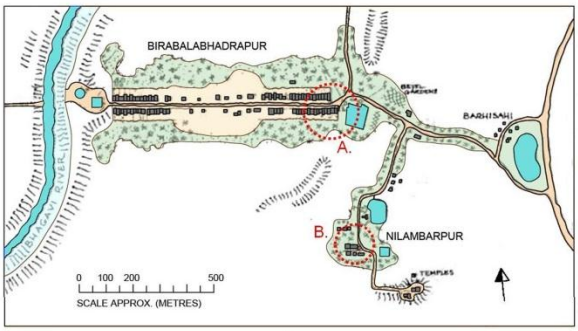
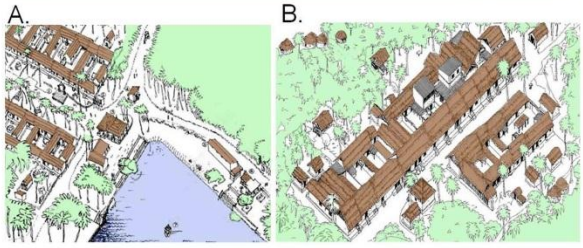
VERNACULAR ARCHITECTURE
VILLAGE DWELLINGS, BIRABALABHADRAPUR, ORISSA

The settlment of Birabalabhadrapur, 8 km north of Puri, is a settlement built in the 1650s comprising of around 120 households is a good example of **climate responsive architecture** that emphasizes the **use of local materials**. The village is formed along an east-west running tree lined path connecting two temples. Either side of the straight road, two parallel rows of one-storey courtyard houses face one another, about 25 metres apart. Their frontyards are surrounded by clusters of tall coconut palms.

MATERIAL USAGE & CONSTRUCTION SYSTEM

TYPOLOGY	Courtyard houses attached to each other with courtyards in each.
STRUCTURE	Timber and cured bamboo framing encased in mud. Bamboo is cured in water for two weeks, in the sun for two weeks and then smoked indoors as protection against insects. Rough-hewn laterite posts are sometimes used.
ROOFING SYSTEM	Sloping roofs with wooden ridge members and purlins run between cross walls covered with a mat of bamboo and thatch is of rice straw. Ceilings are unfinished bamboo. Double roof construction is used in storage areas with a mud roof some 300-400 mm below the thatched roof. (U-value : 0.23 W/m²K)
WALLING SYSTEM	External walls are generally 200-300 mm thick, the mud held in place by loose bamboo mesh that is densely woven using a wattle and daub technique (U-value : 2W/m²K). The wall framing and the infill mesh can be entirely of bamboo with timber for the main posts, beams and rafters. Division walls standing alone are thatched. Over time, mud walls have begun to give way to brickwork or laterite blockwork.
DOORS/WINDOWS	Doorways and window grills are wooden. The windows are often richly carved.
FLOOORS	All roofed parts of the house are raised above the ground, the open-to-sky part of the courtyard remaining at ground level. Laterite bricks are used instead of mud in a 600 mm high plinth. The floor inside the house is of swept earth. In some places there is suspended floor, with a pit underneath for even cooler storage. The swept earth of the floor modulates into small fire pits, with an air hole in front, and is moulded to hold a pot.
SEMI-OUTDOOR SPACES	A narrow open to sky courtyard in each house with a large covered space around it that acts as the living room. Generally one side of the courtyard is covered by a roof; the wall on the other side is sheltered by the overhang of the neighbour's roof, while at its foot, the neighbour's platform projects a plinth to protect base of the wall, as well as forming a useful seating area and shelf. The fronts of the houses form a continuous row, raised on a high plinth, projecting at the front of the house to from a shaded sitting place beneath thatched eaves.





Map of village settlement of Birabhalabhadrapur. A. view of temple ghats and end of path of Birabalabhadrapur settlement. B. view of Nilambarpur, a similar nearby support village

Views of the settlement

Plans of a typical courtyard house

LCCR FEATURES

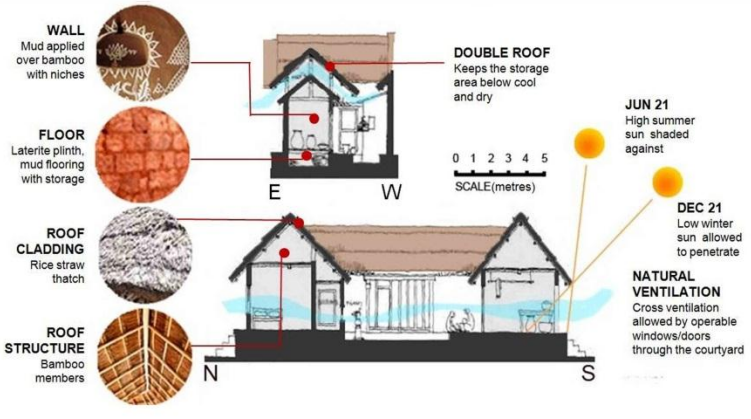
Siting and orientation:
- Protected from wind, run and sun from the east and west by adjacent houses and tree clusters.
- External openings to the north and south.
- The deep narrow courtyard allows sun in north and south sun. East and west sun gets shaded well by the eaves of nearby roofs.

