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Bio-climatic Analysis of Anantapur: An Investigation on the Design of Buildings for Human Comfort with Natural Ventilation

Dr. P. Sanjeeva Rayudu,

[1] Professor of Mechanical Engineering Department, BIT Institute of Technology, Hindupur, Andhra Pradesh, India

Abstract

The objective of this paper is to study and analyze the local climate of Anantapur, to assess the feasibility and application of natural ventilation with various related theories in providing thermal comfort conditions. Bio-climatic charts facilitate the analysis of the climate characteristics of a given location from human comfort point of view, as they present the concurrent combination of temperature and humidity at any given time on a psychrometric chart. They can also specify building design guidelines to maximize indoor comfort conditions when the building's interior is not mechanically conditioned. All such charts are structured around, and refer to the comfort zone presented by Sayigh, A., et al.. The range of conditions within which at least 80% of the people would feel comfortable, can be termed 'comfort zone' and this has been shown on the bio-climatic charts.

Keywords: *Bio-climatic, Comfort Zone, Thermal Comfort, Natural Ventilation*

1. Introduction

The relationship between Climate, Buildings (Architecture) and Comfort of People is non-linear and complexly interdependent. Climate is the average weather conditions over a long period of time for a given place. Knowledge of the climate at a given location can help the designer to build a house that filters out its adverse effects, while simultaneously allowing those which are beneficial. Hence climate plays a pivotal role in determining the design and construction of a building for thermal comfort of people.

ASHRAE [5] states that climatic design information is commonly used for design of buildings for air-conditioning as well as natural ventilation, and for other energy-related issues in residential, agricultural, commercial and industrial applications.

The Givoni's [3] bio-climatic chart predicts the indoor conditions of the building according to the outdoor prevailing conditions. The chart combines different temperature amplitude and vapour pressure of the ambient air plotted on the psychrometric chart and correlated with specific boundaries of the passive cooling techniques overlaid on the chart. These techniques include evaporative cooling, thermal mass, natural ventilation cooling and passive heating. The Olgay's bio-climatic chart, incorporate the outdoor climate of any place into building design, indicates the zones of human comfort in relation to mean ambient temperature and humidity, wind speed, solar radiation and evaporative cooling. Based on the dry bulb temperature and humidity of a place, one can locate a point on the chart and analyze the climate characteristics of a particular place. Ommid Saberi [6] summarized that Givoni and Olgyay bio-climatic models, working with pictures rather than charts, so more easily they could be used by architects although they have very rough comfort zone.

2. Climate Analysis:

The Anantapur climatic conditions for a decade, like outdoor mean temperatures, mean relative humidities of different months (summarised in Table 1), can be plotted on the bioclimatic charts and can be evaluated: the duration of months lying in the comfort zone, duration of months which require other techniques viz. natural ventilation, thermal mass, evaporative cooling and other passive cooling techniques to provide human comfort conditions.

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3. Tables and Figures

Table 1: Ten Years of Mean Wind Data for ANANTAPUR

S. No.	Month	Out door Temp. To (°C) Mean	Mean Max.	Mean Min.	Mean Range	Avg. RH (%)	Avg. Vo (m/s)	WD*	Season
1	JAN	23.5	31	16	15	48	1.3	E/NE	Winter
2	FEB	26	34	18	16	35	1.4	E/SE	
3	**MAR**	**29.3**	**37**	**21.5**	**15.5**	**38**	**1.3**	E/SE	**Summer**
4	**APR**	**31.8**	**39**	**24.5**	**14.5**	**37**	**1.6**	E/SW	
5	**MAY**	**31.8**	**38.5**	**25**	**13.5**	**43**	**3.0**	W/SW	
6	JUN	29	34.5	23.5	11	54	**4.1**	W/SW	**Monsoon**
7	JUL	28.3	33.5	23	10.5	58	**4.6**	W/SW	
8	AUG	27.3	32.5	22	10.5	59	**4.4**	W/SW	
9	SEP	27.5	32.5	22.5	10	66	2.4	W/SW	Post - Monsoon
10	OCT	26.5	31.5	21.5	10	63	1.5	W/NE	
11	NOV	24	29.5	18.5	11	63	1.2	E/NE	
12	DEC	22.8	29.5	16	13.5	57	1.0	E/NE	Winter

*Monthly Frequency Distribution of prevailing Wind Directions (WD) for the Ten years.

