APPROPRIATE TECHNOLOGIES

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Chandigarh

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- **Context of Buildings-- Resources/ environment**

BUILDINGS- CONTEXT, ROLE AND IMPORTANCE

- Buildings-- integral part of human history, growth, development
- Buildings – definer of future journey of human growth
- Buildings-- a manmade environment
- Buildings-- vital for human growth
- Buildings – living organism
- Buildings – structures catering to all human activities
- Buildings --valuable - 80% human life spent in buildings
- Buildings- full of dualities and contradictions
- Buildings -- largest consumers of energy
- Buildings - largest consumers of resources
- Buildings – largest generators of waste
- Buildings- largest polluter of environment /ecology
- Buildings --- responsible for largest carbon footprints
- Buildings -- responsible for global warming
- Buildings -- major determinant of global sustainability
-

BUILDINGS-CONTEXT, ROLE AND IMPORTANCE

- **Buildings– provide optimum/worst living conditions**
- **Buildings -- make people healthy/sick**
- **Buildings -- vital to overcome human/ ecological concerns, global warming, reducing carbon footprints**
- **Making Buildings Sustainable-- essential to make value addition to -- resources, environment ,ecology**
- **Researches made/Studies carried out revealed —**
- **Green buildings-- create win-win situation for owners, occupants & users**
- **A Green School-makes learning easy & more meaningful**
- **A Green House--makes people happy, healthy, productive**
- **A Green Hospital-- cures patients quickly**
- **A Green Shopping Mall-- increases sale / profits**

BUILDINGS --AS CONSUMERS OF RESOURCES

- **Built environment-significantly impact environment and consumption of resources:**
  - **16% of world's fresh water withdrawal.**
  - **25% of wood harvested.**
  - **30% of consumption of raw material.**
  - **50% of global energy consumption.**
  - **35% of world's CO2 emission**
  - **40% of Municipal solid waste.**
  - **50% of Ozone depleting CFC's still in use.**
  - **30% of residents having sick building syndrome**

- --70% of global warming outcome of ;
- --built environment & transportation

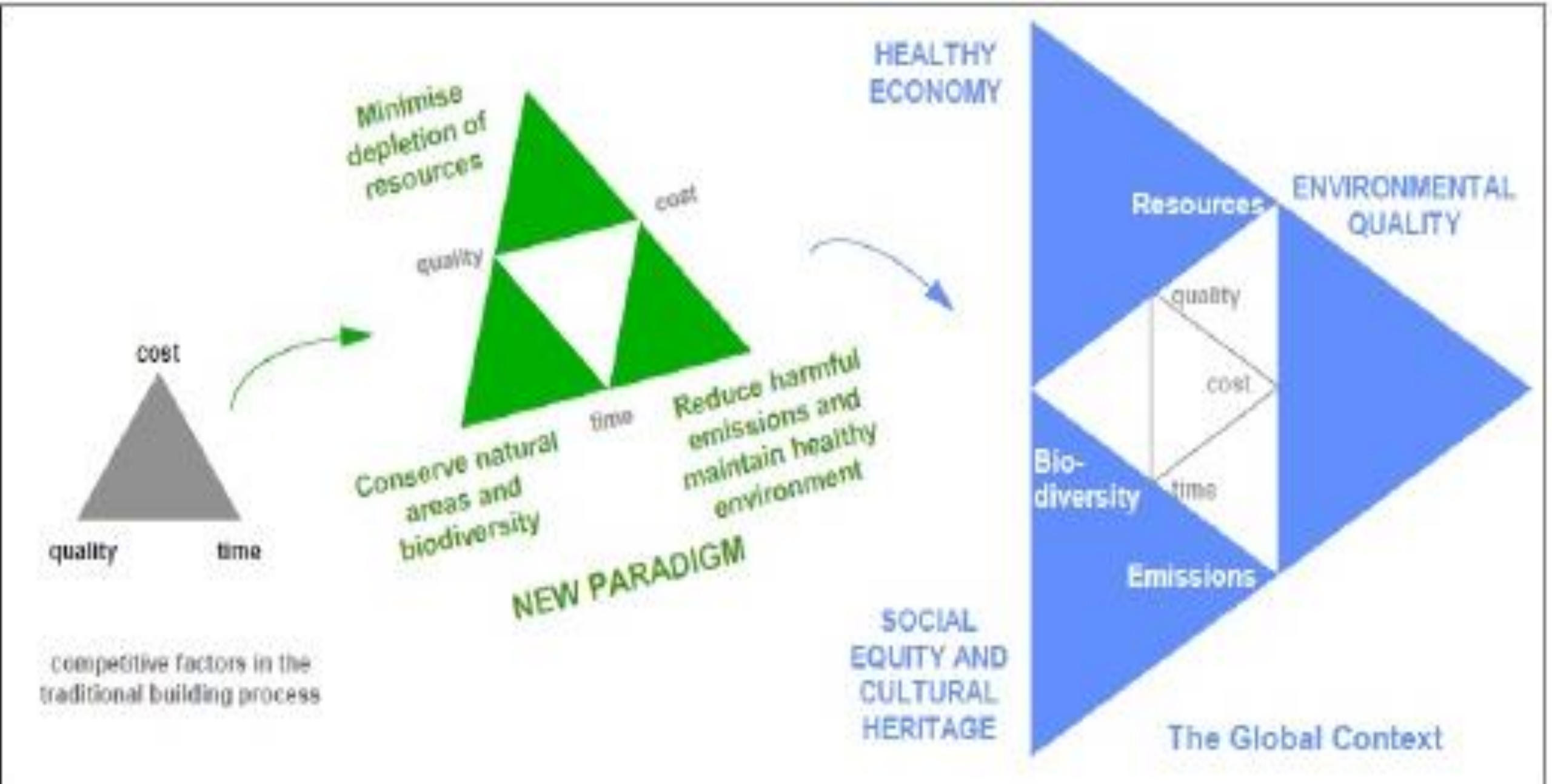
-- Majority of existing buildings

--- low concern for energy conservation.

IMPLICATIONS OF BUILT ENVIRONMENT

Aspects of Built Environment	Consumption	Environmental Effects	Ultimate Effects
• Siting • Design • Construction • Operation • Maintenance • Renovation • Deconstruction	• Energy • **Water** • Materials • Natural Resources	• Waste • Air pollution • Water pollution • Indoor pollution • Heat islands • **Stormwater runoff** • Noise	• Harm to Human Health • Environment Degradation • Loss of Resources

CHANGING CONSTRUCTION PERCEPTIONS

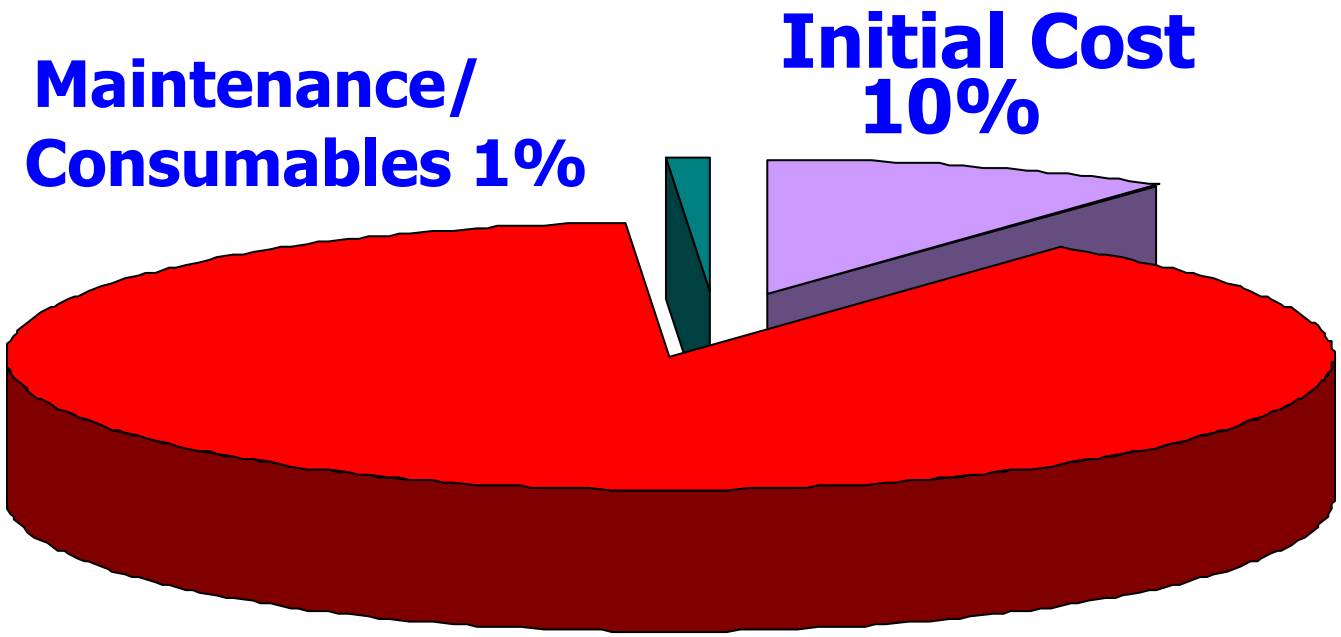


BUILDINGS- COST

-- Initial Cost

- Life Cycle- cost

GREEN BUILDINGS- LIFE CYCLE COSTS



WHAT CONSTITUTES INITIAL COST OF BUILDING

- **Cost of building includes:**

I Cost of land

ii Cost of construction

iii Cost of maintenance and

iv Cost of operations

- **Building cost viewed --in both -- short term & long term**
- **Building cost also evaluated -- Initial Cost & Life Time Cost**
- **Short Time Cost includes-- Initial Cost of Construction of building**
- **Long Term Cost component --- whole life cost.**
- **Whole life Cost of building includes:**
- **--initial design cost**
- **--construction cost,**
- **-- on-going operations and**
- **-- maintenance cost ,**
- **-- parts replacement cost**
- **-- disposal cost or salvage value, and**
- **-- useful life of the system or building**
- **To promote economy in building– Life cycle cost of building will be critical**

DESIGNING BUILDINGS

- SDGs
- Green Buildings
  - Principles for designing
- Integrated Approach
- Climate
  - Orientation
- Planning

SDG 11- MAKE CITIES AND HUMAN SETTLEMENTS INCLUSIVE ,SAFE, RESILIENT AND SUSTAINABLE

WORLD GREEN BUILDING COUNCIL

SUSTAINABLE DEVELOPMENT GOALS

DEFINING- GREEN BUILDINGS

DEFINITION:

- "A green building is one which uses less water, optimises energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building."

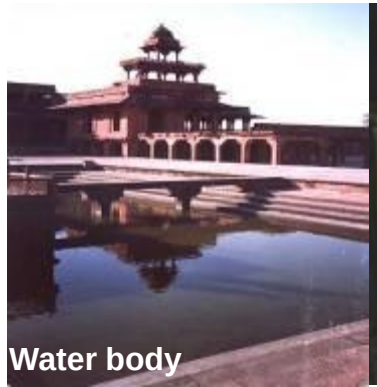
DESIGNING BUILDINGS

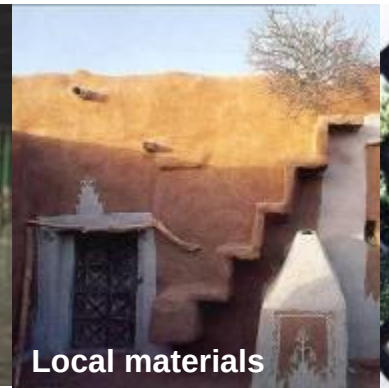
- --Adopting integrated approach to Green building design
- --Design based on Climate
- Macro Climate – Regional climate;
- Meso Climate– local climate
- Micro Climate--Site climate -- based on site characteristics,
- --Orientation -- to optimize light , heat gain/ heat loss
- Sun movement-- to maximizes use of free solar energy for heating /lighting
- --Wind direction---using air movement for ventilation/ cooling
- --Planning of Building-- optimize site, size, shape of building, planning of spaces, allocating uses, placing rooms, circulation, promoting building efficiency, promoting natural sunlight, air / ventilation
- --Designing Building Envelop--– Mass – space relationships/ solids/voids, positioning – openings/projections, shading devices, height, shape of building, natural lighting and ventilations etc
- --Materials- Materials used for buildings -- low embodied energy materials; locally available; used in natural form, lightweight –
- --Technology- cost effective/material efficient/speedier/energy efficient
- -Indoor Air Quality-Creating optimum living conditions for occupants

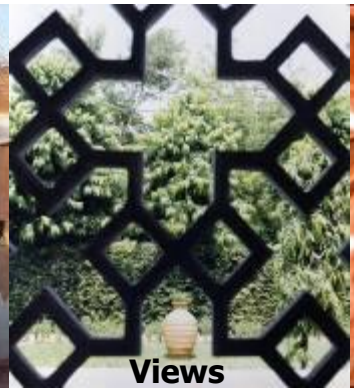
INDIAN WAY OF APPROACHING DESIGN

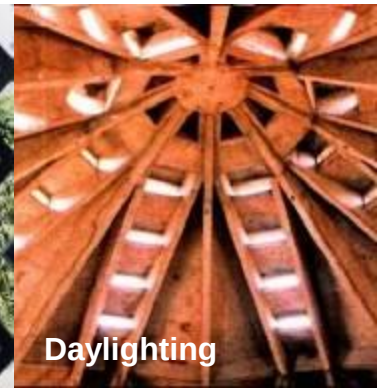
- **Rediscovery of the Indian ethos**
  - **We worship 5 elements of Nature (Panchabhutas)**

