SUSTAINABLE DESIGN APPROACHES TO ENHANCE THERMAL COMFORT OF THE CONTEMPORARY RESIDENTIAL BUILDINGS IN HUMID CLIMATES

ABSTRACT

The ozone layer depletion and the greenhouse gas emissions such as CO2, CFC, etc are some of the major concerns in today's scenario. One of the major reasons for emission is air conditioning the spaces. To reduce these emissions at a rapid pace, the air conditioning within the spaces has to be reduced. Unless and until thermal comfort is achieved, people will use the air conditioning systems. If thermal comfort is achieved by designing the spaces efficiently, air conditioning the spaces will not be needed anymore. Thus, thermal comfort can be achieved by

- designing the openings with appropriate position and sizes,
- designing the most suited shading devices for openings,
- choosing the appropriate materials for the newly constructed buildings and also by choosing the most suited materials for insulation of walls and roof in retrofit buildings
- designing the residence with courtyard and placing them on the right orientations

So, the best solution to these problems is to design the spaces in such a way that thermal comfort is achieved and maintained well within these spaces.

This project majorly deals with the thermal comfort of residential buildings in humid climates, the retrofitting and prototype design of the residential buildings with and without courtyard by determining the position and size of windows, designing the appropriate shading devices, insulating the walls and roofs, etc. The readings of DBT, WBGT, RH and VA are taken using instruments such as heat stress meter, hot wire anemometer and to analyze the readings using IMAC and questionnaire survey using SPSS software. Thus, the guidelines for a sustainable residential design are framed.

Keywords: Sustainable design, Thermal Comfort, opening and operation of windows, shading devices, U value

Abbreviations: CO2 (Carbon-di-Oxide), CFC (Chloro Fluoro Carbon), DBT (Dry Bulb Temperature), WBGT (Wet Bulb Globe Temperature), RH (Relative Humidity), VA (Velocity of Air)

AIM

To recommend sustainable design strategies to enhance thermal comfort in contemporary residential buildings in humid climates. This study focuses on the readings to be taken in dwelling units, questionnaire surveys and also on the manual calculations for finding out the most effective and suited materials for the building envelopes and roof.

RESEARCH OBJECTIVES

To analyze the existing apartment in hot humid climate in terms of openings, shading devices and insulation materials before and after retrofitting

To choose the individual villas with courtyard and without courtyard of the same scale from warm humid climate and analyze in accordance with thermal comfort

To compare the passively designed residences with the contemporary residences in terms of materials, construction technology, etc.

To frame the guidelines for a sustainable residential design by

- referring ECBC-R, SP 41 for doing manual calculations
    - to determine the opening sizes,
    - to determine the width and inclination of shading devices in different orientations,
    - to determine the U value of the buildings
- taking readings of VA, DBT, RH and comparing those with the standard values
- administering questionnaire surveys to the residents of the dwelling units

RESEARCH QUESTIONS

The following research questions will be addressed through this study.

- Will the position and size of the openings in different orientations play an important role in bringing in thermal comfort?
- Will the opening of windows for air circulation during the day/night be an effective solution? If so, should the windows be opened during the summer/ winter season? Should the windows facing the particular orientation be opened?
- Will the insulation for the building envelope be helpful to reduce the heat gain within the building? What kind of materials can be used for different scenarios? What would be the thickness of the materials used?

LIMITATIONS

- The limitation of the project is that it is focused on contemporary residential buildings in humid climates. Other climatic conditions or buildings other than the contemporary residential buildings are not within the scope of this project. Only thermal comfort parameters are focused and the other parameters are not within the scope.
- The position and size of the windows, Shading devices, materials for walls, roofs and insulation are under the major focus and no other parameters are taken into consideration.

EXPECTED OUTCOME

- To find out the most effective ways to create thermal comfort in the living spaces of apartments of Chennai in the existing setting by doing retrofitting measures such as position and size of windows, appropriate shading devices and suitable materials for the wall and roof insulation.
- To find out the effectiveness of the individual villa with courtyard in accordance with thermal comfort.
- To design a prototype model for an individual villa and apartment building focusing on the opening of windows, shading devices and materials used for construction.
- To recommend sustainable design strategies for designing a contemporary residential building in humid climates in accordance with thermal comfort requirements.

LITERATURE REVIEW

Madhavi Indraganti (2010) studied behavioral adaptation and the use of environmental controls in summer for thermal comfort in apartments in India.

A thermal comfort field study conducted in 45 apartments of Hyderabad in 2008 collected 3962 comfort responses and the use of controls of over 100 occupants in summer and monsoon months using Class-II protocols for field study. The indoor temperature in May was very high and was moderate to high in the monsoon season.

Madhavi Indraganti (2010) did a field study in Hyderabad, India on thermal comfort in naturally ventilated apartments in summer.

The subjects used traditional ensembles and slowed down their activities adaptively to restore thermal comfort. Clothing adaptation was found to be impeded by many socio-cultural and economic aspects.

Madhavi Indraganti (2010) studied the adaptive use of natural ventilation for thermal comfort in Indian apartments

The occupants adapted through clothing, metabolism and the use of various controls like windows, balcony and external doors and curtains. The subjects operated the controls, as the indoor temperature moved away from the comfort band. At comfort temperature, maximum use of openings was found, which correlated robustly with indoor/outdoor temperature and thermal sensation.

Huibo Zhang, Hiroshi Yo Shino (2010) analyzed the indoor humidity environment in Chinese residential buildings.

The indoor humidity environment in the investigated houses has strong correlations with outdoor humidity level, heating and cooling system (type and operation hours), human behavior as well as in building airtight performance.

Ricardo Forgiarini Rupp et al. (2015) did a review of human thermal comfort in the built environment

Several research topics are addressed involving naturally ventilated, air-conditioned and mixed-mode buildings, personalized conditioning systems and the influence of personal (age, weight, gender, thermal history) and environmental (controls, layout, air movement, humidity, among others) variables on thermal comfort.

TOOLS NEEDED AND THEIR COST

S.NO	TOOLS NEEDED	USED FOR FINDING	BRAND /MODEL	COST
1	HEAT STRESS METER	WBGT, DBT,RH	EXTECH HT30 Heat stress WBGT meter	Rs 13,434/-
2	HOTWIRE ANEMOMETER	VA	TENMARS TM-4001 Hot Wire Air Velocity Meter	Rs 14,500/-

BUILDINGS CHOSEN FOR CASE STUDY

1. Rajparis Harmony Apartment in Medavakkam, Chennai for HOT HUMID APARTMENT RETROFITTING
2. A contemporary individual villa in Medavakkam, Chennai and a Mylapore house for PASSIVE AND CONTEMPORARY RESIDENCE COMPARISON
3. A contemporary individual villa with a courtyard and another contemporary individual villa without courtyard for INDIVIDUAL VILLA WITH AND WITHOUT COURTYARD STUDY