AHMED ALAA MOHAMED MOHAMED EZTLOU SUSTAINABLE EARTH ARCHITECTURE: HASSAN FATHY AS EARTH ARCHITECT NEU 2020

SUSTAINABLE EARTH ARCHITECTURE: HASSAN FATHY AS EARTH ARCHITECT

A THESIS SUBMITTED TO THE GRADUATE SCHOOL OF APPLIED SCIENCES OF NEAR EAST UNIVERSITY

BY
AHMED ALAA MOHAMED ABOUELFETOUH MOHAMED EZTLOU

In Partial Fulfillment of the Requirements for the Degree of Master of Science in Architecture

NICOSIA, 2020

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Approval of Director of School of Applied Sciences

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We certify this thesis is satisfactory for award of the degree of Masters of Science in Architecture

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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ACKNOWLEDGEMENTS

I would like to thank my supervisor Assist. Prof. Dr. Çiğdem Çağnan for her assistance. I would also like to dedicate this thesis to my family and my wife for all their encouragement and support.

To my parents…

ABSTRACT

The building materials are an important factor in building the architectural structure. This is one of the main effects that continuously affect the construction of the architectural form and the responsibility of forming the internal spaces. The earth materials are the oldest materials used by man and its development through many different techniques of construction, commensurate with their potential, and in accordance with environmental conditions. This thesis aims to analyze earth material construction techniques in general.

Many architects have developed earth building construction techniques like Hassan Fathy Laying the foundations for environmental construction with its surroundings and he clarified the idea of the earth as a sustainable material. The main aims of the thesis are to analyze earth-materials construction techniques, examining the history of construction with earth materials, and introduce Hassan Fathy and his concepts as earth architect, and making proposals to facilitate the use of the building with ground materials and select areas that are best used for building with earth materials. As the concluding remarks, the study proposes that building with earth materials is important to preserve the environment. Also, it can be achieved through sufficient awareness of its importance.

The qualitative method was used to discuss how to preserve and develop the construction of the earth materials, and Hassan Fathy used the earth materials in the construction and developed the construction methods, and compare projects to find the best in them. The literature review has been reviewed from books, magazines, and online articles.

Keywords: Earth material; sustainability; Hassan Fathy; environmental design; mudbrick

ÖZET

Yapı malzemeleri mimari yapının yapımında önemli bir faktördür. Bu, mimari formun yapımını ve iç mekanları oluşturma sorumluluğunu sürekli olarak etkileyen ana etkilerden biridir. Toprak malzemeleri, insan tarafından kullanılan en eski malzemelerdir ve inşaat birçok farklı teknikleri ile geliştirilmesi, potansiyelleri ile orantılı, ve çevre koşullarına uygun. Bu tez, genel olarak toprak malzemesi yapım tekniklerini analiz etmeyi amaçlamaktadır.

Birçok mimar, Hasan Fathy'nin çevreyle çevre inşasının temellerini atması gibi toprak yapı yapım tekniklerini geliştirmiş ve dünya fikrini sürdürülebilir bir malzeme olarak ortaya çıkarmuştur. Tezin temel amacı, toprak malzemeleri ile inşaat tarihini incelemek, yer malzemeleri ile inşaat tarihini incelemek, Hasan Fathy ve toprak mimarı olarak kavramlarını tanıtmak, zemin malzemeleri ile yapının kullanımını kolaylaştırmak ve toprak malzemeleri ile yapı için en iyi kullanılan alanları ve seçilmiş alanları yapmaktır. Sonuç olarak, çalışma toprak malzemeleri ile bina önemli olduğunu öneriyor. Ayrıca, öneminin yeterli farkında lığı ile elde edilebilir.

Nitel yöntem, toprak malzemelerinin nasıl korunup geliştirilmeye başlandığını tartışmak için kullanıldı ve Hassan Fathy inşaatta toprak malzemelerini kullandı ve inşaat yöntemlerini geliştirdi ve projelerin en iyisini bulmak için karşılaştırma yaptı. Literatür incelemesi kitaplardan, dergilerden ve çevrimiçi makalelerden gözden geçirilmiştir.

Anahtar Kelimeler: Toprak malzemesi; sürdürülebilirlik; Hasan Fathy; çevresel tasarım; kerpiç

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LIST OF ABBREVIATIONS

AD:	After Christ
BC:	Before Christ
CM:	Centimeters
CO2:	Carbon Dioxide
M	Meter
SQ FT:	Square Foot
UNU:	United Nations University
USA:	United States of America
USC:	University of Southern California

CHAPTER 1
INTRODUCTION

1.1 Background of The Thesis

Earth materials are the first and most essential building materials used to fit the environment and have previously used around the world and are still being in several countries and are a significant building material in poor villages for easy access.

Diversity of earth-building techniques, the most recent developments, and the regularizing perspectives. The oldest human-made earth developments are known back to 10,000 BC. From that point forward, earth has stayed a well-known structure material since the beginning. With time, various strategies advanced, beginning from sundried adobe squares to cob developments, slammed earth walls, and compacted earth blocks. Today these methods are as yet being improved, and elective covers, explicitly adjusted admixtures, and surface medicines are being created. Although it was almost 33% of the total populace lives in an earth development, hardly any particular structure benchmarks.

From the site of the building when digging foundations or foundations. In industrialized countries, the reckless exploitation of resources and central capital associated with energy-intensive production is not only a waste of resources; it was also polluting the environment and increasing unemployment. In these countries, the earth is being revived as a building material. Increasingly, people demand that homes write energy-efficient, cost-effective buildings that focus on a healthy and balanced internal climate. It will recognize that mud, as a natural building material, is overpowering industrial building materials such as brick, concrete, and limestone-sandstone.

Earth has been promoted in many modern-day countries as a sustainable building material, with new techniques developed to improve the properties and performance of materials. In some of the least developed countries. Several architects have developed earth-based construction

techniques such as Hassan Fathy and laid down the crisis foundations for integrated construction with its surroundings, which was seen as the beginning of earth building

1.2 Problem Statement

Although most countries suffer from pollution and from the scope of the last to suffer from the ability to afford the costs of building housing, the contribution of local building materials such as building earth technologies of different costs of housing is negligible, while the Earth has become recognized as building materials.

After the recent expansion of the buildings, the effect on life and buildings in terms of construction and various building materials has significantly affected the selection of building materials that led to indoor pollution in buildings, and not to care for the preservation of the environment.

1.3 Aims & Objectives

This thesis aims to investigate the potential use of earth with modern technologies and sustainable applications of building materials, and possible means and appropriately encourage their use to provide sustainable and affordable housing. To make this goal, the following points are being discussed under this thesis:

1. To analyze earth-materials construction techniques in general.
2. To ascertain that earth materials as an entry point for the concept of sustainability.
3. To examine the history of construction with earth materials.
4. To introduce Hassan Fathy and his concepts as earth architect.
5. To achieve suggestions to ease the exploitation of the building with earth materials.
6. To find out which area of the world by the best means.

1.4 Significance of The Thesis

For the lack of research related to the construction of earth materials and the relationship of earth architects to the development and laying the foundations of the architecture with earth materials, that considered the best solutions to reduce pollution and preserve the culture of the surrounding place.

The thesis will provide an insightful overview of the construction with earth materials, and illustrate the percentages of the use of these materials in construction all over the world, and also clarify all the different methods of construction that have been used around the world, depending on their geographical location and the surrounding materials in which the climate factor influenced their composition, and that is the main reason for the multiplicity of construction methods.

Show timeline for history the construction with earth materials from BC until now, including all times and explain the examples of each era and the methods of construction used at that time. The thesis will concentrate on Hassan Fathy as earth architect, and also the factors that affected his thinking and philosophy.

1.5 Research Methodology

The study used a qualitative method to discuss the preservation and development of construction with earth materials, and Hassan Fathy as one of the pioneers of construction with earth materials. Lecture review is made from books, journals, and internet resources. A comparative analysis is made to measure the development of earth buildings and Hassan Fathy`s concepts and find the countries which are best in optimizing the use of the earth as a sustainable material.

1.6 Organization Chart

The chart below shows the structure of the entire thesis. In this chart, chapters as main subjects and related sub-subjects are given systematically. See Figure 1.1, which shows the structure of the thesis.

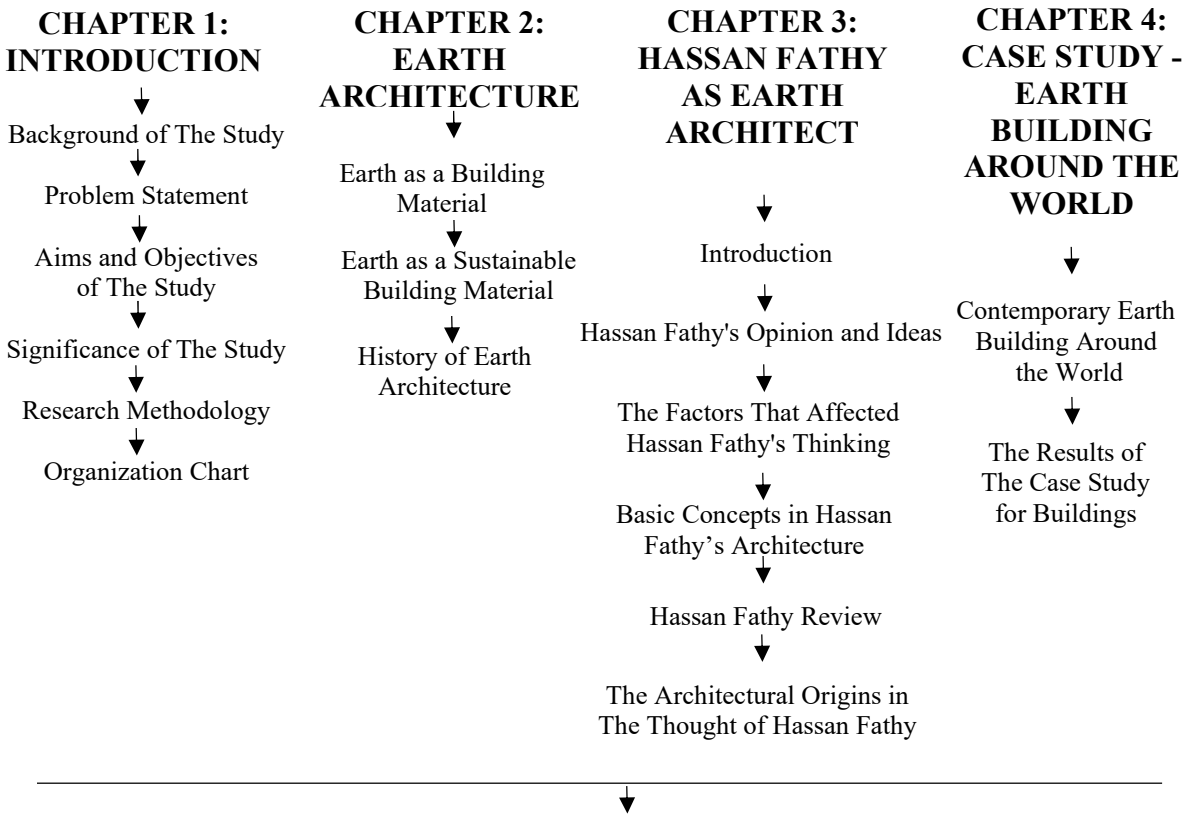


Figure 1.1: Thesis outline

CHAPTER 2
EARTH ARCHITECTURE

The practice of the earth building construction is prevalent in developing countries that lack advanced technologies and often labors and local material are needed, where an absence of latest innovations and regularly the accessibility of workers and nearby materials empower the utilization of these structure methods that are very simple (Cerqueira, 2018).

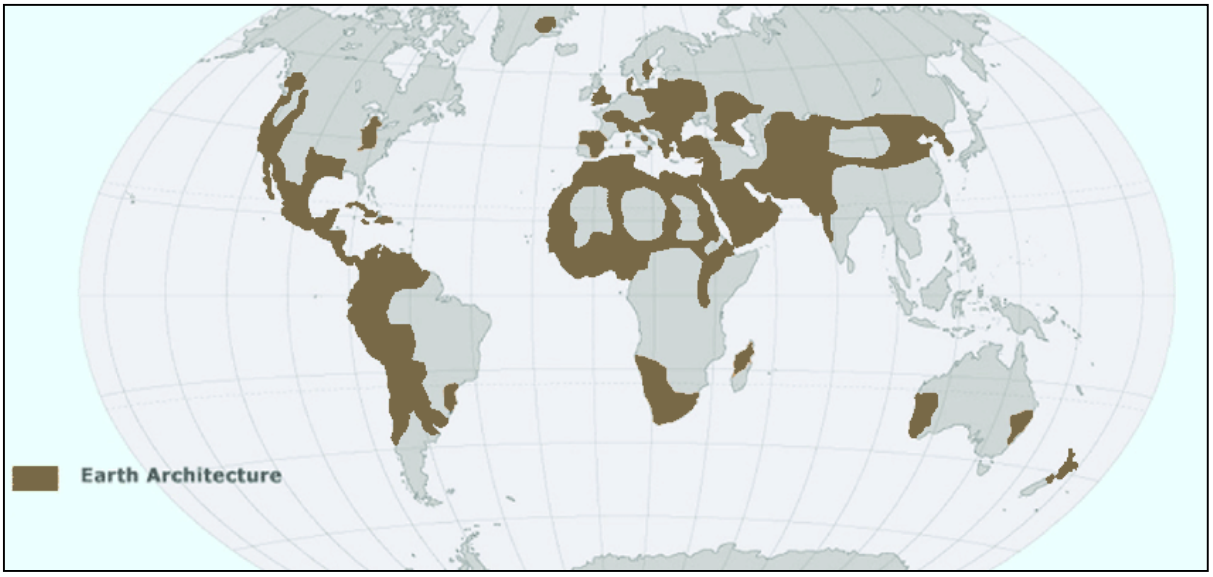


Figure 2.1: Earth construction zone

2.1 Earth as a Building Material

Earth building materials were used throughout all world for 10,000 years (Schroeder, 2007), it is appreciated 50% of global people today are living and working in earth building Earth is the most abundant of fundamental buildings materials It is without any technology carried out manually or with a simple tool and can be used by anyone to construct an excellent architectural design this building is highly durable with a reasonable regulation for sound organization and humidity in the building.

