Study of Building Structures & Construction Techniques in Hilly Regions: Hotel Dalhousie

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Abstract:
Architecture on hills always seems to be beautiful, attractive and soothing to eyes of the people, but a challenge for an architect and structure engineers. As Himachal Pradesh is one of the most tourist attracting states, therefore, to acquire most of the people from all over the world, hotels play a major role. In this paper the research of a particular building, Hotel Dalhousie, is explained. Major part of the paper consists of the design approach of a building in hilly regions and construction techniques used. Hotels are the majorly built buildings in city Dalhousie as it is a tourist place. Therefore, study of a hotel is taken as a research to take a step ahead for the urbanization in hilly areas.

Keywords: hilly regions, topography, building structure, hotels, local materials, design approach.

I. INTRODUCTION

According to topographic features, 10.7% of land area in India is mountains, 18.6% are hills, 27.7% are plateaus, 43% are plains. Hill areas are all the weathered high lands. It is the extended landform above surrounding terrain. Hills have unique ecosystem which has visual resources and is rich in biodiversity. When we talk about the architecture on hills some factors come through such as slope, vegetation, flora and fauna, heterogeneity of climate, and land use pattern. In some years the architecture and the growth of urbanization is expanding rapidly in the hilly areas. Any area above 600 meters in height from the sea level is considered as hilly. According to this Jammu & Kashmir, Himachal Pradesh, Sikkim, Manipur, Meghalaya, Nagaland, Tripura, Arunachal Pradesh and Mizoram are considered as the hill states of India. If we go through the geography of Himachal Pradesh, It extends from the latitudes 30°22’40” North to 31°12’40” North and longitudes 75°45’55” East to 79°04’20” East. The altitude of Himachal Pradesh ranging from 350 meters to 7000 meters above sea level. The altitude of the region is increasing from west to east and from south to north. Himachal Pradesh is divided into three distinct regions, the Shivalik or outer Himalayas, middle Himalayas or inner Himalayas, and greater Himalayas or the alpine zone. Due to extreme variation in elevation, great variation occurs in the climatic conditions of Himachal. The climate varies from hot and sub humid tropical in the southern tracts to, with more elevation, cold, alpine, and glacial in the northern and eastern mountain ranges. The state has areas like Dharamshala, Dalhousie that receive very heavy rainfall.

Figure.1. Traditional look
Broadly, Himachal experiences three seasons: summer, winter, and rainy season. Summer lasts from mid-April till the end of June and most parts become very hot with the average temperature ranging from 28 to 32 °C (82 to 90 °F). Winter lasts from late November till mid March. Snowfall is common in alpine tracts. Dalhousie is a hill station in Chamba district, in the northern state of Himachal Pradesh, India. It is situated on 5 hills and has an elevation of 1,970 metres above sea level. It is surrounded by snow-capped peaks. Dalhousie is situated between 6,000 and 9,000 feet (2,700 m) above sea level. The best time to visit Dalhousie is in the summer, and the peak tourist season is from May to September. Scottish and Victorian architecture are prevalent in the bungalows and churches in the town. Dalhousie is a beautiful tourist spot and therefore plays an important role in the economy of the state. The major industry is tourism there are just over 600 hotels, which provide temporary jobs to about 5,000 to 8,000 individuals every year. Hotel Dalhousie is one of the old hotels in the city, situated 2km from the main bus stop and on the main centre of the city Gandhi chawk near the main city market mall road. The hotel is built considering the traditions and vernacular architecture of Himachal Pradesh. The hotel has its own food and cafe facilities and has the rooms in rows. Beautiful wooden flooring used in the rooms. Dormers provided. The roofs have all modern facilities with the traditional look.

II. PROBLEM FORMULATION

Land area of hotel Dalhousie is 80ft * 50ft (approx). The hotel has g+3 floors. Each floor height is 3m. The hotel is expanded horizontally along the market. Vertically the building is constructed and grows downwards along with the slopes of the hills.

III. PAST WORK REVIEW

As architecture on hills is an interesting topic for a research work therefore many people has studied and has done research on hotels in hilly regions. Hotel Dalhousie is one of the oldest hotels in the city. It is constructed by the use of local materials available. Hotel Dalhousie particularly do not have the research work done previously but the hotels and buildings in hilly areas and the construction techniques used there for the stability of the building. Construction technique used in general practice in Himachal Pradesh is kath khuni. The technique which includes the use of locally available materials such as stone, wood, slate, etc. When it comes to the design approach there are certain points which were observed by some people and are practiced practically in the hotels.

