



“APPLYING VERNACULAR TECHNIQUES FOR MAKING CONTEMPORARY ARCHITECTURE SUSTAINABLE”

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Abstract: Built forms when developed according to the climate, locally available materials and techniques, traditions and culture of a particular region have proved to be sustainable, climate responsive and provides the built form with its unique cultural identity. Today Globalization has led to making built forms so similar to each other that they have lost their sense of identity. The built forms are so similar to each other that we cannot differentiate if the building is in Mumbai, New York, or Brisbane. Are these structures which have an aesthetic appeal to them environment friendly and sustainable? This concern has been analyzed in this review paper. An attempt has been made to research about vernacular techniques and analyze if the application of these techniques to the contemporary built forms, will help them to develop a unique cultural identity of their own along with enhancing their chances to become a sustainable environment friendly project. The research concentrates on techniques used in climatic zones which are “Hot & Dry” and “Hot & Humid”. The research shows that using vernacular techniques in contemporary built forms has increased the human comfort not only on a physical level but also on a physiological level. This research can be useful in integrating vernacular techniques to contemporary architecture making them sustainable and environment friendly.

Key Words: Vernacular Techniques, Contemporary Architecture, Sustainability Aspects, Human Comfort, Traditional and Cultural Essence.

1. Introduction:

Shelter or home has always been considered as the most basic and important need of the human race. Since the ancient times when humans lived in caves to their coming together for settlements near rivers and fertile soil, to development of neighborhoods, early civilizations and societies, shelter has been the most important part of human beings. With each developing phase new technologies and techniques have also been developed for constructing these built forms. From ancient times-built forms have been developed using locally available materials in such a way that it is climate responsive and caters to the cultural and traditional needs of its occupants, which is known as Vernacular. In today’s fast paced scenario easy travel, mass media, electronic communication and telecommunication has converted the whole world into a Global Village.

On one hand this has really been helpful in understanding and developing fast paced construction techniques and technologies with easy access to the knowledge and data from all over the world, but on the other hand it has deeply impacted the cultural identity and traditional essence of a built form which was earlier showcased through vernacular architecture by giving them a similar appearance irrespective of the region in which they are built. The Global use of materials technologies and techniques have developed a Contemporary Architecture style which believes in expressing itself, defying gravity, developing huge volumetric buildings, integrated smart lighting systems, curvilinear shapes etc. which brought into existence a less time consuming and eye-catching type of architecture.

The price of using such high-end technology which is providing us so much of comfort and economical advantage is being borne by our environment. Environmental agencies have shown their concern about the amount of negative impact construction industry is having on the environment by the amount of CO₂ emission and waste production.[1] The Architecture, Engineering and Construction (AEC) Industry contributes to huge amount of carbon emission and waste production, also the amount of energy consumption is huge in AEC industry. This negative impact of the construction industry and concern for the environment has raised the issue of developing and utilizing ways and methods which make the built forms more sustainable, i.e., they consume less amount of energy during and after their construction and have a reduced carbon footprint to enhance the environmental conditions.

This research paper focuses on how the traditional and vernacular techniques can be integrated in the contemporary built forms to make them more energy efficient, sustainable, and give them a sense of their unique cultural and traditional identity.

2. Methodology:

The methodology used for this review paper is collection of research papers and study material related to the subject. The selection criteria for academic research papers have been kept that the reviewed papers must be a part of a Journal having a high reputation in the field. Through these review papers the various Vernacular Techniques used in Hot and Dry regions and Hot & Humid regions have been analyzed along with their sustainability aspects. Also, the various elements which define Contemporary architecture have been taken into consideration to deeply analyze and understand its sustainability criteria and the changes required. With the help of these review few case studies were taken, and a comparative analysis was done on their various performance aspects regarding human comfort, both before and after application of Vernacular techniques. The aim of the research paper is to find out if application of Vernacular techniques will be helpful in making Contemporary architecture sustainable.

