An-Najah National University

Faculty of Engineering and Information Technology.

Building Engineering Department

Graduation Project II (10611591).

"An Integrated Redesign of Anti-Corruption Commission in Ramallah City"

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Presented in partial fulfilment of the requirements for Bachelor degree in Building Engineering.

Dedication:

This work was provided to the Department of Building Engineering and to all those who helped us throughout our study journey, especially to those who supported us with energy and confidence in ourselves that we will finish this path successfully. This work is for all faculty members in the Department of Building Engineering at An-Najah National University, especially our supervisor, Dr. Luay Dwaikat, who was the main director and supporter, to get the best results and learn before we come up with a full integrated project. Finally, we dedicate this work to ourselves as a result of good hard work these years and hope it reflects on our acquired knowledge.

Acknowledgement

The big and always thanks for God every time at any situation. From this platform we would like to thank our parents who were the main supporter despite all the circumstances. In addition, we want to thank all the professors in the construction engineering department from whom we learned directly and were the reason for reaching this much knowledge, and all the special thanks to our supervisor Dr. LuayDwaikat who supported us until this work was accomplished. Finally, a big thank you to An-Najah National University that has given us the opportunity to study over the past five years to discover and develop our interests with all available possibilities.

Disclaimer

This report was written by student (Lama daghlas, Fatima Daraghma, Deema shakhsher) at the Building Engineering Department, Faculty of Engineering, An-Najah National University. It has not been altered or corrected, other than editorial corrections, as a result of assessment and it may contain language as well as content errors. The views expressed in it together with any outcomes and recommendations are solely those of the student (Lama daghlas, Fatima Daraghma, Deema shakhsher). An-Najah National University accepts no responsibility or liability for the consequences of this report being used for a purpose other than the purpose for which it was commissioned.

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Abstract

Integrated building design has emerged as one of the most crucial needs necessary in the modern days, this is to ensure the comfort of users in order to be the proper function, and to ensure that buildings are designed to the highest standards.

An office building is any structure, space, or portion thereof that is used exclusively or primarily for administrative, office, or other types of work.

To ably the principles of integrated design the Anti-Corruption Commission building, which has been designed and constructed and the building is under operation the purpose of the project to reevaluate the design of the current building and performance, which is located in the Al-Bireh Governorate of Ramallah, on a plot of land that is 1800 square meters in size. It has a total area of 4600 square meters, which is divided among 7 floors, plus a two-story basement that is 1800 square meters in size

Information has been collected as the first step in our project, the information collected has been used to evaluate the objectives of the architectural design. Before making any alterations, we assessed the building's essential facilities including emergency staircases, escape routes, car parks and elevators to ensure they comply with standards.

The building has been assessed from an environmental point of view depending on the Revit program and the Design Builder program. The cooling load (237Kw) and the heating load (192 Kw) were calculated, and comparing the results with those after the adjustments. The energy consumption of the building has been estimated (85 Kw/m2).

And then the best structural system that supports the building and meets the necessary economic criteria is selected. Next, computer programs are used to create a safe design. In this project Investigation has been carried out by using computer programs like AutoCAD, Revit, Etabs, Design Builder, and Lumion.

in part two the following investigation done:more details in environmental design (passive system) proposed to improve the system performances,Further detailed structural considerations were conducted for the design, following specific standards. By incorporating these detailed structural considerations within the design process, the project aimed to achieve a sustainable, safe, and cost-effective solution that aligns with the specified design standards.In addition to the architectural and structural considerations, the project also encompassed the electromechanical aspects. These aspects involved the integration and design of various engineering systems to ensure optimal performance and functionality By addressing these electromechanical aspects, the project aimed to ensure the seamless integration of various engineering systems, resulting in a fully functional and sustainable building that meets the desired performance requirements. As part of the project, a comprehensive quantity surveying and cost

estimate process was conducted. This involved a detailed analysis of the materials, labor, and other resources required for the construction project, along with an estimation of the associated costs The quantity surveying and cost estimate process provided valuable insights into the anticipated project costs, enabling effective budgeting, cost control, and informed decision-making throughout the project lifecycle.

the final product of our project be an integrated redesign of all engineering systems in accordance with this type of building recommendations.

Key word: environmental, office building, energy efficiency, energy consumption, Integrated building design.

1 Chapter1 Introduction

1.1 Introduction

The office building is now a place for collaboration, talent recruitment, onboarding, and inspiration with new requirements and expectations that combine physical spaces with technologically supported ways to work, in the office or remotely. Office building is a building that contains separate offices or private companies. The main objective of offices is it to make a suitable work environment for employees to work all for the company goals.

Office environment directly effects on employee satisfaction, creativity, and productivity. Therefore, companies aimed to develop a good reputation in amazing workspaces.

HAYAT MUKAFAHAT AL-FASAD is an office building in al-Bireh governorate in Ramallah, it located on a land that its area is about 1911 square meter with total area of the building 6776 square meter that distributed on two basement floors as garages, seven office floors and roof.

1.2 statement of the problem

Anti-Corruption Commission building has two basement floor, and number of Parking in the floors are not enough, this distribution gave it a weak point in covering all the needs of the building's users and has little vitally.

And the building consists of court stretching from ground floor to third floor, give an anaseismic shape to the building, this is a problem that we tried to find solutions to be better effective and serve the building in terms of ventilation and light input to the building.

Emergency drawers in the building are one of the most important needs that must be met in the building to serve the preparation of employees. Emergency drawers have been checked and those who need to be adjusted to follow specifications for emergency drawers have been modified.

1.3 Objectives

The main objective for this project is to solve the building architecturally, structurally, environmentally and safely to get an integrative design. This process will be according to international standards and specifications.

Analyze the building from an environmental point of view and whether the load in the building is suitable for this type of building or not to follow the specifications specified for it, and see what environmental additions and improvements can be added to improve the use of the building.

1.4 Methodology

The process of this project will run sequentially starting from the existing design until we get a better design and take the desired objective.

Deep understanding and analysis for the existing design is the first step. All systems will be evaluating to find the problems and detections and avoid it in the redesign process.

Firstly, collect standards from books for the building spaces according to its function and compare it with exist design, and the standard of emergency stair, and parking standard and compare it with exist design. Secondly, make site analysis for the project location to take it in consideration in the environment design. Thirdly, evaluate case study have the same function and study the problems that can face. Finally, redesign the building architecturally, structurally, mechanically. electrically, HVAC, lighting, acoustics and fire safety. The redesign will be achieving according to the concepts that done in the previous courses and by using some computer software.

1.4.1 Environmental Architectural Analysis and Environmental

To achieve the desired goals in architecture and environmental fields the research will go in this:

1. Study all standards and requirements such as (parking, emergency stair, spaces) using some book (IBC, NUEFURT 4th edition, Time-saver Standards for Building Types, Metric)
2. Comparison between the standards and origin design then redesign it as specifications.
3. Environmental analysis and site study to get the maximum benefit from passive resources in the redesign.
4. Make analysis about the requirements that give thermal comfort for the redesign spaces.

1.4.2 Site Analysis

To achieve the desired goals, the research must contain these information's:

1) Information's about the project site.
2) Analysis and identification the noise sources existing in the building and its surroundings.
3) Studying the effects of surrounding on the building

1.4.3 Structural Analysis

To achieve the desired goals, the research must contain these information's:

1) Determine the structural system that will be use in the project.
2) Building analysis using computer software such as (SAP, ETABS, REVIT).
3) Compare the results with standards and solve the existing problems.

1.5 Design constraints

1) Economic Constraints: The Project has to be constructed within the Budget of the owner, Hence, this budget.
2) Society Constraints: According to our being a place to work in the building, it is important to design the building space to meet the needs of all employees, for example, those with special needs, since this building serves all people
3) Environment Constraints: calculate the energy consumption of the building and dose the result make sense compared to this type of building? and what the environment friendly power sources and how can it be used to achieve the desired result, and check the noise pollution and the effect on my building.

1.6 Standards and Specifications (Codes)

- **IBC 2012: International Building code**: is a model building code developed by the International Code Council (ICC). he IBC addresses both health and safety concerns for buildings based upon prescriptive and performance related requirements
- **NUEFURT 4th edition**:is a reference book for spatial requirements in building design and site planning. First published in 1936 by Ernst Neufert
- **Time-saver Standards for Building Types:**The only comprehensive reference to all building types, Time-Saver Standards for Building Types is loaded with all the essential design criteria and standards you need to prepare preliminary designs, execute programming requirements, and analyze the functions and uses of a building
- **The Metric Handbook:** is the major handbook of planning and design data for architects and architecture students, As well as buildings, the Metric Handbook deals with broader aspects of design such as materials, acoustics and lighting, and general design data on human dimensions and space requirements. The Metric Handbook is the unique reference for solving everyday planning problem
- **Palestinian Civil Defense Code**
- **The American concrete institute code (ACI 318-14):**Building Code Requirements for Structural Concrete" ("Code") provides minimum requirements for the materials, design, and detailing of structural concrete buildings and, where applicable, nonbuilding structures

1.7 Earlier Course Work

This project will be achieving by using main concepts taken from previous courses in these fields:

- Architectural design:
    - The main concepts and understanding the spaces in the plans and relations between spaces in any building according to its function have learned from the principles of architectural design course.
    - Make 2-D plans with all its detailing by AutoCAD, make 3-D models by Revit software in the design of buildings using the computer course, and advanced Revit course.
- Environmental design:
    - Lighting concepts in choose the suitable sources for the spaces and its best distribution all these have learned in (design of environmental systems (1) - lighting) course.
    - Acoustic concepts and calculations of acoustic amount that give the comfort and suitability for each space taken from (design of environmental systems - acoustics) course.
    - Taking maximum benefits from the sun energy to serve the building needs taken from solar course.
    - The amount of thermal energy that building materials can take naturally taken from (Thermal simulation of buildings) course.
- Structural design:
    - (concrete1, concrete2, advanced concrete and earthquake resistant buildings) courses. From all these courses, we learned the design systems and check the safety for each and give all details need for work.

2 Chapter 2 Environmental - Architectural Aspects.

2.1 Introduction:

Architectural design is a discipline that focuses on covering and meeting the needs and demands, to create living spaces, using certain tools and especially, creativity. Therefore, the aim is to combine the technological and the aesthetic. In this part, we want to make a study and analysis for the existing design and check if there are some ideas that doesn't fit with the specifications and come up with more innovative ideas to improve the performance of the building. Office building can service many functions, so it should achieve all requirements such as dimensions of spaces and the function.

Administrative building Facilities

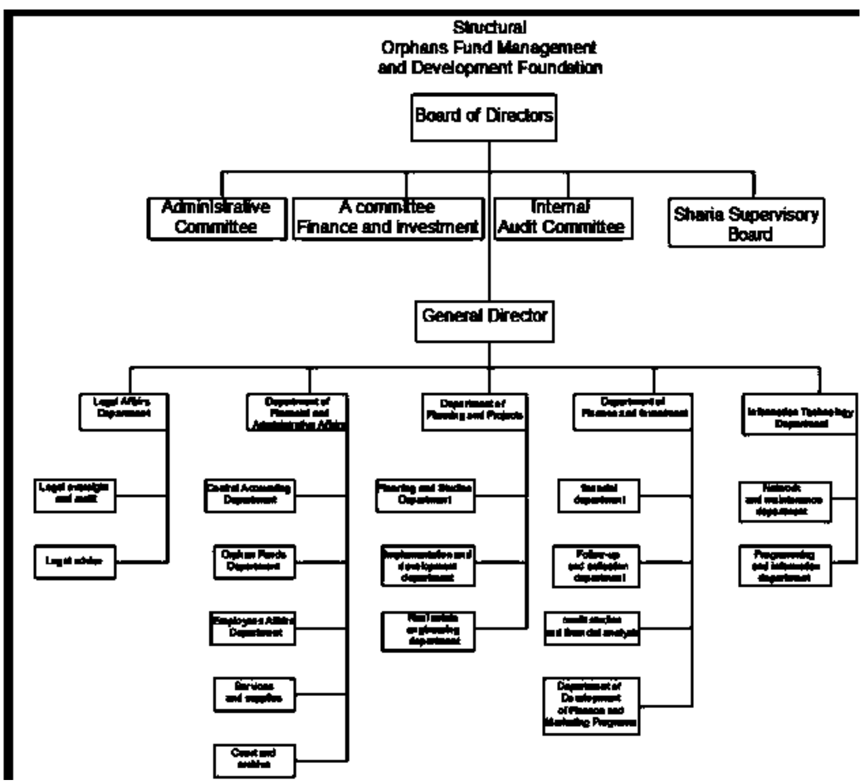


*Figure2-21- **Sections of the Administrative building***

2.2 Relations between spaces and main components and other spaces in the building

The functional relationships between the departments:

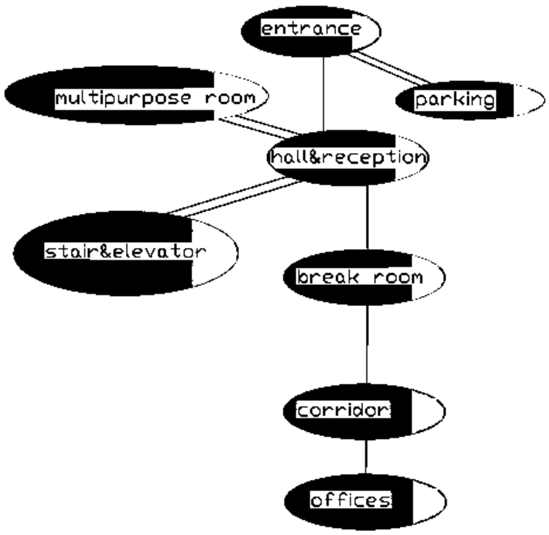


Figure 2-2 ***Bubbly diagram for Ground floor***

2.3 Literature review

2.3.1 Architectural Standards:

2.3.1.1 Building Rooms:

1. Meeting room

These rooms are used for the employees to gather in and do their meeting and discuss their ideas. Meeting rooms are essential is these types of buildings because it has a wide-open space where everybody can see and hear each other clearly. The air volume for each person in these rooms is about 4.5 m^2 and each person needs between 1.1 – 1.25 m^2 as min of area in this type of rooms.

Wiley,J(2012).Neufert E. West Sussex, P019 8SQ, UK: Blackwell)

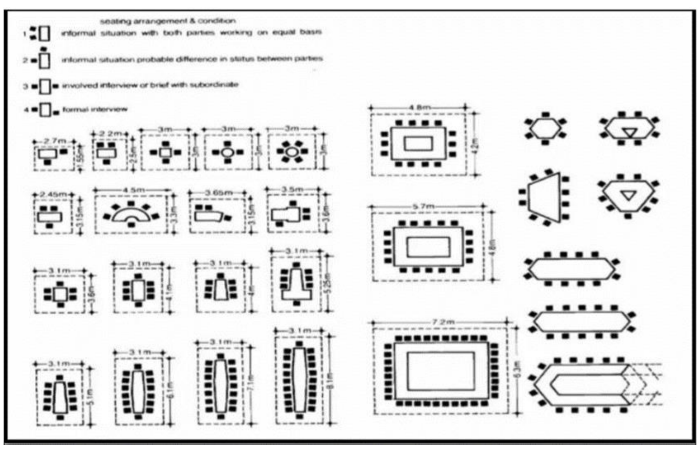


Figure 2-3Meeting room's dimension (Neufert 4th edition, 2015)

A meeting room needs a table with a total area of 27.5 in addition to a movement space, so the required space for the meeting room is not less than 32 square meters,

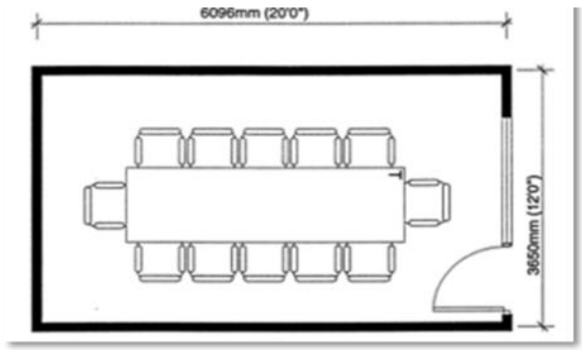


Figure 2-33 Standard of area for meeting room (European Commission, 2011).

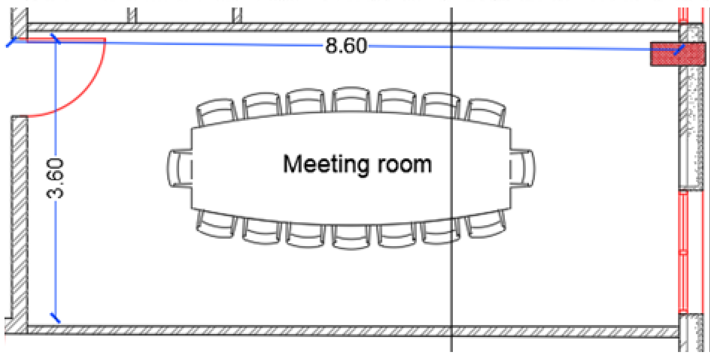


*Figure 2-4**Meeting Area in our Building***

Dimension of Plan > Standard ..ok

2. Entrance area.

Entrance area Connection between public and working areas. The important functions are lobby, access control, information, visitor registration and waiting zone. Important area for the company's corporate identity- the first impression is decisive. The entrance hall should be enclosed where the entrance leads directly to the open air with an inner door (wind lobby function) It should also offer sufficient room for a lot of moving around .

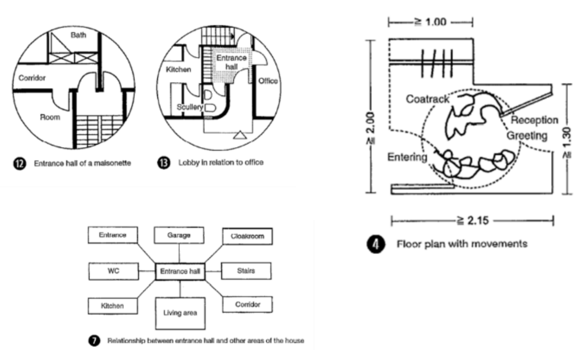


*Figure 2-5**Entrance Area in our Building***

3. Maintenance room:

There are two sorts of upkeep room:

1. Upkeep and fix for broken gadgets: -

This sort of upkeep room contains a few hardware with various sizes for each one.

2. Upkeep for building frameworks: -

“The maintenance of mechanical, electrical, heating and other building systems, e.g., boiler rooms, gas and electric meter rooms, elevator control rooms, and workrooms for maintenance employees, but excluding such spaces as janitors' broom closets.”Wiley,J(2012).Neufert E. West Sussex, P019 8SQ, UK: Blackwell)

4. Kitchen:

Kitchen is truly essential to staff in their work place. An all-around planned kitchen with assortment of offices will develop a climate in a positive working spot that will prompt more effective and long haul representatives at work. Kitchenette is considered as asocial area so it should be as near to the workstations as possible and connected with the communications zones. Space requirements for the kitchenette is one (10 m2) for every approximate 50-100 workplaces

The area in plan: 8 m^2

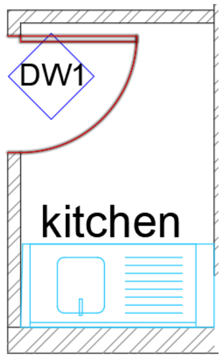
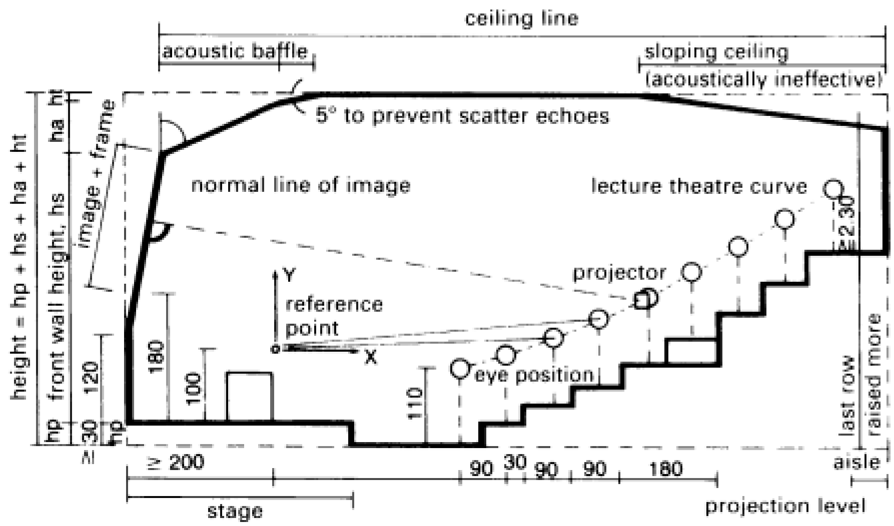


*Figure 2-6**Kitchen in our Building***

5. Lecture Room:



③ **Long section of a lecture theatre**

Figure 2-7 ***Lecture Room standard***

usual size for lecture theaters is 100,150.200,300,400,600 seats , theater with up to 200 seats have a ceiling height have a ceiling height of 3.5 m and are departmental building ,if large they are better separate building

these figure show the plan of rectangular lecture theaters.

the amount of space per student for seating in comfort is 70 *65 cm2.

6. Offices

Designing offices requires careful consideration because it is the primary space where employees spend the majority of their working hours in a building. Adequate space is crucial for employee comfort and should accommodate both the employee and those working around them.

type of offices:

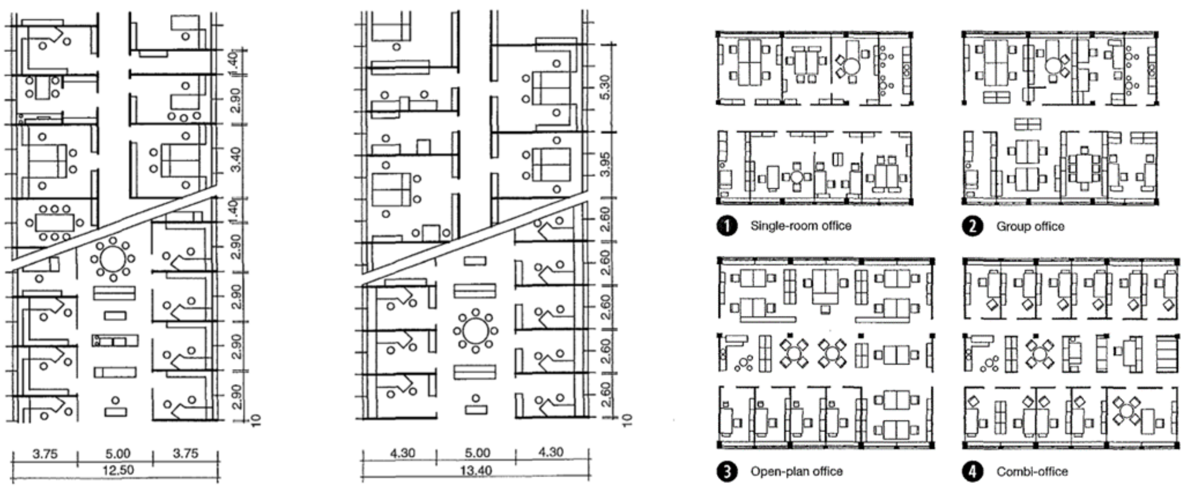
1- single offices.

2- open- plan offices.

3- group offices.

The modular dimensions, which have proved successful in recent years, are 1.50 m for single-room offices and 1.35 m for office types based on the combo principle. According to

(Wiley,J(2012).Neufert E. West Sussex, P019 8SQ, UK: Blackwell)



1 Grid module 1.50 m, building depth 12.50 m, an economical form of building for single offices or for combi-offices; this provides a narrow communal zone and 10% fewer workstations at the window than with 2.

2 Grid module 1.35 m, building depth 13.40 m, an economical form of building for combi-offices, but for single offices this produces deep and badly proportioned rooms.

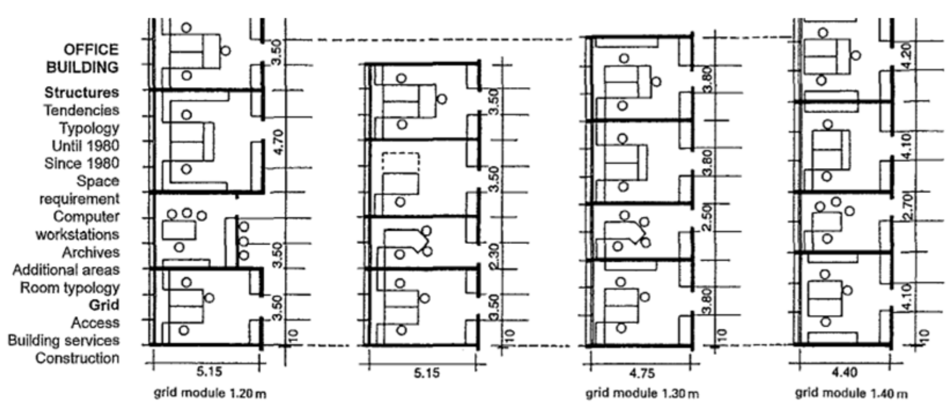


Figure 2-8the type of offices.

Single plan office:

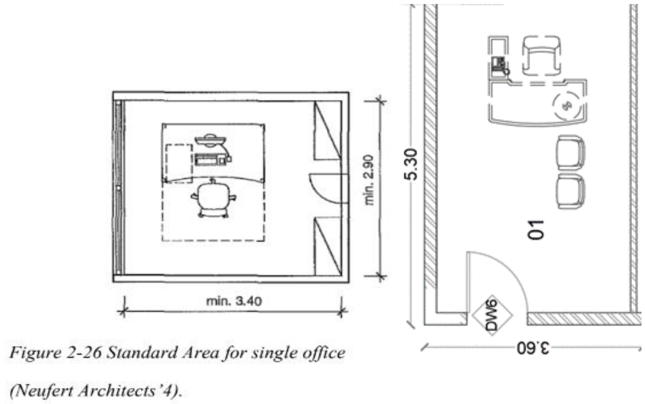


Figure 2-9 single plan office

Dimension of Plan (single office)

Dimension of Plan >Standard. ok

Double office:

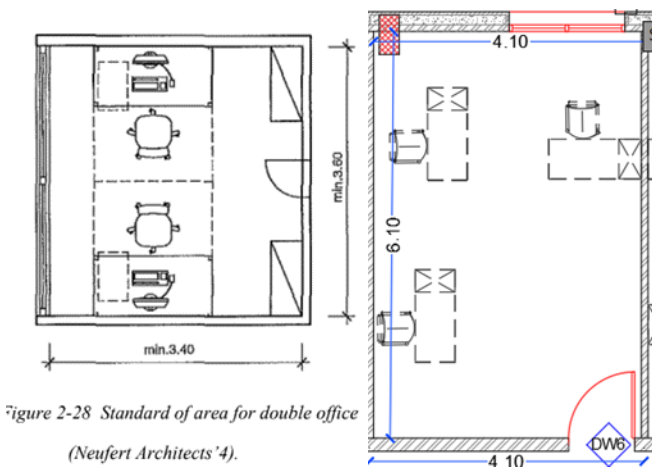


Table 1 Double office plan

Dimension of Plan (Double office)

Dimension of Plan >Standard ok

Management office: The standard dimensions of the manager's roomWiley,J(2012).Neufert E. West Sussex, P019 8SQ, UK: Blackwell)

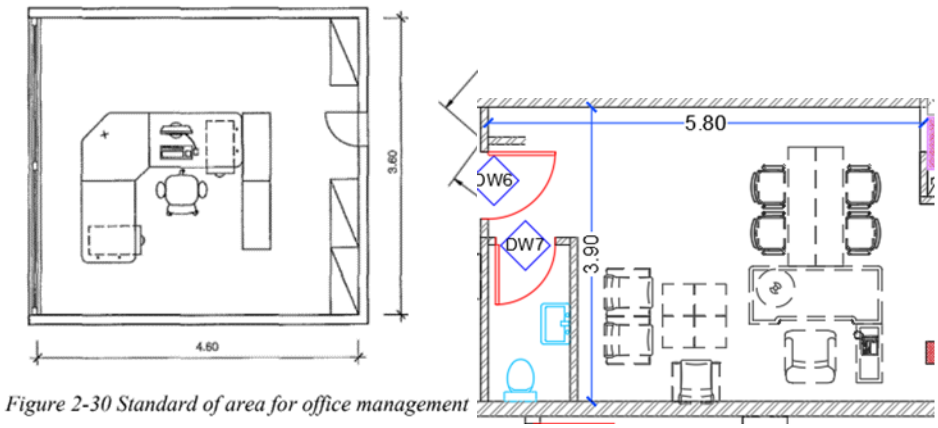


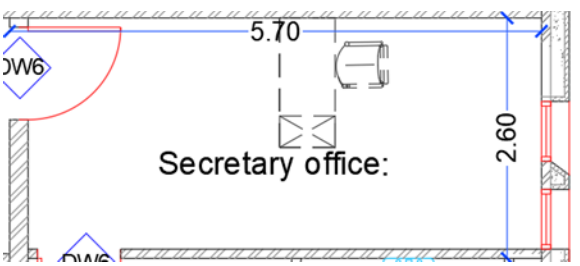
Figure 2-10standard of area for office management

Dimension of Plan (Management office)

Dimension of Plan > Standard…ok

Secretary office: Secretary room the standard area is 10 m2.

(Neufert et al., 2012).



area =14.8m2

Dimension of Plan >Standard.. ok

Workstations are places where items like a computer screen, an alphanumeric keyboard, and a document or sound recording device are essential for completing tasks. Items that are regularly used during the workday should be placed in prominent locations where they are visible and reachable. At the workstation, there should be at least 1.5 m2 of unrestricted mobility space

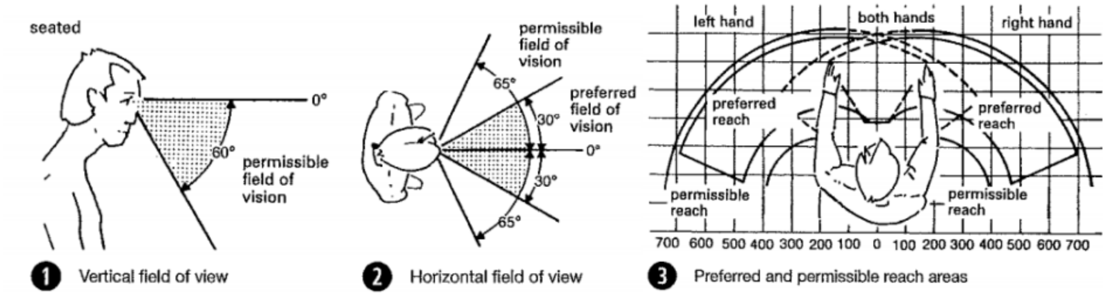
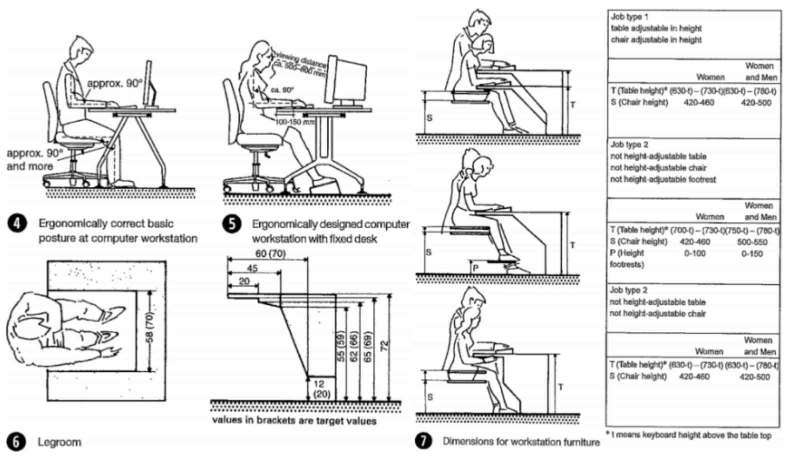


Figure 2-11workstation's standard (Neufert 4th edition, 2015)

The selection of furniture is a critical factor in creating a productive and appropriate work environment for employees. Adhering to the following standards can ensure that the furniture meets the necessary criteria:



Workstation's furniture dimension (Neufert 4th edition, 2015)

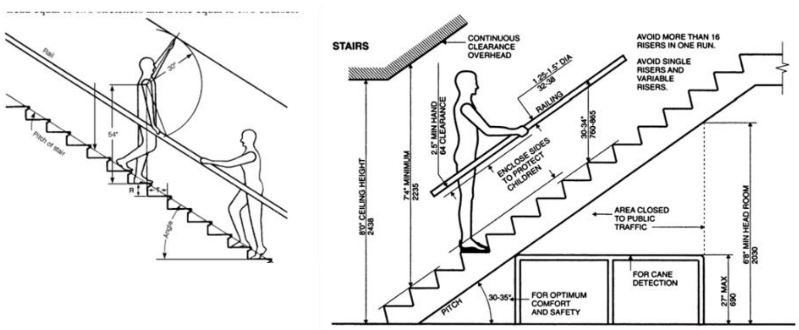
7. Stairs:

For optimal placement, it is ideal to locate a space near the main entrance that is easily accessible and in a common area where electric elevators can be reached. The selection of stairs is based on the number of individuals utilizing the building, with a fixed handrail for protection being a key consideration to ensure safety.

0.55 m width allows 1 person to pass.

- 1.25 m width of allows 2 people to pass.

- 1.875 m wide allowing 3 people to pass.



.(Wiley,J(2012).Neufert E. West Sussex, P019 8SQ, UK: Blackwell)

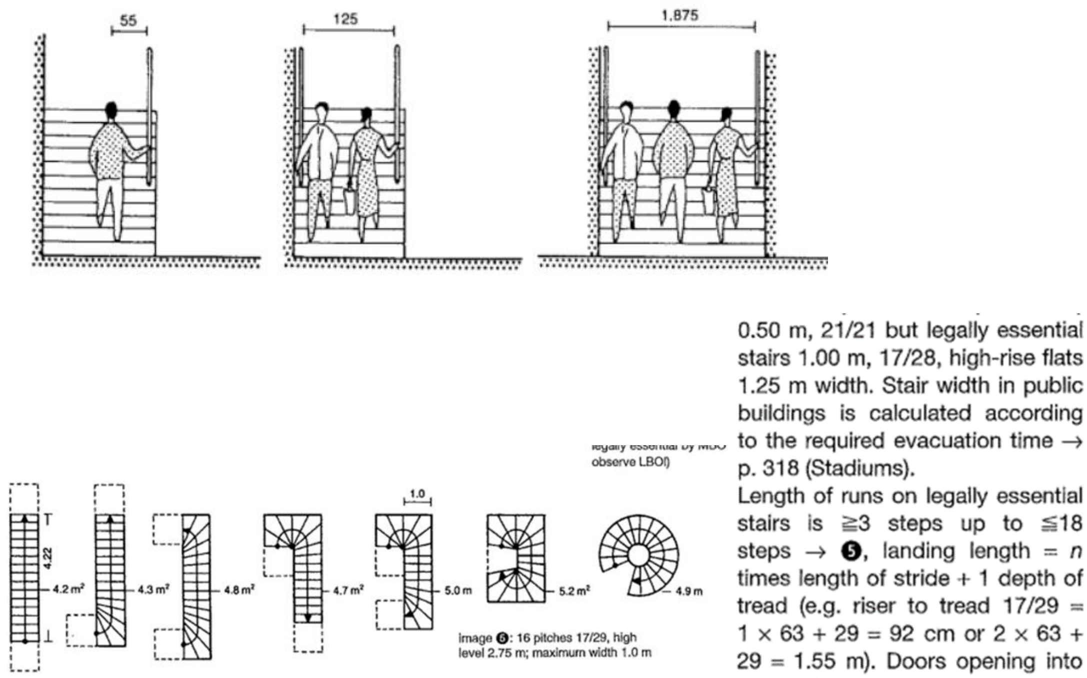


Figure 2-12Stair's dimension (Neufert 4th edition, 2015)

Stairs in the building

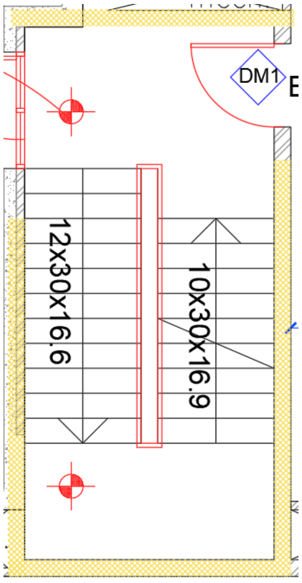


Figure 2-13 Stairs in the building

It Could be noticed that the main stairs in our building matches the standards mentioned above. The width of the stair is 1.4 m which allows the passage of two people beside each other, one ascending and the other descending.

8. Elevator:

To prevent the transmission of mechanical noise and movement to adjacent rooms, it is crucial that the elevator wall is constructed using fire-resistant and sound-insulating materials, and it should not share a wall with any other room. Adequate artificial lighting and ventilation are also essential requirements, both day and night, to ensure a comfortable experience for users. The number of elevators required is determined based on the number of users in the building, and it is preferable to locate them near the entrance for ease of access.

Elevators must have a minimum clear width of 1.10 meters and a minimum clear depth of 1.40 meters. The mobility space in front of the doors must be at least 1.50 m wide and 1.50 m deep, and it must be as large as the car's floor area.

The speed of the elevator in administrative buildings:

- 5 floors → 30 m/min.

- 8 floors → 40 m/min.

- 20 floors → 150 m/min.

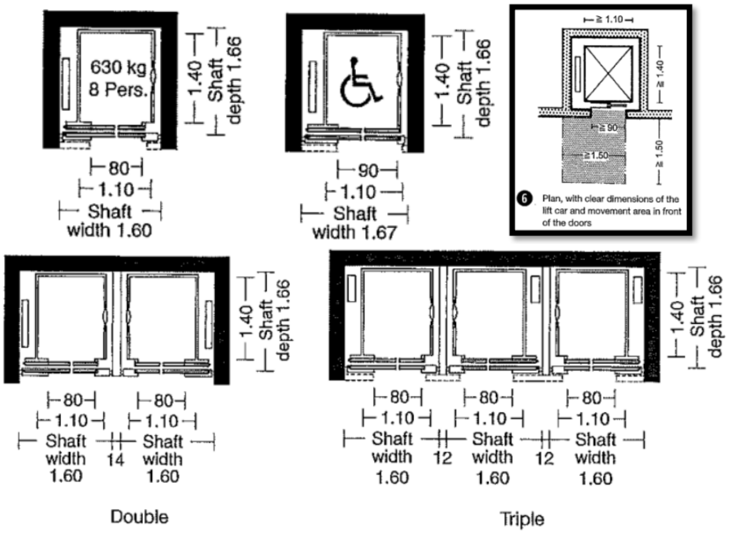


Figure 2-14Elevator's standard (Neufert 4th edition, 2015)

Elevators in the building:

In the main elevators in the building, It Could be noticed that the elevators in the building matches the standard and satisfy all the required dimensions either for the normal users or for the users with disabilities like having a wheelchair.

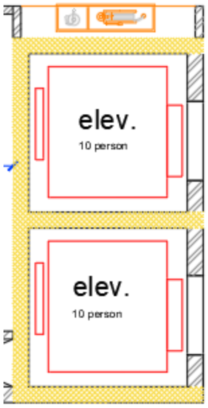


Figure 2-15the elevator in the building

Calculating the number of elevators:

(offices) consisting of 7 floors, with a floor area of 660

Calculating

Total area =4592M2

Net area for person =10-12m2/person

PHC= (14-16) %

Population =Total area/10=4592/10=459person

HC =%Hc*population=0.16*459=73.44Person/5minute

Compute rise in order to determine the options, Rise = (7-1)*4=24

Minimum car speed: = 350fpm - 400fpm

Capacity options = 2500 lb / 3000 lb /3500 lb

Interval (I) = 25-29 second

Table 2evaluate number of elevator in office building

	2500/400	2500/300	3000/400	3000/300	3500/400	3500/300
	13	13	16	16	19	**19**
p	95	98	105	110	115	**119**
RT	41.05	39.79	45.71	43.64	49.57	**47.9**
hc	1.78	1.845689872	1.606650623	1.682859762	1.481541255	**1.533194154**
N	1	1	1	1	1	**1**
N*	95	98	105	110	115	**119**
I	8.94335512	8.668845316	9.958605664	9.507625272	10.79956427	**10.43572985**
PHC	2	2	2	2	2	**2**
N2	47.5	49	52.5	55	57.5	**59.5**
I2	17.88671024	17.33769063	19.91721133	19.01525054	21.59912854	**20.87145969**
PHC	3	3	3	3	3	**3**
N3	31.66666667	32.66666667	35	36.66666667	38.33333333	**39.66666667**
I3	26.83006536	26.00653595	29.87581699	28.52287582	32.39869281	**31.30718954**
PHC	4	4	4	4	4	**4**
N4	23.75	24.5	26.25	27.5	28.75	**29.75**
I4	35.77342048	34.67538126	39.83442266	38.03050109	43.19825708	**41.74291939**

PHC	not acceptable	not acceptable	not acceptable	not acceptable	not acceptable	**not acceptable**

To evaluate the elevators in our building in a right way the following tables were used from the (MEEB Book, 11th Edition), the main goal is to make the waiting time for the users as less as possible.

According to the results shown above, it is clear that the building needs a fourth elevator. But three elevators were sufficient based on the limited building area and that the building is less crowded.

The following tables used in calculation:

Table 3the car passenger capacity (p)

Facility Type	Interval (sec)	Waiting Time[a] (sec)
OFFICE BUILDINGS		
Excellent service	15–24	9–14
Good service	25–29	15–17
Fair service	30–39	18–23
Poor service	40–49	24–29
Unacceptable service	50+	30+

Table 4 the minimum percent handling capacities (PHC)

Table 2.5: The car passenger capacity (Table 31.5 from MEEB Book, 11th Edition)

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

Table 5 the population of typical buildings for estimating elevator and Escalator requirements

Building Type	Net Area
OFFICE BUILDINGS	FT2 PER PERSON (M2/PERSON)
Diversified (multiple tenancy)	
Normal	110–130 (10–12)[a]
Prestige	150–250 (14–23)
Single tenancy	
Normal	90–110 (8–10)
Prestige	130–200 (12–19)

Table 2.6: The minimum percent handling capacities (Table 31.6 from MEEB Book, 11th Edition)

Facility	Percent of Population to Be Carried in 5 Minutes
OFFICE BUILDINGS	
Center city	12–14
Investment	11.5–13
Single-purpose	14–16

Table 2.8: The elevator equipment recommendations (Table 31.9 from MEEB Book, 11th Edition).

	Car Capacity[a]		Rise		Minimum[a] Car Speed	
Building Type	**lb**	**kg**	**ft**	**m**	**fpm**	**m/s**
Office building	2500 3000 3500	1250 1250 1600	0–125 126–225 226–275 276–375 Above 375	0–40 41–70 71–85 86–115 >115	350–400 500–600 700 800 1000	2.0 2.5 3.15 4.0 5.0

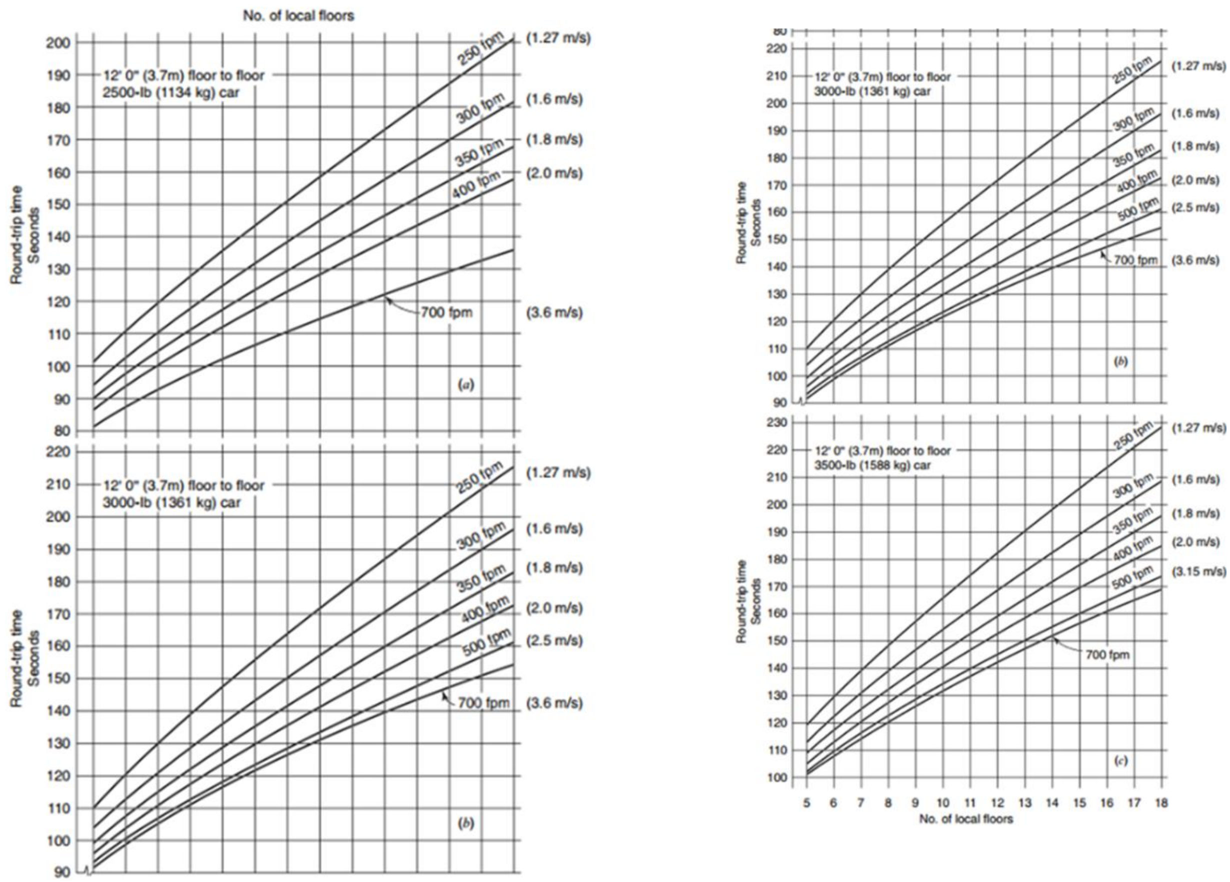


Figure 2-16Relationship between No of local floor & time

9. W.C:

a room containing a bath or shower and typically also a washbasin and a toilet.

(Adler, 1999)Table 6 number of bathroom in standard.

Sanitary appliances for any group of staff		
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	
Alternative scale of provision of sanitary appliances for use by male staff only		
Number of men at work	**Number of WCs**	**Number of urinals**
1 to 15	1	1
16 to 30	2	1
31 to 45	2	2
46 to 60	3	2
61 to 75	3	3
76 to 90	4	3
91 to 100	4	4
Above 100	One additional WC for every unit or fraction of a unit 50 men provided at least an equal number of additional urinals are provided	
If public also use staff toilets, add 1 to each number of conveniences above		
If work involves heavy soiling of hands and forearms		
Number of persons at work	**Number of washing stations**	
1 to 50	1 per 10	
more than 50	1 additional per 20 or part of 20	

We checked the bathrooms in this building according to this standard And their number is enough ,And available bathroom for people with disabilities

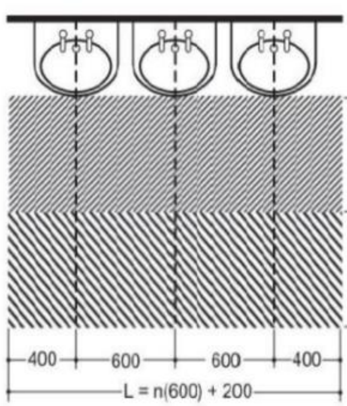


Figure 2-38 Range of hand-rise basins (non-recessed), activity and circulation spaces

Figure 2-38 Range of hand-rise basins (non-recessed), activity and circulation spaces

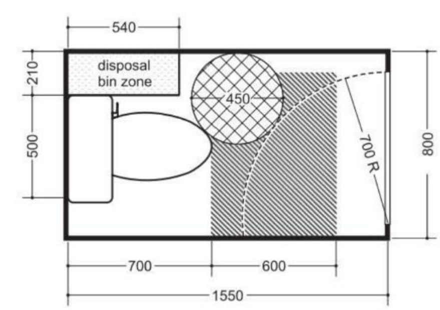


Figure 2-39 WC cubicle, inward-opening door, sanitary bin zone

(Buxton & Pamela, 2015)

Figure 2-17 Dimension of WC's

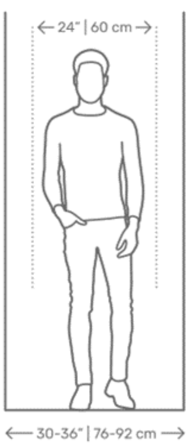
Table 6 calculate Number of WC in our Building

floor	Area	number of person	number of wc
GF	610.6	61.06	3
1 floor	610.6	61.06	3
2 floor	600	60	3
3 floor	600	60	3
4 floor	600	60	3
5 floor	600	60	3
6 floor	600	60	3
7 floor	600	60	3

so the bathroom **ok**

10. Corridors:

hallways, are long passages in a building with doors on one (single-loaded) or both sides (double-loaded). corridors provide the most efficient horizontal means of access and egress to a large amount of rooms. For high density apartment buildings, hallways are shared between many residential units and connect back to vertical modes of circulation in the form of stair cores and elevator lifts. Corridor widths vary to service diverse demands from single users in private homes to large groups of people in public facilities.



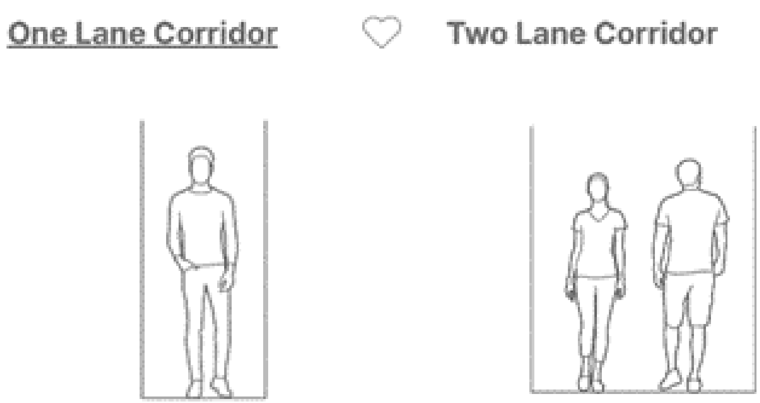
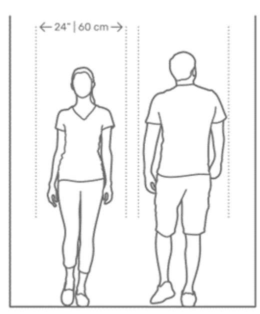


figure 7 corridors One line

figure8 corridors two line



The corridor in plan ok

11. Parking:

Having sufficient parking space for both employees and visitors is crucial to avoid any inconvenience of parking far from the building or in a no-parking zone. The parking facility can be located around the building on the site or underground, depending on the availability of space and to make optimal use of the area.

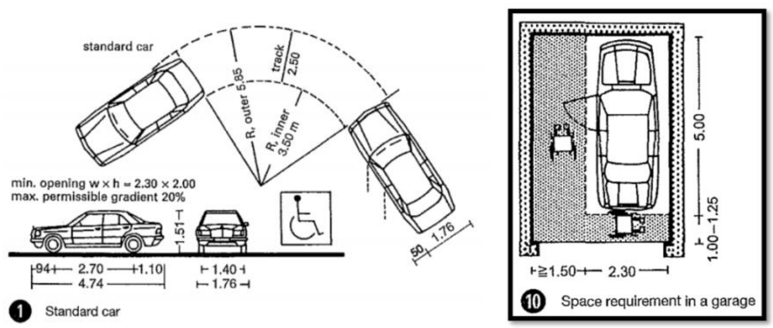


Figure 2-18Space requirement in parking (Neufert 4th edition, 2015)

The driving path between the parks must be wide depend on the style you use when you arrange your parks, but it’s preferable not to be less than 5 m. The dimensions of the standard garage are (2.5 * 5.5 m), these dimensions could be less in private buildings and could be more like if the parking is borders by pillars, walls and columns:

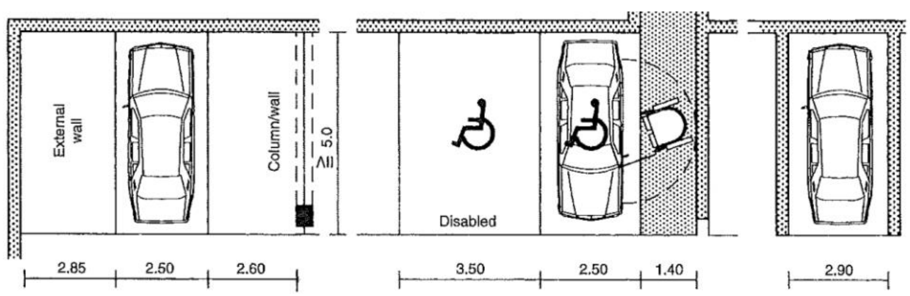


Figure 2-19Space requirement in parking (Neufert 4th edition, 2015)

parking standard:

accessible entrance for building

According to (N.D (2012)-IBC) codein public building at least 60 % of all public entrance shall be accessible.

1-Parking garage: where provided direct access for pedestrians from parking structure to building or facility entrance shall be accessible (N.D (2012)-IBC Code))

2-Entrances from tunnels or elevated walkways: at least one entrance to the building from each tunnel or walkway shall be accessible.

3- Restricted entrance: at least one restricted entrance to the building.

4- Entrance for inmates or detainees: this entrance used only for inmates or detainees, at least one entrance to the building.

5- Service entrance.

parking and passenger loading facility:

table shows Accessible parking spaces, this table from (N.D (2012)-IBC code **Shows** the relation between total number of bays and minimum number of accessible spaces:

TOTAL PARKING SPACES PROVIDED	REQUIRED MINIMUM NUMBER OF ACCESSIBLE SPACES
1 to 25	1
26 to 50	2
51 to 75	3
76 to 100	4
101 to 150	5
151 to 200	6
201 to 300	7
301 to 400	8
401 to 500	9
501 to 1,000	2% of total
1,001 and over	20, plus one for each 100, or fraction thereof, over 1,000

figure 9 Required minimum number of accessible spaces

parking spaces and types:

Parking spaces are usually outlined by 12-20 mm wide yellow or white painted lines. When parking is facing a wall, these lines are often painted at a height of up to 1 m for better visibility.

{nuefert.3 TH}. Where cars are parked in the parking lot facing the wall or facing each other, in this case, cross barriers can be used.

These photos show bays size according to parking shape: (Wiley,J(2012).Neufert E. West Sussex, P019 8SQ, UK: Blackwell)

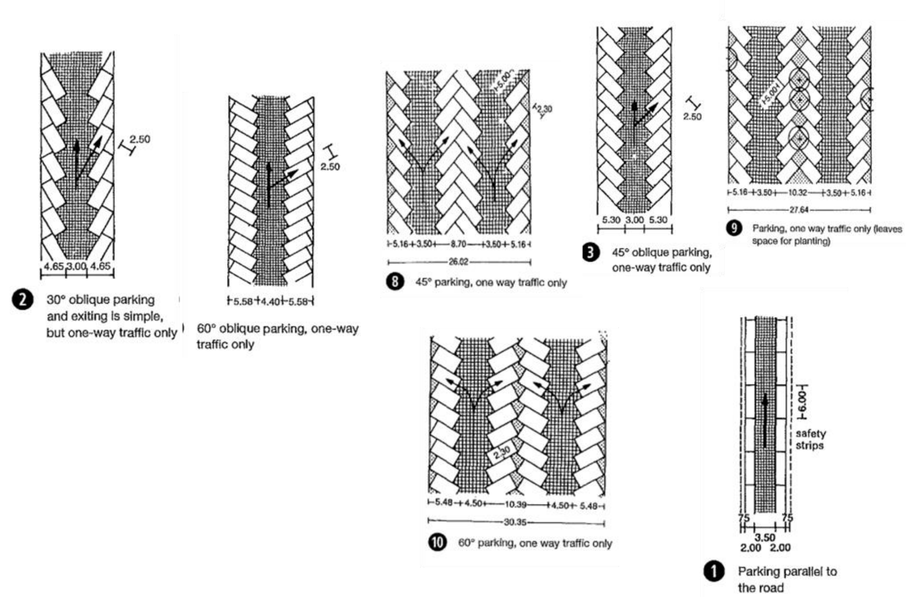


Figure 2-20bays size according to parking shape

according to (Wiley,J(2012).Neufert E. West Sussex, P019 8SQ, UK: Blackwell) /planning standard design and good practice supplementary planning document]

vehicle size: Minimum bay size for vans {7.5 * 3.5m**]**

Minimum bay size forcers

{5 * 2.5m only used exceptional circumstances

According to the Palestinian Building Law, Article 31, Specifications for Car Parks

1- The length of the car park shall not be less than 55 and the width of the car park shall not be less than 25

2- The width of the outer passage shall not be less than:

A- 3.5 for parking spaces of no more than 30 carsB-5.25 for car parks with more than 30 cars, and in the event that a separate entrance and exit are provided, item A applies.

multi-story car parking:

For multi-story car parks the requirements for the layout of parking spaces and access are in principle the same as for open car parks{ (Wiley,J(2012).Neufert E. West Sussex, P019 8SQ, UK: Blackwell) }. The proper parking width is 23, however, FGVS recommends a minimum width of 25. All structural elements must be fire-resistant, and the recommended floor height for multi-story parking is from 2.75 to 3.

In the multi-story parking, there are openings that cannot be closed, which leads to open air with a size of one third of the total area of the envelope wall, with the opposite wall at a maximum distance of 70 m This provides good ventilation and protection from external weather factors.(Wiley,J(2012).Neufert E. West Sussex, P019 8SQ, UK: Blackwell)

parking number:

Minimum According to the Palestinian Building Law Article 28.2011 {one car parking must be provided for Every 70 square meters of construction area in office buildings}.

According to metric hand book, {offices: staff; one space for each 25 m2 of gross floor area, or one space for each managerial and executive staff, plus one space for others visitors 10% of the staff parking provision.The following table will show the number of employees on each floor in **the Palestinian Anti-**Corruption Commission building

Note: This number has been calculated based on the space allocated for each person, taking into account the function of the room.

number of managerial and executive staff = 29

each one need one space {29 parking space}

➔number of other employee = 206

each four need one space {52 parking space}

➔**total** number of parking for employees = 81

plus 10 % of the staff parking for visitor {9parking}

total number of parking needed for this space = 90 spaces

number of parking available for this building = 75 space {not enough}

12. Ramps:

Ramps are a vital element in modern buildings to ensure accessibility for people with disabilities, particularly those using a wheelchair. The presence of ramps allows them to navigate the building safely and independently, making it easier to move through the various facilities and spaces within the building.

The max slope is 6% for the ramps and it’s always better for them to be straight not curved to make it easier for them to move.

If the ramps are longer than 6 meters, an intermediate landing with a min length of 1.50 m is necessary

The width must be at least 1.5 m in corridors, main routes and next to stairs up and down.

- The doors must be with width of 0.9 m at least for clear passage. Toilets changing rooms and showers must open outward

Elevators must have a min clear width of 1.10 m and a min clear depth of 1.40 m. The mobility space in front of the doors must be at least 1.50 m wide and 1.50 m deep, and it must be as large as the car’s floor area

The standards are the following

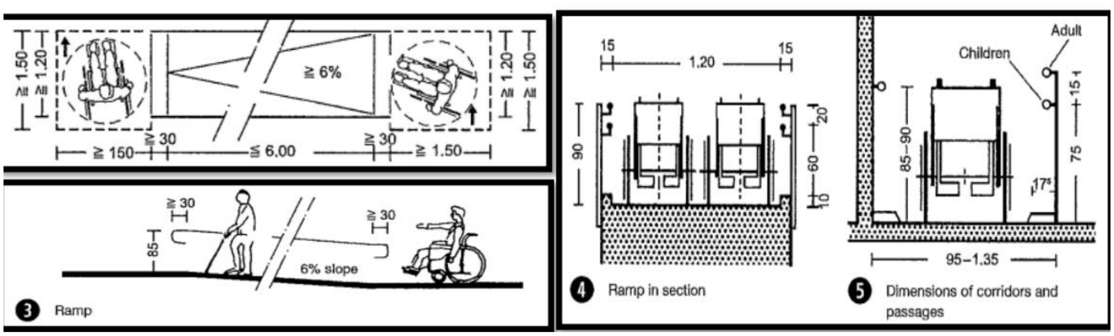


Figure 2-21 Dimension Ramp that fit wheelchair (Neufert 4th edition, 2015)

Table VIII Maximum ramp length between landings

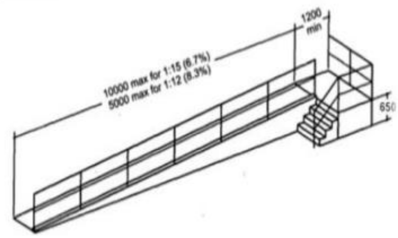
Gradient	Length of ramp between level landings (m)
1:20	10
1:19	9
1:18	8
1:17	7
1:16	6
1:15	5
1:14	4
1:13	3
1:12	2

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

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

Any ramp should also have:

- A level landing at the top and bottom of the same width as that of the ramp and at least 1.2 m long
- Any intermediate landing of the same width as that of the ramp and at least 1.5 m long; landings should be clear of any door swinging onto it
- Handrails on both sides of the ramp
- Any open side of a ramp or landing should have a 100 mm high kerb.



Design Ramp (Neufert 4th edition, 2015)Figure2 22-

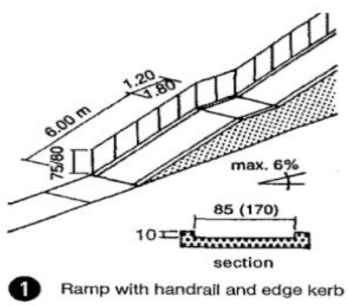


Table V Space required for users of self-propelled wheelchairs to turn through 180° (Figure 4.7)

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

* 90% of uses.

Figure2 23-Space required for wheelchair (Neufert 4th edition, 2015)

Reception in the building

The reception area has a pretty good dimensions and it’s near the entrance and very visible for the visitors.

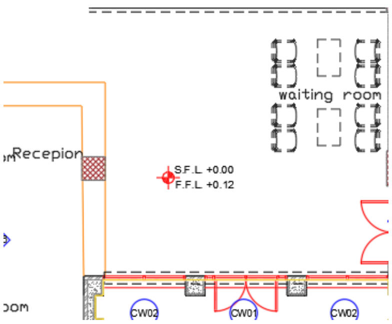


Figure 2-22the recaption in building

	in	cm
A	40–48	101.6–121.9
B	24 min.	61.0 min.
C	18	45.7
D	22–30	55.9–76.2
E	78 min.	198.1 min.
F	24–27	61.0–68.6
G	36–39	91.4–99.1
H	8–9	20.3–22.9
I	2–4	5.1–10.2
J	4	10.2
K	44–48	111.8–121.9
L	34 min.	86.4 min.
M	44–48	111.8–121.9
N	54	137.2
O	26–30	66.0–76.2
P	24	61.0
Q	30	76.2
R	15–18	38.1–45.7
S	29–30	73.7–76.2
T	10–12	25.4–30.5
U	6–9	15.2–22.9
V	39–42	99.1–106.7

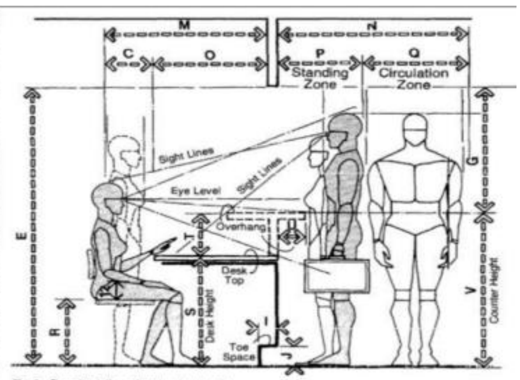


Fig. 2 Receptionist's workstation/desk height.

Figure 2-23 Standard Reception (Neufert 4th edition, 2015)

2.3.2 Emergency standard:

According (Palestinian Civil Defense Code)p(71-76)

Fire Escape Stairs:

(It is a non-insulated, lightweight external drawer made of metal),If the fire escape method consists of an internal staircase and a fire escape staircase, each must meet the fire protection requirements of indoor stairs and fire escape drawers.

Handle:

Fire escape inserts are provided with walls or handrails on each side that are not less than 0.75 meters high and not more than 1.05 meters.

Material resistance:

Non-combustible materials such as: iron, steel or letter, shall be used in the establishment of fire escape drawers, balconies and other staircase components, as approved by the competent official authority.

Number of exits:

(1) The number of exits serving a floor, balcony or two scales shall not be less than two separate and spaced exits, except as stipulated in this Code for each occupancy case shown in sections V to XII. The number of exits in the building shall not be less than: Three separate and spaced exits if the work load ranges between 500-1000, Four separate and spaced exits if the occupancy load exceeds (1000) person.

By " (n.d(2012).IBC)" p (293-279)

In General, Buildings or portions thereof shall be provided with a means of egress system as Required by this chap ter. The provisions of this chapter shall control the design, Construction and arrangement of means of egress components required to provide an Approved means of egress from structures and portions thereof.

Minimum requirements: It shall be unlawful to alter a building or structure in a manner that Will reduce the number of exits or the capacity of the means of egress to less than Required by this code. Maintenance: Means of egress shall be maintained in accordance with the International Fire Code.

Fire safety and evacuation plans: Fire safety and evacuation plans shall be provided for all Occupancies and buildings where required by the International Fire Code. Such fire safety and evacuation plans shall comply with the applicable provisions of Sections 401.2 and 404 Of the International Fire Code.

GENERAL MEANS OF EGRESS:

1. Applicability: The general requirements shall apply to all three elements of the means of egress system, in addition to those specific requirements for the exit access, the exit and the exit dis charge detailed elsewhere
2. Ceiling height. The means of egress shall have a ceiling height of not less than 7 feet 6 inches (2286 mm) Exception:
    1. sloped ceiling in accordance
    2. Ceilings of dwelling units and sleeping units within residential occupancies
    3. Allowable projections
    4. Stair headroom
    5. Door height
    6. Ramp headroom
    7. The clear height of floor levels in vehicular and pedestrian traffic areas in parking garages in accordance with Section
    8. Areas above and below mezzanine floors in accordance

- Floor surface:

Walking surfaces of the means of egress shall have a slip-resistant surface and Be securely attached.

- Means of egress continuity:

The path of egress travel along a means of egress shall not be Interrupted by any building element other than a means of egress component as specified, Obstructions shall not be placed in the required width of a means of egress except Projections per mitted. **By** (N.d,(2012).IBC)**" p (293-279)**

- Elevators, escalators and moving walks:

Elevators, escalators and moving walks shall not be Used as a component of a required means of egress from any other part of the building. (N.d(2012).IBC)

- Design occupant load:

In determining means of egress requirements, the number of Occupants for whom means of egress facilities shall be provided shall be determined.

- Intervening spaces:

Where occupants egress from one room, area or space through another, the design occupant load shall be based on the cumulative occupant loads of all rooms, areas or spaces to that point along the path of egress travel.

- Stairways:

The capacity, in inches (mm), of means of egress stairways shall be calculated by multiplying the occupant load served by such stairway by a means of egress capacity factor of 0.3 inch (7.6 mm) per occupant. Where stairways serve more than one story, only the occupant load of each story considered individually shall be used in calculating the required capacity of the stair ways serving that story. (N.d(2012.IBC)

- Other egress components:

The capacity, in inches (mm), of means of egress components other than stairways shall be calculated by multiplying the occupant load served by such component by a means of egress capacity factor of 0.2 inch (5.1 mm) per occupant.

- Continuity:

The capacity of the means of egress required from any story of a building shall not be reduced along the path of egress travel until arrival at the public way.

- Distribution of egress capacity:

Where more than one exit, or access to more than one exit, is required, the means of egress shall be configured such that the loss of any one exit, or access to one exit, shall not reduce the available capacity to less than 50 percent of the required capacity.

- Egress convergence:

Where the means of egress from stories above and below converge at an intermediate level, the capacity of the means of egress from the point of convergence shall not be less than the sum of the required capacities for the two adjacent stories.

- Doors.

Doors, when fully opened, shall not reduce the required width by more than 7 inches 178 mm. Doors in any position shall not reduce the required width by more than one-half (N.D(2012).IBC)

Improvement:

In order to address the limited parking spaces in the building and improve traffic flow, we have added a parking facility with a circular movement pattern. Additionally, a ramp has been installed to provide easier access to the building. The parking area has been expanded to accommodate a larger number of vehicles within the available space. We have made modifications to the emergency staircase, widening it and improving the exit to comply with fire safety regulations. Furthermore, the windows in the building have been enlarged to allow for sufficient natural lighting and ventilation. We have also implemented architectural and environmental modifications, such as adding solar chimneys to the top three floors. And make a double volume in first &second floor

2.4 case study

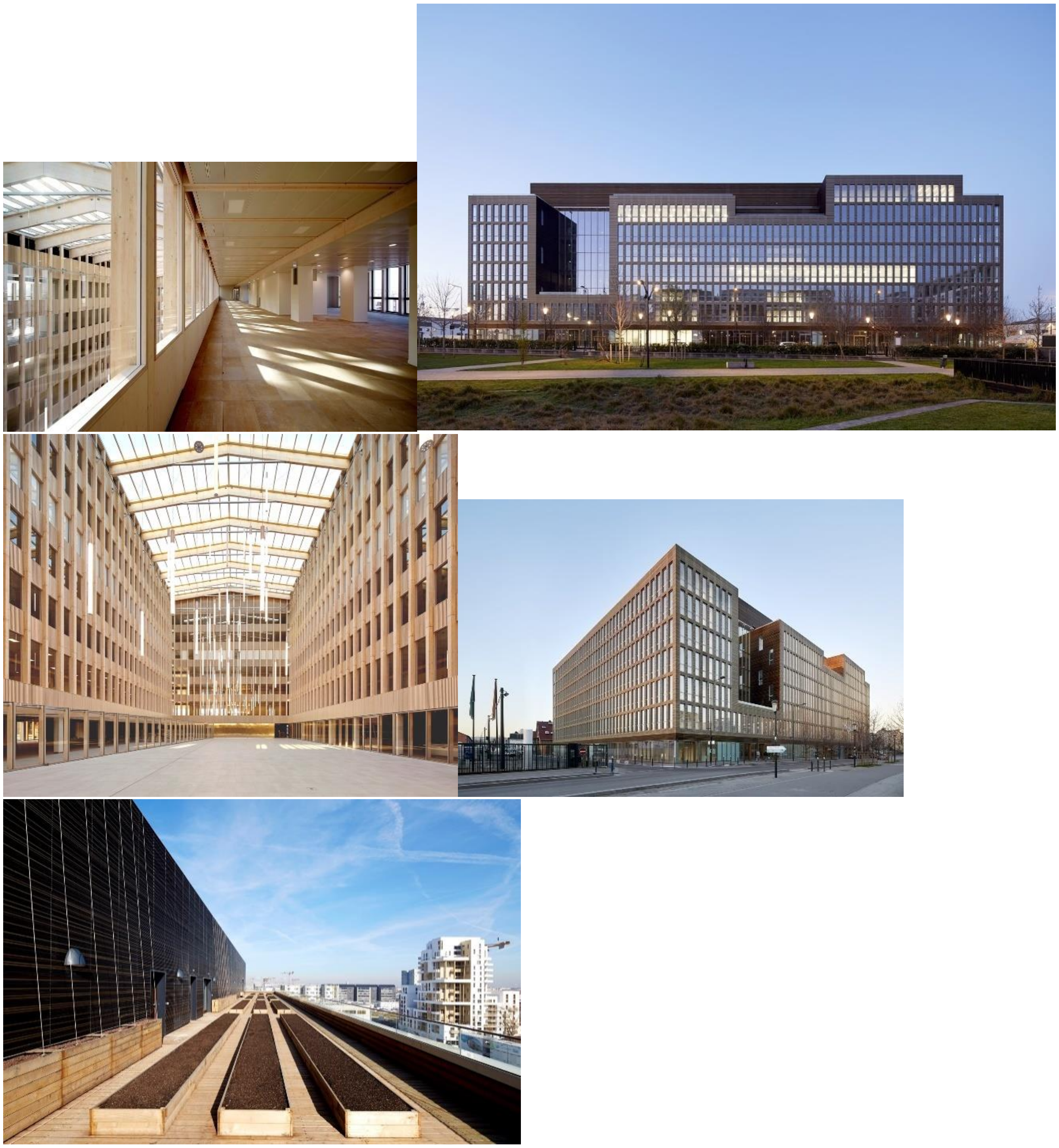


Figure 2-24case study photo

1.1.1 case study location:

from arch daily

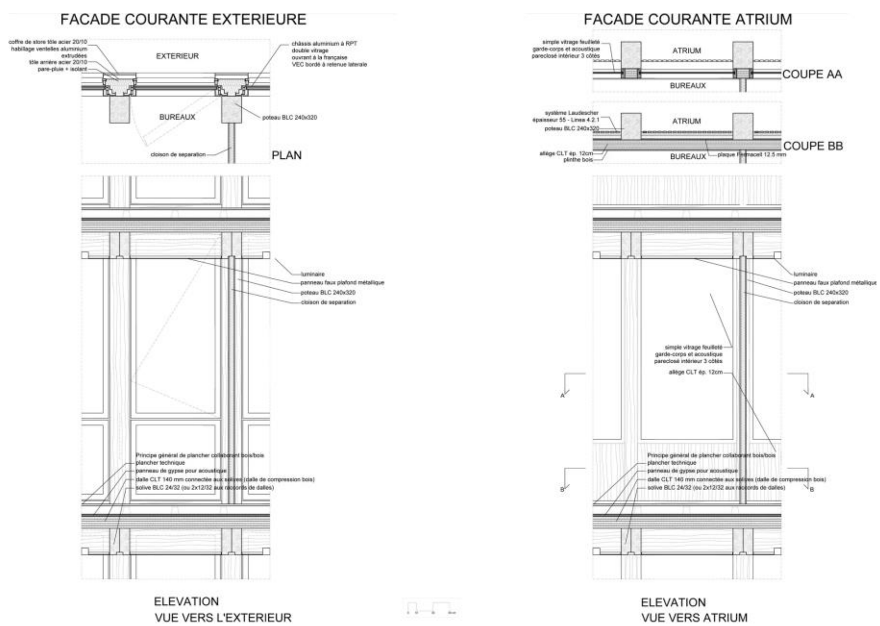
Location: Saint-Denis, France

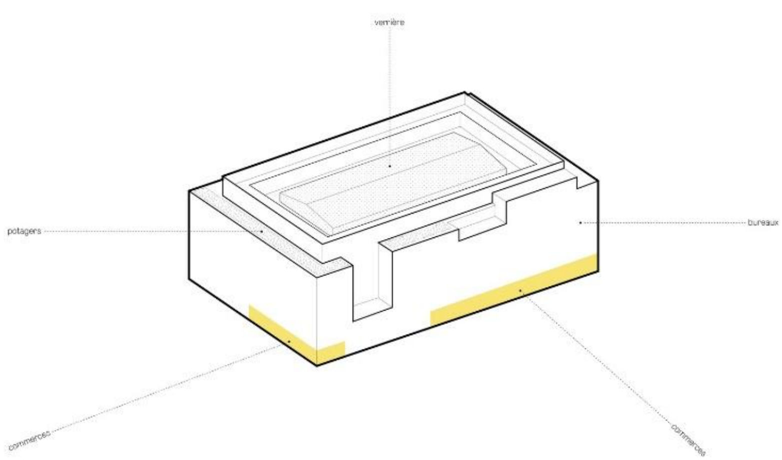
Completion: 2019

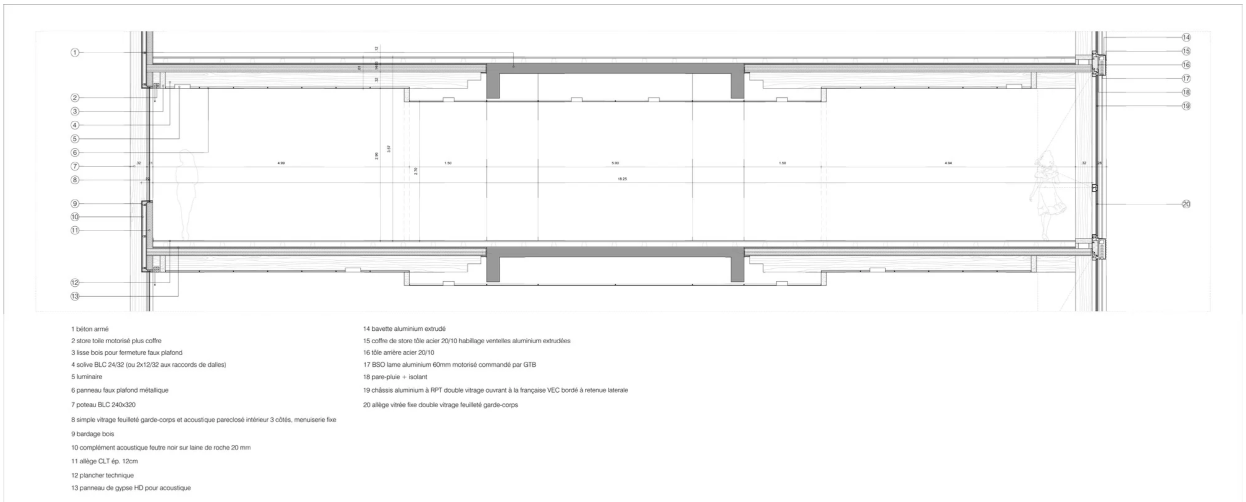
Gross Floor Area: 29,450 m^2

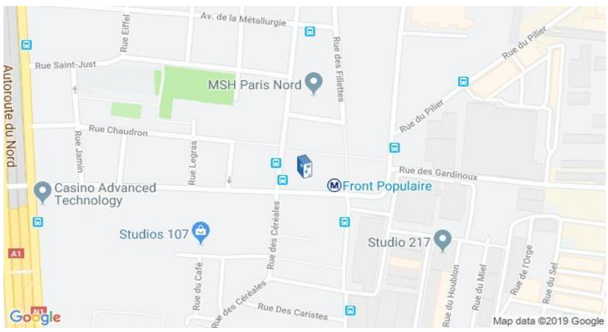
Costs: 65,700,000 Euros

Wood Structure: Barthes Bois









Façades: Arora

Figure 2-25section in case study building

Figure2-2 26-case study location

1.1.2 Disruption

Pulse is a seven-story office building. The building's core – a vast atrium – is covered with a glass roof letting the natural coming into the wooden nave. The rigor of the construction system contrasts with the warm atmosphere and colors of the workplace

Wood can be found in all parts of the building, from the entrance hall to the many floors, creating a warm, quiet and peaceful work environment. The building structure is dual, mixing core elements in concrete with wooden columns, beams and floors. Services and facilities for employees, including three catering areas, are located around the atrium on the ground floor. An urban garden and terraces can be found on the last floor

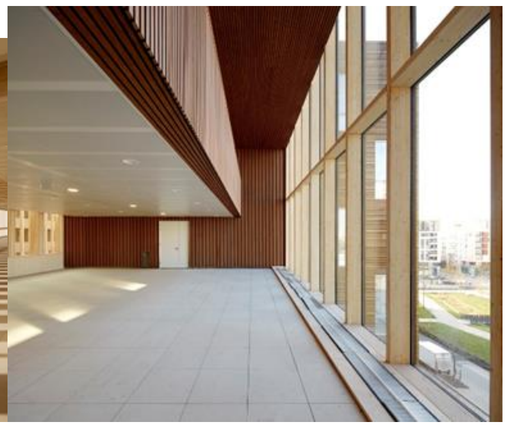


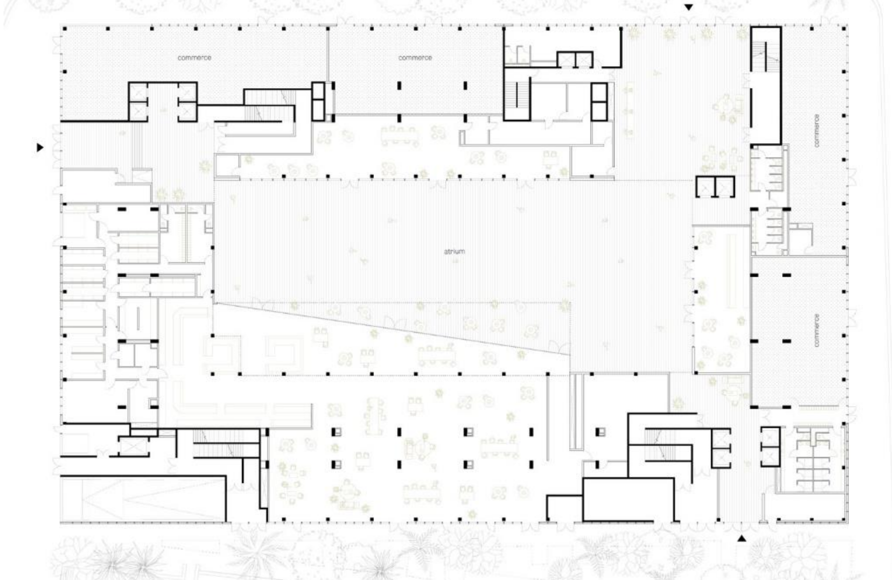
Figure 2-27material use in our case study building

The façade of this building is made up of three layers of wood, protected by aluminum slats of three different colors. The metal, concrete and glass that give this project its material identity are replaced with timber, a warm, cozy natural material antithetical to cold Rationalism.

