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DIGITAL DOCUMENTATION AND RECONSTRUCTION OF MOHRA MORADU: PRESERVING GANDHARAN ARCHITECTURAL HERITAGE

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KEYWORDS	ABSTRACT
Digital Documentation, Gandhara, Stupa, Preserve, Reconstruction.	Gandhara region has played a distinguished role in the spread of Buddhism to Central Asia and East Asia. Due to its strategic location, the small settlements around it grew into large metropolises with fine assembled monuments. These monuments are the finest examples of material and their applications. Their form assembling, craftsmanship and the structural soundness of these structures is proven by the ruins, still standing after several decades. This article presents a research study and analysis conducted on an urban settlement, Mohra Muradu, in the Gandhara region. The aim of this research work is the documentation and digital preservation of Pakistan's rich architectural past. A comprehensive research methodology was devised to study the design and then carry out its critical analysis. Various geometric proportions were recorded and analyzed for digital reconstruction. This research will result in a fine digital recreation of monastery and Stupas of Mohra Moradu. A Digital model will provide an option for a virtual reality walk through allowing for easy accessibility and bringing Pakistan in limelight for its rich inheritance. This methodology can be applied to other historic sites as well and by doing so all such locations can be digitally preserved.
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Introduction

Buddhist monuments are thought of as: "A spot not too far from the town and not too near suitable for going and coming, easily accessible to all people, by day not too crowded, at night not exposed to noise and alarm, clean of the smell of people, secluded for men, well fitted for retired life" (Barnes, 1995).

Buddhist monuments were like manuscript that hold within itself a long mystery of its development. This mystery consists of several phases, out of which Gandhara was one small phase. Gandhāra was an ancient region comprising Kabul, Peshawar, Swat, and Taxila areas of what are now northwestern Pakistan and eastern Afghanistan. As Gandhara region was at the crossroad of silk route, it encountered diverse cultures. The Persians, Macedonians, Mauryans and philhellenic Indus Greeks, Scythians (Sakas), Parthians and Kushans invaded Gandhara one after another, and most of them stayed on and made Gandhara their home. Some features of their cultures were absorbed into Gandhara. Each Invader contributed to building of art and architecture of Gandhara region (Samad, 2011). They left behind their influences that can be seen in the art and architecture of the Gandhara sites (Phuoc, 2010).

Taxila Valley, one of the most important cities of the Gandhara Civilization, is located east of the Indus River, about 30 kilometers from Pakistan's capital, Islamabad (Cunningham, 1963). The city was known in ancient times as Takshasila. The 20-kilometer-long valley in which the city of Taxila is located. It is bounded on the east by Murree hills, an outcrop of the Himalayas (Samad, 2011). The average height of the valley is about 549 meters (1,800 ft.) above sea level. The whole area is well watered by the main River Haro as well as numerous small rivulets (Edgerton, 1925). The climate of this region is pleasant. The valley partly belongs to Punjab and partly to Khyber Pakhtunkhwa.

Buddhist monastery complex is the most ancient architectural memorials discovered (Vogel, 1953) in the dictionary of architecture. Buddhist Sangharama (Buddhist monasteries complex) comprise of basic two units: a sacred stupa and a residential compound. Its simple planning is based on the composition of squares and rectangles on a flat ground. This composition of compound is raised from the ground, one having a canopy known as chatra known as Stupa. Other produces a roofed quadrangular-shaped complex and is known as walled monastery. Many such complex compound establishments as monolithic structures are found along the silk route (Vogel, 1953). Unfortunately, this type of fully developed scheme of layout and monolithic sort of development seemed to appear from nowhere and likewise disappeared into nothingness (Dar, 1989). Thus, more the reason that they should be studied and preserved. Later it can be analyzed to develop a scholarship for the scholars and researchers who are interested in reference. From the previous Gandhara studies, it is considered that the evolution of the monolithic layouts of these monasteries' form and function took place over time (Dar, 1989).

