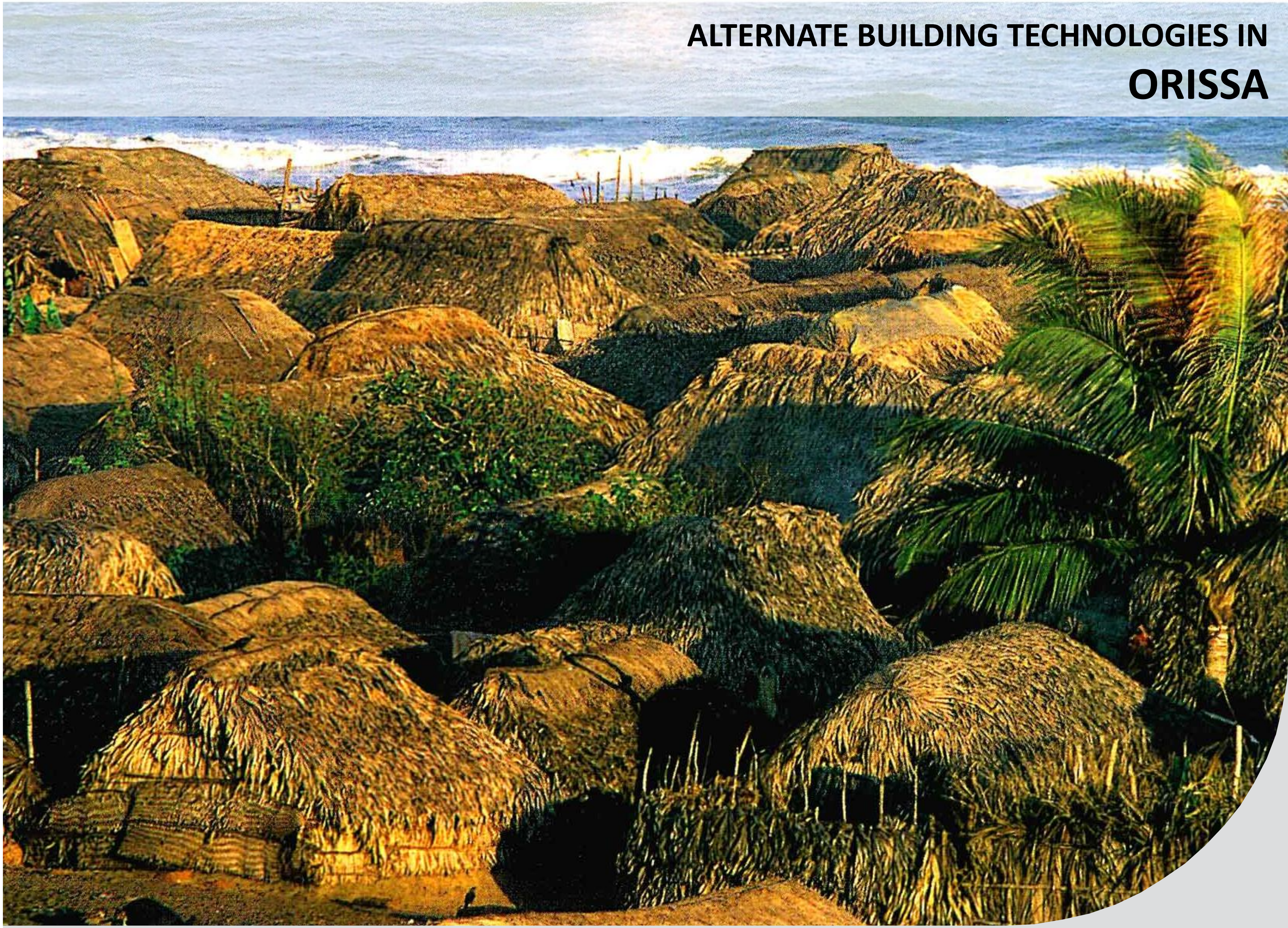
ALTERNATE BUILDING TECHNOLOGIES IN ORISSA



DESIGN FOR LCCR CONSTRUCTION

Development Alternatives

Low Carbon Climate Resilient Strategies

Low Carbon Climate Resilient Construction

Minimised embodied energy

Rationalizing the use of high energy materials like cement, steel, brick, aluminium.