These buildings have low biological impression low epitomized vitality, and mainly if all materials are assets on structure site, earth originates from destroying the substratum dismantle

into mineral particles with different dimensions ranging from dust to clayey rocks. Rocks This mud is allotted to farming other layers at the top layer utilizing for the developments There is of various sorts for the earth as indicated by the amounts of the accompanying segments: clayey, earth gravelly, earth silty, and earth sandy as shown in Figure 2.2 (Ciancio and Gibbings, 2012).

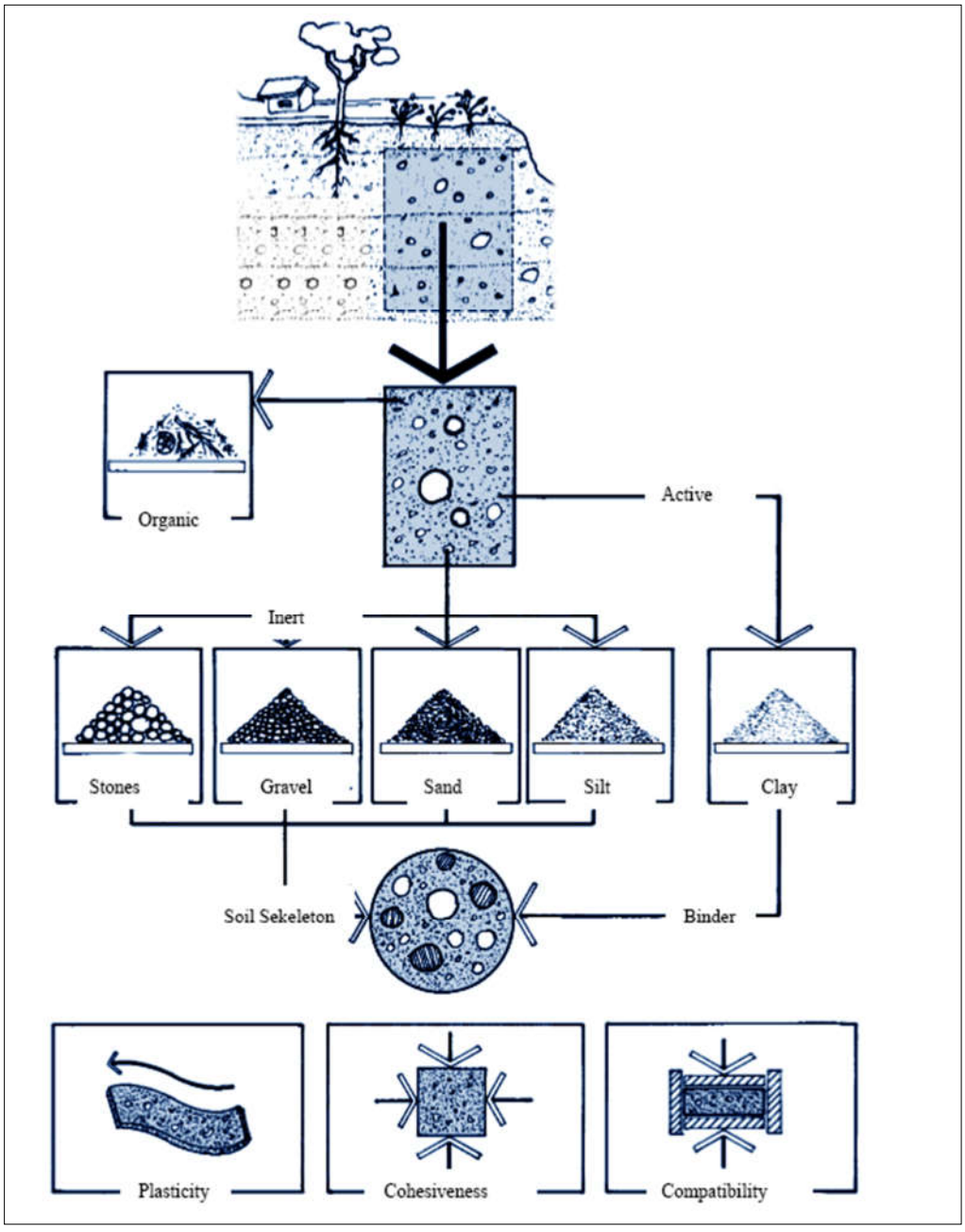


Figure 2.2: Earth types (Wilfred, 2003)

Earth building techniques as shown in Figure 2.3, and methods for earth construction varies according to resources, climate, and culture, but this is done within the framework of a sustainable movement, it has categorized as many of types: Cob buildings, adobe, rammed earth, wattle and daub buildings, light-straw buildings, earth-bags, and shaped earth buildings (Keefe, 2012).

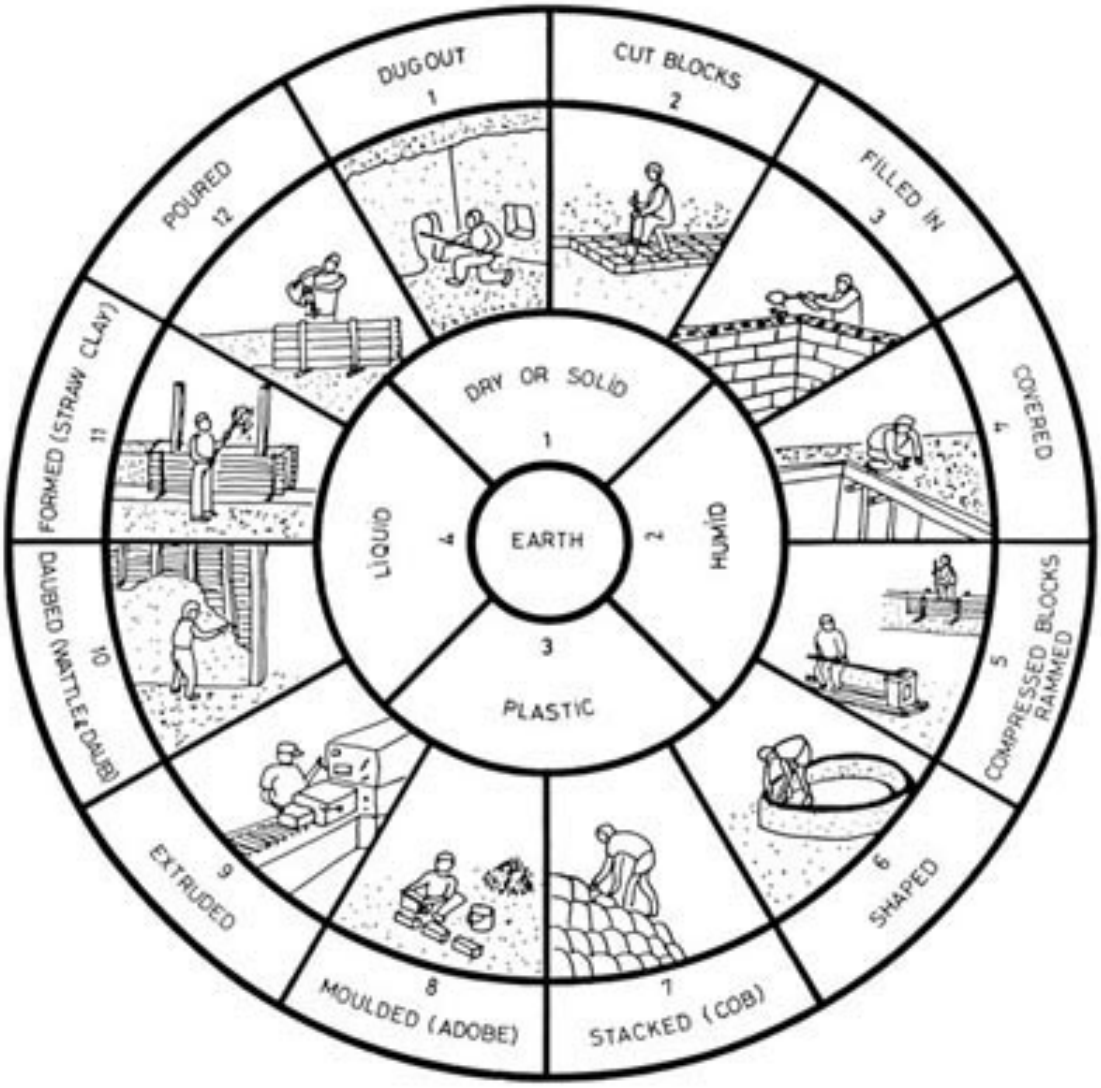


Figure 2.3: Main earth techniques (Asmamaw, 2008)

2.1.1 Cob building

Cobs are produced using clammy subsoil blended with straw and stand and worked in substantial mud portions that are then slammed hands together to shape a self-structure planned. Cobs are dries nearly as fast as concretes and could be utilized for self-sustainment, carrier walls. It has been worked 182.88 cm wide by working with all the layers, allowing everyone solidifies before including following the layers. The walls are then put on with the soil or the lime-mortar. However, humid atmospheres, a shade, or maybe asylum may be essential to ensure an incomplete divider. Working with cob is basic, modest, and requires few devices other than hands and creative minds; it can be tedious. However, there are numerous preferences to cob, including its extraordinary sturdiness, quality, imperviousness to fire, insulation properties, and the ease with which it can be aesthetically shaped and sculpted. This technique is using it until now (Hamard and Morel, 2016).

Example 1: Saudi Arabia – Masmak

Construction al-Masmak, as shown in Figure 2.4, two traditional methods for the structure were utilized: Utilizing layers of compacted earth materials in the external walls to give it quality and utilizing mud bricks to assemble quickly in the internal parts. The external walls were a heap bearing walls, yet the internal walls were a choice structure. The speculation structure was built by stone sections with wooden shafts (El-Rahman, 2012).

Figure 2.4: Saudi Arabia, Masmak (Abdulaziz, 2011)

Example 2: Southern Yemen – Shibam

Shibam, as shown in Figure 2.5, contains 500 multi-story houses nestled against each other in the middle of the valley of Wadi Hadramawt. The buildings are oven 100-200 years old, sometimes even as old as 400 years. These buildings are about 30m high, constructed by traditional earth martial using cob building technique by subsoil mixed with sand and straw (Lewcock, 1986).

Figure 2.5: Southern Yemen, Shibam (Meyer, 2004)

Example 3: Niger, Agadez – Minaret

Minaret, as shown in Figure 2.6, is the gateway of the desert in Agadez. It is 27m high made entirely by mud-brick, its known as the highest mud-brick structure in all the world. It was built in 1515 at the time when the city was captured by the Songhai Empire. The minaret was restored in 1844 (Van Damme and Houben, 2018).

Figure 2.6: Niger, Agadez – minaret (Lundberg, 2007)

2.1.2 Rammed earth

Rammed-earth is of the oldest earth technique of building, and it is very comparative to adobe technique; soil generally sandy mud. The material is compacted or packed into spots are the things that matter, generally with structures that make a level vertical surface. Earth is mixed totally with water to get a reasonable moist mix. This rammed-earth is filled structure in a small layer after that smashed to manufacture its thickness. Develop of thickness constructs compression quality and when water block. It usually was done carefully assembled.

The general custom of crushed earth advancement has shown that possible to achieve trustworthy and elevated structures from a single to multi-story (Miccoli and Fontana, 2014), as Morocco and China.

Example 1: Kasbah of Taourirt, Morocco

Kasbah Taourirt that shown in Figure 2.7 is located in the city of Ouarzazate at an elevation of 1,160 meters south of the High Atlas Mountains, multi-story houses nestled against each other, rammed-earth the building technique of this city was followed. Restoration of damaged walls and lost or collapsed parts of the buildings was carried out using primarily rammed earth and mud bricks (Boussalh and Won, 2016).

Figure 2.7: Kasbah of Taourirt in Morocco (Jaquin, 2008)

Example 2: Village of Hakkas clan, China

The village of Hakkas, as shown in Figure 2.8, is located in Clan city, and the construction technique was developed to use earth local materials. Tulou was a mixed structure of using rammed-earth, stone, and brick (Lowe, 2012).

Figure 2.8: China Fujian province – village/house of Hakkas clan (Leslie, 2019)

2.1.3 Daub and wattle

Daud and wattle are blended structure material utilized for making structures, particularly walls. It has areas of stick or bamboo shafts that fixed with nails and wires in an ornate wooden structure, which enables a better-finished assembly, as shown in Figure 2.9. Earth mix is applied to this assembly, and then finishes are applied to the wall surfaces.

The pre-assembled board is a wooden frame loaded up with entwined stick or bamboo secures embedded, so they are anchoring. There is both a cane and bamboo frame structure. This technique was used for 6,500 years; also, it is still the essential building materials (Halwatura, 2016) examples, that shown in Figure 2.10- 2.11.

