WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Buildings, Climate And Thermal Comfort – A Case Study Of Traditional And Modern Residential Building At Village Chinigaon, District Kinnaur, H.P.

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ABSTRACT

In order to have thermal comfort inside the buildings, lot of energy is consumed on heating, cooling, air conditioning etc. Besides, the household appliances like television, refrigerators, day lighting etc. consume a lot of energy component. Such excessive utilisation of energy can be reduced to significant extent by adopting the Solar Passive Housing Features. However, information on many building techniques and materials having energy efficiency and conservation features are available to the engineers and architects, the practice of self sustainable energy conscious designs is not common. The technology available with the expert institutes/ engineers/ architects has not percolated to the target groups. Moreover, there is a need of continuous monitoring of energy efficient and climate responsive buildings post occupancy for evaluation of thermal comfort and energy savings. Around the world, with the passage of time and from his learning experience and trial, the man has developed and adopted several eco friendly and energy conserving traditional housing techniques, based on building design, climate and the life style, for protection against extremities of the climate.

Keywords: Traditional House, Modern House, Thermal Comfort, Solar Passive, U value (Thermal Transmittance)

Introduction

It is observed that global energy consumption has grown by 2.3% in 2018, which is almost double the average growth rate since 2010. This demand is mostly driven by a use of heating, cooling and ventilation needs in some parts of the globe. Such higher level of energy consumption has led to increased CO_2 emissions which in now standing at 33.1 Gt CO_2, higher by 1.7%. Thermal power based on Coal-fired power is the single largest emitter at 30% of total carbon dioxide emissions [1].

The pattern of energy consumption can be usually classified into three main sectors: industry, domestic, agriculture and others, which include commercial, traction & railways etc. At present the residential and commercial sector is accounting for 30% of total electricity consumption and it is rising at a rate of 8% per annum. This sector include all commercial and public buildings, which also include schools, restaurants, hotels, hospitals, etc. with a wide variety of uses and energy services Heating Ventilation and Air Conditioning (HVAC), domestic hot water, lighting, refrigeration, food preparation, etc.. The increasing population has also resulted in increased demand for energy for buildings [2].

As per World Business Council for Sustainable Development, 2009; the buildings are responsible for 40 percent of primary energy use in most countries. According to International Energy Agency estimate (2008) the current trends in energy demandwill catalyse approximately half the energy supply investments by 2030 for buildings. The rise of energy consumption and emission of CO_2 in the building environment has forced us to made energy efficiency and energy saving a priority objective for energy policies in most countries [3]

In the present paper an effort has been given towards reduction of conventional energy consumption in housing sector, where a lot of energy is consumed for space heating or cooling in achieving thermal comfort and other domestic purposes. A comparative analysis has been carried out between traditional, and modern buildings at village Chinigaon, District Kinnaur, Himachal Pradesh. A relation has been established to find out the energy efficiency of traditional and modern buildings. The study reveals that a healthy living environment would be maintained and the dependency of human beings on fossil fuel resources, and auxiliary energy would be reduced significantly if the practice of traditional buildings is carried on.

Review of literature

Vernacular architecture refers to structures which are built using local materials in a functional style devised to meet the needs of common people in their time and place. Most of these building built using the principle of vernacular architecture responds to the regional climate. The development of vernacular architecture is the result of modification in structural designs evolved over a significant period of time through feed-back mechanisms inherited from the system, which signify the environment, culture and historical context in which they live. The style of vernacular architecture vary from region to region as per climatic conditions. In order to fulfil various necessities of indigenous people, vernacular architectures developed through the centuries has many original and interesting design practices and technologies [4].

There are different types of architectural built forms in the city of Shimla, the capital of Himachal Pradesh, India. This type of architecture

was started from the Scottish Baronial style in the time of British rule – when Shimla was the summer capital of India, followed by the traditional vernacular styles, coming up with the New-Tudor style and in recent times with the Modern Architectural style. However, the raw building materials used for all of these styles are stones, timbers, batten boards and glass. Extensive use of stone and wood makes the built form to be sculpted out from the hills itself to balance the settlement of the built forms with the nature making it harmless for the hills. Use of locally available materials and adopting local construction techniques are more responsive to the climate and geographic conditions [5].

