राष्ट्रीय ग्रामीण विकास एवं
पंचायती राज संस्थान
NATIONAL INSTITUTE OF RURAL
DEVELOPMENT AND PANCHAYATI RAJ
Ministry of Rural Development, Government of India

TRAINING & CAPACITY BUILDING | RESEARCH & CONSULTANCY | POLICY FORMULATION & ADVOCACY | TECHNOLOGY TRANSFER | ACADEMIC PROGRAMMES | INNOVATIVE SKILLING & LIVELIHOOD

National Rural Building Centre

Blending the Traditional with Modern Technologies

Rural Technology Park

Centre for Innovations and Appropriate Technologies (CIAT)

National Institute of Rural Development and Panchayati Raj (NIRDPR)
Ministry of Rural Development, Government of India, Rajendranagar, Hyderabad - 500030, T.S., India

NATIONAL RURAL BUILDING CENTRE (NRBC):

Showcasing Appropriate || Sustainable || Cost-effective || Environment-friendly housing models

As part of the efforts to support the Government of India's rural housing programme in India, the NIRDPR, Hyderabad has established the 'National Rural Building Centre' (NRBC) on the Rural Technology Park premises. The centre is one of its kind, established to showcase live demonstrations of various sustainable housing design typologies. The centre also undertakes skill development training programmes for engineers, masons and entrepreneurs on various sustainable construction techniques and production of necessary building materials.

The range of sustainable building typologies showcased at the NRBC are a blend of both the traditional and new techniques of construction. The technologies depicted are suitable for disaster-prone locations (earthquake, cyclone, fire, etc.). These structures are erected utilising the locally available resources and skills of the people. The cost of construction will be in the range of 25 to 40 per cent less than that of the conventional construction methods. The variation in cost will depend on soil typology and local availability of resources and labour. Over 100 different sustainable housing techniques are depicted in the 20 structures built in this centre. All of these structures are environment-friendly, as they are based on green building concepts.

The NRBC houses have four different domains:

i) Demonstration of Appropriate Housing Typologies
ii) Building Material, Design and Production Unit
iii) Sanitation Park
iv) Water Management, Roof-top Rain Water Harvesting, Water and Wastewater Management Resource Centre

Cost-effective Housing Models: Blending Traditional with Modern Technologies

1. JACK ARCH UNIT

This is one of Laurie Baker's cost-effective technologies. Jack Arch roofing is an alternate technology to the normal RCC roofing. They are easy to construct and more suitable for hot climatic conditions. Brick arches are provided over the beams in semi-circular shape and plastered on the outer surface.

A small formwork is required for the arches which can be removed in two to three days. This technology requires no steel or concrete. The other technologies adopted in the structure are non-erodible mud plaster for the outside and inside walls. The plan essentially consists of two small rooms to be functional as shops. This is a model plan and design of Laurie Baker's technology.

2. RAT TRAP BOND BRICK WALL

This typology is Laurie Baker's cost-effective design. The concept is based on making a judicious choice of structural designs and materials. Hexagonal shaped rooms can be built using Rat Trap Bond brick walling and Filler Slab roof. The Rat Trap Bond construction technology is a cavity walling system designed to optimise the use of bricks and cement mortar. A model anganwadi building is constructed in RTP.

One room can be used as a classroom for pre-school children and the second room can be used as residence for the anganwadi workers. Front and rear open air enclosed verandahs have been provided, which may be used as classrooms or for children to play in a safe and enclosed area. Hexagonal shape is given to provide an aesthetic appearance. The other technologies used are brick arch foundation, brick *jallies,* brickbat flooring and non-erodable mud plaster.

3. MUD BLOCK STRUCTURE

In this typology, sun dried mud blocks with or without terracotta face tiles have been used to construct the walls between the columns. They can be made at the site and used directly. A simple mould is used to make the mud blocks. Stabilised mud has been used to plaster the walls. This technology is not new or even 'rural'. It is an economical option to build a small home without using energy-intensive material.

The spherical roof is made with conical tiles known as 'Wardha Tumblers' and the top is covered with cement plaster, waste and broken glazed tiles to prevent water seepage. Fly ash bricks have been used as columns with the vertical reinforcements provided. Plinth and lintel level beams have been provided to withstand earthquakes.

4. STONE MASONRY HOUSE

Stone masonry is a traditional building technology in the rural areas of Uttarakhand and in Himalayan regions, where different varieties of stones are found in abundance. Stones are used to make foundations and walls in rural areas. In this typology, two floors are constructed with separate entrances provided for each floor. The entrance to the ground floor is from the ground and to the first floor it is from the hillside. This makes both the floors independent from each other, based on the topography of the area. The ground floor has a cow shed in one part. The first floor consists of rooms used as living rooms with a large space. A large wooden balcony is provided in the front on the first floor. Similarly, on both sides of the building, two small balconies are provided. There is also a provision made for roof water harvesting, which is essential for optimum use of rain water.

