استخدام خليط من البوليمرات والنانو سيليكا لحماية جدران مسجد الأحمدى بطنطا من تأثير الرطوبة

Using a mixture of polymers and Nano-silica to protect the walls of Al-Ahmadi Mosque in Tanta from the effect of moisture

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Abstract

The study aims to conduct an experimental study through which the efficiency and effectiveness of different methods and materials, whether known traditional or modern materials, which are evaluated by making different experimental formulations of these traditional and modern materials in different proportions and different concentrations, as well as making treatments using multiple materials as a mixture or individually in successive steps that are standardized to achieve high effectiveness. Especially in the processes of surface insulation of the roofs of ancient buildings and their application by possible methods, whether traditional or modern methods, so that we can effectively overcome the problems of moisture in ancient buildings. Moisture, its types and its impact on ancient stone buildings, as well as various sources of moisture, have been studied and each source and its impact on ancient buildings have been known. Stone buildings, as well as the factors affecting the moisture content inside the walls of ancient stone buildings, as well as the dynamics and mechanisms of moisture movement inside ancient stone buildings, different methods of measuring moisture, as well as manifestations of damage caused by moisture on stone buildings, as well as the role of fungi, algae and lichens in the damage of ancient stone buildings, and an experimental study was prepared in order to reach the best materials for appropriate concentrations to reduce the rate of moisture absorption in stone buildings, and analysis of building materials were carried out. The petrographic examination was done by preparing thin section sectors using a polarizing microscope. The examination was also done using X-ray diffraction (XRD) of limestone samples, and it was found that it consists of calcite $CaCO_3$ along with the presence of SIO_2 quartz and some other

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minerals. The experimental study included the use of three types of moisture-insulating materials, which varied between water-based materials and organic-based materials, in order to compare them and obtain the best results, in addition to the Nano-silica material Sio_2.

Keywords
Archaeological buildings - water repellent materials - chemical insulation - Nano silica.

Introduction:
Moisture in its various sources, whether ground moisture represented by ground water or atmospheric moisture represented by rain water or condensation water, causes damage and deterioration to ancient buildings, as it rises or penetrates into the walls with the dissolved salts it carries in the form of salt solutions that crystallize between the components of the stones and lead to their disintegration and damage after the evaporation of water also leads to damage to the walls, including the microorganisms it carries, and the effect it causes in the activation of chemical reactions, and thus the occurrence of more damage and deterioration. The study was conducted on the walls of the Ahmadi Mosque in Tanta, which suffer from the effect of moisture. Samples of the stones of the Ahmadi Mosque were examined using a polarizing microscope, a scanning electron microscope, and X-ray diffraction. The physical and mechanical properties of experimental samples similar to the stones of the Ahmadi Mosque were also measured, and the angle of contact between the surfaces of the stones was also measured. Treatment with an experimental study to see the effectiveness of water repellent materials, then it was done applying the treatment according to the results of the experimental study on the stones of the Ahmadi Mosque in Tanta.

Materials and methods:

The properties of Nano scale chemical insulation materials and the reasons for their selection
The Nano-silica material SIO_2 was chosen as a Nano-material for the study, as a result of several characteristics that characterize the Nano-materials, as follows:

1- The accuracy of the Nano-grains and their achievement of good coverage on the surfaces of the stones.

2- The quality of the optical properties of nanomaterial in addition to the quality of the electromagnetic properties of those materials and their improvement to the materials added to them.

3- Nanomaterial are characterized by chemical stability and structure with nanometer molecular chains.

4- Most nanomaterial are safe materials that do not affect the environmental system, in addition to the diversity of protection sources between protection from dust, against UV rays, and against the influence of microorganisms.

1- **Sika gard 701 W**

Physical appearance	Yellow liquid
Chemical composition	Alkyl AlkoxySiloxane Microemulsion
Morphological structure	Liquid
Density	٢٠° C for 1 kg/l
Flash point	٢٧°c

2- Estel 1100

Physical appearance	Colorless liquid
Chemical composition	Ethyl silicate and Polysiloxane
Morphological structure	Liquid
Density	٠,٩٧c at 20° c per 1 kg/l
Viscosity	١٢cp at a temperature of 25°c

3- Trimethylmethoxysilane (MTMS)

Physical appearance	Liquid
Chemical composition	CH3SI(OCH3)3
Purity	98%
Density	٠,٩٥٥at 25°C per gm/mL
Molecular weight	١٣٦,٢٢

Examination using spectral and X-ray diffraction (XRD) and XRF patterns

Sample (1)

It contains silica SIO_2 present at 5.20%, titanium TIO_2 present at 0.08%, aluminum trioxide AL_2O at 0.44%, iron trioxide Fe_2O_3 at 0.66%, manganese oxide MN at >0.01%, magnesium oxide MgO at 0.21%, calcium oxide CaO at 52.43% and sodium oxide Na_2O at 0.01%. >%, potassium oxide K_2O by >0.01%, phosphorus dioxide P_2O_5 by 0.06%, chlorine CL by >0.01%, and sulfur trioxide SO_3 by >0.01%.

