Structural Design of Training Center Units

By:-

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Submitted to the College of Engineering

In partial fulfillment of the requirements for the degree of

Bachelor in Building Engineering

Palestine Polytechnic University

May 2015

CERTIFICATION

PALESTINE POLYTICHNIC UNIVERSITY

HEBRON-PALESTINE

STRUCTURAL DESIGN OF TRAINING CENTER UNITS

AMAL MUHTASEB   ASEEL SHAHEEN

ISAM SHROKH   MAHER ATAWNEH

By the guidance of our supervisor, and the approval of member of the testing Committee, this project is delivered to the Department of Civil and Architectural Engineering, in the College of Engineering and Technology to be as partial fulfillment of the requirements of the department for the degree of B.Sc. in Building Engineering.

Supervisor Signature: Head of Dep. Signature:

Name:……………….....   Name:………........

Committee members signature:

Name:…………… Name:……………. Name:……………

Palestine Polytechnic University

May 2015

DIDICATION

To Palestine…

To our Parents….

To The Soul of Martyrs….

To our Teachers ….

To our Friend's …

To whom we Love ….

To Everyone who gave us Help …

To Dr. Mohammad Taha …

WORK TEAM.

ACKNOWLEDGMENT

We would like to thank and gratitude to Allah, who gives us the most Merciful who granted us the ability and willing to complete 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 Dr. Mohammad Al-Sayyed, who gave us the knowledge, valuable help, encouragement, supervision and guidance.

Thanks for all teachers that gave us a lot of their time to 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.

WORK TEAM.

ABSTARCT

STRUCTURAL DESIGN OF TRAINING CENTER

PROJECT TEAM:-

AMAL MUHTASEB ASEEL SHAHEEN

ISAM SHROKH MAHER ATAWNEH

PROJECT SUPERVISOR

Dr. MOHAMMAD TAHA AL-SAYYED AHMAD

The main aim of this project is to prepare all the structural design and construction details of the:

1. Mosque.
2. Festival and lecture halls.
3. Parking sheds and fence.
4. Two underground tanks ($2 \times 2500m^3$).

All of these elements are located in a Training center in Bethlehem.

The project contains the structural analysis for vertical and horizontal loads, the structural design, and details for each element. ACI 318m-08, Jordanian loads code 2006, and some engineering programs were used in the design of the structures.

خلاصة المشروع

التصميم الإنشائي لمركز تدريب

في مدينة بيت لحم

فريق المشروع :-

أسيل شاهين   أمل المحتسب

عصام الشروخ   ماهر عطاونة

جامعة بوليتكنك فلسطين- ٢٠١٥

إشراف:-

د. محمد طه سيد أحمد

يهدف هذا المشروع إلى التصميم الإنشائي لجميع العناصر الإنشائية التي يحتويها المشروع، والذي يتضمن أربع وحدات تشمل مسجد وسور وخزان وقاعة احتفالات وقاعات تدريس من جسور وأعمدة و أسلسات وجدران.

من الجدير بالذكر انه تم استخدام الكود الأردني لتحديد الأحمال الحية، و لتحديد أحمال الثلوج والرياح والزلازل، أما بالنسبة للتحليل الإنشائي وتصميم المقاطع فقد تم استخدام الكود الأمريكي (ACI 318m-08) ولابد من الإشارة إلى انه سيتم الاعتماد على بعض برامج الحاسوب مثل:

Autocad2007 – Atir – SAFE – ETAPS 3013 – Microsoft word

CHAPTER

1

INTRODUCTION

INTRODUCTION

1.1 BACKGROUND.

1.2 RESEARCH PROBLEM.

1.3 AN OVERVIEW OF THE PROJECT.

1.4 THE OBJECTIVE OF THE PROJECT.

1.5 PROJECT STEPS.

1.6 REASONS TO CHOOSE PROJECT.

1.7 THE SCOPE OF THE PROJECT.

1.8 SCHEDULE.

1.1 Introduction:-

These places must have all the means to ensure comfort and safety. General design process requires the introduction of all aspects of the building to be created both in the architectural appearance of the building and how to distribute the spaces and areas within various service sections linked to each other, or structural terms dealing with structural system capable of carrying the loads affecting the building taking into account the minimum possible economical system construction as is compatible with the architectural design choice.

The project includes the architectural and structural design of Mosque, festival hall and lecture halls, parking sheds and fence and two underground tanks. Distributing columns and bridges in line with architectural and design elements from components to bases and foundations and structural schemes and processing in order to produce an integrated project and implementation.

1.2 Research Problem:-

The problem centralized in the project analysis, architectural design and structural system of all sections of the buildings. Forces and loads of structural components, such as beams and columns, ribs, etc. will be analyzed in the project. Then the dimensions and the arming of various structural elements will be determined.

1.3 An overview of the project:-

This project includes the structural design of four units of training center. Mosques are places include the Hall with large spaces that fulfilled all the requirements for comfort and safety according to usage requirements.

Festival and lecture halls, are huge building contains five lecture halls and festival hall that accommodate to 250 persons in each hall, and festival hall with an area of almost 1120.5m².

Parking fence and sheds at the entrance of the training center, and two underground tanks designed to serve the center and all visitors and worker.

1.4 The objective of the project:-

The objectives of the project are divided into two parts:

1. Architectural goals:

   In this project architectural design is not the mean goal as civil and building engineers, however this buildings where necessary to achieve beauty and utility requirements, cost and durability in these facilities, which are the basic architectural design requirement.

2. Structural goals:

   Structural design of the units will be done in this project, with prepare all structural drawings for beams, slabs, columns, footings and shear walls to be ready for fulfillment on the location of the project.

One way rib slab and solid slab were used in the units, in addition of paneled beams and shells which is the main system in the mosque and halls respectively. This systems was choose because its effectiveness in long spans buildings. Parking sheds and fence were designed as frame carrying solid slab. Underground tanks were designed as shear walls underground closed with solid slab.

1.5 Project Steps:-

1. Architecture design (construction drawings, elevations, sections, public location).
2. Study the units structurally to identify structural elements, loads on the buildings, and the selection of appropriate structural system.
3. Distribute columns to the chosen structural system.
4. Structural analysis of all structural elements of the units.
5. Structural design of all structural elements.
6. Preparation of construction drawings of the building to remove the executable image.
7. Writing project in accordance with the requirements of the construction engineering.

1.6 Reasons to choose project:-

The reason of selecting the project back to several things, including the conquest of skill in design for structural elements in buildings, In addition to increasing knowledge of machine construction systems in our country and other countries, as well as the conquest of scientific knowledge and the process followed in the design and implementation of construction projects and the structural engineer after graduation in the work market in the future.

This search is to submit it to the department of civil engineering and architecture at the College of engineering and technology at Palestine Polytechnic University to meet graduation requirements and a Bachelor's degree in civil engineering for building engineering.

1.7 The scope of the project:-

This project contains several chapters are detailed as follows:

- Chapter One: a general introduction to the project.
- Chapter Tow: includes description of architectural project.
- Chapter Three: contains a description of the structural elements of the project.
- Chapter Four: Analysis and structural design of all structural elements.
- Chapter Five: The results that have been reached and recommendations.

