

IDENTIFYING PASSIVE COOLING TECHNIQUES IN VERNACULAR ARCHITECTURE OF HIRABAD HYDERABAD SINDH

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Abstract— The aim of the research is to identify material in the ancient buildings, analysing the passive cooling techniques in traditional building design and strategy in Hirabad Hyderabad. This research is aiming to identifying passive cooling techniques and the conditions of indigenous and raj period buildings in vernacular architecture of Hyderabad. Architecture of hirabad has a traditional beauty. It's just not only beautiful but functional, realistic and artistically very pleasant as well as the details are inspirational. So, for now this is important to include these features in modern architecture to decrease active energy usage in the buildings. It is clearly witnessed that the vernacular architecture has well-built coherent foundation based on natural features, climate, local material and intellectual responses to the physical factors to provide comfort and inspirational forms according to the environment of hirabad Hyderabad. The Main problem is to find the cooling techniques between nature and vernacular buildings and focuses on which techniques and architectural structure will capable to conserve the energy at high level.

Index Terms— Vernacular architecture, Passive cooling techniques, Hirabad, wind catchers, orientation, energy crises, traditional materials

1 INTRODUCTION

Hyderabad previously known as paris of sindh. It is located on the east of river indus and its almost 150 kilometres away from karachi the capital city of Sindh. Two largest highways of pakistan the national highway and indus highway connected at Hyderabad. Population of Hyderabad is nearly 1.733 millions people. Hyderabad is very important historical city with glorious past. Once the streets of Hirabad, were cleaned with rose water. Climate of Hyderabad is hot and humid with cool and breezy nights.

Hirabad is the neighbourhood in the city of Hyderabad that is older than the rest of the neighbourhood in Hyderabad and lies in the eastern part of the city along with the old city.

Architecture of Hirabad the beauty and its architectural details are the inspiration but the main problem is that these beautiful buildings will be reprocessed by concrete structures.

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Buildings in Hirabad which are built in 19th-20th century consist of many unique and special countenance which are not only beautiful but also functional, realistic, and artistically very pleasing as well. As wind catchers creates ventilation in the building, balconies for beautification and ventilation and also for social interaction. House keeper's room in the basements which are direct connection with street level. So for now this is important to include these features in modern architecture to decrease active energy usage in the buildings.

Hyderabad city is also popular for high rise buildings as growing trend and the city is going through a rapid modernization program new flyovers, shopping malls, hotels, trauma centres are being planned.

Vernacular architecture has well-built coherent foundation based on natural features, climate, local materials and intellectual responses to the physical factors to provide comfort and inspirational forms according to their environment. Vernacular architecture is most convenient for the residential buildings. The system that reduce or prevent the energy spending and the use of new techniques.

The passive cooling technique is a design technique which targets on heat gain and heat excess control in an architectural structure to maintain the inner temperature with less mechanical power usage. And the word vernacular means domestic. vernacular architecture is an example of building natural sustainable characteristics as energy, material and local resources.

Vernacular practices are developed with locally available, easily workable and natural building materials which are mostly renewable in nature like timber, thatch, mud, and local trees been found such as Bahun, Kirir, Loherro which have good climatic response. Vernacular architecture built by those experts whose design resolution are according to their mythology and traditions in their cultures.

This study is about utilization of materials and features of vernacular architecture for improving passive cooling techniques and arousing affective interior heat control techniques and conditions in modern buildings of Hyderabad Sindh. The study introduces an access to classify noticeable vernacular features and estimating its passive cooling performance in old vernacular houses of Hyderabad as well as recognizing most advantageous construction using vernacular building techniques in Hyderabad Sindh.

Main problem is to find the cooling techniques between nature and vernacular buildings and focuses that through what to save energy and from which techniques an architectural structure will capable to conserve the energy at highest level.

There has been a growing demand in energy utilization in buildings. From the last decade we are encountering with electric power crises because of continuous usage of air conditioning system in both commercial and residential buildings. Due to excessive usage of active energy in our structures our surroundings are totally affected with environmental pollution like global warming and usage of active energy in buildings is very excessive and is predicted to be increasing further because of advance life standards and rapid growth in worlds population

Artificial industrial materials have high embodied energy and cause lot of pollution during manufacturing and transportation and Energy crises in Pakistan.

After influences of modern material and architecture the building design has created a problem against human friendly environment.

