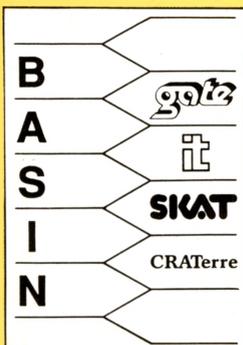
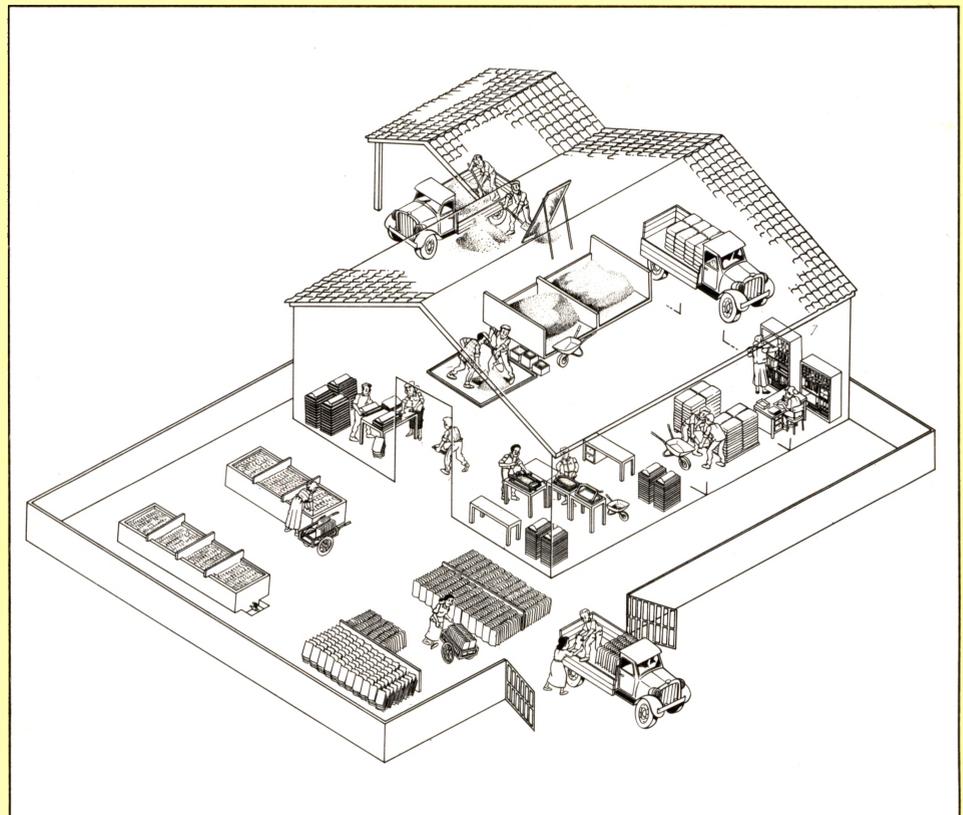




SKAT Swiss Centre for Development Cooperation
in Technology and Management

WORKSHOP AND EQUIPMENT

All about the setup of a professional MCR Workshop



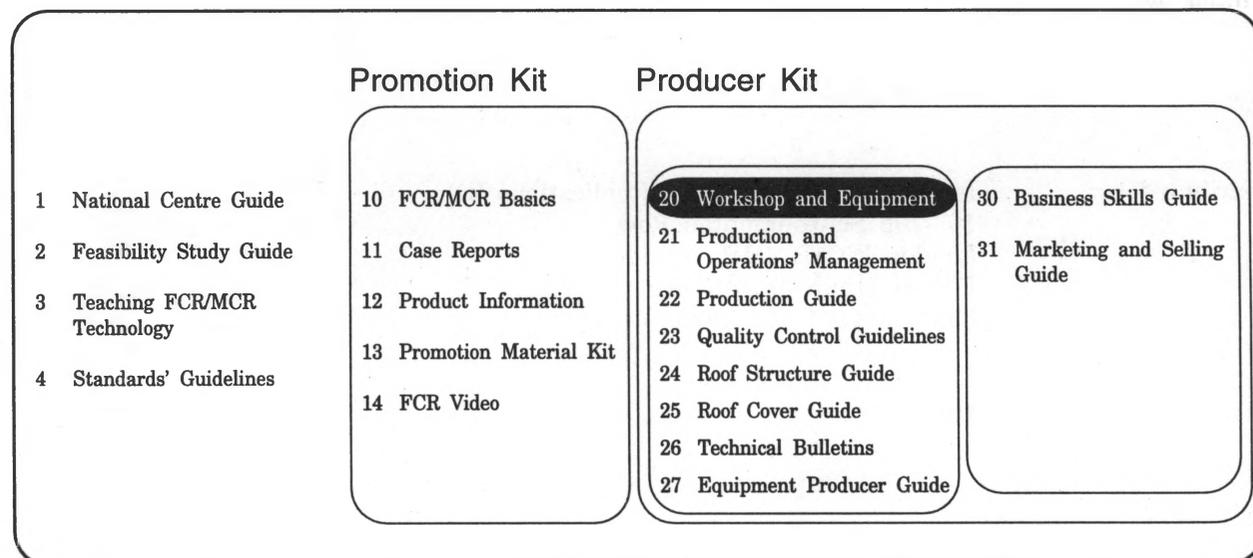
WORKSHOP AND EQUIPMENT

All about the setup of a professional MCR Workshop

A publication of the Swiss Centre for Development Cooperation in
Technology and Management (SKAT)

MCR Toolkit – Overview

National Centre Kit



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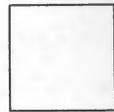
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Preface

The history of FCR/MCR

The Fibre Concrete Roofing/Micro Concrete Roofing (FCR/MCR) technology was developed in the 1970s after many years of experience with concrete tiles and asbestos cement sheets. During the 1980s it found applications in many countries all over the world. Today, the technology is at a mature stage, and experience has shown that it offers a reliable roofing material that can compete, in most cases, with conventional roofing materials.

Since MCR tiles are superior to FCR tiles in quality, durability and profitability, RAS promotes only MCR tiles today.

