

**BIOCLIMATIC DESIGN OF
BUILT-ENVIRONMENT FOR
NORTH-EAST INDIA**

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Certificate

This is to certify that the thesis titled “**Bioclimatic Design of Built-Environment for North-East India**” is being submitted by **Mr. Manoj Kumar Singh** to Instrument Design Development Centre, Indian Institute of Technology Delhi, for the award of the degree of **Doctor of Philosophy**. This thesis is a record of bona-fide research work carried out by him under my guidance and supervision. In my opinion, the thesis has reached the standards fulfilling the requirements of the regulations relating to the degree.

The results contained in this thesis have not been submitted to any other university or institute for the award of any degree or diploma.

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To My Parents

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Abstract

Design plays an important role in making buildings comfortable for human beings. Human beings spend most of their time in buildings. So the built environment must be designed for optimal thermal comfort to support the life and its sustainability. It is inherent in human being to always look for enhanced level of comfort. This activity leads to increase in the energy consumption of buildings directly or indirectly. In today's scenario, it becomes important or rather unavoidable to look for the building design solutions which provide the optimal comfort and consume minimum energy.

This study is carried out on North-East India to study the vernacular buildings design for the climate oriented features that can be applied to modern architecture and status of comfort in those buildings. We have classified the North-Eastern region of India at micro-climate level based on the climatic conditions in relation to the geography, in three bioclimates (*warm and humid, cool and humid and cold and cloudy*). This classification provides more specific information of each climatic zone. Bioclimatic charts are developed to estimate the potential passive design strategies for two seasons summer and winter.

We have studied vernacular architecture and different climatic oriented features as well as solar passive features available in vernacular houses of the region along with their functionality. This study tried to investigate why these traditional structures are still very popular and widely constructed. This study also identifies the functionality of these ver-

vernacular architectures and based on it three houses(one in each climatic zone) are selected for long term monitoring. Later in the study, it is found that the functionality of the houses is in harmony with socio-cultural setup and thus makes the architecture very popular.

In these three selected houses, monitoring work has been carried out in all the seasons of the year followed by comfort survey. Based on the data collected, we have done thermal performance study to find the comfort status and to define the range of comfort temperatures. Based on the data, predictive formulae has been developed to predict the indoor thermal environment. It has been also tried to incorporate behavioral factor in developing the mathematical formula. The developed formula is successfully validated with $CC > 0.9$. When detailed analysis of the data collected during comfort survey has been done, it has been found that PMV (Predicted Mean Vote calculated according to ISO 7730 standard) deviates from AMV (Actual mean vote recorded on 7 point ASHRAE sensation scale) for same thermal environment. To explain the deviation a mathematical relation has been developed to evaluate the corrective term called “adaptive coefficient (λ)”, which has been added to PMV to get $cPMV$ (Corrected Predicted Mean Vote). The value of “ λ ” may be negative or positive depending on the adaptation level of the occupants.

In the end, simulations of vernacular architecture has been carried out with the objective of designing of indoor environment for optimal human thermal comfort. Model of vernacular buildings generated in TRNSYS provides the indoor temperature variation with fair accuracy as compared to what has obtained during actual field measurements. Finally important conclusions are drawn based on the research work with a discussion on limitations and future scope of study.

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