Thermal strategy:
- Terraced typology and overhanging roofs provides shade.
- Courtyard allows rise of hot air through stack effect and acts as a buffer space for rooms.
- The high roof with the bamboo ceiling further cools down the interior because of the air gap in between (especially in storage areas).

Ventilation strategy:
- Cross ventilation through the courtyard and the double roof.

Daylighting:
- Spaces needing maximum luminance level (i.e the cooking and living spaces) receive much diffused light through the courtyard or directly from the open sky.

Rain sheltering:
- Sloping roofs provide a clear run off for all rainfall
- A 600mm high plinth provides protection from damp and termites.
- The storage spaces for food are the most interior in the house plan, getting maximum protection from the rain.



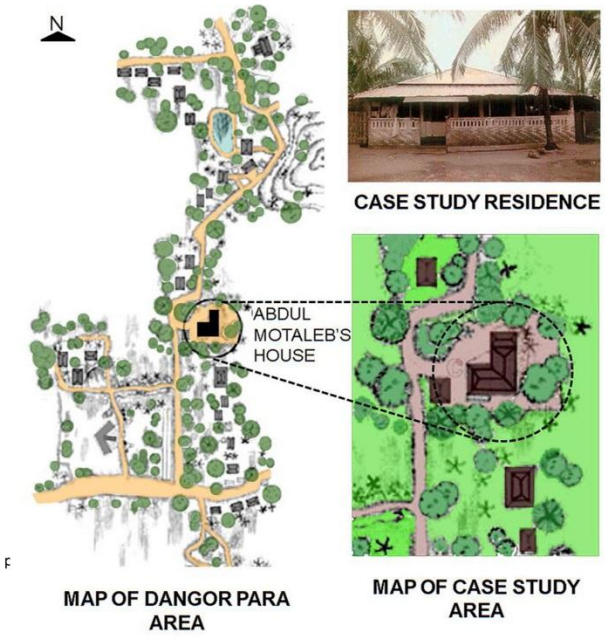
Sections of courtyard houses showing various passive strategies employed

KNOWLEDGE DEVELOPMENT AND DISSEMINATION FOR PROMOTING LOW CARBON CONSTRUCTION IN THE RURAL AREAS AND SMALL TOWNS OF INDIA AND SOUTH ASIA

CDKN Climate & Development Knowledge Network
Development Alternatives
TARA
Directorate of Town Planning
PLOINDOT COLLEGE OF ARCHITECTURE ABIT ESTD. 1992
KIIT School of Rural Management KIIT UNIVERSITY Bhubaneswar, Odisha, India

CYCLONE RESISTANT HOUSING
DANGOR PARA, TEKNAF, BANGLADESH

During the cyclone of 1994 the house belonging to Abdul Motaleb became a shelter for hundreds of women and children of the Dangorpara area. The local people felt confident that the house would withstand the cyclone as it had withstood previous ones. This case study shows how indigenous housing can be modified to withstand harsh climatic conditions.



