



## ARTICULATING A NEW ARCHITECTURAL PATTERN THE MASONRY DOMES OF EGYPT

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### ABSTRACT

The major development of the dome in Egypt was in the medieval ages, predominantly during the Mamluk period - the self-perpetuating corporation of military slaves [1]. They ruled Egypt for more than two and a half centuries 1250-1517 A.D.: divided into two salient stylistic époques. The scale of the Mamluk buildings reflects the wealth of their patrons which was a result of the domination of the trade route between East and West. Wealth encouraged the expression of a high exquisite taste, which was originated and developed in Cairo. Their creativity was prominent in implementing new ideas and expressing high cultural meanings within a vivid and integrated physical setting.

The Mamluk buildings were mainly constructed of rubble and dressed with stones. In the early period of their rule wooden domes and ceilings were used to cover bigger spaces, while brick and stone domes were used for smaller spaces due to lack of masonry stone construction knowledge. Towards the late 14<sup>th</sup> century, the Mamluks changed the architectural conceptual designs of their buildings to cope with the crowded context of Cairo. They developed the construction of domes that adorned the skyline of Cairo with high and elegant architectural profiles.

After the fall of the Mamluks, the development of the masonry dome declined reflecting the impact of changing economic and social conditions on architectural aesthetics.

**KEYWORDS:** Islamic architecture, domes, traditional buildings, architectonics

### INTRODUCTION

People living in Cairo during the medieval ages must have enjoyed the urban life that existed in the well-defined city. Although the visual form of Cairo has changed much in the later centuries by modernity, the impact of masonry buildings erected during the 14<sup>th</sup> and the 15<sup>th</sup> centuries is dramatic and impressive. The physical urban environment of Cairo is unique and provides clarity in identifying the main characteristics of the related dynasties and manifests the ingenuity of the architects, high technical ability and skill of the craftsmen as well.

Due to the continuity of economic stability and wealth during the medieval ages in Egypt, the succession of the rulers kept the ongoing process of building investment. Over the course of long periods of time, the streets of Cairo were typified by characteristic architectural patterns, manifested by the manipulation of elements of style: pointed arch, monumental portal, *Mashrabiyya*, *Sabil- Kutab*, minaret, and one of the most characteristic architectural features that adorned the skyline of Cairo, the dome.

In a country like Egypt, building with brick or stone is mandatory since both materials are locally obtainable and are highly qualified to integrate environmentally. Moreover, wood had to be imported from southern countries in the heart of Africa. Those three basic materials were mainly used in construction during the medieval period and they were adequate to articulate new features and to originate a unique style. A scientific investigation of the development of the dome profile, shape and decoration was carried out to establish a common understanding for the role of building material, construction techniques and the impact of social changes of the Egyptians on this development.

### **HISTORICAL BACKGROUND**

In the 7<sup>th</sup> century, Muslims conquered Egypt and introduced a new type of religious building: the mosque. The earliest Muslim religious building that exists is the mosque of Amr Ibn Al A`as which was built using mud brick. There was very little decoration adorning the mosque following the conservative discipline of Omar the Caliph of the Muslims, a concept that was totally abandoned after his death. The ceilings were constructed using lumber and wooden clogs. The dome that covers the bay in front of the prayer niche was also constructed of wood. During this period no postmortem structures were allowed according to Islamic restrictions [2].

In the 9<sup>th</sup> century, the Abbasid Caliph handed the rule of Egypt to Ibn Tulun who was a Mamluk from Samaraa, Mesopotamia. The new ruler brought to Egypt thousands of slaves including craftsmen and master builders who were already known for their high proficiency in building with bricks. This proficiency reflected on the second mosque that was built entirely with bricks; massive piers replaced the structural role of marble columns, while the roof and the *qibla* dome were still constructed of wood [3].

