

DEVELOPMENT OF CLAY MATERIAL AS AN ANCIENT INSPIRATION FOR COOLING ENCLOSED SPACE FOR CONTEMPORARY SRI LANKA

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Abstract

Huge energy demand can identify in the contemporary world not only in Sri Lanka. Environment cooling is a most considerable aspect in energy consumption. The research discovers the possibility of using ancient techniques with clay material for maintain indoor thermal comfort. Clay is a material which has remote history and numerous qualities. The research is based on the 'clay' material which creates a cooling condition. When concern on the properties of clay, evaporative cooling and low heat conductivity are pair of main important properties. Clay and mud were used in civilizations which were in hot climatic regions. Sri Lanka also used clay material in various methods for traditional houses as wattle, roofing tiles and floor and domestic usage as Guruleththuwa, pinthaliya etc on maintain a cooling condition. The research investigates condition of cooling indoor space in traditional houses. It analyses data from quantitative and qualitative methods based on interviews and observations in traditional houses which were made from clay material under three climatic regions. According to investigation clay material maintain cool space in afternoon comparatively outdoor. It was a positive behaviour of clay material that contradictory adapts in indoor temperature comparatively outdoor temperature. The research investigates how effect clay properties in house envelopes for enhancing cooling effect. It reveals that the clay body can develop as a product for cooling enclosed space with value additions. This study is the initial step of the innovation to identify clay properties in building envelopes as a traditional inspiration.

Keywords: *Clay material, Design, Cooling inner space*

1. Introduction

"Sri Lanka is a tropical country with 28-30 °C average temperature. It is quite hot, and some month's temperature goes beyond 33°C. Hence, air-conditioning is desperate need in countries like Sri Lanka." (Wickramasinghe, 2014) According to Sri Lanka Sustainable Energy Authority most of units of energy consumed for cooling the environment. Electric methods like fans, intercoolers and mostly air conditioners obtain highest energy consumption in domestic context. "The inefficiency of existing buildings in tropical countries especially in Sri Lanka means that large amounts of energy would be required to maintain comfortable temperatures especially with future scenarios like global warming. In this context, evaporative cooling could offer many advantages as an effective low energy consuming means for providing thermal comfort." (Arandara, Attalage, & Jayasinghe, 2010) The research investigates the possibility of ancient techniques for contemporary world as a solution for this energy crisis. Design considerations have investigated in research which are inspired by traditional clay usage.

The clay is one of material which can be used for a cooling purpose. Wattle wall, floor and the Sinhala roofing tile are the supportive clay design components used in traditional houses for cooling indoor space. Guruleththuwa, Pintathaliya and water storing clay pots also declare the possibility of cooling in clay material compose with water. The based cooling technique was evaporative cooling. "The principle underlying evaporative cooling is the fact that water must have heat applied to it to change from a liquid to a vapor. When evaporation occurs, this heat is taken from the water that remains in the liquid state, resulting in a cooler liquid" (What is evaporative cooling, 2010). Possibility of using this passive cooling system will investigates in the research as a historic inspiration.

2. Literature Review

Shelter was in the priority of needs in historic human. Though they had practiced using natural caves when they were nomadic people. But with the cultivation the traditional dwellings were made by own in specific area. Clay, wood, straw and coconut brunches were used for houses which were found around the village. Further needs were emerging in order for aught there was the idea of sheltering. They were

used to make their house components according to the respective climate changes. Although heating and natural ventilation have been given attention in the architecture of early civilizations, the visual and structural aspects have been predominated the minds of architects. (Coorme & Roberts, 1981, p. 1) Mostly they were considered on the comfortability of the dwelling they were built. They had experiment with the house form, material usage and many other ways to face their climate changes. According to Oremus, attempts to control indoor temperatures began in ancient Rome, where wealthy citizens took advantage of the remarkable aqueduct system to circulate cool water through the walls of their homes. (Oremus, 2013) Most of the ancient people were consider on keep their houses in cooling condition as well.

Sri Lanka was a country which was situated in close to equator. With the various climates in Sri Lanka they also consider on ventilation of their inner houses. The heat would probably have made such a house unliveable. However, Kandyans have incorporated in their houses certain architectural feature that would mitigate the effects of heat. (Uragoda, 2000, p. 214) Even Kandyan people were consider on the thermal comfort in their houses. Courtyard concept was one of their structural adaptation for more comfortability of indoor environment of the house.

