Original Research Paper

Volume-8 | Issue-6 | June-2018 | PRINT ISSN No 2249-555X

Science

UNDERSTANDING THE VALUES OF THE FORGOTTEN WORLD HERITAGE PYRAMIDS IN SUDAN

Maha Mohani Fahmi	Lecturer, Sudan University of Science and Technology
Yahaya Ahmad	Associate Professor, Dean, Faculty of Built Environment, UM
Helena Hashim	Senior Lecturer, Faculty of Built Environment, UM

ABSTRACT Concealed within the walls of heritage moments are a plethora of enigmas and scientific ideas that are ahead of their times, waiting to be decoded. Albejrawiayh ancient rulers' pyramids of the Merotic civilization in Sudan are one of such example. This paper aims to extend the understanding of unique values for these long forgotten pyramids in Sudan. And also recommend to add the structural value as an additional value, analyzing the structural approach of these pyramids has been carried out for this purpose. A fieldtrip was organized to carry out observations and interviews with local and international experts who are currently conducting conservation work on site. Plus developed a model to explain the structural approach that the pyramids was base on. The data obtained was used to extend the understanding of the values and adding the structural approach as additional value. To date, this structural approach has not been discussed in the existing literature.

KEYWORDS : heritage pyramids, structural approach, values

INTRODUCTION

About 2,000 years ago in Sudan, the heart of Africa, an awe-inspiring civilization, known as the Kush or Meroitic civilization, flourished. This civilization was ahead of its time in many aspects. When the word pyramids is mentioned anywhere in the world, people think of Egyptian ancient civilization. Not many are aware that there are quite an impressive number of ancient pyramids in Sudan; about 220 pyramids. Some in Nuri and others in Al Kurru and the latest were unearthed in Meroe Al Bejrawiayh. At the Bejrawiayh site, there are 44 great pyramids of the Kushite kingdoms and Meroe Empire. They were believed to have been built about 2000 years ago between 324 BC and 350 AD Welsby [23]; Hakem, [9]; Hinkel, [20]. These were constructed. The Meroitic kingdom was well known to the ancient Greeks and Romans. It is documented in historical writings that Emperor Nero (54-68 AD) sent an expedition of exploration to beyond the Meroitic kingdom. As such, many Greek art forms found their way to Meroe [9]. The conquest of Egypt by Pankhy (747-716 BC) and his successors has enabled the Meroitic to import not only the idea of pyramids but also many techniques, perceptions, religious ideas and attitudes of life [9].

Since Sudan is sharing a border with Egypt, the people of Kush were highly influenced by the Egyptian architectural philosophy and they went on to build a massive number of pyramids [9]. However, the Meroitic architecture has its own styles. Sudanese pyramids cannot stand in competition with their Egyptian counterparts in terms of height and age. The Meroitic pyramids are steep, reaching the inclination of 73º while the Egyptian pyramids do not exceed 52º [20]. In terms of the building materials, the Meroitic pyramids are made of sandstone of different qualities, which were available in quarries close to the cemetery grounds, while their Egyptian peers used granite blocks. Further difference lies in the functions of the pyramids. As the ancient Sudanese burial chamber is beneath the pyramids structure, it is deeply cut into the ground or sandstone substrata with a staircase leading down to them. It is not the case with the Egyptian pyramids, as the burial chambers are located inside the pyramid structure [19]. Recently, a study led by Barsoum [5] and other scholars from Drexel University discovered additional differences as the Egyptian pyramids were built using 3 types of stones containing cast blocks. Undoubtedly, Sudan has a rich legacy of buildings and monuments with outstanding craftsmanship and architectural quality. Together they form impressive historic features that are the heritage of talented and skilled past work builders. Many travelers, who had visited Meroe have helped to put it in its rightful place as a hidden cultural and social heritage of the African continent. Meroe pyramids at Al bejrawiayh village boast of burial sites of Kushite rulers and the result of about 2200 years' history has made Meroe (and Sudan) a multicultural society and their presence is still very visible through the built heritage that are still standing.

