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Faculty of Science and Technology
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Presentation Memory in order to obtain

Diploma of

Master in Architecture

Option: Architecture and Environment

Subject: Local Materials Between Physics and Esthetic.

Project: National Museum

Presented by:

Abdullah Ali Al Bukhari

Framed by:

Pr : Zemmouri Noureddine

By the jury

Name of the president jury: Mme Madhoui Meriem.	President
Name of Examiner member: Mme Fouzia Meliouh.	Examiner
Name of Examiner member: Dr Djihed Berkhouk**.**	Examiner
Name of the rapporteur member: Dr Mahaya Shafik.	Rapporteur

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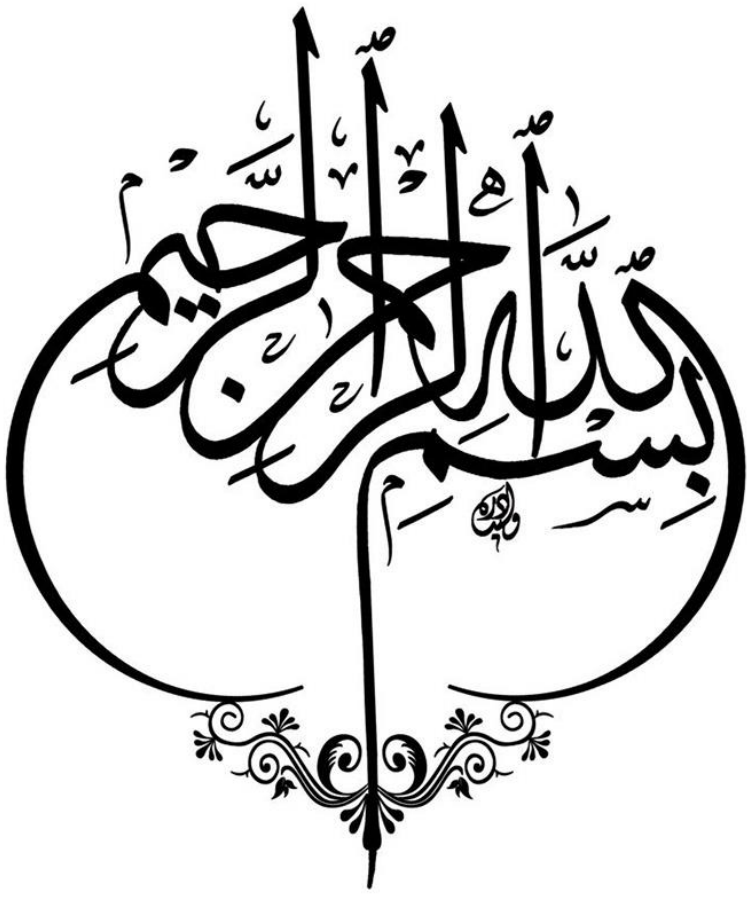

Thanks

I would to thank first and foremost ALLAH the Almighty, who gave us the strength and patience to do this work in the best conditions.

I thank my family for the sacrifices they made so that i could finish our studies.

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Dedication

First thank Allah for the completion of this work and ask him for success.

To the one who gave me love and tenderness, to the pure white heart, to a tree planted in the face of the hurricanes of life, to who praying to me all the time, to who was the secret of my success .to the love of my life My Dear Mother Wafa Al shibah

To who has given me a moment of joy, who has reaped the thorns on my path to guide me the way of science, Who taught me how to hold the pen and how to adjust the words without remorse, to who dreamed to see me on this day. My Dear Father Ali Al Bukhari

To the heart that awaits my return patiently, to whom I have affection in my heart My Dear Sister and Brother

Essra and Ayman Al Bukhari

To my second mother and the light of my eyes My dear grandmother

Faynab Al Abous

To my dear family who had a great role in my success. Dear (Majda, Amal, Afrah, Huwaida, Kholoud Al shibah)

To my older brothers, my dear friends and my dear family (Muhammad Al shibah, Hussam Al shibah, Ahmad Al shibah)

To that rare, generous man, to my big brother and friend

Dr. Abdullah Al Moutauakl

To my dear brothers and friends: (Mohammed Faisal, Moath Al bothaedhy and Kamal Al Maasar)

To my beloved Yemen, God willing, returns as happy as ever.

to My second homeland, my beloved Algeria

- Abstract:

This work examines the local materials in architecture in terms of their physical and aesthetic properties and their application in the National Museum project in the city of Sana'a in the Republic of Yemen, through a summary of the study of the main subject of research local materials and the theoretical study of the national museums and through the analysis of examples and practical articles we reach several goals in the project.

The theme of the research is closely related to the project, where the topic speaks about local materials and their characteristics. The project is a national museum in Sana'a Yemen, where Yemeni architecture is characterized by the use of local materials in construction. The objectives of the project are to design a modern museum using Yemeni style and architecture Applying the characteristics of local materials in what provides beauty and economy and being environmentally friendly.

After completing the theoretical part, comes the analytical part, which includes the analysis of some museums around the world and know the similarities and differences between them, and also includes the study of the ground recognition of the ocean to contribute to the design process. Finally, the project was presented (drawings, interfaces, sections) and the presentation of some of the techniques applied in it.

Keywords: Local materials – National Museum - Architecture of Yemen

- ملخص :

هذا العمل يدرس المواد المحلية في الهندسة المعمارية من حيث خصائصها الفيزيائية والجمالية وتطبيقها في مشروع المتحف الوطني في مدينة صنعاء في الجمهورية اليمنية ، من خلال خلاصة دراسة الموضوع الرئيسي للبحث المواد المحلية و الدراسة النظرية للمتاحف الوطنية ومن خلال تحليل الامثلة والمقالات العملية نتوصل لعدة اهدف وعزوم لتطبيقها في المشروع .

موضوع البحث مرتبط بشكل كبير مع المشروع حيث ان الموضوع يتحدث عن المواد المحلية وخصائصها والمشروع هو متحف وطني في صنعاء اليمن ، حيث يتميز الفن المعماري اليمني باستخدام المواد المحلية في البناء ، من اهداف تصميم المشروع هو عمل تصميم حديث لمتحف وطني باستخدام الاسلوب والفن المعماري اليمني المميز وتطبيق خصائص المواد المحلية في ما يوفر الجمال والاقتصاد وان يكون صديق للبيئة .

وبعد الانتهاء من الجزء النظري، يأتي الجزء التحليلي الذي يحتوي على تحليل بعض المتاحف حول العالم ومعرفة أوجه التشابه والاختلاف بينهم، ويشمل أيضاً دراسة الأرضية التعرف على المحيط ليساهم ذلك في عملية التصميم.
وفي الأخير تم عرض المشروع (مخططات، واجهات، مقاطع) وعرض بعض التقنيات المطبقة فيه.

الكلمات المفتاحية: المواد المحلية - المتحف الوطني – العمارة اليمنية

- Résumé:

Ce travail examine les matériaux locaux dans l'architecture en termes de leurs propriétés physiques et esthétiques et leur application dans le projet du Musée national dans la ville de Sanaa dans la République du Yémen, à travers un résumé de l'étude du sujet principal de la recherche locale matériaux et l'étude théorique des musées nationaux et à travers l'analyse d'exemples et d'articles pratiques nous atteignons plusieurs objectifs dans le projet.

Le thème de la recherche est étroitement lié au projet, où le sujet parle des matériaux locaux et de leurs caractéristiques. Le projet est un musée national à Sanaa au Yémen, où l'architecture yéménite se caractérise par l'utilisation de matériaux locaux dans la construction. Les objectifs du projet sont de concevoir un musée moderne utilisant le style et l'architecture yéménites. Appliquer les caractéristiques des matériaux locaux dans ce qui fournit de la beauté, de l'économie et de l'environnement.

Après l'achèvement de la partie théorique, vient la partie analytique, qui comprend l'analyse de certains musées du monde et de connaître les similitudes et les différences entre eux, et comprend également l'étude de la reconnaissance au sol de l'océan pour contribuer au processus de conception. Enfin, le projet a été présenté (dessins, interfaces, sections) et la présentation de certaines des techniques appliquées.

Mots-clés : Matériaux locaux - Musée national - Architecture du Yémen

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GENERAL INTRODUCTION

INTRODUCTION:

Nature has provided materials for construction. As these materials need less processing or shipping, economic and environmental costs are low. Some resources like (trees and straw) are renewable; some are so abundant that count as endless resources like (stone and sand). On the other hand, since stone, clay, brick and wood give the building native identity or belonging to the place, it is pleasant and desirable *(Khoda Bande et al., 1978).*

Providing the cheap dwelling is one the basic problems of burghers, so designers and architects have effective roles in lowering the building costs, this is due to the fact that they can move toward sustainable urban development by rendering the appropriate approaches in the field of construction using local and traditional materials considering the principles of expenditures reduction *(BashiriMahsa,1991).*

Problematic*:*

The National Museum is a mirror of the history of the country's events throughout the ages. It reflects in a cultural way the sufferings and the stupidity of our predecessors to reach what we are now, and as it embodies history, it is closely related to the past in terms of methods, techniques and lifestyle. In the past, our forefathers used the local natural materials in construction, which proved their strength and benefits to this day. It has the advantages we need now in terms of economy and it is environmentally friendly materials and reflects the surrounding environment in aesthetic beauty. Witch is **Local Materials Between Physics and Esthetic**.

In the "HQE" approach, the choice of materials is based on a set of criteria: * Use * economic * techniques * aesthetic and environmental criteria that treat the economy of natural resources and control of environmental and health risks, during the life cycle.

Hot and arid regions have a climatic problem with respect to the choice of type of materials: thermally insulating materials, durable materials that help to reduce energy consumption. In this case a local material is the optimal answer to these conditions.

From the key words cited (local material, sustainability, hot and arid zone, scientific research center, experiments) an important question is born:

* How can the National Museum be designed? Will the quality of materials be taken into account in providing comfort, reflection of the cultural aspect and the impact of the choice of building materials on these areas?

- local building materials should be used to achieve sustainability in a cold and dry area.

- the aesthetic value in the use of local materials.

- the effects of integrating local materials into modern construction and architecture.

Hypothesis:

The stones and mud bricks are local materials adapted to the cold and dry climate that can be involved in design and construction, thus ensuring the concept of sustainability.

Goals (Objectives):

- Link the project with its surrounding **environment**.

- Demonstrating the aesthetics of **modern projects** using **local materials** and traditional architecture.

- Achieve **climatic comfort** using local materials.

- **Economy**: The use of local materials achieves economic efficiency in the establishment of projects.

- **Recycling** of local materials: The local materials are recyclable making them environmentally friendly which achieves our green architecture.

Research method:

we aim to build a museum using building materials that provide a minimum of comfort in a passive way on the one hand. on the other hand, the chosen materials must add an aesthetic touch and give a cachet of a local architecture that reflects the identity of the city of Sanaa.

To this end, we will carry out a deep theoretical research on the materials used and those available in the site we chose for our project. in addition, we will look in recent scientific articles on the different characteristics of materials that will influence directly or indirectly the well-being of the user. this research will also help us to develop principles and arguments that can be followed in the future in order to choose suitable building materials for our project.

an analysis of similar projects will be performed in order to understand the functional and specific aspects of the project. we hope that this analysis will draw us guidelines for our design, and will guarantee us a good choice of terrain, shapes, colors, ... etc.

Memorandum Structure:

- **The introductory chapter:** consists of the introduction, the reason for choosing the subject of the study, the problem, the hypothesis, the research objectives and the methodology used in the research.
- **Chapter 1:** " Local Materials Between Physics and Esthetic ", in which some principles are presented on local materials and their types.
- **Chapter 2:**

  Part I: "Architecture of Museums" which provides theoretical information about the National Museum.

  Part II: "Architecture in Sana'a Yemen" and contains some information about the Yemeni-Sana'a architecture.
- **Chapter 3:** "Analysis of Articles" This chapter contains an analysis of the studied scientific articles.
- **Chapter 4:** "Analysis of Examples,
- **General Conclusion:** Elements of passage" This chapter contains a summary Ground Location Analysis and analysis of the ground Location. "Presentation of the project in which the project is presented with an explanation of how to implement the theoretical study in the project.

Theoretical part: theories and concepts.

Chapter 1: Physics and Esthetic of Local Material

I. INTRODUCTION

Sufficiency as a maximum use of available facilities and local materials was an old method of constructing a building. If this method can be adjusted with our country's engineering and technical requirements, one of the most fundamental measures of providing dwelling for low - paid people will be taken. Almost everywhere, nature has provided materials for construction.

Providing the cheap dwelling is one the basic problems of burghers, so designers and architects have effective roles in lowering the building costs This is due to the fact that they can move toward sustainable urban development by rendering the appropriate approaches in the field of construction using local and traditional materials considering the principles of expenditures reduction

Comparing the spaces of old and new houses clarifies the importance of traditional and new architecture and consequently the effects of technology, so that by studying and investigating some samples of old house architecture and analyzing the interior and introspective spaces of traditional houses, the role of material becomes clear in sustainable housing development considering climatic factors which are effective on sustainable housing designs.

Using local technology and materials, technology in current vernacular houses and modular design by prefabricated materials as well as considering the sustainability principles to achieve cheap houses would be efficient. In this article it is attempted to study the features of traditional architecture considering durability, and positive and adaptable points of current life method, and utilizing the advantages of technology in designing, an opportunity is provided following the mentioned process and in its adjustment and combination with present conditions to take further steps toward sustainable development.

Figure 1.1: local materials

Source: 2014 | Published by The Standard International Journals (The SIJ)

II. LOCAL MATERIALS

II.1. Definition:

In recent years, local materials have polarized research in both building and geotechnical engineering. The nomination "local materials" or "Appropriate Materials" are the building materials that by their characteristics fit favorably into a given framework and a perspective of sustainable development.

III. MATERIALS AND METHODS

III.1. Local Materials

III.1.1. Wood:

In warm and humid areas, it is better to use the materials that have less thermal mass and don't store heat in themselves. Climatically, the basic problem is the extreme heat and it is not a right thing to store the warmth of day for night. Due to this fact wood is the best material in these areas since it transfers heat slowly and the absorbed heat during the day remains on the surface of wood and during the night with a relatively cool breeze it loses its heat.

Figure 1.2: Using wood

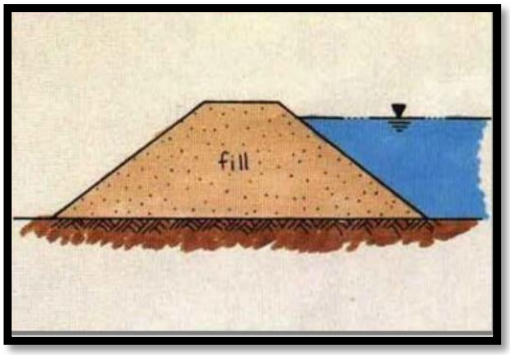

Figure 1.3: Making Embankment

Source :2014 | Published by The Standard International Journals (The SIJ)

Resistance: At equal weight, wood is 6 times stronger than reinforced concrete. Its mechanical strength is related to the composition and positioning of its capillary fibers, parallel to each other and oriented longitudinally. Thus, the wood supports very well edge bending, compression and traction, exercised in the direction of the tree.

Lightness: The wood has a very high mechanical resistance to density ratio: at the same strength, it is the lightest structural material. Thus, while a 100 m2 masonry house will weigh about 100 tons, the weight of a wood frame house will only be 35 tons.

III.1.2. Stone:

Natural Stone is a collective for thousands of different types of stone from careers around the world. The appearance and properties of natural stone depend on how the stone has formed (rivers, volcanoes, mountain formation,).[1]

Natural stone, formerly called *building stone*, is a building material made from the rock from which it is extracted. It is distinguished from manufactured products such as concrete blocks or clay bricks, which are called artificial stone

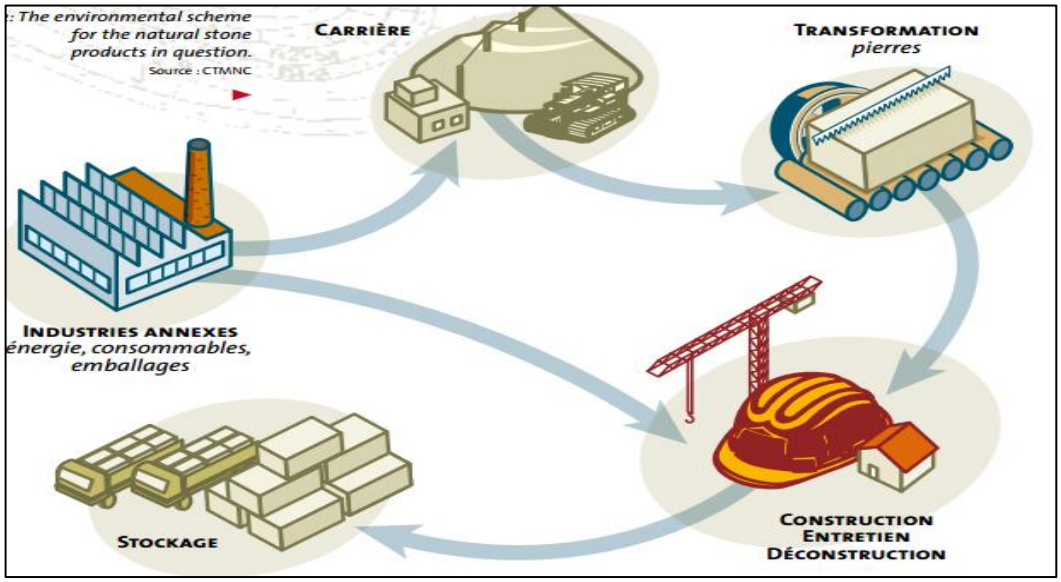

Figure 1.4: HAL archives-ouvertes.fr Building stone, a material for development

Source : Article « Pierre naturelle ses atouts »

Types Of Natural Stone : Natural stone is divided into 3 groups:

1. Igneous rocks (e.g. granite) come from liquid deposits deep in the earth's crust or from liquid magma cooled and solidified on the surface of the earth.
2. Sedimentary rocks (e.g. sandstone, blue cut stone, shale, travertine) are formed by deposition or sedimentation of detrital materials. Sedimentary rocks can be subdivided into:
   - *GRES:* sedimentary rock with mainly grains of sand as a base
   - *SHALE:* Rock based petrified clay.
   - *LIMESTONE :* fossil collection or fragments as grains of quartz or lime balls.
3. Metamorphic rocks (e.g. quartzite and marble) result from the metamorphosis of an igneous or sedimentary rock. The structure is modified by pressure, temperature or a combination of both, which completely changes the mineral composition and pattern.

Property of natural stone:

- Unique and sustainable: the process of forming natural stone lasts for millions of years; a natural stone floor is indestructible and survives for many generations. Each natural stone is unique because no place on earth undergoes the same geological processes, does not have the same soil composition. As a result, even natural stone slabs of the same type of stone may have different appearance and properties.
- Elegant and aesthetic: the rich palette of colors and the living aspect also give a natural stone floor its aesthetic value. The superb shades are particularly highlighted in the case of large areas of soil. There are many possibilities to achieve a unique natural stone floor covering a combination of different tones, contrasts with dark and light types, a peripheral or central pattern, are just a few of the countless options. Natural stone also harmonizes perfectly with other materials.
- The surface finish: is particularly decisive for the appearance, ambience and application. Most natural stones can have a smooth, rough surface. The surface then has a different structure, design and tone and, from a general point of view, a different stamp. Smooth finishes include polishing, softening and sandstone finishing. Rough finishes: sandblasted, flamed, chiseled or happily, frosted or hammered.

III.1.3. The cut stone:

The cut stone is a material that is used for large works, it is a natural stone whose faces have been cut and whose face is perfectly straight. Often of calcareous origin, the stone is not very porous (sandstone, granite). It can be integrated into the wall or apparent, the joints are then very fine and regular for a result 100% guaranteed natural and truthful.

The cut stone can be defined in two ways, namely it must be resilient, that is to say, be able to withstand bad weather on all its faces and edges, resist shocks and it must be non-freezing (that is, i.e. non-porous and not micro-fissured).

We find the stones in specific quarries for home use for load-bearing walls, basement walls, openings frames, construction of pillars or as a fence wall.

