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ELIMINATING ONE OF THE POLLUTION RESOURCES BY THE USE OF WAX AS A REPLACEMENT FOR THE WATER-PROOFING TAR USED IN THE ROOFING SYSTEM OF BUILDINGS

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ABSTRACT: Buildings with flat roofs are common in Iraq. In spite of the limited rainfall of 5- 15 Cm per year, roofs are normally protected by several water- proofing layers, one of which is a liquidized Tar layer(s). Tar as a natural durable material is known of its superior water-proofing property. To make it workable, Tar should be liquidized by heating for 8-12 hours before application. During heating process huge amount of smoke consisting of polluting gases like SO2. NO, CO is transmitted to air. These gases are considered poisonous if inhaled by the workers and the surrounding people especially in busy cities. In this research, liquidized candle wax was heated to facilitate its penetration into the top surface of concrete for an average depth of 4mm. By filling the concrete voids with Wax to a certain depth, a proposed impermeable concrete can be generated. Tests have been done to monitor the performance of such concrete subjected to stagnated water. Reductions in water levels for three models (without treatment, with Wax layer and a plastic pan having the same dimensions) were listed with respect to time. Seepage and evaporation measures were similar for the treated model and the plastic pan, while it was much faster for the untreated specimen. Results showed that a durable impermeable concrete can be reached by the use of Wax. Moreover, this treatment can replace the use of Tar as a water-proofing material which is considered as one of the pollution resources.
KEYWORDS: water- proofing layers, pollution resources, wax

❖ INTRODUCTION

To protect Iraqi buildings against humidity and water percolation, the following procedure is normally followed [1]: After the complete hardening of the concrete of a reinforced roof slab, see Fig 1, a liquidized Tar is placed over the roof top surface to perform a water- proofing layer followed by another transverse Tar layer. Each of the two layers should have a thickness of not less than 4 mm. The next layer is constructed by using dry clay soil having a variable thickness of 5-10 cm to facilitate drainage slope requirements and to serve as a thermal insulation, then the whole system is covered by 80 x 80 x 4 cm square precast concrete tiles laying over a 5 cm sand layer to accelerate water expulsion. Joints between tiles are filled with water-proofing bituminous material (mastic).

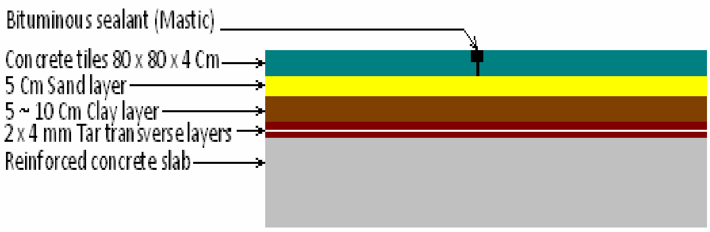

Fig. 1. Roofing System

Tar as a natural material always takes the shape of hard broken blocks mixed with sand and other impurities. It is required to use heat to transfer it to its liquid state to be workable for placing as a continuous layer and to enhance its adhesive properties with concrete surfaces. Heating process takes 8- 12 hours to reach the harmony of Tar and to let all the mixed debris to sink.

[2] Tar is a complex mixture of variable composition containing primarily condensed aromatic ring compounds (coal-derived substances) or phenols (wood creosote). Therefore, it is not possible to represent this material with a single chemical formula and structure.

Unfortunately, heated Tar transmits huge amount of smoke, see Fig 2, containing high concentrations of some poisonous gases like SO2, NO, and CO. [3] Inhaling high concentrations of these gases is harmful for the health of the constructing team and the people nearby, especially in busy cities. [4] Long- term excessive exposure to Tar and its vapors has been associated with an increased risk of developing cancer at several sites including the lungs, kidneys, skin, and bladder. Exposure to high vapor concentrations may produce headache, nausea, vomiting, and other symposiums. Prolonged or repeated exposure to the vapors has also been associated with an increased risk of bronchitis.

