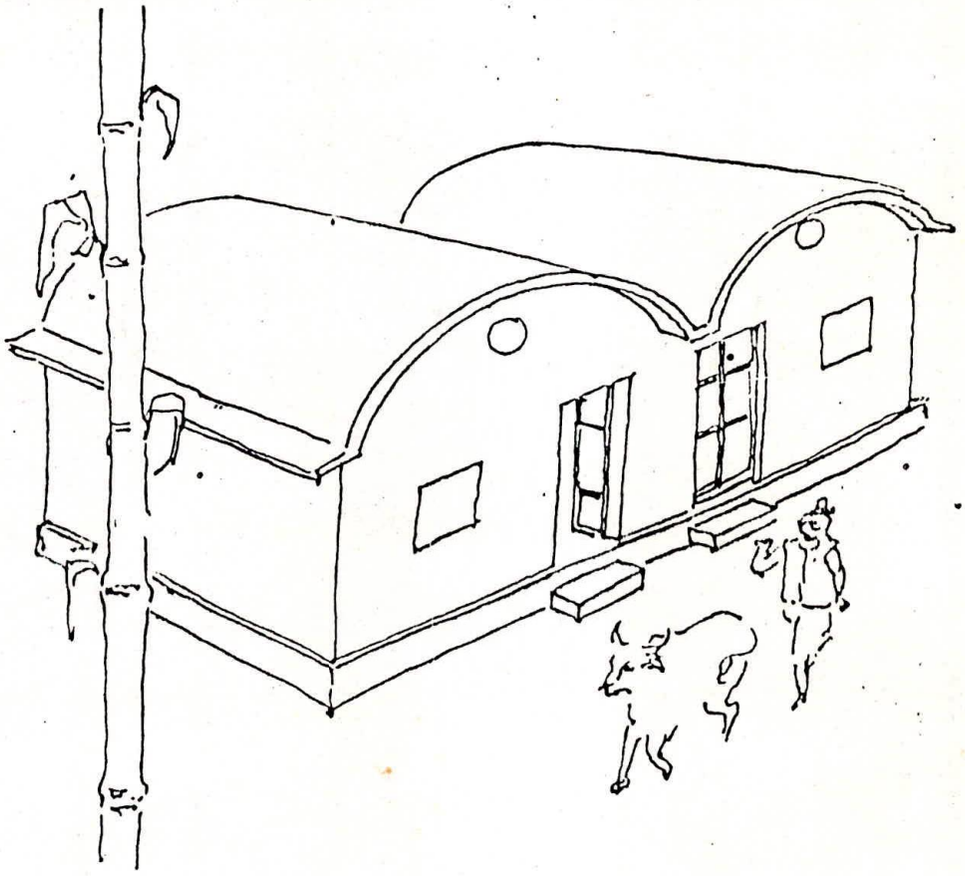
A LOW COST HOUSE

□ Wardha



Your kit Contains...

The technologies, that were demonstrated in the due course of Workshop given in the order of their record are :

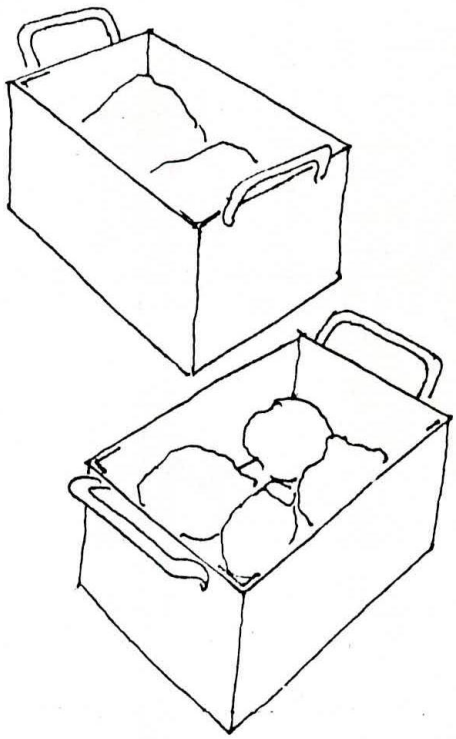
- Precast stone block Masonry.
- Partially prefabricated Brick pannel Roofing system.
- Precast lintel and chajja.
- Guna Vault Roofs.
- Tile faced Mud blocks.
- Improved Thatch.
- Stabilised Mud Block.
- Frameless Doors and windows.
- Cavity Walls.
- Water proofing of Mud walls.
- Ferro cement construction.
- Pile foundation.
- Spill water system
- Soak pit.
- Bamboo construction Material.

PRECAST STONE BLOCK MASONRY

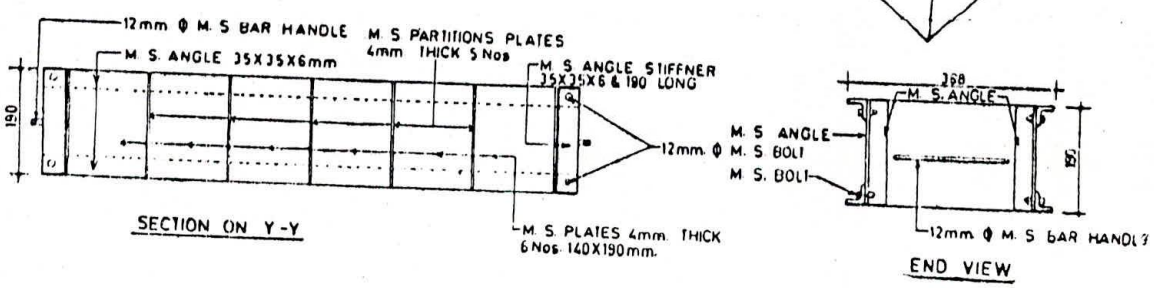
In regions, where stone is available in abundance, random rubble masonry is a traditional method of wall construction. However, a rubble wall has to be thick and therefore consumes a lot of stone as well as cement/lime.

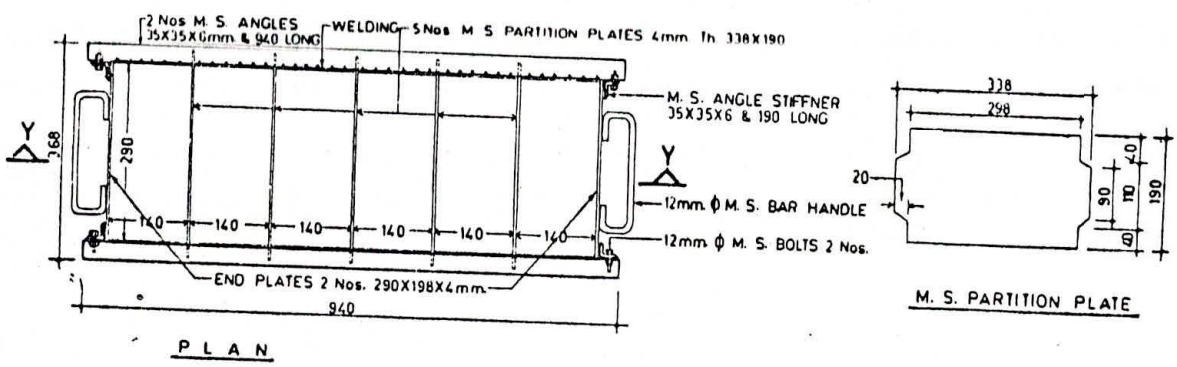
Precast Stone Block Masonry method has been evolved by C.B.R.I. to cut on the excessive use of materials as well as skilled labour. In addition, this method uses stone spalls (5 cm to 25 cm.) which otherwise find little use.

Large size stone spalls are first placed on the bottom of the mould leaving a minimum gap of 1.5 cm. between two stone pieces or the mould wall. The gaps are filled up with lean cement concrete mortar 1:5:8 (Cement : Sand : 10 mm and down coarse aggregates). Proper filling up is ensured by tapping the mould walls and deep trowelling alternately.