III.1.4. Soil:

on one hand, the Soil is considered as a material in construction by the designers and engineers. On the other hand, it is utilized as a natural environment by human being. Using soil as a material (optional application) for making an embankment in the back of retaining wall, drainages, paving the roads and airports and also as the main substance of making mortar, brick, ceramic, china, fireproofs, concrete and etc. using soil as an environment and bank (obligatory application): for the infrastructures and the bank that a house is built on it, road substructures, bridge substructure, the location of pipes and mechanical and electrical facilities and etc.

III.1.5. Adobe:

Using adobe has the following advantages: doesn't pollute ecosystem, is inexpensive, stores thermal mass, has the optimal heating transfer features for heating in the summer and cooling in the winter. Since soil is a suitable substance for construction and is available all around the word and regarding the fact that soil materials need the least amount of processing, production can be local and decentralized and construction can be done by a self - assistance method to reduce expenses. Adobe production only needs 1percent of the energy required for producing brick and Portland cement. Construction by using adobe generally needs manpower, thus it helps domestic economy, reduces sound transmission, it is not toxic and also soil acts better in humidity balance in comparison with other traditional materials. (Figure 4)

Figure 1.5: Using Adobe in Iran

Figure 1.6: Using Adobe in Sana'a Yemen

Source :2014 | Published by The Standard International Journals (The SIJ)

III.1.6. Clay-wall:

It is possibly the oldest and simplest solid building system. A clay-wall building may have a long life by providing proper roof, infrastructure and coil and also protecting the building with external coating if necessary. High thermal Composites were made of sticky material (mostly Epoxy) and appropriate amount of fibers. These fibers can be made of carbon, glass, Aramid, etc. and the obtained composites respectively are called CFRP, GFRP, and AFRP. The main advantage of composites is their resistance against corrosion. Due to this fact, applying FRP composites in ferroconcrete instead of steel rebar is highly considerable. The main advantage of rebar made of FRP is its resistance against corrosion, nonetheless, other properties of FRP composites such as high tensile strength (up to 7 times more than steel), acceptable elasticity module.

III.2. NEW AND COMMON MATERIAL USED IN CONTEMPORARY BUILDINGS:

III.2.1. Steel:

term is used for that iron alloy that contains %25 to 2 percent of carbon. Alloy steels often are accompanied with other metals. Steel traits depend on the percentage of carbon in it, conducted heating operations and alloy provider metals in it. Usually the internal wall of furnace used to produce steel is covered by bricks made of materials that help melting. This cover absorbs some of the emitted oxides. Usually in order to separate impurities open furnace method is applied. This furnace consists of a plate-like container which can take 100-200 tons of melted iron. Onto of this container, a concave roof is placed to reflect heat to the surface of melted iron. An intensive flow of oxygen is passed over the melted metal to burn its impurities. In this method, due to heat transmission in the liquid and scattering, all the impurities come to the surface of the liquid and this refinement takes a couple of hours.

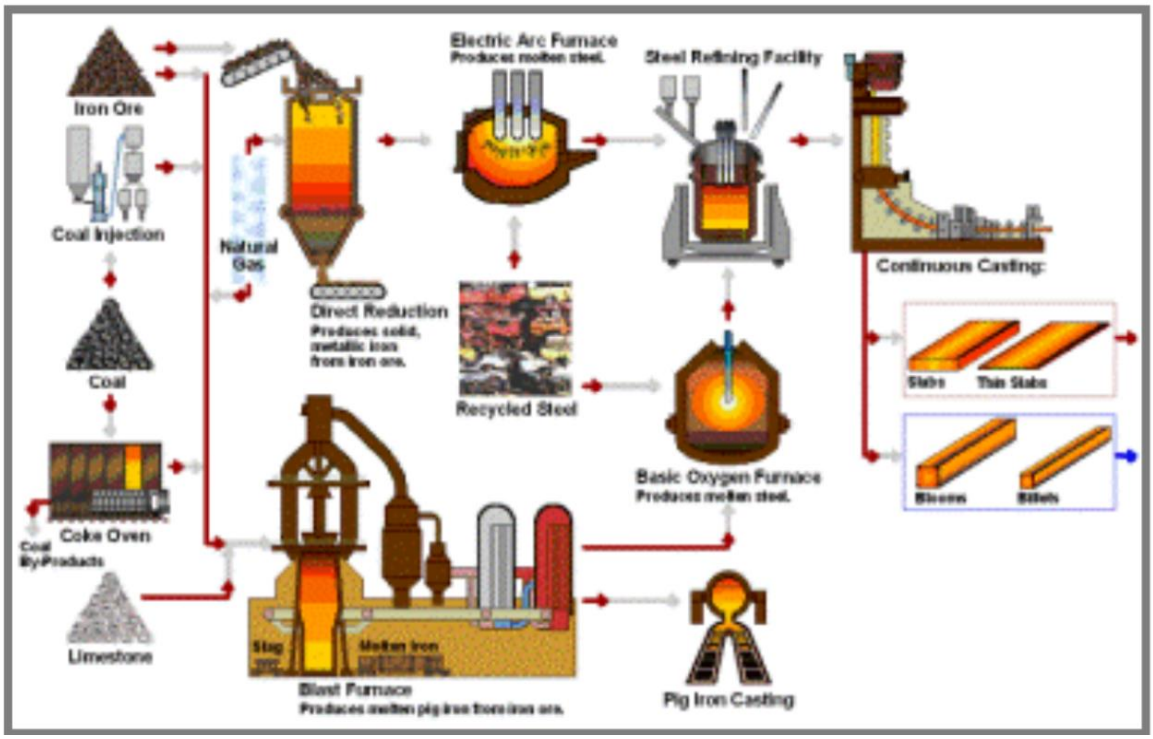

Figure 1.7: Iron smelting

Source :2014 | Published by The Standard International Journals (The SIJ)

III.2.2. Concrete:

it is produced through the combination of water and cement and the reaction between them. Concrete along with steel is one of the most widely used construction and development materials which is utilized in building dams, bridges, houses, roads, streets and etc. nowadays, concrete and steel are extremely used in construction and development workshops. Concrete and steel structure are designed and built based on the type of application. The components of concrete are: cement (about 7-15%), water (about 14-21%), and rock grains (about 60-75%).

III.2.3. Composite:

Using new materials and specially composites instead of steel abrasion and decay and higher self-cleaning feature of these surfaces" in last decade was very popular all around the world.

III.2.4. Glass:

is one of the most useful materials in building which not only makes the building bright, but also provides a visual communication without door. However, because of a low insulation property, it is problematic in hot and cold seasons, and that's the reason why in past and present many different equipment's like, sunshades, and curtains in summer were used to prevent entering extreme heat and light and in winter some equipment like thick curtains were used to prevent wasting the heat and energy inside the building.

III.2.5. Carbon Nanotubes:

A carbon nanotube is created through rolling a one-atom thick graphical sheet. This substance is 100 times stronger and 10 times lighter. This tube is also electricity conductor and fire resistant and has high durability and flexibility; meanwhile, they can be transparent and crystalline. However, the most astonishing feature of these substances is that, they can be designed and produced from the beginning based on the consumers' application and requirement.

III.2.6. Nano-Coatings:

These compositions can prevent the growth of bacteria and fungi and other pathogens; using these compositions in materials and glaze of tiles and ceramics and utilizing them in public places like hospitals avoids the spreads of pathogenic bacteria. "the most outstanding advantages of applying Nano coatings include providing desirable insulator coating, preventing the penetration of corrosion factors into these coatings, elevating resistance against heat transfer.

III.3. Comparison Between Old and New Materials

Old Materials		
Material	**Pros**	**Cons**
Wood	1)heating and cooling insulation 2)fairly well mechanical resistance and elastic property in stroke 3)surface polishing capacity, tonality, craving and cutting 4-possibility of property modifying (fire proof, water proof, antifungal materials).	Pests, process lacking, damager, and diseases lead wood not to be categorized based on its physical and resistance features. Wood sample cannot often be found among different types. Cracks, middle part weakness, and branch twist produces tension in the trunk.
Soil	Soil, on one hand, is considered as a material in construction by the designers and engineers and on the other hand is utilized as a natural environment by human being.	1)armature and molding in these structures requires expertise and spending more time rather than other structures 2) due to increasing number of segments in these structures they are heavier than other metal structures
adobe	Using adobe has the following advantages: doesn't pollute ecosystem, is inexpensive, stores thermal mass, has the optimal heating transfer features for heating in the summer and cooling in the winter	Generally, adobe has 2 disadvantages, it doesn't remain solid in water and it cracks after drying
Clay –wall	A clay-wall building may have a long life by providing proper roof, infrastructure and coil and also protecting the building with external coating if necessary. High thermal mass and insulation combination makes it ready to be used in proper passive solar constructions	The problem of using muddy clay-walls in rooms is that they are not vertical and flat which doesn't have that much beauty. Another problem is their heaviness which makes them non-resistant against earthquake
brick	Thermal conductivity of brick depends to its glass and crystal ratios and its porosity. Thermal conductivity increases by the elevation of humidity.	Complexity and deformation, cracking, boiling half baking, darkening hollowness and Efflorescence's

Table 1.1: Old Materials

New Materials		
Material	**Pros**	**Cons**
Steel	High resistance, elastic properties, formation, cohesion, retrofitting, light weight	Weakness in high temperature, corrosion and metal decay against external factors, tendency of compressed parts to buckle, inappropriate building
Concrete	1) due to ductility possibility of new concrete, mold and armature, they are applicable in different areas 2) these structures are fire proof	——
Composite	High ratio of strength to weight and stiffness to weight, non-corrosive and non-magnet, suitable energy absorption trait, long lifer capability of putting sensor in it to control its function	High price of crude materials and making procedure, low toughness, environmental contamination specially about polymer composites
Polycarbonate Sheet	Light weight of polycarbonate foil that is less than half of glass weight in an equal thickness, high resistance against break between 100 to 250 times of glass and resistance against ultra violate ray (UV), which is the main factor of skin cancer and pale-furniture and sky light	Its most striking fault is the excessive heat under these sheets specially in warn months
Glass	Prevents wasting energy, provides beautiful vision and prevent extra noises	Chipping scratching bending and smoke stains
Nano Powders	Radiation elimination in buildings, vast range of usages in industries like producing high-potential explosives, paints and coatings, polymers and biopolymers, chemical mediators, glues, super conductors and so on, size distribution of control particles.	——
Carbon Nanotubes	Low thickness, extremely high resistance, low weight, transparency and clearness, designing based on consumers' requirement.	——
Cement and Concrete	Causes improvement of mechanical traits and increase in concrete quality, disinfection and self-cleaning features, greater structural resistance against incoming loads, reduction of ability to penetrate into concrete, prevention from destruction and corrosion of reinforcement.	——
Nano coatings	Prevents the growth of bacteria, fungi and other pathogens, avoids the penetration of corrosion factors into the coatings, increases resistance against heat, corrosion, abrasion and decay and elevates the self-cleaning feature of these surfaces.	——
Nano Glass	Self-cleaner, energy controller, stainless and disinfections fire resistant	——

Table 1.2: New Materials

IV. THE EFFECT OF LOCAL MATERIALS ON ARCHITECTURAL AESTHETICS

The great architectural works testify that stone is the first building material for centuries. Civilizations illustrate their history through the realization of masterpieces such as Roman, Greek, ... etc. Researchers and archaeologists believe that stone construction is the aestheticism associated with nature. Beyond that, they consider the stone construction is sustainable, seine and ecological construction.

Another category of research states that wood is also a creator of aesthetics associated with nature under one question: "Can you imagine the planet in the absence of trees? ".

Between these two constructive ideologies, another wave thinks of the clarity, values the visual continuity between inside and outside, between the man is his environment, his entourage. Can you guess what is it? Of course, it's the glass!

.**Figure 1.8:** An ecological house built in stone.
Source : Rédigé palan, 2013, construction en pierre**.**

V. Constructive attestation:

V.1 Stone house:

"The Pierre House"

This house is made by TOM KUNDIG. Maintained on a rock wall in the beautiful San Juan Islands in the United States. The building is mainly made of steel, smooth concrete and plasterboard.

Figure 1.9: The project is made of stone

Figure 1.10: The entrance to the house created between the rock wall and the

Figure 1.11: The presence of stone as a decorative

V.2 Timber house:

« VIGIE FOR SURVEILLANCE OF FOREST LIGHTS»

Designed by OH! SOM Architects. This project is nominated at the prices of the Silver Square 2014 category 1st work. This project is purely built of wood. It is considered an ecological and sustainable construction. Every summer, the auxiliaries of the protection of the Mediterranean forest take control of the vigie on the municipal territory of Saint Miter-the-ramparts. They spend 5 months, from June to October, from 10h to 21h.

Figure 1.12: The project consists of wooden squares.

Figure 1.13: The project respects the environment and offers its occupants a pleasant and functional working environment.

Figure 1.14: The Figuerolles Park had a temporary lookout, exposed to the wind and solar radiation, disassembled at the end of the season, each year. Intended to accommodate two guards during the summer season.

Figure 1.15: The blackout of the windows is done by a system of butterfly shutters whose exterior finish is identical to the rest of the cladding. The reinforced building insulation, made of wood wool and cellulose wadding (walls and roofing) will ensure thermal comfort to the

V.3 Glass House:

« A house made entirely of glass»

A unique house in terms of materials used and philosophy. The architect CARLO SANTAMBROGIO and the designer ENNIO AROSIO have imagined a house made entirely of glass. This house offers a new start in the art of living and living in perfect harmony with the environment. The glass house provides a 360-degree view through its magical material.

.**Figure 1.16:** The glass staircase

Figure 1.17: External project view. An insulating glazing, heating if necessary, would solve the problems

VI. Conclusion:

Generally, the first thing which comes to mind about traditional and old monuments is their local material. The way of using the local materials and corresponding with region and climate where the building is constructed is of paramount importance, but nowadays due to the developments in architectural knowledge.

vernacular architecture all over the world that were inspired of the nature and the environment has been forgotten and mostly modern materials, which they have no relevance with climate, are used. Nowadays, more than ever, architecture profession is faced with a vast range of materials and substances. Nanotechnology makes the monitoring of intrinsic features feasible by developing some structures in nanometer scale.

This means that, fewer materials with better quality are required for a determined function, Library method to investigate the issues has been chosen, and its results show that modern construction of the local materials was more effective than modern materials in raising the level of life safety considering the physical, mental, and economical aspects and consequently will lead to healthy individual, healthy family and healthy community.

Theoretical part: theories and concepts.

Chapter 2: The National Museum, culture, communication and society.

I. INTRODUCTION

PART ONE: ARCHITECTURE OF MUSEUMS

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- **II.1.2. The Role of Museum**
- **II.1.3. Classification of museums**
- **II.1.4. Types of museums**

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PART TWO: ARCHITECTURE IN SANA'A YEMEN

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- **VI.3.4. Free configuration of facades**
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- **VI.3.6. Interfaces**

VI.4. The variation in Yemeni heritage architecture:

VII. CONCLUSION

I. INTRODUCTION

Faced with contemporary challenges, institutions around the world have begun a profound transformation, placing the educational mission at the heart of their project. A jewel of art and knowledge, tools of knowledge and conscience, museums are guardians of memory, ramparts against oblivion, ignorance, unfounded. Reflecting on the society that gave birth to them, all reflect a vision of the world, including that of their time.

In a century, museums have become true cultural institutions, changing the conditions of communication with the public, society and cultures. By redefining the practices but also the representations of the relationships between art, culture, society, they represent an important field of research.

in this chapter, we will first try to define the museum, and to understand the classifications and typologies of museums. then, then, a thorough research on the functional and spacial aspects will be carried out. the goal is to gather as much information as possible about the functioning of a museum, and thus to understand the interactions between the interior spaces, and between the interior and exterior spaces. finally, define the specific needs of each space for a better mastery of design.

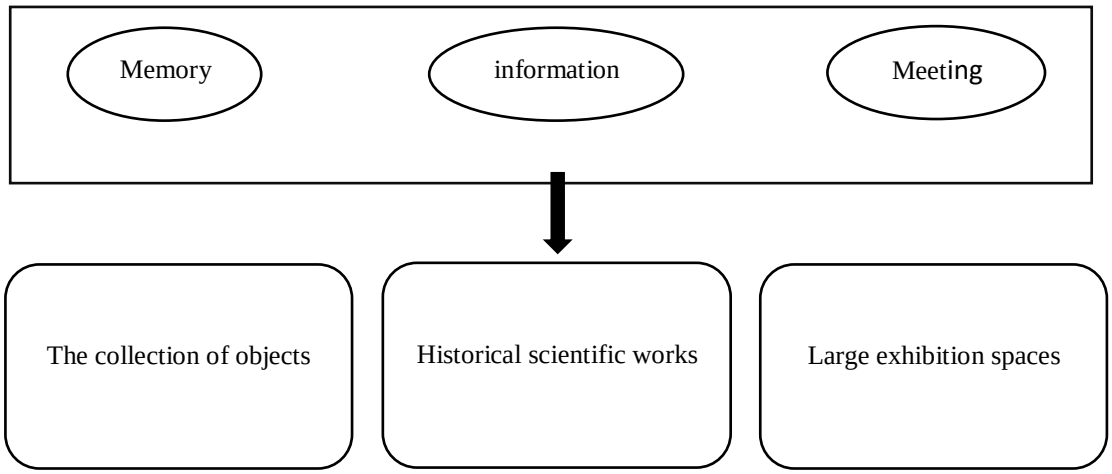
PART ONE: ARCHITECTURE OF MUSEUMS

II. TO THE MUSEUM DISCOVERY!

II.1. Definition of the Museum

A museum is a permanent, non-profit institution serving society and its development, open to the public, and researching the material witnesses of human and his environment, acquires them, preserves them, communicates them, and in particular exposes them for purposes of study, education and enjoyment. " **Official definition of I.CO.M. (the International Council of Museums).**

The museum is an institution, where a collection of works of art, objects of cultural, scientific or technical interest is conserved, exhibited and displayed.
It is concluded that the museum is the place of:



Source: Official definition of I.CO.M. (the International Council of Museums).

II.2. The Role of Museum

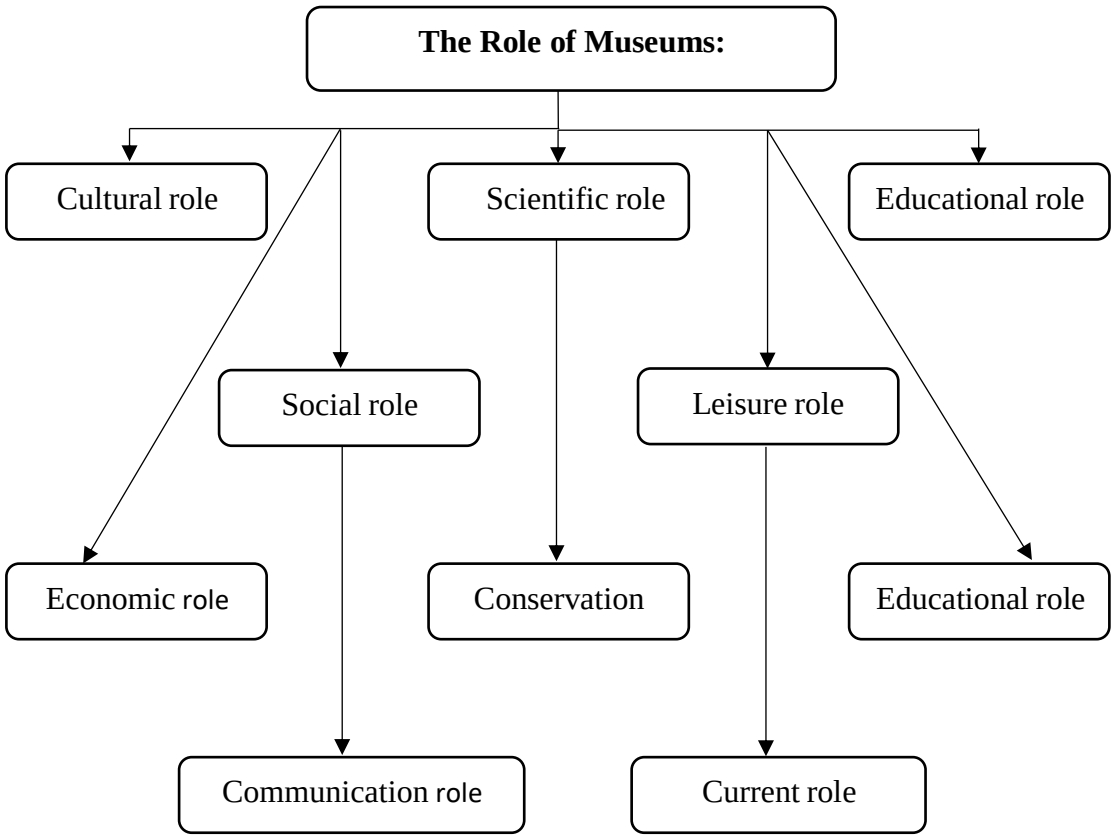
Protects: Protects cultural heritage and integrates it into current life to safeguard the history of a nation.

