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ARTICLE

An exploration of traditional building technology of the hill districts of Kumaun Himalaya: Tracing the historical and cultural legacy

Reetesh Sah[1] · **Rohit Kumar Singh Bhakuni**[1]

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Abstract
Throughout history, human needs have revolved around food, sustenance, and shelter. Early societies sought refuge in caves before transitioning to huts and, later, more elaborate dwellings. Beyond mere utility, homes represent security, cultural identity, and socio-economic status while serving as vital centres for preserving and transmitting heritage. This study explores traditional construction methods in Kumaun, focusing on materials, tools, artisans, and the cultural significance of various structures. These methods, deeply rooted in the region's history, climate, and geography, highlight indigenous wisdom passed down through generations. However, traditional construction faces numerous challenges in the modern era, including demographic shifts, natural disasters, restrictive policies on natural resource use, and the declining availability of skilled masons. Additionally, the easy accessibility of modern materials further threatens traditional practices. Field visits to villages and interviews with masons, carpenters, blacksmiths, and labourers provide valuable insights into Kumaun's architectural heritage. The study documents the advantages of traditional construction, including climate adaptability, durability, and sustainability, while also addressing the obstacles that hinder its continuation. The evolution of these techniques has been influenced by changing cultural values, government policies, and economic transformations. A major challenge is obtaining permits to use essential materials, such as timber and stone, which are integral to traditional architecture. The study aims to preserve and analyse this knowledge, advocating for a balanced approach that integrates traditional methods with contemporary construction practices. By doing so, it seeks to preserve these time-honoured techniques while promoting sustainable, locally adapted building solutions.

Keywords Building technology · Traditional houses · Cultural legacy · Construction · Traditional knowledge

1 Introduction

In *Sapiens: A Brief History of Humankind*, Yuval Noah Harari highlights the evolution of human houses through the lens of the Agricultural Revolution, marking a profound shift in architectural practices. Before the advent of agriculture, foragers lived in temporary, portable shelters made from organic materials, reflecting a nomadic lifestyle characterised by mobility and adaptability. The advent of farming, however, led to the establishment of permanent settlements and the construction of durable houses using materials such as mud bricks, stone, and wood. These early homes served practical purposes, such as storing surplus food, sheltering domesticated animals, and providing stable living spaces for families. This transition also introduced the concept of private property and individualised spaces, contrasting with the communal arrangements of nomadic societies. Villages emerged, with clustered houses and shared spaces. At the same time, architecture began to reflect social hierarchies, as larger or more refined homes were a clear indication or symbol of wealth, power, or higher social standing in the community. Although permanent dwellings offered protection and stability, they also presented challenges such as overcrowding and sanitation issues. Harari suggests that this shift laid the foundation for humanity's enduring

✉ Reetesh Sah
reeteshsah@gmail.com

✉ Rohit Kumar Singh Bhakuni
rohitbhakuni755@gmail.com

[1] Department of History/UGC-MMTTC, Nainital, Kumaun University, Uttarakhand, India

relationship with architecture as both a functional necessity and a symbol of societal transformation.

Uttarakhand is historically one of the oldest and archaeologically richest parts of India. From an architectural perspective, Uttarakhand has a vibrant past. Uttarakhand developed its architectural style based on the abundant materials of wood and stone. The people of Uttarakhand maintained a symbiotic relationship with their environment and developed technologies that were suited to local conditions. For example, many wood and stone temples are unique in terms of durability, grandeur, and artisanship. Uttarakhand is rich in terms of its remarkable domestic architecture as well as the heritage of the people of this region. It was based on locally available materials, such as stone, wood, and clay. In traditional village houses, one can find abundant use of stone and wood. Traditional village houses, made of stone quarried from nearby locations, are cost-effective and long-lasting, and are best known for their resistance to adverse climatic conditions. These traditional houses are the architectural wealth of this region and are as diverse as Uttarakhand. Uttarakhand is situated in a seismically active zone where earthquakes frequently occur. Considering the substantial damage caused by seismic activity, traditional houses in this region are both secure and cost-effective **(**Bisht, 2011, pp. 101–102). In Kumaun, the word '*kud*/*kudi'* is used in the local language to refer to these residential buildings, which means a clan or family. In the medieval period, the term *'ghar-kudi van chodi'* is repeatedly mentioned in the copper plates of Chand rulers (Mankoti, 2011, p. 59). In modern times, the concept of history has evolved, and there is a growing interest among people to learn more about the past. In reality, the true history is the history of the people and an important means to understand it is the residential buildings of the people (Chauhan, 2011, p. 2; Kerr, 1972), which play a significant role in determining various situations, such as social, economic, cultural, political, etc., all at once (King, 1976).

Building construction in hilly regions requires comprehensive planning, site selection, and design for slopes, as well as sustainable concrete construction practices. In response to these harsh development conditions, numerous vernacular practices and styles have evolved, utilizing local materials and indigenous techniques to fulfill the needs of people, causing minimal damage to the environment and promoting sustainability. However, despite the numerous benefits of these vernacular practices, they are often not utilised in new development due to increased demand for more built spaces resulting from rapid growth, the availability of new construction materials and techniques, and the reluctance of residents to adopt vernacular practices. The economic growth and rapid urbanization in hilly regions have further encumbered real estate development, placing an onus on developing multi-story buildings. Hilly regions, though tempting to construct structures in, exhibit wide variations in geology, geomorphology, climate, altitude, and material resources. The unpredictable geological situations and ongoing development activities, as well as precarious climatic variations and hydrogeological conditions, result in different types of hazards, such as landslides and mudflows, in these areas, which make planning and designing buildings in a hill settlement a herculean task (Joshi, 2000–2001, pp. 233–248). However, the extensive development using contemporary materials results in environmental issues, including pollution, loss of vegetation, increased soil erosion, heightened surface runoff, a decline in the water table, flooding, alterations in microclimates, and a surge in instability occurrences. These factors collectively pose a severe threat to the sensitive and fragile environment in and around hill settlements (Kumar & Gupta, 2014, p. 5).

