	Loan Manager	0.081	1.27
	Conference Room	0.259	3.64
	Training Room	0.182	2.84

#of indoor units (Wall Mounted Unit) in Both Floors

Table below shows the number of AC indoor units needed for each space to be thermally comfortable (GF&FF)

Table 35 - #of wall mounted units for each space in GF

Floor	Zone	Design Flow Rate(m3/s)	Design cooling load (KW)	Model used (FDK22KXZE1) 2.2 KW	#of Units
	Office	0.056	0.91	0.41	1
	Office	0.018	0.3	0.13	1
	Office	0.031	0.49	0.22	1
	Office	0.013	0.21	0.1	1
	Office	0.018	0.28	0.15	1
	Auto Cashier	0.014	0.22	0.1	1

	Office	0.013	0.21	0.1	1
	Office	0.019	0.31	0.16	1
	Office	0.023	0.37	0.17	1
	Office	0.045	0.63	0.28	1
GF	ATM Room	0.020	0.32	0.16	1
	Office	0.054	0.87	0.4	1
	Office	0.047	0.66	0.29	1
	Office	0.018	0.28	0.15	1
	Cashier	0.141	2.27	1.03	2
	Office	0.031	0.49	0.22	1
	Office	0.060	0.98	0.45	1
	Vault Room	0.231	3.70	1.68	2
	Safes Room	0.278	4.47	2	2

Table 36 - #of wall mounted units for each space in FF

Floor	Zone	Design Flow Rate(m3/s)	Design cooling load (KW)	Model (FDK22KXZE1) 2.2 KW	#of Units
	Office	0.026	0.4	0.18	1
	Corridor	0.115	1.78	0.8	1
	Office	0.019	0.3	0.13	1
	Security Room	0.071	1.12	0.51	1
	Office	0.019	0.3	0.13	1
FF	Server Room	0.84	0.061	0.27	1
	Kitchen	0.033	0.52	0.23	1

	Rest Room	0.037	0.58	0.26	1
	Loan Manager	0.081	1.27	0.57	1
	Training Room	0.182	2.84	1.3	2

#of fan coil and duct sizing for both floors:

Figures below shows the number of fan coil needed in each area for ground floor

Table 37 - #of fan coil units for each space in GF

Floor	Zone	Design Flow Rate(m3/s)	Design cooling load (KW)	Model	#of Units
GF	Waiting area	0.073	2.22	FDUT22KXE6F-E (2.2 KW)	1
	Waiting area	0.231	5.89	FDUT71KXE6F-E (7.1 KW)	1
	cashier	0.141	2.27	FDUT28KXE6F-E (2.8 KW)	1

Table 38 - #of fan coil units for each space in ff

Floor	Zone	Design Flow Rate(m3/s)	Design cooling load (KW)	Model	#of Units

GF	Waiting area	0.34	5.6	FDUT56KXE6F-E (5.6 KW)	1
	Conference Room	0.259	3.64	FDUT71KXE6F-E (7.1 KW)	1
	Meeting Room	0.207	2.82	FDUT71KXE6F-E (7.1 KW)	1

4.2.2. Duct Sizing:

The graph below is used to acquire the suitable duct sizing using the design flow rate for each zone.

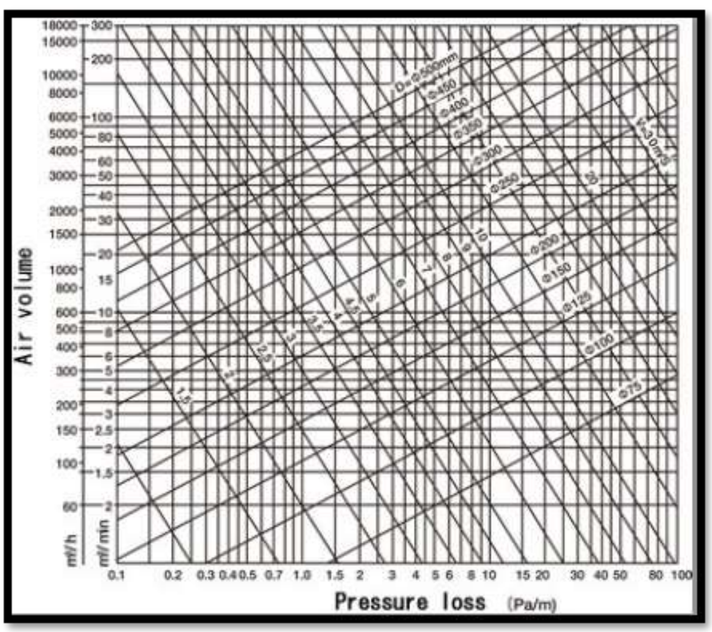


Figure 211 - Duct sizing graph

Figures below shows the duct sizing for Main and branch ducts for each Room (GF, FF)

Table 39 - Duct sizes (GF)

Floor	Duct	Room type	Flow rate (M^3/S)	Velocity	Duct size
GF	Main Duct	Waiting room	0.073	5	200 mm
		Waiting room	0.231		250 mm
		Cashier	0.141		200 mm
	Branch Duct	Waiting room	0.073	3.5	125 mm
		Waiting room	0.231		200 mm
		Cashier	0.141		150 mm

Table 40 - Duct sizes (FF)

Floor	Duct	Room type	Flow rate (M^3/S)	Velocity	Duct size
FF	Main Duct	Waiting room	0.340	5	300 mm
		Meeting Room	0.207		250 mm
		Conference Room	0.259		250 mm
	Branch Duct	Waiting room	0.340	3.5	250 mm
		Meeting Room	0.207		200 mm
		Conference Room	0.259		200 mm

4.2.3. Plan Drawings:

GF HVAC plan:

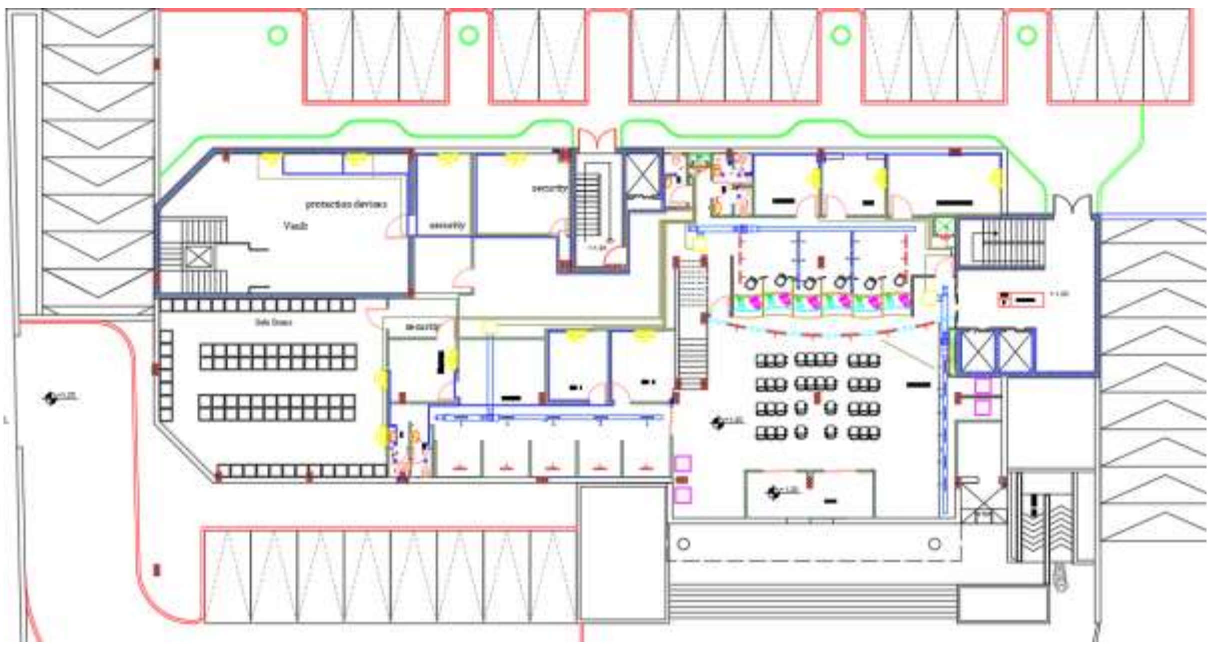


Figure 212 - HVAC

4.3. Power design

Electricity distribution system made up of a main distribution board, sub distribution boards on each floor, luminaries, outlets, switches, and copper wires that connect the distribution boards to all the other electrical elements.

Figure below shows the basic electrical symbols that will be used.

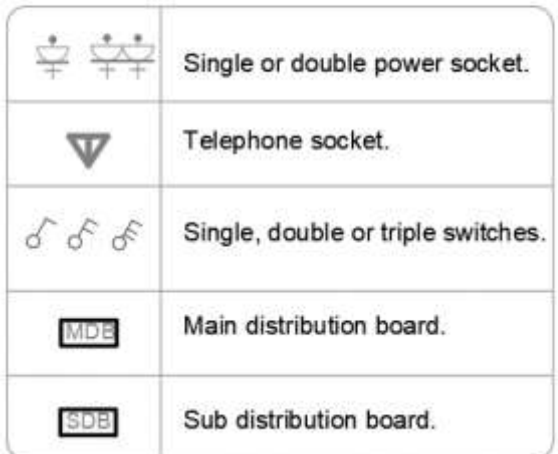


Figure 213 - Electrical symbols used.

I phase system will be used for the most electronic equipment and lighting.

At the ground floor there is 34 sockets, 6 telephone sockets, 76 luminaries.

Three distribution boards are needed in each floor, where the elevators and the fan coils need high power to run.

- Power sockets demand factor = 0.2
- Lighting loads demand factor = 0.8
- The factor of safety for the conductors and circuit breakers is 1.2
- Power factor 0.9

The cross-sectional area of conductor(wire) will be chosen according to

Table 41: Wires cross sectional area due to current.

Nominal cross-sectional area (mm^2)	Single phase current (Amp.)	Three phase current (Amp.)
1	11	9
1.5	13	11
2.5	18	16
4	24	22
6	31	28
10	42	39
16	56	50
25	73	66
36	90	80
50	131	117

4.3.1. Lighting calculations

P= I(current) * Voltage* Power Factor

Power factor: From luminaire specifications

I_{Load} = P / (VXPF) = 61x 4/ (220x0.9) ----->I_{Load} = 1.23 A

According to Table 41 the required conductors cross sectional area is 1 $mm^{2.}$

- Voltage drop Check (V_{Drop}):

V_{Drop} < 5% *voltage=5%x220= 11 Volt

V_{Drop} = I x R = I x (δ x L x2/A)

δ: Resistivity of copper = $1.6x10^{-8}$

L: Conductor length

A: wire Cross Sectional Area

V_{Drop} = 1.23x ($1.6x10^{-8}$x 23 x2/$1x10^{-6}$) = 0.90 V < 11 Volt ---->ok

4.3.2. Power load calculation

P= I X VX PF

I_{Load} = P / (VXPF)

= 400 x 7/ (220x0.9) ----> I_{Load} = 14.14A

According to Table 41 ,the required conductors cross sectional area is 2.5 mm^2.

Voltage drop Check (V_{Drop}):

V_{Drop} = 14.14x (1.6x10^{-8}x 32 x2/2.5x10^{-6}) = 5.79 V < 11 V volt---->ok

Power load

Table 42: Power loads calculation results in each floor

Power factor	0.9		
Voltage	220		
Floor	Total power	I load	Cross section(mm2)
B2	-	-	2.5
B1	-	-	2.5
GF	5353.92	23.51	4
1st	4867.20	21.38	4
2nd	4232.35	18.59	4
3rd	4030.81	17.70	2.5
4th	4030.81	17.70	2.5
5th	4030.81	17.70	2.5
6th	4030.81	17.70	2.5
7th	4030.81	17.70	2.5

P= I X VX PF

I_{Load} = P / (VXPF) = 800 / (220x0.9)

I_{Load} = 4.04 →cross-sectional area is 2.5 mm^2.

- **Voltage drop Check** (V_{Drop}):

V_{Drop} = I x R= 4.04x (1.6x10^{-8}x 32 x2/2.5x10^{-6}) = 1.65 V < 11 V ---->ok

Summary of the electrical loads

Table 43:Electrical loads summary

Floor	Sub-distribution board name	Lighting loads (Amp)	Power loads (Amp)	Total Current (Amp)
B2	SDB1	2.88	-	2.88
B1	SDB2	16.39	-	43.24
GF	SDB3	10.32	22.72	33.04
First	SDB4	16.24	21.69	37.93
Second	SDB5	12.12	11.36	23.48
Third	SDB6	13.12		
4th	SDB7	7.88		
5th	SDB8	7.88		
6th	SDB9	7.88		
7th	SDB10	7.88		
Total		57.94	82.63	140.57

circuit breaker cross sectional area:

Table 44: circuit breaker cross sectional area.

Category	Cross sectional area
Circuit breaker for lighting	1mm2
Circuit breaker for Power	2.5mm2

Total power = 27261.50 watt

One phase of 220 volts will be used in SDB-1.

Total current in SBD-1 = Total power/ (√3 x V x D.F)

= 27261.50/ (√3 x 220 x0.9)

= 79.5 Amp.

I_{CB} (Circuit Breaker Current) = 1.15 x I = 91.4 Amp.

I_{CBC} (Circuit Breaker Cable Current) = 1.15 x I C.B = 105.12 Amp.