With the fast emerging globalization, the energy resources are depleting rapidly and feeling extra pressure of meeting out the demands. The sustainable development, in such situations, is the only solution to reduce such enormous pressure on depleting resources. Over exploitation and unplanned use of fossil fuels would pose a threat of being getting exhausted. As buildings account for more than 30% of global energy consumption, reduction of energy consumption in buildings would lead to significant energy savings which in turn would provide a way for sustainable housing. Use of natural sources of energy would be helpful in sustaining the energy use, and therefore, the energy resources could be utilised by the future generations for long. Solar passive housing is a step towards achieving sustainable housing. The present paper describes the factors of solar passive building design.

It has been observed that timber-frame houses with large glazing mostly on the southern facade of the buildingcould be designed in aesthetic manner. However, as per general design guidelines, the buildings should becompact shaped to minimise the use of external energy [6].

Various climatic aspects are to be kept in mind while designing the buildings. These climatic parameters are solar radiation, temperature, humidity, wind speed etc. Climate-responsive design or vernacular architecture is considered to be one of the major components for achieving self sustainable development in building sector.

The Solar Passive heating strategies in particular make the use of the windows, walls, roof, and other building components to store, collect, and distribute the solar heat to dependency on auxiliary sources of space heating. Generally walls are massive, roofs are insulated and fenestrations are natural which allow heat gain and losses. These typical buildings would have high thermal mass, appropriately shaded, well coupled with ground and shape would be compact in plan [7].

As a rapid increase in global warming has been noticed in few past years, the building designer should be skilled enough to ensure that the building performance is in accordance with the set principles of passive solar and can continue to meet the user needs and expectations [8].

Thermal performance of traditional and modern residential buildings at Chinigaon, District Kinnaur

Table: Building Characteristics – Traditional House, Chinigaon, Distt. Kinnaur

Parameters	**Building characteristics/ specification**
Type of Building	Traditional Building
Address	Village Chinigaon, District Kinnaur (6 Kms from Reckongpeo)
Altitude	2600 Meters (absl)
Climate	Cold and Cloudy
Outer Walls	18 inches Stone Masonry
Interior partition Walls	Deodar Wood (Cedrus Deodar)
Windows	Wooden with 4mm Glass
Doors	Wooden
Roof Type	CGI Sheet roofing with wooden false ceiling
Floor height	False Ceiling at a level of 8 Feet
Orientation	Longer Axis of the building is making an approximate angle of 10^{o} with North South Direction.
Window Size	Small as compared to modern house
Flooring	Wooden Flooring
Vegetation	Deodar Trees nearby along with Apple orchards
Veranda	Acting as Sunspace in front of bedrooms

Snowfall	2 to 3 Feet of annual snowfall during December to February
Monitoring Period	Between November – December 2018

During the monitoring period, the minimum outdoor temperature of -0.5°C was observed on 14th November, 2018 at 8.00 AM. As per meteorological data the temperature falls much below the freezing point for many times on different days in December 2018, January 2019 and February 2019.

Being part of Greater Himalayas region reels under severe cold. Regions beyond Kalpa remain under snow for about 5-6 months in a year. The maximum temperature recorded during monitoring period is that of 12.7°C at 3.00 PM when the outdoor temperature at the same time is 7.5°C. The temperature during most part of monitoring period lies around 10°C. It is important to notice that the artificial heating appliances are used only during snowfall days. Otherwise, the residents successfully maintain a level of thermal comfort using proper clothing. Besides, the building has a sunspace attached to the bedroom which acts as verandah as well. The verandah (Sunspace) acts as buffer zone and does not allow the captured heat during the daytime to escape. The use of locally available wood for verandah, floor, and false ceiling is providing an insulating cover to the building. The wooden insulation is perfectly capturing the room energy keeping the temperatures around 10-12°C throughout the monitoring period. The traditional building has a compact shape, it is a two storey building with stone masonry, small windows. The thick stone masonry acts as capacitive insulation, the walls release the heat, absorbed during the daytime, to the interiors of the building during night hours. No heating appliances are used in the room. Residents maintain a level of thermal comfort easily with the indoor temperature and proper clothing. The temperature in the rooms adjoining to the Kitchen was recorded as high as 14°C during these months, which is very close to the comfort standard for these extremely cold climates. Moreover, the longer axis of the building is facing the south east, which is in accordance with the principles of orientation for passive solar housing. The verandah (Sunspace) has been designed is in front facade of the building to maximise the solar gain. So the traditional building has many features in compliance with Solar Passive Housing Technology responsible for keeping the indoors warm even in extreme climates [9].

