

Energy Efficient Passive Techniques in Traditional Indian Architecture

Anup Naik¹

Research Scholar, BMS College of Architecture, Basavanagudi, Bengaluru, India¹

ABSTRACT: The traditional “Ecologically Sensitive – Energy Conscious “Indian way of living and the built forms that evolved out of its timeless Vedic philosophies, were aligned and appropriate to the very essence of life-based on knowledge, wisdom and the interactions between nature and humans. The architecture formations thus based on manifestations from nature and life’s learning have left an indelible mark on how we perceive, think and design traditionally.

This traditional architectural heritage reached its helm wherein the sound principles of Indian spiritual and moral value system translated into an honest approach towards creating profane structures and redefining world architecture.

The tipping point has come today when the ever-growing concerns of costs and preserving our finite resources put into the buildings and structures enforces us to take a moment, pause and look back at the ancient passive ways since the modern buildings today exemplify thermal discomfort and have to be mechanically driven to provide these comfort conditions.

KEYWORDS: Passive-Right Approach, Sustainable Design, Climate Change Mitigation, Vernacular Architecture

I. INTRODUCTION

Migration and increasing urban population have been always highlighted when discussing urbanization in developing countries. An opportunity offering urban city has become a go-to place for every young aspirant in under-developed rural areas. These opportunities are offered in various forms like increased job openings, higher pay, improved lifestyle, modern technologies and availability of infrastructure. Though urban areas offer a variety of opportunities, the rapidly growing urban population is resulting in an ever-increasing pressure on natural resources like land, non-renewable energy, water and air, thus deteriorating the quality of life offered in cities today. On a national scale, this is creating issues like climate change, with its most adverse effects on the poor section of the country. (Ghosh, Saxena, Parikh, Soni, & Narain, 2009)

As per the census conducted in 2011, 21.9% of India’s population lives below the national poverty line, thus making imprudent use of resources a topic of immediate concern across the country. A number of approaches towards sustainable and low energy consuming designs have been demonstrated by designers in India and across the globe, which propose design principles and theories to ‘reduce’ the amount of energy consumed, in comparison to the current consumption of resources. This paper suggests circumventing the complete idea of energy consumption, post-construction, required to maintain internal thermal comfort, day-lighting, availability of clean water and fresh air.

Though any active space or structure, occupied and used by human beings, zero consumption of resources could be an idealistic and paradoxical scenario to achieve; but keeping the goal would help the designers achieve the least possible consumption requirements in a given context and for the said activity. Most of the perspectives discussed and followed under the banner of sustainable design focus on counteracting the impact of natural resources which leads to active design solutions, whereas, in order to achieve the above set consumption goals, one has to adapt to the available natural resources through design, forming passive-right solutions. Adaptive or responsive design is best demonstrated in our past, in absence of any designer, where natural resources like sun, water, vegetation and wind are used as assets of the proposed space unlike the present developments.

Cities of Indian country have evolved with time, responding to their diverse cultural and geographical characteristics, until recent developments from the mid-twentieth century where modernization and urbanization have been defined by replicating western architecture. This paper aims towards materializing a language of development from vernacular and propagating awareness of passive-right solutions to cater rapidly growing issues of globalization and climate change in Indian cities.

From the early civilizations to forts and passive houses our ancient lineage has shown a meticulous passive approach. Even though gradually, but architects and designers are turning towards regionalism and culturalism to find low-energy consuming solutions. In this era of modern technologies and urbanization, the traditional architecture is fading out, thus creating an opportunity of re-discovery and learning from the past.

II. VERNACULAR ARCHITECTURE OF INDIA

Vernacular architecture is something that is derived purely from a user's need and response to climate. India is a land of diversity and witnesses a variety of solutions for different climatic, socio-cultural and topographical needs.

1. Harappan Architecture and Planning

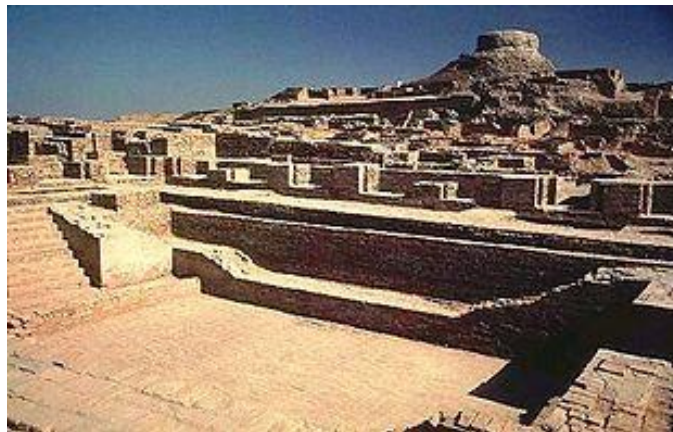


Figure 1: Image showing ruins of Indus Valley Civilization

Source:

