Understanding Vernacular Architecture in terms of Sustainability: Lessons from Turkey and India

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Abstract

The elementary purpose of housing/buildings is to contribute towards a complacent living environment which is protected from the harshness of climate and natural catastrophe. The term "vernacular architecture" stands for the art of constructing buildings and shelters which is spontaneous, environment-oriented, community-based; which reflects the technology and culture of the indigenous society and environment. Furthermore, it is a cost-effective architecture, both economically and socially, that is self-sufficient in natural resources, has a low environmental impact, and hence is a sustainable input. Nonetheless, vernacular architecture was and is very much alive and well in today's society, its architecture, and in terms of sustainability all over the world.

By presenting two examples from India and Turkey, the study explores several dimensions of sustainability such as environmental sustainability, socio-cultural sustainability, and socio- economic sustainability.

Keywords: Vernacular architecture, Climate, Planning, Environmental, Sustainable development

Introduction

Vernacular architecture expresses a conscious sense of belonging to one's immediate surroundings. It governs and promotes the social and cultural aspects of people, starting with the material and technological assets of a region. Originally portrayed as non-pedigree architecture, vernacular architecture has been described as an act of aboriginal, spontaneous, rural, and largely anonymously produced constructions (Rapoport,1969; Dayaratne, 2008). Bernard Rudofsky promoted native architecture as a controversial phenomenon across multiple disciplines such as anthropology, art, social sciences, engineering, and architecture through his exhibition 'Architecture without Architects: A short introduction to non-pedigreed architecture' in 1964.(Rapoport, 1969).

Traditions and folkloristic culture were the Centre of 'vernacular' culture in the nineteenth century, which was sparked by the cultural upheaval of the industrial revolution (Upton, 1983; Martin, 1971). The Arts and Crafts movement (1880-1910) reintroduced the creative significance of the built environment, resulting in a fresh concentration on traditional

building methods (Vellinga, 2006). The focus of early vernacular studies was on the architectural forms; and materials; and styles of structures. Vernacular dwellings are passed down through the generations, yet they are not permanent structures. They have altered as a result of citizens' reforms in their traditions and ideals (Oliver, 1989).

Traditional buildings made using indigenous people's knowledge passed down through generations, using materials and workmanship available locally, in response to the local climate, as well as the region's economic and social standards, are referred to as vernacular architecture.

The most important aspect is that vernacular architecture is a reaction to the surround ing environment, constructed by people who are familiar with their culture and surroundings (Oliver, 1997; Lawrence, 1987).

This type of architecture provides good thermal comfort. Besides it can also withstand all types of natural calamities faced by that particular region. These structures are also cost-effective both in terms of economy and social fabric. Since they utilize locally available materials, techniques and labor they have low environmental impacts. The response of such structures at the time of natural calamities is noteworthy and thus they are sustainable.

Pre-Industrial Vernacular Architecture

It is a direct answer/reaction of the community that recognizes its own spatial needs as well as requirements; solutions to architectural problems are pass on through verbal transfer of knowledge over the generations. Generally, these vernacular houses are built by their owners with uncomplicated construction techniques which are easy to understand and accepted with minimum exotic requirements. It can be easily taught by one generation to another generation. The conclusion/outcome of their answer is typically highly traditional; and as a result, vernacular dwellings follow a very consistent model. As a result, vernacular housing refers to structures constructed by members of the community without the use of specialist trades (Rapoport,1969).

Post-Industrial Vernacular Architecture

After the industrial revolution, vernacular architecture has changed a lot in order to develop something new that includes the use of new techniques and new building materials. These new building materials and techniques required a special set of skills. A new, more modern and unique set of considerable design, conception and construction have emerged in this era. As new sorts of construction trades arose, residents sought their assistance in constructing the structures. Even though the residents of these types of houses are not active participants in the construction process, they are not only at the user end of the process; They also contribute to the finalisation of the design and construction of a house. Individual differences can thus be seen in these homes, but because a society structure is bound by traditional norms, the gap between shared values and heritage is blurred. These homes are frequently devoid of pretentious aesthetic displays, since they strive to solve problems in the most straightforward way possible, working with the site and microclimate while also respecting the environment and other members of the community (Rapoport,1969).