The complete dominance of Buddhism in the Taxila Valley seems to exist between the 3rd and 7th century AD. As the number of Buddhist followers grew and people flourished, sites around Taxila valley also developed under Buddhist influence figure1.

The knowledge about Gandhara art can be found in abundance (Barnes, 1995; Siddiqui, 2006) whereas the architectural principle and planning are very little to be found. Thus, observation and understanding are required to preserve and reproduce the original sites graphically and digitally. It is very important to understand the development of these edifices that housed the important monks, scholars, and travelers.

Analysis of Buddhist Monastery Site Selection Criteria for Construction of Sangharama

Buddhist Monasteries are mostly placed on mountain tops leaving behind the attractions and distractions of everyday life in order to devote themselves to spiritual living. Mountains are generally not highly populated, so they are far from the madding crowd. Locations near a water source are prioritized while the distance is kept not too far or not too near the city. This gives a place of solitude, to concentrate on prayer and to distance oneself from worldly matters.

Buddhist Monastic architecture progressed through various forms before becoming what we see today as a standard. The rectangular walled monastery architecture form reached its final form little after 150 AD. Before reaching the rectangular form, it developed through five distinct phases of gradual and systematic changes (Dar, 1989). The last (sixth) stage of development also is a rectangular walled monastery (Sangharama form) but with an enclosed Stupa within the courtyard.

Mohra Moradu belongs to the 2 BC to 7 AD period. It was built near all three ancient cities of Taxila valley which are: The Bhir mound, The Sirkup, and The Sirsukh. In this Buddhist site, there are two structures; one is the sacred Buddhist Temple and the other the Monastic part (Behrendt, 2003).

Importance of Mohra Moradu

Mohra Moradu is a well-preserved site that gives a decent picture of Gandhara Buddhist monastic Sangharama. Its near-fully developed form meets eyes almost in a shape that can be easily evaluated. Another important aspect of the site is the limited amount of research work done related to the site that would allow people to regulate its importance in the present day. It stands in isolation in a valley where monks could meditate in isolation and stillness of the surroundings.

Mohra Moradu appears to have been established near the end of phase II of Monastic Architecture progression. The main stupa and monastery were built in diaper masonry repairs in semi ashlar suggest that they were initially fabricated near the time of transition in building types (Vogel, 1953).

Analysis of Mohra Moradu Stupa and Monastery

Mohra Moradu is a twin structure monastery establishment, containing both the sacred stupa and the monastery as shown in figure 3.

Buddhist Stupa is not a real temple but an idea that is complete in existence as it stands aloof. This burial mound idea has a sacred significance that stands on a platform. Hence, replacing the uneven ground with a controlled surface as a foundation for meditating space around the building. This flat platform is a starting level for the geometric discipline of the temple itself and detaches it from the found world. It rises above the ground in several levels degrading in width and ascending in height (Unwin, 2009).

A composition of three different geometric shapes and carefully composed together hold the Main stupa of Mohra Moradu with a stone finish. Stone seemed to be readily available at the site. The scale of the temple relates not to the usual size of human beings but it maintains the proportions. The stupa has its own ideal system of proportions within its own structure, complete in itself. It does not respond to other architecture but more likely that other architectural structures relate to it as a focus and point of reference. Main Stupa of Mohra Moradu represents an established centre and other building responds around it. The stupa creates an axis, to something distant and above the ordinary: hence a mass culminating into the non-material above.

The main stupa was constructed together with a small stupa just south of its steps, later an adjacent two-celled relic shrine (not shown on plan) was also constructed. The scale of both the monastery and the main stupa was much larger. The main stupa has a high base, with a stairway providing access to a moderately large area immediately in front of the drum as shown in figure 4. "Although it is possible to walk around the stupa at the level of the plinth, this would have been impractical and dangerous, because the passage is narrow with no railing" (Behrendt, 2003) The devotee could have used plinth projects, to conduct appropriate ritual activity on this open platform. Circumambulation would have occurred around the base of the stupa. This is the main stupa format that was generally adopted throughout Greater Gandhara by the end of phase II (Dar, 1989).