The shortage of conventional energy sources and escalating energy costs have caused the re-examination of the general design practices and applications of air conditioning systems and the development of new technologies and processes for achieving comfort conditions in buildings by natural means. Globally, buildings are responsible for approximately 40% of the entire world's annual energy consumption. Most of this energy is for the provision of lighting, heating, cooling and air-conditioning. The increasing level of damage to the environment has created greater awareness at the international level, which resulted in the concept of green energy building in the infrastructural sector. Hence, the major focus of researchers, policy makers, environmentalists and building architects has been on the conservation of energy and its utilization in buildings. It is further established that alternative energy sources, techniques and systems can be used to satisfy a major portion of the cooling needs in buildings.

This topic, identification of passive cooling techniques in vernacular architecture, covers all-natural processes and techniques for cooling buildings. It is cooling without any form of energy input, other than renewable energy sources.

Table 1 criteria and mechanism, the eligibility of passive cooling techniques used in Hyderabad

Passive cooling techniques	Mechanism and criteria
Cavity walls	Building envelopes is the interface between internal and external environment. the air gap between the two layers of buildings envelop may resist heat flow from the outer to inner layers. The gap between two layers of the external walls should be ventilated in order to decrease heat transfer by convection. The ventilation between the two layers can

	<p>lead to energy savings on indoor cooling. Heat transfer is directly proportional to thickness of the gap. The thickness of the air gap is considered an important factor in order to resist heat flow from the outer to inner leaf of cavity wall, the gap should not be less than 200 mm to keep a well performance for cavity walls. However, the total thickness of cavity walls may contradict with the area allowed for building.</p>
Sun breakers	<p>Sun breakers installed over or around windows block solar radiation and prevent it from entering the indoor space during particular time of the day.</p> <p>Dimensions, orientation, and qualities of sun breakers depends upon the sun path and the location of the building.</p> <p>The function of the sun breakers is protecting the windows from intense solar radiation, however the glass area of window in hot, arid zones should limited from the early design stage in order to undermine the impact of solar radiation, therefore the contribution of sun breakers to thermal comfort will be a limited too.</p>

Building form and orientation	<p>Form and orientation constitute two of the most important passive design strategies for reducing energy consumption and improving thermal comfort for occupants of a building. It affects the amount of sun falling on surfaces, daylighting and direction of winds. Towards net zero energy goals, form and orientation have significant impact on building's energy efficiency, by harnessing sun and prevailing winds to our advantage.</p> <p>The compact form and its orientation may reduce the heat gained through the surfaces of buildings exposed to solar radiation. Building forms providing a great deal of shadow as well as the houses in hirabad Hyderabad are well oriented according to the building form.</p>
Wind catchers	<p>The wind catchers (Mangh) trap cool and fresh air from the upper air layers, moving it down and into the tower shaft. The cool air then rushes towards the indoor space.</p> <p>Wind catchers are very single form of ventilation, triangular structure almost like chimneys are on top of the houses are used to funnel cool breeze in .they</p>

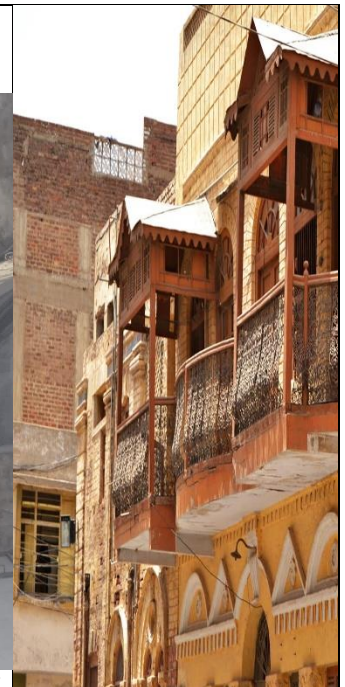
	<p>were fixed on the housetops to catch the southwesterly breeze in the hot summer days and evenings. The wind entering the wind catchers would penetrate into the room and keep it cool. There equipment's are considered as alternative solutions or replacements to meet the environment needs of the region.</p> <p>In hirabad Hyderabad the shape of windcatchers were square that is surrounded by two vertical sheets.</p> <p>The average size of wind catcher is approximately 1sqmtr and the height is more than 5 meters.</p>
Courtyards	<p>The courtyard acts as storage for cool air during the night where the temperature drops to the minimal value. The cool air is then distributed into the indoor space during the hotter periods of the day. Thus, small courtyards are an effective technique for cooling the high thermal mass structures through nocturnal ventilation.</p> <p>The area required for the internal courtyards can be a major reason for the rejection of this technique, despite its ability as a thermal regulator in hot arid</p>

