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THE COMPARISON BETWEEN THE THERMAL PERFORMANCE OF A CONTEMPORARY HOUSE AND TRADITIONAL HOUSE IN THE DENSE DHAKA CITY IN BANGLADESH

A field study was conducted at Dhaka city in Bangladesh

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ABSTRACT

Bangladesh Traditional houses (B.T.H) which are located in warm humid tropical climate represent a unique phenomenon with device capable to meet the comfort demand through environmental well adapted design. Recently the traditional house and the contemporary design house (C.D.H) for Bangladesh are examined by comparing the thermal performance within the same outdoor condition and the climatic region at the dense Dhaka city. This comparison is based on field measurements of thermal performance of the traditional house and the contemporary design house within the same summer period. Quantitative method is used to measure the thermal performance. The field survey was conducted using two set of thermal data loggers were installed in both selected houses to record the air temperature and relative humidity of the outdoor and indoor spaces. Data collection was carried out for the hot and wet month of summer period in June. The research result concluded that the traditional houses of Bangladesh provided useful indicators of appropriate architectural design response to climate, particularly in the context of purely passive environmental control. However it is required to adapt a critical approach towards the modern contemporary architectural design strategy of deriving lesson from traditional houses to extend the period of indoor thermal environment inside the contemporary houses.

Keywords: Traditional House, Contemporary House, Thermal Performance, Indoor Environment, Comfort, Bangladesh.

INTRODUCTION

Housing has been changing its forms and styles throughout its history in response to socio-economic forces as well as climatic conditions and geographic locations of Bangladesh. Settlements in Bangladesh territory initially took place in the highlands of southeastern areas covered with forestations that gave natural protection from ../../AppData/Local/PHD worksall/Conferencecapksuconf/selected/Content HTF_ 0103.HTM floods, tides of the rivers, sea and cyclones. Gradually, with increase in population the settlements have spread throughout the areas. The growth of population ultimately came out as the single major factor for spreading the settlements all over Bengal, which almost entirely remained rural until the close of the 17th century. Vernacular is not only a unique and a special approach to the building (Nur, 2006). The Dhaka city now accommodates nearly 6 million people (Population Census 2006) on an area of 815 square kilometers. The above two number indicate density of about 8251 persons per square kilometer. Traditional houses are influenced by the local available materials, climate depended and economic ability of the people (laksmi, 2006). According to the comfort demand, most of the time traditional houses are designed by the owners (Rumana, 2007). In Bangladesh urban development is currently threatening to the traditional houses almost total destruction. On the other hand, contemporary designed house which are characterless, thermally inefficient and expensive to run, are replacing traditional houses which are light weight, cool, made of renewable materials and able to be built largely by sweat equity. Modern housing has been criticized for its lack of response to the local environment (Mehdi, 2006). In many traditional buildings, both primitive and vernacular, some ingenious solutions to the architectural problems of resisting extremes of weather and maintaining comfortable indoor climate can be seen (Sangkertadi, 2008). The natural material is good for health and optimization for environmental design of building (FX Teddy, 2006). Comparative study reveals the inner logic from the vernacular precedent (Cai Hui, 2006). From history it has been shown that the owner of the traditional house are changing and rebuilding the design of traditional houses deserve its ability to maintain comfortable

conditions for longer periods than the contemporary houses (Kevin mecartery, 2006). So it is essential for designers of Bangladesh to take some sensitive approach to solve this problem with appropriate formal solution for future environment of the contemporary design houses.

Research Questions

Does the B.T.H. provide indoor thermal comfort environment better than the C.D.H. in the context of dense Dhaka city in summer season?

Aim and Objective

The aim of the study is to investigate the thermal performance of both B.T.H. and C.D.H. in Bangladesh in the same area within the same context of uncomfortable dense surroundings of Dhaka city with the following objective,

1. To study the thermal performance of B.T.H. and C.D.H. in Bangladesh.
2. To evaluate the comparative study of effectiveness of indoor comfort environment between B.T.H. verse C.D.H. in Bangladesh.