Prithvi (Earth)	Sustainable Sites
Jal (Water)	Water Efficiency
Agni (Energy)	Energy Efficiency
Vayu (Air)	Indoor Environmental Quality
Akash (Sky)	Daylight

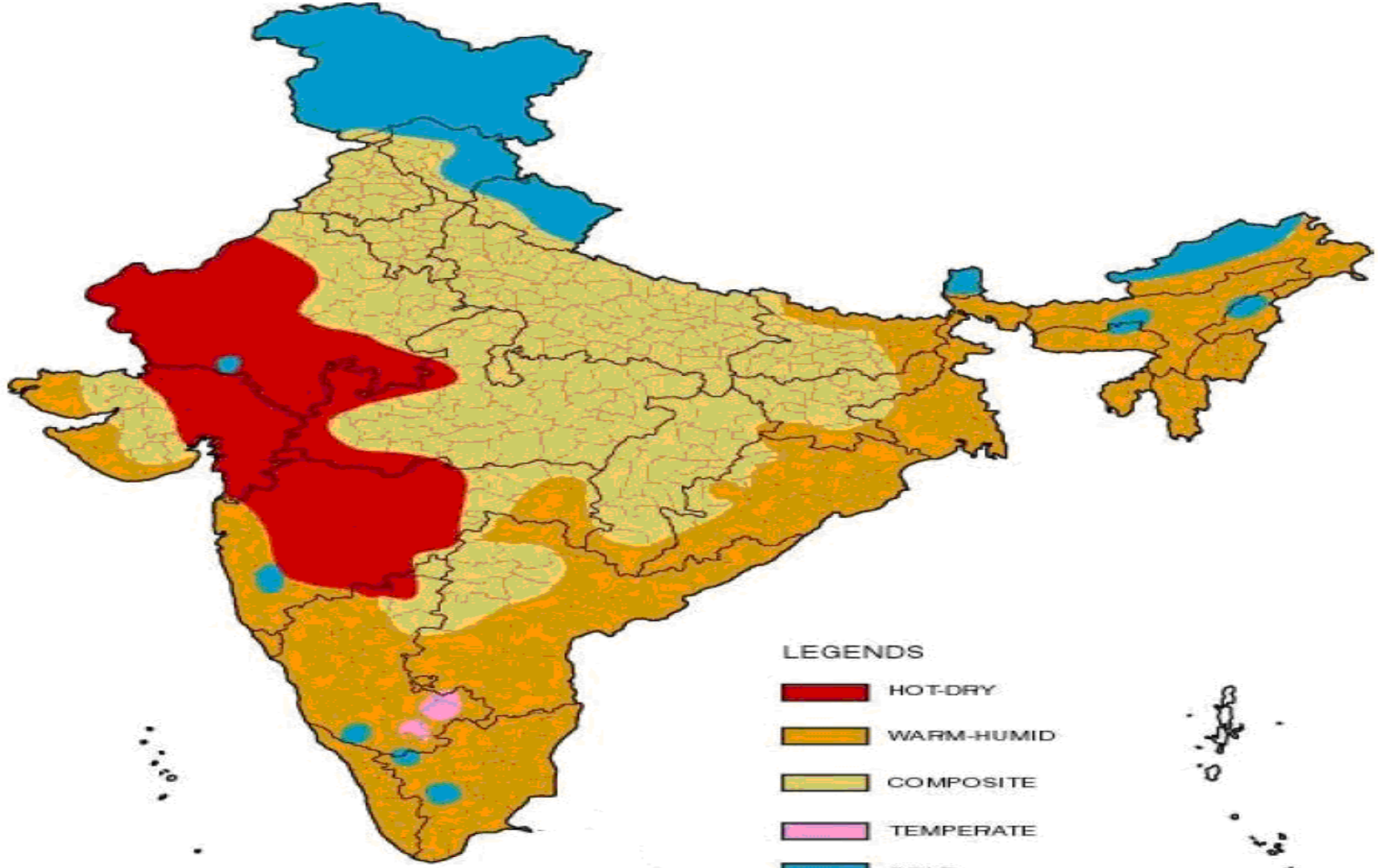

Water body


Local materials


Views


Daylighting

INDIAN CLIMATIC ZONES



Source: National Building Code 2005

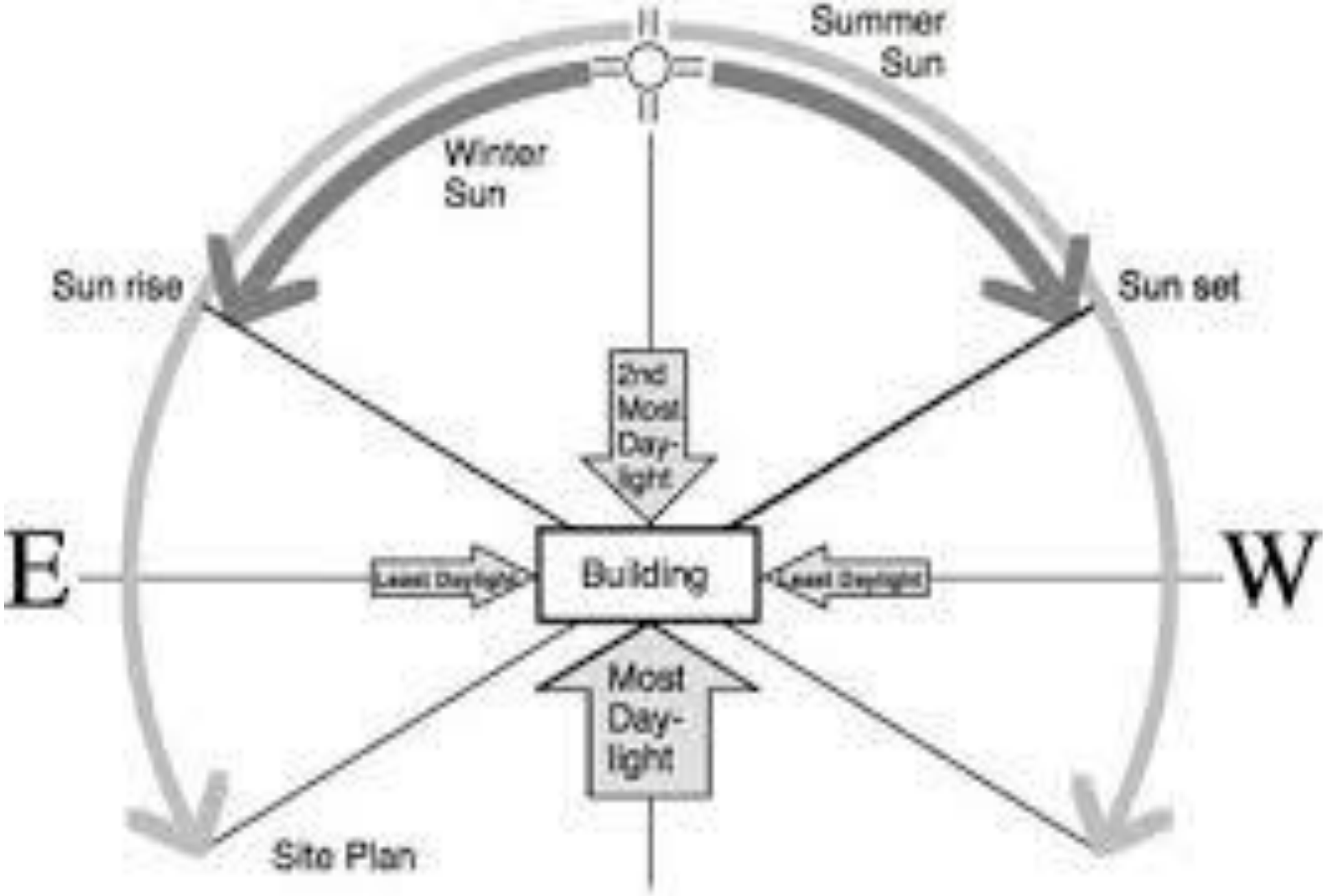
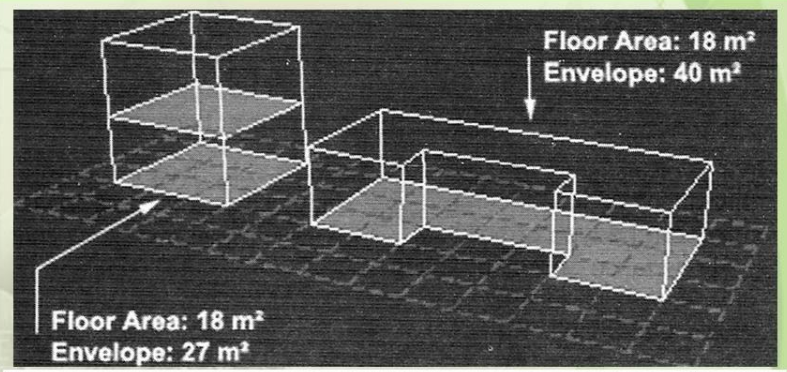
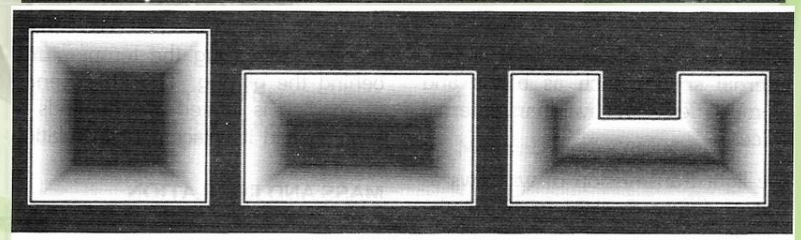
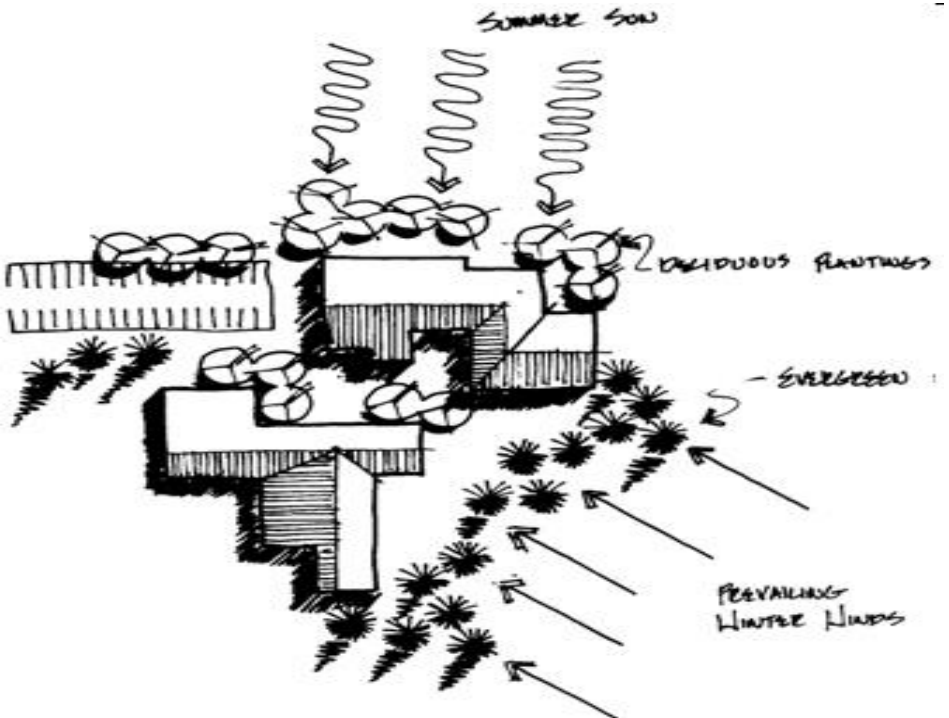

Summer
Sun
Winter
Sun
Sun rise
Sun set
2nd
Most
Day-
light
E
Least Daylight
Building
Least Daylight
W
Most
Day-
light
Site Plan

