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Eco-friendly Concepts in Architectural Features of Cave Monasteries

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Abstract

Considering the internal geographical spread of the country, it is possible to confirm how the country's governance system functioned according to regional divisions in different periods. The aforementioned border determinants had an impact on the structural formation of this nation's social, cultural, political, economic, and religious cultures at the time that the primary divisions of Ruhunu, Maya, and Pihiti were in place. Along with the patterns of settlement expansion that occur in accordance with the allocation of control power's priorities, the structural arrangement of the aforementioned fundamental sectors may be recognised. Even in religious culture, it is evident that the social corporation of monks and forest inhabitants and the creation of the physical environment corresponding to it formed the basis for how the geographical environment has affected the variety of policy. From 3 BC until the Rajarata Kingdom moved to Polonnaruwa, the cave monasteries were constructed on remote mountain ruins far from the local settlement. According to the design technology of those cave monasteries, the eco-friendly usage of their architectural elements was investigated in this study. The research objective was to confirm the relation of the architectural features of the cave monasteries with the built environment, and the research problem was to determine the spatial evolution of the architectural features of the cave monasteries over time in the cultural landscape. The methodology used in establishing architectural features is as follows, observing the geophysical location and space of cave zones, recording cultural markers (inscriptions, Painting, other symbols) to construct the spatial evolution of each cave. Confirmation of architectural characteristics, their relationship to the built environment (such as slope direction and elevation), and their reporting through plans, documentation, and photographs. A conceptual approach had to be offered in order to represent the entire geographical region while presenting the concept of eco-friendly, even if the research location was the cave monastery complex from the Rohana sub-kingdom era.

Keywords: Monastic complex, Eco-friendly, Caves, Geography, architecture

Introduction

A structure connected to the natural environment is what the word "cave" means in the Sinhala dictionary. It states that a "cave" is a natural opening made by the ground, rocks, and trees. That hole is also known by the names "Benaya, and Bilaya" (Sinhala Dictionary, 2011:691). "Caves" are acknowledged as proper residences for monks in the VinayaPitaka (Chullavaggapaliya, 2005:129). After accepting the *Mahamegha* forest donated by King Devanampiyatissa to MihiduThera and the delegation, when the rainy season came, they returned to *Mihintalea* and

prepared the caves there for living[9]. The *Mahavamsa* indicates that King Devanampiyatissa sacrificed 18 caves (Mahavamsa, 1996). Later, cave monasteries were built around these natural locations. *Mihidu*Thero and others have been using caves, not "caves" since early times. Although "cave" is used as a synonym for "caves", the word "cave" implies an artificial construction. Although there is information about "caves" which are considered to belong to the prehistoric era of Sri Lanka, the monks are offered special caves. In later times, various changes took place in its external structure as "caves" took on a different form of use as caves. Guttering, floor preparation, wall foundation preparation, and access preparation, among others are important. But it can be considered that the "cave" where *Mihindu*Thero spent the first day of his visit to Sri Lanka is called *MihinduGuhava* because of an artificial construction in it.

The *VinayaPitaka* has given instructions regarding the selection of such a place. Places such as "high peaks, mountains" are mentioned and the reasons for this are the safety, clean water, rainwater availability and isolation of these places (Basnayake, 1992, 20). Kudumbigala, Rajagala, Situlpavwa, Hennanigala, Samanabedda, Padikemgala, Galapitagala, Buddhangala, Piangala, Tharulengala are the main places built around a place with this topography.AD B.C. beginning in the third (03) century, this process continued until the end of the Kandy period, when the caves were used as monks' abodes. The work of making these caves suitable for living and offering them to the monks was done by the kings, *Parumakas*, *Gamikas*, *Brahmins*, *Gruhapathi* etc. Inscriptions found in the various places of Sri Lanka clarifiedit.

