CONSTRUCTION MANUAL FOR ARTISANS & MASONS

COASTAL AREAS

ARTISANS CONSTRUCTION MANUAL

ABOUT THE MANUAL

This manual specifically looks at LC-CR construction for coastal climate for artisans. The state of Orissa acts as a model for similar coastal regions across the Indian subcontinent as well as South Asia. The target group includes artisans, masons and supervisors of sustainable/ low carbon habitat projects. The objective of the manual is to impart knowledge on constructing resource and energy efficient buildings.

This manual aims to:

- Provide basic principles and guidelines to masons about good quality construction practices, in particular focusing on alternative, environment friendly building practices.
- Improve their skills and seeks to fill the gaps in their knowledge and understanding to upgrade the quality of their work.
- Reinforce the significance and the immense potential of their work to improve our living environment.

This manual is intended to serve as a practical guide for the capacity building of artisans in LC-CR construction.

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FOREWORD

With rising temperatures and erratic weather patterns, climate change is one of the most pressing problems facing the world today. Threats associated with climate change are further compounded by the increasing pressure exponentially growing population is placing on natural resources. The construction sector, especially, has been identified as a high priority sector for action on this front.

The construction sector is a resource and energy intensive sector. It contributes to large scale environmental degradation during extraction and transport phases as well to global climate change through increased carbon emissions. On the other hand, the exponentially growing sector contributes substantially to the national GDP, while employing over 18 million people in the country.

On the other hand, the impacts of the changing climate like rising sea levels, increased occurrence of severe weather events and natural disasters, severe water shortages, etc. are also felt keenly by the sector and warrants immediate response. At the same time nationally and internationally, construction has been identified as a sector where large savings in energy and carbon emissions are possible.

The manual seeks to address knowledge needs of masons with good experience in specific/ general construction practice and, preferably, also an orientation in alternative construction techniques. The content of the manual is also relevant to construction supervisors and for masons who want to independently manage construction assignments as small contractors for LCCR projects.

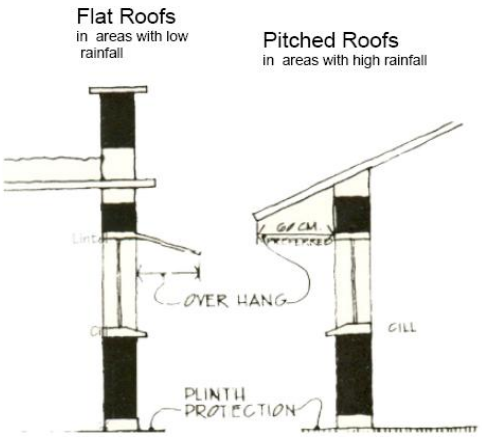
The technologies have been chosen based on the following key parameters:

- 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
- Cost efficiency

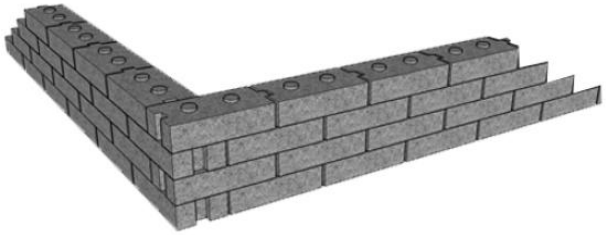
COMPRESSED EARTH BLOCK TECHNOLOGY

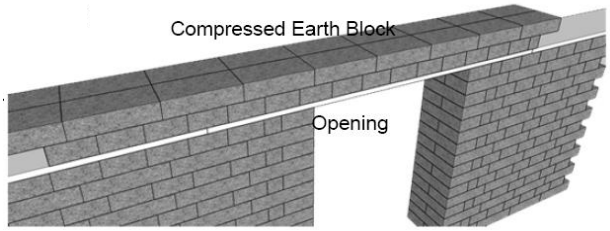
INTRODUCTION

Compressed Earth Blocks (CEB) are masonry units, made with earth / soil by compressing the soil mix in a manually or mechanically operated press. Depending on the soil press, they are available in various sizes, including the conventional burnt brick size of 230 mm x 115 mm x 75 mm. The variable nature of soil makes this a sensitive material to work with, but with an appropriate soil mix and adequate production quality control, CEBs are a high quality viable walling option.

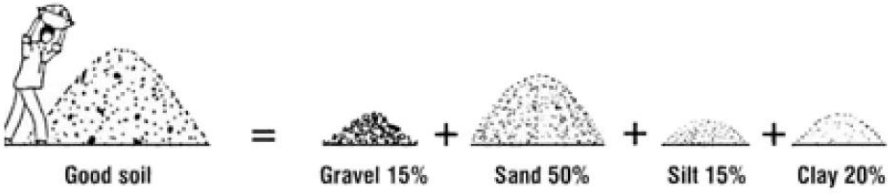


The Stabilised CEB is well suited for load bearing houses of a scale normally witnessed in rural areas. It is a more durable option than the conventional earth based technique of sun-dried adobe blocks common in rural areas. CEBs are made by compressing moist earth using a manual or motorized machine.



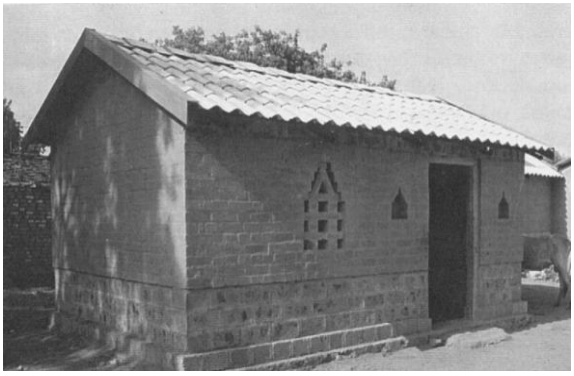


STEPS OF CONSTRUCTION



The quality of soil is a very important parameter for construction with CEB. Generally, soils can be used fro CEB, except unstable soils like black cotton soils.

1. Firstly, it should be ensured that the base of the wall has adequate damp proofing. This can be done by raising the plinth level to at least 20 cm above ground level. Alternately, in cases where foundation is constructed in random rubble masonry, it can be extended till the sill level over which CEB masonry can be constructed.

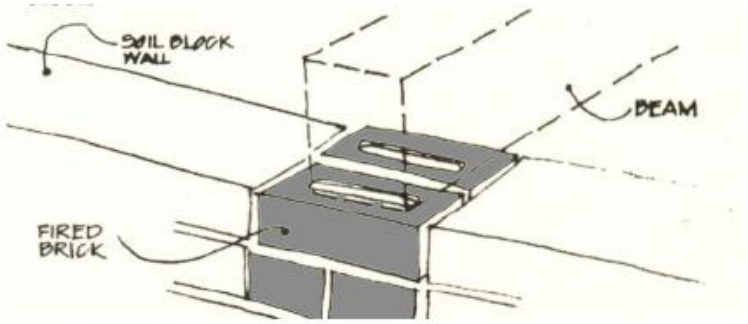


2. All the basic rules of level and plumb which are followed in brick masonry also apply to construction with CEB.

3. Several mortars can be considered for CEB masonry – cement mortar 1:6, cement-lime-mortar 1:1:6, cement-soil mortar 1:2:6 or 1:2:7 or mud mortar.

4. In case of exposed SCEB masonry, the joints should be pointed with 1:3 mortar or 1:1:2 cement-soil-sand mortar (using fine sand) to prevent water absorption/ leakage through the joints. Flush pointed walls perform better than walls with recessed pointing.
Soil mortars may be used for walls of single storey buildings. These walls should not be raised more than 60 cm in one day to avoid loss of plumb.

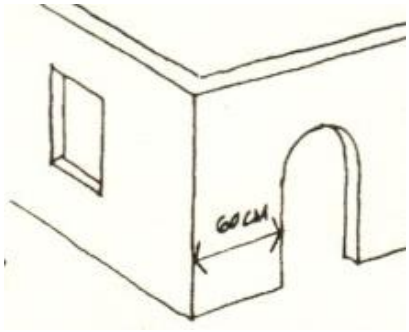
Do not place beams directly on soil blocks. A bed of burnt clay bricks or plain cement concrete can be provided at the location of the beam.



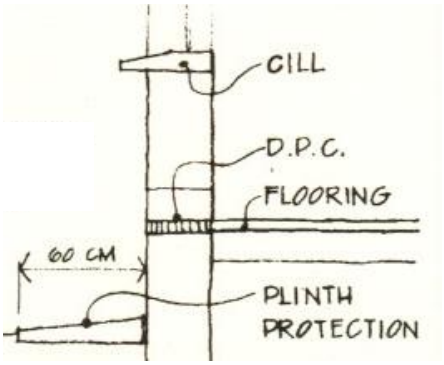
DOs & DON'Ts

1. The soil composition and mix should be checked by an engineer or an expert mason who has knowledge of local soils.

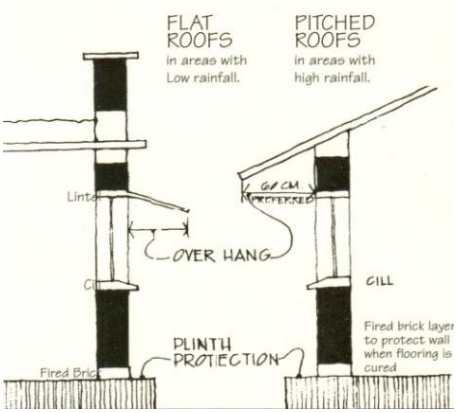
2. Opening should be atleast 60 cm away from corner.



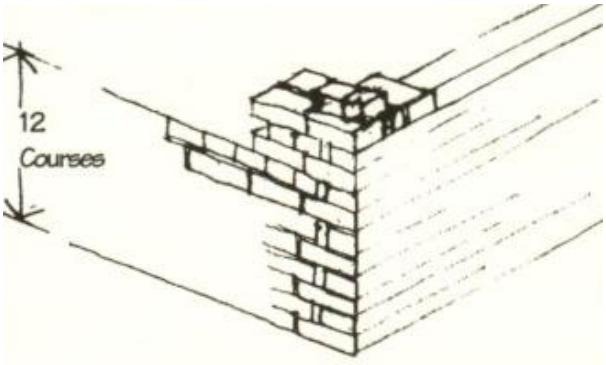
3. Use sand and chemical treatment in foundation walls to prevent from termites.