The shelter facility has been substantially influenced by the climate of the region since its inception. Vernacular solutions display a wide range of designs that are tied to the surroundings, honouring Nature, culture, the symbolic interpretation, and also the reasoning of comfort in that place (Rapoport,1969). Thus, while these solutions differ from place to place, they are usually regulated by the culture of that location, even when responding to similar conditions. Simultaneously, the idea of comfort changes from culture to culture. As a result, a careful consideration of thermal comfort of vernacular architecture is necessary because it differs from one person to the next (Das,2006).

Aim of the Study

The aim of the paper is to give an overview of vernacular architecture of India and Turkey since vernacular architecture is generally considered as the architecture for the local needs utilizing local construction techniques and local materials communicating local traditions and culture. This paper will help us understand how vernacular architecture forms are highly influenced by climatological conditions, geography of the area and socio-cultural factors.

Methodology for Intervention

Vernacular architecture is a source to simple sustainable solutions with significant environment-friendly features such as providing human comfort using low energy techniques, use of locally available materials and resources and integral approaches to form and orientation. Thus, it has strong ties to culture and social traditions in harmony with the climate, built forms and people (Dili, et al., 2010; Darus, et al., 2009)

In order to attain sustainability, the major parameters considered are:

- Environmental sustainability
- Socio-cultural and socio-economic sustainability
- Planning practices

The methodology to carry out the study includes secondary data. This data pertains to traditional architecture of Kutch Region, Gujarat and traditional architecture of Kashmir region which includes Dhajji-Dewari and Taq. It will also have, one example from Turkey i.e., Vernacular houses of Harran, Turkey is taken.

All these parameters of sustainability are being explained and conclusions are drawn based upon unique features of each type of vernacular architecture belonging to different regions of India and some parts of the world.

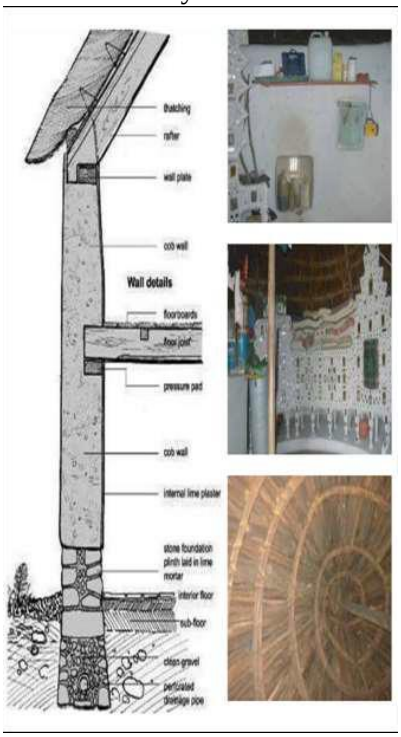
Case Study1: Traditional architecture of Kutch Region, Gujarat (Bhonga)

The north-western part of the Gujarat is named as “Katchua”. This part of Gujarat has its own vernacular architecture. The classical architecture of Kutch region is actually resultant of the extreme climatic conditions, prevailing topography and the natural forces. The vernacular architecture of the region integrates well with the socio-cultural setup of the place the traditional buildings of this region are time-tested. Since this region is highly prone to earthquakes these structures have withstood even the worst earthquakes (Chiara Chiodero,2006).

