American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-13, Issue-7, pp-80-92
www.ajer.org
Research Paper Open Access

Artificial stone formations (sharrafat) in the tomb of Ismail Sidqi Pasha, a model of green architecture, aspects of deterioration and restoration.

Khaled Zid [1], Mohamed Hawash [2], Osama Ahmed [3], Musa Babiker [4], Gamal Saad [5] , Abd El Nasser Ali[6]

1 - Civil and Architectural Engineering Department ,College of Engineering and Computer Science, Jazan University, Kingdom of Saudi Arabia. . & Architectural Engineering Department, College of Engineering, Helwan University, Egypt.
2- Department of restoration, faculty of archaeology, Cairo University, Egypt.
3,4,5- Civil and Architectural Engineering Department ,College of Engineering and Computer Science, Jazan University, Kingdom of Saudi Arabia.
6-Conservation Department, Faculty of Archaeology, Sohag University, Egypt.

Abstract:
Basic green architecture has been around since the time of ancient Civilizations. Green architecture calls for the erection of buildings whose design, construction and conservation management System guarantee the health and safety of users, while minimizing any environmental risks. Objective of green architecture principles and conditions are therefore to overcome drawbacks and to establish the basis for architectural design.
The building of the Ismail Sidqi Pasha tomb conforms to green architecture standards, in terms of design, building materials, the presence of a landscape, no consumption of water and energy, and no occurrence of heat islands. The sharrafat made of artificial stone (one of the stucco applications) are an ideal model for green architecture applications, as they are cheap building materials that do not consume energy in their manufacture and do not produce polluting emissions. The damaged parts were reused when restoring and completing the missing elements. Analyses the Old damaged sharrafat binder by X-ray diffraction XRD , the thin sections of plant reinforcement material were observed under transmitted light using optical microscope (Model XSZ-10BN).
After identifying the components of the sharrafat, a mold was made on one of the sharrafat to re-cast the lost units in preparation for their reassembly. The process of casting sharrafat was carried out with the same components of the old ones, while using the old broken parts during the installation of the new sharrafat . This confirmed that the artificial stone sharrafat is considered an example of an ideal element that contributes to making architecture green architecture.

Keywords:
Green architecture, Green Building design, Sustainable design, green building technology, Eco-friendly architecture, stone aggregate , Sawdust , Artificial stone . stucco .

Date of Submission: 04-07-2024 Date of acceptance: 15-07-2024

I. INTRODUCTION :

Modern Architecture was responsible for 40–50 percent of waste deposits in landfills and 20–30 percent of greenhouse gas emissions. [1]
Green building is the practice of creating structures and using processes that are environmentally responsible and resource efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. [2]
Our building consider Eco-friendly architecture, as Cemetery building In line with green building standards,
The Housing and Building National Research obtain the following criteria from the GPRS project
Center in conjunction with Egypt-GBC (2011) [3]

Table 1 : shows green building standards

Aspects of Built Environment:	Consumption:	Environmental Effects:	Ultimate Effects :
▪ Siting ▪ Design ▪ Construction ▪ Operation ▪ Maintenance ▪ Renovation ▪ Deconstruction	▪ Energy ▪ Water ▪ Materials ▪ Natural Resources	▪ Waste ▪ Air pollution ▪ Water pollution ▪ Indoor pollution ▪ Heat islands ▪ Storm water runoff ▪ Noise	▪ Harm to Human Health ▪ Environment Degradation ▪ Loss of Resources

Description of the building

The building is a large burial chamber containing 6 graves. The area of the building is 85.5 m2, and its dimensions are 9 x 9.5 m. The height of the building is 10 m. The main entrance is located on the north side with a door measuring 3 m high and 160 cm wide. Around the door is a window on the right side. It is 2.5 meters high and 1 meter wide. There is a similar window on the left side, and on each of the other facades of the building there are three windows. Similar wooden windows in the main façade , at the top of each, there are twin windows made of stucco windows covered with glass, surmounted by a A circle-shaped stucco windows covered with glass with a muqarnas (Islamic decorative design) cornice at the top. On top of the building, there are artificial stone formation (sharrafat) in the form of Islamic decorations surrounding the building from the top. There are 19 units (sharrafat) in each façade Image (1). The landscape area is 3000 m^2 and contains a number of Camphora officinarum trees reaching a height of 15 meters and also there ara ornamental flowers Image (1,2).

