Iraqi Journal of Science
ISSN: 0067-2904

The possibility of manufacturing bricks from Quaternary Deposits from Al-Muthanna Governorate/ southern Iraq

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Abstract

This study is concerned with the identification of the validity of the Recent sediments deposited in the Playa for the purpose of making the laboratory bricks by extrusion and pressing. The steps followed in this study included the formation and then burning of the pyramids at (950-1100) C° for one hour of maturity to determine their applicability to the brick industry.

The study area is located in Al Muthanna province, south of Iraq. It is located south of the district of Samawah at a distance of 80 km and to the north-west of Salman district, 64 kilometers south of Baghdad, represented by three hosts: (DHS 1, DH2 and S).

The results of the chemical analysis of the study samples showed that they consist of the following major oxides:

SiO_2 = (39.34-42.82) TiO_2 = (0.52-0.76)
Na_2O_3 = (0.97-1.22)
Fe_2O_3 = (4.19-5.89) CaO = (14.78-19.4)
K_2O = (0.91-1.14)
Al_2O_3 = (8.02-9.85) MgO = (3.85-5.95)
L.O.I = (16.31-19.32)

silica SiO2 represented the highest ratio followed by Al2O3.

Was manufactured 36 samples of the laboratory were manufactured and prepared by extrusion method were measured in dimensions (7 * 3.5 * 2.5) cm by extruding method and were burned at (950-1100) C° for the purpose of conducting physical and mechanical checks on them including Linear and volume shrinkage, color, Water absorption, Efforescence, and compressive strength. The results of these tests showed a decrease in water absorption and Efforescence, a decrease in the values of compressive strength with increased burning temperature, decreased Linearand volume shrinkage in most samples and increased in other samples with increasing burning temperature. In addition, 12 samples were made of the cylindrical laboratory size (diameter 50 mm, height 60 mm) in semi-dry pressing method, and were burned at (950-1100) C° for the purpose of physical and mechanical tests, color, Water absorption, Efforescence, and compressive strength. The results of these tests showed a decrease in water absorption and Efforescence and an increase in the values of compressive resistance while increasing the temperature of burning, while the colors of the samples ranged from light brown and yellow or pale yellow to white.

The results of physical assays were met Linear and volume shrinkage, color, Water absorption and Efforescence. As well as mechanical tests: compressive strength results were in accordance with the Iraqi standard for this industry where the data of the results of this study showed the validity of these samples for the industry mentioned above.

Keywords: Catered, Class, Brick.

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امكانية تصنيع الطابوق من ترسبات العصر الرباعي في محافظة المثنى/ جنوب العراق

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الخلاصة

تعنى هذه الدراسة بالتعرف على مدى صلاحية الاطيان الحديثة المترسبة في الفيضات لأغراض صناعة الطابوق المختبري بطريقتي البثق والكبس. شملت الخطوات التي تم اتباعها في هذه الدراسة تشكيل ثم حرق الأطيان بدرجات حرارة (950 ، 1100) م° لوقت انضاج ساعة واحدة للتعرف على مدى صلاحيتها لصناعة الطابوق.

تقع منطقة الدراسة في محافظة المثنى/ جنوب العراق، وتحديدا جنوب قضاء السماوة بمسافة (80) كم والى الشمال الغربي عن قضاء السلمان بمسافة (64) كم في جنوب العاصمة بغداد متمثلة بثلاث فيضت ام الفرس1 (DH1) وام الفرس2 (DH2) والسلحوبية (S).

أظهرت نتائج التحليل الكيميائية لعينات الدراسة بأنها تتكون من الاكاسيد الرئيسية التالية:

SiO_2 = (39.34-42.82) TiO_2 = (0.52-0.76)
Na_2O_3 = (0.97-1.22)
Fe_2O_3 = (4.19-5.89) CaO = (14.78-19.4)
K_2O = (0.91-1.14)
Al_2O_3 = (8.02-9.85) MgO = (3.85-5.95)
L.O.I = (16.31-19.32)

