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Comparative Analysis of Traditional and Contemporary Architecture in Context to Sustainable Characteristics and its Construction Techniques: A Case of Kumaon Region

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Abstract: ***This research focuses on the study of traditional architecture of Kumaon, and how it has changed over the period of time. Kumaon region in Uttarakhand shows great examples of traditional architecture which has proven to be the best earth-resistant structures. The concept of science and earthquake-resistant structures were beyond the thought process of the people of that time. These traditional structures were cost effective, energy-efficient, provide thermal comfort for the longer period of day. The buildings of that time were locally constructed by the skilled person of the community using conventional materials like stone, mud, timber slates etc. With rapid urbanization, the need for rapid development has increased, transportation has improved, and the need for high rise structures has encouraged the use of modern materials such as concrete. However, society continues to demand better services, faster and easier construction to meet the needs of residents, resulting in serious damage to the fragile environment in and around settlements. To minimize the environmental impact of damage caused by modern technology, the use of indigenous practices needs to be revived. This research comprises of the comparison of traditional architectural style "Koti banal" which is rarely being used in many northern parts of Uttarakhand and current construction technique which is affecting the natural terrain of Kumaon resulting in natural calamities like landslide, soil erosion etc. The vernacular practices and patterns followed in conventional hill settlements have splendid capability to emerge as the premise for brand new improvement and system of suitable constructing policies for hill settlements.***

Keyword: ***Kumaon region, traditional architecture, earthquake resistant structures, Construction techniques, Koti-banal, construction materials.***

I. INTRODUCTION

Kumaon region in Uttarakhand is positioned on the foothills of the Himalayan Mountain ranges, it is largely a hilly area, surrounded by China in north, Nepal in east, Uttar Pradesh in south and Himachal Pradesh in north-west. In spite being located in a seismically vulnerable area, Kumaon shows a unique style of constructing multi storeyed houses. Kumaon had developed its own style of architecture based on abundantly available materials; like wood and stone. Traditional Kumaon architecture maintains a high level of comfort for a longer period of the day while potentially lowering energy usage, i.e., creating low-cost, energy-efficient, and disaster-resistant structures. The majority of the vernacularly made dwellings were built locally with traditional construction materials such as mud, wood, and stone.

The sensitive and fragile ecology in and around hill settlements is affected by the current situation, which involves numerous buildings being created in various hill settlements using modern materials and techniques without regard for the context. The loss of ancient knowledge systems, the lack of experienced craftspeople, the introduction of modern building materials, and government policies are only a few of the factors that can have an impact on and drive current construction methods in Uttarakhand's hills. This has resulted in the adoption of an architectural style that is not indigenous to hills but is commonly found in flat regions.

A. Research Background

Uttarakhand state is located in seismically highly sensitive zone.it is categorised under zones IV and V of the earthquake risk map of India (Figure 1). Kumaon architecture exemplifies the region's richness of art. Kumaon has a distinct sense of style when it comes to art and architecture. Despite being disaster prone region, few traditional buildings have proved to be disaster-resilient.

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On the other hand, Uttarakhand has observed many natural calamities in last few decades, in spite of that we can examine that people are nonetheless using construction techniques which are being used in plain areas. This practice has also given birth to loss of traditional architecture and loss of lives and properties. Traditional knowledge in the area has been affected by the use of modern building materials, the lack of skilled artisans, and other factors.

There is need to study traditional architecture and draw lessons learned from the traditional built environment and combine it with contemporary practices to attain sustainability, a modern approach to life, conservation of cultural heritage preservation and disaster risk reduction.

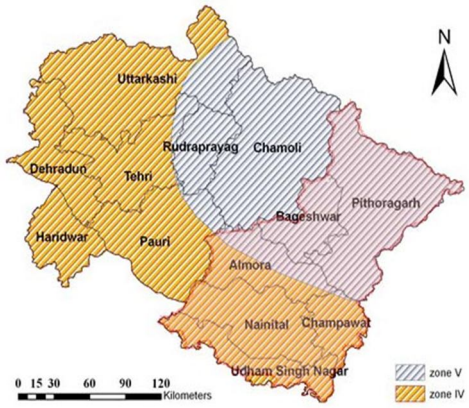
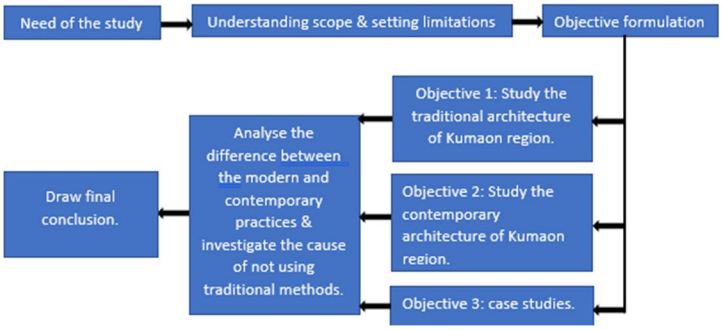


