Kenya Vibrated Concrete Products Production Manual

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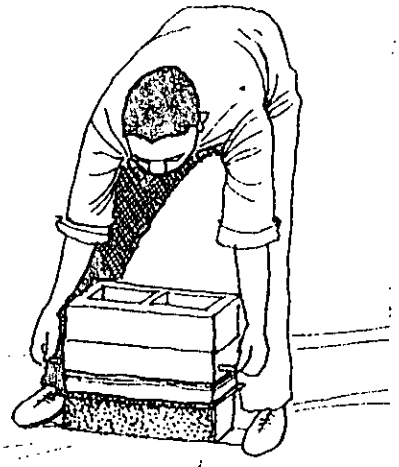
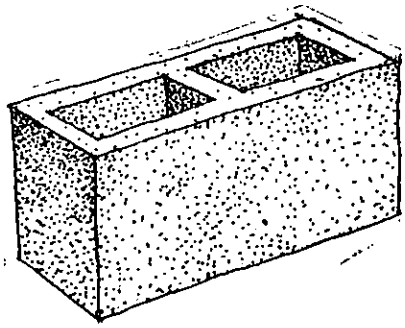
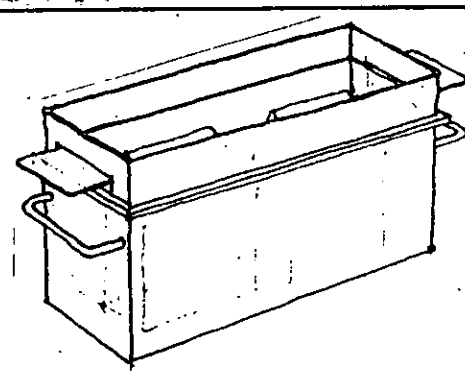
Vibrated Concrete Products



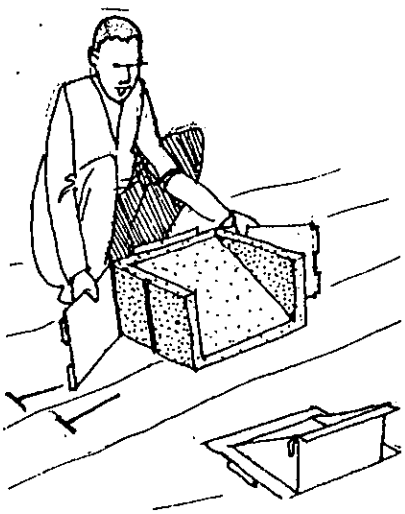


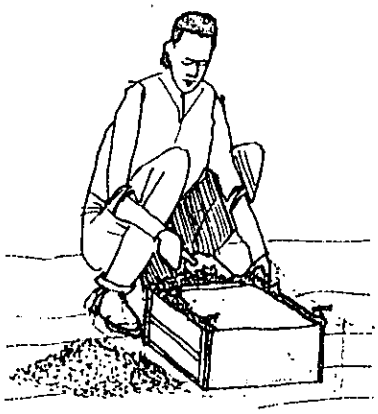


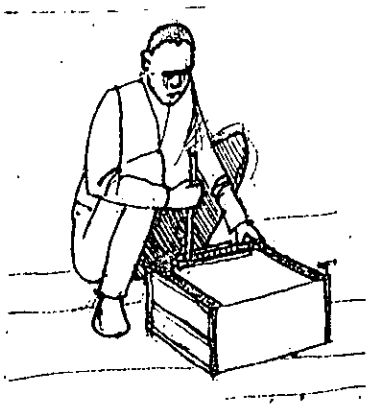
Production Manual

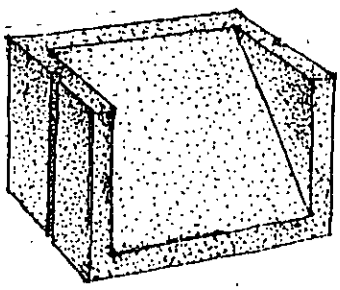
Amon Ng'ang'a

Building Materials and Shelter Programme of IT-Kenya









Foreword

The Vibrated Concrete Products (VCPs) manual was conceived to inform small scale entrepreneurs as objectively as possible an effecient way of starting and sustaining a VCPs business. The aim of this manual is not to deal with the technology in depth, as sufficient literature is available in alternative books, but to give practical information for producers to be able to produce VCPs on their own.

Use has been made of numerous illustrations and simple English to enable many of our target groups to follow the steps in VCPs production. It is hoped that this manual will become an invaluable field companion for small scale enterpreneurs who are interested in starting a VCPs workshop.

☞

The technical details on the production of VCPs are from the producers and other literature sources on the technology. ITDG-Kenya is not in a position to verify these data and will not therefore be held liable for any inaccuracies in the production of VCPs.

Acknowledgements

The author wishes to sincerely thank all those individuals and organizations that were actively engaged in the preparation of this manual. Special thanks go to Francis Macharia and Peter Wambu both of University of Nairobi for their research and illustrations on various aspects of VCPs Production.

I would also like to record my appreciation for the support given to me by E. Agevi (ITDG) and Keith Wright in editing and restructuring the manual.

Finally, very special acknowledgements go to the many individuals and organizations that provided useful information on various aspects of VCPs production. It is not possible to include all their names, but special mention should be made of - Christian Industrial Training Centre (CITC) - Thika, Joe Munene (Shelter Works), Makiga Engineering Works. To all of you I say a big thank you.

Amon Ng'ang'a, October 1994

Abbreviations

BMSHEL: *Building Materials and Shelter*

FCR: *Fibre Concrete Roofing*

FICROPAK: *Fibre Concrete Producers Association of Kenya*

IT - KENYA: *Intermediate Technology - Kenya*

ITDG - KENYA: Intermediate Technology Development Group - Kenya

KBS: *Kenya Bureau of Standards.*

MCR: *Micro Concrete Roofing*

MICROPAK: *Micro Concrete Producers Association of Kenya*

OPC: *Ordinary Portland Cement*

VCPs: *Vibrated Concrete Products*

NGOs: *Non-Governmental Organizations*

CBOs: *Community Based Organizations*

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INTRODUCTION

Building Materials and Shelter Programme of IT-Kenya

For the majority of Kenyans, hopes of building affordable and decent shelters are fast diminishing due to the ever increasing cost of building materials. The problem is complicated further by lack of alternative affordable appropriate building materials. It is therefore not surprising that three quarters of the kenyan rural Population cannot afford to build with conventional building materials despite their dwindling local traditional building materials.

Similarly, the major urban centres are experiencing an acute shortage of housing. In Nairobi, for instance, over 60% of its residents continue to live in unplanned, overcrowded and poorly sanitated dwellings.

It is against this background that *IT-Kenya* set up the Building Materials and Shelter *(BMSHEL)* Programme. Under this programme *IT-Kenya* hopes to achieve the following objectives:

- Give people access to choice of housing at a reasonably affordable cost.
- Stimulate growth of local building materials industries through encouraging and supporting new and existing producers to use widely available local materials.
- Encourage decentralized small-scale production and use of low cost building materials and technologies.
- Promote the use and acceptance of proven appropriate technologies and building materials amongst the policy Makers both within the Government and the private sector.
- Share information with other local agencies and guiding policy makers in the building industry.
- Create a forum for monitoring progress made in the research and dissemination of building materials and technologies through regular participation in seminars and workshops organized by IT-Kenya or other Shelter Forum Institutions.

This illustrated manual outlines the production of VCP using a simple language. It is hoped that the manual will be an invaluable companion to builders and users of VCPs

1 VIBRATED CONCRETE TECHNOLOGY PRODUCTS PROJECT

The vibrated concrete technology is a relatively recent technology, having been started in 1985 by *BMSHEL*.

Vibrated Concrete Technology is based on the fact that when concrete is vibrated air pockets in this concrete are forced out. This creates a strong product using little cement.

Advantages of Vibrated Concrete Technology

Simple Technology

With proper training anyone (even unskilled workers) can successfully make Vibrated Concrete Products (VCPs).

Small-scale production

VCPs can be produced locally in small workshops. The initial capital required to buy the workshop equipment is affordable for small scale producers.

Job Creation

Since most of the *VCPs* are produced manually, many jobs can be created for Kenyans both in the rural and urban areas. The vibrated concrete technology is also adaptable to any scale of production including one man enterprise.

Foreign Exchange Savings

VCPs require little initial investment in equipment and energy supply. The raw materials required for the production of VCPs are widely available locally thus saving in foreign exchange.

Low cost technology

The VCPs are cheaper and of comparable quality to other locally available conventional building materials.

Maintenance Costs

The maintenance cost of the vibrating table, the moulding equipment and other working tools used in the production of *VCPs* is minimal.

Durable

VCPs have high compressive strength and offer good resistance to weathering and abrasion.

Safe and Attractive

VCPs are safe and non-toxic. They have no harmful effect on the environment. When produced and installed correctly, VCPs are of similar quality to the conventional building materials.

2 ORGANIZATION AND MANAGEMENT

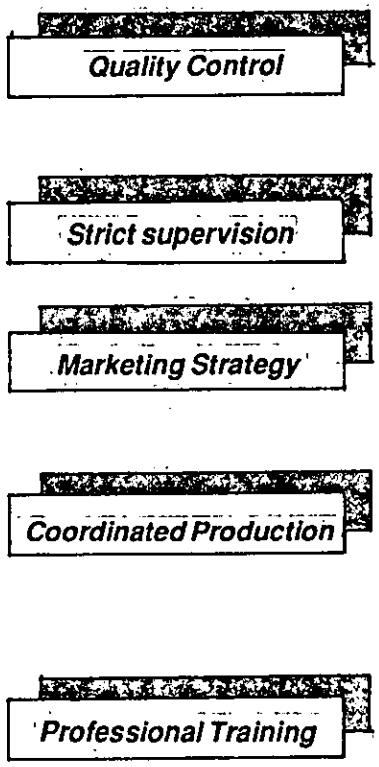
It is essential to have good business organisation management.

Quality Control

Continuous and strict control of the quality of raw materials used in the production of VCPs as well as of the finished products and its installation is very important for boosting sales. This calls for testing the raw materials before use and testing the finished products for load-bearing, impact strength and water-tightness. Guidelines for general quality control are included in this manual.

Strict supervision

Like in any other business enterprise, a successful VCPs workshop will require proper choice of raw materials and their storage. Qualified and highly motivated workers will be a big advantage to an entrepreneur. Daily supervision of the production and quality of VCPs and maintenance of workshop equipment should be carried out.



Marketing Strategy

The building material market is very conservative and takes time to accept any untested products. However, through dynamic marketing strategy, an entrepreneur can successfully find a market for good quality VCPs.

Coordinated Production

Improper and unco-ordinated production of VCPs will lead to poor reception by the targeted consumers and low sales. It is therefore the responsibility of all producers of VCPs to adhere to stringent quality guidelines as advocated for by their umbrella organization of Fibre Concrete Producers Association of Kenya (FICROPAK).

Professional Training

Production of VCPs requires special attention to training both in technique and business management. It has been noted that most failures in small-scale businesses enterprises are due to bad know how transfer and insufficient professional training.

3 EQUIPMENT AND TOOLS

Equipment and Tools

Stocking a VCPs workshop with all the required equipment and tools is a fairly expensive exercise. It is adviseable therefore that enterpreneurs work out a phasing system by setting out priority equipment and tools. Alternatively, through community based organizations (CBOs), entrepreneurs can organize a revolving loan system to enable each one of them buy the necessary equipment and tools.
Below is a list of the basic equipment and tools set that you will certainly require for day to day running of your VCPs workshop:

Equipment

Together with a set of ordinary workshop tools e.g. spades, wheelbarrows, sieves, trowels, batching boxes, measuring pans, watering cans, the VCPs workshop will require the following specialized equipment:

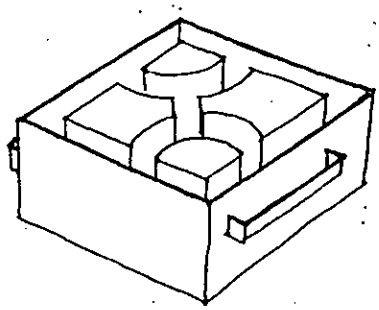
- Vibrating table (1.5 m x 1.2 m x 0.5m)
- Moulds for each type of product
- Quality testing equipment (slump cone).

Vibrating Table

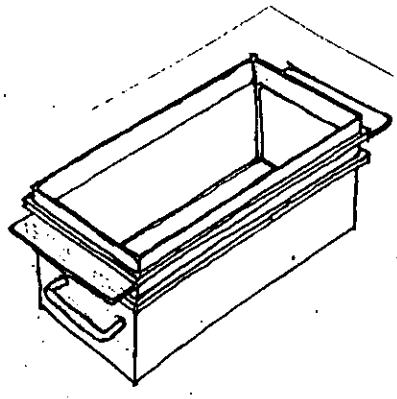
The vibrating table provides a surface for vibrating VCPs. It comprises of the vibrating surface and a hidden vibrating mechanism (motor) on the underside. The table can make different types of VCPs.

Setting Moulds

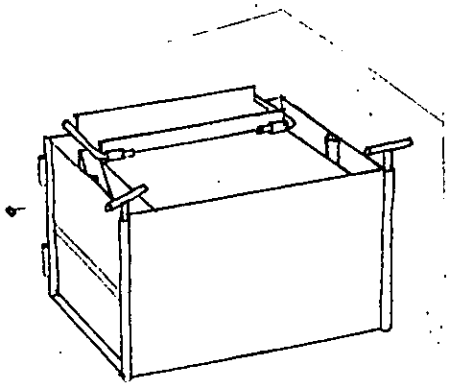
These are available in various shapes, materials and sizes depending on the product required. The moulds are fabricated from plastic, timber, concrete, steel or fibre glass. Fibre glass and plastic moulds are expensive. Timber, and steel moulds are easy to fabricate and to maintain. Concrete moulds are easily broken.



Air Brick Mould



Solid Concrete Block Mould



Louvre Air Brick Mould.

You will need at least as Many moulds as the number of products produced in two working days of the following moulds.

- Steel Concrete Block Moulds (6" x 9")
- Fibre Glass Tile Mould
- Concrete Tile Mould
- Paving Slab Mould (18" x 18" x 2")

Testing Equipment

Depending on the use and desired performance of the VCPs, careful selection of the type and proportion of cement, aggregates and water is necessary.

The uniformity of fresh concrete is usually ensured by the slump test: Fill the conical mould in four layers of equal volume and rod each layer 25 times, smoothing the top, lift off the mould and measure the difference in heights of the mould and the fresh concrete specimen. Slump between 25 and 100 mm is most suitable.

Other Equipment and Tools

In additon the following simple hand tools will be required for production of VCPs.

- Trowels
- Floats (Wooden/Steel)
- Spades
- Panga / Scissors
- Wheelbarrows
- Karais (Batching Boxes).
- Watering cans

Care and Maintenance of Equipment

Ensure that all the tools and equipments are cleaned, dried and oiled after each day's production is completed. Good maintenance of equipment and tools will reduce the unnecessary cost of replacement and will also ensure that the VCPs produced are of high quality.

