

# Sustainable Indian Architecture, “Case Study–Bandebambli”

Nishant Nathani<sup>1</sup>, Pragnya Prakash<sup>2</sup> and Mustakeem Raza Khan<sup>3</sup>

<sup>1,2</sup>Ph.D. Scholar, Architecture & Planning, Amity University Haryana, Haryana, India

<sup>3</sup>Architecture & Planning, Amity University Haryana, Haryana, India

E-mail: <sup>1</sup>nishantnathani@gmail.com, <sup>2</sup>arpragnya@gmail.com, <sup>3</sup>ar.mkahn@gmail.com

**Abstract**—The Traditional wisdom of building human habitats in India is known to be tested by time for its sustainability in various settlements. Sustainability in Indian settlements is a phenomenon which is shaped based on the living practices rather than an induced character to the built habitat. This paper talks about one such 14th century settlement “Bandebambli”, located in Southern India enunciating sustainability through Planning and Architectural practices evolved due to socio economic and environmental factors. The factors resulting in sustainable built form is analyzed in macro and micro level studies. Macro level study covers Planning and Architecture aspects whereas Micro level study covers Art, Architectural details and Social practice affecting built habitat. Planning of the settlement is influenced by the surroundings on the basis of natural features, resource availability, safety and environmental constraints. The architecture of the settlement takes cue from the Planning perspective and details out the features at building level. Architectural character is mostly influenced by Bahmani and Vijaywada Resign Architecture. The visual appearance of the settlement is dominated by rustic stone mass and narrow streets along with details evolved to suit the hot-dry climatic condition and prevalent social customs. Along with the compulsive forces for development, the art and craft of the settlement is evolved with a quality character. Explicit wooden joinery details in load bearing structure and exquisite wooden carvings symbolize the social and economic classes among the society are few unique features. Due to migration of people out of settlement for economic reasons, many of these unique houses are in stage of dilapidation and require urgent attention to save the rich traditional wisdom.

**Index Terms:** Sustainable Architecture, Settlement, Stone Mass, Masonry and Details

## 1. INTRODUCTION

Emerging habitats stress on sustainability to mitigate the ill effects on humans and their habitats in the path of new development. Traditional wisdom of building human habitats in India is tested by time for its sustainability in numerous settlements across the country. Sustainability in Indian settlements is a phenomenon which is shaped based on the living practices rather than an induced character to built habitat.

This paper focuses on one such vernacular settlement describing the traditional approach towards sustainability. The settlement is almost 600 years old and the buildings are 250-300 years old. The settlement-“Bandebambli”, etymologically defined in “Kannada Language” as Bande–Rock, Bam–back, Bli–near, the village is situated at the back of the granite rock. Enunciating sustainability through Planning and Architectural practices shaped due to socio economic and environmental practices, Bandebambli forms a unique case study for investigation. Sustainable built form is analyzed in macro and micro level studies. Macro level study covers Planning and Architecture aspects whereas Micro level study covers Art, Architecture details and Social practice effecting built habitat.

## 2. LOCATION & DEMOGRAPHY

The settlement is located in Yadgir district, state of Karnataka in India. 38 Kilometers from the district headquarters and is connected by Other District Road (ODR) [1]. Latitude-17° 46' 60N, Longitude-76° 45' 0E, Altitude-355 meters, Area: 1.8 sq. km. It has a population of 4000 as per 2001 census. Temperature in this region varies from 48 degree Celsius in summer to 13 degree Celsius in winters. The settlement lies at the bank of river Krishna and in between Krishna and Bhima rivers, the area is named as Sagara Nadu.



Source: Author

Fig. 1:-Settlement Location

### 3. HISTORY-EVOLUTION OF SETTLEMENT

History of settlement dates back to 14<sup>th</sup> century. The revolt of Muslim officers appointed from Delhi resulted in founding of Bahamani Sultanate by Hassan Gangu, who chose Gulbarga (approx. 125 km from settlement) as his capital. The Bahamani Sultanate chose Bandebambli as a refugee camp for their soldier’s family, while the soldier is serving in war or in danger[2].