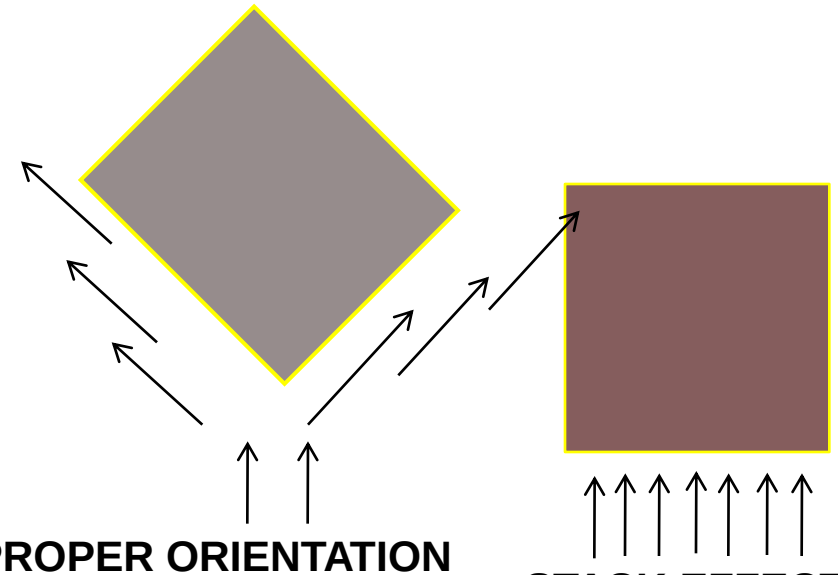
Figure 1

Shape

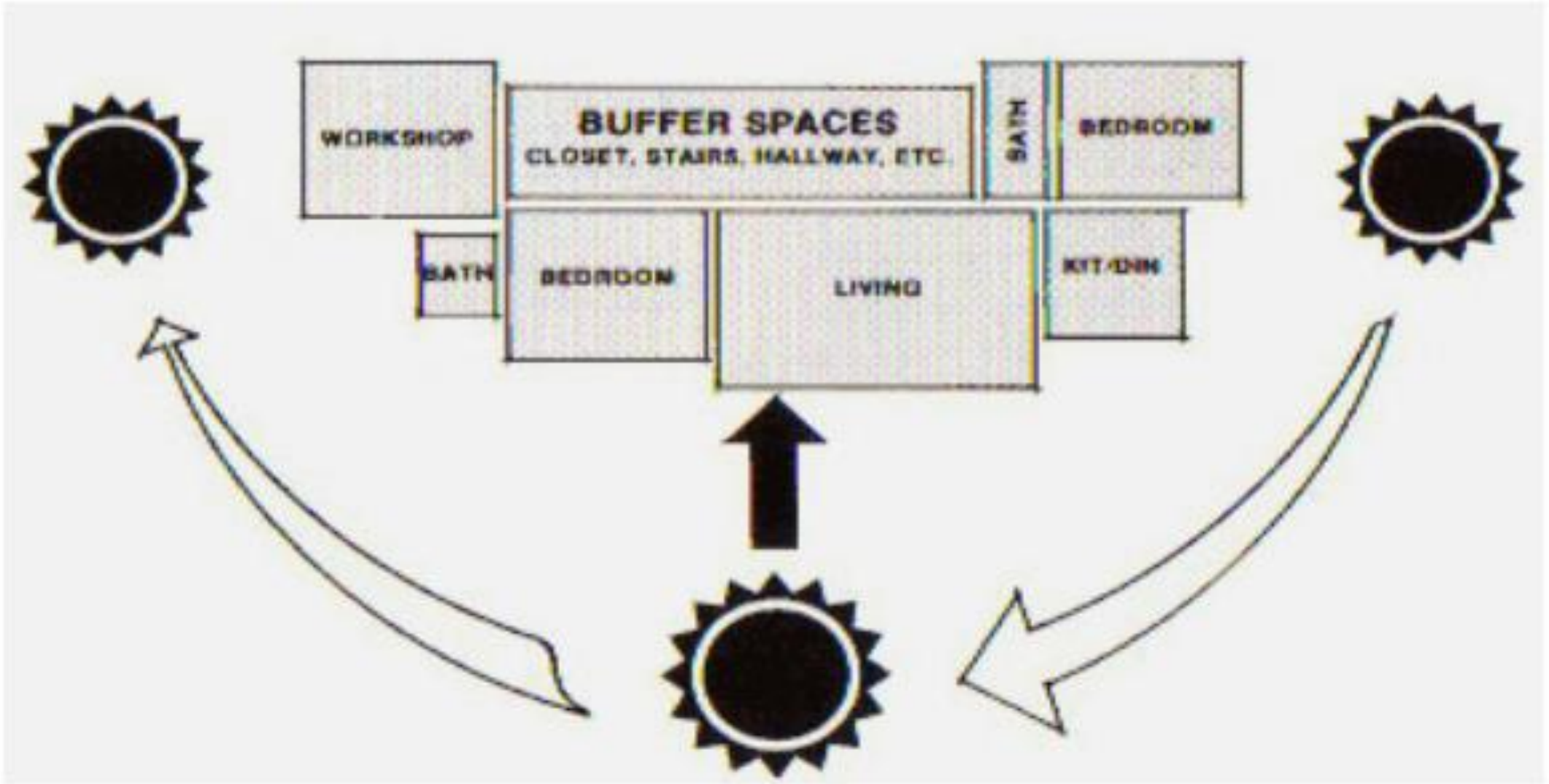

Floor Area: 18 m²
Envelope: 40 m³
Floor Area: 18 m²
Envelope: 27 m³



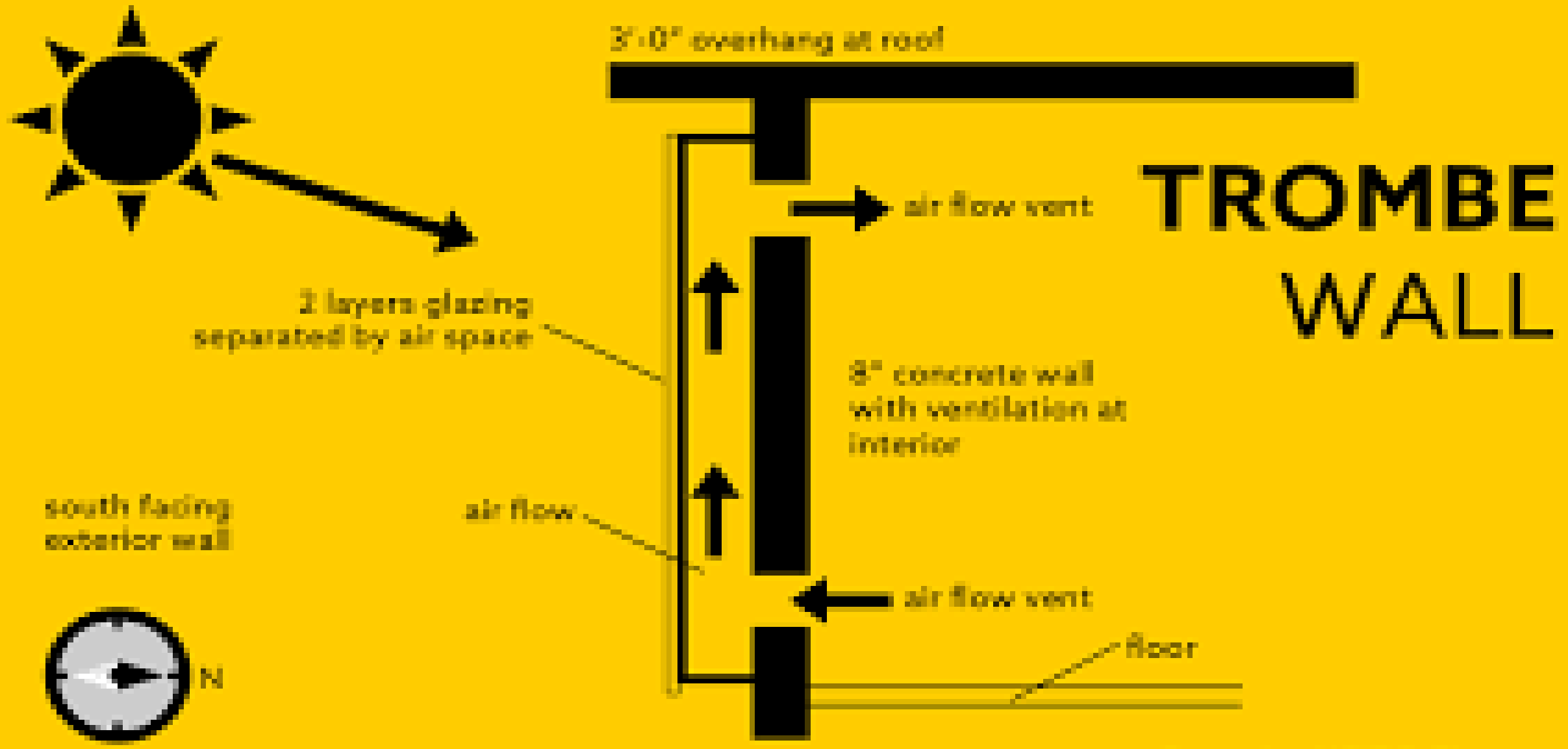

SUMMER SUN
DECIDUOUS PLANTINGS
EVERGREEN
PREVAILING WINTER WINDS


PROPER ORIENTATION
STACK EFFECT

PLANNING FOR SPACES IN BUILDINGS



TROMBE WALL


3'-0" overhang at roof
air flow vent
TROMBE
WALL
2 layers glazing
separated by air space
8" concrete wall
with ventilation at
interior
south facing
exterior wall
air flow
air flow vent
floor
N
Opractice NCIDQ Glossary

REDUCING COST OF BUILDING- DESIGN

Architectural design and Planning

– Best option to reduce cost—Site planning based on optimum utilization of the land/available resource

Minimizing area under roads, services, parking etc

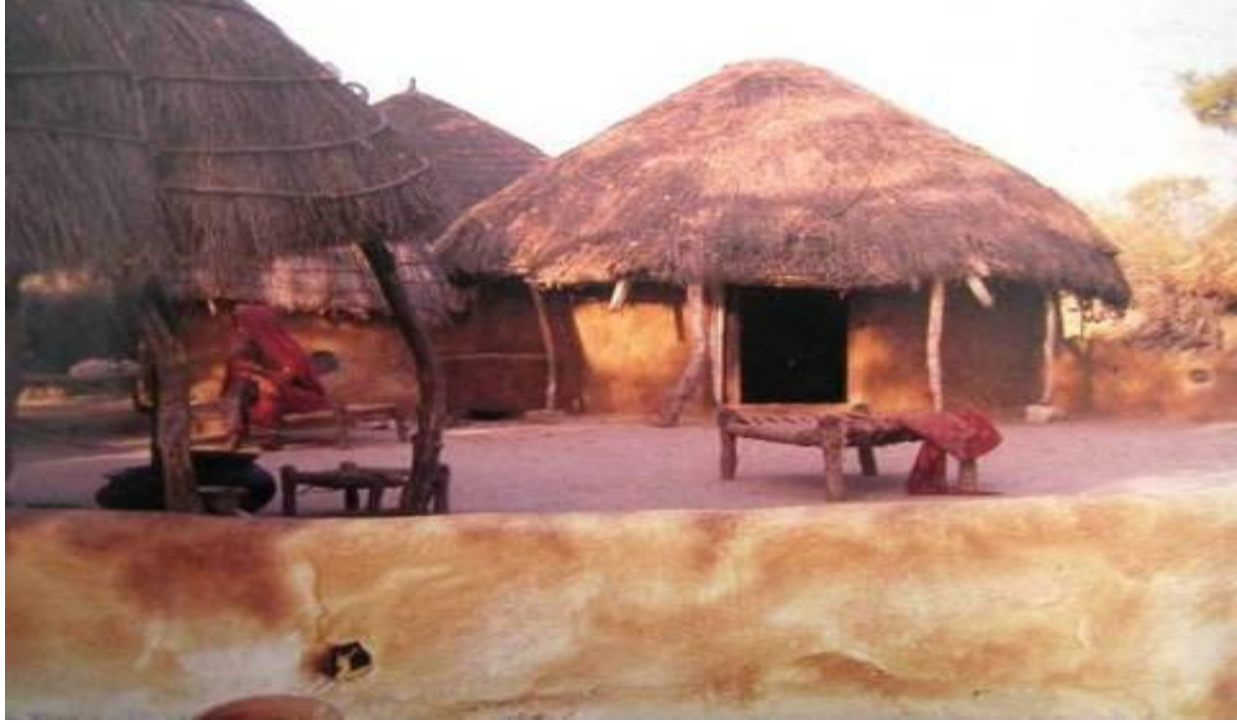
- **Adopting optimum design solutions- architecturally, structurally, Services etc**
- **Adopting Simple form, ;**
- **Optimum utilization of spaces- both within/outside ; Multiple uses of spaces,**
- **Minimizing area under walls, circulation etc,**
- **High building efficiency (high carpet area/covered area ratio),**
- **Low rise- avoiding lifts;;**
- **Minimum wood work-- minimum doors**
- **Minimizing variations in the sizes of doors and windows,**
- **Avoiding large openings**
- **Room/corridors sizes based on the available sizes of tiles /marbles for avoiding wastage when laying flooring etc.**
- **Using windows/ glass opening sizes based on available sizes of wood/glass in market**
- **Making simple safety provisions for disaster management**
- **Promoting Standardization; Reducing Building Load- self/ occupied, Designing thin and lean structures**
- **Minimizing PH fixtures/toilets ; Clubbing/planning all public health services in close proximity.**
- **Adopting efficient structural system**
- **Avoiding large spans; Avoiding large projections ; Avoiding large area under balconies and projections.**
- **Making optimum use of day lighting**
- **Making optimum use of prevailing wind direction for cross –ventilation, where required; Designing with nature**
- **Making optimum use of Panchbhutas while designing- Prithvi, Agni, Vaayu, Jal and Aakash**
- **Making optimum use of orientation;; Making optimum use of sun for heat and light**
- **Adopt integrated approach to design**
- **Minimize single loaded corridors, promote doubly loaded corridors to minimize area under circulation**
- **Minimizing building foot- prints ;; Designing compact buildings**
- **Designing Green Buildings –to reduce cost of electricity/water and generating its own energy**

URBAN HOUSING

Cluster Type

URBAN HOUSING

HIGH RISE



RURAL HOUSING

Stabilized Earth

BAMBOO HOUSES WITH BAMBOO MAT

Bamboo & Thatch

RURAL HOUSING

Bamboo and Brick houses

- APPROPRIATE
- Technologies

APPROPRIATE TECHNOLOGY

- a movement representing ;
- --technological choice made applicable locally on;
- --small-scale,
- -- which is affordable ,
- decentralized,
- labor-intensive,
- energy-efficient,
- environmentally sound and
- people-centric.
- Involving locally autonomous solution to solve local issues / work
- -- originally articulated as intermediate technology --by economist Ernst Friedrich "Fritz" Schumacher-- in his work *Small Is Beautiful*
- Outcome of -- energy crisis of the 1970s
- focuses-- on environmental / sustainability issues
- Mahatma Gandhi -- often cited --"father" of appropriate technology movement.

