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Towards The Rehabilitation of Al-Qastal Palace

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Abstract

This study aims to rehabilitate al-Qastal Palace, an important historical and archeological site, located in the southern of Amman (capital of Jordan), and built in the first half of the eighth-century during the Umayyad period. The importance of this study stems from the fact that all studies conducted so far were limited to the description of the monument ignoring the intrinsic value of its rehabilitation. In this research, the authors visited the al-Qastal palace to investigate the materials used in the building. The study team explored the procedures to restore the palace and present it to visitors.

Samples of the original materials used in the construction of the palace were taken from different locations of the site in order to study some of their more important properties. Results indicate that the mortar joints between the soft stone blocks are the weakest point of the load-bearing walls of the palace.

The analyses used in this study provide guidelines for the conservation of this neglected monument.

Keywords: Umayyad monument, rehabilitation, Qastal, palace, limestone, mortar, construction materials.

1. Introduction

Al-Qastal palace built by Umayyad in the first half of the 8th century, in the southern of Amman city (map. 1). Many parts of the palace were subjected creativity to severe damage over 1000 year the past due to humans effect, earthquakes, weathering processes, denudations and erosion; hence, the palace became under imminent danger (fig. 1).

Natural sculpted stones and dimension stone blocks of various sizes were used as building materials in long and high stable walls, arches, domes in addition to the other architectural features in the palace. The creativity of the ancient cultures is reflected in the stability of the major parts of these ruins against weathering and earthquakes of various intensities over the past centuries.

The current investigation will concentrate on determining the physical, chemical, and mechanical properties of the stones and mortars that were used during the construction of the palace. This study sheds light on the constructional techniques, architectural forms, and materials used in the original building. Providing a brief description of the current state of preservation of the palace. It also provides few recommendations for future rehabilitation works. The study consists of two parts; the first describes the various element of the palace while the second part deals with the analyses of the stone and mortars used in the original monument.

2. Historical Introduction

In the first half of the eighth-century, members of the ruling Umayyad dynasty made of Jordanian steppe stream with luxurious residential buildings decorated with colored mosaics, fresco paintings, carved stucco and marble veneer. It is these buildings rather than those of the major urban centers, which provide us with an idea about Islamic art and architecture in its formative stage. For many decades those buildings were interpreted as Badiyas, I.e, (Bisheh, 1994; 2000) , desert retreats of Umayyad princes who, being of nomadic origins grew weary of city life with its congested atmosphere and attempted to return to the desert where their nomadic instincts could be best expressed (Grabar, 1973).

This theory was seriously challenged by the French orient list Jean Sauvaget who pointed out that these chateaux were located on extensive and elaborately irrigated latitudinal and as such were centers for agricultural exploitation, and represented the efforts made by the Umayyad to reclaim the land and push the cultivated zone to steppes areas. Qastal is one of the Umayyad sites which fit Sauvaget's agricultural theory (Sauvaget, 1967).

3. Qastal and its values

Qastal is situated 25 Km to south of Amman, near the highway which leads to Queen Alia International Airport. The site comprises a conglomerate of separate and widely spaced units, which includes a palace and adjacent mosque, a cemetery, reservoirs and over 50 underground Cisterns as well as substantiate dam about 420 m. long and 4.50 m wide, situated 1 Km to the east of the palace across the highway (Carlier, 1987).

The potential tourist use of Qastal for national, international and school groups is extremely promising, but currently not only underused but not used at all. The Umayyad monuments are in a dilapidated condition and heaps of dressed stones mingled with debris are dumped haphazardly all over the site. This is sad because with proper restorations and presentation, Qastal with its ideal location can serve as a staging point for visiting the network of Umayyad palace (Mushatta, the largest of the Umayyad palatial residences is only 5 Km) and the various monuments is Madaba and its vicinity.

4. The palace

The 67 m × 67 m square palace, built of dressed limestone blocks, occasionally of Megalithic size, with rubble core (Carlier, 1989). Nowadays most of the northwestern quadrant of the palace is occupied by a modern two-story house, which belongs to sheik shibli al-Fayez (Abu Abdullah); additional 19th and early 20th century structures obscure the internal layout. Scattered throughout are delicately carved stones panels, blind niches (one of them portrayed on the 10 J.d currency units, (fig. 2) Corinthian capitals (Bisheh, 2007). The plan of the palace (plan 1) consists of stones paved central courtyard surrounded by porticoes and group of self-contained units (Bayts), ones on each side (Addison, 2000).

The porticoes and most of the rooms were originally paved with color mosaics, which can still be seen here and there (fig. 3).

The center of the courtyard is occupied by a large subterranean cistern, which has four heart-shaped voids radiating from the corners of a small central square. Unfortunately, this cistern has been used as a cesspool for a number of years.