Fig 1. Uttarakhand earthquake hazard zonation (source: Uttarakhand State Disaster Management Authority)

B. Research Methodology

1) Study of Kumaon region on the basis of construction techniques, local material used and sustainable factors.
2) Compare modern construction techniques with traditional architecture.
3) Draw a final conclusion from the case study and literature study.



C. Research Questions

1) What is Koti-banal style of architecture?
2) What effects modern materials are having on the environment in the hilly region?
3) Are traditional construction practices done were better than contemporary construction practices?

II. TRADITIONAL ARCHITECTURE OF KUMAON

The architecture of Kumaon defines the artistic richness of the region. Kumaon has a unique sense for art and architecture. On the one hand, it can be seen as a scattered settlement in the high mountains and populated agricultural valleys of the Himalayas, and on the other, as a temple, forts and dharmshalas. We can observe the following points in this type of traditional architecture-

1) In order to receive significant solar exposure and protection from north winds, settlement patterns were developed on the southern slope.
2) Placement of buildings were along the contours to allow minimum disturbance to terrain.
3) The orientation of the houses is kept towards the east, south and west directions to get the benefit of the maximum direct sunlight.

4) The immense availability of stone and timber can be seen in the traditional houses.
5) Buildings with simple, regular and symmetry in both plan and elevation that produce less magnitude of twist during any hazard-landslide, flood, earthquake, wind velocity etc., are considered to be very stable.
6) Large projections are avoided. The small projection of 1 to 1.2 mt., seen as the balcony projection on the upper floor.

A. Traditional Construction Techniques: Koti-banal Construction

Koti Banal style,found in Uttarakhand, is one of the oldest architectural forms. It exhibits in-depth understanding of indigenous materials. Investigations revealed that it was an earthquake-resistant wooden and stone construction that was developed 1000 years ago. The buildings are constructed using the locally available building materials such as long thick wooden logs, stones, and slates. This architectural style is one of the most suitable for building in these regions. This style is proven to have minimal environmental impact and maximum earthquake resistance.

The Uttarakhand region has witnesses some of the catastrophic earthquake in the past. Kumaon earthquake of year 1720 and Garhwal earthquake of 1803 are termed as two of the great earthquakes(magnitude>8) that shook the region, yet this type of construction has survived major earthquake resistant properties. The following are major earthquake-resistant characteristics noticed in Koti Banal architecture:



Fig.02 Koti Banal House (Source: https://madhusudanks.wordpress.com/2015/11/07/koti-banal/)



(Fig 3. Source: https://hierleben.net/koti-banal-architecture-49/)

1) *Choice of Site*

a) These structures are often found on flat, sloping, and hilly terrain. They don't have any shared walls with buildings adjacent to them.

b) These buildings were built independently, apart from any other constructions.

c) The typical distance from a neighboring building is 2.0 - 4.0 meters.

d) Slope stability and the selection of solid ground are critical seismic factors.

2) *Choice of Materials:* local materials such as wood and stone were used for this type of construction. Wood is ductile and stone is a brittle material. Adding wood reinforcement to stone masonry improves the tensile property of the structure.

3) *Building configuration:* Koti Banal buildings are characterized by Very simple rectangular plan configurations while the lengths and widths are varying between 4 and 8 meters. The ratio between both dimensions varies between 1.1 and 1.4. The buildings rest upon a raised and elaborated stone in the continuation of the foundation trench made of field and rubble stones. The height of the platform varies between 2 and 4 m above the ground.

