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INTRODUCING OF WAXY CLAY BRICKS AS A WATER PROOFING MATERIAL

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ABSTRACT: The ancient Iraqi brickwork buildings are suffering from the rise of under-ground water. Water proofing materials were found to be insufficient to prevent water from climbing upwards by the capillary action. The cycle of salt dissolving / crystallizing near the outer surfaces of clay bricks is considered as the main reason for the deterioration in the function and appearance of old brick constructions.
In this paper clay bricks immersed in liquidized wax were subjected to several standard tests to figure out its advantages compared with ordinary bricks. Experimental results showed that; waxy bricks are impervious, salt quarantining and having an improved compressive strength. This type of improved bricks was employed to build full scale brick walls to monitor its adequacy in preventing water attacks.
Final conclusion: Waxy Clay Bricks can be recommended as a dependable water proofing material in the aim of protecting buildings against water percolation and its consequences.
KEYWORDS: Clay brick, Wax, Water proofing, Salt quarantining, Building appearance

❖ INTRODUCTION

Long ago till now, clay bricks are considered as the most popular Iraqi building material. It has many positive properties, like strength, durability, and simplicity in manufacturing and construction. It can be considered as a perfect material if it can be protected from water soaking. Many researches have been done in this field, [1] had concluded that the addition of 40% fly ash with the row clay will produce bricks having low water absorption compared with those untreated bricks. Unfortunately, no body yet has managed to eliminate bricks absorption completely. Moreover, in practice it is impossible to prevent water from reaching bricks. According to construction methods, bricks should be immersed in water prior to its use as a building material for enabling water to fill the bricks inner voids. This process is done to prevent bricks from sucking water from the cement mortar used to bind it together.

There is also a serious local problem of the high underground water levels in most Iraqi sites. The fluctuating underground water level in a footing zone is a challenge for structural engineers especially when clay bricks are used as a foundation material. Bricks texture normally contains voids, in one way or another these voids can be imagined to be like hair pipes allowing water to climb up for several meters by the capillary action. Taking into account the existence of soluble salts in the brick material means a movement of salt will occur through wet brick walls.

Due to evaporation process, the movement will start from the inner side of a brick to its outer surfaces. This phenomenon will end into two bad results; the first one is the deterioration of any type of finishes while the second one is the more destructive and it can be briefed as follows:

- [2] Mentioned that after lowering the underground water level and the continuing of the surface water evaporation, some of the soluble salts will start to return to its crystallized form before reaching the brick outer surface. Taking into account that the crystallized size of salt is greater than its soluble size, a considerable internal pressure will build up due to the expansion of the hardened salt inside the internal brick voids leading to develop cracks and even fragmentation of a (1-2) cm of the outer bricks surface. Figure 1 shows the trace of salt leached from brick walls and the amount of deterioration occurred due to the cycles of wetting and drying in such unprotected or poorly protected structures.
- [3] Explained the construction method used to deal with water movements in brick buildings. A fine, calcium based, powder is added to a concrete mixture with a mixing ratio of 5% of the volume of cement. This white powder, currently called seca or padlo, was originally mixed with some oily substances during its production process to make it water repellant in addition to its role in filling

most of the concrete voids. The mentioned mixture is used to construct a continuous water proofing separating layer of a thickness of 8 to 10 cm, normally having the level of the ground floor as shown in Figure 2.

Figure 1. Traces of leached salt and deterioration in a brick fence and a bearing wall.

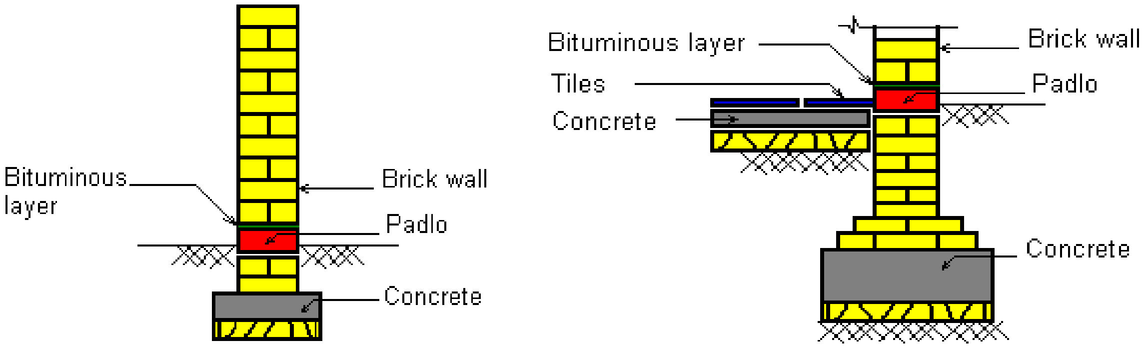

Figure 2. Water proofing position, in typical brick walls

Many criticisms due to inadequate materials, improper construction control or deficiencies in the supporting soil might cause fractures to the Padlo. Any crack in this layer will lead to an uncontrollable water movement through the building. Moreover the construction of this layer, usually require the halting of the work for not less than two days to allow for the hardening of the concrete

In order to overcome the mentioned problem and to improve the available construction materials properties, this research concentrates upon using of wax as filler for bricks voids aiming to introduce water-proofing bricks. The suggested new material was subjected to all the required standard laboratory experiments in addition of monitoring its performance in a full scale test.