Fassio, Viaud and Bocabeille use a soft, natural form of Rationalism in which not only the walls but the beams, columns, ceilings and floors are covered with timber. Warm hues of this natural material reverberate throughout the building, contrasting with the rigor of its construction.

Pulse will primarily contain offices and workspaces, as well as service areas and leisure facilities. The building's countless windows are repeated without interruption all over the building, letting daylight into every part of its interior. On the top floor are a big city garden with terraces and a bar and coffee shop, all open to the public.

The pulse office building has been designed to provide all the advantages of a leading, modern building office with an excellent geospatial situation and easy national and international access. The building's cladding, made of aluminum sheeting in three different colors, sparkles in the light of the sun, underlining its friendly rigor while sheltering it against the weather.



1.1.3 plans

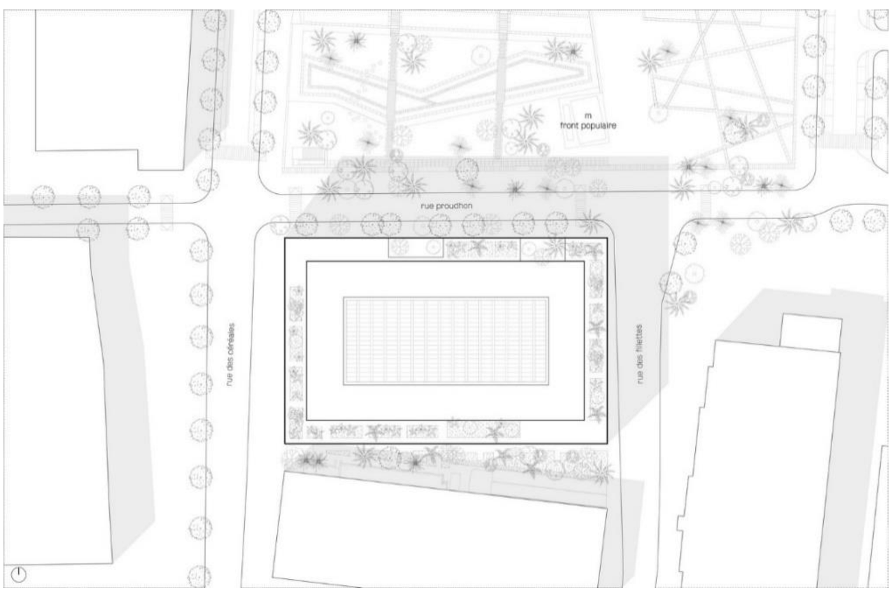


Figure 2-28plan of case study building

2.site

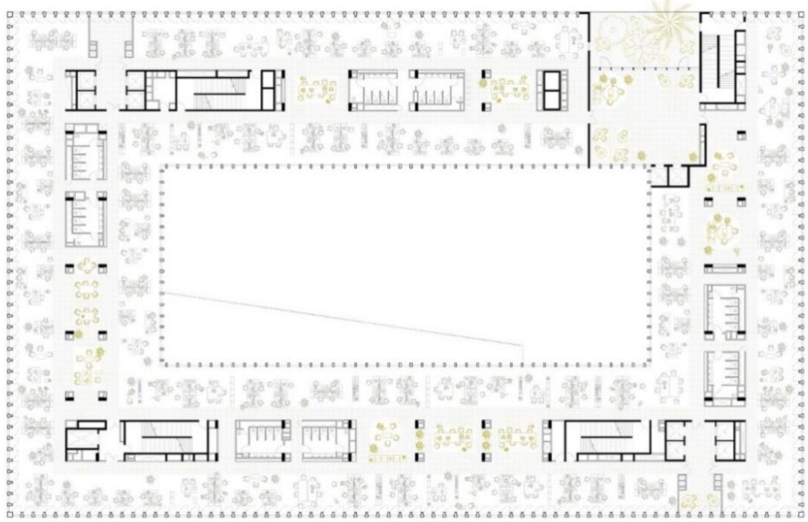
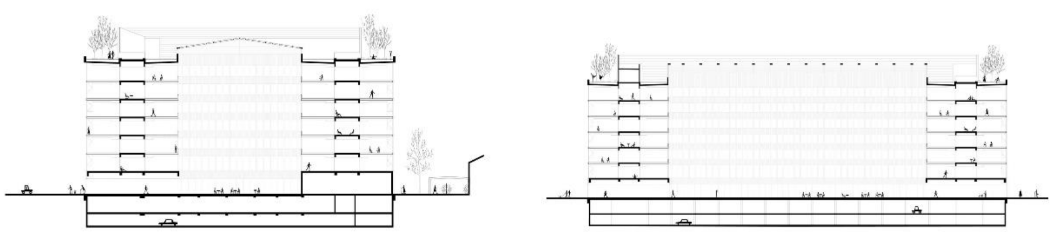


Figure 2-29site of case study



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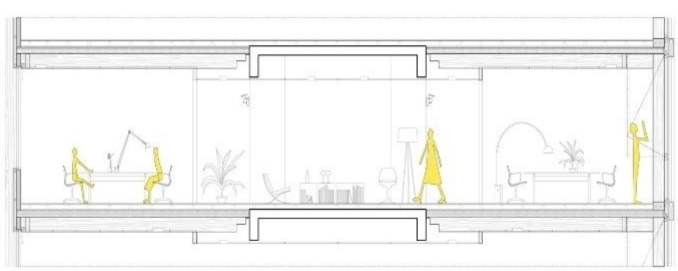
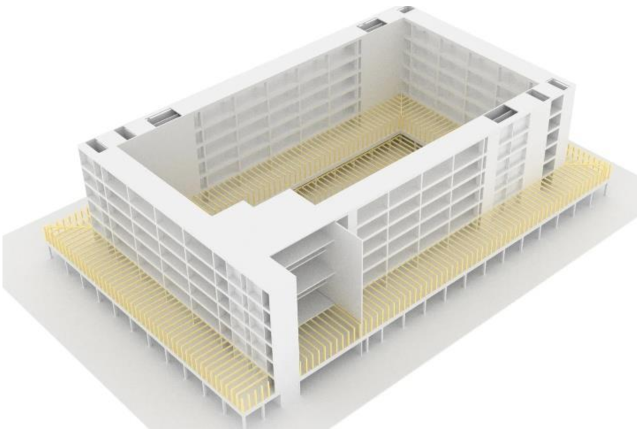
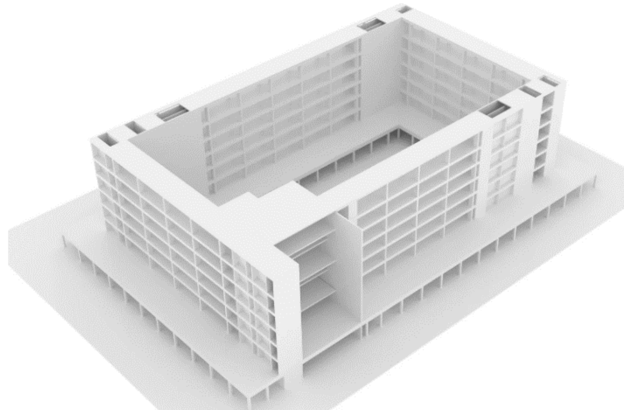
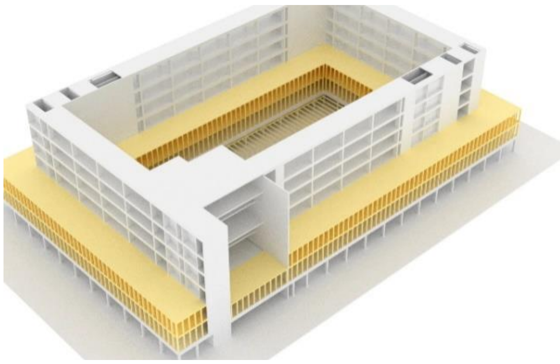


*Figure 2-30*section of case study

1.1.4 <u>3d modeling:</u>







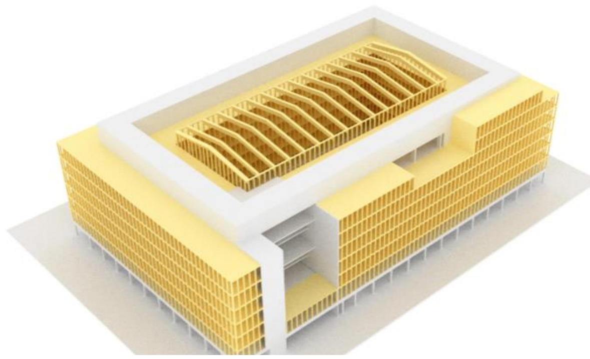


Figure 2-313D modeling

2.5 Architectural 3D Model use Lumion program

Figure 2-32 Architectural 3D Model

Figure 2-33Architectural 3D Model

Figure2-234- Architectural 3D Model

Figure 2-35 Architectural 3D Model

2.6 Site analysis:

2.6.1 Introduction:

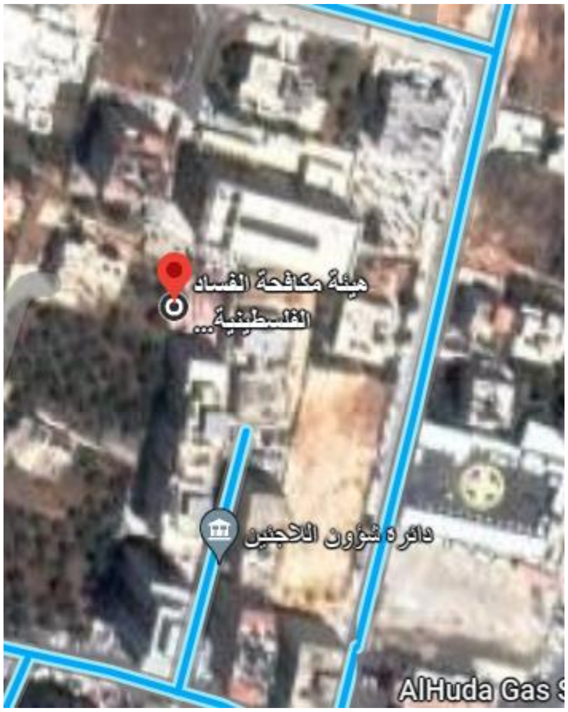
A site analysis process will look at issues such as site location, size, topography, zoning, traffic conditions and climate. The analysis also needs to consider any future developments, or changes to the site's surroundings, such as a change of road designations, changing cultural patterns, or other significant building developments within the area. Then, the result is use as a starting point for the development of environment-related strategies during the design process. where all these things must be taken into account to obtain an optimal comfort For users.

1. Location and description & Site accessibility & Site roads:

Anti Corruption Building in" maka street" in Al-Bireh - Ramallah on latitude 31.5419° and 35.1254°..Ramallah is located in the middle of the central mountain range of Palestine within the Jerusalem mountain range. The city rises above sea level between 830-880 meters.

The building is in an active and crowded place due to its location as the movement is crowded during the expected working hours of the institution and the movement is active at night also in the area as it is a vital area in the city.

As the building is located on a corner, where it borders two main streets and is expected to be a source of high nuisance, and from the east side there is the a palestine liberation organization department of refugee building which will negatively affect the sunlight that was It can be used positively for the building.



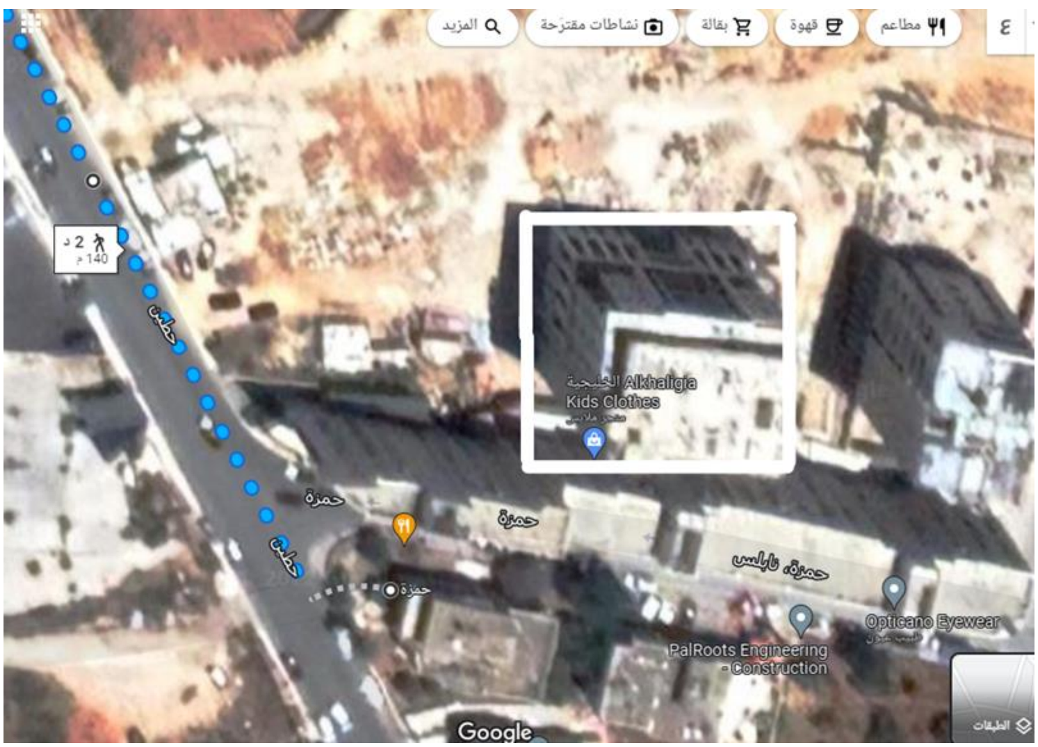


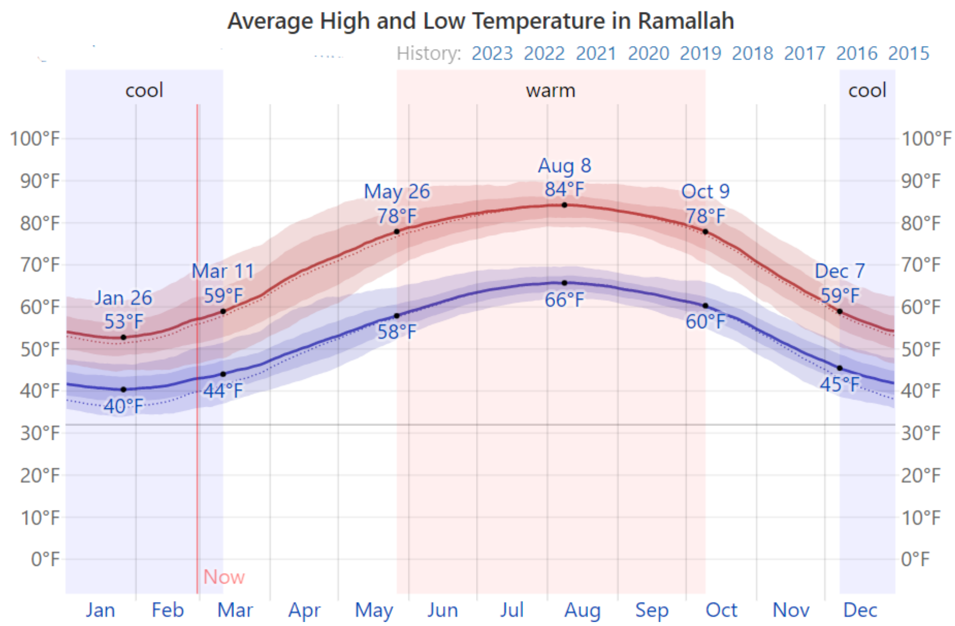
Figure 2-36 Location of Anti-Corruption Commission Building .

2. Topography & Area:

There is a very slight slope to the land, as the lowest point is at a height of 840.7 and the highest point is at a height of 841, meaning that the land is almost flat.

Temperature:

The temperature in Palestine ranges between 9-24 degrees Celsius and may reach a maximum of about 40 degrees Celsius in the hot summer during the day and may reach in the cold winter to approximately -3 degrees Celsius, as the Ramallah area has an average temperature a little high.



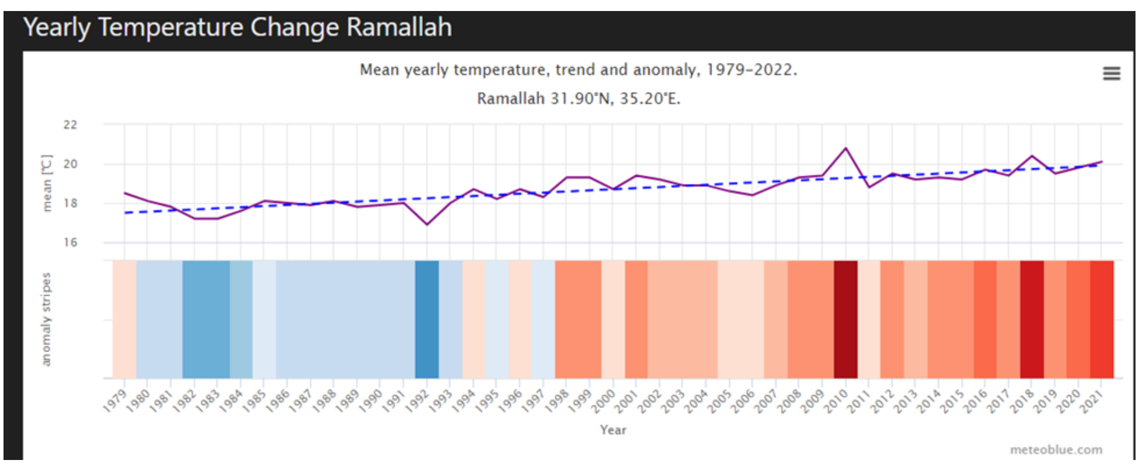


Figure 2-37 estimate of the mean annual temperature for the larger region of Ramallah

The top graph shows an estimate of the mean annual temperature for the larger region of Ramallah. The dashed blue line is the linear climate change trend. If the trend line is going up from left to right, the temperature trend is positive and it is getting warmer in Ramallah due to climate change. If it is horizontal, no clear trend is seen, and if it is going down, conditions in Ramallah are becoming colder over time.

In the lower part the graph shows the so called warming stripes. Each colored stripe represents the average temperature for a year - blue for colder and red for warmer years. "(Climate Change Ramallah - Meteoblue, 2022).

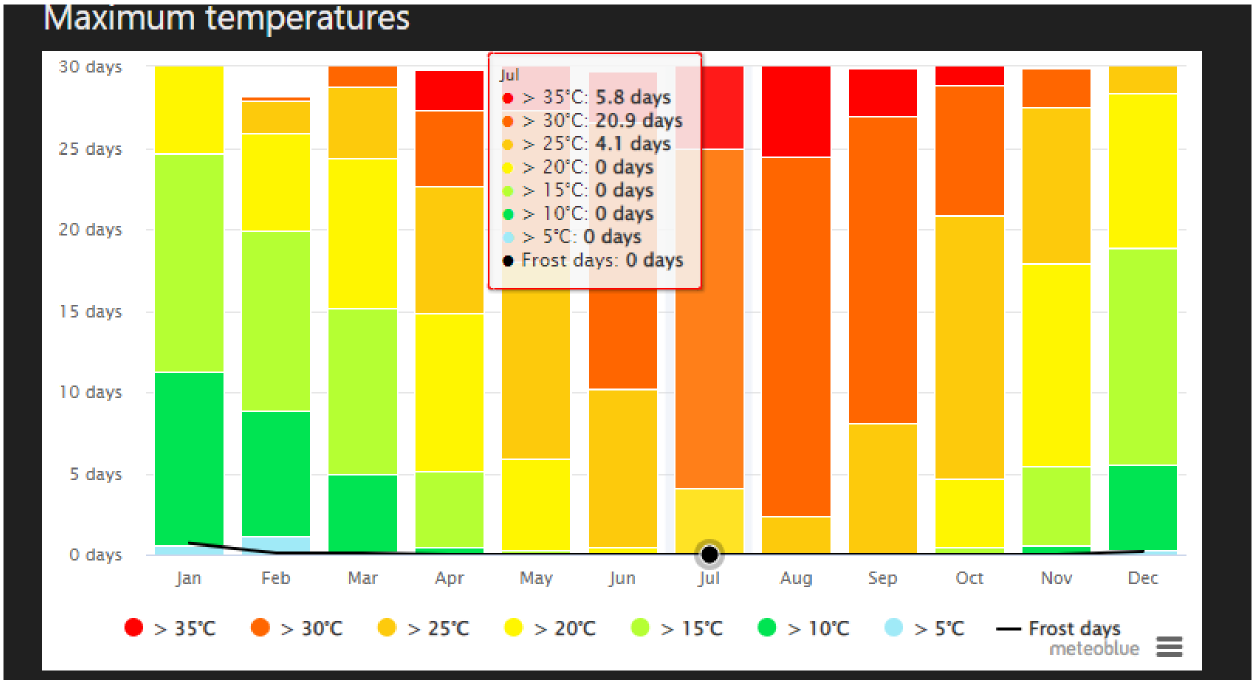


Figure 2-38 Ramallah climate temperature(Climate Change Ramallah - Meteoblue, 2022

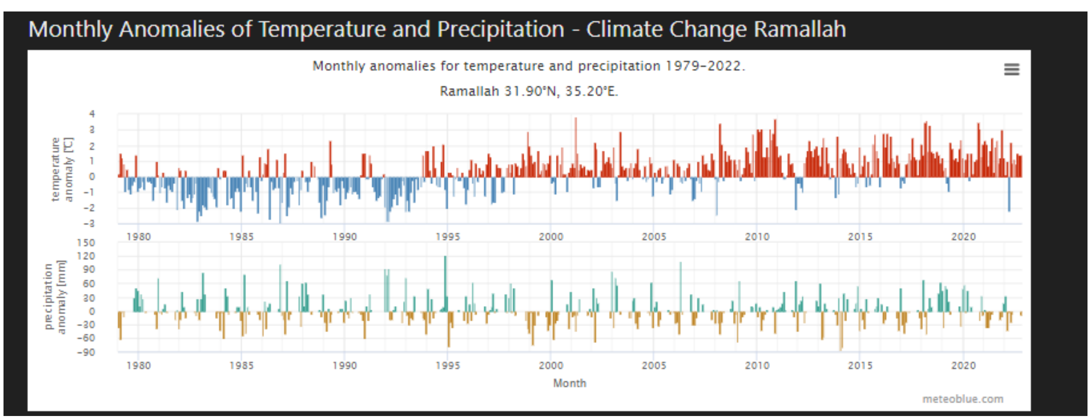
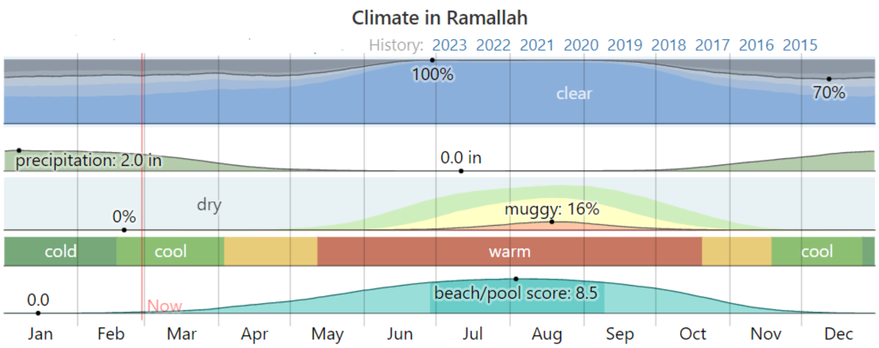


Figure 2-39Monthly anomalies for temperature and precipitation 1979-2022

3. Climate:

In this project, the climate of the city of Ramallah-Al-Bireh must be studied, which is characterized by a moderate climate as it is located within the Mediterranean basin at a length of 35.20 and a latitude of 31.90, and the summer season extends for more than 5 months per year and the climate is dry and hot, and extends the short, cold, rainy winter season that does not exceed 3 months most of the time.



4. Humidity:

The relative humidity in Ramallah reaches 65%, which is the average annual rate, as humidity is generally affected by temperature and wind speed .

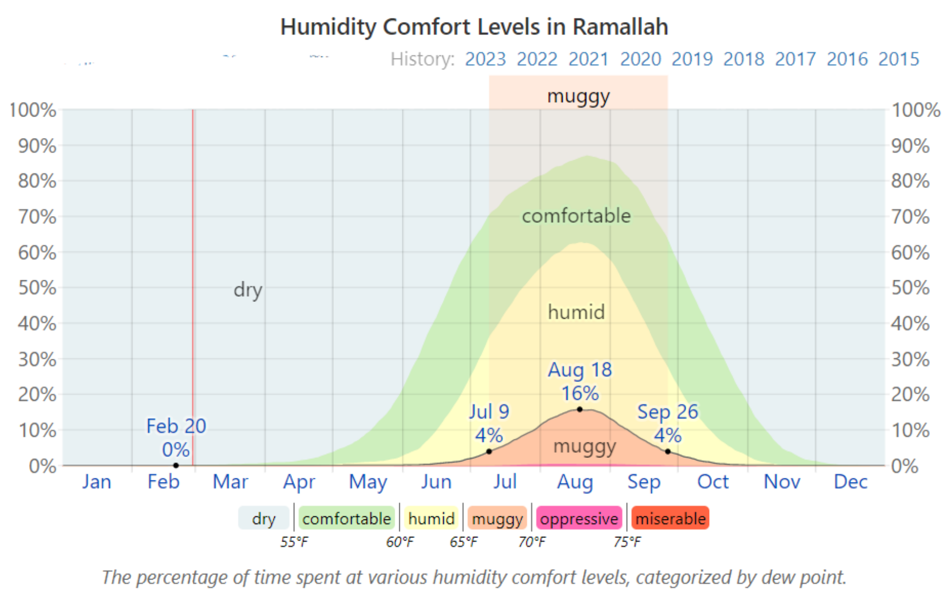


Figure2-240-The percentage of time spent at various humidity comfort levels, categorized by dew point in Ramallah (Weather spark)

5. Land setback:

The building is set back from the western side, which is the back of the palestine liberation organization department of refugee building 3 m, and it is set back from the south, which is adjacent to the street and it is set back from the eastern side, which is the front side of the building opposite the street 12 m, and it is set back from the north side, which is the side to the residential building and adjacent to the street 7 m.

6. Rainfall:

The average rainfall in Ramallah is 598 mm per year,January is the most rainy with **12 days**, and the average number of days in which rain is expected per year is 54 days.

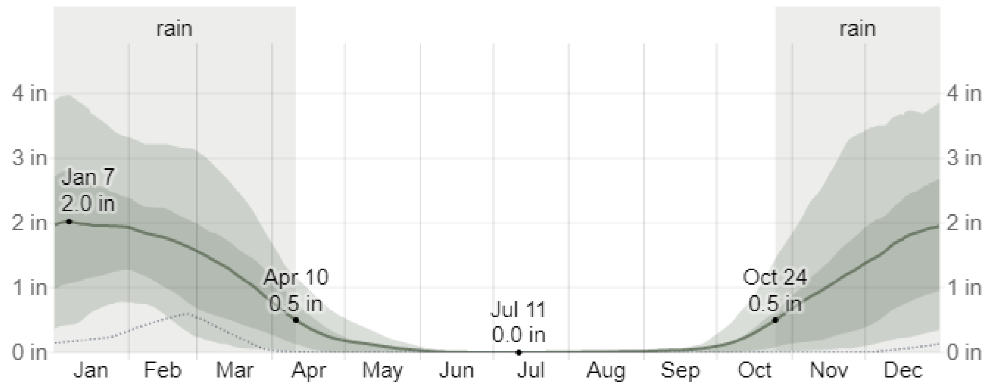
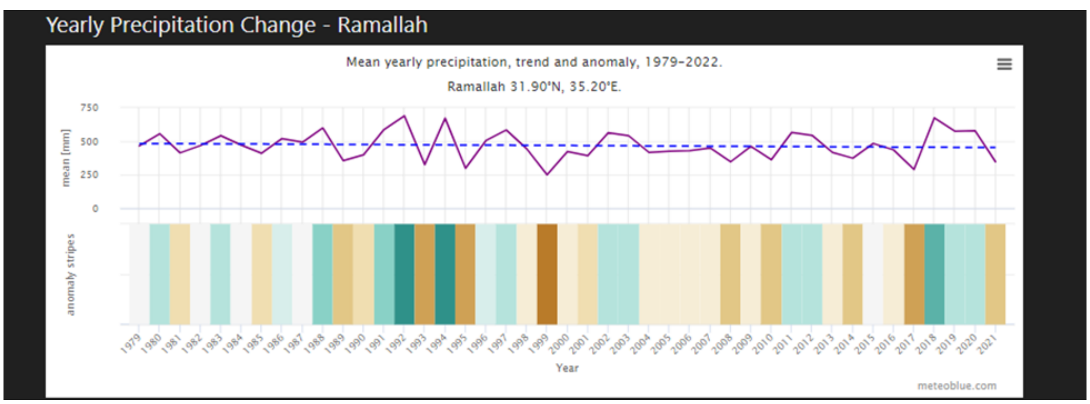


Figure2-241-Average rainfall in Ramallah (Weather spark)



The top graph shows an estimate of mean total precipitation for the larger region of Ramallah. The dashed blue line is the linear climate change trend. If the trend line is going up from left to right, the precipitation trend is positive and it is getting wetter in Ramallah due to climate change. If it is horizontal, no clear trend is seen and if it is going down conditions are becoming drier in Ramallah over time.In the lower part the graph shows the so called precipitation stripes. Each coloured stripe represents the total precipitation of a year - green for wetter and brown for drier years. (Climate Change Ramallah - Meteoblue, 2022).

7. Wind:

Average wind vector per hour at a height of 10 m above the ground. Instantaneous wind speed and direction vary more considerably than hourly averages, and the wind experienced at any one site is strongly dependent on the local terrain and other factors. The average hourly wind speed in Ramallah experiences moderate seasonal variation throughout the year. The average hourly wind speed in Ramallah is *essentially constant* during the spring, remaining within *0.2 miles per hour* of *7.0 miles per hour* throughout.

July is the windiest month of the year, with an average wind speed of 7.5 miles/h. The windy part of the year lasts from May 28 to September 18, with average wind speeds of over 7.0 miles/h. The quietest time lasts from September 17 to May 28. The quietest month of the year in Ramallah is October, with an average hourly wind speed of 6.6 miles/h.The lowest daily average wind speed during the spring is *6.7 miles per hour* on *May 11*.

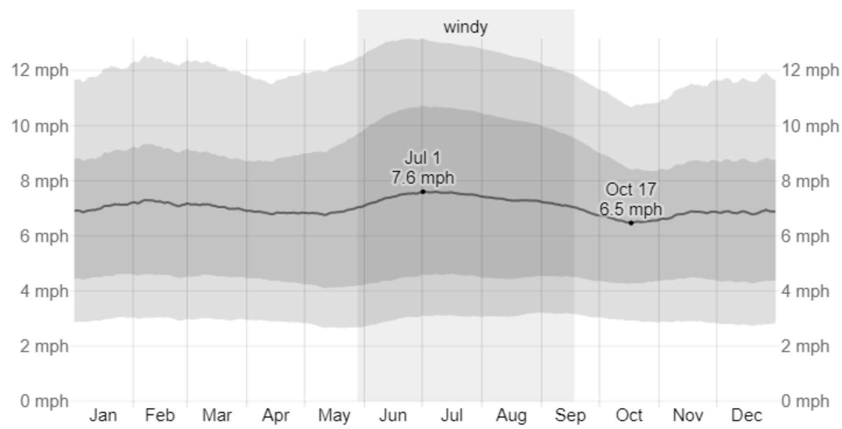
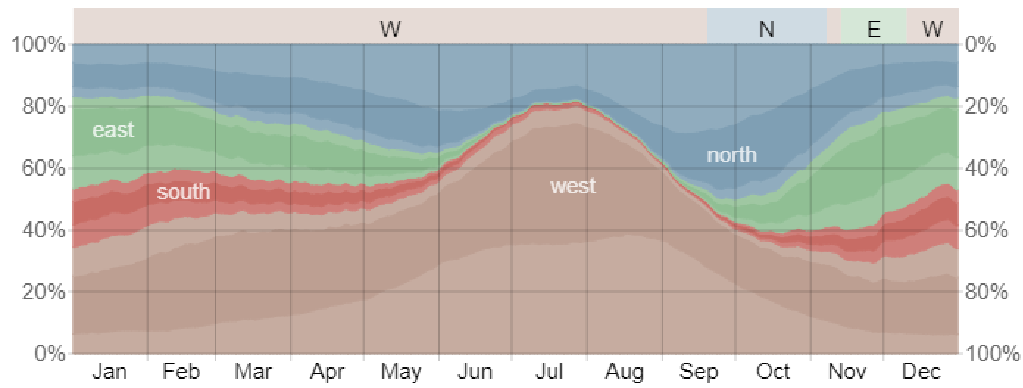


Figure 2-42The average of mean hourly wind speeds in Ramallah (Weather spark)

The winds are mostly from the north from September 18 to November 8, peaking at 55% on September 30. And from the west from November 8 to November. And from the south from December 10 to September 18 with a peak rate of 30%. And from the east from November 13 to December 10 with a percentage peak of 35% on November 27.



)Figure2-243-Wind Direction in Ramallah (Weather spark

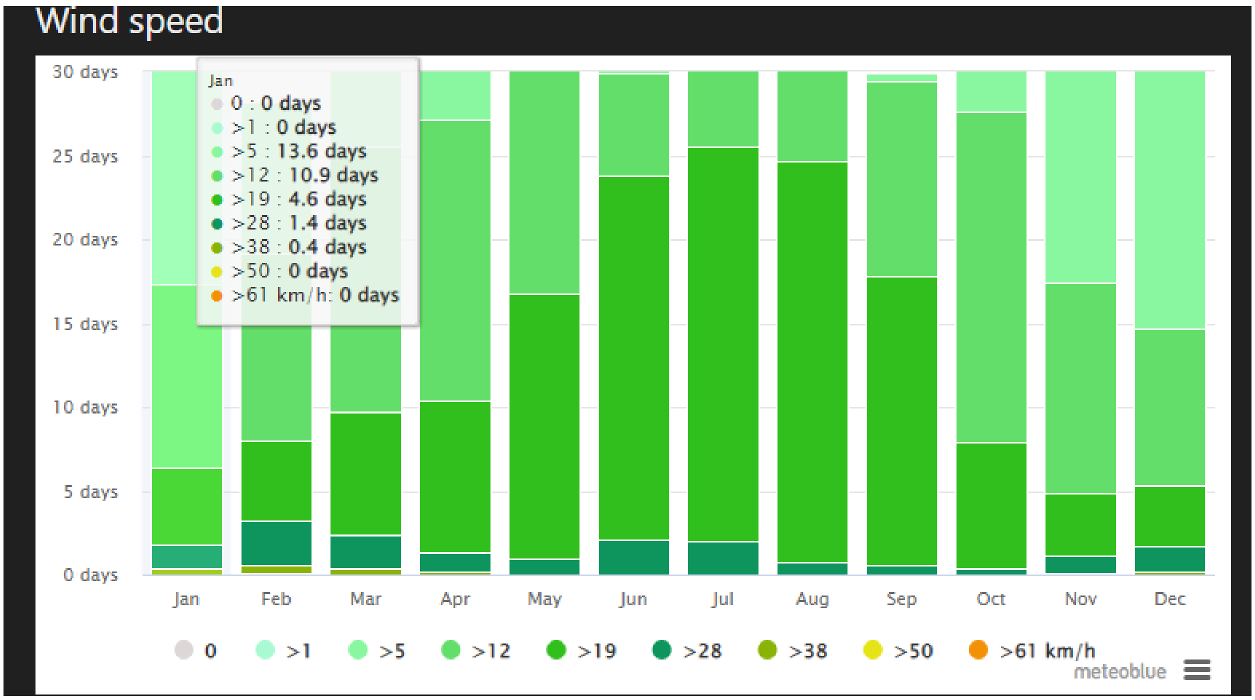


Figure 2-44 : wind speed in a year (Climate Change Ramallah - Meteoblue, 2022

8. Wind Rose for Ramallah:

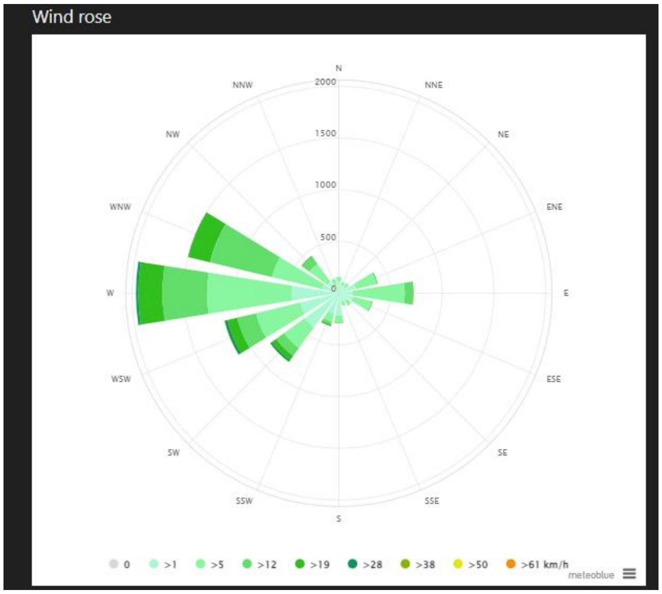


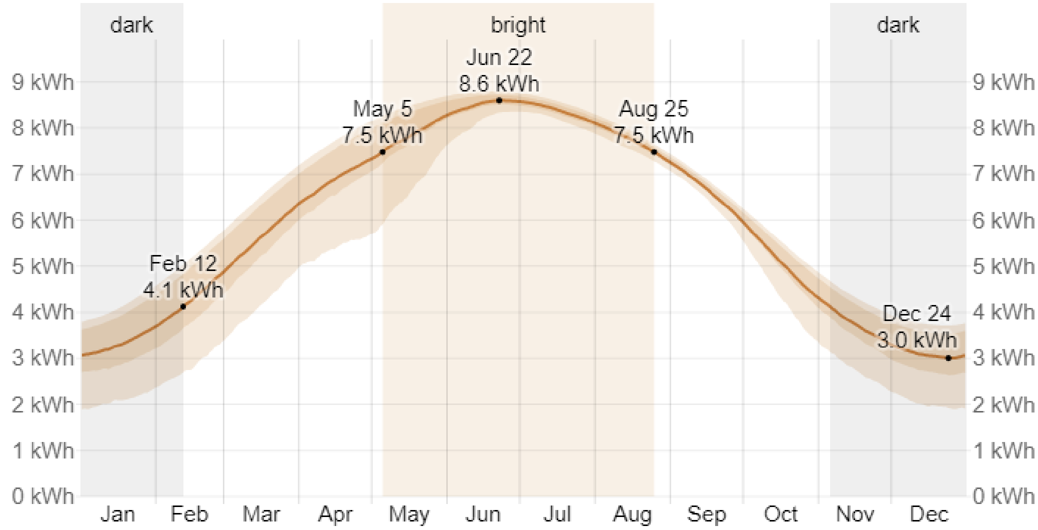
Figure 2-45 wind rose for Ramallah (Climate Change Ramallah - Meteoblue, 2022)

9. Solar Energy:

he total daily incident shortwave solar energy reaching the surface of the ground over a wide area, taking full account of seasonal variations in the length of the day, the elevation of the Sun above the horizon, and absorption by clouds and other atmospheric constituents. Shortwave radiation includes visible light and ultraviolet radiation.The average daily incident shortwave solar energy experiences *extreme* seasonal variation over the course of the year.

The *brighter* period of the year lasts for *3.6 months*, from *May 5* to *August 25*, with an average daily incident shortwave energy per square meter above *7.5 kWh*. The *brightest* month of the year in Ramallah is *June*, with an average of *8.5 kWh*.

The *darker* period of the year lasts for *3.2 months*, from *November 5* to *February 12*, with an average daily incident shortwave energy per square meter below *4.1 kWh*. The *darkest* month of the year in Ramallah is *December*, with an average of *3.1 kWh*.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Solar Energy (kWh)	3.3	4.3	5.7	6.9	7.8	8.5	8.4	7.7	6.6	5.0	3.7	3.1

Figure 2-46Solar Energy

10. Topography:

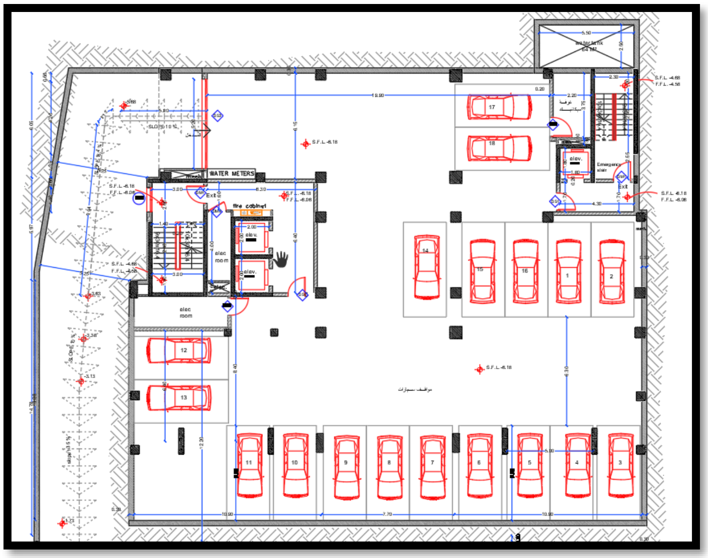
Ramallah's geographic coordinates are 31.90 degrees latitude, 35.20 degrees longitude, and 2,800 feet elevation for the purposes of this study.

A maximum elevation change of 919 feet and an average height of 2,658 feet above sea level can be found in the terrain within two miles of Ramallah. There are considerable height changes within 10 kilometers (3,153 feet). There are significant elevational changes within 50 kilometers (5,482 feet).

2.7 Architectural Drawings

2.7.1 before modification

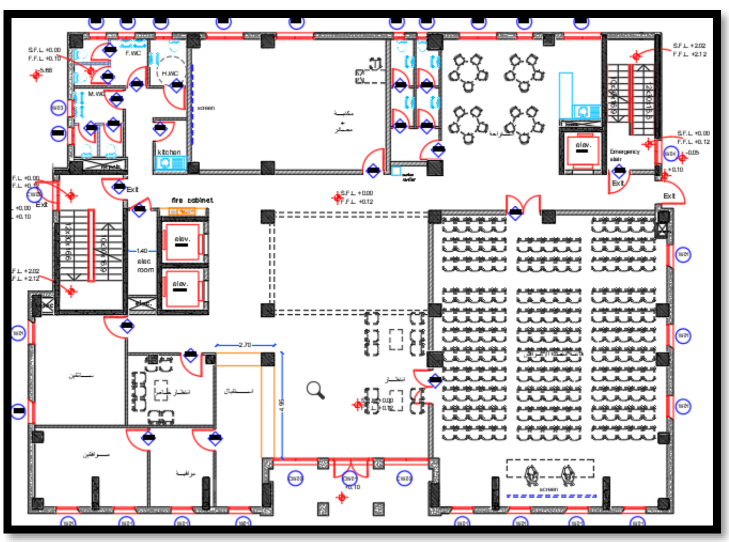
2nd Basement:

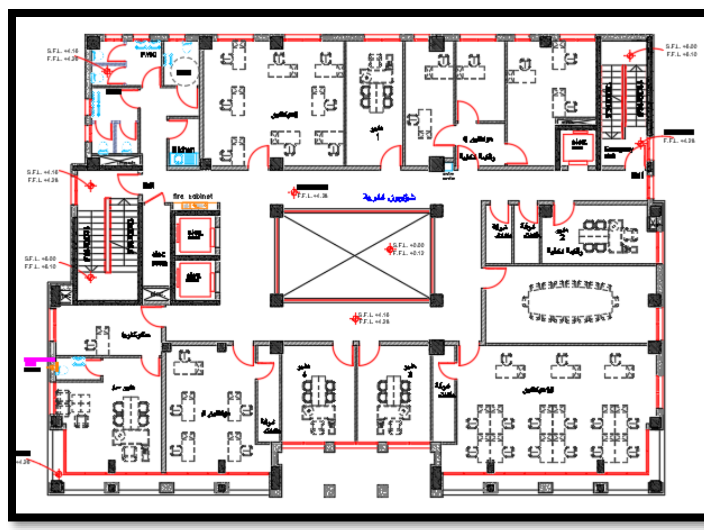


1st Basement:

Ground floor:

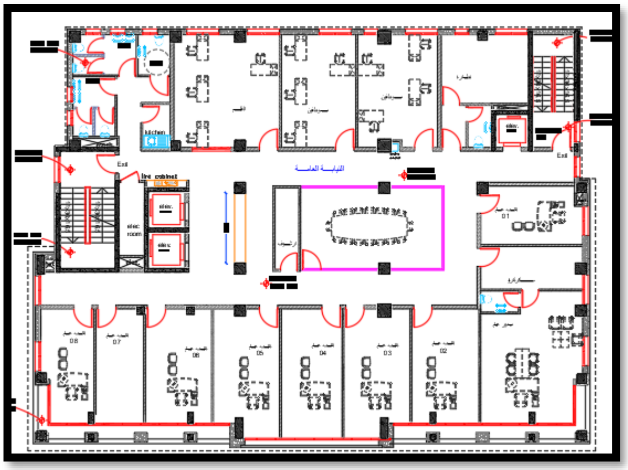
1st floor





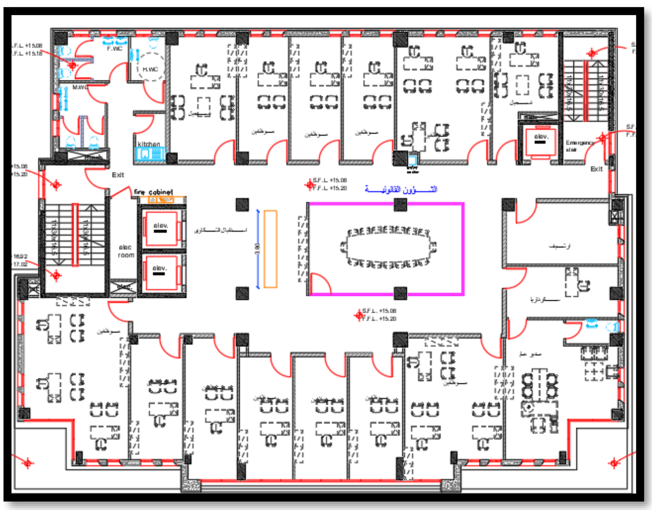
2ndfloor :

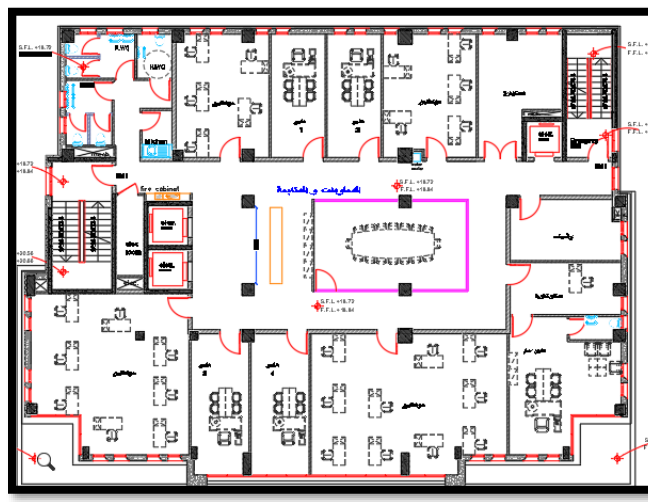
3rd floor



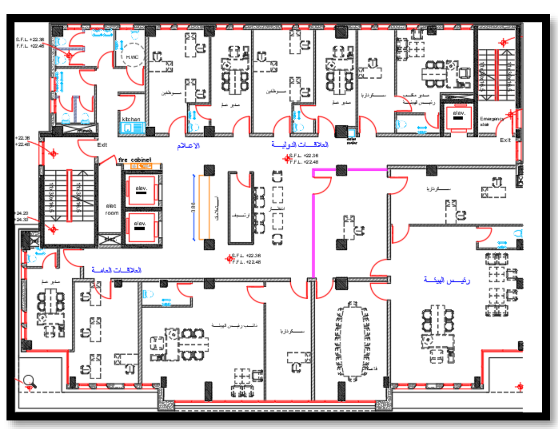
4th floor :

5th floor



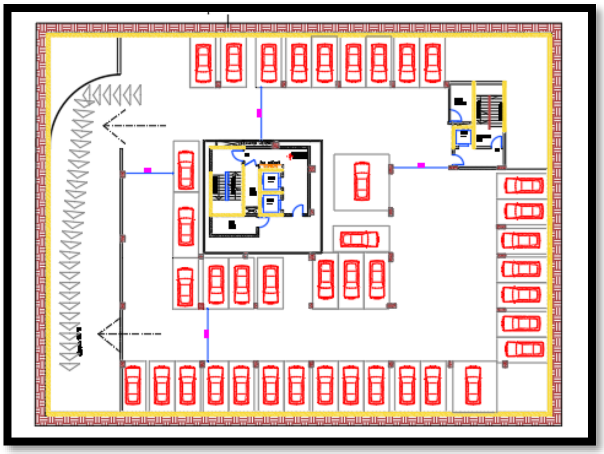


6th floor

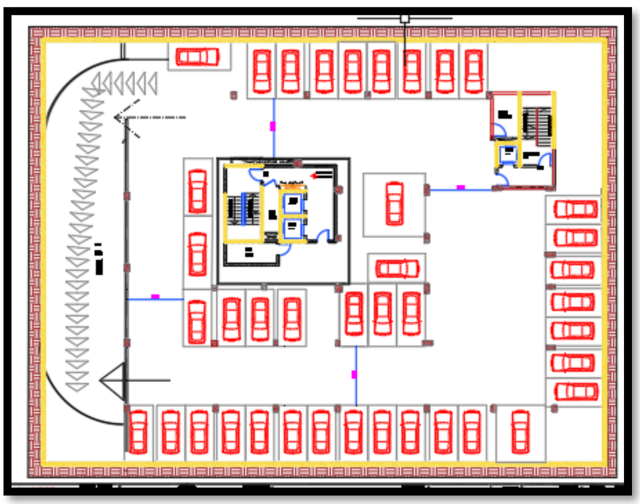


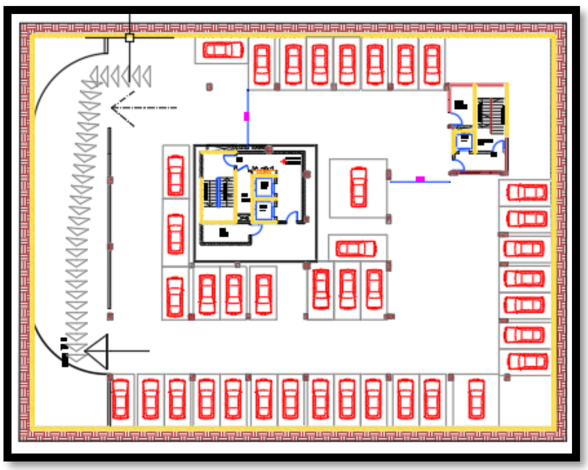
2.7.2 architectural drawings after modification

3rd Basement

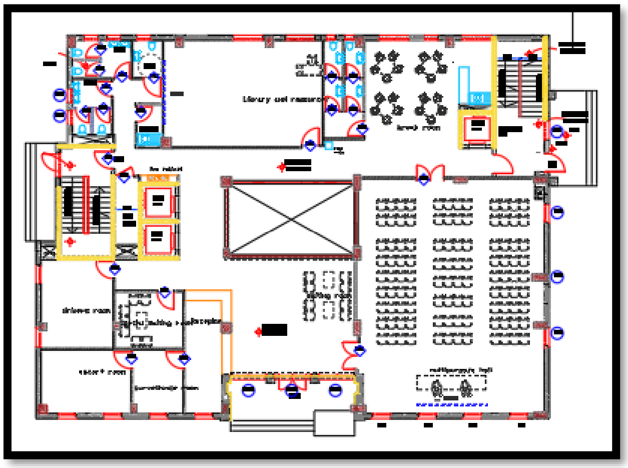


2nd Basement:1st Basement:

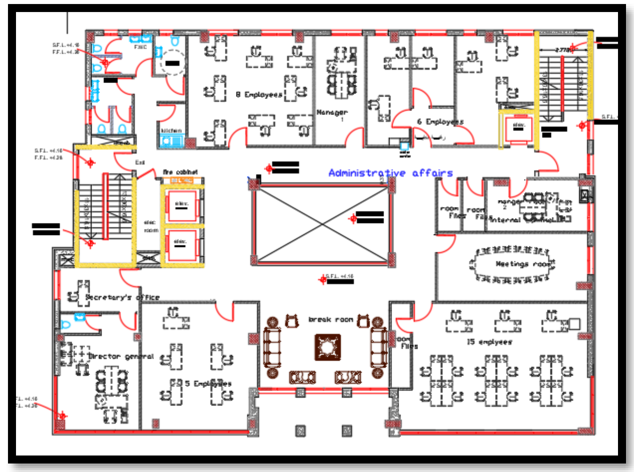




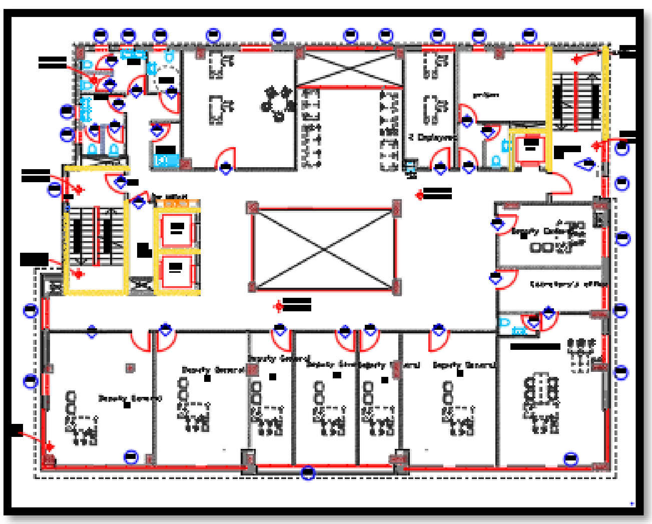
Ground floor:



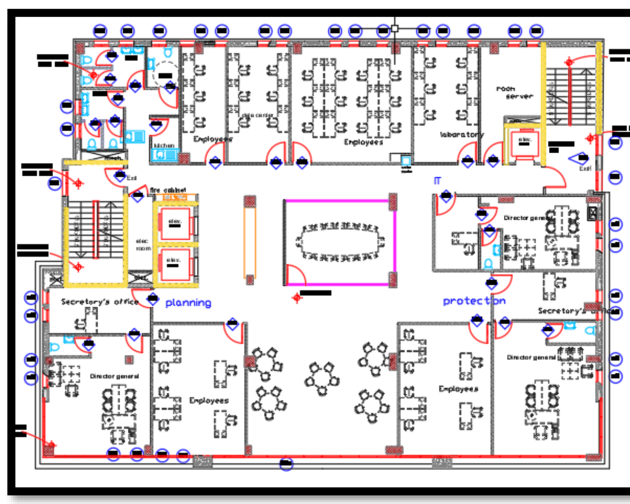
1st floor



2ndfloor:

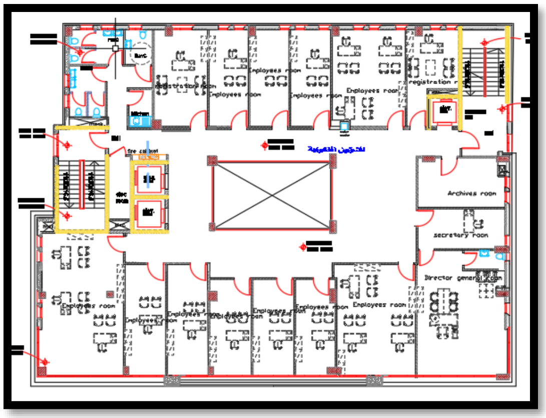


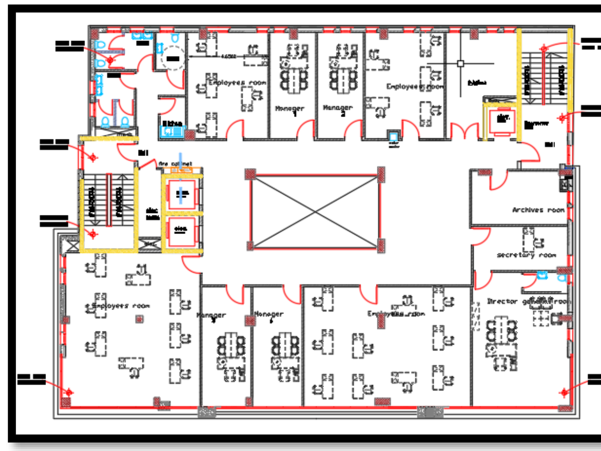
3rd floor



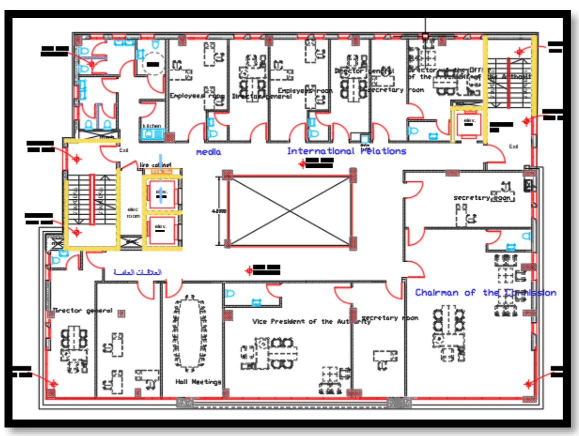
4^th^floor :

5th floor





6th floor



2.8 Environmental analysis

2.8.1 Introduction:

At this time, it is vital to take into account environmental factors while creating any structure because of the requirement imposed by the growth in population, the decline in non-renewable energy sources, and the reliance on non-renewable energy sources.

It is crucial to create an integrated design for the building and consider all environmental factors, including the building's orientation, the amount of natural lighting, solar energy, and the industrial heating and cooling values that will be needed. this factors will have an impact on the comfort of users , the building's initial construction costs and also the operating costs of the building.

2.8.1.1 Massing of the building:

Description of the shape of the building affects the ratio of the building's exposure to the sun and wind and various environmental factors. Also consider the ratio of windows and openings to the ratio of facades in The building that controls the amount of sun entering the building. All of these factors It plays a very important role in reducing energy consumption, saving costs, materials and user convenience

2.8.1.2 Orientation of the building:

The orientation of the building is one of the most crucial factors that must be strongly focused on, as it will affect all the specifics and features of the building that are being designed, as well as having a significant impact on the outcomes of the environmental analysis, including the amount of solar energy, the percentage of exposure to the sun, the effect of wind, and other environmental matters that It plays an important role in s The following image displays the building's orientation from above

Figure 2-47Orientation of the building

2.8.2 Shadowing and overshadowing

Summer (21/6) At 8:00 AM

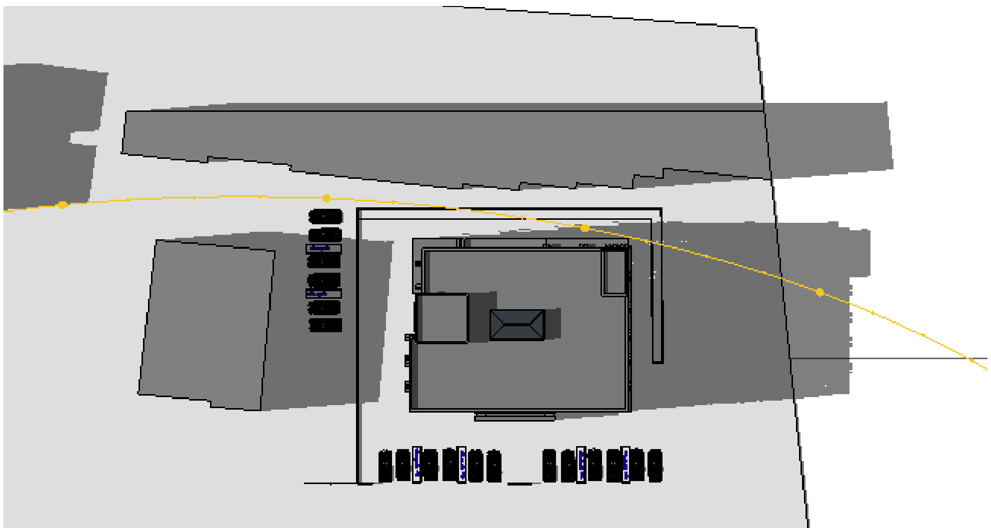


Figure 2-48 : shadow effect on site

As shown on the Figure the height of the building makes the most shadow effect in the morning and the near buildings make a little effect according to the distances between the buildings.

North elevation

Figure 2-49 : shadow effect on north elevation

In this North elevation show in figure the height of the building makes the most shadow

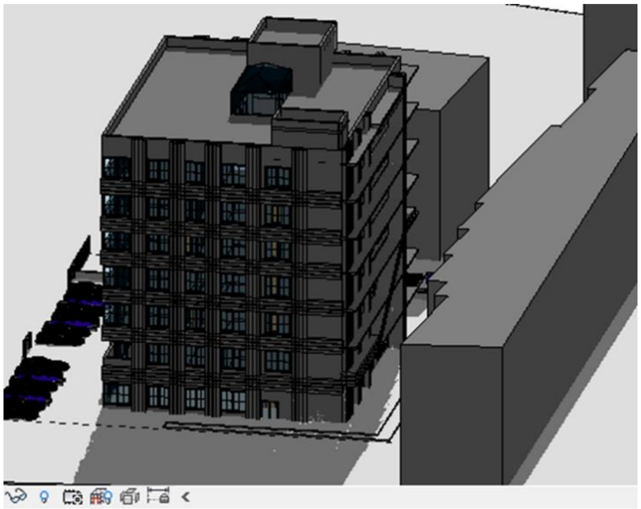


Figure 2-50 : shadow effect on west elevation

In eastern elevation show in figure The facade was not affected by the shadows of the neighboring buildings, but by the shadow of the building itself

Figure 2-51 : shadow effect on east elevation

In western elevation show in figure The facade was not affected by the shadows of the neighboring buildings, and the shadow of the building itself.

At 12:00 pm

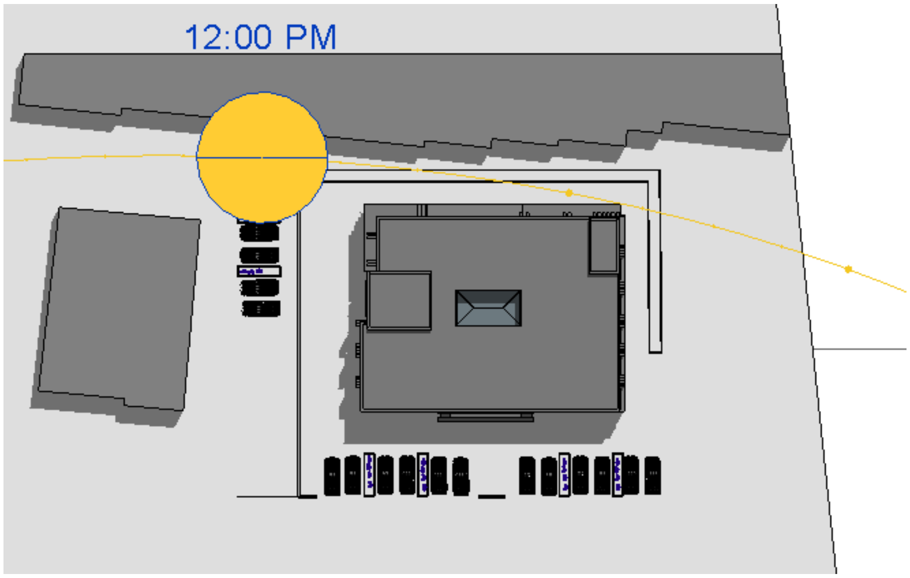


Figure 2-52 shadow effect on site

Figure 2-53As shown on Figure, the shadow not effect is big from all buildings.

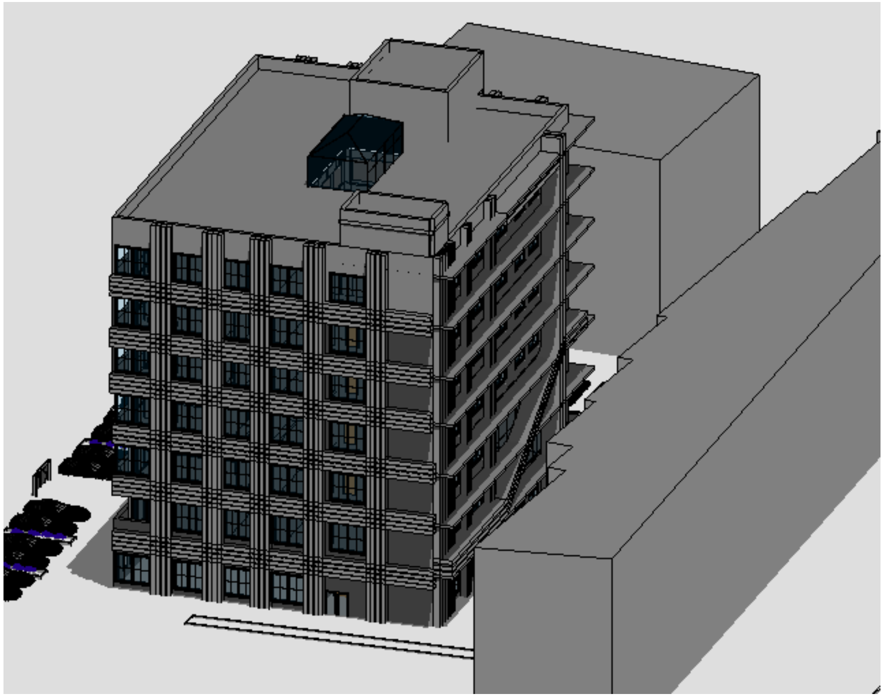


Figure 2-54 : shadow effect on west elevation

As shown in Figure, the shadow effect totally cover the area of north elevation on this time

in this figure the western elevation, there is no shadow effect on elevation on this time.

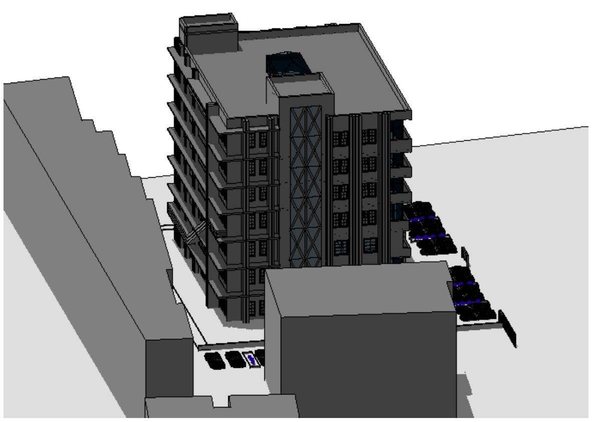


Figure 2-55 : shadow effect on south elevation

this figure the southern& eastern elevation, there is no shadow effect on elevation on this time.

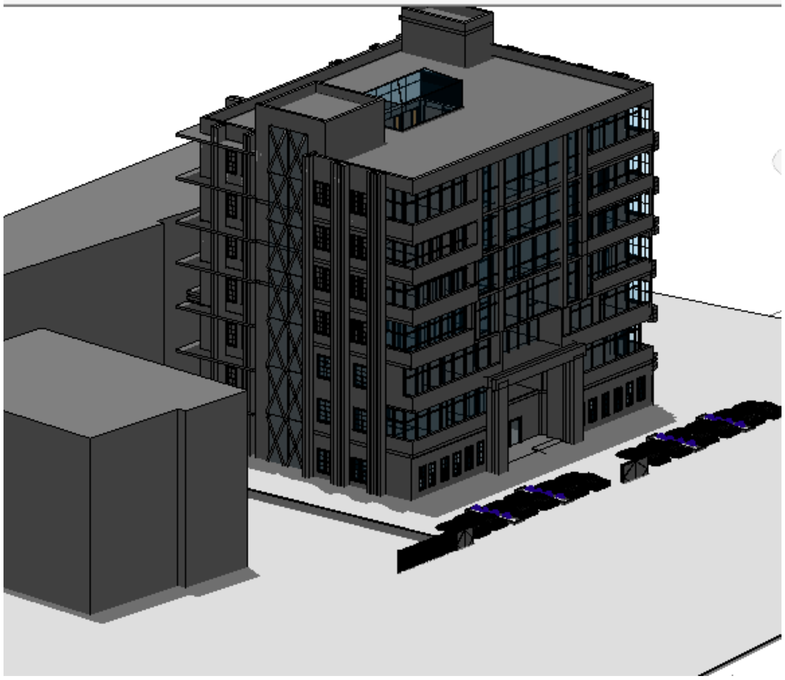


Figure 2-56shadow effect on northern& eastern elevation

At 2:00pm

Figure 2-57 shadow effect on site

As shown on Figure, the shadow effect is small from all buildings heights.

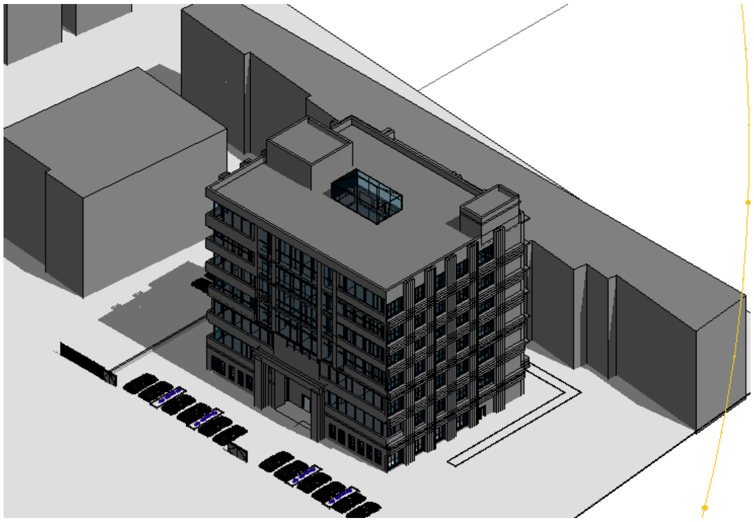


Figure 2-58 shadow effect on north elevation

As shown in Figure, the shadow effect totally covers the area of north elevation on this time.

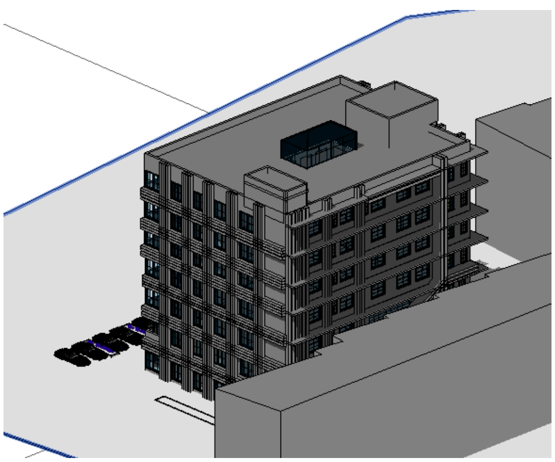


Figure 2-59 shadow effect on west elevation

As shown in Figure, there is no shadow effect on west elevation on this time.

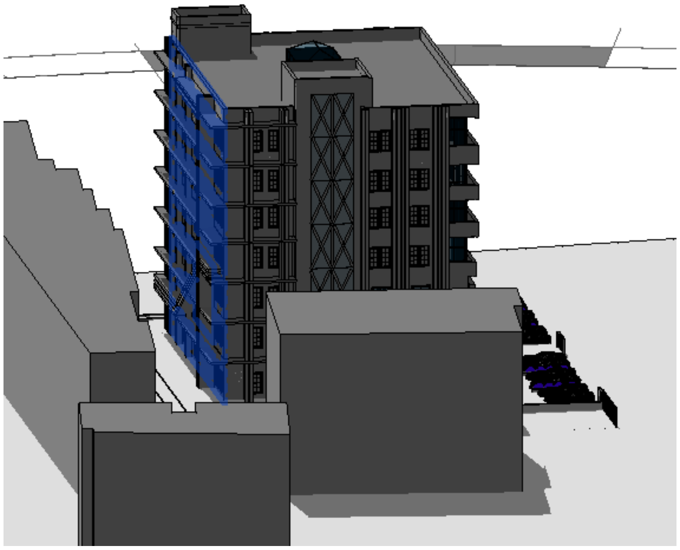
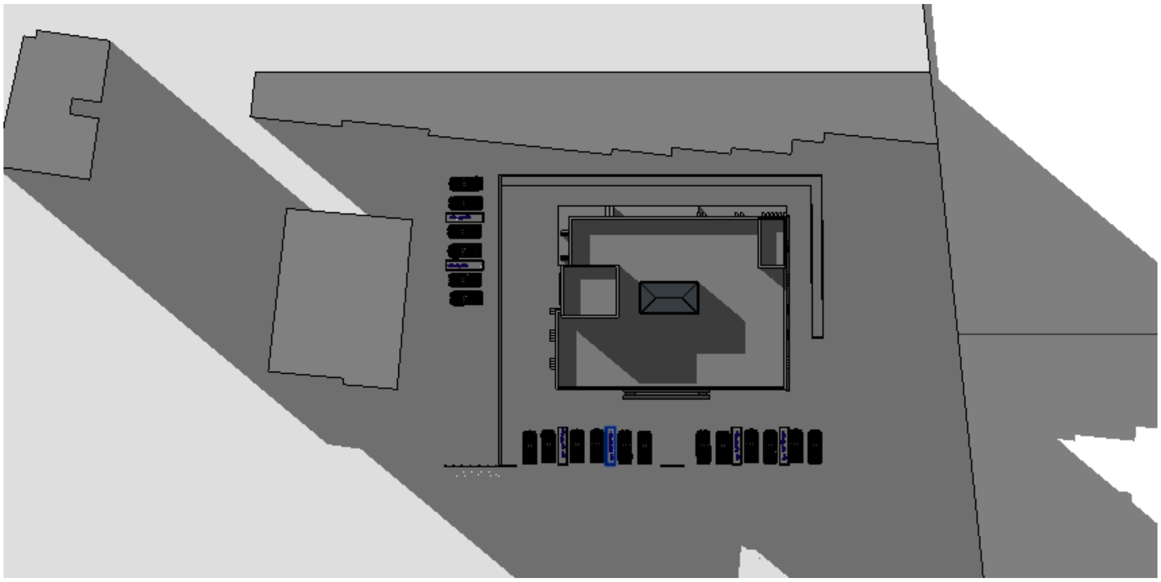


Figure 2-60 shadow effect on east elevation

As shown in Figure, the shadow effect covers small area of south & east   elevation on this time.

Figure 2-61shadow effect on North & east elevation



Winter (21/12) At 8:00 AM

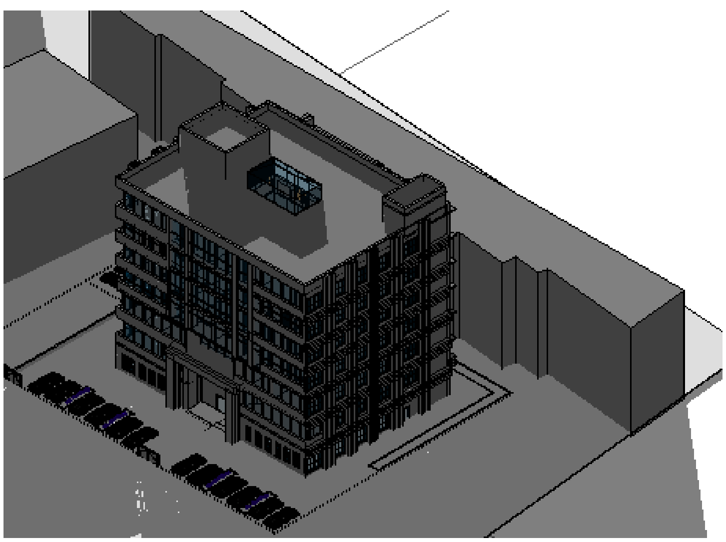


Figure 2-62 shadow effect on site

As shown on Figure, the shadow effect is so big according in the small height of sun in the sky comparison with its height on summer. In addition, near buildings make big shadow effect to our building according to the same cause.

