

HARD BUILDING MATERIAL AND SUITABLE ARCHITECTURE. THE CASE OF UMM EI JIMAL – JORDAN

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Abstract

This paper tries to spell out a connection between building material and technical solutions. The standing town of Umm el Jimal is the best preserved example of late-antique (4th-9th c.) rural domestic architecture in the East Mediterranean. The research follows a field survey and analytical method by exploring the mechanical and chemical prosperities of the basalt stone and the relatively used architecture.

Umm el Jimal was built entirely with basalt. Basalt is the solidified lava that oozed from various fissures in the terrain sloping down from Jabal Druz south east of Syria, in periods of volcanic activity so that it forms the top stratum of bedrock in the region. Compared to limestone basalt is extremely hard, has great tensile strength, is much more resistant to erosion and more difficult to cut and dress.

The architectural forms illustrated in the ruins of umm el Jimal, i.e. the ground plans, the construction of the super structures of the buildings and their ornament, present something more than the common types that are familiar to us in the numerous towns of the Hauran¹. The girder arch, the corbel courses, and roofing slabs, all the principle details and constructive principles that were developed in the purely lithic architecture in basalt throughout Southern Syria, are exemplified in a hundred different buildings here; but there are to be observed, at the same time, a number of features, important in construction and significant in ornament, which are not common in the architecture of Hauran.

The use of basalt resulted in the following distinctive features: Corbelling: where, The use of cantilevered ceiling and roof support designed to carry stone or wooden beam, Cantilevered Stairways: where, Basalt lent itself to the cantilevering of stairway treads from the walls, Rough wall finish: where, the hardness of basalt get difficult to dress to a smooth finish, Building quality: where, The majority of walls are of a simple rubble-filled type in which stones dressed only on the one exterior face are used, and Doorway and window treatment: where, doorways and windows are weakening interruptions in the structure of the wall much greater attention was paid to the quality of the frame construction.

The use of local material had been always considered as a key element for a sustainable architecture, although when it was used a very hard material such as the basalt stone in the case of Umm El Jimal.

Keywords: Umm el Jimal, Basalt, Characteristics, Techniques

¹ Hauran - the region that occupies parts of South Syria and North Jordan.

ВЛИЯНИЕ МЕСТНЫХ СТРОИТЕЛЬНЫХ МАТЕРИАЛОВ НА АРХИТЕКТУРУ. НА ПРИМЕРЕ УММ ЭЛЬ ДЖИМАЛЬ - ИОРДАНИЯ

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Аннотация

В статье предпринята попытка сформулировать связь в архитектуре между строительными материалами и конструктивными решениями, на примере города Умм-эль-Джималь - лучше всех сохранившегося образца сельской архитектуры поздней античной (IV - IX века) Восточного Средиземноморья. Исследования основаны на базе аналитического метода изучения механических и химических свойств базальтового камня и его использования в архитектуре.

Умм-эль-Джималь был полностью построен из базальта. Базальт - это застывшая лава, которая сочилась из земли в периоды повышенной вулканической активности в местности, простирающейся от Джебель-Друзь к Юго-Востоку от Сирии. Поэтому именно базальт образует верхний слой коренных пород в регионе. По сравнению с известняком, базальт имеет большую прочность на разрыв и значительную стойкость к эрозии.

Использование местного, очень твердого материала, такого как базальт, в городе Умм-эль-Джималь рассматривается как ключевой элемент существования устойчивой архитектуры.

Ключевые слова: Умм-эль-Джималь, базальт

Introduction

Basaltic rocks have been widely used as aggregate for various purposes. They show a variety of textural and mineralogical characteristics that may affect their physic-mechanical properties as well as their use as construction material.

Basalt is a volcanic stone. In nature it is found in mass or flow. Basalt is one of the most robust natural materials in the world. Its colour changes from grey to black. Basalt owns a high structural resistance against erosion, climate and time.

