

Occupants' Comfort in School Buildings

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Abstract—ISO 7730 and ASHRAE 55 specify the various thermal comfort standards based on adult based experiments. But no standards specially for children are mentioned in any of the norms. Schools are the buildings where children spend most of their time. The surrounding environment of children should be providing extreme comfort in all senses so that they are able to perform wonderfully well in day-to-day life. The paper discusses about the various comfort parameters related to children those arise in any school building during the daytime. The main focus of the paper is to highlight the importance of the necessity of investigation required towards finding out the thermal comfort factors of children in naturally ventilated school buildings in coastal Karnataka.

Keywords—School Building Design, Comfort Parameters, Thermal Comfort, Visual Comfort.

I. INTRODUCTION

SCHOOL BUILDINGS are the premises where children grow learning things and understanding values. And children are the assets of any country, simply because the future of the nation lies in their hands.

According to Census of India 2011, the total population of the country is 1,21,05,69,573. Whereas child population in the age group 0-6 years is 16,44,78,510. It is recorded that in India, the total number of buildings is 306,162,799 out of which 2,106,530 are educational buildings [1].

The main prerequisites such as health and well-being of living beings are maintained comfortably by the thermal equilibrium balanced between the body and the environment. It is universally observed that children respond more sensitive to the environmental changes happening around them slightly higher than adults do. The various properties of building envelope contribute to the comfort of the inhabitants. Therefore in case of children, experiments have to be conducted to find the various levels of comfort standards that can be accepted in various climates.

It is commonly believed that the children are unable to make statements on their feelings of comfort. But contrary to it many similar studies on thermal comfort of children have proved that they respond well to the questionnaire if framed the questions properly for them to enjoy certain activity.

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II. COMFORT OF CHILDREN IN SCHOOL BUILDINGS

A. Physical Comfort

Physical comfort and psychological comfort are always interlinked. Physical comfort is achieved mainly by the body organs and more specifically by the five senses of our body.

Our skin senses the texture as well as the temperature of the surface which is in contact. Skin of children is very supple. So they are more sensitive than adults. Smooth and dust free surfaces with acceptable temperature values give them comfort. Normally it is the hand which comes in contact with wall surface as well as other furniture and materials. But for activities such as Dance, Yoga etc. children perform with their bare feet. Rest of the body will be in contact with the clothing. Clothing gives insulation to some extent which is indicated by its Clo. value.

Children normally do not register smell as easily as an adult. But air freshness is of extreme importance in case of children. Foul smell from nearby toilets and littering of food particles are the normal cause of discomfort in classrooms. Above all the carbon dioxide concentration in the surrounding air has to be investigated for doing necessary rectification. Most importantly the air temperature that is being inhaled is also a factor which causes thermal comfort of the body.

Next sense organ is the ear. Studies have indicated that babies experience hearing sound while they are in the womb. And in schools it is the ear by which children first grasp things better. The ease of hearing is achieved only if the outdoor noise is completely eliminated. Music is the best aid through which children start learning in kindergarten. Therefore music is an inevitable part in learning even later.

Tongue is merely for taste. Even though this sense organ has nothing to do with building design, it is necessary to mention that the food habits plays a vital role in maintaining the core temperature of the body through proper metabolism.

Finally the remarkable one is the visual comfort. The elders always warn the children whenever they read in the dark. But recent studies indicate that just sufficient illumination is necessary for comfortable reading. Visual comfort is also an emotional phenomenon. Students should be encouraged to sit where they feel most comfortable, and teachers should experiment with placing restless, fidgety youngsters into softly lit sections and reversing that procedure for listless, unresponsive ones [2].

It is universally known that glare causes discomfort. Apart from light there are various other factors such as colour, form, shape etc. which affect visual comfort in children.

With other body organs the factor of satisfaction is maintained by the space standards of rooms as well as the ergonomics of furniture.

B. Psychological Comfort

If Physical comfort is achieved to a great level then the psychological comfort follows. In children there could be many other external factors such as their relationship with friends, predominant mental attitude etc. which are influential reason for peace of mind.

Various activities in the school should keep children energetic. Freedom along with discipline if imposed on children gives them ease of approach in anything they do.

Spaces like wide corridor, enclosed open areas like courtyards, compact but simple designs are some of the architectural features preferably maintained in school building design.

III. THERMAL COMFORT

The basis of comfort is always the adaptive thermal comfort a person develops in that atmosphere. The variables in the heat content of the body can be calculated by considering the metabolic rate as well as radiative, convective and evaporative heat exchanges with the external environment.

According to B. Givoni, there are primary and secondary factors affecting the heat exchange of the clothed body. The primary factors are metabolic rate, air temperature, air motion, vapour pressure and clothing type. The secondary factors are clothing temperatures, air motion beneath clothing, skin temperature, sweat rate, wetness of skin and clothing and finally cooling efficiency of sweating [3].

