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To Study the Appraisal of Construction Techniques in Lower Himalayas of Himachal Pradesh

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Abstract - *Traditional buildings have confronted natural hazards and environmental influences over centuries and sustained themselves in their original style. Contemporary materials are gaining acceptance in the hills as they are readily accessible. But the modern houses have not accustomed themselves to the regional climatic conditions and seismic constraints. Hence, there is a high demand for techniques which are sensitive to the local climate and geographical conditions and caters to the aspirations of the individual. For the study, the traditional and contemporary techniques popular in the region are studied and appraised for their suitability in the modern context. Traditional knowledge should be merged with recent materials and construction technology for sustainable construction.*

Key Words: **Alternative Construction Technique, Climatic Response, Contemporary Construction Techniques, Material Suitability, Traditional construction technique**

1. INTRODUCTION

Construction techniques and materials employed in buildings play a significant role in their safety, response to local environmental conditions and their cost-effectiveness. The construction industry is one of the highest consumers of energy. The material used for construction has a direct impact on energy consumption and consequently affect the environmental impact of the building. Sustainability is the foremost concern in the world today due to impending climatic change. Sustainable development takes a whole new magnitude in the fragile ecological context of the hill regions. The regions are not only fragile but also experience harsh climates and are susceptible to environmental impacts like landslides, earthquakes, etc. In such a scenario, planning, designing and construction of new settlements need to be a response to the climatic conditions and disaster vulnerability of hills.

Traditional construction techniques have evolved over centuries as a response to the varied climates and availability of materials. They have withstood the test of times, resisting natural hazards and environmental impacts. The traditional construction techniques employed in the hilly region use the local materials and the expertise of the ages to minimize their impact on the ecology. The traditional buildings in the hills seem to have sprung from the ground, merging with the landscape of the hills. F.L. Wright defined traditional buildings as "Folk building growing in response to actual needs, fitted into the environment by people who knew no better than to fit them with native feeling." [5]

Fig -1 Traditional Settlement in Hilly region

Apart from the benefits, vernacular buildings have various concerns like, need for regular maintenance, low strength of building materials, unavailability of traditional technique practicing craftsmen, lack of traditional materials results in diminished use of these sustainable vernacular practices for construction of new structures in the hilly region. The construction practices are prevalent in hills nowadays are no different from the construction in plains due to easy availability of cement and bricks. Thus, transformation in the serene and pleasant visuals of the hills. Increased exposure to new materials and technologies and consequently the aspirations of the people have undermined the use of traditional techniques. The inefficient performance of these building practices in terms of energy and stability against natural hazards is a lesson to learn. Massive development with contemporary materials has lead to pollution, loss of vegetation, increase in soil erosion, increase in surface runoff, lowering of the water table, flooding, change in micro climate and increase in occurrences of instability, which cause severe damage to the environment in and around the hilly region. However, innovations in technologies and new materials that more efficient, better looking and at times even cost-effective can provide a solution to create a sustainable environment.

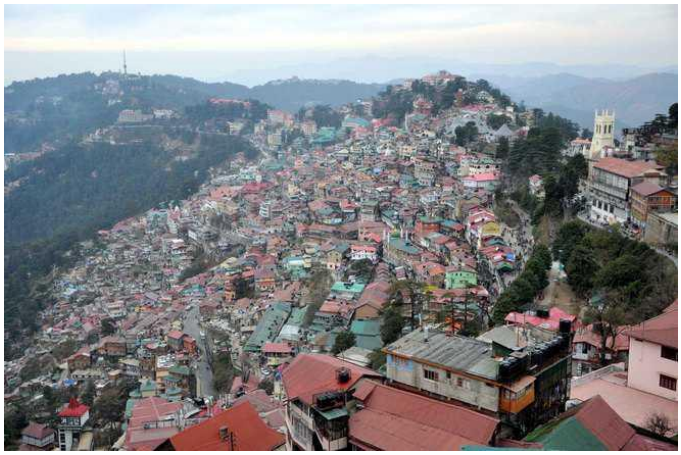

Fig -2 Massive multi-storey development in hill region (Source:https://www.tribuneindia.com/news/himachal/community/plan-to-rid-shimla-of-haphazard-growth/262047.html)

2. CLASSIFICATION OF ZONES

The state of Himachal Pradesh nests in the western Himalayas covering with the elevation ranging from about 350 metres (1,148 ft) to 6,000 metres (19,685 ft) above the sea level. There is great variation in the climatic conditions due to extreme variation in elevation. The state can be broadly classified into three regions depending upon their elevations.