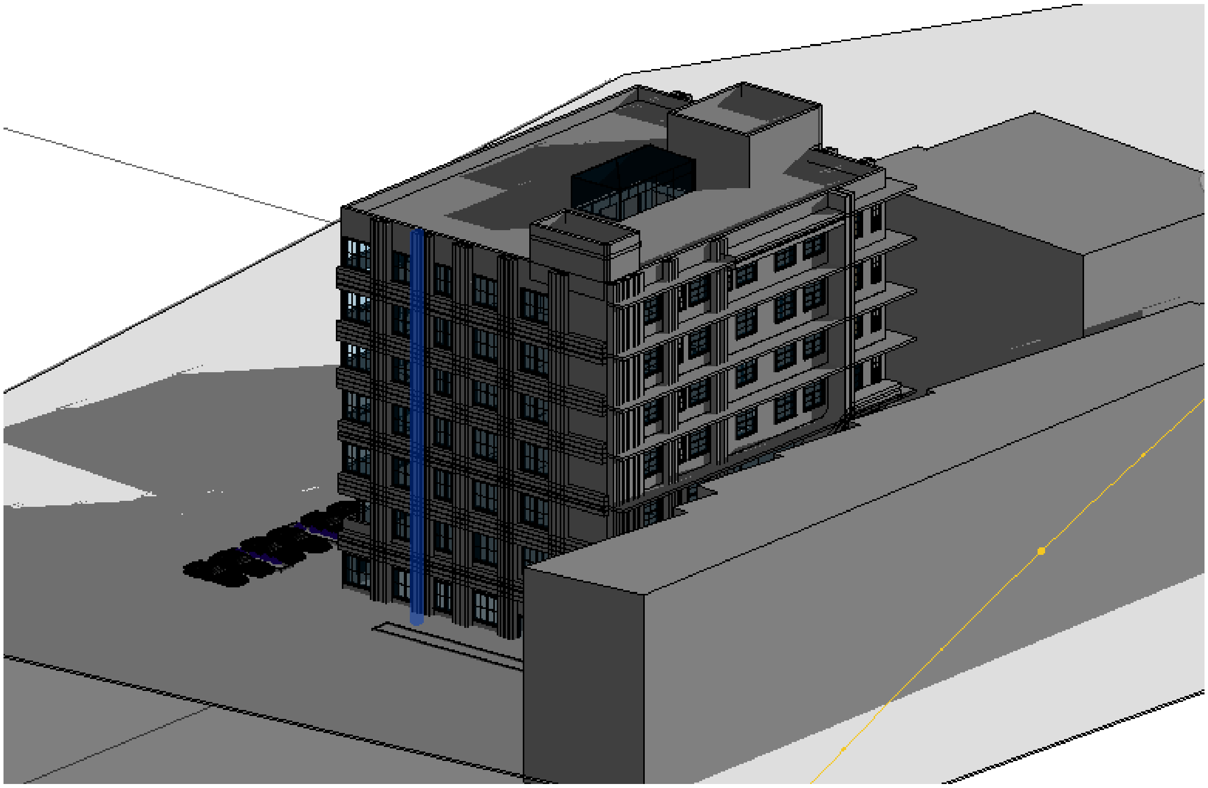


Figure 2-63 shadow effect on north & west elevation

As shown in Figure, the shadow effect totally covers the area of north elevation on this time

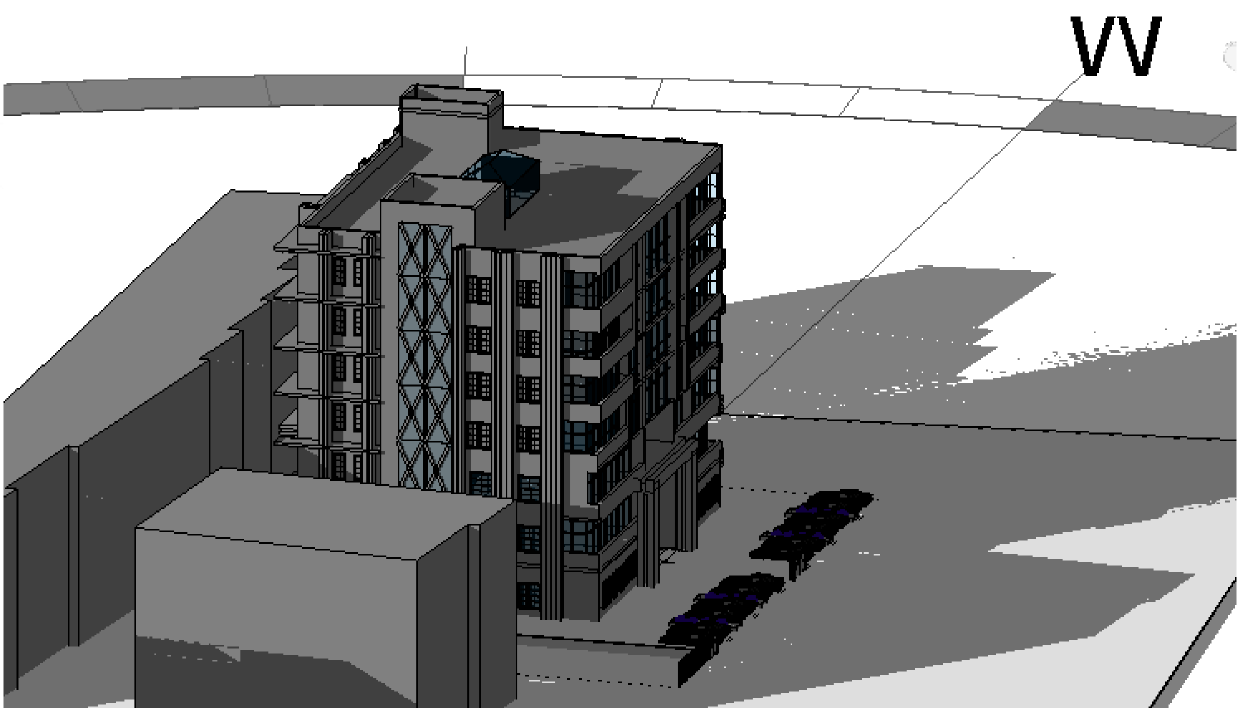


Figure 2-64 shadow effect on west & south elevation

As shown in Figure, the shadow effect totally cover the area of west elevation on this time

Figure 2-65 shadow effect on east & north elevation

As shown in Figure, the shadow effect covers small area of east elevation on this time

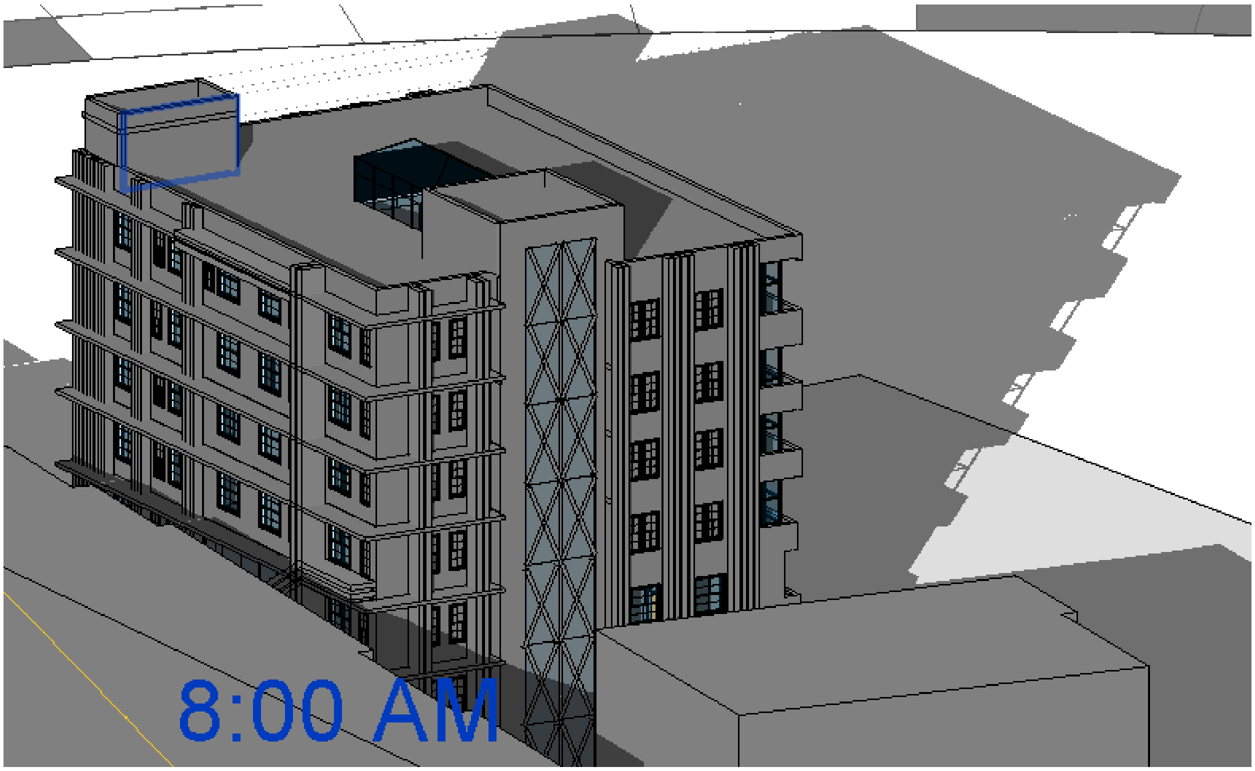


Figure 2-66 shadow effect on east & south elevation

As shown in Figure, the shadow effect cover small area of south & east elevation on this time

12:00pm

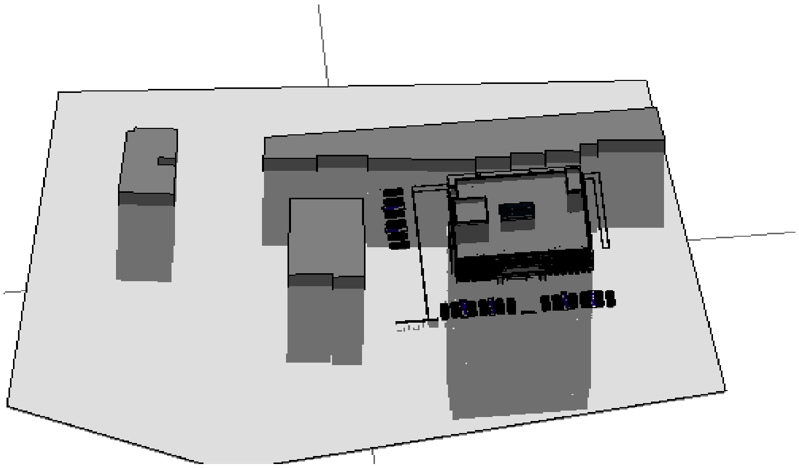


Figure 2-67shadow effect on site

As shown on Figure, the shadow effect is big from all buildings heights.

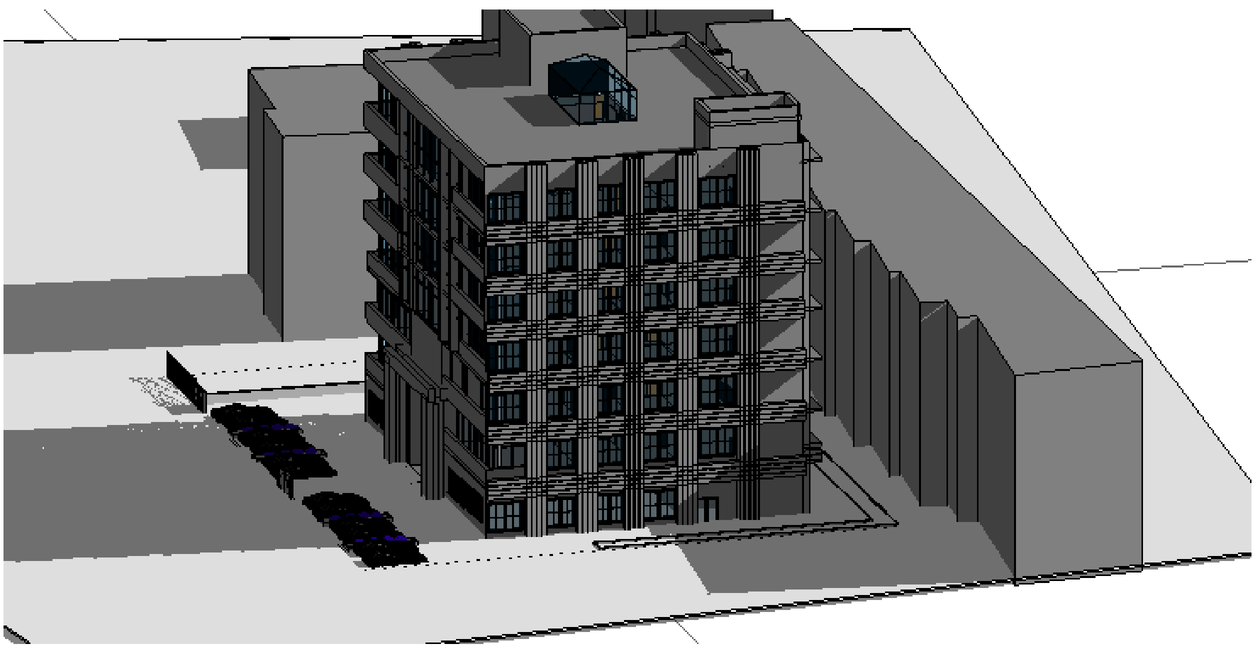


Figure 2-68 shadow effect on west elevation

As shown in Figure, the shadow effect covers small area of west elevation on this time

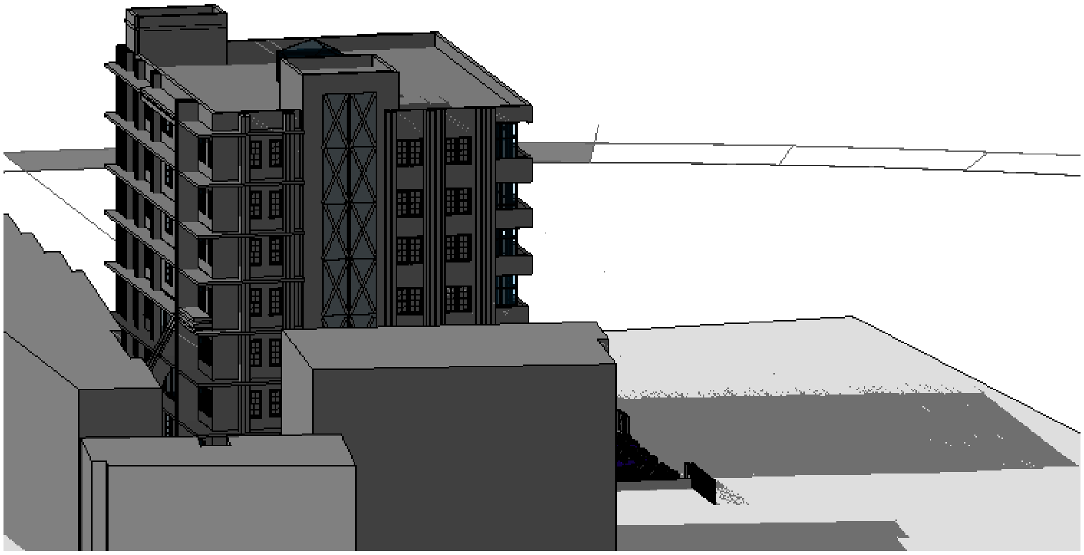


Figure 2-69 shadow effect on east elevation

As shown in Figure, the shadow effect covers small area of east & south elevation on this time

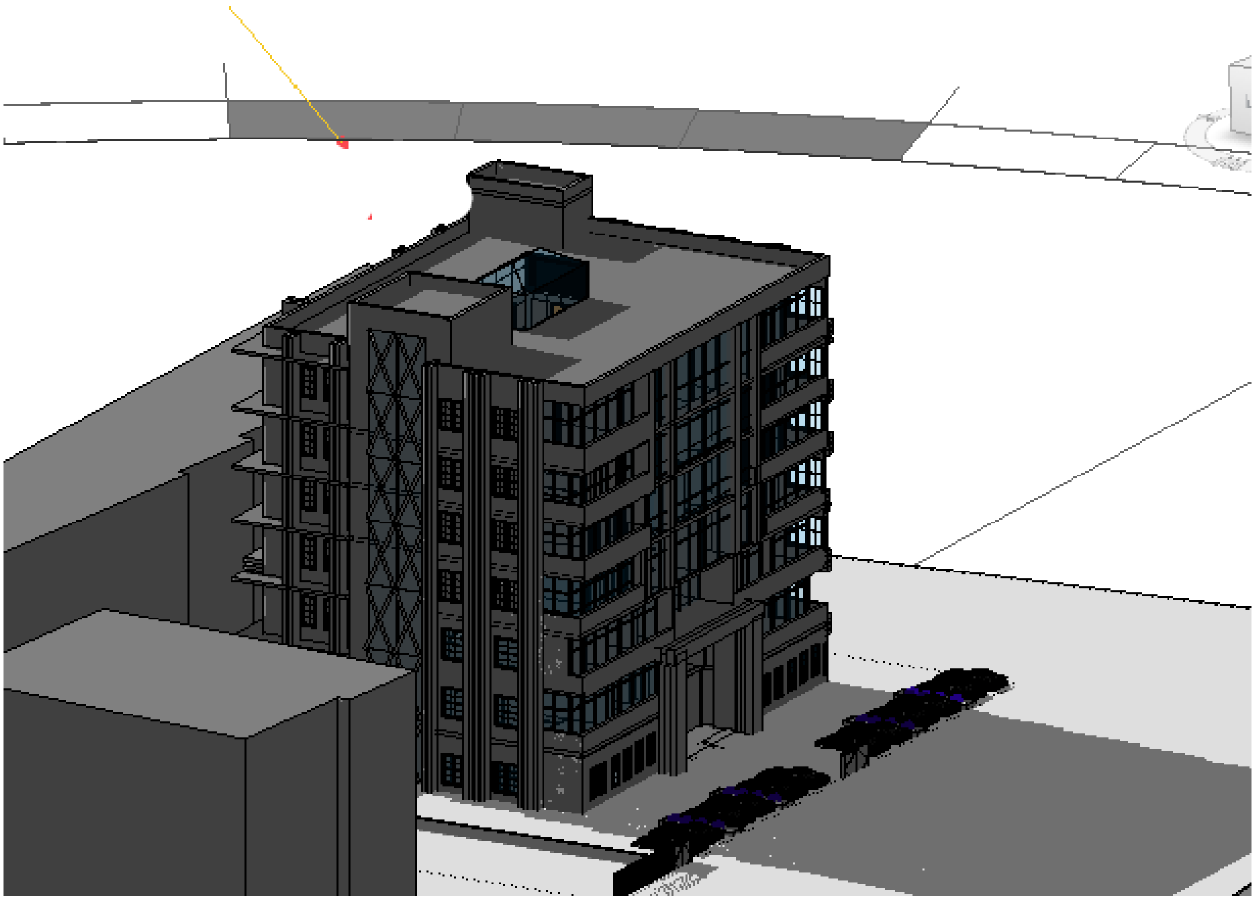
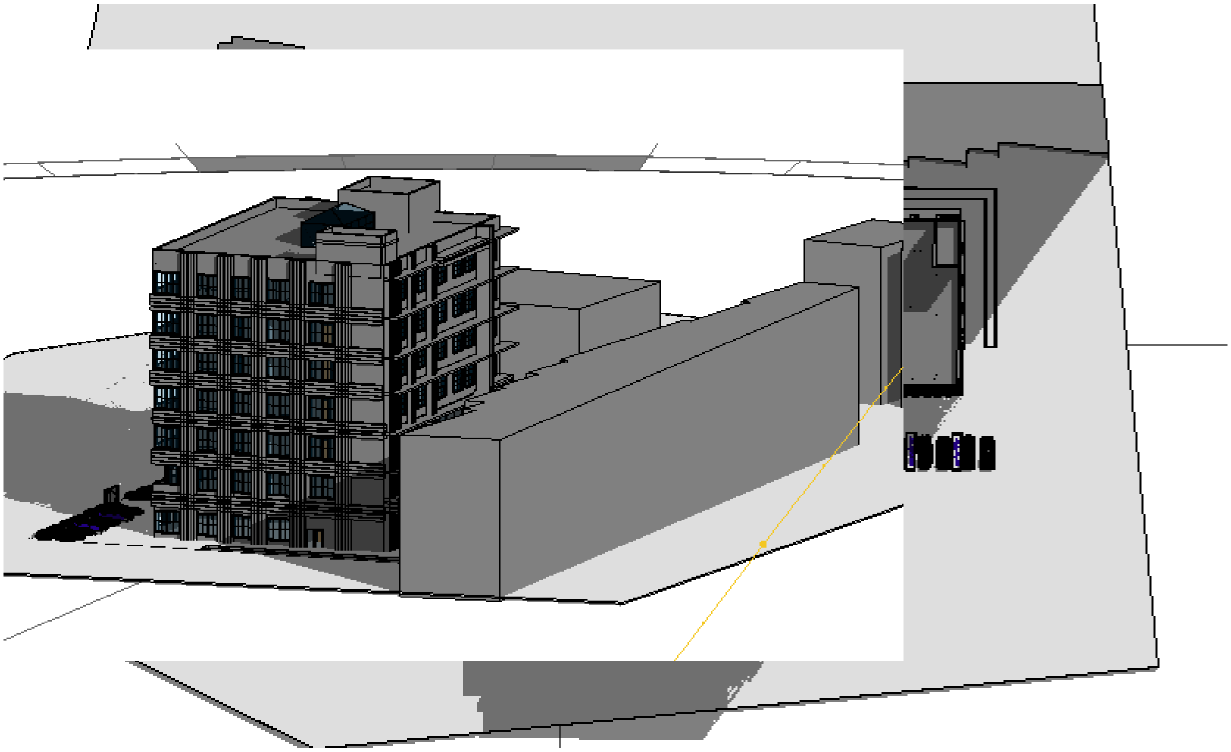


Figure 2-70 shadow effect on east & north elevation

As shown in Figure, the shadow effect covers small area of east elevation on this time

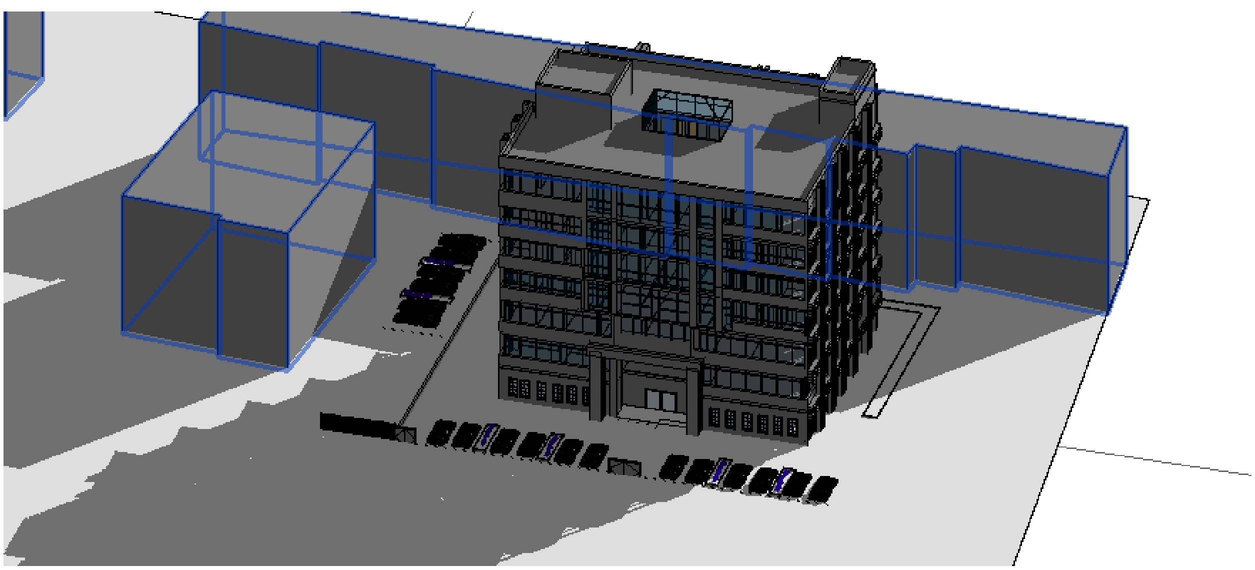
At 2:00pm

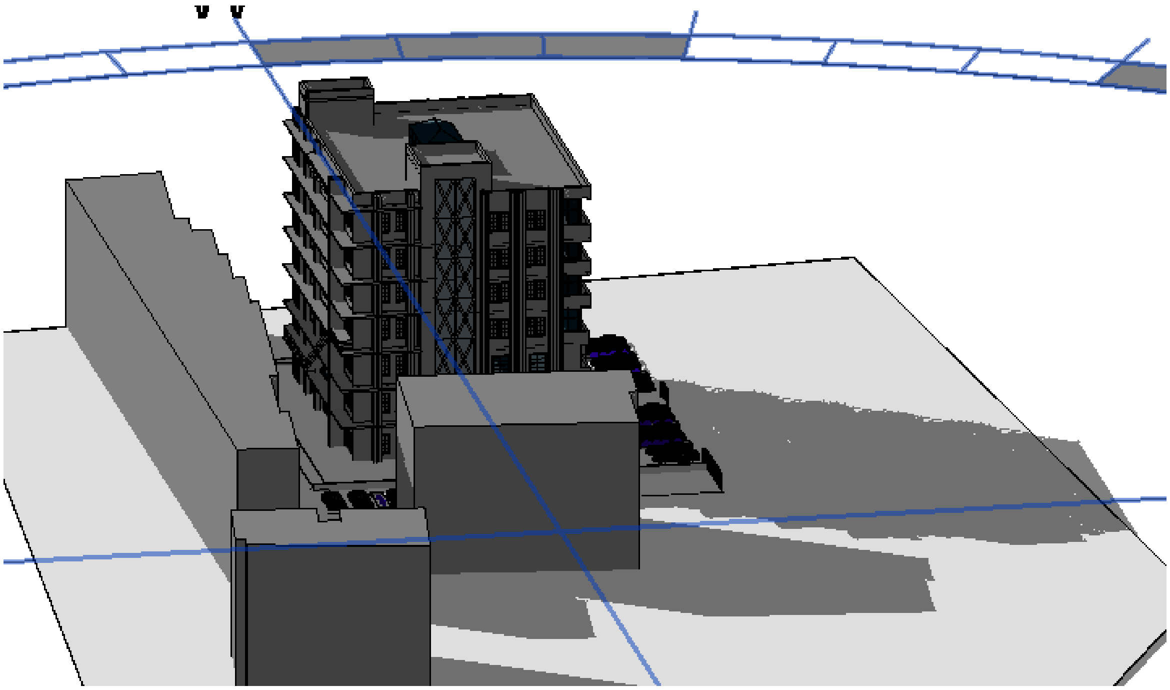
Figure 2-71 shadow effect on site



As shown on Figure, the shadow effect is big from all buildings heights.

Figure 2-72 shadow effect on north elevation





As shown in Figure, the shadow effect totally cover the area of north elevation on this time.

Figure 2-73 shadow effect on east elevation

As shown in Figure, the shadow effect covers small area of east & south elevation on this time

Figure 2-74 shadow effect on west elevation

As shown in Figure, the shadow effect covers small area of west elevation on this time

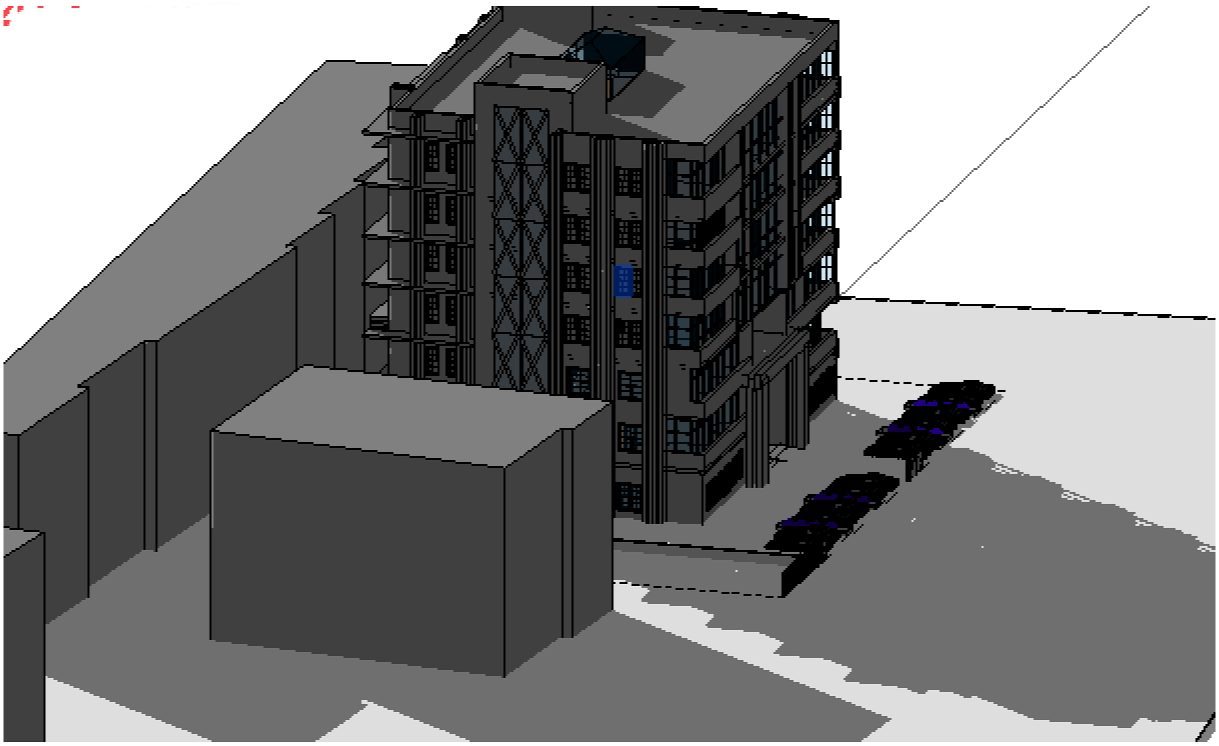


Figure 2-75 shadow effect on east elevation

As shown in Figure, the shadow effect covers small area of east elevation on this time.

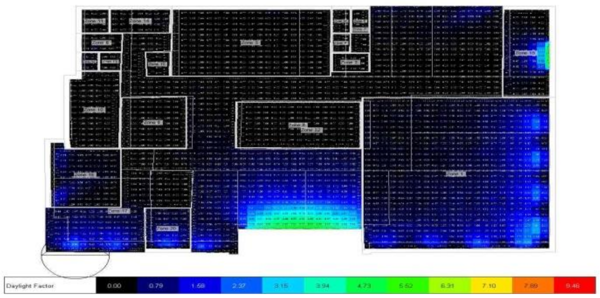
2.8.3 Daylight Factor

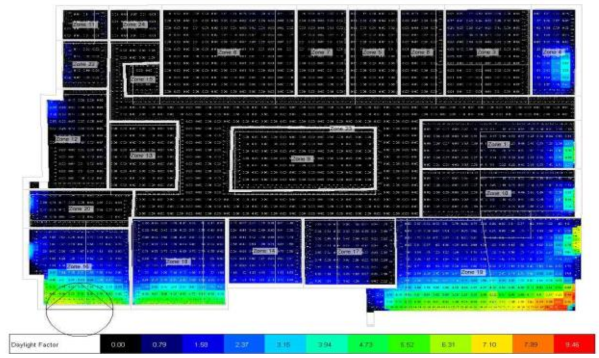
The daylight factor (DF), a measure of daylight availability, compares the amount of unobstructed daylight available outside in overcast sky conditions to the amount of daylight available inside a room (on a work plane) (Hopkins,1963).

The amount of light in the room increases with the DF. Even though rooms with an average DF of 2% or higher can be considered daylight, visual tasks may still require the use of electric lighting. When the average DF is 5% or higher, a room will appear to be strongly daylight; in this case, electric lighting will likely not be used during the day (CIBSE, 2002).

We want to evaluate our building according to the specifications and recommendations so we use Revit software, this software does this analysis basing on the principle of the daylight factor which must range between (2-6) %, we will get the results of the rooms from the software and compare the results before and after. Rooms in which the day-light factor is larger than the range will be dealt with in various ways, such as changing the properties of the glass and using louvers and other methods that will be clarified later. As for the rooms in which the day-light factor is less than the range, they are treated using artificial lighting. The next pictures show the daylight factor analysis results for the different floors of the building.

The solutions that we used for the daylight factor will be mentioned later after the next figures:



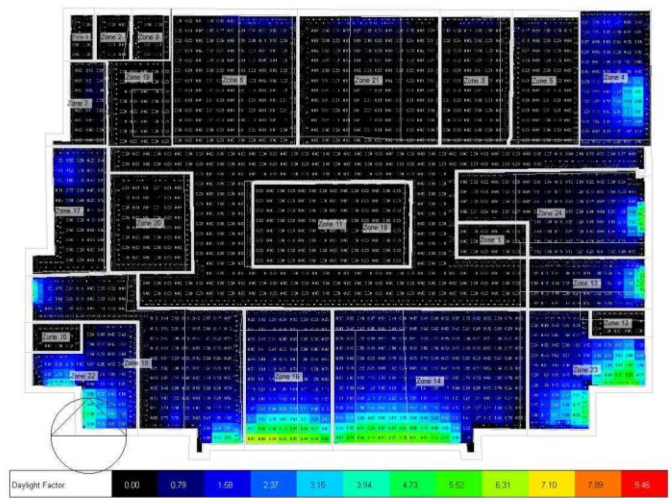


2.8.3.1 Daylight factor before modification: in Design Builder program:

Ground floor & First floor

*Figure 2-76Daylight factor before modification **Ground floor & First floor***

Second floor & Third floor



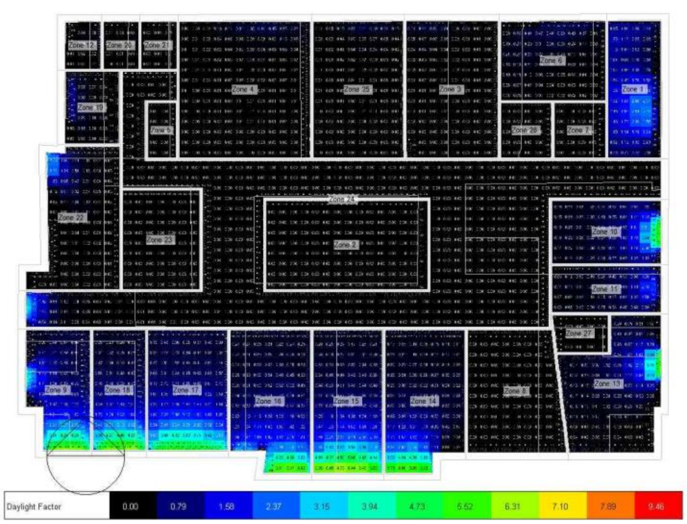
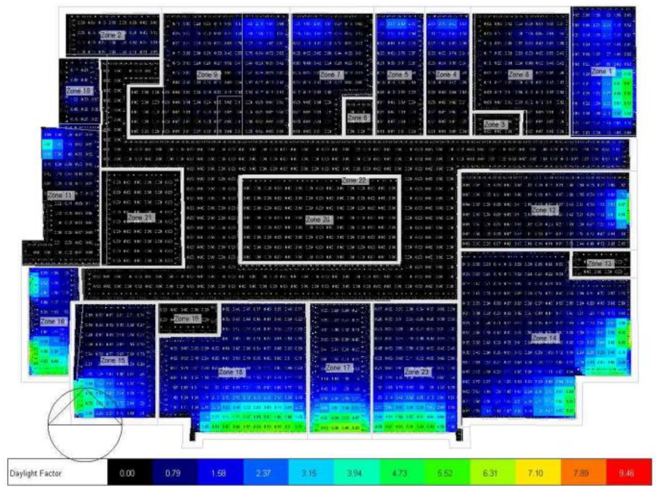
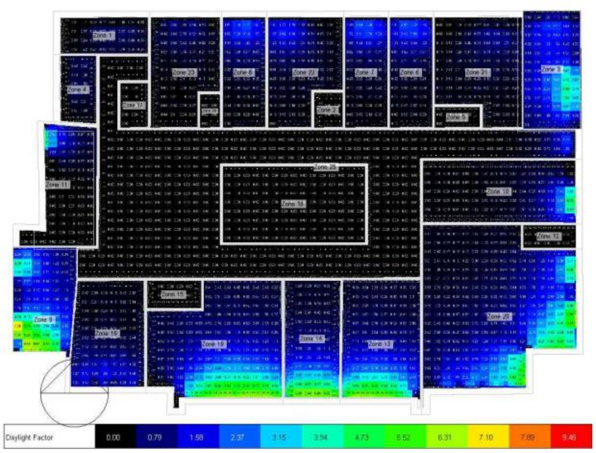


Figure 2-77Daylight factor before modification second & third Floor

fourth floor & Fifth Floor & Sixth Floor





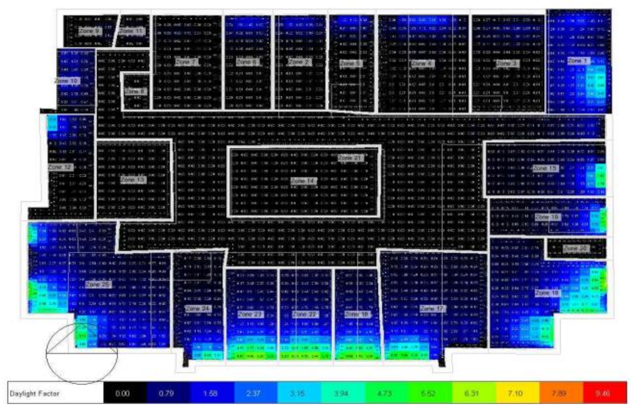
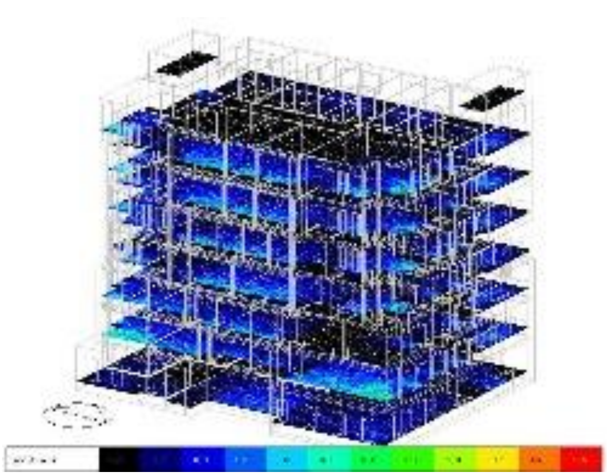
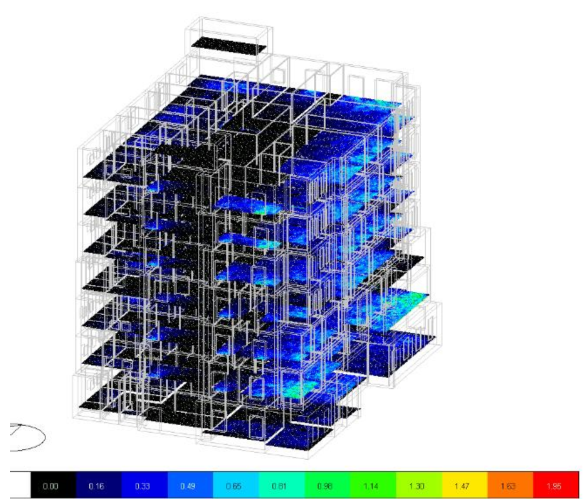


Figure 2-78Daylight factor before modification ***fourth floor & Fifth Floor & Sixth Floor***

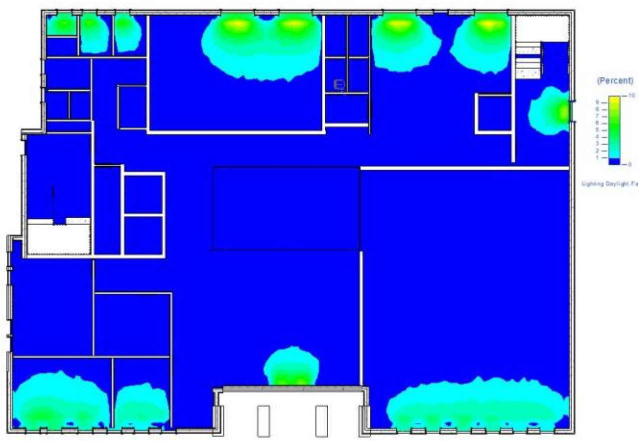


3D all Building



2.8.3.2 Daylight factor before and after modification: in Revit program:

Ground Floor& First floor



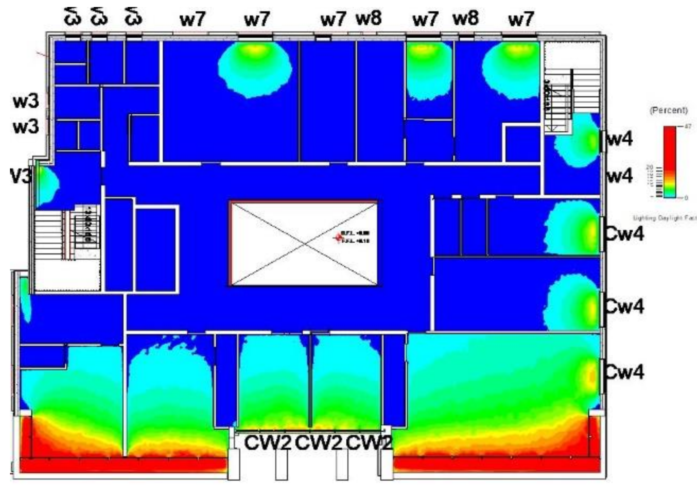
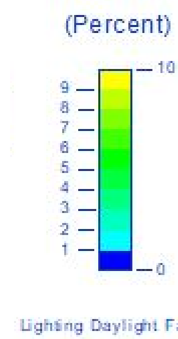
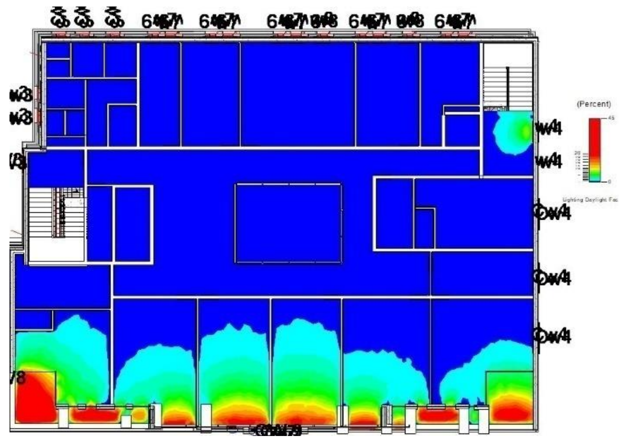


Figure2-2 79-daylight factor analysis in Revit for GF & FF before modification.

This is the result for daylight factor on the ground floor, as shown in Figure there is regions that have low values in the center of story & in the reception area that is (1% or less), and regions have large values especially near the glass that reaches to (12%).



Second Floor& third floor



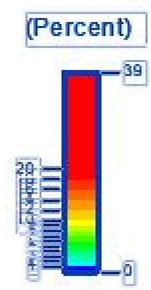
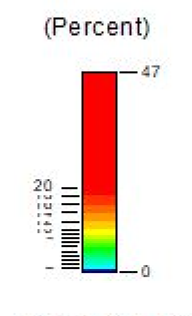
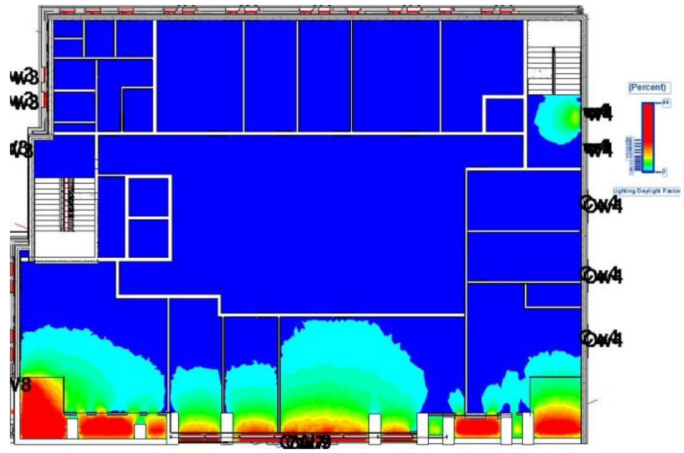


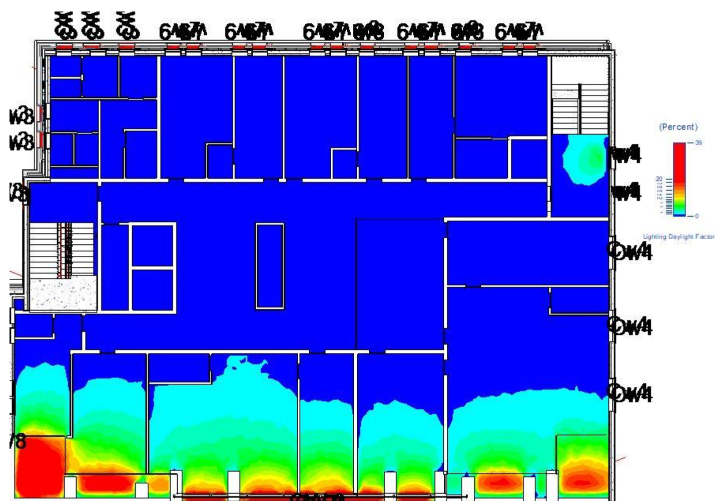
*Figure 2-80daylight factor analysis in Revit for **Second Floor& third floor** before modification.*

This is the result for daylight factor on the second floor, as shown in Figure here is regions that have low values in the center of story that is (1% or less), and regions have large values especially near the glass that reaches to (16%)



Fourth& fifth & sixth floor





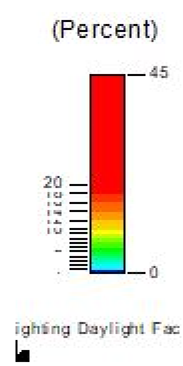


*Figure 2-81daylight factor analysis in Revit for **Second Floor& third floor** before modification.*

This is the result for daylight factor on the Fourth floor, as shown in Figure there is regions that have low values in the center of story & south elevation of the building that is (1% or less), and regions have large values especially near the glass that reaches to (18%).

2.8.3.3 Daylight factor after modification

We make some modifications on the building to resolve the daylight factor to take better natural light to achieve the comfort as recommendations:

- Add glass from the modified one up the court
- Increase the depth of the architecture design on the glass walls to work as cantilever
- Adding a side double volume on the first and second floors from the southern side, and an addition court that helped to light the corridors.

Ground Floor& First floor

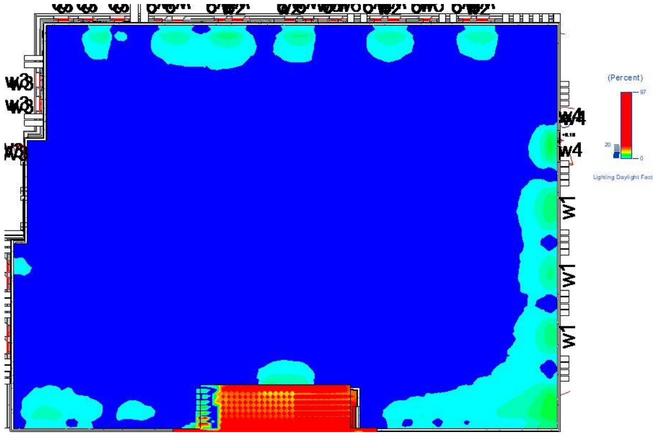
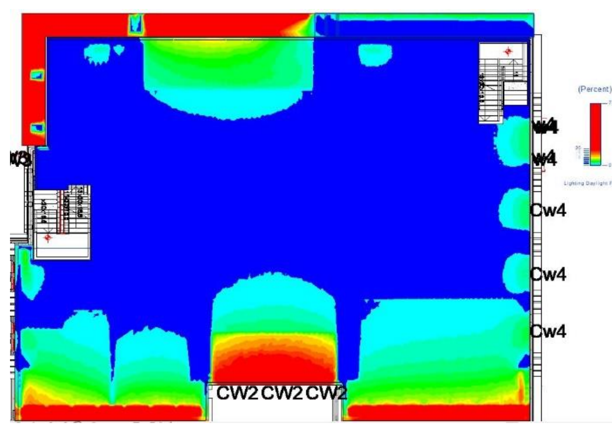


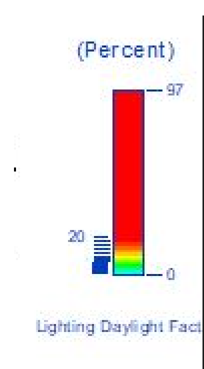
*Figure 2-82daylight factor analysis in Revit for **Ground Floor & First floor** after modification.*

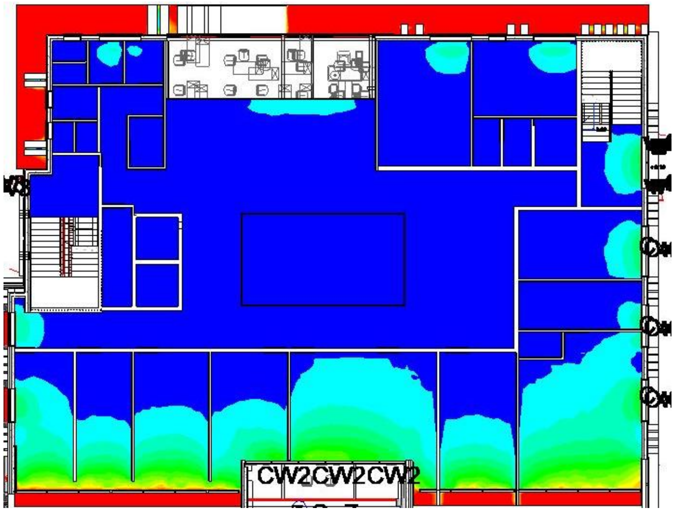
After modification the daylight become better and the maximum value decrease to 12percent but it doesn’t reach to the standard value so we can internal shutter or curtains to give the users free to control the amount of natural light enter the space

The red color is out of the building



Second Floor& third floor





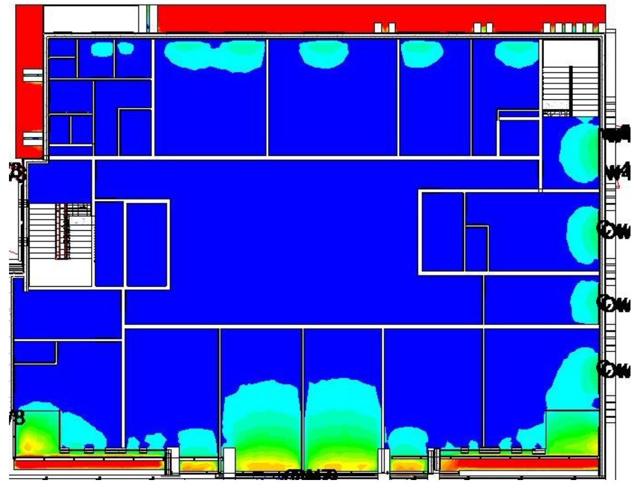
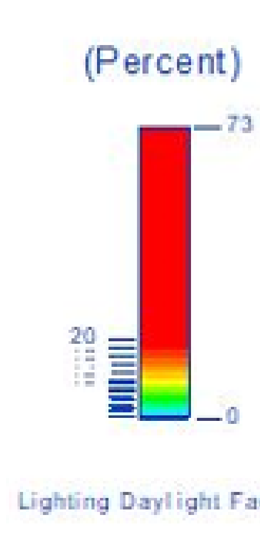


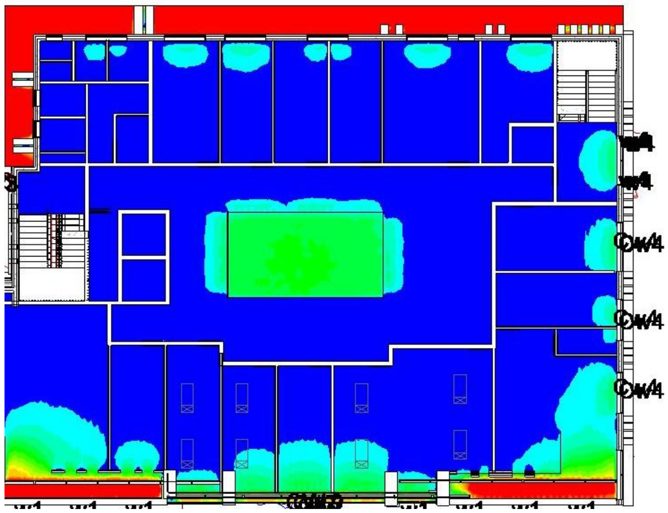
Figure 2-83 daylight factor analysis in Revit for SF& 3rd F after modification

After modification the daylight become better and the maximum value decrease to 15 percent but it doesn’t reach to the standard value so we can internal shutter or curtains to give the users free to control the amount of natural light enter the space.

The red color is out of the building



Fourth Floor& Fifth Floor & Sixth Floor



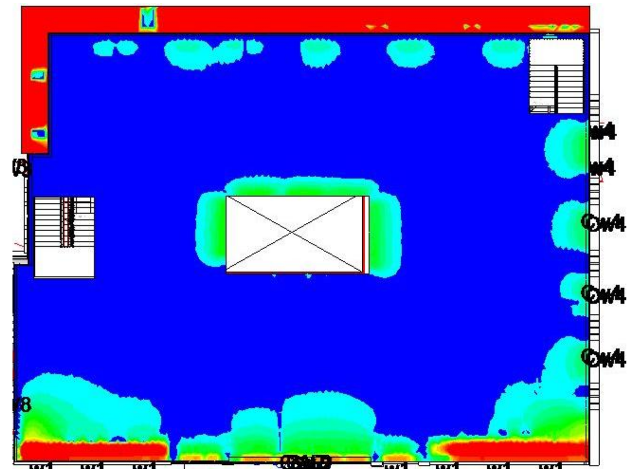
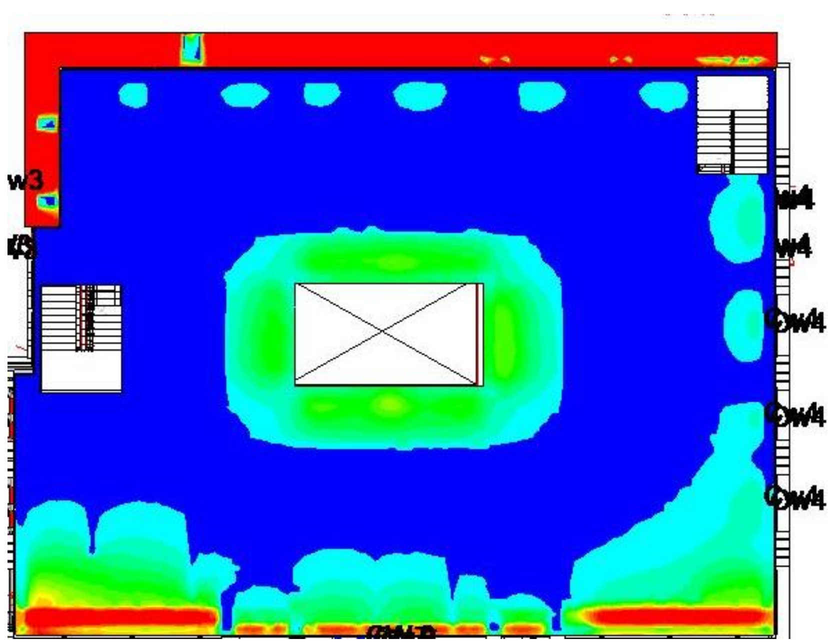


Figure 2-84 daylight factor analysis in Revit for 4th F& 6th&5th F after modification



After modification the daylight become better and the maximum value decrease to 15 percent but it doesn't reach to the standard value so we can internal shutter or curtains to give the users free to control the amount of natural light enter the space.

The red color is out of the building

2.8.3.4 Solutions For the daylight

We added transverse and longitudinal louvers (cross louvers) on the southern, eastern and western façades to add aesthetics to the building and taking into account architectural considerations, this louver was exploited to add green space to the building.

Figure 2-85 solution for Daylight

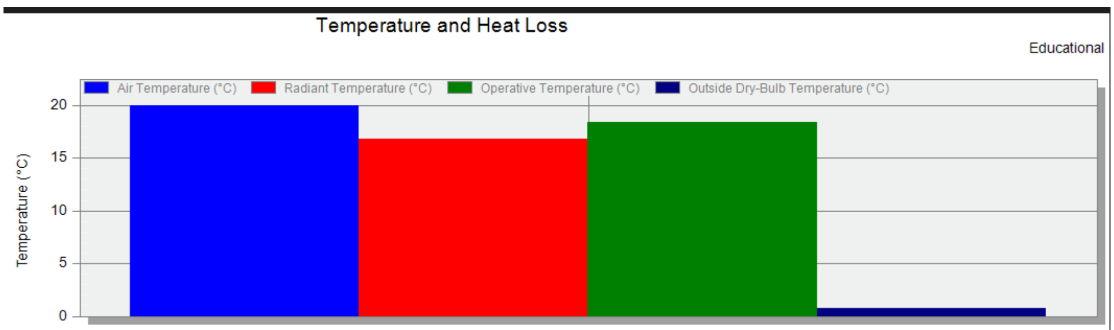
2.8.4 Heating and Cooling

2.8.4.1 Introduction

Through the Design Builder program, a simulation was conducted to find out the annual energy consumption of the building. The first case is a simulation without any thermal insulation or any environmental modifications that reduce energy consumption.

Case 1 (Without Insulation Material):

The heating loads:



Air Temperature (°C)	19.95
Radiant Temperature (°C)	16.78
Operative Temperature (°C)	18.36
Outside Dry-Bulb Temperature (°C)	0.70
Glazing (kW)	-23.13
Walls (kW)	-57.87
Ceilings (int) (kW)	-1.17
Floors (int) (kW)	1.17
Roofs (kW)	-18.52
Floors (ext) (kW)	-21.59
External Infiltration (kW)	-58.52
External Vent. (kW)	-418.02
Zone Sensible Heating (kW)	597.19

Temperature for case 1

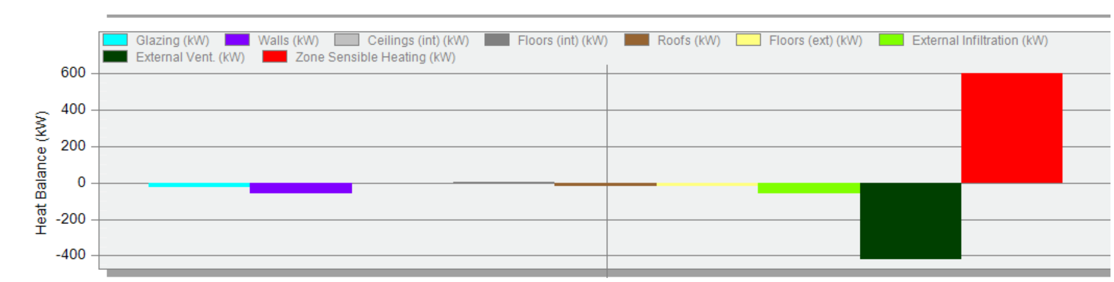
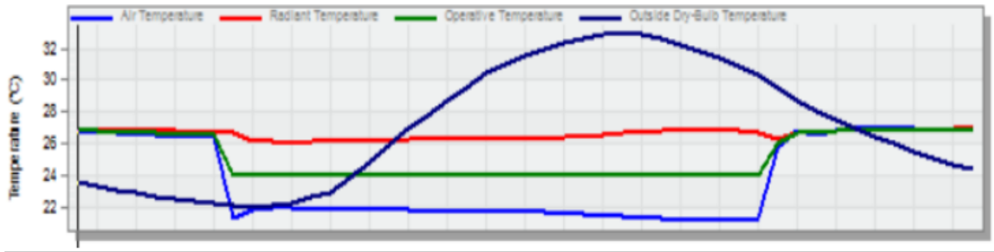


Figure 2-86The heating loads

Heat losses for case 1.

The cooling load:



.Figure 2-87The cooling load:

Temperature case 1

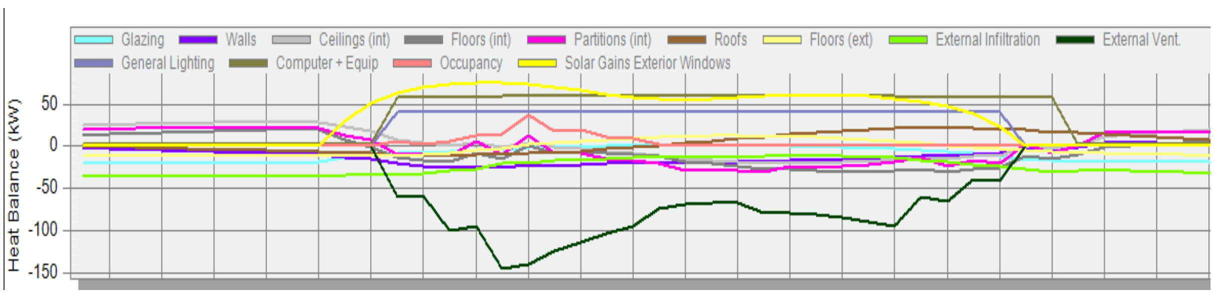


Figure2-288-Heat gain case 1.

The wall without insulation layers:

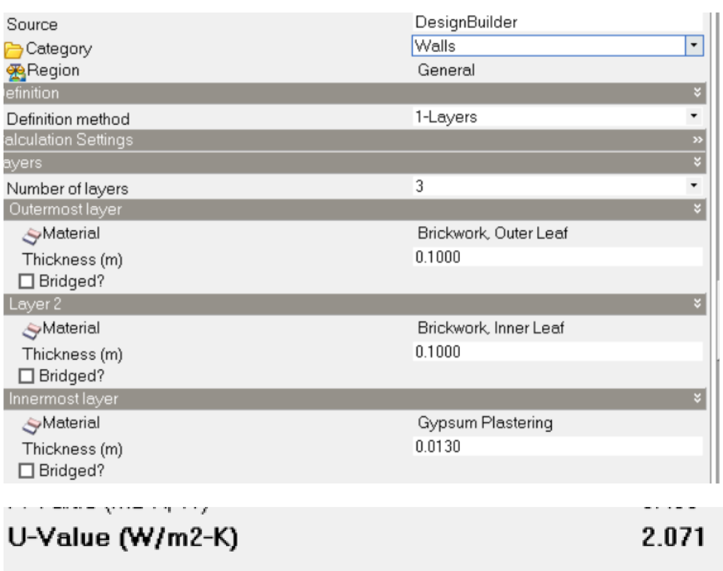


Figure 2-89The wall without insulation layers:

Case 2 (With Insulation Material and Environmental Adjustments).

Environmental Adjustments:

Some environmental modifications were made to reduce energy consumption to suit the Architectural form of the building. Cantilever and some vertical louvers have been placed to create shading on windows and facades to allow winter sunlight to enter the building to help reduce the amount of heating and to reduce the cooling load in summer. Glass type and U-Value have been improved, add insulation in wall and choose good efficient light in building.

The heating loads:

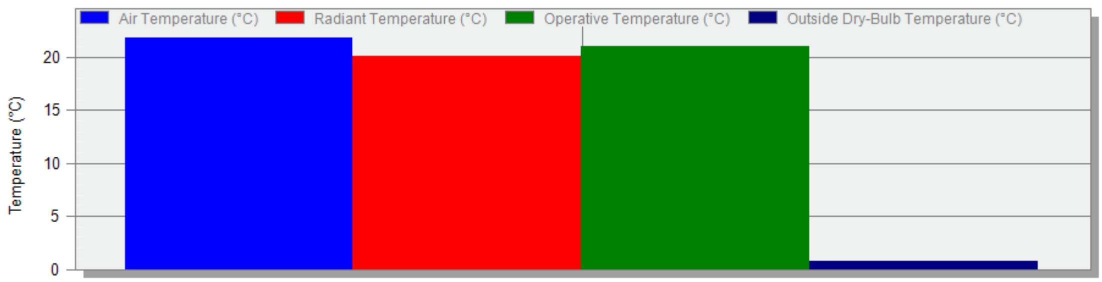


Figure2-290-The wall without insulation layers:

Temperature for case2

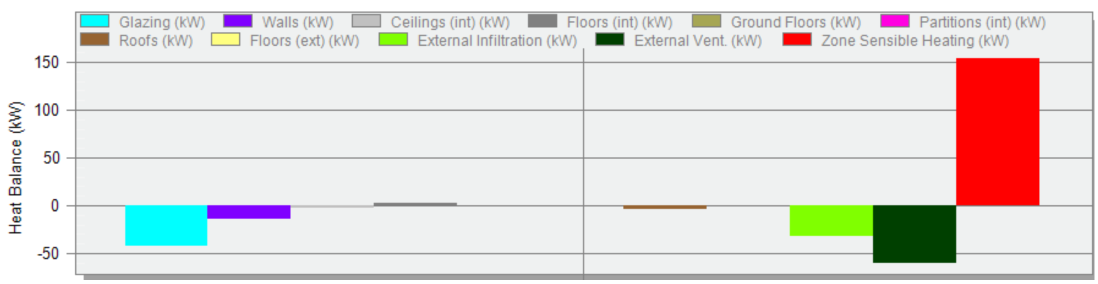
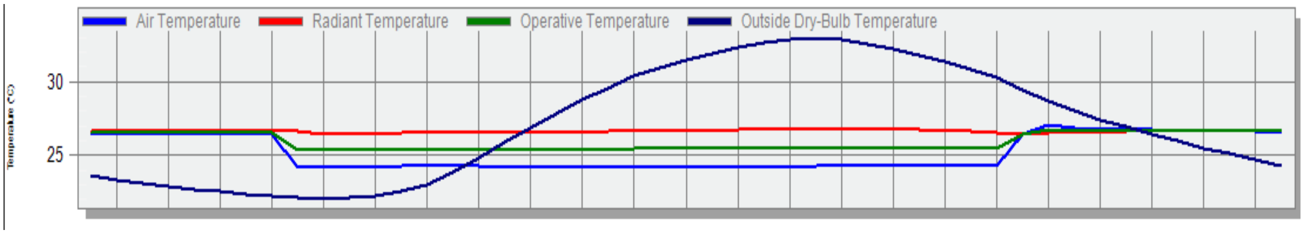


Figure 2-91Heat losses for case2

The temperature is very small compared to the first case due to the addition of insulation materials in the walls and environmental modifications, which leads to increased comfort for users.

The cooling loads:



Temperature case 2

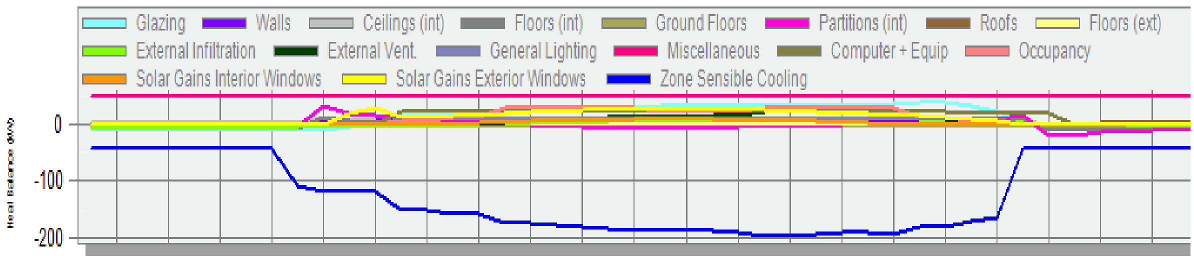


Figure 2-92Heat gain case 2.

There is a difference between radiant heat and required heat, which is less than the first case, so the cooling system will be smaller and result in lower annual energy consumption. The heat gain from glass windows was also reduced as a result environmental modification in its kind and the addition of insulators in the outer walls.

Thermal Comfort:

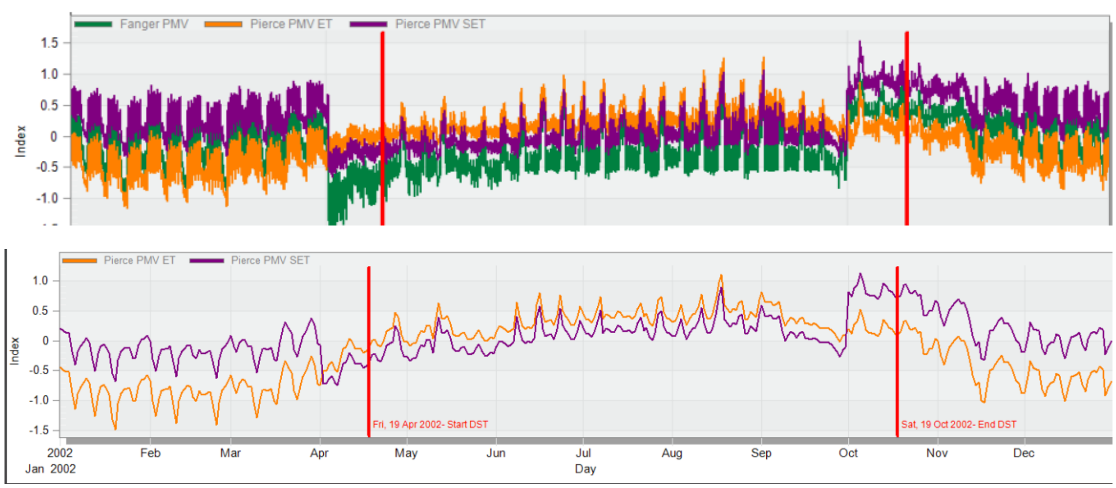


Figure2-293-PMV for Building case 2

Table11.Comfort and Setpoint Not Met Summary case2

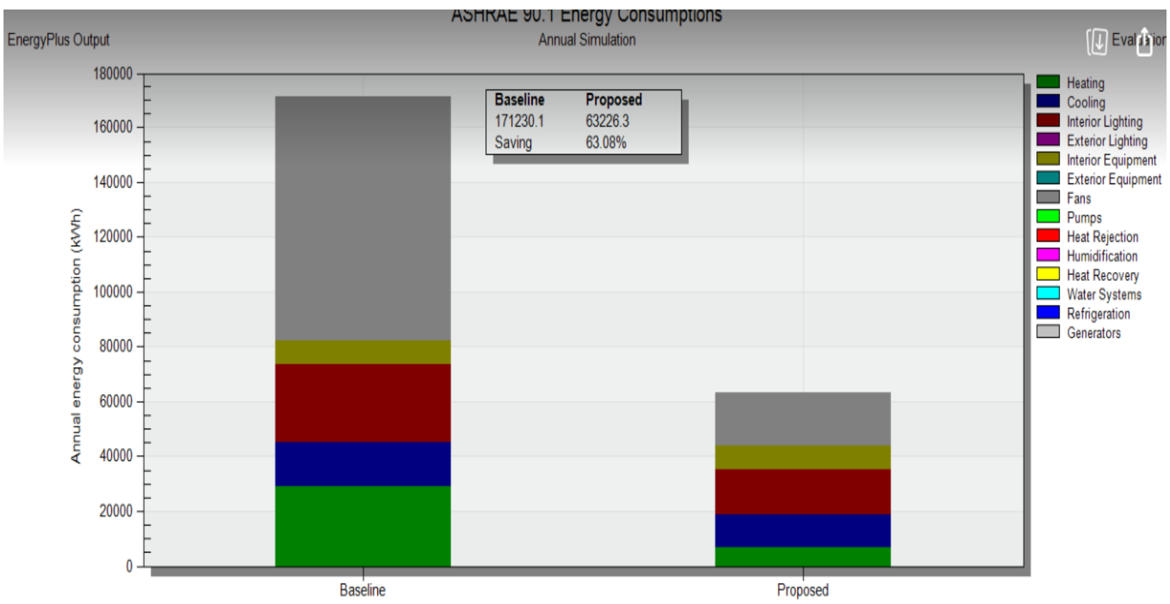
Comfort and Setpoint Not Met Summary

	Facility [Hours]
Time Setpoint Not Met During Occupied Heating	0.00
Time Setpoint Not Met During Occupied Cooling	0.00
Time Not Comfortable Based on Simple ASHRAE 55-2004	400

From the previous table and graphs, it can be seen that the number of hours thermal comfort is very small for case, which indicates the efficiency of insulation and environmental modifications.

According to the ASHREA 90.1

global energy consumption reference and baseline, energy the consumption of the building is much lower than what is in it, and this indicates that the design is excellent

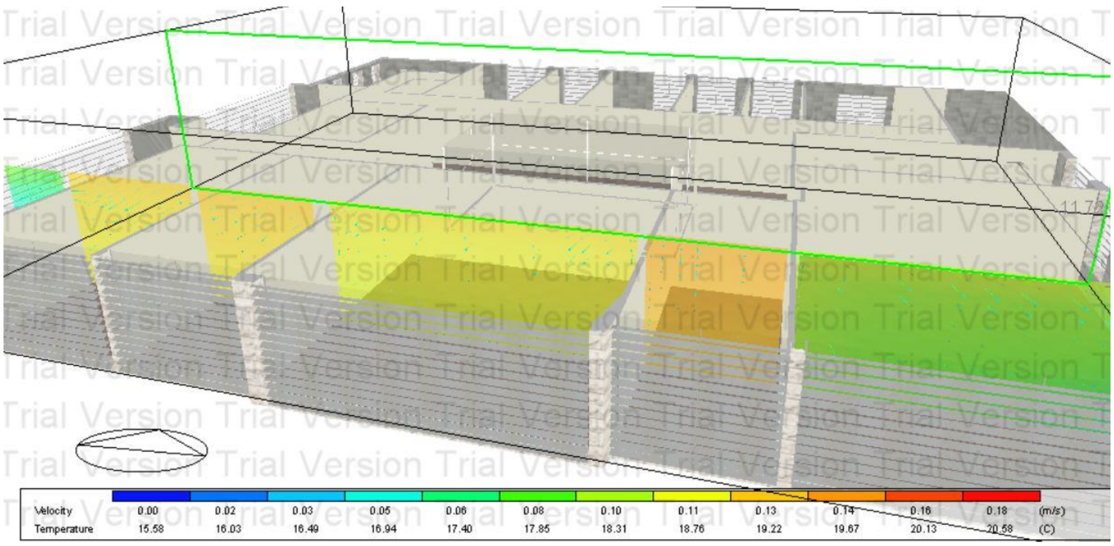


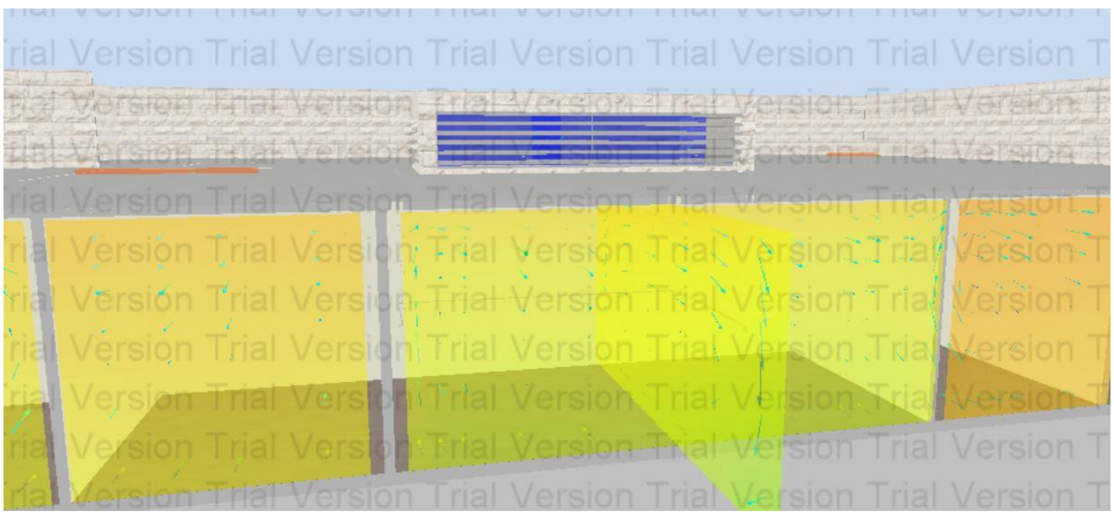
Heating	29017.15	6929.55
Cooling	16291.96	11702.32
Interior Lighting	28277.99	16627.79
Exterior Lighting	0.00	0.00
Interior Equipment	8577.86	8691.57
Exterior Equipment	0.00	0.00
Fans	89065.16	19275.05
Pumps	0.00	0.00
Heat Rejection	0.00	0.00
Humidification	0.00	0.00
Heat Recovery	0.00	0.00
Water Systems	0.00	0.00
Refrigeration	0.00	0.00
Generators	0.00	0.00

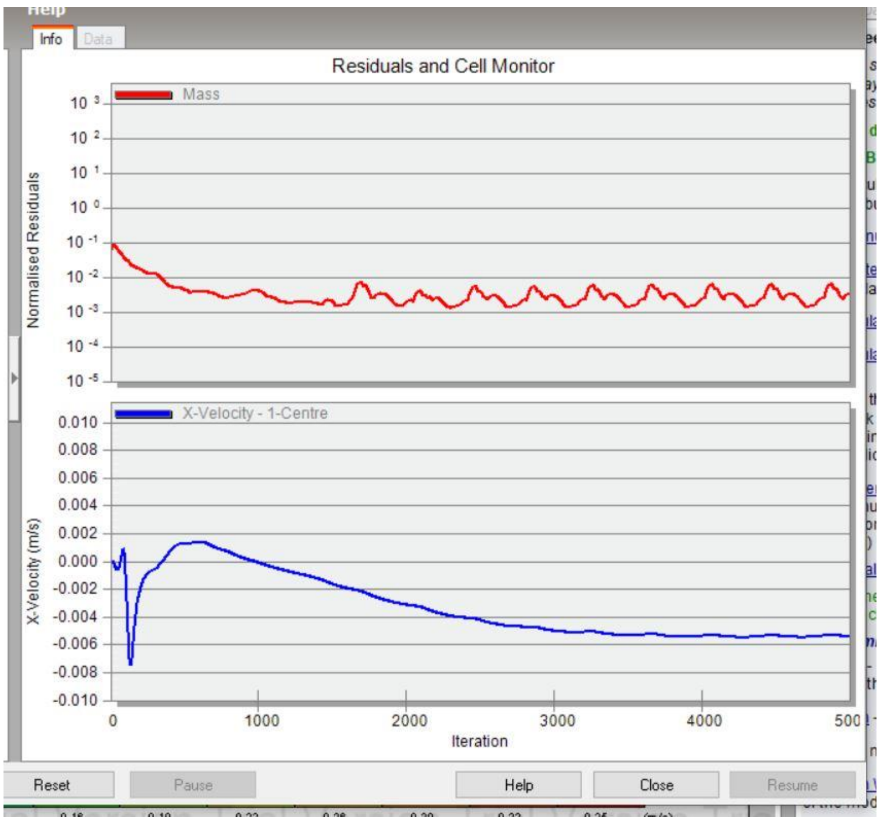
Figure 2-94ASHREA 90.1 energy consumption

The consumption of the building after insulation is much better than the baseline, as the conservation ratio between the building after insulation and the baseline is 63.06% and this is an excellent result.