http://en.wikipedia.org/wiki/Indus_Valley_Civilization

The cities of Indus Valley Civilization are studied and admired by architects, planners, archaeologists and historians for their urban planning with elaborate drainage systems, water supply systems, and clusters of large non-residential buildings. Apart from its planned layout and rectilinear structures arranged in a grid-iron fashion, the Harappans are also known for innovating with building materials. Fired and mortared bricks, sun-dried mud bricks and wooden superstructures are a few techniques used in that era. The building of huge walls around the entire city exhibiting the settlement's strength and also protecting the residents from floods and war. Sensitive approaches like tapering the land away from the city walls to prevent water from flooding inside can form basic principles, further combined with modern technologies to face challenges for the growing population, increased frequency of natural calamities and intensifying effects of climate change.

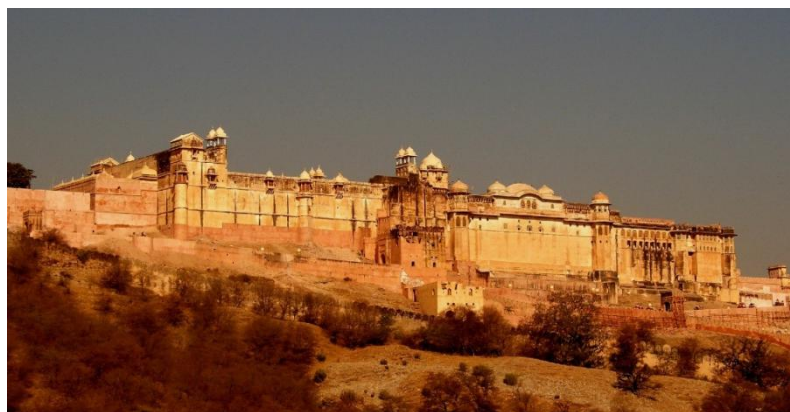


Figure 2: Amer Fort, Rajasthan, India

Source: <http://www.thehistoryhub.com/wp-content/uploads/2014/04/Amber-Fort-Images.jpg>

2. Thermal Comfort in forts of Rajasthan

Rajasthan region of India experiences extreme climatic conditions with very cold winters and extremely hot summers. Stone is the most common material used for any structures throughout the region, known for its high heat retaining properties keeping the internal spaces cool in hot summers and warm in cold winters. Also, the structures are seen lined with a number of small openings catering to both the cultural aspect of women's safety and climatic conditions of blocking the direct entry of harsh sunrays within the structure.

Amer fort noted for the use of high thermal mass strategies and evaporative cooling techniques. Sheesh-mahal (a room with mirrored walls) was created to light up lamps across the fort to create heat during cold winters. Outdoor gardens near the lake and other water bodies would provide a cooling effect for comfort from the hot sun.

3. Passive Cooling Techniques in Jaisalmer

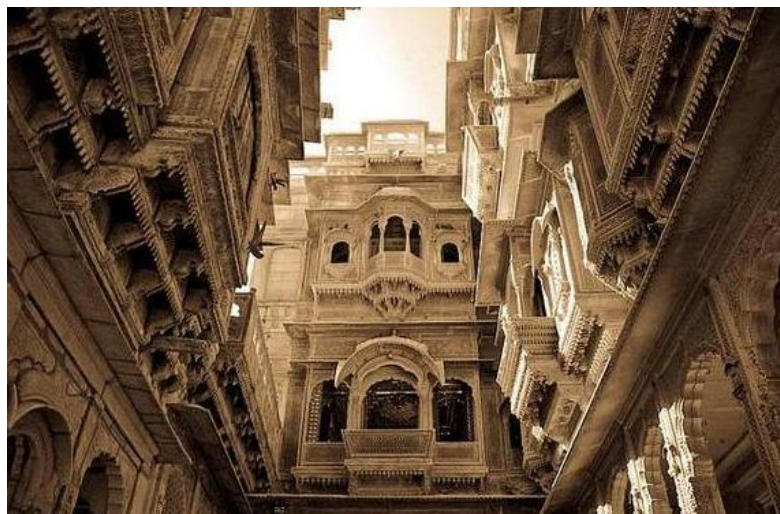


Figure 3: Haveli in Jaisalmer

Source: <http://www.lauriebaker.net/index.php/photos-and-videos/pictures-of-buildings>

In the absence of all the modern technologies, the medieval Indian men have created an urban environment completely in synchronization with the climate and nature. The planning also fulfills the basic needs and requirements of the inhabitant's aptly. Narrow streets, compact planning, intensely carved facades, and the jharokas (multiple small openings in the building façade) form the most ideal formula to subdue the harsh and high temperatures of the region. Haveli's of this hot and dry region reflected the passive design elements of high thermal mass like mutually shaded surfaces, variety of jallis (intricately carved openings) and, courtyards that influence, regulate and cool down the hot wind. Varied sizes of openings also help the sand settle down in this desert region. Elements like jharokas and jallis form key identities of the region as well as resemble the cultural factor of privacy and women's safety. A socio-cultural element of markets further offers shade to pedestrians by sheltering the narrow streets along with added vibrancy and activity for any passer-by.

