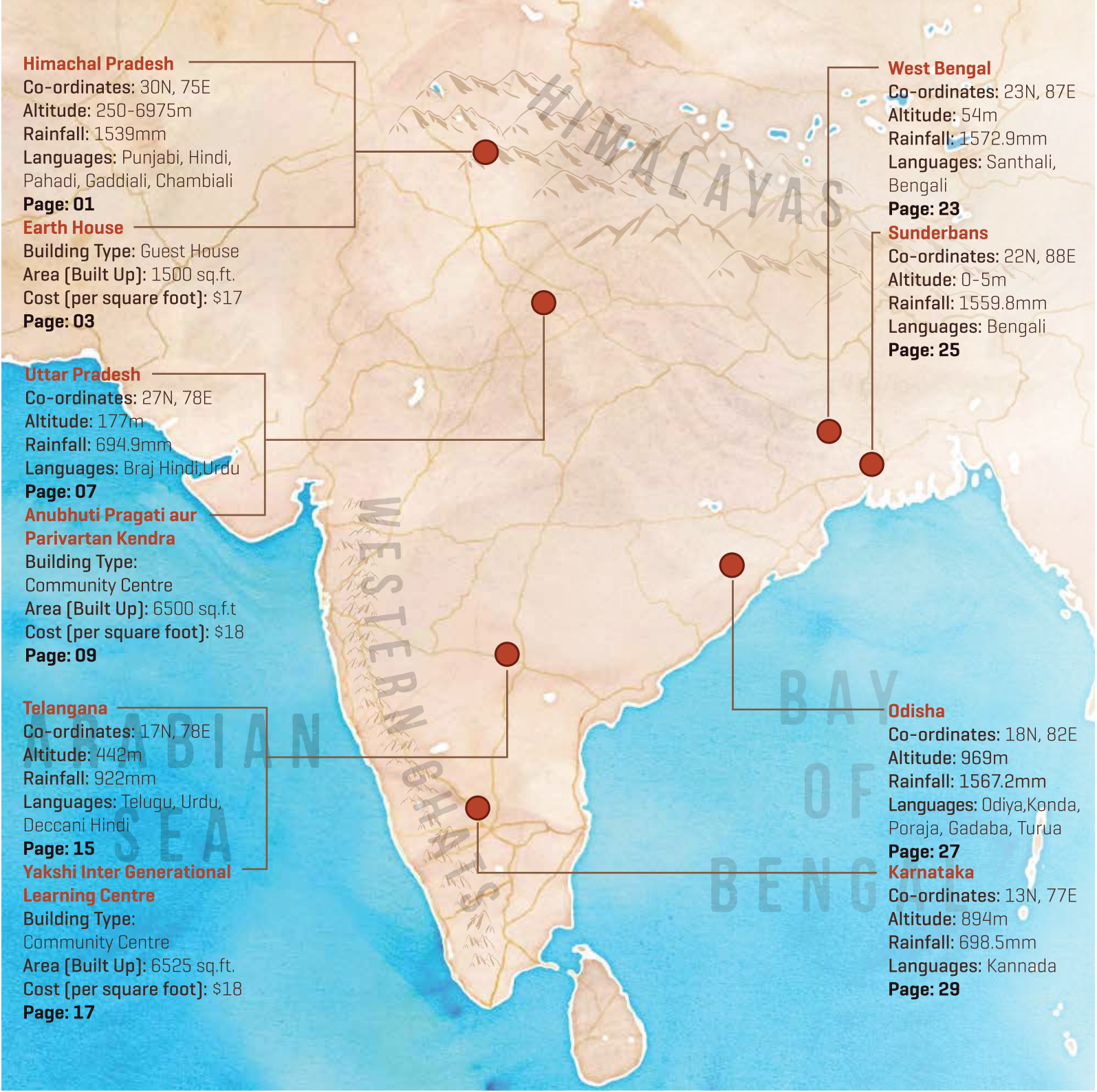

Himachal Pradesh
Co-ordinates: 30N, 75E
Altitude: 250-6975m
Rainfall: 1539mm
Languages: Punjabi, Hindi, Pahadi, Gaddiali, Chambiali
Page: 01

Earth House
Building Type: Guest House
Area (Built Up): 1500 sq.ft.
Cost (per square foot): $17
Page: 03

Uttar Pradesh
Co-ordinates: 27N, 78E
Altitude: 177m
Rainfall: 694.9mm
Languages: Braj Hindi,Urdu
Page: 07

Anubhuti Pragati aur Parivartan Kendra
Building Type:
Community Centre
Area (Built Up): 6500 sq.f.t
Cost (per square foot): $18
Page: 09

Telangana
Co-ordinates: 17N, 78E
Altitude: 442m
Rainfall: 922mm
Languages: Telugu, Urdu, Deccani Hindi
Page: 15

Yakshi Inter Generational Learning Centre
Building Type:
Community Centre
Area (Built Up): 6525 sq.ft.
Cost (per square foot): $18
Page: 17

West Bengal
Co-ordinates: 23N, 87E
Altitude: 54m
Rainfall: 1572.9mm
Languages: Santhali, Bengali
Page: 23

Sunderbans
Co-ordinates: 22N, 88E
Altitude: 0-5m
Rainfall: 1559.8mm
Languages: Bengali
Page: 25

Odisha
Co-ordinates: 18N, 82E
Altitude: 969m
Rainfall: 1567.2mm
Languages: Odiya,Konda, Poraja, Gadaba, Turua
Page: 27

Karnataka
Co-ordinates: 13N, 77E
Altitude: 894m
Rainfall: 698.5mm
Languages: Kannada
Page: 29

I am an independent architect, moving between building projects across the Indian states of Himachal Pradesh, Uttar Pradesh, Telangana and Karnataka. My work lies at the interface of traditional design and aesthetics, ecology, and socio-cultural understanding of indigenous communities. I believe that the choices we make as architects have a significant impact on marginalized communities around the world. There is an urgent need to unmask the layers in the production and consumption of architecture and focus on the people and processes behind them.

By documenting and studying salient features of traditional knowledge of building, I strive to provide contextual and contemporary design solutions in rural areas of resource poor states of the global south. This is achieved through three main aspects of my practice -

• Use of locally sourced materials-mud, bamboo, stone, wood to reinforce local village economies

• Investment in community oriented building techniques to utilize large labour resources and promote dignity in labour

• An inter-disciplinary and collaboration-focused nature of practice with teams of indigenous craftsmen who have an equitable stake in the building process.

The use of material culture and design practice as a tool to address issues of socio-economic inequality, ecological and cultural degradation, and political inequity is an important part of my goal. I wish to formulate an inclusive, participatory and pluralistic process, which satisfies multiple hitherto marginalized stake holders while balancing the classical duties and responsibilities of an architect.

Siddharth Menon
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District Kangra | Himachal Pradesh

Latitude: 30N; **Longitude:** 75E

Altitude: 250-6975 m

Average Annual Rainfall: 1539 mm

Average Precipitation Days: 34-35 days

Max. Summer Temperature: 34-35°C

Min. Winter Temperature: 0-3°C

Languages of Indigenous Craftsmen: *Pahadi, Gaddiali,* Hindi, *Chambiali,* Punjabi

Traditional Materials: *Kacchi inth* (Adobe), *Gaara* (Mud mortar), *Ukhadu* (River stone), *Kup* (Local sand stone), *Baans* (Bamboo), *Cheer* (Himalayan Pine wood), *Deodar wood, Chakka* (Slate stone tiles), *Reth* (River sand), *Bajri* (Gravel), *Gobar* (Cow dung), *Paani* (Water)

A traditional village settlement

The Kangra Valley of Himachal Pradesh, a former part of Punjab state, lies on the windward side of *Dhauladar* mountain range - a southern branch of the main Outer Himalayan chain of mountains in north India. Due to this, it receives heavy rainfall for most parts of the year compared to the rest of the state giving it a unique ecosystem of lush greenery and flowiing *khuds* (rivulets) and a rich reservoir of natural building materials like stone, bamboo and wood. Summer temperatures here are pleasant and winter temperatures drop to below freezing point with some areas experiencing annual snowfall. The indigenous *Gaddi* tribes of the region are nomadic shepherds, spending their winters at the foothills of the mountain while migrating to greener pastures above in summers along with their herd of sheep. Hence their homes are designed and built for winters

Houses are designed to have large south facing verandahs and courtyards to maximize the effect of the low winter sun. Verandahs are also provided on the upper storey and are used extensively for day time activities. Moulded over time by the force of running water, river stone is used for foundations along with mud mortar. Thereafter for plinths and walls up to a certain height dressed stone is used either with mud mortar or using the dry stack masonry technique. Adobe or sun dried mud brick is the main building material here. Sizes are generally 12 inch by 6 inch by 3 inch and walls are 18 inch thick. This thickness gives walls the required compressive strength to carry the weight of a G+ 1 house and also provides the necessary thermal thickness for the heat battery effect thereby protecting the inhabitants from the intense winter cold. Mud for adobe is generally excavated after leveling slopes and contours on one's land.

