



S & T Interventions in the Traditional Architecture of Rural Areas of Himachal Pradesh

R. Dharmaraju*, Ashish Pippal, Swati Kulashri

CSIR-Central Building Research Institute, Roorkee, UK, India

Received: 30.02.2017 Accepted: 09.04.2017 Published: 30-06-2017

*rdrajucbri@gmail.com



ABSTRACT

The ancient constructions in Himalayan regions are the finest examples of the traditional architecture, providing sufficient thermal comfort under extreme geo-climatic conditions of the region. These indigenous construction practices include the use of locally available materials such as wood, stone etc. One such native construction techniques, that has been practiced in the state of Himachal Pradesh is known as ‘Kath-Khuni’ and its architecture is created with a mesh of interlocking horizontal sleepers and is dressed or raw stones are packed without any mortar. The designs of these houses are best suited for the harsh environmental climatic conditions of the region. The present state of knowledge reveals that usage and construction of such houses are not in practice due to non-availability of timber and modern architecture. However, such kind of houses can be strengthened and preserved by deploying affordable S&T inputs. For these reasons, about 120 traditional architectural styles of rural houses in Himachal Pradesh have been studied and documented. Subsequently, S&T interventions have been suggested to strengthen and maintain the traditional architecture of rural houses based on the gaps identified.

Keywords: Documentation; Himachal Pradesh; Rural housing; S&T intervention; Traditional architecture.

1. INTRODUCTION

Himalayan ranges of India has both cold climatic hilly regions and hot and composite climatic plains. In cold climates, houses are heavily insulated to prevent heat from moving out from indoors to cold outside through building fabric. During the ancient time, the people of the region have built traditional houses for living which gave maximum comfort.

The state of Himachal Pradesh is spread over an area 55,673 km² and is bordered by Jammu and Kashmir on the north, Punjab on the southwest, Haryana on the south, Uttarakhand on the southeast and Tibet on the east. Himachal is a mountainous region, rich in its natural resources. Most of the area of this state is mountainous region with extreme climatic conditions. December and January during winter observe lowest temperatures ranging from – 4 °C to 20 °C, with snowfall. Annual highest temperature in summer ranges from 25 °C to 37 °C during May to August. Months of July and August are rainy because of monsoon, having around 15 cm rainfall monthly. Climate is pleasant in October and November.

Due to this extreme climatic conditions and topography the people of Himachal Pradesh have developed their own style of building construction which is quite suitable for the climatic and topographic conditions of that region. These indigenous construction practices include the use of locally available materials such as wood, stone etc. This technique of construction

is known as ‘Kath-Khuni’. In Kath-Khuni architecture a mesh of interlocking horizontal sleepers is created and in this mesh dressed or raw stones are packed without any mortar. The present state of knowledge reveals that such houses are not been constructed due to non-availability of timber and modern architecture. The maintenance and protection of exposure of traditional architecture is necessary to preserve our culture and retain traditional knowledge. This paper basically focuses on the study & documentation of the vernacular construction techniques, and suggests the S & T interventions required to strengthen and maintain the traditional architecture style rural houses in Himachal Pradesh.

2. FIELD STUDY

The detailed field survey has been done to collect information of the traditional architecture in different districts of Himachal Pradesh in a format designed for the collection of the required information from each individual house. During the survey, 120 houses of various villages covering about five districts i.e. Kinnaur, Shimla, Kullu, Mandi & Kangra have been collected. It is found that these traditional houses have been constructed by using a different type of architectural style called “Kath-Khuni”.

Kath Khuni is the architecture of the effective use of resources at hand in the most meaningful way without being wasteful. The indigenous construction

practices in Himachal Pradesh reflect the following key features of sustainable design in the widest possible sense.

2.1 General House Layout

- Traditional architecture is dictated by use of local materials like stone and timber for structural and decorative purposes.

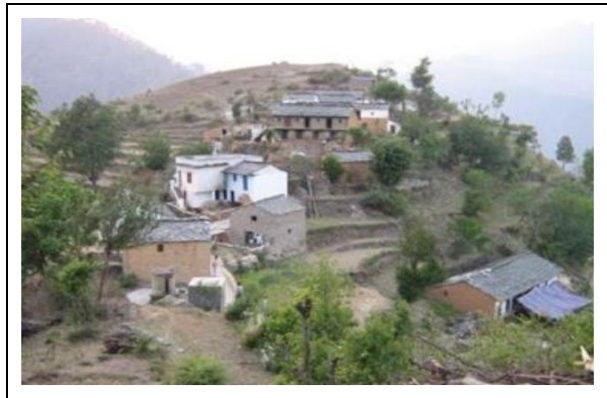


Fig. 1: Arrangement of houses in contoured pattern.