2 Objective

Exploring traditional Kumauni houses involves examining the significance of various parts and their benefits. By studying these buildings closely, one tries to understand the cultural and practical meanings of each architectural element. At the same time, the investigation examines the specific parts and materials used in these houses, revealing the secrets behind their sustainability and local origin, including timber, stone, and clay. Yet, amid the richness of tradition, locals face challenges when trying to use these old building methods in today's world. The clash between ancient construction techniques and modern needs creates practical problems, prompting a closer look at how to overcome these challenges. In this quest, understanding the traditional building method is crucial, not just for its historical importance but also for learning valuable lessons on how to adapt and preserve cultural heritage in today's changing times. Furthermore, an endeavour has been undertaken to understand the ongoing governmental initiatives aimed at preserving the cultural and historical heritage of Kumaun, Uttarakhand.

3 Materials and methods

The current investigation was systematically carried out in the hill districts of the Kumaun region of Uttarakhand by in-depth interviews with the traditional masons and other artisans (Stonemasons, carpenters, and blacksmiths). Following the acquisition of their consent and a detailed explanation of the study's objectives. A pre-designed questionnaire, encompassing both closed and open-ended questions, was employed to systematically document diverse information on the local materials and technologies used in the construction of traditional buildings in the Kumaun

region. The research encompasses the hill districts of the Kumaun Himalayas. The information was gathered through a questionnaire in 2023–2024 (July–January). In this study, we examined the existing literature and conducted field surveys and interviews.

4 Construction material

The material used extensively in the residential architecture of the Kumaun region is stone, referred to as *'Pathar'* or *'Dhung'* in the Kumauni language. After this, the second main material used is 'wood'. It is noteworthy that both these items are easily available in abundance in the region. By observing the walls and roofs of the ancient buildings located in the region, it becomes clear that the stones used in them are *'Katau'*, *'Kamras', and 'Sagar'*, which are locally available in different areas. *'Katau'* stone is used in the walls of most buildings. The reason for this seems to be the speciality of *'Katau* stone', which can be easily cut and moulded into different shapes. After masonry in the wall, one section can be connected to the other. It is found in such a way that the joints of the pieces are not visible with a cursory glance, and also, due to exposure to air, this stone becomes hard, due to which its lifespan becomes very long. (Sometimes, excessive use of mortar in masonry can lead to the fear of walls not setting properly. Therefore, for plastering without or with less mud plaster, *Katau Dhung* (stones) are used (Kumar & Pushplata, 2013, pp. 183–192). In Kumauni-style buildings, stone is used in different names and sizes in different parts. The stone blocks used in the walls are called *'Pathar'* or '*Dhung*' in the Kumauni language (Fig. 1), while the stones used in the roof or *'Pakh'* are called '*Patal*' (Fig. 2), and the stone block covering the joint of two plates is called *'Tok'* (Kerr, 1972).

The second most used material in the buildings of the region is 'wood'. The Kumaun region has been covered with forests since ancient times; hence, various types of timber, such as *Tun* or *Tuni* (*Toona ciliata*), Deodar (*Cedrus deodara*), Pine (*Pinus*), and *Bitain* or Walnut (*Juglans regia*), were easily available here. Of these, the *'Bitain'* tree is small and is produced in relatively small quantities, but the speciality of its wood is that it is not affected by insects. That is why, in the Kumauni buildings, *Bitain* wood has been especially used in the form of a vertical plaque, or *'Patau'*, above the door or window. According to strength and age, *'Bitain'* ranks first, followed by *'Tun'*, 'Deodar', and 'Pine' respectively. Tun and cedar are mostly used in doors and frames, while pine is used more in roofs or *'pakh'*. The wood used in buildings is also referred to by different names depending on the location and intended use. The wooden beam used in the vertical plate above the door or window is called *Patou* (wall plate), the circular beam with a relatively larger circumference used on the roof is called *Bansa* (Beam), and the wooden pillar with a relatively smaller circumference used on the top of the Beam is called *Dundar* (small beam) and the wooden planks used to cover the two dundars are called *'Dadar'* (small pieces of split wood) (Kerr, 1972) (Fig. 3).

After wood, the other material used in the ancient buildings of the region is clay. It is used as a mortar in the masonry of walls. 'Slurry' is made by filtering ordinary soil and adding water to it. This soil is generally 'loamy soil'. It is generally said that in ancient times, '*maas*' or *urad dal* was used as mortar instead of soil in specific buildings. Perhaps this was the case, but no such example came to light in the survey. The interior walls of the building were plastered or 'coated', but the exterior walls were generally not coated; for coating, *chila* (wheat husk) was mixed in the

Fig. 1 *Pathar* and stones used in the walls. ICHR Project work

Fig. 2 *Patal* used on the roof. ICHR Project work

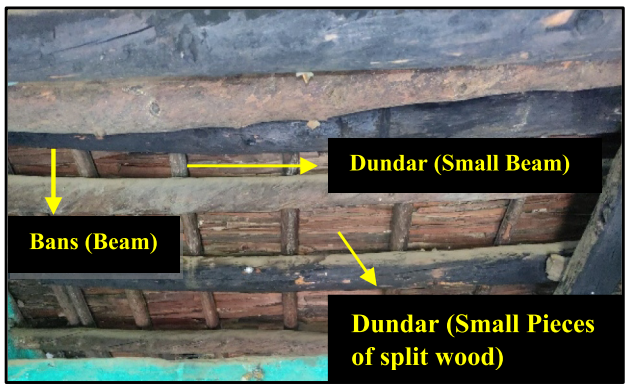


Fig. 3 Different names of wood used in a traditional house. ICHR Project work

mortar of loamy soil. In *'Pakh'* also, the mortar was poured over *'Dadar'*, so that the *patal* (stone slate)) above it sets properly. Even at the joint of two *'Patals'*, '*Tok'* was laid by pouring *garra* (mortar). In some areas of the region, another small stone block was also laid beneath the drain to protect it from water, which is referred to as *'Panakat'* in the local language (Kerr, 1972).

Among the other materials used in building construction, cow dung was applied after the mortar was used to the walls of the '*Khand*' (room) and before the walls were painted white. Generally, *'Kamet'* (white clay) was used for painting. *'Dung'* and smooth red soil were used for coating the floor of the 'room' and for making the 'ceiling/floor'. Apart from these, iron was used in very small quantities as locks of doors and windows called *Sankal* and *Gulmekh* (Large iron nail) was used to attach the *dundars* (small beam) with the *Bansa* (beam) by hammering the iron nail (Kerr, 1972). A *sankal* can be seen in Fig. 4.