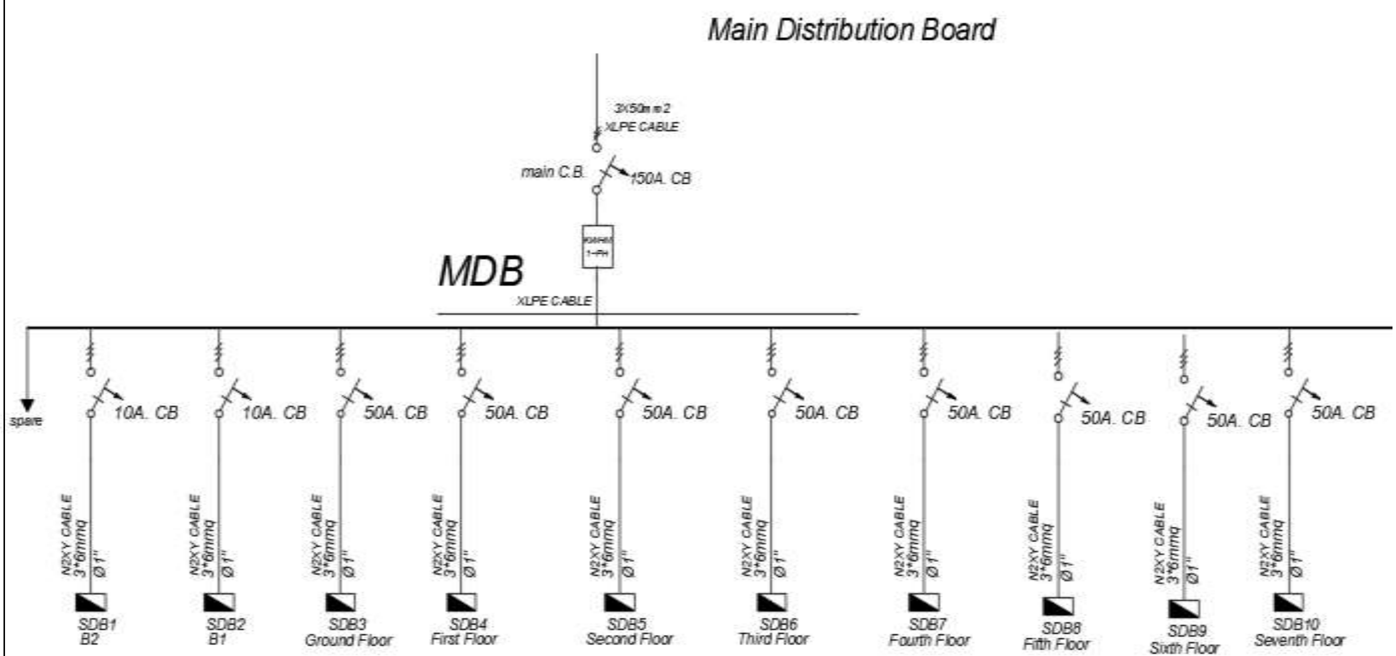
Main cable size = 50mm2

Distribution board:

The distribution boards in the building include: main distribution board located in the ground floor, sub-distribution board 1 located in the b2 floor, sub-distribution board 2 located in the b2 floor, sub-distribution board 3 located in the ground floor, sub-distribution board 4 located in the first floor, sub-distribution board 5 located in the second floor, sub-distribution board 6 located in the third floor, sub-distribution board 7 located in the fourth floor, sub-distribution board 8 located in the fifth floor, sub-distribution board 9 located in the sixth floor and sub-distribution board 10 located in the seventh floor.