Scope

This research attempts to examine the hidden process of B.T.H. adaptation through a comparative analysis on the B.T.H. and C.D.H. in Bangladesh in the same surrounding condition. Through this comparative study of these two types of houses, it is intended to find out what kind of knowledge is adapted into this both type of house and how the different adaptation processes are reflected in their final design performance. Hence this research attempts to look for explanation of such unknown process of B.T.H precedent adaptation in design which is important to create an inspiration for C.D.H. in future.

Significance of Research

The most important contribution of the study is that it reveals the inner logics from the traditional precedent to the design product in terms of indoor comfort. The analysis of the interrelationship between the performance and operation can help to understand the transference of the factors which controlling heredity of the indoor comfort environment.

CLIMATE OF BANGLADESH

In terms of ecological region or biomes described by UNESCO (Lean 1990) Bangladesh, lying between 20º34′ N to 26º33′ N and 88º 01′E to 92º 41′E, is in the Indo-Malayan Realm. Classifications, such as Terjung and Maunder's Human Climatic Index, based on 13 climate features (Houghton, 1985) or a simpler classification by Atkinson, based on air temperature and relative humidity (Koenigsberger, 1973), address the issue of comfort in the context of a regional climate.

The climate of Bangladesh, based on the widely used classification by Atkinson (Koenigsberger, 1973), is categorized as warm-humid. Generally the climate has short and dry winters while the summer is long and wet. Although a large part of the country's land mass lie above the Tropic of Cancer, the nature of the climate being tropical is attributed to the regional geographical character. The Himalayan mountain range and Tibet Plateau being in the north causes a significant amount of rainfall (Hossain and Nooruddin, 1993; Rashid, 1991). The humidity is fairly high throughout the year and especially during the months June to September when it is often over 80%. Annual maximum temperature is 34.5ºC in summer season and minimum is 12.7ºC during winter season.

DESCRIPTION OF THE SELECTED HOUSES

In Bangladesh according to the use of materials the traditional houses are broadly divided into four types. Those are Mud house, Bamboo house, Timber house and Stilts house. Detail description are available in *"Traditional House of Bangladesh: Typology of House According to Material and Location"*- Author's another paper (Rumana, 2007). For this research the stilts house was selected.

Typically traditional stilts houses (Figure 1) are raised on timber stilts and have a floor made of split timber planks of good quality timber. Stilted house is usually prevalent in areas that are relatively better off economically, or where timber is available locally, especially if the floor and ceiling is made of timber planks and the walls are made of Corrugated Iron (C.I) sheet. So stilts houses are popular in Dhaka and suburban areas of Dhaka. The use of reinforced concrete (RC) posts as stilts is becoming common in areas with a tradition of stilted housing, substituting the typical timber and bamboo stilts.

The contemporary house, (Figure 2), is constructed with concrete structure and floors, brick walls with plaster, reinforce cement concrete roof slab (150mm thickness) without any type of insulation. The windows are single glazed. This is considered typical of contemporary design house (C.D.H) being built in all regions of Bangladesh.

Figure 1. Typical Bangladesh Traditional Stilts House

Figure 2. Typical Contemporary Design House in Bangladesh

METHODOLOGY OF RESEARCH

This research is developed through practical field measurement of the natural thermal performance of the both B.T.H. and C.D.H. in Bangladesh at the same time within same outdoor condition. Both type of house are selected from same area at the Gulshan in the Dhaka city. The distance between selected B.T.H. and C.D.H. is near about 25 meter. Quantitative method is used to measure the thermal performances. The field survey was conducted using thermal data loggers. Two sets of data loggers were installed in both selected houses to record the ambient air temperature and relative humidity of outdoor and indoor spaces. The field measurements were carried out in both houses during the same period of the hot and wet summer season in month of June. Both house orientations are same and south west corner bedroom of both houses is selected for recording the climatic variables. Any kind of mechanical ventilation is not allowed during field measurement.

The comparative thermal performance evaluate-on was made on the basis of the air temperature difference between B.T.H. and C.D.H with the outdoor ambient temperature. The evaluation of comfort conditions is based on the analyses of air temperature and relative humidity values. According to the research conducted by Mallick (1994), air temperature for comfort with no air movement and for people wearing normal summer clothing, engaged in normal household activity indoors are within the range of 24 ºC and 32 ºC and for relative humidity between 50% and 95% in still air condition, people feel comfortable even in higher humidity, which is expected response in a location where humidity is generally high for most of the years. With the introduction of airflow relative humidity up to 95% is tolerated.

