Abodes in Adobe

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A BRIEF REVIEW
Designing Climate Responsive residences in the composite zone of Northern India as a means to conserve natural resources

The climate of the plains of northern India is characterized by harsh summers and extremely cold winters which results in buildings being air conditioned all year round, a colossal waste of energy, adds to the carbon footprint. This paper is based on the research and construction of a prototype of a small residence constructed with the object of developing a building vocabulary of materials and techniques which cater to the contemporary tastes yet derives its roots from the vernacular architecture of the place.

As 90% of the construction in rapidly urbanizing smaller towns of India is ‘individual homes’ it is important to develop/construct a model or sample of a ‘shelter’ that is affordable, comfortable, aesthetical, functional and eco-friendly.

The architect spent over four years in developing this prototype and the paper will elucidate the solar passive design techniques and the material selection and construction methodology that has gone into the construction of this ‘home’ which has dispensed only rise from the ground but return to it, without causing any harm to any living system. This is ecology, this is good design.

A truly revolutionary concept, that needs to be popularized.

INTRODUCTION

Construction Industry is the largest growing sector in the Indian economy and is also responsible for a heavy depletion of our natural resources, from timber in building, to coal in burning bricks in kilns, to oil in transportation and mostly in the production of cement and steel. Our buildings need to be designed in response to the climate and with regard to the environment. If 90% of the buildings are for residential purposes, does that imply “Our homes are destroying our environment?”

Design leads to manifestation of human intention. What we make with our hands must honor the earth, and they must not only rise from the ground but return to it, without causing any harm to any living system. This is ecology, this is good design.

Are we aware that more than 80% of our construction activities cater to less than 5% of our population? That an average house for a single family uses 8 times the cement needed for its stability?

INTENT AND OBJECTIVES OF APPLIED RESEARCH

Our firm, Imarat, has been committed to building green for a number of years now, using solar passive design and eco-friendly material. It has been our prime objective to bring good architecture to the door step of the common man – which needs designing cost-effective homes, that are aesthetical & provide all modern day conveniences. As the vernacular architecture of the Indo-Ganges plains offers very valuable lessons in terms of planning & material, it was imperative to combine traditional wisdom with contemporary necessities.

Objectives:

1. To develop a building vocabulary of materials and techniques which caters to contemporary tastes, yet derives its roots from the vernacular architecture of the place.
2. To incorporate the wisdom of vaastu-shastra (the ancient Indian text on building design and construction) with the principles of climatology.
3. To build our basic structure, an average home that blends with nature, while maintaining its unique sculptural beauty and aesthetics.
4. To use and promote construction material and technology which is environment friendly and locally available.
5. To develop a module/sample of a shelter that is affordable, comfortable, aesthetical functional and eco-friendly.

PROCESS/APPROACH

Site Analysis

The site is in a mango orchard in agricultural fields on the outskirts of Karnal.

1. Topography (Site Profile): The plot is in a mango orchard in agriculture land, the design is site responsive with fields on one side.
2. Climatic condition: The climate of Karnal is monsoon-influenced humid subtropical climate with high variation between summer and winter temperatures and precipitation. It has relatively dry winters and has a prolonged spell of very hot weather.
3. Maximum temperature of the city reaches up to 48°C in summers and minimum temperature in winter season falls down to 1°C. January is the coldest month with average minimum temperature of 7°C.
4. Rainfall: The annual rainfall of the Karnal is recorded to be about 600mm. Rainfall is unevenly distributed and decreases from south east to southwest. Rainy season starts by July and ends in September. About 80% of the total rainfall is received during this period. Some amount of rainfall is received from western disturbances during the winter season.
5. Wind Flow: It is influenced by southwest monsoon winds in the summer and westerly and northwesterly winds during the winter. The wind direction is NW and SE.
6. Population: Karnal metropolitan area has a population of 3,03,425 persons. The district has a population density of 598 inhabitants per square kilometer.