By this time, many Buddhist caves had been made in places like Ajanta and Ellora in India's Barabar Mountains. It is pointed out that the characteristics of the Indian caves cannot be seen in the Sri Lankan caves of this period (Thapar, 1973:121). The exterior of these caves can be seen in a very ornate manner. According to Mr. Silva, the two cave monasteries of *Lomasa*, *Rishi* and *Sudamaya*, which were offered by Emperor Ashoka for Indian residents, are the source of the history of Indian cave monasteries (Silva, 1992th11). The creative form of the caves in Sri Lanka is simple. "*Katharama*" carved to prevent water from seeping into the cave was also used to prepare the rock cavity for one or at most two persons to live (Paranavithana, 1914:284). Various complexities can be identified here in *Kalyama*. In particular, it can be pointed out the design of the walls, including brick walls, windows, doors, and ceilings. Complexes of cave monasteries were formed when natural caves were built into "caves" in a complex form in terms of physical structure. Two prominent features of the cave monastery complexes are pointed out (Gunawardena, 2009:65).

- Cave monasteries built with Mahinda's journey, AD. In the 6th and 7th centuries, the use of caves as abodes in PabbataViharārama complexes was a tradition of independently built

[9]Paranavitana, 1970:No.423;Paranavitana, 1970:No.424;Paranavitana, 1970:No.428;Paranavitana" 1970:No 426);Paranavitana" 1970: No 425;Paranavitana" 1970: No 422.

vihararamas that became a counter-introduction. Each cave monastery is found in clusters according to its natural location in the environment, etc.

Results and discussion

The architectural features of the cave monasteries discovered as a result of research in the study could be confirmed in this way. Foundations, roofs, walls, windows and doors, *Kataram*, steps, Entrances, two-storied caves, and cold and residual structures are important among them.

Base Design

Over time, the spatial organization of cave monasteries has taken on a complex face according to the evolution of material and design technology. Two main evolutionary stages in the making of the base were shown here. That is, the first stage is the formation of the base in cases where the front face of the caves is exposed to a rock face and the front face of the caves is exposed to a rough slope or a terrace. When the front of the cave has steep slopes and uneven topography, a fence is used to prepare the area as a flat area, then a strong base is created and walls are built on top of it. The base is designed perpendicular to the walls, which are about 1 1/2 feet thick, and join the walls about 2 1/2 feet below. In this interspace region cave inscriptions can be seen stating that Len was sacrificed. In this interspace region cave inscriptions can be seen stating that Len was sacrificed. It is a measure taken to ensure the strength of the walls and the resistance of the ground to water erosion by designing the base from a depth of about 2 1/2 feet from the ground level and extending to a height of about 1 1/2 feet from the ground level. Clay and granite parts have been used as material interventions for that. The lower part of this base, which is about 4 ½ 2 feet deep and wide, has been prepared using large granite pieces and on top of that, small granite pieces and clay have been used as binders to complete the base. An important distinguishing feature is the making of the base in proportion to the structural form protruding to the front of the natural cave.

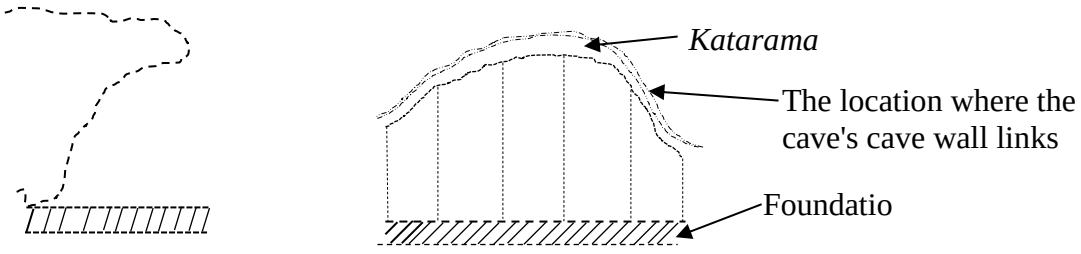

Figure 01: The place where the wall connects to the cave

In the foundation design, large granite blocks have been used for the first layer. In examining the usefulness of this, a fact that is confirmed is that this kind of material intervention has been used for the purpose of controlling the entry of groundwater into the walls through the foundation due to capillary force. Through that theory, it is shown that the space for water to move up along a thin tube is at a high intensity, thus the space for capillary water to move up is prevented by applying

the thickness and width of granite to the bottom of the foundation. Otherwise, the chances of the walls collapsing and discoloration due to the upward movement of underground water have been controlled.

