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Architectural Heritage Conservation in the City of Qurh: Assessing and Stabilizing Islamic Era Mud Brick Structures

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ABSTRACT

Qurh is an early Islamic city located in the al-Ula governorate, northwest of the Kingdom of Saudi Arabia. It dates to the Umayyad dynasty during the 1st/7th C AD and continued until the Abbasid era during the 6th/12th C AD. The city of Qurh occupies a strategic location on the Syrian pilgrimage route, on the bank of Wadi al-Qura, one of the most important sources that provided the city with abundant quantities of water for drinking and agriculture. The city contains a large number of buildings and various archaeological remains, some of which have been excavated and the rest, which constitutes the largest part of the city, is still under the sand. Since the main building material in Qurh is mud brick, the city's architectural structures are subject to deterioration and collapse. Mud brick is one of our ancestor's precious legacies; however, they face changing factors of deterioration from harsh weather, which caused mud brick decay and mechanical properties reduction which need to be urgently consolidated. To our knowledge, it is the first report on the application of Calcium Hydroxide Nanoparticles $Ca(OH)_2$. for the consolidation of mud brick deteriorated the archaeological city of Qurh in al-Ula. Nowadays, nanotechnology provides advanced concepts and new materials for the protection of mud bricks. In this study, a novel method for the consolidation of mud brick was proposed with Calcium hydroxide Nanoparticles $Ca(OH)_2$. Mud brick was investigated, characterized by using different techniques and methods, such as Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM-EDX), Polarized Microscopy (PLM), X-ray Folrences (XRF) and X-ray diffraction (XRD). The results showed that Calcium hydroxide Nanoparticles have enhanced the surfaces of mud bricks. Therefore, this study aims to highlight the historical and architectural value of the city of Qurh, develop a plan to conserve the heritage buildings in the city, and treatment of mud bricks.

Keywords: Qurh, Mud Brick, Preservation, Calcium Hydroxide, Nanoparticles, Deterioration.

INTRODUCTION

The Islamic city of Qurh is located about 20 km southeast of the town of al-Ula in northwestern Saudi Arabia. Qurh is considered one of the most important Islamic cities that flourished and developed during the early Islamic period and became a complete Islamic city with a real urban entity with multiple urban functions. Based on the scientific studies on a group of archaeological finds, Qurh dates to the Umayyad period during the 1st/7th C AD and continued until abandoned by the population during the 6th/12th C AD in the Abbasid period. Qurh went through several residential phases, each phase leaving its historical and archaeological imprint, which was represented by numerous finds of objects and buildings built of mud bricks and painted with mud and plaster. The city of Qurh

occupies an important and strategic location on the Syrian Hajj route (Figure 1), which is an important artery for pilgrims and travelers traffic coming from Damascus to the Holy cities of Mecca and Medina (Al-Ibrahim, Al-Talhi, Gilmore, & Morsi, 1985). Qurh is one of the remaining archaeological examples that still remains of buildings built of mud bricks and coated with clay and plaster (Khali, Khodary, Youssef, Alsubaie, & Sallam, 2022). It is also known in Islamic times and to this day that some buildings are used as shrines or sites where a small shrine-like building was built in memory of a prophet or an important person such as a leader. This type of site is known throughout Islamic cities, but unfortunately, only the structures remain (Shqairat, Abudanah, & Bdour, 2018).

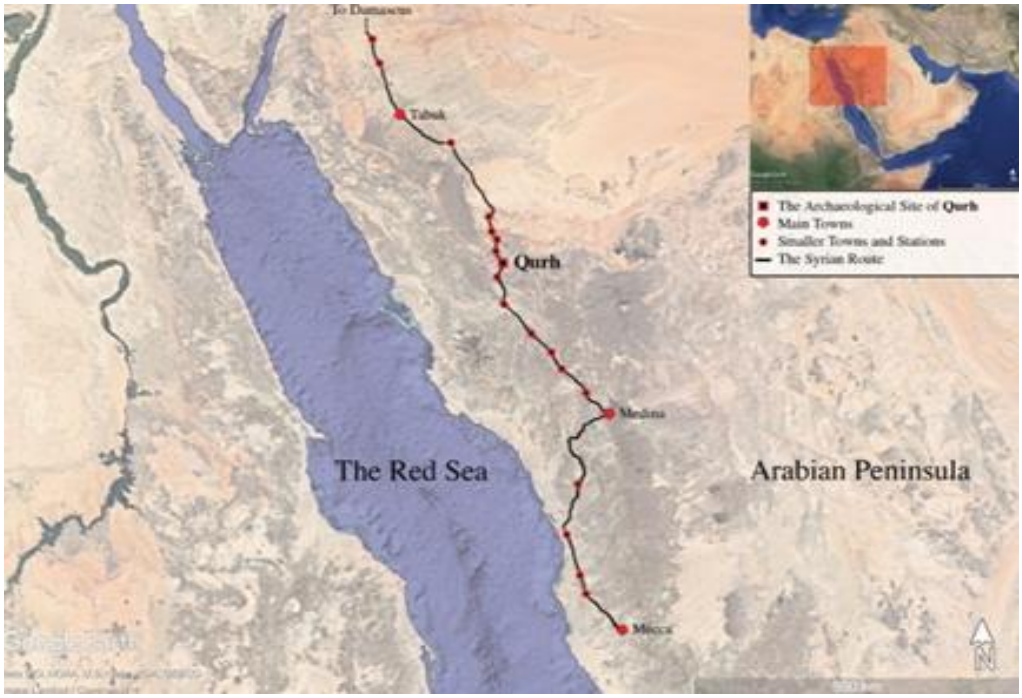

Figure 1. The Location of the Islamic City of Qurh on the Syrian Hajj Route

Qurh reached a high level of development and prosperity during the early Islamic period and was one of the most prominent and famous Arab commercial markets. According to some travelers and geographers during the tenth century, Qurh was one of the largest Islamic cities in the Arabian Peninsula. Al-Istakhri (d. 346/957) mentions that Qurh is the fourth city after Mecca, Medina, and Al-Yamamah (Al-Istakhri, 1937). In addition, Al-Maqdisi (d. 380/990) describes Qurh as the second city in the Hijaz after Mecca (Al-Maqdisi, 1906). When dealing with antiquities and history, study them from several angles and in a different framework. Without assuming the inevitability of any course of events that occurred, we find that there is always an influential role for environmental and climatic conditions in archaeological and heritage aspects (Alexander, Ioannis, & Changhong, 2022).

Qurh contains a large group of diverse architectural structures that represent a link in the development of Islamic buildings in the Arabian Peninsula. A large part of the city was discovered during the extensive archaeological excavations conducted by the Department of Archeology at King Saud University, Kingdom of Saudi Arabia, over a period of 16 seasons, starting from 2004 until 2019. The size of the city is approximately 640,000 m^2, and it is surrounded by remains of an ancient, irregular wall. Inside the wall are located a number of buildings and archaeological remains, such as houses, markets, narrow streets, canals, wells, mosques, and others. Outside the city wall to the north are the remains of a ruined fort built over a medium-height plateau and an Islamic cemetery, in which parts of tombstones written in Kufic script were found (Figure 2). The city also contains a very large number of archaeological finds scattered on the surface, the most prominent of which are fragments of Islamic pottery and parts of brick tiles (Al-Omair et al., 2006; Al-Muaqil et al., 2011; Al-Aboudi, Al-Shammari, Al-Yousef, & Qaoud, 2019).

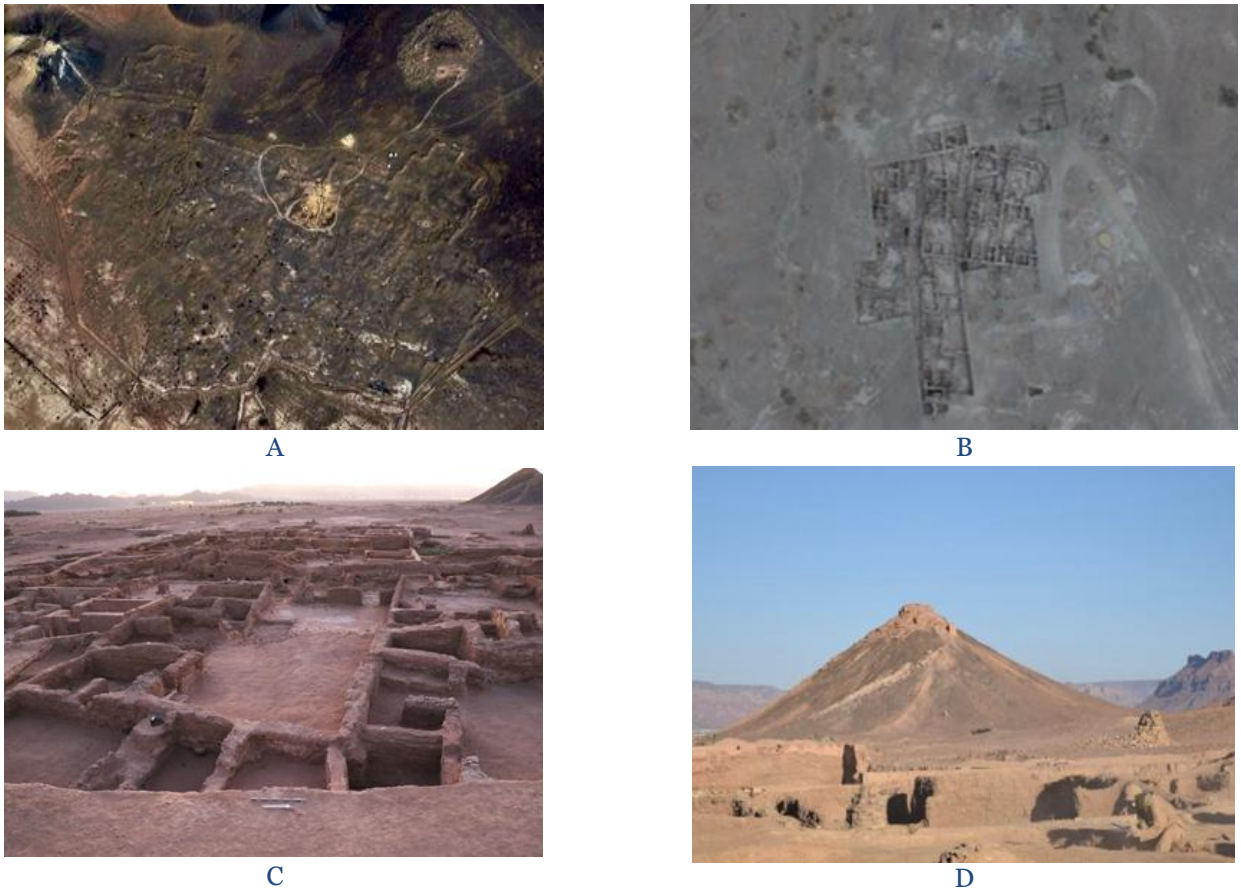

Figure 2. (A) Satellite Image of Qurh Showing the City Borders with its Wall, (B) One of the Archaeological Excavations Conducted by King Saud University, (C) Some Buildings in the City after Excavation, (D) The city's Fort

Regarding the natural environment in the al-Ula governorate, it boasts a range of features and diverse topography. In the central parts of the governorate, there are plains that reach 500 meters above sea level. As you move towards the north, east and west, the elevation rises to 1500 meters above sea level. The area is characterized by plateaus, which are an aspect of its landscape and are part of the Hijaz plateau. Additionally, there are formations that date back to the geological periods, with Harrat Awerid being one of the most significant ones. Covering 18.9% of the Al Ula governorates area, Al Harrat serves as a crucial underground water source, and its soil can be used for agriculture once settled and cleared of rocks at its edges. Most of the land in al-Ula is covered by layers that become thicker towards the east, northeast and north, with volcanic eruptions (harrats) or modern valley sediments in some areas (Al-Faidi, 2014).

