

Analysis of Traditional and Existing Construction Practices for Sustainable Rural Houses in the Southern Western Part of Rajasthan

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Abstract- 'Built environment comprises' Man-Made Environment. It includes the relationship between environment, ecology, town/village, buildings and human being. A conventional building or Traditional building is a building constructed in accordance with the traditional construction practices and regular building code in a specific country during a particular time period (Sartorim and Hestnesrt, 2007). Traditional rural houses built with locally available material with traditional techniques and vernacular Architecture designs creating ideal environment with sustainability which is the need of the hour today and future also. In traditional rural houses, there is a total richness due to space, sun, greenery, fresh-air, unpolluted environment and grooming around is god gift for the village human being for their mind and body. Now-a-days population is gradually increasing and due to emergence of large, densely populated villages, pressure on resources at the local level and its severe scarcity, threat of climatic change, water, air and land pollution has raised to importance to eco-friendly construction and sustainable villages.

When we talk about smart villages, it should be S-Sustainable, M-Measurable, A-Affordable, R-Replicable & T-Technology. The villagers have all the potential of development socially, scientifically, economically and environmentally. If we understand the eco-system of the Indian villages, truly there are all the opportunities and avenues to make our villages and our country a sustainably developing nation. In rural houses Climatic, Cultural, Ecological, Economic, Health, Social and Spatial sustainability are the dimension of sustainability which are essential for integrated development planning of a smart village house. We must integrate with traditional construction techniques with modernisation and evolves models which must grow from within. Traditional techniques and materials have become obsolescence in the present time. Modern building materials like Cement Concrete, Steel and bricks are gaining increased demand due to greater acceptance because of easy availability. But these thoughtless constructions of modern houses do not behave well in the local climatic conditions.

For the purpose of this study, the prevalent traditional and modern techniques in Southern-western part of Rajasthan are analysed and assessed for their suitability in the present era. Traditional knowledge of building houses should be collaborated

with the modern materials and latest construction technology for both affordable housing and sustainable development.

Keywords: Rural Housing, Traditional Construction Techniques, Smart Villages, Sustainable, Eco friendly construction, Vernacular Architecture

I. INTRODUCTION

Traditional architecture, which is sustainable also is a term used to categories method of construction which uses locally available resources and traditions to address local need. The traditional architecture tends to evolve over time to reflect the environmental cultural and historical context in which it exists. It has often been dismissed as crude and unrefined, but also has proponents who highlight its importance in current design. According to Laurie baker "The use of local material with consideration to local climate and participation of the people leads to a holistic design approach." [11].

In Rajasthan traditional house which is made by vernacular architect the conception of space begins with a single cell shelter. This is irrespective of the form and the material which may very form one context to another. Rajasthan vernacular architecture is the informal, functional architecture of the rural houses. These houses built of local material and designed to meet the needs of the local people [12]. The builders of these houses are unschooled in the formal architectural design and their work reflects the rich diversity of Rajasthan's climate locally available building material and the intricate Variations in local social customs and craftsman. It has been observed that, in the rural area of Rajasthan 90% of all building is vernacular. It is for daily use for ordinary, local people and built by local craftsman [13].

According to census 2011, in Rajasthan only 45% rural are in good condition, 50% livable and 5% houses are in dilapidated condition.

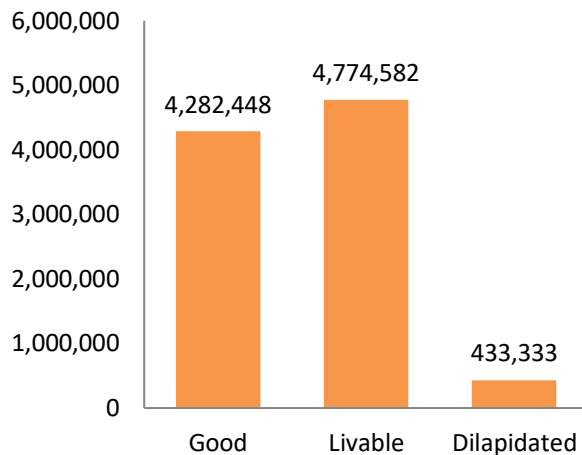


Fig. 1. Households by condition of census house in Rural Area of Rajasthan[19]