Adobe used for walls above window cill level

Intermediary floors are made of 3.5 inch- 4.5 inch diameter *baans* (bamboo) rafters over which is placed *chachhra* (split bamboo mat). This acts as a base on which a traditional 3 inch mud floor is laid out. Upper storey walls are also made of adobe and have a low ceiling height. The floor-ceiling heights of both floors is kept low so that there is lesser volume of air to heat up in the bitter cold months. Roofs are pitched at angle of 22.5 degrees and have a system pine wood trusses and bamboo rafters that are nailed together. Over this are wooden battens and thin tiles of *chakka* (slate) measuring 9 inch by 18 inch are nailed onto the same. These slate tiles can be arranged in two local patterns-a simple pattern and the *lehri* pattern. Roofs have a deep 3 foot overhang to protect mud walls from splashing rain

A small house with south facing verandah

Dry stack masonry walls

Continuous horizontal wood beams are provided at the lintel levels above doors and windows to counter lateral movements during earthquakes as this region lies in a Zone 5 seismic zone. *Cheer* (Pine wood) is generally used for the same. Three coats of mud plaster are applied to walls to protect it from rains. Also north faces have deeper overhangs and verandahs as the microclimate of the region is governed by the northern *Dhauladar* Mountains due to which monsoon rains lash from that side. River sand, wheat husk and cow dung is used in mud plasters and natural dyes are added to the final coat to personalize plasters and finishes.

South facing courtyard used for drying clothes

Earth House | Himachal Pradesh

Location: Village Chandpur, Block Baijnath, District Kangra, Himachal Pradesh

Client: Linger, Bangalore

Building type: Guest house

Crafts, Castes & Communities: *Gaddi* stone cutters, *Chamaar* carpenters, *Lohaar* carpenters, *Pandit* slate cutters, *Thakur-Rana* labour, *Chowdhury* masons, *Patiyaal* painters, *Masand* labour

Commencement: June, 2013

Expected Completion date: August, 2015

Area (Built up): 1500 Square feet

Cost (per square foot): $17

Foundation and plinth in local dressed stone

Located in the Kangra Valley of Himachal Pradesh, the Earth House is a three room guest house for a travel company that wanted to promote responsible tourism in the Himalayan region. Set in the lower fields of Chandpur village, with the constant buzz of the Ava *khud* (stream) flowing close by, the site afforded a spectacular view of the northern *Dhauldhar* mountain range. With the nearest motorable road being a 20 minute trek uphill, the design called for the use of materials from the immediate vicinity as much as possible to reduce the cost of carriage and transportation. The tight budget also needed careful and compact planning which would maximize views from site. Since the site is also completely off the electric grid, the design would have to respond to local climatic conditions in order to be independent of fossil fuel energy.

The above challenges called for the study and use of the indigenous building vocabulary of the region to build a contemporary space that would fit into the landscape and provide valuable jobs for local people without compromising on basic comforts of the urban guest.

The design encompassed a compact two storey building with a common room, kitchen, store room, stairs and guest room with attached toilet-bath on the ground floor. The first floor would have a covered verandah and two guest rooms with attached toilet-baths. Each of the guest rooms required to be able to house a family of four - two adults and two children. The challenge was to achieve this without increasing the area of the rooms thereby preventing escalation of costs. This called for ingenious ways of providing bunks and lofts by using dead space above stairs and below pitched roofs.

Adobe drying on site

Furthermore space had to be provided for a water tank at sufficient altitude to provide the required water flow. A wrap around L-shaped south facing verandah was also incorporated on the ground floor so that occupants could bathe in the warm winter sun.

Adobe Walls over stone plinth

The site is a narrow undulating plot set between two thorny trees and is covered with a lush carpet of grass. The first task was to level the contours on site to so that earth could be used to make adobe or sun dried mud brick which is an indigenous building technology of the region. Before the earth was leveled, care was taken to remove top soil which contained rich organic matter that is not fit for building purposes and can be used for gardening or farming. Load bearing foundation trenches were dug to a depth of roughly 3 feet.

Round moulded river stone for the foundation was procured from the adjoining *khud* with the help of donkeys or *khacchars* (donkeys). This was used in conjunction with mud mortar to form a strong strip foundation for the building. The site yielded good quality sandstone which was excavated using local *Gaddi* stone cutters. This was then dressed on site by skilled *Chowdary* masons to produce cuboids of roughly 1 foot by 6 inch by 6 inch in size.

These stones were used in the plinth and external walls with stabilized mud mortar containing 1 part cement, 6 parts sand and 6 part mud. This reduces the amount of cement and sand used in building thereby decreasing the environmental pressure on rivers due to rampant dredging. A 3 inch thick reinforced cement concrete (RCC) band is cast at the plinth level running along the lenght of all walls.

Adobe walls and bamboo rafters over pine wood beam

First floor walls

Adobe is made on site with mud from the foundation and leveling of ground. This is mixed with *tudi* (wheat husk), *reth* (river sand) and water. This mix is then shaped into wet bricks by local *Thakur-Rana* labour using a wooden mould 12 inch by 6 inch by 3 inch in size which is then dried under the sun till it turns light brown to be stacked and stored. This process can take three to five days depending on the intensity of the sun and requires a brick yard and an impervious storage area. The amount of wheat husk and sand in the wet mix is worked out on site based on the cracking of mud brick and clay content in soil. This whole process of making adobe from mud excavated from site has a low ecological impact on the earth apart from providing valuable employment opportunities for the local village inhabitants without increasing overall cost of building.

Since adobe is susceptible to damage by moisture, external walls are built in stone up to window cill level. Internal walls need only a single course of stone after which mud walls can start. Indigenous *Gaddi* masons build adobe walls.

Covering adobe walls to protect from rains

Since adobe is poor compressively, walls have to be at least 1.5 feet thick to take the load of the floor above. This thickness helps in increasing the thermal properties of the built space. The walls act as a heat battery absorbing heat during the day and releasing it into the interiors during cold winter nights. Hence there is a difference of 6-8 degree Celsius between indoor and outdoor winter night temperatures. Adobe is brittle and corners chip and break easily. Care is taken to make special chamfered bricks for corners and pillars.

Intermediary floor is made of a composite system of Pine wood sleeper, over which is 4 inch diameter bamboo rafters at 1 foot c-c spacing running orthogonally. This is topped by *chachhra* (split bamboo) which acts a permanent shuttering for the 2" ferro-cement layer above. This layer acts as an impervious layer over which is a 3" traditional mud floor. The mud floor is warm underfoot material during cold winters. Upper floors walls are also made of adobe. These rise to a low height of about 6 feet after which the pitching of the roof starts. Since pine wood sleepers are available in standard sized of 9 foot length, care is taken to design spaces to conform to this indigenous proportion and scale.

Bamboo and split bamboo roof underbelly

The roof is pitched at an angle of 22.5 degrees to provide sufficient slope so that there is not back flow of rain water. The main roof structure is made of Pine wood trusses and bamboo rafters. Pine wood is used for important members like the ridge and hipped beams. Bamboo rafters are nailed onto these. Over this, split bamboo and chachhra is again used to act as a permanent reinforcement for the 2 inch ferro-cement layer above. Wooden battens are placed on the ferro-cement layer and thin slate or *chakka* tiles measuring 18 inch by 9 inch are nailed onto them with a slight overlap.

The impervious ferro-cement layer ensures that there is no seepage of water in to the building incase tiles are moved out of position by wind or monkeys. It also provides an extra layer of insulation in the cold winter months. Skilled *Chamaar* carpenters are employed to work on the intricate roof system. These techniques give an incentive to the local craftsmen to continue to hone their skills and hence have a stake in the building process. Since these techniques are labour intensive, it ensures more work days for the skilled craftsman to produce better workmanship without increasing overall costs of building.

Chamaar and Lohaar carpenters fixing slate over verandah roof

View of the finished building

The money invested into the skilled workers is used for the betterment of the local community and education of their children. This ensures a healthy village economy.

Doors and window shutters are made of the superior *Deodar* wood. Three coats of mud plasters are applied to the exterior and interior walls. Mud is sieved and mixed with sand and tudi and this is applied in successive layers, one above the other once it dries. In the final coat, a modern chemical adhesive is added along with cow dung and mud to decrease the need for constant maintenance and increase it life. In this way small modern additions to indigenous building systems and ideologies help in creating contemporary spaces for urban users which benefit the environment and the local indigenous community as a whole.