Al-Ula region is home, to valleys, with Wadi al-Qura being the significant among them. It is one of the most famous valleys in the Arabian Peninsula. Qurh was established along this Wadi and was the main base of it, and became known by the name of the Wadi itself. Wadi al-Qura was characterized by its abundance of water, dense vegetation, and moderate climate, and it was filled with a set of towns that were established on its banks. Wadi al-Qura supplied the city of Qurh and the rest of the towns with abundant amounts of water, which revitalized the agriculture aspect of the region and increased its agricultural yield and animal production (Al-Bakri, 2002: Al-Omair et al., 2006). The deposits found within Wadi al-Qura consist of a mixture of clay, silt, sand, gravel, and boulders. They possess porosity and permeability, making them valuable sources of water in the governorate. The presence of surface and subsurface water and diverse wildlife makes Wadi al-Qura and other wadis an important natural feature of the region.

Also, in al-Ula governorate, we can find an array of mountains with varying heights and captivating formations that are truly remarkable. These mountains differ in their composition; some are made up of sandstone, while others consist of rocks and others sand dunes. In fact, due to the distinctive natural characteristics of al-Ula, it has played a prominent role as a center of civilizations since ancient times through Islamic times, which led to the emergence of aspects of civilizational development and the exchange of influence between various cultural worlds (Al-Faqir, 2009).

Several scholarly works and projects have focused on the historical and archaeological aspects of Qurh, including the reports of archaeological excavations at the site conducted by King Saud University (as mentioned above), "Al-'Ula (Saudi Arabia): A Report on a Historical and Archaeological Survey" by Al-Nasif (1981), (The Architecture of the city of Qurh in Light of the Archaeological Discoveries of King Saud University, a Picture of the Early Islamic Civilization in Northwestern Saudi Arabia" by Al-Aboudi (2021) and (Islamic pottery in the archaeological site of Qurh: selected samples from the 16th season excavations, 2019: an archaeological and artistic study) by Alsubaie (2023). In addition, the Royal Commission for al-Ula recently contracted with ZRS Ingenieure under the supervision of the German Archaeological Institute (DAI) with the task of investigating the structural and material conditions of the archaeological remains in Qurh, identifying the causes of deterioration and providing options for preserving the site (https://www.zrs.berlin/en/project/al-mabiyat/).

However, this research delves into the material composition and conservation techniques for the mud-brick structures at Qurh. We provide a detailed analysis of the deterioration mechanisms affecting these materials and propose innovative conservation methods, thus filling a crucial gap in the existing literature on Qurh. The novelty of our research lies in its comprehensive approach to assessing and preserving the mud brick architecture of Qurh. Our study is the first on the application of Calcium Hydroxide Nanoparticles $Ca(OH)_2$ for the consolidation of mud brick deteriorated the archaeological city of Qurh in al-Ula.

Qurh has not received many scientific studies related to the restoration of its many facilities. Therefore, this study came to shed light on the historical, archaeological, and architectural importance of the city of Qurh, and to develop a plan for managing and rehabilitating the city to become a viable model in the region. In addition, the paper will focus on assessing the most important risks to which city buildings are exposed and reviewing the most important damage factors affecting the structural condition of those buildings. The heritage is suffering serious deterioration factors, including wind erosion, salt weathering, and variation in air temperature and humidity, therefore, they became fragile and brittle. Wind represents an erosion factor; its effect abreast with sea spray may lead to total loss of building materials (Moussa, 2019). Cultural Heritage (CH) is a unique expression of many human achievements, which, unfortunately, are now threatened with extinction. The world is losing many monuments and sites faster than can be documented. Therefore, documenting and protecting it is extremely important to enable heritage scholars to study and interpret it for the benefit of current and future generations (Haddad, Fakhoury, & Sakr, 2021).

The study aims to highlight the importance of this part of the Kingdom of Saudi Arabia and the necessity of preserving its architectural heritage. In addition, developing the concept of restoration to include sustainable development of heritage sites in al-Ula, which can be exploited socially and economically by activating archaeological awareness and sustainable tourism development programs, thus ensuring the protection and continuity of our ancient heritage.

MATERIALS AND BUILDING

Qurh contains various architectural elements built with multiple materials, Including mud bricks, stones, bricks, gypsum, and lime. The walls were built of mud-brick and brick. Most of the walls are destroyed. Numerous finds of buildings constructed of mud bricks and painted with mud and plaster indicate that Qurh had several phases of residential life. Each phase left its own historical and archaeological imprint (Figure 3). Clay bricks are available in a variety of shapes, sizes, textures, and colors, which makes them serve structural purposes in construction. They were used in ancient times and still are today (Calderón, Sandoval, Araya-Letelier, & Aguilar, 2023). Structural clay bricks are widely used in building construction as they provide thermal comfort, among other advantages that make them an attractive material as a cost reducer and easy to use when formed into building blocks (Azeredo, Alexandre, Azevedo, Xavier, & Monteiro, 2015).

Figure 3. The Walls of Qurh was Built of Mud Bricks and Painted with Mud and Plaster

Indeed, the Islamic city of Qurh is a scattered collection of archaeological hills, which confirm the existence of a rich civilization that had great significance in the past. Extensive excavations were conducted in the city by the archaeological excavation missions at King Saud University, as we mentioned above. These excavations indicated that the site constitutes a large Islamic city rich in archaeological and civilizational components and distinguished by its unique decorations and architectural styles. Among the most important architectural features of the city are the buttresses and columns and the clay floors covered with brick tiles (Figure 4). The buttresses are square in shape and different-sized. They have been characterized by the good paving of the stones that have been installed and the filling of spaces between them with plaster material. Some of the buttresses are made of stone, and others are made of mud brick. Columns are constructed from triangular brick tiles where triangles are rounded and repeated until the required height is reached, and the pillars appear in three patterns. First Pattern: slim circular columns with a square stone base where the rib length of the triangles of the wage tiles is 20 cm and the thickness is 5 cm, and they are left with spacers measuring 4mm horizontally and 2 mm vertically to place the fastener anchor material. Second Pattern: it is the same as the first style, but the size of the brick triangles differs, as the length of the two sides of the triangles is 27 cm and the thickness is 5 cm. The third pattern is double circular columns (Al-Aboudi et al., 2019).

Figure 4. Examples of Mud Brick Circular Columns in Qurh

As for mud brick tiled floors (Figure 5), they were formed with different templates in shape and size and used for paving the floors of units, residential facilities, lower doorsteps of entrances and stairs, as well as the cladding

of wall facades. The mud brick tiles came in four different forms: the first form is smooth square tiles with three sizes: large (25 cm×25 cm), medium (20 cm×20 cm), and small. The second one is square tiles contain geometric and plant decorations, printed with a uniform template. The third and fourth forms are triangular and circular.

A B

Figure 5. (A) Smooth Tiles, (B) One of the Decorative Mud Brick Tiles

THE CONSERVATION PLAN OF THE ISLAMIC CITY OF QURH

The city of Qurh, which holds a place in history, is a vibrant representation of the diverse facets of Islamic civilization. It reflects not only architectural achievements but also the intricate social and cultural dynamics that have shaped its unique character over time. In times, there has been a growing sense of urgency to protect and revive Qurh due to the increasing threats it faces and its immense historical value. To address these challenges effectively, it is crucial to develop a conservation plan that draws upon expertise and practical considerations (Jokilehto, 2017).

Qurh, renowned for its history, has played a role as a hub for cultural, economic, and intellectual interactions (S. Albu, I. Albu, & D. C. Albu, 2022). Its strategic position along the Hajj route has contributed significantly to this dynamic. The architectural styles found in Qurh are a captivating fusion of influences from dynasties and the indigenous pre-Islamic elements (Hawting, 2000). These structures not only captivate the eye but also provide insight into the ever-changing socio-political landscape of the region. The mud brick buildings in Qurh hold stories that reflect the city's journey through time. Recognizing the value of Qurh, its preservation goes beyond national importance and becomes part of humanity's collective heritage narrative (Graham, Ashworth, & Tunbridge, 2016).

A thorough understanding of the current conditions of Qurh relies on research studies and archival materials. Important sources, such as surveys conducted in the part of the 20th century, have been essential in uncovering the city's spatial dynamics and historical timelines. Recent assessments conducted by national bodies have provided insights into preserving the site for generations. Additionally, academic articles exploring Qurh styles and socio-economic significance have contributed to our knowledge of the city. The efforts of community-driven initiatives have also played a role in documenting histories and cultural narratives that complement Qurh's physical structures. The legal frameworks that govern heritage protection, including treaties and national laws, provide a foundation for this conservation plan, ensuring its alignment with both global and local standards (Crone, 1989).

The spread of cracks of all types and degrees displays the archaeological building structures of the courtyard. Therefore, Restoration operations are recommended, such as reinforcement as well as isolating traditional building materials from sources of moisture, Preserving this unique cultural heritage (El-Sayed, 2021).