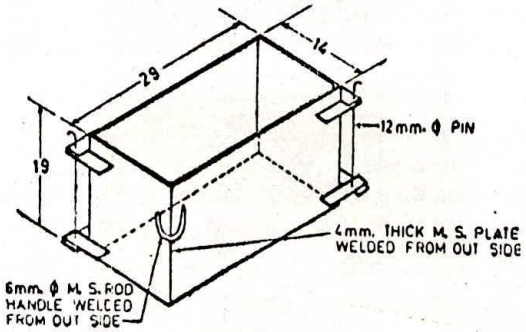
Demoulding can be started 5 to 10 minutes after casting depending on weather. The moulding can be done either in individual or gang moulds. The details of different types of moulds are given in the illustration.



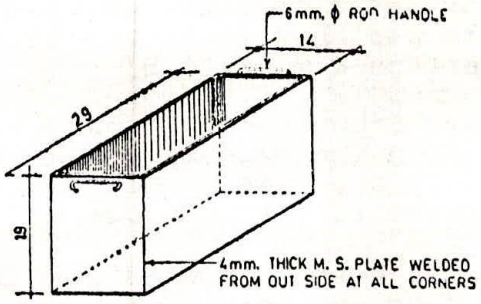


GANG MOULD OF SIX BLOCKS

ALL DIMENSIONS IN mm.



Split type mould



Fixed type steel mould

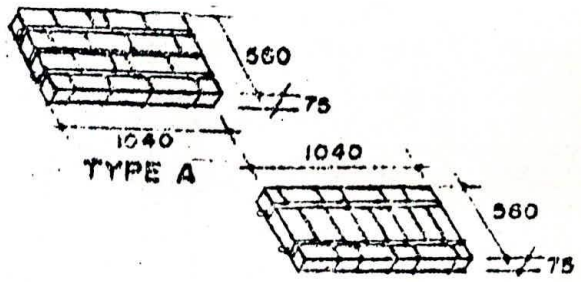
To break vertical joints, 1/2, 1/3 and 2/3 sized blocks can also be casted with same moulds using 4 mm thick steel plate partitions.

Partially prefabricated Brick Panel Roofing System

Flat roofs serve as additional living spaces in low rainfall temperate climates. However, the R.C.C. slab is quite expensive for this.

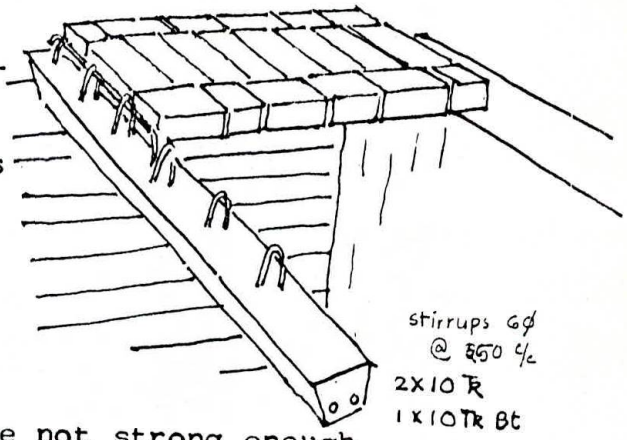
Partially prefabricated Brick Panel Roofing system saves not only money but also scarce and energy intensive materials like steel and cement besides substantially reducing the use of shuttering work. It also does away with the complications inherent in cast-in-situ work.

Bricks can be arranged either as in type A or in type B for brick panel of size 560 mm x 1040 mm. The panel is reinforced with two M.S. Bars of 6mmØ with their hooks projecting outside the precast panel.



TYPE B

The roof panels are supported on the partially precast joists and joined together in 1:2:3 concrete (grit) mortar. Temperature reinforcement is provided by 3 mmØ wire at a spacing of 550 mm, parallel to joists and 1040 across them. 6 mmØ bars for negative reinforcement are provided, where necessary. 25 mm thick concrete mortar of grade M-150 is laid all over the roof panels, to develop T beam action with joists.



These partially precast joists are not strong enough to carry the weight of the brick panels and the erection personnel. Therefore these joists are supported by two props which can be safely removed after 7 days of the top concreting.

Many interesting details about the structural action of panel can be extracted from your resource persons!

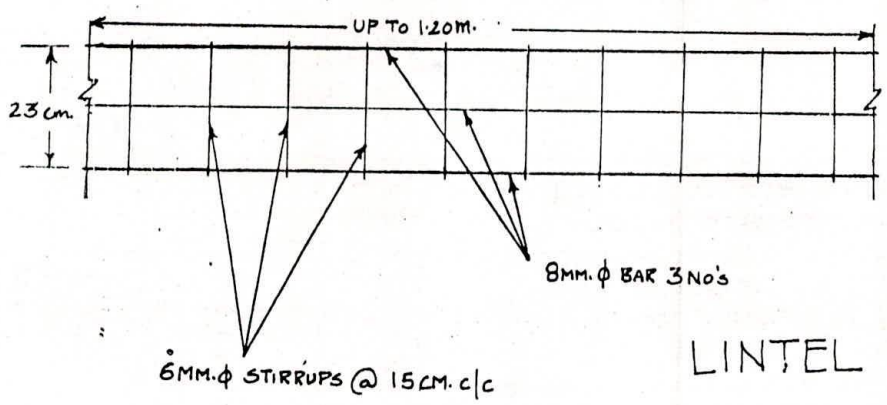
Reference : Verma, Narendra, 1974, "Prefab Brick Panels for low-cost Rural Houses", Journal of the institute of Town planners, India, September, 1974 No: 82

PRECAST LINTEL & CHAJJA

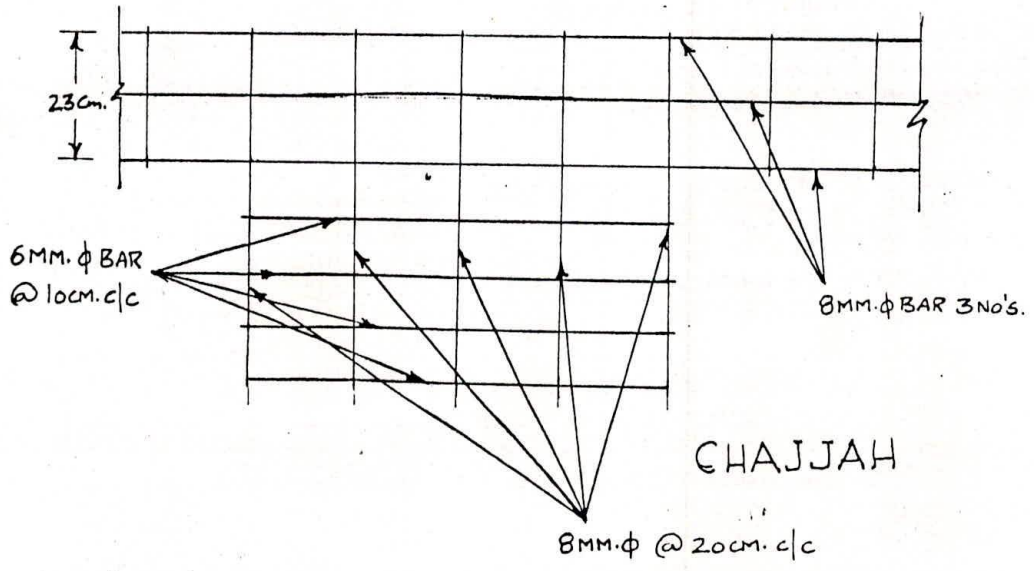
The cost component of centering, shuttering and scaffolding in R.C.C construction has always been a matter of concern, since its inception. Also, the quality control in R.C.C construction, which enables the full realisation of its potential has been a difficult task in in-situ construction.

Small components like chajjahs and lintels can be casted on ground at a substantial saving of materials, while exercing greater quality control.

The details of lintel & chajja, that will be precast on site is given in the illustrations.