3. Techniques of Vernacular Architecture:

There are five climatic zones which are Tropical, Dry, Temperate, Continental, and Polar. The zones near and just above the equator have Tropical and Dry climate. This research paper concentrates mainly on these two climatic zones. For Tropical climatic zones the temperature remains above 18°C all-round the year and each year precipitation is more than 59 inches. Dry climatic zones are extremely dry due to which the moisture evaporates from the air rapidly and the precipitation is very less.

Because of these extreme conditions Ventilation systems and natural cooling have been an integral part of architecture for the regions having such type of climate. To achieve human comfort at a low-cost with higher energy efficiency, different types of construction techniques and materials were also used along with Natural Cooling and Ventilation Systems.

3.1 Elements: a. Wind Catcher

A Wind Catcher can be defined as a device as device which is used for achieving thermal comfort inside a built form. A common definition of wind catcher is published in the Dictionary of Architecture and Construction: —In hot regions of the Middle East, a device is used which consists of a small tower. This tower on the roof is provided with an opening on the side of the prevailing winds. This device ventilates the house by letting in the cooler outdoor air through the inlet area at a higher wind velocity forcing the air to go down the shaft and ventilated the interior spaces.

This element has been used in various hot and dry regions having different names and a few changes in the design, but its function remains the same.

In Egypt its known as the '*Malqaf*' [3] which is a shaft having a unidirectional opening rising above the building and facing the prevailing winds. It catches the wind flowing over the buildings and through internal ducts pushes it down into the internal spaces of the built form. As it is a small tower it is independent of the roof.

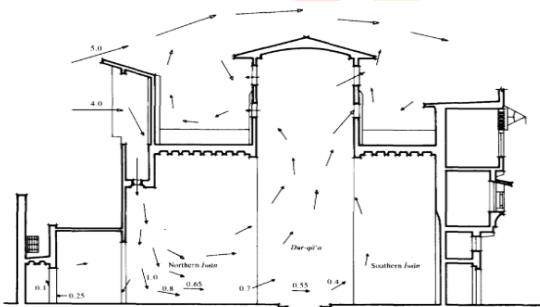


Fig-1 Working Mechanism of Malqaf [3]

In Persia this element is known as Badgir [3], which is a tall tower and because of its height its totally independent of the roof.

Wind Catcher is an element which is connected to the roof and is down not like a tower.

All these elements work on the principle of pressure difference on the outside and inside of building resulting in the inflow of air through duct into the building.

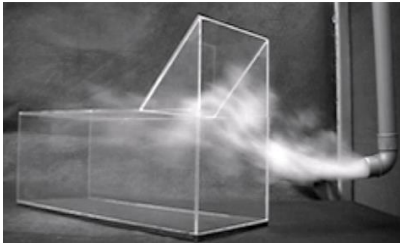


Fig-2 Model showing working of a Wind Catcher[3]

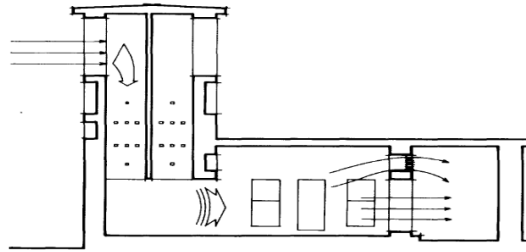


Fig-3 Section through Badgir [3]

b. Earthquake Resistant Piers:

These are piers made of stabilized earth blocks. These earth blocks are stabilized using only 5% of cement. These blocks have a 5cm diameter hole in the center which has steel ties increasing the shear strength of the piers making them earthquake resistant.



Fig-4 Earth Block with holes[10]

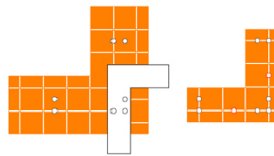


Fig-5 Earthquake Resistant Piers[10]

c. Vaults

Using Vaults for covering larger spans. These vaults are made of compressed stabilized earth blocks which makes the construction cost effective and energy efficient. It can cover a span of 9.32m and can be effectively modified for covering even larger spans.

