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Building Techniques in Palmyra*

Palmyra, situated on the crossroads of civilisation, was exposed to different cultural trends. Hellenistic and Roman influences on its architecture are very well attested, and although Palmyrene architects borrowed many Roman decorative motives and patterns, they were able to keep local building techniques for a long time. Moreover, they invented their own building system.

Up to the end of the first century BC, roughly dressed stone and mud-brick were basic materials for the construction of shrines, temples, tombs and other buildings. Examples are the tomb discovered in the Baalshamin Temple court, shrine of the Allat Temple, the Atenaten Tower and other tower tombs. The yellowish white soft limestone was employed for decorated parts.

The construction of the Bel Temple at the turn of the era became the turning point. The Temple applied Near Eastern fashion to gigantic architecture, of which 'Irāq al-Amīr and Ba'albak are the best examples.[1] The Bel Temple building resulted in the adoption of the best masonry techniques available in antiquity.[2] Implementation of the project required not only very well experienced architects and masons, but also high quality stone. Therefore, a new quarry of hard white limestone was opened 10 km north of Palmyra. In the next decades the hard limestone became the basic building material. Acquired experience of ashlar masonry was adopted in numerous buildings, such as the Agora, and the Temples of Nabu, Baalshamin and Allat. It also influenced the construction process of Palmyrene tower tombs. The walls of older monuments were built with undressed stones, while the later ones, from the end of the first century AD, were built with ashlars. This resulted in vertical outer walls. But the most important factor in tower tombs development was the use of hard limestone slabs for ceilings. In the early towers the slabs were rather short and did not exceed 1.5 m in length, therefore corbelling was necessary for their support. In later tombs the slabs reached up to 3 m in span, which allowed chambers to become more spacious and corbelling for supporting shorter slabs to be abandoned. Employment of the new building techniques influenced the design of the tower tombs, improving their building system.

From the middle of the second century AD the ashlar masonry was modified. In Near Eastern monumental architecture we observe the tendency to increase the dimensions of the blocks. In Palmyra this resulted in increasing the length and width while retaining the same weight of individual blocks. Thus the thickness of the blocks was considerably diminished. The classical form of cubic ashlars was abandoned in favour of larger but thinner blocks. The form of these blocks resembles ceiling slabs used in the first century AD. Their average size was 1 x 3.5 x 0.35 m. Pairs of such blocks were set vertically and joined together with thin mortar filling. Such walls were 70 cm thick and no dowels or clamps were used for strengthening them. This building system enabled the limitation of the number of elements needed for construction. Large blocks needed also less time for preparation and assembly. These factors resulted in a very efficient and cheap building system. Being original and unique to Palmyra, this form of masonry allowed me to name it "*opus Palmyrenum*" (FIG 1).[3] In this system, the ordinary "*opus emplectum*" method was visually improved by giving the impression of large ashlar masonry. This building method was employed in the beginning of the third century for the construction of houses, shops and other buildings. This building technique was used simultaneously with others. There were buildings where

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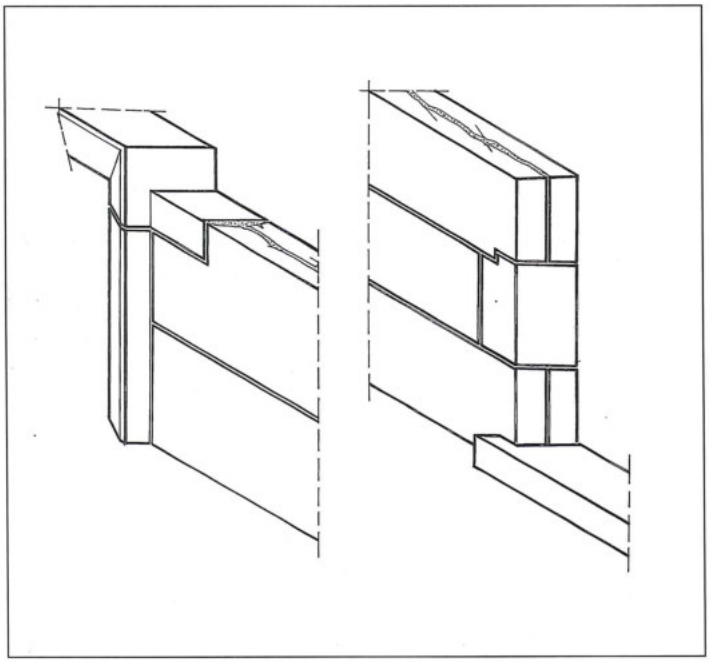
1 E. Will, 'Du trilithon de Baalbeck et d'autres appareiles collosaux', in *Mélanges offertes à K. Michalowski*, Varsovie 1966, pp. 725-729; M. Baranski, 'The Colossal Order in the Near East', in *Akten des XIII Internationalen Kongresses für Klassische Archäologie - Berlin 1988,* Mainz 1990, pp. 358-359.