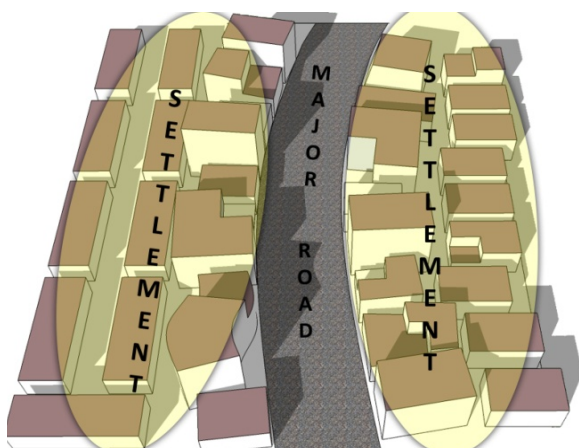
The location of the settlement is influenced by the presence of river and granite rock. River serves for agrarian purpose, a similar practice of traditional settlements around world and granite rock serving as a defense for watching area to keep vigilant to far places. The granite rock also used as building material for construction of buildings. The bold, rustic and massive elevation made out white granite resembles the concept of forts having elements such as Overhangs, Chattries, Courtyards, Highly decorative entrance doors add on to the aesthetics.

### 4. MACRO LEVEL STUDY: PLANNING

The physical planning of the settlement is extensively formed as a response to the climatological constraints and social attributes of inhabitants.

#### 4.1 Physical Setting

Planning of the settlement is influenced by the surroundings on the basis of natural features, resource availability, safety and environmental constraints. The settlement lies in rich agrarian belt along river bank of Krishna and near a granite rock serving as a primary source for building material and strategic defense point to keep vigil till far places. Environmentally, the harsh hot-dry climate forced the built forms closely knit with narrow lanes for movement.

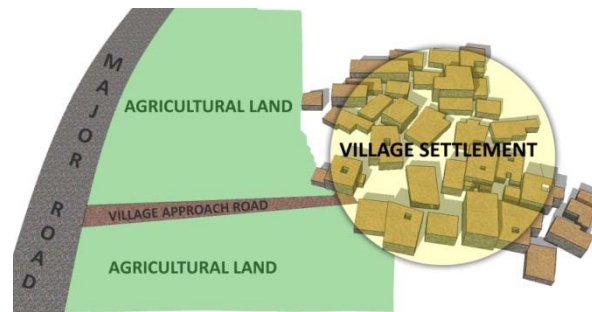


Source: Author

**Fig. 2: Ribbon development of settlement**

Generally ribbon development of settlements is found in India, inviting trouble with increase in traffic affecting the settlement

fabric and lifestyle. In this case, the settlement traditionally is planned off the main road. This character is extended to various settlements in this region. The settlement is connected to main road by an approach road.



Source: Author

**Fig. 3: Settlement connectivity**

#### 4.2 Environmental Setting

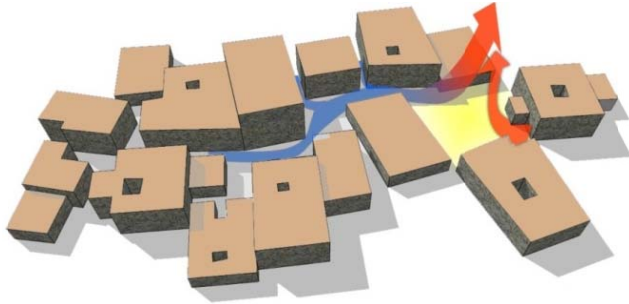
The settlement is connected through network of narrow shaded streets. The widths of the streets are restricted to 1.5m to 5m wide. Streets are of smaller width in the lanes with low height buildings and increased width among the lanes with higher building height. Functionally smaller houses are occupied by low income people with less tools/ vehicles for which smaller lanes sufficed. Environmentally, the streets were shaded in maximum part of the day remaining conducive for walk trips.



Source: Author

**Fig. 4: View of settlement**

Courtyards used for stack effect to drag air: The shaded streets would lead to courts/ courtyards varying scale according the size of the streets. The courts paved by stones heats up the air and sucks air from shaded lanes with comparatively lower temperature forming stack effect at macro level.



Source: Author

**Fig. 5: Courtyard acting in Lingayat cluster as stack effect**

### 4.3 Social Setting

Areas in the settlement are segregated based on social class. The central part, heart of the settlement is occupied by higher class of society where as the outer part being occupied by lower class of people.

Bigger houses, occupied by rich and elite class are placed in central part of the village depicting their importance. Characteristically these houses consist of huge courtyards internal and external to their houses. For privacy, Jharokhas (private balconies) for ladies were part of the houses to be the witness of functions outside.

Courtyards are major component of the settlement fabric with multiple functions as social gatherings, agriculture produce processing with larger courtyards being used for festival gatherings and entertainment purposes. Thus, courtyards are utilized for multiple uses such as public, religious, working and interactive spaces. Social activities are practiced in such a way, resulting to environmental adaptation of built habitats. Multiple functions of spaces and alleys create appreciative and sensible built form.