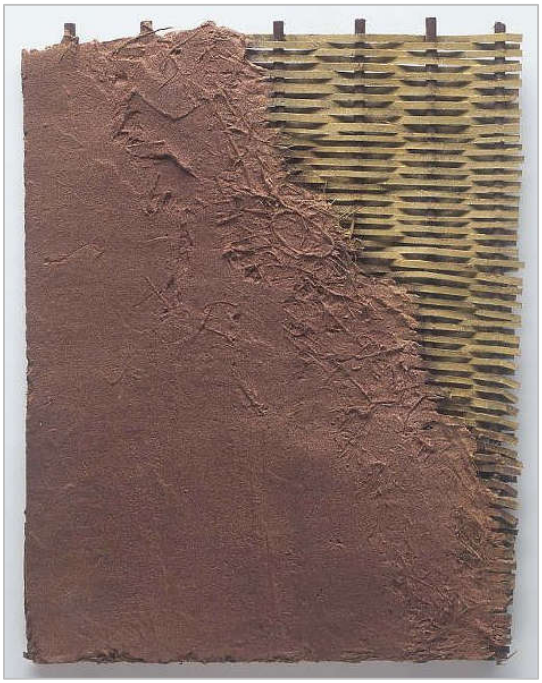


Figure 2.9: Both layers of wattle and daub earthen building (Hirsch, 2017)

Daub and wattle in building structure, course of making walls in which aplomb awkward stakes, or wattles, are woven with even twigs and branches, and then daubed with clay or mud. It is one of the first weatherproof that was built at that time.

Figure 2.10: A daub and wattle house used by Native Americans (Spiro, 2005)

Figure 2.11: France bersse saint triviers de court farmhouse (Ricochet, 2015)

2.1.4 Straw clay

It is a mixture of both rammed earth and cobs, also includes straw that swarmed by a hard clay slide in a wood frame. Straw clay is lighter than cob, and it is more high insulation value, be that as it may, is not reliable as the remaining and should just be utilized as an infill with the timber casing. Walls initially permitted to dry before putting happens; straw-clay has likewise been utilized between rafters as rooftop protection (Minke, 2012), for example, see Figure 2.12-Figure 2.13 and Figure 2.14.

Figure 2.12: Germany, Hessen, Gross German (Volhand, 2010)

Figure 2.13: Germany, Darmstadt (Volhand, 2010)

Figure 2.14: Darmstadt in Germany (Volhand, 2010)

2.1.5 Earth-bags

Earth-bags is soil-filled bags used to create walls and warehouse structures. This technology is being investigated, its improvement from the dugouts made by the military, however, appears to offer a brisk and straightforward strategy for healthy structure, and also may be especially suitable for the homeless (Stouter, 2008).

They are using wet soil to put into a plastic pack, stacked in spot on a wall, after that compacted utilizing a straightforward hand instrument. Earthbags are progressively being utilized as establishments for each of the straw and cob houses (Stouter, 2008).

The steps of preparing earthbags:

- USA, California, cal-earth – filling superadobe, as shown in Figure 2.15.
- USA, California, cal-earth – tamping the tubes, as shown in Figure 2.16.

Figure 2.15: USA, California, cal-earth – filling superadobe (Khalili, 2012)

Figure 2.16: USA, California, cal-earth – tamping the tubes (Khalili, 2012)

2.1.6 Shaped earth

Direct is forming utilizes plastic-earth and does not take shape or formwork. Plastic earth is formed. The nature in soil, it is planning, and the water cohesion is known uniquely for builders. This procedure introduces little freedom for utilizing negligible and straight forward apparatuses, and to utilize at least work which is essentially talented. This strategy permits liquid design with an unusual variety. The restriction of this procedure is mostly experienced in soil quality and control of degradation when the wall dry (Vyncke, 2018). Shaped earth is still using a lot in Africa, on the Sahel, just in tropical districts. Significant precedents could be found in Cameron, where formed the earth has utilized for homes and silos.

The regular stabilizer has been utilized generally on nations like Ghana, yet on adding in more nations around thereof the world. They are either utilized the juice of vegetal and plants seeds or different plants to get ready characteristic pastes which were added to the soil (Vyncke, 2018). Figure 2.17 - 2.20 shows the examples.

Figure 2.17: Nigeria, Joss – shaping a granary (Gert, 2012)

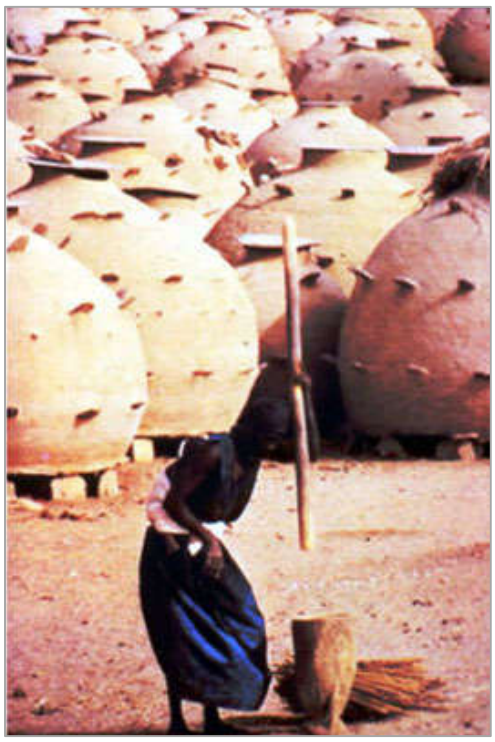


Figure 2.18: Cameron – granaries (Gert, 2014)

Figure 2.19: Togo – granary (Gert, 2014)

Figure 2.20: Burkina Faso, Tiébélé – granary (Aurelie, 2017)

2.1.7 Adobe

Adobe is sundried mud brick, is without a doubt, is the most traditional structure materials that humanity used: The most seasoned recognized adobe was created at least 9,000 BC in Dja De ElMughara in Syria. Adobe is making from thick, soft and pliant mud, frequently included with the straw. After thrown leave to dry under the sun. It is generally either handcrafted or parallel. This technique utilized everywhere worldwide since remembrance time, as could be seen in various emblematic representations and Egyptian sacrosanct works. The most prepared models' knowns were found on the site of Jericho, in Jordan Valley (Cerqueira, 2018).

It was a date from 8,000 BC, and they were hand formed. It has resembled a lengthened portion. Fingerprints of the skilled workers who did them are as yet unmistakable, and some have wooden blocks. The strategy has been utilized everywhere throughout the world since dedication times, as can be seen in different symbolic representations and ancient Egyptian sacred texts. The most old-example known was found on the site of Jericho, in the Jordan Valley, in Mesopotamia. Its date from 8,000 BC, and it was hand-formed. They resembled a stretched portion. Fingerprints of the skilled workers who did them are as yet noticeable on some of them (Cerqueira, 2018), examples as shown in Figure 2.21- 2.22.

Figure 2.21: Egypt, New Baris – market by Hassan Fathy (Bertini, 2008)

Figure 2.22: Egypt, New Gourna village by Hassan Fathy (Ryckaert, 2011)

2.2 Earth as a Sustainable Building Material

The utilization of locally accessible earth materials has a few focal points as far as manageability. They are:

- Diminish of vitality cost identified with the transportation.
- Diminish of material expenses because of decreased transportation costs.

- Supporting the local companies and sources bases.

These cares should take to guarantee that unsustainable earth material is not over-extricated. True parity inside that the locale must be kept up while effectively using its assets. Numerous nearby providers convey material that's been dispatched on from out of the zone. Both of bricks and stones materials are stylishly satisfying, tough, and very low maintained. The exterior wall, with a pleasant climate, eliminates the need for constant refining and leak proofness. The interior utilizing of blocks and stones can be likewise given extremely brilliant warm mass, or be utilized for giving warmth and radiation. Some of the stones and blocks make a perfect ground surface or outside clearing materials, cool in the mid-year, and having a decent warm property for uninvolved sun-powered warming (Morel, 2001).

The energy devoured if a transfer can be decreased by 85% when contrasting rammed earth with an ordinary concrete home. In another project in India (Venkatarama and Jagadish, 2003), the use of cement and soil to make unfired stonework squares brought about a 62% decrease in exemplified energy when contrasted and a fortified cement confined structure and 45% decrease when contrasted and mud-brick quality and strengthened solid-slab construction.
According to (USC, 2007) it has the following environmental advantages: Reduced CO2 emissions, thermal mass, noise reduction, high power, durability, low maintenance, fire resistance, plague resistance, food, rapid construction, eco-friendly.

Rammed earth walls are almost maintenance-free, low-income homeowners' insurance, a functional, energy-efficient living area, solar-powered designs, environmentally-friendly interiors, and outdoor infrastructure. It has rammed the land houses for 600 years. Earth is a natural, sturdy, durable, and healthy building material. It is also relatively inexpensive and retains heat, which means that it can help save on heating and cooling costs. It can be used in most cases, provided it is designed and designed to provide rain protection (Easton, 1996). It has been a very common construction material throughout the world. According to the crammed-earth, adobe, 2x6 tires, and straw bale, as shown in Table 2.1, shows the level advantages of each material.

Table 2.1: Earth materials properties (Easton, 1996)

	Commercial Status			**Implementation Issues**		
	Technology	Suppliers	Cost	Financing	Acceptance	Regulatory
Bricks						
Stones						
Caliche						
Foundation						
Bricks						
Stones						
Caliche						
Floors						
Bricks						
Stones						
Caliche						
Walls						
Stone						
Brick						
Rammed-Earth						

Legend

- Satisfying results in limited conditions
- Satisfying results
- Satisfying results in most of the conditions
- Unsatisfying results

There is a range of sustainable structure materials that are the two friendly earth and wealthy meanwhile. Mud-brick development method is just a few of the options available for the earth amicable construction. Working with elective materials can be a difficult, remunerating

experience. Mudbrick, likewise alluded to by the Spanish name of adobe, which means mud or puddled earth, by and large, alludes to the procedure of structure with sun-dried mud obstructs in either burden-bearing or bearing not loaded development. Mudbricks are ending up progressively economically accessible in a scope of balanced out and non-settled bricks. Mudbrick has a few favorable circumstances over ordinary terminated earth or solid stonework. The advantages:

- Employment of natural sources.
- Minimum usage of manufactured products.
- Excellent properties for sound absorption.
- Very low in embodied energy.
- Suitable for a wide range of soil.
- Easy to manufacture and work.

2.3 History of Earth Architecture

Earth construction materials strategies have been known to structure 9,000 years. Mud bricks houses were since 8,000 been found in Russia (Pumpelly, 1908). The ammed earth was Found since 5,000 BC been found in the Assyrian Empire. Earth utilized as the structural material in every single old culture, for homes, however, for religious structures too. Vaults in Temple of King Ramses 2 at Gourna in Egypt from mud-brick for 3,200 years ago.

2.3.1 History of earth architecture in B.C

Egypt used soil before the making of mud-bricks were developed. Human has used earth material for building purpose for thousands of years. Mudbrick back to 7000 BC, which makes it one of the oldest building materials. Ancient Egyptian comprised of a blend of sand, sediment, and the clay that is taken from the Nile mud and blended with straw that went about as a reinforcing and restricting material. Clay brick, produced using mud, was utilized as the essential structural material for houses all through Egyptian history and was utilized close by stone in tombs and sanctuaries all things considered and locales. Development of walls and vaults in mud-brick was efficient and moderately, in fact, uncomplicated, and mud-brick design

gave an increasingly agreeable and progressively versatile living and workplace when contrasted with stone structures (Sameh, 2014).

- *On architecture and construction in B.C*

The barrel vault is one of the least complex types of vault types. It is made by an arrangement out of curves put next to each other. It is usually formed by the appearance of a single curve, usually circular, along a certain distance giving the half-cylinder shape of the overall design. It has been utilized generally by early arrange progress, for example, ancient Egypt. This development technique likely emerged out of need to utilize stonework in the material rather than the uncommon wood The more significant part of antiquated Egyptian artistry vaults were for all intents and purposes of this kind of vault The adobe stonework barrel vault in Old Egypt were developed of courses or flat or upstanding mud blocks tilted with a simple point to vertical side against the support walls as shown in Figure 2.23 (Kemp, 2000).

Figure 2.23: Mud-bricks laid tilted in Egypt (Beck,1987)

The tendency of bricks from vertical drove the majority of the heaviness of bricks to move the lower-courses which previously had been laid as opposed to acting downwards; subsequently, the heaviness of each new brick was borne by those officially laid.

The brick was held in its position and adhered to the brick of the lower course by mud mortar. The barrel vaults were raised generally without brief assistance or centering for a reason as of late referenced, particularly by virtue of vault in inward rooms or cellar which were supported on the walls of the rooms or the storm cellar. On the off chance that there ought to emerge an event of greater vaults, for instance, 860 cm vaults of the magnificent stable in Madiinet Habu or because of a vault with a lower twist may have been worked over supporting bend the structure of verticals blocks or a short undesirable divider viably ousted after construction. (Choisy, 1904). To expand the creation of brick groups of brick producers went up against one another, Figure 2.24 shows the workers making the bricks in ancient Egypt (1550-1292 BC).

Figure 2.24: Stages of building with mudbrick in ancient Egypt 1.500 BC (Schroeder, 2012)

Old Egyptians architects utilized in the development of the adobe barrel vaults brick with explicit shapes. To lessen the heaviness of the vault, the brick was slenderer than the standard brick. Likewise, straw was added for weight diminishing and to give some rigidity to the bricks and along these lines limiting splitting. Brick was given the wedged-shape to be increasingly suitable to the vault development. Explicit brick was made with one curved side, as indicated in Figure 2.25. To guarantee the bricks mortar bond, the bricks were made with depressions organized in parallel lines, as shown in Figure 2.26. The furrows were made by the laborer's fingers during the assembling process. The utilization of such brick began as right on time as the old kingdom time frame (Zidan and Yassin, 2016).