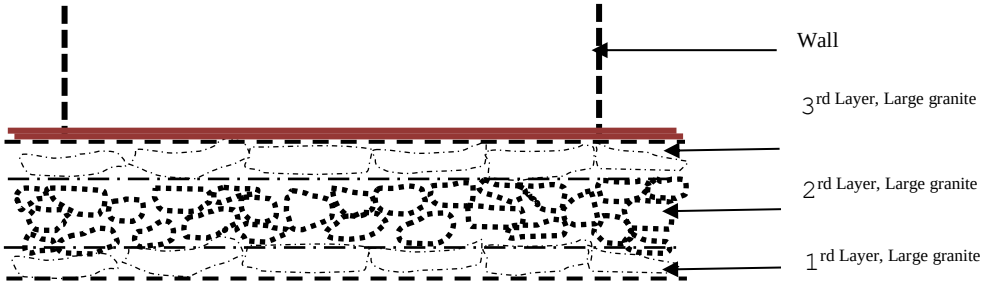

Figure 02: Layers of Foundation techniques

Only when the front of the cave is open to the ground, the base is created in this way, and the base of the caves located on a rock plane is built with minimum height and minimum granite. It is clear that the strength between the rock slab and the foundation has been increased by using a lot of clay in creating the base on a rock slab. The other point is to create a footing on the bedrock by cutting a groove about 2 feet wide and 3 inches wide and creating the footing on it. This is a measure taken to control the drifting of the base and bedrock over time.

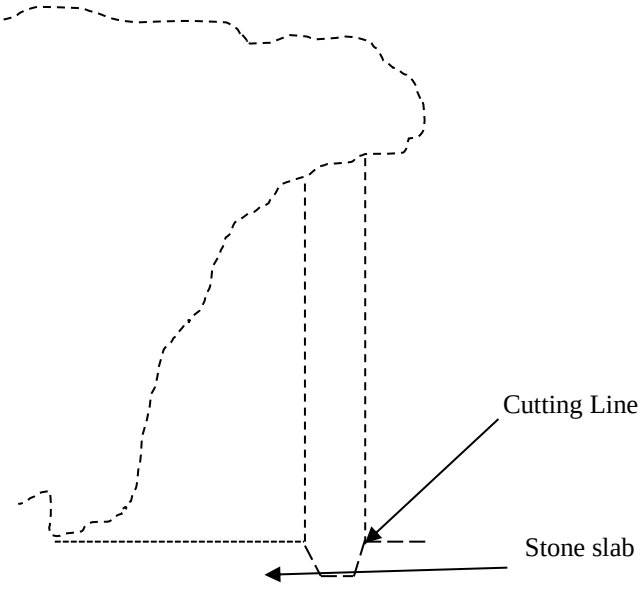

Figure 03: Structure of wall of cave

According to the elevation of the land, there are cases where the ground in front of the caves was prepared before the foundation was created. The base of the caves with rough slopes in the monastery premises like *Situlpavwa*, *AmparaRajagala*, *Kudumbigala,* etc. has been prepared as a suitable flat zone.