- PREFABRICATION -Technology for
- BUILDINGS

PREFABRICATED BUILDINGS

- Prefabricated buildings are buildings,
- -- designed /constructed in factories in parts,
- -- as per modular design,
- - Transported and placed on site
- --joints taken care through in-situ concrete or anchors.
- numerous prefab technologies used in India/ in different countries.
- National Building Code of India,--
- -- has prepared design standards for
- --various prefab Technologies being used in India.

TRADITIONAL ON -SITE CONSTRUCTION-ISSUES

- Majority of construction in India follow;
- -- traditional on-site pattern of construction.
- --Known as linear construction,
- -- where every component not only constructed on site,
- -- but also completed before project moves to next phase.
- --Such construction has major implications in terms of
- -- time;
- -- cost,
- --quality,
- safety,
- noise,
- pollution,
- manpower

TRADITIONAL ON -SITE CONSTRUCTION-ISSUES

- Highly time consuming-time intensive
- Generating large scale waste- material inefficient
- Construction largely dictated by prevailing weather conditions.
- Pollution intensive; Unsafe for workers deployed in construction.
- Large manpower needed for making /supervision-manpower intensive
- Large inventory of material-material intensive/Storage facilities
- Creation of accommodation for workers deployed at construction
- Loss/theft of material- Constructed/Individual/human oriented
- Large variation in quality- dependent on work force deployed
- Use of lot of water/energy – resource intensive- Grey Buildings
- Increased initial cost of construction- cost inefficient
- Uneconomical in cost/resources- cost overrun
- Delayed return on project Unpredictable project schedule- Construction inefficiency
- Limited application in hazardous areas
- Large site disruption ; Adverse impact on surroundings

PRE- FABRICATION/MODULAR CONSTRUCTION/OFF-SITE- ADVANTAGES

- Building in Hazardous Area
- Assured Quality Construction
- Material Efficiency
- Cost- Efficiency
- Green Construction
- Flexibility
- Reduced Site Disruption
- Time Efficiency
- Safety

PRE- FABRICATION/MODULAR CONSTRUCTION/OFF-SITE- ADVANTAGES

- ***Building in Hazardous Area***-----**Advantages in remote area/disasters/ areas hit by disasters where-**
- **accessibility/manpower/transportation of materials/time available problem --best option for construction in minimum time /cost.**
- **--In hill areas with extreme climatic conditions--pre-fabrication help in creating well insulated structures/least susceptible to extreme outside climate. -Leh, Ladakh, Lahaul, Spiti**
- ***Assured Quality Construction***
- **Constructing building components in industrial setting----- under highly controlled environment -- involving lot of quality checks/ balances, - components produced has assured uniform quality unlike site-built structures.**
- **Modular buildings manufactured to code-making owners free from worry of quality,-- saving of time/energy involved in supervision**

PRE- FABRICATION- ADVANTAGES

Material Efficiency

- Prefabricated buildings-- known for material efficiency --both onsite /off-site..
- -- do not produce waste, since material for construction arrives in finished state .
- -- leave/ create very little waste --during the manufacturing, assembly, disassembly
- ---involves just putting together-- all components as per approved design..

Cost- Efficiency

- Capacity to promote economy /cost- efficiency,
- generally achieved through; large discounts received from material suppliers,
- -- reduction in construction time,
- --- mass production of components and
- -- economy achieved through standardisation,
- ---repetitive nature of operations and large scale operations.
- --Reduction of wastage and in- house recycling of the extra materials
- -- less storage cost ,
- -- less material loss
- -- saving on labour hours /manpower cost in construction
- --without weather constraints and on-site/off-site-- work done simultaneously

PRE- FABRICATION-- ADVANTAGES

Green Construction

- -Modular buildings require less power consumption compared to traditional constructions,
- -- Eco-friendly, both in long / short-term.
- --lower life cycle energy implications as compared to on-site construction
- -- Minimum requirement of water due to --absence of onsite watering of brick/concrete
- -- Energy efficiency-- achieved through using recycled materials
- -- Resource efficient /greener construction process-- due to reduced material waste/ pollution -- increased use of recycled materials

Flexibility

- Flexibility --based on easy dismantling /Relocation of buildings to different sites,
- being made of numerous individual parts-- also permit flexibility in building structure/ design by changing design of specific prefab component.

PRE- FABRICATION-- ADVANTAGES

- **Reduced Site Disruption**
- Traditional construction-- involves major site disruption
- -- all building processes performed on site
- -- transporting/storage/mixing of materials/water storage/creating residential space for labour etc
- --- In prefab construction much of these disruptions taken away from the site
- -- factory manufacturing reduce traffic, equipment/ material suppliers around final construction site.
- **Time Efficiency**
- -- Time efficient to build-- taking less than half time when compared to traditional construction
- --due to better planning, reduced site disruptions and quicker fabrication of multiple components.
- -- Permits multiple projects simultaneously -- Reduced on-site construction manpower /supervision leads to construction efficiency.
- -- Minimum operation for finishing on site including watering of concrete/ brick walls, seasoning of wood, painting and polishing of wood/door etc, which minimises t time span for construction

Safety

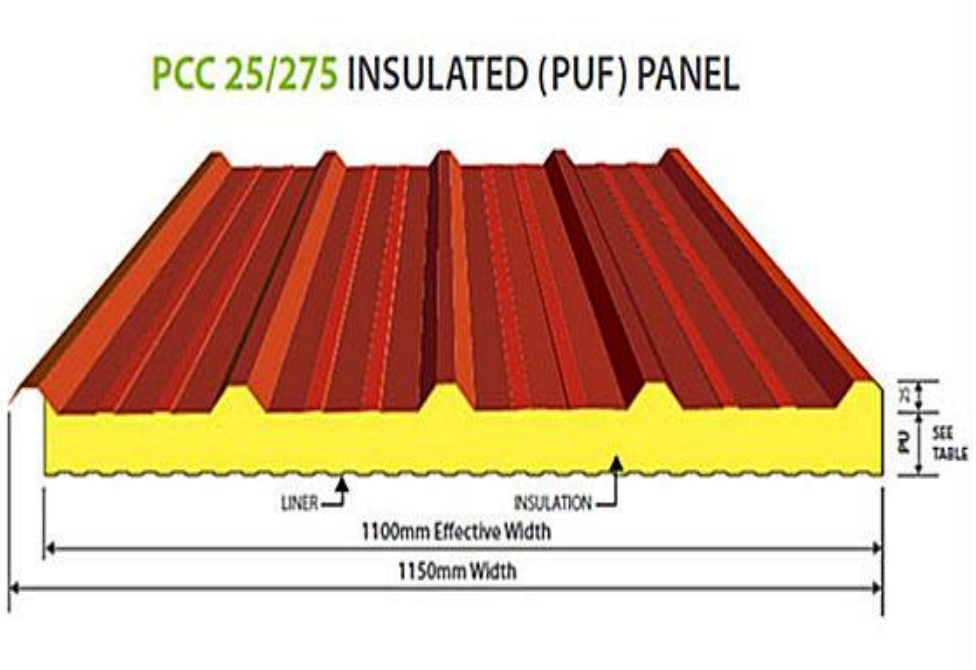
- Promote safety of building after construction including safety of workers at site during construction
- . Risks/ dangers posed by hazardous sites, weather, etc., neutralized
- -- components mostly manufactured in a controlled/ safe environment

PRE- FABRICATION-- LIMITATIONS

- Monotony
- Restricting additions and alterations
- Reduced Resale Value
- Roadblock in Financing
- Accuracy and Precision
- High Transportation Cost
- Mass Production
- Skilled Manpower and Cost

LEH REHABILITATION PROJECT FOR VICTIMS OF CLOUD BURST - HUDCO

- 133 Houses constructed in solar colony, Leh in a record of 45 days only
- The material transported in trucks to Leh-- in lots of 4 units
- Plinths consisting of 9 nos. Concrete stumps were commissioned at site with help of local contractors and labor in ahead of arrival of PUF(Polyurethane Foam) panels.
- PUF panels are more warmer than the mud blocks.
- PUF panel is one of the most effective ways to maintain the energy efficiency of th building.



CRYSTAL PALACE LONDON

QUONSET HUTS, PRE-FABRICATED LIGHTWEIGHT


2392

COLLEGE OF ARCHITECTURE

FRONT FAÇADE ADORNED WITH DEEP SCREEN OF PRE-CAST CONCRETE, A SORT OF MINIATURE brise-soleil

PREFAB HOUSING BY HUDCO

PREFAB HOUSING BY BMTPC

SPECIFICATION OF PREFAB HOUSING TYPOLOGY

S.No.	SPECIFICATIONS	
1	Structure	Load Bearing Structure/Framed
2	Wall	Thin walls of Panels/Precast
3	Roof	Prefabricated with Steel
4	Flooring	Sheet/Tiles
5	Skirting/Dado	Sheet/Tiles
6	Plaster	May/May Not
7	Mud Fuska	May/May Not
8	Parapet	Prefabricated
9	Joinery	Prefabricated
10	CC Gola/Khurrah/Coping	May/May Not

- Hudco- Building Centres

BUILDING CENTRES- HUDCO

- Building Centres developed –for constructing;
- -- affordable housing
- -- employment/ income generation at local levels.- Imparting Training
- -655 (577 Urban + 78 Rural) Building Centres approved -- 442 Building Centres functional
- - Trained on-- cost effective- technologies -- over 3,10,854 artisans
- -introduced technologies in ---production of building components
- --construction of houses & buildings worth Rs1820 crores
- - Saving cost savings from 15 to 4--0% over conventional costs.

--Rated Best Practices -Global 100 List 1998 of the UNCHS (HABITAT)

--Number of Centre achieved sustainable-

-- helping creation of micro enterprises.

-- Introduced;

-- Solid/Hollow concrete Blocks

-- Pavement tiles -- substituting bricks.

-- Ferro Cement,

--FAL-G Products- Flyash lime –Gypsum products

--Wood Substitute Products

-- In southern states, --- ferro cement elements, FAL-G components, MCR tiles,

-Micro –Concrete Roofing Tiles RCC ---doors/window frames-- widely used in construction

MCR TILES- MICRO –CONCRETE ROOFING TILES

PREFEBRICATE BLOCKS-RURAL BC LEDEG

KARNATKA RURAL BUILDING CENTRE

BANGLURU BUILDING CENTRE

- Building Material Technology Promotion Council’
- India-BMTPC

BMPTC

- Established 1990,
- -promotion of— cost-effective, environment-friendly & energy-efficient
- innovative building materials / construction technologies
- for housing in urban / rural areas / disaster resistant tech.-Taking technologies from lab to land.
- Using , mechanization, standardization, dissemination, capacity building /field level application.
- . introduced building materials / technologies
- –using agro-industrial wastes
- --flyash based bricks/blocks,
- -- cellular light weight concrete,
- -- bamboo based materials, bagasse boards etc.
- -- Partial pre-fabrication / pre-fabricated components,
- -- Constructed houses -- for demonstration purposes.
- For increased productivity /quality, the Council -- developed easy-to-operate simple machines, used in construction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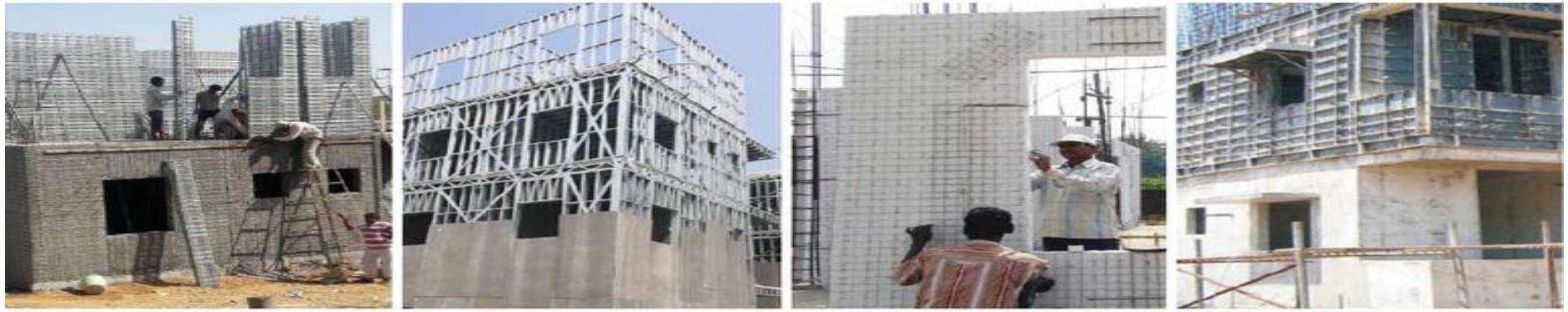
Compendium
of Prospective Emerging Technologies for Mass Housing