4 RAW MATERIALS

Raw Materials

The basic raw materials required for the production of VCPs are:

- Cement
- Sand
- Aggregates (3/4" and 3/8")
- Quarry dust
- Water
- Colour additives (where necessary for MCR tiles)

Cement

Ordinary Portland Cement (OPC) of the standard quality should be used. This should conform to KBS specification **KS02-21**

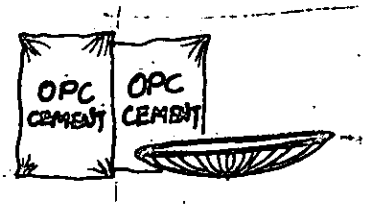
Sand

Clean, sharp and evenly graded sand should be used. The sand should be free of silt, clay or dirt as they reduce the cement - sand bond. In order to minimize the amount of voids in the VCPs, use sand particles of grain size between 0.125 - 2.00mm. The small particles fill the gaps between the large ones hence less cement is needed.

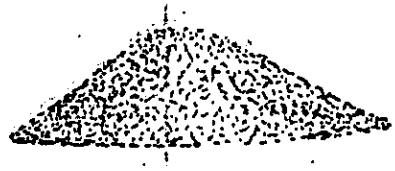
Water

Only the cleanest available water free of salts and other contaminants should be used. The water should be of drinking quality. Sufficient and clean water is also required for curing the VCPs.

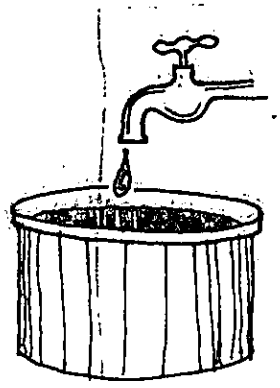
☞ ***Too much sand in a mix will result in brittle and porous VCPs. Too little sand requires more cement and a greater chance for the products to crack while curing.***



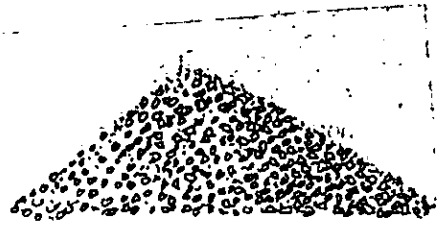
Cement



Sand



Water



Aggregates

Water - Cement Ratio

The water-cement ratio varies for various VCPs mixes. Too much water for dry mixes makes the VCPs collapse after demoulding while too little water makes the mix disintegrate after demoulding. Experience will generally help in determining the proper water-cement ratio.

The correct amount of water to be added to the mix will depend on the:

- type of mix proportions of the aggregates and cement
- the required product strength and
- the equipment in use.

As a general guide, the concrete mix should contain just enough water to facilitate production without any slumping occuring after demoulding.

Aggregates

In order to facilitate transportation, handling and laying VCPs, it is necessary to make them light. This can be achieved by either reducing their compaction thus ensuring a relatively high proportion of air gaps between the aggregates or using lightweight aggregates.

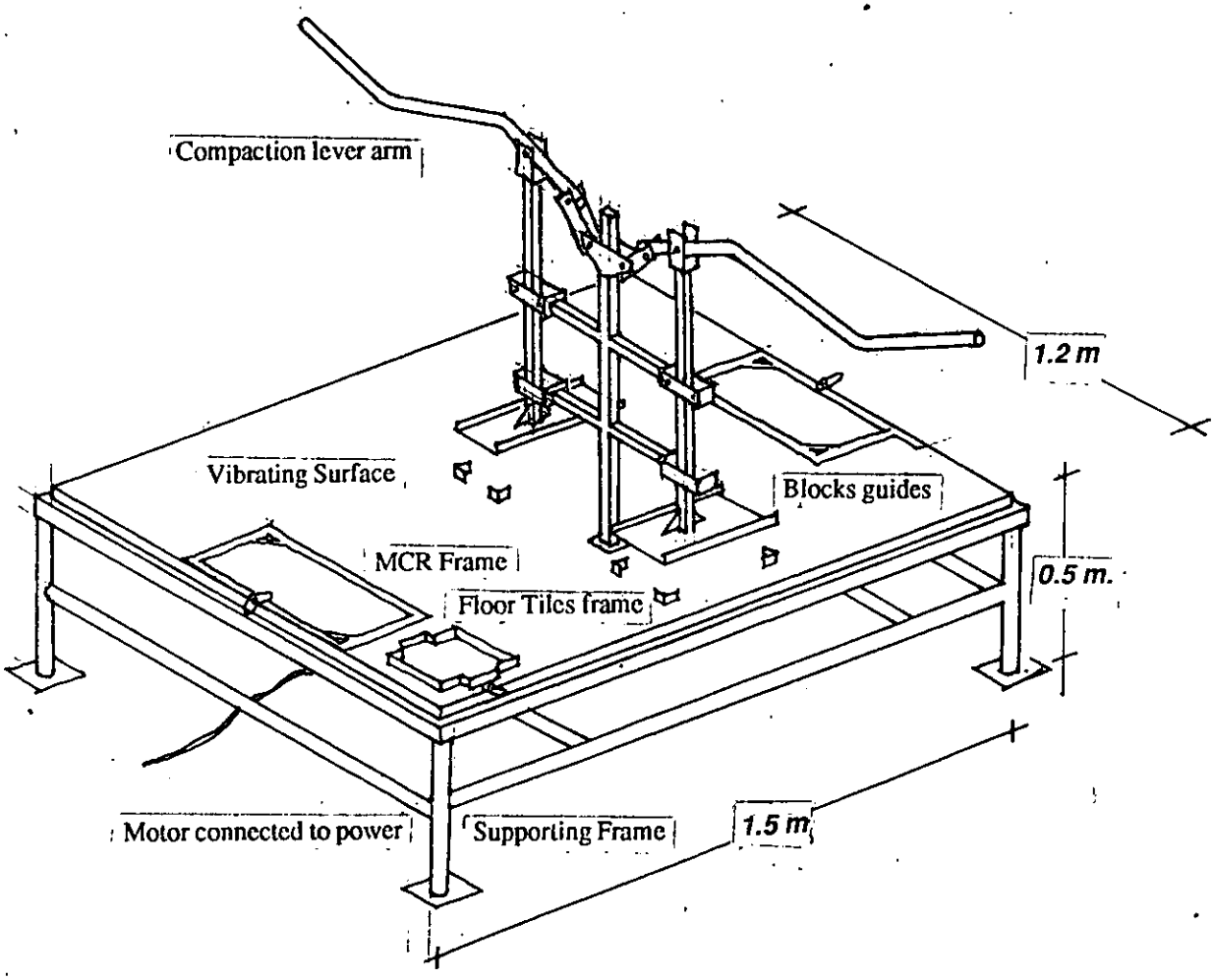
Hence it is important to have a relatively high proportion of coarser particles (3/4" and 3/8" aggregates) because too much fine aggregates would fill the air gaps and increase the density of the VCPs. However a certain mount of very fine particles (quarry dust) is necessary to produce the cement paste required to bind the coarser particles.

☞ ***All aggregates, whether fine or coarse, must be clean and free from silt, clay, dust, organic matter, salts or any other chemical impurities that could interfere with the bond between cement and the aggregates.***

Aggregate - cement Ratio

The cement aggregate proportion is very important: If it is too high the mortar will lack cohesiveness for *"green strength"* and the final product will be too weak. If on the other hand, the ratio is too low the mortar will be very cohesive and the mix may not flow easily duringmixing and filling the moulds.

5 THE VIBRATING TABLE



The Vibrating Table

Care and Maintenance of the Vibrating table

The vibrating (screeding) table is a major investment in a VCP workshop and should therefore be handled well.

Avoid over-vibrating the table more than is necessary for the production of any particular VCP.

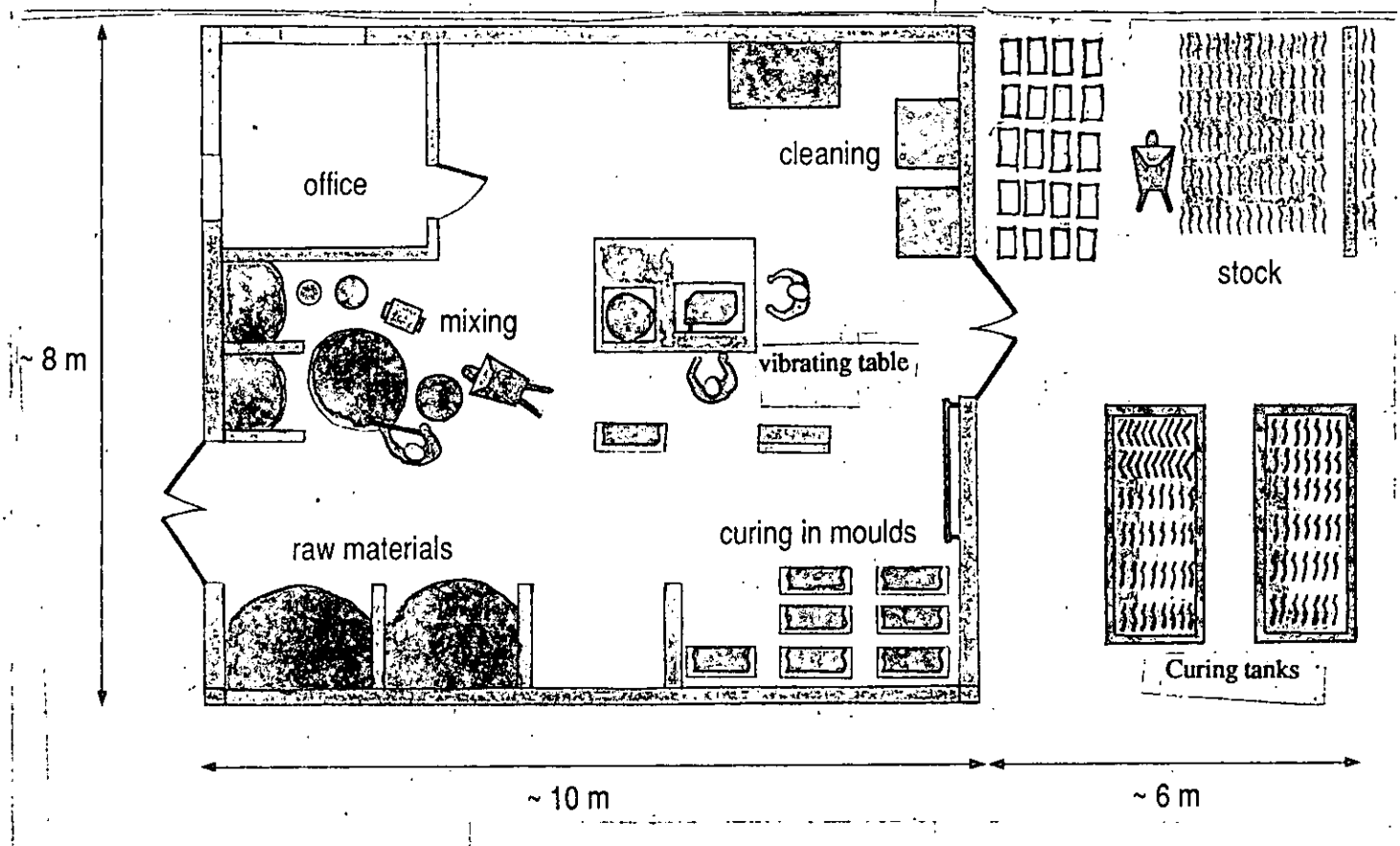
Make sure that the table is not *'overloaded'* by ensuring that only the optimum number of VCPs are placed on it at any one vibrating time. (The equipment supplier will tell you the maximum loading weight).

Regularly, oil the vibrating table's moving parts and keep them clean.

Always clean the table top and joints at the end of each day's production.

It is important that the table be kept in a well protected shed (workshop) to guard against its theft and damage by weather. The foot-switch should be kept on a flat, firm surface close to the user and should be regularly inspected for any defects.

6 THE VCPs PRODUCTION WORKSHOP



Typical layout of a VCP workshop

Production Area Layout

The VCPs workshop should be laid out in such a way that all the unnecessary movements by the workers and of raw materials are avoided. Sand, cement, and aggregates should be close to the batching area. Water for mixing the concrete should also be within reach.

Dry and wet mixings should be done close to the vibrating table. The stacking and curing site should be close together to minimise breakages due to movements.

Other important factors that should be considered in the planning of the workshop are:

Clean Water Availability

Clean water is needed for mixing the concrete, curing VCPs and for general cleaning of the equipment and tools. The workshop must therefore be assured of a constant and reliable supply of water.

The working area

The production area must be sheltered from rain wind, and direct sun. The working area should also be big enough for temporary storage of sand, aggregates, and cement. In addition, have areas for mixing, vibrating and, filling the moulds and mould storage. For an average one vibrating table operation a covered floor area of 25-35 sq. m. is recommended.

Curing Tanks

The curing tanks must be big enough for the anticipated output of VCPs. They should be built near the workshop and enough water to fill them to the required level should always be available for as long as the production of VCPs is in progress. They can be either dug out or built up using stones or concrete. An old oil drum can be used for wet curing small VCPs such as floor and MCR tiles.

Storage and Service Area

Additional space will be needed for storing the finished products. Sufficient external service space must also, be provided for vehicles bringing in raw materials or collecting the finished VCPs.

The recommended minimum area is about 200 sq. m, however more space may be useful for future expansion of the workshop.

7 GENERAL PRODUCTION PROCESS

All the VCPs covered in this manual will follow the procedure outlined here. However the concrete mix ratio and type (dry mix or wet mix) will vary depending on the product being made. Notes on the batching ratios for various VCPs and the type of mix required are given under each VCP.

☞ ***The producers are advised to strictly follow the instructions in the order given in this manual to avoid disappointing results in VCPs production.***

Sieving

- Sieve the sand and other fine aggregates (quarry dust) to remove the big particles silt, clay and other unwanted objects before use.

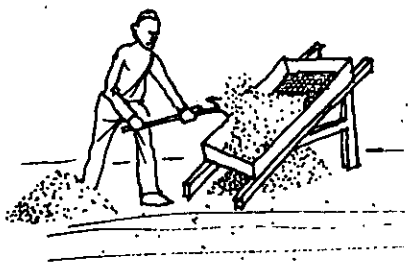
Batching

- Measure out the required aggregates, sand and cement using the batching boxes or *Karais* in the required proportions. Take care not to exceed the recommended batching proportion for each *VCP*.
- Aggregates should be batched by volume or weight; (by weight is more accurate.)
- Cement should be batched by weight, or preferably by using whole bags of 50kg.
- Some VCPs can be coloured using colourants, e.g. MCR tiles, floor tiles,
- For small scale production workshops with less strict quality control batching by volume using buckets, batching boxes, wheel barrows, *Karais* etc is quite acceptable if carefully done.