4.3.3. Main distribution board:

Figure 214: Main Distribution board



Sub-distribution board 1

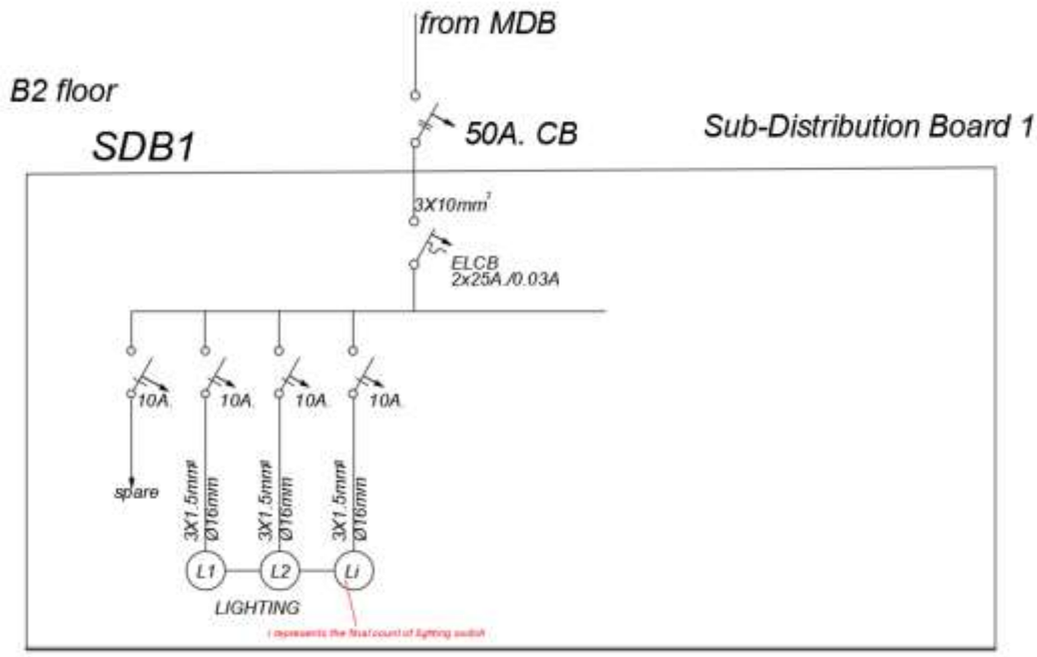


Figure 215: Sub-distribution board 1

Sub-distribution board 2

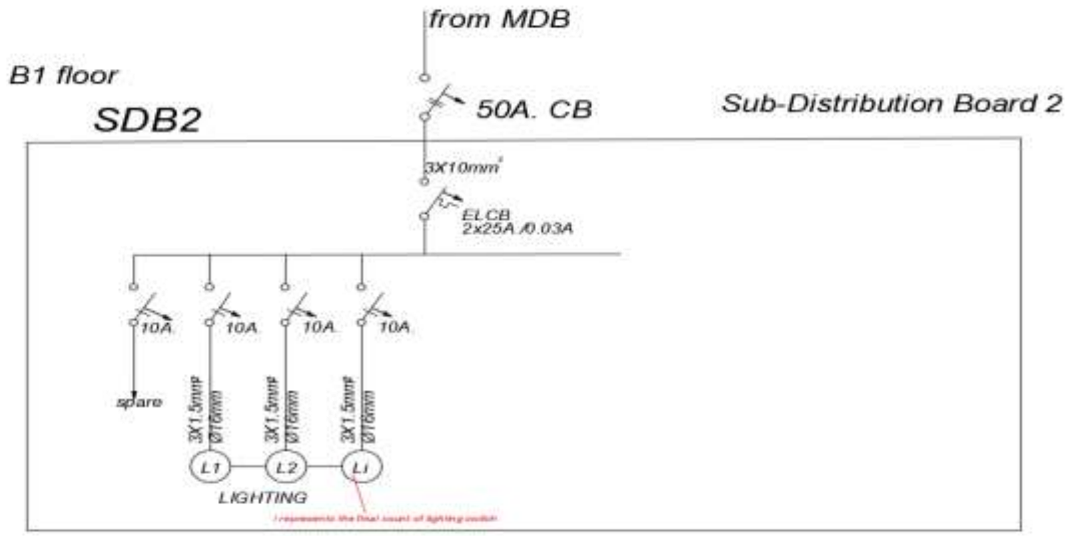


Figure 216: Sub-distribution board 2

Sub-distribution board 3

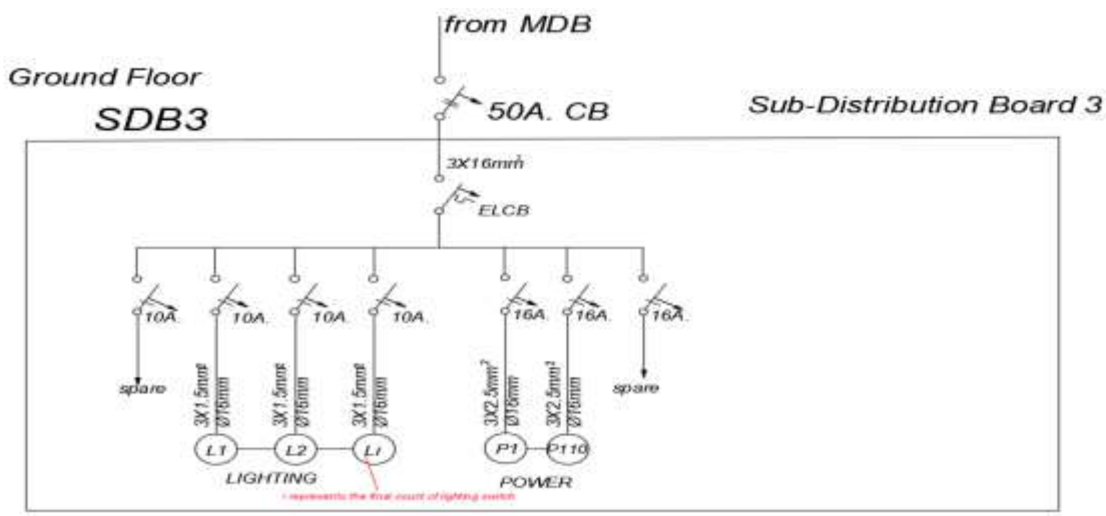


Figure 217: Sub-distribution board 3

Sub-distribution board 4

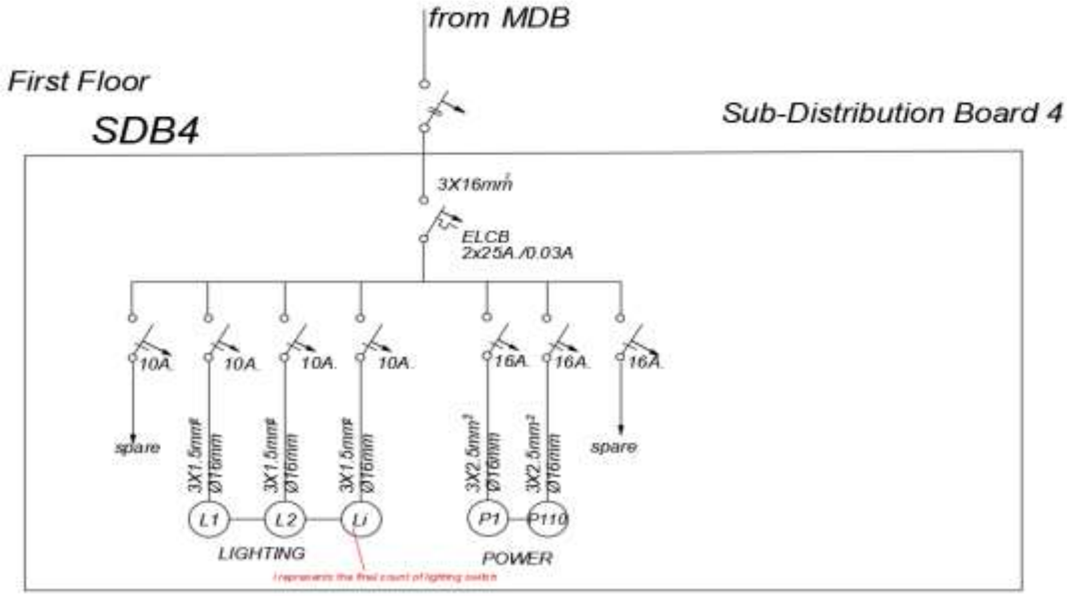


Figure 218: Sub-distribution board 4

Sub-distribution board 5

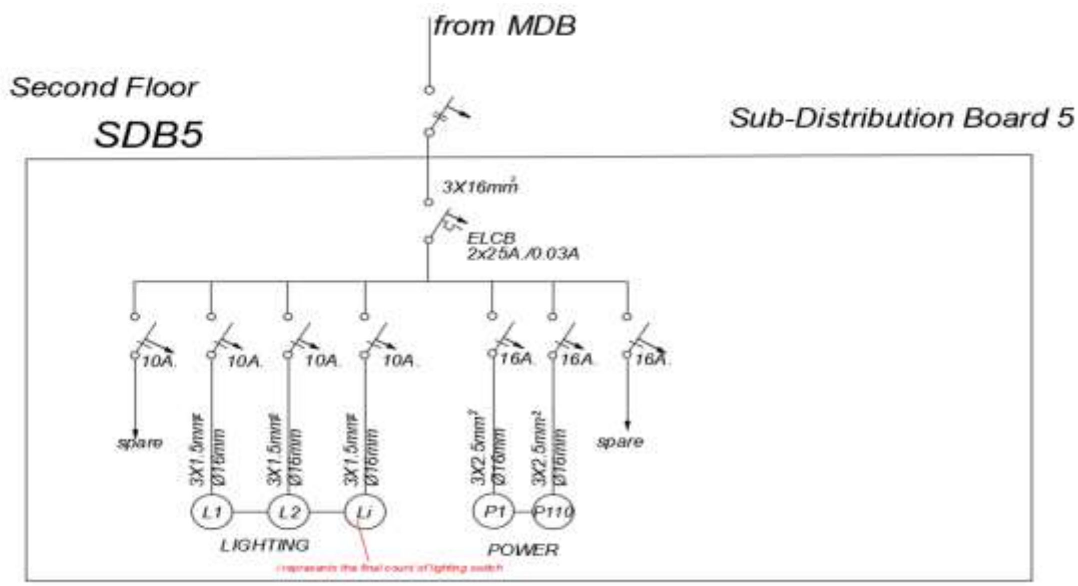


Figure 219: Sub-distribution board 5

Sub-distribution board 6

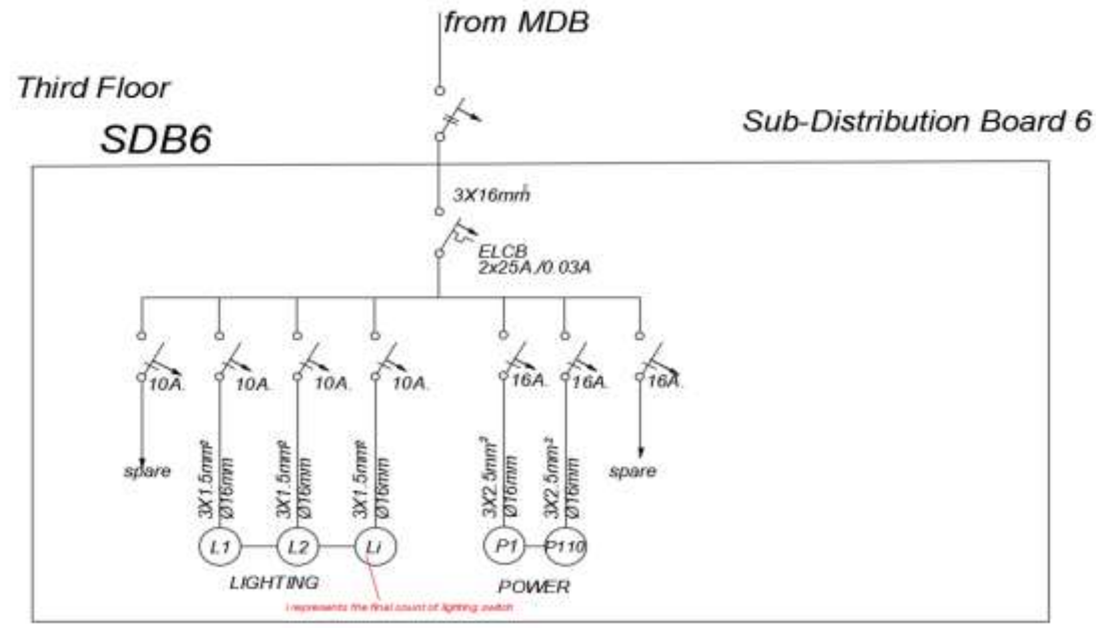


Figure 220: Sub-distribution board 6

Sub-distribution board 7

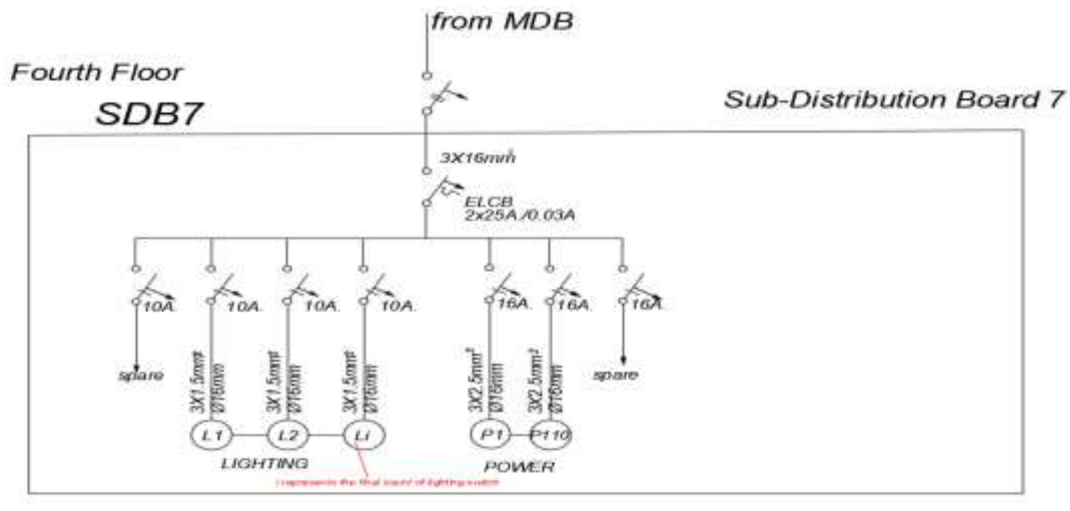


Figure 221: Sub-distribution board 7

Sub-distribution board 8

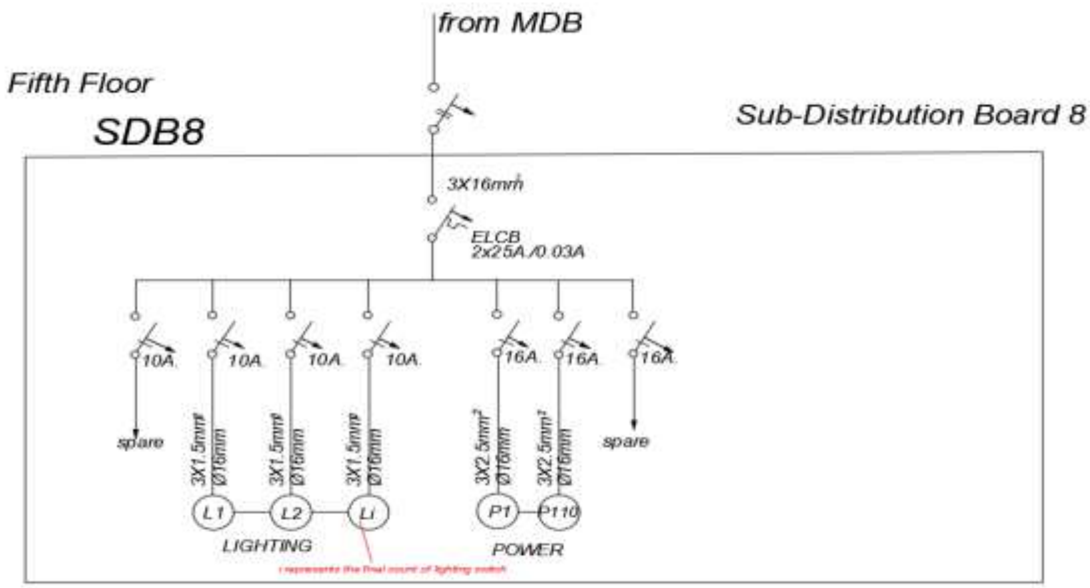


Figure 222: Sub-distribution board 8

Sub-distribution board 9

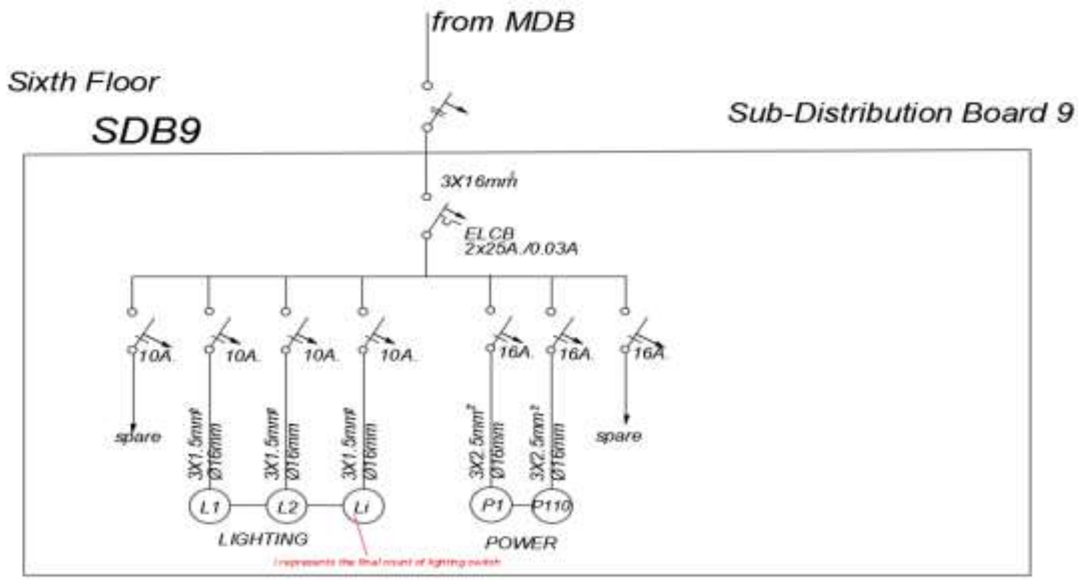


Figure 223: Sub-distribution board 9

Sub-distribution board 10

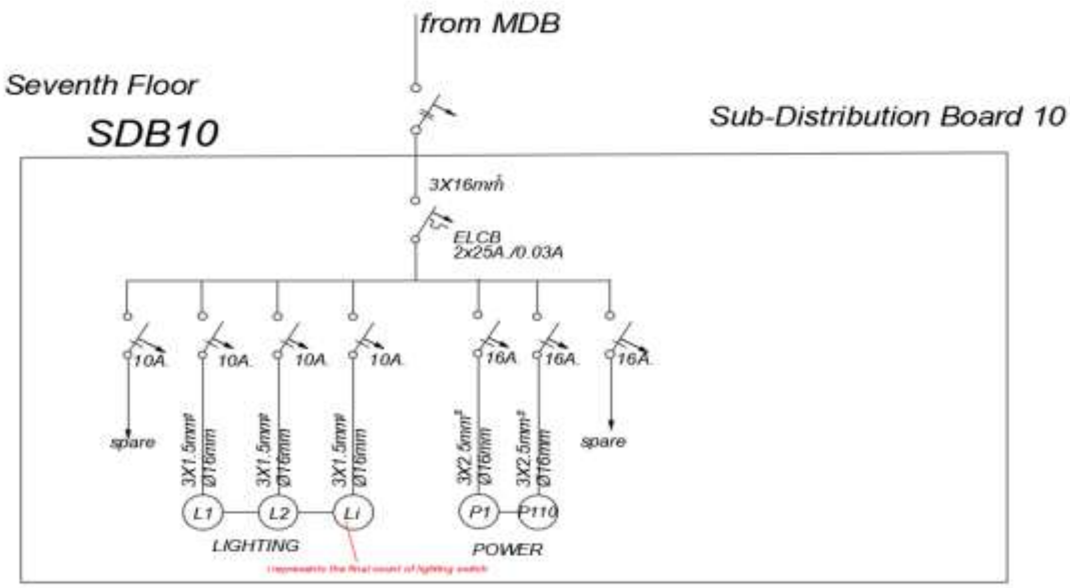


Figure 224: Sub-distribution board 9

4.4. Acoustic Design

Acoustical design is essential for optimum integral design. Acoustical design is divided into many categories ex. RT60, STC, and SPL calculation, which need to meet certain standard to be suitable for each function.