RESULT OF RESEARCH

The research result is analyzed by comparing the thermal performance of B.T.H and C.D.H, is derived that the indoor air temperature in the C.D.H is too high for longer periods than the B.T.H (Figure 6). Therefore, if there is no mechanical means of controlling the internal environment, the B.T.H is more comfortable for longer periods than the C.D.H within the same outdoor condition of Dhaka city. This phenomenon is probably due to the higher cross ventilation rate in indoor, wooden elevated floor, use of all light weight materials with low time lag and well ventilated double layer roof section (Attic space), which protect the indoor living space from the direct solar radiation in B.T.H.

From the result of measurement it can be noted that thermally the B.T.H representing indoor comfort condition at 6pm to 10am is always with in comfort temperature range (24 ºC to 32 ºC) where as C.D.H offers the indoor comfort condition from 4am to 9am. The time (after 5pm) when maximum people back to home B.T.H already become comfortable. This means that the construction elements of B.T.H can respond with outdoor climate. When the outdoor air temperature is extremely higher than the indoor air temperature of B.T.H tends to be lower but in the C.D.H the indoor air temperature tends to be higher than B.T.H and outdoor air temperature.

Figure 3. Physical position of the Bangladesh Traditional House (B.D.H) and the Contemporary Design House (C.D.H) at Gulshan in Dhaka city