Wide disparity can be seen in the housing conditions of rural areas. Also there is a large share of obsolescent and non-serviceable kutch houses. Based on above census data we can broadly divided rural houses into the three categories-

A katcha is a building made of natural material such as mud, grass, bamboo, thatch or sticks and is

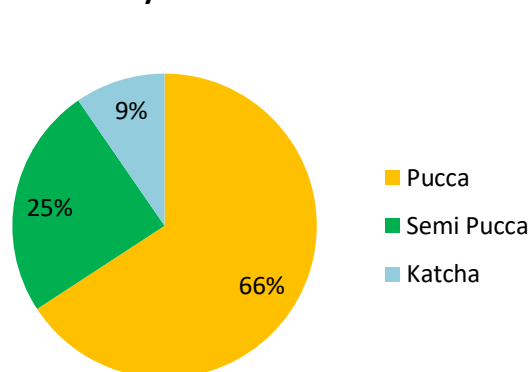
therefore a short lived structure. Since it is not made for endurance it required constant maintenance and replacement.

A pucca is a structure made from material resistant wear, such as forms of stone or brick, clay tiles, metal or other durable materials, sometimes using mortar to bind, that does not need to be constantly maintained or replaced. However such structures are expensive to construct as the materials are costly and more labor is required. A pucca may be elaborately decorated in contrast to a katcha,

A combination of the katcha and pucca style, the semi-pucca has evolved as villagers have acquired the resource to add the element constructed of the durable materials characteristic of a pucca. Architecture as always evolves organically as the needs and resources of people change[14].

This is also evident from the fact that in India and Rajasthan the construction of Katcha houses in 2012 was only 9 % and pucca houses reaches in India up to 66% and in Rajasthan up to 76% [Figure2]. The declining trend in construction of houses using traditional techniques has almost vanished in the present date.

Distribution of Rural Households living in various type of Houses in India from July 2012-Dec 2012



Distribution of Rural Households living in various type of Houses in Rajasthan from July 2012-Dec 2012

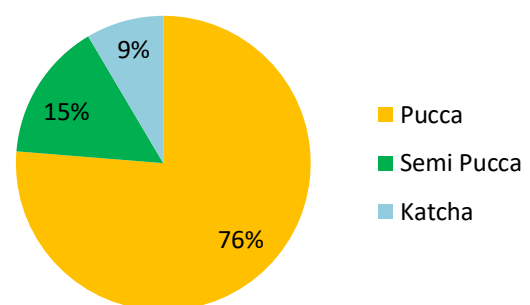


Fig. 2. Distribution of Rural Households living in various types of Houses in India and Rajasthan from July 2012 to Dec 2012 (According to Census Report 2011)[19]

We are re-thinking on Rural Houses of Rajasthan because of losing cultural heritage of local house construction pattern which is more sustainable and affordable as compared to modern construction. Due to modernization in rural housing sector, the use of modern material is increasing and modern materials

have great impact on environment because of high energy consumption. So the biggest problem is that the houses being built today are neither sustainable nor affordable. Un-planned modern construction made un-hygienic and less or non ventilated houses. The shift of trend to build modern houses

without proper knowledge of modern day materials result in tremendous amount of rise in construction cost. Indian vernacular architecture is almost all on the verge of end, thus local architecture, cultural

heritage, should be prevented and new technology must be introduced, but in a minimalist way so we can make sustainable and affordable rural houses build with locally available material[12].