5. Towards restoring the palace

5.1 Introduction

In 2012, the authors visited the al-Qastal palace, and took random samples of mortars and stones. The palace was constructed from three different types of load-bearing masonry walls having large dimensions in both width and height. The outer wall was built from two natural limestone block walls filled with small pieces of stone and mud in between. The total wall thickness (double wall) is about 1.20 m. Figure 4 shows the main entrance wall of the palace (eastern wall).

In general, joints between blocks were ranging between few to 40 mm, some joints were filled with mortar. Gaps between stone blocks with some mortar or with no mortar are noticed; in this case, the load is concentrated at some areas of the stone faces namely the upper and lower faces instead of the whole face. Figure 5 shows limestone blocks and joints with and without mortar.

The Second type of the load-bearing walls is the inner wall. The inner walls were constructed from limestone pieces in two opposite faces. Small size of stone pieces mixed with sand and clay fills the area in between the stone blocks. The thickness of this type of inner walls is around 0.8 m. Figure 6 shows the palace from inside; it shows another type of inner bearing-wall constructed from two block rows in the first course. In the heading course, stone blocks almost have a similar size. This type of wall has a thickness of around 0.40 m.

Roofs constructed from stone arches are still existed. Figure 7 shows tunnel-vault of one of the palace rooms.

6. Tested Materials

6.1 Limestone

Limestone samples were taken from two different location of the palace. The first sample was brought from inside the inner load-bearing wall while the second sample was brought from the northern side outer wall. The compressive strength was determined by testing 60 x 60 x 60 mm cubes in accordance with ASTM C 170 (ASTM C 170-90). Specimens were tested by axial compression in both wet and dry conditions. To determine the static modulus of elasticity, a quadratic prism was prepared with vertical and horizontal demec points glued on two opposite faces of the prism. The prism was tested in accordance with BS 6073: Part 1: 1981.

Water absorption and specific gravity were tested in accordance of ASTM C 97 (ASTM C 97-90). A limestone sample was analyzed by x-ray fluorescence in order to determine the chemical composition in accordance ASTM C 1271-99 (ASTM C 1271-99). The analyses were carried out at Natural Resources Authority Laboratories (NRA) in Amman. Tables 1 and 2 summarize all the results carried on limestone samples.

6.2 Mortars

Mortars samples were taken from two different locations of the palace, from the inner load-bearing wall (having a width around 0.8 m) and from the ground slab of one of the palace rooms. The floor near where t2he sample was taken is constructed from mortar materials topped by mosaic pieces forming an artistically arranged picture.

Unlike limestone specimens, it was very difficult to prepare standard specimens from the ancient mortar taken from the site. For this reason, the compressive strength of ancient mortar obtained by testing specimens having parallelepiped shape with varied height and compressed area.

X-ray fluorescence test was performed on samples taken from the two mentioned locations. The obtained chemical compositions of the two mortar samples are given in Tables 4 and 5. All the x-ray fluorescence tests were carried out in NRA laboratories in Amman.

7. Discussion of Test results

Table 1 gives the results of specific gravity, water absorption and compressive strength for the limestone specimens. The compressive strength results were the average of wet and dry conditions. The results show that the compressive strength of the tested limestone specimens is 8.4 N/mm^2, which is very weak. The elastic modulus of the tested stone specimen was 10.09 kN/mm^2, which is an indication of soft limestone material.

Table 2 gives the results of x-ray fluorescence carried on limestone sample. As expected CaO (lime) has the major percentage of the weight of the sample. All the other oxides have a sum percentage of 1.03 % of the total weight of the sample. The table shows that the percentage of L. O. I. is high, and the percentage of whiteness is low. This is because of aging and decay of the limestone blocks.

Tables 3-a and 3-b give the results of specific gravity, water absorption and compressive strength for the mortar specimens. The mortar sample taken from the inner wall is very weak. It failed during sawing the samples or even before. This is because the location where the sample was taken from is a semi-collapsed wall, which is open to the condition of the atmosphere. The results show a very high absorption value with percentages of 61.8% for the mortar sample taken from the inner wall and 34.2% for mortar samples taken from the ground slab.

Table 4 gives the results of x-ray fluorescence carried on mortar sample taken from the inner load-bearing wall. The results show a high percentage of CaO (lime), medium percentage of SiO_2 and low percentages of the other oxides. The percentage of SO_3 is acceptable when it is compared with today's standards of building materials.

Table 5 gives the results of x-ray fluorescence carried on mortar sample taken from the ground slab of one of the palace rooms. The results show a notable difference between the percentages of the chemical compositions taken from the ground slab and the bearing- wall. This indicated that the construction of the wall and the floor slab, which was covered of mosaic was not at the same time or from the same mortar components.

8. Conclusions

This study made apparent that the al-Qastal palace is in need of thorough restoration in order to present this historical site in a manner attractive and comprehensible to the visitor.

The experimental results obtained from this investigation indicate that the castle was built from soft limestone material in which the stone became even weaker because of the weathering conditions. The mortar is in very bad state. Therefore, it is recommended to make mixtures having the same ingredients of the tested mortars to match older materials for restoring purposes.

