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Thermal Characteristics of Vernacular Architecture in Warm Humid Region

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ABSTRACT

Vernacular architecture is evolving from theparticipation of people living under different worldwide climatic conditions by adopting local and regional resources in response to the local climate and with the help of climate responsive design strategies. The traditional houses existing in urban settlement changing the moving patterns of living by adopting modern lifestyle and change in climate. This paper aims to understand the thermal characteristics of the vernacular architecture of the warm-humid region and to understand climate change and its impact on studyon Pune city, cultural capital of Maharashtra State, India. Literature method is adopted to analysedthe changes in vernacular-built environments and the causes.

Key words: *Climate change, Climate responsive techniques, Vernacular architecture*

Introduction

Vernacular architecture evolves by considering design and construction techniques and adopting locally available resources based on the environmental, cultural and historical background of people (Shastry *et al.*, 2014). Currently architectural style of the region is influence by the globalization on the edge of extermination as it has been abandoned by people to follow the modern influence architectural style. Climate change poses a severe hazard to building performance and the human settlements (Crawl, 2008). The depletion of energy resources and the risk of global warming are calling for sustainable development in the building sector based on renewable energies and energy efficiency (Robert and Kummert, 2012). Climate-sensitive shelter design is inbuilt into the human knowledge (Zhai and Previtali, 2010). India's vast and diverse building traditions evolved over five millennia in response to the sociocultural, economic and thermal needs of the population, they display a remarkably sophisticated thermal adaptation (Gupta, 2016). The environmental elements are significant for the type of scale either architecture scale, meaning the scale of a building, and the urban scale. Sustainability defines as a longevity, analysing the urban pattern and architecture of regional societies and cultural aspects considering environmentover the course of time bring passive design solutions to both urban and architectural design (Azarbayjani, 2019).

The Study will focus on all the vernacular features which acts as passive design features and there uses in summer and winter season and also understand the role of surrounding on the vernacular house form the region. Study will also analyze the socio – cultural aspects and their role in vernacular-built form of the particular society.

Literature Review

India'svernacular-traditional architecture has been impacted by a wide range of climatic circumstances,

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traditional wisdom, and cultural conceptions (Patidat and Raghuwanshi, 2014). Traditional tactics have evolved over time, utilising locally accessible materials and illustrating a technological apex in their time (Choudhary, 2016).

Chandel *et al.* (2016) offered a detailed overview of the state of vernacular architectural research. The study's goal is to uncover energy-efficient vernacular architecture aspects that affect indoor thermal comfort conditions so that they might be used in modern building to suit modern lifestyles. Built mass design, sun direction, space planning, apertures, sunspace provision, construction processes, and building and roof materials are the primary aspects recognised (Chandel *et al.,* 2016). Based on this literature review is done considering

Vernacular Architecture as Resilience to Climate Change

Report published by The Energy and Resources Institute (TERI, 2014) suggested rise in average temperature by 2030 over different regions of Maharashtra with the baseline and IMD data increase in temperature of 1-1.5 ^{o}C during all seasons with warm nights are increasing more in the Pune and situation will be more critical in 2050 and by 2070 there will be 2.5 – 30 ^{o}C rise in daily average temperature in Pune. The Study will focus on all the vernacular features which act as passive design features and there uses in summer and winter season and also understand the role of surrounding on the vernacular house form the region. Study will analyse the socio – cultural aspects and their role in vernacular-built form of the particular society. Wada which was derived from the 'Vata' a Sanskrit word means plot meant for a residential unit. Wada design considering multifamily or one big family who stayed together, basically called as a courtyard house mansion (Dhepe Sushama, 2017). Wada house form have variations in terms of economic status, size of Wada, no. of courtyard, but all Wadas do have basic elements and characteristics of traditional aspects of the region.

Alapure, George, and Bhattacharya in their research identify passive-cooling and climate responsive strategies placed in Wada, and analyse a vernacular built form of Raghoba Salunkhe Wada from Pune District of Western Maharashtra,on the basis of literature review selection of case studies. Study was conducted with the help of existing passive-cooling strategies employed in Wadas with considering thermal performance. Study analyse the combination of internal courtyard with varandah, along with fountains, pools, terraces, attic spaces, lattice windows, arches performances as a microclimate modifier for the indoor thermal comfort. Reasonably bigger thermal mass of Wada helps to create constant conditions inside the built form (Alapure *et al.,* 2017).

Dhepe and Valsson The current research looks at how traditional characteristics and architectural features of vernacular houses are manifested in contemporary architecture. The research looks at the "Dhape wada" design, which was built in 2015 and is based on traditional vernacular architecture from Pune.Plan form (Character and geometry), Space (Spatial configuration), Semi-open and Open spaces (Courtyard and Varandah), Structural elements (Wall, roof, Staircase), and façade aspects were analysed with the help of a case study to understand the modifications made to traditional architecture for contemporary architecture (Dhepe Sushama, 2017). This study increases the awareness amongst contemporary designers to consider the importance of adopting regional design traits and incorporating local qualities, style, and elements into their work (Nagapurkar *et al.,* 2020). According to the author, incorporating the traditions of the region into current design by using traits, elements, style, and expression will merge the traditions of the region in numerous ways.