تمثل لسليكا SiO_2 تمثل النسبة الأعلى وتليها نسبة الالومينا Al_2O_3. تم تصنيع (36) عينة من الطابوق المختبري بأبعاد (2.5 * 3.5 * 7) سم بطريقة البثق وتم حرقها بدرجات حرارة (950 ، 1100) م° لغرض إجراء الفحوصات (التقيمية) الفيزيائية والميكانيكية عليها التي تضم : اللون، التقلص الطولي والحجمي، امتصاص الماء، التزهر، ومقاومة الانضغاط حيث بينت نتائج هذه الفحوصات نقصانا في نسبة امتصاص الماء ومدى التزهر وانخفاض في قيم المقاومة الانضغاطية مع زيادة درجة حرارة الحرق ، كما انخفضت نسبة التقلص الطولي والحجمي في معظم عينات الدراسة وزادت في عينات اخرى مع زيادة درجة حرارة الحرق. وايضا تم تشكيل (12) عينة من الطابوق بالحجم المختبري الاسطواني (القطر 50 ملم ، الارتفاع 60 ملم) بطريقة الكبس شبه الجاف وتم حرقها بدرجات حرارة (950 ، 1100) م° لغرض إجراء الفحوصات (التقيمية)الفيزيائية والميكانيكية عليها التي تضم : اللون، امتصاص الماء، التزهر، ومقاومة الانضغاط حيث بينت نتائج هذه الفحوصات نقصانا في نسبة امتصاص الماء ومدى التزهر وزيادة في قيم المقاومة الانضغاطية مع زيادة درجة حرارة الحرق. أما ألوان العينات فقد تراوحت بين البني الفاتح وبنية صفراء او الأصفر الباهت الى الابيض.لمطابقة نتائج الفحوصات التقويمية (الفيزيائية): الانكماش الطولي، الانكماش الحجمي، امتصاص الماء، التزهر. فضلا عن الفحوصات الميكانيكية: مقاومة الانضغاط كانت النتائج مطابقة للمواصفة العراقية لهذه الصناعة حيث أظهرت معطيات نتائج هذه الدراسة صلاحية هذه الأطيان للصناعة المذكورة أعلاه .

Introduction

It is important to study the characteristics of bricks industry and know the problems that are exposed to them. The most important of these problems is the problem of the raw material and its appropriate precipitation conditions and its proximity to transportation methods and the ease of transport to the laboratory sites , And mud bricks of structural materials characterized by low production costs and durability and not affected by the fire and its good thermal insulation [1]. Due to the wide discovery of the quaternary deposits in the Playa in Al-Muthanna Governorate and to contain large quantities of mud deposits in different Playa as well as urban expansion in the province.