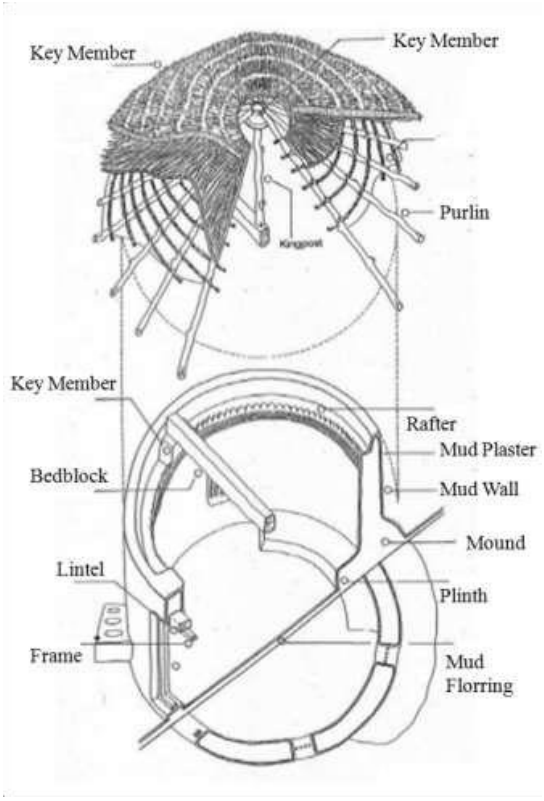
Fig. 1: Typical Bhungas House of Kutch
Source: Lathiya, 2016

Spatial Configuration

Architectural Typologies in Kutch region are climate responsive, functional having very strong sense of socio-cultural factors. Locally available materials are used like Bamboo, Cane leaves, Mud, stone, Lime etc. A Bhonga consists of a single cylindrical room having conical roof and cylindrical walls. A typical house consists of one or two Bhongas or even



more (generally upto three). The domain of the house is commonly established by a raised platform which is known as otla, Otla is generally raised from the ground level from a few centimetres to up to one metre. The bhongas of the house have diameters ranging from 3 to 6



meters.

Fig. 2: Typical Wall Section of a Cob Wall
Source: Lathiya, 2016

Fig. 3: Bhunga House components
Source: Lathiya, 2016

Typical layout of the house consists of Aangan (Public gathering space) or Front yard, room for men, room for women and children, cooking area and a backyard. The bhongas are not attached to each other in order to avoid cracks which may have serious implications at the time of earthquakes. A typical Bhonga comprises of a door and few small windows which are symmetrically arranged. The house also has a low height platform which is known as pedlo on which the classic/traditional utensils and furniture are placed (Kulbhushan & minakshi jain,2000).

Construction Techniques

- Construction techniques involve the usage of Cob. Cob is basically a natural building material which comprises of subsoil, straw, lime and water. Large lump of cob mixture is sculpted into the shape of an elongated egg.
- The size of the rounded cob is roughly between 30-40 cm (12-18 inches) long and its diameter is 6 inches.

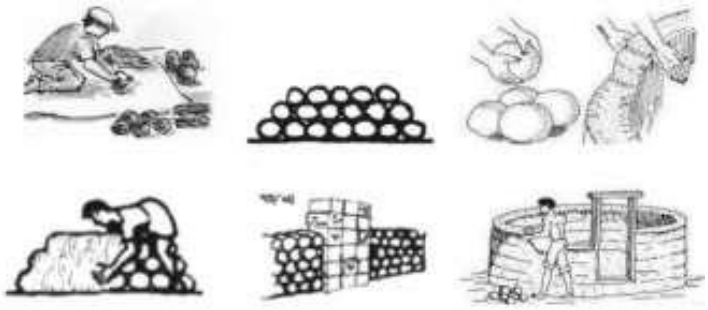


Fig. 4: Construction of Cob
Source: Lathiya, 2016

- A row of mud cobs is laid side by side and after that they are pressed and an additional row of mud cob is placed on top. After the laying of three courses or four courses, one above the other, the sides are levelled over for the filling of holes and cracks.
- The wooden rafter is laid down horizontally on the wall. The ends of the rafter rests on the wall and fixed with the help of the pegs.

Environmental Sustainability

The thick walls of bhongas are made up of mud which keep the interiors cool at the time of high temperatures since the temperature rises to 40+ degrees Celsius in summers. It also provides the warmth in winters when the temperature drops below 5 degrees in winter. Hence, these structures are environmentally sustainable.