Third Edition

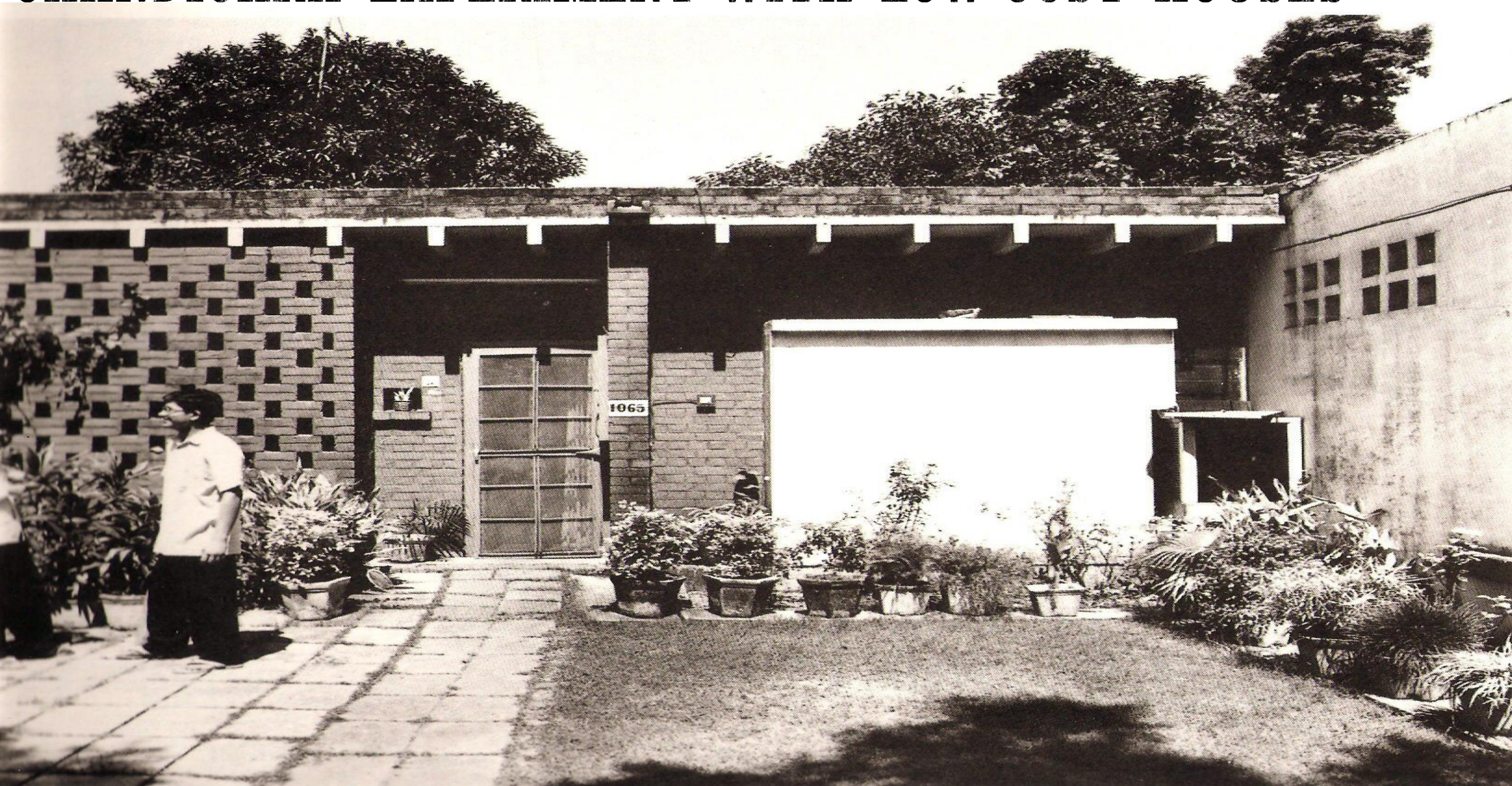
bmtpc

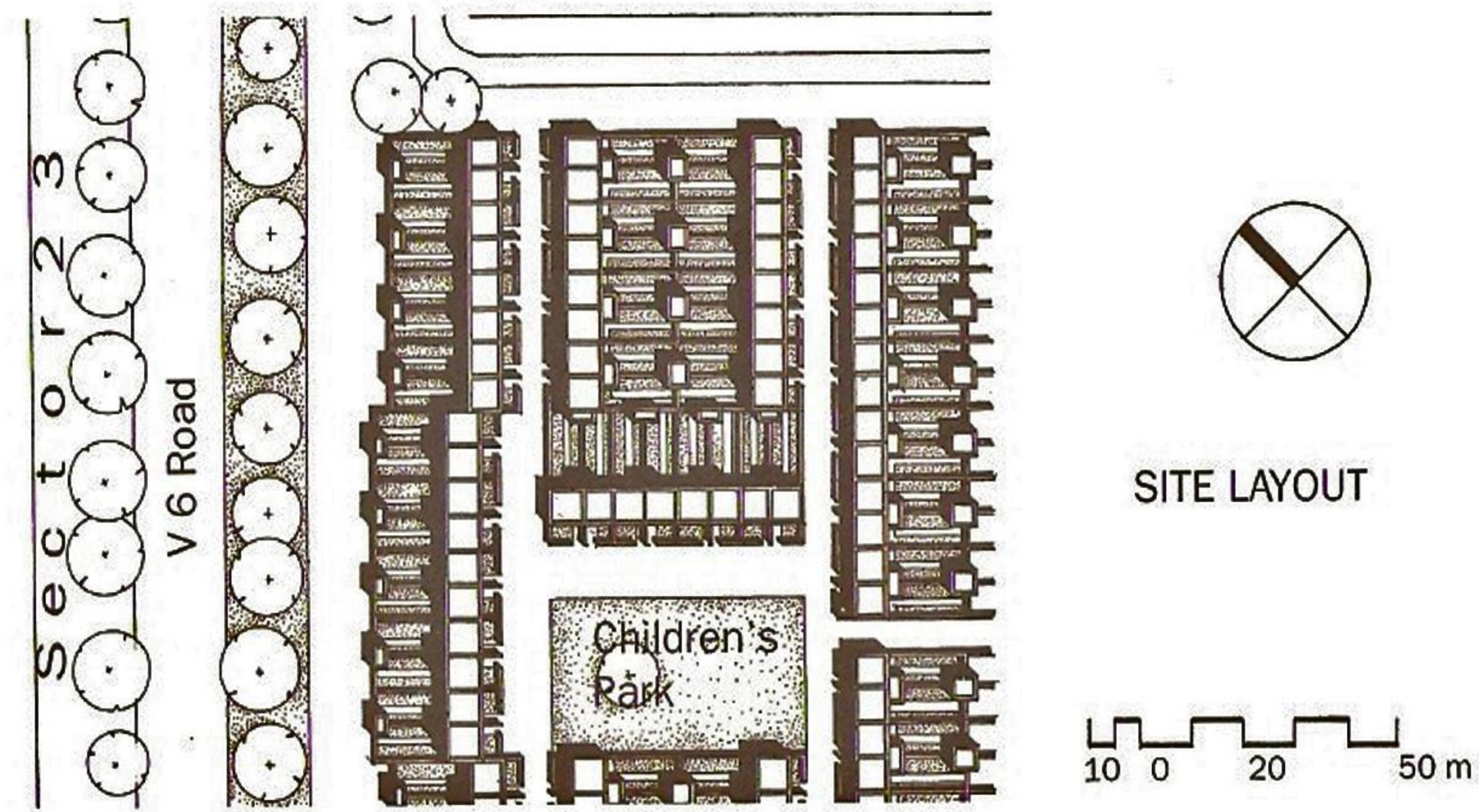
Building Materials & Technology Promotion Council
Ministry of Housing & Urban Affairs
Government of India



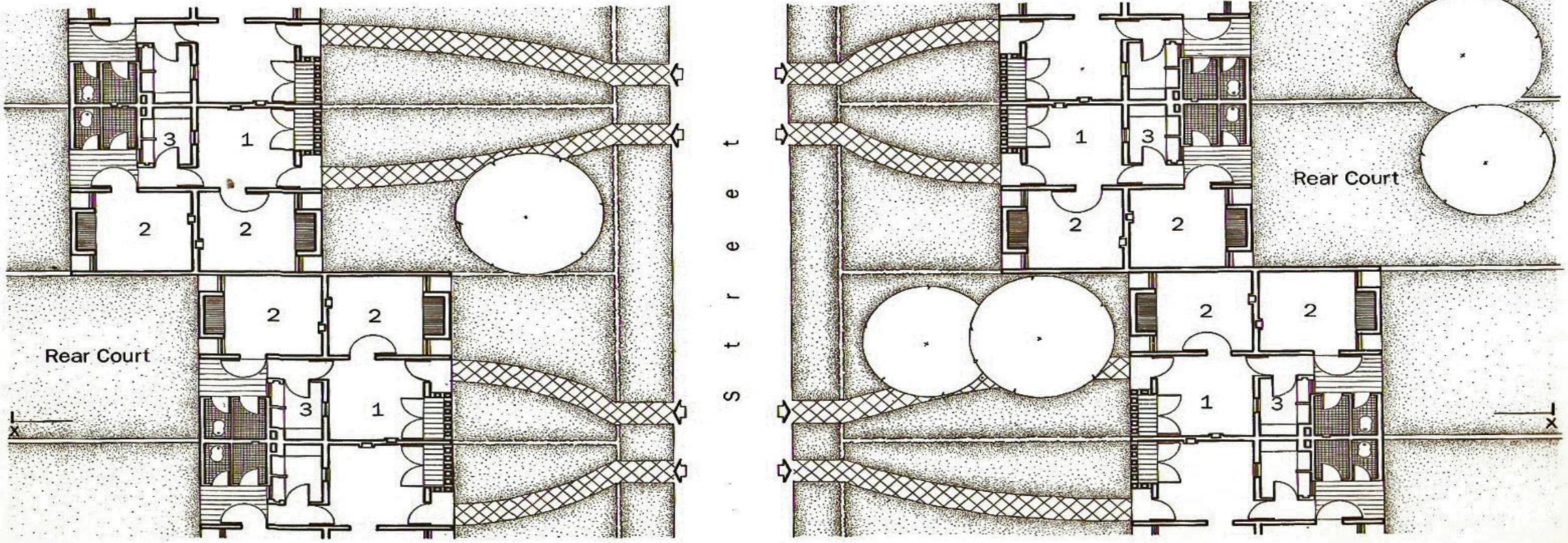
- Use Local Material In Natural Form Material

CHANDIGARH EXPERIMENT WITH LOW-COST HOUSES





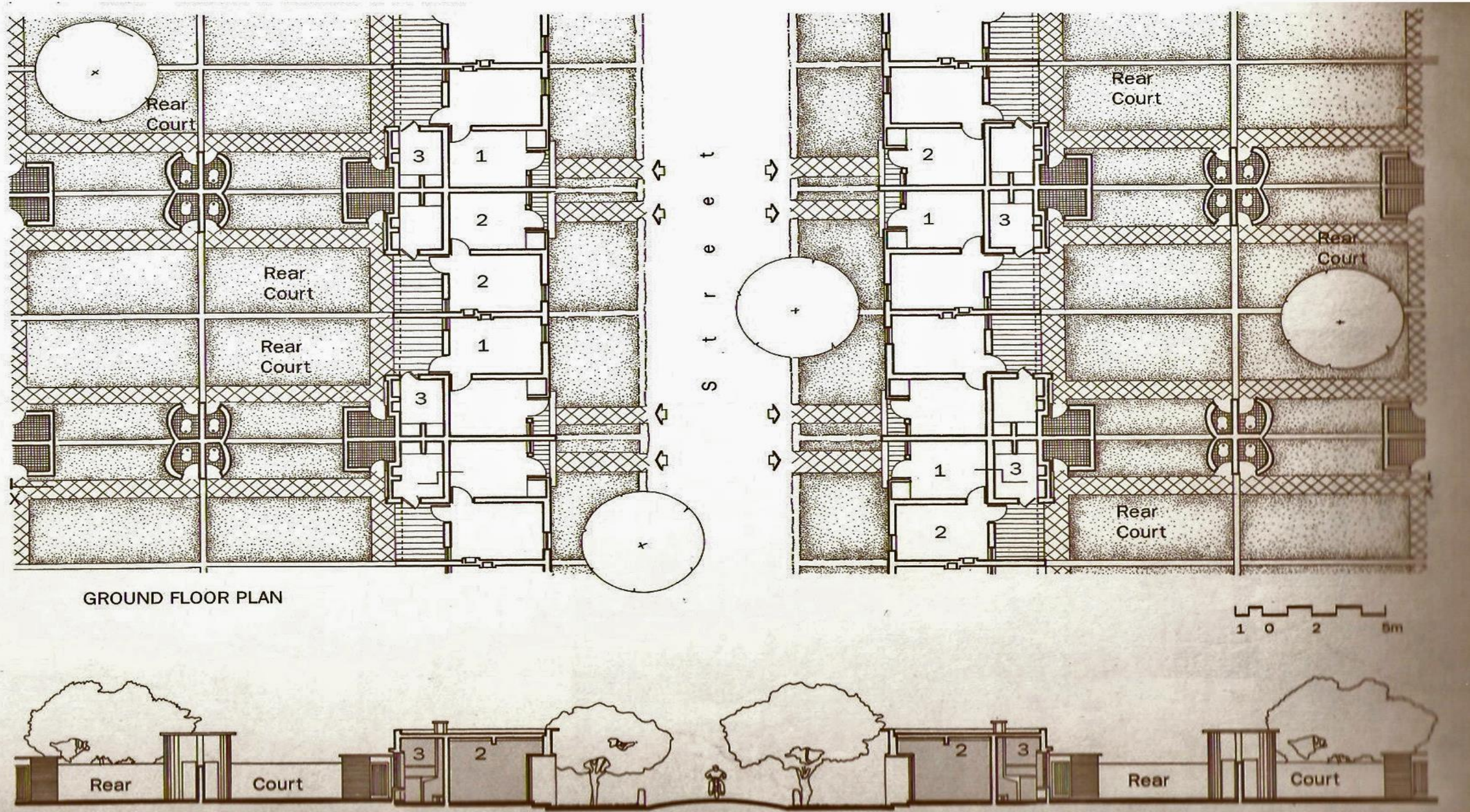
SITE LAYOUT



GROUND FLOOR PLAN

CHANDIGARH WAY OF COST- EFFECTIVENESS

- **Housing- Type 12**
- Cost-effectiveness -- Adopting design solutions providing for optimum utilization of space
- ; row housing to minimize area under walls;
- common walls between adjoining houses to economize on space and cost;
- using bricks, locally available ;using modular system of optimum grid of 8’-3”;
- using walls as the structural elements to support the roof;
- using pre-cast battens and tiles for the roof
- clubbing of services within house /adjoining houses
- ; extensively using brick jallis for perforation
- minimizing size of openings -to economize on cost of wood and glass;
- using standard battened doors with cross braces;
- bringing large area under exposed brick work to minimize maintenance;
- variety in design achieved through recessed entrances, small square windows, projecting structural walls, exposed roof battens
- using pre-cast gargoyles for draining rain water instead of cast iron rain water pipes;
- maximum height of room placed at 9’-6”;
- using simple floors made of plain cement;
- maintaining high quality of construction using quality bricks ;
- minimizing use of steel ,concrete and shuttering.
- Adopting a clustering approach in layout plan



