The role of the Architect in Producing Thermal Comfort in the context of existing conditions in Dhaka

ZEBUN NASREEN AHMED*

Abstract

The building and its elements should be properly utilised to create appropriate building-climate interactions. The end result must be the creation of more comfortable and suitable interiors than existing exteriors. The Architect during the design process is involved in taking various decisions which have a direct impact on this relationship. The approach to these problems, namely those of orientation, shading, internal planning, choice of materials, etc., is dependent on the characteristics of climate that a region is facing. The appropriate approach for Dhaka has been discussed in view of some recent research.

Whereas climatic designing is not the only consideration in the designing of buildings the proper recognition of the effects of climate on the building fabric will ultimately help the Architect to produce better environments more easily.

The achievement of comfort has always been one of the main aims of designers of buildings all over the world. The means to achieve comfort, however, may be varied for different climates, depending on the nature of the problem, i.e. whether it is hot dry, hot-humid or cold.

According to Atkinsons Climate Classification (1), Bangladesh may be placed in a zone called

* *Lecturer, Dept. of Architecture,B.U.E.T., Dhaka.*

Composite or Monsoon' climatic zone. These climates usually occur in large land masses near the tropics of Cancer and Capricorn, which are sufficiently far from the equator to experience marked seasonal variations in solar radiation and wind direction. These climates are normally said to have two distinct seasons, a hot-dry and a warm-humid season, and often a third, best described as cool-dry.

The air temperatures in shade, specified for the different seasons in this zone are found to be in remarkable agreement with the prevailing conditions in Dhaka, as seen by comparing Tables 1 and 2 .

Table 1. Shade air temperatures for Composite or Monsoon, Climate, Specified by Atkinson.

Seasons	Hot-dry	Worm-humid	Cool-dry
Dagtime mean-max	32°-43 C	27°-32 °C	upto 27 °C
Night time mean-max	21°-27°C	24°-27 °C	4°-10°C
Diurnal mean range	11-22 degC	3-6 degC	11-22 degC

Table 2 Shade air temperatures in Dhaka (2).

Seasons	Hot-dry	Warm-humid	Cool-dry
Daytime mean-max	33.6 °C	31.3 °C	26.6 °C
Night time mean-max	21.7 °C	25.4 °C	14. 6 °C
Diurnal mean range	11.9 degC	5.9 degC	12 degC

The means to produce comfort in such a climate is different for the different seasons. Thus, in the hot-dry summer, we would prefer to keep our interiors cool by keeping out the dry and dusty heated air and encourage humidification to a certain extent. In the warm-humid season, on the other hand, we would like to encourage breeze penetration into the interior, thereby supplementing cooling by evaporating the moisture ever-present on our skin surface. Dehumidification would also alleviate discomfort to a great extent.

Depending on the economic condition of the occupant of a space, comfort is achieved by employing different methods, given the same situation. Thus, the more affluent society in this country tend to resort to the use of air-coolers, while others who can afford it are satisfied with the mechanical inducement of air movement with the help of electrical fans. The common mass however depends largely on natural ventilation.

Among other things, the Architect during the design process has control over various design decisions which produce varied climatic responses in a building. The decisions involved are :

Building orientation
Window orientation
Window shading
External colour
Coordination of external-internal spaces
Choice of material

Proper manipulation of these design decisions is bound to produce comfort conditions for the occupant. Once this is done conciously, it becomes possible to achieve the maximum amount of comfort possible for a given site, within the limits set by the climate.

When the conditions are such that natural breeze penetration and radiation prevention are still not adequate in producing comfort, as is often the case in Bangladesh, one could resort to the use of artificial means only then, such as fans and air-conditioners.

But the load on the system could be considerably reduced by proper climatic designing, and thus expenditures could be brought down significantly. This would benefit not only individual owners, but its effect would also be felt on a wider sphere in a reduction of world- wide fuel consumption, which is one of the aims of all designers in this "energy-crisis" era.

