Structural Design of Information Technology center

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DIDICATION

To our homeland Palestine…

To our families our parents, brothers, sisters….

To The Soul of Martyrs and their families ….

To the captives and Wounded of Al- intifada……

To our dreams, to the best future……

To the hard moments that made us and let us give our best…...

To our best moments, to the funny ones……

To the unspoken words, to the unreached souls

To our Teachers, to our Friend's …

To every one love us and wish the best for us ….

To Everyone Help us …

To Eng. Fahed Salahat Who help us in our project

and guide us to do the best ..…

Thanks & Dedicate

The first thank and gratitude to Allah, who gives us the most Merciful who granted us the ability and willing to start project.

We thank "Palestine Polytechnic University", "Department of Civil and Architectural Engineering" and wish to it more progress and successes. We express our thanks to Eng. Fahed Salahat, who gave us the knowledge, valuable help, encouragement, supervision and guidance.

Thanks for all teachers that gave us a little of theirs time and answers our questions.

Finally, our deep sense and sincere thanks to our parents, brothers and sisters for their patience, and for their endless support and encouragement also for everybody who tried to help us during our work and gave us strength to complete this task.

ABSTARCT

The idea of this project revolves around the architectural and Structural design of "information technology center in Hebron city exactly near Hebron university", which was selected after a study set of different architectural projects.

The information technology center consists of three floors: Ground floor consist of Entrance, consists of: entrance hall, reception elements of the movement (elevators and stairs),and public administration department which consist of offices, secretarial office ,conference room ,archive. Department of administration and finance which consist of department of administrative affairs , finance section ,archive . health units ,kitchen ,surfer room .first floor which consist of cafeteria ,department of scientific search , manufacturing department, Marketing department consists of: offices, laboratory quality inspection, stores, Entertainment section consists of: showrooms, three-dimensional cinema, public services, health units. Second floor which consist of Department of Education

This project will provide an acceptable solution for both sides architectural and structural , so that it is taking into account the functional and aesthetic purposes, provide comfort , ease and speed of use, the project will include the well-known structural elements as slabs, beams, columns, foundations ... etc.

This project project will be designed based on the Code ACI 381 - 11, several programs will be used for, such as: AutoCAD 2010, Office 2007, ETABS 2013, SAFE 12, BEAMD, references and several projects will be referred, eventually a structural details, load analysis and elements design will be offered for these units, added to the architect design.

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Chapter I

Content:

1-1 Introduction:

Today we live in an era of progress and technology, age does not accept improvisation or spontaneity, an era when man tries to use nature and control it, and seeks every individual in which to invest everything on its land, water and air, an investment does not limit or end .

From here, we find that scientific research and technological applications is an urgent need for man can't live without them, has become his weapon, which supports its reality and inform the truth. The major discoveries of human attempts to have stemmed the interpretation of the results of its research, and technical applications of these discoveries that are used for the benefit of humanity is only human and making a mockery of his progress and give reasons for generation after generation.

In the past twenty years, progress has been very fast in various fields of science and technological applications, were these applications form the backbone upon which the modern human life and give him the form of its existence and survival and progress.
But the impact of science on people varies within the global context also differs because of the difference between rich and poor countries in the world, causing variation in the benefits to be derived from this area and that can be added to the quality of life of individuals and nations.

In the arms of this competition, which is unprecedented, it has become an urgent necessity, especially in Third World countries and developing countries to increase the contact patch individuals to the field of science that the private life of the individual in dire need of multiple colors of knowledge, and various types of experiences.

Information Technology Center is a place to bring together the people of research in various fields of knowledge, of the most important features of these centers help researchers presence within a purely scientific environment as well as they make it easier for them to obtain the required information will also facilitate them meeting in one place. This Association leads researchers to diligent progress in various fields of science to the presence of all stimuli.

Information Technology Center is a project in which all requirements and events that provide scientific atmosphere for scholars and students are available through laboratories, classrooms and auditoriums, libraries specialized and museums provide in addition to a special section concerned with the public service and work to develop their skills and scientific ideas.

1-2 Reasons for choosing the project:

The importance of choosing the project refers to several things, the most important skill acquisition in constructional design elements in buildings, especially large buildings such as the project, which we are introducing in this search. In addition to increasing knowledge of the construction of the systems in place in our country, as well as the acquisition of scientific knowledge and the process followed in the design and implementation of construction projects that lie ahead after graduation in the labor market.

1-2-1 General reasons:

there are several reasons led to the selection of this project; including reasons related to the nature of the project as a technology center, and the other belonging to personal reasons can be summarized as follows:

1. emphasis on the scientific value in terms of scientific research is a cornerstone of human knowledge in all squares is also salient feature of the modern era.

2. the need for the provision of building works to provide scientific atmosphere for researchers and students and take into account their needs to do research that serve the society and elevate him to the highest levels.

3. Providing building serves the surrounding environment and works to minimize damage them as much as possible.

4. closer ties between researchers, graduate students because of the active role of both scientific research.

1-2-2 Personal reasons:

The need of a structural project as the project team desired, to acquire the structural design skills by linking theoretical aspects that have been gained from the courses studied, and apply it effectively in this project and the contents of various structural elements, the design of these elements to fit with loads located them, taking into account the provision of global and durability economy.

1-3 Objectives of the project:

1-3-1 Architectural objectives:

Large projects attracts the attention of citizens, visitors and tourists, so it must be good to focus on the architectural aspects, it is through these projects can architecture that makes it a historic event through the blocks harmonious used elements of the facades, and the research centers of its own Architectural shows the evolution of architectural taste, and this It shows the evolution of the city and its culture.

1-3-2 Structural objectives:

1. To come up with the best structural design of our facility , able to resist internal and external forces that affect it also can keep up with the human evolution , taking into account the preservation of human safety .
2. The ability to write project description and imagine the whole project.
3. Design the project with its structural components so it is consistent with architectural plans.
4. The ability to choose the most appropriate structural components with its different types for our project to achieve best serviceability, factor of safety as well as to the most appropriate economic cost
5. To have the ability to choose the appropriate software that help us in the structural analysis and design process.

1-4 Methodology:

1. Preparation of architectural plans complete and evaluated in terms of architecture and its compatibility with the objectives of the project and its services.
2. Study of constituent structural elements and choosing the most appropriate mechanism for the distribution of these elements as columns, beams, ribs do not collide with architectural design topic and achieve the economic aspect and a Security.
3. Analysis of the structural elements and loads affecting them.
4. Design of structural elements based on the results of the analysis.
5. Design by different design programs.

6. Completion plans of structural elements which have been designed to project the final and executable.

1-5 Research problem:

The problem with this project in the analysis and structural design of all structural components of the technology and information center which was adopted to be an example for this search, and in this area we will study all the element of the structure such as tiles, ribs, columns and beams analysis .... etc. Select the loads that affected them and then determine its dimensions and design them according to the structural design code, taking into account the safety factor of origin, and then working on the work shop drawings for structural elements that have been designed, to take out of this project into the proposal into effect.

1-6 Risks:

1. Environmental constraints preclude the completion of work on the project.
2. The occurrence of a strike and holidays.
3. A malfunction or a defect in some software used.
4. Expired software which prevents completion of the use.

1-7 Team:

This project will be done by Ala 'Al-Irjan and Esra' a Awawda, under the monitoring of Eng. Fahed Salahat.

1-8 Time schedule:

Week / Mission	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	2
project selection																							
Site study																							
Data Collection																							
Architectural study																							
Structural study																							
Preparation of project introduction																							
Project introduction																							
Structural analysis																							
Structural design																							
Prepare project plans																							
Writing project																							
Project presentation																							
Complete structural analysis																							
Complete structural design																							
Preparation of project plans																							
Writing project																							
Project presentation																							

Chapter II

Content:

2-1 Introduction:

Architecture is one of the most prominent engineering sciences, which is not the result of this era, it is since God created humans who uncorked his talents and his thoughts, human by this talent lift from the life of the caves to the best form of welfare, Taking advantage of the beauty that God gave to this picturesque nature.

Architecture has become an art and talent and ideas. It derives its fuel from what God gave to the architectural beauty of the talents. For each art or science controls and limits, but architecture not subject to any limit or restriction, it is oscillating between fantasy and reality, although of simplicity of some architecture buildings but may have many surprises for us when we enter and interact with the details.

The building may seem simple from the outside like a piecemeal to several large pieces without a sense of communication between these pieces, but in fact it is connected and interconnected through the distances and multiple bridges and building support in the engineering formation depends entirely on the geometric Figure of normal recurring unit throughout the building, although they sometimes skew and cut out the visual composition do not suggest be associated with the regular form.

The design of any structure or building process Performs through several stages until it is done to the fullest, begin first phase of architectural design where they are at this stage to determine the Figure of origin and taken into account to achieve the different functions and requirements for which will be the establishment of this building, where it is a primary allocation to accompany, in order to achieve the required spaces and dimensions and determine the columns and axis positions, and are in the process also study lighting, ventilation, movement and other functional requirements.

After the completion of the architectural design phase and out final form, structural design process which aims to identify the dimensions of structural elements and characteristics begin depending on various loads located and which are transported through these items to the foundations and then into the soil.

2-2 Overview of the project:

Thinking about implementing each project, there must be a goal from it, so the main goal of this proposal is to work on the establishment of a separate building serve. As an Information Technology Center, which is an educational project meaningful, contain spaces and a variety of activities, and therefore helps to attract the attention of the younger generation, so the project needs a large tract to achieve the desired purpose, and sufficiently to embrace the talents and abilities of this generation.

So the idea of the project are summarized in the creation of technology information center will be useful for the emerging generation and meets their needs and encourage them to education and innovation in a comfortable learning environment and organization.

The Center of technology includes rooms, cinema, cafeteria, terraces and teaching rooms, laboratories and libraries meet all the needs, and the offices of various uses including administrative and other services.

Architectural plans for this project was obtained from the Civil and Architectural Engineering Department at Palestine Polytechnic University to enable structural design work and preparation of structural working drawing for all structural elements covered.

2-3 Project location:

For the design of any project, it should be considered a location to create the building carefully whether relating to geographical location or the impacts of climatic prevailing in the region, so the existing elements and their relations with the proposed design in concert to achieve the optimal design, therefore, should give a general idea of the elements of the site, to clarify land for the proposed building and the relationship of the site and services surrounding streets, and the height of surrounding buildings, and the direction of the prevailing winds and the path of the sun.

2-3-1 Proposed sites:

Depending on the planning and design standards, and on the strategy in determining the project site, two sites have been proposed for the establishment of an information technology center, which is as follows:

The first proposal: Selected plots of land in the northern part of the city of Hebron, near the traffic circle, the site is accessed from the eastern side of the head during the Jura Street, is access to capital quarry roundabout located in the West End, an area of about 10 acres from Hebron University to the top of the Jura.

Figure 2-1 : The proposed land near the traffic circle.

The second proposal (selected location): Located pieces of the proposed land second option in the northwestern part of the city of Hebron, near Hebron University, where he is accessing the site through a branch road linking Hebron's main University Street with Al-Salam arterial street, an area of about 10 acres, while the slopping reach to 6%.

2-3-2 Reasons for choosing land near Hebron university:

After a comparison between the proposed sites for the establishment of information technology Centre, it has been selected suitable land a land located near Hebron University, because :

1. It is too close to the Hebron University and thus could be a magnet for a certain segment of young people, on the grounds the center is primarily an educational.

2. Widening swath of land.

3. Accessibility of the site.

4. The availability of public services.

5. Visible Site and sights.

6. The availability of green areas.

2-3-3 The project land analysis:

After the appropriate location has been chosen for the project we analyzed the land as follows:

2-3-4 Roads and Transport:

The project site of the active sites in Hebron, and the advantage is easily accessible by public transport. Where are accessing the site through several streets, including street that leads to Hebron University, and through Al Salam Street.

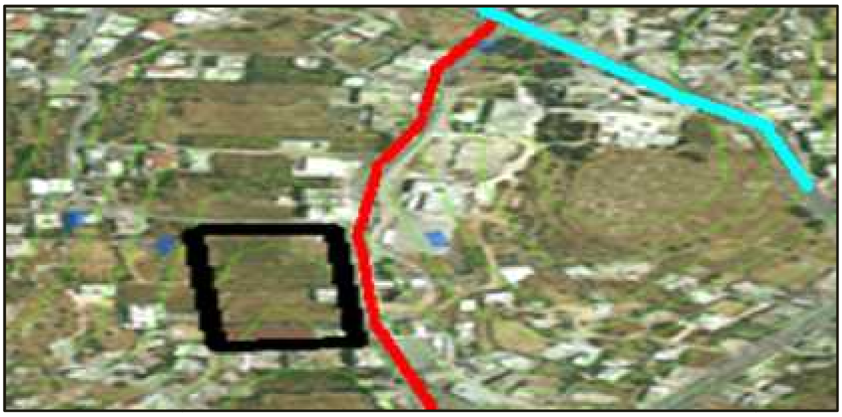


Figure 2-2: Land near the proposed site of the Hebron University.

2-3-5 Movement of the sun:

The amount of solar radiation varies throughout the year and reaches its maximum rate in the city June 8 cal / cm2 / day, while the annual rate of radiation amounts to 18 thousand kcal / cm 2. The annual average number of hours that radiate the sun is 3300 hours / year. Great and her end of 4400 hours.

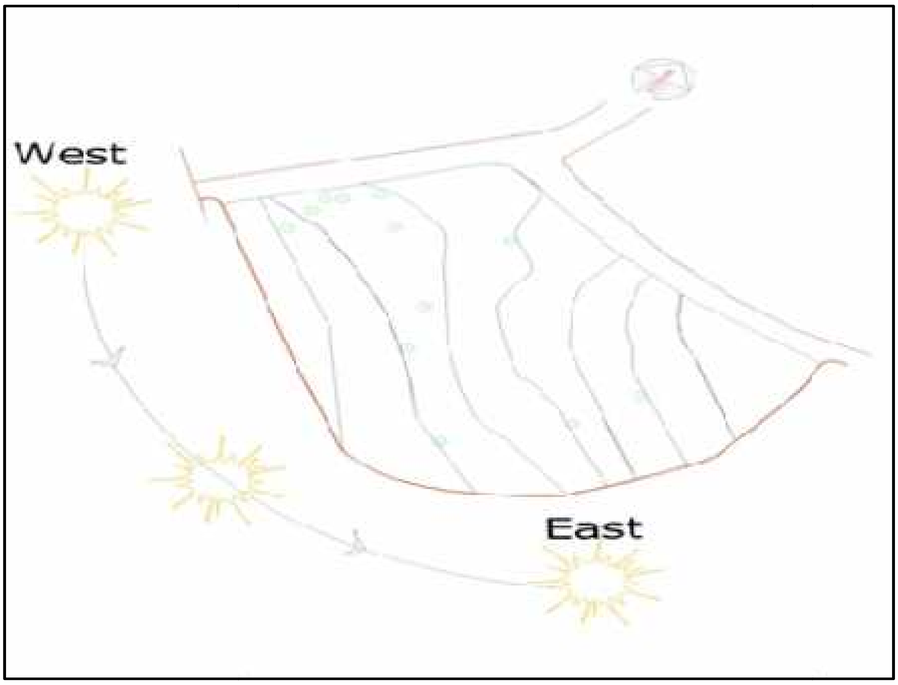


Figure2-3 : Movement of the sun.

2-3-6 Wind movement at the site:

Wind affects the buildings either on the walls or the structure in addition to erosion processes and erosion, therefore, taking into account the wind direction when directing the building is essential in the design process. Usually Wind direction and speed from one area to another is different and separate to the other, local factors of pressure and terrain have a significant impact in the winds that are organized in the General Lines difference, and the most important wind blowing on the city of Hebron and affect the proposed site is south-east wind blowing in winter , North West that blows in summer and winter and the wind, so you must pay very close attention when directing the building to avoid the winds that have a negative impact on the building.

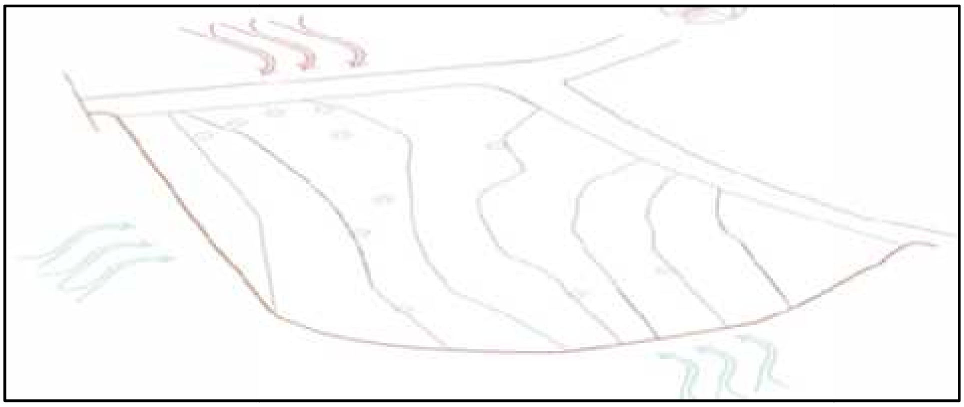


Figure 2-4: Wind movement.

2-3-7 Topography of the site:

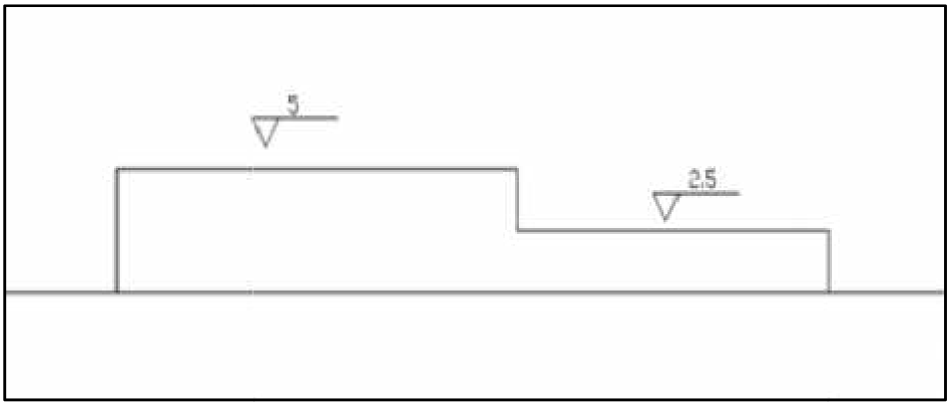


Figure 2-5: Topography of the site.

2-3-8 Contour lines:

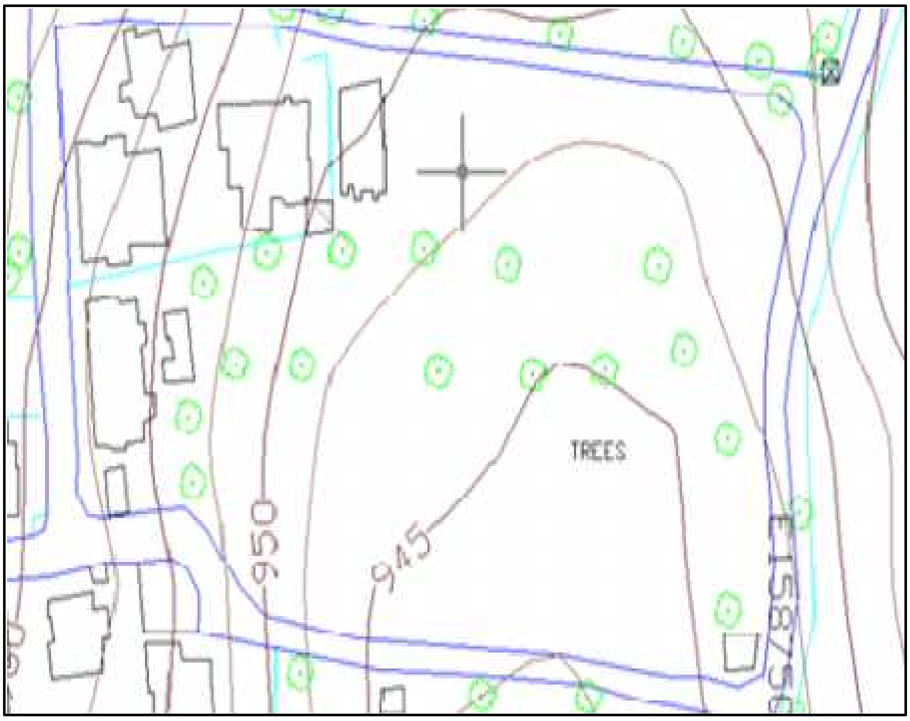


Figure 2-6: Contour earth.

2-3-9 Project land:

Figure 2-7: Project land.

2-4 Description of the project elements:

2-4-1 Ground floor :

The area of this floor is 1530 m2, It consist of :

1. Entrance, consists of: entrance hall, reception elements of the movement (elevators,
2. Public Administration consists of: office of the director general of the center of information technology, secretarial office, a conference room, an archive.
3. Department of administration and finance consists of: department of administrative affairs, finance section, archive.
4. Health units, kitchen, server room.

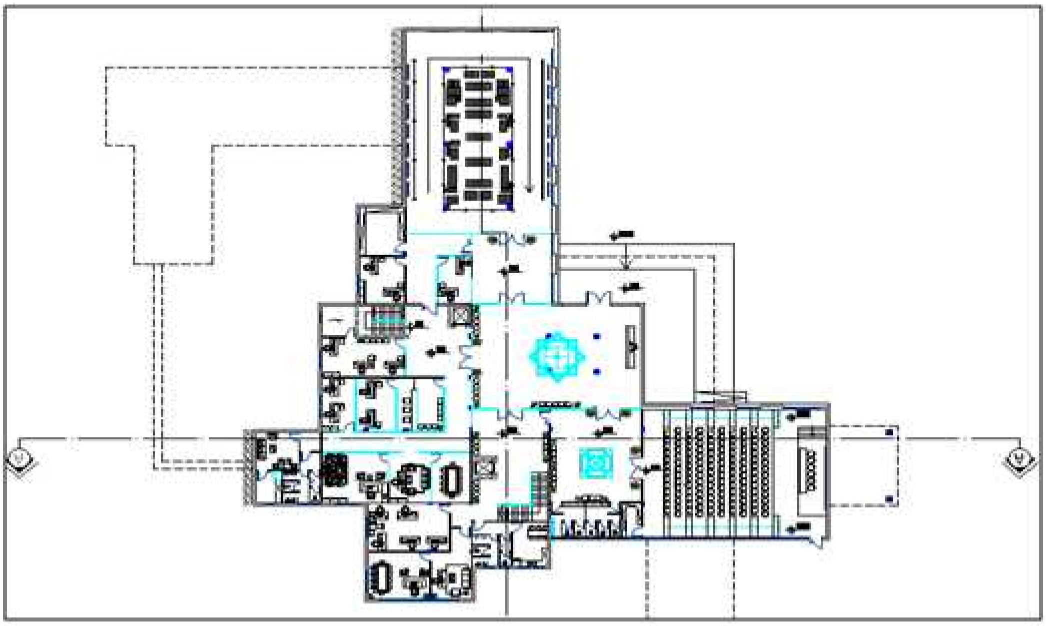


Figure 2-8: Ground floor plan

2-4-2 First floor: the area of this floor is 1720m2, consist of:

1. Cafeteria, department of scientific search, education, manufacturing department, production.
2. Marketing department consists of: offices, laboratory quality inspection, stores.
3. Entertainment section consists of: showrooms, three-dimensional cinema, public services, health units.

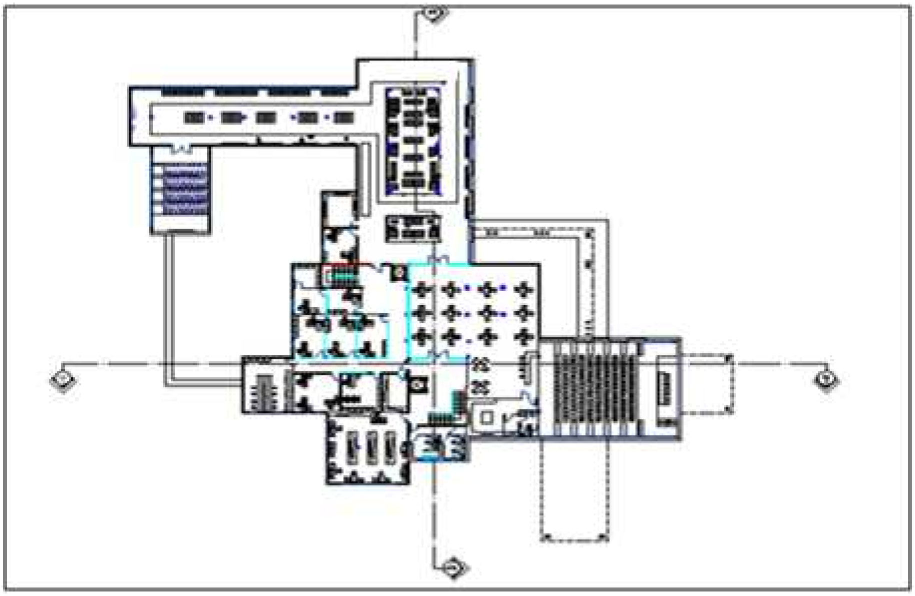


Figure 2-9: first floor plan.

2-4-3 Second floor:

The area of this floor is 800 m2, consists of: Department of Education consists of administration Tutorial section consists of: lecture halls, hall listed, computer labs, hands-on training labs, technological museum, scientific library Health units.

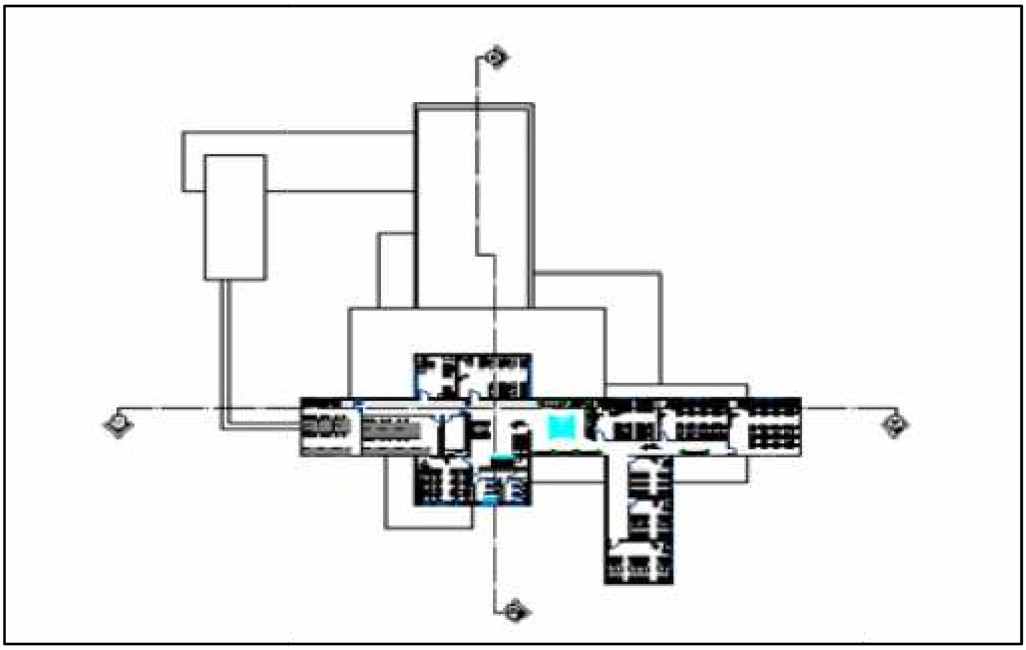


Figure 2-10: second floor plan.

2-5 Description of elevations:

There is no doubt that elevations emanating from any design give the first impression of the building and the extent of his relationship with the surrounding environment, but it is showing the different function of the blanks and reflected by the interface; this comes through the holes shown by the interface, which must be commensurate with the function of the vacuum system, or through elevations and uneven.

2-5-1 Southern elevation:

Looking at the southern elevation note architectural creativity through the diversity of the blocks and differentiated in sizes and heights and designed to match the slope of the ground.

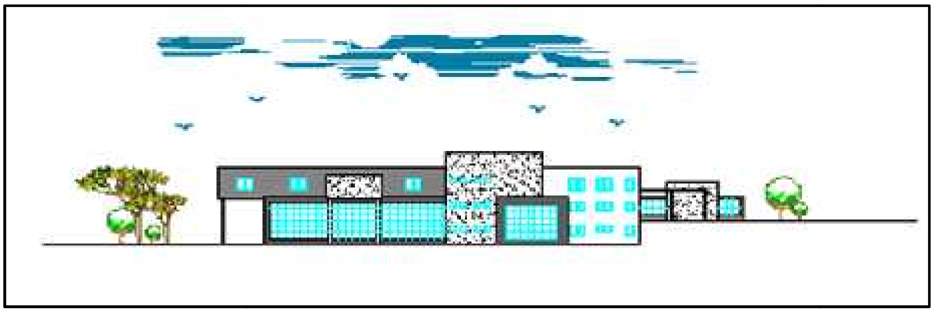


Figure2-11: Southern elevation.

2-5-2 Eastern elevation:

This elevation appears in the main entrance of the center and note the use of a variety of materials and the varying heights of the blocks.

Figure 2-12: East elevation.

2-5-3 Northern elevation:

Note by looking at this interface diversity of materials used in the interfaces and varying altitudes blocks.