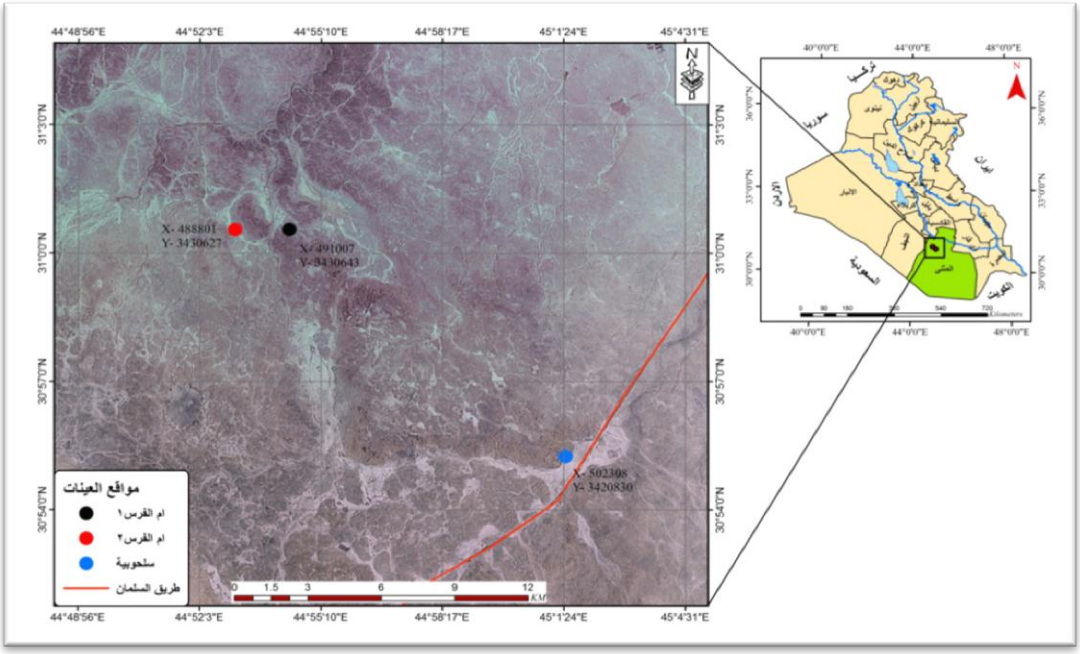

Figure1- Location map of the sampling sites based on outputs

Therefore, the current study examined the possibility of using the Quaternary deposits in Al-Muthanna for the manufacture of bricks. The study area is located in Al-Muthanna province, south of the Baghdad, and is limited to two latitudes (44° 16 ' 44" – 45° 12 ' 10") and between the two displays (30° 25 ' 99" – 31° 17 ' 16") It is located south of the district of Samawah at a distance of (80) km and to the north-west specifically the district of Salman (64 km). This area is one of the most densely populated areas of Playa deposits, which are widespread in low and wide valleys and Playa, as shown in Figure -1.

Geology of the study area

Quaternary Deposits (Holocene)

The quaternary deposits consist of gravel, sand, clay and gypsum, and are collected by floods and runoffs toward depressions and valleys, especially on fragile soils, whose origin is inherited from the parent's rocks that they wash away. Sediment thickness extends from (1-3m) to 10m (8m).

Previous studies

There are many studies that dealt with the subject of the brick industry in terms of conducting metal, chemical and physical analysis of the soil and indicating the validity of the brick industry in different areas. [2] studied the properties of some of the neo gene layers from north and northeast of Iraq and evaluated them for ceramic purposes and gave positive results of the possibility of using some of these samples for the manufacture of bricks[3] conducted a quantitative and qualitative assessment of the muddy soil applied in the formation of the Injana for the construction of mud bricks in the north-east of the city of Tikrit in the province of Salah al-Din and this study reached the classification of bricks to class (B) according to Iraqi standards No. (25) for the year (1993) for the manufacture of bricks. The study [4] dealt with an industrial experiment for the production of pottery bricks of the Daqouq Jay region in the form of extruding in Taameem governorate. The result was the production of the type A. [5] metal and geochemical studies of the composition of the tree from selected sites in central Iraq, With the Iraqi Standard No. (25) for the year (1993), this study reached the classification of these samples to class (A, B, C). The study [6] investigated the physical, chemical and mineral properties of mud deposits for the Injana formation of five different sites in the range of the foothill zone and their use as raw materials in the manufacture of mud bricks. This study identified the type of bricks manufactured in the category (A, B) after the conformity with Iraqi standards No. (25) for the year (1993) for the manufacture of bricks. Finally, [7] studied the validity of the Injana formation in the area of Alkhanokh for the manufacture of clay bricks in four sites in the methods of pressing and extruding and found a comparison of the results of the evaluation tests of the study samples with the

Iraqi standard No. 25 (1993) for the manufacture of bricks that three of these sites fit and one not good.

Aims of the study: The present study aims to:

1. Preparation of the bricks by extrusion and pressing, using the clay deposits of the quaternary sediments after conducting chemical and physical tests.
2. Determination of the validity of the clay bricks industry after conforming to the Iraqi Standard No. (25) of (1993) for the manufacture of bricks.
3. Access the quality of the bricks with high specifications and quality by changing the materials method and degree of burning bricks.

Field description of the Playa under study

Umm Al- Faras 1: It contains layers of red and brown clay with a thickness of 50cm. A layer of light brown sandstone is about 60cm thick. The thickness of these deposits is about 1.1m, Small surrounded by all the sides are isolated hills composed of limestone of Zahra formation.

Umm Al- Faras 2: Contains a layer of silty sand up to 35cm, alternating with clay layers of brown color, at the bottom interspersed with thin gypsum veins, the thickness of this layer is 1.15 m, so the thickness of the sediment reached 1.5m.

Al-Salhubia: composed of soft deposits of silty to clay with a thickness of 1.3m, light brown color granules with a soft feel surrounded by the top member of the Dammam formation from the west.

Laboratory work

- **Preparation of samples:** 36 samples were prepared from the Quaternary deposition layers of the brick industry in the way of extruding. Also 12 samples of the same samples were made for the manufacture of the laboratory bricks in the pressing method, where the samples were sampled to a size of 2 mm and experiments were carried out as follows:

A. Extrusion method

The samples under study were initialized after the aggregates were shredded and then grinded to 300 microns by a crusher, a German type (Retch-RX-57) and obtained a homogeneous volume distribution [8]. The material is mixed thoroughly after the preparation of the samples for the purpose of physical uniformity, by continuous flipping of the sample and then the sample is fermented by adding an appropriate amount of water estimated at (24%) to the sample powder where the fermentation period is two to three days [9]. Dimensions (7* 3.5 * 2.5 cm) and then left the specimens in the air for drying for at least two days to dry at room temperature and then dried samples of the laboratory bricks also after the formation in the drying oven type Binder at 110 C° and for (24) hours [10].