In the middle of the 10<sup>th</sup> century, the *Shiate* Fatmids conquered Egypt and controlled North Africa and some provinces in Armenia. The *shi`i* doctrine is different from the *sunni* concept and is particularly reflected in the architecture for building mausoleums. The Fatmids built brick domed mausoleums with different and peculiar zones of transition like the ones seen in the Fatmid cemetery in Aswan (Figure 1), and in the mausoleums of Sayda Ruqayya, Sayda Attaka and Hasawaty in Cairo [4].

The Auides who eliminated the Fatmid rule in the middle of the 12<sup>th</sup> century continued building mausoleums but only for pious people. Unlike the Fatmids, the Auides preferred these types of shrines to be of large dimensions to receive large numbers of people seeking the blessings and holiness of the pious man. However, the dome of Al- Imam al-Shafe`i was large enough to discourage the use of masonry giving way to wood again as the building material rather than bricks.

Shajarat al-Durr, the wife of the last sultan of the Auidids, attached a brick domed mausoleum for her husband to his religious school, the *madrasa*, a combination which was witnessed for the first time in Egypt, and was continued in the 14<sup>th</sup> and the 15<sup>th</sup> centuries during the Mamluk period. The attachment of the domed structure to the Islamic institutes paved the way for the dome to take its fair share in the architectural development process parallel to the rest of the characteristic features that urbanised the streets of Cairo.



**Figure 1 - The Fatmid cemetery in Aswan, Egypt**

In the beginning of the 16<sup>th</sup> century and after the Ottoman military campaign to the Middle East, eliminating both the Abbasid Caliphate and the Mamluk rule in Egypt, they introduced a new model of mosques. The model is based on the concept of a central dome that dominates the whole structure, emphasizing a new role for the dome that adorned the skyline of Cairo.

### **THE ASSOCIATION OF FORM WITH FUNCTION**

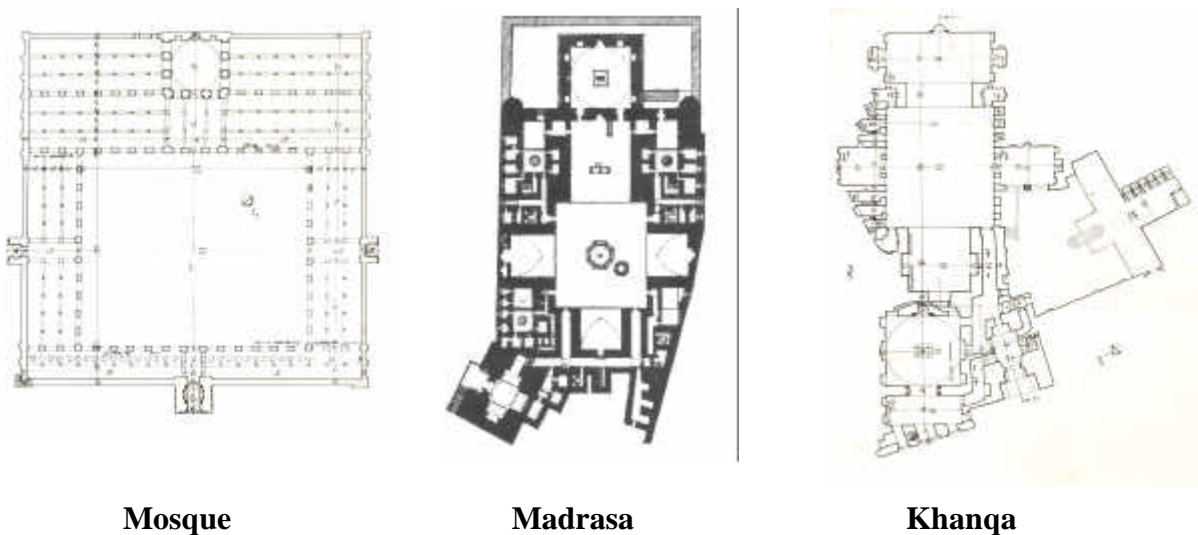
In some communities, some forms and architectural elements were connected to certain functions, others were interchangeable. During the Islamic periods in Egypt, the continuous shifting in the ruling dynasties affected the urban form. Each dynasty came with different concepts, criteria and new disciplines to apply. They sought new forms, and modified existing architectural elements to best express their own needs and purposes. There were changes in local experience, material, design concepts that had to transform shape, profile, and decoration to designate the new space underneath and to express new significance as well.