Research Aim

This paper aims to extend the understanding of the unique values of the Sudanese world heritage at the Al bejrawiayh via discuss the design of these pyramids and the understanding of the architectural style, materials characteristics / structural approach, in order to highlight the unique value and use it as a base to add additional value.

Methodology

In this research, the structural approach of the pyramids and their unique architectural style were analyzed based on the field work trip to the site and is verified by the literature review and is associated by a model developed by the author in order to elucidate the structural concept that the pyramids were based on. Also, the pyramids values are discussed and the reliability of the results was confirmed by interviews with the project directors on site.

Authenticity of Design

Many scholars have pointed out that authenticity is a relative concept with several definitions. For a considerable number of scholars, authenticity has different aspects [18]. These aspects maintain, preserve and safeguard the authenticity of ancient heritage [13]. Based on ICOMOS, authenticity has a number of attributes. These attributes include the design, materials, workmanship, traditional techniques, function, intangible heritage, spirit and setting. So in order to emphasize the authenticity of the Sudanese ancient pyramids, it is very important to discuss their architectural design and styles.

According to Durhan [6], Meroitic pyramids have 7 architectural patterns or styles. However, with regard to the Meroitic Al Bejrawiayh pyramids, there are only three main architectural styles. The first one is the stepping pyramid, which was created by retreating stone courses. The second style is the moulded corner decorations or smooth surfaces. Finally, the third one is similar to the second style in terms of the smooth corners but it has one deep retreat in the corners [20]. Based on the researcher's site visit observation, it is noteworthy to mentioned that, there is a fourth style; the retreating sandstone course in two layers. However, there is only one pyramid in this fourth style. All these varied styles indicate architectural modes of fashions (Figure 1).

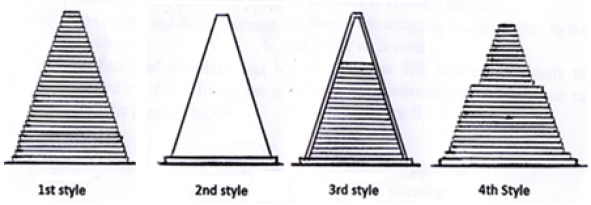


Figure 1: Meroitic Architectural styles Drawing by Author

Welsby [23] who analyzed several aspects of the Kingdom of Kush states that the Meroitic architecture has 3 main functional patterns: the religious architecture, which included temples and altars, the secular architecture, which contained palaces and houses and the Funerary architecture comprised of tombs, Mastaba and pyramids. This paper will focus only on the design, structure and construction materials of the funerary Meroitic architecture.

According to Hinkel [19]; [20] a unique line drawing was found, engraved on one of the chapel walls in the Northern cemetery. This drawing delineated the proportion ratio between the height to base as 8 to 5 (= 2.5+2.5). This ratio represents the harmonic proportion of 8:5 and it is very close to the golden Ratio or architectural golden rule (Hinkel [20]; Welsby [23]; Hakem [9]). The Golden Rule is a division of a line segment into two segments such that the ratio of the original segment to the larger division is equals to the ratio of the larger division to the smaller division. Research on the Egyptian metrological data revealed that this proportion has also been used in ancient Egyptian monuments such as the Buhen Temple in Nubia and Giza pyramids (http://jwilson.coe.uga.edu>hobgood>kate_files). However, and based on the researcher's site visit (2014, 2015), these engraved line does not currently exist. It might have been swept away due to harsh sand erosion and desertification on the pyramids site.

The Sudanese ancient pyramids comprised two parts. One under the ground, which is called the substructure, consisting of a varying number of burial chambers deeply cut into the ground or sandstone substrata with a staircase leading down to them. The superstructure is composed of two parts, the pyramid and the offering chapel. The superstructure is normally constructed above the substructure. It is noteworthy here, to assert that the superstructure is erected by the successor not the owner, unlike the Egyptian counterpart [20].