1.8 Schedule:-

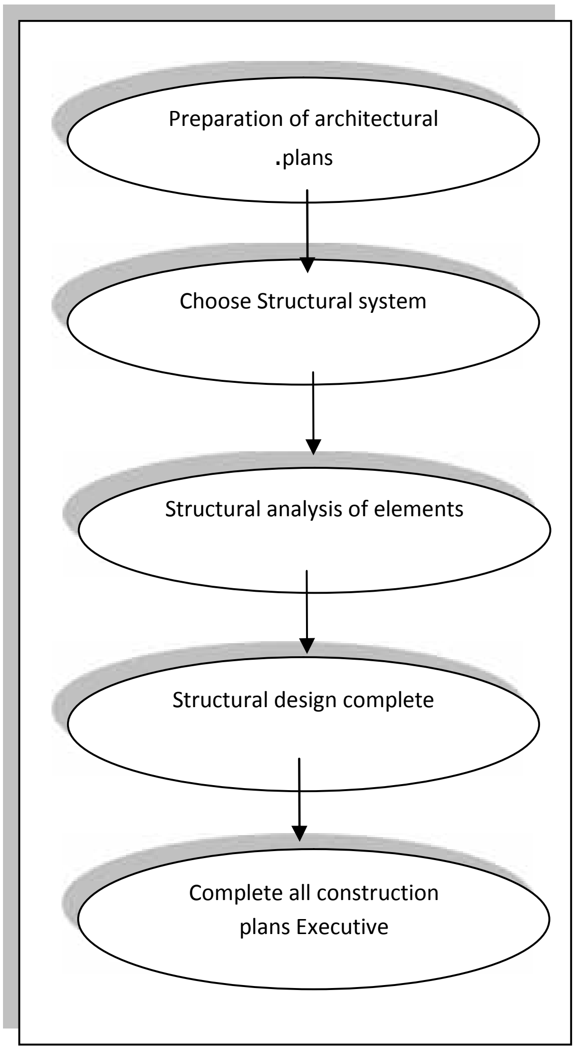


Figure (1.1): shows the stages of the project.

Activities / Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Choose project			■													
Preparation of architectural plans				■	■											
Distribute columns					■											
Study the building structurally						■										
Structural analysis of the project						■	■									
Structural design of the project								■	■							
Preparation of construction drawings										■	■	■	■			
Writing project														■	■	
Present the project																■

Table (1.1): Project schedule for first semester.

Activities / Week	6	7	8	9	10	11	12	13	14	15	16
Analysis and Design of one way rib	■	■									
Analysis and Design of beams		■	■								
Analysis and design of columns				■	■						
Analysis and design of foundations						■	■				
Writing project								■	■	■	
The printing and delivery of the project											■

Table (1.2): Project schedule for first semester for structural design and analysis.

Activities / Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Preparation of architectural plans			■													
Distribute columns				■	■											
Study the building structurally					■											
Structural analysis of the project						■										
Structural design of the project						■	■									
Preparation of construction drawings								■	■							
Writing project										■	■	■	■	■		
Print the project															■	
Present the project																■

Table (1.3): Project schedule for Second semester.

Activities / Week	6	7	8	9	10	11	12	13	14	15	16
Analysis and Design of one way rib	■	■									
Analysis and Design of beams		■	■								
Analysis and design of columns				■	■						
Analysis and design of foundations						■	■				
Writing project								■	■	■	
The printing and delivery of the project											■

Table (1.4): Project schedule for second semester for structural design and analysis.

CHAPTER

2

Architectural Description

2.1 INTRODUCTION.

2.2 DESCRIPTION OF THE MOSQUE.

2.2.1 DESCRIPTION OF THE ELEVATION.

2.2.2 ARCHITECTURAL ELEMENTS.

2.2.3 Movement.

2.3DESCRIPTION OF PARKING SHEDS AND FENCE

2.4DESCRIPTION OF TWO UNDERGROUND TANKS.

2.5 DESCRIPTION OF FESTIVAL AND LECTURE HALLS.

2.5.1 DESCRIPTION OF THE ELEVATION.

2.5.2 ARCHITECTURALELEMENTS.

2.5.3 Movement.

2.1 Introduction:-

Architectural description is the most important things that should be consider when preparing for any project because of its importance in defining and understanding the nature of the project and its sections.

Architectural design requirements task must meet the desired job and human needs in the present time, these terms are in the functional, lasting beauty and economy, it is important in these conditions can interact between each other and in harmony to achieve our vision of optimal design and get an integrated and comprehensive architectural design, and this is achieved by understanding the functional demands of the building and space as well as taking into account nature movement of each part of the project.

Architectural study that must precede the start of architectural design must be easy to handle and understand different events that it contains building and functional relations among them, and the nature of the association movement and using these parts, and other things of importance that give a clear picture of the project and therefore it will be possible to locate the columns and other structural elements to suit architectural design.

2.2 The Mosque:-

The mosque has an area of 525 m², where is the hall of prayer and ablution rooms and bathrooms.

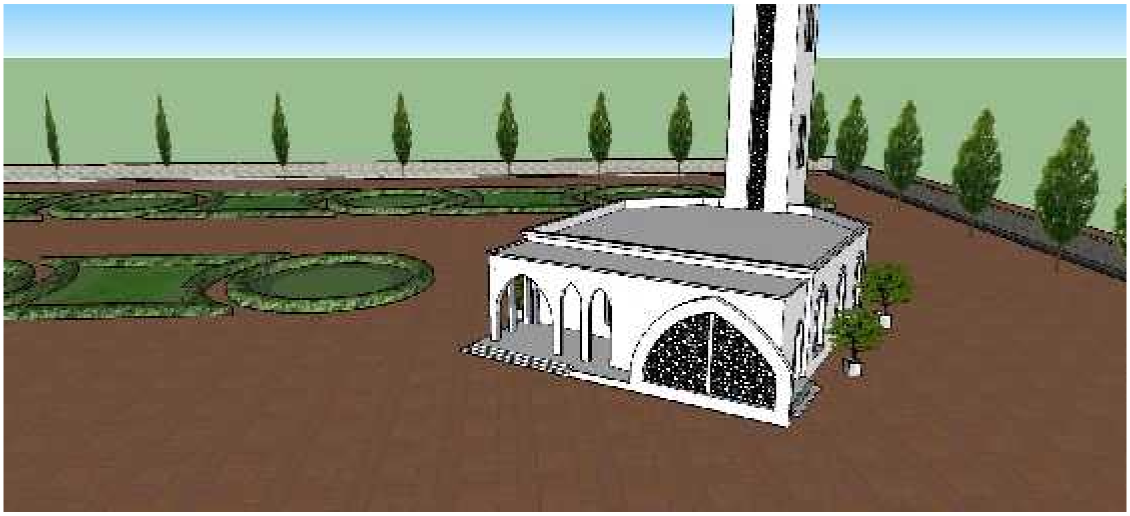


Figure (2.1): The mosque.