In order to understand the continuity of the dome along different Islamic dynasties, its significance to the Islamic culture must be revealed. The word 'dome' was derived from the Latin word *domus*, which means the 'house of God'. From this etymological meaning the role of the dome is expectedly associated with spiritual spaces. In Medieval Cairo, especially during the 14<sup>th</sup> and the 15<sup>th</sup> centuries, domes were installed to indicate two distinct functions of the spaces they covered. The first was to cover the bay in front of the prayer niche of a mosque, known as *qibla*, and is referred to as '*qibla* dome.' The other was to cover post-mortem constructions and is referred to as 'mausoleum dome.'

The two different purposes of the dome are likely selected for separate schemes. However, during the Mamluks, the evolution of complex buildings gave the opportunity for both schemes to be installed in one building challenging each other according to the importance of the covered space. In the same religious complex, the two domes played different roles; the *qibla* dome, which covers the area of the prayer niche indicates the orientation to Mecca: the Muslim prayer orientation. Hence the rest of the mosque must follow the orientation which usually orientates the dome far from the main elevation: a design principle that makes the dome hard to notice from the street level (see Figure 2). The other dome covers the mausoleum of the patron, free to be attached anywhere with the same restriction to *qibla* orientation. This free positioning gives the domed structure the advantage of overlooking the street and forms the main elevation, giving it a high profile to be noticed and appreciated by the pedestrians. Accordingly, the importance and preference in design and decoration between the two domes is given to the mausoleum dome due to its higher profile position.

The dome structure of mausoleums was usually attached in three religious buildings that played a major role in the urbanization of the medieval Cairo; the mosque which is *aljami`*, the school which is the *madrasa*, and the monastery for the *sufis* which is called *Khanqa*. The plan of the mosque consists of four arcades around an open courtyard. The sanctuary usually comprised more aisles than the other arcades. A transept with a wider aisle than the rest was set perpendicular to the prayer niche, which is covered by a dome (see Figure 3).

The plan of the *madrasa* was different; it consists of two or four *iwans* open directly onto an open courtyard. There were neither arcades nor a transept, and consequently no dome. Usually the mausoleum of the founder is connected to the *madrasa* which is a domed chamber accessed from within. The domed chamber is always considered in the main urban space whether it is a square, piazza, or a main street. The *khanqa* did not have a specific plan, sometimes looking like a *madrasa* and others looking like a mosque. When the idea of complexes emerged, mosques, religious schools, and Sufi *khanqas* were included within one structure and the building became one multi-purpose structure (Figure 2).



**Figure 2 - The domed structure in each building type**

The Dome was the main and most important architectural feature in all of these buildings, even though the patron might have already built a mausoleum; the new attached mausoleum could be used for the patron's family members. The significant importance of the dome to the urbanism of Cairo during the medieval centuries lead to particular revolution in the development of the dome: in profile, in material of construction, and consequently in structure.

### **THE STRUCTURE OF MASONRY DOMES**

The Mamluks during the 14<sup>th</sup> century had to promote the dome to meet their high esteem. They tried several materials and techniques in wood, brick and stone to render the dome after it became an apparent feature in the streets of Cairo.

Since wood was expensive to import, difficult to maintain and to stylize in massive work, it was not preferred in construction nor for external decoration of the dome. The brick domes of the Fatmids during the 12<sup>th</sup> century manifested wonderful shapes but were considerably smaller in size due to the lack of structural knowledge. The Mamluks faced the same structural problems of the dome which always lies in transitioning the square plan of the roof to a circular one, and in transferring the load of the dome to the straight walls of the square. In wood, the problem was easy to solve because it is light and some diagonal wooden braces can sufficiently carry the weight of the dome. In masonry, transferring load is quite problematic especially in the zone of transition where the load transfers from the circular plan of the dome to the supporting polygonal structure. Moreover, the transferring load element is preferred to be from the same material of construction to maintain consistency against the shrinkage and expansion factors. The interaction of the Islamic civilization with the Persian and Roman empires had introduced two main structural features to the Islamic world: the squinch and the pendentive. The squinch is a semi domed shape that can be installed in the four corners of the square to increase the supporting points of the dome, while the pendentive is a curved triangular shape that terminates at one of the corners of the square. The development of both the squinch and the pendentive within the Islamic world has lead to the birth of the stalactite (Figure 3).

