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

Graduation Project 2
"Integrated design of a Bank building"

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Dedication

All praise be to ALLAH.

To give us the knowledge and health to complete our first graduation project research.

We offer this work to our first and true source of inspiration, to the prayers and supplications of our fathers and mothers, and to our dear doctors and assistant engineers, to all of you.

We hope that this project will impress you and fulfill all the required requirements.

We ask God to help us with more knowledge to be effective and useful in the long run.

Acknowledgment

We are students of the Department of Construction Engineering; we thank all the doctors for Helping and supporting us to reach this rank, who endeavored a lot to guide and lead the students and help them correct their paths .We are honored and pleased to thank the Department of Construction Engineering and all the trainers in the department. A special mention goes to our supervisor, Dr. Luay Dwaikat who was credited with helping us solve our problems.

We are pleased to thank everyone who was involved in directing us to do the work, helping us and providing us with the required information.

Disclaimer

This report was written by Nasser Abu Baker, Mazen Abd Al-Haq, and Ali Zawawi 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 students. 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

Due to all the advantages and the role it plays in preventing future small or catastrophic consequences, integration design in buildings is a crucial component of any design stage in the modern building industry.

The project we decided to work on is called "BANK." The primary factor that led to the selection of this project was its significance, particularly in light of the fact that banks have grown to play a significant role in Palestinian society and have altered the course of developing nations and contributed to their development. Because of their significance, banks must be made a comfortable and secure environment for both employees and visitors. This project presented us with a worthwhile challenge in creating an integrated.
We found this project to be a good challenge in creating an integrated building design that manages to combine all aspects of the environmental, architectural, and structural design in the best possible way to achieve the highest level of energy efficiency and the best comfort for those who will use the building. This will allow the building to be environmentally friendly and be regarded as a green building. Along with ensuring that the initial cost of the building and the operating costs remain within the bounds of reason and even attempt to make it as low as we can, all these goals will be met.

By comparing, modifying, and gathering data using engineering software programs like Revit and Design Builder as well as construction simulation programs like ETAB and SAP, we will assess the building and the site.

Chapter 1: introduction:

This institution is considered as administrative building in which employees work to provide services to the concerned parties in the community.

The project we chose can provide many challenges and problems especially in the Palestinian offices building style.

Many of these challenges came from the limited and low budget that came with these kinds of projects which leads in most cases in delaying the project completion date, and sometimes the delay extends to months or even years, and in other times, part of the project is excluded, such as dispensing a floor or part of the building due to lack of budget.

In this project, we will apply all the knowledge and theories we've been learning among all 4 years in the college to come up with an optimum design in all the disciplines of engineering which are the structural, architectural, electrical and mechanical.

1.1 Definition of the building project:

The building lies in Nablus city specifically in Rafidia, the South façade of the building faces the main road on Rafidia St., the Western façade faces the Tunisia St., the North faces a building and eastern side faces a building away 6 meter which means the building lies at a corner.

The building consists of 5 stories including the ground floor besides another 3 stories as basements which make the total number of floors as 8 floors.

- ground floor with an area 944 $m^{2,}$ first floor with an area 944 $m^{2,}$ second floor with an area 944 $m^{2,}$ third floor with an area 944 $m^{2,}$ fourth floor within area 442 $m^{2,}$ then it contains 3 floors basement as a parking, money safes and offices, B1, B2, B3 within an area for each of them equal 1982.3 m^2. The total area of project is about 10,165 $m^{2.}$
- There are 22 car parking outside the building on the site level.
- We have 2 main entrances in the west side of the building another entrance is on the south side, and there is an 2 emergency exit on the west and on the north.
- There are 5 elevators in the building.

- The main stairs are the same are the emergency stairs, located in the north side of the building.
- The high of the (G.F – 4^{th}) = 4 meter
- Basements = 3.5 m

1.2 Project Problems:

Weaknesses and problems in this building will be determined based on international standards for building and codes that are followed in Palestine, the problems will be analyzed, discussed and calculated using numbers in order to figure out the best solution and make sure that this solution won't make any kind of problems in the future.

The building will also be analyzed in terms of energy consumption and environmental aspects to ensure that there are no problems that may affect the comfort of residents and workers in the building.

Many problems were found in this building, they are:

1- Energy effectiveness of the building
2- Thermal, lighting and acoustical comfort
3- Earthquake resistance
4- Internal distribution of spaces
5- Effective natural ventilation

1.3 objective:

The main aim of this project is to analyze the building and figure out the problems, mistakes and weaknesses in order to provide a new premium integrated design based on the solutions that we will chose according to the standards so we can reach a better level of comfort for the users and employees in this building, it's also recommended to provide new improvements In order to improve and reduce energy consumption in the building and make it an environmentally friendly building, all these improvements and changes must be made along with taking into account that the initial cost of the project and the operating cost will be within the reasonable limits and will even decrease.

1.4 Limitation and scope:

The main scope is analyzing the building from all aspects to reach a premium and integrated design that can solve the problems and strengthen weaknesses of the building.

We faced many obstacles among preparing this project, the most important of them are:

1- Shading of other buildings and specially the one that lies next to the southern façade which will lead to many problems especially in the environmental aspect.
2- Lack of data on building users.

1.5 Methodology:

Similar building designs were used for evaluating our project's current design in all different aspects, so we can build a wide & whole picture about this type of buildings and their function. To make our new changes and improvements based on a solid ground which was made of other designer's mistakes and ideas to avoid falling in the same mistakes again.

After checking the standards, we will be able figure out some efficient solutions for the problems that we will face when we start analyzing the building in all different aspects.

In this project we will evaluate the building and figure out the compliance of the building to the international codes and how much it matches the standards in all different aspects starting from the architectural design then through the structural, mechanical, electrical and environmental design.

After that we will point out the problems and weaknesses so we can provide the available solution to make them right in an integrated method so we can make sure that every solution we provide in any issue won't make any problems neither in the same issue nor in another to reach a premium design for the building in all aspects.

We will make sure that the improvements we will make will be within the reasonable and available borders and that they won't lead to any kind of damages or losses in the future. About the energy manner, we will make some improvements to reduce the building's energy consumption and make it as environmentally friendly as possible.

Finally, the initial cost of the building will be improved in a way to make the operational cost less though all the improvements that we will provide in all previous manners so we can reach the premium comfort for users and employees in the building.

1.6 Codes and standards:

In Architectural design:

1. Ernst and Peter Neufert Architects' Data Forth Edition.

2. The Metric handbook for David Littlefield.

3. (IBC Code)2018 International Building Code)

4. Time saver standards for building types 2nd Edition. 5. Time savor standards for architectural design data 7th edition.

In Structure design:

1. ACI-318 (for concrete reinforcement design).

2. UBC-97 (for Earthquakes Load).

3. ASCE (for load combinations).

In Energy and Mechanical system:

1. ASHREA 90.1 2016.

2. ASHREA 55.5

Chapter 2: Architectural - Environmental Aspects & Analysis:

2.1 Environmental Aspects & Analysis:

2.1.1 Site analysis:

2.1.1.1 Introduction:

The Arab Bank is in Nablus, Rafidia St. the building area 10165 m^2, contains offices, waiting halls, basements and safes of the money.

It is important to analyze the site because it helps to know appropriate orientation for the building, there are many things that affects site, the movement of the sun, shadows, noise, entrances, exits and access to the site, as well as the humidity of the area and rainfall, where all these things must be treated carefully to obtain comfort for the users.

Location and description & Site accessibility & Site roads:

The building is being constructed in Rafidia- Nablus in front of al Tel Al Akhdar store and its longitude 35.31 and latitude of 31.78.

The building is in active and its crowded place due to its location next to a church and a Sbaitani center, as the movement is crowded during the expected working hours of the institution and the movement as it is a central area in the city.

The most active sides form the building are bordered by a street from the south and west side of the main street on the east side is a street.

As the building is located on a corner, where it borders two main streets from the south and from the west and is expected to be a source of high nuisance and on the west side there is a church building that will affect the wind stream negatively partially, and from the north side there is an empty land with a residential building also from east side there is building away 8 meters.

The building is set back from the western side, which is the main street 3 meters, and it is set back from the north, which is adjacent to the empty land the residential building, 3 meters, and it is set back from the eastern side, 4 meters, and it is set back from the south side, which is the main side to the building and adjacent to the street 5 meter.

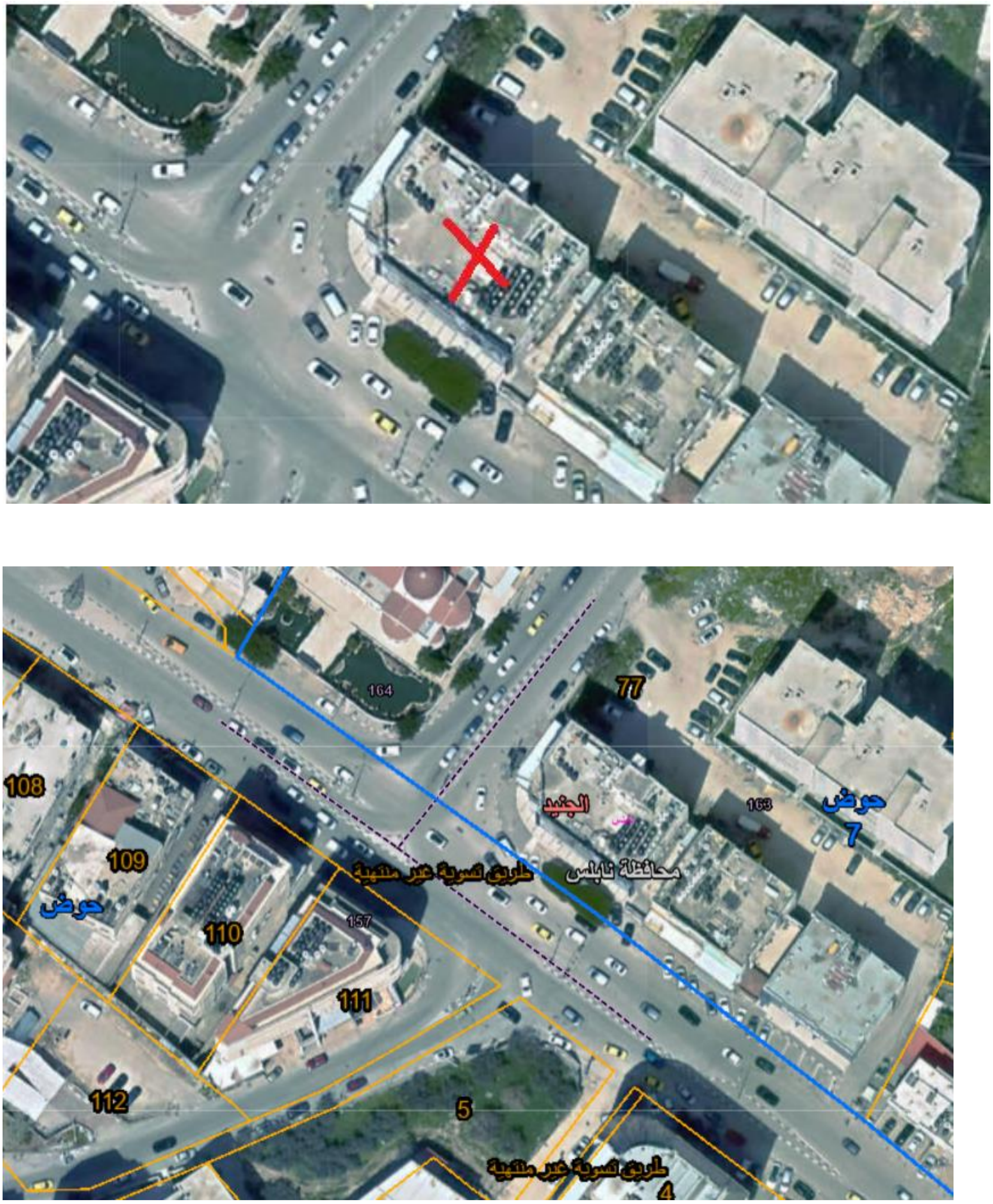


figure 2. 1: An aerial photo showing the site, location and the surrounding lands of the project (Geomolg)

2.1.1.2 Topography:

There is a very slight slope to the land, as the lowest point is at a height of 558 and the highest point is at a height of 560, meaning that the land is almost flat.

figure 2. 2: topography.

2.1.1.3 Temperature:

The temperature in Palestine ranges between 10-25 degrees Celsius and may reach a maximum of about 39 degrees Celsius in the hot summer during the day and may reach in the cold winter to approximately -4 degrees Celsius.

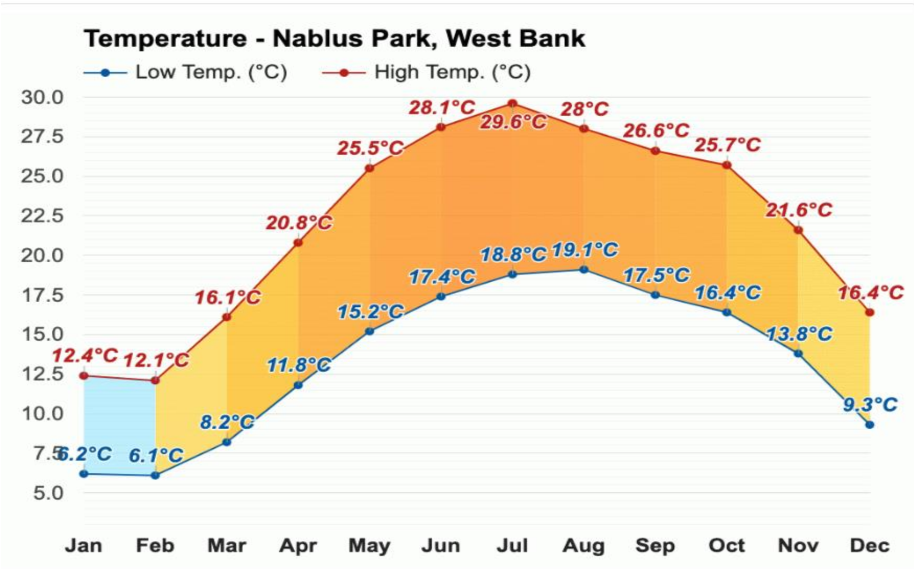


figure 2. 3: Average Temperatures in ˚C in Nablus per month (atlas Weather)

2.1.1.4 Climate:

the climate must be studied for the city of Nablus, which is characterized by a moderate climate as it is located at a length of 35.31 and a latitude of 31.78, 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.

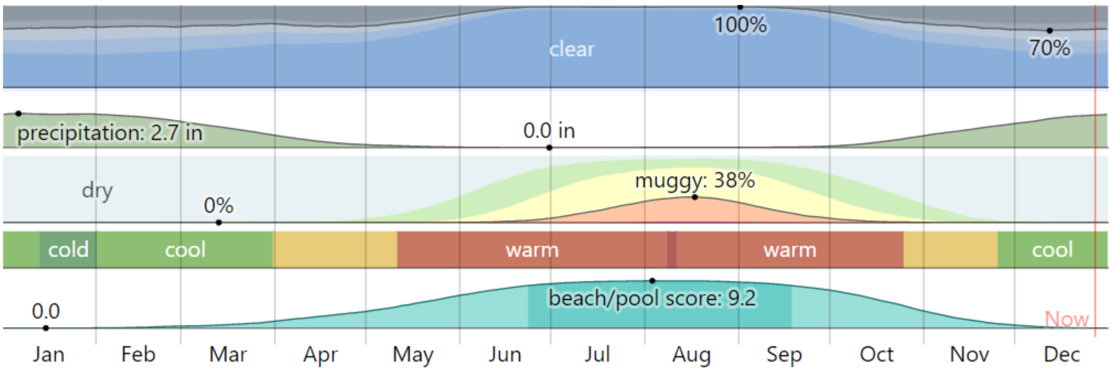


figure 2. 4: Nablus weather by month (Weather spark)

2.1.1.5 Humidity:

The relative humidity in Nablus reaches 75%, which is the average annual rate, as humidity is generally affected by temperature and wind speed .

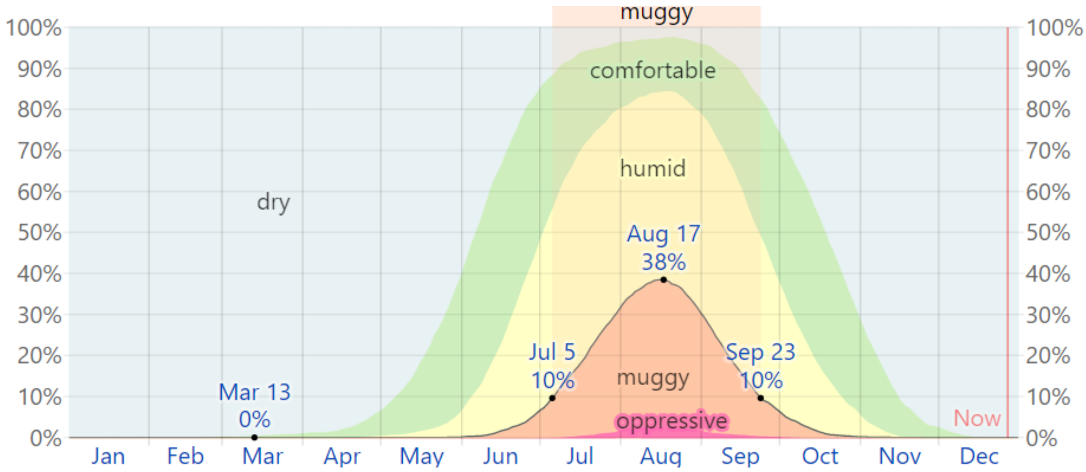


figure 2. 5: The percentage of time spent at various humidity comfort levels, categorized by dew point in Nablus (Weather spark)

2.1.1.6 Rainfall:

The average rainfall in Nablus is 458 mm per year, with the peak occurring in January, and the average number of days in which rain is expected per year is 54 days

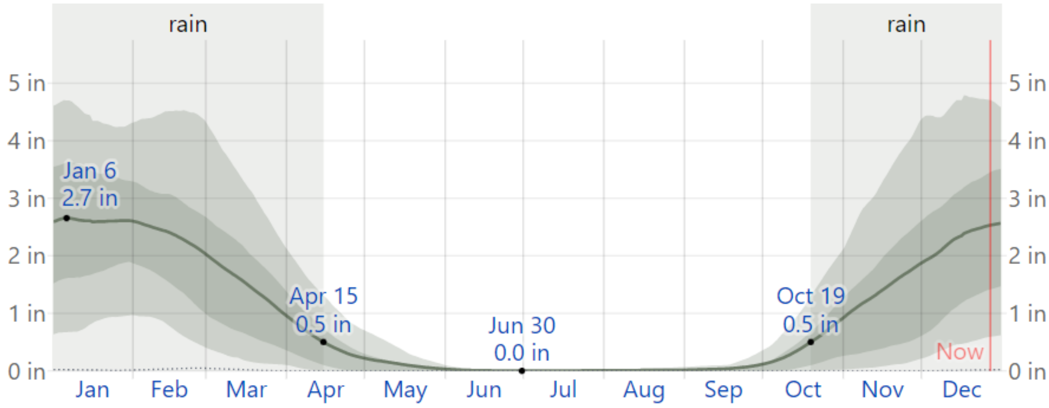


figure 2. 6: Average rainfall in Nablus (Weather spark)

2.1.1.7 Wind:

Wind depends on local terrain and other factors. The average hourly wind speed in Ramallah experiences moderate seasonal variation throughout the year.

The wind is most often from the *north for 1.0 months*, from *October 2* to *November 3*, with a peak percentage of *44%* on *October 11.* The wind is most often from the *west* for *1.1 weeks*, from *November 3* to *November 11* and for *9.4 months*, from *December 22* to *October 2*, with a peak percentage of *33%* on *November 3.* The wind is most often from the *east* for *1.4 months*, from *November 11* to *December 22*, with a peak percentage of *38%* on *November 27.*

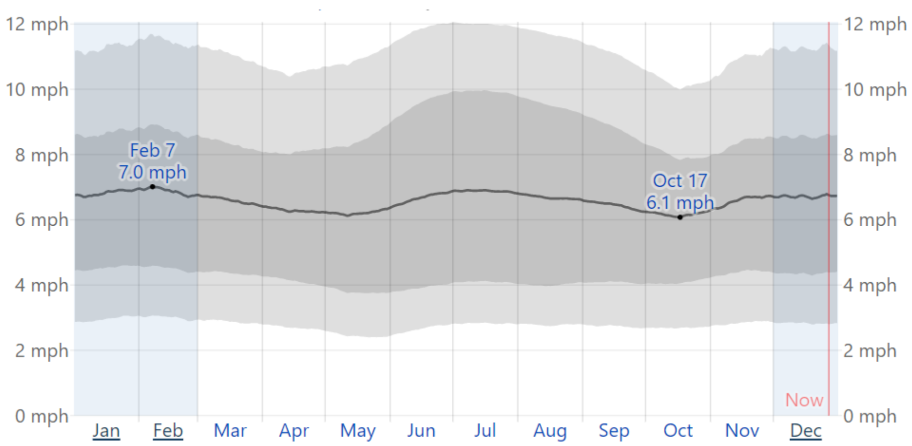


figure 2. 7: The average of mean hourly wind speeds in Nablus (Weather spark)

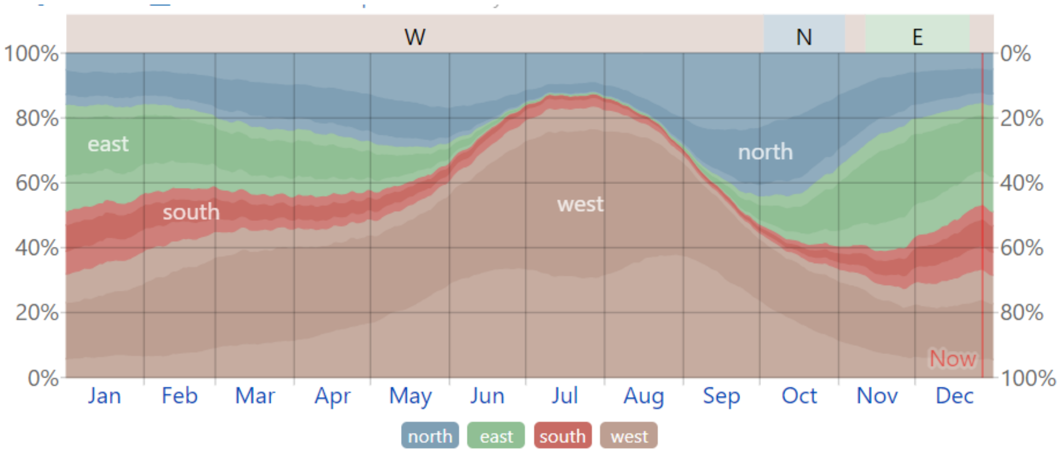


figure 2. 8: Wind Direction in Nablus (Weather spark)

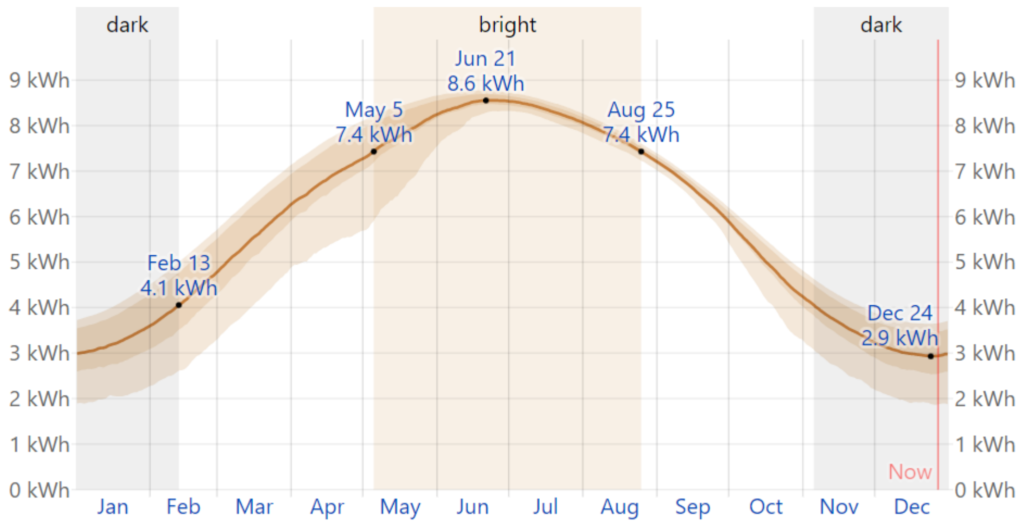
2.1.1.8 Solar energy:

This section discusses the 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 *7.4 kWh*. The *brightest* month of the year in Nablus 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 13*, with an average daily incident shortwave energy per square meter below *4.1 kWh*. The *darkest* month of the year in Nablus is *December*, with an average of *3.0 kWh*.



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

figure 2. 9: Average Daily Incident Shortwave Solar Energy in Nablus (Weather spark)

2.1.1.9 Sun path and shadowing:

The sun path is different in the summer from the winter, as its path is longer in the summer than in the winter. The sun rises in the summer from the north-east and sets in the north-west, and its angle of elevation in the middle of the day is higher in the summer than in the winter. The path of the sun also affects the formation and length of shadows.

The following images show the path of the sun and the resulting shadows at the exact times for each image:

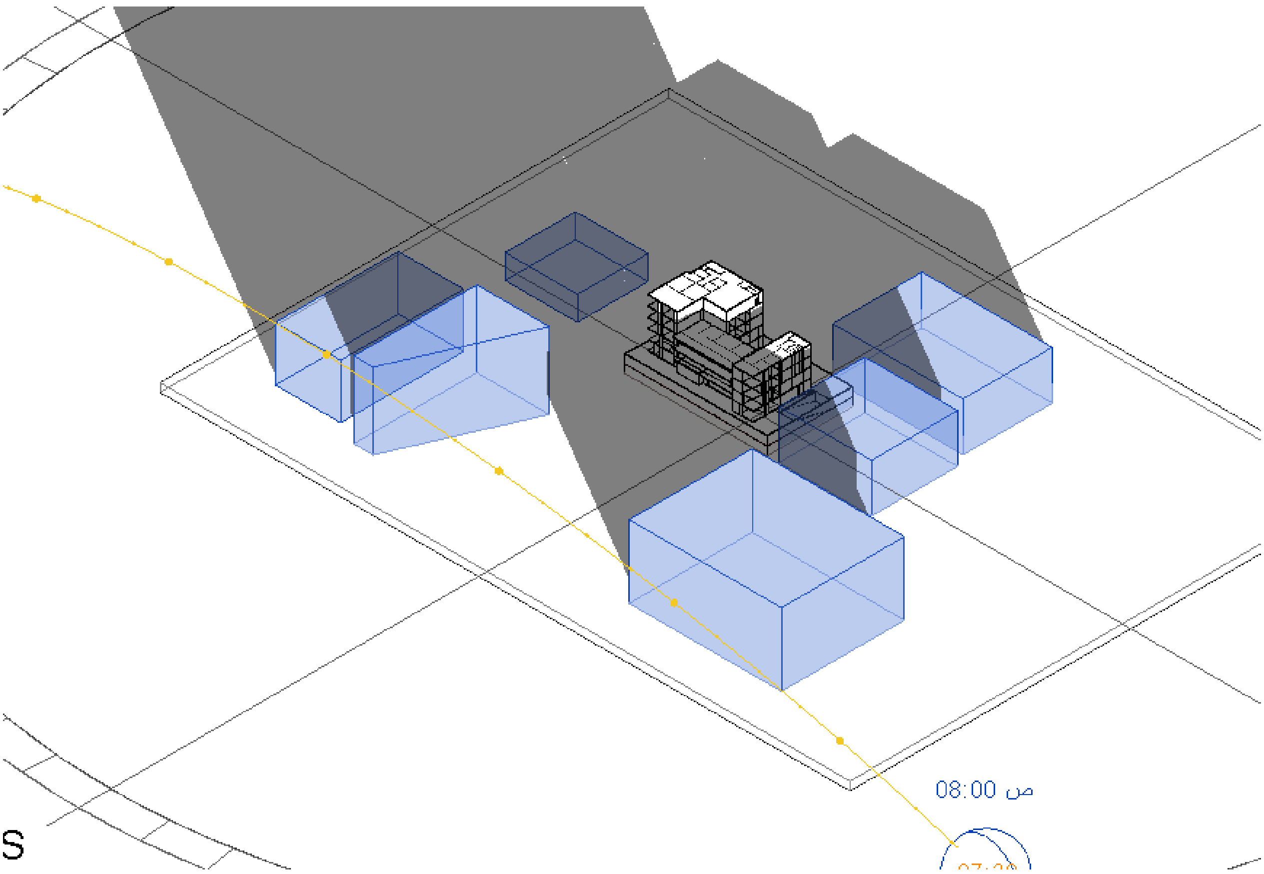


figure 2. 10: Shadow analysis in winter at 8:00 AM (Revit).

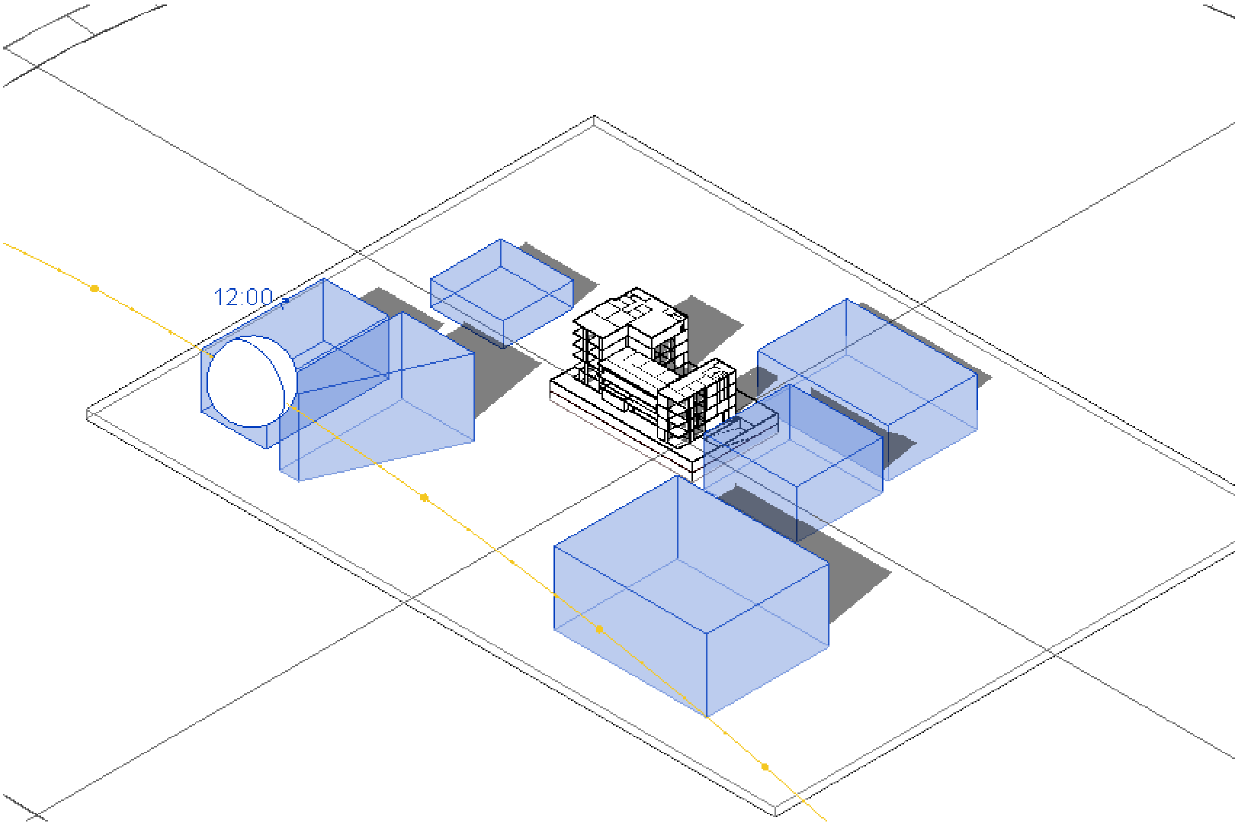


figure 2. 11: Shadow analysis in winter at 12:00 PM (Revit).

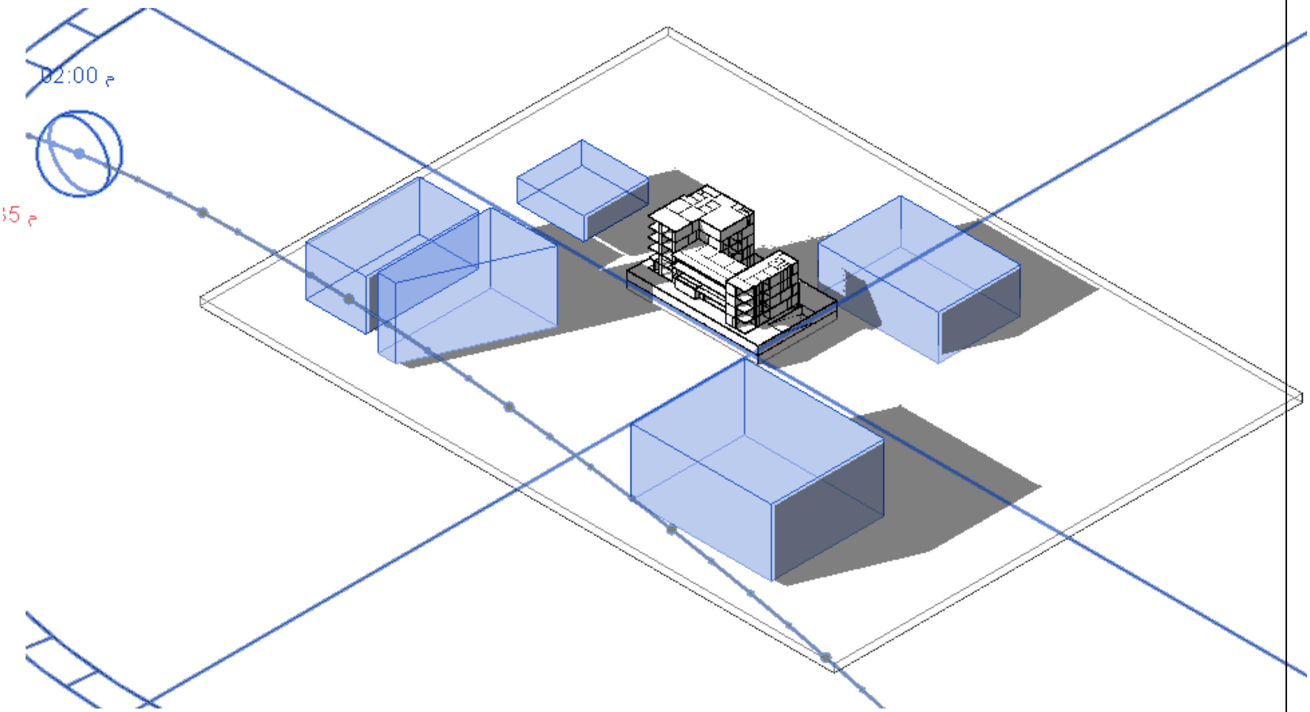


figure 2. 12: Shadow analysis in winter at 2:00 PM (Revit).

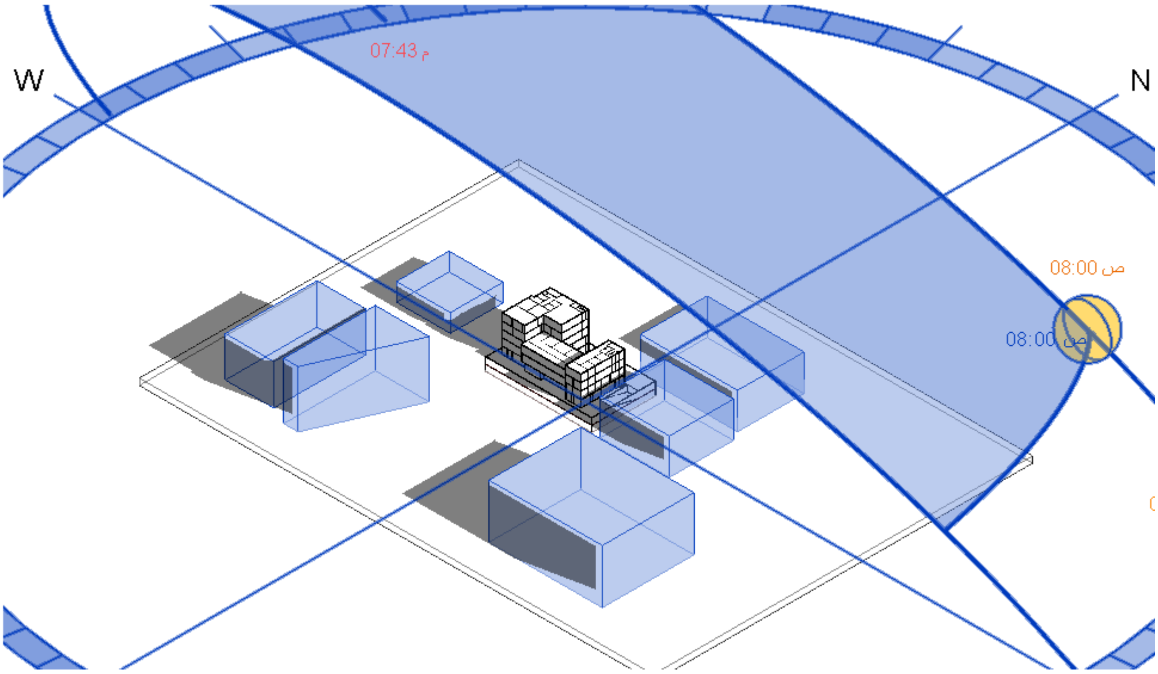


figure 2. 13: Shadow analysis in summer at 8:00 AM (Revit).

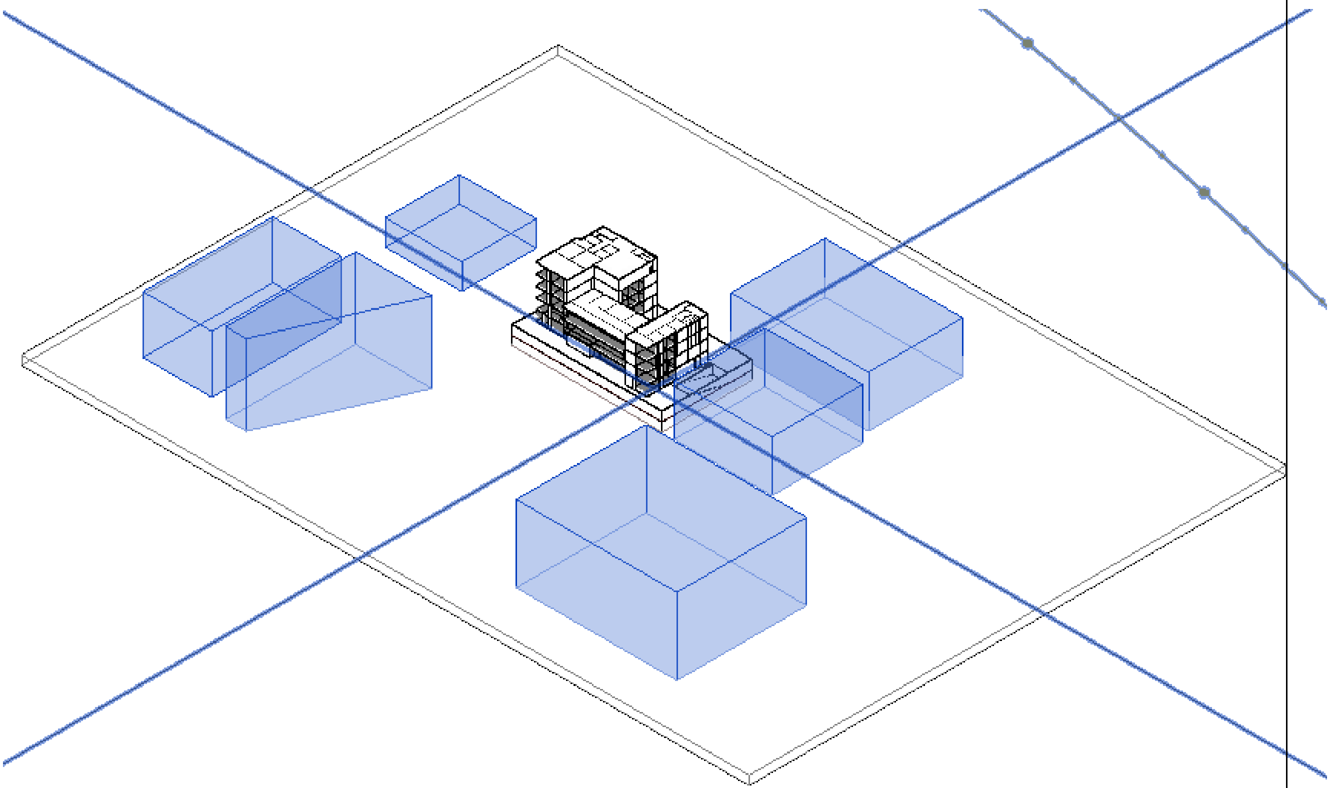


figure 2. 14: Shadow analysis in summer at 12:00 PM (Revit).

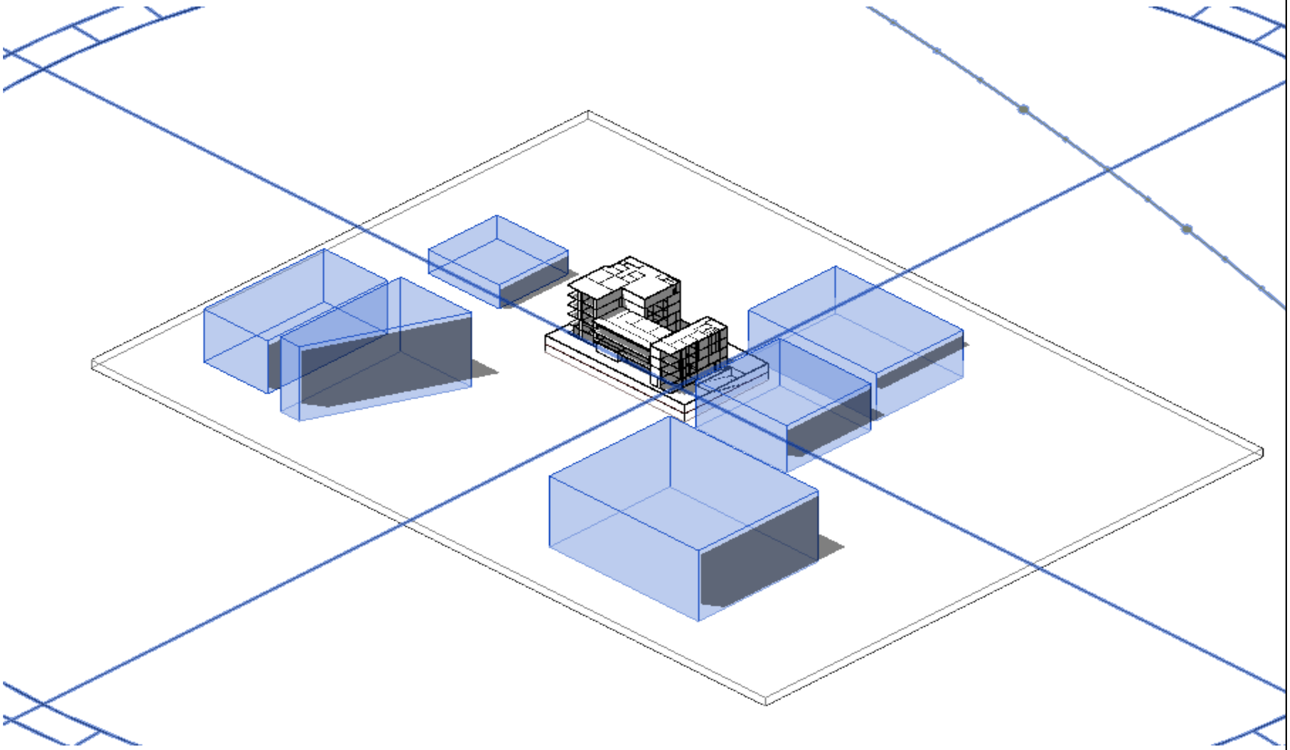


figure 2. 15: Shadow analysis in summer at 2:00 PM (Revit).

2.1.2 Environmental aspects:

2.1.2.1 Introduction.

It is important to make an integrated design for the building and take into account all the environmental aspects such as the orientation of the building, the amount of natural lighting, solar energy, and the industrial heating and cooling values that will be required, as all these aspects will affect the initial building costs and also the operating costs of the building and will play a key role in the comfort of users and their well-being.

2.1.2.2 Massing of the building:

It is interested in looking at the ratio of windows and openings to the ratio of facades in the building, which would control the amount of sun that enters the building. All of these things would play a very important role in reducing energy consumption and saving costs and materials, which would increase the welfare of the residents and users of the building.

2.1.2.3 Orientation of the building:

The orientation of the building is one of the most important things that must be focused on strongly, because it will affect all the details and characteristics of the building that is being designed, as well as its strong impact on the results of the environmental analysis, such as the percentage of exposure to the sun, the amount of solar energy, the effect of wind and other environmental matters that It plays an important role in saving costs and giving the greatest amount of convenience to users.

2.1.2.4 Daylight:

Daylight factor analysis:

One of the things that must be taken into account when designing is to provide sufficient daylight that is commensurate with the nature of the space and the nature of the activity that will be done within this space to provide visual comfort for users and to make this space an energy-saving space. It is worth mentioning here that the study of natural lighting must be carried out in parallel with the study of the solar gain of the building so that a solution is reached that achieves satisfactory results from both, and it is not right to pay attention to one of them while neglecting the other.

Daylighting is the controlled admission of natural light into a space through windows to reduce or eliminate artificial lighting.

Daylighting design is not so much how to provide enough daylight to an occupied space, but how to do so without any undesirable side effects.

Daylight factor (DF) is defined as the ratio of the actual illuminance at a point in a room (lux) and the illuminance available from an identical unobstructed sky.

$$DF = (E\ internal/E\ external) * 100\%$$

In this project, the sky condition will be overcast with E ext. = 9000 lux and the Recommendations for daylight factors and illuminance are shown in **Error! Reference source not found.** and **Error! Reference source not found.**.

Table 1: recommendation values for illuminance

Standard Maintained Illuminance (lux)	Characteristics of Activity/Interior	Representative Activities/Interiors
50	Interiors used rarely with visual tasks confined to movement and casual seeing without perception of detail	Cable tunnels, indoor storage tanks, walkways
100	Interiors used occasionally with visual tasks confined to movement and casual seeing calling for only limited perception of detail	Corridors, changing rooms, bulk stores, auditoria
150	Interiors used occasionally or with visual tasks not requiring perception of detail but involving some risk to people, plant, or product	Loading bays, medical stores, plant rooms
200	Interiors occupied for long periods or for visual tasks requiring some perception of detail	Foyers and entrances, monitoring automatic processes, casting concrete, turbine halls, dining rooms
300[a]	Interiors occupied for long periods, or when visual tasks are moderately easy (i.e., large details [>10-min arc]) and/or high contrast	Libraries, sports and assembly halls, teaching spaces, lecture theaters, packing
500[a]	Visual tasks moderately difficult (i.e., details to be seen are of moderate size [5–10 min arc] and may be of low contrast); also, color judgment may be required	General offices, engine assembly, painting and spraying, kitchens, laboratories, retail shops
750[a]	Visual tasks difficult (i.e., details to be seen are small [3–5 min arc] and of low contrast); also, good color judgments or the creation of	Drawing offices, ceramic decoration, meat inspection, chain stores

Table 2:recommendation values for daylight factor

Building Type	Location	DF_{avg}%	DF_{min}%
Concert Halls	Foyers, auditoria, Corridors, Stairs	1 2 2	0.6 0.6 0.6
General area	Entrance halls	2	0.6
Schools	Classrooms Assembly halls	5 1	2 0.3
Domestic	Lounges Bedrooms Kitchens	1.5 1 2	0.5 0.3 0.6

See **Error! Reference source not found.**, which shows us another classification for recommendation daylight factor according to the type of function that performs in space.

Table 3:recommendation daylight factor according to function.

Task	DF[a]
Ordinary seeing tasks, such as reading, filing, and easy office work	1.5–2.5%
Moderately difficult tasks, such as prolonged reading, stenographic work, normal machine tool work	2.5–4.0%
Difficult, prolonged tasks, such as drafting, proofreading poor copy, fine machine work, and fine inspection	4.0–8.0%

Daylight factor analysis before modifications:

- Ground floor daylight factor analysis:

See **Error! Reference source not found.** , which show the results of daylight factor analysis for ground floor before modifications using design-builder.

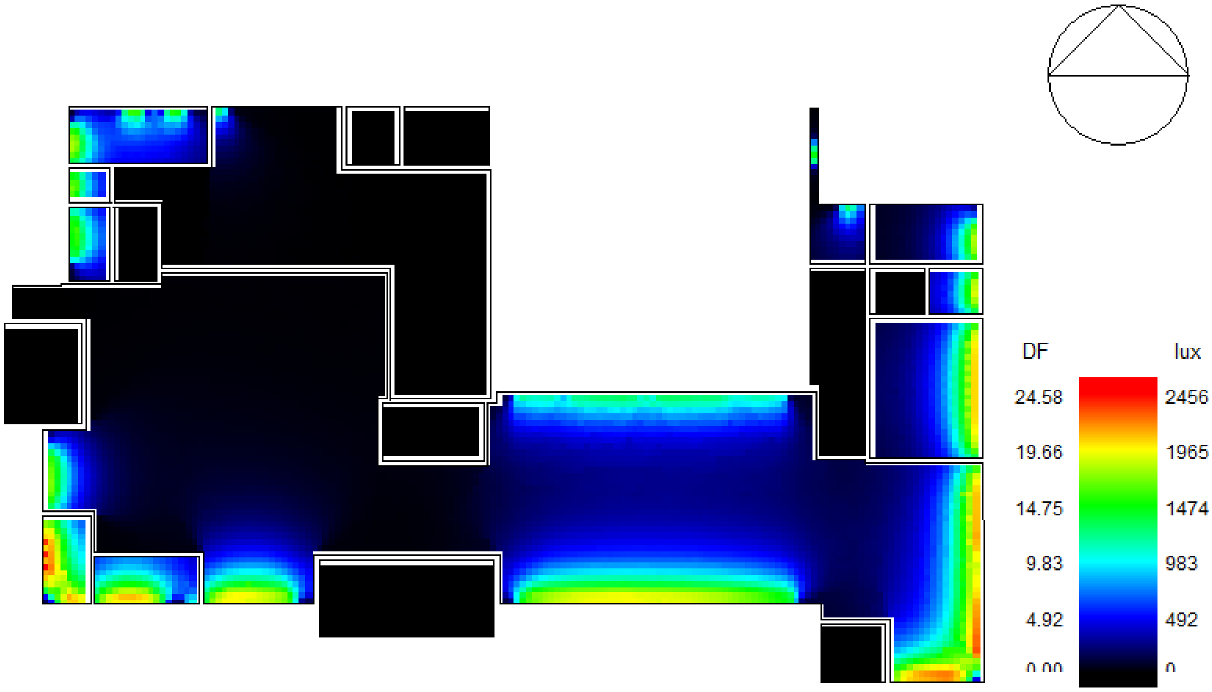


figure 2. 16:daylight factor anaylsis for ground floor.

From **Error! Reference source not found.** we note that the values have divided the space into three levels, the first is less than the required limit, the second is within the required limit, the third is higher than the required limit, and from here we realize the importance of environmental modifications in order to reduce the values that exceed the required limit.

- First floor daylight factor analysis:

See **Error! Reference source not found.**, which show the results of daylight factor analysis for first floor before modifications using design-builder.

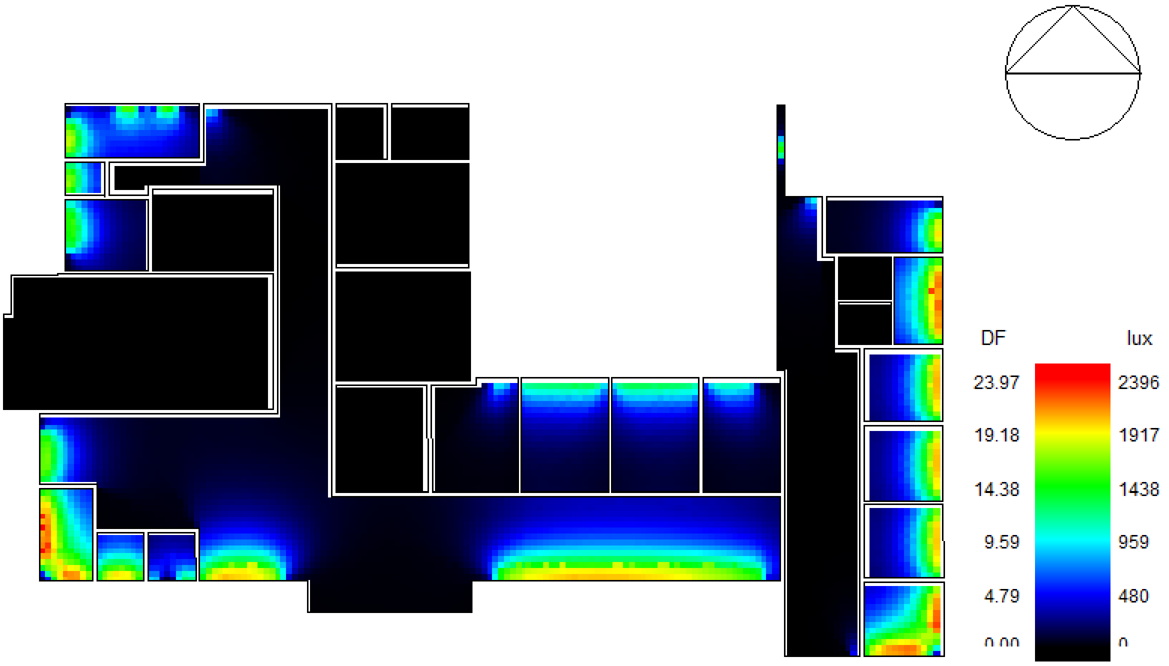


figure 2. 17:daylight factor analysis for first floor

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From **Error! Reference source not found.** we note that the values have divided the space into three levels, the first is less than the required limit, the second is within the required limit, the third is higher than the required limit, and from here we realize the importance of environmental modifications in order to reduce the values that exceed the required limit.

- Second floor daylight factor analysis:

See **Error! Reference source not found.**, which show the results of daylight factor analysis for second floor before modifications using design-builder.

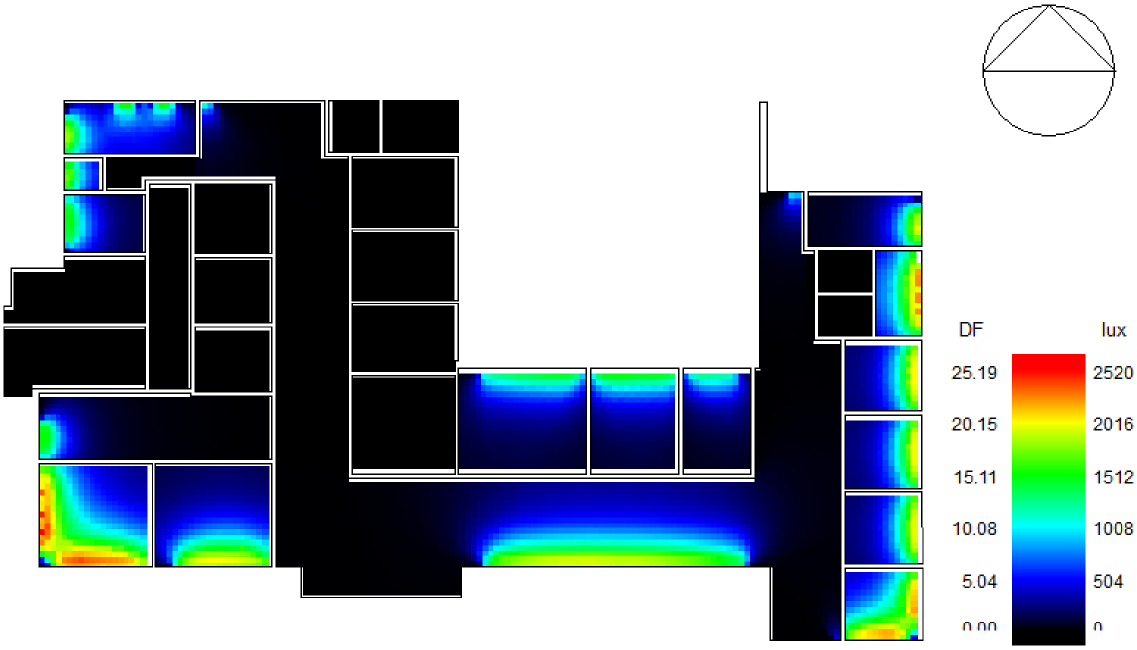


figure 2. 18:daylight factor analysis for second floor.

From **Error! Reference source not found.** we note that the values have divided the space into three levels, the first is less than the required limit, the second is within the required limit, the third is higher than the required limit, and from here we realize the importance of environmental modifications in order to reduce the values that exceed the required limit.

- Third floor daylight factor analysis:

See **Error! Reference source not found.**, which shows the results of daylight factor analysis for the third floor before modifications using design-builder.

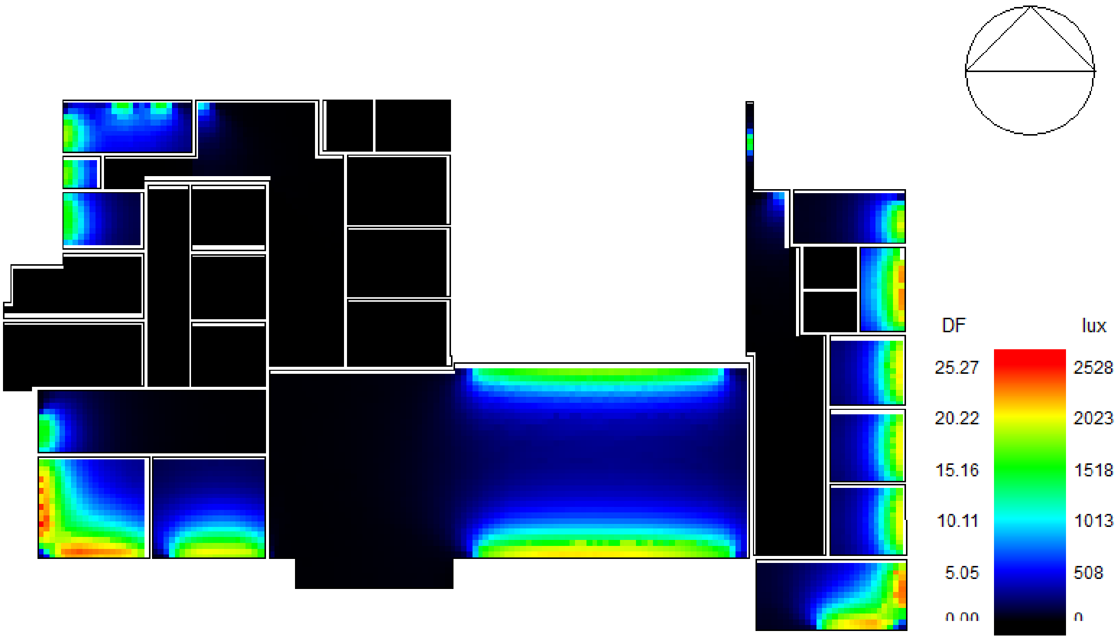


figure 2. 19:daylight factor analysis for third floor.

From **Error! Reference source not found.** we note that the values have divided the space into three levels, the first is less than the required limit, the second is within the required limit, the third is higher than the required limit, and from here we realize the importance of environmental modifications in order to reduce the values that exceed the required limit.

- Fourth floor daylight factor analysis:

See **Error! Reference source not found.**, which shows the results of daylight factor analysis for the fourth floor before modifications using design-builder.

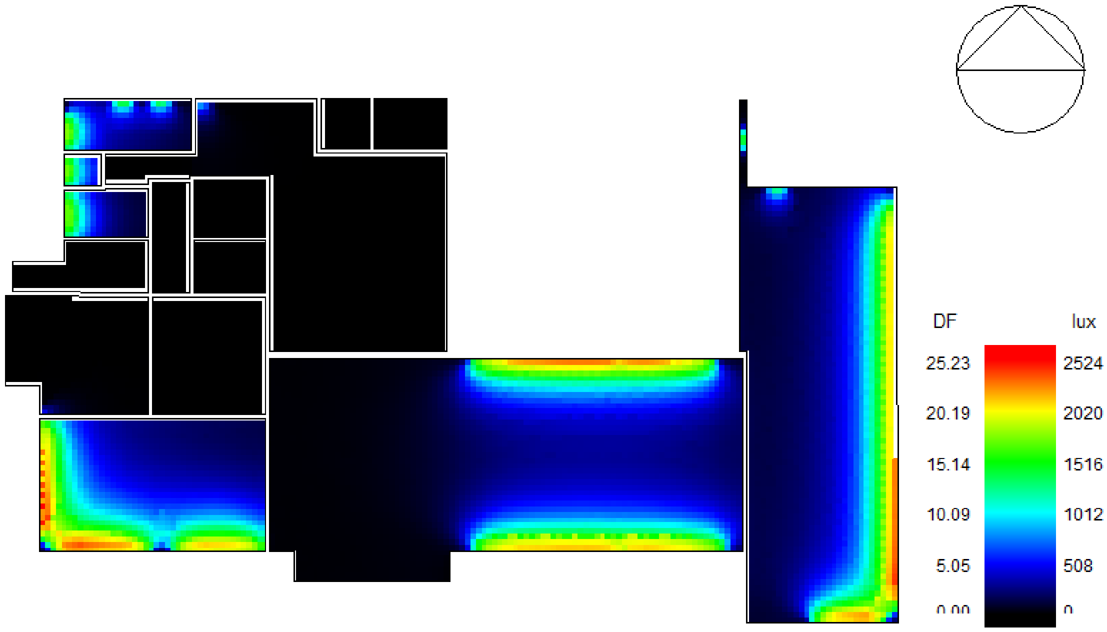


figure 2. 20:daylight factor analysis for fourth floor.

From **Error! Reference source not found.** we note that the values have divided the space into three levels, the first is less than the required limit, the second is within the required limit, the third is higher than the required limit, and from here we realize the importance of environmental modifications in order to reduce the values that exceed the required limit.

