

Climate Changes and their Impact on The Design of Plaster Windows in Modern Mosques

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Abstract:

Architectural design is one of the disciplines that is most concerned with the study of weather and climate and their effect on homes, cities, countries, and others; since it has a direct relationship with the impact on urbanization, cities, dwellings, gardens, etc., which concern humans and nature in the first place. It takes into consideration the factors of harmony and balance, and that the determinants of the surrounding environment represent a necessary need to provide comfort, safety, privacy, and the continuation of the harmonious development of man and place. Thus, the optimal employment of the available and potential climatic and natural elements takes modern balanced methods, and the compatibility of the environment and urbanism is a necessary necessity to achieve a homogeneous urban system.

Architectural design specialization is linked to a devoted relationship with the climate; as there is no project of any kind except that it is related to the climate, in terms of natural lighting, solar radiation, the height of the sun in summer and winter, wind movement and direction, rates and types of precipitation, humidity and temperatures, all of which are studied over the four seasons. The climatic effects also have a direct impact on the shape and height of the building, the materials included in its design, the shape and area of window openings, the degree of reflection of the glass used, and the plants used in the gardens, their types and shapes...etc.

Architectural openings are considered an essential source of communication between the internal and external space so, the architects had great attention to the openings from the aesthetic, plastic and functional point of view, in an attempt to make a fit in the interdependence relationship between the inside and the outside. It became an entrance to the design of the façades, and the shading networks turned into an essential element in the design of the architectural block. In this research paper, the focus will be on the use of gypsum openings in mosque architecture, as applied to one of the modern mosques, and the clarification of the need to take advantage of the heritage to create contemporary architecture that expresses the era; since this art has developed in terms of diversity, unity, difference, contrast, repetition, and the achievement of architecture compatible with the current era and respects its users.

Keywords:

Climate Changes, Plaster, Glass Art

Introduction

The **Research Issue** is that the architectural openings are concerned with the functional aspect only, without the aesthetic aspect, and without taking into account the different climatic changes, which have a fundamental role in shaping the architectural openings.

The **Research Aims** to study the climatic changes affecting the gypsum glass openings in Islamic architecture as the most important architectural elements that affect the architectural formation of the facade.

Gypsum Composition Glass Art:

Stained glass represents the most effective and successful executive media in terms of its chromatic presence, which is an important consideration, especially in Islamic art, which calls for abstraction, austerity, and distance from striking and attractive colors. Maybe this consideration was one of the things that called for the use of gypsum glass in Islamic architecture, but it is noted that this type of stained glass treatment has limited possibilities of use in modern architecture. There is no longer the presence of thick walls in which walls and openings of this type of glass was fixed and which provides protection from weather factors, in addition to that the type of designs that prevailed in glass works in the past and were appropriate to the style of architecture at that time and which are no longer appropriate to the prevailing architecture now. Although gypsum and stained glass materials, which met the aesthetic requirement in the past, can be adapted and used to meet this requirement in modern architecture, whether in terms of design or implementation methods.

Glass is one of the materials known to man since ancient times, and the oldest use of glass in buildings dates back to Roman times. However, the art of stained glass is a fairly modern art, because it has developed during the past years a great development due to its influence on history, religion, social changes, scientific discoveries and plastic schools, and perhaps the discovery the glass was made by chance, and so far, it has not been conclusively determined that the glass was discovered, but the discovery of fire led to the discovery of industries that depend on heat, such as pottery, porcelain, and glass. Since the beginning of the Eighteenth Dynasty in ancient Egypt, glass production has been known on a large scale and in a regular manner. Several glass factories were found in Egypt, the oldest of which was found in Thebes and dates back to King Amenhotep of the third, one of the kings of the eighteenth Pharaonic dynasty, followed by three or four factories found in Amarna during the reign of Akhenaten. Alexandria was the greatest centers of the glass industry in the past, and in some documents from the Roman era several references to Egyptian glass, as the art of glass industry in Egypt reached An extent that made it coveted by kings for its ability to make glass and its multiplicity of colors, which led to Emperor Nero bringing in a group of Egyptian makers to the island of Murano, Rome, and established its first factory, and this was the beginning of the establishment of this industry in the West.