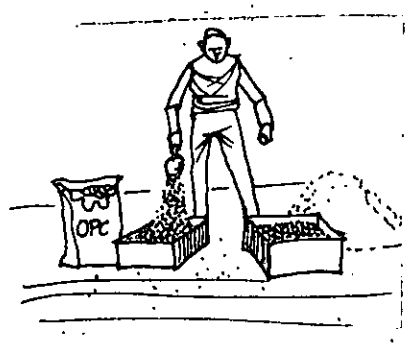
☞ ***Since the concrete mix begins setting within 30-60 minutes, only enough concrete mix must be batched to avoid wastage.***

Dry Mixing

- The batched sand, aggregates and cement mix is now ready for dry mixing.
- Mix the batched sand, aggregates and cement thoroughly in their dry state before any addition of water. For best results turn the mix at least three times.
- Make sure that the mixing surface is a clean, smooth level hard surface. A concrete slab is the best for dry mixing.



Sieving



Batching

Dry Mixing

Wet Mixing

Wet Mixing

- The thoroughly mixed dry concrete mix is now ready for watering . Use only clean water.
- Add a limited amount of clean water gradually until the concrete mix is of the required flow. With experience, workers will be able to estimate the required quantity of water that is just enough for wet mix.
- For dry mixes use less water as compared to wet mixes.
- Turn the wet mix thoroughly (at least a minimum of 3 times) until all the wet mix is uniformly wet.
- Avoid adding excess water as this will wash away the fine aggregates and cement as well as making the mix less cohesive.

☞ ***As a simple test for cohesiveness no excess water should be visible when a lump of concrete is squeezed in the hand.***

- Rub the concrete mix quickly with a smooth round metal bar or tube (2 - 4 cm diameter). A concrete mixture will form a slight film of water or paste on the surface.
- Perform slump test as described before.
- The concrete mix is now ready for use.

Assembling the Mould

- Before pouring any concrete mix into the moulds, ensure that they are securely bolted (locked) so that no concrete pours out.
- Proper assembly of moulds should be done to avoid defective VCPs since they take the shape of the mould.
- The procedure and order for assembling the moulds is illustrated in the manual for each VCPs.
- Any defective or broken moulds must be replaced or repaired before use.

☞ ***Do not use any defective or broken mould since this will obviously produce defective and poor quality VCPs even if all the other procedures outlined in the manual are correctly followed.***

Cleaning and Oiling the Moulds.

- Clean the correctly assembled moulds with clean water to remove surface dirt (This should always be done at the end of each day's production before storage of moulds).
- Wipe the moulds dry and thoroughly oil them using old engine oil.
- Oiling the surfaces of the moulds allows easy demoulding of the VCPs since they can easily slip out of the mould.
- The oiled, well assembled mould is now ready to be filled with concrete.

Filling the Mould with concrete

- Fill the oiled mould with the required amount of concrete mix
- Avoid any unnecessary wastages of concrete by carefully pouring the concrete into the mould.
- Transfer the filled mould to the vibrating table.

Vibrating the concrete mix

- Place the mould filled with concrete in the correct position on the vibrating table as indicated. Make sure the mould is securely held by the guiding marks on the vibrating table (There are securing marks for concrete blocks mould and MCR tiles). Vibration should be done for 15 - 30 seconds.

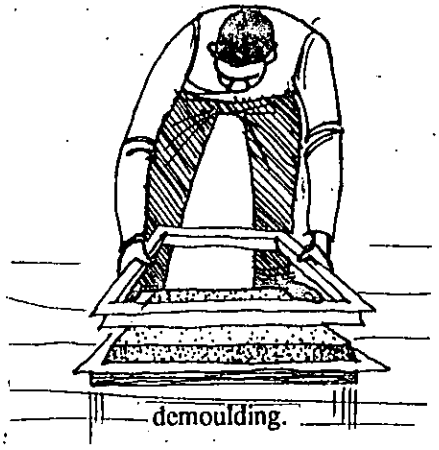
Step on the foot switch for a short time (about 15 - 30 seconds) and while the concrete mix is under vibration, systematically level and screed it with a float.

Screeding the concrete mix

To screed the concrete is to spread it smoothly with a float.

- Screed the concrete mix systematically using a steel or wood float concrete mix as it is being vibrated.
- Keep filling up the mould with extra concrete as the concrete level falls below the mould frame top.
- Continue screeding with the float and filling the mould until the screeded concrete mix is flush with the top of the mould frame.
- As a general guide, the screeding and vibration of the concrete mix should stop when a thin film of water or paste forms on top. This should take about 45 seconds of vibration.
- With experience, workers should be able to know a well screeded concrete mix.
- Dry mixes should particularly be carefully screeded so that enough water comes to the top surface of the concrete mix to help in making the VCP cohesive.

☞ ***The whole procedure of vibrating while at the same time screeding the concrete mix should be done very well as it greatly determines the end quality of the VCPs.***



demoulding.

Demoulding

- The vibrated concrete must be transferred to a very flat surface in the shade for demoulding or setting.
- Dry mixes should be demoulded immediately since they are cohesive enough and therefore do not collapse after demoulding. e.g. hollow and solid concrete blocks, air bricks and concrete.
- Take great care when demoulding to avoid damaging the VCPs. Some VCPs such as the hollow and solid concrete blocks require rapid and swiftly executed movements when demoulding to avoid distortions.
- Other VCPs such as the concrete lourne require slow and careful demoulding by unbolting the mould.

Setting

- Some VCPs (e.g. MCR tiles, floor tiles, concrete slab, fence posts) and generally the wet mixes should be left to set overnight before demoulding since they will collapse if demoulded immediately.
- Protect the VCPs while setting from direct sunlight, rain and wind by placing them in a level surface under a shade.
- VCPs such as the MCR tiles will require special setting racks since their moulds cannot be laid upright on a level surface.
- Demould the wet mix VCPs the next day taking the same care as when demoulding the dry mix VCPs.

Curing

- The demoulded VCPs are now ready for curing
- Dry mix VCPs that are demoulded immediately after vibration should be left for 24 hours before the curing process is started.
- The wet mix VCPs are ready for curing after setting is complete

Dry curing

- Dry mix VCPs should be sprinkled with water daily and protected with either polythene sheeting or damp hessian bags (sacks) to regulate drying.
- In dry curing very little and controlled amount of water should be sprinkled daily in the morning and evening for a minimum of 7 days.

Wet curing

- Wet curing involves full immersion of VCPs in water
- Wet mix VCPs should be wet cured in fairly clean water after setting for a minimum of 14 days.

Stacking

- Stacking the finished VCPs in the stacking area and avoid necessary breakages due to careless handling.

8 DEFECTS AND QUALITY TESTS FOR VCPS

The production of poor quality or defective VCPs will certainly lower sales for any enterpreneur. It is therefore important that small-scale enterpreneurs who are about to embark on a VCPs business strictly follow production guidelines set out in this manual. Amongst the commonest defects to be found in poorly produced VCPs are:

Voids

Voids are holes found on VCPs and contribute to weakening the product.

Causes

- If concrete mix is not vibrated enough
- Too much water being used in mixing the concrete
- Sand and aggregates are too big

Solutions

- Vibrate the concrete mix until a thin film of water forms on top. This should take about 45 seconds
- Use the correct quantity of water in mixing the concrete
- Sieve the aggregates and sand to get the required sizes.

Cracks

A defectively produced VCP will develop cracks either during setting, curing or after installation

Causes

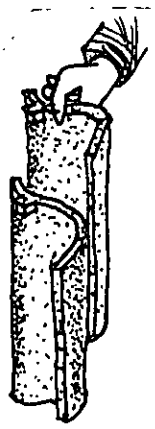
- Excessive clay or silt in the sand being used
- Drying too fast during curing or setting

Solutions

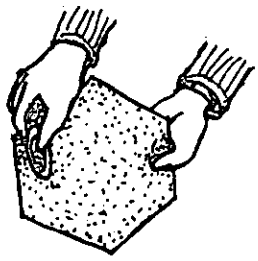
- Use sand with a silt/clay content not exceeding 5%
- Setting and curing of the VCPs should be controlled under shade. Protect the VCPs from direct sunlight, rain, and excessive wind
- Use hessian bags (sacks) or polythene sheeting to cover the VCPs so that they dry slowly.

Deformed VCPs

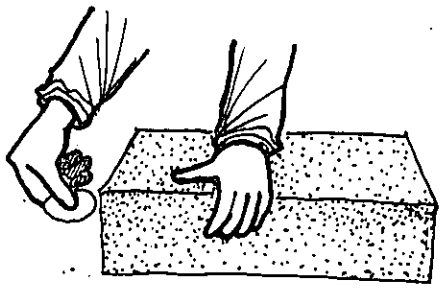
Deformed products lower the sales while at the same time discouraging prospective builders using VCPs. If the producer is to attract more customers then he should aim at high quality VCPs.



Nib Test (MCR Tiles)



Ring Test (Floor Tiles)



Scratch Test (Solid Concrete Blocks).

Causes

- Deformation could occur if demoulding is not properly done either through twisting or shaking.
- Using of poor fabricated moulds
- Uneven levelling of the concrete during vibration of the VCPs. (poor screeding and vibration)

Solutions

- Always demould the VCPs with great care. Do not shake or twist the moulds while demoulding
- Use a level hard surface for setting after demoulding.
- Align the concrete mix with the mould frame evenly by using a float while steel vibrating and screeding.
- The vibrating table should always be positioned on a hard, level surface.

Field tests for VCPs

Field tests for VCPs should be conducted after curing of the products.

Scratch Test

Scratching the VCP at the corners or edges using a coin to determine their strength. Well produced VCP should not scratch off easily.

Ring Test

This test can be done on the wet mixed VCPs such as MCR and floor tiles. Hold the product vertically and tap it with a coin. The higher or sharper the ring the strong the VCP.

Nib Test (MCR only)

- Drop the MCR tile against another tile from a height of about 30 mm. A 10% nib breakage could be due to:
- Wrong cement, sand and aggregate ratio
- Inferior quality of sand and aggregates
- Poor curing and setting of the tiles due to rapid uncontrolled drying
- Too much water used during mixing of the concrete.

Porosity Test

This test should be done to determine whether the MCR tiles are leaking.

Procedure

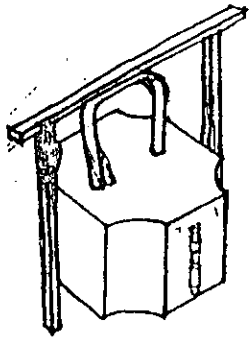
- Use mortar to form two walls on the MCR tile as shown
- Fill the tile with water and measure the depth.
- Re-measure the depth after 24 hours. A fall of more than 12 mm indicates serious leakages.

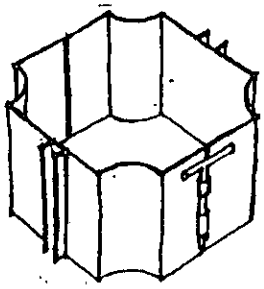
Leakage could be attributed to:

- too much water during mixing of concrete
- poor quality sand and aggregates
- not enough vibration of the concrete mix.

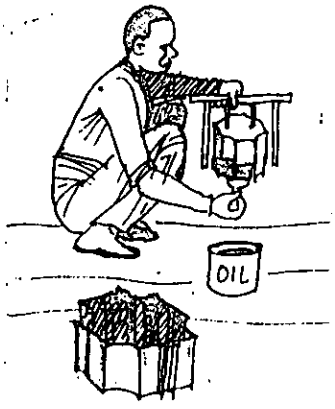
9 AN ILLUSTRATED GUIDE TO VCPS PRODUCTION

Dry Mixing





A Mould



Oiling

In the following pages, the production of assorted examples of VCPs are illustrated and the critical production steps outlined for beginners to acquaint themselves with the vibrated concrete technology. Please take your time to thoroughly read the steps before embarking on full scale commercial production of VCPs.

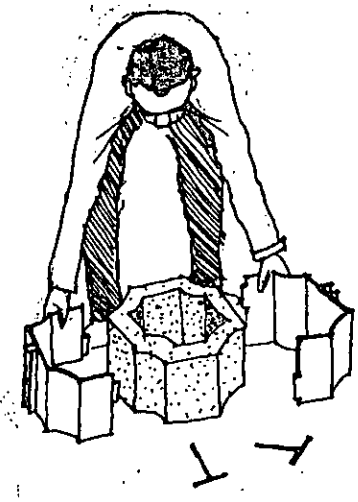
It is advisable that the beginners only make few samples initially and test them for strength and quality. A summary of important notes on the production VCPs are:

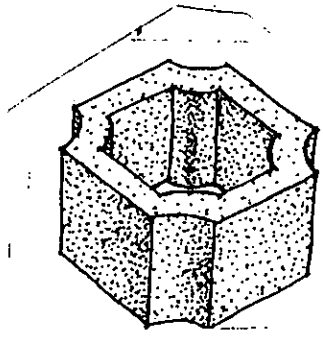
1. Assembling the mould
2. Oiling the mould
3. Batching the raw materials
4. Dry mixing the batched raw materials
5. Wet mixing the raw materials
6. Filling the mould with the concrete mix
7. Placing the concrete (inside the mould) on the vibrating table
8. Vibrating (Screeding) the concrete mix
9. Levelling the concrete mix
10. Transfering the moulded VCPs to a curing shed
11. Demoulding the VCPs in the curing shed
12. Removing the moulds (some mould parts are separated e.g. concrete block mould).
13. Overnight initial curing to allow the VCPs to set
14. Dry curing or wet curing the VCPs
15. Storage and stacking of the VCPs

☞ ***It is important that non of these steps is omitted or the sequence of steps change for any reason if good quality VCPs are to be realised.***

Filling a mould

Scrapping off excess concrete

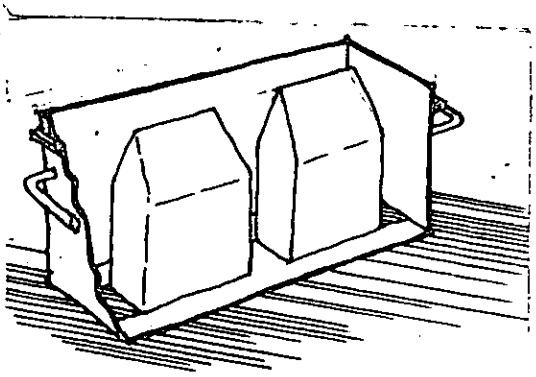




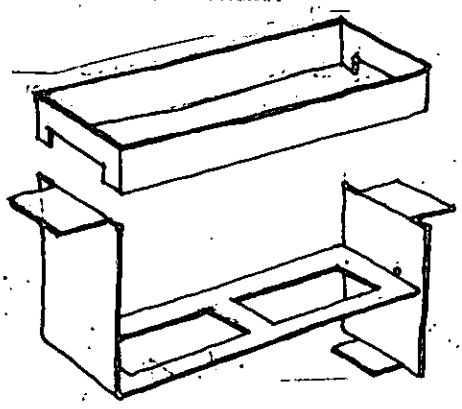
Finished VCP

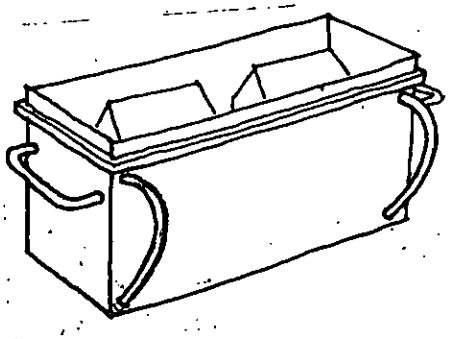
10 SOLID AND HOLLOW CONCRETE BLOCKS

Assembling the Hollow Concrete Block Mould.