Minimised operational energy

Maintaining comfortable indoor environmental conditions by adopting passive design strategies

Disaster Resilience

Providing adequate protection from extremities of local climate and calamities

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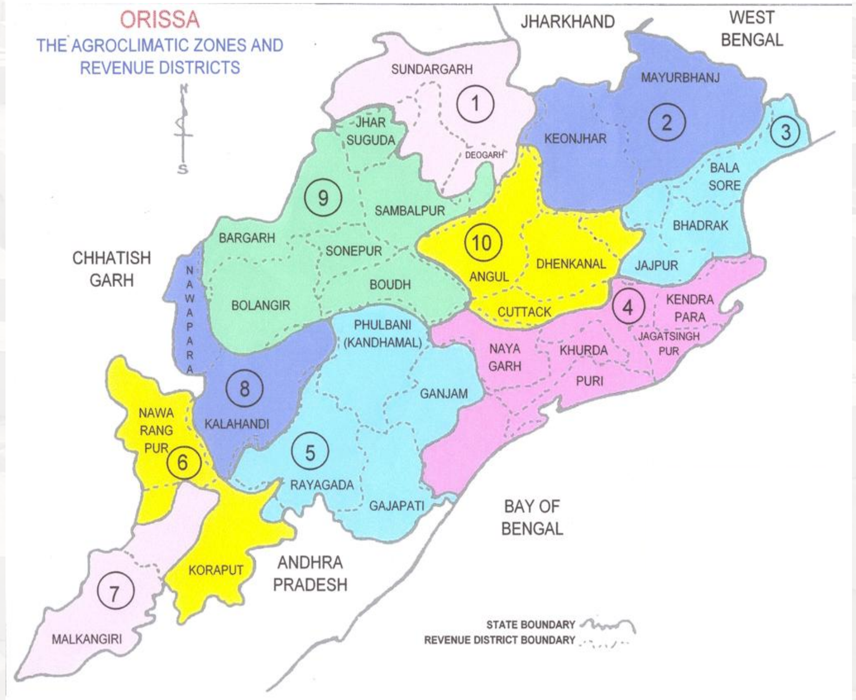
Climate Responsive Design

Each climate has specific seasonal characteristics that need corresponding passive design strategies to create a comfortable indoor environment without over-dependence on mechanical heating, cooling and ventilation and by using freely available renewable sources of energy such as sun, wind and natural vegetation.

Parts of Orissa lie in the coastal climatic zone.



MICROCLIMATIC FACTORS IN ORISSA:

Wind - Velocity and direction of the wind

Solar exposure - Direction of available solar radiation

Rain – Intensity of precipitation

AGROCLIMATIC ZONES

1. NORTH WESTERN PLATEAU
2. NORTH CENTRAL PLATEAU
3. **EAST & SOUTH EASTERN COASTAL PLAIN**
4. **NORTH EASTERN COASTAL PLAIN**
5. NORTH EASTERN GHAT
6. EASTERN GHAT HIGH LAND
7. SOUTH EASTERN GHAT
8. WESTERN UNDULATING ZONE
9. WESTERN CENTRAL TABLE LAND
10. MID CENTRAL TABLE LAND

Seasonal Passive Strategies for Coastal Climate

Seasons:

Summer:

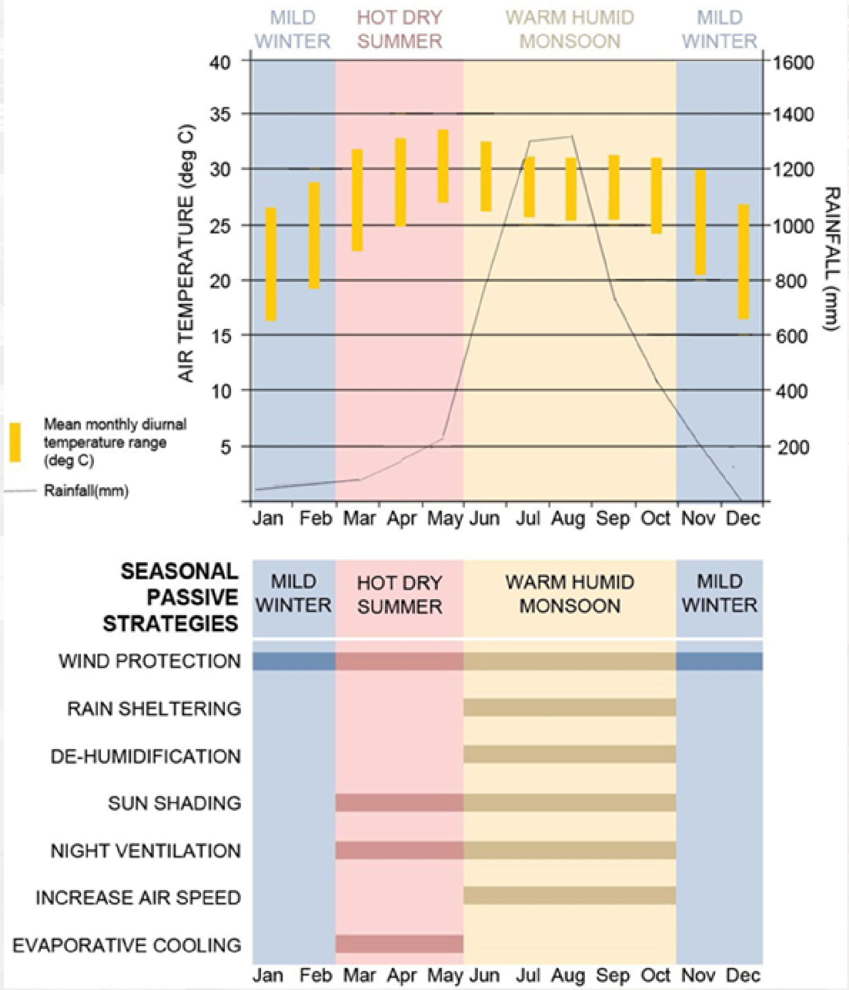
- Temperature peaks ≈ 40°C.
- Diurnal range of temperature> 10^{o}C.
- Low humidity levels and high solar gains.

Monsoon:

- Heavy rains resulting in floods.
- Humidity levels high
- The diurnal range of temperature < 10^{o}C.
- Temperatures remain below 32^{0}C.
- High wind speeds with risk of cyclones.

Winter:

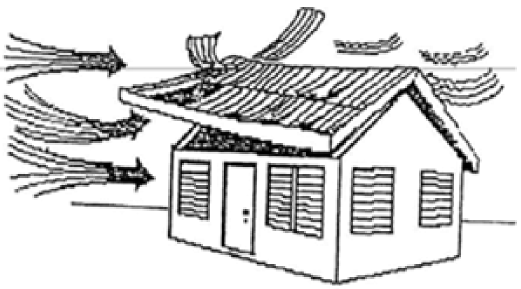
- Mild weather with moderate temperatures and low humidity
- Diurnal range of temperature> 10^{o}C.
- Cold winds keep the temperatures low in spite of the bright sunshine.



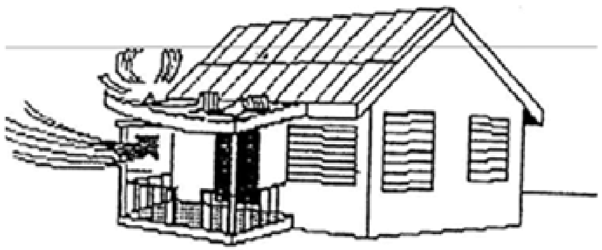
Seasonal Passive Strategies for Puri, Orissa

Cyclone Resistance

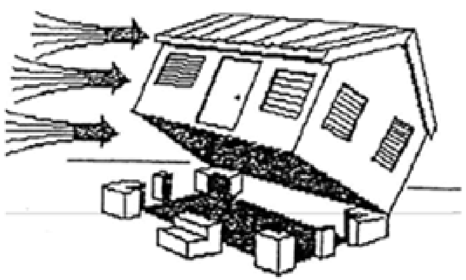
In coastal Orissa, the main extreme weather events that threaten buildings are cyclones, floods and excessively heavy rainfall.



