

Passive Systems of Traditional Rural Houses in Bangladesh

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ABSTRACT: Bangladesh is predominantly a rural based country. In Bangladesh like any other part of the world, traditional architecture shows its sustainability with their harmonic balance within the surrounding society and climatic environment and also with their specific characters of forms and spatial relationships. Generally the traditional rural houses are designed and formed based on the way of life of rural people, their social ethos and response to the local resources, and to the climatic elements. The climate of the Bangladesh is tropical “warm-humid”. During the summer months the temperatures are high and the sun is directly overhead. The winter months are moderately cold. The major passive system strategies of traditional rural houses in Bangladesh are the use of locally available materials having good insulation and cooling properties, cross ventilation, open court yard and surrounding vegetations which are very effective in providing thermally comfortable environment inside and outside spaces of the houses. The principle and techniques of those passive systems of traditional houses can be employed in the modern houses of the country as a step towards energy efficiency and better indoor air quality. This paper presents the passive systems of the traditional rural houses in Bangladesh with particular focus on the construction materials used based on the regional climatic condition, natural ventilation and other passive cooling techniques.

Keywords: Bangladesh, tropical climate, passive systems, rural house, ventilation, local materials

1. INTRODUCTION

It is a generally accepted idea that today's architectural activities should be environmentalist and sustainable. The most significant design input is “climate” for using sustainable energy in buildings [1]. Bangladesh is located in the tropical monsoon region and its climate is characterized by high temperature, heavy rainfall, often excessive humidity. The traditional rural houses in Bangladesh are well adapted to the climate and resources. Now-a-days, a large amount of energy is

consumed in modern buildings for air-cooling and for heating them. To minimize this energy consumption, energy effective passive systems must be used in the design of the buildings. It is obvious that there is much knowledge which we should learn from traditional architecture in the context of passive strategies for energy effective design of modern buildings. This paper mainly reviews the passive system strategies of traditional rural houses of Bangladesh in terms of the form, materials and the construction techniques that provide

comfortable thermal environment in the country's hot humid climate.

2. LOCATION AND CLIMATE OF BANGLADESH

Bangladesh is located approximately between the 20°N and 27°N latitudes and the 88°E and 93°E longitudes. It is situated within such a latitude and longitude that it has got a weather that is tropical in nature. The tropic of cancer is directly over Bangladesh.

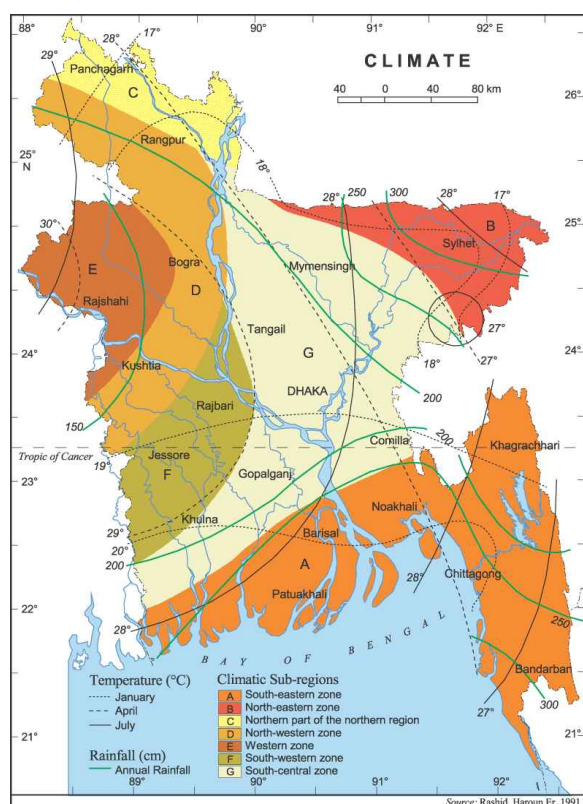


Figure 1: Climate of Bangladesh [2]

