Earth Architecture in the Siwa Oasis –Egypt- and Building with Karshif Material


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ABSTRACT

Earth architecture is one of the oldest architectural styles in the world since ancient times, We find this clear, especially in the Middle East, this material, which is a part of our environment, allow us to get an environmental friendly building, energy-saving and available to both poor and rich people alike, In this paper, we will define the feature of mud architecture and the soil types in siwa oasis, Karshif as a building material used in siwa, which contains a residue of NaCl crystals with a little dust of clay and sand & some other minerals, also will mention about the thermal properties of mud architecture and karshif, as they have proven efficient in thermal properties in the building & for being a good thermal insulator as well, This was obvious in the presented example from Siwa Oasis. where the construction is made with the local material Karshif, when compared temperatures outside with inside a mud house & a skeleton house. the mud tradtional house gave the best result.

Overall, the importance of considering thermal properties of building materials in addition to the karshif insulation properties are demonstrated, Therefore it's important for designers to understand the impact of choicing the materials has on the comfort of users and building energy performance.

Keywords: Architecture of poor, back to earth, Karshif, Siwa Oasis, earth architecture, thermal properties

1. INTRODUCTION

It is known that two-thirds of the world's population lives in buildings constructed at least in part from mud, and the techniques used in their construction have varied to the greatest extent. These buildings were constructed using raw mud bricks, Egypt has many oasis in the Western Desert such as Bahareya, Siwa, Kharga, Dakhla, Farafrah, Baris oasis, Siwa Oasis is one of the famouest example from Egypt in mud buildings. The construction material used in siwa oasis is karshif, it's a material taken from the shore around salt lakes, and it has the same properties of mud especially in thermal performance, It is also distinguished by the presence of salt particles, in addition, it creates a best low-cost and zero carbon building techniques, these properties will be shown in the mud and karshif material with an illustrative example as well.

Mud architecture mainly depends on mud as a building material with all its properties, and It has characteristics in such as:

- It is a natural material available in most areas of Egypt and the Western Sahara,
- It has thermal gain and storage, so it does not lose heat quickly, which helps in the prorated improvement of the climate.

- The optimal investment in these available materials is a real threat to modern building materials production projects, Because it considere a strong competitor with what the modern buildings cause like: the depletion of natural resources, the spread of pollution, and the impact on the ecological balance.
- Recreate the friendly relationship between man and architecture; Which are represented in: values, shapes, arts, and heritage comming from society and in harmony with the human scale; which is often forgotten by the owners of the so-called world style.

Mud architecture has been known in Egypt since ancient times, that's because of the rich soil, whether around the River Nile or the Western Desert. The soil in western Egypt is rich of different types of soil, like: The Argillite, used as binder in the realisation of the mortar in the ancient masonries, Taken from quarries 8 km from Siwa Oasis, on the road to Marsa Matruh. Tafla, Mud can be found under the salt crust around salt lakes uses in mortar, Limestone, Sandstone and the Karshif.

2. THE KARSHIF MATERIAL

2.1 The Karshif Material, Its Components & its Extraction Place

The traditional building materials in Siwa mainly are taken from the environment like, salty mud mortar, olive trees and palm tree trunks and salt blocks.The salt blocks, called karshif, it consists as a result of the process of evaporation of water from the lakes, it contains a residue of NaCl crystals with a little dust of clay and sand and are taken from the shore around the salty lakes, it contains also some other secondary salts like KCl.

During this process, in occasion of sandstorms, minerals like quartz, feldspar calcite and clay minerals can be included as impurities in the salt. As mentioned above, Karshif is found around salt lakes, so it is extracted from the shores around of these salty lakes.

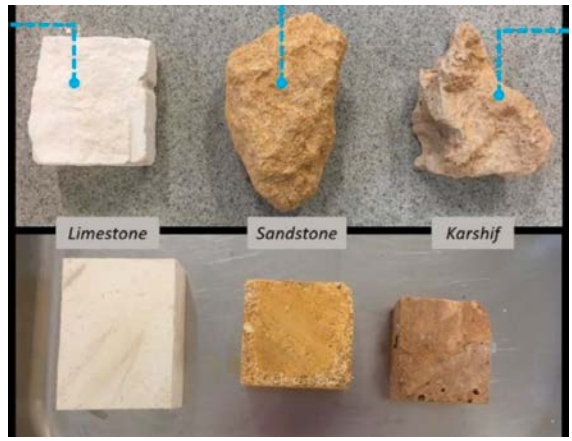


Figure 2-1. The three different types of stons (Daniel Maskell, 2019)

Figure 2-2. The salty lakes where extracting the karshif (Calogero Montalbano, 2011)

The supply site of karsheef: the bottom of the salt lake presents a continuous crust of salt and mud that detaches spontaneously in clods because of the volumetric variations by the salt crystallization.