Sample (2)

It contains silica SIO_2 present at 0.15%, titanium TIO_2 present at 0.03%, aluminum trioxide AL_2O at >0.01%, iron trioxide Fe_2O_3 at 0.16%, manganese oxide MnO at 0.01%, magnesium oxide MgO at >0.01%, calcium oxide CaO at 55.75% and sodium oxide Na_2O <0.01%, potassium oxide K_2O by <0.01%, phosphorous dioxide P_2O5 by <0.01%, chlorine CL by <0.01%, and sulfur trioxide SO_3 by <0.01%.

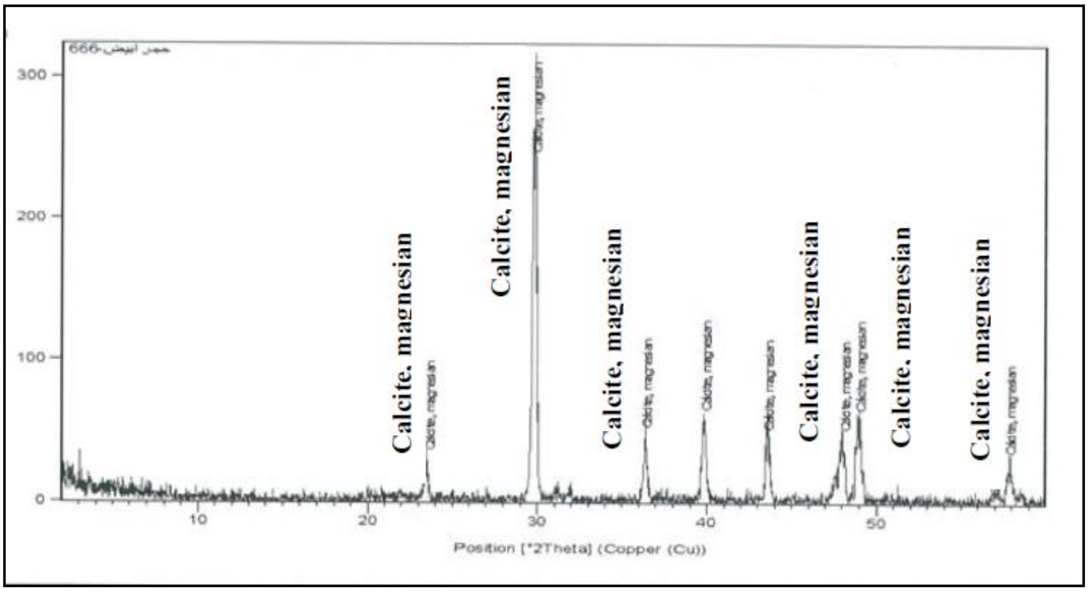


Figure (1) shows the X-ray diffraction pattern of the white stone sample

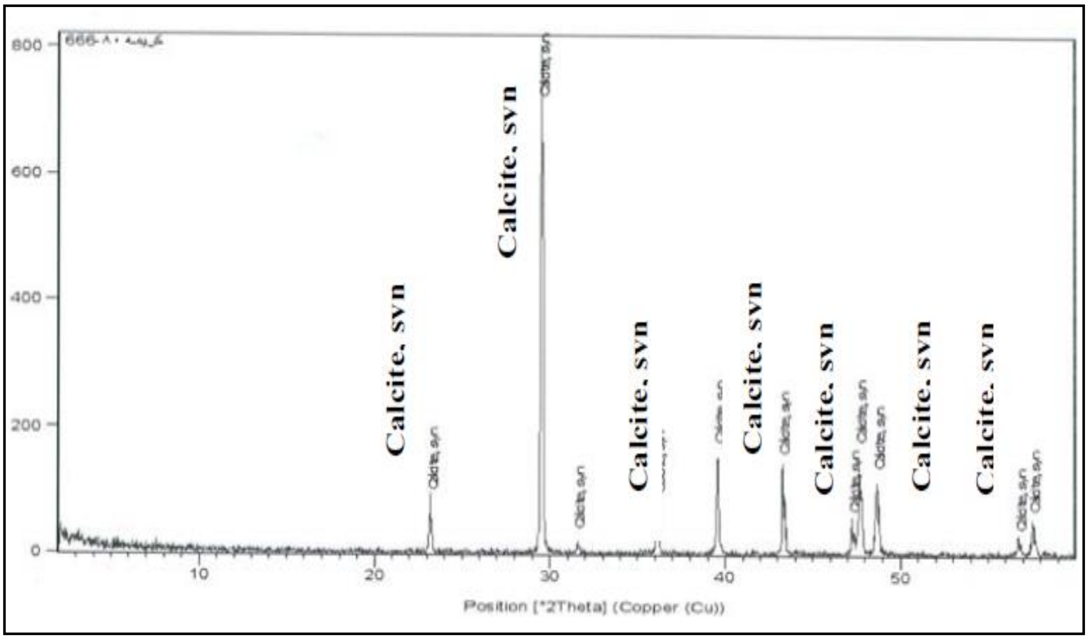
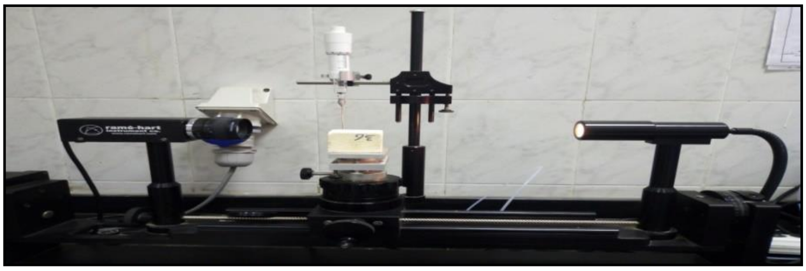