Because of the weak limestone blocks, it is recommended for restoring purposes to use mortars having low to medium compressive strength and modulus of elasticity to match the weak limestone material. This is to prevent the masonry components of the load-bearing wall, namely stone blocks and mortar joints from forming stress concentration areas.

The researchers recommend the following:

- It is recommended to make mixtures having the same ingredients of the tested mortars to match older material for restoring purposes.

- Because of the weak limestone blocks, it is recommended to use mortars with low to medium rigidity.

- Removing salts from stone surfaces by means of batches, if it is noted, then, treating the surfaces with Wacker OH, which helps in the elimination of sucking water out.

- Setting up pathways around the palace and connecting it with the site's main street. The pathways should be lower than the level of the palace floor in order to prevent water leakage to walls and floor. In order to restore the damaged parts, there is a need to establishing a small workshop to perform stone cut and prepare them in the same style that used in preparing the original stones.

- At the same time area plans and landscaping designs will be prepared designating vehicle and pedestrian access, walking routs, parking area, shading and benches and gardens.

Finally, people in charge of maintenance and restoration works should conduct experimental studies before pursuing their works. Expertise and capabilities of some academic institutions, where equipment and experiences are available, should be steered to in order to perform the required analyses and performances. All that leads to synergy of efforts and translation of means of cooperation in service of these unique historical sites.

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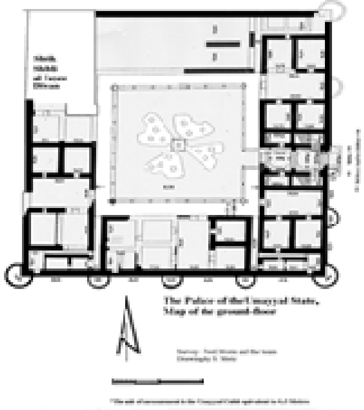
Map 1. Desert monuments in Jordan

Figure 1. Al-Qastal palace



Plan 1. Qastal palace, after Carlier, 1987

Figure 2. Qastal, carved stones panel

Figure 3. Al-Qastal, color mosaics

Figure 4. The Palace main entrance wall (eastern wall)

Figure 5. An inner load-bearing wall showing the stone blocks and mortar joints

Figure 6. The palace from inside

Figure 7. Tunnel-vault of one of the palace rooms

Table 1. Some important properties for stone sample

Specific Gravity	Water Absorption (%)	Compressive Strength(N/mm^2) Average of wet and dry conditions	Modulus of Elasticity (kN/mm^2)
2.14	3.34	8.4	10.09

Table 2. X-ray fluorescence results of the stone sample

Fe_2O_3 Wt.%	**MnO Wt.%**	**TiO_2 Wt.%**	**CaO Wt.%**	**K_2O Wt.%**	**P_2O_5 Wt.%**	**SiO_2 Wt.%**
0.17	0.00	0.005	55.90	0.00	0.13	0.62
Al_2O_3 Wt.%	**MgO Wt.%**	**Na_2O Wt.%**	**SO_3 Wt.%**	**Cl Wt.%**	**L.O.I Wt.%**	**Whiteness %**
20.00	0.00	0.037	0.036	0.033	43.0	67.3

Table 3-a. Some important properties for mortar sample (from the wall)

Specific Gravity	Water Absorption (%)	Compressive Strength(N/mm^2)
2.16	60.8	Failed before testing

Table 3-b. Some important properties for mortar sample (from the ground slab)

Specific Gravity	Water Absorption (%)	Compressive Strength(N/mm^2)
2.70	34.2	1

Table 4. X-ray fluorescence results of the mortar sample (from the wall)

Fe_2O_3 Wt.%	**MnO Wt.%**	**TiO_2 Wt.%**	**CaO Wt.%**	**K_2O Wt.%**	**P_2O_5 Wt.%**	**SiO_2 Wt.%**
1.01	0.018	0.161	42.80	0.51	1.35	10.60
Al_2O_3 Wt.%	**MgO Wt.%**	**Na_2O Wt.%**	**SO_3 Wt.%**	**Cl Wt.%**	**L.O.I Wt.%**	**Whiteness %**
1.90	3.90	0.18	0.32	0.083	37.20	33.80

Table 5. X-ray fluorescence results of the mortar sample (from the floor)

Fe_2O_3 Wt.%	**MnO Wt.%**	**TiO_2 Wt.%**	**CaO Wt.%**	**K_2O Wt.%**	**P_2O_5 Wt.%**	**SiO_2 Wt.%**
1.72	0.04	0.32	36.50	1.42	0.79	19.90
Al_2O_3 Wt.%	**MgO Wt.%**	**Na_2O Wt.%**	**SO_3 Wt.%**	**Cl Wt.%**	**L.O.I Wt.%**	**Whiteness %**
3.11	3.11	0.14	0.53	0.14	32.3	------