Response against natural calamity

Very few bhongas in Kutch region experienced some serious damage at the time of Bhuj earthquake 2001, and the damage that did occur to bhongas was mainly due to the use of low-quality building construction materials and ill maintenance of the bhongas. It has also been observed that the collapse of bhongas during the last earthquake caused very few injuries to the occupants, it was majorly due to the type of collapse that did occur.

Case Study2: Vernacular Dome shape houses of Harran, Turkey

Harran is a town in the south-east of Turkey, between rivers of Euphrates and Tigris. The town draws a lot of attention due to its interesting vernacular architecture which is peculiar to the town itself and is found nowhere in Turkey. Vernacular houses of Harran, Turkey emphasize upon the concept of flexible buildings which utilize locally available and re-usable building materials and climatically sustainable building design. (Nahya, 1983).

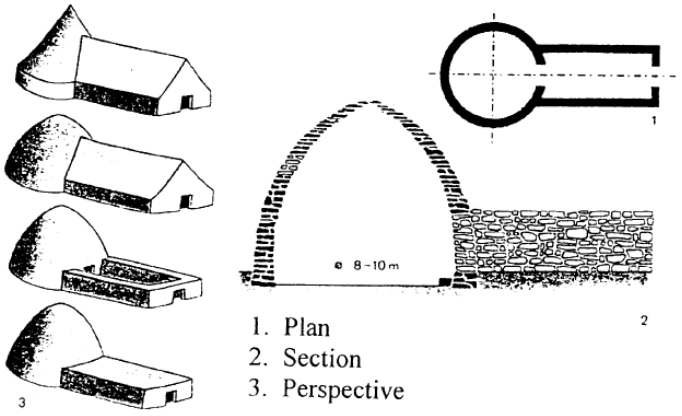


Fig. 5: Domed building forms found at Mesopotamia excavations belonging to 7th century B.C.
Source: Muller and Vogel, 1974

Spatial Configuration

The Houses at Harran are built with conical domes covering mainly square shaped rooms. Each room has a conical dome at the top which acts as a building unit and serves for varying purposes like living room, kitchen, store, or barn. These rooms are generally connected to each other with the help of internal doorways. Some of these rooms open to the courtyard spaces through arches or small doors. A bathing place is generally incorporated in one of these rooms which commonly serves as a Kitchen. At the times of the winter season, Kitchen area is also utilized as a living room and it is commonly known as “tandirlik” The toilets are not kept within the building premises. They are generally accommodated away from the rooms at the corner of the courtyard. In some cases, the courtyards have a well close to the centre.

The number of rooms in a conventional domed house is determined by the building owners' financial level, family size, and basic needs. As the number of the family grows, extra rooms are added to the house. As a result, Harran dome-shaped vernacular houses are very adaptable and expandable to meet the demands of each household. When it comes to the house's spatial layout, the rooms are organised in one, two, or more rows on one side of the courtyard. The rooms are placed in rows along an East-West axis. As a result, the solar radiation from the west is shadowed by conical domes, resulting in cold regions (Ozdeniz, Bekleyen, Gonul, Sarigul, Ilter, Dalkilih, Yildirim,1998).

Construction Techniques

The burnt bricks or sun-dried bricks which are gathered from the older ruins are used for the making of conical dome at the top. The Conical dome is built with the help of flat bricks which slides inwards at each row. The thickness of the dome wall varies between 25-30 cm. The top of the domes is intentionally left open just like the oculus and acts like chimneys. The diameter and the height of the dome is not similar, the height of the dome is 3-5 m high from the base. The domes are rendered with mud externally in the month of June every year. In order to climb the dome at the time of the mud rendering some stone projections are generally left on the sides of the domes which are usually used in the form of scaffolding while the internal mud rendering is only done up to the height of human being.