4.1 Site selection and construction feasibility

In traditional building architecture, a meticulous approach is taken to assess the suitability of the chosen location. This involves a thorough examination of potential landslide-vulnerable areas to ensure the structural integrity of the building. The evaluation involves scrutinising the slope and sequence of rock structures to determine the stability of the terrain. Moreover, careful consideration is given to the presence of subsurface water, as this factor can significantly impact the foundation and long-term stability of the structure. The presence of subsurface water in an area may lead to the formation of cavities, therefore inviting landslides. Additionally, an assessment of existing streams is conducted, taking into account their potential influence on the construction site. These comprehensive checks are integral to the traditional building process, emphasising a holistic understanding of the natural surroundings for sustainable and resilient architectural outcomes (Tamta, 1997, pp. 45–76).

Fig. 4 A *Sankal* in the main door of the house. ICHR Project work

Building construction methods in the Kumaun region are closely tied to the use of stones. During construction, there is a prevalent adherence to religious traditions and conservatism, which is an integral part of the construction process. Firstly, the mud of the chosen site for the building is taken to the '*Pandit'* (astrologer) for consultation. If the *Pandit* deems the site suitable for construction, the foundation is then laid. Before filling the foundation, a stone is carved into a right-angle shape and placed in the right corner, known as 'Gardaak *Dhung*.' Underneath this stone, coins and a lit lamp (*diya*) are placed. Following this, religious rituals and other ceremonies are performed in reverence to the stone. Some individuals may offer sacrifices, such as goats or chickens, during these rituals. For those who do not believe in sacrifices, coconuts are broken as part of the worship. Subsequently, the process of filling the foundation commences (Kumar & Pushplata, 2013, pp. 183–192).

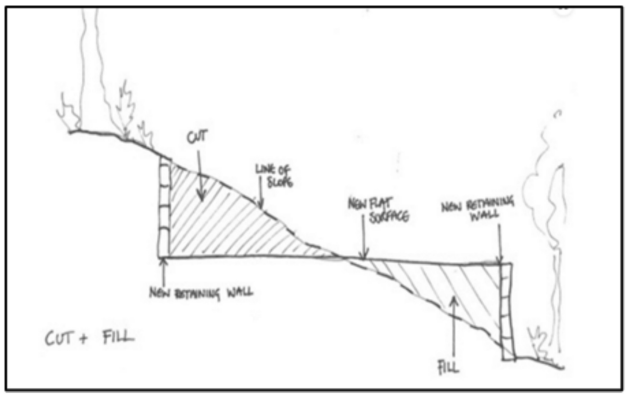


Fig. 5 Cut and fill technique for developing a flat surface. Chawhan & Kamal, 2021

4.2 Cut and fill technique (Fig. 5)

In hill-building architecture, cut-and-fill technology plays a crucial role in shaping the landscape to accommodate structures. This earthwork technique involves excavating material (cut) from elevated areas and using it to fill and level depressed zones (fill), creating a suitable and flat platform for construction. While seemingly straightforward, it demands careful planning and execution to ensure stability, minimise environmental impact, and respect the natural topography.[1]

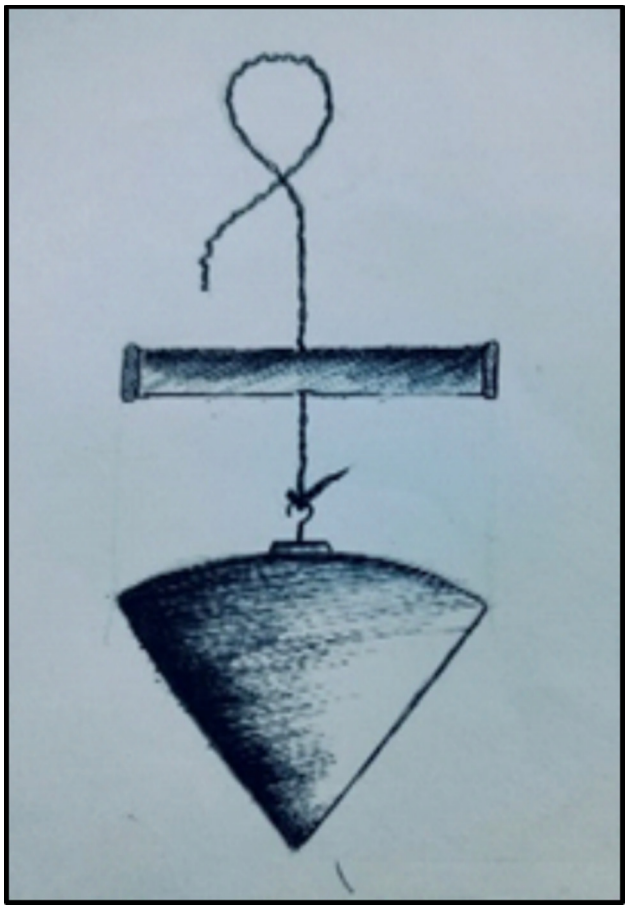


Fig. 6 *Sahul* and Dori. ICHR Project work

5 Building construction method

To commence construction of the building, various ceremonial activities, including land survey, laying the foundation stone, and worship of Vaastu deities, were undertaken. The width of the foundation was meticulously adjusted in proportion to the height of the building. For two-story buildings with heights ranging from 14 to 18 feet, the foundation width was approximately 3 feet. For three-story buildings with heights ranging from 20 to 24 feet, the foundation width was increased to around 4 feet. The construction of the foundation was determined exclusively by considering the weight and balance of large, uncut stones, with minimal use of mortar (Tamta, 1997, pp. 45–76).

The foundation was excavated by digging a trench from the surface of the ground to a certain depth, and above it, the walls of the building were constructed. On the ground floor of the two-story building, the wall thickness was approximately 2 feet, which was reduced to about 1.5 feet on the first floor. Similarly, in the three-story building, the thickness of the wall at the foundation was approximately 2.5 feet, which was reduced to less than 2 feet on the first floor and further decreased on the second or third floor. The walls between the different sections (Khand) of the building, which were constructed to separate various compartments, also followed a similar ratio in terms of thickness (King, 1976).