The planning composition of Monastery introduced in Mohra Moradu has a quadrangle with all four sides of the designed residential complex of rooms developed with an Assembly Hall, and the Chapel area occupied by these various rooms is almost as large as the cloister courtyard. It has a rectangular walled and roofed structure with rows of 27 cells behind a covered veranda arranged on all four sides of a sunken courtyard about eighteen inches in depth. There is also a bath (jantaghar) in one corner of the courtyard, a private chapel in one of the cells, as shown in figure 5.

There are two courtyards in this monastery linked through the cell number 7 as shown in figure 6. When cell number 7 is approached it leads to the second courtyard. At one side of the second courtyard is an Assembly Hall, Refectory (Upatthanasala) for the bhikshus. The kitchen (agnisala), the bathroom (Jantaghara), a ware house (kotthaka) and raised bath Gantaghara (Vogel, 1953).

Tracing the History through Available Data and Case Studies

The collected data was studied and case studies of different stupas were done which helped in redesigning structures that no longer existed. Various precedence studies were done through available data and net search only, due to the constraints on mobility during the Covid Pandemic.

Jatka Stories and Museum

Jatkas is art stories of Buddha's life. Mostly this is chiseled out in relief on stone and placed around stupas to narrate the life of Buddha. These are great source of information, and they share different architectural elements details for example a grill 3 detail can be traced and its placement as next to the column gives a clear picture of how these architectural details were made in 2nd century BC. Looking at the artifact at museum also gave the making detail of the grill as shown in figure 7.

Case studies of the monastery from Nepal clearly explain the use of rotunda space. The courtyard was designed and connected internally to another courtyard through a corridor hence generating the necessary direction of movement in monastery (Shakya, Takada, & Kanki, 2018).

Monastery courtyard is a sacred space where monks conduct daily worship. This also functions as the center of religious activities, it is also an important living space used for discourse, laundry, ritual bath, etc.

Main door and a transition space is located before the entrance of the first courtyard at Mohra Moradu. After passing through the corridor there is an access to the main services area. This route developed is to control and hinder people from freely entering the monastery. On the ground floor, in addition to "Gundakuti" and other worship spaces like assembly hall with an enshrined space where assemblies and dinner sessions were held.

Most likely Mohra Moradu was the residence of the celibate monks who studied mainstream Buddhism. It was also the residence of academic-centered Buddhist monks and those monks who performed rituals and lived similar to ordinary citizens and was the place where communal activities were conducted. It was not the primary place to conduct rituals from the beginning. The extension that took place after the 2nd century proves that the activity increased at a later time. During the extension along with the service area and kitchen, the Gundakuti portion i.e., the main room of Buddhist deities, was also added where the possible deities were placed. Gundakuti is located on the ground floor in front of the entrance of the courtyard where a prayer/chanting chamber is also allocated. Gundakuti is the most important part of the services area. Mohra Moradu monastery also houses this prototype.

Design Elements and Color Palette

Kafiriat Tepe Monastery, in Afghanistan, was also studied and its digital reconstruction by national geographics gave a clue to the color palate. Almost all the design elements discovered in the above-mentioned monastery were the same as shown in figure 8.

The stupa has many similarities with Mohra Moradu stupa like a rectangular shape with a dome over drum and decorative pilaster stucco columns which repeat throughout the base. The moldings on the edges are also found similar to the Mohra Moradu Stupa. The material used for stupa was stone masonry laid with a special technique which is seen throughout the structure.

A pair of large feet, which is all that remains of a 10 ft statue in the central room of Monastery, was discovered very closely resembling the statue in the Mohra Moradu monastery corridor area. Monk cells were provided with vents for ventilation and being used as a light source. All the similarities between the two Monasteries gave clue to use the discovered elements and colors in the regeneration of the ruins of Mohra Moradu.