Along with our ancestors, a few sensitive architects and designers have offered energy-efficient, passive design solutions for the modern, globalized era. The factors defining vernacular change with time so do the physical manifestation of the values and principles discussed under traditional architecture.

4. Laurie Baker defining Vernacular in Modern Era

Laurie Baker believed in minimalist, unique structures adhering to the surrounding context. He enjoyed exploring local materials and workmanship, thus creating job opportunities, propagating particular art or skill and, a cost-effective end product that is aesthetically appealing in context to its surroundings. Laurie Baker epitomized the architectural principles of cost-effectiveness, use of locally available materials, respect for nature, avoidance of energy-intensive materials and waste minimization to create low-cost and at the same time high-quality buildings which perfectly define pre-empted modern concepts of eco-friendliness and sustainable architecture.

His structures form the best-case examples to understand the mutual relationship between built and unbuilt and their concurrence to enhance one another.

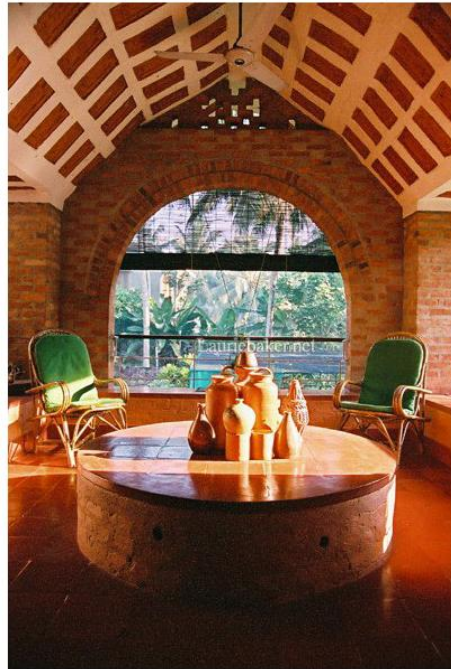


Figure 4: Structure by Laurie Baker
Source: <http://www.lauriebaker.net/index.php/photos-and-videos/pictures-of-buildings>

5. A Contemporary Expression of Sustainability



Figure 5: T-Zed Project, Whitefield, Bengaluru
Source: <https://sustainabilitynext.in/sustainability-strategy/how-bcil-has-paved-the-path-of-imaginative-urban-sustainability/>

A modern-day expression of the passive right approach to design is the T-Zed project. The project highlights passive drivers for architectural design, material selection, comfort conditioning and, site planning. Along with forming comfortable housing for the residents, the project offers minimal or optimum use of energy and resources. The techniques used to achieve cost-effective and environmentally considerate solutions are tried and tested by the construction group in the past.

With the increasing awareness and tragic impacts of climate change, designers and developers are gradually drifting towards energy conscious solutions.

History shows the importance of the relationship between human activity and nature. Human lives remained much dictated by solar and seasonal cycles, instead of trying to homogenize living conditions throughout the year. The future lies in coexisting with nature rather than against it.

“Passive design” is an approach to designing a space that uses architecture in a way to minimize consumption of energy and enhance its thermal comfort. The intent of the paper is to explore the need to follow our past lineage of passive architecture in building form and thermal performance of building elements (including architectural, structural, envelope and passive mechanical) which are to be integrated and optimized for interaction with the local microclimate. Traditionally Indian architecture is driven by the need to arrive at harmony with nature which was an important design element. With development and progress and a desire to copy the west harmony which was an intrinsic Indian element was sub due d for artificial control resulting in buildings without context. History is full of examples of the relationship between h u m a n a c t i v i t y and n a t u r e . Human lives right from the very first planned civilizations like Indus Valley remained much dictated by solar and seasonal cycles, instead of trying to homogenize living conditions throughout the year.

The crux is to find ways to live, thrive and work with nature rather than against it.

Traditional architecture is the outcome of centuries of optimization of climate consideration, material use, and construction techniques. A large part of the Indian Subcontinent has for the majority of the year ample ‘Sun’- (renewable, non- polluting, abundant and direct) sources of all present natural cycles on earth. For building design in the majority of these regions, the necessity is to learn the art to control and simultaneously utilize this abundance.

In the modern context, buildings represent enclosed, isolated boxes where environment is artificially controlled hence requiring a considerable amount of energy. A problematic relationship between architecture and technology is visible which outlines the definition of modern age building syndromes of thermal and visual discomfort translating into occupant fatigue.