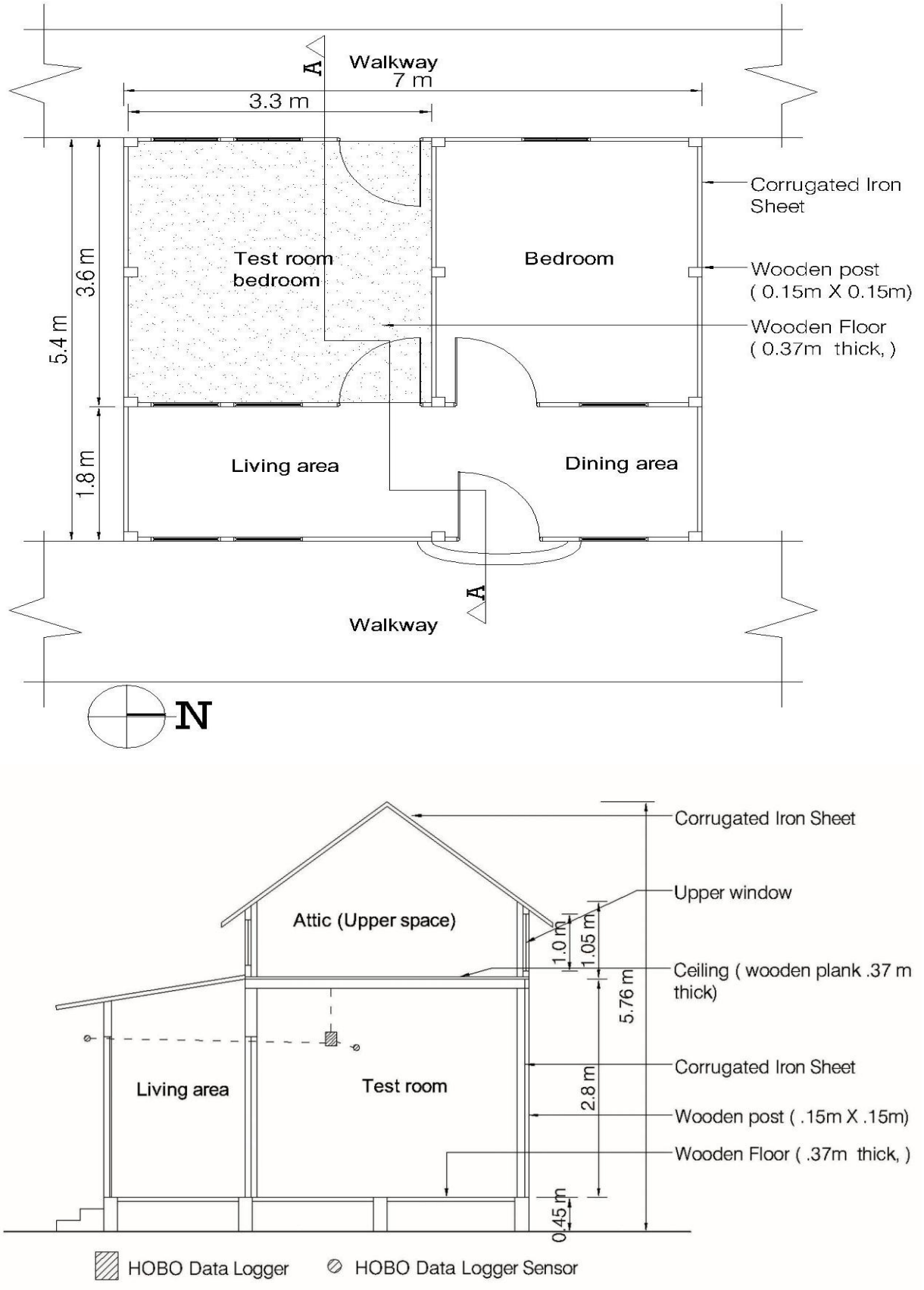

Figure 4. Plan and Section of typical traditional house and the position of thermal data loggers and sensors.