LINTEL

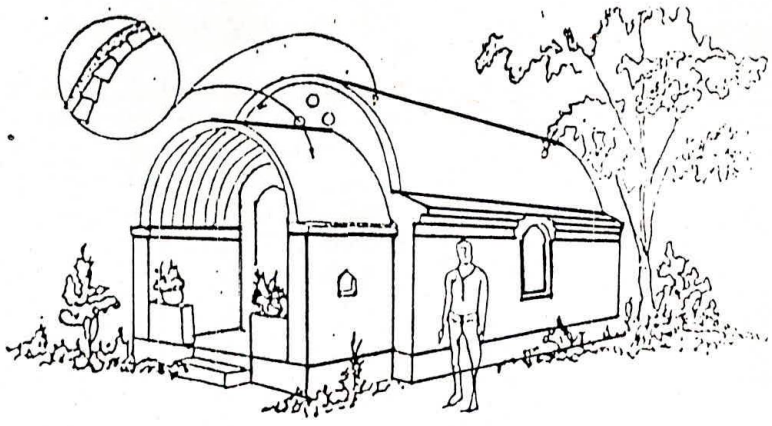


CHAJJAH

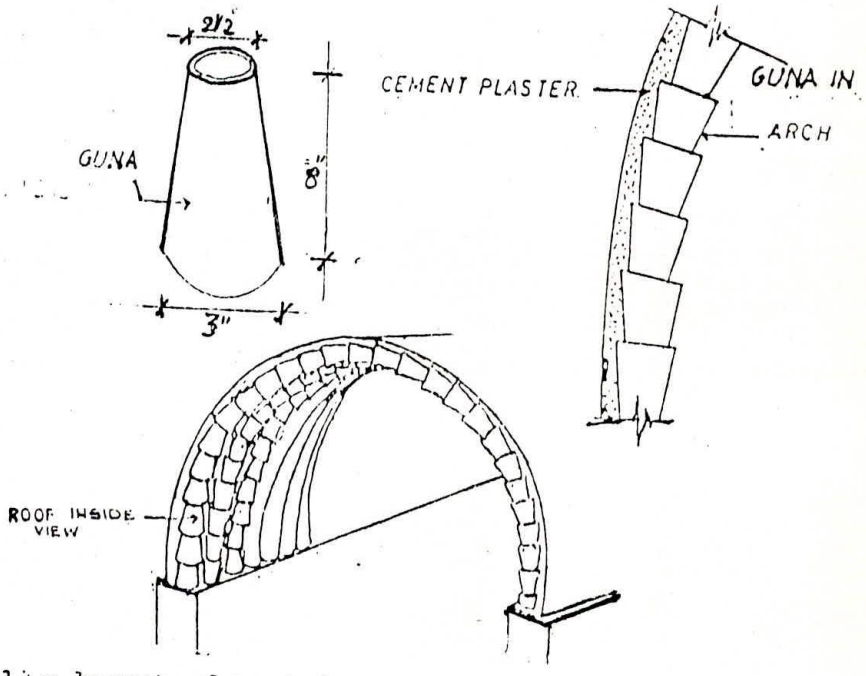
GUNA VAULT ROOFS

Roof is technically the most critical structural element even in the simplest of houses. It has to be light in weight, strong and durable. It has to also withstand the severest of sun, rain and dust. It therefore requires high environment/energy/monetary cost materials like steel, timber, cement etc. to meet these specifications.

Guna vaults are a low cost, rural technology based non-traditional alternative which we have been working upon for last 8-10 years.



A 'Gunna is a tapered clay tube thrown on a potter's wheel. (It is normally broken into two halves to make pan tiles for traditional roofing). Over a skeleton, these Guna's are socketted into each other to form a series of arches, thus making into a barrel vault. The top surface is plastered in cement mortar to bind the Guna elements together and seal the built element to penetration of water.



Guna vault (made of essentially burnt clay tubes - excellent insulators) stays cool even under scorching South Asian Summers besides needing little maintenance. present cost Rs. 18.00 per sq.ft.

Reference :

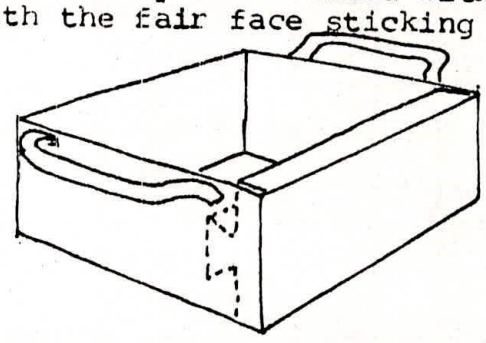
C.S.V., Manual on alternatives.

TILE FACED MUD BLOCKS

Plain mud surfaces suffer from erosion and pock marks due to weathering. This can be countered by building in terra cotta lining, to face the elements.

MOULDING THE BLOCKS

Terra-cotta (burnt clay) lining tiles are made to size to start with. They are moulded with a dovetailing rib at the back with the fair face sticking to the facing side of the block, the



tile is placed into the mould. Prepared mud is now hand pressed into the mould working it into the acute corners of the rib. As the mud dries and hardens the tile becomes an integral part of the adobe block.

LIME / CEMENT POINTING

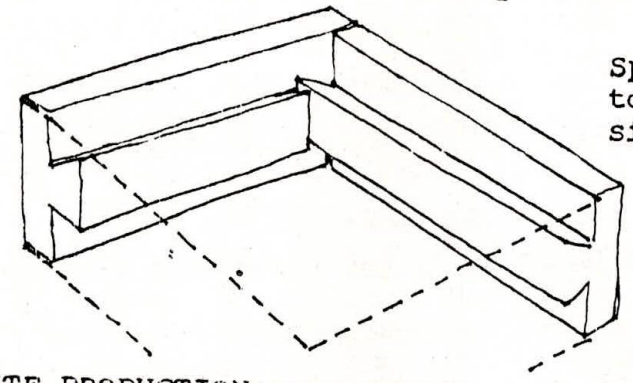
On drying, the blocks are built into an exterior wall with the tile skin to face the exterior side, using mud mortar to join them. The joints are then raked out to provide lime/cement pointing. This pointed tiled skin effectively seals the wall from moisture.

LOCAL CORRECTION

In regions near Wardha, the only available soil is black cotton soil which has an unmanageable shrinkage factor. In making blocks from this soil, we have added murrum (heavily disintegrated trap) @ 70% to correct the shrinking tendency.

QUOIN BLOCKS

The corner blocks must have protective skin on two sides.



Specially moulded tiles have to be placed on the two facing sides before the mud filling.

SITE PRODUCTION

For casting the blocks one may use appropriate steel/wooden moulds as suitable. Block sizes normally used at CSV are 300x225x100 mm and 225x225x100 mm. A pair of workmen can cast 200 - 225 blocks per day.

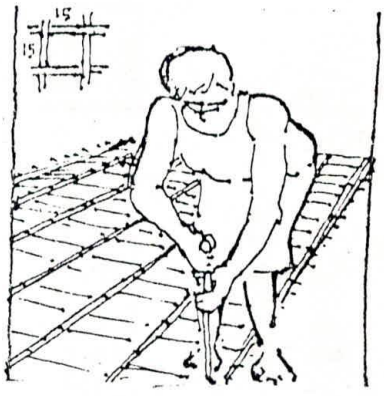
Reference :- C.S.V., Manual on Alternatives.

IMPROVED THATCH

Thatch roofs are very popular in rural areas owing to the ready availability of the materials (grasses, palmyrah/coconut leaves etc) and the simplicity of construction. However, it suffers from the risk of fire besides needing frequent replacement.

Pressed Thatch Panels :

Bamboo splints are arranged in a grid 15-30 cm (depending on the thatching material) and tied together to form panels (about 2.5 metres wide x full length + overhang). The thatch bundles are laid on the grid and tied strongly to the grid panel, by G.I. wires and a bar bender's 'J' hook. These panels are placed on purlins and tied well.