In view of the limited resources at our disposal coupled with occupant discomfort, it is very much essential to review the historical origin of Architecture & Technology to restore the comfort back inside the buildings. Climate responsive architecture is the need of the hour. Consumption of energy can be reduced from 50-80% if the architects and designers plan the buildings considering the microclimate of the region, its topographical conditions, and other external features; this further enhances the comfort levels of indoor as well as outdoor environment.

Controlled microclimate by the use of passive design features was always given importance and eye for detail in indigenous design by understanding and exploring these principles. This happened from vast urban settlements to forts to Havelis and extended into a simple dwelling for the common man. This article explores these principles for the concepts and their applications that translate into architecture and urban design.

III. PASSIVE TECHNIQUES AND FEATURES

The main components of passive techniques and its features which are intrinsic to design are explored in the examples and illustrations below:

A. HEAT GAIN PREVENTION TECHNIQUES

The interaction with built mass is the source of maximum heat gain inside the building space. The most innate and naturally submissive way of cooling a building, therefore, can be achieved by minimizing the incident solar radiation on the building surface. This can be achieved by properly orienting the building, adequate and well-thought layout with respect to the buildings around, using proper shading elements and increasing the surface area to an extent in order to distribute the incident solar radiations on a larger area.

1. Orientation of Building

Maximum solar radiation is received by the roof (horizontal surface) followed by the east and west walls, this is the direction of major concern that needs to be addressed while orienting the buildings in our region. It is therefore desirable that the building is oriented with the longest walls facing north and south so that only short walls face

east and west. Thus, the least surface area of the wall should be exposed to the harsh sun rays in the morning and evening.

The sun path and its radiations, with respect to different locations, are unique and thus the structures in the locality. Use of modern tools, created to measure and mark varying radiations and their intensity, help us derive the optimized orientations to minimize heat gains and reduce the consumption of energy, otherwise required to maintain internal thermal comfort.

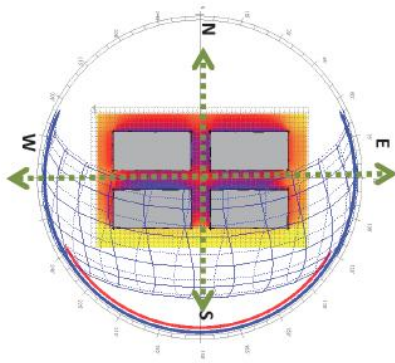


Figure 10: North-South orientation of layouts having spatial configuration to minimize heat gain
Source: Author

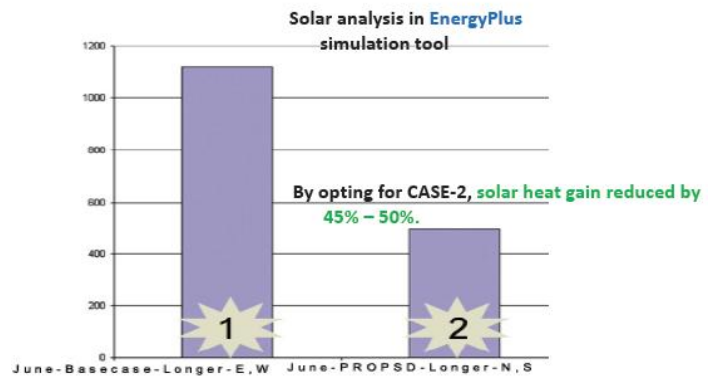


Figure 11: Case 1: Longer Axis E-W Orientation
Case 2: Longer axis N-S Orientation
Source: Author

2. Shading through Neighboring Buildings

A very common method of preventing heat gain in regions with harsh and hot climate is planning the structures in a way that they mutually shade the building façade of neighboring structures as well as offer shade to activity bearing spaces on the ground (markets, streets). The effective heat blocked by this method depends on building types, the purpose of the cluster, needs and requirements of the users and activities happening in and around such a cluster. This method of mutual shading along with other elements discussed earlier in the paper form basic and minimalistic passive solutions. Observing the past and understanding the current demands, these mutually shaded spaces can be classified into three basic types based on activities performed and cluster formations:

a. Pavilions

These are usually isolated structures or clusters of buildings surrounded by large open spaces. The major purpose of these structures is to shade surrounding spaces for semi-private outdoor activities and rely on other shading elements like alleyways, jharokas and jallis for internal thermal comfort. These structures if accurately oriented can form beautiful and comfortable outdoor spaces even in extreme climatic zones.



Figure 12: Hotel in Rajasthan shading external activities

Source:
http://images.travelnow.com/hotels/6000000/5280000/5275500/5275437/5275437_18_b.jpg

b. Courtyards

These are pavilions turned inside out, with clusters placed in a way to form internal, shaded open spaces, leading to more private activities bound to the cluster and its users. These along with forming shaded spaces, also supplement the wind flow, thus maintaining the internal temperatures of the buildings.