Red, yellow, and blue colors were commonly used colors in the monastery, probably due to easy availability of these colors. The statues of Buddha were mostly gilded with gold. This color scheme is still used in most Buddhist monasteries all around the world as depicted in figure 9.

Badlapur Monastery

Badlapur monastery, regeneration project done by Muhammad bin Naveed was a guideline in reconstruction process. The survey was done on the report and drawings that also helped in the rebuilding of MohraMoradustupaandmonastery.

Digital Regeneration:

Proper plans were drafted that helped in the drafting of elevations. The principles of symmetry, harmony, and proportion in architecture were practices throughout the history. (Morgan & Warren, 1914). Proportions were observed in the square base and the columns on the base of the existing stupa as shown in figure 10. These proportions were further used for the drafting of the Hermica, chatra, and the finial.

The study of votive stupa revealed that it had proportions in every element. The proportions followed the ratio of odd numbers such as 1,3,6 and 9. The same proportions were kept as a standard for the proposed elements of the votive stupa. The base of the structure has a height of 9 inches and this height was made the constant for all the bases of the proposed votive stupa design development such as the drum and the Vashti (Bhatti & Mohyuddin, 2014).The pilaster on the square base followed the same ratio mentioned above and this pilaster was mirrored for the ornamentation of the drum in the votive stupa. The Buddha sculptors on the front of the stupa were proportionate based on actual anthropometry which gave naturalism to the sculptors. The height of the Anda was the same as its radius. The Hermica was based on the ratio given above but

the odd numbers were increased to increase the size of the complete Hermica. The collective height of hermica, chatra, and final was equal to the height of the drum of the votive stupa.

The Chatras rod (Vashti) had a base of 9 inches which slowly decreased with the same ratio while ascending. Similarly, the thickness of every circular plate in the chatra also decreases. The distance between the plates decreased with the ratio while ascending. The diameter of the seven plates also decreased with the standard ratio. For recreation of the chatra the analysis of other Buddhist stupas was done. figure 11 show the comparison with the chatras present on other Buddhist Stupas and figure 12 is the recreated drawing of the Chatra at Mohra Muradu. The same ratio was followed in the construction of the finial as shown in figure 13. The developed complete elevation of the Stupa is shown in figure 14 and the complete master plan depicted in figure 15.

Conclusion

Finally, the elevations generated were converted into 3D walk through design Models. By doing this type of survey and following the sequence, the ideas manifest in the work of great architects may be traced back and their experiences can be encountered. This can make it easy to understand the design methodologies of these great structures.

Heritage buildings are representative of culture, aesthetics, building techniques and lifestyle of a certain period (Ali & Qi, 2020). Preservation involves keeping an object from destruction and seeing to it that the object is not irredeemably altered or changed. In preservation, the final appearance is no longer the prime factor, but rather, retaining the maximum amount of building fabric. This method of studying, identifying, documenting and developing design is a step in rebuilding the past. Digital preservation and regeneration can be a vocabulary of our precious possessions. Such studies and observations need encouragement to facilitate the world to get a glimpse of one important civilization that once was the center of attraction and a focal point of a major religion of the time.