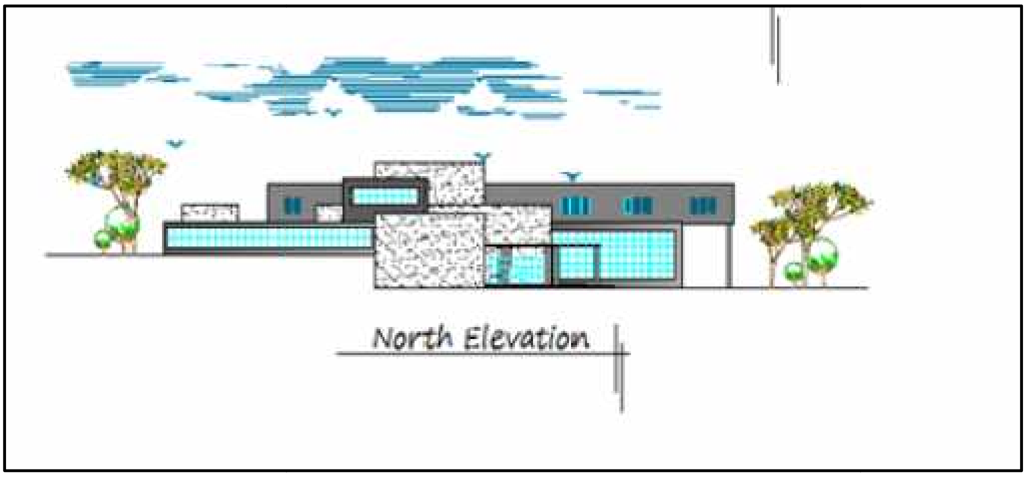


Figure 2-13: North elevation.

2-5-4 Western elevation:

We note in this interface using glass in abundance, which gave it a nice look and use a variety of materials .

Figure 2-14: West elevation.

2-6 Description of movement in the building:

Movement in the building is smoothly and easily through the use of stairs and electric elevators to move between floors.

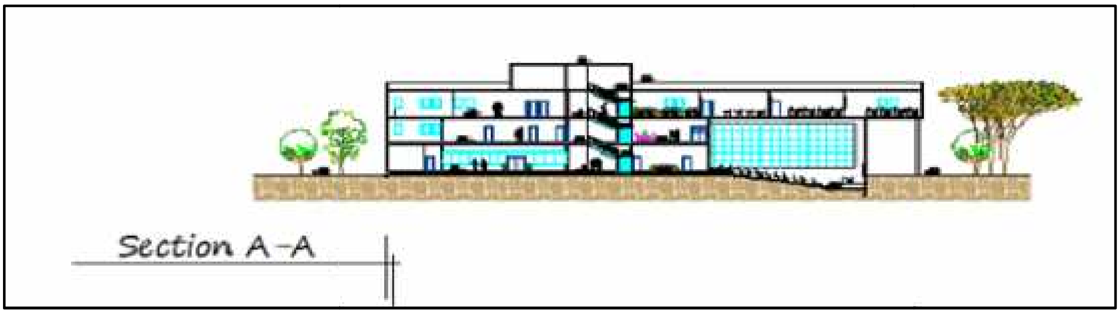


Figure 2-15: Building section.

Chapter III

Content :

3-1 Introduction.

3-2 The purpose of structural analysis and design.

3-3 Analytical and theoretical studies.

3-4 Construction elements.

3-1 Introduction:

The process of structural analysis and design of any building is integrated and indivisible, so after finishing the description of the architectural elements and the building of the Centre of information and technology, we turn to Study the existing structural elements so we can choose the structural optimization system for the building so we can design it.

In this chapter we study different structural elements such as columns, beams, foundations and other structural elements, will also specify values for the different loads on each of these elements, these types of loads can be dead or live loads or other environmental loads accordance with the requirements and standards which we will mention later.

3-2 The purpose of structural analysis and design:

The purpose of structural design, is to have an integrated and interdependent building, works as one united unit to resist the circumstances and factors affecting such live, dead and environmental loads. When designing any construction element we must take into account the following criteria:-

1. **Safety:** It is accessed by selecting the appropriate structural element, in the right place, capable of resisting the loads and strains safely.
2. **Coast:** Achieved through the kinds of construction materials used and affordable and adequate for the purpose which will be used for, without overdoing it.
3. The limits of serviceability in terms of avoiding deflection and avoid cracks that distort the building architectural, and structural weakened.
4. Maintaining the beauty of the building.

3-3 Analytical and theoretical studies:

3-3-1 Soil investigation:

The purpose of our investigation is to explore and evaluate the subsurface conditions at various locations in the project site in order to develop geo-technical engineering recommendations for foundation design and construction.

Before the construction analysis of any building becomes work of geotechnical studies for the site, it means every process related to explore the site and study the soil, rocks and groundwater, and analysis of information and translated it for predicting the soil behavior .The most important thing is to get the soil bearing capacity in order to know how to design and build on it.

3-3-2 Site condition:

The site is situated on top of high raise hilly area where the ground surface slopping towards the south side with ground surface covered by clayey gravels and rock fragments materials.

3-3-3 Laboratory tests and its results:

The results of laboratory and field-testing are presented in the boring logs and the physical and mechanical laboratory testing results are shown in table 1-3 with:

Table 3-1 : Laboratorv tests and its result

Boring	Depth m		γ_d	ω	Strength			Soil Description
					q_u	Su	Φ	
	From	To	gm/cm³	%	MPa	KPa	°	
BH 1	TOP	3.0	2.338	0.8	23.5	678	40	LIMESTONE, hard, thickly bedded, dry, rosy
	3.0	12.0	2.295	1.3	11.4	328	40	LIMESTONE, medium hard, thickly bedded, dry, gray
BH 2	TOP	3.0		0.9				LIMESTONE, hard, thickly bedded, dry, rosy
	3.0	8.0	2.288	1.7	13.8	420	40	LIMESTONE, medium hard, thickly bedded, dry, gray
B-3	TOP	3.0		0.5				LIMESTONE, hard, thickly bedded, dry, rosy
	3.0	8.0		2.0				LIMESTONE, medium hard, thickly bedded, dry, gray
BH 4	TOP	1.0		1.0				LIMESTONE, hard, thickly bedded, dry, rosy
	1.0	12.0	2.298	2.2	13.6	555	40	LIMESTONE, medium hard, thickly bedded, dry, gray
BH 5	TOP	8.0		2.9				LIMESTONE, medium hard, thickly bedded, dry, gray
BH 6	TOP	8.0	2.271	2.7	12.4	220	40	LIMESTONE, medium hard, thickly bedded, dry, gray
BH7	TOP	4.0		1.6				LIMESTONE, hard, thickly bedded, dry, rosy
	4.0	8.0	2.277	3.0	9.4	155	40	LIMESTONE, medium hard, thickly bedded, dry, gray
B-8	TOP	2.0	2.299	1.4	22.6	661	40	LIMESTONE, hard, thickly bedded, dry, rosy
	2.0	3.8		2.1				LIMESTONE, medium hard, thickly bedded, dry, gray
	3.8	4.0						SMALL VOID
	4.0	8.0						LIMESTONE, medium hard, thickly bedded, dry, gray
BH 9	TOP	12.0	2.251	2.7	11.8	481	40	LIMESTONE, medium hard, thickly bedded, dry, gray

The structural analysis process addressed mainly the study of loads that affects the facility, to develop a ways of resisting by a very well structural form with a required precision and care.

3-3-4 Loads:

3-3-4-1 Loads classification:

Loads which are directly affects the building classified into:

1. **Main loads (direct):** which include dead and live loads and environmental loads.
2. **Secondary loads (indirect):** These include shrinkage of concrete drought, heat impact and crawl and consolidation.

So in structural calculation, we must consider the accuracy in the process of representation of loads on structural elements as the previous classification, concrete, for example, has an expansion and shrinkage factor different than its reinforcement steel factor.

The designed structural elements must be able to carry loads without the occurrence of any failure, and these loads are:

1. **Dead loads.**
2. **Live loads.**
3. **Environmental loads.**

3-3-4-1-1 Dead loads:

Are loads resulting from the self-weight of building, which consists of the weights of building materials used which include all the structural elements and fixtures weight loads are inherent in the building permanently with a fixed amount and direction. With regard to specific density of the materials used are as follows:

	Material	Density (kN/m^3)
1	Tiles and mortar	22
2	Reinforced concrete	25
3	Sand	16.4
4	Plaster	22

Table 3-2 : specific density of the used materials.

3-3-4-1-2 Live loads:

Loads experienced by buildings and construction because of their different uses, including distributed and concentrated loads, which include:

1. **Dynamic loads:** such as equipment which give rise to vibrations affecting the entity.
2. **Static loads:** and that can change places from time to time such as weights of people and furniture houses, and the stored material and furniture and the table below shows the value of live loads depending on our building uses by the Jordanian code.

Table 3-3 : live loads.

Tybe of structure	Live load (kN/m)
Educational buildings:	
Classrooms	3
Laboratories	3
Assembly halls and theater	5
Offices	3
Stairs	4
Storage room	10-5
Cafeteria	2
Halls	5
Libraries: Reading room	4
Stationery	6.5

(From the Jordanian code for loads.)

3-3-4-1-3 Environmental loads:

Are loads caused by the environmental effects on the building.

3-3-2-1-4 Wind load:

A horizontal forces affect the building which can clearly show in high-rise ones, it has a positive value as a result of pressure and negative as a result of tension, measured in kiloNewton per square meter (KN / m2). The determination of wind loads depending on the height of the building above the ground, and its location from the surrounding buildings, whether high or low, and these loads are resisting through shear walls which are distributed according to the loads acting on them.

3-3-4-1-5 Snow loads:

loads that can affect the building due to snow accumulation, snow loads can be evaluated as the following:

1. The height of the building above sea level.
2. Slope of roof.

The following table shows the value of snow loads according to height above sea level by the Jordanian code.

Table 3-4: snow loads according to Jordanian code.

Height of building above sea level (m)	Snow load (KN /m²)
h < 250	0
500 > h > 250	(800) /h-250
1500 > h > 500	(h-400) / 320

(From the Jordanian code for loads.)

3-3-4-1-6 Earthquakes:

One of the most important environmental loads affecting the building, consist of a horizontal and vertical forces that generate moments, including overturning and torque moments , that can be resisted using shear walls with a thicknesses and reinforcement enough to assure the safety of the building when exposed to such loads that must be considered in the design process to reduce risk and maintain the performance of the building during earthquakes. We will use code (UBC 1997) in order to define and determine the seismic loads and the shear force according to it.

(3-4) Construction elements:

The building is an outcome of the coherence of structural elements with each other, to become a single integrated block, confrontational loads that are exposed, the most important of these elements, slaps, beams, columns, shear walls, foundations and others.

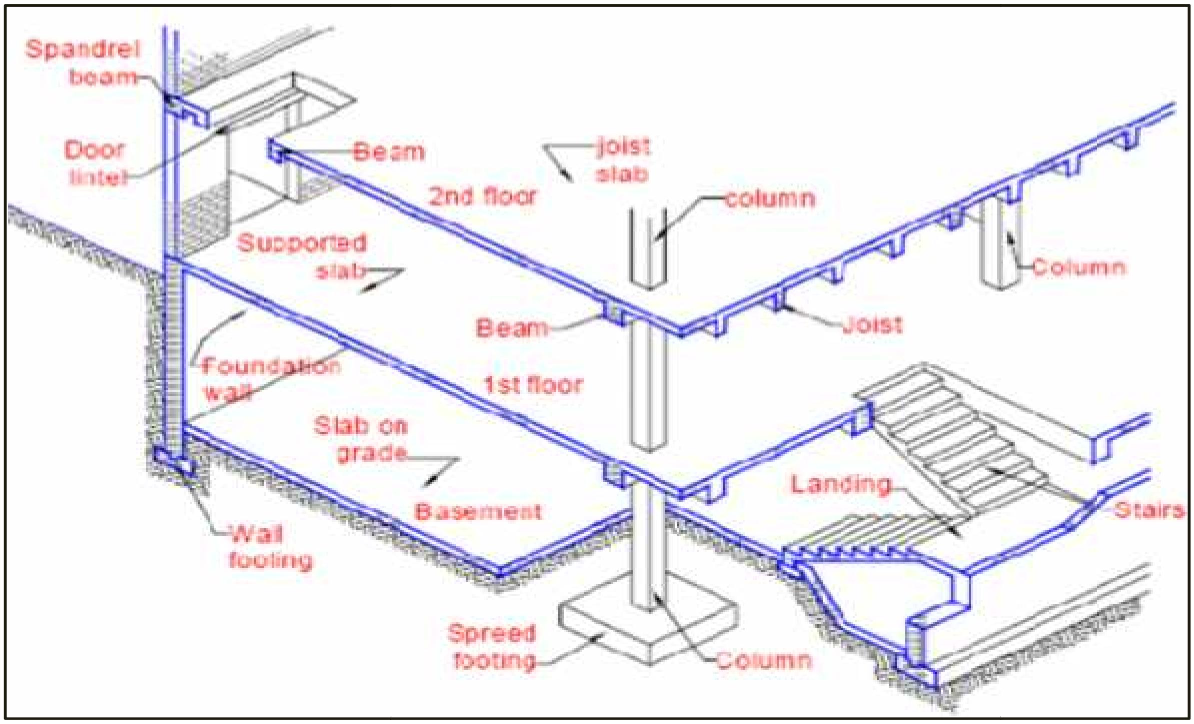


figure 3-1: Some of the construction elements in the building.

3-4-1 Slabs:

Slabs are structural elements that transfer the vertical forces due to the loads affecting the structural elements of the building such as beams, walls and columns, without distortions.

There are many different types of commonly used reinforced concrete slabs, including the following:

1. **Solid slabs.**
2. **Ribbed slabs.**

Because there are many activities in this project, and the diversity of architectural requirements, we have been using both types as appropriate for the nature of use, which will clarify the structural design in the classroom Suffix.

3-4-1-1 Solid Slabs:-

1. This type is divided into two parts:-

   One Way Solid Slabs: which Have been used in some stairwell slaps.

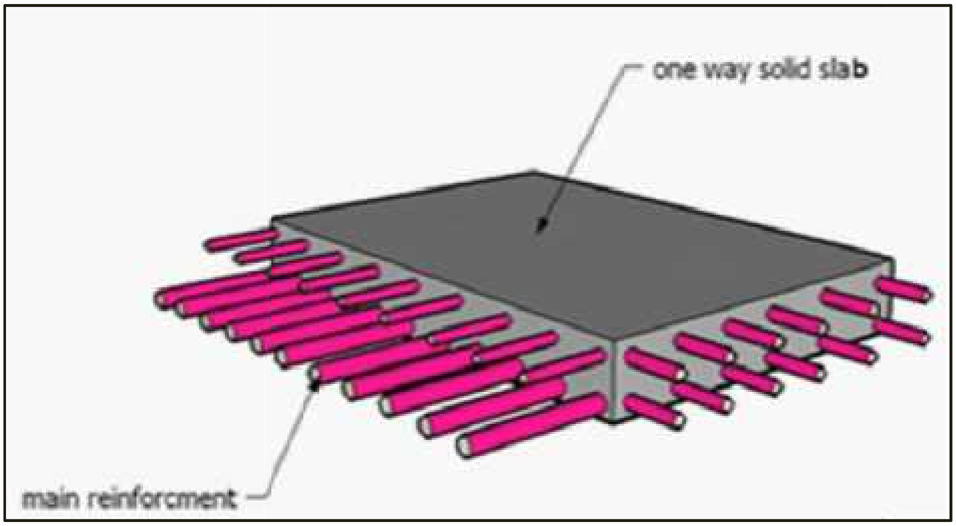


figure3-2: One way solid slab

2. **Tow way solid slabs:** which have been used in some stairwell slaps.

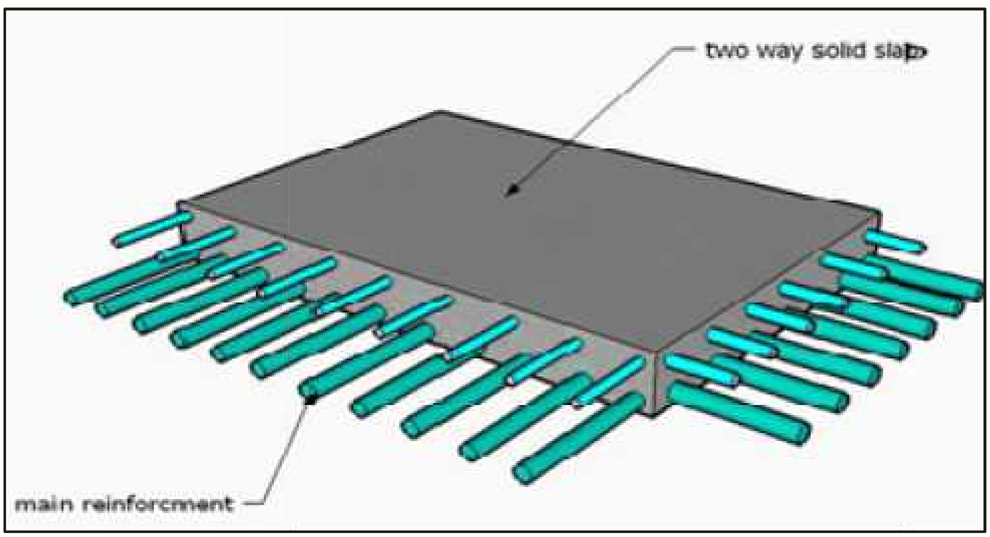


Figure 3-3: Two way solid slab

(3-4-1-2) Ribbed slabs:

Divided into two sections:

1. **One way ribbed slabs:** which consists of hollow slabs with a total depth greater than that of solid slabs. The system is most economical for buildings where superimposed loads are small and spans are relatively large, such as schools, hospitals, and hotels etc.… .

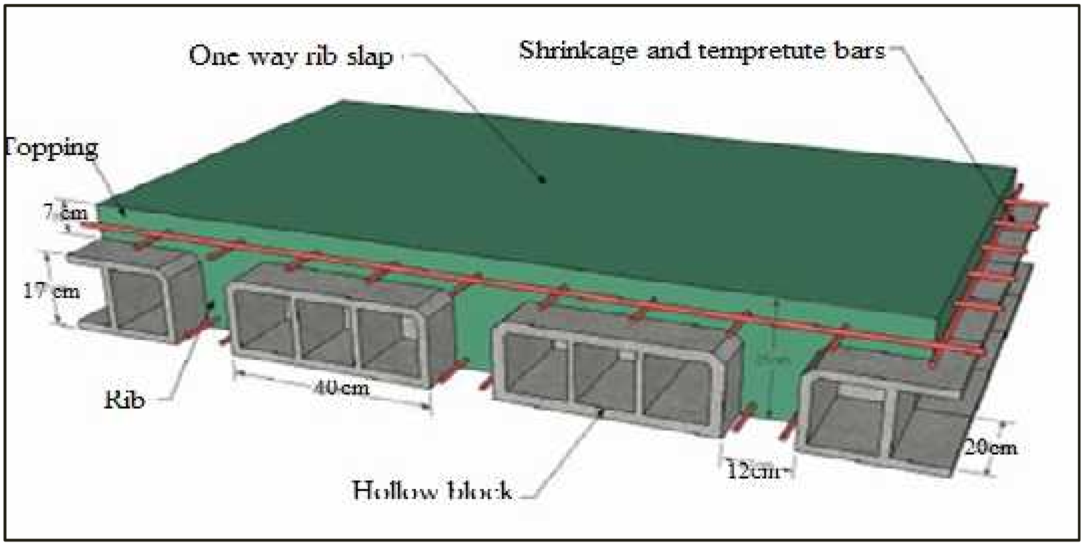


Figure 3-4: One way ribbed slab

Two way ribbed slabs: used in the case of relatively large spaces, especially when spans are close spacing and with distances more than 6 m.

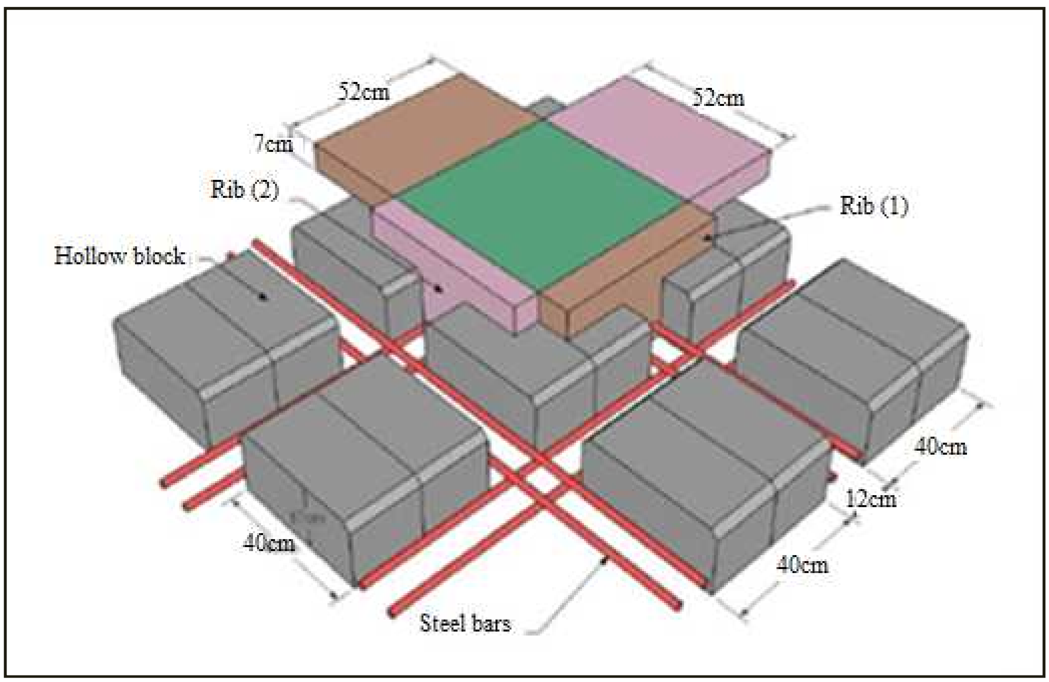


Figure 3-5: Tow way ribbed slab

3-4-2 Beams :

They are essential structural elements, transporting loads of ribs and solid slaps to move them to the columns, and concrete beams on two types:-

1. **Hidden beams:** a beams hidden inside the slap so that its height equals the height of the slap.
2. **Drop beams:** a beam whose height is greater than the height of the slap, the excess part of the beam is in both directions lower one (Down Stand Beam) or upper (Up stand Beam) so that these bridges are called L -section, T-section.

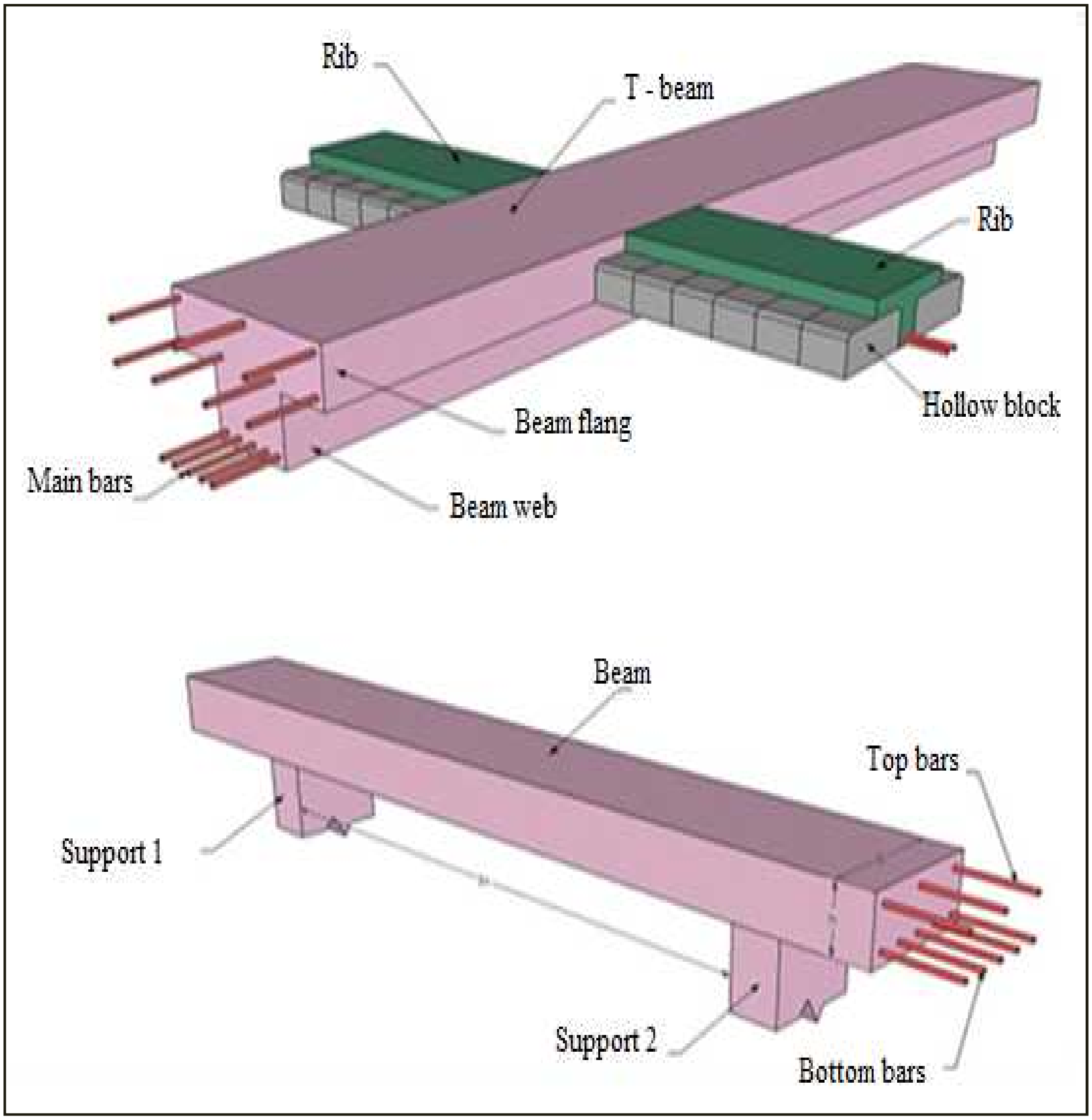


figure3-6: Beams

3-4-3 Columns:

Columns are considered as the main component in the transfer of loads from slaps, beams and transferred it to the foundations , so it is an essential structural component in the transfer of loads and the stability of the building. So they must be designed to be able to carry and distribute of loads that's affecting them.

For the types of the columns they are two types: short and long columns. Columns sections have many forms, including rectangular, circular, polygon, box and the boat. Another classification of columns is in terms of the type of construction material used such as concrete, metal, wood.

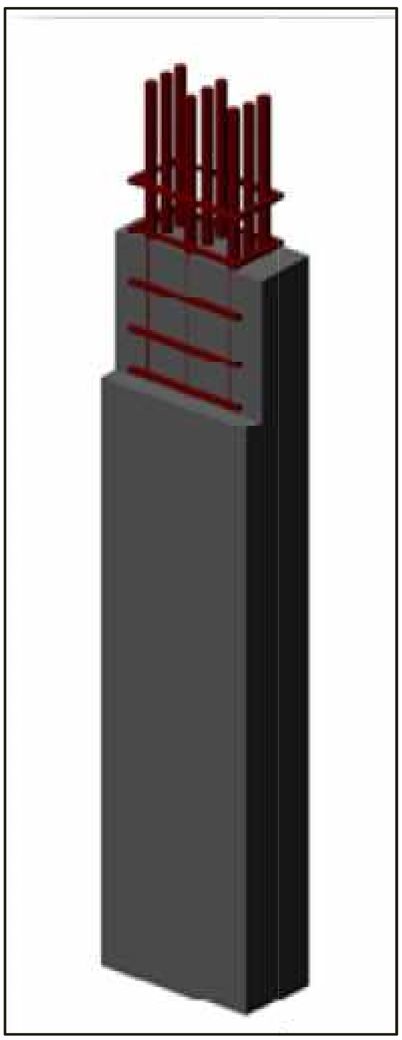


figure 3-7: Rectangular column

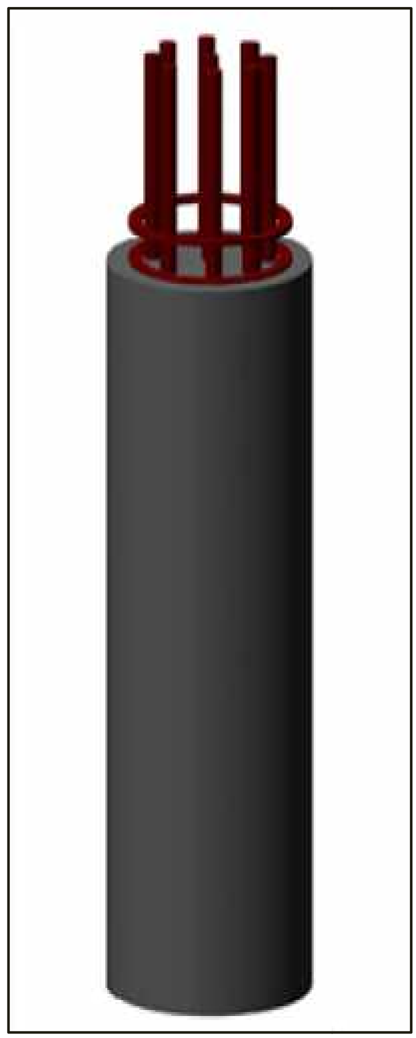


figure 3-8: Circular column

3-4-4 Shear walls:

Structural elements resisting the vertical and horizontal forces which affecting them, and used primarily to resist horizontal loads such strong winds and earthquakes.

These walls resisting the vertical weights transferred to them, and resist the horizontal forces that affecting the building, so they must be available in both directions, taking into account that the distance between the center of rigidity that the shear walls represent and the center of gravity of the building to be as less as it can and to be enough to reduce the generated torques and their effects on the building walls that resist the horizontal forces.