5. BAMBOO HOUSE

Indigenous bamboo housing is unique in India's rural tapestry since time immemorial. Rural people have used bamboo houses extensively as dwelling places. Bamboo houses are ideal for earthquakes and flood-prone regions as they reduce human casualties. It is light weight, no energy, low-cost, eco-friendly and a self-sustaining material available in many parts of the country. Bamboo groves can be easily developed in the backyards of rural homes. Bamboo is the traditional medium of shelters in the North-East. These types of houses are self-sustaining and eco-friendly, and also provide job opportunities in rural areas. Good quality bamboos are treated before use in the columns and formwork. Bamboo crete wall made using cement mortar. Bamboo mat corrugated sheets are used to cover the roof, and bamboo ply can be used for interior partitions and decor. Products developed using modern bamboo technologies like bamboo composites, panels and corrugated sheets offer exciting and exotic prospects for making cost-effective houses.

6. WATTLE AND DAUB HOUSE

The geography of Sikkim ranges from low hills to high altitudes, interspersed with valleys. Landslides/slips are an annual occurrence. Cement and steel costs are high. Thus, the existing structures are traditional houses built using locally available materials.

The design typology has been executed retaining the traditional basic features, such as, framework based on stills, wooden and mud flooring, stabilised mud blocks by 'ram rod' method, bamboo walls plastered by mud or lime mortar and CGI roofing, based on steel framework. Roof water harvesting is yet another feature. The traditional techniques of making low-cost walls based on bamboo's splits plastered with mud is known as Wattle and Daub walling. One coat of lime plaster is applied on the wall along with non-erodable mud mix. The wattle and daub walling is provided between rammed earth columns. Vertical and horizontal bands are provided to protect against earthquakes.

7. BRICK DOME STRUCTURE

Brick dome roof making is a part of the rich architectural heritage of India. Lauri Baker - the Messiah of cost-effective building technology - has been reenlisting interest in this technology among the rural masses. Dome construction is being revived due to its aesthetics, cost, durability and savings in energy. Only bricks are used to make the dome roof without concrete. No steel is used. No centring is required. It is labour-intensive because only two rows at a time are made on a daily basis. The other cost-effective technologies used are the ferro cement arch roofing, rat trap bond walls, brick *jallis* for windows and arch type stone masonry foundation. This typology is a low cost community structure, designed to function as Panchayat house. The plan consists of a hexagonal central hall and a corridor around it. It retains all Laurie Baker's fundamentals of reducing costs. Yet, its grandeur and ethnic look is unique.

8. FERRO CEMENT CHANNEL CONSTRUCTION

A Ferro Cement (FC) channel is a longitudinal, semi-circular pre-cast channel prepared by using a simple mould. It is made by covering layers of mesh with cement mortar on both sides. It has the same strength as an RCC slab, but cement and steel used are much less. It is durable, light, waterproof and cost-effective. Concrete mixer, vibrator, scaffolding, shuttering are not required for this construction. A simple manufacturing unit with a large open space for pre-fabricating and curing the channel is essential. If the channels are not manufactured at the site, proper transportation has to be organised to avoid damage. This typology is low-cost housing under the Indira Awas Yojana Scheme and is based on participatory labour contribution. This will enable the rural poor to own a house at an affordable cost.

9. FILLER SLAB DWELLING UNIT

Filler slab is Laurie Baker's cost-effective technology roofing, which is eco-friendly and socially acceptable housing is necessary to meet the housing shortages in rural areas. In this typology, the roof is made of solid reinforced concrete slab. The concrete in the tension zone is replaced partially by low-cost and light filler material such as conical tiles, wardha tumbler, brick panels, hollow clay tiles / blocks or Mangalore tiles. The filler material can replace 25 per cent of the concrete thus, saving 15-20 per cent in the cost of construction.

A multi-functional mezzanine floor provides additional space under the sloping roof. Walls and columns are made of fly ash bricks. This typology has been successfully executed under the Indira Awas Yojana Scheme. Several models have been planned and this design is meant for an economically weaker section family unit. With slight modifications, it can be built in the coastal regions prone to Tsunami.

10. LATERITE STONE CONSTRUCTION

The word 'laterite' is derived from the Latin word 'Laterite's' which means brick stone. It is a red or brown superficial deposit of clay or earth, which gathers on the surface of rocks and is produced by their decomposition. However, it is strong and stable and is cut out of the ground in the form of blocks. It hardens further when stacked and exposed to air. It is rich in iron and is found in many tropical regions. It is abundantly available in Goa, Maharashtra, Kerala, Karnataka and other places of the Deccan peninsula and places along the east coast in Odisha. Buildings with exposed laterite are actually fashionable, giving them an ethnic look. In Karnataka and Kerala, laterite stone masonry has been incorporated in the Government Schedule of Rates of construction.