	<p>areas, the cost of urban land and the privacy required in residential buildings with multi families has forced architects to neglect the design and implementation of this in new projects.</p> <p>The orientation of courtyards can positively or negatively impact the thermal performance.</p>
Traditional building materials	<p>In hot dry zones, clay and wood have low thermal conductivity, this climate needs a material with high thermal capability.</p> <p>The building materials such as clay, wood (sheesham, saghwan), stone, marble, Glass are used in the traditional architecture of hirabad Hyderabad.</p>
Upper openings in roofs or external walls	<p>The accumulated hot air in the upper part of the indoor space, due to its low dynasty, may b a source of thermal discomfort, therefore the upper openings designed in the external walls or roofs can release the blockaded heat and enhance cross ventilation.</p> <p>The openings(ventilators) may cause difficulties as dust and insects may penetrate into the indoor space. The solar radiation is likely to rush into the rooms during the mid-day period</p>

	<p>when the sun became semi-perpendicular. The openings of the roofs can only release accumulated heat from the top floor. However, the upper openings in the external walls can not only perform the same function of openings in the roofs. Thus, they are more effective than openings in the roof.</p>
<p>Undulating roofs (domes or vaults)</p>	<p>Undulating forms of roofs, such as domes and vaults, results in heterogeneous thermal pressure in the indoor space, due to differentiation between the shaded and solar radiation exposed parts.</p> <p>There are no limitations on the orientation of the dome, because its plan is a circle and its shape is neutrally oriented. However, the vaults should be oriented correctly to attain the greatest amount of shade and shadow.</p>



Windcatcher in the house of Hiraabad



A house in hiraabad built in 1923



An old stone building demolished by the builders



Damaged interior of the old building

temperature 2 C° : 4 C° compared to outdoor

RESEARCH QUESTION

The passive cooling of buildings is broadly categorized under three sections

- (i). Heat prevention/reduction, (Reduce heat gains)
- (ii). Thermal moderation (Modify heat gains)
- (iii). Heat Dissipation (Remove internal heat).

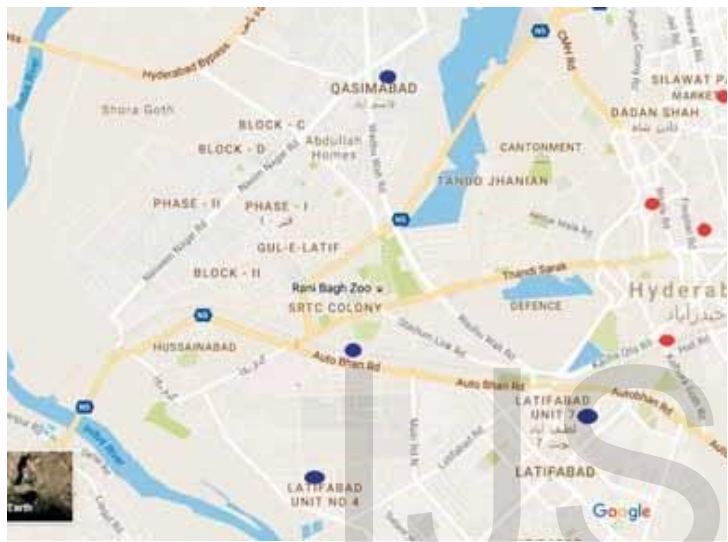


Figure 1 Hyderabad ;the blue marks indicates newly developed areas of Hyderabad while the red ones are the older locations.

RESEARCH METHODOLOGY

This research is designed to conduct a survey of historical vernacular architectural buildings of Hyderabad to analyze how buildings are being ventilated with in past years and what are the issues from the past and to research about buildings that are energy efficient and possess the application of passive cooling techniques. This study will give many ideas on building cooling, to remove unwanted heat from the sun to the structure and to know the approaches that are applicable or not.

The basic and effective method to collect the data is by surveying and conducting interviews from local community, architects, engineers, and also from experts. The interview will help to understand about vernacular and overall passive cooling

techniques. The opinions of the interviewee will give a lot in collection of data and information about passive cooling design techniques and materials , design techniques innovations and originality in local architecture of particular area.

In order to study buildings of hirabad Hyderabad , a multidisciplinary research methodology has been used which focuses on the following.

