Natural Stone in Jordan: Characteristics and Specifications and Its Importance in Interior Architecture

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Abstract: Architecture in Jordan characterized by using the most basic raw materials in the natural environment (such as stone, straw and mud etc.). Jordanian designer interacts with natural materials and link these materials to the local environment and the climatic characteristics of the place. This research focuses on the basic material in construction in Jordan, a substance of natural stone, where the researchers studied the historical relationship between architecture in Jordan and natural stone material, and also studied the properties, specifications, types and methods of formation of this natural material. This research aims to shed light on the modern material of architecture in Jordan and how the architects deal with natural stone and other alternative materials where the architects became underestimate the use of natural stone material and use modern materials far from the architectural heritage and which are sometimes not compatible with the construction environment in Jordan. To conclude from this study the importance of maintaining the continuity of the historical relationship between natural stone and Jordanian architecture, where the study recommends to the possibility of development of use this material through using it in interior architecture to conserve on natural stone as a feedstock in the architecture of Jordan.

Key words: Natural stone, interior architecture, materials, design.

1. Introduction

The stone known as basic material for building since the dawn of history, all civilization that came to any part of the world characterized with particularly pattern distinguish their homes, palaces and temples. These civilizations have left clear imprint on the architectural styles, construction methods and stone types.

Jordan characterized by availability and diversity of building stone, due to the spread of the rock layers with specifications suitable for construction purposes, throughout history. The population in each region in Jordan becomes known by using building stone closest to their home areas for accessibility. They used limestone in the northern, central and western Jordan, and they used basalt stone in the northeast and the sandstone in the far south of Jordan.

There is an intimate relationship between natural stone and Jordan architecture in particular and Arab architecture in general. But the Jordanian architecture concentrated on using stone in exterior facades in buildings without cares about internal facades that by finding internal session provides comfort and calm to the user through the study of materials and colors.

This theory and application finding in architecture is associated with the ability of the designer on the excitement, and it shows when able architect to bring happiness and joy to the beholder through the special relations of the components of architectural work externally and internally, This movement between inside and outside reflects the sense of movement for users as a result of the use of raw materials with...
different colors and the exchange of shadow and light on the prominent and internal parts.

2. Aim

This study aims to preserve on the using of natural stone in construction, and use it in the interior architecture to be an architectural element forming the basis for Jordanian architectural identity, and encourage architects and interior designers to create new patterns for the use of stone, especially in interior architecture. Because of the traditional Islamic architecture towards the inside, the designer must focus on the inside, in line with traditional Islamic architecture using modern techniques to achieve this. And insert natural stone from the outside to the inside and thus rely on what was called the internal courtyard or yard and opening towards the inside in the building.

Research questions:
(1) What is the historical relationship between natural stone and Jordanian architecture?
(2) What are the characteristics and specifications of natural stone in Jordan?
(3) Why not use natural stone in interior architecture in Jordan widely?

3. Research Methodology

The researchers in their study depended on theoretical approach and analysis of the study questions, through the study of the history of stone building material relationship in Jordan and study specifications and description the current reality of the natural stone in the design and construction process in Jordan.

(1) History of using natural stone in the architecture of Jordan through the ages:

The stone is the most important elements of an old building, and this day the stone enters in the building facades of stone, concrete, foundations, floors and other items that fall within the stages of construction. The researcher found that the human being since ancient guided to the stone as a major material in building his home instinctively.

There is no doubt that the art of dealing with the stone as a construction material in terms of style and technical evolutes of the time to time until it became as what it is seen today of interfaces cortical stone gives the scene, but differ in structural behavior terms, and has been adopted by researchers and archaeologists whose devided the periods of history experienced by the human in Jordan, according to the evolution that happened in the way of life, tools, beliefs and economic, and social life, and it has been divided into several historical periods from ancient times to the present day, namely: stone ages, copper ages, bronze ages, iron ages, hellenistic ages, byzantine ages, Islamic ages, middle and modern ages [1]. It has been used stone in the construction in Jordan through these times where the man began to build simple forms for the home and was about a group of stones contain a rounded wall determines to it an architectural space, and used a timber Ceiling. It was appear a clear evolution to stabilize and rebuild old man where he built housing units attached to each other and formed the so-called agricultural villages; watching at the site of Basta in southern Jordan and the location of Ain Ghazal, which date back to Neolithic 8000-4500 BC. M, they used Al-ghasheem stone (untreated) linked by overlapping mud layers and small stone. In this period human knew polished plastering, consisting of lime and gypsum for floors and interior walls, as is clear at the site of Ain Ghazal (Fig. 1) [2].