CFD:in the last three floor which have a solar chimney







This is excellent result

Wall after insulation :

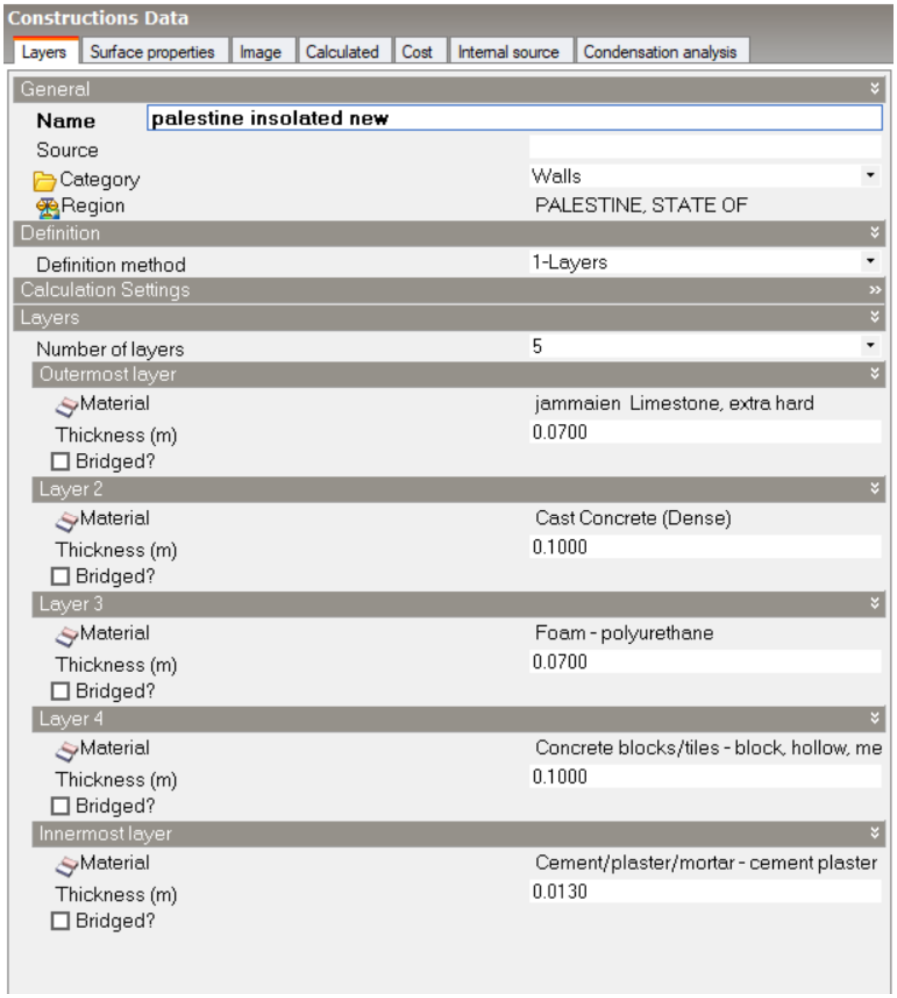


Figure 2-95wall layers after insulation

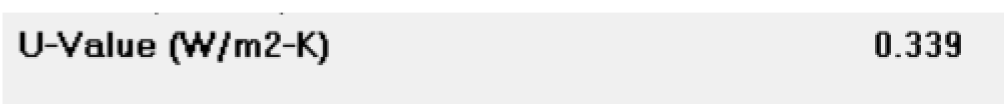


Figure 2-96U value for wall

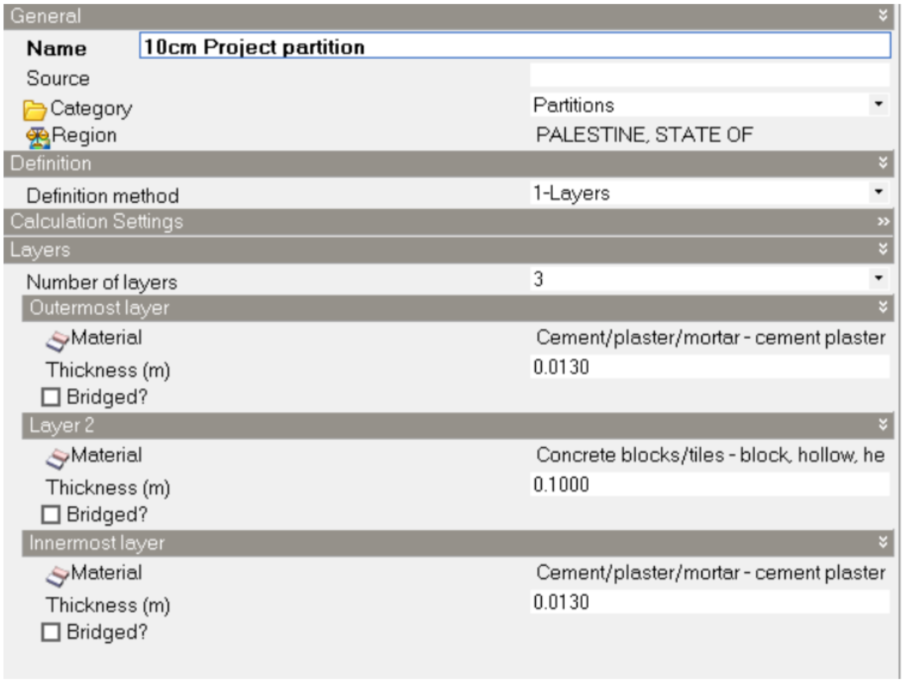
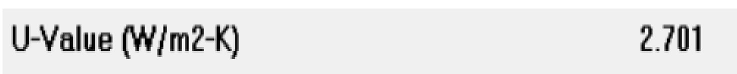


Figure 2-97Partitions layer



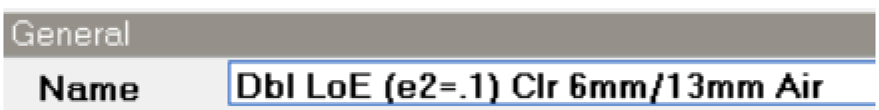


Figure 2-98Glass used in this project

3 Chapter3: Structural Aspects

3.1 STRUCTURAL ASPECTS

3.1.1 introduction:

The building's structural framework serves as its skeleton and prevents it from collapsing and falling. There are many different types of construction systems since they vary Depending on the components they contain, such as concrete, steel, and wood. The Structural system of the building we have selected for our graduation project is based on Concrete. Slabs, beams, columns, and footings are just a few of the components that come Together to form this system. Each of these components must be designed in accordance with the correct specifications and standards in order to support the building and all the loads placed upon it while still being safe for all building occupants.

3.1.2 problem definition

The building has consisted of 10 stories 3 of them are basement stories, the structural system Has been used in two-way ribbed slab since span length from (7-10) m due to architectural Design.

In this project many designing check will be done by using ETABS software such as {Compatibility,equilibrium, stress - strain, deformation}.

3.1.3 Materials:

3.1.3.1 Concert:

One of the most crucial parts of the structural elements in contemporary industry is Concrete. Cement, fine aggregates, and coarse aggregates are combined with water to Create concrete, a building material that can be poured and will eventually become hard. Although concrete is one of the strongest materials for bearing pressure because it can Withstand extremely high pressure, it performs poorly when it comes toTherefore, the strength of concrete is determined by its capacity to withstand pressure. Withstand tensile strength (compressive strength.

3.1.4 Project designing loads

- **Dead load (DL):**It includes the weight of the building and structural elements Such as columns, slabs and beams.
- **super imposed load (SID):**these are represented in the weight of the nonstructural Elements in the building such as: the load of any finished, partitioning cladding, false ceiling Are all super dead loads.
- **Live load (LD):**these are represented in the weight of the movable elements in the building such as:occupancy,furniture. the live load used in our project 2.4 KN/m^2 for Commercial floor (ASCE/SEI 7-05, 2010), and l.l = 4 kn/m^2 for parking. (ASCE/SEI 7-10, 2010).

The following table shows the load from ASCE CODE 7-16.

Table 10the load from ASCE CODE 7-16

TABLE 1–4 • Minimum Live Loads*

Occupancy or Use	Live Load psf	Live Load kN/m²	Occupancy or Use	Live Load psf	Live Load kN/m²
Assembly areas and theaters			Residential		
Fixed seats	60	2.87	Dwellings (one- and two-family)	40	1.92
Movable seats	100	4.79	Hotels and multifamily houses		
Dance halls and ballrooms	100	4.79	Private rooms and corridors	40	1.92
Garages (passenger cars only)	50	2.40	Public rooms and corridors	100	4.79
Office buildings			Schools		
Lobbies	100	4.79	Classrooms	40	1.92
Offices	50	2.40	Corridors above first floor	80	3.83
Storage warehouse					
Light	125	6.00			
Heavy	250	11.97			

*Reproduced with permission from *Minimum Design Loads for Buildings and Other Structures*, ASCE 7-05.

3.1.4.1 Reinforcement steel:

An excellent material for tensile resistance, was used to solve the problem of concrete's Inability to withstand tensile forces, and the two components were combined in many uses to form what is known as reinforced concrete.

- Live load is 2.4KN/m2, we use2.5 KN/m^2.
- Live load for car garages = 4 KN/m^2,
- SID is assumed = 4 KN/m^2
- Wall load = 20 KN/m-

3.1.5 Design codes and specification:

American Society of Civil Engineers (ASCE) for loads..

Uniform Building Code (UBC 97) for seismic design and combinations..

American Concrete Institute code ACI 318-14 **..**

3.1.6 Structural elements:

3.1.6.1 Slabs

The structural components known as slabs give people inside a building a surface on which to walk and work. There are a variety of slab types that are employed, and they vary Depending on their constituent parts. The most well-known of these types are the solid slab, The one-way ribbed slab, the two-way ribbed slab, and the voided slab. The rapid slab, which Relies on the use of steel reinforcement as a primary component and uses bricks to use less Concrete, is one of the most common types.

3.1.6.2 Beams:

As they transfer loads from the slab and pass them to the columns, beams are one of the Most crucial structural components in the building that connects the columns to one Another. There are many different types of beams, such as hidden beams, where the Thickness of the beam is similar to. There are drop beams, where the beam thickness is Greater than the slab thickness. thickness of the slab. Beam tracks were utilized in this Project primarily due to their increased stiffness and suitability for the spans and purpose of the building.

3.1.6.3 columns:

As they transfer loads from the slab to the beams, then the columns, and finally to the building footings, columns are among the crucial structural components in a building the Columns, which are what give the building its true height, are carefully designed so that Their sections and lengths are adequate.

3.1.6.4 Footing:

The transfer of all incoming loads from the building and all of its structural and non-Structural components through the footings to the soil is crucial. Because the footings are Designed with the proper dimensions to perfectly distribute the loads on the soil, their Design greatly depends on the type of soil and how durable it is.

3.1.6.5 Shear wall

Shear walls are considered one of the structural elements that have very high stiffness and Acts like columns in transferring loads. In the underground floors, where they are known as Retaining walls, they are also utilized when there are horizontal loads.

3.2 Structural design:

The ETABS Software was used for the design simulation, and the following calculations and checks were made to ensure that the model design is accurate:

3.2.1 Designing information and data:

3.2.1.1 material used

- Concert B350 for slabs and beams and columns (fc`=28 MPA,=25 KN/m^3)

-Steel rebar E = 200 GPA , FC =420 MPA , unit weight (ɣ=78 KN/m^3)

3.2.1.2 system designing data

the used slab system in the project is two way ribbed slab with hidden beams .

table:depicts the minimum thickness for solid slab, which will used to determine the

Table 11 Two way ribbed slab , Slab required thickness as shown:

f_y, psi[†]	Without drop panels[‡]			With drop panels[‡]		
	Exterior panels		Interior panels	Exterior panels		Interior panels
	Without edge beams	With edge beams[§]		Without edge beams	With edge beams[§]	
40,000	$\ell_n/33$	$\ell_n/36$	$\ell_n/36$	$\ell_n/36$	$\ell_n/40$	$\ell_n/40$
60,000	$\ell_n/30$	$\ell_n/33$	$\ell_n/33$	$\ell_n/33$	$\ell_n/36$	$\ell_n/36$
75,000	$\ell_n/28$	$\ell_n/31$	$\ell_n/31$	$\ell_n/31$	$\ell_n/34$	$\ell_n/34$

[*]For two-way construction, ℓ_n is the length of clear span in the long direction, measured face-to-face of supports in slabs without beams and face-to-face of beams or other supports in other cases.
[†]For f_y between the values given in the table, minimum thickness shall be determined by linear interpolation.
[‡]Drop panels as defined in 13.2.5.
[§]Slabs with beams between columns along exterior edges. The value of α_f for the edge beam shall not be less than 0.8.

as a rule of thumb: the required thickness for the two-way ribbed slab = 1.1 $*^{LN}/_{33}$

The maximum span length = 7.5 m.

h required = 1.1* $^{7.5}/_{33} = .25$

h = .25 m (initial dimentions)

3.2.2 Beams initial dimensions:

All beams are hidden with main beam in two dimension, with thickness 250 mm and Beam width = 900 mm .and there are drop beam with dimension (500mm*600 mm).

3.2.3 columns initial dimensions:

The following formula used to determinate columns dimension

Ac = $^{\boldsymbol{p} * \boldsymbol{M}}/_{\boldsymbol{n} * \boldsymbol{fc}}$

Where:

P: is the total axial load imposed on the column-

M: factor of safety equal 1.1-

n: reduction factor depends on column location-

fc=compressive strength for concrete in MPa.

The Dimensions of the columns have been changed due to the Etabs checks, which will be clarified later, Table below shows the initial dimension:

simple calculation for columns

	width	**length**	**tributary area**	**WU**	**pu**	**Ac**	**length**	**width**
corner	5.25	2.25	11.8125	18.544	2190.51	286.8525	500	**300**
center 1	3.65	9.05	33.0325	18.544	6125.547	1203.232	1	**500**
edge	3.5	5.4	18.9	18.544	3504.816	550.7568	600	**300**
center 2	4	4.5	18	18.544	3337.92	655.6629	700	**300**

3.3 Model check

3.3.1 gravity checks

3.3.1.1 Compatibility checks

This Check to make sure that the building model after running is linked and acting Together.

The Figure depicts it.

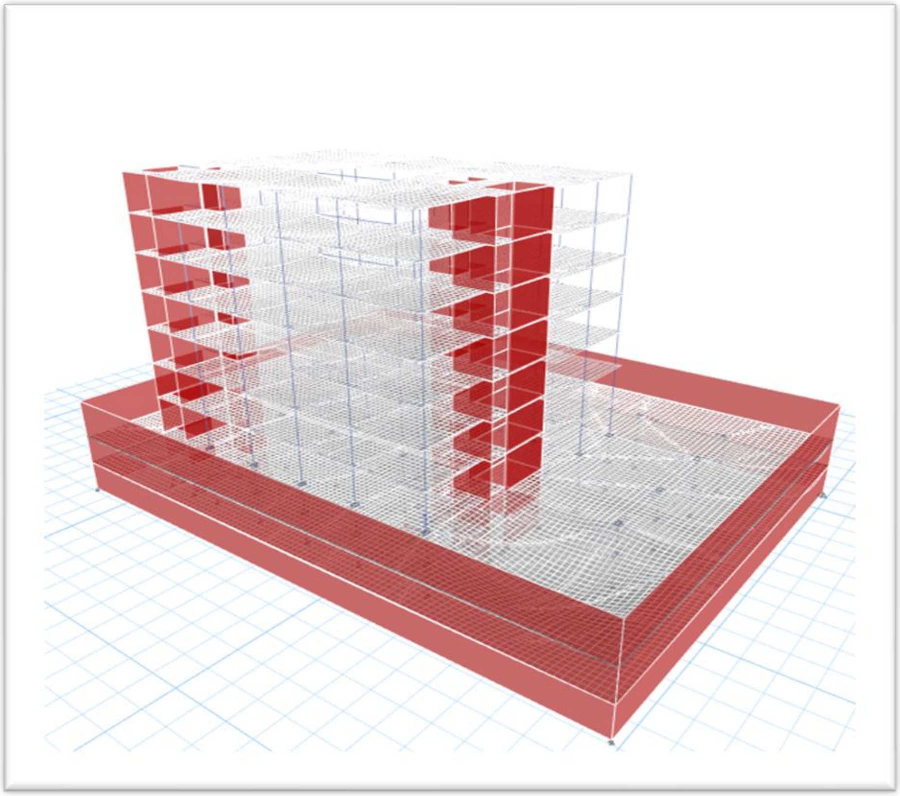


Figure 3-3-1Compatibility checks

3.3.1.2 Equilibrium checks

This check comparesload’s reaction from ETABS with manual reaction from loads inputted to the model:

Dead load:

- **Weight of SLAB:**

Table 12slab area for each story

ground	571.8
1	571.8
2	601.2
3	620.8
4	580.8
5	580.8
6	580.8
Base 1	1735.8
Base 2	1736.1
total	*7643*

*weight of slabs = SLAB AREA * SELF WEIGHT OF SLAB *UNIT WEIGHT OF CONCRET*

weight of slabs= 7643 {(.55*.55*.25)-(.4*.4*.17)/.55^2}*25 = 30587KN.*

- **Weight of beams :**

primary beam dimension :

(.9 m.25m). /hidden beam*

drop beam : (.5m.6m).*

*total weight of beams = beams width * beam depth * unit weight of concert (KN/m^3) *total length .*

.9mm.25mm* 25 * 2287 =12864 KN. total weight of hidden beam beams =*

.6mm.5mm* 25 *755=5662.5 KN. total weight of hidden beam beams =*

- **Weight of columns :**

Weight of columns = Column Cross Sectional area x total length of column x Unit Weight of concrete (γ).

➔Weight of column (0.6 x0.3) = 21colum*0.6 x 0.3 x 34.68x 25= 3277.26kN.

➔Weight of column (0.6 x0.3) = 7*0.6 x 0.3 x 9x 25= 50 kN.

➔Weight of column (0.5 x0.5) = 3*0.5 x 0.5 x 34.68x 25 = 650.25 kN.

➔Weight of column (0.4 x0.4) = 2*0.4 x 0.4 x 34.68x 25 = 277.44kN.

➔ **Total weight of all Colum =** 3277.26**+**50+650.25+277.44**= 4254.95kN.**

- **From shear wall:**

Weight of shear wall = Perimeter of wall x weight /m

Weight of wall /m = [wall thickness (m) x wall height (m) x Unit Weight of concrete (γ) (kN/m^3)].

= [0.3 (m) x 34.68 (m) x 25 kN/m^3] = 260 kN/m.

Weight of shear wall = 43.5 x 260 =**11310kN.**

- **From Basement wall :**

Weight of basement wall = Perimeter of wall x weight /m

Weight of wall /m = [wall thickness (m) x wall height (m) x Unit Weight of concrete (γ) (kN/m^3)].

= [0.3 (m) x 9 (m) x 25 kN/m^3] = 67.5kN/m.

Weight of shear wall = 173.4x67.5 =**11677.5kN.**

total building weight = 76360 KN

Table 13the following table shows ETABS reactions:

Output Case	Case Type	Step Type	Step Number	FX kN	FY kN	FZ kN
Dead	LinStatic			-7.038E-07	-2.276E-06	75007.4064
Live	LinStatic			0	-7.92E-07	24393.0101
sid	LinStatic			0	-1.242E-06	30575.3685

Dead Load from ETABS = 75007

equluipruim check base reaction from etabs

➔**% of error** = $\frac{|\text{Manual}-\text{Sap}|}{\text{SAP}}$ **X 100**% = $\frac{76360-75007}{75007}$ **X 100** % = **1.8** <**5%**

SID load:

SID manual calculation:

Weight Total Area of floors (m2) x SID Load/m2
SID Load/m2 = 4 KN /m2.
Weight =7643* 4 =30572 kN.

from ETABS = **30575 KN.**

➔% of error = $\frac{|\text{Manual}-\text{Sap}|}{\text{SAP}}$ X 100% = $\frac{30572-39575}{35075}$ X 100 % = **.2**<5%

live load:

live manual calculation:

Weight Total Area of floors (m2) x SID Load/m2
SID Load/m2 = 4 KN /m2.
Weight =3471* 4 + 4109 * 2.5=24312kN.

from ETABS= **30575 KN.**

➔% of error = $\frac{|\text{Manual}-\text{Sap}|}{\text{SAP}}$ X 100% = $\frac{24312-24393}{24393}$ X 100 % = **.3**<5 %

The load of the building is equilibrium

3.3.1.3 stress - strain check:

- <u>**column check :**</u>

take three column to check:

column 1 :

<u>(Hand Calculation):</u>

*Axial Force <u>(Hand Calculation)</u>: →Column weight +beam weight + Tributary Area of column (m^2) x no. of stories x height of stories * wu*

<u>axial load</u> =.3.6*6*25*1.2+12*.9*.25*25*1.2+(7.15*5)*2*(1.2*(4+4.06)+1.6*4)= 1238kn.*

<u>(from Etabs):1358</u>

Figure 3-3 the following figure shows the ETABS value

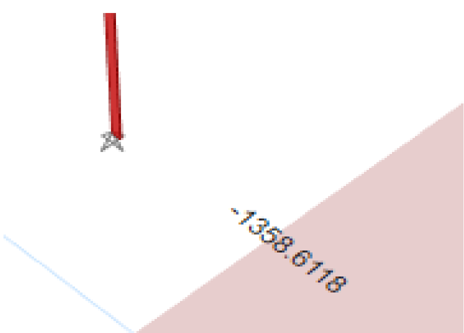


Figure 3-2axial value for column 1 from ETABS

➔% of error = $\frac{|\text{Manual}-\text{Sap}|}{\text{SAP}}$ X 100% = $\frac{1238-1358}{1358}$ X 100 % = **8**.8 <10 % OK

- **column 2:**

<u>(Hand Calculation):</u>

*Axial Force <u>(Hand Calculation)</u>: →Column weight +beam weight + Tributary Area of column (m^2) x no. of stories x height of stories * wu*

Axial force =.3.6*31.64*25*1.2+10.2*.9*.25*25*1.2+(6.3*5.4)*2*(1.2*(4+4.06)+1.6*4) +(6.3*5.4)*7*(1.2*(4+4.06)+1.6*2.5)= 4564kn.*

<u>(from Etabs):4405</u>

Figure 3-4the following figure shows the ETABS value

→% of erro

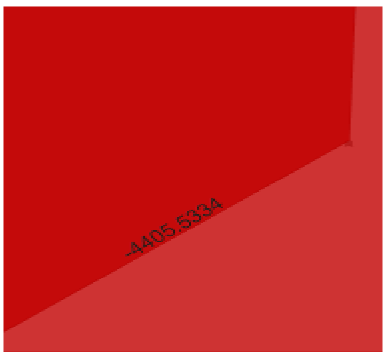


Figure 3-2axial value for column 2 from ETABS

Error = $\frac{|\text{Manual}-\text{Sap}|}{\text{SAP}}$ X 100% = $\frac{4564-4405}{4405}$ X 100 % =3.6 <10 % OK

column 3 :

<u>(Hand Calculation):</u>

*Axial Force (Hand Calculation): →Column weight +beam weight + Tributary Area of column (m^2) x no. of stories x height of stories * wu*

axial load =.6.6*31.64*25*1.2+11.3*.9*.25*25*1.2+(4.55*7.1)*2*(1.2*(4+4.06)+1.6*4)+(6.3*5.4)*7*(1.2*(4+4.06)+1.6*2.5)= 5073kn.*

(from Etabs): 5264Kn

the following figure shows the ETABS value

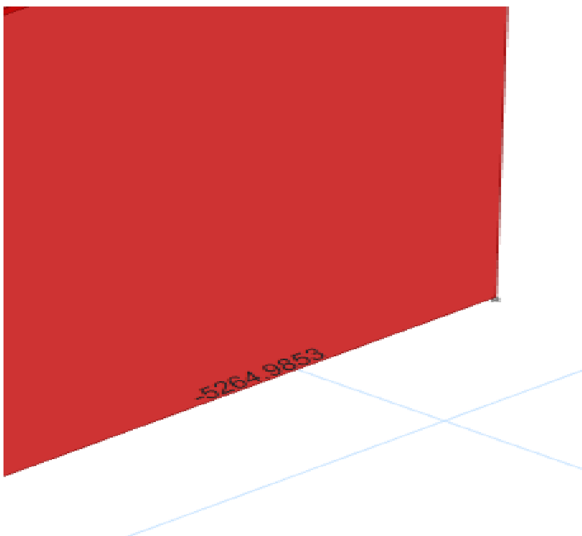


Figure 3-3axial value for column 3 from ETABS

→% of error = $\frac{|\text{Manual}-\text{Sap}|}{\text{SAP}}$ X 100% = $\frac{5073-5264}{5264}$ X 100 % =3.6 <10 %OK

for Slab and beam check:

Manual calculations:

In order to use the Direct Design Method, the following limitation must be satisfied:

1)3 spans or more in each direction

The following figure shows there are 3 span or more

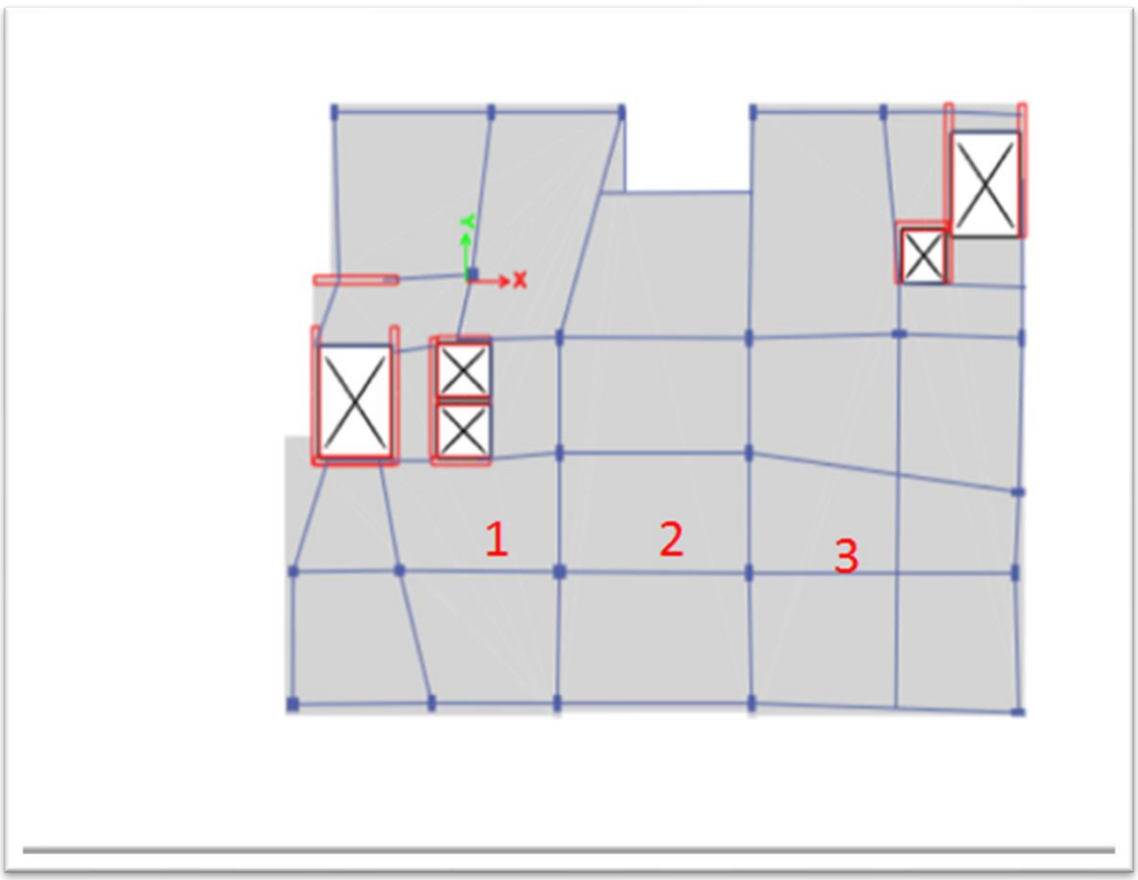


Figure 3-4Limitation (1) 3 span or more in each direction

.

2) ***Rectangular panel with*** $^{l\ long}/_{l\ short}$ ***in any panel ≤ 2***

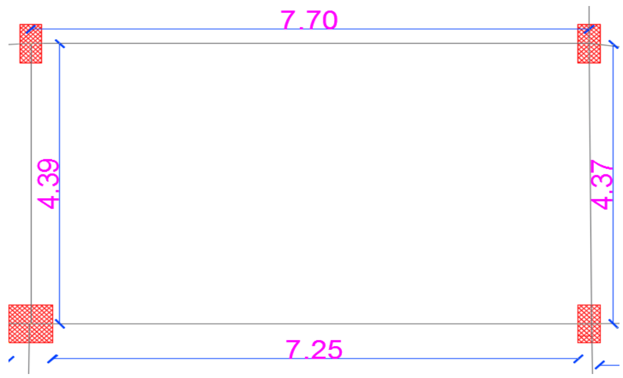
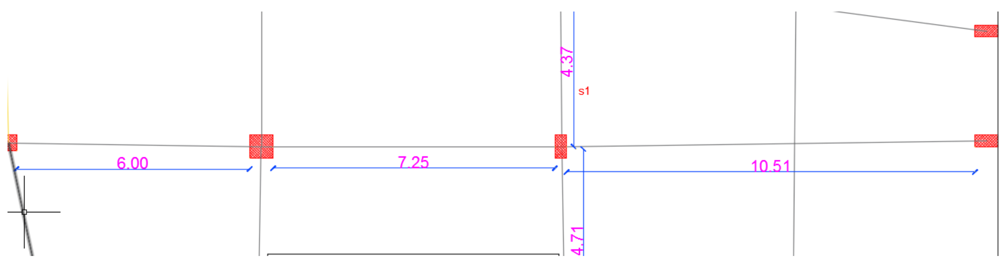


Figure 3-5limitation 2 rectangular panel

3)For successful span $^{llong}/_{l\ short} \le 1$.



limitation (3)for successful span $^{llong}/_{lshort} \le 1$

7.7/4.4 =1.7< 2 OKK.

Table 14the following table shows the limitation is satisfied

	L long /l short	
Span 1-2	7.25/6	1.25
Span 2-3	10.5/7.25	1.44

4)Column offset ≤10% of smaller span in the column offset direction.

*max offset = 10% *Min (s1,s2)*

*max offset = 10% *4.7 = .47.*

actual offset = 1/10.5= 9.5 5 < 10 % okk.

5)UNIFORM GRAVITY LOAD WITH LL/ DL < 2

live load = 2.5 KN/m2

dead load = 4 KN/m2

LL / DL = .6 < 2 OKK

*6**)For slab with beams*** *.2≤$\frac{afAB/lAB^2}{afBC/LBC^2}$≤ .5*

afi=$\frac{EcB*Ib}{EcS*Is}$.

Ecb = modulus of elasticity of the beam concrete.

Ecs = modulus of elasticity of the slab concrete.

*I beam = $\frac{900*250^3}{12}$ = 2.2*10^9*

*I slab = $\frac{7.25*250^3}{12}$ = 9.1*$s10^9$*

Table 15alpha f for beams

	Frame	I slab	I beam	afi
AB	7700	1E10	2.2*10^9	0.116
BC	7250	.944E10	2.2*10^9	0.124
CD	439	.6E10	2.2*10^9	.205
DE	4397	.6E10	2.2*10^9	0.204

.2≤$\frac{.116/7.7^2}{.124/7.25^2}$≤ 5

.2≤1.06≤ 5

The limitations are satisfied

Table 16limitation for all frames

LAB	L BC	afiAB	afiBC	Limitation	
7.7	7.25	*0.116*	*0.124*	1.06	***OK***
LBC	**L CD**	***afiBC***	***afiCD***	***Limitation***	***OK***
7.25	***4.39***	*0.124*	*.205*	1.65	
LCD	**L DE**	***afiCD***	***afiDE***	***Limitation***	***OK***
4.39	***4.37***	*.205*	*0.204*	***1***	

7)Moment redistribution is not permitted: No redistribution has been done at any moment, so this limitation is fulfilled.

Uimate load of the beam:

Wu for beam = beam own weight + (Wu for slab x triputary width of beam)]

= [(1.2 x.5 x.6 x25) + (13.6 kn /m2*3.75 m)] = 48.91 kN/m.

Moment= $\mathrm{wu} * \mathrm{ln2}/_{8}$ +$\mathrm{wu\ ln2}/_{12}$

Moment= $9 * 10.5\text{^}2/_{8}$ + $51 * 10.5\text{ ^}2/_{12}$

moment = 592 KN.M

From ETABS :

the following figure illustrate the values of Moments in the selected interior beam

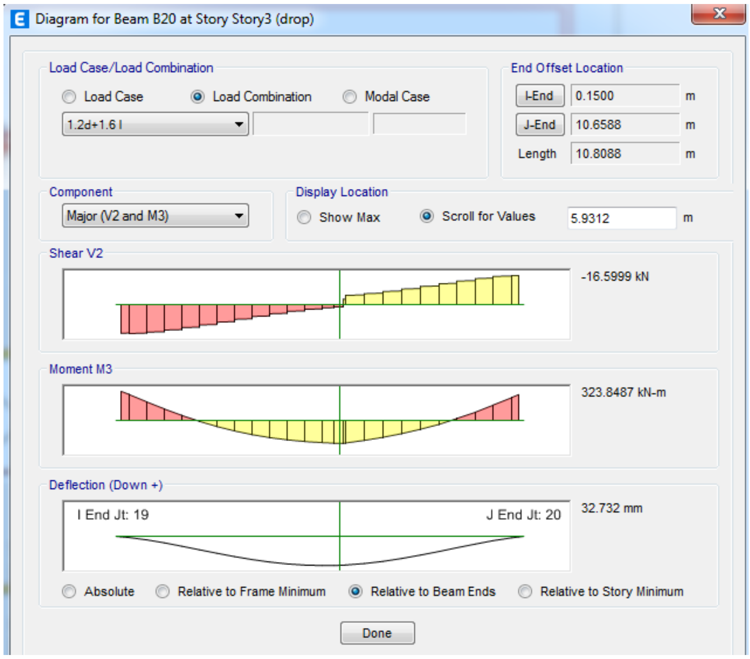


Figure 3-6positive moment for beam.

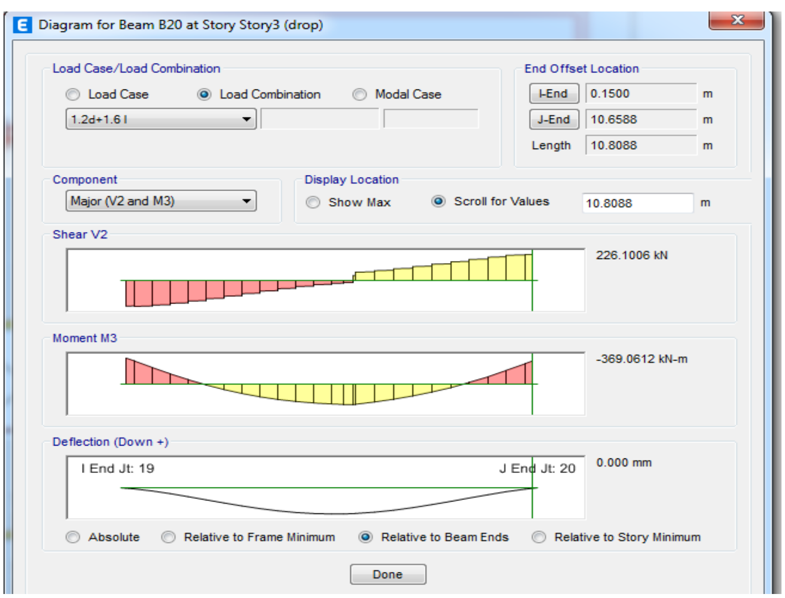


Figure 3-7negative moment for beam

moment=M1-M1/2 - M+ = 692

$\rightarrow$difference = $\frac{|\text{Manual}-\text{Sap}|}{\text{SAP}}$ X 100% = $\frac{592-692}{692}$ X 100 % =14.4 %< 15 % OK

Slab check :

middle strip moment= W L2(Ln12) ²/8

WU = 13.6 Kn/m2

l2 = $\frac{4.3}{2}+\frac{4.3}{2}$= 4.3m.

ln2= 7.7 -.45= 7.25m.

middle strip moment = $13.6 * 4.3 * (7.25)^{\wedge}2 / 8$ =384.23 Kn.m

(from Etabs): the figure below illustrate the values of Moments in the selected interior frame.

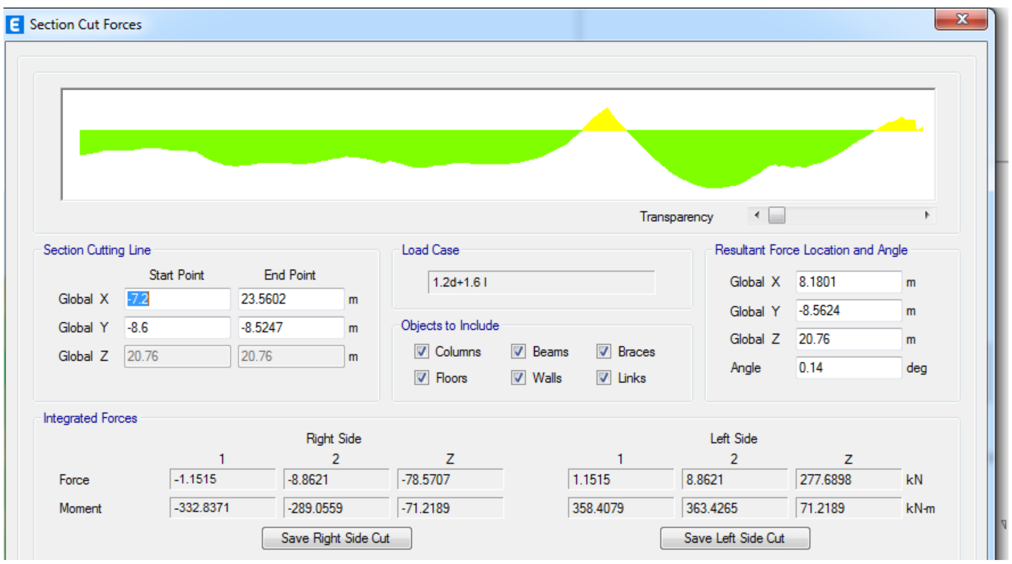


Figure 3-8moment for middle strip slab

from ETABS= 332 KN.M

$\rightarrow$difference = $\frac{|\text{Manual}-\text{Sap}|}{\text{SAP}}$ X 100% = $\frac{384-345}{345}$ X 100 % =11.3 %< 15 % OK

column strip :

column strip moment= W L2(Ln12) ²/8

WU = 13.6 Kn/m2

l1 = $\frac{\textbf{Min (S1/l1)}}{\textbf{4}}$

l1= $^{4.3}/_{4}$ =1.075

ln2= 7.7 -.45= 7.25m.

column strip moment = $^{13.6 * 1,075 * (7.25)^{\wedge}2}/_{8}$ =96 Kn.m.

the figure below illustrate the values of Moments in the selected interior frame.

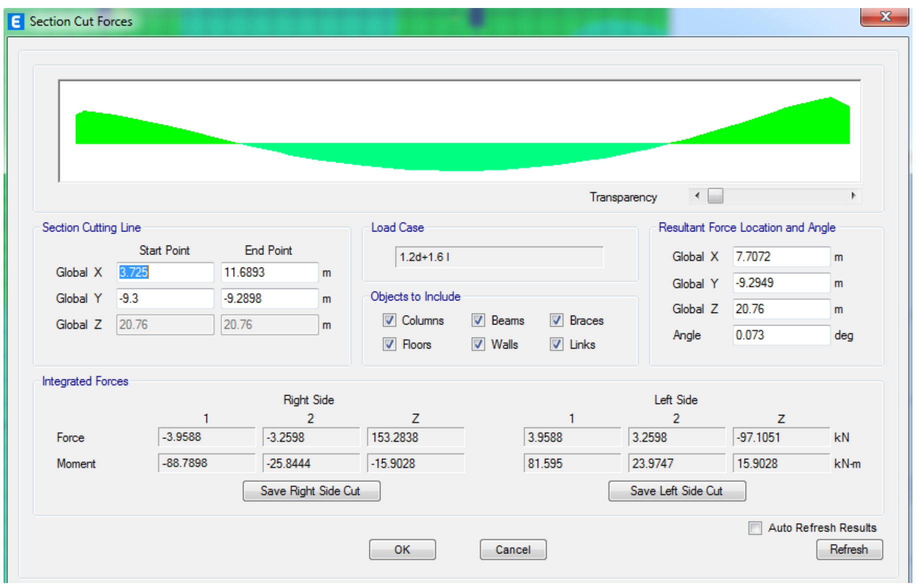


Figure 3-9moment for column strip slab

from ETABS= 332 KN.M

➔difference = $\frac{|\text{Manual}-\text{Sap}|}{\text{SAP}}$ X 100% = $\frac{96-88}{88}$ X 100 % =9 %< 15 % OK.

3.3.1.4 Deflection check:

To ensure that the occupants of the facility are at ease and do not experience anxiety or fear of it failing, it is necessary to examine the deflection of the slab.

Following table shows examples of how the maximum permitted deflection (limit) is calculated :

TABLE 9.5(b) — MAXIMUM PERMISSIBLE COMPUTED DEFLECTIONS

Type of member	Deflection to be considered	Deflection limitation
Flat roofs not supporting or attached to nonstructural elements likely to be damaged by large deflections	Immediate deflection due to live load ***L***	**ℓ/180***
Floors not supporting or attached to nonstructural elements likely to be damaged by large deflections	Immediate deflection due to live load ***L***	**ℓ/360**
Roof or floor construction supporting or attached to nonstructural elements likely to be damaged by large deflections	That part of the total deflection occurring after attachment of nonstructural elements (sum of the long-term deflection due to all sustained loads and the immediate deflection due to any additional live load)†	**ℓ/480‡**
Roof or floor construction supporting or attached to nonstructural elements not likely to be damaged by large deflections		**ℓ/240§**

*Limit not intended to safeguard against ponding. Ponding should be checked by suitable calculations of deflection, including added deflections due to ponded water, and considering long-term effects of all sustained loads, camber, construction tolerances, and reliability of provisions for drainage.

†Long-term deflection shall be determined in accordance with 9.5.2.5 or 9.5.4.3, but may be reduced by amount of deflection calculated to occur before attachment of nonstructural elements. This amount shall be determined on basis of accepted engineering data relating to time-deflection characteristics of members similar to those being considered.

‡Limit may be exceeded if adequate measures are taken to prevent damage to supported or attached elements.

§Limit shall not be greater than tolerance provided for nonstructural elements. Limit may be exceeded if camber is provided so that total deflection minus camber does not exceed limit.

Figure 3-10The maximum permitted deflection for immediate deflection based on this table is l/360

The maximum permitted deflection for immediate deflection based on this table is l/360

L: The slab's critical span length in millimeters

= 10.77/360 = 29m The following figure shows the max deflection from live load by ETABS :

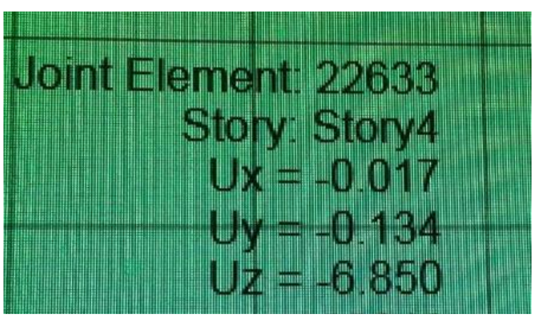


Figure 3-11deflection value from live load

Δsap=0.007<Δmax ok.

figure :illustrate the values of deflection in the selected interior frame.

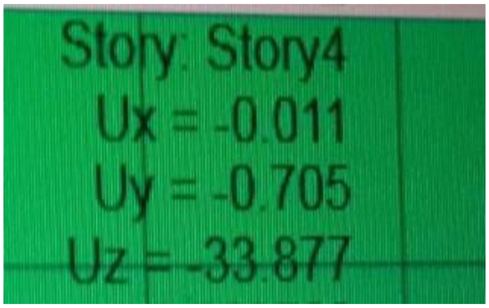


Figure 3-12deflection value from service load

The observed numbers are in millimeter

Δmax= l/240 from service lood

Δmax=10.77/240=44mm

Δsap=33≤Δmaxok.

3.4 seismic design:

3.4.1 seismic load analysis

The seismic analysis will be done on this model according to UBC-97 code and with response Spectrum method.

There are some parameters that should be defined during the seismic analysis as follows:

3.4.1.1 seismic zone factor (z) :

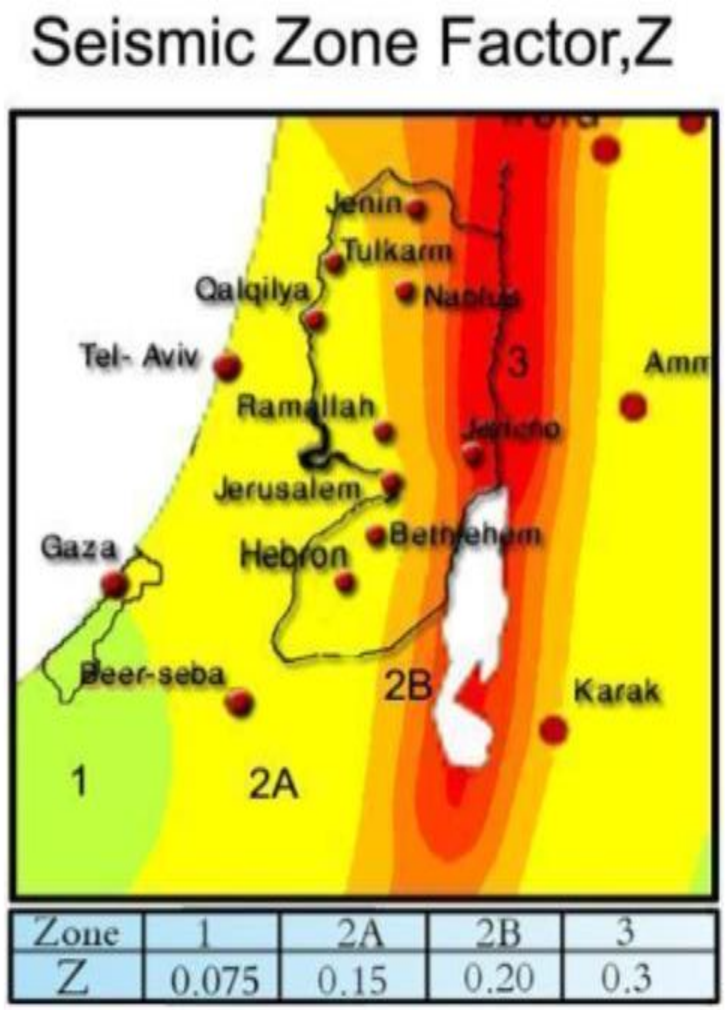


Figure 3-13sesmic hazard map

The building is located in ramallah city wich mean the the sesmic zone is 2A and from the ,map above the sesmic zone factor = .15

3.4.1.2 Soil profile type :

The soil under the building is very dense soil with bearing capacity =350 KN/m2.

*its mean that the soil profile is **SC**.*

Table 3.5: Soil profile types:

TABLE 16-J—SOIL PROFILE TYPES

SOIL PROFILE TYPE	SOIL PROFILE NAME/GENERIC DESCRIPTION	AVERAGE SOIL PROPERTIES FOR TOP 100 FEET (30 480 mm) OF SOIL PROFILE		
		Shear Wave Velocity, $\bar{v}_s$ feet/second (m/s)	Standard Penetration Test, $\bar{N}$ [or $\bar{N}_{CH}$ for cohesionless soil layers] (blows/foot)	Undrained Shear Strength, $\bar{s}_u$ psf (kPa)
S_A	Hard Rock	> 5,000 (1,500)	—	—
S_B	Rock	2,500 to 5,000 (760 to 1,500)		
S_C	Very Dense Soil and Soft Rock	1,200 to 2,500 (360 to 760)	> 50	> 2,000 (100)
S_D	Stiff Soil Profile	600 to 1,200 (180 to 360)	15 to 50	1,000 to 2,000 (50 to 100)
S_E[1]	Soft Soil Profile	< 600 (180)	< 15	< 1,000 (50)
S_F	Soil Requiring Site-specific Evaluation. See Section 1629.3.1.			

[1]Soil Profile Type S_E also includes any soil profile with more than 10 feet (3048 mm) of soft clay defined as a soil with a plasticity index, $PI > 20$, $w_{mc} \geq 40$ percent and $s_u < 500$ psf (24 kPa). The Plasticity Index, PI, and the moisture content, w_{mc}, shall be determined in accordance with approved national standards.

3.4.1.3 Acceleration-Dependent Seismic Coefficient (Ca) :

The sesmic cofficant (ca) can be obtained from the folowing figure . (at soil profile sc and z = .15 CA = .18)

Table 3.6: Seismic Coefficient Ca:

TABLE 16-Q—SEISMIC COEFFICIENT C_a

SOIL PROFILE TYPE	SEISMIC ZONE FACTOR, Z				
	Z = 0.075	Z = 0.15	Z = 0.2	Z = 0.3	Z = 0.4
S_A	0.06	0.12	0.16	0.24	$0.32N_a$
S_B	0.08	0.15	0.20	0.30	$0.40N_a$
S_C	0.09	0.18	0.24	0.33	$0.40N_a$
S_D	0.12	0.22	0.28	0.36	$0.44N_a$
S_E	0.19	0.30	0.34	0.36	$0.36N_a$
S_F	See Footnote 1				

[1]Site-specific geotechnical investigation and dynamic site response analysis shall be performed to determine seismic coefficients for Soil Profile Type S_F.

3.4.1.4 velocity-Dependent Seismic Coefficient (Cv) :

The seismic coefficient from table = .25 from table at z = .15 , and soil profile =Sc

TABLE 16-R—SEISMIC COEFFICIENT C_v

SOIL PROFILE TYPE	SEISMIC ZONE FACTOR, Z				
	$Z = 0.075$	$Z = 0.15$	$Z = 0.2$	$Z = 0.3$	$Z = 0.4$
S_A	0.06	0.12	0.16	0.24	$0.32N_v$
S_B	0.08	0.15	0.20	0.30	$0.40N_v$
S_C	0.13	0.25	0.32	0.45	$0.56N_v$
S_D	0.18	0.32	0.40	0.54	$0.64N_v$
S_E	0.26	0.50	0.64	0.84	$0.96N_v$
S_F	See Footnote 1				

[1]Site-specific geotechnical investigation and dynamic site response analysis shall be performed to determine seismic coefficients for Soil Profile Type S_F.

3.4.1.5 Important factor :

It usually serves to describe or demonstrate how significant a building is :

TABLE 16-K—OCCUPANCY CATEGORY

OCCUPANCY CATEGORY	OCCUPANCY OR FUNCTIONS OF STRUCTURE	SEISMIC IMPORTANCE FACTOR, I	SEISMIC IMPORTANCE[1] FACTOR, I_p	WIND IMPORTANCE FACTOR, I_w
1. Essential facilities[2]	Group I, Division 1 Occupancies having surgery and emergency treatment areas Fire and police stations Garages and shelters for emergency vehicles and emergency aircraft Structures and shelters in emergency-preparedness centers Aviation control towers Structures and equipment in government communication centers and other facilities required for emergency response Standby power-generating equipment for Category 1 facilities Tanks or other structures containing housing or supporting water or other fire-suppression material or equipment required for the protection of Category 1, 2 or 3 structures	1.25	1.50	1.15
2. Hazardous facilities	Group H, Divisions 1, 2, 6 and 7 Occupancies and structures therein housing or supporting toxic or explosive chemicals or substances Nonbuilding structures housing, supporting or containing quantities of toxic or explosive substances that, if contained within a building, would cause that building to be classified as a Group H, Division 1, 2 or 7 Occupancy	1.25	1.50	1.15
3. Special occupancy structures[3]	Group A, Divisions 1, 2 and 2.1 Occupancies Buildings housing Group E, Divisions 1 and 3 Occupancies with a capacity greater than 300 students Buildings housing Group B Occupancies used for college or adult education with a capacity greater than 500 students Group I, Divisions 1 and 2 Occupancies with 50 or more resident incapacitated patients, but not included in Category 1 Group I, Division 3 Occupancies All structures with an occupancy greater than 5,000 persons Structures and equipment in power-generating stations, and other public utility facilities not included in Category 1 or Category 2 above, and required for continued operation	1.00	1.00	1.00
4. Standard occupancy structures[3]	All structures housing occupancies or having functions not listed in Category 1, 2 or 3 and Group U Occupancy towers	1.00	1.00	1.00
5. Miscellaneous structures	Group U Occupancies except for towers	1.00	1.00	1.00

the building important factor = 1

3.4.1.6 Force Reduction Factor (R) :

The used structural system in the building is #2-3-a which is Building frame system with concrete shear walls. Seismic reduction factor R = 5.5 & Ω =2.8.

TABLE 16-N—STRUCTURAL SYSTEMS[1]

BASIC STRUCTURAL SYSTEM[2]	LATERAL-FORCE-RESISTING SYSTEM DESCRIPTION	R	Ω_o	HEIGHT LIMIT FOR SEISMIC ZONES 3 AND 4 (feet) × 304.8 for mm
1. Bearing wall system	1. Light-framed walls with shear panels			
	a. Wood structural panel walls for structures three stories or less	5.5	2.8	65
	b. All other light-framed walls	4.5	2.8	65
	2. Shear walls			
	a. Concrete	4.5	2.8	160
	b. Masonry	4.5	2.8	160
	3. Light steel-framed bearing walls with tension-only bracing	2.8	2.2	65
	4. Braced frames where bracing carries gravity load			
	a. Steel	4.4	2.2	160
	b. Concrete[3]	2.8	2.2	—
	c. Heavy timber	2.8	2.2	65
2. Building frame system	1. Steel eccentrically braced frame (EBF)	7.0	2.8	240
	2. Light-framed walls with shear panels			
	a. Wood structural panel walls for structures three stories or less	6.5	2.8	65
	b. All other light-framed walls	5.0	2.8	65
	3. Shear walls			
	a. Concrete	5.5	2.8	240
	b. Masonry	5.5	2.8	160
	4. Ordinary braced frames			
	a. Steel	5.6	2.2	160
	b. Concrete[3]	5.6	2.2	—
	c. Heavy timber	5.6	2.2	65
	5. Special concentrically braced frames			
	a. Steel	6.4	2.2	240
3. Moment-resisting frame system	1. Special moment-resisting frame (SMRF)			
	a. Steel	8.5	2.8	N.L.
	b. Concrete[4]	8.5	2.8	N.L.
	2. Masonry moment-resisting wall frame (MMRWF)	6.5	2.8	160
	3. Concrete intermediate moment-resisting frame (IMRF)[5]	5.5	2.8	—
	4. Ordinary moment-resisting frame (OMRF)			
	a. Steel[6]	4.5	2.8	160
	b. Concrete[7]	3.5	2.8	—
	5. Special truss moment frames of steel (STMF)	6.5	2.8	240
4. Dual systems	1. Shear walls			
	a. Concrete with SMRF	8.5	2.8	N.L.
	b. Concrete with steel OMRF	4.2	2.8	160
	c. Concrete with concrete IMRF[5]	6.5	2.8	160
	d. Masonry with SMRF	5.5	2.8	160
	e. Masonry with steel OMRF	4.2	2.8	160
	f. Masonry with concrete IMRF[3]	4.2	2.8	—
	g. Masonry with masonry MMRWF	6.0	2.8	160
	2. Steel EBF			
	a. With steel SMRF	8.5	2.8	N.L.
	b. With steel OMRF	4.2	2.8	160
	3. Ordinary braced frames			
	a. Steel with steel SMRF	6.5	2.8	N.L.
	b. Steel with steel OMRF	4.2	2.8	160
	c. Concrete with concrete SMRF[3]	6.5	2.8	—
	d. Concrete with concrete IMRF[3]	4.2	2.8	—
	4. Special concentrically braced frames			
	a. Steel with steel SMRF	7.5	2.8	N.L.
	b. Steel with steel OMRF	4.2	2.8	160
5. Cantilevered column building systems	1. Cantilevered column elements	2.2	2.0	35[7]
6. Shear wall-frame interaction systems	1. Concrete[8]	5.5	2.8	160
7. Undefined systems	See Sections 1629.6.7 and 1629.9.2	—	—	—

3.5 load combination :

According to UBC -97 , there are two group of combination :

3.5.1 Ultimate combination :

- **1.4 D**
- **1.2D + 1.6 L**
- **1.2D +L + E**
- **.9 D + E**

Which E = ρ Eh + Ev

ρ: Redundancy factor and it shall be taken (1) because the structure is located in seismic

zone2 .

Eh = EQx + 0.3 EQy OR EQY+ .3 EQX

Ev = 0.5 Ca I D, which it may be taken as zero for allowable stress design .

EV = .09 D.

the following table shows the ultimate load combination

Table 17ultimate load combination

Ultimate load combination	
U1	1.4 D
U2	1.2 D +1.6 L
U3	1.29 D +L+EOX+.3 EQY
U4	1.29 D +L-EOX-.3 EQY
U5	1.29 D +L+EOY+.3 EQX
U6	1.29 D +L-EOY-.3 EQX
U7	.81 D +EQX+.3 EQY
U8	.81 D -EQX-.3 EQY
U9	.81 D +EQY+.3 EQX
U10	.81 D -EQY-.3 EQX
ENVELOP	U1 +U2+U3+U4+U5+U6+U7+U+U8+U9+U10.

3.5.2 Service load combination :

- **D**
- **D+L**
- **D+E/1.4**
- **.9 D ± E/1.4**
- **D + .75 (L+E/1.4)**

the following table shows the ultimate load combination

Table 18service load combination

Service load combination :	
S1	D
S2	D +L
S3	D + .71 EQX +.21EQY
S4	D - .71 EQX -.21 EQY
S5	D + .71 EQY +.21 EQX
S6	D- .71 EQY -.21 EQX
S7	.9 D +.71 EQ X+.21 EQY
S8	.9 D -.71 EQ X-.21 EQY
S9	.9 D +.71 EQ Y+.21 EQX
S10	.9 D -.71 EQ Y-.21 EQX
S11	D +.75 L +.53 EQX+.15 EQY
S12	D +.75 L -.53 EQX-.15 EQY
S13	D +.75 L +.53 EQY+.15 EQX
S14	D +.75 L -.53 EQY-.15 EQX
Envelop	S1+S2+S3+S4+S5+S6+S7+S8+S9+S10+S11+S12+S13+S14

3.6 seismic checks:

3.6.1 Period check:

To ensure that the ETABS generation period is within the period limits from the manual calculation based on the UBC code formula, the following condition must be satisfied :

T ETABS <= 1.4 T method A

period by method A

T = $ct * (hn)^{3/4}$

Ct is a factor given by :

.Ct = 0.0853 for steel moment-resisting frames

Ct = 0.0731 for reinforced concrete moment-resisting frames and eccentrically braced

frames.

Ct = 0.0488 for all other buildings.

hn :building height.

--The building was considered as a bearing shear wall system, hence, the factor (Ct) used for the building was 0.0488.

- hn = 31.9 m

1.4 T manual =1.4 * .0488 * $31.9^{\frac{3}{4}} = .92$

Ty ETABS from mode 1 :

The following figure shows the period by ETABS software.

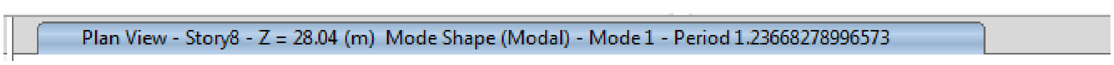


Figure 3-14period value from mode 1

Ty from mode 1 =1.2 sec >1.4 T manual .

Tx ETABS from mode 2 :

The following figure shows the period by ETABS software.

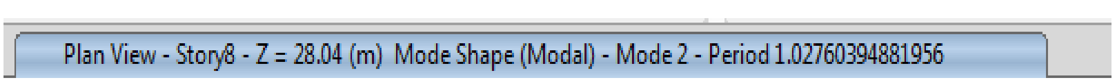


Figure 3-15period value from mode 2

TX from mode 2 = 1.02 sec> T manual .

The number will be accepted even though it is the larger than the allowable limit Because the code permits some deflections.

3.6.2 Model participation mass ratio:

At least 90% of the components of the model by the modes that are supposed to function in a seismic situation must move and shift in both directions.

the table below shows the model participation mass ratio:

Table 19model mass participation ratio

Case	Mode	Period sec	UX	UY	UZ	SumUX	SumUY	SumUZ	RX
Modal	32	0.056	0.0023	0.0001	0	0.8872	0.8628	0	0.
Modal	33	0.056	0.0002	1.187E-05	0	0.8874	0.8628	0	1.34
Modal	34	0.055	0.0059	0.0001	0	0.8934	0.863	0	0.
Modal	35	0.054	0.0005	0.0054	0	0.8939	0.8684	0	0.
Modal	36	0.053	0.0001	0.0126	0	0.8939	0.881	0	0.
Modal	37	0.052	0.0001	0.0003	0	0.894	0.8813	0	0.
Modal	38	0.052	0.0002	0.0213	0	0.8942	0.9026	0	0.
Modal	39	0.051	0.0004	0.0056	0	0.8946	0.9082	0	0.
Modal	40	0.048	2.597E-05	0.0003	0	0.8946	0.9085	0	0.
Modal	41	0.048	0.0003	0.0008	0	0.8949	0.9094	0	0.
Modal	42	0.046	0.0001	0.0003	0	0.895	0.9097	0	0.
Modal	43	0.046	8.79E-06	0.0005	0	0.895	0.9102	0	0.
Modal	44	0.045	0.0229	0.0013	0	0.9179	0.9114	0	0.
Modal	45	0.045	0.0027	0.0004	0	0.9206	0.9118	0	0.

At mode 45 the building satisfies more than 90% of its component's displacement in each

Direction . The summation of Ux& Uy > 90% ➔ check is ok.

3.6.3 Base shear check :

In this check manual base shear should be less than Etabs result .

Base shear can be calculated using the following formula :

v = min (2.5 ca , cv/t) w * $\frac{I}{R}$

Where :

Cv: velocity seismic coefficient .

I: Importance factor of the building.

R: numerical coefficient representative of the inherent over strength and global ductility.

T: This is the basic natural period of a simple one degree of freedom system which is the time required to complete one whole cycle during dynamic load.

Ca: Seismic coefficient

W: is the summation of the own weight of the structure, SID, and partial of live load KN

Where: W = Dead + SID + 0.25 Live

The table below show the load cases from ETABS :

Table 20load cases from etabs

Load	FZ (KN)
Dead	75007
Sid	30575.3685
Live	24393.0101

The table below show the BASE shear from ETABS :

Table 21base shear from ETABS

Load	T min	V manual KN	VETABSKN	old scale factor	new scale factor
x	0.919	5523.8415	2817.3329	1783	3495.86284
y	0.919	5523.8415	2831.8096	1783	3477.99138

Base shear results from ETABS are less than manual calculations, so the scale factor shall be maximized .

New scale factor = ($\frac{F\ manual}{F\ etabs}$) * old scale factor = 3495.8

the table bellow shows the ETABS base shear after modify the scale factor:

Table 22Base shear from ETABS

Load	T min	V manual KN	VETABSKN	new scale factor
x	0.919	5523.8415	5523.3	3495.86284
y	0.919	5523.8415	5523	3477.99138

% ERROR =$\frac{5523-5522}{5522}$*100 % = .08 % < 5 % ok.

3.6.4 drift check :

According to UBC-97, the drift limitation should be more than the lateral displacement between the floor in the building .

The following table shows all drift from floor , If T > 0.7, the drift limitation = 0.02×H story.

Table 23Drift check for all floor

Story	story height	Displacement x	Displacement y	drift x	drift y	delta x	delta y	delta limit	
story 1	3	0.21	0.29	--	--	--	--	--	
story 2	3	0.9	0.9	0.69	0.61	2.6565	2.3485	60	SAFE
story 3	3.84	3.8	2.9	2.9	2	11.165	7.7	76.8	SAFE
story 4	3.62	8.1	5.4	4.3	2.5	16.555	9.625	72.4	SAFE
story 5	3.62	12.6	8.3	4.5	2.9	17.325	11.165	72.4	SAFE
story 6	3.62	17	11	4.4	2.7	16.94	10.395	72.4	SAFE
story 7	3.62	23	15	6	4	23.1	15.4	72.4	SAFE
story 8	3.62	28	19	5	4	19.25	15.4	72.4	SAFE
story 9	3.62	31	23	3	4	11.55	15.4	72.4	SAFE

Calculation example story 2:

drift x = displacement - x (n) - displacement - x (n-1)

drift y= displacement - y (n) - displacement - y (n-1)

delta - x = .7*R*Drift- x .

delta - y = .7*R*Drift - y.

delta limit = .02* story height .

Here are some figure showing the value of displacement at the center from service envelop combination .

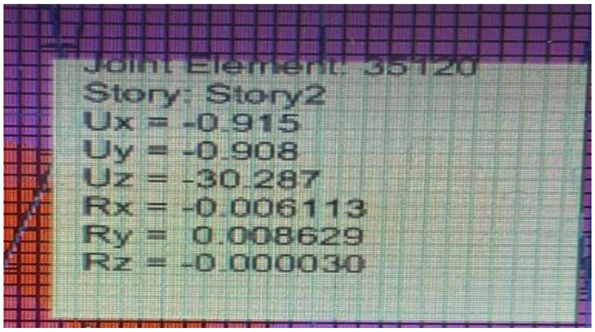


Figure 3-16displacement in basement 2

The above figure shows displacement in FROM b2 Ceiling

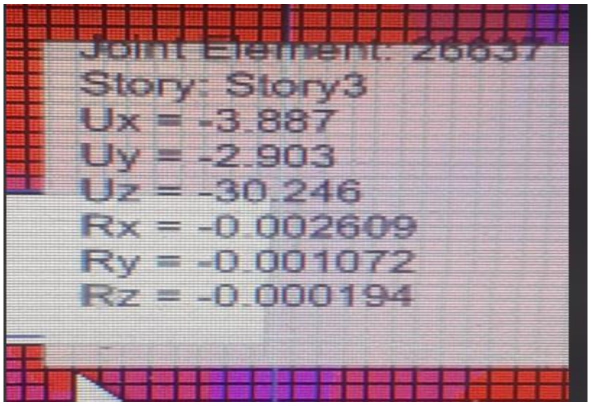


Figure 3-17displacement in ground floor

The above figure shows displacement in ground Ceiling .

3.6.5 p-delta check :

The effect of ▲-p can be neglect if the following condition satisfied :

Øx $=\frac{P}{Sx*H}< .1$

Øy $=\frac{P}{Sy*H}< .1$

where :

p : the maximum service axial force on the story.

Sx :the lateral stiffness in the story in x direction.

Sy :the lateral stiffness in the story in y direction.

Sample of calculation for the first story :

P= 13353 kn.

Sx= 227917.356 kn/m.

sy = 176295.978kn/m

Ɵx $=\frac{13353}{23392*3.6}< .1$ ok

Ɵy $=\frac{13353}{31833*3.61}< .1$ okk

The following figure shows the p - delta check for all stories :

Table 24p- delta check

	P(kn.)	Stiffness x kn/m	Stiffness y kn/m	Ɵx	Ɵy	check
base2	198224.6	30440546.7	26811881	0.002171	0.002464	**ok**
Base1	172873.8	5418980.14	6458279	0.010634	0.008923	**ok**
ground	152932.6	2036630.2	1378019	0.019761	0.029205	**ok**
1	105138	645618.85	818679.4	0.04511	0.035673	**ok**
2	85709.8	538719.555	674721.7	0.044072	0.035286	**ok**
3	77555	482694.939	554847.6	0.044507	0.038827	**ok**
4	46854.12	434676.474	432317.1	0.029859	0.030105	**ok**
5	28109.22	359215.195	302444.5	0.021676	0.025817	**ok**
6	13353.12	227917.356	176296	0.016229	0.02104	**ok**

3.7 Required design element :

3.7.1 Column design :

The columns will be designed based on seismic effect axial and shear based on ACI-318-14 Code.

the flowing figure shows columns distribution in plans.

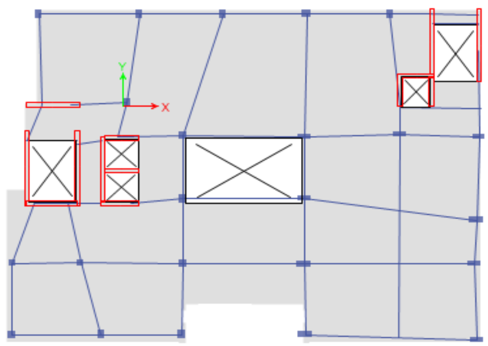


Figure 3-18column layout

The following table shows the column design :

Table 25column design and reinforcement

Column	Length (mm)	Width (mm)	AS (mm^2	Longitudinal rebar	Stirrup used near support	Stirrup used away support	S0 (mm)	S1 (mm)	Lo (mm)	Lab splice (mm)
C1	600	500	2700	14 Ø16	3Ø10	3Ø10	125	150	600	800
C2	800	350	10085	22 Ø25	3Ø10	3Ø10	100	150	800	1250
C3	900	400	15654	20 Ø32	3Ø10	3Ø10	100	150	900	1600
C4	450	600	11859	16 Ø32	3Ø10	3Ø10	100	150	600	1600
C5	450	600	7155	16 Ø25	3Ø10	3Ø10	100	150	600	1250
C6	600	600	9877	22Ø25	3Ø10	3Ø10	150	150	450	1250

3.7.1.1 manual design calculation :

THE COLUMN WITH PU =5500 KN WILL BE DESIGNED MANUALLY .

-FY = 420 MPA , FC` = 28 MPA , P =.01 .

AG = $\frac{pu}{.65*.8(.85*fc*(1-.01)+.01*420)}$= 380985.6 m$m^2$

DIMENSIONS = 900*450 =405000 Mm^2>380985MM 2

$\text{Øpn}=.65*.8*(.85*fc`*(AG-AS)+AS*FY)$

pn $=.65*.8*(.85*28*(405000-.01*405000)+(.01*405000)*420)$ =5846 kn

5846 KN> 5500 KN ok .

AS = .01*405000 = 4050 mm^2 USE 10 Ø25 AS = 4900 mm^2.

To achieve the seismic design for the column:

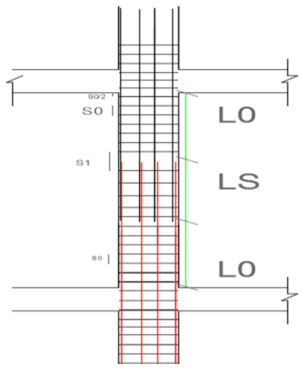


Figure 3-19seismic design requirement in longitudinal section in column

Where:

$$S_0 = min\begin{cases} \dfrac{least\ column\ Dimention}{2} \\ 8*db \\ 24*ds \\ 300mm \end{cases}$$

$$S_1 = min\begin{cases} least\ column\ dimmention \\ 16*db \\ 48*ds \end{cases}$$

$$L_0 = zone\ 1\ length = max\begin{cases} clear\ height\ of\ column\ /6 \\ maximum\ column\ dimention \\ 450mm \end{cases}$$

lab splice:

1. Rebar percentage ρ between 1% and 6%.
2. Lap splice of bars shall be used at the middle height of the column with lap splice length, and shall be designed as tension lap splices and enclosed within transverse reinforcement conforming to the following section.
3. Lap splice equals 50 db

figure 3-20seismic design requirement in column

3.7.2 Slab design:

The slab is two way ribbed slab h =30 cm ,the required reinforcement will be found using slab concert design in ETABS .

$$AS\ min = \begin{cases} \dfrac{1.4}{fy} \\ \dfrac{.25\sqrt{f`c}}{fy} \end{cases} *150*300$$

Use 2 Ø 12

in figure , shows the top reinforcement in the slab in X direction:

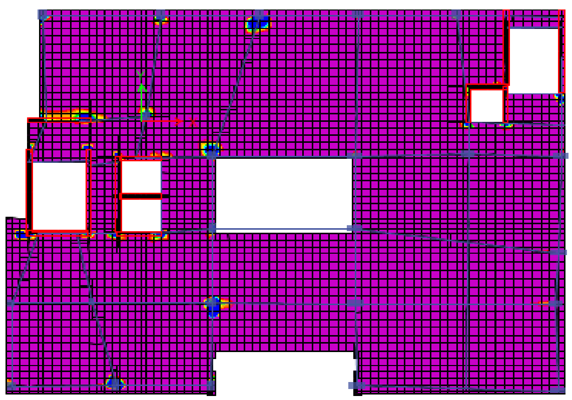


Figure 3-21the top reinforcement in ground floor in x direction.

The slab need 2Ø12as minimum reinforcement and2Ø 14 in the maximum area as shown .

In figure , shows the bottom reinforcement in the slab in X direction :

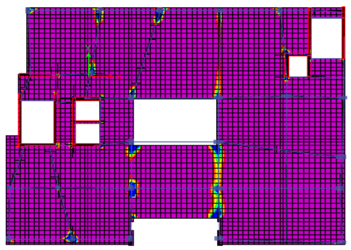


Figure 3-22the bottom reinforcement in ground floor in x direction.

The slab need 2 Ø12 as minimum reinforcement and 2Ø 14 in the maximum area as shown .

In figure , shows the top reinforcement in the slab in y direction :

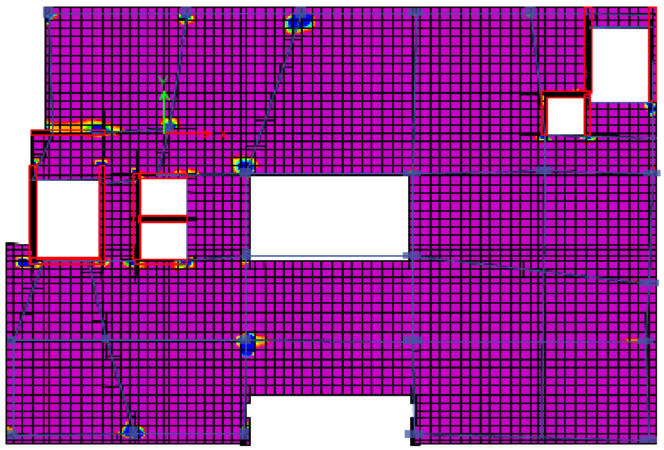


Figure 3-23the top reinforcement in ground floor in x direction.

The slab need 2 Ø12as minimum reinforcement and 2Ø 14 in the maximum area as shown .

In figure , shows the bottom reinforcement in the slab in y direction :

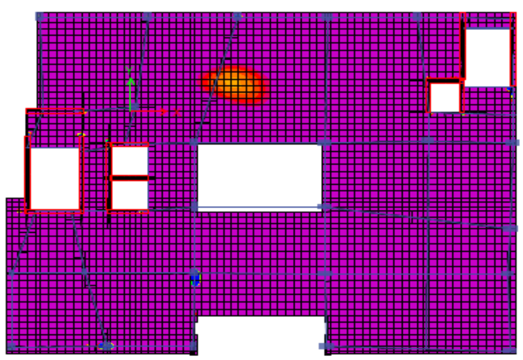


Figure 3-24the bottom reinforcement in ground floor in y direction.

The slab need 4 Ø12 as minimum reinforcement and 2Ø 14 in the maximum area as shown .

3.7.2.1 check punching shear for the slab:

For panel with beam $\frac{\gamma f*l2}{l1}$> 1 ….no need to check punching shear.

For panel with hidden beam the punching shear will be checked by ETABS program.

The slab's punching shear stress must be lower than its punching shear stress capacity. The Figure , show the punching shear stress for the first story by ETABS program :

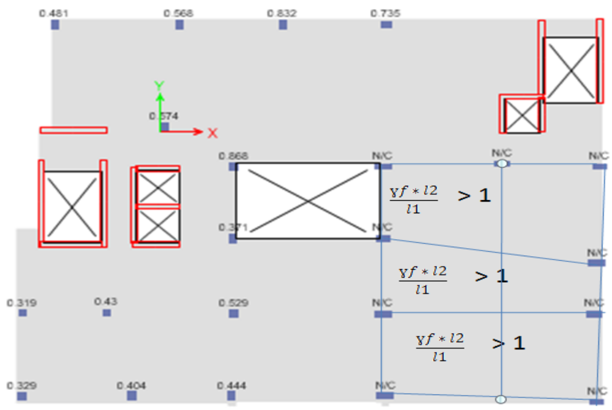


Figure 3-25punching shear factor in each column

The value of vup / Ø vcp< 1 , the punching shear check is ok. The figure below shows the punching shear value in the slab ,the following table shows the $\frac{\gamma f*l2}{l1}$> 1 value for the panel :

the$\frac{\gamma f*l2}{l1}$ value

Panel	$\frac{\gamma f*l2}{l1}$>1
panal1	**1.22742**
panal2	**1.580585**
panal3	**1.516563**
panal4	**1.616186**
panal5	**1.293344**
panal6	**1.847657**

3.7.3 Beam design :

Based on shear and moment regarding the seismic effect, the beam needs to be reinforced With longitudinal bars and stirrups.

