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RESEARCH ARTICLE

LAND USE AND RECOGNİTİON OF CONSTRUCTİON TECHNİQUES BASED ON LAND USE AND GEOGRAPHİCAL CLİMATİC CONDİTİONS.

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Abstract

Technology controls our lives in a very high way and thus reflected on architecture, it leads us to two pints, first, gradually we stay away from the architectural identity in some countries like in Egypt, Sec. The prices of building materials and housing prices increased significantly. While the environment provided to us a natural materials to use. As Hassan Fathy Said "Allah has created in every environment materials what resists its problems, the intelligent architect who can deal with those materials in a right way". The aim of this research is to use one of the most important materials in Egypt, the Palm Frond, instead of rice straw. The Research Methodology is Knowledge of this architectural style, studying the climatic and geographical conditions for making mud brick (Adobe) especially in Egypt, Learn about Hassan Fathi's philosophy and his experience in this field and studying the mud brick content. According to this knowledge we used the Palm fronds, It has been chemically analyzed to know the percentage of cellulose which is important for fermentation process, also analyzed a samples of Delta soil from Egypt, after mixing all together we get a good result, the palm frond affect good in the brick strength.

Introduction:-

Adobe structures are extremely durable, and account for some of the oldest existing buildings in the world. Compared to wooden buildings, adobe buildings offer significant advantages due to their greater thermal mass, in hot climates.

Egypt is one of the oldest countries to start building Adobe, houses and temples, also Egypt is one of the largest countries producers of palm trees, Due to the low water level of the Nile recently and the low rate of rice planting, we thought of replacing the palm frond Instead of rice straw for making Adobe brick and Test the same process of rice straw but with palm frond, the fermentation process, brick strength and analyzing the components of palm frond.

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The percentage of cellulose in palm fronds was higher than the rice, so the final result after testing the strength of the bricks made of palm fronds was good and close to the same with rice straw, which mean we can replace using palm frond as a fabric in adobe

Geographical Distribution:-
Around the world we will find earth architecture mainly in the countries which famous for hot and dry, rare rains and desert weather, that's as UNESCO statistics shows. (figure1)

Egypt is famous for the hot and desert weather, River Nile is the main source for mud in Egypt, it is divided into three main regions according to the course of the Nile, (figure2)

Upper and Middle Egypt, Delta region, Mediterranean coasts.
It is known that Egypt is an agricultural country, and agricultural life has led to the stability of the Egyptian man around the Nile Valley and the delta region

Therefore, mud buildings are located around the Nile valley, especially in Upper Egypt, Luxor, Aswan and Nubia, and in the delta region, where the soil is fertile with clay soil. The Adobe buildings are also located in the oases, due to the dry (figure3) atmosphere.

That's why we did analyzed some samples of soil from different lands in Egypt, then the result was as follows.

Soil components:-
In the North Delta, quartz sand, containing calcium carbonate (CaCo3), is dominated by 4-10%
And the proportion of clay and 5-10% and the percentage of salts drops to 0.1%
By analysing a sample of delta soil we got that results

PH	EC	Hco3	Cl	Na	K	Ca	Mg
8.15	1062	143	107	100	11	132	49
N	P	Co3					
5	12	-					

As a result of analysis of samples of Delta soil in Egypt 2
source: the researcher
Which mean it's a rich soil for mud bricks.

The historical background:-
The word adobe /əˈdoʊbiː/ has existed for around 4,000 years, with relatively little change in either pronunciation or meaning. The word can be traced from the Middle Egyptian (c. 2000 BC) word dj-b-t "mud [i.e., sun-dried] brick,

As Middle Egyptian evolved into Late Egyptian, Demotic, and finally Coptic (c. 600 BC), dj-b-t became tobe "[mud] brick

Adobe structures are extremely durable, and account for some of the oldest existing buildings in the world. Compared to other materials buildings, adobe buildings offer significant advantages due to their greater thermal mass, in hot climates.

Homes of sun-dried or Adobe bricks were built in Egypt in 3800 B.C. Mud from the bottom of the River Nile was mixed with straw, shaped and dried in the sun until as hard and strong as rock. Adobe homes were the most efficient structures for the hot and dry Egyptian climate.