Clay material were used in most traditional houses in Sri Lanka. And in Experience there were cool indoor environment in the traditional houses. Influence of the material of clay for this cool condition will investigate on the research.

2.1. DIVERSITY OF TRADITIONAL HOUSES IN SRI LANKA.

2.1.1 Early settlements in Sri Lanka- cave

There was a nomadic lifestyle were maintained by the earliest human in Sri Lanka. They had settled in a natural dwelling which was like stone caves. Aborigines were in Sri Lanka introduce as 'Vaddas' in here.

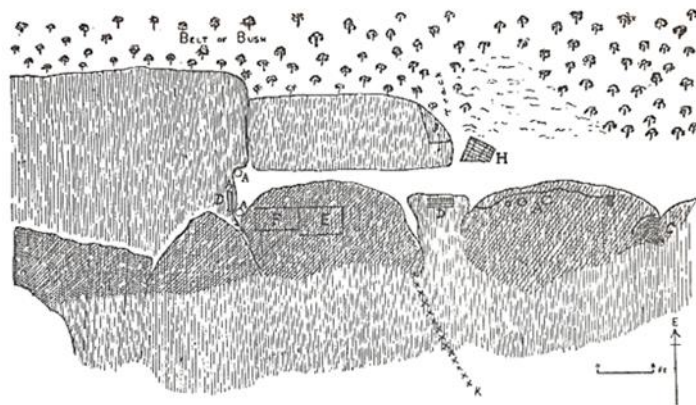


Figure 1, Plan of caves Bandiyangala (Seligman & Brenda, 1993)

The family life of the wilder Veddass centres round the rock-shelters which are truly their homes. And even among those Veddass who practice chena cultivation, but have not formed permanent settlements, these rock shelters play an important part, the movements of the community of family group from shelter to shelter being regulated according to season and available food supply. (Seligman & Brenda, 1993, p. 6) With the cultivation some of human settled as village after several years. The villagers were indeed to make their lifestyle with the farming, hunting and also with honey collecting. Gradually they had become for permanent dwell for live as a family.

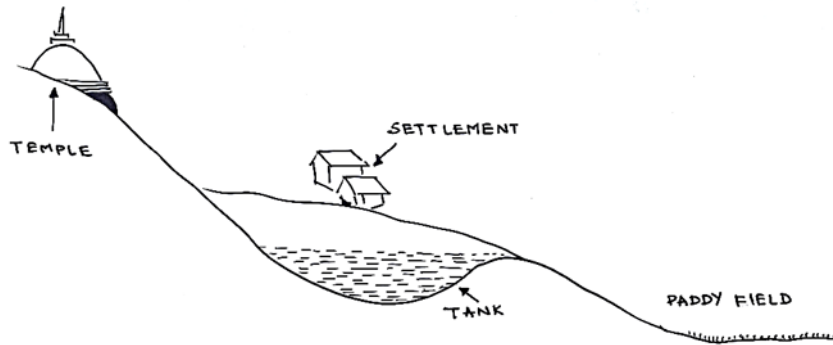


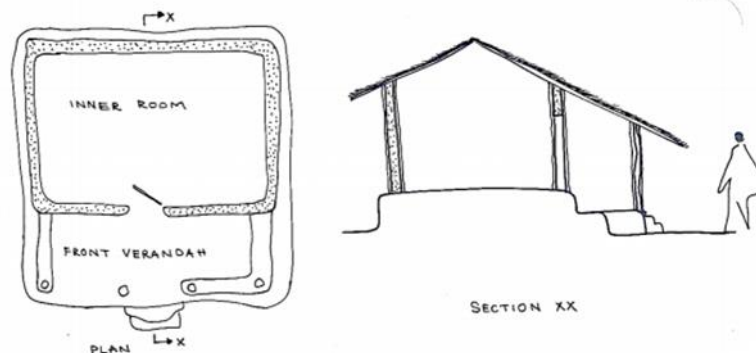
Figure 2, Gamai, Pansalai, Wewai, Dagebai (Village, temple, lake and stupa)

2.1.2 Early traditional house- In lake fed village

In early settlements of the village made as a circular pattern. There was a central square in the village common for the few individual houses named 'Gammedda'. And another open space was on rear side of these individual houses. This is the 'Tisbamba' or communal reserve of the settlement. The 'Tisbamba' is maintained with the two-fold object of sanitating the immediate living surround by compelling the use of the jungle to satisfy the needs of nature, (Brohier, 1973, p. 113)