2.2 The Thermal Properties of Mud & Karshif

2.2.1 Thermal properties of mud buildings (mud material)

The building is mainly affected by external weather factors (the temperature + amount of sunlight + humidity). Also, the internal heat in the building which is caused by variable factors such as (The amount of lighting, household appliances, human activity and the number of people in the building), Temperatures are highest in the building in the summer, As a result of a natural rise in the outside atmosphere. The use of passive cooling technologies, such as Sunbreakers and other natural system of energy-efficient methods, It might not work well as we plan, if the building is built from concrete or Not environmentally friendly materials, The result is resorting to mechanical methods such as air conditions, It may cool inside, but it increases the outside temperature because of the motors, While mud has other properties and a positive impact on the building in summer and winter and positive impact on the environment as well, This is because mud has the following positive characteristics, which is, the mud absorbs the sun rays falling on the wall during the day (daytime), so, the mud naturally stores the heat comes from the sun, and loses it gradually and slowly during the night. and This is how the natural mud material works.

The amount of heat emitted inside the building is less than the amount of heat lost outside, then the wall acts as a natural insulator. Heat which is stored throughout the day inside the mud wall, as a result of this process, makes the room cold during the daytime, then the wall gradual losses the heat at night (heat that was stored during the daytime), by this way the temperature starts to rise slightly in the room, This point can be solved by the ventilation holes in the place and create air movement in the building, carrying the cold air from the outside. At night, the mud wall loses the heat it had stored during the daytime, so that it gets cool again by the next day, and so on.

Those were the properties of the mud material in general, Which also applies to Karshif material, But the karshif material contains salt crystals that give the mud other properties.

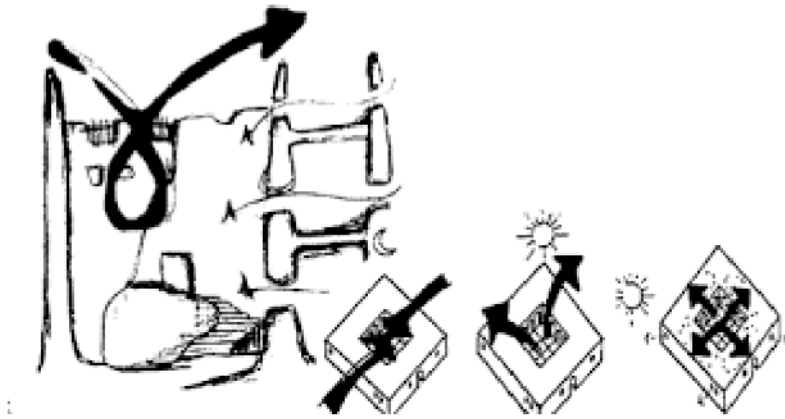


Figure 2-3. The natural vantilation through passive cooling during the daytime and night.
(R.M. Ahmeda, 2014)

2.2.2 The thermal properties of Karshif

The karshif material does not differ in its thermal properties than mud, it has the same thermal properties of mud. researchs found also the Karshif material is excels at temporary moisture storage, But if the humidity exceeds 80%, it will lead to partial dissolution. Karshif exhibit excellent humidity-regulating behavior, provided not to be used in areas where humidity is regularly higher than 80%. Moisture and temperature interact, and one controls the other. As temperature changes, so does the amount of evaporation and moisture, or humidity, in the air. Thus, temperature, evaporation and moisture are interrelated environmental phenomena. (Daniel Maskell, 2019).

An example from the traditional architecture of the oasis buildings will be shown, which will show more about the thermal effect of the karshif material.