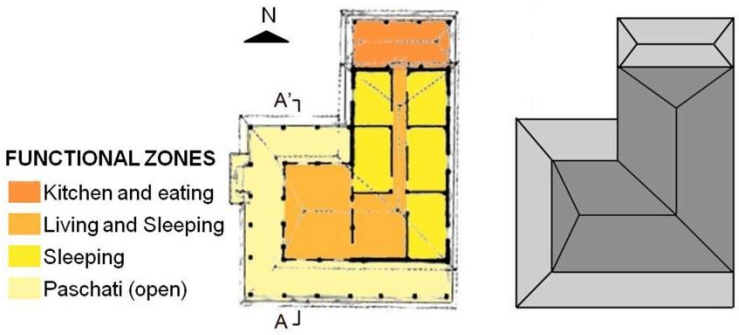
CASE STUDY RESIDENCE

MAP OF DANGOR PARA AREA

MAP OF CASE STUDY AREA

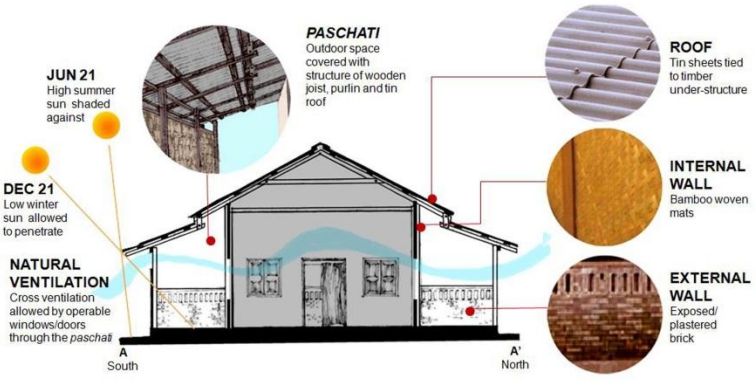
MATERIAL USAGE & CONSTRUCTION SYSTEM

TYPOLOGY	Detached individual house
ROOFING SYSTEM	A hip roof. The structure consists of wooden joists and purlins with a roofing material of tin sheets supported by wooden pillars. (U-value : 0.9 W/m²K)
WALLING SYSTEM	The internal walls are mostly bamboo mat and wooden plank.The external walls are brick and plaster. (U-value : 0.31 W/m²K)
FLOOR	Tinted Concrete Floor
DOORS/WINDOWS	Wooden planks with wooden frames
BUFFER SPACES	The traditional houses in these areas consist of a *pashchati* - a verandah type space enclosed with a parapet/wall



GROUND FLOOR PLAN

ROOF PLAN



Sections of courtyard houses showing various passive strategies employed

LCCR FEATURES

Siting and orientation:
- Surrounded by trees and other houses that act as wind breaks.
- The paschati of the house is mostly north and south facing.

Thermal strategy:
- The paschati, acts as a thermal buffer with the exterior for the inner living spaces. Also, the thermal functionality of this space varies seasonally.
- The solar gain in the summer seasons is minimal due to effective shading provided by the eaves of the roof while in winter, there is low sun received into the paschati.

Ventilation strategy:
- Good cross ventilation through the house out into the paschatis.
- Exhaust from cooking area does not reach living areas.

Daylighting:
- The spaces which need maximum luminance levels (i.e the kitchen and the living room, are either on the exterior or gain much diffused light through the paschatis.

Occupant Adaptation:
- The paschatis are used during the winter season when sunlight percolates into the building envelope well while during the summer, the interior cooler spaces of the house are occupied.

Cyclone resistance:
- To reduce the high pressure on the internal surfaces of the wall these houses are built with only one opening on the pashchati.
- The pashchati wall works as a barrier and reduces water penetration into the house during high wind accompanied by rain.
- The roof shape hence invariably is hip roof, and the pashchati roof is separated from the hip roof; and because of this separation, roof of the pashchati usually suffers wind damage without affecting the roof of the house.
- High level of competence in joinery details further increases cyclone resistance. These connections to resist high velocity winds include - the use of steel angles and bolted connections to fix the different members of the roof structure to the vertical wooden post; extra support to the ridge of roof, and extra tie for extended roof overhang.

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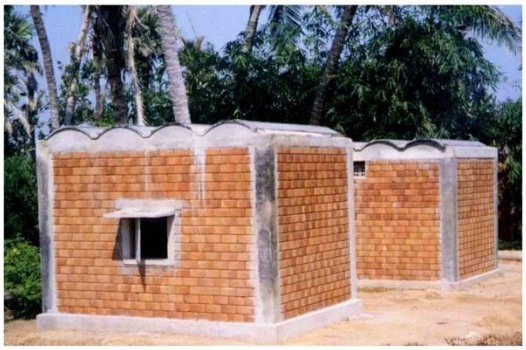
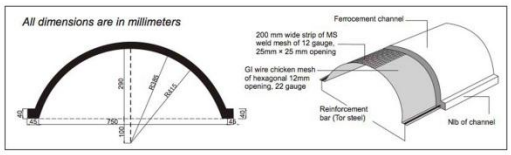
POST-CYCLONE RECONSTRUCTION WORK
ASHRAYA CORE HOUSE PROGRAM, ORISSA

The Ashraya Core House Construction Program, in partnership with CARE India designed to respond to the reconstruction needs after the **Super Cyclone in October 1999**. It addresses the immediate shelter needs of about 1400 families by providing a fast response to construct **Core Shelter**. At the same time a process has been initiated to ensure long term habitat improvement in the region. The project aimed to construct 1400 dwelling units in 100 villages and set up building material based enterprises.