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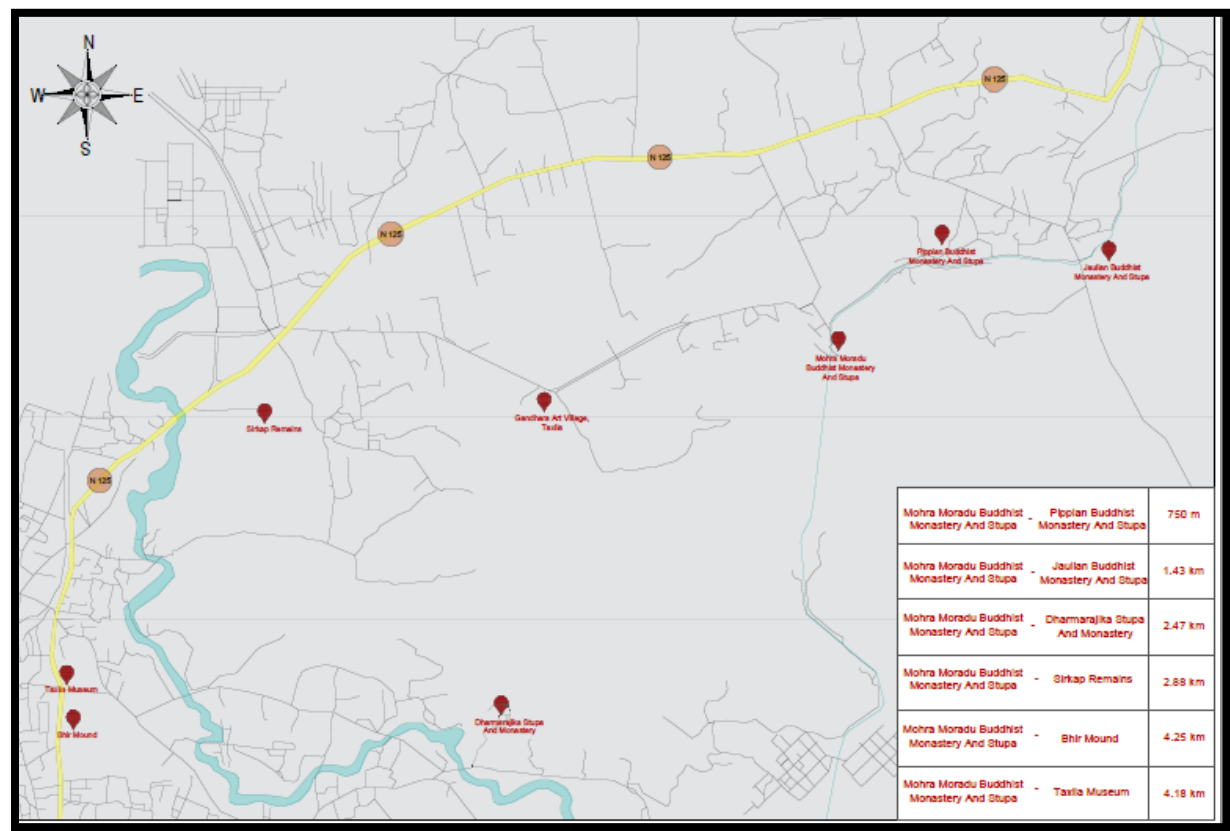


Figure 1: Mohra Moradu distance from other important monumental metropolises

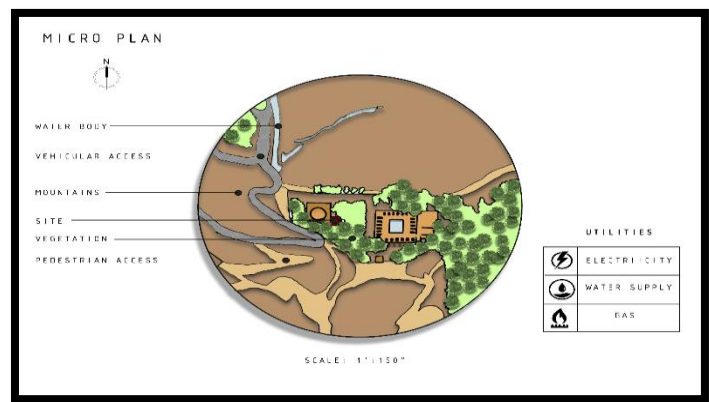


Figure 2: Site plan of Mohra Moradu.



