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THERMAL PERFORMANCE OF CONTEMPORARY HOUSE IN THE CITY OF DHAKA

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ABSTRACT

A contemporary house located within a dense area of Dhaka, the capital city of Bangladesh was selected to evaluate its thermal performance. The study was based on the field measurements conducted during selected days in the summer period. The field survey was conducted using one set of thermal data logger installed in the selected house to record the air temperature and relative humidity of both indoor and outdoor spaces. The research result concluded that the contemporary house experienced much higher temperature during night and early morning. The indoor air temperature during the daytime was equal to the outdoor or sometime higher illustrating that it was overheating. On the other hand, previous study on traditional house within the same area showed that indoor air temperature was lower than outdoor air temperature, something that the contemporary house failed to achieve.

Keywords: Contemporary House, Thermal Performance, Indoor Environment, Thermal Comfort

INTRODUCTION

Dhaka city is now accommodating nearly 6 million people on an area of 815 square kilometers (Population Census 2006). The figures illustrate density of about 8251 persons per square kilometer. Housing in Dhaka is in developing stage now where contemporary design is fast replacing traditional one. However, many feel that the contemporary house design is unsuitable to climate of Dhaka. User response often point to inadequate climatic performance and perceived waste of space (Rashid, 1991; Ahmed, 1990).

Traditional houses in Bangladesh are influenced by the local available materials, climate depended and economic ability of the people (Rumana, 2007). Thermal performance study of the Bangladesh traditional house shows that the indoor environment is comfortable during both summer and winter period (Rumana and Mohd Hamdan 2007). On the other hand, contemporary designed houses are characterless, thermally inefficient and expensive to run and they are now rapidly replacing the traditional houses built in cool, lightweight, renewable materials and largely built by sweat equity (Kevin, 2006).

AIMS AND OBJECTIVE

This study on a selected single storey reinforced cement concrete (R.C.C) post and beam structural system contemporary house in Dhaka is used to illustrate the typical resultant indoor thermal environment. The aim of the study is to investigate the thermal performance of contemporary house design in Bangladesh within the City of Dhaka during summer season. The objective is to illustrate the resultant thermal performance of the contemporary house and indirectly inform the contemporary designer to be aware of the unsuitability of the typical modern solution in providing good thermal comfort environment.

BACKGROUND STUDY

Climate of Bangladesh and the City of Dhaka

Bangladesh lies between 20º 34′ N to 26º 33′ N and 88º 01′ E to 92º 41′ E, and is in the Indo-Malayan Realm. The climate of Bangladesh if based on the widely used classification by Atkinson (Koenigsberger, 1973) is categorized as warm-humid.

Generally the climate has short and dry winter 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 of June to September when it is often over 80%. Annual maximum temperature is 34.5°C in summer season and minimum is 12.7°C during winter season.

Description of the Selected Contemporary Houses

The contemporary house construction system in Bangladesh has brick wall structure and reinforce cement concrete (R.C.C) post and beam structure. Brick wall load bearing structure has its limitation. The highest possible structure is up to five floors with limited size of opening allowed, but not suitable for flood and risky during earthquake. On the other hand, R.C.C post and beam structure has no limitation in construction and easy to construct. For this reason, concrete post and beam type of contemporary house design is most popular and being built in all regions of Bangladesh thus influenced the selection of this type of contemporary house in this study.

Figure 1 shows the selected contemporary house constructed with R.C.C structure and floor, brick walls with plaster, and reinforced cement concrete roof slab (150mm thickness) without any type of insulation.

Figure 1. Typical Contemporary Design House in Bangladesh.

The windows are single glazed. This is considered typical of contemporary house design being built in all regions of Bangladesh. In comparison figure 2 illustrates typical traditional house raised on timber stilts. While figure 3 shows the close proximity between the two types of houses within highly dense area of the city.

Figure 2. Typical Bangladesh Traditional House.

Figure 3. Physical position of the Bangladesh Traditional House (B.D.H) and the Contemporary Design House (C.D.H).

METHODOLOGY

This research is developed through a practical field measurement of the selected contemporary house in Dhaka, Bangladesh. The resultant indoor thermal environment is compared with measured outdoor condition. The survey was conducted using thermal data logger (HOBO Data Logger). Figure 4 illustrates the installation of the data loggers.

One data logger (Ti) was installed above 2m height from floor level in the master bedroom of the selected house to record the ambient air temperature and relative humidity of the indoor. One sensor (To) was installed above 2.5m from ground level under the sun-shade of the window in the outdoor to record the outdoor ambient air temperature and relative humidity. The field measurement was carried out during the hot and wet summer season in the period

of the third (3rd) June to the twenty-fifth (25th) June in the year of 2007.

The comparative thermal performance evaluation was made on the basis of the air temperature difference between contemporary house and the outdoor ambient air temperature.