Methodology and Stakeholder Engagement

Preserving the Islamic City of Qurh requires a balance between research and practical considerations on the ground. In this section, we will discuss the approaches used and highlight the involvement of stakeholders in the conservation process. The effects of physical and mechanical weathering on the properties of building materials cannot be easily studied. Therefore, non-destructive techniques are used to determine the physical and mechanical properties of building materials and are therefore preferred for testing materials that require small-sized samples (Ali, Moussa, & El-Sayed, 2022).

There are some important things to consider when you start preserving clay architecture. In general, clay

handles bad weather (especially humidity) and time very poorly. For this reason, it is recommended that clay masonry be protected at the end of each excavation season before deterioration begins. For reasons including compatibility with ancient materials when restoring it, mud architecture must be preserved with the same mud, and even if the clay used is of good quality, it must be replaced regularly because bad weather negatively affects this protection. Therefore, the structures need constant maintenance over the years. It is also better to plan some measures, including measures to prevent water stagnation at the bottom of the walls, even if the rainy season is short. We find that over the past few years, methods for preserving and restoring clay structures have developed, and natural and chemical products can be used for this purpose in precisely defined proportions. For mud walls, ideally, the tops of the walls should be protected with a layer of new mud brick or a thick layer of soil. The faces of walls covered with clay plaster should also be protected. If the wall is very damaged, holes and cracks should be filled with mud, perhaps mixed with very small stones, but these stones should not be visible (Gelin, 2008).

Comprehensive Site Surveys and Utilization of GIS

Our methodology is built upon conducting site surveys, which go beyond inspections. These surveys involve in-depth assessments of the city's state with a focus on the integrity and stability of its buildings. To enhance our evaluations, we utilize Geographic Information Systems (GIS), a technology that plays a role in mapping Qurh's heritage assets. GIS helps us analyze data and gain insights into environmental risks and areas of concern. By combining survey methods with GIS techniques, we ensure a thorough understanding of the physical condition of the site.

Using modern spatial technologies, unmanned aerial vehicles (UAV), Global Positioning System (GPS) and ground control points, the area to be studied is accurately photographed, and its geographical reference is determined using photogrammetry software to have a true picture of the study area, which in turn provides us with a basic map. To then analyze it via a Geographic Information System (GIS). The primary goal of collecting all this information is to create a temporal and spatial display of the city's development while providing additional data such as population fluctuations, structural elements, and buildings. With this digital depiction of the evolution of the urban fabric, a clear narrative of the history of the city itself begins, and digital technologies are therefore, essential for defining the management of cultural heritage (Panagiotidis & Zacharias, 2022).

Thirty-two rock tombs are considered from Petra and Madaa'in Saleh in northern Saudi Arabia. Satellite images were used from Google Earth and its additional amenities on compass and slope calculation. Some comparison of locations was completed with an situ compass and total station analysis. The Nabatean graves at Petra and Madaa'in Saleh seem to have variable orientation without any consistent pattern but rather geological and geographical motives. Tomb architecture seems to have had no visible effect on either the terminology from inscriptions or deliberate skyscape connection. In specific, the illumination inside the chambers of Al Khuraymat during southern alignment occurs a little earlier than any sunset at changed sea-sons. This may have served their needs of any possible rituals inside of the cavity. At the same time, the related crux, widely known to Mediterranean people, may have aided as a noticeable point for their beliefs or nomadic movements. All orientations at Madaa'in Saleh are related to winter and equinox sunsets, but in Petra, the royal tomb at al-Khazneh is related to solstitial sunrise (Liritzis, Al-Otaibi, & Castro, 2015).

Diverse Stakeholder Engagement

The success of any conservation project heavily depends on the participation and support of stakeholders. In the case of Qurh, we understand the significance of incorporating perspectives from a range of individuals. The involvement of communities is crucial. Our approach emphasizes the importance of preserving their identity. Their unique insights and firsthand experiences provide an understanding of practicing conservation in a respectful manner. Historians and scientific experts bring knowledge about the Qurh context and the best approaches to archaeological preservation. Their advocacy for grounded methods ensures that our conservation efforts are effective while respecting the site's significance. Also, navigating through heritage conservation laws and international guidelines is essential. Legal experts help ensure that all our conservation activities align with laws and international best practices, such as those outlined by UNESCO and the Venice Charter. This legal alignment is not about compliance but about upholding ethical stewardship, for Qurh heritage (Frost & Hall, 2009). Cultural tourism benefits countries, providing that the enhanced cultural monuments are properly studied, recognized, and restored to develop in harmony with the environment and society, apart from the educational and academic dimensions. Here, the role of NGOs associated with UNESCO and other accredited global administrations is huge. Indeed, cultural tourism is an asset for countries so much for cultural diplomacy as much as sustainability development goals (Dabanlı & Şimşek, 2023).

State of Preservation and Assessment of Needs

The city of Qurh, with its heritage, poses a demanding conservation challenge. Currently the archaeological

treasures of Qurh face vulnerability due to factors such as erosion and seasonal floods. These natural processes, along with activities, have hastened the degradation of this important location. It is crucial to thoroughly assess the existing preservation status in a manner to develop an efficient conservation plan.

Understanding the Current Condition

To truly understand the level of preservation needed, it is crucial to begin with assessments that evaluate the stability of the deteriorating buildings on the site. This entails examining all components ranging from the foundations to the roofs. It is important to approach this process with consideration, for Qurhs characteristics, which reflect its rich historical and cultural heritage.

Addressing Immediate Risks

Considering the site's vulnerability, it is important to implement emergency measures. These actions serve a purpose; not only do they prevent immediate collapse or further damage, but they also protect the site for future generations. This could entail setting up support structures regulating access to areas and implementing other stabilization efforts. Striking a balance between preserving the site's integrity and ensuring its safety and accessibility is crucial.

Environmental Impact and Long-Term Goals

It is equally important to carry out analyses of the impact. These studies are crucial to comprehend the risks that may hasten degradation at the location. It is necessary to examine factors, like climate change alterations caused by activities and occurrences of natural disasters, to create a long-term preservation strategy that is both adaptable and robust (Brandi, 2005).

To successfully restore the site, it is crucial to take a carefully planned approach. The restoration process should be done in phases following recognized conservation standards. This ensures that any actions taken preserve the cultural significance of the site. It is important to consider how new structures or materials can be integrated without compromising the authenticity of the site (Tomlan & Jokilehto, 1999).

Legal, Regulatory and Ethical Considerations

Preserving the Islamic City of Qurh goes beyond its historical importance. It involves navigating a web of regulatory and ethical factors. To successfully navigate this terrain, it is crucial to find a balance between maintaining the site's authenticity and following the legal requirements and ethical standards that govern heritage conservation (Blake, 2015).

At the local level, the site must adhere to the guidelines set out in the Saudi Arabian Antiquities, Museums and Urban Heritage Law. The significance of local laws was highlighted by Jukka in 2017 as they provide a foundation for safeguarding and managing historical sites. These guidelines go beyond regulations; they serve as a guide that shapes every decision made to preserve Qurh with utmost effectiveness and respect for its intrinsic value (King, 1998).

Internationally, Qurh conservation efforts align with the World Heritage Convention principles (Orbasli, 2007). This alignment is vital not only for gaining recognition but also for ensuring that Qurh's conservation practices adhere to globally accepted standards. As pointed out by King in 1998, the World Heritage Convention emphasizes the significance of sites like Qurh and advocates for their preservation as part of humanity's shared memory and heritage.

In addition, the conservation efforts at Qurh are guided by the principles and technical guidelines outlined in the Venice Charter for the Conservation and Restoration of Monuments and Sites. The Venice Charter is a document in the field of heritage preservation emphasizing the importance of maintaining the authenticity and historical integrity of sites. As highlighted by Blake in 2015, adhering to the Venice Charter ensures that all restoration and preservation activities at Qurh are rooted in a dedication to accuracy, scientific precision, and a deep appreciation for the site's architectural uniqueness.

The ethical considerations involved in the preservation of Qurh go beyond simply following regulatory frameworks. They involve a commitment to making sure that the preservation process honors and safeguards the rights and interests of communities who have a strong connection with the site. This means not only recognizing their ties to the site but also actively involving them in decision-making. Upholding the standards of integrity throughout all preservation efforts. This means basing restoration work on research and archaeological evidence, ensuring that there is no misinterpretation or distortion of the site's historical significance (Mahmoud, 2020). And carrying out all preservation activities with transparency and allowing them to be scrutinized by stakeholders. This approach builds trust and ensures that preservation efforts meet the expectations and requirements of communities, international bodies and non-governmental organizations (Nassif, 1995).

Conservation Strategy and Implementation

The conservation plan for the Islamic city of Qurh is a designed approach that aims to find a balance between preserving the site and promoting sustainable development while actively involving the community (Panagiotidis & Zacharias, 2022). This strategy is based on an understanding of the city's cultural and architectural importance. It incorporates methods and practices to ensure that each action taken is grounded in validity and ethical responsibility.

Historical Authentication and Multidisciplinary Engagement

Our strategy revolves around the importance of authentication. We take care in verifying. Validating every aspect of our conservation work through extensive research and reference to historical records. Preserving the authenticity of the site is our priority. We are dedicated to ensuring its integrity in the most accurate manner possible. To accomplish this, we involve a group of individuals, including communities, historians, policymakers, and conservation experts. This multidisciplinary collaboration allows us to take an approach where decisions are influenced by a range of perspectives and expertise. By involving stakeholders, we not only enhance the conservation process but also foster a sense of collective ownership and responsibility towards this valuable heritage site.

Sustainable Practices and Digital Preservation

Sustainability is a principle that guides our conservation practices. We employ techniques and methods that aim to minimize harm to the environment while ensuring the long-term durability and strength of restored structures. This sustainable approach supports the economy while avoiding any strain on its historical assets (Richards, 2006). In addition to restoration, we are dedicated to preserving the site as well. By utilizing technologies like 3D scanning and Geographic Information Systems (GIS), we create replicas and detailed maps of the area. These tools not only assist with restoration work but also serve as valuable resources for future research and preservation initiatives (Feilden & Jokilehto, 1993).

In recent years, archaeologists have started to incorporate new skills that can support them in archaeological excavations. Such technologies contain 3D Imaging Surveying methods (LiDAR, Mobile and Terrestrial 3D Scanners), Unmanned Aerial Systems (UAS), Photogrammetry, as well as 3D Visualization Systems (Virtual and Augmented Reality) for the three-dimensional or two-dimensional show of sites where archaeological excavations are approved out. A large benefit of novel technologies is the extremely increasing abilities and operator sociability over cost ratio, which inspires archaeologists to enter the emergent realm of Digital Archaeology (Psarros, Stamatopoulos, & Anagnostopoulos, 2022).