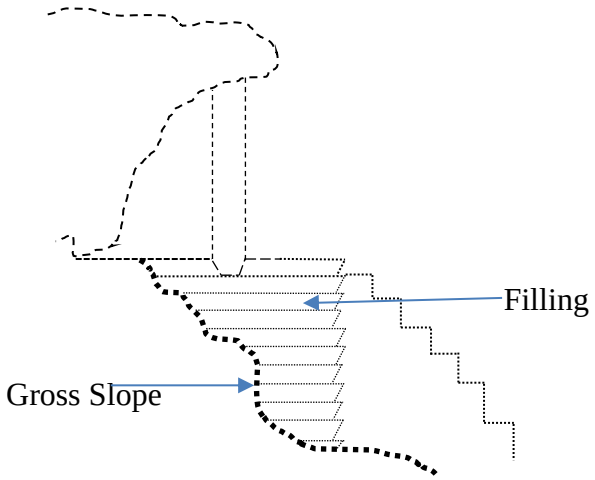

Figure 04: Slope of the cave

Climate, weather, and geophysical location are the factors that influenced the Eco-friendly concept revealed in the foundation design, which is the main architectural feature of the caves. The soil water is not maintained at a high level for most of the year on the Sesha hills and the groundwater level is high due to the activation of natural springs only in one season of the year. Due to the fact that cave monasteries are located in the center of the rocky valleys with slight slopes or rough slopes, constant flooding affects these places more. As a remedy for this environmental process, the above methodology was adopted for base design[10]. In creating the base of the caves facing the natural soil zone, the base is created from the inside of the earth about 2 1/2 feet above the surface soil level. Thus, in the analysis of the structural layers of the foundation, it is revealed that this kind of technique has been used to control the concentration of underground soil water along the foundation to the walls of the cave. Through this process done by capillary Power[11], an objective of controlling the wall discoloration, collapse, and fading of the walls over time is confirmed by

10The lower part of the base is prepared using large granite rock fragments, on which small granite rock fragments and clay and again granite rock fragments are used to treat the surface with fine clay.

11 Water is able to move upwards along a thin tube. As the ground water capacity of the ground increases, the
Capillary power increases.

using large granite pieces to create the initial and final layers to drink the underground water rising to the walls along the base.

Inter Flow of Cave

A common architectural feature can be identified among cave monasteries. Most of the natural caves were used as human habitations in the prehistoric period, but during the pre-Buddhist period, they were used as hermit monk residences. In the process of cultural formation process[12], the original settlement layers have been removed from the cave and the Interflow of the cave has been prepared. This is evident from the fact that 5 or 6 feet of soil has been removed from the interior of the caves and granite pieces have been used inside. For the lowest layer, large granite flakes are used, and for the second and third layers, rock fragments and flakes are used and clay mortar is used to prepare the house.

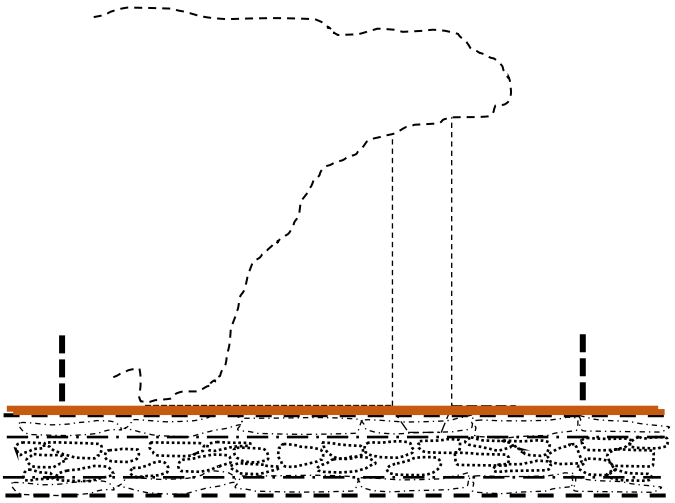

Figure 05: Flow of the inside of the cave

By making the floor in this fashion, the eco-friendly idea is to maintain the cave's inner coolness even under arid environmental conditions. Clay is utilized in the construction of the house, and because of its excellent air-absorbing qualities, it offers a strong foundation for balancing the interior coolness. Clay and granite fragments are prepared as a filler about 2 feet thick for the cave

12(Site Formation)" (Primary deposition process), (Post / Secondary - deposition process) (Accidental
Deposition)" (Coincidental Deposition)" (Intentional Deposition Deliberately)" (Coincidental deposition)
(Intentional deposition) (deliberately) (Natural formation) (Cultural formation), (Renfrew and Bahn, 1991:195).

floors that are situated on a rocky plateau. This prevents the rocky plateau from being too hot. Additionally, clay plaster has been applied to the cave walls in such a physical place to regulate the issue. Due to the heat absorbing and re-cooling properties of clay, it is the most suitable material for the dry environment of tropical countries.