### 4.4 Water Supply and Drainage

Wells are main source of water in the settlement and are located in different locations in settlement. Most of temples have a well nearby. Recently bore well has been installed and are located at various points on the peripheries of settlement.

Rain water and waste water drains off on the pathways. Due to sloping topography towards the river in most places, waste water runs off easily or dries due to sharp sun. New soak pits have been constructed in some houses. Community toilets are present in various locations at the fringe of the settlement.

### 4.5 Vegetation

There are two types of soil found in and around settlement –

“Alluvial soil” and “Black cotton soil”. Due to hot dry climate, main vegetation is; Neem trees and thorny shrubs. Important crops are; Chilly, Bajra, Cotton, Pulses, Paddy, Green gram and Sunflower.

## 5. MACRO LEVEL STUDY: ARCHITECTURE

Architecture of the settlement takes cue from the planning perspective and details out the features at building level. Architectural character is mostly influenced by Bahmani and Vijaywada Resign Architecture.

### 5.1 Physical Setting

The character of the village is dominated by usage of granite as building material. Locally available white granite stones are used for construction. Stones are dressed single line to double line (single line represents roughly finished and double line representing better even finish than the previous and used in the outer face of the building to provide visually pleasing character).

The settlement was influenced by “Vastushaastra” (a treatise of Architecture). The houses had a basic plan which comprises of 9 squares arranged to form a large square with Central Square forming internal core i.e. courtyard. All the houses has entry either form north or east and having kitchen towards south east, store room on south west [3].

### 5.2 Environmental Setting

Due to the high temperature in the region, certain architectural adaptations are made to overcome the heat within the building.

**5.2.1 Composite wall construction:** The wall thickness lies between 600-800 MM throughout the settlement irrespective of internal or external wall. Walls are composite in nature and made up of stone, lime and clay is being used as mortar. As discussed earlier, the outer stone surface of wall provides higher lag of heat transmission. Since the material varies in composite construction with mud as a part of composite, the heat lag increases reducing transmission of heat due to convection.

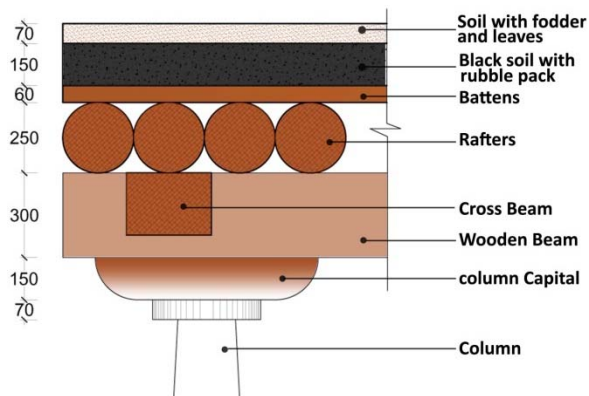


Source: Author

**Fig. 6: Ashlars & Rubble wall construction**

**5.2.2 Composite roof Construction:** The roof of the buildings is also of composite nature and is of great significance. The roof consists of 5 layers; starting with wooden beam, second layer is rafter, third is batten, fourth is

Black Soil with rubble pack and top layer is clay, leaves and straw. The thickness of the roof increased in longer term as the new layer of mud applied on the top layer before rainy season.



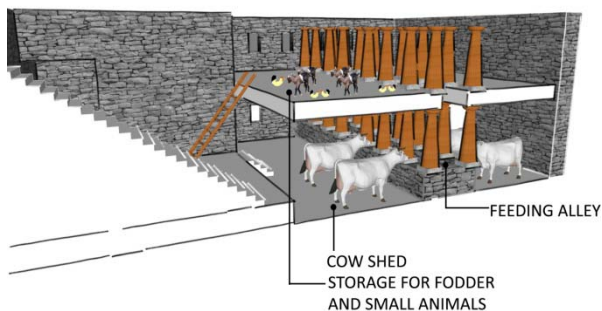
Source: Author

**Fig. 7: Composite roof construction (Dimensions in MM)**

Minimal openings in the buildings depict common built character of the village. The heat from the sun entering into house by radiation is cut off with minimal openings, helping to maintain minimal air change within building and avoid intake of hot air inside building.

### 5.3 Social Setting

People in Indian settlements have great affinity towards animals. Cows are considered holy. Rural livelihood is heavily dependent on cows to obtain milk for nutrition and cow dung to be used as fuel for cooking and also used to keep exteriors dust free by applying cow dung on ground. Even they are farmer's friend in agricultural field as it is the prime source of tilling farm land from period of pre-mechanization in agriculture.