Phased Restoration and Community-Based Approaches

The restoration of Qurh is planned to be carried out in phases, allowing for planning and execution at each stage. This approach ensures that all interventions are done with consideration for the context and current condition of the site (Muñoz-Viñas, 2004). Community involvement plays a role in this phased approach. By engaging communities, we ensure that the restoration work resonates with those who have a deep connection to the site, thus preserving the cultural relevance and significance of Qurh (Tracey, Smith, & Lawrie, 2016). Education initiatives also form a part of our long-term strategy, aimed at increasing awareness about the heritage of the site and fostering a sense of responsibility among both residents and visitors (Chabbi, Jerome, Jigyasu, Kelley, & Reap, 2014).

Ongoing Evaluation and Adaptation

We believe in the importance of evaluating and adjusting our conservation efforts. To achieve this, we have put in place a system to monitor and periodically assess the effectiveness of our interventions based on predetermined benchmarks (Rosina & Pili, 2020). This ongoing evaluation enables us to modify our methods and strategies as we learn from research, overcome challenges and benefit from advancements in conservation science (Konsta & Della Torre, 2021). By doing so, we maintain transparency and accountability, which are crucial for gaining the trust and support of all those involved in preserving Qurh.

Looking Ahead

As we gaze into the future, our conservation plan for the Islamic city of Qurh stays flexible and adaptable to the changing requirements of the site. We understand the significance of keeping up with advancements in fields like Artificial Intelligence (AI) and the Internet of Things (IoT), which present fresh opportunities for better monitoring and safeguarding the site. Moreover, it will be essential to foster cooperation to utilize knowledge and acquire extra resources and assistance for our conservation initiatives (Liritzis et al., 2015).

The environment in which cultural remainders are conserved is an imperative factor that controls whether it

has weakened, what kind of deterioration has happened, and to what degree. By reviewing the reasons and mechanisms of environmental changes in the normal atmosphere within an area, it is probable to conclude the state of undiscovered heritage and formulate consequent preservation and excavation strategies, and this knowledge can also be used in the world' s cultural artefact conservation (Pu & Wang, 2023).

To sum up, the conservation strategy, for Qurh, is a thoughtful plan that finds a harmonious balance between honoring the past, meeting present needs and embracing future possibilities. This strategy not only focuses on safeguarding a cultural site but also strives to guarantee its enduring significance as a fount of wisdom, motivation, and communal pride for future generations.

SYMPTOMS OF DETERIORATION

There were many factors that contributed to the destruction of the Qurh, including the risks associated with humans, natural hazards and erosion, the evacuation of the site and the lack of awareness by the local community about cultural heritage, which damaged part of the site under consideration. Mud bricks face challenge factors of deterioration from harsh weather, which causes mud mortar decay and mechanical properties reduction, which need to be urgently consolidated (Figure 6).

Figure 6. The Walls are Totally or Partially Destroyed by Natural Hazards and Erosion, Windstorms and Rainfall Mutually Influence Each Other, Resulting in Destruction of Mud Brick Features on Facades

Based on the field studies of Qurh, it appears that the main deterioration factors of Qurh two main reasons for deterioration are:

The absence of a heritage management plan additionally, a lack of awareness of the local community towards heritage management and environmental hazards such as climate change. As for environmental hazards, these are very harsh because the Qurh site is located in the desert. The prevailing hazards of climatic are represented in: high variations in temperature rates, windstorms and unexpected aggressive flash floods that destroyed many walls and facades of adobe.

Hazards of climatic mostly affected the mud bricks causing increasing weakness, cracks and disintegration of mud bricks and most facades were deteriorated by wind erosion. As a result of the high temperatures at Qurh, there was an increase in thermal loads, which resulted in cracking and microcracking. Due to severe windstorms and heavy rain, mud brick features on facades are lost (El-Hafez, 2018). Many mud brick walls were destroyed by the sudden rain and blurred the features of the Qurh's mud brick facades (Figure 7).

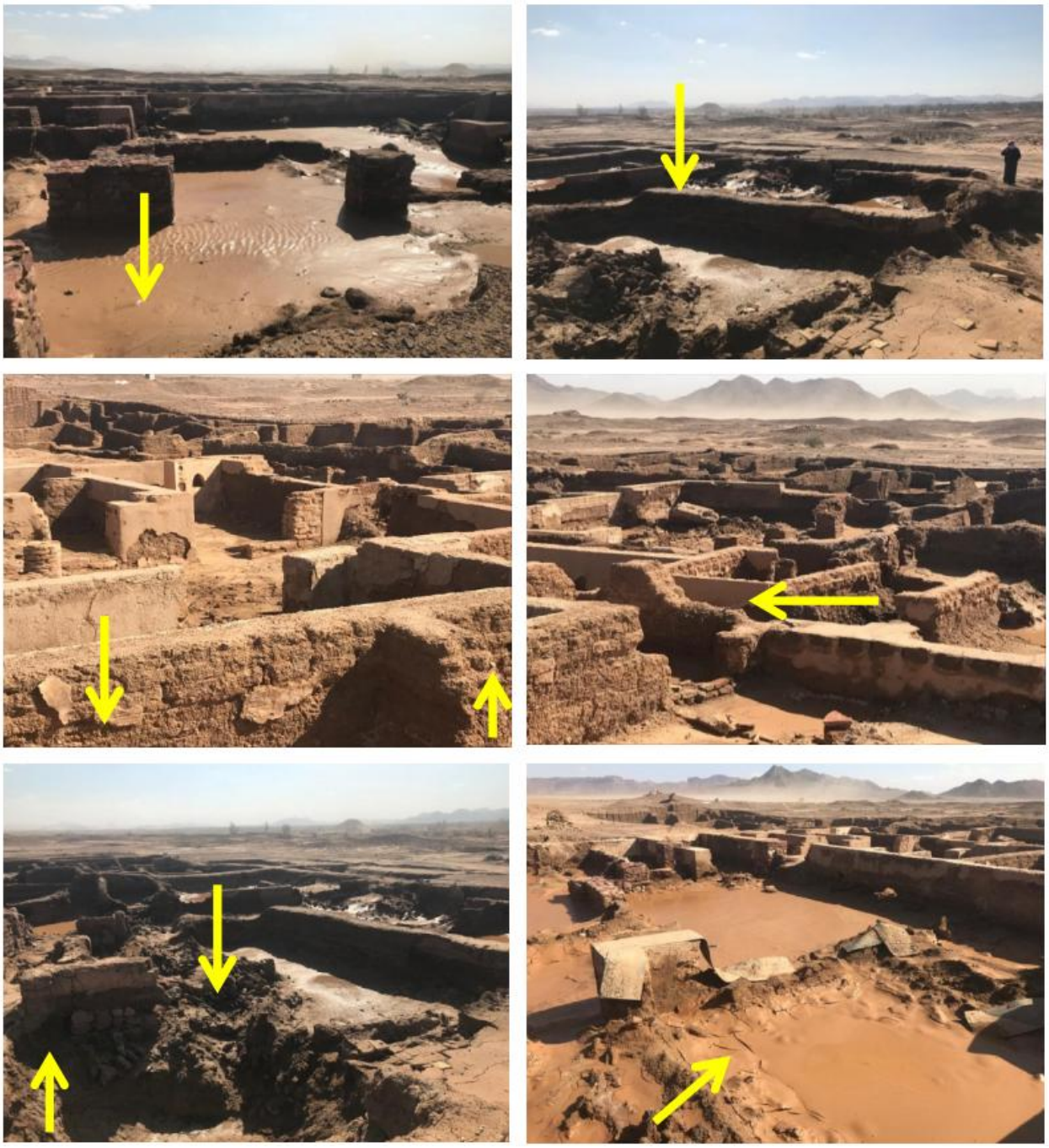

Figure 7. The Facades of Adobe were Blurred Because of Flash Floods and Heavy Rain

MATERIALS AND METHODS

The two samples were prepared using Epoxy Number 27-751, hardener, as well as the different sizes of sandpaper 800, 1000, 2000, and 4000 to provide information about fragments of mud bricks (Figure 8).

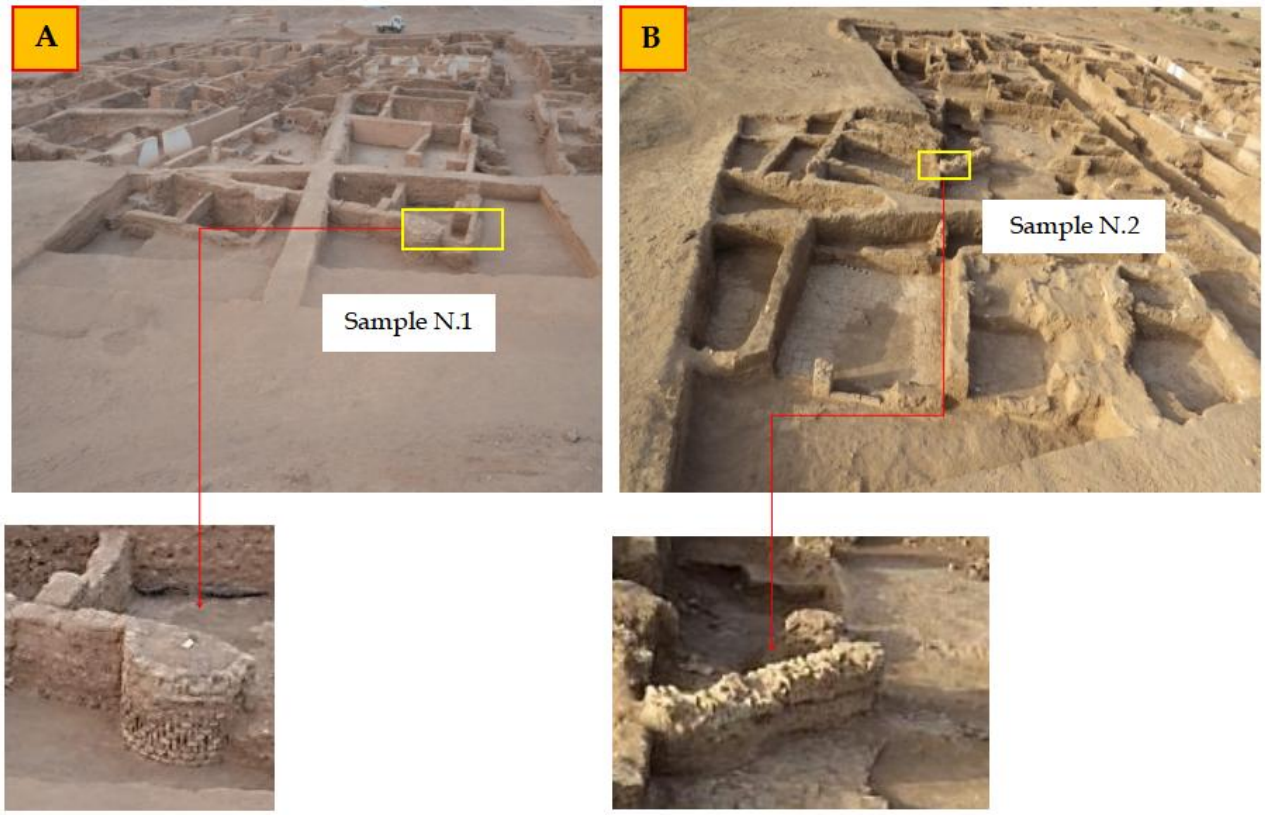

Figure 8. (A) General View Showing the Sample Number One (The Wall Bottom), (B) The Sample Number Two (The Wall Top)