Loamy Nile mud mixed with straw resulted in surprisingly strong bricks. A sunbaked mud brick without straw had a strength of less than 6 kp/cm², the addition of straw resulted in a brick three times as strong (about 20 kp/cm²) . As long as groundwater did not dissolve their foundations and floods did not reach them, well-tended mud brick walls could stand for generations. (figure4)

In every location during a building project brick moulds of equal size were used, which were between about 45 to 30 cm in length and 20 to 15 cm in width. The brick size was thus standardized, e.g. 30 by 15 by 7.5 cm during the

Middle Kingdom. At Karnak the bricks measured 40 by 20 by 15, at the Late Period Naukratis they were about the same size. These dimensions suggest they were generally laid in cross bond (English bond). But other bonding patterns such as running bond, Flemish bond, and stack bond were apparently also used at times.

A modern mud brick maker can produce between 1000 and 2000 bricks a day. One may assume that ancient workers were about as efficient. Five days' work should, therefore, have sufficed to make about 5000 bricks needed for a worker's one-storey house of 60 to 80 m² with 40 cm thick walls. (figure5,6)

One of the earliest tombs to be opened at Nebesheh was built of red baked bricks, dated to Egypt's Nineteenth Dynasty

Hassan Fathy and Architecture of Poor:-
His gouaches alone could perfectly describe his work, but we'd like nonetheless to hint at the general principles as guidelines to understand them. Fathy believed in the importance of human values, in the use of technology suitable to time and place [that is climate and local economies] , in the need for socially-oriented cooperative construction techniques. He assigned an essential role to tradition and hence to the re-establishment of a national cultural pride, a goal to attain by means of the act of building

he was intellectually stimulated by the art of the pharaonic period and was directly influenced by vernacular architecture. He studied the buildings of the old city of Cairo and Nubia in order to create a national architectural language based on the employment of traditional elements and building techniques. it appear in ElGorna village in Luxor (figure7,8)

Both for the value he attributed to manual work and for economical and ideological reasons, he resorts, for the realization of his projects, to traditional techniques that extremely reduce the use of machinery and exploit what is available in a cheap way: earth, straw, man's labour, stones. The brick is, in fact, the only material used in his works. The supporting walls are made either of sun dried bricks made of mud and reinforced with straw (Adobe) or of local stones or fired bricks (figure9)

His philosophy:-
his point of view can be seen through his words like "At all costs, I have always wanted to avoid the attitude too often adopted by professional architects and planners: that the community has nothing worth the professionals' consideration, that all its problems can be solved by the importation of the sophisticated urban approach to building. If possible, I want to bridge the gulf that separates folk architecture from architect's architecture. " which reflect a part of his philosophy
It lead us to know and learn more about the Thermal properties of Adobe bricks.

Thermal properties of Adobe buildings:-
Adobe brick is considered to be one of the worst conductors of heat, it is due to the significant reduction in its natural conductivity.
We found the Heat conduction for:
0.22 ca/min/cm2 for Thickness of bricks made of 20% Fine sand
0.32 ca/min/cm2 for Thickness of bricks made of 80% Coarse sand

The mud building is characterized by thermal insulation that loses heat at night and absorbs it during the day, The amount of heat lost outside the building is greater than the amount of heat that is radiated to inside the building.
So the building gets cold during the day time and warm at night which creates a natural conditioning.
In Egypt we resort to other treatments such as the construction of domes and vaults (figure10)

Components of Adobe bricks:-
In Egypt.
Soil + sand + straw + water = the mixture
3 : 1
70% : 30% : as the mix need
Mix all together by feed and leave it for 8 to 40 h to ferment well, covering the mixture by plastic cover, Fermentation Produce Lactic acid because of the Lactose in the straw. (figure11)

After fermenting process we start to put the mixture in the brick form (25*15*5 cm), and then we leave it under sun for 3-6 days (depend on the season winter or summer) to dry well. (figure12)
We found the brick made of pure soil shrank 37% after drying process

Adding straw has two advantages, first: it works as a fabric for the mud that makes the bricks in coherence Sec. Reduces the shrinkage rate of the brick.