Bangladesh has a tropical monsoon climate characterized by wide seasonal variations in rainfall, high temperatures, and high humidity. Regional climatic differences in this flat country are minor. Three seasons are generally recognized: a hot, muggy summer from March to June; a hot, humid and rainy monsoon season from June to November; and a warm-hot, dry winter from December to February. In general,

maximum summer temperatures range between 38 and 41 °C. April is the hottest month in most parts of the country. January is the coolest (but still hot) month, when the average temperature for most of the country is 16-20 °C during the day and around 10°C at night. The average relative humidity for the whole year ranges from 78.1% to 70.5% with a maximum in September and a minimum in March. Regional climatic differences in this flat country are minor. Heavy rainfall is characteristic of Bangladesh. With the exception of the relatively dry western region of Rajshahi most parts of the country receive at least 2300 mm of rainfall per year. About 80 % of Bangladesh's rain falls during the monsoon season [3].

The most striking feature of its climate is the reversal of the wind circulation between summer and winter. During the winter season, a stream of cold air flows enters the country through its northeast corner by changing its course clockwise, almost right-angle. During this season, wind inside the country generally has a northerly component (flowing from north or northwest). On the other hand, during the summer season, a stream of warm and moist air from the Bay of Bengal flows toward the Bangladesh. This wind is the part of the summer monsoon circulation of the sub-continent. So, the prevailing wind direction in Bangladesh during the summer season has generally a southerly component (flowing from the south, southwest or southeast). However, wind directions during the transition seasons (in spring and autumn) are variable. Generally, winds are stronger in summer (8-16 km/hr) than in winter (3-6 km/hr) [3].

The rural house form has developed over centuries of modifications to environmental factors. An understanding of the climatic performance of the traditional house form can be based on the evaluation of its response to each individual element of climate which has a direct effect in the built form.

3. TYPES AND CONSTRUCTION OF TRADITIONAL RURAL HOUSES IN BANGLADESH

The houses of rural Bengal can be categorised into different types on the basis of enclosing materials or walls [4]. These are as follows-

3.4 Bamboo walled houses

Bamboo is used for making posts (and frames) and enclosing elements, which is called *Bera*. Sometimes timber is used for the post and making an upper horizontal floor in the room. The bamboo walls with C.I. sheet roofs are the common practice in the rural areas.



Figure 2: Bamboo wall house [5]

3.4 Mud walled house



Figure 3: Mud wall house

Many countryside areas where relatively less rainfall, dry climate and lateritic soil are found are characterised by mud walled houses. These mud walled houses are generally oblong in shape and covered with the roofs made with clay tiles, thatch or C.I. sheets. The houses with two or three levels are also made in some areas.

3.5 Timber houses

Timber houses are common in the certain part of the country such as forest and hilly areas. Generally, the houses are built on raised wooden platforms. The lower parts of the houses are used for various purposes like storage, keeping domestic animals, different family activities etc.



Figure 4: Timber wall house [5]

3.6 Timber and brick built houses

The floors, plinths and the lower parts of the walls are constructed with brick while the rest portions of the walls are constructed with bamboo reeds covered with cement or mud on the both sides. Posts are made with timber logs and roofing with C.I. sheet or thatch.

3.7 C.I. sheet built houses

It is very common to build houses (walls and roofs) with corrugated iron (C.I.) sheets. C.I. sheet was not being used as the indigenous building material in this region.



Figure 5: C.I sheet wall house

Later on, for the durability it became one of the major building materials in local tradition. C.I. sheets are providing protection against rain and dampness of the weather.

3.8 Thatched/straw walled houses

In the rural areas houses are very common characterised by thatch walls, where straw, long grass, jute sticks and thatch are available and cheap. Those materials are also used for roofing purposes except jute sticks.



Figure 6: Thatch wall house [5]

4. METHODS AND STRATEGIES USED AS PASSIVE SYSTEMS IN RURAL HOUSES

Traditional rural houses in Bangladesh have achieved comfortable thermal

environment in the hot humid climates through different passive strategies.