Located in the region, the masonry used in the construction of residential buildings in Kumaun primarily consists of materials such as stone blocks (*Dhung*) and mud mortar. When the foundation of the building reached a certain height above the ground floor, it was appropriately lined with mortar. Upon this, the construction of the first 'course' (*haar*) was carried out by placing stone blocks in a well-arranged manner, and sufficient mortar was placed above these stone blocks and on top of the first 'course' to create the proper alignment for the construction of the second 'course.' During the construction of each 'course' in this process, the use of '*Sahul'* (Heavy metal piece) and '*dori*' (thread) (Fig. 6) was applied to ensure that the wall was straight and balanced. It was also carefully observed that if stone blocks were used as 'headers' in the first 'course,' they should be

[1] Ram, B. (Mason). Village- Khirakot, P.O- Chanouda, Distt. – Almora. Interviewed on January 20, 2024.

Fig. 7 Ground floor or *Goth*. ICHR Project work

Fig. 8 *Goth* can be seen in the red boxes. ICHR Project work

placed as 'stretchers' in the second 'course,' and this process was followed while aligning the other 'courses' to construct the wall. Through this process, the blocks in one 'course' interlock with the blocks in the second 'course,' resembling a form of English bond masonry. This method contributes to the exceptional strength and solidity of the wall (King, 1976).

There is a legend that *ground urad* (split black lentils) and *gahat dal* (horse gram) were used in place of mortar in the masonry of ancient temples and buildings. However, no reliable evidence has been found for this. The use of urad dal for 'mortar' has also been mentioned by Joshi and Saxena, but no physical evidence has been presented in its support (Joshi, 1994, pp. 232–244).[2]

[2] Ram, B. (ITI, Mason). Village- Dauni, Teh- Garur, Distt. – Bageshwar. Interviewed on January 23, 2024.

5.1 *Goth*/ground floor (Figs. 7 and 8)

In Kumauni residential buildings, the ground floor is called *goth*. The origin of the word *goth* seems to be a combination of the words *'gau'* (cow) and *'thor'* (place). Even today, agriculture and livestock play a crucial role in the rural economy of the Kumaun region. In ancient times, when these buildings were built, essentially all the residents were engaged in agriculture and animal husbandry (mainly cattle). That is why, due to the use of the ground floor of the building as a *'gwad'* (cow shed), it got the name *'goth'* or *'cow place'*, even though people later lived in it (King, 1976).

Since animals live in the cowshed, it is not possible to cover or lock the doors from inside. If they are closed from the outside, the doors will open from the outside, creating a fear of theft or attack by wild animals. Therefore, for this, the lock is done from the upper floor. For this, a hole about 3 square inches is made in the middle of the *patava* of the *gotha*. The hole extends from the wall to the floor of the second floor, and it gradually widens upwards, which is known as *huvaghor*. In the *huvaghor*, a *huv* (huv is a square wood, which is less wide at the bottom and thick at the top) is inserted from the inside. Half of the *huva* gets stuck in the doors of the *goth* from inside, and the other half remains in the wall of the upper floor, due to which the doors do not open from outside (Kumar & Pushplata, 2013, pp. 183–192). Even in *goth*, there are two rooms named *malgoth* (inner room) and *talgoth* (outer room), in which animals are kept in the outer room and fodder in the inner one (Saksena, 1994). As far as the 'usefulness of the place' is concerned, the ground floor was used as *a 'wad',* but the *'goth'* was also considered an appropriate place for various religious and marriage rituals. Apart from this, *'pal'* (floor) of *'goth'* was also used for the preservation of food items. The height of the cowshed is generally kept at 5 to 5 ½ feet so that the animals can be protected from getting cold during winter days. One of the reasons for making a *goth* in the lowest part of the house is that the heat emanating from their bodies also provides warmth to the upper rooms, due to which the people living in the upper rooms also get some respite from the cold. Many people used to make a kitchen in the *goth* itself. Generally, this trend is seen only in two-storey houses, where people make a kitchen in the *talgoth* and use the *malgoth* to keep the animals.

5.2 *Jaal*/*jav* (Fig. 9)

The walls of Kumauni buildings were made very thick to accommodate *jaal* and *almirah*. Apart from storing various objects, the *jaal* was also used to hold lamps, etc., so that lighting could be arranged in the evening. In the outer walls of the ancient buildings of Kumaun, Uttarakhand, *jaal* can be seen, which was mainly used to keep cow urine

Fig. 9 *Jaal/Jav* can be seen in the red boxes. ICHR Project work

(*gomutra*). The main purpose of keeping cow urine was that, before entering the house, a person should purify themselves by pouring cow urine. It is noteworthy that cow urine is a powerful antimicrobial agent (King, 1976).

5.3 *Sapyal/ sapeli/ kanas* (Fig. 10)

After the masonry of the *'goth'* or ground floor of every traditional building is completed, *'balliyan'* (wooden blocks) or *'dundaar'* are laid on top of the walls of *'goth'* or ground floor to make the pal (earthen floor) of the upper floor. To hide the laid *balliyan*, *'patal'* (stone slate) is placed over the *balli*. These *patals* are placed in such a way that the inner part of the *patals* remains limited to the walls, but the outer part comes out from the walls by about 1 *'kun'* (18–20 cm). The *patals* are sheathed by masonry on top of the wall. In this way, the *patals* protruding from the walls are called *'sapeli'* or *'kanas'*. At places where *'patal'* is not available, *'pathar'*, cracked or carved stone, is used as per availability. It is noteworthy that *'sapeli'* or *'kanas'* has many benefits, such as the outer ends of the *balli* used in making floors, which come out from the walls of the building. *'Sapeli'* protects them from water and prevents them from rotting. It also protects the windows, doors, etc., used in *'goth'* from water. It also protects the whitewash, etc., in the building from water. By placing a ladder on it and placing a whitewashed vessel on it, whitewashing can be done carefully. Apart from keeping flower pots and small items, it also proves to be very useful for storing pumpkins, cucumbers, seeds, and other items, and drying them. However, not everyone makes them in their homes. Currently, it is also falling out of trend (Kumar & Pushplata, 2013, pp. 183–192).