Educate: Gives an idea about the heritage of a country through the organization of conferences.

Communicate: Allows visitors to communicate with the past through objects.

Keep: Keep all types of objects and other "traces" and "footprints" that man or even Nature has left us.

Exhibit: Put under the eyes of the visitors, all the works of Art which catch their attention.



II.3. Classification of museums

II.3.1. Central museum: Contains samples of all that can be found through the museum is content to exhibit photos or maps ...

II.3.2. museum of history and antiquities: Among these main characteristics, the possession of historical or archaeological documents of the region or country at a given period, without neglecting the economic, social, cultural, handicraft and ideological side (of this region or from this paid).

II.3.3. museum of the arts: Concerns the exhibitions of the different painted art sculptures .... Etc. this kind of museum comes to sensitize the visitor and give him more abstract perceptions about art.

II.3.4. ethnographic museum: Its role is to study the social structure of everything that can be belief, customs, traditional or other art, which defines more a research center than a museum.

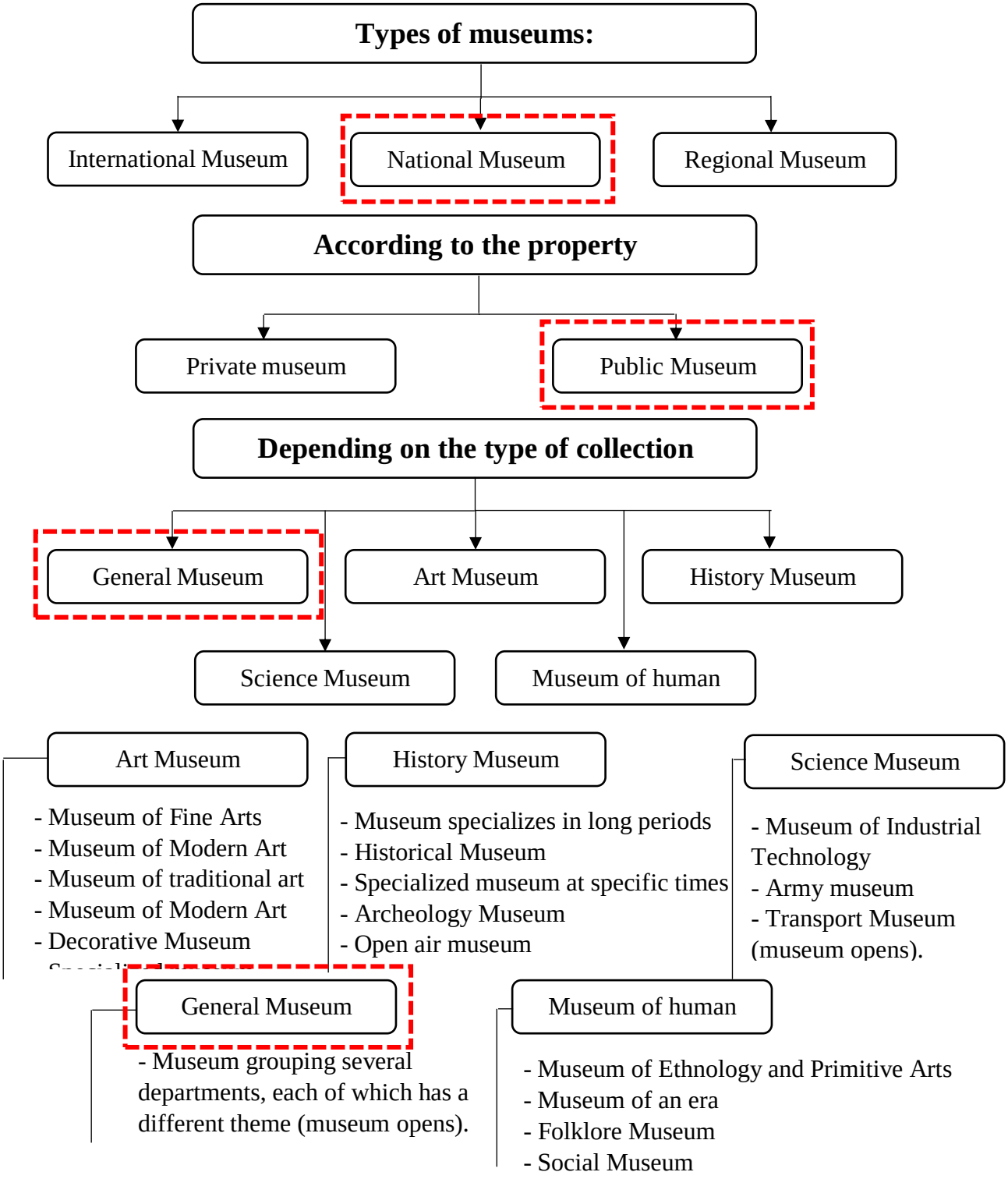
II.3.5. Museum of Natural Sciences: Interested in geology, offering a scientific enrichment to students who have chosen this type of vocation.

II.3.6. Museum of Science and Technology: Specialized in the exact sciences the techniques, its role is to facilitate complicated industrial techniques.

II.3.7. regional museum: Provides only for a specific region of a country, affecting its history, culture, origins and economy. This does not mean that it can not present exhibitions of foreign works, whether national or international.

II.3.8. specialized museum: These are the museums that interpret a single theme in a very detailed way.

II.4. Types of museums



III. FUNCTIONAL AND TECHNICAL REQUIREMENTS

III.1. Reception of the public

The precise indication, access roads and means of public transport, signposting, parking area, the clearing of spaces, the adaptation of its equipment, the ability to follow without wandering the recommended path, resting points, sanitary facilities, all the amenities required for the visit of the physically handicapped and the elderly.

III.2. Reception

Located at street level, gardens or parking lots, rest area, locker rooms, sanitary ware, phone boxes, crates, information devices, signs, screens, information tables a counter hostess (s), a general documentation center, a general documentation center Bookstore, Restaurant. Cafeteria.

III.3. Management

spaces for the administration, central monitoring station, maintenance workshops, cafeteria-restaurant, infirmary, technical-waste rooms, a function apartment.

III.4. Exhibition conditions of the collections

pollution, light dust, 150 to 200 lx for sensitive objects, 50 to 80 lx for very sensitive, humidity and temperature, relative humidity: 55 ± 5%; for the temperature: 18 ± 20 C.

III.5. Security against fire and theft

Protection of people, works and premises against fire, systems, possibly coupled, detection and extinguishing, exits and escape routes Protection against theft and depredation, enhanced protection alarm devices.

III.5.1. Theft: In order to avoid this danger, we must ensure:

- The supervision of the entourage.
- Internal surveillance.
- The surveillance of the works.
- Routine surveillance: provided by security officers.

III.5.2. Fire: There are three categories of fire (a), (b), (c) each according to its origin.

- Fire (a) results from ordinary materials such as paper ...
- fire (b) concerns oil, paint and flammable materials.
- The fire (c) results from a short circuit.

Each category corresponds to a technique to extinguish it, hence the obligation to equip the museum accordingly.

III.5.3. Other dangers: There are other dangers that threaten museums such as: riots, vandalism, and natural disasters (floods, earthquakes ...).

III.6. Animation

Make the museum more attractive, livelier, scheduled one-off activities, temporary exhibitions, an audiovisual room, adjoining service rooms, rooms for records exhibitions, a multipurpose auditorium hall, meeting rooms.

III.7. Research

conservation, knowledge of collections, reserves, study rooms, a laboratory, restoration workshops, a shooting studio and a photographic laboratory, a library, archives.

III.8. Specific reception

Adult groups, assembly and waiting areas, checkpoints, speaker space School groups, assembly points, physically handicapped, sufficiently large spaces and as close as possible to the entrance, ramps permanent or mobile, calibrated lifts, easily passable doors, frequent resting points, adapted toilets, studied signage.

IV. THE MUSEUM TYPOLOGY

IV.1. The internal organization:

IV.2. Routes and type of traffic:

IV.2.1. linear path

The exhibition spaces are arranged on both sides of a main artery.

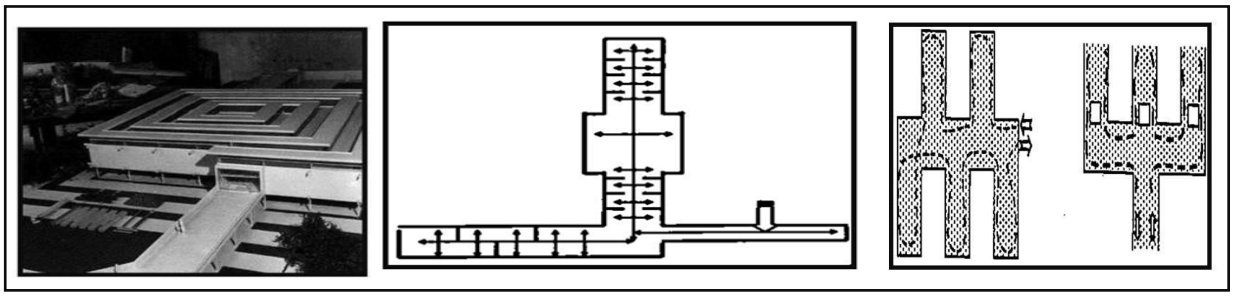


Figure 2.18: Linear path Source: Official definition of I.CO.M.

IV.2.2. circular path:

A central space articulates the exhibition spaces located in the periphery.

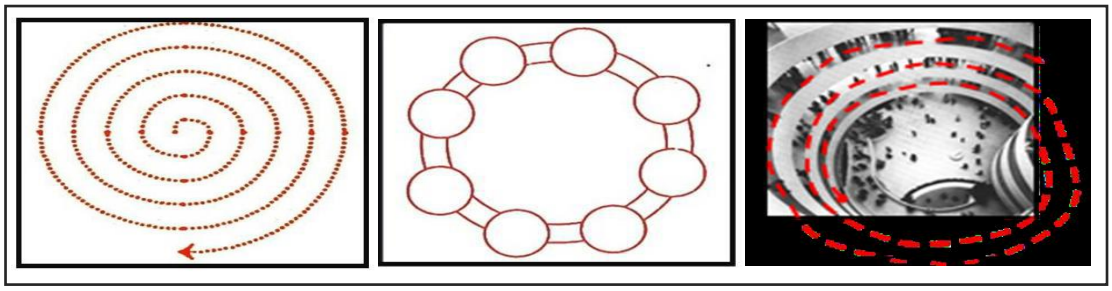


Figure 2.19: Circular path
Source: Official definition of I.CO.M.

IV.2.3. Radiant course:

The central space is the starting point for several linear spaces in the form of radii.

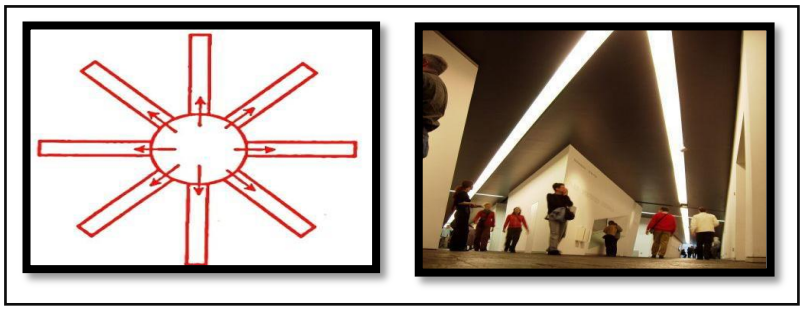


Figure 2.20: Radiant path
Source: Official definition of I.CO.M.

IV.2.4. Fan Path:

The vector has a wide choice of displacemen.

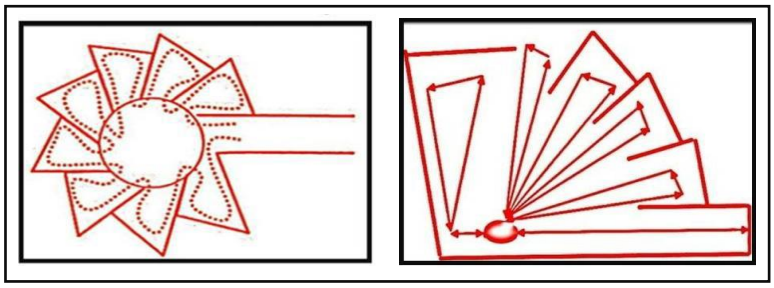


Figure 2.21: Fan path
Source: Official definition of I.CO.M.

IV.2.5. Labyrinth course:

In this kind of route, the exhibition spaces are almost all in relation to each other and the visitor has the freedom to choose his route.

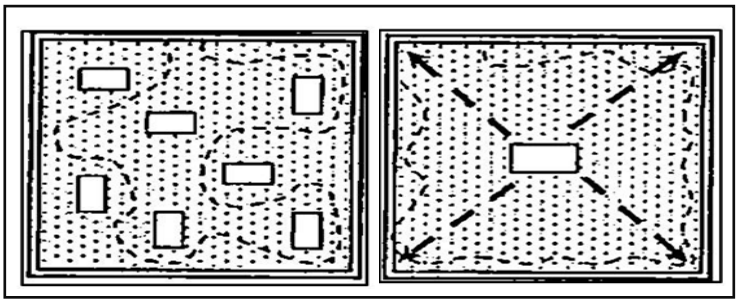


Figure 2.22: Labyrinth course
Source: Official definition of I.CO.M.

IV.3. Exhibition room

IV.3.1. Exhibition modes

-nailed to the walls:

Dedicated For the exhibition of paintings.

Figure 2.23: Nailed to the
Source: Official definition of I.CO.M.

-plinth:

It's a support where we expose the statutes. Its size depends on that of the exhibit.

-Panels:

Used in temporary exhibitions**:**

Figure 2.24: Panels
Source: Official definition of I.CO.M.

-Suspended by ceiling cables:

This guy is prevalent in the exhibition of planes, cars.

IV.3.2. Light and lighting:

Light depends on two different and complementary sources: natural and artificial.

IV.3.2.1. Natural light

- **Zenithal lighting:**

Through windows, skylights, cupolas or pyramids, it allows to control the lighting / reserve the walls for the exhibition / the homogeneous lighting.

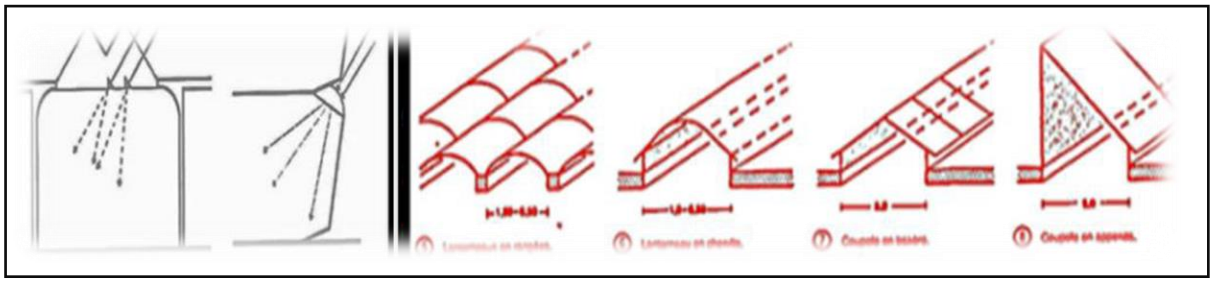


Figure 2.25: Zenithal lighting

Source: Official definition of I.CO.M.

- **The side lighting:**

Side lighting is the only solution at the multi-story museum.

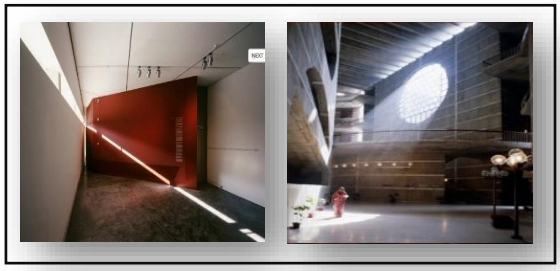


Figure 2.26: natural side lighting

Source: Official definition of I.CO.M.

IV.3.2.2. Artificial light:

- **oriented lighting:**

The light comes from a single source with parallel radiation and the appearance of shadows.

- **Reinforced lighting**:

It is characterized by a strong concentration of radiation in one direction only.

Figure 2.27: Artificial lighting

Source: Official definition of I.CO.M.

- **The indirect lighting:**

1-The lighting of the paintings.

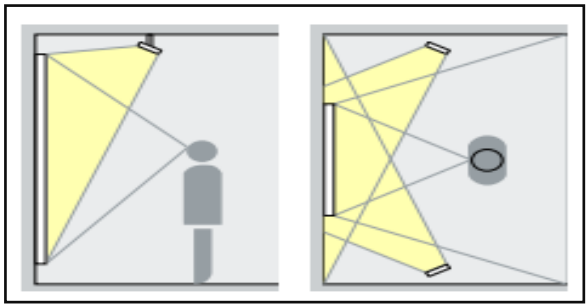


Figure 2.28: Indirect lighting
Source: Official definition of I.CO.M.

- **The lighting of objects.**

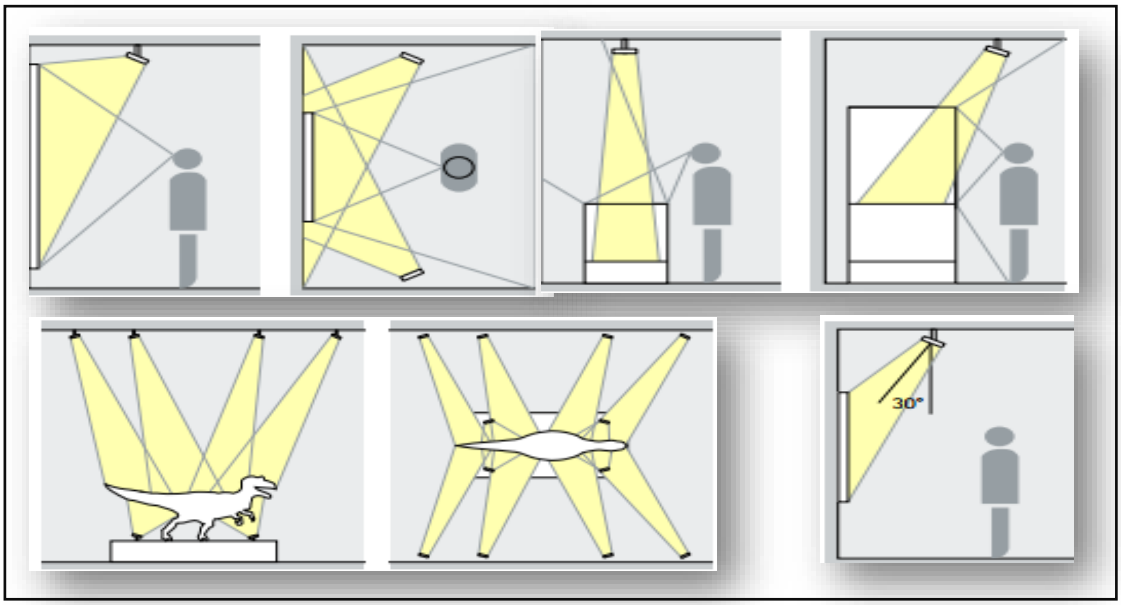


Figure 2.29: lighting of objects
Source: Official definition of I.CO.M.

PART TWO: ARCHITECTURE IN SANA'A YEMEN

Yemen is also recognized by the Arab historians as the country of the cradle of civilizations and the source of the Arabs. "Yemen was characterized by several ancient cultural arts, and the most important characteristic of Yemen is the original architectural art of other countries. This art is the art of history, the art that amazed and impressed everyone who visited Yemen! Seen or heard by both, form and design.

Figure 2.30: Old Sana'a Yemen
Source: Book of Characteristics of Yemeni Architecture,

VI.1 Local Architecture in Yemen

Yemen has long belonged to its land and its environment, which has always sought the elements and means that help it to express its existence through architecture and urbanization. And the organization of its buildings derived from the nature of the land that is settled by different environment and climate, and the most important of these characteristics are.