Here it is revealed that the design technology of the architectural features was directed to maintain the environmental humidity constant in the regions with tropical climate. Material interventions have been shown as three layers in the design of Gebima. As there is a constant ventilation space in the second layer, there is a constant exchange with the external ambient temperature. Due to this, it is possible to maintain a cool air in the cabin, and it is not affected by the growth of insects in the house, the house being rotten, etc. Due to the void nature of the internal soil where the internal air is not mixed with the external air, the soil becomes dead due to the dead soil condition. To control this situation, creating the interior of the house with air space and treating the surface of the house with clay mortar are two technical options used to maintain this process.

The walls

A common architectural feature of all cave monasteries, the wall design is tailored to the structural, and effective needs and interior space of the cave. A common factor can be revealed as two or three complete walls. Cases where a wall was created taking into account the structural arrangement of the interior of the cave are also revealed. Such cases are most likely to be confirmed when the interior of the cave contains a "*doona*''or fragmented rock fragments. Fully preserved wall parts can be discovered in the Rajagala monastery complex and in the caves around *Maneva Kanda*, *MihintaleKaludiya* Pond and *Situlpavwa*, which is an inter-complex. Depending on the location of the caves, the structural form of the walls is determined, and in order to create more space inside the cave, it is common to see cases where the walls are designed as two parts. There are cases where there is only a single chamber in the interior, and there are cases where the interior of the caves is separated into two chambers.

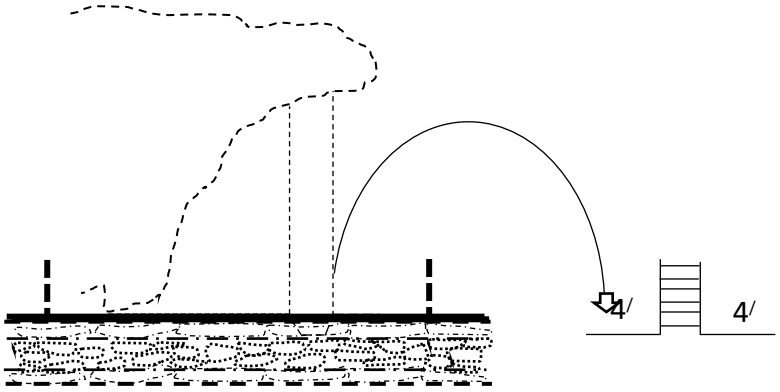

Figure 06: Wall-made techniques on flow

Examining the wall construction technique, the walls were built from the center of the main base, 4 inches from the sides, and small pieces of granite and clay were used. These features can be safely identified in the caves associated with Piangala. From the base of the walls, the cave is connected slightly inwards to the premises where the catacombs are located. Due to this, the walls are protected from rain water.

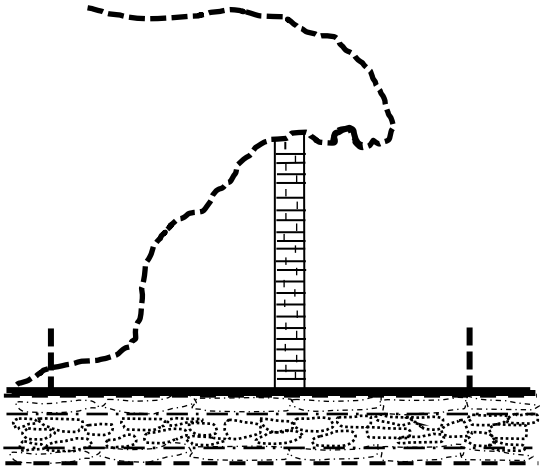

Figure 07: Techniques of walls protected from rainwater

After the construction of the walls, a type of white lime mortar is treated and finished with coarse mortar and fine clay mortar. Paintings can also be seen on this mural. *Hennanegala*, *PunchiSigiriya*, *RajagalaSihamukha* caves are places where such paintings can be identified. It is clear how the rocky walls and upper parts of the interior of the cave have been prepared using the mortar that has been used to finish the walls of many cave monasteries. The wall factor is an architectural element that has a more direct effect on ambient temperature and groundwater than