MCR Toolkit Series

This guide is part of the MCR Toolkit Series. This series presents the entire know-how required in the field of FCR/MCR technology, covering technical as well as economic, organisational, management and marketing aspects. The MCR Toolkits' Overview shows how the series is structured.

Roles of BASIN, SKAT/RAS

SKAT and ILO are co-publishers of the MCR Toolkit Series, of which this guide is one element.

BASIN

SKAT is a member of BASIN (Building Advisory Service and Information Network), a coordinated network of experienced international professionals. It was established to provide qualified advice and information in the field of building materials and construction technologies.

The activities of BASIN are divided among four leading European, non-profit organisations in the field of appropriate technology: GTZ/GATE in Germany, ITDG in the UK, SKAT in Switzerland, and CRATerre in France. Each of these organisations covers a specialised subject area, and can provide the necessary expertise in a professional and efficient manner.

SKAT

SKAT is an information and documentation centre and a consultancy group engaged in promoting and implementing appropriate technology in partner countries worldwide.

RAS

As a member of BASIN, SKAT specialises in roofing technology, particularly MCR technology. Within BASIN, SKAT established the Roofing Advisory Service (RAS). To facilitate the promotion and dissemination of roofing technologies, SKAT/RAS produces the MCR Toolkit Series, of which the "Workshop and Equipment" is one element.

Network of specialists

A worldwide network of specialists and specialised institutions provides technical support to new and existing producers of MCR. This helps to ensure the reliability and quality of the products in this growing market. This MCR network is coordinated by SKAT/RAS.

Contact address

Information on all the above is available from:

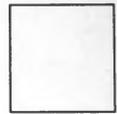
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We would like to thank all the experts, technicians and producers who gave their valuable insights and comments to this publication. Special thanks go to Mr. Huub Luyk, Mr. Segundino Balnaja and Mr. Daniel Mostrales, all very experienced MCR technology experts from the Philippines who contributed significantly toward this publication.

Comments

Comments and feedback to improve this guide are welcome and may be sent to SKAT/RAS.



Introduction

FCR / MCR in General

What are FCR and MCR?

FCR (Fibre Concrete Roofing) is roofing made of concrete tiles of cement mortar mixed with a small amount of natural or synthetic fibre.

In the case of MCR (Micro Concrete Roofing), fine aggregate is used instead of fibre. For many years, RAS has recommended the production of MCR tiles only.

For more basic information, please refer to "FCR/MCR Basics, Element 10".

Properties of MCR

The technology provides an inexpensive and reliable roof cover and especially suits the needs of developing countries. The main properties are:

- The raw materials are available locally and thus foreign exchange is saved.
- The use of appropriate technology enables decentralised and small-scale production.
- The technology requires less investment than other roofing material.
- The production is labour-intensive rather than capital-intensive, and thus creates jobs.
- Compared to metal sheeting, rooms covered with MCR provide greater comfort because of better thermal insulation.
- During rain, MCR-covered roofs are less noisy than those covered with metal sheeting.
- The product is environmentally appropriate.
- The technology is easy to learn.

Limitations of MCR

The durability of MCR is roughly the same as that of ordinary concrete tiles, with a service life-span that exceeds 50 years. At times, however, the material has been found to have less strength than that of modern concrete tiles and AC-sheets. This generally occurs when production is carried out by small units, which produce with lower consistency resulting from improper standards and skills in production and operations management.

Contents of this Guide

Objectives

This guide provides basic information about the workshop and equipment required to establish and operate an MCR workshop.

It enables the entrepreneur

- to determine the required working space as well as the specific equipment and tools needed for the various activities involved in producing MCR tiles.
- to design and plan an efficient layout of his workshop.
- to incorporate in the planning stage of the production workshop some possible expansion to other concrete product lines.

Target group

The guide is meant for groups or individuals who are seriously considering MCR production and helpful to existing MCR tile producers in improving their facilities so as to increase productivity. The guide is not designed for persons who are interested in general or detailed information on MCR technology and business.

For basic information we suggest the booklet "The Basics of Concrete Roofing Elements," available free of cost from SKAT in English, French and Spanish.

For detailed information on the various aspects of MCR technology and business, the respective elements of the MCR Toolkit Series can be consulted (available from SKAT).

1. The Tile-Making Process

The basis

The layout of an MCR workshop is product-oriented. A product-oriented layout is appropriate for the production of MCR tiles, usually in large volume.

The basis for the layout and construction of a workshop is the planned scale of operation. Once the entrepreneur has decided how many vibration tables he will require to produce the planned number of tiles, the step-by-step tile-making process forms the basis for the workshop layout.

Time is money

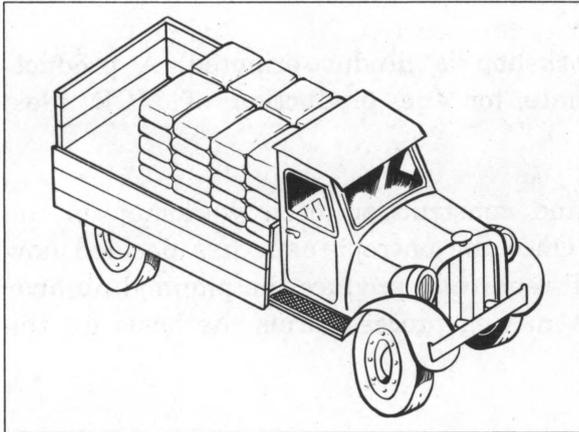
It is important that the tile production steps are fine-tuned to the movement of the workers in order to avoid long walking distances between the different production operations. Wasted time is wasted money and working against normal movements reduces the production rate of workers.

Layout guide

From the raw material delivery to the supply of the finished MCR tiles we have divided the tile-making process into nine major steps to guide us through this publication. For a detailed explanation of the MCR tile production process, please refer to **MCR Toolkit, Element 22, Production Guide**.