Fig. 10 Sapyal/ Sapeli can be seen in the red boxes. ICHR Project work

5.4 *Chaukhat* (Fig. 11)

The tall (standing) pillars of the door frame are called *nakoi*. The slanted wood used on top of *nakoi* is called *mathav*, and the wood below is called *dei*. Traditional door frames were made approximately one kun (18–20 cm) square and as long (high) as required. Its *mathava* was as square as that

Fig. 11 A Chaukhat built in traditional style. ICHR Project work

of the *nakoi*, while the *dei* was comparatively wider. To fit the doors in the door frame, a wooden *patav* (horizontal bar) was placed behind the *nakoi*, parallel to the *mathav*. Just behind both the holes of *patva and dei,* depressions 2–3 fingers deep and with a diameter were made; these depressions were called *khurghor*.

In this type of frame (*chaukhat*), 'doors' made of a single plank (*takhta*) were used, which were made of relatively thick planks. In the upper and lower corners of these doors, there was provision for one cylindrical bulge, which was called *'khur'*. Then these *'khur'* were stuck in the *'khurghauro'* of *'dei'* and *'patav'*. It is necessary to have a handle to open and close the doors; hence, for this, holes of 2 fingers' diameter each were made in the middle of both doors, through which a rope with a knot on the inside was passed from inside to outside. With the help of this rope, the doors were closed by pulling them outwards. To lock the door, a '*sankal'* (like an iron chain) was inserted into the door from outside. After closing the door, the *'sankal'* was stuck in a round iron knob hammered into the *'nakoi'* or *'mathav'* of the door frame, so that the door could not open. This type of *'sankal'* is still seen in old buildings (Kumar & Pushplata, 2013, pp. 183–192).

5.5 *Kholi* (main entrance door) (Fig. 11)

Till about 2–3 generations ago, there was a trend of *'kholi'* for the main entrance in the traditional buildings. It was built in only two- or three-storey buildings. The *'kholi'* was about 5–6 'hands' (18–20 inches) high and 2 to 2 1/2 'hands' (1 hand = 18–20 inches) wide. It was built based on the size of the building and the owner's prosperity. It takes a lot of wood and time to make it, and it occupies relatively more space in the building; therefore, its trend has gradually come to an end. As a result, there is no provision for *'kholi'* in modern architecture. Although *'kholi'* is still visible in some old buildings. After seeing these *'kholi'* and from the old craftsmen, it is known that the *'kholi'* is approximately 18–20 inches above the ground level of the building. This was the main entryway to the upper floors. The '*nakoi*' (pillars) of *'kholi'* were called *'kham'*/'*dwarkham'*, which were made thicker and more ornate than the standard door frame. However, on top of its *'mathava',* three pieces of *balli* (Wooden block) about 1 and 1/2 'hands' long were placed at equal distance in *'muthi'* style (one end towards inside and the other towards outside). One end of these was kept protruding forward about 1' *Kun* (18–20 cm). The protruding front was decorated with figures resembling the mouths of various animals and birds, known as *'twaad'* (Fig. 12). On the outside, a wooden plate or stone slate of similar size was placed on top of them, which was used to store various types of goods. In these too, *'khurghaur'* style 'gates' were made (Kumar & Pushplata, 2013, pp. 183–192).

Fig. 12 The protruding front called *Twaad* can be seen in the red box. ICHR Project work

5.6 *Chakh* or *baithak* (drawing room)

There is a plan with a special provision in the basement of the buildings for the construction of the 'main entrance'. Under this, from whichever side the building was to be entered, a projection of approximately 2 × 3 feet was provided in the quadrangular basement of the building, according to the height of the *'kholi'*. A quadrangular platform, approximately 2 × 8 feet, was then constructed parallel to it on the inside, raised in the form of stairs along the middle walls of *'chakh'* (common drawing room) or *'baithak'* (drawing room). Stairs were made above the platform to reach the first floor. In the vacant space above the stairs, parallel to the outer walls of the building, a wooden *'pedya'* was made. In this same *'pedya'*, the hinged doors were made. *Kuthedi* / 'Dark Room (Chamber) was constructed in the space below the stairs that were built to reach the first floor from *kholi* (King, 1976). *Chakh* is also used for the meeting room where guests are seated, and after the month of *Asoj* (Ashwin, according to the traditional lunar calendar), it is also used as a storage room to protect grains drying outside from rain, among other purposes. *Chakh* walls are

made thick because Almirah and Jaal have to be built in these walls (Saksena, 1994).

5.7 Pal (floor) (Fig. 13)

Two types of *'pals'* are found in the buildings of the region. In the first type, planks (*takhte*) are used over the beams, whereas in the second type, only *'dadar'* (small pieces of split wood) is used over the beams. The reason for these differences seems to be the financial condition of the building owners. To create the floor using planks, small beams (*balli*) were placed in the building at a height of approximately 7–8 feet along the width of the section, with a distance of 1 foot to 1.5 feet between each beam. Before laying the planks, according to the distance between the small beams, cuts of half an inch wide and half an inch deep were made in the upper part of the beams at the places where the joints of the planks came after laying the planks. The planks were placed on the Beams and fixed with *'gulmekh'* (a long iron nail). After placing the beams on top of the wall to form the floor, the *dadar* was neatly laid on top of the small beam, and care was taken to ensure there was no gap between the *dadars*. After making the wooden pal, the soil was filled in on the pal, and the floor was made level. Next, the floor was plastered by mixing smooth red soil and cow dung (King, 1976).

6 *Majhyal/ malkhan* (middle floor) (Fig. 13)

The room inside the *chahak* is called *malkhan*. *Mal* means inside, and *khan* means room. *Malkhan* is built just above *malgoth*. To make it, the same type of process is adopted as is adopted to make *Chaakh*. In buildings built in traditional style, the *malkhan* of the house bears a lot of weight. To bear the weight, the *thumi* (thick wooden pillar) is made in *malkhan* and *malgoth*, which supports the weight of the roof. In two-storey buildings, the roof is made just above the *malkhan*, in which the entire load of the roof is kept in the *thumi*. This *thumi* extends from *malkhan* to *malgoth*, as a result of which the entire weight of the roof and house is transferred to the ground.

The room used for storing food items in Kumauni residential buildings is called *'bhanar'*. *Bhanar* is usually built on the kitchen floor. Large wooden boxes were kept in the *'bhanar'* called *'bhakar'*. Grains were kept in the *bhakar*. A wooden rack for storage under the ceiling is called *bharpati*. This *bharpati* was used to store cut vegetables and wet wood in the *pakh* (roof) after drying them throughout the day, in the evening, to protect them from dew and other elements.