Roofing materials not anchored can be blown away.



Light weight verandah roofs are more susceptible to damage by high speed winds.

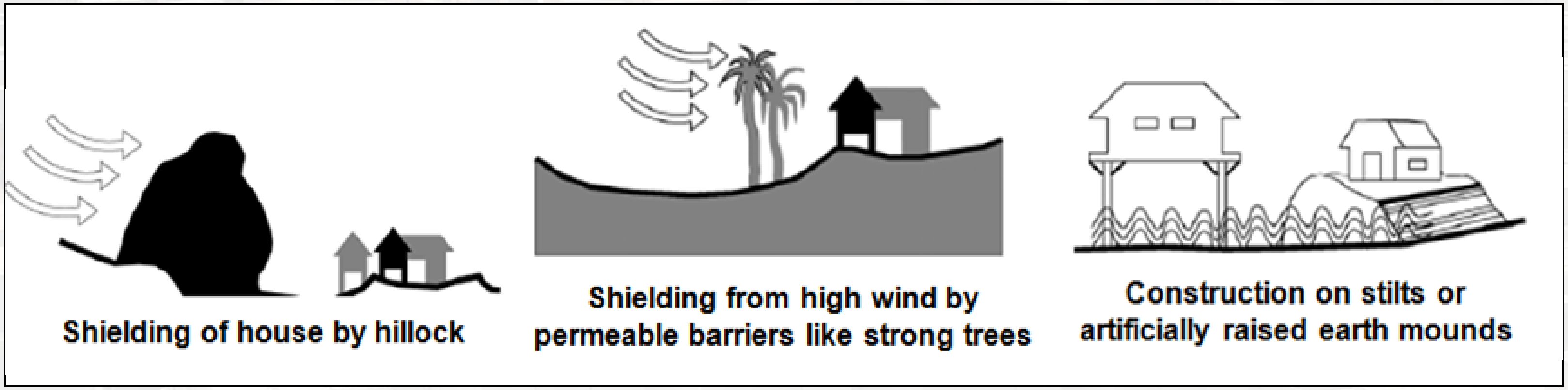


Due to the high wind pressure and improper connection of the house to the footings it can be blown away.

When cyclones are accompanied with heavy rain for a long duration, the building can be damaged due to flooding.

Hence, rain-sheltering, wind protection and water-proofing become key design criteria for designing in this area.

Cyclone Resistance



Location:

- The natural topography and vegetation of the land should be used as protection from cold winds.
- Location of the building should be above the storm water surge level.

Passive Strategies for Coastal Regions

Objective		Physical manifestation
Resist heat gain	Decrease exposed surface area	Orientation and shape of the building.
	Increase thermal resistance	Optimum roof insulation, wall insulation.
	Increase shading	Walls, glass surfaces protected by overhangs, fins and trees.
	Increase buffer spaces	Balconies and verandahs.
	Increase surface reflectivity	Light coloured and reflective finishes. Reflective surface on roof.
Pomote heat loss	Increase air exchange rate.	Cross-ventilation through windows/ exhausts, courtyards, wind towers, etc. Ventilated roof construction.
	Decrease humidity levels	Dehumidifiers/ dessicant coolers.
Disaster resistance	Cyclone resistance	Structurally stable building configuration, opening sizes, stiffness distribution and ductility. Use of trees and vegetation as wind barriers.
	Flood resistance	Structural resistance to storm surges. Incorporating rain-sheltering features.
	Siting	Locating building in areas that are not flood or landslide prone.