District Kasganj | Uttar Pradesh

Latitude: 27N; **Longitude:** 78E

Altitude: 177 m

Average Annual Rainfall: 694.9 mm

Average Precipitation Days: 66 days

Max. Summer Temperature: 42-43°C

Min. Winter Temperature: 3-4°C

Languages of Indigenous Craftsmen: *Braj* Hindi, Urdu

Traditional Materials: *Kacchi Inth* (Adobe), *Pakki Inth* (Baked Brick), *Gaara* (Mud Mortar), *Chuna* (Slaked Lime), *Laal Pathiya* (Red Sandstone Slabs), *Sarkandi* (Reed), Neem Wood, *Mamma* (Jaamun) wood, *Baan* (Hemp), *Baalu* (Fine sand), *Bajarupur* (Coarse crusher sand), *Murram* (Red crusher gravel), *Gobar* (Cow dung), *Paani* (Water)

Adobe wall with alcoves and niches to maximize space

The vast fertile plains of the Ganges have harboured countless dynasties in history. The clayey fertile soil is ideal for the production and use of *kacchi inth* (adobe) or sun dried bricks. Cheap, abundant and easy to make these have been the answer to the housing needs of the masses in this region for generations. The baked brick with its superior compressive strength and imperviousness to moisture is certainly a more refined material, but its costs are a hindrance being more than 4 times as expensive its unbaked cousin. It is used sparingly only in elements of building construction where you need their advantages- foundation and verandah pillars.

Adobe wall section showing 27 inch wall thickness

There are two advantages to this. Firstly, the baking of bricks involves the burning of huge amounts of non-renewable fossil fuel like coal and firewood

especially in large scale kilns, leading to environmental destruction and degradation. Secondly, adobe is poor compressively and hence one builds thicker walls to compensate for the same. These thick walls act like a heat battery, slowing absorbing the heat during the day and releasing it into the interiors during the night. This provides adequate relief from the peak summer and winter temperatures.

House with South Facing Lean to Verandah made of sarkandi reed

This region receives 694.9 mm of rainfall annually (Agricultural Contingency Plan for District Kasganj, 2014) compared to the National average of 1183 mm (GOI Ministry of Statistics and Programme Implementation). This is reflected in the indigenous architecture of the region with use of flat roofs

Flat Roof of Neem wood beam, joists and battens

Adobe walls with lime plaster

made of *Neem* beams, joists and battens. It is topped with a mud-lime screed, gently sloped to handle the rain water runoff. Only verandahs have a lean to pitched roof made of *sarkandi* (reed) thatch which is grass that grows in water beds and lakes and is harvested every summer.

The size of the adobe is a standard 9 inch by 4.5 inch by 4.5 inch and wall thicknesses vary from 18 inch to 27 inch. As built space is at a premium, alcoves and niches are created in the thick walls are used to store items and light *diyas* (oil lamps) at night. Walls are plastered with a mud and *gobar* (cow dung) mix or whitewashed with *chuna* (slaked lime) slurry.

Anubhuti Pragati Aur Parivartan Kendra | Uttar Pradesh

Location: Village Daheli Buzurg, Block Sidhpura, District Kasganj, Uttar Pradesh

Client: Anubhuti Sewa Samiti, Lucknow

Building type: Community Centre

Crafts, Castes & Communities: *Vaalmiki* masons, *Sonaar* masons, Muslim carpenters, *Kumhaar* potters, Traditional baan (hemp) weavers, *Valmiki* adobe makers, *Lodhi - Rajput* labour, *Gupta* material traders, *Yadav* plumbers, Muslim electricians.

Commencement: December 2013

Expected Completion date: August 2015

Area (Built up): 6500 Square feet

Cost (per square foot): $18

Baked brick external walls upto cill level

Anubhuti Sewa Samiti (www.anubhutisewa.org) is a not for profit organization based in Lucknow. Deeply disturbed by the abject poverty and growing economic disparity in their home state of Uttar Pradesh, a group of likeminded individuals particularly women, decided to intervene by setting up this organization whose primary aims are to motivate and catalyze the capacity for self-help among the local populace, to provide for economic opportunity to all the sections of society, to deliver relief in emergencies and adversities of life, to optimize influences at policy decisions at political, social and economical arenas and to address discrimination in all forms and curb it to negligibility.

Until 2013, the organization conducted their programs, workshops and activities in leased out spaces in small towns, some distance away from the target beneficiaries of these programmes-the inhabitants of villages. Transport was difficult and cumbersome and this added to overall costs. The need arose for a community centre in the rural setting that could function as the base for all the activities of the organization. This would get the benefits of these programmes straight to the people who direly needed them.

Since the community centre is set in the context of rural Uttar Pradesh, it made common sense to harness the centuries old indigenous building vocabulary of the region and breathe into it a sense of contemporariness. After all, this building would address the dreams, aspirations and ambitions of the community over the next few generations and it was important to address the same. This required nearly three months of study and documentation of traditional housing patterns and technology, available local materials and skill of local craftsmen, wind flow directions, solar orientations and angles, rainfall data and peak summer and winter temperatures of the area. Time was also spent with the local community to understand their socio-cultural habits and patterns, their economic conditions and limitations and the socio-political implications of these. Only after this comprehensive study and understanding, a design solution was proposed.

Making adobe or sun dried mud brick

Building Adobe Walls

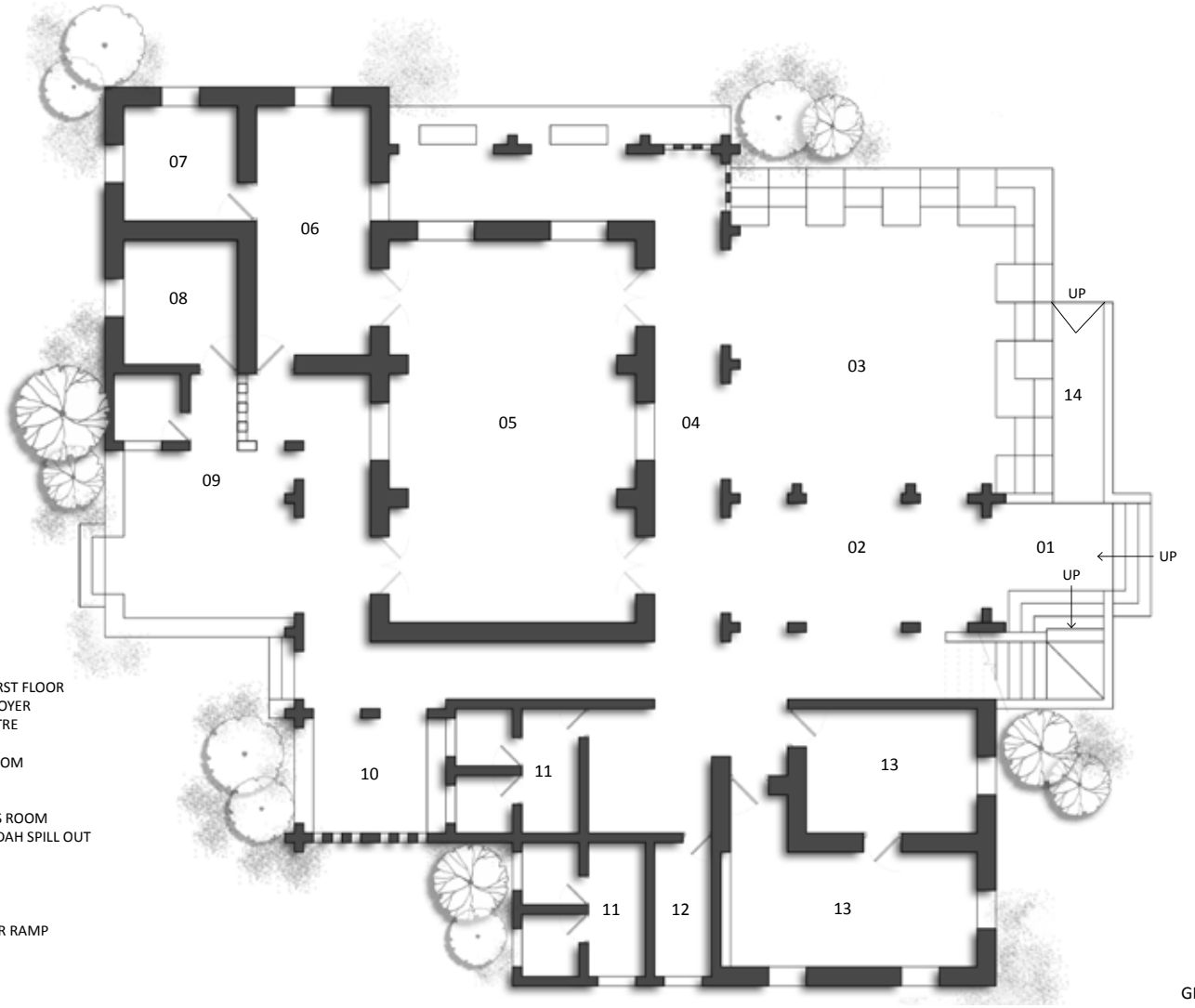
The Anubhuti Pragati aur Parivartan Kendra is a G+1 mud building spread over an area of 6500 square feet in rural Uttar Pradesh which witnesses extremes of summer and winter. This called for the building to be oriented in the cardinal North-South directions so that the southern courtyard and amphitheatre can act as a spill out space to tap the low winter sun. This amphitheatre is shaded by the shadows of the western part of the building thereby becoming a space that can be used post 3p.m. on all days. The built space is open to the east and south and the deep southern verandahs let in low winter sun while blocking harsh summer sun. The built space includes two 40 person meeting rooms, kitchen with stores, an office, resource person rooms and common toilets. The kitchen and meeting rooms are oriented to receive the first rays of the sun, while the common toilets face the brunt of the western sun. High 12 foot ceilings and ventilators create a natural draft in the rooms which let warm air rise and escape while drawing in cool air from windows. This keeps in check the ambient air temperature inside rooms.