Image (1) shows the Burial building and the its surrounding landscape

Image (2) shows the Burial building and the its surrounding landscape

How can the building be considered a model of green architecture? When it achieves many green architecture standards, By application to the buried building, There are many standards present in the building, such as the genius of design, the use of simple raw materials from the surrounding environment, and the presence of the landscape surrounding the building.
One of the most important standards is the use and recycling of waste materials, such as broken stones and sawdust, in implementing artificial stone formations (sharrafat).

Efficient Use of Construction Materials

Environmentally friendly construction materials comprise two basic conditions. The first condition is that the materials should not have a high rate of energy consumption (during their manufacture, during their use in construction and even for their maintenance). The second condition is that the materials not

Pollute building interiors; in other words, building and finishing materials should belong to the 'safe' category,

Which includes mostly natural construction materials. [4]

Climatic architectural design has two principal objectives , First: In the winter, architectural designs aim at realizing optimum heat (sunrays) absorption and minimal heat dispersal from building interiors. Second: In the summer, buildings need to be cooled; therefore designs aim at avoiding direct sunshine and minimizing heat absorption, while encouraging heat dispersion from building interiors and using various architectural strategies to cool internal spaces. [5] Landscaping can help reduce the amount of heat absorbed and it can allow cooling of the air around a Building. Trees and shrubs can provide shade and windbreaks, and they can help filter pollutants. [6] Instead of beautifying the environment, landscape design may help to prevent from extensive building heat gain, as well as produce the natural and healthy ambience to the surrounding. Landscape design in green buildings should be viewed as not just mere decorative afterthought but it must be well conceived as a multi-function factor that provides various critical green services for a building. [7]

Upcycling Repurposing old structures can save natural resources. [8]
Benefits of Upcycling Old Buildings
1- Eliminates Demolition Waste. Waste reduction is the immediate benefit of repurposing buildings instead of demolishing them.
2- Makes Urban Centers More Sustainable.
3- Saves Time, Money and Resources.
4- Keeps Old Architecture Alive. [9]
This is done by collecting and re-using recyclable waste and construction materials , re-using and renewing Resources Image (3, 4)

The formations of artificial stone (sharrafat) implementation method
More than one way was used.
First: hollow casting with sawdust, The artificial stone material is poured into the mold, then the casting material is distributed along the edges of the mold, the sawdust is distributed which occupies a large part of the volume of the casting, and the artificial stone material is re-poured to finish the casting. Image (26, 27)
Second: Solid pouring with broken stone and filling mortar.
The components of the artificial stone are poured into the casting mold, and distributed along the edges of the mold, the waste broken stone are added, in addition to a filling mortar with sand. Image (4) figure (3, 4, 5, 6)

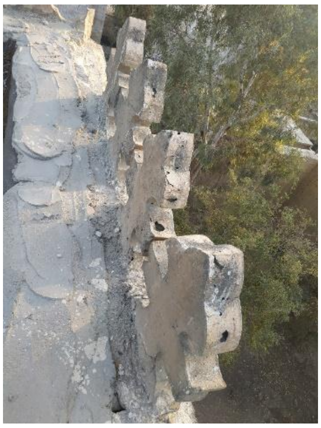

Image (3) shows the formations of artificial stone (sharrafat) and shows the holes that confirm that the core is empty and is considered a hollow cast.