Figure 1 → (a) Wind Flow inside the building (b) Population Distribution

Residential
Commercial
Healthcare
Others

[Diagram showing population distribution]

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Design Development

The overall form of the building was detailed by the trees on site. No tree was felled – rather, the building was designed to fit in the open space between trees. The flowing curves of the building meander between the trees and the building height was kept lower than average height of a tree i.e. 17'. The built structure looks a part of its surrounding, merging in the natural grove. The basic plan is designed with the principles of solar passive planning.

Table 1. Advantages of Space Positioning

<table>
<thead>
<tr>
<th>Space</th>
<th>Direction/Position</th>
<th>Advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prayer Area</td>
<td>North East</td>
<td>Gets early morning sun</td>
</tr>
<tr>
<td>Kitchen</td>
<td>South East</td>
<td>Gets natural light all day and gets morning sun-rays which act as a disinfectant.</td>
</tr>
<tr>
<td>Main Bedroom</td>
<td>3’ below ground level</td>
<td>Earth Cooling, Easy Plumbing</td>
</tr>
<tr>
<td>Bathrooms</td>
<td>Stacked above one another In the West</td>
<td>Traps the heat from the afternoon sun in summer and prevents heating up of rooms.</td>
</tr>
<tr>
<td>Windows (Large)</td>
<td>North</td>
<td>Gives heat –free / glare free light</td>
</tr>
<tr>
<td>Lobby (Open to the sky)</td>
<td>Center of the building</td>
<td>Improves the energy flow within the building and also cools it in summers.</td>
</tr>
<tr>
<td></td>
<td>Openable skylight</td>
<td>Acts as a duct for evaporative cooling in extreme heat and improves air circulation and wind flow.</td>
</tr>
</tbody>
</table>

Materials and Construction

This project showcases the techniques of constructing in mud, bamboo, thatch, terracotta and burnt brick. The age-old techniques have been refined and improvised so as to ensure longevity, ease of maintenance, cost effectiveness, contemporary demands viz-a-viz aesthetics and comfort. A lot of research and improvisation was done to reach an optimum solution. The ancient science of vaastu viewed buildings as a whole with man and environment.

Adobe: The typical adobe wall is built on the top of a foundation of concrete block, or stone and mortar, which rises high enough above ground level to eliminate the erosional action of standing water. The tar can be used as a moisture barrier between the concrete block and adobe. A concrete bond beam formed on the top of the last course of adobe ties the wall together and supports the roof framing. This works well in moderate and hot climates. Builders of energy–efficient homes often augment these thermal qualities with insulation, particularly in cold climates. Some adobe walls are left exposed, and deep overhangs protect them from moisture.

Construction

The foundation up to plinth level was done in burnt brick. Two steel bars 8mm were used in the plinth beam and junctions to ensure seismic resistance. Also the burnt brick plinth prevents the harmful effect of ground moisture on adobe. During the construction of the foundation, the mud bricks were being made on site by earth dug out. This eliminated the requirement for fuel for transport. Burnt bricks have been used only up to plinth and in service areas as this ensures better plumbing and results in contemporary washrooms—a necessity with the modern-day users.

The structural strength of mud bricks and burnt bricks is carefully utilized with due preference given to the former as they are more sustainable and less energy intensive. Reinforced concrete bands are run above openings as well as plinth to ensure seismic-resistant safety. The structural safety is ensured, while working towards reducing the carbon footprint of the building. For the main lobby area terracotta filler slab is used as it more cost effective and provides better insulation.

A detailed study of the vernacular architecture revealed that the grass grown along the irrigation canal could be used for roofing. This particular weed grass (Saccharum bengalense) is insect resistant and fire resistant, however, over a period of time, as RCC roof slabs became the norm, the techniques of thatch roofing were hard to find. An extra layer was added for the waterproofing, between two layers of thatch. The local labour was thus trained for future use. Not only does the roof cost much lesser, its thermal insulation is far superior and no transport of material was necessary.