1. Documentation through photographs and qualitative interviews
2. Identification of the features and techniques used in each building through site documentation
3. Discussion and interviews about buildings with present inhabitants and people from the neighborhood.
4. questionnaires and case studies

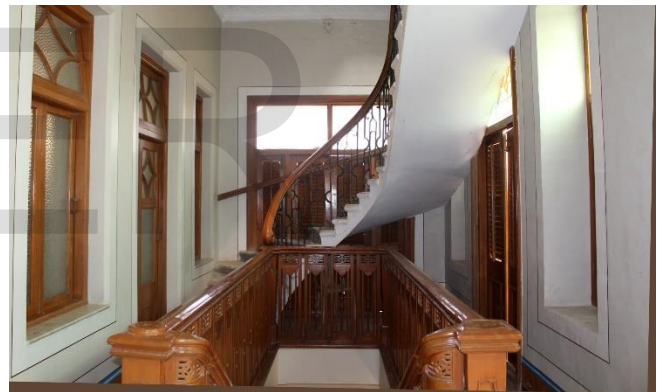


Figure 2 interior of the house in hirabad



Figure 3 interior of old building (passive cooling technique used)



Figure 4 an old image of wind catchers (munch) in Hyderabad

DISCUSSIONS AND ANALYSIS

Passive cooling is a mean to stop the heat from entering inside the building and to take away the heat from it. The exact techniques can be applied according to the location and climatic condition of the location of building. Passive cooling engages structure like wind catchers, windows, high ceiling, massive walls.

There are two main techniques which are used to reduce energy usage in terms of energy storage first is “energy conservation” and other is “energy efficiency”.

The thermal gains can be due to various causes such as penetration of hot and humid air from outside, because of heat direction which is continuously effecting on the building, heat gain from the windows, heat gain from the inhabitants and equipment’s inside the

building and architectural structure like wind catchers are used for the maximization of cooling strength in the building.

Passive energy techniques maintaining a person’s thermal comfort that means the persons which are present in the building are not feeling too hot environment nor too cold.

1. .Kamal (2012)^[1] specify in recent study that almost from 20 years we observes a severe power crises in developing countries specially throughout the period of summer season because of requirement of cooling in building .
- 2 Glassie (1990) ^[2]Vernacular architecture also known as domestic or local material made architecture as also defined as indigenous architecture. Which is made according to the needs of the people in nature, culture and its community.
- 3 (BEE, 2010 singh et al 2009a).^[3] As energy utilization in building sector is highly excessive and is likely to increase more due to advance living standards and huge increasing rate in the growth of population of world.
- 4 Kamal (2012) ^[4] explains how passive cooling technique design effects on the use of natural processes for heating or cooling to achieve balanced interior conditions the flow of energy in passive design by natural means like radiations ,conduction or convention without using any electrical device. To keep a happy environment with in a building in a hot climate relies on reducing the rate of heat gains into the building and encouraging the removal of excess heat from the building.
- 5 Gong et al.(2012)^[5] accept a path in which the orthogonal and listing techniques are include in which the research is done that how energy usage is minimized in house by optimizing solar passive design to part for different cities in the world .These measures include the altering thickness of the wall, thickness of roof insulation, thickness of external wall insulation, window orientation , window wall ratio ,glazing type and sun room depth. Through improving the study its proved that passive design could reduce thermal load of building effectively.

- 6 Lauber^[1] (2005)^[6] wrote that the most typically used materials in the tropics include clay ,wood and bamboo. However these materials are rejected by most new cities which refer to use concrete, steel, glass, and shiny metals.
- 7 Cavelius et al. (2007) ^[7] describes the comfort ventilation, nocturnal ventilation, radiant cooling, evaporating cooling, and using the earth as a cooling source are the key factors of the passive cooling.
- 8 A.W.N Pugin and sir George Gilbert Scott,^[8]. The study of vernacular architecture has been recommended by them since as early as 1839. Their research on that vernacular architecture inspired a whole architectural movement and the subject has generally been studied separately from architectural history as a whole.
- 9 Ismail (2000) ^[9] the cooling equipments which plays a important role in afford a comfortable habitat has been over worked and devote to energy misuse.



old wooden showcase in the building

floor design (pattern) in the old house



rooms of the old house

a view from the old house



façade of the visited old hirabad building

main entrance from the interior side



wooden cupboards installed in old building

wooden cupboards installed in old building



interior of the room in old building

marble pattern on the floor of the old building



veranda view of the old building

ventilators at the old building

This research is concluded on surveys of old buildings of hirabad. It revealed some very interesting passive techniques which are used in the buildings of hirabad Hyderabad those techniques that are now out of use and increasingly became extinct. It is spatially relevant in the context of old buildings of hirabad which are built in another era and represents social values and norms of that time frame.

There is an urgent need to document these old edifices and to take some effective measures to preserve these structures that are an essential part of our heritage. tangible heritage once lost can not be restored at all. If these old but elegant buildings are renovated and restored, they can present an opportunity to promote tourism in the region and be of economic benefit.

The techniques which are used in these old buildings of hirabad must be applied on modern architecture to reduce power crises and make building sustainable and efficient.

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CONCLUSION

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