2.1 The Trans- Himalayan region,
2.2 The Higher Himalayan

2.3 The Lower Himalayan region

2.4 The Lower Himalayan region

The Lower Himalayan region is marked by slight slopes and plain areas. It comprises of lower ranges of Kangra, Una, Hamirpur and Sirmour. Due to its proximity to the plains, this region experiences cool winters but hot summers. Heavy monsoons occur in the months of July to August. Mud for construction and stone for rubble masonry are easily available. For the study, region of Kangra is identified .This paper is dedicated to the study of the modern, traditional and alternate construction techniques prevalent in the lower Himalayan- region. An assessment of these techniques in the region is also done in terms of climatic response, material suitability and structural and seismic stability.

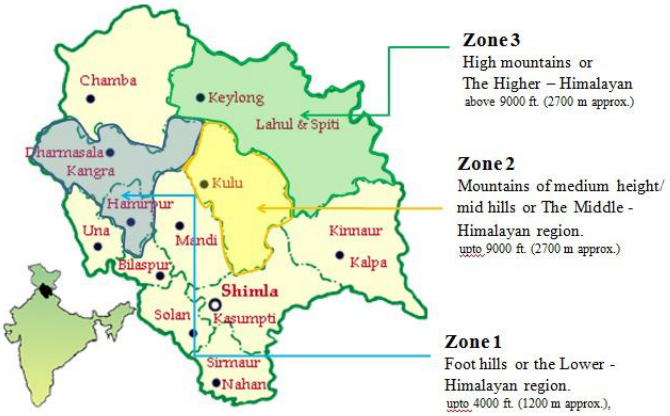

Fig -3: Map of Himachal Pradesh showing classification of zones (Source:www.indianetzone.com/3/himachal_pradesh.html)

2.4.1 Introduction to Kangra

The region has both hilly as well as plain terrain with the average elevation of 733 metres and is formed by the basins of three rivers Bener River and Majhi River, and Beas. Climatically, Kangra is hot in the summers with comfortable winters while certain regions receive very heavy rainfall in the monsoon. Mud and wood are easily available in the region which is thus used in the traditional construction. A typical traditional house in laid in square or rectangular form with the living areas laid around the kitchen which is the main activity zone.

Fig -3: View of a typical traditional house of Kangra valley (Source:https://lh3.googleusercontent.com/QviX1ZS6N_dH_WicBfo18ABkpy5lPgkP4NcmPi3ZwZ93xplBGiqJMJ-Y4UNC7T6IvF9G=s113)

2.4.1.1 Traditional Construction Techniques

In a typical house of Kangra, the foundation is built with thick rubble stone masonry.12'thick wall is made with sun-dried mud bricks and mud mortar. The floor rests on the load-bearing walls and the wooden planks are laid over the rafters. Floors are finished with mud mortar combined with twigs and later a layer of mud mortar

slurry including cow dung makes the floor last longer. Walls are treated with the mud and cow dung slurry to an altitude of 3 feet on the internal and the external wall. Roofs are laid with slates fastened to wooden members.

2.3.1.1.1 Analysis of Traditional Construction Techniques

The sustainability of traditional technique is analysed in terms of climatic response, material suitability and seismic suitability to assess its appropriateness.