Waste utilization in building materials

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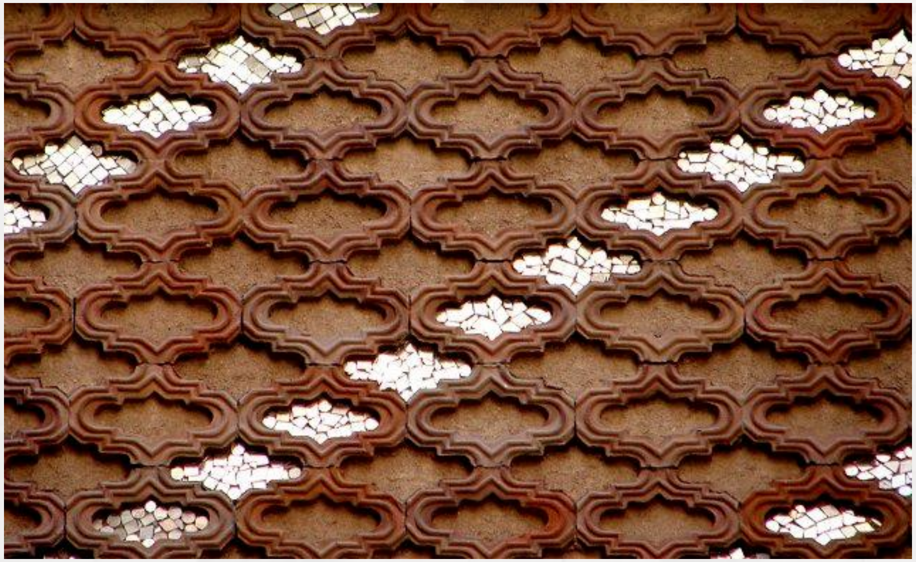
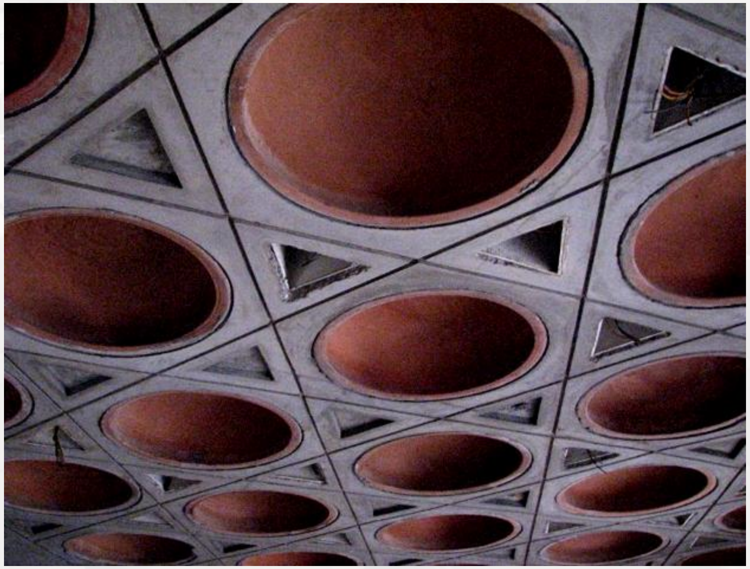
- **Fly ash from power plants – bricks/ blocks, tiles, road construction**
- **Blast furnace slag– partial replacement of cement in concrete**
- **Sponge iron dolochar – internal fuel in brick making**
- **Red mud (alumina waste) – soil substitute in brick making**
- **Agro waste (rice husk) – light weight concrete, particle boards, insulation boards**

BENEFITS OF ALTERNATE BUILDING TECHNOLOGIES

- Reduced embodied energy and fuel consumption hence reduced carbon emissions
- Reduced environmental damage through optimal resource use and waste utilization
- Better thermal efficiency and comfort
- Resistant to natural disasters
- Aligned to local production in terms of material and skill availability