4.1 Building materials

Rural houses are mainly made of indigenous materials locally available, such as, straw, grass, jute stick, Golpata (*Nipa fruticans*), Son [Shon] grass (*Imperata arundinacea*), bamboo, mud and CI sheets. Different combinations of them make the main type. Those materials can take advantage or provide comfort in hot summer and even in cold winter. Such as thatch wherever used as roofing materials is laid out in layers and is itself a good insulator. A thatched roof ensures a house cool in summer and warm in winter.

Houses constructed by mud is not only economically viable, it results in pleasant and energy efficient houses. Mud walls provide good thermal mass, which helps to keep indoor temperature stable and maintain comfort conditions inside both in summer and winter.

Bamboo mat walls have pores in them and can “breathe” keeping the interior cool. The colour of mud and bamboo construction is dull and because no colour is used on the surfaces there is no glare reflected from the houses itself.

Wood is an excellent thermal insulator. Wood contains a high proportion of cell cavities. In dry wood, these cavities are filled with air which is one of the best known thermal insulators.

4.2 House orientation and construction techniques

A rural homestead (bari) usually consists of several one or two roomed buildings constructed separately. The reasons for it, the humid climate necessitates separate buildings to maximize cross-ventilation, more difficult to achieve in larger buildings with many rooms [6]. Structures are of one room depth and since there are usually no partitions and there is uninterrupted air flow and living spaces.

The climatic “front” of the house and a “south facing house” is the popular concept for a comfortable house in Bangladesh. Air flow during the summer months is from the south south-west direction and all living spaces in homesteads are usually oriented in that direction [7]. Some age old saying (Khanar Bachan) reflects this concern for climate: “South facing is king of rooms, East is it’s vassal, West meets the wretched ones, North belittle”[8].

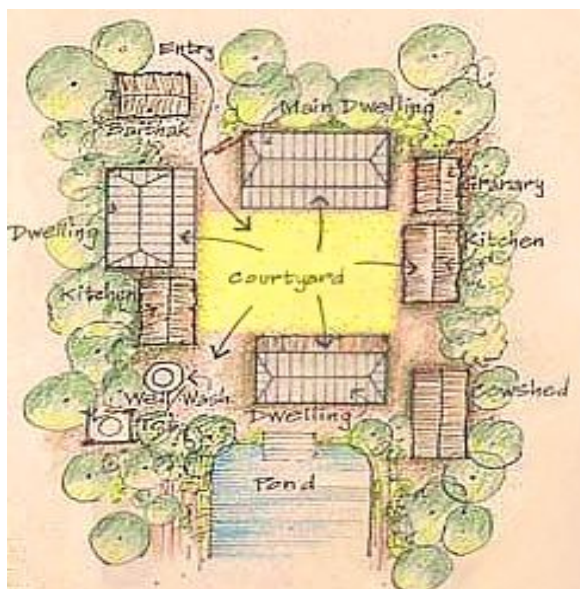


Figure 7: Orientation of houses around court yard in rural area [6]

Pond is an important part in the villages of Bangladesh. In the homesteading process, a pond is excavated to obtain soil for raising the land; a backyard pond with bathing steps (pukur ghat) can be found in many large homesteads. The pond provides for rearing ducks and fish, and for bathing. It also keeps the surrounding homestead area cool. “Ducks in the east, bamboo in the west” is another old saying that implies a pond in the east and bamboo groves in the west. Thus wind from the south and south-east cooled by the water ultimately cool the house. On the other hand, bamboo groves on the west protect the house from intense solar radiation [9].

4.3 Court yard

A typical morphological feature of the rural homestead (bari) is the arrangement of a number of closely spaced single-storied (or occasionally double-storied) one to two roomed rectangular buildings (ghors) around a square or rectangular open courtyard (uthan). There is usually a single row of buildings around a courtyard. The courtyard draws in air and ventilates the buildings facing it [6]. Open to sky courtyard, which is more suitable for hot climate has been widely practiced in a warm humid country like Bangladesh [Figure:7].

4.4 Vegetation

Perennial trees surrounding the houses are a common picture in almost all rural areas of the country. Each homestead has a fair share of trees and they provide shade to the living areas.