Image (4) shows the formations of artificial stone (sharrafat) and shows the empty core with Sawdust and is considered a hollow cast. There is another part with solid casting and stone fragments

II. MATERIALS AND METHODS:

We chose the Artificial stone components conforming to ASTM stander , Hydrated lime conforming to ASTM C207 standard was used ,Gypsum conforming to ASTM C317/C317M-00(2019) .

Methods.
Analyses the Old damaged sharrafat binder by X-ray diffraction XRD Device specifications
The qualitative mineralogical analysis was carried out by XRD (powder diffractometer, Philips PW-1050, λ Cu-Kα radiation, scanning speed 0.05 $^{\circ}$ /s). The samples were tested in powder. The thin sections of plant reinforcement material were observed under transmitted light using optical microscope (Model XSZ-10BN) equipped with Amscop MD 500 digital camera.

Study of the components of artificial stone formations

Image (5) show a sample of artificial stone formations (fragments)

Image (6) A outer surface , B inner mortar , C filler stone aggregate , D reinforcement plant material .

An X-ray diffraction analysis was performed for the samples in powder form after grinding it and separating the stone fillers. The sample here expresses, (A) outer surface, (B) inner mortar, (C) filler stone aggregate,

Sample (A) outer surface

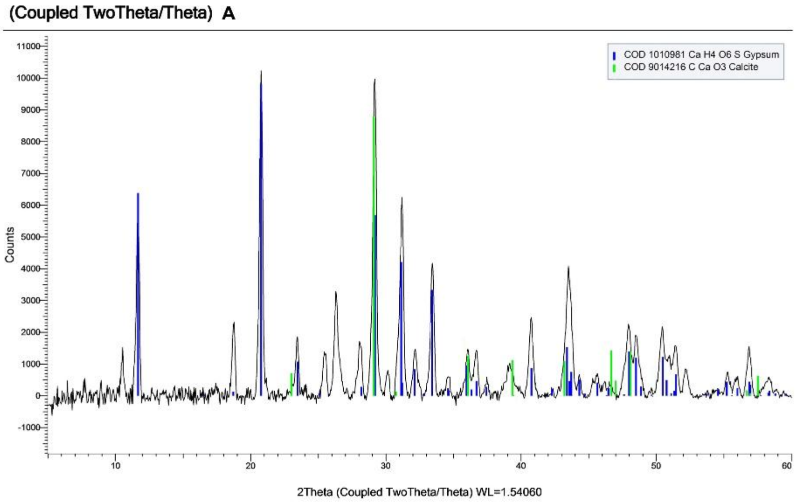

Figure (1) shows the X-ray diffraction pattern of the sample A

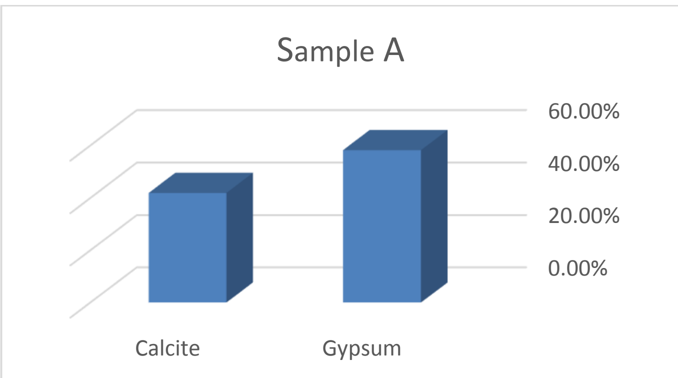

Figure (2) shows the percentages of minerals that consist the sample A

Table (2) shows the percentages of minerals that consist the sample A

sample A		
Mineral	chemical composition	ratio %
Gypsum	$CaSO_4{\cdot}2H_2O$	58.2%
Calcite	$Ca\ CO_3$	41.9%