B. Pressing method

The samples were then prepared and then grinded to 300 microns, and 700 g of each sample was taken and water (8%) was added to the sample and then mixed thoroughly by hand and sieves The samples were then stored in sealed bags for the purpose of fermentation and to avoid loss of moisture from the samples. They were placed in a refrigerator for more than 24 hours and then the samples were compressed using a single-axis hydraulic piston with dimensions (diameter 50 ml, height 60 ml) With a pressure of 250 kg / cm^2, and samples were dried [10].

- **Burning of samples:** The incineration operations were carried out for the samples prepared in the electric oven of the Iraqi Geological Survey and as detailed in Table -1.

Table 1- The brick burning program under study.

Temperature C °	Maturation (hour)	Heat lifting rate (C ° / min)
950	1	4
1100	1	4

- **Quaternary deposits assessment in Playa**

The analysis of the size fraction in a hydrothermetric method was used to identify the clay, sand and silt content and the texture classification of these sediments by drawing the relationship between the weights of the basic components (sand, silt, clay) on the Folk triangle [11], Figure -2 In addition to an examination of its plasticity according to the world divisions of Atterberg.

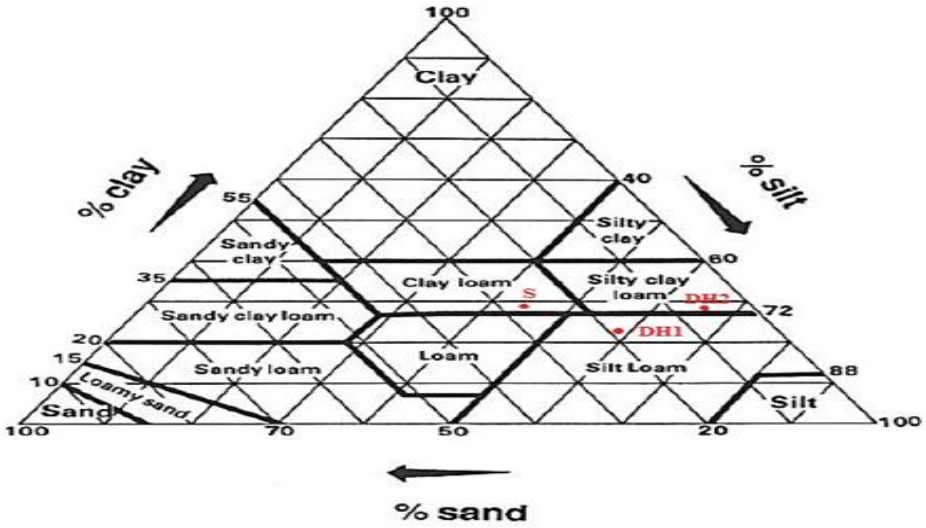

Figure 2- The relative distribution plot of clay, sand and silt parts According to the classification of Folk [11].

Sampling Inspection: Done physical tests and mechanical tests: Linear and volume shrinkage, color, Water absorption, Efforescence, and compressive strength, As well as mechanical tests: compressive strength The results of the physical and mechanical tests of laboratory bricks samples prepared by extruding and pressing methods from modern sediments were compared with the Iraqi Standard No. (25) for the year 1993Table- 2

Table 2-Iraqi Standard No. (25) for the year (1993) for the manufacture of bricks

Categories	Minimum pressure tolerance Kg / cm ^{2}		Upper limit for water absorption (%)		Efforescence (Salts)
	Pressure bearing rate for one brick	Pressure bearing rate for ten brick	Absorption rate for ten brick	Absorption rate for one brick	
Class A	180	160	20	22	Slight
Class B	130	110	24	26	Moderate
ClassC	90	70	26	28	-

- **Study results**

The use of agricultural soils in the manufacture of regular bricks in Iraq has a negative effect on arable land areas. .So began to interest in finding alternatives to these sects and was directed by using and study the possibility of validity of the modern deposits in Al- Muthanna Governorate. After the experiments, the success of the modern deposits was shown without the addition of materials or treatment. The results of the size fraction of the study samples showed that the percentage of the silt was predominant in the three sites as a whole. The percentage ranged between (45.0 - 66.0). The sand ratio ranged between (6.0-27.0) while the clay percentage ranged between (23.0-28.0). Table -3.