Samples Preparation

The samples to be used for Cross-Section were divided into small pieces, then embedded in epoxy (Number 27-751, mix the epoxy and the hardener in a 100 : 2 mL ratio). After the complete hardener and drying of the epoxy, the samples were ground and polished by using sandpaper sizes (800 : 4000) with wet-type sandpaper to get a smooth and good surface The sample's surface was observed by BM each time. The other sides of the sample were polished then, the prepared samples were observed using the BM and SEM.

Polarizing Microscope investigation

Olympus' BX53 polarizing microscope is innovatively designed and provides excellent performance when polarized light is used, using UIS2 infinity-corrected optics. BX53 microscope is equipped with a wide variety of compensators to handle observations and measurements across a broad range of applications. The Cross-Section of the mud brick samples were investigated using BM (Olympus BX53).

SEM Investigation (Morphological Study)

The surface morphology of the mud brick samples was investigated using a Scanning electron microscope (JEOL-5500LV). The Acel. Volt was 15 : 20 kV. The investigation was carried out in (SEI), and the samples of mud brick were examined at Laboratory of Central, South Valley University.

XRF Analysis (Spectroscopic Study)

X-ray fluorescence (XRF) has been used in the identification of mud brick minerals. Samples were prepared at Central Laboratory, South Valley University, Qena, Egypt.

XRD Analysis

As well as the preservation involves information about the structure methods, properties of the used materials as well as deterioration factors. For these determinations, a considerable group of samples were

collected with two mortar samples from the preparatory layers and analyzed by X-ray diffraction (Arina, Shiyyab, & Al Sekhaneh, 2020). X-ray diffraction (XRD) has been used in the identification of mud brick minerals. Samples were prepared at Central Laboratory, South Valley University, Qena, Egypt.

Preparation of Calcium hydroxide Nanoparticles

Construction materials like calcareous stone and mortars rich in calcitic content have been widely used in ancient memorials. Conservation effectiveness may be enhanced considering the mechanisms underlying deterioration due to wet precipitation. In the current work, we have tested the possibility of treating calcitic materials with suspensions of amorphous calcium carbonate (am-$CaCO_3$, ACC) and amorphous silica (am-SiO_2) nanoparticles (NPs). Pentelic marble (PM) in crushed form, to maximize surface area and a mortar containing calcium carbonate and silica aided as test materials for the validation of the application of suspensions of NPs for protection to the erosion in slightly acidic solutions undersaturated with respect to calcite (pH 6.50). The result was credited to the chemical and structural affinity of the NP preparations with the treated building materials (Pavlakou, Lemonia, Zouvani, Paraskeva, & Koutsouko, 2023).

Calcium hydroxide $Ca(OH)_2$ is an important chemical with numerous chemical, industrial, environmental and architectural applications; especially in architecture and decorative arts, it has been traditionally used as a primary material (Ashurst & Dimes, 1998; Elert, Rodriguez-Navarro, Pardo, Hansen, & Cazalla, 2002). In addition, it is one of the most interesting products for performing consolidation of calcareous materials such as stone sculptures, monuments or mud brick. Lime (—lime wash ‖ putty) has been used in the past as an air-hardening binder and in the preparation of the walls for paint application where calcite and silica are the main components of the substratum (Rodriguez-Navarro, Ruiz-Agudo, Ortega-Huertas, & Hansen, 2005; López-Arce, Gómez-Villalba, Martínez-Ramírez, De Buergo, & Fort, 2011). Other examples of its applications include drinking water, sewage sludge, and wastewater treatment; flue gas de-sulfuration; pollutant emission control; dentistry; and as an additive in lubricating oil (Rodriguez-Navarro et al., 2005).

Preparation Methods

$Ca(OH)_2$ nanoparticles were synthesized via the ball mill technique for calcium hydroxide bulk (Loba Chemie, India), in which the powder was milled by using a ball mill machine (planetary-ball-mill-pm-400) for 10h, speed 350rpm and 3min intervals (Konsta & Della Torre, 2021).

XRD Analysis of $Ca(OH)_2$ Nanoparticles

An XRD pattern has been performed using the XPERT-PRO Powder Diffractometer system, with 2 thetas (20°-70°), with Minimum step size 2Theta: 0.001, and at wavelength (Kα) = 1.54614° (Figure 10).

TEM Investigation of $Ca(OH)_2$ Nanoparticles Size & Shape

TEM was performed on JEOL JEM-2100 high-resolution transmission electron microscope at an accelerating voltage of 200 kV, respectively.

Preparation of the $Ca(OH)_2$ Nanoparticles for Consolidation

The $Ca(OH)_2$ nanoparticles (average size 50 nm) were dispersed in an ethanol concentration of 10%. The $Ca(OH)_2$ nanoparticles were treated using the sonication technique by dispersing 100 gm wt% of $Ca(OH)_2$ nanoparticles powder in 1000 mL of ethanol for 30 min using an ultrasonic and magnetic stirrer. Study on the effect of consolidation of calcium hydroxide nanoparticles dispersed in an alcoholic medium on limestone. The treatment materials are applied to limestone samples from the archaeological site as well as other new samples on which tests are performed. Various factors were taken into consideration to evaluate the effectiveness of the reinforcement material, including porosity, water absorption, compressive strength, etching resistance and resistance to salt crystallization damage. From the comparison between these properties before and after incorporation, it is clear that the application of nanoparticles prepared in propanol-1 significantly improved the mechanical properties of the treated stone (Al-Omary, Al-Naddaf, & Al Sekhaneh, 2018).

Treatment Samples

In order to apply $Ca(OH)_2$ nanoparticles on the surface of the mud bricks, multiple brushings were performed 4-5 times per day for 5 consecutive days. Polyethylene sheets were also used to prevent the treatment from evaporating from the mud brick surface.

RESULTS AND DISCUSSION

Qurh Archaeological Deterioration Factors

The current status of the archaeological heritage in Qurh is in a weak and poor condition, due to environmental factors Such as erosion and seasonal flooding, which pose constant threats to the stability of the site. Therefore, it is necessary to initially conduct assessments to determine the structural integrity of deteriorating buildings. Then follows developing plans and measures to ensure the preservation of areas and parts that require stability. These measures are to prevent collapse and further deterioration. To achieve these goals, an environmental impact analysis is conducted in conjunction with immediate studies to understand the risks that may lead to accelerating the deterioration process at the site (Tomlan & Jokilehto, 1999; Chabbi et al., 2014).

Clay material from the earth is one of the most commonly used elements of building materials in the world but it is also considered one of the most Weaknesses and lack of homogeneity of the soil materials that make up it. Building regulations make it problematic to categorize overall decay associated processes and manipulations (Rainer, 2008). These need understanding when thinking about developing a restoration work plan and identifying the causes of deterioration, with the aim of achieving deterioration. Mapping is an essential step before a full intervention Site preservation plan. The causes of deterioration of these structures can be classified as inherent when related to materials. Composition or with construction and external technology When external factors such as water, wind, etc. Environmental and contextual factors play a role.

The most common type of deterioration experimental on adobe bricks The Slot structures appear to be related to erosion by wind and rain (external factors). Aeolian erosion is facilitated by the absence of roofs or shelters. Likewise, unexpected heavy rain can fall on structures that are not well-endangered, thus accelerating decay. Commonly, this harm tends to occur at the top of the wall and on the entire surface where the corrosion occurs. It occurs in the form of non-structural destruction such as parting, Delamination, peeling and cracking. And at the bottom of the wall (Chabbi et al., 2014). In case of water penetration/infiltration and high humidity producing basal erosion and inefficient protection, paint can cause structural destruction that leads to upper wall movement, tilt, and collapse (Bizzarri et al., 2020; Rainer, 2008).

The great standards of temperature mostly affected the mud brick in the Islamic city of Qurh. It affected increasing loads, which are named thermal loads; these loads appear in the form of all kinds of cracks (fine and huge cracks), as well as weakness and breakdown of plasters. The mechanical conditions, wind and rain properties play a main part in enhancing the action of thermal loads. The wind has a negative action on the Islamic city of Qurh, so most mud bricks of Qurh deteriorated by wind weathering and weakening due to windstorms. The unexpected precipitation of rain damaged numerous adobe walls.

The biological hazards are playing an important part in the deterioration of greatest mud brick building at Qurh. The white ants are considered the main factor in deterioration processes; they feed on cellulose found in wooden elements or the straw used in mud brick manufacturing. After the termite attacks, most mud brick Qurh became damaged. The contribution between climatic factors and biological agents has led to fixed damage to all mud brick Qurh.

Instead, wild bees, beetles and moths have a plain role in weakening and distorting the stated Qurh. For example, wild bees shape their solid nests on the building materials, beetles and moths attack the organic building materials, as well as the organic secretions of these insects are damaging and collapsing to the building materials. Furthermore, bats, rats, reptiles, fierce dogs, and wolves are considered a significant cause of biological damage to Qurh because of the equality of the site from inhabit ends. These animals previously stated are digging tunnels and making drillings, hovels, and scratches due to the direct resistance with the building: soil, walls and architectural elements. This severe factor caused a structural dysfunction in many architectural elements of the studied mud brick; the scientific and investigative studies showed that the bat excretions, in specific, contribute significantly to the deterioration of historic building materials, causing: aesthetic biogeophysical and biogeochemical damages, as a result of the presence of phosphate salts in bats guano which accrued on the structure materials.