In Coppery Stone Age (4500-3200 BC), excavation revealed the important location named as (Tlelat al gosol) in Fig. 2, which is located at a distance of eight

![Fig. 1  Ain Ghazal site located at east-north Amman city.](image-url)
Fig. 2 Some discoveries in tlelat al gosol shows natural stone used in construction in that period.

kilometers to the north-east of the Dead Sea, where a rectangular houses were built from stone and not grilled brick, and using stone in foundations of clayey walls.

Bronze Age (3200-1200 BC) is considered as the new civilized start, where the writing is known, and fortified cities, religious buildings and public buildings were originated. The stone was used as a construction material clearly. Thickness of walls demonstrates understanding builder for the role of construction, the thickness of the walls in the main building is bigger than those used breaker between rooms.

The classical period (Hellenistic and Romanian), was dealing with construction as an aesthetic art that appears human creativity in expression of beauty. The stone was used in an accurate and beautiful form, where it was sculpted in an expression forms give indications of religious, social and cultural indications, which is clearly appear in Amman, Jerash and Umm Qais buildings (Fig. 3).

In the same period, the Nabataeans were more creative in dealing with rock interfaces which need to appropriate finite resolution. The classic architectural style extended to the Byzantine period, where they interested in the architecture of the churches building and also was utilized special properties of basalt stone and limestone; for example, site umm jemal in Mafraq governorate (Fig. 4).

It is noticeable in this period that the builders have dealt with the stone construction with mechanical specifications, and used them in the right place, limestone carving beautifully, the basalt used in places that were need strength and durability. Marble used in humid places where absorbed little water and because of its hardness it used in sculpture of statues.

In the early Islamic period, the first mosque was simple, although it was built of stone. But Umayyad caliphs—especially Abdul Malik bin Marwan—began to care in architecture, especially religious architecture, such as the Dome of the Rock the year (73 AH) and the great Umayyad Mosque, (86 AH), also built Umayyad desert castles and baths, Quasair Amra (Fig. 5), Qaser al mashta, Khatranah, al hallabat and Qastal in Jordan.

Fig. 3 Umm Qais city, which is located at north of Jordan in ancient city of Irbid and shows creativity and the inscription on the stone in that period.

Fig. 4 Some method of installation of stone (basalt) in Umm al jemal area in archaeological mafraq.

Fig. 5 Quasair Amra one of the Umayyad desert castles and the figure showing the use of stone in the interior façade in that period.
Using of stone continued in the building since then until this day, before the intervention of technology in the stone carving, builders and sculptors were who forming the stone with their hands and are interested in aspects of doorways and windows, and the rest of the space interfaces built from (al-ghasheem stone) and packaging it with mud and stone, and wall thickness of more than 60 cm, and is plastering from the inside with mud mixed with lime and straw, for example, village (Samad), which is located south of the city of Irbid (Fig. 6).

In this article the historical depth of the using stone in construction is noted in many locations in Jordan, producing many structural and aesthetic elements such as arches, vaults and domes.

3. What Are the Characteristics and Specifications of Natural Stone in Jordan?

The preparation of stone building passes in several stages the most important of it is concretion: The process of stone extracting from its position in the quarry, and by direct extraction of stone (Fig. 7). You should check the validity of stone to use, and make sure that the stone achieve the requirements in terms of strength, hardness, the possibility of manufacturing, durability, color and porosity. And there are other factors should be took attention, such as ease of concretion, transportation, the depth of concretion and nearness the layers to the surface. All of these are important factors to study the validity of stone for construction. Stone to be suitable material for construction, should be have the following characteristics (Fig. 8):

![Heritage Samad village located south of Irbid city showing using of natural stone in interior-architecturally and structurally.](image)

![Examples of the inscription form of natural stone.](image)

![Hand Tools used in shaping and forming of natural stone; hand tools used in the formation and refinement of natural stone.](image)
• Strength: many types of stone have the strength more than enough in case of compression resistance. The resistance to shear is 1/10 of compression resistance;
• Hardness: important when the stone is used in the floor covering, paving and pedals of stairs;
• Durability: resistance to weathering such as rain, wind and freezing, this is necessary when the stone is used in the external works;
• Operational: the hardness of stone and granular texture appropriate to stone extraction from the quarries, composition and inscription;
• Density: permeability of the stone affects in its ability to bear freezing factors;
• Appearance: such as color, composition and granular texture.