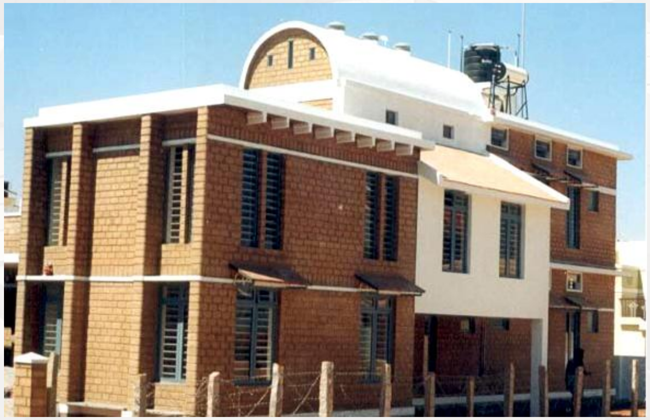


WALLING TECHNOLOGIES:
STABILIZED COMPRESSED EARTH BLOCKS

Principle: (CEBs/CSEBs) are mechanically compressed block of local soil. The soil is mixed with a binding material such as cement, lime, rice husks or straw.

Design:

It can be used in the construction of various structures like wall masonry with arched openings, jack arches and domes for roofing. The component made of these blocks needs protection from water and tensile forces; hence walls made of these blocks should have appropriate overhangs from chajja or roof.



Low Carbon Climate Resilient Features
• Lower embodied energy material due to minimal use of high energy material. • Low environmental impact as there is no burning involved. • Thermally efficient nature imparted by soil which is a main constituent.

WALLING TECHNOLOGIES: CAVITY WALL CONSTRUCTION

Principle:

- A cavity wall consists of two layers of masonry, separated by a cavity (of 50-100 mm) that has better insulation properties than a regular masonry wall .
- The isolation of the exterior and interior layers by the air space allows heat to be significantly absorbed and dissipated in the outer layer and cavity before reaching the inner layer and building interior.

Design:

- It has good potential for use in public buildings, where significant savings in operational energy can be realized.

Low Carbon Climate Resilient Features

- Significantly improved thermal performance reducing need for mechanical cooling or heating.

WALLING TECHNOLOGIES: RAT TRAP BOND

Principle:

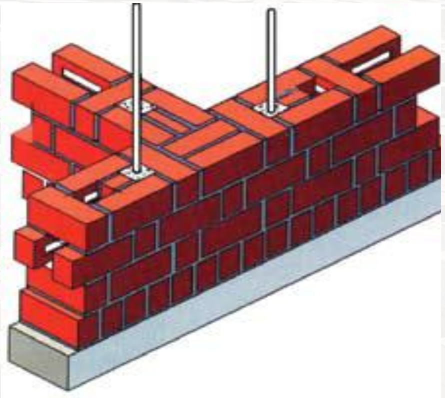
• Rat-trap bond is a masonry technique in which the bricks are laid in such a manner that a discontinuous cavity is formed between two faces of the wall. Typically, a 75mm cavity is formed in a 230mm thick wall by placing the bricks on edge in a modular fashion .

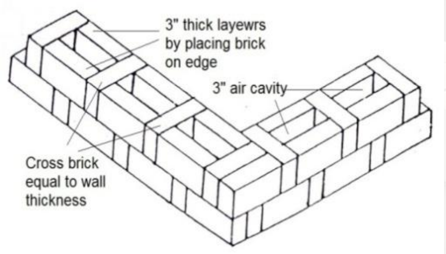
•**Design:**

• Usable up to 2 storeys of load bearing masonry, wherever burnt clay brickwork is used.

• As infill walls, usable in multi-storeyed buildings.

• Well-suited to exposed brickwork because of its neat appearance.





Low Carbon Climate Resilient Features

- This technique reduces the number of bricks by at least 20%. and saves at least 30% mortar. It reduces the overall cost of wall by at least 25%.
- Improves insulating capacity of brickwork.
- 30% less emissions from brickwork as compared to a conventional English bond brick wall.