The walls of the square planned base are generally made up of sun-dried adobe, sun-dried bricks and small number of stones are also used. Since the bricks are not manufactured in kilns, they are hand-made bricks so their sizes show variance. Nevertheless, a complete brick size on an average is 24cmx24cmx4.5 cm and a half brick size on an average is 13cmx24cmx4.5 cm. Generally, stone is used to make the building intact and it is used at top corners of the base walls and the dome. The stone is not extensively used but in small quantities. In order to join the stones and bricks only mud mortar is used. At the time of the mud rendering, sliced straw is also mixed.

Fig. 6: A house at Harran
Source: Ozdeniz et.al, 1998

Fig. 7: A half ruined dome displaying the structure
Source: Ozdeniz et.al, 1998

Environmental Sustainability

Harran has a hot-dry climate. The maximum mean temperature goes up to 39 degrees Celsius in the month of July and August while the mean minimum temperature touches 2 degree Celsius in the month of January. Due to dry climate of the region the wood is rarely available. So, the houses are made up of the materials which are extensively available like adobe, bricks and stone in small quantities. Another important characteristic feature of these structures is that they can be built rapidly.

Another feature of these structures is that ventilation holes are given on the sides of each dome. There is one at the top that functions as both a chimney and a ventilation hole. The holes are arranged in two, three, or four orientations, but they all face each other to allow for cross ventilation. On the side walls, there are also windows that open to both the street and the courtyard. In the winter, the windows and holes are opened for natural ventilation, while in the summer, they are closed.

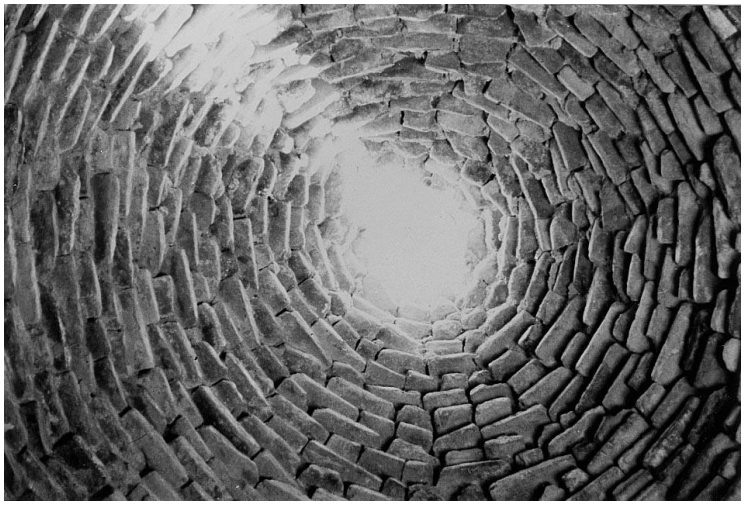
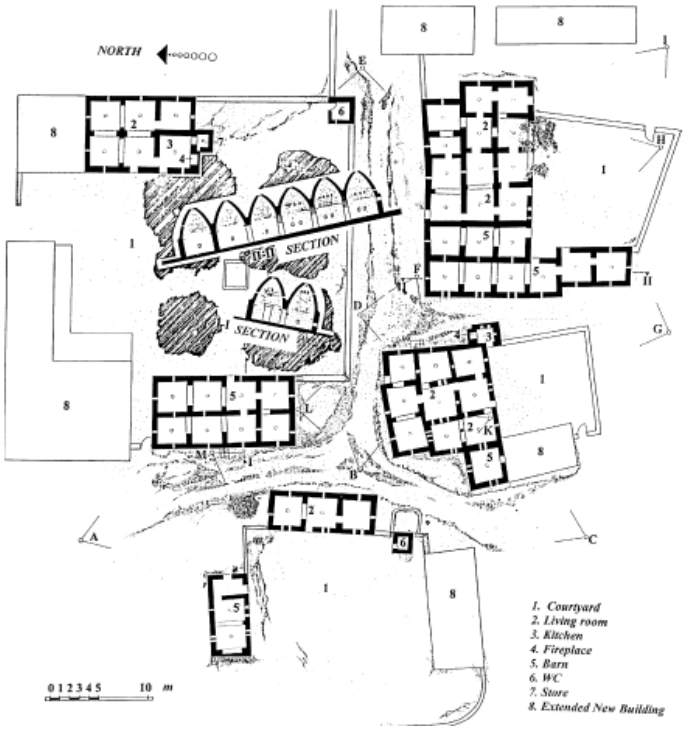