Fire retardant treatment :

The prestressed thatch panel is now made fire retardant by dipping it in 14% solution in water of fertilizer di-ammonium phosphate and sodium flouride. If the chemical is not available, alternately the following combination can be used to give fire retarding treatment.

- Copper sulphate
- Boric acid
- Zinc chloride
- Sodium dichromate
- Water

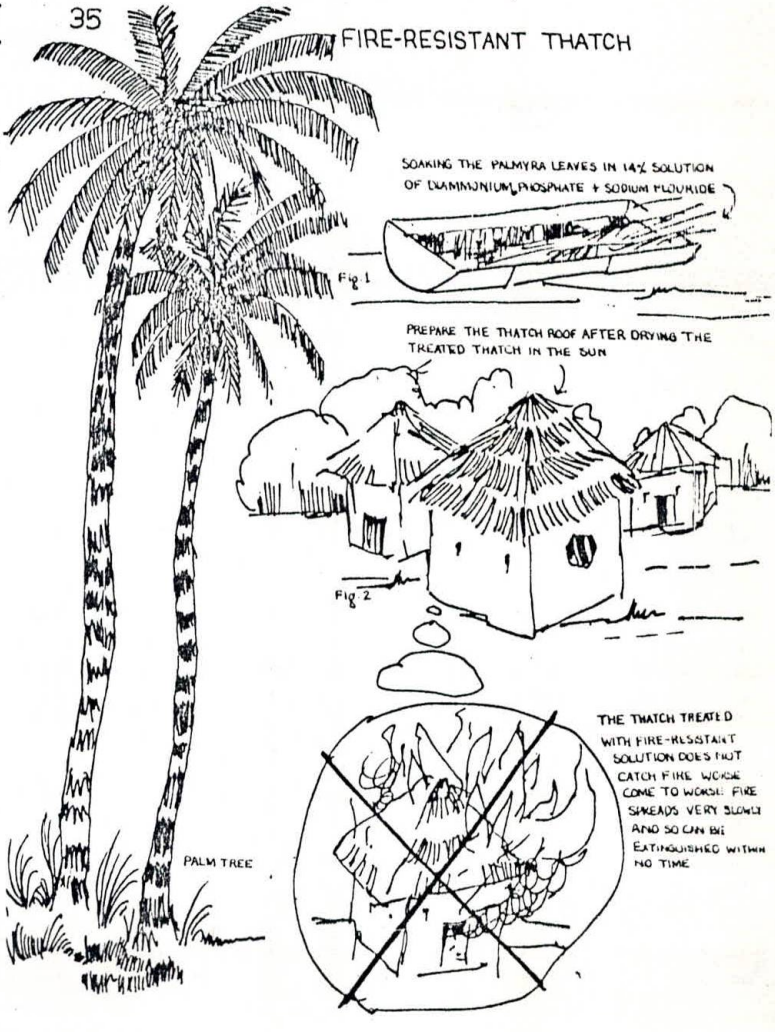
One Kg. of chemical mixture is sufficient to treat 10 Kg. of thatch grass.

Preparation of Mud & NEM :

The mud is reinforced by adding cut straw and pugging the whole mass together at intervals for a week or so.

Bitumen cutback is prepared by adding molten bitumen (80-100 grade) to Kerosene in 5:1 ratio and vigorously stirring the mixture to form a solution.

FIRE-RESISTANT THATCH



This cutback is laid over a mud heap (about 5 Kg of cut back for one cubic metre of soil) and the whole mass is kneaded well by using spades. This mixture is called Non-Erodable-Mud (NEM) plaster.

Application of Plaster in two coats :

Plaster is now applied to the pressed thatch panel in two coats. The first coat is of straw reinforced mud and rendered thick enough to cover the unevenness of the thatch panel including the overlaps.

NEM plaster is now applied to a good smooth finish and allowed to dry. Cracks would normally appear which are filled up with mud + gobar slurry. It is finished with two coats of gobar wash.

Further solution containing one part of bitumen mixed with 2 parts of kerosene is applied over the gobar wash to make it water resistant.

To do away with the black colour of bitumen further coating of gobar wash would give it a touch of harmony with the surroundings.

References :

C.S.V., 'Science & Technology for Women', DST, New Delhi.

C.B.R.I., "A cheap and effective fire retardant Treatment for thatch" in Building Research note, 1983.

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Stabilised Mud Blocks

Mud blocks, under dry conditions, are strong enough-exercising high compressive strengths. However, when in contact with moisture, the block tends to lose strength and suffer erosion as the moisture causes expansion of the soil. Dimensional stability and moisture resistant properties of the soil depends upon the soil composition - clayey soil having high shrinkage tendencies as compared to sandy soils. Thus, the addition of a stabiliser, which can counter the shrinking tendencies would improve the block properties immenesly.

Lime and cement are the two commonly adopted stabil isers. The choice and percentage of which again depends on the field conditions. Jaggery/Gud/Belfruit etc. are the traditional stabilisers, used since ages by humble rural folks, the details of which as usual needs to be explored.

ASTRA, DA, CSV to name the few has been working on the technique to suit their local soil requirements. More details about the technique can be obtained from the resource persons on field.

Reference :

Jagdish K.S. and Venkatarama Reddy B.V.; A manual of soil Block construction, ASTRA, Bangalore.

FRAMELESS DOORS & WINDOWS

Doors & Windows comprise 6% to 7% of total expenditure of the house, in which just the frames account for 1.5 to 2% of the total cost. Modified & improvised fixtures can do away with the frames thus saving in cost and also in consumption of scarce resource like timber.

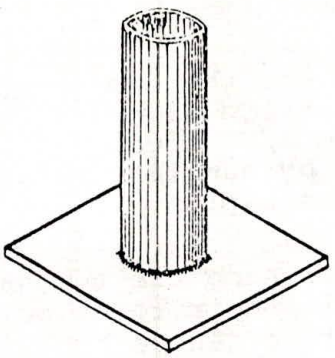
There are two types of such fixtures, Pivot type & Fork type to meet different applications.

(a) Pivot system : It consists of a pin & socket arrangement. The sockets are embedded both in floor (sill in case of a window) and in lintel, while the pins are mounted on shutters, both on top & bottom. It is of extreme importance that the two sockets are in perfect alignment to ensure smooth operation of the door during its life.

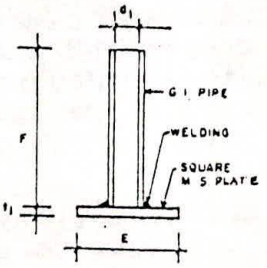
The top socket works as a guide while the floor socket at the bottom carries the weight of the door.

The top socket is a simple piece of G.I. pipe while the floor socket is made by welding a piece of G.I. pipe to a square shaped piece of M.S.plate. To carry the weight of the door and ensure smooth operation, a glass marble is inserted in the floor socket just before fixing of floor pin.

The pin's are welded on the shorter leg of the two unequal angles (or built up by welding two pieces of M.S. flat section) while the longer leg is provided with screw holes to fasten it to the shutter from sides.