Daylight factor analysis after modifications:

- Ground floor daylight factor analysis:

See **Error! Reference source not found.**, which show the results of daylight factor analysis for ground floor after modifications using design-builder.

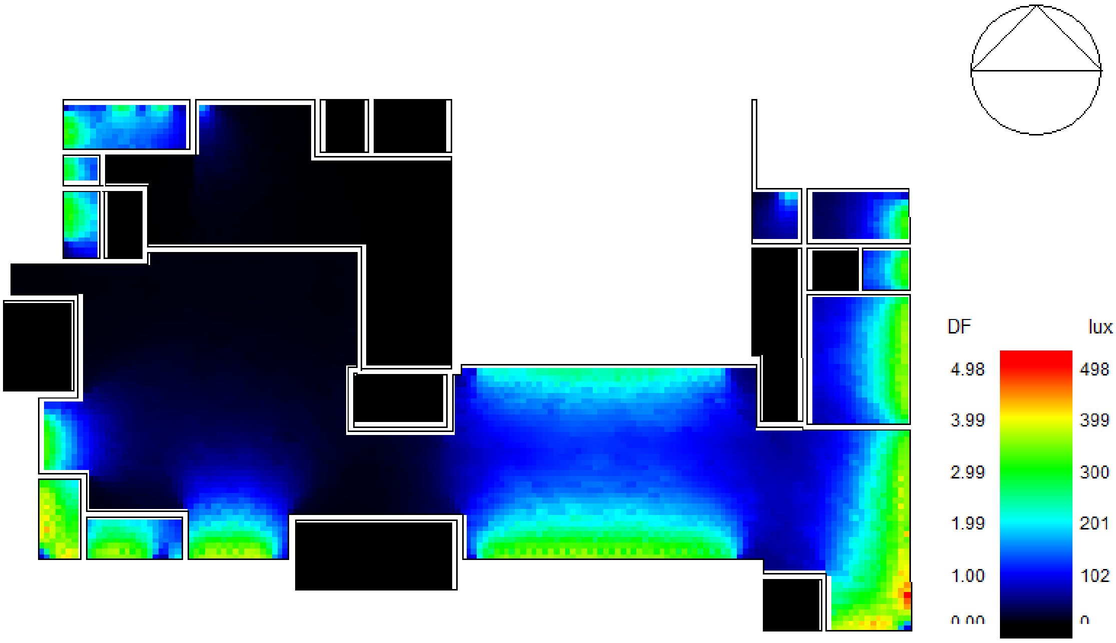


figure 2. 21:daylight factor analysis for ground floor.

After making the necessary and effective adjustments, it was noticed that the values had improved, as different areas were included, so that the values became standard, and this happened in particular in the areas near the windows, and thus the glare problem was solved.

- First floor daylight factor analysis:

See **Error! Reference source not found.**, which show the results of daylight factor analysis for first floor after modifications using design-builder.

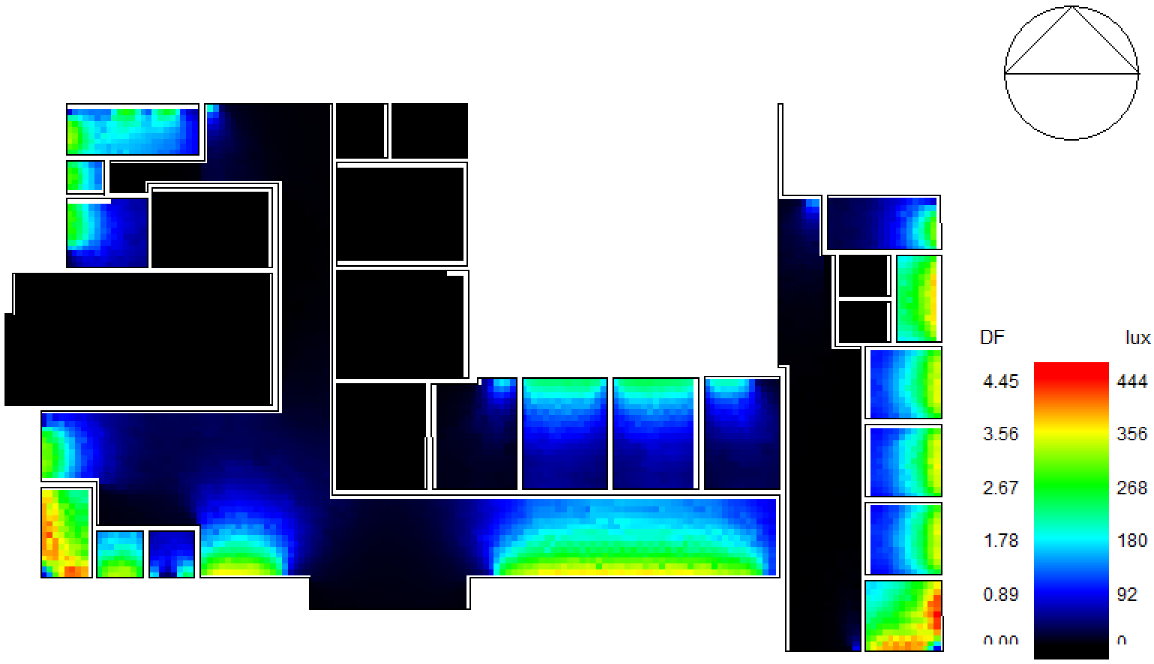


figure 2. 22:daylight factor analysis for first floor.

After making the necessary and effective adjustments, it was noticed that the values had improved, as different areas were included, so that the values became standard, and this happened in particular in the areas near the windows, and thus the glare problem was solved.

- Second floor daylight factor analysis:

See, which shows the results of daylight factor analysis for the second floor after modifications using design-builder.

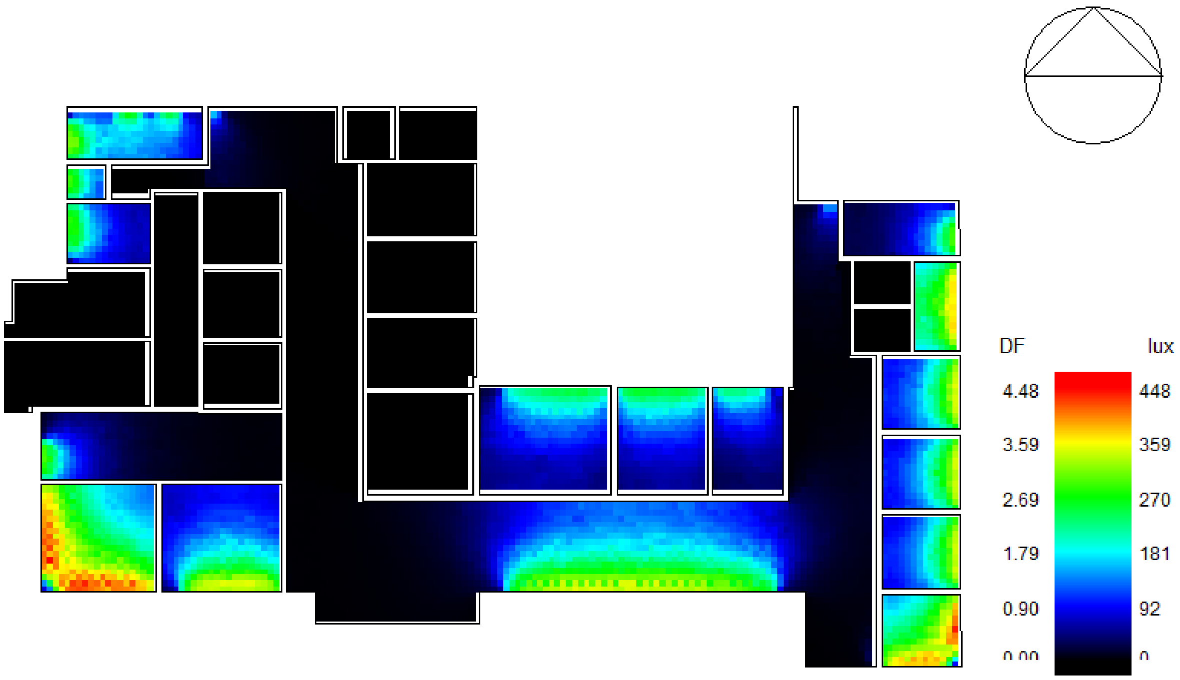


figure 2. 23:daylight factor analysis for second floor

After making the necessary and effective adjustments, it was noticed that the values had improved, as different areas were included, so that the values became standard, and this happened in particular in the areas near the windows, and thus the glare problem was solved.

- Third floor daylight factor analysis:

See **Error! Reference source not found.**, which shows the results of daylight factor analysis for the third floor after modifications using a design-builder.

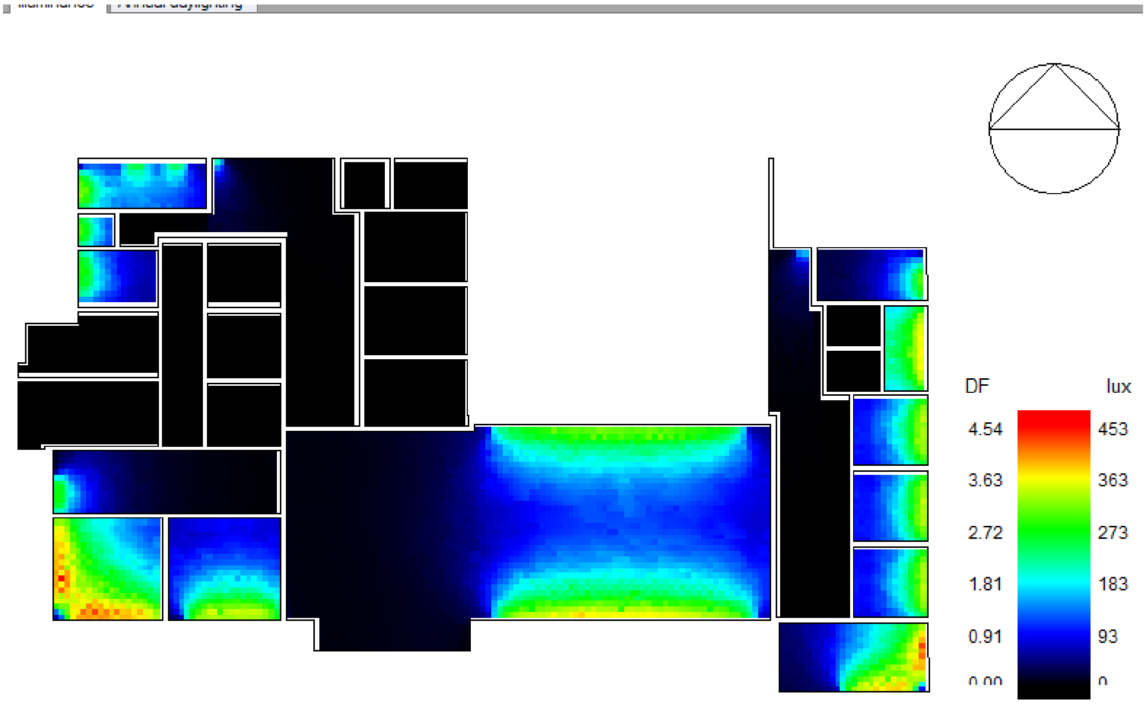


figure 2. 24:daylight factor analysis for third floor.

After making the necessary and effective adjustments, it was noticed that the values had improved, as different areas were included, so that the values became standard, and this happened in particular in the areas near the windows, and thus the glare problem was solved.

- Fourth floor daylight factor analysis:

See **Error! Reference source not found.**, which shows the results of daylight factor analysis for the fourth floor after modifications using a design-builder.

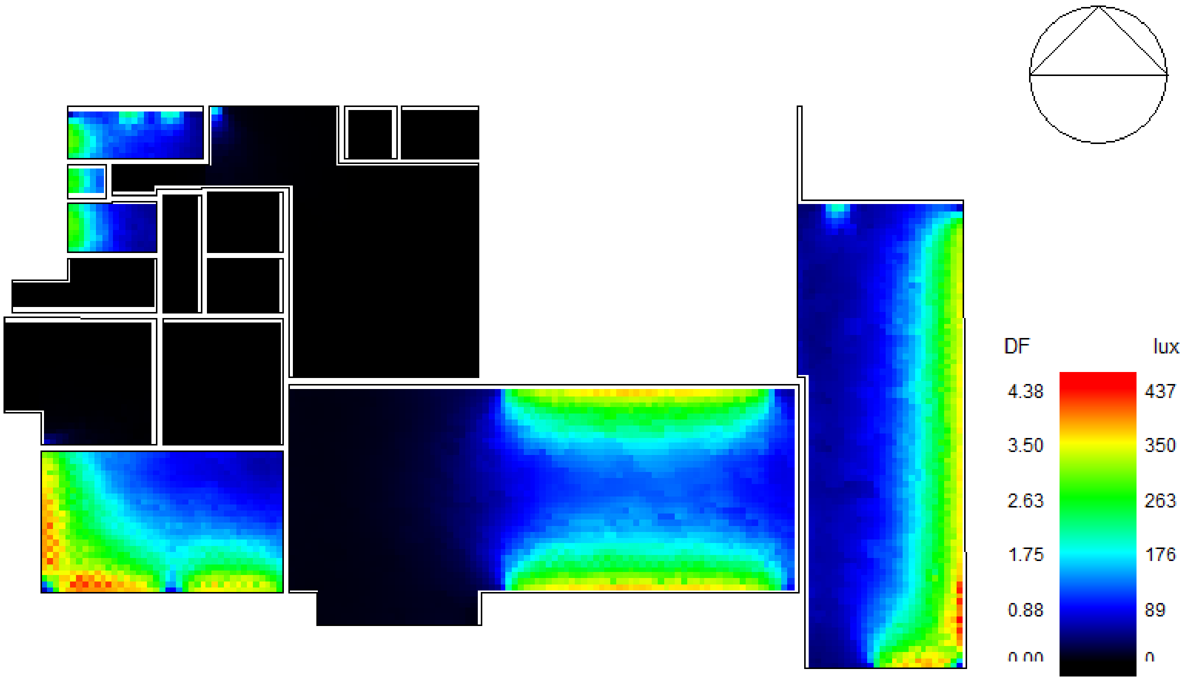


figure 2. 25:daylight factor analysis for fourth floor

After making the necessary and effective adjustments, it was noticed that the values had improved, as different areas were included, so that the values became standard, and this happened in particular in the areas near the windows, and thus the glare problem was solved.

2.1.3 case study:

2.1.3.1 Introduction:

Fujian CMB Tower is located north of Jiangbin Street, in the former area of Tea Leaves Import and Export Trading Company. Being a rectangular plot of land in a prime location alongside the Min River.

figure 2. 26:CMB Tower.

Its location from satellites:

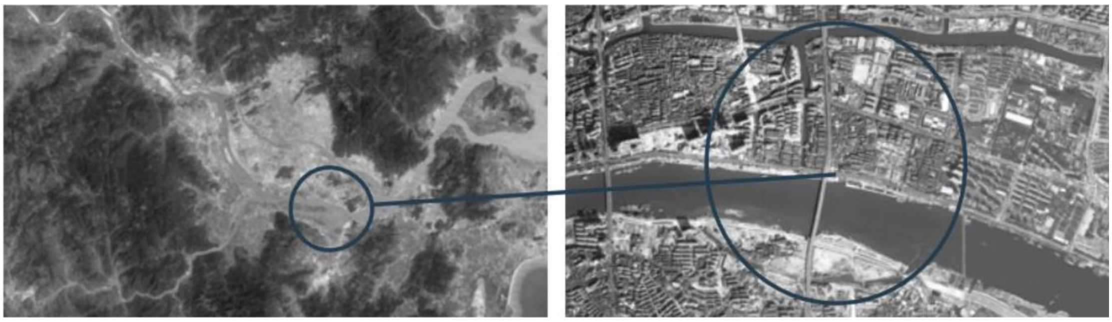
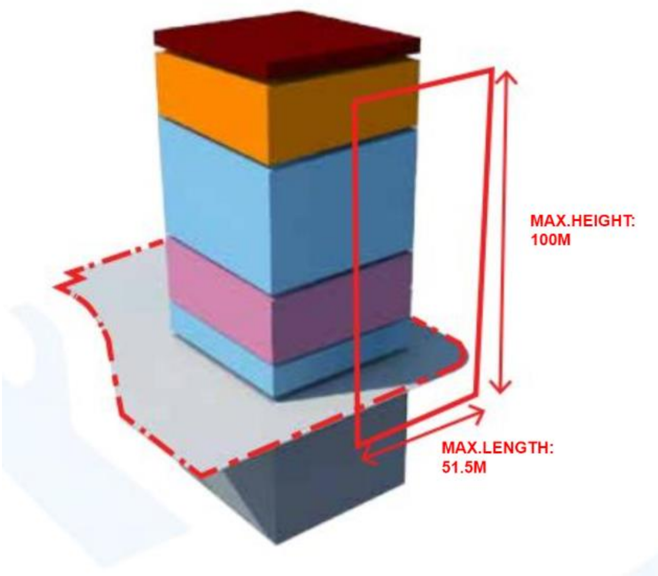


figure 2. 27:location of the tower.

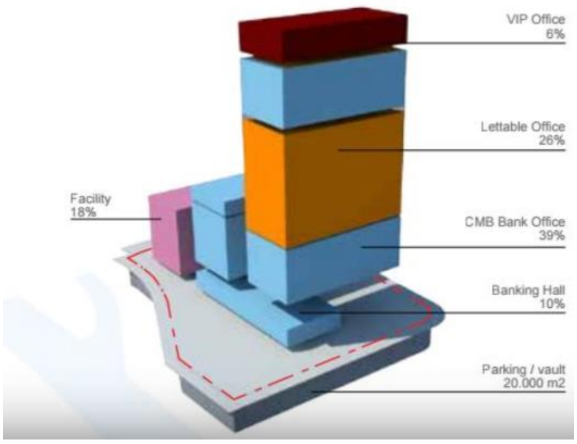
2.1.3.2 The bank massing:

2.1.3.2.1 Brief analysis:

To get the best view, the bank is placed along the Jiang Bin Road, the views over the river are maximized by enlarging the width of the building, and by raising the tower to its maximum height, one hundred meters. The building will then expose the maximum surface towards the River.

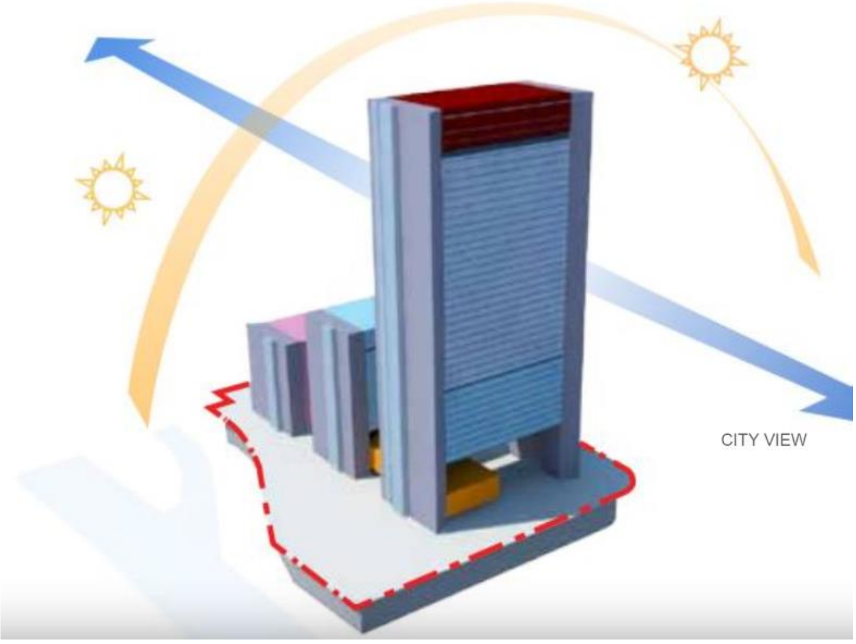


Three parts have been created: Two office interconnected towers and one lower that accommodates all the staff facilities. The Office, being the more important spaces, have been pushed to the southern edge of the site along Jiang Bin Road facing South and the River, while the ancillary spaces, requiring less daylight and more level of privacy and connectivity have been placed closer to the northern edge of the site. The VIP Banking and the CMB Executives offices have been clubbed into the highest tower at the very top maximizing their views while the banking hall and the business banking have been horizontally spread across the podium to maximize their frontage and accessibility



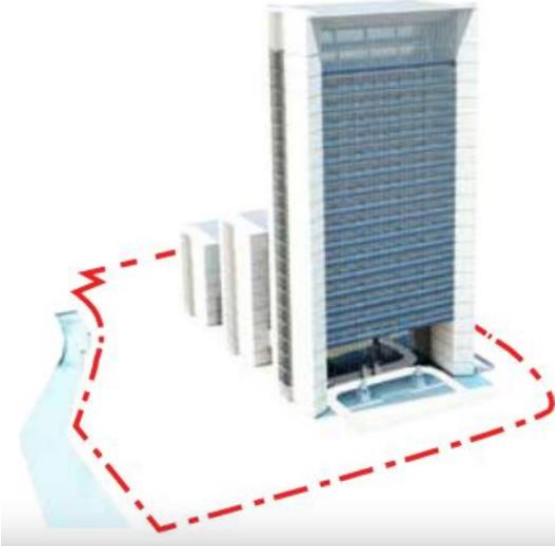
2.1.3.2.2 Sustainability:

The cores carefully located at the east and west facade, protecting the building from the aggressive morning and afternoon sun, and at the same time work as noise barrier, screening off the highway. Also the top of the tower has been slightly tapered to provide self-shading against the noon sun.



2.1.3.2.3 Façade:

The alter Nance of opaque natural stone and transparent facade with louvers to minimize the solar impact will create a vibrant building and energy savings. Energy efficiency begins with strong fundamentals, this begins with creating a building composition that takes advantage of the site orientation then creating an architectural envelope that protects against heat gains whilst maximizing daylight and views. The facades developed for the design proposal respond strongly to orientation and will ensure minimum energy transfer takes place through the building.



2.1.3.2.4 Façade design:

The design has been carefully considered to be energy efficient through simple passive measures such as good orientation. The main glazed facades face south and north, with the southern facade further protected by horizontal sunshades. This also fully capitalizes on views over the adjacent river to the South. Unlike many office towers a central core is not employed. Instead the cores are located to the east and west to protect against low sun in the mornings and evenings. Opening windows permit cross ventilation during the spring and autumn.

figure 2. 28: Façade Design.

2.1.3.3 the most useful ideas:

It was helpful on the architectural level, the distribution of the spaces from entrance to offices until the VIP spaces also the façade design and how we fix our project windows and the glass walls to make it comfortable for the humans, make it good for heating and cooling.

A tall, perforated screen that simulates the use of a Louvers (breathing wall) landscaping inside and out on the front facade cuts out the glare in the summer months. This screen also prevents the use of blackout blinds on the front facade. Panels painted in different colors stand out in the restrained concrete facade.

2.2 Architectural Aspects:

2.2.1 Introduction:

This aspect is one of the most important means of design, which is in the first stage in the design of any building or project, whether it is commercial, residential or professional, as the architectural design is in the first stage to meet the needs of the building for the purpose for which it was built, where we must find the best architectural design in a series of steps Modeling ideas to produce a complete, comfortable and beautiful project

In this part, we will study the functions of the building completely so that they are within the standard standards to provide comfort to the users of the building and must meet all the requirements for the void of the dimensions of the void and the relationships between the spaces and the function of the void to obtain the best architectural design.

2.2.2 Standards:

2.2.2.1 The functional relationship between the rooms:

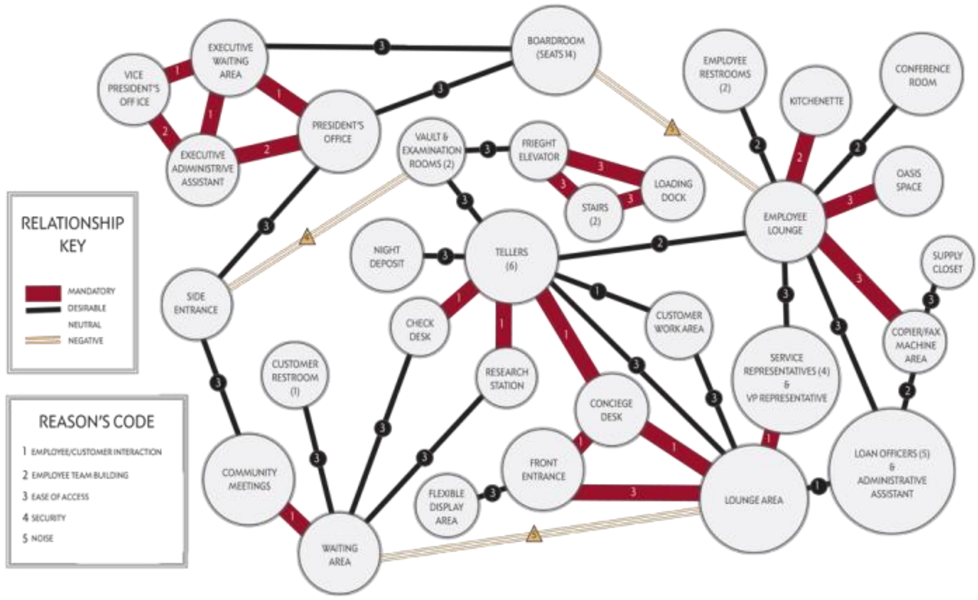


Figure 2. 29: functional relationship between the rooms.

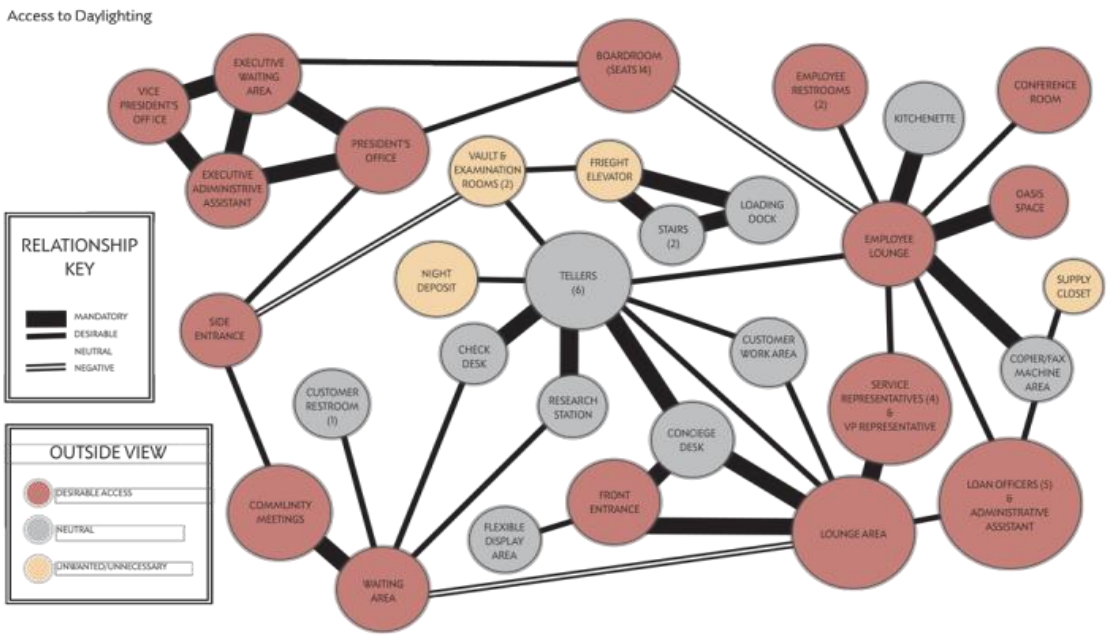


figure 2. 30:Access to daylight for rooms.

2.2.2.2. Offices:

Offices must be given great care when designing, as it is the place where employees will spend most of their time during their work in the building. The office should have enough space to be comfortable for the employee and for all those around him. There is no longer any defined minimum size for workplaces, according to the new Workplace Regulations. However, because of the needs of accident insurers and the fact that today's workplaces all contain computer screens, the applicable DIN EN norms and regulations apply. There are several types of offices formations that can be followed when designing offices for example here are the most common:

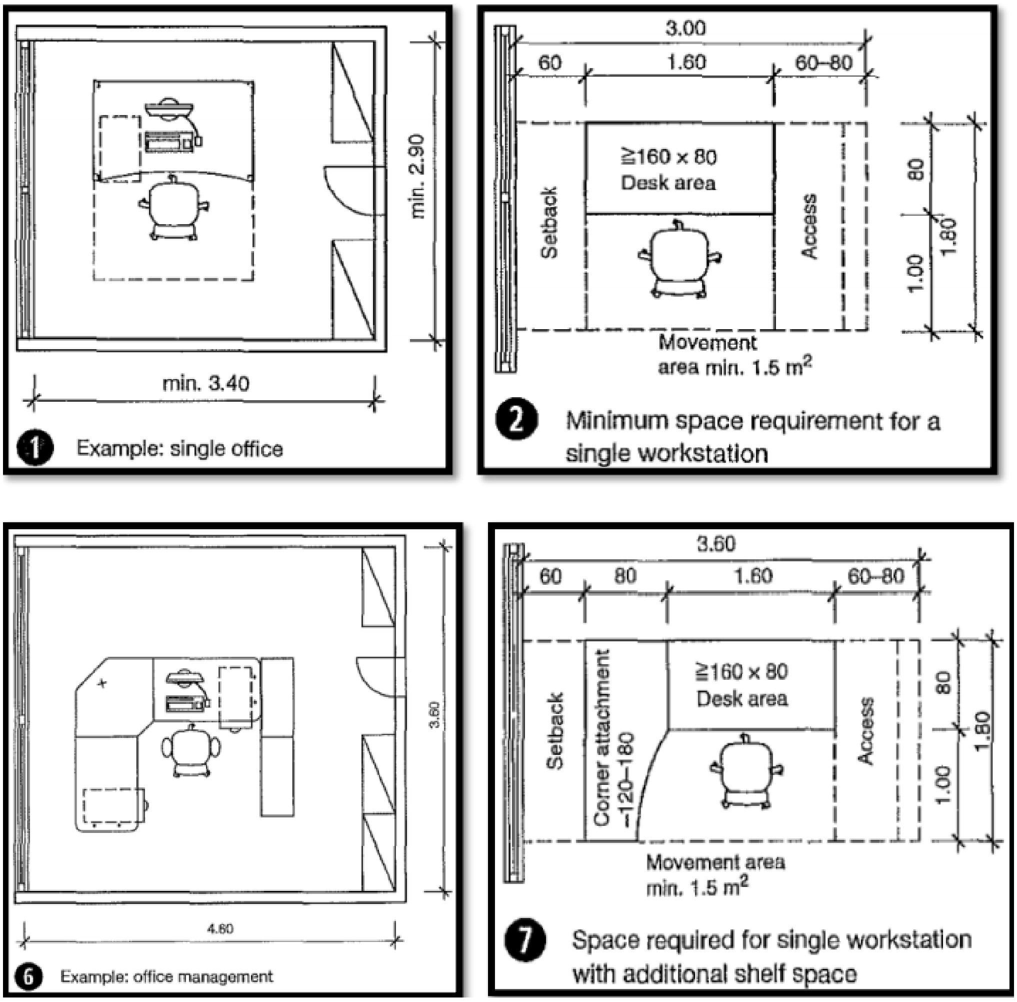


figure 2. 31: Office's dimension width (Neufert 4th edition, 2015)

The formation and locations of different areas that make up the workstation are differentiated by the standards; nevertheless, they can overlap if this does not limit the function.

The areas are:
- work area: table
- shelf area: plan area of the furniture
- furniture function area: space required for doors and drawers
- movement area at the workstation
- traffic and through-passages

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.

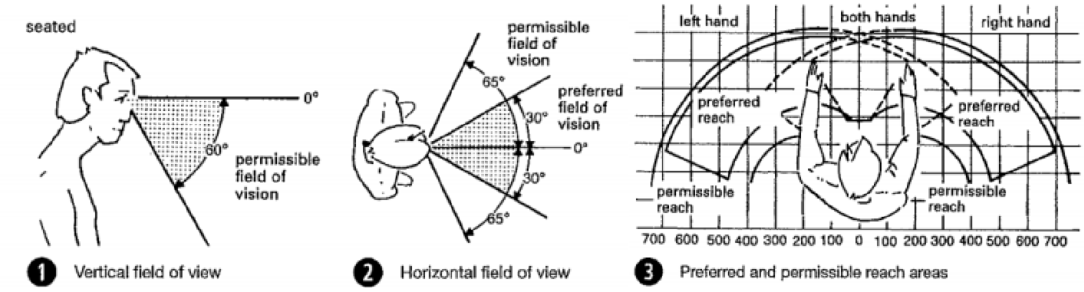


figure 2. 32: Workstation's standard (Neufert 4th edition, 2015)

The furniture also plays an important role in building a good and suitable work environment for the employees as the following standards:

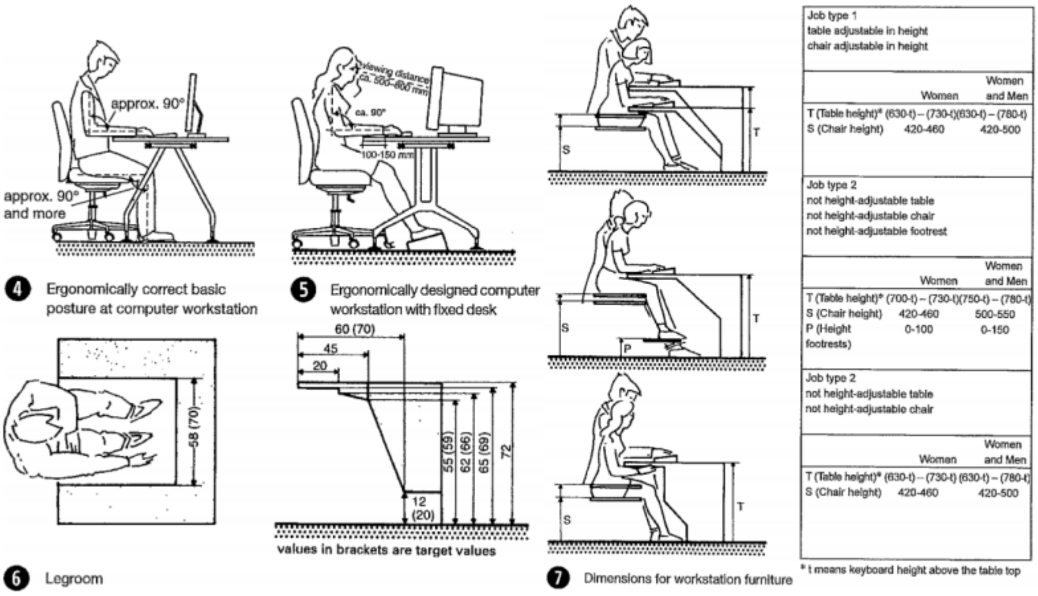


figure 2. 33 : Workstation's furniture dimension (Neufert 4th edition, 2015)

- Closed offices:

Table 2.1: Max & Normal dimension for closed offices (The world of architectural manifestation).

Place	Normal dimension (m)	Max dimension (m)
Room depth	3.75 - 7.50	9.5
Room height	2.50 - 4.00	5
Width of a single corridor	1.50 - 2.00	2.5
Width of a double corridor	1.75 - 2.50	3.25
Middle window	1.00 - 3.25	6

- Open offices:

Table 2.2: Normal dimension for open offices (The world of architectural manifestation).

Place	Normal dimension (m)
Office employee	6.00 - 9.00
Secretary	10
employee in a shared office	3.80 - 4.80
employee among several employee	5

figure 2. 34: Dimensions of offices.

2.2.2.3 Stairs:

It is preferable to be in a place close to the main entrance, and to be in a common area of contact with the electric elevators. Stairs are selected based on the number of people using the building. Taking care of the presence of a fixed handrail for protection.

- 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.

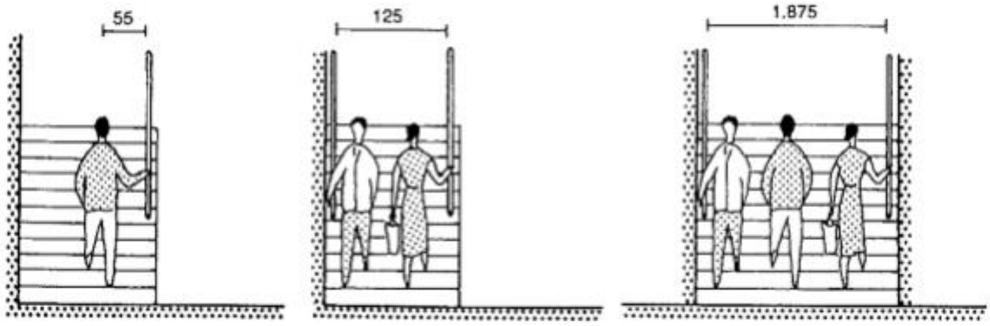


figure 2. 35: Stair's dimension (Neufert 4th edition, 2015)

2.2.2.4 Elevators:

The elevator wall must be made of fire-resistant and sound-insulating materials, to prevent the transmission of movement noise and mechanical devices to adjacent rooms, so it must not share with the wall of any other room. It's essential to make sure to provide artificial lighting through both day and night and provide a good ventilation inside. The number of elevators is determined by the number of users of the building. Preferably near the entrance to make it easy to reach. 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.

- Large offices: 1 person / 4.5 m2.

- Private offices: 1 person / 7.5 m2

The speed of the elevator in administrative buildings:

- 5 floors → 30 m/min.

- 8 floors → 40 m/min.

- 20 floors → 150 m/min.

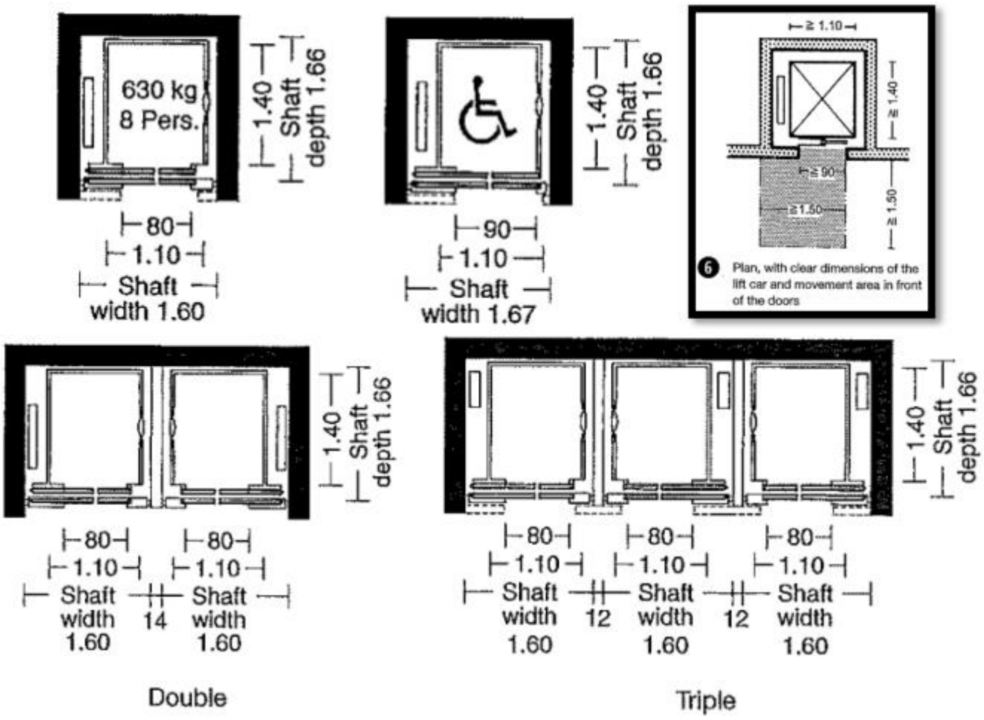


figure 2. 36: Elevator's standard (Neufert 4th edition, 2015)

2.2.2.5 Emergency stairs:

The importance of the emergency staircase increases in administrative buildings, especially those whose height is more than 40 m, and the building that can accommodate 200 people needs a staircase emergency width of 1 m, but if the building contains more than 200 people, it needs to be width of the staircase is 1.25 m. The emergency staircase must be made of materials that are not affected by fire. All doors should be open to the emergency staircase and easily accessible, and it is better for the emergency staircase to lead the people from the floor where they are directly to the outside road without passing any other floors. Emergency corridors for users, these must be at least 2 m wide. The door should be easy to open and close. Therefore, side-hinged doors or swing-out doors should be used for a space with a user load of more than 50 people. Escape routes should be provided on the same floor, if it is possible to walk in opposite directions, leading to outdoor exits or to emergency staircase. It should be accessible at a distance 25 meters from each point (or 35 meters for other areas or lanes). The doors must open in the direction of the escape, main entrance, or corridor. It must be provided within 10 meters (linear distance) from each point.

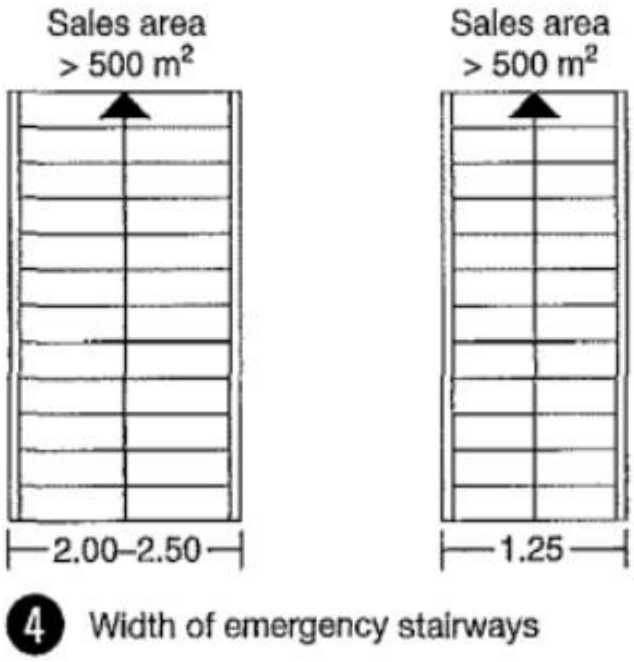


figure 2. 37: Emergency Staircase standard (Neufert 4th edition, 2015)

2.2.2.6 Meetings rooms:

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 m2 and each person needs between 1.1 – 1.25 m2 as min of area in this type of rooms.

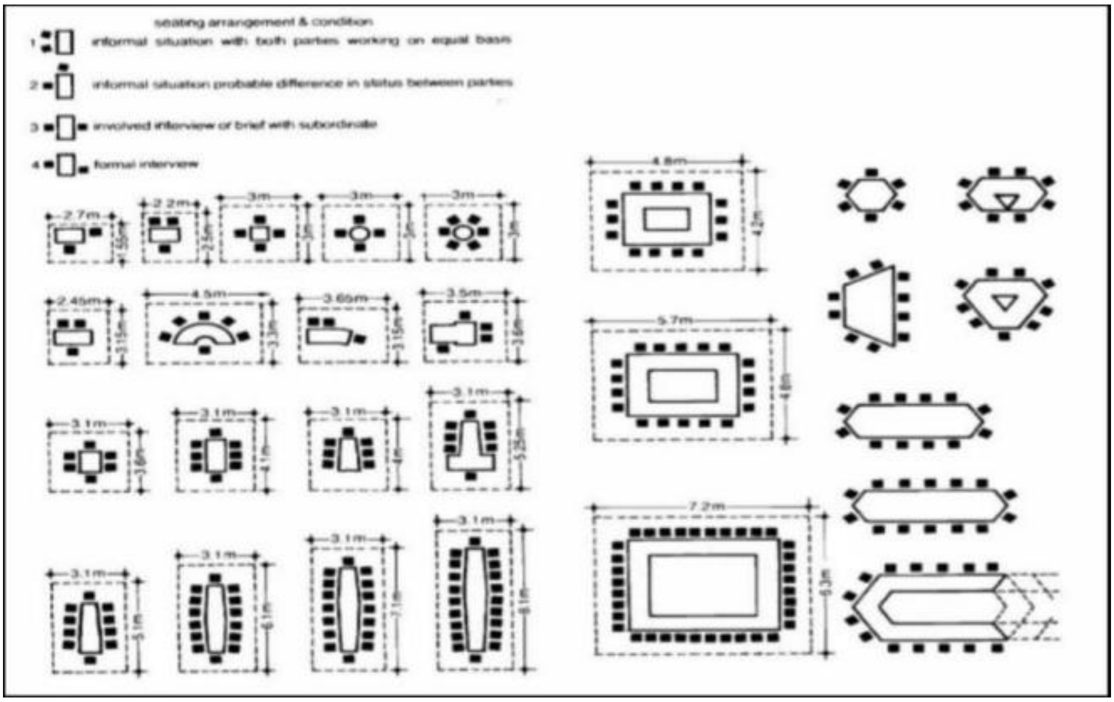


figure 2. 38: Meeting room’s dimension (Neufert 4th edition, 2015)

2.2.2.7 WC's:

It’s very important to have enough WCs for all employees and users in the building, and it’s more important to have separate WCs for both men’s and ladies. It must be within the standards so that it is not too narrow and doesn’t allow freedom of movement, and it must preserve the privacy of users so that it is not in an inappropriate place in the building, and it must also have adequate ventilation.

- Toilets are to be located at not more than 100 meters from each workstation or, at the farthest, one story height (if no escalator is available).

- Separate toilets must be provided for both women and men if there are more than 5 employees, and the number of toilets depends on the number of employees as the table below shows.

- Unless the facilities only have one toilet and no direct access to a work, social, changing, wash, or sanitary room, toilet facilities consist of a lobby with washbasins (at least one washbasin per five WC's) and a fully separate room with at least one WC. Lockable toilet cubicles are required, and if light partitions (incompletely separated WC cubicles) are used, the partition must have a height of at least 1.90 m and a gap of 10-15 m at the bottom. Urinals must be positioned such that they are not visible from the main entrance.

- There should be no more than 10 WC cubicles and 10 urinals in a toilet facility.

- At least one toilet in all sanitary facilities must be provided for wheelchair users with a 48 cm for the seat height.

- To the right or left of the toilet, the moving space must be at least 95 cm broad and 70 m deep. There must be at least 30 centimeters between one side of the toilet and the wall or furniture.

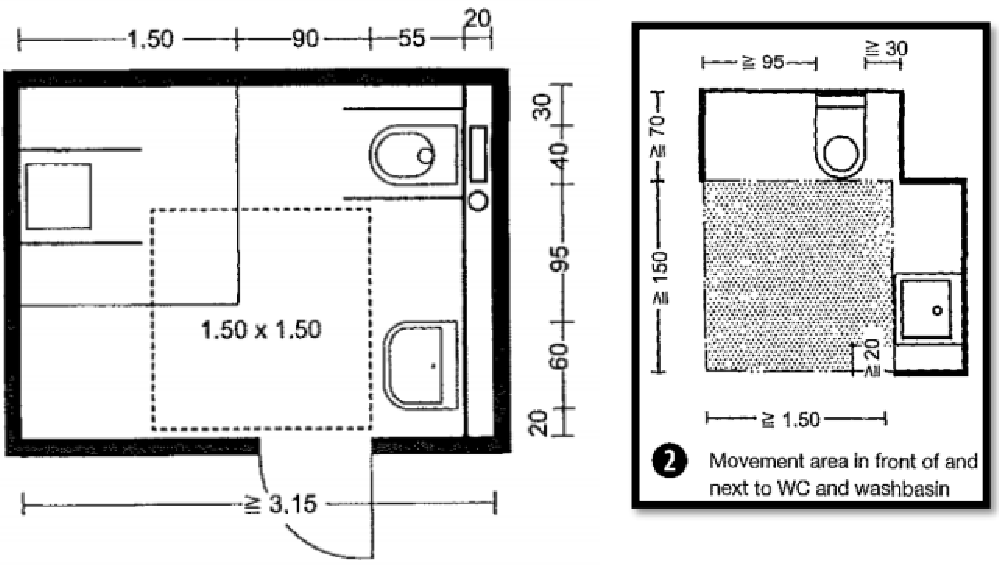


figure 2. 39: WC's standard (Neufert 4th edition, 2015)

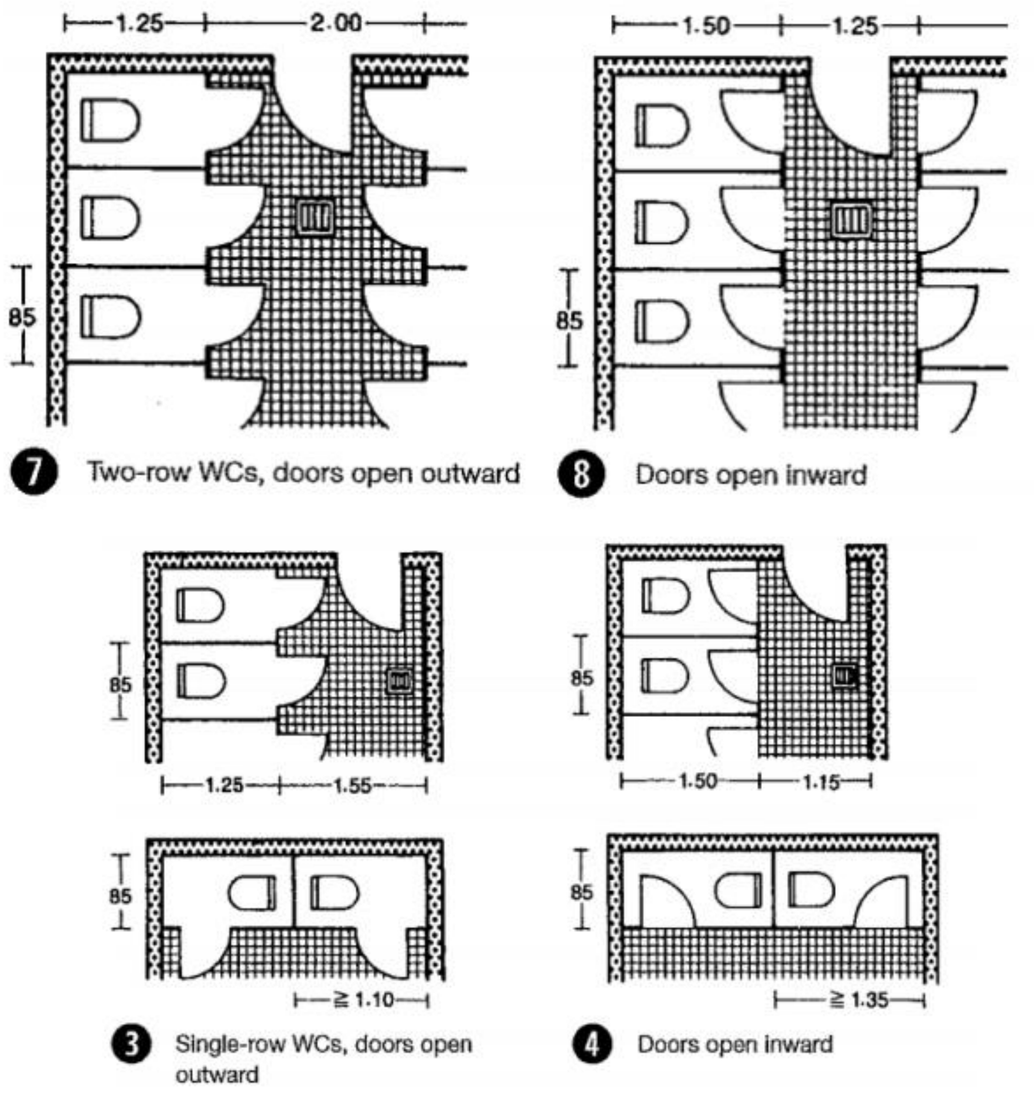


figure 2. 40: Doors in WC (Neufert 4th edition, 2015)

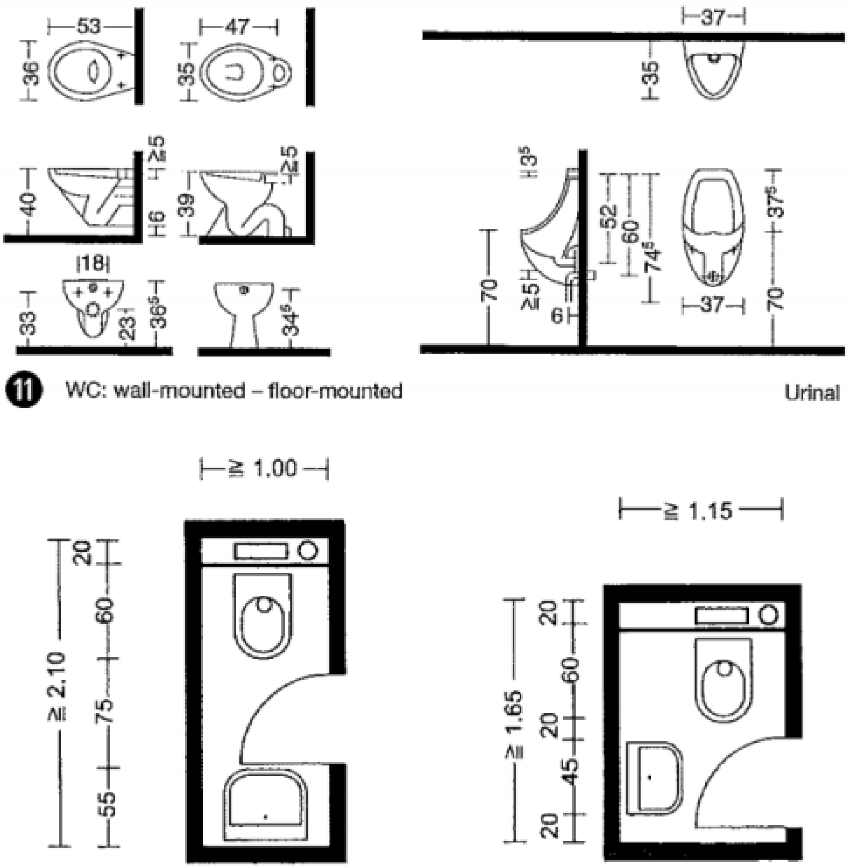


figure 2. 41: WC's dimension (Neufert 4th edition, 2015)

Men							Women					
number of employees	flushing WCs	urinals	gutter (m)	washbasins	additional flushing WCs	additional urinals	number of employees	flushing WCs	washbasins	additional flushing WCs	waste bins	bucket sink
10	1	1	0.6	1	1	1	10	1	1	1	1	1
25	2	2	1.2	1	1	1	20	2	1	1	1	1
50	3	3	1.8	1	1	1	35	3	1	1	1	1
75	4	4	2.4	1	1	2	50	4	2	2	1	1
100	5	5	3.0	2	1	2	65	5	2	2	1	1
130	6	6	3.6	2	2	2	80	6	2	2	1	1
160	7	7	4.2	2	2	2	100	7	2	3	1	1
190	8	8	4.8	2	2	3	120	8	3	3	1	1
220	9	9	5.4	3	3	3	140	9	3	4	1	1
250	10	10	6.0	3	3	4	160	10	3	4	1	1

⑩ Required number of WC fittings (according to Workplace Guidelines 37/1, → p. 263 ❷)

figure 2. 42: Required number of WC fittings (Neufert 4th edition, 2015)

2.2.2.8 Ramps:

The ramps are essential component in every modern building so people with disabilities like having wheelchair can access the building with no problems and count on themselves and make sure that the building is safe for them especially in the side of the spaces where they will move through the facilities of 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.

- At least 1 toilet in all sanitary facilities must be provided for wheelchair users with a 48 cm for the seat height.

- Routes and corridors which are longer than 15 m must include a passing place for 2 wheelchairs with at least 1.8 m for both width & depth.

- Each dwelling must have a weather-protected car parking space or garage. Next to the long side of the car, a moving area of 1.50 m depth should be provided.

- To the right or left of the toilet, the moving space must be at least 95 cm broad and 70 m deep. There must be at least 30 centimeters between one side of the toilet and the wall or furniture.

- 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.

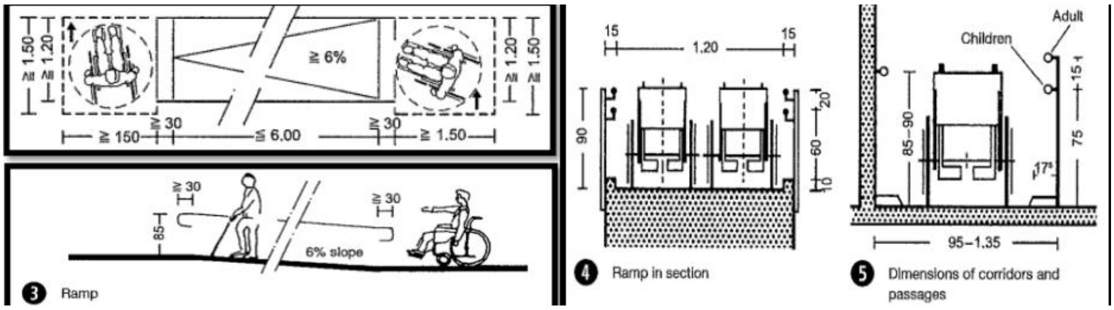


figure 2. 43: Dimension Ramp that fit wheelchair (Neufert 4th edition, 2015)

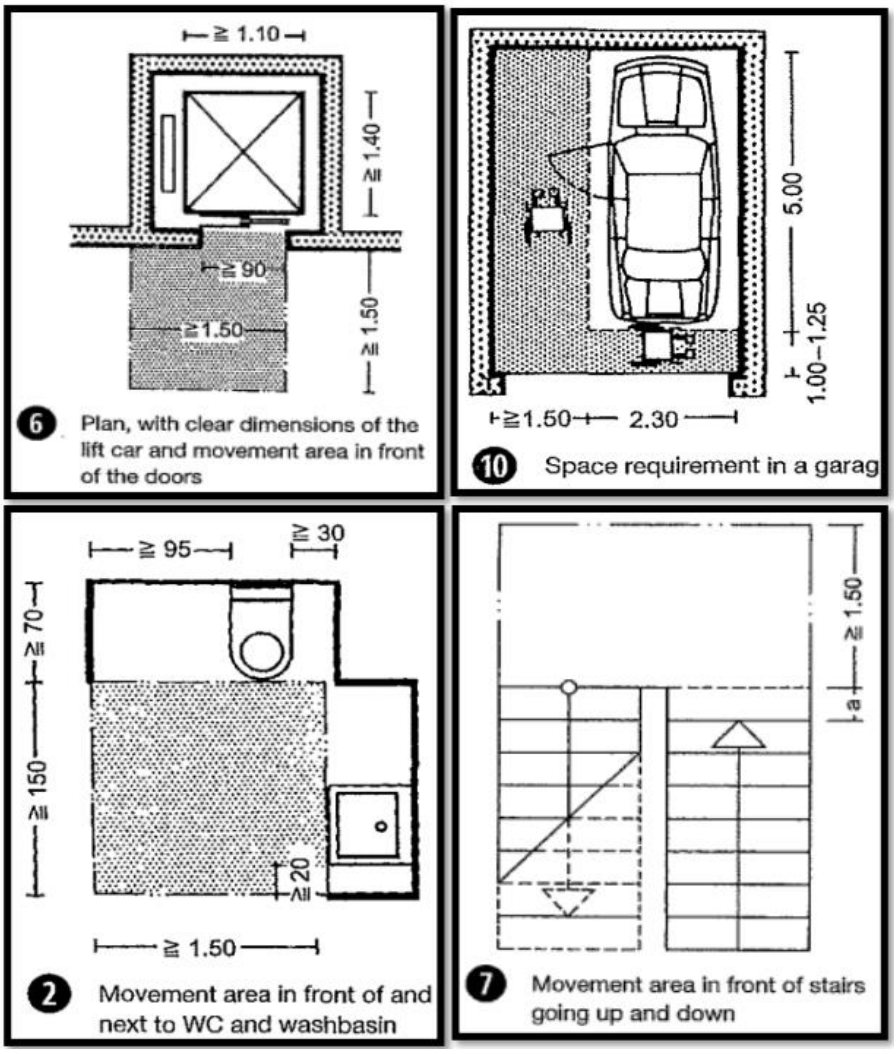


figure 2. 44: Movement area for different places (Neufert 4th edition, 2015)

2.2.2.9 Waiting areas:

People are naturally impatient, and this can affect any kind of business in negative way, so it's important to make sure that the waiting area in our building is comfortable for people who are visiting the building. The waiting area must have enough area so we won't end up with people who are forced to stand or feel cramped, on the other hand we also must overestimate and end up with unused apace that could have been used in better ways. A good standard to use is giving each person 20 sq. ft Waiting room should be close to the entrance of the building and visible to the reception area, but without reducing the privacy of the people in it. Access to the waiting area should be easy and the movement path should be free of any obstacles, and it should contain different types of seating types like chairs with armrest for older people so they can get in and out easily and chairs without armrest so people who use wheelchairs can transfer to them with no problems. Another important issue is that we mustn’t make the waiting area too way comfortable like using some deep, plush seating because it gives the people the impression that the waiting time will be long.

2.2.2.10 Reception:

The reception room is very important and must be taken care of, as it is the first thing a visitor will see when entering the building. When designing the reception area, we must be careful when deciding space, color scheme, lighting, and graphics because they are all elements that should be considered while conveying a company's message. It's also crucial to have enough comfy seating in the waiting area. The receptionist should be able to see the waiting room so he can take care of all visitors. Clear traffic flow must be maintained in this area by allocating enough space for the reception area. A good standard to go by is 20 sq. ft. per person which is pretty like the waiting area because both are very connected to each other, we must mention that extra space is needed for tables, water cooler, snacks, etc.

