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Abstract:

The ruins of the structures built in the wall of Qena, which are built of red and mud bricks, dating back to the Roman era. These ruins suffer from several aspects of damage such as cracks, disintegration and peeling, hard crusts, crystallization of salts, fractures and growth of microorganisms, and the aim of this study is to study the damage of red bricks so that a treatment plan can be prepared that suits their condition Currently, modern scientific methods have been used such as polarizing microscopy (PLM) and electron microscopy coupled with energy-dispersive X-ray spectroscopy (SEM-EDX) and X-ray diffraction (XRD) and X-ray fluorescence (XRF) have been used to identify the mineral composition and damage products of bricks, the results showed the crystallization of halite salt which due to the severe effects of Existing damage factors and due to the prevailing environmental conditions, Suitable water-resistant materials such as ethyl silicate (TEOS) can be used to strengthen weak brick units and also provide protection from sodium sulfate. To re-install the separated brick blocks, wholly or partially, lime mortars can be used from the same site with the addition of primal to improve its mechanical properties. Titanium dioxide (TiO2) nano coating can be used to prevent the growth of microorganisms on bricks.

Key words: Qena Wall , well, the Golden Triangle, red bricks, damage, proposed treatment,

دراسة تلف مباني الطوب الاحمر بمنطقة حائط قنا، المثلث الذهبي بمصر وخطة العلاج المقترحة

ملخص الدراسة :

شيدت أطلال المباني التي تقع بحائط قنا من الطوب الأحمر والطوب اللبن و تعود إلى العصر الروماني، وتعاني هذه الأطلال من عدة جوانب من التلف مثل التشققات و التفكك والتقشير و القشور الصلبة و تبلور الأملاح و الكسور و نمو الكائنات الحية الدقيقة ، والهدف من هذه الورقة البحثية هو دراسة الأضرار والآليات التي تؤثر على وحدات الطوب لهذه الأطلال حتى يمكن إعداد خطة العلاج التي تناسب حالتهم حاليًا ، وتم استخدام الأساليب العلمية الحديثة مثل الاستقطاب المجهري (PLM) والمجهر الإلكتروني إلى جانب التحليل الطيفي للأشعة السينية المشتتة للطاقة (SEM-EDX) وحيود الأشعة السينية (XRD) لتحديد التركيب المعدني وتلف منتجات الطوب كما أظهرت النتائج تبلور كلوريد الصوديوم وكبريتات الصوديوم (ثيناردييت) نتيجة للتأثيرات الشديدة لعوامل الضرر الموجودة وبسبب الظروف البيئية السائدة، ويمكن استخدام مواد مناسبة مقاومة للماء مثل سيليكات الإيثيل (TEOS) لتقوية وحدات الطوب الضعيفة كما انه يوفر الحماية من كبريتات الصوديوم، ولإعادة تركيب كتل الطوب المنفصلة كليًا أو جزئيًا يمكن استخدام مونات جيرية من نفس الموقع مع إضافة مادة البريمال لتحسين خواصها الميكانيكية، ويمكن استخدام طلاء نانو ثنائي أكسيد التيتانيوم (TiO_2) لمنع نمو الكائنات الحية الدقيقة على الطوب .

الكلمات الدالة : حائط قنا – الابار– المثلث الذهبي_ الطوب الاحمر– التلف– العلاج المقترح .

1. Introduction.

Qena Wall consists of a mud and red brick building, with the exception of some of the lower defensive wall of the slabs. The fortress's towers are located in three corners of the fort. Most of the inner buildings of the fortress were constructed of mud and red bricks and preserved to a certain extent. In addition to the west, there is a huge rectangular tank that is partially lined with red bricks and contains two wells, it located to the east of the new road, the Red Sea Road linking Qena to the Sohag - Safaga road, and 200 meters from the new road, which allowed the opportunity to visit it as it is before that it was difficult to reach in the heart of the desert, the means of private transportation equipped for those desert places.

The fort is built of red and mud bricks, and the maximum dimensions of the external walls of the fortress are 35 x 75 m, and the average thickness of the walls is about 60 cm, and the height of those walls 8 meters long, there are three watchtowers that the entrance to this fortress was located on the southern side facing the lower castle, which is located in the valley. Most of the northern wall of this fortress does not exist and there are no remains of it. This fort may have been used as a watchtower for the area. The second fortress located in the valley is similar to other forts in the area. The area of the castle is about 76 x 45 meters. The entrance is surrounded by two towers in the form of a semi-circle of red bricks and mud. It is noted that it is destroyed and in poor condition. There is a red brick square tower in the east gate tower. The height of the remaining part of it is about 8 meters. The construction of the walls of the fort is generally of mud mortar and gravel in the lower part, and the remaining parts contain additions of mud bricks in the upper part. Inside the gate on the western side there is a

huge rectangular tank partly lined with red bricks. The fortress also contains two water wells, and inside the fort there is a tower of mud and red bricks, and there is also a passage for the southern wall of the fortress, perhaps a waterway that connects to the reservoir inside the fort by a canal.