Walling Technologies: Fal-G Bricks

Principle: Fal-G bricks are manufactured from a mix of industrial by products (fly ash, lime and calcined gypsum). The bricks are manufactured by mechanically compressing the raw material and do not need firing or autoclaving for curing.

Design:

• Usable in all traditional applications of burnt clay bricks and even in cavity walls.

• Has good compressive strength with less water absorption property.

• Are of superior quality and finish can be made as compared to conventional bricks and can be left unplastered.

Low Carbon Climate Resilient Features
• Utilization of waste - reduction in the embodied energy of building envelope through masonry which incorporates an industrial waste to the extent of at least 50% by weight.

WALLING TECHNOLOGIES: HOLLOW CONCRETE BLOCKS

Principle: Hollow concrete block masonry that uses lesser concrete as compared to solid concrete blocks and provides better thermal insulation due to cavity.

Design:

• Usable in wall masonry and as roofing blocks along with precast inverted T- beams.

•Hollow Concrete blocks incorporate at least 40% air cavity in gross volume and masonry can be strengthened with steel reinforcement (typically corners, openings), which makes them well-suited for low-rise load bearing construction instead of the RCC frame which is conventionally adopted.

Low Carbon Climate Resilient Features
• Solid and Hollow concrete blocks may be particularly useful in places where there is scarcity of good quality clay required for burnt clay brick manufacture. • The aggregate can be resourced locally.

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ROOFING TECHNOLOGIES: PRECAST ARCH PANEL ROOFING

Principle: The roof is constructed with pre-cast panels made with burnt clay tiles placed on pre-cast reinforced concrete beams. The arch profile imparts lateral or transverse strength to the panels for distributing the roof load through compressive forces. The panels serve as a lost formwork for the finished roof, after topping concrete has been laid over the pre-cast components.

Design:

• Usable economically till a span of 5 metres.

• Recommended for areas where burnt clay products are commonly used and produced in good quality – both the semi arid and coastal study area.

Low Carbon Climate Resilient Features
• Simple technology to replace conventional RCC roof for moderate spans
• 40% less steel used - however, the energy content is ultimately determined by the embodied energy of the brick tiles.
• Finishes like plaster and paint are not needed

ROOFING TECHNOLOGIES: FUNICULAR SHELLS

Principle: A Funicular Shell is a 3 dimensional catenary on a rectilinear base. The roofing system consists of doubly curved shells made with materials of good compressive strength such as waste stone pieces and brick tiles, supported on reinforced concrete edge beams.

Design:

• A series of these shells in variable geometric configurations supported on a grid of concrete beams, identical to a coffer slab, provides an attractive roof for small to medium span

• It does not need plastering/ painting.

• It is particularly well suited for large spans, eg. community buildings/ halls where a grid of beams can support a variety of funicular shells.

Low Carbon Climate Resilient Features
• Utilises waste stone to provide a roof which can be very well adapted to structural requirements. • Low embodied energy due to virtual elimination of steel in the slab portion.

ROOFING TECHNOLOGIES: MCR ROOFING

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Principle:

•Micro concrete is a type of cement concrete which uses fine aggregate – typically less than 6mm size, which is then moulded as a roofing tile which can be used as a cladding material for sloping roofs.

Design:

• With an appropriately designed understructure, MCR roofs can be used for a variety of applications in low cost housing, institutional buildings, factories and parking areas.

Low Carbon Climate Resilient Features
• Low environmental degradation during extraction and production.
• Utilises waste such as filtered extracts from sand, waste from stone quarry etc.
• Low embodied energy due to less use of cement.
• Low scale production requirement.