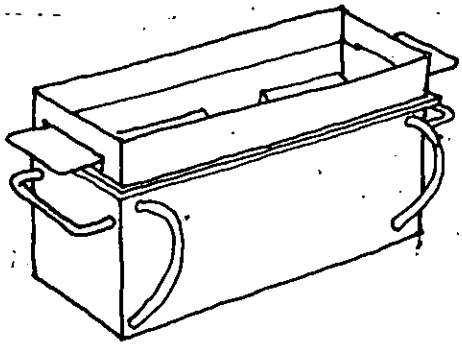


• The cut-out mould section



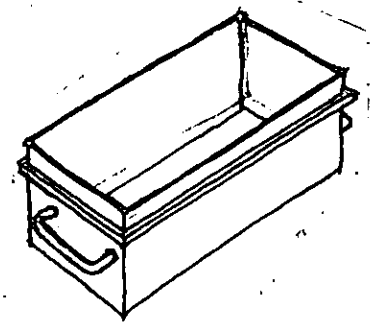


• Parts of the Hollow Concrete Block Mould

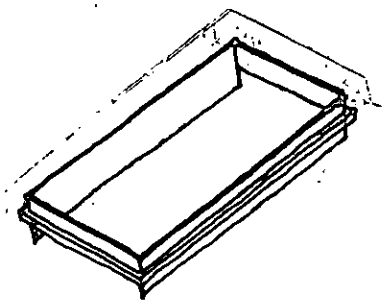


• The complete Hollow Concrete Block Mould.

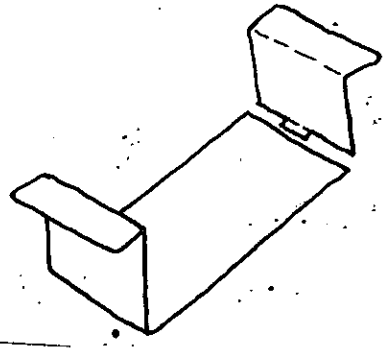
Assembling the Solid Concrete Block Mould



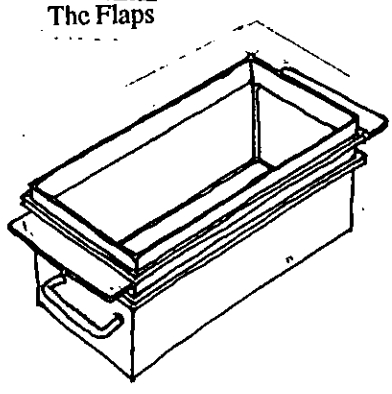
The Box



The collar



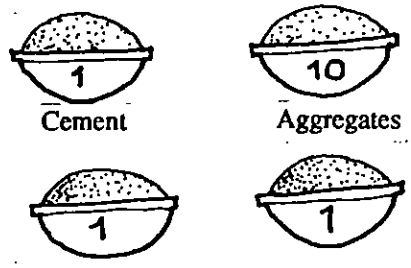
The Flaps



The complete solid concrete block mould.

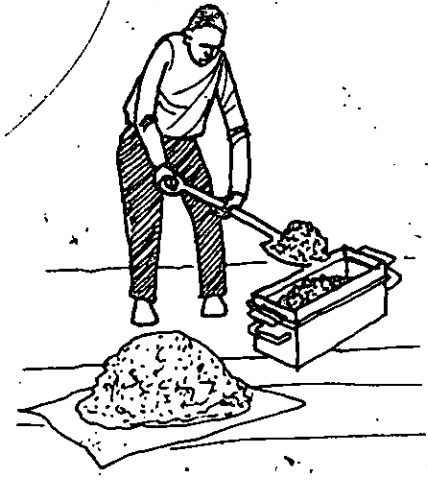
Making the Hollow Concrete Block

Correctly batch and mix the raw ma required dry mix

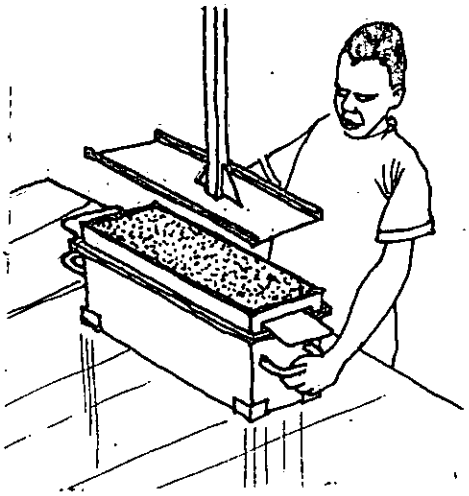


Correctly assemble the mould.

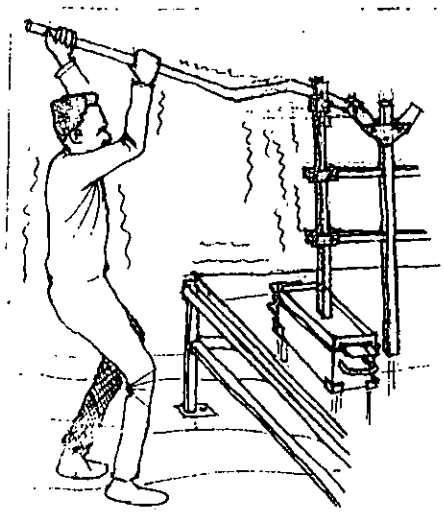
• Oil the mould thoroughly



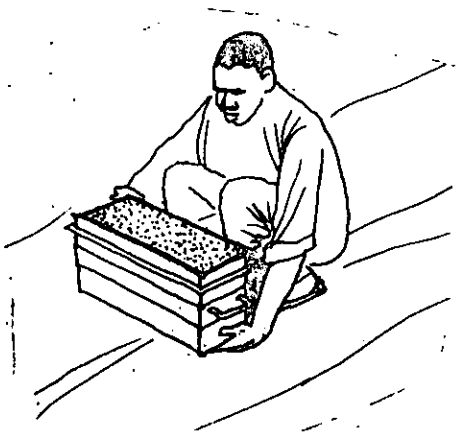
• Fill the block mould to the high level shown



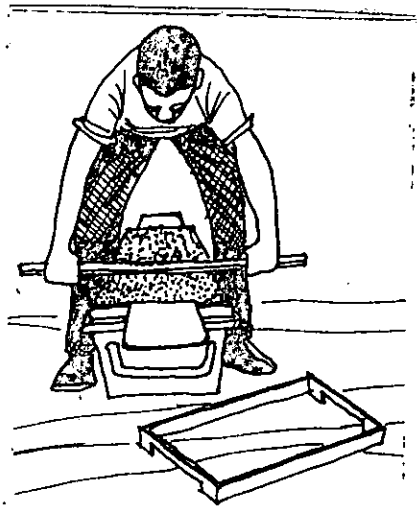
- Place the mould on the marks shown on the vibrating table



- Lower the compaction lever to firmly cover the mould top.
- Switch on the vibrating table
- As the vibration is goes on, press down firmly the compacting levers of the vibrating table up to the low mark of the mould.
- After about 15 - 30 secs, switch off the vibrating table or until there is no more compaction.



- Put the mould down on a flat surface.



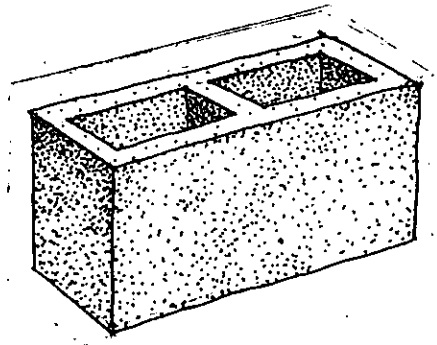
- Sweep off the excess concrete using a straight strip of timber.

- Demould the concrete block in a protected shade.
- Swiftly overturn the mould taking care not to shake it sideways.
- Hold the overturned mould's frame with your feet.

- Carefully lift out the centre cone of the mould vertically

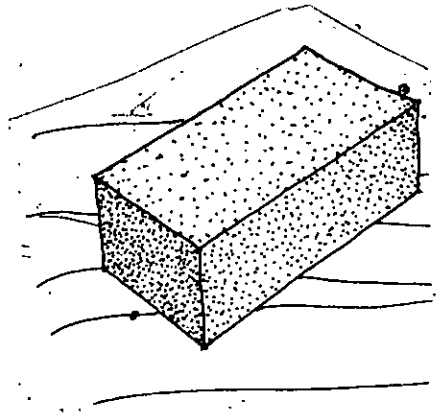
- Remove the figure 8 (for hollow block) and the flaps (for solid block)

Removing figure 8



The block after demoulding

- Stack the blocks neatly in the protected shade.
- Allow the stacked blocks to initially cure for 24 hours.



The Solid Concrete Block

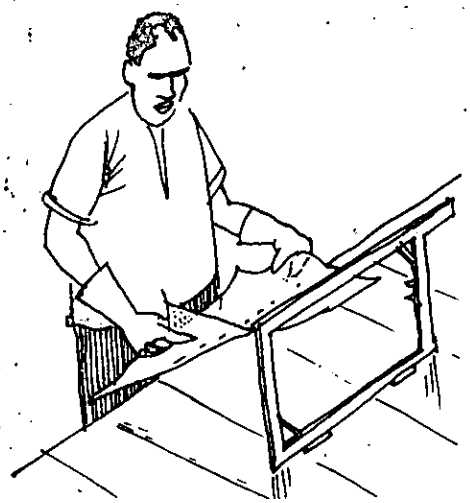
- Dry cure the blocks by spraying them with a little water daily after setting for a further 24 days.

11 MICRO CONCRETE ROOFING (MCR) TILES

Batching and Mixing

- Correctly batch and mix the raw materials to give the required wet mix for MCR tiles production.

Cement Sand Dust

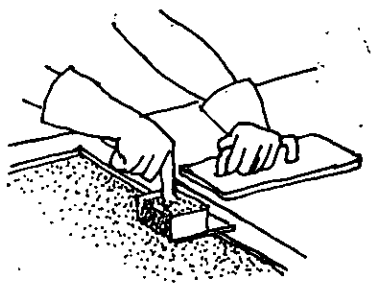


- Open the frame of the vibrator and place a well stretched polythene sheet flat on the vibrating table.

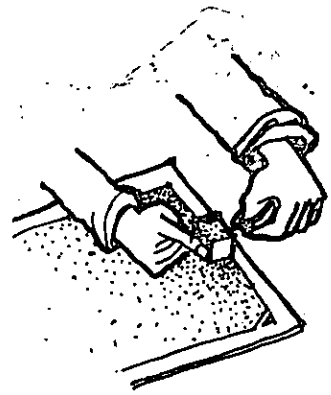
- Firmly lock the tile mould frame on the marks shown on the vibrating table.

- Placejust enough wet concrete mix into the tile frame to fill the frame.

- Switch on the vibrating table. Start screeding the concrete mix using a float until a thin film of water paste forms on top. This takes about 15 - 30 seconds.
- Take care not to vibrate for too long
- the nib is the projection on the tile that helps in fixing the tile to the batten.

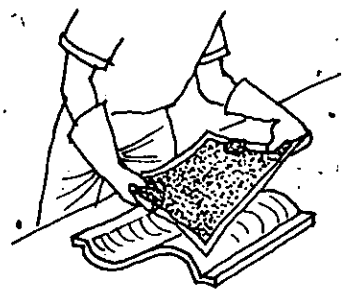


- To make the nib, fill the nib slot with enough concrete mix and vibrate for a few seconds. Continue screeding when the table is vibrating.

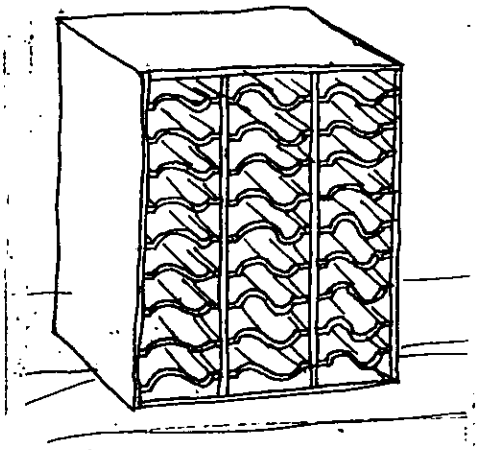


- Make a hole in the nib using a 50/75 mm nail.
- Fix a galvanized wire in the nib to assist in fixing the tile to the roof battens.
- Switch off the vibrating table.
- Unlock the tile mould frame while holding down the nib with one finger to ensure that the tile does not stick in its frame.

- Transfer the tile by holding the polythene sheet diagonally.

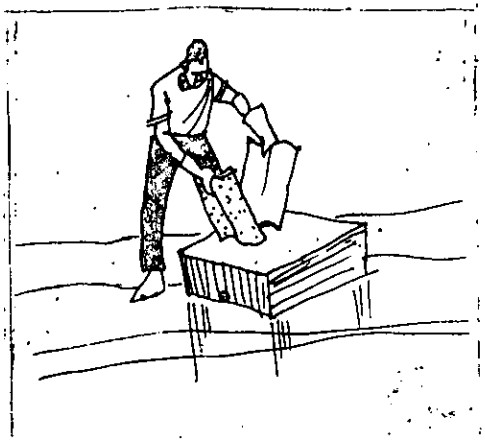


- Align the screed to match the margin indicated on the mould



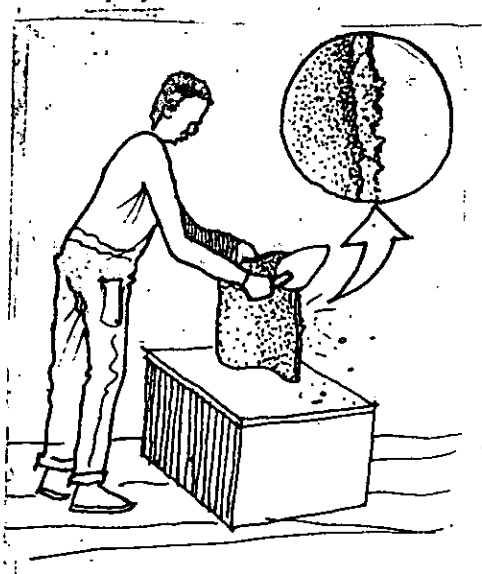
Placing tiles in rack

- Let the MCR tile set for 24 hours in the curing rack.
- Protect the tiles from direct sunlight and wind by covering the rack with a polythene sheet if necessary.