According to research conducted by Mallick (1994), air temperature for comfort without air movement and for people wearing normal summer clothing engaged in normal household activity indoors were within the range of 24 ºC and 32 °C. Further, he suggested that the relative humidity

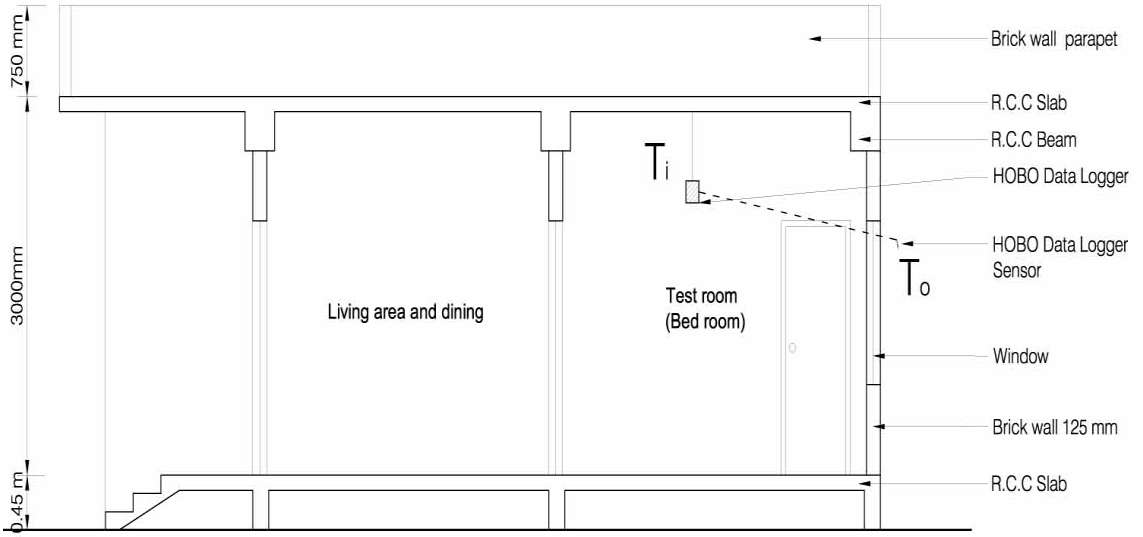

Figure 4. Section of typical contemporary designed house and the position of data logger and sensor.

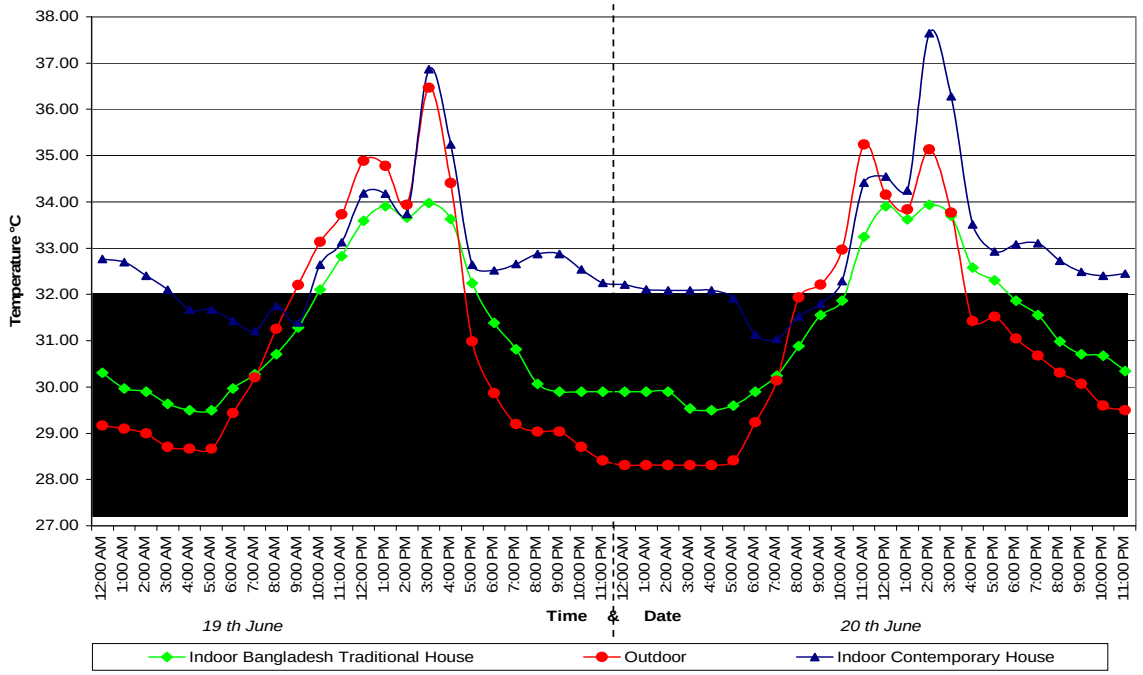

Figure 5: Profile of indoor air temperature of B.T.H (taken from Rumana, (2008)) and C.D.H compare to outdoor air temperature with identified comfort zone.