Exposed brick arches

The indigenous technology of using *kacchi inth* (mud bricks) has been used for load bearing walls. These are made on site with earth excavated from the foundation trench with help of local *Valmiki* labour. The earth is excavated and then mixed with sand, wheat husk and slaked lime. This mix is then put through steel moulds of 9 inch by 4.5 inch by 3 inch to produce wet mud bricks which are then allowed to dry in the sun. Once dried, they are picked up and stacked and used in construction using regular bonding patterns for 18 inch thick walls. This whole process is labour intensive and ensures that money spent on material circulates within the village economy and can be used for education, health and development of village amenities.

Eucalyptus rafters at 1 foot spacing

Building a 12 foot span brick masonry vault for stairs above

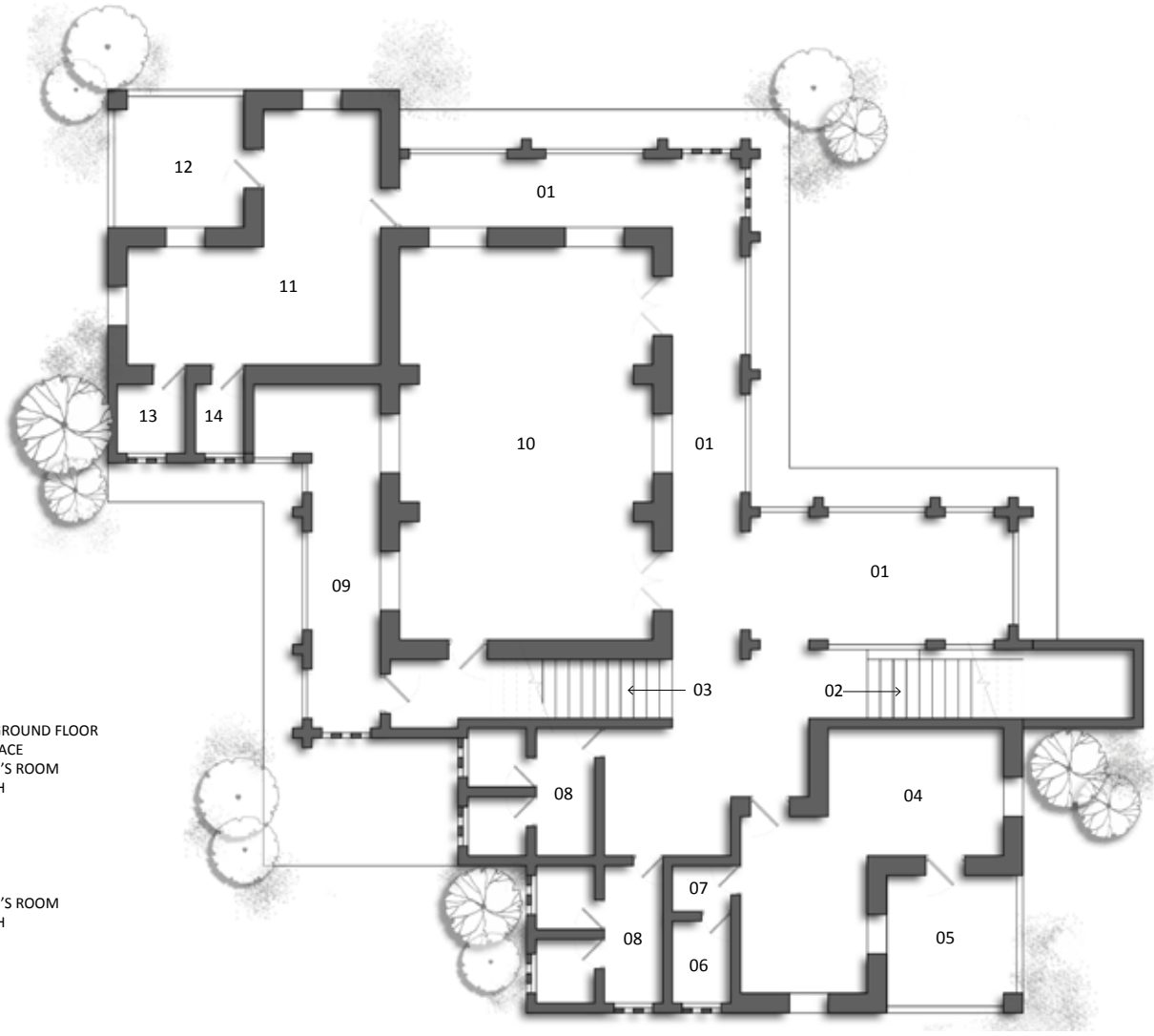


01 - STAIRS TO FIRST FLOOR
02 - ENTRANCE FOYER
03 - AMPHITHEATRE
04 - VERANDAH
05 - MEETING ROOM
06 - KITCHEN
07 - STORE
08- CARE TAKER'S ROOM
09- BACK VERANDAH SPILL OUT
10 - WASH AREA
11 - TOILETS
12 - STORE
13 - OFFICE
14 - WHEEL CHAIR RAMP

N

10'

GROUND FLOOR PLAN



01 -VERANDAH
02 - STAIRS DOWN TO GROUND FLOOR
03 - STAIRS UP TO TERRACE
04 - RESOURCE PERSON'S ROOM
05 - PRIVATE VERANDAH
06 - BATH & TOILET
07 - WASH AREA
08- COMMON TOILETS
09- BACK VERANDAH
10 - MEETING ROOM
11 - RESOURCE PERSON'S ROOM
12 - PRIVATE VERANDAH
13 - BATH
14 - TOILET

N

10'

FIRST FLOOR PLAN

Nubian vault

They are not siphoned off into the global economy with the procurement of expensive market materials. Since adobe is made on site, it uses no scarce fossil fuel in its production and transportation therefore having a low embodied energy. Also as adobe has poor compressive strength, walls need to be at least 18 inch thick to take the weight of the load above. These thick walls act like a heat battery absorbing and storing solar heat during the day and releasing it at night. This helps in regulating internal temperatures. Adobe walls are plastered with 3 coats of mud plaster using sand, wheat husk which is an agricultural bi-product, slaked lime and cow dung. As a modern addition, synthetic adhesives are used in the final coat to hold the plaster together for a longer time and decrease the frequency of periodic maintenance.

Brick jali

Baked brick is used to a minimum only in the foundation, plinth, external walls upto cill level and wet walls to take advantage of its superior compressive strength and imperviousness to moisture as compared to adobe. Although in this context, baked brick is an indigenous material, it still uses huge amounts of fossil fuel and hence it must be kept to a minimum. There is a wrap-around verandah connecting the meeting rooms, office and resource person rooms which can be used in all seasons as a transition space between the inside and the outside. The pillars of these are made of un-plastered baked brick which gives the mason some stake in the project to produce better craftsmanship and to inhibit the use of energy intensive cement plaster to cover up bad workmanship. Baked brick has also been used as *jalis* (lattice) to screen the harsh summer sun and as window openings in toilets to save on energy consuming wood and glass along with a standard rat-trap bond. A cement-lime mortar is used for baked bricks.