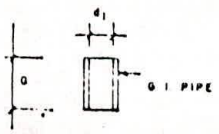


FLOOR SOCKET-VIEW

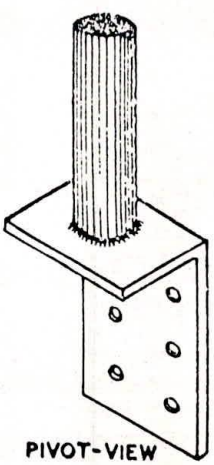


FLOOR SOCKET-SECTION

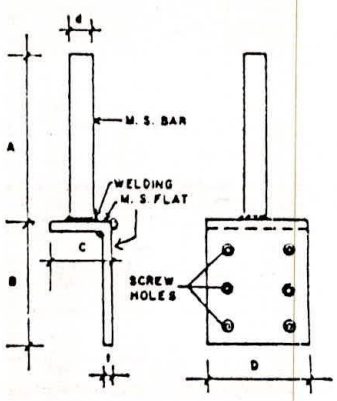
TOP SOCKETVIEW



TOP SOCKET-SECTION

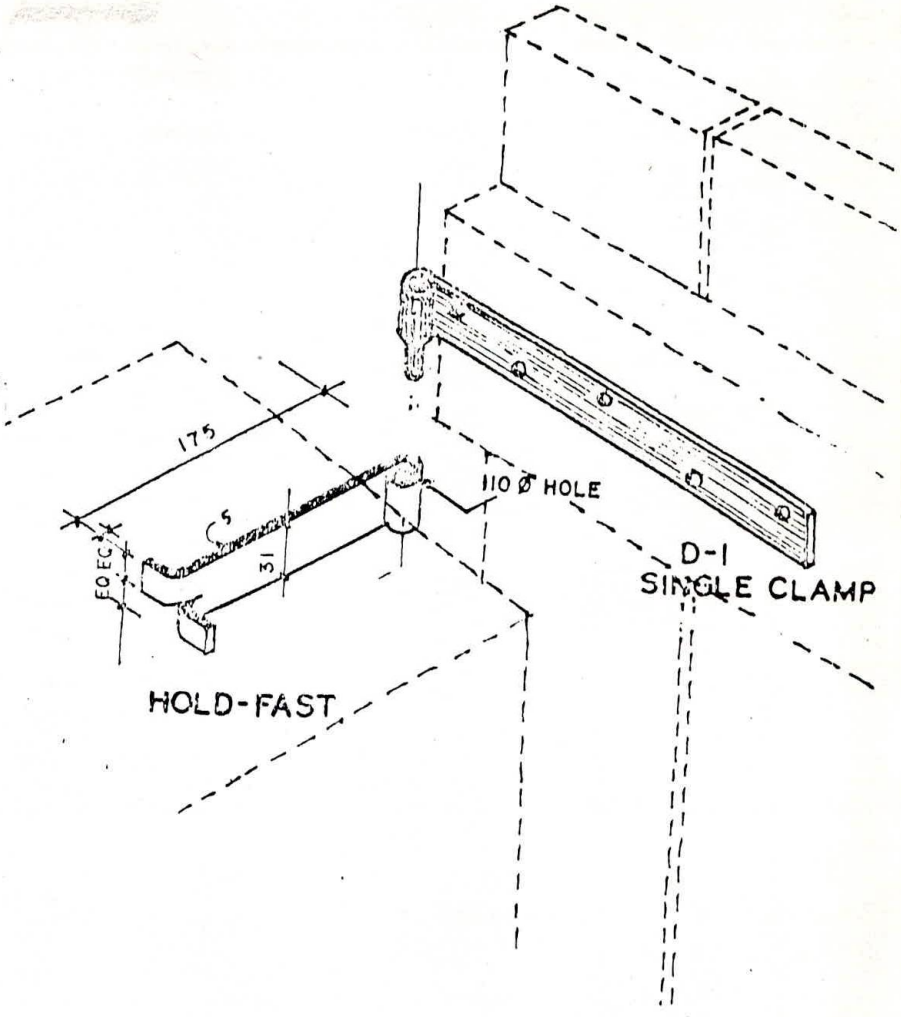


PIVOT-VIEW



PIVOT-SECTION PIVOT-ELEVATION

(b) Fork system: Fork hinge is fabricated out of M.S.flat. The piece to be embedded has a fork end on the wall side. while the other end is formed into a tube. The other leaf of the hinge is a M.S. flat provided screw holes to fasten it to the shutter. M.S. pin is welded at the free end of the flat to pivot into the tube.



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CAVITY WALLS

Brick has been probably the oldest of building materialS. More important than this is the fact that it is anatomically scaled module. The length, width, thickness, weight and texture are all the qualities which merge to form a brick. Very surprisingly the brick is the golden mean of what the soil can sustain and what a human paw can handle comfortably. The walls, the domes, the vaults, the piers, the butteresses, the arches, the drains, the pavings, the aqueducts have been the gamut of application of this simple material.

The cavity brick wall, which are of many variations has mainly two purpose.

(i) In tropical countries, the cavity brick walls function to ward off the excessive heat from out side.

(ii) In cold countries, the cavity brick walls are used for thermal insulation. (To maintain the heat inside)

The other salient features of cavity wall are:-

(i) Good exposed surface can be obtained,

(ii) Saving of bricks in volume from 19.3% to 45.5% as compared to solid brick wall.

(iii) Reduction in dead weight.

(iv) Reduction in use of cut brick, thus economical brick work can be done.

"Swastik Bond" is other variation in brick bond. It is the combination of Brick on Bed & Edge. By this Bond 8" thick brick wall can be made, which is structurally sound and economical.

AXONOMETRIC BRICK :

Salient features

(i) 4½" brick wall can be made with vertical and horizontal reinforcement.

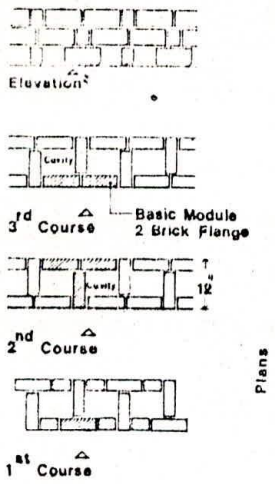
(ii) Brick slab can be made using horizontal reinforcement.

(iii) 8" thick wall using Swastic Bond can be made, which is supposed to be the strongest brick work.

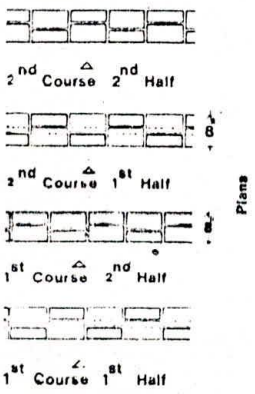
In a Bond, because of rigidity the two elements of wall have to have same variation of brick work e.g. Brick on bed to bed and edge to edge. The μ (Mu) joint however offers a different variation.

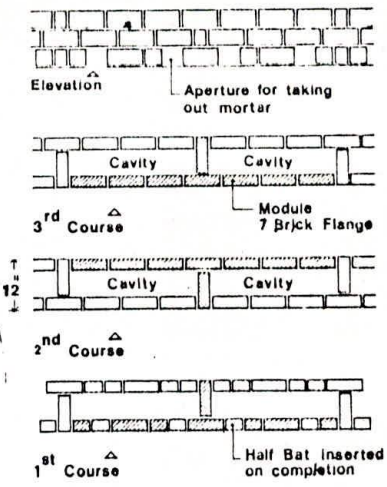
Like any living being, μ joint basically has two elements of walls in the vicinity of each other joined with flexible material like metal strap. The two elements of wall being non-colinear,

JOSHI BOND



CAVITY WALL



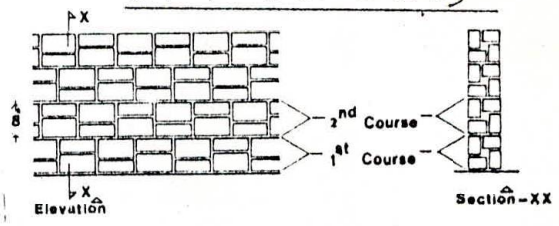


Saving of bricks (in volume) as compared to solid 12" Brick wall in

2 - Brick Flange	35.7%
3 - "	40.0%
4 - "	42.3%
5 - "	43.8%
6 - "	44.6%
7 - "	45.5%

NEW BRICK BOND (BRICK ON EDGE) FOR ECONOMY & INSULATION

CAVITY WALL extra light



1. A combination of stretcher course of Brick-on-Bed and Brick-on-Edge
2. Frogs of Brick-on-Edge are kept outside for better seating of plaster.
3. Thickness of wall reduced by 1" while using conventional 9" Brick.
4. Strength same as regular 9" (1 Brick wall)

← SWASTIK BOND →

Ar. Ashok Joshi

FEATURES

1. Flanges elongate by One-Brick for succeeding variation with larger cavity.
2. Thermal insulation in an increasing order as T-flange increases.
3. Saving of bricks (in volume) as compared to solid One-and-a-Half (14") Brick wall in:

2	Brick Flange	19.3%
3	"	23.0%
4	"	25.0%
5	"	26.5%
6	"	27.4%
7	"	28.0%
8	"	28.5%

4. Reduction in dead weight as well as saving in bricks by
   - 2 or 3 Brick Flange in Ground Floor
   - 4 or 5 " " in First Floor
   - 6 or 7 or 8 " " in Second & above Floors
5. Elimination of metal ties.
6. Reduction in use of cut bricks.
7. Provision for taking out mortar falling in the cavity.
8. Useful as external walls in houses, granaries, hospitals etc. in hot-dry climates.

the load bearing strength is not reduced. On the other hand a damage caused in one arm does not get transferred to the other. Replacement of any one element also is easy in ll joint.