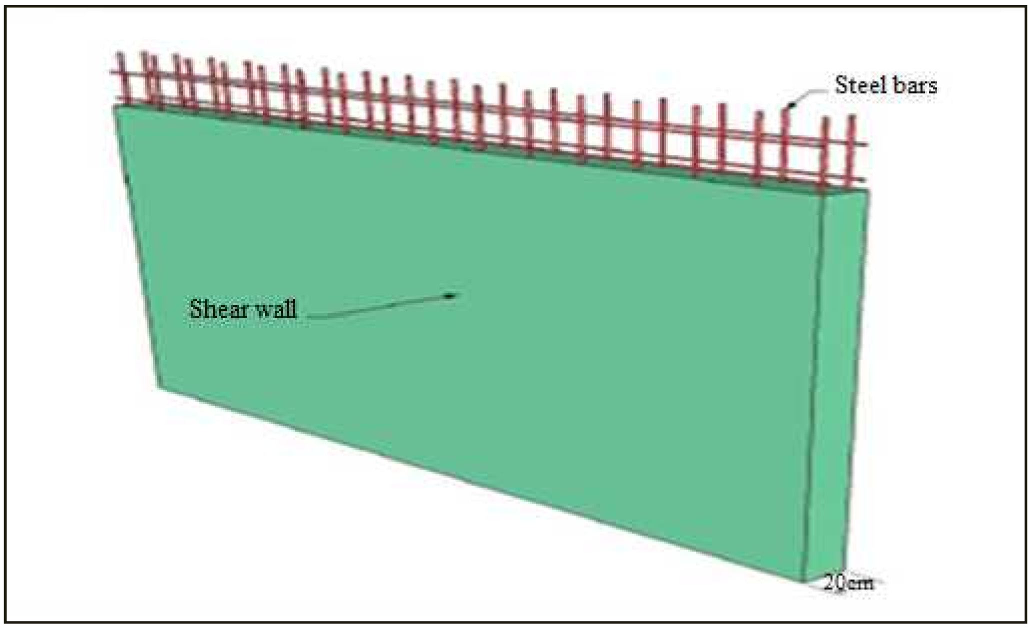


figure 3-9:shear wall

3-4-5 Foundations:

Foundations are the link between the structural elements of the building and the land, the weights and loads which have been carried by them, they come from the loads located on slaps moves into beams and then to the columns and finally to footings into the soil. The foundation must be responsible for carrying the dead loads of the building and also dynamic loads resulting from wind and snow, and earthquakes and also live loads within the building.

These loads are loads of design for foundations, and from the loads, and the nature of the site is specifying the type of foundation used, and it is expected to use different types of foundations depending on soil bearing capacity and loads along each foundation.

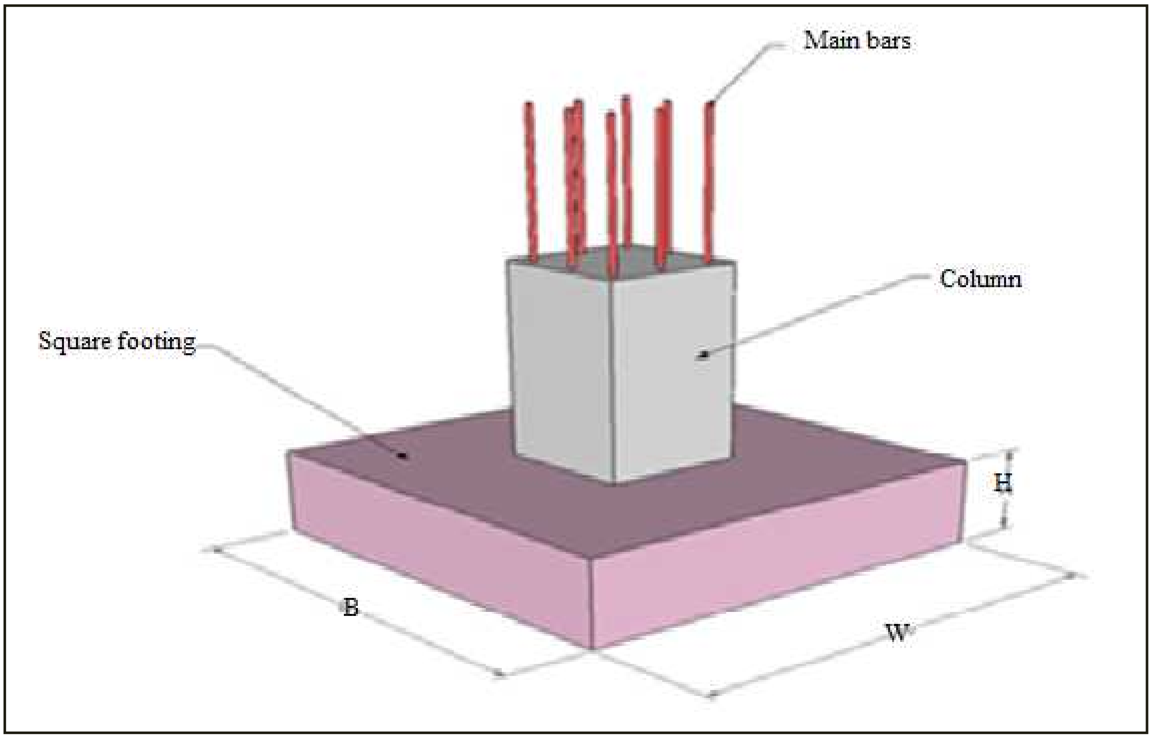
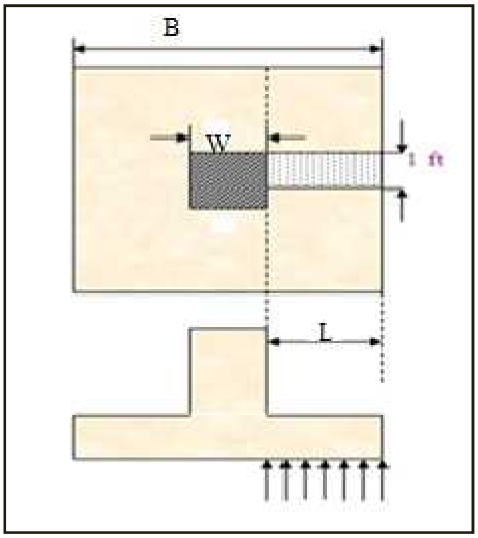


Figure3-10: isolated footing



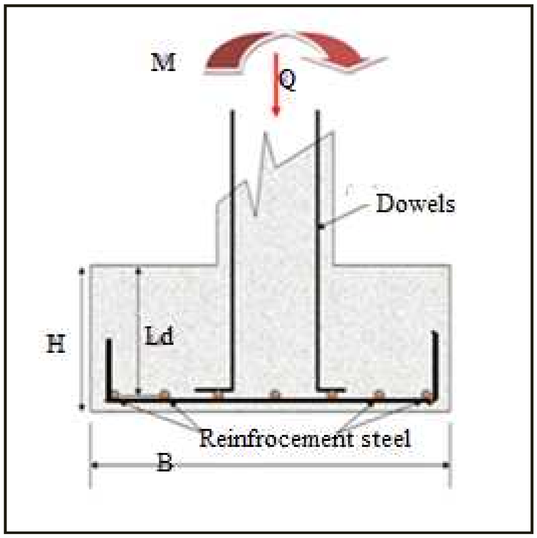


figure 3-11: isolated footing plan figure 3-12: isolated footing section

3-4-6 Stairs:

Structural element responsible for vertical movement between floors in the building where floor height is divided into small heights representing high of it. Staircase design is structurally as a solid slap in one direction.

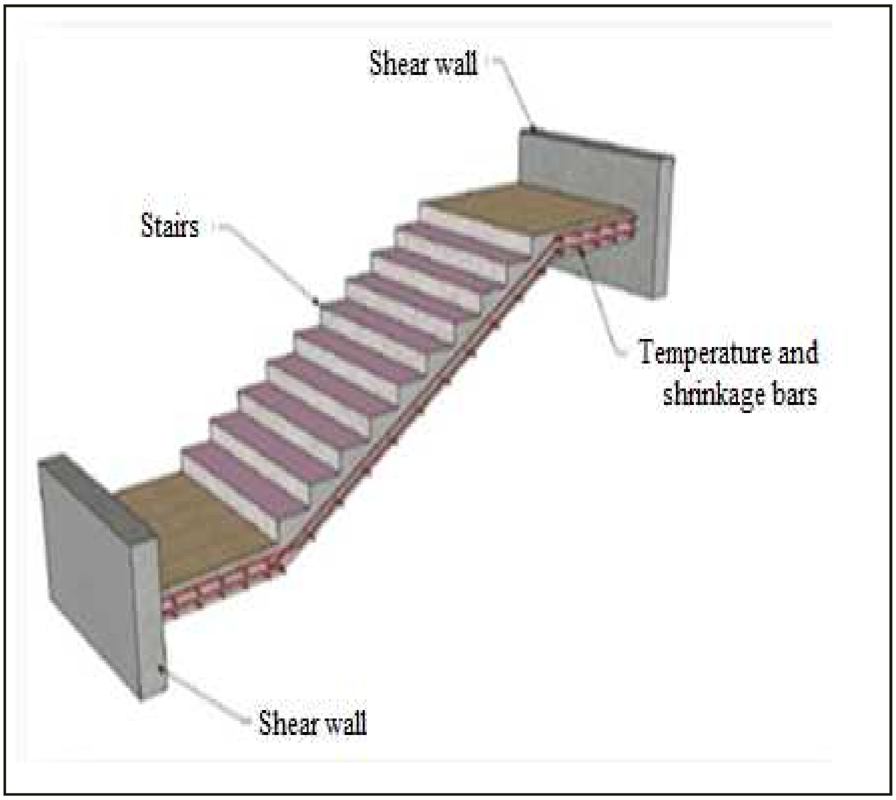


figure 3-13: Stair diagram

3-4-7 Retaining Walls:

These walls are built to support the soil and water which left behind it and it's resulting pressure trying to fluctuation or move this wall, retaining walls designed to resist the vertically weight of the soil and horizontal soil pressure and the lifting pressure of ground water.

Because of the obvious difference in levels of project land, we will use bearing walls to protect the soil from falling or slipping, these walls construction materials can be concrete, reinforced concrete and stones.

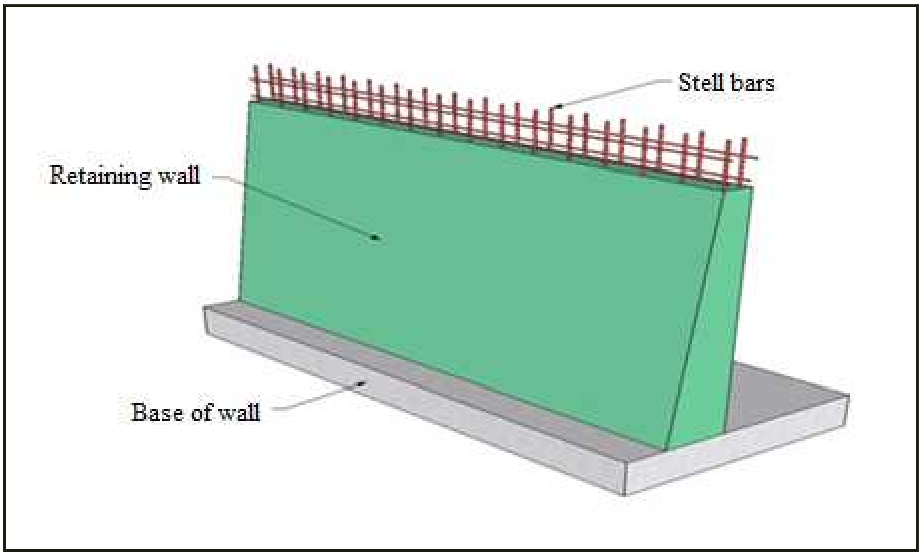


figure 3-14: Retaining wall

3-4-8 Expansion Joints:

Implemented in buildings with large horizontal dimensions or shapes and special situations, thermal or settlement joints may be for both purposes, a splitter is placed if the width of the building (35-40) Meter to allow the building to expand without leading to cracks. In the analysis of constructions considered as a resistance to seismic actions called these intervals with seismic expansion joints, and these expansion joints some requirements and recommendations in accordance with the following:

1. Thermal expansion should be used in the building, that these intervals up to the upper face of the foundation without impenetrable. The vast distances of the dimensions of the building block as follows:
   a. 40m in areas with high humidity.
   b. 36m in areas with normal humidity.
   c. 32m in the medium humidity areas.
   d. 28m in dry areas.
2. Expansion joint width should not be less than (3cm).

Chapter II

Content:

2-1 Introduction.

2-2 Overview of the project.

2-3 Project location.

2-4 Description of the project elements.

2-5 Description of elevations.

2-6 Description of movement in the building.

2-1 Introduction:

Architecture is one of the most prominent engineering sciences, which is not the result of this era, it is since God created humans who uncorked his talents and his thoughts, human by this talent lift from the life of the caves to the best form of welfare, Taking advantage of the beauty that God gave to this picturesque nature.

Architecture has become an art and talent and ideas. It derives its fuel from what God gave to the architectural beauty of the talents. For each art or science controls and limits, but architecture not subject to any limit or restriction, it is oscillating between fantasy and reality, although of simplicity of some architecture buildings but may have many surprises for us when we enter and interact with the details.

The building may seem simple from the outside like a piecemeal to several large pieces without a sense of communication between these pieces, but in fact it is connected and interconnected through the distances and multiple bridges and building support in the engineering formation depends entirely on the geometric Figure of normal recurring unit throughout the building, although they sometimes skew and cut out the visual composition do not suggest be associated with the regular form.

The design of any structure or building process Performs through several stages until it is done to the fullest, begin first phase of architectural design where they are at this stage to determine the Figure of origin and taken into account to achieve the different functions and requirements for which will be the establishment of this building, where it is a primary allocation to accompany, in order to achieve the required spaces and dimensions and determine the columns and axis positions, and are in the process also study lighting, ventilation, movement and other functional requirements.

After the completion of the architectural design phase and out final form, structural design process which aims to identify the dimensions of structural elements and characteristics begin depending on various loads located and which are transported through these items to the foundations and then into the soil.

2-2 Overview of the project:

Thinking about implementing each project, there must be a goal from it, so the main goal of this proposal is to work on the establishment of a separate building serve. As an Information Technology Center, which is an educational project meaningful, contain spaces and a variety of activities, and therefore helps to attract the attention of the younger generation, so the project needs a large tract to achieve the desired purpose, and sufficiently to embrace the talents and abilities of this generation.

So the idea of the project are summarized in the creation of technology information center will be useful for the emerging generation and meets their needs and encourage them to education and innovation in a comfortable learning environment and organization.

The Center of technology includes rooms, cinema, cafeteria, terraces and teaching rooms, laboratories and libraries meet all the needs, and the offices of various uses including administrative and other services.

Architectural plans for this project was obtained from the Civil and Architectural Engineering Department at Palestine Polytechnic University to enable structural design work and preparation of structural working drawing for all structural elements covered.

2-3 Project location:

For the design of any project, it should be considered a location to create the building carefully whether relating to geographical location or the impacts of climatic prevailing in the region, so the existing elements and their relations with the proposed design in concert to achieve the optimal design, therefore, should give a general idea of the elements of the site, to clarify land for the proposed building and the relationship of the site and services surrounding streets, and the height of surrounding buildings, and the direction of the prevailing winds and the path of the sun.

2-3-1 Proposed sites:

Depending on the planning and design standards, and on the strategy in determining the project site, two sites have been proposed for the establishment of an information technology center, which is as follows:

The first proposal: Selected plots of land in the northern part of the city of Hebron, near the traffic circle, the site is accessed from the eastern side of the head during the Jura Street, is access to capital quarry roundabout located in the West End, an area of about 10 acres from Hebron University to the top of the Jura.

Figure 2-1 : The proposed land near the traffic circle.

The second proposal (selected location): Located pieces of the proposed land second option in the northwestern part of the city of Hebron, near Hebron University, where he is accessing the site through a branch road linking Hebron's main University Street with Al-Salam arterial street, an area of about 10 acres, while the slopping reach to 6%.

2-3-2 Reasons for choosing land near Hebron university:

After a comparison between the proposed sites for the establishment of information technology Centre, it has been selected suitable land a land located near Hebron University, because :

1. It is too close to the Hebron University and thus could be a magnet for a certain segment of young people, on the grounds the center is primarily an educational.

2. Widening swath of land.

3. Accessibility of the site.

4. The availability of public services.

5. Visible Site and sights.

6. The availability of green areas.

2-3-3 The project land analysis:

After the appropriate location has been chosen for the project we analyzed the land as follows:

2-3-4 Roads and Transport:

The project site of the active sites in Hebron, and the advantage is easily accessible by public transport. Where are accessing the site through several streets, including street that leads to Hebron University, and through Al Salam Street.

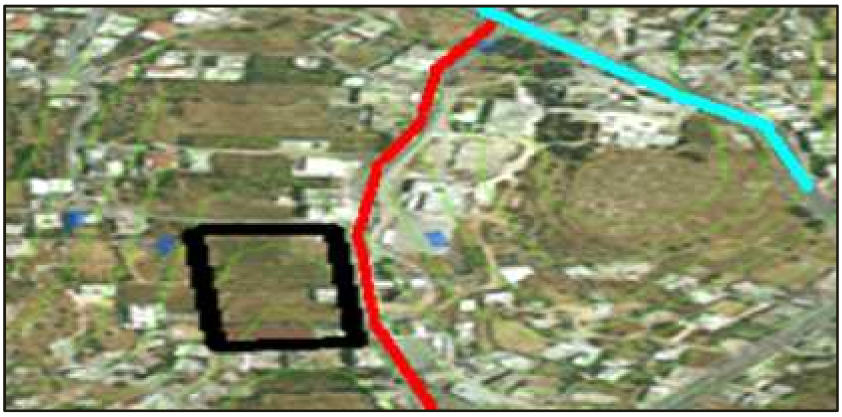


Figure 2-2: Land near the proposed site of the Hebron University.

2-3-5 Movement of the sun:

The amount of solar radiation varies throughout the year and reaches its maximum rate in the city June 8 cal / cm2 / day, while the annual rate of radiation amounts to 18 thousand kcal / cm 2. The annual average number of hours that radiate the sun is 3300 hours / year. Great and her end of 4400 hours.

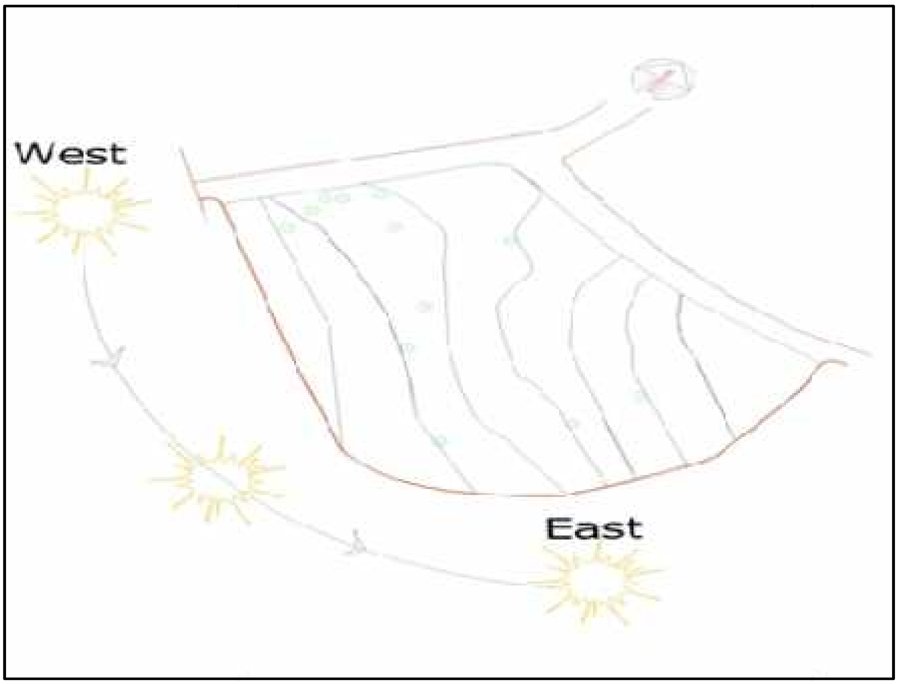


Figure2-3 : Movement of the sun.

2-3-6 Wind movement at the site:

Wind affects the buildings either on the walls or the structure in addition to erosion processes and erosion, therefore, taking into account the wind direction when directing the building is essential in the design process. Usually Wind direction and speed from one area to another is different and separate to the other, local factors of pressure and terrain have a significant impact in the winds that are organized in the General Lines difference, and the most important wind blowing on the city of Hebron and affect the proposed site is south-east wind blowing in winter , North West that blows in summer and winter and the wind, so you must pay very close attention when directing the building to avoid the winds that have a negative impact on the building.

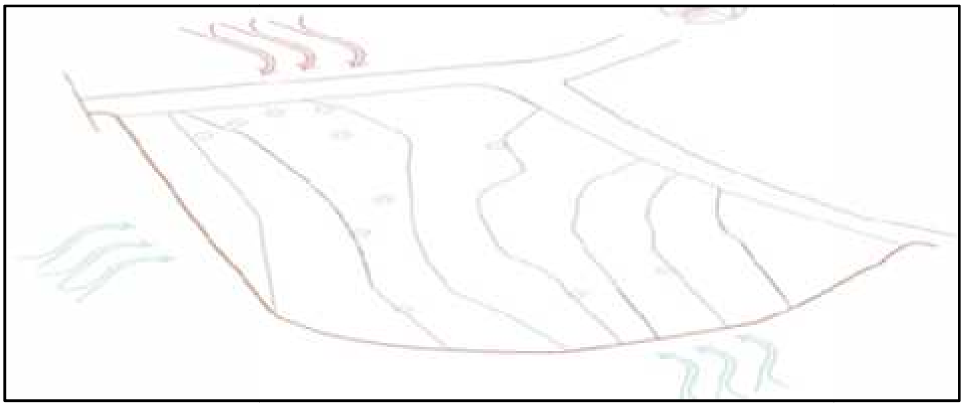


Figure 2-4: Wind movement.

2-3-7 Topography of the site:

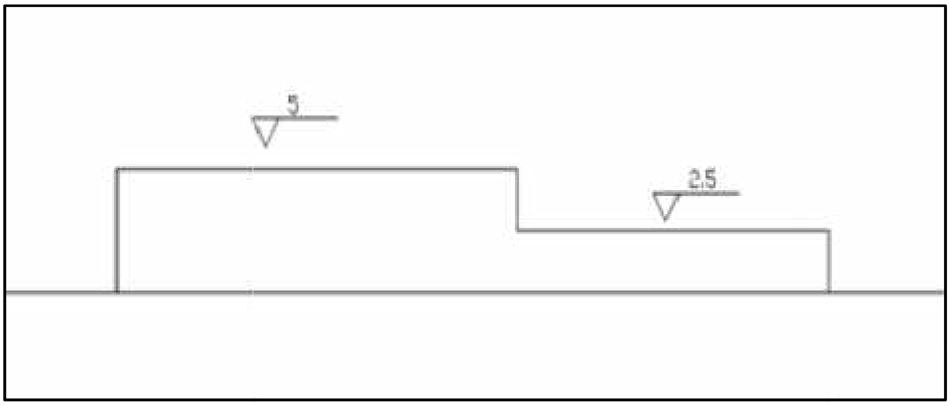


Figure 2-5: Topography of the site.

2-3-8 Contour lines:

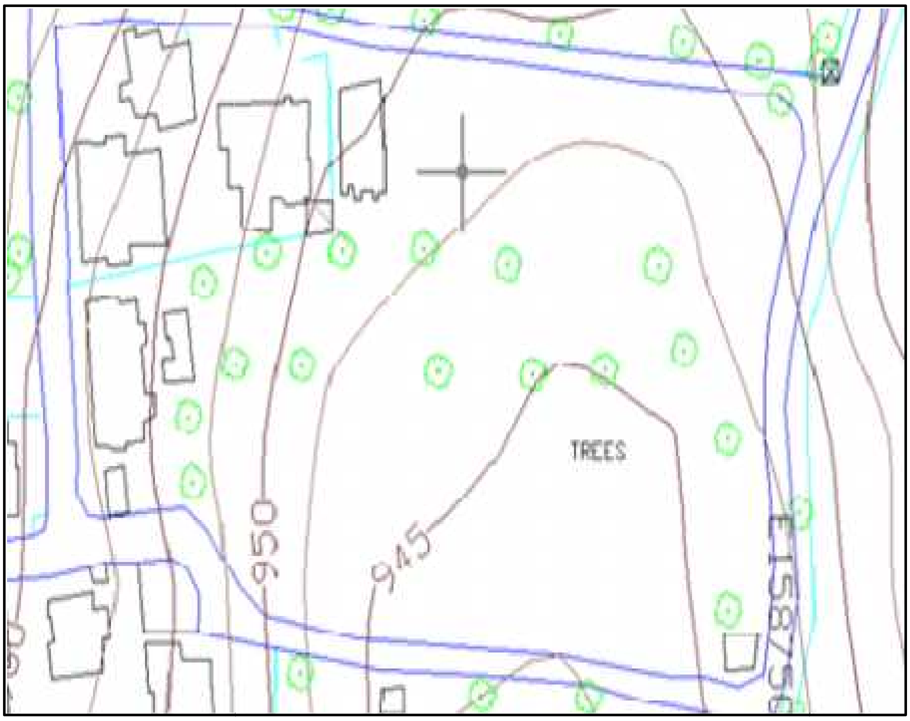


Figure 2-6: Contour earth.

2-3-9 Project land:

Figure 2-7: Project land.

2-4 Description of the project elements:

2-4-1 Ground floor :

The area of this floor is 1530 m2, It consist of :

1. Entrance, consists of: entrance hall, reception elements of the movement (elevators,
2. Public Administration consists of: office of the director general of the center of information technology, secretarial office, a conference room, an archive.
3. Department of administration and finance consists of: department of administrative affairs, finance section, archive.
4. Health units, kitchen, server room.

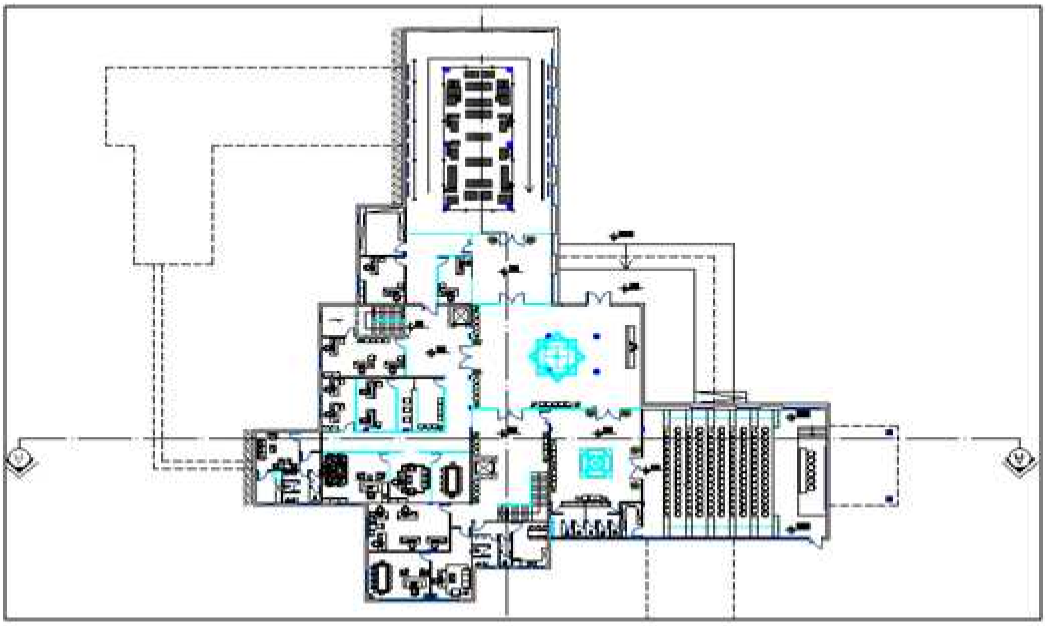


Figure 2-8: Ground floor plan

2-4-2 First floor: the area of this floor is 1720m2, consist of:

1. Cafeteria, department of scientific search, education, manufacturing department, production.
2. Marketing department consists of: offices, laboratory quality inspection, stores.
3. Entertainment section consists of: showrooms, three-dimensional cinema, public services, health units.

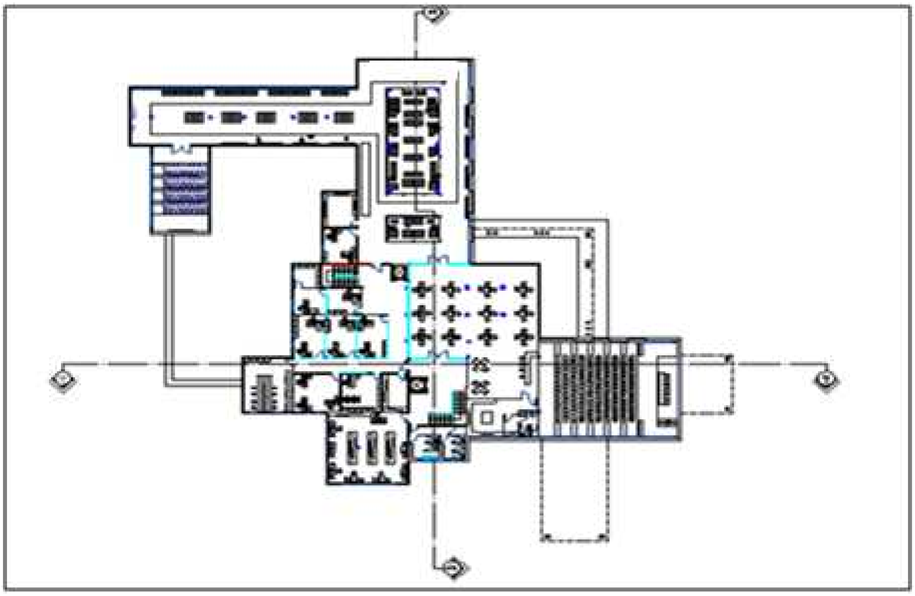


Figure 2-9: first floor plan.