Before the Final Roof

Clay pots used in R.C.C filler slab

The indigenous vocabulary of western Uttar Pradesh does not have adequate natural tensile materials like bamboo and wood. Hence compressive masonry elements like arches and vaults are used to span lengths and spaces including 1 ½ brick thick masonry vault over a 15 foot span with built up stairs above. Although these are traditional techniques, the skill of constructing them has diminished over the years due to the advent of reinforced cement concrete (RCC). These techniques inculcate an atmosphere of using more labour work days and lesser energy guzzling cement and steel, without increasing the overall cost of building thereby giving the mason an incentive to produce better work.

Time had to be spent on site with *Vaalmiki* and *Sonaar* craftsmen to relearn basic principles of building arches and vaults. Door and window frames are made of locally available Mamma (Jamun) wood by local Muslim carpenters. This prevents the encouragement and use of plantation timber and all its negative effects. Locally grown Eucalyptus or safeda trees are used as floor joists to supports the weight of the floor above. This is topped with a ¾" plywood layer and a 2" impervious ferro-cement layer.

Reinforced Cement Concrete (RCC) is used for the final roof with clay pots acting as the filler material. This not only reduces the amount of cement as dead weight in the slab but also creates employment opportunities for the local *Kumbhar* potter and gives him a stake in the project. RCC is also used as two continuous 3" horizontal bands- one at the plinth level that acts as a damp proof course and the other at the lintel level above all doors and windows. These are connected at junctions and corners with one single 12mm vertical reinforcement that binds them together and helps in countering lateral forces during earthquakes that cause extensive damage. Locally available *Laal pathiya* (red sandstone slabs) are used for tiling and flooring instead of energy intensive ceramic tiles. These slabs are also used as *chajjas* over windows to cut out the harsh mid day sun. These slabs are also used as *chajjas* (overhangs) over windows to cut out the harsh mid day sun. *Baan*, a hemp that grows in rivers and waterbeds is harvested in the summer to weave intricate patterns for *khaats* (cots) traditionally. Indigenous *Baan* craftsmen have been employed to produce indoor screens and lattices to create opportunities for them to continue their craft.

Laying of cement-concrete mix over clay pots

While working with the indigenous community here, one of the main challenges was to overcome the negative perception with respect to their own traditional materials and technology. Mud brick or *kacchi inth* is considered a material of the poor. Once the root cause of these prejudices was understood and overcome, and the space built, it had a direct visual and psychological reference to the place and community due to the range and sensitivity of local materials used. Additionally, care had been take to understand and respect local proportions, scales and spans giving the built space a sense of rootedness in this context. This was an importance factor for it to be accepted as a community centre by the people for them to occupy and use.

District Medak | Telangana

Latitude: 17N; **Longitude:** 78E

Altitude: 442 m

Average Annual Rainfall: 922 mm

Average Precipitation Days: 52 days

Max. Summer Temperature: 46-47°C

Min. Winter Temperature: 6-8°C

Languages of Indigenous Craftsmen: Telugu, Urdu, *Deccani* Hindi

Traditional Materials: *Maati* mudda [Cob Mud balls], *Bendadi* [Rough granite stone], *Maati* [Mud mortar], *Dulalu* [Neem wood beams], *Komralu* [Neem wood pillars], *Parata* [Neem wood battens], *Kunaa perudu* [Semicircular hollow clay roof tiles], *Chunnam* [Slaked Lime], *Tandoor* [Shahbad stone slabs], *Kadappa* stone slabs, Vepaku [Neem Leaves], *Isuka* [Fine river sand], *Chinna kankara* [Small gravel], *Pedda kankara* [Large gravel], *Neeru* [Water]

A typical Medak house with cob walls over 3 feet high granite stone walls

The Medak District of Telangana of the newly formed state, is a study in contrast. Located in the Deccan Plateau region of the Indian Subcontinent at an altitude of 442m AMSL, this region is characterized by hot and dry summers and moderately cold winters. The prevalent building construction technique here is that of cob- balls of semi-wet, stiff mud slapped on and massaged together to form load bearing walls. These walls vary in thickness from 18 inch to 24 inch and can rise up to 20 feet in height if built well. Good quality granite stone is available in this region. Due to its superior compressive strength and impervious nature, they are dressed by *Vaddera* stone craftsmen and used in the foundation, plinth and external walls upto the cill level using mud mortar. This is done to protect the external mud walls from the splash back of the rain.

Stone chips are used in the cobbing process to prevent excessive cracking due to drying.

Cob mud balls being prepared from the loamy mix

Cob balls being thrown up to the master mason

Neem trees are part of courtyards of houses here and are weaved into community culture due to medicinal values. Door and window frames and shutters are made of this wood. The availability of wood had a given encouragement to refined *Vadrangi* wood craftsmanship.

This can be extrapolated from the intricate wood work that is found in some of the upper caste houses here. Unfortunately with migration to cities and their eventual loss of skill, these skills are slowly dying. Two storeyed houses have a system of Neem wood beams, joists and battens forming the intermediate floor. This is topped by a 3 inch layer of mud which forms the floor of the room above. Window sizes are small owing to the limitation of the spanning materials and the use of the space, as most day time is spent outdoors in manual labour.

Intricately carved Neem wood brackets

Annual average rainfall here is 922 mm, which is more than UP. This change is reflected in the pitched roofs of this region. They are made of an intricate system of *Neem* wood trusses, rafters and battens and inclined at an angle of 23 degrees.

The closely spaced battens provide an almost impervious surface on which is topped a stiff mixture of mud, 3 inch-5 inch thick. This section of mud has two purposes- to hold the semi- circular hollow clay tiles that come over them and to provide an extra layer of insulation from the intense summer sun. Niches and alcoves are provided in the walls for storage. External walls are whitewashed with lime. In some cases you see continuous horizontal bands in the walls. This showcases the height of each course of cob done in a day, so that the wall dries and does not collapse under its own wet weight. *Neem* leaves are mixed into the cob mix as it is believed to act as a deterrent to termites. *Shahbad* stone slabs are used to provide a 1.5 foot overhang at the eaves level of the roof to protect the walls from the rain.

Intermediate roof of Neem wood beam, joists and battens

Yakshi Inter Generational Learning Centre | Telangana

Location: Village Badampet, Block Hathnoor, District Medak, Telangana

Client: Yakshi, Hyderabad

Building type: Community Centre

Crafts, Castes & Communities: *Kurma* labour, *Mudaraj* masons, *Vadrangi* carpenters, *Vaddera* stone craftsmen, *Uppera* cob builders, Muslim plumbers, *Vaishya* material traders

Commencement: Dec., 2013

Expected Completion date: March, 2016

Area (Built up): 6525 Square feet

Cost (per square foot): $18

Random rubble for foundation with mud mortar

Yakshi (www.yakshi.org.in) is a Non- Government Organization based in Hyderabad. They are a team of indigenous educators, theatre activists, artists, researchers, community organizers and leaders, primarily from *adivasi* communities who work with adivasi communities in India, towards reclaiming democracy and for indigenous self-determined visions of development. Their work supports and strengthens the efforts of these adivasi communities to protect their lands, resources, cultures and worldviews, through democratic governance structures of self-rule, using customary laws, and other safeguards in Indian and International law. Yakshi also facilitates spaces for *adivasi, dalit*, pastoralist and peasant communities to connect and interact around common concerns related to resources and food sovereignty and work especially with young people and children of these communities.

Masons checking plumb line of granite plinth

Up till 2013, the organization's participatory workshops, community level meetings and programs were held in rented spaces in Tier 3 cities thereby adding to overall costs without giving much back to communities. There arose the need for a community space in the village which could be used as a base where all activities of the organization could be consolidated. This primary need was the genesis of the program brief which required a community kitchen and a dining hall to seat and feed 40 persons at a time, a 40-person meeting room for workshops and meetings, a community seed bank managed by women *sanghams* (self help groups) from the surrounding villages, two resource person rooms to host activists and volunteers from outside, a women's dormitory for 20 people, common toilets for both men and women, a caretaker's room and an open air amphitheatre to be used on hot summer evenings for folk artists for their theatre, music and dance. Tight budget constraints required the meeting room to double up as a men's dormitory at night during large workshops and gatherings.