The Straw:-

Rice and Palm fronds:-

Palm trees have been in existence since the dawn of human civilization, the earliest fossilized palms on record dating back nearly 80 million years to the Cretaceous period. They played an integral role as a resource that could be utilized not only for the fruits some of the trees provided but for a variety of different purposes. They were used whole as thatching to build roofs and walls for houses, the strong mid ribs used to make crates, fences, weapons and furniture and the smaller leaves used as a material for fashioning clothing, baskets, rope and cooking tools. Today, palm trees can be found growing around the world in a variety of different climates. The majority of species, however thrive and can be found growing in warm tropical and sub-tropical climates.

Egypt is one of the famous and largest producers of palm trees, containing about 11.5 million palm trees, each Palm tree produces about 12 palm frond per year. And unfortunately we are using a small amount of those palm fronds in some hand crafts and we waste the largest amount costs millions of Egyptian pound every ear. recently we face a real problem in rice Planting and Low water level in the River Nile, so we found the palm frond will be the good replacement for the rice straw.

By analyzing the Palm frond to see the components, and analyses the Cellulose and Hemisylose, the two important items in fermentation process to get a strong brick.
So the Lab result was

Results:-

Chemical and physical determinations for date palm leaf samples were presented as follows:

Chemical and physical determinations for date palm leaves:-

Sample	%							
	Moisture content	Extracted component	Dissolving in		Cellulose	Hemicellulose	Lignin	Ash
			Cold water	Hot water				
1	7.82	28.86	18.13	23.49	38.72	32.94	28.34	10.82
2	7.80	30.30	19.26	24.55	39.96	34.60	25.44	10.70
3	7.38	27.61	18.85	23.96	35.47	35.93	28.60	10.80
Mean	7.67	28.92	18.75	24.00	38.05	34.49	27.46	10.77
SD	0.25	1.35	0.57	0.53	2.32	1.50	1.75	0.06

From the above mentioned results, the moisture content % of date palm leaves samples were done according to American Standard Measurements (ASTM) on oven dry-base for all chemical determinations except cellulose and hemicellulose, which determined according to Nikitin (1960) and Rosmarin and Simionescu (1973), respectively. All chemical determinations were done on samples passed from 40 mesh sieves and impassable from 60 mesh. Cellulose, hemicellulose and lignin contents were determined on samples free from the extracted component. (figure13,14,15)
**mesh No= Number of pores in one inch length.

According to Rice straw components, we found it's higher than rice straw in Cellulose and Hemisylose, the two important items in fermentation process
In rice straw we found
Cellulose: 39.73% (+/- 1.01)
Hemicellulose: 25.77% (+/- 0.43)
Lignin : 13.43% (+/- 0.81)

Ash: 16.66% (+/- 0.33)

The Adobe brick strength Testing:-
The same proportions of soil were mixed with palm fronds and water,
Samples were left during fermentation process for different hours, between 12, 17 and 24 hours the shrinkage ratio in the bricks was not significant, it was in between 0.1 to 0.3 cm in Length and width (figure16)

Sample	Dimension (cm)	Weight/ Kg	Cracking Load
1	25* 11.5* 6	2.1	17/40
2	26* 12.2* 7.1	2.41	22/42
3	25.4* 11.9* 6.8	2.69	20/65

The samples strength testing results
Source: researcher

After Exposed samples to the strength test in both (figures 18,19) show the pressure resistance of different samples of Adobe bricks during the test and the level of cracking, it leads us to the (figures 20) which shows sample after cracking level while it's consistent according to the old brick sample took from Luxor Hassan Fathy Gourna village (figure21)

Test of absorbing water:-
Adobe brick samples were exposed to water by putting each brick in a tank of water, letting the edge of the brick touching the water and watching the amount of water absorbed each hour, the result was as follow. (figure 22,23,24)