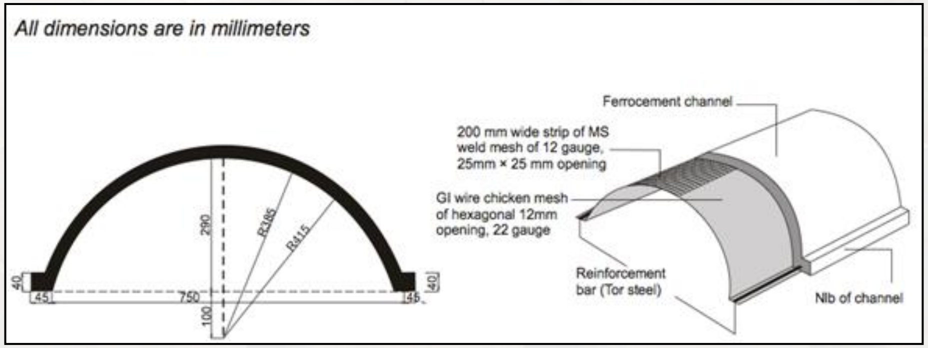
ROOFING TECHNOLOGIES: FERRO CEMENT CHANNEL ROOFING

Principle:

The building system uses pre-cast ferrocement roofing channels of a segmental arch profile which are placed adjacent to each other and spanning over two supports. After partly filling the valley between channels with concrete, the channels form an idealized T-beam and are able to carry the load of a roof / floor.

Low Carbon Climate Resilient Features

- Re-utilises waste like flyash.
- Reduced use of steel.
- Pre-casting of roof leads to much reduction in construction time.



Roofing Technologies: Filler Slabs

Principle:

• It is a roofing system which is based on replacing the concrete portions of a roof slab with filler materials like REBs or earthen pots.

Design:

• Suitable for large spans flat, sloping or domed roofs.

• The aesthetic and acoustic properties of using various materials as fillers must be utilized.

Low Carbon Climate Resilient Features
• Consumes 30% less concrete and 40% less steel due to reduced weight of slab by the introduction of a less heavy, low cost filler material like two layers of burnt clay tiles.   • Enhances thermal comfort inside the building due to insulating properties   • 23% saving on cost of this slab compared to the traditional slab.

ROOFING TECHNOLOGIES: PLANK AND JOIST ROOFING

Principle: This is a system which uses precast concrete elements to construct a roof. The planks are supported over partially precast RC joists side by side and then joined together with in-situ concrete poured over the entire roofing area. Both elements of the roof – planks and joists can be manually produced at site using a wooden moulds. Alternatively, given the context of a large scale use such as housing project, they can be produced in a small enterprise mode using steel moulds mounted on vibrating tables.

Design:

- The roof can also be used an intermediate floor.
- The building should be designed keeping in mind the modular size of the planks.

Low Carbon Climate Resilient Features
• Simple technology for a flat roof which is not vulnerable to damage by cyclones. • Reduces at least 25% low embodied energy as compared to a conventional RCC roof.

Walling Technologies: Bamboo Superstructure

Principle: Due to its renewable property, Bamboo and bamboo composites have immense potential to serve as a green building material in housing and construction. More over due to its tensile property it is also used as a tension member in many roofing system e.g. bamboo truss.

Design:

• Usable in foundation, columns, floor, roof trusses, wall infill panel, post and beam. The materials include Bamboo Mat Board, Bamboo Mat Corrugated Sheet, Treated Bamboo Post, etc.

Low Carbon Climate Resilient Features
• Low embodied energy because of natural material – the main energy component comes from the bamboo treatment or processing into sheets • Lightweight building material capable of resisting seismic forces through appropriate designed structural connections • Both the wet hilly regions as well as the coastal region have good bamboo resource and are appropriate for bamboo based construction techniques

SANITATION: ECOSAN TOILET

Principle:

The basic principle of the Ecosan toilet is separation of faeces and urine and separate storage of the two wastes and then application of the nutrients contained in human waste as manure and fertilizer in agriculture.

The toilet has a special pan to separate the solid and liquid waste.

The faeces are stored and decomposed for a period of around 6 months and urine is diluted with water before use.

Low Carbon Climate Resilient Features

- Promotion of recycling by safe, hygienic recovery and use of nutrients, organics, trace elements, water and energy.
- Appropriate sanitation solution for areas of high water table or soil types where leaching of waste is not feasible.

Thank you

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