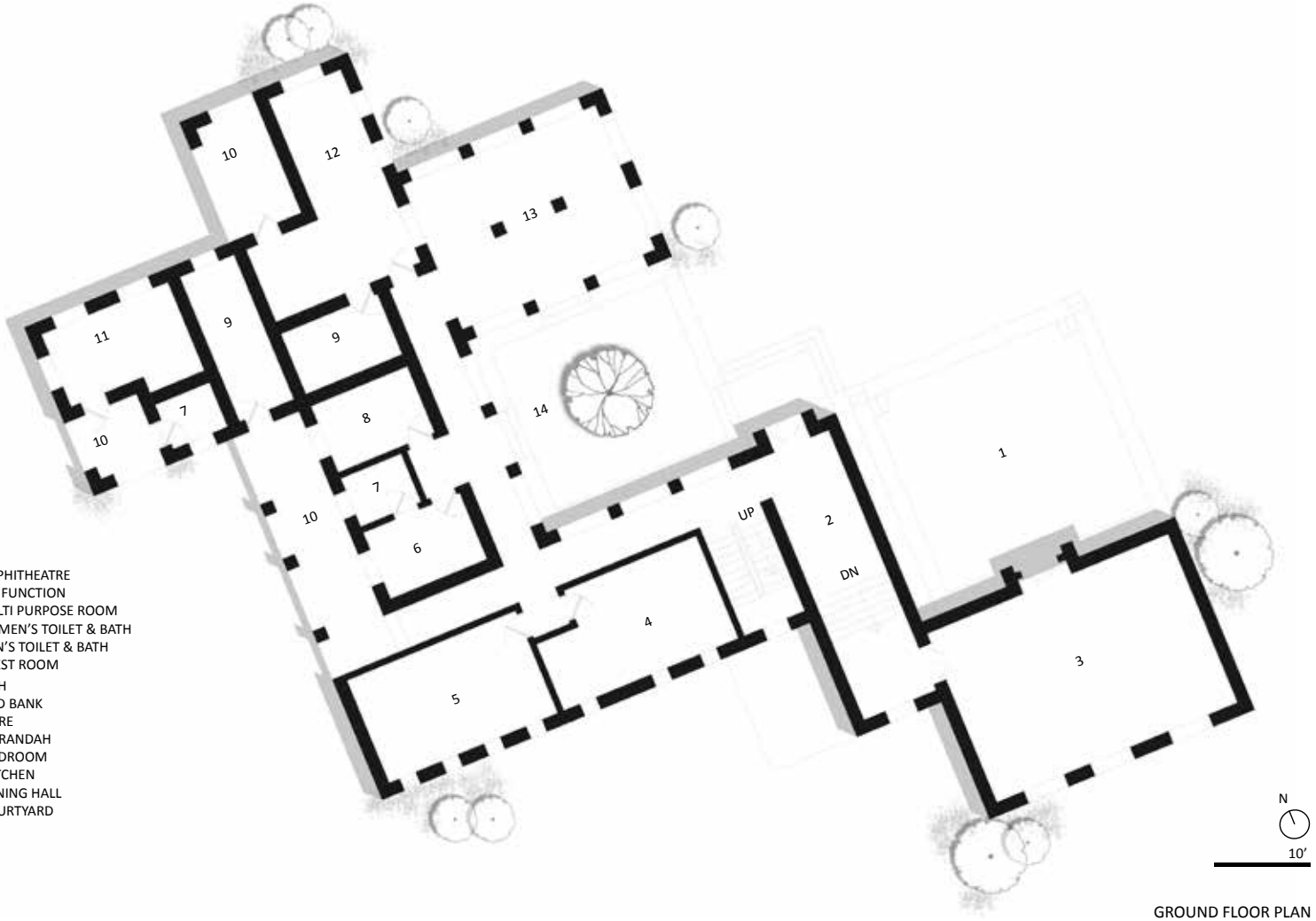
External walls in granite upto cill level

Since the built space is set in the context of rural Telangana, it made most sense to adopt an indigenous building vocabulary of the region. After spending a few months studying the traditional building systems and patterns, available materials and skill of craftsmen, wind flow directions, solar orientations and angles, rainfall data and summer and winter temperature, a design solution was mooted. This solution propagated the use of the vast indigenous building knowledge in terms of building material, technology and principles to build the Yakshi Inter Generational Learning Centre after carefully weighing its benefits and limitations.

The Centre is a G+1 mud building spread over a ground area of 5160 square feet. Oriented in the cardinal North-South directions, the central east facing courtyard acts as the heart of the built space. To the north is the semi open dining room with two carved wooden pillars at its center. The kitchen is located in the north-east corner of the building and gets the first rays of the sun. The central courtyard acts as a spill out for the dining room on hot summer afternoons and cool evenings. A 6 feet wide stone pillared verandah circulates around the central courtyard and connects the dining room to the community seed bank, common toilets, meeting room and stairs. Apart from being a circulation space, the verandah also acts like a transition space between the inside and outside to be enjoyed and used in all seasons. Three toilets and two baths have been provided for men and women each including a dry compost pit toilet. This aims to provide a solution to the acute water shortage in this region while also engaging in dialogue with local customs & prejudices related to it.

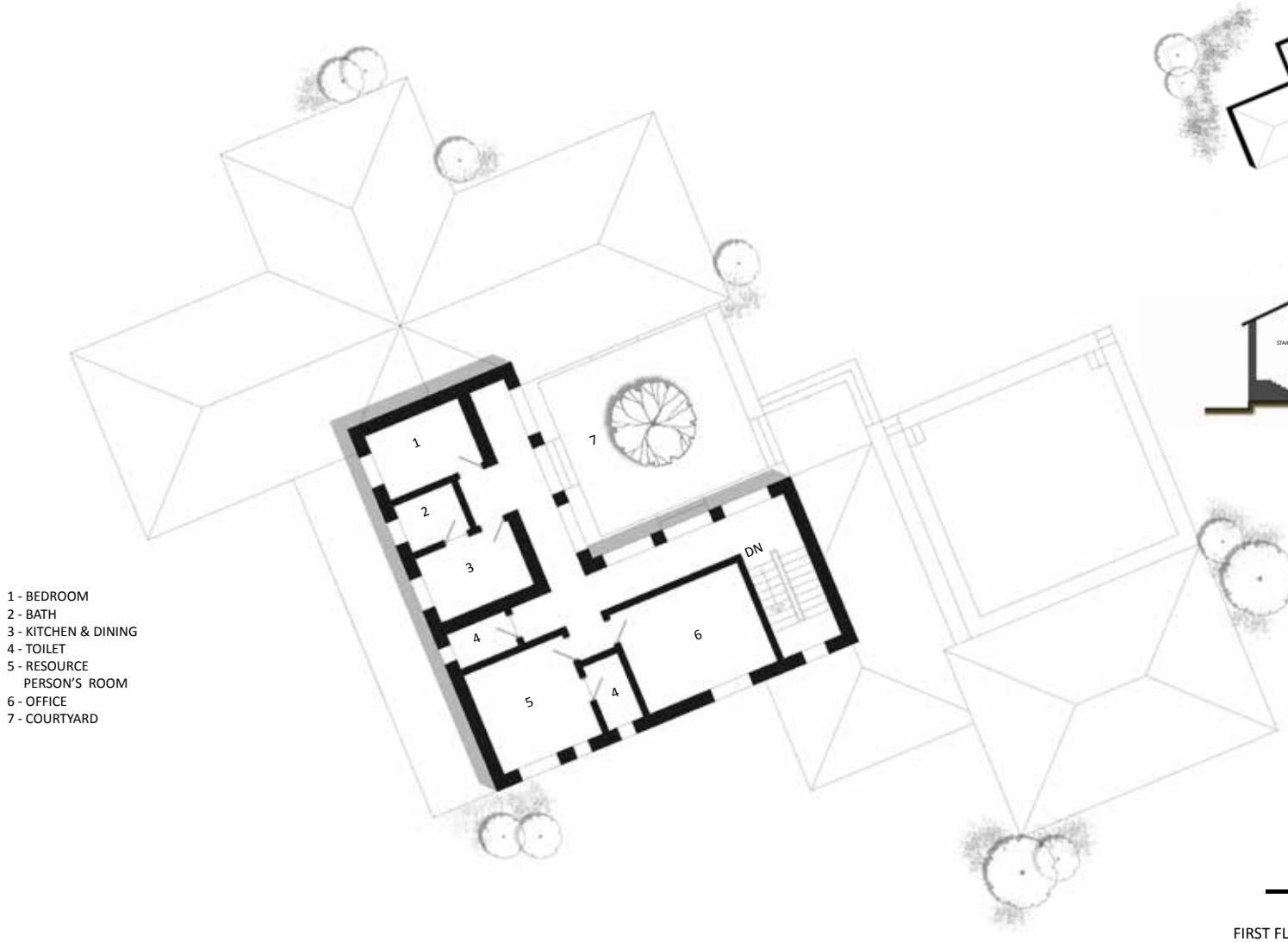
Buffaloes mixing mud, lime slurry and water for cob walls

The upper floor contains more private spaces of the resource person's rooms and an office. The toilets are placed to the south of the building as this faces the brunt of the sun for most parts of the year. The south and west wings of building is two storied of 20 feet height ensuring the post mid day sun casts a cool shadow onto the east facing courtyard. Thereby the courtyard becomes a usable space post 3 pm every day due to mutual shading of the building. Moreover south and west facades of the building elevation have been broken using a lean to roof which protects mud walls from South-west monsoons. Since earth is required to build walls of the centre, the meeting room and amphitheatre are sunk into the ground to a depth of 3 feet. This also ensures the space remains cool in the summer and warm in the winter owing the thermal mass of the earth surrounding it.