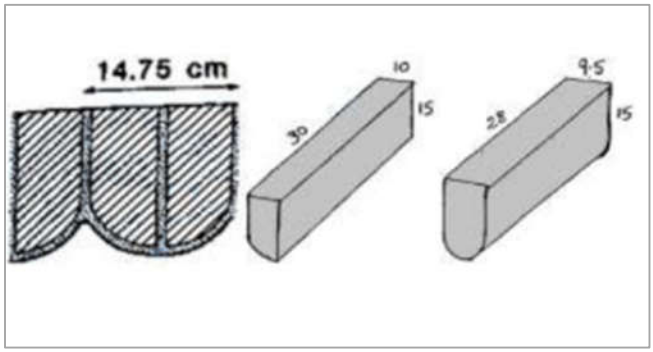


Figure 2.25: Mudbrick with a curved side made for vault construction (Spencer, 1979)

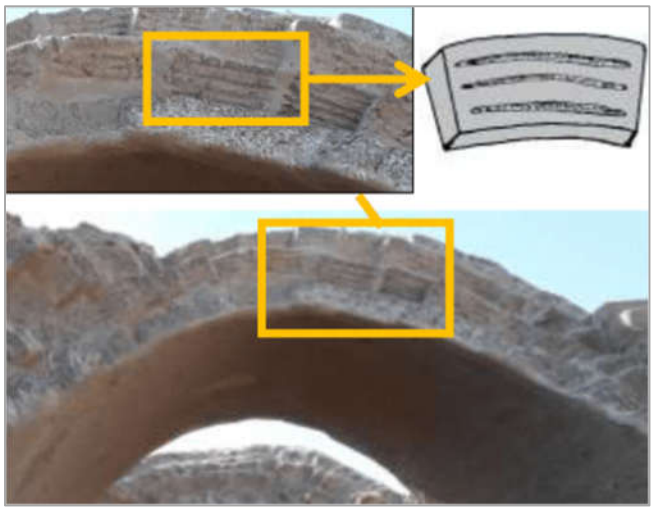


Figure 2.26: Mudbrick made with the groove to guarantee the brick-mortar (Spencer, 1979)

2.3.2 History of earth architecture in A.D

Tabo Monastery as shown in Figure 2.27, known as the most seasoned consistently working Tibetan Buddhist cloister, the art of which magnificently communicates the power of the transmission of Buddhism from India to Tibet and the dynamic blending of societies was established in 996 AD.

Figure 2.27: Tabo village, Spiti valley, India (Manish, 2015)

- *On architecture and construction*

Tabo monastery was built a fort with strong walls. The wall of this structure is 3 feet (0.91 m) in thickness, and it is the purpose behind its survival throughout the time of plunders and frequent disasters. The high mud block divider which encases around 6,300 square meters (68,000 sq ft). Notwithstanding the sanctuaries, window ornaments, and the monk's residence, there is an extension that houses nun's residence (Luczanits, 2010) shown in Figure 2.28.

Figure 2.28: Tabo Gompa residence (John, 2004)

2.3.3 History of earth architecture in the early modern period

Shibam Haḍramawt, as shown in Figure 2.29, lies in the middle of Wadi Hadramawt valley eastern Yemen. Bulwarks encase a trapezoidal formed zone somewhere in the range of 380 meters from east to west, and the tall exteriors of contiguous houses rise 20 to 25 meters high. Inside the walls, one finds a one-off the unique concentration of 500 tall mud buildings that house around 8,000 occupants; it has been in presence for around 600 years (Mehta, 2009).

Figure 2.29: Shibam Hadramawt (George, 2012)

- *On architecture and construction*

Residences of Shibam as shown in Figure 2.30, are made out of mud brick, and about 500 tower mud-bricks, which is the rise 5 to 11 stories high, with every floor have a couple of rooms. This design style was utilized to shield inhabitants from Bedouin assaults. While Shibam has been in presence for an expected 1,700 years, the vast majority of the city's homes begin from the sixteenth century. Some, however, have been revamped on various occasions over the most recent couple of hundreds of years (Lewcock, 1986).

Figure 2.30: Shibam Haḍramawt (Sergej, 2011)

2.3.4 History of earth architecture in late modern period

Great Mud Mosque, Djenné see Figure 2.31, the Mosque is made of mud. It was built in 1907. However, the town's mud design goes back to in any event the fourteenth century. To make the structures, bricklayers pack mud and straw into bricks, enable them to dry in the sun, and stack them to frame walls. A layer of mud put on top gives a smooth surface and better stability (Bourgeois, 1987).

Figure 2.31: Mosque of Djenné in Mali (Geourdu, 2010)

- *On architecture and construction*

The walls of the Mosque of Djenné has made of mud-brick, clay was used as a plaster to give sleek to the building. The Wall size is 40 to 60 centimeters (Marchand, 2006).

The whole structure is built on “75 x 75” meter. A three-meter platform rises above the ground to secure the mosque from the annual flooding of the Bani River (Marchand, 2006). Half of the mosque is covered by a roof, and the other half is an open-air hall, as shown in Figure 2.32.

Figure 2.32: Bird’s eye view of the mosque (Yann, 2017)

2.3.5 Contemporary earth architecture

Nubian homes in Aswan, Egypt, mud bricks, are considered one of the most essential local materials used in construction to date. Figure 2.33 is showing that Nubian homes were compatible with the environment. It is not cost per-timescale achieving a cheap climate for the home, not only because of its environment-friendly technologies but also because of the compatibility of its designs (Graves, 2011).

Figure 2.33: Nubian home constructed of mud bricks (Almasry, 2018)

- *On architecture and construction*

The walls home has made of mud-brick; A Nubian homes method usually requires a back wall to install the blocks on it. The cage was built after the arch, so the courses were placed vertically. The cover, which is about 1-1.5 cm thick, was the clay soil of the Nile, the masses used were clogged, and the dried bricks of the sun. Inequality of opportunity has made it necessary to bend slightly from cycles, to increase cohesion by gravity (Dahmen, 2012).

CHAPTER 3
HASSAN FATHY AS EARTH ARCHITECT

3.1 Introduction

Hassan Fathy is an Egyptian architect and one of the essential architectural pioneers in the 20th century, having his thought and philosophy, which raised him to the level of leadership in the architectural world of construction. In the first half of the 20th century, the use of reinforced concrete for construction and structural construction was widespread, and architects around the world headed to the local building of Europe, making it the same building in Cyprus or Egypt". Under the blind tradition of architecture in Egypt, Fathy contradicted all these trends and immersed in the Egyptian environment and the depths of the Egyptian man to come out with new thought and new labels such as "architecture of the poor" and "mud architecture," and his ideas became the nucleus of what was then known as "environmental architecture." Nevertheless, Hassan Fathy's ideas did not come from scratch; they were the revival of ancient architectural concepts that had been applied in Egypt for thousands of years, in a more definite sense since ancient Egyptian civilization. The architecture of this great civilization grew from its surroundings, and the buildings, whether temples, houses or warehouses, succeeded in achieving full harmony with the environment and addressing climate problems, using architectural elements that are now essential for environmental architecture, such as the inner courtyard, wind-catchers, and others, the merger of Islamic civilization and ancient Egypt has brought mashrabiya into its works and is designed for distinctive buildings (Hamid, 2010).

3.2 Hassan Fathy Review

The complex circumstances of the colonial presence that arose from what was said to have been the acquisition of knowledge in Egypt had a strong formative effect on Hassan Fathy, the shape of his life, and his approach to his work. To assess the scope of that impact, there must be an overview of the colonial situation, on which he formulated his response. Although Egypt had a long history of foreign occupation, Napoleon's short attempt to claim France in 1798 and the

British colonial period that began almost 80 years later, was determining the experiences of Fathy and will now be described. Fathy was born in March 1900 near Tanta. in the delta region of Egypt, close to the Mediterranean coast. His father was a relatively well-off landowner; his mother was Turkish. After a private. Secondary education, he entered Cairo University as an Agricultural major in 1922. Switching to architecture after he found he had no aptitude for farming. The majority of his instructors were British, who followed an Ecole des Beaux-Arts curriculum based on classical principles and prototypes (Serageldin, 2007).

After he graduated in 1926. Fathy opened his practice in Cairo. His first project, for a private school in Talka. Completed in 1927, was typically Beaux-Arts in style, with classical columns, pediments, and details. Over the next ten years, he designed many private homes and offices in Cairo, gradually shifting away from his Beaux-Arts training toward a modernist language. The flat roofs, severe, angular forms, industrial materials, and lack of ornamentation typical to all of these projects indicate more than a passing familiarity with hangs then taking place in Europe and cohesively developed at the Bauhaus in Dessau, Germany. Fathy was known for his improved architecture, where he built buildings and houses that take into account the needs of the people in the first place, especially the poor. He believed that houses should be built from local materials according to local design and traditional methods and methods that are common to people, and using this method he could reduce the cost of these homes and, most importantly, respect the culture of the place, as well as traditional construction methods and local materials are more suited to the regional climate (Miles, 2006).

The walls of Fathy are thick to keep the heat as high as possible and surround an inner courtyard with windows wells in the ceilings and move it down into the building. These natural ways, Hassan Fathy, made the houses cool indoors in the summer and warm in the winter.

One of Hassan Fathy's most famous creations is the New Gourna near Luxor, Fathy Figure 3.1 is showing trained the people on the roads of mud building, and then the people themselves built new houses all of them of mud while maintaining the excellent and distinctive features of their former homes in the old Gourna (Miles, 2006).

Figure 3.1: New Gourna (Little, 2011)

Despite the death of the great architect, Hassan Fathy, his works inspired many architectures in the Middle East. Throughout the world, he offered ideas that fit local styles and local construction methods to meet today's needs (Britannica, 2008).

He was also suffering from the dominance of Western culture over the ideas of the architects of the period, and he was not even-handed over to some of his colleagues who imitate everything in Western culture. The importance of Fathy was due to his being the first person to be the underwriter of the Egyptian architects due to the achievements of the western architecture, Hassan Fathy, adding that he is an architect, he is an artist, poet, and the greatest preacher of the local architecture, his life to serving the architecture in the Islamic world, it was said that "Hassan Fathy, with a multiplicity of his acquaintances, approaches like him the greatness of the Renaissance, he is a sociologist, a psychologist, a technologist, an economist, and an artist whose examples are rare in the Third World (Pyla, 2007).

3.3 The Factors That Affected Hassan Fathy's Thinking

Among these factors, the factors that influenced Hassan Fathy's thinking and developed his distinctive character in the architecture are the following.

3.3.1 Cultural background and relevance to Hassan Fathy's architectural style

The work of Fathy was reflected in an overlap between the eastern and western data on the one hand and the contradiction between them. On the other hand, as Hassan Fathy respects the European traditions and, on the other hand, sought to recover many colonialists who threatened identity in Egypt. This is why Hassan Fathy's thinking began to flourish and crystallize by focusing on how to preserve the Egyptian identity trying to restore the remaining ideas to benefit from them, rejecting all the extraneous factors that would disrupt authentic local architecture, he was trying to save what he could save from the architectural heritage even though it was found and discarded, trying to restore confidence in the architectural heritage (Seamon, 1984).

Perhaps Fathy is considered an architectural messenger, whose mission is only to return the so-called original architecture that comes from needs and to meet the needs of the same spirit of the place and the same earth that we walk on and the wood that breathes the air through it, and we can also consider his architecture as an entrance and a good reason for the emergence of our contemporary architects such as Makiya, Al-Jarji, and Al-Wakil. Also, it was a race to eliminate the inferiority complex the achievements of Western architecture in an era when the Renaissance was linked to the advancement of the Ottomans in Europe (Seamon, 1984).

3.3.2 The beginning of his appearance as an architect

The first works of Hassan Fathy were the "Toussaint Abi Al-Jabal" residence in Giza countryside in 1940, which is a reinforced concrete, although it follows the architectural design of the traditional residence, in the late 1980s, he built the residence of the artist Hamed Said in the Marj countryside between 1945 and 1942. His work in this period focused on the design of houses and some public projects. After that, he took a new path in design which is more of a design level such as village and town design, an example of which is the design of the Gourna

village, after which he became famous and obtained many architectural prizes, perhaps this village was not built but was the beginning of the emergence of the leader of the thought of Hasan Fathy (El-Shorbagy, 2010).

3.3.3 Philosophy and thinking

As many may know, Fathy has devoted himself to the poor in developing countries like Egypt and Mexico, and he is one of the few architects who have called for improved rural housing. Fathy has sought to create an authentic environment with minimal cost and to do so to improve the economy and standard of living in remote rural areas. Also, Fathy used ancient methods and design materials and was familiar with the economic situation of the Egyptian countryside, in addition to his extensive knowledge of the design techniques used in his country, so he trained residents in building techniques to make the environment of their own hands and local materials surrounding them (Radwan, 2007).

Fathy has restored his role and right in the formation of his place, which is the house that represents a mirror of his residence, like architecture for him, is not as much a building rule as a platform for expressing the heritage values, part of the national conscience of a nation and an arena for resisting the permanent local personal waste by invading western models and random imported forms, as the house is the perfect place, culture, and paradise, it was the first cell of what we call the homeland, so there should have been a balance between housing construction and the community in which the nation coexists. It hated countless barriers because those who created them were themselves, who were radically at odds with them, the enemies of the poor, and also the architect of the poor (Seamon, 1984).

It is worth noting that, despite its association with the local heritage of construction, its call was closer to universality, because it responds to the Third World's diseases beyond the borders of the Egyptian, Arab and Islamic world to the concerns of our sad planet if we ask a question, what if Hassan Fathy was put under other circumstances in a rural environment, he was not born, suffered from a lack of physical identity, did not live under the so-called colonization, and

did not suffer or have not been affected by the background of his father, could Fathy emerge without these conditions?