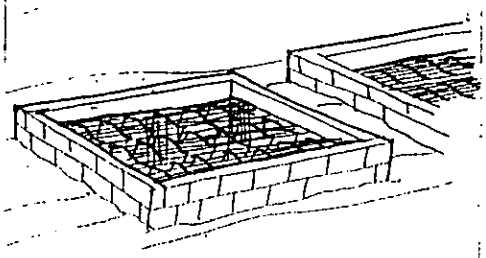


Demoulding

- Demould the tiles after 24 hours
- Place your hand on top of the tile and gently turn over the mould
- Gently slip off the tile together with the polythene sheet from the mould.

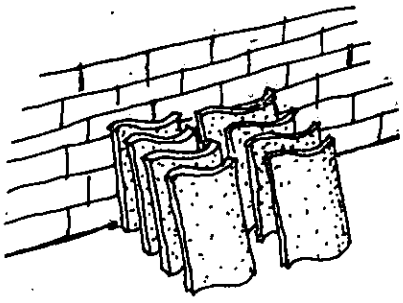


- Carefully trim off the excess mortar from the tile edges with the help of a hand trowel.



Wet Curing

- Transfer the tiles to a curing tank full of water.
- Submerge the tiles upright
- Leave the tiles in the curing tank for 10 days.

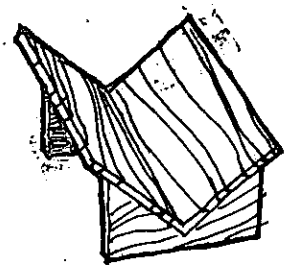


- Remove the tiles from the curing tank
- Stack the tiles upright as shown in open air
- After 14 days your MCR tiles are ready.

Field tests.

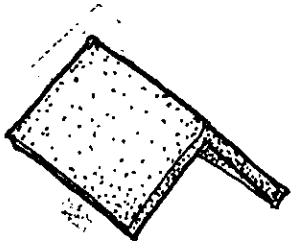
- Perform the following tests to determine the quality of your tiles; ring test, nib test, porosity test (as described in page 8)

- Place a polythene sheet on vibrating table
- Fill the ridge tile frame with enough concrete
- Switch on the vibrating table.
- Screed the concrete mix while vibrating it.
- Switch off the vibration table.



- Transfer the vibrated concrete mix to the ridge tile mould
- Align the concrete mix with the ridge tile mould

- Allow the concrete to set for 24 hours.
- Demould the ridge tiles after 24 hour
- Put the tiles in a curing tank for 7 - 10 days.



Stacking the ridge tiles

- Stack the cured ridge tiles in open air for a further 14 days
- The ridge tiles are now ready for use.

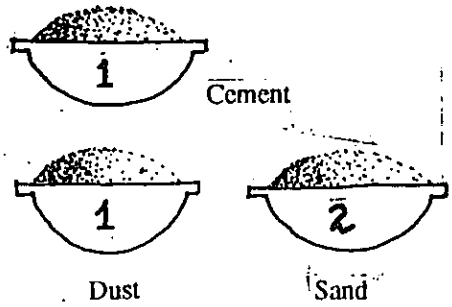
☞ ***The MCR tiles and ridge tiles can be produced in the designed colour by adding colourants during batching.***

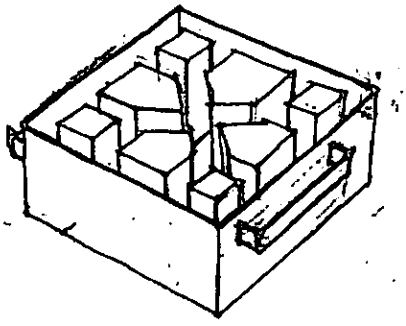
Field tests

- Perform similar filed tests on the ridge tiles as for MCR tiles.

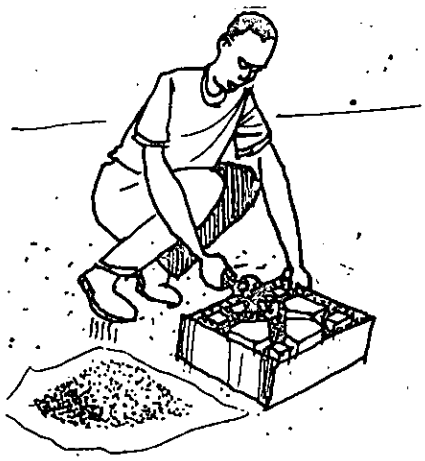
12 AIR BRICKS

Use the right amount of water to give you the optimum dry mix so that the air brick does not callapse after demoulding.

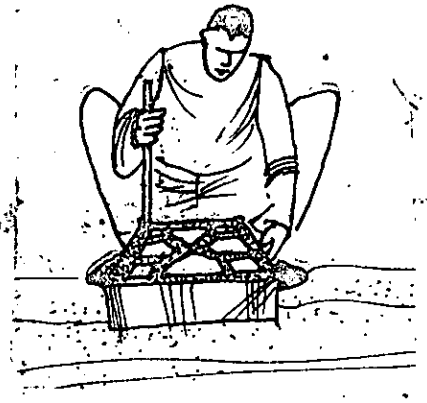




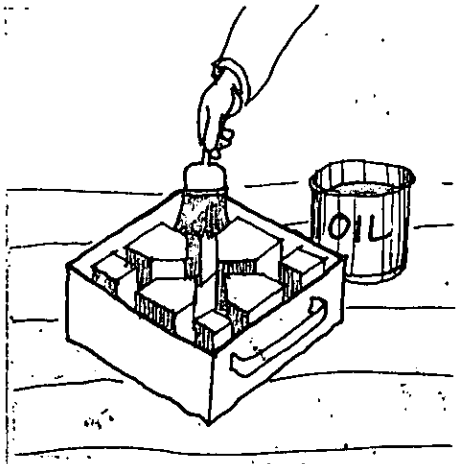
- The air-brick mould



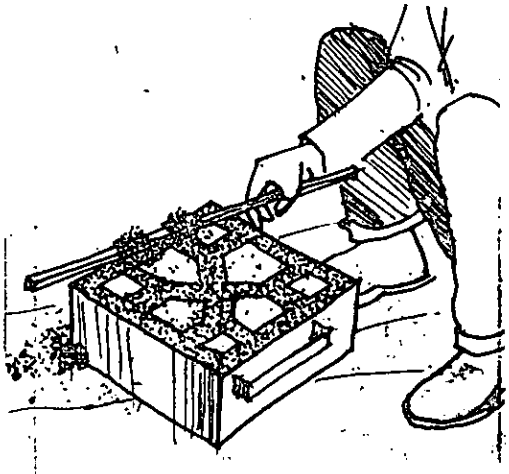
- Fill the mould with concrete



- Using a rodding stick, compact the concrete mix



- Assemble and oil the mould

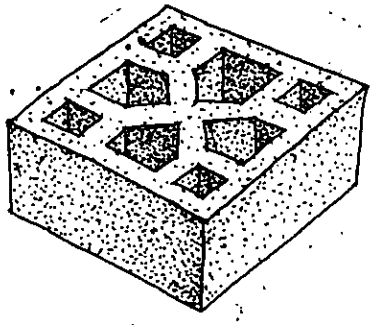


- Scrap off excess concrete with a stick

- Gently, turn the air brick mould until it lies horizontally on a firm leevl surface.
- Gently knock the sides of the mould so that during demoulding the formed air-brick is not deformed.
- Demould the air- brick on a flat and firm surface.

Air bricks mix should be dry enough to avoid collapsing after demoulding.

- Leave the air brick to set overnight under a shade
- After initial setting, wet cure the air-brick by sprinkling it with little water daily for atleast 7 -10 days.

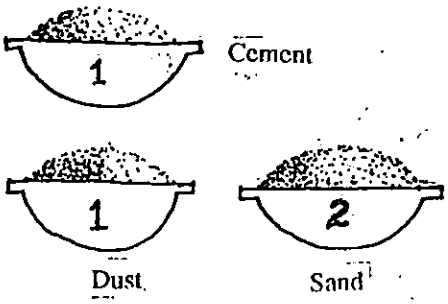


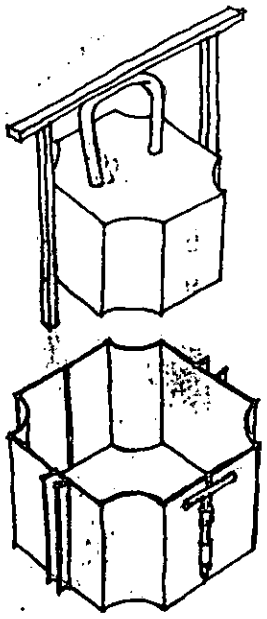
The completed air brick

Field Tests

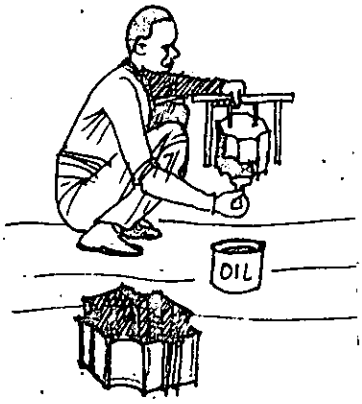
Perform the scratch and ring tests as described before.

- Follow the same batching and mixing procedures as outlined for air bricks

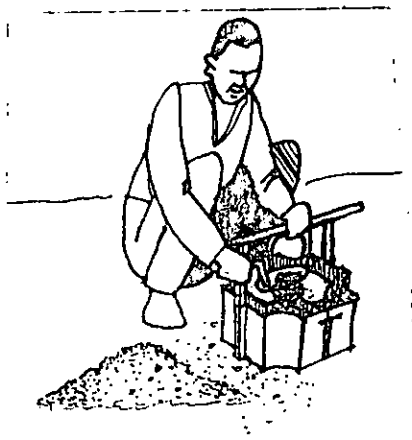




- The air-brick mould



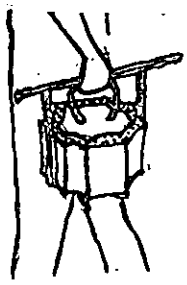
- Oil the air-brick mould



- Fill the mould with concrete

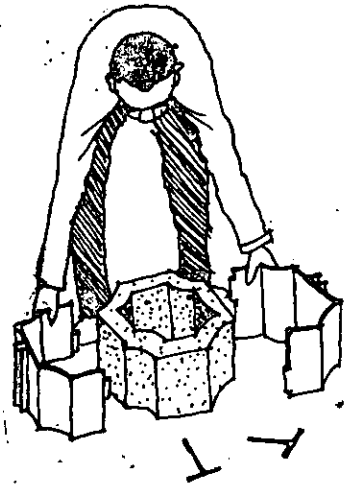
- Compact the concrete mix with a rod.

- Scrap off the excess concrete mix



- Carefully transfer the mould to the demoulding shade.

- Knock the sides of the mould to ensure that the air-brick is not deformed during demoulding.
- Demould the air-brick on a firm and flat surface.

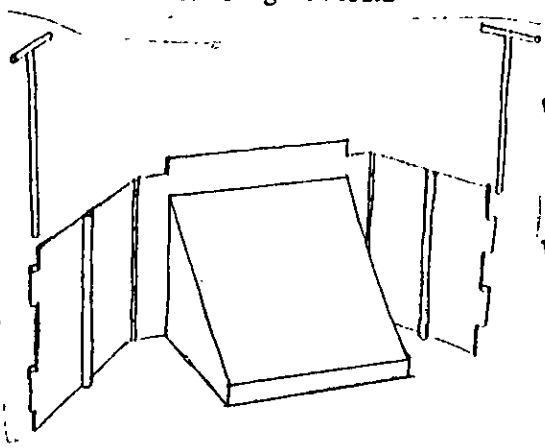


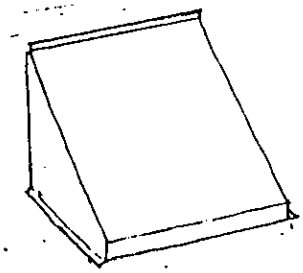
- Unbolt the side flaps of the mould to complete demoulding

- Leave the air brick to set overnight
- Dry cure the air-brick by sprinkling it with a little water daily for 10 days