Figure 13: Internal courtyard in Jaisalmer
Source: www.chocolate-fish.net

c. Streets

These are the narrow public spaces formed between long building blocks. Apart from being the major component of connectivity, these also help buildings shade each other as well as the pedestrians, public activities and commuters on the ground level. Varied sizes of such streets also enhance the wind flow thus cooling the hot air and maintaining the optimum temperatures in a neighborhood.

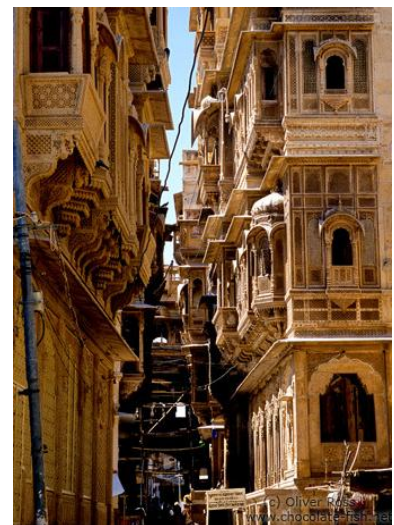


Figure 14: Mutually shaded streets in Jaisalmer
Source: <http://www.tourismguideindia.com/jaisalmer.htm>

3. Shading by Vegetation

Shading by trees and vegetation is a very effective method of cooling the ambient hot air and also helps protect the building from direct solar radiation. As discussed above, openings and walls aligned to the East-west axis tend to receive almost 50% more sunlight than that received by openings and walls oriented along the North-South axis. The positions for trees and vegetation should be determined by drawing lines starting from the centre of respective openings, mostly on the eastern and western facades, towards the sun's position based on the given time and date. Based on the Indian growth cycles and seasonal rotations, Southside should be planted with deciduous trees. Trees along with filtering the daylight also help maintain the line of privacy between private buildings and public streets.

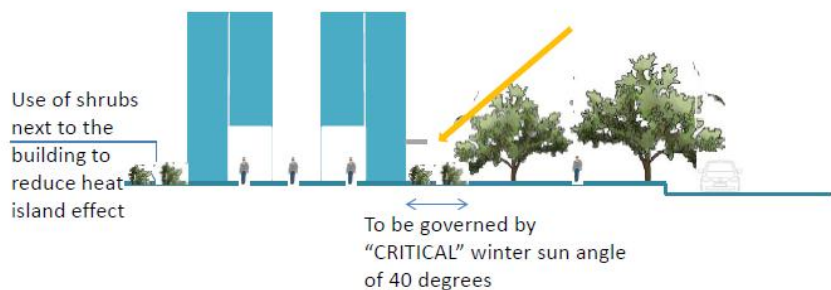


Figure 15 Typical Section of Built mass and integrated landscape & street
Source: Author

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4. Shading by Overhangs, Louvers and Textured Facade

Another way of lowering the impact of a hostile climate is by modifying the external façade in order to block, reflect or refract the sunrays. This has been explored both in past and present by adding different elements to the façade or by experimenting with the facade's texture and material. The elements used are further classified into the following categories:

a. Movable Opaque elements :Adding components like roller blinds, curtains, or multiple glazing options are highly effective in reducing the amount of solar penetration, but at the same time, these features obstruct the views and also impede the airflow, thus giving rise to multiple other issues.



Figure 16: External Louvers

Source: <http://drasiskchatterji.hubpages.com/hub/JALI-lattice-work-A-photographic-introduction>

b. Louvers

These are elements either fixed or partially movable, based on their design, on the external surface of a structure, provided in order to maintain the internal ambiance and effectively cut down the solar penetration within the building. Though environmentally and aesthetically a feasible option these structures lead to an interrupted view and air movement.

c. Fixed Overhangs

Similar to jharokas of Rajasthan, these form external structures, protecting the building from sun rays as well as rainwater without obstructing views and wind flow, unlike above-discussed objects. Though the most efficient solution these structures being bulky cannot be attained in high rise structures. These can be modified to suit the modern requirements in order to serve its purpose better.



Figure 17: Jharokas in Rajasthan

Source:

http://4.bp.blogspot.com/_P9SC_L7zD20/TEaoG5RgUTI/AAAAAAAAAvw/TRBUfcyP6AU/s1600/Patwon+ki+Haveli.jpg

d. Textured Façade

Various innovative materials and external treatments are being explored in order to manage the solar radiation affecting the internal ambiance. The most basic example for the same would be a textured plaster which increases the effective surface area of incident rays and its uneven face leads to multiple reflections of sun rays thus reducing their intensity. Apart from the vertical façade, a building’s roof is the surface with the highest heat gain ratio. Along with the façade, the roof should be protected and appropriately treated to minimize the heat absorption.