This study aims to shed light on the antiquities area to take the necessary measures so that it can be included within the archaeological sites, Several scientific techniques were used to identify the characteristics of the damage and the source of the raw materials of bricks. , which are obtained by mixing the mountain valley silt which extracted from the sediments of the flood plains in Wadi Qena with the possibility of introducing other components rich in calcium carbonate, and this is a goal for the future conservation strategy to make the new materials compatible with the archaeological components for use in restoration work, Which contributes to the preservation of those archaeological sites under study.

Red brick is the result of industrial technology and is a natural or unnatural mixture of sediment that is used in the manufacturing process[i], as the microscopic study shows the geochemical composition, mineral composition and deterioration characteristics of the bricks in the study area so that basic data can be provided About the methods of manufacturing bricks in that period and this desert site., to determine the possible source and the possible raw materials that were used in the manufacture of bricks and the possible burning methods that were used in the past so that they can be used and compared to them in the restoration and maintenance work in the future[ii].

The study area is characterized by a hot desert climate due to its geographical location, and it is possible that the raw materials used in the bricks are from the valley

deposits in Wadi Qena, which are characterized by suitable physical properties in terms of particle size distribution, clay content and plasticity. The new study is based on calcareous clay materials consisting of decomposed products of carbonate limestone near the Eocene that are mixed with clay materials reconstituted from pre-existing sediments in the area.

1.1.Red bricks decay

Linear expansion meter is used to measure freezing expansion in building materials[iii]. The combustion process of bricks is one of the main ways to test the durability of bricks, and the raw materials used in the bricks' composition and processing methods can affect the short- and long-term changes that occur to the bricks when exposed to moisture ،and some lime materials are friable unless treated with steam or water during the drying process, as bricks made from raw materials rich in fiber kaolin attributed to the fact that kaolin materials need a higher firing temperature, and bricks with a lower sulfate content should be chosen, as they expand at lower temperatures more and absorb [iv], Less strong, and more susceptible to damage than bricks fired at high temperatures, and many components of bricks have a relatively short vitreous range which is the period between low combustion to optimal combustion in brick production processes[v], it appears that the use of temperatures above the optimum levels causes a series of high-temperature stages to crystallize, with a corresponding increase in strength and a decrease in the degree of water absorption, and the occurrence of moisture expansion.[vi]-[vii].

Bricks are damaged by cracks and dust. Moisture penetration into cracks or porous passages of bricks often causes varying degrees of damage, but the expansion of

mortar due to sulfate attack causes damage to bricks and mortars in some cases, damage of the bricks also contain some small cracks between the bricks and mortar, This increases the rate of water permeability in brick walls, and it is often noted that the mortar decomposes faster than bricks in many cases, and the interaction between tri-calcium aluminate, the dissolved salts in bricks are also an important source of sulfate.

To assessment the damage of brick buildings, in terms of physical description, determining the pH, determining the rate of water absorption or determining the degree of permeability, and hardness tests, in addition to measuring the content of sulfates and nitrates, and measuring the penetration of air and water. Determine the rate of damage by detection. Indirectly from hydroxyl or water by visible infrared light or by microwave techniques, acoustic methods can also be used to detect the rate of damage and estimate the hardness. This is to detect areas of surface damage, it may also be helpful to do some measurements on the surface of the bricks and at various depths inside the wall.

The restoration and preservation process is carried out by cleaning and painting the walls to increase their resistance to solutions or penetration by atmospheric sediment[viii].

The expansion behavior of clay in bricks which contain high percentage of lime content shows 2 types of cracks in the bricks, this are related to the stresses result from dimensional changes during the firing process[ix-x]. physio-chemical properties of bricks have some decrease in the strength degrees of the bricks, under some harsh conditions to which the bricks are exposed [xi-xii], The potential expansion of fired bricks due to moisture can be determined by the molecular ratio (CaO + MgO) / K_2O + Na_2O of unburned bricks [xiii].

The mineral and chemical composition of the bricks have an influence on determining the degrees of moisture expansion in the fired bricks, and there is a relationship between the maximum humidity expansion and the content of mica or kaolinite in bricks.

From quartz - kaolin - mica, there is also a linear relationship between the highest degree of moisture expansion and the molecular ratio of aluminum oxide Al_2O_3 / carbon C / potassium oxide K_2O +sodium oxide Na2O for the same type of clay with no additional flow factors, and the maximum moisture expansion depends on the chemical composition of the bricks when there are flow factors Additional [xiv].