	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

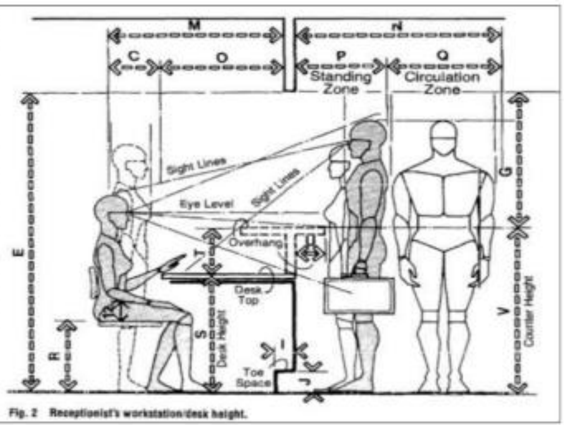
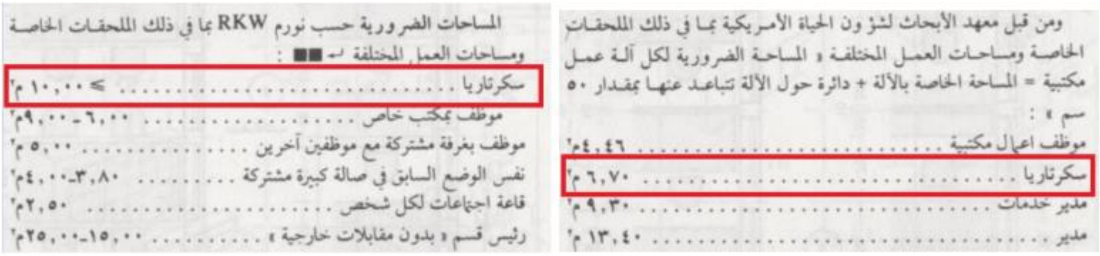


figure 2. 45: Standard Reception (Neufert 4th edition, 2015)

2.2.2.11 Secretary:

The secretary plays a very important role in organizing matters within each department, as it is her responsibility to organize the manager’s appointments and employees’ agendas and carry out all her responsibilities such as paperwork, organizing visitors, setting appointments, agendas and visits. Therefore, the presence of a secretary's office is necessary in every department of the institution. The secretary's office should be adjacent to the department manager's office as much as possible so that the visitor passes over the secretary before entering the department manager’s office. It should also have enough space and not narrow, and it is better that it contains some waiting chairs. The secretary's office better be in contact and close to the employees' offices in the department. According to Neufert’s standards there are 2 limitations for the area of the secretary room as the following:



ومن قبل معهد الأبحاث لشؤون الحياة الأمريكية بما في ذلك الملحقات الخاصة ومساحات العمل المختلفة و المساحة الضرورية لكل آلة عمل مكتبية = المساحة الخاصة بالآلة + دائرة حول الآلة تتباعد عنها بمقدار ٥٠ سم » :

موظف اعمال مكتبية	٤,٤٦م٢
سكرتاريا	٦,٧٠ م٢
مدير خدمات	٩,٣٠ م٢
مدير	١٣,٤٠ م٢

المساحات الضرورية حسب نورم RKW بما في ذلك الملحقات الخاصة ومساحات العمل المختلفة لـ ■■ :

سكرتاريا	≤ ١٠,٠٠ م٢
موظف بمكتب خاص	٦,٠٠ـ٩,٠٠م٢
موظف بغرفة مشتركة مع موظفين آخرين	٥,٠٠ م٢
نفس الوضع السابق في صالة كبيرة مشتركة	٣,٨٠ـ٤,٠٠م٢
قاعة اجتماعات لكل شخص	٢,٥٠م٢
رئيس قسم « بدون مقابلات خارجية »	١٥,٠٠ـ٢٥,٠٠م٢

figure 2. 46:Standard for Secretary (Neufert Arabic edition, 2007)

According to RKW: area must be equal or more than 10 m2. According to Research Institute for American Life: area must be equal or more than 6.7 m2.

2.2.2.12 Corridors:

Corridors considers as a social area which work on connecting all facilities and branches in the building with each other, it’s important for them to have good width so the traffic movement won’t stop, and no accident would happen. Well, as Neufert’s book mentioned "The width of the corridors is dependent on the size of office workers and the spatial needs of various uses and takes into account the passage of two people side by side”.

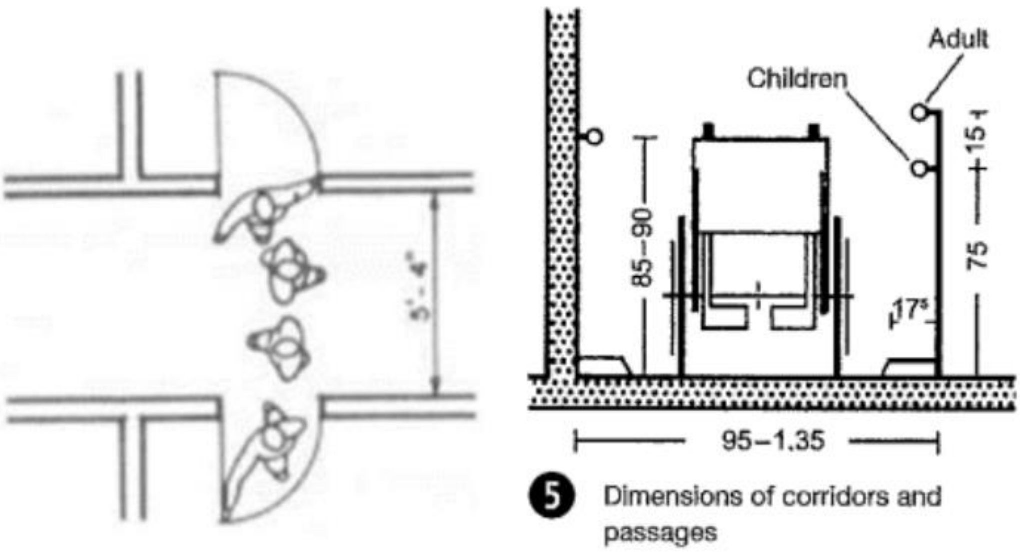
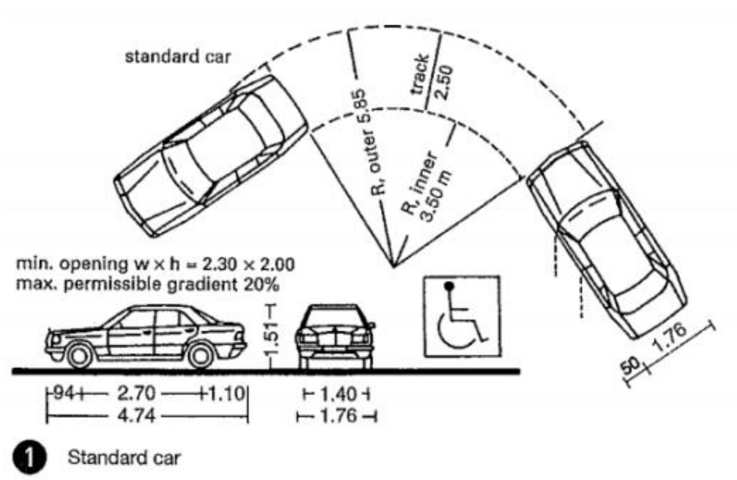


figure 2. 47:Corridor’s dimension (Neufert 4th edition, 2015)

The minimum width for corridor is about 1.3m which is also enough for a wheelchair to move comfortably from space to another.

2.2.2.13 Parking:

It's very important to have enough parking for both employees and visitors of the building, so no one will end up parking his car far from the building or even in no-parking area. The parking can be somewhere around the building on the site, or it can be underground if there is not enough space on the site or if we want to make better use of the space.



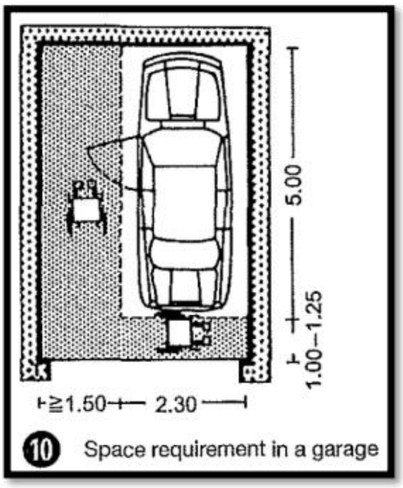


figure 2. 48:Space requirement in parking (Neufert 4th edition, 2015)

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:

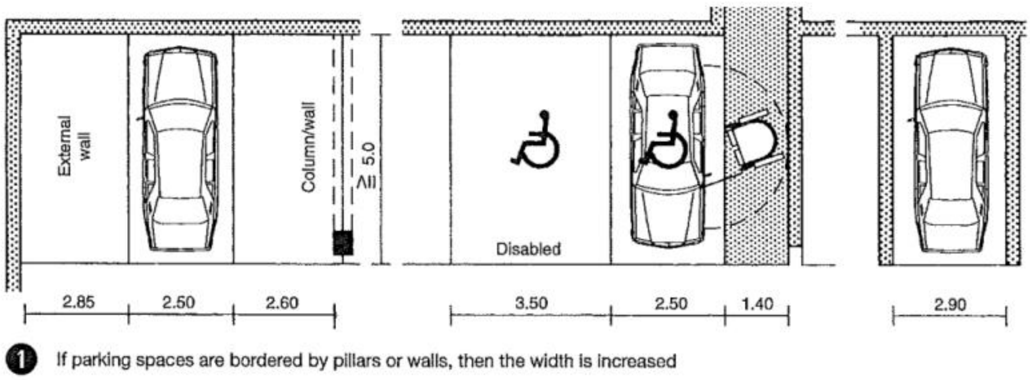


figure 2. 49:Standard dimension for parking (Neufert 4th edition, 2015)

According to Nuefert's book there are a variety of ramp systems for overcoming height variations and accessing the various levels of multi-story parking garages.

Ramps should not have a gradient of more than 15% and can be up to 20% for small cars parks. There must be a horizontal run of at least 5 meters between public roads and ramps with more than a 5° grade, or at least 3 m run in the case of car ramps with up to a 10% gradient. There must be parks with suitable areas for people with wheelchairs, so they won’t find any problem in parking their cars and getting in & out from it. The next picture shows some important regulations about the parking according to (Council of Ministers Resolution No. (6) of 2011 Regulating Buildings and Organization of Local Authorities).

مادة (28)	يجب توفير موقف سيارة واحدة لكل (70) م² من مساحة البناء في مباني المكاتب.
مادة (31)	أن لا يتعدى انحدار الممر الخارجي "الرامب" عن (20%).
مادة (31)	أن لا يقل عرض الممر الخارجي عن: أ. (3.5) م لمواقف السيارات التي لا تزيد عدد السيارات فيها على (30) سيارة.

Article No. 28 & 31 (Council of Ministers Resolution No. (6) of 2011 Regulating Buildings and Organization of Local Authorities).

2.2.2.14 Windows:

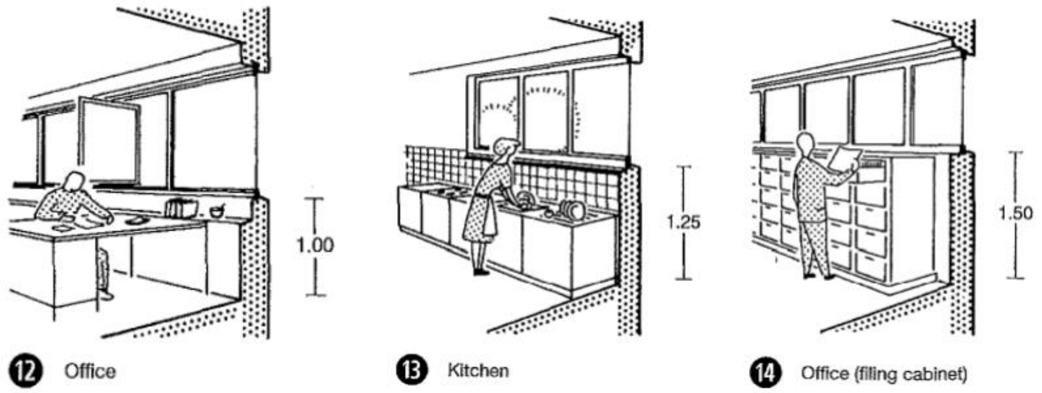


figure 2. 50:Window’s dimensions (Neufert 4th edition, 2015)

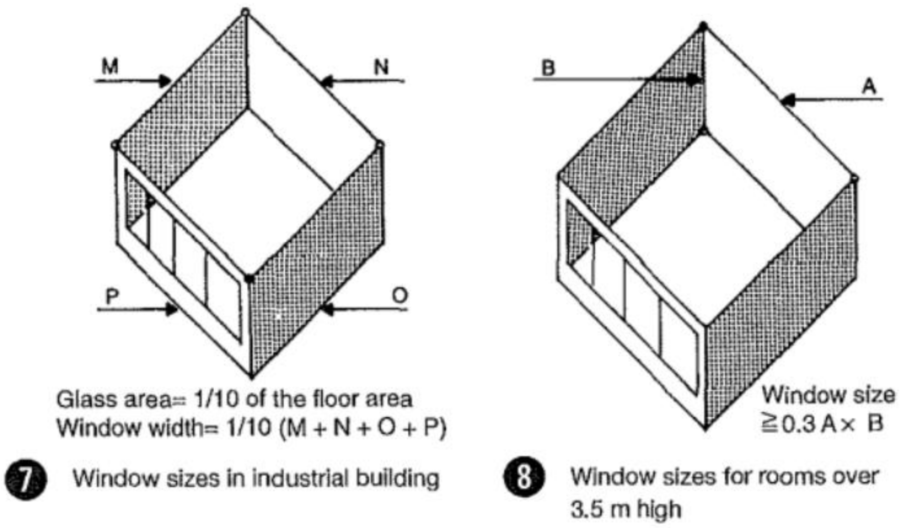


figure 2. 51:Window's sizes (Neufert 4th edition, 2015)

2.2.2.15 Doors:

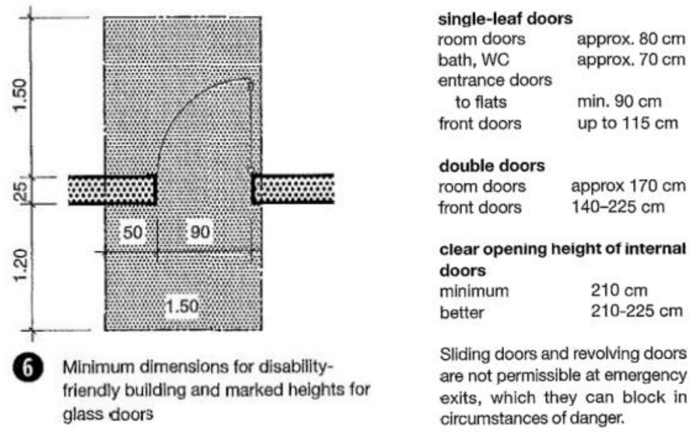


figure 2. 52: Door's standard dimension (Neufert 4th edition, 2015)

2.2.3 Improvements:

1- To better balance the available space and the need to better provide the following spaces in the building: a bathroom for the disabled, a small kitchen and an electronic room, they were perfectly distributed between the floors as shown in the plans.
2- The width of some narrow corridors has been increased to improve the passage of people in them.
3- the emergency stair has been improved to make it better for the users. For the basements, the B1 is added as parking for the staff, and the B2 is added as a service story that can include some facilities like a water tank and a generator. Finally, a safe room has been added in the headmaster office to save all the money and important things.
4- For the basements, the B1 and B2 is added as parking for the staff, and the B3 is added as a safes story
5- Finally, a safe room has been added in the headmaster office to save all the money and important things.

2.3 Energy Simulation of Building:

Heating and cooling calculations:

Thermal comfort is one of the basic things that must be taken into account in the design because of its effects on the users, therefore for the space to be suitable for the purpose for which it was designed, all human comforts must be available as thermal comfort is one of these means. The heating and air conditioning system is a system that supplies the building with the heat loads necessary in both summer and winter to maintain a suitable working space temperature and it is also a system that supplies the building with fresh air and draws polluted air. For the heating and air conditioning system to function properly, we must make accurate calculations to know the capacity needed for this system to work efficiently in all conditions. Some factors affect the capacity of the system such as the type of building, type of material used, glass type, conditions weather, and so on.

Heating and cooling loads before modifications:

Here I will present a general picture of the status of the heating and cooling loads in the building before any modifications, through which we can know the matters that need to be modified and propose effective solutions to improve these values.

See **Error! Reference source not found.**, which shows us how each element of the building contributes to the effect on heating loads before making modifications.

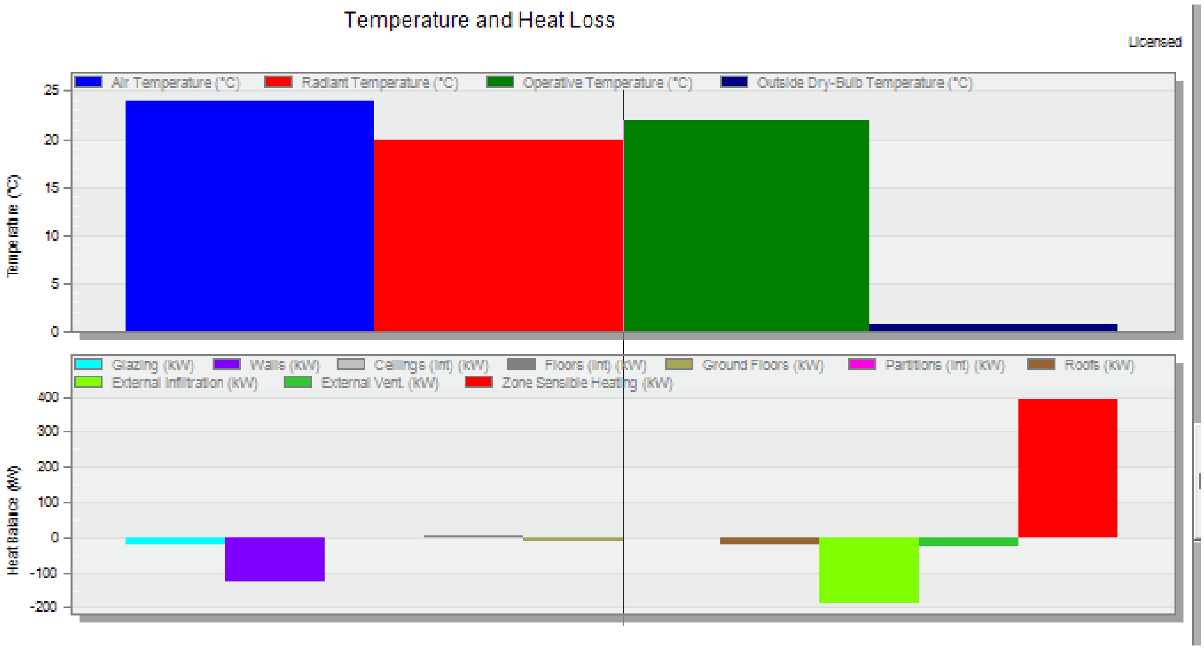


figure 2. 53: heating design before modification

From **Error! Reference source not found.**, we have noticed that there are high contribution values for the basic elements in the building that affect the heating loads, where the percentage of the contribution of the roof and walls has the largest share, and then comes the percentage of the contribution of glass, and from here we realize the importance of thermal insulation of the building and the use of a suitable type of glass as a kind of necessary adjustments to reduce The contribution of these elements thus reduces the necessary heating loads.

See **Error! Reference source not found.**, which shows us how each element of the building contributes to the effect on cooling loads before making modifications.

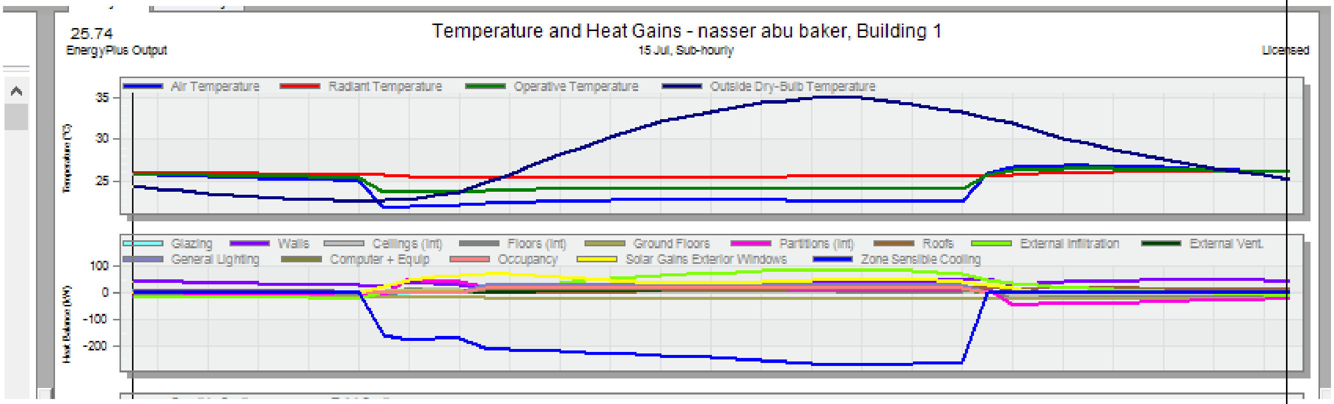


figure 2. 54:cooling design before modification.

From **Error! Reference source not found.**, we have noticed that there are high amounts of solar gain that pass through the external windows, and this greatly affects the values of cooling loads. Therefore, an adjustment must be made to reduce the amount of solar gain in the summer as much as possible to reduce the necessary cooling loads.

Definitions of materials that were used:

Definitions of materials and their thermal properties that were used as a kind of modification to improve the heating and cooling values.

To improve the overall situation in the building in terms of heating and cooling values, I have defined the materials used in building each element of the project and what are the layers that each of these elements consists of, determining specific thicknesses for each layer so that satisfactory thermal properties have been achieved for each element. It is worth noting that thermal insulation of the building was done here using insulating materials that have certain properties.

Here I will provide a detailed explanation of some of the construction elements in the project, what are the layers that were formed from, and what is the thickness of each layer, which had a fundamental impact on the values of the heating and cooling loads.

- External walls:

See **Error! Reference source not found.** which shows us the cross section for external walls.

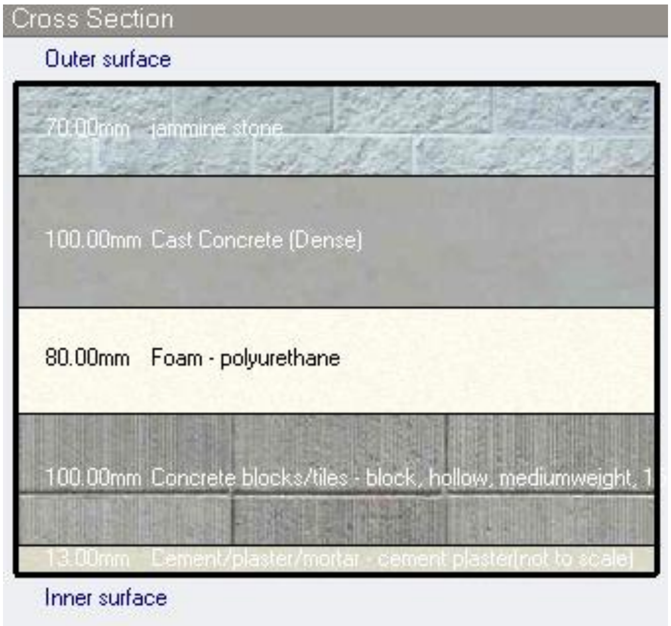


figure 2. 55:Cross section for external walls.

See **Error! Reference source not found.** which shows us the thermal properties of external walls.

Inner surface	
Convective heat transfer coefficient (W/m2-K)	2.152
Radiative heat transfer coefficient (W/m2-K)	5.540
Surface resistance (m2-K/W)	0.130
Outer surface	
Convective heat transfer coefficient (W/m2-K)	19.870
Radiative heat transfer coefficient (W/m2-K)	5.130
Surface resistance (m2-K/W)	0.040
No Bridging	
U-Value surface to surface (W/m2-K)	0.319
R-Value (m2-K/W)	3.305
U-Value (W/m2-K)	**0.303**
With Bridging (BS EN ISO 6946)	
Thickness (m)	0.3630
Km - Internal heat capacity (KJ/m2-K)	95.2224
Upper resistance limit (m2-K/W)	305
Lower resistance limit (m2-K/W)	3.305
U-Value surface to surface (W/m2-K)	0.319
R-Value (m2-K/W)	3.305
U-Value (W/m2-K)	**0.303**

figure 2. 56:thermal properties for external walls

The u-value for the external wall is 0.303 < 0.5 which means that the thermal insulation in the external walls was effective.

- Flat roof:

See **Error! Reference source not found.** which shows us the cross section for the roof.

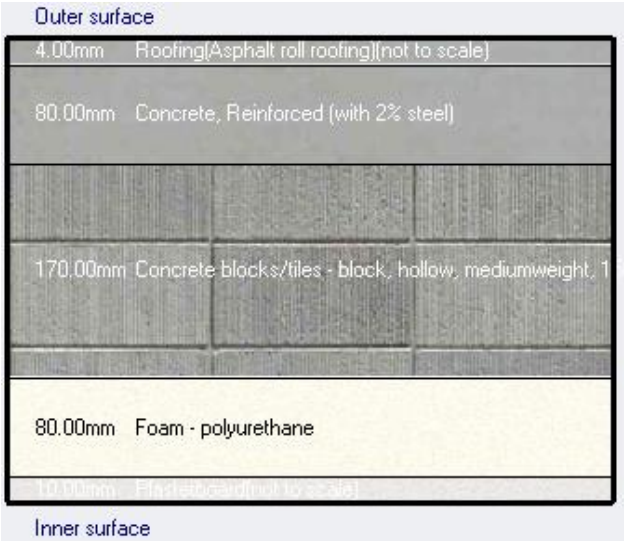


figure 2. 57:cross section for flat roof.

See **Error! Reference source not found.** which shows us the thermal properties of the roof.

Inner surface	
Convective heat transfer coefficient (W/m2-K)	4.460
Radiative heat transfer coefficient (W/m2-K)	5.540
Surface resistance (m2-K/W)	0.100
Outer surface	
Convective heat transfer coefficient (W/m2-K)	19.870
Radiative heat transfer coefficient (W/m2-K)	5.130
Surface resistance (m2-K/W)	0.040
No Bridging	
U-Value surface to surface (W/m2-K)	0.310
R-Value (m2-K/W)	3.370
U-Value (W/m2-K)	**0.297**
With Bridging (BS EN ISO 6946)	
Thickness (m)	0.3440
Km - Internal heat capacity (KJ/m2-K)	37.3520
Upper resistance limit (m2-K/W)	Km - Internal heat capacity (KJ/m2-K)
Lower resistance limit (m2-K/W)	3.220
U-Value surface to surface (W/m2-K)	0.321
R-Value (m2-K/W)	3.252
U-Value (W/m2-K)	**0.307**

figure 2. 58:thermal properties for the roof.

The u-value for the roof is 0.307 < 0.39 which means that the thermal insulation in the roof was effective.

- Internal walls (partitions):

See **Error! Reference source not found.** which shows us the cross section for partitions.

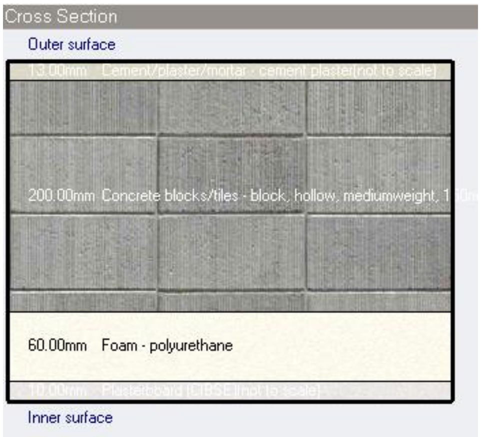


figure 2. 59:Cross section for partitions

- Internal floors:

See **Error! Reference source not found.** which shows us the cross-section of the internal floors.

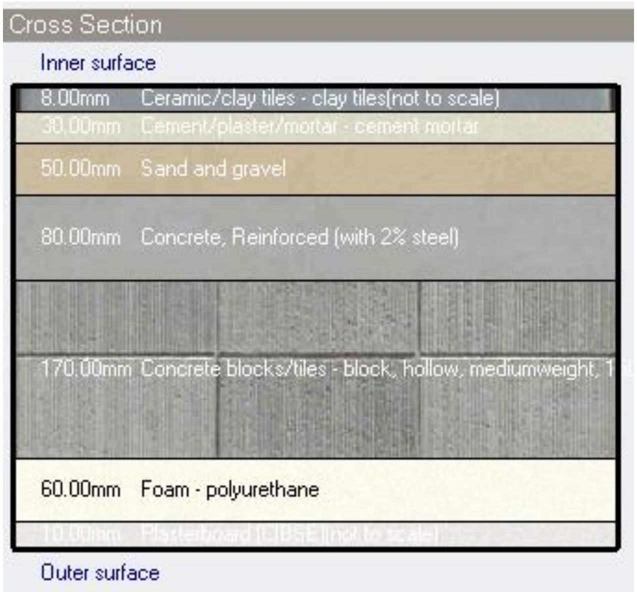


figure 2. 60:Cross section for the internal floor.

- Glazing:

See **Error! Reference source not found.** which shows us very important values for glazing that we used in the project.

Table 4:properties for glazing

Calculated Values	
Total solar transmission (SHGC)	0.282
Direct solar transmission	0.208
Light transmission	0.408
U-value (ISO 10292/ EN 673) (W/m2-K)	1.148
U-Value (W/m2-K)	**1.338**

u-value for glazing = 1.338 and this value is considered an acceptable value.

Heating and cooling loads after modifications:

Heating load:

See **Error! Reference source not found.**, which shows us how each building element contributes an impact to the heating load after modifications have been made.

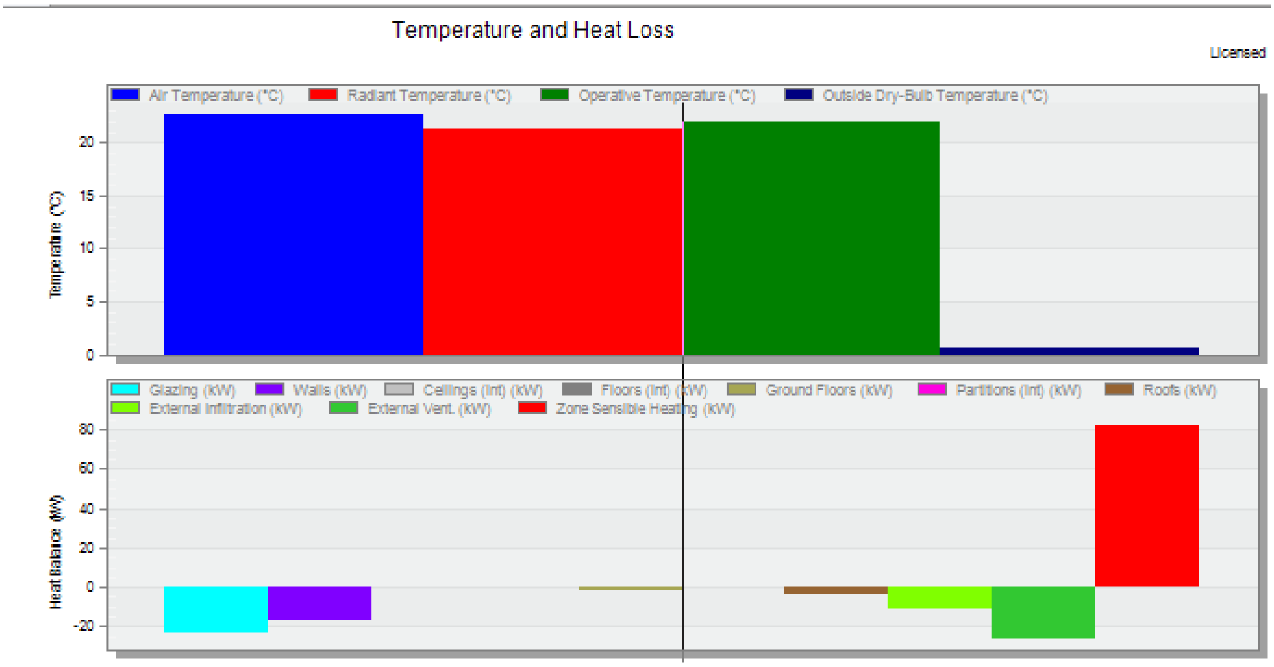


figure 2. 61:heating design after modifications.

From **Error! Reference source not found.** we can notice the clear difference in the amount of the contribution of each element of the building in affecting the heating loads if there is a significant decrease in the values in which these elements participate, due to the modifications that have been implemented to convert the building into a thermally insulated building, and therefore this thing will reduce the loads, The necessary heating in the building and provides a comfortable thermal environment.

It is also worth mentioning here that the thermal insulation process of the building reduced the amount of difference between each the air temperature and the radiant temperature, and this improves the performance of the heating and cooling system, which helps in providing a good operative temperature and thus creating a thermally comfortable environment. It also reduces the energy consumption used in running the system.

See **Error! Reference source not found.**, which shows us some important values in heating design for the building.

Table 5:heating load for each space

G	F	E	D	C	B	A
Design Capacity (W/m2)	Design Capacity (kW)	Steady-State Heat Loss (kW)	Comfort Temperature (°C)	Zone	Block	Building
16.5392	2.9	2.32	22	archieve2	basement 3	Building 1
15.2555	2.54	2.03	22	archieve3	basement 3	Building 1
18.0494	2.87	2.29	22	meeting	basement 3	Building 1
15.3853	0.6	0.48	22	lobby2	basement 3	Building 1
25.3574	0.39	0.31	22	office7	basement 3	Building 1
18.9046	0.68	0.54	22	archieve1	basement 3	Building 1
13.7176	0.39	0.32	22	office4	basement 3	Building 1
19.7932	0.53	0.42	22	office3	basement 3	Building 1
50.9913	0.87	0.69	22	lobby1	basement 3	Building 1
42.87	0.27	0.22	22	kitchen1	basement 3	Building 1
12.536	0.88	0.7	22	office1	basement 3	Building 1
26.5603	0.69	0.55	22	office2	basement 3	Building 1
21.8221	0.63	0.51	22	office6	basement 3	Building 1
24.7011	0.75	0.6	22	office5	basement 3	Building 1
18.1861	0.58	0.46	22	office8	basement 3	Building 1
17.2842	0.27	0.21	22	office1	basement 2	Building 1
36.402	0.21	0.17	22	office2	basement 2	Building 1
17.3177	0.27	0.22	22	office1	basement 1	Building 1
38.5437	0.2	0.16	22	office2	basement 1	Building 1
12.5903	1.72	1.37	22	working area	ground floor	Building 1
48.4451	0.35	0.28	22	kitchen1	ground floor	Building 1
102.9699	0.93	0.74	22	lobby2	ground floor	Building 1
59.3502	0.42	0.34	22	office2	ground floor	Building 1
20.5214	0.15	0.12	22	office1	ground floor	Building 1
G	F	E	D	C	B	A
20.5214	0.15	0.12	22	office1	ground floor	Building 1
19.0889	9.72	7.77	22	waiting area	ground floor	Building 1
22.3319	0.52	0.42	22	lobby1	ground floor	Building 1
12.1535	0.17	0.14	22	office3	ground floor	Building 1
30.67	1.2	0.96	22	office5	ground floor	Building 1
42.5961	0.37	0.3	22	office4	ground floor	Building 1
19.1735	5.5	4.4	22	lobby1	first floor	Building 1
23.5628	1.99	1.59	22	lobby2	first floor	Building 1
48.9223	0.74	0.59	22	office10	first floor	Building 1
27.9544	0.65	0.52	22	office8	first floor	Building 1
48.8217	0.75	0.6	22	office11	first floor	Building 1
73.6986	1.1	0.88	22	office9	first floor	Building 1
48.9043	0.74	0.59	22	office12	first floor	Building 1
24.9444	0.14	0.11	22	kitchen2	first floor	Building 1
12.9476	0.33	0.27	22	office4	first floor	Building 1
19.8586	0.5	0.4	22	office5	first floor	Building 1
32.6798	0.86	0.69	22	office6	first floor	Building 1
32.7449	0.86	0.69	22	office7	first floor	Building 1
13.8921	0.54	0.43	22	office3	first floor	Building 1
14.7535	0.54	0.43	22	office2	first floor	Building 1
48.4606	0.36	0.28	22	kitchen1	first floor	Building 1
40.9317	0.62	0.5	22	archevie1	first floor	Building 1
12.6689	0.33	0.26	22	office1	first floor	Building 1
20.2754	6.52	5.21	22	lobby2	second floor	Building 1
50.4988	0.36	0.29	22	kitchen1	second floor	Building 1

G	F	E	D	C	B	A
50.4988	0.36	0.29	22	kitchen1	second floor	Building 1
21.1802	0.43	0.35	22	office10	second floor	Building 1
21.149	0.43	0.34	22	office11	second floor	Building 1
20.3812	0.41	0.33	22	office12	second floor	Building 1
48.5316	0.74	0.6	22	office20	second floor	Building 1
12.2941	0.35	0.28	22	office13	second floor	Building 1
27.7804	1.06	0.85	22	office14	second floor	Building 1
34.1628	0.88	0.7	22	office15	second floor	Building 1
33.5662	0.67	0.53	22	office16	second floor	Building 1
48.5155	0.75	0.6	22	office19	second floor	Building 1
19.7294	0.29	0.23	22	office4	second floor	Building 1
20.2895	0.28	0.23	22	office3	second floor	Building 1
20.4028	0.28	0.23	22	office2	second floor	Building 1
15.9365	0.67	0.53	22	office1	second floor	Building 1
31.8257	1.06	0.85	22	office8	second floor	Building 1
48.657	0.74	0.59	22	office18	second floor	Building 1
13.2715	0.32	0.25	22	lobby1	second floor	Building 1
47.0036	0.6	0.48	22	office5	second floor	Building 1
23.4899	0.54	0.43	22	office6	second floor	Building 1
20.2457	0.52	0.41	22	office7	second floor	Building 1
51.7237	1.66	1.33	22	office9	second floor	Building 1
43.6777	0.26	0.21	22	kitchen2	second floor	Building 1
73.4584	1.11	0.89	22	office17	second floor	Building 1
13.697	1.06	0.85	22	LOBBY2	third floor	Building 1
50.3769	0.36	0.28	22	KITCHEN 3	third floor	Building 1

G	F	E	D	C	B	A
50.3769	0.36	0.28	22	KITCHEN 3	third floor	Building 1
22.2492	1.54	1.23	22	LOBBY1	third floor	Building 1
21.5752	0.44	0.35	22	OFFICE7	third floor	Building 1
13.795	0.32	0.26	22	LOBBY3	third floor	Building 1
20.6736	0.28	0.23	22	OFFICE11	third floor	Building 1
46.2399	0.6	0.48	22	OFFICE8	third floor	Building 1
23.3054	0.54	0.43	22	OFFICE9	third floor	Building 1
20.8383	0.28	0.23	22	OFFICE13	third floor	Building 1
21.5561	0.44	0.35	22	OFFICE6	third floor	Building 1
19.7411	0.52	0.42	22	OFFICE10	third floor	Building 1
21.0286	0.28	0.23	22	OFFICE12	third floor	Building 1
20.7789	0.42	0.34	22	OFFICE5	third floor	Building 1
48.8753	0.74	0.6	22	OFFICE4	third floor	Building 1
20.7332	5.9	4.72	22	lobby4	third floor	Building 1
16.591	0.67	0.54	22	OFFICE14	third floor	Building 1
48.7795	0.75	0.6	22	OFFICE3	third floor	Building 1
32.2591	1.07	0.85	22	OFFICE16	third floor	Building 1
48.8846	0.74	0.59	22	OFFICE1	third floor	Building 1
51.8286	1.67	1.33	22	OFFICE15	third floor	Building 1
43.649	0.26	0.21	22	KITCHEN2	third floor	Building 1
49.1467	1.47	1.17	22	OFFICE2	third floor	Building 1
26.455	3.64	2.91	22	MEETING	fourth floor	Building 1
62.4643	0.44	0.35	22	KITCHEN	fourth floor	Building 1
50.4518	0.58	0.47	22	OFFICE6	fourth floor	Building 1
33.9358	0.41	0.33	22	CIRCULATION	fourth floor	Building 1

G	F	E	D	C	B	A
26.455	3.64	2.91	22	MEETING	fourth floor	Building 1
62.4643	0.44	0.35	22	KITCHEN	fourth floor	Building 1
50.4518	0.58	0.47	22	OFFICE6	fourth floor	Building 1
33.9358	0.41	0.33	22	CIRCULATION	fourth floor	Building 1
24.2315	0.28	0.23	22	OFFICE5	fourth floor	Building 1
25.0657	0.27	0.22	22	OFFICE4	fourth floor	Building 1
19.2613	0.78	0.62	22	OFFICE3	fourth floor	Building 1
44.0239	3.92	3.13	22	OFFICE2	fourth floor	Building 1
30.2882	1.44	1.16	22	ARCHIEVE	fourth floor	Building 1
39.4618	0.68	0.54	22	OFFICE1	fourth floor	Building 1

Some comments on the values in **Error! Reference source not found.**:

- The temperature in all spaces has been set at 22 Celcius, provided that it is the operative temperature, and this helps in achieving a thermally comfortable environment.
- It's easy to see the impact of the modifications that were made since all the values are logical and acceptable.
- Design capacity(w/m^2) in all spaces < 80 which means the building is considered energy efficient.

Cooling load:

See **Error! Reference source not found.**, which shows us how each building element contributes an impact to the cooling load after modifications have been made.

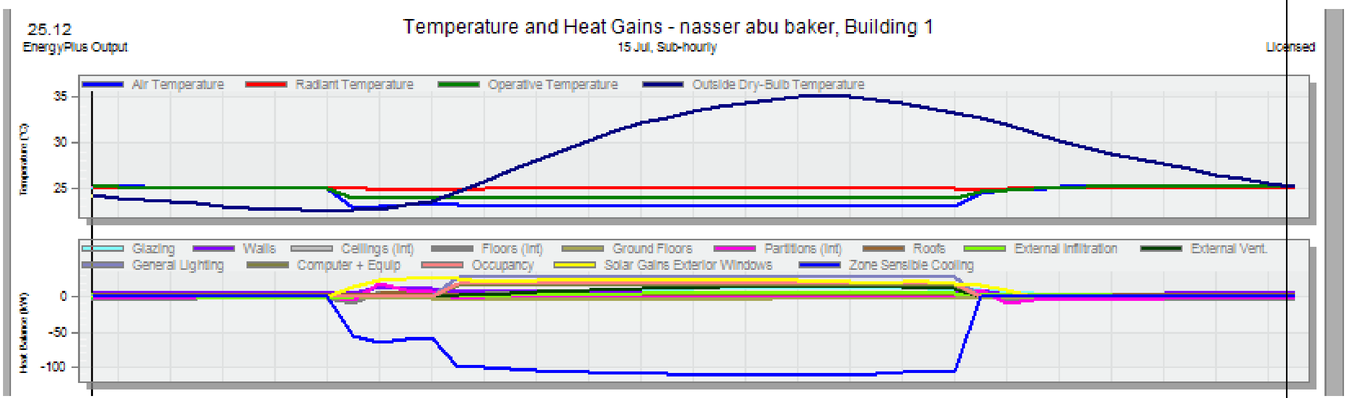


figure 2. 62:cooling design after modifications

From **Error! Reference source not found.** we can notice the improvement in the values, especially the value of solar gain through the windows. In general, these values have become acceptable, and this is all as a result of the modifications that have been implemented, which in turn also caused a reduction in the necessary cooling loads and made the different temperatures as close to each other as possible, which contributes to saving the Thermally comfortable environment and reduces energy consumption.

See **Error! Reference source not found.**, which shows us some important values in cooling design for the building.

Table 6:cooling load for each space

Design Cooling Load Per Floor Area(W/m2)	Total Cooling Load (kW)	Design Flow Rate (m3/s)	Design Capacity (kW)	Zone	Block	Building
26.6	4.06	0.3222	4.66	Basement3:Archieve2	basement 3	Building 1
25.7	3.73	0.291	4.29	Basement3:Archieve3	basement 3	Building 1
26.4	3.64	0.2833	4.19	Basement3:Meeting	basement 3	Building 1
13.2	0.44	0.03	0.51	Basement3:Lobby2	basement 3	Building 1
39	0.52	0.0391	0.6	Basement3:Office7	basement 3	Building 1
27.1	0.84	0.0693	0.97	Basement3:Archieve1	basement 3	Building 1
26	0.65	0.0487	0.75	Basement3:Office4	basement 3	Building 1
28	0.65	0.0521	0.75	Basement3:Office3	basement 3	Building 1
37.8	0.56	0.0431	0.64	Basement3:Lobby1	basement 3	Building 1
63.9	0.35	0.0253	0.41	Basement3:Kitchen1	basement 3	Building 1
19.7	1.2	0.1001	1.38	Basement3:Office1	basement 3	Building 1
31.8	0.72	0.0585	0.82	Basement3:Office2	basement 3	Building 1
30.2	0.76	0.0595	0.88	Basement3:Office6	basement 3	Building 1
33.1	0.88	0.0706	1.01	Basement3:Office5	basement 3	Building 1
28.9	0.8	0.0624	0.92	Basement3:Office8	basement 3	Building 1
34.7	0.47	0.0395	0.54	Basement2:Office1	basement 2	Building 1
61.3	0.31	0.0242	0.36	Basement2:Office2	basement 2	Building 1
35.4	0.48	0.0404	0.55	Basement1:Office1	basement 1	Building 1
64.8	0.3	0.0232	0.34	Basement1:Office2	basement 1	Building 1
17	2.01	0.1604	2.31	GroundFloor:WorkingArea	ground floor	Building 1
71.7	0.46	0.0366	0.52	GroundFloor:Kitchen1	ground floor	Building 1
122.8	0.96	0.0972	1.11	GroundFloor:Lobby2	ground floor	Building 1
151	0.93	0.0961	1.07	GroundFloor:Office2	ground floor	Building 1
46.8	0.3	0.023	0.35	GroundFloor:Office1	ground floor	Building 1
46.8	0.3	0.023	0.35	GroundFloor:Office1	ground floor	Building 1
26.1	11.55	1.0377	13.29	GroundFloor:WaitingArea	ground floor	Building 1
27.7	0.57	0.0435	0.65	GroundFloor:Lobby1	ground floor	Building 1
32.6	0.4	0.0317	0.46	GroundFloor:Office3	ground floor	Building 1
65.4	2.23	0.227	2.56	GroundFloor:Office5	ground floor	Building 1
55.1	0.42	0.0345	0.48	GroundFloor:Office4	ground floor	Building 1
27	6.73	0.57	7.74	FirstFloor:Lobby1	first floor	Building 1
26.6	1.96	0.163	2.25	FirstFloor:Lobby2	first floor	Building 1
94.3	1.24	0.1263	1.42	FirstFloor:Office10	first floor	Building 1
47	0.95	0.0825	1.09	FirstFloor:Office8	first floor	Building 1
92	1.22	0.124	1.41	FirstFloor:Office11	first floor	Building 1
110.7	1.44	0.147	1.66	FirstFloor:Office9	first floor	Building 1
92.5	1.22	0.1236	1.4	FirstFloor:Office12	first floor	Building 1
70.5	0.35	0.0246	0.4	FirstFloor:Kitchen2	first floor	Building 1
33.9	0.76	0.0596	0.87	FirstFloor:Office4	first floor	Building 1
38.3	0.84	0.068	0.97	FirstFloor:Office5	first floor	Building 1
49.8	1.14	0.1026	1.31	FirstFloor:Office6	first floor	Building 1
50.4	1.15	0.1036	1.32	FirstFloor:Office7	first floor	Building 1
29.9	1.02	0.0823	1.17	FirstFloor:Office3	first floor	Building 1
31.3	1	0.0846	1.15	FirstFloor:Office2	first floor	Building 1
93.3	0.6	0.0442	0.69	FirstFloor:Kitchen1	first floor	Building 1
94.7	1.25	0.118	1.44	FirstFloor:Archevie1	first floor	Building 1
33.5	0.75	0.0592	0.87	FirstFloor:Office1	first floor	Building 1
26.9	7.52	0.6096	8.65	SecondFloor:Lobby2	second floor	Building 1
74.1	0.46	0.0366	0.52	SecondFloor:Kitchen1	second floor	Building 1

74.1	0.46	0.0366	0.52	SecondFloor:Kitchen1	second floor	Building 1
40.9	0.72	0.0572	0.83	SecondFloor:Office10	second floor	Building 1
40.7	0.72	0.057	0.83	SecondFloor:Office11	second floor	Building 1
39.3	0.69	0.0538	0.79	SecondFloor:Office12	second floor	Building 1
90.4	1.21	0.1218	1.39	SecondFloor:Office20	second floor	Building 1
32.6	0.8	0.0632	0.92	SecondFloor:Office13	second floor	Building 1
43.3	1.43	0.1305	1.65	SecondFloor:Office14	second floor	Building 1
53.3	1.19	0.1081	1.37	SecondFloor:Office15	second floor	Building 1
53.8	0.93	0.0817	1.07	SecondFloor:Office16	second floor	Building 1
92	1.23	0.1251	1.42	SecondFloor:Office19	second floor	Building 1
44.3	0.56	0.0422	0.64	SecondFloor:Office4	second floor	Building 1
45.1	0.54	0.041	0.63	SecondFloor:Office3	second floor	Building 1
45.4	0.55	0.0413	0.63	SecondFloor:Office2	second floor	Building 1
42.5	1.54	0.1349	1.78	SecondFloor:Office1	second floor	Building 1
55.3	1.61	0.1491	1.85	SecondFloor:Office8	second floor	Building 1
90.9	1.21	0.122	1.39	SecondFloor:Office18	second floor	Building 1
23.9	0.5	0.0351	0.57	SecondFloor:Lobby1	second floor	Building 1
107	1.18	0.112	1.36	SecondFloor:Office5	second floor	Building 1
40.3	0.8	0.0672	0.92	SecondFloor:Office6	second floor	Building 1
38.3	0.85	0.0687	0.98	SecondFloor:Office7	second floor	Building 1
89.1	2.5	0.2643	2.87	SecondFloor:Office9	second floor	Building 1
77.2	0.4	0.0292	0.46	SecondFloor:Kitchen2	second floor	Building 1
110.7	1.46	0.1488	1.68	SecondFloor:Office17	second floor	Building 1
20.9	1.41	0.111	1.62	ThirdFloor:LOBBY2	third floor	Building 1
74.1	0.46	0.0366	0.52	ThirdFloor:KITCHEN3	third floor	Building 1
74.1	0.46	0.0366	0.52	ThirdFloor:KITCHEN3	third floor	Building
27.7	1.67	0.1419	1.92	ThirdFloor:LOBBY1	third floor	Building
42.4	0.75	0.0594	0.86	ThirdFloor:OFFICE7	third floor	Building
25	0.51	0.0356	0.58	ThirdFloor:LOBBY3	third floor	Building
45.5	0.54	0.0409	0.62	ThirdFloor:OFFICE11	third floor	Building
105.9	1.2	0.1136	1.38	ThirdFloor:OFFICE8	third floor	Building
40.5	0.82	0.0688	0.94	ThirdFloor:OFFICE9	third floor	Building
46	0.54	0.0407	0.62	ThirdFloor:OFFICE13	third floor	Building
42.4	0.75	0.0593	0.86	ThirdFloor:OFFICE6	third floor	Building
38.2	0.88	0.0716	1.01	ThirdFloor:OFFICE10	third floor	Building
46.6	0.55	0.0414	0.63	ThirdFloor:OFFICE12	third floor	Building
41.3	0.73	0.0601	0.83	ThirdFloor:OFFICE5	third floor	Building
92.7	1.23	0.1245	1.41	ThirdFloor:OFFICE4	third floor	Building
26.9	6.66	0.5976	7.66	ThirdFloor:Lobby4	third floor	Building
43.6	1.54	0.1345	1.77	ThirdFloor:OFFICE14	third floor	Building
92.5	1.23	0.1248	1.41	ThirdFloor:OFFICE3	third floor	Building
56.8	1.63	0.1523	1.88	ThirdFloor:OFFICE16	third floor	Building
92.1	1.21	0.1231	1.4	ThirdFloor:OFFICE1	third floor	Building
90.5	2.53	0.2698	2.91	ThirdFloor:OFFICE15	third floor	Building
77.2	0.4	0.0293	0.46	ThirdFloor:KITCHEN2	third floor	Building
72.7	1.89	0.1873	2.17	ThirdFloor:OFFICE2	third floor	Building
46	5.5	0.5059	6.33	FourthFloor:MEETING	fourth floor	Building
93.6	0.57	0.0485	0.66	FourthFloor:KITCHEN	fourth floor	Building
109.6	1.1	0.1114	1.27	FourthFloor:OFFICE6	fourth floor	Building
52.5	0.55	0.041	0.64	FourthFloor:CIRCULATION	fourth floor	Building
52.5	0.55	0.041	0.64	FourthFloor:CIRCULATION	fourth floor	Building 1
48.3	0.49	0.0426	0.57	FourthFloor:OFFICE5	fourth floor	Building 1
49.5	0.47	0.0402	0.54	FourthFloor:OFFICE4	fourth floor	Building 1
40	1.4	0.1273	1.61	FourthFloor:OFFICE3	fourth floor	Building 1
72	5.57	0.6124	6.4	FourthFloor:OFFICE2	fourth floor	Building 1
50.6	2.1	0.1915	2.41	FourthFloor:ARCHIEVE	fourth floor	Building 1
61.3	0.92	0.0814	1.05	FourthFloor:OFFICE1	fourth floor	Building 1

Some comments on the values in **Error! Reference source not found.**:

- The temperature in all spaces has been set at 24 Celcius, provided that it is the operative temperature, and this helps in achieving a thermally comfortable environment.
- It's easy to see the impact of the modifications that were made since all the values are logical and acceptable.

- Design capacity(w/m^2) in all spaces < 80 which means the building is considered energy efficient.

Annual building utility performance summary:

- The site and source of energy:

See **Error! Reference source not found.** which shows us the annual energy consumed at the site, and the amount of energy consumed per square meter.

Table 7:site and source energy.

	Total Energy [kWh]	Energy Per Total Building Area [kWh/m2]	Energy Per Conditioned Building Area [kWh/m2]
Total Site Energy	366652.62	84.27	84.27
Net Site Energy	366652.62	84.27	84.27
Total Source Energy	807179.19	185.53	185.53
Net Source Energy	807179.19	185.53	185.53

Based on the values given in **Error! Reference source not found.**, the general condition can be assessed in general as acceptable, but a comparison must be made with another similar building to accurately assess and reach the best possible condition.

- End uses:

See **Error! Reference source not found.** which shows us the distributions of energy consumed at the site.

Table 8:end uses.

	Electricity [kWh]	Natural Gas [kWh]	Additional Fuel [kWh]	District Cooling [kWh]	District Heating [kWh]	Water [m3]
Heating	0.00	0.00	0.00	0.00	11283.49	0.00
Cooling	0.00	0.00	0.00	172727.38	0.00	0.00
Interior Lighting	106058.00	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	63949.17	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00	0.00
Fans	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	12634.57	197.84
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	170007.17	0.00	0.00	172727.38	23918.07	197.84

Note: District heat appears to be the principal heating source based on energy usage.

From **Error! Reference source not found.** we can realize the logical extent of the values, and this makes us conclude that the work has been done correctly.

Thermal comfort:

It is very important to evaluate the situation of the building in terms of its ability to achieve comfort for the users, and there is no value for the building if people do not feel comfortable while they are inside it. Therefore, this examination is considered one of the very important examinations, and it must be dealt with smoothly and try to make it the best possible to achieve a thermally comfortable environment for all building users.

PMW index: It is an indicator that expresses the thermal comfort that people feel while they are in the building.

See **Error! Reference source not found.** which shows us the index values throughout the year.

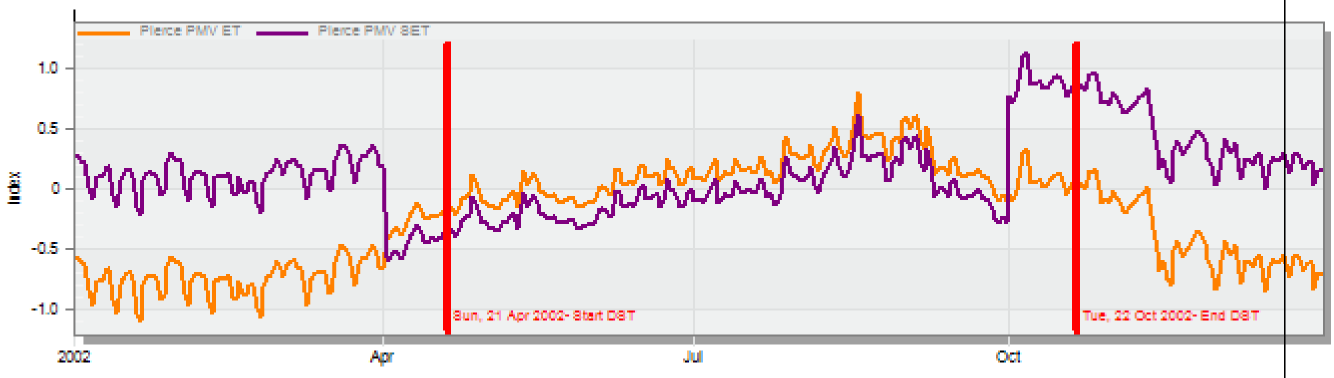


figure 2. 63:PMV index for users in building

From **Error! Reference source not found.** we have noticed that the values were acceptable throughout the year, and this means that people feel thermal comfort well while they are inside the building, except for short periods, which are when there are high climatic fluctuations, which occur when switching from one season to another.

2.4 Acoustic system:

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)

2.4.1 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). Use ease software to evaluate RT60 for spaces.

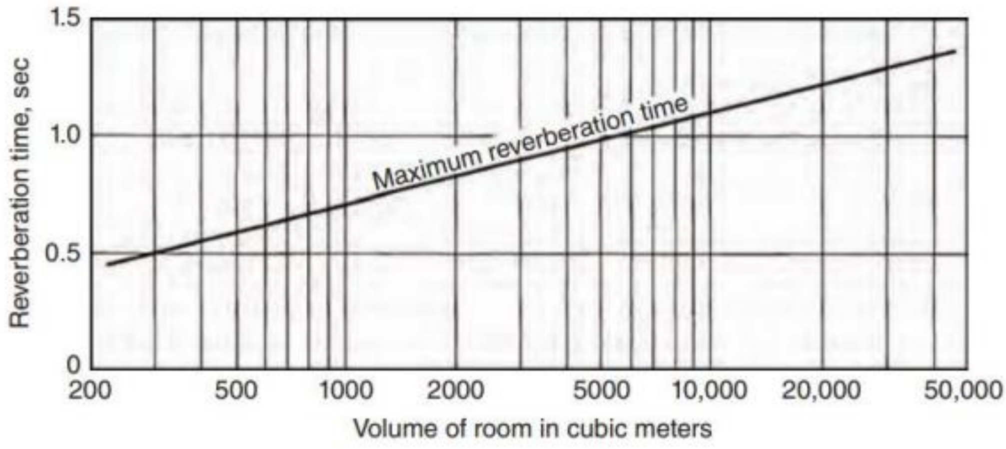


figure 2. 64:Maximum recommended reverberation time for speech in office (Grondzik, & Kwok, 2015, P.1059).

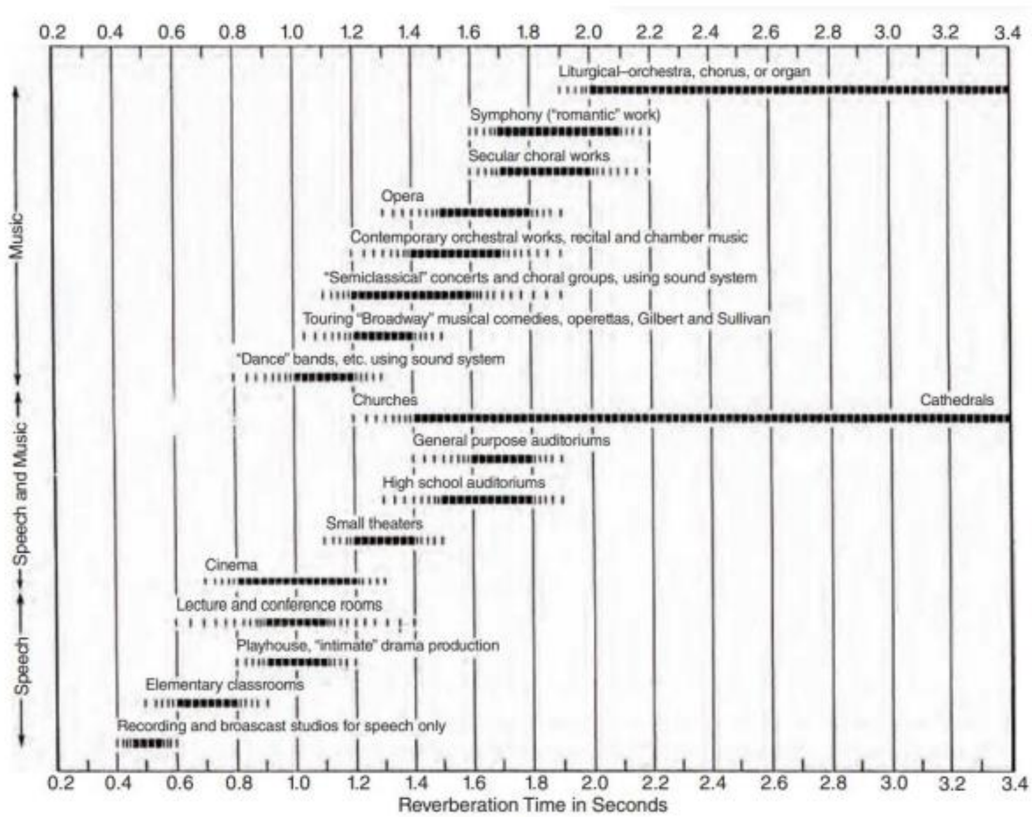


figure 2. 65:Optimum reverberation times at midfrequency (500–1000 Hz) for various types of facilities (Grondzik, & Kwok, 2015, P.1060).

TABLE 19.8 Suggested Noise Criteria Ranges for Steady Background Noise

Type of Space (and Acoustical Requirements)	NC Curve
Concert halls, opera houses, and recital halls (for listening to faint musical sounds).	10–20
Broadcast and recording studios (distant microphone pickup used).	15–20
Large auditoriums, large drama theatres, and houses of worship (for excellent listening conditions).	20–25
Broadcast, television, and recording studios (close microphone pickup only).	20–25
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
Bedrooms, sleeping quarters, hospitals, residences, apartments, hotels, motels, and so forth (for sleeping, resting, relaxing).	25–35
Private or semiprivate offices, small conference rooms, classrooms, libraries, and so forth (for good listening conditions).	30–35
Living rooms and similar spaces in dwellings (for conversing or listening to radio and TV).	35–45
Large offices, reception areas, retail shops and stores, cafeterias, restaurants, and so forth (for moderately good listening conditions).	35–50
Lobbies, laboratory work spaces, drafting and engineering rooms, general secretarial areas (for fair listening conditions).	40–45
Light maintenance shops, office and computer equipment rooms, kitchens, and laundries (for moderately fair listening conditions).	45–60
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.	—

figure 2. 66: suggested noise criteria ranges

RT60 is defined as the measure of the time after the sound source ceases that it takes for the sound pressure level to reduce by 60 db.