GROUND FLOOR PLAN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SECRETARIAT

COLLEGE OF ARCHITECTURE

FRONT FAÇADE ADORNED WITH DEEP SCREEN OF PRE-CAST CONCRETE, A SORT OF MINIATURE brise-soleil

- Rat Trap Bond- Masonry

Lawrence Wilfred "Laurie" Baker (1917 – 2007) -- British-born Indian architect, renowned for cost-effective/ energy-efficient architecture -- that maximized space, ventilation /light / maintained striking aesthetic sensibility

Laurie Baker

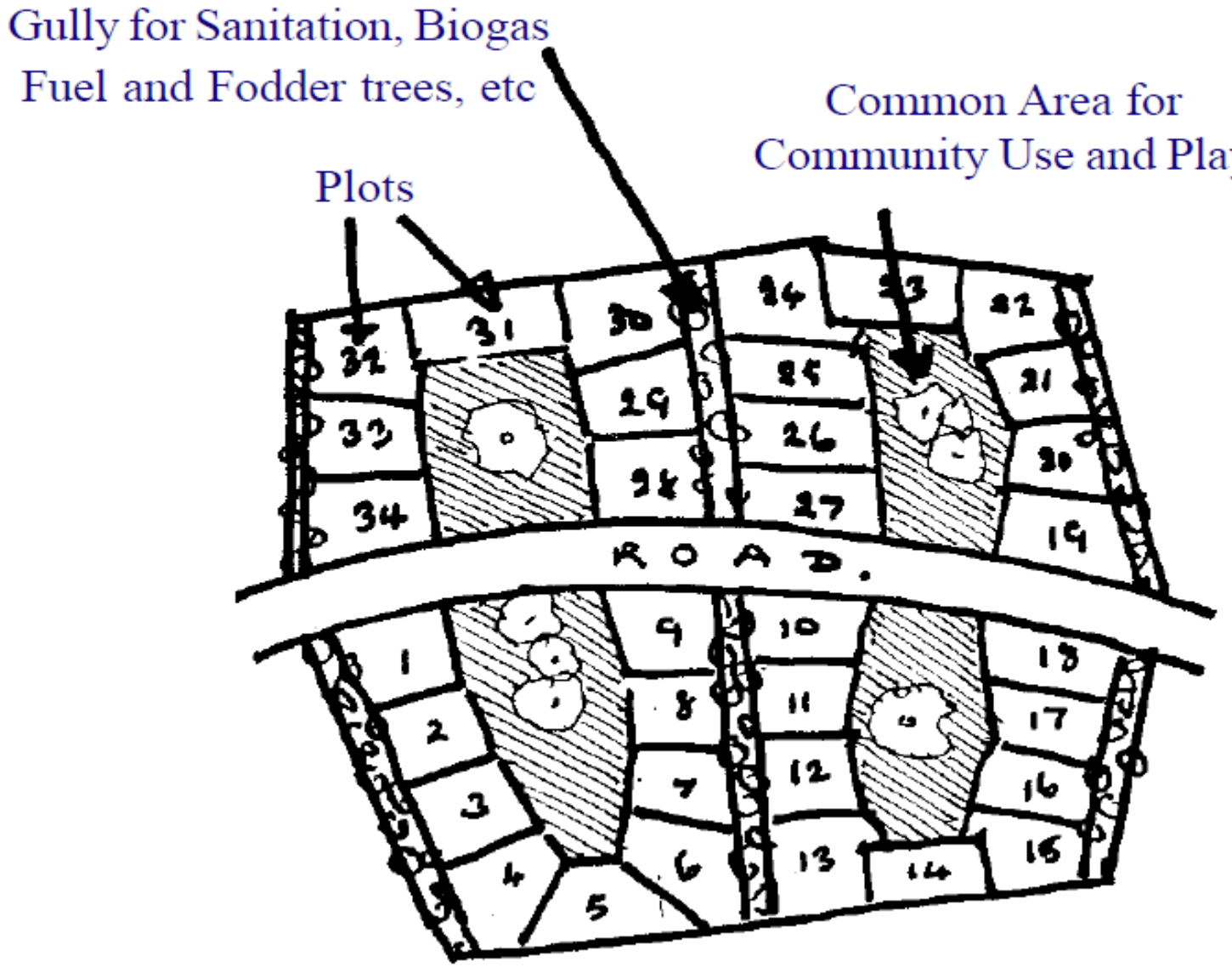
A MANUAL OF COST CUTS FOR STRONG ACCEPTABLE HOUSING

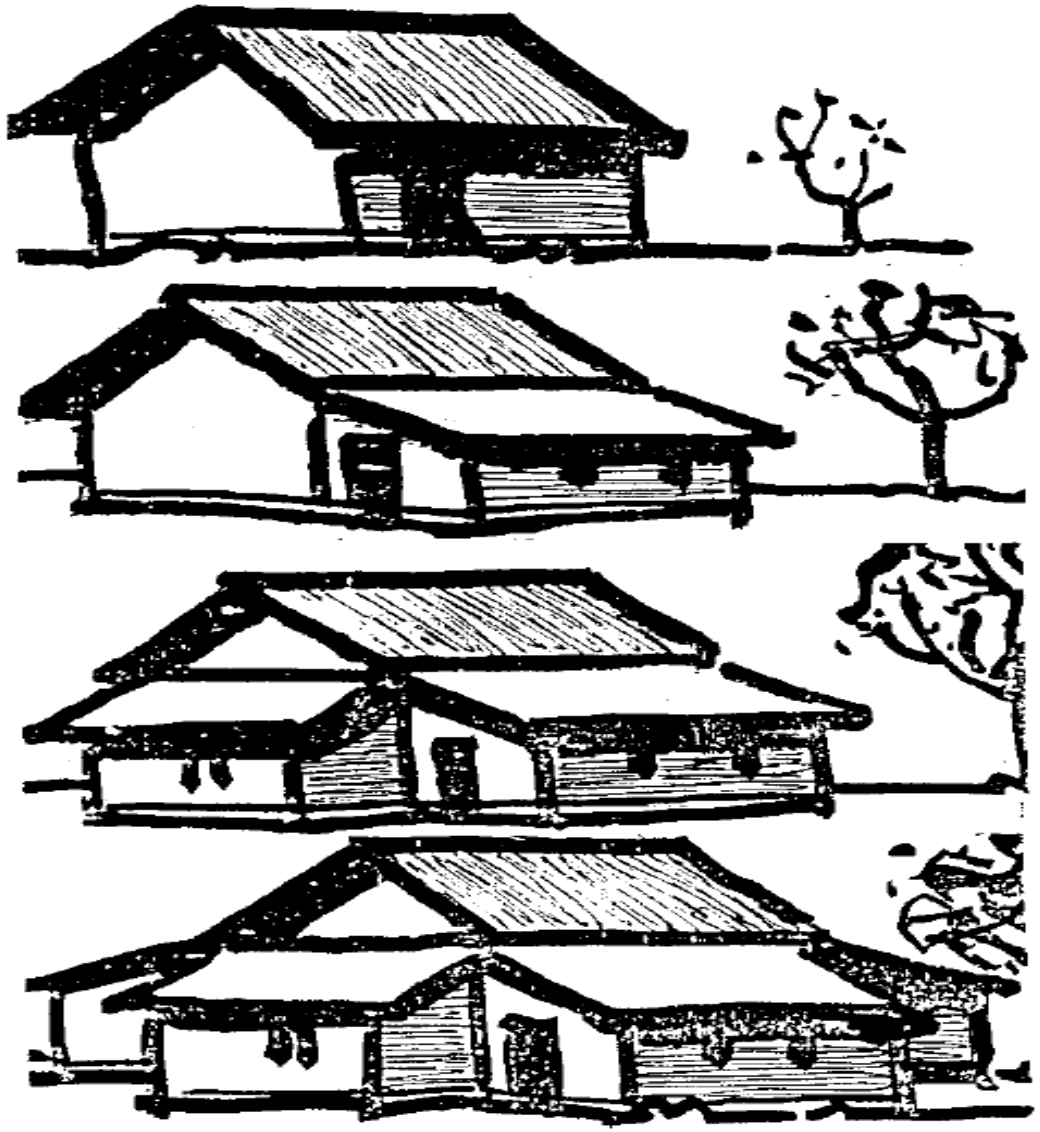
COSTFORD

COST- EFFICIENCY

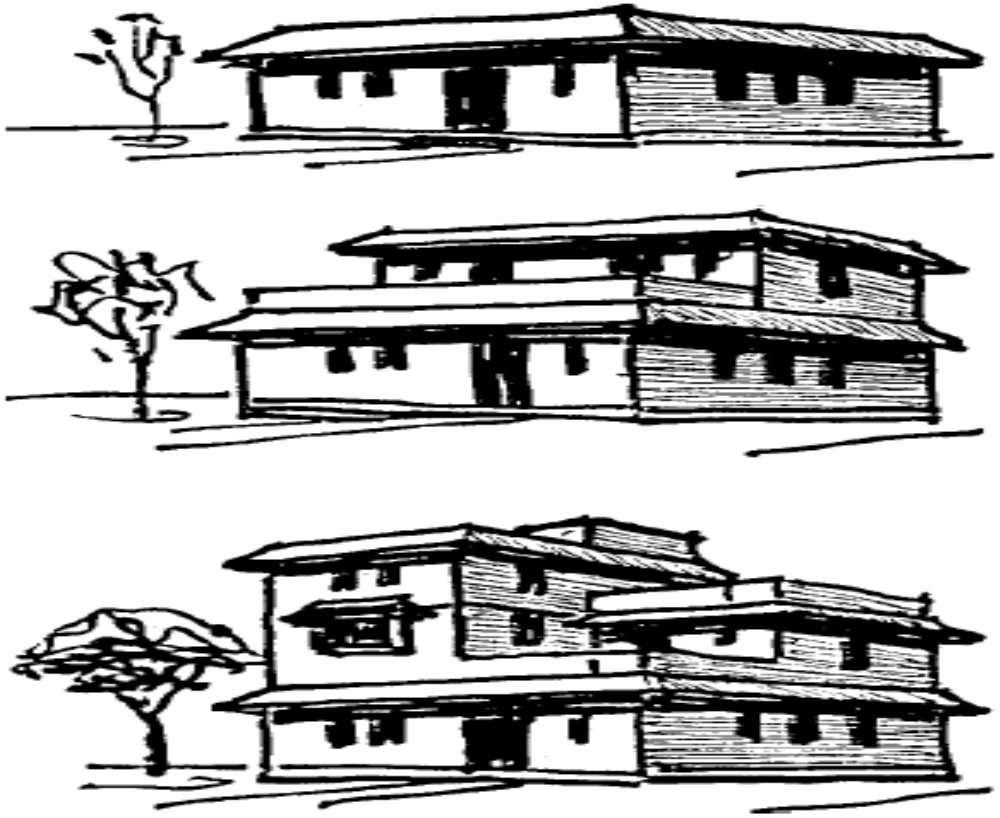
- With the country having millions of homeless families, it is imperative that what money is available
- must be used ONLY for essentials, and none of it for fancy frills!
- There are many factors that must be kept in mind;
- MATERIALS – are the materials we want to use for building LOCALLY AVAILABLE? If not – can we afford transport costs? Can we not use only locally available items as far as possible?
- Then we must ALWAYS keep the CLIENT in mind.--Remember that the CLIENT is the beneficiary – not a Government Department etc!--Will he be able to accommodate comfortably all his dependants?
- Will he be able to extend the house when, later, his sons grow up and earn money?
- Will the house be STRONG and SECURE?
- Can sheds or verandas be added by him for home occupations, like carpentry or weaving etc?
- Does the plan allow for local cultural and religious ways of living?
- What about water and sanitation? And what about approachability?
- Our aim of "Cost Efficiency" must include all these things.