- Pattern of internal space organization and design irrespective of the social and economical class of the owners and only difference is the decoration of the entrance hall.
- Houses are oriented facing south, west and east to get maximum advantage of the sun.
- Heights of buildings and spacing between them are purposely graded to ensure that the building blocks get direct sun.
- Houses are rectangular in plan, built along the contours and generally two or three storey with sloping roofs.
- Approach to the living areas is through an open flight of steps for drying the crops and other outdoor activities, open space in front of the houses are also provided. 75cm wide balcony in front of the house is an integral part of the house.
- In construction; stone, wood and slate have been used extensively for walls, floors and roofs. The height of lower storey ranges between 1.5m to 1.8m.

2.2 Architecture & Planning Features

- The material and climate are the basic parameters guiding for the architecture
- Square /Rectangular in plan
- Load bearing walling system of construction
- Sloping roof
- Opening kept minimum to avoid the cold
- Height of building Ground Floor: 1.5-1.8 m
- Upper Floor: 2.7- 3.0 m

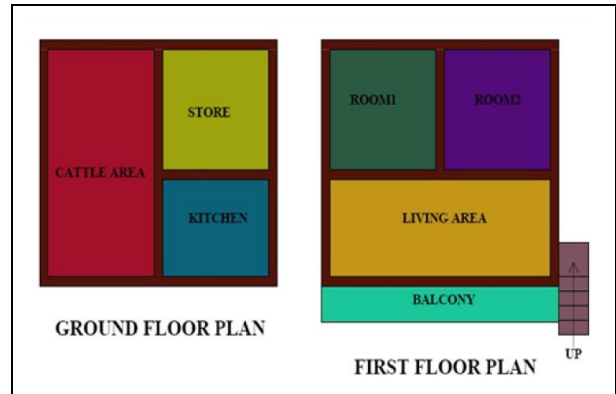


Fig. 2: Basic house plan.

2.3 Typical Construction Materials Used

Stone & Wood has been used as a building material due to its abundant availability, workability and ease to repair and simple technical skill requirements. Wood is mainly used as structural elements like wall & columns, Door, window openings and for flooring etc.

2.4 Construction Techniques

- Timber tie bands are used at regular interval in construction of wall. Space between the timber bands are filled with dry stone masonry available locally.



Fig. 3: Timber tie bands.



Fig. 4: Wooden pegs.

- Wooden pegs are created in wooden beams for interconnecting the beams and other structural components. These pegs are interlocked in the space made on the other beam.
- The height of doors and windows are kept low and are laid with heavy wooden frame in order to accumulate the stresses during earthquake, also height of floor is kept low to keep the Centre of gravity down and make the structure stable.



Fig. 5: Low door height.

- Over the walls a network of wooden rafters and purlins is laid to support the roof; cladding over the top of the roof is done by nailing the slate stones to the wooden frame.



Fig. 6: Wooden rafters & purlins.

2.5 Advantages of the 'Kath-Khuni' Style

Time and Resource Efficiency

The indigenous technique use stone and wood, two environmental friendly materials that are close at hand, together with rubble as an alternative to slow setting mortar. These results in use of resources at hand instead of material produced, processed and moved from outside.

Design Efficiencies

Walls of considerable thinner section than the normal stone wall can be made using the Kath-Khuni construction techniques with the net result that maximum height can be reached using minimum material.

Structural Resilience

Kath-Khuni construction techniques demonstrate superior resilience against earthquake unlike structures dependent on non-local materials and rigid construction techniques.

Low Maintenance

The traditional building techniques require very low efforts and skills to maintain and repair.

Resource Reuse

There is rarely any wastage of material since construction techniques involve use of both unfinished and finished materials which do not deteriorate overtime and that can also be used elsewhere.

Biodegradable Materials

Construction of vernacular houses revolves around naturally biodegradable materials with very limited use of metal or no fixating agents like mortar or any other synthetic material.