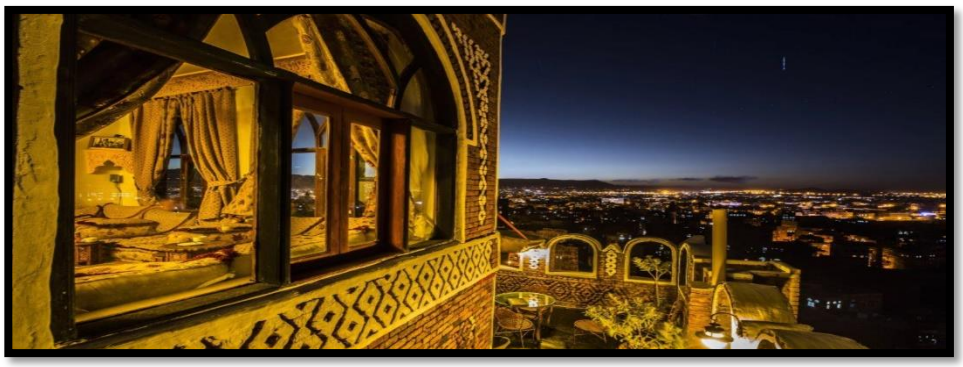


Figure 2.31: Tayramana Old Sana'a
Source: Book of Characteristics of Yemeni Architecture,

VI.2 Compatibility of heritage cities with climate and surrounding environment:

The general climate of the Yemeni lands varies and varies according to the regions and the prevailing terrain. These sites coincide with the residential communities built on them, in such a way that the appropriate exploitation of the land patch and the construction of the urban assembly, and the multiple climates and terrain helped to create architectural diversity with distinctive traditional styles and building patterns.

1. **The urban complex located on the slopes of the mountain sites.**

Figure 2.32: Wady Dahr Yemen
Source: Book of Characteristics of Yemeni, 2004

2. **Urban assembly on the flatlands in the mountainous highlands.**

Figure 2.33: Sana'a Yemen
Source: Book of Characteristics of Yemeni, 2004

3. **Urban assembly on the desert plains.**

Figure 2.34: Hadramot Yemen
Source: Book of Characteristics of Yemeni, 2004

VI.3 Characteristics of Architecture in Old Sana'a:

VI.3.1 **Building materials**:

The main traditional building materials are the burnt bricks or the powdered mud and the stone, which is usually used in the lower floors. The burnt bricks are used in the upper floors. This use conceals a structural philosophy that acquired its natural knowledge by the Yemeni man. The land is characterized by stability, safety, permanence, authority and respect. This explains the tendency to make the lower floors heavy and built of stone. The stone is available in abundance in Yemen and its sources, types and colors vary according to the areas available.

1: These stones feature multiple colors of up to five colors or more.
2: The tests carried out on these stones indicate that they have several different qualities in terms of resistance to pressure strength and water absorption.
3: Stones resist the weather factors and fit the hot and cold.
4: Easy cutting and shaping during the construction process.

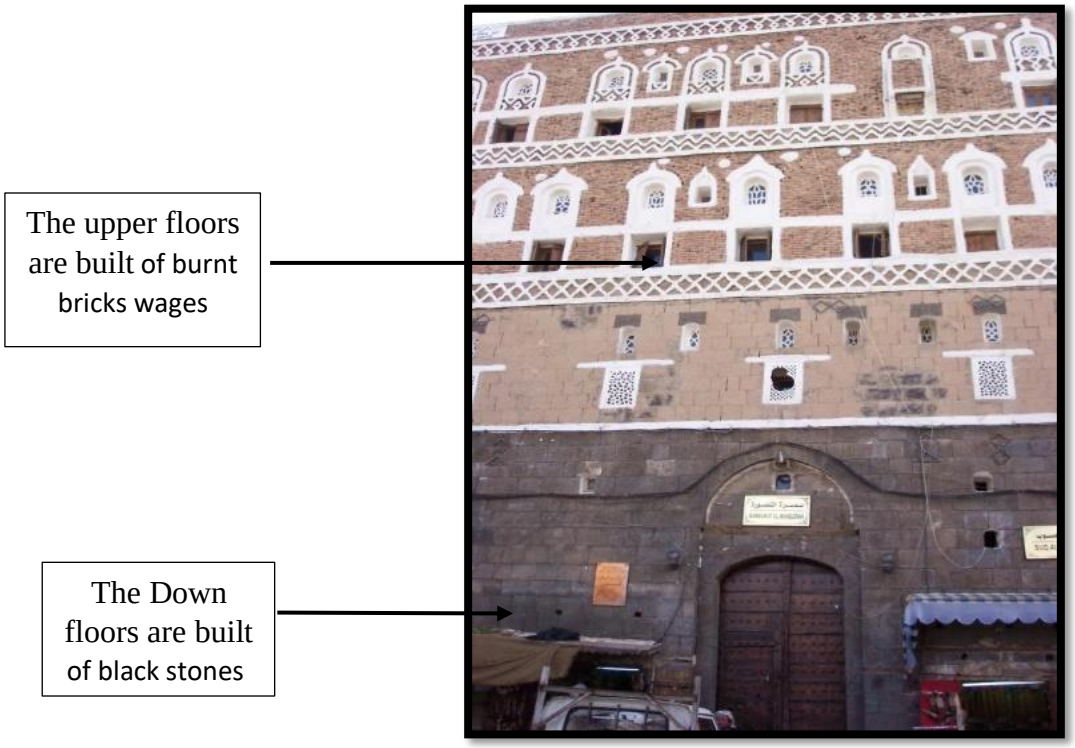


Figure 2.35: Building in old Sana'a
Source: Book of Characteristics of Yemeni, 2004

VI.3.2 openings:

There are usually two types of openings in the traditional architecture, one upper and the other lower and the use of these two openings as follows: The lower aperture is used for exterior and ventilation, while the upper is circular in order to be used for lighting and adornment, and there are many works of decoration and engravings and the prevailing mood and uses.

Figure 2.36: Qamaria
Source: Book of Characteristics of Yemeni, 2004

VI.3.3 Plaster decoration:

The plaster material is formed by burning limestone in special incinerators and produces a soft texture of white matter. It has various uses such as:

Tealis walls, ceilings, interior floors, and any material of building materials such as Stone, jag or mud, as used in both Sana'a and Zabid in the exterior decoration of the exterior decoration, and was used in the work of shelves and decorations on the walls and ceilings of the rooms, and also used in the lumines and taste stained glass and produced a great heritage in this aspect, The old buildings are semi-circular, one-piece transparent Alabaster, which is executed by light and this type of stones are cut from special quarries in the form of fine flakes and according to demand.

Figure 2.37: Sana'a

Figure 2.38: Hadramot

Source: Book of Characteristics of Yemeni, 2004

VI.3.4 Free configuration of facades:

The Yemeni heritage architecture does not adhere to the academic rules in the composition or the aesthetics of architecture or the fine arts, which gave it its advantage and its inherent nature. The buildings and urban communities came in distinct, spontaneous and spontaneous works from the accumulated experience of the Yemeni man and in his taste for his architectural and popular art. Traditional through a number of simple elements.

Figure 2.39: traditional house of Sana'a

Figure 2.40: Tayramana in Sana'a

Use plaster in the Qamaria and Decorations

Source: Book of Characteristics of Yemeni, 2004

VI.3.5 Building Block:

The Yemeni residential buildings are of equal size in parallel to the exterior walls of the building and have a similar position to adjacent buildings. This overlap is created in three situations:

1: suction cup in one

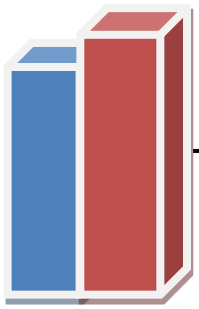


Figure 2.41: Sana'a Yemen

Source: Book of Characteristics of Yemeni, 2004

2: suction cup in two faces.

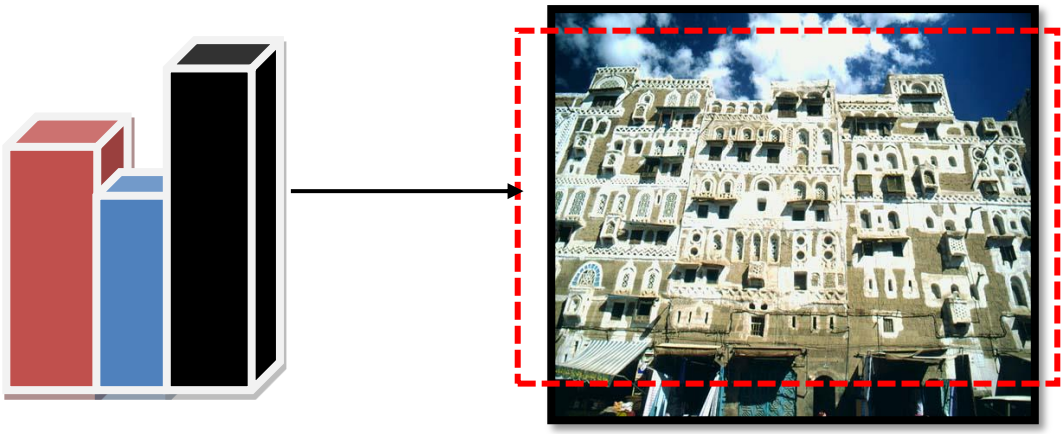


Figure 2.42: Sana'a Yemen

Source: Book of Characteristics of Yemeni, 2004

3: adhesion in three interfaces.

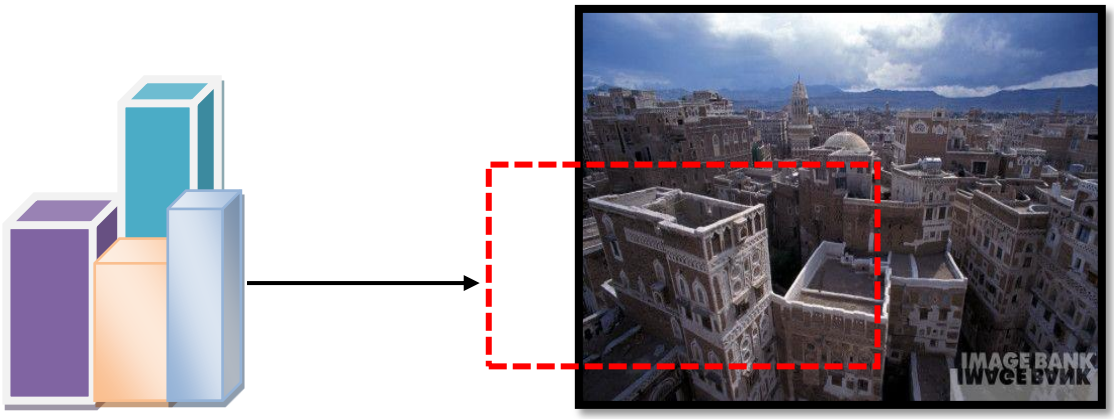


Figure 2.43: Sana'a Yemen

Source: Book of Characteristics of Yemeni, 2004

4. Hierarchy in construction and traditional architectural design.

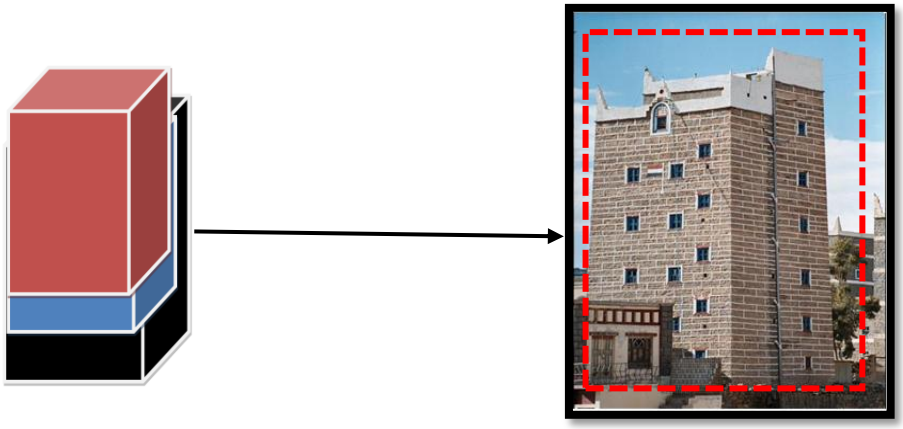


Figure 2.44: Eafa Yemen

Source: Book of Characteristics of Yemeni, 2004

VI.3.6 Interfaces:

The facades are expressed in traditional Yemeni architecture through the building materials and decorations that are executed on the facades:

Prominent formations of brick or stone

Figure 2.45: Rada'a Yemen Figure 2.46: Sana'a Yemen
Source: Book of Characteristics of Yemeni, 2004

VI.4 The variation in Yemeni heritage architecture:

The contrast is clearly visible by placing the white color that is framed as a frame around the openings, the highlights and the dark color of the clay or stone walls. This variation is superficial. The variation in size is formed by the salient masses of functional use such as marshmallows.

Figure 2.47: Old Shorfah
Source: Book of Characteristics of Yemeni, 2004

VII CONCLUSION

The museums are several types and each type has bases in terms of organization, size and lighting. In the National Museum, the foundations of this type of museum and the theories applied in the project were followed.

Yemen's architecture is distinguished by its distinctive characteristics. It reflects Yemen's culture and history. Right-wing architecture is heavily influenced by the environment, the terrain of Yemen and plays a major role in creating this architecture. In the museum project, these architectural features have been applied to the project to be integrated with the Yemenite-Yemeni environment. It reflects the value of this heritage and the importance of aesthetic and distinctive and the importance of these local materials and their aesthetic, economic and environmental features.

Figure 2.48: Dar Al Hajar
Source: Book of Characteristics of Yemeni, 2004

Chapter 3*:*
Local materials and review

I. Introduction

II. Article's Analysis:

II.1. Motivation of choice.

II.2. Presentation of the article:

- ✓ Title
- ✓ author(s)
- ✓ year
- ✓ journal

II.3. Building materials and thermal comfort in hot zone: Application to regions Cameroonian climate.

II.4. Acoustic Properties of Innovative Material from Date Palm Fiber.

II.5. Thermophysical characterization of wood of Date palm for use in Thermal insulation in the habitat

II.6. Determining the Optimum Addition of Vegetable Materials in Adobe Bricks.

III. Discussion

III.1. Analysis of the results.

IV. Conclusion.

I. Introduction:

The following articles present experiments and tests on local building materials. Hereafter, several authors use the different local materials in their studies of engineering and architecture. Those studies goals are to show the impact of local materials in the building, their characteristics and their environmental influence.

II. Article's analysis:

II.1. Motivation of choice:

Article	Motivation of choice
Building materials and thermal comfort in hot zone: Application to regions Cameroonian climate.	This article is chosen to know the thermal effect of the different types of local building materials compared with the thermal effect of modern building materials.
Acoustic Properties of Innovative Material from Date Palm Fiber:	This article is chosen to know the acoustic effect of palm wood through its fibers in construction.
Thermophysical characterization of wood of Date palm for use in Thermal insulation in the habitat.	This article is chosen for the purpose of showing the characteristics Thermal renewable parts of date palm.
Determining the Optimum Addition of Vegetable Materials in Adobe Bricks.	This article is chosen to show the mechanical strength of material of adobe construction after its improvement with a plant material.

Table 3.3: Presentation of choices.

Source : Revue des Energies Renouvelables. Vol. 14 N°2 (2011) 239 – 248

II.2. Presentation of articles:

Article	Author(s)	Year of publication	Journal of publication	Affiliation	Number of pages	Context
Building materials and thermal comfort in hot zone: Application to regions Cameroonian climate.	A. Kemajou and L. Mba	2011	Renewable Energies Review. Flight. 14 No. 2 (2011) 239 - 248.	Laboratory of Refrigeration and Air Conditioning, 'ENSET' University of Douala. Cameroon	**9 pages**	
Acoustic Properties of Innovative Material from Date Palm Fiber:	Abd AL-Rahman L. et al	**2012**	American Journal of Applied Sciences 9 (9): 1390-1395, 2012	Department of System of Dynamics Control, Malaysia Malaysian Palm Oil Boar, Selangor.	**5 pages**	
Thermophysical characterization of wood of Date palm for use in Thermal insulation in the habitat.	AGOUDJIL B. et al	**2009**	1 Laboratory of Physics, Applied Energetics (LPEA)	(LPEA), University El-Hadj-Lakhdar, Batna, Algeria Mechanical Engineering Laboratory, Mohamed Khider University Biskra, Algeria. 3Université Paris-Est / CERTES, 61 Avenue of General de Gaulle, France.	**7 pages**	
Determining the Optimum Addition of Vegetable Materials in Adobe Bricks.	Calatana G. et al	**2013**	Explore scientific, technical, and medical research on ScienceDirect	Faculty of Civil Engineering, Technical University of Cluj-Napoca, C-tin Daicoviciu Street, No. 15, 400020, Cluj-Napoca, Romania	**8 pages**	

Table 3.4: Presentation of articles.
Source : Revue des Energies Renouvelables. Vol. 14 N°2 (2011) 239 – 248

II.3 Building materials and thermal comfort in hot zone: Application to regions Cameroonian climate

A. Problematic:

Architects and architectural specialists are interested to know: What is the thermal effect of local building materials in the different regions of Cameroon? and how can they reduce energy consumption in the building?

B. Objectives:

This study will focus on achieving thermal comfort in the home through the judicious use of building materials. Studied the influence of the type of materials (hollow agglomerate block, earth brick, wood) used in each climatic zone on the evolution of the interior temperature of the room.

C. Methodology:

This study is based on thermal simulation, which is a promising tool for making progress in the construction of thermal systems in developing countries. The data is simulated with Delphi and Meteocal so that they can be understood by the simulation software Pleiades + Comfie treatments made using several software:

- The conversion of hourly tri temperatures into hourly temperatures,
- Calculations of global horizontal and diffuse horizontal flows,
- Global average daily extra atmospheric irradiations horizontal and diffuse horizontal with Excel software.

D. Case Study Presentation:

The simulated habitat is of the mono-zone type (15 m²) of living space and a height from (2,8m). It includes: a single glazed window 4 mm thick, dimension (1 × 1.2 m²), with light wood frame, a light wooden door of dimension (1 × 2.2 m²). The openings are located on the north facade of the habitat.

II.4 Acoustic Properties of Innovative Material from Date Palm Fiber

A. **Problematic**:

What is the role of palm wood fiber as its use in construction?

B. Objectives:

This study is done to know the potential of using palmwood fibers as a sound absorbing element, the thickness effect of the insulating layer of palm wood, its density and acoustic absorption coefficient.

✓ **Methodology:**

The impedance tube consists of two tubes, one for low frequencies (100 mm) in diameter and the other for higher frequencies (28 mm) in diameter. For the test, the small diameter tubes are connected can be mounted for high frequency measurements that can also act as standalone with its own speaker. The microphones are connected to the PC, which also includes a random noise generator. Using Microphones GRAS 26 AK, Sound Generators, Amplifier and Symphony Dual-channel Real Time Acquisition Unit.

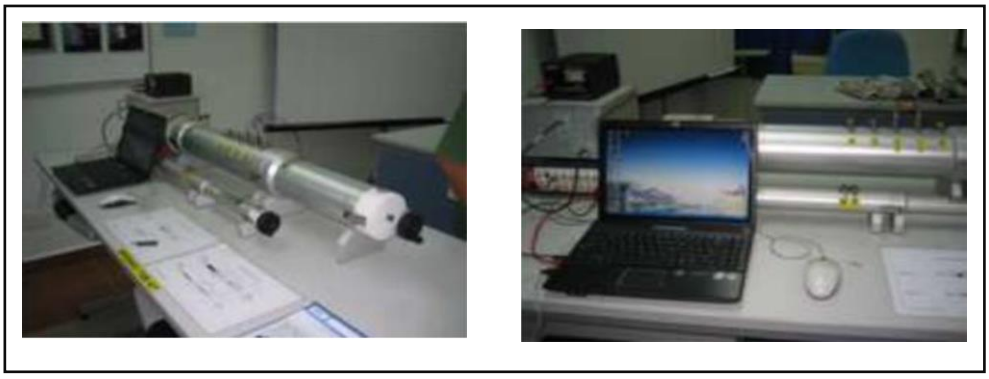


Figure 3.49: Impedance tube instrument and Configuration of Acoustic characteristics.

✓ **Case Study Presentation:**

A- Raw palm fiber.

B- Chop the fiber.