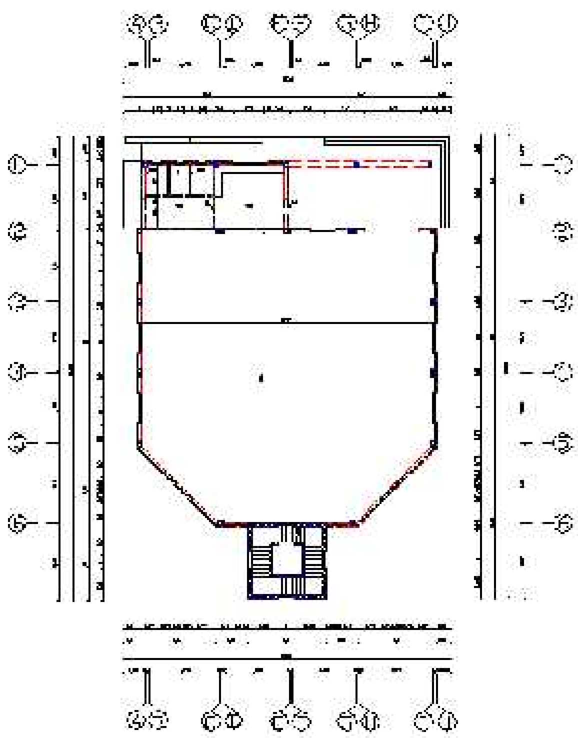
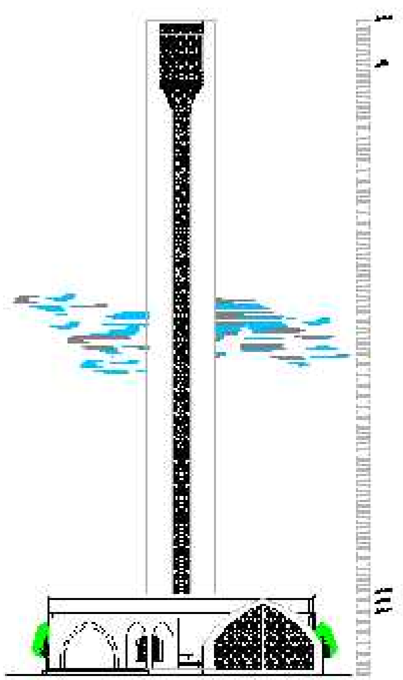


Figure (2.2): The plan for mosque.

2.2.1 Elevations:-



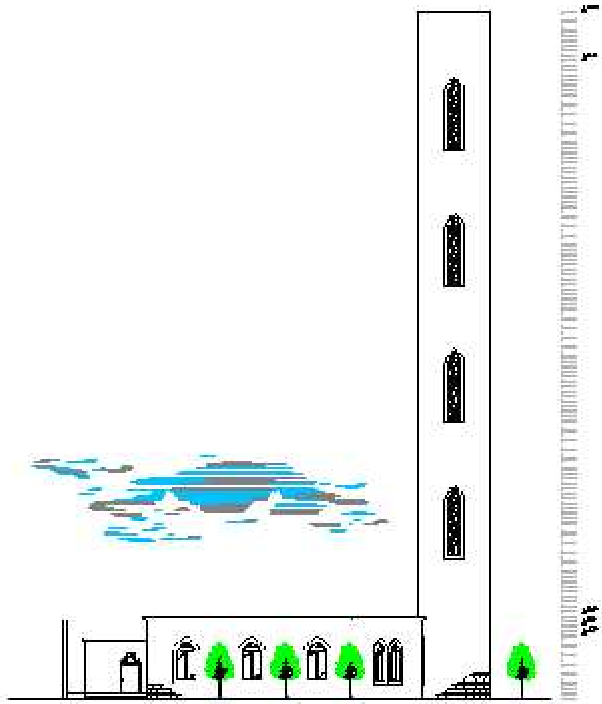


Figure (2.3): West North Elevation.Figure (2.4) West South Elevation.

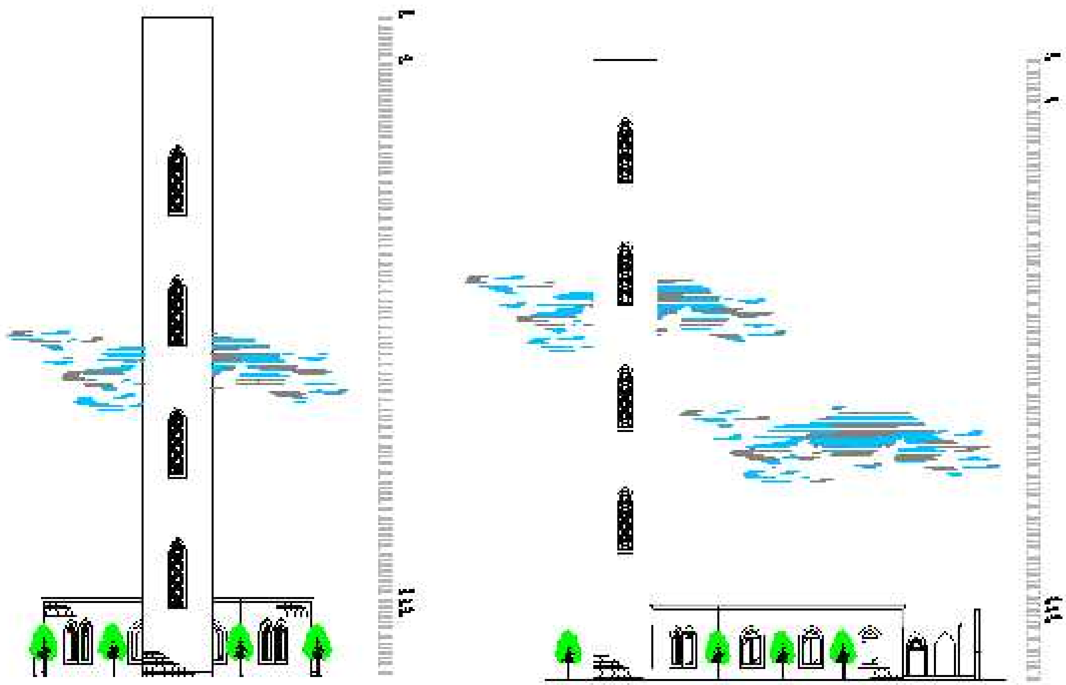


Figure (2.5) East South Elevation.Figure (2.6) East North Elevation.

2.2.2 Architectural elements:-

This project (Mosque) consisting of architectural spaces: the Hall for prayer and ablution rooms and bathrooms.

1. Prayer hall:

Prayer hall with an area of 500 m^2, and includes the platform for the head of the mosque, stair and elevator for Minaret.

2. Ablution rooms and bathrooms:

Ablution rooms and bathrooms with an area of 25 m^2 including laundries and baths, and also has two entrances.

2.2.3Movement:-

The method of movement in the design of the project will be taken into account, where the portal is designed to allow entry for worshipers to comfortably and easily.

2.3The Parking Sheds:-

A parking sheds is a cleared area that is intended for parking vehicles.

Figure (2.7):The Parking Sheds.