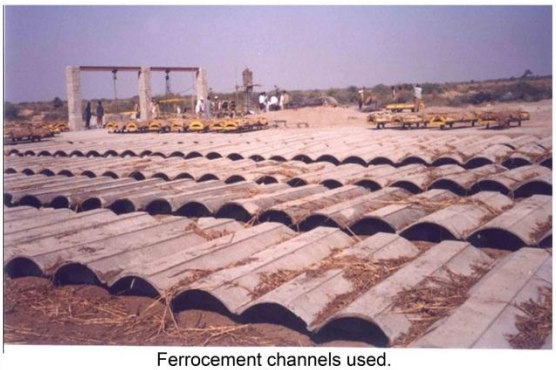
MATERIAL USAGE & CONSTRUCTION SYSTEM

TYPOLOGY	Detached individual "core houses".
STRUCTURE	Precast RCC members.
ROOFING SYSTEM	Flat roof with precast ferrocement channels.
WALLING SYSTEM	Hydrafoam masonry blocks manufactured locally.
DOOR/WINDOWS	Precast RCC frames and shading device.
FLOOR	Laterite masonry rock foundation.





Details of ferrocement channel roofing used.



Ferrocement channels used.

LCCR FEATURES

Cyclone resistance:
- The 'Core House' that was designed to withstand cyclones with a flat roof, so people could shelter from floods.

Innovative building technologies:
- Hydrafoam masonry blocks, ferrocement roofing channels, wattle and daub and laterite masonry rock foundation.

Building Materials and Services Banks (BMSB):
- Acted as one-stop-shops for local production and supply center of improved building materials, elements and skills.

POST-TSUNAMI RECONSTRUCTION WORK
RIDIYAGAMA HOUSING SCHEME , AMBALANTOTA , SRI LANKA

This housing scheme is for 30 families near the coast in Sri Lanka. The Samadhi Foundation provided these houses for tsunami victims, most of them belonging to **a low-income community of fishermen** from Ambalantota. Similarly oritented single-storey houses of about 46 m^2 floor area are built in a row.

MATERIAL USAGE & CONSTRUCTION SYSTEM

TYPOLOGY	Detached individual houses.
STRUCTURE	Compressed earth brick columns.
ROOFING SYSTEM	A sloping roof that uses local cured timber for understructure of the clay tile cladding.
WALLING SYSTEM	The rammed earth walls which are made with cement-stabilized earth are constructed with steel slip formwork.
DOOR/WINDOWS	Timber door and window frames.

LCCR FEATURES

Use of local materials:
- Appropriate choices of local material for this rural area as material transport costs would be high, while labour intensive and environmentally friendly building methods are more cost-effective.

Ventilation:
- Inside the house, the cross ventilation is good.

Orientation:
- The openings of the house are well orientated to the north and south facades, with none to the east or west.

Rain sheltering:
The sloping roof overhang provides good shelter from the rain as well as solar protection during the summer.

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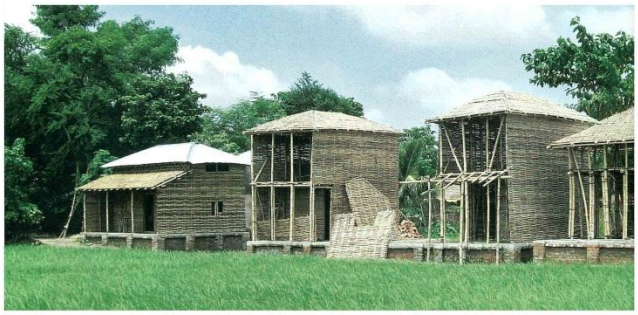
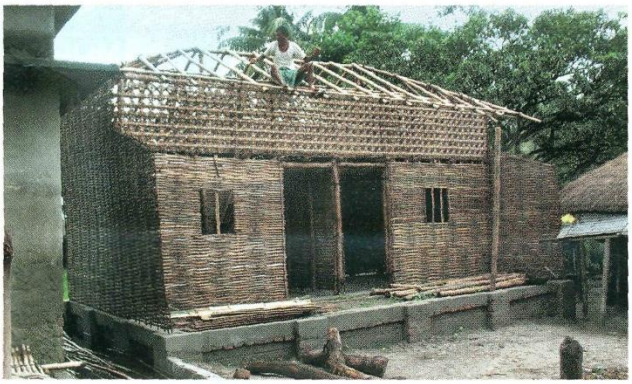
POST FLOOD RECONSTRUCTION WORK
ORLAHA & PURAINI OF SUPAUL DISTRICT, BIHAR