In the Islamic era, glass was used by Muslims in what they called “Kamariea” to the moon or “Shamsiea” relative to the sun, and this explains the function of these windows that glass reflects brilliant colors when the sun's rays fall on them during the day or the moonlight at night. Its openings are made of colored glass. These openings consist of Islamic motifs of plant branches, geometric drawings, or inscriptions. It is more likely that the beginning of the use of these windows dates back to the second half of the seventh century AH - the thirteenth century AD. In the beginning, gypsum windows with vegetal and geometric motifs were hollow and free of stained glass. The scarcity of Islamic art is due to many reasons that combine aesthetic values with commercial and organic material values. The basic materials from which these

Islamic works of art are made, especially stained glass or mashrabiyyas, are wood, gypsum and glue, which are materials that can be destroyed by natural factors.

Among the oldest examples of the use of this type of windows: Four windows in Ahmed Ibn Tulun Mosque in Cairo, dating back to the year 265 AH. After that, the artist developed this type of gypsum windows with hollow openings by covering these openings with pieces of colored glass. Ahmed Ibn Tulun renewed the glass factory in Alexandria, restored the lighthouse and repaired the glass mirror, and decorated his mosque with chandeliers and glass moonlights of colors and writing.



Figure (1) Windows in the Ahmed Ibn Tulun Mosque in Cairo

Gypsum stained glass windows were found in most ancient Islamic buildings, whether religious or civil, where these windows play an important role in protecting the inside of the building from wind and dust and at the same time providing an appropriate amount of lighting to enter the interior in addition to this. The type of windows does not represent a burden on the walls from an architectural point of view. In addition to making gypsum stained glass windows, the artist in the Mamluk era made shallow gypsum domes with hollow decorations interlaced with Shallow Gypsum Stained Glass Windows to cover the halls and bathrooms.



Figure (2) Making gypsum stained glass windows

As for Spain, glass is distinguished from others in that it bears the Arab-Islamic character in the general form and the artistic character in the way it was made during the fourteenth and fifteenth centuries AD, when Andalusia was a center for the glass industry. In the ruins of Granada, the Alhambra Palace is decorated with chandeliers and semi-circular glass moonlights with colors and prominent gilded writing.



Figure (3) The gypsum windows in the Palace of Granada

The emergence of gypsum glass art:

The art of glass composed with gyps is one of the arts that has a special aesthetic and utilitarian characteristic, and before it is exposed to studying its technology, restoration, and method of maintenance, you must know its origin and the purpose for which this type of work is used, as it is related to Islamic and Arab architecture and architectural openings of its various styles and countries.

Architecture in general and Islamic architecture in particular is not isolated as a science and art from human life and what constitutes within it and its relationship with the outside in a membership and an artistic unit that reflects the culture and environment of this spot temporally and spatially from religious beliefs and social customs that differ from one society to another. Likewise, the purpose of each building differs according to the function it performs. The house, the club, and the hospital are in both form and function, although the scientific foundations of any of them are not in dispute.

Shamsieat and Kamari are among the decorative phenomena that spread in Islamic architecture and became one of its prominent features. This combination of plaster and glass was used by Muslims, especially in Egypt, in what they call Shamsieat and Kamari. Plants, birds, architectural or engineering drawings, or Islamic writings to address the upper parts of the walls of mosques. If light falls on them from the outside, it enters the mosque with colored lights through colored transparent glass, creating a poetic spiritual atmosphere for the place. Perhaps this poetic influence falling from above is the reason for naming the moons. On this type of windows whose mission was to reduce the severity of the light as well as give that wonderful effect. These windows are known as Kamari if they are round in shape, and as Shamsiea if they are not in the shape of a circle. They were invented for various purposes, including the motive to reduce the intensity of light in Islamic architecture. The two arches are small arches, the arches of which are sixtieth in the style of the large arches, the ends of which rise on the weight of the two large arches. The purpose of these arches is to reduce the weight on the legs and to

create an aesthetic shape at the intersection of the building. The Muslim builders took the idea of placing small pieces of colored glass adjacent to the Byzantines in a frame of hollow marble slabs, but the Muslims using plaster instead of slabs of marble gave them more freedom in formation, through which they were able to produce a large number of decorative designs, and the paintings pass. It is clear from those windows that they were fully aware of the origins of technology so that they fulfill the required purpose. It is clear that the glass composed of gypsum is technically different from the glass composed of lead, and both of them deal with creating an environment inside and outside the building and preparing a spiritual atmosphere.

Gypsum composite glass is a development of composition with wood or stone perforations that was known in early Christian architecture, where Muslims took it from the Byzantines. Gypsum with colored glass pieces.