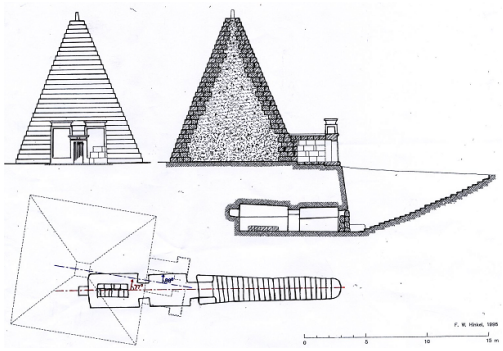


Figure 2: Al Bejrawiayh pyramids architectural set Source: Hinkel (2000).

Sudanese ancient civilization has a magnificent architecture style and this is clearly demonstrated in their brilliant pyramids design. As shown in Figure 2, each pyramid consisted of a substructure and a superstructure attached to the fascinating chapel room, which is illustrated with the King's life.

Based on an interview that was conducted in early 2016 with the German conservator and local inspector at Al bejrawiayh and in line with the literature, the Offering chapels can be considered a unique architectural feature of Meroitic royal burials that distinguished them from their peers in Egypt. The chapel's rooms are oriented to the east side of each pyramid. In the most basic form, they are rectangular, with the long axis extending away from the pyramids (Figure 3a). At the other end of the chapel, there is a plain vertical wall pierced by a niche often containing a stela. The gap between the vertical end wall of the chapel and the sloping face of the adjacent pyramid is filled solid with masonry or rubble [23]. The inner chapel relief walls are illustrated with drawings recounting the king's life story and achievements. The construction technique for this chapel consisted of 4 walls. The first wall is for roofing, to carry the roof loads (Figure 3b), the other 3 external walls are functionally added to shape the chapel's architectural style (Figure 3c). This construction technique proved that the ancient Meroitic architects were very particular about the appearance of their special architectural style. Often, innovations can be seen through their architectural style, design, materials and construction techniques. Based on Hinkel's [20] account during his restoration work for some pyramids, he declared that he found vertical wooden posts (cedrus libani) in the central shaft of four pyramids, which proved the use of "Shaduf" as a construction device during the Meroitic era.

3a

3b

3c

Figure 3: Pyramids' Chapel
Photos were taken by Author 2015

Authenticity of the structural approach

The main structural approach for the pyramids was based on the **"Mastaba"** concept. The analysis revealed that they built it row by row. In other words, they built a row then fill up the filler to support the load of the sandstone blocks. In explaining this point the researcher has developed a layer model (cut away scaled model) as can be seen in Figure 4.

Figure 4: Cut-Away Scaled Model for building pyramid done by author

The intelligent and authentic architectural design for the Meroitic nation has appeared particularly in their structure approach. However, this structural approach has some weak points that need to be considered such as the porous characteristic of the sandstone rock. In analyzing the structural approach, a scaled model was developed to demonstrate the basic principles of the pyramid structural stability through fieldwork trip observation and photos. All the three main architectural pyramid styles or shapes have the same structural approach and load distribution, using friction forces between sandstone blocks to hold the stone in place instead of mortar. This can be further explained through Figure 5a. The photo on the left is the scaled cut away model explaining this point, while the photo on right is the in situ image.

1. The pyramid's strength is at the end edge as shown in Figure 5a.

Figure 5a: Pyramid's strength at the edge.
(Photo is author's own, 2015).

Furthermore, it was observed that the Meroitic did not use mortar in the construction of their pyramids; they often used the hierarchy shape or pyramid shape to create a stable structure. This pyramid or hierarchy concept can also be seen used in the pyramid chapels as shown in Figure 3c.

2. Figure 5b below illustrates that they used sandstone rocks, which are characteristically porous, to build all the pyramids.

Figure 5b: The porous characteristic of sandstone.
(Photo is author's own, 2015)

3.It can be seen in Figure 5c that no mortar was added between the joints of the sandstone blocks.

Figure 5c: No mortar between sandstone joints.
(Photo taken by author 2015)

4. The friction forces are decreased as we go up and the weights are decrease too. Based on this approach, the Meroitic architect had chosen the pyramid shape in order to reach the desirable pyramid height.
5. The sandstone blocks are rough and this increased the friction factor as well as the stone weight over each other Figure 5d.