Typical freezing curves show the presence of expansions, and this may be applied as a simple test by which to evaluate the strength and durability of bricks[xv]. The moisture expansion of bricks can be controlled to a certain degree, and the expansion due to unconstrained moisture must first be determined over a period of five years, as accelerated brick damage tests produce some results from which the rate of expansion can be predicted in the long run [xvi]-[xvii]. Expansion and damage to the bricks may occur due to the reaction between the sulfate in the solution and the hydrated tri-calcium aluminates. [xviii].

Water-soluble salts are present in the bricks as a result of exposure to external factors, as the salts are transferred to the bricks from the surrounding environment, where sodium chloride penetrates the bricks from the soil in the presence of a high proportion of relative humidity, and the dissolved salts crystallize in many phases and result in Micro cracks in the bricks (Fig. 10) which results in a decrease in the physico-chemical properties of the bricks[xix].

Brick damage is a complex phenomenon in its study (Sakar, 1992), where bricks go through many different damage mechanisms, which result in the occurrence of different forms of damage, such as cracks, decomposition, melting and weak cohesion[xx].

Burnt bricks go through several stages of drying in the sun, then the process of burning in brick kilns at temperatures between 500-700 degrees Celsius, where it turns into red bricks. The bricks are currently used in two forms: small bricks and large bricks, and the combustion stage is one of the critical stages in the brick manufacturing processes, where the bricks acquire hardness and durability, and the temperature is raised slowly and gradually to evaporate all the water associated with the bricks physically or chemically, then the temperature is raised To the level required for the production of red bricks [xxi].

There is a relationship between the rate of moisture expansion in burnt bricks in the presence of water vapor[xxii-xxiii]. A case of cracking and cracking occurs in the bricks as a result of the migration of soluble salts from red bricks to mortar, and the most effective are those soluble salts in red bricks. Therefore, the efflorescence of salts is considered more than a problem that affects the bricks from an aesthetic point of view; Rather, it goes beyond that and affects the stability of dimensions and the durability of brick construction, Diversity of moisture content leads to smaller volume changes in well fired bricks when compared to mortar used, and expansion of fired bricks when wet, as a result of volume differential changes between bricks and mortar due to variation in moisture content, which are greater than Those resulting from those normal changes as a result of changes in temperature and changes in volume of bricks are less in the case of sandy limestone mortar.

And by studying the effect of glass on the components of burnt bricks, which had expanded due to moisture, a liquid phase which result of it. the glass phase which formed during the brick burning processes, and studies indicate that the glass phase in the components of the burned brick is not considered a major cause of moisture Studies have also shown that in the event of an increase in the glass content in the components of the burnt bricks, this leads to a decrease in the rate of moisture expansion of the burned bricks, and this may be as a result of a decrease in physio -chemical properties f bricks as porosity and surface area,[xxiv]. and insects as termites cause many of Damage in compounds of bricks[xxv], in addition to the growth of microorganisms, and the low temperatures of burning bricks may have a key role in [xxvi].

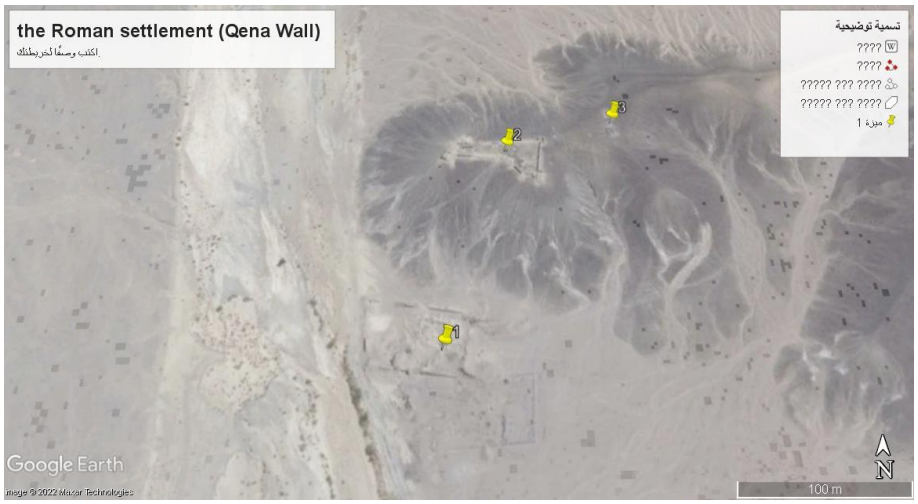


Fig.1. Location map of study area, Google 2022.

Location 1., It is believed to be the Valley Temple as a site of worship for the garrison present.

N: 26.607304°

E: 32.762769°

Location 2. and 3., It is believed that they are the locations of the existing military garrison, and it is noted

that they are located in two separate locations and in different spatial levels.

Location 2 N: 26.608597°
E: 32.763224°

Location 3 N: 26.608770°
E: 32.763982°

a

b

c

d

E

f

Fig.2 showing the red bricks from which the walls and wells are built in the study site and it shows the loss of parts of the bricks, in addition to the weak cohesion of the brick components and the appearance of some cracks and salts.