Rooms used to design:

- Meeting Room
- Waiting Area
- Office

4.4.1. Reverberation Time (RT60)

RT is an important factor to consider while designing by using Ecotycy program

Table 45 - RT for material

Body	Finish	Frequency (Hz)								
		65	125	250	500	1000	2000	4000	8000	16000
Wall	Plaster	0.12	0.09	0.07	0.01	0.01	0.01	0.02	0.01	0.02
Window	Wind glass	0.12	0.10	0.06	0.04	0.03	0.03	0.03	0.04	0.04
Door	Hollow Core Plywood	0.44	0.41	0.35	0.25	0.20	0.15	0.14	0.13	0.12
Floor	Tiles	0.02	0.02	0.02	0.02	0.03	0.04	0.07	0.07	0.09
Ceiling	gypsum	0.28	0.28	0.20	0.10	0.08	0.08	0.12	0.13	0.15
Coverage	Moquette	0.1	0.2	0.5	0.6	0.8	0.8	0.8	0.8	0.8

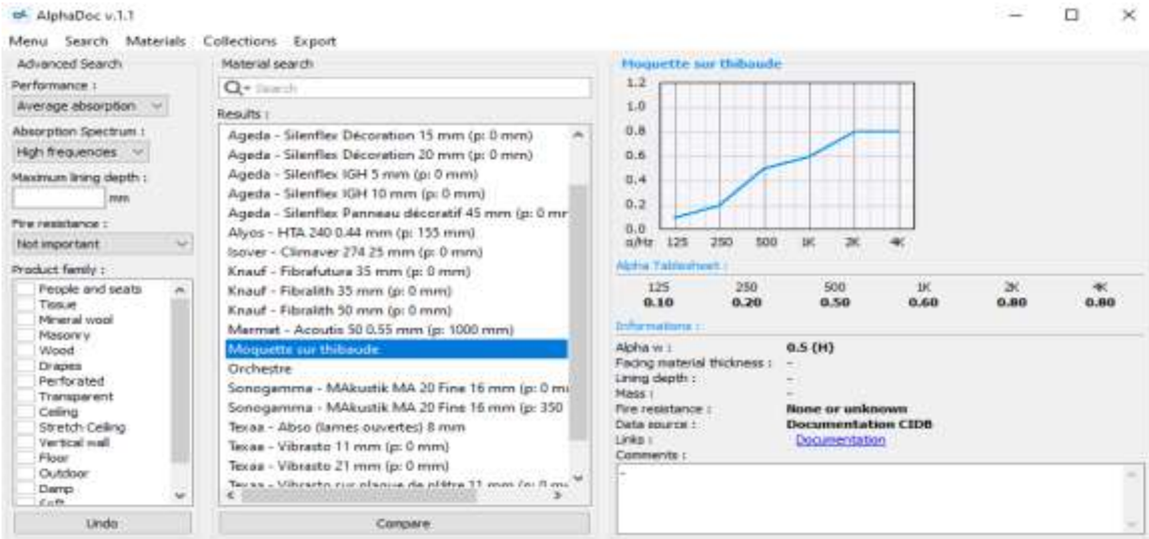


Figure 225 - Moquette

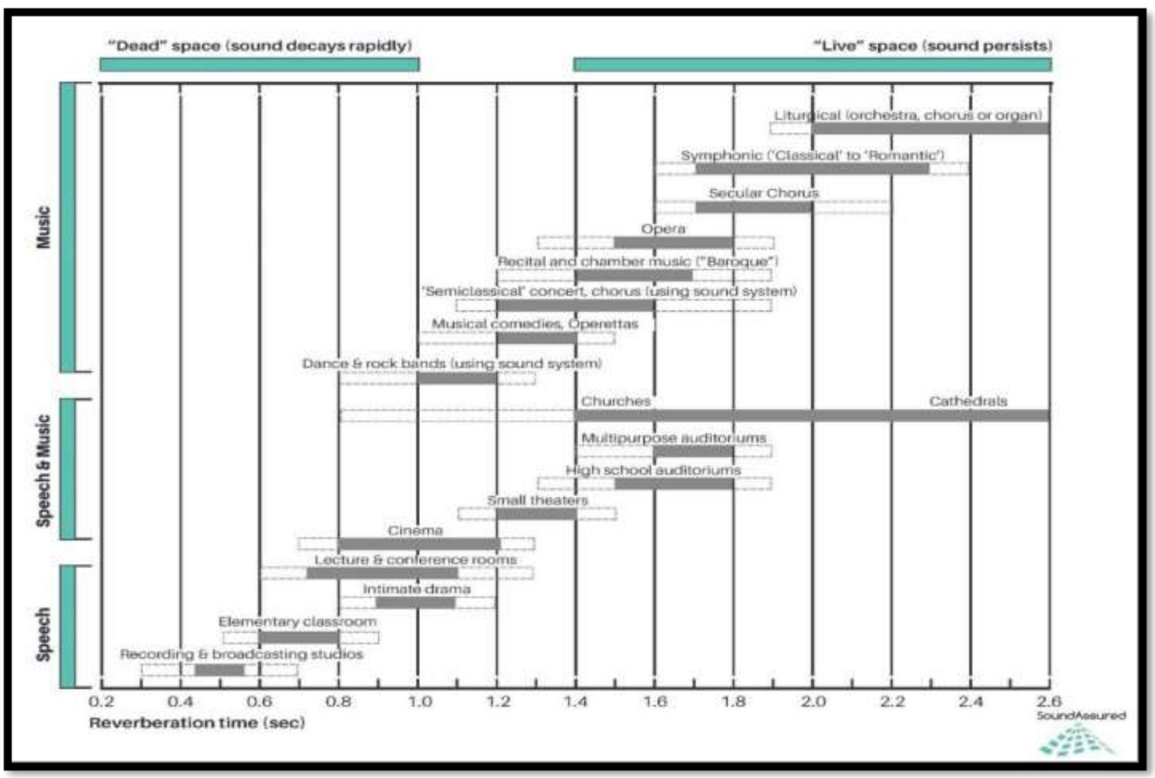


Figure 226 - Standard for RT

1- Meeting Room:

Table below shows RT for meeting room

Table 46 - RT for Meeting Room

Frequency (Hz).	RT60		
	0%occupied	50%occupied	100%occupied
63	0.76	0.72	0.70
125	0.76	0.72	0.69
250	0.75	0.71	0.68
500	0.73	0.70	0.70
1000	0.83	0.80	0.76
2000	0.81	0.78	0.74
4000	0.78	0.75	0.71
8000	0.75	0.73	0.70
16000	0.84	0.81	0.75

Standard range for Meeting Room is between (0.7-1.2), as shown in the table above all reading are ok

2- Waiting Area

the reverberation time was calculated as below:

Table 47 - RT data Waiting area

Frequency (Hz).	RT60		
	0%occupied	50%occupied	100%occupied
63	0.63	0.63	0.63
125	0.63	0.63	0.63
250	0.72	0.71	0.71
500	0.88	0.85	0.85
1000	0.83	0.83	0.83
2000	0.72	0.72	0.72
4000	0.55	0.52	0.52
8000	0.57	0.55	0.55
16000	0.61	0.60	0.60

Standard range for office is between (0.7-1.2), as shown in the table above all reading are ok

3- Office

Table below shows RT60 for office:

Table 48 - RT for office

Frequency (Hz).	RT60		
	0%occupied	50%occupied	100%occupied
63	0.63	0.61	0.62
125	0.64	0.63	0.63
250	0.66	0.62	0.64
500	0.66	0.630	0.64
1000	0.61	0.6	0.62
2000	0.81	0.78	0.74
4000	0.78	0.75	0.71
8000	0.75	0.73	0.70
16000	0.61	0.60	0.60

Standard range for office is between (0.5-1) , as shown in the table above all reading are ok

4.4.2. STC insulation (INSUL)

Sound transmission class is calculated to prevent any noise in any room (W. Grondzik, A. Kwok, B. Stein, 2017), standard for room function is shown in the table below

Table 49 - STC standard

	Wall, Partition, or Panel Between		Sound Isolation Requirement: Background Level in Room Being Considered	
Type of Occupancy	Room Being Considered and	Adjacent Area	Quiet	Normal
Normal school buildings without extraordinary or unusual activities or requirements	Classrooms	Adjacent classrooms	STC 42	STC 40
		Corridor or public areas	STC 40	STC 38
		Kitchen and dining areas	STC 50	STC 47
		Shops	STC 50	STC 47
		Recreation areas	STC 45	STC 42
		Music rooms	STC 55	STC 50
		Mechanical equipment rooms	STC 50	STC 45
		Toilet areas	STC 45	STC 42
	Music practice rooms	Adjacent practice rooms	STC 55	STC 50
		Corridor and public areas	STC 45	STC 42
Executive areas, doctors' suites; confidential privacy requirements	Office	Adjacent offices	STC 50	STC 45
		General office areas	STC 48	STC 45
		Corridor or lobby	STC 45	STC 42
		Washrooms and toilet areas	STC 50	STC 47
Normal office; normal privacy requirements; any occupancy using rooms for group meetings	Office	Adjacent offices	STC 40	STC 38
		Corridor, lobby, exterior	STC 40	STC 38
		Washrooms, kitchen, dining	STC 42	STC 40
	Conference rooms	Other conference rooms	STC 45	STC 42
		Adjacent offices	STC 45	STC 42
		Corridor or lobby	STC 42	STC 40
		Exterior of building	STC 40	STC 38
		Kitchen and dining areas	STC 45	STC 42
Large offices, drafting areas, banking floors, etc.	Large general office areas	Corridors, lobby, exterior	STC 38	STC 35
		Data-processing area	STC 40	STC 38
		Kitchen and dining areas	STC 40	STC 38
Motels and urban hotels, Hospitals and dormitories	Bedrooms	Adjacent bedrooms[a]	STC 52	STC 50
		Bathroom[a]	STC 50	STC 45
		Living rooms[a]	STC 45	STC 42
		Dining areas	STC 45	STC 42
		Corridor, lobby, or public spaces	STC 45	STC 42

Internal partition:

Using the insul program the STC =45 STC which lies between the standard stated in the table above 42 dB