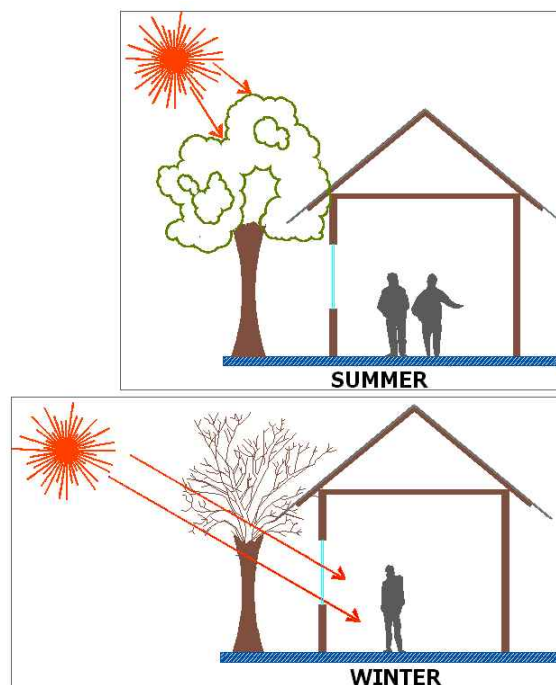


Figure 8: Shading by trees, transmission can be as low as 20% in the summer and as high as 70% in the winter

They are effective protection against solar radiation and contribute to evaporative cooling around the house. In many

homestead specially in open areas trees are planted on east and west sides to block the rising and setting sun. People often trim the trees in winter to allow low winter sun rays and heats inside the houses. However in the summer, trees block the high summer sun very effectively by their grown branches. Some times special type of trees (e.g. Nim tree) are planted beside the houses which lose their leaves during winter and allow sun light and heat to fall on the roof, thus the house keeps on heated and comfortable. Vegetation also helps direct air flow. Some homestead areas have a row of trees planted in its north side for protection against cold northern winds during winter.

4.5 Veranda and overhang

The front of the traditional house usually has a full-length or partial veranda. The verandas serve as a transition space between inside and outside. Use of verandas on the longer sides of the house protects the walls from the heat and rain. They produce deep shadows on the wall surface thus keeping them cool. Generally roof overhangs and sunshades over the windows are made in the rural houses.

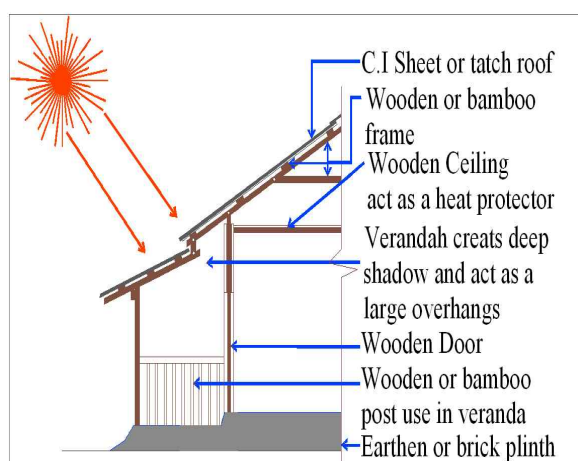


Figure 9: Veranda acts as overhang and produce deep shadow.

In the winter, overhangs allow the low winter sun to enter south facing windows. In

the summer, the overhangs block the higher sun.