Fig. 2. Heated Tar transmitting smoke

This research aims to replace the polluting Tar by Wax. Wax is having some desirable properties like water- proofing, durability and low cost. Moreover, it has less polluting effects even when heated to be a liquid during construction.

The procedure followed in this work contains of placing a sheet of Wax on the top surface of dry concrete, then directing a heating flame to liquidize that layer, see Fig 3. Different sheet thicknesses were tried to select the optimum thickness. Liquidized Wax has the ability to percolate into concrete through its voids. After the removal of the heating instrument, Wax filling all the concrete voids will return to its sold state blocking all the expected paths water can seep through. Further experiments have been done to prove this improvement in concrete water resisting new property.

Fig. 3. Water-proofing of concrete by Wax

❖ MATERIALS USED

The following materials/ tools have been used:

- ☐ Concrete having 1:2:4 mix ratio and 45% of water- cement ratio.
- ☐ Wax, ordinary candle wax having a melting point of 65°C.
- ☐ Moulds having the size of 20 x 20 x 5 cm.
- ☐ Cubic moulds having the size of 15 x 15 x 15 cm.
- ☐ Plastic ring having an inner diameter of 15 cm.

❖ TESTING PROCEDURE

Five concrete specimens with 20 x 20 x 5 cm dimensions were cast using a mix ratio of 1:2:4 and water- cement ratio of 45% by weight. All its ingredients were satisfying the standard specifications. To simulate the average compressive strength of common roof slabs the attended design compressive strength of the concrete model was 25MPa.

Six 15 x 15 x 15 cm standard concrete cubes were also molded to be crushed in the laboratory for indicating the effect of adding Wax upon the compressive strength of the concrete.

During the period of curing and attending the concrete to gain its full 28 days strength, Wax was melted and poured in a flat steel try. Wax was cast to take the shape of layers having 1, 2, and 3mm thickness.

The 3mm thick Wax layer was laid directly over the top surface (25 x 25 cm) of the completely hardened and dried 20 x 20 x 5 cm concrete specimen. Then a direct Bunsen burner flame was applied. Wax was melted again and partially absorbed by the top surface of concrete. Due to the excess of Wax, It was found that there was a flow of melted Wax around the sides of

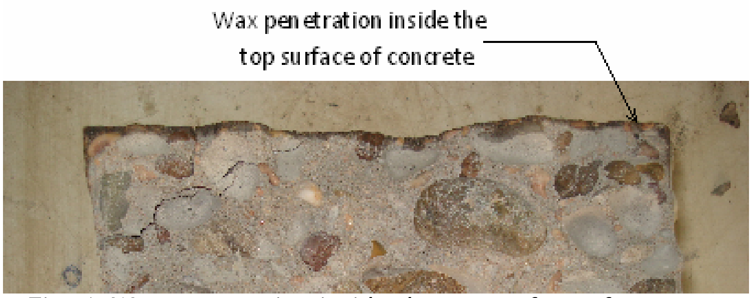

Fig. 4. Wax penetration inside the top surface of concrete

the concrete block. Repeating the same procedure, using thinner Wax layers of 2 and 1 mm thicknesses showed that the layer having a thickness of 1 mm was the optimum regarding to the ability of concrete to absorb Wax, while the Wax layers of 2 and 3 mm thicknesses were found to be out of the accommodation ability of concrete. The measurements of the penetration depths of Wax inside concrete showed that liquidized Wax can penetrate to an average of 4mm inside the top surface of concrete, see Fig 4. This depth is thought to be enough for permanent water- proofing and acceptable regarding economy aspects. Therefore, the 1mm thick Wax sheet will be adapted while thicker sheets will be ignored.