2-4-3 Second floor:

The area of this floor is 800 m2, consists of: Department of Education consists of administration Tutorial section consists of: lecture halls, hall listed, computer labs, hands-on training labs, technological museum, scientific library Health units.

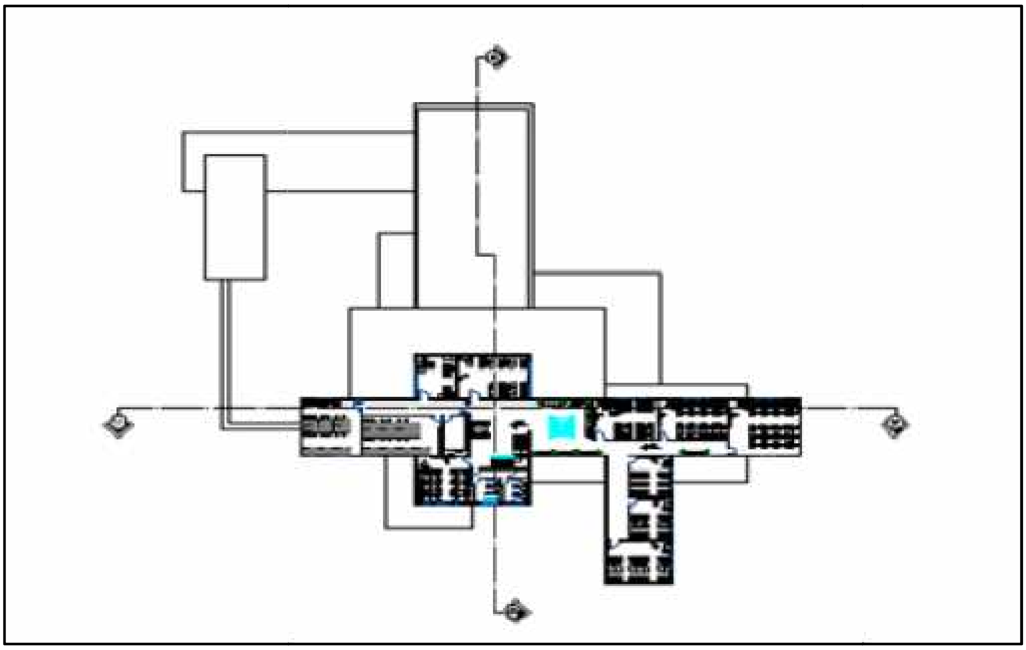


Figure 2-10: second floor plan.

2-5 Description of elevations:

There is no doubt that elevations emanating from any design give the first impression of the building and the extent of his relationship with the surrounding environment, but it is showing the different function of the blanks and reflected by the interface; this comes through the holes shown by the interface, which must be commensurate with the function of the vacuum system, or through elevations and uneven.

2-5-1 Southern elevation:

Looking at the southern elevation note architectural creativity through the diversity of the blocks and differentiated in sizes and heights and designed to match the slope of the ground.

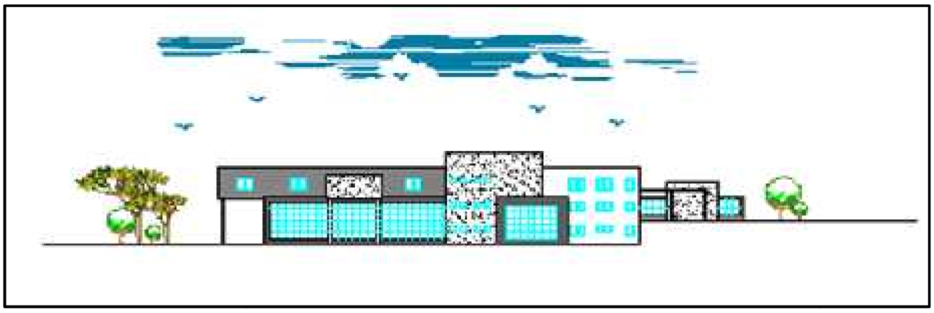


Figure2-11: Southern elevation.

2-5-2 Eastern elevation:

This elevation appears in the main entrance of the center and note the use of a variety of materials and the varying heights of the blocks.

Figure 2-12: East elevation.

2-5-3 Northern elevation:

Note by looking at this interface diversity of materials used in the interfaces and varying altitudes blocks.

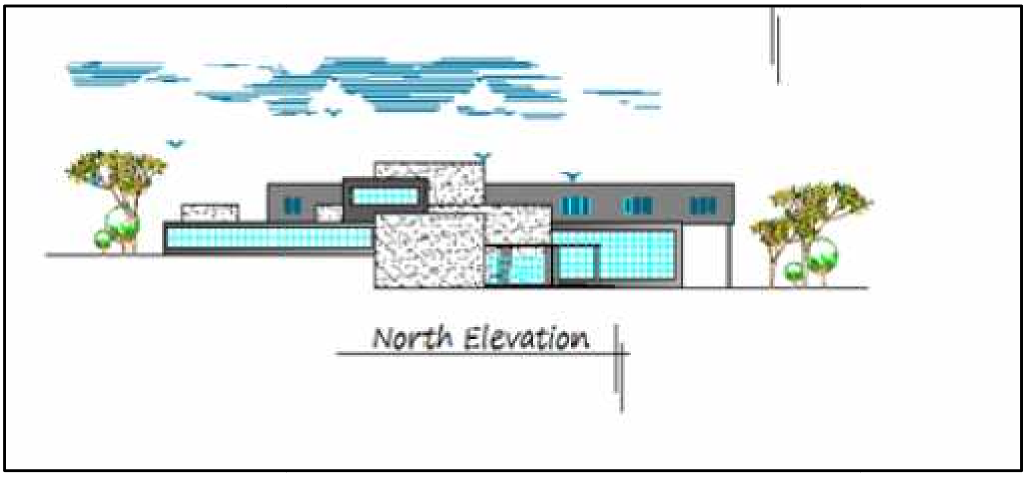


Figure 2-13: North elevation.

2-5-4 Western elevation:

We note in this interface using glass in abundance, which gave it a nice look and use a variety of materials .

Figure 2-14: West elevation.

2-6 Description of movement in the building:

Movement in the building is smoothly and easily through the use of stairs and electric elevators to move between floors.

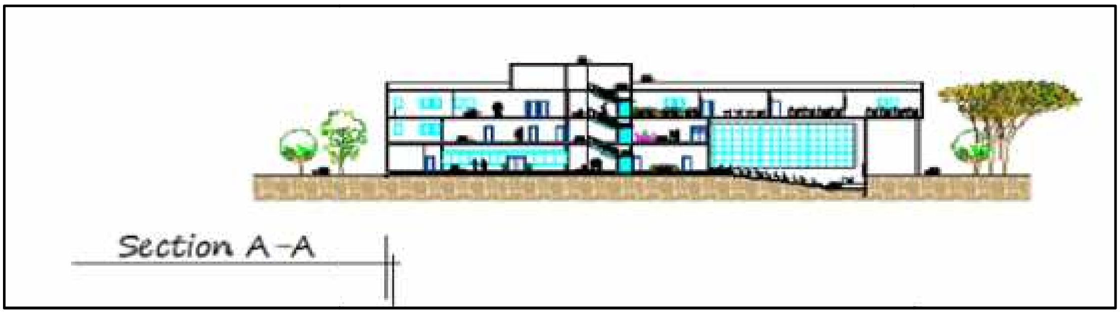


Figure 2-15: Building section.

Chapter III

Content :

3-1 Introduction:

The process of structural analysis and design of any building is integrated and indivisible, so after finishing the description of the architectural elements and the building of the Centre of information and technology, we turn to Study the existing structural elements so we can choose the structural optimization system for the building so we can design it.

In this chapter we study different structural elements such as columns, beams, foundations and other structural elements, will also specify values for the different loads on each of these elements, these types of loads can be dead or live loads or other environmental loads accordance with the requirements and standards which we will mention later.

3-2 The purpose of structural analysis and design:

The purpose of structural design, is to have an integrated and interdependent building, works as one united unit to resist the circumstances and factors affecting such live, dead and environmental loads. When designing any construction element we must take into account the following criteria:-

1. **Safety:** It is accessed by selecting the appropriate structural element, in the right place, capable of resisting the loads and strains safely.
2. **Coast:** Achieved through the kinds of construction materials used and affordable and adequate for the purpose which will be used for, without overdoing it.
3. The limits of serviceability in terms of avoiding deflection and avoid cracks that distort the building architectural, and structural weakened.
4. Maintaining the beauty of the building.

3-3 Analytical and theoretical studies:

3-3-1 Soil investigation:

The purpose of our investigation is to explore and evaluate the subsurface conditions at various locations in the project site in order to develop geo-technical engineering recommendations for foundation design and construction.

Before the construction analysis of any building becomes work of geotechnical studies for the site, it means every process related to explore the site and study the soil, rocks and groundwater, and analysis of information and translated it for predicting the soil behavior .The most important thing is to get the soil bearing capacity in order to know how to design and build on it.

3-3-2 Site condition:

The site is situated on top of high raise hilly area where the ground surface slopping towards the south side with ground surface covered by clayey gravels and rock fragments materials.

3-3-3 Laboratory tests and its results:

The results of laboratory and field-testing are presented in the boring logs and the physical and mechanical laboratory testing results are shown in table 1-3 with:

Table 3-1 : Laboratorv tests and its result

Boring	Depth m		γ_d	ω	Strength			Soil Description
					q_u	Su	Φ	
	From	To	gm/cm^3	%	MPa	KPa	°	
BH 1	TOP	3.0	2.338	0.9	23.5	678	40	LIMESTONE, hard, thickly bedded, dry, rosy
	3.0	12.0	2.295	1.3	11.4	328	40	LIMESTONE, medium hard, thickly bedded, dry, gray
BH 2	TOP	3.0		0.9				LIMESTONE, hard, thickly bedded, dry, rosy
	3.0	8.0	2.288	1.7	13.8	420	40	LIMESTONE, medium hard, thickly bedded, dry, gray
B-3	TOP	3.0		0.5				LIMESTONE, hard, thickly bedded, dry, rosy
	3.0	8.0		2.0				LIMESTONE, medium hard, thickly bedded, dry, gray
BH 4	TOP	1.0		1.0				LIMESTONE, hard, thickly bedded, dry, rosy
	1.0	12.0	2.298	2.2	13.6	555	40	LIMESTONE, medium hard, thickly bedded, dry, gray
BH 5	TOP	8.0		2.9				LIMESTONE, medium hard, thickly bedded, dry, gray
BH 6	TOP	8.0	2.271	2.7	12.4	220	40	LIMESTONE, medium hard, thickly bedded, dry, gray
BH7	TOP	4.0		1.6				LIMESTONE, hard, thickly bedded, dry, rosy
	4.0	8.0	2.277	3.0	9.4	155	40	LIMESTONE, medium hard, thickly bedded, dry, gray
B-8	TOP	2.0	2.299	1.4	22.6	661	40	LIMESTONE, hard, thickly bedded, dry, rosy
	2.0	3.8		2.1				LIMESTONE, medium hard, thickly bedded, dry, gray
	3.8	4.0						SMALL VOID
	4.0	8.0						LIMESTONE, medium hard, thickly bedded, dry, gray
BH 9	TOP	12.0	2.251	2.7	11.8	481	40	LIMESTONE, medium hard, thickly bedded, dry, gray

The structural analysis process addressed mainly the study of loads that affects the facility, to develop a ways of resisting by a very well structural form with a required precision and care.

3-3-4 Loads:

3-3-4-1 Loads classification:

Loads which are directly affects the building classified into:

1. **Main loads (direct):** which include dead and live loads and environmental loads.
2. **Secondary loads (indirect):** These include shrinkage of concrete drought, heat impact and crawl and consolidation.

So in structural calculation, we must consider the accuracy in the process of representation of loads on structural elements as the previous classification, concrete, for example, has an expansion and shrinkage factor different than its reinforcement steel factor.

The designed structural elements must be able to carry loads without the occurrence of any failure, and these loads are:

1. **Dead loads.**
2. **Live loads.**
3. **Environmental loads.**

3-3-4-1-1 Dead loads:

Are loads resulting from the self-weight of building, which consists of the weights of building materials used which include all the structural elements and fixtures weight loads are inherent in the building permanently with a fixed amount and direction. With regard to specific density of the materials used are as follows:

	Material	Denity (kN/m^3)
1	Tiles and mortar	22
2	Reinforced concrete	25
3	Sand	16.4
4	Plaster	22

Table 3-2 : specific density of the used materials.

3-3-4-1-2 Live loads:

Loads experienced by buildings and construction because of their different uses, including distributed and concentrated loads, which include:

1. **Dynamic loads:** such as equipment which give rise to vibrations affecting the entity.
2. **Static loads:** and that can change places from time to time such as weights of people and furniture houses, and the stored material and furniture and the table below shows the value of live loads depending on our building uses by the Jordanian code.

Table 3-3 : live loads.

Tybe of structure	**Live load (kN/m)**
Educational buildings:	
Classrooms	3
Laboratories	3
Assembly halls and theater	5
Offices	3
Stairs	4
Storage room	10-5
Cafeteria	2
Halls	5
Libraries: Reading room	4
Stationery	6.5

(From the Jordanian code for loads.)

3-3-4-1-3 Environmental loads:

Are loads caused by the environmental effects on the building.

3-3-2-1-4 Wind load:

A horizontal forces affect the building which can clearly show in high-rise ones, it has a positive value as a result of pressure and negative as a result of tension, measured in kiloNewton per square meter (KN / m2). The determination of wind loads depending on the height of the building above the ground, and its location from the surrounding buildings, whether high or low, and these loads are resisting through shear walls which are distributed according to the loads acting on them.

3-3-4-1-5 Snow loads:

loads that can affect the building due to snow accumulation, snow loads can be evaluated as the following:

1. The height of the building above sea level.
2. Slope of roof.

The following table shows the value of snow loads according to height above sea level by the Jordanian code.

Table 3-4: snow loads according to Jordanian code.

Height of building above sea level (m)	Snow load (KN /m²)
h < 250	0
500 > h > 250	(800) /h-250
1500 > h > 500	(h-400) / 320

(From the Jordanian code for loads.)

3-3-4-1-6 Earthquakes:

One of the most important environmental loads affecting the building, consist of a horizontal and vertical forces that generate moments, including overturning and torque moments , that can be resisted using shear walls with a thicknesses and reinforcement enough to assure the safety of the building when exposed to such loads that must be considered in the design process to reduce risk and maintain the performance of the building during earthquakes. We will use code (UBC 1997) in order to define and determine the seismic loads and the shear force according to it.

(3-4) Construction elements:

The building is an outcome of the coherence of structural elements with each other, to become a single integrated block, confrontational loads that are exposed, the most important of these elements, slaps, beams, columns, shear walls, foundations and others.

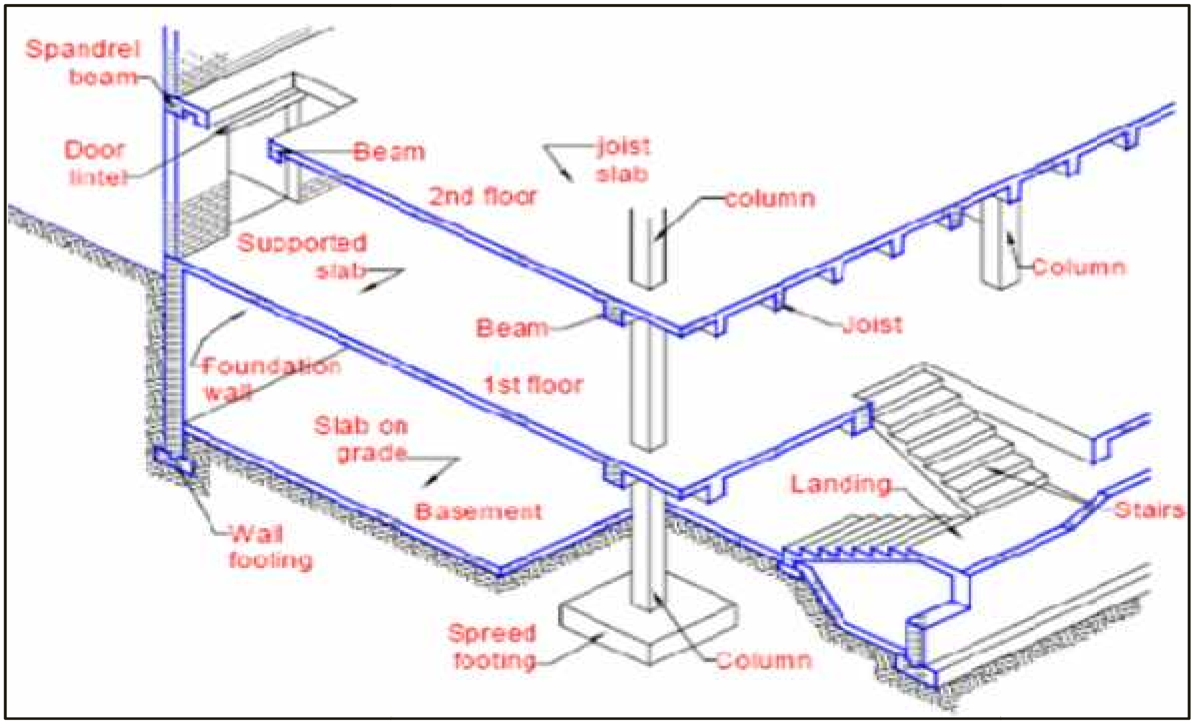


figure 3-1: Some of the construction elements in the building.

3-4-1 Slabs:

Slabs are structural elements that transfer the vertical forces due to the loads affecting the structural elements of the building such as beams, walls and columns, without distortions.

There are many different types of commonly used reinforced concrete slabs, including the following:

1. **Solid slabs.**
2. **Ribbed slabs.**

Because there are many activities in this project, and the diversity of architectural requirements, we have been using both types as appropriate for the nature of use, which will clarify the structural design in the classroom Suffix.

3-4-1-1 Solid Slabs:-

1. This type is divided into two parts:-

   One Way Solid Slabs: which Have been used in some stairwell slaps.

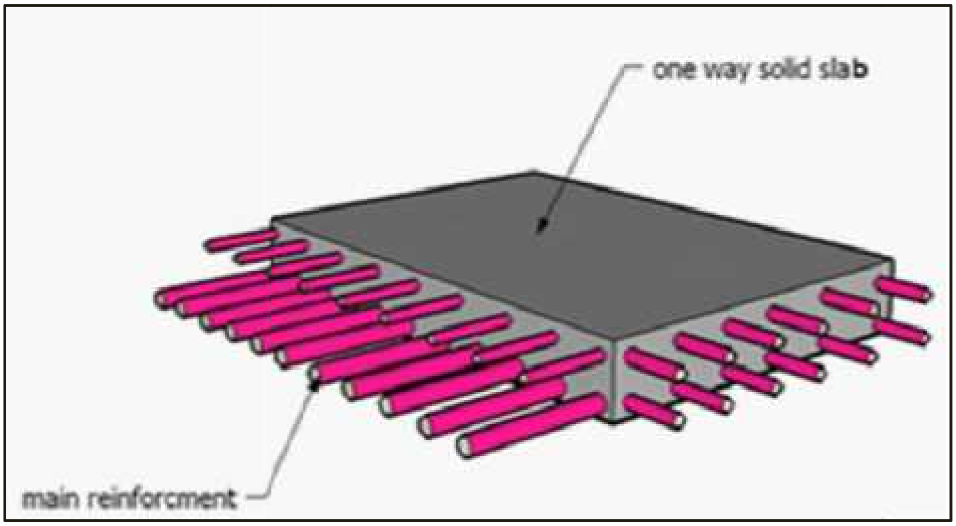


figure3-2: One way solid slab

2. **Tow way solid slabs:** which have been used in some stairwell slaps.

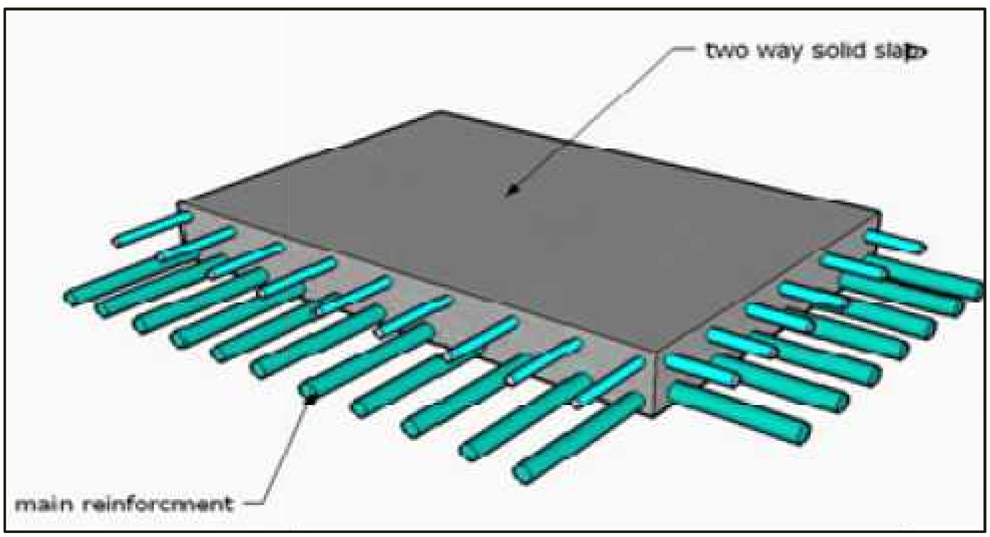


Figure 3-3: Two way solid slab

(3-4-1-2) Ribbed slabs:

Divided into two sections:

1. **One way ribbed slabs:** which consists of hollow slabs with a total depth greater than that of solid slabs. The system is most economical for buildings where superimposed loads are small and spans are relatively large, such as schools, hospitals, and hotels etc.… .

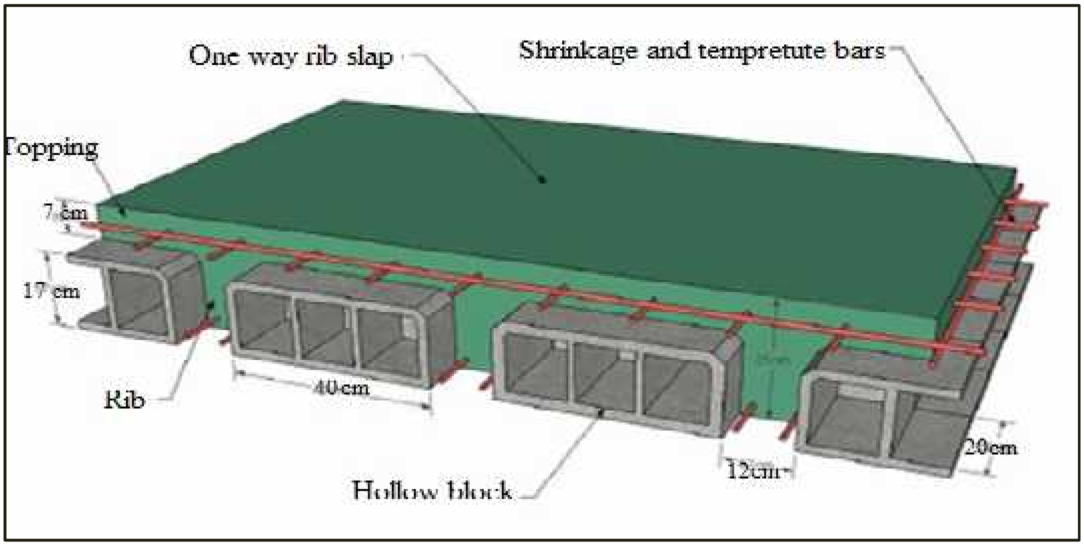


Figure 3-4: One way ribbed slab

Two way ribbed slabs: used in the case of relatively large spaces, especially when spans are close spacing and with distances more than 6 m.

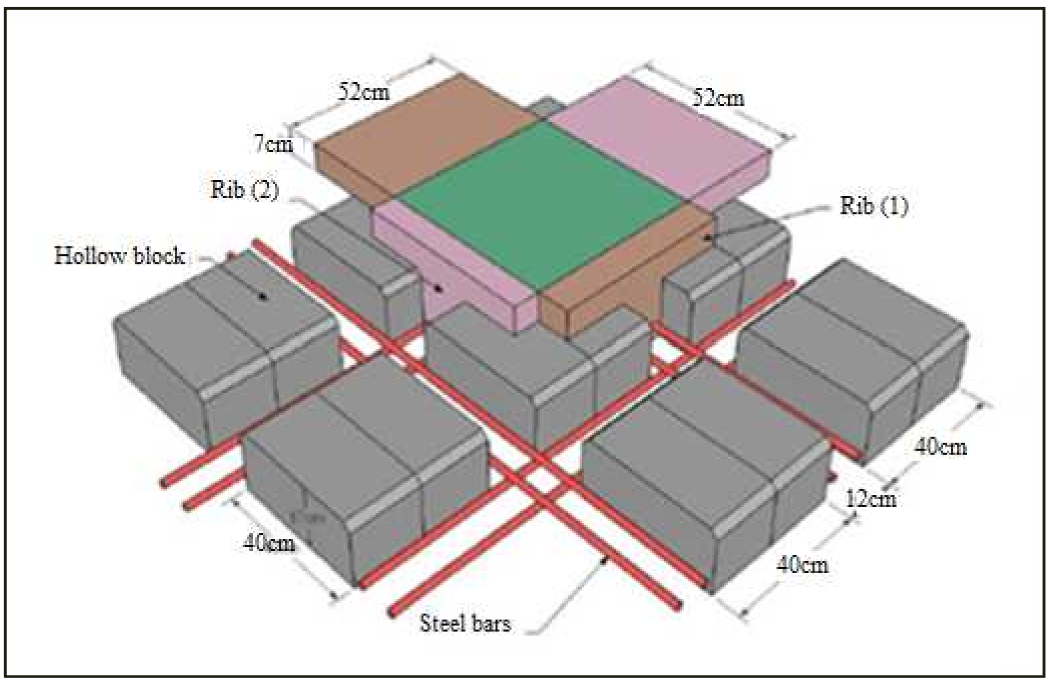


Figure 3-5: Tow way ribbed slab

3-4-2 Beams :

They are essential structural elements, transporting loads of ribs and solid slaps to move them to the columns, and concrete beams on two types:-

1. **Hidden beams:** a beams hidden inside the slap so that its height equals the height of the slap.
2. **Drop beams:** a beam whose height is greater than the height of the slap, the excess part of the beam is in both directions lower one (Down Stand Beam) or upper (Up stand Beam) so that these bridges are called L -section, T-section.

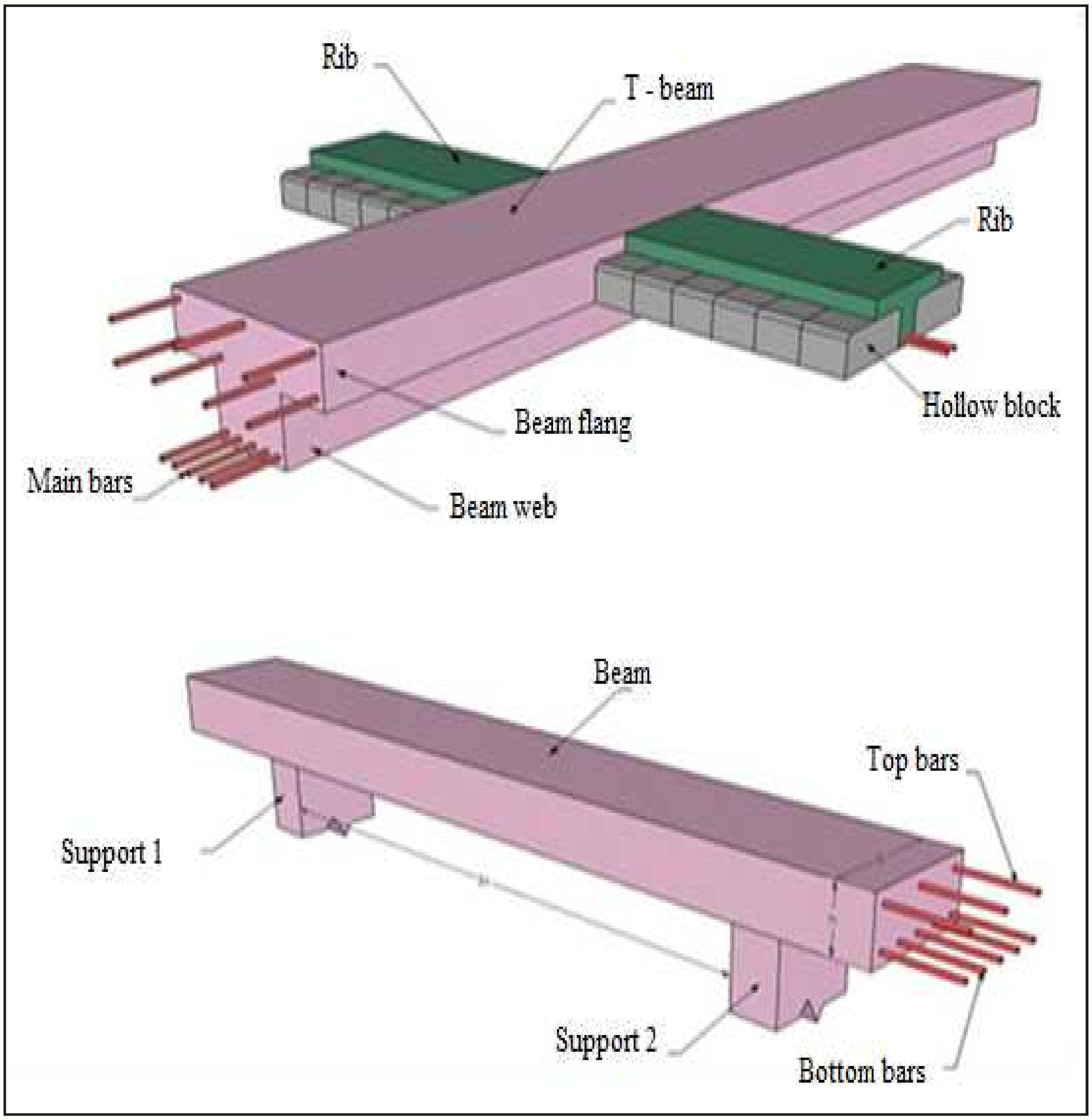


figure3-6: Beams

3-4-3 Columns:

Columns are considered as the main component in the transfer of loads from slaps, beams and transferred it to the foundations , so it is an essential structural component in the transfer of loads and the stability of the building. So they must be designed to be able to carry and distribute of loads that’s affecting them.