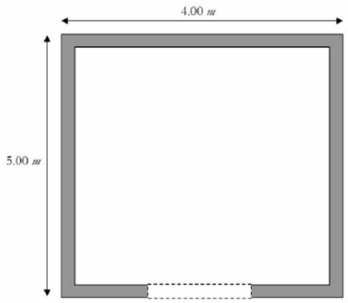


Fig.4 typical plan of single unit construction

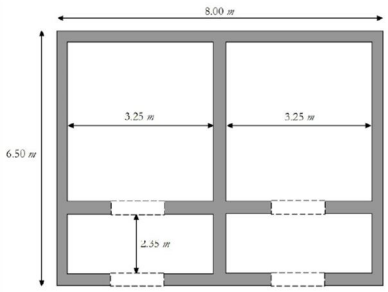


Fig. 5 typical plan shape of double unit construction

4) *Building Plan and Massing*

a) Houses were symmetrical about axis.

b) Simple rectangular shaper and enclosed areas.

c) Simple structures, no or very little ornamentation.

d) Height of the building were usually 7-12m.

III. BARAKOT VILLAGE, ALMORA

Barakot village is situated on the top of the hills in Almora. The entire settlement is planned in a linear manner with street in centre and houses on its side. It is a mix of row houses and single houses. Row houses are planned in a straight manner with houses on both side of the road.

1) Houses in this village are mainly placed along the contours and have agricultural field. Terrace farming is adopted in most parts of Kumaon because of sloppy terrain.

2) Main buildings are placed on the first floor which comprise of a fore-court, kitchen, living room, and bedroom. The kitchen is mostly placed at the end of the unit.



Fig.8 Barakot village in Almora (source: okuttarakhand.com)

3) Windows were placed in the front façade of the building as well as the opposite façade to ensure cross ventilation.

Following characteristics were observed in Barakot village:

a) Thermal comfort

- Thermal comfort is achieved by keeping height of the windows and doors small so that the interior remains warm, and the interior warmth is not transferred to the outside.
- Ceiling height is also kept low so that the interior remains warm and insulated.
- Gaushala on the ground floor helps to keep upper floor warm. The windows are generally smaller so that the warmth from gaushala is transferred to first floor.

b) Walls

1.5 ft. thick Stone masonry walls of these structures running in all four directions keep itself intact in times of calamity and seasonal changes.

c) Door/window Openings

Rear side of the house, which does not face sun usually have no windows or other openings.

d) Shape of the Plan

Shape of the plan is rectangular.

e) Siting off the House

Entire settlement is placed in linear manner without disturbing terrain. The houses were planned with streets in centre and houses on its side.

f) Foundation

The foundation of these individual dwellings are mostly 3-4 feet deep and large stones are used in masonry work.

IV. HARKOT VILLAGE, MUNSIYARI

Harkot village is located at the base of the mountains on comparatively flat land in Munshiyari. The area around this village has been converted into stepped terraces. These villages also exhibit typical architecture corresponding to their culture and livelihood. The Harkot village is sited in the landscape so as to make optimal use of the available flat land and direct sunlight and to avoid direct wind. So, the siting of these villages may be understood by taking a look at some physical aspects.



Fig 10. conceptual sketch of Harkot village and its setting (Source: https://villageinfo.in/uttarakhand/pithoragarh/munsiari/harkot.html)

1) Villages are always sited on the sunniest slopes.

2) Stepped terraces are usually cut into the mountain slopes and then carefully dammed with stone walls and vegetation as reinforcement to prevent erosion.

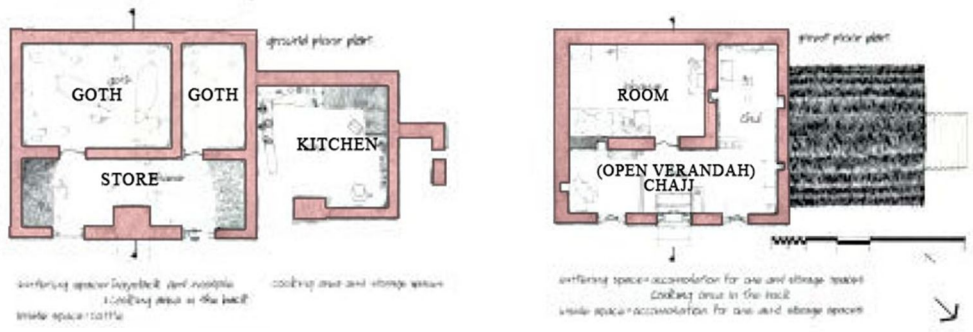


FIG.11 ground and first floor plan of Harkot village showing living space (Source: Report on traditional vernacular architecture of Kumaon)