Of course, the answer will be the exile, Hassan Fathy, a man with two kinds of customs and traditions, half Turkish and half Egyptian, not the ordinary Egyptian, but the rural type "Sadi" may be one of the most important things that his architectural character has created, which is characterized by direct interference between the West and the East, and this has undoubtedly reflected on his thinking, he has suffered a lot from colonization, as colonization only leaves destruction and crops for people's movements and their choices, and converting their individuals into workers and architecture as a vital part of this country was from the occupation not only in Egypt but in all colonized countries starting with India and ending with South Africa. They are not the only ones, as professional colleagues were architects with the same thinking, and this is one of the reasons for their disagreement with him. Fathy has tried in one way or another to convince people that they are better suited to their environment to build than others, and they know their affairs (Fathy, 1986).

3.4 The Architectural Origins in The Thought of Hassan Fathy

The architecture of Fathy was linked to the environment in which it was located as well as to the economic side and has revived many architectural elements that were used in the ancient Egyptian architecture also in the Islamic architecture, and its list is for use in its architecture. The most important of these are the following see Figure 3.2.

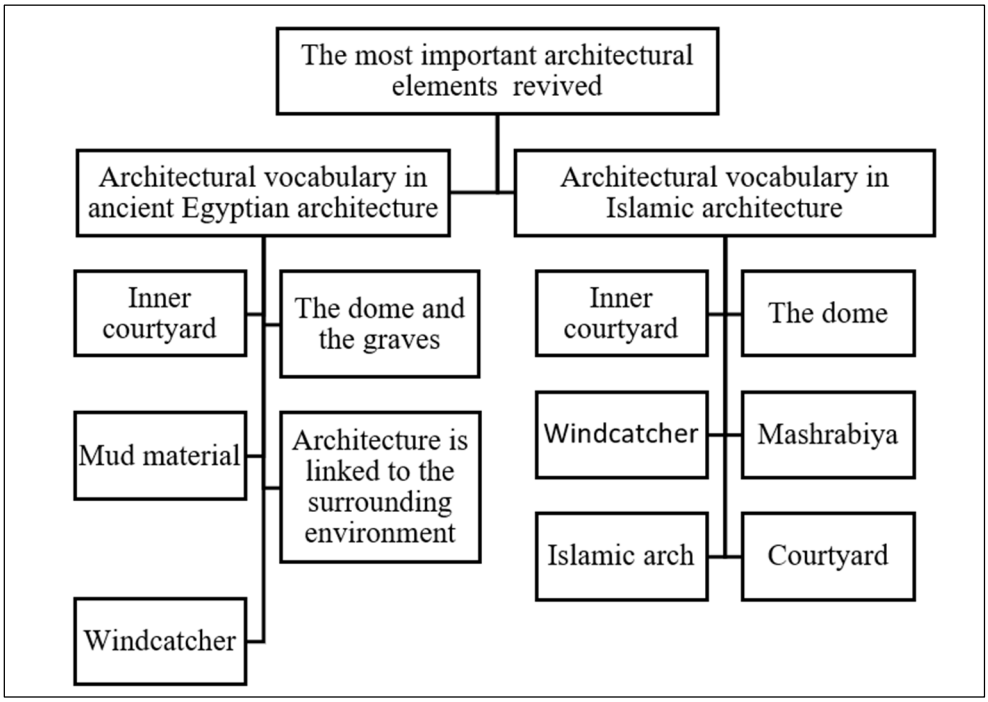


Figure 3.2: The most important architectural elements revived

3.4.1 Ancient Egyptian architecture vocabulary used by Hassan Fathy

Hassan Fathy used Ancient Egyptian architecture vocabularies Such as mulqaf, domes, windcatcher, mud brick, and architecture is linked to the surrounding environment

3.4.1.1 Inner courtyard and mulqaf.

Examples of this include the Nebamun House in1340 A.D, which sits in the middle of an inner courtyard with a double-decked air roof. Pick-up is a wide walkway rising from the rest of the house, placed on the head of the northern end of the hall, leaving the north and west sides of the tongs open in the upper part of the cool breeze from the north-west, then pushing it to the lowest seating area, in this house, there are two of the Mulqaf, each turns his back to the other, the first faces the wind direction, while the second is in the direction of the wind blowing to push the hot air out an example shown Figure 3.3 (Petrie, 2013).

Figure 3.3: Malqaf of the pharaonic home of Neb-Amun 1340 A.D (UNU, 1986)

3.4.1.2 The dome and the graves

Fathy used two methods to form the dome in covering the architectural spaces, and used another way to cover complementary spaces, both of which are the oldest architectural elements, it was built from three civilizations: The Egyptian, the Hellenistic, and the Sasanian, and the grave is a building whose formation depends on two solid walls determined by the wall of the end, and the axis of the basement was parallel to the Nile - that is, the north-south. Graves in ancient Egyptian architecture has evolved as follows:

1. ***Prehistoric Egypt*:** The graves were used to cover the graves dug into the ground at a depth sufficient to be the length of the human being to appear from the basement a portion above the surface of the earth, the first primitive cellar was pointed out, which is a slender structure based on two walls of the hole as shown in (Finkenstaedt, 1980).

2. ***Third Dynasty of Egypt:*** The basement has a more fluid form, which is a set of repetitive half-oval arches, one of which tends to be at parallel levels with a defined slope (Roth, 1993).
3. ***Old Kingdom of Egypt*****:** Dome ceiling rose above the ground to become a free origin, to be a visible expression of his function, and the study finds that the coverage of the cellar was not crucial in ancient Egyptian architecture at this time other than the cemeteries architecture. Also, the construction was not the central element in the architectural formation, but rather the outer vaulted from that distinguishes and differentiates between the building of the living and between it, and there is much evidence that the domed ceilings were used throughout the ages, but their use in religious architecture remained limited. A high dome of up to four meters appeared in religious and mud-brick buildings, by building a wall at the end of the room higher than the two walls of the opposite room, then starting with rows of bricks anchored on the end of each side of the two walls, with bricks leaning toward the end of each side and so that the two walls of the cellar meet the two hundred at the top. See Figure 3.4 that showed how the Ancient in Egypt built used the domes (Roth, 1993).

Figure 3.4: Using the domes in ancient Egypt (Phouka, 2003)

3.4.1.3 Using of mud material

It has been used for thousands of years and in many parts of the world, it is entirely ecological and uses thousands of years and in many parts of the world.
The use of this material is due to the following:

- Available in abundance.
- It can be recycled.
- The implementation process does not consume energy.
- It is used for millennia in Chile and is therefore widely known to them.
- Easy to use.
- It has excellent thermal properties.

In the early Egyptian architecture, the building was used extensively, especially in residential buildings and temples in their primitive models, in the primitive forms of the ancient Egyptian residence, the residence was an oval or round-shaped hut built by a tangled fence covered with a layer of thatched mud mixed with straw. It was then developed by ancient Egyptians who built their mud bricks.

3.4.2 The terms of Islamic architecture used by Hassan Fathy

Fathy resorted to using Islamic architecture vocabulary such as the hall, the broken entrance, iwan, the most important of this is the inner courtyard, which connects the courtyard to the top of the residence, and also the use of wooden coverings. More than this is the clarity of the change in the sense of vacuum while moving between successive voids and at different levels. Also, Hassan Fathy benefited from the idea of "confusion" in the Islamic residence, which is a place to sit between two courtyards, one big and the other a small one, and thus works on the air between them, where there is confusion - and what the archeologists know - and a seat for men for non-important interviews, and has no location linked to a specific direction in the house and overlooking the hall (Hamid, 2010).

3.4.2.1 Islamic arches

It is also known that the arches are used in Islamic architecture, especially in mosque architecture, where the carrying columns that end with different arches are used to be the carrier of the plaster roof tiles in the building, its domes and its dates. Figure 3.5 below is showing Islamic arches used in Islamic architecture. There are many types of arches used in Islamic architecture, such as the ring contract, the pointed contract, and the three-dimensional plaster contract, which is why in the days of the Islamic caliphate, architecture was not as advanced as these days in ratios, structural engineering. The design of the contracts carried by the mayor was either natural stone or marble to resist the force of the ceiling and to bear it, as well as to give it a more beautiful form (Fathy, 2000).

Figure 3.5: Blue mosque in Istanbul, Turkey (Saengchai, 2012)

3.4.2.2 Domes in Islamic architecture

The dome in Islamic architecture has a particular view, as it was not an environmental, climatic or structural solution only, it symbolizes the sky, where it was a picture of what Arabs in the

desert see and the sky expand and manage it above it, and the shapes of the domes and its embankments varied, and it was in the shape of half the ball, oval, optical, pyramid and polygon (Zenho, 2006).

In the analysis of Hasan Fathy's dome in Islamic architecture, he noted that the surface of the spherical dome appears from outside to slow down, so the Muslim architecture was interested in equalizing this influence in several ways, including making the outer dome curve as a convex contract with the dome's crust recede slightly from the bottom, making it as if it would be separated from the earth and fly into the sky. Fathy said, "The Muslim architect has increased the influence of the lightness and the rise of the dome to the top because its outer surface is carved with plant motifs since the plant symbolizes the rise. On the other hand, the dome reflects the most significant amount of sunlight as it provides a measure of humidity and shadows, which lightens the thermal loads inside. It also increases the height of the middle portion of the ceiling, which helps absorb the hot air rising, and the air movement increases the pointy (Zenho, 2006).

3.4.2.3 Mashrabiya in Islamic architecture

Mashrabiya is a feature window of the building wall and plays the window role on the upper floors, seen from inside the house outside without seeing it thanks to the narrow openings of the Mashrabiya; it is made of small pieces of wood that are mixed and combined into frames that make it a small rectangular projected chamber or a corrugated, which is the dominant form in Cairo, in addition to the social and religious task of maintaining privacy. Mashrabiya has other functional roles to play, reducing the power of light entering the house directly or indirectly while allowing air to break through with a filter carrying dust, for example, Figure 3.6 (Mohamed, 2014).

Hassan Fathy say that the advantages of mashrabiya in Islamic architecture, he believes that the circulation of parts of mashrabiya alters the intensity of the contrast between the bright parts and the locked parts, this is not available in modern architectural elements that serve as a mashrabiya to block or break the sun, the closed parts appear in the mashrabiya and are surrounded by a lower light than the outside light. The holes appear in the small mashrabiya n

the lower parts to confirm privacy, and if they reduce the amount of light inside and replace them with the full holes in the upper parts (Ashour, 2018).

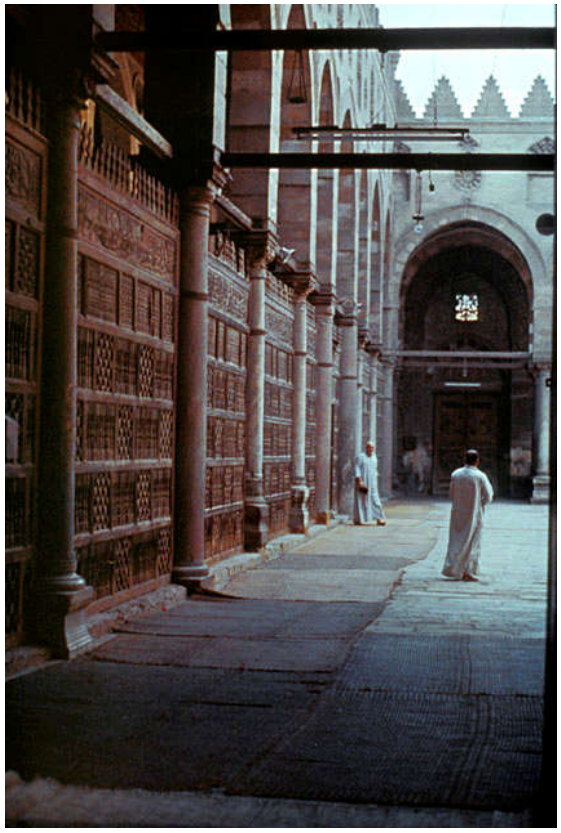


Figure 3.6: Wooden mashrabiya in masjid Altinbugha al-Maridani, Egypt (Williams, 1978)

3.5 Hassan Fathy's Opinion and Ideas

Fathy has had a social responsibility and devoted to the architect's life. He spent all his time building several luxurious villas for his wealthy clients in building houses and villages for the poor peasants. These were the clients he served, and his opinion is: The customer who was interested in him is emerging as a model among the 800 million people whom the statistics say are people in the Third World who are dying early because they live under conditions. This is the customer that the architect must service, but the architects do not pay attention to these poor people, such as, some doctors are barefoot in China, poor people also need barefoot architect (Fathy, 1986).

- Fathy's projects were mostly only mud-brick, it was profoundly beautiful, sculpted architecture, substantial ceilings, and elegant courtyards.
- The buildings have been given some vitality through glass or wooden windows that control the light entering courtyards and courtyards, as well as in schools, mosques, theaters, and markets.
- Although he studied architecture in Cairo in a Western-style, he could not give up his relationship with the whole past.

Fathy was not convinced of the existence of a uniform architectural model that could be used in all places; he proved that each place has its own culture that interferes with the design processes and also its awareness of the resources located in the constructivist site, which defines the building materials (Nemeth, 1979).