For the types of the columns they are two types: short and long columns. Columns sections have many forms, including rectangular, circular, polygon, box and the boat. Another classification of columns is in terms of the type of construction material used such as concrete, metal, wood.

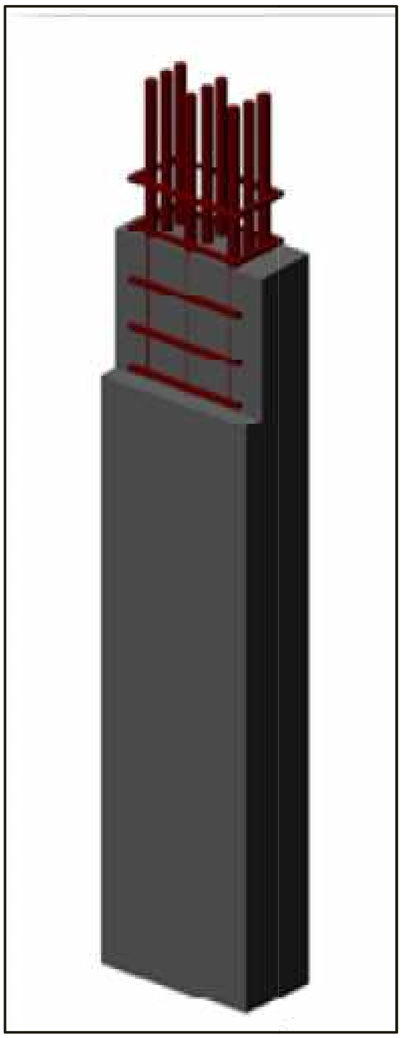


figure 3-7: Rectangular column

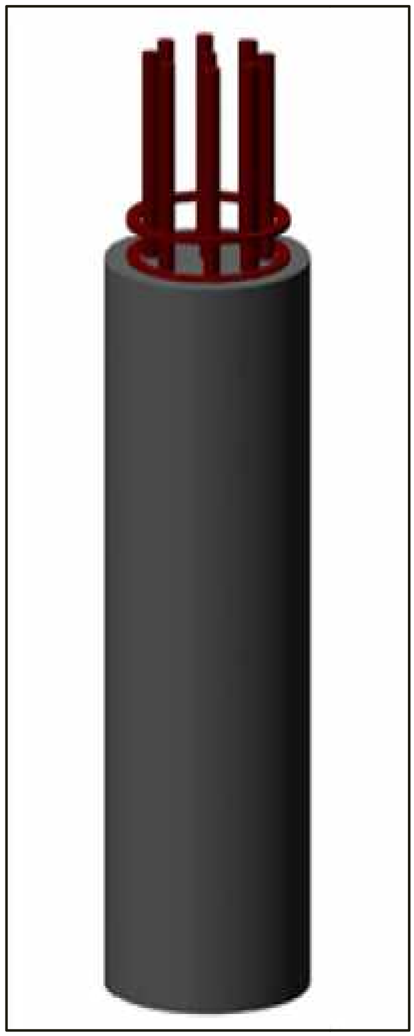


figure 3-8: Circular column

3-4-4 Shear walls:

Structural elements resisting the vertical and horizontal forces which affecting them, and used primarily to resist horizontal loads such strong winds and earthquakes.

These walls resisting the vertical weights transferred to them, and resist the horizontal forces that affecting the building, so they must be available in both directions, taking into account that the distance between the center of rigidity that the shear walls represent and the center of gravity of the building to be as less as it can and to be enough to reduce the generated torques and their effects on the building walls that resist the horizontal forces.

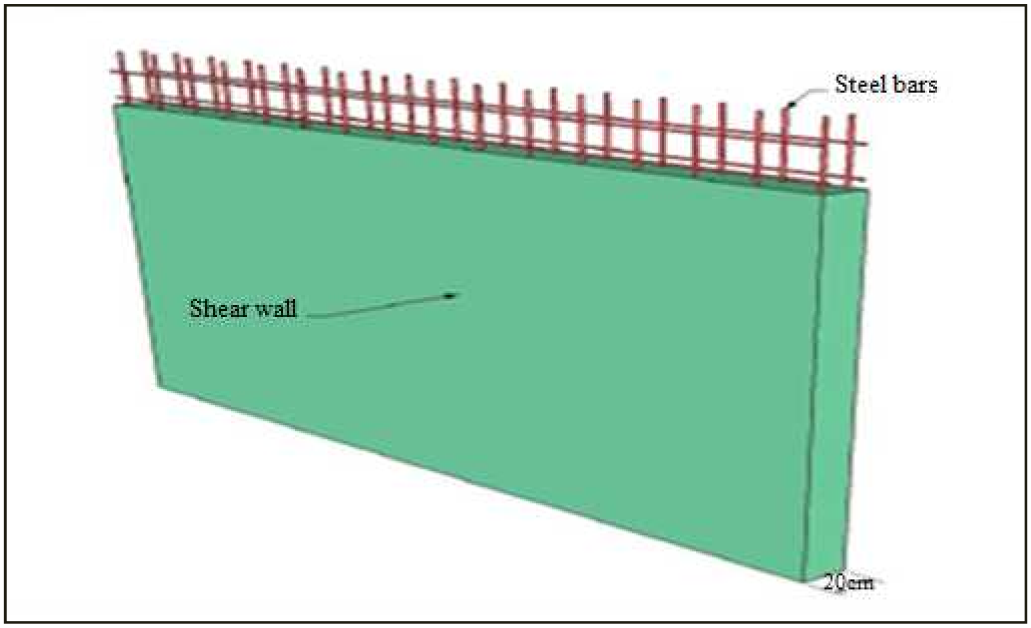


figure 3-9:shear wall

3-4-5 Foundations:

Foundations are the link between the structural elements of the building and the land, the weights and loads which have been carried by them, they come from the loads located on slaps moves into beams and then to the columns and finally to footings into the soil. The foundation must be responsible for carrying the dead loads of the building and also dynamic loads resulting from wind and snow, and earthquakes and also live loads within the building.

These loads are loads of design for foundations, and from the loads, and the nature of the site is specifying the type of foundation used, and it is expected to use different types of foundations depending on soil bearing capacity and loads along each foundation.

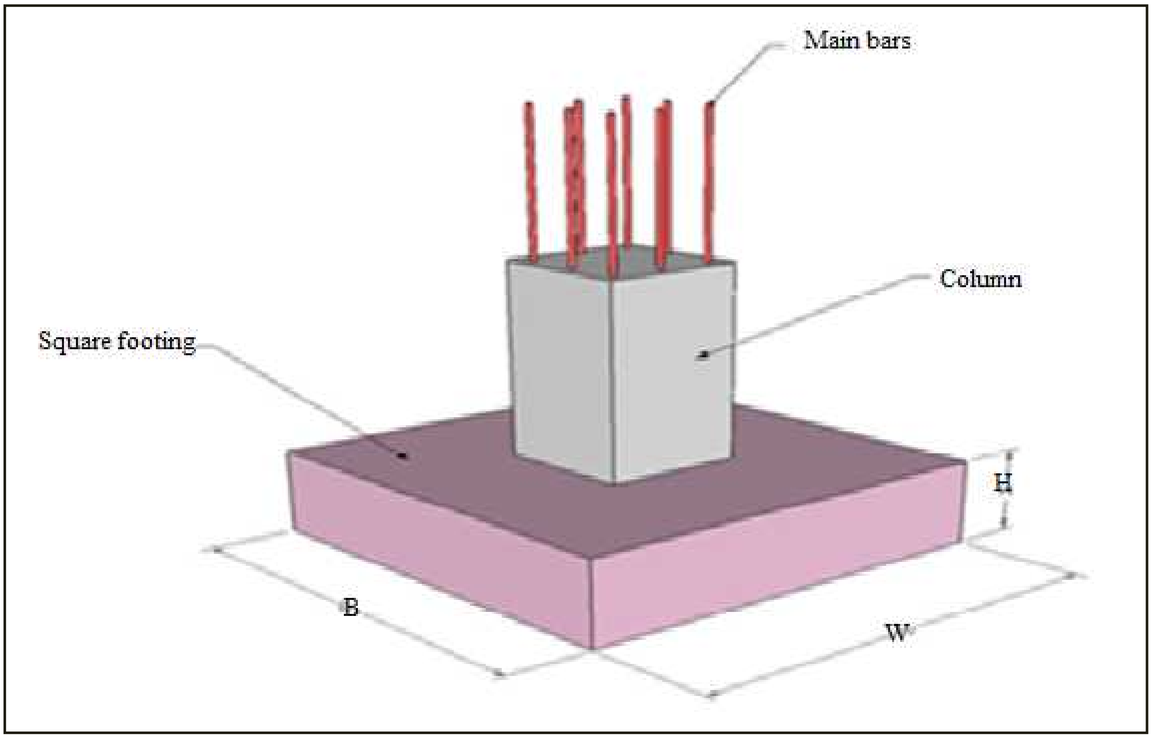
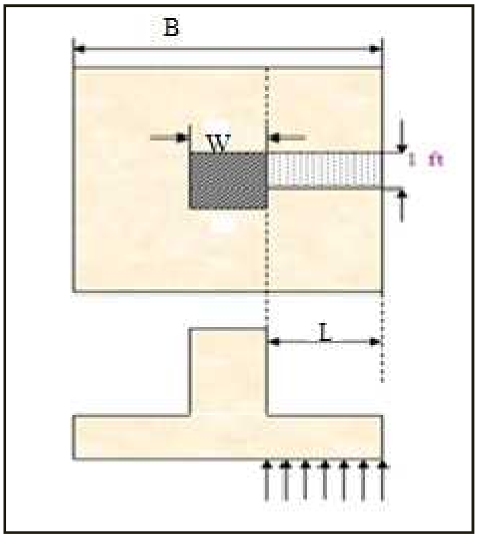


Figure3-10: isolated footing



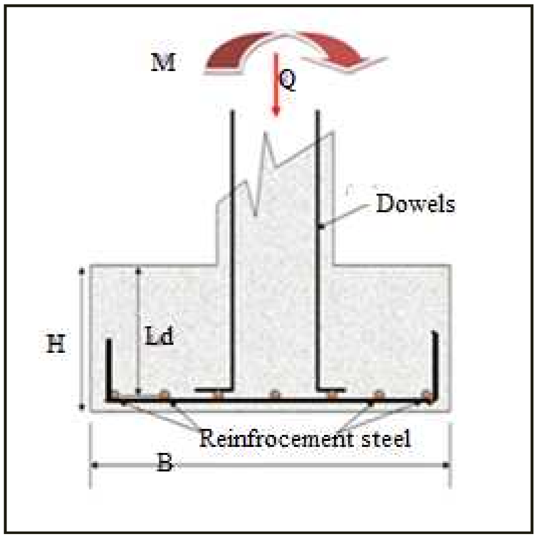


figure 3-11: isolated footing plan figure 3-12: isolated footing section

3-4-6 Stairs:

Structural element responsible for vertical movement between floors in the building where floor height is divided into small heights representing high of it. Staircase design is structurally as a solid slap in one direction.

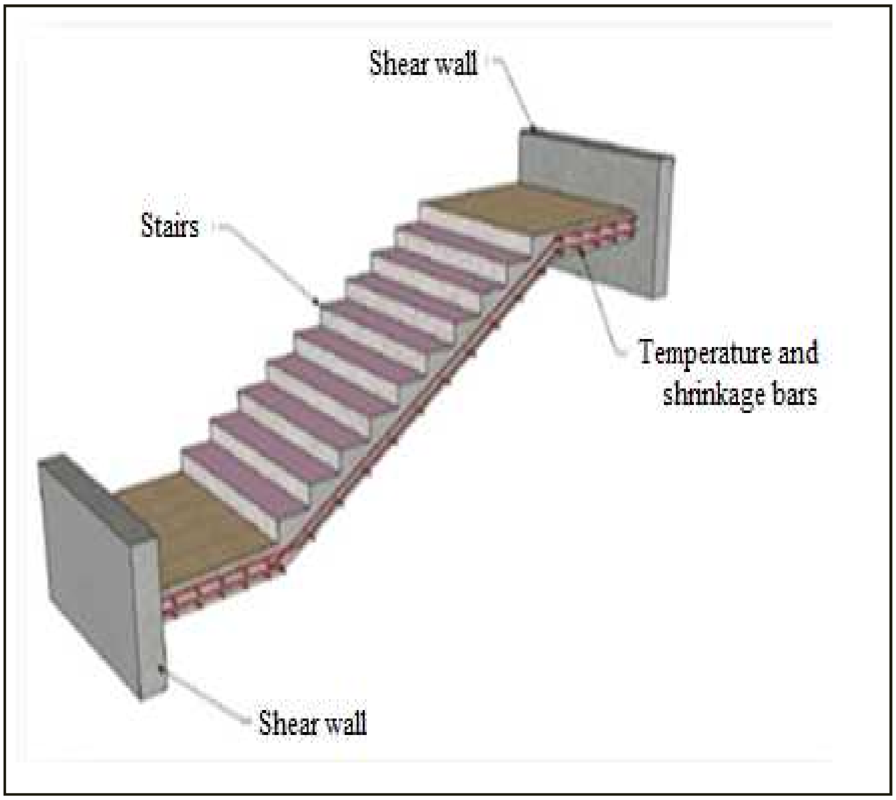


figure 3-13: Stair diagram

3-4-7 Retaining Walls:

These walls are built to support the soil and water which left behind it and it's resulting pressure trying to fluctuation or move this wall, retaining walls designed to resist the vertically weight of the soil and horizontal soil pressure and the lifting pressure of ground water.

Because of the obvious difference in levels of project land, we will use bearing walls to protect the soil from falling or slipping, these walls construction materials can be concrete, reinforced concrete and stones.

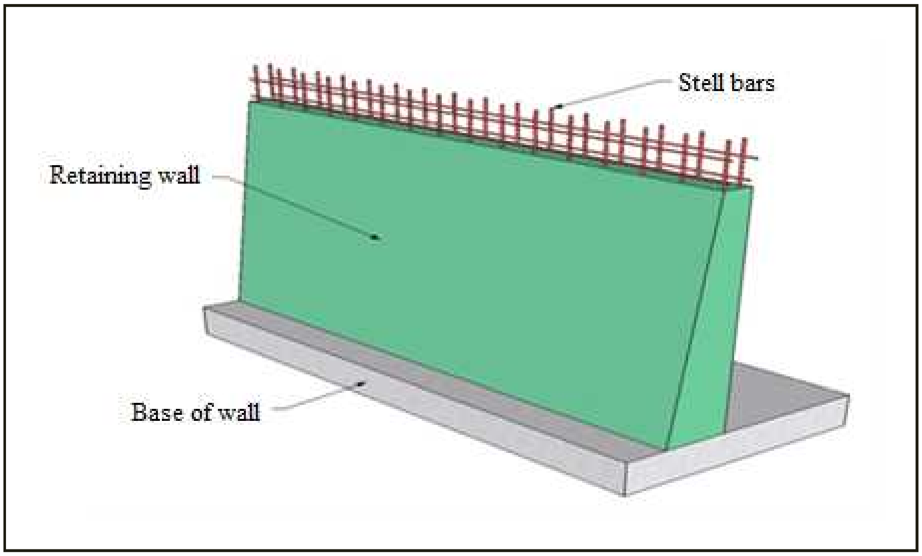


figure 3-14: Retaining wall

3-4-8 Expansion Joints:

Implemented in buildings with large horizontal dimensions or shapes and special situations, thermal or settlement joints may be for both purposes, a splitter is placed if the width of the building (35-40) Meter to allow the building to expand without leading to cracks. In the analysis of constructions considered as a resistance to seismic actions called these intervals with seismic expansion joints, and these expansion joints some requirements and recommendations in accordance with the following:

1. Thermal expansion should be used in the building, that these intervals up to the upper face of the foundation without impenetrable. The vast distances of the dimensions of the building block as follows:
   a. 40m in areas with high humidity.
   b. 36m in areas with normal humidity.
   c. 32m in the medium humidity areas.
   d. 28m in dry areas.
2. Expansion joint width should not be less than (3cm).

Chapter IV

Content:

4-1 Introduction:

Concrete is a construction material composed of cement (commonly Portland cement) as well as other cementations materials such as fly ash and slag cement, aggregate (generally a coarse aggregate such as gravel, limestone, or granite, plus a fine aggregate such as sand), water, and chemical admixtures. The word concrete comes from the Latin word "concretus", which means "hardened" or "hard".

Concrete solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. The water reacts with the cement, which bonds the other components together, eventually creating a stone-like material. Concrete is used to make pavements, architectural structures, foundations, motorways/roads, bridges/overpasses, parking structures, brick/block walls and footings for gates.

In This Project, there are three types of slabs: solid slabs, one-way ribbed and two-way ribbed slabs. They would be analyzed and designed by using finite element method of design, with aid of a computer Program called " ATIR- Software" to find the internal forces, deflections for ribbed slabs, and then hand calculation would be made to find the required steel for some members.

The design strength provided by a member, its connections to other members, and its cross-sections in terms of flexure, and load, shear, and torsion is taken as the nominal strength calculated in accordance with the requirements and assumptions of ACI-code.

NOTE:

$fc' = 24\,N/mm^2\,(MPa)$ For concrete slab.]

$fc' = 24\,N/mm^2\,(MPa)$ For beams.

$fc' = 24\,N/mm^2\,(MPa)$ For column and footing.

$fy = 420\,N/mm^2\,(MPa)$ For flexural Reinforcement Steel.

$fyt = 420\,N/mm^2\,(MPa)$ For shear Reinforcement Steel.

4 -2 Factored Loads:

The factored loads on which the structural analysis and design is based for our project members, is determined as follows:

$q_u = 1.2DL + 1.6LL$ *ACI – 318 - 08 (9.2.1)*

4.3 Determination of Thickness:

4.3.1 Determination of Thickness for One Way Rib Slab:

The structure may be exposed to different loads such as dead and live loads. The value of the load depends on the structure type and the intended use.

The overall depth must satisfy ACI Table (9.5.a): The minimum required thickness of the joist is:

for interior span. from ACI-318-08 (9.5a):

$$\frac{L_1}{21} = \frac{6.00}{21} = 0.30m$$

for exterior span from ACI-318-08 (9.5a):

$$\frac{L_2}{18.5} = \frac{3.725}{18.2} = 0.201m$$

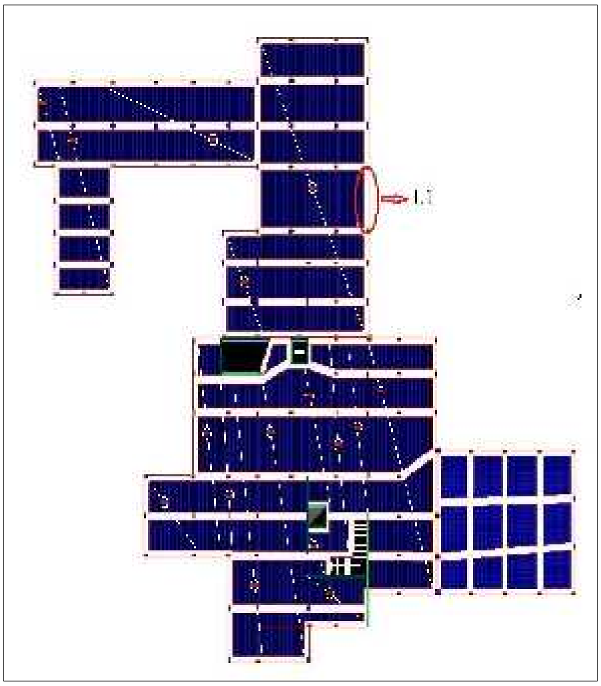


Figure 4.1: Maximum spans

4-4 Design of Topping:

Design of Topping for Ribbed Slab:

Dead load for topping =

0.03 × 23 ×1 (tiles)

+ 0.03 × 22×1 (mortar)

+ 0.07 × 17×1 (sand)

+ 0.06 × 25×1 (slab)

+ 2.38×1 (partitions) = 6.42 kN/m

Live Load = 5×1 = 5KN/m. (for Stores) .

Wu = (1.2 × 6.42) + (1.6 × 5)

= 15.704 kN/m

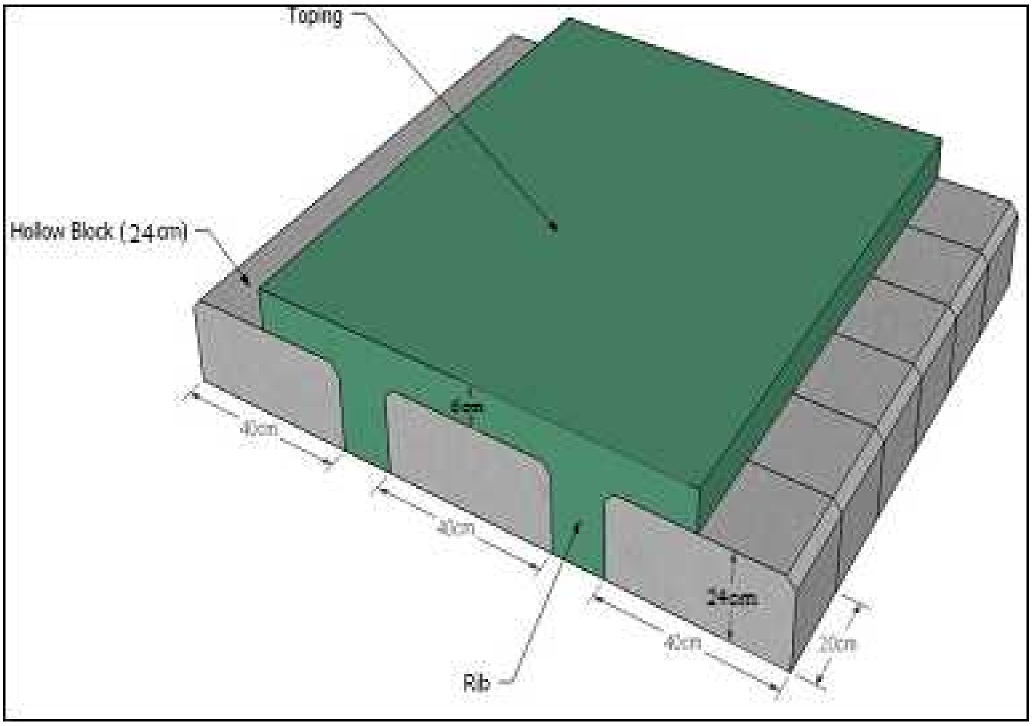


Figure 4-2: topping

→ For a one meter strip Wu = 15.704 kN/m

Assume slab fixed at supported points (ribs):

$$Mu = \frac{Wu \times l^2}{12}$$

$$Mu = \frac{15.704 \times 0.4^2}{12} = 0.209 \text{ KN.m}$$

$$fr = 0.42 \times \sqrt{fc'}$$ *ACI-318-08 (22.5.1)*

$$fr = 0.42 \times \sqrt{24} = 2.0576\, MPa$$

$$= 2.0576 \times 1000 = 2057.6\, KN / m^2$$

Mn = fr × s

$$S = \frac{bh^2}{6} = \frac{1.00 \times 0.06^2}{6} = 6 \times 10^{-4} m^3$$

Mn = 2057.6× 6×10^{-4} = 1.23 KN.m

Φ Mn = 0.55 × 1.23 = .679 KN.m

Φ Mn = .679 KN.m > Mu = 0.209 KN.m

No structural reinforcement is needed. Therefore, shrinkage and temperature reinforcement must be provided.

For the shrinkage and temperature reinforcement:
ρ =0.0018 *ACI-318-08 (7.12.2.1)*

As = ρ × b × h = 0.0018 × 1000 × 60 = 108 mm^2

Try bars Φ 8 with As = 50.27

Bar numbers $n = \frac{As}{As¤8} = \frac{108}{50.27} = 2.14$

Take 3 Φ 8 with As = 150.8 mm²/m strip or Φ 8 @ 300mm

In both direction step (S) is the smallest of :-

1) 3h = 3*60= 180 mm…………control ACI-318-08 (10.5.4)
2) 450mm.
3) $s = 380\left(\frac{280}{fs}\right) - 2.5Cc = 380\left(\frac{280}{\frac{2}{3}\times 420}\right) - 2.5\times 20 = 330\ mm$ but

$$s \le 300\left(\frac{280}{fs}\right) = 300\left(\frac{280}{\frac{2}{3}\times 420}\right) = 300\,mm$$ ACI-318-08 (10.6.4)

4) Take Φ 8 @200mm in both direction S= 200mm<Smax =240mm…..ok

Use 8 @ 20 cm

4-5 Load Calculation:

4-5-1 One - way ribbed slab:

For the one-way ribbed slabs, the total dead load to be used in the analysis and design is calculated as follows:

Effective Flange width (b_E) *ACI-318-08 (8.12.2)*

b_E For T- section is the smallest of the following:

b_E = 2.83 / 4 = 70.75 cm

b_E = 12 + 16 t = 12 + 16 (6) = 108 cm

b_E = 52 cm .... control.

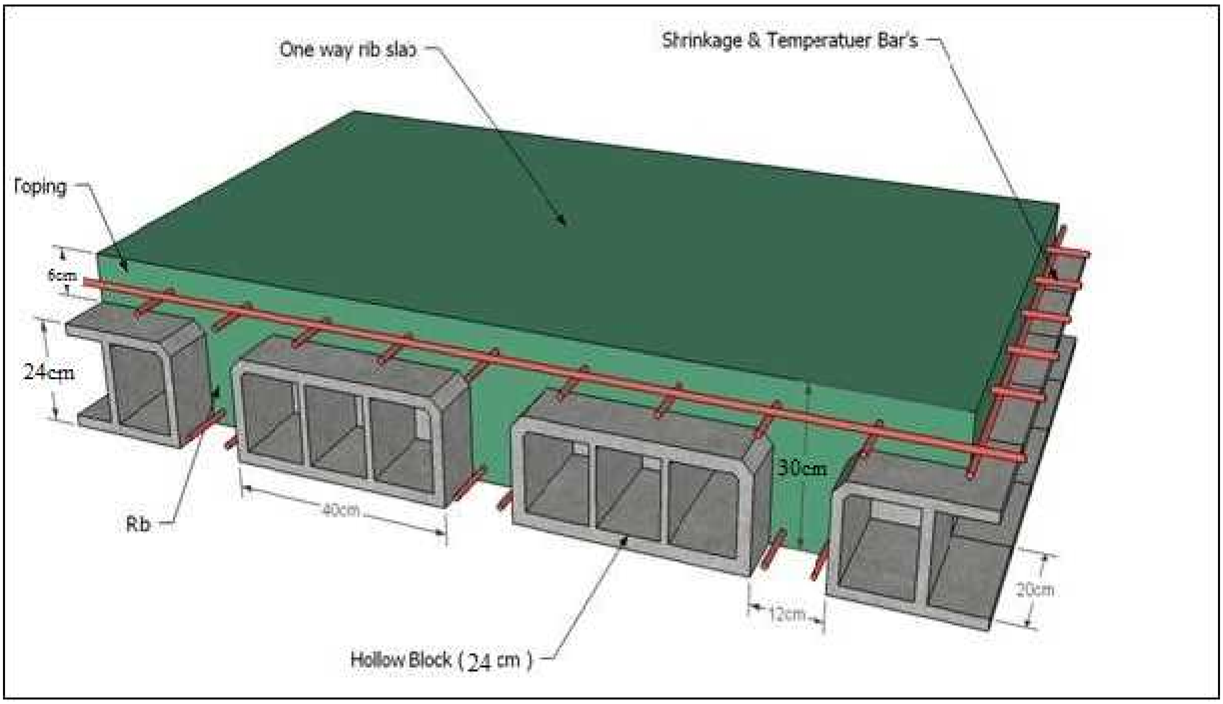


Figure 4-3: One way rib slab

Calculation of the total dead load for one way rib slab is shown in the following table:

Table (4 – 1) Calculation of the total dead load for one way rib slab.

No.	Parts of Rib	Calculation	
1	Rib	0. 23 × 0.25 × 0.12 = 0.69 KN/m	
2	Top Slab	0.06 × 0.52 × 25 = 0.78 KN/m	
3	Plaster	0.03 × 0.52 × 22 = 0.3432 KN/m	
4	Sand Fill	0.07 × 0. 52 × 17 = 0.6188 KN/m	
5	Tile	0.03 × 0. 52 × 23 = 0.3588 KN/m	
6	Hollow Block	0.24 × 10 × 0.4 = 0 .96	
7	Mortar	0.03 × 0. 52 × 22 = 0.3432 KN/m	
8	partition	2.3 × 0.52 = 1.196 KN/m	
		5.29	KN/m

Nominal Total Dead Load:

D.L. $_{total}$ = 0.69 + 0.78 + 0.3432 + 0.6188+ 0.3588 + 0.96+ .3432 + 1.196 = 5.29 kN/rib

For technology center the live load is 5 KN/m²

Live load = 5 × 0.52 = 2.6 KN/m of rib.