11. TRADITIONAL MUD HOUSE

Mud is nature's gift to mankind. It is readily available, widely accepted, strong, durable and a low-cost building material. It is used extensively by the rural poor for building their home. Cost-effective technical developments have improved its bonding characteristics. The Karnataka typology is based on the use of a mix of mud with hay, (COB), which enhances bonding characteristics of the material. COB techniques - traditional composition of mud and hay are used to construct walls and are commonly found in rural Deccan peninsula. The roof is covered with Mangalore tiles. This structure is eco-friendly and cost-effective, which is recommended for community purposes in rural areas.

12. STABILISED MUD BLOCK HOUSE

The concept of the Bhunga can be traced to the Meghwal-the traditional building and craft community for the *Maldharies* (Nomads) of the Banni region of Gujarat. The development of the circular thatched conical roof Bhunga can be traced back to the period after the 1819 earthquake. The 2001 earthquake took the tradition one step further. Modern technologies have been blended with the traditional design to make these cost-effective structures. The low and circular walls prevent from developing cracks. The cluster of two circular wall- hexagonal shaped roof structures offer many unique cost-effective technology features. They rarely collapse as they have an arch action in the lateral thrusts of an earthquake. Stabilised mud blocks have been used to construct walls. Plinth sill and lintel horizontal bands along with vertical reinforcements, which have been provided to enhance earthquake resistance capability. Mangalore tiles have been used to make the roof and secured by M.S. Wire to the wooden framework to withstand cyclonic gales.

13. STONE PATTI HOUSE

In rural Rajasthan, three factors determine housing design and construction method in the past: physical security; (weather-heat or cold) and locally available stone, mud and lime mortar materials. Today, the change is easily discernible i.e., cement is replacing mud and lime mortar for stones jointing, roof waterproofing and wall plastering. Provision of a central courtyard with three walls on one side and the dwelling place on the other side is the traditional design to meet the functional needs. Stone patties and joists are used to make the roof flat or sloping on stone masonry walls. The desert conditions make it necessary to enclose the central courtyard with high walls and small wind apertures to allow air circulation as well as preventing dust blow-ins during sand storms. The modified typology is designed as a school building with two rooms and corridors are provided on both sides of the building. A staircase has been provided to go to the open terrace, which may be used as an open-air classroom during winter/rain water harvesting for the whole roof area has been provided and it is connected to a tank constructed at the ground level in the verandah.

14. BRICK PANEL HOUSE

The speciality of this typology is usage of brick panels for roofing. The brick panels innovated by Central Building Research Institute (CBRI), Roorkee, have been standardised for replication by local masons/artisans, using locally available materials. Pre-fabricated brick panel and partially precast joists require burnt clay bricks, cement, sand, coarse aggregate and reinforcing steel as major raw materials. No major plant, equipment and machinery is required. The brick panels are durable, leak-proof, fire-resistant, thermal-efficient and less noisy during rains. They are very cost-effective and generate employment opportunities in rural areas for masons/labourers. This typology is based on Laurie Baker's cost-effective construction style and is designed to be utilised as a health centre. The space is planned for a doctor's room, dispensary, waiting room, four-bed sick bay, residence for nursing staff and toilets.

15. CONVERGENCE INITIATIVE UNDER MGNREGA

Awareness-cum-Demonstration Workshop for Mason/Artisans was organised by RTP-NIRDPR, Hyderabad, in collaboration with UNDP & COSTFORD during 1st September to 15th September, 2014 with 53 participants from 17 States. During this training period, the participants constructed two permanent buildings, which are being used by the NIRDPR. This typology is Lauri Baker`s cost-effective design. The concept is based on making judicious choice of structural designs and materials. It is holistic in this approach, which includes site selection, foundation techniques, walling, roofing, plastering and flooring. Rectangular shaped rooms have been built using Rat Trap Bond brick walling and filler slab roof. The Rat Trap Bond construction technology is a cavity walling system, designed to optimise the use of fly ash bricks and cement mortar. One room can be used as village office for meeting of SHGs and other room for office related materials keeping.

16. PRE - FABRICATED STEEL HOUSE

The steel house is designed and promoted by the Institute for Steel Development and Growth (INSDAG) to address the housing problem of low income communities, especially located in remote areas and earthquake zones. The house is built using pre-fabricated steel frames and ferro cement panels which are welded in a given site after transportation from the industry. As the ferro cement panels for the roof as well as the walls are welded to the steel frames, there is no need of centring or shuttering works. This is an innovative housing technology which is especially suited for remote areas where conventional construction materials are not available. The design is earthquake-resistant and also durable. The cost of the steel house is also low. The thermocol is used in between panels to provide good thermal insulation.