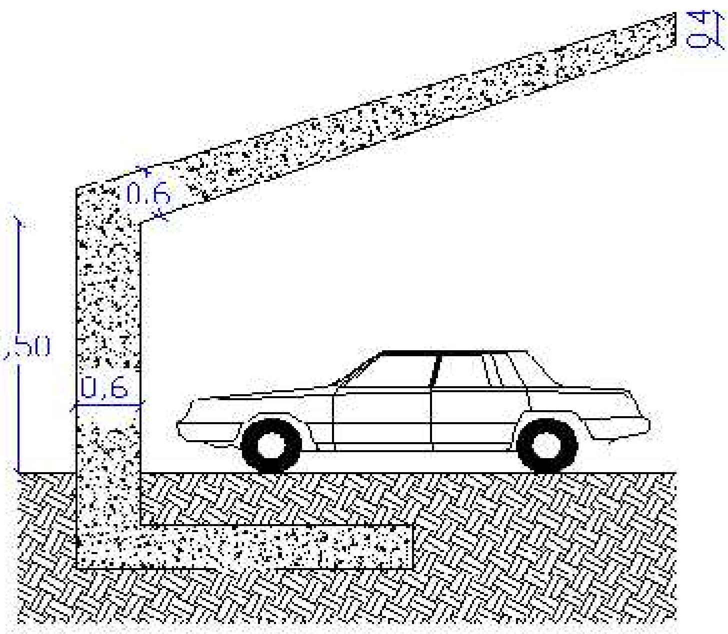


Figure (2.8): Section for the Parking Sheds.

2.4The two underground water tanks:-

A water tank is a container for storing water,this tank space for 2,500 cups.

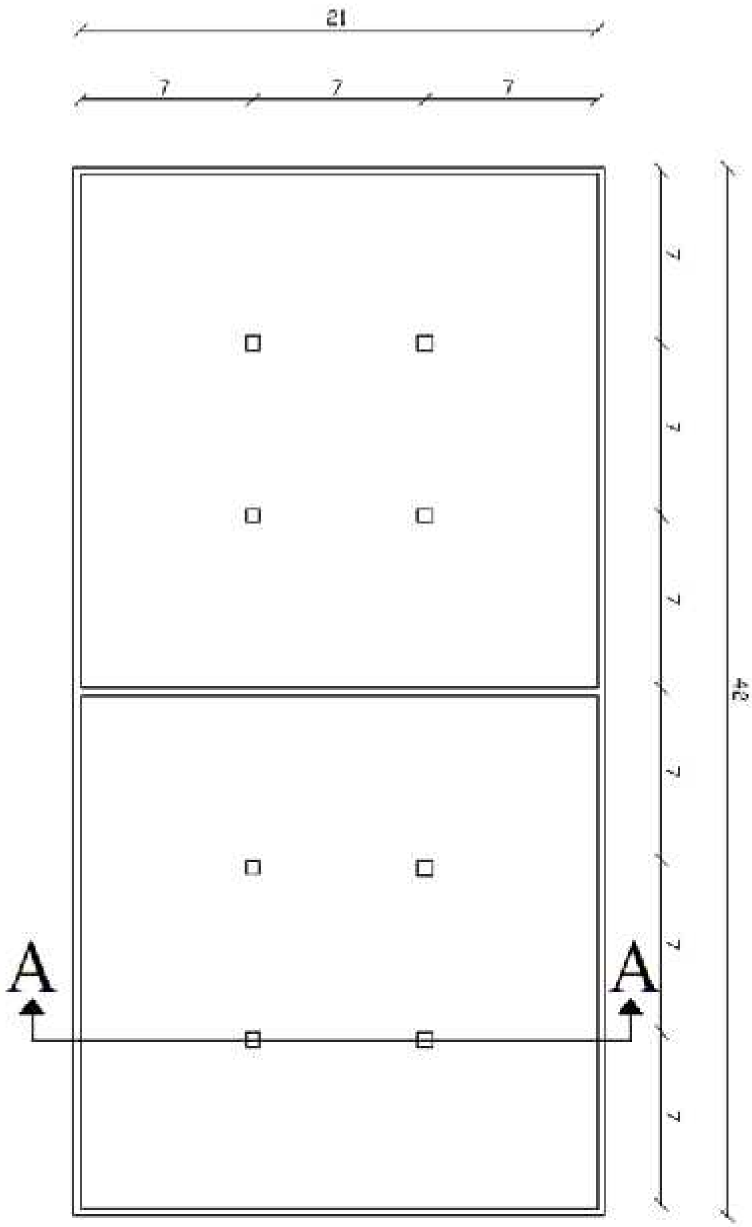


Figure (2.9):The two underground water tanks plan.

2.5Design for festival hall and lecture rooms:-

The festival hall and lecture rooms has an area of 1554.5 m², where is thefour lecture halls and festival hall.

Figure (2.10): The festival hall and lecture rooms.

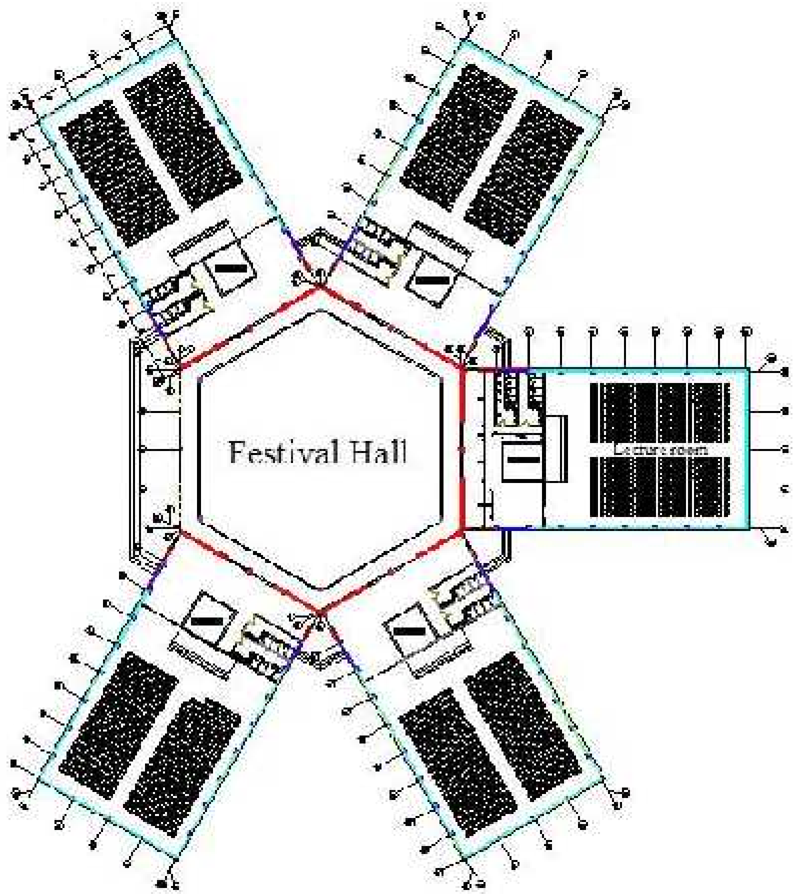


Figure (2.11): The festival hall and lecture rooms plan.