2.Materials and methods

Field observations were made during the year 2020 to 2022 for the study area to characterize the characteristics of the bricks and the degree of damage through visual study processes, non-destructive samples were collected from the walls and well sites, brick samples were taken. Randomly from walls and wells (the ruins of the built structures in Sur Qena, Egypt) to study the deterioration condition, Petrographic by Nikon polarizing microscope. JEOL JSM5500LV, Central Laboratory, South Valley University, Egypt, XRD (Phillips diffractometer, Cu K radiation, XRD lab. central lab., Sohag Univ., Egypt), the Chemical analysis were studied by XRF, Central lab., South Valley Univ., Egypt, scanning electron microscopy (SEM, Central Lab., South Valley Univ., Egypt was used to study microstructure, decomposition and different

texture properties of the red bricks under study. In order to identify the geological origin of brick raw materials.

3.Results

During field observations of the red bricks of the wells under study, many signs of damage were found. Fig. 2. It shows some more decomposition, such as discoloration of red bricks (a, b); efflorescence salts especially in the lower regions (d); the presence of some droppings of insects, reptiles and rodents (e); the presence of cracks in the surface crust of red bricks (d); The mortar compounds decomposed between the bricks (c and d), and some parts of the bricks turned into powder (c); partial and complete collapse and weakening of the brick structure (a and b); Sharp edges and semicircular corners are eroded by bricks (b); Numerous pits in the bricks (d), the presence of previous effects of water and moisture, which may have been caused by rain or torrential rains scattered in the area (c); Brick roofs are given sintered layers of earth and sand tipped in area (c); Partial collapse of some parts of the red brick (b, c) and the presence of bird and insect nests on the roofs of the red brick (c). This led to the brick losing its aesthetic shape and was seriously affected by many decay factors that had an important role in the deterioration of the red brick walls. Micrographs of the thin section of brick samples taken for study by PLM. Fig. 3, This is explained by the presence of a coarse texture containing large grains of abortive dyed with iron oxides. Calcium silicate minerals (C) can be observed. (e) The microstructure resulting from the presence of the newly formed abortive clusters; (f) Presence of reunite and edit as non-essential minerals, bricks show small cracks and cracks, resulted of presence of apatite and tourmaline, which leads to increased secondary porosity.

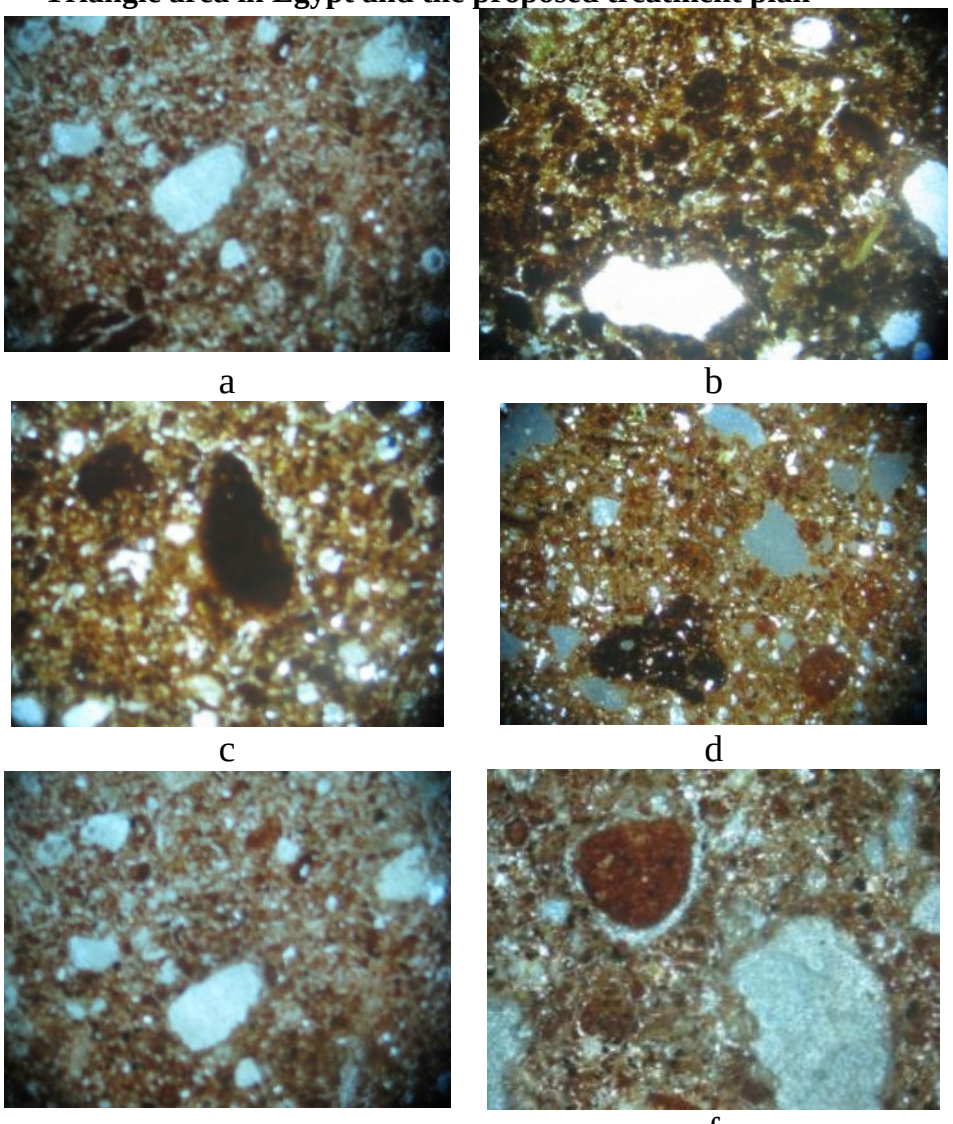
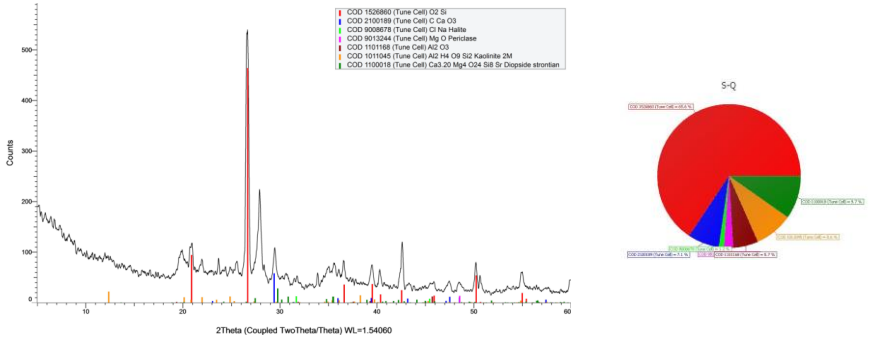