Sample (B) inner mortar

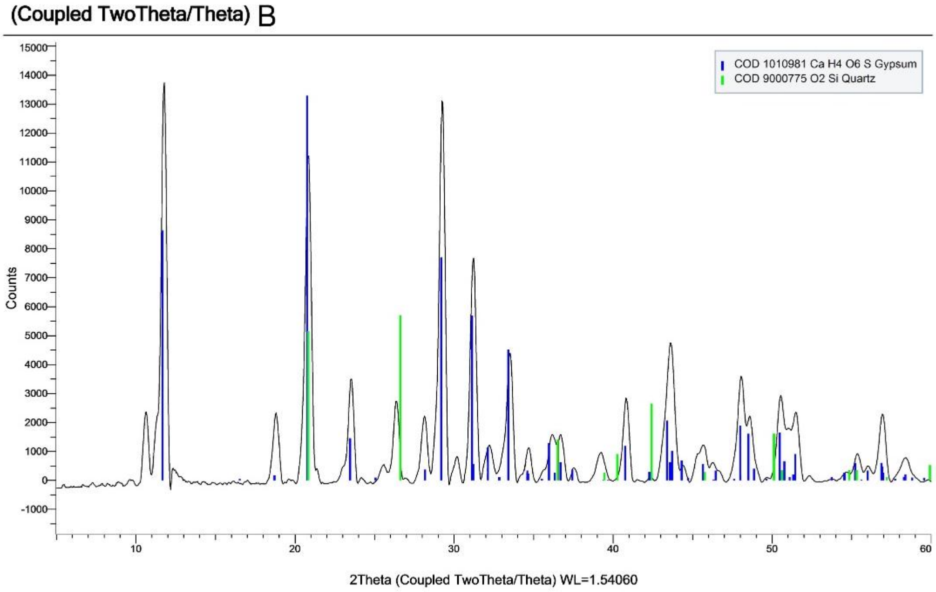

Figure (3) shows the X-ray diffraction pattern of the sample B

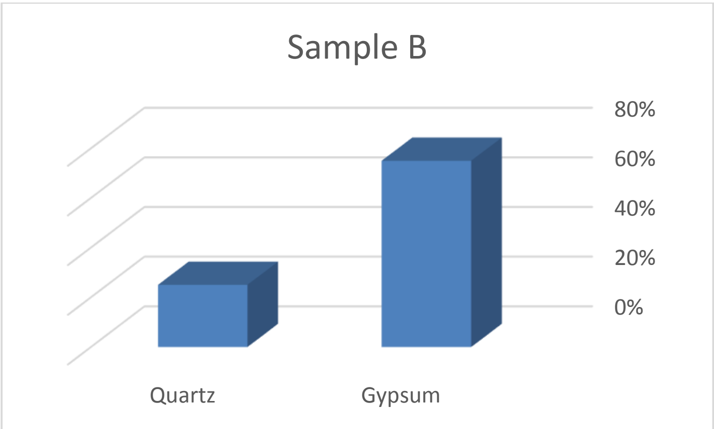

Figure (4) shows the percentages of minerals that consist the sample B

Table (3) shows the percentages of minerals that consist the sample B

Sample B		
Mineral	chemical composition	ratio %
Gypsum	$CaSO_4{\cdot}2H_2O$	75%
Quartz	$Si\ O_2$	25%