C- Test palm samples with different thicknesses (100, 28 mm).

Figure 3.50: Date palm fiber

II.5 Thermophysical characterization of wood of Date palm for use in Thermal insulation in the habitat.

A. Problematic:

To benefit from palm wood materials, the experts in this work direct their efforts to find the thermal characteristics of this material and how can they use it in construction?

B. Objectives:

Show that palm wood has a low thermal conductivity (and therefore a good insulator) to use as insulation material in the construction.

C. Methodology:

The observations by scanning electron microscopy were performed using a JEOL JSM-6301F electron microscope. The observations were supplemented by spectroscopic measurements (DHS) to determine the chemical composition of the fibers of this type of wood.

The thermal conductivity k and thermal diffusivity a were measured using the DICO measuring device. This device is based on a thermal excitation in periodic regime. The sample, square section (44mm side) and a few mm thick is inserted between two metal plates and subjected on one of its faces to a thermal flow modulated at different frequencies.

✓ **Case Study Presentation:**

Echantillon	P	k	a	ε_r
	mbar	$W.m^{-1}.K^{-1}$	$\times 10^{-7}\ m^2.s^{-1}$	-
PDN//	10^{-4}	0.046 ± 0.003	1.65 ± 0.10	-
PDN	10^{-4}	0.042 ± 0.003	2.16 ± 0.15	-
PDN//	1000	0.084 ± 0.003	3.31 ± 0.31	10.38 ± 0.52
PDN	1000	0.083 ± 0.003	2.29 ± 0.20	8.09 ± 0.26
PMD	1000	0.073 ± 0.003	3.13 ± 0.49	24.70 ± 1.61
PEG	1000	0.072 ± 0.002	2.76 ± 0.24	2.58 ± 0.02
BDN	1000	0.085 ± 0.004	1.91 ± 0.21	5.81 ± 0.08
BMD	1000	0.084 ± 0.005	2.07 ± 0.30	5.70 ± 0.10
BEG	1000	0.074 ± 0.004	2.29 ± 0.30	5.13 ± 0.09

Table 3.5: Measured values of thermal conductivity k, thermal diffusivity a and dielectric permittivity.

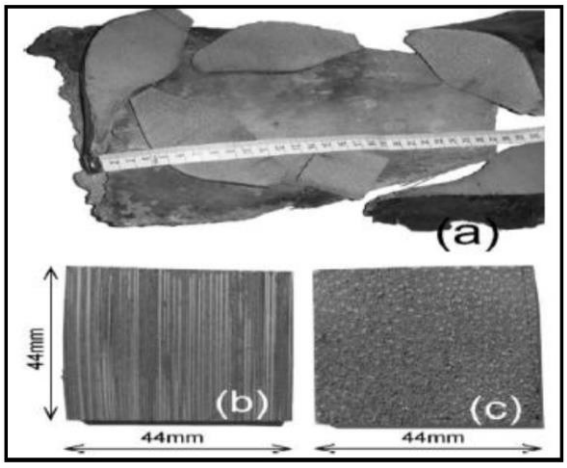


Figure 3.51: petioles used (a); sample with fibers.

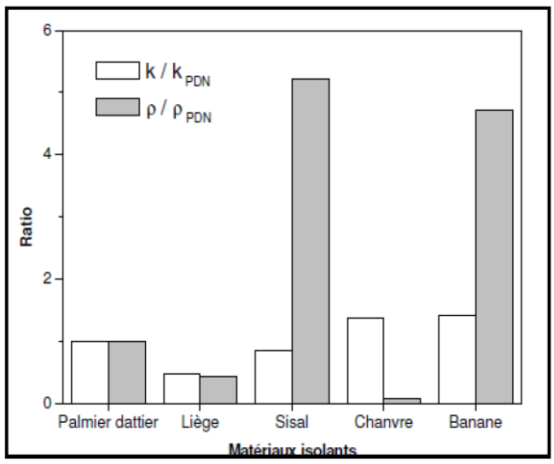


Figure 3.52: Comparison of density and thermal conductivity of date palm wood with other

II.6 Determining the Optimum Addition of Vegetable Materials in Adobe Bricks.

A. **Problematic**:

This article looks at the effectiveness of reinforcement dispersed in natural fibers in the adobe bricks. What is his role ?

And how will he improve the resistance mechanical adobe bricks?

B. Objectives:

The improvement of the adobe bricks by the use of hemp and straw fibers to reinforce its mechanical resistance.

C. Methodology:

Experimental tests were performed using a predetermined mixture of sandy clay, sand, bone glue, lemon paste and water in which were introduced different amounts of hemp or straw fibers. For each composition were continued the following parameters: workability, axial shrinkage at drying, cracking, bulk density, compressive strength and tensile coefficient, bending and heat transfer. To obtain the experimental mixtures, a sandy clay soil extracted from Dragan Valley, Cluj, Romania was used. Characteristics of grain, in conjunction with data of literature [5-7, 14, 17, 30] indicated that this material is adapted to the chosen purpose. Characterization of the sandy clay was performed by identifying the oxide composition thereof.

✓ **Case Study Presentation:**

Table 1. Particle size distribution of used sandy clay

	sand 0,5<d<2	medium sand 0,25<d<0,5	fine sand 0,05<d<0,25	powder 0,005<d<0,05	clay d<0,005
Content (%)	37,53	20,15	16,72	18,26	7,34

Table 2. Oxide composition of sandy clay

Identified Oxide	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	TiO_2	PC
Concentration [%]	74,17	12,74	4,38	0,7	1,0	1,43	0,73	0,05	4,78

Table 3.6 :Particle size distribution of spent sandblasted clay and the oxide composition in the matrix clay.

In the clay matrix, vegetable matter was introduced in varying amounts, expressed as a percentage by volume, relative to the clay mixture. Thus, 3%, 8%, 9%, 10%, 12% or 15% by volume by volume of hemp fiber, respectively 10%, 20%, 30%, 40%, 50% or 60%, were introduced. volume, straw. Hemp fibers were used as such. The straw, with a high-water absorption, in advance, was immersed for one hour in Water, in order to avoid the phenomenon of water absorption in the clay matrix. From each mixture thus produced, a set of three prismatic specimens, 40x40x160 mm, were manufactured to determine apparent density, axial shrinkage and mechanical forces and a set of 3 specimens, slab type, 300x300x40 mm, to determine conductivity. thermal. The samples were stored in the laboratory until reaching moisture at equilibrium. Throughout the tests were followed the appearance and evolution of the cracks.

The compressive strength, Rc, was determined. It was calculated the flexural strength and compressive strength according to equations (1) and (2).

$$R_f = \frac{1.5xF_f xl}{b^3} N/mm^2 \quad (1 \qquad R_c = \frac{F_c}{1600} N/mm^2 \quad (2$$

Rf - bending strength (N / mm2) * b - the side of the square section of the prism (mm) Ff - the failure load applied in the middle of the prism (N), l - distance between supports (mm) * Rc - compressive strength (N / mm2), Fc - faulty load (N), 1600 = 40x40 mm * surface of the plates or auxiliary plates (Mm^2

III. Discussion:

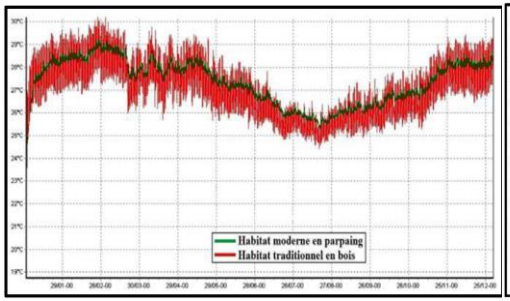
<table>
<tr><th>Article</th><th>Results</th><th>Discussion</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Building materials and thermal comfort in hot zone: Application to regions Cameroonian climate.</td><td>


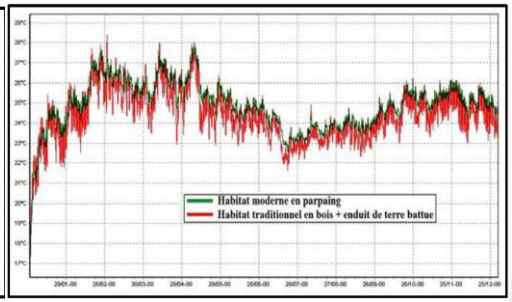
Figure 3.53: Thermal response of habitats in the equatorial climate Zone 'Ia. Source: Revue des Energies Renouvelables 2014


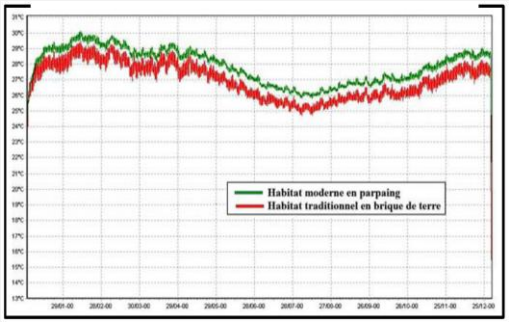
Figure 3.54: Thermal response of habitats in equatorial climate, Zone 'Ib Source: Revue des Energies Renouvelables 2014</td><td rowspan="2">At the end of this work, it appears that thermal comfort can be achieved by a judicious choice of building materials and a good architectural construction policy. This architectural policy must above all be in line with the architectural habits of the population.</td></tr>
<tr><td>


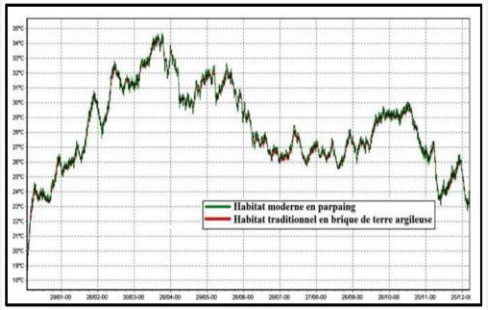
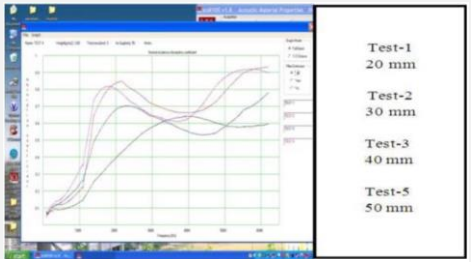
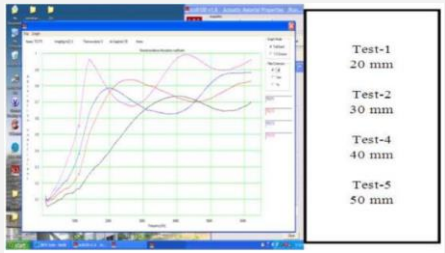
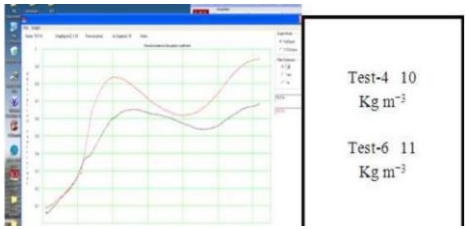
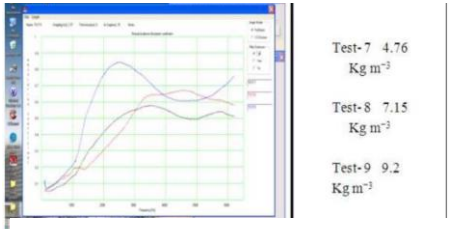
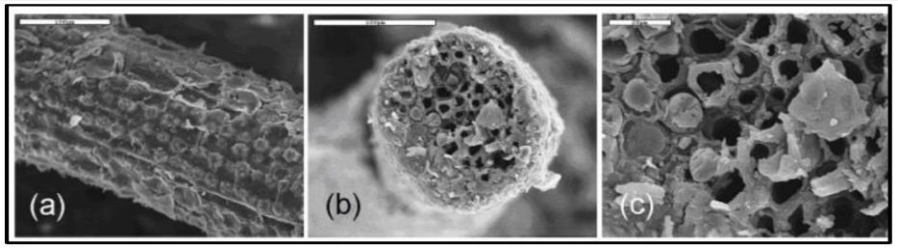
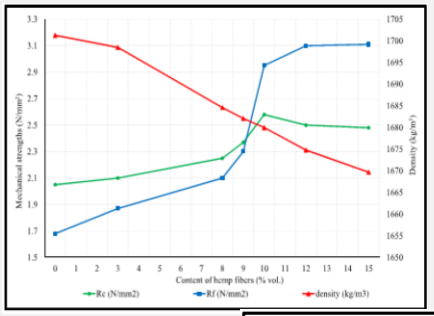
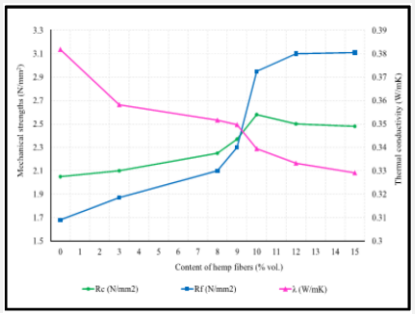
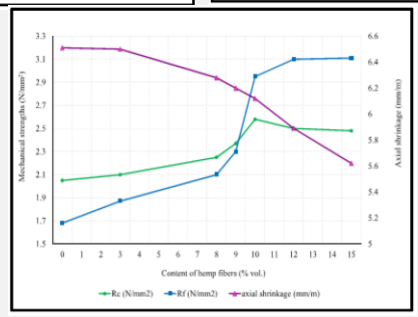
Figure 3.55: Thermal response of habitats in equatorial climate, Zone 'I, c' (*). Source: Revue des Energies Renouvelables 2014


Figure 3.56: Thermal response of habitats in tropical climate zone (II and III) (**). Source: Revue des Energies Renouvelables 2014</td></tr>
</table>

Article	Results	Discussion
Acoustic Properties of Innovative Material from Date Palm Fiber:	 Figure 3.57: AAC comparison between different thickness layers of date palm fibers (20, 30, 40, 50 mm) without latex.  Figure 3.58: Comparative AAC between different thicknesses of date palm fibers (20, 30, 40, 50 mm) with latex and  Figure 3.59: AAC of comparison between different sample densities of date palm fiber without overlap with 35mm thickness (10, 11 Kg m-3) compression time 5min  Figure 3.60: AAC comparison between different densities of unsupported date palm fiber with 35mm layer thickness (4.76, 7.15, 9.2 Kg m-3) compression time 7min Table 1: The maximum acoustic absorption coefficient at various thicknesses samples Thickness of fibre mm / Frequency Hz / Acoustic absorption coefficient 20 / 3884 / 0.64 30 / 4978-5000 / 0.83 40 / 4950-5000 / 0.84 50 / 4950-5000 / 0.86 Table 3.7: Presentation of results. Source: American Journal of Applied Sciences 9 (9): 1390-1395, 2012	Date palm fiber was introduced as one of the sound absorbers in this study. The results of the experimental tests show that it has good acoustic properties at low and high frequencies and can be used as a synthetic commercial product replacement. The study based on the characteristics of palm wood fibers allows us to benefit from its advantages over acoustic insulation.

Article	Results and Discussion
Thermophysical characterization of wood of Date palm for use in Thermal insulation in the habitat.	Figure 13 shows three SEM images of a fiber from a petiole sample of the Deglet-Nour variety. Figure 3 (a) shows the rough surface consisting essentially of lignin, a typical surface for most natural fibers. The diameter of this fiber is about 200 microns. Figures 3 (b) and 3 (c) show the internal structure of these natural fibers. Each fiber consists of an assembly of fibrils. The central part of each fibril, called the lumen, is hollow. The study based on the characteristics of palm wood fibers allows us to benefit from its advantages over thermal insulation. The results of this experimental work have shown that the renewable parts of the date palm (petiole and cluster) constitute a good thermal insulator with a low density. The effect of fiber orientation on thermal conductivity is not significant. Moreover, the effect of the high porosity of the material has been evidenced by measurements under vacuum.  Figure 3.61: SEM images of a petiole fiber (Deglet-Nour variety); scales: 100 µm (a), 100 µm (b) and 20 µm (c)

Article	Results	Discussion
Acoustic Properties of Innovative Material from Date Palm Fiber:	   Fig. 3.62. Variation in compressive strength, bending tensile strength, bulk density,Thermal conductivity and axial shrinkage based on the amount of hemp fiber of a clay mixture.	The article shows a way to determine an optimal addition of plant materials, hemp fiber or straw, while considering the main factors to follow to reach the sandy clay bricks: axial contractions, absence of cracks, apparent density, mechanical forces and thermal performance. **2- Point of view on the article:** Thanks to the types of plant species chosen the experts obtained a very improved earthen material than raw earth material (from the point of view of its mechanical characteristics). It helps us think about using adobe in modern construction to benefit from their environmental and economic virtues

IV. Conclusion:

Through the analysis of the practical articles we find the physical and aesthetic properties that can be applied in the selection of materials used in the museum project, the local materials studied in the scientific articles enable us to benefit from the control of the climatic comfort in the project through its physical properties.

The local materials studied in the articles have good climatic uses and will be exploited in the project. It also has aesthetic uses in the architectural plot of the exterior of the museum.

Chapter 4:
Analysis of Examples

I. Analysis of Examples part one

I.1 Technical sheet

I.2 Context and integration

I.3 spatial-functional study

I.4 Study Materials

II. Analysis of Examples part two

II.1 Technical sheet

II.2 Context and integration

II.3 spatial-functional study

II.4 Study Materials

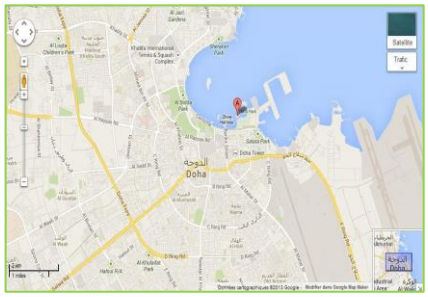
III Syntheses

I Analysis of Examples part one:

I.1 Technical sheet:

	EXMPLE: 01	EXMPLE: 02
	Museum of Islamic Art in Doha  Figure 4.63: projet source: Arch Daily	**Kiasma Museum of Finland**  Figure 4.64: projet source: Arch Daily
Year of production	2007	1998
Architect	PEI Partnership Architects (New York), Wilmott & Associates - Architecture	Steven Holl
Notions	- This is the first museum specific to Islamic art. - It is unique in its kind as it is built in an artificial island . - It was imagined by Leoh Ming Pei the great architect American of Chinese origin - The shape of the museum is inspired by the fountain at ablutions of the mosque of Ibn Touloun in Cairo . - This is a project that is part of the Doha policy to give the image of the Islamic art and culture of the country, and the consistency of the collections on display, highlight the cultural ambition of the country.	- Project history played important thing in the shape. - The symbolism of the museum. - Integration with location and surrounding environment - The shape of the project curved

I.2 Context and integration:

	EXMPLE: 01	EXMPLE: 02
Urban integration: Situation:	 Figure 4.65: plan source: Goolge	 Figure 4.66: plan source: Goolge
	 Figure 4.67: plan source: Goolge	 Figure 4.68: plan source: Goolge
	Pei has located his museum on a small artificial peninsula. The silhouette of the museum looks like a big block of stone in the middle of the sea	Located in the Finnish capital Helsinki.
Accessibility	 Figure 4.69: plan source: Goolge Main Entry Parking access MIA Park Access Exit	 Figure 4.70: plan source: Goolge Near environment Immediate environment Environment away

The entrees

Figure 4.71: source: Arch Daily

Figure 4.72: source: Arch Daily

Figure 4.73: source: Arch Daily

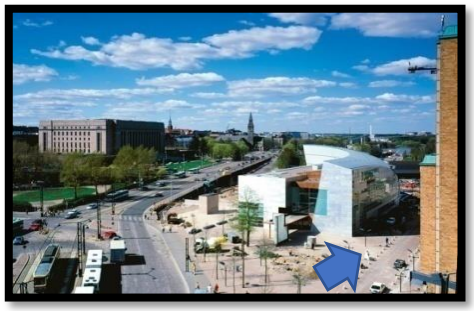


Figure 4.74: source: Arch Daily

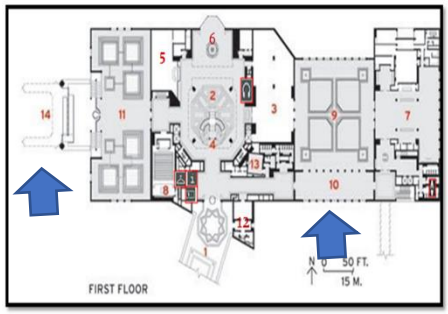


Figure 4.75: plan source: Arch Daily

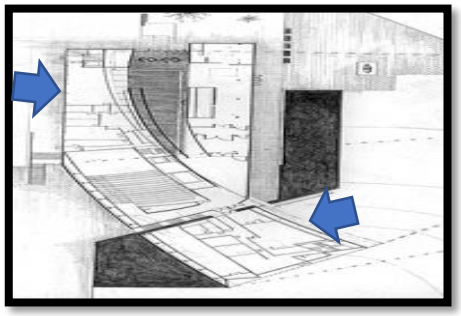


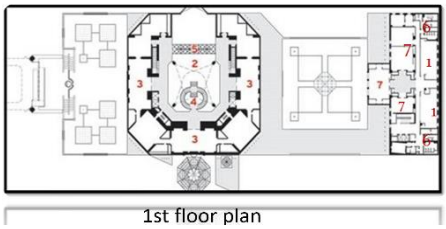
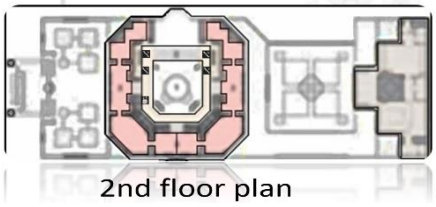
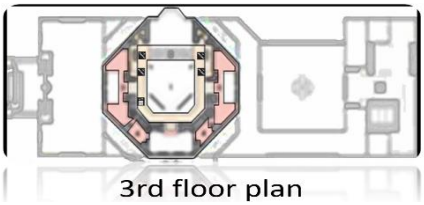
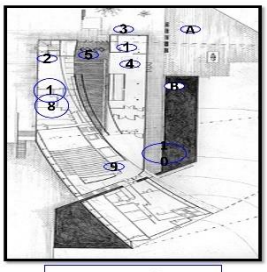
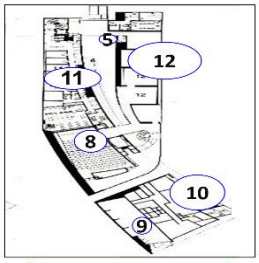
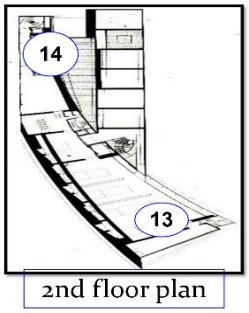
Figure 4.76: plan source: Arch Daily

Figure 4.77: plan source: Goolge

Figure 4.78: plan source: Goolge

Volumetric	 Figure 4.79: source: Arch Daily **Silhouette**: straight lines -The project silhouette is compatible with the urban interface.	 Figure 4.80: source: Arch Daily **Silhouette**: Diagonal -The spiral is slanted on one side and the other is straight.