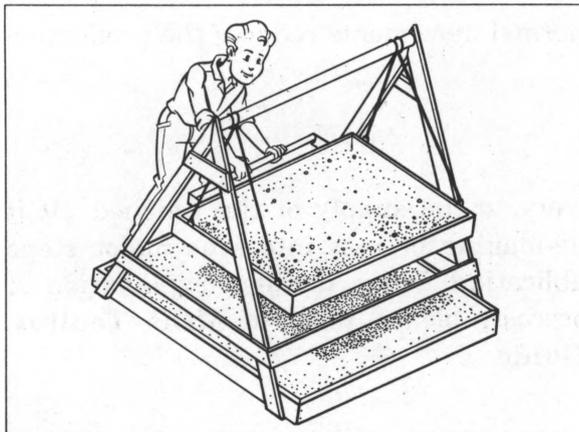
1.1 The Nine Steps of Production

1. MATERIAL SUPPLY



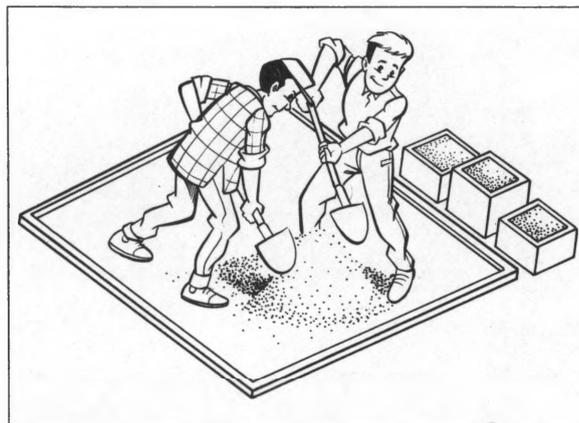
Cement
Sand
Aggregate
Miscellaneous, wire, additives

2. MATERIAL PREPARATION AND STOCKING



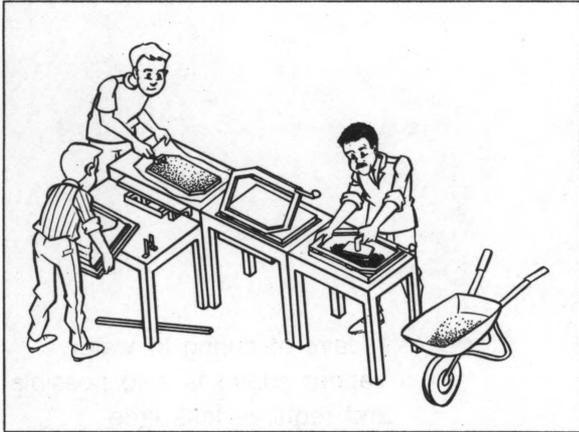
Sieving of aggregate
Sieving of sand
Preparing fixing device

3. MIXING



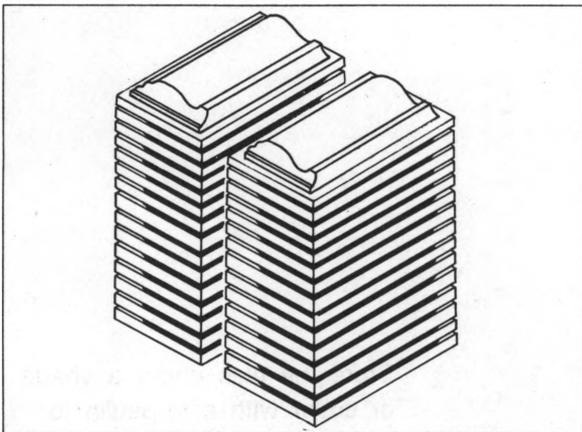
Mortar preparation
Testing workability

4. VIBRATING AND MOULDING



Vibrating fresh mortar
Nib making
Placing and aligning on mould

5. MOULD CURING



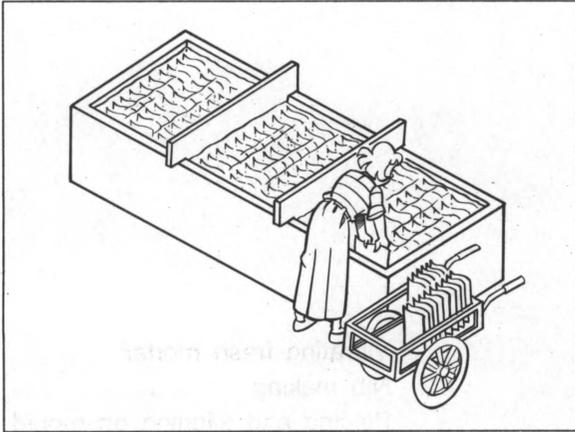
The first 24 hours is the wet mix curing period

6. DEMOULDING



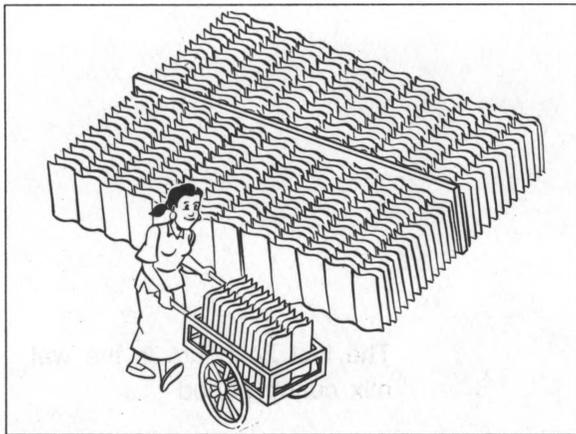
Taking the tile out from the mould and cleaning the interface sheets and the moulds
Testing the tile strength

7. WATER AND VAPOUR CURING



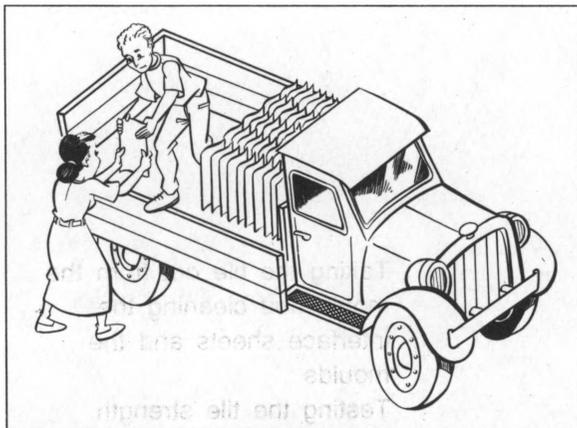
7 days of curing in water
Vapour curing is also possible
and requires less time