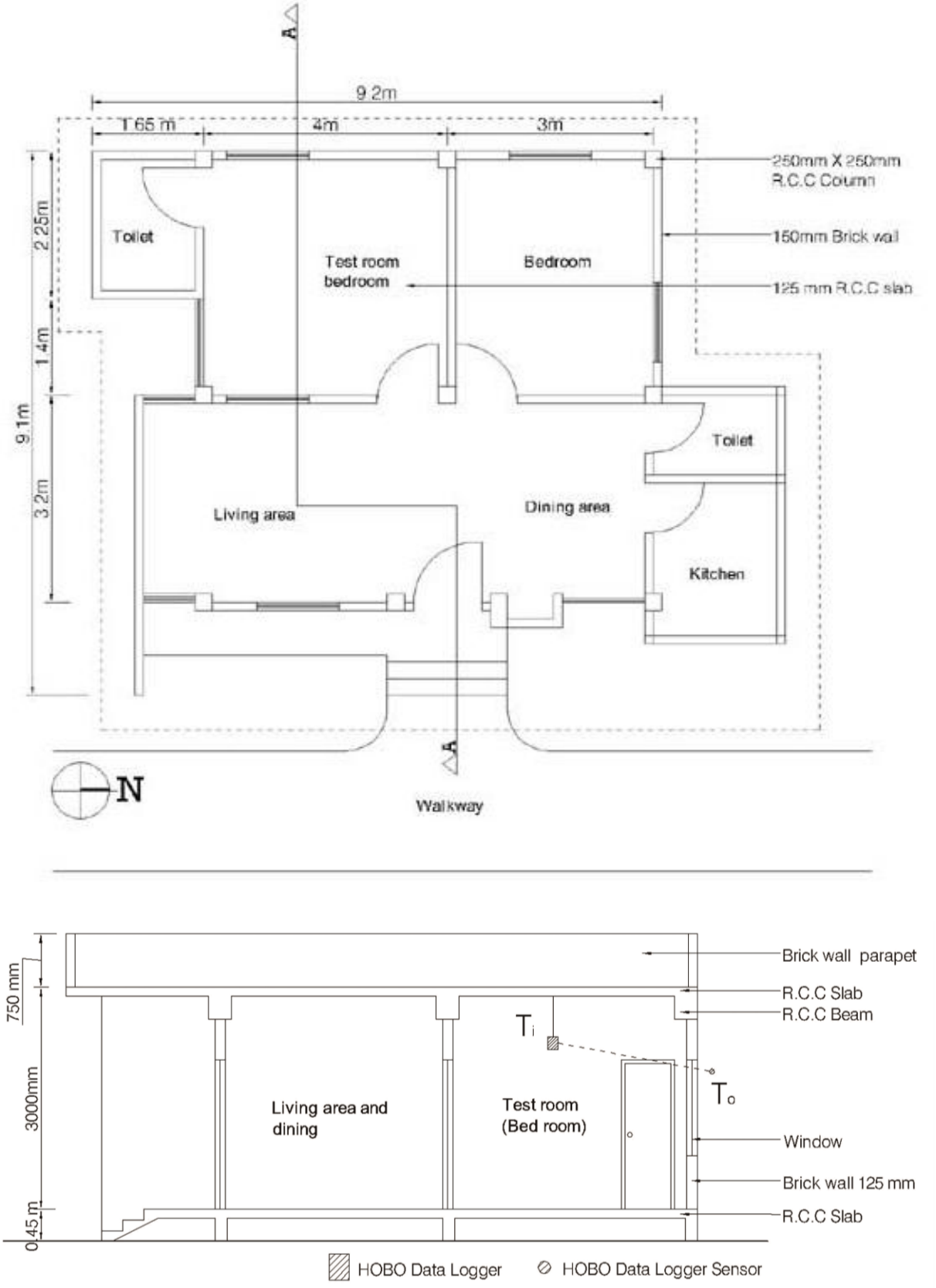

Figure 5. Plan and Section of typical contemporary designed house and the position of thermal data loggers and sensors.

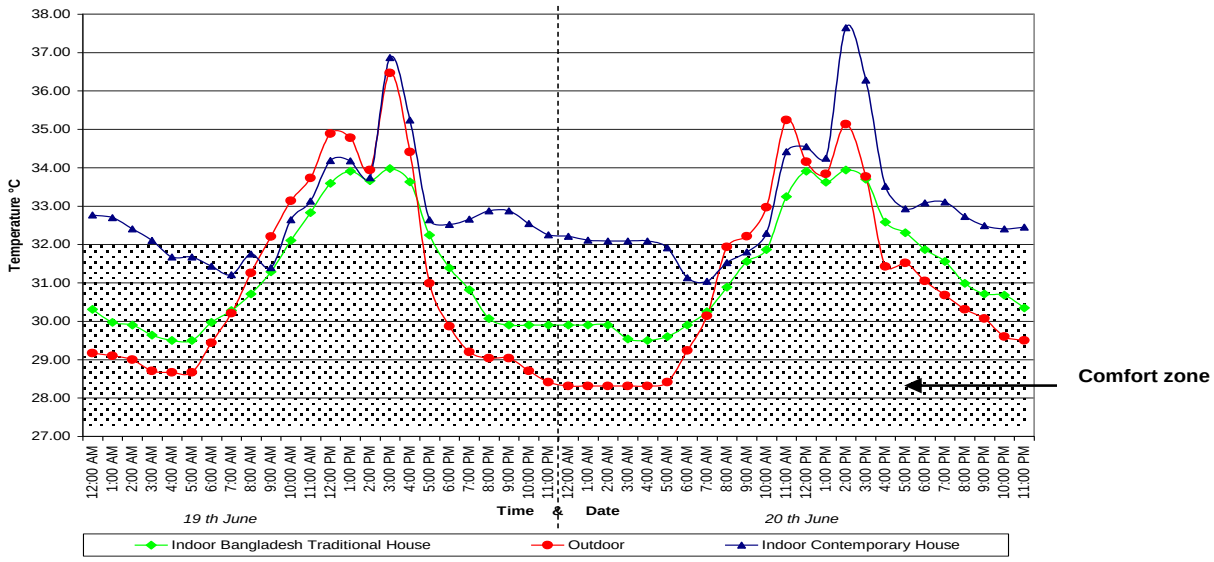

Figure 6. Profile of indoor air temperature of B.T.H and C.D.H and outdoor air temperature with comfort zone