Fig. 8: An inside view of Harran Dome
Source: Ozdeniz et.al, 1998

Hot air in the dwellings ascends and is expelled through the top hole during the summer season due to the stack effect. As a result, even in the high heat of summer, a very cool and comfortable environment is experienced. Furthermore, due to the employment of domed and cubical shapes, vernacular structures have lower surface area and volume ratios. As a result, with the holes and windows covered in the winter, heat is lost far less, making these structures incredibly warm and cosy in the winter. Aside from the shape of these structures, the building materials utilised, such as 60-70 cm thick adobe walls, give good thermal insulation and temporal lag. As a result, these structures are environmentally friendly.

Case Study 3: Sustainability of Traditional Architecture of Kashmir, J&K

Nestled in the Himalayan mountains, Kashmir has generally hosted historically varying cultures with a distinct touch to architecture and engineering. Kashmir valley lies at the top of the active geological fault belt which actually opens the way for seismic complexities above the ground level. Most of the area of the Kashmir valley generally falls under seismic zone IV & V. In the year 2005, October 8th, a massive earthquake of 7.6 magnitude, affected the Kashmir valley. The damage was immense, resulting in the destruction of millions of homes and almost 75000 deaths. But fortunately, it was noticed that the structures which were constructed using traditional Kashmiri architecture of "Dhajji-Dewari (timber frame with masonry infill)" and "Taq system- (timber-laced masonry)" generally suffered less or almost negligible damage. This type of construction practice is generally developed from the use of local materials (mud, stones and bricks), amply available blue-pine combined together to construct these Timber framed houses with the help of the masonry which adequately suit local extreme climate, distinct natural environment, soil type



and culture and essentially the high seismic risk of the area. This case-study will generally highlight the seismic advantages of

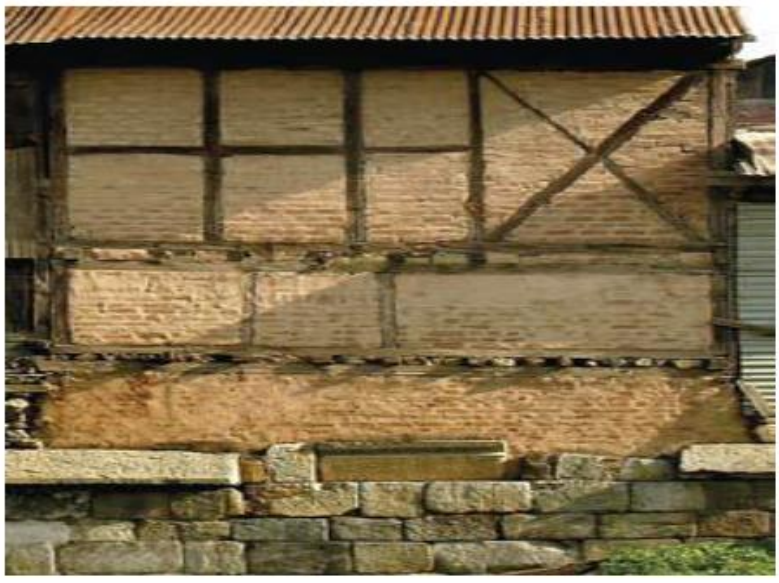
Fig. 9: Plans and Sections of a typical Harran neighborhood
Source: Ozdeniz et.al, 1998

Dhajji- dewari and Taq system of construction. (Dar, Ahmad,2015)