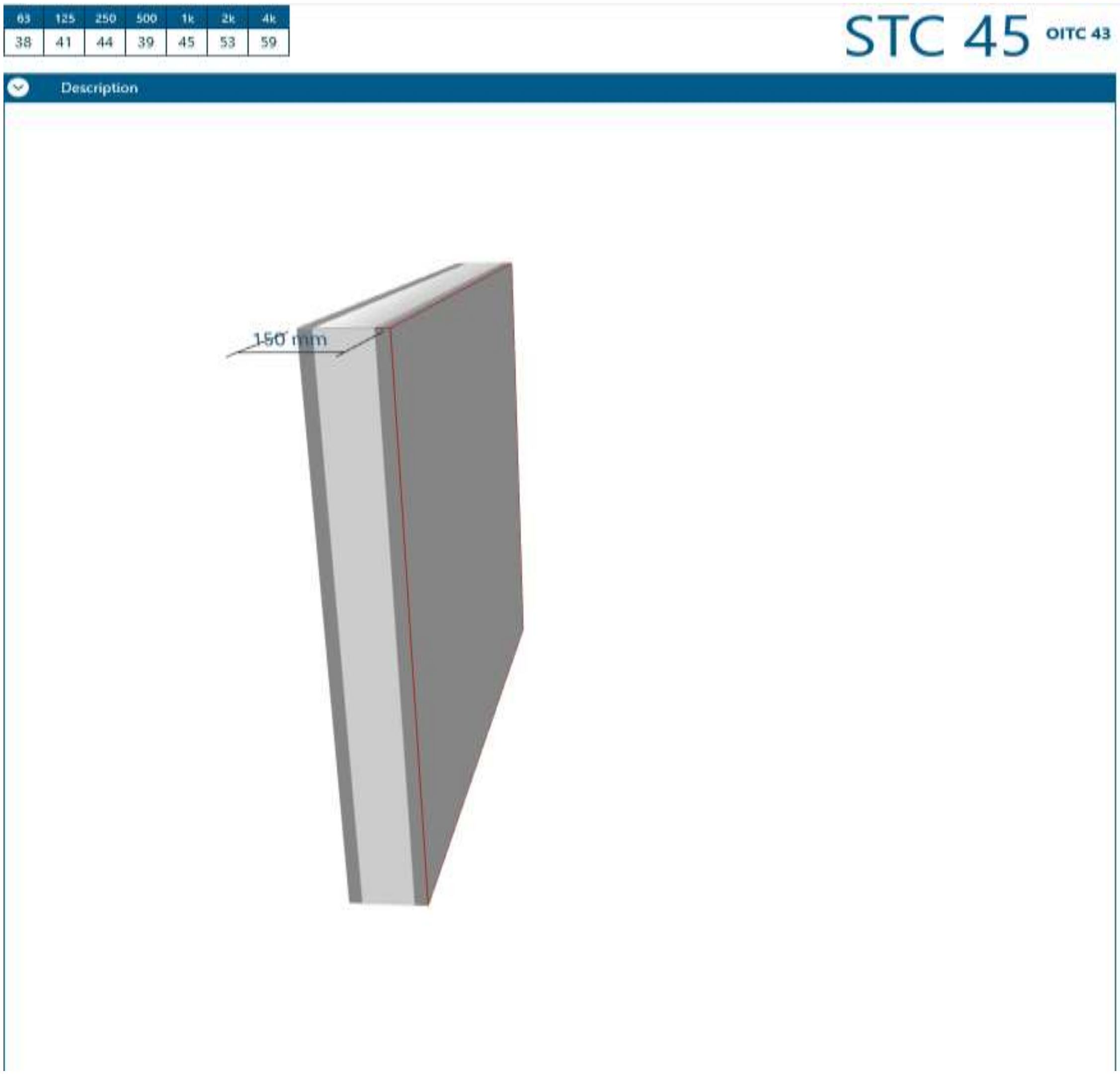


Figure 227 - Internal Partition

1. For glass in windows the STC was calculated = 51 . which is above the required STC for glass in the table of standard

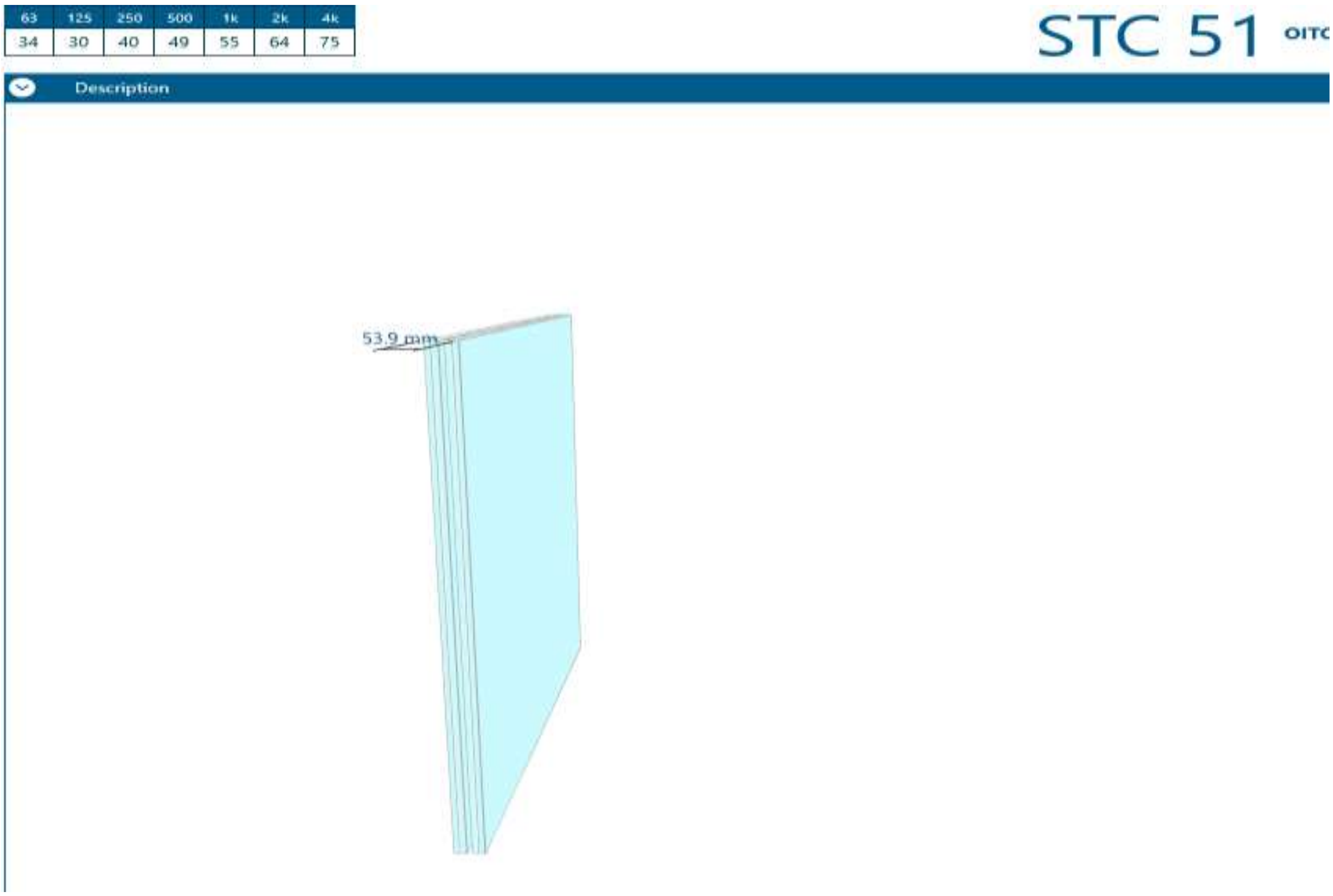


Figure 228 - Glass STC

- External Wall

1. External walls were calculated in the insul program = 92 STC. which is more than listed in the table of standard

63	125	250	500	1k	2k	4k
53	69	80	98	110	111	120

STC 92 OITC 77

Description

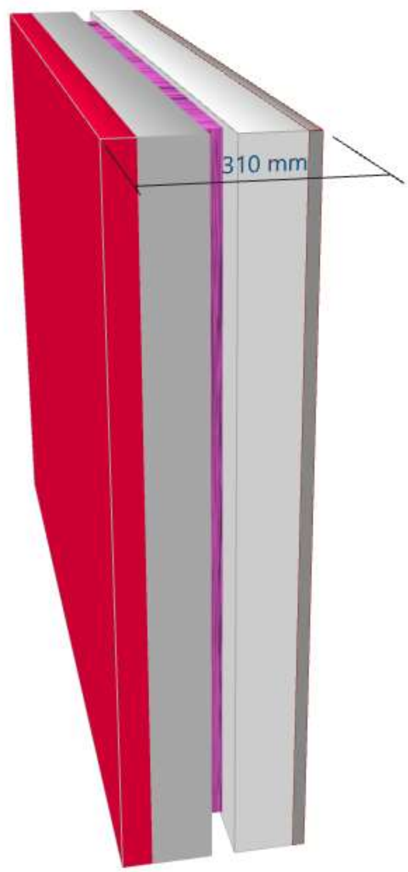


Figure 229 - External wall STC

Classification	IIC	FIIC
Minimum Code	50	45
Minimum Quality	55	50
Medium Quality	65	60
High Quality	75	70

Figure 230 - IIC Standard

Roof Calculation (IIC , Rain)

Roof layers are calculated in insul with two different categories

Impact insulation Coefficient (IIC) = 76 dB

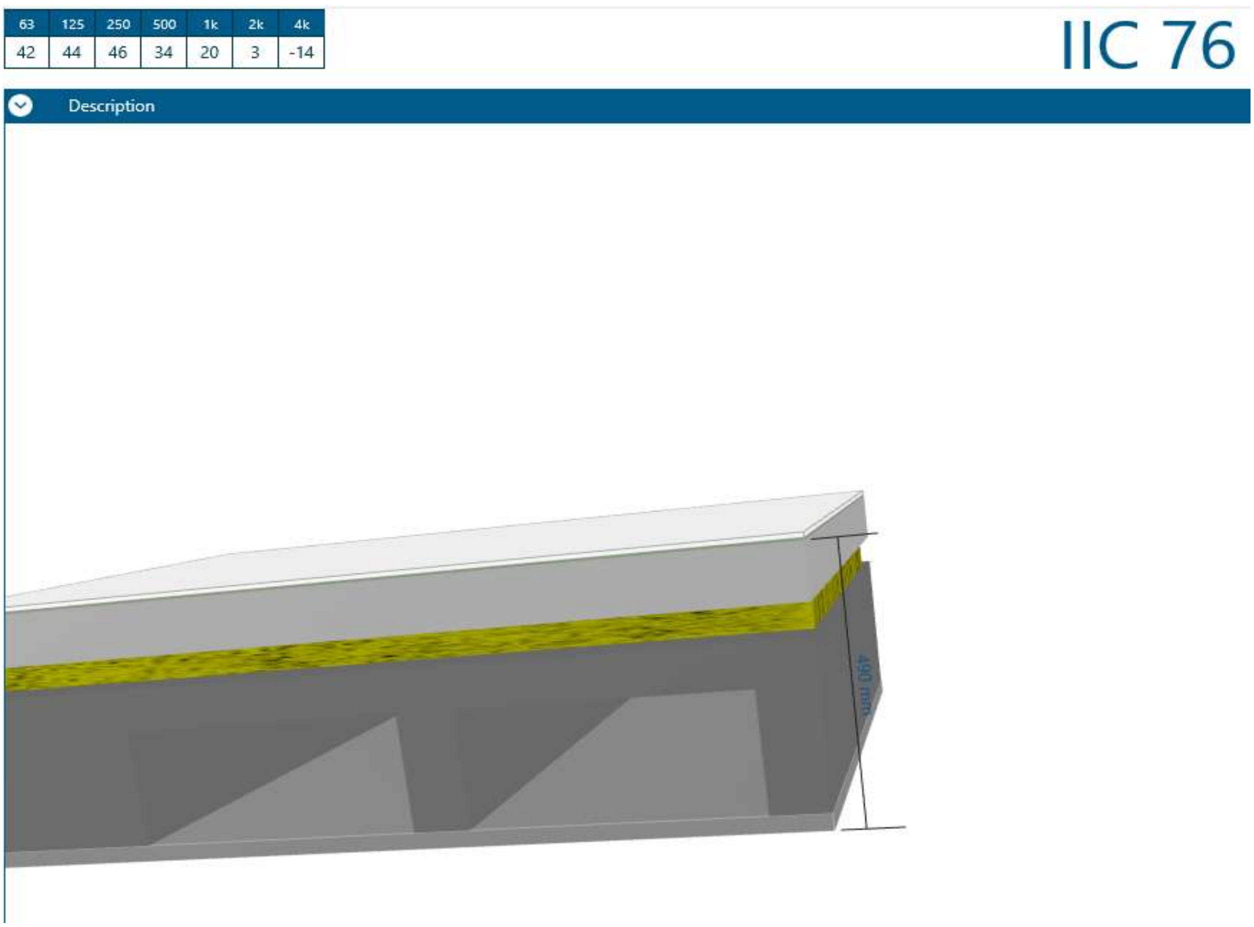


Figure 231 - IIC for Roof

- Rain LIA db = 3

Rain LIA is an indicator that gives rain sound insulation

63	125	250	500	1k	2k	4k
14	7	8	2	-8	-36	-56

LiA 3 dB

Description

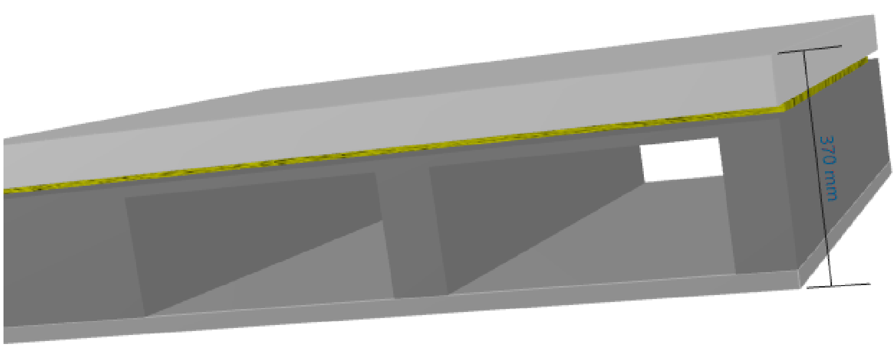


Figure 232 - Rian insulation

4.4.2.: Electro-Acoustical

The spaces needed to have electric sounding system are:

1. Conference room.
2. Waiting area.

Speaker used:

The type used in the rooms are:

Figure 233 - T-A67 Speaker

4.4.3. SOUND Power Level (Ease program)

Standard for background Noise for each room is listed in the table below

Table 50- Background Noise standard

Type of Space (and Listening Requirements)	Preferred Range of Noise Criteria	Equivalent dBA Level*
Concert halls, opera houses, broadcasting and recording studios, large auditoriums, large churches, recital halls (for excellent listening conditions)	< NC-20	< 30
Small auditoriums, theaters, music practice rooms, large meeting rooms, teleconference rooms, audiovisual facilities, large conference rooms, executive offices, small churches, courtrooms, chapels (for very good listening conditions)	NC-20 to NC-30	30 to 38
Bedrooms, sleeping quarters, hospitals, residences, apartments, hotels, motels (for sleeping, resting, relaxing)	NC-25 to NC-35	34 to 42
Private or semiprivate offices, small conference rooms, classrooms, libraries (for good listening conditions)	NC-30 to NC-35	38 to 42
Large offices, reception areas, retail shops and stores, cafeterias, restaurants, gymnasiums (for moderately good listening conditions)	NC-35 to NC-40	42 to 47
Lobbies, laboratory work spaces, drafting and engineering rooms, general secretarial areas, maintenance shops such as for electrical equipment (for fair listening conditions)	NC-40 to NC-45	47 to 52
Kitchens, laundries, school and industrial shops, computer equipment rooms (for moderately fair listening conditions)	NC-45 to NC-55	52 to 61

*Do *not* use A-weighted sound levels (dBA) for specification purposes. Spectrum shapes and noise characteristics can vary widely for background noises with identical A-weighted sound levels (see Chap. 1).