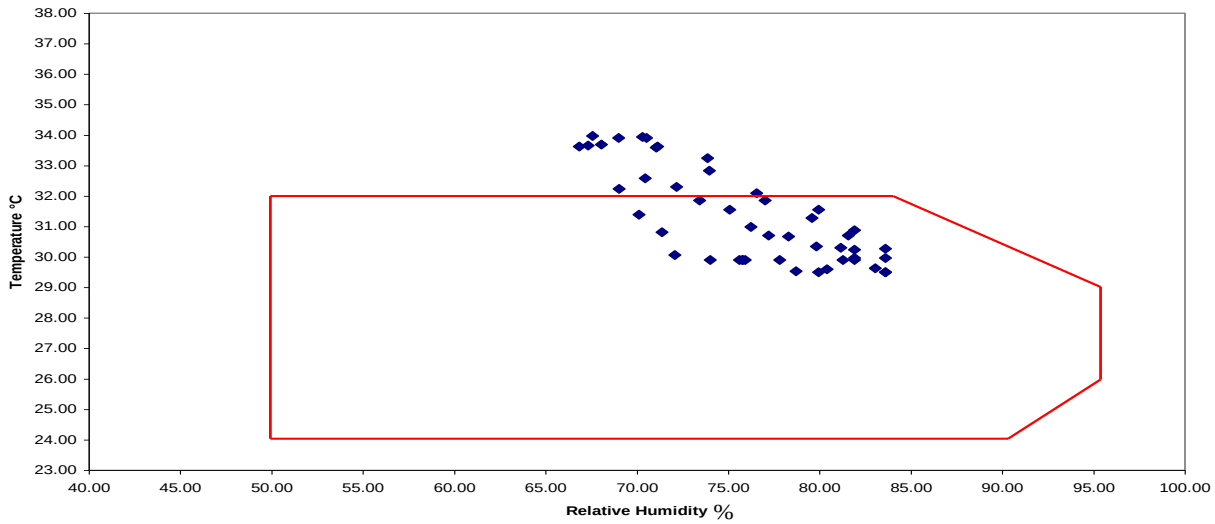

Figure 7. Plotting of the indoor air temperature and the indoor relative Humidity of B.T.H within summer comfort zone

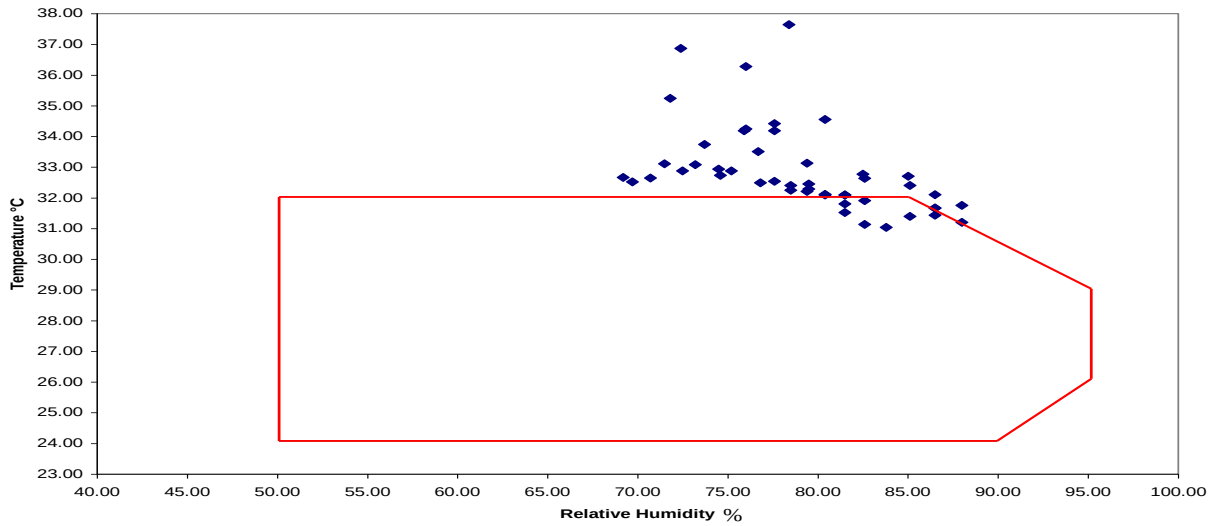

Figure 8. Plotting of the indoor air temperature and the indoor relative Humidity of C.D.H within summer comfort zone

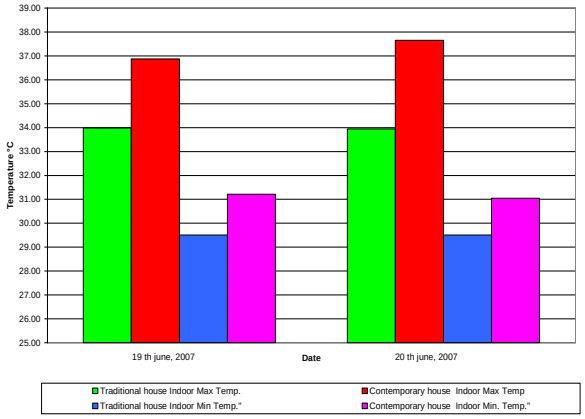

Figure 9. Profile of maximum and minimum air temperature of B.T.H and C.D.H.