The top steel bars were divided into 3 zones in the beam and the bottom steel bars into one Zone, and the stirrups were also divided into 3 zones where the stirrups were condensed Near the columns

To achieve the seismic design for the beam for :

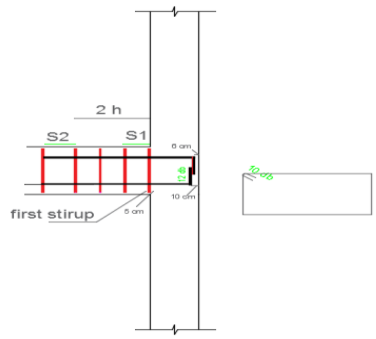


Figure 3-26Seismic requirement for beam section

db : main bar diameter .

h : beam depth .

s1:least of (h/4 or 8* Ø main bar diameter or 24* diameter stirrup).

s2 :least of (h/2 or 12 * Ø main bar diameter or 30 cm).

figure below shows the stirrup distribution in beam section :

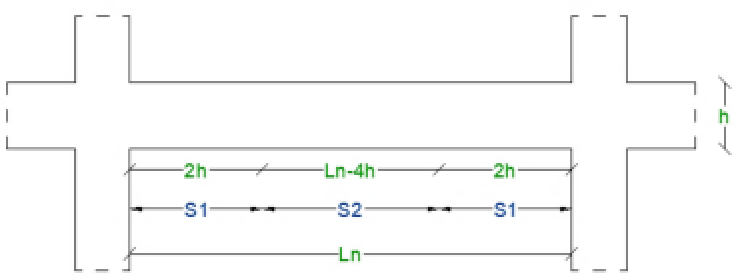


Figure 3-27disruption of stirrups in beam section

The figure , shows the required longitudinal reinforcement for the beams in the ground Floor by ETABS program :

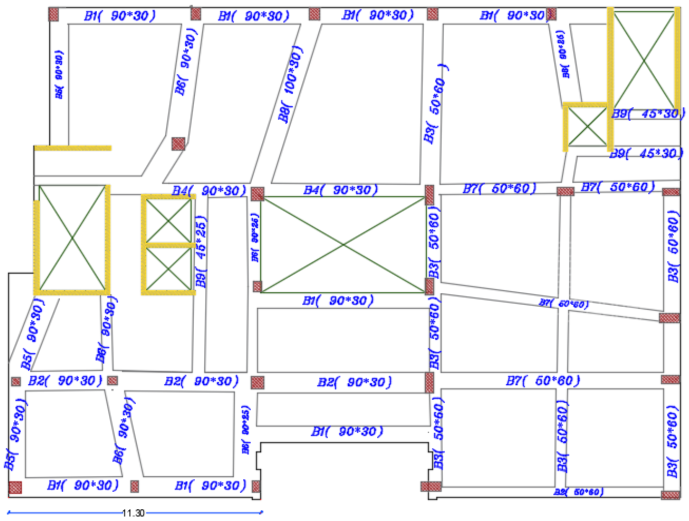
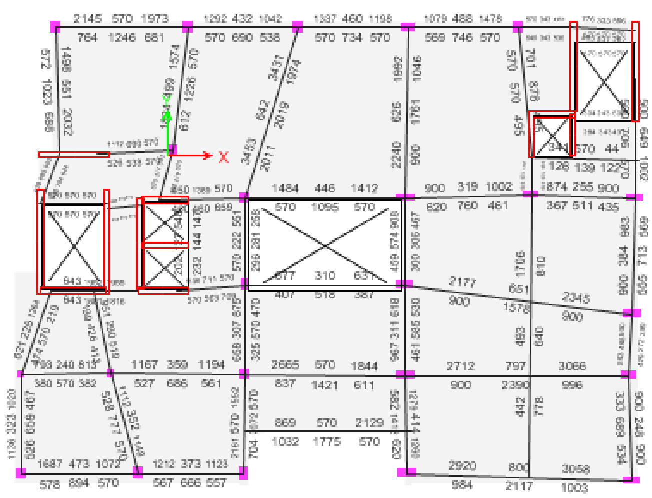


Figure 3-28longitudinal reinforcement for the beams in the ground floor

To make it easier to identify the reinforcement details, the beams should be given names. Figure show the beam layout in ground floor :



beam layout in ground floor

3.7.3.1 Flexural design for beam :

Table below shows the number of bars for beams on top and bottom :

Table 26longitudinal reinforcement in beams floor

		H	d	B	AS	AS min	AS max	Ø	#Ø	S	
B1	**TOP**	300	**260**	900	1600	**780**	**4212**	18	8	122.333	OK
	Bottom	300	**260**	900	570	**780**	**4212**	14	4	268	OK
B2	**TOP**	300	**260**	900	2500	**780**	**4212**	20	10	73	OK
	Bottom	300	**260**	900	870	**780**	**4212**	14	4	197.5	OK
B3	**TOP**	700	**660**	500	1412	**1100**	**5940**	20	5	90	OK
	Bottom	700	**660**	500	360	**780**	**4212**	14	4	268	OK
B4	**TOP**	300	**260**	900	1550	**780**	**4212**	16	8	90	OK
	Bottom	300	**260**	900	570	**780**	**4212**	14	4	268	OK
B5	**TOP**	300	**260**	900	2020	**780**	**4212**	20	8	85	OK
	Bottom	300	**260**	900	630	**780**	**4212**	14	4	268	OK
B6	**TOP**	300	**260**	900	1815	**780**	**4212**	20	8	77	OK
	Bottom	300	**260**	900	607	**780**	**4212**	14	4	268	OK
B7	**TOP**	700	**660**	500	2336	**1100**	**5940**	32	6	55	OK
	Bottom	700	**660**	500	900	**1100**	**5940**	16	4	75	OK
B8	**TOP**	300	**260**	1200	3660	**866**	**3660**	32	10	75	OK
	Bottom	300	**260**	1200	3660	**866**	**3660**	32	10	120	OK

3.7.3.2 Shear design :

table below shows the number of stirrups for beams on top and bottom :The

Table 27shear reinforcement in beams floor

	vu	vu/Ø	vc	VS	VS MAX	AV/S	AV/AS min	Av/s USED	Ø	AV	s	S1
B1	199	265.	**206**	58	825	0.5	0.75	.75	2Ø8	157	133	75
B2	97	129	**206**	77	825	0.7	0.75	0.75	2Ø8	157	133	75
B3	225	300	291	10	1164	0.3	0.416	0.41	2Ø8	157	254	150
B4	73	97	**206**	109	825	0.9	0.75	0.9	2Ø8	157	128	75
B5	136	181	**206**	25	825	0.22	0.75	0.75	2Ø8	157	130	75
B6	300	400	**206**	193	825	1.7	0.75	1.7	2Ø8	157	100	75
B7	350	466	291.0	175	1164.	0.6	0.41	0.6	2Ø8	157	160	75
B8	300	400	275	124	1100	1.1	1	1.1	2Ø8	157	90	75

Manual Calculation for flexural reinforcement :

for B1

SMIN= max $\begin{cases} \frac{1.4}{FY} * b * d \\ .\frac{25}{fy} * \sqrt{f`c} * bd \end{cases}$ = .003*b*d

AS top = 1212> AS min Use 6Ø 16 WITH SPACING = 142 mm between bars .

AS bottom = 560< AS min Use 4Ø 14 WITH SPACING = 268 mm between bars .

Manual Calculation for shear design :

-for B1

VU = 199 KN .

VU = $\frac{\mathbf{199}}{\mathbf{.75}}$*= 265 KN.-*

VC =$\frac{1}{6} * \sqrt{fc`} * b * d$

VC =$\frac{1}{6} * \sqrt{28} * 900 * 260$

VC =206 KN. -

VS = $\frac{VU}{Ø} - VC$

VS = 265 -206=58 KN.

VS max = 4VC = 825> 58 . the section is ok.

--$\frac{AV}{S}$= $\frac{vs*1000}{fy*d}$ *=1.11.*

$\frac{AV}{S}\min = \frac{.35*BW}{FY}$*=.75 mm^4 /mm.-*

-As $\frac{AV}{S}$>$\frac{AV}{S}$ *min.*

-Assume use 2 Ø10 @157 mm .

According to earthquake design
S = min {24ds or h/4 or 8db or 300} =75 mm

Use 2Ø10 mm @ 75 mm

3.7.4 Stairs design :

The figure below shows the stairs dimension :

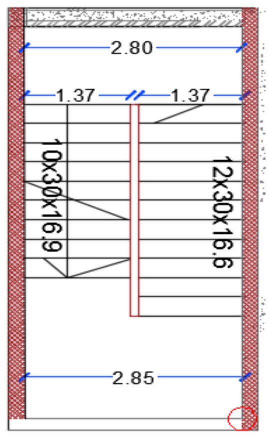


Figure 3-29stairs dimension

The figure below shows the assumption load to design stairs :

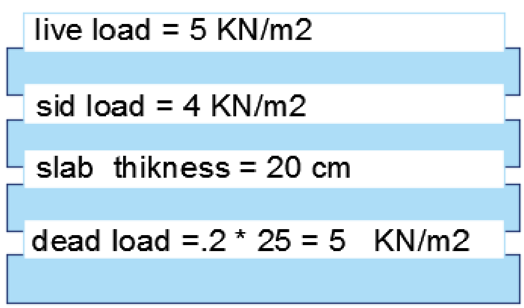


Figure 3-30design loads for stairs

3.7.4.1 Design of stairs span :

*WU (ultimate load on slab) = 1.2 D+1.6L= 1.2 (5+4)+1.6*5 =18.8 KN/* m^2.

The slab is simply is simply supported , SO MU= $\frac{wu*l2}{8}$

$\frac{18.8*3\text{^}2}{8}$*= 21.15 KN.m=mu*

3.7.4.2 Longitudinal reinforcement

p = $\frac{.85*28}{420}$** (1-*$\sqrt{1-(\frac{2.61*10^6*21.15}{1000*28*170}}$*)*

P = .002

thus :

AS =.002 1000 *170 = 340 mm^2/m. use 4 Ø12 /m .*

*AS = .0018 *1000*200 =360 mm^2/m. In each direction.*

3.7.4.3 Check shear for the steps of the stairs:

vu = $\frac{WU*L}{2}$= $\frac{18.8*3}{2}$=28.2 KN/m.

ØVC =$\frac{.75}{6}$*$\sqrt{28}$*bw*d.

ØVC =$\frac{.75}{6}$*$\sqrt{28}$*170 *1000=112 .44 kn/m > VU

Shear check is ok .

3.7.5 Ramp design :

The design of slab for the ramp is solid ,the following figure shoes the assumption load :

live load = 5 KN/m2

sid load = .5 KN/m2

slab thikness = 25 cm

Figure 3-31design load for stairs

Figure , shows the ramp slap model by ETABS .

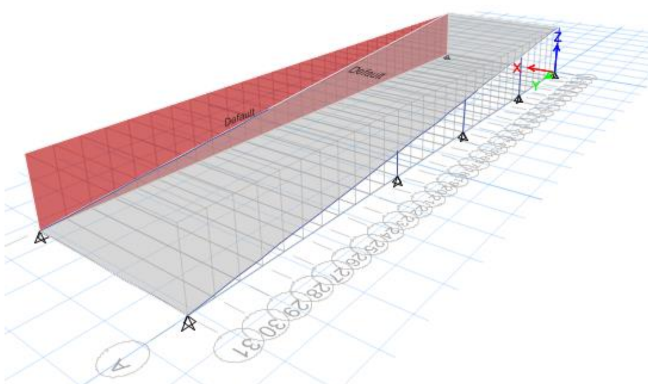


Figure 3-32ramp model

3.7.5.1 longitudinal reinforcement

mu =.5 KN/m2 the moment value for ramp are too small use area steel shrinkage

AS min = .0018 * 1000*250 = 450 mm2/m. use 1 Ø12 @25 cm.

3.7.5.2 shear check for the ramp :

from ETABS Vu= 30KN/m .

Øvc = .75* $\sqrt{f`c}$*1/6*bw*d = .75* $\sqrt{28}$*1000*210*10^{-3}= 138 kn/m^2

Øvc> vu no need for shear reinforcement Ø

3.7.5.3 footing design :

there are two type of footing that have been designed in the building :

1- Single footing .

2- Mat foundation .

3-Wall footing

1. single footing

sample of calculation :

design assumption :

-fC`=28 MPA .

FY =420 MPA. -

Bearing Capacity of soil under footing (Q all)= 350 kN/m2-

- Sample Column dimension (450*600 mm) .

-Ultimate force 3100 KN .

AS the support is pin and the column is concentric , so there is no moment in the footing .

Q all < 350 KN/ m^2 $\frac{p}{A}$< 350 $\Longrightarrow$, Then $\frac{3100}{A}$< 350 $\Longrightarrow$ A= 8.8 m2 A = m2 .

Assume that the footing is square with area = B*L= 9 $\Longrightarrow$ (B= L= 3m)

The figure , show the footing dimension wit column .

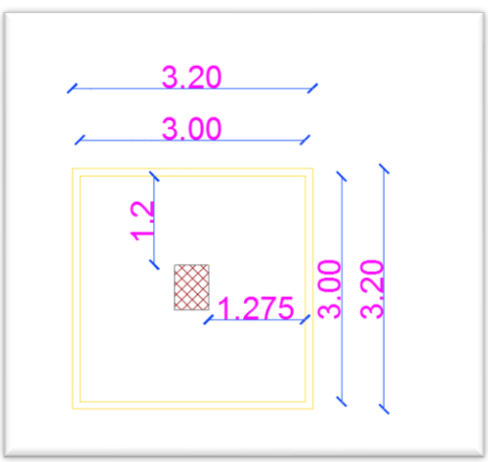


Figure 3-33footing dimensions

PU = 3100 *1.4 = 4340 KN .

PU = 1.2 * (1030 +633) + 1.6 *633 = 3008 KN .

AS a primary depth for the footing from punching shear 10 $\sqrt{pu}$; d = 660 mm .

The depth of footing based on wide beam shear :

d +$\frac{150}{q\ all}d^{\frac{2}{3}}$ = 1.275 m.

D =850 m .

The wide beam shear covered .

h = 960m ; and hence D = .9 m.

check punching shear :

the column dimension 600 mm *450 mm.

The figure ; shows the critical area dimension .

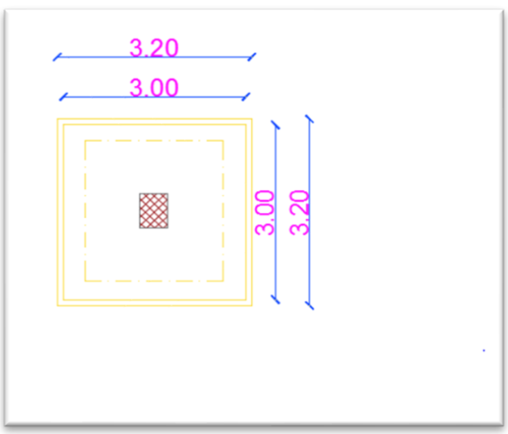


Figure 3-34critical area dimension

Bo = $2 * (width\ of\ column + d)$+ 2* (length of column +d). = 2* (450+900) +2* (600 +900)= 5.7m

To safety punching shear check :

- V up ≤ Ø VCP
- VUP = pu − σ u(critical area).
- $\sigma u\ (critical\ area\ )= \frac{PU}{A\ FOOTING} = \frac{4340}{9}$ = 482 KN $/m^2$.

$\Rightarrow$ VUP = $4340 - 482 == 3857\ KN$.

$$\emptyset V_{cp} = 0.75 \times \min\begin{Bmatrix} 1/3 \\ 1/6\left(1+\frac{2}{1.5}\right) \\ ***** \end{Bmatrix} \times \sqrt{fc} \times bo \times d \times 10^{-3}.$$

$$\emptyset V_{cp} = 0.75 \times \min\begin{Bmatrix} 1/3 \\ 1/6\left(1+\frac{2}{1.5}\right) \\ ***** \end{Bmatrix} \times \sqrt{28} \times 5700 \ \times 900 \times 10^{-3} = 6779 > \text{vup OKK} .$$

Check wide beam shear :

Two failure line to be check as shown in figure :

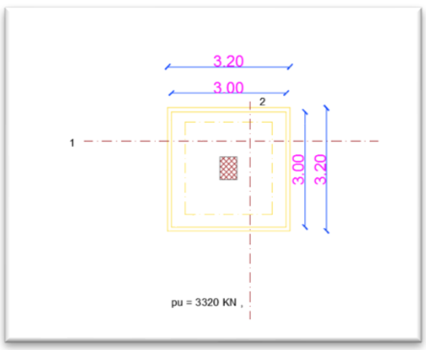


Figure 3-35failure line for wide beam shear in the footing

Failure line 1 :

$\Rightarrow$ $\sigma u\ (critical\ area\ ) = 482\ KN/m2.$

$\Rightarrow$ vu = $\sigma u * (Arm\ lenghth - d\ \ )$.

$\Rightarrow$ Arm length (L1)= 3-.45/2 = 1.275

Arm length (L2)= 3-.6/2 = 1.2

Take the largest line .

$\Rightarrow$ $vu = 482\ * (1.275 - .9\ \ )$= 180 KN /m.

$\Rightarrow$ $\emptyset V_{cp} = 0.75 \times 1/6 \times \sqrt{f'c} \times bw \times d \times 10^{-3}$

$\emptyset V_{cp} = 0.75 \times 1/6 \times \sqrt{28} \times 1000 \times 900 \times 10^{-3}$

$\emptyset V_{cp} = 595\ KN\ /m2$. > VU OKK

<u>single Footing Reinforcement :</u>

Longitudinal reinforcement :

Side of line 1 :

Mu1 = $\frac{qu*l2}{2}$= $\frac{482*1.2}{2}$ = 347 kn.m2.

$$\rho = \frac{0.85 \times 28}{420}\left(1 - \sqrt{1 - \frac{2.61 \times 10^6 \times 347}{28 \times 1000 \times 900^2}}\right) = .00114$$

AS = .00114 *1000*900 = 1026 mm2/m.

As MIN = ,0018 *1000*960 = 1728 mm2/m > AS $\Rightarrow$ use 7Ø18/m .

Transfer reinforcement :

Side of line 2 :

Mu1 = $\frac{qu*l2}{2}$= $\frac{482*1.275}{2}$ = 391 kn.m2.

$$\rho = \frac{0.85 \times 28}{420}\left(1 - \sqrt{1 - \frac{2.61 \times 10^6 \times 391}{28 \times 1000 \times 900^2}}\right) = .00129$$

AS = .00129 *1000*900 = 1200 mm2/m.

As min = ,0018 *1000*960 = 1728 mm2/m > AS $\Rightarrow$ use 7 Ø18 /m .

The table below shows the required dimension for each column in the basement:

Table 28single footing reinforcement

	PU	length	Width	Depth	wide beam shear	punching shear	Longitudinal rebar	Transfer Rebar
F2	1900	2.45	2.45	0.8	Safe	Safe	7 Ø16	7 Ø16
F3	900	1.8	1.8	0.5	Safe	Safe	5 Ø16	5 Ø16

2. Raft Foundation:

Since the single footing area covers more than 60 % of the building area, a1000 mm thick mat foundation was Used ***checks of mat foundation :***

<u>Compatibility check :</u>

All mat foundation part are moving as one part , the check is ok. figure below shows that .

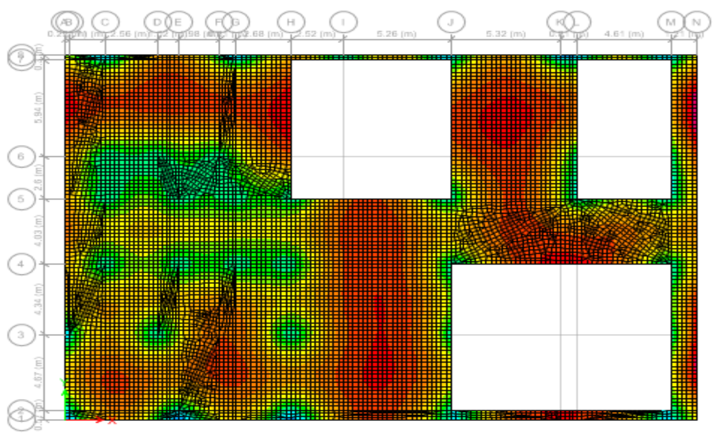


Figure 3-36compatibility check for mat foundation

<u>deflection check :</u>

The maximum allowable deflection 10 mm , the maximum deflection in the footing = 4 mm , the check is ok Figure , show deformation value for the footing .

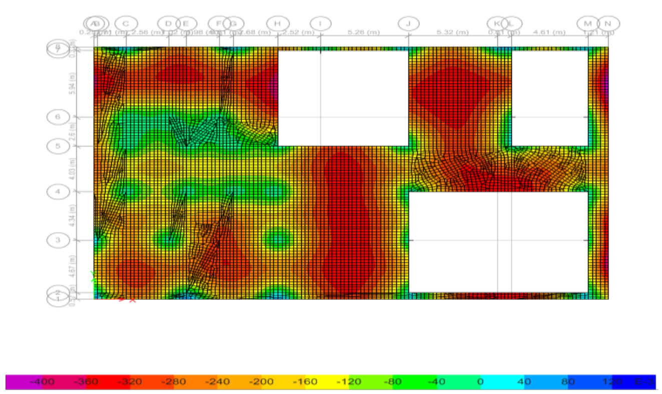


Figure 3-37deformed shape from service load

soil bearing capacity check :

The soil pressure under the foundation are less than q allowable for the soil . figure   , shows the soil pressure Value for the footing .

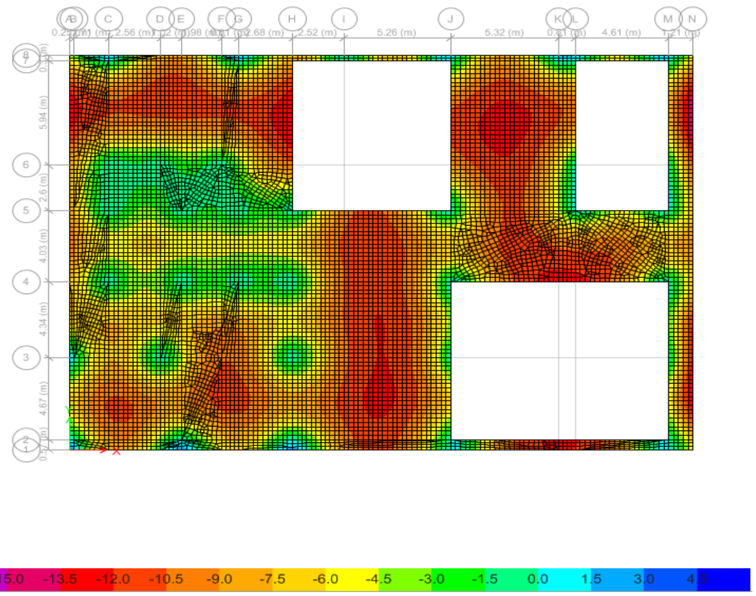


Figure 3-38soil pressure under mat foundation

3Wide beam shear capacity check :

$$\emptyset V_{cp} = 0.75 \times 1/6 \times \sqrt{f`c} \times bw \times d \times 10^{-3}$$

$$\emptyset V_{cp} = 0.75 \times \frac{1}{6} \times \sqrt{28} \times 1000 \times 390 \times 10^{-3} = 257\ KN\ /m.$$

Max shear (Vu) from ETABS = 90 kn/m2 ,the maximum shear less than $\emptyset V_{cp}$, the shear is ok .

Figure below shows the shear value in mat foundation.

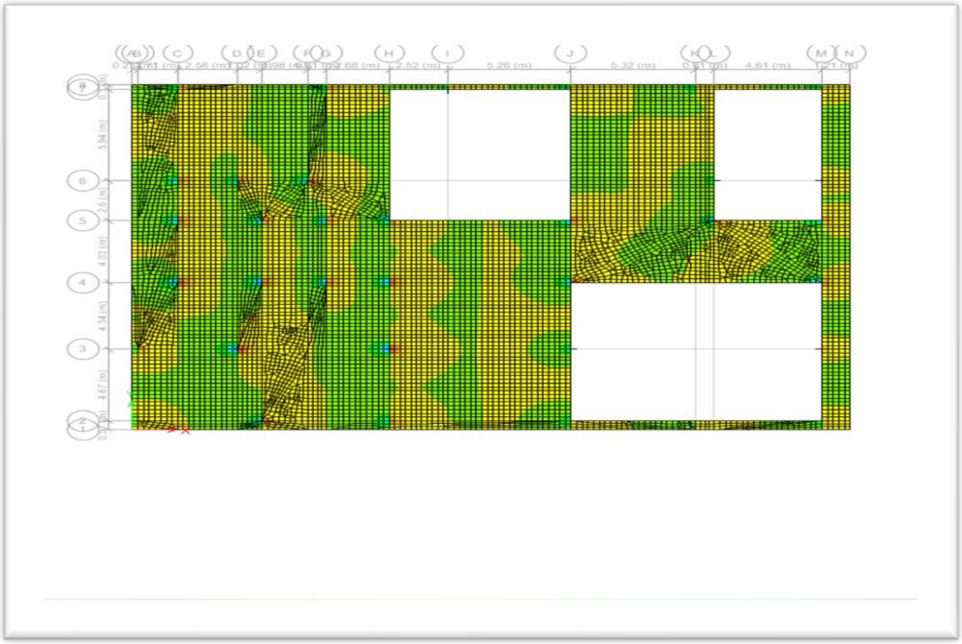


Figure 3-39shear check in mat foundation

B n

<u>Punching shear check :</u>

The value of vup / Ø vcp< 1 , the punching shear check is ok. The figure , shows the punching shear value in The mat foundation .

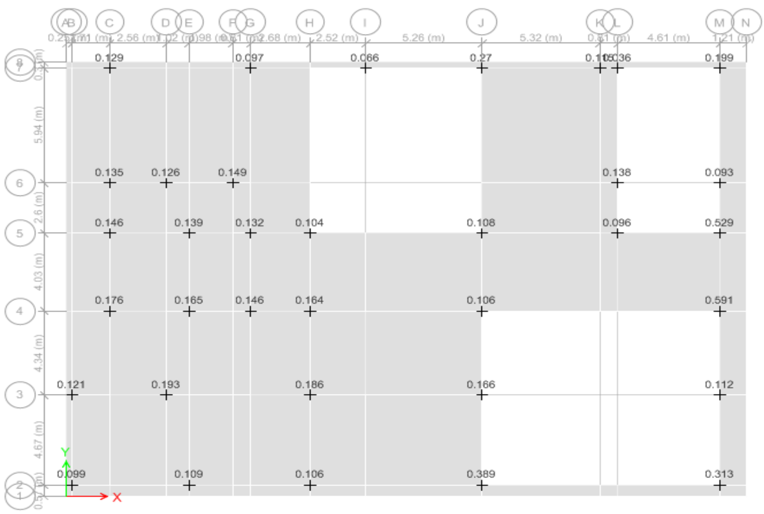


Figure 3-40punching shear in mat foundation

Mat foundation reinforcement :

the mat foundation is solid slab , the required reinforcement will Be found by ETABS by divide the footing into stirp.

Minimum reinforcement required =.0018 * B *H = .0018 * 1000 *1000 = 1620mm2 . USE 6 Ø 20/ m. Figure below show the top reinforcement in x direction .

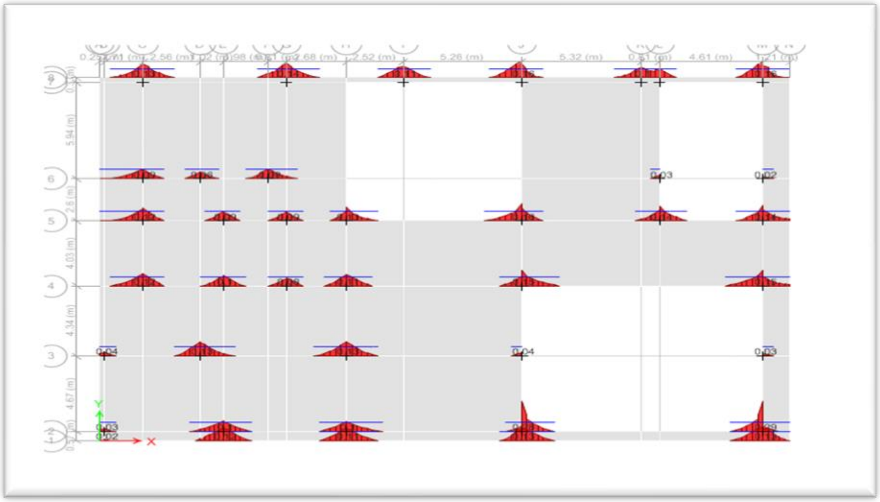


Figure 3-41top reinforcement in x direction for mat foundation

As the figure shows all stirps less than minimum reinforcement , use 6 Ø 20 / m.

Figure below show the bottom reinforcement in x direction .

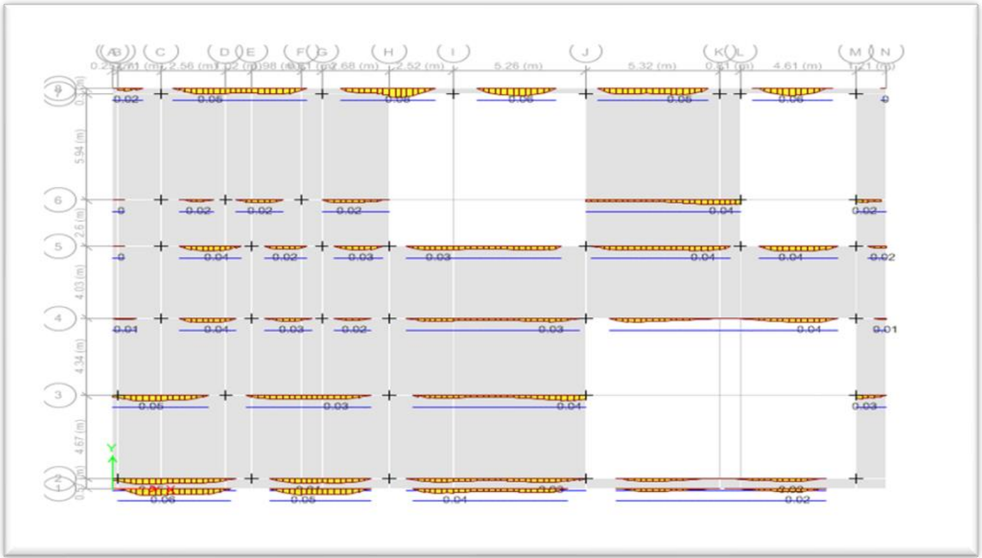


figure 3-42bottom reinforcement in x direction for mat foundation

As the figure shows all stirps less than minimum reinforcement , use 6 Ø 20 / m.

Figure below show the top reinforcement in y direction .

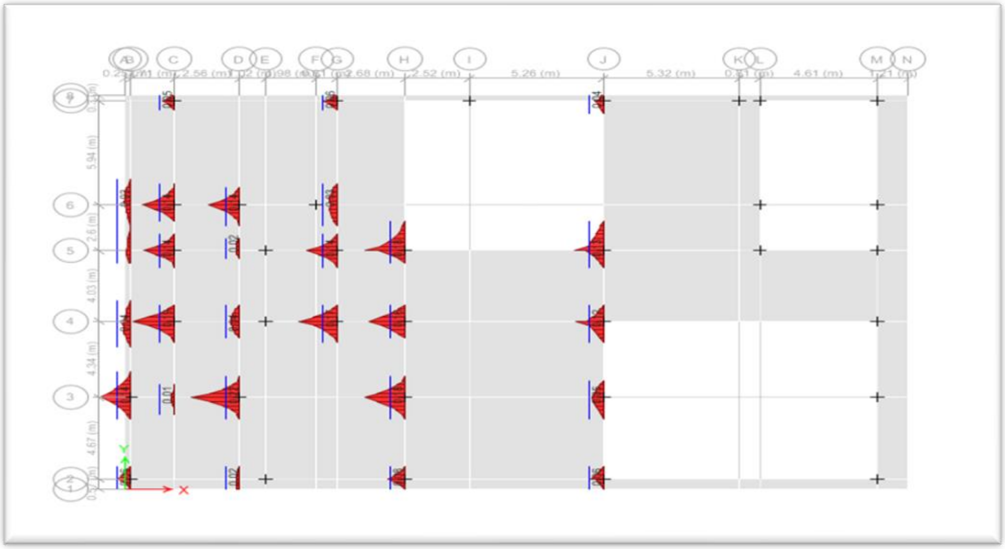


Figure 3-43top reinforcement in y direction for mat foundation

As the figure shows all stirps less than minimum reinforcement , use 6 Ø20 / m.

Figure below shows the bottom reinforcement in y direction .

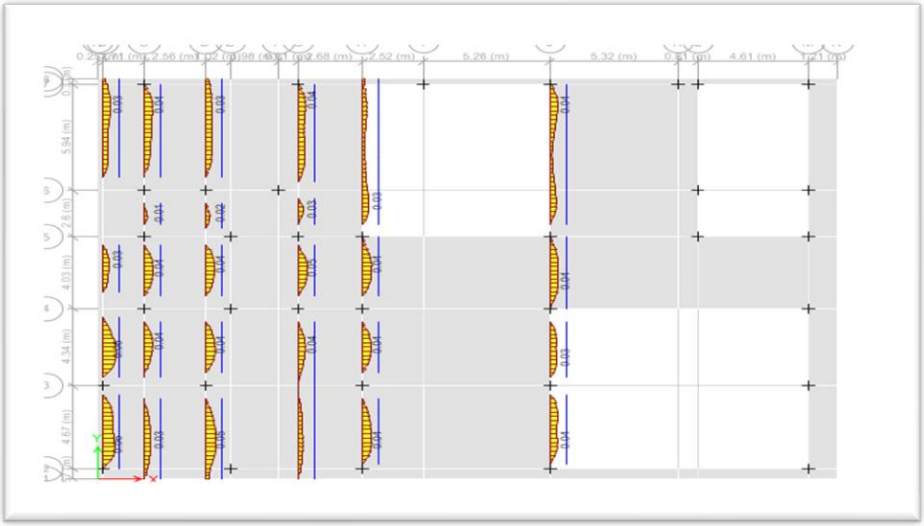


Figure 3-44bottom reinforcement in y direction for mat foundation

As the figure shows all stirps less than minimum reinforcement , use 6 Ø 20 / m.

3.7.6 shear wall design :

The shear wall shall be designed to resist the axial lateral load and moment from the seismic effect;

The following figure shows the shear wall-pier 16 layout in the ground floor

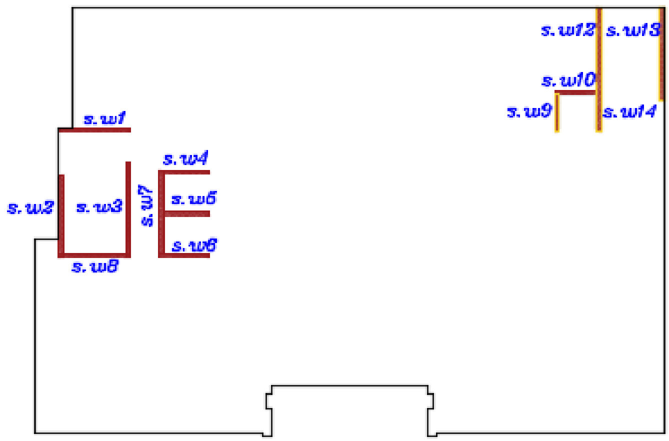


Figure 3-45shear layout for the building

figure , shows the reinforcement for shear wall 2 -Pier 16 by ETABS .

ETABS Shear Wall Design

ACI 318-14 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
Story1	P16	17600	987.5	2075	300	0.621

Material Properties

E_c (MPa)	f'_c (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
24870.58	28	1	413.69	413.69

Design Code Parameters

ϕ_T	ϕ_C	ϕ_V	ϕ_V (Seismic)	IP_{MAX}	IP_{MIN}	P_{MAX}
0.9	0.65	0.75	0.6	0.04	0.0025	0.8

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	17600	-50	17600	2025	2075	300
Bottom	Leg 1	17600	-50	17600	2025	2075	300

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	5422	0.0087	0.0054	4-1	-1313.5293	0.4387	-556.8837	622500
Bottom	5127	0.0082	0.0054	4-1	-1275.7125	0.5586	444.2578	622500

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	750	envelop ultimate	-1313.5293	549.7386	203.1559	157.5513	543.8301
Bottom	Leg 1	750	envelop ultimate	-1275.7125	444.2578	203.1559	192.4381	578.7169

Figure 3-46shear wall reinforcement from ETABS

*The wall should be reinforce in two region , according to **ACI -310-14** :*

1-Boundaries.

2- web .

- *Boundary dimension = Min (.1h/4b).*

where h: wall height .

b : wall thickness.

- *Boundary dimension = Min (.32/1.2) , use(.32*.3) m.*

ACI -310-14requirement :

-- spacing in vertical and horizontal = 250 mm .

-- p in boundary area = 1 %.

-- Minimum p in vertical and horizontal direction = .25 %.

--maximum p vertical =35 %.

- *The steel reinforcement in boundary = 1%* 300 * 320 = 960 mm2 ⇨ use 8 Ø 14 in boundaries . 4 Ø 14 on each face.*

- *The steel reinforcement in web :*

*p vertical from ETABS = .0087 >> .0025 ⇨ AS = .0087 * 1000* 300 = 2610 mm2*

use 14 Ø16/m in vertical ⇨ 7 Ø16for each side

AS horizontal minimum = .25% 300* 1000 = 750 mm2/m = As FROM ETABS*

USE 8Ø 14/m in horizontal dimension .4for each side

3.7.6.1 check shear for wall :

$$\emptyset V_{cp} = 0.75 \times 1/6 \times \sqrt{f`c} \times bw \times d \times 10^{-3}$$

$$\emptyset V_{cp} = 0.75 \times 1/6 \times \sqrt{28} \times 100 \times 240 \times 10^{-3}$$

$$\emptyset V_{cp} = 158\ KN/m2 > vu\ ETABS\ = 80\frac{kn}{m}.$$

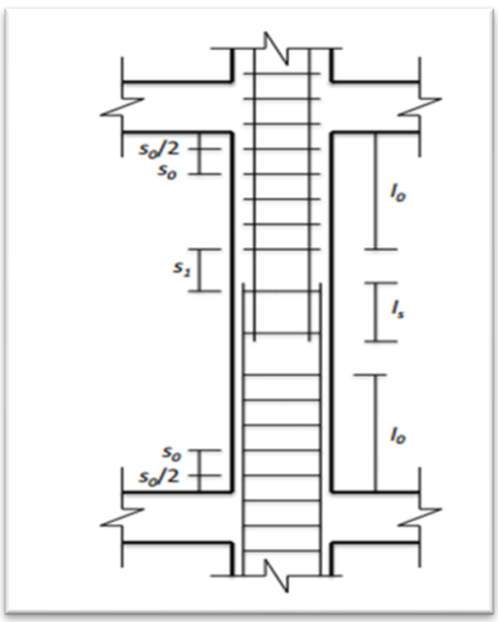
3.7.6.2 Stirrup at Web

The following figure shows the web and boundary dimensions for shear wall .

the web and boundary dimensions for shear wall .

Web reinforced like column :

The following figure shows the seismic requirement for web stirrup spacing ;



$$S1 = min \begin{cases} leastcolumndimensssion \\ 16\ db \\ 48ds \end{cases} = \begin{cases} 300/2 \\ 16 * 14 \\ 48 * 8 \end{cases} = 150mm$$

Use 2 Ø 8 @ 150 mm

The following table shows the other shear wall reinforcement :

Table 29shear wall reinforcement

	thickness	length	webrein fortwosides	veritcal rein.	horizantal rein.	shear check	web stirrup
s.w1	300 mm	3.43 m	8ø 14	8ø20/m	8ø12/m	ø vc > vu	2ø8/150mm
s.w2	300 mm	4.28 m	8ø 14	9ø32/m	8ø12/m	ø vc > vu	2ø8/150mm
s.w3	300 mm	2.44 m	8ø 14	8ø25/m	8ø12/m	ø vc > vu	2ø8/150mm
s.w4	300 mm	2.44 m	8ø 14	14ø20/m	8ø12/m	ø vc > vu	2ø8/150mm
s.w5	300 mm	2.44 m	8ø 14	14ø20/m	8ø12/m	ø vc > vu	2ø8/150mm
s.w6	300 mm	2.44 m	8ø 14	14ø20/m	8ø12/m	ø vc > vu	2ø8/150mm
s.w7	300 mm	4.62 m	8ø 14	10ø14/m	8ø12/m	ø vc > vu	2ø8/150mm
s.w8	300 mm	3.41 m	8ø 14	9ø25/m	8ø12/m	ø vc > vu	2ø8/150mm
s.w9	300 mm	2.21 m	8ø 14	8ø25/m	8ø12/m	ø vc > vu	2ø8/150mm
s.w10	300 mm	2 m	8ø 14	5ø25/m	8ø12/m	ø vc > vu	2ø8/150mm
s.w11	300 mm	6.55 m	8ø 14	10ø25/m	8ø12/m	ø vc > vu	2ø8/150mm
s.w12	300 mm	4.86 m	8ø 14	16ø18/m	8ø12/m	ø vc > vu	2ø8/150mm

3.7.7 Basement wall :

The basement wall shall be designed to resist the axial lateral load and moment from the Seismic effect:

figure , shows the reinforcement for basement by ETABS .

ETABS 20.0.0 License #*1TK94KCDM5UVHRE

ETABS Shear Wall Design

ACI 318-14 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
Story1	P20	2592.1	-25834.4	49025.1	300	0.481

Material Properties

E_c (MPa)	f'_c (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
24870.58	28	1	413.69	413.69

Design Code Parameters

ϕ_T	ϕ_C	ϕ_V	ϕ_V (Seismic)	IP_{MAX}	IP_{MIN}	P_{MAX}
0.9	0.65	0.75	0.6	0.04	0.0025	0.8

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	-21920.4	-25830.7	27104.7	-25838.2	49025.1	300
Bottom	Leg 1	-21920.4	-25830.7	27104.7	-25838.2	49025.1	300

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	36769	0.0025	0.0051	DWalS6	3907.027	721.583	-9605.6388	14707523
Bottom	36769	0.0025	0.0051	DWalS6	4789.4783	608.1492	-8878.3357	14707523

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	750	envelop ultimate	2981.873	2703.0218	3299.8527	13242.3677	22368.8002
Bottom	Leg 1	750	envelop ultimate	3875.365	8963.5421	3299.8527	13376.39	22502.8225

Boundary Element Check (ACI 18.10.6.3, 18.10.6.4)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa	C Depth mm	C Limit mm
Top–Left	Leg 1	Not Required	3-1	6879.9407	-2145.2925	0.49	5.6		
Top–Right	Leg 1	Not Required	3-1	6879.9407	-2145.2925	0.45	5.6		
Bottom–Left	Leg 1	Not Required	3-1	8302.8935	-586.6431	0.57	5.6		
Bottom–Right	Leg 1	Not Required	3-1	8302.8935	-586.6431	0.56	5.6		

Figure 3-47shear wall reinforcement from ETABS

The following table shows the basement wall reinforcement

Table 30basement wall reinforcement

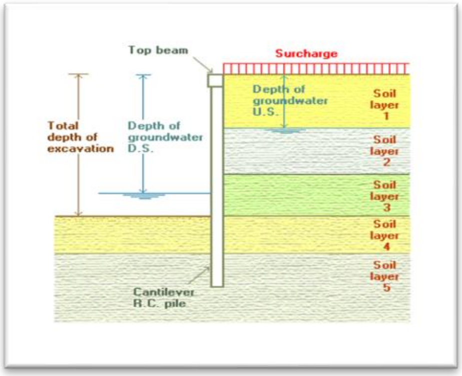
	thickness	length	webrein	veritcal rein.	horizantal rein.	shear check
s.w1	300 mm	49.3m	8ø 14	8ø14 /m	8ø14 /m	ø vc > vu
s.w2	300 mm	37 m	8ø 14	8ø14 /m	8ø14 /m	ø vc > vu

3.7.8 sheet piles :

sheet pile was designed because building retaining walls would be risky due to the proximity of the project to other structures and the potential for collapse Due to the depth of the excavation, by using **geo5 2023 program**.

Ɣ= 18 kn/m2.

3.7.8.1 sheet pile depth manual calculation:



manual calculation for pile depth :

ka = $\frac{1-\text{SIN } 30}{1+\text{SIN } 30}$ **= .333 .**

Active earth pressure = (q +hƔ) ka -2c$\sqrt{ka}$.

the following figure shows the active earth pressure for each point

Table 31the active earth pressure

point	Ea	Ea (t.m)
1	0-2*1* $\sqrt{.33}$	**.18**
2	9*1.8)*.33-2*1* $\sqrt{.33}$(	**4.197**
3	9*1.8+D*.8)*.33-2*1* $\sqrt{.33}$(	**1.227+.27D**

kp = $\frac{1+\text{SIN } 30}{1-\text{SIN } 30}$ **= 3**

Passive earth pressure = (q +hƔ) ka +2c$\sqrt{ka}$.

the following figure shows the passive earth pressure for each point :

Table 32the passive earth pressure

point	EP	EP (t.m)
4	0-2*1* $\sqrt{3}$)-(	**3.46-**
5	D*.8)* 3-2*1* $\sqrt{3}$-(	**3.46+2.4D-**

The following figure shows the moment value for each shape :

Table 33moment value

Shape	Force	arm	MOMENT
1	1.62	4.5D	**1.62D**
2	18.07	3+D	**18.07+54D**
3	4.197D	.5D	**2.0985 D**
4	.135D^2 -1.46D	D/3	**.045 D^3-.486d^2**
5	3.46D	.5D	**-1.73 D^2**

Shape	Force	arm	MOMENT
6	1.2 D2	D/3	**-.3996D^3**

⇨ **M @ point 3 =0**

By solving the equation D = 6,therefor total length = 9(excavation depth)+1.3*6= 16.8m

3.7.8.2 Sheet pile length by geo5 :

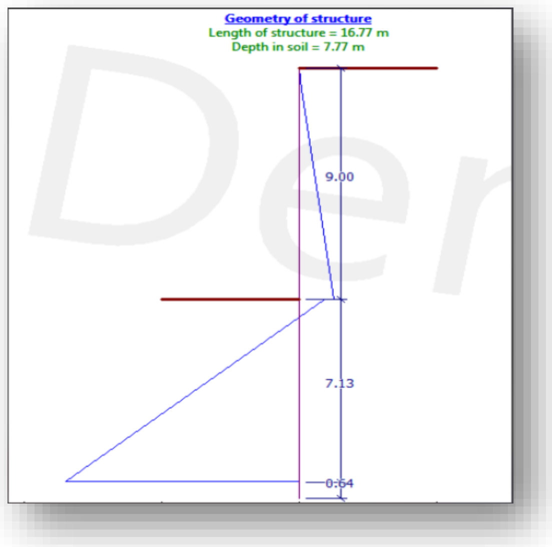


Figure 3-48sheet pile depth by GEO 5

D = 7.13m , total pile length = 17m .

Diameter of sheet pile and spacing:

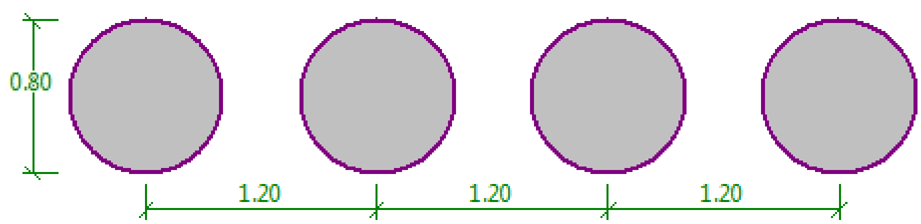


Figure 3-49sheet pile spacing and diameter

sheet pile reinforcement :

figure   , shows the maximum bending moment .

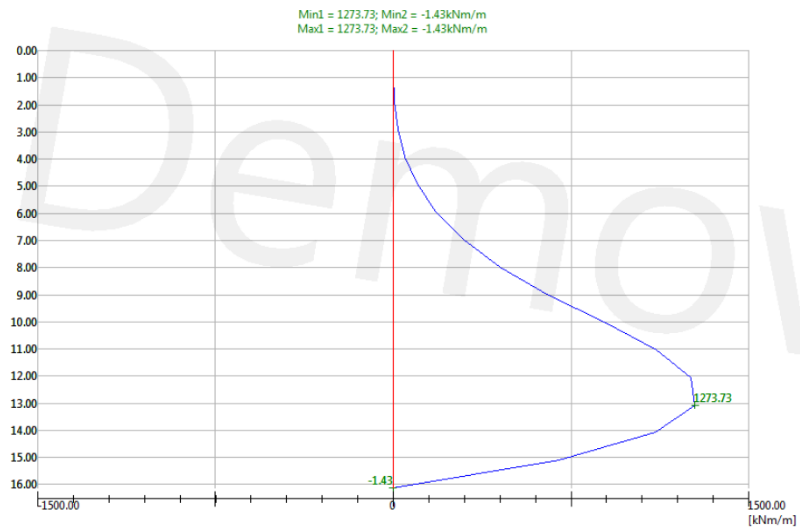


Figure 3-50bending moment value foe sheet pile

figure below shows the maximum shear force .

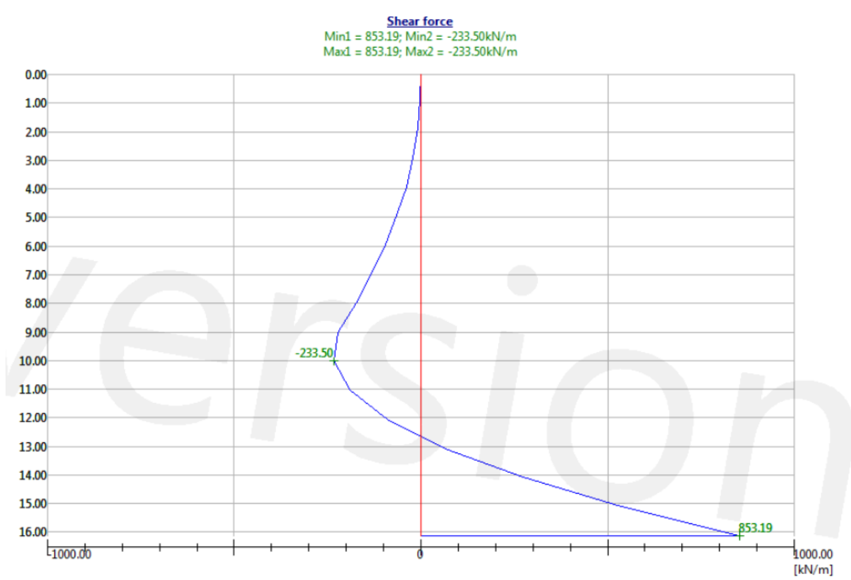


Figure 3-51shear value for sheet pile

Result from geo5 :

sheet pile detailing :

The following figure the reinforcement result from geo5 :

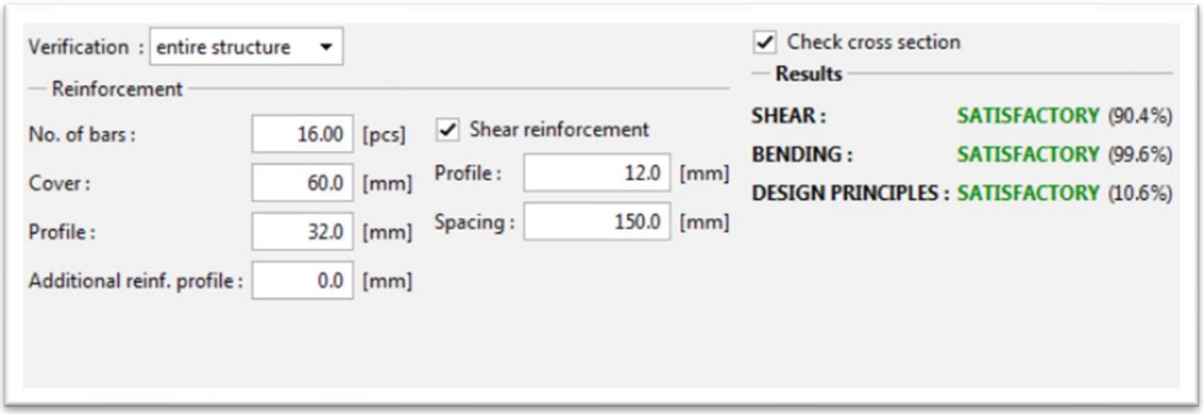


Figure 3-52sheet pile reinforcement by geo5

The following figure shows the sheet pile reinforcement :

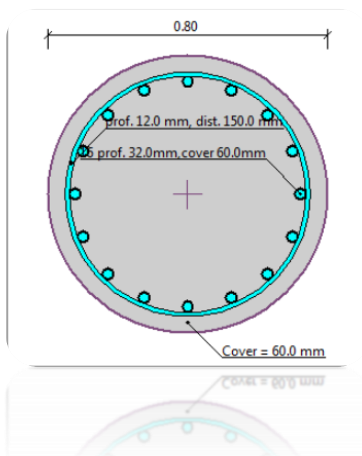


Figure 3-53sheet pile detail

The following figure shows the piles details :

pile length = 17 m.

pile diameter = 80 cm./ pile spacing = 1 .2m.

longitudinal reinforcement 16 Ø32

shear reinforcement = Ø12 @ 150 mm .

pile length = 17 m.

pile diameter = 80 cm./ pile spacing = 1 .2m.

longitudinal reinforcement 25Ø32

shear reinforcement = Ø12 @ 150 mm .

3.7.9 Water tank:

⇨ the tank in the basement story, The building water tank is intermediate, therefore load transfer in two directions.

⇨ *{2 >length /height >.5} .*

<u>Water tank load:</u>

live load on water tank roof = 4 Kn/m2.

*water pressure on water tank base = γ*h*

*= 10 * 3 = 30 kn/m2 .*

3.7.9.1 Water tank check :

1. ***compatibility check:***

All water tank element are moved as one element ⇨ *the check is okk*

Figure below shows the water tank .

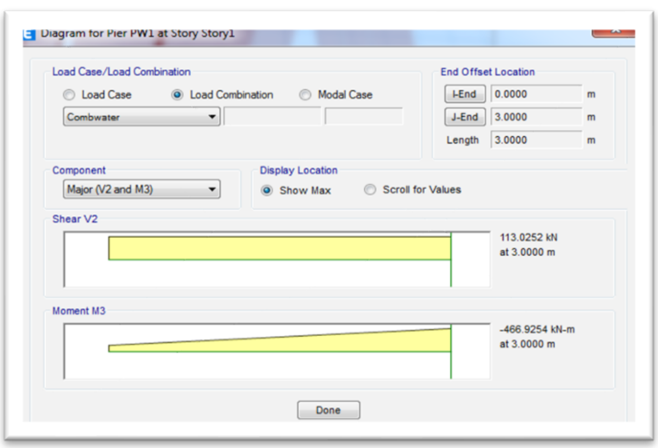


Figure 3-54compatibility check for water tank

2. shear check for wall :

-Øvc = $.\frac{75}{6} * \sqrt{F`C} * bw\ d * 10^{\wedge} - 3$

-Øvc = $.\frac{75}{6} * \sqrt{28} * 1000 * \ 340 * 10^{\wedge} - 3$

-Øvc = 224 kn. figure belw shows the maxium shear in the wall

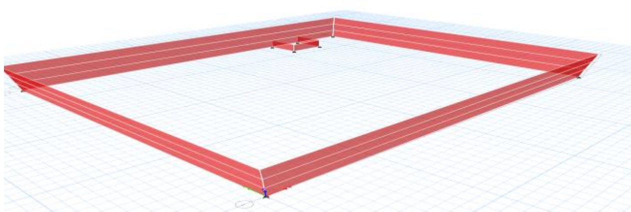


Figure 3-55shear value for water tank wall by ETABS

⇨ *vu= 1.4*VU =158 kn/m2 <Øvc   shear check is ok*

3. shear check for r base :

-Øvc = $.\frac{75}{6} * \sqrt{F`C} * bw\ d * 10^{\wedge} - 3$

-Øvc = $.\frac{75}{6} * \sqrt{28} * 1000 * \ 240 * 10^{\wedge} - 3$

-Øvc = 158 kn.

figure blow shows the maximum shear in the water tank base.

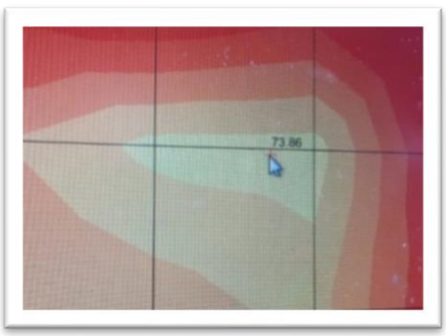


Figure 3-56shear value for water tank base by ETABS

vu= 1.4*70 =106 <Ø vs okk.

3.7.10.1.4Tension design and check :

For wall:

Figure below shows the ultimate torsion in the wall

Figure 3-57tension value for water tank

TU design = Sd TU.

Where sd : durability factor .

sd = $\frac{Ø\, FY}{\text{Ɣ}*FS\; max}$

capacity reduction factor = .9Ø:

average load factor =1.4 γ:

fs :max for normal condition (water) = 138 MPA .

sd = $\frac{.9*\,420}{1.4*138}$*= 1.956.*

*TU design = 1.956*136= 266 Kn/m*

⇨ check thickness for tension :

AS =$\frac{tu\; design}{.9*420} * 1000$*= 703 mm2/m.*

use 6 Ø 14 /m ⇨ *3 Ø 14 for each layer .*

⇨ $\frac{T+c\; Es*As}{AG+n\; As}$*>1/3 ** $\sqrt{f`c}$

where :

c : shrinkage strain

n : modular ratio

T : Service tension.

ES : modules of elasticity for steel

As : area of steel .

A g : gross area

n = $\frac{200000}{4700*\sqrt{FC}}$*= 8.05.*

$\frac{13600+.0003*200000*703}{400000+8.05*703}$*>1/3 ** $\sqrt{28}$

1.07 < 1.76 ⇨ *the thickness is ok .*

Check tension for base :

the ultimate torsion in the wall TU =

⇨ *TU design = Sd TU.*

Where sd : durability factor .

sd = $\frac{\emptyset FY}{\gamma*FS\ max}$

Ø:capacity reduction factor = .9

γ *: average load factor =1.4*

fs :max for normal condition (water) = 138 MPA .

sd = $\frac{.9*420}{1.4*138}$*= 1.956.*

*TU design = 1.956*10 = 19 Kn/m*

Check thickness for tension :

AS =$\frac{tu\ design}{.9*420}*1000$*= 50mm2/m.*

use 4Ø 8 /m ⇨ *2 Ø 8 for each layer .*

⇨ $\frac{T+c\ Es*As}{AG+n\ As}$*>1/3 ** $\sqrt{f`c}$

n = $\frac{200000}{4700*\sqrt{FC}}$*= 8.05.*

$\frac{19000+.0003*200000*50}{500000+8.05*50}$*>1/3 ** $\sqrt{28}$

.01< 1.76 ⇨ *the thickness is ok*

3.7.9.2 Wall design and reinforcement:

Mu design= 1.06 sd Mu.

Assume normal exposure , two way and the spacing 150 mm and h ≥ .4.

Figure below shows fs max value:

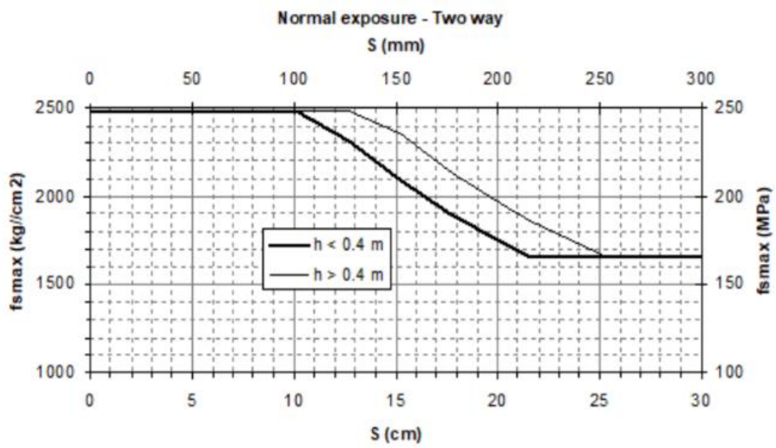


Figure 160:normal exposure -two way

⇨ *f s max = 210 Mpa.*

sd = $\frac{.9*420}{1.4*240}$*= 1.125*

1) Vertical reinforcement -outside surface :

from ETABS Mu= 439 Kn. m .

*Mu design= 1.06 * 1.125* 439 = 523 Kn.m .*

$$\rho = \frac{0.85 \times 28}{420}\left(1 - \sqrt{1 - \frac{2.61 \times 10^6 \times 523}{28 \times 1000 \times 340^2}}\right) = .0135$$

*AS = .0135*1000*340 =4615mm2/m +703/2 for tension* ⇨ *11 Ø 25 /m for vertical reinforcement*

2) Vertical reinforcement -outside surface :

from ETABS Mu= 255 Kn. m .

*Mu design= 1.06 * 1.125* 255 = 304Kn.m .*

$$\rho = \frac{0.85 \times 28}{420}\left(1 - \sqrt{1 - \frac{2.61 \times 10^6 \times 304}{28 \times 1000 \times 340^2}}\right) = .007$$

*AS =.007*1000*340 =2527mm2/m +703/2 for tension* $\Rightarrow$ *7 Ø 25 /m for vertical reinforcement.*

3) Horizontal reinforcement -inside surface :

from ETABS Mu= 50 Kn. m .

*Mu design= 1.06 * 1.125* 50 = 60Kn.m .*

$$\rho = \frac{0.85 \times 28}{420}\left(1 - \sqrt{1 - \frac{2.61 \times 10^6 \times 60}{28 \times 1000 \times 340^2}}\right) = .00139$$

*AS =.00139 *1000*340 =471 mm2/m .*

*As min (horizontal)= .003 b h =.003 * 400*1000 = 1200*

Use As min + 703/2 for tension $\Rightarrow$ *use 8Ø 16 /m.*

4) Horizontal reinforcement -outside surface :

From ETABS Mu= 45 Kn. m .

*Mu design= 1.06 * 1.125* 45 = 53kn.m .*

$$\rho = \frac{0.85 \times 28}{420}\left(1 - \sqrt{1 - \frac{2.61 \times 10^6 \times 53}{28 \times 1000 \times 340^2}}\right) = .001$$

*AS =.00139 *1000*340 =352 mm2/m* $\Rightarrow$ *4 Ø 14/m for horizontal reinforcement.*

*As min (horizontal)= .003 b h =.003 * 400*1000 = 1200.*

Use As min + 703/2 for tension $\Rightarrow$ *use 8Ø 16 /m.*

3.7.9.3 Development length:

ld = 20 Ø bar.

*ld = 20*25 = 500 mm.*

The thickness is not ok

This problem will be solved in water tank detail.

3.7.9.4 Base design and reinforcement

moment values for base are small use AS min

As min = .0018 *1000*500 = 900 mm2/m ….use 5Ø16/m .

3.8 Detailing:

All the structural element detail in the project drawing .

4 Chapter 4: Electro-Mechanical Aspects

4.1 Artificial lighting design:

4.1.1 Introduction:

Electric lamp-based lighting is typically referred to as "artificial lighting." In most cases, artificial light may be simply controlled to produce the desired lighting effect. The light can be colored, focused, directed, increased, or diminished. As a result, lighting may provide a variety of effects depending on the needs of a location. The kind of place that needs lighting (office, living room, bathroom, etc.), the kind and quality of light that is required, and the energy consumption of the light fixture will all influence the choice of artificial lighting source. In our project, there are different areas, each of, which needs a different amount of lighting, and this has been taken into account to provide appropriate lighting in all places.

4.1.2 Recommended Lux Levels:

Table 34Recommended Lux Levels

Libraries	Bookshelves	200
	Reading areas	500
	Counters	500
Public car parks (indoor)	In/out ramps (during the day)	300
	In/out ramps (at night)	75
	Traffic lanes	75
	Parking areas	75
	Ticket offices	300

The following guidance tables provide recommended lux levels for specific working areas within public sector buildings. In our building we need the lux level for offices and parking. These figures are based on the recommended lux levels by CIBSE (Chartered Institute of Building Services Engineers) and the code for interior lighting. (Recommended Lighting Levels in Buildings - Archtoolbox, n.d.)

Table 35recommended lux levels for specific working areas within public sector buildings

Offices		$\bar{E}_m$
	Filing, copying, etc.	300
	Writing, typing, reading, data processing	500
	Technical drawing	750
	CAD work stations	500
	Conference and meeting rooms	500
	Reception desks	300
	Archives	200
Retail premises		
	Sales areas	300
	Till areas	500
	Wrapper tables	500
Places of public assembly		
General areas	Entrance halls	100
	Cloakrooms	200
	Lounges	200
	Ticket offices	300

Offices	Suggested Lux Level
Filing, copying etc...	300
Writing, typing, reading, processing	500
Technical drawing	750
CAD workstations	500
Conference & meeting rooms	500
Reception area	300
Archives	200
Design office	1,000
Toilets	250
General lighting	120
Precision assembly	1500

Table 36suggested lux level for the offices

Table 37suggested lux level for the car parks.

Car Parks	Suggested Lux Level
Parking bays (multi storey / underground)	75
Access lanes (M-S/UG)	75
Ramps (M-S/UG)	150
Corners (M-S/UG)	150
Intersections (M-S/UG)	150
Multi storey roof level	30
Entrance / exit zones (M-S/UG) day time	300
Entrance / exit zones (M-S/UG) night time	75
Pedestrian areas (M-S/UG)	100
Stairs & lifts (M-S/UG)	100

4.1.3 Artificial lighting design

artificial lighting in the building deserves a lot of attention in this part, Because it significantly influenced users' comfort. While consideration must be given to the lux level, color, direction, color temperature, and the way of dispersing them within the areas without overlooking the amount of energy required by the lighting equipment employed.

The reflection factors used according to the DiaLUX software are the following:

- **Ceiling: 75**
- **Floor: 60**
- **Wall: 30**

Calculations and design will be using the DiaLUX software and according to the required standards and specifications of each space, where one space of each category will be designed and all the required luminaires will be given with a plan of their distribution in the space along with a plan of the lux map contour in the space, the glare will also be checked by making some calculation object surfaces in the important areas, as the following:

4.1.3.1 Employees Office:

The standard lux value in this type of spaces is 500lx with 3500 - 4000 K lighting temperature as the next calculations which is done all by the DiaLUX software shows:

Figure 4-13D lighting mode EmployeesOffice.

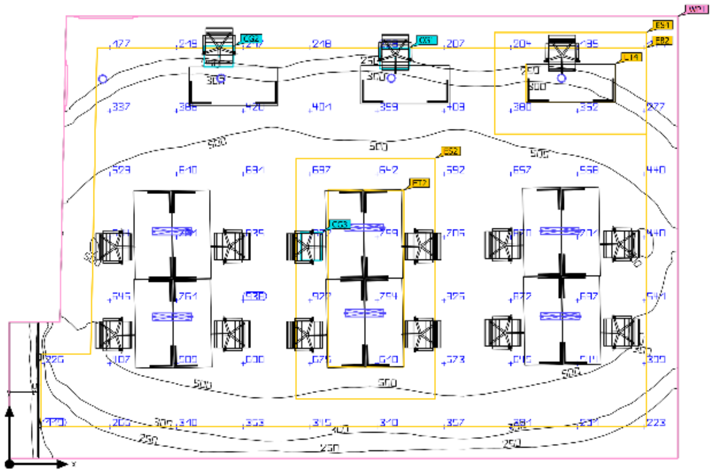


Figure 4-2lux level on Employees Office

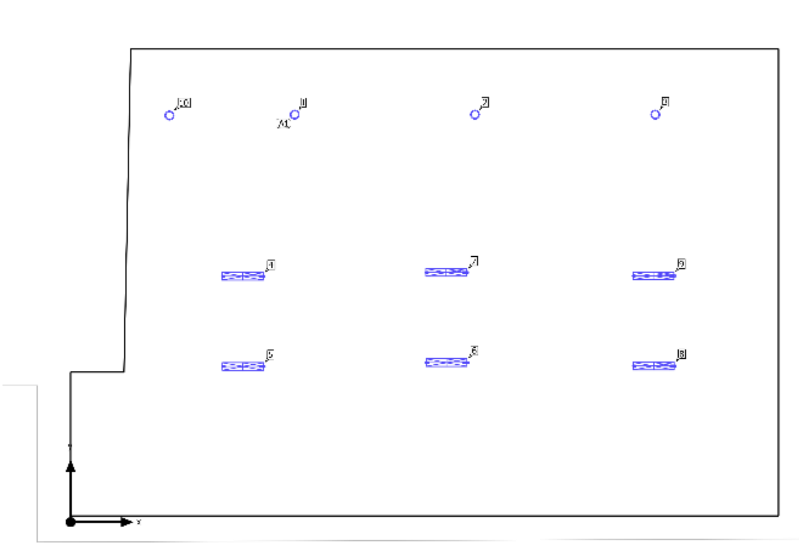
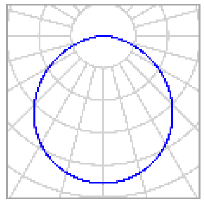


Figure 4-3 Distribution lighting luminaire.

Luminaire layout plan

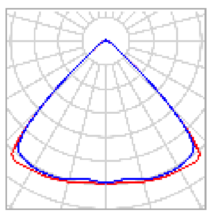


Manufacturer	Regiolux
Article No.	1000 14W 830 ET ws (37691114140)
Article name	relo-UP-RDAS-O/140 LED - Diffusor opal | Opal diffuser
Fitting	1x LED

P	13.8 W
$\Phi_{Luminaire}$	1007 lm

Figure 4-4ceiling downlight unit.

Luminaire layout plan



Manufacturer	Regiolux
Article No.	6500 43W 840 ET vw RAL 9016 (41231044120)
Article name	zatta-ZTTAB-2 LED - Individual.Lens.Optic | Individual.Lens.Optic
Fitting	1x LED

P	42.5 W
$\Phi_{Luminaire}$	6531 lm

Figure 4-5ceiling downlight unit.

Glare check:

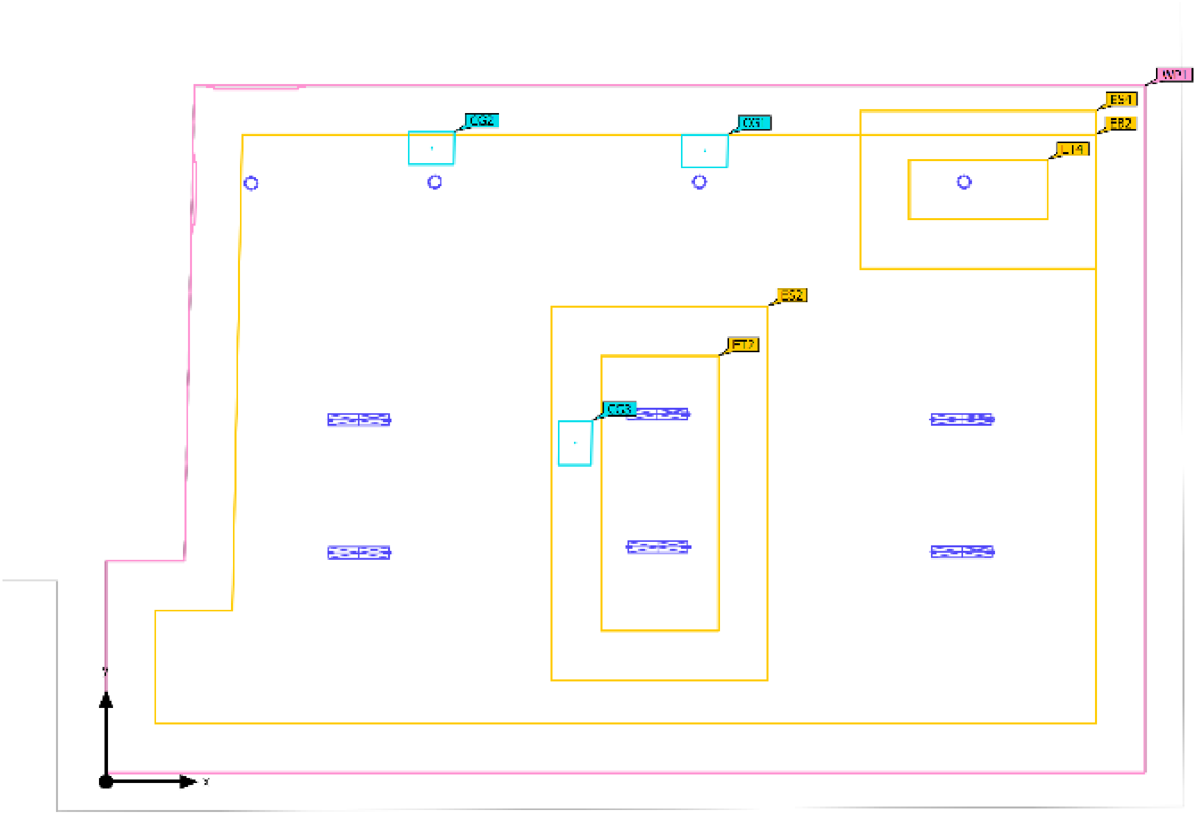


Figure 4-6distribution of luminaires and workplan places

glare 1 (UGR)

Strongest glare at	120°
max	<10
Target	≤19.0
Viewing sector	60° - 120°
Step width	15°
Height	1.200 m
Index	CG1

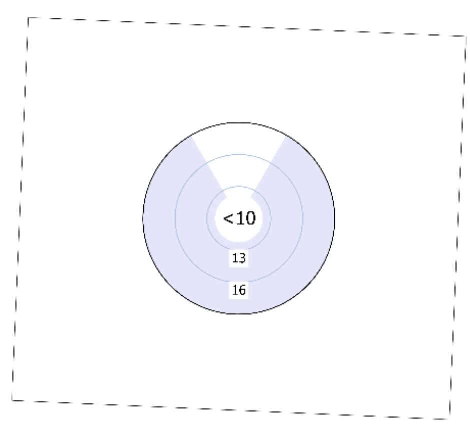


Figure 4-7Glare Rating(UGR1 ofEmployees Office).

glaer2 (UGR)

Strongest glare at	60°
max	<10
Target	≤19.0
Viewing sector	60° - 120°
Step width	15°
Height	1.200 m
Index	CG2

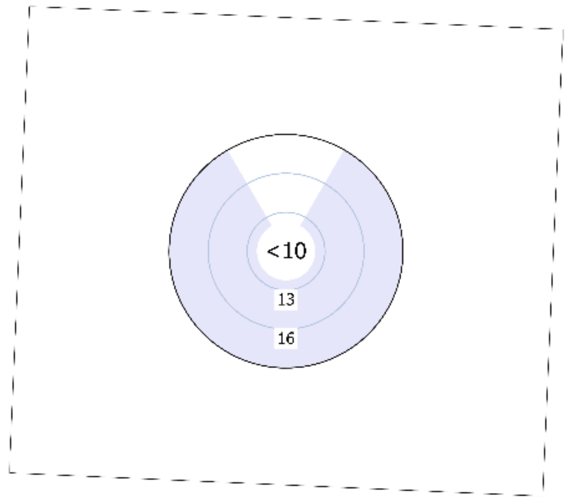


Figure 4-8Figure 4-9Glare Rating(UGR2 ofEmployees Office).

glaer3 (UGR)

Strongest glare at	60°
max	16.7
Target	≤19.0
Viewing sector	300° - 60°
Step width	15°
Height	1.200 m
Index	CG3

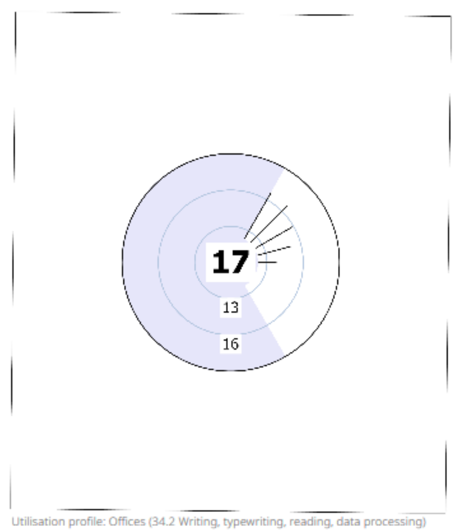


Figure 4-10Figure 4-11Glare Rating(UGR3 ofEmployees Office).

Results: the space’s artificial lighting design achieve all the requirement and specifications; the light is distributed well and the glare is within the right range and not annoying.

4.1.3.2 Meeting room:

The standard lux value in this type of spaces is 500lx with 3500 - 4000 K lighting temperature as the next calculations which is done all by the DiaLUX software shows:

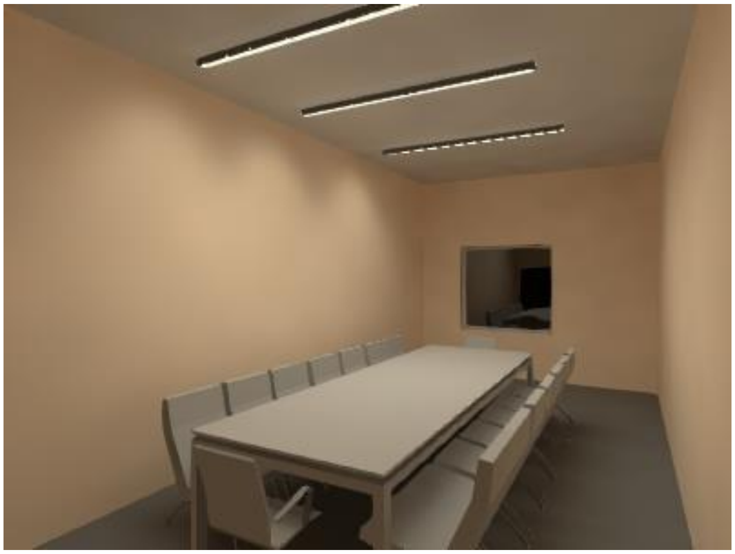


Figure 4-123D lighting mode meeting room.

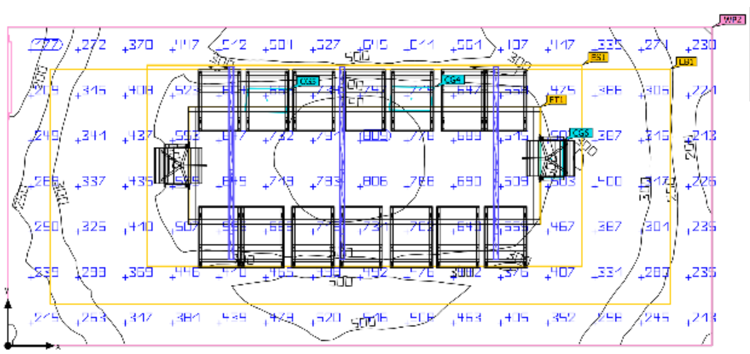


Figure 4-13lux value in meeting room

Ground area	31.95 m²	Clearance height	3.500 m
Reflection factors	Ceiling: 70.0 %, Walls: 81.7 %, Floor: 20.0 %	Mounting height	3.500 m
		Height Working plane	0.800 m
Maintenance factor	0.80 (fixed)	Wall zone Working plane	0.000 m

Results

	Symbol	Calculated	Target	Check	Index
Working plane	$E_{perpendicular}$	739 lx	≥ 500 lx	✓	WP2

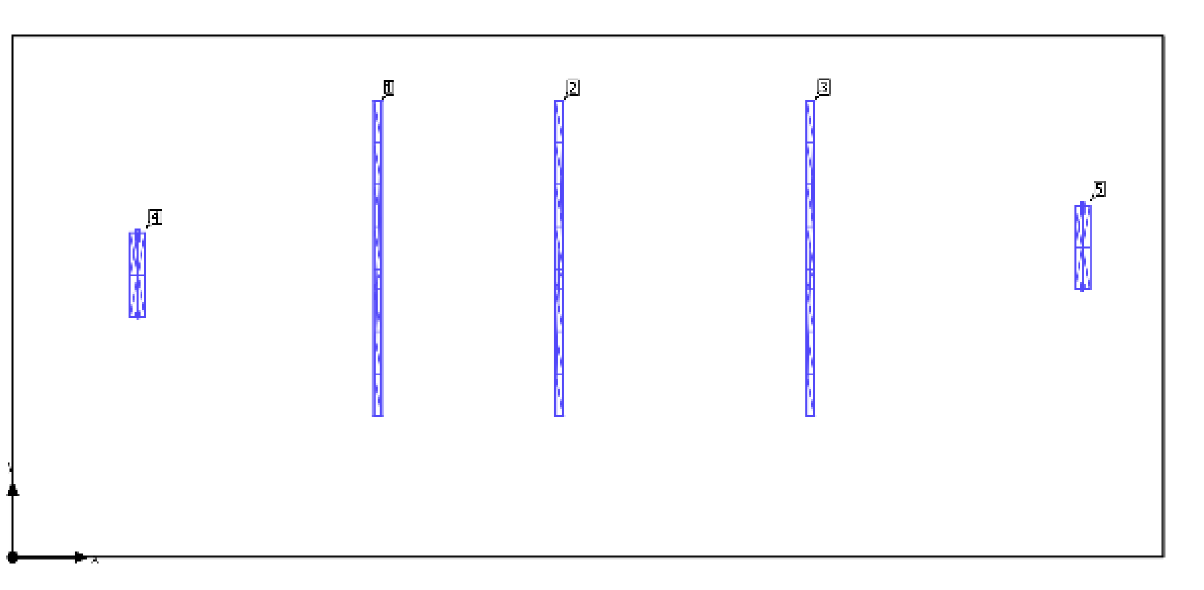
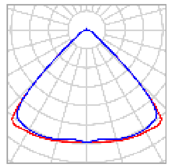


Figure 4-14Distribution lighting luminaire of meeting room.

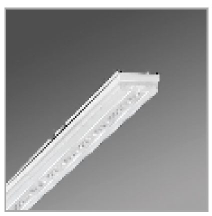
Luminaire layout plan

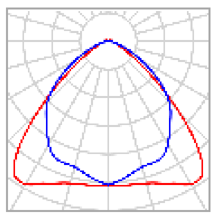


Manufacturer	Regiolux
Article No.	6500 43W 840 ET vw RAL 9016 (41231044120)
Article name	zatta-ZTTAB-2 LED - Individual.Lens.Optic | Individual.Lens.Optic
Fitting	1x LED

P	42.5 W
$\Phi_{Luminaire}$	6531 lm

Luminaire layout plan





Manufacturer	Regiolux
Article No.	7000 36W 830 IP64 DALI2 vw RAL 9016 (SRT+19512026090)
Article name	SRT-System IP64-SRGSCB/2250 LED - Geräteträger fix Central.Line.Optic | Device mount fix Central.Line.Optic
Fitting	1x LED

P	35.7 W
$\Phi_{Luminaire}$	6396 lm

Figure 4-15ceiling downlight unit.