I.3 spatial-functional study:

	EXMPLE: 01	EXMPLE: 02
Presentation of the program	 Figure 4.81: plan source: Arch Daily  Figure 4.83: plan source: Arch Daily  Figure 4.85: plan source: Arch Daily  Figure 4.87: plan source: Arch Daily	 Figure 4.82: plan source: Arch Daily  Figure 4.84: plan source: Arch Daily  Figure 4.86: plan source: Arch Daily

Space	Surface m²
1- Accueille	370,792
2- Atrium	686,04
3- Temporary exhibition gallery	909,70
4- Stairs	200
5- Shop	349,01
6- Coffee	377,22
7- Educational component	1 702,92
8-Auditorium (197 Places)	302,44
9- Central Court	1 854,96
10- Arcade Gallery	466,61
11- West Court	1 854,96
12- Security / security room	139,46
13- Prayer room	82,38
14- Boat dock	150
Audio-visual	26,89
sanitary	110,47

Table 4.8: program source: Archidaily

space	area
The entrance	50
Cloakroom for children	15
Library	105
cafeteria	25
hall	110
sanitary	6
club	60
Meeting Room	80
Technical area	30
club	60
offices	20
Projection room	60
Exhibition hall	120
workshop	64
Outdoor area	150

Table 4.9: program source: Archidaily

I.4 Study Materials:

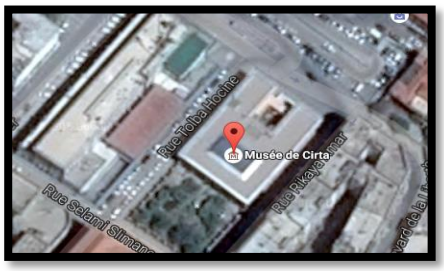
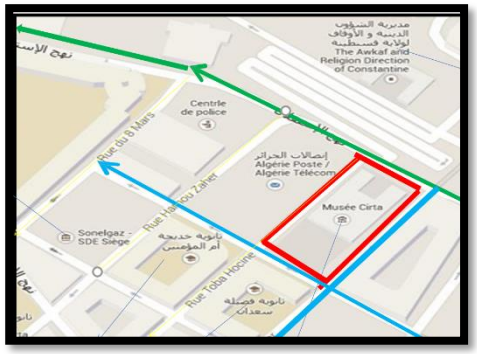
EXMPLE: 01	EXMPLE: 02
 Figure 4.88: source: Arch Daily	 Figure 4.89: source: Arch Daily
 Figure 4.90 : source: Arch Daily	 Figure 4.91: source: Arch Daily
 Figure 4.92: source: Arch Daily - glass - Concrete - Marble Transparency - panoramic view of the sea from Glass	 Figure 4.93: source: Arch Daily - Use of glass and aluminum. - The use of glass to create transparency between the inside and outside is strong

II Analysis of Examples part Two:

II.1 Technical sheet:

	EXMPLE: 03	EXMPLE: 04
	Almodjahed Museum of Batna  Figure 4.94: projet source: Goolge	**CIRTA museum**  Figure 4.95: projet source: Google
Year of production	2004	1931
Architect	Khalil ben Boulaid	Castelet
Notions	- The concept of this project is to create open space outside and closed at the same time to ensure privacy Inside. ¬- In this project, architects relied on the shape for the surrounding environment. - Use of simple local materials.	- Museum at the Algerian national level. - This museum was built since the French occupation. - The shape of the building Ramani. The use of simple materials and glass interfaces to create a link between the inside and outside.

II.2 Context and integration:

	EXMPLE: 03	EXMPLE: 04
Urban integration: Situation:	 Figure 4.96: plan source: Goolge	 Figure 4.97: plan source: Goolge
	 Figure 4.98: plan source: Goolge - Almodjahed Museum South East of Batna.	 Figure 4.99: plan source: Goolge Located in front of the ancient rock near the big post office and also Houria high school in the heart of the city Constantine.
Accessibility	 Figure 4.100: plan source: Goolge immediate close distant	 Figure 4.101.: plan source: Goolge Les axes routière Boulevard Limite du terrain

The entrees

Figure 4.102: source: Goolge

Figure 4.103: source: Goolge

Figure 4.104: source: Goolge

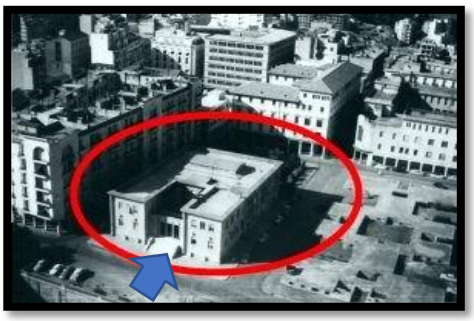


Figure 4.105: source: Goolge

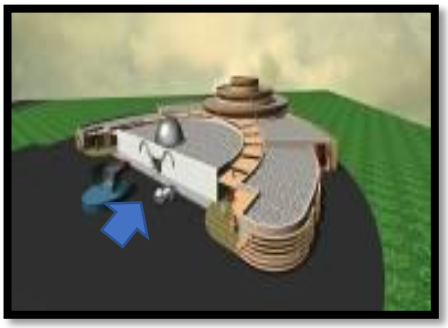


Figure 4.106: source: Archicad 3d

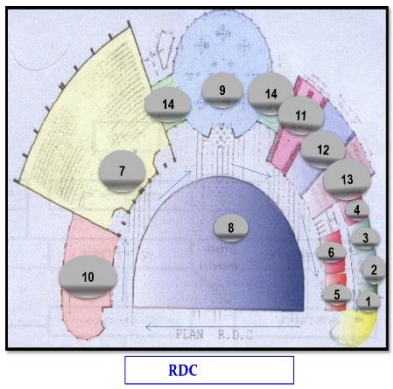
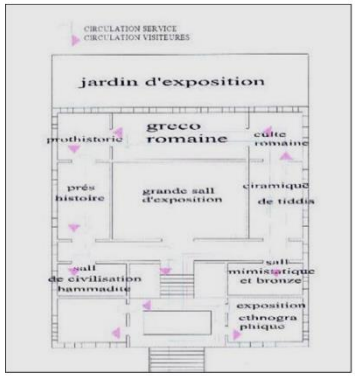
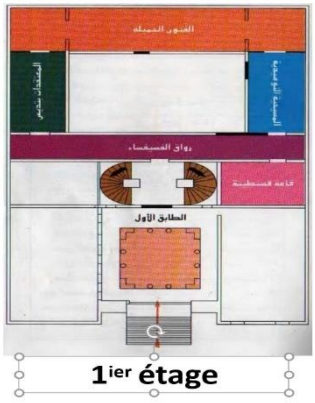
Figure 4.107: source: Goolge

Figure 4.108: plan source: Goolge

Figure 4.109: plan source: Goolge

Volumetric	 Figure .110: source: Goolge **Silhouette**: Diagonal The silhouette is direct lines.	 Figure 4.111: source: Goolge **Silhouette**: Project silhouette is compatible with the urban interface.

II.3 spatial-functional

	EXMPLE: 03	EXMPLE: 04
Presentation of the program	 Figure 4.112: plan source: Goolge	 Plan du RDC Figure 4.113: plan source: Goolge  Figure 4.114: plan source: Goolge

les Espaces	Les Surfaces
1 Réception	19.87 m2
2 Bureaux	30.75m2
3 SECRITARIA	29.53m2
4 Bureaux comptable	29.53m2
5 Bureaux Directeur	37m2
6 Bureaux d'informatique	35.30m2
7 salle conférence	748.89m2
8 Salle d'affichage	701.73m2
9 Salle d'affichage	390.28m2
10 Salle du rainions	207.54m2
11 Archive	106.59m2
12 Bibliothèque	106.59m2
13 salle du lecture 14 salle d'affichage	106.59m2 /47.90m2

Table 4.10: program source: Archidaily

	espace	Surface m²
	Exposition:	
01	préhistoire	30
02	antique	15
03	civ.numide	48
04	croyances	20
05	poterie	24
06	Les Ecus	50
07	Vie de tidis	24
08	civ.hammadide	40
09	ethnographie	12
	Administration:	
10	comptable	20
11	directeur	15
12	secrétaire	9
13	Chef service	8
14	Chef personnel	12
	-surface totale	327

Table 4.11: program source: ArchDaily

II.4 Study Materials:

EXMPLE: 03

Figure 4.115: source: Goolge

Figure 4.117: source: Goolge

Figure 4.119: source: Goolge

- glass - Concrete - Marble -wood

EXMPLE: 04

Figure 4.116: source: Goolge

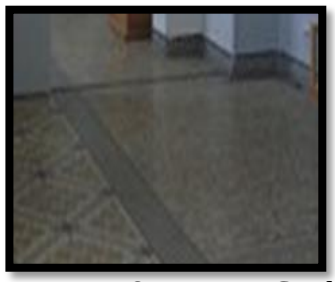


Figure 4.118: source: Goolge

Figure 4.120: source: Goolge

- glass - Concrete - Marble -wood

III Syntheses:

EXMPLE: 01	EXMPLE: 02
❖ These examples are examples at the global level and are in accordance with international architectural conditions , A good example and contemporary.	
❖ The Doha Museum in Qatar is a modern museum built to reflect the heritage value of the State of Qatar. ❖ Used of local materials, which focus heavily on Qatar's heritage and tradition. ❖ The block of one building reflects modern Qatari architecture. ❖ The museum's site serves the museum's cultural and tourist function as it overlooks the sea in a beautiful view. ❖ Good and beautiful integration between modern and minimal architecture.	❖ The Museum of Finland is one of the most important museums and landmarks in the city. ❖ It is a destination for city residents, visitors and tourists. ❖ The shape of the modern architectural museum was a key factor for visitors' generosity. ❖ Used with modern technology and environmentally friendly materials. ❖ The shape of the building was integrated with its surroundings.

EXMPLE: 03	EXMPLE: 04
❖ These examples are at the Algerian national level, subject to the conditions of Algerian national architecture, it's an important museum for their historical and architectural value.	
❖ Mujahid Museum in Batna is a national museum and a shrine to the city's residents. ❖ The museum has recently been built to meet the needs of visitors. ❖ Used simple materials in the surrounding environment. ❖ The building is integrated with the surrounding environment of Batna.	❖ Constantine Museum built in the French colonial period. ❖ The museum and its facades are of the Roman type. ❖ This museum has an important archaeological value through a constructive period. ❖ It has a main glass interface to connect the outside with inside.

General conclusion

I Elements of passage

I.1Objectives and intentions

I.1.1 Goals (Objectives)

I.1.2 The intensions

I.1.2.1 The Urban Dimension

I.1.2.2 Integration to the site

I.2 Architectural Dimension

I.2.1 The architectural aspect of the project

I.2.2 Space organisation

I.2.3 Functional organization

I.2.4 The environmental dimension

II Program

III The criteria for choosing the land

III.1 The proposed land is located in the city of Sana'a

III.2 Presentation of the site

III.3 site location

III.4 Conclusion

IV project idea

V project

I.1 Objectives and intentions

I.1.1 Goals (Objectives)

Based on the field analysis and recommendations developed and also using the analysis syntheses of the examples I started the goals and intentions for my project:

The creation of a museum reflects a vision of the past, in which the history of the Republic of Yemen is presented to the present day.

- The design of a building is integrated with the ground. The land that is related to the history of the land of Yemen.
- Building a building that works taking into account the aesthetic aspect with an essential intension on the comfort of the users
- Design an equipment that incorporates the environmental and ecological aspect into a high architectural quality space
- Building design reflecting the value of local materials of the Republic of Yemen

I.1.2 The intensions

I.1.2.1The Urban Dimension:

- ✓ Site and accessibility: Good application of the museum.
- ✓ In a square-shaped square.
- ✓ The entrance and parking lot will be on the southwest side.
- ✓ Exploit views especially the main interface through visual communication between the inside and outside.

I.1.2.2 Integration to the site:

- ✓ For a good integration with the site, the form of the project must meet the configuration of the site.
- ✓ Respect the heights of the buildings in this space which goes to maximum RDC + 2 not to disturb the visual continuation.
- ✓ Give the project its character and architectural style without prejudice to what exists.
- ✓ Consider all climate data from a hot, arid region in any part of the ground plan project up to facade treatment.

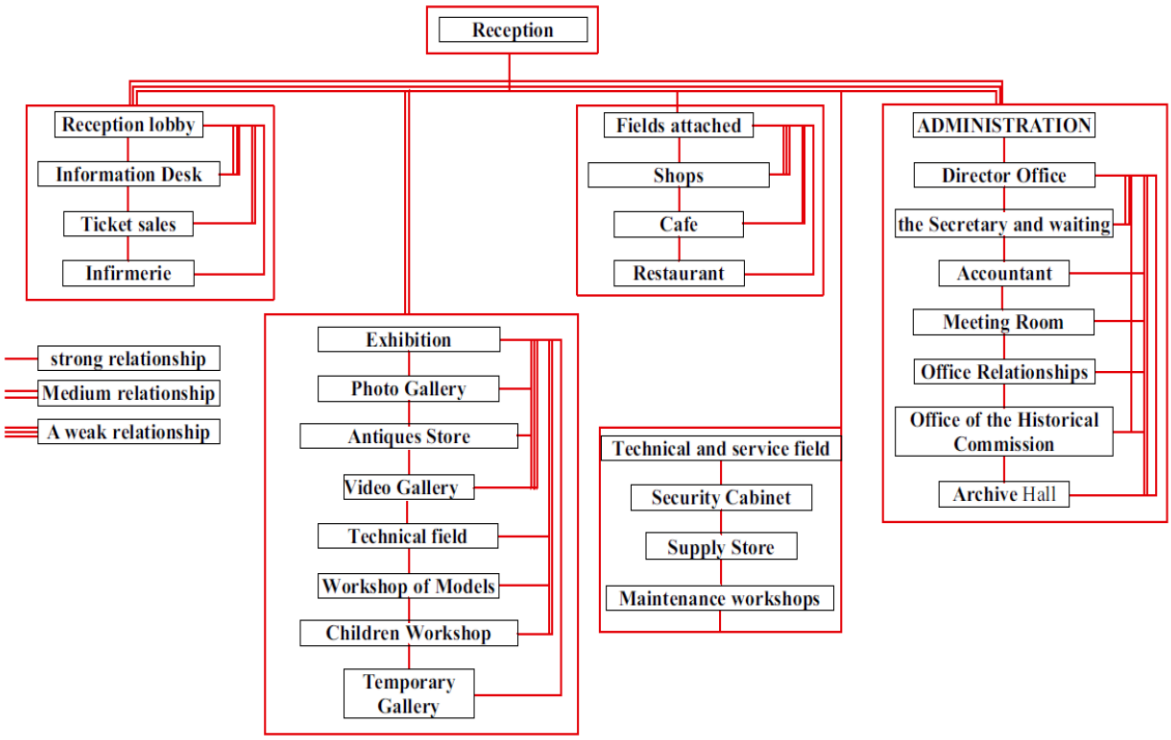
I.2 Architectural Dimension:

I.2.1 The architectural aspect of the project:

Implementation gold and project orientation climate and environmental data must be taken into account to establish a project from:

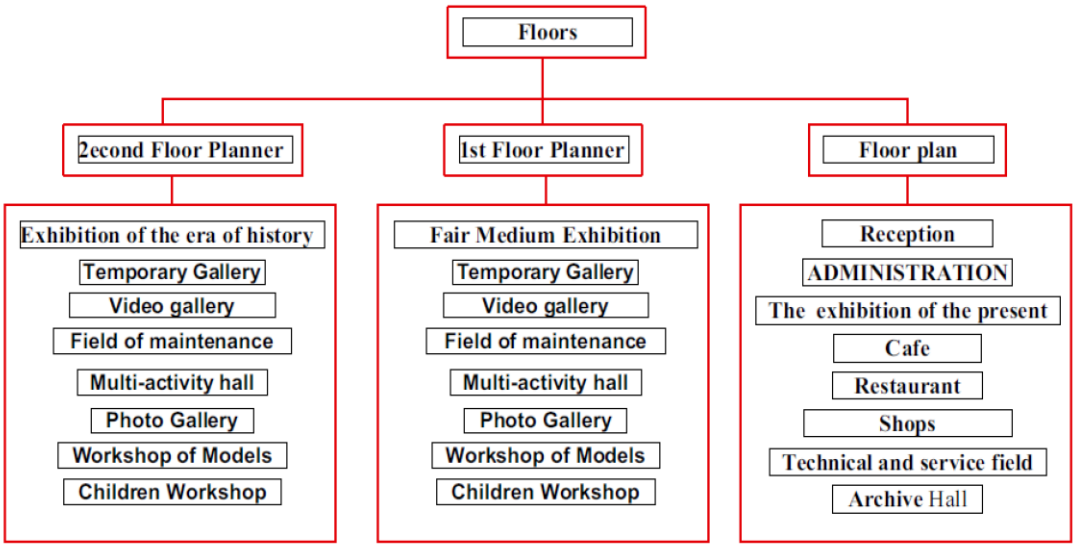
- ✓ Do not climb too high to respect the horizontal line.
- ✓ Use compact shapes flexible and fluid harmonious with the shape of the site.
- ✓ All a transparent treatment of the facades must be teamed with a solar protection in order to merged the outside inside the project without having any nuisance on the comfort.
- ✓ Facade treatment must respect the identity of the local in a modern way.
- ✓ Articulation between the different entities of the project for a well-balanced volume.
- ✓ Treatment of each orientation by a specified treatment of facades: size and shape of openings, type of glazing, proportion between empty and full.

I.2.2 Space organisation:



- ✓ A main entrance must be made close to the parking and the ground entrance.
- ✓ Make secondary entrance to the museum to facilitate the internal transfer of a building.
- ✓ Separate the field of management and the field of improvement from other areas.
- ✓ Create a gallery area open to visitors.
- ✓ Create an area of motion so that the visitor is attracted to see different viewing areas.