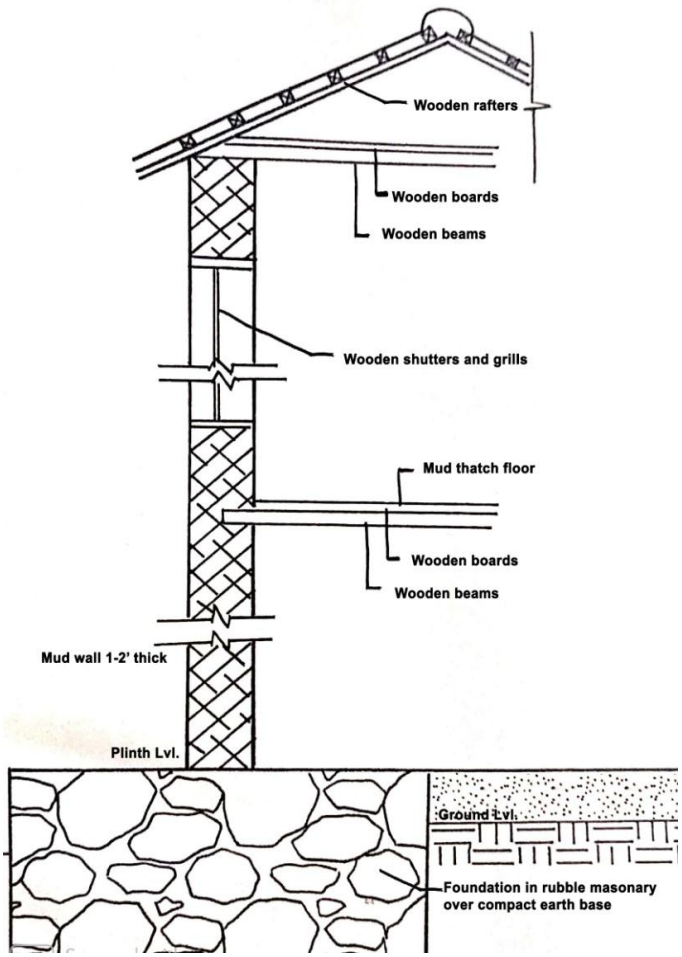

Fig -5: Section of Mud wall

A. Climatic Response

- The mud keeps the inner temperature comfortable in the hot summers.
- Due to improper ventilation inside, the moisture might affect the mud wall.
- Mud flooring insulates the floor and does not allow heat dissipation.

B. Material Suitability

- Mud construction is not perceived as a pukka construction since there is a need for maintenance after rain.
- Sun-dried bricks are more energy efficient as it does not require fuel burning for its assembling.

C. Structural and Seismic Stability

- Mud construction is monolithic thus performs well structurally. However, thick walls lead to be prone to earthquake damage.
- Absence of any wall plate or horizontal member makes the wall receptive to the earthquake.
- Higher walls and heavy roofs in traditional houses can succumb to failure.(**Fig -6**)

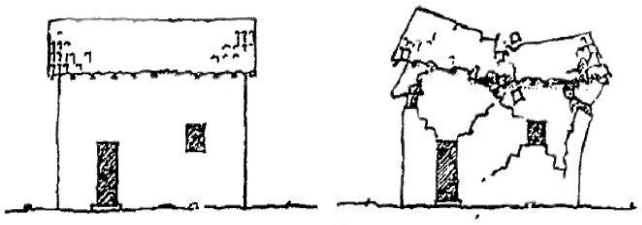

Fig -6: Failure in mud walls

2.3.1.2 Contemporary Construction Techniques

Modern construction with fired brick, cement concrete and R.C.C is prevalent in the region as materials are easily approachable from the plains. Extensive use of glass results in higher heat gain, creating uncomfortable conditions in summers. This type of construction is maintenance-free and high rise structures are also feasible.

Fig -7: Typical Modern concrete building of Kangra valley

2.3.1.2.1 Analysis of Contemporary Construction Techniques

The sustainability of modern construction techniques for this region is analysed in terms of climatic response, material suitability and seismic suitability to assess its appropriateness.

A. Climatic Response

- Fired brick wall construction with flat R.C.C roof is not climatically adapted to the region. The structures don't protect from the hot summers.
- Brick wall construction safeguards against the rain in the region.

B. Material Suitability

- Fired brick and cement are accessible in the nearby regions.

C. Structural and Seismic Stability

- The houses are not built as per the earthquake guidelines making them vulnerable to earthquakes. Absence of plinth band and lintel band makes them unstable.
- The houses are built with lesser grade materials and the construction joints in the structural members are tend to be faulty causing failure in case of any disaster.

2.3.1.3 Alternate Construction Techniques

Fig -8: House of Didi Contractor
(Source:https://www.surfacesreporter.com/articles/10647/didi-contractor-a-life-dedicated-to-inspire-love-nature-and-nurture-humanity)

Use of mud construction with cement is a technique practiced by an American architect –Didi Contractor working in the region. A typical house was studied and the suitability of the technique was analysed(**Fig -8**). House is built over a bed or rubble masonry bonded with mud plaster. At the plinth level, R.C.C beam 450 mm high is laid concerning earthquake safety. The Earth excavated from the site is utilised for making adobe (sun-dried mud blocks) of size 6x12x3 inches to build the 18'wide wall over the plinth beam. If the site doesn't have good earth, clay or sand or straw is added to attain the appropriate mix.

Wall is provided with a layer of cement plaster up to 1 m high as damp protection. To counter the problem of washing out with water three layers of plastering is done. The first layer consists of traditional mud plaster. After drying, a thin slurry of mud is applied. This layer fills the cracks developed in the plaster. Following that, a layer of mud plaster blended with twigs, cow dung and stabilisers is applied. Pulped waste paper can also be used as fibre.