8. AIR CURING AND STOCKING



Store the tiles under a shade
or cover with a tarpaulin for
the next 21 days

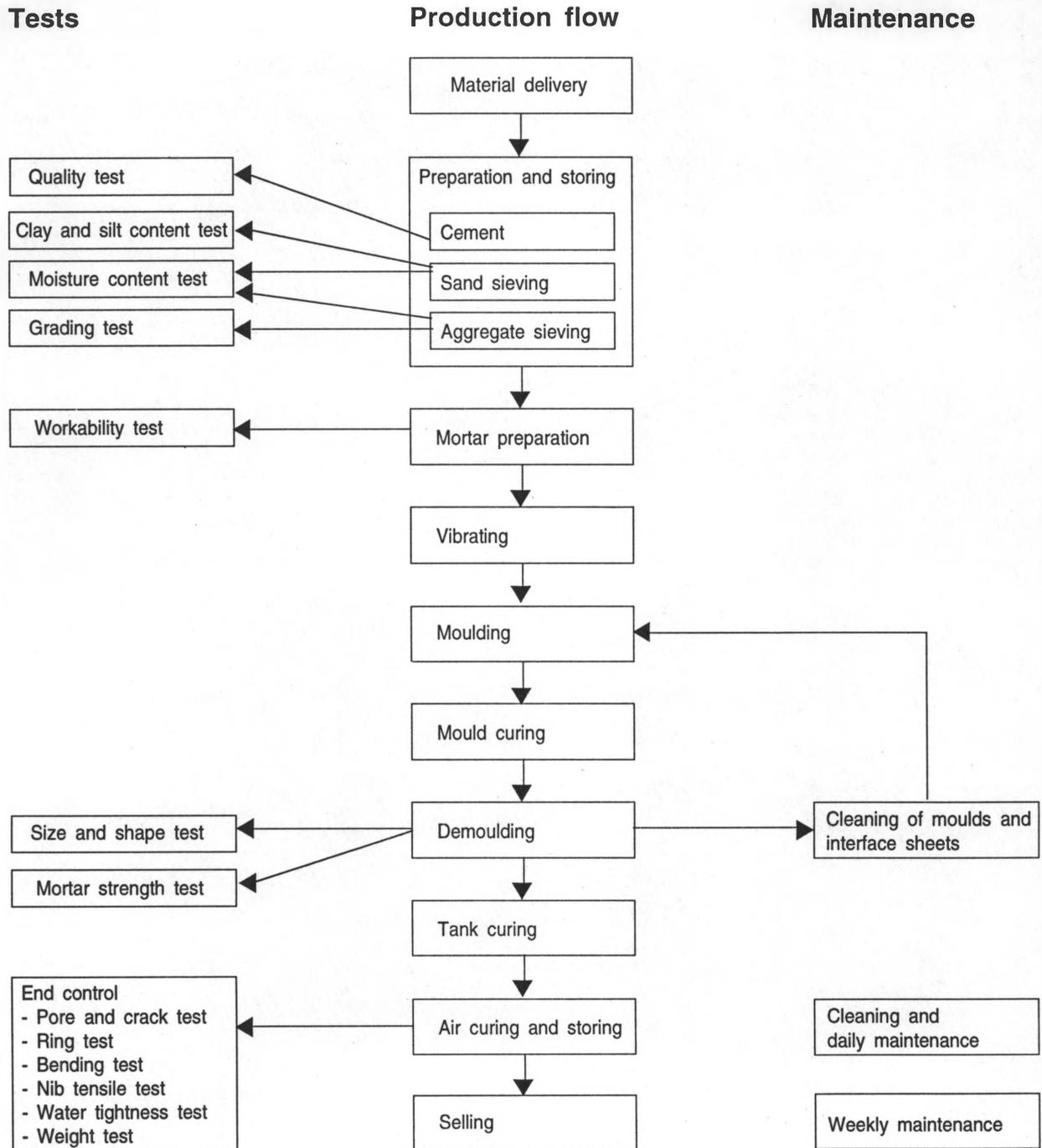
9. TESTING AND SELLING



Final quality check

For details see
MCR Toolkit Element 23,
Quality Control Guidelines

1.2 Flow-chart of MCR production process



Government of New Brunswick

Two-way

Production Line



2. Workshop Layout, Buildings and Fixed Equipment

Introduction

The size and design of a workshop depends mainly on the production capacity which is envisaged. This capacity has to be carefully planned and should be based on a professional market study.

The planning should also incorporate future expansion prospects as well as possible diversification strategies such as the manufacture of other concrete-based building materials.

Design principles

The distances between the different elements of the workshop should be short, especially where a direct and often-used link takes place, and between which heavy materials are moved.

Crossings should be avoided whenever possible.

Passages should be wide enough, especially where carts or wheelbarrows are used.

A good way to optimise the layout is the following:

- a. Draw the floor-plan of the building in which the MCR production line is to be established. Include the surrounding area such as road, parameter or field. Use an easy scale, e.g. 1:20
- b. Cut the shapes representing the various activity nodes in coloured cardboard.
- c. Now move the various models around on the floor-plan and try to find the layout that is most suitable.
- d. Once you are satisfied with the layout, measure the distances between the various nodes and imagine an MCR roof tile being made.

Add all the distances together (from sand and aggregate movement to the mixing area to a ready tile to permanent storage): this is the total travel distance of a tile.

- e. If changes need to be made in the layout, compute again the total travel distance and compare it with the previous one.

It is logical to try to make the travel distance as short as possible. If the travel distance of a tile can be shortened by 15m by placing the vibrator table in a more strategic place, a worker will walk 200 (tiles/day) x 15m = 3km a day less!!