3.5.1 Remove the contradiction between originality and modern science

In addition to the fact that it is not possible to use modern science and its discoveries in the development of local architecture, the theory of soil mechanics, construction, materials resistance, and the nature of construction, including ventilation, light and thermal insulation on its buildings, Fathy has proved that the intellectual has no choice between the local self and science both complement each other. In his buildings, Fathy has incorporated time and space, so the element of time cannot be separated from the spaces of his buildings, having an integrated object. The inner space of the dwellings is designed with compassion, serenity, gentle containment of the human being, and deep compassion. Hassan Fathy lived to confirm his theories of construction, in which he called for applying Arab Islamic architectural styles (Khlosi, 1997).

Fathy's ideas were a departure from the old reconstruction system of the time. He has therefore faced many criticisms and frustrations, and those who read his book "Building the Poor" know that the failure of the New Gourna village is due to the ideas of the bureaucrats who refused to create the village in the style of Hassan Fathy and to fight his thought (El-Shorbagy, 2019).

3.6 Basic Concepts in Hassan Fathy's Architecture

The basic concepts related to Hassan Fathy's works which he implemented, which gave him distinction and uniqueness can be seen in Figure 3.7.

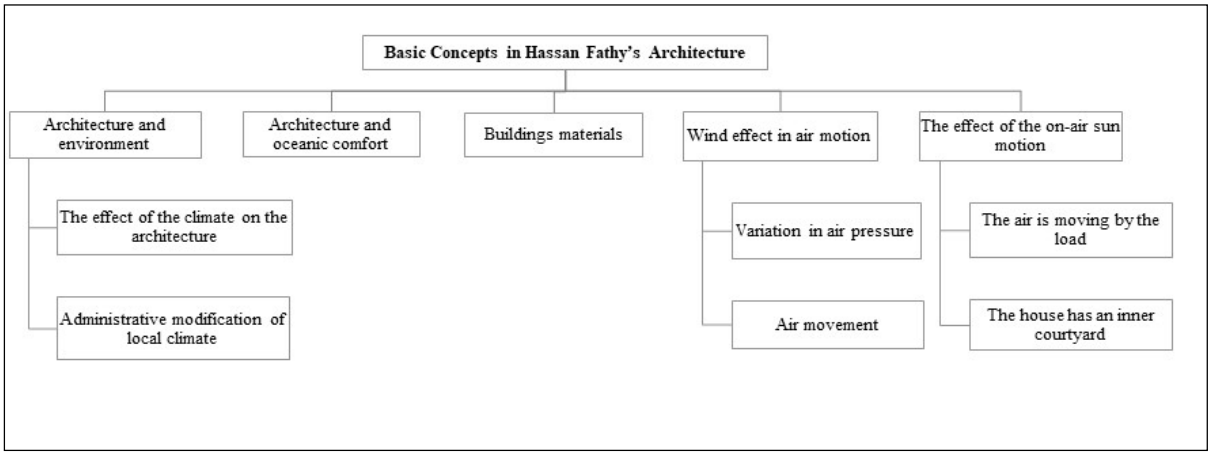


Figure 3.7: Basic concepts in Hassan Fathy's architecture

3.6.1 Architecture and environment

Hassan Fathy believed that the environment in which the building is located has a significant impact on the architectural and construction design of the building. The term "environment" is all around the site in that part of the earth, including the landscape, whether desert, valley, mountain, etc. It is also all that is found in the seven layers that cover the soil and affect life on its surface.

a. The effect of the climate on the architecture

The environment mainly affects the architectural form in a way that can be seen easily; for example, the ratio of window area to wall area decreases as we approach the equator. In hot regions, people avoid sun-rumbling and heat. In the tropical areas, changes in the architectural form are needed to solve problems that result from excessive heat more clearly, the example in Egypt and hot places shaping balconies and overhead casts a long shadow over the walls of the building.

b. Administrative modification of local climate

Changing the local environment is an essential objective of the construction process to create a comfortable and sustainable environment in which the local environment in each construction site is transformed as a result of the housing process itself into different and different regional climates, the weather next to a southern wall is very different from the local atmosphere next to a northern wall, and inside the building, each room has its climate, Before the advent of the industrial age, man relied on natural sources of energy and local resources available in his home country according to his physiological needs. Each organic material retains some of its original properties with its response to climate as long as its original structure has not been substantially destroyed or modified.

3.6.2 Architecture and oceanic comfort

In the design and planning of warm, dry and humid areas, the architecture faces two significant constraints: Free protection and adequate cooling, The Sun, the primary source of light and heat for Earth, forms elements of the secondary climate of wind and moisture that affect the physiological well-being of humans, the physical environment also changes in the local climate, as how buildings are distributed and oriented to the sun and the formation of buildings in the vacuum create a specific locational climate for each site, Besides, the effect of the building materials, their exterior appearance, the colors of the sun's exposed surfaces, the way streets are designed, exposed places and gardens are designed, and the interaction between human-made features on the earth's wave and the natural local climate results in those factors that affect human's comfort at home (Fathy, 1986).

3.6.3 Buildings materials

Fathy called for using the local building materials and called for reviving and developing the traditional construction methods as a technology that is dependent and compatible with the environment, all for economic, social, and cultural reasons. He focused in particular on mud bricks as a critical material for the reconstruction of rural Egyptian villages and the desert

villages, Fathy believed that the materials surrounding the building housing were significant for the protection of the free and cold and that much care should be taken in selecting the materials of the walls and ceilings and their thickness to match their physical properties of thermal conductivity and the property of the inversion of light, it is worth mentioning that the mud bricks bear the pressure efforts that are confined to the walls, but they do not bear the tension and bending efforts of the flat roof, which require the use of raw materials such as wood, new and reinforced concrete (Pyla, 2007).

The practical and technical solution to this obstacle was the work of the vaulted ceilings, which made the efforts to which the domes were subjected limited to pressure efforts, and thus the mud bricks were used in the ceiling as in the walls.

3.6.4 Wind effect in air motion

Hassan Fathy asserts that through the architecture design, the movement of natural air can be guaranteed by using one of these principles:

1. ***First principle:*** It depends on the variation in air pressure caused by differences in wind speeds, which causes air to flow from the high-pressure zone to the low-pressure zone.

2. ***Second principle:*** It depends on air movement because of the load caused by heating and getting higher than what is required by more effective solutions than in place, and this is a moderate-cold airflow in the area between the warm area and the mild air inlet opening of the bridge. Figure 3.8 shows the rate of airflow in buildings is determined by the load as the difference between the curvature of the different holes.

The higher the difference between the responder, the greater the airflow, when the outside air is quiet with the need to ventilate the inside to provide the comfort needed, it becomes significant.

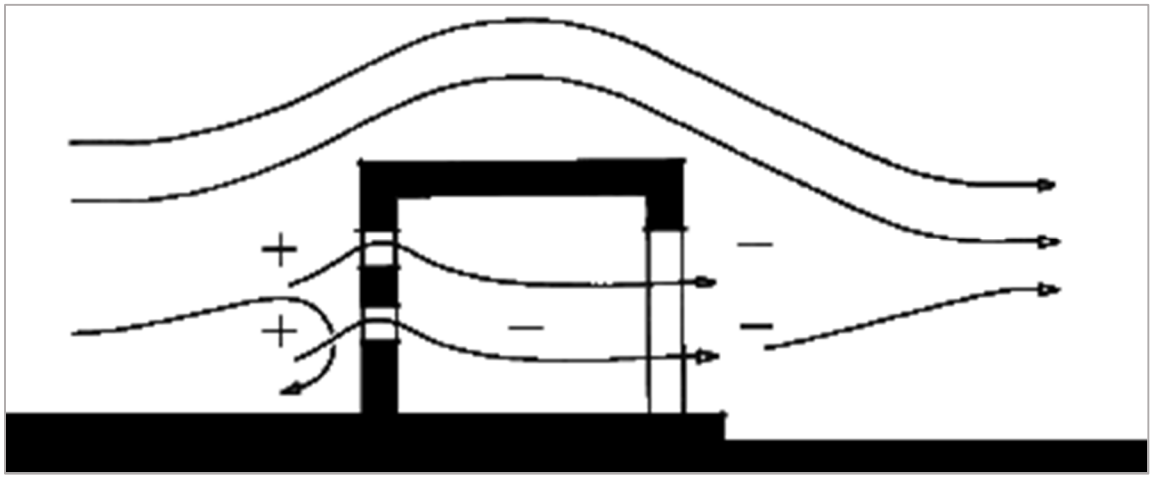


Figure 3.8: Diagram of the dynamics of airflow and the change in pressure (UNU, 1986)

To improve the efficiency of the natural ventilation system, Hassan Fathy used the following:

a. Claustrum is often better to use small ventilation holes instead of the large, few openings to provide privacy and security, regular airflow distribution, direct sunlight blocking, and a beautiful view, as shown in Figure 3.9. However, large openings for lighting and ventilation can be made in some regions of the building and covered with interlaced construction (Hui, 2005).

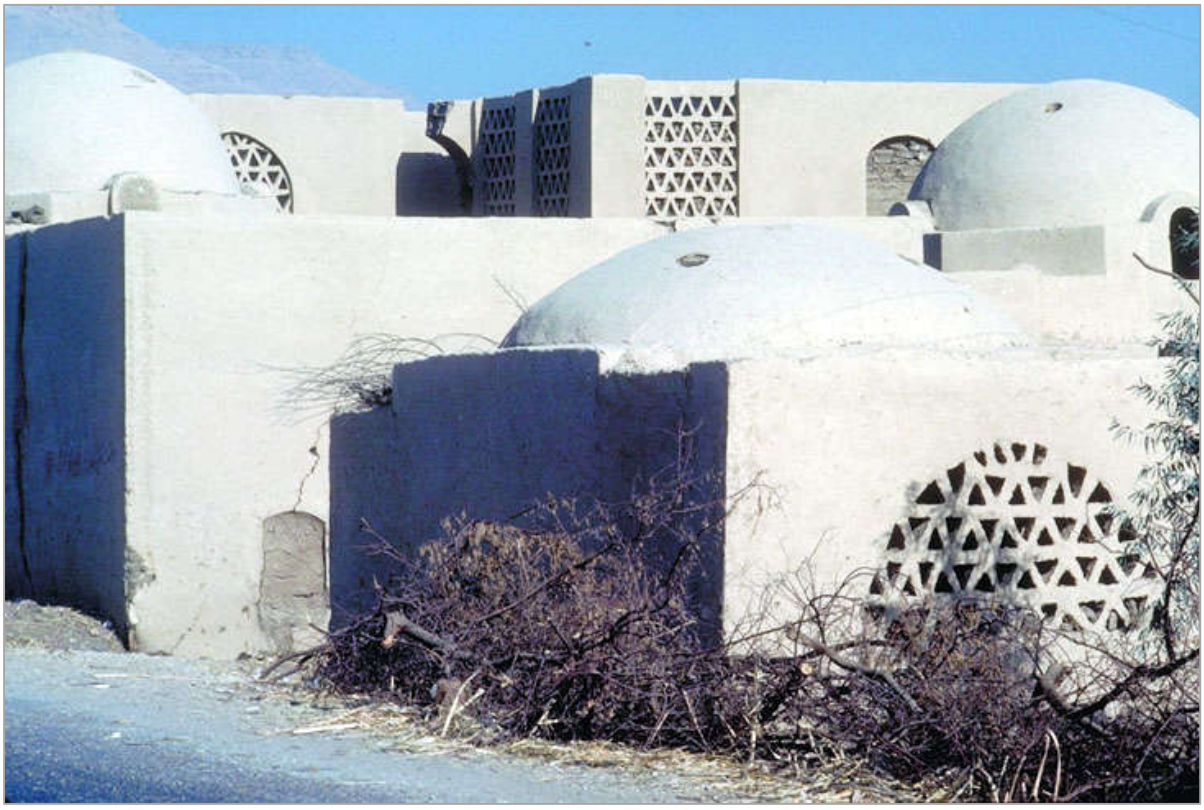


Figure 3.9: Claustrum that was used in theatre in New Gourna (Avedissian, 2011)

b. Mulqaf used in the hot, dry areas, the window has difficulty performing the following functions: Ventilation, lighting. For the window to operate the ventilation function, it should be small in size, in which case light is not sufficient. If the windows are large, they allow hot airflow from outside, which will cause inconvenience and inconvenience. To ventilate, Mulqaf 's idea, used in ancient Egyptian architecture, is a shaft above the building and has an opening against the direction of the wind movement, which is usually cold air and then draws and pushes it into the house, also reducing the entry of dust that is outside as shown in Figure 3.10.