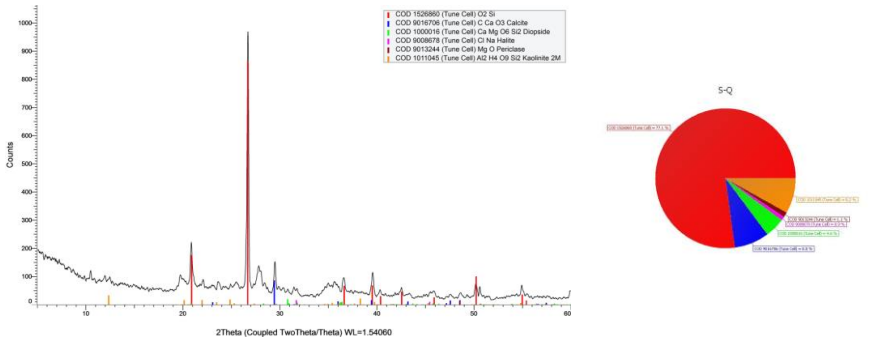
Figure (3) shows red weathered bricks by PLM, a. Quartz granules, b. Micro granite, c. Chopped straw, d. Deformed Alanite Crystals, e. Crystallization of Mica into Secondary Chlorite and epidote, f. Iron oxides dyed calcite grains in brown.

XRD analyses of the bricks reveal that: The Mineral composition of the whole sample of the ancient brick

includes: Silicone dioxide SiO_2 calcium carbonate $CaCO_3$ sodium chloride NaCl, Magnesium oxide MgO periclase, Kaolinite , Diopside , Feldspar, Prehnite , Apatite, Tourmaline , Anorthite ,], dolomite , tridymite , illite , mullite . the refined unit cell dimensions and volume of quartz constituting the main content of this sample are typically the same of those of the theoretical one fig. 4.



a



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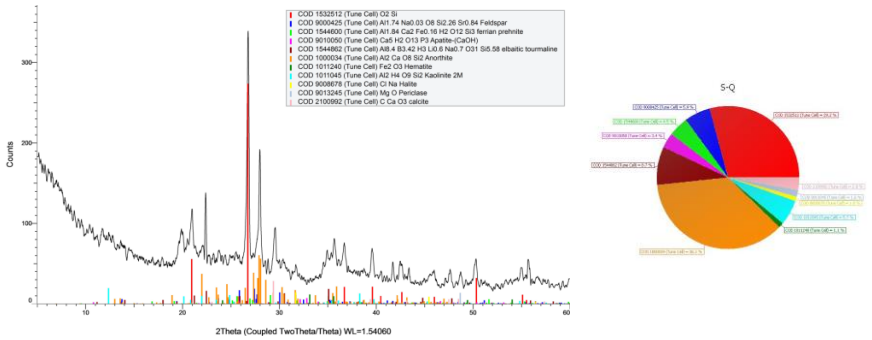