3.2 Techniques: a. Solar Passive Techniques

Solar Passive Techniques can be applied through various different ways like *Orientation* of the building is done in such a manner that it becomes perpendicular to the prevailing summer breeze. Providing water bodies for *Evaporative* cooling. Maximizing stack effect by increasing the building height and providing large fenestrations and roof overhangs are few of the ways through which Solar Passive Techniques can be applied in a built form.

b. Compressed Rammed Earth Blocks

The conventional ways through which construction materials like Fired Bricks, Aluminum, Cement and Steel are manufactured contribute to at least 25% of India's carbon emission.. But Compressed Rammed Earth Blocks use the same earth which has been excavated from the site and are stabilized using only 5% cement. The area from which the earth is excavated can also be used for harvesting rainwater. This makes these blocks four times cheaper, three times stronger and ten times less polluting as compared to conventional bricks.



Fig-6 Compressed Rammed Earth Blocks Source UNEP-SBCI(2010)[10]

c. Rammed Earth Foundations

This technique is based on the concept that the foundation is excavated with precision and the excavated earth itself is sieved, mixed, and rammed and used for the foundation. This technique results in zero wastage of raw materials and is very cost effective.

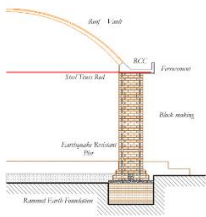


Fig-7 Rammed Earth Foundation Source UNEP-SBCI(2010)[10]

d. Passive Downdraft Evaporative cooling

This technique is a bit similar to the way Wind Catchers work by generating an air drafting system in the built form. The used hot air from various spaces in the built form rises above and moves out through the outlets provided at heights. This creates a draft for the fresh air to come inside, this fresh air at the inlet points is sprayed with water through nozzles at a pressure of 50 Pa creating a mist which cools the incoming fresh air and circulates in the usable spaces of the building. This technique is extremely effective in hot and dry regions and works in critical conditions when outside temperature is 40°C or even more. This method not only increases the energy efficiency of the building but is also very cost effective.

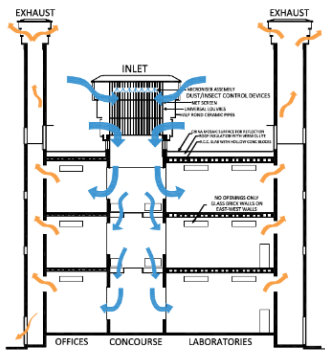


Fig-8 Section of PDEC system

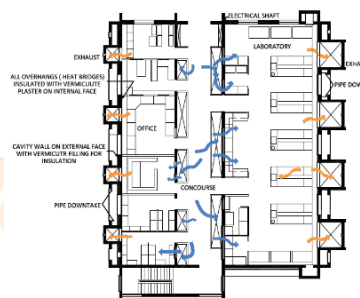


Fig-9 Typical Floor Plan

3.3 Materials:

Vernacular Architecture uses the locally available materials for construction. This material is affordable by any category mix of the society and responds to the climatic needs of that particular region. Some such materials are Mud Walls, Thatched Roofs, Mud Floorings, Dried Weaved Coconut Fronds, Stone blocks, Red Oxide Floorings, Mosaic and Ceramic Floorings[2] are few such materials which because of their availability and climatic response can increase the Sustainability of the structure. These materials are frequently used in rural areas for low-cost housing but with application of few adaptive techniques these materials can be used at a larger scale for contemporary built forms even in the urban areas. For example, standardization of Mud blocks and Stone blocks can make the construction very fast paced along with the increase in energy efficiency.