I.2.3 Functional organization:



- ✓ Divide the exhibition areas into three time periods: historical, past, and present. The movement between these time periods will be vertical.
- ✓ The creation of each area for each time period with all the related areas.
- ✓ Create a special protection area for valuables.
- ✓ Creating temporary and permanent workshops.

I.2.4 The environmental dimension :

- ✓ A design respecting the climatic context
- ✓ Choice of orientation of the space according to their needs views and natural lighting and each orientation has a special treatment.
- ✓ The integration of the plant aspect and the water inside to create an ambitious micro climate.
- ✓ Creation of patios in the form of a winter garden to benefit from natural ventilation and natural lighting.
- ✓ Ventilation system by bio filter of air and geothermal energy.

II. Program:

DESIGNATION	SURFACE m2
A- Reception	**197.00**
- Reception lobby	150.00
- Information Desk	15.00
- Ticket sales	8.00
- Men's bath	7.00
- Women's Bathroom	8.00
-Infirmerie	9.00
B-Fields attached	**184.00**
-Shops	16.00*3
-Cafe	60.00
-Restaurant	109.00
- Men's bath	7.00
- Women's Bathroom	8.00
C- ADMINISTRATION	**188.00**
-Director Office	24.00
-the Secretary and waiting	20.00
-Accountant	20.00
-Meeting Room	35.00
-Office Relationships	23.00
-Office of the Historical Commission	25.00
-Archive Hall	10.00
-Technical field	25.00
-Store	6.00
D-Cultural Section	**474.00**
the library	107.00
Media Hall	107.00
Hall of projection	107.00
Sound Detector	50.00
Multi-activity hall	70.00
Prayer Hall	18.00
Bath men	7.00
Bath women	8.00

E-Exhibition halls and workshops	**1484.00**
-Permanent Exhibition Hall. Historical	350.00
-Temporary Exhibition Hall. Intermediate Period	260.00
-Temporary Exhibition Hall. Current time period	190.00
-Photo Gallery	150.00
-Antiques Store	45.00
-Video Gallery	64.00
-Technical field	55.00
-Field of maintenance	52.00
-Workshop of Models	67.00
-Children Workshop	45.00
-Multi-activity hall	50.00
-Temporary Gallery	141.00
-Bath men	7.00
-Bath women	8.00
F- Technical and service field	**829.00**
-Security Cabinet	180.00
-Supply Store	84.00
-Maintenance workshops 3*	50.00*3
-Temporary housing	400.00
- Men's bath	7.00
- Women's Bathroom	8.00
TOTAL SURFACE	3356.00

Analysis of the ground location

III The criteria for choosing the land:

III.1 The proposed land is located in the city of Sana'a:

1: One of the most important cultural and tourist areas in the city of Sana'a.

2: The location is very well connected with the city.

3: The surrounding facilities serve the proposed project.

4: The surrounding environment helps to create a modern design of Yemeni architecture.

5: The site is located between two important streets.

III.2 Presentation of the site:

- **Location Studding:** Republic Location: The Republic of Yemen is located south-west of Asia, specifically, in the southern part of the Arabian Peninsula between latitudes 12.8.20 North.
- According to some sources, the area of Yemen in 2007 is about (527.970 km2). The official sources are (555000 km2). Yemen's population is estimated at 22,211,743.
- The Republic of Yemen is bordered on the north by Saudi Arabia, on the south by the Arabian Sea and the Gulf of Aden, on the west by the Red Sea and on the east by the Sultanate of Oman.

Figure 5.121: Sanaa Location

Source: Google Earth

- **Sana'a location:**

Located in the middle of the western mountain range from the far north of Yemen to the south, it is bordered to the north by the governorates of Jouf and Amran, from the east to Marib, to the south by Dhamar governorate and to the west by the governorates of Mahweet and Hodeidah.

III.3 Site Location:

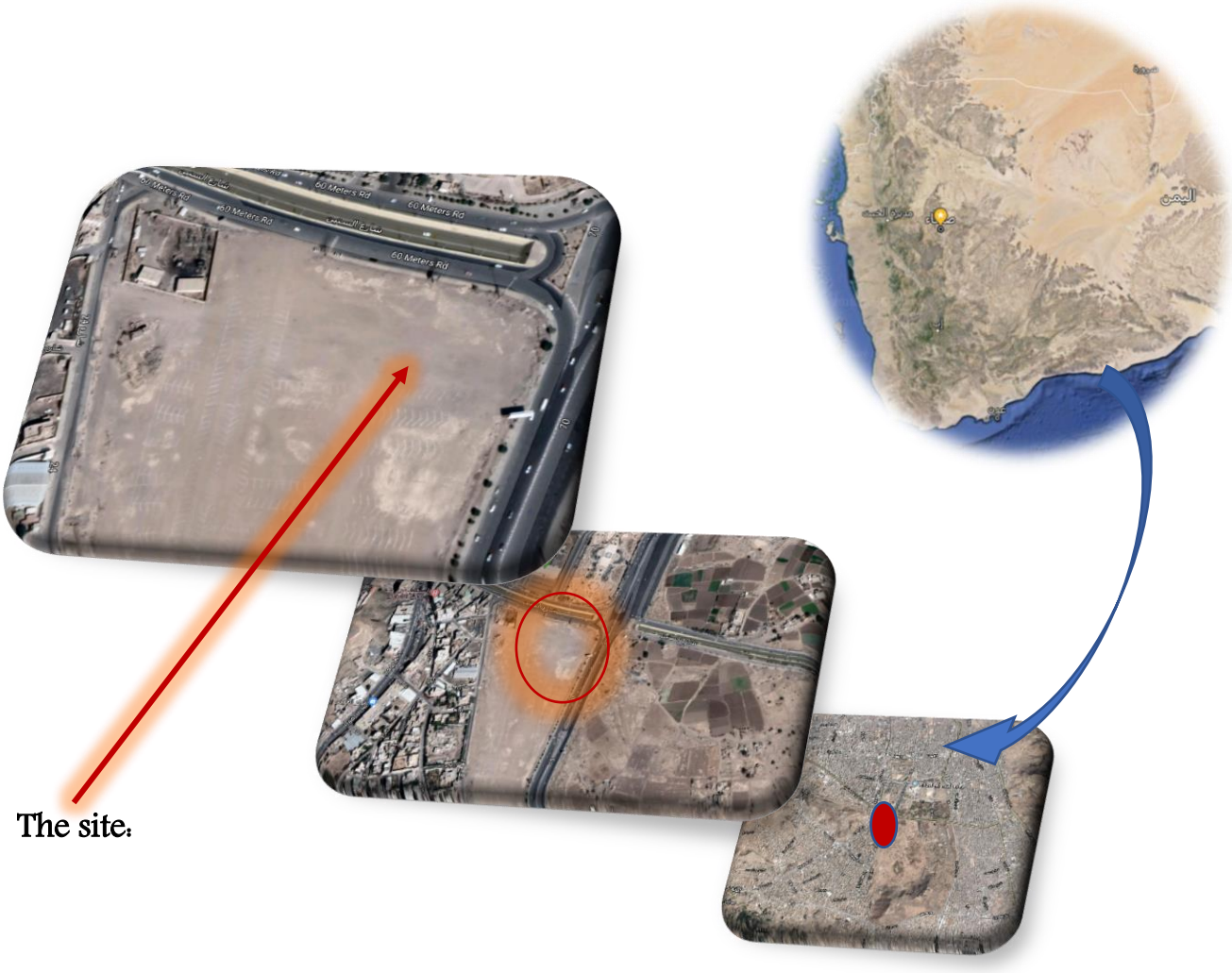
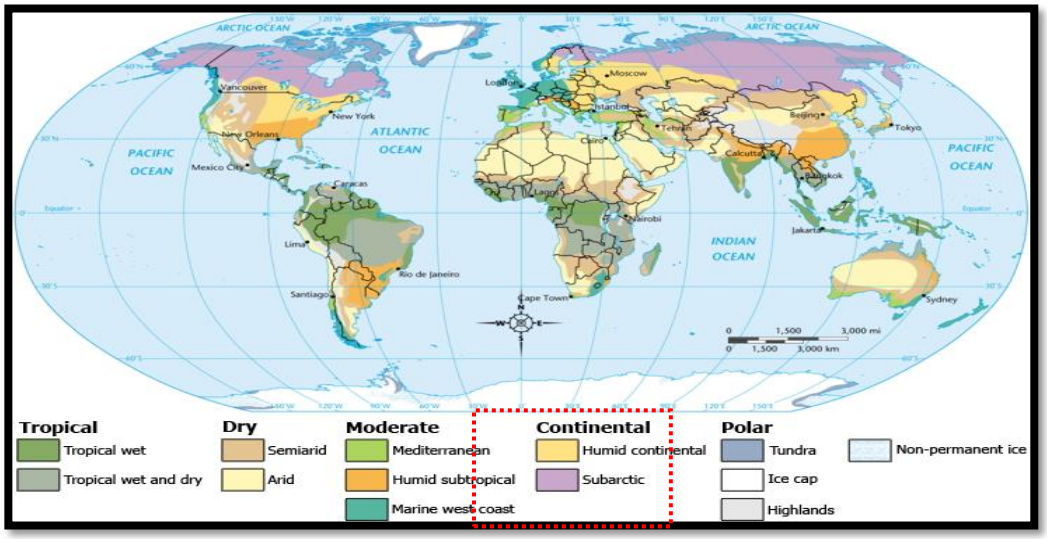


Figure 5.122: Site Location

Source: Google Earth

- **Climate situation:**



- Figure 5.123: Climate Situation

Source: Google Earth

-

- **Situation in the urban fabric:**

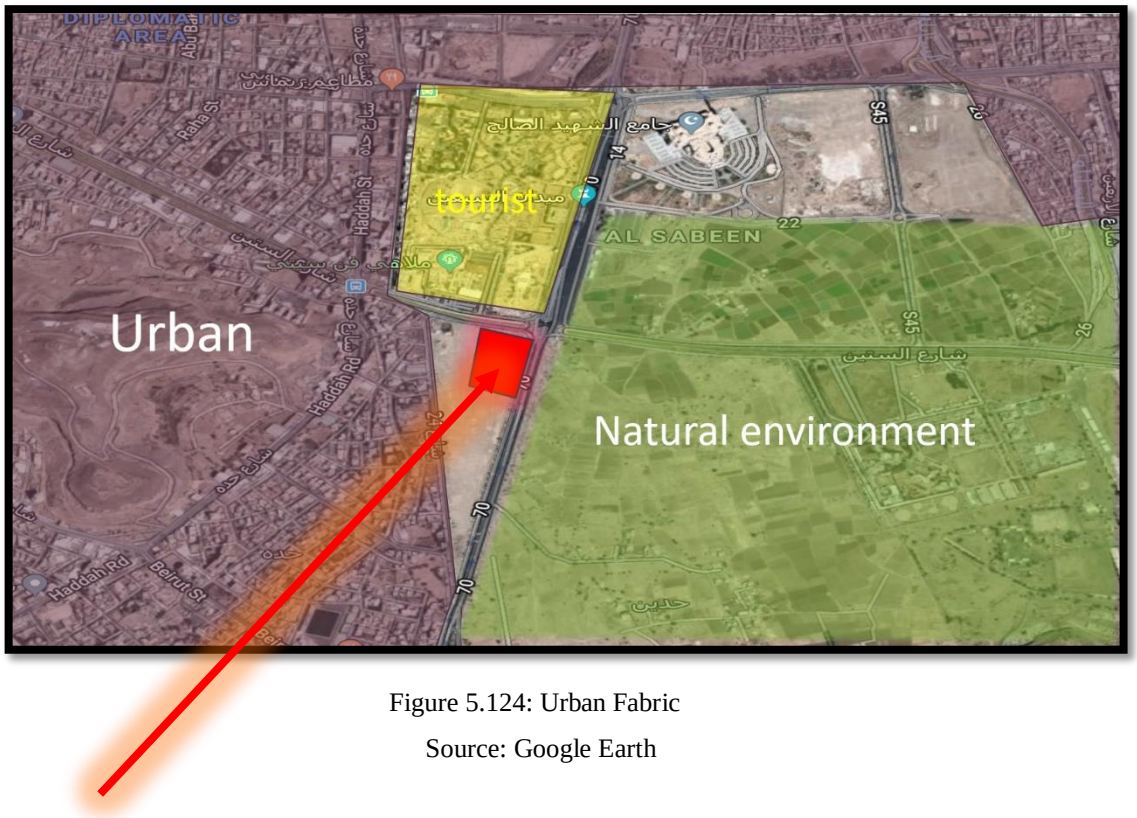


Figure 5.124: Urban Fabric

Source: Google Earth

The site:

- **The immediate environment:**

funny city

Figure 5.125: Funcity Sana'a

Figure 5.126: Site Location

Al Sabeen Square

Figure 5.127: Al Sabeen Square

Al saleh Mosque

Figure 5.128: Al Saleh Mosque

Source: Google

- **Images of the surrounding area of the site:**

Figure 5.129: Funcity sana'a

Figure 5.130: Al saben square

Figure 5.131: Site Location

Figure 5.132: Mosbahy rotary

Figure 5.133: Mosbahy

Figure 5.134: Subway

Source: Google

- **Accessibility:**

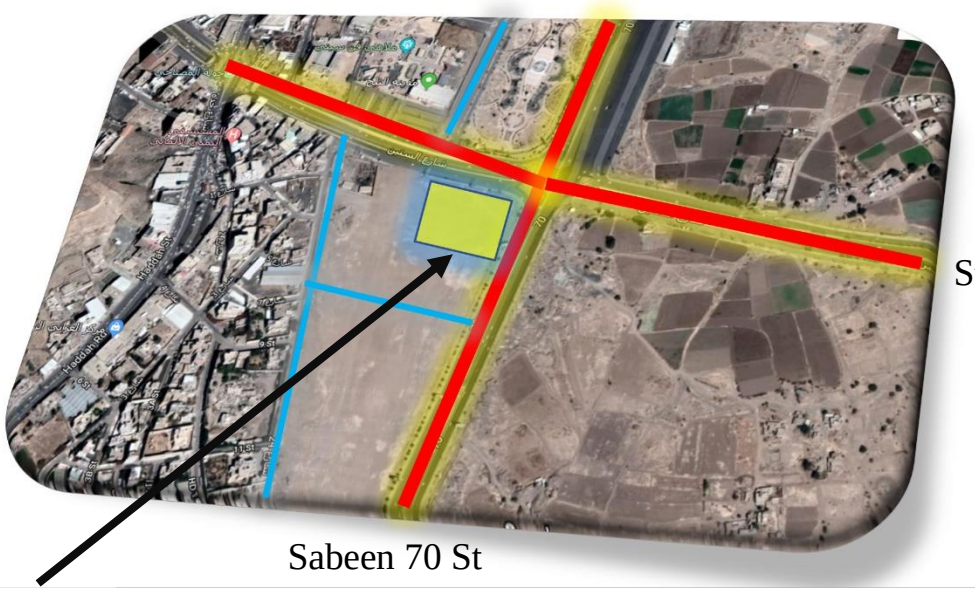


Figure 5.135: Site Location
Source: Google Earth

- **Local materials in the surrounding environment of the site:**

The surrounding mountains in Sana'a contain mines for the extraction of stones used in construction and is one of the most important building elements in local materials.

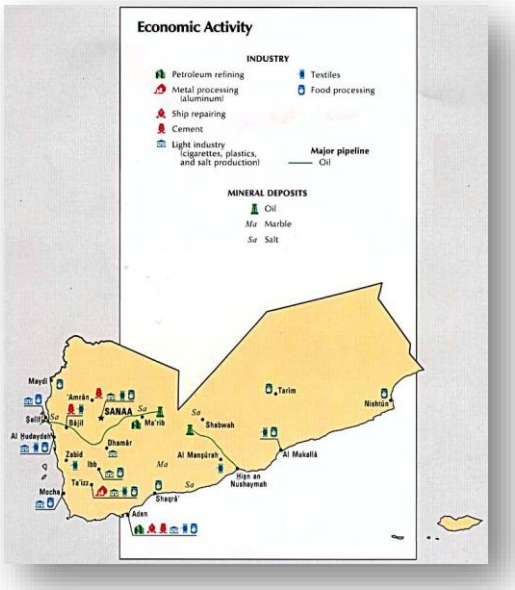


Figure 5.136: Sana'a Map
Source: Natural Resources of Yemen 2007

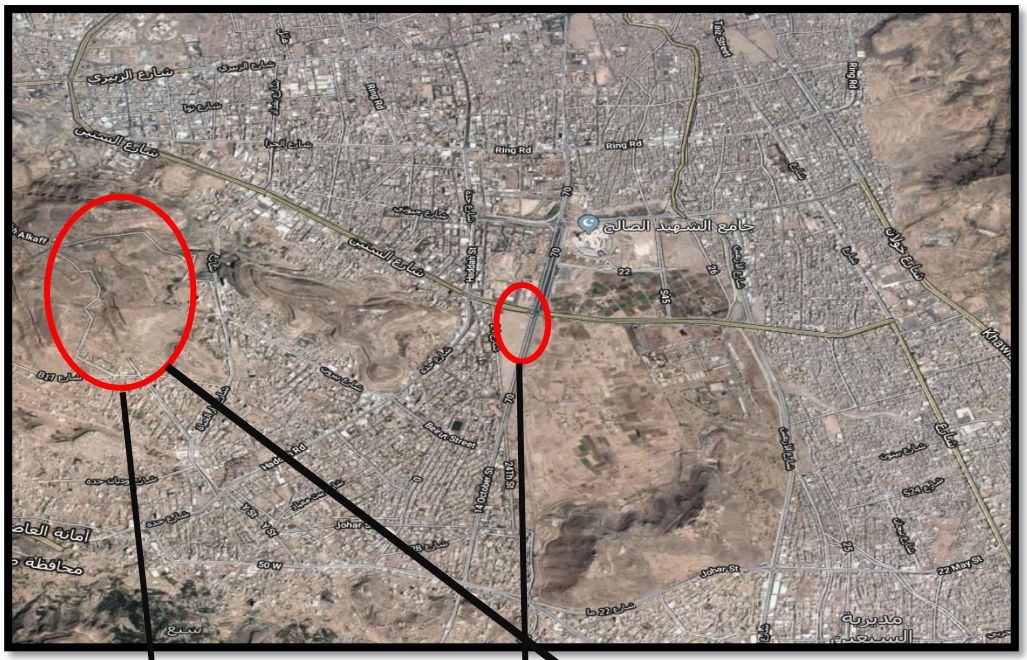


Figure 5.137: Sana'a Map Source: Google Earth

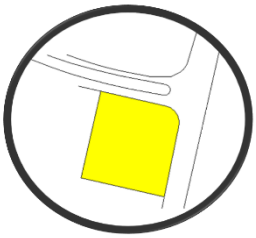
Figure 5.138: Sana'a Mountain
Source: Natural Resources of Yemen 2007

The site:

Figure 5.139: Sana'a Mountain
Source: Natural Resources of Yemen 2007

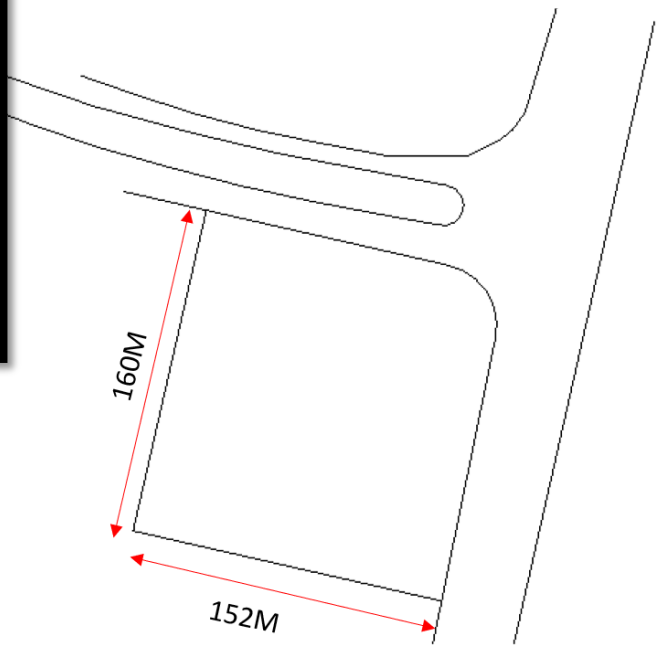
Used materials are available in Sanaa White Gypsum which is used in the work of windows and architectural plot of facades.