To conclude, we also find that the manufacturing cost of brick does not depend merely on quantity. The manufacturing process of brick costs much less as compared to other building materials like cement, steel, etc.

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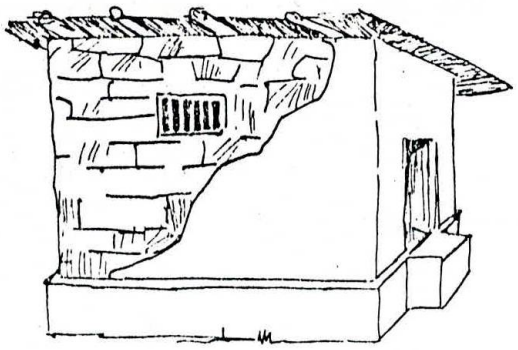
WATER PROOFING OF MUD WALLS

Mud walls, although good insulators have great disadvantage against rains. Traditionally, mud walls are rendered on the external face with mud plaster which consists of local soil and mud collected from the pond mined with bhusia (straw) with a final coating of gobar (cow dung) slurry. This method however, cannot with stand continous rains thus leading to the erosion of walls.



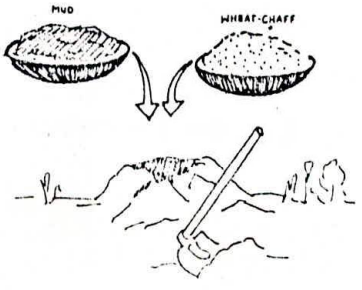
ERODED MUD WALL

A simple technique, incorporating bitumen offers a durable water proof coating to the already standing mud walls.

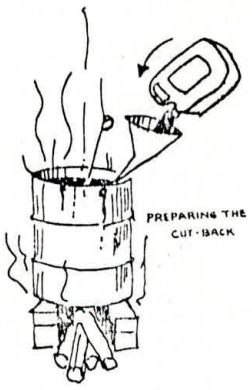
The process involves three steps.

i) Preparation of mud plaster
ii) Preparation of cut back
iii) Preparation of Non-erodable & water proof plaster.

(i) Preparation of mud plaster : The soil should neither be too clayey nor too sandy - a clay content of 20 to 25%, sand content of 40 to 45% and a plasticity index of 6 to 20 is suitable. A soil fairly free from organic material, gravel, pebble etc. is durable. Bhusa (wheat straw) at the rate of 6% by weight of dry soil be about 64 Kg. for every M^3 of soil, is added to the dry soil and throughly mixed. The soil straw mixture, if kept wet and well kneaded, enhances the cohesion and strength of mortar.



(ii) Preparation of cut back : 80/100 grade of molten bitumen is slowly added to the kerosene oil in the ratio of 5:1 by weight or 1:1 by volume (latter being convenient on field) the mintule is vigorously stirred to have a thorough mixing. Bitumen should be added to the kerosene and not the other way as otherwise kerosene remains on top rendering mixing difficult.



(iii) Preparation of NEM Plaster : The cutback is spread over a heap of mud mortar uniformly and worked up with spades several times to ensure its thorough mixing. About 53 Kg. of bitumen and 10.5 litres of kerosene are required for cutback to be added to 1 M^3 of dry soil.

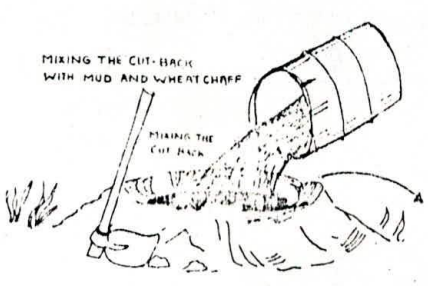
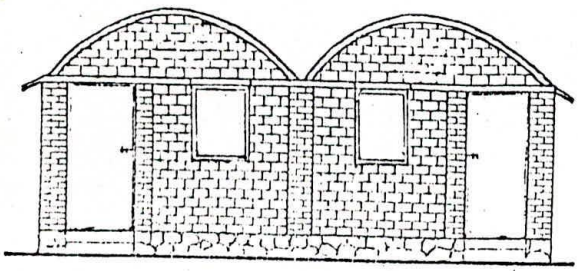


Fig 6.

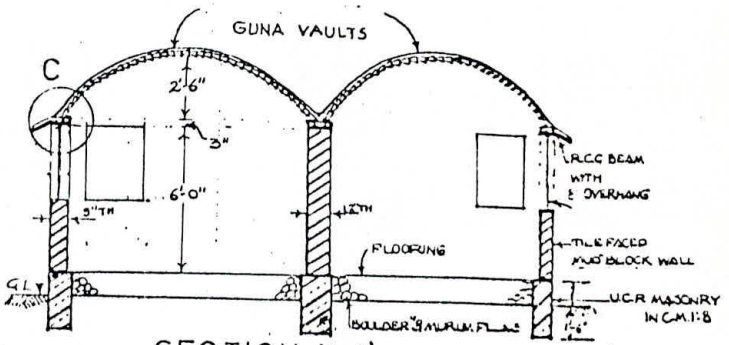
Reference :

C.B.R.I. "Non Erodable Mud Plaster on Mud Wall for Rural Houses" in Building Research Note.

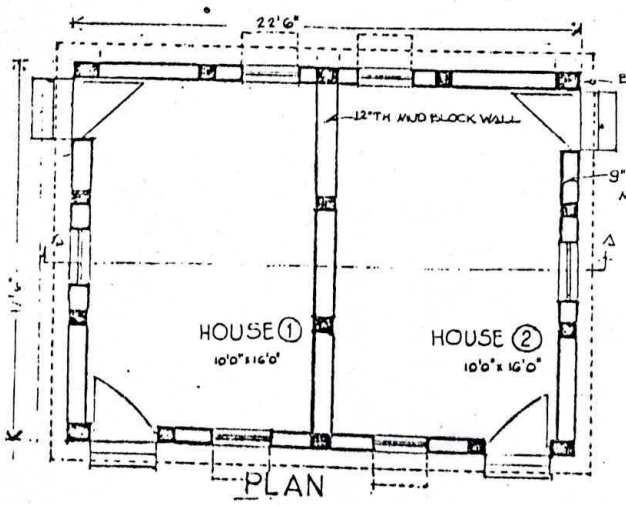
** ** **



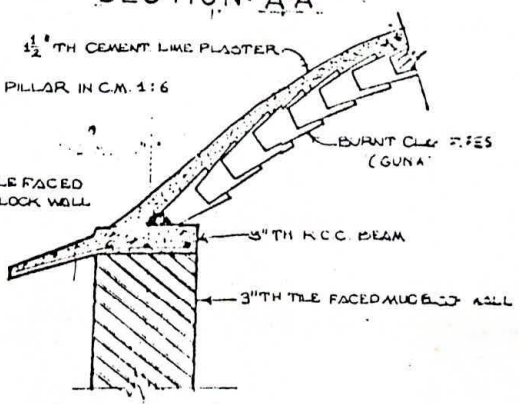
FRONT ELEVATION



SECTION A-A'



PLAN



DETAIL AT 'C'