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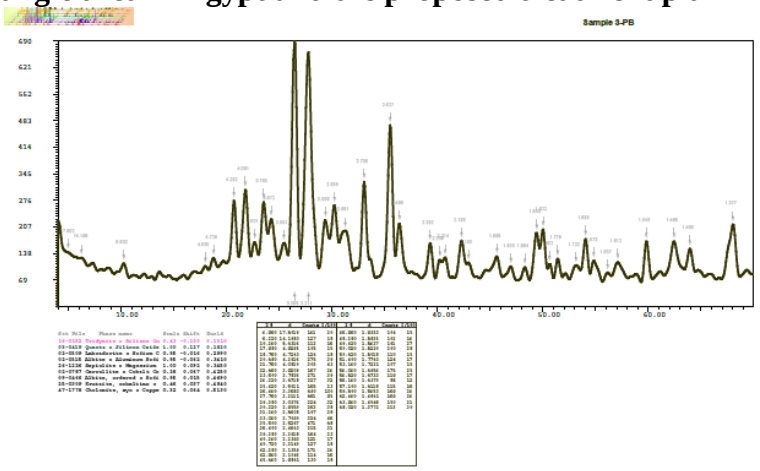


D

fig. 4. XRD analyzes of bricks samples.

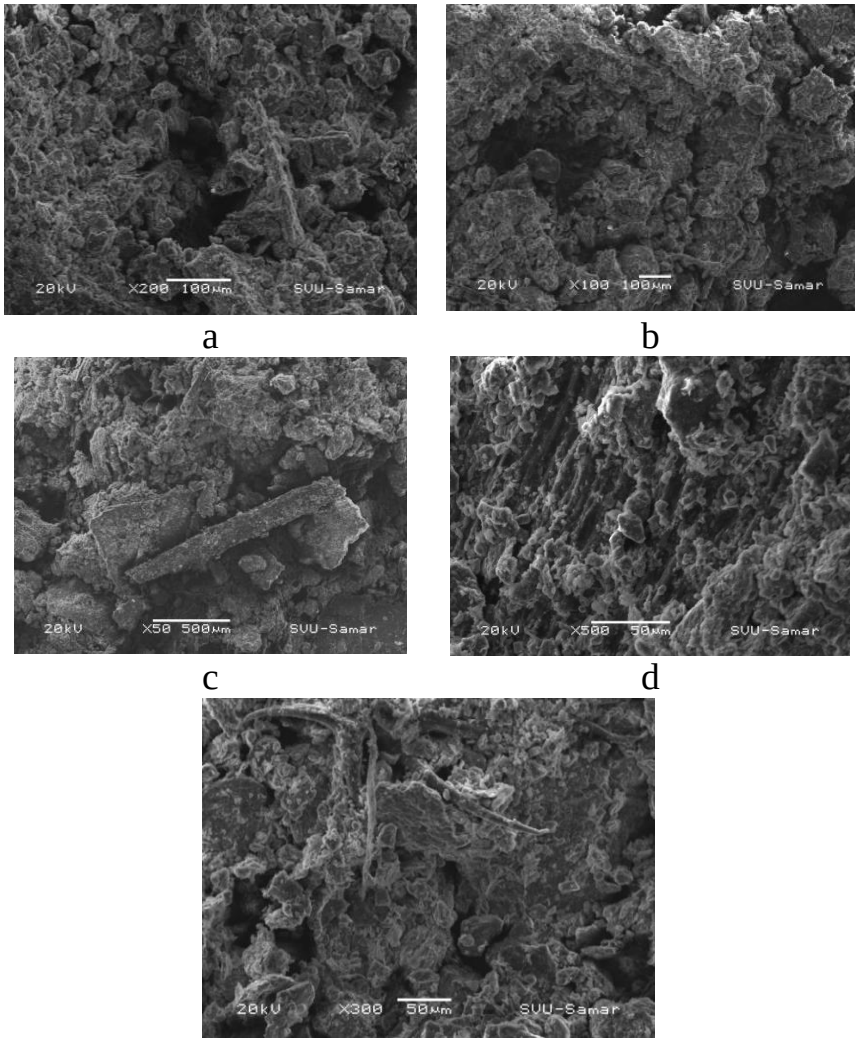
The analytical results of the samples using XRF that were examined showed that bricks are strongly affected by deterioration factors, and what was obtained helps to understand the mechanisms of deterioration in it tab. (1).

Tab. (1) shows the XRF analysis of the study for weathered red bricks.