Two other materials which are now being used at a very large scale under 'Modern Earth Architecture'[4] for contemporary built forms are:

- Adobe
- Rammed Earth

Adobe: These are rectangular bricks which are made out of earth mixed with locally available organic materials like straw, cow dung, plant juices and water. Then these bricks are sun dried and ready for use. While assembling these bricks adobe mud is used for bonding them together to make a structure. Though the process of making these bricks is quite labor intensive but this drawback becomes an advantage of raising the local economy by generating employment avenues for the local artisans. These bricks have optimal sound transmission levels, thermal mass storage and heat transmissive properties. They can be used for multistoried structures if provided with appropriate thickness. They face a major drawback that their wet compressive strength is near zero and thus have a high annual maintenance cost if used in humid areas but in hot and dry regions they are quite effective.

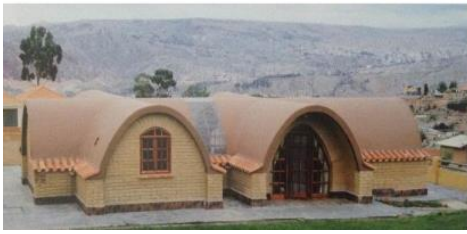


Fig-10 Residence built of hand-made adobes, designed by Raul Sandoval in Bolivia[4]



Fig-11 Adobe residence built by owner builder in USA

Rammed Earth:

Buildings which are built using Rammed earth utilize the bulk materials which are available on the site. These materials are compacted into form work and are directly laid on the foundation. This rammed earth usually comprises of stone and concrete. If the walls made out of Rammed Earth are properly designed and constructed the use of construction materials and construction waste can be reduced many folds. Thus, increasing the energy efficiency of the building throughout its operation cycle. The major advantage of using rammed earth is that it is absolutely recyclable, it is low cost, has superior thermal and acoustic quality and great interior comfort. Rammed Earth needs protection from rain and moisture and less low insulation properties which can be increased by providing a lining on the interior side. It has great thermal quality providing a difference of at least 6°C in the outdoor and indoor areas thus making an apt material to be used in Hot and Dry areas.



Fig-12 Net zero residence with rammed earth walls designed by Noel Cross+Architects in California

4. Elements defining Contemporary Architecture:

4.1 Contemporary Architecture:

Contemporary Architecture can be defined as the architecture of present day or in other words the architecture of now. The buildings which are a part of contemporary architecture are radically different from each other, they are expressive, having more curves and sometimes gravity defying shapes, also they showcase the use of new building materials and techniques. Contemporary architecture need not be necessarily defined for large scale projects but is also clearly visible in projects as small as an Eco Capsule, a mirrored cube tree house or a cantilevered apartment building. Contemporary architecture also makes use of computer aided designs which help them to design unconventional, nontraditional buildings which can defy gravity logic etc. and act as a showstopper building showcasing hyper realistic and futuristic designs.



Fig-13 Cardiff Bay Opera House
Source- Google Images

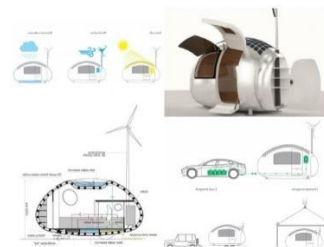


Fig-14 Design of Eco Capsule by Nice Architects
Source- Google Images

Contemporary architecture is the architecture of the present day and hence it does not follow any particular style of any era. Contemporary architecture promotes the usage of curved lines, rounded forms, and unconventional volumes. Contemporary architecture not only uses new materials like steel, glass, titanium, aluminum etc. but also used the new technology for its construction.