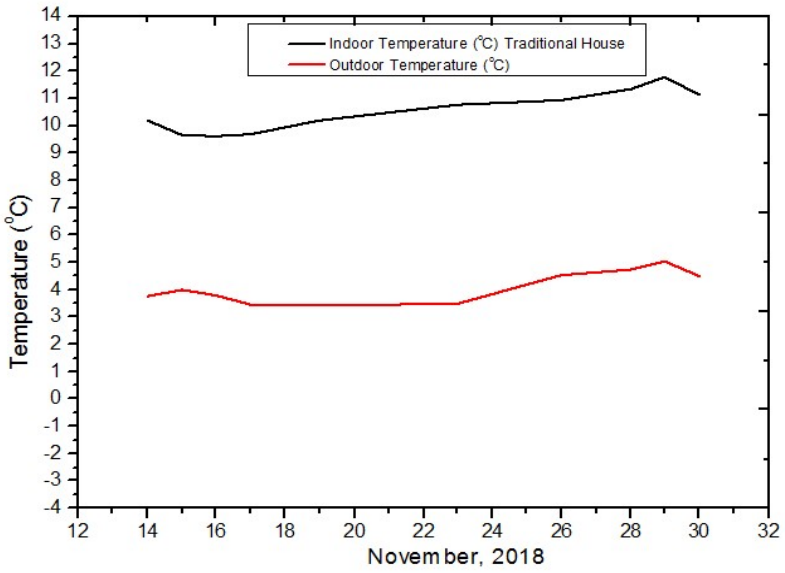

Fig: Plot of room temperature in traditional house Vs. outdoor temperature for the month of Nov, 2018 – Chinigaon, Distt.Kinnaur.

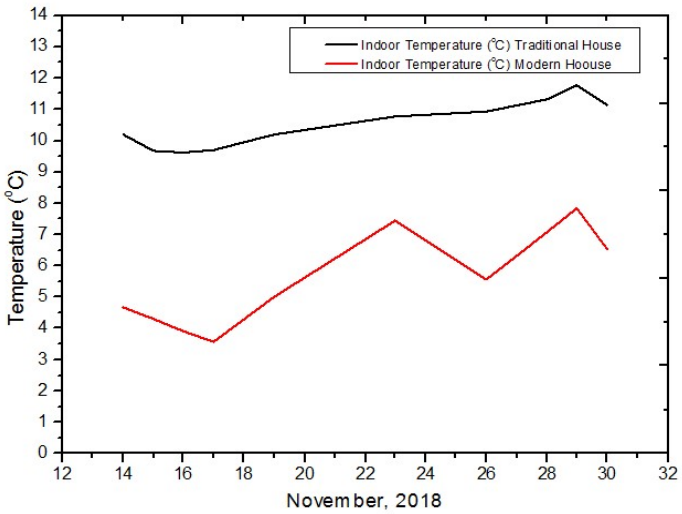

Fig: Plot of room temperature in traditional house Vs. modern house for the month of Nov, 2018 – Chinigaon, Distt. Kinnaur.

The indoor temperature in traditional house, on an average, is about 5 - 6°C more than the average outdoor temperature. This much difference is significant as lesser energy is required, in comparison to modern house, for achieving a level of thermal comfort. The U value (Transmittance value) of wood, stone is far less than the cement concrete and bricks. Hence the heat losses in traditional house are less in comparison to modern cement concrete house, as is evident from the following graph between room temperature in modern house and outdoor temperature. The modern house is built using steel, cement concrete, and bricks. Also it could be easily analysed from the same graph that the indoor temperature in modern house is varying with even small variation in outdoor temperature. However, the indoor temperature in traditional house is almost behaving in steady state and is around 10°C – 11°C throughout the monitoring period.