Glare check:

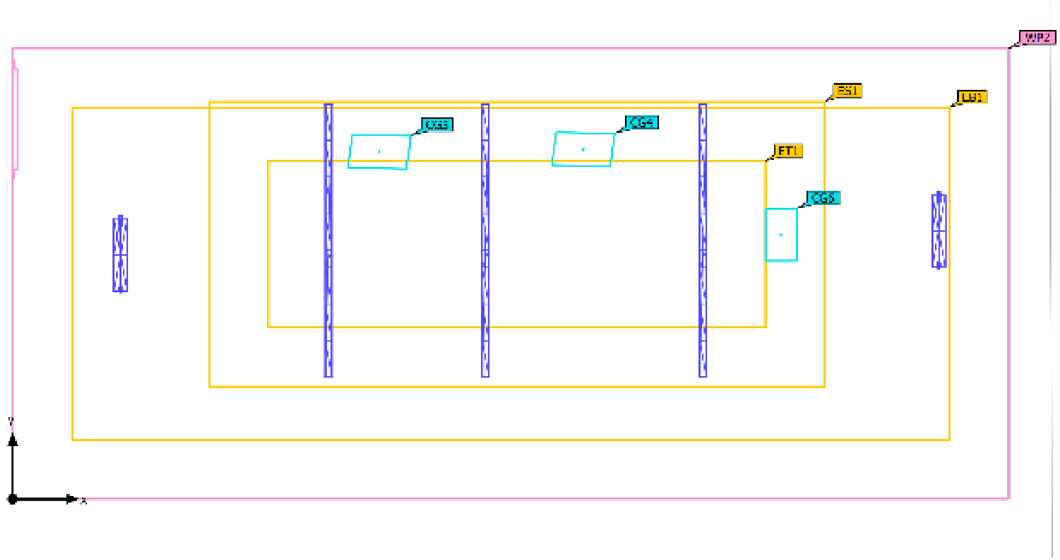


Figure 4-16Glare Rating(UGR)

meeting room Glare 1 (UGR)

Strongest glare at	-33°
max	<10
Target	≤19.0
Viewing sector	60° - 120°
Step width	15°
Height	1.200 m
Index	CG4

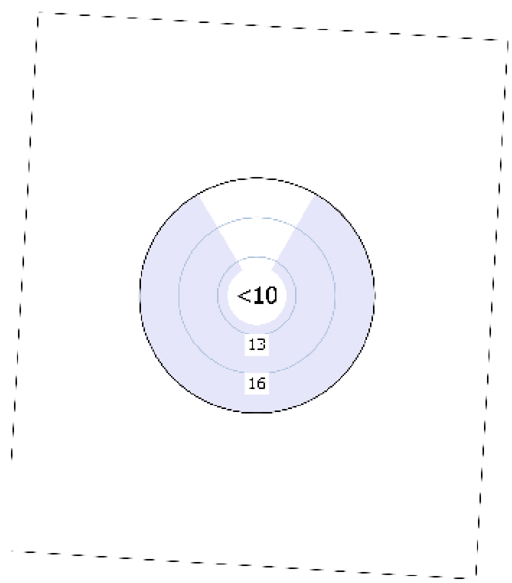


Figure 4-17Glare Rating(UGR1 ofmeeting room).

Calculation surface 5 (UGR)

Strongest glare at	195°
max	15.9
Target	≤19.0
Viewing sector	120° - 240°
Step width	15°
Height	1.200 m
Index	CG6

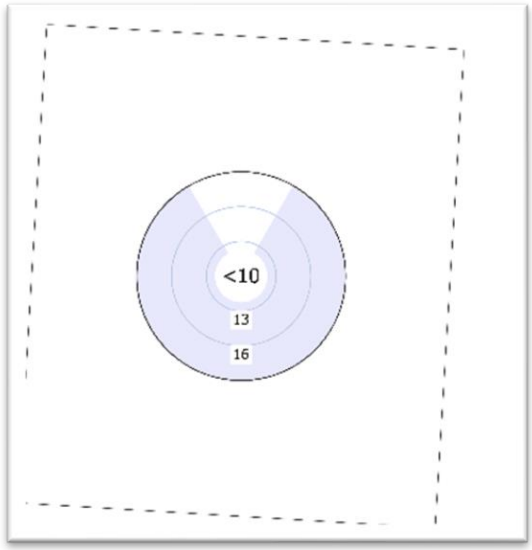
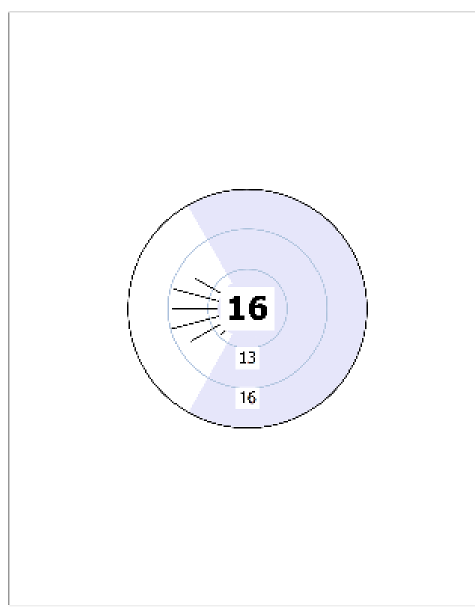


Figure 4-18Figure 4-19Glare Rating (UGR2 ofmeeting room).

meeting room Glare 2 (UGR)

Strongest glare at	-33°
max	<10
Target	≤19.0
Viewing sector	60° - 120°
Step width	15°
Height	1.200 m
Index	CG5



Utilisation profile: Offices (34.5.1 Conference and meeting rooms)

Figure 4-20Figure 4-21Glare Rating (UGR3 ofmeeting room).

4.1.3.3 Manager room:

Figure 4-22 3D modeling of manager room

Results

	Symbol	Calculated	Target	Check	Index
Working plane	$\bar{E}_{perpendicular}$	675 lx	≥ 500 lx	✓	WP3

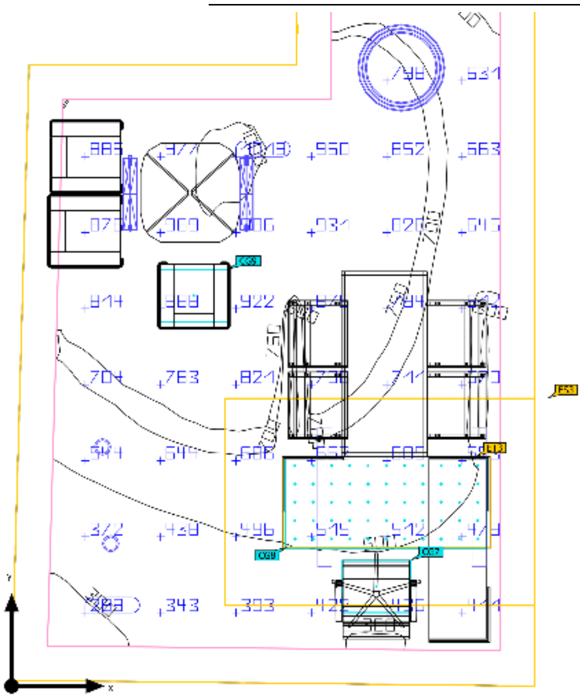


Figure 4-23 lux value in manager room

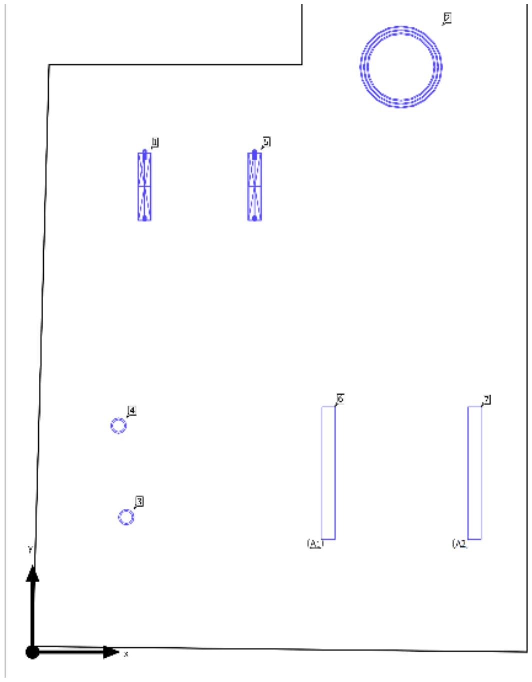
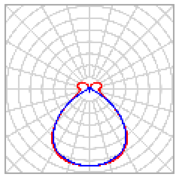
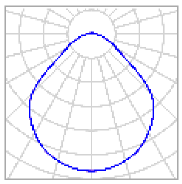


Figure 4-24 Distribution lighting luminaire in manager room.



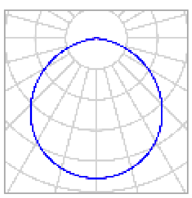
Manufacturer	3F Filippi S.p.A.
Article No.	1930
Article name	03F 28W DT8 TW L1204 (CCT 2700)
Fitting	1x LED L - TW

P	35.0 W
$\Phi_{Luminaire}$	4115 lm



Manufacturer	Aura Light
Article No.	24318305586
Article name	Kvill CE D750 MP 42W 5500 DALI EM 3h 830 White
Fitting	1x LED

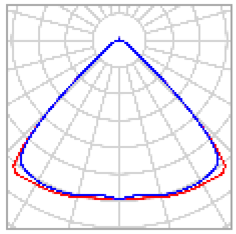
P	42.0 W
$\Phi_{Luminaire}$	5260 lm



Manufacturer	Regiolux
Article No.	1000 14W 830 ET ws (37691114140)
Article name	relo-UP-RDAS-O/140 LED - Diffusor opal | Opal diffuser
Fitting	1x LED

P	13.8 W
$\Phi_{Luminaire}$	1007 lm

Figure 4-25 ceiling downlight unit.

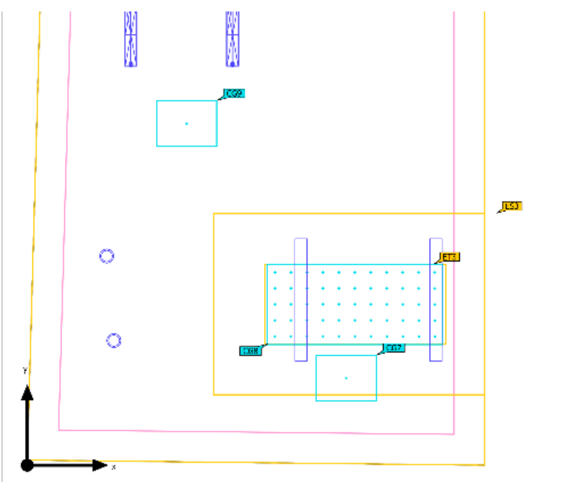
REGIOLUX  

Manufacturer	Regiolux
Article No.	6500 43W 840 ET vw RAL 9016 (41231044120)
Article name	zatta-ZTTAB-2 LED - Individual.Lens.Optic | Individual.Lens.Optic
Fitting	1x LED

P	42.5 W
$\Phi_{Luminaire}$	6531 lm

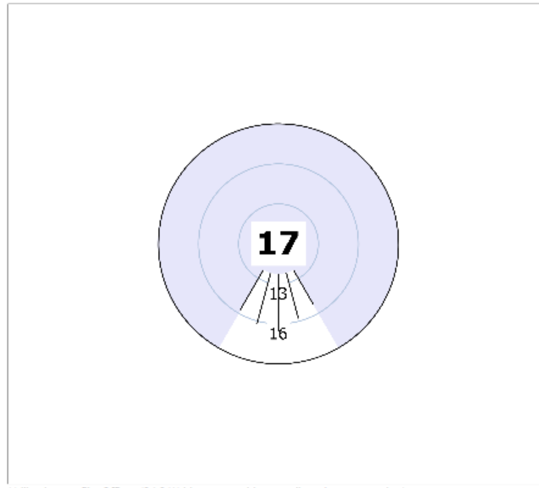
Figure 4-26 ceiling downlight unit.

<u>Glare check:</u>



glare1 (UGR)

Strongest glare at	-33°
max	<10
Target	≤19.0
Viewing sector	240° - 300°
Step width	15°
Height	1.200 m
Index	CG7



Utilisation profile: Offices (34.2 Writing, typewriting, reading, data processing)

Figure 4-27Glare Rating(UGR1 ofmanager room).

glare2 (UGR)

Strongest glare at	270°
max	16.5
Target	≤19.0
Viewing sector	240° - 300°
Step width	15°
Height	1.200 m
Index	CG9

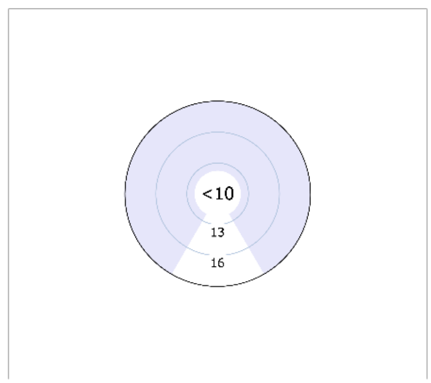


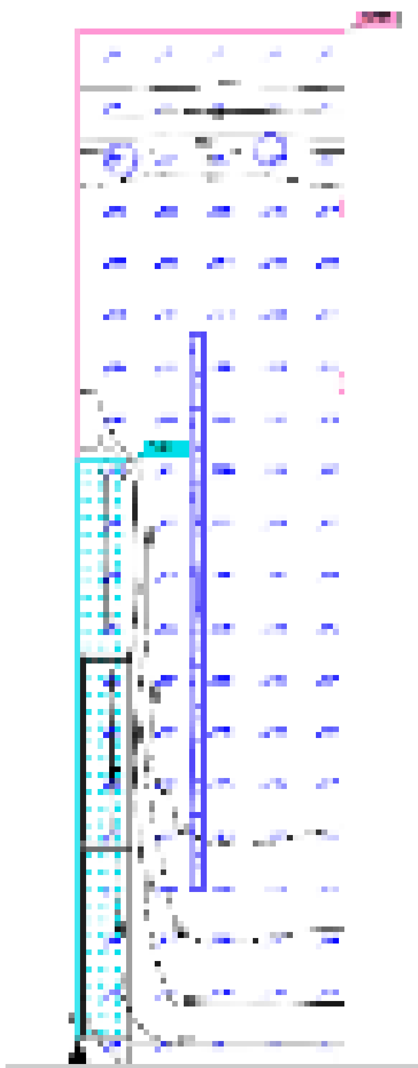
Figure 4-28Glare Rating(UGR2 ofmanager room).

<u>Results:</u> the space's artificial lighting design achieve all the requirement and specifications; the light is distributed well and the glare is within the right range and not annoying.

4.1.3.4 Archive room:

Figure 4-29 3d modeling room

Figure 4-30lux value in Archive room



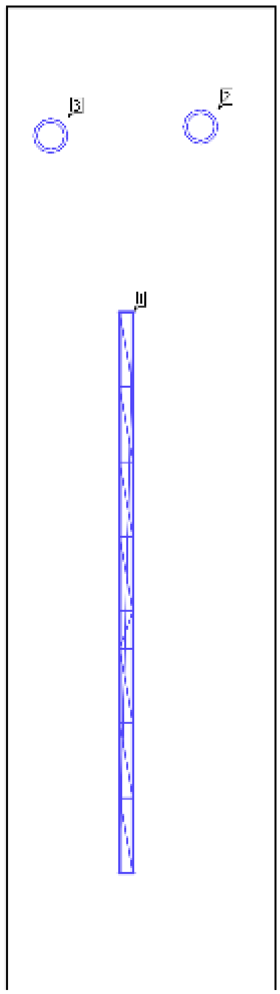


Figure 4-31 distribution luminaire in archive room

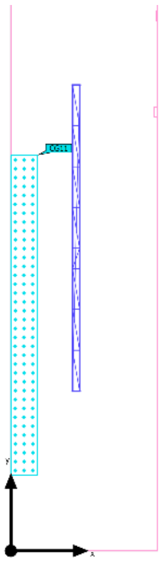
Luminaire layout plan

Manufacturer	Regiolux	P	13.8 W
Article No.	1000 14W 830 ET ws (37691114140)	$\Phi_{Luminaire}$	1007 lm
Article name	relo-UP-RDAS-O/140 LED - Diffusor opal | Opal diffuser		
Fitting	1x LED		

Luminaire layout plan

Manufacturer	Regiolux	P	35.7 W
Article No.	7000 36W 830 IP64 DALI2 vw RAL 9016 (SRT+19512026090)	$\Phi_{Luminaire}$	6396 lm
Article name	SRT-System IP64-SRGSCB/2250 LED - Geräteträger fix Central.Line.Optic | Device mount fix Central.Line.Optic		
Fitting	1x LED		

Figure 4-32ceiling downlight unit.



Calculation object:

Calculation surfaces

Properties	Ē	E_{min}	E_{max}	g_1	g_2	Index
Calculation surface 9 Perpendicular illuminance (adaptive) Height: 2.400 m	962 lx	322 lx	1318 lx	0.33	0.24	CG11
Calculation surface 9 Perpendicular illuminance Height: 2.400 m	941 lx	264 lx	1295 lx	0.28	0.20	CG11
Calculation surface 9 Vertical illuminance Rotation: 0.0°, Height: 2.400 m	375 lx	116 lx	532 lx	0.31	0.22	CG11
Calculation surface 9 Horizontal illuminance Height: 2.400 m	941 lx	263 lx	1296 lx	0.28	0.20	CG11

Figure 4-33 calculation object in archive room

Results: the space's artificial lighting design achieve all the requirement and specifications; the light is distributed well and the glare is within the right range and not annoying.

4.1.3.5 Multipurpose room:

The standard lux value in this type of spaces is 500lx with 3500 - 4000 K lighting temperature as the next calculations which is done all by the DiaLUX software shows:

Figure 4-34 3D modeling at multipurpose room

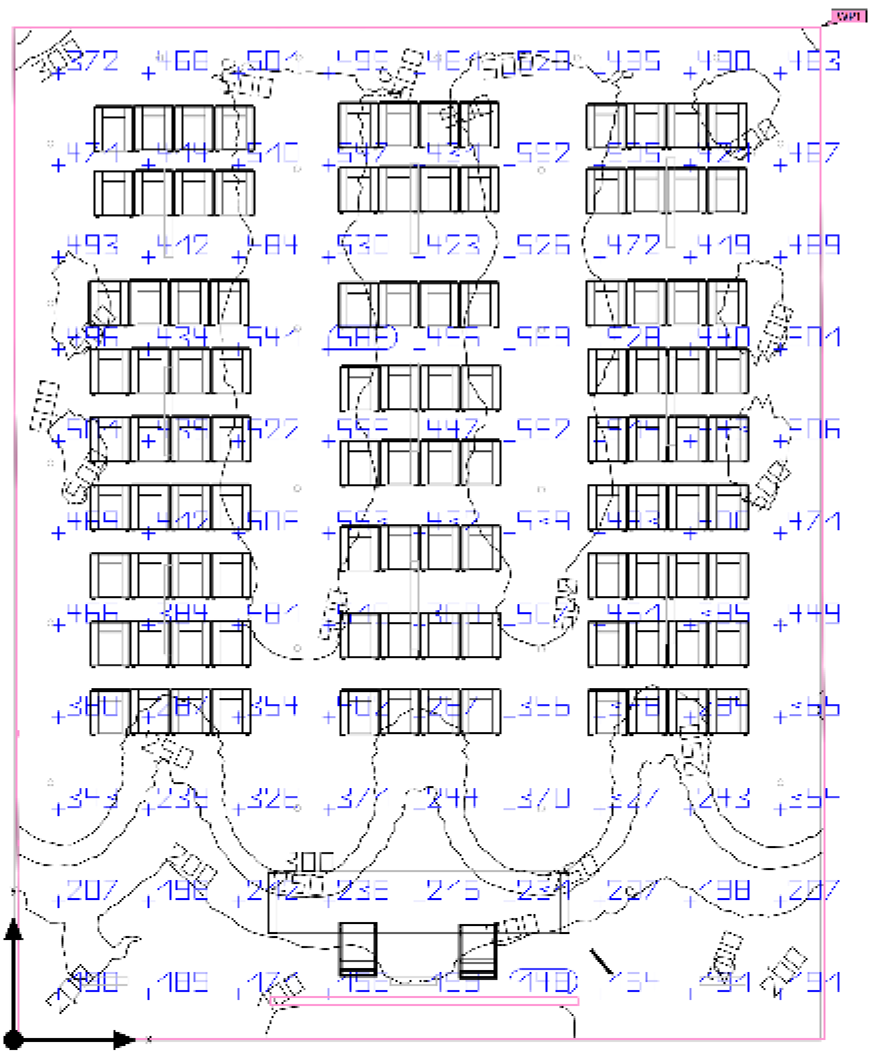


Figure 4-35lux value in multipurpose room

Results

	Symbol	Calculated	Target	Check	Index
Working plane	$\bar{E}_{perpendicular}$	642 lx	≥ 500 lx	✓	WP1

Figure 4-36 lux value is within the range.

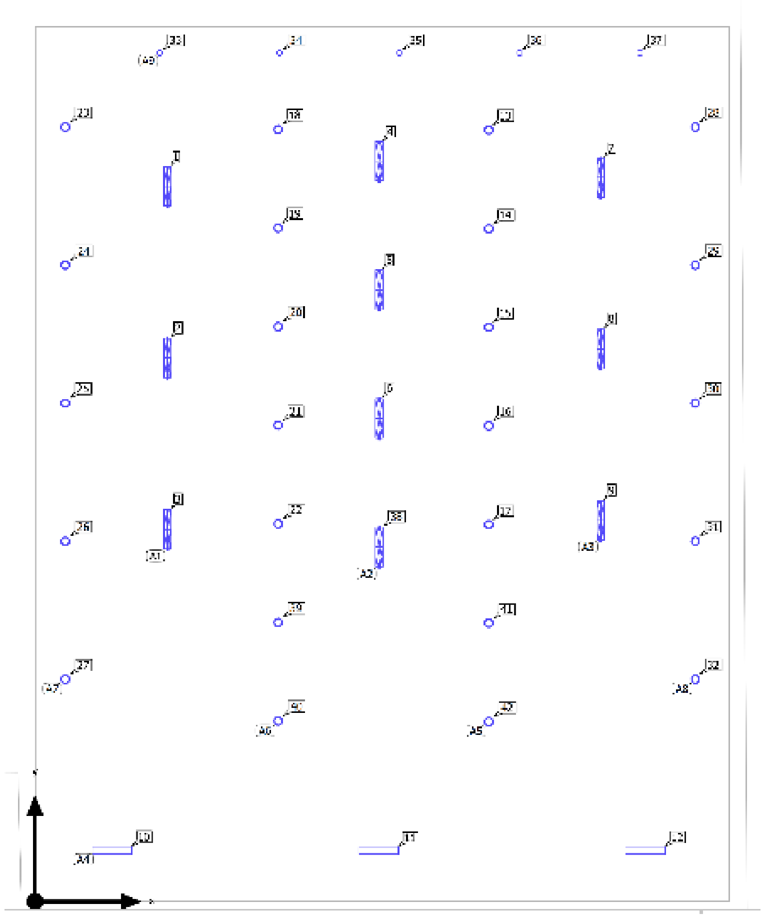
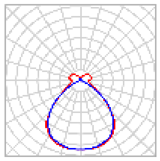
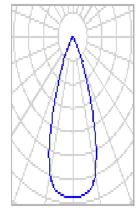


Figure 4-37Distribution lighting luminaire in manager room.

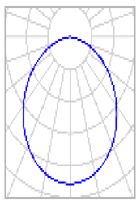
Luminaire layout plan



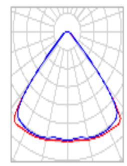
Manufacturer	3F Filippi S.p.A.	P	20.0 W
Article No.	1867	$\Phi_{Luminaire}$	1983 lm
Article name	03F 18W/940 DALI L620		
Fitting	1x LED L - 940		



Manufacturer	NVC	P	16.9 W
Article No.	70115181	$\Phi_{Luminaire}$	990 lm
Article name	NLED8213AXL 15W 55° 4000K 直下式(窄边) 赫兹酒店筒灯		
Fitting	1x Luminus LED COB		



Manufacturer	Regiolux	P	13.8 W
Article No.	1000 14W 830 ET ws (37691114140)	$\Phi_{Luminaire}$	1007 lm
Article name	relo-UP-RDAS-O/140 LED - Diffusor opal | Opal diffuser		
Fitting	1x LED		



Manufacturer	Regiolux	P	42.5 W
Article No.	6500 43W 840 ET vw RAL 9016 (41231044120)	$\Phi_{Luminaire}$	6531 lm
Article name	zatta-ZTTAB-2 LED - Individual.Lens.Optic | Individual.Lens.Optic		
Fitting	1x LED		

Figure 4-38ceiling downlight unit.

Glare check:

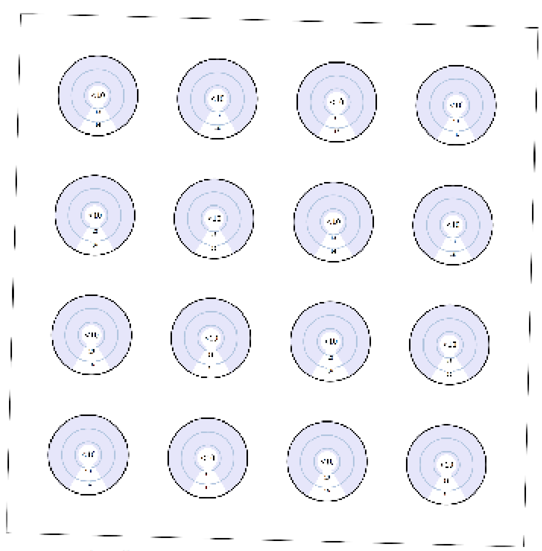


Figure 4-39Glare Rating (UGR)

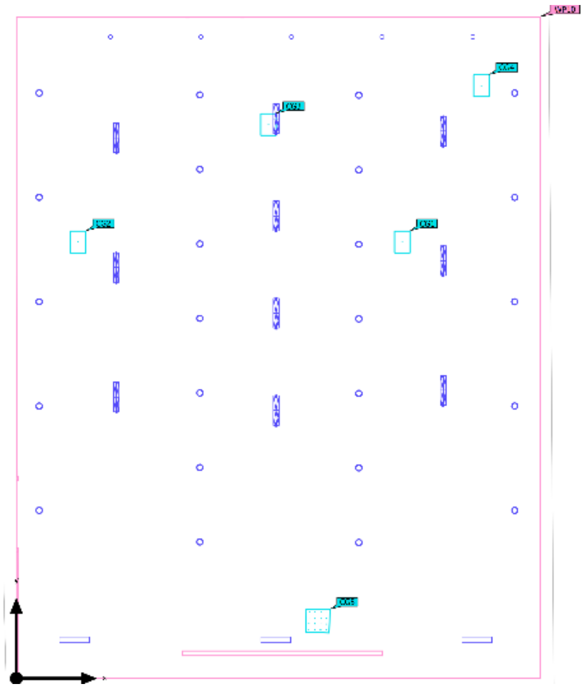


Figure 4-40Glare Rating (UGR) plan

glare 8 (UGR)

Strongest glare at	120°
max	10.6
Target	≤19.0
Viewing sector	60° - 120°
Step width	15°
Height	1.200 m
Index	CG3

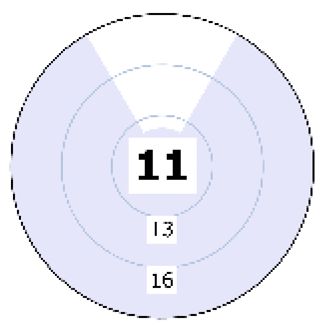


Figure 4-41Glare Rating(UGR1 ofmultipurpose room).

glare 9 (UGR)

Strongest glare at	120°
max	<10
Target	≤19.0
Viewing sector	60° - 120°
Step width	15°
Height	1.200 m
Index	CG4

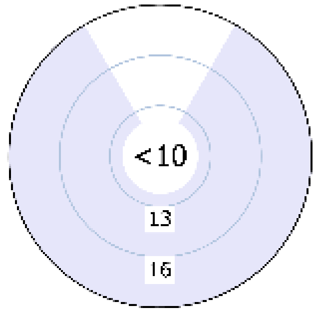


Figure 4-42Glare Rating (UGR 2 ofmultipurpose room).

glare10 (UGR)

Strongest glare at	300°
max	<10
Target	≤19.0
Viewing sector	240° - 300°
Step width	15°
Height	1.200 m
Index	CG5

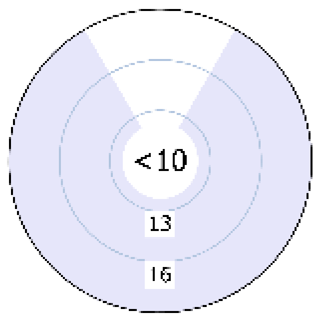


Figure 4-43Glare Rating (UGR3 ofmultipurpose room).

<u>Results:</u> the space's artificial lighting design
achieve all the requirement and specifications;
the light is distributed well and the glare is within the right range and not annoying.

4.1.3.6 Reception + waiting room

The standard lux value in this type of spaces is 300lx with 3500 - 4000 K lighting temperature as the next calculations which is done all by the DiaLUX software shows:

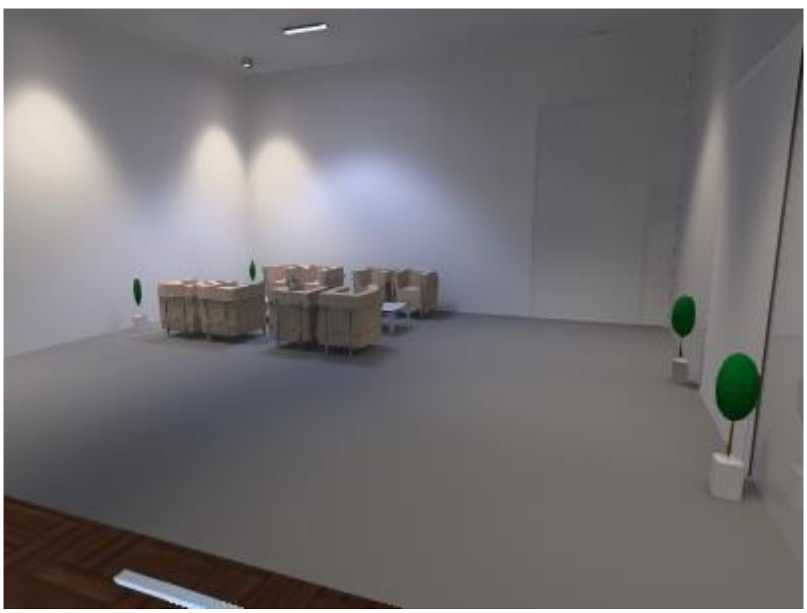


Figure 4-44 3D modeling of Reception + waiting room

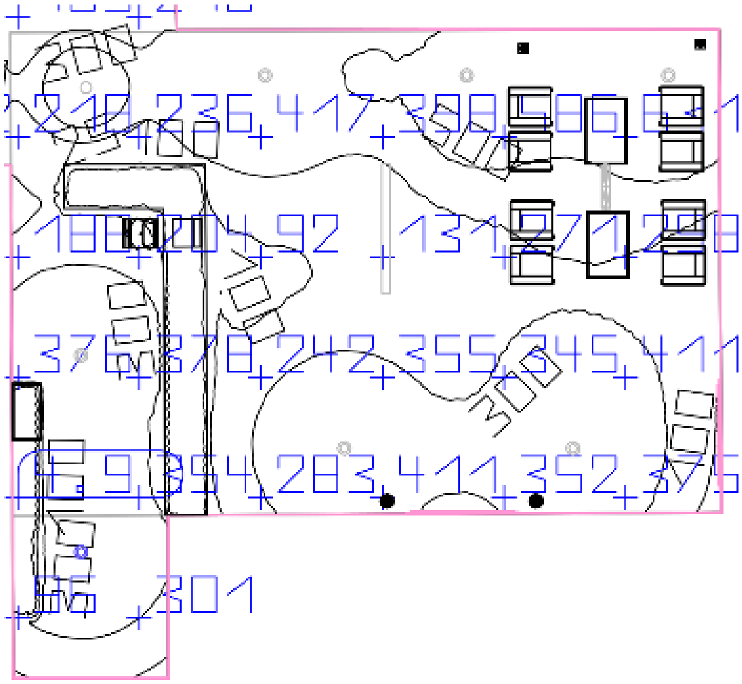


Figure 4-45lux value in multipurpose room

Results

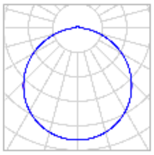
	Symbol	Calculated	Target	Check	Index
Working plane	$\bar{E}_{perpendicular}$	379 lx	≥ 300 lx	✓	WP12

Ground area	176.45 m^2
Reflection factors	Ceiling: 70.0 %, Walls: 43.8 %, Floor: 20.0 %
Maintenance factor	0.80 (fixed)

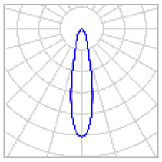
Clearance height	3.850 m
Mounting height	3.850 m – 3.976 m
Height $_{\text{Working plane}}$	0.800 m
Wall zone $_{\text{Working plane}}$	0.000 m

Figure 4-46lux value is within the range.

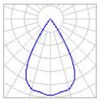
Luminaire layout plan



Manufacturer	Aura Light	P	27.0 W
Article No.	465336	$\Phi_{Luminaire}$	2780 lm
Article name	Collina CE D400 Sensor On/Off EM		
Fitting	1x LED		



Manufacturer	NVC	P	30.0 W
Article No.	70076150	$\Phi_{Luminaire}$	2300 lm
Article name	NLED621D 30W 24° 象鼻型 4000K 大功率天花射灯		
Fitting	1x LED COB		



Manufacturer	Philips	P	31.5 W
Article name	RS343B 1 xLED39S/827 VWB	$\Phi_{Luminaire}$	3783 lm
Fitting	1x		

Figure 4-47ceiling downlight unit.

Glare check :

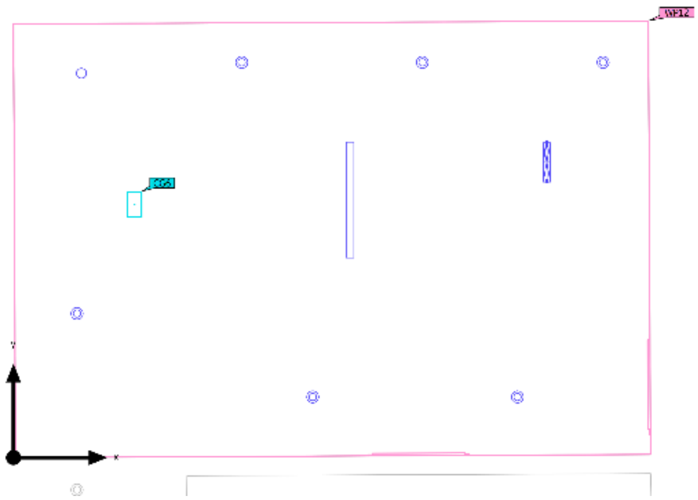


Figure 4-48Glare check at Reception + waiting room

Calculation surface 5 (UGR)

Strongest glare at	15°
max	16.9
Target	≤22.0
Viewing sector	300° - 60°
Step width	15°
Height	1.200 m
Index	CG6

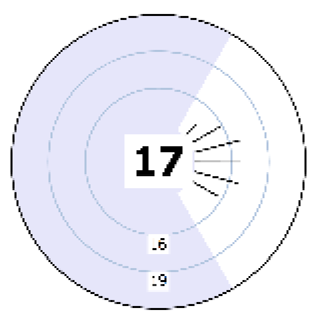


Figure 4-49Glare check at Reception + waiting room

<u>Results:</u> the space’s artificial lighting design achieve all the requirement and specifications, the light is distributed well and the glare is within the right range and not annoying.

4.1.3.7 Corridor:

The standard lux value in this type of spaces is 100lx with 3000 - 4000 K lighting temperature as the next calculations which is done all by the DiaLUX software shows:

Figure 4-50 3D modeling Corridor

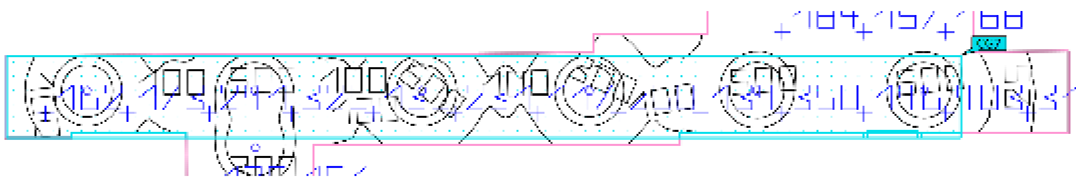
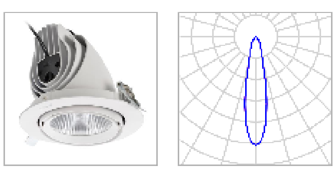


Figure 4-51 lux value in multipurpose room



Manufacturer	NVC	P	30.0 W
Article No.	70076150	$\Phi_{Luminaire}$	2300 lm
Article name	NLED621D 30W 24° 象鼻型 4000K 大功率 天花射灯		
Fitting	1x LED COB		

Figure 4-52 celling downlight

4.1.3.8 Kitchen + cafeteria

The standard lux value in this type of spaces is 500lx with 3500 - 4500 K lighting temperature as the next calculations which is done all by the DiaLUX software shows:

Figure 4-53 3D modeling at the kitchen

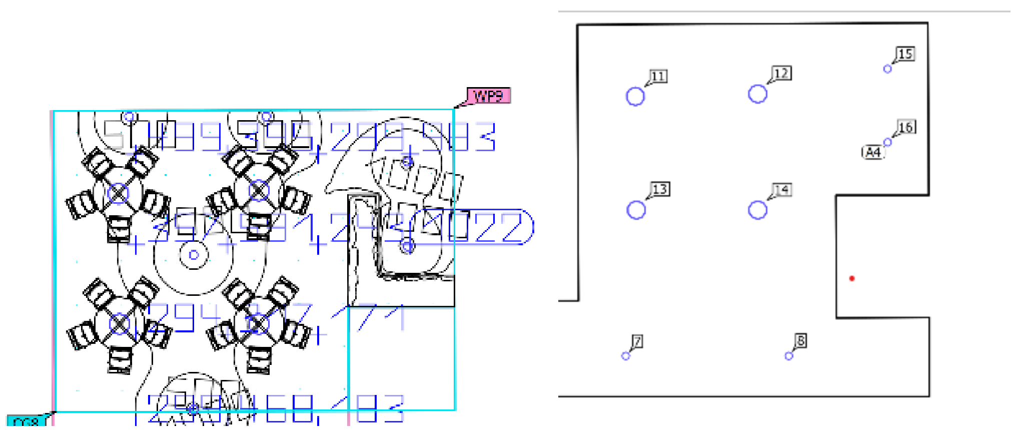
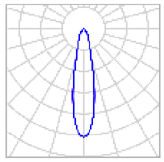


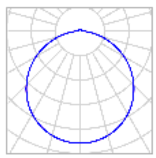
Figure 4-54 lux value at the kitchen



Manufacturer	NVC	P	30.0 W
Article No.	70076150	$\Phi_{Luminaire}$	2300 lm
Article name	NLED621D 30W 24° 象鼻型 4000K 大功率 天花射灯		
Fitting	1x LED COB		

Figure 4-55 celling downlight

Luminaire layout plan



Manufacturer	Aura Light	P	27.0 W
Article No.	465336	$\Phi_{Luminaire}$	2780 lm
Article name	Collina CE D400 Sensor On/Off EM		
Fitting	1x LED		

Figure 4-56 celling downlight

<u>Results:</u> the space's artificial lighting design achieve all the requirement and specifications; the light is distributed well and the glare is within the right range and not annoying.

4.1.3.9 Bathroom:

The standard lux value in this type of spaces is 100lx with 2700 - 3000 K lighting temperature as the next calculations which is done all by the DiaLUX software shows:

Figure 4-57 3D modeling at bathroom

Properties	Ē (Target)	E_{min}	E_{max}	g_1	g_2	Index
Workplane (bathroom) Perpendicular illuminance (adaptive) Height: 0.800 m, Wall zone: 0.000 m	188 lx (≥ 100 lx) ✓	68.0 lx	369 lx	0.36	0.18	WP35

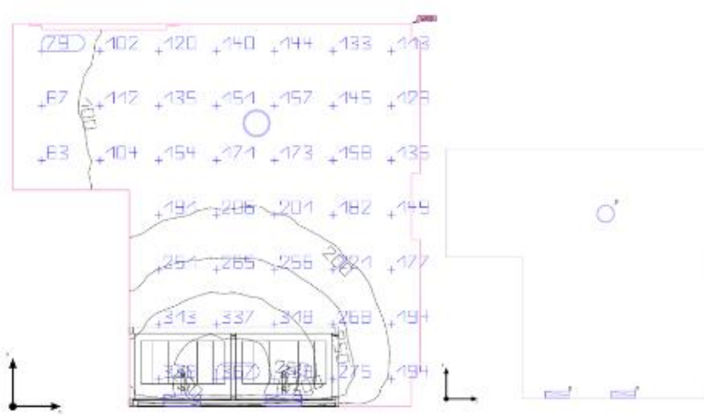
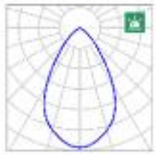
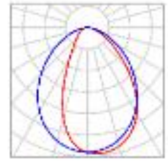


Figure 4-58 lux value is within the range



Manufacturer	Endo Lighting Corp.
Article No.	ERD2804W_RAD848F
Article name	Fixed Downlight
Fitting	1x Lamp_Disk75_4000K_SuperWide

P	6.2 W
$P_{Emergency\ lighting}$	6.2 W
$\Phi_{Luminaire}$	710 lm
$\Phi_{Emergency\ lighting}$	710 lm
ELF	100 %



Manufacturer	SIMES
Article No.	S.7201N
Article name	MINILOOK APPLIQUE SINGLE EMISSION L 220mm
Fitting	1x LED 4000K

P	13.0 W
$\Phi_{Luminaire}$	513 lm

Results: the space's artificial lighting design achieve all the requirement and specifications; the light is distributed well and the glare is within the right range and not annoying.

4.1.3.10 W.C :

The standard lux value in this type of spaces is 100lx with 2700 - 3000 K lighting temperature as the next calculations which is done all by the DiaLUX software show

Figure 4-59 3D modeling wc

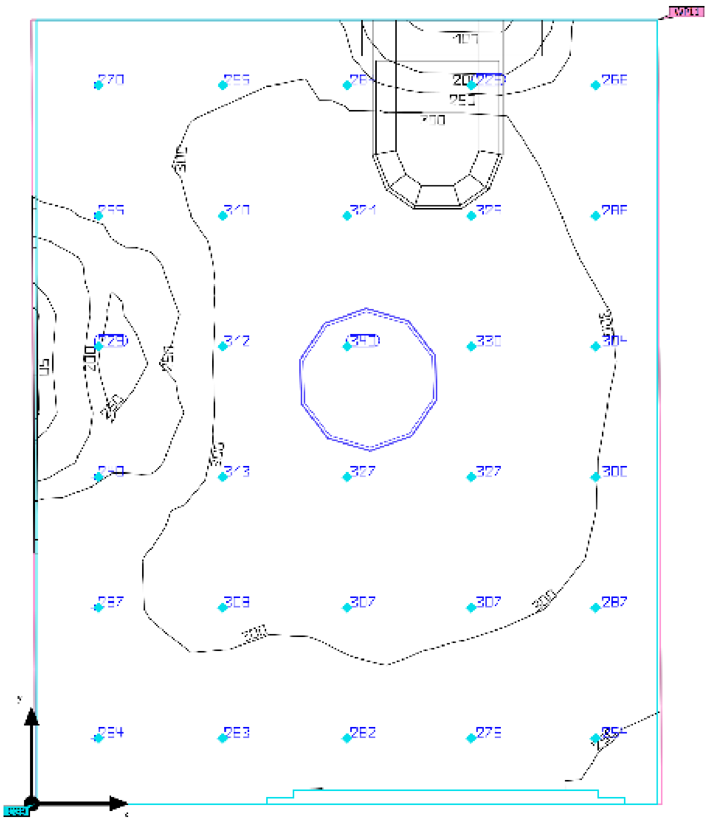


Figure 4-60 lux value at wc

Luminaire layout plan

Manufacturer	Aura Light	P	27.0 W
Article No.	465336	$\Phi_{Luminaire}$	2780 lm
Article name	Collina CE D400 Sensor On/Off EM		
Fitting	1x LED		

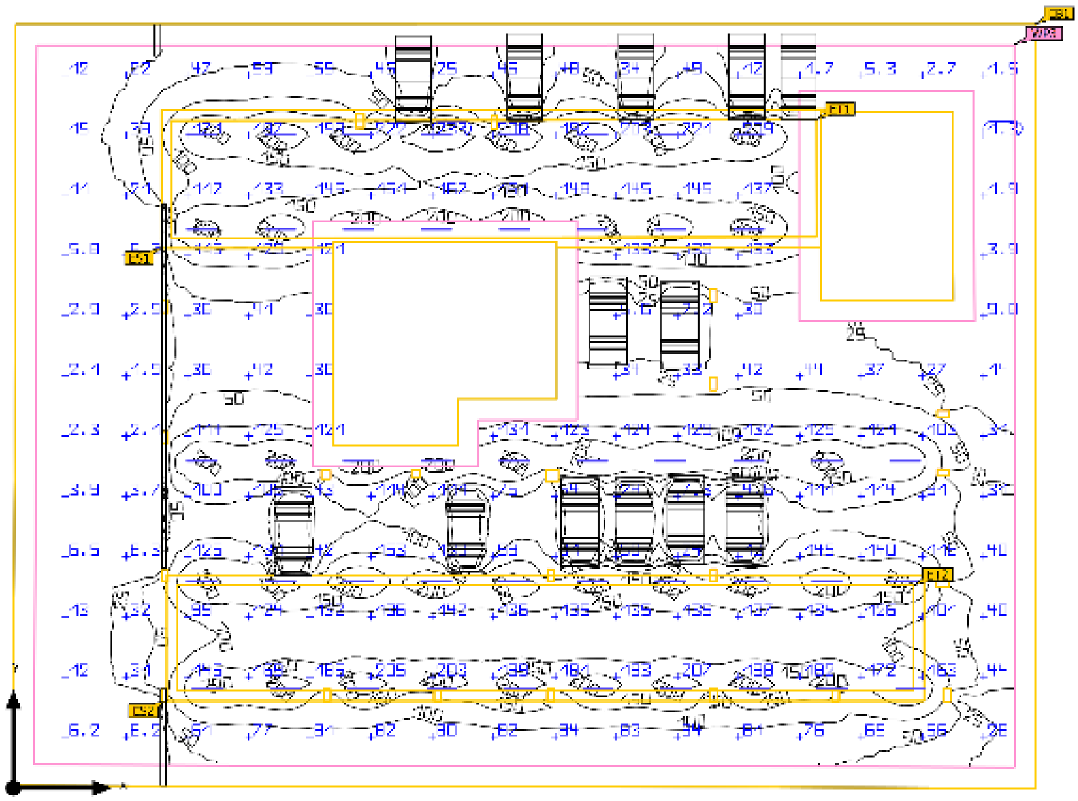
Figure 4-61 celling downlight

<u>Results:</u> the space’s artificial lighting design achieve all the requirement and specifications; the light is distributed well and the glare is within the right range and not annoying.

4.1.3.11 Garage:

The standard lux value in this type of spaces is 75lx with 4000 - 5000 K lighting temperature as the next calculations which is done all by the DiaLUX software show

Figure 4-62 3D modeling at garage



Results

	Symbol	Calculated	Target	Check	Index
Working plane	$\bar{E}_{perpendicular}$	87.6 lx	≥ 75.0 lx	✓	WP3

Figure 4-63 lux value at garage

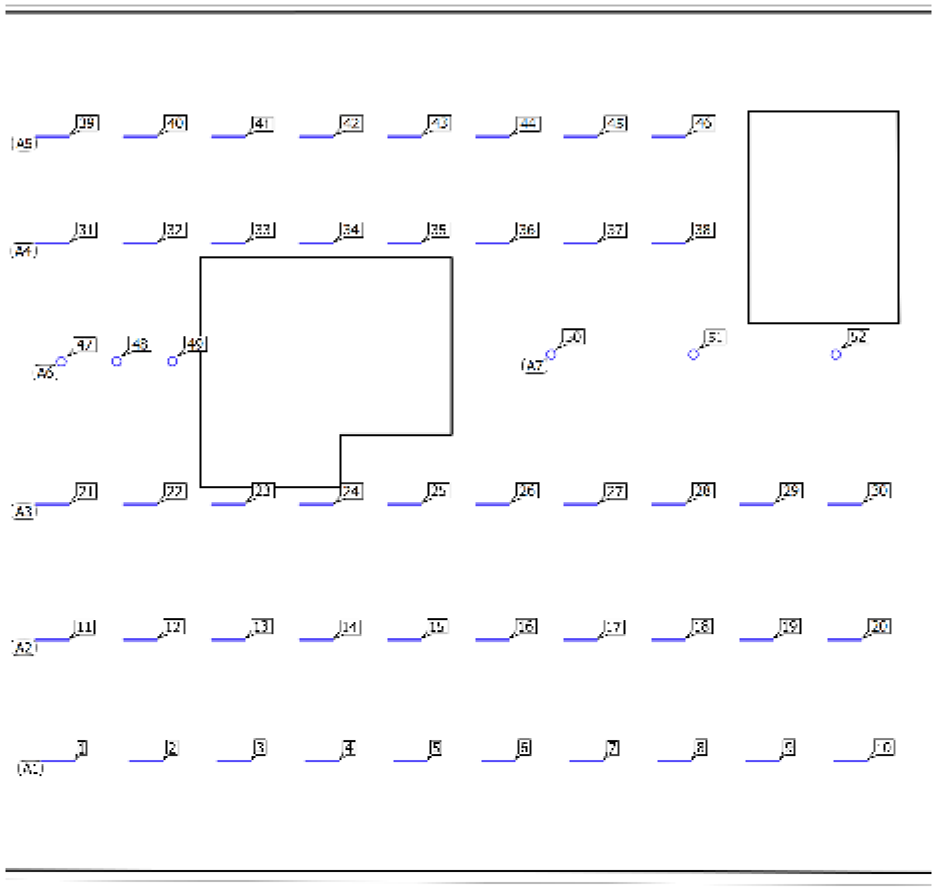
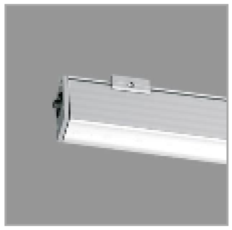
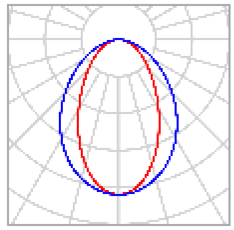


Figure 4-64 Distribution luminaire in garage

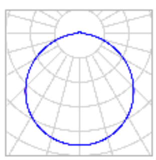
Luminaire layout plan





Manufacturer	NORKA	P	22.0 W
Article No.	5396808424-E-MC3	$\Phi_{Luminaire}$	2734 lm
Article name	BRIG m1500, 3760 lm, PMMA Transopal (impact strengthened), 840/4000 K, concentrated beam		
Fitting	1x LED		

Luminaire layout plan



Manufacturer	Aura Light	P	27.0 W
Article No.	465336	$\Phi_{Luminaire}$	2780 lm
Article name	Collina CE D400 Sensor On/Off EM		
Fitting	1x LED		

Figure 4-65 celling downlight

Results: the space's artificial lighting design achieve all the requirement and specifications; the light is distributed well and the glare is within the right range and not annoying.

4.1.3.12 library:

The standard lux value in this type of spaces is 300lx with 3500 - 4000 K lighting temperature as the next calculations which is done all by the DiaLUX software shows:

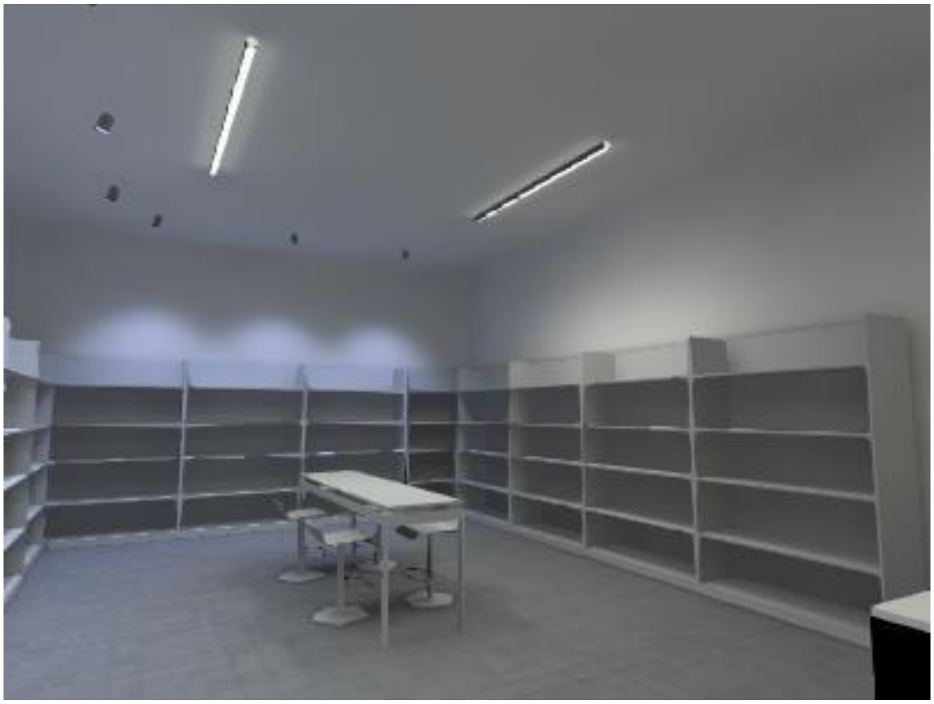


Figure 4-66 3D modeling library

Results

	Symbol	Calculated	Target	Check	Index
Working plane	$E_{perpendicular}$	326 lx	≥ 300 lx	✓	WP13

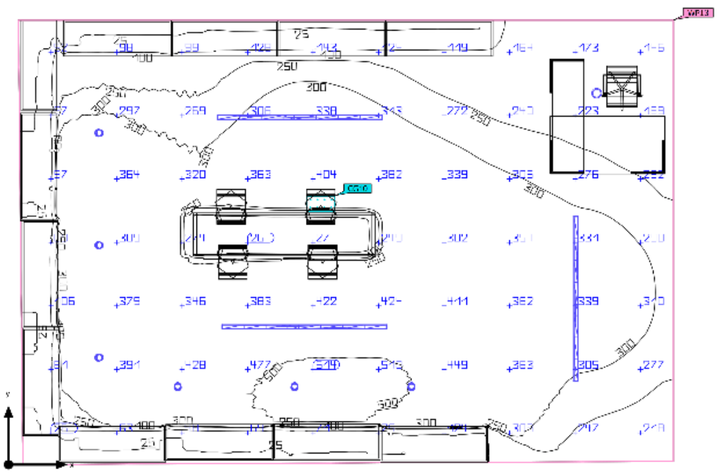


Figure 4-67 lux value at library and it within the range

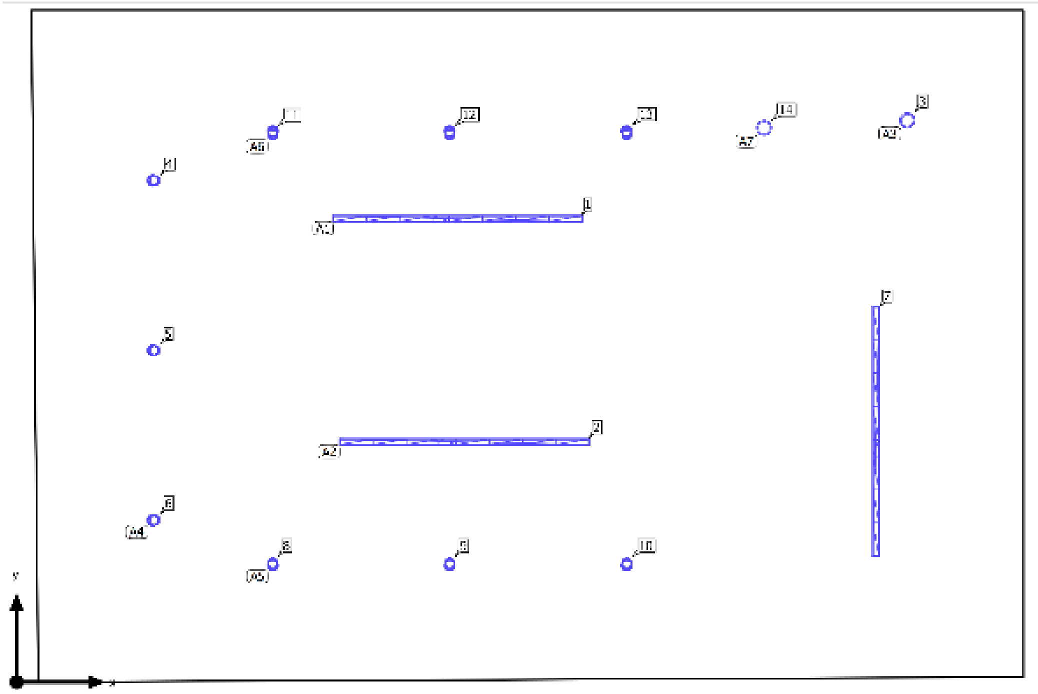
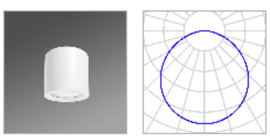
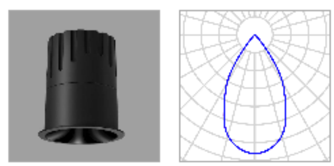


Figure 4-68 distribution luminaire in library



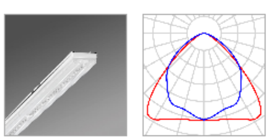
Manufacturer	Regiolux
Article No.	1000 14W 830 ET ws (37691114140)
Article name	relo-UP-RDAS-O/140 LED - Diffusor opal | Opal diffuser
Fitting	1x LED

P	13.8 W
$\Phi_{Luminaire}$	1007 lm



Manufacturer	PAK 三雄极光
Article No.	PAK565165
Article name	LED天花射灯
Fitting	1x LED/18W/4000K/60°

P	18.0 W
$\Phi_{Luminaire}$	1334 lm



Manufacturer	Regiolux
Article No.	7000 36W 830 IP64 DALI2 vw RAL 9016 (SRT+19512026090)
Article name	SRT-System IP64-SRGSCB/2250 LED - Geräteträger fix Central.Line.Optic | Device mount fix Central.Line.Optic
Fitting	1x LED

P	35.7 W
$\Phi_{Luminaire}$	6396 lm

Figure 4-69 celling downlight

Glare check:

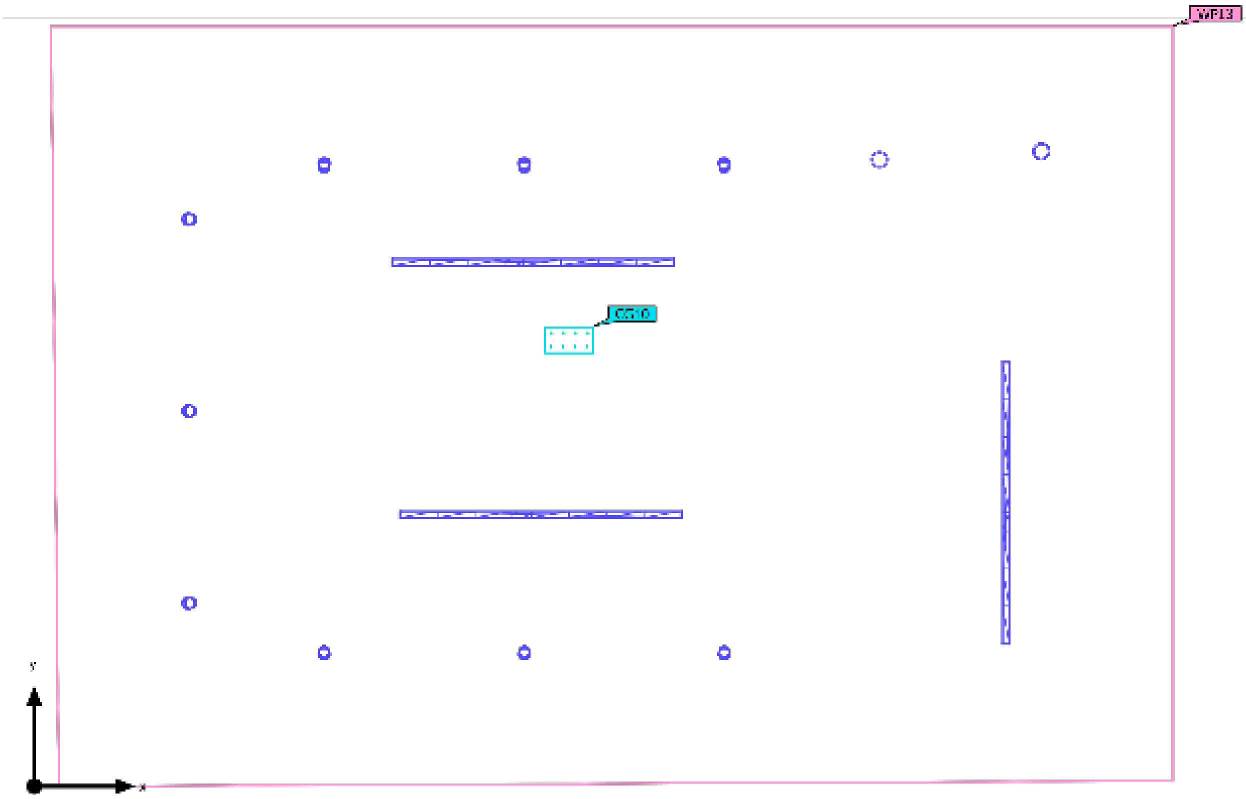


Figure 4-70 glare check at library

Working planes

Properties	Ē (Target)
Working plane (library) Perpendicular illuminance (adaptive) Height: 0.800 m, Wall zone: 0.000 m	326 lx (≥ 300 lx) ✓

glare (UGR)

Strongest glare at	-33°
max	<10
Target	≤19.0
Viewing sector	120° - 240°
Step width	15°
Height	1.200 m
Index	CG10

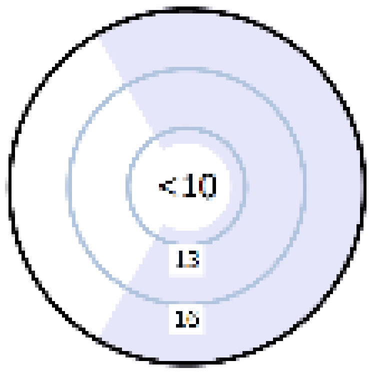


Figure 4-71 glare check in library and it within the range

<u>Results:</u> the space's artificial lighting design achieve all the requirement and specifications; the light is distributed well and the glare is within the right range and not annoying.

4.1.4 Summary & conclusion:

One space was designed from each category and the requirements were indicated in each of them, whereby the lighting in each of the spaces was designed according to the correct standards and principles. The selected lighting units was distributed with great care in order for the results to be as accurate as possible.

The artificial lighting units were distributed as perfectly as possible in order to ensure that the light reaches all areas of the room and not leave any dark areas.

The names, pictures and the specifications of the lighting units that were used in every space were added, along with some results that show that the design meets the correct and required specifications, in addition to plans for the locations of the lighting units and contour diagrams for the lux in each space that was designed.

The results were excellent, as all the spaces were Conform to the correct conditions, requirements and specifications.

4.2 Power design:

4.2.1 Introduction:

It is in this part of the project that the electrical wiring of the building is designed. The necessary exits and switches were distributed and the breakers board designed for the building. Since all of the electrical tools in the building are powered by the primary energy feeder to the building, electric energy is one of the most essential commodities in life and has a significant impact on our everyday lives. To meet the building's electrical energy needs, the primary cable must be carefully constructed.

4.2.2 Lighting power calculations: -

4.2.2.1 Sample of calculation:

the circuit breaker load is usually 10 amperes, for lighting so to find the maximum load can 10- ampere circuit breaker has as the following calculations:

Icb = 1.2 * I lode

10 amperes = 1.2 * I lode

I lode =8.333 ampere

To find how many circuit breakers we need in each space on all floors will be taken as a sample of calculation as the following calculations:

In multipurpose hall we have power equal 688

Power (Watt) = I load (Ampere) * Volt (V) * Power factor

688 watt = I load * 220 * 0.9

I load = 3.44 ampere.

Number of circuit breaker for fashion store = 3.44/8.33 =1 circuit breaker

4.2.2.2 Number of lighting circuit breaker for each space in the building.

Table 38 Number of lighting circuit breaker for ground floor

Ground Floor Lighting							
Space	Type of luminaire	Luminaire Power (W)	No. of luminaires	power	total power	I load	N0 0f CB
multipurpose hall	downlight	20	10	200	688	3.474747	1
	downlight	42.5	3	127.5			
	track light	13.8	20	276			
	track light	16.9	5	84.5			
Reception + waiting room	downlight	27	1	27	296	1.494949	1
	downlight	30	2	60			
	downlight	31.5	6	189			
	downlight	20	1	20			
Special waiting room	downlight	20	2	40	40	0.20202	1
escort room	downlight	30	3	90	90	0.454545	1
surveillance room	downlight	30	2	60	60	0.30303	1
drivers' room	downlight	31.5	2	63	103	0.520202	1
	downlight	20	2	40			
corridor	downlight	30	10	300	300	1.515152	1
cafeteria	downlight	27	4	108	288	1.454545	1
	downlight	30	6	180			
library	track light	18	9	162	296.7	1.498485	1
	downlight	35.7	3	107.1			
	downlight	13.8	2	27.6			
Bathroom	downlight	13	6	78	115.2	0.581818	1
		6.2	6	37.2			
small kitchen	downlight	30	2	60	60	0.30303	1

Table 39Number of lighting circuit breaker for first floor

First Floor Lighting							
Space	Type of luminaire	Luminaire Power (W)	No. of luminaires	power	total power	I load	N0 0f CB
15 employees room	downlight	13.8	4	55.2	310.2	1.566667	1
	downlight	42.5	6	255			
break room	downlight	42.5	3	127.5	210.3	1.062121	1
	downlight	13.8	6	82.8			
5 employees room	downlight	42.5	5	212.5	212.5	1.073232	1
6 employees room	downlight	42.5	5	212.5	212.5	1.073232	1
8 employees room	downlight	42.5	8	340	340	1.717172	1
meeting room	downlight	35.7	3	107.1	192.1	0.970202	1
	downlight	42.5	2	85			
manager 1	downlight	30	10	300	300	1.515152	1
manager 2	downlight	27	4	108	288	1.454545	1
	downlight	30	6	180			
3 room file	downlight	35.7	1	35.7	107.1	0.540909	1
	downlight	35.7	1	35.7			
	downlight	35.7	1	35.7			
Bathroom	downlight	13	6	78	115.2	0.581818	1
	downlight	6.2	6	37.2			
small kitchen	downlight	30	2	60	60	0.30303	1
cooridor	downlight	13.8	18	248.4	248.4	1.254545	

Table 40 Number of lighting circuit breaker for second floor

second Floor Lighting							
Space	Type of luminaire	Luminaire Power (W)	No. of luminaires	power	total power	I load	N0 0f CB
	downlight	42.5	4	170	170	0.858586	1
2 employees	downlight	42.5	2	85	98.8	0.49899	1
	downlight	13.8	1	13.8			
2 employees	downlight	42.5	2	85	112.6	0.568687	1
	downlight	13.8	2	27.6			
Deputy General	downlight	42.5	5	212.5	212.5	1.073232	1
Deputy General 01	downlight	42.5	5	212.5	212.5	1.073232	1
Deputy General 02	downlight	42.5	2	85	85	0.429293	1
Deputy General 03	downlight	35.7	2	71.4	71.4	0.360606	1
Deputy General 04	downlight	30	2	60	60	0.30303	1
Deputy General 05	downlight	27	5	135	135	0.681818	1
Deputy General 06	downlight	35.7	5	178.5	178.5	0.901515	1
Deputy General 07	downlight	42.5	3	127.5	127.5	0.643939	1
break room	downlight	42.5	3	127.5	127.5	0.643939	1
	downlight	13.8	6	82.8	82.8	0.418182	1
cooridor	downlight	13.8	18	248.4	248.4	1.254545	1
Bathroom	downlight	13	6	78	115.2	0.581818	1
	downlight	6.2	6	37.2			

Table 41Number of lighting circuit breaker for third floor

third Floor Lighting							
Space	Type of luminaire	Luminaire Power (W)	No. of luminaires	pow er	total power	I load	N0 0f CB
room service	downlight	42.5	3	127.5	127.5	0.643939	1
employees	downlight	42.5	4	170	197.6	0.99798	1
	downlight	13.8	2	27.6			
employees	downlight	42.5	4	170	197.6	0.99798	1
	downlight	13.8	2	27.6			
Deputy General	downlight	42.5	4	170	170	0.858586	1
Deputy General 01	downlight	42.5	4	170	170	0.858586	1
employees	downlight	42.5	5	212.5	212.5	1.073232	1
kafiteria	downlight	35.7	5	178.5	178.5	0.901515	1
IT department	downlight	30	4	120	120	0.606061	1
employees	downlight	27	2	54	54	0.272727	1
data center	downlight	35.7	4	142.8	142.8	0.721212	1
laboratory	downlight	42.5	4	170	170	0.858586	1
cooridor	downlight	13.8	18	248.4	248.4	1.254545	1
meeting room	downlight	35.7	3	107.1	192.1	0.970202	
	downlight	42.5	2	85		0.970202	
Bathroom	downlight	13	6	78	115.2	0.581818	1
	downlight	6.2	6	37.2			

Table 42Number of lighting circuit breaker for sixth floor

sixth Floor Lighting							
Space	Type of luminaire	Luminaire Power (W)	No. of luminaires	power	total power	I load	N0 0f CB
employees room	downlight	42.5	2	85	112.6	0.568687	1
	downlight	13.8	2	27.6			
employees room	downlight	42.5	2	85	98.8	0.49899	1
	downlight	13.8	1	13.8			
employees room	downlight	42.5	2	85	112.6	0.568687	1
	downlight	13.8	2	27.6			
employees room	downlight	42.5	2	85	112.6	0.568687	1
	downlight	13.8	2	27.6			
secretary room	downlight	42.5	2	85	85	0.429293	1
secretary room	downlight	42.5	2	85	85	0.429293	1
meeting room	downlight	35.7	3	107.1	192.1	0.970202	1
	downlight	42.5	2	85		0.970202	1
main office	downlight	13.8	6	82.8	82.8	0.418182	1
	downlight	42.5	2	85	85	0.429293	1
main office	downlight	13.8	6	82.8	82.8	0.418182	1
	downlight	42.5	2	85	85	0.429293	1
director general	downlight	42.5	2	85	85	0.429293	1
director general	downlight	35.7	2	107.1	192.1	0.970202	1
corridor	downlight	13.8	18	248.4	248.4	1.254545	1
Bathroom	downlight	13	6	78	115.2	0.581818	1
	downlight	6.2	6	37.2			

Table 43Number of lighting circuit breaker for forth floor

forth Floor Lighting							
Space	Type of luminaire	Luminaire Power (W)	No. of luminaires	power	total power	I load	N0 0f CB
employees room	downlight	42.5	2	85	112.6	0.568687	1
	downlight	13.8	2	27.6			
employees room	downlight	42.5	2	85	112.6	0.568687	1
	downlight	13.8	2	27.6			
employees room	downlight	42.5	2	85	112.6	0.568687	1
	downlight	13.8	2	27.6			
employees room	downlight	42.5	2	85	112.6	0.568687	1
	downlight	13.8	2	27.6			
employees	downlight	42.5	2	85	85	0.429293	1
employees	downlight	42.5	2	85	85	0.429293	1
employees	downlight	42.5	2	85	85	0.429293	1
employees	downlight	42.5	2	85	85	0.429293	1
employees	downlight	42.5	2	85	85	0.429293	1
employees	downlight	42.5	2	85	85	0.429293	1
employees	downlight	42.5	2	85	85	0.429293	1
employees	downlight	42.5	2	85	85	0.429293	1
employees	downlight	42.5	2	85	85	0.429293	1
Registration room	downlight	35.7	2	107.1	192.1	0.970202	1
cooridor	downlight	13.8	18	248.4	248.4	1.254545	1
Bathroom	downlight	13	6	78	115.2	0.581818	1
	downlight	6.2	6	37.2			

Table 44Number of lighting circuit breaker for fifth floor

fifth Floor Lighting							
Space	Type of luminaire	Luminaire Power (W)	No. of luminaires	power	total power	I load	N0 0f CB
employees room	downlight	42.5	2	85	112.6	0.568687	1
	downlight	13.8	2	27.6			
employees room	downlight	42.5	2	85	112.6	0.568687	1
	downlight	13.8	2	27.6			
employees room	downlight	42.5	2	85	112.6	0.568687	1
	downlight	13.8	2	27.6			
employees room	downlight	42.5	2	85	112.6	0.568687	1
	downlight	13.8	2	27.6			
employees	downlight	42.5	2	85	85	0.429293	1
employees	downlight	42.5	2	85	85	0.429293	1
employees	downlight	42.5	2	85	85	0.429293	1
employees	downlight	42.5	2	85	85	0.429293	1
employees	downlight	42.5	2	85	85	0.429293	1
employees	downlight	42.5	2	85	85	0.429293	1
employees	downlight	42.5	2	85	85	0.429293	1
employees	downlight	42.5	2	85	85	0.429293	1
employees	downlight	42.5	2	85	85	0.429293	1
Registration room	downlight	35.7	2	107.1	192.1	0.970202	1
corridor	downlight	13.8	18	248.4	248.4	1.254545	1
Bathroom	downlight	13	6	78	115.2	0.581818	1
	downlight	6.2	6	37.2			

Cable size:

To find the electricity cable diameter for lighting switches we used the following formula:

I cable = 1.2 * I circuit breaker ➔ 1.2 * 10 = 12 Ampere

According the following table, I cable = 1.5mm2 .

Table 45 cable cross-sectional area due to current

Nominal cross sectional Area (mm2)	Current (ampere)
1	11
1.5	13
2.5	18
4	24
6	31
10	42
16	56
25	73
36	90
50	131

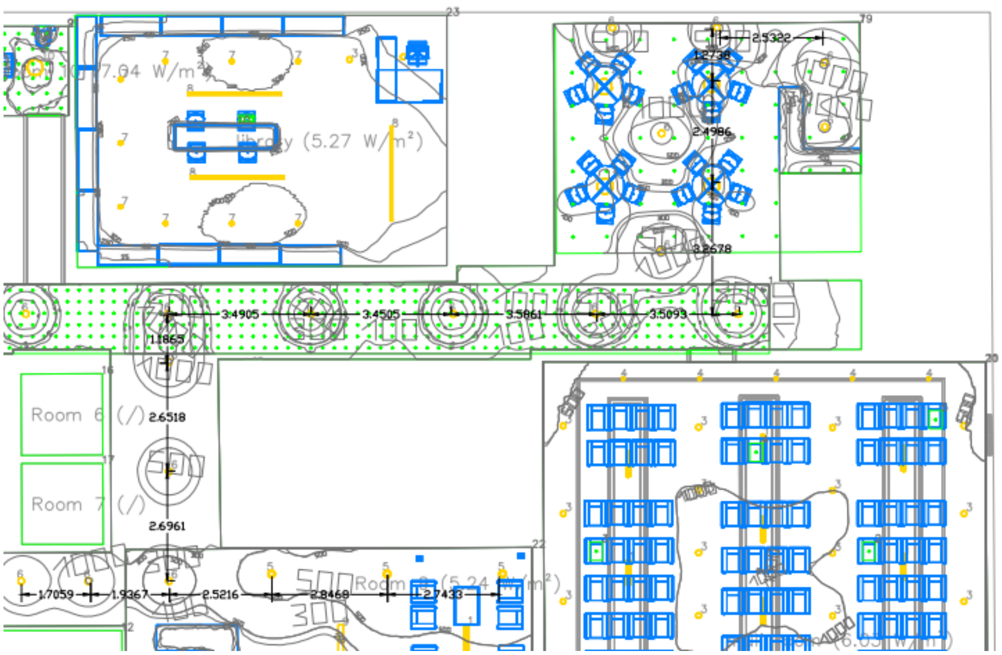
4.2.2.3 Voltage drop

We took the furthest room from the electrical panel to calculate voltage drop and we used the following formula:

V drop = I load * R.

V drop = I * (δ * 2L /A).

The maximum allowable voltage drops = 5% * 220V = 11Volt



As shown from the previous figure the farthest distance between lighting unit and distribution board is approximately 33m, therefore, voltage drop check can be calculated from the following formula:

V drop = I load * R

R= $L*\frac{\mathcal{P}}{\mathrm{A}}$,

Where:

L: max length between lighting unit and electrical distribution bored.

A: Wire cross-sectional area.

$\mathcal{P}$: Copper resistivity =1.7*10^{-8}.

R: electrical wire resistance.

The maximum allowable voltage drops = 5% * 220V = 11Volt.

V drop =$\frac{\mathcal{P}*2\mathrm{L}}{A}$ * I= $\frac{1.7*10^{-8}*2*33}{1.5*10^{-6}}$ * 3.47=2.618 <11 so it is ok.

4.2.3 Sockets design:

Special load

Assumption: -

We designed special load sockets for fan coil and split unit.

Special lode for HVAC design:

1. Fan coil with diffusers: we put fan coil with diffusers in ground, first, second, and third floors Because we have a large areas and a lot of people flock come to this place.

2. Split unit: we put split unit in offices.

The power of fan coil is 4500 W and the power of split unit is 500W.

Power = $I*V*powerfacto$

4500= I * 220 * .9 I = 22.7 Amp.

I design = I load * 1.15^2

I design = 22.7 * 1.152 = 30 Amp.

Cross wire 6 mm2 .

R= $L*\frac{\mathcal{P}}{\mathrm{A}}$ = $\frac{1.7*\ 10^{-8}\ *10}{10*10\hat{}-6}$= .03 Ω.

Drop voltage = $I*\frac{\mathrm{R}}{\mathrm{V}}$ = 30*$\frac{0.03}{220}$ =0.4 <11 V so it is ok .

For split unit:

Power = $I{*}V{*}powerfacto$

500 = I * 220 * .9 I = 2.52 Amp.

I design = I load * 1.15^2

I design = 22.7 * 1.152 = 3.34 Amp.

Cross wire 1 mm^2 .

R= $L{*}\frac{\mathcal{P}}{\mathrm{A}}$ = $\frac{1.7{*}\ 10^{-8}\ {*}9}{10{*}10\hat{}{-6}}$= 0.153 Ω.

Drop voltage = $I{*}\frac{\mathrm{R}}{\mathrm{V}}$ = 3.34$*\frac{0.153}{220}$ =0.2 <11 V so it is ok .