Table 3-Results of the size fraction analysis of the soil of the study area.

Sample No.	Clay (%)	Silt (%)	Sand (%)	Total %
DH1	23.0	59.0	18.0	100
DH2	28.0	66.0	06.0	100
S	28.0	45.0	27.0	100

- **Atterberg's check results**:

The plasticity limit for the study samples ranged from (19.956% to 22.104%). The liquidity limit for the study samples ranged from (23.923% to 25.958%). The elasticity of the study samples ranged between (3.850% - 4.097%), Table -4. The study samples were divided according to the plasticity coefficient [12]. The samples of the three sites are located within the Poorly Plastic field, Table -5.

Table 4- Results of the Atterberg limit tests for the study samples

Sample No.	(Atterberg limit)		
	Liquid limit (L.L) (%)	Plastic limit (P.L) (%)	Plasticity lndex (P.I) (%)
DH1	23.923	19.956	3.967
DH2	25.928	21.831	4.097
S	25.958	22.104	3.850

Table 5- Samples of the study according to the coefficient of its plasticity based on classification [12]

Classification	Plasticity Index	Sample No.
Super plastic	> 25	
Plastic	15 – 25	
Moderately plastic	7 – 15	
Poorly plastic	< 7	DH1, DH2, S
Non plastic	Not forming a plastic mass	

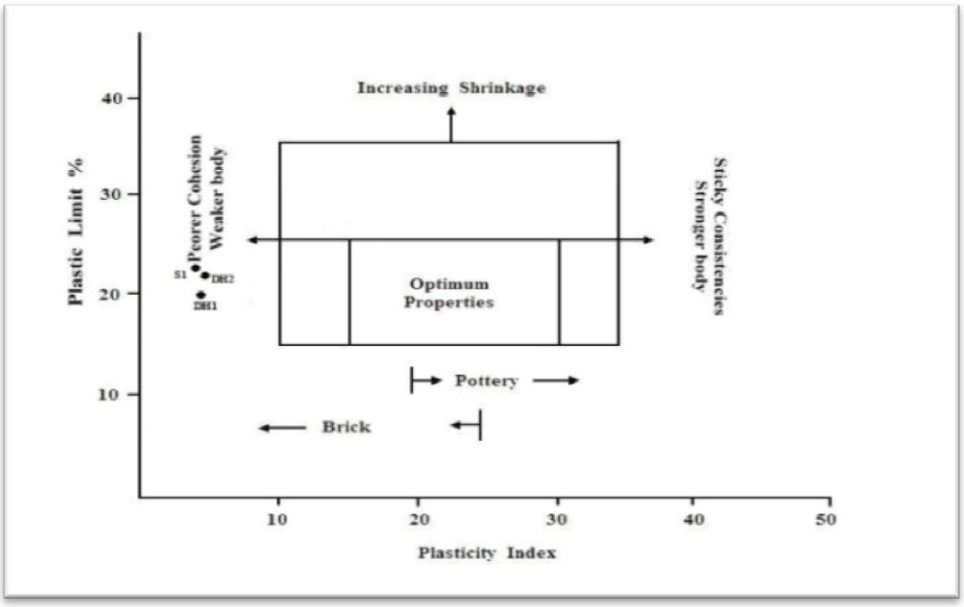

Figure 3- Distribution of the studied sites on the plan of the validity of mud according to the British Geological Survey of the [13].

- **The results of the tests of the evaluation of the samples of the bricks prepared by extrusion**

1. Color and exterior shape:

The colors of the samples of the three Quaternary deposits examined before the burning process between light red and brown and after burning at temperatures of (950-1100) C° the colors of these samples varied. The colors of the samples were burned at (950) C° for sites (DH1, DH2, S) with yellow-brown colors, Figure-4, At (1100) C°, the sample colors of the sites (DH1, DH2, S) were pale yellow to white. The main reason for the change in the colors of the brick samples after the burning process was the interactions between the clay paste components during the burning process, The most important reactions are oxidation of iron and organic matter at temperatures (350 - 950) C°. After the burning of the samples at a temperature of (950) C° were all of the dimensions of regular and the angles of the list and the edges of the straight and sound and flat surfaces and free of cracks, while the samples burned at a temperature (1100) C ° failed has been characterized by cracks in the body bricks and break the edges During the burning process.

