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Role of Design and Planning Features for Energy Efficient Indoor Thermal Environment of Vernacular Houses

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Abstract—*Vernacular buildings are known to have bio-climatic features that effectively maintain thermal comfort inside the houses. Design and planning features like simple shapes of square or rectangle, provision of sun spaces, small windows, sloping roofs, and low roofs coupled with layout provisions like planning as per direction of sun and wind and layout according to contours, use of locally available materials like bamboo, mud as adobe, wood, slates all lead to creation of a very comfortable indoor built environment. Present paper presents relation of indoor temperature with building materials and design-planning features which together helps to maintain comfortable indoor environment.*

1. INTRODUCTION

Vernacular architecture is the local architecture developed by local people and hence the habitations so developed are called vernacular buildings [1, 2]. These buildings include such design and planning techniques which correspond to climate, local topography. Therefore in vernacular buildings planning, design and construction aspects necessarily correspond to traditional knowledge which is the outcome of trial and error methods being refined, modified and perfected over the ages by people [3]. Vernacular buildings are known to have inherent thermal comfort advantages owing to their unique design and planning characteristics which have developed over time as a response to climate and topography of the area. Vernacular houses includes use of locally available building materials which are assembled for a residence in such a way that respects sun-wind and other bioclimatic parameters his makes them climate responsive [4,5,6]. This paper presents study of these parameters in relation with indoor temperature which is direct indicator of indoor thermal environment.

2. METHODOLOGY

For understanding the architectural features in terms of vernacular architecture of Hamirpur district and their relation with indoor temperature, a thermal comfort study was conducted. The thermal comfort survey was conducted for months January, April, July and October [7,8,9,10] .The field survey was conducted between 11:00 h and 13:00 h, due to limited access to these vernacular houses due to socio-cultural factors. Nearly 30 vernacular houses were studied with features of very old construction and involves usage of vernacular materials for construction of various systems like local stone and adobe bricks for foundations, adobe bricks for walls, bamboo and wood for roof and rammed earth and mud phuska for floors and V1.1, V.1.2, V.1.3 represents similar styled houses for same category or architecture style. Study was done to understand the socio-economic–cultural patterns affecting the energy consumption requirements. The research involved study of design parameters like wall thickness, materials and construction techniques, number of openings, materials and size of openings, roof coverings, and roof height with their effect on thermal performance and energy efficiency of the houses.

3. ANALYSIS: DESIGN FEATURES AND INDOOR TEMPERATURE

Using instruments for measurements of physical thermal variables, indoor temperature and outdoor temperatures were recorded for analysis of their relation with spatial design features as given in Table 1.

On the basis of a thermal survey of houses, energy efficient features of traditional vernacular houses enhancing indoor thermal comfort were identified and have been discussed here. The trend showed that residents of vernacular houses do not use any equipment for heating or cooling in winters or summers. Both material and architectural design features result in the better thermal performance of these houses. Thermal insulation of house is excellent which curtails the need of external energy equipment either in winters or summers owing to massive 0.45 m.(18″) thick adobe walls, use of wood for roof and mud phuska (mix of mud and cow-dung) which are all thermally insulating materials. Further, compactness of the houses, the orientation of the houses towards the south, the presence of sunspaces like verandah, small windows in north side etc. also accounts for better

indoor thermal environment and energy efficiency of these houses.

Table 1: Comparative indoor-outdoor temperature profile for three category houses

Month	Mean outdoor temperature To (°C)	V-1: vernacular houses	V-2: additive vernacular houses	C: conventional modern houses
		Mean Indoor temp. Ti (°C)	Mean Indoor temp. Ti (°C)	Mean Indoor temp. Ti (°C)
Jan	16.68	19.5	18.12	12.36
April	31.6	22.94	23.84	34.86
July	26.6	22.18	25.21	32.66
Oct	23.5	21.34	21.93	25.16

4. CONCLUSION

From the studies carried out to understand features of varied architectural styles with respect to design , planning , orientation, materials, construction techniques and thermal comfort performance of buildings , it was found that vernacular construction techniques and materials although perform very well in aspects of thermal comfort parameters and sustainability as compared against the conventional materials and construction techniques (modern materials like R.C.C, Marble ,Burnt bricks etc.), but due to difficulties in their day-to- day use like laborious , tedious and frequent repair and maintenance, poor to average durability against weathering agents , infestation by pests and termites, it is losing its glory and vanishing at a very rapid rate giving way to less sustainable and energy efficient conventional architecture . The address to this problem will not only revive vernacular architecture techniques but also would help in achieving energy efficiency and put less pressure to existing resources thereby fulfilling definition of sustainability.

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