the floor itself. Through the design of the walls, three main design cases were pointed out, which were followed with the aim of controlling the adverse process that occurs inside the walls after absorbing the water through capillary action or other external factors. The final design opportunity here is to coat the clay walls or the rock walls connected to the cave with a fine clay mortar and finally treat it with a type of lime mortar. Not only the clay walls but also the stone walls are treated with fine clay and finally finished with a special white lime mortar. Not only the clay wall but also the rock walls have chances of water seepage through any method. In such cases, the unique property of lime mortar is that the water vapor inside is absorbed and released into the air due to the chemical activity of the lime. Whitewash can be identified on the walls of each cave monastery. The fact that the paintings painted on the walls have survived for a long time is also a result of this Eco-friendlyly balanced concept. During the colonial period, this situation was improved and whitewash mixed with soap was used in those houses.

Windows and doors

A recognizable architectural feature associated with cave monasteries is the use of gateways and portholes. These architectural elements are small in size and from this several facts related to human micrograms can be revealed. That is, this type of structural measurement index may have been used for the purpose of honoring the height of the people in this period or the chief monk who lived in the cave in question. These architectural features are now decaying through the caves and these features can be revealed from the cold region of the AmparaRajagala archaeological site, the Anuradhapura Kaludiya Pond cave monasteries and the Maneva cave monastery premises. A variety of material uses can be discerned and gateways made of granite boulders can be identified. In cases where several cave monasteries can be identified on the same rock face, a main gateway was used to access the rock. Later, a stone gateway covered with bricks can be seen on both sides of the entrance to the cave monastery premises (MihinthalayaKaludiya Pond).

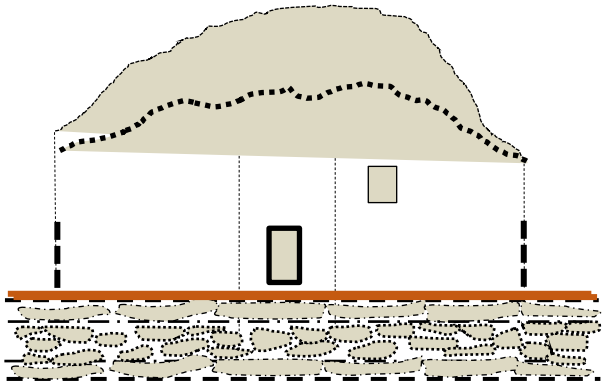

Figure 08: Established window and door of the cave

Entrance doors and window designs in the caves may have remained a common feature, but have decayed due to the impermanence of material interventions. It can be recognized that these features were made of wood and granites over time. Cases of wooden doors and windows cannot be identified at present(Rajagala and Maneva monastery complexes), and cases of stone entrance doors and windows (Mihinthalaya Kaludiya Pond, Arankalaya Monastery Complex) remain. The concept of using these architectural elements in cave monasteries takes a broad form. In cases where several cave monasteries are located on the same rock plateau, the common entrance door is made of granite and strong ashlars are also used (the stone ashlar in the Rajagala monastery compound). The ecological concept that is revealed through these two small-sized features is that since the environmental temperature in a tropical country is high, this kind of structural form may have been created to control the entry of heated air into the cave.

The Outer roof of the cave

It is possible to discover evidence that a step was made on the outer roof of the cave of the caves. The outer roof of the cave has been created in cases where the caves are located in the direction of the wind according to the geo-global position. There are two characteristics that can be recognized as having created this feature. At the junction of the gutter and the wall, square small holes are arranged and in front of the cave are stones about 6/7 feet high with a rough finish. The small square boxes above are the supporting elements connected to the wooden rafters, and in front of the stone pillars, the roof of the outer roof of the cave has been prepared using wooden parts horizontally. At present, no cave monastery whose roof can be uncovered can be identified from the remains. Cave slopes are created relative to a rough slope or wind direction. There are also cases where it is not. It is a factor determined by the geographical location and there are no walls around the outer roof of the cave and it is exposed to the environment. The outer roof of the cave is built with a rough elevation, limiting the space for rainwater to enter the cave along with high winds.