Normal load:

Normal load has a 2-ampere lode which means in other words 400 watt of power, so the circuit breaker load for normal power can be loaded 5 sockets.

Power = $I{*}V{*}powerfacto$

400 = I * 220 * .9, I = 2.02 Amp

I design = I load * 1.15^2

I design = 2.02 *1.15^2= 2.67 Amp.

Cross wire 1 mm^2

R= $L{*}\frac{\mathcal{P}}{\mathrm{A}}$ = $\frac{1.7{*}\ 10^{-8}\ {*}9}{10{*}10\hat{}{-6}}$= 0.153 Ω.

Drop voltage = $I{*}\frac{\mathrm{R}}{\mathrm{V}}$ = 2.67$*\frac{0.153}{220}$ =0.18 <11 V so it is ok .

This calculation are the same for all floors.

4.2.4 circuit breaker:

A circuit breaker is an electrical safety device designed to protect an electrical circuit from damage caused by an overcurrent or short circuit.

Note: for each special load socket has one line in the distribution board

Figure 4-72 circuit breaker

4.2.5 distribution board:

A distribution board, also referred to as a panel board, breaker panel, electric panel, DB board, or DB box, is a part of an electricity supply system that separates a main electrical circuit into smaller circuits while providing a protective fuse or circuit breaker for each circuit in a single enclosure. A primary switch is typically also included, and more recently, one or more residual-current devices (RCDs) or residual current breakers with overcurrent safety (RCBOs). n.d. (Distribution Commission)

Figure 4-73distribution board

4.2.6 Demand factor:

The calculation:

The total power load = (special load * demand factor) + (normal load*demand factor) + (lighting load *demand factor).

Table 46:Demand factor.

Demand factor	
normal	0.3
special	1
lighting	0.8

Table 47Total power lighting.

floors	lighting power
parking 1	1400
parking 2	1400
parking 3	1400
Ground floor	2337
First floor	2596
Second floor	1922.5
Third floor	2181
Fourth floor	1770.7
fifth floor	1692.4
sixth floor	1692.4

Total power =18392

Sample of calculation:

- The power of a branch for lighting:

The power of a branch of light = # of lamps * power of 1 lamp

Total power for lighting = total power * demand factor = 18392 * .8 = 14713.6 w

- The power of a branch for normal lode:

Total number of normal power branch circuits = 100.

each normal power branch circuit has total power = Power of each socket * NO. of sockets connected with branch * Demand Factor.

Total Power = 400 * 5 = 2000 Watt,

hence total power = 2000 * 100* 0.3=60000Watt.

Table 48 Total power for special lode

special lode	total power
special lode for fan coil	108000
special lode for split unit	25000
total	133000

The power of a branch for special lode:

The Each special power for branch circuits has total power = Power of each socket * NO. of sockets connected with branch.

The total power load = (special load * demand factor) + (normal load*demand factor) + (lighting load *demand factor) = 60000+14713.6+133000=207713.6 w

Total current = ((Total power/ (√3 ×power factor)) = (207713.6/ (√3 ×220×.9)) = 605.6 Amp.

Total current for the circuit breaker = 1.15 × I load = 1.15*605.6=696.5 Amb. Hence, the circuit breaker needed was 1000 Amb.

The total current in the cable = 1.15 * I C.B = 1.15*696.5 = 801 Amb. The cross-sectional area was needed for cable = 3 * 240 mm2

4.3 HVAC Design

HVAC system calculations:

Table 49The total Cooling and Heating Load in the building

The total Cooling and Heating Load in the building	
The Design Cooling Load in the building (KW)	237
The Design Heating Load in the building (KW)	192

The Outdoor Unit:

Various outdoor units for the VRF system are shown in the following Daikin catalog:

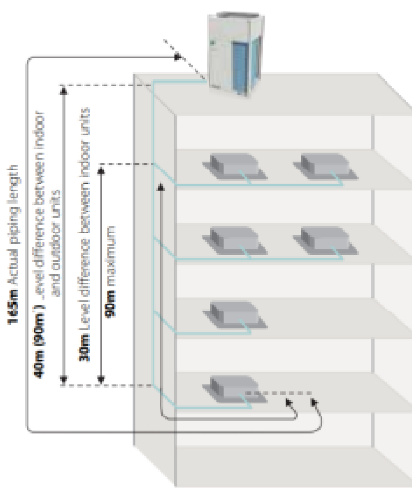
Table 50The Types of the VRF Outdoor Units(Your Business Our, 2022)

OUTDOOR SYSTEM					RYYQ38T	RXYQ38T	RYYQ40T	RXYQ40T	RYYQ42T	RXYQ42T	RYYQ44T	RXYQ44T	RYYQ46T	RXYQ46T	RYYQ48T	RXYQ48T	RYYQ50T	RXYQ50T	RYYQ52T	RXYQ52T	RYYQ54T	RXYQ54T
System	Outdoor unit module 1				RYMQ8T	RXYQ8T	RYMQ10T	RXYQ10T	RYMQ10T	RXYQ12T	RYMQ12T	RXYQ12T	RYMQ14T	RXYQ14T	RYMQ16T	RXYQ16T	RYMQ16T	RXYQ16T	RYMQ16T	RXYQ16T	RYMQ18T	RXYQ18T
	Outdoor unit module 2				RYMQ10T	RXYQ10T	RYMQ12T	RXYQ12T	RYMQ16T	RXYQ16T	RYMQ16T	RXYQ16T	RYMQ16T	RXYQ16T	RYMQ16T	RXYQ16T	RYMQ16T	RXYQ16T	RYMQ18T	RXYQ18T	RYMQ18T	RXYQ18T
	Outdoor unit module 3				RYMQ20T	RXYQ20T	RYMQ18T	RXYQ18T	RYMQ16T	RXYQ16T	RYMQ16T	RXYQ16T	RYMQ16T	RXYQ16T	RYMQ16T	RXYQ16T	RYMQ18T	RXYQ18T	RYMQ18T	RXYQ18T	RYMQ18T	RXYQ18T
Capacity range				HP	38		40		42		44		46		48		50		52		54	
Cooling capacity	Nom.			kW	106.0		112.0		118.0		124.0		130.0		135.0		140.0		145.0		150.0	
Heating capacity	Nom.			kW	120.0		125.0		132.0		138.0		145.0		150.0		156.0		162.0		168.0	
Power input - 50Hz	Cooling	Nom.		kW	31.0				33.3		35.0		37.0		39.0		40.7		42.4		44.1	
	Heating	Nom.		kW	29.9		30.9		33.0		34.7		36.8		38.4		40.0		41.6		43.2	
EER					3.42		3.61		3.54				3.51		3.46		3.44		3.42		3.40	
ESEER					6.36[1]		6.74[1]		6.65[1]		6.62[1]		6.60[1]		6.50[1]		6.46[1]		6.42[1]		6.38[1]	
COP					4.01		4.05		4.00		3.98		3.94		3.91		3.90		3.89		3.89	
Maximum number of connectable indoor units					64[2]																	
Piping connections	Liquid	OD		mm	19.1																	
	Gas	OD		mm	41.3																	
	Piping length	OU - IU	Max.	m	165[1]																	
	Total piping length	System	Actual	m	1,000[3]																	
	Level difference	OU - IU		m	90[3] Outdoor unit in highest position / 90[3] Indoor unit in highest position																	
Current - 50Hz	Maximum fuse amps (MFA)			A	100										125							

[RYYQ42T], a 118-kW outdoor unit, was chosen.

The Design Cooling Load = 237 KW, so the number of outdoor units needed = 237/106 = 2 Outdoor Units.

As shown in the accompanying Figure, the maximum permissible distance among outdoor and interior units is 90 meters, which is highly practical in high buildings.



Split unit:

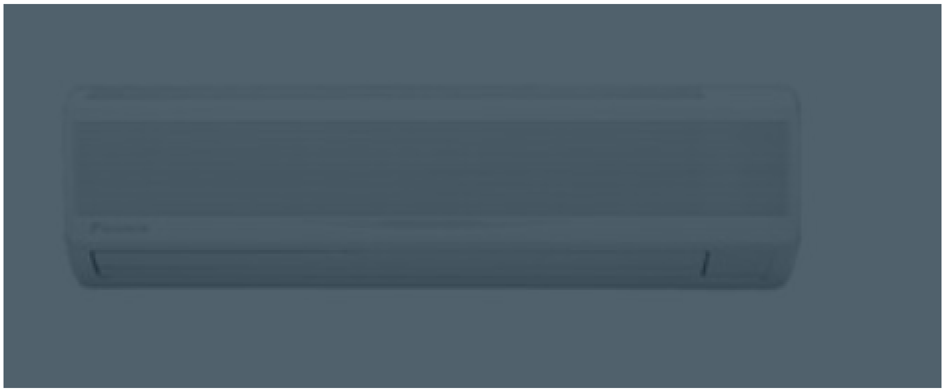
Table 51The needed number of split units and their types for Offices.

Block	Zone	Design Flow Rate (L/s)	Total Cooling Load (kW)	Used Hvac System	HvacSysytem Cooling Capacity (W)	Required Number of Split Indoor Units
First floor	Office	89.4	1.07	Split UnitType(FXAQ32P)	2.2	1
First floor	Manegar	96.7	1.16	Split UnitType(FXAQ32P)	2.2	1
First floor	Meeting	197.8	2.56	Split UnitType(FXAQ32P)	3.6	1
First floor	Employer	306.1	3.74	Split UnitType(FXAQ50P)	1.7	2
First floor	EmployerZ1	140.1	1.68	Split UnitType(FXAQ32P)	1.7	1
First floor	ManegarZ1	61.6	0.74	Split UnitType(FXAQ32P)	3.6	1
First floor	ManegarZ2	56.4	0.68	Split UnitType(FXAQ32P)	3.6	1
First floor	ManegarZ3	55.3	0.66	Split UnitType(FXAQ32P)	3.6	1
First floor	EmployerZ2	175.9	2.11	Split UnitType(FXAQ32P)	3.6	1
First floor	Secutary	62	0.74	Split UnitType(FXAQ32P)	2.2	1
First floor	Director	197.8	2.33	Split UnitType(FXAQ32P)	3.6	1
second floor	Office5	148.6	1.81	Split UnitType(FXAQ32P)	3.6	1
second floor	Office2	218.8	2.64	Split Unit Type(FXAQ50P)	1.7	2
second floor	office3	108.8	1.33	Split Unit Type(FXAQ32P)	3.6	1
second floor	Prison	57.7	0.67	Split Unit Type(FXAQ32P)	3.6	1
second floor	Office4	102.5	1.26	Split UnitType(FXAQ32P)	3.6	1
second floor	Office	57.4	0.7	Split UnitType(FXAQ32P)	2.2	1
second floor	Office1	63	0.77	Split UnitType(FXAQ32P)	2.2	1
second floor	Office6	58.9	0.72	Split UnitType(FXAQ32P)	2.2	1
second floor	Office7	85.9	1.05	Split UnitType(FXAQ32P)	2.2	1
second floor	Office9	125.5	1.53	Split UnitType(FXAQ32P)	2.2	1
second floor	Office8	203.7	2.46	Split UnitType(FXAQ50P)	5.6	1
Third floor	Office1	132.4	1.61	Split UnitType(FXAQ32P)	3.6	1
Third floor	Office2	213.5	2.57	Split UnitType(FXAQ50P)	5.6	1
Third floor	Office8	63.7	0.77	Split UnitType(FXAQ32P)	3.6	1

Third floor	Office3	64.3	0.79	Split Unit Type(FXAQ32P)	3.6	1
Third floor	Office7	112.9	1.38	Split Unit Type(FXAQ32P)	3.6	1
Third floor	Office6	65.1	0.8	Split Unit Type(FXAQ32P)	3.6	1
Third floor	Office4	98.3	1.2	Split UnitType(FXAQ32P)	3.6	1
Third floor	Office10	128.6	1.56	Split UnitType(FXAQ32P)	3.6	1
Third floor	Office	77.5	0.93	Split UnitType(FXAQ32P)	3.6	1
Third floor	Office9	212.2	2.56	Split UnitType(FXAQ50P)	5.6	1
Forth floor	Office	74.2	0.86	Split UnitType(FXAQ32P)	3.6	1
Forth floor	OfficeZ1	64.3	0.75	Split UnitType(FXAQ32P)	3.6	1
Forth floor	OfficeZ2	239.7	2.8	Split UnitType(FXAQ50P)	5.6	1
Forth floor	OfficeZ3	167.7	1.95	Split UnitType(FXAQ32P)	3.6	1
Forth floor	OfficeZ4	65	0.75	Split UnitType(FXAQ32P)	3.6	1
Forth floor	Ofice	302.7	3.56	Split UnitType(FXAQ50P)	2.2	2
Forth floor	OfficeZ5	80.1	0.94	Split UnitType(FXAQ32P)	3.6	1
Forth floor	OfficeZ6	85.9	1	Split UnitType(FXAQ32P)	3.6	1
Forth floor	OfficeZ7	79.2	0.92	Split UnitType(FXAQ32P)	3.6	1
Forth floor	OfficeZ8	78.8	0.92	Split UnitType(FXAQ32P)	3.6	1
Forth floor	Office4	72.9	0.84	Split UnitType(FXAQ32P)	3.6	1
Forth floor	Office3	60	0.69	Split UnitType(FXAQ32P)	3.6	1
Forth floor	Office2	60.8	0.7	Split UnitType(FXAQ32P)	3.6	1
Forth floor	OfficeZ9	59.6	0.69	Split UnitType(FXAQ32P)	3.6	1
Forth floor	OfficeZ10	102.8	1.19	Split UnitType(FXAQ32P)	3.6	1
Forth floor	OfficeZ11	74	0.85	Split UnitType(FXAQ32P)	3.6	1
fifth floor	Employer1	86.7	1.06	Split UnitType(FXAQ32P)	3.6	1
fifth floor	Manegar1	50.8	0.62	Split UnitType(FXAQ32P)	3.6	1
fifth floor	Manegar2	55.5	0.68	Split UnitType(FXAQ32P)	3.6	1
fifth floor	Employer2	84.5	1.04	Split UnitType(FXAQ32P)	3.6	1
fifth floor	Employer3	242.5	2.96	Split UnitType(FXAQ50P)	5.6	1
fifth floor	Director	205.5	2.47	Split UnitType(FXAQ50P)	5.6	1

fifth floor	Employer	342.6	4.16	Split UnitType(FXAQ50P)	5.6	1
fifth floor	Manegar3	77.9	0.95	Split UnitType(FXAQ32P)	3.6	1
fifth floor	Manegar	77.5	0.94	Split UnitType(FXAQ32P)	3.6	1
sixth floor	Director	90.2	1.1	Split UnitType(FXAQ32P)	3.6	1
sixth floor	ChairMan	348	4.2	Split UnitType(FXAQ50P)	5.6	1
sixth floor	Presidient	213.6	2.6	Split UnitType(FXAQ50P)	5.6	1
sixth floor	Meeting	172.5	2.24	Split UnitType(FXAQ32P)	3.6	1
sixth floor	Office	126	1.53	Split UnitType(FXAQ32P)	3.6	1
sixth floor	DirectorZ1	223.3	2.62	Split UnitType(FXAQ32P)	2.2	1
sixth floor	Employer	76.9	0.94	Split UnitType(FXAQ32P)	3.6	1
sixth floor	DirectorZ2	57.1	0.7	Split UnitType(FXAQ32P)	3.6	1
sixth floor	EmployerZ1	72.4	0.88	Split UnitType(FXAQ32P)	3.6	1
sixth floor	DirectorZ3	54.1	0.66	Split UnitType(FXAQ32P)	3.6	1

1-1 TECHNICAL SPECIFICATIONS				FXAQ20MAVE	FXAQ25MAVE	FXAQ32MAVE	FXAQ40MAVE	FXAQ50MAVE	FXAQ63MAVE
Nominal Capacity	Cooling		kW	2.20	2.80	3.60	4.50	5.60	7.10
	Heating		kW	2.50	3.20	4.00	5.00	6.30	8.00
Power input (Nominal)	Cooling		kW	0.016	0.022	0.027	0.020	0.027	0.050
	Heating		kW	0.024	0.027	0.032	0.020	0.032	0.060
Casing	Colour			white (3.0Y8.5/0.5)					
Dimensions	Unit	Height	mm	290	290	290	290	290	290
		Width	mm	795	795	795	1050	1050	1050
		Depth	mm	230	230	230	230	230	230
Weight	Unit		kg	11	11	11	14	14	14
Heat Exchanger	Dimensions	Nr of Rows		2	2	2	2	2	2
		Fin Pitch	mm	1.40	1.40	1.40	1.40	1.40	1.40
		Face Area	m²	0.161	0.161	0.161	0.213	0.213	0.213
		Nr of Stages		14	14	14	14	14	14
Fan	Type			Cross flow fan					
	Quantity			1	1	1	1		
Air Flow Rate	Cooling	High	m³/min	7.50	8.00	9.00	12.00	15.00	19.00
		Low	m³/min	4.50	5.00	5.50	9.00	12.00	14.00
Fan	Motor	Quantity		1	1	1	1	1	1
		Model		QCL9661M	QCL9661M	QCL9661M	QCL9686M	QCL9686M	QCL9686M
		Output (high)	W	40	40	40	43	43	43
		Drive		Direct drive					
Refrigerant	Name			R-410A					



Wall mounted unit

(FXAQ50P, FXAQ32P, FXAQ20P), a 5.6-kW, 3.6-kW respectively indoor units (Split Units), was chosen

Fan coils and diffusers design:

floor	Zone	Floor Area (m2)	Total Cooling Load (kW)	Design Flow Rate (L/s)	Used Hvac System	Hvac Cooling Capacity (kW)	Required Number of Fan Coil	The Volumatric Flow Rate /m 2	The Diffuser Voumatric Flow Rate (L/s)	Req no of diffuser
GF floor	0:BreakRoom	59.1	2.15	186	[FXSQ40]	4.5	1	3.1	68 L/S (150x150 mm)	1
GF floor	0:Carridor	100.6	2.82	234	[FXSQ40]	4.5	1	2.3	127 L/S (225x225 mm)	2
GF floor	Library	57.5	4.57	368.7	[FXSQ40]	4.5	1	6.4	127 L/S (225x225 mm)	3
GF floor	Driver	22	0.94	77.7	[FXSQ40]	4.5	1	3.5	68 L/S (150x150 mm)	1
GF floor	0:MultiPurpose	152.8	12.01	928.2	[FXSQ40]	4.5	3	6.1	127 L/S (225x225 mm)	7
GF floor	0:GlassRoom	33.7	1.01	83.6	[FXSQ40]	4.5	1	2.5	68 L/S (150x150 mm)	1
GF floor	0:Kitchen	5.7	0.21	17.5	[FXSQ40]	4.5	1	3.1	34 L/S (150x150 mm)	1

floor	Zone	Floor Area (m2)	Total Cooling Load (kW)	Design Flow Rate (L/s)	Used Hvac System	Hvac Cooling Capacity (kW)	Required Number of Fan Coil	The Volumatric Flow Rate /m 2	The Diffuser Voumatric Flow Rate (L/s)	Req no of diffuser
GF floor	0:Reception	18.3	0.68	55.4	[FXSQ40]	4.5	1	3	34 L/S (150x150 mm)	2
GF floor	0:WaitingRoom	12.8	0.38	31.3	[FXSQ40]	4.5	1	2.4	34 L/S (150x150 mm)	1
first floor	1stFloor:Corridor	118.4	4.33	364.3	[FXSQ40]	4.5	1	3.1	127 L/S (225x225 mm)	3
first floor	1stFloor:Kitchen	3.7	0.17	13.8	[FXSQ40]	4.5	1	3.7	34 L/S (150x150 mm)	1
first floor	1stFloor:GlassRoom	34.6	1.2	100.5	[FXSQ40]	4.5	1	2.9	68 L/S (150x150 mm)	2
First floor	Employer	77.4	3.74	306	[FXSQ40]	4.5	1	4.0	127 L/S (225x225 mm)	2
First floor	EmployerZ1	43.7	1.68	140	[FXSQ40]	4.5	1	3.2	68 L/S (150x150 mm)	1
Third floor	Office7	39.3	1.38	113	[FXSQ40]	4.5	1	2.9	68 L/S (150x150 mm)	1
Third floor	Office6	21.6	0.8	65	[FXSQ40]	4.5	1	3.0	34 L/S (150x150 mm)	1
Third floor	Office10	34.3	1.56	129	[FXSQ40]	4.5	1	3.8	127 L/S (225x225 mm)	1
Forth floor	Office	74	0.86	17.7	[FXSQ40]	4.5	1	0.2	34 L/S (150x150 mm)	1
Forthfloor	Ofice	303	3.56	42	[FXSQ40]	4.5	1	0.1	34 L/S (150x150 mm)	1
second floor	2nd:Carridor	161	5.78	471.9	[FXSQ40]	4.5	2	2.9	127 L/S (225x225 mm)	4
second floor	2nd:Kitchen	2.7	0.17	14.5	[FXSQ40]	4.5	1	5.4	34 L/S (150x150 mm)	1

floor	Zone	Floor Area (m2)	Total Cooling Load (kW)	Design Flow Rate (L/s)	Used Hvac System	Hvac Cooling Capacity (kW)	Required Number of Fan Coil	The Volumatric Flow Rate /m 2	The Diffuser Voumatric Flow Rate (L/s)	Req no of diffuser
third floor	3rd:Kitchen	4.6	0.26	20.5	[FXSQ40]	4.5	1	4.5	34 L/S (150x150 mm)	1
third floor	3rd:Carridor	131.9	4.62	20.5	[FXSQ40]	4.5	1	0.2	127 L/S (225x225 mm)	1
forth floor	4:Carridor	131.9	4.62	378.1	[FXSQ40]	4.5	1	2.9	127 L/S (225x225 mm)	3
forth floor	4:Kitchen	3.4	0.17	15	[FXSQ40]	4.5	1	4.4	34 L/S (150x150 mm)	1
forth floor	4:GlassRoom	32.2	1.27	109.6	[FXSQ40]	4.5	1	3.4	68 L/S (150x150 mm)	2
fifth floor	5:Carridor1	116.3	3.92	339.4	[FXSQ40]	4.5	1	2.9	127 L/S (225x225 mm)	3
fifth floor	5:GlassRoom	32.2	1.15	93.5	[FXSQ40]	4.5	1	2.9	68 L/S (150x150 mm)	1
sixth floor	6:Carridor	105.4	4.4	358.2	[FXSQ40]	4.5	1	3.4	127 L/S (225x225 mm)	3
sixth floor	6:GlassRoom	31.3	3.2	269	[FXSQ40]	4.5	1	8.6	68 L/S (150x150 mm)	4
sixth floor	6:Kitchen	3.7	0.21	16.8	[FXSQ40]	4.5	1	4.5	34 L/S (150x150 mm)	1

2-1 Technical Specifications				FXSQ20P	FXSQ25P	FXSQ32P	FXSQ40P	FXSQ50P	FXSQ63P	FXSQ80P	FXSQ100P	FXSQ125P	FXSQ140P
Cooling capacity	Nom.		kW	2.2 (1)	2.8 (1)	3.6 (1)	4.5 (1)	5.6 (1)	7.1 (1)	9.0 (1)	11.2 (1)	14.0 (1)	16.0 (1)
Heating capacity	Nom.		kW	2.5 (2)	3.2 (2)	4.0 (2)	5.0 (2)	6.3 (2)	8.0 (2)	10.0 (2)	12.5 (2)	16.0 (2)	18.0 (2)
Power input - 50Hz	Cooling	Nom.	kW	0.041 (1)		0.044 (1)	0.097 (1)		0.074 (1)	0.118 (1)	0.117 (1)	0.185 (1)	0.261 (1)
	Heating	Nom.	kW	0.029 (2)		0.032 (2)	0.085 (2)		0.062 (2)	0.106 (2)	0.105 (2)	0.173 (2)	0.249 (2)
Power input - 60Hz	Cooling	Nom.	kW	0.041 (1)		0.044 (1)	0.097 (1)		0.074 (1)	0.118 (1)	0.117 (1)	0.185 (1)	0.261 (1)
	Heating	Nom.	kW	0.029 (2)		0.032 (2)	0.085 (2)		0.062 (2)	0.106 (2)	0.105 (2)	0.173 (2)	0.249 (2)
Casing	Colour			Unpainted									
	Material			Galvanised steel									
Dimensions	Unit	Height	mm	300									
		Width	mm	550			700		1,000		1,400		
		Depth	mm	700									
	Packed unit	Height	mm	355									
		Width	mm	770			920		1,220		1,620		
		Depth	mm	900									
Required ceiling void \>			mm	350									
Weight	Unit		kg	23			26		35		46		47
	Packed unit		kg	28			32		42		54		55
Decoration panel	Model			BYBS32DJW1			BYBS45DJW1		BYBS71DJW1		BYBS125DJW1		
	Colour			White (10Y9/0.5)									
	Dimensions	Height	mm	55									
		Width	mm	650			800		1,100		1,500		

[FXSQ40], a 4.5-kW unit, was chosen.

the number of fan coils needed = The Design Cooling load for the space/ Cooling capacity for the unit

the number of fan coils needed =4.33/4.5=1 unit

Diffusers Calculation:

The corridor (1st floor) volumetric flow rate is 364 L/s.

The corridor volumetric flow rate per m2 = tot. volumetric flow rate for the space /total area

The corridor volumetric flow rate per m2 =364/118=3.1 L/s/m2 .

The Volumetric flow rate per m2 should be between (5-15) L/s ➔ 3.1 < 5

So, the min. flow rate = 5 × Space Area = 592 L/s.

DF / DE Supply		Core 21						
Total pressure drop (Pa)		150 x 150	225 x 225	300 x 300	375 x 375	450 x 450	525 x 525	600 x 600
9	l/s	34	76	135	211	304	413	540
	Min Max (m)	1.0-2.0	1.5-2.5	2.0-3.5	2.5-4.5	2.5-6.0	3.0-6.5	3.5-7.0
	L_w	-	-	-	23	24	26	28
15	l/s	45	101	180	282	405	551	720
	Min Max (m)	1.0-2.5	2.0-3.5	2.5-5.0	3.0-6.0	3.5-7.5	4.0-8.0	4.5-8.5
	L_w	-	25	28	30	31	33	35
23	l/s	56	127	225	352	506	689	900
	Min Max (m)	1.5-3.0	2.5-5.0	3.0-6.0	4.0-7.5	4.5-9.0	5.0-10.0	5.5-10.5
	L_w	27	31	34	36	37	39	41
33	l/s	68	152	270	422	608	827	1080
	Min Max (m)	2.0-3.5	2.5-5.5	3.5-7.5	5.0-9.5	5.5-11.0	6.5-13.0	6.5-13.0
	L_w	32	36	39	41	42	43	45
43	l/s	79	177	315	492	709	964	1260
	Min Max (m)	2.0-4.5	3.0-6.0	4.5-8.5	5.5-11.0	6.5-13.0	7.5-15.0	7.5-15.0
	L_w	36	40	43	45	46	48	49

The first chosen diffuser can handle 34 L/S airflow, and the dimension of the diffuser is (150x150) mm.

The second chosen diffuser can handle 68 L/S airflow, and the dimension of the diffuser is (150x150) mm.

The third chosen diffuser can handle 127 L/S airflow, and the dimension of the diffuser is (225x225) mm.

Duct Sizing:

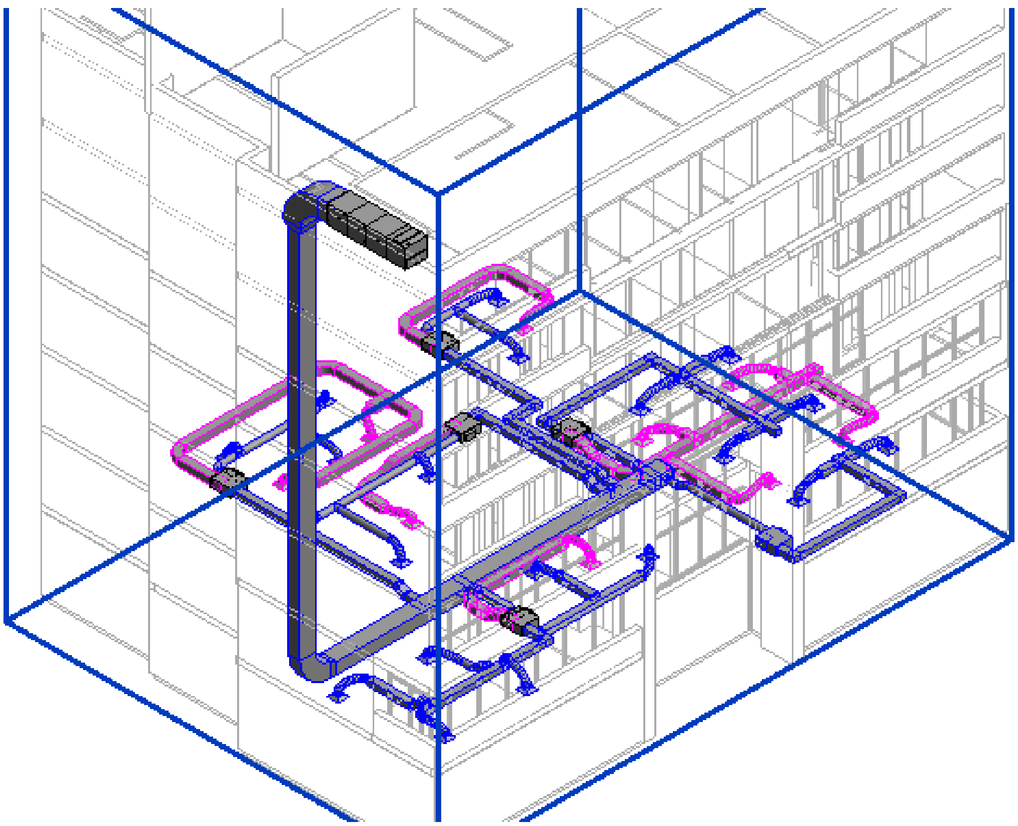
Depending on the required airflow in each area, we will choose the volume. The DUCTULATOR program was used with the channel depth = 300 mm under the drop beams and the Velocity = 5 m/s.

floor	Zone	The Diffuser Voumatric Flow Rate (L/s)	Req no of diffuser	Airflow	Duct Width (mm)	Duct Dim (mm)
first floor	1stFloor:Corridor	127 L/S (225x225 mm)	3	364.3	275	314
first floor	1stFloor:Kitchen	34 L/S (150x150 mm)	1	34	50	122
first floor	1stFloor:GlassRoom	68 L/S (150x150 mm)	2	136	125	207
second floor	2nd:Carridor	127 L/S (225x225 mm)	4	508	375	366
second floor	2nd:Kitchen	34 L/S (150x150 mm)	1	34	50	122
GF floor	0:BreakRoom	127 L/S (225x225 mm)	1	127	100	183
GF floor	0:Carridor	128 L/S (225x225 mm)	2	254	200	266
GF floor	0:MultiPurpose	129 L/S (225x225 mm)	7	889	675	482
GF floor	0:GlassRoom	68 L/S (150x150 mm)	1	68	75	155
GF floor	0:Kitchen	34 L/S (150x150 mm)	1	34	50	122
GF floor	0:Reception	34 L/S (150x150 mm)	2	34	50	122
GF floor	0:WaitingRoom	34 L/S (150x150 mm)	1	34	50	122
third floor	3rd:Kitchen	34 L/S (150x150 mm)	1	34	50	122
third floor	3rd: Corridor	127 L/S (225x225 mm)	1	127	100	183
forth floor	4: Corridor	127 L/S (225x225 mm)	3	381	275	314
forth floor	4: Kitchen	34 L/S (150x150 mm)	1	34	50	122
forth floor	4: Glass Room	68 L/S (150x150 mm)	2	136	125	207

floor	Zone	The Diffuser Voumatric Flow Rate (L/s)	Req no of diffuser	Airflow	Duct Width (mm)	Duct Dim (mm)
fifth floor	5: Carridor1	127 L/S (225x225 mm)	3	381	275	314
fifth floor	5: Glass Room	68 L/S (150x150 mm)	1	68	75	155
sixth floor	6: Corridor	127 L/S (225x225 mm)	3	381	275	314
sixth floor	6: Glass Room	68 L/S (150x150 mm)	4	272	200	266
sixth floor	6: Kitchen	34 L/S (150x150 mm)	1	34	50	122

3D HVAC system by Revit program

If the system is VRV system in Ground Floor



4.4 Acoustic System:

4.4.1 Introduction

The acoustic design is an important part no less than any other design part in the building, because of its psychological and health impact on the comfort of the users. There are some criteria that should be take into account during design. Things will calculate is:

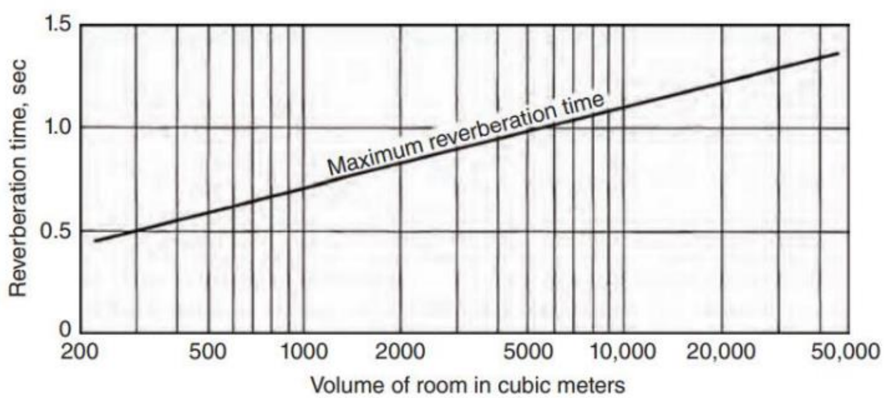
1- Reverberation time (RT 60)

2- Articulation loss (AL)

3- Sound Transmission Class (STC)

Reverberation time (RT60):

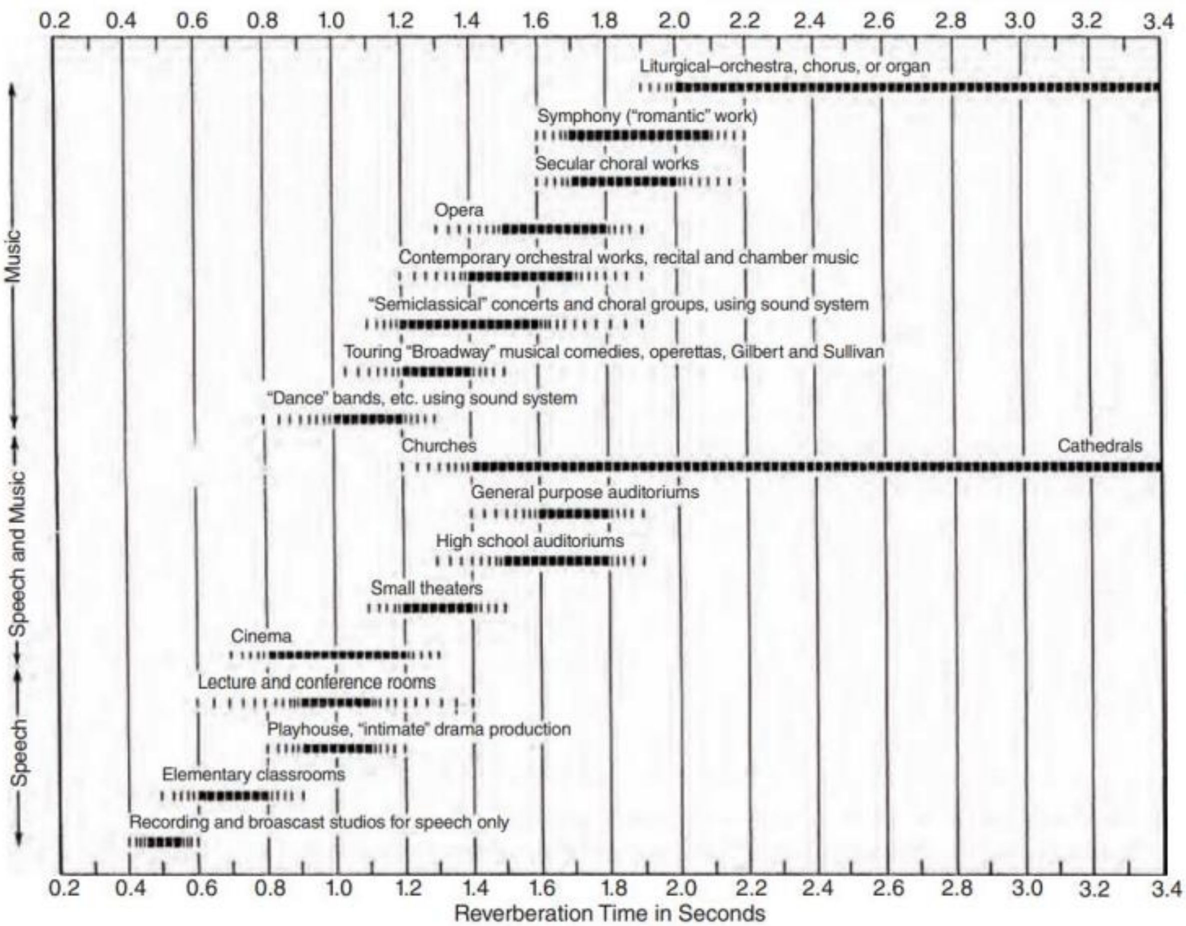
The time required to reduce the sound to the level of sound that a person can clearly hear, equal to 60 (dB),Using Ecotect to preform simple acoustical analysis for spaces.



Maximum recommended reverberation time for speech in office

Grondzik, & Kwok, 2015, P.1059

Figure4 74-bellow show the recommended values for RT60



Optimum reverberation times at midfrequency (500–1000 Hz) for various types of facilities (Grondzik, & Kwok, 2015, P.1060).

Articulation:

Articulation (pronunciation and talking) is the ability to physically move the tongue, lips, teeth and jaw to produce sequences of speech sounds, which make up words and sentences.

The level of comprehension and auditory comprehension will be determined within the spaces.

Table 19common sound pressure level

TABLE 22.5 Common Sound Pressure Levels

Sound Pressure Level (dBA)	Typical Sound	Subjective Impression
150		(Short exposure can cause hearing loss)
140	Jet plane takeoff	
130	Artillery fire, riveting, machine gun	(Threshold of pain)
120	Siren at 100 ft (30 m), jet plane (passenger ramp), thunder, sonic boom	Deafening
110	Woodworking shop, hard-rock band, accelerating motorcycle	Sound can be felt (threshold of discomfort)
100	Subway (steel wheels), loud street noise, power lawnmower, outboard motor	
90	Noisy factory, unmuffled truck, train whistle, machine shop, kitchen blender, pneumatic jackhammer	Very loud, conversation difficult; ear protection required for sustained occupancy
80	Printing press, subway (rubber wheels), noisy office, supermarket, average factory	(Intolerable for phone use)
70	Average street noise, quiet typewriter, freight train at 100 ft (30 m), average radio, department store	Loud, noisy; voice must be raised to be understood
60	Noisy home, hotel lobby, average office, restaurant, normal conversation	
50	General office, hospital, quiet radio, average home, bank, quiet street	Usual background; normal conversation easily understood
40	Private office, quiet home	
30	Quiet conversation, broadcast studio	Noticeably quiet
20	Empty auditorium, whisper	
10	Rustling leaves, soundproof room, human breathing	Very quiet
0		Intolerably quiet Threshold of audibility

Common sound pressure levels (Grondzik, & Kwok, 2015, P.1032).

Table 20 suggested noise criteria ranges

TABLE 24.8 Suggested Noise Criteria Ranges for Steady Background Noise

Type of Space (and Acoustical Requirements)	NC Curve	Equivalent[a] dBA
Concert halls, opera houses, and recital halls (for listening to faint musical sounds).	10–20	20–30
Broadcast and recording studios (distant microphone pickup used).	15–20	25–30
Large auditoriums, large drama theatres, and houses of worship (for excellent listening conditions).	20–25	30–35
Broadcast, television, and recording studios (close microphone pickup only).	20–25	30–35
Small auditoriums, small theatres, small churches, music rehearsal rooms, large meeting and conference rooms (for good listening), or executive offices and conference rooms for 50 people (no amplification).	25–30	35–40
Bedrooms, sleeping quarters, hospitals, residences, apartments, hotels, motels, and so forth (for sleeping, resting, relaxing).	25–35	35–45
Private or semiprivate offices, small conference rooms, classrooms, libraries, and so forth (for good listening conditions).	30–35	40–45
Living rooms and similar spaces in dwellings (for conversing or listening to radio and TV).	35–45	45–55
Large offices, reception areas, retail shops and stores, cafeterias, restaurants, and so forth (for moderately good listening conditions).	35–50	45–60
Lobbies, laboratory work spaces, drafting and engineering rooms, general secretarial areas (for fair listening conditions).	40–45	50–55
Light maintenance shops, office and computer equipment rooms, kitchens, and laundries (for moderately fair listening conditions).	45–60	55–70
Shops, garages, power-plant control rooms, and so forth (for just acceptable speech and telephone communication). Levels above PNC-60 are not recommended for any office or communication situation.	—	—
For work spaces where speech or telephone communication is not required, but where there must be no risk of hearing damage.	—	—

Background noise (Grondzik, & Kwok, 2015, P.1107)

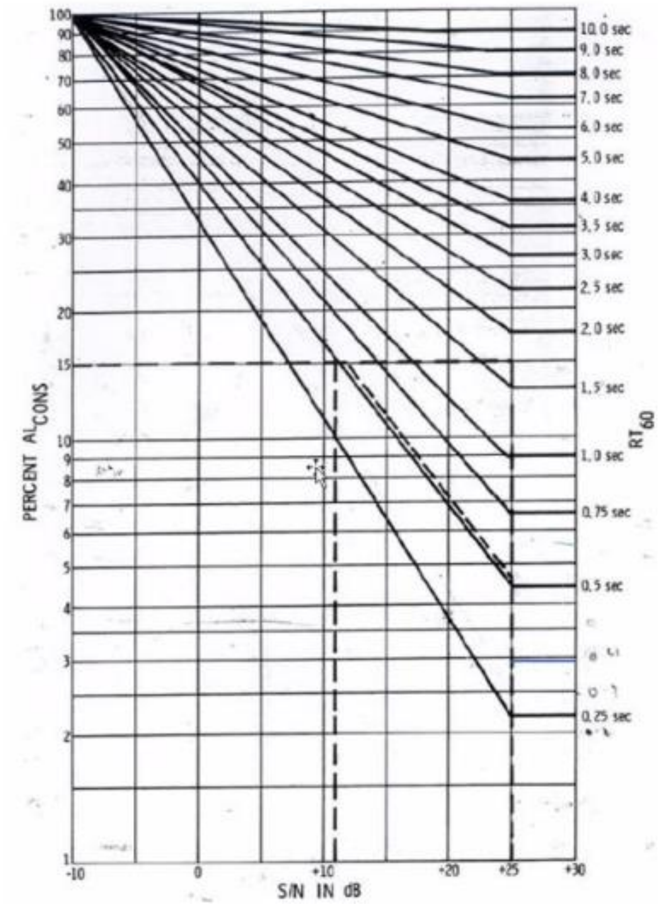
From above figure, we determined background noise for each space.

Example Source	Sound Pressure Level (dB) 63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	dBA
Home									
Alarm clock at 4 to 9 ft (ringing)	..	46	48	55	62	62	70	80	80
Electric shaver at 1 ½ ft	59	58	49	62	60	64	60	59	68
Vacuum cleaner at 3 ft	48	66	69	73	79	73	73	72	81
Garbage disposal at 2 ft	64	83	69	56	55	50	50	49	69
Clothes washer at 2 to 3 ft (wash cycle)	59	65	59	59	58	54	50	46	62
Toilet (refilling tank)	50	55	53	54	57	56	57	52	63
Whirlpool, six nozzles (filling tub)	68	65	68	69	71	71	68	65	74
Window air-conditioning unit	64	64	65	56	53	48	44	37	59
Telephone at 4 to 13 ft (ringing)	..	41	44	56	68	73	69	83	83
TV at 10 ft	49	62	64	67	70	68	63	39	74
Stereo (teenager listening level)	60	72	83	82	82	80	75	60	86
Stereo (adult listening level)	56	66	75	72	70	66	64	48	75
Violin at 5 ft (fortissimo)	..	..	91	91	87	83	79	66	92
Normal conversational speech at 3 ft	..	57	62	63	57	48	40	..	63
Outdoors									
Birds at 10 ft	..	..	..	..	..	50	52	54	57
Cicadas	..	..	..	..	35	51	54	48	57
Large dog at 50 ft (barking)	..	50	58	68	70	64	52	48	72
Lawn mower at 5 ft	85	87	86	84	81	74	70	72	86
Pistol shot at 250 ft (peak impulse levels)	..	..	..	83	91	99	102	106	106
Surf at 10 to 15 ft (moderate seas)	71	72	70	71	67	64	58	54	78
Wind in trees (10 mi/h)	..	..	..	33	35	37	37	35	43
Transportation									
Large trucks at 50 ft (55 mi/h)	83	85	83	85	81	76	72	65	86
Passenger cars at 50 ft (55 mi/h)	72	70	67	66	67	66	59	54	71
Motorcycle at 50 ft (full throttle, without baffle)	95	95	91	91	91	87	87	85	95
Snowmobile at 50 ft	65	82	84	75	78	77	79	69	85
Train at 100 ft (pulling hard)	95	102	94	90	86	87	83	79	94
Train siren at 50 ft	88	90	110	110	107	100	91	78	109
Car horn at 15 ft	..	..	..	92	95	90	80	60	97
Commercial turbofan airplane at 1 mile (from takeoff flight path)	77	82	82	78	70	56	..	..	79
Military helicopter at 500 ft (single engine, medium size)	92	89	83	81	76	72	62	51	80
Interiors									
Amplified rock music performance (large arena)	116	117	119	116	118	115	109	102	121
Audiovisual room	85	89	92	90	89	87	85	80	94
Auditorium (applause)	60	68	75	79	85	84	75	65	88
Classroom	60	66	72	77	74	68	60	50	78
Computer equipment room	78	75	73	78	80	78	74	70	84
Dog kennel	..	..	90	104	106	101	89	79	108
Gymnasium	72	78	84	89	86	80	72	64	90
Kitchen	86	85	79	78	77	72	65	57	81
Laboratory	65	70	73	75	72	69	65	61	77
Library	60	63	66	67	64	58	50	40	68
Mechanical equipment room	87	86	85	84	83	82	80	78	88
Music practice room	90	94	96	96	96	91	91	90	100
Racquetball court	82	85	80	86	83	75	68	62	86
Reception and lobby area	60	66	72	77	74	68	60	50	78
Teleconference	65	74	78	80	79	75	68	60	83

: *Figure4 75-recommended values for STC (Bruno, 2019)*

Sound pressure level (Egan, 1988, P.34).

From above figure, we determined sound pressure level in each space



Graph for AL

We will calculate S/N, we already have RT60; So, we can find percent AL from above figure.

S/N = (sound pressure level - background noise)

Acoustical Assessment for rooms:

- AL < 5% → very good.
- AL < 10% → acceptable.
- AL < 20% → bad.
- AL > 20% → very bad.

- S/N >= 20 → good.
- S/N < 20 → acceptable.
- S/N <15 → very bad.

Acoustical assessment for rooms

For Multipurpose room

SPL for multi is 83dB, and background noise in Multipurpose room is between 25-30

SPL	BN	S/N	RT60	AL	articulatior
83	30	53	1.28	9	91
		good		accept	

S/N = 83- 30 = 53> 30, so it’s good.

From graph we find AL = 9%< 10%, so it’s accepted

Articulation = 100% - 9% = 91%

For office:

SPL for praying area is 77 dB, and background noise in office is between 35-40

SPL	BN	S/N	RT60	AL	articulatior
77	35	42	0.7	6	94
		good		accept	

S/N = 77- 35 = 42> 30, so it’s good.

From graph we find AL = 6%< 10%, so it’s accepted

Articulation = 100% - 6% = 94%

Sound transmission class (STC)

The ability of wall layers to absorb sound and provide room privacy.

Table 52Recommended STC for partitions (Grondzik, & Kwok, 2015, P.1129).

TABLE 24.13 Recommended STC for Partitions; Specific Occupancies

	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

Table 53Typical STC values for doors (Grondzik, & Kwok, 2015, P.10950).

TABLE 24.3 Typical STC Values for Doors

Door Construction	STC
Louvered door	15
Any door, 2-in. (51-mm) undercut	17
1½-in. (38-mm) hollow core door, no gasketing	22
1½-in. (38-mm) hollow core door, gaskets and drop closure	25
1¾-in. (45-mm) solid wood door, no gasketing	30
1¾-in. (45-mm) solid wood door, gaskets and drop closure	35
Two hollow core doors, gasketed all around, with sound lock	45
Two solid core doors, gasketed all around, with sound lock	55
Special commercial construction, with lead lining and full sealing	45–65

23Typical STC values for windows (Grondzik, & Kwok, 2015, P.1098.Table

TABLE 24.4 Typical STC Values for Windows

Window Construction	STC
Operable wood sash, ⅛-in. (3.2-mm) glass, unsealed	23
Operable wood sash, ¼-in. (6.4-mm) glass, unsealed	25
Operable wood sash, ¼-in. (6.4-mm) glass, gasketed	30
Operable wood sash, laminated glass, unsealed	28
Operable wood sash, double-glazed, ⅛-in. (3.2-mm) panes, ⅜-in. (9.5-mm) air space, gasketed	29
Fixed sash, double ⅛-in. (3.2-mm) panes, 3-in. (76-mm) air space, gasketed	44
Fixed sash, double ⅛-in. (3.2-mm) panes, 4-in. (102-mm) air space, gasketed	48

4.4.2 Acoustical software results

Multipurpose room

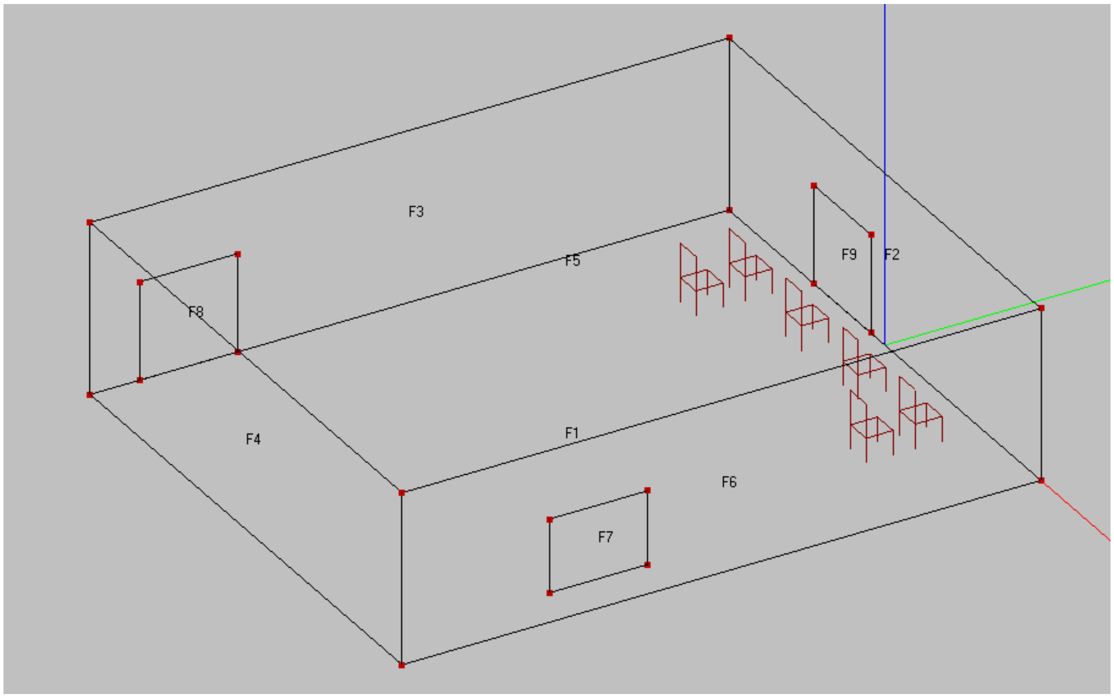
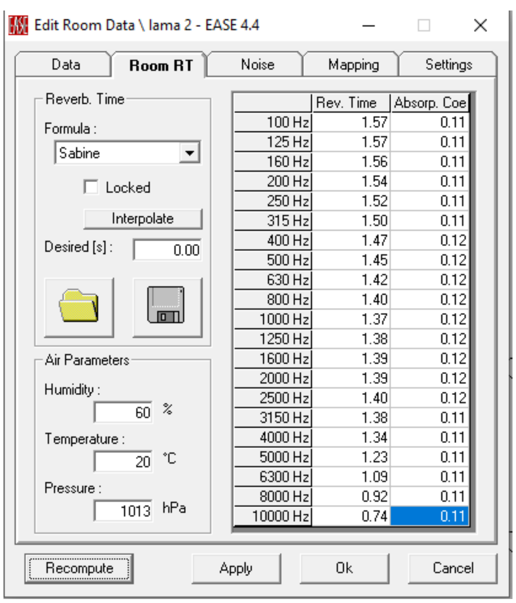


Figure44 76- model of multipurpose room by ease software



	Rev. Time	Absorp. Coe
100 Hz	1.57	0.11
125 Hz	1.57	0.11
160 Hz	1.56	0.11
200 Hz	1.54	0.11
250 Hz	1.52	0.11
315 Hz	1.50	0.11
400 Hz	1.47	0.12
500 Hz	1.45	0.12
630 Hz	1.42	0.12
800 Hz	1.40	0.12
1000 Hz	1.37	0.12
1250 Hz	1.38	0.12
1600 Hz	1.39	0.12
2000 Hz	1.39	0.12
2500 Hz	1.40	0.12
3150 Hz	1.38	0.11
4000 Hz	1.34	0.11
5000 Hz	1.23	0.11
6300 Hz	1.09	0.11
8000 Hz	0.92	0.11
10000 Hz	0.74	0.11

Figure4 77-reverberation time for multipurpose room at different frequencies

Meeting room

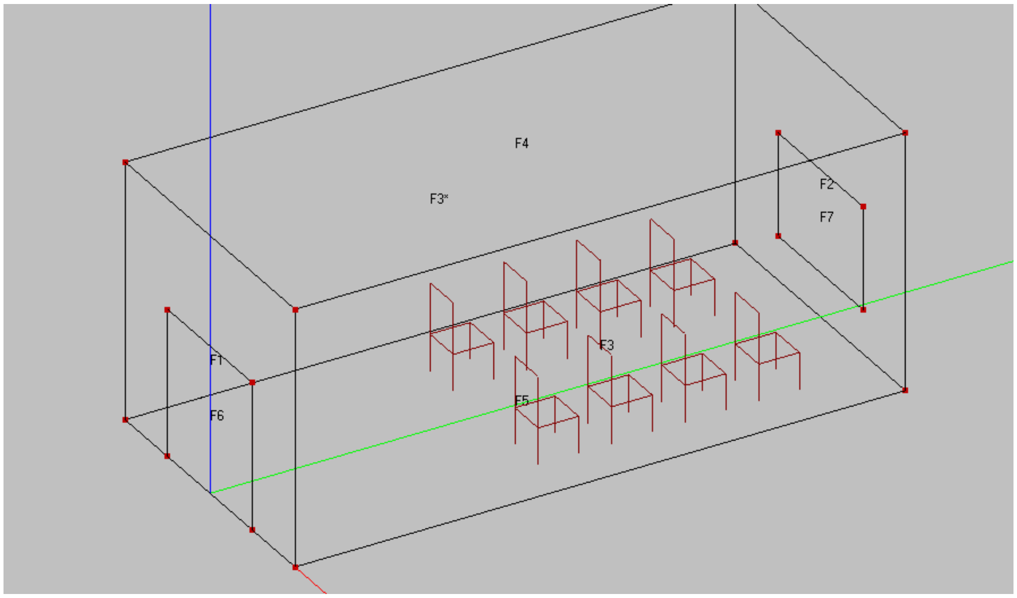


Figure4 78- model of meeting room by ease software

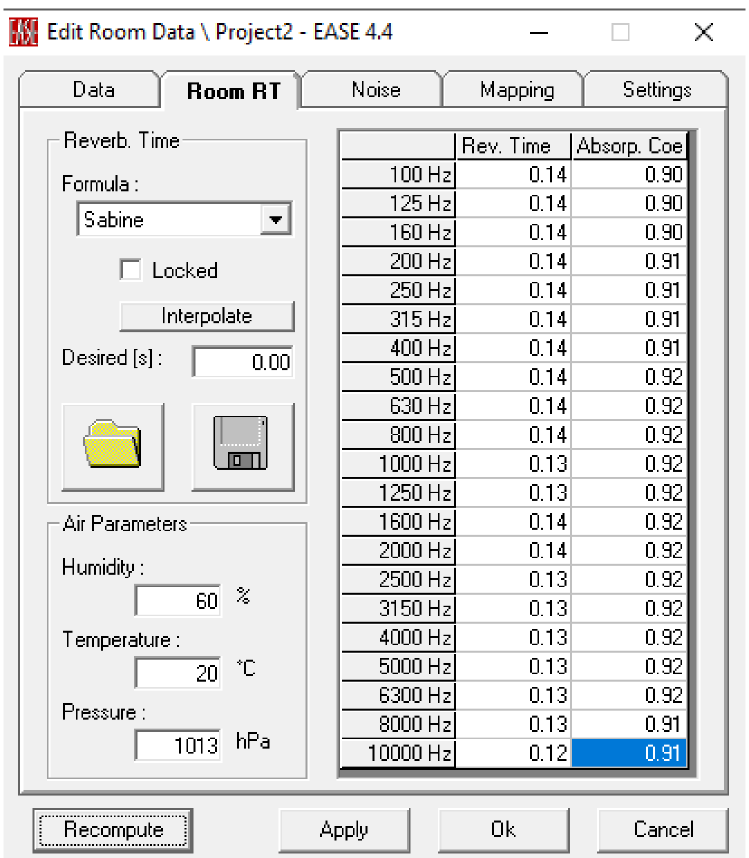


Figure4 79-reverberation time for meetingroom at different frequencies

Employees room:

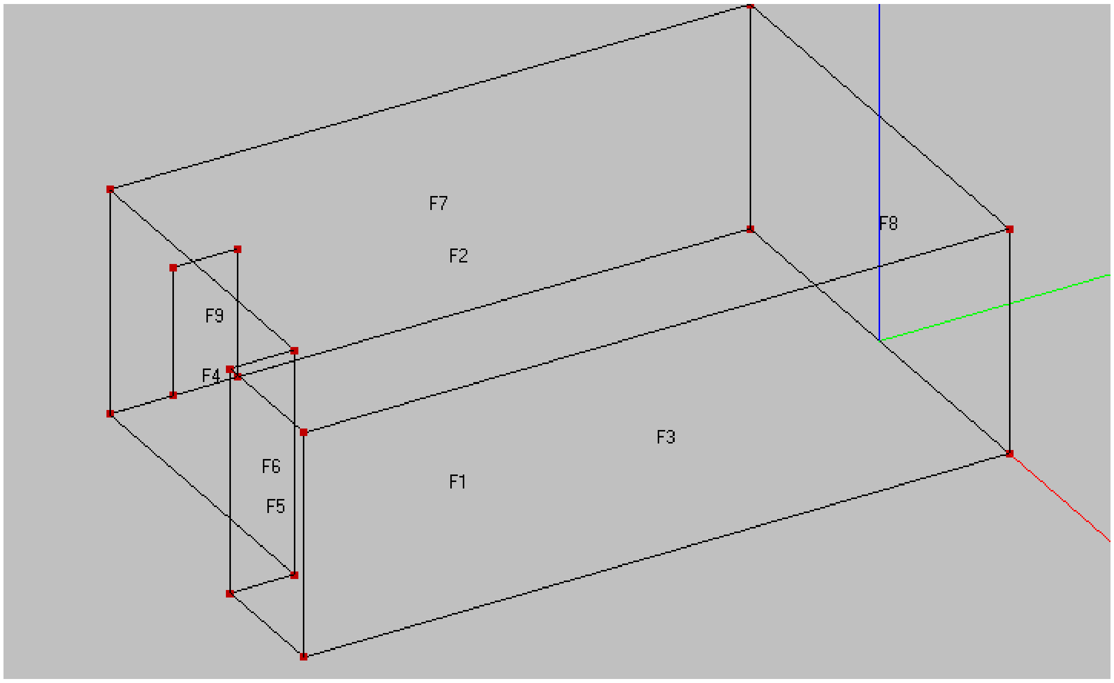


Figure480- model of employee room by ease software

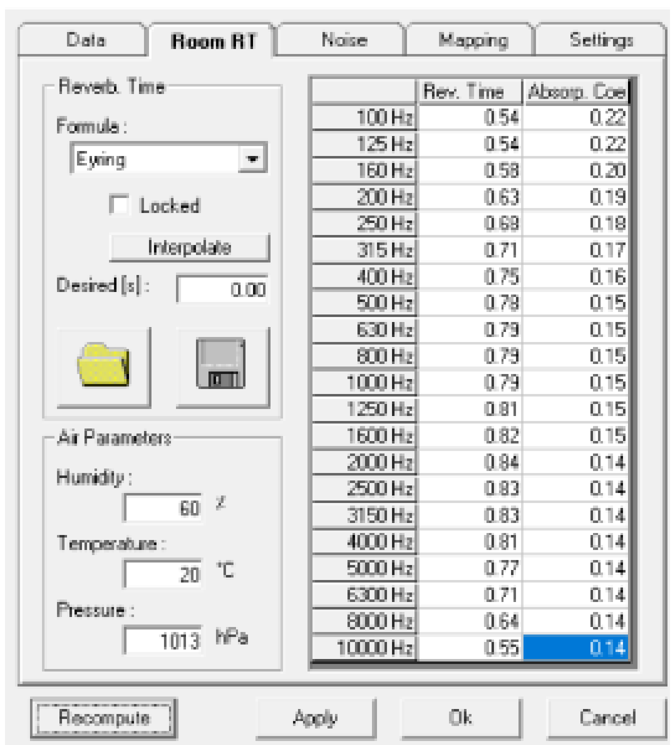


*Figure 4-74reverberation time for **Employees room**at different frequencies*

Private office

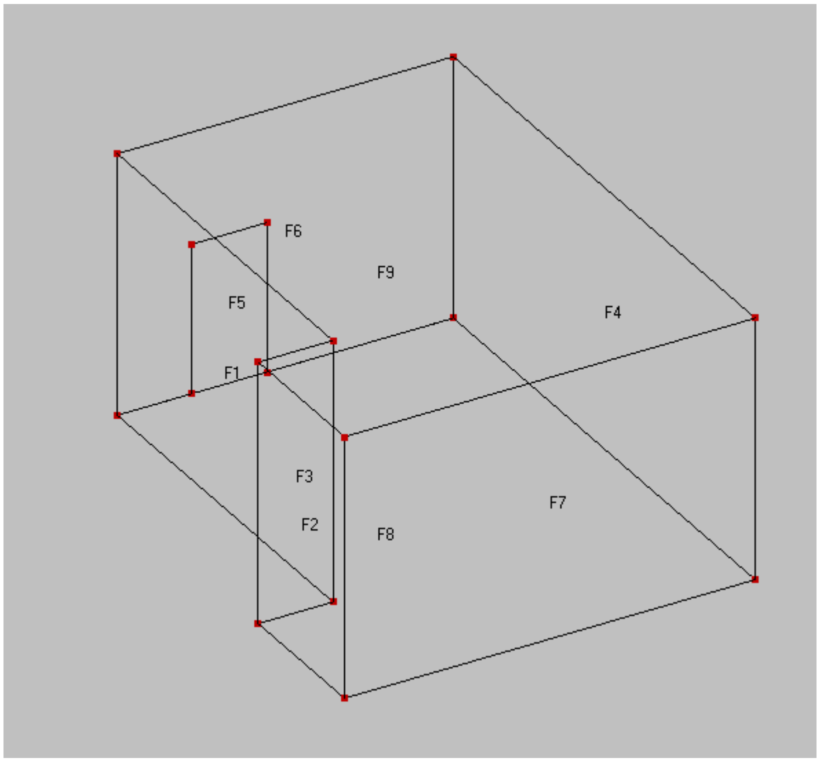


Figure482-model of private office by ease software

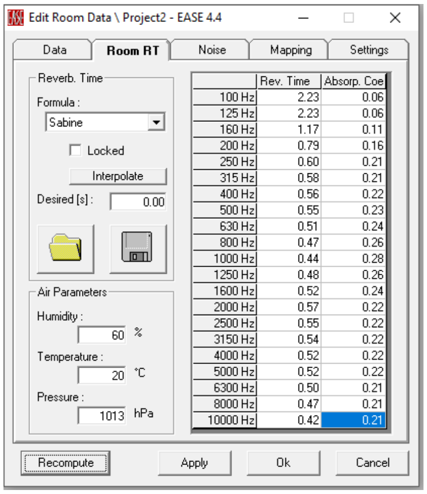


Figure483-reverberation time for private office at different frequencies

4.4.3 Used Material for space elements

Finishing material effects on acoustics values according that each type of material has different absorption coefficient. Because the building is office building, most of the .spaces have the same finishing materials

Element	Finishing material
Floor	Tile floor
Ceiling	Ceiling Plaster
walls	Plaster
Doors	Wood (hollow)
windows	Wind. Glass

4.4.4 Structural Elements design acoustically

Each two adjacent spaces affects each other acoustically so its important to design it according to specified criteria to reach the most suitable and comfortable design according to the requirements of space.

4.4.4.1 Wall:

Sound transmission loss (STC) is the coefficient that matter in wall design. It describes how much the combination of layers behave as acoustic insulator

Multipurpose room - lobby

The recommended value is STC 45 to consider it as normal and STC 50 to consider it as quiet.

63	125	250	500	1k	2k	4k
38	39	36	42	47	53	59

STC 46 OITC 42

Description

Wall: + 1 x 20 mm Plasterboard + 1 x 200 mm CMU Hollow (115 lb/ft³) + 1 x 20 mm Plasterboard

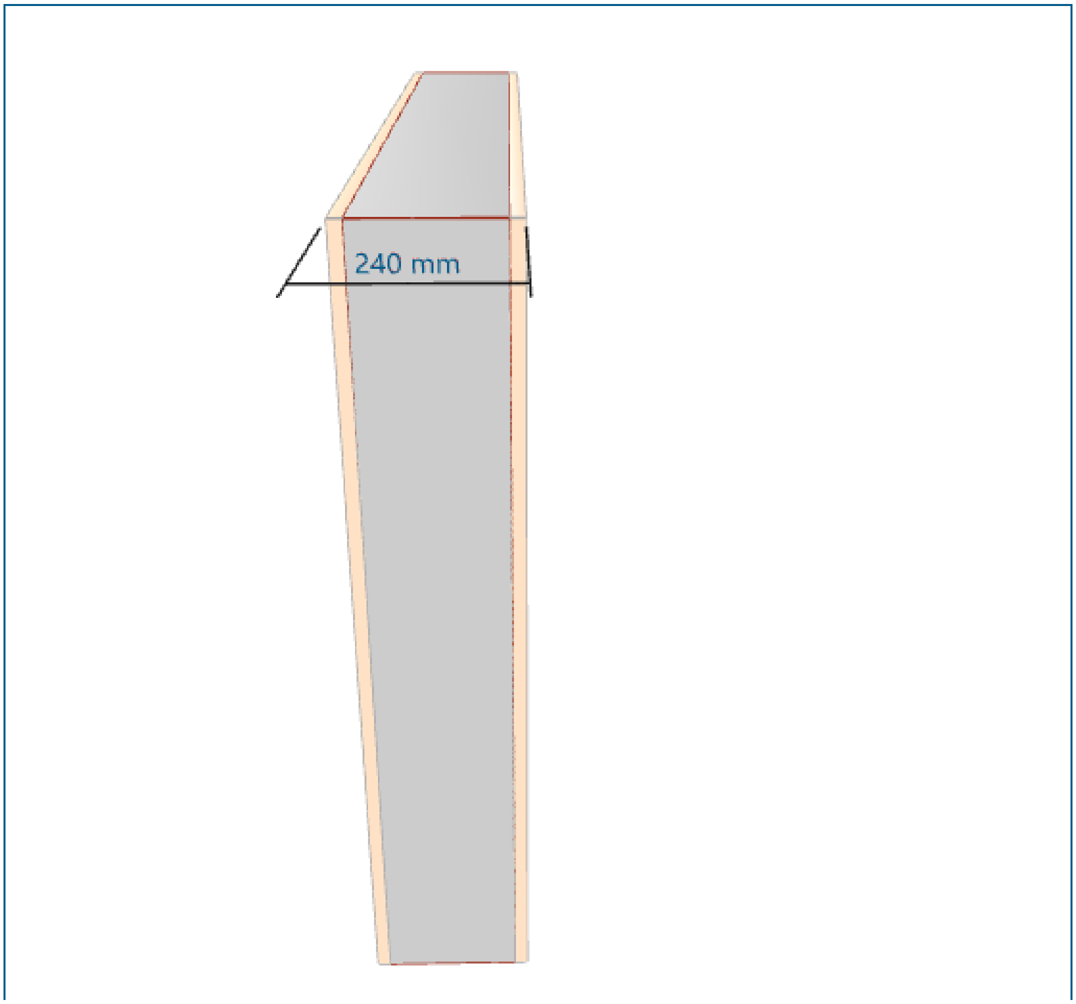


*Figure 4-75 wall layers between **Multipurpose room - lobby** by INSUL software*

Meeting room - Private office

The recommended value is STC 42 to consider it as normal and STC 45 to consider it as quiet.

63	125	250	500	1k	2k	4k
36	38	34	40	45	51	57

STC 44 OITC 40

Description

Wall: + 1 x 20 mm Plasterboard + 1 x 200 mm CMU Hollow (95 lb/ft^3) + 1 x 20 mm Plasterboard

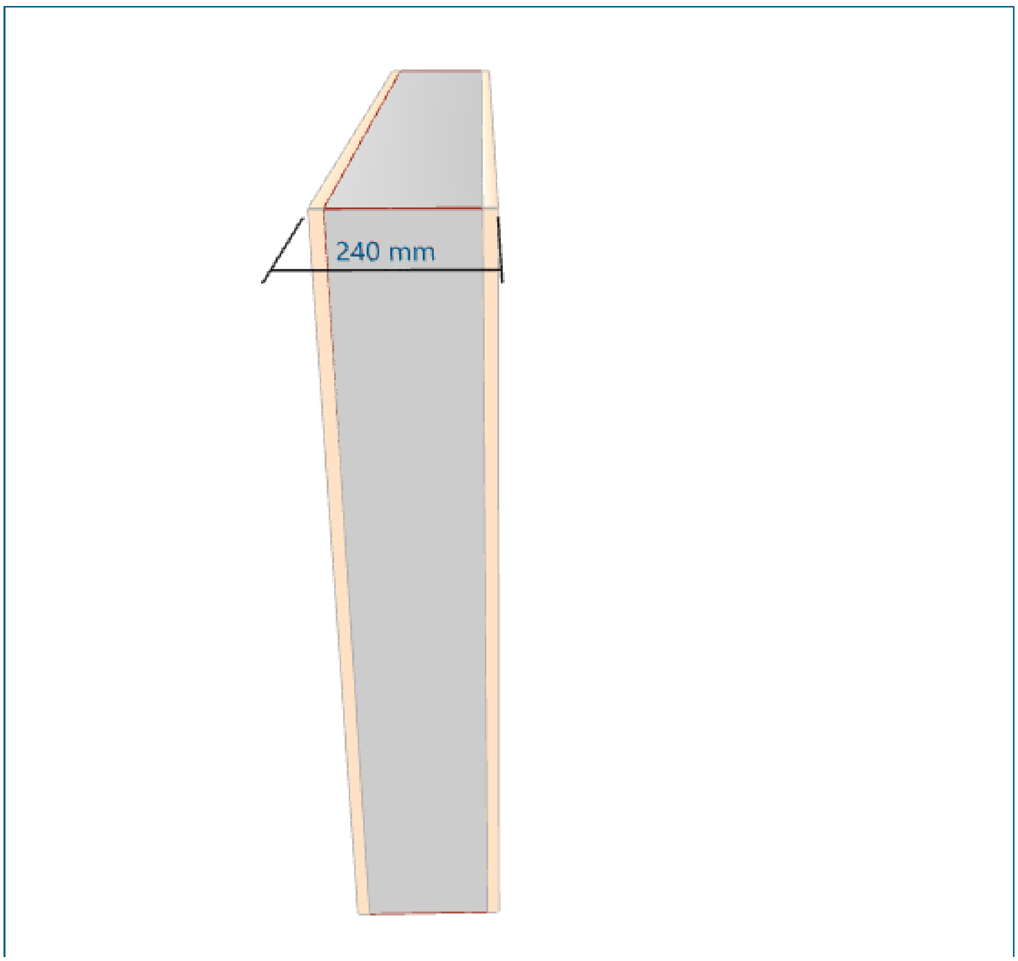


*Figure 4-76wall layers between **Meeting room - Private office**by INSUL software*

Office – toilet:

The recommended value is STC 47 to consider it as normal and STC 50 to consider it as quiet.

63	125	250	500	1k	2k	4k
39	40	37	45	48	54	60

STC 48 OITC 43

Description

Wall: + 1 x 20 mm Plasterboard + 1 x 200 mm CMU Hollow (135 lb/ft^3) + 1 x 20 mm Plasterboard

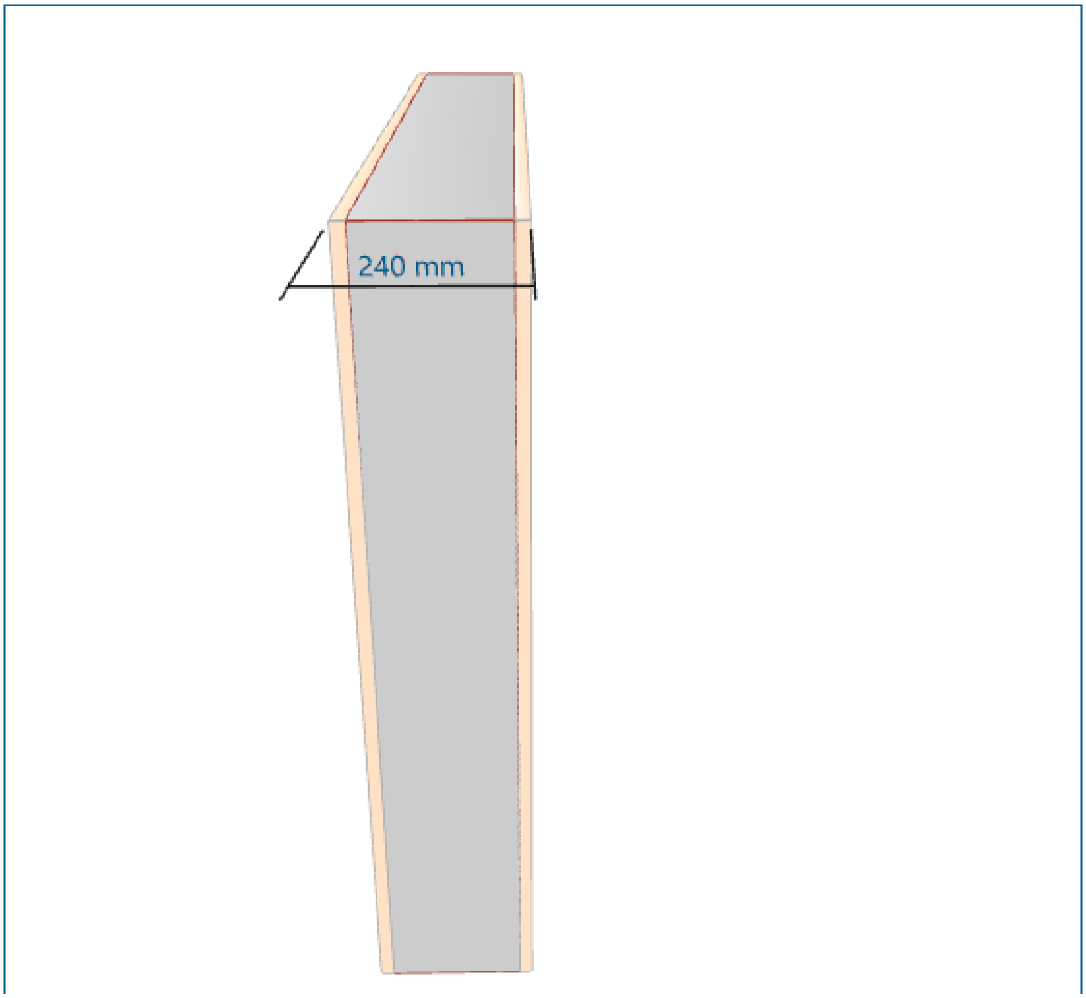


Figure 4-77 wall layers betweenOffice – toilet: by INSUL software

Office – loopy

The recommended value is STC 42 to consider it as normal and STC 45 to consider it as quiet.

63	125	250	500	1k	2k	4k
34	38	40	35	42	49	55

STC 42 OITC 39

Description

Wall: + 1 x 20 mm Plasterboard + 1 x 100 mm CMU Hollow (135 lb/ft³) + 1 x 20 mm Plasterboard

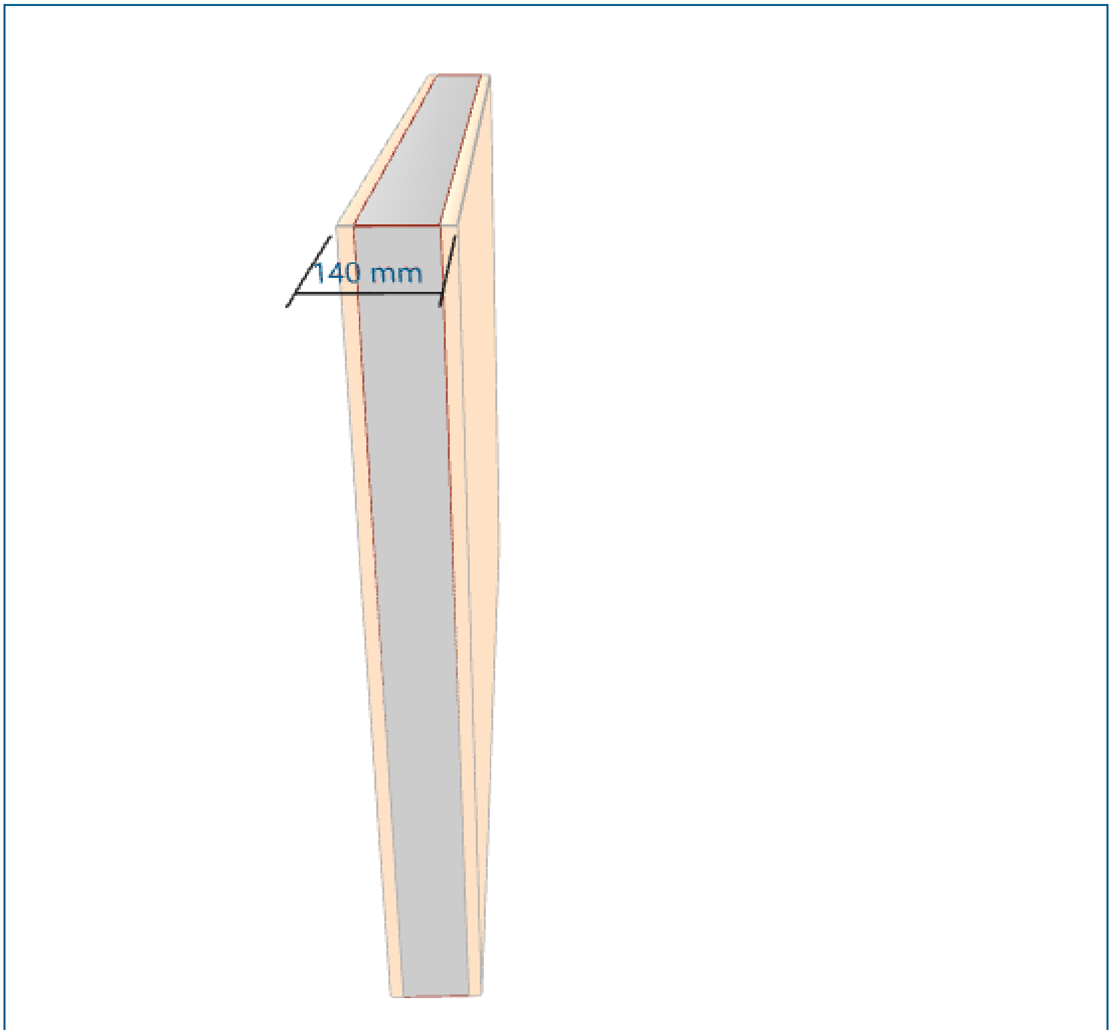


*Figure 4-78 wall layers between **Office – loopy** by INSUL software*

office & outside:

Between the office and outside there is a wall consisting of 10 mm plaster, 100 mm concrete hollow block, 100 mm cast concrete, & 90 mm limestone.