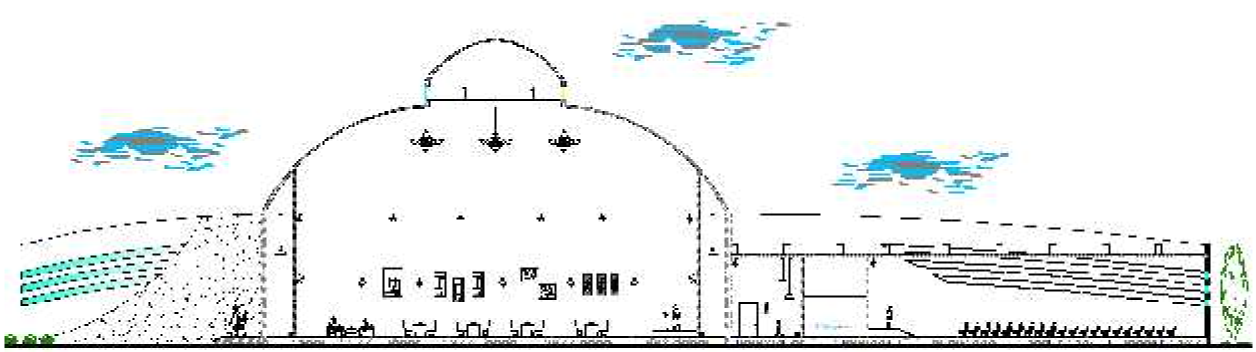


Figure (2.12): Section for the festival hall and lecture rooms.

2.5.1 Elevations:-

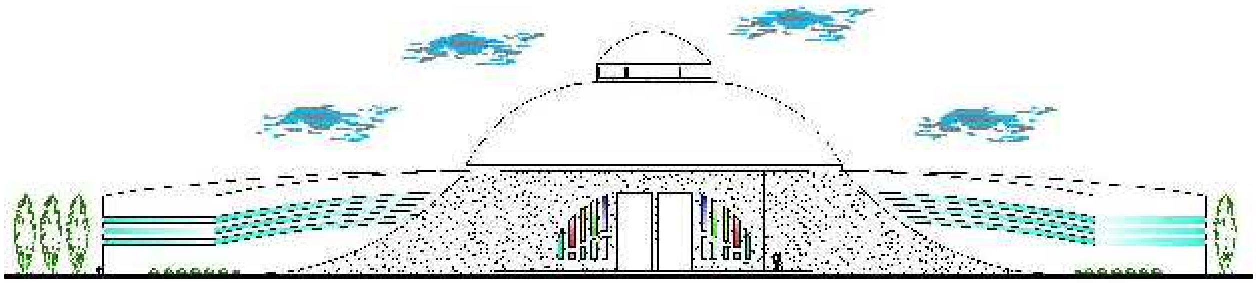


Figure (2.13): East Elevation.

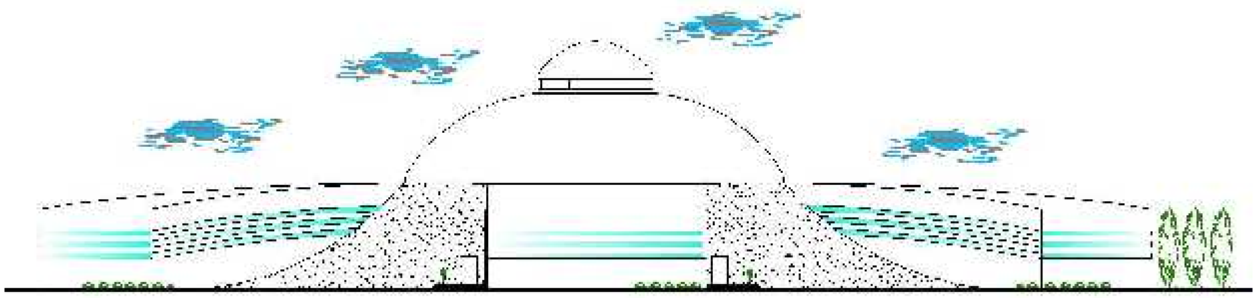


Figure (2.١4): North Elevation.

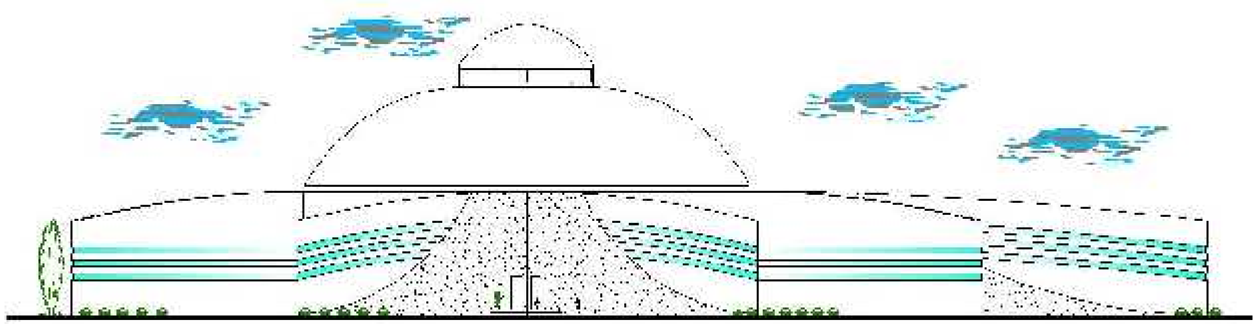


Figure (2.15): West Elevation.

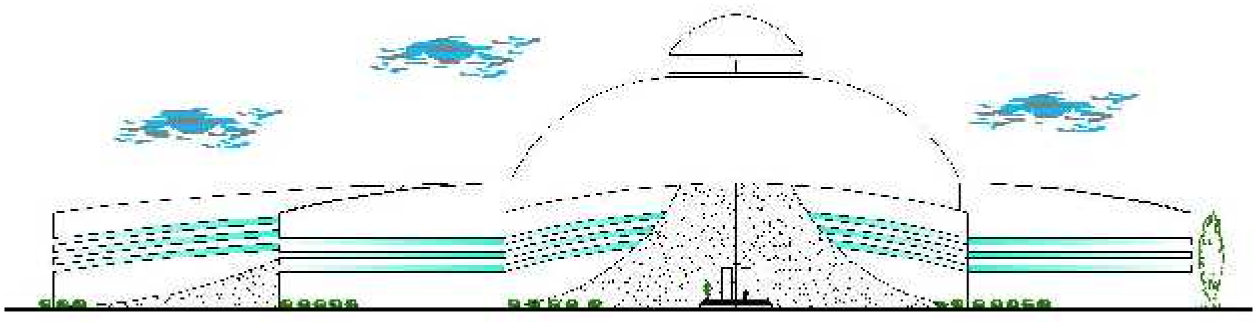


Figure (2.16): South Elevation.

2.5.2 Architectural elements:-

This unit (festival hall and lecture rooms) consisting of architectural spaces: the Hall for festivalhall and lecture rooms.

1.Festival hall:-

Festival hall with an area of 1120.5m², and includes the platform for the head of the mosque, stair and elevator for Minaret.

2.Lecture rooms:-

Lecture rooms with an area of 108.5 m² including baths.

2.5.3Movement:-

The method of movement in the design of the project will be taken into account, where the portal is designed to allow entry for students and other people to comfortably and easily.

CHAPTER

3

Structural Description

3.1INTRODUCTION.