1. Waiting area

Figure below shows SPL Direct of the waiting area

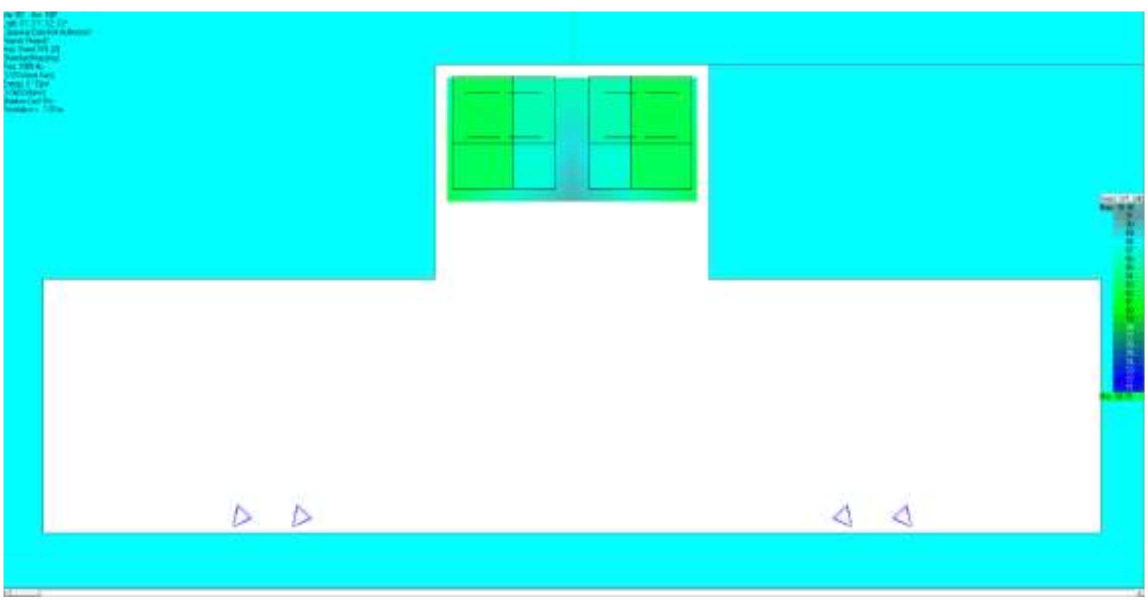


Figure 234 - Waiting Area SPL

Table below shows SPL readings for each frequency

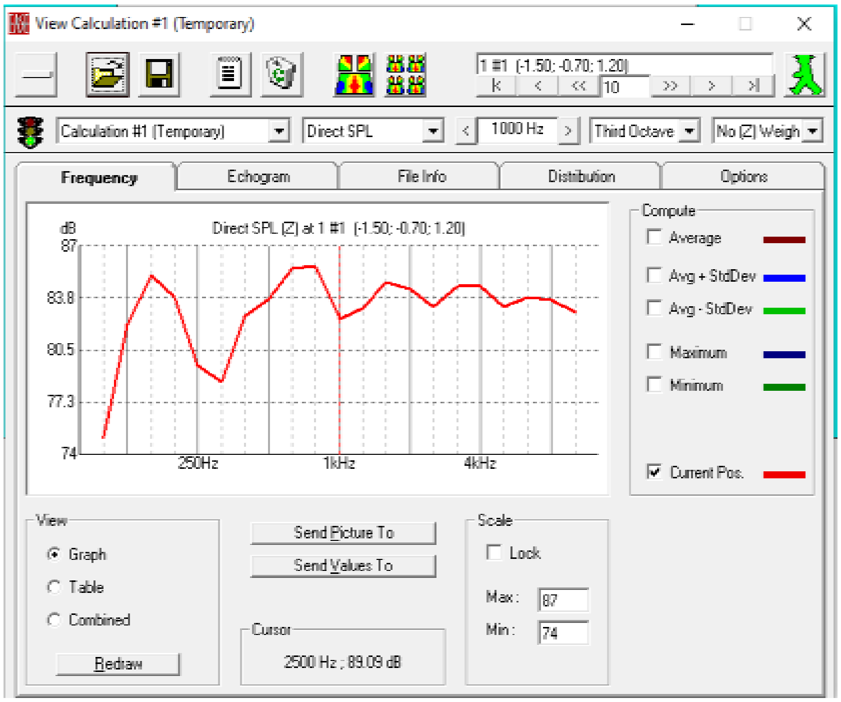


Figure 235 - SPL Graph (Waiting Room)

The SPL average for waiting room = 87 – 30 (Background noise) = 57 dB , which more than the required in the standard

2- Meeting Room

The table below shows the graph with Direct SPL for every frequency

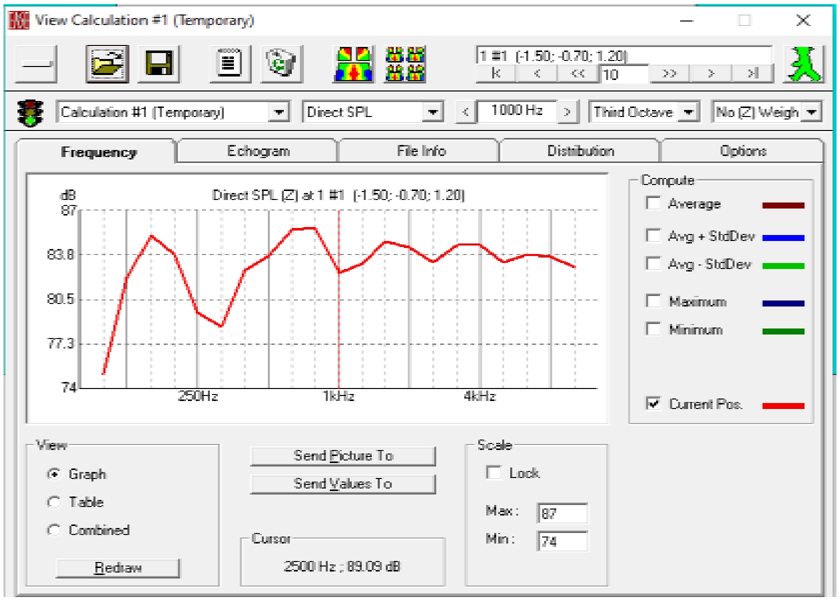


Figure 236 - SPL Graph (Meeting Room)

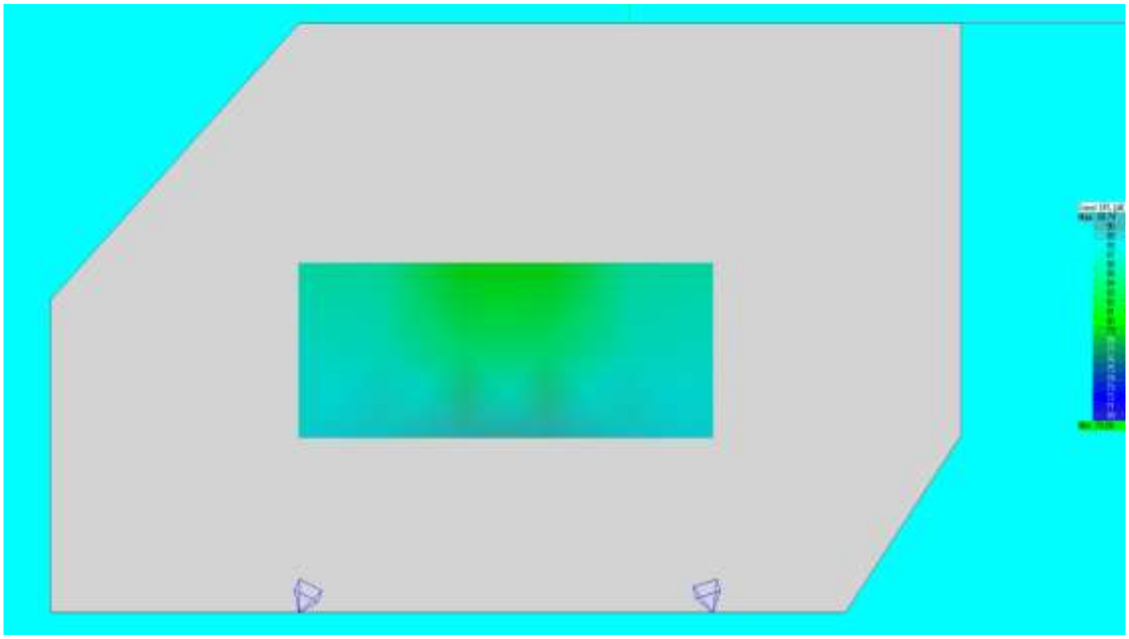


Figure 237 - Meeting Room Direct SPL

The graph below shows the total SPL meeting room after speaker addition which averages 100 dB

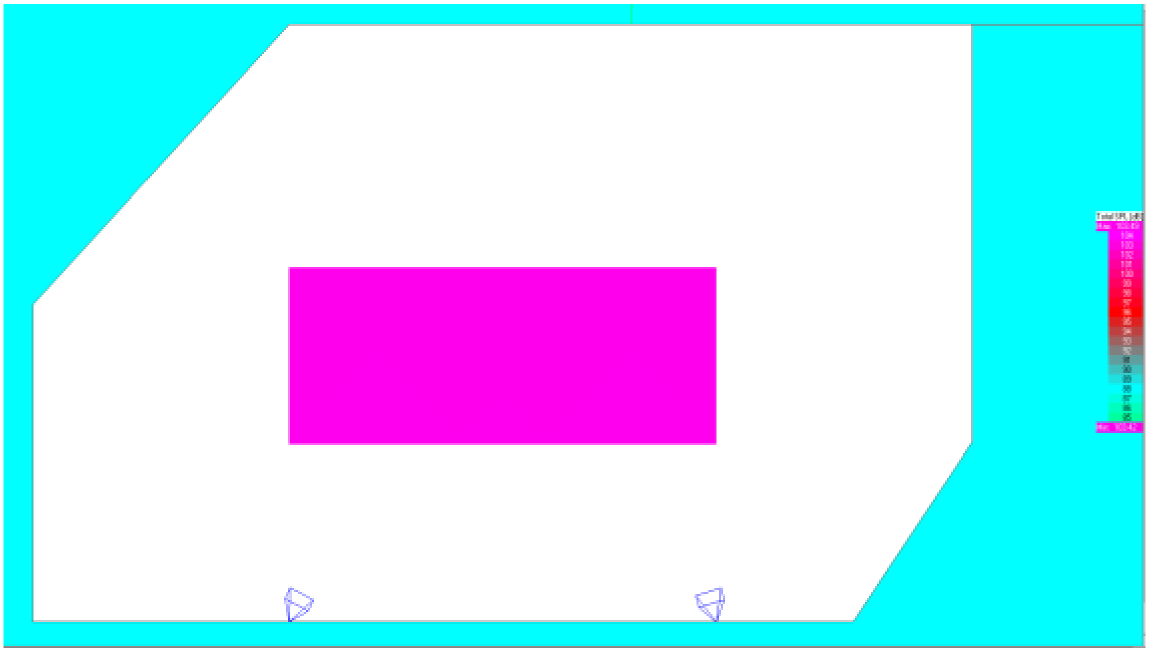
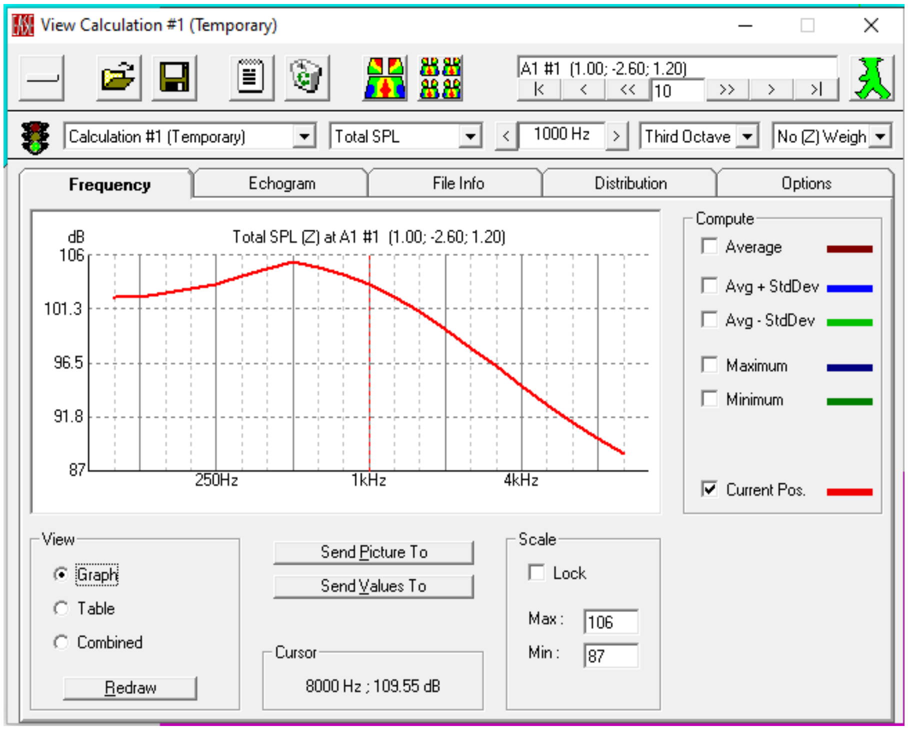


Figure 238 - Meeting Room total SPL



Figure

239 - SPL Graph (Meeting Room) total

4.5. Fire Alarm and Fire Fighting System

During this design phase, safety comes first to protect the building and the people who use it from various hazards. These dangers are shown in the figure



Fire Hazard Mechanical Hazard Electrical Hazard many systems have been used to prevent fire hazards

1) Detection and notification system.
2) Emergency sings lights.
3) Suppression System.

4.5.1. Detection and notification system.

This system is important to reduce the likelihood of a fire starting or reducing the risk of a fire spreading through early warning.

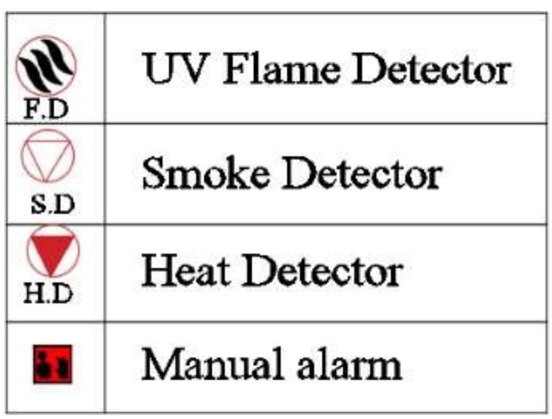


Figure 240 - Fire System Legend

- **The detection and notification system:**

- **Automatic Fire Alarm**

Automatic means that no manual control is required. They work automatically when a fire is likely and according to the function of the room, there are many kinds

Ultraviolet flame detector:

It is used in high hazard areas to provide the fastest response as this type provides the fastest response when detecting flames.

Figure 241 - Flame Detector Model

Heat detector:

is utilized in the kitchen and parking lot because these areas are better suited for vapor and smoke.

Figure 242 - Heat Detector Model

Smoke detector:

is utilized in rooms with combustible materials, and it should be placed away from sources of high airflow, such as HVAC diffuser.