Radhikrisnan S did assessment on the climate responsive passive solar design techniques for traditional Chettinadu houses of the warm humid zone of Tamil Nadu in India. In order to find out a real term solution two traditional house form and two contemporary house form of the same region were selected to study the thermal performance of traditional houses and modern house form. Measurement tool AES (Architectural Evaluation System) setup for Air Temp, Globe Temperature (For MRT), Relative humidity record to find out the internal temperature parameters between these two house typologies (contemporary and modern) and in comparison with the prevailing outside temperature (Radhakrishnan *et al.,* 2011). To strengthen the study, an occupant survey of comfort and preferences was also conducted between the occupants of the houses of the same locality.

The east-west axis is strictly followed by these homes. The walls are less exposed to direct sunlight because the building's longer side faces north and

south. The dwellings are constructed in such a way that they run parallel to one another. As a result, there is a lot of air circulation in the building. Traditional house forms in these regions are more climate responsive than modern ones, according to the research (Shanthi Priya *et al.*, 2012).

Dili *et al.,* (2010), did the analysis ofpassive design environment regulator system embedded in the vernacular residential buildings of Kerala vernacular architecture. The study was done with the help of data logger, Architectural Evaluation System (AES), and computer interface to continuously record the thermal comfort parameters (Dili *et al.,* 2010). The experimental investigation finds out that the thermal discomfort is summer is not only due to rise in temperature but also due to rise in humidity in the atmosphere which causes the discomfort. It was also observed that the vernacular architecture of Kerala achieved comfort this with highly insulative building envelope and presence courtyards in harmony with the opening in external wall help to achieve comfortable condition as comparative to the conventional architecture.

Vernacular Architecture as Bioclimatic

Climate-sensitive shelter design is ingrained in human experience. A structure is frequently referred to as a person's third skin, with clothing serving as the second, covering the first (biological) skin. In the absence of active systems, these three factors work together to keep the deep body temperature at 37 degrees Celsius. The broad and diversified building traditions of India emerged over time (Indraganti, 2018). in her study explores the bio-climatic vernacular architecture of India's diverse climate zones. Warm-humid regions, according to research, have less yearly and diurnal temperature variance than other climatic zones, therefore ventilation in semi-open transition spaces provides better comfort than indoors. Openings with best sized and wall ratio in respect to the micro climatic gives better wind patterns. Raising plinths and wing

Considering literature following table is derived to understand the following aspects.

(Author, Year)	G. M. Alapure, 2017	Indraganti, 2018	Radhakrishnan S, 2011	A.S. Dili, 2010	Sushama S. Dhepe, 2017	S.S. Chandel, 2016
Sub - Domain	Quantitative Analysis	Bio-climatic design	Thermal Characteristics	Resilience to Climate Change	Features of wada	Energy efficient
Type of methodology	Field Study	Case Study	Comparative	Experimental	Documentation of wada house form	Qualitative and Quantitative
Documentation	Field Study and survey	Five regions with different climatic conditions	Field Measurements and Questionnaire	Field Measurements and Questionnaire	Case study approach	Field Measurements and Questionnaire
Study Conducted	Considering Settlement pattern and Built Form and Materials	Weather Data and Its impact on House Form	Weather Data and Its impact on House Form of traditional Chettinadu houses vs Modern House form	Weather Data and Its impact on House Form of Kerala vernacular house form	Plan form of Peshawa period traditional house form of Pune region	60 houses in 82 villages was studied family size varying from three to five
Analysis Done	Using Field Data	Studying Building Envelope	AES (Architectural Evaluation System) setup for Air Temp, Globe Temperature	Architectural Evaluation System (AES), data logger, and computer interface.	Documentation of traditional house forms with comparative analysis.	Energy Uses - equipment for heating or cooling in winters or summers.

walls to windows capture the local winds better. As thermal gradients are minimal, stack ventilation indoors may not be practical.

Vernacular Architecture as a passive design Architecture

Throughout the world solar passive techniques are in used while designing and constructing the vernaculararchitecture-built for (Singh *et al.*, 2010). Thermal comfort considered as one of the major parameters to analyse the occupants comfortable and also governs energy consumption in the building. Singh, Mahapatra, and Atreyaconducted significant research on the thermal performance of vernacular buildings around the world. The notion of climate-responsive architecture is represented by the vernacular architecture of North-Eastern India (Singh *et al.*, 2009), which is still lacking in experimental validation and quantitative analysis. Detailed field studies were performed by the researcher to evaluate on thermal performances of the Vernacular House form.

Kerala, India's southernmost state, has a typical Warm-Humid climate, extending from 8°18' to 12°48' N latitude, 74°52' to 72°22' E longitude, and located near the Arabian Sea on the west and the Western Ghats with its evergreen rain forests on the east side. Because there is less evaporation when there is a lot of moisture in the air for most of the year, it creates thermal discomfort and sweating. Climate responsive design is one that responds to seasonal changes in the weather to create a comfortable interior environment. Kerala's vernacular architecture has evolved over time, with the environment playing a significant effect (Dili *et al.*, 2010).

Discussions - Comparative Understanding of Five Review Research

Conclusion

Literature discusses all the parameters about resilience to climate change, bio climatic architecture, sustainability and energy aspects of the vernacular architecture considering performance of the vernacular form of architecture in the different climatic zones. As well as there are many studies done on vernacular house form but none of the study discussing about impact of climate change as rise in temperature on vernacular house form. Here there is an opportunity to study of change in temperature and its impact on vernacular house and that is motive to go for the research and understand the various implication of rise in temperature on vernacular architectural built form.

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