Main Constituents Wt%	(a)	(b)	(c)
SiO_2	42.0204	43.1274	42.2304
TiO_2	2.7365	2.4688	2.3255
AI_2O_3	11.0060	11.4563	10.4593
Fe_2O_3 tot.	19.9307	19.2481	19.2536
MgO	1.6055	1.5964	1.6244
CaO	14.6756	14.1607	14.5215
K_2O	2.0694	2.0852	2.0622
SO_3	2.8944	2.7824	2.8533
MnO	0.2876	0.2862	0.2802
ZrO_2	0.1026	0.1037	0.1072
SrO	0.1815	0.1838	0.1843

V_2O_5	0.0734	0.0722	0.0733
ZnO	0.0635	0.0636	0.0620
P_2O_5	2.3531	2.3652	2.3544

some weathered brick samples that were studied by scanning electron microscope (SEM) showed that the bricks were strongly affected Which shows the presence of cracks fig.5.



a b c d e

Fig. (5) SEM microscopic study of red bricks a. the occurrence of Cracks and ruptures in the internal

masonry of bricks, b. chopped straw, c. The growth of fungal hyphae, d and e. halite salt ,Sodium chloride.

4.Discussion

This paper offers an archaeological assessment of the very significant and forgotten archaeological site of Qena Wall , conspicuous remains of fortress buildings possibly belonging to a large Roman settlement in the study area were discovered by the author. The initial field investigation suggests the functioning of metal-producing center in the study area, it should be mentioned that there is a high possibility of close links existing between the ancient mining activity in the proximal mountains and the evidence for the functioning of metal-processing center on the site, confirmed by archaeological materials present in the study area. For now, it cannot be positively stated either.

From the study, the construction method used in constructing walls and water wells was clarified. The dimensions of the bricks were approximately 28 x 14 x 6 cm. Bricks contain organic and inorganic materials, mainly Wadi Qena sediment clay, sand, lime and animal dung, as well as straw as a binding material. Pottery fractures were added after grinding well to improve the mechanical properties.

The study of the bricks by polarizing microscope showed that the grains range from fine grains (silt) to very coarse (sand) due to the contrast of the raw clay materials used in the manufacture of these bricks, which contain pottery pieces, fragments of red bricks.

In addition, bricks contain some organic materials such as; Chopped straw (hay) and animal dung. The presence of these materials in the bricks after the burning process is completed caused many various damage, bricks

samples contain inorganic materials, which are represented mainly in quartz, feldspar, mica, alanite, zircon and iron oxide, as well as minerals. Ceresite and chlorite as secondary components and it is noted that all the materials used are related to the Egyptian environment, the varying free crystalline quartz grains were studied In their size and shape, which range in shapes from sub angular to angular, crystals of plagioclase, alkali feldspar, plagioclase have been observed. Micro- crystals appeared in a semi-surface shape in addition to the presence of some additional components such as zircon, pyroxene and amphibole. In addition to numerous stone fragments of various igneous as Micro granite grains resulting from the weathering processes of its rocks, which are located in the runoff from the Red Sea Mountains region, east of the study site, which mixed with the components of the flood plain in Wadi Qena. and silicon rocks, brick deterioration properties are observed, deformed and cracked, as well as the mineral mica (biotite), which strongly transforms into chlorite and Perot, like iron oxides in the studied samples. It is distributed over most mineral grains.

XRD analyses of the bricks reveal that: The Mineral composition of the whole sample of the ancient brick includes: fig.4. a,b and c. showed that bricks consist of Silicone dioxide SiO_2 [65.5% - 77.1- 29.2], calcium carbonate $CaCO_3$ [7.1 - 8.0- 2.8%], sodium chloride NaCl [1.2- 0.9- 1.0%], Magnesium oxide MgO periclase [1.2- 1.1- 1.6%], Kaolinite [8.6- 8.2 - 5.7%], Diopside [9.7- 4.6%], Feldspar[5.9%], Prehnite [4.5%], Apatite[3.4%], Tourmaline [8. %7], Anorthite [36.1%], Hematite [1.1%], fig.4.d. showed that quartz [32.1%], feldspars [31.8%], dolomite [9.6%], tridymite [6.5%), illite [5.6%], mullite [5.3 %].

SEM Studies proved the decay of the bricks and contained of some plant fibers, residual organic matter and chopped straw added during the brick making process. It depends on the organic materials in the bricks for nutrition, The microorganisms damage the bricks such as loss of strength and durability, displacement of mineral grains, and cracking and disintegration of brick components. It also works to activate salt weathering in the bricks, where salt solutions penetrate from the soil to the internal construction of the bricks, which leads to the crystallization of salts when appropriate environmental conditions are available, especially at extreme temperatures, weakening as The disintegration of the bricks occurred due to the high rates of changes in their size as a result of the stresses of the crystallizing salts.

Decay of bricks led to an increase in the porosity in it, in addition to a weakness in the strength and durability of the bricks, which led to the collapse of the internal grains and the occurrence of internal peeling. The internal structure of the granules was ruptured, and some fractures caused an increase in the ability of water and salt solutions to move within the pores of the bricks, which contributes to the melting and loss of brick components, which leads to the disintegration and damage of the bricks. It was also observed that there were large voids in the form of cavities in the bricks, and the microscopic SEM images showed some of the remaining fibers and organic materials that were added during the brick making process, represented by chopped straw and hay, which showed that the burning temperature was not suitable, and the organic materials caused severe damage. It was also observed the crystallization salts such as halite and they corresponded to the XRD analyzes. mineral granules fig.5.