Sample (C) filler stone aggregate

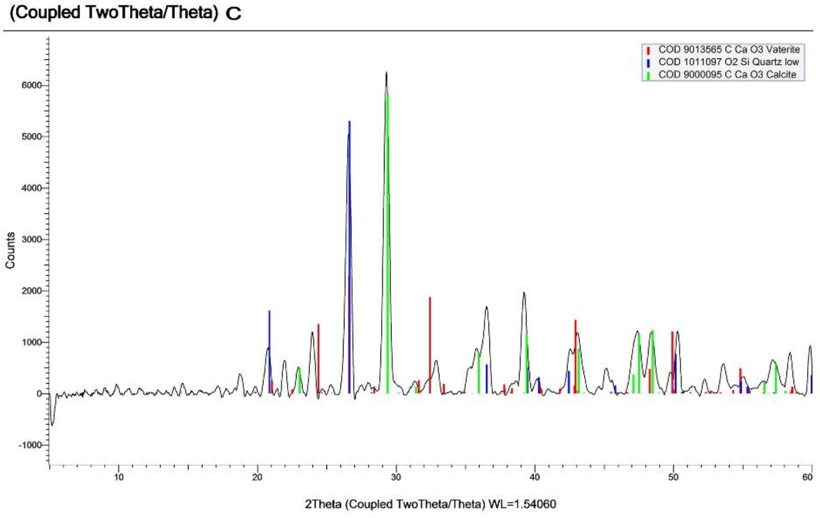

Figure (5) shows the X-ray diffraction pattern of the sample C

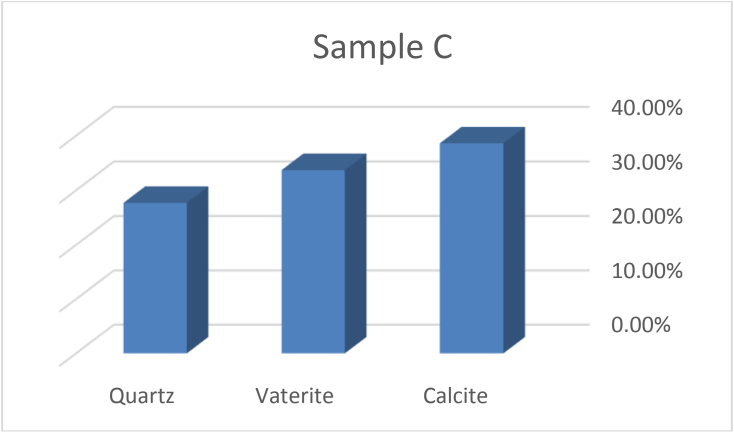

Figure (6) shows the percentages of minerals that consist the sample C

Table (4) shows the percentages of minerals that consist the sample C

Sample C		
Mineral	chemical composition	ratio %
Calcite	$Ca\,CO_3$	38.6%
Vaterite	$Ca\,CO_3$	33.7%
Quartz	$Si\,O_2$	27.7%

Identifying the reinforcement material (sawdust) sample (D)

The original sample (D) was examined and compared with a sample of Abies alba (Silver Fir) wood [10], and the two samples appear to be identical.

Transverse section (TS)

Growth ring boundaries conspicuous, generally abrupt, rarely gradual transition from earlywood to latewood- No resin canals.

Radial longitudinal section (RLS)

Ray tracheids commonly present- Smooth ray tracheid cell walls- Distinctly pitted end walls of ray parenchyma cells- Distinctly pitted horizontal walls of ray parenchyma cells.

Tangential longitudinal section (TLS)

Rays exclusively uniseriate- Average ray height 15 to 25 (sometimes up to 40) cells.

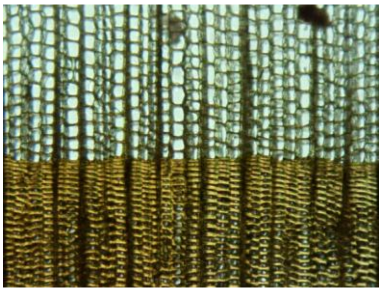
Image (7) shows Transverse section sample (D)

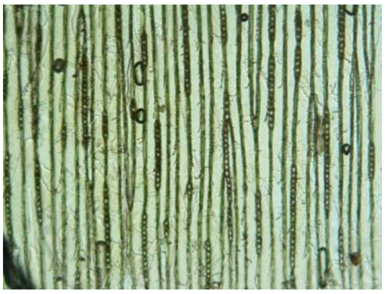
Image (8) shows Tangential longitudinal section (TLS) sample (D)