❖ TESTING PROGRAM

Materials used

The following materials were used:

- ☐ Clay bricks having the following properties, compared to Iraqi standard specification No.25[4], are listed in Table 1 below:

Table 1. Properties of tested bricks to the standard Iraqi specification.

Property	Test result	standard Iraqi specification
Dimensions	223×110×78mm	240×115×75mm ±3%
Absorption	29%	≤ (20-24-26)%
Compressive strength	10.5N/mm^2	9-13-18 N/mm^2
Efflorescs	Excessive	Acceptable
Soluble salt	4.5%	≤ 5%
Weight/ brick	2275kg	-------

- ☐ Wax; ordinary candle wax was used.

Testing procedure

Stage-1

Ten bricks were entered in the laboratory oven for 24hours under a temperature of 80C$^{\circ}$. The dried bricks immersed in a melted wax then were picked out after 5, 10, 15, 30 and 60 minutes. Figure 3 shows the wax percolation with respect to time. While, Table 2 shows the depth of wax penetration and its absorbed weight with time.

Table 2. Depth of wax penetration with time and Weight of absorbed wax/brick

Immersing time (min)	5	10	15	30	60
Average Penetration (cm)	1	2	2.5	3	3.9
Weight of absorbed wax (gm)	225	300	345	415	450

Figure 3. Wax percolations inside clay bricks with respect to time (minutes).

By deep verifying of the initial results, it was found that; Immersing of bricks in melted wax for 5 minutes or less will not assure a reliable water proofing shield for tested bricks. While the increase of the immersing time up to 60 minutes will enable the wax for full penetration. Figure 4 shows the expulsion of air during this process. According to economical aspects, it was noticed that more energy was required to keep the wax in its liquidized state, moreover the amount of the absorbed wax was greater by 50% than that required for the 10 minutes of immersion. Therefore, a decision had been taken to adapt the immersion time of 10 minutes to get the advantages of all the above mentioned reasons.

Stage 2

Another forty dried bricks were immersed in a melted wax for 10 minutes to be prepared for the following standard experiments:

- Efflorescent test showed a perfect impermeability of the specimens compared with the untreated bricks, as shown in Figure 5.
- Compressive strength showed an average value of 13.25N/mm^2, that means an increase of 27% compared with ordinary bricks.
- Water absorption showed Zero percentage compared with that of 29% for the old bricks.

Figure 4. The expulsion of air bubbles during immersing process.

Figure 5. Efflorescent for (W) waxy and (O) untreated old bricks.

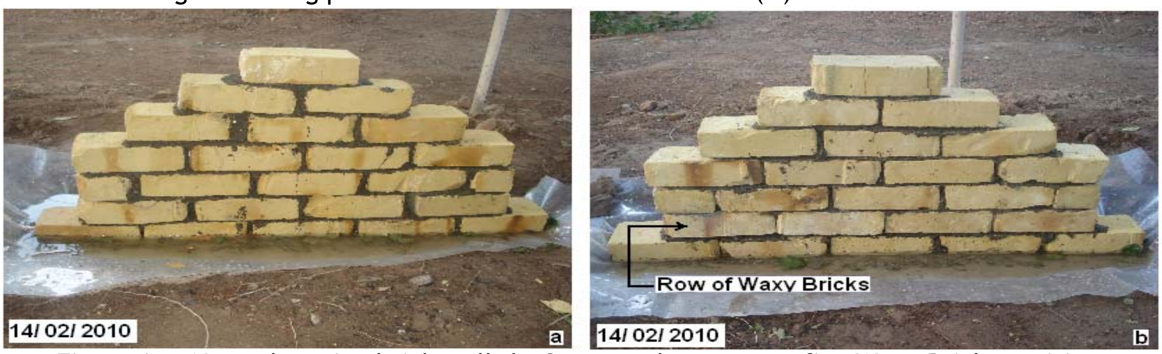

Figure 6 a. Normal testing brick wall, b- Suggested water proofing Waxy Bricks position.