To verify the actual water propelling properly of the wax treated concrete, three testing models have been prepared. The first model was done by gluing a plastic ring, having 15 cm inner diameter, to the top of the treated concrete block, see Fig. 5. The second model was the same but without wax treating while the third one was prepared by gluing a similar plastic ring to an impermeable plastic plate having the dimensions of 20×20×1 cm. The idea of the test is to compare between the three samples regarding their efficiency to stop the penetration of water. The third sample was completely impermeable and it was used to monitor the vanishing of water due to evaporation while the first and the second samples were watched to clarify their abilities of water proofing.

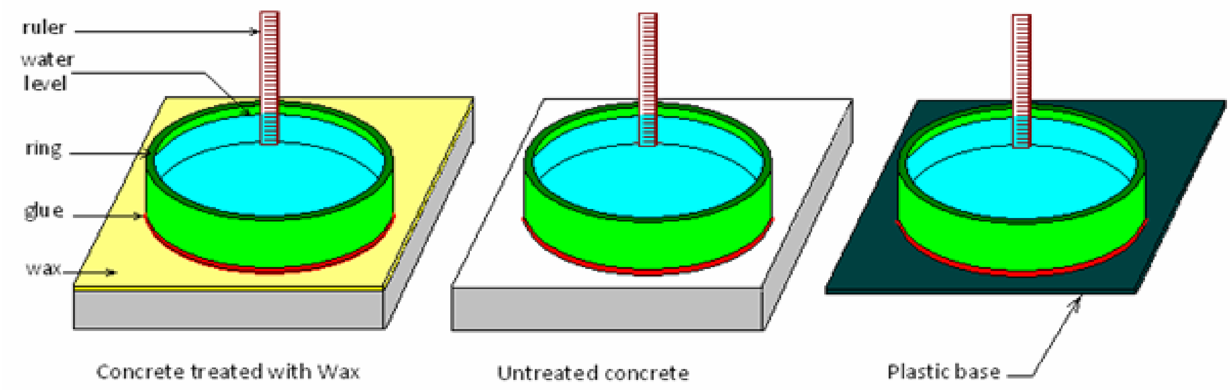

Fig. 5. Measurements of water seepage through Wax treated Concrete compared with a model of a plastic base

The test started with filling each ring with 700gm of water which gave a rise of water to 40mm. A water depth measuring ruler was attached inside each ring. The average surrounding air temperature during the test was 25C. The result of monitoring the change of water depths with time of each sample were listed in table 1.

Table 1. Reduction of water levels with time

Time (hours)		0	3	6	9	12	15	18	21	24	27	30	33	36	39
Treated	Water level (mm)	40	38	35	32	29	26	21	19	15	11	8	5	2	0
Untreated		4	0	0	0	0	0	0	0	0	0	0	0	0	0
Plastic base		40	38	35	32	29	26	21	19	15	11	8	5	2	0

To verify the effect of Wax upon the most decisive property of concrete, that is the compressive strength, three 15 x 15 x15 Cm standard concrete cubes were compressed till failure to indicate its strength also another three similar cubes but were treated with Wax were crushed. Test results showed that there is no noticeable variation among the six tests and the average of the entire test was around the design strength of 25MPa.

❖ TEST RESULTS

It is clear that the Wax treated concrete shows a complete water- proofing similar to that of the impermeable plastic base sample. Both samples required 38 hours to lose stagnated water by evaporation, which means that they were completely impermeable. The reduction of water level was due to evaporation rather than seepage into concrete. While the untreated sample rapidly lost its water after 1h 14 min of adding water.

Standard concrete cube compressive strength did not altered due to Wax treatment.

❖ CONCLUSIONS

The following conclusions can be derived throughout this research:

1. Tar used in the process of building water- proofing system is considered as one of the polluting agents.

2. Wax can be used as a replacement to tar to protect buildings roofs against water percolation and humidity.
3. 1 mm thick layer of Wax can be melted over the top surface of reinforced concrete roof slab to provide a water- proofing barrier.

Wax penetrating 4 mm inside concrete is enough to protect it against the undesired water effects.

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