3. SIWA OASIS

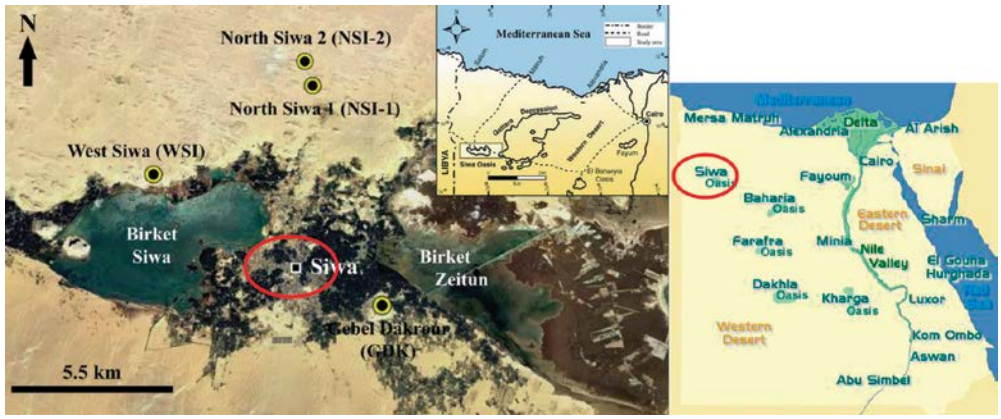


Figure 3-1. Siwa oasis location (Ahmed El-Sabbagh, 2017)

3.1 About Siwa Oasis

The location: Siwa Oasis is a virgin Oasis in Egypt between the Qattara low and the Great Sand Sea in the Western Desert, 50 km (30 mi) east of the Libyan border, and 560 km (348 mi) from Cairo. The Siwa protected area covers 7800 m2 of the western desert.

Siwa oasis is one of the largest groundwater reservoirs in Egypt. Despite being a place of global significance in medical tourism, its isolation from the urban lifestyle has made it a virgin land. Cleopatra's Pool is one of its natural and famous springs, where the queen Cleopatra was swimming. İn addition there is another sulphur hot spring called the Great Sand Sea Spring, right in the middle of the Great Sand Sea. There is also the Kegar Spring which is one of the sulphur springs used to heal rheumatic diseases, as well as several other springs.

The Oasis inculding some big lakes, Like, Az-Zeitoun Lake, it is one of them, which is a salt-lake in east Siwa, estimated at 5760 feddans (5978 ac). The protictive area is characterized by biological and geological diversity, as it has sand dunes, highlands and wetlands.

Western Sahara in general and Siwa Oasis, in particular, are Characterized by its various cultural features, where Ancient Egyptian culture, the culture of Central Africa and the Arabian culture with their multi tributaries are melted.

The Ancient Egyptian name of the oasis was Sekht-am, which meant "palm land" it's because of the huage number of palm trees it famouse for. The architecture of the oasis were developed by the residents of the oasis that's by using local raw materials, the buildings design has reflected the local materials which has been used to overcome climate problems through different historic periods.

İn the Siwa Oasis, the 5th century BC temple to Amun of thebes on Aghurmi hill, the famous oracle visited by Alexander the great to gain approval for usurping power as Pharaoh, The temple witnesses an astronomical phenomenon called the vernal equinox, where the sun perpendicularly to the temple twice a year, on March 20 or 21, which is the date of the springal equinox, and September 22 or 23, which is the date of the autumnal equinox, and the phenomenon is observed only a day of the year, where night and day are equal after 90 days.

Also one of the most important historical monuments, Gebel Al-Mawta (Mountain of the Dead), It is a mountain that includes a group of ancient tombs dating back to the period between the fourth and third centuries BC. Also we have Bathet cemetery, Altemsah "Crocodile" cemetery, Miso Isis cemetery and Shalli castel.

Figure 3-2. Upper view of the Oasis (URL 14)

Figure 3-3. Amun temple, Siwa oasis (URL 12)

Figure 3-4. Batahot tomb, Siwa oasis (URL 12)

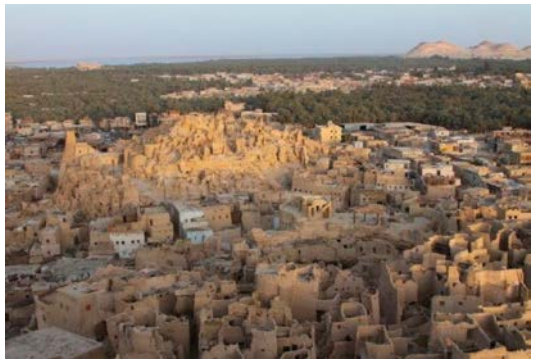


Figure 3-5. The remain of Shali, Siwa oasis (URL 12)

3.2 An Example of Siwaian Traditional House

as mentioned before, the traditional houses in Siwa are built by the local materials from the environment, like, karshif, olive trees and palm tree trunks, salty mud mortar, the example shown, a traditional Siwian house, built from local materials, where the wall made of karshif material with useing the salty mud mortar. Karshif material can be formed in bricks (in organic shape) that can be stacked on top of each other to make at the end a beautiful shape of the house that is closer to the organic shape. The construction is done in successive layers, and the blocks which formed from karshif are left for one to two weeks until each layer dries up.