1 - AMPHITHEATRE
2 - PRE FUNCTION
3 - MULTI PURPOSE ROOM
4 - WOMEN'S TOILET & BATH
5 - MEN'S TOILET & BATH
6 - GUEST ROOM
7 - BATH
8 - SEED BANK
9 - STORE
10 - VERANDAH
11 - BEDROOM
12 - KITCHEN
13 - DINING HALL
14- COURTYARD

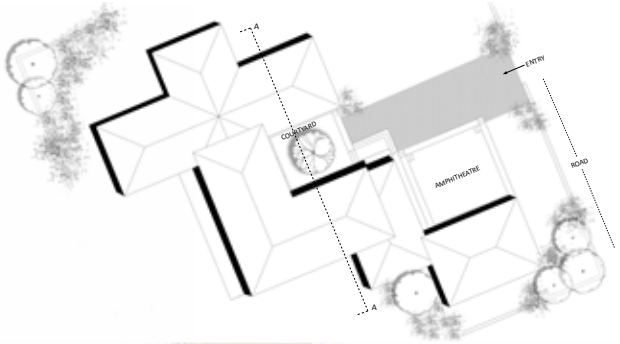
GROUND FLOOR PLAN



1 - BEDROOM
2 - BATH
3 - KITCHEN & DINING
4 - TOILET
5 - RESOURCE PERSON'S ROOM
6 - OFFICE
7 - COURTYARD

N
10'

FIRST FLOOR PLAN



N
10'

ROOF PLAN

SECTION AA

Community women making cob balls

The load bearing walls of the building have a strip foundation of roughly cut granite stones with mud mortar, granite being sourced from a local quarry. The foundation has a depth of 3 feet below which the hard strata begins. Once the buildings emerge above the ground, granite blocks dressed on site by skilled *Vaddera* craftsmen are used. These are bonded using a stabilized cement mud mortar of 1 part cement, 6 part sand and 6 part mud. A reinforced cement concrete (RCC) band is cast at the plinth level that runs across all the walls and doubles up as a damp proof course. *Neem* wood being a part of local culture and vocabulary is used extensively for tensile elements. Door frames of *Neem* are placed and external walls are raised in dressed granite to the window cill level. This is done to prevent the erosion of mud on exterior walls due to splash back of the rain.

Interior walls need only a single course of stone after which the mud walls can begin.

The technique of mud that is used indigenously in this region is that of cob-balls of slightly wet stiff mud slapped and massaged on top of each other to form walls. The earth that is excavated from the foundation and the sunken amphitheatre are mixed well with water, sand and slaked lime slurry. *Chunnam* (Lime) acts as a local stabilizer binding the clay particles together and consumes lesser energy in its production than its cousin cement. Also mud walls with lime can be easily recycled and reused for agriculture on the completion of life of the building. This is not possible if stabilized with cement, as cement changes the chemical properties of soil and renders it un-cultivable. Lime also acts as a strong deterrent to termites.

Building cob walls

Carpenter Santosh fixing shahbad stone overhangs or chajjas

The wet mud is mixed together with the use of local *barreloo* (buffaloes) that use their webbed feet to good use. Moreover they also enjoy an occasional cool splash and sprawl in this mix. This is then made into small balls 6-9 inch diameter that are easy to hold and throw from one person to another. Each ball thus forms a single building unit akin to a brick in conventional buildings. Once they are slapped on top of each other, they amalgamate into one homogeneous mass and cannot be differentiated from the other. Each wall section is made to be not more than 1 ½ feet high by *Uppera* cob builders. This is left to dry for a few days before the next sections begins to prevent the wall from collapsing under its own wet weight. A strategy is applied to complete one course across all buildings walls before the commencement of the second course. This ensures that the first course dries up completely until the second one comes along. The top surfaces of two successive courses are made rough with the addition of small protruding pieces of granite.

Corner bracket detail in Neem wood

This is done to ensure sufficient bonding between them. Coarse sand and small gravel are added to the mix to decrease cracking due to drying. Large flat pieces of granite measuring 18 inch wide by 3 feet long by 6 inch 4-6inch high are used intermittently in corners and junctions to prevent the formation of continuous vertical joints. As mud is poor compressively, walls need to be at least 18 inch thick. This adds to the its thermal mass thereby acting like a heat battery, slowly absorbing and storing the heat during the day and radiating it back in the night. There is significant difference of 8-10 degree Celsius between peak summer and winter interior and exterior temperatures. This calls for a nomadic lifestyle on behalf of the occupants to maximize the advantages of living in such a building. Summers call for days to be spent indoors and nights outdoors or in verandahs while winters call for days to be spent outdoors under the southern sun and nights indoors in the warmth of the mud walls. This is similar to living patterns of the local community. The RCC lintel band helps in redistributing the load on mud walls and provides for larger window openings to negate the drawbacks of traditional building materials.

An intricate *Neem* wood truss, beam and rafter pitched roof system is adopted based on local traditions. Neem is extensively found in this region and has socio-cultural and religious implications. Local *Vadrangi* carpenters have a history of detailed designs and carvings in *Neem*, and due encouragement has been provided to entice them to produce good craftsmanship and thereby have a stake in the building process. They are the trustees of this heritage and it is easily incorporated into the built space without increasing building costs. The trusses are made to fit into each other without the use of nails, staying in place owing to the weight of the roof and tiles above. *Neem* wood battens are used to provide an impervious layer above the rafters on which lie hollow semi-circular clay tiles.

Rooftruss with carved Neem wood pillars

Care and respect of indigenous spans and proportion were followed to initiate the craftsmen to take ownership of the built space as they were familiar with it. Due to slow demise of these roofing systems in this area with the advent of RCC flat slabs, potters had ceased to make these hollow clay tiles. This problem was overcome with the sensitive adaptive reuse of hollow clay tiles from old neglected houses of the region. These tiles are fixed by *Mudaraj* tile masons on a 2 inch-3 inch thick layer of mud which also provides the requisite thermal insulation from the torturous summer heat. The mud walls are plastered with 3 coats of mud plaster, the final coat of which is mix of cow dung, water, and millet husk. As a modern addition, chemical adhesives work well to hold this final layer together for a longer period of time and decrease the need for constant maintenance. An advantage of reusing old clay tiles is that they are have already weathered beautifully with the ravages of time and this gives the built space a sense of timelessness, like it has existed in this context for centuries. It is completely of its place.

View during final plaster

District Birbhum | West Bengal

Latitude: 23N; **Longitude:** 87E

Altitude: 54 m

Average Annual Rainfall: 1572.9 mm

Average Precipitation Days: 68 days

Max. Summer Temperature: 38-39˚C

Min. Winter Temperature: 25-26˚C

Languages of Indigenous Craftsmen: Bengali, Santali

Traditional Materials: Cob (Mud balls), Laterite stone, Bamboo, *Mahua* tree (Bassis latifolia) wood, Bitumen, Rice straw thatch, Termite mound mud, Local reed

Cob walls over laterite stone foundation

The *Santhal* tribals are the natives of the Birbhum District of West Bengal and are expert cob builders. They are the third largest tribe in India and reside in parts of West Bengal, Bihar, Orissa, Jharkhand and Assam as well.

Santhal houses are generally two-storeyed with cob walls rising to 18 feet in height. Red laterite stone found in this region is used in the foundation and plinth as it stronger and more impervious to water than mud. These are not dressed. Thereafter cob walls start and their thickness ranges from 18 inch to 24 inch. All houses have an upper storey or attic which is used for sleeping, etc. This is made using bamboo and *Mahua* tree trunk, topped by bundles of reed and a 3 inch mud layer which forms the top of the floor. Windows and openings are generally small. Staircases are made with bamboo and mud to form the profile.