Using EASE software to find RT60 for spaces:

Design Meeting Room:

figure 2. 67: pic. for meeting room

RT 60:

Recommended reverberation time is approximately 1 second.

NRC:

NRC of at least 0.50, ideally at least 0.80.

NC:

NC 25-30.

STC:

UBC requirements for walls: STC rating of 50 (if tested in a laboratory) or 45 (if tested in the field*).

UBC requirements for floor/ceiling assemblies: STC ratings of 50 (if tested in a laboratory) or 45 (if tested in the field*)

IIC:

UBC requirements for floor/ceiling assemblies: IIC ratings of 50 (if tested in a laboratory) or 45 (if tested in the field*).

**** The field test evaluates the dwelling's actual construction and includes all sound paths*.***

Room type	dB (A)	NC value
Meeting rooms	38-42	30-35
Management offices/ administration offices	38-47	35-40

figure 2. 68 dB & NC values

Using EASE software:

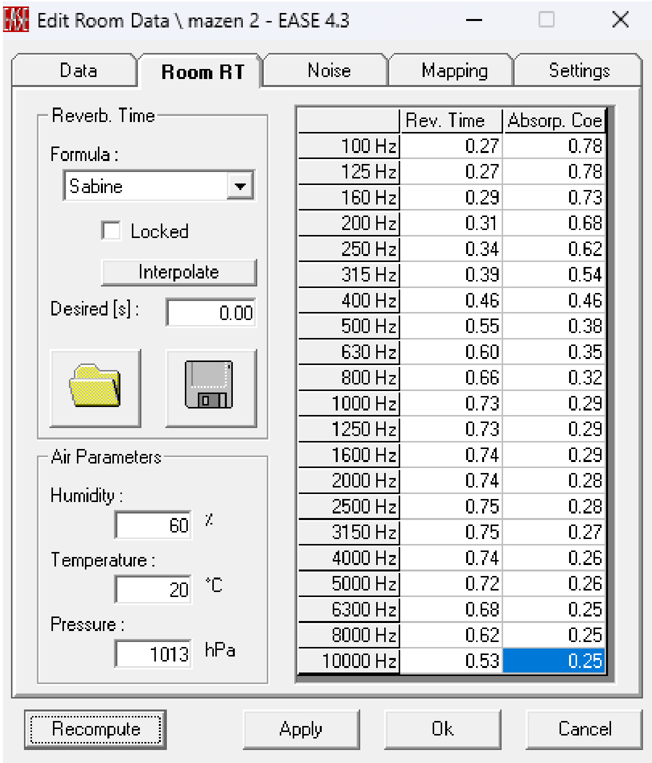


figure 2. 69: ease system RT

RT60 IN THE RANG << 1 SECOND ITS OK

Design waiting room:

	Noise Level [dB]
100 Hz	35.00
125 Hz	35.00
160 Hz	35.00
200 Hz	35.00
250 Hz	35.00
315 Hz	35.00
400 Hz	35.00
500 Hz	35.00
630 Hz	35.00
800 Hz	35.00
1000 Hz	35.00
1250 Hz	35.00
1600 Hz	35.00
2000 Hz	35.00
2500 Hz	35.00
3150 Hz	35.00
4000 Hz	35.00
5000 Hz	35.00
6300 Hz	35.00
8000 Hz	35.00
10000 Hz	35.00

	Rev. Time
100 Hz	0.27
125 Hz	0.27
160 Hz	0.29
200 Hz	0.31
250 Hz	0.34
315 Hz	0.39
400 Hz	0.46
500 Hz	0.55
630 Hz	0.60
800 Hz	0.66
1000 Hz	0.73
1250 Hz	0.73
1600 Hz	0.74
2000 Hz	0.74
2500 Hz	0.75
3150 Hz	0.75
4000 Hz	0.74
5000 Hz	0.72
6300 Hz	0.68
8000 Hz	0.62

figure 2. 70:waiting room on ease

RT60 <1 sec its ok

We used :

1. panel gypsym board in the ceiling.

2.wood panel in the wall

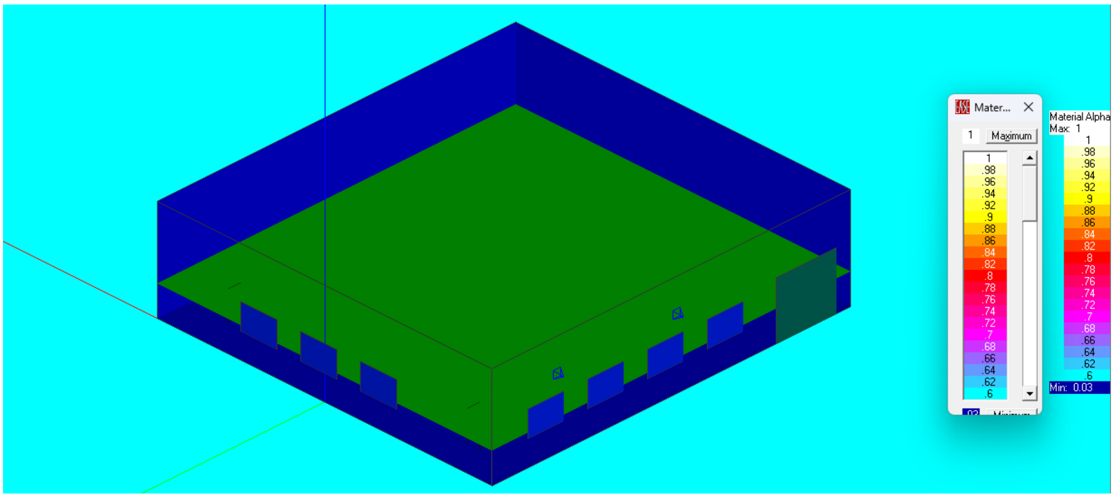


figure 2. 71: materials

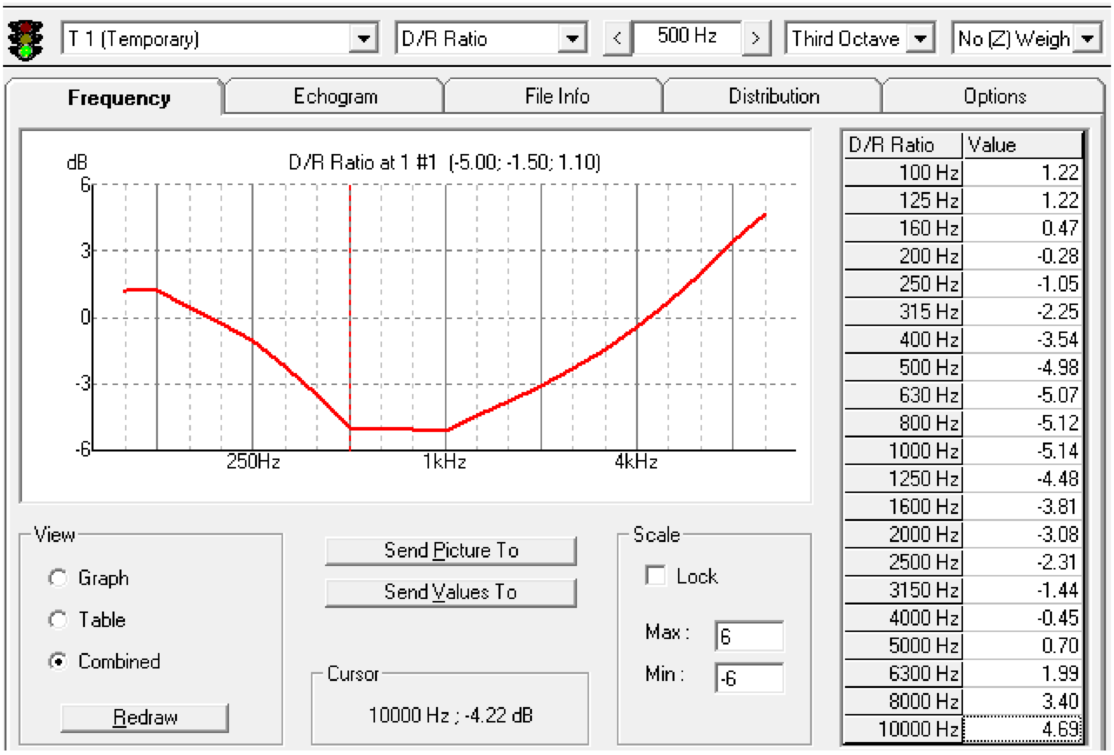
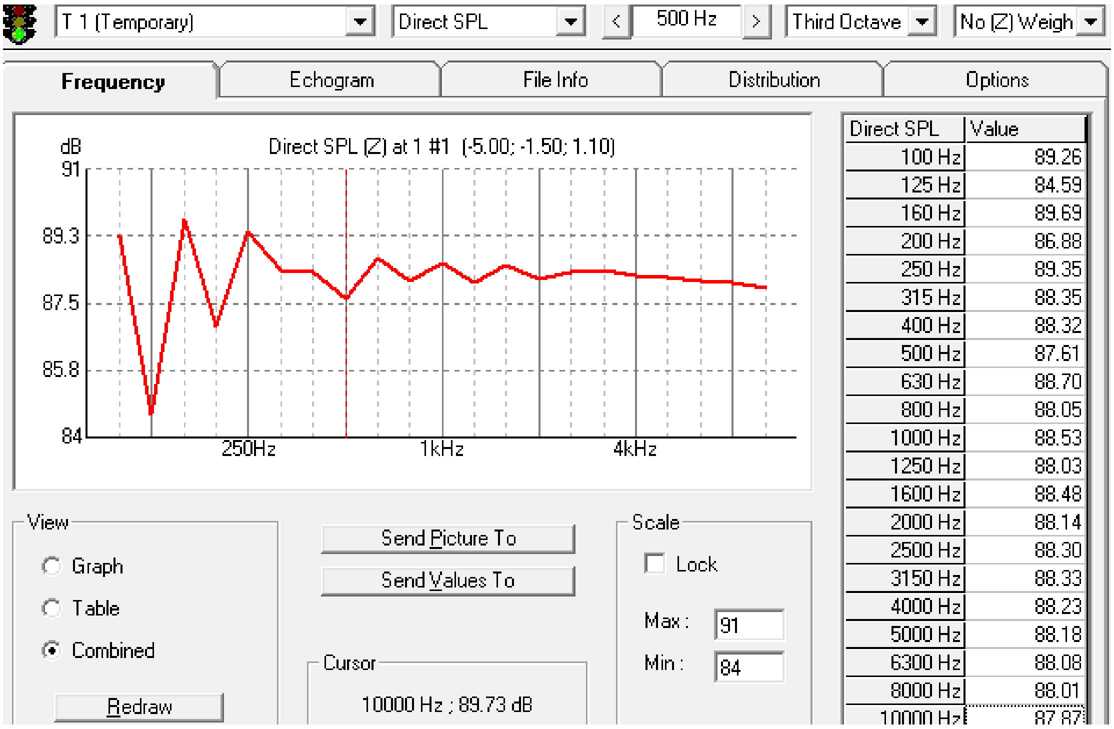
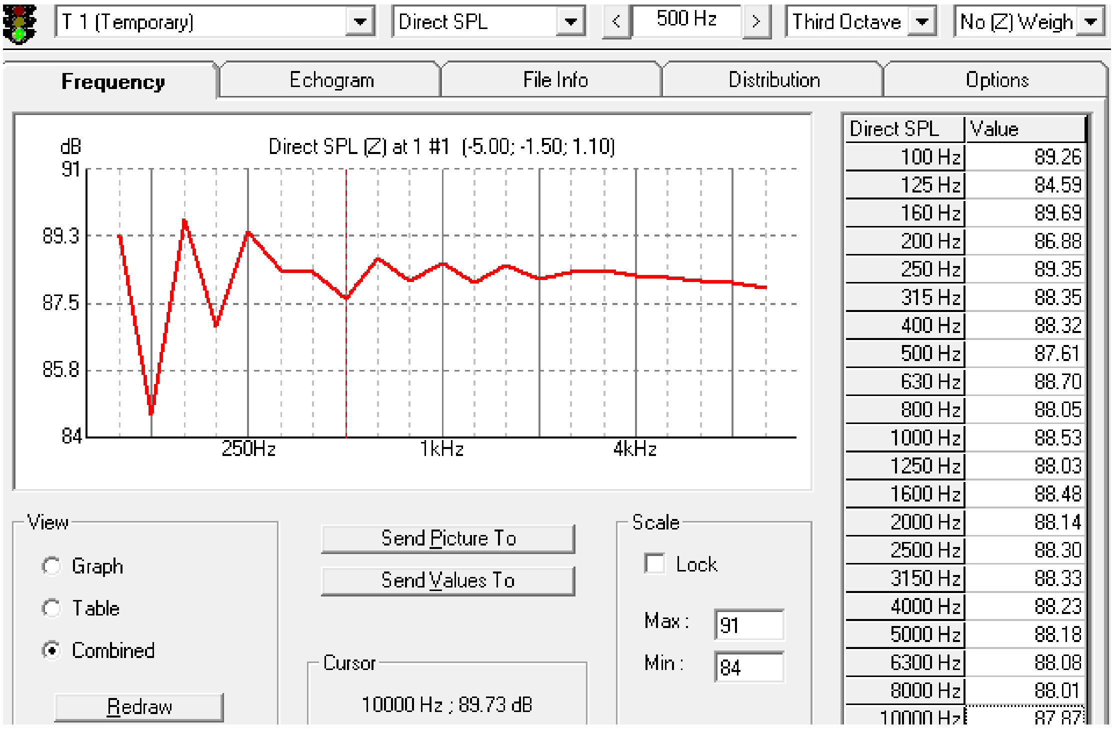


figure 2. 72: frequancy values


T 1 (Temporary)
Direct SPL
500 Hz
Third Octave
No (Z) Weigh
Frequency
Echogram
File Info
Distribution
Options
Direct SPL (Z) at 1 #1 (-5.00; -1.50; 1.10)
dB
91
89.3
87.5
85.8
84
250Hz
1kHz
4kHz
Direct SPL Value
100 Hz 89.26
125 Hz 84.59
160 Hz 89.69
200 Hz 86.88
250 Hz 89.35
315 Hz 88.35
400 Hz 88.32
500 Hz 87.61
630 Hz 88.70
800 Hz 88.05
1000 Hz 88.53
1250 Hz 88.03
1600 Hz 88.48
2000 Hz 88.14
2500 Hz 88.30
3150 Hz 88.33
4000 Hz 88.23
5000 Hz 88.18
6300 Hz 88.08
8000 Hz 88.01
View
Graph
Table
Combined
Redraw
Send Picture To
Send Values To
Cursor
10000 Hz ; 89.73 dB
Scale
Lock
Max : 91
Min : 84


T 1 (Temporary)
Direct SPL
500 Hz
Third Octave
No (Z) Weigh
Frequency
Echogram
File Info
Distribution
Options
Direct SPL (Z) at 1 #1 (-5.00; -1.50; 1.10)
dB
91
89.3
87.5
85.8
84
250Hz
1kHz
4kHz
Direct SPL Value
100 Hz 89.26
125 Hz 84.59
160 Hz 89.69
200 Hz 86.88
250 Hz 89.35
315 Hz 88.35
400 Hz 88.32
500 Hz 87.61
630 Hz 88.70
800 Hz 88.05
1000 Hz 88.53
1250 Hz 88.03
1600 Hz 88.48
2000 Hz 88.14
2500 Hz 88.30
3150 Hz 88.33
4000 Hz 88.23
5000 Hz 88.18
6300 Hz 88.08
8000 Hz 88.01
View
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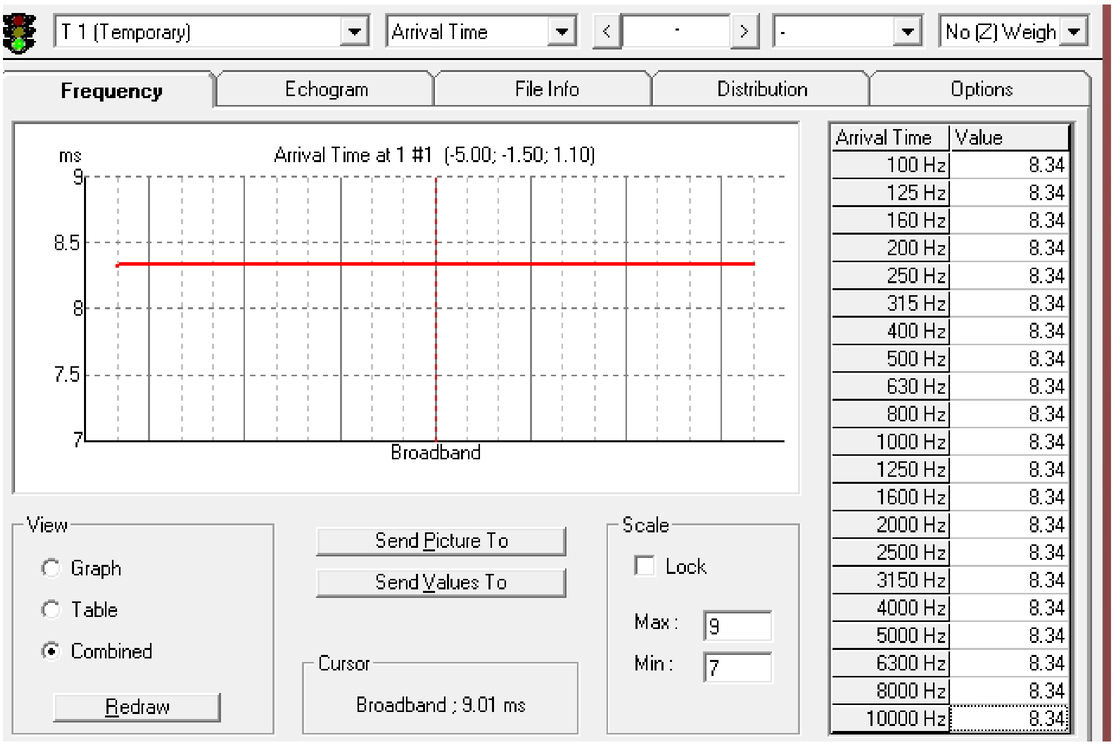
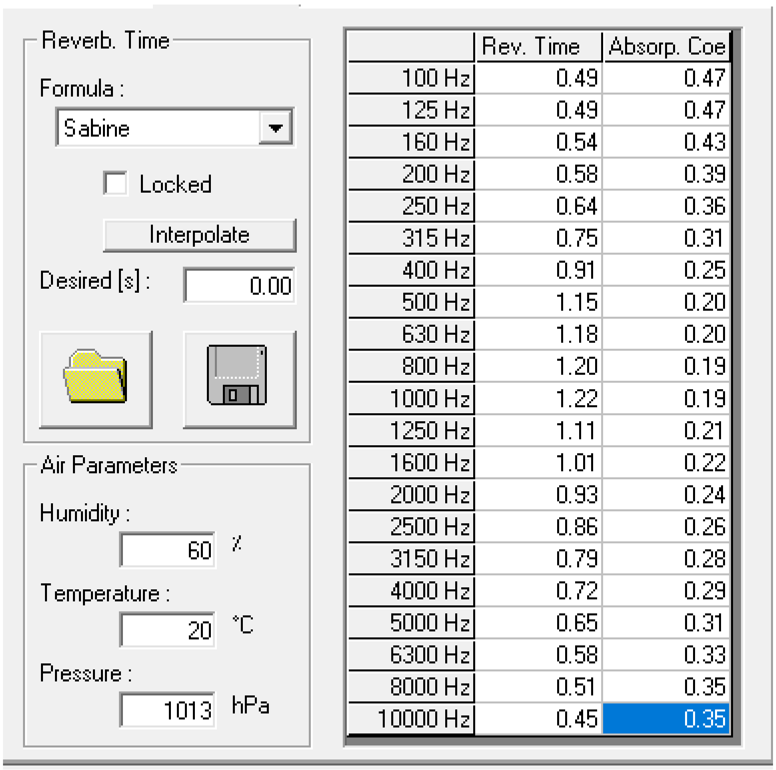
Scale
Lock
Max : 91
Min : 84



Arrival Time	Value
100 Hz	8.34
125 Hz	8.34
160 Hz	8.34
200 Hz	8.34
250 Hz	8.34
315 Hz	8.34
400 Hz	8.34
500 Hz	8.34
630 Hz	8.34
800 Hz	8.34
1000 Hz	8.34
1250 Hz	8.34
1600 Hz	8.34
2000 Hz	8.34
2500 Hz	8.34
3150 Hz	8.34
4000 Hz	8.34
5000 Hz	8.34
6300 Hz	8.34
8000 Hz	8.34
10000 Hz	8.34

Design office room:



	Rev. Time	Absorp. Coe
100 Hz	0.49	0.47
125 Hz	0.49	0.47
160 Hz	0.54	0.43
200 Hz	0.58	0.39
250 Hz	0.64	0.36
315 Hz	0.75	0.31
400 Hz	0.91	0.25
500 Hz	1.15	0.20
630 Hz	1.18	0.20
800 Hz	1.20	0.19
1000 Hz	1.22	0.19
1250 Hz	1.11	0.21
1600 Hz	1.01	0.22
2000 Hz	0.93	0.24
2500 Hz	0.86	0.26
3150 Hz	0.79	0.28
4000 Hz	0.72	0.29
5000 Hz	0.65	0.31
6300 Hz	0.58	0.33
8000 Hz	0.51	0.35
10000 Hz	0.45	0.35

figure 2. 73 office room on ease

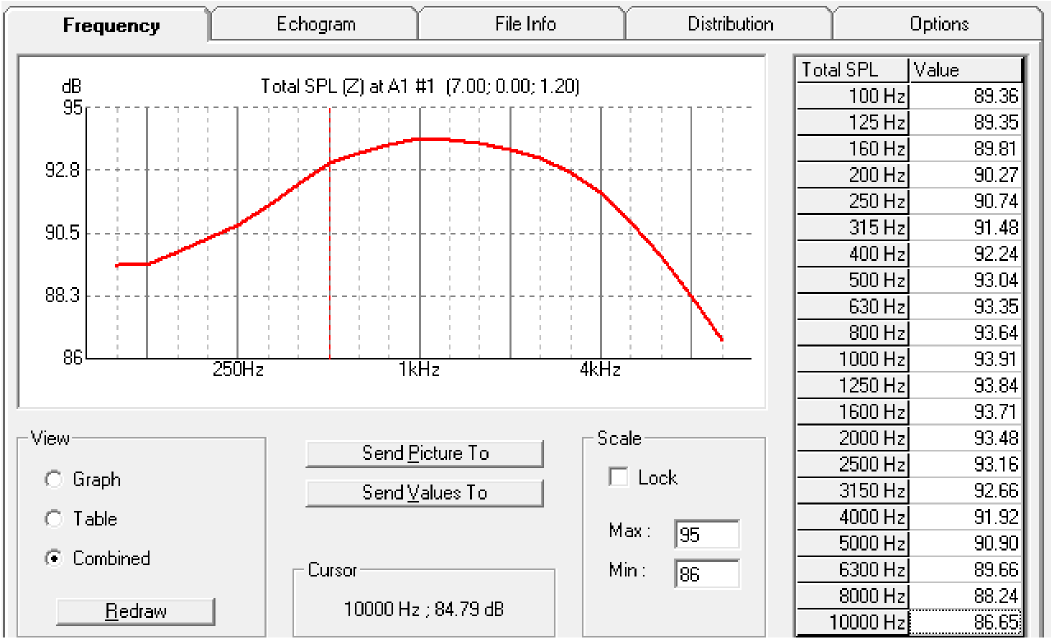


figure 2. 74: office room on ease freq.

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
		[redacted]	[redacted]	[redacted]
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
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Hospitals and dormitories		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

figure 2. 75: STC schedual

2.4.2 Sound transmission class (STC):

The ability of wall layers to absorb sound and provide room privacy.

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

figure 2. 76:Recommended STC for partitions (Grondzik, & Kwok, 2015, P.1129)

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

figure 2. 77:Typical STC values for windows (Grondzik, & Kwok, 2015, P.1098).

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

figure 2. 78:Typical STC values for doors (Grondzik, & Kwok, 2015, P.10950).

By using INSUL software to find STC:

Between offices (Internal partition):

Between the office and the office there is a wall consisting of 13 mm plaster, 200 mm concrete hollow block, 60 mm foam & 10mm plaster as picture shown.

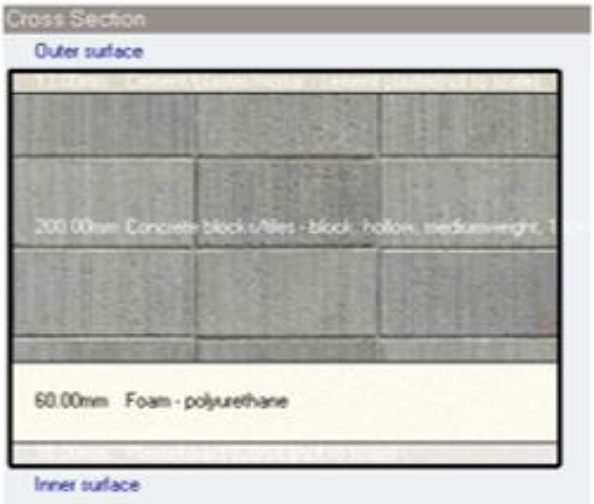


figure 2. 79: cross section in internal partion

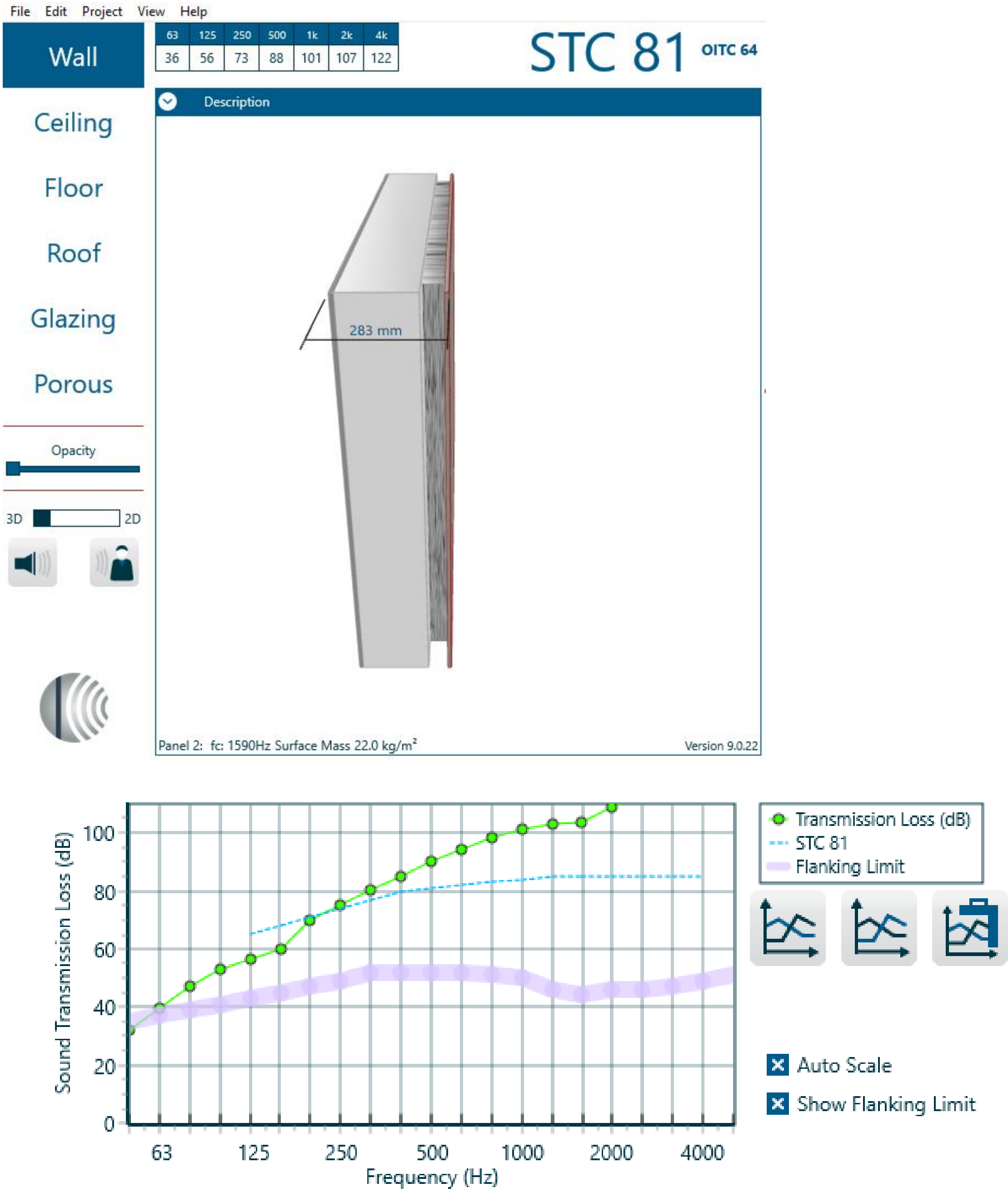
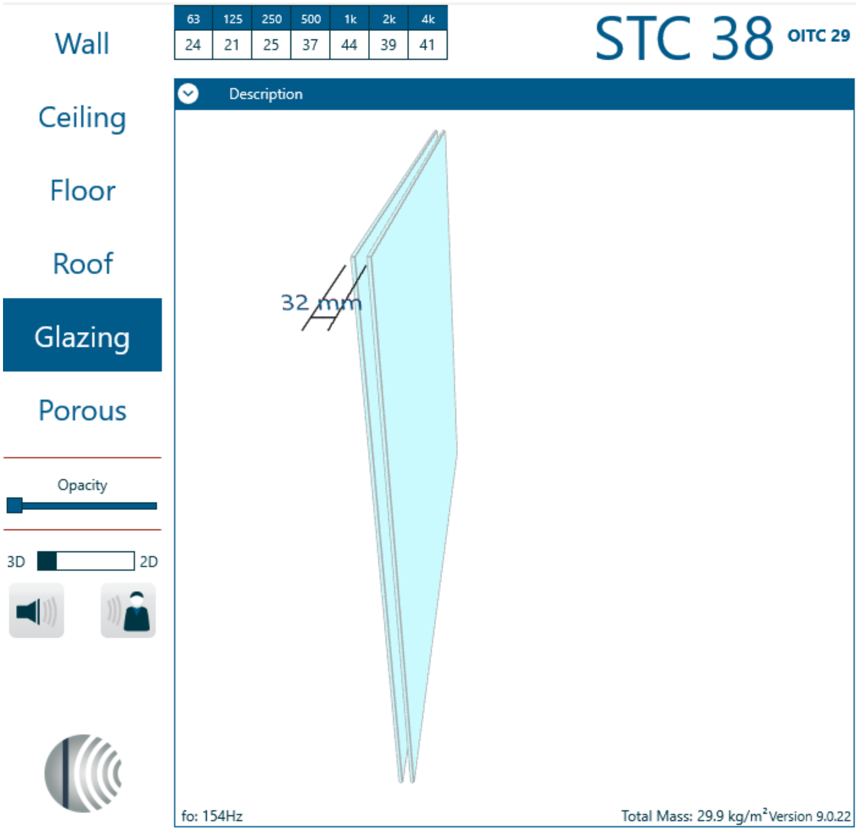


figure 2. 80:STC for internal partion

The recommendation STC is 38.

The STC for partition wall is 81 >>>> 35, its ok.



The STC for partition wall is 38 >>>> 35, its ok.

At external wall:

This wall consisting of 70 mm stone , 100 mm concrete , 80 mm foam , 100mm hollow block & 13 mm plaster as picture shown.

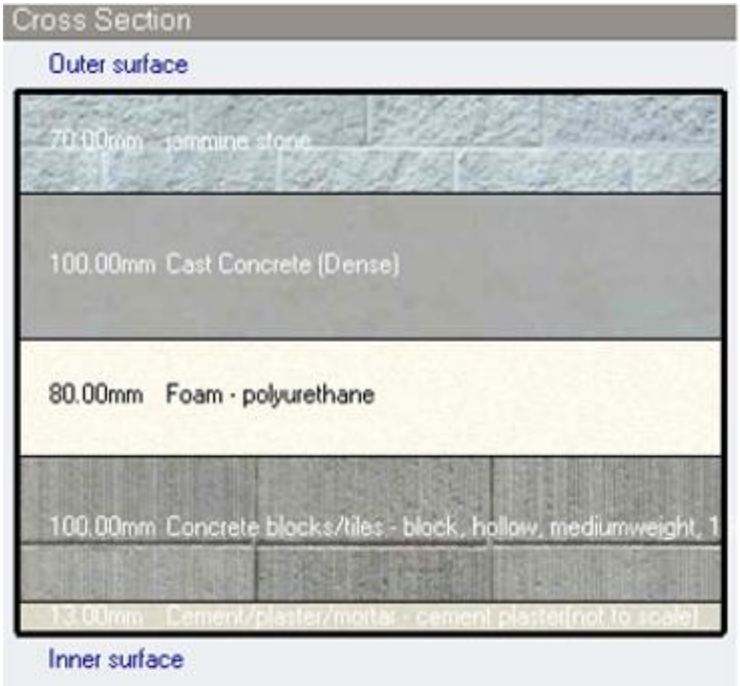
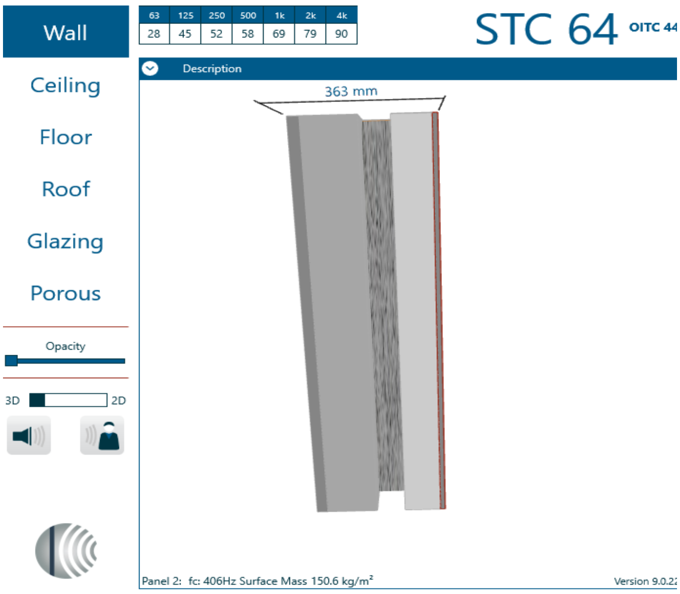


figure 2. 81: external wall partions



1/3 Octave | 1/1 Octave

Element	Area	50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1k...	1k6	2k	2k5	3k...	4k	5k	STC	OITC
wall	45.0	24	24	23	22	18	20	26	31	34	37	40	42	44	46	47	47	44	37	40	44	48	39	29
glass	40.0	24	24	23	22	18	20	26	31	34	37	40	42	44	46	47	47	44	37	40	44	48	39	29
Total	85.0	24	24	23	22	18	20	26	31	34	37	40	42	44	46	47	47	44	37	40	44	48	39	29

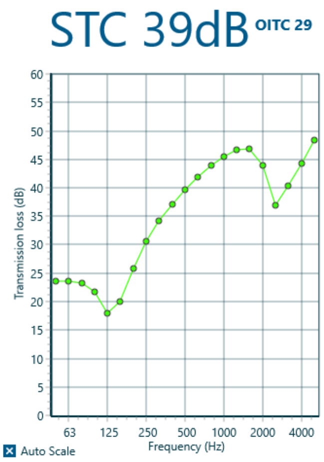


figure 2. 82: external in STC

The recommendation STC is 38.

The STC for partition wall is 39 > 38, its ok.

2.4.3 Impact insulation class (IIC):

Impact Insulation Class". This is a unit of measurement that determines the degree of soundproofing of the impact noise of a floor/ceiling assembly on site rather than in a laboratory. The higher the IIC, the better the acoustic insulation.

FLOOR:

Consisting of 8 mm ceramic, 30 mm cement plaster, 50 mm sand and gravel, 80 mm concrete &170 mm block, 30 mm foam and 10 mm plaster as picture shown.

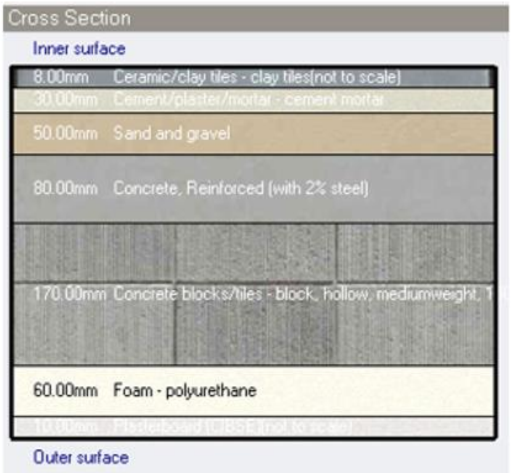
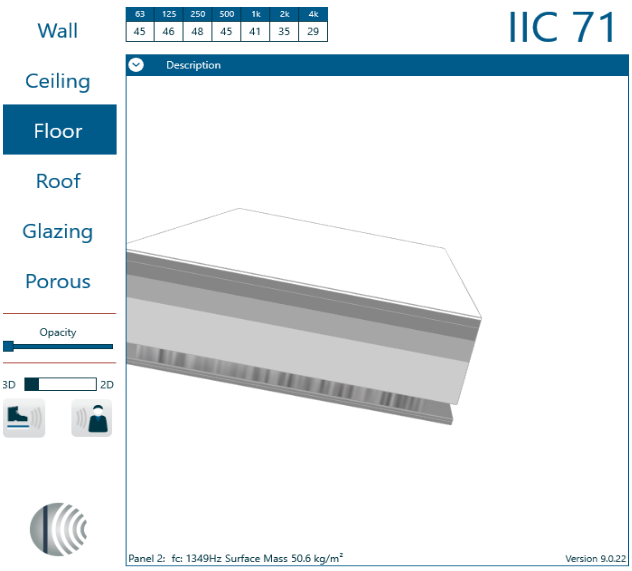


figure 2. 83: cross section in floor

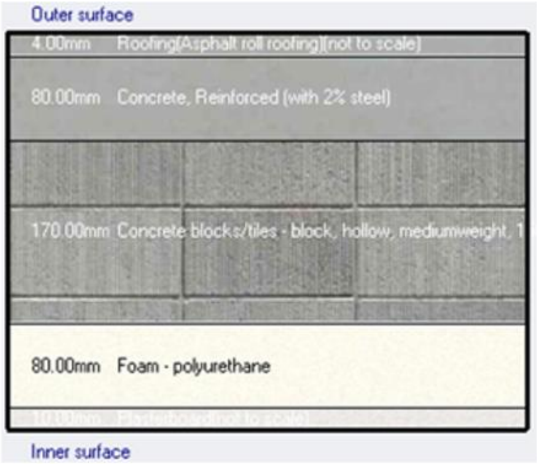


Recommended IIC between (34-55) db.

IIC = 71 >>>>55 ITS ok.

Roof:

Details shown in the picture.



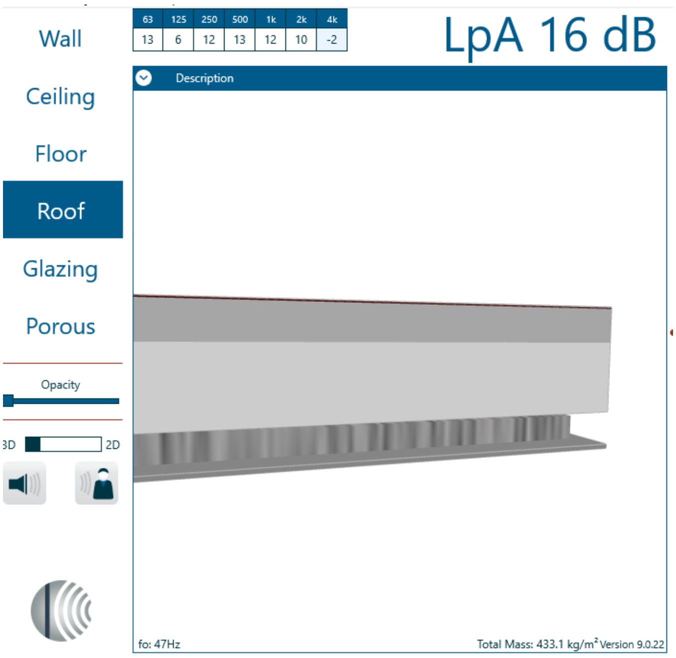


figure 2. 84: cross section in roof

LPA =16 dB that's ok in the rang (15-20).

Chapter 3: Structure:

3.1 Structure Aspect:

3.1.1 Introduction:

The structural structure of the building is the skeleton on which the building rests and keeps it from collapsing and falling. There are many construction systems as they differ according to the materials that make up them, such as concrete, steel and wood. In the building that we have chosen as a graduation project, the structural system is based on concrete. There are many elements that work with each other to form this system such as the slabs, beams, columns and the footings, which must be designed according to the correct specifications and standards so that it can carry the building and all the loads loaded on it and be safe for all users of this building.

3.1.2 Loads:

The loads are all the weights that the structure will carry, and they differ according to the nature of the building and its function. Live load is considered one of the most important of these loads, as it comes from all things whose weight cannot be identified precisely like people. As for things whose weight can be determined, such as furniture, they are dead loads. The super imposed loads come from filling material which are used in the building. To achieve balance and stability in the building, all these loads must be taken into consideration when designing the building. The dead load can be founded by calculating and the live load is from the code of the American concrete institute (ACI).

Occupancy or Use	Uniform psf (kN/m^2)
Office buildings	
File and computer rooms shall be designed for heavier loads based on anticipated occupancy	
Lobbies and first-floor corridors	100 (4.79)
Offices	50 (2.40)
Corridors above first floor	80 (3.83)

Figure 3. 1: Live load in office building (Table 4.3-1 in ASCE 7-16).

3.1.3 Materials:

3.1.3.1 Concrete:

Concrete is one of the most important components of the structural elements in the modern industry. Concrete is a construction material that produced from mixing cement, fine aggregates and coarse aggregates with water until a mixture is formed that can be poured to harden over time. Concrete is one of the strongest materials in bearing pressure, as it can withstand very enormous pressure, but when looking at the other side, it is a bad material in its ability to withstand tensile strength, so the strength of concrete is measured by its ability to withstand pressure (compressive strength).

3.1.3.2 Reinforcement Steel:

To solve the problem of concrete in its inability to bear tensile forces, reinforcement steel was used, which is an excellent material in its tensile resistance, and the two components were combined in many uses to form together what is called reinforced concrete.

3.1.4 Codes and Specifications:

ASCE-7 (loads and combinations).

The American Concrete Institute code (ACI 318-14).

Uniform Building Code (UBC 97) for the seismic design

3.1.5 Structure elements:

3.1.5.1 Slabs:

Slabs are the structural elements that provide a working and moving surface for people in the building. There are many types of slabs that are used, which differ according to their components and the way they distribute the loads on them, the most famous of these types are the one way ribbed slab, two way ribbed slab, voided and Solid Slab. Rapid slab is considered one of the most widespread types as it uses bricks to use less amount of concrete and also relies on the use of steel reinforcement as a main component.

In this project, we used 3 types of slabs, which are the one-way ribbed slab, two way ribbed slab and solid slab, where the one way and two way were used in the regular floors of the building, and solid slab was used in the rebound ceiling located in the first basement in the building, as it will be clarified Later.

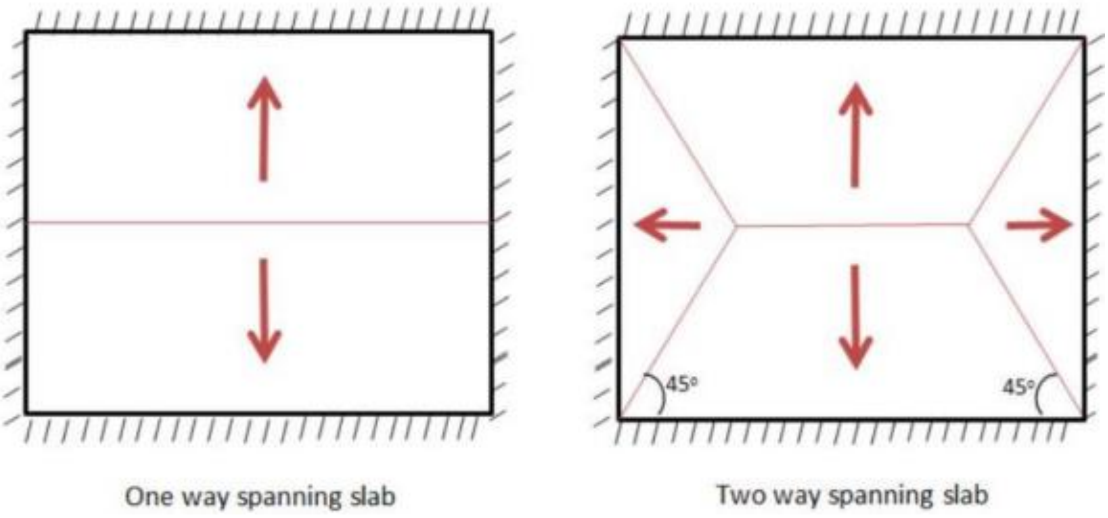


Figure 3. 2: Distribution of load on One way & Two way slab (Basic Civil Engineering).

3.1.5.2 Beams:

Beams are one of the most important structural elements in the building that connect the columns to each other, as they transfer the loads from the slab and pass them to the columns. There are many types of beams, such as the hidden beams, where the beam thickness is like the thickness of the slab, and there are also the drop beams, where the beam thickness is larger than the Slab thickness. In this project, beam tracks were used mainly because they have more stiffness and suitable for spans and function of the building.

3.1.5.3 Columns:

Columns are also within the important structural elements in the building, as they take the loads coming from the slab to the beams and then to the columns to pass them to the building footings. The columns are designed carefully so that their sections and lengths are sufficient, as they are what give the building its real height.

3.1.5.4 Footings:

The footings play an essential role in transferring all coming loads from the building and its structural and non-structural elements through them to the soil. Therefore, the design of the footings depends largely on the type of soil and its durability, as it is designed with appropriate dimensions to perfectly distribute the loads on the soil.

3.1.5.5 Shear walls:

Shear walls are considered one of the structural elements that have very high stiffness and act like columns in transferring loads. They are also used when there are horizontal loads, especially in the underground floors, where they are called retaining walls.

3.2 Structure Design:

The design simulation was done using the ETABS Software, and to make sure that the model design is correct the following calculations and checks was done:

3.2.1 Selected Materials:

- B350 Concrete with f`c =28 MPa for columns.

- B300 Concrete with f`c =24 MPa for slabs and beams.

- Steel yield strength Fy = 420 MPa for reinforcement steel.

- ɣ for concrete = 25 KN/m3 - ɣ for steel = 78 KN/m3

3.2.2 Selected Systems:

The system will be used flat plate voided slab.

3.3 Important first calculations:

3.3.1 Slab Thickness Calculations:

After calculation slab thickness is 500mm

Slab wight /m2 = 8.29 KN/m2

3.3.2 Load Calculations:

TABLE 1-4 • Minimum Live Loads*

Occupancy or Use	Live Load psf	Live Load kN/m^2	Occupancy or Use	Live Load psf	Live Load kN/m^2
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.

Figure 3. 3Minimum live loads (Table 1-4 in ASCE 7-05).

1. Live load= 3 KN/m^2

2. Assume super imposed load= 4 KN/m^2

3. Wall load = 20 KN/m

3.4 Checks required:

3.4.1 Model checks:

3.4.1.1 Compatibility check:

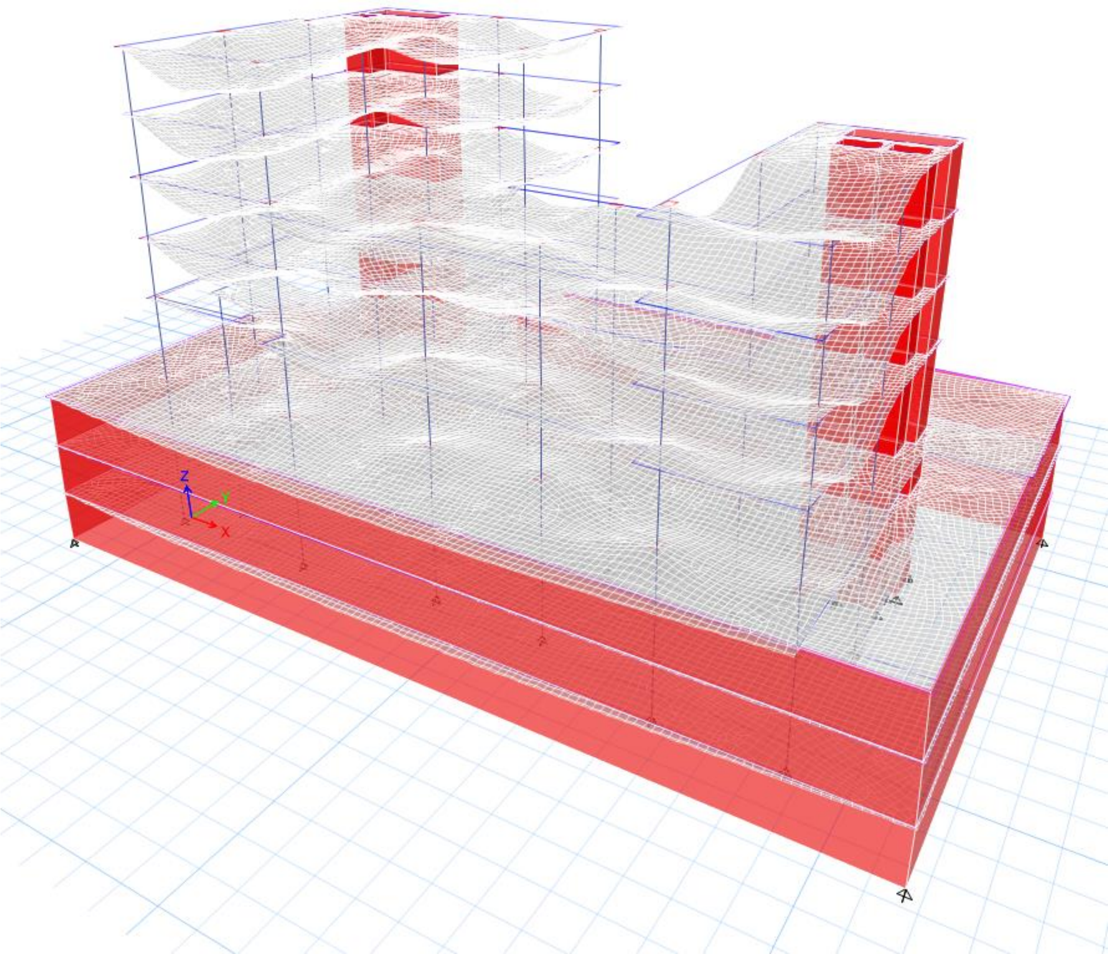


Figure 3. 4: compatability check

3.4.1.2 Equilibrium check:

Table 9: equilibrium check

Load type	Etabs	Manual	%Error	Case
Live	28903	29277	-1.20%	<5%-->ok
SID	38538	39036	-1.20%	<5%-->ok
Dead	130738	columns	11585.40	<5%-->ok
		Slabs	96614.10	
		Shear walls	17162.50	
Total manual dead load			125362	
ETABS dead load			130738	
%Error			-4.11%	

3.4.1.3 Stress Strain check:

Check columns:

From Live loads:

Table 10: stress strain check: column

Column Type	Etabs	Manual	%Error	check
Interior	1959	1992	-1.68%	Ok
Corner	948	906	4.43%	Ok
Edge	1070	1033	3.46%	Ok

Slab check:

From live load:

Table 11: stress strain chebk: slab

Panel type	Etabs	Manual	%Error	Ok/Not ok
Exterior	20.7	21.52	-3.96%	Ok

3.4.1.4 Deflection check:

From live load:

Limit =12.64 /360 =35.11 mm

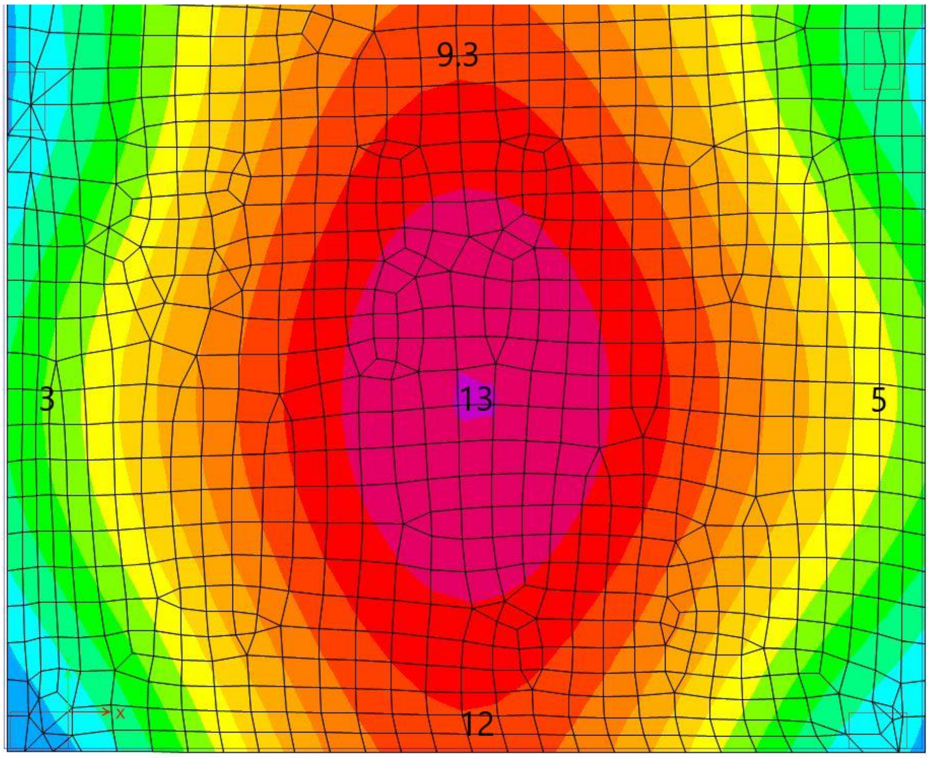


Figure 3. 5: deflection check

Etabs deflection = 5.70 mm<<35.11mm

From service loads:

Limit =12.64/240=52.66mm……………………is ok

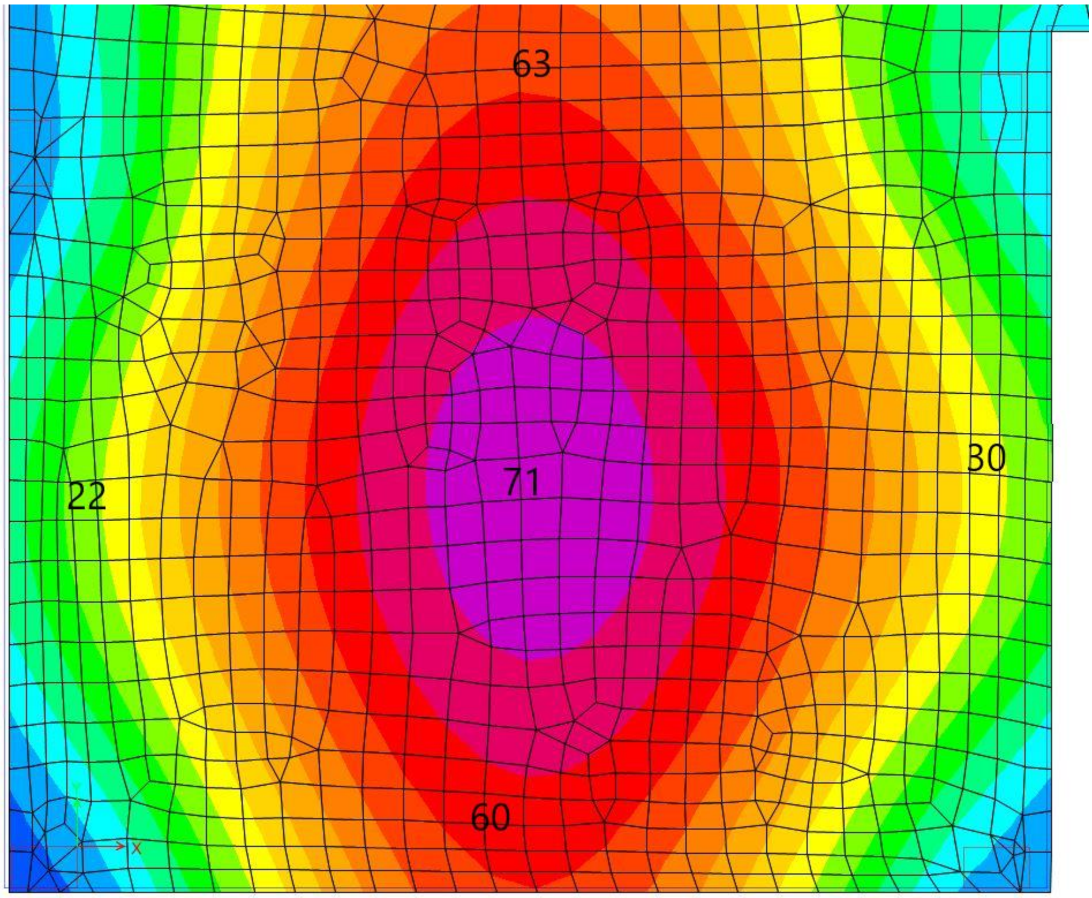


Figure 3. 6: deflection check

Etabs deflection = 27.25 mm<<52.66mm……………………is ok.

3.4.1.5 Design check:

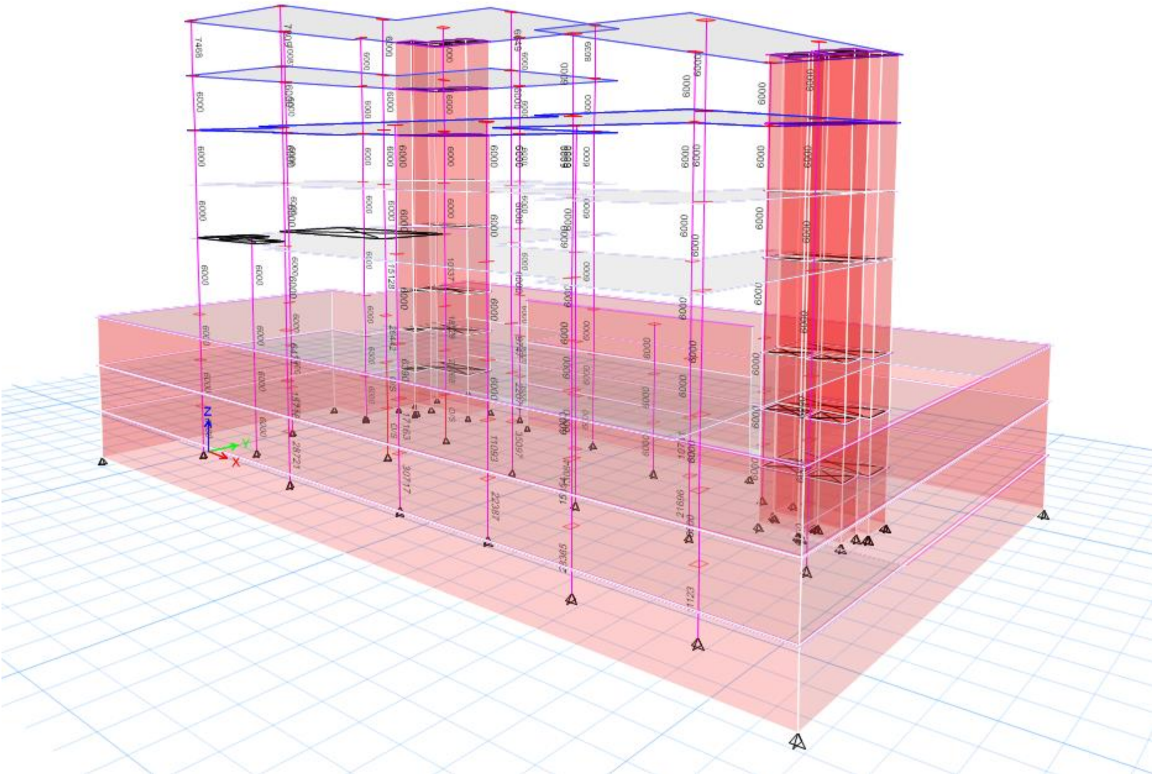


Figure 3. 7:Design check

3.4.1.6 Punching shear check:

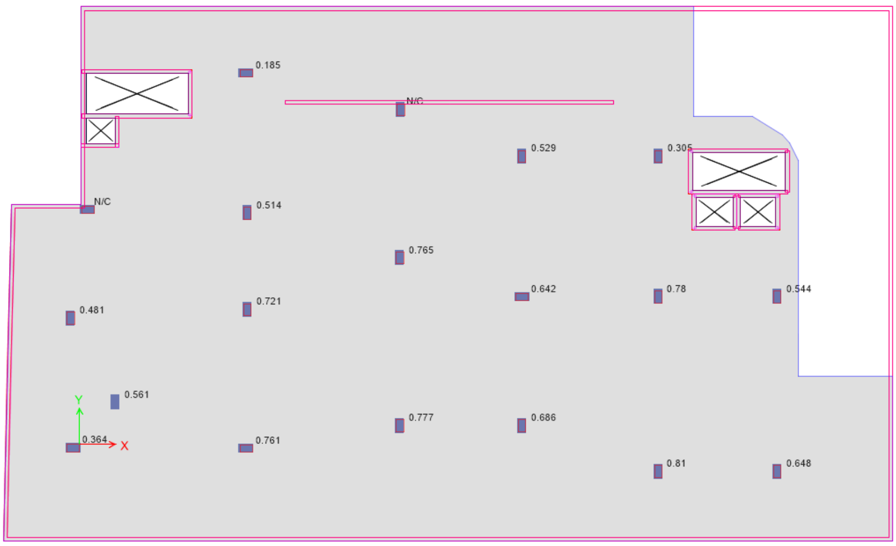


Figure 3. 8:Punching shear check

Punching shear is ok.