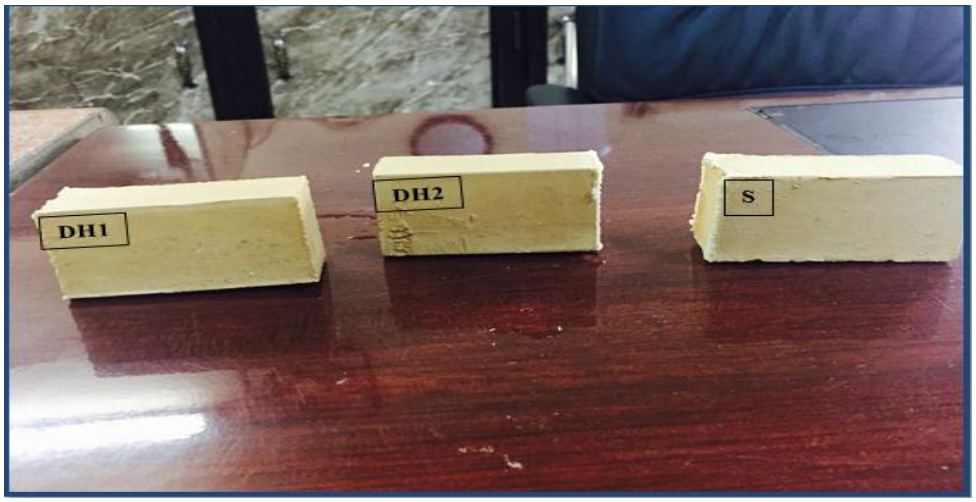

Figure 4- The colors of the samples of the blocks prepared by extruding and burned at a temperature (950) C°.

2. Linearand volume shrinkage after burning

The length of the samples manufactured at burning temperatures of (950-1100) C° for the semi-parallel forms prepared by extruding method is observed to be less than the original length before burning. This is due to the loss of water in the crystalline structure and consequently the breakdown of the crystalline structure at burning temperature Between 750 C ° and 850 C ° [14]. Increased water loss increases the overall porosity of the samples. The continued combustion and high temperatures and the start of the process of sintering at a temperature of 1000 C ° working on the convergence of granules from each other and eliminate pores between them and the occurrence of longitudinal contraction.

The Linearand volume shrinkage is positively affected with the increase in the proportion of clay in the samples. The percentage of shrinkage increases as the ratio of the clay increases due to increased water loss by burning.

3. Water Absorption

There is an inverse relationship between water absorption and increasing burning temperature [15]. This is due to the start of sintering at 1000 C ° [14], which binds the grains together and closes pores. (6). The continued rise in temperature to 1100 C ° causes a significant reduction in water absorption and porosity due to the formation of the glass phase.

4. compressive strength

The positive relationship between burning temperature and compressive strength can be explained by the fact that the persistence of high burning temperatures leads to the bonding of the granules with each other and then closing the pores between them as the process of Catered of the burned body begins. As a result of the increase in the compressive strength values of the burned samples, the compression ratio of the brick samples prepared by extrusion method decreased with increasing burning temperature, Table -6 due to small cracking in the brick body which facilitated the escape of the gases during combustion, In the values of compressive strength [16].

5. Efforescence

The results of the experiments of burning the samples at temperatures (950-1100) C° showed positive data with respect to the lack of Efforescence or slight appearance, Table-6, indicating that the recent deposits of the era of the Quaternary free of sulfur (SO3) or exist in very small proportions , Figure-5.