5. Shelter against Hot Winds

Hot winds during summer in hot and dry climate zones add to the heat gain in structures of these regions thus making the internal atmosphere uncomfortable for the users. The structures can be best sheltered from the wind by using natural barriers as opaque built obstructions can cause turbulent flow of wind. Man-made barriers further add to the accumulation of heat from the surfaces exposed to the sun. Natural elements like trees and shrubs can form efficient wind barriers, also elevated terrain or landmass if available, can be utilized to regulate wind movement.

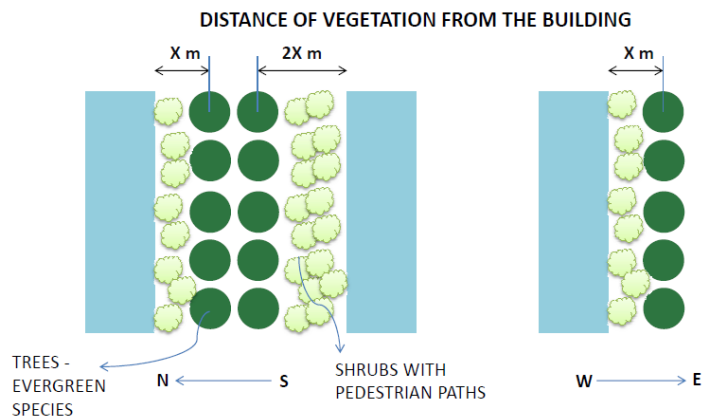


Figure 18:Diagram showing trees as wind barriers
Trees are lined closer to the South façade to cut off direct radiation. Evergreen species are to be planted to ensure shade from the trees all year round. Vegetation is lined slightly away from the North façade to allow shallow daylight. Similarly, the distance of trees from the East façade needs to be arrived to ensure the cut off of direct radiation after 7.30am in the ground and first floors.
Source: Author

B. ROOFING TECHNIQUES

Roofs are the structural elements that receive the maximum and the harshest sun radiations compared to any other part of the building. Thus, treating the roofs to reduce heat gain can help manage the internal thermal comfort.

1. Shading of Roof and Walls

Surfaces of a building can be sheltered either by a separate covering element or it can form an integral part of the entire building envelope thus preventing the penetration of any excess heat from the sun. The use of highly textured and undulating surfaces has parts in shade thus reducing heat gain considerably. This also increases the surface area of the external façade which results in a greater coefficient of convective heat transfer. This natural process of heat transfer leads to faster cooling of the structure in the evening and night when the external temperature is lower than the internal building temperature.



Figure 19: View showing options of protective layers for roofs
Source: Author

2. Reflecting Surfaces

Using colours and chemical components known for their reflective properties also help reduce heat gain in a building considerably. Cities have taken the initiative of painting all the roofs with reflective materials and colors in order to lower the heat gain and therefore reduce energy consumptions at an urban scale.



Figure 20: Translating cities roof line white – reducing heat gains
 Source <http://www.gatewaygreen.org/white-roofs-a-new-sustainable-direction-for-cities/>

3. Building Surface Cooling

Cooling the building using a thin and uniform film of water throughout the roof or terraces of a building derived from surface evaporative cooling techniques forms a constructive method of maintaining thermal temperatures in a structure. This method helps achieve lower roof temperatures when compared to other methods of surface cooling. The roof evaporative process works successfully in hot and dry as well as warm and humid climatic zones. The type of construction plays a vital role in determining the efficiency of this system of cooling.

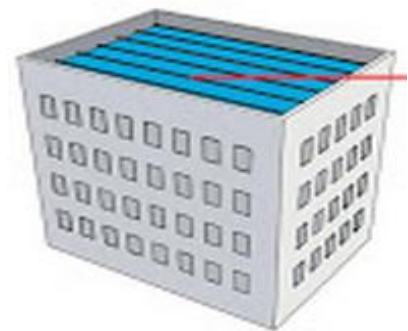


Figure 21: Roof Spray

Source:
<http://www.ruanginterior.com/2011/06/sustainable-solutions-green-building.html?m=1>

4. RoofPonds

The roof or terrace is designed in a way to store water which serves as both heat-absorbing source and heat-reflecting sink, therefore making this system beneficial in summers and winters. The water pond provided above the roof is the major element of heat gain and reflection, the roof insulation is kept close to negligible. During summer days, the solar heat is reflected away from the water as it keeps receiving heat from lower space through the roof, thus maintaining cooler temperature in spaces below. During the night, the water on the terrace loses the accumulated heat by the virtue of evaporation, radiation and convection, thus regaining its capacity to cool the spaces below. In winters, the reflection over water is removed during the day, allowing heat gain through the roof thus warming up spaces below. And during the night water is covered with insulation thus preventing the reverse movement of heat and trapping it in spaces in order to maintain the warmth naturally.