Figure 243 - Smoke Alarm Model

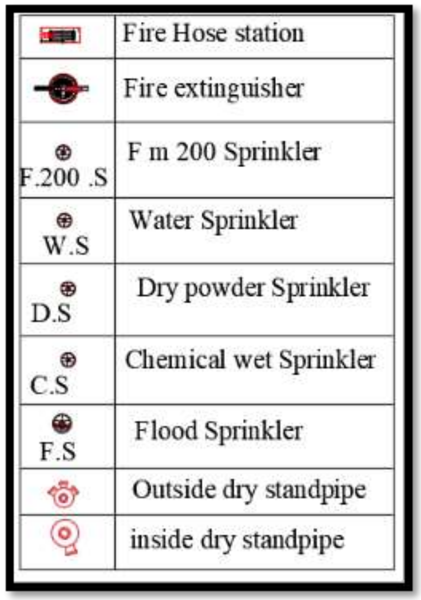
4.5.2. Manual fire alarm

The manual fire alarm will be used by the tenants when anyone notices that the fire will arise and it cannot be put out by an extinguisher. As a result, it must be accessible to the occupants before the fire spreads.

Figure 244 - Manual Fire Alarm

4.5.3. Suppression System

fire plans' use of suppression system symbols



	Fire Hose station
	Fire extinguisher
F.200 .S	F m 200 Sprinkler
W.S	Water Sprinkler
D.S	Dry powder Sprinkler
C.S	Chemical wet Sprinkler
F.S	Flood Sprinkler
	Outside dry standpipe
	inside dry standpipe

Figure 245 - Fire Suppression Symbols

The main types of suppression system

Sprinklers

is a mechanical device that activates when a fire occurs and cannot be controlled by the occupants. It has an ON-OFF head, which allows the sprinkler to shut off when the fire is out and open up again when the fire returns. As a result, the building will feature a wet pipe system, which uses water under pressure to enable rapid response suppression. Table 104.The list of sprinkler types used in banks is provided below.

Table 51 - Sprinkler Type for each space

Space	Sprinkler Type
Halls	Water Sprinkler
Chemical and Electrical Rooms	Wet Chemical Sprinkler
Offices	Dry Sprinkler
Kitchen	Wet chemical Sprinkler
Safe Boxes	Dry Sprinkler

1) Extinguishers

Simple and non-wide fires are suited for this kind of suppression equipment. suitable for small, contained fires to prevent significant damage that might result from using the incorrect type of extinguisher or failing to control the fire from the start. There are some unique features, as shown below.

- It was created for a particular circumstance.
- A rather small operating distance of between 1.2 and 1.83 meters.
- A restricted discharge period of between 24 and 90 seconds.
- A small quantity of extinguishing agent.

Figure 246 - Fire Extinguisher

2) Hose station

When extinguishers are insufficient, this type can be utilized manually by the residents. Additionally, at the first sign of a fire alarm, to stop the spread of the fire. Fire hose, an extinguisher, and an axe should be kept in the fire hose station.

Figure 247 - Hose Station

The hose station's coverage area is approximately 400 m2 and 25 m long.

3) Emergency Lighting and signs

the fire plans' usage of emergency lights and signs

	Emergency Light
	Fire Exit
	Fire Rout

Figure 248 - Emergency signs

These signs and lights should be placed inside every structure because when a fire hazard occurs, the occupants will be scared and disoriented and won't know where to flee.

A) Emergency lighting

It is preferable to have emergency lights in the hallways and corridors to achieve safety throughout the evacuation process. These lights have batteries and will turn on when a short circuit occurs.

Figure 249 - Emergency Lighting Equipment

B) Exit sign

It must be placed close to the emergency exits because the inhabitants will be getting closer to the building's safe section once they see this notice.

Figure 250 - Emergency Exit Sign

3.Emergency rout sign

It should be placed in the hallways in a visible spot to instruct people in the event of an evacuation.

4.6. Drainage system and Water Supply:

Drainage fixture units:

Table 52 - Fixture Units

Fixture(s)	Drainage Fixture Units (dfu)	Minimum Trap Size	
		in.	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 53 - Pipe Diameter

Diameter of Pipe		*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)			
(in.)	(mm)[b]	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

Parking:

for the drainage of water entering the parking lots, PVC pipes with a diameter of 4 " have been installed and drainage.

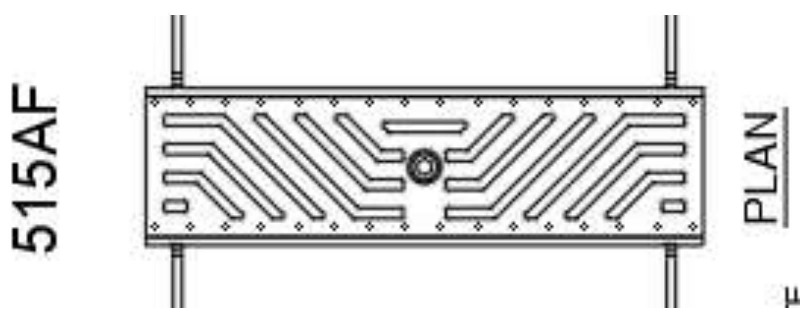


Figure 251 Parking Pipe Drainage

4.6.1. Sample of calculation:

pvc	max dfu	slope %
2"	21	2%
4"	180	1%

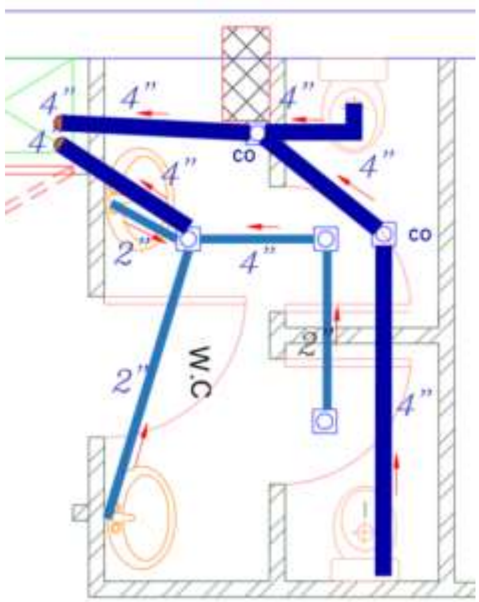


Figure 252 - Pipe Distribution (Bathroom)

The figure below shows the distribution of all points and then gives each pipe its diameter by dfu per unit:

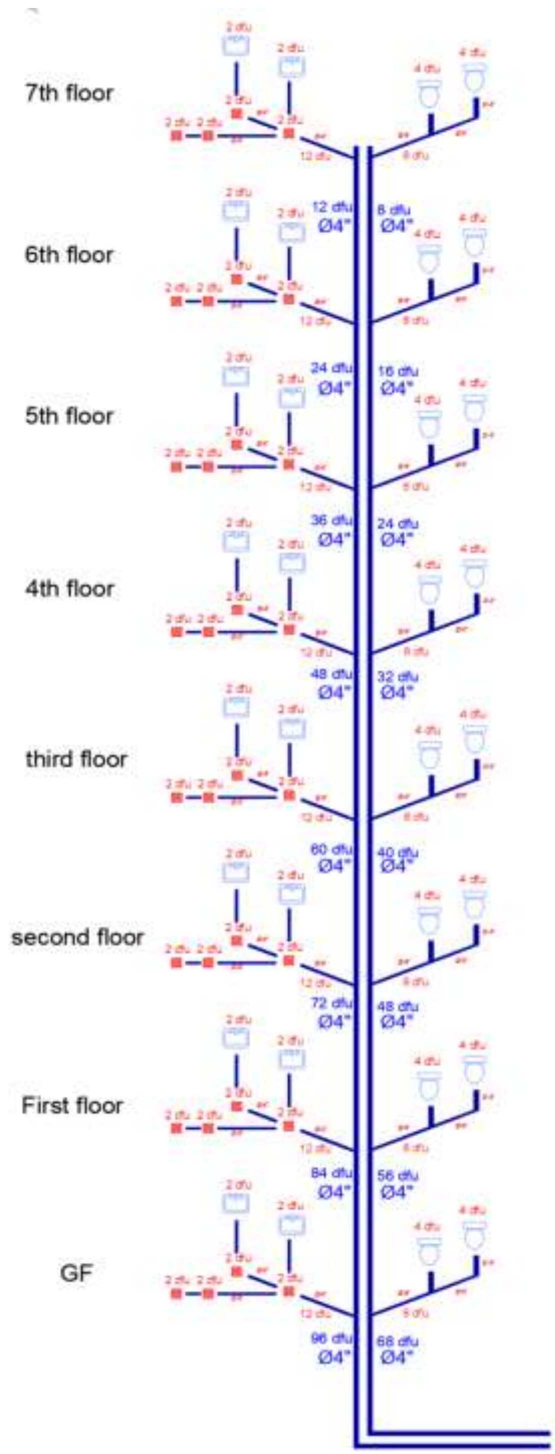


Figure 253 Drainage Dfu and Pipe Diameter Plan

4.6.2. Water supply design:

Tank sizing:

60 liters / person required for an office building.

Tanks size in roof =60*360 = 21600 liters = 21.6 m3

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

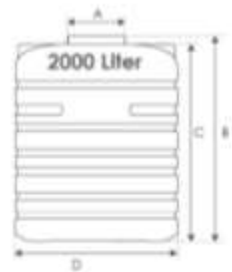


Figure 254 - Water Tank

No. of thank needed = 21.6 /2 = 10.8 tank ------ 11 tank

4.6.3. Pipe design:

Weigh of the fixture units:

Table 54 - Fixture Units (Hot and Cold)

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 unit :

Table 55 - Flow Rate/Fixture Unit

Fixture Served	Minimum		Maximum Flow Rate or Quantity
	Flow Rate gpm (L/s)[a]	Pressure psi (kPa)[b]	
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

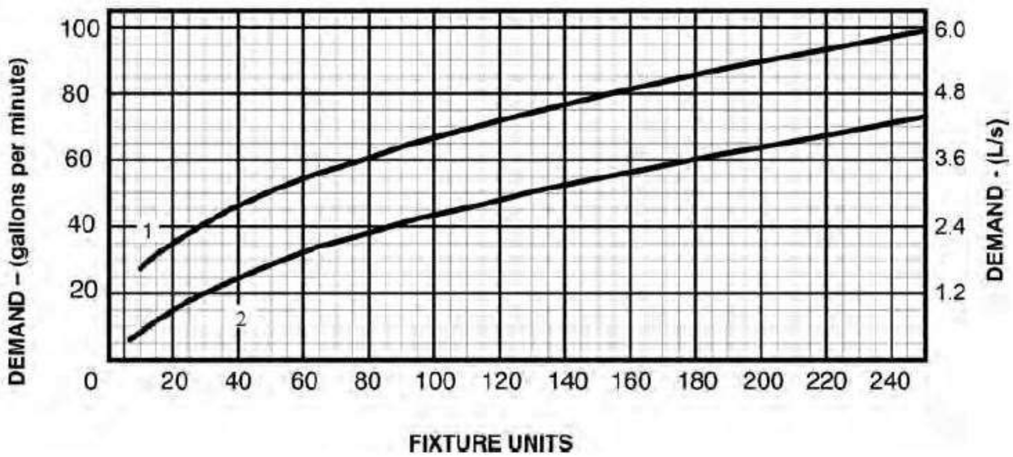


Figure 255 - Fixture Unit Demand

4.6.4. Design pipes size:

The following table show weigh fixture unit for water sources:

Table 56 - Fixture Unit for water

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
	water closet	5	flush tank	5	25
F1	sink	8	lavatory	2	16
	kitchen sink	1	kitchen sink	4	4
	water closet	8	flush tank	5	40
f2	sink	3	lavatory	2	6
	kitchen sink	1	kitchen sink	4	4
	water closet	3	flush tank	5	15
f3	sink	3	lavatory	2	6
	water closet	3	flush tank	5	15
f4	sink	3	lavatory	2	6
	water closet	3	flush tank	5	15
f5	sink	3	lavatory	2	6
	water closet	3	flush tank	5	15
f6	sink	3	lavatory	2	6
	water closet	3	flush tank	5	15
f7	sink	3	lavatory	2	6
	water closet	3	flush tank	5	15
total fixture unit					225

Pressure calculations for each floor:

P= 0.433*H

H =cumulative height of floors in feet.