Orientation

Proper building orientation is one of the features rightly emphasised from the early stages of design. Often the most coveted orientation for Dhaka, .i.e. north-south, is impossible for a given site, because of the site's geometry and orientation. Givoni's studies in the Middle East (3) show however, that often buidings inclined to the wind produce significantly better indoor air-movement/circulation patterns than buildings which face the prevailing direction of flow directly. In whatever way the architect decides to design the building, however, he should keep in mind that the end result must be an interior where thermal conditions are significantly better than the exterior.

In a recent study conducted by this author in the U.K.(4), window orientation for buildings in Dhaka was studied aiming to exclude solar radiation during the hot periods of the day. It is a known fact that southern and western walls of a building receive huge amounts of solar radiation during the course of each day in our hemisphere. When these walls are pierced by windows, direct radiation from the sun penetrates into the indoor areas, thus creating an even greater source of heat. There are two ways to avoid this, the first being the total avoidance of windows, which of course, is a total impossibility from the ventilation point of view. The other alternative is to properly shade the windows which face those parts of the sky in which the sun will pass. The sun position in the sky can be found from graphical projections of the sky for the latitude in question, among other methods.

Window shading

When a window is provided with shading, the shaded part of the window receives no direct radiation, though it continues to receive its share of diffuse radiation from the sky (5), as seen in

The shading can be internal, eg. curtains and blinds, or external, eg. horizontal overhangs, vertical fins and eggecrate, and they can be fixed or adjustable. Researchers show that external devices are much more efficient than internal ones and can eliminate more than 90% of the heating effect of incident solar radiation when properly utilised. (6)

Table 3. Dimensions and Proportions of Shading

Shading Window orientation	Horizontal over window (x window ht)	Vertical shade beside window (x window width)
North	none	0.5 on West
South	1.19	0.96 on West
East	0.7	none
West	not possible	not possible
North West	none	2.74 on West
North East	0.36	0.36 on East
South West	2.14	11.4 on West
South East	1.07	none

Table 3. shows the dimensions and proportions of external, vertical and horizontal shading devices relevant for buildings in Dhaka, calculated by the author (4), for eight directions. It is clear from the Table 3 that windows facing west in Dhaka are impossible to shade from above or the sides. These windows can be shaded by slanting louvres.

A knowledge of cloud cover of the area in question should also be kept in consideration during shading design. For the skies in Dhaka, which remain predominantly overcast from May/June to October, the sun position may not be the determining factor in shading design. In our overcast skies, glare is often a greater problem than direct solar radiation, as the overcast sky has an illuminance often exceeding 700^{0} candela /m2, where the deep blue sky may have values as low as 1700 candela/m2, according to Koenigsberger et al (7).

When glare from the overcast sky vault is the problem, any part of the visible sky will produce the glare; the higer the area visible, the greater will be the glare. In such cases the view of the sky at the horizon may be acceptable.

For situations where we are faced with clear as well overcast skies, the shading solution has to be thought out with greater care, weighing the pros and cons properly.

Another area directly under the control of the architect during the design process is the external colour of the building.

On testing the internal temperatures of buildings of various colours researchers found (7) that buildings of white exteriors keep considerably cooler than even light grey or coloured ones. Black buildings were found to be extremely heated.

Co-ordination of external-internal space

Probably the Architect is best trained in the proper planning of internal spaces and after years of experience, the manipulation of these spaces for greater thermal comfort comes naturrally and

intuitively to him. In this respect, the architectd is required to keep areas much in use properly ventilated and shielded from the sun. Along with this he must also consider the external-internal space relationship and realise its impact on the overall comport of the occupant. With this in mind, it is important to ensure that the incoming air is not unduely heated, prior to entry, by passing over heated surfaces like external pavings. This would point to the avoidance of large areas of pavings on the southern parts of the building.