Workshop layout optimising example for a 1000 tiles production per week

Nodes	size (m)	1:20 (cm)	no.
Raw materials bin	1 x 1	5 x 5	3
Vibrator table	0.4 x 0.6	2 x 3	1
Mould stack (4 x 50 Pc)	0.4 x 0.6	2 x 3	4
Tool table	0.3 x 0.6	1.5 x 3	1
Alignment tool	0.8 x 1	4 x 5	1
Table	0.6 x 1.2	3 x 6	1
Storage shelf	0.5 x 2	2.5 x 8	1
Mixing area	2 x 2	10 x 10	1
Curing tank	2 x 3	10 x 15	1
Wash area	0.6 x 0.6	3 x 3	1
Display area	2 x 3	10 x 15	1
Quality control area	1 x 4	5 x 20	1
(add any other item)			

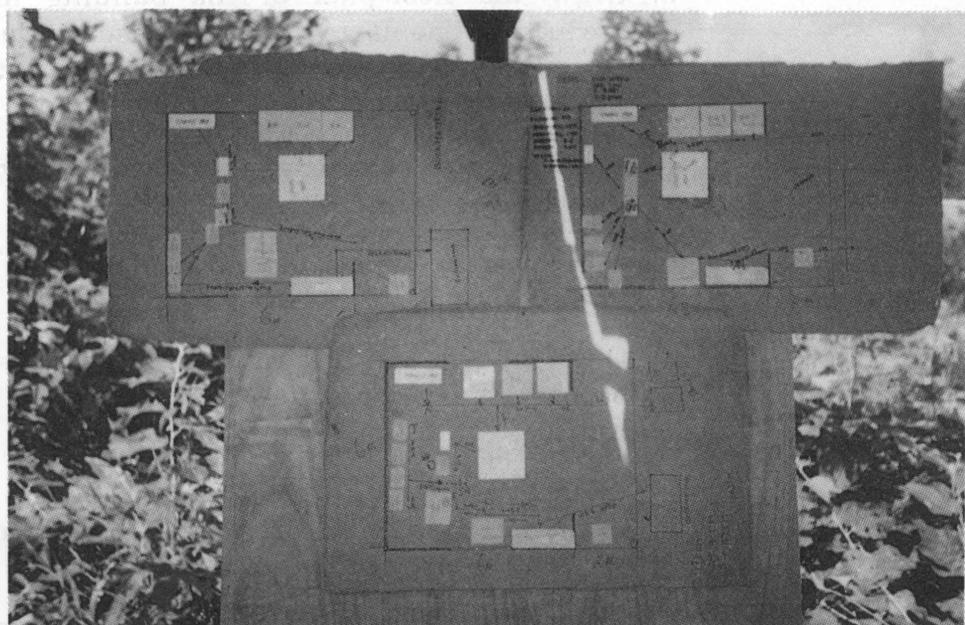


Photo showing workshop layout exercise during an MCR technology training, using the above mentioned method

Types of layout

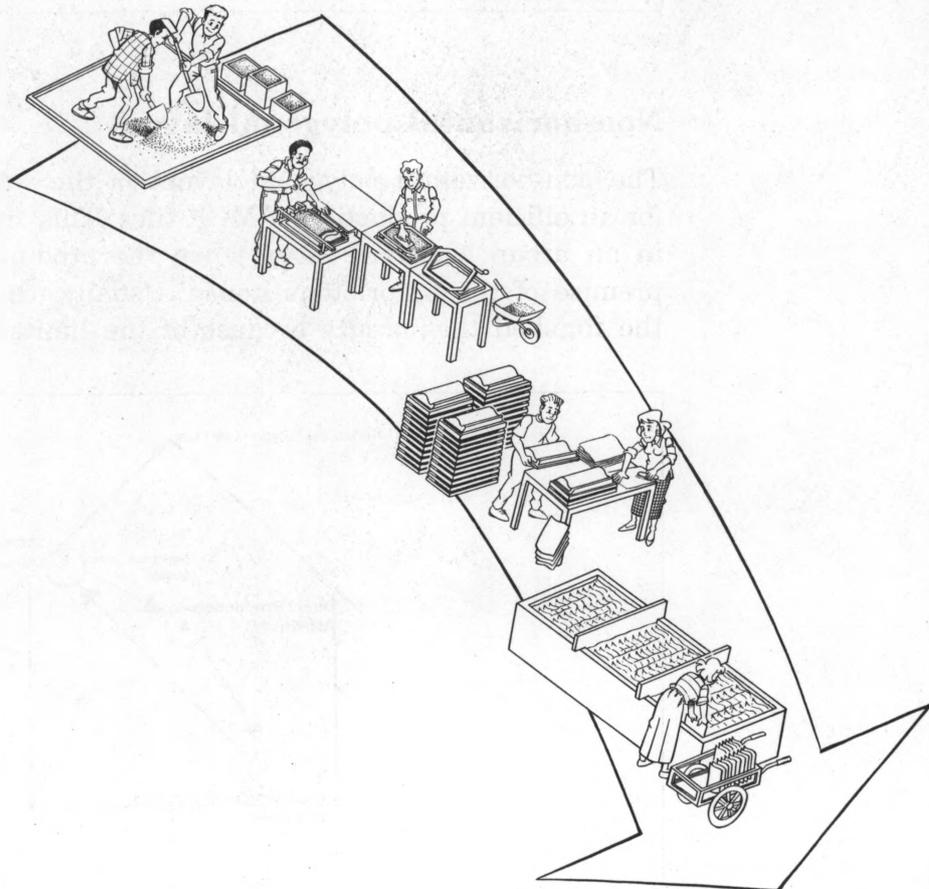
Most new MCR tile entrepreneurs start their first MCR tile production unit with limited working space in order to cut down the initial capital investment. Therefore, if there is an imposed limitation on space, the prospective MCR tile producer should carefully assess the available options for the production layout.