Figure 3: Mohra Moradu Monastery and stupa

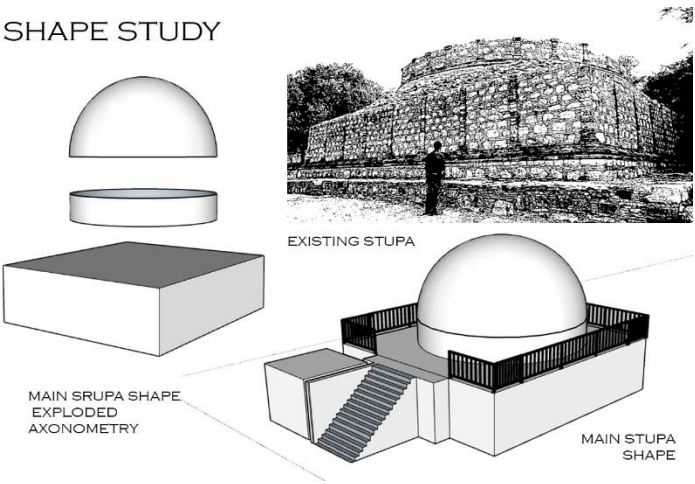


Figure 4: Form and shape of Mohra Maradu



Figure 5: Plan of the Monastery Courtyard 1

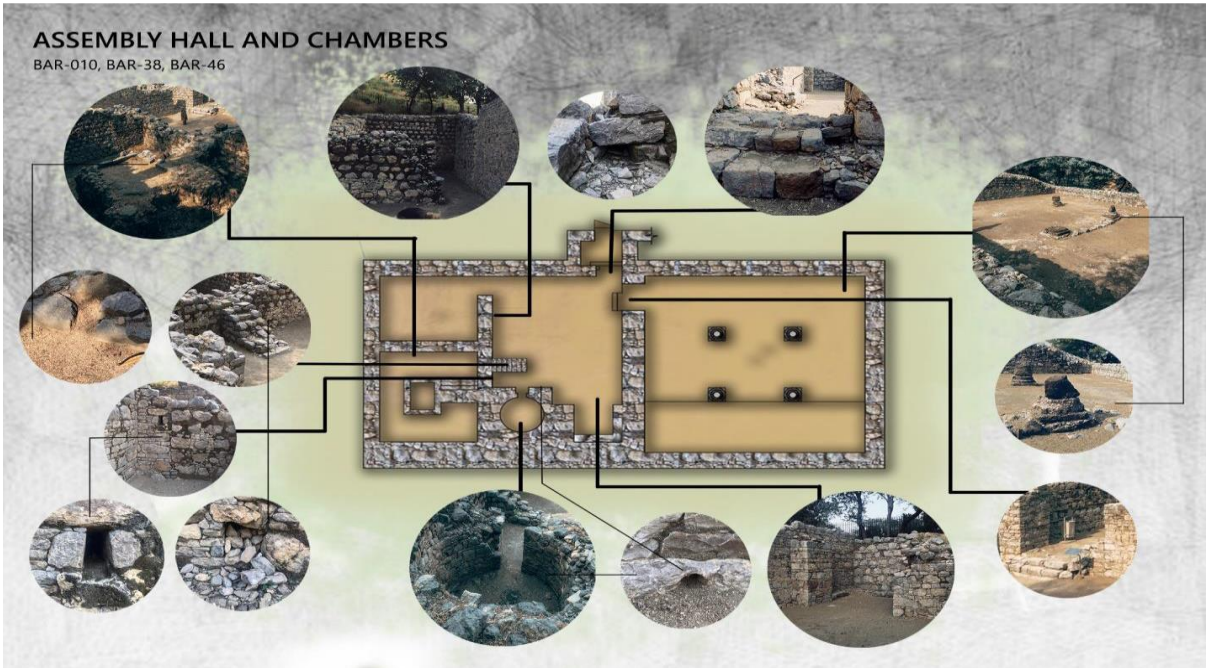


Figure 6: Second Courtyard (Services area) connected through cell number 7



(a)