3.4.1.7 Period check:

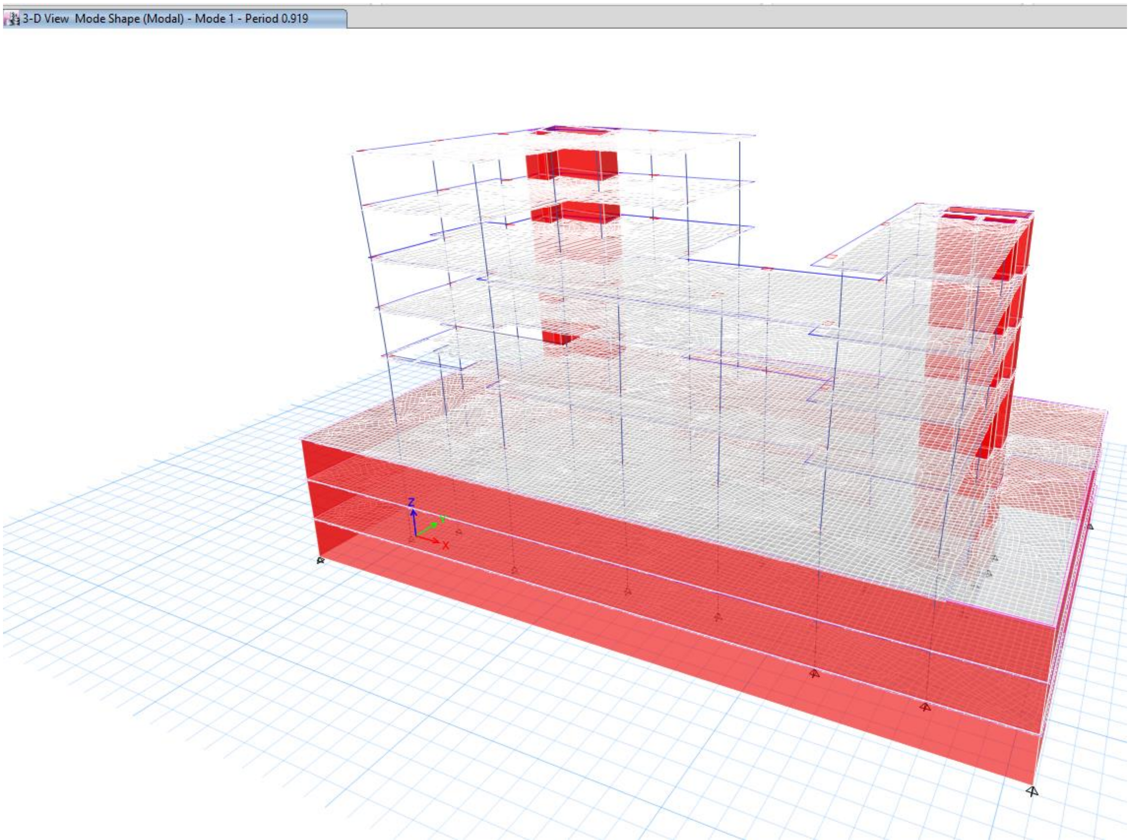


Figure 3. 9:Period check.

Period less than 1 which is ok.

3.4.1.8 Slab shear check:

$\Phi Vc = \frac{0.75}{6} * \sqrt{fc} * b * d = \frac{0.75}{6} * \sqrt{28} * 1000 * 330/1000$ =218.21 KN

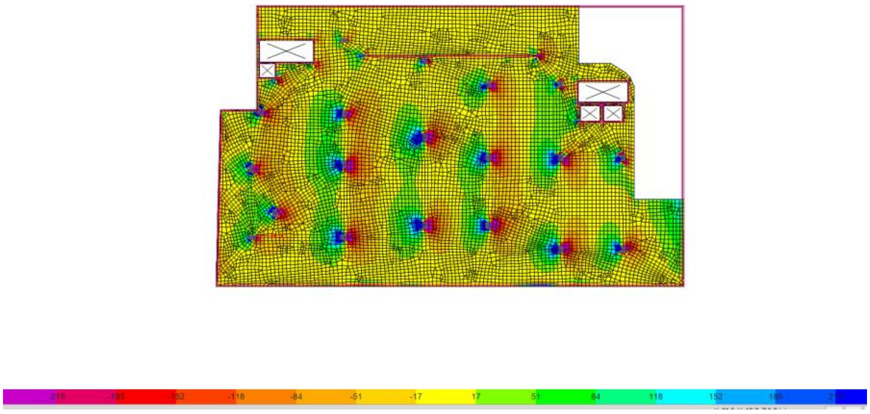


Figure 3. 10:Slab shear check

Vu< ΦVc ok

3.5 Seismic design:

3.5.1 Seismic load analysis:

The used code is UBC 97 and by using the Model Response Spectrum or the dynamic seismic method.

3.5.1.1 Seismic zone factor (Z):

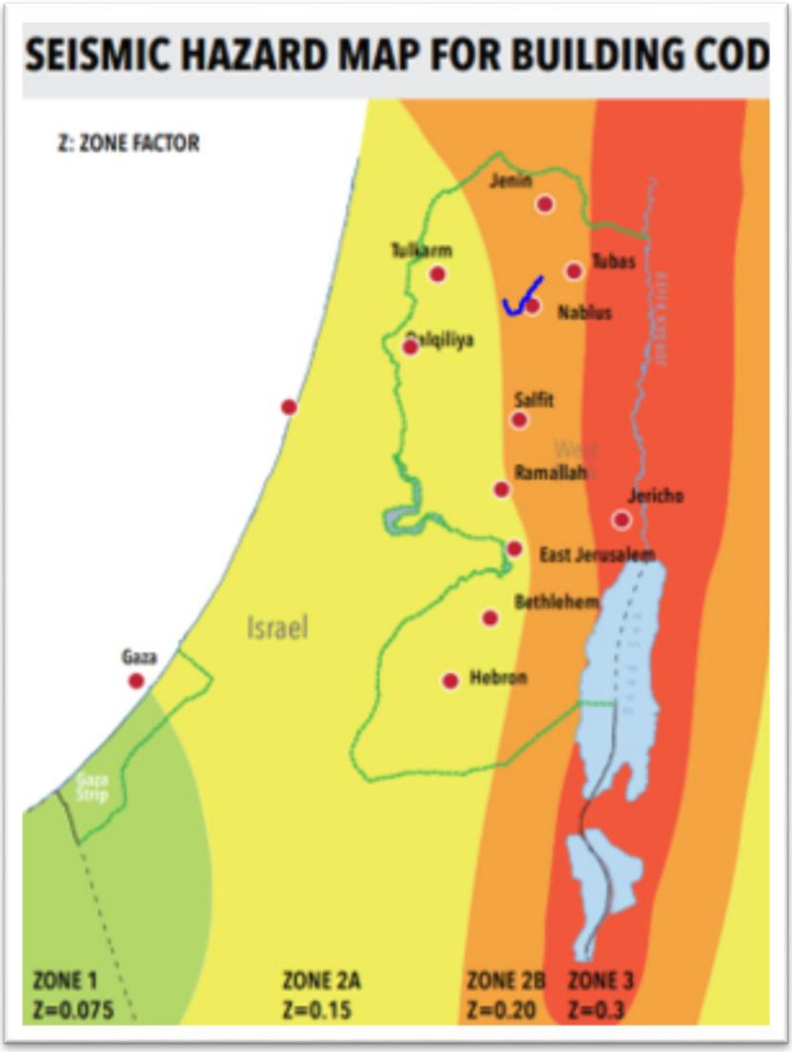


Figure 3. 11: seismic zone

Zone: Nablus------> Z=0.20

3.5.1.2 Soil profile types:

Table 12: soil types profile

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.

Soil profile SC

3.5.1.3 Seismic coefficient (Ca):

Table 13: Ca Coefficent

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.

3.5.1.4 Seismic coefficient (Cv):

Table 14:Seismic coefficient (Cv):

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.

3.5.1.5 Structural system:

Table 15: structural system

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	—	—	—

3.5.1.6 Importance factor (I):

Table 16: importance factor

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

R	I	Z	SOIL PROFILE TYPE	Ca	Cv
5.5	1	0.2	Sc	0.24	0.32

Figure 3. 12: seismic factors

3.5.2 Seismic checks:

3.5.2.1 Period check:

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

Ct= 0.0731 , hn=30.9 m

T (method A)= 1.02

1.4 * T (method A)= 1.43 > T period from etabs =0.875 …………. Is ok.

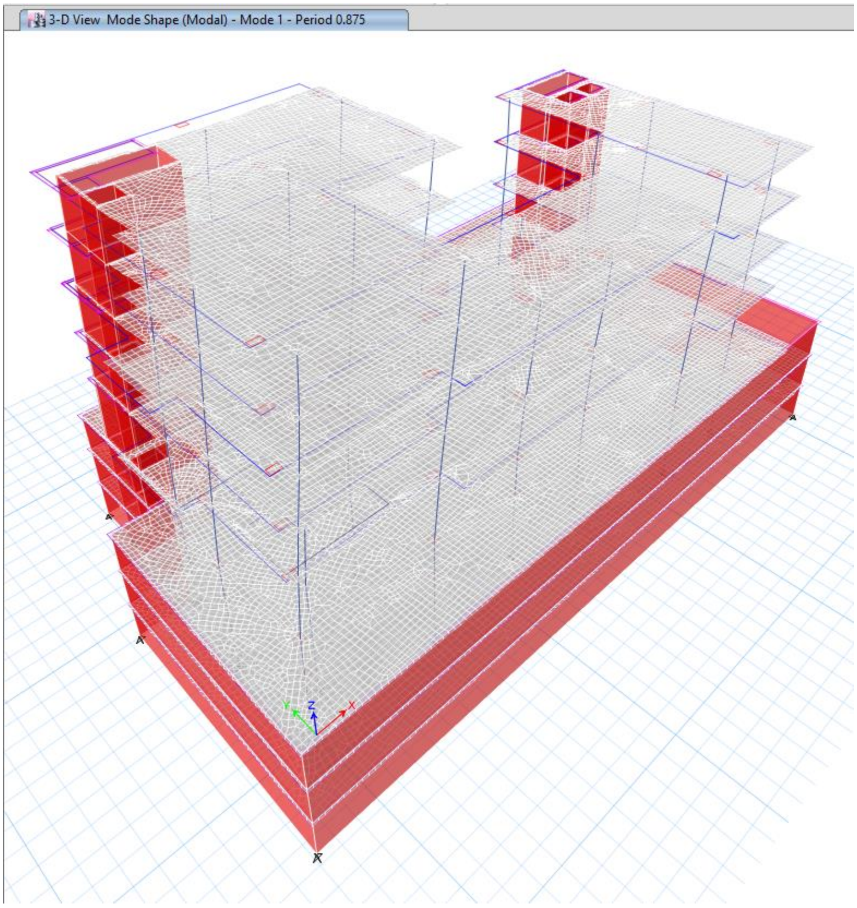


Figure 3. 13: Period from etabs model

3.5.2.3 Draft check:

Table 17: draft check

story	H	DIS X	DIS Y	DRIFT X	DRIFT Y	DELTA X	DELTA Y	LIMITATION
0		0	0					
1	3700	0.066	0.42	0.066	0.066	0.2541	0.2541	92.5
2	3700	0.048	0.45	-0.018	0.03	-0.0693	0.1155	92.5
3	3700	0.24	0.5	0.192	0.05	0.7392	0.1925	92.5
4	6000	1.08	2.13	0.84	1.63	3.234	6.2755	150
5	4200	1.8	3.62	0.72	1.49	2.772	5.7365	105
6	4200	2.7	5.15	0.9	1.53	3.465	5.8905	105
7	4200	5.26	6.27	2.56	1.12	9.856	4.312	105
8	4200	7.23	8.17	1.97	1.9	7.5845	7.315	105

Check is ok

3.5.2.3 Model participant mass ratio check:

Table 18: Model participant mass ratio check.

Modal Participating Mass Ratios

1 of 40 Reload Apply

Case	Mode	Period sec	UX	UY	UZ	Sum UX	Sum UY
Modal	17	0.099	0.0024	0.0001	0	0.5622	0.9149
Modal	18	0.097	0.0003	0.0053	0	0.5625	0.9202
Modal	19	0.095	0.2306	4.09E-05	0	0.7932	0.9202
Modal	20	0.094	0.0651	0.0041	0	0.8583	0.9243
Modal	21	0.087	0.0396	0.003	0	0.8979	0.9273
Modal	22	0.084	1.924E-06	2.153E-06	0	0.8979	0.9273
Modal	23	0.082	1.081E-05	0.0001	0	0.8979	0.9274
Modal	24	0.079	0.0001	0.0001	0	0.898	0.9275
Modal	25	0.075	0.013	0.0004	0	0.9111	0.9279
Modal	26	0.074	0.0002	0.0011	0	0.9113	0.9291
Modal	27	0.07	0.0022	0	0	0.9135	0.9291
Modal	28	0.069	0.0014	4.117E-06	0	0.9149	0.9291
Modal	29	0.065	2.454E-05	1.281E-05	0	0.9149	0.9291
Modal	30	0.062	0.0004	0.0331	0	0.9153	0.9621
Modal	31	0.06	0.0001	0.0003	0	0.9154	0.9624
Modal	32	0.06	0.0017	3.74E-05	0	0.917	0.9625
Modal	33	0.058	0.0157	0.0022	0	0.9327	0.9647
Modal	34	0.057	0.0002	0.0007	0	0.9329	0.9654
Modal	35	0.057	0.0001	9.949E-06	0	0.933	0.9654
Modal	36	0.056	2.627E-05	4.789E-05	0	0.933	0.9654
Modal	37	0.054	0.0105	0.0019	0	0.9435	0.9673
Modal	38	0.053	0.0021	2.618E-05	0	0.9456	0.9673
Modal	39	0.052	0.0024	0.0006	0	0.948	0.968
Modal	40	0.051	0.0075	0.0002	0	0.9555	0.9682

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

3.5.2.4 Base shear check:

EQ max from ETABS = 13202

W =D.L+SID +0.3 *L.L = 208288.9 KN

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

CV =0.32

I=1

R=5.5

T=0.875

SO V = 13849 KN

Error =$\frac{13849-13202}{13849} * 100\% = 4.6\% < 5\% \ldots\ldots\ldots\ldots ok$

3.6 Required Design elements:

3.6.1 Column Design:

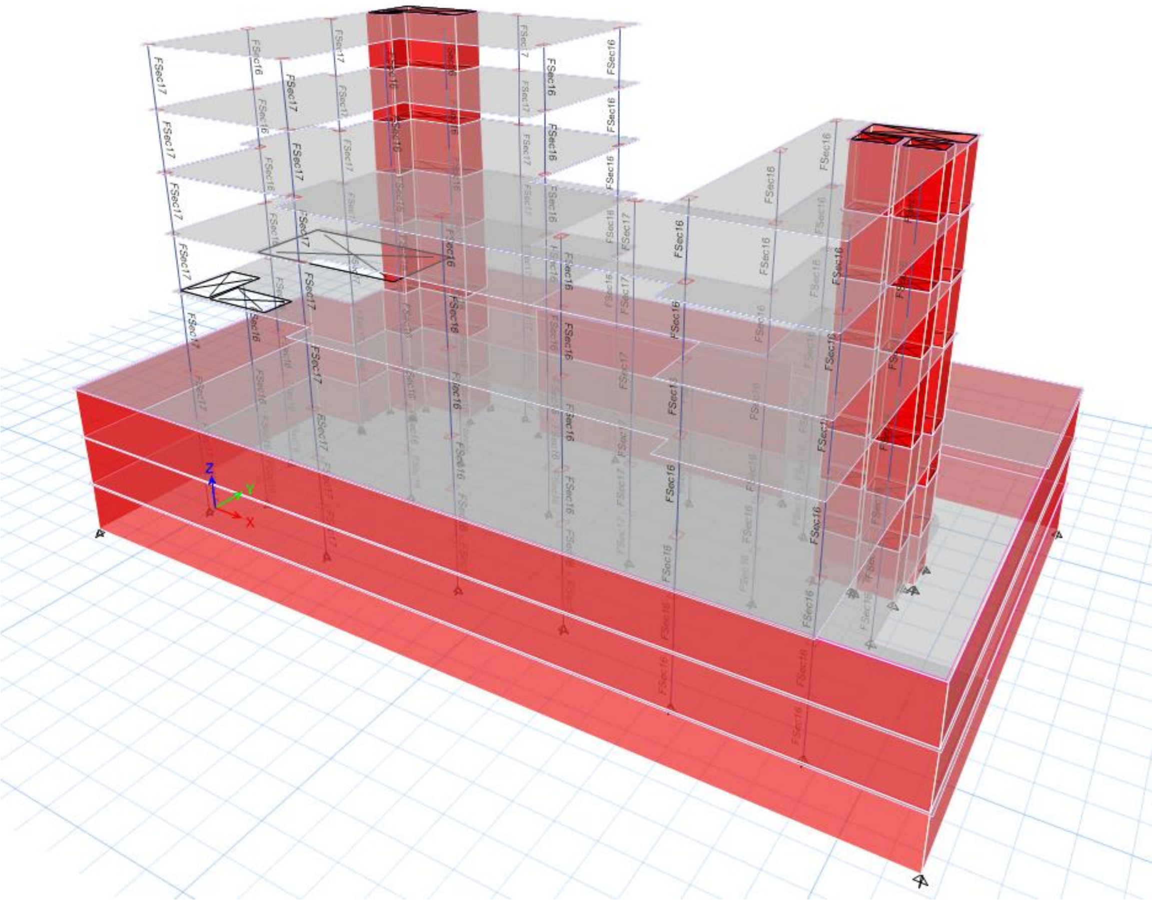


Figure 3. 14: Etabs model column

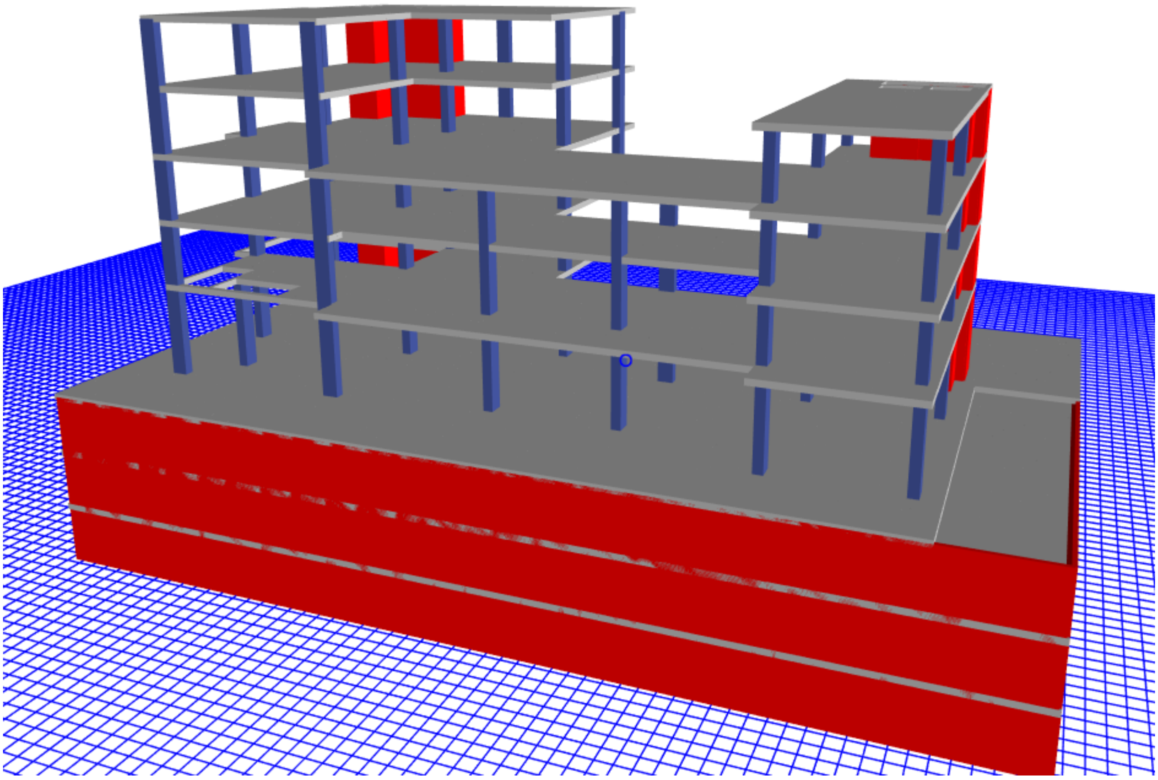


Figure 3. 15: Etabs model column2

Column layout:

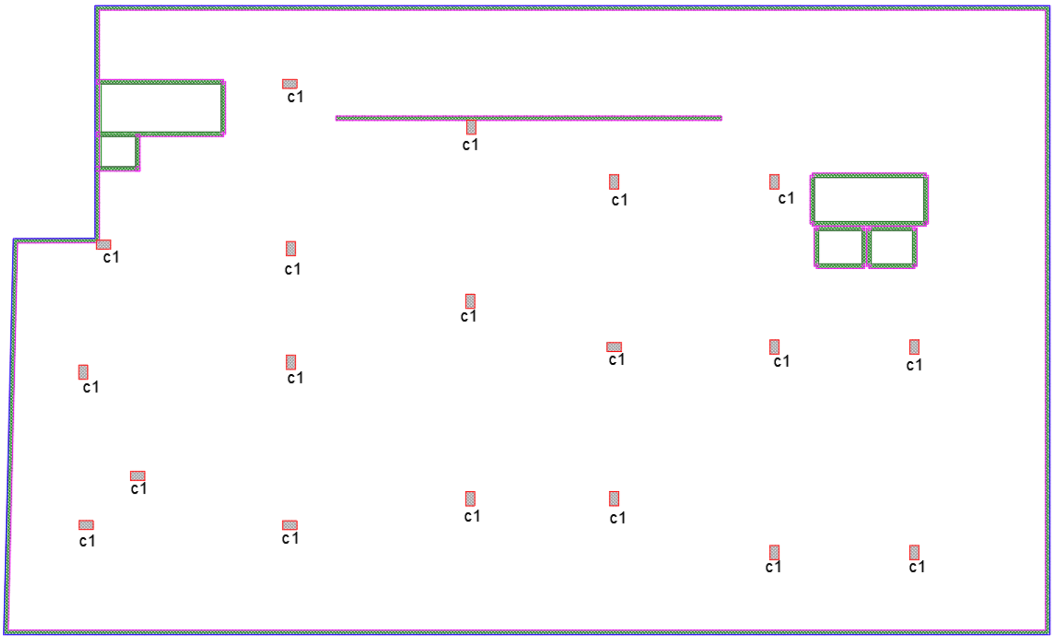


Figure 3. 16: column layout

Column detailing:

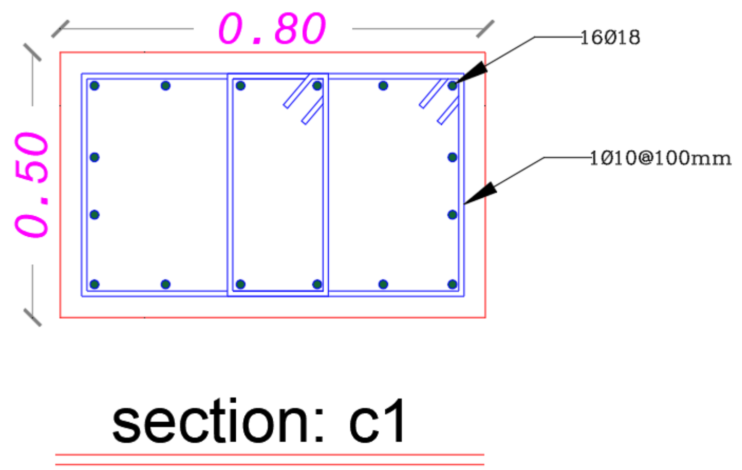


Figure 3. 17: column detailing

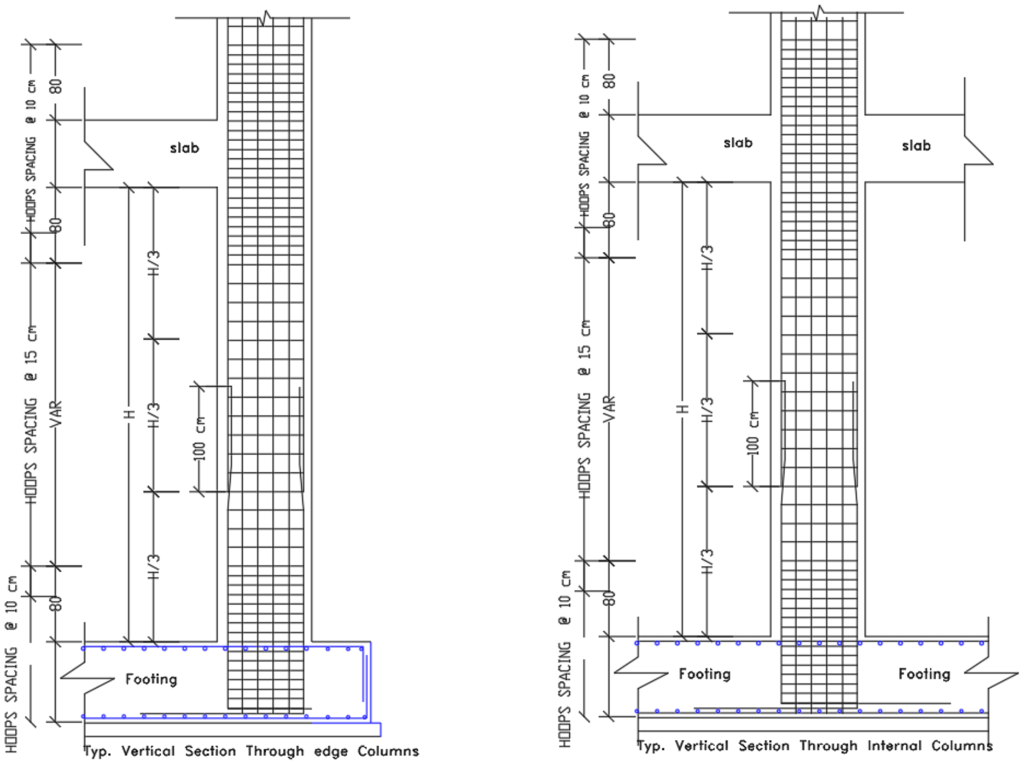
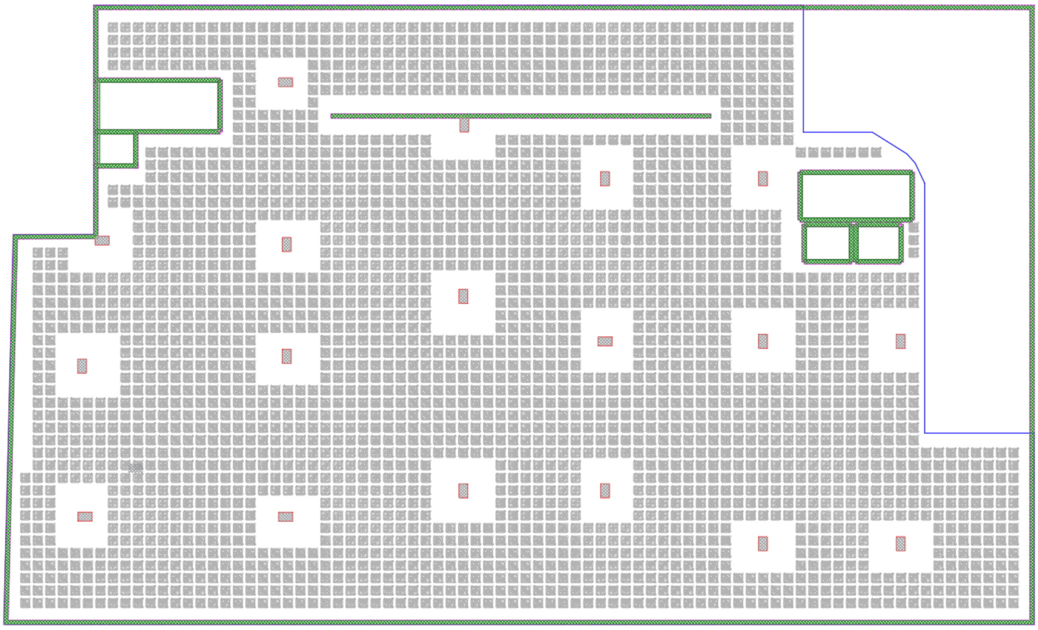


Figure 3. 18: column detailing

3.6.2: Slab design:

Slab layout:

Slab layout B3:



!

Figure 3. 19: slab layout B3

Slab layout B2:

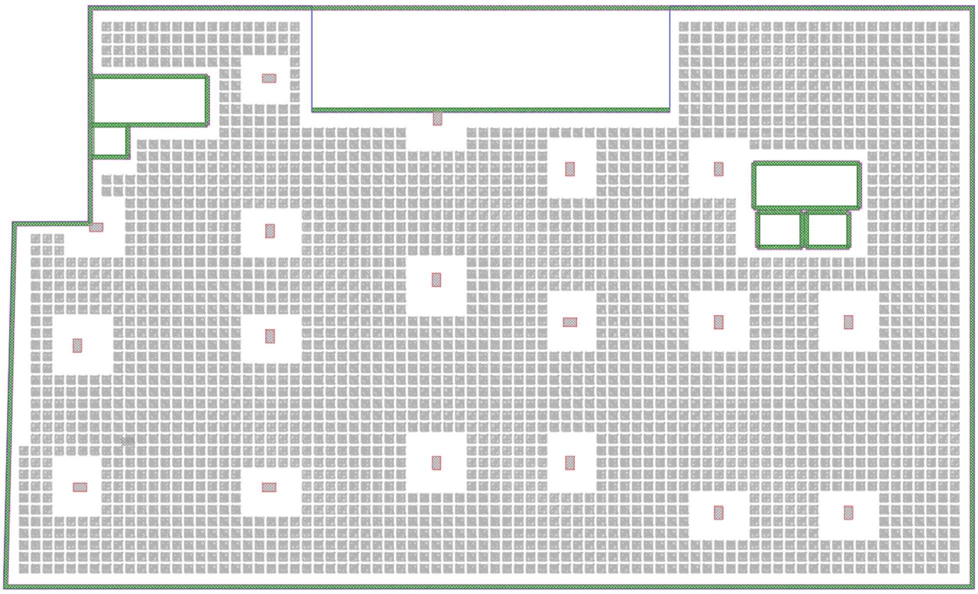


Figure 3. 20: slab layout B2

Slab layout B1:

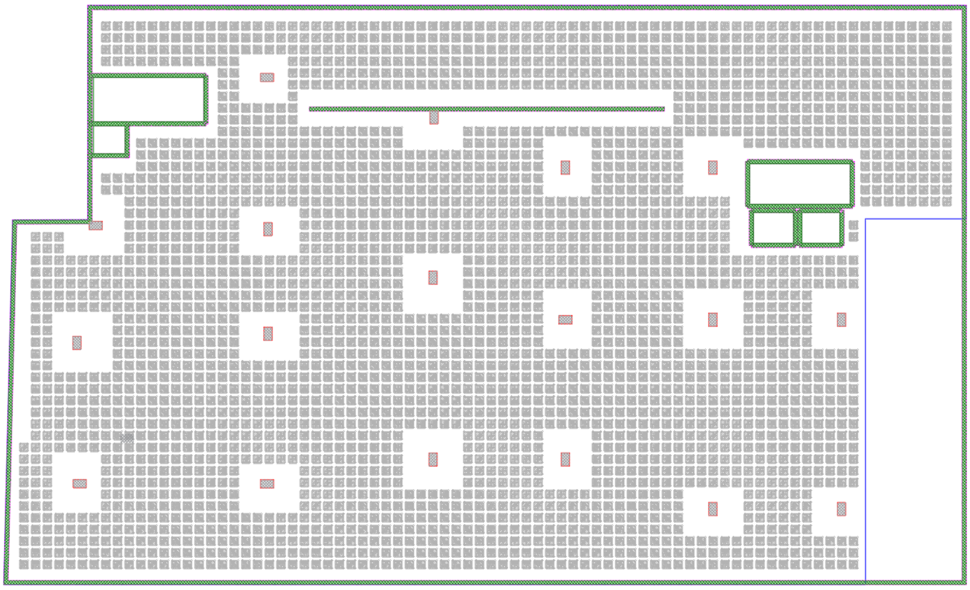


Figure 3. 21: SLAB LAYOUT B1

Slab layout G.F:

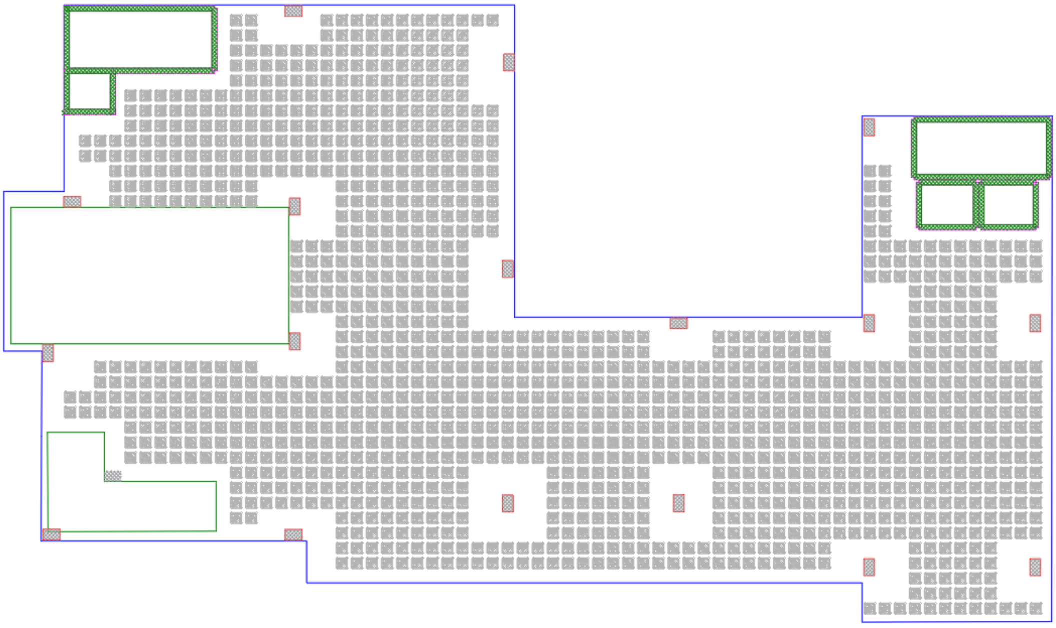


Figure 3. 22: slab layout G.F

Slab layout F1:

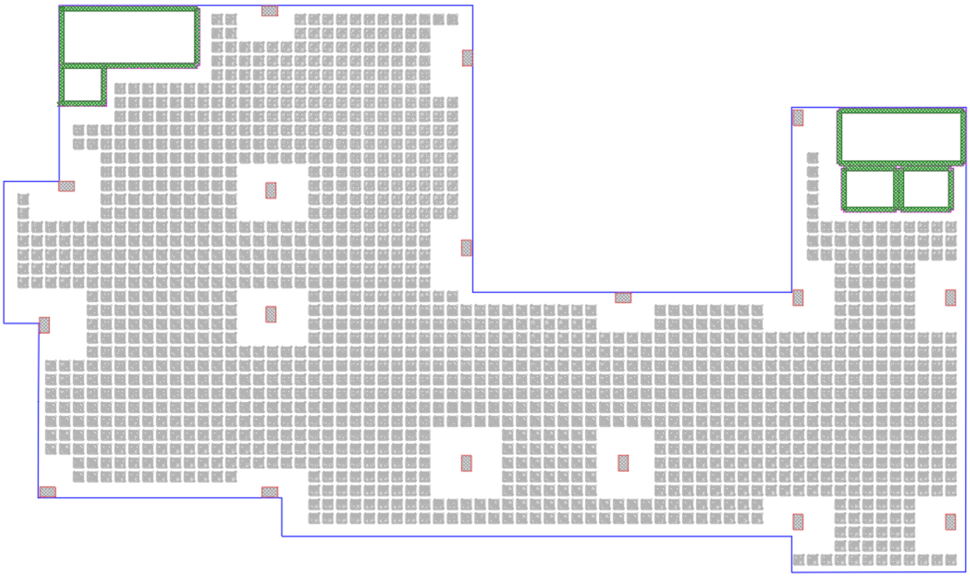


Figure 3. 23: slab layout F1

Slab layout F2:

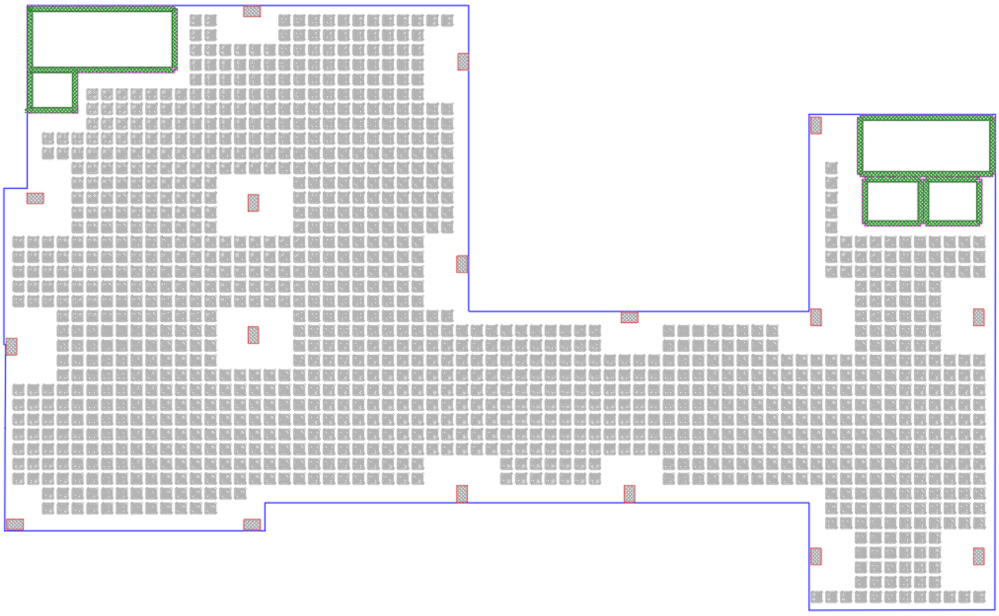


Figure 3. 24: slab layout F2

Slab layout F3:

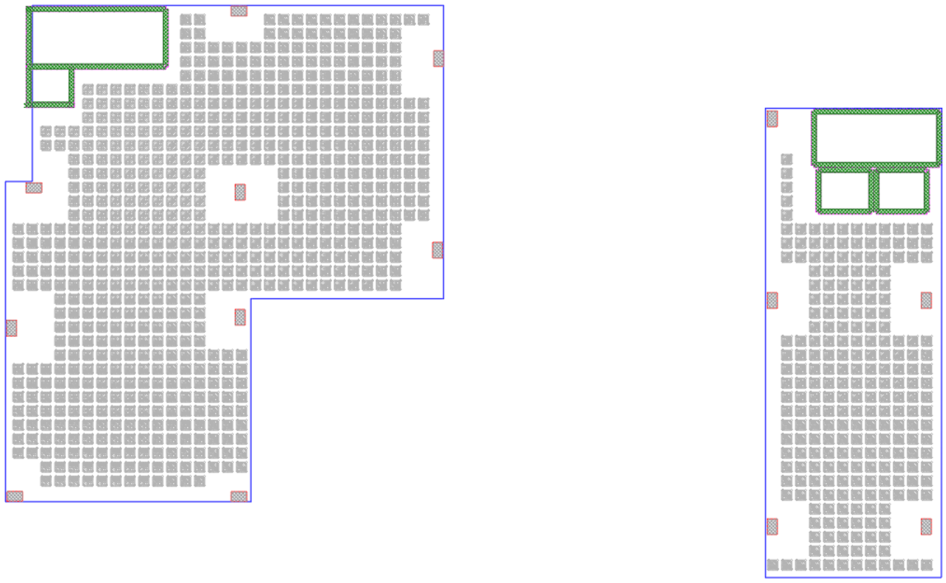


Figure 3. 25: slab layout F3

Slab layout F4:

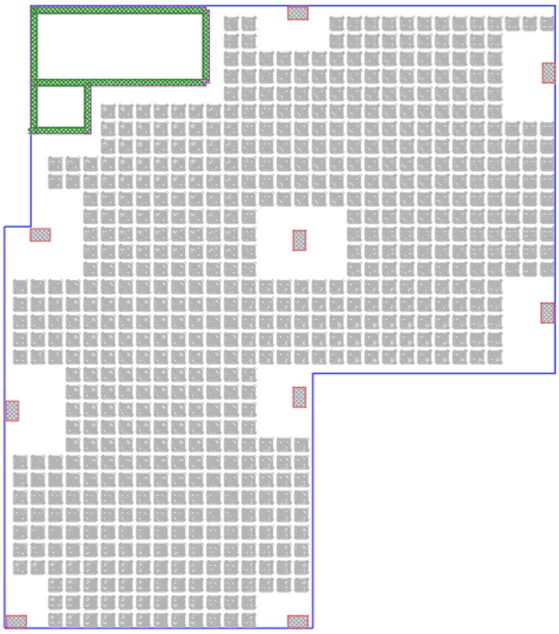


Figure 3. 26: slab layout F4

Slab detailing:

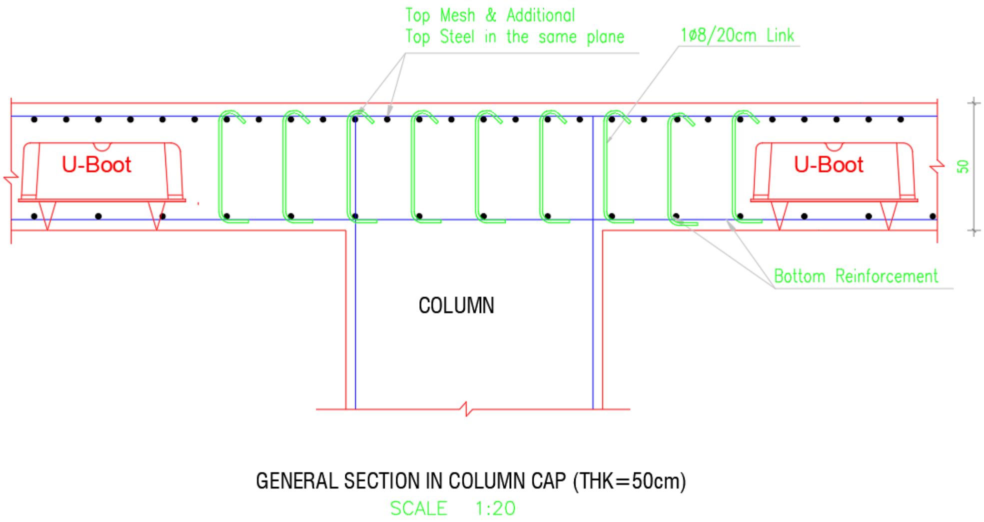


Figure 3. 27: slab detailing

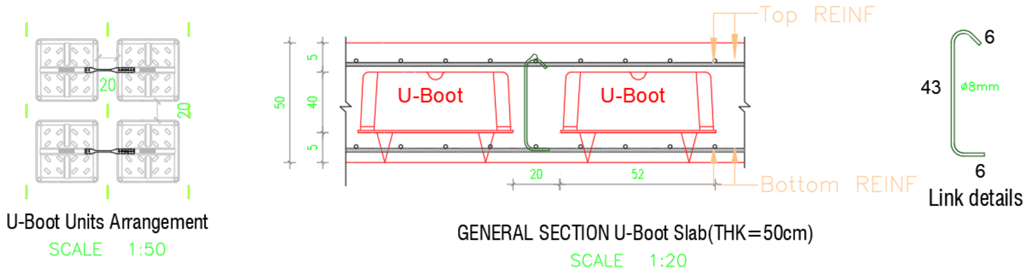


Figure 3. 28: slab detailing

Slab detailing for b3:

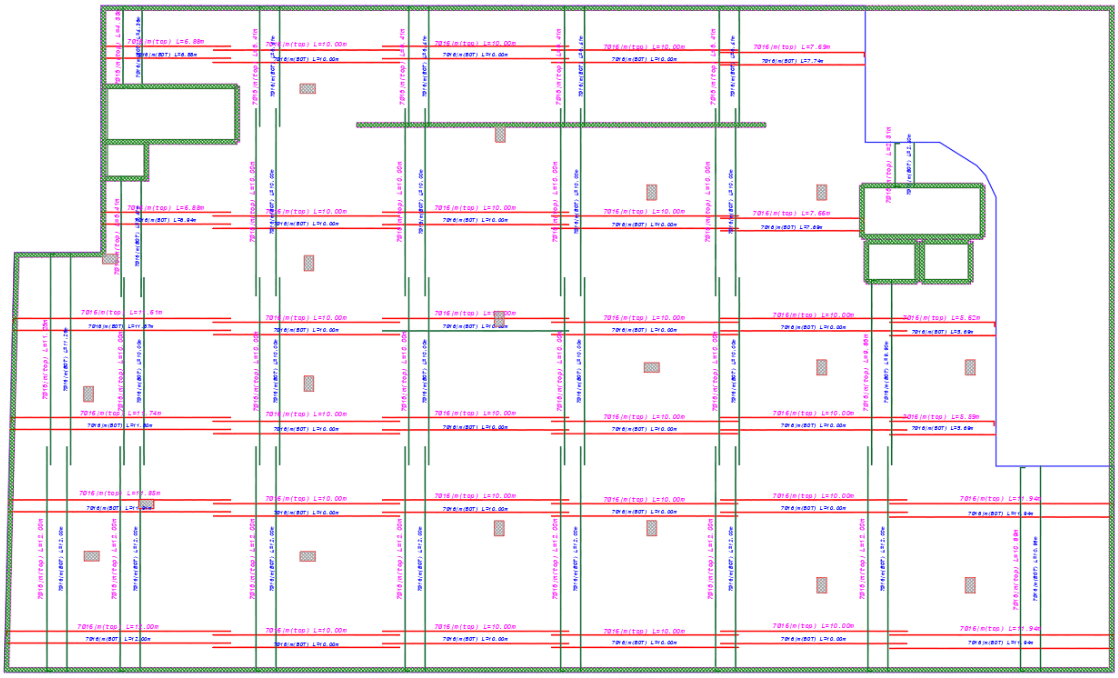


Figure 3. 29:Slab detailing .b1

Slab detailing for b2:

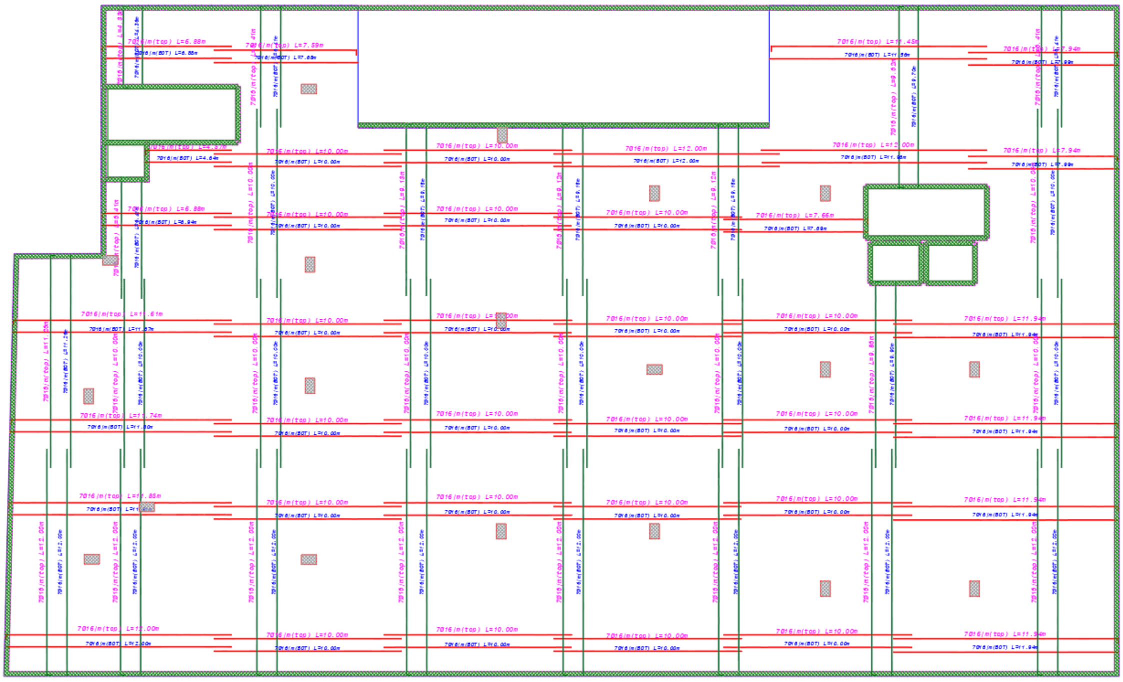


Figure 3. 30:Slab detailing b2

Slab detailing for b1:

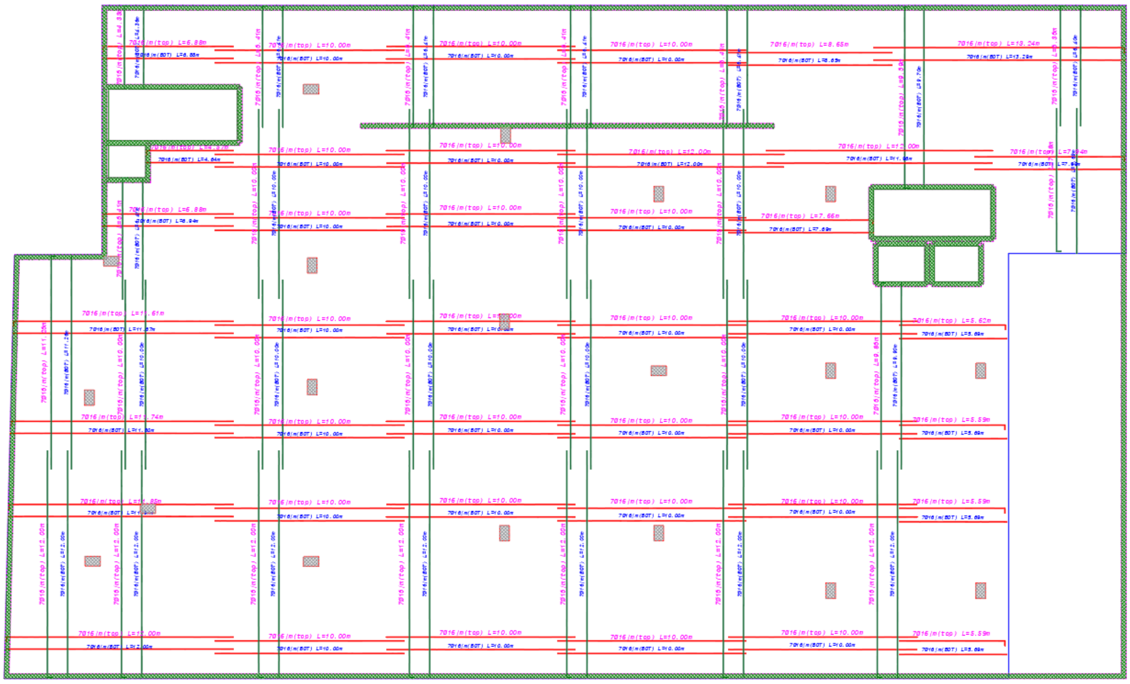


Figure 3. 31:Slab detailing .b3

Slab detailing for gf:

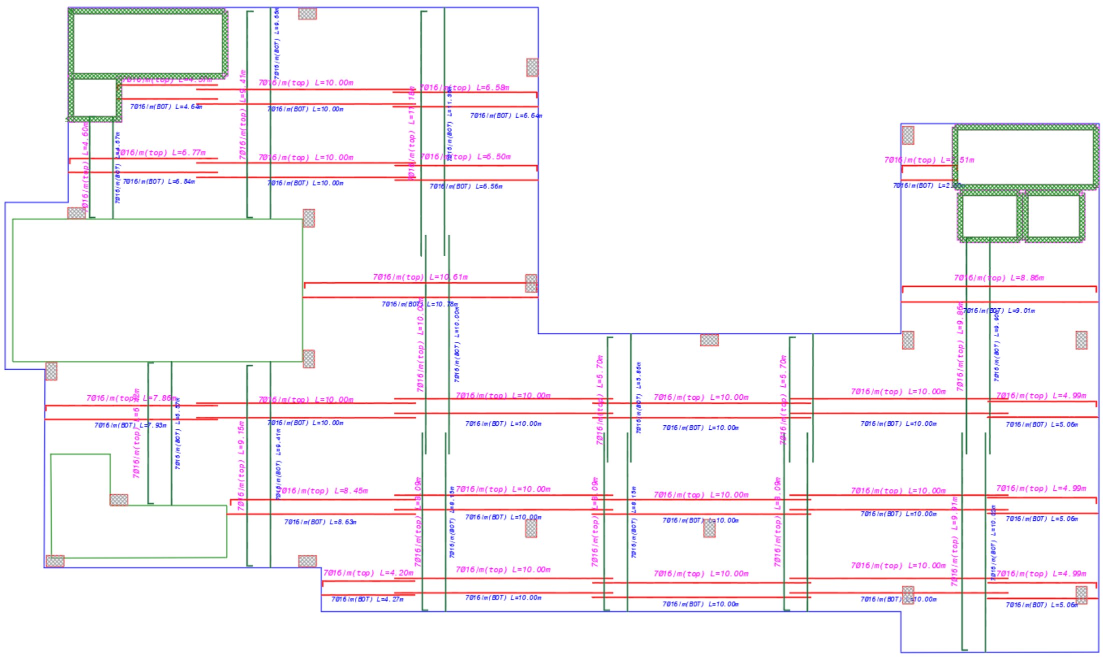


Figure 3. 32:Slab detailing G.F

Slab detailing for f1:

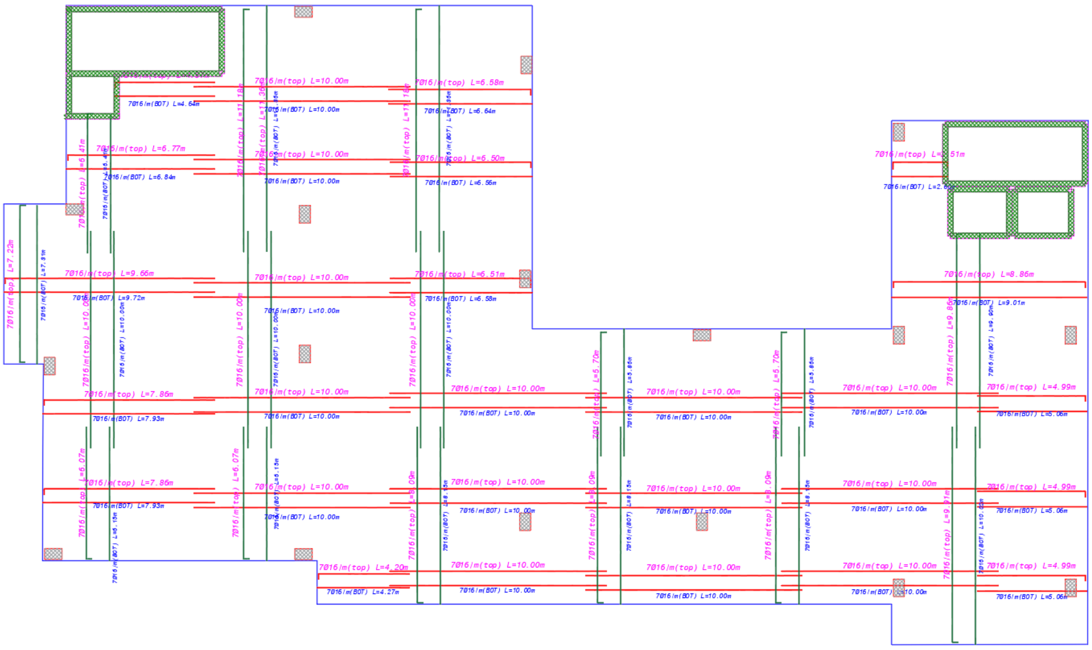


Figure 3. 33:Slab detailing f1

Slab detailing for f2:

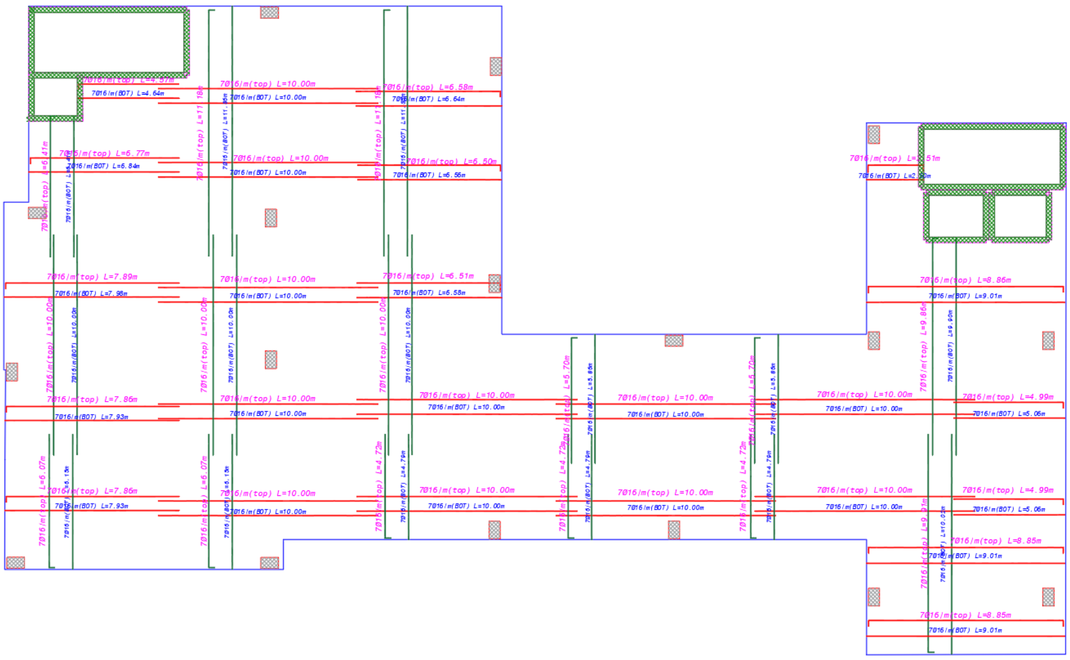


Figure 3. 34:Slab detailing f2

Slab detailing for f3:

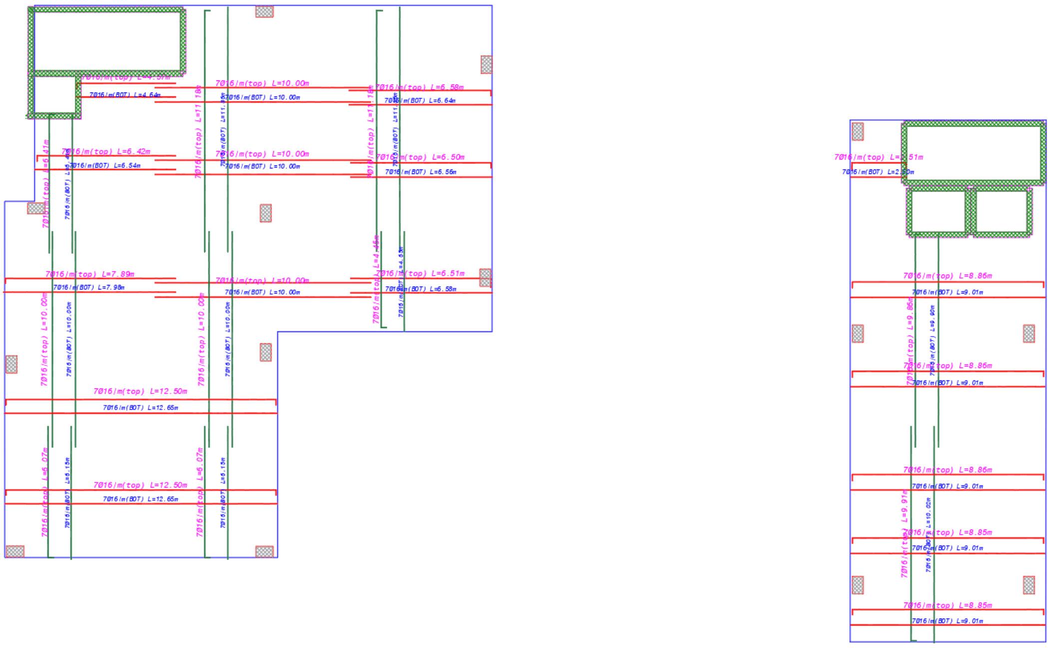


Figure 3. 35:Slab detailing f3

Slab detailing for f4:

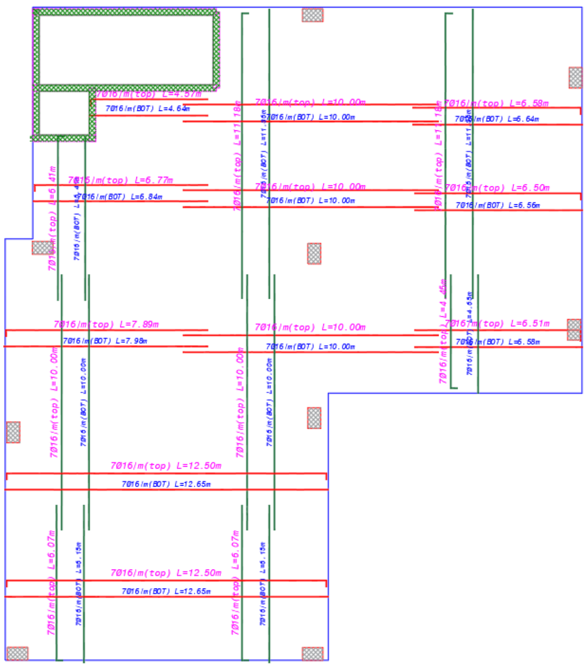


Figure 3. 36:Slab detailing f4

3.6.3 Footing design:

Soil allowable bearing capacity = 250 KN/m^2.

Footing type: Mat footing

In this type, the reinforcement will be a mush at the top and a mush at the bottom.