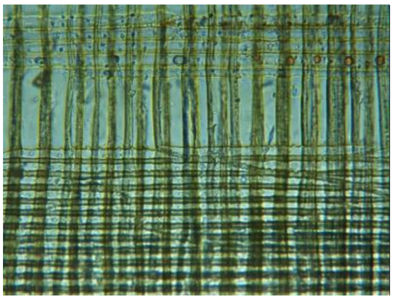
Image (9) shows Radial longitudinal section (RLS) sample (D)

III. RESTORATION (IMPLEMENTATION) ARTIFICIAL STONE FORMATIONS:

Mold preparation

Followed the following steps to implement the mold.

1- Choose one of the sharrafat with No damages to implement the mold on
2- Clean the model
3- Adjust the edges of the model to facilitate the process of separation from the mold
4- Isolate the model with a mixture of oil and soap
5- Casting the first polyester layer
6- making Reinforcement with fiberglass
7- Re-casting polyester


Image (10) shows an sharrafa of the artificial stone for which a mold will be made


Image (11) shows an sharrafa Cleaning before making the mold


Image (12) shows Adjust the sides to make it easier to remove the mold


Image (13) shows The process of isolating the surface using a mixture of oil and soap

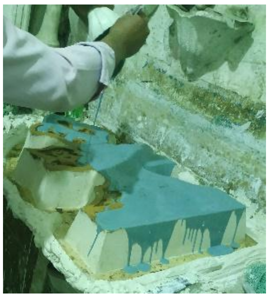
Image (14) shows the polyester casting on the surface of the model


Image (15) shows the polyester casting on the surface of the model

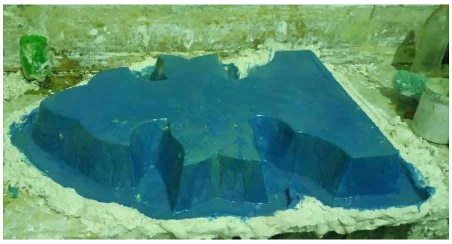

Image (16) shows Finishing the polyester casting and prepare for reinforcement with fiberglass

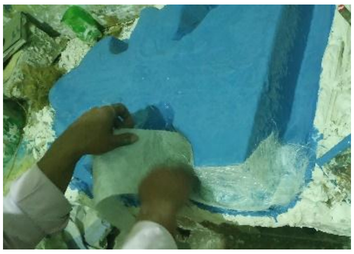

Image (17) shows Reinforcement with fiberglass

Image (18) shows Re-pour a layer of polyester onto the reinforcement fibers

Image (19) shows Re-pour a layer of polyester onto the reinforcement fibers

Image (20) shows Re-reinforcement with a second layer of fibers

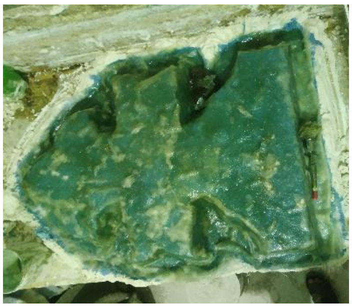

Image (21) shows Re-pour a layer of polyester onto the reinforcement fibers

Casting artificial stone formations (sharrafat)

The analysis proved that the components of artificial stone are as follows

The surface layer that contains the decorations consists of 3 parts gypsum + 2 parts limestone powder Figure (1,2) Table (2)The internal bonding mortar around broken stone or sawdust consists of 3 parts gypsum + 1 part sand Figure (3,4)Table (3)In addition to crushed limestone, the percentage of which varied between each unit and another , so sawdust was relied upon as a filler material to give the units lightweight. Image (27)

Image (22) shows Completion the polyester mold

Image (23) shows Casting the artificial stone components according to the analysis result