Dhajji-Dewari System of Construction

The 'Dhajji Dewar' is the vernacular system of construction of Kashmir which is much thinner and lighter form of wall construction. It comprises of timber framing with infills of brick, (Fig 1,2) and in few cases the infills are of stone masonry. In the case of the 'dhajji- dewar' the walls will generally have higher ductility and damping. Furthermore, the vertical and horizontal cage formed by the timber are diagonally braced against shear. The cross member is usually placed at the corner, but it provides the entire framing a resistance against shear forces. Shear crack propagation is often limited by the close proximity of timber studs. The upper-level brick walls are likewise broken up into comparatively smaller multiple panels, each of which is independent, thanks to this form of framed structure. In this instance, the collapse of any one panel will very certainly not resulting in the entire wall, and thus the entire structure, collapsing. The small panels, which are usually formed of masonry and bordered by wood parts, provide significant protection against out-of-plane collapse. "Dhajji-Dewari" frames are typically "platform frames," meaning each storey is framed separately on the one below (Langenbach, 1989).

The floor joists are generally wedged between the plates in 'Dhajji-dewari' construction. This form of framed structure distinguishes "Dhajji-dewari" from heavy timber framed architecture, which typically relies on posts that stretch over multiple stories for stiffness and strength. When it comes to "Dhajji-Dewari" construction, it's a very effective approach for holding structures together even when they're significantly out of plumb. In the mountainous region, where settlements of buildings caused by soft soil or sand were not a problem, the use of timber persisted because it was locally and abundantly available. Additionally, the use of timber judiciously reduced the amount of masonry work required, allowing for more cost-effective construction. It's also worth noting that "Dhajji-dewari" has



performed admirably in previous earthquakes. (Malik,2019).

The layout and panel sizes of dhajji frames vary significantly, and the earthquake resistance of the "Dhajji-Dewari" system is stable until the timber frames or panel sizes are typically large, it lacks overburden weight (Langenbach, 1989).

Fig. 10: Elevation of Dhajji-Dewari construction in down-town Srinagar, Kashmir-India.
Source: Langenbach, 1989

Taq System of Construction

Taq system of construction generally refers to load bearing piers of masonry with infill walls. In many cases Taq is generally expressed by distinctive use of materials. The piers are generally made of stone and the infill walls of brick. Basically, in Taq construction the timber runners at each level tie the walls. The Timber embedded in the infill walls generally increase the elasticity of the walls. (Malik,2019).

Fig. 11: Details of Taq System
Source: Malik, 2019

Fig. 12: Taq Construction in Srinagar-Kashmir, India.
Source: Langenbach, 1989.

The Taq system of construction consists of a bearing wall masonry construction with horizontal timber lacing integrated into the brickwork to avoid cracking and spreading. There is a general construction of masonry piers of size 1-2 feet square and the window bay (taqshe) 3-4 feet in width in the Taq system of building. In general, the masonry piers are thick enough to support vertical loads. (Malik,2019)

Sustainability

The houses in Kashmir are generally developed with the use of local materials like timber, stone etc. These materials are available in abundance. Building the house is generally a community-based process. Most of the time families help each other to build their houses. This type of community-based organization/ grouping of labour is very much prevalent today and it was quite evident after the earthquake for the process of repairing of houses and also the reconstruction of the damaged houses (Langenbach, 1989).

The community-based labor expedites the transmission as well as the refinement of the techniques and skills required for the building process. This process generally helps in the development of local understanding of vernacular materials and methodology of putting them together. This understanding about the construction methodology is holistic and it is well connected to different aspects of living in the particular environment. This methodology helps in the prevention of exploitation of natural resources beyond the necessity of its inhabitants. The building technologies developed in this system are easy yet robust. The building technology is developed from the utilization of the by-product. Talking about the building materials dung-mortar and mud is a by-product obtained from animal husbandry. These by-products can also be utilized as manure. Agriculture waste are generally utilized as fodder but they are often used for insulation. While stone and mud can be utilized for terracing or shaping the ground. The activity of building houses is related to the survival of the family and community. This community-based system is fundamentally related to the

doctrine of Reduce, Re-use and Recycle, which is the major slogan of our cotemporary movement towards sustainability. (Malik,2019).