1) Parking on the roof which comes to the level of the road and further building is continued downwards.
2) Sloping roofs are used because of the the climatic condition of the city. To protect the building from snow and rain.
3) Step construction is generally practiced to make the proper use of sloping site.
4) Locally available materials are used for the stability and strength of the structure.

In this paper the further approach is studied towards the building design on hills.

IV. APPROACH TO THE BUILDING STRUCTURE

Buildings in hilly regions are the major challenge for architects. Buildings such as houses, small shops, temples, etc, can be easily constructed as compared to large scale buildings such as hotels acquiring the population of tourists. Therefore building and the construction has to be structurally strong enough to resist the topography and frequent seismic tremors and also bare the load of the building and as well as the building should be aesthetically attractive for tourists. According to the topography and requirement of the building, design and planning plays a major role. Hotel Dalhousie is very smartly designed considering the design parameters. Some of the design approaches to be taken care of our settlement patterns, materials used in various spaces, open interactive spaces, sloping roofs, interior designs (rooms), retaining wall, etc.

V. STRUCTURAL APPROACH FOR HOTEL DALHOUlIE

- Settlement pattern: For the thermal comfort of the occupants, function of shelter is provided for reducing the heat loss from the building, therefore, for solar heat gain, the building is oriented to equator towards the south and to reduce heat, settlement have compact layout. Narrow pathways provided. Opening towards south-east and south-west.

- Shape of the building (massing): Constructed with the functional requirements of user and locally available materials suitable for the building. Linear arrangement of rooms, connected with balcony. Wet areas kept separate from living areas. Balcony oriented towards south. Height of the rooms kept lower. Maximum windows were south facing.

- Materials: Materials used in the building were stone, slate, wood; plaster work. Stone was used for the construction of walls. Slate for the roof and dormers. Wood was used in the flooring, room separations, doors and window framing.

Figure.2. Shape of the building

Figure.3. Materials
- **Open spaces:**
  Open spaces in the form of balconies were provided as the interactive spaces in the hotel. The space facing towards the south because of the climate. Wooden railings provided all around the balcony or the open space.

- **Roofs:**
  Roofs are the major part of the building. Beautiful sloping roofs. Slate pieces used for the strength. To protect the building from heavy rains and snowfall the slates were projected little out.

- **Dormer:**
  Dormer as a component was used above the windows as a shading device. Dormer functions to resist the direct sunlight inside the rooms, protects from the rains and snowfalls. It plays an important role in the construction of buildings in rainy and snowy regions.

- **Interior designs (rooms):**
  Rooms are the most important part of a hotel. It should be protective from the climatic factors and as well as aesthetically good. Rooms are compact, cosy and luxurious. Wooden floors and partitions. Inner roof of the rooms are wooden. Skylight window at the entrance. Entrance door and maximum large windows towards south.

- **Retaining walls:**
  Before starting any construction work on hilly areas, retaining walls are the foremost construction work. It is important to make the strong retaining walls all around the building or site. It is constructed to support the active and passive pressure of earth. Retaining wall is constructed by using the locally available stone and cement work.
VI. CONSTRUCTION TECHNIQUES

As Himachal Pradesh has different climatology and topography, therefore, the construction in such areas, according to their climatic and geographic conditions, are different from general construction techniques used in other states. For the human comfort, buildings were designed using locally available materials and construction technology according to the climate and topography of the land. In the upper hills of Himachal Pradesh a vernacular building technique of construction called Kath-Khuni is practiced which provides buildings an effective mechanism to resist the seismic tremors which occurs frequently. Kath-Khuni is the construction technique which makes the buildings on hills strong and can easily be constructed by the local people. Construction techniques in hilly areas have to be used with a great care as there are many chances of natural hazards. Kath-khuni was in knowledge of the local people from many years ago and was practiced locally from years. The technique is best suited for the topography and climate of the region. From small houses to the hotels the construction technique of the buildings in Himachal Pradesh is same i.e., kath-khuni. The wet regions of Himachal Pradesh are rich in the natural resources of forest and water. Natural hazards are the main and serious problem of the region such as cloudbursts, flash floods, landslides, and earthquakes. As the region has rich traditional ways and also have the impact of climate and complicated topography the local people and the architecture of the region follows a vernacular traditions and techniques. The architecture in Himachal Pradesh is based on some locally available materials such as timber, soil, stone, and slate. But as the urbanization is rapidly increasing, high density of construction work is done with RCC frames and burnt brick masonry, and as a result there is a huge loss of old traditions and traditional construction practices. But still much construction work is practiced according to the vernacular techniques. Kath-Khuni architecture has the characteristics to be seismically sound, aesthetically pleasing, and sustainable. If we talk about the materials which were observed or studied and are used in this technique are:

- **Wood (deodar):** Wood is the most common material used in the construction work of Himachal Pradesh. Wood as a material is used for the flooring, wall separation, doors, windows, etc. Wood is the locally available material from the trees of deodar which are abundantly grows on the hills of Himachal. The tree deodar has the quality to resist in heavy rain for about 1000 years, and is 50metres high and has diameter of 3metres, therefore, the wood is the majorly used material in construction practice.

- **Stone:** Stone is one of the most important locally available materials for the construction as the granite stones are widely found in Himachal which are used for various purposes such as for the finished work on external facades of the buildings, and loose filler material used between wooden wall frameworks. Stone is used for the bonds between the blocks because of its ability to absorb heat. It is widely used for the construction of Kath-Khuni architecture as it resists the impact of earthquake and landslide tremors.

- **Slate:** Roofs plays a major role in the buildings of Himachal Pradesh to resist from continuous heavy rains and snowfalls. Slate is the material which is cut into thin sheets from the heavy metamorphic rocks. A slate is cut into triangular and rectangular shaped units and protects the building from heavy rains and snowfalls.

**Construction technique for roofs:**
Slates are the major vernacular locally available material which is used for the construction of roofs in Himachal regions. As slates are the small units of a defined shape and are systematically arranged.

- The units are typically and simply placed in rows on the roofs by overlap between them for the proper bond.
- Another alternative is to drive the nails to the wooden frame underneath to fasten them.

Because of the dead weight of the slate it keep in the place itself. Slate is the sunlight reflective material, is frost resistant, heat absorbent and moisture barrier as it is containing high quartz content.

**Different materials have their different roles in the construction such as:-**

- Stones are used for the plinth work.
- Wood and stones for walls.
- Wooden projecting balconies on upper levels.
- Over hanging slate roof fixed to the wooden frame.

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![Figure.9. Construction techniques](http://ijesc.org/)

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**Wooden construction techniques:**
- Easy availability of wood for construction work makes it the most commonly used material.
- Wood provides relief from the cool winters because of its thermal properties.
- Wood for the 2-3 storey buildings is used as the vertical wooden post to carry the load.
- Wooden battens are in-filled in the horizontal members which are placed at different levels.
- Providing living space all around as the upper floors are cantilevered.
- Stone masonry used for the ground floor, and wood for the upper floor.

**Some other techniques:**
- Structural walls are made of deodar and slate stone.
- The plinth is constructed entirely of stone.
- Base of the structural wall are flat installed stones having two parallel layers.
- Infill of random rubble for the gap in middle, depending on the size of stone.
- Stability is provided by stacking up the larger stones on the outer edge and the corners of the wall.
- Both wood and stone used for the wall construction.
- Materials are stacked horizontally, in alternating rows, parallel to the ground.
- Timber beams side by side are fixed between layers of stone and form square or rectangular frame.
- Infill of rubble to give mass and support to frame.
- Wooden planks used for the interior surface.
- Light timber frames for seismic bracing.

**VII. CONCLUSION**

Himachal Pradesh is the land of snow peaks, glorious green hill-slopes, mountains, streams and the hills of Himalayas welcome the tourists from all over the world. Himachal Pradesh is full of hill resorts, pilgrimages, adventure sports destinations, and wildlife that attract a wide range of tourist traffic. Today, Himachal Pradesh is one of the most important tourist destinations in India. Therefore, hotels play the major role today in the state. Construction in hilly regions is a difficult task. The construction techniques have to be used in proper way. Building structures of hilly regions has to be studied and understand properly for the construction in such topography.

**VIII. REFERENCES**


[2]. http://himachaltourism.gov.in