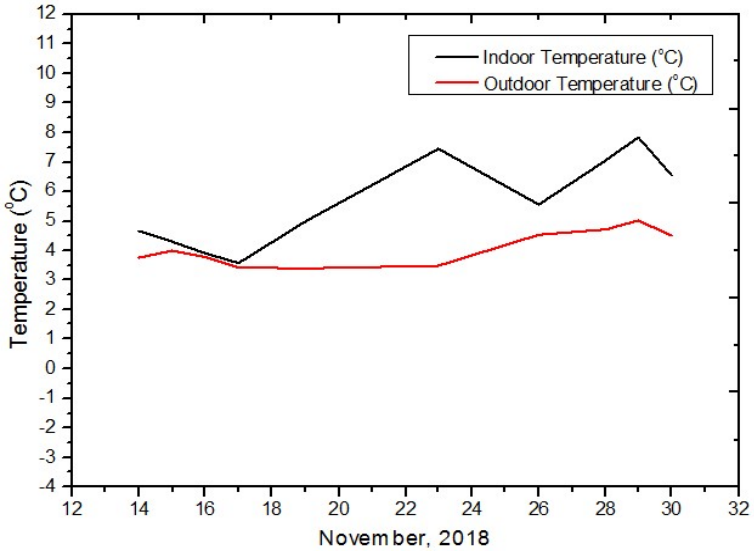

Fig: Plot of indoor temperature in modern house Vs. Outdoor temperature- Chinigaon, Distt. Kinnaur for Nov, 2018.

Conclusion

The results of the study reveal that the orientation, construction methods and architectural designs in traditional dwellings/ houses have been developed over a period of time by generations and such houses behave in resonance with local climatic conditions. The thick massive walls, Dhajji wall construction techniques, use of local wood, stone provide a good level of thermal mass in traditional buildings. Such materials are responsible for providing a level of indoor thermal comfort during entire winter months without any auxiliary heating. It has been observed that the traditional houses have been designed as per the principles of vernacular architecture. Such houses built using local materials easily blend with the natural beauty of the mountains and, therefore, are not only comfortable, but also are an object of art to be appreciated. On the other hand the modern houses built using cement concrete do not respond to climatic variations and hence consume lot of energy in attaining a level of thermal comfort.

References:

1. The latest trends in energy and emissions in 2018. *Global Energy & CO_2 Status Report, IEA March 2019*.
2. Nagaraju Kaja (2017) An Overview of Energy Sector in India. *International Journal of Science and Research (IJSR)*, ISSN (Online): 2319-7064, Vol. 6, 3: 1589-1594.
3. Luis Pe´rez-Lombard, Jose´ Ortiz, and Christine Pout (2008). *Energy and Buildings*: 394–398.
4. Albatici R (2009) Elements and strategies for sustainable intervention in the residential building sector: a case study. *Indoor and Built Environment*18 (5)*:* 447–453.
5. Rajroshi Chatterjee, Sayantani Saha, Dr. Debashish Das (2017) Comparative analysisof differentArchitectural Built Formsand theirThermal Comfort aspects–Case Study Shimla. *Journal for Studies in Management and Planning,* Vo l3 Issue 1, January 2017
6. Premrov M, Vesna Zegarac Leskovar, and Klara Mihalic (2015) Influence of the building shape on the energy performance of timber-glass buildings in different climatic conditions*,* ***Energy***. http://dx.doi.org/10.1016/j.energy.2015.05.027.
7. Almusaed Amjad (2011) Biophilic and Bioclimatic Architecture. *Analytical Therapy for the Next generation of Passive Sustainable Architecture:* 377.
8. Silke A. Krawietz, Passive Solar Heating Methods For Energy Efficient Architecture. Proceedings of ISES World Congress 2007 (Vol.1-Vol.5): *Solar Energy and Human Settlements.* University of Catania Faculty of Architecture: 862-863.
9. Dhar Shashi (2021) Thermo Comfort Analysis of Houses for Cold Region of Himachal Pradesh, Ph. D thesis, eternal University Baru Sahib, District Sirmour, HP.