It always comes to mind when mentioning moonlights and umbrellas throughout history and Islamic architecture to which this technology is associated. Shamsiat and Kamari are one of the prominent elements in Arab and Islamic buildings that the artist employed to find a relationship that combines aesthetic and utilitarian value. One of its functions is to prevent insects that infiltrate from outside the building into it. It achieves a security principle related to human life; as it guides the amount of light entering the place, and prevents dust, wind variables, and air gusts throughout the year, and it reduces loads on the columns bearing the arches. From this, it is clear that it has a functional, basic, utilitarian value in addition to the aesthetic value that is related to the construction on the one hand and related to the interior design of the place on the other hand, not neglecting the spiritual aspects, as it gives peace and spirituality to the place.

Egypt is considered one of the most Islamic countries that uses this type of art (gypsum glass) in mosques, houses, palaces and suffocations, where these openings were distinguished by their diversity and the different methods of decoration and coloring according to the nature of the palace and the type of decoration prevailing in it, as well as according to the nature of the place. For example, in mosques, the openings are represented by Shamsiat, Kamari and windows. As for the mausoleums covered with domes, these openings are located in the places between the transition areas and at the neck of the dome in a formation known as the simple lamp or the compound lamp. It spread a lot in homes and palaces, and it is the mashrabiya, where the well-known architect used to cover the upper parts above the mashrabiya composition with plaster windows that were smaller in size. In Cairo, there are nearly a hundred of the most famous monuments that contain in their content glass composed of plaster - their eras varied between the Tulunid - Fatimid - Ayyubid - Ottoman- Mamluk Burji and Mamluk Bahri.

Climatic elements and their impact on gypsum stained glass openings:

When studying any architectural or urban project, we must collect the necessary information about the environment surrounding the project site; as the study of topography, geology, soil, groundwater, vegetation, natural hazards such as torrents, floods and earthquakes, local climate elements, and the study of vision trends and landscapes.

The most important climatic elements that architects and urbanists need to study:

- **Solar heat and radiation:** Temperatures directly affect the types of insulation that must be used in buildings, as well as the materials for the external facades, the internal materials used, the colors, their degrees, and the degree of heat absorption. It also affects the level of garden

design (LANDSCAPE), and here plants that live in certain temperatures must be taken into account based on the region, as tropical plants, for example, do not live in cold regions, and vice versa. Urban design based on the principle of sustainability. Solar radiation is considered one of the most important elements of the climate affecting man and the surrounding environment architecturally, where: The size and area of the openings in the buildings, especially in our regions, if the main facades are oriented to the north; as the designs require the expansion of the openings in the northern direction due to not being exposed to direct sunlight to gain more natural lighting.

- **Atmospheric pressure and wind**: The wind also directly affects the orientation of the buildings in order to make the most of the natural air and also to develop solutions for the high wind speed, and to direct the spaces based on the direction of the wind.
- **Humidity**: Humidity in the atmosphere greatly affects the design of buildings, and affects the types of materials used, methods of insulation, and orientation of spaces.

Factors that lead to damage to stained glass openings with gyps:

Humidity

Humidity affects whether it rises or falls below the appropriate Egyptian climatic rates. The gypsum material changes from the dry state to the anhydrite phase, where this transformation is accompanied by the loss of the two water molecules chemically combined with calcium sulphate, which leads to irregular cracks in the gypsum.

It leads to excess moisture, which helps dissolve soluble salts, whether in the blocks of stones used in the construction of the material itself or in the mortar that binds the gypsum opening and the stones, and this leads to the transfer of these salts and their crystallization on the surface of the gypts, which exposes it to slow dissolution in atmospheres with high humidity and migrates in its place to large areas where gypsum crystallizes on the surfaces of adjacent stone blocks.

Low Temperature

The product of carbon dioxide is one of the most atmospheric gases that generally affects plaster artifacts, as the wet atmosphere turns into sulfuric acid that affects the surface of the glass and gives a thin, opaque layer on it. H₂S hydrogen sulfide gas present in the atmosphere of industrial cities also affects the plaster surfaces and leads to their blackening as well. Carbon granules resulting from incomplete combustion of lighting and car exhausts lead to the occurrence of a black layer of dust on the gypsum surfaces. The vibrations resulting from earthquakes, air traffic, traffic, and heavy transport lead to the fall of some parts of the wall openings.