Response against Natural Calamity

The unreinforced masonry infill is enclosed by concrete ring beams and columns in Dhajji dewari building, which is theoretically/conceptually connected to'restricted masonry' construction. The key difference is that the sand and cement mortar used to join the masonry pieces together in a constrained masonry system is brittle and rigid, but traditional dhajji dewaris have a very weak mud mortar that allows it to give strains even under tiny lateral forces. Furthermore, masonry panel sizes in dhajji dewari building are frequently smaller than in conventional restricted masonry construction, which may be advantageous. Instead of non-linear material deformations of the frame components, as in modern steel or reinforced concrete construction, the energy in the dhajji dewari system is primarily dissipated through friction between the infill and the frame, as well as in the infill's mortar joints (Langenbach, 1989).

The study demonstrated the value of keeping the system together. More research is needed to determine the best joint designs and component arrangements for dhajji dewari construction. When it comes to nails, which are prone to corrosion, the importance of proper carpentry connections should not be underestimated in order to ensure its longevity (Langenbach, 1989).

Contribution to favorable seismic behavior is due to the unique energy absorbing properties of the system. It is possible to imagine that after an earthquake, a dhajji dewari building will sustain only minor and repairable damage. This is a substantial advantage over many modern engineering approaches already in use for structures of comparable scale and purpose, particularly in urban and rural areas that are rapidly developing (Langenbach, 1989).

Conclusion

The economical circumstances, cultural identities, and climatic reactivity of Kutch all impact the region's architecture. A range of climate responsive design qualities arose during the study of traditional architecture, including temperature regulation, increased natural ventilation, and protection from natural calamities like as floods and earthquakes. However, due to the use of non-treated materials, fire hazard and termite infestation, as well as a lack of damp proofing and the use of non-stabilized soil for construction, which can lead to moist walls and washouts during heavy rains, are all characteristics that are missing in traditional housing.

Once the Kutch construction and design community understands the advantages and disadvantages of traditional typologies, advanced construction techniques can be diligently combined with conventional typologies to eliminate problems and enhance benefits, resulting in a modern yet sustainable architecture for the Kutch region.

When it comes to Harran houses, the themes of flexible construction, reusable building materials, environmentally friendly construction, climatic building design, and sustainable living are all evident in the vernacular Harran houses that are studied in architecture. A flexible building is made up of single-story housing units connected to neighbouring apartments by arches or entrances. As additional requirements arise, they might be enlarged. Houses with two or three apartments are more cost-effective for individuals on a tight budget, and more units can be added later. It is feasible to re-use burned clay bricks with a weak mud mortar. The domes are not plastered on the inside. The external rendering, on the other hand, is made of straw and mud mortar. The image is updated every year following the winter rains.

New methods of external rendering must be developed that are less expensive, have a longer service life, and are earth-toned. More research is needed to establish the efficacy of mud with cement rendering.

In view of the global concern for seismic adequacy of civil engineering infrastructure, the seismic performance of the taq and dhajji buildings in Kashmir is good and crucial. These aren't just old buildings waiting to be demolished and replaced, with a few worth preserving in a theme park or museum. They are buildings that embody architectural marvels and distinctly modern construction features: - features that, once fully researched, understood, and embraced, can save lives. In comparison to current steel, concrete block, and reinforced concrete constructions, these structures are significantly more environmentally benign.

This style of earthquake-resistant architecture is both cost-effective and effective at mitigating earthquake forces. As a result, it is inexpensive to people of lower socio- economic status. It may be useful in the future in saving many lives. If we transition to the Dhajji-diwari and Taq building techniques, we can improve the seismic performance of our structures at a lower cost.

During the course of this investigation, it was discovered that vernacular houses were built in a very short period of time. Few people could build two pieces of this load-bearing structure in a few days without much expert aid or complex construction tools. As a result, it could be viewed as a solution to the housing issue.

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