A simple structure was in these earlier traditional houses. Inner room and the front verandah were the main components in individual house. Front verandah uses as a transition space between public and private space and multi-functional space. The verandah face to the common central square of the village. Raised plinth eaves and enclosed sides with wattle and daub half wall, called Pil kote formed the defined place for such activities. The high plinth is used as a built-in seat or a bed depending on the time of the day and specific activity. It is the workplace during the daytime and men's sleeping place during night. (Abeygunawardena, 1994, p. 40) Natural material was used as constructing material. Smoothly plastered and cow dunged, formed the floor and verandah, and projected outside the walls as a narrow ledge or outer verandah (pila) used to sleep or sit on. (Coomaraswami, 2011, p. 199) Roofing was done by the thatch. With the help of small door, the pila or front verandah gave access to the main inner room, where they had their private activities such as cooking, sleeping area for females and small children, sexual activities and storage facilities. This place was rather dark and had very small windows or small opening used only for ventilation. (Abeygunawardena, 1994, p. 41) Earlier development of the very first individual clay house is adding a rear verandah. According to undergraduate Dissertation of 'House forms and its evaluation' the rear verandah used for cooking mostly in dry zone. But kitchen was situated separately to the house in wet zone.

Type 1



Type 2

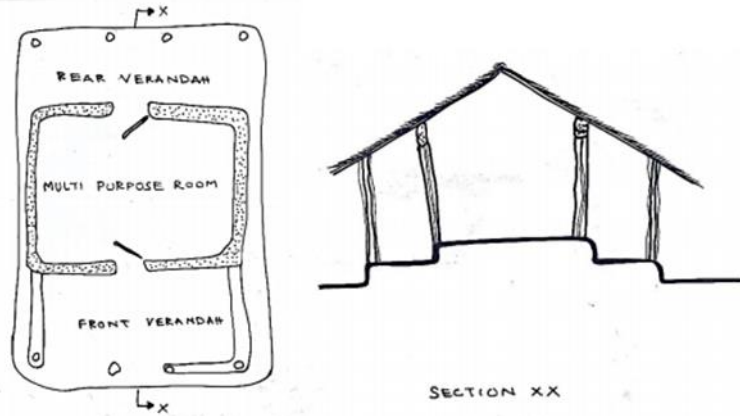


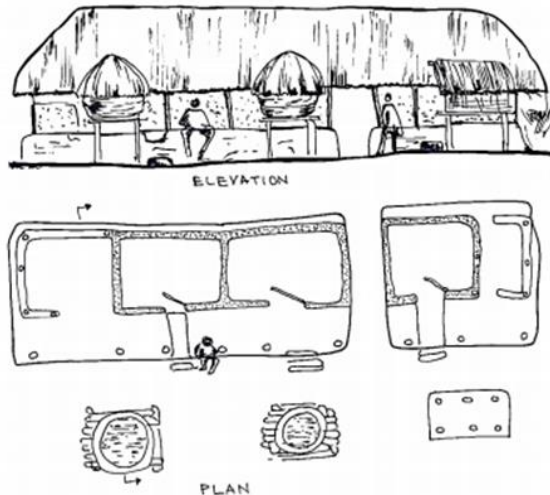
Figure 3, Early traditional house- In lake fed village Type 1,2

2.1.3. Early traditional house- in rain fed village

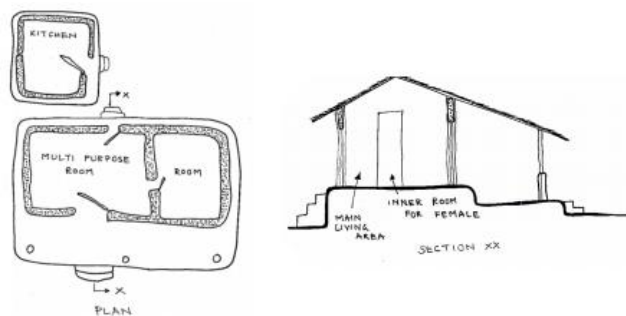
There was a difference of the traditional houses depend on the climate changes. Sometimes that deference can identify as a feeding fact of the village. The most significant difference of the tank fed village and these two-rain fed and hill country valley villages is the emergence of the individual family unit as the powerful entity of the village at the expense of the cluster of families or the community. It still consists of the front open verandah and the inner room. But sometimes this unit was larger than the genetic form with three rooms per unit. The front verandah faced the footpath. (Abeygunawardena, 1994, p. 46)

The circular pattern of the individual house settlements became to leaner pattern in the rain fed villages. There was a different housing structure in rain fed village housing. Specialty was their kitchen was located separate with the main house structure. The inner space was separate in to two parts. A room and a multi-purpose space were they. 'Wee bissa' was a common part in those all kind of houses as a separate part near the house structure. After the one room and free space structure the house form rise with a pass over the square shape. The main structure became to the 'L' shape.