Field observations, analyzes and laboratory study made it clear that the bricks used in the study area suffer from deterioration factors and poor properties, so they need various preservation operations through the work of archaeological studies of the site and the mechanical cleaning required for the crystallized salts on the surfaces of the bricks during drought periods, in addition to completing the missing parts of those ruins.

Bricks become very weak and loses the cohesion between its components due to exposure to many factors of damage special the physicochemical properties and mineral composition of raw materials and the burning temperature of bricks. These conditions played an important role in the deterioration such as; The occurrence of changes in the chemical and physical properties of the bricks, which resulted in scaling due to the crystallization of salts under the surface of the bricks and in the sub-layers, disintegration, cracks, and fractures. Also, moisture penetrates these cracks or into the pore passages causing severe damage to the bricks.

The various damage phenomena also caused the loosening of the cohesion between the bricks, in addition to the weakness of the building components and the internal components of the bricks, as well as the loss of the mortar used to bind the bricks during the construction process.

This study examines for the first time the bricks in the study area, which shows many aspects of the decomposition of bricks, as many techniques, it is obtained by mixing valley silt (extracted from the sediments of the flood plains) with the possibility of introducing other components rich in calcium carbonate. This is a goal for the future conservation strategy to make new materials suitable with archaeological bricks.

5.Recommendation treatment and development

Consolidation of weak brick units using suitable water-resistant materials such as ethyl silicate (TEOS), It also provides protection from sodium sulfate, to re-install the separated brick blocks, wholly or partially, lime mortars can be used from the same site with the addition of primal to improve its mechanical properties. The mechanical removal of dry biological residues is also must be removed, and chemical pesticides can be used to remove it, and prevent its future growth. In addition, titanium dioxide (TiO2) nano-coating can be used to prevent the growth of microorganisms on the bricks, with periodic and continuous monitoring of the bricks to notice any changes in them [xxvii]. Before starting cleaning work, the goal or purpose of cleaning is determined first, as there are many important reasons for cleaning brick surfaces in order to reveal and highlight the aesthetic values of bricks, and cleaning is a necessary work in restoration. Cleaning here means removing harmful components from surfaces such as water-soluble salts and many contaminants. Cleaning is also an important step in preparing the surface for consolidation if needed [xxviii].

In order to development the Golden Triangle area culturally, archeologically and touristically, the Golden Triangle area must be studied in historical times, the history of the region in ancient times, and the history of the region in the medieval period and History of the region in modern times, The methods used in the restoration and conservation of archaeological sites and techniques for the restoration and conservation of archaeological sites in the region and future projects for the conservation and restoration of archaeological sites and the experience of the Ministry of Antiquities for the

registration and preservation of antiquities. The ancient Egyptian religious thought in the region must be studied through textual and archaeological sources and the civilized role in the region through the ages and Artistic and architectural styles of archaeological installations in the region, a study of the historical geography of the region are so helpful for development this region , in addition to a study (administrative development from ancient times to the present age).

Urbanism in the area and study (historical urban stores of capitals and major cities - rural urbanism – urbanization), attention must also be paid to the tourist information and its impact on the rates of tourism growth (tourism programs - flyers - gifts - banners - instructions - methods - ..... etc.).

6.Conclusion

This research paper concluded, through field observations, laboratory tests and chemical analyzes, that red bricks are exposed to various types of damage agents, and the chemical composition and physical properties of bricks are the main causes of brick damage. This is due to the mineral components of the bricks decayed, and the temperature of combustion of the bricks plays an important role in this, as it was found from the examination that was carried out using the PLM polarized microscope that the bricks contain some organic materials such as chopped straw and animal dung, which were added during the manufacturing processes in order to work on Improving the properties of the bricks were burned at low temperatures, which caused many damage of bricks, and the decomposition of many components of the bricks. The study also showed signs of brick damage such as peeling and cracking, salt formation, and partial collapse of walls and wells, and

this was confirmed by various tests. And the analyzes of the study, in addition to the presence of salts, especially halite, which weakened the strength and durability of the bricks, and also helped to accelerate the processes of brick damage. The brick study indicates that the raw clay material that was used in the manufacture of red bricks was local from the same site, where raw materials from Nearby deposits rich in carbonates, which are present within the valley sediments as limestone clay. Help clarify the sources of the raw materials used, which can be used in the restoration work by choosing the appropriate materials that were used in the past, and the temperatures that were used in the burning of bricks, all of this will contribute to the development of an appropriate scientific plan that can be used in the stages of Restoration of the area is under study.

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