Image (24) shows The process of pouring the first surface layer that gives the shape of the decoration

Image (25) shows Distribution of cast material

Image (26) shows Distribution of cast material

Image (27) shows Adding sawdust to the components of the sharrafat

Image (28) shows Completion of casting of sharrafa

Image (29) shows Detachment of the casted sharrafa from the mold

Image (30) shows The mold , the original model, and the reproduced model

Reinstalling artificial stone formations (sharrafat)
The installation processes were as follows

1- Taking measurements of the missing areas of artificial stone formations (sharrafat)
2- Perforating the places of the coils to install the artificial stone (sharrafat)
3- Fill cement mortar around the coils to fix them
4- fixing the sharrafa in the coils with galvanized mesh
5- Making linen bands at the back of each sharrafat
6- Apply cement mortar to the linen ties and galvanized mesh attached to the coils and use the broken pieces with mortar from the damaged sharrafat
7- Dividing one of the sharrafat to create a corner piece
8- Make the slop at a 45 degree angle
9- Installing the corner piece

Image (31) shows Taking measurements of the missing areas of artificial stone formations(sharrafat)

Image (32) shows Perforating the places of the coils to install the artificial stone (sharrafat)

Image (33) shows Fill cement mortar around the coils to fix them

Image (34) shows The beginning of placing and installing one of the sharrafat

Image (35) shows fixing the sharrafa in the coils with galvanized mesh

Image (36) shows Making linen bands at the back of each sharrafa

Image (37) shows Apply cement mortar to the linen ties and galvanized mesh attached to the coils Place the broken pieces with mortar from the damaged sharrafat

Image (38) shows Dividing one of the sharrafat to create a corner piece

Image (39) shows the slop at a 45 degree angle

Image (40) shows a corner piece with a perpendicular edge angle

Image (45) shows Installing the corner piece

Image (46) shows Installing the corner piece

Image (47) shows Installing the corner piece

Image (48) shows Completing the installation of the missing sharrafat

Image (49) shows Completing the installation of the missing sharrafat Eastern facade

Image (50) shows Completing the installation of the missing sharrafat Eastern facade

Image (51) shows Completing the installation of the missing sharrafat Western facade

IIII. DISCUSSION:

Cemetery buildings, by the nature of their function, are to preserve the dead and not buildings for living. We find that they meet many green building standards because of that function. For Examples energy and water consumption. By the nature of their function, there are no water connections to the building, and therefore water consumption is 0 value, and energy consumption is also very low because the families of the dead enter the building for a limited number of times during the year. This also applies to the consumption of materials and natural resources.

If we study the environmental impacts of the building, we will find that they are mostly positive impacts. There is no waste coming out of the building. There is no air pollution. There is no water pollution. There are no heat islands. There is no consumption and depletion of water. There is no noise. This is due to one reason: we are in a Burial building.

The Ultimate effects of the building are also positive there is no harm to the health of people dealing with the building because the number of visits during the year is limited, and as previously mentioned, there is no encroachment on the environment of any kind, and there is no harm or loss of resources. Therefore, the Burial building is considered to meet all the standards of green architecture, and therefore ideal conditions are also available to preserve the building because it is a heritage building.

By studying the design standard, we find that the building's design is very simple. It is a large square room with a height of up to 10 meters. It has two types of window openings, the first wooden for ventilation and natural light, and the second stucco covered with glass to let light in. Therefore, cooling and ventilation occur naturally, especially in presence of a 3000 square meter landscape with many trees and plants, which makes the building not need to consume any source of energy.

Building materials of limestone, artificial stone, lime mortar, and gypsum were used. These materials do not consume energy during their manufacture and have no emissions that affect the building's internal environment.