Clay plays a chief character in the building process and the traditional architecture in the Kingdom of Saudi Arabia. Clay uses it to build all internal and external walls. In addition, it can be used as a material for interior plastering and a material with which the courses between bricks are connected. It can also be used to cover ceilings with palm leaves, which may have been used originally. We find that clay is available in areas where water accrues. Clay is composed of some remains of organic materials and carries the same characteristics as the region in which it is formed.

Therefore, we find that it is characterized by specific properties, and among its physical properties is that it is

distinguished in current insulation and when analyzing a model that was used in the town. In the ancient city of al-Ula, we found that the material that makes up clay has proportions in specific compounds. The percentage of silica was 50%, the percentage of aluminium was 34%, while iron oxide was 8%. There was lime and magnesium, and its percentage was 6%. In addition to the presence of organic materials, it was the percentage is 2%, thus making a total sample of 100%.

Mud bricks are formed from mud under the rays of the sun after adding straw to them to increase the strength and symmetry of the clay. Clay molds are used in the molds, and wooden molds are formed in sizes found in the buildings of the city of al-Ula so here are three sizes of bricks, which are 50.5 by 32.7 cm. There was another size that was 32.5 by 30.5 cm and another size that was 2505 by 23 cm.

Small cracks come back in clay bricks, as well as drilling, cracking, and falling clay Plaster due to physical and biological factors as manifestations of weathering. We find this clear from the results of the examination using SEM ,which shows the surface morphology for the samples studied, which appear to be broken up for the most part (El-Gohary, 2017). Gypsum and made of clay mud are extremely rare in the archaeological sites. However, this varies considerably in the thickness of the painted layer and the morphological features of the surface coat layer (Bugini, Corti, Folli, & Rampazzi, 2017).

The desert climate is hot from the beginning of May until September, with temperatures ranging between 30-45 degrees Celsius (70-105 degrees Fahrenheit). The weather in al-Ula is generally characterized by a much lower humidity level than the rest of the cities of the Arabian Peninsula, so the climate is hot and dry in the summer (https://www.accuweather.com/ar/sa/al-ula/296755/november-weather/296755).

Water caused by flash floods is one of the most common factors causing Deterioration at the base of the walls, while the capillaries rise, and Rain causes visible erosion at the top of the walls, resulting in the formation of Deep grooves. We need to study the site and analyze the reasons that led to it. Deterioration has led to two ways to reduce corrosion and environmental protection necessary for those Earth structures:

By adjusting the slopes of the site to eliminate standing water and reduce runoff. In addition, the facilities must be insulated against external factors by:

Protect exposed surfaces with materials such as Soil, mud brick and clay plaster (Dehkordi, Vatandoust, Madjidzadeh, & Kashi, 2008). The first step is to address the issue of rainwater drainage. It is necessary to identify the naturally formed channels through which water passes Tends to drain. Then, these channels were precisely formed. It must be filled with drainage material, which facilitates the flow of water in the direction of the definite stream, and at the same time, no noticeable change occurs in Site appearance (Bizzarri, 2015).

They neglected these archaeological sites for a long time. Therefore, much of the damage was done. Instead, there are no smooth roads leading to the popular sites. Recently, the Saudi government has established some roads leading to Qurh as well, but there is no good documentation of that architectural heritage; these make restoration procedures too difficult.

Polarizing Microscope Investigation

The polarizing microscope is an advanced method of creating detailed images that are capable of magnifying samples 500 times in high detail and resolution [Figure 5 (A), (B) & Figure 6]. A cross-section image showes the structures of mud brick, mainly clay minerals, lime, sand, aggregates, and animal dung, in addition to chopped straw as binding cementing materials under normal and UV light [Figure 9 (A), (B) & Figure 10 (A), (B)].

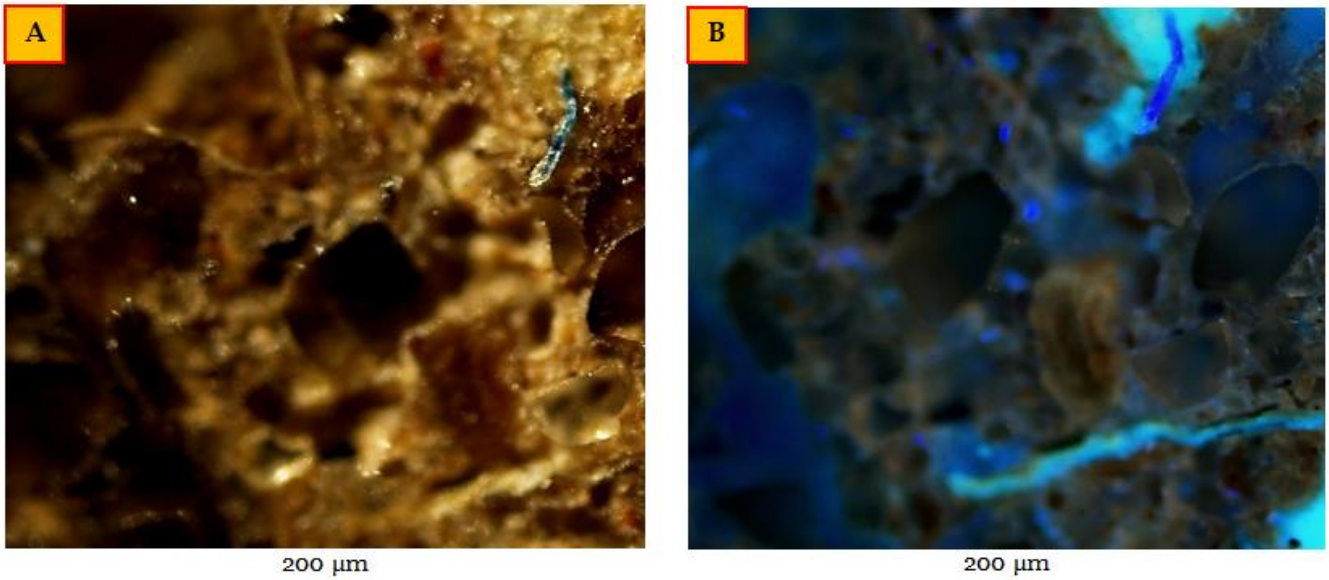

Figure 9. (A), (B) Photomicrograph of Cross-section Image showing the Structures of Mud Bricks shows the Contains Sand and Organic Material in Mud Bricks, as well as Gaps, Cracks, Micro Cracks and Surface Details in High Resolution under Normal Light under Plm (Bmm), (B) Under UV Light

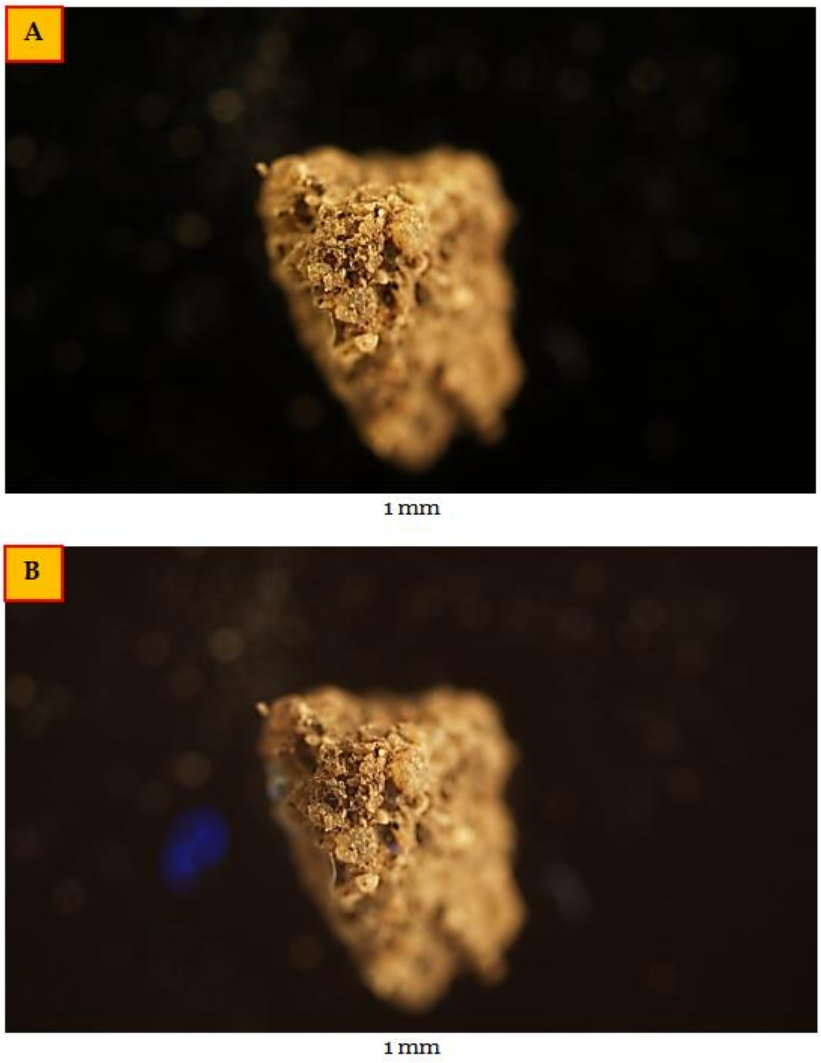

Figure 10. (A) Photomicrograph of Cross-section Image showing the Structures of Mud Brick under Normal Light under PLM (BMM), (B) Under UV Light

SEM Investigation (Morphological Study)

The result obtained from SEM shows some disintegration in grains of quartz, loss of clay minerals and due to harsh weathering (wind erosion and large temperature) led to a weakness in the materials of binding, micro cracks, and cracks before treatment [Figure 11 (A), (B)].