Test 1:-Adobe brick made of Palm frond straw

Time	Absorbing water level (cm)	Notes
12:50 Pm	0 – 1 cm	Normal starting for absorbing process
13:40	3 cm	Normal absorbing with some foam appearance Erosion in right side of the brick
14:30	4 cm	More erosion in right side More foam appearance
16:00	5 cm	Normal absorbing in front side of the brick Little higher absorbing in back side
17:00	5 cm	No change
18:00	6 cm	No change
19:00 – 21:00	7.5 cm	Absorbing process getting slower with erosion in the bottom
22:00	8 cm	No change
23:30	8.5 cm	No change
00:30 Am	9 cm	Collapse of the back side
1:30	9.5 cm	Slow absorbing
7:30	12 cm	Absorbing level in 6 hours 2.5 cm
9:40 - 11:30 Am – 12:30 Pm	12.2 cm	Absorbing process is almost stable
14:00	12.2 cm	No more absorbing

In 24 hours the total absorbing level is 12.2 cm (researcher)
Corrosion was observed at the base of the bricks as shown in (figure25)

Test (2) :-
Adobe brick made of rice straw
We used the same technique with Adobe brick made of rice straw to compare the final result with Adobe made of Palm frond straw, and what we get as shown in the table:

Time	Absorbing water level (cm)	Notes
12:50 Pm	0 – 1 cm	Normal starting for absorbing process
13:40	3 cm	Normal absorbing with some foam appearance

		Erosion in right side of the brick
14:30	4 cm	More erosion in right side More foam appearance
16:00	5 cm	Normal absorbing in front side of the brick Little higher absorbing in back side
17:00	5 cm	No change
18:00	6 cm	No change
19:00 – 21:00	7.5 cm	Absorbing process getting slower with erosion in the bottom
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14:00	12.2 cm	No more absorbing

Conclusion:-

Building by Adobe bricks is an old construction system, appeared in many ancient civilizations, and can be still used till today.

Adobe brick is famous for mixing the Rice straw with earth for years, though each environment has its special plants can be used and probably can be stronger than rice straw for the mixture, replacing the palm frond instead of rice straw gave us a good results for brick strength as well, specially Palm tree is famous for its strength and living long. Egypt is already conceders one of the biggest produced for this tree, so why we don't use it to revive an old and environmental friend cultures.

Activities and Magazine:-

Workshop, Georges Nez, Tom Rijven, Christo Markham, Adrien Vertallier, Laura Dedieu, IFAC, International Festival of Art and Construction (Bergen, Pays Bas), Netherlands, 2015

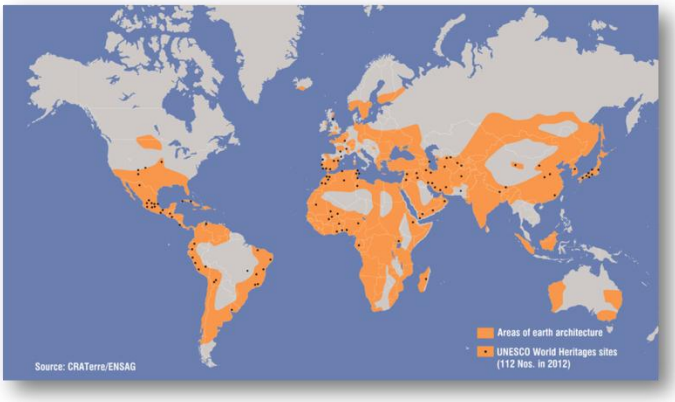
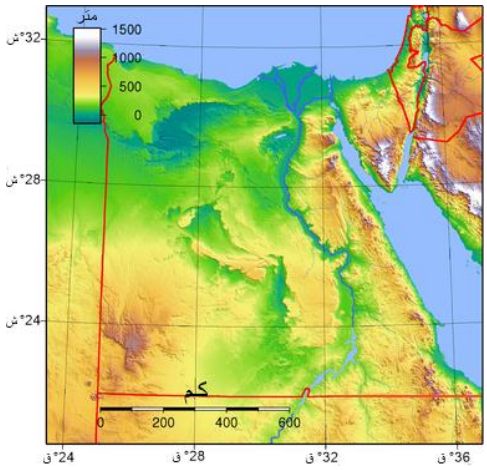


Figure 1:-The map shows the most famous places over the entire world using earth architecture.