4-6 Design of Rib for one way rib slab :

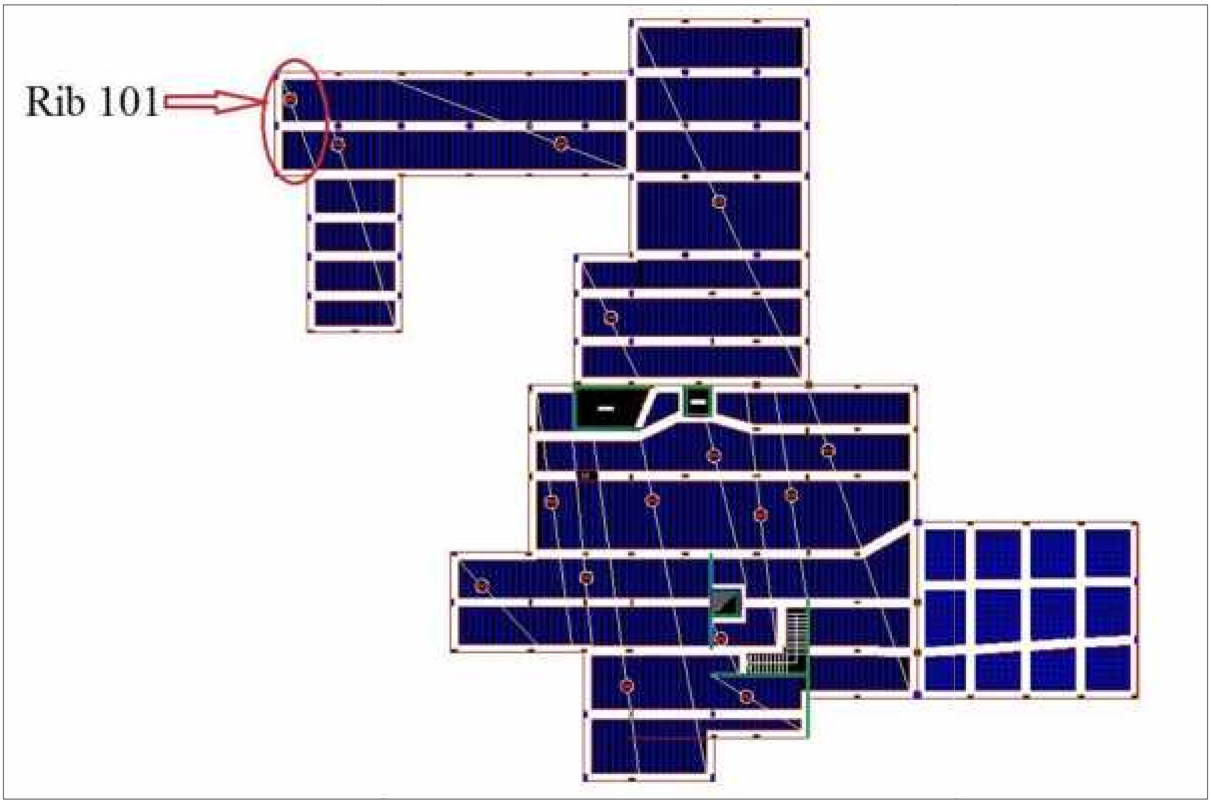


Figure 4-4: Rib location

By using **ATIR** program we get the envelope moment and shear diagram as the follows:-

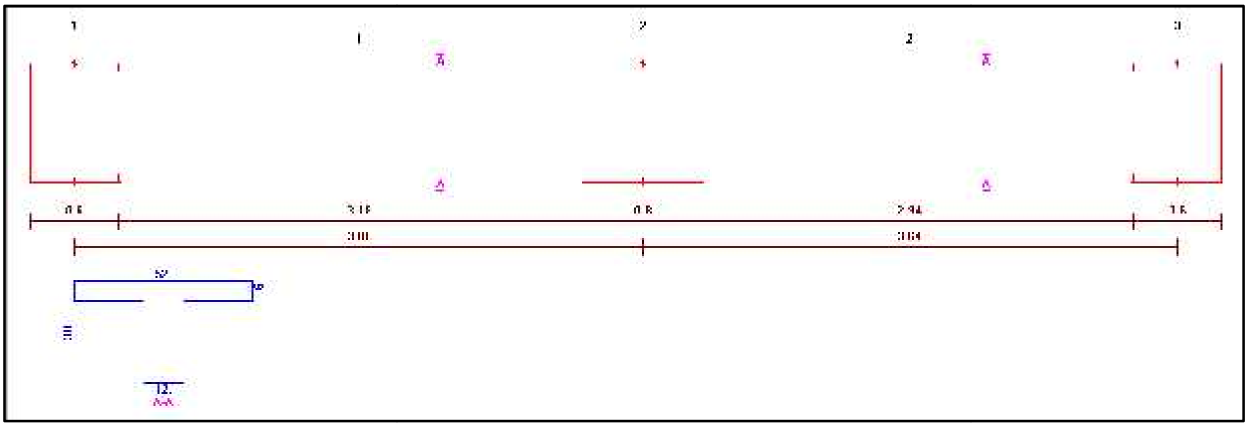


Figure 4-5 Spans length of rib

Figure 4 - 6 surface Load of rib (1)-(kN/m).

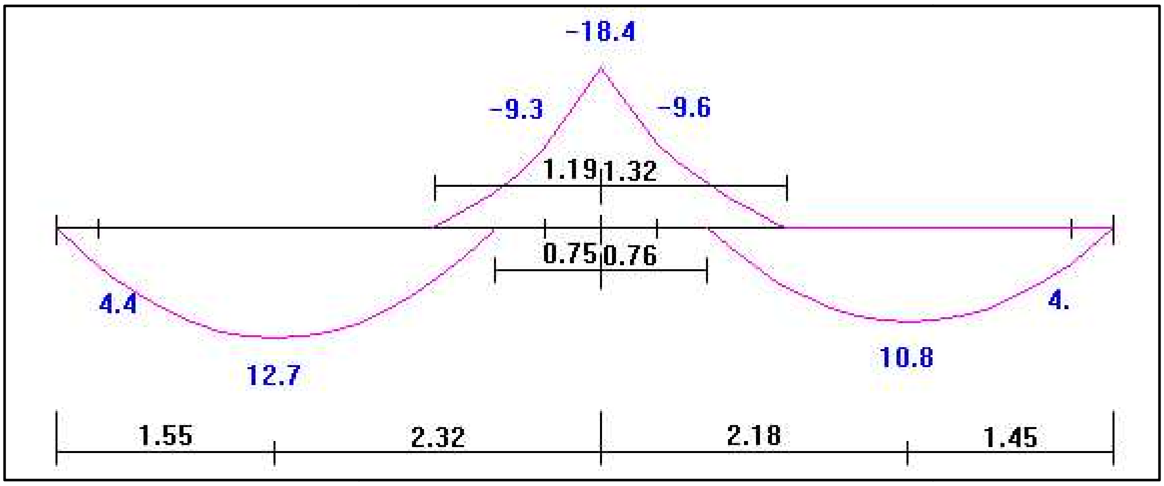


Figure 4 - 7 Moment diagram for rib -kN.m

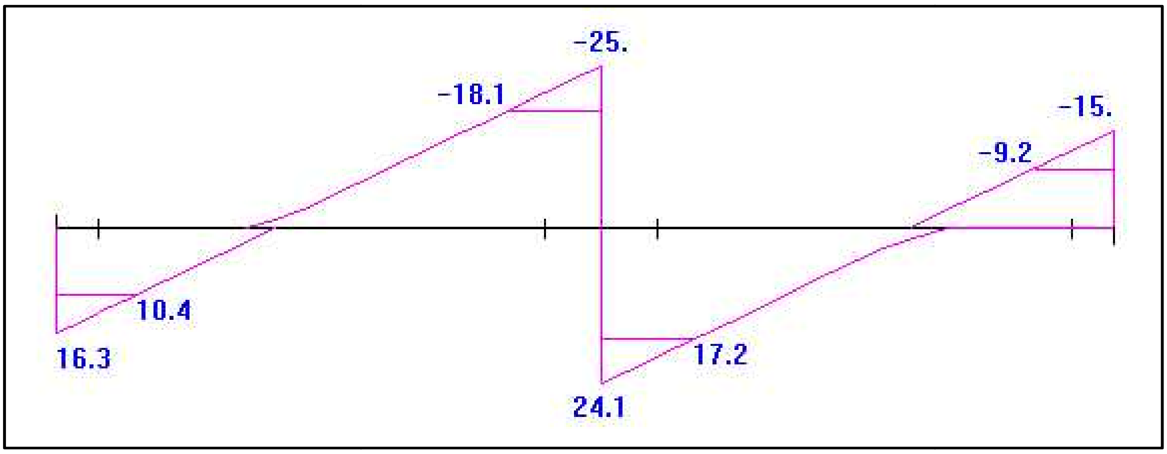


Figure 4 - 8 Shear diagram for rib -(kN).

4-6-1 Design of Positive Moment for Rib:

Assume bar diameter Φ 12 for main positive reinforcement :-

$$d = h - \text{cov}er - d_{stirrups} - \frac{db}{2} = 300 - 20 - 10 - \frac{12}{2} = 264mm$$

The maximum positive moment in all spans of rib 101 Mu =12.7 KN.m

» Use M_u max positive for span 1 = 12.7 kN.m

» Determine whether the rib will act as rectangular or T – section:

For hf = 0.06 m

d = $300 - 20 - 10 - \frac{12}{2} = 264mm$

$$¤Mn = 0.9 \times 0.85 \times f'c' \times b \times hf \times (d - \frac{hf}{2})$$

$$¤Mn = 0.9 \times 0.85 \times 24 \times 0.52 \times 0.06 \times (0.264 - \frac{0.06}{2}) = 134KN.m$$

Φ Mn = 134 KN.m > M_u = 12.7 KN.m

Design as a rectangular with b_E = 52 cm

$$As\ \min = \frac{\sqrt{fc'}}{4(fy)}(bw)(d)$$ *ACI-318-08 (10.5.1)*

$$As\ \min = \frac{\sqrt{24}}{4(420)}(120)(264) = 92.38mm^2$$

$$As\ \min = \frac{1.4}{(fy)}(bw)(d)$$

$As\ \min = \frac{1.4}{420}$ (120)(264)= 105.6 …..control

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

$$kn = \frac{Mn}{bd^2} = \frac{(12.7/0.9) \times (10)^{-3}}{(0.52)(0.264)^2} = 0.389\ MPA$$

$$° = \frac{1}{m}\left(1 - \sqrt{1 - \frac{2mkn}{fy}}\right) = \frac{1}{20.59}\left(1 - \sqrt{1 - \frac{2 \times 0.389 \times 20.59}{420}}\right) = 0.000935$$

As = 0.000935(520)(264) = 128.35mm^2 > As min = 105.6 mm^2

# of bars = A_s / $A_{s\ bar}$ = 128.5 /113 = 1.13 * Note $A_{\Phi 12}$ = 113 mm^2

Select bottom bars 2Φ12

Total As $_{(provide)}$ =226 mm^2

* Check Strain:

Tension = Compression

$$A_s \times fy = 0.85 \times f_c' \times b \times a$$

$$226 \times 420 = 0.85 \times 24 \times 520 \times a$$

$$a = 8.94mm$$

$$c = \frac{a}{{}_1}$$

$$c = \frac{8.9}{0.85} = 10.5mm$$

$$£_s = \frac{264 - 10.5}{10.5} \times 0.003 = 0.072$$

$$£_s = 0.0724 > 0.005$$

Ok…….

» Use M$_u$ max positive for span 2 = 10.8 kN.m

Φ Mn = 134 KN.m > M$_u$ = 10.8KN.m

Design as a rectangular with b_E = 52 cm

$$A s \min = \frac{\sqrt{fc'}}{4(fy)}(bw)(d)$$ *ACI-318-08 (10.5.1)*

$$A s \min = \frac{\sqrt{24}}{4(420)}(120)(264) = 92.3mm^2$$

$$A s \min = \frac{1.4}{(fy)}(bw)(d)$$

A s min = $\frac{1.4}{420}$ (120)(264)= 105.6 …..control

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

$$kn = \frac{Mn}{bd^2} = \frac{(10.8/0.9) \times (10)^{-3}}{(0.52)(0.264)^2} = 0.331\ MPA$$

$$° = \frac{1}{m}\left(1 - \sqrt{1 - \frac{2mkn}{fy}}\right) = \frac{1}{20.59}\left(1 - \sqrt{1 - \frac{2 \times 0.331 \times 20.59}{420}}\right)$$

$$° = 0.000794$$

$As = 0.000794\ (520)\ (264) = 109.08\ mm^2 > As\ min = 105.6\ mm^2$

\# of bars = $A_s / A_{s\ bar} = 109.08/79 = 1.38$ * Note $A_{\Phi 10} = 79\ mm^2$

Select bottom bars 2Φ10

Total $As_{(provide)} = 158\ mm^2$

* Check Strain:

Tension = Compression

$$A_s \times fy = 0.85 \times f_c' \times b \times a$$

$$158 \times 420 = 0.85 \times 24 \times 520 \times a$$

$$a = 6.25mm$$

$$c = \frac{a}{_1}$$

$$c = \frac{6.25}{0.85} = 7.36mm$$

$$£_s = \frac{264 - 7.36}{7.36} \times 0.003 = 0.104$$

$$£_s = 0.104 > 0.005$$

Ok…….

4.6.2 :Design of Negative Moment for Rib :

According to ACI 8.9.3 — for beams built integrally with supports, design on the basis of moments at faces of support shall be permitted.

The maximum negative moment at the face of support is

Mu = 9.6 kN.m

$\Phi\ Mn = 134\ KN.m > M_u = 9.6\ KN.m$

Design as a rectangular with $b_E = 12$ cm

$$As\ min = \frac{\sqrt{fc'}}{4(fy)}(bw)(d)$$ *ACI-318-08 (10.5.1)*

$$As\ min = \frac{\sqrt{24}}{4(420)}(120)(264) = 92.38mm^2$$

$$As\ min = \frac{1.4}{(fy)}(bw)(d)$$

= A s min = $\frac{1.4}{420}$ (120)(264)= 105.6 …..control

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

$$kn = \frac{Mn}{bd^2} = \frac{(9.6/0.9)\times(10)^{-3}}{(0.12)(0.264)^2} = 1.257$$

$$\circ = \frac{1}{m}\left(1 - \sqrt{1 - \frac{2mkn}{fy}}\right) = \frac{1}{20.59}\left(1 - \sqrt{1 - \frac{2\times 1.257 \times 20.59}{420}}\right) = 0.00309$$

A s = 0.00309(120) (264) = 97.93 mm^2 < A s min = 105.6 mm^2

# of bars = A_s / $A_{s\ bar}$ = 105.6 /113 = .934 * Note $A_{\Phi 12}$ = 113mm^2

Select top bars 2Φ12

Total As $_{(provide)}$ =226 mm^2

* Check Strain:

Tension = Compression

$$A_s \times fy = 0.85 \times f_c' \times b \times a$$

$$226 \times 420 = 0.85 \times 24 \times 120 \times a$$
$$a = 38.77mm$$

$$c = \frac{a}{1}$$

$$c = \frac{38.77}{0.85} = 45.6mm$$

$$£_s = \frac{264 - 45.6}{45.6} \times 0.003 = 0.0143$$
$$£_s = 0.0143 > 0.005$$

Ok…….

4-6-3 Design of shear for rib:

1- Design of shear at support (1) & (3):

Critical section at distance $d = 264\ mm$ from the face of support

$f_{yt} = 420\ MPa$

$\boldsymbol{V_{u,max}\ between\ two\ value\ = 10.4\ kN}$.

$V_c = 1.1 * \frac{\sqrt{f_c'}}{6} b_w d$

$= 1.1 * \frac{\sqrt{24}}{6} * 120 * 264 * 10^{-3} = 28.45\ kN.$

$\frac{1}{2}\phi * V_c = 0.5 * 21.33 = 10.66\ kN$

$\phi * V_c = 21.33\ kN > V_u = 10.4kN > \frac{1}{2}\phi * V_c = 10.66\ kN$

***NO shear reinforcement is provided* at support 1 & 3 .**

2- Design of shear at support (2):

Critical section at distance $d = 265\ mm$ from the face of support

$f_{yt} = 420\ MPa$

$\boldsymbol{V_{u,max}}$ ***between two value*** $\boldsymbol{= 18.1\ kN}$.

$\phi * V_c = 1.1 * \frac{\sqrt{f_c'}}{6} b_w d$

$= 1.1 * \frac{\sqrt{24}}{6} * 120 * 264 * 10^{-3} = 28.45\ KN.$

$\phi * V_c = 0.75 * 28.45 = 21.33\ KN$

$\frac{1}{2}\phi * V_c = 0.5 * 21.42 = 10.66\ kN$

$\phi * V_c = 21.33\ KN > V_u = 18.1\ KN > \frac{1}{2}\phi * V_c = 10.66\ KN$

***NO shear reinforcement is provided* at support 2 .**

Use Ø8@150*mm*.

except for **concrete joist construction. So, No shear reinforcement is provide**

4.7 Design of two way Ribbed slab.

4.7.1 Determination of Thickness for Two Way Ribbed Slab:

Assume the thickness of slab is 30 cm .

y' $= (40 \times 6 \times 3 + 30 \times 12 \times 15)/(40 \times 6 + 30 \times 12) = 10.2cm$

$I_{b,80} = (b*h^3)/12 = (.8 * .30^3)/12 = 18*10^{-4}\ m^4$

$I_{b,60} = (b*h^3)/12 = (.6 * .30^3)/12 = 13.5*10^{-4}\ m^4$

$I_{rib} = (.52 * .102^3)/3 - .4*.062/3 + (.12 * .178^3)/3 = 4.412 * 10^{-4}\ m^4$

Short direction:

»L = 5.3 m , bf = 52 cm , bw = 60 cm .

»L = 5.3 m , bf = 52 cm , bw = 80 cm .

$Is = (Irib*(L/2 + bw))/b_f = (4.412 * 10^{-4} * (5.3/2 + .8))/(.52)$

$= 2.972*10^{-3}\ m^4$.

Long direction:

»L = 5.64 m , bf = 52 cm , bw = 60 cm.

$Is = (Irib*(L/2 + bw))/b_f = (4.412 * 10^{-4} * (5.64/2 + .6))/(.52) = 2.9*10^{-3}\ m^4$.

»L = 5.64 m , bf = 52 cm , bw = 80 cm.

$Is = (Irib*(L/2 + bw))/bf = (4.412 * 10^{-4} * (5.64/2 + .8))/(.52) = 3.07*10^{-3}\ m^4$

$\alpha f = I_b/I_s$

$\alpha f1 = I_b/I_s = (18 * 10^{-4})/(2.972 * 10^{-3}) = .606$

$\alpha f2 = I_b/I_s = (13.5*10-4)/(2.9*10-3) = 0.465$

$\alpha f3 = I_b/I_s = (13.5*10-4)/(2.757*10-3) = 0.489$

$\alpha f4 = I_b/I_s = (18*10-4)/(2.972*10-3) = 0.605$

$\sum\alpha_{fm} = I_b/I_s = (0.606 + 0.465 + 0.489 + 0..605)/4 = 0.5412$

$2 > \alpha fm > 0.2$

$\beta = L_{Long}/L_{short} = 5.64/5.30 = 1.064$

h_{min} = (l_n ∗ (0.8 + f_y/1400))/(36 + 5β ∗ (α_(fm − 0.2))) = (5640 ∗ (0.8 + 420/1400))/(36 + 5 ∗ 1.1.064 ∗ (0.5412 − 0.2)) = 16.406 cm < h = 30cm …Ok

4.7.2 Two-way ribbed slab load calculation:

For the two-way ribbed slabs, the total dead load to be used in the analysis and design is calculated as follows:

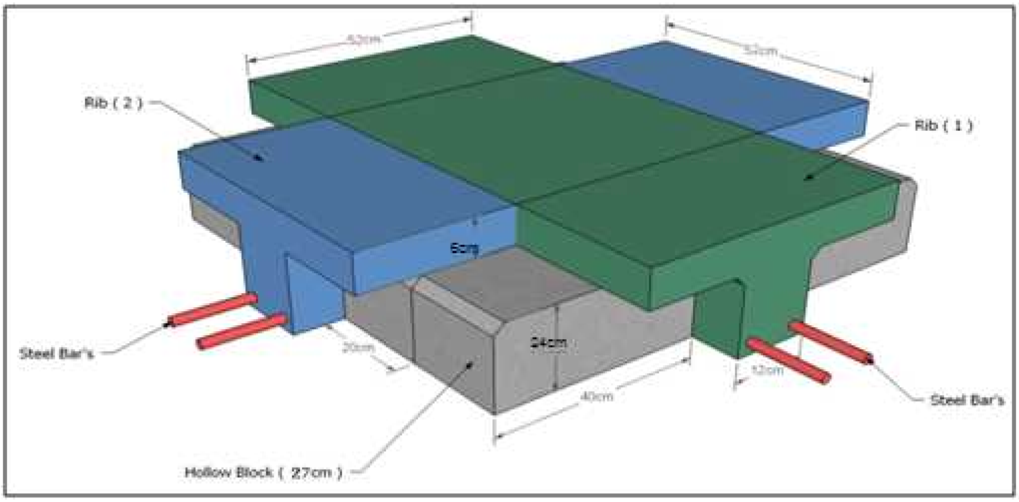


Fig. 4-9 : Two way rib slab

Table (4 – 2) Calculation of the total dead load for two way rib slab(104).

Dead load:

Tiles	**0.03 ×0.52 ×0.52 × 22**	**= 0.178464KN/rib**
Mortar	**0.02 ×0.52 ×0.52 ×22**	**= 0.118976 KN/ rib**
Coarse Sand fill	**0.07 ×0.52 ×0.52 ×16.4**	**=0.3104192 KN/ rib**
Topping	**0.06 ×0.52 ×0.52 ×25**	**= 0.4056kN/rib**
Concrete Rib	**0.24 ×(0.4+0.52) ×0.12 ×25**	**=0.6624 kN/ rib**
Plaster	**0.02 ×0.52 ×0.52 ×22**	**= 0.118976 kN/ rib**
partition	**0.52 ×0.52 ×2.38**	**= 0.643552KN/rib**

Design of two way ribbed slab reinforcement:

Nominal Total Dead Load = 2.438 kN/rib

WuD=1.2×2.438/$(0.52)^2$ =10.82KN

WuL =1.6 $\times$ 5 = 8 kN/m^2

Material :-

concrete B300 Fc' = 24 N/mm^2

Reinforcement Steel fy = 420 N/mm^2

W_D= 1.2 × 8.1 = 10.82 KN/m^2.

W_L = 1.6 × 5 = 8 KN/m^2.

W_{total} = 10.82 + 8 = 18.82 KN/m^2.

4.7.3 Moments calculations:

Ma = C_a× W × L_a^2 × b_f , b_f = 52 cm

Mb = C_b × W × L_b^2 × b_f , b_f = 52 cm

l_a/l_b = 5.30/5.64 = 0.94 **Case (1)**

» Positive moments : (Table2+ Table 3) :

$C_{a,D}$ (l_a/l_b = 0.94) = 0.043

$M_{a,pos,D}$ = 0.043 × 10.82 × 5.30^2 × 0.52 = 6.8 KN.m

Ca,L (l_a/l_b = 0.94) = 0.043

$M_{a,pos,L}$ = 0.043×8×5.30^2 ×0.52 = 5.02 KN.m

$M_{a,pos}$= $M_{a ,pos,D}$ + $M_{a ,pos ,L}$= 6.8 + 5.02 = 11.82 kN.m

$C_{b, D}$ (l_a/l_b = 0.94) = 0.03

$M_{b, pos,D}$= 0.03 × 10.82 × 5.64^2× 0.52 = 5.37 KN.m

$C_{b, L}$ (l_a/l_b = 0.9) =0.3

$M_{b, pos,L}$ = 0.03 × 8 × 5.64^2× 0.52 = 3.67 KN.m

$M_{b,pos}$=$M_{b ,pos,D}$ +$M_{b ,pos ,L}$= 5.37+3.67 = 9.4 kN.m

» Negative moment at Discontinuous edges = (1/3×positive moment)

$M_{a ,neg}$ = 1/3× 11.82 = 3.94 KN.m

$M_{b ,neg}$ = 1/3× 9.4 = 3.13 KN.m

4.7.24 Design of flexure:

4.7.4.1 Design of positive moment :-

»Short direction

d = depth - cover – diameter of stirrups – (diameter of bar/ 2)

= 300 – 20– 8 –12/2= 266 mm.

$b_E \le 1/2 * \text{clear span} + b_w$ = 0.5×400+120 = 520 mm …………Controlled.

≤ Span/4 = 5300/4 = 1325 mm.

≤ $(16\times t_f) + b_w$ =(16× 80) +120 =1400 mm.

→ **b_E= 520 mm.**

Maximum positive moment $Mu^{(+)}$ = 11.82 KN.m

→ $M_{nf} = 0.85 f_c' * b_E * t_f * (d - t_f/2)$

$= 0.85 * 24 * 0.52 * 0.08 * (0.266 - 0.08/2) * 10^3 = 191.8$ KN.m

$\emptyset M_{nf}$ = 0.9 × 191.8 = 172.6 KN.m

→ $\emptyset M_{nf}$ =172.6 KN.m> $M_{u\,max}$= 11.82 KN.m.

∴ Design as rectangular section.

Mn = Mu / $\emptyset$ = 19.74/ 0.9 = 13.13 KN.m.

$m = f_y/(0.85 f_c') = 420/(0.85 * 24)$ = 20.59

$K_n = M_n/(b * d^2) = (13.13 * 10^6)/(520 * 266^2)$ = 0.356 MPa

$\rho = 1/m\left(1 - \sqrt{1 - (2 * K_n * m)/f_y}\right)$

$= 1/20.59\left(1 - \sqrt{1 - (2 * 0.356 * 20.59)/420}\right)$ = 0.000857.

→ As_{req} = ρ × b_E ×d = 0.000857 × 520 × 266 = 118.28 mm^2.

$As_{min} = \sqrt{f_c'}/(4 f_y) * b_w * d \ge 1.4/f_y * b_w * d$

$= \sqrt{24}/(4 * 420) * 120 * 266 \ge 1.4/420 * 120 * 266$

=93.08 mm^2 < 106.4 mm^2 ………… Larger value is control.

→ As_{min} = 106.4 mm^2 < As_{req} = 118.28 mm^2.

∴ $As = 118.28\ mm^2$.

2 □12 with $As = 226.1\ mm^2 > As_{req} = 118.28\ mm^2$ .... OK.

∴ Use 2 12

→ **Check for strain:-($\varepsilon_s \geq 0.005$)**

Tension = Compression

$A_s \times fy = 0.85 \times f_c' \times b \times a$

$226.1 \times 420 = 0.85 \times 24 \times 520 \times a$

a = 8.95 mm.

$c = a/\beta_1 = 8.95/0.85 = 10.53$ mm × Note: $f_c' = 24$ MPa< 28 MPa → $\beta_1 = 0.85$

$\varepsilon_s = (d * .0003)/c - 0.003$

$= (266 * .003)/10.53 - 0.003 = 0.072 > 0.005$

∴ $\emptyset = 0.9$ .... OK.

»Long direction

d = depth - cover – diameter of stirrups –diameter of bar – (diameter of bar/ 2)

= 300 – 20– 8 –12–12/2 = 254 mm.

$b_E \leq 1/2 *$ clear span $+ b_w$= 0.5×500+120 = 620 mm ………..Controlled.

≤ Span/4 = 5640/4 = 1410 mm.

≤ $(16\times t_f) + b_w$ =(16× 80) +120 =1400 mm.

→ **b_E= 620 mm.**

Maximum moment $Mu^{(+)}$ = **9.4 KN.m**

→ $M_{nf} = 0.85 f_c' * b_E * t_f * (d - t_f/2)$

$= 0.85 * 24 * 0.52 * 0.08 * (0.254 - 0.08/2) * 10^3 = 181.6$ KN.m

□M_{nf} = 0.9 × 181.6 = 163.45 KN.m

→□M_{nf} =163.45 KN.m> $M_{u\ max}$= 9.4 KN.m.

∴ Design as rectangular section.

Mn = Mu / ϕ = 9.4 / 0.9 = 10.44 KN.m.

$m = f_y/(0.85 f_c^{'}) = 420/(0.85*24)$ = 20.59

$K_n = M_n/(b*d^2) = (10.44*10^6)/(520*(254)^2)$ = 0.311 MPa

$\rho = 1/m (1 - \sqrt{1-(2*K_n*m)/f_y})$

$= 1/20.59 (1 - \sqrt{1-(2*0.311*20.59)/420})$ = 0.000747

→ $A_s = \rho \times b_E \times d$ = 0.000747× 520 ×254 = 98.56 mm^2.

As = 98.56 mm^2 < As_{min} = 106.4 mm^2

∴ 2 Ø12 with As = 226.2 mm^2 > As = 106.4 mm^2

∴ Use 2 12.

→ **Check for strain:-($\varepsilon_s \geq 0.005$)**

Tension = Compression

$A_s \times fy = 0.85 \times f_c^{'} \times b \times a$

226.2× 420 = 0.85 × 24 × 520 × a

a = 8.95 mm.

$c = a/\beta_1 = 8.95/0.85$ = 10.54 mm × Note: $f_c^{'}$ = 24 MPa< 28 MPa→ β_1 = 0.85

$\varepsilon_s = (d*.0003)/c$ - 0.003

$= (254*.003)/10.54$ - 0.003 = 0.07 > 0.005

∴ $\emptyset$ = 0.9 .... OK.