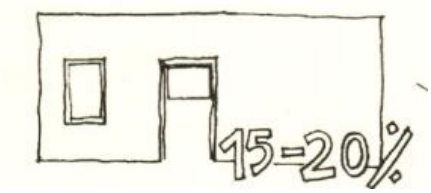
4. Provide adequate roof over hang to prevent the blocks from water.

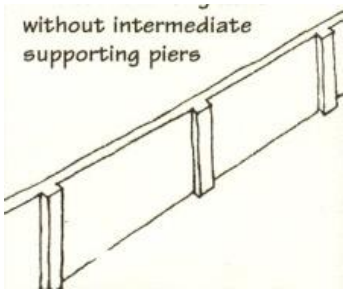


5. Do not lay more than 12 courses per day.

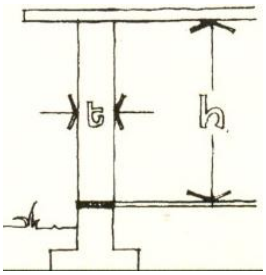


6. Opening should not be more than 15-20% of the wall area.





7. Do not make long walls without intermediate supporting piers.



8. Slenderness Ratio of wall = h/t < 16.
i.e. for a 230 mm thick wall the floor height should not exceed 3.68m

ADVANTAGES

- Can be very cost effective, specially when the blocks are produced on site
- Soil is an easily available resource in rural housing
- Provides a uniform good strength of around 50 kg/cm^2
- Provides good thermal comfort
- Provides aesthetic wall finish, no plaster required
- Creates additional local employment in block production
- Can be made with locally available earth which makes it cost effective.
- Thermally comfortable, aesthetically pleasing and one of the most environment friendly alternatives for wall construction.

LIMITATIONS

- Reduced durability - if not regularly maintained and properly protected, particularly in areas affected by medium to high rainfall.
- Low tensile strength - poor resistance to bending moments,
- Low resistance to abrasion and impact if not sufficiently reinforced or protected.
- Need to provide adequate roof over hang to prevent the blocks from water.

Materials	**Quantity**	Size of wall – 10’ x 10’ Size of Compressed earth block – 9” x 4.5” x 2.75” Mortar – 1:2:5 – cement : soil : sand, Number of blocks used – 1075 Cement used – 5% = 165 grams per block
Soil , For production of blocks For masonry mortar	 150 cubic feet 7 cubic feet	
Cement, for production of blocks for masonry mortar	 4 bags 3 bags	
Coarse sand	16 cubic feet	
Labour		
Skilled mason	2 mandays	
labour	11 mandays	

RAT TRAP BOND TECHNOLOGY

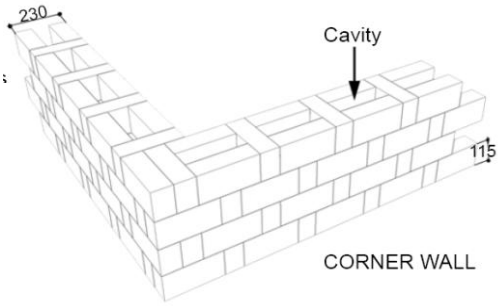
INTRODUCTION

The 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. Headers and stretchers laid on edge. Typically, a 75 mm cavity is formed in a 230 mm thick wall. This is done by placing the bricks on edge in a modular fashion.

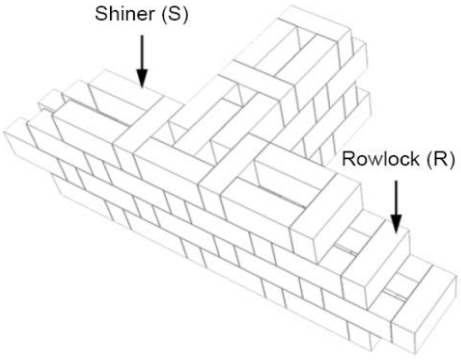
For the purpose of housing, this system can be used for in-fill walls (in an RCC frame) in multi-storied housing or for single storied row housing. It is also possible to construct single storied housing in reinforced load-bearing .

Rat-trap masonry. It can be used for building houses of fewer than 3 stories and is still used as an economical bond, as well for the insulation properties offered by the air cavity.

With this technique there is reduction in cost of the wall by 25%, as with conventional English bond (9''thk wall) 350 bricks are required per cu. m whereas in Rat-trap bond only 280 bricks are required and also the reduced number of joints reduces the mortar consumption.



CORNER WALL



T-JUNCTION

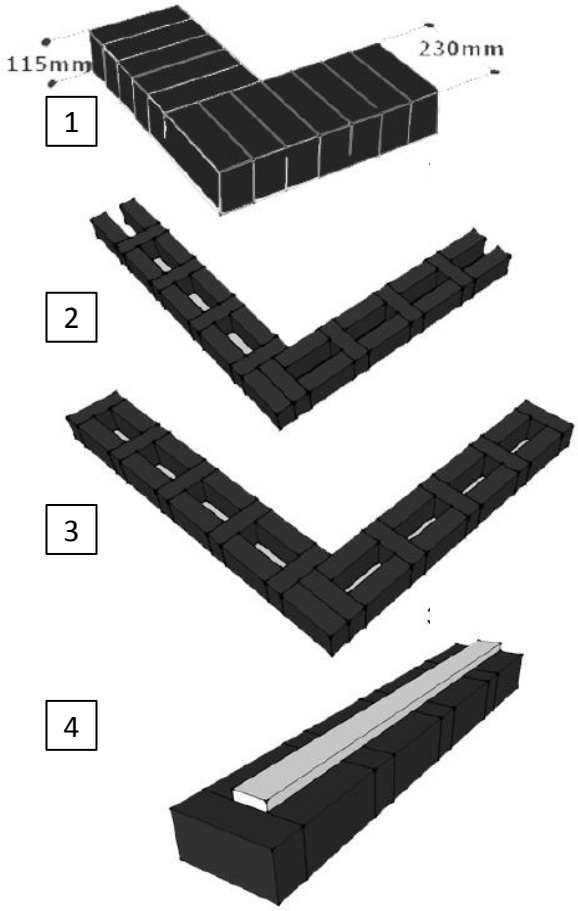
STEPS OF CONSTRUCTION

1.) Standard (2 ¼" x 4" x 8") fired clay bricks can be used. Lay the frist course with brick on edge in 1:6 cement mortar.

2.) The next row above the base row of bricks should have 2 bricks laid parallel with each other along the exterior and interior surface of the wall with a cavity between them.

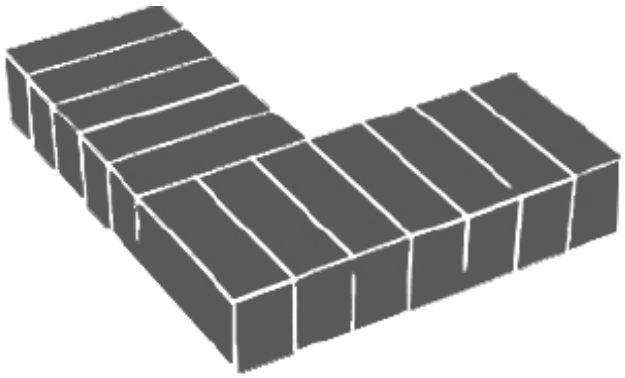
3.) The ends of these bricks will be stabilised with the placement of a single brick on edge that spans the width of the wall.

4.) As the mortar i slaid on each course, a wooden strip may be used to prevent mortar from falling in to cavities

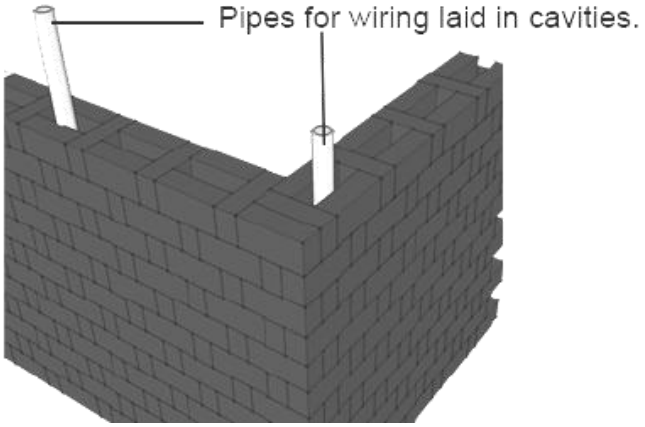


DOs

• A solid course of brick on edge should be laid at plinth, door and window sill/lintel level and roof level.
• The first course should be set right. The brick pattern should be kept straight and vertical.
• The size of openings should be kept in multiples of the rat trap module size.
• Services should be planned in advance so as to avoid exposed wiring and plumbing.

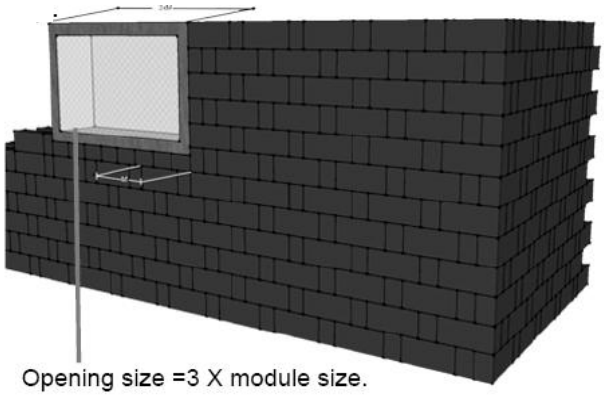


First Course of brick work.



DON'Ts

• There should be no water penetration in to the cavity. For that joint should be properly tooled in with mortar.
• Vertical joints should be avoided.
• No untrained masons should work in rat trap bond walling to avoid wastage of mortar falling into the gap.



Opening size =3 X module size.

ADVANTAGES

• Reduction in consumption of bricks by 25% and mortar consumption as compared to 230 mm thick solid brick wall.
• Reduction in load of walls in foundation as Rat Trap Bond load is 80% of solid walls.
• Good thermal insulation due to the air gap created by bond.
• Construction is appealing to the eye from both internally & externally, plastering is not necessary.

LIMITATIONS

• Excavation of soil needed for manufacturing of bricks may lead to environmental problems.
• Building can be built up to 3 storey height only.

MICRO CONCRETE ROOF TILE

INTRODUCTION

Micro Concrete Roofing (MCR) is a roofing technology developed more than 20 years ago. It consists of concrete tiles made of a cement mortar mix (1:2, 1:3) supported by substructure. The substructure can be timber, steel or even bamboo. MCR tiles are produced on a small vibrating table, which can be operated by single trained worker.