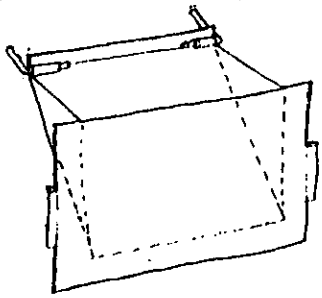
13 LOUVRE AIR BRICKS

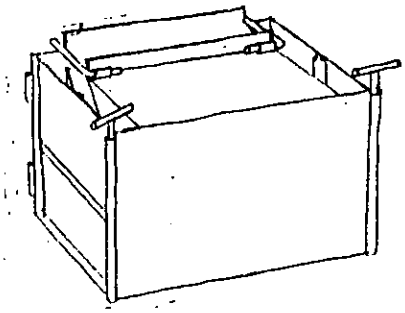
Assembling the Mould





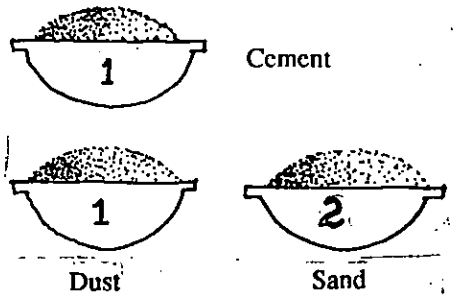
- The inner mould piece

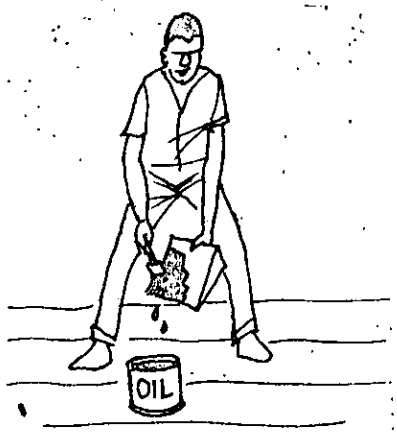




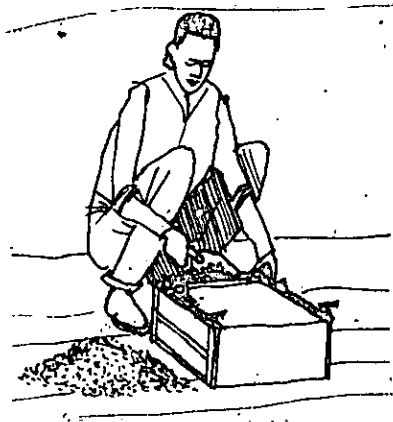
- The Louvre brick mould

Follow the same batching and mixing procedures as for other dry mixes

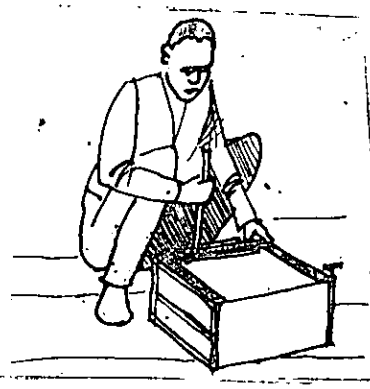




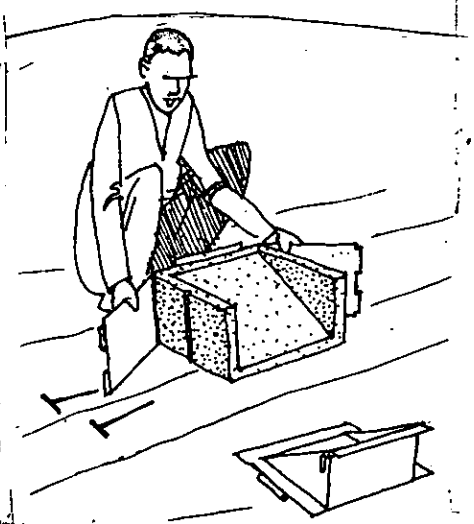
- Assemble and oil the mould



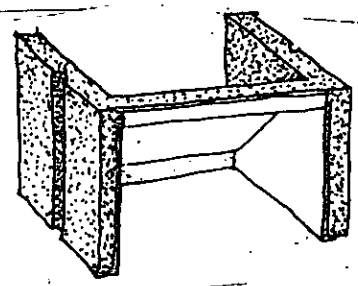
- Fill the mould with concrete

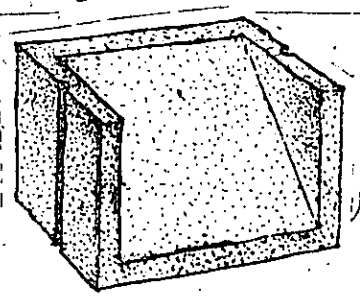


- Using a rodding stick, compact the concrete mix

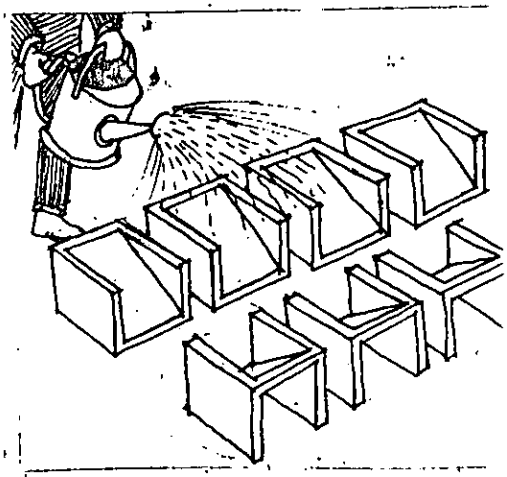


- Demould the rodded concrete mix carefully
- Leave the Louvre air brick to initially set for 24 hours





- The complete Air- Brick



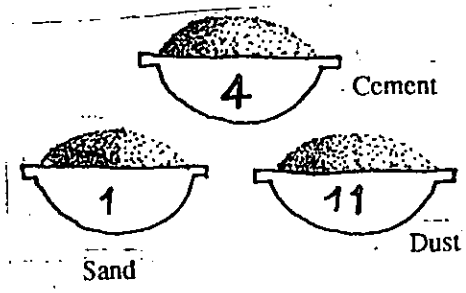
- After 24 hours, sprinkle the louvre air bricks with little water.
- Dry cure the louvre-air bricks for a minimum of 10 days.

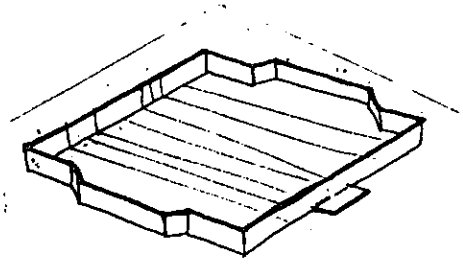
Field Tests

Perform the scratch and ring tests as described

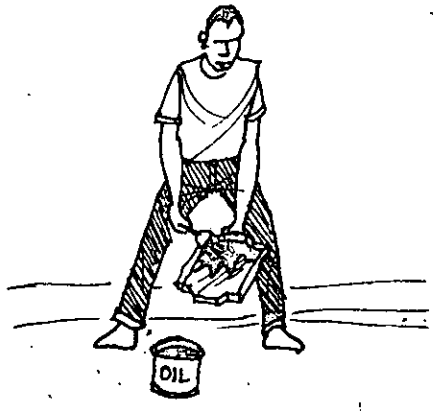
14 Floor Tiles

- Correctly batch and mix the raw materials to get the required wet mix





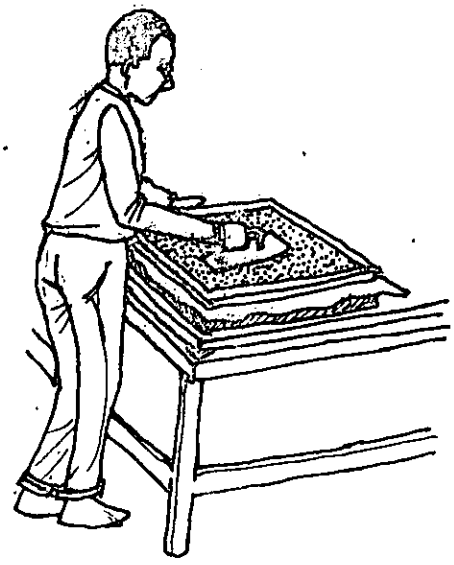
The floor tile mould



- Oil the mould thoroughly

- Place enough concrete mix into the mould to fill just to the top of the mould frame

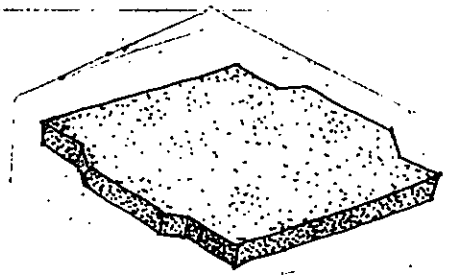
- Screed the concrete mix while vibrating it for about 15 - 30 seconds.



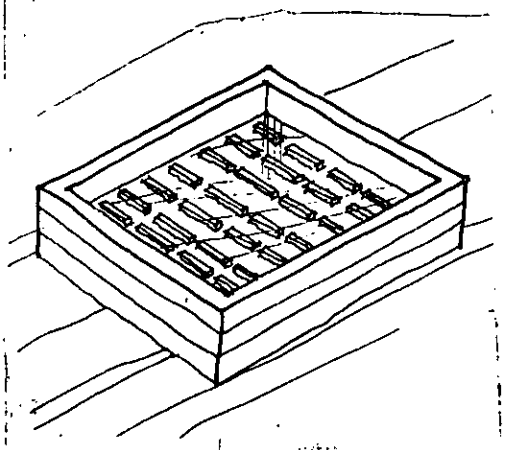
- As the vibration is going on systematically screed the concrete mix with a float until the mortar is flush with the top of the tile frame.
- Continue screeding until a thin film of water forms on top of the concrete mix

- Switch off the vibrating table
- Transfer the tile mould to the setting shade.
- Leave the tile to initially cure for 24 hours in the covered shade.

- Demould the floor tile carefully after setting is complete.

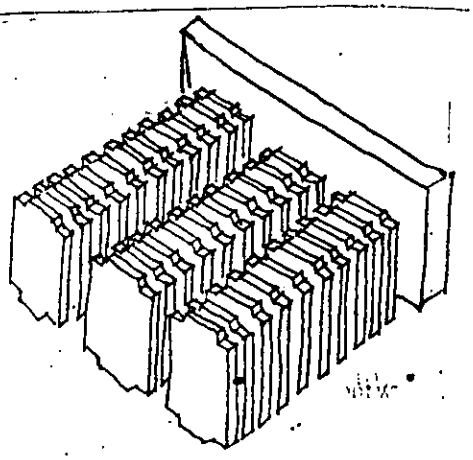


- Transfer the tiles to the curing tank.
- Submerge the tiles upright
- Leave the tiles in the water for 10 days



Curing in water

- Remove the cured floor tiles from water and stack them in open air for a further 14 days for final strengthening.



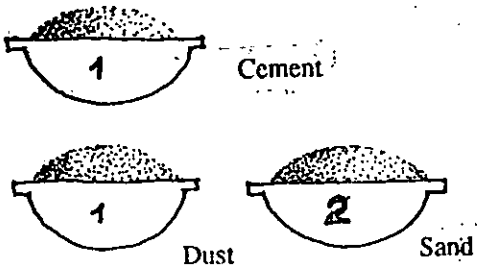
Stacking tiles in the open

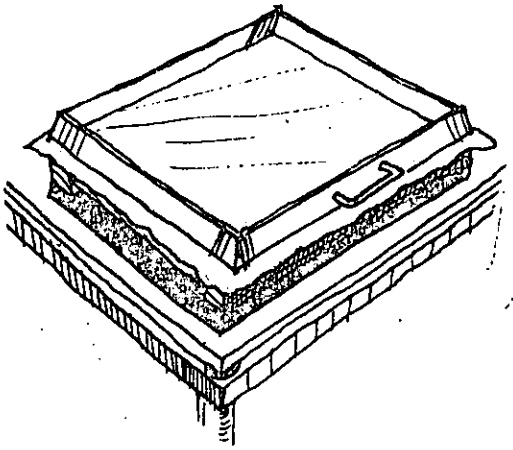
Perform the necessary tests to determine the quality of your tiles.

Follow the same procedure as for other dry

15 Floor Slabs

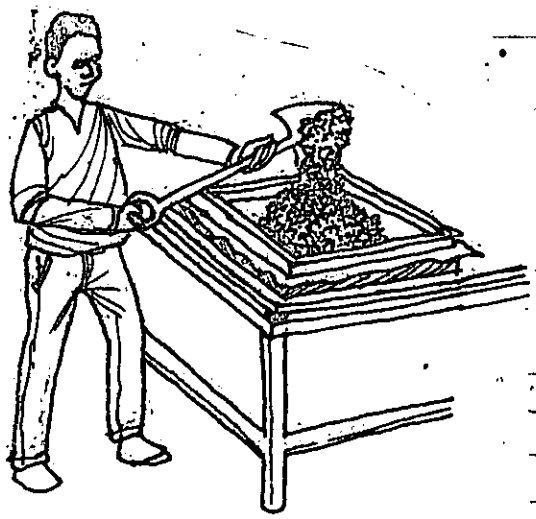
Follow the same procedure as for other dry mix VCPs.



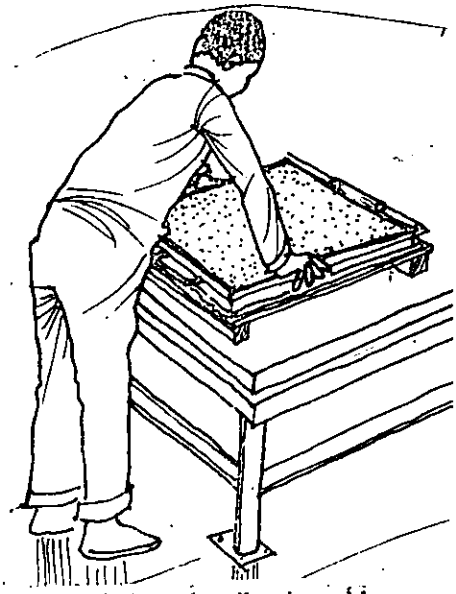


Place the timber palate and mat (or polythene sheet) under the slab mould ring.
Place the assembled slab mould on the vibrating table

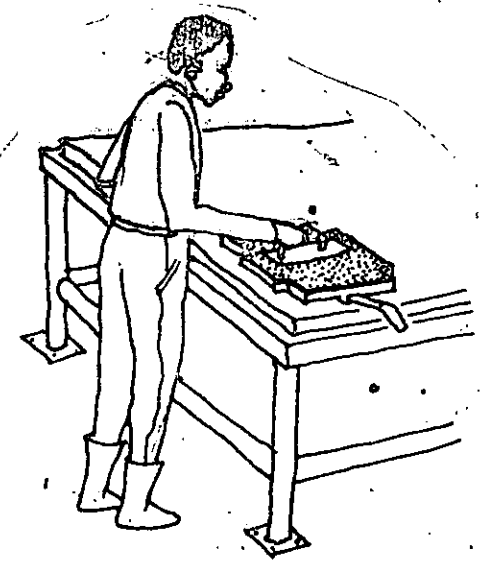
Oil the mould and the mat.



Fill the mould with concrete



- Switch on the vibrating table
- Screed the concrete mix until a thin film of water forms on top. This should take about 15 - 30 seconds.

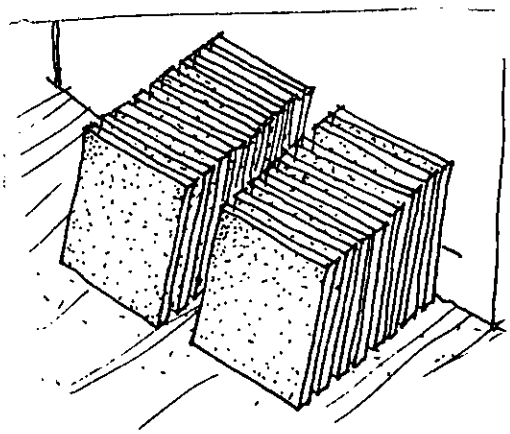


- Level and finish smoothly the concrete mix.

- if the slab ring mould is used demould immediately.

- if the hollow slab mould is used leave the slab to set for 24 hours before demoulding

Demould carefully as shown.



- After 24 hours sprinkle the slabs with water daily for 24 days until the slabs are well cured.