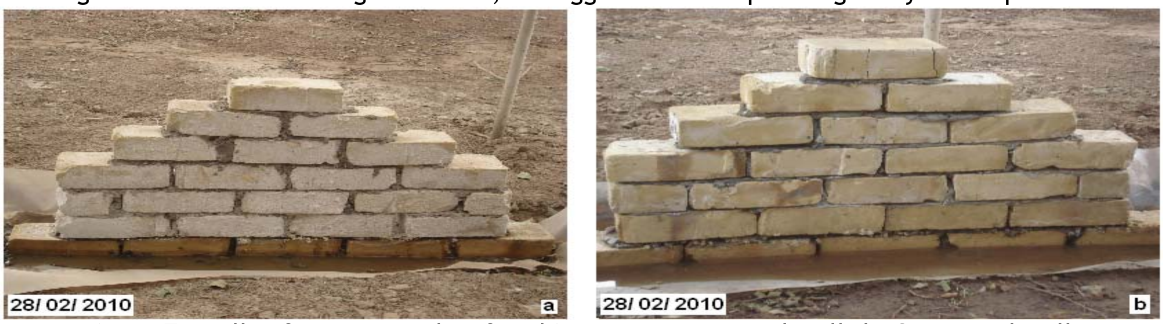

Figure 7. Walls after two weeks of soaking, a- Unprotected wall, b- Suggested wall.

Stage 3

The remarkable improvements reached in stage 2 gave an encouragement to proceed for a full scale test in this stage. Two brick walls a & b were constructed as shown in Figure 6. The wall-a- was built by using untreated clay bricks, while the wall-b was similar except the use of waxy bricks to form the water-proofing second row of bricks. Both walls were constructed over the ground with a separation nylon membrane to insure the permanent accumulation of the added water and to let the half depth of the first brick row to be continuously submerged in water. Figure 7 shows the clear difference between the protected wall-b with respect to the self- explaining shape and the amount of deterioration in the unprotected wall-a after two weeks of water soaking.

❖ RESULTS AND DISCUSSIONS

It was found that the immersion of a dried clay brick in melted wax for 10 minutes will consume 300gm of wax/ brick. The absorbed wax will fill all the voids of the outer part of the brick to an average depth of 2cm. After picking a brick out of a melted wax, the surrounding air temperature will transfer the wax again to its sold state. The hardened wax inside the voids of a brick will make it permanently water repellant; moreover it will be neither ready to return to its liquid state by normal air temperature again nor to be dissolved by water.

A perfect result was emerged from the efflorescent test which showed the development of a complete impermeability and a complete control upon salt solid state.

Compressive strength test also showed an increase of 27% for waxy bricks compared with the untreated bricks. [5] Confirmed that clay bricks should be tested wet according to BS3921 [6] that is just to simulate the actual situation of building bricks. Saturated bricks will give low compressive strength compared with dry bricks, because the uncompressible absorbed water will distribute the applied pressure eventually from inside the tested brick leading to a premature failure.

Using wax to eliminate bricks porosity and to prevent water absorption will allow conducting the standard compression test without the need of wetting the bricks, simply due to its newly created impermeability.

Most of Iraqi soil having high percentage of salts. Taking into account that the main raw material for brick manufacturing is soil, this fact will demonstrate the difficulty of producing good quality bricks with low prices. [Neil] mentioned that the total soluble salt content of clay bricks may be as high as 5% by weight, although it is more commonly 0.1 to 1%. Our bricks showed that it contains 4.5% of soluble salts, which makes it poorly graded for use according to all standards including the Iraqi one. Dry or quarantined salt will have neither bad effect upon brick compressive strength nor upon the deterioration of the overall construction appearance, therefore the waxy bricks with its impermeability and salt containment will solve the mentioned aspects in addition to an expected future role in reducing the strict standard limitations of using salt contaminated soils.

Finally, the use of waxy bricks to construct full scale walls showed the efficiency of this newly born constructing material as a water proofing layer and its ability to prevent water from climbing upwards by capillary action through brick walls due to the closure of all its inside voids hair pipes by wax. Moreover, the construction of walls with this method will not require any delay to wait for the curing of the current water proofing cement-based layer.

❖ CONCLUSION

It was found that the immersing of clay bricks in melted wax for 10 minutes will improve its properties as follows:

- ☐ Producing a completely impermeable bricks.
- ☐ Eliminating the movement of the soluble salts.
- ☐ Preventing the deterioration of brick wall finishing materials and maintaining their good architectural appearance for a long time.
- ☐ Increasing the compressive strength by 27% compared with untreated bricks.
- ☐ It can be used as an efficient construction water proofing material to prevent the rising of water through walls, fences and other structural units required to be built in a direct contact with water

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