As stated by Fergus Nicol et. al, the factors that affect the thermal comfort of a person are food habits, clothing, activity behavior, topography, climate and most importantly the building envelope. The context, culture, buildings and climate are unique to any particular place, so are the comfort needs and expectations of the inhabitants [4].

IV. THERMAL COMFORT OF CHILDREN

Emphasis is given by Ken Parsons on the importance of investigation of comfort conditions of babies, children and pregnant women since their metabolic rates and surface area ratios completely differ from normal adults [5].

The environmental variable such as air speed, radiant temperature, ambient temperature, relative humidity and carbon dioxide concentration have to be recorded in live class rooms through a longitudinal and transverse surveys. A simple and attractive questionnaire has to be framed for the children to express their thermal acceptability. Thermal sensation voting on ASHRAE Scale will be a little to elaborate for the children [6]. So it should be slightly modified. The questionnaire should additionally contain parameters such as occurrence of sickness, food habits, type of their residences etc. for a detailed investigation pertaining to the locality. These are factors never found incorporated in any of the

previous research.

Over the years several studies have taken place on thermal comfort of children starting from 1973 onwards. The countries where these research have taken place include United Kingdom, Italy, Netherlands, Japan, Taiwan, Kuwait and Singapore. Many research on thermal comfort of occupants in residential and office spaces have taken place in India too. Scientists like Fergus Nicol, J. Mathews, H. B. Rijal, I. A. Raja, M. R. Sharma, S. Ali, Arvind Krishen, Madhavi Indraganthi, Sadhan Mahapatra, Manojkumar Singh, S.K. Atreya etc. have made thermal comfort studies in India. But no record on such study on school buildings or children have been ever made in India.

V. SCHOOLS IN COASTAL KARNATAKA

A. Geographic location

Karnataka State situates in South India which is bounded by Arabian Sea on the western side. Coastal Karnataka extends across the latitude of 13°N to 15°N and longitude of 74°E to 75°E.



Fig. 1 Location Map of Karnataka

B. Climate of Coastal Karnataka

Maritime climate with average temperature of 26.5°C has been recorded. The annual rainfall has gone upto 4000mm. [7]. In fact half of the year the climate is tropical warm humid and the remaining months it will be wet humid due to monsoon.

C. Physical Features

Soil type is Sandy loam, yellow loamy soil or red laterite soil. Ground water and surface water is abundantly available [7]. Vegetation is abundant everywhere.

D. Common Building Materials in the Region

There are vernacular and conventional types of school buildings. Alternative building construction method is also sparsely found.

Vernacular type is normally built with laterite masonry, lime

plaster, Mangalore pattern tiles and wood. Whereas modern type buildings are built using clay bricks, cement plaster, reinforced cement concrete and openings made of metal, glass and wood. Alternative building material used in the region include hollow clay/cement bricks (sometimes even exposed without plaster) for walls, prefabricated ceiling tiles and door/window frames.

E. Control Measures in School Buildings

No schools are provided facilities for mechanical air conditioning anywhere in the region. Because climate is in fact not too intense for artificial means of cooling or heating to be provided indoors. Apart from this, India is a developing country due to which these mechanical means of air conditioning is not affordable.

Nonetheless ceiling fan is an unavoidable device very commonly seen in all the habitable rooms; used to provide air motion mainly to facilitate evaporation of sweat. Simultaneously fans eliminate stuffiness and reduces carbon dioxide concentration around the occupants' livable area.

F. Other Influential Factors on Thermal Comfort

There are many other minor elements that contribute to the comfort issues like clothing material, type of their dwellings, food habits, daily routine, mode of transportation to school etc.

VI. CONCLUSION

There is a gap and urgent necessity identified to carry out research on thermal comfort requirements of children in school buildings in Indian context.

The climate of coastal Karnataka is such that mechanical means of air conditioning is never required in school buildings. Even then, at every transition period of the weather many children are found being absent in school due to sickness. This can be prevented to a great extent by controlling the basic climatic elements indoors. For doing this awareness of necessary measures of control on building elements requires to be done through detailed experimental investigations.

Function of operating fan is an example for this. Fan is an unavoidable equipment for comfort to eradicate the discomfort of sweating during warm weather. The same fan when operated to remove stuffiness of air in monsoon climate causes the chill air surround the body. This will be a discomfort for most of the children who are instantly unable to operate the openings on walls or cover themselves up with clothing according to the situation. Therefore air motion has to be in some different direction during the rainy season.

Making an attractive questionnaire to impress the minds of children is an art. The format to express their answers should not be in the way of making them simply talk or write.

Air pollution is another factor which causes discomfort in the warm season. Therefore architectural design elements of school buildings should be entirely well-thought so as to provide specific interior details as well as modification in topography, efficient space designs etc.

Research should never be stopped at the stage of finding out thermal comfort values of children in the premises. Instead modifications in building design to achieve this comfortable indoors should be always investigated.

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