a) *Foundation:* Individual dwellings have a shallow stone foundation, one to three feet deep, commonly of large stones extracted locally.
b) *Flooring:* The flooring is made of wooden planks supported with wooden trunks as beams and then smeared with a paste of cow dung and clay mixed on every second or third day
c) *Construction:* The construction of these dwellings was traditionally a family and communal affair. Members of the extended family and community members usually lent a hand with the building.
d) *Walls:* Walls are made of local stone and wood and daubed with mud. dry stone walls were built Without any mortar.
e) *Roofing:* Sloping roof of stone slates were used. People used native grass called selum to cover sloping roof to help regulate warmth inside house.

f) *Thermal Insulation*
Low floor height and small door and window openings allows heat to trap for longer period of time.

V. CURRENT SCENARIO OF CONTEMPORARY CONSTRUCTION

With rapid urbanization and need for fast development, started the use of contemporary materials and techniques. The materials like concrete became one of the most readily available materials which have reduced the use of these traditional practices in India. The industrialization of cement production in the last 30 years has eroded traditional methods of building, local skills and local markets. The use of such contemporary materials and techniques resulted in significant changes to the environment and surrounding, creating a risk and vulnerability for the local communities. The life span of these structures is estimated to be 50 to 80 years by its developer while the built environment created using the vernacular practices have withstood a much longer lifespan with minimum maintenance, and are much environmentally friendly than these modern practices.

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A. *Consequences of Contemporary Construction*
1) The major consequences of these construction techniques are landslides which causes loss of life and property.
2) Another consequence of these construction techniques is the depletion of the regional architectural style and construction techniques.
3) The loss of traditional knowledge and cultural heritage of that region.

VI. THE KUMAON, ALMORA

The small hotel in India's Uttarakhand is located 1600 metres above sea level in the Kasar Devi village close to Almora. The anticipation is increased by a row of bamboo trees that are used to block the view of the villas beyond and conceal the mountain vistas. On the site's highest point, the main building is located. The best example of how contemporary technologies and conventional materials can coexist. From door and window frames to floor finishes, local pinewood was widely utilised. The overall appearance is one of rustic simplicity, emphasising the use of local resources. Both the fly ash walls and the concrete soffits are left unplaster.

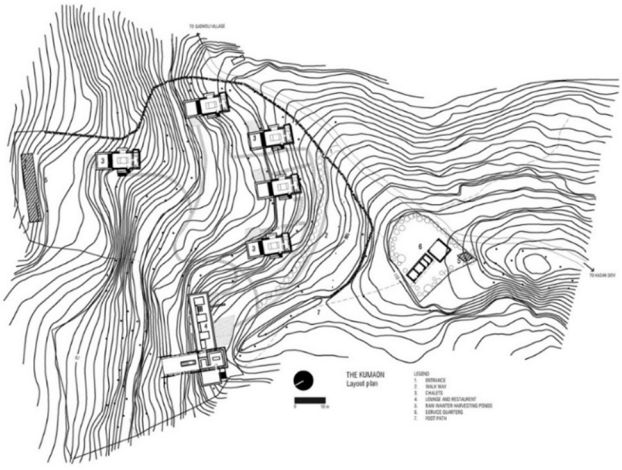


Fig. 12 Site plan (Source: thekumaon.com)

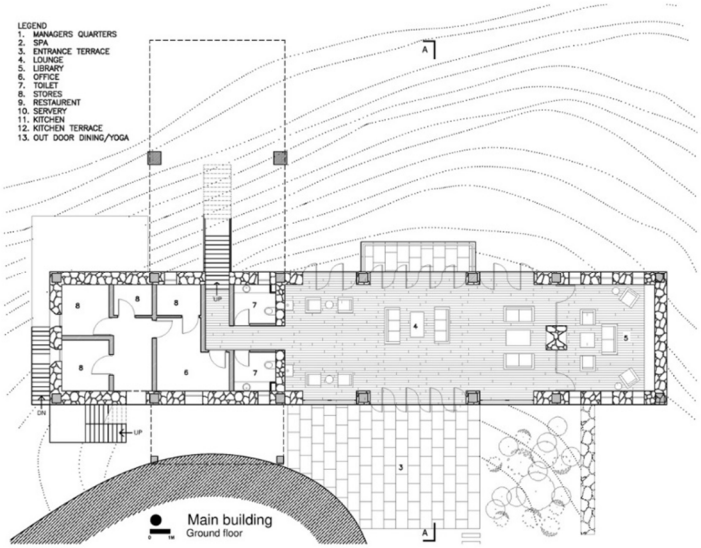


Fig. 13 main building- ground floor (Source: thekumaon.com)