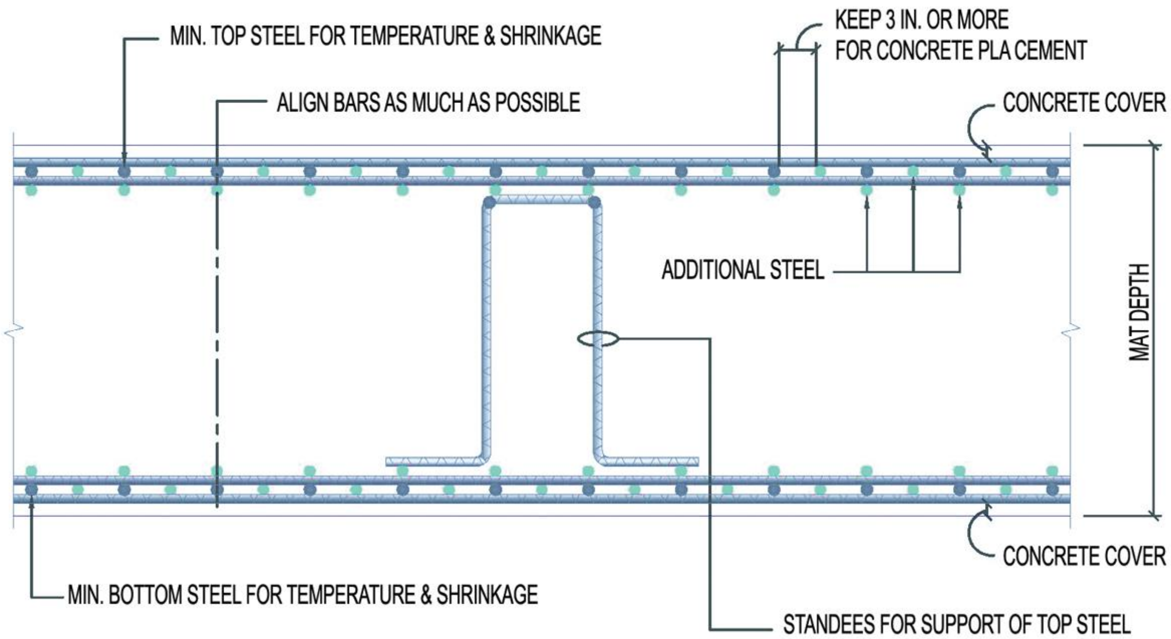


Figure 3. 37: reinforcement of mat footing

Software used: Safe 2016

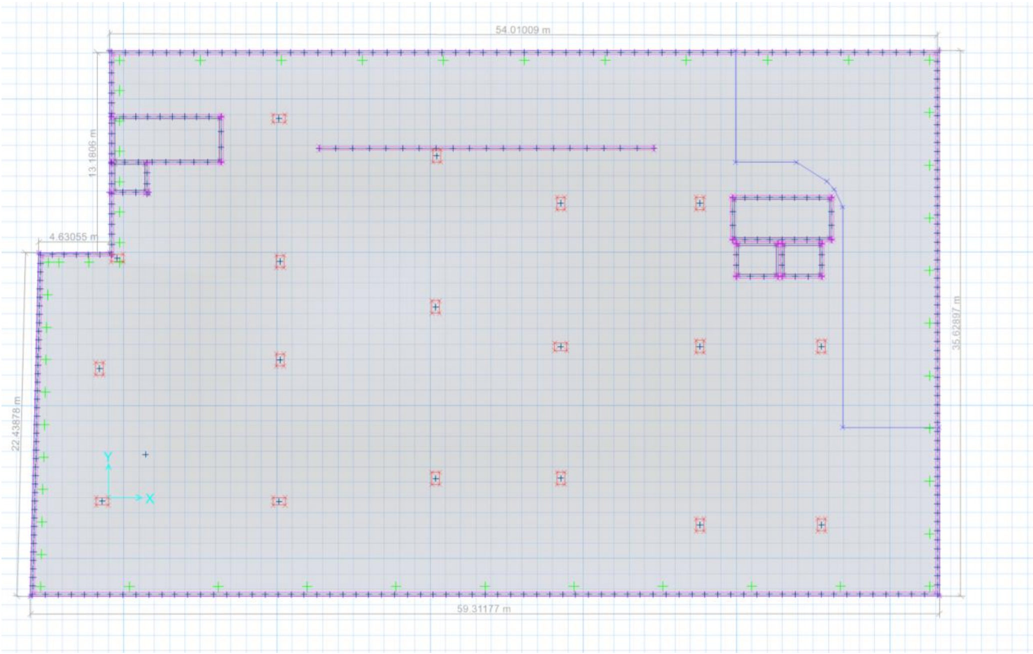


Figure 3. 38: footing design

Thickness was calculated equal =900 mm

Model checks:

Bearing capacity check from service load:

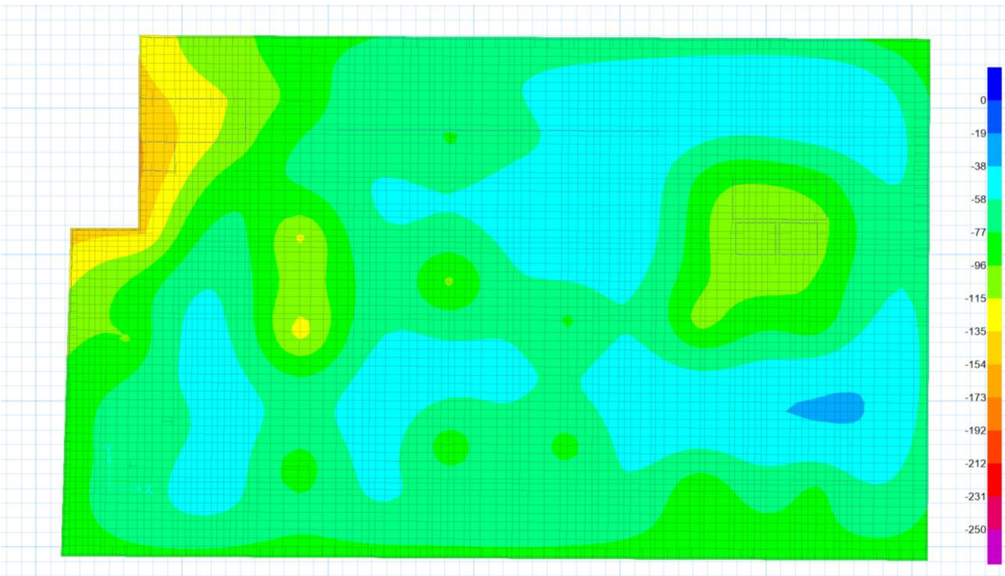


Figure 3. 39:Bearing capacity check from service load

Footing stresses < allowable bearing capacity ….is ok

Punching shear check:

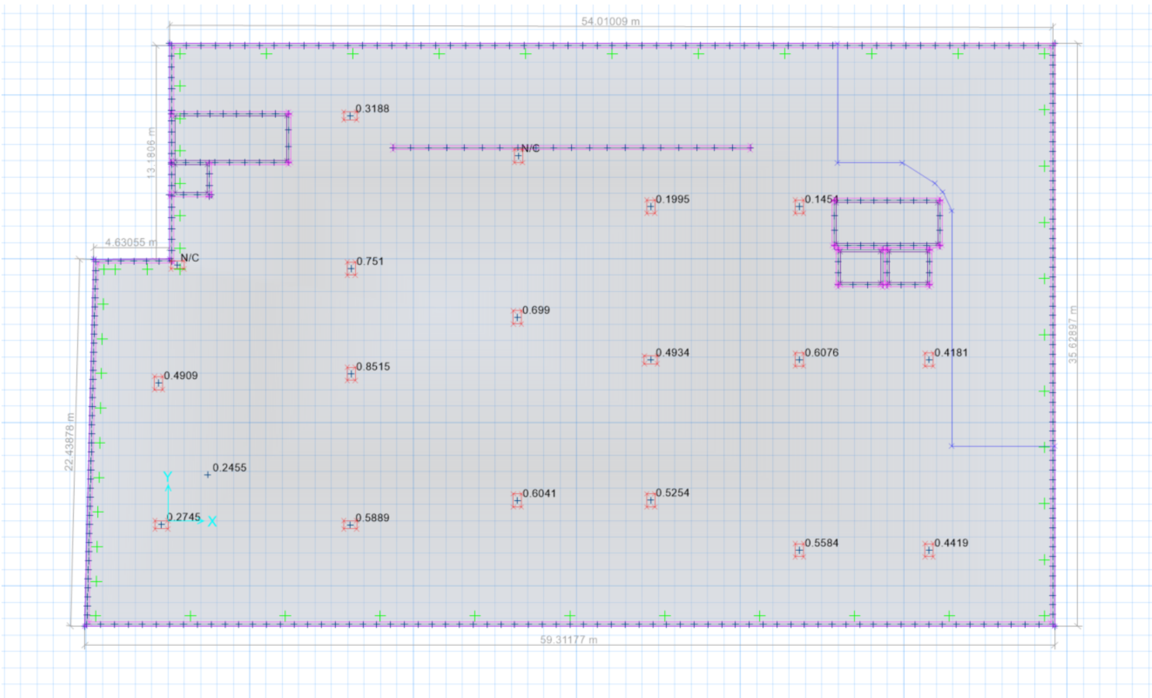


Figure 3. 40:Punching shear check

As shown, all rations<1but at the shear walls N/C which ok.

Footing detailing:

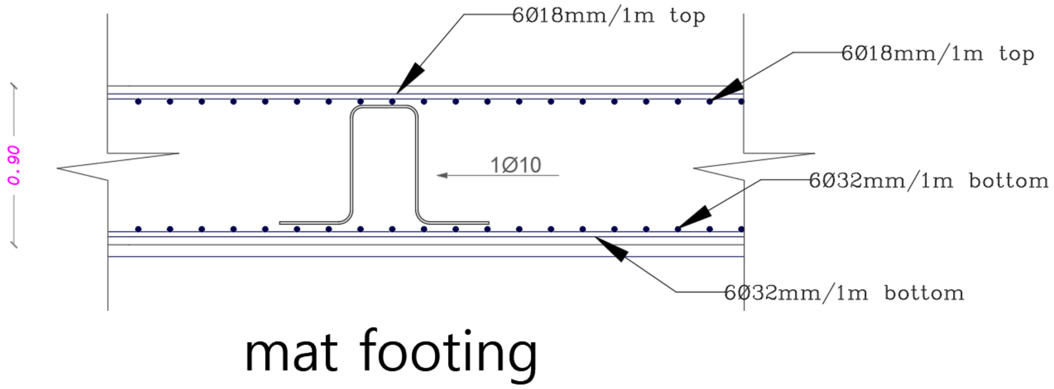


Figure 3. 41:Footing detailing

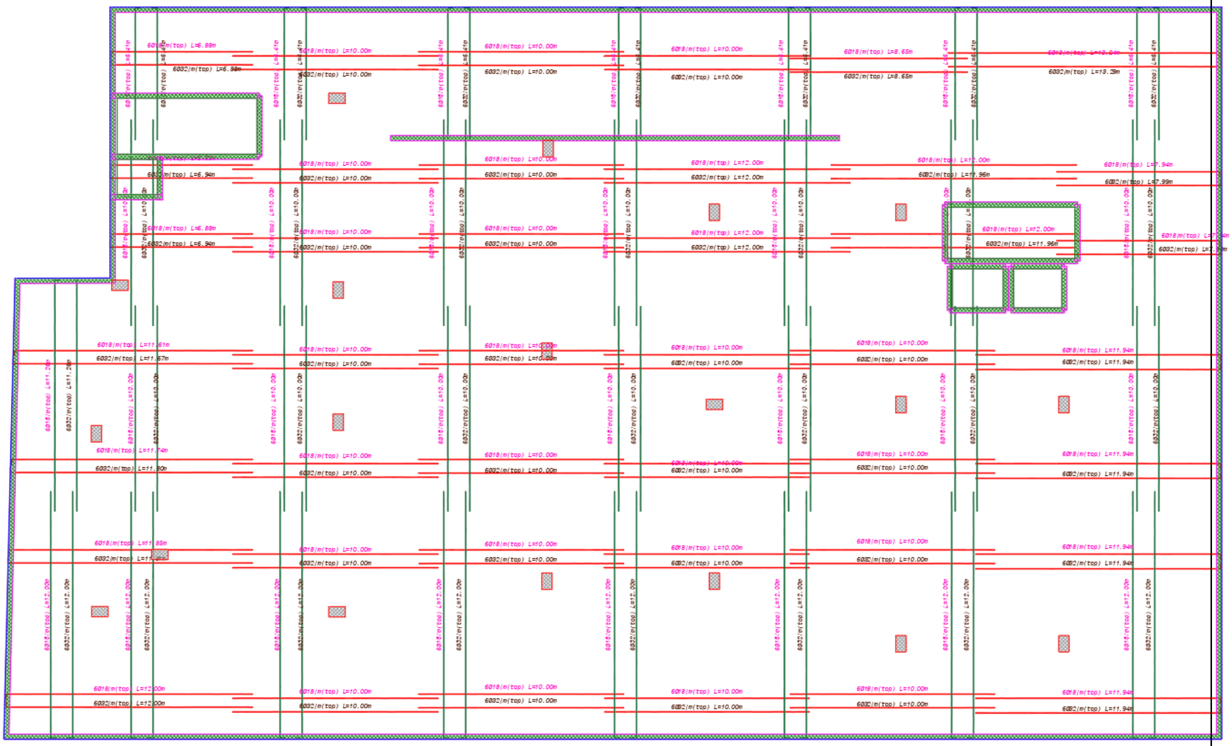


Figure 3. 42:Footing detailing

3.6.4 Stairs design:

The stairs is designed in Etabs program to make sure compatible and design .

Live lead =3.50 KN/m2

SID=4.50 KN/m2

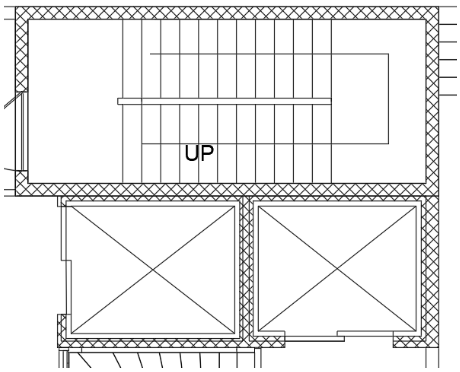


Figure 3. 43:stairs plan.

Modal ETABS:

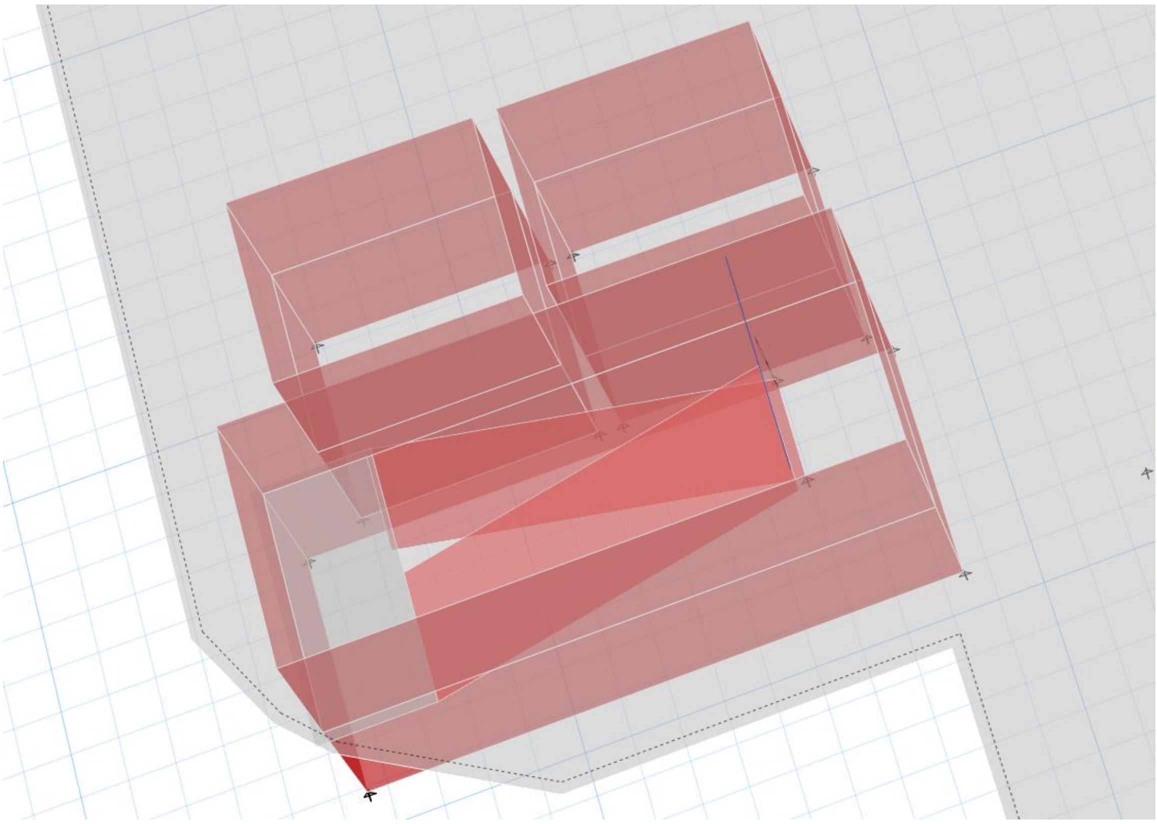


Figure 3. 44:Modal etabs stairs

Compatibly check:

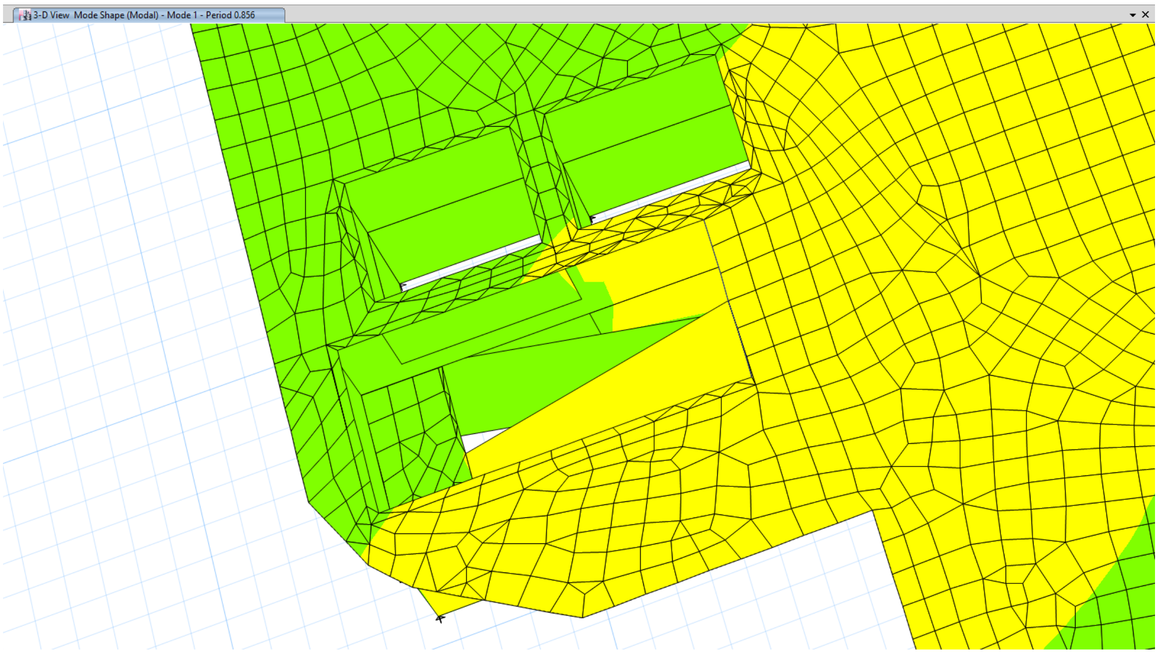


Figure 3. 45:Compatibly check stairs

The stair is compatible

Shear check in stairs:

$$\Phi Vc = \frac{0.75}{6} * \sqrt{fc} * b * d = \frac{0.75}{6} * \sqrt{28} * 1000 * 160/1000 = 105 \text{ KN}$$

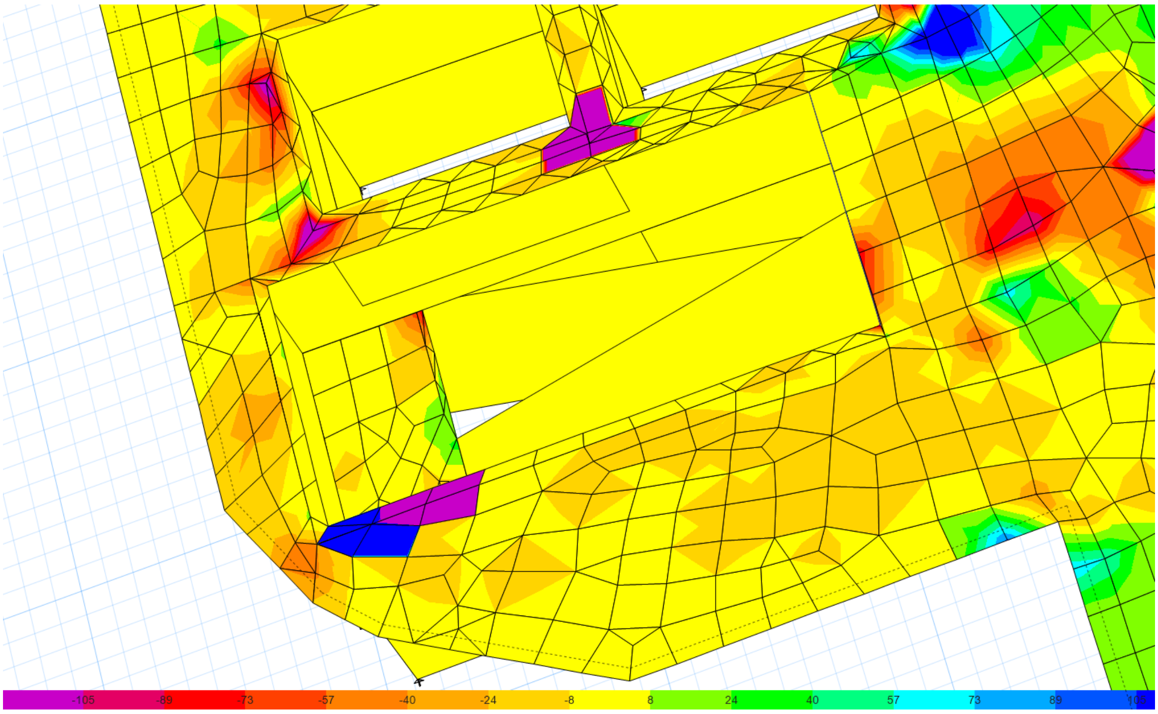


Figure 3. 46:Shear check in stairs

$\Phi Vc > Vu$……………ok

Moment results from ETABS:

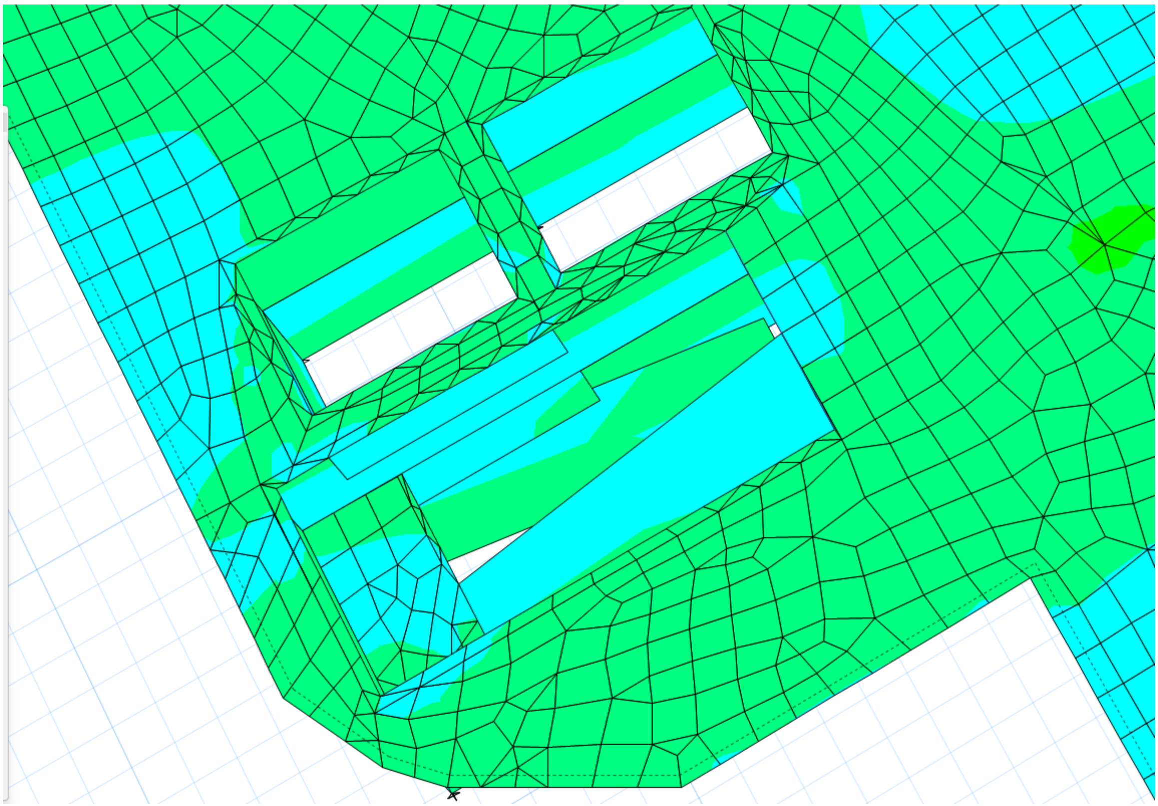


Figure 3. 47:Moment results from etabs

Max moment from ETABS = 6.1 kn.m .

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

=0.000695

ρ min = 1.4/ fy = 1.4 /420 = 0.003

so, use AS min

As min = 0.003 * 1000 * 200 = 600 mm^2 use 6 Ø12/ m

Stairs detailing:

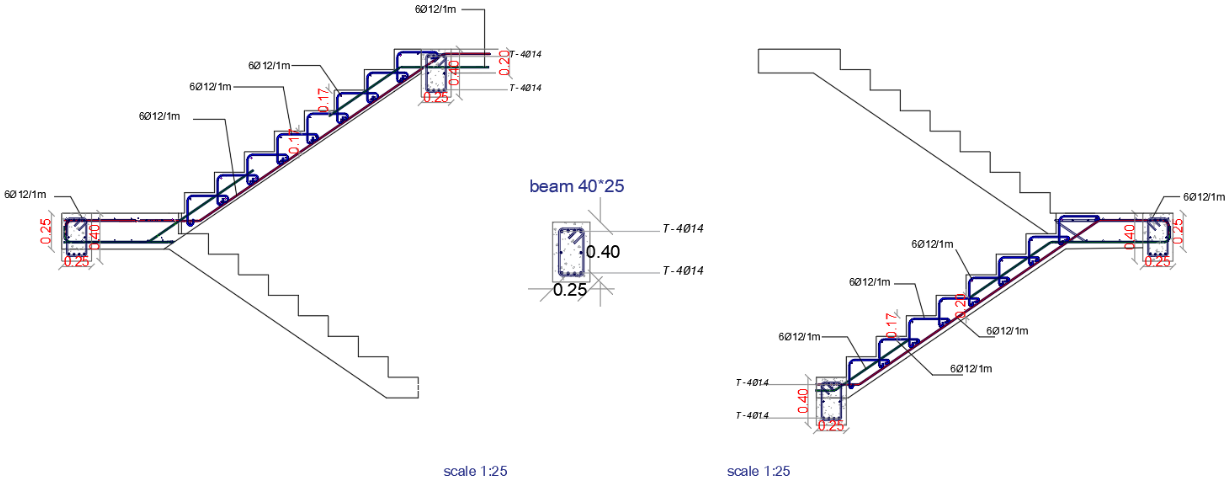


Figure 3. 48:Stairs detailing Stairs detailing

3.6.5 Shear wall design:

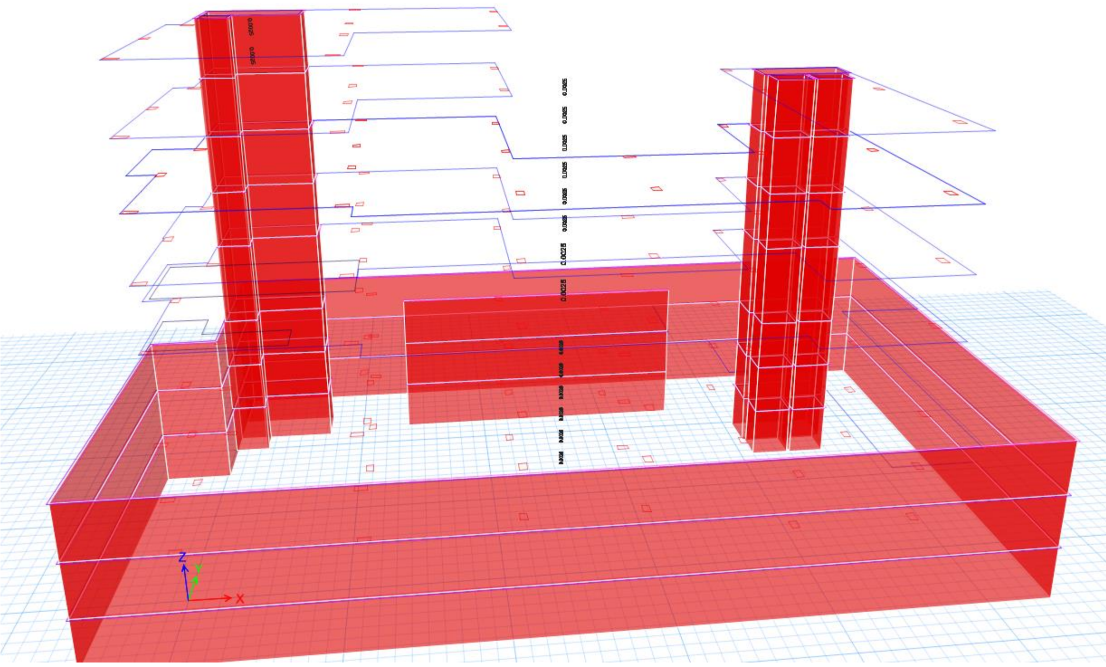


Figure 3. 49:Shear wall design

Table 19:Shear wall design

Shear Design

Station Location	ID	Rebar mm²/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	ΦV_c kN	ΦV_n kN
Top	Leg 1	625	DWal3	2058.2473	475.8136	188.8929	514.9237	918.9348
Top	Leg 2	634.77	DWal6	1197.7877	-481.1504	215.8282	368.5781	707.4921
Top	Leg 3	625	DWal6	1214.9766	178.5714	85.3986	514.151	917.556
Top	Leg 4	625	DWal6	1483.2382	-776.1675	334.039	362.9079	696.607
Top	Leg 5	625	DWal4	1705.0763	-17.7026	45.399	539.2912	962.4212
Top	Leg 6	634.77	DWal6	1193.6895	-497.5525	224.026	368.5781	707.4921
Top	Leg 7	625	DWal6	1166.2952	-43.3325	34.2154	767.3147	1189.8385
Top	Leg 8	625	DWal6	1046.4336	-1027.8123	526.8431	362.9079	696.607
Top	Leg 9	625	DWal4	2923.422	875.9271	92.3836	1166.5291	2168.0434
Top	Leg 10	625	DWal5	2098.6008	-101.5894	191.9731	1718.8942	2720.4085
Top	Leg 11	634.77	DWal4	1126.0959	-294.4563	63.8801	420.9744	854.262
Top	Leg 12	625	DWal6	1083.0749	-294.7362	183.2177	760.571	1187.1885
Top	Leg 13	625.54	DWal6	5308.286	5846.3839	734.4021	1421.0822	2536.0689
Top	Leg 14	625.54	DWal6	3947.0768	5113.1962	814.4933	1421.0822	2536.0689
Top	Leg 15	622.23	DWal6	3720.8797	-328.9517	200.091	585.6663	1045.1824
Top	Leg 16	625	DWal6	1482.2213	-409.3639	190.1755	332.4602	654.2145

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

Design for shear wall:

Table 20:Shear wall design1

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	168641	0.0025	0.0124	DWal10	44404.3419	162802.2133	-73020.8092	67456267
Bottom	168641	0.0025	0.0124	DWal10	49398.4177	160691.1512	-72752.9833	67456267

The ratio reinforcement in all shear wall in building is 0.0025.

Area of streel on 1m = 0.0025*1000*300 =750mm ----so use 7 Ø12 /1m.

Shear wall detailing:

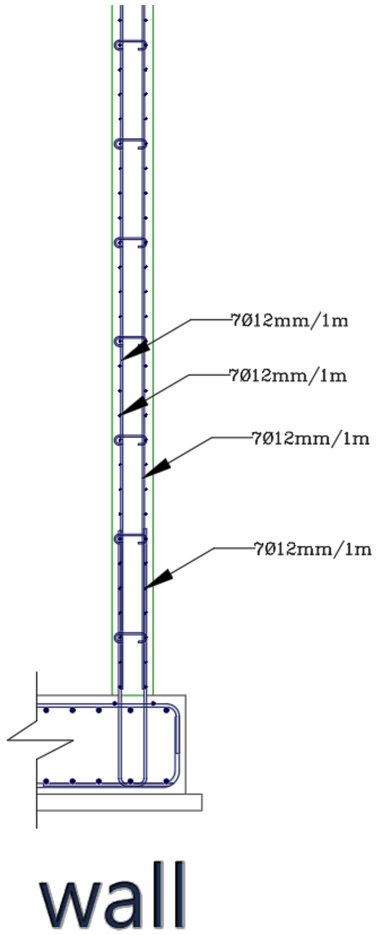


Figure 3. 50:Shear wall detailing.

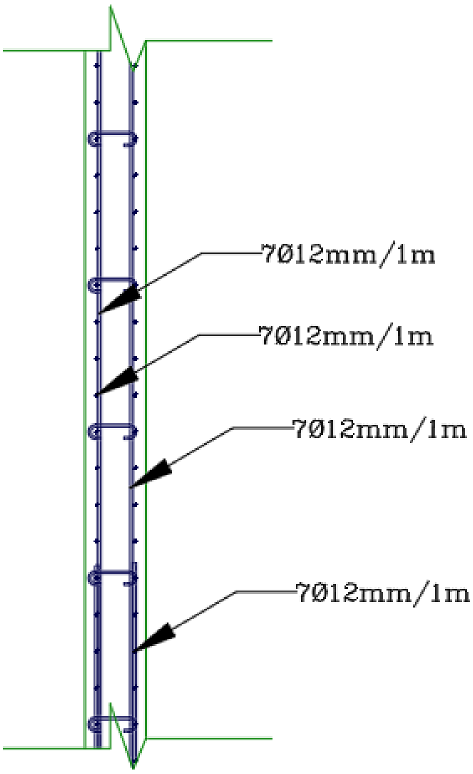


Figure 3. 51:Shear wall detailing

3.6.6 Sheet piles design:

Sheet pile design is concrete used to provide temporary or permanent earth retention solutions in various construction projects. They are commonly used in applications such as retaining walls, cofferdams, bulkheads, and deep excavations.

We used geo5 2020 for design concrete sheet pile.

Soil:

Table 21: soil sheet piles

Unit weight	**18 KN/m³**
Angle of internal fraction	**30⁰**
Cohesion of soil	**0.00 Kpa**
Angle of fraction soil	**30⁰**
Saturated untie weight	**25KN**
Height of water	**3 m from bottom**
Stress state effective	

Sheet pile dimension:

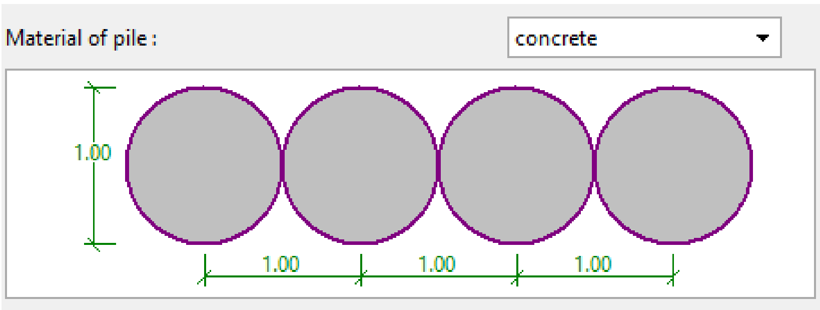


Figure 3. 52:Sheet pile dimension:

Sheet pile geometry, Bending moment and shear force:

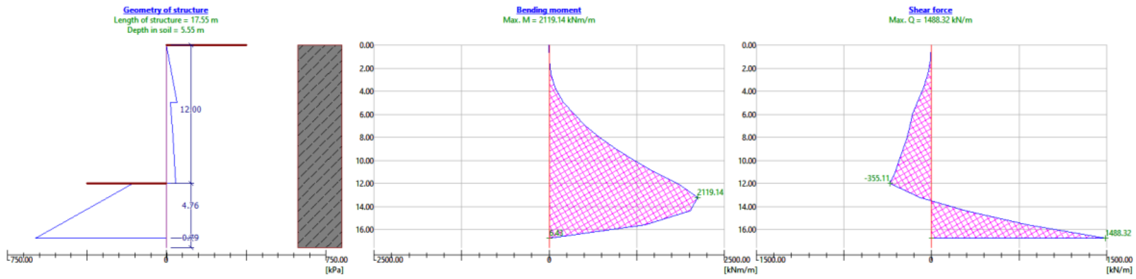


Figure 3. 53: Sheet pile geometry, Bending moment and shear force.

Results from geo5 2020 program:

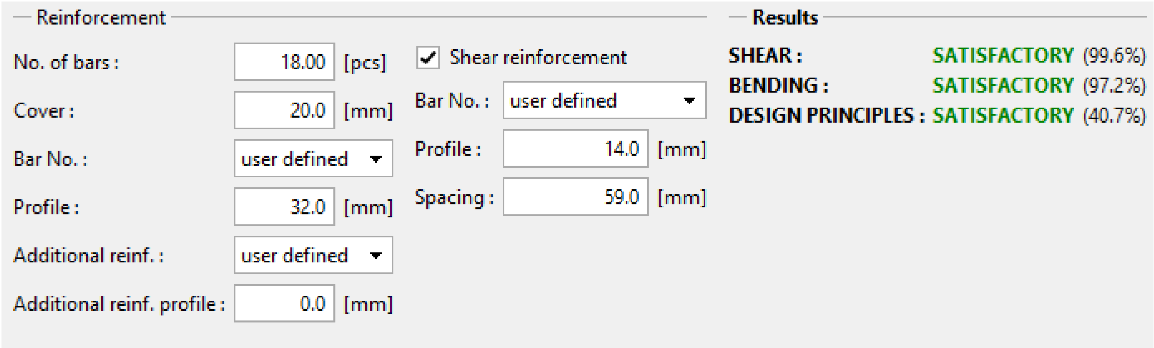


Figure 3. 54: Results from geo5 2020 program

Sheet pile detailing:

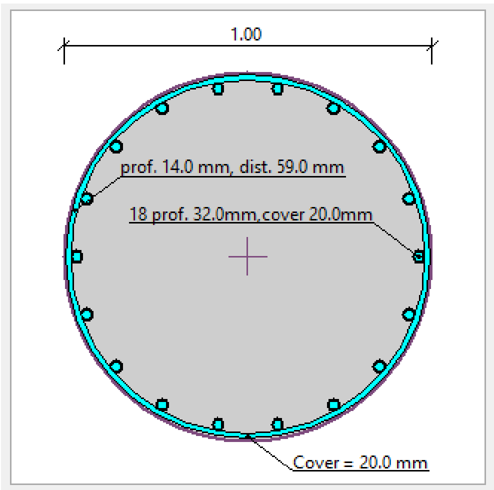


Figure 3. 55:Sheet pile detailing.

Chapter 4: Electro - Mechanical Design:

4.1 Lighting:

4.1.1 Introduction:

Lighting has always been a fundamental element in the conception of architectural spaces, for it is capable of playing with volumes, distorting the perception of space and even dramatizing the shapes and textures of the materials, enhancing their aesthetic features dramatically. However, **light does not only play a major role at a decorative level**. The quality of illumination makes all the difference when it comes to the comfort -even the health- of those who experience living in these space

4.1.2 Artificial lighting design:

In this section, much attention should be paid to artificial lighting in the building because it played a major role in the comfort of users. Where attention must be paid to the amount of lux, color, direction, color temperature and the method of distributing them within the spaces without neglecting to look at the amount of energy consumed by the lighting units used.

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:

Ground floor rooms:

1-waitng hall:

The standard lux value in this type of spaces is 200lx with 3500 - 4000 K lighting temperature as the next calculations which is done all by the DiaLUX software shows:

Properties	Ē (Target)	E_{min}	E_{max}	g_1	g_2	Index
Waiting room Perpendicular illuminance (adaptive) Height: 0.800 m, Wall zone: 0.000 m	208 lx (≥ 200 lx) ✓	13.9 lx	243 lx	0.067	0.057	WP29

Figure 4. 1: Artificial lighting calculation for waiting room.

Figure 4. 2: Waiting room from DiaLUX

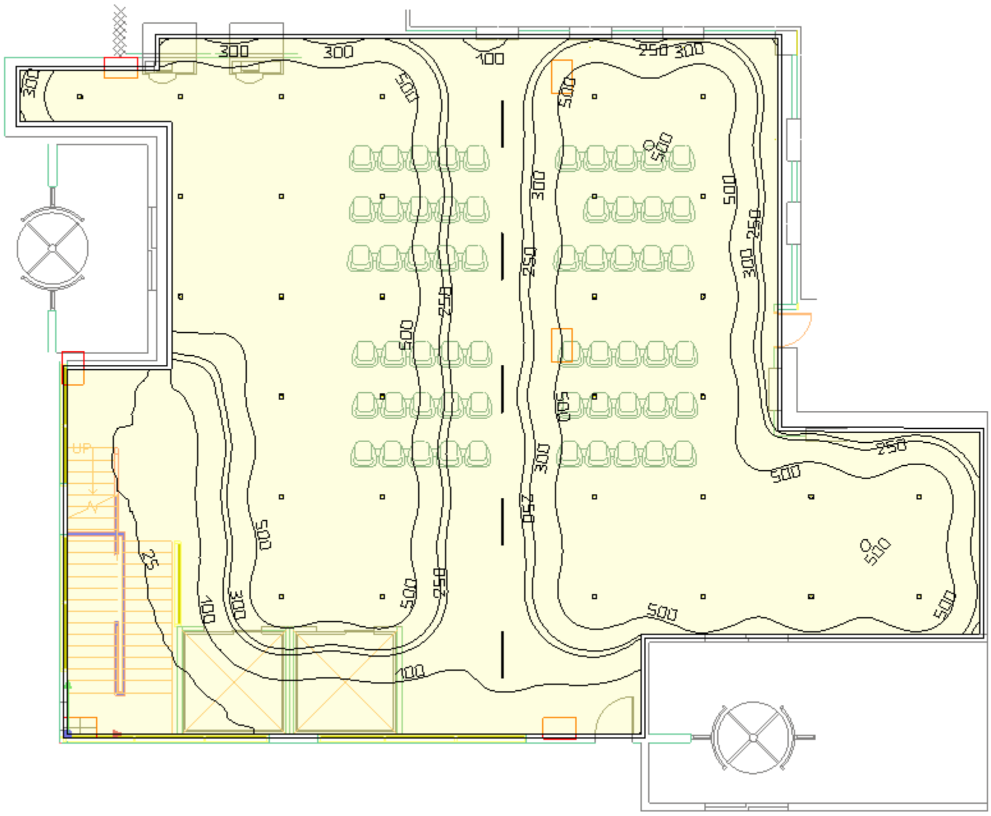
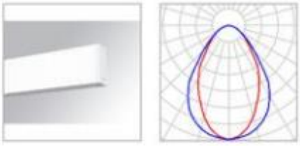


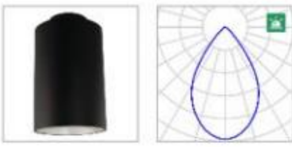
Figure 4. 3:Light scene of lux values for artificial lighting in waiting room with plan of luminaires.

LAMP
Worktitude for light



Manufacturer	LAMP	P	12.1 W
Article No.	F31SF112LOOC830N W	$\Phi_{Luminaire}$	1064 lm
Article name	FIL35 SUR 1120 1600 WW OP COMF WH.		
Fitting	1x LED		

COOPER
Lighting Solutions



Manufacturer	Cooper Lighting	P	10.0 W
Article No.	HCC6S10D010BZ-HM612830-61NDHWF	$P_{Emergency\ lighting}$	10.0 W
Article name	HCC6 LED 6" Cylinder Downlight Series	$\Phi_{Luminaire}$	851 lm
Fitting	1x LED	$\Phi_{Emergency\ lighting}$	851 lm
		ELF	100 %

Figure 4. 4:Used type of luminaires in waiting 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

2-Reception area:

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:

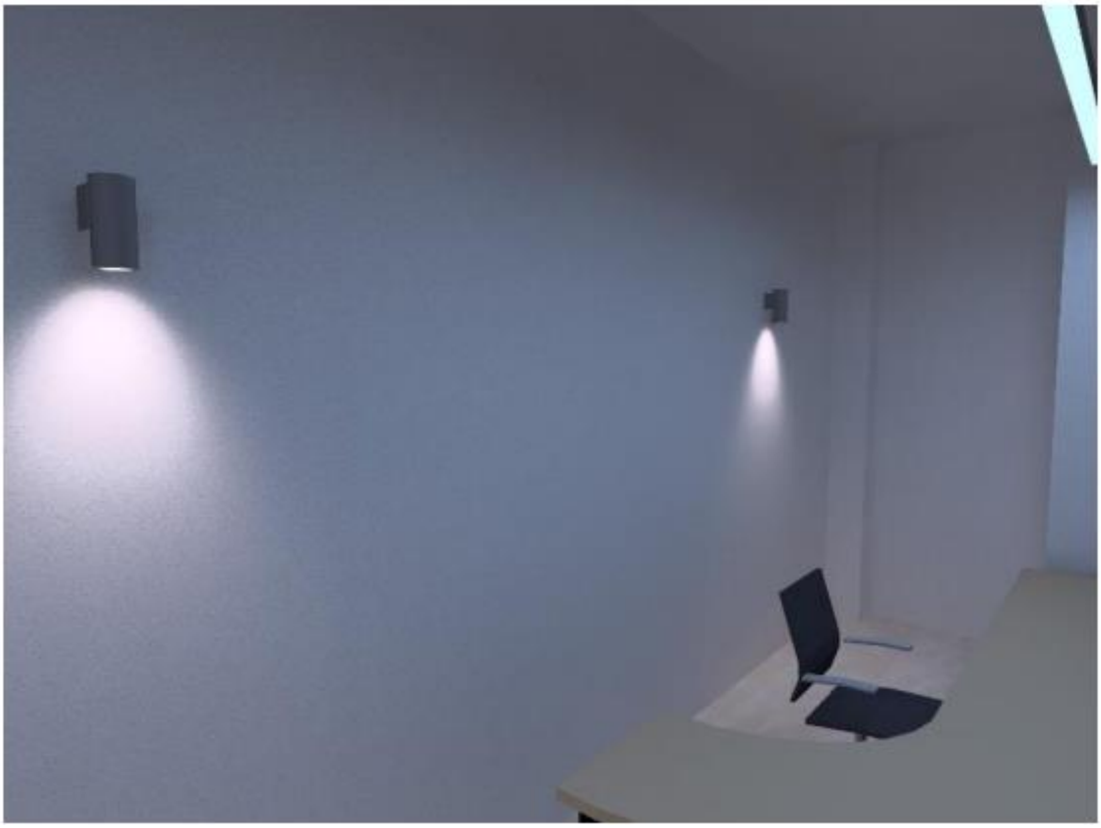


Figure 4. 5:Reception room from DiaLUX.

Properties	Ē (Target)	E_{min}	E_{max}	g_1	g_2	Index
Workplane (reception) Perpendicular illuminance (adaptive) Height: 0.800 m, Wall zone: 0.000 m	309 lx (≥ 300 lx) ✓	26.3 lx	572 lx	0.085	0.046	WP30

Figure 4. 6:Artificial lighting calculation for reception room.

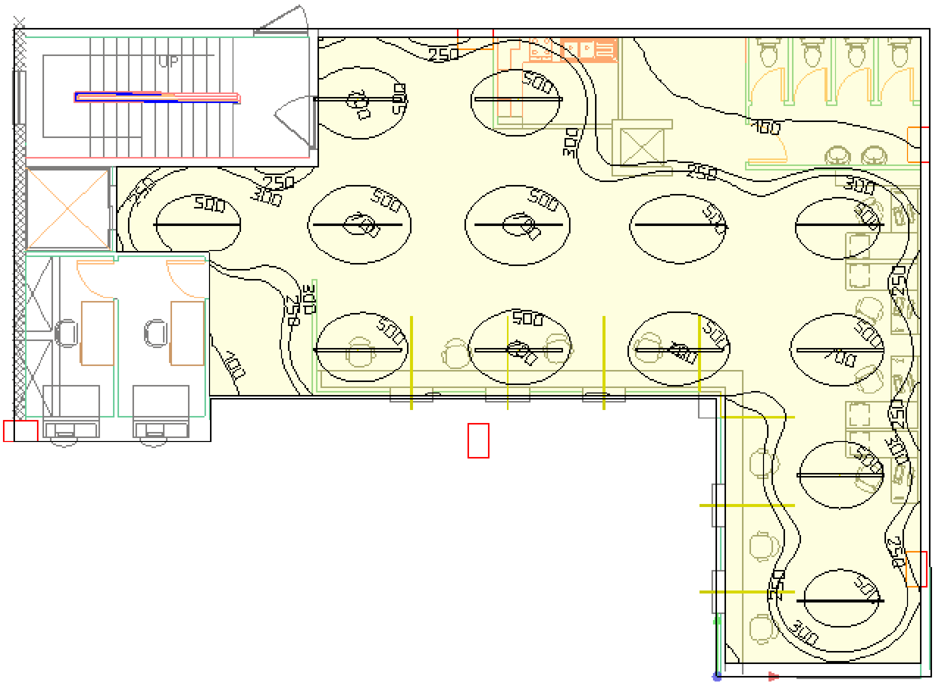
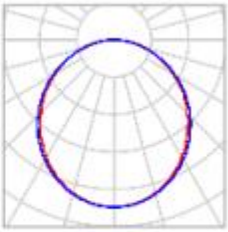


Figure 4. 7:Used type of luminaires in reception room.

ES-SYSTEM
A GLAMOX COMPANY



Manufacturer	ES-SYSTEM	P	49.0 W
Article No.	F0630-00146RANODL 2023	$\Phi_{Luminaire}$	3000 lm
Article name	FX65 OP 2023 LED 840 6000lm 49W IP20 ANODA DRV DIM DALI		
Fitting	1x LED		

Figure 4. 8:Used type of luminaires in reception 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.

3- Security 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:

Properties	Ē (Target)	E_{min}	E_{max}	g_1	g_2	Index
Workplane (secertary) Perpendicular illuminance (adaptive) Height: 0.800 m, Wall zone: 0.000 m	310 lx (≥ 300 lx) ✓	1.02 lx	397 lx	0.003	0.003	WP7

Figure 4. 9:Artificial lighting calculation for secretary room

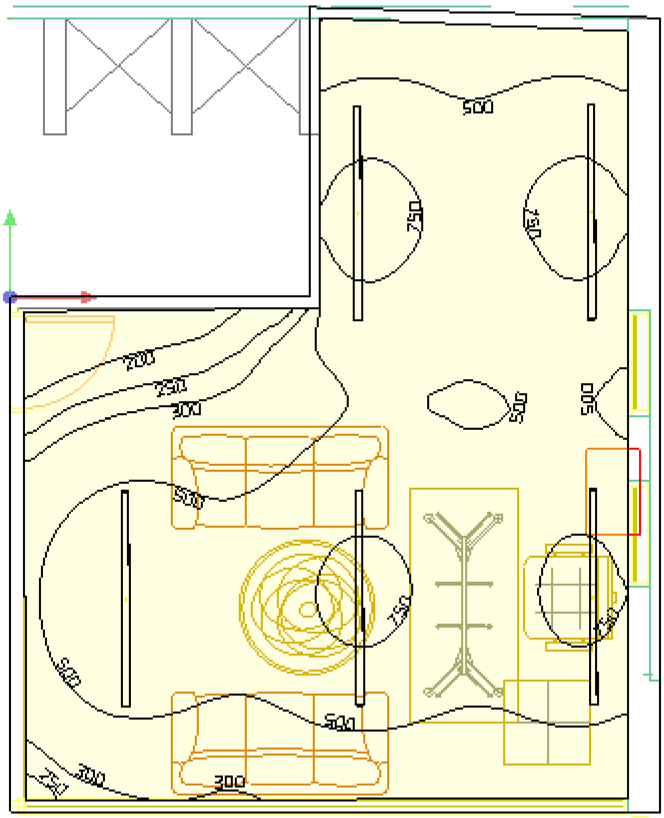


Figure 4. 10:Light scene of lux values for artificial lighting in secretary room with plan of luminaires

1st floor rooms:

1- Offices:

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. 11:Employees office from DiaLUX

Properties	Ē (Target)	E_{min}	E_{max}	g_1	g_2	Index
Workplane (employees office) Perpendicular illuminance (adaptive) Height: 0.855 m, Wall zone: 0.000 m	511 lx (≥ 500 lx) ✓	0.80 lx	654 lx	0.002	0.001	WP9

Figure 4. 12:Artificial lighting calculation for employee's office

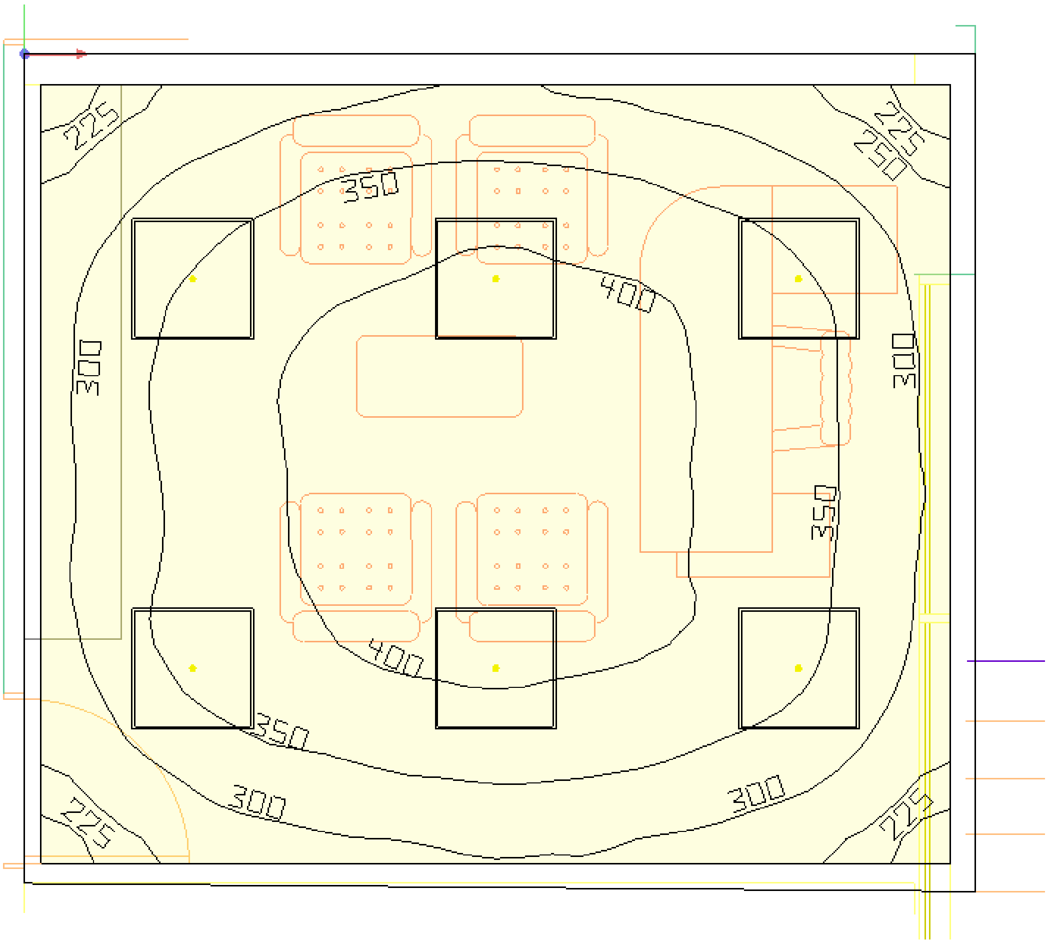
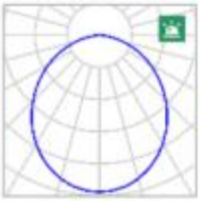


Figure 4. 13:Light scene of lux values for artificial lighting in employee's office with plan of luminaires.



Manufacturer	Thorlux Lighting
Article No.	PU17713
Article name	Plateau LED 625 x 625 - 20W - 4000K
Fitting	1x PLATEAU LED 20W 4000K

P	23.0 W
$P_{Emergency\ lighting}$	23.0 W
$\Phi_{Luminaire}$	2850 lm
$\Phi_{Emergency\ lighting}$	2850 lm
ELF	100 %

Figure 4. 14:Used type of luminaires in employee's office

Glare check:

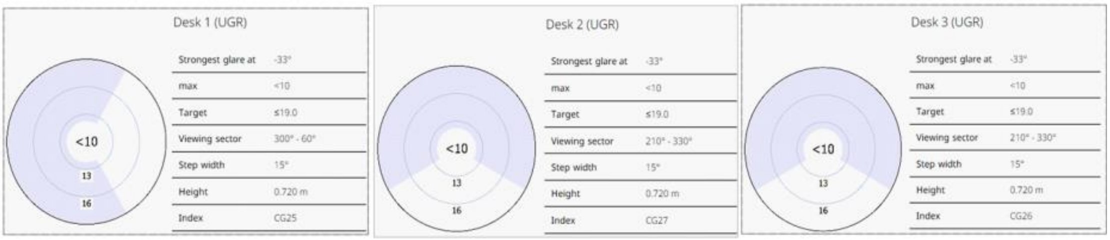


Figure 4. 15:Glare results in employee's office.

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

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. 16:Bathroom from DiaLUX

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. 17:Artificial lighting calculation for bathroom.

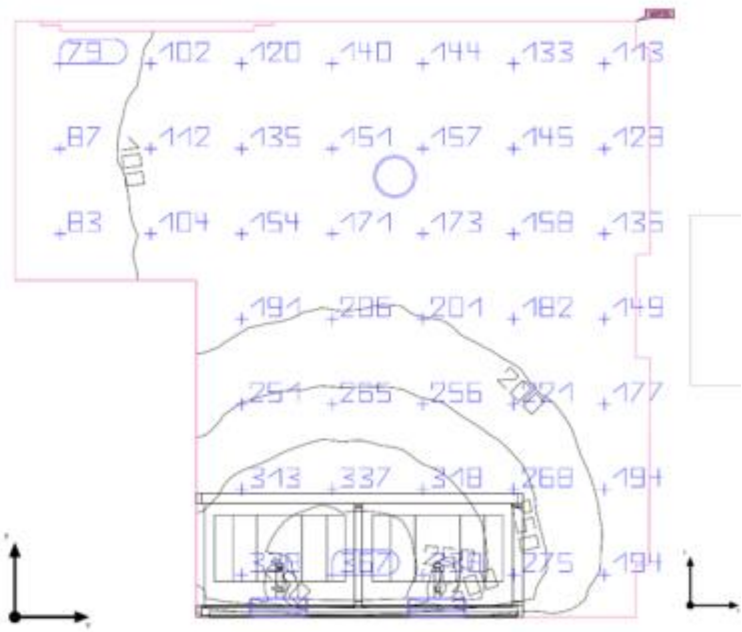


Figure 4. 18:Light scene of lux values for artificial lighting in bathroom with plan of luminaires

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.

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 shows:

Figure 4. 19:W.C from DiaLUX

Properties	Ē (Target)	E_{min}	E_{max}	g_1	g_2	Index
Workplane (WC) Perpendicular illuminance (adaptive) Height: 0.800 m, Wall zone: 0.000 m	106 lx (≥ 100 lx) ✓	82.9 lx	119 lx	0.78	0.70	WP34

Figure 4. 20:Artificial lighting calculation for W.C.

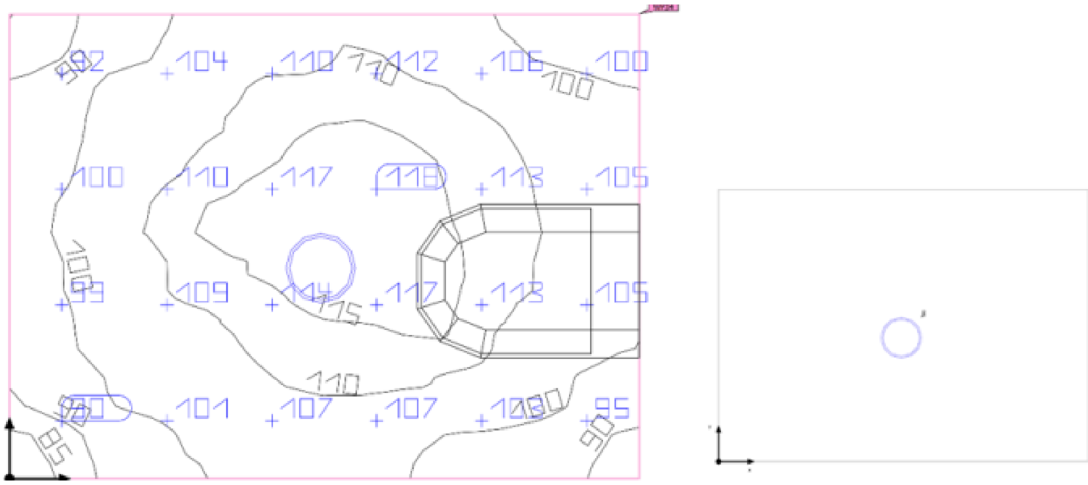
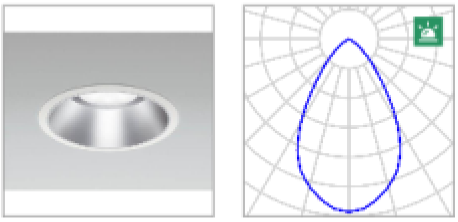


Figure 4. 21:Light scene of lux values for artificial lighting in W.C with plan of luminaires

ENDO LIGHTING CORP.