4.7.4.2 Negative moment at discontinuous edges:-

$Mu^{(-)}$ = (1/3×positive moment)

As = $(A_{pos})/3 = (226.1)/3$ mm^2 < As_{min} = 106.4 mm^2

→ $A_s = As_{min}$ = 106.4 mm^2

∴ Use 2 10

4.7.5 Design shear for two way- ribbed slab :

Case (1):

Wa= 0.54 Wb=0.44

»total load on the panel being = 5.64 ×5.3 ×18.82 = 562.57 KN

»Load per rib at face of long beam is

$V_{u,face}$= 562.57 ×0.54×.52/(2×5.64) = 14 KN … control

»Load per rib at face of short beam is

$V_{u,face}$ = 562.57 ×0.44×.52/(2×5.30) = 12.14 KN

The shear strength of one rib in slab is

V_c = (1.1) ×1/6 × √(f_c^') × 〖b〗_(w)×d = (1.1)×1/6 × √24 × 120 × 254 × 10^{-3} = 27.37 KN.

ϕV_c =0.75 × 27.37 = 20.53 KN .

$1/2 \phi V_c$ = 0.5×20.53 = 10.26 KN .

$\phi Vc =$ 20.53

.No need for shear reinforcement

4.8 Design Of beam(034) for flexure :

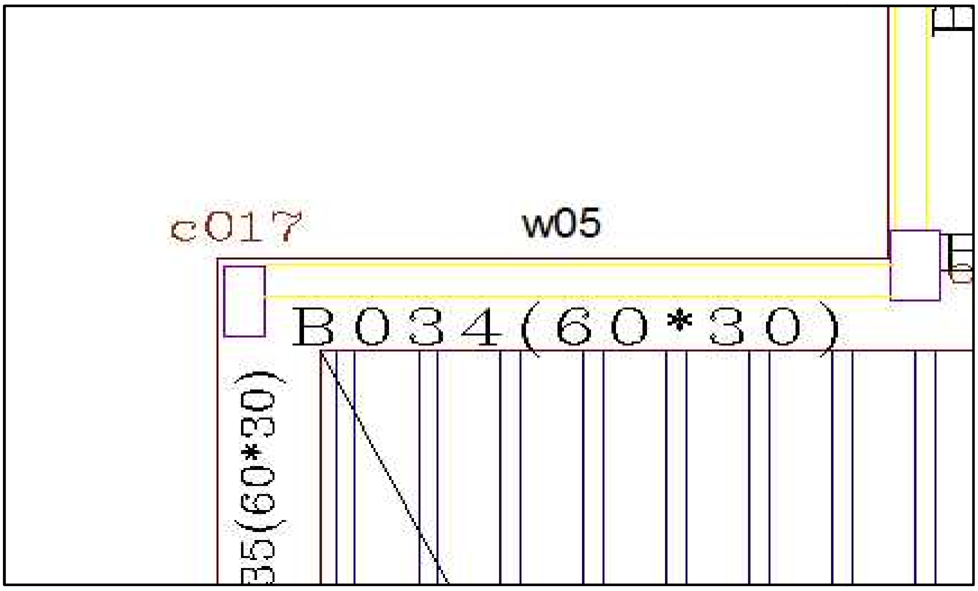


Fig.4-10 : Beam location

4.8.1 Load calculations for Beam 034:

The distributed Dead and Live loads acting upon the Beam 034 can be defined from the support reactions of the rib **002.**

Factored				
DeadR	6.22	22.42	24.76	7.69
LiveR	5.26	15.82	16.88	5.93
Max R	11.48	38.24	41.64	13.62
Min R	5.02	28.08	32.38	6.77
Service				
DeadR	5.18	18.69	20.63	6.41
LiveR	3.28	9.88	10.55	3.71
Max R	8.47	28.57	31.18	10.11
Min R	4.43	22.22	25.4	5.83

Fig. 4-11 : support reactions of the rib 002.

4.8.2 Dead Load calculations:

The maximum support reaction (factored) from Dead Loads for rib **001** upon beam **002** is **6.22 KN** . The distributed Dead Load from the Rib **002** on Beam **034**:

Assume the width of the beam **= 0.6m** , then the own weight of the beam and the weight of the floor layers within the beam width can be calculated:

WDL(from rib 002) =6.22/.52=12 (KN/m)

Dead load of topping =

0.03 × 23 ×0.69 (tiles)

\+ 0.03 × 22×0.6(mortar)

\+ 0.07 × 17×0.6 (sand)

\+ 0.30 × 25 ×0.6 (RC beam)

\+ 0.03 × 22 × 0.6 (plaster)

\+ 2.30× 0.6 (partitions') = 7.8 (KN/m)

The total factored Dead Load: WDL= 12+1.2×7.8= 21.36 KN/m

4.8.3 Live Load calculations:

The maximum support reaction (factored) from Live Loads for rib **002** upon beam **034** is **5.26 KN** . The distributed Dead Load from the Rib **002** on Beam **034**:

WLL(from rib 002) =5.26/.52=10.12 (KN/m)

The Live Load within the beam width (**b=0.6 m**) can be calculated:

LL = 1×5 = 5 (KN/m)

The total factored Live Load: WLL = 10.12+1.6 ×5 = 18(KN/m)

By using **ATIR** program we get the envelope moment and shear diagram as the follows:-

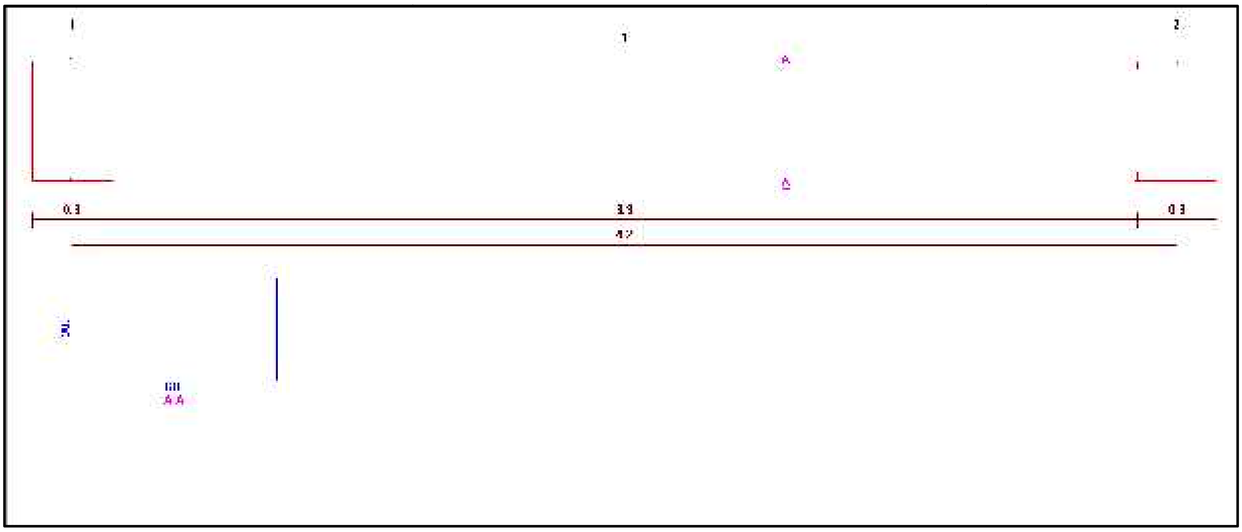


Fig. 4 - 12 : Spans length of Beam.

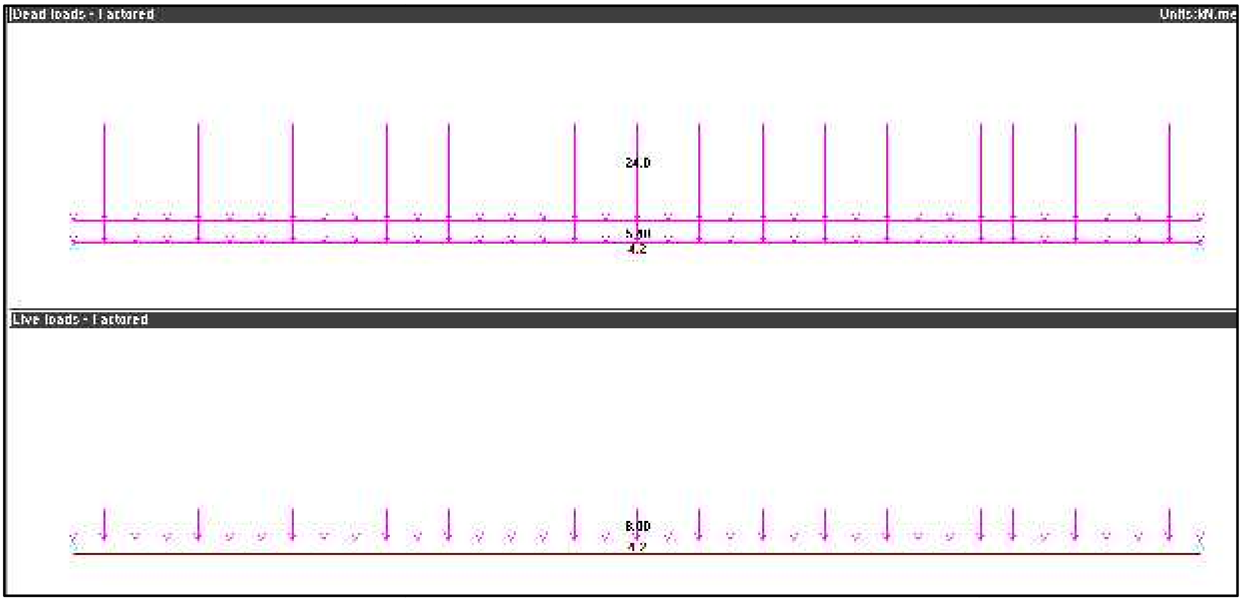


Fig. 4 - 13 : Factored Load of Beam-(KN.m).

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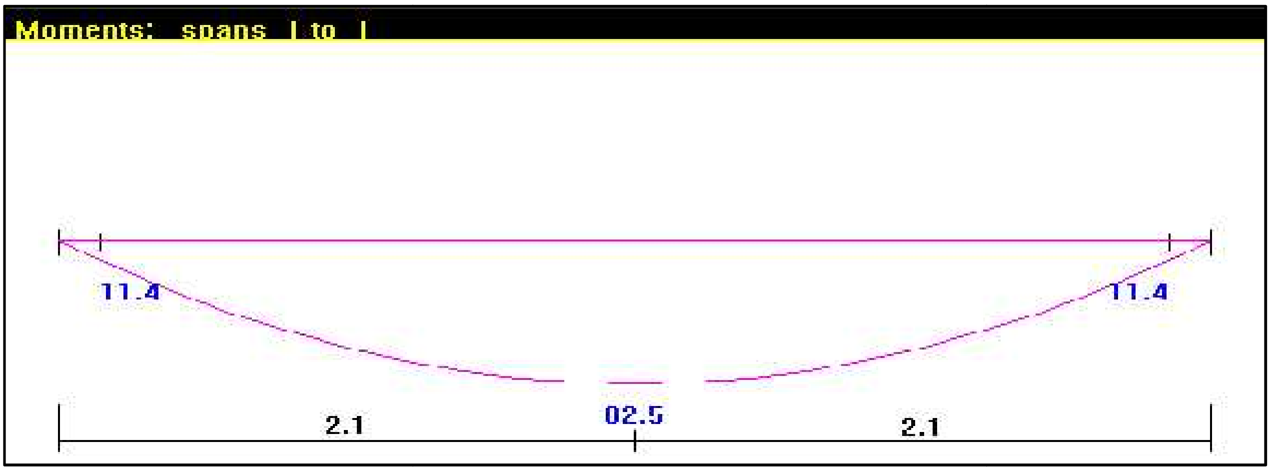

Fig. 4 - 14 : Moment diagram for beam -(KN.m).

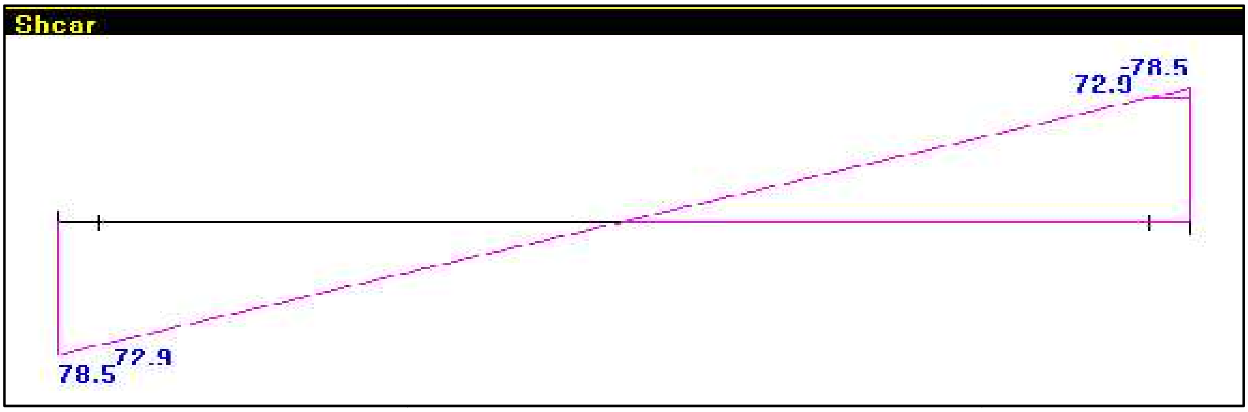

Fig. 4 – 15 : Shear diagram for Beam (KN)

4.8.4 Design of beam for flexure:

Assume bar diameter Φ 18 for main positive reinforcement.

bw =60cm

d=300-40-8-18/2=243mm

The width of the Beam **034** can be defined from the maximum factored moment.

The maximum factored moment in Beam **034 Mu =-82.5KN.m .**

Take Φ = 0.9 for flexure as tension-controlled section

Assume ρ = 0.4 ρ b

Take β = 0.85 (fc' = 24).

ρ b=.85*24/420*.85*(600/600+420)=0.0289

ρ = 0.4 ρ b = 0.4 × 0.0289 = 0.01156

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

Rn=0.01156*420*(1-(0.01156*20.6)/2)=4.28 Mpa

$$bd^2 = \frac{Mu}{\phi kn} = \frac{82.5 \times 10^6}{0.9 \times 4.28} = b \times 243^2$$

$$b = 560.7mm$$

here we take b=60cm.

Usually in construction the maximum width of the beams is 100 cm. Here, take **b=60cm** and no need to recalculate the loads acting on the beam.

Note that the factored moments of other supports and spans may be satisfied by the section width of **60 cm** as a singly reinforced beam sections, but the support section with **Mu =82.5KN.m**

Check whether the section will be act as singly or doubly reinforced section:

Maximum nominal moment strength from strain condition ε s =0.004

C = $\frac{3}{7}$ d = $\frac{3}{7}$ × 243= 104.14 mm .

a = β ×c = 0.85 × 104.14= 88.519mm .

Mn max = 0.85× fc' × a × b × (d- a/2)

= 0.85 × 24 × 88.519 × 600× (243–88.519/2)*10^-6 = 215.33KN .m

Φ Mn = 0.82 ×215.33= 176.6kN .m

Φ Mn=176.6KN.m > Mu=82.5KN.m

** Design of beam as singly reinforcement concrete :

Design of moment :

Take Mu =82.5 $kN.m$ ………… from Atir program

Kn = $\frac{Mn}{b \times d^2}$ = 82.5*10^6/0.9*600*243^2=2.33

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

ρ = $\frac{1}{20.59}$ (1-√1-(2*20.95*2.33/420)= 0.006

$$As_{\min} = \frac{\sqrt{fc'}}{4(fy)}(bw)(d) \geq \frac{1.4}{fy}(bw)(d) \longrightarrow (ACI - 10.5.1)$$

=0.25*√24/420*600*243=425.2 mm²

As,min=1.4/420*600*243=486…control

As = 0.006*(600) (243) = 874.8mm² >As min =486mm²

Of bars = 874.8/254.34=4 bars Note $A_{\Phi 18}$ =254.34 mm²

Select 4Φ18 for bottom reinforcement

Total As $_{(provide)}$ =1017.4 mm^2

Check for yielding:

Tension = Compression

$$A_s \times fy = 0.85 \times f_c' \times b \times a$$

1017.4*420=0.85*24*600*a

a=35

c=35/0.85=41.1

ε_t =0.003*((243-41.1)/41.1)

=0.015>0.005….OK

Check for displacement:

Sb=(600-40*2-8*2-4*20)/3

Sb=141.3mm >25mm…..ok

4.8.5 Design of Beam for Shear :

ACI – 318 – Categories for shear design:

Critical section at d=243mm

Vu_{max} =72.9 KN

Vc=1/6*1*√24*600*243*10^-3=119 kN

Check for section dimensions:

Vs=72.9/0.75-119

=21.8 kN

Vs,max =2/3*√24*600*243*10^-3

=476.2 kN

VS =21.8 kN < Vs,max=634.9kN

The section is large enough.

Find the maximum stirrups spacing.

If VS<vs′ then Smax≤d/2

vs′ =1/3√24*600*243*10^-3

=238.1 kN

VS=21.8kN<vs′=238.1 kN

Then Smax ≤ 600 …

Smax ≤ 243/2=121.5 mm

Check Vs, min:

Av, min =1/16*√24*bw*S/fyt ,,,but not less than

Av, min =1/3*bw*s/fyt …control(√24/16>1/3)

Vs,min =1/16*√24*800*243*10^-3=59.52 kN

Vs,min =1/3*600*243*10^-3

=48.6 kN…control

Φ Vc < Vu< Φ(Vc+ Vs,min)

_case IV

Compute the stirrups spacing required to resist the shear force

Assume (2_leg Φ8) ,Av=2*50.27=100.54 mm^2

Av/s=Vs/fyt*225

S=Av*fyt*d/Vs=201.1*420*243/196.6*10^3

=104.4mm

Take 2_U Shape (2leg stirrups) Φ8@100mm<S,max=104.4mm

4.9 Design of column(C13):

4.9.1 Load calculation:

DL= 690 KN LL= 480 KN

P_u = 1596 KN $P_{n,req}$ = $1596/0.65 =$ 2455.4 KN

Assume rectangular section with **= 1.2% > 1%**

P_n = 0.8× Ag× (0.85× fc'+ $_g$×(fy - 0.85 fc'))

2455.4 = 0.8× Ag×(0.85× 24 + 0.012 × (420 - 0.85× 24))

A_g = 1218.2 cm^2

Use 30×50 cm with Ag = 1500 cm^2 > $A_{g,req}$ = 1218.2 cm^2

4.9.2 Check slenderness effect:

Lu: Actual unsupported (unbraced) length.

K: effective length factor (K= 1 for braced frame).

R: radius of gyration =$\sqrt{(I/A)} = 0.3\,h$

Lu = 3.5 m

M1/M2 =1

In 50cm -Direction

Klu/r < 34- 12 ($M1/M2$) < 40

$(1 \times 3.5)/(0.3 \times 0.5)$ = 23.33 >22 => long

In 30cm -Direction

Klu/r< 34- 12 ($M1/M2$)

$(1 \times 3.5)/(0.3 \times 0.3)$ = 38.88 > 22 => long

long in both direction

4.9.3 Calculation for reinforcement:

In 50cm -Direction

$E_c = 4700 \times \sqrt{24} = 23025.2$ MPa

$_{dns} = (1.2\, D\, (sustained))/Pu = (1.2 * 690)/1596 = 0.5188$

$I_g = [b \times h]^3/12 = [0.3 \times 0.5]^3/12 = 0.003125$ m^4

$EI = (0.4 \times Ec \times I)/(1 + \beta dns) = (0.4 \times 23025.2 \times 0.003125)/(1 + 0.5188) = 18.95$ MN.m^2

$P_c = (\pi^2 \times EI)/[(Klu)]^2$

$= (\pi^2 \times 18.95)/[(1.0 \times 3.5)]^2$

$= 15.27$ MN

$Cm = 0.6 + 0.4 \times (M1/M2) = 1$

$_{ns} = Cm/(1 - (Pu)/(0.75\, Pc)) = 1/(1 - (1596)/(0.75 \times 15.27 \times 1000)) = 1.16 < 1.4$

$e_{min} = 15 + 0.03\, h = 15 + 0.03 \times 500 = 30$ mm

$e = e_{min} \times {}_{ns} = 30 \times 1.16 = 34.857$ mm

$e/h = 34.857/500 = 0.0697 < 0.1$…….(e = 0.082h < 0.1h)

In 30cm -Direction

$E_c = 4700 \times \sqrt{24} = 23025.2$ MPa

$_{dns} = (1.2\, D\, (sustained))/Pu = (1.2 \times 690)/1596 = 0.5188$

$I_g = [b \times h]^3/12 = [0.5 \times 0.3]^3/12 = 0.001125$ m^4

$EI = (0.4 \times Ec \times I)/(1 + \beta dns) = (0.4 \times 23025.2 \times 0.001125)/(1 + 0.5188) = 6.822$ MN.m^2

$P_c = (\pi^2 \times EI)/[(Klu)]^2$

$= (\pi^2 \times 6.822)/[(1.0 \times 3.5)]^2$

$= 5.5$ MN

Cm = 0.6 + 0.4×($M1/M2$) = 1

$_{ns}$ = $Cm/(1-(Pu)/(0.75\,Pc)) = 1/(1-(1596)/(0.75\times 5.5\times 1000))$ = 1.63 > 1.4

e_{min} = 15 + 0.03 h = 15+ 0.03 × 300 = 24 mm

e = e_{min} × $_{ns}$ = 24× 1.63 = 39.12 mm

$e/h = 39.12/300 = 0.1304$ < 0.1…….(e = 0.082h < 0.1h)

→Here we can solve this column as short tied column

P_n = 0.8× Ag× (0.85× fc' + $_g$×(fy - 0.85 fc'))

P_n = 0.8× 300×500× (0.85× 24 + 0.0121 × (420 - 0.85× 24))

=3028.2 KN > $P_{n,req}$ =2455.4 KN …….OK

4.9.4 Design of the tie reinforcement :

S ≤16 db (longitudinal bar diameter)

S≤ 48dt (tie bar diameter).

S ≤ Least dimension.

spacing ≤16×d_b=16×1.6 =25.6 cm …. control

spacing ≤48×dt=48×1.0 = 48 cm

spacing ≤ least.dim =40 cm

Use¤10@20 cm

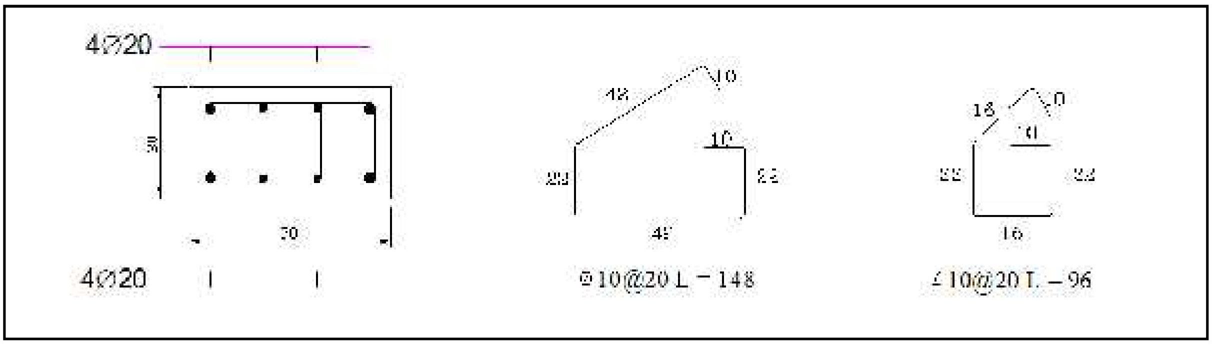

Fig. 4–16 : Reinforcement of column.

4.10 Design of stair:

h min= (5.60 / 20) = 0.28 m=28 cm

h min= (5.60/28)= 0.20m=20cm …….. take **h = 25 cm**

$\theta = \tan^{-1}(rise/run) = \tan^{-1}(160/300) =$ 28.07°

4.10.1 Load calculation :-

Flight dead load computation :-

The structural system & dead load calculation :-

Plaster =(0.03×22×1)/(cos 28.07) = 0.75 KN/m

Concrete slab = (0.25×25×1)/(cos 28.07) = 7.08 KN/m

Mortar = (0.3+0.160)/.3×0.02×22×1= 0.675 KN/m

Stair = (0.160×0.3)/2×1×25/(0.3) = 2 KN/m

Tiles = (0.35+0.160)/.30× 0.03×27= 1.377 KN/m

Total load = 11.88 KN/m

Dead load = 11.88 KN/m , Live load = 5 KN/m

Landing dead load computation :

Tiles = 0.03×22×1 = 0.66 KN/m

Mortor = 0.02×22×1 = 0.44 KN/m

Concrete = 0.25×25×1 = 5.0 KN/m

Plastering = 0.03×22×1 = 0.66 KN/m

Total dead load = 8.01KN/m , Live load= 5 KN/m and Total factored load =1.2D+1.6L

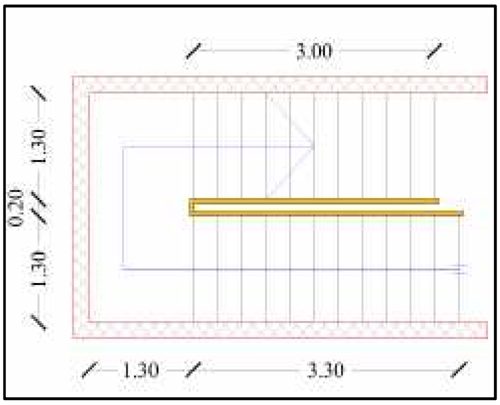

Fig. 4-17 : Stair plan

For flight =1.2x11.88+1.6x5=22.26 KN/m

For landing=1.2x8.01+1.6x5=17.61KN/m

Because the load on the landing is carried into two directions only half the load will be considered in each directions 17.61/2=8.81 KN

By using atir program:

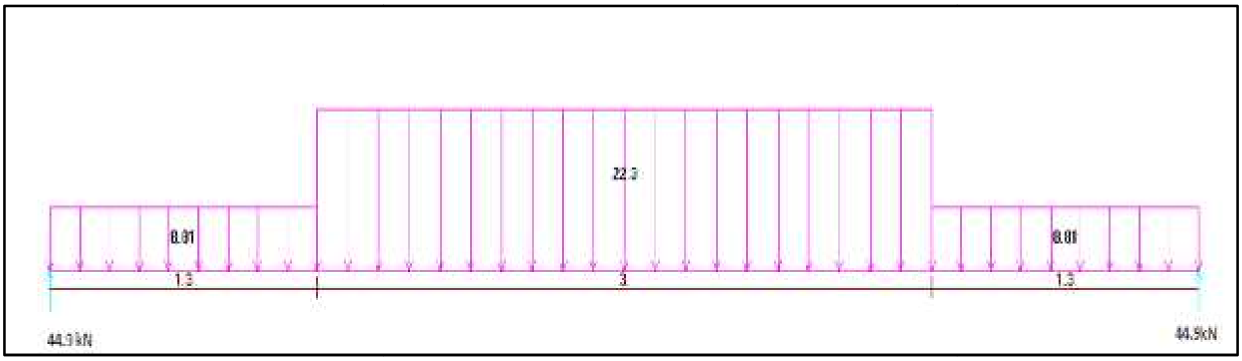

Fig. 4-18 : Load diagram for landing

Max Reaction =44.9 KN.

Check for shear strength :

Assume ϕ 14 for main reinforcement

d=h-20-db/2=250-20-7=223mm

assume beam width 20cm

Vu=44.9-8.81x(0.10+0.223)= 42.1 KN

ϕVc = 0.75($\sqrt{20}$ ×1000×0.223) / 6 = 166.2 KN/1m strip

0.5× ١٦٦.٢ = ٨٣.١ KN > 42.1 KN

The thickness of slab is adequate enough.

4.10.2 Design for flexure:

Mu= 44.9 x(5.6/2)-8.81x1.3x((1.3+3)/2)-22.3x(3/2)x(3/4)=76.02KN.m

Mn= 76.02/ 0.9 = 84.5 KN.m /m

Rn= Mn / (b x d^2)

= 84.5x10^6/ (1000×223^2)

= 1.7 MPa

m = fy / (0.85× fc')

= 412 / (0.85 × 20)

= 24.24

$\rho = \frac{1}{m}\left(1-\sqrt{1-\frac{2\times R_n\times m}{f_y}}\right)$

$\rho = 1/24.24(1-\sqrt{(1-(2\times1.7\times24.24)/412)}\ )$

$\rho = 0.004$

$\rightarrow As_{req} = \rho \times b_E \times d = 0.004 \times 1000 \times 223 = 892\ mm^2$.

$As_{min} = 0.0018 * b * d$

$= 0.0018\times1000\times223$

$=401.4\ mm^2 < 892\ mm^2$ ………… Larger value is control.

Use 14

n= As/As□14

= 892/153.9

= 5.8

$s = \frac{1}{n} = \frac{1}{5.8} = 0.172m$ m

∴ **Take 6 14/m ,**With As= 923.4 mm^2/m or **14 @15 cm**

step (S) is the smallest of :-

1) 3h = 3×250=750 mm
2) 450 mm
3) $380\ (\frac{280}{fs}) - 2.5 \times C_c$

   $= 380 \times (\frac{280}{\frac{2}{3}*412}) - 2.5\times 20 = 337.4$ mm

4) $300\ (\frac{280}{fs}) = 300\ (\frac{280}{\frac{2}{3}*412}) = 305.8$ mm – control

S= 150 <Smax = 387.4 mm …. ok

For the shrinkage and temperature reinforcement :-

$\rho = 0.0018$

$A_s = \rho * b * h = 0.0018 * 1000 * 250 = 450\ mm^2$.