By dispersing the built structure around the site and also by the bamboo cladding we were able to dissolve the visual impact a building such as this can have in a sensitive environment. All the structures were designed for rain water harvesting, with a drain system taking the water to a large holding tank at the bottom of the site. The hotel plans to replant seasonal crops in the terraces and left over spaces, using the produce for its own kitchen. The goal was to draw attention to the breathtaking natural surroundings and concentrate on the mountain views. while paying tribute to local resources, tradition, and culture. A sustainable solution has been project while using the traditional methods with modern construction methodology.

VII. INFERENCES OF THE CASE STUDY

1) Modern buildings are designed considering the need of the today's life-style.
2) Traditional buildings lack sense of living if we compare it to the today's living lifestyle.
3) The traditional buildings were no doubt stable, having life-span of 1000 years and above.
4) Current practices done by architects are no doubt sustainable and following standard design consideration of hilly region, but they somehow lack the traditional methods which are much stable in the hilly terrain.
5) Current generations do not know about the traditional Koti-banal, if we incorporate old structures with modern materials, we can revive the old methods.

VIII. OBSERVATION AND INFERENCES

S.no.	Parameter of analysis	Case study-1 Barakotvillage, Almora	Case study-2 Harkot village, Munshiyari	Case study-3 The kumaon, Almora
1	Siting	situated on stepped lands without disturbing natural terrain.	Entire settlement is placed in linear manner without disturbing terrain. The houses were planned with streets in centre and houses on its side.	terraced which is typical of agricultural plots
2	Orientation	Oriented along east and south	sited on the sunniest slopes	Located along south-east
3	Foundation design	3-4 feet deep stone foundation	shallow stone foundation, one to three feet deep	Load bearing stone foundation
4	Shape of the plan	Shape of the plan is rectangular and the ratio of the width is 1.2 times of its depth.	Rectangular in shape	Rectangular units
5	Thermal insulation	Ground floor was made with small windows to make it warm; people live on first floor, livestock on ground.	Low floor height and small door and window openings allows heat to trap for longer period of time.	Bamboo and Stone walls acts as barrier for thermal conductivity.
6	Roofing	The slabs of the stone are cut into tiles and then used as a roofing material	Stone slate slab, native grass called *selum used to* cover the sloping roof to help regulate the warmth	Kota stone terrace supported on wooden beams
7	Walls	Stone masonry with wooden beam introduced at 30cm gap alternatively	1.5 ft. thick Stone masonry walls	Fly-ash walls and stone
8	Door /window opening	Rear side of the house, which does not face sun usually have no windows or other openings.	Ground floor was made with small windows to make it warm; people live on first floor; livestock were on ground	Window opening were much bigger, Mechanical means were used to warm the interior space
9	Ceiling height	Ceiling ht kept low ,2.4-2.5	Ceiling ht. was kept low.	ceiling ht of units were kept low
10	Cost effectiveness	All the materials were locally excavated and construction were done by the owner family	All the materials are locally sourced and the construction done by the owners of the house.	Some materials are exported like fly ash bricks and bamboo cladding. Major construction was done from stone
11	Environmental impact	Local materials were used which were available in abundance.	Stone and wood are available in abundance.	Units are placed partly to reduce the bulk of the building and also to reduce the overall footprint of the development.

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IX. CONCLUSION

The changes that have taken place in the Koti Banal style of architecture are reflections of social and environmental changes that have taken place in the society. They indicate that it is not easy to hold on to the construction techniques and the historic vernacular forms, due to the contemporary aspirations. The macro level components—materials for building, methods of construction, and the form of house—are particularly vulnerable to the mentioned changes. They are strongly impacted by resource availability and market dynamics (current trends; supply-demand), aspects that are beyond the control of the community. The macro level changes in interior-architecture have brought long lasting changes in the life of the community. Also, the continuity of vernacular traditions is threatened.

There is a need to delve into new materials with the old principles of structural design and community involvement, which Koti Banal style embraced.