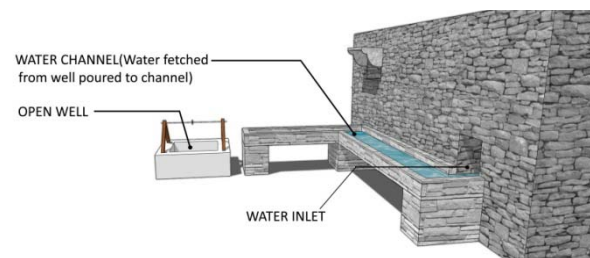
Source: Author

**Fig. 8: Split level for animal habitat**

Animals are given equal importance as humans in the village. They form a part of the house to ward off the heat and sun. Cow sheds are generally built within the house with split floor levels. In higher income group houses, cow shed was

segregated from living area but in lower income group cow shed is the part of living area.

Water supply techniques from well to interior: The class system and untouchability prevailed in the social customs of India. As a result of this stigma, several unique techniques were evolved in architecture. The higher class employed workers of lower class who were not allowed inside house or certain part of house. The source of water to house is well in the backyard of the house. Workers were employed to fetch water from well and arrangements are made in the building features with channels connecting from backyard near well to kitchen and bathroom inside house.



Source: Author

**Fig. 9: Water supply system**

Higher class of people with big houses has various segregated common spaces and personal spaces defined by various courtyards. A common feature of social fabric in the settlement is interaction with neighbors and friends. The architectural feature to support this habit is in form of "Juglis" (A platform in front of each house accommodating seating).

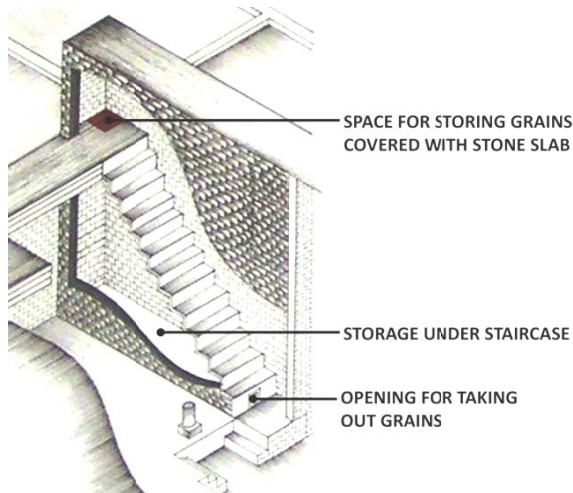
Sustainable development even includes socio economic development along with environmental development. The physical form of buildings represented the affinity towards social beliefs about vaastushastra and environmental adaption in built form. The architectural features such as juglis and courtyards formed as interactive spaces acting as a medium for social harmony and recreation. The social class segregation defined role of activities resulting in architectural modifications. These practices overall represents the fusion of social beliefs and environmental adaptations in architecture.

## 6. MICRO LEVEL STUDY: ARCHITECTURE

Apart from the major architectural feature of the village, there are several small features enhancing the uniqueness of the settlement architecture. The techniques are evolution as per the need of the people. The features are discussed below.

### 6.1 Grain Storage Technique

Being an agrarian society, the grains and agricultural produce were to be stored and safeguarded. Maize is among main produce in the region. Various techniques were devised to store grains.

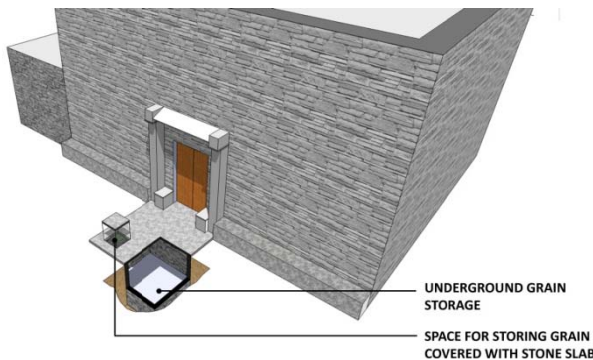


Source: Author

**Fig. 10: Under staircase grain storage system**

**6.1.1 Under Staircase:** The part below steps is used to store grains. Maize is dropped from the top landing of the staircase. For daily use, a small opening is kept at the first riser from the ground level to pull out required maize. Few places the depth of the storage under stairs are deeper than the finished floor level and for bulk consumption, there was a bigger opening on the side wall supporting the staircase.

**6.1.2 Underground Storage:** Storage chambers were made underground in the courtyards or sometimes outside the house in the lane. The inner surfaces of the chambers were treated with soil, kerosene oil and cow dung and chaff. The maize was stored and the surface is made as before for regular usage, open for traffic.