This technique which made by the people of Siwa makes the building integrate with the environment, and also maintains the suitable temperature in winter and summer as well, in addition of being a material that prevents carbon emissions unlike the current widespread cement material that is not suitable for the desert environment, while the karshif wall acts as an insulator for hot and cold air.

The house is containing two floors connected by a staircase, and after the enterance there's a courtyard is serving as a ventilation speace, By attracting the air inside the courtyard and expelled it in a circular movement. a guest room for visitors located close to the main entrance, The external wall has a coarse texture, to create a shadow on the facade, and reducing the solar radiation affect, and sometimes are painted white for emitting the solar radiations too. The roof is made of palm tree trunks as beams, and it covered by the mud mortar, for covering the palm trees trunks beams.

In figure 4-6 shown the example of traditional house which is made by local materials, such as:
1. Karshif wall, 2. Palm trunks roof, 3. A mortar of Karshif and sand to fill the voids and holes, 4. The first floor, 5. The sec. floor, 6. Outer mortar, 7. The door made of Palm trunks, as it has shown in Figure
A- Details A of the ceiling
B- Details B of the wall.

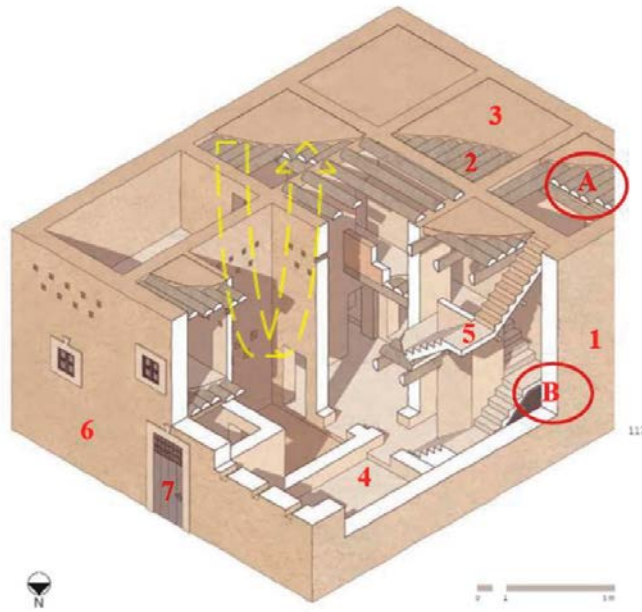


Figure 3-6. Perspective view of a traditional house (Calogero Montalbano, 2011)

Figure 3-7. Details A, showing the wooden ceiling (The author)

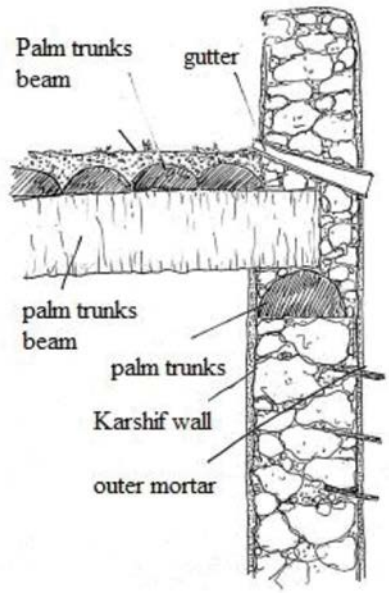


Figure 3-8. Details B, a section on karshif wall (URL 11)

Figure 3-9. The technique of constructing the karshif wall (Calogero Montalbano, 2011)

As mentioned before, one of the advantages of the mud material is that it works as a thermal insulator, cooling the house in summer and heating in winter. in the example the outside temperatures were measured, also measured inside a traditional mud house, and compared with temperature measured inside another modern skeleton type house at the same rooms in both, and when Compared the Thermal Performance of Traditional and Modern houses, the comparing between internal temperatures in main rooms of a traditional karshif house and a modern skeleton type house, the result was that, the temperatures in the karshif house give low readings compared to the readings of the skeleton house as it shown in chart 4-1. Also the thermal insulation for both houses was compared, the karshif traditional house gave the best percentage for thermal insulation as in chart 4-2