With an appropriately designed under structure, MCR roofs can be used for a variety of applications in low cost housing, institutional buildings, factories, parking areas,
farm houses, gazebos, highway constructions (dhabas),verandahs and pavilions, etc.

In areas with heavy rainfall, MCR tiles are used extensively for cladding material offering both waterproofing and aesthetic appeal. It has been used extensively in cost effective housing schemes, workplaces, restaurants and poultry farms.

The MCR tile is made using a design mix of cement, sand and aggregates in the ratio. They are available in two profiles as shown -

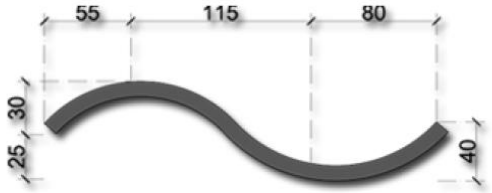
Roman tile - 240mm X480 mm - 9.5” x 19.5”

Pan tile - 240mm X 488mm - 9.5” x 19.25

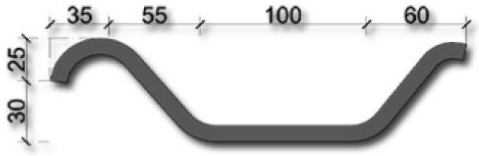
The purlins of understructure for laying the tiles are always provided at a distance of 400mm or 16”.

The supporting structure for purlins depends on the span between the vertical supports which can be a wall or a column. Depending on this span, a support is created:

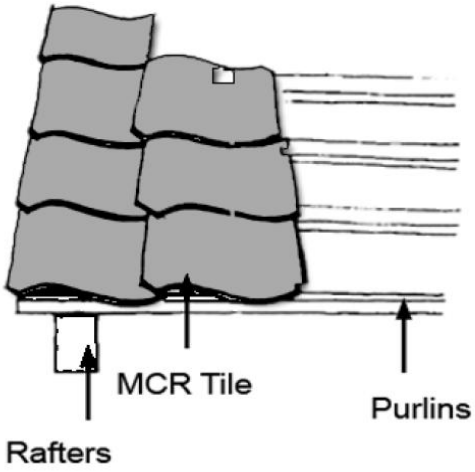
with trusses for span > 4m and rafter beams for span <4m



PAN TILE



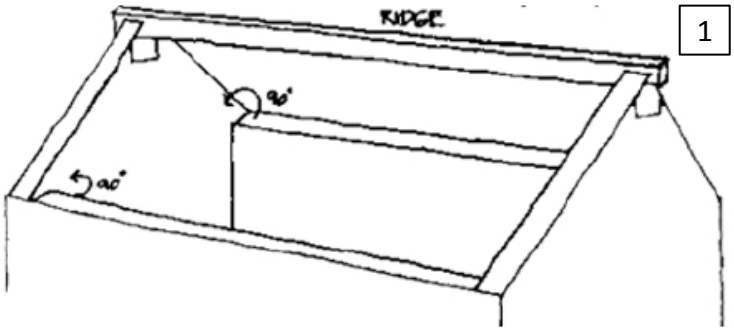
ROMAN Tile



Components of MCR Understructure

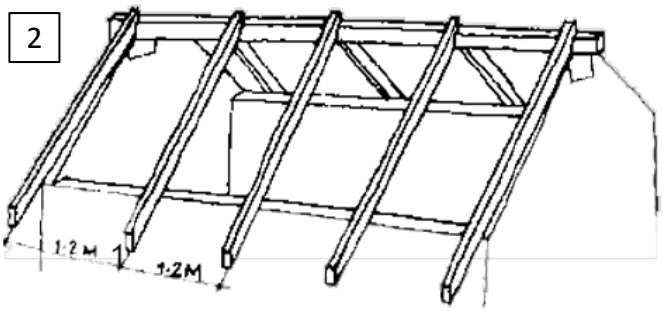
STEPS OF CONSTRUCTION

1. Place the blocks without mortar first.



2. Place the ridge on the gable wall. The rafters should be in one plane.

2



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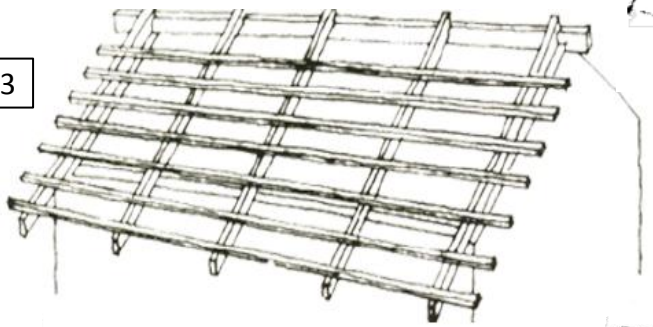
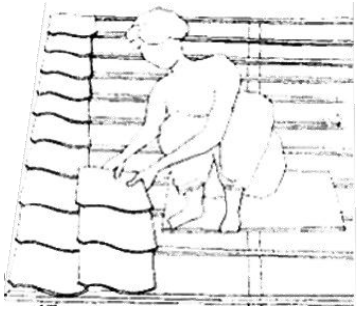


3. Purlins work is the critical part that needs to be perfect for the accurate MCR application.

4. Start laying tiles from the left. Ensure overlap and laying pattern of tiles to check run-off of water



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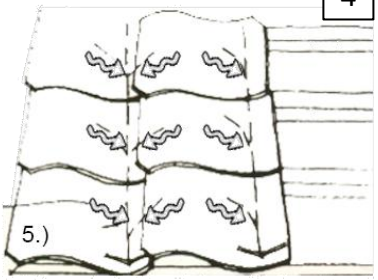
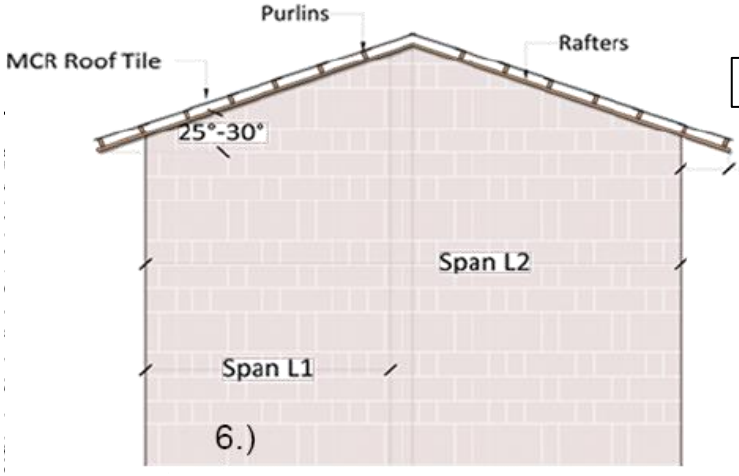


5. The angle of the slope should be 25-30 degrees. Grout ridge tiles with 1:3 mortar



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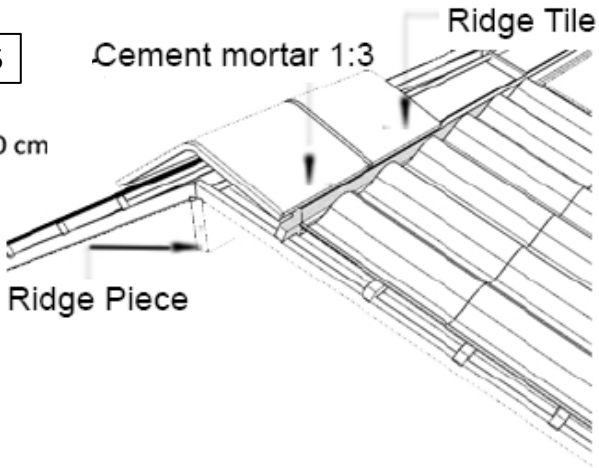
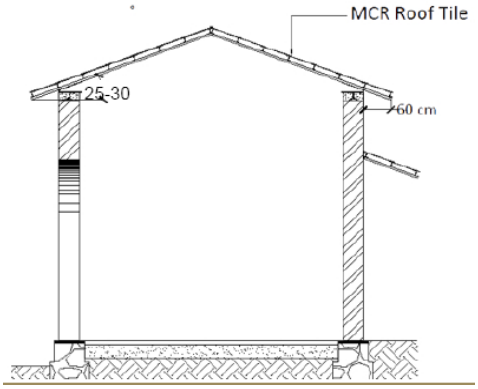


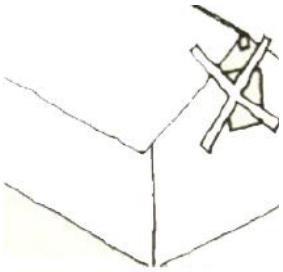
DOs

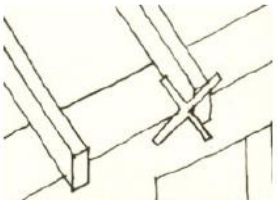
- Provide an overhang of at least 60 cms to protect the wall.
- Provide slope to help run-off rain water and counteract lift-off due to wind pressure.
- Walls should levelled and all walls to be checked for right angles.
- Slope should be between 25-30 degrees.



DON'Ts

• Do not place rafters directly above soil blocks.
• Do not place rafters directly above openings.
• Do not make openings under ridge in gable wall.





ADVANTAGES

• Thermal comfort in comparison to the metal sheets.
• Very simple production method.
• Easy maintenance.
• Production can be started with low investment.
• Material cheaper than the other roofing material.
• Less maintenance cost.

LIMITATIONS

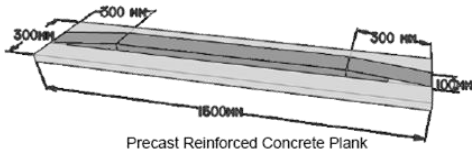
• Minimum inclination required for MCR application is 22°.
• Not recommended in freezing temperature and hail storm areas.
• Not recommended for high wind velocity areas

PLANK & JOIST ROOFING

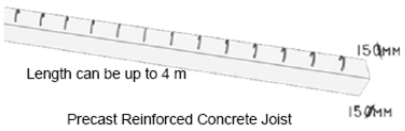
INTRODUCTION

Plank and Joist is a building system, in which precast RCC slabs – planks- are supported over pre-cast RCC beams – joists- placed across walls. To complete the roof, concrete is then poured over the gaps between slabs and beams, which ties all pre-cast elements together.
This technique can easily be adapted by masons who are familiar with similar techniques of placing stone slabs over girders to construct roofs.