3.2 THE GOALOF THE STRUCTURAL DESIGN.

3.3 SCIENTIFIC TESTS.

3.4 STAGES OF STRUCTURAL DESIGN.

3.5 LOADS ACTING ON THE BUILDING.

3.6 STRUCTURAL ELEMENTS OF THE BUILDING.

3.1 Introduction:

The main objective of the process design is to ensure the existence of necessary operating advantages with structural elements on the most suitable dimensions in terms of security and economic terms.

The knowledge of structural elements of any project is essential in the design of reinforced concrete structures to make comparisons between different types of these elements for the construction of safer system. So the structural elements that go into the design of this project will be described.

3.2 The goal of the structural design:-

The structural design is an integrated and balanced structural system capable of carrying it meet the established requirements and desires of users, and thus determines the structural elements from the following:

1- Factor of Safety: Is achieved by selecting sections for structural elements capable of withstanding the forces and resulting stresses.
2- Economy: Check by choosing the appropriate building materials and by choosing the perfect low-cost section.
3- Serviceability: To avoid excessive landing (deflection), fissures (cracks).
4- Preservation of architectural design.
5- Preserving the environment.

3.3 Scientific tests:-

Before the design of any construction project must be doing some tests, tests of the soil to see breaking strength, specifications, type, the underground water level and depth of the foundation layer, and through holes up and depths measured by the appropriate International Center for Geotechnical Engineering Studies (ICGES) in Bethlehem, and took samples of the soil, has been getting the value soil durability of Earth-based project.

3.4 Stages for structural design:-

We will distribute the structural design of the project in two phases:-

1. The first stage:-

In this stage, the appropriate structural system of project construction and analysis for this system will be determined.

2. The second stage:-

The structural design of each element of the set is detailed and accurate according to the chosen construction system and structural blueprints for executable.

3.5 Loads acting on the building:-

Is a group of forces that is designed to endure, and that any building is subjected to several types of loads must be calculated and selected carefully because any error in identifying and calculating loads reflect negatively on structural design of various structural elements. The building is exposed to loads of live and dead loads, wind loads, snow loads, loads of earthquakes.

The permanent forces and resulting from strong gravity which are fixed in terms of amount and location and does not change during the age of the building, and the loads on the weight of structural elements and the weights of the items based upon sustainably as cutters and walls, as well as the weight of the body adjacent to the building permanently, and the calculation and estimate the loads by knowing the dimensions of the structural elements and specific gravity of the material used in the manufacture of structural elements, And are most often include: concrete, and Rebar, and plaster, and bricks, tiles and finishes, and the stone used in building coverage abroad, there is also a tube extensions, as well as suspended ceilings and decorations for the building.

الجدول (٣-١-ب)

تابع الأحمال الحية للأرضيات والعقدات

الحمل المركز البديل	الحمل الموزع	الاستعمال	نوع المبنى	
كن	كن/م²	الاشغال	خاص	عام
4.5	4.0	للممرات والمداخل والأدراج و[illegible] ومسطحات الأدراج والممرات المرتفعة الموصلة بين المباني.	تابع القاعات، قاعات الاجتماعات، المطاعم، المتاحف، المكتبات،	تابع مباني التجمعات العامة.
4.5	7.5	للمنصات.	النوادي، المسارح، ستوديوهات الإذاعة.	
4.5	4.0	أرضيات [illegible] وممرات عرض الأفلام.		
2.7	3.0	أماكن العبادة [illegible] والكراسي.		

Figure (3.1) Determination of live load, Jordanian loads code (Page25).

Snow loads:-

Figure (3-2): snow loads.

Snow loads can be calculated by knowing the altitude using the table below by Jordanian code.

الجدول (٣ – ٥)

أحمـ . . ـال الثلـ . ـوج

حمل الثلـ ـج (S_o) (كن/م٢)	ارتفاع المنشأ عـ ـن سطح البحر (h) (بالمتر)
0	250 > h
(h-250)/800	500 > h > 250
(h-400)/320	1500 > h > 500

Figure (3.3): Determination of snow load, Jordanian loads code (Page44).

Based on the scale of previous snow loads and after selecting the high building surface and that equals (700 m) according to item III snow load is calculated as follows:

SL= (h-400)/320

SL= (775-400)/320= 1.17KN/m²

Earthquake load:-

Produce earthquakes of horizontal and vertical vibrations due to the relative motion of the Earth rock layers, resulting in strong cut affect the origin, and these loads must be taken into account in the design to ensure resistance to earthquakes. This will be resisted by shear walls in a building on the construction accounts.

Figure (3-4): Earthquake map for Palestine.

Wind loads:-

Wind loads affect the horizontal forces on the building, and the wind load determination process is depending on wind speed and change height from the surface of the Earth and the location of where his high buildings or having established himself in the high or low position and many other variables.

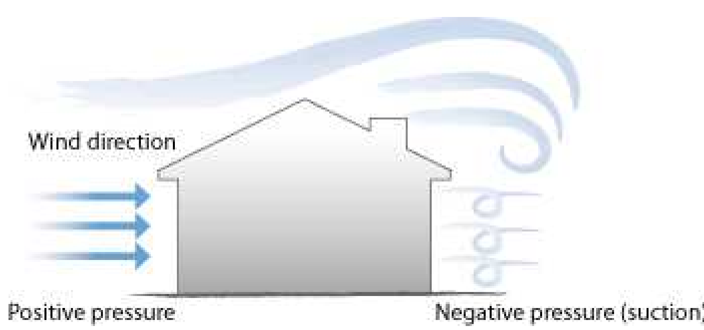


Figure (3-5): Wind Pressure on buildings.

3.6 Structural elements of the building:-

All buildings are usually consists of a set of structural elements that work together to maintain the continuity of a building and its suitability for human use, and the most important of these slabs and beams and columns and load-bearing walls, etc.

- **Slabs:**

Structural elements are capable of delivering vertical forces due to the loads affecting the building's load-bearing structural elements such as beams, columns and walls, without distortions.

In this project, two types of components both in its appropriate place, and which will clarify the structural design in the subsequent chapter, and below these types:

1- One Way Ribbed Slab.
2- Tow Way Solid Slab.

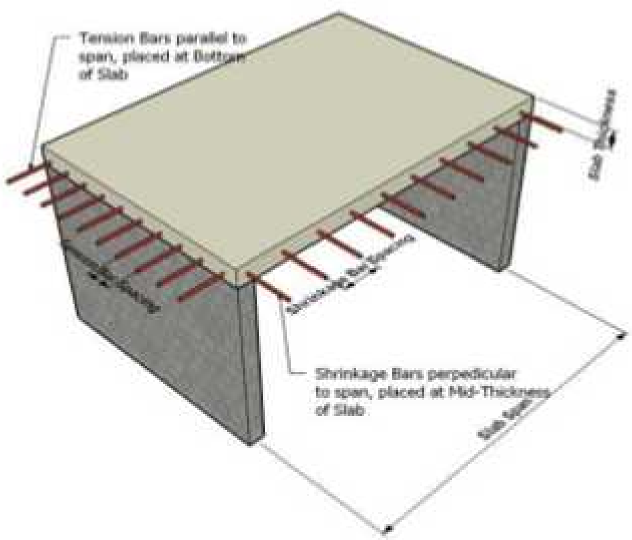


Figure (3-6): Solid Slab.