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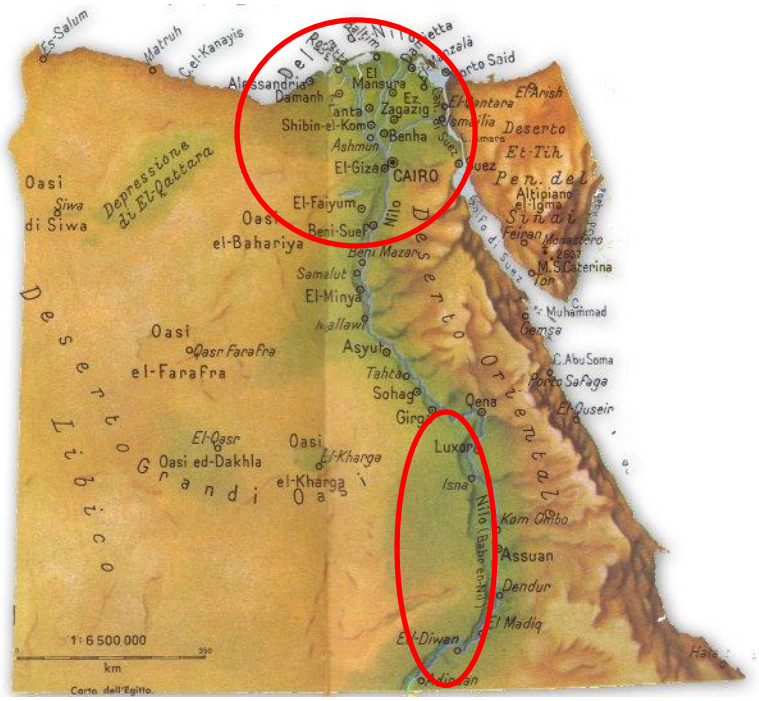

Figure 3:-Spread of mud brick construction on the Nile Valley, Delta and oases

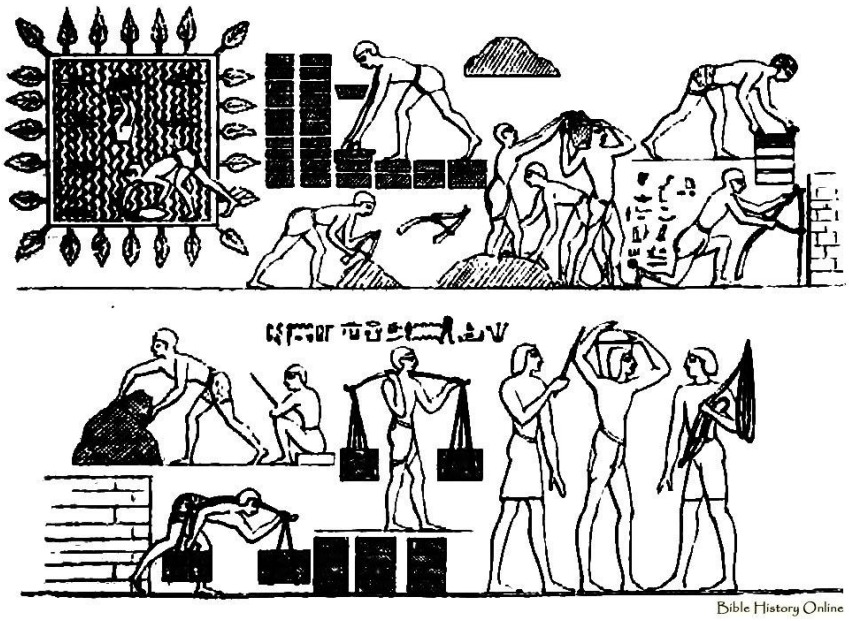

Figure 4:-Ancient mural illustrates how was the ancient Egyptians method of mixing and building mud
Source:-http://uzume-asso.org/fabrication_adobes.html