4.2 Elements of Contemporary Architecture:

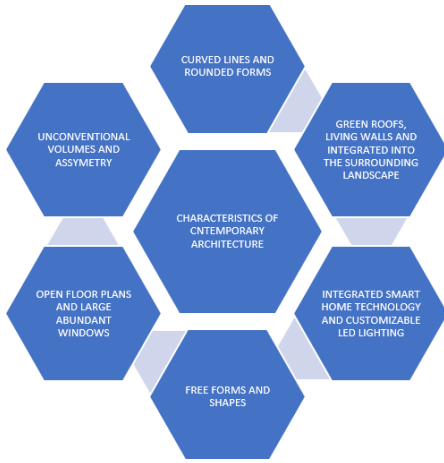


Fig-15 Elements defining Contemporary Architecture

Though Contemporary architecture does not have a specific definition but certain key elements which help us to identify a contemporary building are:

- Curved Lines
- Rounded Forms
- Free form shapes

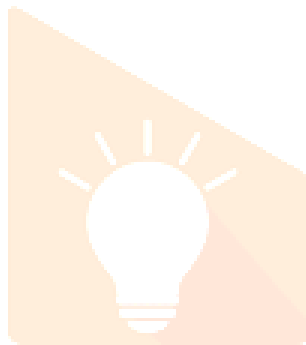


Fig-16 The Auditorio de Tenerife designed by Santiago Calatrava.

Fig-17 Freedom Park, South Africa

- Unconventional Volumes
- Asymmetry
- Green Roofs, living walls
- Integrated into the surrounding landscape



Fig-18 Vertical Forest of Milan by Stefano Boeri Architetti

Fig-19 Guayasamin House and Museum by Diego Guayasamin

- Open Floor Plans
- Large abundant windows
- Integrated smart home technology
- Integrated customizable LED lighting



Fig-20 Bird's Nest National Stadium Beijing



Fig-21 Alcácer do Sal Residences by Aires Mateus
(Alcacer do Sal, Portugal)

5. Sustainability Aspects of a Built Form:

5.1 Sustainable Architecture

Sustainable architecture can be defined as the architecture which aims to increase the energy efficiency of a built form and decrease its negative impact on the environment by moderation in material usage, space development and considering the ecosystem at large.

Sustainable Architecture aims to ensure judicious use of resources, is done in such a way that it does not have any adverse effect on the environment, as well as to conserve the resources for the future generation usage. The idea of sustainability is to provide us with a healthy livable environment with built forms using green energy resources which are renewable thus reducing the carbon footprint on the environment.

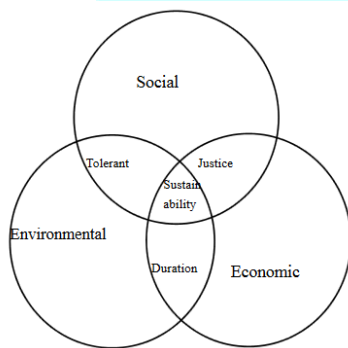


Fig-22 Indicators for a Sustainable Built Form[8]

Sustainable Architecture includes the following principles: [8]

- Maximizing non-renewable energy resource conservation
- Enhancing the natural environment
- Eliminating or minimizing the use of toxic materials.
- Influence of cultural, environmental, and climatic conditions.
- Harmony and consistency with nature and the environment.
- Energy Saving.
- Correct response to operational needs.
- Correct use of material both visually and environmentally.



Fig-23 Sustainable high-quality homes for low-income group in Las-Vegas



Fig -24 Two Storeys floating homes for coastal communities

5.2 Benefits Sustainable Architecture:

The benefits of Sustainable architecture are as follows:

- Environmental Benefits:
 - Conserve Natural Resources
 - Reduce Energy Consumption
 - Improves the air and water quality
 - Protects Biodiversity and Ecosystems
 - Uses local materials with low embodied energy
 - Reduces the production of construction waste
 - Enhances the waste management System
 - Improves the green spaces and landscaped areas around.
 - Impacts and improves the larger ecosystem as a whole.
- Economic Benefits:
 - Expansion of the green products due to more use of green materials
 - Reduces the operating cost of the building
 - Increases the life cycle of the building
 - Increases the property value
 - Improves the occupant's productivity by enhancing the surrounding environment.
- Social Benefits:
 - Creates an aesthetically pleasing environment
 - Takes care of and improves the wellbeing of humans
 - Minimizes strain on local infrastructure.