There are basically three types of layout options, namely:

- linear layout
- horizontal polygonal layout
- non-horizontal polygonal layout

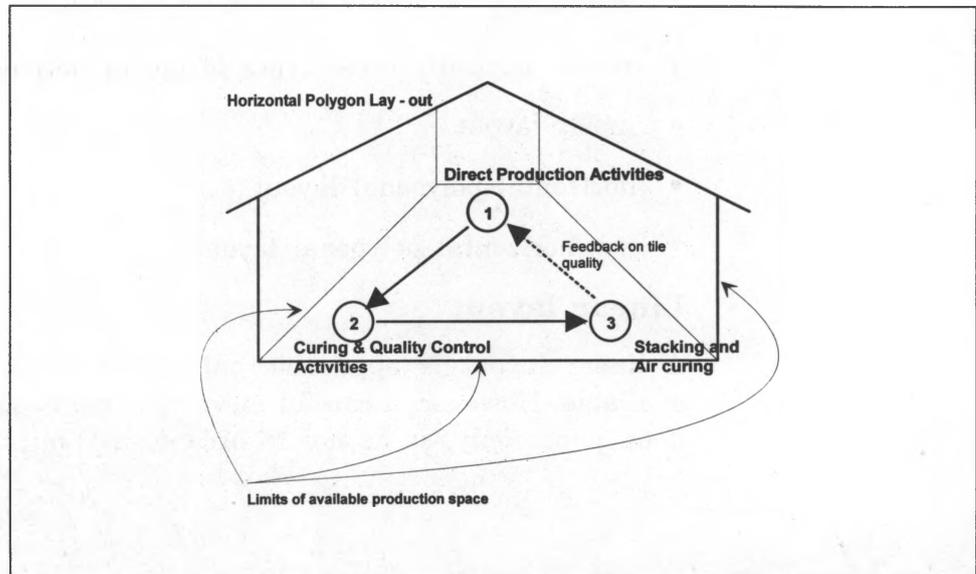
Linear layout

A linear layout is applicable only when there is plenty of space available. However, a careful movement study should be made, even if on paper only, so as not to exceed the limits of efficiency.



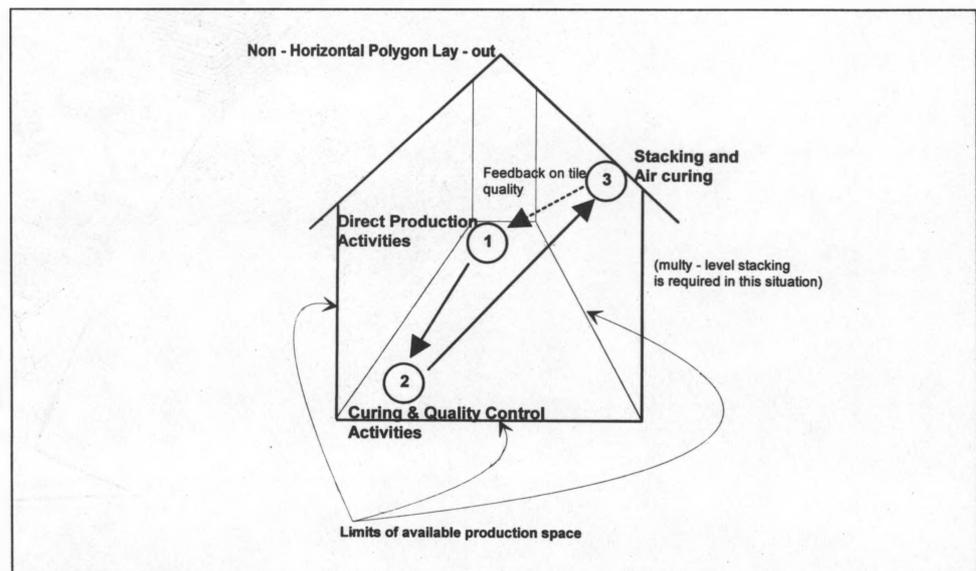
Horizontal polygonal layout

The horizontal polygonal layout is applicable for most common workshop situations. Working space may be limited for various reasons, the main one being cost. A proper design of the horizontal polygonal layout is essential to an efficient MCR tile production.



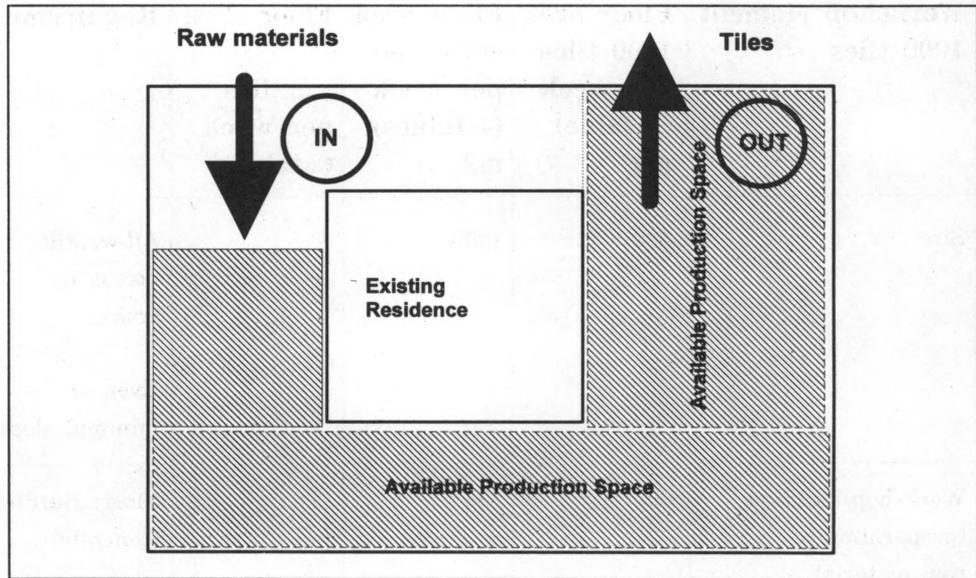
Non-horizontal polygonal layout

The non-horizontal polygonal layout is the worst possible situation for an efficient production of MCR tiles. This situation usually occurs in an urban backyard setup when the production facility is on the premise of the proprietor's house. Usually, the problem of stacking the finished tiles occurs because of the limited space.