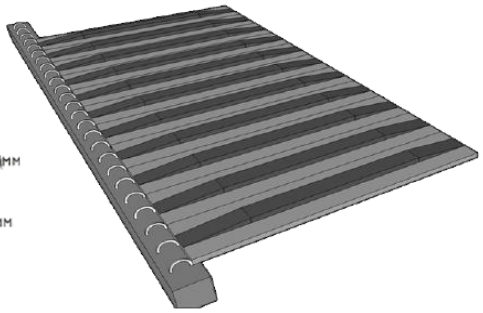
The pre-cast planks are typically 30 cm wide x 1.5 m long, although the length can vary from 1.2-1.8 m, depending on the size of room. Due to its small size, the plank needs only nominal MS reinforcement; typically 6 mm bar to meet the structural requirements.
For joists, a 15 cm x 15 cm section can be used for a span of up to 4 metres. Plank and Joist construction provides an attractive finished ceiling with excellent acoustic qualities and lighting efficiency.



Precast Reinforced Concrete Plank

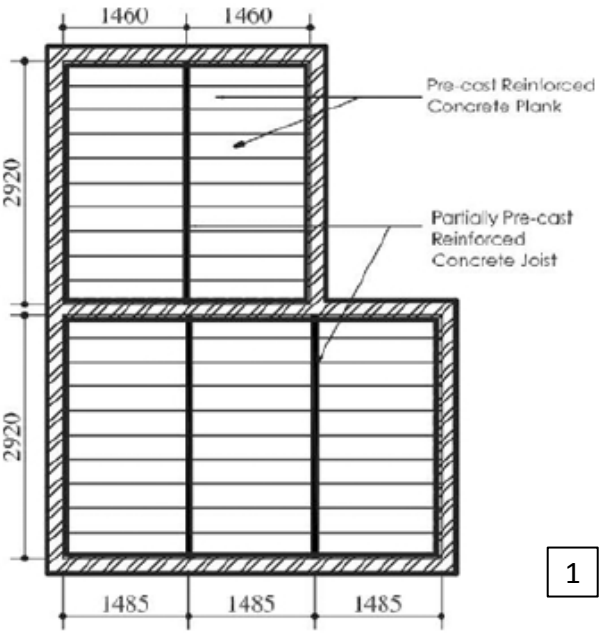


Precast Reinforced Concrete Joist



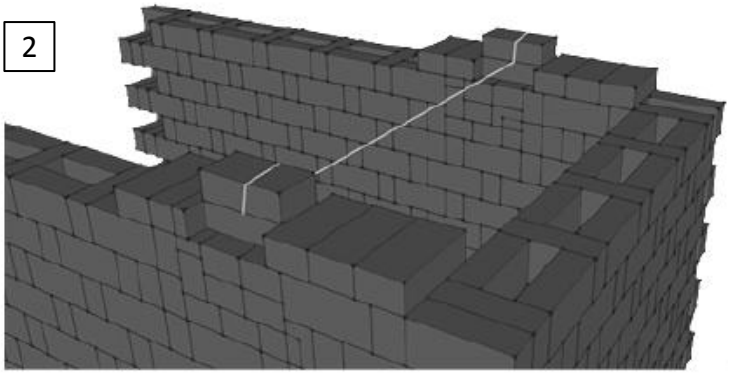
STEPS OF CONSTRUCTION

1. It is preferable to design the room size as per the modular size of precast planks, ensuring that the roof can be constructed with a certain number of planks and joists.



2. Before installing plank and joists, their accurate positioning for a given room size should be ascertained. To ensure this, the centre points of all joists should be marked on the wall masonry before placing them.

2



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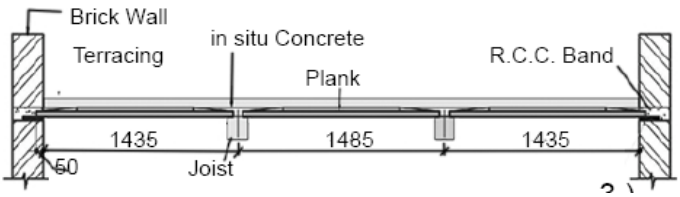
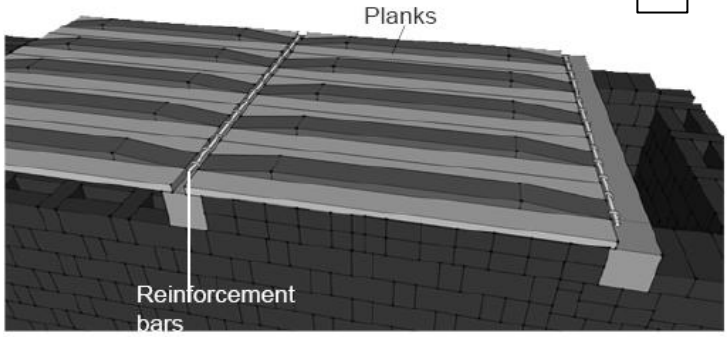


3.) After marking the centre points, place the joists accordingly. Joists can be placed at the defined spacing over a cement concrete bed, which can be in the form of a roof band, if needed, as per engineer's specifications. If the cementconcrete bed is not provided, concrete blocks of size 1'x9"x3" should be placed in the wall to distribute the point load of joists.

4.)Before pouring in-situ concrete over planks and joists, additional nominal reinforcement is placed. 4 MS reinforcement bars of 6mm dia should be placed with every plank – 2 bars are placed on both sides of the tapering concrete portion of the plank and 2 bars are placed parallel to the joists on both sides. This reinforcement satisfies requirements for a normal residential building.

4



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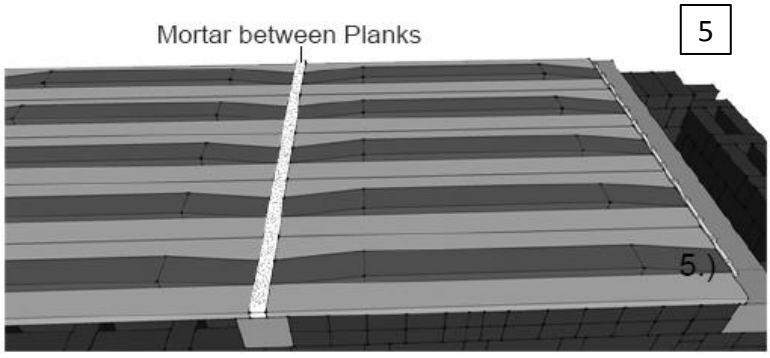
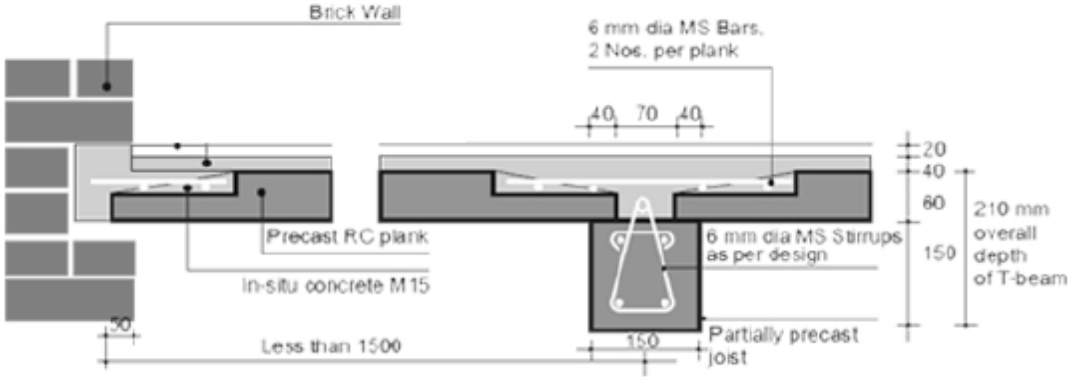


5. After laying the planks, all joints between adjacent planks should be filled with a thick paste of cement sand mortar of ratio 1:4 to fix the planks in place.

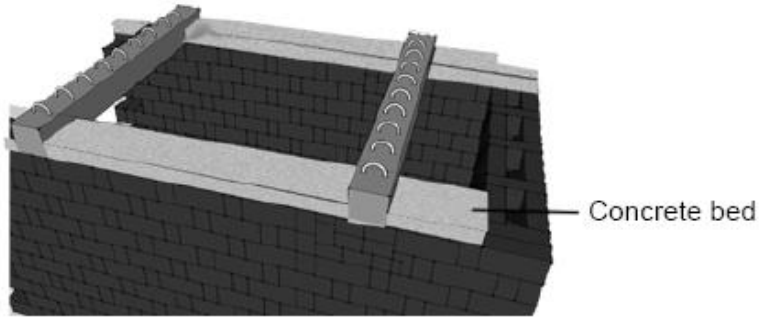
DOs

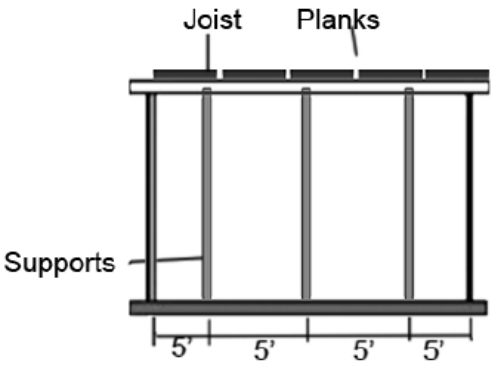
• The concrete mix used to make precast plank and joists should be of good quality preferably M15.
• The planks and joists (once built) should be cured for 7-10 days.
• The size of room should be kept in plank and joist module size.
• To avoid failure concrete should be filled in between planks after placing planks on joists.rain water and counteract lift-off due to wind pressure.
• Walls should levelled and all walls to be checked for right angles.
• Slope should be between 25-30 degrees.



DON'Ts

• Do not use plank and joist in rooms > 4 meters length.
• Do not lay joists directly over brick course, these should be laid over a layer of concrete bed or concrete blocks.
• Do not lay the planks without supporting the beam at every 5 feet along its length with a temporary support of a steel pipe/bamboo.





ADVANTAGES

• Pre-casting of roof leads to substantial reduction in construction time 15 to 20% saving in cost possible because of no shuttering and reduction in steel quantity.
• Much better quality control can be maintained during pre-fabrication.
• Moderate size of components which can easily be handled manually without mechanical handling and erection equipment.
• Simple technology which can easily be adapted by semi-skilled labour.

LIMITATIONS

• High degree of quality control and precision is required.
• Due to the size of planks and joists it requires casting space, curing tank and space for air drying.
• If the beams and planks are to be transported to the site then there is a higher risk of damage if not kept vertically.
• Not recommended for large spaces.