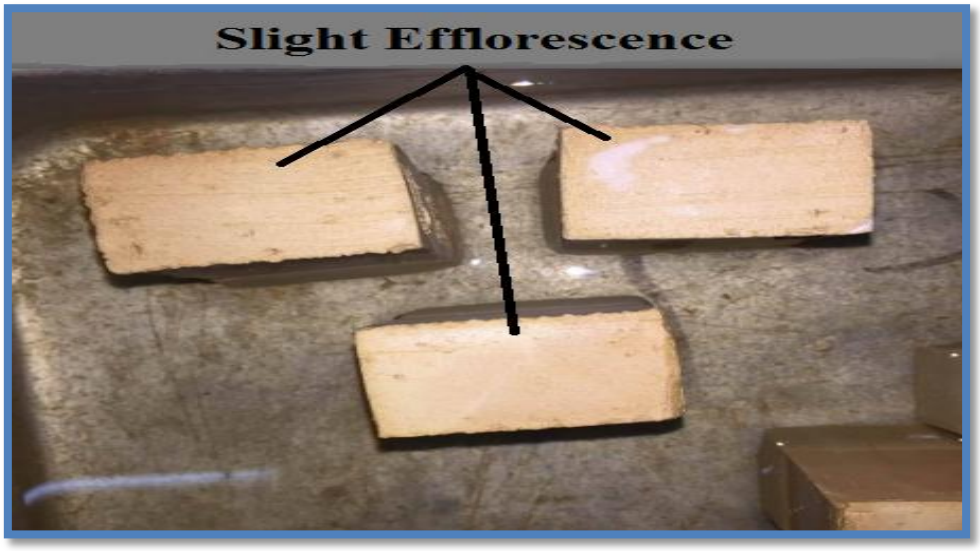

Figure 5- The process of Efflorescence for samples of laboratory blocks prepared by extruding and burning at a temperature of (1100) C°

- **Assessment of laboratory bricks under study**

The results of the evaluation tests of laboratory brick samples (prepared by extrusion method) were compared with Iraqi Standard No. 25 for the year (1993). Table-5 shows that the samples burned at 950 C° for all three sites under study (DH1, DH2, S) are categorized as (C), Table -6, When the

samples are burned at a temperature of (1100) C°, it is observed that their results are unsuccessful due to a very low compressive strength, although the degree of Efflorescence is low and the water absorption rate is low. The occurrence of cracks and imperfections in the ceramic body of the bricks during incineration due to the failure or some cracks in the body of the blocks to contain a high percentage of the silt and a small amount of mud, which did not get the process of Catered and Glazing ceraamic, which increases the value of compressive strength and thus be outside the Iraqi standard No. (25) For the year (1993) for the manufacture of bricks.

Table 6- Results of physical and mechanical tests of laboratory brick samples prepared by extruding and burning method at (950-1100) C° and distribution of samples prepared according to Iraqi Standard No. 25 of 1993 for the manufacture of bricks

Burning temperature	Sample No.	Dimensions of the brik cm			Linearand shrinkage %	Volume shrinkage %	Physical properties			
		Length	Width	Height			Compressive strength (kg / cm^2)	Water absorption %	Efflorescence	Class
950 C°	DH1	7.10	3.72	2.49	1.2	4.0	90	27	Slight	C
	DH2	7.13	3.72	2.48	0.6	4.7	94	27	Slight	C
	S	7.13	3.70	2.51	1.6	3.4	102	26	Slight	C
1100 C°	DH1	7.06	3.73	2.47	0.5	3.6	6.8	19	Slight	Failed
	DH2	7.11	3.70	2.46	0.3	4.4	49	16	Slight	Failed
	S	7.10	3.69	2.50	2.0	4.6	41	18	Slight	Failed

• The results of the tests for the evaluation of the samples of the bricks prepared by pressing

1. Color and exterior shape:

The samples of the bricks of the first site (DH1) failed after 24 hours of burning. The samples were suddenly broken at room temperature, so they were only tested for Compressive strength and were not subjected to an examination to examine the water absorption of water and the degree of Efflorescence. The sampling of the bricks of this site and prepared by the method of pressing is a failure. The samples of the second site (DH2) have been preserved after the process of burning at temperatures (950 - 1100) C° did not show any cracks or cracks, in respect of the samples belonging to the site (S), which was burned at temperatures (950 - 1100) C°, where some cracks and curvature of the outer edge appeared, Figure -6.

Figure6- The outer shape of the brick samples prepared by pressing the third position (S)

2. Water absorption

The samples of the extrusion brick with the water absorption values are higher than the values of the brick samples prepared by the pressing method, due to the presence of fracture and cracks in the samples of the brick prepared by extruding, which helped the escape of the gases during burning and thus led to an increase in the values of water absorption Table -7 As well as that the pressing reduces the porosity and thus reduce the water absorption rate, Table-7.

3. Efflorescence

The degree of Efflorescence of the burnt brick samples at (950) C° and the two locations (DH2, S) were all Slight Efflorescence, Fig. (7). As for the temperature (1100) C°, since all samples taken from the signatories (DH2, S) were Nil Efflorescence, Table-7.