Pitched roofs of a steep 45 degree pitch are extensively found here and it is dictated by the limitations of the roofing material- rice paddy straw thatch. Any lesser slope would not have been able to handle the rain

Rice Paddy straw thatch

A Santhal house with tar render upto 3' height

Even though some families have switched over to Corrugate galvanized iron sheets, the steep pitch is still continued. Roof structure is made with bamboo and *Mahua* tree wood. These are either tied together or nailed to each other..

External walls are rendered with bitumen or tar only up to a certain height. Bitumen is a very good waterproofing layer and this is exploited beautifully by the *Santhals*. Further up, external walls are lime washed and this process is in sync with socio-cultural customs and practices. The *Santhals* are very artistic in their expressions and this is evident in some of the mud relief work that they do on their walls.

Detail of joinery between mahua wood ridge and bamboo rafters

Sunderbans: District North 24 Parganas | West Bengal

Latitude: 22N; **Longitude:** 88E

Altitude: 0-5 m

Average Annual Rainfall: 1559.8 mm

Average Precipitation Days: 65 days

Max. Summer Temperature: 32-33°C

Min. Winter Temperature: 24-26°C

Languages of Indigenous Craftsmen: Bengali

Traditional Materials:
Wattle and Daub (Mud plaster on wood/bamboo frame), Sundri tree wood, Rice paddy thatch, Bamboo, Local jungle wood

Pre-cast RCC posts for the house frame anchored in mud

The Sundarbans delta is one of the richest ecosystems in the world. The region contains arguably the world's largest remaining area of mangroves, and is known for its exceptional biodiversity, including numerous threatened species such as the Bengal tiger and several species of river dolphin. It was accorded status of World Heritage Site by UNESCO in 1987.

This rich forest does not have a long history of inhabitation. In the early nineteenth century, the British East India Company leased out land to the *Zamindars* (landlords) to harvest and clear out the forest, who in turn hired people from other parts of the state including indigenous *adivaasi* (tribals) to carry out this task. These people cultivated the cleared land and became the first settlers of this region.

Ever since then, the preferred technique of building here has been Wattle and Daub. Not a load bearing form of construction, this framed structure uses pillars and posts made of bamboo or trunks of the *Sundri* tree. Within this frame is a complex mesh of bamboo strips or *Sundri* tree branches which are weaved together to form a porous membrane with air gaps in between them. A 1.5 inch - 2 inch coat of mud plaster is applied on both sides of the wall thus forming a thin porous breathing wall.

This works extremely well in the hot and humid climate here as the air circulation through the house enables cooling through evaporation of perspiration. Openings for doors and windows are left un-plastered.

Wattle made of branches of the Sundri tree

Steep pitched roofs of bamboo are found here. Rice paddy straw thatch is the prevalent roofing material and the steep 45 degree pitch takes care of the water runoff. The bamboo rafters and trusses are connected to the vertical posts and the load is carried down to the ground through them. Due to the non availability of a strong impervious material, foundations and plinth are made of mud. Plinth are kept high, around 3-4 feet to account for periodic flooding that occurs here.

In many parts of the Sunderbans, the sea level is higher than the land level and there is an extensive set of mud and brick embankments to protect the land from the sea. This combined with periodic cyclones, floods and torrential downpour makes this a very intimidating place for human habitation.

A typical Wattle and Daub House

Rice paddy straw thatch roof

District Koraput | Odisha

Latitude: 18N; **Longitude:** 82E

Altitude: 969 m

Average Annual Rainfall: 1567.2 mm

Average Precipitation Days: 84 days

Max. Summer Temperature: 38-40°C

Min. Winter Temperature: 10-12°C

Languages of Indigenous Craftsmen: Odiya, *Konda, Poraja, Gadaba, Durua*, Hindi

Traditional Materials: Adobe (Sun dried mud brick), Cob (Mud balls), Mud mortar, Laterite stone, *Mahua* (Bassis latifolia) wood, Bamboo, Rice paddy thatch, *Mangalore* tiles (Local roof tiles)

Red laterite stone and mud for foundation and plinths

The Koraput district of Odisha lies in the southernmost part of the state bordering Andhra Pradesh and is home to 62 different indigenous tribes who contribute to more than half of the district's population. These tribals have been grouped into three major classes- Dravidian race represented by Kondh, *Poraja, Gond and Koya*, forming major part of the population, *Munda* or *Kolarian* race which includes *Savara* and *Gadaba* tribes and the Austro-Asian race, the *Bondas*, one of the most primitive tribes. Each tribe has its own social bond administration, tradition and judicial system and here lies its inherent diversity.

Adobe walls of 1foot thickness with mud mortar

The region is abundant in rolling hills, streams and forests on whose produce the tribals are dependent. Rich in mineral resources like bauxite, this region has also seen land right struggles between the indigenous *adivasis* and multinational corporations who seek to commercially exploit the same.

External walls plastered with mud and natural dye pigments

Traditional rice paddy thatch for pitched roofs

The indigenous populations have traditionally built their homes with cob (mud balls) and adobe - sun dried mud brick. Foundation and plinths are made of red laterite stone which is abundant in this region and houses are restricted to the ground floor. All homes have long verandahs where most day time activities happen. At night this space doubles up as a sleeping space for the occupants. Since this region receives heavy rainfall, the verandah becomes an important feature between the inside and outside of the house. Verandah pillars are made of adobe or *Mahua* (Bassis latifolia) tree wood whose flowers produce an intoxicating local liquor. Thicknesses of mud walls vary from 1' thick to 1.5' thick and since there are no upper floors, this provides the necessary compressive strength for walls. These walls are plastered with mud plaster. Natural dyes and lime wash are added to exterior finishes to produce different patterns.

Traditionally roofs are pitched and have a system of *Mahua* wood trusses and bamboo. This is topped with rice paddy thatch which works well in the humid climate prevalent here allowing hot air from inside to rise and escape thereby creating convection currents to draw in the cooler air near the ground. Rice paddy thatch has to replaced almost every monsoon depending on its wear and tear. Due to this, people have started shifting to factory produced burnt *Mangalore* tiles. Roofs are mostly gable ended, providing for high ceilings and attics to allow hot air to rise and escape thereby maintaining indoor ambient temperatures.

Lean to verandahs with Mangalore tile roofs

District Tumkur | Karnataka

Latitude: 13N; **Longitude:** 77E

Altitude: 894.6 m

Average Annual Rainfall: 698.5 mm

Average Precipitation Days: 39 days

Max. Summer Temperature: 34-35˚C

Min. Winter Temperature: 16-17˚C

Languages of Indigenous Craftsmen: Kannada

Traditional Materials: Adobe (Sun Dried Mud Brick), Granite Stone, Mud Mortar, *Areca* Nut Trunks, Coconut Palm Trunk, Granite Slabs, Granite Pillars, Bamboo, Coconut Leaves Thatch, *Kadappa* Stone slabs, *Shahbaad* Stone Slabs, *Mangalore* tile (local roof tile)

Adobe Walls with 1.5 inch mud plaster

The Tumkur district of Karnataka lies on the leeward side of the Western Ghats due to which its average annual rainfall is much lesser than Udupi although they both are on the same latitude. The material of choice of the indigenous people been adobe, made of mud, sand, rice straw, the latter being added to act as fibrous reinforcement to prevent excessive cracking when dried. Like Uttar Pradesh, the size of the brick is 9 inch by 4.5 inch by 3 inch and wall thickness do exceed 18". These houses are generally only a single storey high.

Good quality granite stone is readily available. Due to its impervious nature and strength, they are used in the foundations along with mud mortar. Above the ground the stones are dressed by skilled masons and raised to height of 3 feet on the exterior walls. This is done to protect the adobe walls from the splash back of the rain. Thereafter the adobe walls continue to the eaves level of the roof. Granite corner stones are used in the adobe wall section to distribute the load over a larger cross section area and break vertical joints if any.

Abundance of good quality granite stone

Adobe walls with granite corner stone for adequate distribution of load and breaking of vertical joints

Roofs are pitched with bamboo, areca nut and coconut palm wood rafters and beams. The roofing material traditionally was coconut leaves thatch. This has given way now to the omnipresent *Mangalore* tile due to superior strength and lack of maintenance. *Shahbad* stone slabs are used as 1.5 foot long overhangs at the eaves level to protect the exterior mud walls from the rain.

A 1.5 inch coat of exterior plaster is provided on the external walls to protect them from the rain. As the mud is not stabilized with any chemical stabilizers, this protection is very essential. This plaster needs to redone every few weeks to months depending on its wear and tear. Generally these processes are woven into the community culture with festivals or childbirth offering reasons for the community/ family to plaster and lime wash their walls.

Adobe walls over 3 feet high impervious granite stone walls.

Adobe Walls Section showing 18inch thickness