Igneous rocks used by the ancient Egyptians include: granite, granodiorite, quartz diorite, diorite, and pyroxenite (plutonic intrusive); andesite and dolerite porphyries as well as other porphyritic rocks (volcanic dikes and lava flows); basalt and obsidian (volcanic lava flows); and tuff and related rocks (volcanic pyroclastics) [Harrell J.A., 2008].

Inside the city of Umm el Jamal the visitor is plunged into a scene of eerie beauty. Walls run every direction without apparent plan or order. Neatly stacked courses of stone appear to grow out of the mad confusion of tumbled upper stories. The blue-grey of basalt everywhere gives a sombre and cool sense of shadow in spite of the bright and blazing desert sun. Here and there pinnacles of wall reach up three stories high, their fingers of cantilevered stone silhouetted against the cloudless sky, defying gravity. Doorways and alleys lead from room to room, building to building, more stone, more walls. This city closes you in, swallows you up. Excitement becomes mixed with confusion and aloneness.

Five thousand people once lived here: People knew how to shut out the hostile desert and create comfort even for their animals: people who knew how to channel and store the precious winter rain to slack the summer thirst.

Umm el Jimal is no Jarash. No Hadrian commissioned building here. A small arched window, easily overlooked among the Corinthian columns there, is an existing find here. The place is plain, without frills. But this too is being fraught with significance. Whereas Jarash is monumental, a symbol to the glory of Rome, Umm el Jimal gives us a glimpse of local people—Arabs, Syrians, Nabataea's, living plain lives. These were the people who provided the backbone of the Roman order and economy. They benefited and proposed from the security Roman rule brought, but at the same time their solid, settled community provided a vital link in that very system of security out there on the desert frontier.

While Jar ash was built almost exclusively of limestone, Umm el Jimal was built entirely with basalt. Basalt is the solidified lava that oozed from various fissures in the terrain sloping down from Jabal Druz in periods of volcanic activity so that it forms the top stratum of bedrock in the region. Compared to limestone basalt is extremely hard, has great tensile strength, is much more resistant to erosion and more difficult to cut and dress.



Fig. 1. North Jordan. The location of Umm el Jimal

Research objectives and methods

The main objective of this research is defining the relationship between basalt as a construction material and the selected building techniques by discovering the physical and chemical properties of the basalt stone.

The architectural forms illustrated in the ruins of umm el Jamal, i.e. the ground plans, the construction of the super structures of the buildings and their ornament, present something more than the common types that are familiar to us in the numerous towns of the Hauran. The girder arch, the corbel courses, and roofing slabs, all the principle details and constructive principles that were developed in the purely lithic architecture in basalt throughout Southern Syria, are exemplified in a hundred different buildings here; but there are to be observed, at the same time, a number of features, important in construction and significant in ornament, which are not common in the architecture of Hauran.

The few buildings of the Roman period show none of the elaborate ornamental features that are most expressive of the imperial architecture in the northern parts of the province, and the

scattered details of Roman buildings that perished during the early Christian period show delicate and complex surfaces, but no carving on any kind.

According to Bert De Vries "The houses are all of the traditional Middle Eastern type: a single entry opens onto a central enclosure or courtyard surrounded by a multistoried complex of rooms, accessible from the enclosure via doorways and stairways. While the whole complex is closed off from the outside human and natural environment, daily domestic and family activities focus on the sheltered and protected courtyard where family members and animals intermix with intimate familiarity. The presence of so much housing space for animals helps to explain the apparently large open spaces that exist inside the city walls much of this space was probably used for penning these animals" [De Vries, 1982]. The churches present a far greater variety of ground plans and superstructures than can be found in any other part of the Hauran.

The type of the domestic architecture is the one common in all the towns of the locality, but the proportion of large and tall houses is much larger. The use of the columns, in some porticos and loggias, adds interest to the general appearance of the houses. Houses with two large arched stories in front and four stories of narrow chambers, without arches, behind, are common throughout the ruins.