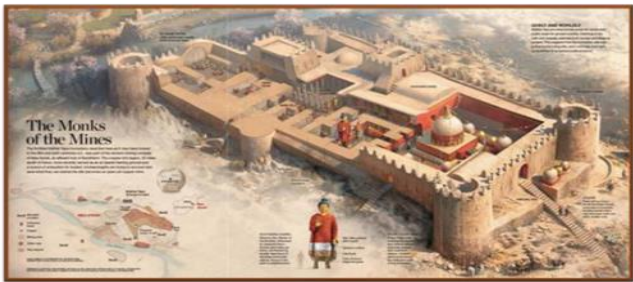


(b)

Figure 7: a) Railing detail at Taxila Museum display; b) Grill design from Jatka



(a)



(b)

Figure 8: a) Main Stupa Kafiriat Tepe; b) Mes Aynak Complex generated by National Geographic Buddhist Archeology Afghanistan



Figure 9: a) Guided statues of Mes Aynak ([reference link](#)); b) gilded statues of Mohra Moradu (picture taken from Taxila museum)

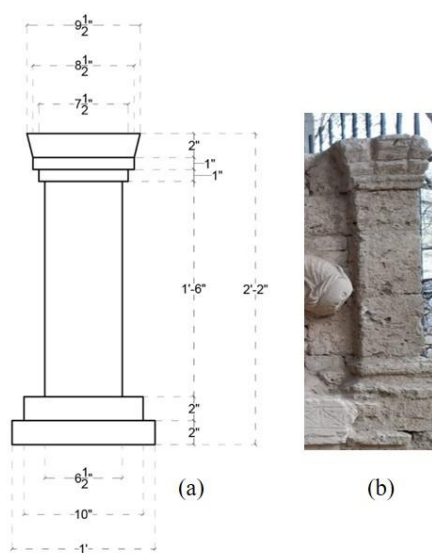


Figure 10 a) Column digitally drawn; b) Original Column



Figure 11 Comparison of stupa architecture. Left: Thalpan-Chilas, stone 30:1, Tafel III a (Bandini-König [2003](#)). Centre: schist reliquary stupa (centre), 83 cm height, from Gandhara, possibly Taxila, 1st–2nd century CE (Carlton Rochell Asian Art Gallery, private collection, New York). Right: Thalpan-Chilas, schematic of stone 41:3, Tafel 25 (Bandini-König [2003](#))(Van Aerde, Yang, Bork, Fang, & Mischke, 2019)

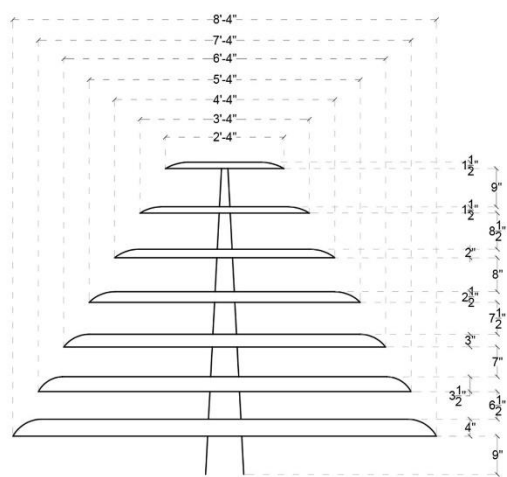


Figure 12 The drawing of Chatra recreated

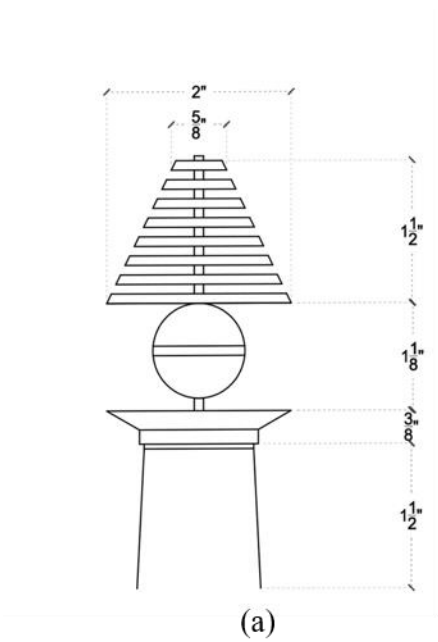


Figure 13: Finial with the same proportion as the Chatra (a) recreated (b) Original