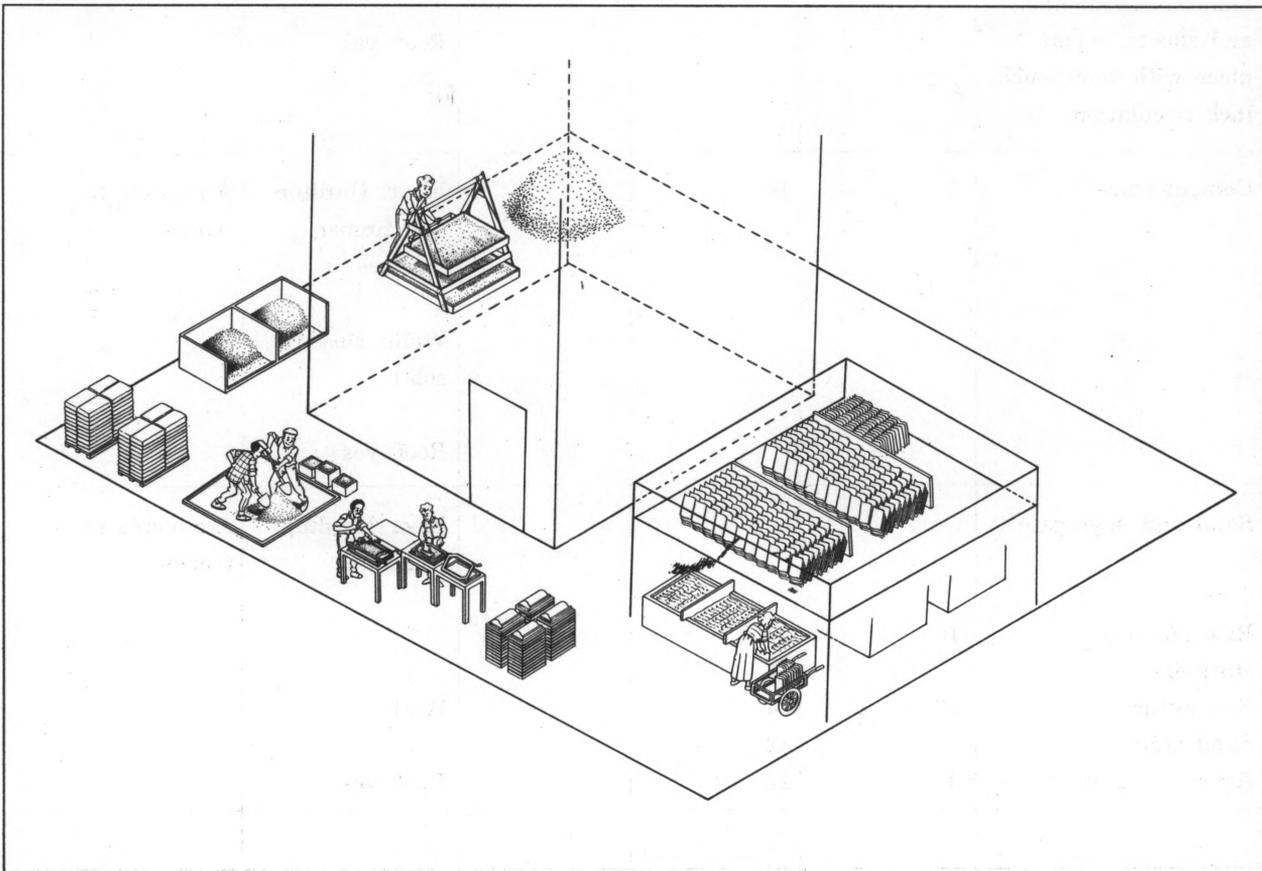


Example of a non-horizontal polygon layout

Floor-plan: (production on a 'backyard' set-up)



3-D Design of the backyard production set-up



2.1 Requirements for Workshop Elements Overview

Workshop element 1000 tiles	Floor area 1000 tiles per week (1 table) m2	Floor area 4000 tiles per week (4 tables) m2	Floor areatiles per week (...tables)	Requirements	Remarks
Site	400	1200		All-weather access to trucks Even or minimal slope	The compound should be fenced and guarded
Workshop building (preparation of raw material, mortar mixing, vibrating, moulding, demoulding, testing, maintaining moulds and sheets, repair place with workbench, incl. circulation)	60	180		Floor: Hardtop (concrete) Walls: with windows or large openings Roof: yes	Good daylight Good ventilation
Cement store	5	16		Floor: Hardtop and timber palettes Walls: closed, solid Roof: yes	Accessible to trucks
Sand and aggregate				Floor Hardtop (concrete)	Accessible to trucks
Raw material stockpile	10	24			
Sieving area	10	24		Walls:	
Sand store	4	12			
Aggregate store	3	12		Roof: yes	

Workshop element	Floor area 1000 tiles per week (1 table) m ²	Floor area 4000 tiles per week (4 tables) m ²	Floor areatiles per week (...tables)	Requirements	Remarks
Storage for tools and spare parts				Floor: Hardtop (concrete) Walls: Roof: yes	Must be lockable
Mould curing and demoulding area	10	40		Floor: Hardtop (concrete) Walls: Roof: yes	Stored in enclosed, airtight racks
Curing tanks including circulation area	30	100		Floor: Walls: Roof: not required	
Air curing and the storing area	100 (20,000 tiles capacity)	360		Floor: Sand bed Walls: not required Roof: not required	Open air possible, but protection needed from air circulation and direct sun radiation during the first 4 weeks
Painting	40			Floor: Hardtop Walls: Roof: yes	
Selling, despatch					Accessible to trucks
Office	10	30		Floor: Walls: Roof:	Must be lockable Good daylight Good ventilation

Other rooms that need to be considered for the layout of the workshop are:

- Laboratory
- Display area
- Staff facilities such as canteen kitchen, wardrobe, washing facilities (shower), toilets, watchmen's facilities

2.2 Requirements for Workshop Elements Detailed Design

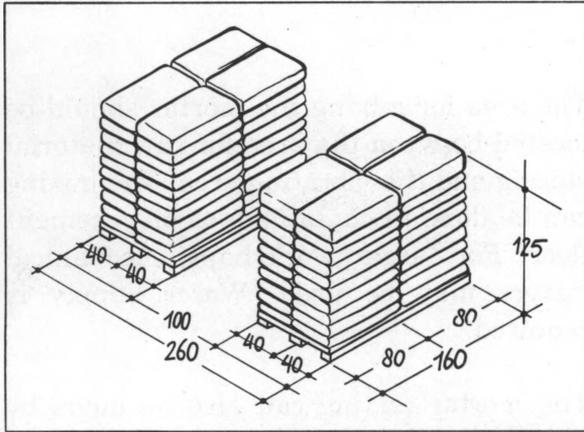
2.2.1 Material preparation and stocking

Total storage capacity

- The required capacity of storage space depends on the daily consumption and on the intervals between raw material supply.
- The storing capacity must be sufficient to cover at least the raw material requirements between two deliveries. (See also **Toolkit Element 21: Production and Operations Management**)

For an MCR tile workshop with a production of 1000 tiles per week, about 14 to 15 bags of cement are required. This means that a maximum of 60 bags of cement per month is needed. Since cement stacking should not exceed 1 month, and this figure already includes the stacking period in the dealer's warehouse, it would be safe to use a two-week stacking cycle to ensure a consistently good quality of cement for the production of MCR tiles.