The use of basalt resulted in the following distinctive features:

1) CORBELING

The use of cantilevered ceiling and roof support designed to carry stone or wooden beam, this technique could help to support a considerable load without cracking and held in place by the weight of the walls of the floor above. Because the length of the stone ceiling beams placed on the corbels was limited to about three meters, the typical room constructed this way tends to be rather narrow. Although it could be indefinitely long. To create larger halls, walls could be opened up with well-constructed arches five to ten meters in width. In this way it was possible to create corbel ceiling rooms and halls up to ten meters wide and indefinite in length.

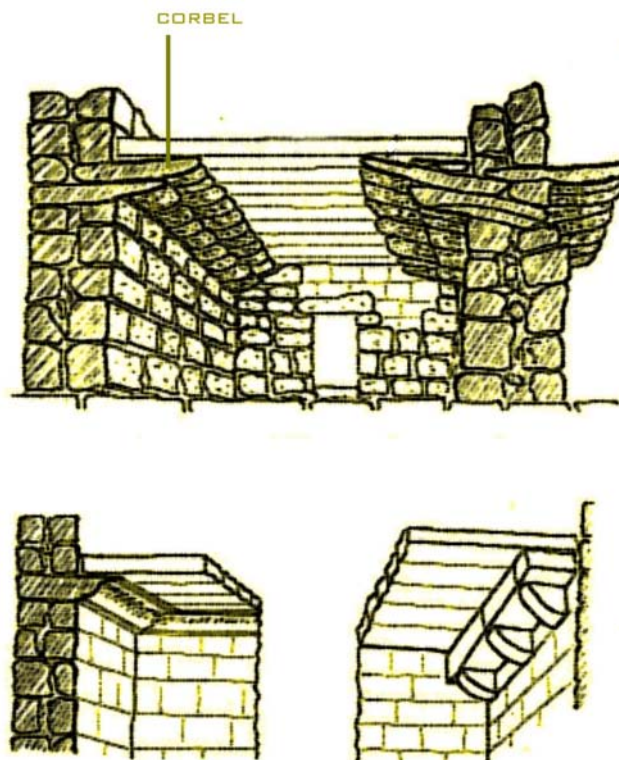


Fig. 2. The use of Cantilever Ceiling and roof support at Umm El Jimal

2) CANTILEVERED STAIRWAYS

Basalt lent itself to the cantilevering of stairway treads from the walls. Because of the narrowness of the rooms on the inside, these were usually constructed on the outside, particularly in the courtyards of buildings. These stairways make an interesting pattern combining the 45 degree slope of the stairs with horizontal stoops in front of upper story doorways.



Fig. 3. Reconstruction of stairs in east wall of Court XVIII- Bert De Vries 1982



Fig. 4. Cantilevered stairways – Praetorium Umm el Jimal

3) ROUGH WALL FINISH

Because of the hardness of basalt it is difficult to dress to a smooth finish. Although excellent carving and dressing of basalt is evident in wealthier places like Umm Qeis, Bosra and cities of the Jabal Druze, the townspeople of Umm el Jimal could not offer to pay for the time it took to achieve such finesse. Hence most walls are constructed of building blocks with fairly rough faces. It must be remembered that typically buildings were plastered and painted both inside and out, so that the sombre effect created by grey-black colour of the stone today is not typical of how the city appeared in antiquity.