Air Pollution

And after knowing the effect of weather factors on the gypsum glass artifacts, the next stage of research comes, which is the stage of prevention, treatment and restoration of this artifact.

Practical approach to maintenance and restoration of gypsum glass openings

First, the stage of examination and study

Going back to the time period and the era in which the constructions took place, through references and archaeological documents that indicate it. Then, photography of this work is done to determine the apparent damage places and to record the position of the window as it is. Then, samples of plaster and glass are examined with an electron microscope to see the condition Surface and partial damage in depth and the appearance of biodeterioration on gypsum and glass resulting from the growth of Micro Organisms that change color and darkness and cause weakness in the wooden outer frame and cracks that occur in the artwork. Other defects in the artwork can appear through the announced results.

Second: the stage of analyzing the examination results

The study is carried out in order to find out the cause of injury and damage and the factors affecting it, which may arise from the exposure of the fillings to vibrations, shocks, or the accumulation of dust, as they prevent the passage of light through the plate, or because of the presence of some insects that may build their nests in the background of the window, or due to moisture as a result of rain or the influence of other factors. different weather conditions, or as a result of air pollution, or because of lack of knowledge about the wrong repair and restoration. Determining the missing pieces of glass and determining the types of materials used in the restoration, as well as determining the types of decorations and returning to the original design, if possible, in order for the restoration to be carried out on the basis of a correct process.

Third: the stage of methods of treatment, strengthening and restoration

This stage begins first with cleaning and removing the dust accumulated on the surface, whether by manual or mechanical cleaning, using electric suction cups to remove the dust in the openings, then chemical cleaning of one of the alkaline sodium salts or quaternary ammonium compounds or formaldehyde in the form of aqueous solutions at a concentration from 5-10% is done. After that, strengthening the surface by using a dried solution of diluted polyvinyl acetate emulsion in water, then the restoration process begins and the completion of the stucco decorative elements by pouring the broken or corroded part of the stucco with a powder of the soft gypsum paste, taking into account that the same quality of the gypsum used is of the same quality as the gypsum with the opening.

The applied Results of the Research:

The results of this research were applied to the gypsum glass artworks of Al-Sayeda Khadija Mosque in 6th of October City.

Technical Considerations:

The first thing that the artist and designer do towards the implementation of this technique is to study the place well, as the height of the filling above the eye level has a scientific study of the angle Shamsiea and Kamariea excavation. The angle of excavation for the Shamsiea at the level of view differs from it in the case of the height of the opening of eight meters or more, as this is taken into account when designing calculations that failure to take into account this causes the failure to see the combined colored glass openings, but rather the eyes see them as a dark slab of gypsum.

The Method of implementing a gypsum stained glass opening:

First: The design of the opening to be executed must be prepared with the dimensions, requirements and specifications of the site and its effects.

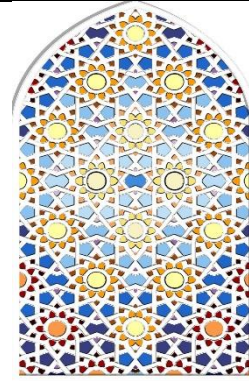


Figure (4) The Design Idea

Second: Making a “frame” of wood with the required sizes, taking into account that inside this wooden frame there is a “hole in the frame” groove that is commensurate with the space required for the gypsum design, and in most cases this notch is not less than 2 cm recessed into the body of the wooden frame.

Third: The reaction of the gypsum "calcium sulfate" with water is prepared in pots for the mixing and reaction process in preparation for pouring the resulting solution into the prepared wooden frame. The specified period is left for that, taking into account that the pouring method is as follows:

- a. A smooth flat surface made of marble or glass and placed above the preparation table until pouring is done on it.
- b. This prepared table with the glass or marble on it shall be thoroughly cleaned and painted with an insulating material consisting of a mixture of oil and soap together, or of wax or talcum powder in order to form an insulating layer between the plaster and the surface to be poured on.
- c. The previously prepared wooden frame for the hole to be executed is placed on the table, with a paste of kaolin “ceramic silt” or clay so that all these voids are filled so that the plaster solution does not leak out during the casting process.