PRECAST ARCH PANEL ROOFING

INTRODUCTION

Arch Panel roofing is a building system, in which 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.

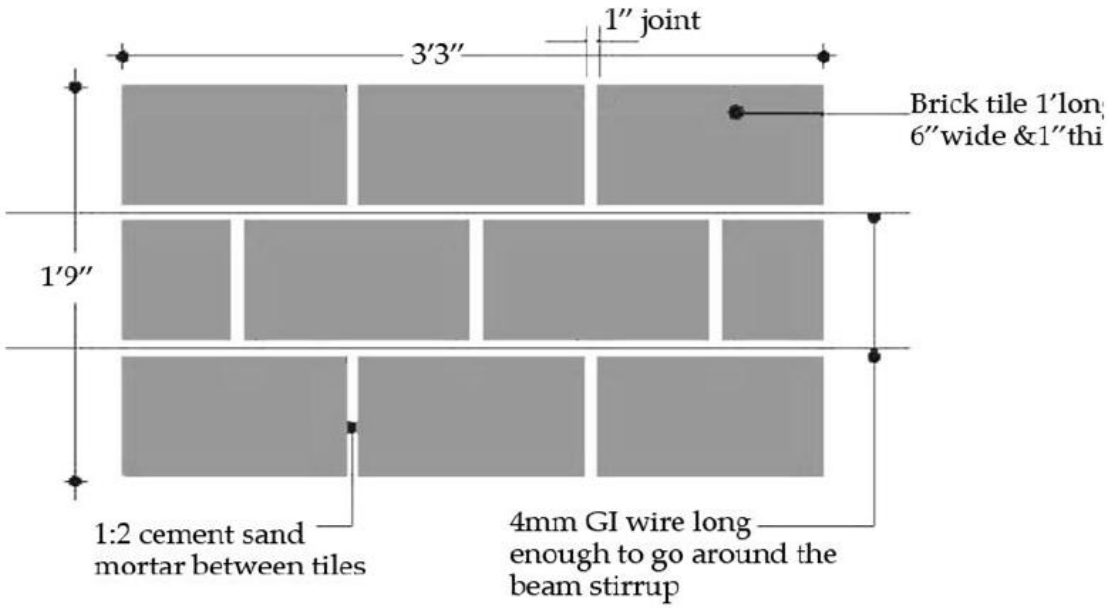
The panels serve as a formwork for the finished roof, after topping concrete has been laid over the pre-cast components.

COMPONENTS

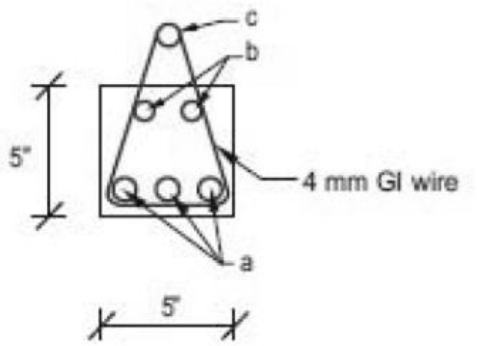
• **Pre cast arch panels: The arch panel can be made with 1** to 2" thick burnt clay tiles. Other material like mud tiles can also be used. The tiles are placed in arch profile, using a pre-designed template, made with steel angle sections. They are bonded with a rich cement mortar to form a panel. The panel is reinforced with 5 mm GI wires which are placed in the mortar joints along the span of the channels. The weight of one panel should ideally not exceed 30 kg, so that it can be lifted by two persons comfortably.

• **Pre cast beam: This is a partially cast RCC beam which can** be manually cast on ground. After placing it on the roof level, the remaining portion of the beam is cast after all arch panels have been placed between beams. In this way the precast beam and the portion of roof concrete over the beam act together as a single beam. The beam is partially cast "T beam", the whole beam being complete when cast into the roof.

• **In- situ concrete: After placing the panels at the roof level, the spaces between two rows of** panels are filled with in-situ concrete. The concrete is reinforced with a single mat of 8 mm bars. This concrete binds the arch panels and beams into a single system. Also, a flat surface is created by the in-situ concrete which is then finished with a terracing layer.



PRE- CAST ARCH PANELS USING BRICK TILES



Length of beam, feet	Reinforcing bar diameter, mm		
	a	b	c
Less than 10'	10	8	8
Between 10' to 12'	12	8	8
Between 12' to 16'	16	8	8

PARTIALLY PRE-CAST BEAM

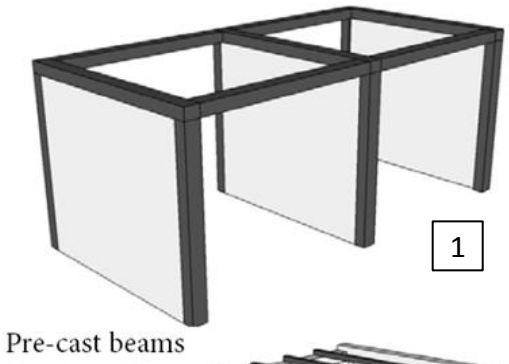
STEPS OF CONSTRUCTION

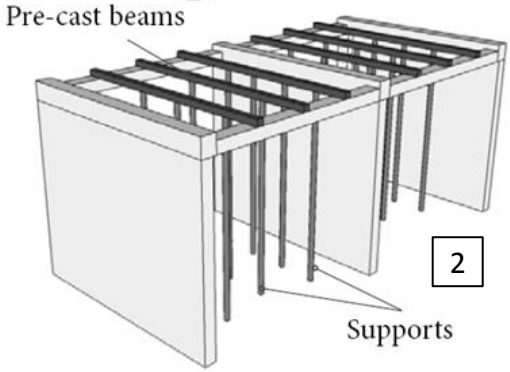
1. Prepare the support structure in masonry or framed structure before installing arch panel roof. The precast beams are lifted and placed over a cement bed at proper intervals.

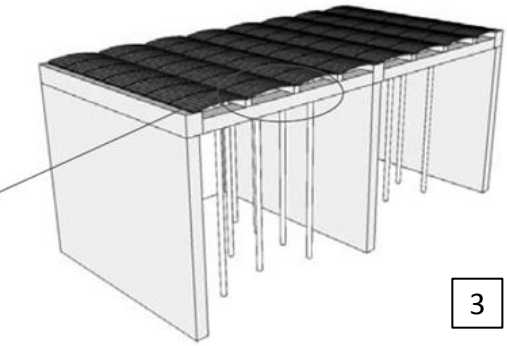
2. Provide the beams with supports at regular intervals till the arch panels are laid and the joints filled.

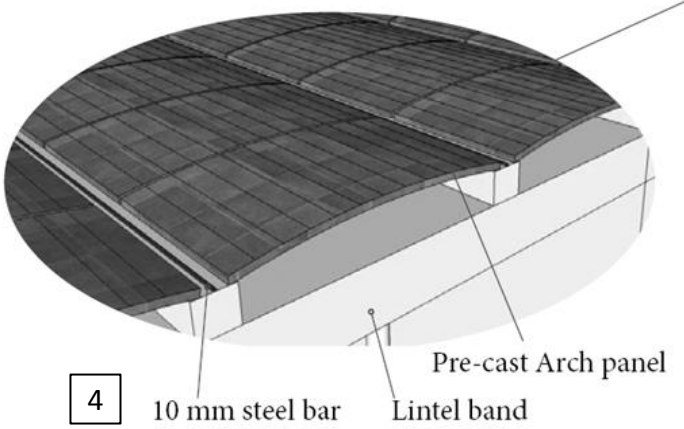
3. Place the panels side by side over supporting beams or walls. Use 75 mm thick lintel band on which the channels should rest.

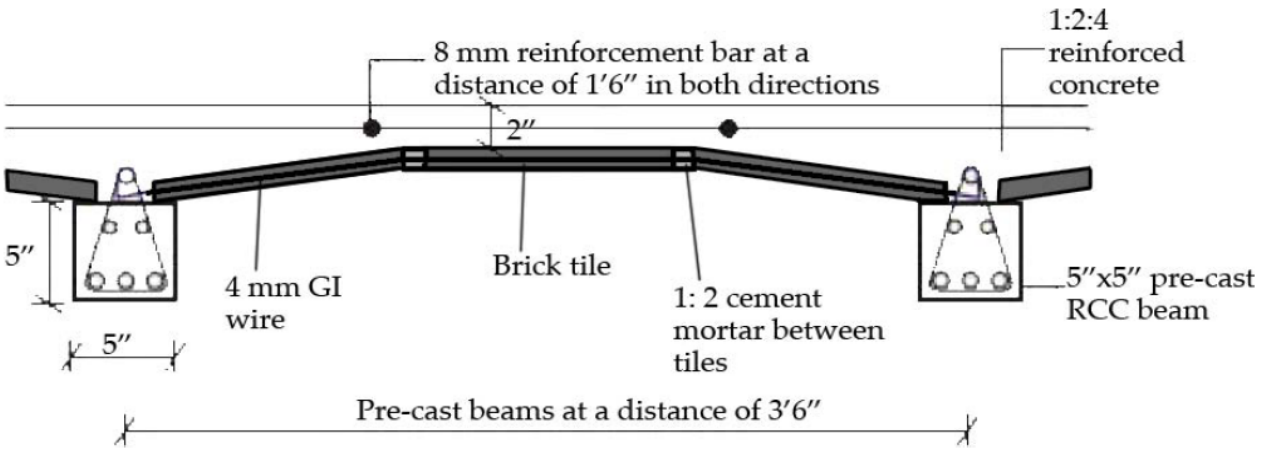
4. Insert GI wire between two panels through out the width of the roof. Cast 1:2 cement mortar in the gap between two channels, consolidate it and water cure for 7-10 days.
Provide 8 mm bars between two panels in both directions. Lay a concrete bed of 50 mm over panels after the reinforcement











INSTALLATION OF ARCH PANELS ON PRE -CAST BEAMS

DOs

- Concrete over should be laid in slope for water drainage.
- The panels should be positioned properly with great care to avoid weak joints and water seepage.
- Joints between two panels should be filled properly with cement concrete.
- Electric wiring should be planned before laying valley concrete.
- Water curing should be continued till 7 days after he construction work.

DON'Ts

- Do not lay beams directly over masonry, a concrete bed should be provided over the masonry.
- Water proofing layer should not be applied before 14 days curing of concrete over arch panels.
- Do not use for spaces larger than 14' as it becomes uneconomical after that.