If the building was two-storeyed, then some other special sections were also made on the second floor, such as *pan* (or *risyakhand*, the Kitchen), *thya* (the prayer room), *bhanar* (the store room), and *panyadi* (the dish washing place adjacent to the kitchen) (King, 1976). *Kholi* was constructed on the ground floor to enter the middle floor, but to reach the paan or third floor from the middle floor, a staircase or wooden stairs were constructed. For the construction of this *daraud*, two intense wooden beams (*balli*), about 2 feet longer than the height of the section (*khand*/room), were placed obliquely against the central pivot wall of the building, and thick wooden blocks were fixed to them with nails. Small planks (*takhte*) were placed on top and fixed with nails (parallel to the floor); the staircase constructed in this way was called *daraud* (King, 1976).

Fig. 13 *Malkhan* and the floor made of mud. ICHR Project work

6.1 *Tipur/Tepur* (Top floor in a three-storeyed building)

The topmost section (*khand*/room) of the three-storey buildings is called *tipur* or *tepur* in the Kumauni language. The kitchen is located in *tipur* itself, within a three-storey building, and the *Bhanar* is also made there. In the walls of kitchens (*pan/rishyakhand*) in traditional houses, there is a special space called "*pataur*," primarily used to store food items such as ghee, curd, and milk. Some houses also have a covered space in the wall for beekeeping. To attract bees, a small hole is made in the wall, and sweet things like jaggery are placed in it (King, 1976). The roof is made over this room, for which a *thumi* is made in the middle of this section to provide support to the roof, which is usually made of strong woods like cedar and pine. This *thumi* has gone through this room to *malgoth* of the house, although the *thumi* installed from *Tipur* to *Goth* is not the same, but different. A *thumi* is installed in each room, which supports the weight of the Bans (Beam).[3]

[3] Bhakuni, H. S. (Retired Forest officer). Village – Khirakot, P.O-Chanouda, Distt. – Almora. Interviewed on January 23, 2024.

Fig. 14 *Pakh* or Roof. ICHR Project work

Fig. 15 A *Pinjar* can be seen in the red box. ICHR Project work

6.1.1 *Pakh* (Roof) (Figs. 2 and 14)

In houses built in traditional style, wood, stone, and mortar are used to make roofs. The wood used in the roof of the building, like *'bharana'*, *'bans* (beam)', *'dundaar* (small pieces of split wood)', etc., was used in the raw state. In some places, the word *'dundaar'* can also be seen, which can be seen in traditional buildings even today (Before the arrival of the British, saws were not available for sawing wood).[4] Therefore, instead of saws, axes, and *basula* were used for woodworking, which sometimes caused the wood to become crooked. The *'bharana'* or *'bans'* are placed horizontally in the adjacent walls of the building, and their edges are not visible outside the wall. In the old buildings here, depending on their size, 8–10 ' Beams' are also kept, but generally, mainly three 'beams' are kept in the building—one in the middle (on the *dhuri)* and the other two around the main beam. They are kept side by side at equal distances. To lay the 'stone' on the roof, vertical beams (*dundars*) are laid on top of the *'bans'* and *'galt'* (long and square or rough beams placed on the front and back walls of the building while making the roof). One end of the *'dundaar'* and the poles are kept in the wall, and the other end is kept in the *'bharan'*. The other two *'bans'* used in the roof are kept solely to support the beams, preventing them from breaking due to the weight of the stones used in the roof. Apart from the beams used to make the roof, a *'galt'*, a massive wooden beam, is also placed on each of the front and rear walls of the building to support the roofing beams. It is approximately 1 *'kun'* (1 *kun* 8–20 cm) thick and 1 'bet' (20–25 cm) wide. The length of this *'alt'* is equal to the front part of the wall of the building. It is square carved/sculpted in the front part of the building, and mostly rough or rounded in the back part (Kumar & Pushplata, 2013, pp. 183–192).

On top of the *'galt'* used in front of the roof of the building, *'twad'* (5–6 'finger' (1 finger = 1 inch) square pieces of the small beam about 1 'hand' (18–20 inch) long) are fixed at a distance of every 1 'hand'. *Twad'*, are 1 *'kun'* (18–20 Cm) protruding outside the galt in which shapes like the mouths of animals and birds are made. In their loops, a groove about 1 inch thick is made on each side, in which pieces of a wide board equal to the thickness of the *'twaad'* are stuck, connecting the two *'twaads'*, which is called *'chasham'*. Holes of different sizes are made in the middle of *'chasham'*, which is called *'pinjar'*. There is a space inside them in which birds make their nests (Kumar & Pushplata, 2013, pp. 183–192). **(**Figs. 15 and 16**).**

After setting the *dundars* (small beams), the *'dadars'* were laid correctly on top of the *dundars* in such a way that no holes were visible when seen from under the *'pakh'*. After covering the *'dadar'*, the *'pakh'* was *'shaded'* (*chana*) with *'patals'* (stone slate). For this, in the first phase, the *patals* were taken out about a foot from the wall and placed on the *'danyari'* (Outer Wall). The front row of *'pathars'* on the roof is called *'danyar' dani*. In the first *'haar'* (course), by making a small hole in the middle of these stone slats, these slats were fixed to the *dundars* either through *'gulmekh'* (iron nail) or, in the case of longer and bigger slats, the slats were fixed by inserting a thick iron sheet in the holes of the slats. It was stuck between *dundars* (small beam) and *bans* (Beam) so that the slats of the first course did not slip out of the *'danyaari'*. This technique of trapping stones has been practised in Kumaun since ancient times, and its use is

[4] Ram, S. (Mason). Village- Titakot, P.O- Chanouda, Distt.—Almora. Interviewed on January 20, 2024.

Fig. 16 Inner view of a *Pinjar.* ICHR Project work

visible in every stone monument here, whether it is a temple or a fort (King, 1976).