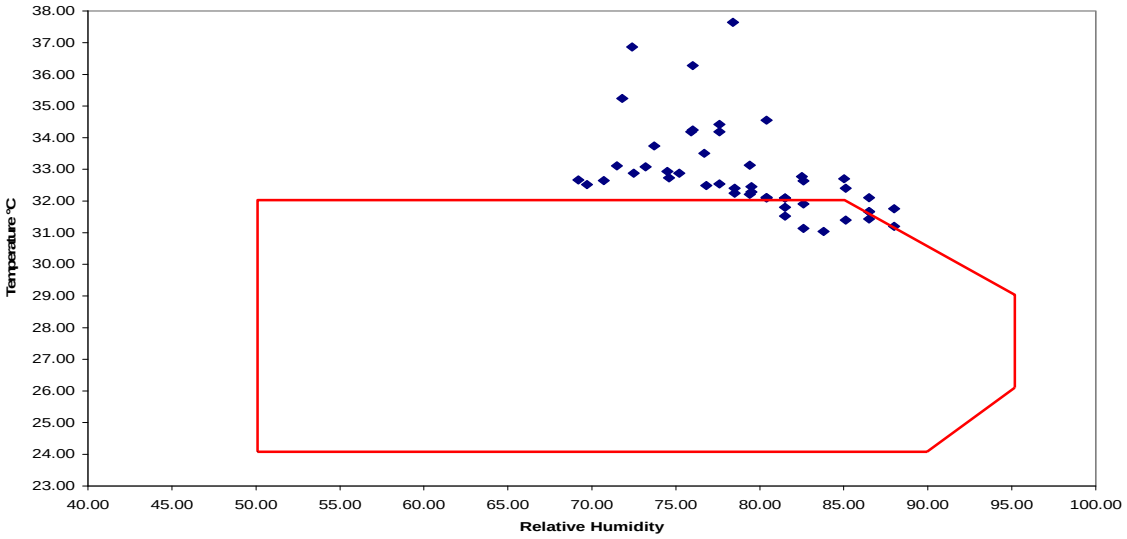

Figure 6. Plotting of the indoor space temperature and the indoor relative Humidity of C.D.H within summer comfort zone.

should be from 50% to 95%. In still air condition, people would feel comfortable even in higher humidity, which is an expected response in a location like Dhaka where humidity is generally high for most of the year.

RESULT S AND FINDING

Temperature in the contemporary house is high especially during the day and the heat is retained at night resulting in high temperature above the outside air temperature (Figure 5). Therefore, if there is no mechanical means of controlling the internal environment, the contemporary house will not be able to achieve the appropriate thermal comfort suggested by Mallick (1994). If we compare to the result of the measurement in traditional house (using previous data from Rumana, 2008) the traditional house perform much better (see also figure 5). This is probably due to the higher passive cross ventilation rate indoor, assisted by wooden elevated floor, use of tall lightweight materials with low time lag and well-ventilated double layer roof section (or attic) which protect the indoor space from the direct solar radiation.

From the result of measurement, it can also be noted that thermally, the contemporary house is always hotter throughout the day than the traditional house. Scatter diagram (figure 6) for contemporary house shows that only 20% of the scattered points are inside the comfort zone.

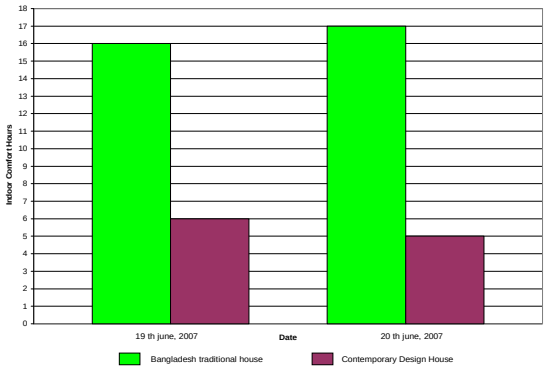

Figure 7. Profile of Indoor comfort hours in both B.T.H and C.D.H within 24 hours.

The thermal performance capability was indicated by longer period of thermal comfort duration indoor. The duration for comfort in the contemporary house is shorter than the traditional house. The contemporary house is only comfortable for 5 to 6 hours (midnight and early morning) while the traditional house is comfortable for 16 to 17 hours in a day (figure 7).

CONCLUSION

It can be concluded that the Bangladesh contemporary house design is thermally inefficient and more expensive to run. It is experiencing higher temperature indoor through out the day. The use of heavy wall and R.C.C roof without any type of

insulation allowed heat gain and transmission through direct solar radiation during daytime. At night the heavy roof also takes time to release heat to night sky. Lack of proper cross ventilation also helps to store the heat in the indoor for longer period. Location within dense city of Dhaka will make the house more unbearable and that is why most contemporary houses have to rely on air conditioning system for achieving thermal comfort. On the other hand, the traditional houses built in cool, lightweight, renewable materials and largely built by sweat equity have better thermal performance. It is hoped that modern house designers can adopt and learn from the traditional house design and its environmental features in order to have better response to the harsher summer condition of Dhaka city and by so doing provide good thermal comfort to the occupant.

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