Construction Technique in Hilly Areas

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Abstract*—Building on the hills is not an easy thing to do because of the difficult terrain, natural hazards, and changes in climatic conditions. Traditional techniques, such as Kath-Khuni, Dhajji-Diwari, and dry-stone masonry, exemplify the efficient utilization of locally available materials as well as designs that are environmentally sustainable and culturally appropriate. These methods are designed to resist natural calamities, such as landslides and earthquakes. On the other hand, the popularity of urban structures and contemporary construction practices has led to the implementation of advanced techniques such as reinforced concrete and prefabricated materials, resulting in increased durability, efficiency, and flexibility to rugged terrains.

***Index Terms*— Hilly Areas, Construction Techniques, Urbanization Challenges, Disaster Resilience, Traditional Methods**

I. INTRODUCTION

India's hill areas are characterized by beautiful and complex architecture reflecting diverse ecosystems and steep terrains. About 29.3% of the Indian territory is occupied by mountains and hills, which are not only sights to be seen but also display a great deal of biodiversity. Nevertheless, the planning, design and construction of buildings in these areas are difficult due to steep gradients, adverse climatic conditions, and the risk of natural events such as landslides and mudflows.

Building in the hilly regions has a crucial component in vast understanding of various parameters like, slope, vegetation, and local climate thus architectural practices are influenced. The traditional construction techniques that they were using have changed over the years and now local materials and traditional methods are used which are eco-friendly and sustainable. These vernacular practices have the potential to inform modern construction, thus promoting resilience and minimizing ecological disruption.

Traditional methods despite the pros have started to be replaced by the new ones, which require the usage of contemporary materials and building structures with multiple floors, irrespective of the specific/unique conditions of the area. This change can result in damage to both the environment and the people's health. The paper addresses this issue, noting the need for the development of appropriate building regulations which cater to the specific challenges of hilly areas and stressing that a balance between development and the environment must be found.

II. LITERATURE STUDY

A. TOPOGRAPHICAL CHALLENGES

The topographic problems in hilly areas, like the steep slopes, unstable soils, and earthquake activity, are the main factors that bring about the construction obstacle. Steep terrain restricts space for building the development and adds to choosing and designing the area for construction. Foundations often demand unusual techniques, such as deep foundations, to manage loose or rocky soils and avoid settlement. Harsh weather conditions, among them heavy rain and snow, demand the installation of proper drainage systems to prevent erosion and damage. Wood and stone are materials that are mostly used because they are easy to get, but they are not always up to date with modern engineering standards. The traditional building techniques of slanted roof construction and contour construction are incorporated into the design process and thus a sustainable scheme is produced and is adaptable to the local environment. (Vrushali Chawhan, 2021)

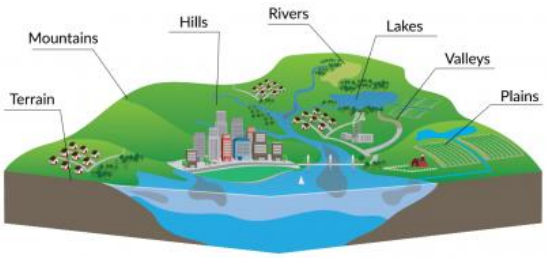

Figure 1 Representation of Topography

Source: https://gisgeography.com/what-is-topography/

B. VERNACULAR ARCHITECTURE

Vernacular architecture in the hills is configured to cater to the local environmental conditions of topography, climate, and availability of materials. Sustainability is at the heart of it; hence, they are using materials that are locally available such as wood, stone, and mud, and include design features to decarbonize the material supply chain and at the same time strengthen the structure. Through the application of indigenous construction methods, houses are made to resist natural disasters like earthquakes, landslides, and heavy rain in the region. As the process of urbanization expands, the problem is how the age-old techniques of work can be incorporated into the framework of modern development to achieve sustainability and disaster resistance at the same time. (Vrushali Chawhan, 2021)

Figure 2 Kath-Khuni Architecture Himachal Pradesh Vernacular Architectural Style

*Source:*https://www.re-thinkingthefuture.com/rtf-fresh-perspectives/a1242-5-vernacular-architecture-styles-in-india/#b7c818db5f44be39b242dd28859ae9a7b1597267

C. NATURAL HAZARDS

The main problems of construction in hilly areas are the risks that come with natural hazards, such as landslides, erosion, and flooding. These hazards are often further exacerbated by rapid urbanization, which puts more strain on the delicate environmental system. Construction regulations and building technologies should embrace these issues and thus, safety and sustainability can be achieved. The right choice of site, the carrying out detailed geological surveys, and the reducing of disturbances to the natural landscapes are crucial measures to lower the risks of natural disasters. Also, the building designs should be based on materials and techniques that can withstand earthquakes and heavy rain, which are typical in such regions. Besides, eco-friendly construction practices and the use of local materials are key in both the reduction of the environmental impact and the stability of the structure (The Constructor)

Figure 3 Landslide In Assam

*Source:*https://www.northeasternchronicle.in/news/assam-landslide-siblings-buried/

D. URBANIZATION

Urbanization in mountainous areas poses serious construction problems due to the uneven terrain, steep hillsides, and environmental hazards such as landslides and soil erosion. Common building techniques usually face the issue that they cannot adapt to a site condition, which makes the utilization of innovative construction technologies imperative. Recent materials such as steel structures, cement/wood panels, and poured-in-place concrete panels are instances that are getting more widely used because of their long-lasting property and lightweight. These materials not only cut the time and costs of construction but also have less of an ecological impact which makes them more applicable to project features involving hilly topography. The appropriate study of urban design and guaranteed use of these specific technologies are important to spatial integrity and sustainability. (Pooja, 2022)