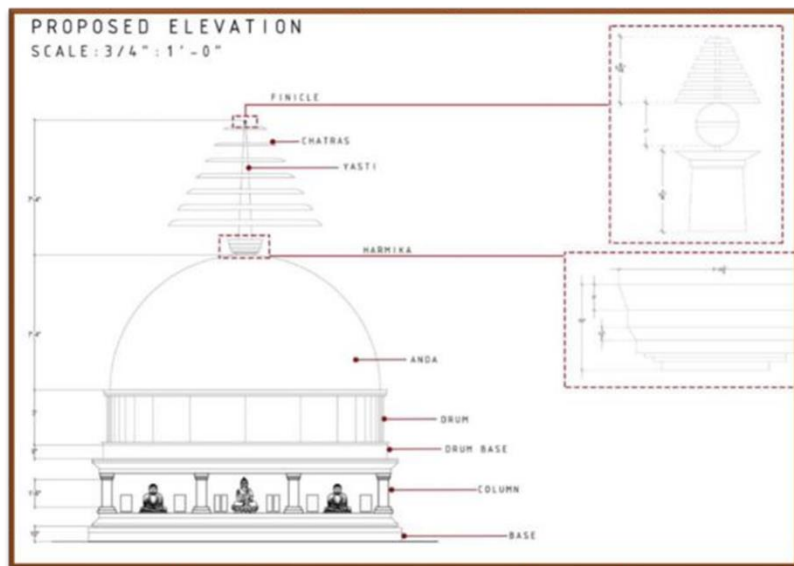


Figure 14 Generated elevation of the Stupa

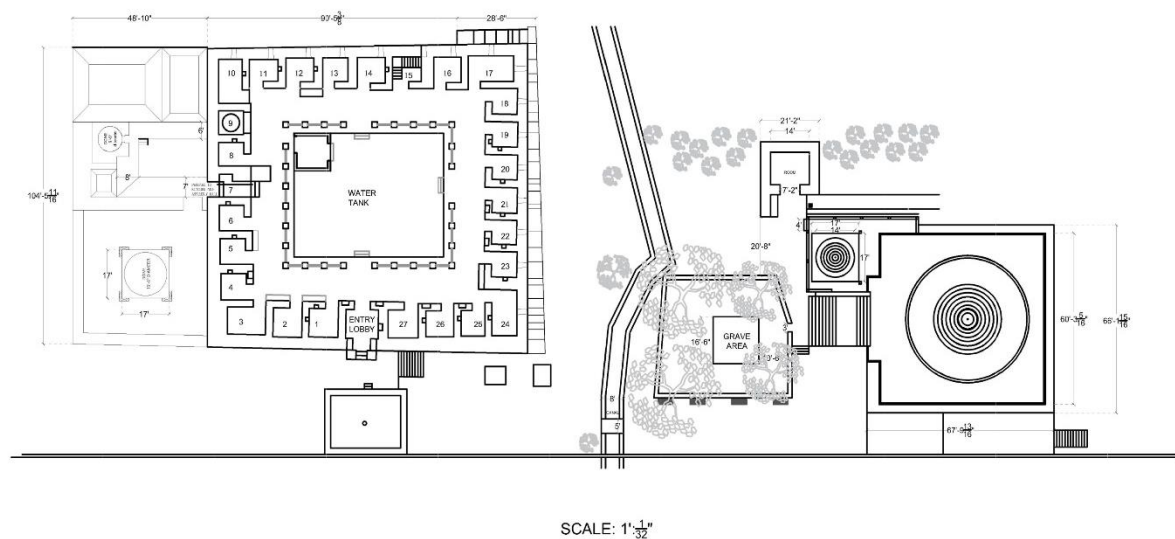


Figure 15 Master Plan of Mohra Muradu Stupa and Monastery (Drawn by author)