2 R. Amy, 'Remarques sur la construction du temple de Bel', in E. Frezouls, ed., *Palmyre. Bilan et pérspectives,* Strasbourg 1976, pp. 53-68; *ibid.* in H. Seyrig, R. Amy and E. Will, *Le temple de Bel a Palmyre,* Paris 1975, pp. 96-112.

3 M. Baranski, '"Opus Palmyrenum"', *Damaszene Mitteilungen* 5 (1991), pp. 59-63; *ibid.* 'Development of the Building Techniques in Palmyra', in *International Colloquium on Palmyra and the Silk Road* (in print).

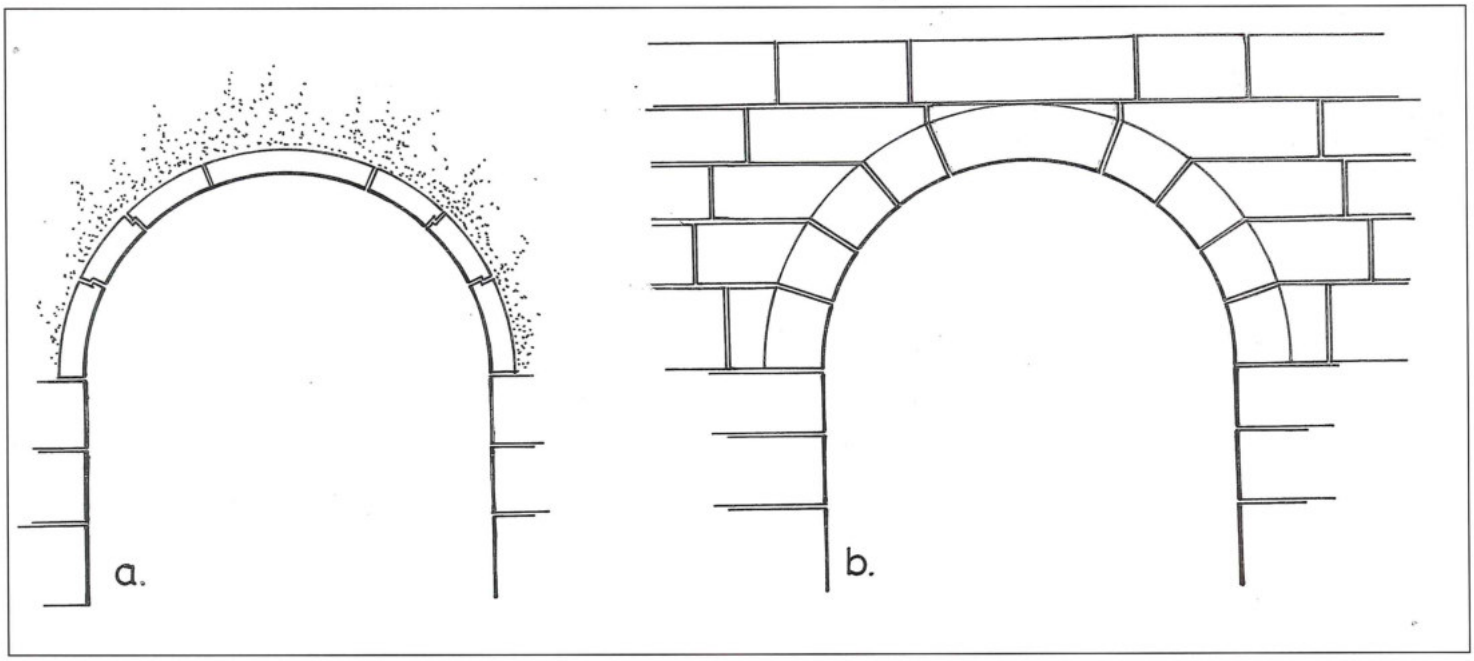
only first floors were constructed of stone blocks, while the upper floors were of mud-brick.

The new idea of constructing with large blocks was also adopted for the erection of columns. The older monuments had columns erected with small drums, while the third century ones employed monolithic shafts. This change can be easily observed in the Great Colonnade, where the columns had the same height. The second century columns were made of 7 or 8 drums. The next columns were constructed of 4 drums of which the drum bearing the *consola* was shorter than the others. Similar trends of using large block masonry can be observed at the same time in Gerasa. Earlier columns of the *Cardo* consisted of a greater number of drums than the later ones. In Palmyra, this crucial development of the building technique was caused by the change in the technique of limestone quarrying. The cutting of large slabs replaced cubic ashlars.