MINIMUM ROAD THROUGH COMMUNITY CLUSTERS





A CORE HOUSE SHOULD BE DESIGNED BOTH IN PLAN AND SECTION SO THAT AS AND WHEN EXTENSIONS ARE TO BE ADDED, ROOFS, DOORS, WINDOWS ETC. ARE IN THE RIGHT PLACES.



A VERTICAL CORE HOUSE

IF A SMALL PLOT WILL NOT ACCOMMODATE LATERAL EXPANSION OF A SMALL HOUSE YOU CAN PLAN FOR FUTURE VERTICAL EXPANSION.

YOU MUST OF COURSE COVER YOUR GROUND FLOOR ROOMS WITH A FLAT ROOF AND IT IS PREFERABLE, ALSO FROM THE BEGINNING, TO PLAN FOR STAIRS.

THESE WILL MAKE YOUR FLAT ROOF UNABLE, AND OF COURSE WILL EVENTUALLY CONNECT THE ADDITIONAL FLOORS WITH THE ORIGINAL GROUND FLOOR.

RAT TRAP BOND- MASONRY

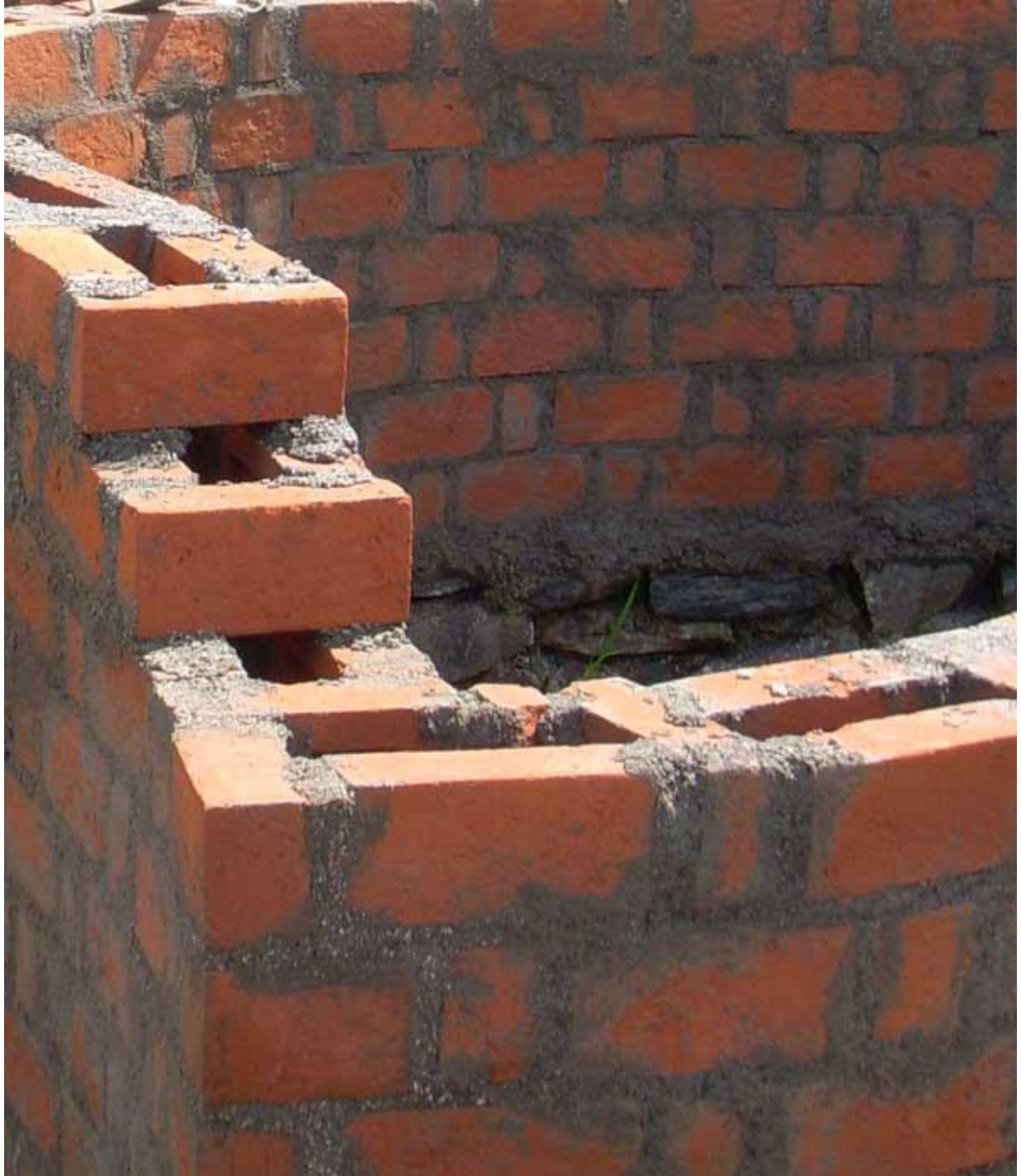
- Rat trap bond--Architect Laurie Baker introduced --in Kerala in 1970s
- -- brick masonry method of wall construction, in which;
- -- bricks placed in vertical position
- - instead of conventional horizontal position
- -- creating a cavity (hollow space) within wall. -- used extensively
- -- lower construction cost,
- -- reduces material
- -- provide better thermal efficiency
- --than conventional masonry wall
- --without compromising
- - with strength of wall

RAT TRAP BOND- MASONRY

- -Bricks placed in vertical position,
- - 110 mm face seen from front elevation, instead of 75mm face
- (considering brick of standard size 230 X 110 X 75 mm).
- - width of wall remains 230mm,
- -- internal cavity created.
- -- Saving Apprx 30% Material (brick and mortar)
- --Cavity--Reduces cost of construction
- -- Cavity provides- effective thermal/sound insulation
- --making rat trap bond-- energy /cost efficient building technology
- - resulting in cooler interiors during summer / warmer interiors during winter
- All vertical / horizontal reinforced bands/ lintels (for standard size openings),
- -- electrical conduits hidden inside wall,
- -- better aesthetic appearance without plastering (exposed brickwork)

RAT TRAP BOND- MASONRY

- Things to consider while using rat trap bond
- Good Quality Bricks used
- with consistent size /straight edges
- First layer (bottom) / last layer (top) of wall—
- should be solid (without cavity).
- Layer at sill / lintel levels of opening /
- sides of opening to be solid (without cavity) for fixing frames.
- Reinforcement bars put in vertical cavities at corners / around openings
- --to improve earthquake resistance. -- Reinforcement bars can be put in horizontally
- --to make lintels / improve earthquake resistance.
- Electrical conduits /plumbing pipes, with prior planning, --can be put inside cavity for better aesthetics.



FERRO-CEMENT

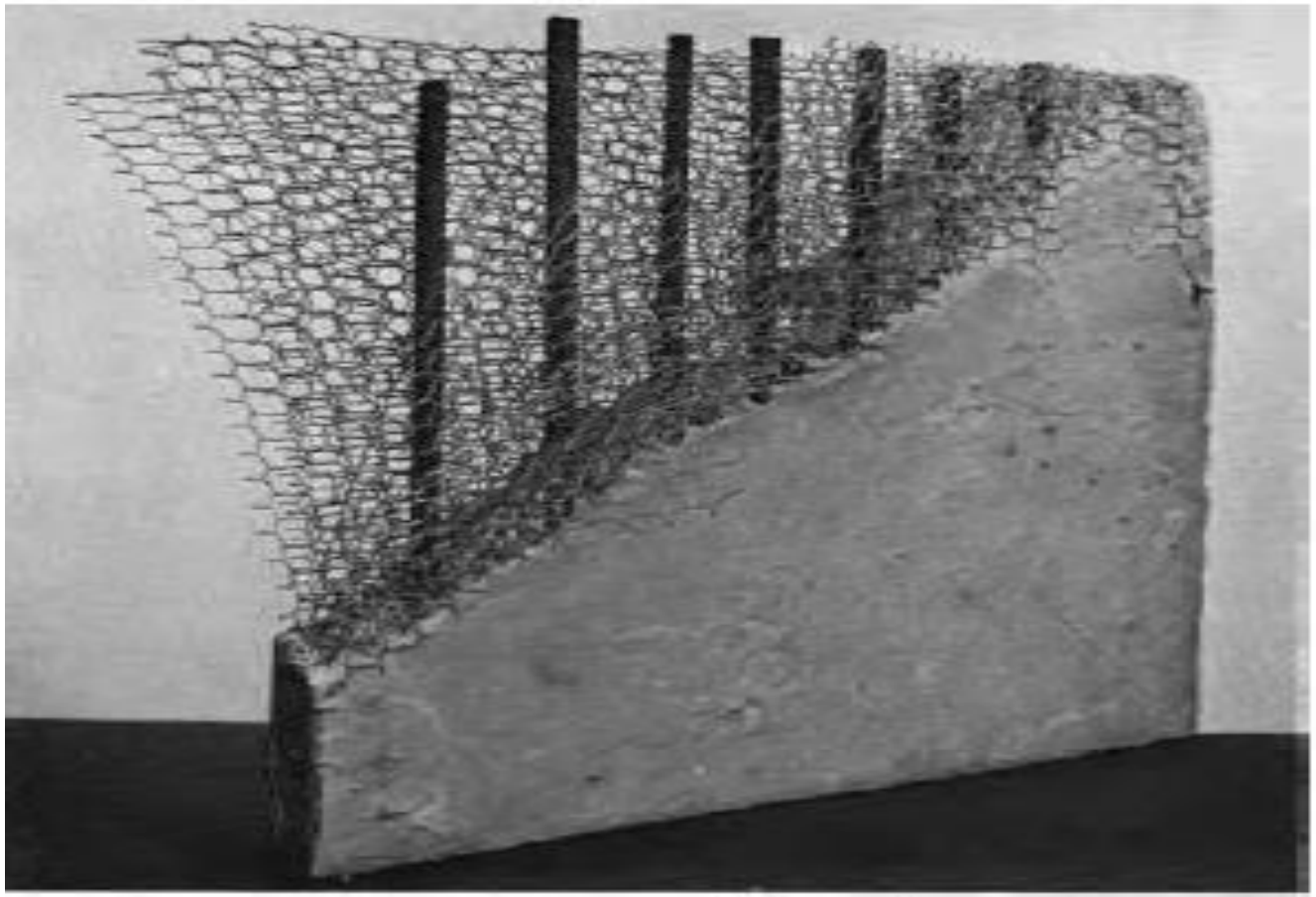
- Ferrocement-- a construction material consisting of;
- -- wire meshes / cement mortar.
- - Large Applications in construction due to
- -- low self weight,
- -- need for lack of skilled workers/ framework etc.
- developed by P.L.Nervi,-- an Italian architect in 1940
- . Quality of ferrocement works – assured
- -- because components manufactured on machinery set up
- -- execution time at work site is less.
- -- Cost of maintenance is low. .
- Strength depends on two factors-- quality of sand/cement mortar mix and quantity of reinforcing materials used.

FERROCEMENT ADVANTAGES & DISADVANTAGES

- ***Advantages***
- **Basic raw materials readily available.; Fabrication into any desired shape.**
- **Low labour skill required. Ease of construction, low weight and long lifetime.**
- **Low construction material cost. Better resistance against earthquake.**
- ***Disadvantages*-- Structures punctured by collision with pointed objects.**
- **Corrosion reinforcing materials-- incomplete coverage of metal by mortar.**
- **Difficult to fasten to Ferrocement with bolts, screws, welding and nail etc.**
- ***Process of Ferrocement Construction*--Fabricating skeletal framing**

FERROCEMENT TECHNOLOGY

- A thin walled composite concrete with a uniform distribution of reinforcement of chicken wire mesh and weld mesh, encapsulated in a rich cement mortar
- Drastic reduction in section thickness & reinforcement; by using an arch Geometry



APPROPRIATE TECHNOLOGIES

Construction of Ferro-cement
Columns and Slabs

MORE TECHNIQUES

FILLER SLAB

- Filler slabs employ replacing concrete by a 'Filler' material
- Reduces the weight of the slab
- Reduces Cost by reducing the amount of concrete used
- Lesser steel is required for reinforcement
- 25-30% Cost Reduction

MORE TECHNIQUES

JACK ARCH

- Provides a structure which eliminates tensile stresses in spanning an open space.
- Can strongly resist compression.
- Energy saving & Eco-Friendly compressive roofing.