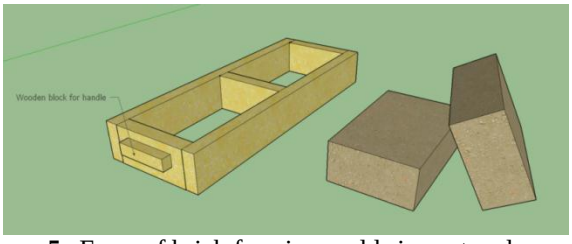

Figure 5:-Form of brick forming molds in past and present.
Source- http://www.artifexbalear.org/egi_con.htm

Figure 6:-Adrère amellal hotel "sewa oasis, Egypt"
Source:- https://www.adrereamellal.net/siwa%20oasis.html

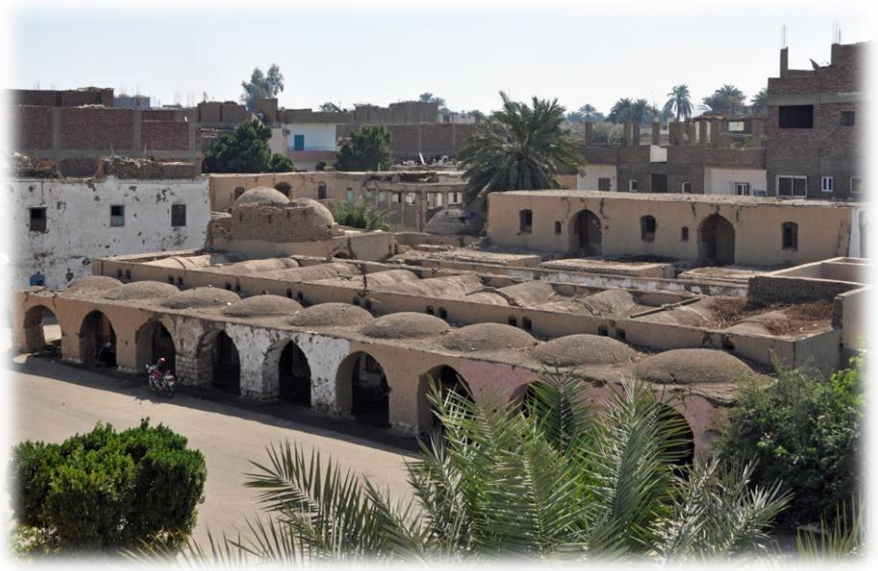

Figure 7:-Some of his work at new Gourna village. Luxor, Egypt
Source:-the researcher

Figure 8:-Some of his work at new Gourna village. Luxor, Egypt
Source:-the researcher

Figure 9:-Dar Alsalam Project, new mexico, USA 1981. The Vaults construction system.
Source:-https://www.researchgate.net/figure/Mosque-at-the-Dar-Al-Islam-project-in-Abiquiu-New-Mexico-USA-designed-by-the-late_fig6_297032349