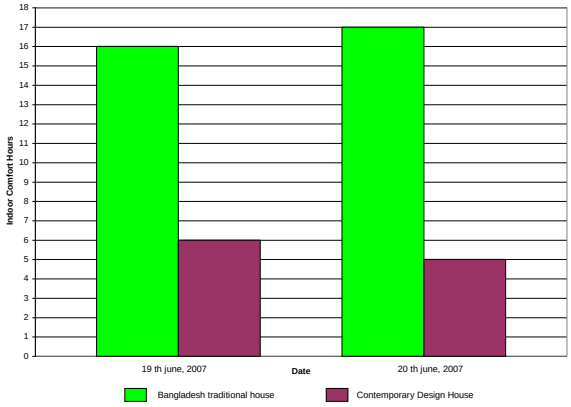

Figure 10. Profile of Indoor comfort hours in both B.T.H and C.D.H within 24 hours

From the comfort zone analysis (figure 7 & 8), it can be seen that the relationship between hourly air temperature and relative humidity with superimposing the summer comfort zone (24°C-32°C). Scatter diagram shows 71% points are inside the comfort zone in the B.T.H and only 20% points are inside the comfort zone in the C.D.H. Therefore indoor condition of the traditional house is more comfortable to live than the contemporary house.

From the figure 9, the both maximum and minimum indoor air temperature conditions of B.T.H are less high than the C.D.H indoor air temperature. The maximum indoor air temperature difference between B.T.H and C.D.H is 3K - 4K and minimum indoor air temperature difference is 1.5K-2.5K (where K= Kelvin)

According to figure 10, the thermal performance capability was indicated by longer period of thermal comfort duration in indoor of B.T.H and C.D.H and it is justified by considering the thermal comfort hours. In B.T.H the comfortable hour within 24 hours is 16 to 17 hours where as in C.D.H is 5 to 6 hours. So the B.T.H is more comfortable for longer period than the C.D.H. Comparing the thermal performance of B.T.H and C.D.H, it can be ensure that the completed Bangladesh traditional houses have an ability to provide a better thermal comfort than the contemporary designed house, within a dense surrounding environment at Dhaka city.

CONCLUSION

It can be concluded that the Bangladesh Traditional House (B.T.H) still has a better ability in providing the indoor thermal comfort for the longer period than the Contemporary Design House (C.D.H) in the same dense surroundings condition. It is proved that the condition of indoor air temperature and relative humidity for both type of house which can be categorized in comfort zone. When outdoor temperature is extremely high then the indoor temperature of B.T.H tends to be lower but in the C.D.H the indoor temperature tends to be higher than B.T.H. By keeping the originality of the B.T.H, it can contribute to provide the natural thermal comfort for occupants although the house lies in a high density environment in Dhaka city. This comparative analysis provides some evidence to support the proposition that the traditional house design is superior to the contemporary house design. So the B.T.H is indeed well adapted to the natural climate of region. It also provides useful indicator of appropriate architectural design responses to climate. However sensitive selectivity is required in deriving lessons from B.T.H in the C.D.H to extend the period of thermal comfort in indoor environment for occupants of the house. Last of all it is recommended from this research for designer that several features from B.T.H offer potential improvements to the C.D.H. This is a matter of concern because designers include design elements which can be used to make modern houses more efficient and sustainable. Many designers attempt to adapt traditional features to C.D.H. but have had limited success because traditional house design have themselves not been clearly understood. New adapted design will not succeed unless it is based upon a deep understanding of traditional houses. It has been established which elements are worth maintaining and which elements may be disregarded. This study is deriving lesson from traditional houses is that ,the uses of design concept of traditional upper space with proper cross ventilation on the contemporary house can extent the period of indoor thermal comfort environment inside the C.D.H. It can protect the concrete flat roof from direct solar radiation which is the main source of heat gain in indoor environment.

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