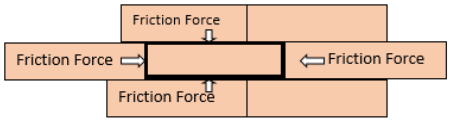


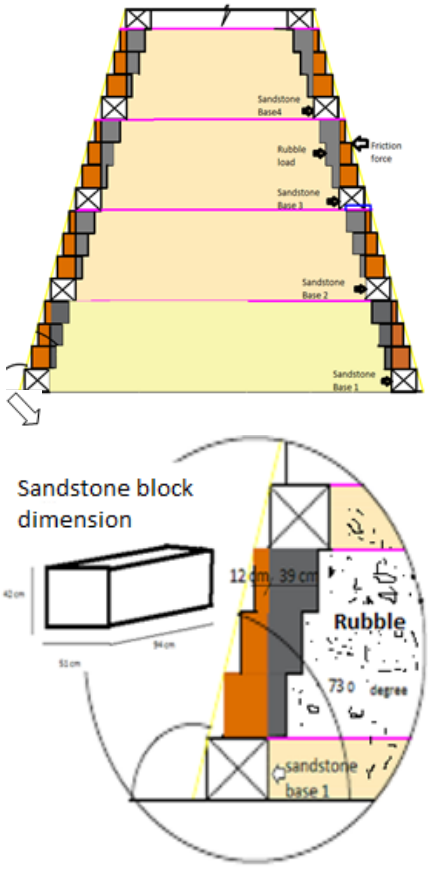
Figure 5d: Friction force

6. The function of the inner filler (rubbles) was to convey the loads to

the pyramid's base and the friction force fixing the rubbles. As such, the rubble kept the shapes of the pyramid, so that when the pyramid's rocks collapsed, the inner rubbles tumble down (Figure 6).

Figure 6: The Structural Function of the Inner Rubble. (Photo taken by Author (2015)

Further structural analysis was done to prove the importance and function of the rubble as well as prove that all the sandstone loads are being transmitted to the pyramids foundation which is located outside the boundary of the burial room:



Detailed A 1

Figure 7: The pyramids' angle and the friction force

Detailed analysis was carried out to explain the friction force and rubble function in relationship with the pyramids' angle. As can be seen in Figure 7 – Detail A shows that the dimension of the sandstone unit is 94, 51, 41 cm (see Detail A) thus the sandstone block weighs about half a ton. This was calculated based on the sandstone dimension and the density ($94 * 51 * 41 * 0.0026 = 2.6$ gram/cm^3).

The analysis revealed that each sandstone block was placed on top of another with around 39cm of overlapping, about 76% from the total sandstone block width. Therefore, the majority of the load is being transferred to the pyramids base (see Detail A) via each sandstone blocks while about 24% of the load is transferred to the rubble, which proves that the rubble filler is an indispensable part of the pyramid structure. It is also noteworthy to mention that, with this 76% sandstone overlapping, the generated friction force is enough to fix the structure of the pyramid and at the same time keep its shape stable over time. Also from the analysis it is proven that the pyramids 73° angle has a deeply functional purpose. It was carefully calculated in order to cause the overlapping area to be 76% and also to fulfill the requirement of reaching the highest height within the minimum base area. And its function was not only to use the "Saduf" device as stated by Hinkel [19].

Results

This study has revealed that the pyramids structural approach is considered to be an additional value that could be added to Bejrawiayh World Heritage Site. The study has also highlighted the Offering chapels as a unique architectural feature of Meroitic architecture, which is a significant value that needs to be emphasized in future. Decision about conserving or restoring should be based on an understanding of the design concept, structural approach and monument value and significance. The more the conservators' team knows about the monuments' values, the more likely the correct decision would be addressed.

CONCLUSIONS

The research undertaken is based on site visit observation supported by scaled model and interviews with the current conservators team. The study highlights some significant facts about the authenticity of Sudanese architectural unique styles that need to be considered in future conservation practice. Moreover, this study shows that the design principles and structural approach used in the construction of the Sudanese World Heritage Pyramids directly led to the discovery of the main factor that led to the major deterioration of these pyramids. Based on the structural analysis of the pyramids, the approach used to construct the pyramids resulted in a unique and stable structure, with the strength of the pyramid focused at the edge of the structure. Therefore, based on the researcher's survey, it can be concluded that Al Beijrawiayh pyramids has unique structural approach that has not yet been discovered.