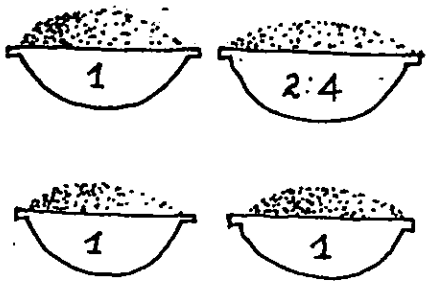
Field Tests

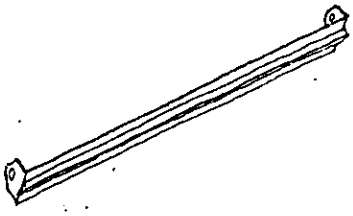
Perform the scratch and ring tests on the slabs as described

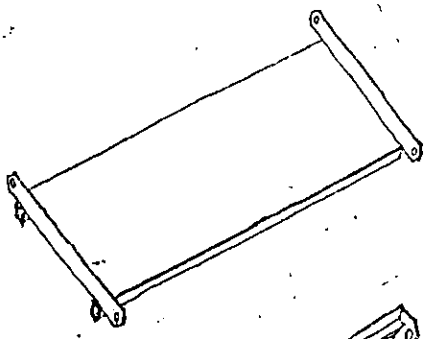
The same production procedure for concrete panels, balustrade rails and coping stone

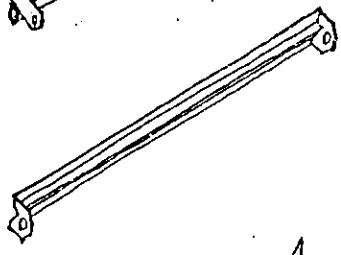
16 FENCING PANELS

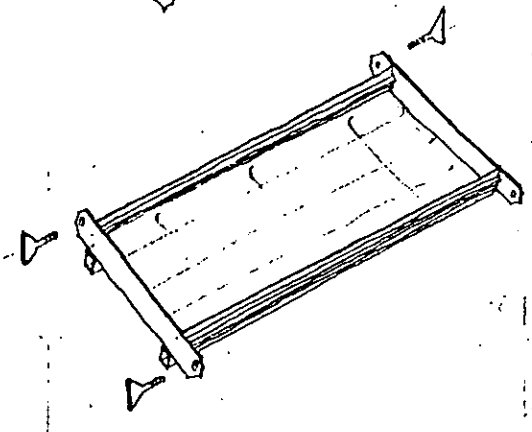
- Correctly batch and mix the raw materials to get the required wet mix



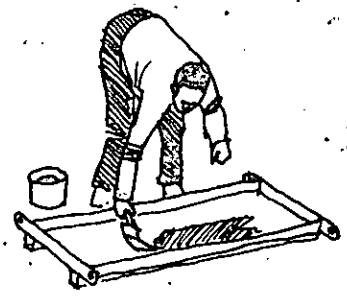




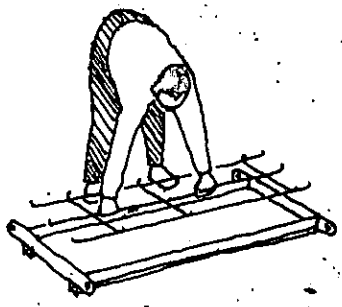




- Assemble the fencing panel mould by fixing the bolts and parts as shown.

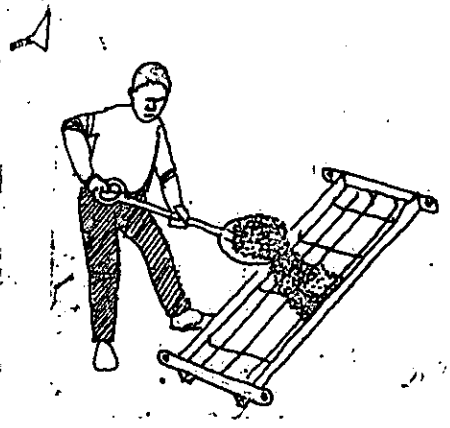


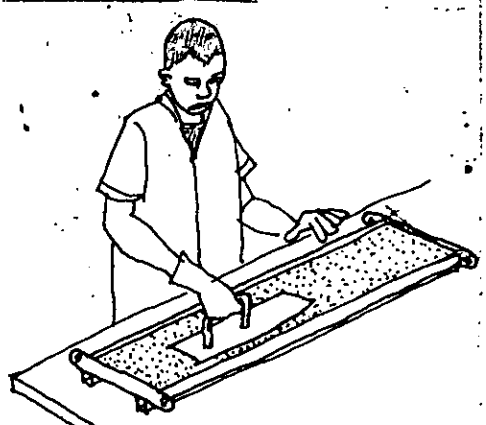
- Oil the assembled fencing panel mould thoroughly.



- Put about 1/2" concrete blinding in the assembled mould to hide its bottom.

- Put the fencing panel reinforcement bars inside the assembled mould
- Place the oiled mould on the vibrating table.
- Fill up the fencing panel mould with concrete.

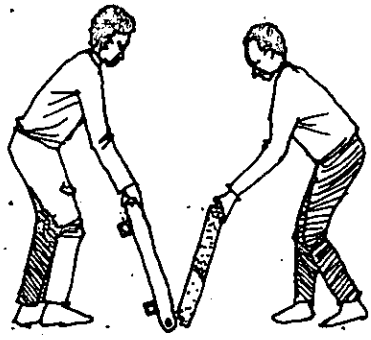




- As the vibration is going on, systematically screed the concrete mix with a float until the mortar is flush with the top of the fencing panel mould. This takes about 15-30 seconds.

After about 15-30 seconds switch off the vibrating table or until there is no more compaction.

- Transfer the fencing panels to the setting shade (2 people)
- Leave the fencing panels to initially cure for 24 hours in the shade.



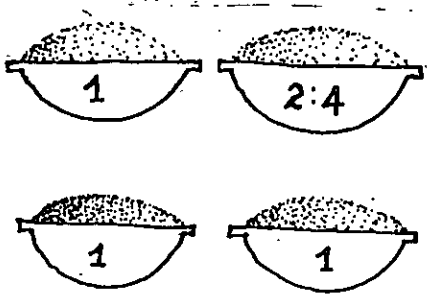
- Carefully demould the fencing panels to a firm level ground for further dry curing
- Sprinkle the fencing panels with a controlled amount of water three times a day for a minimum of 7-10 days.
- Stack the cured fencing panels neatly on a firm level ground.

Field Tests

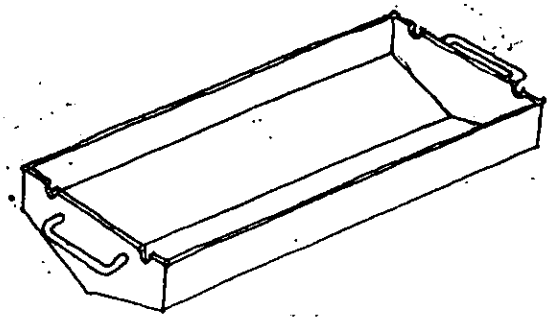
Perform scratch and ring tests on the finished fencing panels as described in the manual.

17 COPING STONE

- Follow the same batching and mixing procedures as for other dry mixes.

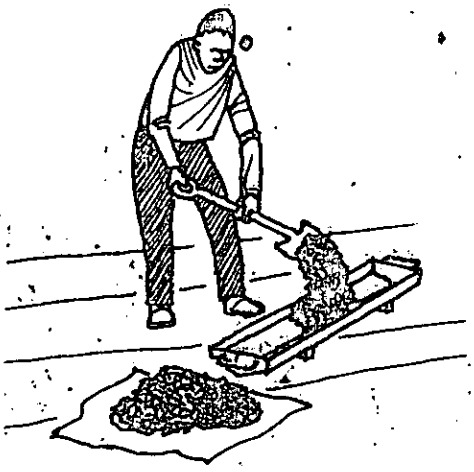


Cement:	Aggregate:	Dust:	Sand
1	2:4	:	1 : 1



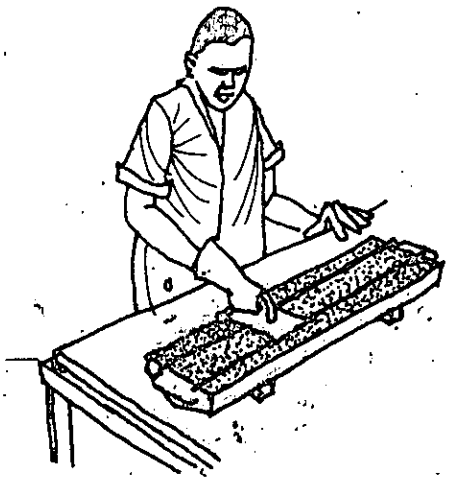
The mould

Oil the mould



- Fill the mould with the concrete

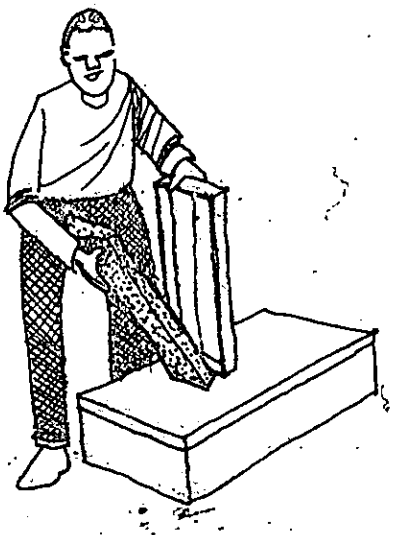
- Place the mould on the vibrating table
- Switch on the vibrating table for about 45 seconds



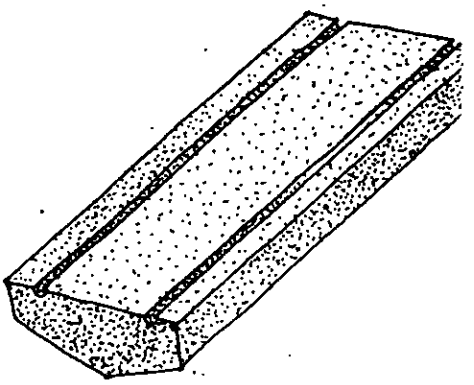
Screeding under Vibration

- While the concrete is being vibrated, use a float to screed the concrete.
- Continue vibrating and screeding the concrete mix until a thin film of water forms on its surface.

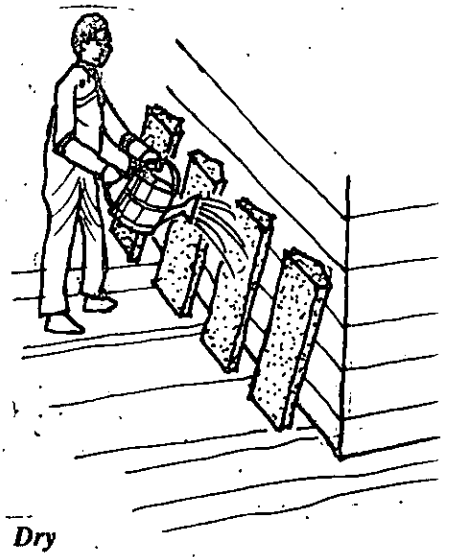
  Transfer the mould to the setting shade.
- Leave the coping to set overnight (24 hours) in the covered shade.



- Demould the coping stone the next day (after 24 hours).



The finished coping stone



Dry

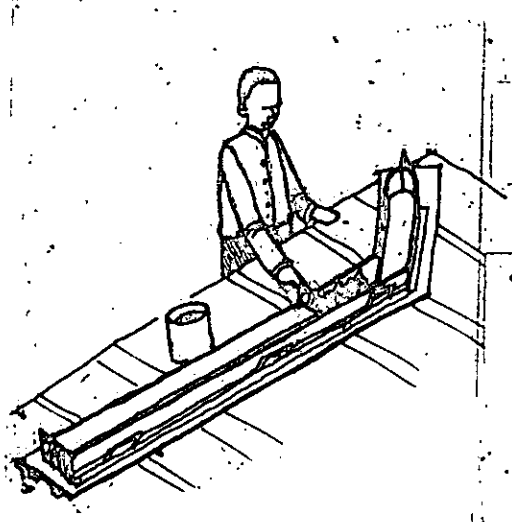
- Dry cure the coping stones for a further 10 days by sprinkling them with a little water daily.

Field Tests

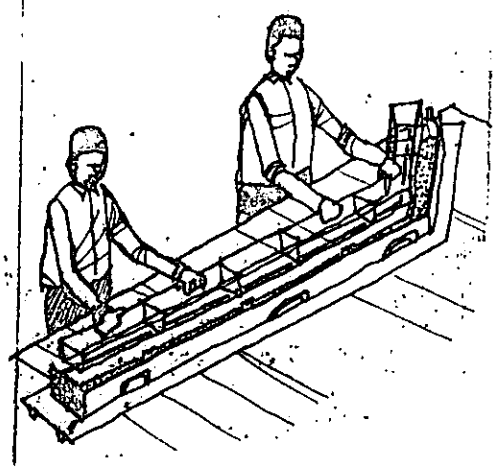
Perform the scratch and ring tests on tl coping stones as described in the manu

18 FENCING POSTS

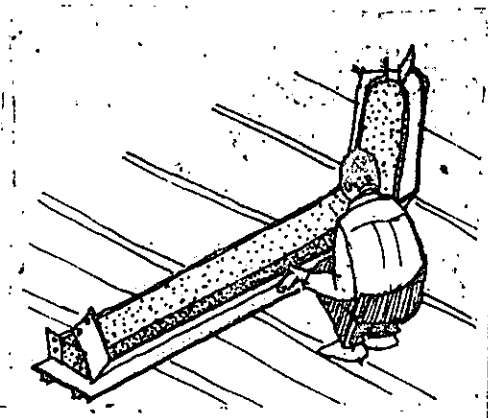
- Correctly Batch and Mix the raw materials to get the required wet mix.
- Assemble the fencing post mould by fixing the bolts as shown



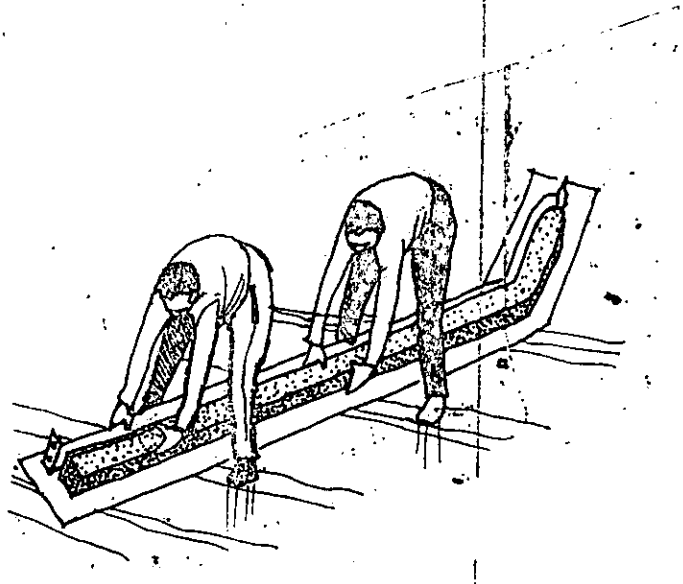
- Oil the assembled mould thoroughly
- Place the oiled mould on the vibrating table (2 people)



- Put about 1/2" concrete blinding in the assembled mould to hide its bottom.
- Put the fencing post reinforcement bars inside the assembled mould
- Fill up the fencing post mould with concrete
- Switch on the vibrating table for about 15-30 seconds.
- A`s the concrete is being vibrated, systematically screed it with a float until the mortar is flush with the top of the mould frame



- Continue screeding until a thin film of water forms on top of the concrete mix.
- Switch off the vibrating table.
- Transfer the fencing post to the setting shade (2 people)
- Leave the fencing post to initially cure for 24 hours in the concered shade before demoulding
- Demould the fencing post carefully as shown (2 people)
- by unlocking the moveable mould flaps and gently tilting the post.



- Dry cure the fencing posts for 7-10 days by sprinkling them with water.
- Stack the finished fencing posts neatly on a horizontal firm ground.