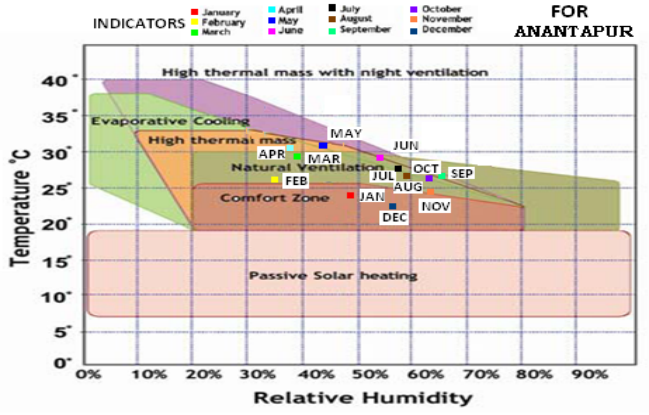

Fig. 1: Basic Bio-Climatic Chart for Anantapur

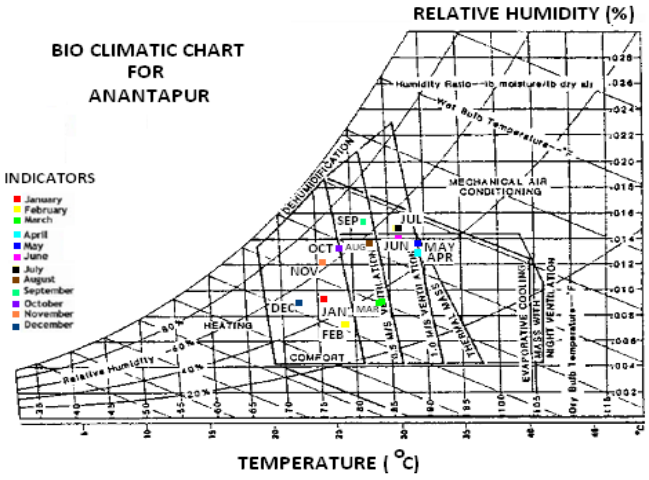

Fig. 2: Givoni's Bio-climatic Chart for Anantapur

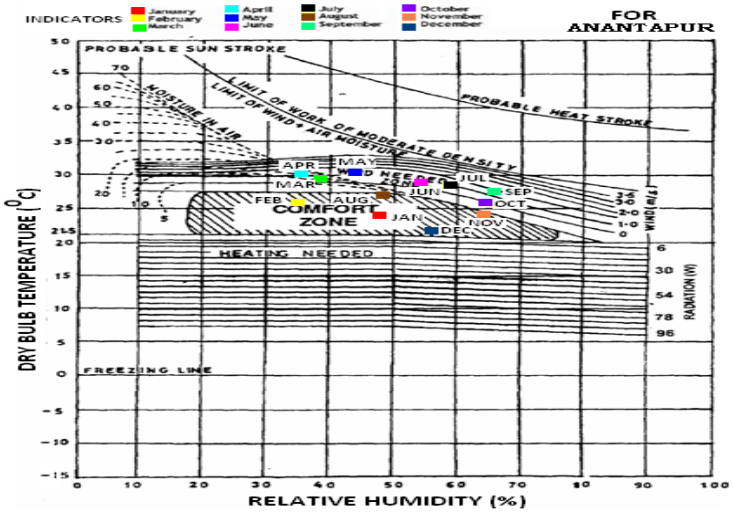

Fig. 3: Olgay's Bio-climatic Chart for Anantapur

4. Conclusions

Based on the analysis of the above Bio-climatic charts, the following design strategies can be adopted to Anantapur climate. The bio-climatic charts (Fig. 1, 2 and 3) for Anantapur climatic conditions show that the outdoor mean temperatures are already within the comfort zone during the months Nov, Dec, Jan, Feb; hence there is no need of any special treatments for thermal comfort. During the months Mar, Aug, Sept, Oct the outdoor mean temperatures are above the comfort zone, needs an air movement of 0.5m/s with natural ventilation techniques for thermal comfort. During the months Jun, Jul; the outdoor mean temperatures are above the comfort zone, needs an air movement of 1.0m/s with natural ventilation. During Apr, May months the '$T_{o,mean}$' lies above the Natural Ventilation zone, hence increased thermal mass with natural ventilation is needed by increasing the wind speed to about 1.5m/s which would bring the mean temperatures into the comfort zone. Thus Bio-climatic charts give ready information about the requirements of comfort and design decisions can be taken accordingly.

The combined effect of evaporative cooling, natural ventilation and thermal mass, produce a significance temperature drop in the peak operative temperature. If the operative temperature is still outside the comfort zone, the comfort conditions in summer or the Summer Comfort Zone for urban residences lies within temperatures of 25-30^{0}C and relative humidity of 55-90% for free-running or non air-conditioned residential buildings.

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For indoor comfort, the local climate dictates that, shading from solar radiation and cross ventilation through openings and courtyards are required for having comfort in the buildings of hot-dry climatic Anantapur. The shaded verandahs and courtyards of traditional houses or loosely arranged rural huts around a courtyard address the problems of climate quite successfully. *This work suggests that a return to the traditional environmental strategies in the modern buildings can provide a much better indoor comfort.*

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First Author Dr. P. Sanjeeva Rayudu, Qualified: B.Tech.- 1997 from SV University, M.Tech.-2003, & Ph.D.- 2011 from JNT University. Service – Teaching & Administration: Lecturer – JNT University College of Engineering, Assoc. Prof. & Professor and HOD in SV College of Engineering & Tech., Principal – PVKK Inst. Of Tech., KKIT Inst. Of Tech. & BIT Inst. Of Tech. , for overall 18 yrs., editorial board member for 6 journals, contributed 13 technical papers, attended 14 FDP programs and credited 4 National & 6 International awards, Professional Memberships – 5 professional societies.