MORE TECHNIQUES

FOUNDATION COST

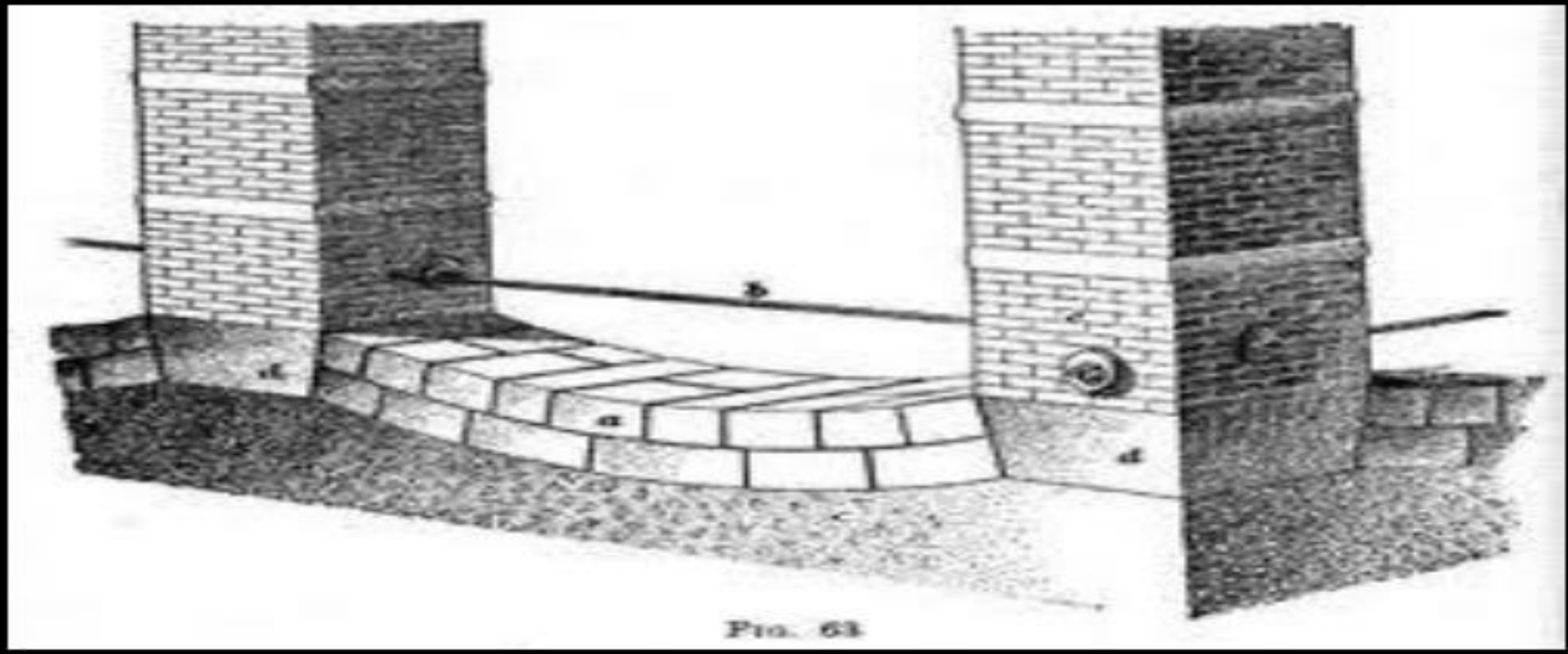


Fig. 63

- Normally the foundation cost is 10 to 15% of the total building .
- Arch foundation should be adopted in ordinary soils.
- In case of black cotton and other soft soils, pile foundation which saves about 20 to 25% in cost over the conventional method of construction.

MATERIALS

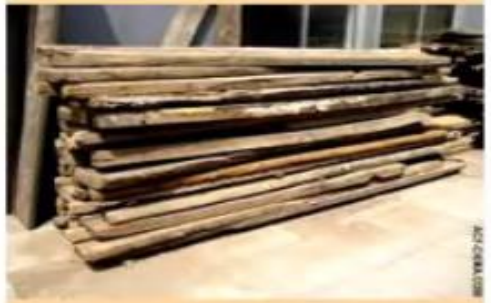
- Using cost-effective materials,
- Using pre-cast, pre- fabricated, re-cycled materials
- Using local materials,
- Using minimum variety of materials
- Using materials in the natural form
- Using recycled materials from demolished structures- bricks etc.
- Using available building components from old buildings- doors, windows, fixtures furniture etc.
- Using materials made from waste- fly ash bricks etc.
- Minimizing use of steel and Cement,
- Using materials requiring minimum maintenance and upkeep/replacement
- Using materials which are light weight
- Using materials which are easy to handle
- Using materials not occupying large space
- Using materials which can be handled by locally available labour and manpower
- Using materials which do not requiring specialized cutting and shaping
- Using materials not requiring special machinery and manpower for handling
- Using materials available in standard shape and size, having little variations
- Using materials requiring minimum fixing and bonding materials.
- Using limited number of variety of materials for flooring, roofing construction to avoid wastage
- Using materials which leaves no wastage.
- Using materials involving less quantity
- Using materials requiring less water for manufacturing/laying/curing
- Using materials requiring less energy for manufacturing- low energy
- Using materials which permit speedier construction
- Using materials involving minimum transportation

Sustainable Building Materials

❖ Focus Areas:

i. Building Reuse/

ii. Reuse of salvaged Material



iii.Material with Recycled Content

iv. Local Material/ Regional Material

v. Wood Based Materials

HOLLOW BLOCKS

Hollow blocks allow ;

- adoption of thinner walls
- increased floor space,
- air space of -- 25% block's total area,
- -- saves material.
- Lightweight
- - less self-load of building- -- - use less material for jointing
- - Withstand earthquake better
- - easy to install
- -- Since blocks are precast, -- surface is smoother

-- requires less plastering material.

.

INNOVATIVE MATERIALS

BAMBOO

i. **Strength at par with hard wood**--- Bamboo extremely strong natural fibre, on par with hardwoods-- when cultivated, harvested, prepared and stored properly

-- Bamboo, like true wood, is a natural composite material with a high strength-to-weight ratio useful for structures.

--**Bamboo has higher compressive strength than wood, brick or concrete and a tensile strength that rivals steel**

- ii **High Flexibility** - Bamboo highly flexible--during growth trained to grow in unconventional shapes.

-- After harvest, may be bent /utilized in archways / curved areas.

iii. **Earthquake-resistance** - Great capacity for shock absorption, -- makes it useful in earthquake- prone areas.

iv. **Lightweight** - Bamboo extremely lightweight.

- -- Building with bamboo can be accomplished faster with simple tools than building with other materials.

-Cranes /other heavy machinery rarely required.

- v. **Cost-effective** – Economical--- especially in areas where cultivated/ readily available.
- --Transporting cost also much lesser.
- -- Helps achieve cost effective construction.

BAMBOO

vi. **vi. Durable** - Long-lasting --as its wooden correlates, when properly harvested and maintained.

- ·vii. **Fast Growing--**Bamboo fast growing species / renewable resource which can be cultivated in most types of soil. ·
- viii. **Simple designing- D**esigns of Bamboo components being simple, there is no need of highly skilled labour.
- ·ix **Reducing use of wood--** Dependency on natural forests for wood reduced thus contributing to the protection of the environment.
- ·x **Eco- friendly--** As it can grow in many types of soil, bamboo cultivation is suitable for rehabilitation of degraded forests and other waste lands thus converting them into fertile lands to some extent.
- xi **Promoting Employment–** Creating employment opportunities especially for rural people --as Bamboo manually woven before making them into Bamboo Mat / Boards, Bamboo Mat Veneer Composites and Bamboo Mat Corrugated Sheets.
- ·**xii Promoting Welfare of society/poor- Promotes** overall welfare of the society, particularly of economically weaker section.
- xiii **Reducing GLOBAL warming-** Captures 17 mts CO_2 per hectare per year- more than any specie
- xiv **Improves indoor air Quality- By** removing carbon and adding oxygen when used as Indoor plant

INDIA PAVILION MADE OF BAMBOO AT SHANGHAI EXPO 2010

STRUCTURAL FLEXIBILITY OF BAMBOO

The circular base and large cone-shaped roof give the building the appearance of a bandstand. It can host up to 250 people for parties, banquets, exhibitions and music performances.

RESTAURANT IN BAMBOO

The roofs of all three new Naman Retreat structures are covered in thatch, helping to give the scheme an traditional appearance.

"This material creates a very tropical image together with the green landscape around the building that enhance the relaxed atmosphere of the resort," said the architect.

GREEN MATERIAL- FLY ASH BRICKS- ADVANTAGES

- **Reduced Embodied Energy: using Fly ash- lime-Gypsum bricks-- 40% reduction** in embodied energy of masonry.
- • **Environment Friendly: Fly ash brick uses unfired Fly Ash technology --** CO2 emissions in manufacturing process limited..
- • **Excellent Thermal Insulation: The buildings using fly ash bricks -- cool in summers and warm in winters**.
- • **Fire Resistance: very high--** as these bricks composed of fly ash as its major constituents, which is un-burnt residue of the coal fired in a thermal power plant.
- • **No Efflorescence: Fly ash bricks resist salt and other sulphate attack, ensuring no** efflorescence in structure.

GREEN MATERIAL - FLY ASH BRICKS

INNOVATIVE MATERIALS

MUD

- Mud as a construction material has been extensively used since ancient times.
- Less embodied energy
- Various techniques used with number of stabilizers to construct with mud.
- Mud construction is mainly found in places which are
  - relatively dry and
  - have mud in abundance.

INNOVATIVE MATERIALS

PRECAST STONE BLOCKS

- **Made by using waste stone pieces .**
- **Shaping stones enables speedy construction**
- **saves on cement,**
- **reduces thickness of stone walls .**
- **Saves Plaster Works.**

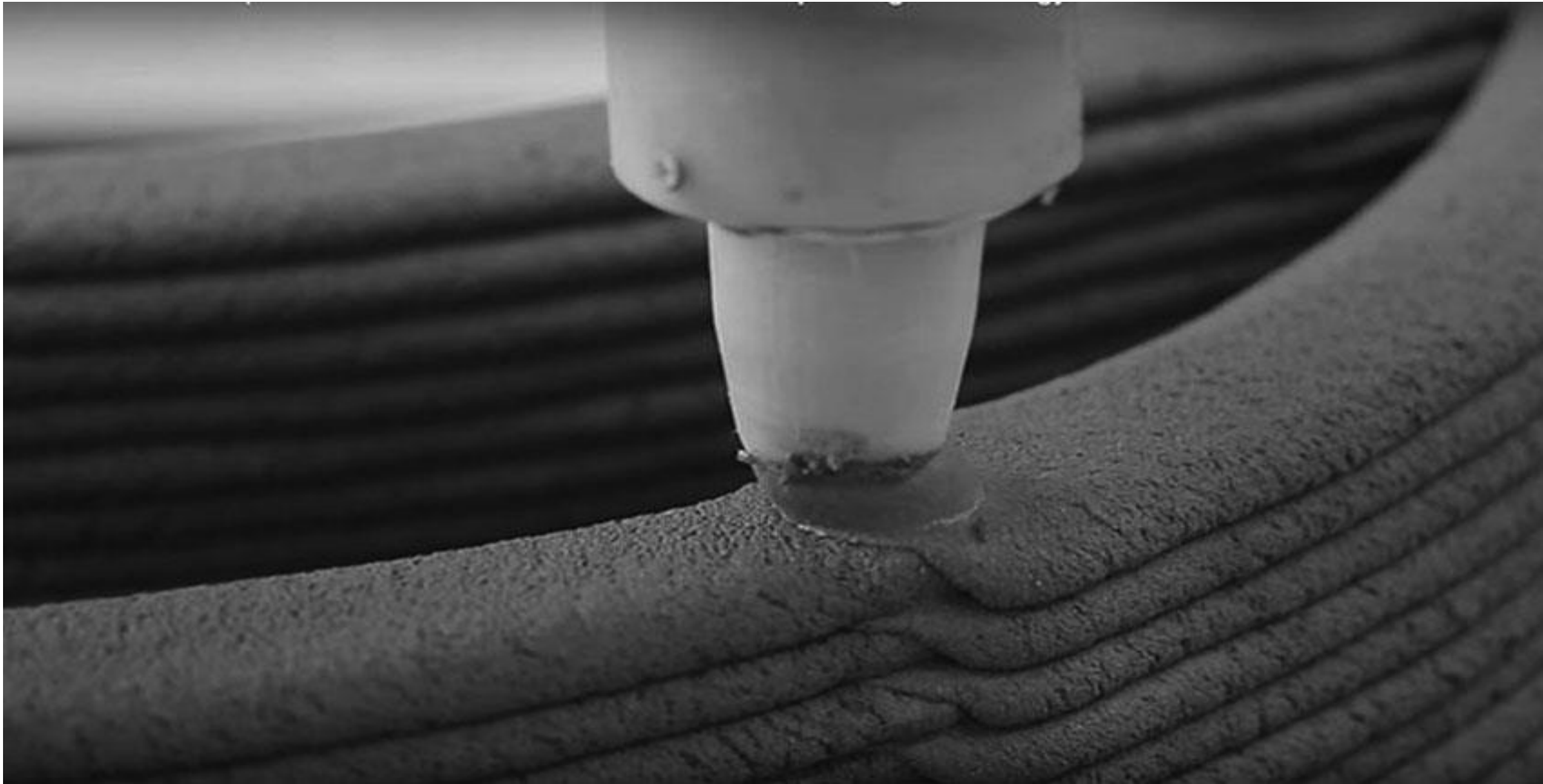
INNOVATIVE TECHNOLOGIES

In rural Nigeria, a few creative visionaries have created something called bottle brick technology that

AUSSIE BRICK-LAYING ROBOT WORKING 20 TIMES FASTER THAN HUMAN BEING

UK CONSTRUCTION SECTOR TO EMPLOY 5,000 DRONES BY 2030

3D PRINTING TECHNOLOGY



STAY LEAN WITH CLOUD BASED TECHNOLOGY

VIRTUAL REALITY - GOOGLE, SAMSUNG, APPLE, FACEBOOK, MICROSOFT
WORKING ON TECHNOLOGY


BIM for Investor


BIM for Designer


BIM for Contractor


BIM for Manufacturer


BIM for FM / Maintenance


Thank You!