In the western region of Rajasthan, districts in this region are Jaisalmer, Barmer, Jalore, Jodhpur, Pali, and Nagaur. This region falls under Western Sandy Plains where the western part of the region falls under sandy arid plains and the eastern part of the region falls under semi-arid transitional plain. The Luni Basin (Godavari tract) passes through Pali and Jalore. 'The Great Desert' falls under this region covered by sand dunes with sparse vegetation which greatly influence the economic activity in this area. Most of the region falls under very hot and arid climate[11]. The western part has a severe arid climate with an average temperature in summer soaring above 34 degree Celsius and 12 – 16 degree Celsius in winter. Rains are deficient every season with average rainfall less than 10 cm in western parts and less than 20 cm average in rest of the region. However semiarid vegetation is also found in east Jalore and Pali districts. Vulnerability to Natural Disaster, the Barmer district lies in seismic zone IV. Other districts falls within seismic zone II or Zone III.

Traditional and Existing construction practices in this area there are Single storeyed houses with small openings in walls are constructed with dressed/semi-dressed/undressed sandstone and stone patti roof. Cooking space is usually provided in traditional circular jhopa which is constructed with sun dried mud blocks and breathing thatch roof. It is observed that traditional jhopa is widely used as kitchen which is detached from the main house. The entrance of jhopa is facing the house and hence maintains the privacy of women while using this space. The space between the Jhopa and house is serving as extended cooking space, space for leisure activities etc.



II. ANALYSIS AND DISCUSSION

Fig. 3. Traditional jhopa is used as kitchen[19]

This region has a fair deposit of sandstone. Thus most of the constructions found in Jodhpur and Jaisalmer area consist of red/pink and yellow sandstone. Lime is also used extensively in most of the surveyed houses in the form of lime-blocks, mortar and plaster. Bricks and cement blocks are also used in Barmer and Pali region. Mud houses are also found in regions where tribal population exist.



Fig.4. District Map of Western Region of Rajasthan[20]

The people in this region are mostly engaged in farming and animal husbandry. Most of the people also work as a daily wager. In this region settlements are scattered and thinly populated. Most families live in clusters with demarcated boundary. Nuclear families usually reside in a plot very close to the family they have nucleated.

There are some learnings and drawback in this area, like for the design of shelter sense of enclosure is critical in low density and sparsely populated areas. Their Response of Shelter towards climate the isolated kitchen keeps the heat generation in a specific location. These spaces have breathing roofs (jhopa). Cross ventilation needs to be promoted through central open area and small openings. Thick walls decrease the heat gain from outside but also take up a lot of liveable space. The house comprises simple load bearing structure. Flat stone patti roofing system transfers load to random rubble foundation through 18" thick dressed or semi dressed stone walls. To promote the environmental sustainability the local procurement of materials should be encouraged. There are Waste

stone found in abundance, we can use these waste stone in flooring and making walling elements e.g. stone-crete blocks. Some traditional elements also present in existing houses like Niches made in external facade for storage and lighting lamps [15].

The Southern region of Rajasthan covers the districts Ajmer, Bhilwara, Rajsamand, Chittaurgarh, Udaipur, Dungarpur, Banswara, Partapgarh and Sirohi. The Aravalli Range passes through parts of Udaipur, Dungarpur and Rajsamand including the north-western corner of Ajmer. The remaining region falls under The Eastern Plains with a small part of Chittorgarh falling under Southern Rajasthan Pathar (Hadoti Plateau). This includes the great watershed of India – Banas Basin which starts from the east of Udaipur. The deeply dissected area of Chappan Plains also falls under this region which includes the hilly tracts of Banswara and Dungarpur. This region is characterized by undulated topography, forested terrains & plenty of vegetation. Semi-arid vegetation is mostly found in this region with high summer temperature. Savannah and monsoon type of vegetation is also found in Udaipur, Banswara and Dungarpur characterized by wet summer and dry winter.



Fig.5. District Map of Southern Region of Rajasthan [20]

This region is mostly characterized by humid region. It receives rainfall between 40cm to 60 cm. Districts like Rajsamand and parts of Udaipur receive winter rainfall associated with cyclones. Vulnerability to Natural Disaster, The entire region is drought prone and lies in Zone II of Seismic vulnerability except for Sirohi which lies in seismic zone III. Traditional and Existing construction practices in this area, there are Rammed earth, sun dried mud blocks and random rubble with mud mortar are predominantly used in traditional construction with clay tile/Mangalore tiles on two way sloping roofs. Agriculture is the main occupation of the people in this region. However during non agricultural season,

they are engaged in daily labour work for construction of houses. This region has the highest tribal population predominantly Bhil tribe among other tribes Meena, Grasia, Damore. The cultural beliefs of the people is reflected in the way they construct their houses in this region. Majority of homesteads in tribal areas are isolated whether they are on mounds or plains [12].