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 %

Figure 4. 22:Used type of luminaires in W.C

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.

2nd+3rd floor rooms:

1-Manager 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. 23:Manager's room from DiaLUX

Properties	Ē (Target)	E_{min}	E_{max}	g_1	g_2	Index
Workplane (manager room) Perpendicular illuminance (adaptive) Height: 0.800 m, Wall zone: 0.000 m	502 lx (≥ 500 lx) ✓	0.45 lx	940 lx	0.001	0.000	WP8

Figure 4. 24:Artificial lighting calculation for manager's room.

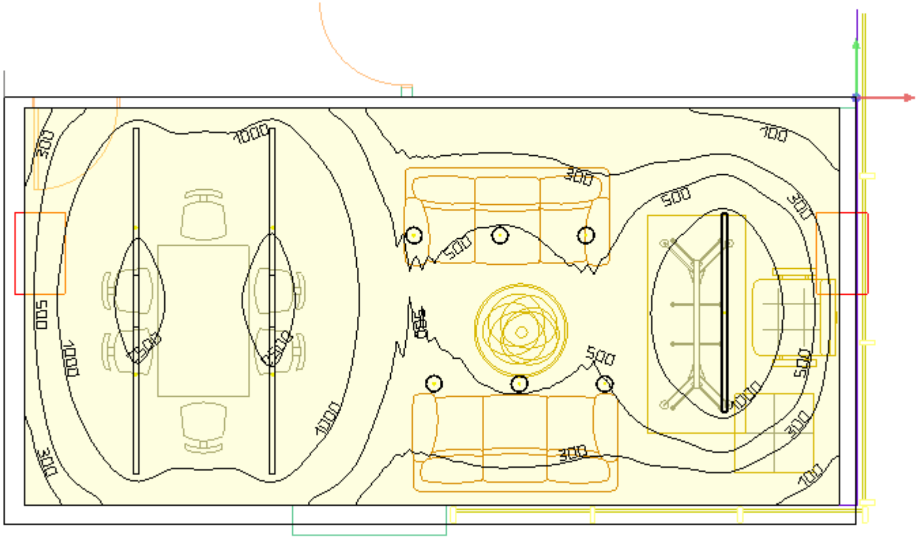


Figure 4. 25:Light scene of lux values for artificial lighting in manager's room with plan of luminaires.

Manufacturer	RZB Rudolf Zimmermann, Bamberg GmbH	P	22.0 W
Article No.	312347.003.1.76	$\Phi_{Luminaire}$	2650 lm
Article name	Less is more 50		
Fitting	1x LED		

Manufacturer	Whitecroft Lighting	P	8.4 W
Article No.	MEDIUM SEMI-SPEC	$P_{Emergency\ lighting}$	8.4 W
Article name	MIRAGE 3 165 ROUND CYLINDER RING	$\Phi_{Luminaire}$	923 lm
Fitting	1x M3MH23K8W1_MA3-CYL	$\Phi_{Emergency\ lighting}$	923 lm
		ELF	100 %

Figure 4. 26:Used type of luminaires in manager's room

Glare check:

Figure 4. 27:Glare results in manager's 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.

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:

Properties	Ē (Target)	E_{min}	E_{max}	g_1	g_2	Index
Workplane (meeting room) Perpendicular illuminance (adaptive) Height: 0.800 m, Wall zone: 0.000 m	502 lx (≥ 500 lx) ✓	234 lx	618 lx	0.47	0.38	WP14

Figure 4. 28:Artificial lighting calculation for employee's office

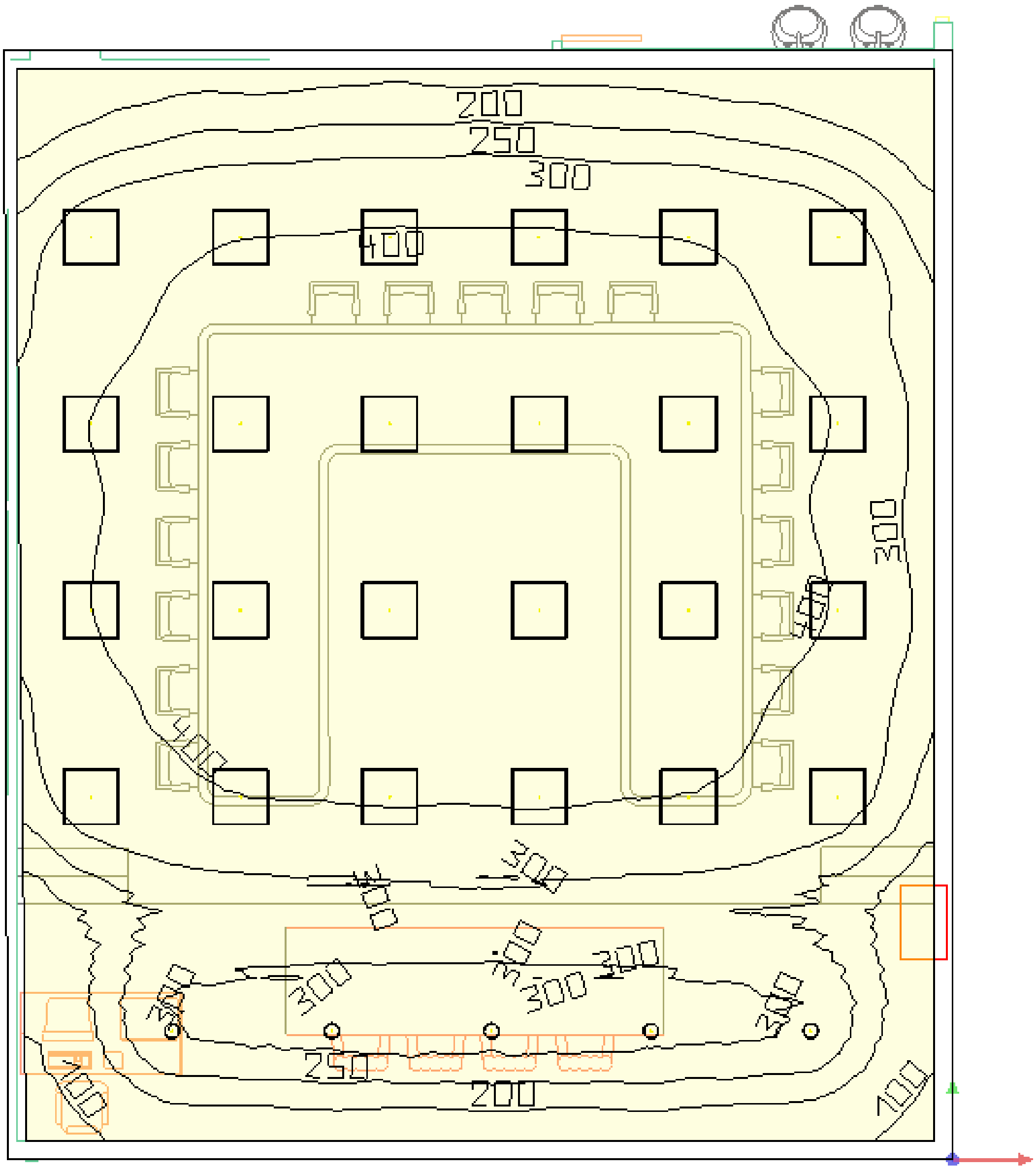
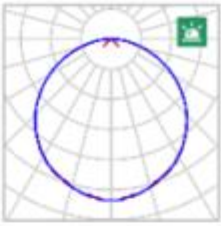


Figure 4. 29:Light scene of lux values for artificial lighting in meeting room with plan of luminaires.

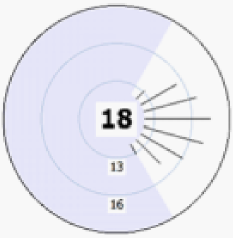


Manufacturer	Performance in Lighting
Article No.	8607891273400
Article name	FLSB 600EL LED OPAL S/A 26W 840 WH-RAL9016
Fitting	1x LED

P	26.0 W
$P_{Emergency\ lighting}$	26.0 W
$\Phi_{Luminaire}$	3065 lm
$\Phi_{Emergency\ lighting}$	3065 lm
ELF	100 %

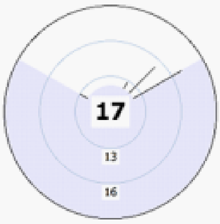
Figure 4. 30:Used type of luminaires in meeting room

Glare check:



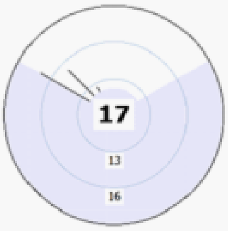
Chair 1 (UGR)

Strongest glare at	360°
max	17.5
Target	≤19.0
Viewing sector	300° - 60°
Step width	15°
Height	0.720 m
Index	CG21



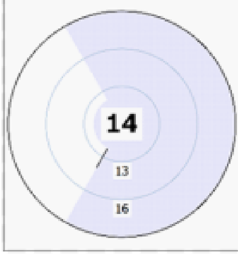
Chair 2 (UGR)

Strongest glare at	30°
max	16.9
Target	≤19.0
Viewing sector	30° - 150°
Step width	15°
Height	0.720 m
Index	CG2



Chair 3 (UGR)

Strongest glare at	150°
max	17.0
Target	≤19.0
Viewing sector	30° - 150°
Step width	15°
Height	0.720 m
Index	CG9



Chair 4 (UGR)

Strongest glare at	240°
max	14.0
Target	≤19.0
Viewing sector	120° - 240°
Step width	120°
Height	0.720 m
Index	CG22

Figure 4. 31:Glare results in meeting room for 1-4 chairs.

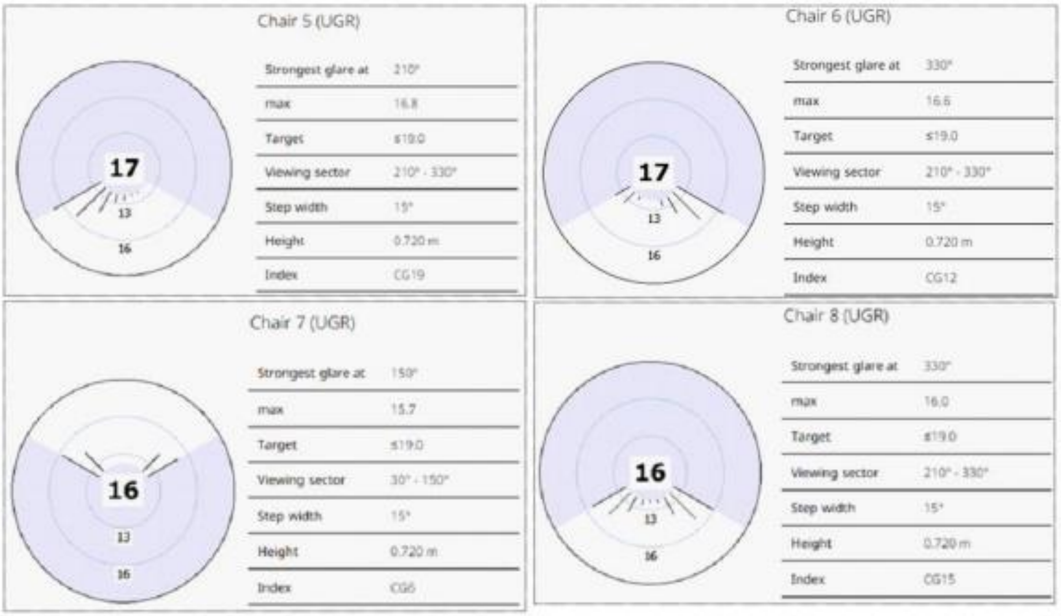


Figure 4. 32:Glare results in meeting room for 5-8 chairs.

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.

3-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. 33:: Corridor from DiaLUX.

Properties	Ē (Target)	E_{min}	E_{max}	g_1	g_2	Index
Workplane (Corridor) Perpendicular illuminance (adaptive) Height: 0.800 m, Wall zone: 0.000 m	105 lx (≥ 100 lx) ✓	15.8 lx	177 lx	0.15	0.089	WP31

Figure 4. 34: Artificial lighting calculation for corridor

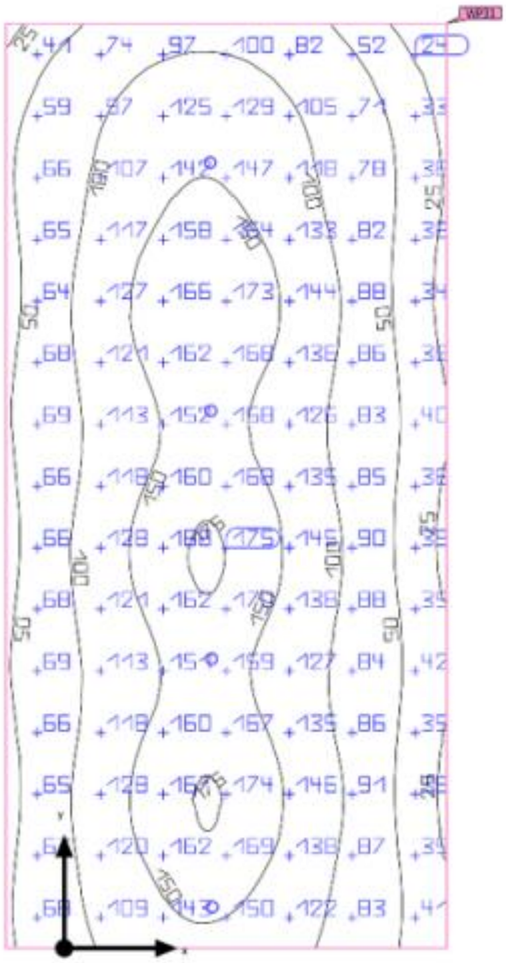


Figure 4. 35Light scene of lux values for artificial lighting in corridor with plan of luminaires

Manufacturer	ING LIGHTING
Article No.	GI0002-007-3
Article name	LED Stop Light
Fitting	1x LED

Figure 4. 36:Used type of luminaires in corridor.

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.

The basement floor:

1-The 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 shows:

Figure 4. 37:Garage from DiaLUX

Properties	Ē (Target)	E_{min}	E_{max}	g_1	g_2	Index
Workplane (Carage) Perpendicular illuminance (adaptive) Height: 0.000 m, Wall zone: 0.000 m	79.6 lx (≥ 75.0 lx) ✓	0.60 lx	164 lx	0.008	0.004	WP36

Figure 4. 38:Artificial lighting calculation for garage.

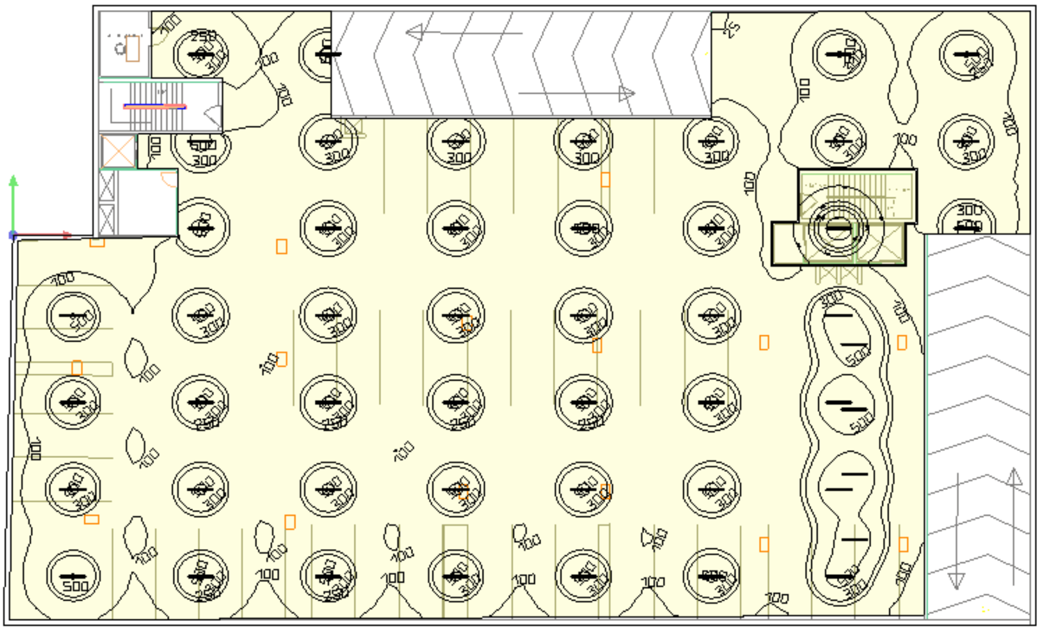
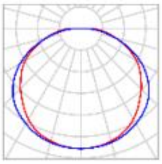


Figure 4. 39:Light scene of lux values for artificial lighting in garage with plan of luminaires.



Manufacturer	BRIGHT SPECIAL LIGHTING S.A.
Article No.	840
Article name	PALIO 1 LED OPAL COVER 1500mm
Fitting	1x PALIO 1L 1500mm 840 OPAL 21W

P	21.0 W
$\Phi_{Luminaire}$	2904 lm

Figure 4. 40:Used type of luminaires in garage

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.

2-Safe room:

The standard lux value in this type of spaces is 200lx with 3000 - 4000 K lighting temperature as the next calculations which is done all by the DiaLUX software shows:

Figure 4. 41:Safe room from DiaLUX

Properties	Ē (Target)	E_{min}	E_{max}	g_1	g_2	Index
Workplane (safe room) Perpendicular illuminance (adaptive) Height: 0.800 m, Wall zone: 0.000 m	223 lx (≥ 200 lx) ✓	0.29 lx	316 lx	0.001	0.001	WP13

Figure 4. 42:: Artificial lighting calculation for safe room.

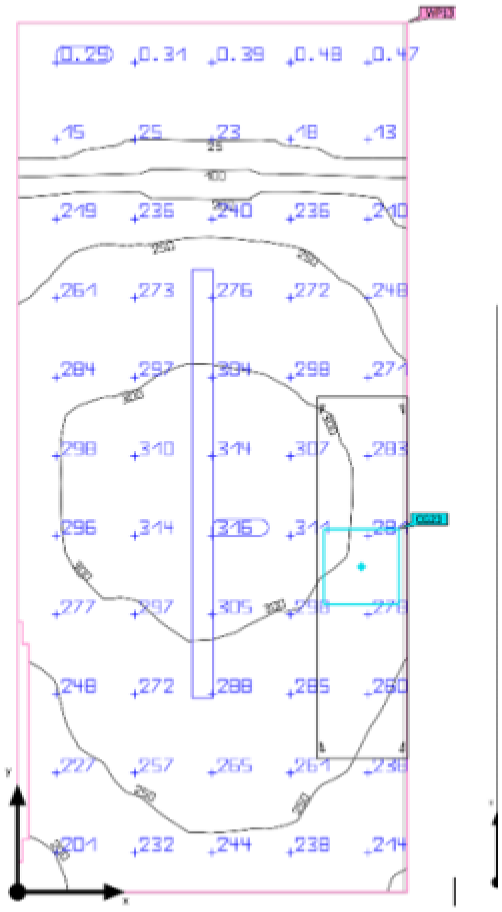
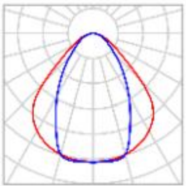


Figure 4. 43:Light scene of lux values for artificial lighting in safe room with plan of luminaires



Manufacturer	eglo		P	16.8 W
Article No.	65616		$\Phi_{Luminaire}$	1770 lm
Article name	Sealza 1			
Fitting	1x LED			

Figure 4. 44:Used type of luminaires in safe 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

4.2 Power:

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.

4.2.2 Power of sockets and lighting:

4.2.2.1 Ground floor:

Lighting

Table 22: lighting G.F

GROUND FLOOR			
Type	NO. OF LIGHT	POWER(W)	NO.*POWER
ES-SYSTEM	19	49	931
LAMP	43	12	516
Theroux lighting	15	23	345
ES-SYSTEM18	5	49	245
TOTAL			1921 W

Demand factor for light = 0.8

Total power for light= power of light * demand factor

Total power for light= (1921)* (0.8) = 1536.8W

Sockets:

Number of sockets = 37.

Demand factor for socket = 0.8.

Power socket = 35 *250*0.8 = 7000 W + 4000 W special power = 11000 W

Total power = power light + power socket = 1536.8 + 11000 = 12536.8 W

Power factor = 0.9 for residential

. I rated = 125368 / (230* 0.9) = 60 A

I c.b > 1.25 * 60 A

I c.b > 75 A … So I c.b = 3*100 A

Cable = 5*25 mm^2

4.2.2.2 First floor:

Lighting:

Table 23: LIGHTING F1

FIRST FLOOR			
Type	NO. OF LIGHT	POWER(W)	NO.*POWER
ES-SYSTEM	17	49	833
LAMP	18	12	216
lighting	70	23	1610
TOTAL			1547 W

Demand factor for light = 0.8

Total power for light= power of light * demand factor

Total power for light= (1547)* (0.8) = 1237.6 W

Sockets:

Number of sockets = 41

Demand factor for socket = 0.8

Power socket = 39 *250*0.8 = 7800 W + 4000 W (SP) = 11800

Total power = power light + power socket = 1237.6 + 11800 = 13037.6 W

Power factor = 0.9 for residential

I rated = 13037.6 / (230* 0.9) = 63 A

I c.b > 1.25 * 63 A

I c.b > 76 A

So I c.b = 3*100 A

Cable = 5*25 mm^2

4.2.2.3 Second floor:

Lighting:

Table 24: Lighting F2

SECOND FLOOR			
Type	NO. OF LIGHT	POWER(W)	NO.*POWER
ES-SYSTEM	12	49	588
LAMP	9	12	108
Theroux lighting	100	23	2300
TOTAL			1354 W

Demand factor for light = 0.8

Total power for light= power of light * demand factor

Total power for light= (1354)* (0.8) = 1083.2 W

Sockets:

Number of sockets = 41

Demand factor for socket = 0.8

Power socket = 39*250*0.8 = 7800 W + 4000 W =11800 W

Total power = power light + power socket = 1083.2 + 11800 = 12883.2 W

Power factor = 0.9 for residential

I rated = 12883.2 / (230* 0.9) = 62 A

I c.b > 1.25 * 62 A

I c.b > 77 A

So I c.b = 3*100 A

Cable = 5*25 mm^2

4.2.2.4 Third floor:

Lighting

Table 25: lighting F3

THIRD FLOOR			
Type	NO. OF LIGHT	POWER(W)	NO.*POWER
ES-SYSTEM	9	49	441
LAMP	9	12	108
Theroux lighting	40	23	920
TOTAL			1264 W

Demand factor for light = 0.8

Total power for light= power of light * demand factor

Total power for light= (1264)* (0.8) = 1011.2 W

Sockets:

Number of sockets = 51

Demand factor for socket = 0.8

Power socket = 46*250*0.8 = 9200 W + 8000 W = 17200 W.

Total power = power light + power socket = 1011.2 + 17200 = 18211.2 W

Power factor = 0.9 for residential

I rated = 18211.2 / (230* 0.9) = 79 A

I c.b > 1.25 * 79 A

I c.b > 98 A

So I c.b = 3*100 A

Cable = 5*25 mm^2

4.2.2.5 Fourth floor:

Lighting:

Table 26: lighting F4

FOURTH FLOOR			
Type	NO. OF LIGHT	POWER(W)	NO.*POWER
ES-SYSTEM	2	49	438
LAMP	28	12	108
Theroux lighting	100	23	437
TOTAL			987 W

Demand factor for light = 0.8

Total power for light= power of light * demand factor

Total power for light= (987)* (0.8) = 789.6 W

Sockets:

Number of sockets = 30

Demand factor for socket = 0.8

Power socket = 17*250*0.8 = 3400 W + 6000 W = 9400 W

Total power = power light + power socket = 789.6 + 9400 = 10189.6 W

Power factor = 0.9 for residential

I rated = 10189.6 / (230* 0.9) = 49 A

I c.b > 1.25 * 49 A

I c.b > 49 A

So I c.b = 3*63 A

Cable = 5*25 mm^2

4.2.2.6 Basement 1:

Lighting:

Table 27: lighting B1

B1 FLOOR			
Type	NO. OF LIGHT	POWER(W)	NO.*POWER
ES-SYSTEM	42	49	2058
TOTAL			2058 W

Demand factor for light = 0.8

Total power for light= power of light * demand factor

Total power for light= (2058)* (0.8) = 1646.4 W

Sockets:

Number of sockets = 3

Demand factor for socket = 0.8

Power socket = 2*250*0.8 = 400 W+ 2000W =2400 W

Total power = power light + power socket = 1646.4 + 2400 = 4046 W

Power factor = 0.9 for residential

I rated = 4046 / (230* 0.9) = 20 A

I c.b > 1.25 * 20 A

I c.b > 25 A

So I c.b = 3*50 A

Cable = 5*16 mm^2

4.2.2.7 Basement 2:

Lighting:

Table 28: lighting b2

B2 FLOOR			
Type	NO. OF LIGHT	POWER(W)	NO.*POWER
ES-SYSTEM	42	49	2058
TOTAL			2058 W

Demand factor for light = 0.8

Total power for light= power of light * demand factor

Total power for light= (2058)* (0.8) = 1646.4 W

Sockets:

Number of sockets = 3

Demand factor for socket = 0.8

Power socket = 2*250*0.8 = 400 W+ 2000W =2400 W

Total power = power light + power socket = 1646.4 + 2400 = 4046 W

Power factor = 0.9 for residential

I rated = 4046 / (230* 0.9) = 20 A

I c.b > 1.25 * 20 A

I c.b > 25 A

So I c.b = 3*50 A

Cable = 5*16 mm^2

4.2.2.8 Basement 3:

Lighting:

Table 29: lighting b3

B3 FLOOR			
Type	NO. OF LIGHT	POWER(W)	NO.*POWER
ES-SYSTEM	9	49	461
TOTAL			461 W

Demand factor for light = 0.8

Total power for light= power of light * demand factor

Total power for light= (461)* (0.8) = 368.8 W

Sockets:

Number of sockets = 10

Demand factor for socket = 0.8

Power socket = 9*250*0.8 = 1800 W+ 2000W =3800 W

Total power = power light + power socket = 368.8 + 3800 = 4168.8 W

Power factor = 0.9 for residential

I rated = 4168.8 / (230* 0.9) = 20 A

I c.b > 1.25 * 20 A

I c.b > 25 A

So I c.b = 3*50 A

Cable = 5*16 mm^2

This figure show the sockets at ground floor:

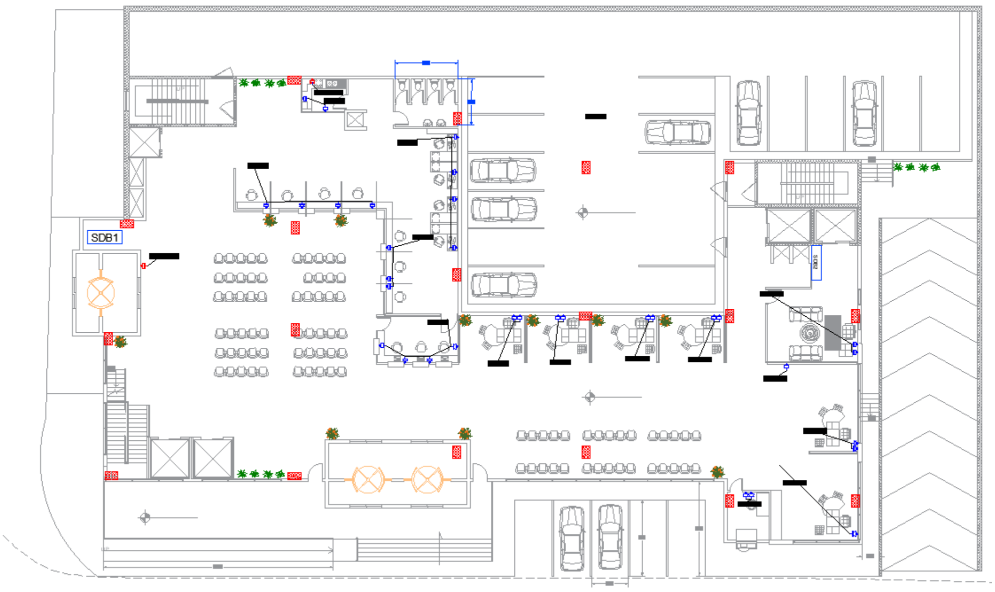


Figure 4. 45:sockets at ground floor

This figure show the lighting at ground floor:

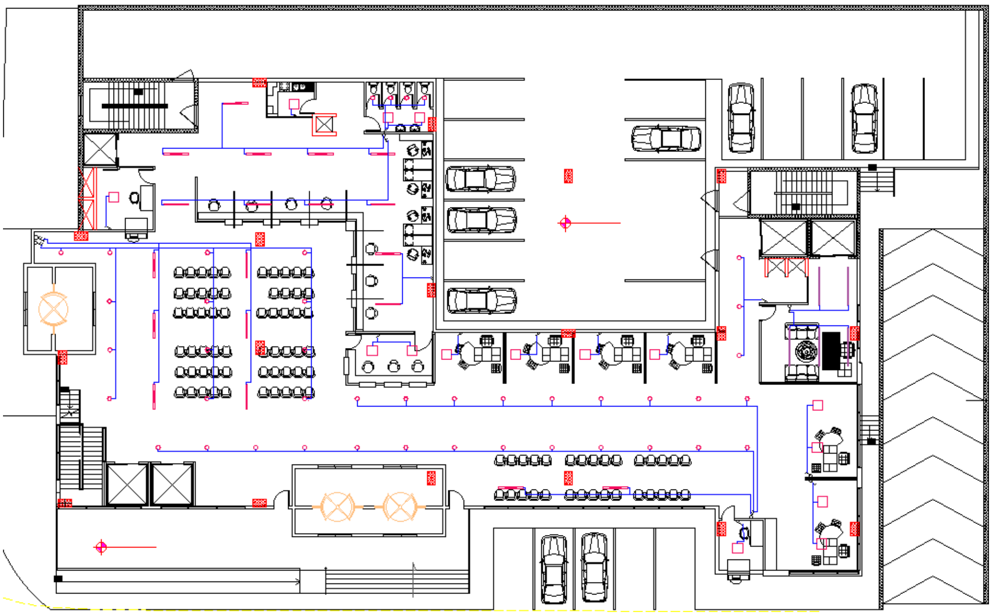


Figure 4. 46:the lighting at ground floor

This figure show the distribution board in ground floor:

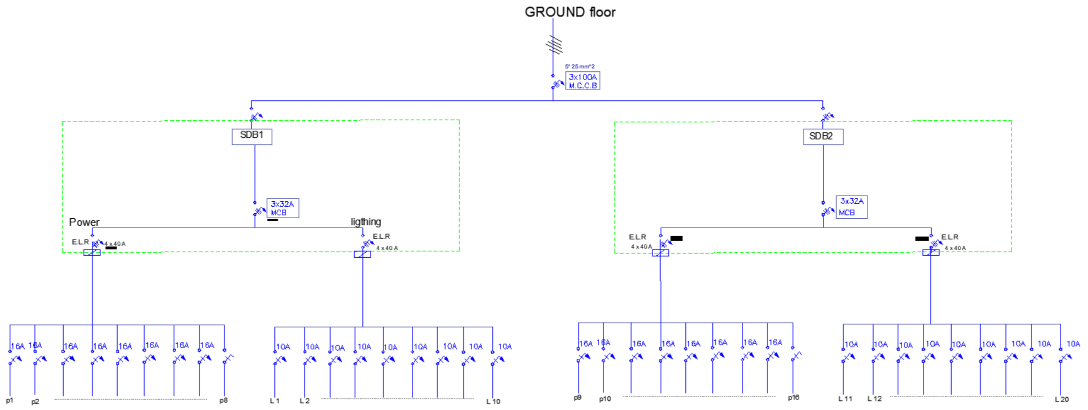


Figure 4. 47:the distribution board in ground floor

4.2.2.9 Main distribution board (MDB):

Total power = total power GF+ total power F1 + total power F3+ total power F4+ total B1+Total power B2 + total power B3 = 79119.2 W +140000 W (chiller) + 22500 = 241619.2.

I rated = 241619.2/ (3^0.5 *400* 0.9) = 387.5 A

I c.b > 1.25 * 387.5 A

I c.b > 485 A

So I c.b = 3*600A

Cable = 5*240mm^2

4.2.2.10 Chiller:

140 kW

Now we will calculate the power of chiller:

I rated =140000/ (3^0.5 *400 *0.85) =237.74 A

I c.b > 1.25 *237.74 A

I c.b > 297.2 A

Then I cb = 300A

Cable = 5*150 mm^2

4.2.2.11 Elevator:

22500W

Now we will calculate the power of Elevator:

I rated = 22500/ (3^0.5 *400 *0.9) =36 A

I c.b > 1.25 *36 A

I c.b > 45 A

Then I cb = 63 A

Cable = 5*25 mm^2

I =115 A FOR **GENERATOR.**

115*400V= 46000 KVA   * 0.8 = 36800 KW

4.2.2.12 GENERATOR:

LIGTHING GENERATOR:

Now we will calculate the power of GENERATOR:

I rated = 9320/ (3^0.5 *400 *0.9) = 15 A

I c.b > 1.25 *15 A

I c.b > 19 A

Then I cb = 25 A

Cable = 5*10 mm^2

POWER GENERATOR:

69800 W /2 = 35000 W

I rated = 35000*0.7/ (3^0.5 *400 *0.9) = 39 A

I c.b > 1.25 *39 A

I c.b > 49 A

Then I cb = 63 A

Cable = 5*25 mm^2

The figure below shows the main distribution board:

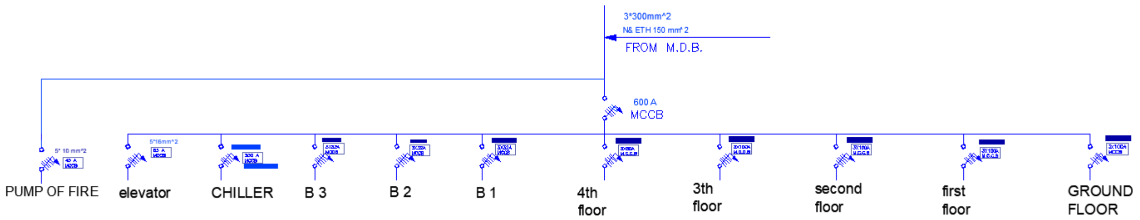


Figure 4. 48:the main distribution board:

4.3 Mechanical Design:

4.3.1 Water supply system:

Designing the building's water installations and calculating the amount of water needed for use 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

Figure 4. 49:Guide for water supply (Grondzik, Kwok, Stein, & Reynolds, 2010, P.872)

In an office building, 50 liters per one person is needed for water supply in a day. The largest number of users of the building per day is about 250 users, the total daily water needed is 12500 liters/day, which equal 12.5 m3 /day.

4.3.1.1 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]

Figure 4. 50:: Domestic hot water consumption (Grondzik, Kwok, Stein,& Reynolds, 2010, P.943).

In a building, 3.8 liters per person is needed for water supply in a day. The largest number of users of the building per day is about 210 users, the total daily water needed is 800 liters/day, which equal 0.8 m3 /day.

But it is an office building there is no need for hot water in the offices or in the kitchen, instead we will use an Atmor in the kitchens, W,C, and in the security room.

4.3.1.2 Diameter calculation:

Water pressure:

In this building, roof tanks will be used, the water pressure will be 0.433h, where h is the distance between the lavatory and the middle of the tank.

Table 30: WATER PRESSURE

Floor	0	1	2	3	4
Pressure (psi)	**31.62**	**25.55**	**20.45**	**15.3**	**10.2**

Water supply fixture units:

TABLE 21.15 Water Supply Fixture Units (WSFU)

			Load Values in WSFU		
Fixture	**Occupancy**	**Type of Supply Control**	**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

Figure 4. 51:Water Supply Fixture Units (Grondzik, Kwok, Stein, & Reynolds, 2010, P.991).

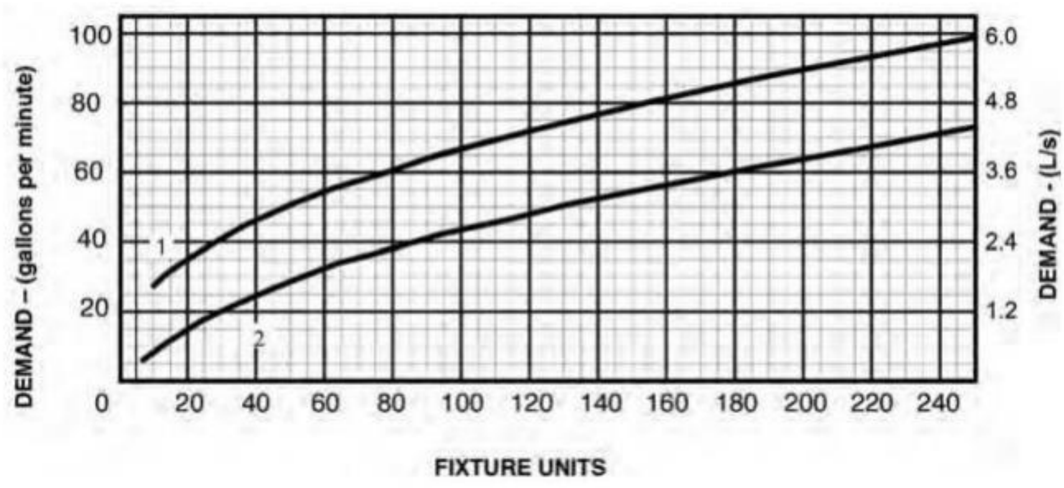
By using upper figure, calculate total FU for each floor.

Table 31:Fixture unit for zone

Floor	WSFU's	Total WSFU'S
1st/2nd/3rd	5*W.C'S*5	55
	9 LAVATORY* 2	
	3 KITVHEN SINK*4	
GF/4th	4W.C'S*5	32
	2LAVATORY* 2	
	2KITCHEN SINK*4	

Water flow rates:

Table 32 Water flow rate (Grondzik, & Kwok, 2015, P.919)



From upper figure, determined water flow rate for vertical, horizontal & branches for each floor.

Table 33:Water flow rate for zone

Pipe	FU	water flow
GF/4th		
Vertical	213	70
Horizontal	32	20
Branch	5	5
Pipe	FU	water flow
1st/2nd/3rd		
Vertical	213	70
Horizontal	39	23
Branch	5	5

Determined diameter pipe & pressure drop

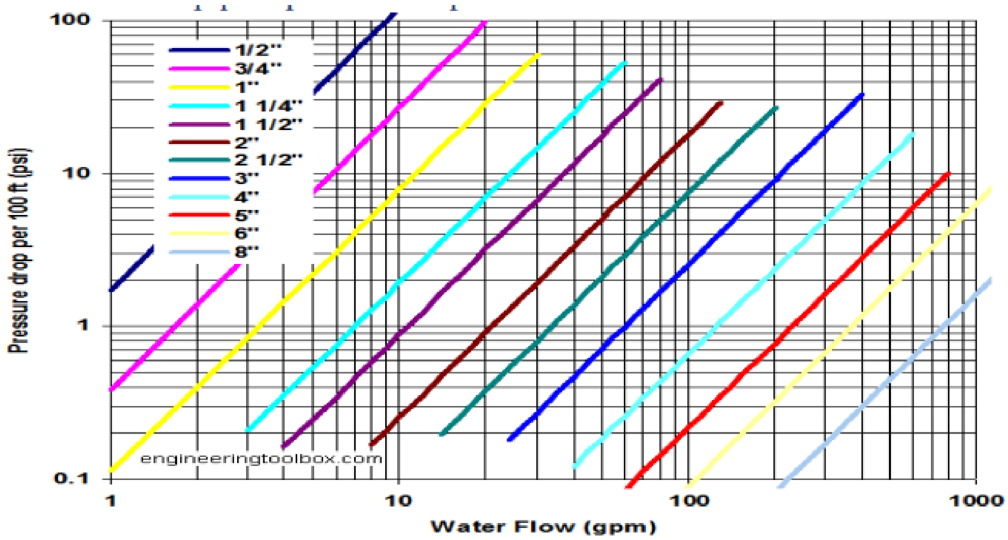


Figure 4. 52:Diameter & pressure drop per 100 ft(psi) for steel pipe

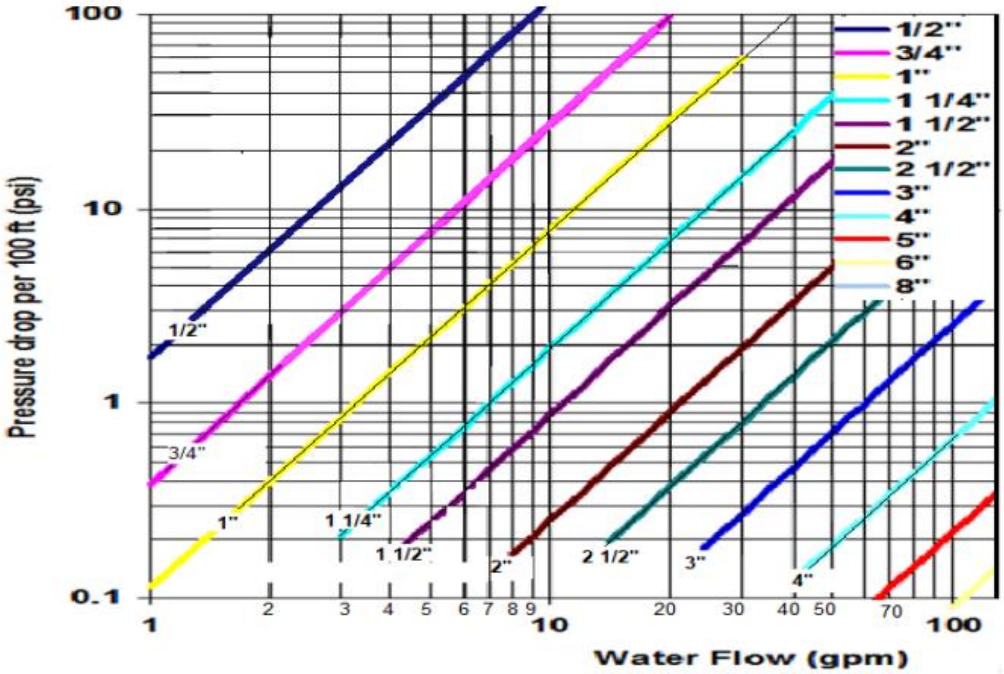


Figure 4. 53:Diameter & pressure drop per 100 ft(psi) for plastic pipe

Friction Pressure Loss in Water Meters

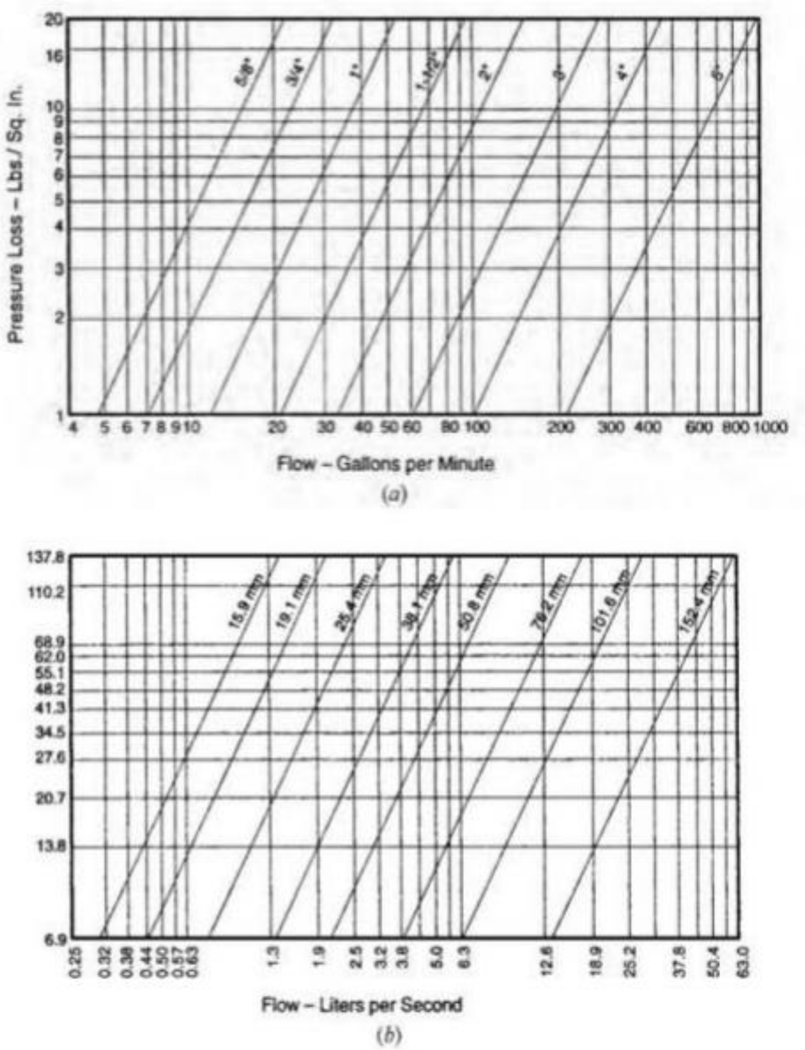


Fig. 21.63 Pressure losses in disk-type water meters. (a) I-P units. (b) SI units. (Reprinted by permission from the 1997 Uniform

From upper figure, determined possible diameter for vertical, meter, horizontal & branches.

Table 34:: Equivalent length for zone Pipe Material A.L

Pipe	Material	A.L (ft)	E.L (ft)
Vertical	Steel	75.7874	113.6811
Horizontal	PVC	8.2	9.84
Branch	PVC	17	20.4

Water flow rate (vertical) = 70 gpm

Table 35:: possible diameter for vertical pipe with pressure losses for zone A

inch	5"	4"	3"	2 1/2"	2"
Loss/100'	0.12	0.35	1.3	3.8	9
Loss /113.68	0.13642	0.3979	1.48	4.32	10.2

Meter Diameter	3"	2"	1 1/2"
Pressure Loss psi	**1.3**	**4.2**	**12**

Water flow rate for GF+4th (horizontal)=20 gpm

Table 36:: possible diameter for horizontal pipe (GF+4thF) with pressure losses for zone A

Horizontal	20	GF	4th
inch	2 1/2"	2"	1 1/2"
Loss/100'	0.4	0.9	3
Loss /9.84	0.03936	0.0886	0.3

Water flow rate for floor FF+THF+5thF (horizontal)=23 gpm

Table 37:possible diameter for horizontal pipe (1st / 2nd / 3rd) with pressure losses for zone

Horizontal	23	1st	2nd	3rd
inch	2 1/2"	2"	1 1/2"	1.25
Loss/100'	0.42	1	3.5	8
Loss /9.84	0.04	0.1	0.34	0.79

Water flow rate (branch)=5 gpm

Table 38:possible diameter for branch pipe with pressure losses for zone A

inch	1 1/2"	1 1/4"	1"	3/4"
Loss/100'	0.09	0.2	7	2.5
Loss /20.4	0.01836	0.0408	1.43	0.51

Selected pipes:

Table 39:selected diameter for pipes (GF&4th) with pressure losses for zone A

Selected GF SF 4

Line	Vertical	Meter	Horizontal	Branch	Total losses
diameter	4"	3"	2 1/2"	1 1/2"	
Press. Loss	0.4	1.3	0.039	0.018	1.757

Table 40: selected diameter for pipes (1st / 2nd / 3rd) with pressure losses for zone

Selected 1 st 2 nd 3rd

Line	Vertical	Meter	Horizontal	Branch	Total losses
diameter	4"	3"	2 1/2"	1 1/2"	
Press. Loss	0.4	1.3	0.04	0.018	1.758

For Ground floor, available pressure is 31.62 psi

The critical pressure is 12 psi

The maximum allowable loss=31.62-12=19.62 psi

The total loss in GF is 0.4+1.3+0.039+0.018=1.75 < max loss so it's ok

19.62-1.75 = 17.87 psi

But we need a limiter 17 psi

For First floor, available pressure is 25.55psi

The critical pressure is 12 psi

The maximum allowable loss = 25.55-12=13.55psi

The total loss in FF is 0.4+1.3+0.04+0.018=1.758

For second floor, available pressure is 20.45psi

The critical pressure is 12 psi The maximum allowable loss=20.45-12=8.45psi

The total loss in SF is 1.75<max loss so it's ok

8.45-1.75=6.7 psi

But we need a limiter 6 psi For third floor, available pressure is 15.3psi

The critical pressure is 12 psi

The maximum allowable loss=15.3-12=3.3psi

The total loss in TH.F is 1.75

3.3+1.75=1.55 psi

No need limiter For fourth floor, available pressure is 10.2 psi

The critical pressure is 12 psi

The maximum allowable loss=10.2-12=-1.8psi

The total loss in Fourth F is 1.75>max loss so isn't ok

4.3.2 Drainage system design:

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

Figure 4. 54:Drainage fixture units (Grondzik & Kwok, 2015, P.945).

From above figure, shown the total drainage fixture unit in a building

Table 41:drainage fixture unit in a building

Floor	WSFU's	Total WSFU'S
1st/2nd/3rd	5*W.C'S* 4	35
	9 LAVATORY* 1	
	3 KITVHEN SINK* 2	
GF/4th	4W.C'S*4	22
	2LAVATORY* 1	
	2KITCHEN SINK*2	
		171

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. 55:Horizontal 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. 56:Building 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. 57:Size and Developed Length of Stack Vents and Vent Stacks (Grondzik & Kwok, 2015, P.947)

Table 42:Diameter & slope for type of fixture

Type of fixture	Diameter (inch)	Slope %
Vent	4	0
Sewer	2	1
Drainage	4	1
Between manhole	6	1

4.3.3 HVAC system design:

4.3.3.1 Introduction:

The heating, ventilation and air conditioning system is one of the necessary and important systems in any project, through which thermal comfort is achieved, by using means of cooling or heating and controlling the temperature of the medium to reach the level of comfort for people inside the building, and obtain fresh air, which helps in improving productivity.

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

1- Inside design temperature = 23˚C in summer and 22˚C in winter.
2- Relative humidity between (30-60) percent.

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

1- Total design heating load = 102.340 KW.
2- Total design cooling load= 164.67 KW.

4.3.3.2 Value of heating and cooling from Design Builder for all spaces:

Table 43:heating and cooling from Design Builder for all spaces

Design Cooling Load Per Floor Area(W/m2)	Total Cooling Load (kW)	Design Flow Rate (m3/s)	Design Capacity (kW)	Zone	Block	Building
26.6	4.06	0.3222	4.66	Basement3:Archieve2	basement 3	Building 1
25.7	3.73	0.291	4.29	Basement3:Archieve3	basement 3	Building 1
26.4	3.64	0.2833	4.19	Basement3:Meeting	basement 3	Building 1
13.2	0.44	0.03	0.51	Basement3:Lobby2	basement 3	Building 1
39	0.52	0.0391	0.6	Basement3:Office7	basement 3	Building 1
27.1	0.84	0.0693	0.97	Basement3:Archieve1	basement 3	Building 1
26	0.65	0.0487	0.75	Basement3:Office4	basement 3	Building 1
28	0.65	0.0521	0.75	Basement3:Office3	basement 3	Building 1
37.8	0.56	0.0431	0.64	Basement3:Lobby1	basement 3	Building 1
63.9	0.35	0.0253	0.41	Basement3:Kitchen1	basement 3	Building 1
19.7	1.2	0.1001	1.38	Basement3:Office1	basement 3	Building 1
31.8	0.72	0.0585	0.82	Basement3:Office2	basement 3	Building 1
30.2	0.76	0.0595	0.88	Basement3:Office6	basement 3	Building 1
33.1	0.88	0.0706	1.01	Basement3:Office5	basement 3	Building 1
28.9	0.8	0.0624	0.92	Basement3:Office8	basement 3	Building 1
34.7	0.47	0.0395	0.54	Basement2:Office1	basement 2	Building 1
61.3	0.31	0.0242	0.36	Basement2:Office2	basement 2	Building 1
35.4	0.48	0.0404	0.55	Basement1:Office1	basement 1	Building 1
64.8	0.3	0.0232	0.34	Basement1:Office2	basement 1	Building 1
17	2.01	0.1604	2.31	GroundFloor:WorkingArea	ground floor	Building 1
71.7	0.46	0.0366	0.52	GroundFloor:Kitchen1	ground floor	Building 1
122.8	0.96	0.0972	1.11	GroundFloor:Lobby2	ground floor	Building 1
151	0.93	0.0961	1.07	GroundFloor:Office2	ground floor	Building 1
46.8	0.3	0.023	0.35	GroundFloor:Office1	ground floor	Building 1
26.1	11.55	1.0377	13.29	GroundFloor:WaitingArea	ground floor	Building 1
27.7	0.57	0.0435	0.65	GroundFloor:Lobby1	ground floor	Building 1
32.6	0.4	0.0317	0.46	GroundFloor:Office3	ground floor	Building 1
65.4	2.23	0.227	2.56	GroundFloor:Office5	ground floor	Building 1
55.1	0.42	0.0345	0.48	GroundFloor:Office4	ground floor	Building 1
27	6.73	0.57	7.74	FirstFloor:Lobby1	first floor	Building 1
26.6	1.96	0.163	2.25	FirstFloor:Lobby2	first floor	Building 1
94.3	1.24	0.1263	1.42	FirstFloor:Office10	first floor	Building 1
47	0.95	0.0825	1.09	FirstFloor:Office8	first floor	Building 1
92	1.22	0.124	1.41	FirstFloor:Office11	first floor	Building 1
110.7	1.44	0.147	1.66	FirstFloor:Office9	first floor	Building 1
92.5	1.22	0.1236	1.4	FirstFloor:Office12	first floor	Building 1
70.5	0.35	0.0246	0.4	FirstFloor:Kitchen2	first floor	Building 1
33.9	0.76	0.0596	0.87	FirstFloor:Office4	first floor	Building 1
38.3	0.84	0.068	0.97	FirstFloor:Office5	first floor	Building 1
49.8	1.14	0.1026	1.31	FirstFloor:Office6	first floor	Building 1
50.4	1.15	0.1036	1.32	FirstFloor:Office7	first floor	Building 1
29.9	1.02	0.0823	1.17	FirstFloor:Office3	first floor	Building 1
31.3	1	0.0846	1.15	FirstFloor:Office2	first floor	Building 1
93.3	0.6	0.0442	0.69	FirstFloor:Kitchen1	first floor	Building 1
94.7	1.25	0.118	1.44	FirstFloor:Archevie1	first floor	Building 1
33.5	0.75	0.0592	0.87	FirstFloor:Office1	first floor	Building 1
26.9	7.52	0.6096	8.65	SecondFloor:Lobby2	second floor	Building 1
74.1	0.46	0.0366	0.52	SecondFloor:Kitchen1	second floor	Building 1

Design Cooling Load Per Floor Area(W/m2)	Total Cooling Load (kW)	Design Flow Rate (m3/s)	Design Capacity (kW)	Zone	Block	Building
74.1	0.46	0.0366	0.52	SecondFloor:Kitchen1	second floor	Building 1
40.9	0.72	0.0572	0.83	SecondFloor:Office10	second floor	Building 1
40.7	0.72	0.057	0.83	SecondFloor:Office11	second floor	Building 1
39.3	0.69	0.0538	0.79	SecondFloor:Office12	second floor	Building 1
90.4	1.21	0.1218	1.39	SecondFloor:Office20	second floor	Building 1
32.6	0.8	0.0632	0.92	SecondFloor:Office13	second floor	Building 1
43.3	1.43	0.1305	1.65	SecondFloor:Office14	second floor	Building 1
53.3	1.19	0.1081	1.37	SecondFloor:Office15	second floor	Building 1
53.8	0.93	0.0817	1.07	SecondFloor:Office16	second floor	Building 1
92	1.23	0.1251	1.42	SecondFloor:Office19	second floor	Building 1
44.3	0.56	0.0422	0.64	SecondFloor:Office4	second floor	Building 1
45.1	0.54	0.041	0.63	SecondFloor:Office3	second floor	Building 1
45.4	0.55	0.0413	0.63	SecondFloor:Office2	second floor	Building 1
42.5	1.54	0.1349	1.78	SecondFloor:Office1	second floor	Building 1
55.3	1.61	0.1491	1.85	SecondFloor:Office8	second floor	Building 1
90.9	1.21	0.122	1.39	SecondFloor:Office18	second floor	Building 1
23.9	0.5	0.0351	0.57	SecondFloor:Lobby1	second floor	Building 1
107	1.18	0.112	1.36	SecondFloor:Office5	second floor	Building 1
40.3	0.8	0.0672	0.92	SecondFloor:Office6	second floor	Building 1
38.3	0.85	0.0687	0.98	SecondFloor:Office7	second floor	Building 1
89.1	2.5	0.2643	2.87	SecondFloor:Office9	second floor	Building 1
77.2	0.4	0.0292	0.46	SecondFloor:Kitchen2	second floor	Building 1
110.7	1.46	0.1488	1.68	SecondFloor:Office17	second floor	Building 1
20.9	1.41	0.111	1.62	ThirdFloor:LOBBY2	third floor	Building 1
74.1	0.46	0.0366	0.52	ThirdFloor:KITCHEN3	third floor	Building 1
27.7	1.67	0.1419	1.92	ThirdFloor:LOBBY1	third floor	Building
42.4	0.75	0.0594	0.86	ThirdFloor:OFFICE7	third floor	Building
25	0.51	0.0356	0.58	ThirdFloor:LOBBY3	third floor	Building
45.5	0.54	0.0409	0.62	ThirdFloor:OFFICE11	third floor	Building
105.9	1.2	0.1136	1.38	ThirdFloor:OFFICE8	third floor	Building
40.5	0.82	0.0688	0.94	ThirdFloor:OFFICE9	third floor	Building
46	0.54	0.0407	0.62	ThirdFloor:OFFICE13	third floor	Building
42.4	0.75	0.0593	0.86	ThirdFloor:OFFICE6	third floor	Building
38.2	0.88	0.0716	1.01	ThirdFloor:OFFICE10	third floor	Building
46.6	0.55	0.0414	0.63	ThirdFloor:OFFICE12	third floor	Building
41.3	0.73	0.0601	0.83	ThirdFloor:OFFICE5	third floor	Building
92.7	1.23	0.1245	1.41	ThirdFloor:OFFICE4	third floor	Building
26.9	6.66	0.5976	7.66	ThirdFloor:Lobby4	third floor	Building
43.6	1.54	0.1345	1.77	ThirdFloor:OFFICE14	third floor	Building
92.5	1.23	0.1248	1.41	ThirdFloor:OFFICE3	third floor	Building
56.8	1.63	0.1523	1.88	ThirdFloor:OFFICE16	third floor	Building
92.1	1.21	0.1231	1.4	ThirdFloor:OFFICE1	third floor	Building
90.5	2.53	0.2698	2.91	ThirdFloor:OFFICE15	third floor	Building
77.2	0.4	0.0293	0.46	ThirdFloor:KITCHEN2	third floor	Building
72.7	1.89	0.1873	2.17	ThirdFloor:OFFICE2	third floor	Building
46	5.5	0.5059	6.33	FourthFloor:MEETING	fourth floor	Building
93.6	0.57	0.0485	0.66	FourthFloor:KITCHEN	fourth floor	Building
109.6	1.1	0.1114	1.27	FourthFloor:OFFICE6	fourth floor	Building
52.5	0.55	0.041	0.64	FourthFloor:CIRCULATION	fourth floor	Building

4.3.3.3 HVAC design system:

VRF system:

VRF system consists of an outdoor unit that supplies, the fan coils with air that is connected to diffusers supplying the diffusers in each space. The number of diffusers is determined based on the airflow.

Diffuser from catalogue:

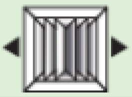
DF / DE Supply		Core 21 						
Total pressure drop (Pa)		150 x 150	225 x 225	300 x 300	375 x 375	450 x 450	525 x 525	600 x 600
9	l/s	34	76	135	211	304	413	540
	Min Max (m)	1.0-2.0	1.5-2.5	2.0-3.5	2.5-4.5	2.5-6.0	3.0-6.5	3.5-7.0
	L_w	-	-	-	23	24	26	28
15	l/s	45	101	180	282	405	551	720
	Min Max (m)	1.0-2.5	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

Figure 4. 58: Diffuser from catalogue

The first diffuser with handles 34 L/S airflow, and the dimension of the diffuser is

(150x150) mm.

The second chosen diffuser with, handle 68 L/S airflow, and the dimension of the diffuser is

(150x150) mm.

The third chosen diffuser with, handle 127 L/S airflow, and the dimension of the diffuser is

(225x225) mm .