Field Tests

Perform the scratch ring tests as described for the VCPs

SUMMARY TABLE FOR VCPs

Vibrated Concrete Product (VCP)	Batching Ratio					Mix Type	Mould Type	Curing	Tests	Output per Bag of Cement	Approximate Production Cost
	Cement	Aggregate (3/8"	3/4")	Dust	: Sand						
MCR Tile	1	-	-	1/4	23/4	Wet	Fibre glass Steel Concrete	Wet	Scratch Ring Test Porosity	89 (10mm) 100 (6mm)	
Floor Tiles	1	-	-	1/4	23/4	Wet	Steel	Wet	Scratch Ring		
Balustrade Railing	1	2	4	1	1	Wet	Timber Steel	Wet	Scratch Ring	25	
Baluster	1	2	4	1	1	Wet	Fibre glass	Wet	Scratch Ring		
Floor Slabs	1	2	4	1	1	Wet	Timber Steel	Wet	Scratch Ring	37	
Coping Stone	1	2	4	1	1	Wet	Timber Steel	Wet	Scratch Ring		
Fencing Post	1	2	4	1	1	Wet	Timber Steel	Wet	Scratch Ring	17	
Hollow Blocks	1	10	-	1	1	Dry	Steel	Dry	Scratch Ring	150	
Solid Blocks	1	10	-	1	1	Dry	Steel	Dry	Scratch Ring		
Fencing panels	1	2	4	1	1	Wet	Timber Steel	Wet	Scratch Ring		
Air Bricks	1	2	4	1	1	Dry	Steel	Dry	Scratch Ring		
Louvre Air Bricks	1	2	4	1	1	Dry	Steel	Dry	Scratch Ring		

1. THE DAILY PRODUCTION RECORDS

This record form acts as the VCPs production calender

Column A

This gives the date of production. If there is no production give the reason for this in column 1. (E.g. Holiday, No Cement).

Column B

This shows the total number of workers for the day recorded

Column C

This shows the total cement consumption for that day.

Columns D, E, G &H

These indicate the number and types of VCPs produced that day

Column F

The total daily breakages and defects recorded here.

Total Row

At the end of the month you can add all the total expenditure costs for labour and materials and compare them with the sales of the VCPs produced for that month. This will give you an indication of the labour cost per VCP.

Efficiency Check

A good indicator of efficiency of a VCP business is the number of breakages and defective VCPs produced for that month.

Another useful information is the cement consumption per VCP element. Divide the total quantity of cement used K by the total number of VCPs element (L+M+O+P). If this figure is high then adjust your batching of raw materials.

1

DAILY PRODUCTION RECORD OF A VCP PRODUCTION UNIT

MONTH _____ YEAR _____ UNIT _____

(A) DATE	WORKERS INITIALS (B)	USED CEMENT Kg (C)	NO. OF TILES PRODUCED (D)	NO. OF RIDGES PRODUCED (E)	NO. OF BREAKAGES & DEFECTIVE (F)	OTHER VCPs (G)	OTHER VCPs (H)	REMARKS (I)
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
TOTAL		_____ (K)	_____ (L)	_____ (M)	_____ (N)	_____ (O)	_____ (P)	

(Q) TOTAL LABOUR COST

BAGS OF CEMENT USED

_____ BAGS = _____ Kg.

CEMENT USED PER VCP $\frac{K}{L+M+O+P}$ = _____ Kg.

BREAKAGES: $\frac{N}{L+M+O+P}$ X 100 = _____ %

2 A. FINANCIAL RECORD

In order to have a good knowledge of where the costs of producing VCPs are going and where the profits are being realised, a producer should keep an accurate Financial record.

The producer should have two of the VCPs financial record sample forms 2A, one form should be marked OUT. (Money Out) and the other IN (Money In)

Money Out

The money out form is for recording the producers expenditure. The expenses include buying raw materials, paying labourers, rent, transport costs etc.

Money In

Mark the other VCP financial record IN on top. This form is for receipts due to sales of the VCPs. Remember to fill the date, receipt number description or your own reference number.

You may add the names of the customers who made the purchases under the column for remarks. At the end of your financial record period (one year or one month) you should add up all the IN and OUT financial forms 2A and transfer them to the Summary Financial Record of a VCP production Unit (Form 2B described next).

2A **FINANCIAL RECORD OF A VCP PRODUCTION UNIT** _____

RECORD FROM _____ TO _____ IN OUT

DATE	RECEIPT / DESCRIPTION	AMOUNT	REMARKS
	TRANSFER FROM_____		
SUBTOTAL OF THIS PAGE / TRANSFER			
	TOTAL		

2 B. SUMMARY FINANCIAL RECORD

In the summary financial record, receipts and expenses are listed in detail.

(A) Salaries

Add up the total amount of money used to pay the workers.

(B) Raw Materials

Record the total expenditure on raw materials.

(C) Maintenance

This should indicate the expenses incurred in repairs of equipment and tools or any other facility within the production unit.

(D) Fixed Costs

D:1 Interest on loan

You should know how much you are using for repayment and interest on your capital if it was bought on loan. Calculate the total for the period of your record.

D:2 Buildings / Site Depreciation

You must know the total cost of investment in building, curing tanks, vibrating table and other equipment. This amount is usually depreciated over a number of years. Calculate the depreciation over the period you record.

D:3 Rent

Indicate the expenditure for paying for rent over the period recorded.

(E) Transport

This is the summary of transport expenses incurred over the financial period recorded.

Note

Calculate annually the total of your profits. Fill forms 2A / 2B financial records monthly and add them up at the end of the year.

2B SUMMARY FINANCIAL RECORD OF PRODUCTION UNIT

PERIOD FROM _____ TO _____ UNIT _____

OUT

Ⓐ SALARIES	① PRODUCTION	from payroll	____
	② _____		____
	③ _____		____
		SUBTOTAL	_____
Ⓑ SALARIES total from forms 2B	① CEMENT		____
	② SAND		____
	③ FIBRES		____
	④ WATER		____
	⑤ G. I. WIRE		____
	⑥ ENERGY		____
	⑦ PLASTIC SHEETS		____
	⑧ PIGMENTS/COLORANTS		____
	⑨ _____		____
	⑩ _____		____
		SUBTOTAL	_____
Ⓒ MAINTENANCE total from forms 2B	① VIBRATING TABLE		____
	② BUILDING & SHADE ROOF		____
	③ TOOLS		____
	④ CURING TANK		____
	⑤ SITE (SECURITY)		____
		SUBTOTAL	_____
Ⓓ FIXED COSTS	① INTEREST ON LOAN		____
	② BUILDINGS & SITE DEPRECIATION		____
	③ RENT		____
	④ _____		____
	⑤ _____		____
		SUBTOTAL	_____
Ⓔ TRANSPORT totals from forms 2B	① RAW MATERIALS		____
	② CR. ELEMENTS		____
	③ _____		____
	④ _____		____
		SUBTOTAL	_____

TOTAL OUT A + B + C + D + E = _____

IN

Ⓕ SALES from forms 2B	_____
Ⓖ TRANSPORT from forms 2B	_____
Ⓗ INSTALLATION from forms 2B	_____
Ⓘ _____	_____

TOTAL IN F + G + H + I = _____

TOTAL IN _____

TOTAL OUT _____

PROFIT _____

3. MATERIAL RECORD

This fom is used to keep a record of your store. Give your card a number for reference and the material (this may include tools and spare parts).

In Column

All materials that go in or out, you write either under **IN** or **OUT** with its quantity e.g. no. of bags, Kg.

Balance Column

The balance column shows the 'Balance' of what is in stock. This gives you the information of what material you have to order to prevent a break in production.

3

MATERIAL RECORD OF A VCP PRODUCTION UNIT _____

CARD No. _____ MATERIAL _____

	IN		BALANCE		OUT	
DATE	RECEIPT No.	QUANTITY		DATE	RECEIPT No.	QUANTITY
	TRANSFERED FROM CARD NO._____				TRANSFERED FROM CARD NO._____	
	TRANSFER				TRANSFER	

TRANSFERED TO LEDGER CARD NO. _____

5. DAILY STOCK RECORD

For each type of VCP element you are producing make one copy of the daily stock record form.

Before any VCP is put to stock, you must test it for quality perfomance.

For Test Column

This column shows tthe number of VCP elements tested.

Rejects column

This indicates the number of VCP elements that have failed the required perfomance tests as indicated in the manual.

Total number tested - Total rejected = Total for Stock *(To Stock)*.

To Stock Column

This column has the total number of tested good quality VCP elements.

Out from Stock Column

Show the number of VCPs being sold.

Balance colurnn

Show the balance:

Balance = To Stock - Out from stock

Transfer the total Balance (C) to the Balance column of the next month.

Note

It is useful to calculate the percentage of the rejected VCPs elements monthly by dividing rejects/for test x 100%. A big reject percentage should cause worry to the producer.

It is adviseable to check the stock regularly (every 3 - 4 months to see if the figures on the stock record and the actual stock are the same.

4 **DAILY STOCK RECORD OF MCR PRODUCTION UNIT** PRODUCT _____

MONTH _____ **YEAR** _____ **UNIT** _____

DATE	FOR TEST	REJECTS	TO STOCK	OUT FROM STOCK		BALANCE	REMARKS
					RECEIPTS NO.	(D)	
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
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26							
27							
28							
29							
30							
31							
TOTAL	(A)	(B)				(C)	
	Rejected: $\frac{B}{A}$ X 100% = _____ %					TRANSFER TO NEXT MONTH	

GLOSSARY

Aggregates:	*Aggregates are raw materials (sand, quarry dust) used in preparing the concrete mix.*
Aggregate:Cement Ratio:	*This is the correct mixing ratio for cement and the aggregates. It determines the strength of the concrete mix.*
Batching:	*The measuring out (by weighing or by volume) of the raw materials required .*
Compaction:	*Involves application of a limited amount of force to the concrete mix to increase the moulding strength of VCPs*
Demoulding:	*Removing the shaped VCP from its mould.*
Dry Mixing:	*Mixing the dry raw materials used in the production of VCPs with very little water.*
Field Tests:	*The tests that should be performed on the VCPs immediately after they have been produced as required.*
Green Strength:	*This is the strength of the VCP after the initial setting.*
Mould:	*The container into which the concrete is poured with the required shape.*
Moulding:	*The whole process of filling the mould with concrete when producing VCPs.*
Nib:	*The projection found on MCR tiles that is used to fix the tile onto the roof battens.*
Nib Test:	*One of the field tests used in determining the quality of MCR tiles.*
Porosity:	*The ability of the VCP to allow water to freely pass through it. Leakages in MCR tiles could be due to high porosity.*
Ring Test:	*A test done for most VCPs .*
Rodding:	*Some of the newer VCPs (Louvre air-brick and air bricks) do not require vibration. Compressing the concrete mix by stabbing with a rod.*
Scratch Test:	*See under Field Tests.*
Setting:	*VCPs are left out overnight (24 hours) to gain initial strength before they can be wet or dry cured.*
Sieving:	*The process of removing unwanted objects or big sized particles when preparing raw materials. Sieves of differing sizes are available depending on the size of particles required to be sieved.*
Slump test:	*One of the main tests to determine if the concrete is correctly mixed see page...*
Stacking:	*Arranging the cured VCPs in an orderly way to reduce breakages and for eefficient storage.*
Trimming:	*Removing excess concrete from MCR tiles at the end of their production process see page...*
Voids:	*Some of the defects that are common in VCPs are small air-holes called voids.*
Water-Cement Ratio:	*This varies depending on whether the VCP requires a wet or dry mix. The ratio is higher for wet mixes.*
Wet Mixing:	*The controlled addition of water after all the other raw materials have been satisfactorily prepared and batched.*

APPENDIX

Contact List

The appendix provides useful contacts of NGOs actively involved in promoting other appropriate low cost technologies. Interested individuals can contact them for more information. You will also find a list of VCPs equipment suppliers. Please do not hesitate to contact any of the suppliers if you are not sure of which equipment is appropriate for you.

Equipment Suppliers List

J. P. M. Parry Associates
Through Haggar Kate
P. O. Box 59280
Tel: 534716/ 5534451/4
Nairobi, Kenya

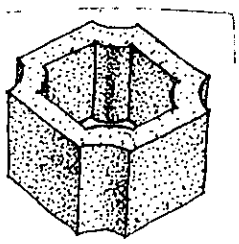
Undugu Society of Kenya
Metal Workshop
P. O. Box 40417
Nairobi, Kenya

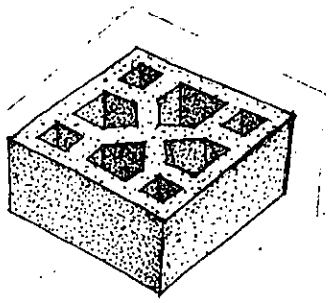
Hartz and Bell
P. O. Box 40185
Tel: 556477
Nairobi, Kenya

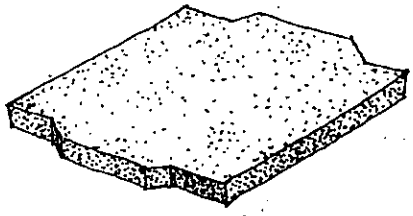
Sai Raj Fibre Glass
P. O. Box 43490
Tel: 820641
Nairobi, Kenya

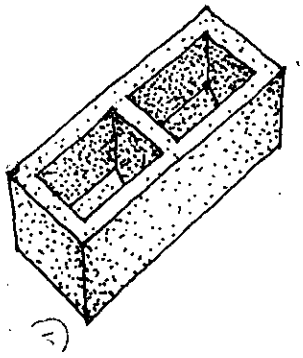
Paul Jaramba
P. O. Box 48538
Nairobi, Kenya

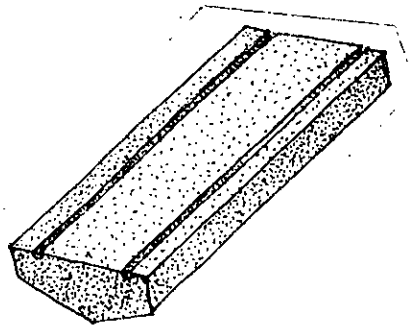
Makiga Engineering Works
P. O. Box 77593
Tel: 782411
Nairobi, Kenya











VCPs Production Records

Many small scale businesses fail due to poor monitoring of their production levels and profits. It is important that entrepreneurs keep good production records to help them know whether they are making profits or losses. A summary of the following production records have been provided as examples:

1. *The Daily Production Records*
2. *The Financial Records*
3. *Material Records*
4. *Daily Stock Records*

☞

This list of production records is not exhaustive. Entrepreneurs can over time invent their own records to monitor other aspects of VCPs production that they feel determine the Production Capacities.

References

1. Fibre concrete (FCR) / Micro Concrete (MCR) Roofing Equipment, Product Information, *K. Mukerji, H. Worner, Skat (1991).*
2. Concrete Block Producing Equipment, Product Information, *K. Mukerji, H. Worner, O. Ruskulis (1991).*
3. Concrete Roofing Elements, Roofing Advisory Service, *SKAT (1989).*
4. Appropriate Building Materials, Roland Stulz, Kiran Mukerji, *SKAT (1988)*
5. Fibre Concrete Roofing/Micro Concrete Roofing, Production Monitoring Logbook, *SKAT, (1989).*
6. FCR/SSB Production Brochures *E.Agevi* (1991).