ADVANTAGES

- Light weight roof as comapred to reinforced concrete roof. 35-40% lesser use of concrete.
- Requires less cement and steel.
- Cost saving of 20%.
- Doesn't need formwork.
- Shuttering, vibrator etc. not required.
- Plaster and paint finishes not needed.
- Simple technology which can easily be adapted by semi-skilled labour. Quality control is easy to maintain.

LIMITATIONS

- High degree of quality control and precision is required.
- Due to the size of channels requires casting pace, curing tank and space for air drying.
- If the channels are to be transported to the site then there is a higher risk of damage if not stacked properly.
- Not recommended for large spaces.

FERRO-CEMENT CHANNEL ROOFING

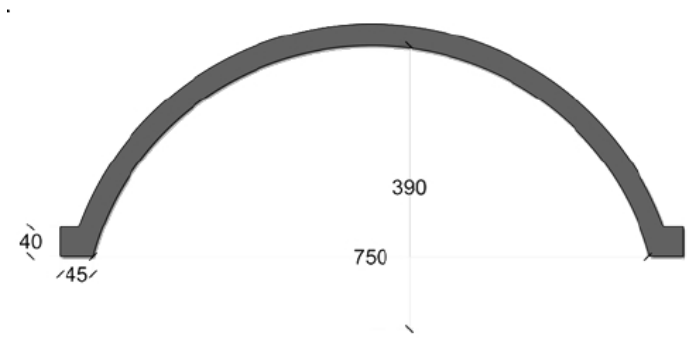
INTRODUCTION

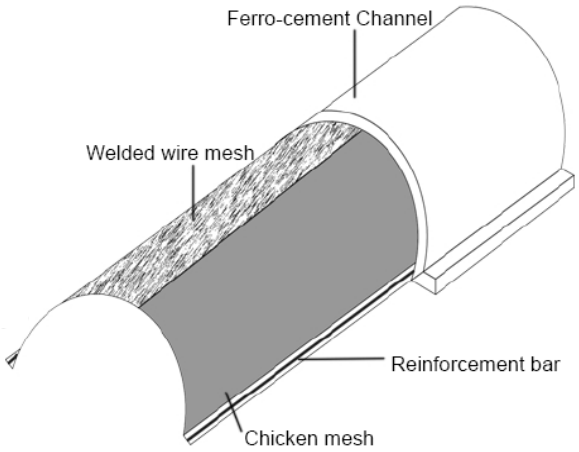
Ferrocement is a type of reinforced concrete which is typically 1 to 1.5” thick and can be cast into various profiles to form pre-cast building elements. Ferrocement uses a rich cement mortar and chicken mesh reinforcement instead of conventional reinforcement
bars. By casting in a semicircular profile, ferrocement channels can be made which are then used for roof construction.

Ferrocement channels can be made by casting the cement-sand mortar in a mould such that it resists loads because of is profile. The circular profile carries load through its ’arch action”. The channel is then supported at its two ends which could be masonry or a beam. The roof is constructed by placing the channels side by side.

Restraining Beam: An RCC restraining beam is cut at the roof level to prevent any movement of channels. This beam is very important, specially in areas which are prone to damage by natural disasters.

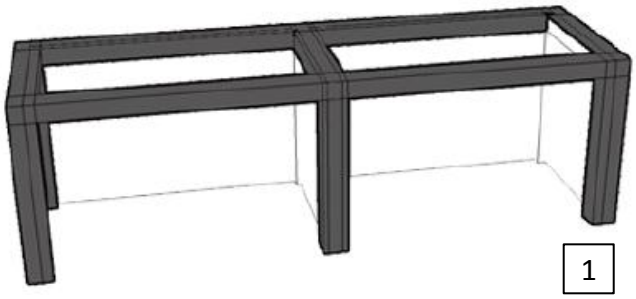
Concrete Filling : After the channels have been placed, the valleys which are formed in between channels are filled. This is done to the joints and also to provide a smooth & level surface, to be used as a floor or terrace, if needed. The film can be done with partially concrete and partially with brickbat concrete. Alternatively, brick bat, lime concrete can also be used.





STEPS OF CONSTRUCTION

1. Prepare the support structure in masonry or framed structure before installing ferro-cement channel roof.



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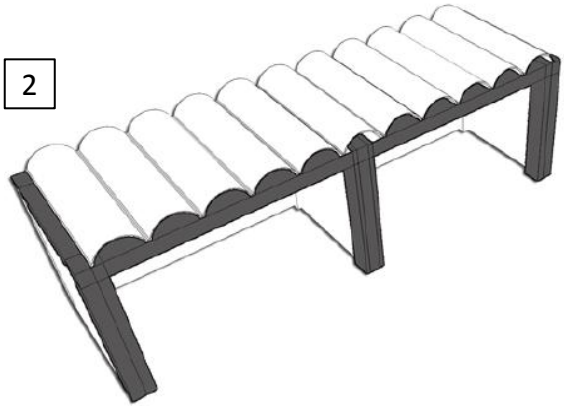
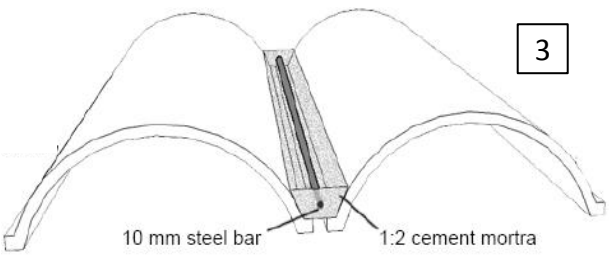


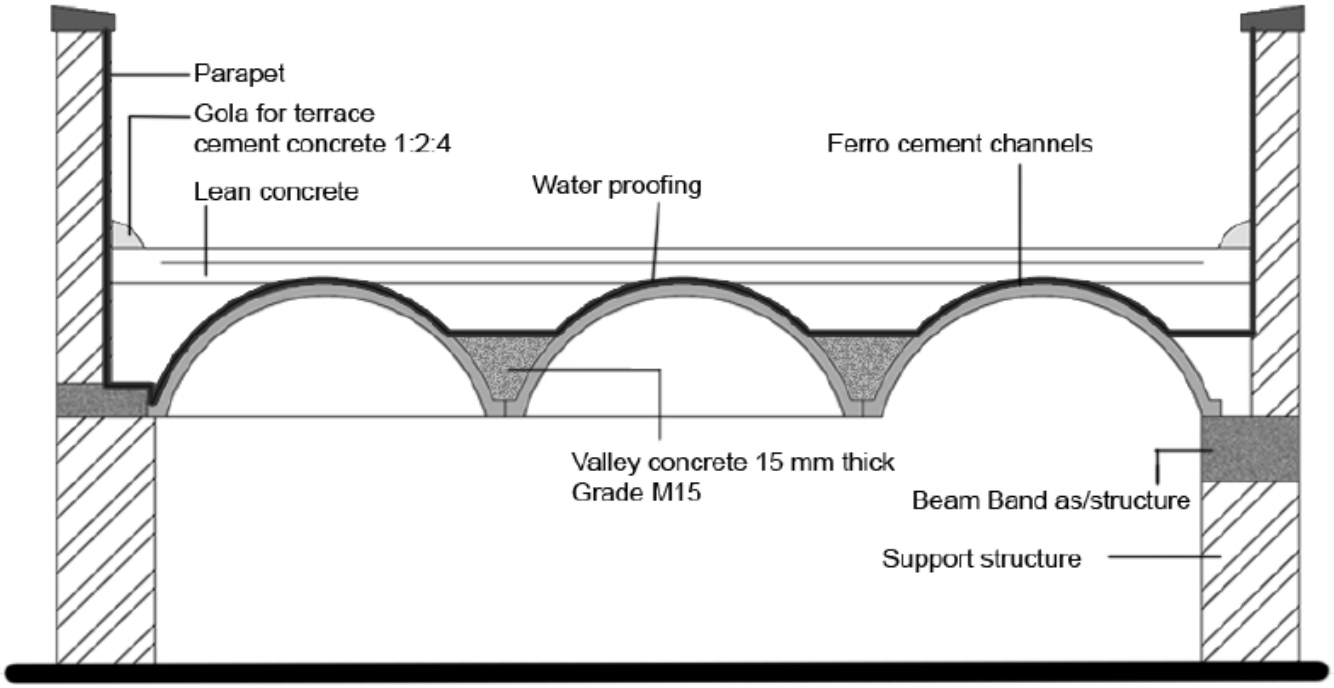
2

2. Place the channels side by side over supporting beams or walls. Use 75 mm thick lintel band on which the channels should rest.



3

3. Cast 1:2 cement mortar in the gap between two channels, consolidate it and water cure for 7-10 days.



DOs

- Valley concrete should be laid in slope for water drainage.
- The channels should be positioned properly with great care to avoid weak joints and water seepage.
- Joints between two channels should be filled properly with cement concrete.
- Electric wiring should be planned before laying valley concrete.

DON'Ts

- Do not use plank and joist in rooms > 4 meters length.
- Do not just lay valley concrete for water proofing. Water proofing is not complete without a water proofing layer like bitumen etc.
- Water proofing layer should not be applied before 14 days curing of valley concrete.