Cement beams are provided at lintel and eaves level. Floors are laid over smoked bamboo purlins which are not damaged by insects and moisture. Above the bamboo, `chira' half bamboo or bamboo mat is laid which is covered with a wire mesh and poured with the mud slurry. Wire mesh binds the mud mortar and provides reinforcement. Walls in the wet areas like toilets are built of fired brickwork and the flooring is done in stone. The roof and floors are laid in the same style as the traditional construction with slate placed over bamboo rafters.

Fig -9: View of House with Alternate Technique
1- The entrance porch is created with stacked stone masonry, elements of Himachal vernacular. 2-Openings are designed keeping in mind the modulation of the wall for practical use and proportion. 3- Combination of mud brick, burnt brick, stone and bamboo.
(Source: A photo-essay by Joginder Singh www.jogisingh.com)

2.3.1.3.1 Analysis of Alternate Construction Techniques

An appraisal of alternate construction techniques in terms of climatic response, material suitability and structural and seismic suitability is done to assess its suitability in the region.

A. Climatic Response

- Use of mud construction is appropriate for the climate of the region.
- The use of cement as plinth protection counters the problem of damage due to heavy rains.
- Not enough provision for ventilation creates damp conditions inside during rainy season.

B. Material Suitability

- Use of mud as a construction material is both energy efficient and cost effective. The techniques available in the market to make mud buildings long lasting can provide great boost to this technology.
- Acceptability of mud as a construction material has changed in the recent times.

C. Structural and Seismic Stability

- For seismic resistance, horizontal bands of cement concrete are provided at different levels which provides this construction structural stability.
- Performance of the thick mud wall under seismic loads is a concern.

Fig -10: View of House with Alternate Technique (Source: A photo-essay by Joginder Singh, http://theinsidetrack.in/greenspeak/didi-contractors-mud-marvels)

3. CONCLUSION

The researcher has concluded from literature reviews and analysis that, traditional construction techniques in Himachal have proven to be not only climatically sensitive but also safe in case of disasters. These techniques however are not sustainable in their original form due to various limitations. Contemporary materials are gaining acceptance in the hills as they are readily accessible. But the modern houses have not accustomed themselves to the regional climatic conditions and seismic constraints. However, alternate construction techniques adapt the traditional knowledge with new materials and technologies. It has great potential in future since the need for a sustainable development is the need of the hour. These alternate techniques have only been used for small scale projects but in future their use for public buildings, heritage buildings, buildings for tourism can not only open new avenues for their use but can also help disseminate knowledge to the masses. Further research in this subject can be carried out for the various safety features in these alternate techniques and testing these for their sustainability for future.

REFERENCES

[1] Kimura Kin-ichi(1994), "Vernacular technologies applied to modern architecture," *Renewable energy*, vol. 5,*part 2,* pp*. 900-907,*August, 1994.

[2] Randolph Langenbach, "Opus Craticium to the Chicago Frame," *International Journal of Indian Heritage*, vol. 1*, part 1,* pp*. 29-57,*May, 2007.

[3] Hicyilmaz k. , Bothara J., and Stephenson, M. (2012), "Dhajji Dewari," *World Housing Encyclopedia,* Earthquake Engineering Research Institute, United States , report no.146,*March*,2012.

[4] Ankita Sood , Aditya Rahul ,Yogendra Singh, Dominik H.Lang. , "Dry Stone Construction," *World Housing Encyclopedia,* Earthquake Engineering Research Institute, United States, report no.172*, August*, 2013.

[5] Ridhima Mahajan, "An appraisal of traditional construction technique," M.arch. thesis, Architecture dept., I.I.T., Roorkee, India;2010

[6] Joginder Singh, "The mud architecture of Didi Contractor," in *Down to Earth*

[7] Ashwani Kumar, pushplata, "Vernacular practices: as a basis for formulating building regulations for hilly areas," *International Journal of Sustainable Built Environment*, vol. 2*,* pp*. 183-192,* June, 2013.

[8] Yash Siroliya, "Development of Andretta Artist's Village," B.arch. thesis, Architecture dept., Chitkara University, India;2018

[9] Ankita Sood, Aditya Rahul ,Yogendra Singh, Dominik H.Lang., "Thathara houses in Himachal Pradesh," *World Housing Encyclopedia,* Earthquake Engineering Research Institute, United States, report no.170*, March*, 2013.

[10] Ching, Frank (Francis D.K.), "SiteWork," A Visual Dictionary of Architecture*, IInd* ed., New Jersey, USA, 2012, pp227–*233.*