Fan coil:

We choose some kind of fan coil from catalogue that is:

1. Fan coil 2 pipe with capacity 8.02 KW, and Dim (564 x1404 x226).

2. Fan coil 2 pipe with capacity 1.54 KW, Dim (564 x774 x226).2

3. Fan coil 2 pipe with capacity 2.93 KW, Dim (564 x984 x226).

FWV01-10C*				2-pipe (*=TN or TV)							4-pipe (*=FN or FV)						
				01	02	03	04	06	08	10	01	02	03	04	06	08	10
Power input			W	37	53	56	98		182	244	37	53	56	98		182	244
Capacity	Cooling capacity	Total capacity	kW	1.54	2.09	2.93	4.33	4.77	6.71	8.02	1.46	1.90	2.87	4.33	4.67	6.64	7.88
		Sensible capacity	kW	1.20	1.51	2.11	3.15	3.65	4.91	5.96	1.14	1.51	2.07	3.15	3.57	4.85	5.85
	Heating capacity (2-pipe)		kW	2.14	2.57	3.81	5.63	6.36	7.83	10.03	-						
	Heating capacity (4-pipe)		kW	-							1.90	2.10	3.08	5.05	5.30	7.91	9.30
Dimensions	H x W x D		mm	564x774x226		564 x984x226	564x1194x226		564x1404x251		564x774x226		564x984 x226	564x1194x226		564x1404x251	
Machine weight			kg	19	20	25	30	31	41		20	21	26	32	33	44	
Sound level	Sound power		dBA	45	50	47	52	56	61	66	45	50	47	52	56	61	66
Water pressure drop	Cooling		kPa	13		11	12	14	12	19	13		11	12	14	12	19
	Heating		kPa	9	11	9		10	9	16	7	8	5	10		8	9
Fan	Air flow rate		m³/h	319	344	442	706	785	1011	1393	307	327	431	690	763	998	1362
Water connections	Std. heat exchanger		inch	1/2					3/4		1/2					3/4	
Required power supply			V/f/Hz	230/1/50													
Water flow	Cooling		l/h	265	359	504	745	820	1,154	1,343	251	327	494	745	803	1,142	1,355
	Heating		l/h	265	359	504	745	820	1,154	1,343	196	182	286	396	465	694	816
Coil	Water volume	heating	l	-							0.5	0.7	1	1.4		2.1	
Maximum absorbed current			W	0.17	0.24	0.25	0.44	0.43	0.80	1.12	0.17	0.24	0.25	0.44	0.43	0.80	1.12

Figure 4. 59:fan coil from catalogue

Basement 3				cooling load (w)	fan coil (KW)
space	Air flow L/S	Diffuser	number		
office 1	100	68	2	1200	**(2930) n=1**
office 2	58	68	1	720	
office 3	52	68	1	650	
office 4	49	68	1	650	
office 5	70.6	68	2	880	
office 6	60	68	1	760	
office 7	39	34	1	520	
office 8	62	68	1	800	**(8020) n=1**
meeting .Room	283	127	2	3640	
lobby 1	30	34	1	560	
kitchen 1	25.3	34	1	350	
lobby 2	30	34	1	440	

Figure 4. 60:b3 fan coil

Basement 2				cooling load (w)	fan coil (KW)
space	Air flow L/S	Diffuser	number		
office 1	40	68	2	470	**n=1 (1540)**
office 2	24	68	1	310	

Figure 4. 61: b2 fan coil

Basement 1				cooling load (w)	fan coil (KW)
space	Air flow L/S	Diffuser	number		
office 1	40	68	2	480	**n=1 (1540)(KW)**
office 2	23	68	1	300	

Figure 4. 62: fan coil b1

ground floor				cooling load (w)	fan coil (KW)
space	Air flow L/S	Diffuser	number		
office 1	23	34	1	300	**2 (8020KW)**
office 2	96	68	2	930	
office 3	32	34	2	400	
office 4	35	34	1	420	
office 5	23	34	2	2230	
lobby 1 ,2	43,97	34,68	1,1	570,960	
reception	100	68	2	2500	
kitchen	36	34	1	460	
waiting room1	170	34	5	4500	
waiting room2	272	34	8	3650	

Figure 4. 63: G.F fan coil

first floor				cooling load (w)	fan coil
space	Air flow L/S	Diffuser	number		
office 1	59.2	34	2	750	3 (8020 KW)
office 2	84.6	68	2	1000	
office 3	82.3	68	2	1020	
office 4	60	68	1	760	
office 5	68	68	1	840	
office 6	102.6	68	2	1140	
office 7	103.6	68	2	1115	
office 8	82.5	68	2	950	
office 9	147	127	1	1440	
office 10	126	68	2	1240	
office 11	124	68	2	1220	
office 12	123.6	68	2	1220	
archieve	118	68	2	1250	
kitchen 1	44.2	34	2	600	
kitchen 2	24.6	34	1	350	
lobby1	570	127	5	6730	
lobby 2	163	127	2	1960	

Figure 4. 64: fan COIL F1

second floor				cooling load (w)	fan coil
space	Air flow L/S	Diffuser	number		
office 1	135	127	1	1540	n=4 (8020KW)
office 2	29	34	1	550	
office 3	41	34	2	540	
office 4	42	34	2	560	
office 5	82	68	2	1180	
office 6	112	68	2	800	
office 7	68.7	68	2	850	
office 8	149	127	2	1610	
office 9	264.3	127	3	2500	
office 10	57.2	34	2	720	
office 11	57	34	2	720	
office 12	54	34	2	690	
office 13	63.2	34	2	800	
office 14	130	127	2	1430	
office 15	108	68	2	1190	
office 16	81.7	68	2	930	
office 17	148	127	2	1460	
office 18	122	68	2	1210	
office 19	125	38	4	1230	
office 20	122	68	2	1210	
lobby1	609.2	127	5	500	
lobby2	111	68	2	7520	
kitchen1	36.6	34	2	460	
kitchen2	29.2	34	1	400	

Figure 4. 65: FAN COIL F2

third floor				cooling load (w)	fan coil
space	Air flow L/S	Diffuser	number		
office 1	152	127	2	1210	n= 4 (8020KW)
office 2	187	127	2	1890	
office 3	125	127	1	1230	
office 4	124	127	1	1230	
office 5	60	68	1	730	
office 6	60	68	1	750	
office 7	60	68	1	750	
office 8	113	68	1	1200	
office 9	70	68	2	820	
office 10	71	68	2	880	
office 11	40	68	2	540	
office 12	41	68	2	550	
office 13	41	68	2	540	
office 14	135	127	2	1540	
office 15	270	127	2	2530	
office 16	152	127	2	1630	
lobby1	142	127	2	1670	
lobby2	111	127	1	1410	
lobby3	36	34	1	510	
lobby4	598	127	3	6660	
kitchen1	37	34	1	450	
kitchen2	293	127	2	400	
kitchen3	37	34	1	460	

Figure 4. 66: FAN COIL F3

fourth floor				cooling load (w)	fan coil
space	Air flow L/S	Diffuser	number		
office 1	81.4	127	2	920	n=2 (8020 KW)
office 2	612	127	2	5570	
office 3	127	127	1	1400	
office 4	42.6	127	1	490	
office 5	41	68	1	550	
office 6	111	68	1	1100	
kitchen	49	127	2	570	
meeting room	506	34	1	5500	

Figure 4. 67: FAN COIL F4

Ground floor with VRF system:

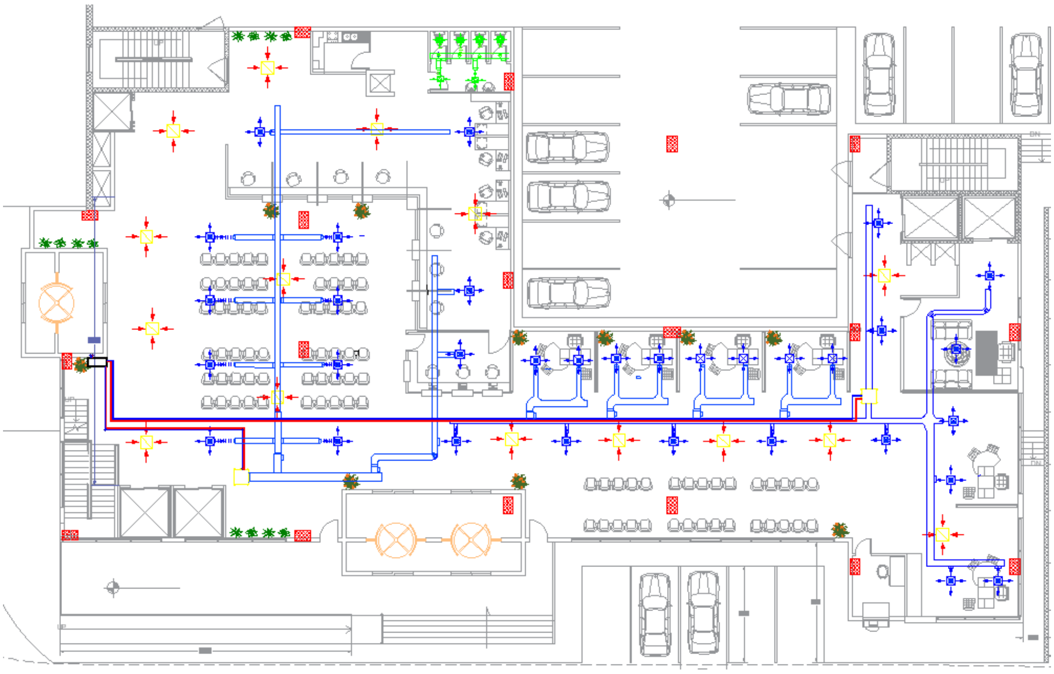


Figure 4. 68:Ground floor with VRF system:

FIRST floor with VRF system:

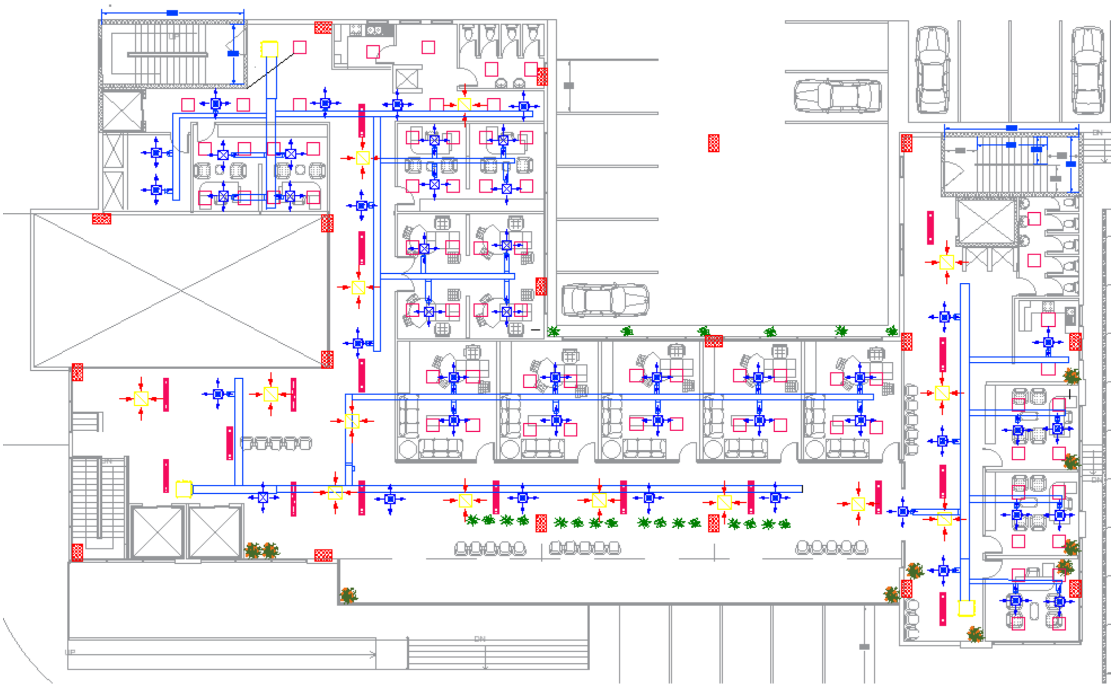


Figure 4. 69:FIRST floor with VRF system:

Second floor with VRF system:

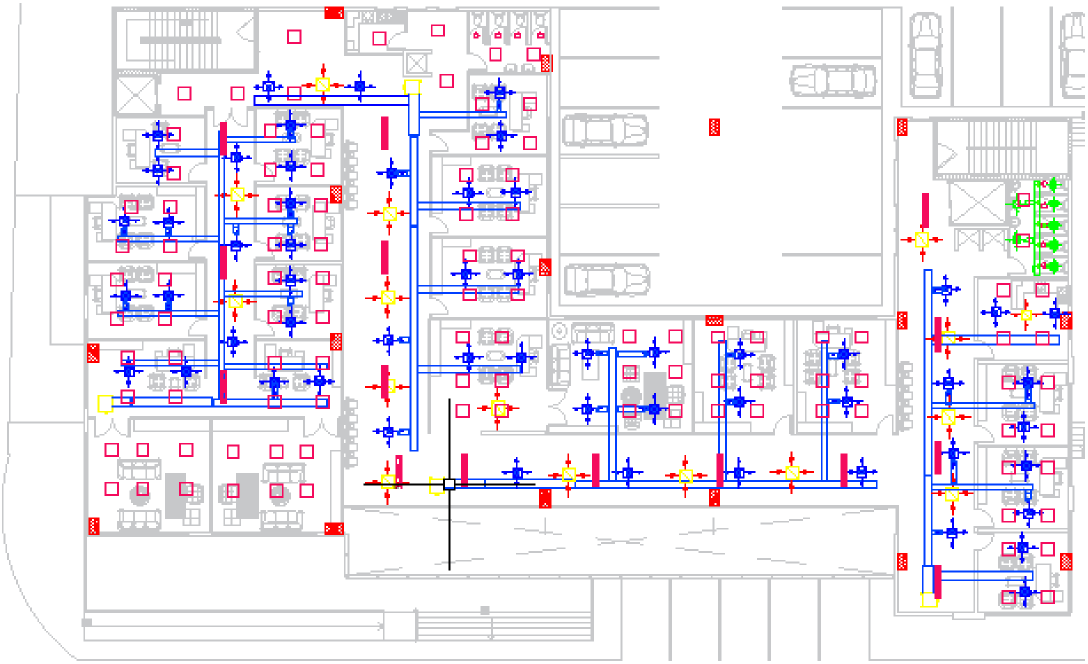


Figure 4. 70:Second floor with VRF system:

Third floor with VRF system:

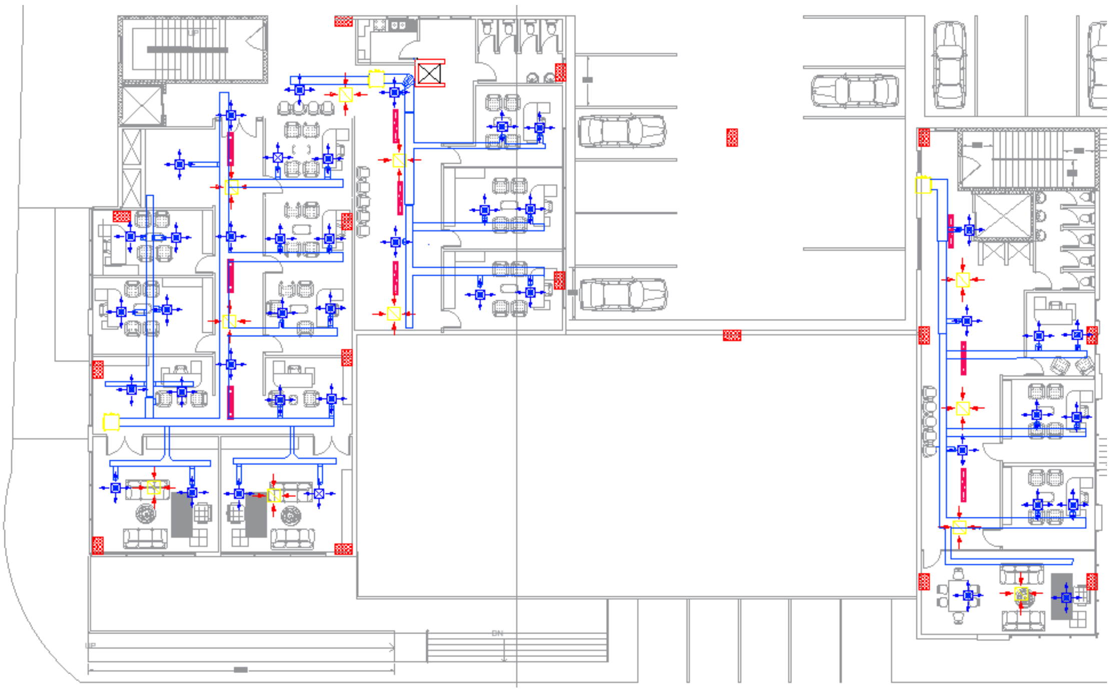


Figure 4. 71:THIRD floor with VRF system:

Fourth floor with VRF system:

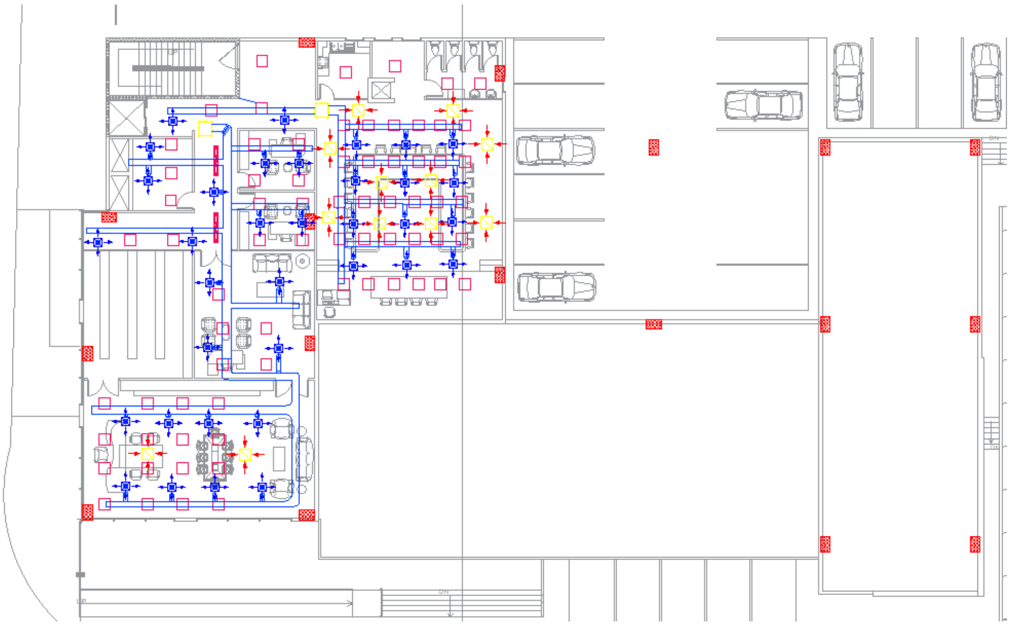


Figure 4. 72:Fourth floor with VRF system:

Basement 1 floor with VRF system:

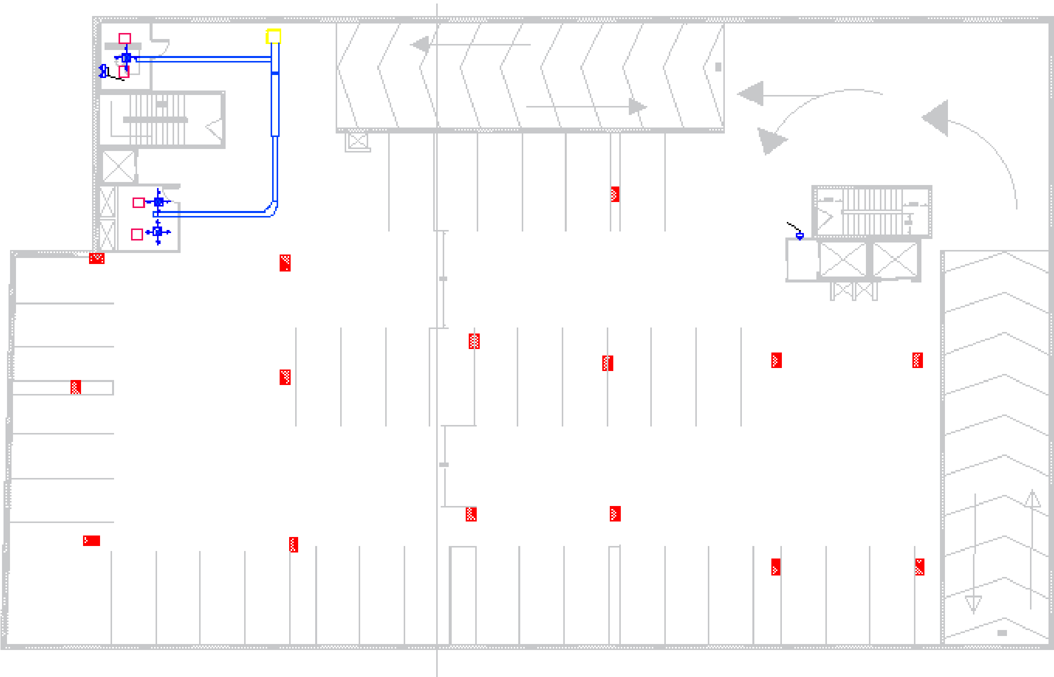


Figure 4. 73:Basement 1 floor with VRF system:

Basement 2 floor with VRF system:

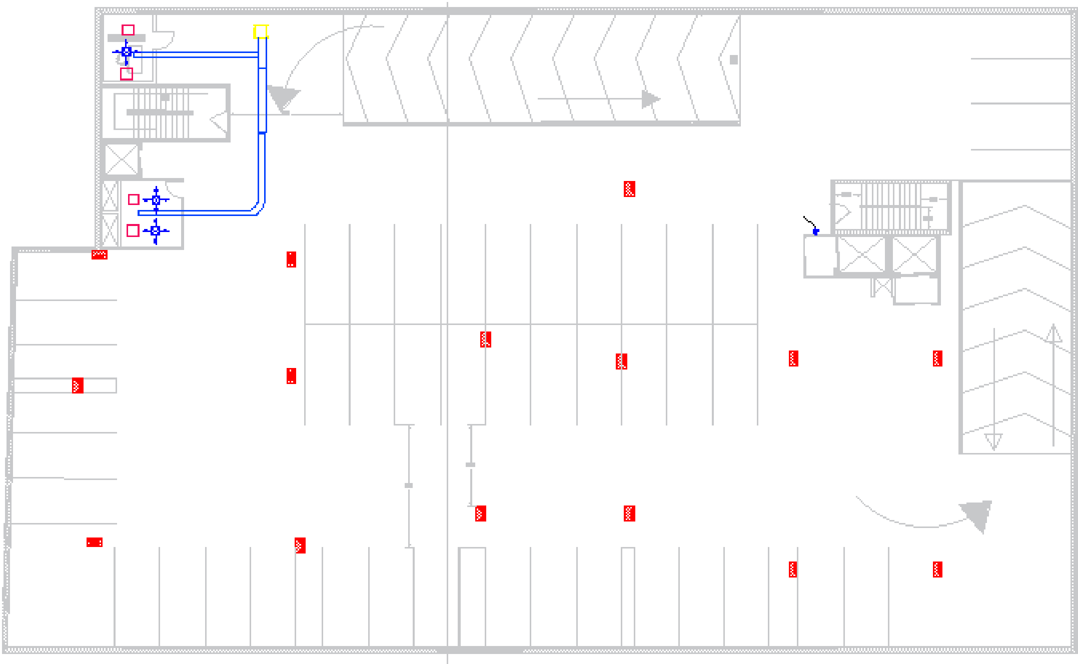


Figure 4. 74:Basement 2 floor with VRF system:

Basement 3 floor with VRF system:

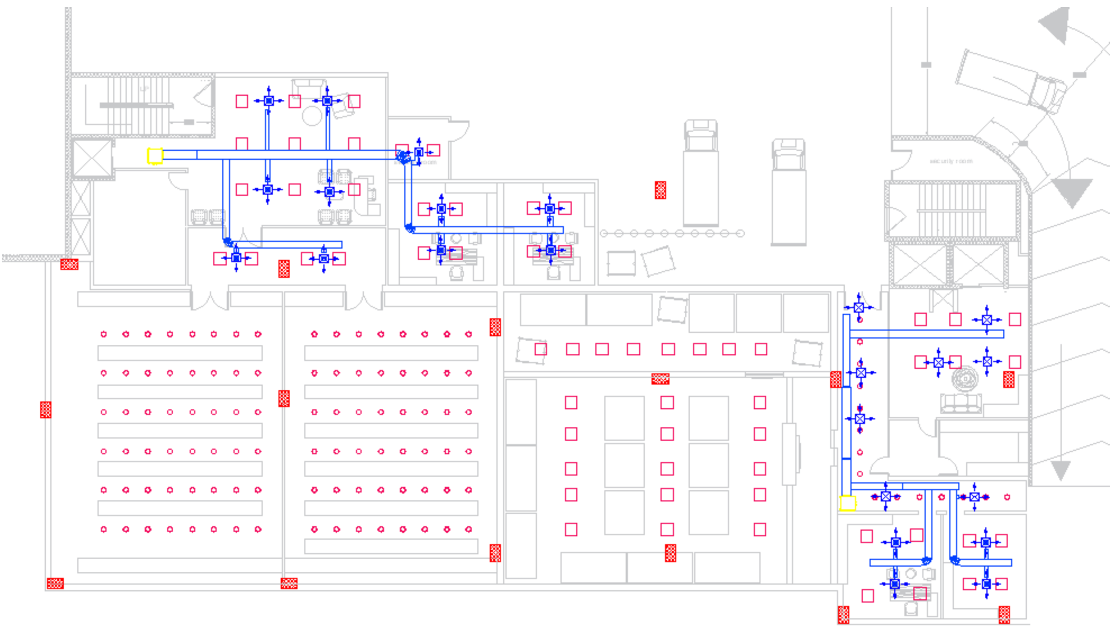


Figure 4. 75:Basement 3 floor with VRF system:

VRF (Variable Refrigerant Flow) Air Handling Unit Selection:

This is for a very quiet and energy efficient system because the variable speed compressor only operates to the capacity needed for the current conditions. Instead of one large, noisy unit that pumps air to the entire space, the VRF system features several smaller air handlers that can be individually controlled and piped back into one system. VRF technology is able to provide both cooling and heat simultaneously to different areas within the space.

A typical system consists of an outdoor unit (comprising one or multiple compressors), several indoor units (often mistakenly called "fan coils"), refrigerant piping running from the outdoor to the indoors, using Refined Joints (copper distributors in pipes) and communication wiring.

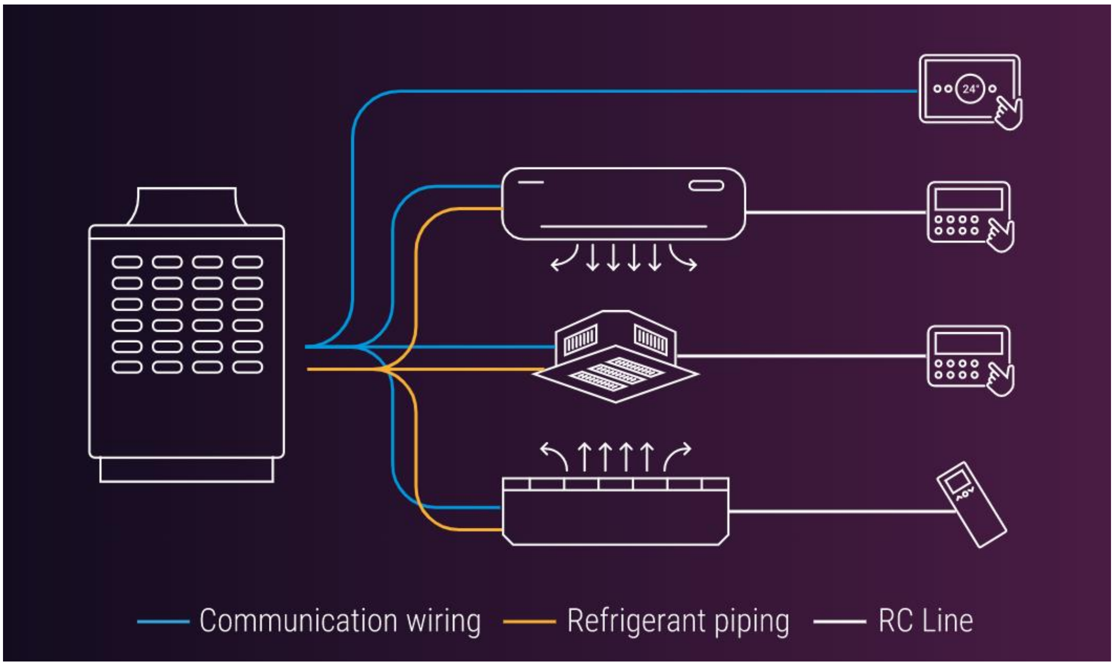


Figure 4. 76: RC LINE

The cooling load 164.67 KW

We will use one of VRF units with a capacity of 47 Tons (165.3 KW)

picture for VRF system:

Figure 4. 77:picture for VRF system:1

Figure 4. 78:picture for VRF system:2

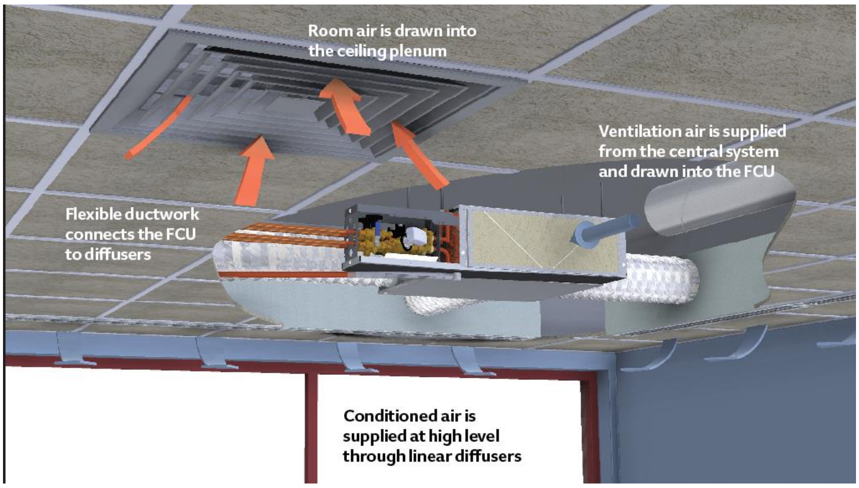


Figure 4. 79:picture for VRF system:3

Figure 4. 80:picture for VRF system:4

Figure 4. 81:picture for VRF system:5

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.

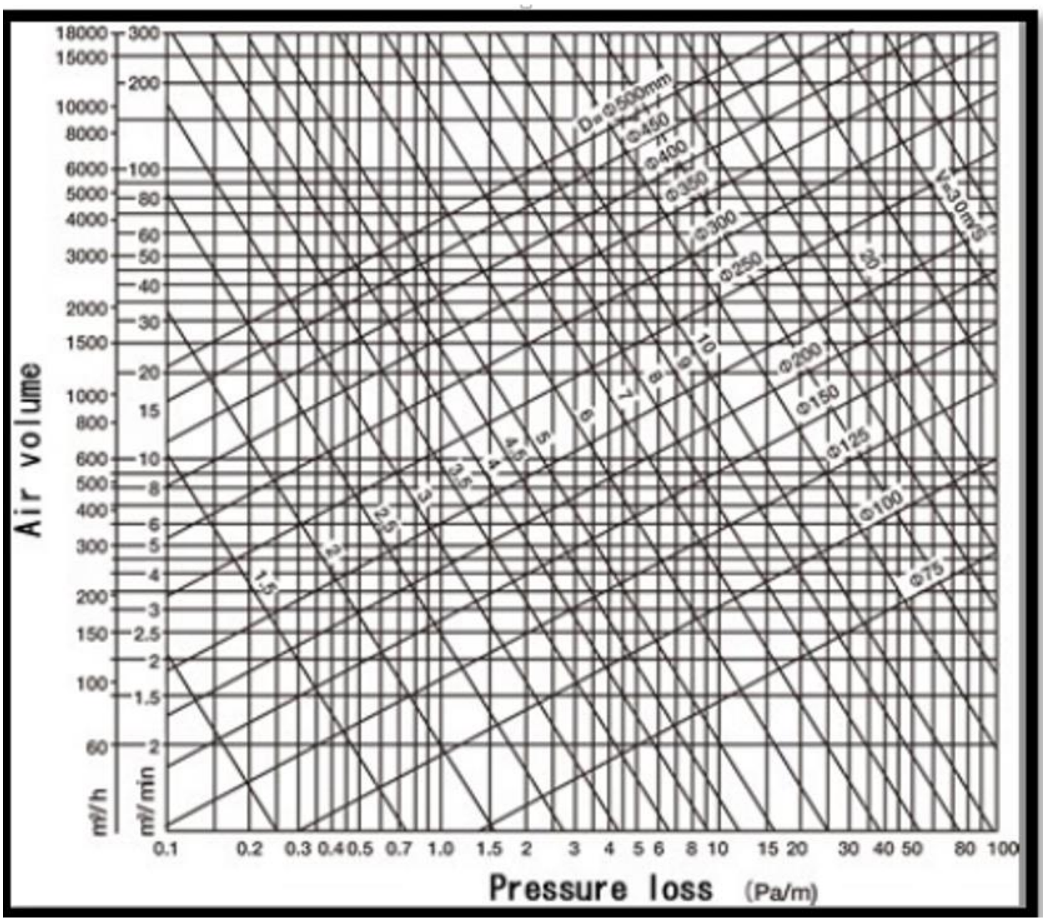


Figure 4. 82:PRESSURE LOSS

Diameter of ducts for ground floor:

Table 44:G.F DUCT

ground floor		
space	Air flow m^3/min	diameter of duct mm
office 1	2	90
office 2	6	155
office 3	2	90
office 4	2	90
office 5	14	250
lobby 1 ,2	6	155
reception	19	300
kitchen	2.2	90
waiting room1	62	500
waiting room2	58	480

Diameter of ducts for first floor:

Table 45:F1 DUCT

first floor		
space	Air flow m^3/h	diameter of duct mm
office 1	4	127
office 2	5	150
office 3	5	150
office 4	4	127
office 5	4	127
office 6	6	155
office 7	6	155
office 8	4	127
office 9	6	155
office 10	6	155
office 11	6	155
office 12	6	155
archive	6	155
kitchen 1	4	127
kitchen 2	2	90
lobby1	34	300

Diameter of ducts for second floor:

Table 46:F2 DUCT

second floor		
space	Air flow m^3/h	diameter of duct mm
office 1	8	210
office 2	1.74	80
office 3	3	120
office 4	3	120
office 5	5	150
office 6	7	205
office 7	4	125
office 8	8	210
office 9	16	260
office 10	3.5	130
office 11	3.5	130
office 12	3.5	130
office 13	3.8	135
office 14	8	210
office 15	6.5	200
office 16	5	150
office 17	9	220
office 18	7.5	210
office 19	7.5	210
office 20	7.5	210
lobby1	36.5	400
lobby2	6.5	200
kitchen1	2	90
kitchen2	2	90

Diameter of ducts for third floor:

Table 47: F3 DUCT

third floor		
space	Air flow m^3/h	diameter of duct mm
office 1	9	220
office 2	11	250
office 3	7.5	210
office 4	7.5	210
office 5	3.5	130
office 6	3.5	130
office 7	3.5	130
office 8	6.5	200
office 9	4	125
office 10	4	125
office 11	2	90
office 12	2	90
office 13	2	90
office 14	8	210
office 15	16	260
office 16	9	220
lobby1	9	220
lobby2	6.5	200
lobby3	2	90
lobby4	36	400
kitchen1	2	90
kitchen2	17.5	300
kitchen3	2	90

Diameter of ducts for fourth floor:

Table 48:F4 DUCT

fourth floor		
space	Air flow m^3/h	diameter of duct mm
office 1	5	150
office 2	36	400
office 3	8	210
office 4	2.5	100
office 5	2	90
office 6	6.5	200
kitchen	3	115
meeting room	30	350

Diameter of ducts for basement 3:

Table 49: B1 DUCT

Basement 3		
space	Air flow m^3/h	diameter of duct mm
office 1	6	155
office 2	3.5	130
office 3	3	115
office 4	3	115
office 5	4	125
office 6	3.5	130
office 7	3	115
office 8	3.5	130
meeting .Room	17	208
lobby 1	2	90
kitchen 1	1	75
lobby 2	2	90

Diameter of ducts for basement 2:

Table 50: B2 DUCT

Basement 2		
space	Air flow m^3/h	diameter of duct mm
office 1	2.5	103
office 2	1.5	80

Diameter of ducts for basement 1:

Table 51: B1 DUCT

Basement 2		
space	Air flow m^3/h	diameter of duct mm
office 1	2.5	103
office 2	1.5	80

4.3.4 Firefighting system design:

Introduction:

All buildings in their life cycle are exposed to fire hazards and damage, hence the importance of firefighting system design.

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.

Procedures:

Table 52:Design Requirement

13/12 متطلبات أنظمة الإطفاء والإنذار :

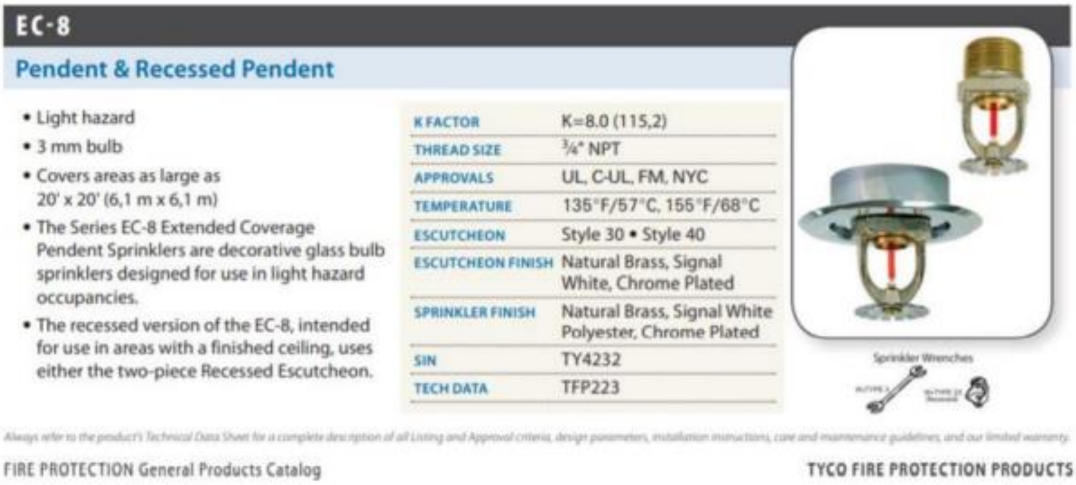
معدات مكافحة و إنذار الحريق لإشغالات التخزين (مرآب السيارات).

	النوع	الحالات المطلوبة
1	معدات الإطفاء اليدوية:	
1	طفايات يدوية	جميع الطوابق لجميع الحالات
2	التركيبات الثابتة:	
1	شبكة خراطيم مطاطية	جميع الطوابق للمراب التي تزيد عن 500 م 2
3	الأنظمة التلقائية الثابتة:	
1	شبكة تلقائية لمرشات مياه مكافحة الحريق	متطلبات مرشات مياه مكافحة الحريق لإشغالات التخزين (مراب 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}

SPRINKLER FIRE FIGHTING SYSTEM DESIGN:

The sprinkler system is effective in putting out fires in places where paper forms are not handled, such as prayer room, 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.

Table 53:Sprinklers


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

Sprinkler Wrenches

FIRE PROTECTION General Products Catalog

TYCO FIRE PROTECTION PRODUCTS

The diameters of all steel pipe that connect the sprinklers together and connect them with supplier was chosen by:

Table 54:Steel Pipes

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

Table 55:Sprinkler's Design and Distribution in Waiting room

Room	Zone Area (m^2)	Coverage Area (m^2)	Max. Distance (m)	Min. Distance (m)	No. of Sprinklers	Steel Pipe Dim (inch)	X	X/2	Y	Y/2
1	73.8	21	4.6	1.8	4	1 1/2	4.6	2.3	3.65	1.825
2	66.1	21	4.6	1.8	4	1 1/2	4.85	2.425	3.15	1.575

Table 56:Sprinkler's Design and Distribution in B1 + B2

Zone	Zone Area (m^2)	Coverage Area (m^2)	No. of Sprinklers	No. of Sprinklers used	Steel Pipe Dim (inch)	Max. Distance (m)	Min. Distance (m)	X	X/2	Y	Y/2
1	130	21	6.19	6	1 1/2	4.6	1.8	3.38	1.69	-	-
2	12.2	21	0.58	1	1	4.6	1.8	-	-	-	-
3	71.3	21	3.39	4	1 1/2	4.6	1.8	3.56	1.78	-	-
4	167	21	7.95	8	2	4.6	1.8	4.4	2.2	4.75	2.38
5	83.5	21	3.98	4	1 1/2	4.6	1.8	3.6	1.8	-	-

Table 57:Sprinkler's Design and Distribution in B3

Zone	Zone Area (m^2)	Coverage Area (m^2)	No. of Sprinklers	No. of Sprinklers used	Steel Pipe Dim (inch)	Max. Distance (m)	Min. Distance (m)	X	X/2	Y	Y/2
1	73.2	21	3.49	4	1 1/2	4.6	1.8	2.95	1.48	-	-
2	24.3	21	1.16	1	1	4.6	1.8	-	-	-	-
3	87	21	4.14	4	1 1/2	4.6	1.8	4.75	2.38	4.58	2.29
4	61.1	21	2.91	3	1 1/4	4.6	1.8	3.23	1.62	-	-

Table 58:Sprinkler's Design and Distribution in Corridor

Zone No.	Zone Area (m^2)	Coverage Area (m^2)	No. of Sprinklers	Steel Pipe Dim (inch)
Zone 1	14.1	21	1	1
Zone 2	22.6	21	1	1
Zone 3	10	21	1	1

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

Figure 4. 83:Detectors

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. 84:CO2 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

Figure 4. 85: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

Technical Details

- **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
- **Pressure :** 700kPa
- **Single Units :** Yes
- **Valve Finish :** Nickel Plated Brass
- **Valve Stem :** Brass

Figure 4. 86:Type A Extinguisher

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:

Manual call points (MCP)

- IP 30 - IK 07
- Surface-mounting or flush-mounting (IP 30)
- Dimensions: 90x90x57 mm (surface-mounting with its base) or 90x90x24 mm (flush-mounting with flush boxes for wiring devices - drilling diameter 67 mm - for 60 mm fixing centres)
- Can be fitted on trunking Cat. Nos 0 104 63/64, 35x105 mm or 50x105 mm, with the universal support Cat. No 0 109 13
- Call by pressing the membrane (pressure 2.5 kg) with clear display of the call position
- Reset on front of device, with special key Cat. No 0 380 38 (supplied with the product)
- Possibility to add an optional mechanical status indicator Cat. No 1 380 93 to provide additional signalling
- Can receive a sealable cover Cat.No 0 380 97

MCP for fire detection and fire alarm systems

- Conform to EN 54-11 standard
- CE-CPR approved
- Type A – simple action
- Color of the mechanical enclosure: red RAL 3000

- MCP - conventional - 2 contacts
- Equipped with 2 NO/NC contacts – 5 A – 24 VDC
- Second contact can be used to trigger CCTV camera (visually and recording - allows remote viewing and recording of any malicious act)

Figure 4. 87:Manual Alarm System

- Sound & Light Alarm System:

Part Number	Description
49AV-WRF	TrueAlert ES Addressable Horn/Strobe Appliance, Wall-Mount, 15/30/75/110/135/185cd, Red, "FIRE"

Figure 4. 88:Sound & Light Alarm System

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 25 meters.

MODEL	TYPE	HOSE SIZE	HOSE LENGTH	WORKING /SERVICE PRESSURE	BURST PRESSURE
SFSJ40R-UL	Single Jacket	1 ½"	15m, 30m	200 psi	600 psi

Figure 4. 89:Fire Hose

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%	II/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%	II/IP40

Figure 4. 90:Evacuation Paths

Chapter 5: Cost Estimation:

5.1 Introduction:

In this chapter, we will calculate the final value of the project, which will be calculated by dividing the project into smaller and smaller sections and activities in order to be calculated more accurately and easier. WPS will work for all works in the project to clarify how they are interconnected with each other, as it is one of the most important foundations on which the project depends. The costs of the various materials and labor needed to complete the project will be accurately calculated using models of similar buildings. There are many factors that play a major role in the cost of the project, as they may increase or decrease the cost according to the way the project depends on it, one of the most important of these factors is the construction systems used in the project, as the cost of a concrete project differs from an iron or wood project The type and quality of materials used play a major role in determining the price of the project, and we must mention that the time required to complete the project plays an important role as well. Great attention should be paid to the initial cost of the project, but without neglecting to look at the operational cost of the building over its years. For example, the use of cheap insulation materials may greatly affect the operational cost of the project for the project, as it will need more energy to be adapted.

5.2: Work break down structure (WBS):

Activity Name						Unit	Item No.
Project							1
	Sturctural						1.1
		Sub-Sturcture					1.1.1
			Eearth Works				1.1.1.1
				Site Leveling		CM	1.1.1.1.1
				Excavation For Footing		CM	1.1.1.1.2
				Total Disposal		CM	1.1.1.1.3
				Site Filling		CM	1.1.1.1.4
			Foundation				1.1.1.2
			Blinding				1.1.1.2.1
					Formwork	SM	1.1.1.2.1.1
					Concrete	CM	1.1.1.2.1.2
				Footing			1.1.1.2.2
					Formwork	SM	1.1.1.2.2.1
					Steel work	Ton	1.1.1.2.2.2
					Concrete work	CM	1.1.1.2.2.3
					Proofing	SM	1.1.1.2.2.4
				Column and shear wall Neck			1.1.1.2.3
					Formwork	SM	1.1.1.2.3.1
					Steel work	TON	1.1.1.2.3.2
					Concrete work	CM	1.1.1.2.3.3
					Proofing	SM	1.1.1.2.3.4
				Tie Beams			1.1.1.2.4
					Formwork	SM	1.1.1.2.4.1
					Steel works	Ton	1.1.1.2.4.2
					Concrete works	CM	1.1.1.2.4.3
				Grounded Slab			1.1.1.2.5
					Formwork	SM	1.1.1.2.5.1
					Steel for Grounded slab	Ton	1.1.1.2.5.2
					Concrete Works	CM	1.1.1.2.5.3

		Super-Structure					1.1.2
			Sturctural Elemnts				1.1.2.1
				Columns			1.1.2.1.1
					Formwork	SM	1.1.2.1.1.1
					Steel work	Ton	1.1.2.1.1.2
					Concrete work	CM	1.1.2.1.1.3
				Shear wall			1.1.2.1.2
					Formwork	SM	1.1.2.1.2.1
					Steel works	Ton	1.1.2.1.2.2
					Concrete Works	CM	1.1.2.1.2.3
				Beams			1.1.2.1.3
					Formwork	SM	1.1.2.1.3.1
					Steel work	Ton	1.1.2.1.3.2
					Concrete work	CM	1.1.2.1.3.3
				Slab			1.1.2.1.4
					Formwork	SM	1.1.2.1.4.1
					Block work	Unit	1.1.2.1.4.2
					Steel work	Ton	1.1.2.1.4.3
					Concrete work	CM	1.1.2.1.4.4
					Formwork Stair case slab	SM	1.1.2.1.4.5
					Steel work Stair case slab	Ton	1.1.2.1.4.6
					Concrete work Stair case slab	CM	1.1.2.1.4.7
				Stairs			1.1.2.1.5
					Formwork	SM	1.1.2.1.5.1
					Steel work	Ton	1.1.2.1.5.2
					Concrete work	CM	1.1.2.1.5.3
			Non-Structural Elements				1.1.2.2

				External Walls			1.1.2.2.1
					Blocks	SM	1.1.2.2.1.1
					Concrete	CM	1.1.2.2.1.2
					Stone	SM	1.1.2.2.1.3
					Sill	M	1.1.2.2.1.4
				Internal Walls			1.1.2.2.2
					Blocks	SM	1.1.2.2.2.1
		Finishing					1.1.3
			Plastering				1.1.3.1
				Ground Floor		SM	1.1.3.1.1
				First Floor		SM	1.1.3.1.2
				Seocnd Floor		SM	1.1.3.1.3
				Third Floor		SM	1.1.3.1.4
				Fourth Floor		SM	1.1.3.1.5
				Fifth Floor		SM	1.1.3.1.6
				staircase		SM	1.1.3.1.7
			Painting			SM	1.1.3.2
				GroundFloor		SM	1.1.3.2.1
				First Floor		SM	1.1.3.2.2
				Seocnd Floor		SM	1.1.3.2.3
				Third Floor		SM	1.1.3.2.4
				Fourth Floor		SM	1.1.3.2.5
				Fifth Floor		SM	1.1.3.2.6
				For the staircase		SM	1.1.3.2.7
			Tiles				1.1.3.3
				Bathrooms Floor Tiles		SM	1.1.3.3.1
				Regular Floor Tiles		SM	1.1.3.3.2
				Wall tiles		SM	1.1.3.3.3
			Doors				1.1.3.4
				Doors		SM	1.1.3.4.1
			Windows			SM	1.1.3.5
		Mechanical					1.1.4
			Drainage system				1.1.4.1
				Tanks			1.1.4.1.1
					TANKS	Unit	1.1.4.1.1.1
					Tank support	Unit	1.1.4.1.1.2
				manholes			1.1.4.1.2
					manholes	Unit	1.1.4.1.2.1
				roof drain water pipe 2 inch		Unit	1.1.4.1.3
					Floor drain	Unit	1.1.4.1.5.1

					Roof drain	Unit	1.1.4.1.5.2
			Water system				1.1.4.2
				Sink and basin			1.1.4.2.1
					wash basin	Unit	1.1.4.2.1.1
					single sink	Unit	1.1.4.2.1.2
				Valve Sink			1.1.4.2.2
					valve sink single	Unit	1.1.4.2.2.1
				WC			1.1.4.2.4
					WC's	Unit	1.1.4.2.4.1
				meters			1.1.4.2.7
					meters	Unit	1.1.4.2.7.1
				collectors		Unit	1.1.4.2.8
			Pipes				1.1.4.3
				6 inch plastic		m	1.1.4.3.1
				4 inch plastic			1.1.4.3.2
					plastic pipe 4 inc	m	1.1.4.3.2.1
		Electrical					1.1.5
			Lighting System				1.1.5.1
				Flourcent		unit	1.1.5.1.1
				Ceiling Light		unit	1.1.5.1.2
				LED and battery BACK		unit	1.1.5.1.3
				Distribution Board Flush mounted		unit	1.1.5.1.4
				Wall Mounted		unit	1.1.5.1.5
				Wall mounted 2*18-PL IP-54 (W.P)		unit	1.1.5.1.6
				Main Distribution Board		unit	1.1.5.1.7
				Exhaust fan outlet		unit	1.1.5.1.8
				Battery back Emergency kit		unit	1.1.5.1.9
				Projector unit LED 150w (W.P) with Box (W.P)		unit	1.1.5.1.10
				1 Gang Switch		unit	1.1.5.1.11
				2 Gang Switch		unit	1.1.5.1.12
				3 Gang Switch		unit	1.1.5.1.13
				2 Gang Switch 2 way		unit	1.1.5.1.14
				Stair case Switch		unit	1.1.5.1.15
				Light Wires		M	1.1.5.1.16
			Power System				1.1.5.2

				Power Socket outlet		unit	1.1.5.2.1
				Water Proof Power Socket outlet		unit	1.1.5.2.2
				Boiler Outlet (H=160 Cmm)		unit	1.1.5.2.3
				Power Wires		M	1.1.5.2.4
			Low Current System				1.1.5.3
				Telephone Socket outlet		unit	1.1.5.3.1
				Electrical bell 6 inch		unit	1.1.5.3.2
				Electrical bell 8 inch		unit	1.1.5.3.3
				Bell Puch Button		unit	1.1.5.3.4
				Network socket (CAT M) for (CAT 6) cable		unit	1.1.5.3.5
				Internal Loud Speaker 6-9 inch		unit	1.1.5.3.6
				External Loudspeaker (45 W) (w.p) with transformer		unit	1.1.5.3.7
				W.P Microphone outlet		unit	1.1.5.3.8
				HUB		unit	1.1.5.3.9
				Low Current Amblifire Wires		M	1.1.5.3.10
				DBG		M	1.1.5.3.11
				L.V.B		M	1.1.5.3.12
			Fire Alarm System				1.1.5.4
				Fire Alarm Panel		unit	1.1.5.4.1
				SMOKING DETECTOR RELLY		unit	1.1.5.4.2
				Heat Detctor		unit	1.1.5.4.3
				Fire alarm red Flasher		unit	1.1.5.4.4
				Fire alarm manual station		unit	1.1.5.4.5
				WEATHER PROOF AT 220CMS FFL.		unit	1.1.5.4.6
				Fire system Wires		M	1.1.5.4.7
			Circuit Breaker				1.1.5.5
				Breaking Capacity_25KA		unit	1.1.5.5.1
				MCB (32AM)		unit	1.1.5.5.2

				25AM		unit	1.1.5.5.3
				20 AM		unit	1.1.5.5.4
				16 AM		unit	1.1.5.5.5
				10AM		unit	1.1.5.5.6
			Earthing				1.1.5.6
				Earthing Electrode		unit	1.1.5.6.1
				Galvanised Steel Plates30*3 mm		M	1.1.5.6.2
				Wire 70 mm inside Pipe Ø 32mm		M	1.1.5.6.3

5.3 Bill of quantity (BOQ):

Item No.	Description	Unit	Quantity	Material cost		Labor Cost					total direct cost	
				Unit Cost	Total Cost	unit MHR	Total MHR	MHR rate	unit cost	total cost	unit cost	total cost
1	bank											
1.1	Structural											
1.1.1	Sub-Structure											
1.1.1.1	Earth Work											
1.1.1.1.1	Excavation for Footing	CM	21756	30							30	652680
	site leveling	CM	612.6	30							30	18378
1.1.1.1.2	Total Disposal	CM	27195	15							15	407925
1.1.1.1.3	Site Filling	CM	1438.89	45							45	64750.05
1.1.1.2	Foundation											
1.1.1.2.1	Blinding											
1.1.1.2.1.1	Formwork	SM	18.8	25	470	0.02	0.376	3.947	15	282	40	752
1.1.1.2.1.2	Concrete	CM	207.2	340	70448	0.556	115.2032	19.444	35	7252	375	77700
1.1.1.2.2	Footing											
1.1.1.2.2.1	Formwork	SM	150.4	25	3760	0.02	3.008	0.3	15	2256	40	6016
1.1.1.2.2.2	Steel Work	TON	45.2	3700	167240	0.556	25.1312	50	90	4068	3790	171308
1.1.1.2.2.3	Concrete Work	CM	1657.36	340	563502.4	0.263	435.88568	0.875	35	58007.6	375	621510

1.1.1.2.2.4	Proofing	SM	150.4	10	1504	0.019	2.8576	0.679	36	5414.4	46	6918.4
1.1.1.2.3												
1.1.2	Super Structure											
1.1.2.1	Structural Elements											
1.1.2.1.1	Column											
1.1.2.1.1.1	Formwork	SM	2700	150	405000	0.02	54	0.3	15	40500	165	445500
1.1.2.1.1.2	Steel Work	TON	45.1	3700	166870	0.556	25.0756	50	90	4059	3790	170929
1.1.2.1.1.3	Concrete Work	CM	500	340	170000	0.025	12.5	0.875	35	17500	375	187500
1.1.2.1.2	Shear Wall											
1.1.2.1.2.1	Formwork	SM	3948	25	98700	0.02	78.96	0.3	15	59220	40	157920
1.1.2.1.2.2	Steel Work	TON	57.3	3700	212010	0.556	31.8588	50	90	5157	3790	217167
1.1.2.1.2.3	Concrete Work	CM	592.4	340	201416	0.025	14.81	0.875	35	20734	375	222150
1.1.2.1.3												
1.1.2.1.3.1												
1.1.2.1.3.2												
1.1.2.1.3.3	Slabs											

1.1.2.1.4	U-boot	SM	20000	4	80000						
1.1.2.1.4.1	Formwork	SM	11112	200	2222400	0.02	222.24	0.3	15	166680	215	2389080
1.1.2.1.4.2	Steel Work	TON	490.3	3700	1814110	0.556	272.6068	50	90	44127	3790	1858237
1.1.2.1.4.3	Concrete Work	CM	2500	340	850000	0.025	62.5	0.875	35	87500	375	937500
1.1.2.1.5	Stair											
1.1.2.1.5.1	Formwork	SM	150	25	3750	0.02	3	0.3	15	2250	40	6000
1.1.2.1.5.2	Steel Work	TON	12.6	3700	46620	0.556	7.0056	50	90	1134	3790	47754
1.1.2.1.5.3	Concrete Work	CM	50	340	17000	0.025	1.25	0.875	35	1750	375	18750
1.1.2.1.5.4	Hand Rail	LM	110	600	66000						600	66000
1.1.2.2	Non Structural Elements											
1.1.2.2.1	External Wall											
1.1.2.2.1.1	Block	SM	54850	40	2194000	0.025	1371.25	0.5	20	1097000	60	3291000
1.1.2.2.1.2	Concrete	CM	260	340	88400	0.008	2.08	0.167	20	5200	360	93600
1.1.2.2.1.3	Stone	SM	2550	250	637500	0.022	56.1	0.778	35	89250	285	726750
1.1.2.2.1.4	Insulation	M	2550	70	178500	0.017	43.35	0.167	10	25500	80	204000
1.1.2.2.2	Internal walls											

1.1.2.2.2.1		SM	1650	31.25	51562.5	0.013	21.45	0.25	20	33000	51.25	84562.5
1.1.3	Finishing											
1.1.3.1	Plastering	SM	41260	30	1237800	0.02	825.2	0.3	15	618900	45	1856700
1.1.3.2	Painting	SM	41260	20	825200	0.016	660.16	0.5	30	1237800	50	2063000
1.1.3.3	Floor Tile	SM	3854	100	385400	1.875	7226.25	21.33	40	154160	140	539560
1.1.3.4	Stair Tile	M	350	160	56000	28.945	10130.75	21.33	40	14000	200	70000
1.1.3.5	Gypsum Board	SM	3000	60	180000	1.875	5625	21.33	50	150000	110	330000
1.1.3.6	Wall Tile	SM	384	80	30720	98.733	37913.472	21.33	40	15360	120	46080
1.1.3.8	Wood Door	piece	50	1200	60000	4	200		25	1250	1225	61250
1.1.3.9	Bathroom Door	piece	8	900	7200	4	32		25	200	925	7400
1.1.3.10	External Door	piece	6	2400	14400	4	24		25	150	2425	14550
1.1.4	Electrical											
1.1.4.1	Power System											
1.1.4.1.1	power socket outlet	unit	200	10	2000	0.267	53.4	4.533	17	3400	27	5400
1.1.4.1.2	water proof power socket outlet	unit	20	15	300	0.267	5.34	4.533	17	340	32	640
1.1.4.1.3	power wires	m	4000	5	20000	0.267	1068	4.533	17	68000	22	88000
1.1.4.2.1	MBD	unit	1	3000	3000	0.267	0.267	4.533	17	17	3017	3017

1.1.4.2.2	MCCB	unit	1	400	400	0.267	0.267	4.533	17	17	417	417
1.1.4.2.3	SBD	unit	1	150	150	0.267	0.267	4.533	17	17	167	167
1.1.4.2.12	Elevator	unit	3	40000	120000	0.267	0.801	4.533	17	51	40017	120051
1.1.4.3	Light											
1.1.4.3.1	NUMBUS Q340	unit	210	200	42000	0.267	56.07	4.533	17	3570	217	45570
1.1.4.3.2	CARDI Plato 2	unit	34	100	3400	0.267	9.078	4.533	17	578	117	3978
1.1.4.3.3	3F Filippi lucequadro	unit	45	150	6750	0.267	12.015	4.533	17	765	167	7515
1.1.4.3.4	spectral stora QA	unit	14	250	3500	0.267	3.738	4.533	17	238	267	3738
1.1.4.3.5	Philips RC 468B	unit	105	300	31500	0.267	28.035	4.533	17	1785	317	33285
1.1.4.3.6	regiolux alevo - avamp	unit	134	200	26800	0.267	35.778	4.533	17	2278	217	29078
1.1.4.3.7	RIO 31W	unit	16	500	8000	0.267	4.272	4.533	17	272	517	8272
1.1.5	Safety System											
1.1.5.1	fire hose station	unit	6	750	4500				30	180		4680
1.1.5.2	sprinklers	unit	370	300	111000				30	11100		122100
1.1.5.3	fire extinguiguisher	unit	30	150	4500				30	900		5400
1.1.5.4	heat detectors	unit	40	135	5400				30	1200		6600
1.1.5.5	smoke detector	unit	100	140	14000				30	3000		17000
1.1.5.6	fire alarm	unit	10	180	1800				30	300		2100
1.1.5.7	fire alarm and red flasher	unit	35	100	3500				30	1050		4550
1.1.5.8	out side dry stand pipe	unit	2	3800	7600				30	60		7660
1.1.5.9	fire exit door	unit	7	500	3500				50	350		3850

1.1.6	Mechanical Work											
1.1.6.1	Drainage system											
1.1.6.1.1	kitchen sink	unit	5	300	1500				85	425		1925
1.1.6.1.2	lavatory	unit	16	150	2400				85	1360		3760
1.1.6.1.3	wc	unit	18	1800	32400				85	1530		33930
1.1.6.1.4	urinal	unit	6	200	1200				85	510		1710
1.1.6.1.5	manholes	unit	12	800	9600				85	1020		10620
1.1.6.1.6	Pipe 4"	m	200	14	2800				85	17000		19800
1.1.6.1.7	Pipe 2"	m	150	8	1200				85	12750		13950
1.1.6.1.8	Pipe 6"	m	700	25	17500				85	59500		77000
1.1.6.1.9	Clean out	unit	35	65	2275				85	2975		5250
1.1.6.2	Water System											
1.1.6.2.1	water tank	unit	11	500	5500				90	990		6490
1.1.6.2.2	water pump	unit	1	5500	5500				85	85		5585
1.1.6.2.3	galvanized steel	M	100	45	4500				85	8500		13000
1.1.6.2.4	PVC pipe	M	200	4.5	900				85	17000		17900
1.1.6.2.5	collector	unit	4	350	1400				85	340		1740

1.1.6.2.6	valve sink	unit	20	60	1200				85	1700		2900
1.1.6.2.7	bidet	unit	18	30	540				85	1530		2070
1.1.6.2.8	shower	unit	4	1600	6400				85	340		6740
1.1.7	Elevator System	unit	2	80000	160000				15000	30000		190000
1.1.8	HVAC System											
1.1.8.1	chiller	unit	5	10000	50000				4500	22500		72500
1.1.8.2	Diffuser	unit	238	300	71400				50	11900		83300
1.1.8.3	fan coil	unit	17	2000	34000				150	2550		36550
1.1.8.4	Duct	M	600	60	36000				35	21000		57000
1.1.9.1	ceiling loudspeaker	piece	2	500	1000							1000
Total Cost												19328665

Chapter 6: Conclusion

This project provided a redesign for “Establishment of Manage & Development Orphans Funds”. The following conclusion can be stated:

• As a first step, the building was evaluated according to architectural standards and recommendations, and modified and re-designed on its basis, including plans and elevations, while keeping in mind the alignment of architectural and environmental aspects. so that care was taken to obtain a more comfortable building that conforms to the requirements and facilitates access to the various spaces in it and moving between them.

• The environmental analysis was performed by Revit and some modifications were made to study analysis Daylight, solar radiation and shadows for the building before and after modification, to create a more comfortable place for users.

• Design steps start by finding the suitable dimensions for the selected system using methods from the ACI code, followed by the calculation of load combinations to then come up with the exact values of moment and shear forces on the structural element. For the structural system to be able to resist the forces and stresses acting on it, forces and stresses can be produced by several types or forms of loads such as dead, live, wind and temperature, so the design of the structural system must consider the ultimate compositions of these loads. The ETAPS program was used to perform the structural analysis, considering all the effects that the architectural design did not consider, the loads were distributed to the structure.

• Finally, an initial construction cost is estimated for the project, by estimating the cost per square meter.

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