- d. Calcium sulphate solution "plaster" is poured into the wooden frame until we get the required thickness, and after that the specified period is left for it to be completely dry and often 24 to 48 hours, due to the different timing of the casting process, summer or winter.
- e. The design prepared for this is printed with a hole on the previously prepared and dried plaster surface, and is marked with special markers for that, which are scratched into the plaster surface so that the design remains during the unloading process. Then, the drilling process is carried out with a special punching machine and manual angles, taking into account that the resulting hole is within the framework of the design and the angles close to the outer line that are to be hollowed out and at the confluence and the angle line, which the angles through the hole can carry out the drilling process.



Figure (5)

Fourth: The design is then engraved with its own angles, according to the special inclination angle in the direction of looking at the presence of the engraved surface, but if the hole is higher than eye level, the angle of inclination of the excavation is applied to it so that the viewer can see the design of the decorations well.

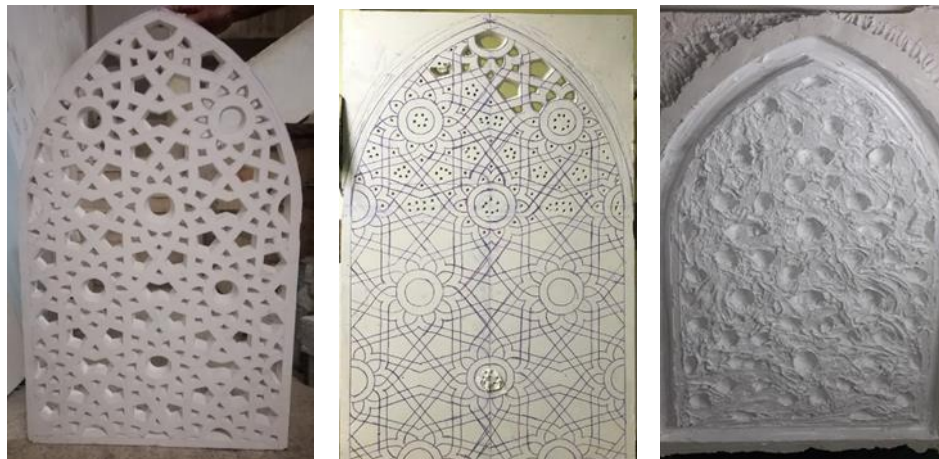


Figure (6)

Fifth: The process of cutting colored glass for interlocking in the plaster is carried out in the usual way, taking into account that the piece of glass will be slightly larger than the hole in the plaster specified for it, so that the piece of glass can be fixed on the surface of the plaster from the back. After the completion of this process, the restoration process that may result from the process of unloading and drilling is carried out, and all gypsum excesses that may be fixed on the glass and adhere to it as a result of the installation process are removed, and the opening is then prepared with the design and glass in preparation for its placement and installation in the appropriate place for it.



Figure (7)

Sixth: Applying the design to the gypsum window. The design prepared for implementation in stained glass interspersed with gyps requires several important conditions that the artist in charge of the implementation should take into account:

- a. Preparing the required design in a natural size over the appropriate area of transparencies - slate - so that the artist avoids sharp corners (unless modern equipment is available that performs cutting sharp corners in glass without any difficulties.)
- b. The artist avoids drawing fine details in the project; as it is difficult to cut small pieces, and it is difficult to interlock small pieces of glass.
- c. Each single line in the design is converted into a double line in addition to two lines to it, each one on one side of the two sides, so that the widths of the tapes are proportional to the size of the glass pieces confined inside them, meaning that the small pieces of glass have small tapes, and the large pieces of glass have the widths of their tapes large, and for the framework surrounding the work, it shall be more wide in order to bear the weight of the project, and it shall be taken into account that the design units are connected to each other and connected to the frame drawn around it.

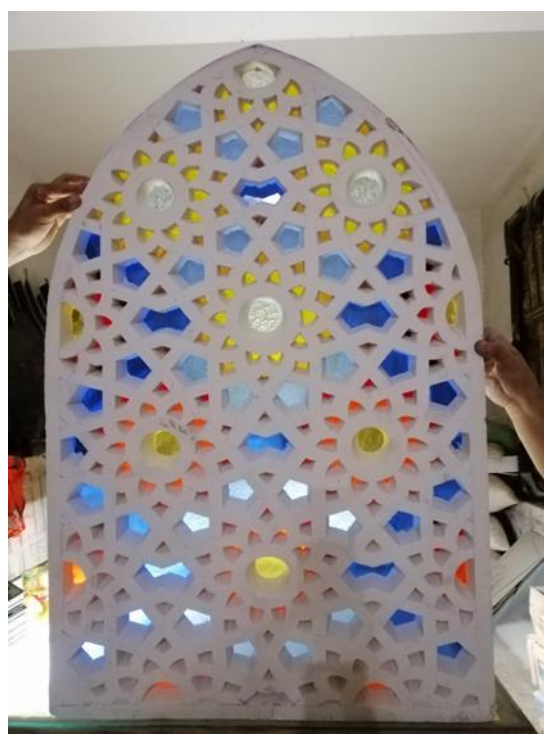


Figure (8)