Water Management, Rooftop Rainwater Harvesting and Water & Wastewater Resource Centre

In the 65 acres premises of RTP, various soil and water harvesting structures have been established to demonstrate the effectiveness of such initiatives to officials and community representatives visiting the campus. The soil and water harvesting structures taken in the campus include contour bunds, field channels, contour trenches, staggered trenches, gully control structures, gabions, check dams and percolation ponds. Besides these, all the buildings which are constructed have been provided with roof-top rain water harvesting system in addition to wastewater recycling systems.

The 'Water and Wastewater Resource Centre' (WWRC) is an initiative aimed at providing demonstration and technical assistance on various technologies of water conservation and wastewater management systems. The Centre will act as a nodal point for providing information, technical support and trainings to village functionaries, government officials, Non-Government Organisations (NGOs,) Community Based Organisations (CBOs), Village Level Institutions (VLIs), students, etc., on water and wastewater management.

Rural Sanitation Park

An attempt has been made to showcase appropriate sanitation models in the Rural Technology Park. The sanitation park was built to enable rural development functionaries to build their knowledge and accelerate transfer of appropriate sanitation models to people. Each model in the park seeks to demonstrate something special, whether it is improvising locally available materials or the adoption of a particular practice or a technique. Nevertheless, there is an effort to ensure that whatever has been showcased is workable. The focus is on three areas: low-cost, less water usage and, most importantly, solid and liquid waste treatment for gainful agricultural activities. To reduce the costs of construction of these models, different cost-effective building materials and techniques are adopted. In order to ensure less usage of water, rural pan with higher slope have been adopted. The different sanitation models which are demonstrated in the park can be grouped broadly under the following categories:

a. Conventional toilet system
b. Wastewater management
c. Domestic sanitation models
d. Solid waste management
e. School sanitation model
f. Waterless urinals
g. Anganwadi sanitation model
h. Eco-san and Bio-toilets
i. Community model

The sanitation models which are showcased in Rural Sanitation Park are as given below:

01. Conventional model based on Septic Tank
02. Two Pit Latrine with Flap Seal Pan and Brick Works
03. Twin Pit Latrine with Brick Panel
04. Twin Pit Latrine with Pre-cast Concrete Blocks
05. Circular Twin Pit Toilet with Bricks
06. Circular Twin Pit Toilet with Pre-cast RCC Rings
07. Bamboo Mat Ply Superstructure
08. Bamboo Reinforced Leach Pit
09. Single Leach Pit Toilet with P-Trap Pan
10. Burnt Clay Segment Leach Pit
11. Modified Midnapur Toilet
12. Eco-Sanitation Toilet
13. Bio-Toilet
14. Deenbandhu Biogas Plant with Toilet
15. Waterless Urinals
16. Anganwadi Toilet Block
17. School Sanitation Toilet Block Model
18. Community Toilet & Urinal Block
19. Soak Pit for Bathroom Platform
20. Spill Water Recycling Model
21. Gappi Fist Tank
22. Kitchen Waste Biogas Plant
23. Household Vermicompost
24. Nadep Composter
25. Home Composter
26. Kitchen Waste Composter cum Planter
27. Shivnash Composter
28. Waste Decomposer for Solid Waste

WATERLESS URINAL TECHNOLOGY

Waterless urinals do not require water for flushing and can be promoted at homes, institutions and public places to save water energy and to harvest urine as a resource. Reduction in infrastructure required for water supply and water treatment is also a spinoff arising from installing waterless urinals. The concept founded on the principles of ecological sanitation helps in preventing environmental damage caused by conventional flush sanitation systems. Waterless urinals result in saving anything between 56,800 litres to 1,70,000 litres of water per urinal per year. Also, the dry operation of waterless urinals and touch-free operations reduce spreading of communicable diseases.

WASTE MANAGEMENT TECHNOLOGIES

Nadep Composter

Kitchen Waste Composter-cum-Planter

Bio-Waste Composting

Cost - effective Sanitation and Wastewater Management Models

Burnt Clay Segment Leach Pit

Circular Twin Pit Toilet with Bricks

Single Leach Pit Toilet with P-trap Pan

Two Pit Latrine with Flap Seal Pan and Brick Work

Twin Pit Latrine with Pre cast Concrete Blocks

Bamboo Mat Ply Superstructure

Eco-sanitation Toilet

Anganwadi Toilet Block

Bio-Toilet

School Sanitation Toilet Block Model

Spill Water Recycling Model

Soak Pit for Bathroom Platforms

Conventional Model based on Septic Tank

ENVIRONMENT-FRIENDLY HOUSING MODELS

(DIRECTOR GENERAL'S BUNGALOW)

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