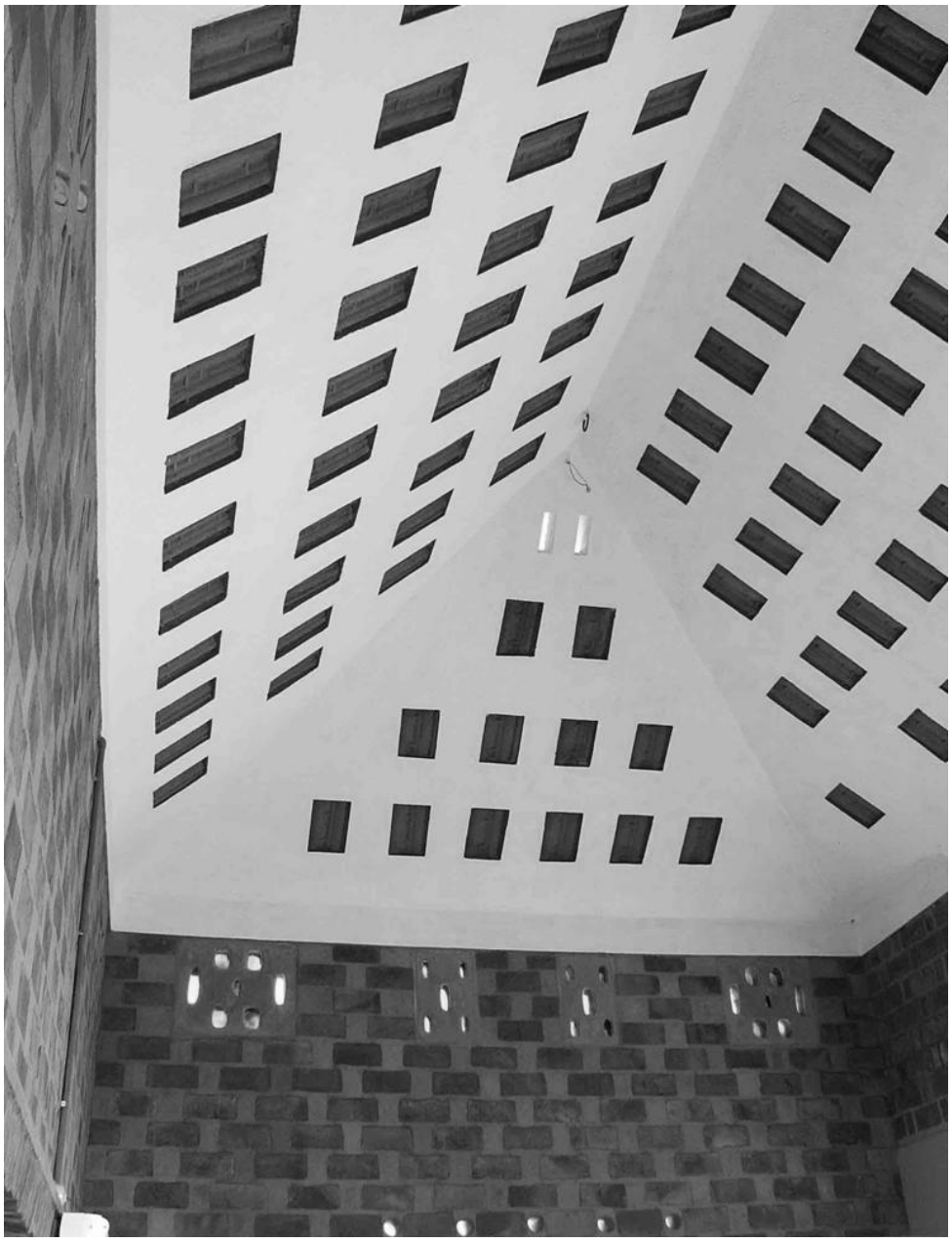
ADVANTAGES

- Light weight roof as compared to reinforced concrete roof. 60% deduction in dead weight.
- Requires less cement and steel. Cost saving of 20%.
- Shuttering, vibrator etc. not required
- Simple technology which can easily be adapted by semi-skilled labour.
- Quality control is easy to maintain.

LIMITATIONS

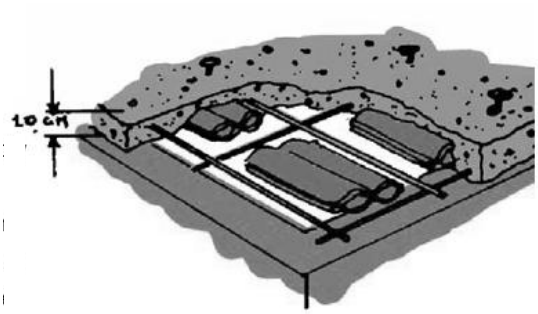
- High degree of quality control and precision is required.
- Due to the size of channels requires casting space, curing tank and space for air drying.
- If the channels are to be transported to the site then there is a higher risk of damage if not stacked properly.

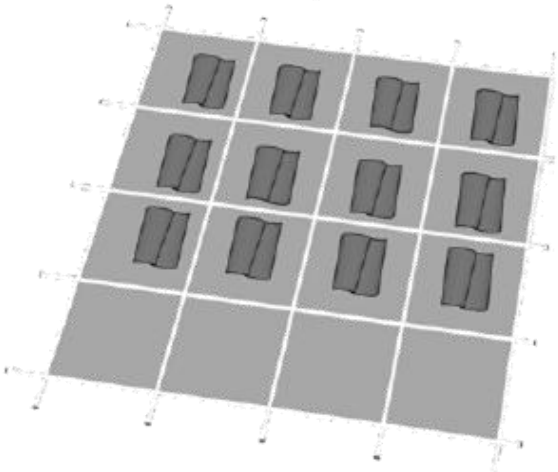
FILLER SLAB



INTRODUCTION

Filler slab is a variation of conventional reinforced cement concrete slab in which part of the concrete is replaced with a filler material which can be a waste material to ensure
economical advantage over an RCC slab. The basic principle in a filler slab is that, considering an RCC slab of a given thickness, the concrete in the bottom half of the slab is simply dead weight and does not play a role in taking up compressive load, which is normally taken up by concrete in an RCC slab. So, this concrete can be replaced by a suitable lightweight filler material which can be accommodated in the bottom half of the slab. Since it reduces the weight of the slab by replacing concrete, savings can also be achieved in quantity of steel reinforcement without any compromise on the quality and strength of the slab. The filler materials commonly used are burnt clay tiles (such as Managalore tiles), bricks, coconut shells, terracotta pots etc.

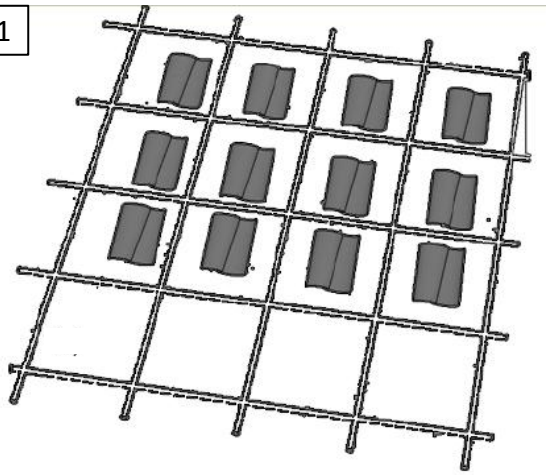




STEPS OF CONSTRUCTION

1. Prepare the support structure in masonry or framed structure before installing ferro-cement channel roof.

1



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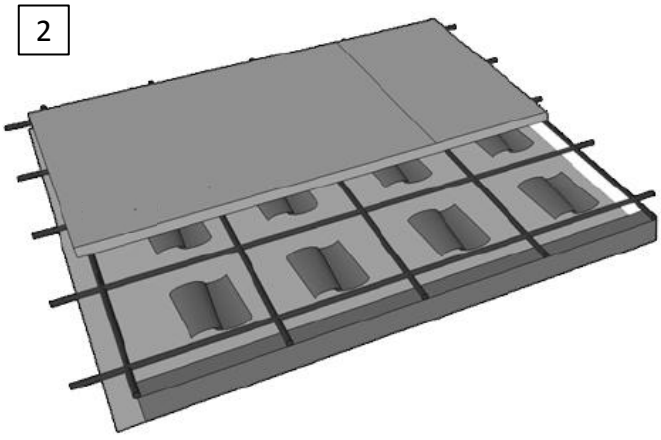
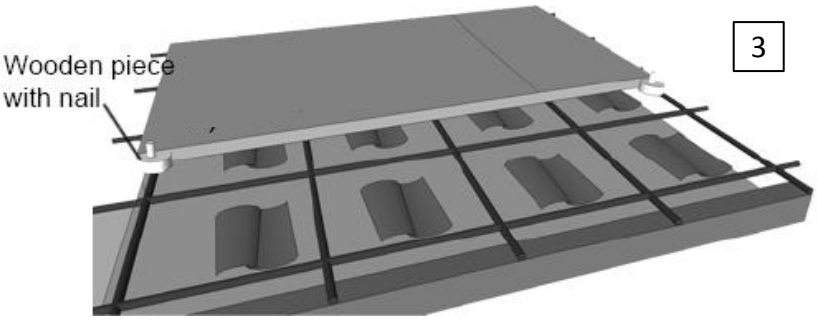


2. Place a pair of filler tiles at the centre of each rectangular space between the reinforcement steel. Check the clear cover of reinforcement (minimum 1.5cms). Lay each pair of filler tiles accurately in a line. Lay only two or three rows of tiles for convenience. If the filler material is not to be exposed, apply cement mortar over the shuttering before the filler material is placed.
Other filler materials may be used as alternatives Prepare well mixed 1:2:4 cement concrete. Pour the concrete in the space between the filler materials as well as on the top

3. Maintain the thickness of the slab using wooden pieces with nails. Establish levels according to the slab thickness required and finish the top layer with proper compaction.



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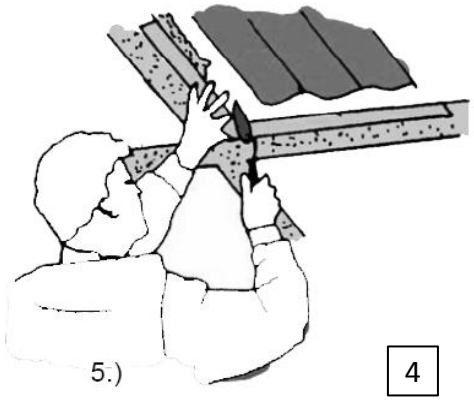


4

4. After removing the shuttering, lightly rake the concrete if required before plastering. The slab can be left unplastered if required. To achieve an attractive appearance, finish the ceiling with a right angle and a trowel.

DOs

• Proper cover for the slab should be ensured by placing pieces of aggregate below the reinforcement before concreting.
• The filler tiles should be positioned properly with great care.
• Other precautions generally taken care in casting RCC slabs should be adhered in this case too.
• Water curing should be continued till 10-14 days after the construction work. case too.

DON'Ts

• While concreting care should be taken not to displace the filler material.
• Water proofing layer should not be applied before 14 days curing of concrete over arch Panels.

ADVANTAGES

• It reduces the dead weight as well as the cost of the slab to 25% (as 40% less steel is used and 30% less concrete).
• Filler slabs are very lightweight slabs.
• Due to the reduction of concrete volume, the overall cost of slab is lower than solid slab even after considering additional cost of filler tiles.
• Plaster and paint finishes not needed.
• Enhances thermal comfort inside the building due to heat-resistant qualities of filler materials and the gap between two burnt clay tiles.

LIMITATIONS

• High degree of quality control and precision is required.
• Filler slab requires an expert to determine the spacing between the reinforcement bars.
• Requires shuttering materials which are sometimes difficult to access in rural areas.