Sustainable Design can thus be defined as a design which has Structural, Mechanical and Electrical systems integrated into it in such a way that it conserves energy, reduces the carbon footprint, and enhances the health of the ecosystem as a whole.

6. Importance of Cultural Identity for a Built Form:

Global village indicates that owing to the advancement in technology, the world has come so closer that it has literally transformed into a global village where information can be accessed immediately irrelevant of the distance and people can communicate with each other right away irrespective of the distance between them.

Even after so many advantages there are some disadvantages of going Global which is affecting the cultural identity of any country. Every country has its own cultural and social elements which defines its identity as well as its diversity from other countries. But if this uniqueness of a particular region comes to an end it would adversely affect its existence. Architecture is like food, when fusion cooking is encouraged to invent something new and bring closer the people of far-off places, a hint through a spice or technique or sauce is always kept to maintain the identity and uniqueness of the original dish. In a similar way the built environment should display the use of materials to make a form or building globally acceptable but at the same time it should also showcase the vernacular techniques and materials to represent the region's uniqueness and culture.

If the built environment or the visual appearances of all the cities, districts and countries becomes same the world will become an absolutely boring place. It is the diversity in culture, techniques and social customs which not only gives a place its identity but also makes its attractive to travel and explore. Moreover, the usage of these vernacular techniques in a built form makes it more environmentally and user friendly, economical, and sustainable. The value of learning about all new techniques, materials, customs, and culture can only be helpful when it acts as an advantage to enhance our own identity and increase the sustainability.

Vernacular Architecture is the architecture of a particular region which is made by using local materials, local techniques and according to the cultural and traditional needs of the people. Since a particular region has its own different culture, materials and techniques, the built forms constructed accordingly have their own unique identity and are more sustainable because of the use locally available material and climate responsive design.

If these Vernacular techniques are integrated in the construction of contemporary built forms it will be helpful to create small villages, towns and districts with their own distinct identities, yet being unified through globalization at world level creating "Unity in Diversity"

GLOBAL VILLAGE WITHOUT CULTURAL ESSENCE



Fig-25 New York Skyline



Fig-26 Skyline of Mumbai



Fig-27 Skyline of Sydney

GLOBAL VILLAGE WITH AN ESSENCE OF VERNACULAR ARCHITECTURE



Fig-28 Building in INDIA



Fig-29 Building in Australia



Fig-30 Building in New York

6. Integration of Vernacular Techniques with Contemporary Architecture:

If these Vernacular techniques are integrated with contemporary architecture it will be helpful not only in making it sustainable and having its own cultural identity but will also increase the human comfort level both physically as well psychologically to a great extent. To explain this two case studies of India have been discussed below:

6.1 Brick House / iStudio architecture

This house built by iStudio Architecture is located in Wada, which is near Mumbai. It is a farmhouse in the hills having an area of 250 sqm. The house is having an organic shape which merges into the sky. The spaces inside are seamlessly integrated and connected to each other through curves with a central courtyard.

The house incorporated use of locally available materials, brick jalis, rat trap bonds, brick arches, filler slabs and built-in furniture. The orientation and activity zoning has been done in response to the climatic conditions of the region. Use of levels for different activities gives them a distinct location keeping the whole unit as a single entity at the same time. On first floor the bedroom is placed in the South-west position in such a way that it provides shade to courtyard and keeps water body cool. [8]

The integration of Vernacular techniques has reduced the construction budget to just INR 20 Lakhs and at the same time the reduced requirement of bricks, steel and concrete has made it eco-friendly and sustainable.