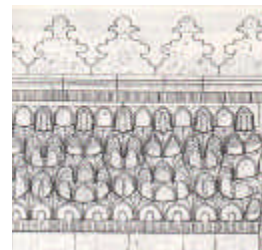
The stalactite compositions are sophisticated geometrical patterns that show the genuine skill of the stonemasons of the Islamic world. The matrix of the stalactites is made out of two basic shapes, where their connectivity to each other, either horizontally or vertically, forms innumerable shapes and an effective architectural device for transferring loads (Figure 3).



Squinches



Pendentives



Stalactites



**Figure 3 - The Transition Zones**

The simplest form of the rounded vault is a shell revolution, in which every horizontal section is circular. However, the 11<sup>th</sup> century domes in the Fatimid cemetery in Aswan are characterized by their multi lobed plan over peculiar circular zones of transition (Figure 1). The multi-lobed structure of the dome the main dominating theme where the other variations such as the ribbing was achieved by using external brick surface treatment of the dome without any structural interference. Sometimes brick domes were covered with plaster or were poorly stylized with stucco, which was a medium for intricate work that can only be appreciated from a close distance.

Very sophisticated stonework was introduced to the Egyptians after the Crusades. The European influence was manifested in two ways: either by the monuments left behind in some of the occupied territories or by European craftsmen who were prisoners of war and subsequently assigned for work in Muslim cities.

In the middle of the 14<sup>th</sup> century in Egypt, stone was the material chosen for construction due to three important reasons: the first is the limitation of brick decoration experience even if it was coated by stucco, the second was the ability of the large stone blocks to facilitate the method of construction in covering large spaces, third, was the durability of stone as a decoration medium which mainly depends on carving.

There was no structural variation for the basic form of the dome after changing the material of construction, because the stonework follows the same structural theory of masonry: which states that stability of masonry is assured by compaction under gravity. The masonry work resists very high compressive stress but does not resist tension forces [5]. The problem that the builders encountered was the increasing the weight of the dome due to the stone density which meant increasing the thickness of the walls to resist the thrust coming from the base of the dome. The equation that characterizes the relation between the two must have been researched to achieve such durable buildings.

These equations were not precisely known by the medieval stonemasons but they gained their expertise through trial and error, and they nearly determined the exact ratio between the thickness of the wall and the diameter of the dome after several trials. This knowledge encouraged them to use stone and to build larger spans of domes. As noted before, the dome structure always overlooked the street which means there were no counter forces coming from any chambers except those of the supporting walls. There are indications that the stonemasons and builders knew the factor of safety through experience and they were able to counter the dome thrust and to determine the required thickness of the dome and the exterior walls.

More confidence in the structural knowledge and stonemason's capability was apparent due to the magnification that occurred in the dome structures. The masonry stone domes became much larger in diameter which can be seen in the two domes of Faraj Ibn Barquq and Sultan Qaytbey in the Northern cemetery. The main focus on the dome design was the surface treatment and detailing: even the profile of the dome was elevated to emphasize the carved stone surface which was an encouraging medium for craftsmen to articulate. The early trials of stone domes had exterior ribs, following the brick dome artistic technique with a major change in the structural concept: unlike the brick domes of the Fatmids, the lobed decorative pattern is incorporated in

the bearing structure of the dome. The stone block that is a part of the load bearing structure is simply articulated from the exterior with consistent circular section from the interior. Christel Kessler discussed these differences as a disadvantage for the early stone dome, stating that the solid bulge of the rib is encumbering the dome shell and impedes vaulting a larger space [6]. This assumption was not verified due to the fact that the stone domes with the same theory of construction were the largest ones in Cairo and not the brick domes.