TWIN UNIT DESIGN

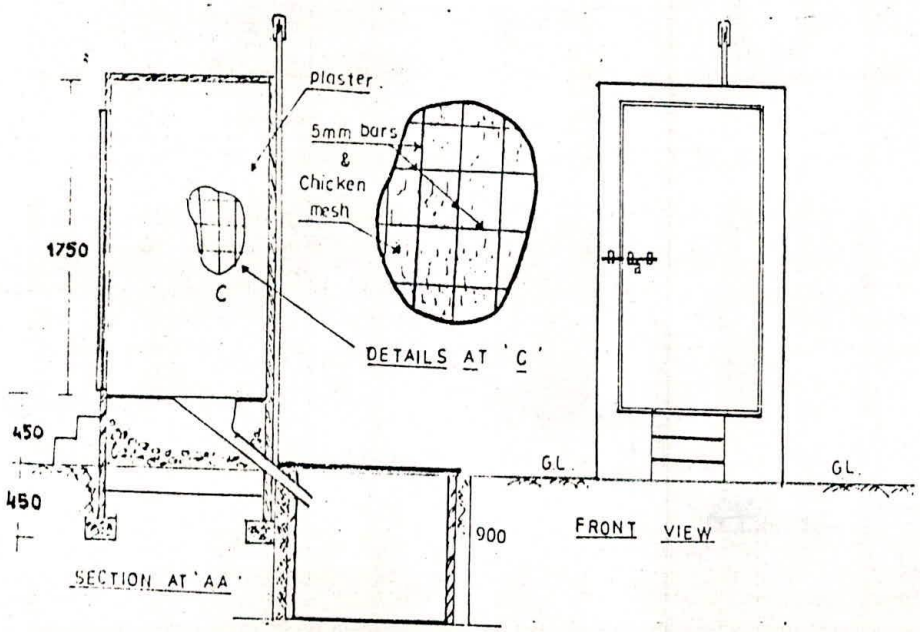
FERRO CEMENT CONSTRUCTION

Ferro cement constitutes cement, sand mortar with wire mesh reinforcement. It is particularly suited in making thin panels which are impossible in conventional reinforced concrete.

Ferro Cement technique, in history, is older than Ferro (Reinforced) concrete, having been displayed at the Great Industrial Exhibition at Paris in 1840, in many novel applications. But it failed to attract the kind of attention that Reinforced concrete did in the coming decades and even more in the coming century.

Ferro Cement found a large scale application under the famous Italian Engineer P.L.Nerwi in the 40's but still continued its dormancy. These special characteristics of a high strength/weight ratio and high mouldability which is now attracting notice the world over in many varied applications.

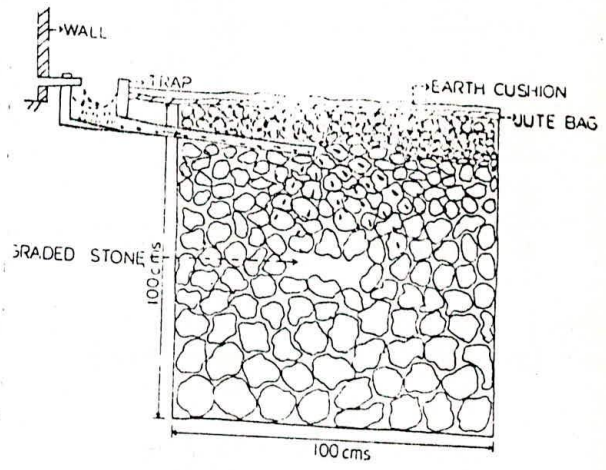
At C.S.V., we have used this technique in constructing low cost rural latrines in a big way, with the slight modification of using 5 mmϕ bars to strengthen the panels, the details of which is given in the illustration.



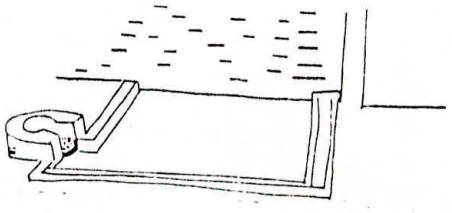
SOAK PIT

Waste water from house-hold operation like cooking, cleaning, laundering and bathing do not need to be connected to the septic tank or centralised sanitation. After removing large sized impurities in traps/inspection chamber, the sullage water can effectively be drained into the soakpit avoiding in-sanitary muddy pools.

A pit 3'x3'x3' (100cmx100cm x100cm) dug close to the drain outlet (at a minimum of 30 cm. away from the nearest wall of the house) serves as soakpit for a house hold emitting a sullage water of 20-30 buckets per day. It is filled with boulders in the bottom one foot. Next one foot of height is covered with stones with pebbles laid on top of it. The stones are loosely placed to enable easy perco lation.



Inspection chamber/trap of 6"x6"x6" in Brick masonry terminates the exit drain. Abo 4" deep chamber is filled with coconut fibres to trap solid wastes in the sullage. These solids should be cleared from time to time.



With little care, soakpit can last for 10-15 years without choking. Rocky soils being unsuitable for the system.

Reference :

C.S.V., 1983, Science and Technology for women, DST, New Delhi.

PILE FOUNDATION

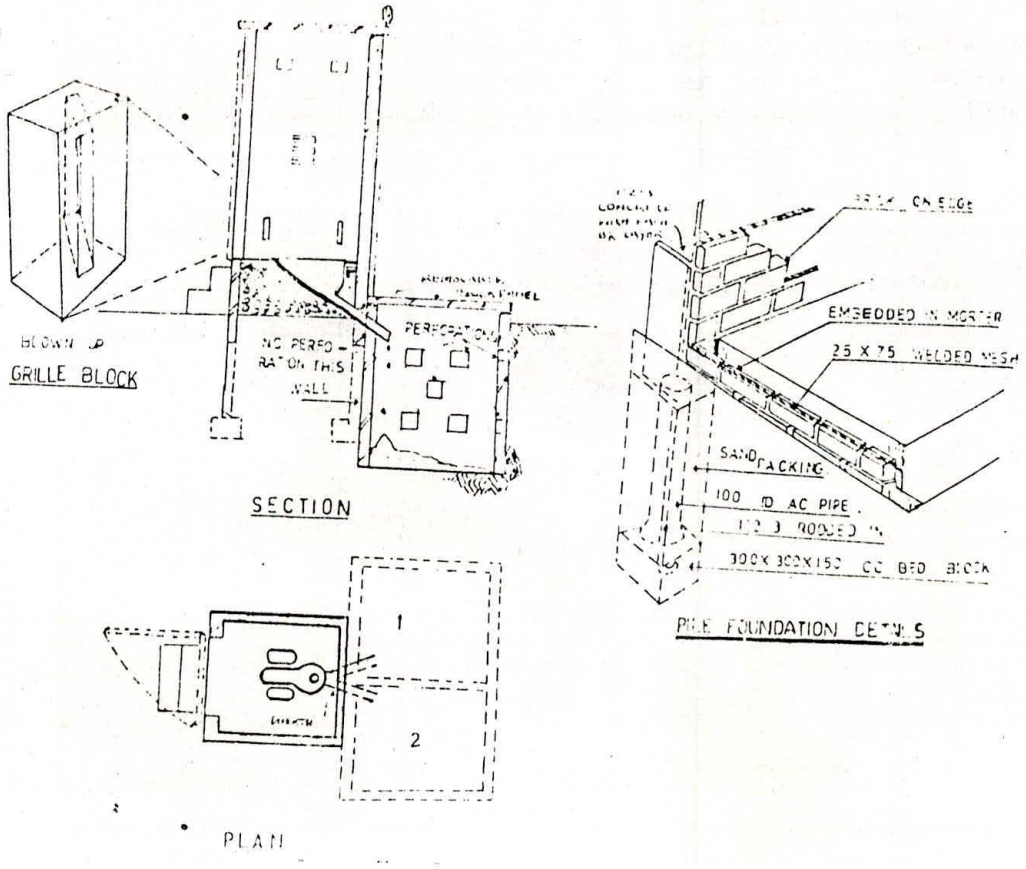
Dimensional stability, has always been a problem with Black Cotton Soils. The soils expand and shrink with increase and decrease in moisture in soil. This causes seasonal ground movements, rendering difficulties for foundation.