The stones can be classified according to the geological origins to the following types:
• Igneous rocks: formed as a result of crystallization of molten volcanic rock such as granite and basalt;
• Metamorphic rocks: composed after passing Igneous rocks in many changes in the establishment, texture and composition as a result of natural factors such as temperature and pressure, such as marble;
• Sedimentary rocks: formed as a result of deposits by ice, such as limestone, sandstone, travertine and sandy rock [3].

In Jordan, studies by Building Research Center at the Royal Scientific Society has been done, and standards for stone building was set by the Department of Standardization and Metrology and Ministry of Public Works where the stone was classified into three categories according to the geometric properties:

(a) Absorption of water

The best stone is a stone that has least absorption of water. The rate of absorption increases due to increase of clay minerals in the stone or increase porosity of it. The color of the stone changes after absorption of the cement concrete water at the completion of the casting process. It must be noted that there is must be a balance between the project owner desire to get on a stone with low absorption and their desire to get on a stone with a uniform color. Stones with low absorption of water have low uniformity in color and according to American Standard specifications (ASTMC97) absorption should not exceed that of 3%, 4.3% and 7.5% of the items a, b and c, respectively (ASTMC97. 2000) [4].

(b) Specific gravity

There is a strong relationship between specific gravity of the stone and the rate of absorption, and in most cases, absorption inversely appropriate with the specific gravity and this means that the inequality which is observed in absorption will observe in specific gravity and density, according to American Standards ASTM-C97 the intensity values for types a, b and c (2.56, 2.45 and 2.16), respectively.

(c) Corrosion resistance

This property reflects the resistance of stone to the weather conditions. ASTM-C141 identified upper limit of the erosion 10% [5].

4. Most Popular Types of Stone Construction in Jordan

The names of construction stone in Jordan are a lot and variable with time. The stone is named according to the town, which were extracted, or to a physical property that distinguish it from others. Here is some of the names of the most widespread stones in Jordan:

Maan Stone: appropriate to city Maan city in southern Jordan, which is the most famous and best quality between the usable stones. It is characterized by rigidity and lack of water absorption, which is white and there are two types of it (surface and island).

Qatraneh Stone: relative to the Qatraneh south of Amman, a stone is solid, with a uniform color and high rate of absorption.

Ajloun stone: relative to the northern city of Ajloun, Jordan, is characterized by rigidity and lack of water absorption and uniform color and not available in high quantities [5].

Ruweished stone: the good types of this stone have
the same characteristics that distinguish Maan stone but less white, which is taken from the same class level for Maan stone.

Al-hayn Stone: it is commonly used because of its reasonable price, and of its acceptable characteristics, it is less rigid and more absorbent of water compared to the previous species, but it is whiter and more uniform in color, and its name is relation to Hayan village in the governorate of Mafraq.

Alsamek stone: one of the accepted species in the Arabian Gulf countries, it is distinguish in the uniformity of color and a big masses which allows to cut it in a large sizes. Its name is relative to the samek village in umm albasateen [6].

5. Why is Natural Stone not Used in Interior Architecture in Jordan Widely?

Natural stone in Jordan is the most important materials used in construction, and architecture in Jordan has become closely linked to natural stone material and it became the architectural identity of Jordan reading through stone material. But today we see a strong tendency for engineering design which in its façades depending on modern materials as Alolkopond and tempered glass, where it began taking a new character to the architecture of Jordan, and is now going to use these materials as an alternative to natural stone which characterized the architecture of Jordan through ages. Because of the characteristics and specification of the usable natural stone nowadays; construction is currently consider low quality compared with natural stones which was used in the past decade and thus rapidly air pollution.

The harder and high quality natural stone became expensive that is pulled architects to adopt modern materials instead of natural stone especially in areas which is crowded with people and vehicles which lead to contamination of the environment and change the color of the stone where become very difficult to clean it, where this modern materials are easily cleaned.

To preserve natural stone as a main feature of buildings and to maintain the Jordanian architecture identity, it must to think in a realistic solution to solve the problem of alternative materials using (Figs. (9-11)).