Early stone domes were all ribbed radiating from the top of the dome downwards. They were coated with plaster to conceal the joints between the stone blocks. Later, the masons learned to conceal the joints in the spaces between the ribs and the stone surface became an inviting surface to decorate [7]. Nevertheless, the carved blocks are arranged in a running bond pattern to give more strength to the structure of the dome (Figure 4).



**Figure 4 - The masonry associated with the decoration**

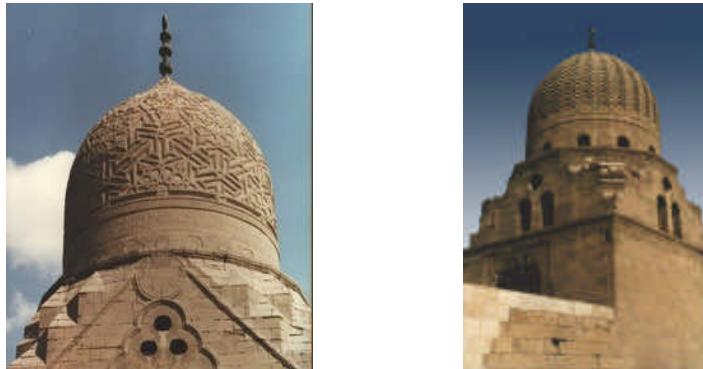
#### **STYLIZING THE NEW MEDIUM**

All the mosques of Egypt till the early period of the Mamluks, with the one exception of Ibn Tulun mosque, were adorned with only one type of crenellation: the ‘stepped and undercut’ type. The second type that lasted till the modern period was the trefoil crenellation (Figure 6). That means the mosques of Cairo were limited to two types of crenellations for centuries.

Similarly, during the first stylistic period of the Mamluks, most of the domes were characterized by ribbing radiating from the apex: straight ribs, twisted ribs, convex ribs, concave ribs and sometimes a combination of any of the previous rib styles together. However, the lack of diversity in the design of the dome is due to neither limited stone decorative patterns, nor the lack of creativity of stone craftsmen. Recognizing a shape and its decoration was one of the main characteristics of the Islamic periods. The final shape has a symbolic meaning that reflects cultural aspects and sometimes a self ego. The second period of the Mamluk, the Burji period or the Sercassian, was a revolutionary phase that modified all the architectural design concepts to go with the new era and its new urban standards. The period is stylistically distinct and the character of the dome profile and its decoration were not just a set of designs, but they were connected to the identification of period, rule and culture.

There are two geometric types of domes characterizing the Mamluk architecture during the Bahry period, each one of them with distinct profile. The first is a dome that curves inward near its base and bears no decoration or carving. The second is cylindrical from the base then it takes the dome shape as it rises up and is usually ribbed [8]. During the Circassian rule and around 1400 A.D., the dome got a higher profile and articulated zone of transition. The ribbed dome

continued conservatively but with a new type of decoration with designs very similar to the metal work of the Mamluks that had evolved (Figure 5).



**Figure 5 - The Exterior Treatment for Mamluk Stone Domes**

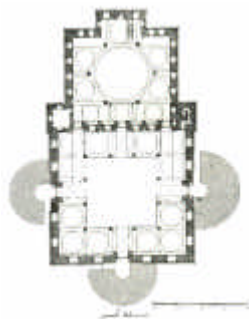
### **NEW SIGNIFICANCE OF THE DOME**

Unfortunately, when the Ottomans took over the rule of Egypt in 1517 AD, turning Egypt from an independent entity to one of the Ottoman Empire territories, the mausoleum domed structures were nearly abandoned due to limitation of funds. Egypt was ruled by *walis* who would spend a limited period of time in Egypt, typically only a few years, before returning to Istanbul for a higher rank [8] This eliminated royal construction investment in Cairo. The absence of the capitalists' and sultans' economic power did not give much chance for the erection of extravagant buildings. However, the dome continued to influence the streets of Cairo because the idea of the domed mosque was adopted by the Ottomans with a very important shift in its role and different visual perception.