Patalas were kept by adding mortar in the first course of *'pakh'*. After laying the slats, a little mortar was poured on them to cover the joints of the slats, and a mortar was laid on them, after which the second 'course' was started. For the construction of the second course, consideration was given to the slope of the *'pakh'* and the thickness of the *'tok'*. To match the slope, the mortar and the small pieces of stones (*khyar-myar*) were laid out in such a way that the slats of the second course could be settled on top of the slats of the first course. During this process, the *patals* (slates) on both sides of the building are brought up to the top of the *bans* (beams) located in the middle part of the roof. However, they were not collapsed or mixed, but rather almost on both sides; a space of about 6 inches was left between the slats. To cover the gap between these slats, a wall about 6 inches high was built over the slats. The ends of the slats were hidden by making a wall on the 'axis' (*dhuri*) of the Building (King, 1976) **(**Fig. 16**)**. *Pathar* (slate) is still laid on the roofs of the buildings here. The place from where these *'pathar'* are extracted is called *'patharkhoni'* (mine of *'pathar'*). Before *'Patharkhoni'*, big stones are taken out in the form of ingots. Then, with the help of a chisel (*chaini*) and a hammer (*hathod*), thin and thick 'stones' of different sizes and shapes are prepared as per requirement. Their thickness is about 1 *'angul'* (1 Inch) or a little more, and their width and length, depending on availability, range from 1 1/2 *'bet'* (8-'10 Inches), and 2 to 2 1/2 *'hath'* (1 *hath* = 18–20 inches) respectively (Kumar & Pushplata, 2013, pp. 183–192).

7 Structure of *bakhali* and its significance (Figs. 17 and 18)

In Kumaun, people build houses in a straight line and refer to the entire structure as "*bakhali*" in their local language. The *bakhali* is a symbol of unity, collectivism, and community living. It shows how people in the community share values and have a common identity. The *bakhali* is not just a physical structure; it also fosters a sense of togetherness among the people living there. This special type of house, with its unique design and shared spaces, reflects how people in the community live together in harmony and support one another. The *bakhali* is more than just a building; it is a testament to the importance of living together and being united within the local culture. In the Kumauni language, all

Fig. 17 A Bakhali of village Devnayi, Bageshwar. ICHR Project work

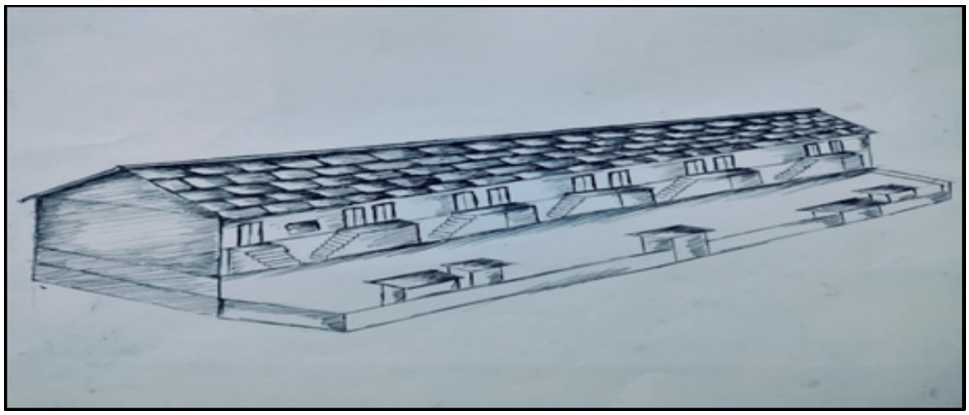


Fig. 18 Representative depiction of the Bakhali in village Kumati, Ramgarh, Nainital. ICHR Project work

the houses in a *bakhali* are collectively referred to as *Mawas* (Tamta, 1997, pp. 45–76). For example, there is a *bakhali* in Ramgarh, Nainital, with 35 *Mawas* (35 Houses), making it the longest *bakhali* in Uttarakhand. Figure 18 displays a representative depiction of the *bakhali* in Kumati village.

8 Difficulties encountered by community members building traditional houses in today's modern setting

Currently, due to modernity, people prefer to build their houses in a modern style. In today's time, while building a house, everyone tries to make their house with modern materials and be equipped with modern facilities. To give newness to the house, people are building their homes in a modern style, incorporating the latest technology. All the materials used for making them are being procured from outside, and along with this, the artisans who build modern houses are also being called in from outside. Most of the artisans who build modern houses come here from Uttar Pradesh and Bihar. Now, Nepali people have started digging foundations or pits and breaking stones. Due to all this, the problem of livelihood has begun to arise for the local artisans engaged in the construction of traditional buildings. To earn a living, the local artisans have started migrating to cities in search of work, leaving behind their inherited traditional knowledge. In the past, the hill areas had a self-reliant economy, but in modern times, the situation has turned quite the opposite. Building a house using traditional methods requires the collaboration of various artisans with specialized skills, such as woodworkers and stone masons. Unfortunately, a significant number of individuals possessing traditional craftsmanship have abandoned their ancestral trades and migrated to urban areas. This migration has led to a scarcity of skilled artisans, making it challenging for those seeking traditional-style houses to find suitable artisans. The intricacies of traditional house construction highlight the interdependence among artisans. For instance, if an artisan employing traditional techniques is unable to find stone workers, the construction process becomes significantly hindered. Similarly, the absence of skilled woodworkers poses a considerable obstacle to the successful completion of a traditional house.

9 Challenges in traditional house construction arise from modernization and forest regulations

The raw materials required to build a traditional-style house are stone, wood, and clay. Obtaining this material is a difficult task in itself. The stone used in traditional houses is mainly extracted from mines, a process that is both time-consuming and requires a lot of hard work. Extracting the stone from the mine and then cutting it into small pieces with the help of a chisel to transport it to the construction site is a very time-consuming process. Forest department permission is mandatory to extract stones from the mine, which is a complex task in itself. The wood used in traditional house construction is obtained from local forests. Due to the strict enforcement of forest laws, cutting wood from the forest without permission is a punishable offence for which both imprisonment and a fine can be imposed. Before cutting wood from the forest to build a house, it is mandatory to take permission from the forest department; this process is also quite time-consuming. In the traditional style, after building a house, the floor is coated with red soil. On every festival or auspicious occasion, the floors in the house are also coated with red soil. The red soil is obtained from the forest by digging in areas where the soil naturally occurs in a red color. The region from which the soil is removed becomes susceptible to landslides. In recent times, the Forest Department has begun granting contracts to contractors for extracting resin from pine trees, which has adversely impacted the quality of pine wood

used in construction. Resin extraction reduces the wood's water resistance, flexibility, and insect resistance, making it prone to quicker deterioration, brittleness, and infestations. This not only compromises its structural integrity but also raises concerns about environmental sustainability and economic viability. To mitigate these issues, treated pine wood or selective usage in non-structural applications can be explored, alongside policy reforms to limit resin extraction in construction-critical areas. Balancing resource utilization with ecological preservation is crucial for sustaining both the forests and the livelihoods that depend on them.[5]