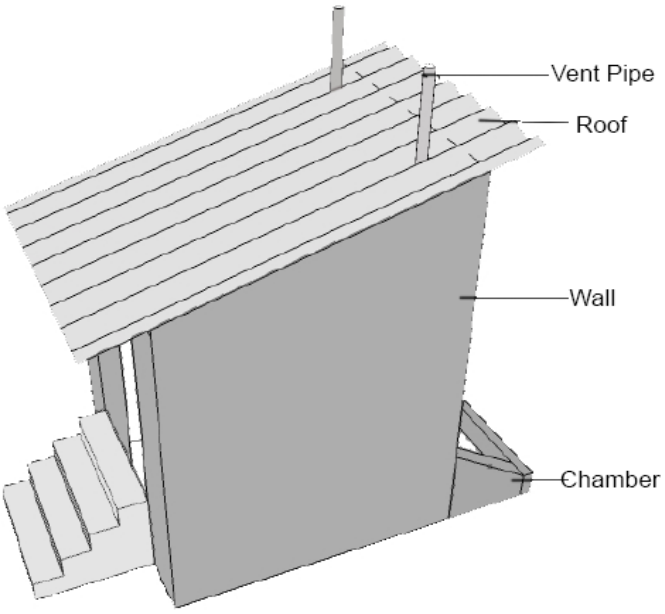
ECO-SAN TOILET

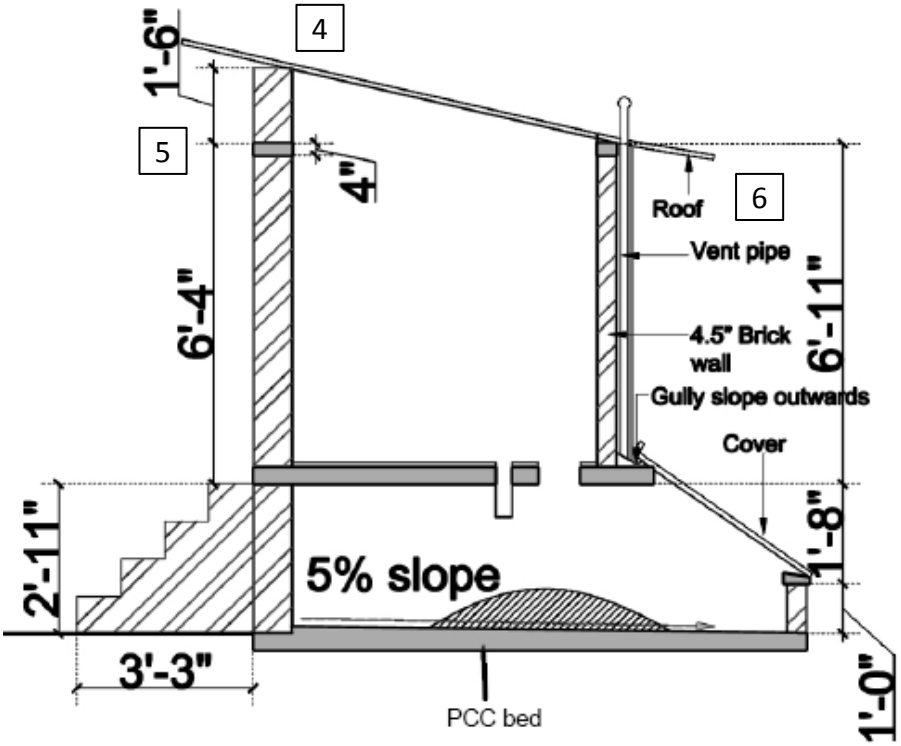
INTRODUCTION

Ecological sanitation, or Ecosan, is a new paradigm in sanitation that recognizes human excreta and water from households not as a waste but as resources that can be recovered, treated where necessary and safely used again. Tailored to local needs, ecological sanitation systems, ideally, enable a complete recovery of nutrients in household wastewater and their reuse in agriculture. In this way, they help preserve soil fertility and safeguard long-term food security, whilst minimizing the consumption and pollution of water resources.

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

Typically, the toilet is built on a raised platform, about 1m high, to create storage space at the ground level for the waste. The faeces are stored and decomposed for a period of around 6 months and urine is diluted with water before use. The toilet has a special pan to separate the solid and liquid waste. The major challenge in the success of Ecosan is the social and habitual change which the user should be comfortable with during use of toilet and later, to recycle the nutrients.





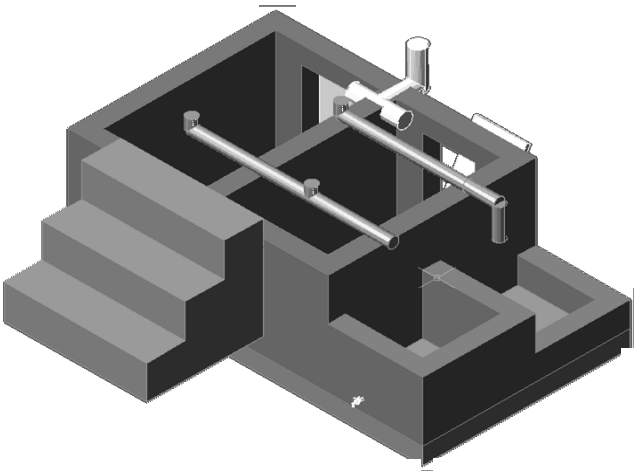
STEPS OF CONSTRUCTION

1. SITE SELECTION AND LAYOUT OF TOILET

Site selection for EcoSan toilet is one of the easiest but most important steps. During selection one needs to consider the position of the emptying hole, urine container and effective use of space. It will be better at to orient the emptying hole at the backside of entrance and there should be adequate space for emptying. After selection layout is done as per the drawing.

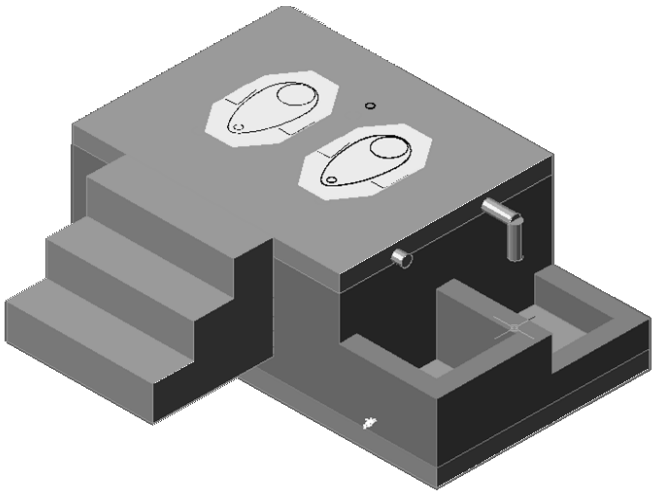
2. EXCAVATION, BRICK WORK IN FOUNDATION AND PCC WORK

Excavation is done for wall foundation. 12" inches wide and 18" depth trench is excavated for foundation wall. Then dry brick soling is done and brickwork for wall is started. The wall should rise up to 6" above existing ground level to insure flooding of water into the vault during rain. 4 inch thick platform is prepared with PCC.



3. BRICK WORK FOR CHAMBER

After setting of platform brick work for chamber is started. Typically 4" brick wall is preferred for chamber construction. Chamber is divided into two vaults by a 4" wall partition. Height of chamber is generally 2 feet. Upon completion of wall construction internal face of wall is plastered and punning is done to reduce possibility of water seepage. Finally concreting of slab is cast over the chamber with pan. Pipe to convey urine and anal wash water is concealed in slab where as Tee for the vent pipe is fitted just under the slab. Pipe fitting work is more sensitive and it requires proper care to ensure that the pipe does not move during the casting of the slab. Otherwise it makes leakage of into the chamber and creates more difficulties to maintain.



4. SUPERSTRUCTURE OF TOILET

The concrete slab will set in few days and then construction of superstructure of toilet can be started. The superstructure is similar to an ordinary toilet. After a complete setting of the concrete slab, i.e. in 2 to 3 weeks , formwork for the slab is removed.

5. PLUMBING WORK

Final work of toilet is plumbing i.e. urine container, vent pipe, black water pipe etc fitting works. Plumber must be careful to control leakage.

6. SOAK PIT OR CONSTRUCTED WETLAND FOR BLACK WATER

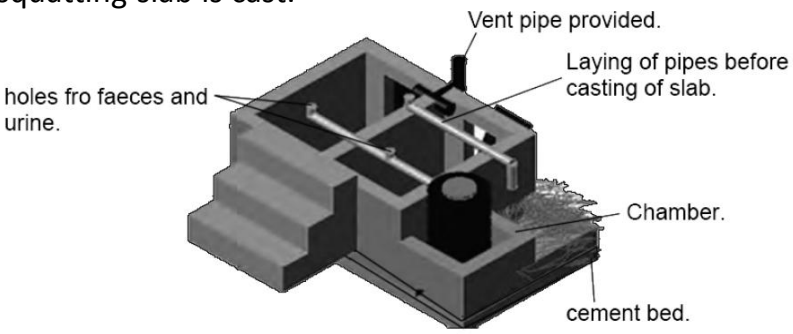
Generally at the side of urine container a soak pit or constructed wetland for the waste water is constructed. The pit should be 12 inches deep and filled with layer of aggregate or brick ballets in bottom and coarse sand layer at the top.

DOs

- Eco san toilets structure should be constructed above ground level.
- The base should be cemented and made impervious.
- Vent pipe should be provided at the junction of the separation walls of the two composting chambers to remove air and gas in the chambers.
- The vent pipe should be of adequate size and provide with fly net at the top.
- The holes in RCC slab should be made with 9” and 4” pipes at the time of casting of slab only.

DON’Ts

- The structure should be made over a pit of given size only. Do not build the superstructure without casting the cement bed and proper curing of the same.
- Do not make the RCC slab without proper formwork.
- Pipes should not be fixed after the squatting slab is cast.
- Do not leave the processing chambers without proper sloping and waterproofing as water should not enter these chambers.
- Do not leave the chamber open as it can lead to health hazards and improper composting.



ADVANTAGES

- It increases soil fertility as the waste is used as fertilizer and prevents water contamination.
- It doesn’t require any flushing mechanism.
- It reuses the human waste.
- Useful for water logged and high water table areas.
- Improves rural and community hygiene.

DISADVANTAGES

- High degree of quality control and hygiene.
- Skilled masons are required for buiding eco san toilets.
- Construction is more costly than regular toilets.
- It needs education for usage and acceptance of people.
- It has continuous use of ash.

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