63	125	250	500	1k	2k	4k
43	47	46	46	54	60	65

STC 53 OITC 49

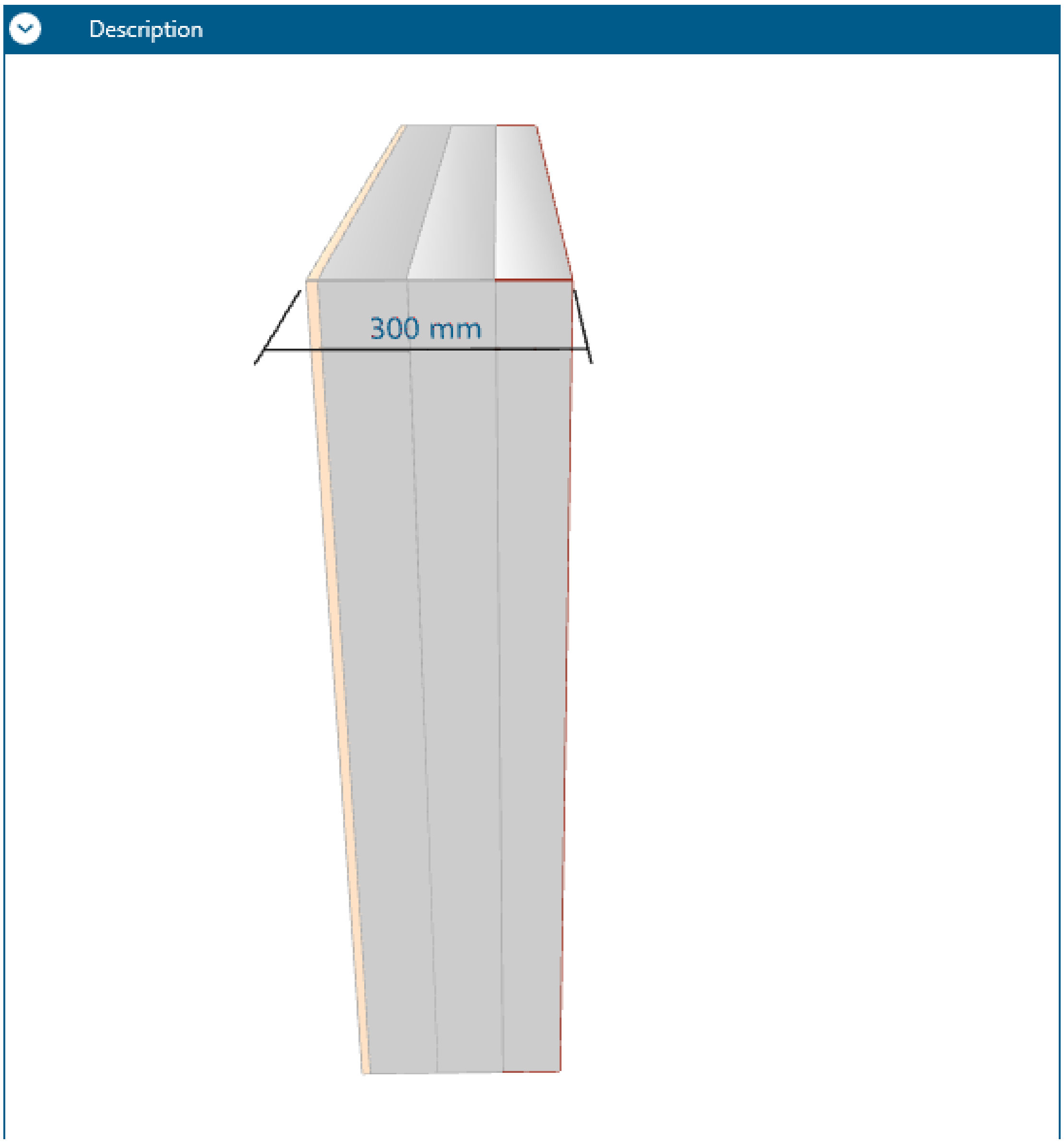


*Figure 4-79 wall layers between **office & outside**:by INSUL software*

4.4.4.2 Ceiling:

Impact insulation class (IIC) is the coefficient that matter in ceiling design. It describes how much the combination of layers behave as acoustic insulator.

4.5 Firefighting system design:

4.5.1 Introduction:

fire hazards and damage are a part of every building's life cycle, firefighting system design is crucial to avoid and guard against the destruction brought on by fire, workplace fire safety is crucial and required. Fire safety lowers the possibility of injuries and building damage that can result from fires. It is essential for everyone's safety who might be inside the building during a fire emergency to develop and implement fire safety protocols in the workplace

Fire influences materials either by melting, cracking, twisting or shrinking. One of the most important basics of protecting people’s lives when a fire breaks out is the resistance of the building and its construction and finishing materials from this danger, so that the occupants of the building can escape in the event of a fire.

In this project, a firefighting system was installed for the Anti-corruption building in Ramallah. Our municipal building is an administrative building, and the risks are low to medium, so there are many types of firefighting and safety systems used in this building: Sprinkler, Detectors, Extinguisher, Alarm System, Fire Hose , exit signals and emergency drawer.

Procedures:

To design this system some basic information from the Palestinian code for fire prevention and protection was used:

8/12 متطلبات الإطفاء للمرائب :

(أ) تزود المرائب التي تزيد مساحتها عن أو تساوي (500 متر مربع أو المرائب التي ليس لها مخرج مباشر بمستوى طابق المنفذ–وبغض النظر عن مساحتها) بأنظمة تمديدات وخراطيم خاصة بمكافحة الحريق، بالإضافة إلى تزويدها بطفايات حريق يدوية، حسب متطلبات الجهة الرسمية المختصة .

(ب) تزود المرائب التي تقل مساحتها عن (500) متر مربع بأجهزة إطفاء يدوية، حسب متطلبات الجهة الرسمية المختصة .

13/12 متطلبات أنظمة الإطفاء والإنذار :

معدات مكافحة و إنذار الحريق لإشغالات التخزين (مرآب السيارات).

النوع		الحالات المطلوبة
1	معدات الإطفاء اليدوية:	
1	طفايات يدوية	جميع الطوابق لجميع الحالات
2	التركيبات الثابتة:	
1	شبكة خراطيم مطاطية	جميع الطوابق للمرائب التي تزيد عن 500 م 2
3	الأنظمة التلقائية الثابتة:	
1	شبكة تلقائية لمرشات مياه مكافحة الحريق	متطلبات مرشات مياه مكافحة الحريق لإشغالات التخزين (مرائب السيارات) طلب من الأقبية أكثر من 1000 م^2
2	شبكة تلقائية لمرشات مواد أخرى	أماكن الخطورة الخاصة حيث لا يمكن استخدم المياه
4	معدات إنذار الحريق:	
1	شبكة الإنذار في المباني السكنية	حسب ما مهو مطلوب للمبنى
2	شبكة إنذار يدوي	في مواقف السيارات أقل من 500م ^{2}
3	شبكة إنذار تلقائي	في مواقف السيارات مغلقة الجوانب اكبرمن 500 م ^{2}

Fire System:

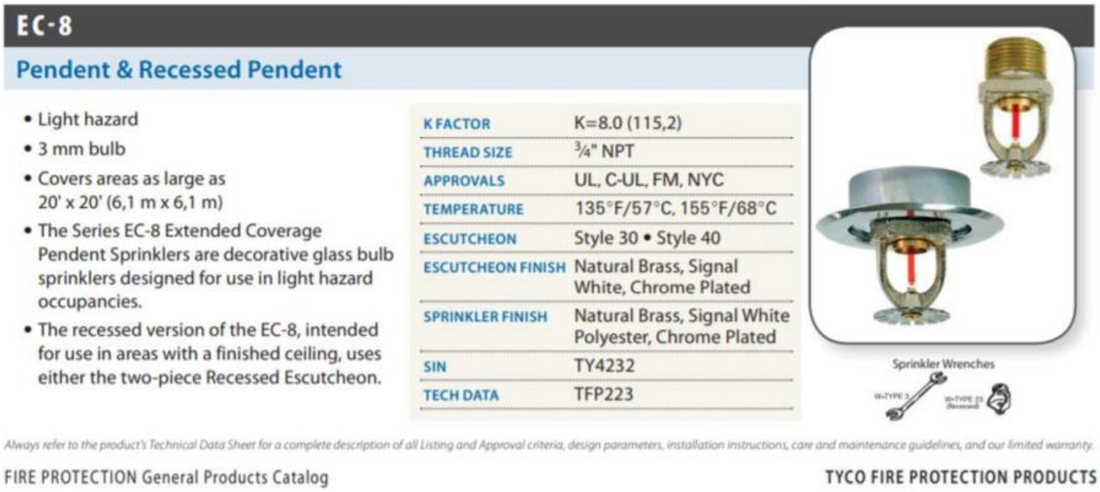
SPRINKLER FIRE FIGHTING SYSTEM DESIGN:

A fire sprinkler system is a network of sprinklers that spray water on a fire to contain and put it out. Heat or smoke triggers these systems to work (or both). Water is an effective fire suppression agent or the most effective one for many types of fires.

Additionally, because sprinklers use water, a relatively cheap resource that most facilities already have access to, they can be less expensive to operate than other fire suppression systems. A fire sprinkler system may not be the best option in these situations because water can harm some types of property and is ineffective against some fires, such as grease fires.

The sprinkler system is effective in putting out fires in places where paper forms are not handled, such as multi-purpose rooms and corridors. A sprinkler has been chosen from Tyco Fire and the model of EC-8

All areas in which this system will be placed are classified as low hazard according to the Palestinian code for fire prevention and protection. Each sprinkler covers an area of 12 m2 and Max. Distance 4.6 m



EC-8

Pendent & Recessed Pendent

- Light hazard
- 3 mm bulb
- Covers areas as large as 20' x 20' (6,1 m x 6,1 m)
- The Series EC-8 Extended Coverage Pendent Sprinklers are decorative glass bulb sprinklers designed for use in light hazard occupancies.
- The recessed version of the EC-8, intended for use in areas with a finished ceiling, uses either the two-piece Recessed Escutcheon.

K FACTOR	K=8.0 (115,2)
THREAD SIZE	¾" NPT
APPROVALS	UL, C-UL, FM, NYC
TEMPERATURE	135°F/57°C, 155°F/68°C
ESCUTCHEON	Style 30 • Style 40
ESCUTCHEON FINISH	Natural Brass, Signal White, Chrome Plated
SPRINKLER FINISH	Natural Brass, Signal White Polyester, Chrome Plated
SIN	TY4232
TECH DATA	TFP223

Always refer to the product's Technical Data Sheet for a complete description of all Listing and Approval criteria, design parameters, installation instructions, care and maintenance guidelines, and our limited warranty.

FIRE PROTECTION General Products Catalog

TYCO FIRE PROTECTION PRODUCTS

The dimeters of all steel pipe that connect the sprinklers together and connect them with supplier was chosen by:

Steel pipes	
1 in.	2 sprinklers
1¼ in.	3 sprinklers
1½ in.	5 sprinklers
2 in.	10 sprinklers
2½ in.	30 sprinklers
3 in.	60 sprinklers
3½ in.	100 sprinklers
4 in.	See Section 8.2

Figure4-480-Sprinkler's Design and Distribution in Parking

Table24Sprinkler's Design and Distribution in Parking

Zon`e	zone area	Coverage Area (m2)	No. of Sprinklers	No. of Sprinklers used	Steel Pipe Dim (inch)	Max. Distance (m)	Min. Distance (m)	X	x/2	y	y/2
A	327	21	15.6	16	2 1/2	4.6	1.8	4	2	5	2.5
B	323	21	15.4	16	2 1/2	4.6	1.8	3.13	1.565	3.38	1.69
C	227	21	10.8	12	2 1/2	4.6	1.8	4.75	2.375	4	2
D	301	21	14.3	15	2 1/2	4.6	1.8	4.875	2.4375	3.875	1.938
F	86	21	4.1	4	1 1/2	4.6	1.8	3.85	1.925		0
G	23	21	1.1	1	1	4.6	1.8				

Table25Sprinkler's Design and Distribution in the Corridors

Ground floor

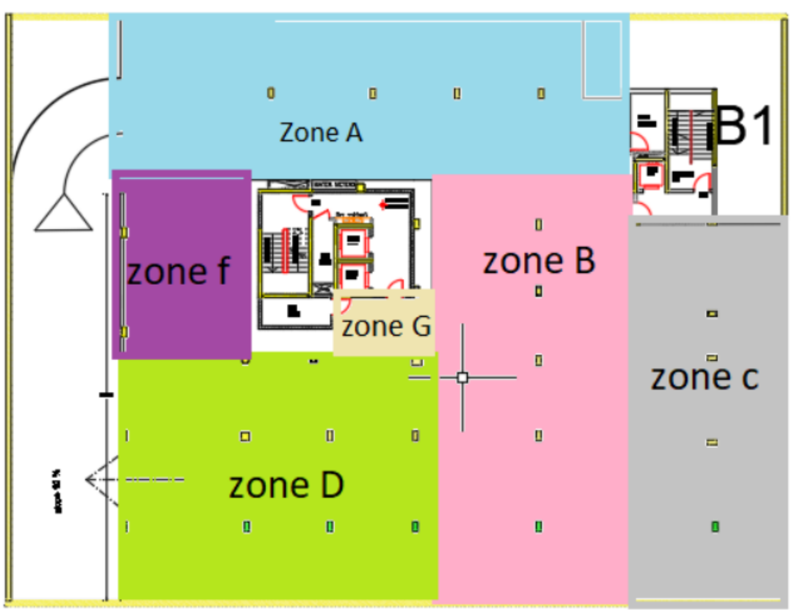
Zone No.	Zone Area (m2)	Coverage Area (m2)	No. of Sprinklers		Steel Pipe Dim (inch)	X	x/2	y	y/2
1	52.7	21	2.509524	4	1 1/2	3.5	1.75	3.8	1.9
2	17.6	21	0.838095	1	1	-	-	-	-
3	3.8	21	0.180952	1	1	-	-	-	-
4	35.8	21	1.704762	2	1	-	-	-	-
5	35	21	1.666667	2	1	-	-	-	-

Table 26Sprinkler's Design and Distribution in the special waiting room (zone7)

zone area(m2)	coverage area (m2)	max distance(m)	no. of sprinkler	steel pipe (inch)	x	x/2
15	21	4	1	1	4	2

Table 27Sprinkler's Design and Distribution in Multi-purpose rooms (zone 6)

Room	zone area(m^2)	coverage area	max distance(m)	min distance(m)	no. of sprinkler	steel pipe dim(inch)	x	x/2	y	y/2
1	147	21	4.6	1.8	7	2 inch	5.2	2.6	3.2	1.6



4.5.2 DETECTORS DISTRIBUTION:

While fires can generally spread quickly, some other fires are started due to periods of intense dormant fires. In such cases, highly sensitive fire detection systems must be in place. The faster you want to detect a fire, the more expensive your fire detection system will be.

SMART4 - Intelligent multi criteria detector

Specifications

• Height:	66 mm installed in B501 base
• Diameter:	102 mm installed in B501 base
• Weight:	176g (inc base)
• Max Wire Gauge for Terminals:	2.5mm²
• Material:	BayblendFR110
• Temperature range:	-20°C to +55°C
• Relative humidity:	15 to 90% (non-condensing)
• CO limits:	0-500ppm

4.5.3 **EXTINGUISHER**:

Used to extinguish or control small fires, often in emergency situations and does not require the expertise of a firefighter. Three types were used according to the use of spaces,CO2 Extinguisher: The best choice for places with a lot of electrical equipment and papers such as offices and archive rooms, because it is safe and works by suppressing the fire and cutting off the air supply, and leaving no residue compared to foam extinguisher.

Type	Part number	Extinguishing agent/ quantity	Model	Propellant	Propellant performance	Extinguishing stream range/ discharge time	Temperature range	Total weight	Bracket H/W/D Ø of container
KS 2 SBS	001831.0000	CO_2 2kg	K 2	CO_2	34 B	3 m 8.5 s	-30°C to +60°C	5.4 kg	520/250/170 mm Ø 117 mm
KS 5 SE	001821.0000	CO_2 5kg	K 5	CO_2	89 B	4-5 m 13.5 s	-30°C to +60°C	12.5 kg	700/480/160 mm Ø 152 mm

Figure 4-80CO2 Extinguisher

Powder Extinguisher:

It is used in places that contain flammable solids, liquids or gases such as textiles, paper, wood, paint, diesel, gasoline, butane and methane. Therefore, this type was used in the sorting room.

PX 6 STAR	800631.3016	ABC powder extinguisher 6kg	PG 6 H	CO_2	55A	233B	C	ca. 6 m ca. 22 s	-30°C to +60°C	ca. 9.9 kg	ca. 500/300/165 mm Ø 150 mm
PH 6 STAR	800631.3015	ABC powder extinguisher 6kg	PG 6 H	CO_2	43A	233B	C	ca. 6 m ca. 22 s	-30°C to +60°C	ca. 9.9 kg	ca. 500/300/165 mm Ø 150 mm
PH 9 STAR	800641.0000	ABC powder extinguisher 9kg	PG 9 H	CO_2	55A	233B	C	ca. 7 m ca. 23 s	-30°C to +60°C	ca. 14.3 kg	ca. 555/290/185 mm Ø 170 mm
P 6 STAR	800631.0000	ABC powder extinguisher 6kg	PG 6 H	CO_2	34A	183B	C	ca. 6 m ca. 22 s	-30°C to +60°C	ca. 9.9 kg	ca. 500/300/165 mm Ø 150 mm
P 12 STAR	800651.0000	ABC powder extinguisher 12kg	PG 12 H	CO_2	55A	233B	C	ca. 7 m ca. 32 s	-30°C to +60°C	ca. 18.7 kg	ca. 600/290/205 mm Ø 190 mm

Figure4-482-Powder Extinguisher

Type A Extinguisher:

Use in places exposed to Class A fires on common combustible materials, such as fabric, wood, paper, rubber, and many plastics. This type was used in the prayer room and corridors

FlameStop 9.0L Air/Water Type Portable Fire Extinguisher

Part Number: G9LAW

FlameStop's water stored pressure extinguishers are commonly used in other areas such as storage for dried goods, wood, paper, plastics etc.

Some features include:

- High Performance Ratings
- Ultra high UV resistant powder coating
- Stainless steel cylinder, handles and brass valve and ferrules
- Supplied with wall bracket

Australian Standard

PLATINUM MEMBER Fire Protection Association Australia

- **Agent Capacity :** 9.0L
- **Agent Manufacturer :** FlameStop Australia Pty Ltd
- **Agent Type :** Air / Water
- **Approvals :** AS/NZS 1841.2
- **Box Quantity :** 1
- **Bracket :** Wall
- **Cylinder Construction :** Stainless Steel
- **Cylinder Finish :** Powder Coated Red
- **Cylinder Pressure Test :** 5 Yearly
- **Dimensions :** W181 x H630mm
- **Discharge Time :** 65 seconds
- **Effective Range :** 6.0 metres
- **Fire Rating :** 3A
- **Gross Mass :** 12.4kg
- **Handle Finish :** Stainless Steel
- **Hose :** Yes
- **Model Number :** FSAW900
- **Nozzle Size :** 3.2
- **Pallet Quantity :** 40
- **Periodic Test Pressure :** 2.5MPa

Figure 4-81Type A Extinguisher

4.5.4 ALARM SYSTEM:

Although strobe lights and sirens do not put out fires, fire alarms can mitigate property losses by alerting people who can do so. Fire alarm systems automatically warn everyone of a fire outbreak, so bystanders, guests or employees inside the building can respond quickly. Fire alarms can also trigger the fire sprinkler system automatically. Two types were used in this project:

- Manual Alarm System

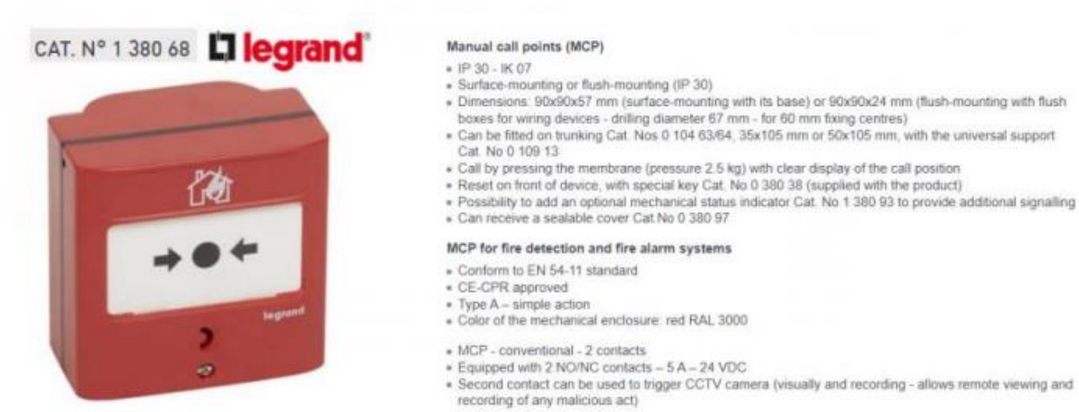


Figure4-484-Manual Alarm System

Sound & Light Alarm System:

Figure4-485-Sound & Light Alarm System

4.5.5 FIRE HOSE CABINET DISTRIBUTION:

A high-pressure hose that carries water or other fire-retardant material such as foam to put out fires. On the outside it is connected to either a fire engine or a fire hydrant. Indoors it can be permanently connected to a building's vertical pipe or plumbing system. It was used in places near emergency exits.

Each fire hose serves about 30 meters.

MODEL	TYPE	HOSE SIZE	HOSE LENGTH	WORKING /SERVICE PRESSURE	BURST PRESSURE
SFSJ40R-UL	Single Jacket	1 ½"	15m, 30m	200 psi	600 psi

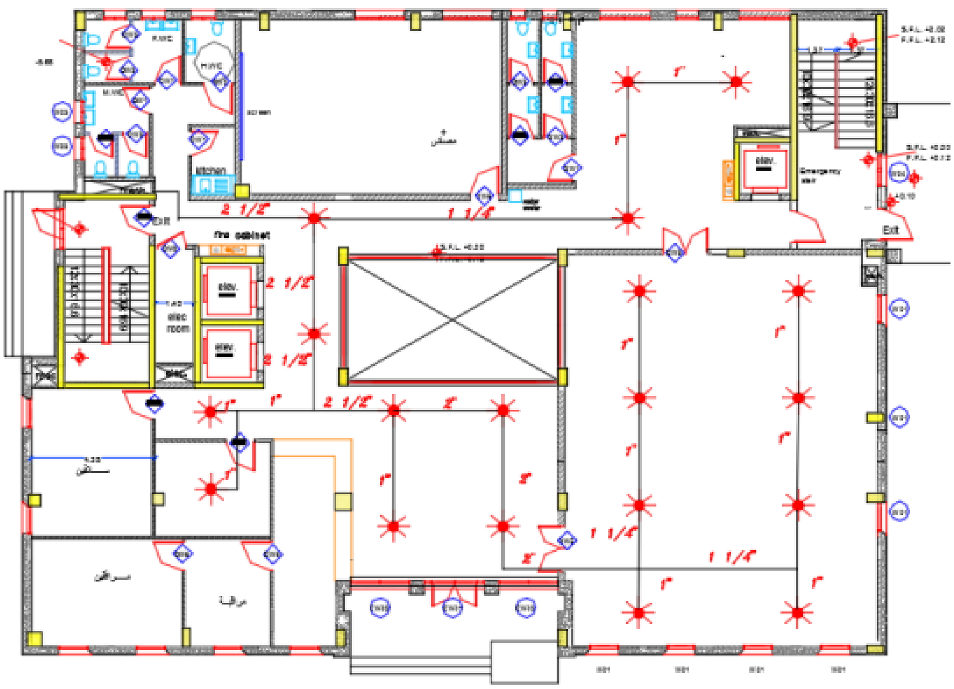
Safety System:

EVACUATION PATHS:

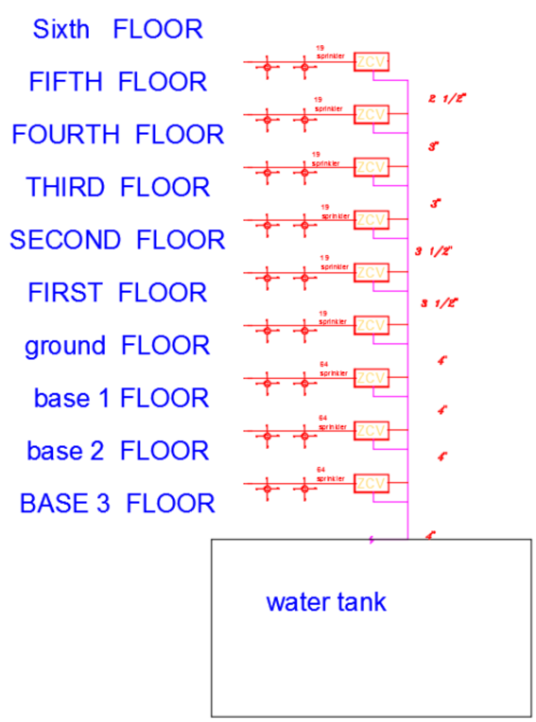
Signs indicate entrances and exits to the building so that visitors can easily access them, and escape quickly in the event of an emergency, thus executing evacuation quickly and minimizing injuries that can result from a fire.

Type	Part number	Dimensions (W x H x D)	Distance	Voltage range	IEC protection class/ IP code
GLO-001	925991.0001	250 x 174 x 34 mm	24 m	230V 50/60Hz, 220V DC +25/-20%	II/IP54
GLO-002	925991.0002	260 x 155 x 70 mm	24 m	230V 50/60Hz, 220V DC +25/-20%	I/IP54
GLO-003	925991.0003	250 x 178 x 34 mm	22 m	230V 50/60Hz, 220V DC +25/-20%	II/IP54
GLO-004	925991.0004	360 x 92 x 125 mm	16 m	230V 50/60Hz, 220V DC +25/-20%	II/IP54
GLO-005	925991.0005	236 x 181 x 64 mm	24 m	230V 50/60Hz, 220V DC +25/-20%	I/IP40

4.5.6 sprinkle distribution:



vertical system:



4.6 Water supply system:

4.6.1 Introduction:

One of the main systems that must done in each building to achieve the requirements and needs of the building and its users is the water supply system. It is very important to design it integrated with the other systems to avoid conflicts.

The design will contain water installations and calculate the amount of water needed inside the building. The diameters of the pipes and the pressure required for water in the floors were calculated, and auxiliary pumps were used.

A boiler was used for hot water.

TABLE 20.2 Planning Guide for Water Supply[a]

	Per Capita (as Listed) Daily Usage	
Building Usage	**Gallons**	**Liters**
Airports (per passenger)	3–5	11–19
Apartments, multiple-family (per resident)	60	227
Bath houses (per bather)	10	38
Camps		
Construction, semipermanent (per worker)	50	189
Day with no meals served (per camper)	15	57
Luxury (per camper)	100–150	378–568
Resorts, day and night, with limited plumbing (per camper)	50	189
Tourist, with central bath and toilet facilities (per person)	35	132
Cottages with seasonal occupancy (per resident)	50	189
Courts, tourist, with individual bath units (per person)	50	189
Clubs		
Country (per resident member)	100	378
Country (per nonresident member present)	25	95
Dwellings		
Boardinghouses (per boarder)	50	189
Additional kitchen requirements for nonresident boarders	10	38
Luxury (per person)	100–150	378–568
Multiple-family apartments (per resident)	40	151
Rooming houses (per resident)	60	227
Single family (per resident)	50–75	189–284
Estates (per resident)	100–150	378–568
Factories (per person per shift)	15–35	57–132
Highway rest area (per person)	5	19
Hotels with private baths (two persons per room)	60	227
Hotels without private baths (per person)	50	189
Institutions other than hospitals (per person)	75–125	284–473
Hospitals (per bed)	250–400	946–1514
Laundries, self-service (per washing)	50	189
Livestock (per animal)		
Cattle (drinking)	12	45
Dairy (drinking and servicing)	35	132
Goat (drinking)	2	8
Hog (drinking)	4	15
Horse (drinking)	12	45
Mule (drinking)	12	45
Sheep (drinking)	2	8
Steer (drinking)	12	45
Motels with bath, toilet, and kitchen facilities (per bed space)	50	189
With bed and toilet (per bed space)	40	151
Parks		
Overnight, with flush toilets (per camper)	25	95
Trailer, with individual bath units, no sewer connection (per trailer)	25	95
Trailer, with individual baths, connected to sewer (per person)	50	189
Picnic		
With bath houses, showers, and flush toilets (per picnicker)	20	76
With toilet facilities only (per picnicker)	10	38
Poultry		
Chickens (per 100)	5–10	19–38
Turkeys (per 100)	10–18	38–68
Restaurants with toilet facilities (per patron)	7–10	26–38
Without toilet facilities (per patron)	2½–3	9–11
With bar/cocktail lounge (additional quantity per patron)	2	8
Schools		
Boarding (per pupil)	75–100	284–378
Day, with cafeteria, gymnasium, and showers (per pupil)	25	95
Day, with cafeteria but no gymnasiums or showers (per pupil)	20	76
Day, without cafeteria, gymnasiums, or showers (per pupil)	15	57
Service stations (per vehicle)	10	38
Stores (per toilet room)	400	1514
Swimming pools (per swimmer)	10	38
Theaters		
Drive-in (per car space)	5	19
Movie (per auditorium seat)	5	19
Workers		
Construction (per person per shift)	50	189
Day (school or office, per person per shift)	15	57

Figure4-486-water supply (Grondzik, Kwok, Stein, & Reynolds, 2010, P.872)

In a building, 57 liters per person is needed for water supply in a day. The largest number of users of the building per day is about 235 users, the total daily water needed is 13395 liters/day, which equal 13.40 m3 /day.

As a result, water is pumped from the municipality every 4 days so it's important to take care that water will never end on a non-pumped day, so we put roof tanks to store water for 5 days at least. Our building considered as commercial building so we need 5 tank.

Figure4..5:the tank use

4.6.2 Domestic hot water consumption:

TABLE 21.10 Domestic Hot Water, Commercial/Institutional

Type of Building	Maximum Hour	Maximum Day	Average Day
Men's dormitories	3.8 gal (14.4 L)/student	22.0 gal (83.4 L)/student	13.1 gal (49.7 L)/student
Women's dormitories	5.0 gal (19 L)/student	26.5 gal (100 L)/student	12.3 gal (46.6 L)/student
Motels: no. of units[a]			
20 or less	6.0 gal (23 L)/unit	35.0 gal (132.6 L)/unit	20.0 gal (75.8 L)/unit
60	5.0 gal (20 L)/unit	25.0 gal (94.8 L)/unit	14.0 gal (53.1 L)/unit
100 or more	4.0 gal (15 L)/unit	15.0 gal (56.8 L)/unit	10.0 gal (37.9 L)/unit
Nursing homes	4.5 gal (17 L)/bed	30.0 (114 L)/bed	18.4 gal (69.7 L)/bed
Office buildings	0.4 gal (1.5 L)/person	2.0 gal (7.6 L)/person	1.0 gal (3.8 L)/person
Food service establishments:			
Type A—full meal restaurants and cafeterias	1.5 gal (5.7 L)/max meals/h	11.0 gal (41.7 L)/max meals/h	2.4 gal (9.1 L)/avg meals/day[b]
Type B—drive-ins, grilles, luncheonettes, sandwich and snack shops	0.7 gal (2.6 L)/max meals/h	6.0 gal (22.7 L)/max meals/h	0.7 gal (2.6 L)/avg meals/day[b]
Apartment houses: no. of apartments			
20 or less	12.0 gal (45.5 L)/apt.	80.0 gal (303.2 L)/apt.	42.0 gal (159.2 L)/apt.
50	10.0 gal (37.9 L)/apt.	73.0 gal (276.7 L)/apt.	40.0 gal (151.6 L)/apt.
75	8.5 gal (32.2 L)/apt.	66.0 gal (250 L)/apt.	38.0 gal (144 L)/apt.
100	7.0 gal (26.5 L)/apt.	60.0 gal (227.4 L)/apt.	37.0 gal (140.2 L)/apt.
200 or more	5.0 gal (19 L)	50.0 gal (195 L)/apt.	35.0 gal (132.7 L)/apt.
Elementary schools	0.6 gal (2.3 L)/student	1.5 gal (5.7 L)/student	0.6 gal (2.3 L)/student[b]
Junior and senior high schools	1.0 gal (3.8 L)/student	3.6 gal (13.6 L)/student	1.8 gal (6.8 L)/student[b]

Figure4-487-Domestic hot water consumption (Grondzik, Kwok, Stein,& Reynolds, 2010, P.944).

In a building, 3.8 liters per student is needed for water supply in a day. The largest number of users of the building per day is about 230 users, the total daily water needed is 900 liters/day, which equal 0.9 m3 /day.

Diameter calculation:

floor	0	1	2	3	4	5	6
pressure(psi)	38.97	33.774	28.578	23.382	18.186	12.99	7.794

Water pressure in a building

4.6.3 Water supply fixture units:

TABLE 21.15 Water Supply Fixture Units (WSFU)

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 lb (3.6 kg)	Private	Automatic	1	1	1.4
Washing machine, 8 lb (3.6 kg)	Public	Automatic	2.25	2.25	3
Washing machine, 15 lb (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

Water Supply Fixture Units (Grondzik, Kwok, Stein, & Reynolds, 2010, P.991)

By using upper figure, calculate total FU for each floor.

floor	WSFU'S	Total WSFU'S
GF +SF+THF	7WC'S*5	**53**
	7 lavatory*2	
	1kitchen sink*4	
FIRST+4F+5F	6WC'S*5	**46**
	6 lavatory*2	
	1kitchen sink*4	
6F	6WC'S*5	**81**
	6 lavatory*2	
	1kitchen sink*4	
total		**378**

Water flow rates:

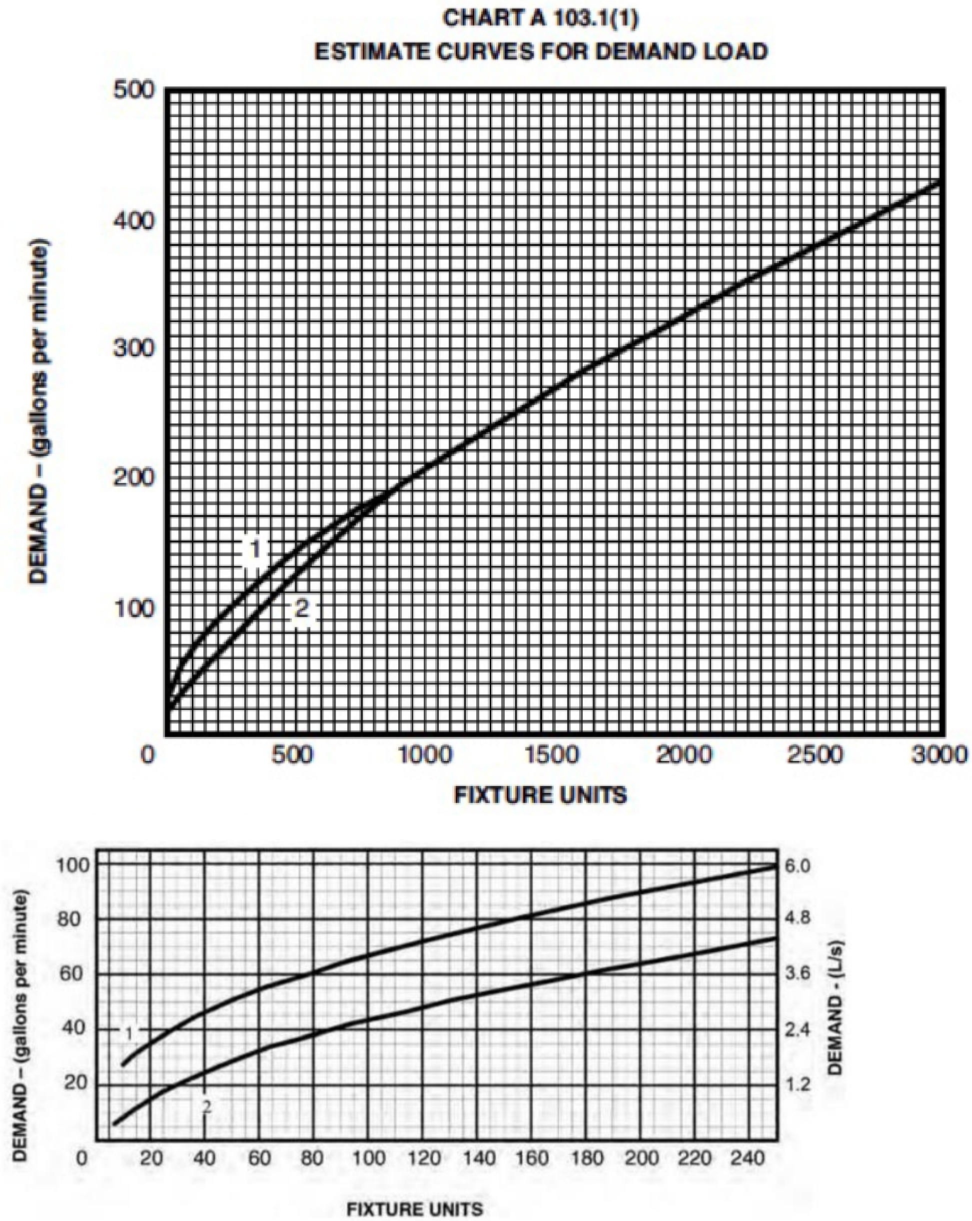


Figure 4-82Water flow rate (Grondzik, & Kwok, 2015, P.919)

From upper figure, determined water flow rate for vertical, horizontal & branches for each floor.

pipe	FU	water flow
GF+SF+THF		
vertical	378	80
horizantal	53	30
branch	5	5
FF+4F+5F		
vertical	378	80
horizantal	46	25
branch	5	5
Pipe	6F	
vertical	378	80
horizantal	81	40
branch	5	5

Determined diameter pipe& pressure drop

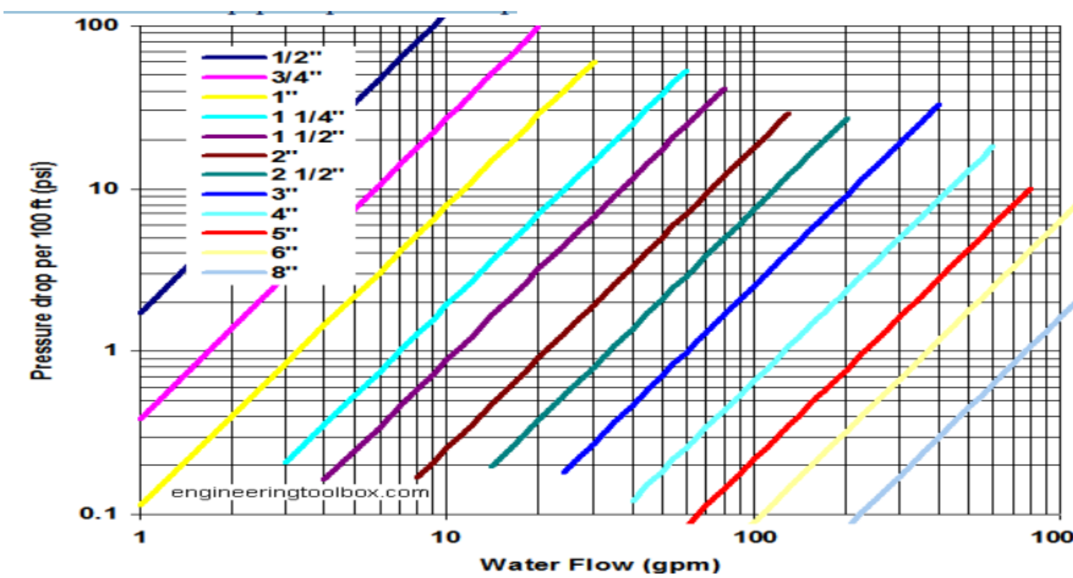


Figure4-489-Diameter & pressure drop per 100 ft(psi) for steel pipe

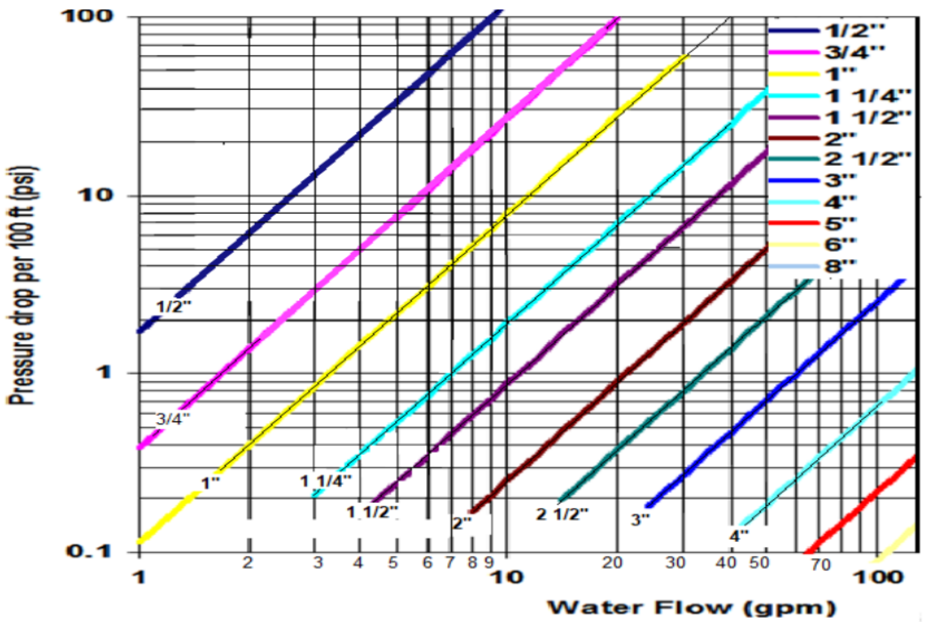
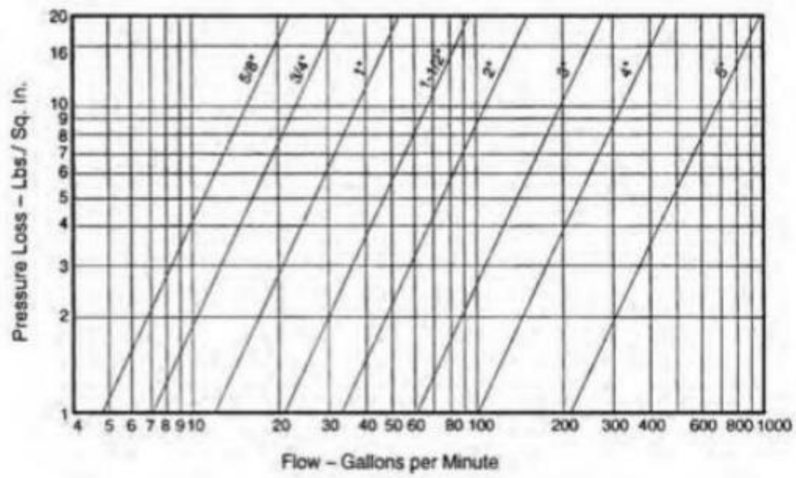
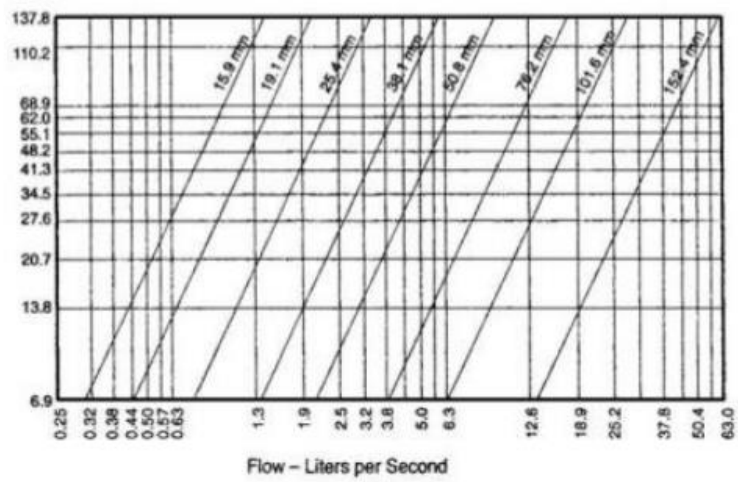


Figure 4-83Diameter & pressure drop per 100 ft(psi) for plastic pipe

Friction Pressure Loss in Water Meters



(a)



(b)

from upper figure, determined possible diameter for vertical, meter, horizontal & branches.

pipe	material	A.L(ft)	E.L(ft)
vertical	steel	81.85696	**122.7854**
horizontal	pvc	20	**24**
branch	pvc	30	**36**

Water flow rate (vertical) = 80 gpm

inch	4''	3''	2 1/2''	2''
loss/100	0.4	1.6	5	**9**
loss/122.79	0.49116	1.96464	6.1395	**11.0511**

possible diameter for vertical pipe with pressure losses for zone A

meter diameter	1 1/2''	1''	3/4''
Pressure loss (psi)	2	6	**16**

possible diameter for horizontal pipe (GF+SF+thF) with pressure losses

Water flow rate for GF+SF+thF (horizontal)=30 gpm

inch	3''	2 1/2''	2''	1 1/2''
loss/100	0.28	0.8	2	**7**
loss/24	0.0672	0.192	0.48	**1.68**

possible diameter for horizontal pipe FF+4F+5F

with pressure losses.

inch	3''	2 1/2''	2''	1 1/2''
loss/100	0.2	0.6	1.5	**5**
loss/24	0.048	0.144	0.36	**1.2**

possible diameter for horizontal pipe 6F with pressure losses.

inch	3''	2 1/2''	2''
loss/100	0.6	1.8	**3.2**
loss/24	0.144	0.432	**0.768**

Water flow rate (branch)=5 gpm

inch	1 1/2''	1 1/4''	1''	3/4''
loss/100	0.21	0.54	2	**7**
loss/36	0.0504	0.1296	0.48	**1.68**

Selected pipes:

selected diameter for pipes (GF&tFF&SF) with pressure losses

LINE	vertical	meter	hor.	branch
diameter	4''	1 1/2''	3''	**1 1/2''**
press. Loss	0.4	2	0.07	**0.05**

Total loss=2.52

selected diameter for pipes (4F+5F+FF) with pressure losses for zone

LINE	vertical	meter	hor.	branch
diameter	4''	1 1/2''	3''	**1 1/2''**
press. Loss	0.4	2	0.04	**0.05**

Total=2.49

LINE	vertical	meter	hor.	branch
diameter	4''	1 1/2''	1 1/2''	**1 1/2''**
press. Loss	0.4	2	0.14	**0.05**

Total=2.6

For Ground floor, available pressure is 38.97 psi

The critical pressure is 12 psi

The maximum allowable loss=38.97-12=26.97 psi

The total loss in GF is 2.52 < max loss so it’s ok

26.97-2.52=24.45psi

But we need a limiter 24 psi

For First floor, available pressure is 33.7psi

The critical pressure is 12 psi

The maximum allowable loss =33.7-12=21.7

The total loss in FF is 2.49<max so its ok

21.7-2.49=19.21psi

But we need a limiter 19

For second floor, available pressure is 28.57psi

The critical pressure is 12 psi

The maximum allowable loss =28.57-12=16.57

The total loss in FF is 2.52<max so its ok

16.57-2.52=14.05psi

But we need a limiter 14

For third floor, available pressure is 23.38psi

The critical pressure is 12 psi

The maximum allowable loss =23.38-12=11.38

The total loss in FF is 2.52<max so its ok

11.38-2.52=8.86psi

But we need a limiter 8psi

For 4F floor, available pressure is 18.18psi

The critical pressure is 12 psi

The maximum allowable loss =18.18-12=6.18

The total loss in FF is 2.49<max so its ok

6.18+2.49=3.69psi

NO need a limiter

For 5F floor, available pressure is 12.99psi

The critical pressure is 12 psi

The maximum allowable loss =12.99-12=0.99

The total loss in FF is 2.49>max so its ok

0.99+2.49=3.48psi

But we need a pump 5psi

For 6F floor, available pressure is 7.79psi

The critical pressure is 12 psi

The maximum allowable loss =7.79-12=-4.21

The total loss in FF is 2.49<max so its ok

4.21+2.6=6.8psi

But we need a pump 7psi

4.7 Drainage system design

4.7.1 Introduction:

One of the most crucial systems in every structure is the drainage system. Human comfort and necessities give it prominence. The major goal of this system is to transport waste over a smooth channel to the municipal sewage system.

The accomplishment of the work is impacted by earth geometry. It relies on the land's tropical surface gradient and the hardness or softness of the soil

4.7.2 Problem definition:

This system mainly will connect from toilets and kitchen. Its very important to have a long life system according to its work sensitivity. Its must take care about choosing the material of work, size and location for each.

Design recommendations:

Wc and floor trap need PVC pipe with diameter of 4 inch with slope of 1%. Lavatory, shower, sink need PVC pipe with diameter of 2 inch with slope of 2%

- Maximum distance between manholes is 15m.

After performing the process of distributing water supply pipes inside the building and based on the distribution of furniture, especially laundries and toilets, a process of drawing and designing sewage drainage system according to its type:

1. Gray water gathers in the shower and in the washbasins.

2. Black water: This is the water that accumulates in the toilets and kitchen sink.

3. Storm water: Rainwater fills this reservoir.

TABLE 20.2 Drainage Fixture Units (dfu)

PART A. BY TYPE OF FIXTURE			
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]	

PART B. BY SIZE OF TRAP		
Fixture Drain or Trap Size in.	mm[a]	Drainage Fixture Unit (dfu) Value
1¼	32	1
1½	38	2
2	51	3
2½	64	4
3	76	5
4	102	6

Drainage fixture units (Grondzik& Kwok, 2015, P.945).

From above figure, shown the total drainage fixture unit in a building

floor	WSFU'S	Total WSFU'S
GF +SF+THF	7WC'S*4	37
	7 lavotary*1	
	1kitchen sink*2	
FIRST+4F+5F	6WC'S*4	32
	6 lavotary*1	
	1kitchen sink*2	
6F	11WC'S*4	57
	11lavotary*1	
	1kitchen sink*2	
total		264

TABLE 20.3 Horizontal Fixture Branches and Stacks[a]

Diameter of Pipe			*Maximum Total Number of dfu Allowable*		
			Stacks[b]		
in.	mm[c]	Horizontal Branch	One Branch Interval	Three Branch Intervals or Less	Greater than Three Branch Intervals
1½	38	3	2	4	8
2	51	6	6	10	24
2½	64	12	9	20	42
3	76	20	20	48	72
4	102	160	90	240	500
5	127	360	200	540	1100
6	152	620	350	960	1900
8	203	1400	600	2200	3600
10	254	2500	1000	3800	5600
12	305	3900	1500	6000	8400
15	381	7000	d	d	d

Figure 4-4-84Horizontal Fixture Branches and Stacks (Grondzik& Kwok, 2015, P.946)

TABLE 20.5 Building Drains and Sewers

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%)	⅛ (1.04%)	¼ (2.1%)	½ (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

Figure 4-85Building Drains and Sewers (Grondzik& Kwok, 2015, P.948)

TABLE 20.4 Size and Developed Length of Stack Vents and Vent Stacks

Diameter of Soil or Waste Stack in. (mm)[b]	Total Fixture Units Being Vented (dfu)	*Maximum Developed Length[a] of Vent, Feet (m)[b]* — *Diameter of Vent, In. (mm)[b]* 1¼ (32)	1½ (38)	2 (51)	2½ (64)	3 (76)	4 (102)	5 (127)	6 (152)	8 (203)	10 (254)
1¼ (32)	2	30 (9.1)									
1½ (38)	8	50 (15.2)	150 (45.7)								
1½ (38)	10	30 (9.1)	100 30.5								
2 (51)	12	30 (9.1)	75 (22.9)	200 (61.0)							
2 (51)	20	26 (7.9)	50 (15.2)	150 (45.7)							
21/2 (64)	42		30 (9.1)	100 (30.5)	300 (91.0)						
3 (76)	10		42 (12.8)	150 (45.7)	360 (109.7)	1040 (317)					
3 (76)	21		32 (9.8)	110 (33.5)	270 (82.3)	810 (246.9)					
3 (76)	53		27 (8.2)	94 (28.7)	230 (70.1)	680 (207.3)					
3 (76)	102		25 (7.6)	86 (26.6)	210 (64.0)	620 (189.0)					
4 (102)	43		25 (7.6)	35 (10.7)	85 (25.9)	250 (76.2)	980 (298.7)				
4 (102)	140		25 (7.6)	27 (8.2)	65 (19.8)	200 (61.0)	750 (228.6)				
4 (102)	320			23 (7.0)	55 (16.8)	170 (51.8)	640 (195.0)				
4 (102)	540			21 (6.4)	50 (15.2)	150 (45.7)	580 (176.8)				
5 (127)	190				28 (8.5)	82 (25.0)	320 (97.5)	990 (301.8)			
5 (127)	490				21 (6.4)	63 (19.2)	250 (76.2)	760 (231.6)			
5 (127)	940				18 (5.5)	53 (16.2)	210 (64.0)	670 (204.2)			
5 (127)	1400				16 (4.9)	49 (14.9)	190 (57.9)	590 (179.8)			
6 (152)	500					33 (10.1)	130 (39.6)	400 (121.9)	1000 (304.8)		
6 (152)	1100					26 (7.9)	100 (30.5)	310 (94.5)	780 (237.7)		
6 (152)	2000					22 (6.7)	84 (25.6)	260 (79.2)	660 (201.2)		
6 (152)	2900					20 (6.1)	77 (23.5)	240 (73.2)	600 (182.9)		
8 (203)	1800						31 (9.4)	95 (29.0)	240 (73.2)	940 (286.5)	
8 (203)	3400						24 (7.3)	73 (22.3)	190 (57.9)	729 (222.4)	
8 (203)	5600						20 (6.1)	62 (18.9)	160 (48.8)	610 (185.9)	
8 (203)	7600						18 (5.5)	56 (17.1)	140 (42.7)	560 (170.7)	
10 (254)	4000							31 (9.4)	78 (23.8)	310 (94.5)	960 292.6
10 (254)	7200							24 (7.3)	60 (18.3)	240 (73.2)	740 225.6
10 (254)	11,000							20 (6.1)	51 (15.5)	200 (61.0)	630 192.0
10 (254)	15,000							18 (5.5)	46 (14.0)	180 (54.9)	571 (174.2)

Figure 4-86Size and Developed Length of Stack Vents and Vent Stacks (Grondzik& Kwok, 2015, P.947)

type	diameter(inch)	slope%
vent	4	0
drainage	4	1
sewer	2	1
between manhole	6	1
Vertical stack	4	0
Sewear to manhole	8	1

Figure 4- 87Diameter & slope for type of fixture

4.8 Photovoltaic Analysis and Design

4.8.1 Introduction:

We developed a solar energy system and utilized sunshine to lower the building's power consumption because our buildings consume a lot of energy and have several equipment that require a lot of electricity.

Designing and procedures:

The energy of solar radiation varies according to the geographical location of the site area, our project is located in Palestine, specifically in Ramallah city.

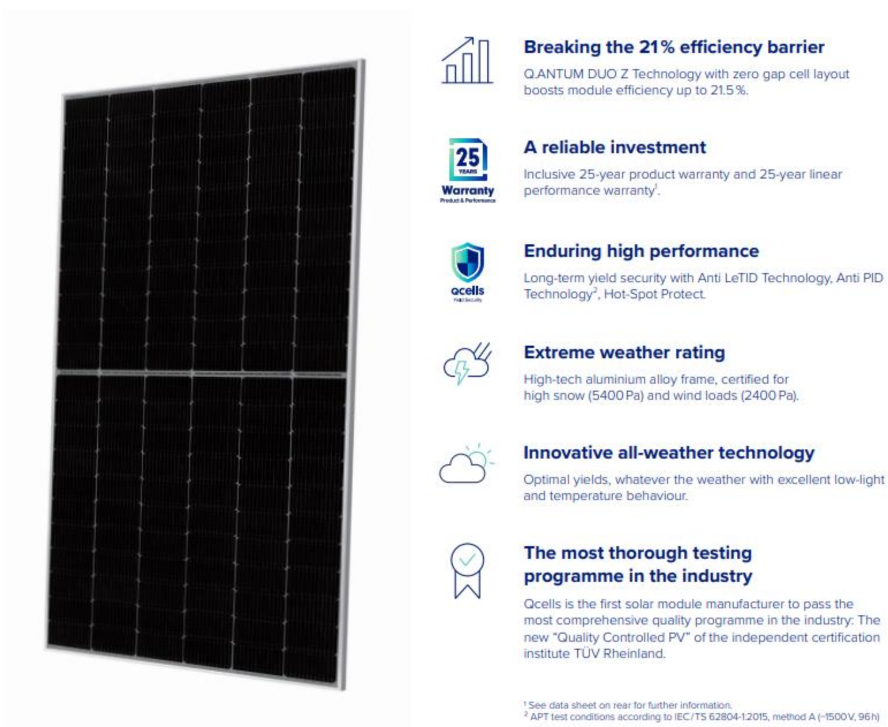
The geographic coordination for the Palestine:

Latitude angle (Palestine) = 32˚.

Longitude angle =35.22°

In Palestine the largest rate of radiation during the year is direct radiation, which is more appropriate for fixing modules as tilted modules.

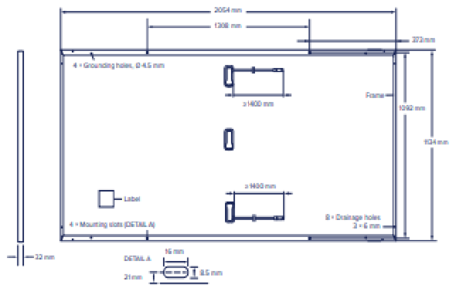
Module selection



:The specification data of the used photovoltaics module.

■ Mechanical Specification

Format	2054 mm × 1134 mm × 32 mm (including frame)
Weight	26.0 kg
Front Cover	3.2 mm thermally pre-stressed glass with anti-reflection technology
Back Cover	Composite film
Frame	Silver anodised aluminium
Cell	6 × 22 monocrystalline Q.ANTUM solar half cells
Junction box	53-101 mm × 32-60 mm × 15-18 mm Protection class IP67, with bypass diodes
Cable	4 mm² Solar cable; (+) ≥1400 mm, (−) ≥1400 mm
Connector	Stäubli MC4-Evo2, Hanwha Q CELLS HQC4; IP68



The mechanical specification data of the used photovoltaics module

■ Electrical Characteristics

POWER CLASS			480	485	490	495	500
MINIMUM PERFORMANCE AT STANDARD TEST CONDITIONS, STC[1] (POWER TOLERANCE +5 W / −0 W)							
Minimum: Power at MPP[1]	P_{MPP}	[W]	480	485	490	495	500
Short Circuit Current[1]	I_{SC}	[A]	13.51	13.54	13.57	13.60	13.63
Open Circuit Voltage[1]	V_{OC}	[V]	45.59	45.62	45.65	45.67	45.70
Current at MPP	I_{MPP}	[A]	12.78	12.83	12.89	12.95	13.00
Voltage at MPP	V_{MPP}	[V]	37.57	37.79	38.02	38.24	38.45
Efficiency[1]	η	[%]	≥20.6	≥20.8	≥21.0	≥21.3	≥21.5
MINIMUM PERFORMANCE AT NORMAL OPERATING CONDITIONS, NMOT[2]							
Minimum: Power at MPP	P_{MPP}	[W]	360.1	363.8	367.6	371.3	375.1
Short Circuit Current	I_{SC}	[A]	10.89	10.91	10.94	10.96	10.98
Open Circuit Voltage	V_{OC}	[V]	43.00	43.02	43.05	43.08	43.10
Current at MPP	I_{MPP}	[A]	10.04	10.09	10.14	10.19	10.24
Voltage at MPP	V_{MPP}	[V]	35.87	36.07	36.26	36.45	36.63

[1]Measurement tolerances P_{MPP} ±3%; I_{SC}; V_{OC} ±5% at STC: 1000 W/m², 25±2 °C, AM 1.5 according to IEC 60904-3 • [2]800 W/m², NMOT, spectrum AM 1.5

The electrical specification data of the used photovoltaics module

The chosen module has a dimension of (2.05*1.130) m. has a maximum power of 500Wp.

In this project, we have630m2 for roof where its area has been exploited and we put 191photovoltaic cells

.

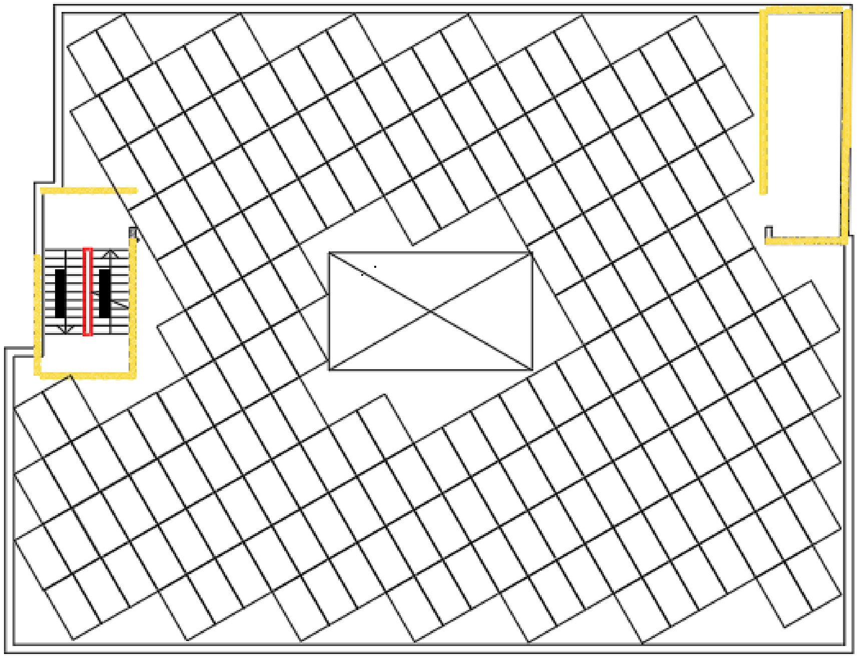
The cells are designed at an angle of 30º tilted portrait. Array power = num. of module *power of module. = 191 * .500 KW = 95.5 KW.

Daily useful energy = peak sun hour * System Efficiency *power peak.

=E = 4.5 *0.8*95.5 = 343.83 KWh/day=125487kwh/year

Cover 30%

The arrangement of the used photovoltaics modules on the roof of the building



We put on parking in gf floor Umbrellas covered with solar panels and we put 86photovoltaic cells

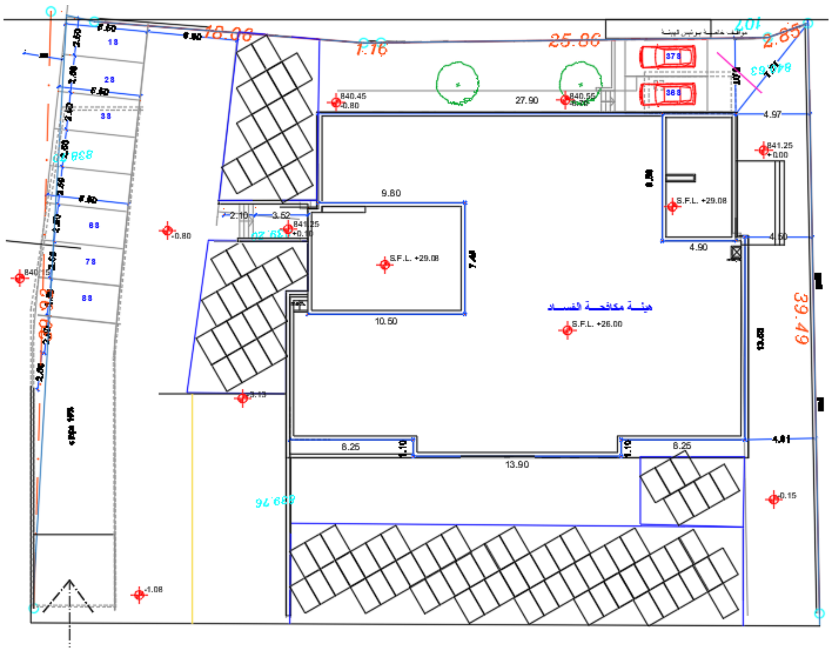
The cells are designed at an angle of 30º tilted portrait. Array power = num. of module *power of module. = 86 * .500 KW = 44 KW.

Daily useful energy = peak sun hour * System Efficiency *power peak.

=E = 4.5 *0.8*44 = 159 KWh/day=57818kwh/year

Cover 19%

The arrangement of the used photovoltaics modules on theUmbrellas covered the parking of car



4.8.2 The inverter selection:

The required power of the inverters (kW) =0.9 * The array power (kW).

=0.9*95.5=85.95KW

For pv in parking

The required power of the inverters (kW) =0.9 * The array power (kW)

=0.9*44=39.6

Output side			
AC Grid connection type	Three phase (3W+PE or 4W+PE)		
Earthing system	TN-S, TN-C, TN-CS, TT		
Rated AC power (Pacr @cosf=1)	10000 W	12500 W	15000 W
Maximum AC output power (Pacmax @cosf=1)	10000 W	12500 W	15000 W
Maximum apparent power (Smax)	10000 VA	12500 VA	15000 VA
Rated apparent power (Sr)	10000 VA	12500 VA	15000 VA
Maximum reactive power (Qmax)	6000 VAR	7500 VAR	9000 VAR
Nominal power factor and adjustable range	> 0.995; 0,8...1 inductive / capacitive		
Rated AC grid voltage (Vac,r)	380V, 400V [1]		
Rated Output Current (Iac nom)	14.5 A	18.1 A	21.7 A
Maximum AC output current (Iac,max)	16 A	20 A	23 A
Contributory fault current	Iac,max x 1,15		
Rated output frequency (fr)	50 Hz / 60 Hz		
Output frequency range (fmin...fmax)	47...53 Hz / 57...63 Hz [2]		
Total harmonic distortion of current	<3%		
Max DC Current Injection (% of Iac,max)	< 0.5%*Iac,max		
Maximum AC cable	16 mm^2 copper		
AC connection type	AC quick fit connector		
Output protection			

The rated output power of the inverter = 15000 W.

The required number of inverters = The total inverters power $/ The output rated power of each inverte$

=85.95/15=6

We need 6inverters.on roof

On parking:

The required number of inverters = The total inverters power $/ The output rated power of each inverte$

=39.6/15=3 We need 3inverters.

5 Quantity surveying and cost estimation :

5.1 introduction :

Estimating costs is one of the most crucial and accurate things that is done before the implementation of any project .after developing every aspect of our building, including the architectural, mechanical, structural, environmental, electrical, HVAC, safety, and firefighting systems, we still need to reach our goal by providing our professors with cost and quantity estimations.

5.2 methodology :

This procedure will be carried out by creating a bill of quantities for all materials and labor utilized in the project, then estimating each material and labor, and finally determining the total cost.

the following table shows The bill of quantities for the faculty schedule, which includes labor costs as well as quantity and unit costs = 11,127,123 NIS

Tabular cost breakdown structure :

the following table shows the bill of quantity and costs ;

	Item description	Unit	quantity	Unit cost				Total cost
ID	Item description	unit	quantity	Material unit cost	Material total cost	Labor unit cost	Labor total cost	Total cost
1	structure							
1.1	sub structure							
1.1.1	earth work							
1.1.1.1	excavation work	cm	17022	35	595770	…..		595770
1.1.1.2	disposal work	cm	25533	35	893655	……		893655
1.1.1.3	Backfilling work	cm	1046	35	36610			36610
1.1.1.4	mobilization	lump sum						30000
1.1.1.5	soil test	lump sum						3000
1.1.2	foundation							
1.1.2.1	footing							
1.1.2.1.1	single footing							
1.1.2.1.1.1	form work	sm	115	2.6	299	9.6	1104	1403
1.1.2.1.1.2	reinforcement	ton	3	4200	12600	800	2400	15000
1.1.2.1.1.3	concert	cm	90	300	27000	14	1260	28260
1.1.2.1.1.4	water proofing	sm	240	7	1680	6.84	1641.6	3321.6
1.1.2.1.1.5	blinding form work	sm	13	2.6	33.8	9.6	124.8	158.6

	Item description	Unit	quantity	Unit cost				Total cost
ID	Item description	unit	quantity	Material unit cost	Material total cost	Labor unit cost	Labor total cost	Total cost
1.1.2.1.1.6	blinding concert	cm	11	300	3300	14	154	3454
1.1.2.1.2	mat +wall footing							
1.1.2.1.2.1	form work	sm	348	2.6	904.8	9.6	3340.8	4245.6
1.1.2.1.2.2	reinforcement	ton	40	4200	168000	800	32000	200000
1.1.2.1.2.3	concert	cm	672	300	201600	14	9408	211008
1.1.2.1.2.4	water proofing	sm	1117	7	7819	6.84	7640.28	15459.28
1.1.2.2	columns neck							
1.1.2.2.1	form work	sm	104	2.6	270.4	9.6	998.4	1268.8
1.1.2.2.2	steel	ton	4.3	4200	18060	800	3440	21500
1.1.2.2.3	concert	cm	14	300	4200	14	196	4396
1.1.2.2.4	water proofing	sm	105	7	735	6.84	718.2	1453.2
1.2	super structure							
1.2.1	structural element							
1.2.1.1	columns and shear walls							
1.2.1.1.1	columns form work	sm	2689	2.6	6991.4	9.6	25814.4	32805.8
1.2.1.1.2	column reinforcement	ton	80	4200	336000	800	64000	400000
1.2.1.1.3	column concert	cm	279	300	83700	14	3906	87606
1.2.1.1.4	S.W form work	sm	3158	2.6	8210.8	9.6	30316.8	38527.6
1.2.1.1.5	S.W reinforcement	ton	127	7	889	800	101600	102489
1.2.1.1.6	S.W concert	cm	435	300	130500	14	6090	136590
1.2.1.2	Basement 3 slab							
1.2.1.2.1	form work	sm	3369	2.6	8759.4	9.6	32342.4	41101.8
1.2.1.2.2	steel slab and ground beams	ton	15	4200	63000	800	12000	75000
1.2.1.2.3	concert slab and ground beams	cm	260	300	78000	14	3640	81640
1.2.1.2.4	water proofing slab and ground beams	sm	2431	7	17017	6.84	16628.04	33645.04
1.2.1.3	basement 2/basement 1 slab							
1.2.1.3.1	form work	sm	3369	2.6	8759.4	9.6	32342.4	41101.8
1.2.1.3.2	steel	ton	10	4200	42000	800	8000	50000
1.2.1.3.3	concert	cm	465	300	139500	14	6510	146010
1.2.1.3.4	# of blocks	block	2007	7	14049	1	2007	16056
1.2.1.3	typical story slab g.f/6							
1.2.1.3.1	form work	sm	4563	2.6	11863.8	9.6	43804.8	55668.6
1.2.1.3.2	steel	ton	29	4200	121800	800	23200	145000
1.2.1.3.3	concert	cm	1177	300	353100	14	16478	369578
1.2.1.3.4	# of blocks	block	4952	7	34664	1	4952	39616
1.2.1.4	Stair work							
1.2.1.4.1	formwork	sm	376	2.6	977.6	9.6	3609.6	4587.2
1.2.1.4.2	steel	ton	4.5	4200	18900	800	3600	22500
1.2.1.4.3	concert	cm	92	300	27600	14	1288	28888
1.2.1.5	Ramp							
1.2.1.5.1	formwork	sm	630	2.6	1638	9.6	6048	7686
1.2.1.5.2	steel	ton	5	4200	21000	800	4000	25000
1.2.1.5.3	concert	cm	165	300	49500	14	2310	51810
1.2.1.6	basement wall							
1.2.1.6.1	formwork	sm	3153	2.6	8197.8	9.6	30268.8	38466.6
1.2.1.6.2	steel	ton	30	4200	126000	800	24000	150000
1.2.1.6.3	concert	cm	464	300	139200	14	6496	145696
1.2.1.7	Beams							
1.2.1.7.1	steel	ton	83	4200	348600	800	66400	415000

	Item description	Unit	quantity	Unit cost				Total cost
ID	Item description	unit	quantity	Material unit cost	Material total cost	Labor unit cost	Labor total cost	Total cost
1.2.1.8	water tank							
1.2.1.8.1	formwork	sm	50	2.6	130	9.6	480	610
1.2.1.8.2	steel	ton	6.5	4200	27300	800	5200	32500
1.2.1.8.3	concert	cm	33	300	9900	14	462	10362
1.2.1.9	sheet piles							0
1.2.1.9.1	steel	ton	281	4200	1180200	800	224800	1405000
1.2.1.9.2	concert	CM	1197	300	359100	14	16758	375858
1.2.1.9.3	excavation work	CM	1197	50	59850			59850
1.3	Non -structural element							
1.3.1	internal partition							0
1.3.1.1	block	sm	3129	19	59451	20	62580	122031
1.3.1.2	insulation volume	cm	156	350	54600	20	3120	57720
1.3.2	external wall							
1.3.2.1	block	sm	2360	19	44840	20	47200	92040
1.3.2.2	stone	sm	2360	120	283200	34	80240	363440
1.3.2.3	concert	cm	236	300	70800	20	4720	75520
1.3.2.4	insulation volume	cm	118	350	41300	20	2360	43660
1.4	OUT SIDE WORK							
1.4.1	Pavement	sm	105	1000	105000			105000
1.4.2	asphalt	sm	1312	50	65600			65600
1.4.3	base coarse	cm	326	600	195600			195600
3								

	Item description	Unit	quantity	Unit cost	Total cost
	Electrical Work				
	Wires 1.5 mm.	M.R	3300	5	16500
	Single Switch	Unit	58	95	5510
	double Switch		88	100	8800
	Electrical generator	Unit	3	5000	15000
	Distribution board	Unit	17	2700	45900
	Lamps (luminaiure)	Unit	804	150	120600
	Photovoltaic modules	Unit	277	600	166200
	Inverts	Unit	9	3000	27000
	Sockets	Unit	142	115	16330
	Mechanical and HVAC system				
	PVC pipes-4"	M.R	120	4	480
	PVC pipes-6"	M.R			0
	Tanks	Unit	5	350	1750
	Tank support	Unit	5	300	1500
	manholes	Unit	3	110	330
	roof drain water pipe 2 inch	Unit	5	25	125
	Floor drain	Unit	40	33	1320
	Roof drain	Unit	5	25	125
	Split unit	Unit	60	2000	120000
	Fan coil	Unit	27	4000	108000
	elevators	Unit	3	100000	300000
	Lavatory	Unit	47	1000	47000
	WC cabinet	Unit	47	1800	84600
	Handicapped lavatory	Unit	7	1200	8400
	Handicapped WC cabinet	Unit	7	1700	11900
	meter		6	150	900
	collectors		6	150	900
	Firefighting system Cost				
	Firehouse				

	Item description	Unit	quantity	Unit cost				Total cost
ID	Item description	unit	quantity	Material unit cost	Material total cost	Labor unit cost	Labor total cost	Total cost
	extinguisher type A	unit	42	100				4200
	fire sprinkler	unit	160	40				6400
	Firehouse	M.R	14	600				8400
	4 inch pipe	M.R	165	20				3300
	2 1/2 inch pipe	M.R	3	15				45
	3inch pipe	M.R	14	15				210
	3 1/2 inch pipe	M.R	5	20				100
	1 inch pipe	unit	120	8				960
	emergency sign	unit	35	30				1050
	jockey pumb	unit	1	200				200
	electrical pumb	unit	1	350				350
	Fire Alarm Panel	unit	6	50				300
	Heat Detector	unit	150	20				3000
	Smoke detectors	unit	40	30				1200
	Fire alarm manual station		65	100				6500
	external finishes							
	Building Stone	SM	1,314	120				157680
	Windows & Door Sills	M.R	265	260				68900
	Stone Joints	CM	72.4	470				34028
	Concrete	CM	2604	300				781200
	Insulation	CM	744	350				260400
	Block	unit	4860	2.5				12150
	Internal finishes							
	partitions	SM	3797.5					
	Plastering	SM	5375	17				91375
	Painting	SM	6870	17				116790
	Ceiling plastering	SM	5200	17				88400
	Floor tiling	SM	4200	85				357000
	Paving for Basement	SM	70	40				2800
	Curb stone for parking	M.R	75	50				3750
	Aluminum louvers	units	200	30				6000
	Curtain walls	SM	850	900				765000
	Aluminum for windows	SM	866	600				519600
	Hanging wood door	unit	65	1200				78000
	Single fire resisting door	unit	7	2000				14000
	External Steel Doors	unit	2	1000				2000
	Stair marble	MR	308	250				77000
	Glazing Doors	Unit	2	1600				3200

5.3 Summary:

The outcomes of gathering complete information about the building and estimating the cost can be stated as follows:

total cost of the building = 11,127,123 NIS

Unit cost = 1300 NIS $/m^2$

6 Conclusion:

The first stage of the project was looking for requirements and standards for public offices and commercial constructions utilizing NEUFERT ARCHITECTS' DATA and METRIC HANDBOOK PLANNING AND DESIGN DATA.

Following that, a design for all required fields was created.

Architectural aspect:

The building's horizontal and vertical circulation was investigated. The linkages of the spaces to one other and the extent of the spaces in the building were also evaluated, and changes were made to ensure that they met the standards.

Environmental aspect:

The environmental factors impacting this project were analyzed in terms of orientation, shading, cooling and heating and the daylight factor in this section of the project, and the required alterations were made so that the daylight within the building meets the criteria.

Structural aspect:

All structural elements in this project were properly designed in accordance with the ACI 318-14 and UBC 97 regulations, and all structural and seismic inspections were completed satisfactorily.

Electro-Mechanical aspect:

In order to improve the facility and meet the project's needs, a number of systems, including artificial lighting, HVAC, power, water, drainage, and vertical transportation, were designed in this section of the project.

Quantity surveying and Cost Estimate:

The last phase of the project involved calculating the overall project cost with the highest level of accuracy feasible. It was discovered that the total project cost is 11,127,123 NIS , with a unit cost of 1300 NIS $/m^2$

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