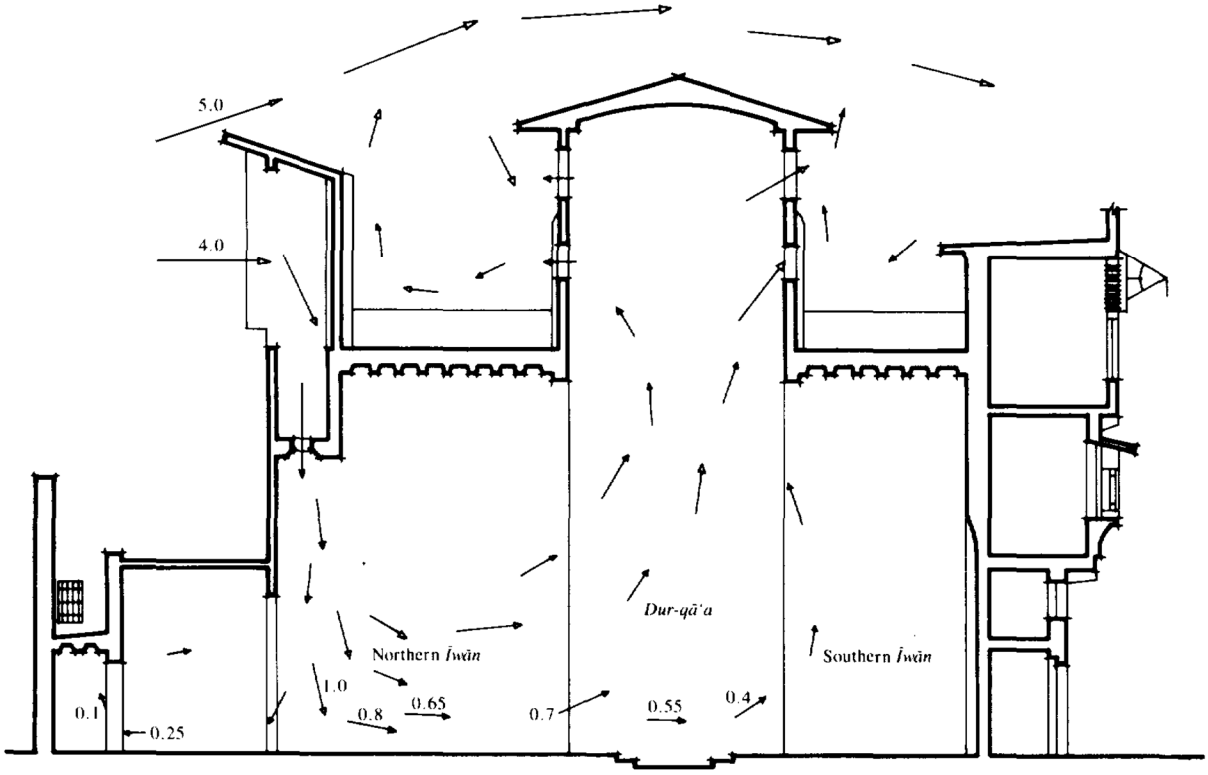


Figure 3.10: Section showing how mulqaf produce internal air movement (Fathy, 1986)

3.6.5 The effect of the on-air sun motion

Fathy studied the effect of the Sun on-air motion, as the sun, which is the primary source of light and heat, creates elements of the secondary climate of wind and moisture that affect the well-being of the physicist (Sun and Zhang, 2007).

The interaction that occurs between this massive source of energy and its effects. Among the natural features of the place, which created the Micro classic. The interaction between human-made features of the physical environment and the local environment reveals those factors that affect human comfort for the following factors of the physical environment: Light, heat, wind, and humidity, Fathy used both of:

1. ***The air is moving by the load:*** It is known that warm air is less dense than fresh if it is in an environment of fresh, moderate air, it rises higher and is called collection and may lead

to the so-called stack effect When warm air rises, it should be replaced by colder air, rising and using a continuous heat source, it generates a constant movement in the air (Maisels, 2001).

2. ***The house has an inner courtyard:*** The relatively static cooling system used in the yard of the house can provide a basis for understanding the modifications that can be made to the design to generate movement in the air due to the load. In dry, hot areas, the temperature falls much after sunset, and the air is free of water vapor. As the evening comes, the sunny inner courtyard, which is heated by the sun, begins to rise, gradually replaced by fresh air, minimalist-night air in the courtyard in layers, and then enters the surrounding rooms to cool it (Fathy, 1988).

CHAPTER 4
EARTH BUILDING AROUND THE WORLD

The clients of earth building materials on the world are living with the most reduced degrees of indoor pollution. However, each country differs from the other in terms of building materials and technology used in construction. The surrounding environment controls construction in terms of the shape. Also, some areas have developed construction in the earth materials, with the help of the earth architects.

Figure 4.1: Case studies buildings with earth materials

4.1 Earth Building Around The World

The different environment has differences in construction methods and materials. Figure 4.1 shows the chosen case studies from various countries just as Egypt, Iran, Turkey, Northern Cyprus, Uganda, and Cameroon. as shown in Table 4.1- 4.11.

Table 4.1: Balat village home in Egypt built with earth building materials

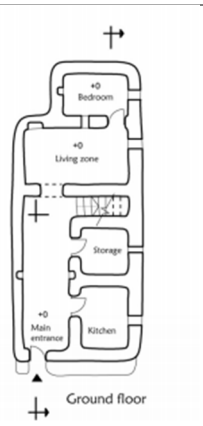
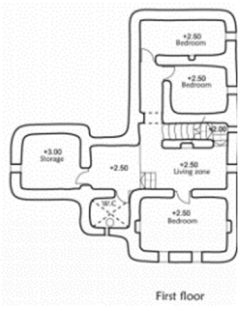
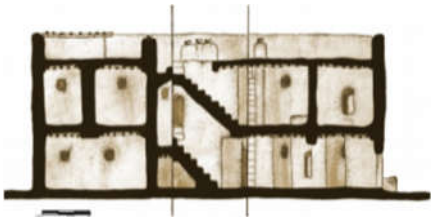
Balat Village Home in Egypt	Plans and Sections	Illustration
This home located in Balat village in Egypt. The building shows the maximum use of building materials on the ground. The project is also a project that rotates five degraded homes. 50% of these materials used in the building are old materials that have been reused to doors and windows. This includes palm wood, clay, stone, and other non-toxic products, renewable, reusable or recyclable.	 **Figure 4.2:** Ground floor (Dabaieh, 2011)  **Figure 4.3:** First floor (Dabaieh, 2011)  **Figure 4.4:** Section house (Dabaieh, 2011)	 **Figure 4.5:** Modelling house (Dabaieh, 2011)  **Figure 4.6:** Modelling house (Dabaieh, 2011)

Table 4.2: Refugee home in Iran built with earth building materials

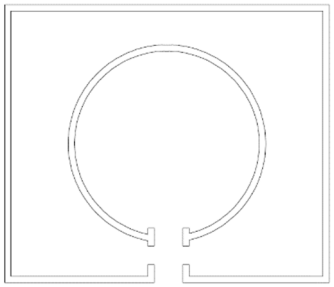
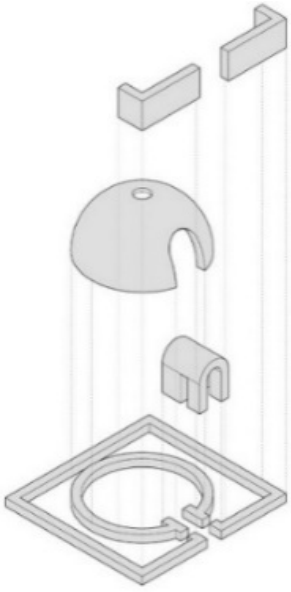
Refugee Homes in Iran	Plans and Sections	Illustration
Refugee homes Built in an Afghan Refugee Camp in Kerman, Iran, the 100-meter square meter domed shelter is comprised of approximately 6,000 mud bricks.	 **Figure 4.7:** Refugee home plan  **Figure 4.8:** Refugee home section (eartharchitecture.org)  **Figure 4.9:** Refugee home section (eartharchitecture.org)	 **Figure 4.10:** Refugee home (archnet.org)

Table 4.3: Mud huts in Uganda built with earth building materials

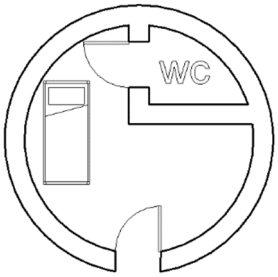
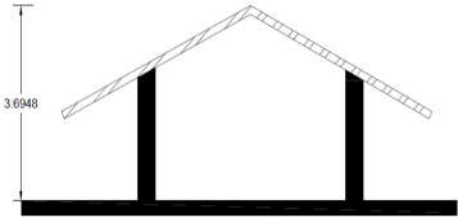
Mud Huts in Uganda	Plans and Sections	Illustration
Traditional dwellings musgum. Walls were made from mud brick; this brick made through the traditional process of the sun drying. This process includes three phases: mixing the mixture, putting it in a mold, and allowing it to be treated in the sun. Roof was made from thatch. The straw is the other crucial element of the structures. The straw overgrows and is readily available in Uganda, so it is used frequently.	 **Figure 4.11:** Mud huts plan  **Figure 4.12:** Mud huts section	 **Figure 4.13:** Mud huts in Uganda

Table 4.4: Hamid Said house in Egypt built with earth building materials

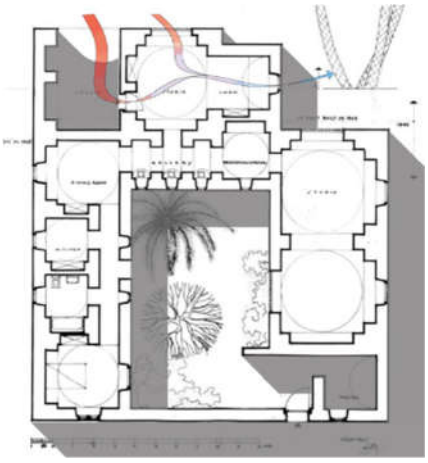
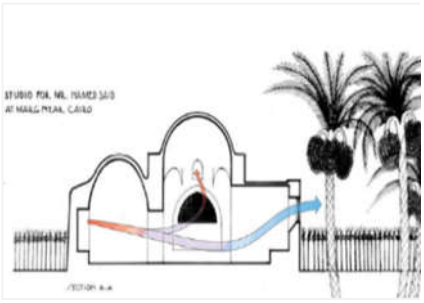
Hamid Said House in Egypt	Plans and Sections	Illustration
Said house in the Al-Marg in Egypt. Design respect for existing environment & context Space planning around a courtyard saving trees Arrangement of building segments provide partial protection for some exterior walls and openings minimizing western exposure Separation of public and private zones. Mudbrick walls and dome roofs have been used in construction. Fathy used the courtyard to regulate the movement of air, which provides homeopathic comfort related to the thermal ocean.	 **Figure 4.14:** Hamid Said house plan (archnet.org)  **Figure 4.15:** Hamid Said house section (archnet.org)	 **F-igure 4.16:** Hamid Said house(archnet.org)  **Figure 4.17:** Hamid Said house (archnet.org)

Table 4.5: Hamdi Seif Al-Nasr resthouse in Egypt built with earth building materials

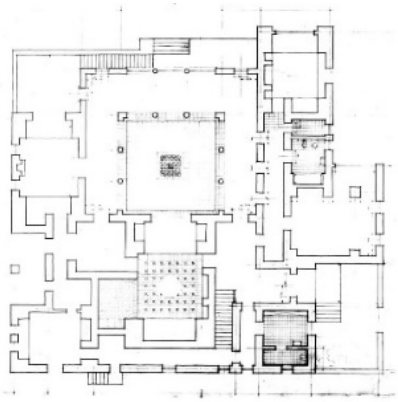
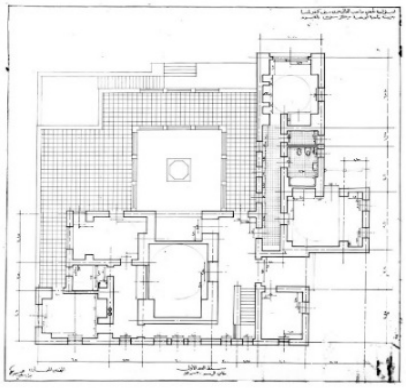
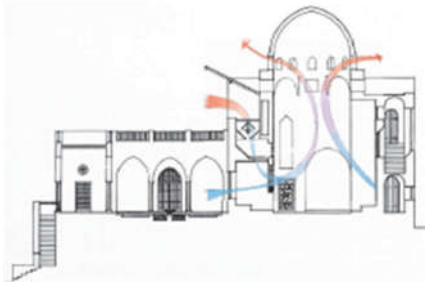
Hamdi Seif Al-Nasr Resthouse in Egypt	Plans and Sections	Illustration
The Hamdi Seif AlNasr rest-house in Al Fayyum, Egypt, was initially designed in two stories around an internal courtyard, which was altered to be external with a sheltered entrance for visitors. The formal arrangement of Durqa'a iwans, and Qa'a in line with the lake views is one of the noblest examples of Hassan Fathy's design tradition. Thick mud-brick walls and roof have been used in construction.	 **Figure 4.18:** Hamdi Seif Al-Nasr ground floorplan (Toros, 2009)  **Figure 4.19:** Hamdi Seif Al-Nasr first floor plan (Toros, 2009)  **Figure 4.20:** Hamdi Seif Al-Nasr home floor section (Toros, 2009)	 **Figure 4.21:** Hamdi Al-Nasr west elevation (Toros, 2009)  **Figure 4.22:** Hamdi Seif Al-Nasr east elevation (Toros, 2009)  **Figure 4.23:** Hamdi Seif Al-Nasr dome (Toros, 2009)

Table 4.6: Musgum dwellings in Cameroon built with earth building materials

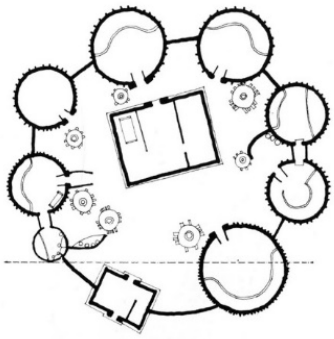
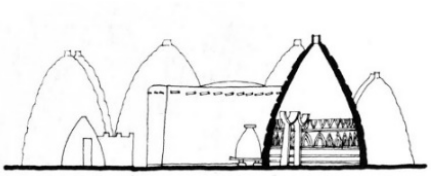
Musgum Dwellings in Cameroon	Plans and Sections	Illustration
Musgum dwellings by the ethnic Musgum people in Cameroon are traditional domestic structures built of compressed sun-dried mud. The dwellings were constructed by residents using few tools and taking advantage of the available materials of the zone, they are an example of sustainable architecture. Musgum dwellings are described as beehive type, buildings made from a circle topped with a domed roof.	 **Figure 4.24:** Musgum dwellings plan (a-i-d.org)  **Figure 4.25:** Musgum dwellings section (a-i-d.org)	 **Figure 4.26:** Musgum dwellings (Carsten, 2010)  **Figure 4.27:** Musgum dwellings (Carsten, 2010)