The researchers believed that the use of natural stone in the internal interfaces rather than external interfaces is a positive shift, the designer can begin the stone formation indoor where the creation in stone formation...
Natural Stone in Jordan: Characteristics and Specifications and Its Importance in Interior Architecture

is seen. Because of increasing in the privacy inside the door the creation using stone in the internal facades leads to preserve and care in natural stone. And will give the home the care of the owner and will maintain the purity and stability of colors, will also facilitate the installation of stone in arches, columns, wall coating and top cornices.

Architect Hassan Fathy says: the open spaces through buildings are a part of the nature of architecture in the Middle East. And there is in the closed spaces in a room or patio, a specific property you can feeling in it clearly, and in fact this sensible area is essential element in the architecture. If there is no genuine sense of one of these spaces, there is no pet may make this space a normal thing from the desired Heritage that belongs to the inside [7].

The researcher believed that its a time to return to the inside and attention in the internal facades especially that the used stone in the architectural interfaces is one of the limestone with low stiffness, and its color changes rapidly according to the vehicle exhaust variability of climate and environment that make this natural stone seems to be different from the primary color, and starts dirty after three or four years from the age of construction. if we were more realistic and talking about many of the buildings that are in need of maintenance and continuous cleaning for dirty interfaces, especially in cities such as Amman, Irbid and Zarqa, where overpopulation with increasing the number of cars in these cities. The researcher saw that one of the means to solve this architectural problem is coming back to the theories of Arab Islamic architecture in tending to the inside and decoration of the internal façade. In the Islamic vision dwelling is the social unit where the construction is not separated from families that live in it. But the requirements of the Muslims family who chooses the inner space of the house which was built from the inside to outside, not vice versa. Islamic architecture rich with plastic and aesthetic supplements based on decorative unit and geometric relationships stemming from the structural bases and technical craft and construction materials [8].

It should be noted that the inner courtyard or the yard was one of the most important climate solutions and has been used in most previous architecture civilizations. Trending to inside we are be away and away from street noise, neighbors and passers-by with creation a privacy calm [9].

If a close example to the local environment like the old Damascene house is taken, innovation in architecture and internal interfaces are seen, this example leads us to return to the home.

After the study, it can deduce from that research that the interest in interior architecture should be increased and supported this trend by using natural stone in interior architecture. The properties of the stone should be studied well so can deal with it according to specifications, If natural stone classified according to its qualities and uses then it can be identified internally and externally so that option remains the strongest competitor to modern building materials and imported to maintain and ensure to keep natural stone the architectural identity in Jordan (Figs. (12-14)).

6. Conclusion

The researchers concluded that the use of natural stone on the facades of buildings in Jordan became shrinking and head towards new materials such as glass and Alakabond that because of the rapid soiling of facades which built of natural stone, These materials may give beauty, vitality and lightness more than the stone. In order not to lose our identity and architectural

Fig. 12  Al-athem Palace (Damascus-Syria) showing using of natural stone in interior facades [10].
character, which is characterized by the Jordan, our attention must focus on use the natural stone in the interior architecture and decorated with architectural heritage elements, and the properties of the stone studied well so we can deal with it according to specifications, and if the natural stone classified according to its attributes and cruelty, its uses can be identified internally and externally, and thus natural stone remains one of the strongest options for imported modern building materials, researchers believe that this approach does not contradict with the orientations of the Arab Islamic architecture, on the contrary, corresponds exactly with what called by the Arab-Islamic architecture.

7. Recommendations

After studying the importance of natural stone in Jordanian architecture in terms of architectural heritage and its properties which compatible with the environment and the nature of the place and to preserve the continuity of the use of this material in architecture, researchers recommend the following:

(1) Necessity to preserve Jordanian architectural identity, through the use of natural stone;

(2) Increasing interest in Interior Architecture in Jordan and study the usable materials in design;

(3) Work to increase harmony between home and outside in the design and make the internal space more dynamic;

(4) Encourage citizens to return to the inner courtyard, through legislation and reduce the repercussions of construction in buildings which contain internal courtyard;

(5) Study the theories of Islamic architecture and using it in construction and opening to the inside and develop it to drop present reality;

(6) To stay away from manufactured and chemical materials in interior architecture and approach of natural raw materials;

(7) Classification of natural stone according to hardness where the harder stones used in exterior facades, and the stones with low hardness in internal interfaces away from the weather conditions;

(8) Further studies in this area to demonstrate the importance of using natural stone in interior architecture.

References


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