Figure 5.140: Sana'a Map
Source: Google Earth



surface

24,103.83 m²



- **Climate Studding:**

-Climate of Sana 'a:

Temperature: The temperature varies throughout the year as it increases in the summer and decreases in the winter. We notice from the graph that in the month of 12 it reaches the lowest level in the winter while in the month of 7 reaches the highest level in the summer so it must be considered in the design by choosing Suitable building materials, insulation and materials.

12	11	10	9	8	7	6	5	4	3	2	1	الشهر
24	25.6	27	28.9	29.7	31	30.5	28.8	28	25	26.5	24	متوسط الدرجات العليا
2	9	13.5	17	18.5	17.2	15.5	17	14.5	13	10.1	8.5	متوسط الدرجات السفلى
23.6	18.6	17.3	15.9	12.8	13.4	15.6	13.7	15.4	15	18	13.5	التقلب اليومي لدرجة الحرارة

-

Table 5.12: Sana'a Temperature
source: Yemen Meteorological Site

- **Wind:** By studying the temperature in the city of Sanaa and through the study of wind, we found that the prevailing winds are the northern winds and they are considered harmful winds cool while the seasonal wind is the seasonal wind beneficial, and note that the highest speed of wind in the month of 8 up to 40 knots, 4 to 20 knots, so consider this when directing the building.

- **Solarization:** The sun tends to lower in the winter of December 21. The sun is vertical and rises at an angle of 75 degrees in the spring and fall. The sun passes vertically and strengthens from the north, and the north west, and the day is longer than night,

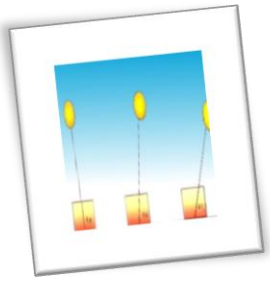


Figure 5.141: Sun light

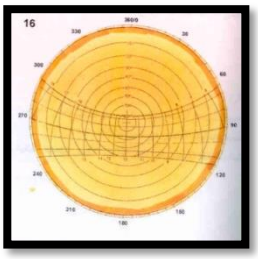


Figure 5.142: Solar projection

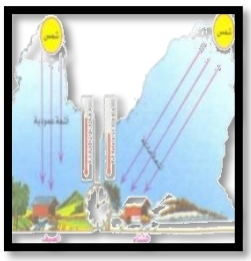


Figure 5.143: Solar

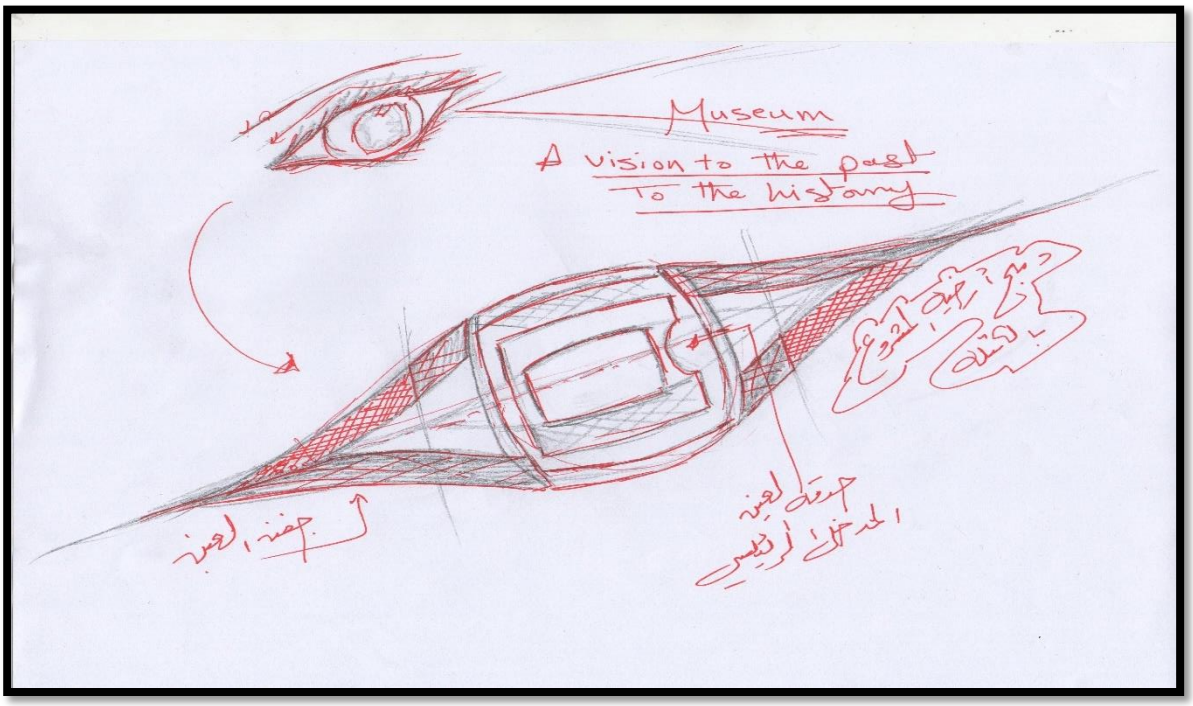
source: Yemen Meteorological Site

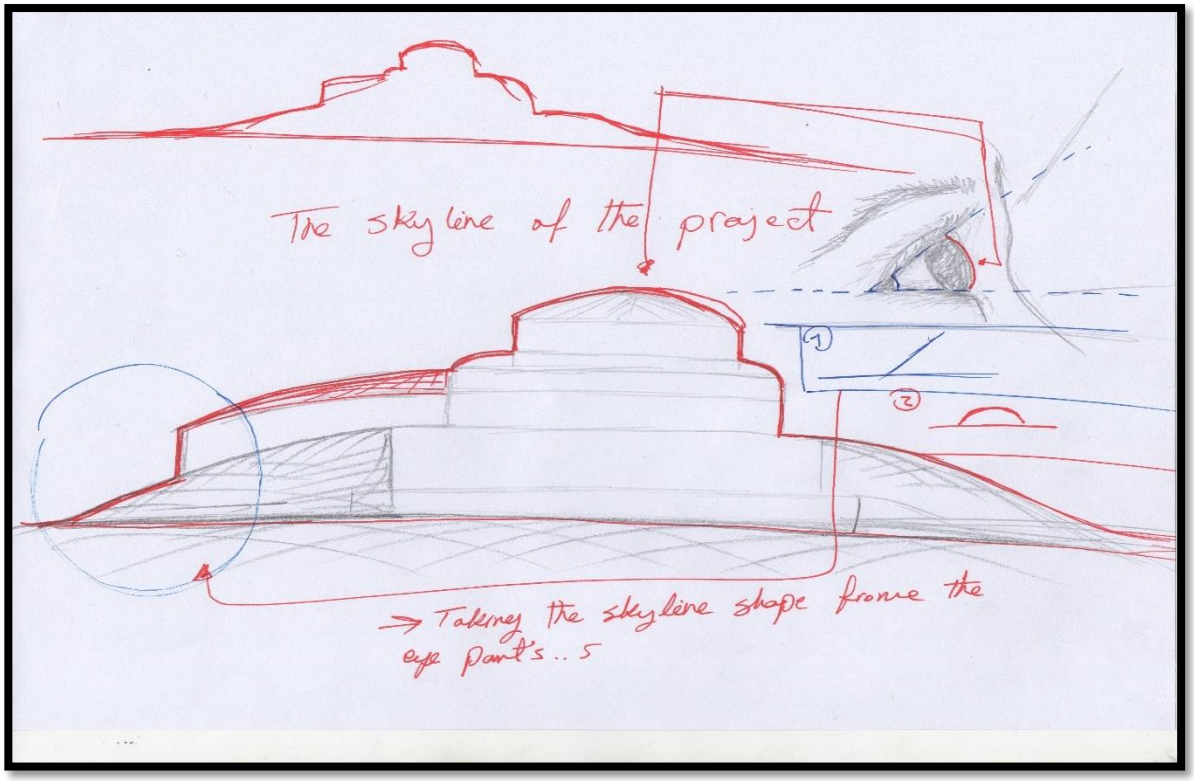
III.4 Conclusion:

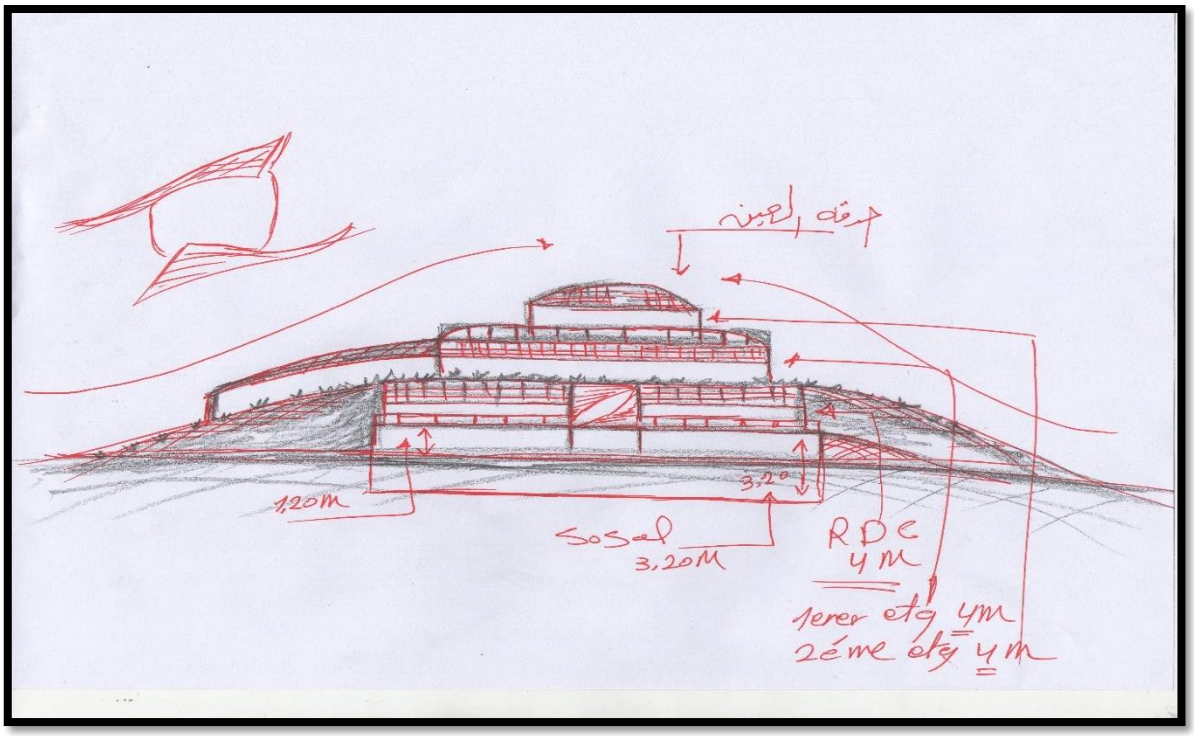
Results of ground location site analysis:

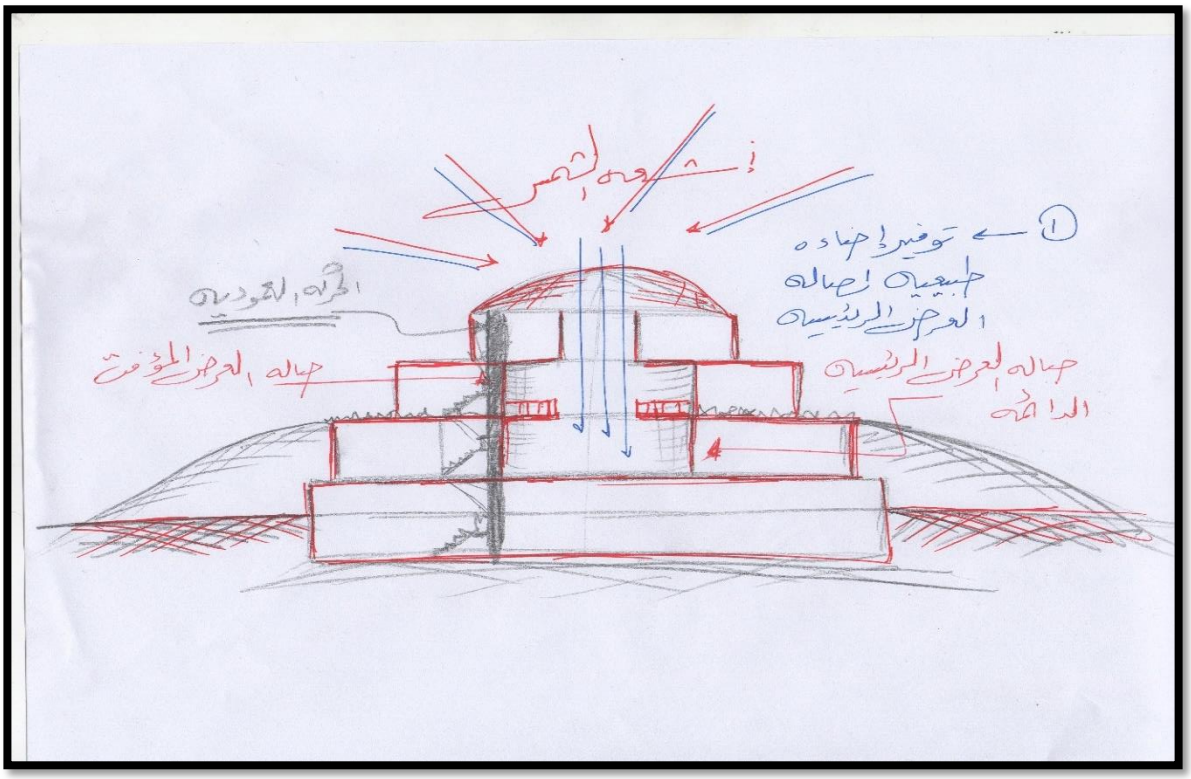
- Through the location of land and the availability of local materials for construction, thus helps to provide materials at a low cost.
- The location of the ground is very good for the establishment of a museum project and therefore to provide good connectivity, and where the nearby fields are tourist, cultural, national and green areas.
- Through climate analysis, Sanaa is a cold city, so we need to use one architectural block to preserve the temperature. The project should be well open outside to provide natural lighting and to benefit from the heat of the sun.

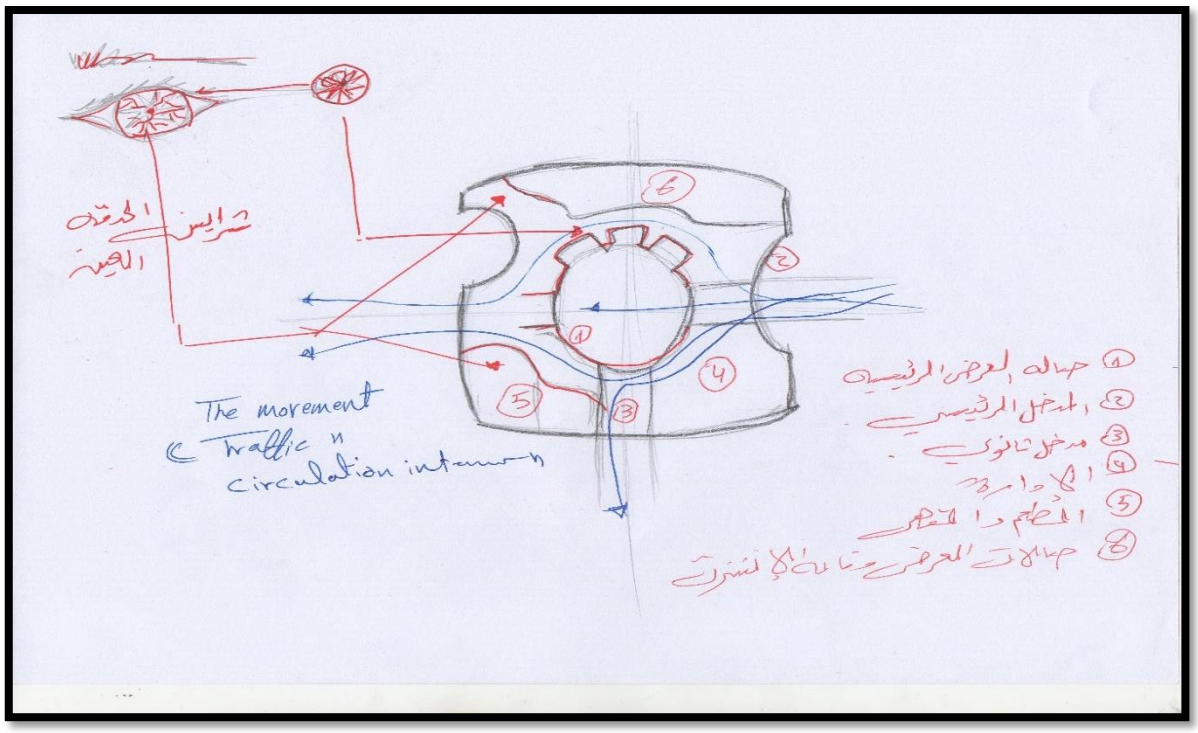
IV. project idea:






1,20M
3,20M
Sosol
3,20M
RDC
4M
1erer etg 4m
2éme etg 4m

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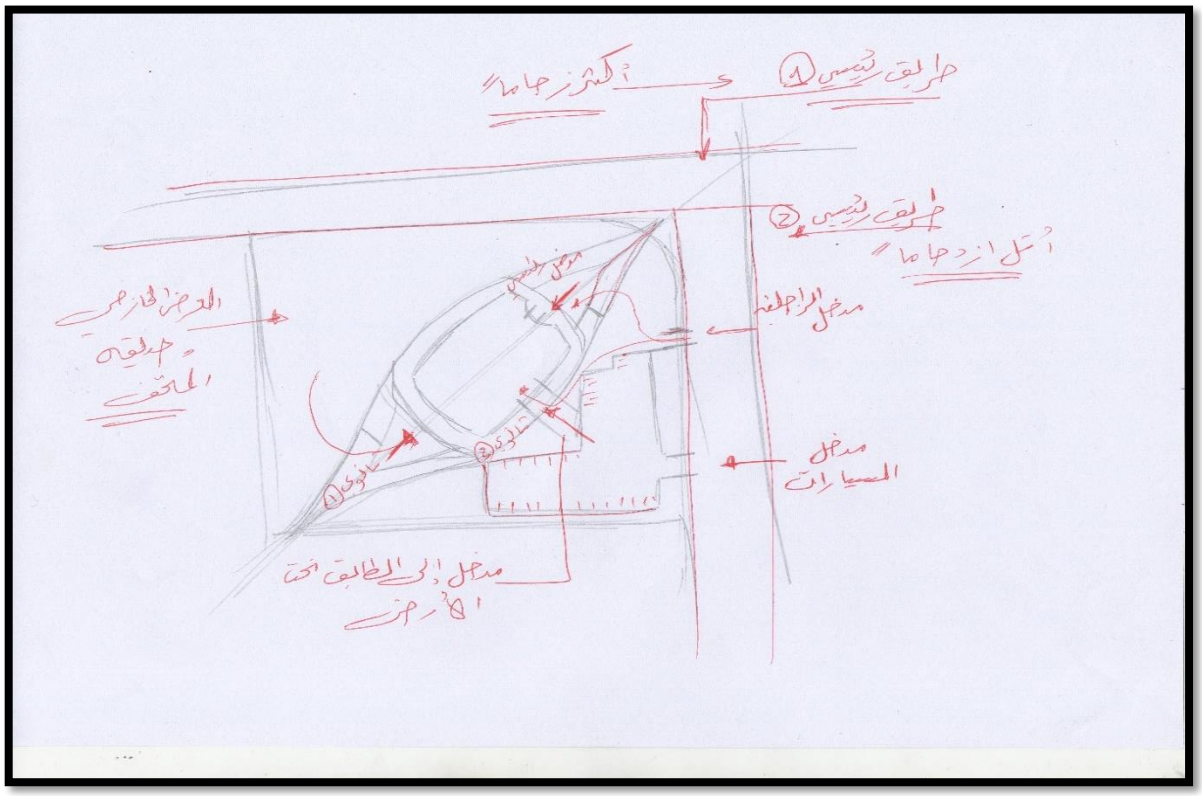

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