Table 4.7: Dome home in Italy built with earth building materials

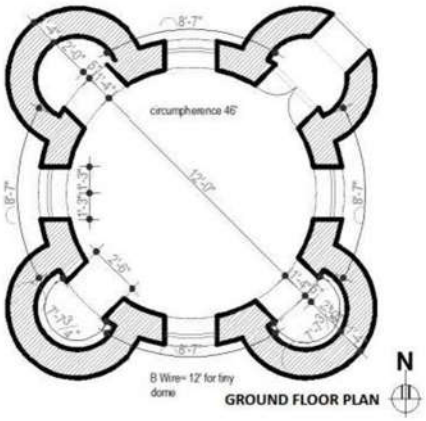
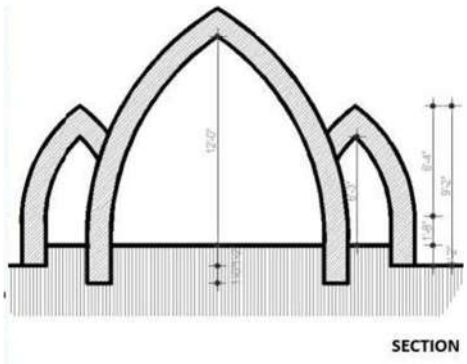
Dome Home in Italy	Plans and Sections	Illustration
The Eco-Dome is a 400 sq ft structure. Sandbags and barbed wire using the engineering of single and double curvature compression shell structures, to reach the ultimate in strength, also and the aesthetics. Because of self-supporting arched roof structure.	 **Figure 4.28:** Dome home plan (archnet.org)  **Figure 4.29:** Dome home section (archnet.org)	 **Figure 4.30:** Dome home (archnet.org)

Table 4.8: The House of Haj Ali in Egypt built with earth building materials

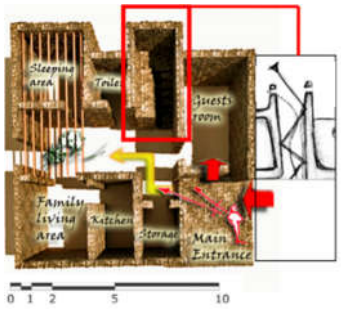
The House of Haj Ali in Egypt	Plans and Sections	Illustration
The house of Haj Ali, Egypt, area 350m2/ floor, and the height are 10 meters. This home one of the Kershef built, and it on of houses that are in good condition up to date. Mud-brick walls have been used in construction. 50 cm high concrete wall on the ground floor to save it from the water, all the walls are supported by the palm of trunks that used to connections on the roof for straitening.	 **Figure 4.31:** Ground floor plan of Haj Ali house (Ahmed, 2014)	 **Figure 4.32:** Haj Ali's House (Ahmed, 2014)

Table 4.9: President Anwar Sadat resthouse in Egypt built with earth building materials

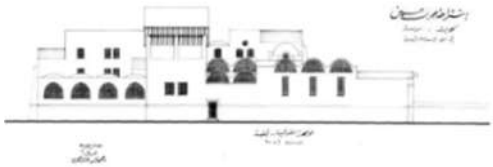
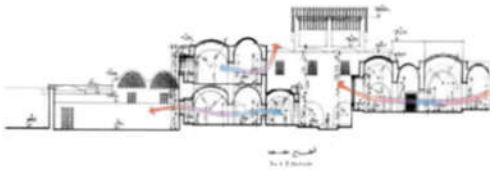
President Anwar Sadat Resthouse in Egypt	Plans and Sections	Illustration
Presidential Rest-house near Lake Nasser in Nubia. In Egypt. The rest-house was a single "walled compound." Thick mud-brick walls and roof have been used in construction.	 **Figure 4.33:** President Sadat resthouse plan (archnet.org)  **Figure 4.34:** President Sadat resthouse section (archnet.org)  **Figure 4.35:** President Sadat resthouse section (archnet.org)	 **Figure 4.36:** Presiden Sadat resthouse (archnet.org)

Table 4.10: Harran domed house in Turkey built with earth building materials

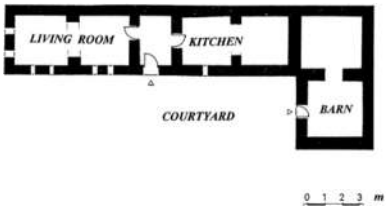
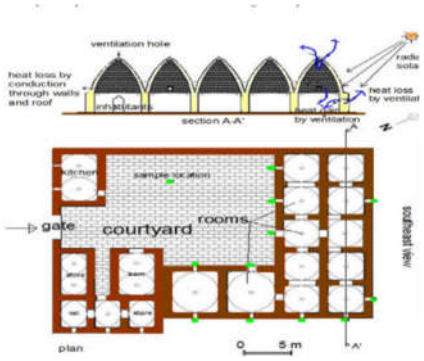
Harran Domed House in Turkey	Plans and Sections	Illustration
Haran's houses are adobe beehive houses, built of clay stones, either sun-dried or burned cubes collected from ruins. In the past, people built their homes with materials they could easily find, such as adobe, brick, and stone. The walls are 60-70 cm thick; the main walls of the spaces built up to a height of 1.70-2.00 cm. When the stone walls are finished, it would be a turning point to close the rows above and build domes at a height of 2.50 - 3.00 meters with bricks.	 **Figure 4.37:** Harran domed house plan (Fieldwork, 2015)  **Figure 4.38:** Harran domed houses plan and section (Fieldwork, 2015)  **Figure 4.39:** Indoor mud-brick roof (Fieldwork, 2015)	 **Figure 4.40:** Courtyard of the house (Fieldwork, 2015)  **Figure 4.41:** External view (Fieldwork,2015)

Table 4.11: Akincilar village home in North Cyprus built with earth building materials

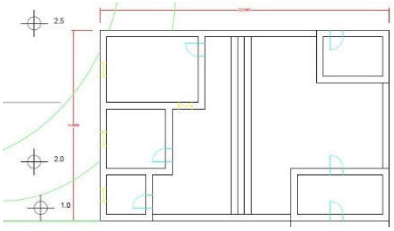
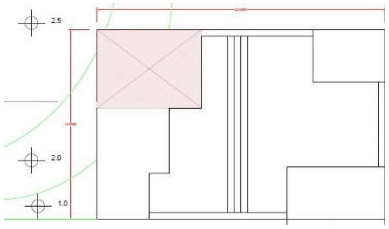
Akincilar Village Home in North Cyprus	Plans and Sections	Illustration
This house is an earthen construction house in village of Akincilar in Northern Cyprus. The main walls have often been constructed by mud brick and were covered by gypsum plaster and mud plaster. Walls thick 50 cm, which help in having an excellent thermal break and keeps the house warm in the winter, and fine in the summer.	 **Figure 4.42:** First-floor house plan  **Figure 4.43:** Second-floor house plan	 **Figure 4.44:** Roof detail in the kitchen  **Figure 4.45:** External view of the house

Table 4.12: Earth buildings according to basic concepts in Hassan Fathy's architecture

	Architecture & environment	Architecture & oceanic comfort	Buildings materials	Wind effect in air motion	Effect of the on-air sun motion
Balat Village Home in Egypt	+	+	+	+	+
Refugee Homes in Iran	+	+	+	-	-
Mud Huts in Uganda	+	+	+	-	-
Hamid Said House in Egypt	+	+	+	+	+
Hamdi Seif Al-Nasr Resthouse in Egypt	+	+	+	+	+
Musgum Dwellings in Cameroon	+	+	+	-	-
Dome Home in Italy	+	+	+	-	-
The House of Haj Ali in Egypt	+	+	+	+	+
Anwar Sadat Resthouse in Egypt	+	+	+	+	+
Harran Domed House in Turkey	+	+	+	+	+
Akıncılar Village Home in North Cyprus	+	+	+	-	-

Key: +: positive - : negative

4.2 The Results of The Case Study for Buildings

After comparing buildings according to basic concepts in Hassan Fathy's architecture the following was detected:

Wind effect in air motion

As the examples show, various climate-responsive buildings techniques been adopted at low cost, inspired by the surrounding environment, summarized as follows:

- Staircase tower is used as a lobby for negative ventilation.

- Create lighting and pipes to maximize using of shaded sunlight at home for hours throughout the day.
- Improve the cooling by separating narrow alleys with the building to create a wind movement, to replace air conditioners.
- Direct the windows in a manner that enhances mutual ventilation as an alternative to air-conditioning that is harmful to the environment.
- The excellent combination of the buildings with the natural environments using traditional vocabulary, not only on the exterior interfaces but also from the internal vocabulary used.
- Create a unique practice of water removal salt furniture and lighting units inspired by the best use of the natural environment.
- Design beautiful yet powerful palm-tree torch ceilings, in keeping with the Kirchesh building's design likewise a material for responsive climate-carbon emissions.

Buildings materials

The earth materials surrounding the project were used and mud-bricks were used in the walls and also in the domes or the wood was combined with the mud in the roofs.

Architecture and oceanic comfort

Homes were designed with adequate cooling in mind and the necessary heating by distributing the rooms with the interior spaces between them and directing them to the sun, and thus this led to the formation of a suitable indoor climate.

The effect of the on-air sun motion

In the houses, on-air sun motion affecting human comfort is considered for the following factors: Light, heat, wind, and humidity. It was done through both of the air is moving by the load and the house has an inner courtyard.

Architecture and environment

In these projects, the environmental impact on design in the selection of building materials and also the construction methods, and this was done by the effect of the climate on the architecture and administrative modification of the local climate.

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

At the end of the thesis, the building with earth materials is the best solution to reduce many problems, such as pollution, economic and post-war crises, and emerging countries .This is because of the easy access to building materials from the surrounding site and reduces costly construction costs. It is also considered one of the best solutions for reducing deaths caused by indoor-pollution.

It is therefore considered one of the best sustainable construction materials if they used the correct orientation of the building. Among the most famous architects who used structural earth materials is the Egyptian architect Hassan Fathy.

- Hassan Fathy was distinguished worldwide by his revival of the architectural concepts applied in ancient Egyptian architecture and Islamic architecture.
- Hassan Fathy's condemnation of the control of the European architectural thought over the social thought was the motive for his search for and restoration of the local heritage identity.

The leadership of Hassan Fathy is characterized by the following:

- He devoted himself to the housing of poor and low-income people in developing countries, in contrast to this, all age architects who were interested in the architecture of the rich.
- He returned man his role and right in the formation of his house to stand in front of the destruction of the local personality under the pretext of universality, as architecture for him is a platform for expressing human and heritage values.
- Use of building materials available in the environment such as silt use in rural dwellings New Gourna village and the use of mashrabiya to cover window openings.
- The architectural design has been closely linked to the environment in its overall project planning, which is concerned with studying the orientation of the building for

the sun and wind direction, and also with studying the effect of the sun on the movement of air inside the building.

- The philosophy of the architecture of Hassan Fathy was the nucleus of a revival of the trend of linking architecture to the environment once again, which has emerged in recent years under different names such as: "green architecture, sustainable architecture and bio-climate architecture".
- Hassan Fathy in his buildings - which he has designed for decades - achieved many concepts that bio-geometry seeks to apply now in the twenty-first century, the design was linked to bioenergy to achieve the positive impact on humans in physiological, psychological and biological terms, and to use its less than half-hemisphere title as well as the use of ecoregions.

To preserve the environment, all institutions must be involved in preserving it.

5.1 Government

The government has a critical and active role to play in preserving the environment and promoting the construction of earth materials. Implementation is considered the common factor between the government and the people in all its vocabulary, and here comes the role of the state in enacting new laws for supervision and regulation.

5.1.1 Future planning

- Document the heritage landscape.
- Value the current ecosystems of the sites.
- Provide urbanization zones that incorporate needs and maintain the culture of the citizens of the region.

5.1.2 Design regulation

- Activate design control and develop guidelines for building new buildings and get out of the constructing of the building.

- Maintain the relationship between the city and its surroundings of nature and the human-made.

5.1.3 Economic

- Supporting development; social and economic activities.
- Revitalization of eco-tourism.
- Local the initiative fund.

5.2 Research Centers

1. Make researches that help to build strengths grow and strengthen the building.
2. Solve problems regarding mud-brick homes.
3. Reliance on construction in local traditions, environment, energy, and local materials.

5.3 Architects

4. Architects must allow an infinite array of a natural talent for building harmonious and friendly environment.
5. Maintaining architectural development-heritage relationship.
6. Suitable construction approaches for innovation.

RECOMMENDATIONS

At the end of this thesis, it can be recommended that the work of Hassan Fathy be reviewed from a new perspective, which seeks to make the most of the thought of this pioneer, whose ideas have already been discussed, so as to overcome the architectural problems that confront now and that have arisen from the tradition of hope and literal transfer of ethnic ideas that do not suit our environment and traditions. Hassan Fathy also worked on teaching the concepts and

principles of Hassan Fathy's architecture in universities to create a new generation of architects linked to his environment.

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Appendix 1

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Appendix 2

Ethical Approval Letter

YAKIN DOĞU ÜNİVERSİTESİ

ETHICAL APROVAL DOCUMENT

Date: 28/05/2020

To the **Graduate School of Applied Sciences**

The thesis titled "Sustainable Earth Architecture: Hassan Fathy as Earth Architect'' has been evaluated. Since the researcher will not collect primary data from humans, animals, plants or earth, this project does not need to go through the ethics committee.

Title: Assist. Prof. Dr.

Name Surname: Çiğdem Çağnan

Signature:

Role in the Thesis: Supervisor