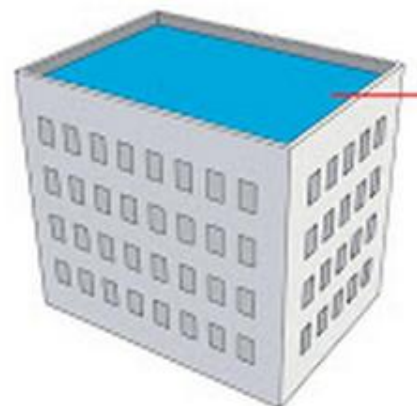


Figure 22: Roof Ponds

Source:
<http://www.ruanginterior.com/2011/06/sustainable-solutions-green-building.html?m=1>

C. VENTILATION TECHNIQUES

Ventilation is the most basic principle based on hot and cold air movement that has been widely used by our ancestors and then modified to suit the present scenario for maintaining thermal comfort. This scientific principle has been used in various forms ranging from windows to courtyards to wind towers in different regions.

1. Windows

Windows play a major role in influencing indoor ventilation due to natural wind flows. A number of factors affect this movement like the climate of the region, direction of the wind flow, area of penetration or location of the opening, size of both the inlet and outlet openings, volume of the space considered, external devices used for shading, presence of wire meshes or screens and, partitions if any inside the space.

Considering the natural flow of wind, the ventilation within the structure is governed majorly by two forces. Firstly, air flows from high pressure to low pressure areas only if an opening is created in the dividing wall and, secondly if the inlet and outlet openings are created on different heights, the wind flows due to a difference formed in density by an upward flow of hot air.

A sensible flow of air can be achieved by providing windows in a way that promotes cross-ventilation. Multiple openings provided on the same wall lead to movement of air to very shallow depths, therefore not affecting the internal ambiance. In such cases, an exhaust or outlet like chimney or ridge terminal in the roof can be provided to release warm air rising up and further helping cold air to move inward through an underfloor air supply on the leeward face of the structure.

2. WindTower

Wind towers work the best in hot and dry climatic zones, where the temperature varies on a wide range with hot day times and extremely cold nights. Clear sky in nighttime results in easy radiative loss of heat from structures in this zone. Wind towers work efficiently as their openings are located in the direction of wind and outlets on the opposite side taking advantage of the varying wind pressures resulting from changing wind speeds and directions. The thumb rule followed for any wind tower is the surface area of the outlet should be three times more to its inlet. The inlet should be strategically placed in order to assure even distribution of air.

During the day time, external hot air enters the wind tower, which cools down immediately on contact with the cold surface of the tower and starts moving downwards (cold air is comparatively heavier). The outlet placed on the opposite side creates a draft of air within the room, thus promoting the circulation of cooler air during warmer day time. As a result of heat exchange throughout the day, the surface of the wind tower becomes comparatively warmer in the night, thus reversing the flow of wind. The cold air heats up once in contact with the warmer surface of the wind tower, reversing the wind flow and thus heating up the internal ambient air during colder nights.

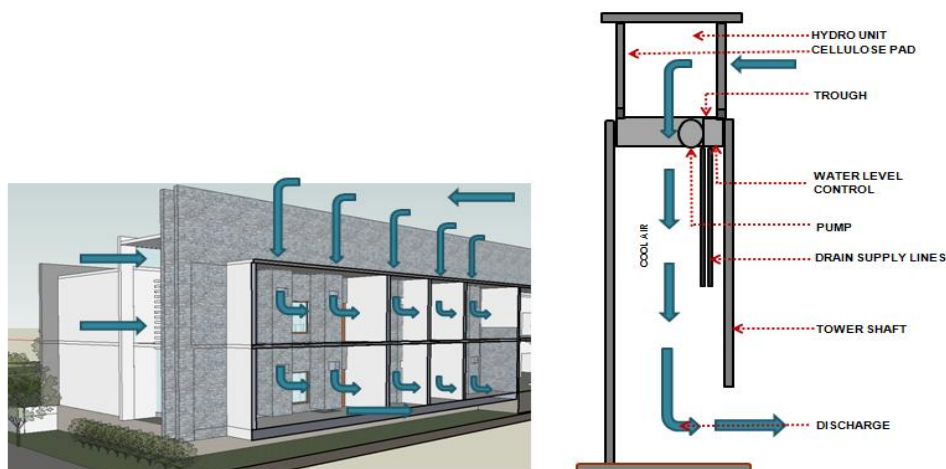


Figure 23: Working of a Passive Downdraft Evaporative Cooling System: Net Energy Savings of upto 60% compared to conventional air conditioning systems with payback after 3 to 4 years.

Source: Author

3. Solar Chimney

A solar chimney works on similar principles as described above, with a slight change, where the air is heated on purpose using natural elements like solar radiations to initiate the wind flow. Thus the chimney is designed in order to maximize the solar gains which in return promotes wind flow in the structure. This is specifically used in the regions with low wind velocity, where an automatic flow of energy is difficult to create.