The Ottomans introduced a new type of mosque in Egypt, though it was regional in style. This immensely affected the four *iwans* and the arcaded mosque types which were nearly abolished except for a few trials. The Ottoman mosques in Egypt were mainly an enclosed prayer area, emphasized by a centralized huge hemispherical stone dome. An open court surrounded by arcades is attached to the domed structure. The new Ottoman design eliminated the high profile dome, which was a typical Mamluk feature, being substituted by a new shape assigned the main role in mosque design. The exterior of the Ottoman dome can be predictable from the interior, due to the clear structural responses that are expressed from underneath. The effect of the dome is dramatic and was appreciated by lots of Egyptians.

The new concept formed a new challenge for the stonemasons, but due to several influential factors, it weakened the role of the stone carvers. The exterior surface of the central dome became much wider making the decoration more expensive. The dome profile is lower than the usual Mamluk domes and centralized making it hard to notice any sophisticated carving from the street level (Figure 6). The last factor was the immigration of the highly skilled stonemasons and craftsmen to Istanbul.

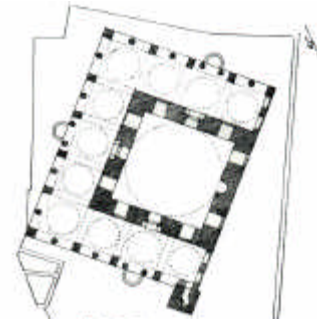




Malika Safia



Sinan Dome



Sinan Plan

**Figure 6 - Regional Ottoman type mosques**

### **CONTEMPORARY REVIVALS**

After the successful results achieved by using reinforced concrete to cover large spaces, masonry domes nearly vanished from public buildings presumably for safety reasons after earthquakes that knocked down a few domes in Cairo. The masonry domes were revived by the famous Egyptian architect Hassan Fathy who succeeded to stylize an architectural theme based on Nubian and medieval architecture [9]. He used adobe to build some models covered by vaults and domes. The experience was published and known world wide as the “architecture of the poor”: due to the low cost and local society co-operative type of construction [10]. Ironically, the new style - which was mastered by his students - was adopted by rich people rather than the poor. As a result of the adoption of the style by the high social class, the material for construction was turned into burnt brick and stone to achieve more stylistic results (Figure 7).



**Figure 7 - The Contemporary Stylized Domes**

The new masonry domes were installed in some elite suburb private houses to immitate a style which is very popular in some Mediterranean cities in Spain and France known commercially as Mediterranean style. The masonry houses manifested a great tendency to the old, antiques, rusted steel, and cracked wooden clogs. The architects dealt carefully with the masonry domes in shape, profile, texture and position in design so the whole building does not resemble any of the religious buildings. Although the number of contemporary masonry domes is considerably less than those constructed in any era in the history of Egypt, especially the 14<sup>th</sup> and the 15<sup>th</sup> centuries, conserving a traditional method of construction is an environmental integration to the suburb context. Those few individual trials have provided appreciation and encouragement for

not abandoning the environmental concepts and reviving the heritage of the traditional methods of construction.

The socio-political change in a community must also lead to changes in its cultural aspects, and traditional visual components, specifically architecture which contributes immensely to the image of the city. The dome as an urban pattern has played an important role for centuries in the Egyptian community, whenever there is a major change in the socio-political situation: the role, shape and style of the dome changes, articulating a new architectural pattern.

The dome was of significant importance to the different subcultures that controlled Egypt, which facilitated the changing in its architectural role. The elimination of a certain function or significance due to the change of social structure or framework did not threaten the dome existence but it introduced the dome with different significance due to the change in its form, position and the function that it covers. Moreover, the influence of different fields of experience in dome construction, masonry and surface treatments was also a factor in the development of the dome.

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