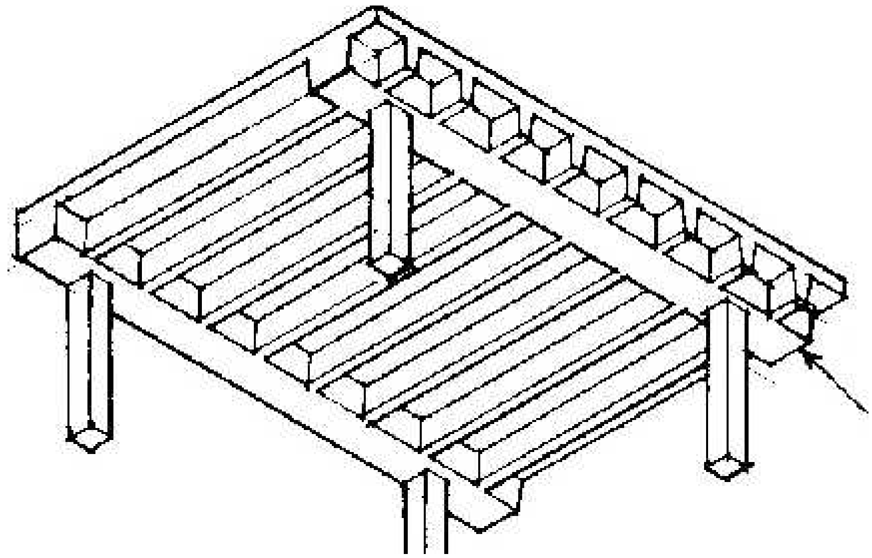


Figure (3-7): One Way Ribbed Slab.

- **Stairs:-**

The architectural elements used for vertical transmission between the different levels of the lever through the building, and will be one of inclusion type design development.

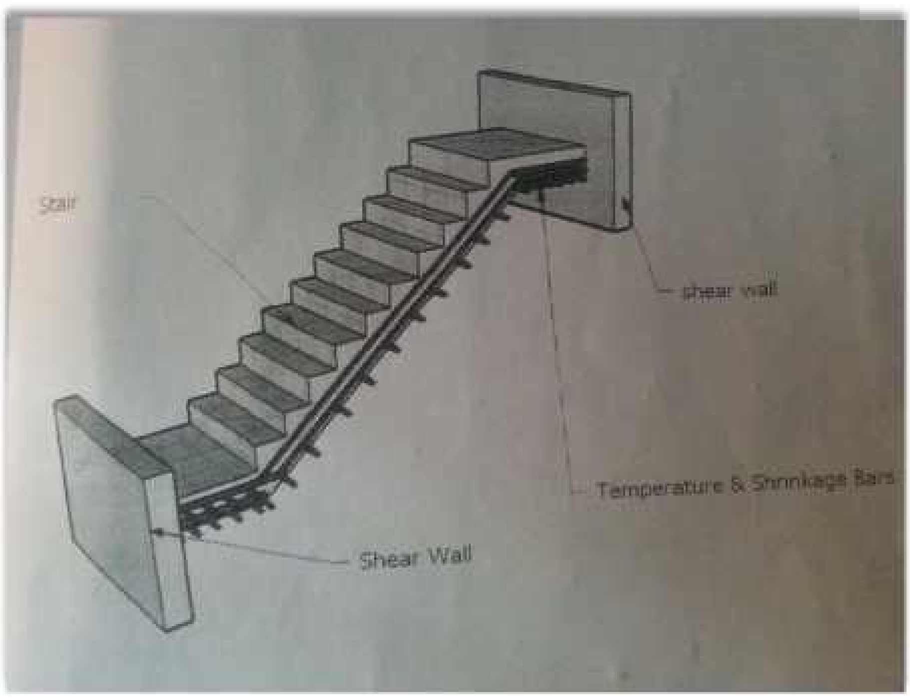


Figure (3-8): The shape of stairs.

- **Beams**:-

The basic structural elements in moving load of tiles into columns, and are of two types:

1- Hidden Beam: Hidden inside Slabs.
2- Dropped Beam: (Paneled Beam).

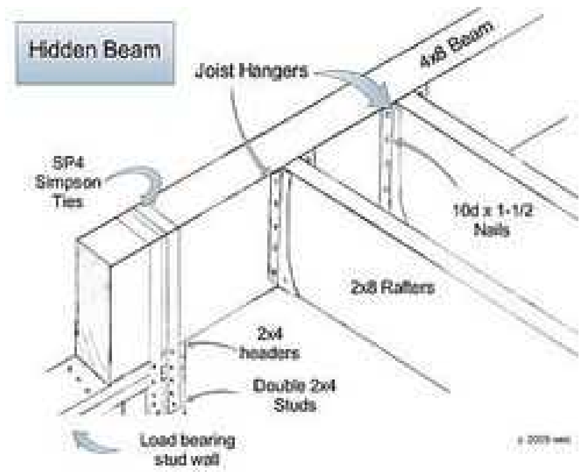


Figure (3-9): Hidden Beam.

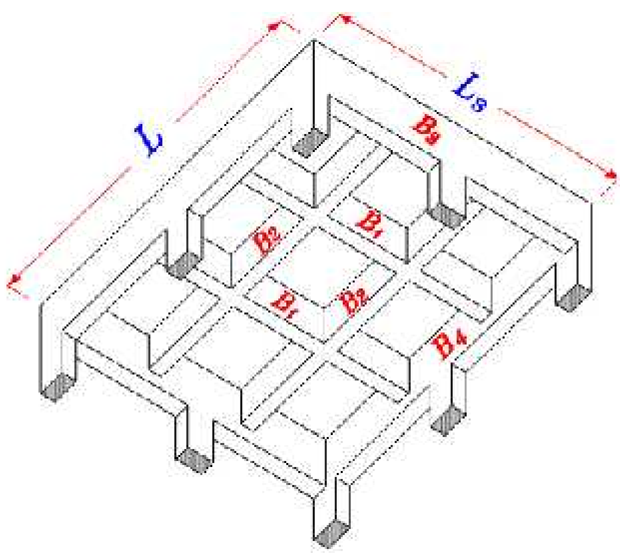


Figure (3-10): Paneled Beam.

- **Column:-**

The column is an important element in moving loads of bridges to the foundations, it is essential to transfer the loads and the building, and therefore must be designed so as to be able to download and load them, and two rectangular and square concrete columns.