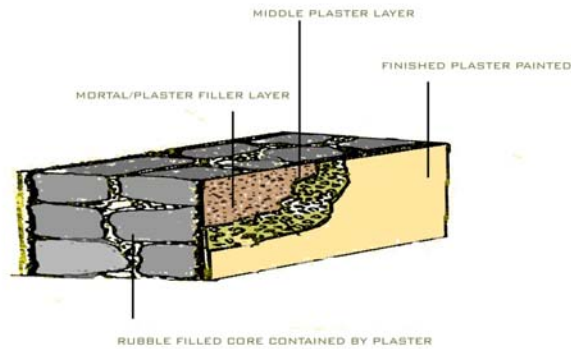


Fig. 5. Wall Construction detail. Source: Bert De Vries 1982

4) BUILDING QUALITY

The majority of walls are of a simple rubble-filled type in which stones dressed only on the one exterior face are used. The two faces are built independently with the interior space carefully filled with small stone chips and soil as construction progressed course by course. The two faces of such a wall were tied together only by ceiling corbels and stairway treads which extend all the way through both faces. The combination of building blocks and rubble formed a solid mass that was kept intact by plaster coatings on both faces. These walls reminded very strong as long as plaster in the joints retained the interior rubble. With the plaster gone however, the rubble would dribble out over time, leaving a hollow core and the two wall faces standing nearly independently from one another. In this condition the wall faces are very unsuitable and tend to pop outward when the equilibrium in the wall is disturbed (through earth tremor or roof collapse).

This building method is far cheaper than the stronger "header-stretcher" wall in which stones are laid alternately parallel and perpendicular to the face of the wall and for which all sides of stones have to be carefully dressed and stones have to be cut to uniform sizes. The builders knew, however, that with basalt, the cheaper method was adequate even for four to six story high structures.

5) DOORWAYS AND WINDOW TREATMENT

Because doorways and windows are weakening interruptions in the structure of the wall much greater attention was paid to the quality of the frame construction. This was achieved by using very carefully dressed blocks for lintels and doorposts so that the joints between the stones are extremely tight and can withstand much greater vertical force than the normally chink and plaster filled joints of the walls.

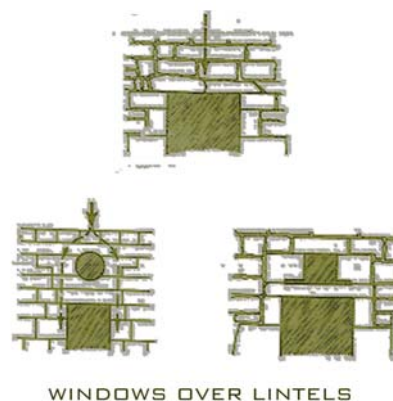


Fig. 6. Doorway and window treatment at Umm el Jimal

Especially the wide lintels of doorways had to be carefully protected from the tremendous weight of the stone mass above them. For this some interesting force relieving devices were used. In one case the placement of a circular window above the door effectively diverts the vertical pressure off the centre of the lintel onto the two strongly built doorposts. A simpler way to achieve the same thing is the placement of a second lintel above the first with a two to three centimetre space between them. A more elaborate version of this is the actual use of a low sprung arch of heavy stones to create a small gap between the lintel and the wall above.

Conclusions

The case of Umm el Jimal reflects a notable relationship between construction material and selected architectural techniques.

Effective and several methods of lightening of the architrave were used at Umm el Jimal, and frequent is also the use of the arch, used here not as well as like a commemorative element, how much rather in order to diminish the lights of the rooms, destined to be covered with beams of limited length.

Umm el Jimal gives us a glimpse of local people's attempt to adapt the local material to their own needs.

Compared to limestone; which is also affordable in the region basalt is extremely hard, has great tensile strength; is much more resistant to erosion and more difficult to cut and dress.

The social identity and daily life functions were clearly incorporated with architectural forms and urban environment through a diversity of technical solutions and local technologies.

Umm el Jimal was not a city of great political importance and representation, nevertheless its construction was tailored to commercial use. It would be an opportune to note that some errors were committed in static order, to exemplify this, is the fact that an entire city had collapsed under the force of some destructive earthquakes as a result of horizontal forces not being taken into account.

Unfortunately, it was the feature of the basalt of poor adherence to the mortar that caused the collapse of the entire system.

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