Influence of Climate on Building Planning and Design:

Analysis of a tropical country (Nasik City)

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Abstract—*Climate to its extent has a greater impact on human life. In India as a developing country there is massive development of infrastructure, in residential as well as institutional and industrial structures. Considering the accountability of climate on these developments greater depths are focused on industrial structures but there is drastic failure in approach to climate design of residential and institutional buildings.The present paper is based on preliminary analysis of building design which focuses on the influence of climate on buildings' living environment. It is shown that performance requirements of buildings may be taken as a systematic system of evaluation of climate related data required as a background for design of buildings.The conclusion is that lack of climate specific data and its uncertainty of relevant climate parameters in itself creates a problem, and that the building sector should be itself more active in presenting its requirements of climate specific parameters to its certainty.*

Keywords-Climate; Sustainable Buildings; Comfort Factors; Evaporation; Radiation; Convection; Conduction & Basal-metabolism.

I.INTRODUCTION

Many models have been developed by researchers and practitioners in an attempt to create standard superior models of the design process of building in integration with climate. The proposed model is based on three modes of evolution; analysis- synthesis- evaluation- as depicting types of activity above three modes and are accounted for here in this paper.

As opposed to design hypothesis forward analysis i.e. analytical work which precedes the formulation of design solution. In all stages data are collected and processed to accumulate and present all information necessary for synthesis of formal solution.Integration between climate and building form blends a driving force behind this scientific process, based on science methodology. Available tools of analysis allow critical analysis of performance of building and evolution of climate approach.

Present paper discusses the analysis stage of climate with respect to building design of a tropical country, in brief facts considered are for Nasik city, being a tropical city having warm and humid climate.

II. Design aids

Design in relation to following schematic models can be organized involving various stages:

- *Forward analysis*
- *Plan development stage*
- *Element Design.*

In the synthesis of design a solution is to be produced to satisfy the psychological and social functions with respect to physical needs of inhabitants of the building. Various aspects and mandatory fields are to be studied before we begin with the design such as:

- *Topography.*
- *Climate.*
- *Economic constraints.*

III. Task of Analysis.

The design should be sound and suitable for construction as well structurally safe as per the National Building Code of India. It is difficult to give priority to any of the specific requirements and hence all the aspects are simultaneously considered for analysis of the building and its integration with climate data.

The problem at this stage involves collection of all relevant information, evaluating and developing all results for constraints thereon without disturbing the designer's freedom. The information should form an important raw source for producing a sketch design.

IV.Synthesis of information

In synthesis the range of thinking of designers is limited to consider a wide range of climate factors for the design of sustainable building simultaneously. Hence to give a focus of designers on wider aspects of climate factors the information output of a climate design should be in a comprehensible manner. The data should not be excessively detailed but should take into consideration chief aspects which influence the design in greater depths. Following stages can be considered for general output;

a. Raw material in organized manner,
b. Building performance,
c. Design justification.

When information is synthesized the hints of raw materials should form an important character in source design data. The building performance depends on standardized factors for climate design factors.

3.1. Tropical Climates

Integration of solar radiation with the atmosphere and gravitational forces, together with the distribution of land and sea masses, produces a diversified climate. Boundaries of climatic zones cannot be accurately mapped. One zone merges gradually and almost imperceptibly into the next. It is not easy to identify the zones, or transition areas between two zones, to which a particular habitation belongs. There is much seasonal variation throughout the year.

Normally Indian Tropical zones are divided into following types

a. Cold and Cloudy
b. Composite
c. Hot and dry
d. Cold and sunny
e. Warm and humid
f. Moderate

In consideration to exhibit the city of Nasik, it is located at an edge of a warm and humid climate zone and composite climate zone. Mostly for the city location the nature of climate is being described as warm and humid, also a specific feature in the region that it records lowest temperature in the state.

Humidity of the said city also remains high throughout the year due to good amount of precipitation throughout the year and nearness to the ocean and water bodies along with good amount of transpiration activities in locality. Humidity, i.e. RH, remains high throughout the year at about 70% and varies from 60% to 80%.

Precipitation is moderate throughout the year and intensifies for a period of a few months and exceeds 200mm for one month, the wettest month.

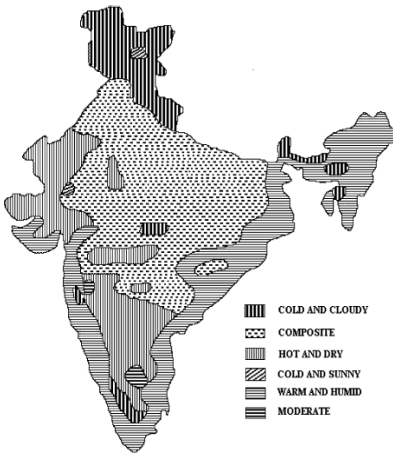

Fig. 1. Existing bio-climatic classification of India.

3.2Comfort

The task of a designer is to create the best possible indoor climate although it is not feasible to regulate out-door conditions. The occupants of buildings judge the quality of design from a physical point of view, the accumulated sensations of well-being or discomfort contribute to total verdict on houses being inhabited as it may be, school, office, factory etc.