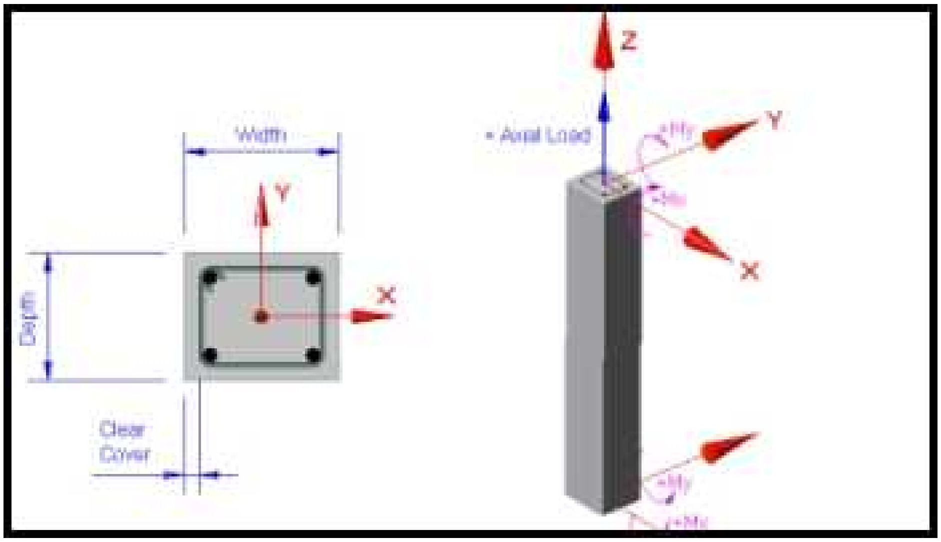


Figure (3-11): Column.

- **Shear wall:-**

Is a structural system composed of braced panels (also known as shear panels) to counter the effects of lateral load acting on the building, the building contains a number of shear wall continued from Foundation to the end minaret.

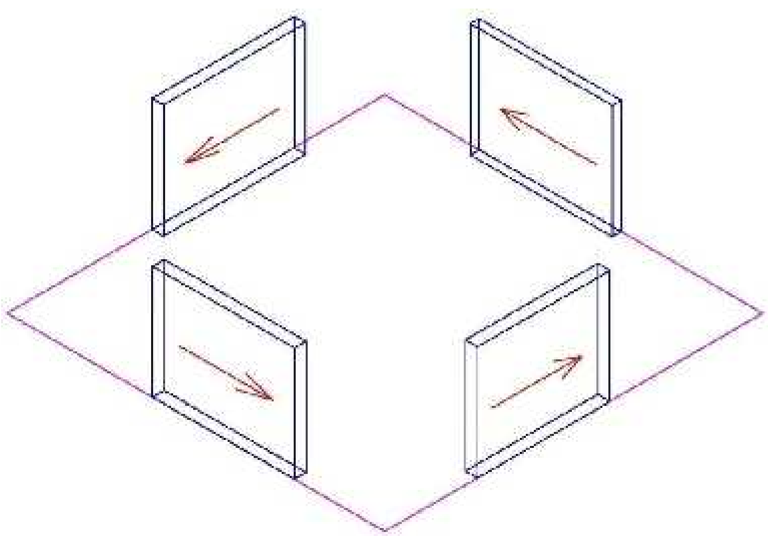


Figure (3-12): Shear Wall.

- **Frames:-**

The frame construction is a method of building and designing structures, primarily using steel or steel-reinforced precast concrete. The connections between the columns and the rafters are designed to be moment-resistant.

Figure (3-13): Frame Structure.

- **Shells:-**

Shell structure, in building construction, a thin, curved plate structure shaped to transmit applied forces by compressive, tensile, and shear stresses that act in the plane of the surface. They are usually constructed of concrete reinforced with steel mesh.

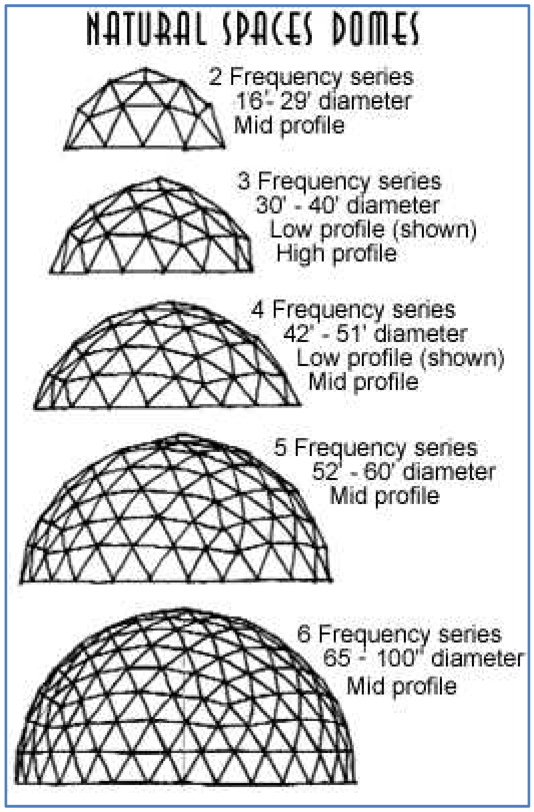


Figure (3-14): Shell Structure.

CHAPTER

5

CONCLUSIONS AND RCOMINDATIONS

5.1 CONCLUSION.

5.2 RECOMINDATION.

5.3 SUMMERY OF THE PROJECT.

1.5Results:-

1. Every engineer or a construction designer should be familiar with all ways of calculations and design for several types of structures to be able to understand how computer programs work.
2. Natural factors and forces around the structures should be studied by the engineers and the architects.
3. The most important steps in structural design are how to connect between several types of components from the holistic view of the structures, and then distribute these components to design individually according structural requirements.
4. As for the computer software used has been to use a program (SAFE –ETABS Column – Foundations) in the design. Comparison with other all items after the calculated manually, and the results were identical as in the examples shown.

.5.2 Recommendation:-

This project has had a significant role in expanding and deepening our understanding of the nature of construction projects in all its details and analyses and designs. Through this experience can provide a set of recommendations that we hope will benefit and advice to plans to choose a construction projects.

5.3 Summary of the project:-

1. Calculate loads, both living and dead, for the building and its various components.
2. The horizontal elements of the design details and ribs and beams and the inclusion of ... Etc.
3. Design of key elements of the columns and walls.
4. Design of foundations of all kinds and various forms.
5. Final edit of construction details, and ensure full compatibility with blueprints and architectural details.
6. Review of the efficiency of shear walls.

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List of Abbreviations:-

- **Ac** = area of concrete section resisting shear transfer.
- **As** = area of non-prestressed tension reinforcement.
- **Ag** = gross area of section.
- **Av** = area of shear reinforcement within a distance (S).
- **At** = area of one leg of a closed stirrup resisting tension within a (S).
- **b** = width of compression face of member.
- **bw** = web width, or diameter of circular section.
- **DL** = dead load.
- **d** = distance from extreme compression fiber to cancroids of tension reinforcement.
- **Ec** = modulus of elasticity of concrete.
- **Fy** = specified yield strength of non-prestressed reinforcement.
- **I** = moment of inertia of section resisting externally applied factored loads.
- **Ln** = length of clear span in long direction of tow-way construction, measured face-to-face of supports in slabs without beams and face to face of beam or other supports in other cases.
- **LL** = live load.
- **Ld** = development length.
- **M** = bending moment.
- **Mu** = factored moment at section.
- **Mn** = nominal moment.
- **Pn** = nominal axial load.
- **S** = spacing of shear or in direction parallel to longitudinal reinforcement.
- **Vc** = nominal shear strength provided by concrete.
- **Vn8** = nominal shear stress.
- **Vs** = nominal shear strength provided by shear reinforcement.
- **Vu** = factored shear force at section.
- **Wc** = weight of concrete. (Kg/m^3)
- **Wu** = factored load per unit area.
- = strength reduction factor.

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