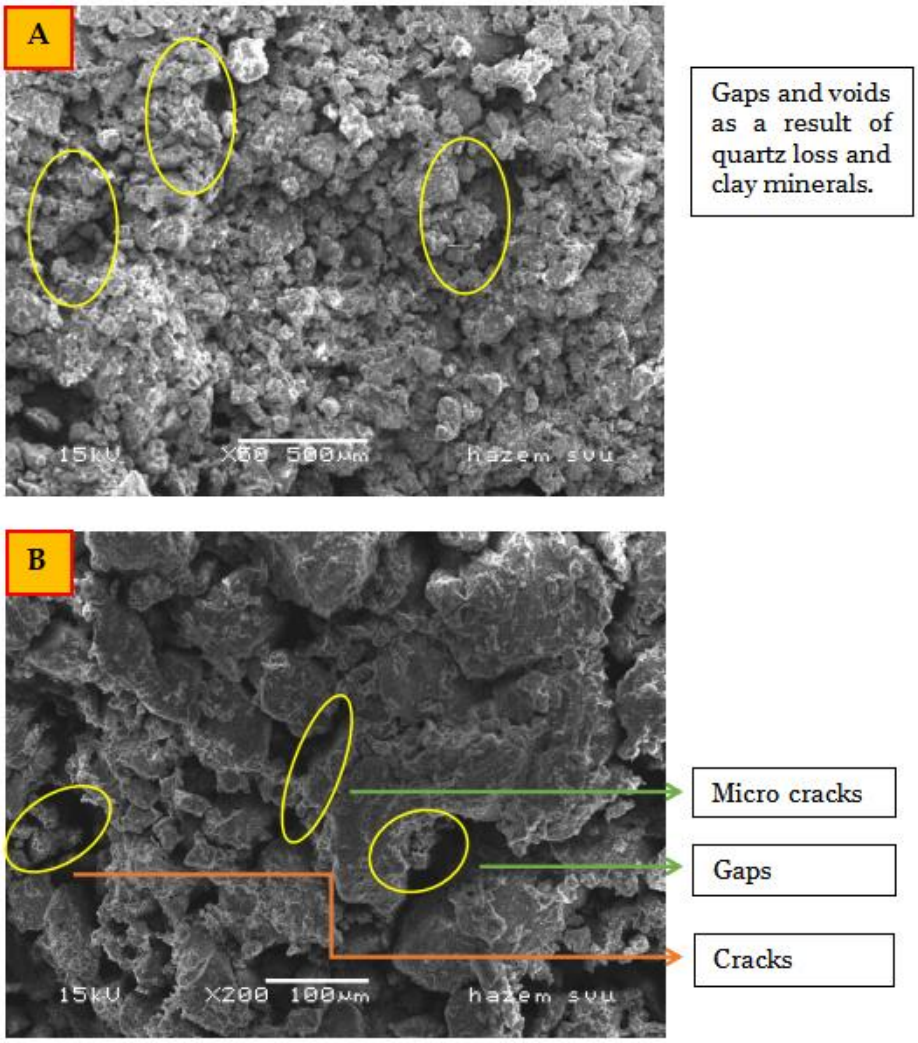

Figure 11. (A), (B) SEM Photomicrograph shows the Presence of Quartz, Kaolinite Presence of Chopped Straw as Binding Materials in the Samples, Collapse of Physical Structure of Mud Brick before Treatment due to Harsh Weathering in the Desert, (B) Gaps and Cracks as a result of Environmental Change

SEM Investigation (After Treatment)

The result obtained from SEM after treatment of $Ca(OH)_2$ nanoparticles shows good distribution of the $Ca(OH)_2$ nanoparticles which effectively dispersed in the pores of the mud bricks and the homogeneous distribution on the surfaces and between the grains [Figure 12 (A), (B), (C)].

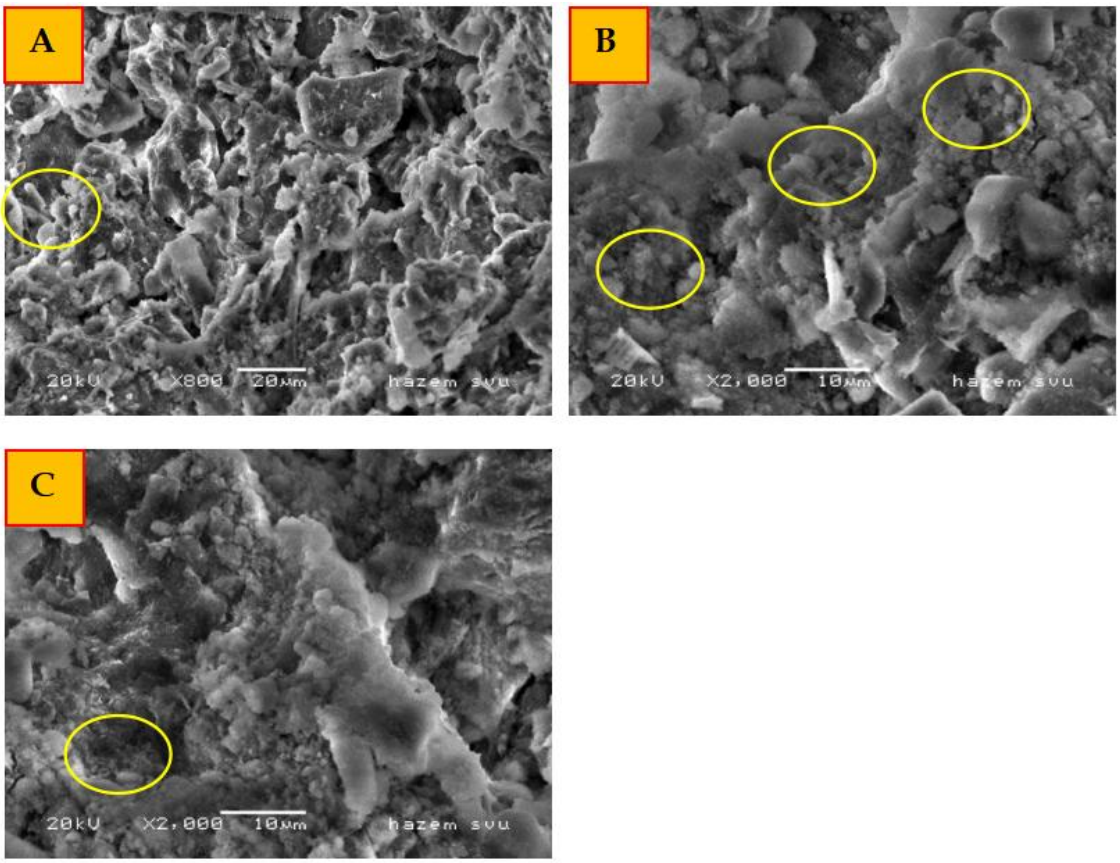

Figure 12. (A), (B), (C) The SEM Examination of the Sample Treated with Calcium Hydroxide Nanoparticles $Ca(OH)_2$ Showed Deep Penetration into the Pores oF THE Mud Bricks and Homogeneous Diffusion

XRF Analysis (Spectroscopic Study)

X-ray fluorescence (XRF) has been used in the identification of elemental mud bricks minerals. The samples of mud bricks consist of silica Sio_2 Quartz, calcite (Ca) calcium carbonate $CaCO_3$, Sodium (Na), chloride (Cl), Sodium chloride NaCl, aluminium (Al), Magnesium (Mg) clay minerals where the high beaks of (Al), and (Si). Iron (Fe) elements iron compounds, and Sulfate (S), $CaSO_4$, H_2O Calcium Sulfate (Figure 13 & Table 1).

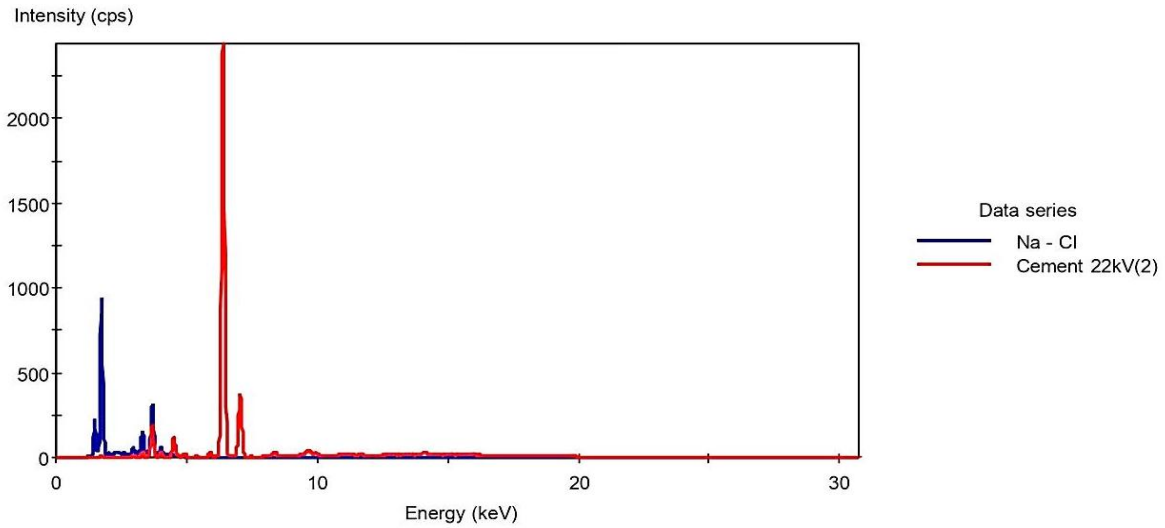

Figure 13. XRF Spectrum of a Sample from Mud Bricks, Qurh

Table 1. The Composition of Elemental of the Analysis Mud Brick Samples from the Qurh

Sample	**Mud brick, Qurh**											
Element	Na	Mg	Al	Si	P	S	Cl	K	Ca	Ti	Mn	Fe
Con.%	0.090	1.78	10.74	54.86	1.30	1.65	1.18	1.16	9.73	3.32	0.09	14.31

XRD Analysis

X-ray diffraction (XRd) has been used in the identification of the compounds of mud brick minerals. The samples result of mud bricks consist of Quartz, Calcite, Kaolinite, and Ilit. Based on the results of the archaeological Qurh, the buildings were constructed of mud bricks. The XRD pattern of the mud bricks is presented in Figure 14.