The usual method to counter this problem has been to provide under reamed piles taken to the depths of 3 m. below the soil. These piles have a safe bearing capacity of 8 tonnes. However, in single storied structures, where the foundation loads normally donot exceed 2.5 tonnes, under reamed piles of conventional design proves uneconomical. Thus, CSV has been working on modified piles to suit the specific requirements on site.

The details of pedestal pile used in low cost latrine construction by CSV is as follows:

Holes are augur bored in the soil to a depth of 1 Meter and the bottom is compacted by ramming. After the reinforcement is placed in position, concrete is poured in the bed for distribution of load (as well as for anchorage in case of upward thrusts). Asbestos cement pipe (normally used in drainage) is now inserted around the bar and concrete in worked down in the pipe. This bar is then carried into the masonry.

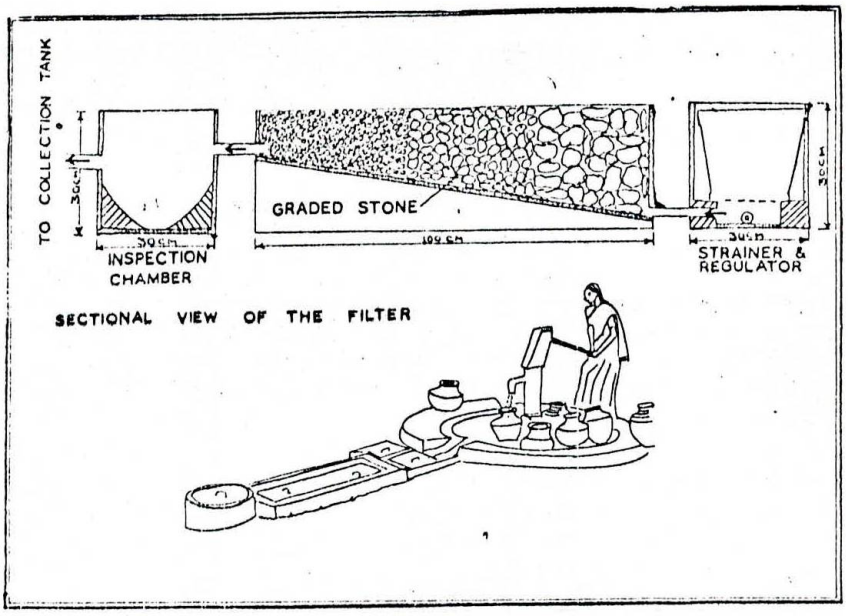
Other details can be seen in the illustration, showing the use of this technique.



SPILL WATER SYSTEM

Water is becoming a scarce commodity under the fast depleting ground water resources in most parts of the world. It would therefore be wiser to put our waste waters to greater use. Spill water system is one such effort, particularly suited to public water points like tube wells now becoming a common sight in our country side.

The system consists of an inlet tank followed by a filter unit which in turn in connected to the inspection chamber and finally to the collection tank. Heavier solid particles in the spilled water settle in the inlet tank and the water finds its passage to the filter unit through a strainer. Filter is a trapezoidal tank of length 1.2 m. Tank is filled with graded stones with bigger ones at the inlet side and smaller ones the further end. Water purified partly by sedimentation and partly by filtration is received at the inspection chamber.



The turbidity of the effluent water can be checked in the inspection tank. In case of unacceptable turbidity, the cleanout operation is periodically necessary.

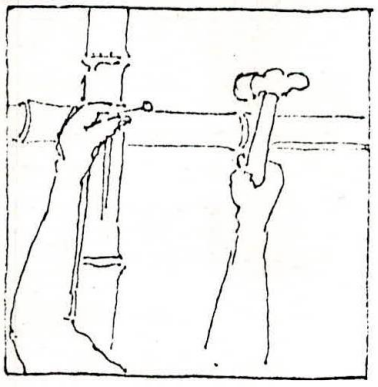
Clean outs are provided both to the inlet tank and the filter tank. The outgoing water is allowed to flow into a soak pit.

Reference :

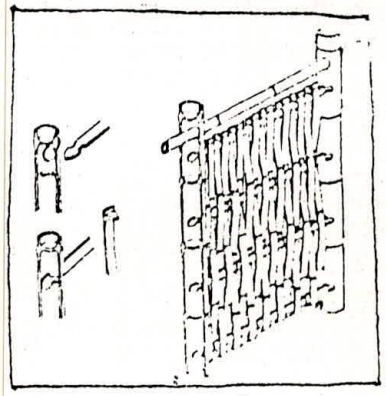
C.S.V., Manual on alternative techniques.

BAMBOO-A CONSTRUCTION MATERIAL

Bamboo, the most versatile natural resource has a broad range of construction applications. The lower density and natural pipe form are great advantages as a structural perforer. Its high tensile and comprehensive strengths comparable with that of steel enables its application in critical structural elements like roof, trusses and purlins etc.



The unidirectional fibre arrangement in bamboo makes for easy extraction and high workability with simple tools. However the anatomical character makes bamboo vulnerable to splitting. Thus bamboo can neither be nailed nor joined like wood.

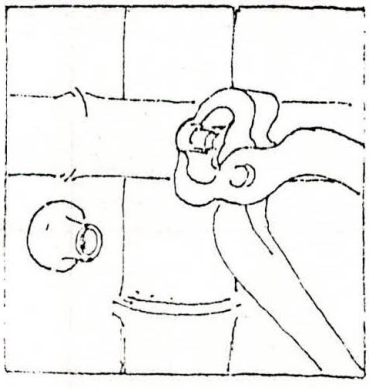


Traditionally bamboo has been used with due respect to this weakness. Ingenuity has produced interesting responses like ladder without nails ropes & glue from the Dandakaranya tribals. There are many regional variants on this theme.

There are some non traditional methods which widen structural application of bamboo items.

Bamboo/Timber pins :

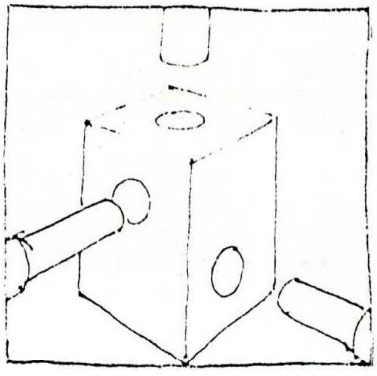
Bamboo can be drilled by machines normally used on Wood and steel. Bamboo/timber pins dipped in glue are malatted through the two bamboo holes. The thinner end of the pins is secured with shoe rivets.



M.S./WOODEN Jointers:

Some places may demand jointers like the ones illustrated here.

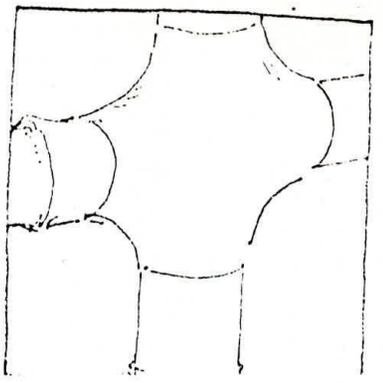
The wood does not have to be expensive (teak, rosewood etc). Many local species hard and durable (and in small lengths) are good enough for making jointers.



Fibre Bandage :

Resin (Unsaturated polyster) matrix in glass fibre, bandaged around the bamboos provide another possibility for versatile application.

There are some biomass options for both the resin and the fibre which are being examined under research project.



Reference :

Kaley, Vinoo; 1989 "Is there no alternative to Bamboo desserts

Kaley, Vinoo; 1992 "Build your House to the Rythm of life"

Janssen, J.A.Jules, "A series of articles on the use of Bamboo in building construction", University of Technology (Eidhoven), Netherlands.

Dunkelberg,Klaus, Bamboo as a Building material, IL Publications