Sal rafters, recycled and bought from old homes (being demolished in various parts of the city) are used for the mezzanine floor. All the furniture, fitting, accessories were crafted on site from the waste wood of naturally felled trees on the site. Thus no new wood was used. However 150 new trees were planned in the vicinity to maintain the regenerative process.

The plastering of the mud wall has been done in straw, mud, cow dung and adhesive. The resultant wall looks like heritage paint and gives a serene effect. Change in the quality of daylight across seasons makes the experience of mud-plastered walls dynamic. Light may reveal their texture in sharp relief or a mellow tone. As there is a potters village nearby, handmade tiles from the local
potters are used in the kitchen and bathrooms. The deck was made out of local eucalyptus and sal wood rafters with bamboo railing. Flooring in mud is done in the living area. Lime red khed was used with mud, clay, cow dung, straw. When rubbed thoroughly it gives a shining mud finish, an excellent floor. Bamboo is used for ceiling treatment, railing and light fixtures.

The underground room and kitchen flooring is in the local “katni” stone. Keeping the current day necessity of security, a state of the art security system is installed. There is also an inverter power backup and a duct for a desert cooler that cools the entire house at very little cost. All services i.e. electrical, sanitary are by green certified companies – Thus ensuring a fusion of traditional techniques and materials with modern necessities.

OUTCOMES

The house has been in use for a year and half and has seen all season of the Indo-gangetic plains of North India from very severe summers to heavy rainfall, to extremely cold winters. Just one desert cooler, with a vent through the central duct was sufficient in summers. In June when the temperature outside was 45°C, inside it was 28°C – perfect for human comfort. In winters, the built in fireplace was used to burn scrap wood collected from the grove and the temperature inside was 22°C, where outside was 13°C. Openable windows ensured perfect cross-ventilation, trapping the breeze in monsoons and creating Venturi effect, thereby adding to the human comfort.

Adobe has excellent thermal insulation and acoustical properties. It also filters out harmful radiations and is low cost – ecologically and economically. A house planned according to the solar passive techniques, principle of Vaastu and built in adobe, thatch and filler slab is cost effective and ensures human comfort without consuming extra energy.

REFERENCES AND CONCLUSION

We cannot ecologically afford 6-8 air conditioners or the tonnes of steel and cement that go into building an average home when thousands have to be built. Operating on a 12 hour cycle of passive cooling and solar heating, adobe dramatically reduces the reliance on air-conditioning units. In a time of volatile fossil fuel prices, the economic benefits of adobe’s natural temperature controls are difficult to ignore.

Smaller towns like Karnal in India, are urbanizing at a great pace, and each individual aspires to own a house. It is estimated that the residential sector in construction is likely to see an unprecedented growth.

If architects and builders were to provide homes like MaatiSirjana could reduce the carbon footprint in this country significantly. Building in mud is seen as building for the poor, if awareness is generated – it could change the mindsets of people in a developing country like India. By reducing a home’s environmental footprint a homeowner can lower operating costs. The owner will enjoy increased comfort due to fewer drafts, better humidity control and better indoor air quality, and will benefit from enhanced durability and less maintenance based on the longer-lived components and systems utilized.

T.E.R.I. Testimonial

The Energy Research Institute, Delhi has introduced GRIHA, a rating system to judge the "greenness" of building. Swagriha is the system in which building with covered area less than 2500 sqm is evaluated.

MaatiSirjana was submitted for the Swagriharating and was approved by the evaluators. Thus it is ecofriendly, green and low cost.

Figure 5 → View from the South West

Acknowledgements

Didi contractor: an architect practicing in the Kangra, attempting to revive the local vernacular, was the inspiration.
Thanks to Ar. ChitraVishwanath, Biome, for her guidance.
The author thanks the entire team that worked on MaatiSirjana specially Ar. Kapil Grover and Bani Kaur.

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