2.6 Documentation of the Traditional Architectural Styles

A compilation of field survey data for more than 120 villages of various districts of Himachal Pradesh reveals that there are basically four categories of houses based on their condition, they are:

- Traditional houses that have deteriorated and cannot be used for living and environmental friendly
- Traditional houses that are still in liveable condition but require some maintenance.
- Stone houses without timber framework.
- RCC framed houses which have been constructed using the modern construction techniques.

3. IDENTIFICATION OF S&T INTERVENTIONS

Traditional architecture has many advantages and drawbacks as well. Based on the detailed study of traditional architecture of rural houses in Himachal Pradesh the following S&T interventions have been suggested to strengthen and maintain traditional architecture of rural houses required:

- Elaborated timber framework, holding dry stone masonry work; gets deteriorated by seasonal exposure to rain and flowing water.
- Massive walls invite large seismic force on the structure during a seismic event.
- Slate stones used for cladding of roof are not fixed properly; which puts a high risk of these slate getting loose and causing injury to the inhabitants during a seismic event. Also, these slate stones increase mass of the roof, which is responsible to the structural damage during earthquakes.
- Slate tiles are supported over a network of wooden rafters and purlins. This wooden network gradually deteriorates with passage of time under the damaging effects of termite, water etc. Any earthquake in the later part of the age of the building may therefore easily cause severe damage.
- Extended cantilever projections are absent in newer constructions; putting walls exposed to direct rain leading to water seepage, faster corrosion and decay of wooden members.
- Still new constructions have no wooden framework due to ban on the use of timber and sharp rise in the cost of timber battens. Such houses are very prone to earthquake damages.
- The older houses were protected from cold winds and harsh climate by a circumferential covered verandah. Newer houses do not have such protection and therefore need better insulation of walls and roofs for thermal comfort.
- The region of Himachal Pradesh has very cold climatic conditions hence besides proper insulation low energy heating systems should be incorporated to keep the inside atmosphere warm.

3.1 Suggestion

Protection of Wooden Members

Wooden bands are placed transverse to the entire length of the wall at regular interval of 500 mm. Stone masonry is used to fill the space between the wooden beams. These bands bear the tensile stresses during earthquake. In absence of a waterproof plaster these timber bands get exposed to rain water. So with passage of time these timber members start deteriorating. To protect these members, a layer of chicken mesh or welded mesh is fixed to the walls and the wooden members using nails of sufficient length covering the complete exposed surface. Thereafter cement plaster is applied over the chicken mesh to the entire surface in the pre-existing structures. And for the new construction timber bands should be replaced by RCC bands.

Massive Walls

Thick walls, about 40 to 60 cm thickness, are made up of stones with timber bands at regular interval. These walls have very thick section, due to which the mass of the structure increases and make them unsafe during earthquake. At the same time the thicker walls reduce the usable floor area for the same plinth area. Undressed stones are used in such constructions because stone is locally available but dressing the stones is very costly. Under these circumstances ‘Stone masonry Blocks’ developed by CSIR-CBRI, Roorkee can be used with advantage. Irregular stone pieces constitute major volume of these blocks giving a high strength at a low production cost. These blocks can be easily casted manually at the construction site or for larger production egg-laying type machines can also be used. These blocks are strong enough for three storey load bearing masonry construction. Hollow blocks can also be used in single storey or RCC framed multi-storey houses. Concrete block walls are cheaper in cost, better looking and more resistant to earthquakes when RCC bands at plinth level, lintel level, sill level and roof level along with corner reinforcement are provided.