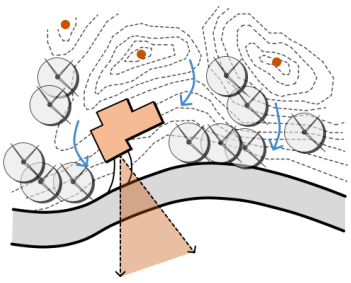

Figure 4Placement of the building

*Source:*https://www.kaarwan.com/blog/architecture/how-to-design-buildings-on-hilly-or-sloping-terrain?id=76

E. CLIMATE CHANGE

Construction techniques in hilly areas have largely been influenced by climate change, the areas being more exposed to such risks as landslides, floods, and soil erosion. Rising temperature and rainfall's abnormal cycle destabilize slopes thus making landslides and rockfalls a common phenomenon. Furthermore, this is facilitated by the thawing of the permafrost in the high-altitude areas, which causes the foundation of buildings to get debased. Since budding technologies have usually been tied to stable weather conditions, they usually are not able to overcome the critical issues brought about by this change in the climate. (Jane Palmer, 2020)

Figure 5Flood In Uttarakhand
*Source:*https://brootle.blogspot.com/2013/06/uttarakhand-and-kedarnath-flood.html

III. CASE STUDY

1. HIMACHAL PRADESH

The construction techniques in Himachal Pradesh are not only influenced by traditional methods but also by modern advances, which have made it possible to cope with the region's mountainous terrain and harsh climate conditions. The traditional methods of construction that are locally adapted, eco-friendly, and culturally sensitive are developed to withstand the severe cold, high rainfall, and seismic activities common in the Himalayas. These methods are indigenous, and they use locally available materials like stone, wood, and mud that are ideal for insulation and durability and have been in use for centuries. (Ar. Sandeep Singh, 2019)

1.1 Traditional Techniques

1.1.1 Kath-Khuni Construction

Materials such as timber and stones are placed in the gap in the wall, which leads to insulation and stability. This type of construction is native to the areas in Central Himachal Pradesh where it gives thermal comfort, making it suitable for cold climates. (Ar. Sandeep Singh, 2019)

Fig -6: Kath-Khuni Construction
Source:https://www.stone-ideas.com/96158/drywalls-kath-khuni-construction-earthquake-safe/

1.1.2 Dhajji-Diwari

It consists of wood, stone, and mud, with wooden frames filled with stone or brick, thus comes in the

form of an inner structure frame of wood and mud. It is very durable, and thermal regulation is environmentally friendly. This technique is used in constructions in the area around Shimla and Kangra. (Ar. Sandeep Singh, 2019)

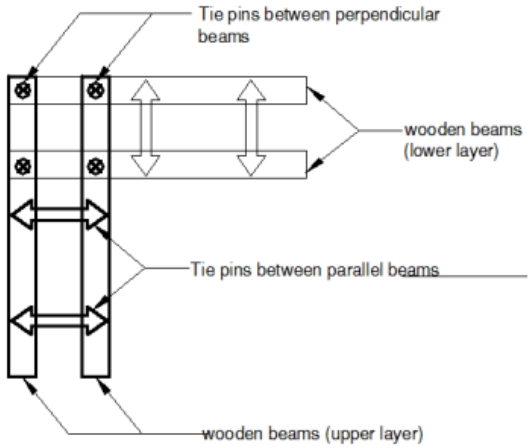

Figure 6 Dhajji Diwari Construction view
*Source:*https://www.ijstr.org/final-print/sep2019/Traditional-Construction-Techniques-In-Himachal-Pradesh.pdf

1.1.3 Dry Stone Masonry

In places like Kangra and Kinnaur stones that are found nearby are pulled together into the pile with no

mortar used, thus the structures that are weather-sturdy and enduring are obtained. (Ar. Sandeep Singh, 2019)

Figure 7Dry Stone Masonry
*Source:*https://www.ijstr.org/final-print/sep2019/Traditional-Construction-Techniques-In-Himachal-Pradesh.pdf

1.2 Modern Construction

The increasing urbanization and natural hazards have brought the need for new technologies which have been also incorporated. The usage of techniques, namely reinforced concrete, steel framing, and prefabricated materials, are now employed in the process of construction to make the structures strong and to speed up the construction process. These new materials go hand in hand with traditional methods, thereby guaranteeing good resistance to earthquakes, landslides, and hurricanes. The new materials that have been used are environmentally friendly and they lead to better energy efficiency thus making them suitable for climate-resilient infrastructure. (Ar. Sandeep Singh, 2019)

IV. CONCLUSION

The construction practices in hilly regions of India are affected by several problems like topographical constraints, natural hazards, and climate change. Conventional methods, exemplifying incredible adaptation to their local environment, provide protection against natural disasters and sustainability through the utilization of locally available materials. Still, with the growth of cities and the manifest of rapid development, modern construction technologies have been used more and more. These are reinforced concrete structures and prefabricated materials that deal with the restrictions of traditional methods, as well as offering more durability and efficiency.

Nevertheless, the issue of development and environmental preservation being separated becomes a major problem today. Besides deindustrializing, newly developed areas can be designed in eco-friendly ways; materials should be used that are endurable to climate changes, which will help to diminish the harmful effects of urbanization and climate change. The knowledge gained from ancient buildings, which are designed with thinking outside the box, added to the new technologies and their application, is the blurred center part of the ways of a sustainable and harmonious approach to building in hill regions, maintaining the structural safety, environmental conformity, and cultural continuity.

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