The model of artificial stone, the subject of the study, meets the standards of green architecture. If we deal with the raw materials involved in the formation of artificial stone sharrafat, we will find that they are simple, cheap materials that do not produce any emissions, such as lime, gypsum, and broken limestone. Rather, among the components is sawdust, which is considered waste produced from Construction operations, was used here as a filling material, which gave a good advantage as it made the weight of the artificial stone sharrafat lighter by half image (27) in addition to the strength of the artificial stone, which is similar to that of natural stone.

Artificial stones are presented and are critically compared with corresponding natural stones. To test suitability for various applications, artificial stones can replace natural stones, thus creating a sustainable development option for the construction industry. [11]

We avoiding wasting reusable building materials by identifying their potential to be reused (either on the same site or somewhere else, Therefore, the broken pieces from the damaged sharrafat were reused while installing the new ones. Reuse is one of the sustainable ways to reduce the use of consumed raw resources. Image (37)

This is in line with the principle of Upcycling Repurposing old structures can save natural resources.

IV. CONCLUSION:

Artificial stone formations (sharrafat) in the tomb of Ismail Sidqi Pasha, a model of green architecture consistent with the principles of green architecture as follows:

1- Fostering the reclamation of reusable building materials.
2- Reuse wasting reusable building materials is one of the sustainable ways to reduce the use of consumed raw resources.
3- The principle of Upcycling Repurposing old structures can save natural resources It has been applied in artificial stones sharrafat.
4- Artificial stone is one of the stucco applications that serve the idea of green architecture.
5- The Ismail Sedqi Pasha Burial building is in line with green architecture standards, even though it. is not a building intended for permanent use such as housing.

REFERENCES:

[1]. https://www.britannica.com/art/green-architecture
[2]. Daniel Stockhammer (2021) .Upcycling Reuse and Repurposing as a Design Principle in Architecture. 2nd edition , Triest Verlag GmbH. P 15
[3]. Egyptian Green Building Council Database. [Online] Available: http://www.egypt-gbc.gov.eg
[4]. Waleed Hussein Ali, Nermine Abdel Gelil Mohamed, (2013) .Green Architecture Assessment System in Egypt with an Application on Zeinab Khatoun House. Developing Country Studies Vol.3, No.14.
[5]. El Essawy, M. A. 2007. The Economics of Environmental Architecture. PhD. Dissertation, Faculty of Engineering, Cairo University, Cairo
[6]. Ruhi Nishat (2024) .Green Design: Sustainable Landscaping and Garden Design. International Journal of Science, Engineering and Technology, 2024, p3
[7]. Norhanis Diyana Nizarudin , Mohd Ramzi Hussain, (2011) .LANDSCAPE DESIGN AS PART OF GREEN AND SUSTAINABLE BUILDING DESIGN. International Conference on Universal Design in Built Environment (ICUDBE2011) 22nd -23rd November 2011 , Kulliyyah of Architecture and Environmental Design International Islamic University Malaysia (IIUM) Kuala Lumpur, Malaysia, p 7
[8]. Monsù Scolaro, A.; De Medici, S (2021) . Downcycling and Upcycling in Rehabilitation and Adaptive Reuse of Pre-Existing Buildings: Re-Designing Technological Performances in an Environmental Perspective. Energies 2021, 14, 6863. https:// doi.org/10.3390/en1421686
[9]. Anelli, D., & Tajani, F. (2022). Valorisation of cultural heritage and land take reduction: an urban compensation model for the replacement of unsuitable buildings in an Italian UNESCO site, Journal of Cultural Heritage, 57, 165-172. https://doi. org/10.1016/j.culher.2022.08.006
[10]. Wheeler, E. A.; Baas, P.; Gasson, P. E., (2004) .List of microscopic features for softwood identification., IAWA Journal 25(1) 1-70, https://doi.org/10.1163/22941932-90000349.
[11]. S. Mavrigiannakis, Z. Agioutantis, (2003) .Suitability of artificial stone as building material: A sustainable development option for the construction industry. International Conference on Sustainable Development Indicators in the Mineral Industries , Milos, Greece.