There are some learnings and drawback in this area, like for the design of shelter the Plot boundary defined by low height wall or bio-fencing. Enclosed verandah doubles as cooking space. There is one interior room with no openings for stores valuables. Doors and windows are important elements and beautifully decorated. House as one component with kitchen integrated in semi covered. Verandah helps to define the core as safe and lockable space and thick walls mitigate break-ins in tribal areas. The houses comprise thick walls, minimum openings and breathing roofs in houses (Mangalore tiles), earth walls help in keeping the house cool. Large overhangs to protect earth walls from high rainfall.

The Structural system of these houses comprises simple load bearing structure, two way sloping roof with Mangalore tile or traditional tiles on timber under structure transferring load to random rubble foundation through 18" thick rammed earth walls. To promote environmental sustainability the local procurement of materials should be encouraged. There is good earth for construction found in abundance; we can use this good earth in various ways. In this region some traditional elements also present like Niches in external facade for storage and lighting lamps and decorative bracket supporting the eave end.

DEVELOPMENT OF CORE HOUSE

The core-house responds to the socio-cultural and economic character of the inhabitant. It is the minimal space that a household cannot do without. This is a safe lockable space that needs to be disaster resilient and also respond to the climatic condition.

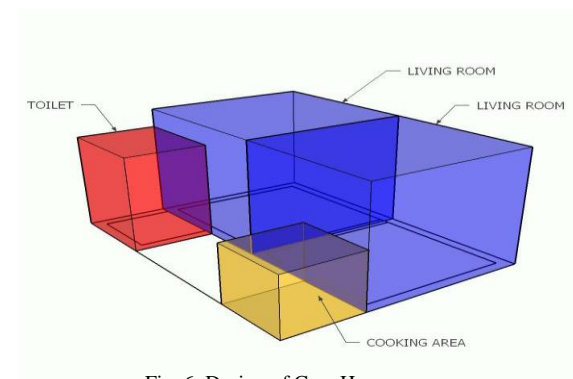


Fig. 6. Design of Core House

For Western Part of Rajasthan

Type A- Module when cooking space is detached from the core and facing towards it to make an enclosure.

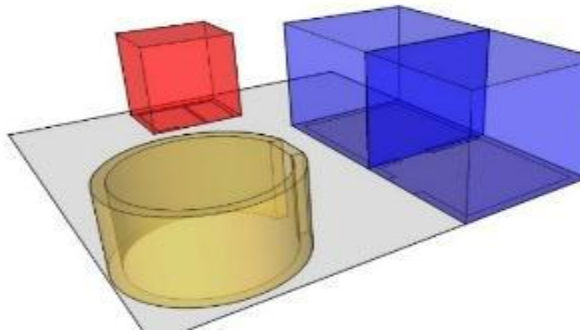


Fig. 7. Design of Core House for Western Rajasthan (Type A)

TYPE B- Module when cooking space is covered and attached with the core.

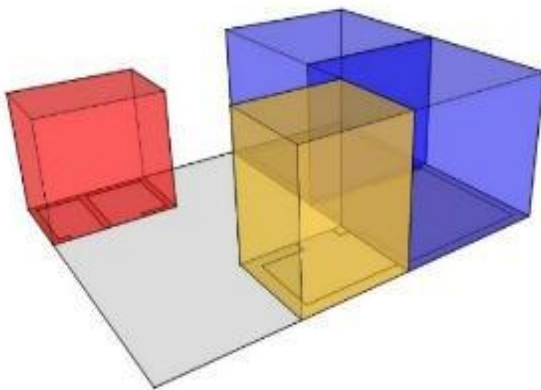


Fig. 8. Design of Core House for Western Rajasthan (Type B)

Material and Technology- For both type A and B
Roof – Stone Patti with Cement-Sand pointing.
Wall- 350mm thick coursed rubble masonry in Cement/cement-lime-sand mortar
Foundation- Coursed rubble masonry in cement mortar

For Southern Part of Rajasthan- Module when cooking space is provided in enclosed verandah. A small storage space is provided in the core.