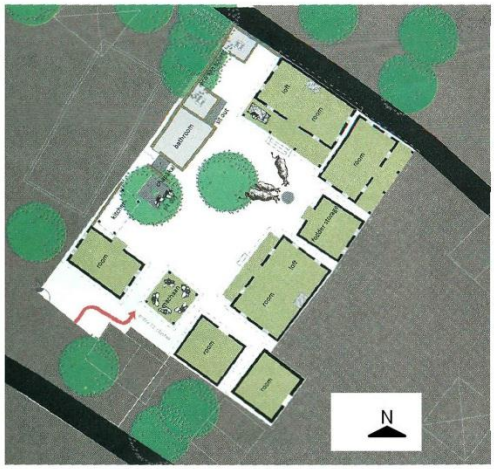
After the devastating Kosi floods of 2008 the people of Orlaha and Puraini of Supaul district, Bihar, reconstructed 45 and 69 houses respectively.
Indigenous labour intensive construction techniques and materials were used to build bamboo houses that incorporated flood, earthquake and cyclone resistant features.



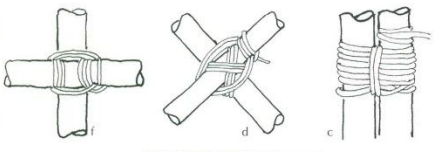
MATERIAL USAGE & CONSTRUCTION SYSTEM

TYPOLOGY	Detached individual houses of 25-30 m².
STRUCTURE	Precast RCC pile foundations Superstructure of well-connected bamboo frame. The different types of joints in the house were secured with three types of lashings (tying with rope) with a bamboo pin to provide rigidity wherever necessary.
ROOFING SYSTEM	Bamboo rafters were used in the roof.
WALLING SYSTEM	Bamboo mesh was used in the walls that were constructed in wattle and daub technique.
SEMI-OUTDOOR SPACES	Some of the units have shaded *verandahs.*

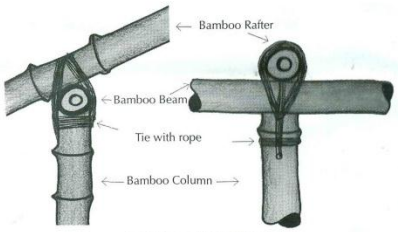




PLAN OF A TYPICAL HOUSE



TYPES OF BAMBOO LASHINGS



BAMBOO JOINERY DETAILS

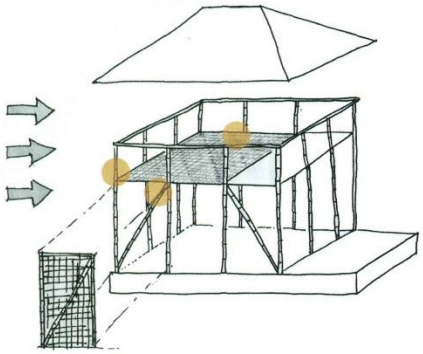
LCCR FEATURES

Local material usage:
- Use of local bamboo and earth reduces transportation costs.

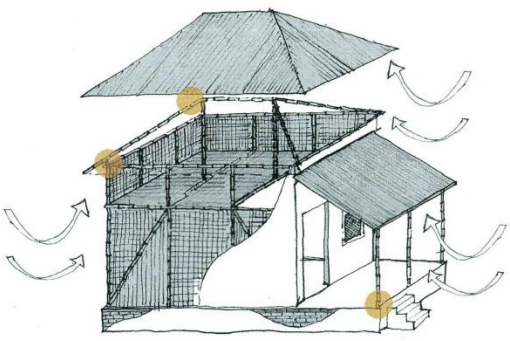
Disaster resistance:
-The connectivity of the plinth through the walls to the roof prevents uprooting during storms.
- Plinths are built higher than the average annual flood level. Attic space is used not only for storage but also refuge from floods.

Sanitation:
- Eco-san toilets have been installed in most houses.

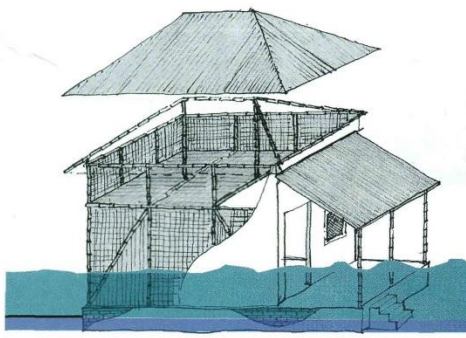
Renewable energy:
- Solar lights have been installed.



EARTHQUAKE-RESISTANT TIES



CYCLONE-RESISTANT FEATURES



FLOOD-RESISTANT MECHANISM

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