Source: Author

**Fig. 11: Underground grain storage system**

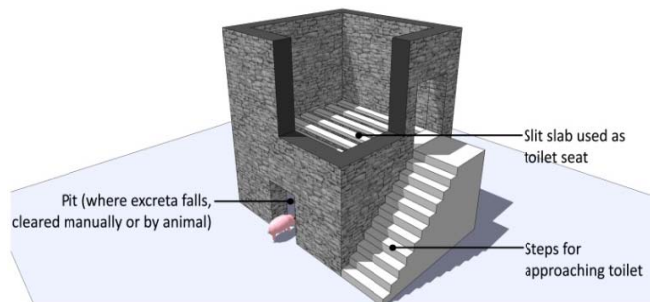
**6.2 Jewellery Storage Technique**

Rich families safeguarded their precious possession within their houses in secret chambers. These chambers were formed by niches within the wall. Stone slabs were slid on top of the niche and an even wall surface is maintained. This

arrangement made it difficult for any new person to find out where the niches are due to similar interiors. This arrangement is obsolete presently.

**6.3 Toilet Detail**

Community toilets were present since the inception of the settlement. The toilets were raised stone slabs about 1 meter above ground and enclosed platform with slit slabs as toilet seat. The excreta slip through the slit onto the ground or pit where it is manually cleaned later or animals cleared the waste. Few big houses had concept of attached toilet to rooms where particular toilet has a hole in the slab at the first floor for the night soil to come down. At the ground that has been cleaned by the sweeper. According to villagers this is the starting point from where the concept of attached toilet emerged. This practice is coming to an end as manual toilet lifting is being considered as a social taboo. Recent intervention from government schemes and due to awareness among people, personal toilets are being built within house

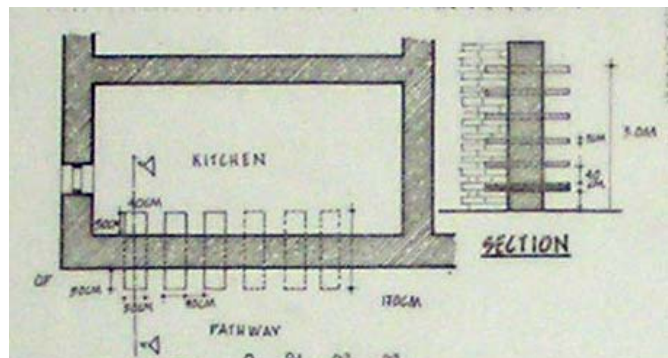


Source: Author

**Fig. 12: Community toilet detail**

**6.4 Steps Used as Storage Racks**

A stone slab is fixed in wall in such a way that half of the portion towards exterior of the house is used as staircase and another half which is inside the house is used as a shelf in kitchen. These slabs are jammed at centre by stone wall as shown in fig-13.



Source: Author

**Fig. 13: Plan of steps and racks**

### 6.5 Jhaorkha (Balconies)

The concept of Jharokha was adopted from Rajasthan. Jharokha were projecting and were supported by cantilever stone slabs. These cantilever stone slabs were carved to resemble the “neck of the horse” and visually pleasing. Interior of the balconies was of compactly arranged stone chips and plastered from Exterior.



Source: Author

**Fig. 14: Location of Jharokha (balcony) in a house**

### 6.6 Sky Light

Sky lights were usually overlooked the bathing area, which was located in kitchen and act as the outlet for smoke. There were various types of skylights installed on the roof. But the typical one was made up of bottomless earthen pot.

Thus, the architectural details were functionally part of Minimalistic Architecture. The innovative ideas of Architectural modifications to accommodate street functions, storage techniques utilizing the streets making people more responsible to keep the street maintained as it formed a part of their house and daily life. The progressive thinking often found lacking in current city context.

## 7. CONCLUSIONS

The synthesis and integration of diverse characters makes Bandebambli a unique settlement. From the inception of the settlement, the concepts of using locally available material, climate responsive architecture and planning of the settlement is prevalent. The habits of the people as per the prevailing social and environmental factors have proven to mould the built habitat in a sustainable manner.

In a race towards future growth, the roots of origin are often being forgotten. Traditional vernacular Indian settlements are losing their importance, value and appreciation of the quality which it possessed resulting in decay of the quality possessed in terms of rich character environmentally, socially and culturally. New generation in search of economic opportunities are out migrating from the settlement and the demand for the artisans for building are diminishing resulting in neglect of the rich structures and dilapidation of the same. It is of high importance to conserve the character of natural

evolution sustainable habitats rather than to induce sustainability later as piecemeal efforts.

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