Figure (2) shows the X-ray diffraction pattern of the yellow stone sample.

Water contact angle measurement

Since the study includes water-repellent chemicals, the contact angle is one of the most important elements in evaluating the treated limestone. The water resistance of the treated, untreated, and treated limestone samples was evaluated by adding Nano-silica to it by measuring the contact angle between water and the surface of the stone. Contact angle measurements were made on stone samples treated using the Rame-Hart Apparatus, picture (1). When the contact angle becomes greater than 90 degrees, the surface is considered hydrophobic, and this appears in weak wetting on the surface of the stones and poor adhesion. In the case of measuring a lower contact angle, the treated surface is hydrophilic and appears wetting, with better and better adhesion to a drop of water.



Picture (1) shows the contact angle device used to measure the contact angle

By comparing the measurements of the contact angles between the water drop and the surface of the stones, the best concentrations added to the nano silica with water-repellent materials were identified, which led to a rise in the contact angle, which makes the surface of the stones becomes a better hydrophobic, which is evident in the following figure (3)

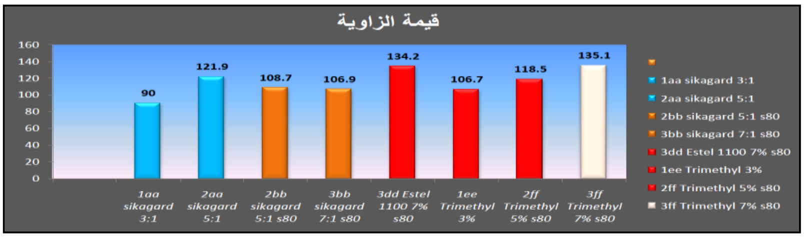
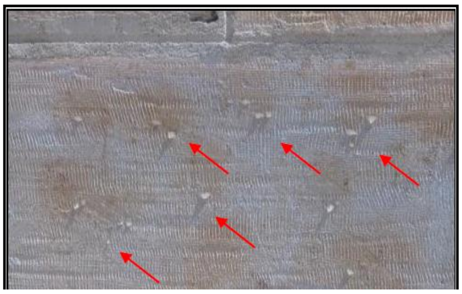


Figure (3) shows the best values of contact angles between a drop of water and the surface of stones treated by adding Nano silica.



Picture (3) showing the non-absorption of water by the treated stones and the persistence and stability of water droplets on them.

Picture (2) shows that the treated stones do not absorb water and water droplets persist on them.

Results:

- It was clear from the examination using the scanning electron microscope (SEM) the excellent and homogeneous spread of Trimethylmethoxysilane at a concentration of 3% with Nano silica in the form of a monolithic layer covering the surface of the sample coating layer, as well as the

good and homogeneous spread of Trimethylmethoxysilane at a concentration of 7% with Nano silica as well as showing the filling of the insulation material for the micro pores without closing them, as well as its packaging of the loose surface granules, which indicates the efficiency of Trimethylmethoxysilane in filling the pores and the good spread between the stone granules. As it turned out by examining the limestone samples of Al-Sayyid Al-Badawi Mosque using a polarizing microscope, it was found that it consists of fine-grained calcite mineral.
Fine Grains Calcite was found full of Foraminifera and fossils, along with some algae and some clay minerals, in addition to the presence of a percentage of fine and graded sand and some shells.
The concentrations of Trimethylmethoxysilane showed lower absorption rates with each of the white stone and yellow stone samples treated with water repellent materials without adding Nano silica, and also showed the best rates of low water absorption by adding Nano silica to it, which makes it the best in reducing water absorption rates compared to other materials.
The tests showed a high rate of mechanical compressive strength tolerance for samples treated with water repellent materials with the addition of Nano silica to it, with concentrations of 3:1, 5:1, 7:1 of Sikagard material with white stone, and also high rates of compressive strength tolerance with concentrations of 3.5%. %, 7% of Estel 1100 material for yellow stone samples, as well as high rates of compressive strength for white stone samples treated with Trimethylmethoxysilane at concentrations of 3%, 5%, 7%, which indicates that the addition of Nano silica Sio2 to water-repellent materials increases the compressive strength of stones after treatment and enhance the strength of stones and also improve the strength of water-repellent polymers and improve their interaction with stone granules.

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