Fig-31 Showing the use of Locally available materials

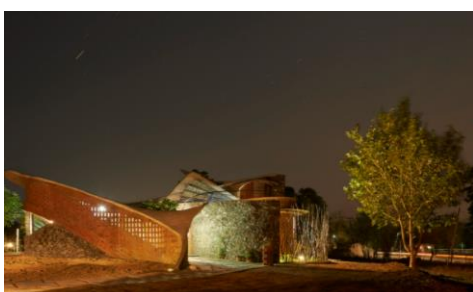


Fig-32 Showing the use of Brick jalis and built-in furniture



6.2 The Pearl Academy of Fashion, Jaipur

The architecture of Pearl Academy of Fashion, Jaipur is a perfect blend of traditional building knowledge and contemporary architecture. The academy has been designed as an environmentally responsive passive habitat having multifunctional zones for the creative activities of the students in the academy. The institutes creates highly interactive spaces which blends the indoors with the outdoors beautifully.

As Jaipur has a hot and dry climate and the adverse microclimatic conditions becomes quite adverse, it was necessary for the institute to incorporate passive cooling techniques to reduce the dependence on mechanical ventilation and equipment.

Elements such as Courtyards, water bodies and Baolis from the traditional vernacular architecture have been modified and incorporated in the Academy building. The exterior of the building has been constructed with a double skin inspired from the traditional brick jalis. The double skin acts as a thermal buffer to the built form. In between the two skins drip channels have been incorporated to create a passive downdraft evaporative cooling system.

The building uses locally available materials along with steel cement and concrete and is 100% energy efficient as far as its water and thermal requirements are concerned, as it promotes rainwater harvesting and wastewater recycling by providing a sewage treatment plant.



Fig-33 Showing the use of Brick jalis and Passive cooling Techniques

7. Comparative Analysis Before and After Integration of Vernacular Techniques:

This analysis compares the human comfort levels achieved without the use of mechanical ventilation before and after integration of Vernacular Techniques:

- Using Wind Catchers has been extremely successful in hot and arid regions. These Wind Catchers do not require mechanical energy for their operation as they are passive cooling devices.. Thus reducing the carbon foot print, increasing energy efficiency of the building and decreasing the operational cost of the building.
- Using rammed earth provides thermal insulation, sound and dust protection from the external environment. Due to this thermal insulation requirement of mechanical devices is reduced which results in reducing the operational cost of the building.
- In Torrent Research Center they have been able to save 200 metric ton of AC Plant capacity by use of PDEC (Passive Downdraft Evaporative Cooling) Technique. Also by providing effective day lighting system they have reduced the cost of artificial lighting thus overall saving an amount of approximately 100,000 dollars per annum.
- Locally made refined flooring known as Athangudi is made of natural soil. It adds beauty to the floor as well as gives it a long-lasting finish which makes it sustainable.
- With growing awareness towards environmental friendly built forms and sustainable solutions architects have been quite successful in creating built forms close to nature which provide warmth and rejuvenation against the madly rush of desires.
- In the hot areas of Egypt usage of Rammed Earth, Different sized opening and Vernacular roofing techniques have reduced the energy consumption very efficiently during the summer time. In a survey conducted amongst the people using the buildings 70% were satisfied with the thermal comfort for winter and 85% for summer seasons, 90% with the natural light (visual comfort) and 95% were satisfied with the indoor air quality.
- These Vernacular techniques since they are based on local artisans and materials can take a longer duration time period for construction and that becomes a major drawback for their implementation as the continuous increase in housing needs requires a fast paced construction technique and materials. But if standardization of such techniques is done on a larger scale the time duration can be reduced and efficiency increased.

8. Conclusion:

It can be concluded that vernacular practices take time for implementation and that is the reason why in today's fast paced life people refuse to adopt them. But with the growing awareness towards sustainability and environment friendly practices AEC industry is working on developing sustainable solutions for Contemporary built form. In such a scenario if the vernacular techniques after certain modifications and standardization are integrated with the Contemporary architecture can be extremely successful in increasing the human comfort level, bringing them close to the nature and providing them with a space of retreat from the fast paced lifestyle. This healthy retreat will not only result in increasing the energy efficiency of the building, reducing its operational cost and carbon footprint, providing the built form a unique identity, make it more environment friendly and sustainable but will also provide a psychological satisfaction to its occupants for contributing the healing process of mother nature.

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