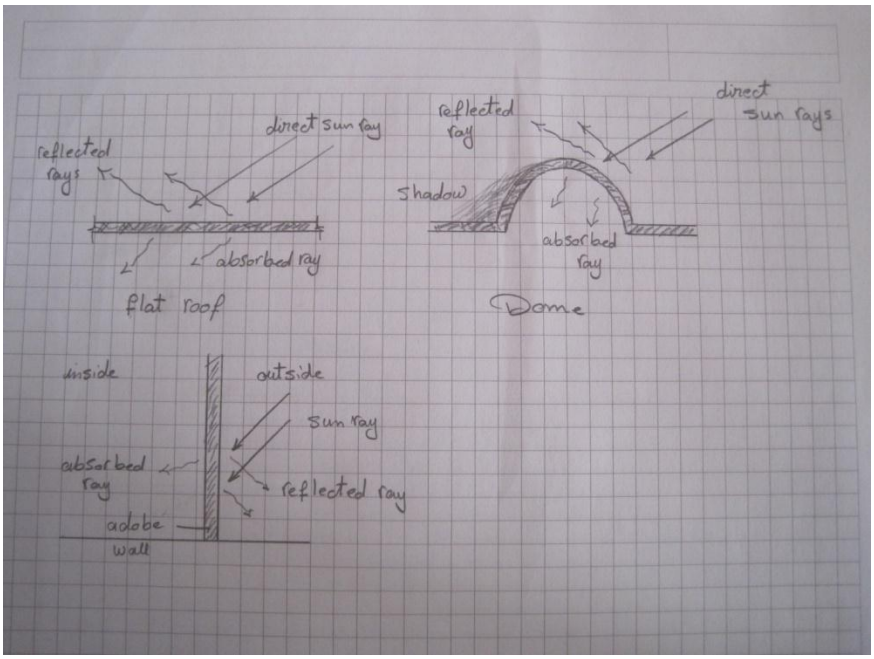

Figure 10:-Thermal properties and the reflected and absorbed part of sun rays
Source: researcher Sketch.

Figure 11:-Mixing and Drying process for Adobe bricks.

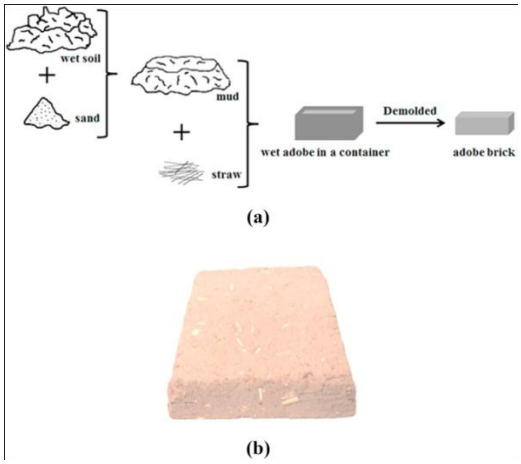

Figure 12:-Steps of making the Adobe brick

Figure 13:- In the first and Sec. Figure it shows us the Length of Palm fronds fiber in the third figure the cellulose percentage in palm frond
Source:- lab work, researcher

Figure 16:-A sample made of 2(mud+sand) to 1 palm frond mixed by water
Source: made by researcher.

Figure 17:-An original old sample from Qourna village Luxor, Egypt
Source: researcher.

Figure 18:-Testing the brick durability and strength
Source: made by researcher.

Figure 19:-The cracking level
Source: made by researcher.

Figure 20:-The brick made of palm frond after reaching the max. pressure
Source: made by researcher.

Figure 21:-The old brick made of rice straw after reaching the max. pressure
Source: made by researcher.

Figure 22, 23, 24:- Adobe brick made of Palm frond straw
source: researcher

Figure 25:-Shows the erosion in the Adobe brick made of Palm frond after the test
Source: researcher

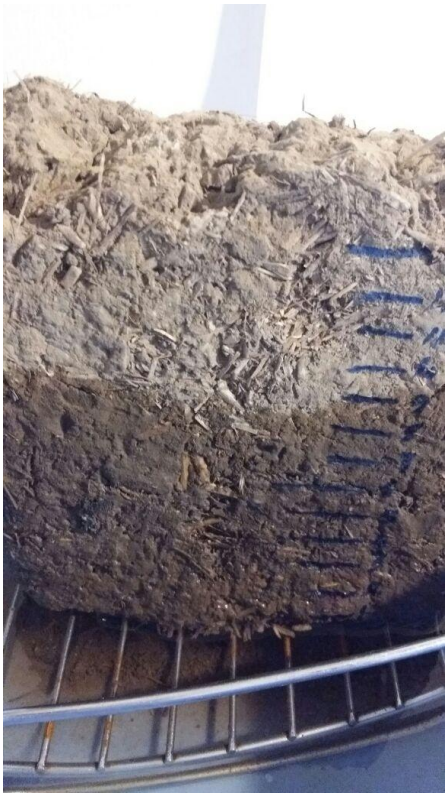

Figure 26:-level of absorbing water in an Adobe brick made of rice straw
source:-researcher

Figure 27:-the final case for the Adobe brick made of rice straw
Source:-researcher

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