Assumption:

L (tank to vertical) = 6 ft

H tank = 8 ft

H floor =13.12 ft

Total no. of floor = 8 floor

floor	pressure
gf	49.78
f1	44.10
f2	38.42
f3	32.73
f4	27.05
f5	21.37
f6	15.69
f7	10.01

floor	weigh in fixture unit
gf	35
f1	60
f2	25
f3	21
f4	21
f5	21
f6	21
f7	21

Design vertical pipes:

vertical pipe	Steel
total no. of unites	225
flow	72
actual length	120.96
eq.length	181.44

Dim	3	2	1.5
loss/100"	1.3	5.3	14
loss/eq.length	2.35	9.61	25.4

Design for horizontal pipes:

Design for ground floor:

horizontal pipe	pvc
total # of unites	35
flow	23
actual length	22
eq.length	26.4

Dim	3	2.5	2	1.5	1.25	1
loss/100"	0.12	0.27	0.8	3	8	22
loss/eq.length	0.03168	0.07128	0.2112	0.792	2.112	5.808

Design for first floor:

horizontal pipe	pvc
total # of unites	60
flow	33
actual length	17
eq.length	20.4

Dim	3	2.5	2	1.5	1.25	1
loss/100"	0.23	0.55	1.6	6.5	15	25
loss/eq.length	0.05	0.11	0.33	1.33	3.06	5.10

Design for second floor:

horizontal pipe	pvc
total # of unites	25

flow	17
actual length	1
eq.length	1.2

Dim	3	2.5	2	1.5	1.25	1
loss/100"	0	0.15	0.5	1.7	4.5	14
loss/eq.length	0.00	0.00	0.01	0.02	0.05	0.17

Design for (3rd ,4th,5th ,6th and 7th):

horizontal pipe	pvc
total # of unites	21
flow	15
actual length	1
eq.length	1.2

Dim	3	2.5	2	1.5	1.25	1
loss/100"	0	0.13	0.36	1.5	3.7	12
loss/eq.length	0.00	0.00	0.00	0.02	0.04	0.14

Design branch pipes:

water closet critical

branch pipe	pvc
total # of unites	5
flow	5
actual length	10
eq.length	12

Dim	1.5	1.25	1	0.75	0.5
loss/100"	0.22	0.5	1.14	5.6	40
loss/eq.length	0.0264	0.06	0.1368	0.672	4.8

4.6.5. Pipes size for all floors

Table 57:Pipes size for all floors

floor	vertical design		horizontal design		branch design		total loss	NACHRAL LOESS	actual pressure	check pump
	steel pipes dimeter	loss psi/100ft	PVC pipes dimeter	loss psi/100ft	PVC pipes dimeter	loss psi/100ft				
GF	1.5	25.4	1.5	0.8	(3/4)	0.6	26.8	49.78	22.98	not need pump
f1	1.5	25.4	1.5	1.33	(3/4)	0.6	27.33	44.1	16.77	not need pump
f2	2	9.61	1.5	3.2	(3/4)	0.6	13.41	38.42	25.01	not need pump
f3	2	9.61	1.5	0.02	(3/4)	0.6	10.23	32.73	22.5	not need pump
f4	2	9.61	1.5	0.02	(3/4)	0.6	10.23	27.05	16.82	not need pump
f5	3	2.35	1.5	0.02	(3/4)	0.6	2.97	21.37	18.4	not need pump
f6	3	2.35	1.5	0.02	(3/4)	0.6	2.97	15.69	12.72	not need pump
f7	3	2.35	1.5	0.02	(3/4)	0.6	2.97	10.01	7.04	need pump

Catalogue:

Figure 256:Auxiliary pump.

Product Information

No.	H.P	Input	Output
44-2031	2	2 inch	2 inch
44-2032	3	2 inch	2 inch

Max Head Flow

No.	6	9	18	21	27	30
44-2031	27	26	21	19	14.5	12
44-2032	33.5	32.5	27	25	19.5	16.5

Figure 257:pump catalogue for F4

use 6 psi

Chapter 5: Quantity surveying and Cost Estimate

5.1. Introduction:

Our bank institution was designed integrally to avoid any conflict between professions, like Architectural, environmental and structural aspect. To acquire the cost of all that work (which is very important to clients) a certain cost calculation methodology should be followed. The main cost calculation method used in Palestine is the unit price method. Because, it ensures fairness for both parties and minimize fraud attempts.

5.1.1. Bill of quantity (BOQ):

Table 58 - Bill of Quantity (BOQ)

Item No.	Description	Unit	Quantity	Material cost and Laber cost	
				Unit Cost	total cost
1	bank				
1.1	Structural				
1.1.1	**Sub-Structure**				
1.1.1.1	**Earth Work**				
1.1.1.1.1	Excavation for Footing	CM	24648	30	739440
	site leveling	CM	924.3	30	27729
1.1.1.1.2	Total Disposal	CM	30810	15	462150
1.1.1.1.3	Site Filling	CM	2139.85	45	96293.25
1.1.1.2	**Foundation**				
1.1.1.2.1	**Blinding**				
1.1.1.2.1.1	Formwork	SM	22.75	25	568.75
1.1.1.2.1.2	Concrete	CM	308.1	340	104754
1.1.1.2.2	**Footing**				
1.1.1.2.2.1	Formwork	SM	3520.7	25	88017.5
1.1.1.2.2.2	Steel Work	TON	100	3700	370000
1.1.1.2.2.3	Concrete Work	CM	3600	340	1224000
1.1.1.2.2.4	Proofing	SM	3520.7	7	24644.9
1.1.2	**Super Structure**				

1.1.2.1	**Structural Elements**				
1.1.2.1.1	**Column**				
1.1.2.1.1.1	Formwork	SM	2520	150	378000
1.1.2.1.1.2	Steel Work	TON	70	3700	259000
1.1.2.1.1.3	Concrete Work	CM	405	340	137700
1.1.2.1.2	**Shear Wall**				
1.1.2.1.2.1	Formwork	SM	6742	25	168550
1.1.2.1.2.2	Steel Work	TON	63	3700	233100
1.1.2.1.2.3	Concrete Work	CM	781	340	265540
1.1.2.1.3.3	**Slabs**				
1.1.2.1.4	U-boot	SM	23071	4	92284
1.1.2.1.4.1	Formwork	SM	10254	200	2050800
1.1.2.1.4.2	Steel Work	TON	324	3700	1198800
1.1.2.1.4.3	Concrete Work	CM	2631	340	894540
1.1.2.1.5	**Stair**				
1.1.2.1.5.1	Formwork	SM	162	25	4050
1.1.2.1.5.2	Steel Work	TON	6	3700	22200
1.1.2.1.5.3	Concrete Work	CM	57	340	19380
1.1.2.1.5.4	Hand Rail	LM	132	750	99000
1.1.2.2	**Non Structural Elements**				
1.1.2.2.1	**External Wall**				
1.1.2.2.1.1	Block	number	43008	1.6	68812.8
1.1.2.2.1.2	Concrete	CM	318	340	108120
1.1.2.2.1.3	Stone	SM	3100	220	682000
1.1.2.2.1.4	insulation	M	3180	70	222600
1.1.2.2.2	**Internal walls**				
1.1.2.2.2.1	Block	SM	1650	50	82500
1.1.3	**Finishing**				
1.1.3.1	Plastering	SM	51270	40	2050800
1.1.3.2	Painting	SM	51270	25	1281750
1.1.3.3	Floor Tile	SM	10200	100	1020000
1.1.3.4	Stair Tile	M	480	150	72000
1.1.3.5	Gypsum Board	SM	3820	60	229200
1.1.3.6	Wall Tile	SM	150	80	12000
1.1.3.7	Acoustic wood panel	SM	500	150	75000
1.1.3.8	gllass Door	piece	86	1500	129000
1.1.3.9	Bathroom Door	piece	50	900	45000
1.1.3.10	External Door	piece	5	10000	50000
1.1.3.11	windows	SM	78	650	50700
	Wall gllass	SM	500	1200	600000
1.1.4	**Electrical**				

1.1.4.1	**Power System**				
1.1.4.1.1	power socket outlet	unit	300	6	1800
1.1.4.1.2	water proof power socket outlet	unit	11	9	99
1.1.4.1.3	power wires	m	2000	0.8	1600
1.1.4.2	**Circuit Breaker**				
1.1.4.2.1	MBD	unit	1	7500	7500
1.1.4.2.2	SBD	unit	10	160	1600
1.1.4.2.3	150A	unit	1	450	450
1.1.4.2.4	50A	unit	10	200	2000
1.1.4.2.5	16A	unit	30	90	2700
1.1.4.2.6	10A	unit	40	80	3200
1.1.4.3	**Light**				
1.1.4.3.1	Spot light	unit	420	25	10500
1.1.4.3.2	LED panel light	unit	631	40	25240
1.1.4.3.3	Parking Luminaire	unit	140	50	7000
1.1.6	**Mechanical Work**				
1.1.6.1	**Drainage system**				
1.1.6.1.1	kitchen sink	unit	2	300	600
1.1.6.1.2	sink	unit	31	150	4650
1.1.6.1.3	wc	unit	31	1800	55800
1.1.6.1.4	manholes	unit	12	800	9600
1.1.6.1.5	Pipe 4"	m	140	14	1960
1.1.6.1.6	Pipe 2"	m	50	8	400
1.1.6.1.7	Pipe 6"	m	700	25	17500
1.1.6.1.8	Clean out	unit	35	65	2275
1.1.6.2	**Water System**				
1.1.6.2.1	water tank	unit	11	500	5500
1.1.6.2.2	water pump	unit	1	5500	5500
1.1.6.2.3	galvanized steel	M	350	45	15750
1.1.6.2.4	PVC pipe	M	692	4.5	3114
1.1.6.2.5	collector	unit	10	350	3500
1.1.6.2.6	valve sink	unit	36	60	2160
1.1.6.2.7	bidet	unit	31	30	930
1.1.5	**Safety System**				
1.1.5.1	fire hose station	unit	18	750	13500
1.1.5.2	sprinklers	unit	215	300	64500
1.1.5.3	fire extinguiguisher	unit	85	150	12750
1.1.5.4	heat detectors	unit	50	135	6750
1.1.5.5	smoke detector	unit	60	140	8400
1.1.5.6	fire alarm	unit	10	180	1800
1.1.5.7	manual alarm	unit	15	100	1500

1.1.5.8	out side dry stand pipe	unit	1	3800	3800
1.1.5.9	fire exit door	unit	20	3000	60000
1.1.8	**HVAC System**				
1.1.8.1	outdoor unit	unit	3	50000	150000
1.1.8.2	Diffuser	unit	30	300	9000
1.1.8.3	split unit	unit	23	2500	57500
1.1.8.4	Duct	M	85	60	5100
1.1.9	**acoustics system**				
1.1.9.1	ceiling loudspeaker	piece	4	440	1760
Elevators					
1.1.9.2	Elevators	Piece	3	60000	180000
Total Cost					**16509312.2**

Unit cots for the total cost = 16509312.2/10080 = 1637.8 NIS/m2

CHAPTER 6: Conclusion

6.1. Brief Assessment:

The bank design was integrally designed, taking into consideration:

- **Architectural**:

All regulation and standards regarding spaces orientation of spaces and safety measurements were fixed and treated:

- ✧ add all missing spaces that are included in any bank, to function properly
- ✧ Adjust all space dimensions to meet the standards
- ✧ Create more waiting area to avoid people jam
- ✧ Add fire staircase escape
- ✧ Create more corridor areas with linear movement, to aid mainly in escaping routes
- ✧ Adding service shaft for easier maintenance
- ✧ Accommodate more parking spaces to fit employees and clients
- ✧ Adding safe room in the basement floor
- ✧ Apply safety precautions

● Environmental

Environmental analysis was divided into 4 categories:

1. Daylight Factor Analysis
2. Solar Radiation
3. Overshadowing
4. Heating and Cooling loads
5. Energy saving

Each category was analyzed using Revit/Design builder program. The treatments regarding the analysis done to the categories mentioned above resulted in treating all four elevations such as:

- ❖ Minimizing glass areas, mainly due to safety reasons and reducing direct sun light and energy
- ❖ Add glazing to glass panels in certain windows, to reduce heating load, also to take advantage of natural ventilation and to maintain view.
- ❖ Using treatments by adding an extra layer in front of the glass area (CNC Aluminum) to avoid overheating and glare
- ❖ Adding horizontal louvers to deny direct sunlight access through glass areas
- ❖ Applying more glass area to south elevation as its exposed more to sunlight during winter and leads to minimizing heating loads

- **Structural:**

At this stage of the building project was checked if structurally viable and stable by applying four different check:

1. Compatibility Check
2. Deflection Check
3. Equilibrium Check
4. Stress and Strain Check
5. Seismic Design

All checks and results were made on Etabs program

Error between hand and Etabs calculations:

- D.L error = 0.036 %
- L.L error = 0.04 %
- SIP error = 0.01 %
- For GF edge Column error = 8%
- For 2nd Floor edge Column error = 2.48 %
- For 7th Floor corner Column error = 1.86 %
- Main Beam in GF error = 1.12 %
- Main Beam in 2nd Floor error = 3.72 %
- Main Beam in 7th Floor error = 1.05 %

As allowable error is anything less than 10%

● Electro-Mechanical:

Electro-Mechanical aspect is divided into six categories, each serving a purpose to achieve an optimum integrated design

❖ Artificial lighting design:

Designed for rooms listed below:

1. Meeting room.
2. Conference room.
3. Tellers.
4. Offices.
5. Entrance.
6. Waiting area.
7. Credit Financial Department

❖ HVAC System

Total heating load: = 148 KW

Total cooling load = 159 KW

Number of outdoor units = 3 Unit

Number of indoor units = 23 split Units, 6 fan coils, 4 Collectors

❖ Power design

Given Information:

Power sockets demand factor = 0.2

Lighting loads demand factor = 0.8

The factor of safety for the conductors and circuit breakers is 1.2

Power factor 0.9

Number of DB:

1 main DB

10 Sub DB

❖ Acoustical design

Materials used:

- Plaster
- Double glazing window
- Hollow core Plywood (Door)
- Moquette (Floor)

RT60 check for the three rooms used are ok

SPL check for rooms with speakers are ok

❖ Fire and emergency system

Automatic fire alarms used:

- Ultraviolet Flame detector
- Smoke detector
- Heat detector

Manual suppression tools used:

- Extinguishers
- Hose station

❖ Drainage and water distribution

Total Dfu for the project = 96 Dfu

Number of tanks = 11 tanks

Pipe on 7^{th} floor need pump 6psi

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