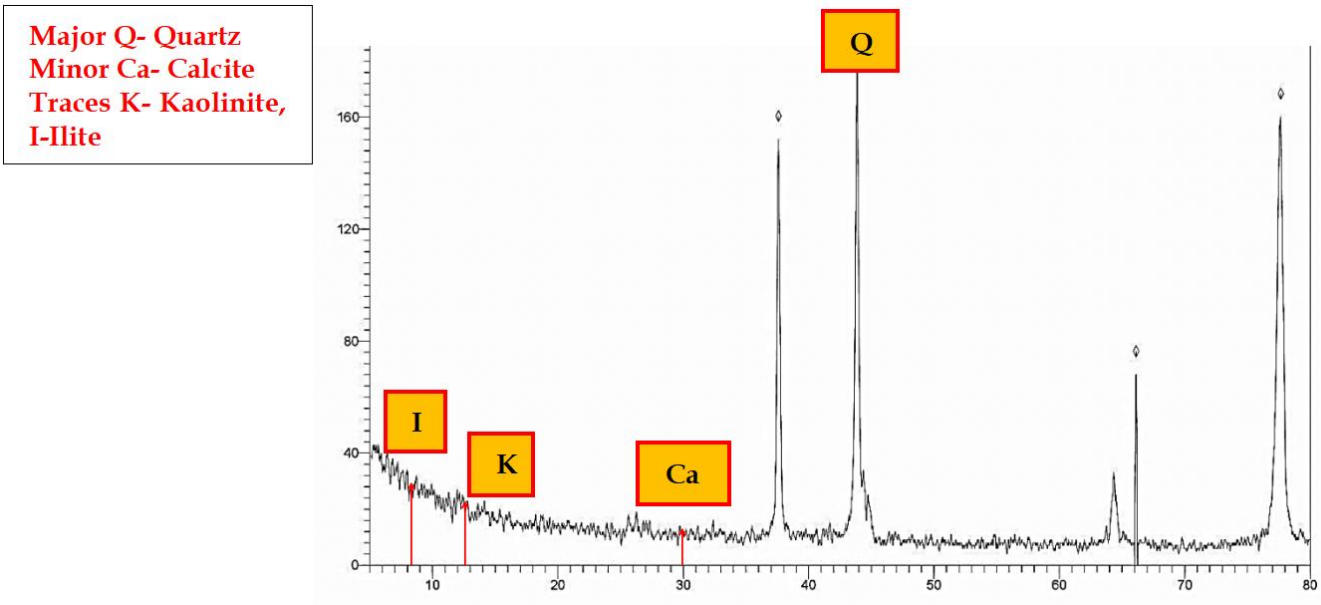

Figure 14. XRD Patterns show the Presence of Quartz, Calcite, Kaolinite, Ilite

XRD analysis of $Ca(OH)_2$ Nanoparticles

$Ca(OH)_2$ nanoparticles were analysed via XRD. An XRD pattern has been performed using XPERT-PRO Powder Diffractometer system, with 2 thetas (20°-70°), with Minimum step size 2 theta: 0.001, and at wavelength (Kα) = 1.54614°. The XRD pattern of the $Ca(OH)_2$ nanoparticles is presented in Figure 15.

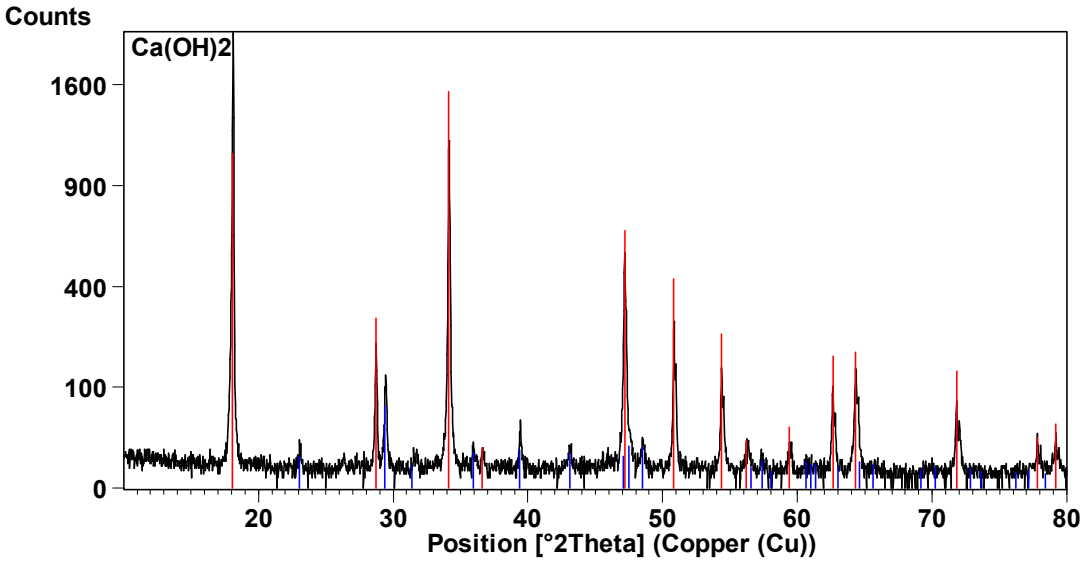

Figure 15. The XRD Pattern of Prepared Calcium Hydroxide

TEM Investigation

Display of TEM images of $Ca(OH)_2$ nanoparticles and particle size distributions is the purpose of using TEM. According to the TEM images the $Ca(OH)_2$ particles are 200 nanometers in size and have some spherical characteristics in shape. These nanoparticles have a poly-nanocrystalline structure, as can be seen from the TEM image, observations showed that the nanoparticles have a spongy morphology. TEM were performed on JEOL JEM-2100 high resolution transmission electron microscope at an accelerating voltage of 200 kV, respectively [Figure 16 (A), (B)].

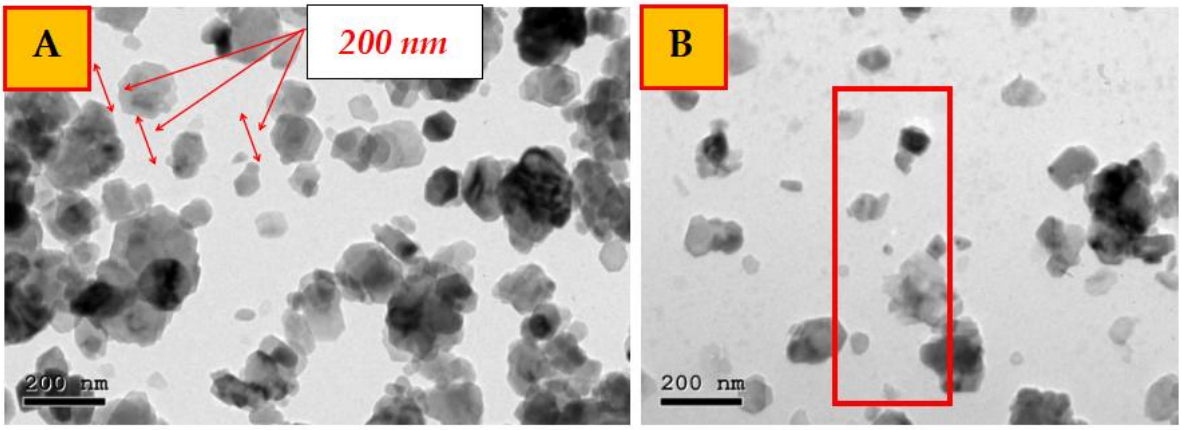

Figure 16. (A) The TEM Images of the Particle Size Distribution and Shape of $Ca(OH)_2$ Nanoparticles (200 nm), Observations showed that the Nanoparticles have a Spongy Morphology and Poly-nanocrystalline Structure, (B) The TEM Images of Prepared NPs and SAED (200 nm)

CONCLUSION

Qurh, a city with a history spanning numerous centuries, traces its roots back to the early Islamic era. The city's building is a mixture of styles influenced by Islamic dynasties and original pre-Islamic elements. Qurh's mud brick structure Serves as a showcase that reflects the city's developing socio-political landscape (Hawting, 2000). Although the heritage area may be distorted, the discovery of these areas begins to shed new light on understanding the nature of the civilization that existed in the place (Sideris, Liritzis, Liss, Howland, & Levy, 2017).

Clay-based construction materials have been very general in buildings and public cultural heritage sites. Exposed plenty of this type of material with apparent protection difficulties mostly caused by swelling phenomena due to water absorption and humidity fluctuations. This led to the alteration of the structural and aesthetic integrity of the archaeological findings, jeopardizing the preservation of the site and, consequently, the archaeological evidence they contain. Samples of mud bricks study the effectiveness of the anti-swelling action of two different categories of calcium hydroxide materials: saturated solution of calcium hydroxide (limewater) and various types of laboratory-produced nano-lime dispersions. The effect of the dispersion medium (water and mixed polar solvents) on the reactivity of calcium hydroxide with clays and the stabilization of their microstructure was investigated on laboratory-produced clay briquettes containing different percentages of montmorillonite (1, 5 and 15% w/w). The interpretation of mineralogical (XRD) and chemical results (FTIR) highlighted the significance of the dispersion medium for the treatments and the beneficial role of laboratory-prepared nano-lime dispersions when they are used as swelling inhibitors. Nanolimes were able to react and stabilize the external layers of clays through the formation of C-S-H, thus resulting in increased durability of mud-briquettes against swelling (Michalopoulou et al., 2020).

Although the mud brick blocks may initially be made of good quality materials, upon study, we find that there are many large cracks/small cracks due to environmental changes. Especially since these heritage places face large changes in temperature, we also find that there is a loss of organic materials that were components of mud bricks, and damage occurs in some parts, mostly due to insects, which represent one of the influential factors of damage.

As a result of the above studies, conservation procedures are in two directions: The first direction manufacture new mud bricks processed by nano hydroxide calcium. The composition ratios of the new mud bricks are similar to almost the same as the old mud bricks. The study suggests the new mud bricks consist of 15 % sand (free of salt) + clay minerals (kaolinite) 70% + nano hydroxide calcium 10% + fibre glass 5%. Second-direction

injections of the micro-cracks and cracks via 10% nano hydroxide calcium start the injection process from the lower to the higher level. The goal of these injections is to prevent the remaining parts of mud bricks and conserve them from collapsing in the long term. The next step of the project will build upon these findings to design an appropriate Retaining and strengthening of this unique cultural heritage through intervention strategies and plans.

AUTHOR CONTRIBUTIONS

Conceptualization, M.S.A. and A.S.; methodology, M.S.A., A.S., S.B.A., A.A.M. and M.M.E.K.; software, A.S., M.M.E.K.; validation, M.S.A., A.S., S.B.A., A.A.M. and M.M.E.K.; formal analysis, M.S.A. and A.S.; investigation, M.S.A.; resources, A.S.; data curation, S.B.A. and A.A.M.; writing—original draft preparation, M.S.A., A.S., S.B.A., A.A.M. and M.M.E.K.; writing—review and editing, M.S.A. and A.S.; visualization, M.S.A., A.S. and M.M.E.K.; supervision, M.S.A. and A.S.; project administration, M.S.A. and A,S.; funding acquisition, M.S.A. All authors have read and agreed to the published version of the manuscript.

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