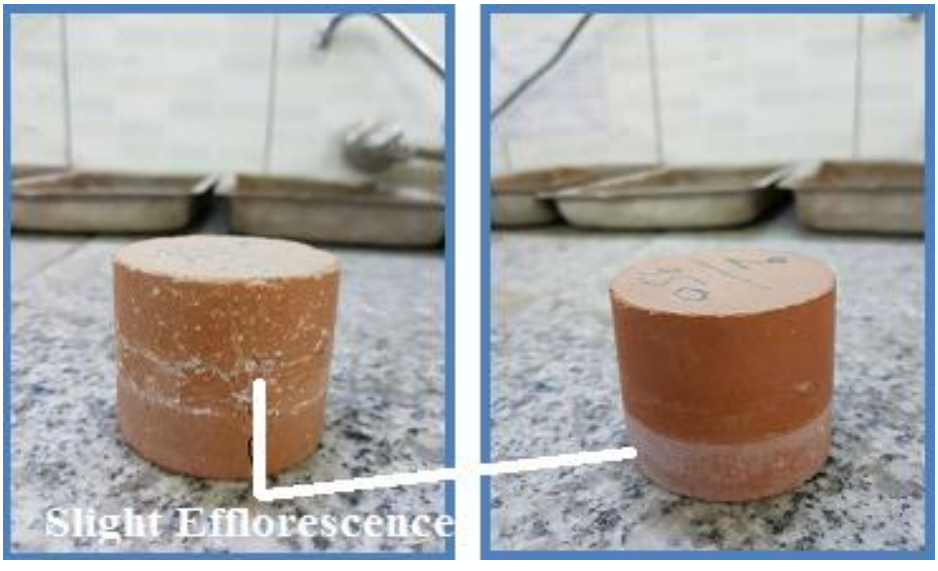

Figure7- Efflorescence process of brick samples prepared by pressing the two sites (DH2, S) and burned at 950 C°.

4. Compressive strength

After observing the results obtained for the three sites under study, it is noticed that the values of compressive strength increase by increasing the temperature at a temperature of (950) C° ranging between 94-194 (kg / cm^2), and ranged at the temperature of (1100) C° between (96-209) (kg / cm^2), Table-7.

- **Assessment of laboratory brick under study**

The samples of the laboratory brick (prepared in semi-dry pressing) and burnt at (950-1100) C° were evaluated. After comparing them with the Iraqi Standard No. 25 for the year 1993, Umm Al-Fars 2 (DH2) and burnt at (1100) C° within class (A) The samples that were burned at a temperature (950) C° classified in class (B), Samples of the site Al-Salhubia (S) burned at 1100 C° were classified as (B). The samples that were burned at 950 C° were classified as failed due to high water absorption values. Table-7Samples of the first site Umm Al-Fars 1 (DH1) were considered unsuccessful due to fracture of samples at normal temperature.

Table7- Results of physical and mechanical tests of laboratory brick samples prepared by pressing and burning at (950-1100) C° and evaluation of samples prepared according to Iraqi Standard No. 25 of 1993 for the manufacture of bricks

Burning temperature	Sample No.	Physical properties			
		Compressive strength (kg / cm^2)	Water absorption %	Efflorescence	Class
950 C°	DH1	96.8	Failed	Failed	Failed
	DH2	193.6	24	Slight	B
	S	94.2	33	Slight	Failed
1100 C°	DH1	117.1	Failed	Failed	Failed
	DH2	208.9	22	Nil	A
	S	95.5	26	Nil	B

- **Conclusions and recommendations**

All samples manufactured from recent clay are characterized by homogeneous colors after burning and have straight surfaces and free of cracks and fracture with homogeneous sections well and nil or slight Efflorescence .

The results of the physical and mechanical tests of the laboratory bricks were verified by two methods of extrusion and pressing with the Iraqi Standard No. 25 of 1993 for the manufacture of clay bricks the samples produced are valid for the manufacture of the bricks by the way of pressing in the playa of the Umm Al-Fars2 after burning them at (1100,950) C° of Class A and B.

The researcher recommends increasing the maturation time to more than one hour (two hours or more) for the purpose of giving sufficient time for the components to disintegrate and new phases give the bricks the desired durability.

The researcher recommends to carry out a laboratory experiment and produce a bricks with a dimension of (21 * 11 * 7) cm and burn it with a laboratory of the working bricks working according to the operational conditions of the laboratory to a temperature of (1100,950) C°.

The researcher recommends that the study follow the pattern of experiments on the recent clay of the Quaternary sediments in Al- Muthanna Governorate because they are characterized by good chemical and physical specifications for the manufacture of bricks.

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