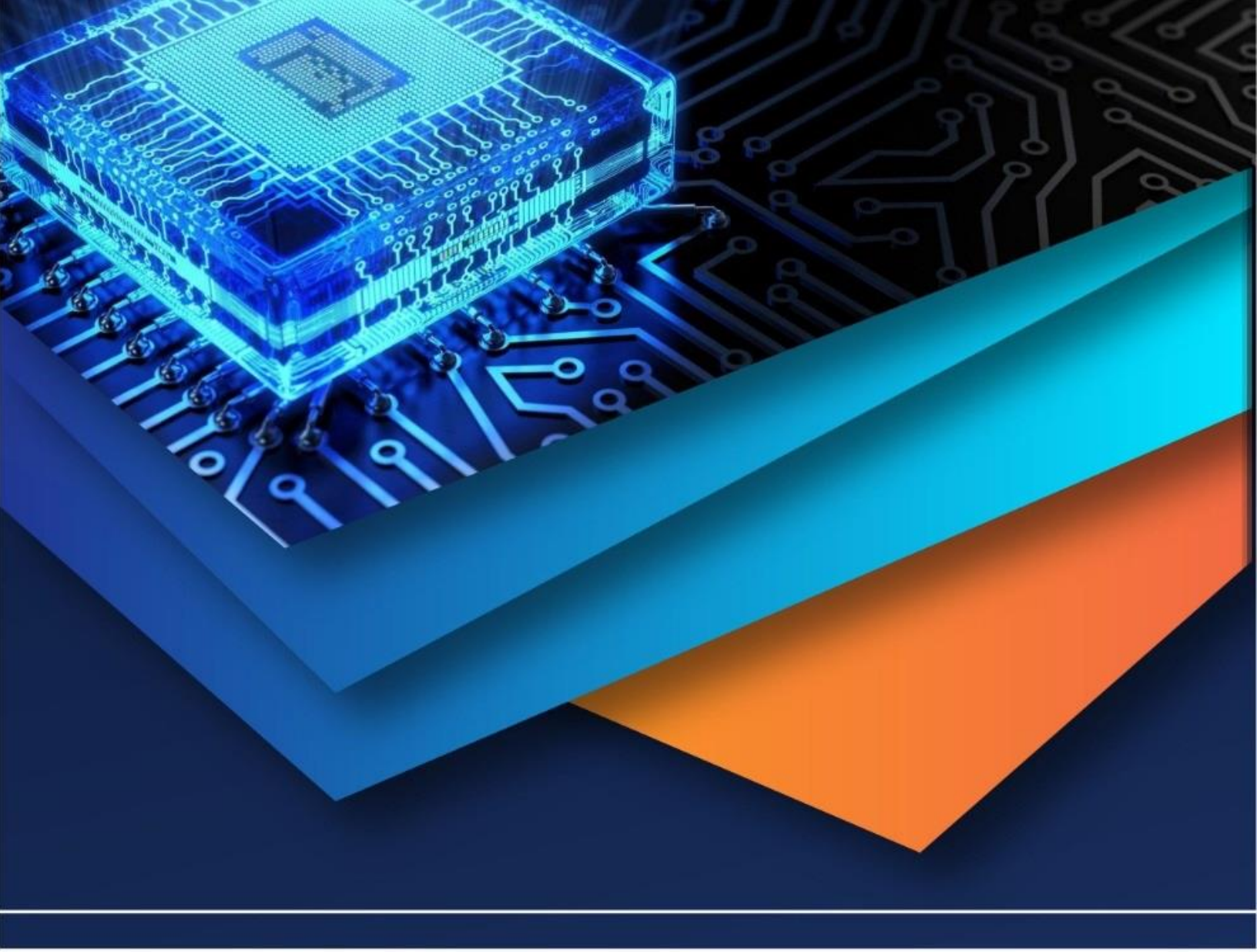
However, having expressed the above, there is still a presence of the "Koti Banal" style. It is at least clear that the style has not been completely abandoned; few selected aspects have been modified to address changes in building materials and lifestyle.

It is also suggested that the Government should ensure that the new constructions proposed, should respect the existing built forms and maintain the unique identity of the state. The government should take the initiative for the revival of this architectural style. Not only it will revive the technique that is near extinction, but will also provide employment and support for those contractors who are skilled in Koti Banal structures. Same approach could be used for government buildings and monuments.

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