The outer roof of the cave design of caves cannot be considered a common feature and is a design element determined by the distribution of geophysical and environmental factors in the region where the respective caves are located. It is special that this feature can be identified only in the caves facing the slope of the cave monastery located in the center of the steep mountain rocks in the studied areas. Rainwater can be considered as an alternative element used to protect the walls or cave interior due to the fact that no evidence has been found that the outer roof of the cave covered the walls in any way. The other thing is to create an increasing slope here. This is confirmed by the variability of the distance between the cutting blades arranged to fit the wooden beams under the gutter and the front granite pillars. Although the water that falls on the top of the cave rock has been funneled to prevent it from entering the cave, the effect of rain on the caves in this location is also high during heavy rains and windy rains. By designing with a minimum slope, water stays on the roof for a longer time, so water enters the cave through a small space. By creating

anouter roof of the cave with a greater slope, the water that falls on the outer roof of the cave is discharged to the outer zone in a short period of time.

Cold Caves

The availability of winter caverns is further confirmed by an inscription. Because the cave is directly connected to the wind current coming from the opposite direction from the east end of the cold cave system through openings in the hill's rocky rise, the air current absorbs the cave's clay walls and keeps the interior cool. It is obvious that this study location and construction were developed with a unique grasp of the natural landscape because a similar cave system cannot be found on any other monastery grounds. However, due to the opposite direction of the face of the rocks where the caves are located, it is not possible to establish a situation with such a geographical position in the rock mass of the cave system in the Mihintalea monastery complex. These caverns are accessible through a gently incline staircase and are well-known for their location. The inter-lands of the caverns have been prepared on a filling utilizing granite, which is the unique feature of these caves. Located in a high-altitude area with a few modest slopes on contour lines 250, 260, 270, and 280.

Unique architectural features

The specialty of the cave system with the stone door is that the design remains of Inter lands of the caves and the Outer area of the cave are made ofgranite and it is clear that the Inter lands of the cave may have been built on the same rock face from the weld marks connected to the rock wall used to protect the boundary in front of the rock face.Another highlight is the granite steps and steps to access the cave system. This is a unique design feature among hermitage architectural features. The specialty of this is that the support walls on both sides connected to the stone entrance are made of granite. No bonding agent has been used in joining the rock sections and the design technique has been manipulated in such a way that there is a vertical balance to the rock plane. It is a special feature that can be discovered in the cave, Inter lands of the cave, wall factors, door factors, foundation factors, and drip factors. It was confirmed that this cave region has the distribution of 120-140-160-180-200 values according to the location of contour lines. The only two-storied cave currently recognizable from a monastery complex in Sri Lanka is located in the Rajagala archaeological site of Ampara district[13].

It is an important factor in studying the structural evolution of the entire cave. It can be recognized that the walls of the lower cave were prepared, but the evidence that the front walls of the second cave had elements is not confirmed. But it is clear that the inner wall was made with and clay in the area with the dona. A staircase is used to access the second floor where a steep topography can

[13]Karunarathna, H. H. A. (2021). A Study on the Cultural Landscape of Rajagala Monastic Complex in the Eastern Province of Sri Lanka. *Archaeology. South Asian History, Culture and Archaeology*, *1*(1), 35-49.

be identified. In the classification of caves, it can be identified as a cave with unique architectural features.

Conclusion

The efficacy of the architectural elements of the cave monasteries in the ancient Rohana state under investigation and the constructed environment could be confirmed through the research. Here, five significant architectural components were examined. Important architectural features include the plinth, gable, entrance doors and windows, steps, gutters, cold caves, and unique architectural aspects. It is obvious that the cave's design strategies were focused on establishing a comfortable spatial environment for the monks who labor and dwell in meditation because each of these design components is tied to the cave.These landscapes, which are semi-tropical with a dry climate and Remnant Mountains with plain valleys from the Vijayan series, have been given a design approach to fit them. Each design element clearly demonstrates an unbreakable connection to the built environment.

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