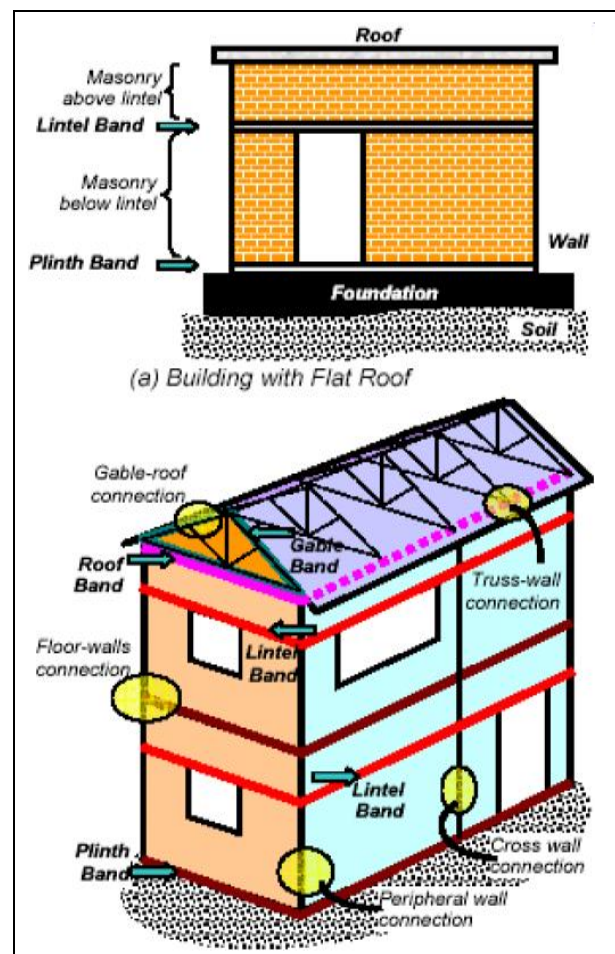


Fig. 3: Horizontal bands in masonry buildings.

Replacement of Slate Stones & Wooden Rafters and Purlins

Since use of slate stone for roofing purpose makes the structure more vulnerable towards seismic event. Thus, a safer and better alternative is needed. Presently, various types of corrugated sheets with or without PUF insulation layers are available in the market. i.e. the slate stones can be replaced by PUF coated sheets. And the wooden network of rafters and purlins also increases the mass of the structure hence it should be replaced by steel pipes and trusses.

Extreme Cold Climatic Conditions

The region of Himachal Pradesh has very cold climate. So to keep the inside warm comfortable for living we should provide proper insulation. Hence hollow blocks can be used with insulating material such as thermocol or pine needles in the hollow spaces between them. Pine needles are available in this region in a large amount hence pine needle boards can be made and used for interior lining of the house. The pine needle boards can also be used for warm floors as a replacement of wooden plank floors.



Fig. 4: Traditional roofing style.



Fig. 5: Suggested roofing modification.

Solar energy can be utilized in keeping the indoors thermally more comfortable. Glazed windows can be provided on the south facing walls to allow more

sun to enter living spaces. Windows in the East walls allow morning sun while windows on the West walls allow evening sun.

Trombe Wall is a good solution to warm up indoors during daytime. Similarly solar water heaters and solar cookers can also be used where good sunshine is available like in the Leh Ladakh region.

Introduction of Two-pit Sanitation System

Two pit sanitation systems can also be introduced in the traditional houses. As it is a low cost rural latrine system with following features:

- Low water consumption
- Free from foul smell and fly nuisance
- Suitable for individual houses
- Manure as by product
- Easy to construct and maintain
- Use of local materials and skills
- Proper sanitation helps reducing the incidence of diseases



Fig. 6: Two pit sanitation system

4. CONCLUSION

The present study revealed the state of present knowledge on the traditional architecture of rural houses in Himachal Pradesh. Further, the efforts have been made to identify the S&T interventions required to strengthen and maintain the traditional architecture intact using the locally available environment friendly materials. The S&T interventions performed are applied to the traditional architecture and the houses constructed by using these new technologies will have following advantages:

- The traditional architectures remain preserved and the drawbacks regarding the structural stability can be removed.

- By considering earthquake safety these houses are more stable.
- Replacement of stone and wood by other materials makes the structure lighter and at the same time wood is not used in large amount so it also prevents environment degradation.
- By giving a little training to the labour this modern technology of construction can be achieved.
- This is a more economical way of construction.

ACKNOWLEDGEMENT

The paper is being published with the kind permission of the Director, CSIR-Central building research institute, Roorkee. Authors thank Ar. S.K. Negi and H. K. Jain for their technical support and help rendered for preparation of the paper.

FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

COPYRIGHT

This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC-BY) license (<http://creativecommons.org/licenses/by/4.0/>).



REFERENCES

- Bharat Dave, Jay Thakkar, Mansi Shah Prathaa: Kath-Khuni architecture of Himachal Pradesh.
- Handa O. C., Himalayan Traditional Architecture, Rupa & co. New Delhi (2009).
- Jay Thakkar, Sheila Skye Morrison; Mātrā: Ways of Measuring Vernacular Built Forms of Himachal Pradesh.