References

[1] Albert. (n.d). The Operational Guidelines - Authenticity and Integrity Retrieved from UNESCO document.
[2] Perhavec.D.D, Rebolj.D, & Suman.N. (2015). Systematic Approach for Sustainable Conservation. Journal of Cultural Heritage, 16, 81-87.
[3] NCAM. (2010). Nomination File: World Heritage Centre The Archaeological Sities of the Island of Meroe (Sudan). 2014,
[4] Sandbhor.S, & Botre.R. (2013). A Systematic Approach towards Restoration of Heritage Buildings- A Case Study. IJRET: International Journal of Research in Engineering and Technology Volume: 02 (03), 229-238.
[5] Barsoum, M. W. (2006). The Great Pyramids of Giza; Evidence for Cast Blocks. Retrieved from Drexel University, Philadelphia, PA 19014.
[6] Dunham, D. (1955). Royal Cemeteries of Kush. UK: Boston.
[7] Fielden, B.M (1982), Conservation of Historic Buildings, Butterworth Architecture, and Oxford, U.K.
[8] Grellan D. Rourke (2013). ICOMOS International. Retrieved from http:// whc. unesco. org/ uploads
[9] Hakem, A. (1988). Meroitic Architecture. Khartoum University press.
[10] Harun, S. N. (2011). Heritage Building Conservation in Malaysia: Experience and Challenges. 20, pp. 41-53. 2nd International Building Conservation in Malaysia. Doi: 10.1016
[11] Lengkeek, J. (2008). The Authenticity Discourse of Heritage.
[12] (NCAM), N. C. (2010, January). Nomination File: World Heritage Centre The Archaeological Sites of the Island of Meroe (Sudan). Retrieved September 12, 2014
[13] Rehman, A. (2011). Conservation of Historic Monuments in Lahore: Lessons from Successes and Failures. Pak. J. Eng. & Appl. Sci. Vol. 8, 8, 61-69.
[14] Rosilena M.Peres, Francisco De Paula S.l. Gastal, Helino A. Greven. (2011). Italian Heritage Building Technology in Pelotas. International Journal of Architectural Heritage:Conservation, Analysis, and Restoration, 5, 677-692.
[15] Mohamed,A. Ali;Bakhiet F. Hassan;Salih,M. Mohamed;DIU. (2014). Salvage Archaeology of Dams on the Nile. NCAM.
[16] Nimir, R. (2014). Alarming bell: Be Aware. Al tayar, p. 11.
[17] Sarah, S. (2012). The latest Archaeological exploration: Sudan is the older Civilization in the Region. Al Entibaha Sudanese newspaper (Arabic translation).
[18] Stovel, H. (2007). Effective Use of Authenticity and Integrity as World Heritage Qualifying Conditions. CECI. Retrieved April 22, 2014, from Http:/ /www.ct.ceci-br.org
[19] Hinkel, F. (2000). The Royal Pyramids of Meroe. Architecture, Construction, and Reconstruction of a Scared Landscape. SUDAN & NUBIA, 4, pp. 11-26.
[20] . Hinkel, F. (1997). Meroitic Architecture;wildness,D.In Sudan Ancient Kingdoms of the Nile.p.p393-415.
[21] Wijesuriya, G. (2003). Restoring Destroyed Historic Sites. Retrieved from India seminar.com/2003/530/530%20gamini%20wijesuriya.htm
[22] Wiles, C. (2007). Conservation of Historical Authenticity in Heritage Tourism Planning and Development. Paper presented at the Proceeding of the 2007 Northeastern Recreation Research Symposium.
[23] Welsby, D. A. (1998). The Kingdom of Kush. UK: Markus Wiener.
[24] ICOMOS. (2011). Evaluations of Nominations of Cultural and Mixed Properties. UNESCO.