The major aspects considered to enhance the rate of ventilation in such regions are the height difference between inlets and outlets in a structure, the area covered between inlet and outlet in a structures cross-section, geometric location of the plate absorbing solar radiations and the angle of inclination of the incident sun rays.



Figure 24: Solar Chimney

Source: <http://www.capcbc.org/passive-heating-cooling-solar-chimney/>

4. Courtyard Effect

The sun heats up the internal air inside a courtyard which rises up creating a vacuum. The cool air from outside enters the courtyard from lower openings, thus initiating a wind flow. In the night this flow is reversed as the surface of the roof loses its heat due to radiation and convection and cools down reaching the dry bulb temperature of the surrounding air. Sloping the roof towards the internal courtyard, the cool air flows inside the courtyard and enters the rooms at a lower level, thus cooling the living spaces in the hot climate.

In order to successfully benefit from this movement of air, it becomes necessary to ensure an adequate amount of radiation reaches the internal courtyard throughout the day in order to create the flow of air. This concept of wind movement can also be achieved by providing two courtyards at different temperatures, with one cooler space shaded with trees and other space heated up using sun radiations thus initiating the airflow.

D. COOLING TECHNIQUES

1. Water

Water is an architectural element that is extensively used in our ancient buildings like Mughal gardens, forming a cooling as well an aesthetical element of the space. Water bodies help attain physical comfort levels by the method of evaporative cooling of the surrounding air.

The rate at which the surrounding air loses its heat depends on the surface area covered by the water body, location and zoning of the water body and the strategic sheltering provided to parts of the water body through natural or physical elements.



Figure 25: Mughal Gardens

Source: <http://www.sodelhi.com/historic-gardens/482-mughal-gardens>

2. Baoli

This method was employed over 1,500 years ago by local people of Rajasthan, who built "baoli" also known as stepped wells -- bodies of water surrounded by a descending set of steps, helping to create a microclimate in the surrounding structure. These structures are famous for offering shelter in a hot climate, water in dry regions of Rajasthan and a cultural gathering space for women of the neighborhood. These structures further formed icons of the region forming an identity for the people residing in the region as well as the tourists visiting this place. Thus, these structures from the past along with being energy efficient and functional also hold an important place in the socio-cultural structure of the community of the region.

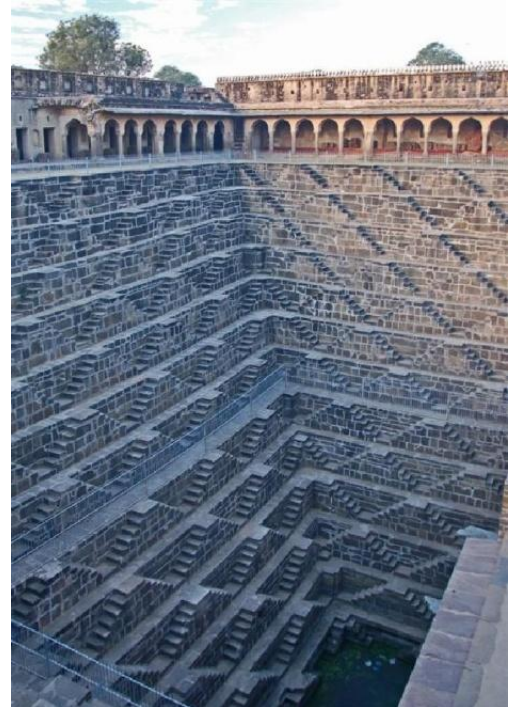


Figure 26: Stepped Wells

Source:<http://sar3dy.wordpress.com/2010/11/30/indian-stepped-wells/>

IV. CONCLUSION

“Human use, population, and technology have reached that certain stage where mother Earth no longer accepts our presence with silence.” Dalai Lama

Architecture and buildings being one of the biggest consumers of today’s resources which are finite and fast depleting give us a chance to put into perspective the learnings of our rich Indian architectural heritage, which had an eye for passive right detail.

Energy and resources are precious and to save these is a matter of prime concern to all of us. It is time to learn and adapt the passive design techniques to maintain a comfortable environment inside without much use of active systems of cooling or heating. Ancient monumental buildings, forts, Havelis, residences etc. have stood the test of time and proven to us time and again that they still are places to relax without fan, coolers and air conditioners. It is important to investigate the optimized use of passive environmental control system from Indian traditional architecture and maximize its potential for contemporary application.

Microclimate control was always part of our Indian architectural heritage and to find the suitability of these principles in today’s’ context is for all of us to explore. This certainly does not mean that we go back to the traditional forms and expression rather ‘imbibe’ these coupled with the global information and technological intelligence that is in our hands to build a foundation of architecture which is passive, to the context and technologically in sync.

It takes time to connect the dots, I know that. But I also know that there can be a day of reckoning when you wish you had connected the dots more quickly.Al Gore

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