Verandahs, which are semi-exterior spaces, should also be placed to cath the breeze, provide shading for the interior and the same time make pleasant seating spaces for the occupants when the need be such. Vegetation and landscaping elements can be made use of as solar shielding devices, both on external paved spaces, as well as critically exposed walls. The courtyard concept, so popular in rural housing in Bangladesh, is an excellent climate nodulator while at the same time being very sympathetic to the social customs prevalent in the area. From the thermal comport point of viewd, these spaces provide natural breeze at the same time as shade. Unfortunately space constraints in the urban scence along with changes in overall social behavior has slowly deleted this element from Dhaka's modern dwellings.

Choice of building material

In the process of decision-making concerning the choice of building materials, the concept of thermal insulation should be kept in mind. Thermal insulation is basically of two types, capacity insulation and resistance insulation.(8)

Materials with high capacity insulation, like stone, insulate chiefly by their mass; thus the thicker they are, the more effective is the resulting insulation. High thermal capacity constructions such as stone, thick walls of concrete, brick or mud, are necessarily heavy-weight constructions and are ideally suited to hot-dry climates where the temperature peaks can be modified to serve thermal needs and the times of these peaks occuring can also be chosen to suit the occupant's activities.

A material with high resistance insulation resists the entry of heat by the very nature of its structure of composition, which is light and porous with plenty of air gaps adding to the overall insulation value, such as insulating timber boards, aerected or light- weight concrete, etc.

Low thermal capacity constructions without insulation respond very readily to external temperature changes (9) and tend to equalise the outdoor-indoor temdperature variation at a rapid rate. Whereas this characteristic may not pose any significant problem during our rainy season, when diurnal variations in temperature are negligible, it will certainly not help in creating pleasant interiors during the hot-dry cool-dry seasons.

As the buildings in Bangladesh have to weather all the three seasons it may be best to choose a material not too low in thermal capacity. 10" brick walls, fortunately appropriate for this purpose.

With small temperature different between indoor and outdoor an improvement in thermal insulation does not bring significant reduciton in the transfer of heat through the building envelope (10). This is the case in Dhaka where wide openings for air ventilation during the

humid rainy season almost equalises the indoor-outdoor temperature values. However, certain western walls and the roof, which recieve large doses of direct solar radiation, will be heated to much higher temperatures than more favourably orientated surfaces and these can be considered separately and may be provided with thermal insulation in order to create more comfortable interiors in adjacent spaces.

For those Composite climatic zones which have a short-hot-dry season, it has been suggested by Mahoney (11), that the roofing material should be light-weight and insulated. The choice of whether to use capacity heavy roofs such as thick concrete, or high insulation light roofs should be based ultimately, on comparative analysis of cost and durability along with the availability of material and technical know-how for installation.

Conclusion

The thermal limitations discussed in this paper often pose great problems for the architect an may make design freedom virtually non-existent. However, the problem exists and must be recongnised as such. The designer must consider these problems, place them in their proper perspective and take steps accordingly. Proper recognition of building-climate interaction can only help to produce better environments at reduced prices, probably one of the chief aims, that the architect is forever striving to achives.

References

1. ATKINSON, G.A., Tropical Architecture and Building Standards. conference on Tropical Architecture, 1953.
2. Meterioldogical Station of Bangladesh, Dhaka.
3. GIUONI, B., Man, Climate and Architecture; Elsevier Publishing Company, London, 1959.
4. AHMED, Z. N. ; "The Effects of Climate on the Design and Location of Windows for Buildings in Bangladesh"; M phill Thesis Octd. 1982, Shefieid, UK.
5. JONES; W. P.; Airconditioning Engineering, Third Edward Arnold Publishers Ltd, London, 1985, p 123.
6. GIUONI, B.; op cit, p 216
7. KOENIGSBERGER, O. H., IDNGERSOLL, T. G., MAYHEW, A., SZOKOLAY, S. V. Manual of Tropical housing and Building, Part one, Climate Design, Longman, London, 1974, p. 142.
8. REID D; Understanding Buildings; A Multi-disciplinary Approach;
9. EVANS, M; Housing Climate and Comfort, The Architectural press, London, 1980, p. 101
10. KOENIGSBERGER.....op cit p.142.
11. MAHONEY, C; Trends in House Design; Climate and House Design. United Nations Centre for Housing, Building and Planning.