Type 1



Type 2



Type 3

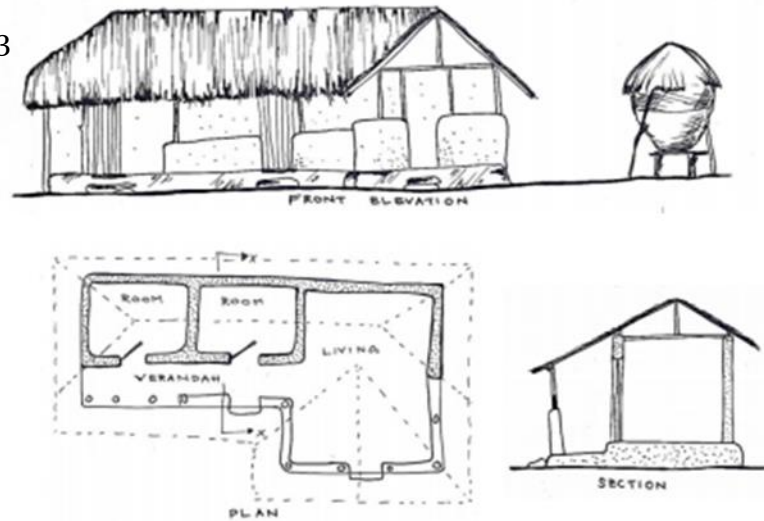


Figure 4, Early traditional house- In rain fed village Type 1,2,3

2.1.4. Kandiyani yeoman's house

The Kandiyani yeoman's house was a direct development of the traditional rural house but taking a different form. (Balachandre, 1990, p. 39) As a considerable change in traditional housing evolution in Sri Lanka was birth of courtyard inside the house. Historic courtyard buildings in warm humid climates have often being adapted for wind-induced cross ventilation other than making use of thermal mass effect. (Rajapakshe, Rajapakshe , & Rajapakshe, 2013) It was a unique characteristic mainly in hill country valley villages. This house form called Kandiyani yeoman's house form.

The kandyani yeoman's house usually consisted of two rooms and a large enclosed space which had an open sunken court in the middle. The both rooms were accessible, from the open court. The rooms were used for storage, sleeping for women and children and for cooking, while internal verandah opening into a courtyard in the middle were the men's domain. This was used for the purpose of sleeping and entertaining friends and relations during the day. The bedrooms rarely contained windows to open to outside, but to the internal courtyard (Balachandre, 1990, pp. 39-40).

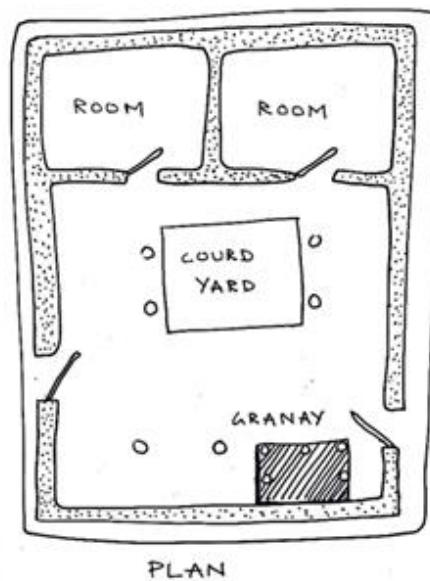


Figure 5, Kandiyani Yeoman's house

2.1.5. 'Walawwa'

'Walawwa' was another housing structure which was residence of the person who Kandyan feudal landowners or chiefs in ancient society in Sri Lanka. They were allured for somewhat comfortable housing structure. These buildings possess some points of architectural interests. The main living area centred around a courtyard open to the sky, known as meda-midula or central compound. This rectangular or square space is bounded on the four sides by a verandah on to which opened the doors of a series of small rooms that lined the sides of the space. Each room or cubicle was equipped on its exterior wall with a miniature window which served mainly as a look-out post for intruders rather than for ventilation. The absence of a door on the outer wall of the rooms was again a concession to security. (Uragoda, 2000, p. 213) Most 'walawwa' are situated in wet climate. That was the reason for central courtyard with suit with relative climate region. Thickened walls is one of considerable facts in 'walawwa'. The roof in a 'walawwa' was usually covered with what are popularly known as Sinhala tiles, which are essentially gutter-like pieces of baked clay. (Uragoda, 2000, p. 214) Sinhala roofing tiles realize better appearance and elegant look for 'Walawwa'.