Due to the aforementioned challenges, a majority of people currently prefer constructing their homes using modern styles and technology, as it saves time and effort. The traditional method involves a lengthy and intricate process, from sourcing stones from mines to utilizing them in construction. In contrast, the modern approach allows for the swift delivery of thousands of bricks, cement, iron rods, and sand to the construction site within a few hours via a simple phone order. Presently, individuals seek a quick and effortless completion of their houses. Consequently, traditional house construction techniques are gradually giving way to modernity.

Traditional building practices have been shaped by demographic transitions, natural calamities, conflicts, policy frameworks, improved transport and communication, and shifting cultural values. Rural–urban migration and post-independence economic diversification have reduced the availability of skilled artisans, while reconstruction after disasters and policy-driven material restrictions have favoured modern construction over indigenous methods (Drummond, 1838; Miranda et al., 2016). Although traditional materials, such as stone and wood, continue to demonstrate structural resilience and continuity across pre- and post-independence periods, the increasing reliance on modern materials and changing lifestyles has marginalized traditional architectural knowledge (Tarang, 2022).

10 Conclusion

Based on various observations and in-depth discussions with owners of traditional buildings and locals involved in constructing structures using traditional styles and technologies, it can be concluded that these traditional buildings are most suitable for the hilly region of Kumaun Himalaya. Their notable feature lies in their resilience against challenging climatic conditions. Houses built in traditional style are not only best suited to local climatic conditions but are also earthquake-resistant, protecting people from sudden earthquakes in the Kumaun Himalaya region. The raw materials used in building houses in the traditional style in the Kumaun Himalayas were obtained locally, making this technology self-reliant. As a result, the local people do not have to rely on outsiders or external resources. Contemporary houses are designed solely to meet human requirements, whereas traditional-style houses not only prioritise human needs but also incorporate provisions for sheltering animals and birds. At the same time, the ground floor included accommodations for animals, and the front and rear sections of the roof featured designated areas for sheltering birds. In the traditional approach, local masons acquired construction skills from their forefathers, starting their apprenticeship at the age of 7–8 by assisting their fathers or grandfathers. This early training played a crucial role in honing their craftsmanship over the course of 20 to 25 years, making them highly skilled. Relying on traditional knowledge, these builders maintained self-sufficiency in their livelihoods, eliminating the need for external dependence. The proficiency gained in traditional building technology spared them from migration issues, allowing them to sustain their livelihoods successfully. Traditional Kumaun architecture stands as a testament to the profound connection between culture, environment, and sustainable living practices. Local materials, such as stone, wood, and mud, are ingeniously employed, showcasing a commitment to eco-friendly construction. The intricate craftsmanship evident in these structures not only reflects the region's rich artistic heritage but also highlights a dedication to detail. Designed to withstand the challenges of the mountainous terrain and ever-changing weather, Kumauni architecture plays a vital role in preserving the local identity and heritage. These buildings seamlessly blend functionality and aesthetics, serving as living monuments that beautifully encapsulate the region's architectural legacy.

Currently, due to modern technology, traditional building construction techniques in Kumaun, Uttarakhand, are gradually disappearing. However, even in the present day, some steps can be taken to preserve it, ensuring that the traditional Kumaun style of Uttarakhand is saved, along with its historical and cultural significance. It involves reviving and supporting traditional methods that are fading in the Himalayan region and among its native people. This includes taking on smaller projects to help the nation's economy. The government can assist by providing training, building skills, and offering subsidies for such initiatives. The Government of Uttarakhand is also starting many schemes to keep the traditional building architecture alive, such as houses and *bakhali* in the traditional building style, which are also being converted into homestays by the Government of Uttarakhand, so that the homeowners can be employed and tourists are getting an opportunity to see our culture and heritage. Apart from this, the Government of Uttarakhand has begun creating small-scale models of traditional houses at select locations of importance from a tourism perspective, thereby promoting the propagation of traditional technology, knowledge, and culture among both local people and tourists in Uttarakhand. Therefore, a joint

[5] Pant, P. Village- Lynthuda, Distt.—Pithoragarh. Interviewed on December 20, 2023.

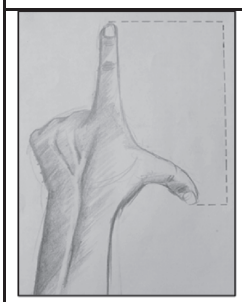
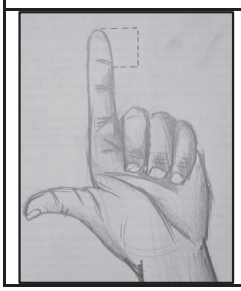
Table 1 Traditional measurements. (Kumar & Pushplata, 2013, pp. 183–192)

Traditional measurements	Modern measurements
1 *Hath*	18–20 inches
1 *Kun*	7–8 inches
1 *Bait*	8–9 inches
1 *Angul*	1 inch

effort from the government, institutions, and the public is needed to restore this historical heritage.

Appendix

See Table 1

Traditional measurement	In inches (approx.)
	**1 Hath = 18-20 inches.**
	**1 Kun = 7-8 inches.**
	**1 Bait = 8-9 Inches.**
	**1 Angul = 1 inch.**

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Author Contributions Dr. Reetesh Sah—Author 1- Conceptualized and designed the study, conducted fieldwork, and analyzed the data. He provided expertise in traditional construction techniques, facilitated interviews with local artisans, and reviewed the manuscript. Rohit Kumar Singh Bhakuni- Author 2—Assisted in fieldwork, conducted interviews, and contributed to the interpretation of findings.

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Data availability The data supporting the findings of this study are based on qualitative fieldwork and archival sources. All relevant data are included within the article. No separate datasets were generated or analysed.

Declarations

Conflict of interest The authors declare No Conflict of Interest regarding the research, authorship, or publication of this study.

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