Results

- 1) The factors that lead to damage to the stained glass openings with gyps have been determined.
- 2) A scientific methodology has been carried out to maintain, restore and treat the glass openings executed by interlocking with gyps.
- 3) The proposed methodology was applied to the gypsum glass artworks of Al-Sayeda Khadija Mosque in 6th of October City, with new gypsum windows made with suggested design ideas.

Recommendations

The researcher recommends that when studying any architectural or urban archaeological project, we must carry out the process of collecting the necessary information about the environment surrounding the project site to reduce the phenomenon of climate change with the development of a mechanism and a systematic plan for maintenance and treatment.

References

1. أبو المجد، أحمد شحاته - هبه ذهني - غادة خالد حسين - المتغيرات البيئية والشكلية وعالقتها بتشكيل الفتحات المعمارية - مجلة العمارة والفنون والعلوم الانسانية - المجلد الخامس - العدد التاسع عشر - فبراير 2020
1. 'abu al mujada, 'ahmad shihatat - habat zahni - ghadat khalid husayn - almutaghayirat albiyyat walshakliat waealaqatuha bitakwin alfutuhat almiemariat - majalat aleimarat walfunun waleulum al'iinsaniat - almujalad alkhams - aleadad altaasie eashar - fibrayir 2020
2. علي، رشا محمد _ التغيرات المناخية وتأثيرهما على الأعمال الفنية الإسلامية _ المؤتمر العالمي الثاني للعمارة والفنون الإسلامية - بمدينة صنعاء _
2. eali rasha muhamad _ altaghayurat almunakhiat wa'atharuha ealaa al'aemal alfaniyat al'iislatmiat _ almutamar alealamiu althaani lileimarat walfunun al'iislatmiat - bisanea' _
3. العياف، سعد عثمان محمد - الأسس التصميمية والتنفيذية لإعداد وحدات زخرفية مستوحاة من التراث في مجال الزجاج المعشق - رسالة ماجستير - جامعة أم القرى _ كلية التربية - قسم التربية الفنية - 2004.
3. aleayafi, saed euthman muhamad - tasmim watanfidh 'usus 'iiedad alwahadat alzuhrufiat almustawhaat min alturath fi majal alzuajaj almueashaq - risalat majistir - jamieat 'umm alquraa - kuliyat altarbiat - qism altarbiat alfaniyat - 2004.
4. نصر، عبد الخالق حسين - نيفين فرغلي بيومي - آيه جمال عبد الواحد - جماليات الفتحات المعمارية في العمارة الإسلامية - مجلة العمارة والفنون والعلوم الانسانية - المجلد السادس - العدد الثلاثون - نوفمبر 2021
4. nasr, eabd alkhalig husayn - nifin firghli biumi - ayt jamal eabd alwahid - jamaliaat alfutuhat almiemariat fi aleimarat al'iislatmiat - majalat aleimarat walfunun waleulum al'iinsaniat - almujalad alsaadis - aleadad althalathwn - nufimbir 2021
5. زينهم، محمد علي حسن - الترميم الدقيق والإتجاهات الحديثة في التطوير بالمساجد والمدارس الأثرية بمصر _ المؤتمر السادس عشر للإتحاد العام للأثارين العرب - 2013
5. zianuhum, muhamad eali hasan - altarmim aldaqiq walaitijahat alhadithat fi tatwir almasajid walmadaris alqadimat fi misr - almutamar alsaadis eashar lilaitihad aleami lilathar alearabiat - 2013
6. زينهم، محمد علي حسن - تكنولوجيا فن الزجاج - الهيئة العامة المصرية للكتاب - 1995.
6. zianuhum, muhamad ealaa hasan - tiknuluja fanu alzuajaj - alhayyat almisriat aleamat lilkitab - 1995.
7. <https://www.arabiaweather.com/ar/content/>