As the world house form differences based on region, there was a diversity in the housing form in Sri Lanka. Sri Lankan traditional houses enhance change of human needs with their lifestyle, social background and the climate condition of region. The material they were used are natural as convenient for find around the village. Flow chart mentioned below expressed that the variation of using materials in Sri Lankan Traditional houses.

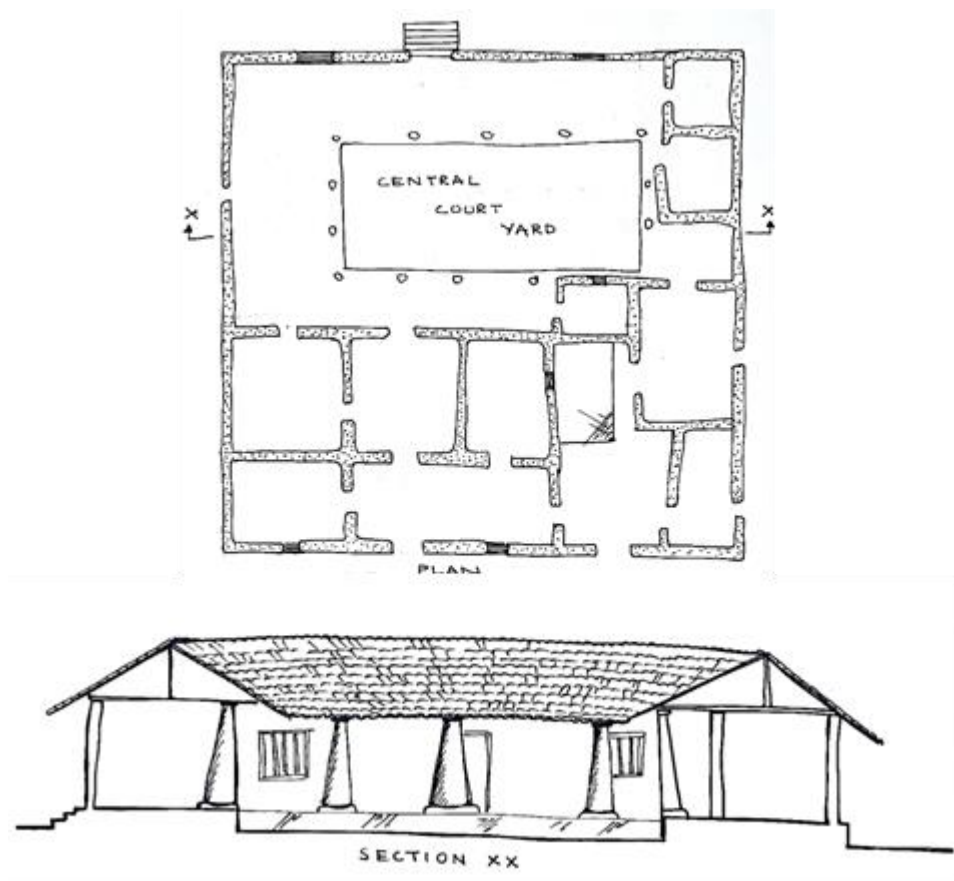


Figure 6, Walawwa

3. Methodology

As the first step research should prove the condition of cooling indoor space in traditional houses. For that the research expect to get data from interviews and observations in traditional houses which were made of clay material under three climatic regions.

The survey main considerations are wattle, Sinhala roofing tile and clay floor which are the most popular usages in Sri Lankan Traditional houses. Those cases were investigating on three climatic regions such as wet, intermediate and dry climatic zones. Material quality is the main consideration in this research. Evaporative cooling and heat conductivity are the methods which are support clay body to create cooling.