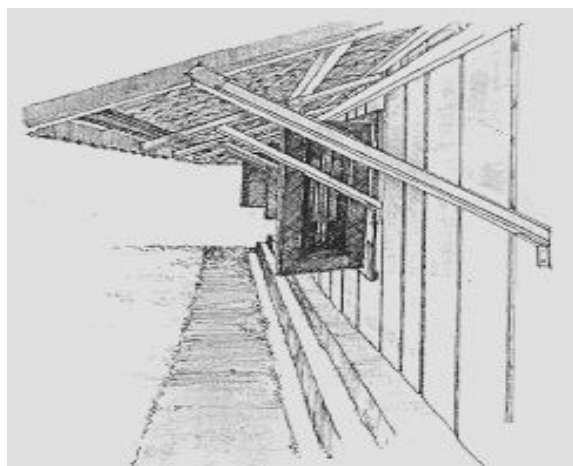


Figure 10: Overhang on the window

4.6 Ceiling

In the traditional houses, roofs are pitched and high with wooden plank or bamboo mat ceiling at a lower level. The space between the roof and the ceiling produces an air gap between the roof surface and the room, and prevents the heat gain of the roof from reaching the interior spaces [7]. People also use this upper space for storage. It is almost a common practice in CI sheet roof house to protect heat. It acts as a thermal buffer both in hot and cold seasons. Sometimes small openings are kept in this upper space for cross ventilation.

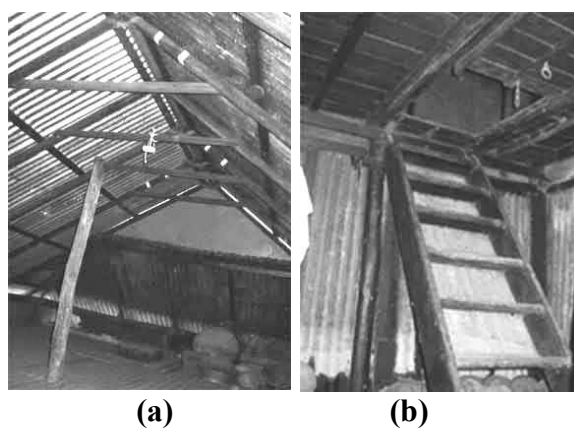


Figure 11: (a) Frame work of roof in upper space (b) Access of ceiling from main dwelling.

4.7 Ventilation

In the rural houses, windows are generally kept on the north and south side of the room, thus cross ventilation is obtained causing airflow across the space.

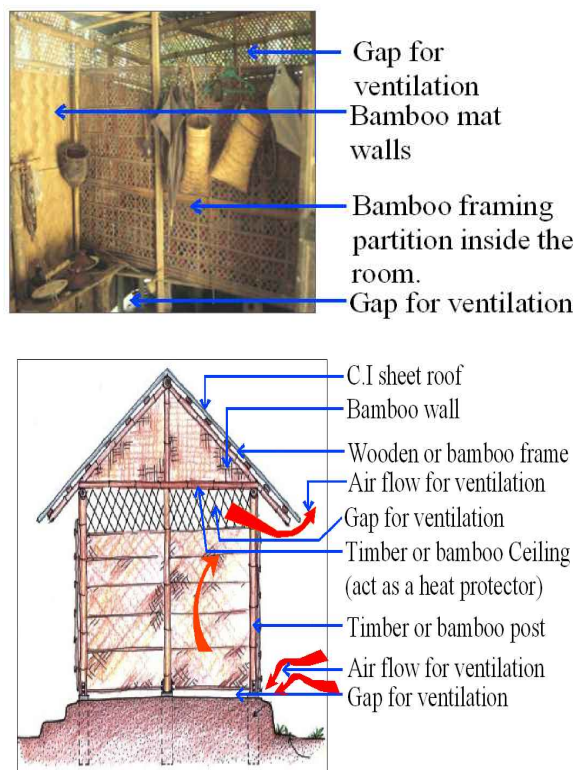


Figure 12: Ventilation systems use in bamboo house

Generally there kept a small gap between wall bottom and floor (foundation), and also another gap (ventilation) is kept between roof and walls in CI sheet and bamboo houses. These lower and upper gaps create an air movement and give cool environment inside the house.

The body level is the most vital area for ventilation for comfort. The traditional rural house allows ventilation at the body level by having many windows and doors at body level.

5. CONCLUSION

The traditional houses in Bangladesh have been developed and adapted in the hot, humid climatic environment with various types of local construction materials and construction techniques which create a very comfortable environment for living. This paper has tried to introduce passive strategies experiences from traditional houses that can provide useful references to the contemporary architectural design practices for regions under similar climatic condition. A deep understanding and implementation of the passive techniques of the traditional house form by the architects can contribute to create a sustainable architecture in the modern houses in Bangladesh.

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