Chart 3-1. The result of comparing between the temperature in a modern and traditional house (Abdelaziz Farouk Mohamed, 2020)

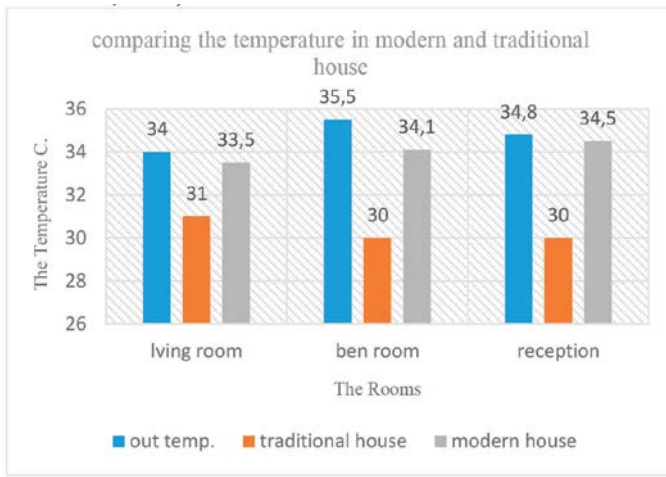
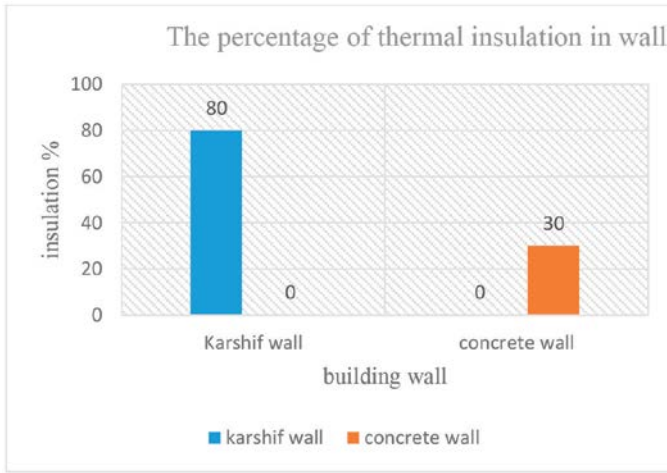


Chart 3-2. The percentage of the thermal insulation of karshif and concrete wall (Abdelaziz Farouk Mohamed, 2020)



4. CONCLUSION

The building technique made of the local materials is more climatic responsive and adds the uniqueness to the design and traditional spirit versus other techniques, it's for more sustainable environment.

the mud architecture through the history has shown an efficiency proper to interaction with the surrounding environment, It also showed efficient thermal performance inside the building, The karshif material, however,

it is a building material, it is also a natural thermal insulation material, This is what appeared in the result of the experiment by measuring the thermal performance inside a traditional karshif house and in a skeleton house. and by comparing the result, the thermal

performance of tradtional karshif house was better, as the temprature inside the house was cooler than outside, while the temprature inside the skeleton house was close to the reading of temprature outside.

Overall, the importance of considering thermal properties of building materials in addition to their karshif insulation properties are demonstrated, In fact, the explanation for the local perception of karshif as a building material that produces good internal comfort, its superior thermal properties, is through the show of its superior properties. Therefore it's important for designers to understand the impact that the choice of materials has on the comfort of users and building energy performance.

Rasha Elborgy, 2003 Graduated from Alexandria Univ. Egypt, 2010 Master degree from A.A.S.T, Alexandria Egypt in Preservation of historical building by relocation, 2007 worked in Bibliotheca Alexandrina (Libraryof Alexandria) in saving heritage Dep. 2019 Ph.D. from F.S.M.V Univ. Turkey about using Palm leaves as an alternative material to rice straw.

Feb. 2019, my 1. Book (Relocation As an Approach for Conservation of Historical Buildings) has been published with Publisher: LAB LAMBERT Academic Publishing, ISBN-10: 6139452554, ISBN-13: 978-6139452552, April 2020 My Book Has Been Translated Into "8" Languages Worldwide.

Feb. 2020 my 2. book "Kerpiçte Hurma Yaprağı"(Date Palm Leaves in Adobe) has been published in Turkish language, Publisher: LAB LAMBERT Academic Publishing ISBN-13:978-620-0-58854-8 ISBN-10:6200588546

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