4. Results and Discussion

The investigation revealed that there was a cooling condition in inner space of the clay houses. Additionally, ventilation and the sheltering are the supportive factors for cooling indoor environment in traditional houses. Evaporative cooling condition in behave with the porosity of the material. Clay body make indoor temperature cool with this evaporation performance. Indoor humidity level increases because of that process. There can be a more efficient clay category to possible for the product design for creates cooling more than traditional ordinary clay types.

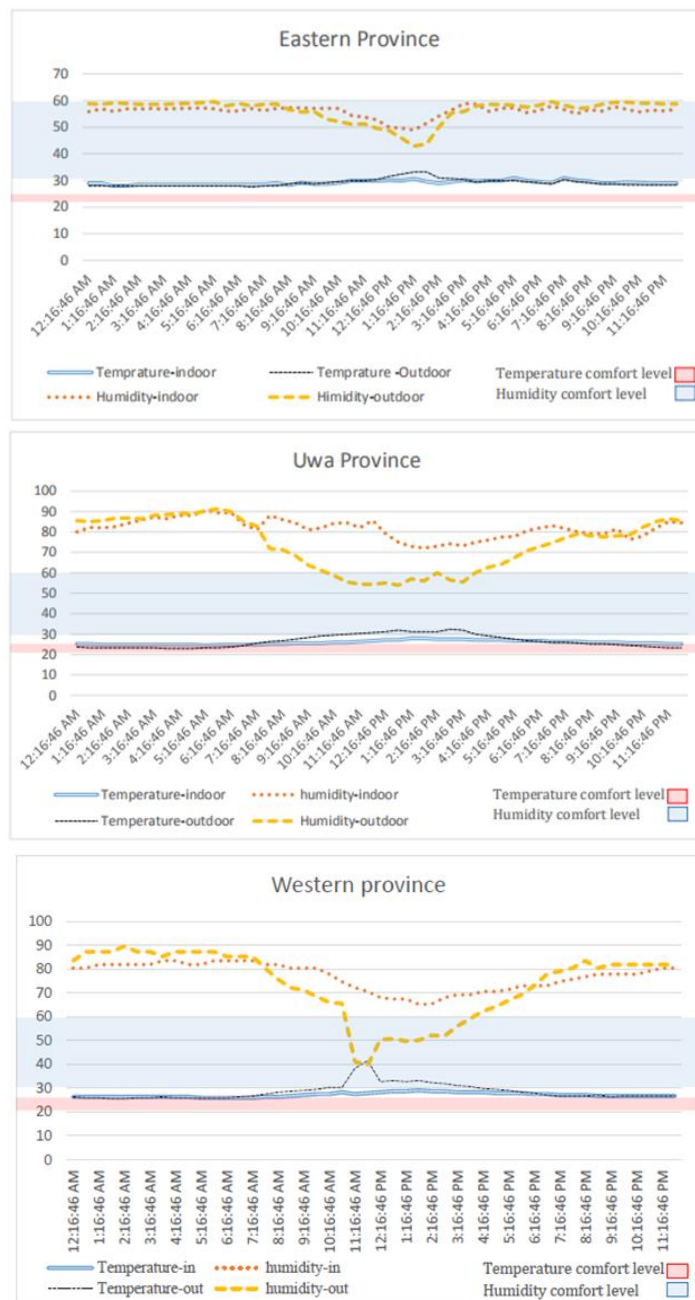


Figure 7, chart of indoor and outdoor air Temperature and Humidity in Uwa, Eastern and Western Provinces

Heat conductivity is one of unique attributes in clay material. At the daytime clay absorb heat and it emits to the indoor in night-time because of this low speed of heat conductivity. Because of that quality

clay material maintain low temperature in daytime and relative high temperature at nighttime. But it can be varying with the thickness of the clay component.

Clay material have a possibility to work as evaporative cooler for indoor cooling in enclosed space. The cooling effect can enhance with various differentiations of the clay body. Thickness, body composition, colour, surface texture, firing temperature and most of the factors can enhance the cooling property of clay body other than the weather condition and structure. The study focused on the house structures and how they affected in the various weather conditions. It is important to consider on value adding and product form for better ventilation in approach to product design.

5. Conclusion

Clay is a material which more qualities. There is a possibility on product design which creates cooling condition. Heat conductivity of the material, evaporation and the additionally ventilation are more significant fact that should concern design applications of the product design on cooling the enclosed space with clay material. The study makes a pathway for innovation in place of an initial step as a inspiration of traditional housing structures and various climatic conditions.

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