Heat is being continuously produced by the body and the generation of such heat is utilized only at a mere percentile to be generated. Hence such heat is to be dissipated to the climate by our body in following forms: Evaporation, Radiation, Convection and Conduction. As the energy is dissipated it may be gained from other sources such as: Conduction, Convection, Radiation, Shivering, and Basal-metabolism Activity.

Acclimatization- exposed to a new set of climatic conditions, the human body will reach full adjustment in about 30 days and by that time the thermal preferences of the body will change. Age and sex may influence thermal preferences. Body Shape, Subcutaneous fat, State of health, food and drink, skin color etc. affect comfort factors.

3.3Principle of thermal Design

Principles of thermal design relates to the thermal quantities and measurements with respect to heat exchange of buildings and periodic heat flow.

Normally in building we use steel, concrete, etc. having density as 7800 and 1200 kg/m3, here the conductivity of these materials are 58 and 0.460 W/m deg C respectively.

In Convection, heat is transferred by bodily movement of a carrying medium, usually a gas or a liquid. This process is regenerating, triggered by its own, or may be energized by external media. The rate of heat transfer in convection depends on temperature difference, rate of movement of carrying mediums & specific heat of carrying medium.

In radiation the heat transfer depends on temperatures of heat emitting and receiving surfaces and on qualities of these surfaces such as remittance and absorbance. Radiation received by the surface can be partly reflected and partly absorbed in proportion of two components as coefficient of absorbance and coefficient of reflectance.

3.4 Climatic Data and analysis using Mahoney Tables

Meteorological stations publish a large amount of data. Observations by these stations are deliberately made in locations where readings are not affected by local topographical features. Unless the magnitude, importance and timing of the project permits the establishment of a site observatory, the designer must accept the data from the nearest meteorological station as depicting the regional climate. Deviations of the site climate from this are rarely large enough to affect the sketch design. Major features, if any, can be recognized and allowed for quite readily, and minor deviations can be in element stage design.

The structural engineer must base his design on extreme conditions. The architect can only base his climatic design on typical

or normal conditions. Such normal conditions are adequately defined by monthly mean minimum and maximum values.

Such data required for forward analysis using Mahoney tables for the city Nasik, in the state of Maharashtra, India, was collected from the Indian meteorological department. The data published for years is related and computed to range and average values.

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y Mean Min	.8			4	.4	.4	2	.3	.9	.5	.6	.6	.8	4	
Monthly Mean Range	19.1	19.8	20.2	17.8	15.8	10.1	5.8	6	7.9	13.2	17.4	18.5	w	AMR	

Location	Nashik
Longitude	73°50'00" E
Latitude	20°02'00" N
Altitude	565 m

Relative Humidity: %												
Average	60	62	62	69	69	78	83	82	80	72	61	60
Humidity Group	3	3	3	3	3	4	4	4	4	4	3	3

Air Temperature: °C															
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	High	AMT	
Monthly Mean Max	29.9	31.8	35.2	37.2	37.2	32.5	28	27.3	28.8	31.7	31	30.1	37.2	24	
Monthl	10	12	15	19.	21	22	22.	21	20	18	13	11	10	26.	

Rain and Wind														
Rainfall, mm	1.3	0.6	5.1	8	18.5	100.8	201.7	136.7	145	56.9	24.1	6.6	705.3	Total

Diagnosis: °C

	J	F	M	A	M	J	J	A	S	O	N	D
Monthly mean max.	29.9	31.8	35.2	37.2	37.2	32.5	28	27.3	28.8	31.7	31	30.1
Monthly mean max.	10.8	12	15	19.4	21.4	22.4	22.2	21.3	20.9	18.5	13.6	11.6
Thermal Stress: day	H	H	H	H	H	H	H	H	H	H	H	H
Indicators Night	C	O	O	O	O	H	H	H	O	O	O	C

3.4. Specifications

The recommended specifications as per the Mahoney Tables results into following values which will form an aid to sketch design, it is just an aid to logical reasoning of any designer. Recommended specifications are as follows:

- *Orientation north and south (long axis east-west)*
- *Open spacing for breeze penetration, but protection from hot and cold wind.*
- *Rooms' Single banked, permanent provision for air movement.*
- *Medium openings, 20-40; Heavy external and internal walls.*
- *Heavy roofs, over 8 h time-lag*

3.5 Conclusions

The tables are to be considered as an aid to sketch design, but this may not restrict the logical reasoning of the designer to his thinking. The above chart shows that the city lies in an arid as well as humid region.

In tables the temperature features of climate play a dominant role in deriving the conclusions the average values of the temperatures for years are taken into consideration and for Nashik city the meteorological department have published the values for last 36 years indicating its monthly mean maximum and monthly mean minimum along with monthly mean rainfall. These features have been closely examined and co-related with humidity and wind data to yield some recommendations.

The later part of elemental design involves careful planning and entrusting of each element of building so as to satisfy the climate design objective.

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