Number of □10 = $\frac{As_{req}}{A_{bar}} = \frac{450}{79.9} = 5.6 \rightarrow$ Spacing(S) = $\frac{1}{5.6} = 17.8$ cm

∴ **Take 5 10 /m** with As= 450 mm^2or **10@15 cm.**

step (S) is the smallest of :-

1) 5h = 5×250 = 1250mm
2) 450 – control

S= 150 <Smax = 450 mm … ok

4.10.3 Design of landing:-

By using Atir program :

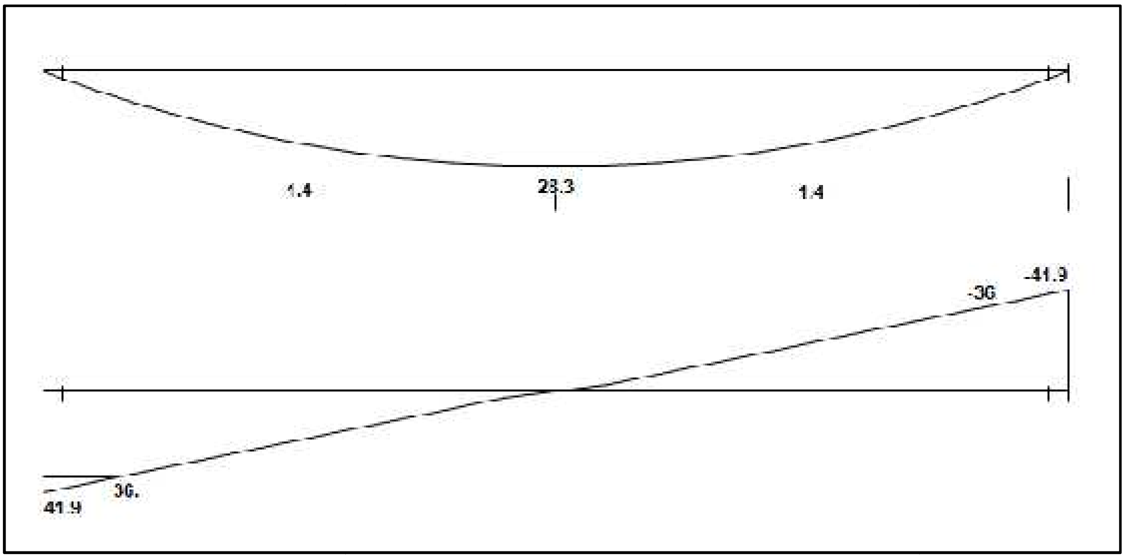

Fig. 4- 19 : Shear & moment envelope diagrams for landing

R =14.98 KN.

4.10.3.1 Design for flexure :

Mu= 14.98x(3.2/2)-8.81x1.5x((1.5+0.2)/2)-17.61x(0.2/2)x(0.20/4)=11.9KN.m

Mn= 11.9/ 0.9 = 11.9/0.9 = 13.22 KN.m

d= 250-20-14-7 = 209mm

Rn= Mn / (b x d^2)

= 13.22x10^6/ (1000×209^2)

= 0.303MPa

m = fy / (0.85× fc ′)

= 412 / (0.85 × 20 = 24.24

$\rho = \frac{1}{m}\left(1 - \sqrt{1 - \frac{2 \times R_n \times m}{f_y}}\right)$

$\rho = \frac{1}{24.24}\left(1 - \sqrt{1 - \frac{2 \times 0.303 \times 24.24}{412}}\right)$

$\rho = 0.001$

→ $As_{req} = \rho \times b_E \times d = 0.001 \times 1000 \times 209 = 209\ mm^2$.

$As_{min} = 0.0018 * b * h$

$= 0.0018 \times 1000 \times 250 = 450\ mm^2$

$= 209 mm^2 < 450\ mm^2$ …………. Larger value is control.

∴ **Use 14**

n= As/As 14

= 450/153.9 = 2.9

$s = \frac{1}{n} = \frac{1}{2.9} = 0.342$

Take 3 14/m with As = 461.7 mm^2/m or **14 @30 cm**

step (S) is the smallest of :-

1) 3h = 3×250=750 mm

2) 450 mm

3) 380 (280/fs) – 2.5 × C_c

= 380 × (280/(2/3 * 412)) – 2.5× 20 = 337.4 mm

= 380 (280/fs) = 380 (280/(2/3 * 412)) = 305.8 mm – control

S= 250 < Smax = 305.8mm …ok

For the shrinkage and temperature reinforcement :-

$\rho = 0.0018$

$A_s = \rho * b * h = 0.0018 * 1000 * 250 = 450 mm^2$.

Number 0f 10 = As_req/A_bar = 450/79.9 = 5.6 → Spacing(S) = 1/5.6 = 17.8cm

Take 6 10 /m with As= 479.4 or **10@15mm**.

step (S) is the smallest of :-

1) 5h = 5×200 = 1000mm
2) 450 – control

S= 150mm<Smax = 450 mm … ok.

4.11 Design of Basement Wall (BW1) :

Fc'= 24 MPa, Fy = 400 MPa ,ϒs = 18KN/m^3, qal l= 400 KN/m^2, φ = 30º ,
surcharge = 3.6 KN/m^2
Wall Thickness = 30 cm

Consider at rest pressure

$$C_a = 1 - \sin\phi = 1 - \sin 30 = 0.50$$

WS = ca * h * ɣ = 0.5 * 3.5 *18 = 31.5 KN/M

WSU = ca * p = 0.5 * 3.5 = 1.75 KN/M

From Atir we have moment and shear envelop :

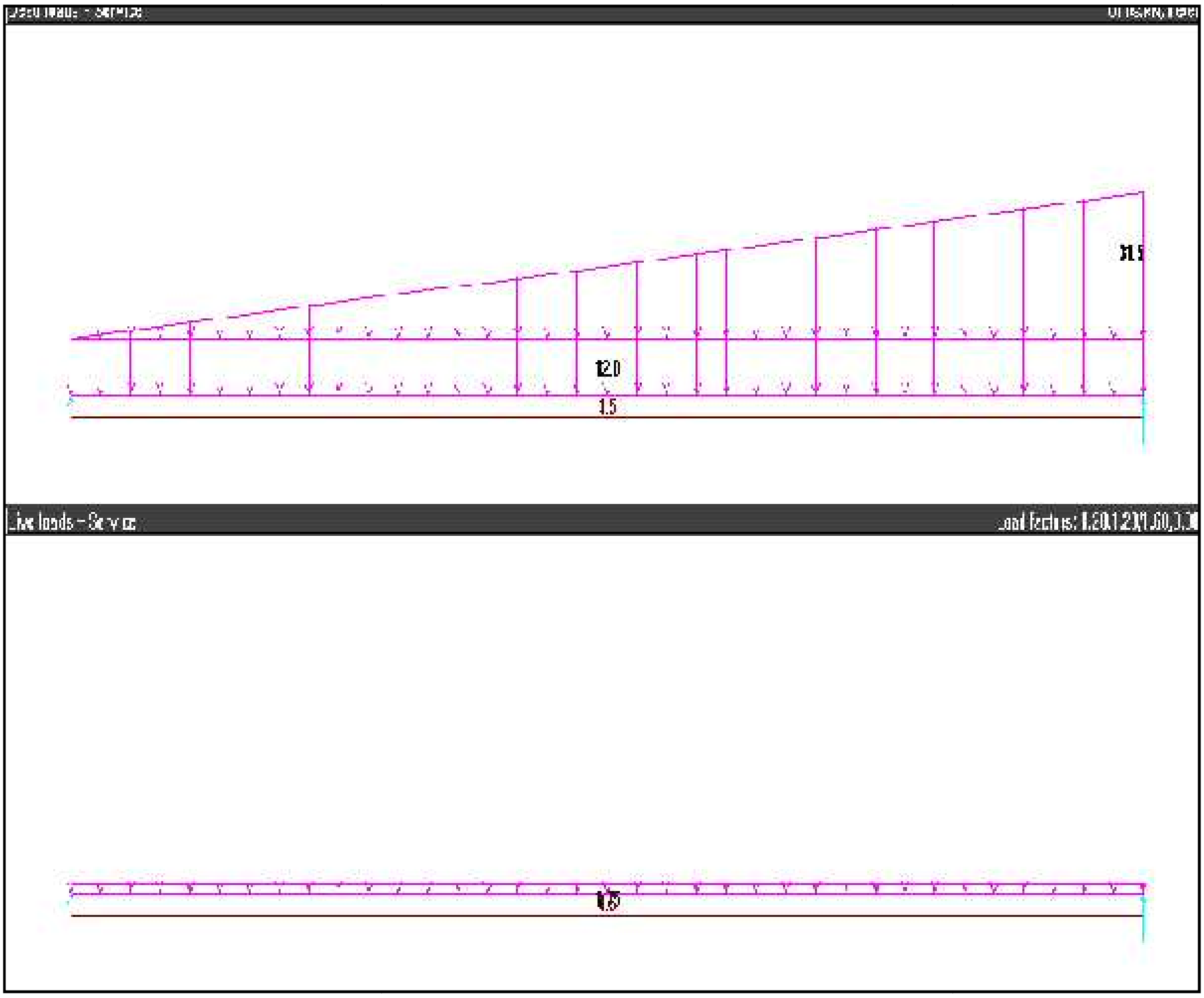

Figure (4-20) : Loading of Basement Wall (BW1)

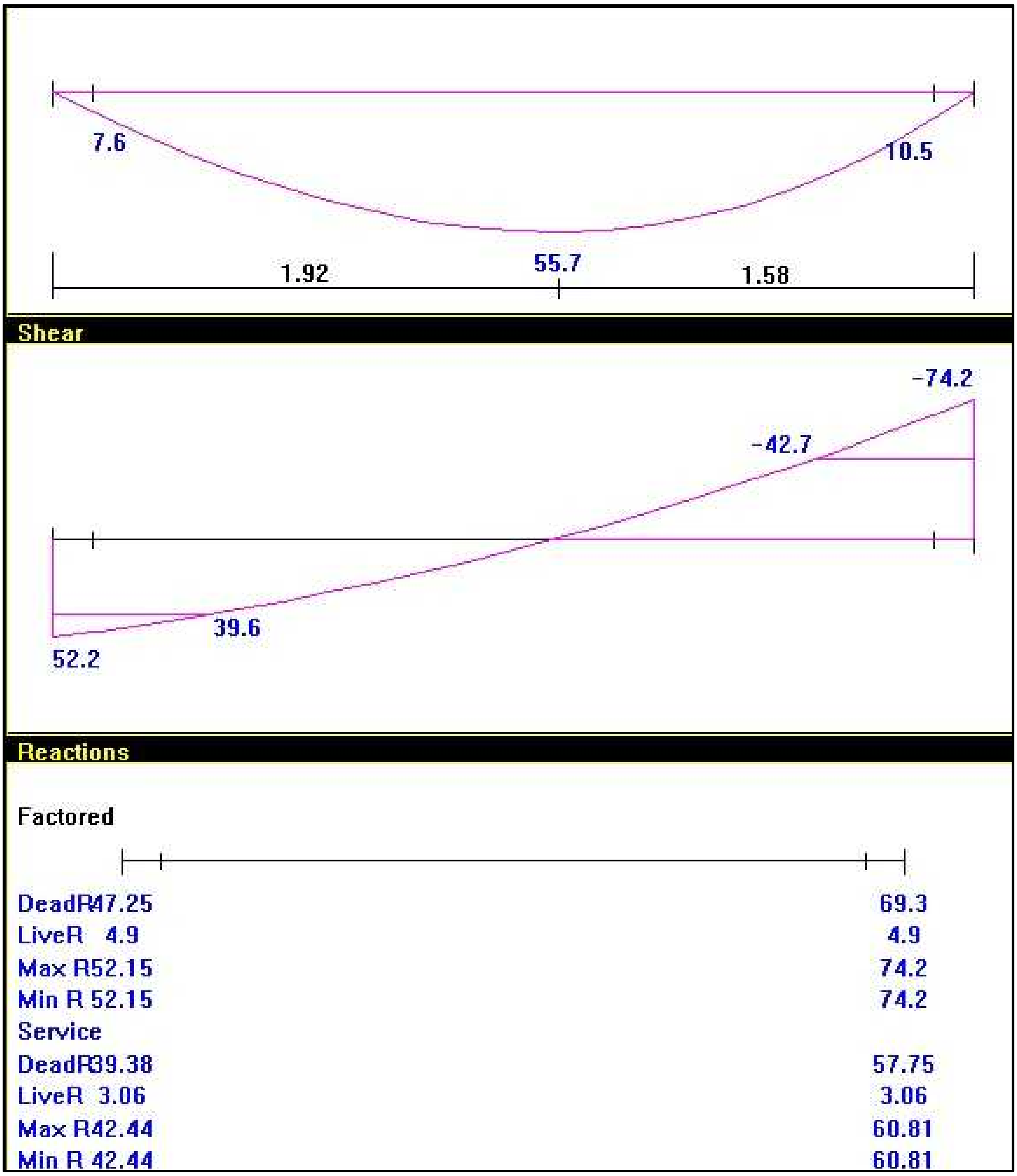

Figure (4-21) : Moment & Shear Envelope of Basement Wall (BW1)

4.11.1 : Design Of Shear :

Check for wall thickness

D= 300 – 75 – 20/2 = 215 mm

$\Phi V_c = \Phi/6 * \sqrt{f_c'} * b * d = 0.75/6 * \sqrt{24} * 1000 * 215 = 131.66$ KN

$V_u = 46.6$ KN

Φ * Vc > Vu…….OK The thickness of Wall is Adequate Enough

4.11.2 Design for Flexure :

Mu = 55.7 KN.M

Φ * Mn ≥ Mu

Mn = Mu / Φ = 55.7 / 0.9 = 61.88 KN . M

Rn = Mn / b * d^ 2

= 61.88 * 10^ 6 / 1000 * (215 ^ 2)

= 1.33 Mpa

m = fy / 0.85 * fc'

= 400 / 0.85 * 24

= 19.61

$\rho = \frac{1}{m}\left(1-\sqrt{1-\frac{2mR_n}{f_y}}\right)$ = 1 / 19.61 *(1 - √(1- (2* 19.61 * 1.33 /400))) = 3.44 * 10^ -3

As req = 3.44 * 10^ -3 * 1000 * 215 = 739.83mm^ 2

$A_{S\min} = \frac{\sqrt{fc'}}{4(fy)}(bw)(d)$ = (√24 / (4*400)) * 1000 * 215 = 658.3 mm^ 2 / m

$A_{S\min} = \frac{1.4}{(fy)}(bw)(d)$ = (1.4/ 400) *1000 * 215 = 752.5 mm^ 2 / m control

Use Φ14/12cm As,provided = 1846.32 mm^2/m

For horizontal bars use the half of the min. in each side

$0.5*Ash_{min}$=0.5*0.002*300*1000 = 300 mm^2/m

Use ϕ =10

Use for horizontal bare ϕ 10@20 cm in each side

Use ϕ 10@20 cm for vertical in outer side to hold the horizontal bares

Check for strain:

Tension = Compression

As * fy = 0.85 * fc' * b * a

1846.32 * 400 = 24 * 1000 * a

a = 30.772 mm

x = a / β = 30.772 / 0.85

= 36.202 mm

ϵ s = (215 – 36.202 / 36.202)* 0.003

= 0.015 ▯ 0.005 → OK

4.12 Design of basement footing:

Soil density = 18.42 KN/m

Allowable soil pressure = 400 KN/m^2

Live load =5 KN/m^2

Assume footing to be about (30 cm) thick.

For 1m length of wall:

Total service load in basement = 25×4.05×0.3= 30.375 KN/m

Total factored load in basement = 1.2× (25×4.05×0.3) = 36.45 KN/m

Footing weigh = 25 * 0.3 = 7.5 KN/m^2

Weight of backfill = 18.42 * 4.05= 74.601 KN/m^2

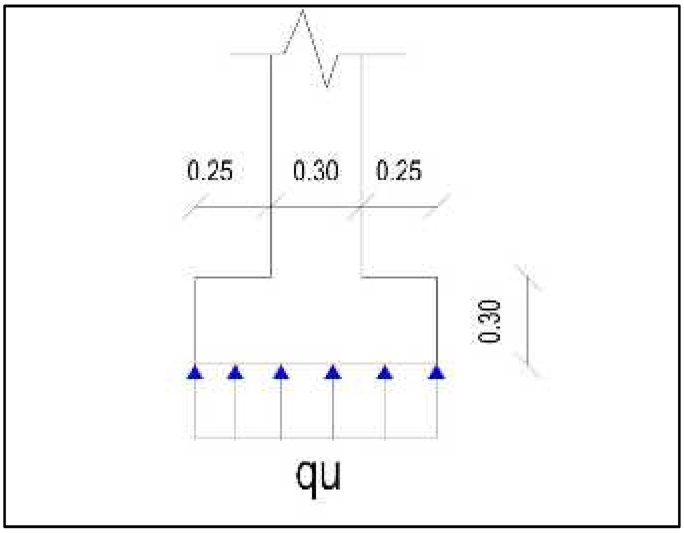

Fig. (4-22) : Strip Footing geometry

$q_{allow,net}$ = 400 – 74.601 – 7.5 - 5

= 312.9 KN/m^2

$$b = \frac{30.375}{1 \times 312.9} = 0.1 \text{ m}$$

Take b = 80 cm , h = 30 cm

d = 300 – 75 - 0.5 * 14 =218 mm

q_u = 36.45 / 1* 0.8 = 45.56 KN/ m^2

4.12.1 Check of one way shear:

V_u = 45.56 *(0.25 – 0.218)

= 1.46 kN

$$\emptyset Vc = 0.75 * \frac{1}{6} * \sqrt{fc'} * b * d$$

$$= 0.75 * \frac{1}{6} * \sqrt{24} * 1000 * 218 * 10^{-3}$$

$$= 133.5 \text{ KN}$$

$\emptyset Vc$>>>> V_u....No Shear Reinforcement is Required.

4.12.2 Design of bending moment:

$Mu = 45.56 \times 0.25^2/2 = 1.42$ KN.m

$Mn = Mu/0.9 = 1.42/0.9 = 1.58$ KN. m

$Kn = (Mn * 〖10〗^6)/(b * d^2) = (1.58 * 〖10〗^6)/(1000 * 〖218〗^2)$

$= 0.033$ Mpa

$m = Fy/(0.85 * fc') = 420/(0.85 * 24) = 20.58$

$\rho = 1/m * (1 - \sqrt{(1 - (2 * Kn * m)/Fy)})$

$= 1/20.58 * (1 - \sqrt{(1 - (2 * 0.033 * 20.58)/420)})$

$= 0.079 * 〖10〗^{(-3)}$

$Asreq = \rho * b * d = 0.079 * 〖10〗^{(-3)} * 1000 * 218 = 17.22$ mm^2

$Asmin = 0.0018 * b * h = 0.0018 * 1000 * 300 = 540$ mm^2

$Asreq < Asmin$

Use $A_{s,min}$

Select Ø14@25cm = 615.6 mm^2 > 540 cm^2

4.13 Design of Isolated Footing (F1c 12).

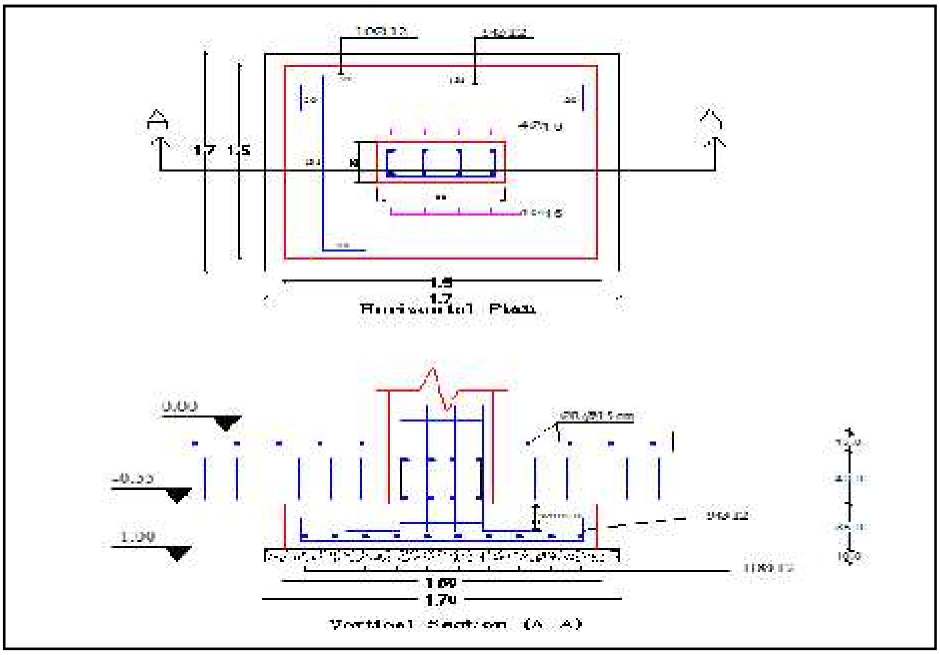

Fig. (4-23) : Footing geometry

From column group1

DL= 442 KN

LL= 294 KN

Factored load = 1000 kN .

Soil weight = 18 kN/m3.

Allowable soil pressure = 400 kN/m2.

Fc' = 24 Mpa

Fy = 420 Mpa

Cover = 7.5 cm

4.13.2 Determine the net soil pressure:

use steel bar 12

Assume h = 35 cm ………d = 350-75-12 = 263 mm

Weight of footing= 0.35*25= 8.75 KN/m^2

Weight of soil= 1*18 = 18 KN/m^2

Total surcharge load foundation:

W= 8.75+18 = 26.75 KN/m^2

qall.net = 400 - 26.75 = 373.52 KN/m^2

4.13.3 : Design of the footing area:

A= $Pn/(qall.net) = (442+294)/(373.52)$ = 1.9 m^2

A= b*l

Take b= 1.5 m

l= 1.9/1.5= 1.3, take l= 1.5m

qu= $1000/(1.5*1.5)$= 444.44 KN/m^2.

4.13.4 Check for one way shear:

For X- direction:

Vu = ((1.5– 0.25)*0.5 – 0.263)× 444.44×1.5

Vu = 241.3 KN

For Y- direction:

Vu = ((L – a)*0.5 – d)× qu×b

Vu = ((1.5– 0.5)*0.5 – 0.263)× 444.44×1.5

Vu = 157.9 KN

ϕVc,x= ϕ (√(fc′) *bw*d) / 6

= 0.75 * √24 * 1500*263*10^{-3} / 6

= 241.5 KN > Vux = 241.3 KN => OK

ϕVc,y = ϕ (√(fc′) *bw*d) / 6

= 0.75 * √24 * 1500*263*10^-3 / 6

= 24 1.5 Kn>Vuy = 157.9 KN => OK

4.13.5 Check for two way shear:

Vu,x = qu*(b*l - (a+d) (c + d))

= 444.44 (1.5*1.5 - (0.25+0.263) (0.5 + 0.263))

= 820 KN.

s = 40 for interior column

β= 50/(25) = 2

bo = Perimeter of critical section taken at (d/2) from the loaded area

bo = 2* (a+d+c+d)

= 2 *(0.25+0.263*2+0.5)

= 2.552 m

Vc the smallest of:

$Vc = 1/6 * (1 + 2/B) \sqrt{fc'} * b * d$ ..where $1/6 * (1 + 2/B) = 1/6 * (1 + 2/2) = 0.333$

$Vc = 1/12 ((\alpha s\, d)/b + 2) \sqrt{fc'} * b * d$ ..where

$1/12 ((\alpha s\, d)/b + 2) = 1/12 ((40 * 0.263)/2.552 + 2) = 0.510$

$V_c = 1/3 * \sqrt{fc'} * b * d$ where $1/3 = 0.333$ … … … … control

Take $V_c = 1/3 * \sqrt{fc'} * b * d = 1/3 * \sqrt{24} * 2552 * 263 * [10]^{(-3)} = 1096$ KN

$\emptyset V_c = 0.75 * 1096 = 822$ KN

$\emptyset V_c = 822 > V_u = 820$ KN … … … ok

4.13.6 Design for bending moment:

4.13.6.1 Design flexure for long direction:

use steel bar □ 12

b =1.5m , h =350mm , $d = 263$ mm

$M_u = 444.44 * [1.5 * 0.5]^2/2 = 83.33$ KN. m

$m = f_y/(0.85\, fc') = 420/(0.85 * 24) = 20.59.$

$R_n = M_u/(\emptyset\, b * d^2) = (83.33 * [10]^6)/(0.9 * 1500 * [(263)]^2) = 0.892$ MPa.

$\rho = 1/m(1 - \sqrt{1 - (2 * R_n * m)/f_y})$

$= 1/20.59 (1 - \sqrt{1 - (2 * 20.59 * 0.892)/420}) = 0.00217$

$A_s = \rho * b * d = 0.00217 * 1500 * 263 = 857 mm^2.$

$As_{min} = 0.0018 * b * h = 0.0018 * 1500 * 350 = 945 mm2$

$As_{min} = 945\ mm^2 > As_{req} = 857\ mm^2.$

$\therefore As = As_{min} = 936\ mm^2.$

$n = As_{req}/(A_{bar}\emptyset 12) = (936)/113.1 = 8.2$.

$\therefore$ Use 9Φ12

$S = (1300 - 75 * 2 - 9 * 12)/8 = 130.25mm$

Step S is the smallest of

3h = 3*400=1200mm

450.........control

S = 115.7 $< S_{max} =$ 450 … … … . ok

4.13.6.2 Design flexure for short direction:

Take steel bare of Ø12

b =1.3m , h =350mm , d $= 263 - 12/2 = 257$mm

$f_c' = 24$ MPa $f_y = 420$ MPa

$M_u = 444.44 * [1.5 * 0.5]^2/2 = 83.33$ KN. m

$m = f_y/(0.85 f_c') = 420/(0.85 * 24) = 20.59$.

$R_n = M_u/(\emptyset b * d^2) = (96.2 * [10]^6)/(0.9 * 1500 * [(263)]^2) = 0.857$ MPa.

$\rho = 1/m(1 - \sqrt{(1 - (2 * R_n * m)/f_y)})$

$= 1/20.59 (1 - \sqrt{(1 - (2 * 20.59 * 0.857)/420)}) = 0.00217$

$A_s = \rho * b * d = 0.00217 * 1500 * 263 = 857$ mm^2.

$As_{min} = 0.0018 * b * h = 0.0018 * 1500 * 350 = 945$ mm^2.

$As_{min} = 945$ mm$^2 > As_{req} = 857$mm^2.

∴ $As = As_{min} =$ 945 mm^2.

n= $As_{req}/(A_{bar}\emptyset 12) = (945)/113.1 = 9.55$

∴ Use 10Φ12

$S = (1500 - 75 * 2 - 10 * 12)/9 = 136.67$mm

S = 136.67 $< S_{max} =$ 450 … … … . ok

4.14.7 Check transfer of load at base of column:

ΦPn= Φ(0.85 fc′Ag)

$= 0.65(0.85)(24)*500*250*[10]^{(-3)}$=1657.5 KN > Pu= 1000 KN.

Since ΦPn > Pu.

∴ Dowels are not required for load transfer

The min. area of dewels= 0.005*Ag = 0.005*250*500 = 625 mm^2.

Use 12Ø16, As= 2412 mm2 >Asmin=625 mm2

Chapter V

Results and Recommendations.

5-1 Results.

5-2 Recommendations.

5-3 References.

5-4 Appendix.

5-1 Results:

Through this research, and to identify the data aspects, has been out with a summary of this research through the results are as follows:

1- Understanding the architectural plans have a major role to play in finding appropriate solutions to the type of construction used in the building.

2- The ability to manual solution necessary structural designer to confirm the calculated programs and understand how they work solution.

3- Identify the structural elements, and how to deal with it, with its mechanism, and it is designed to achieve well-designed safety and structural strength.

5-2 Recommendations:

1- There should be coordination between the architect and the structural designer during the design process even produces an integrated building structurally and architecturally.

2- Recommends the implementation of the project according to the charts attached to the project at the lowest possible changes.

3- Advised the existence of an engineer to oversee the implementation of schemes to abide by the conditions and to ensure better implementation of the project.

4-Must complete the electrical and mechanical design of the project before the implementation of the direct entry of any possible amendments to it in terms of construction.

5-3 References:

1- Jordan's national building codes, coded loads and forces, the National Building Council Jordan, Amman, Jordan, 1990.

2- Notes supervising professor.

3- ACI Committee 318 (2008), ACI 318-08: Building Code Requirements for Structural Concrete and Commentary, American Concrete Institute, ISBN 0-87031-264-2.

4- Nawy, Edward, Prestressed Concrete Fifth Edition Upgrade: ACI, AASHTO, IBC Codes Version (5th Edition), 2009.

5-4 Appendix:

1- Appendix (A):

Architectural Drawings.

This appendix is an attachment with this project.

2-Appendix (B):

Structural Drawings.

This appendix is an attachment with this project.

3-Appendix (C):

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

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

Notes:
Values given shall be used directly for members with normalweight concrete (density w_c = 2320 kg/m^3) and Grade 420 reinforcement. For other conditions, the values shall be modified as follows:
a) For structural lightweight concrete having unit density, w_c, in the range 1440-1920 kg/m^3, the values shall be multiplied by $(1.65 - 0.003w_c)$ but not less than 1.09.
b) For f_y other than 420 MPa, the values shall be multiplied by $(0.4 + f_y/700)$.

Figure 5-1 Minimum thickness of nonprestressed beams ore one way slabs unless defelections are calculated.

TABLE 9.5(b) — MAXIMUM PERMISSIBLE COMPUTED DEFLECTIONS

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

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

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

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

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

Figure 5-2 Maximum permissible computed deflections