1. Solutions applied for the stability of "*opus Palmyrenum*" walls.

Palmyrene vaults and arches are also worth special mention. The oldest arch construction was found in the second century BC tomb excavated in the court of the Baalshamin Temple.[4] The next examples of such construction are tombs of the first century AD but arch construction employed there was done in a very special manner, which is obvious when comparing the thickness of voussoires and the quality of soft limestone. These vaults and domes had voussoires with specially dressed rebated joints (FIG. 2a). By overlapping each other, the voussoires formed a shuttering into which the lime mortar was poured, thereby constructing the solid structure. Such solution was adopted for vaults in hypogean tombs as well as for dome forming.[5] The largest construction spans up to 3.5 m. In the later monuments rebated joints and crosseted voussoires of abnormal length were used in solid stone constructions (FIG. 2b). Such forms of construction prove that Palmyrene architects doubted their



2. System of the first and second centuries arch constructions in Palmyra: a) vault with rebated voussoires; b) vault with crosseted voussoires of abnormal length.

[4] R. Fellmann, *La Sanctuaire de Ba'alshamen à Palmyre V. Die Grabanlage*, Rome 1970.

[5] Tomb no. 98, see: T. Wiegand, *Palmyra*, Berlin 1932, p. 55, FIG. 59; Tomb B, see: M. Gawlikowski, *Monuments funéraires de Palmyre*, Warszawa 1970, pp. 67-68, FIG. 32.

experience to built heavy stone vaults. In ordinary practice, extravagant cutting of crosseted voussoires is carried out purely for appearance sake, but in Palmyra this feature had structural meaning. It presumably assured the masons of structural durability. It seems that local masons knew perfectly the idea of arch and dome constructions, but they were afraid to introduce it in the regular form in stone buildings. This is clearly visible in the side entrance to the Bel Temple temenos, where two contemporary arches of identical span were differently constructed depending on their load bearing. The construction of the famous Monumental Arch of 6.9 m span should not be in fact recognised as an arch. Its main arches were formed as a structure of interacting blocks with a large beam acting as a key stone. Contrary to the second century monuments, arches of the third century were rather bland. At that time at least eight large arches were constructed in the Great Colonnade. They were built of 9 to 11 regularly shaped voussoires. The arch of 6.4 m span situated west of the theatre had 13 voussoires. Arches of nymphea built in the Great Colonnade had spans of about 8.5 m.

The development of the building trade in Palmyra should be united with the building activity and achievements in the whole region of Syria and Palestine. The new investigations confirm that the adoption of the new trends coming from Rome owed much to local architects and proper usage of locally available materials.[6] Innovative approach to building resulted in bold architectural development in the region where each town had its own building specificity.

From the beginning, commercial and cultural contacts between Palmyra and the region of Ḥawrān as well as the Nabataean Kingdom influenced Palmyrene architecture. Forms of architectural decoration, such as early Corinthian capitals, confirm these inter-relations.

Roman presence at the region enormously increased building activity. Due to Roman as well as experienced local architects, many brave constructions were erected in the cities of the Decapolis. Hadrian's Arch of 6 m span, and the baths with vaults of 10 m span and 7 m dome in Gerasa, as well as the baths and *cryptoporticus* in Bostra. These achievements were possible due to perfectly understood properties of locally quarried stone. Employment of arch construction was not limited only to vaults and domes, there were also relieving arches and flat arch lintels. In Palmyra such forms practically did not exist.

The problem of building arches in Palmyra is a very interesting case when compared with numerous constructions erected at the same period in the nearby Ḥawrān. The situation of the treeless Ḥawrān resembled conditions in Palmyra, but the development of the art of building differs considerably. Palmyrene monuments of the second century employed techniques that were introduced at the time of the Bel Temple building. Such long continuity is striking, especially when one observes the rapid accommodation of Roman building ideas in other cities. Dramatic change in Palmyrene architecture at the turn of the second and third centuries can be explained by the great development of the town. Presumably, the investment programmes were beyond the power of local architects. This may be a reason that some skilled architects were hired to Palmyra to continue or begin new prestigious projects. They brought the new ideas and experience of stone arch construction, which presumably pushed forward the development of Palmyrene building techniques.

[6] M. Waelkens, 'The Adoption of Roman Building Techniques in Roman Asia Minor', in S. Macready and H. Thompson, eds., *Roman Architecture in the Greek World*, London 1987, pp. 94-105; H. Dodge, 'The Architectural Impact of Rome in the East', in M. Henig, ed., *Architecture and Architectural Sculpture in the Roman Empire*, Oxford 1990, pp. 108-120.