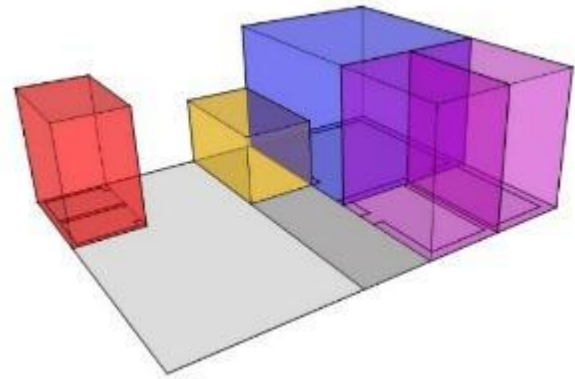


Fig. 9. Design of Core House for Southern Rajasthan

Material and Technology

Roof – Stone Patti with Cement-Sand pointing.

Wall- 230mm thick rat trap brick wall in Cement-sand /cement-lime-sand mortar

Foundation- Coursed rubble masonry in cement mortar

III. CONCLUSION

Western Rajasthan is characterised by low and erratic rainfall, high air and soil temperature, intense solar radiation and high wind velocity. Climate change acts as an additional stress on ecological and socio-economic systems. Major disasters experienced due to climate change are drought, flash floods, Earthquakes, heat waves. Other climate change impacts are increase in temperature, decrease in precipitation, health impacts, increasing drought conditions etc. Rajasthan State Action Plan on climate change estimates the mean annual rainfall would decrease slightly, but extreme rainfall (more than 244.5 mm rainfall in a day) is expected to increase in frequency and intensity in the model projections for 2071-2100. Average temperature in Rajasthan is projected to rise by 2035 in the range of 1.8° Celsius to 2.1° Celsius.



Fig.10.Floods in Barmer District in the Month of August 2006[19]

In August 2006 saw unprecedented rainfall/floods in otherwise drought stricken region of Barmer, Rajasthan. The floods led to a loss of 139 lives and rendered 50,000 homeless.



Fig.11. Traditional Mud Houses in Barmer District[19]

Environmental friendly materials were traditionally used for housing (mud walls & thatched roofs) in this area. The houses were conducive and thermally comfortable in the extreme weather conditions and Circular design protected the structures from strong winds and earthquakes. However, the adobe structures collapsed when severe floods took place.



Fig.12.Mud-Cement Stabilized New Houses in Barmer District[19]

Traditional practices were very appropriate, shortfalls in the water resistant capacity of the mud structures led to damage during floods. Traditional design was effective but need some technological intervention to address unprecedented disaster. Traditional houses which is made from mud, circular in design and had thatched roof not durable during natural hazards like flood. To make traditional houses hazards proof the new houses built were in complete compliance with local environmental and cultural nuances both in terms of design and technology used. At the same time, hazard and vulnerability profile of the area was also

considered to ensure safety from future disasters. Thus new technology must be introduced, but in a minimalist way so as to add value to traditional systems. In above mention construction Mud walling upgraded to soil-cement and traditional roof material retained as well as existing houses. Only traditional design enlarged and reconstruction done in-situ, also household owners provided maximum labour for introduce the modern construction practices for make sustainable house in hazards.

Major materials used in sustainable rural house construction should be locally available and the construction technique should be as simple as possible. Persons living can construct repair and maintain their rural house by themselves. Local architecture, cultural heritage, Vernacular Architecture should be prevented. Good Health of residents, Positive energy creation in houses and Values of Human Life will remain prevented.

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