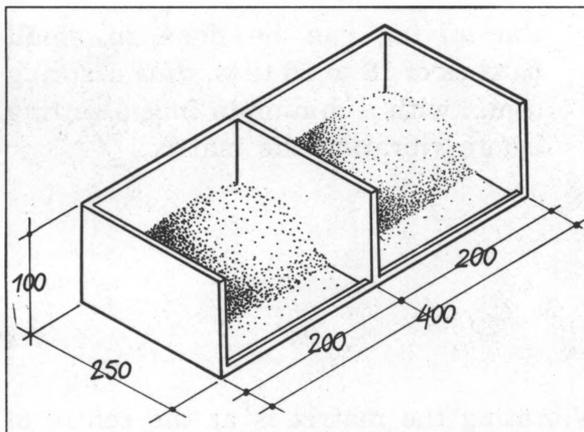
Cement storage



Area: approx. 4 m² per 80 to 100 bags

- Should be accessible by truck.
- Arranged in such a way that rotation of the cement stock is possible: first in, first out (fif).
- Maximum 10-12 bags should be piled up.
- The capacity should be sufficient for approx. one month's production.
- Room should be lockable.
- Cement must be stored dry on timber pallets.

Sand and aggregate storage



For 1000 (10mm) tiles, approx. 0.7 m³ sand and 0.7 m³ aggregate is required (exact amounts depend on mix design).

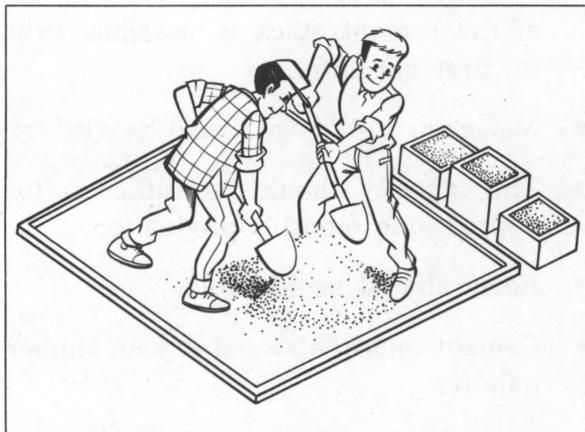
- Should be accessible by truck.
- Located next to the sand-sieving area and the mortar mixing area.
- Hardtop floor and protection from rain and dirt.
- The size depends on the available storage space and the regularity of the supply. In countries with a monsoon climate it is advisable to make large storing facilities if the sand and aggregate contains too much clay and silt contents because of the monsoon rains.

Tile fixing device

- For the preparation of the tile-fixing device (if wire is used), a table is required.
- The required storing space can be neglected.

2.2.2 Mixing

Mortar preparation



Mortar-mixing area approx. 3 x 3m

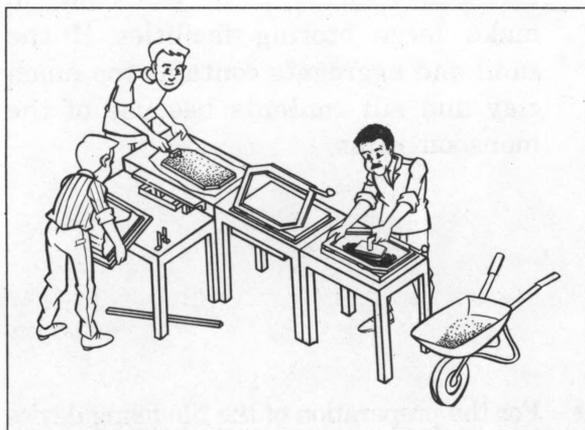
The area for mixing the mortar should be located between the area for raw material storing and the vibrating area. The mixing can be done in containers or on a cement floor. For larger workshops, mechanical mixers may be used. Water supply is required.

The mortar mixing can also be made by using a wheelbarrow as a mixing container. The main advantages are:

- the mixing container is mobile and can be moved from a place near the raw materials to the vibrating table and back.
- the mixing can be done in small batches of 18 to 20 tiles, thus assuring a mix with a minimum initial setting before vibrating the matrix.

2.2.3 Vibrating and moulding

Vibration

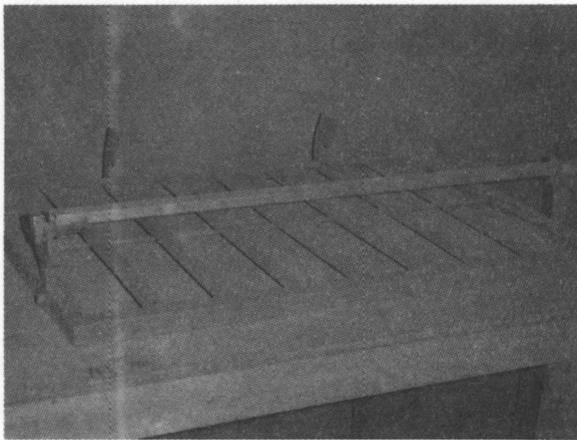


Vibrating the matrix is at the centre of the MCR tile production. Special attention should be paid to ensure that this working area is well situated.

Vibrating can be done with a portable unit, mounted on a large table or on a free-standing vibrating unit.



An MCR tile "Production Street" has been developed by John Parry, Intermediate Technology Workshops, UK, to increase productivity. (Photo left)



In a well-organised MCR tile workshop, tile moulding is done with the help of the alignment tool to ensure total uniformity and, hence, higher quality of the MCR tiles.

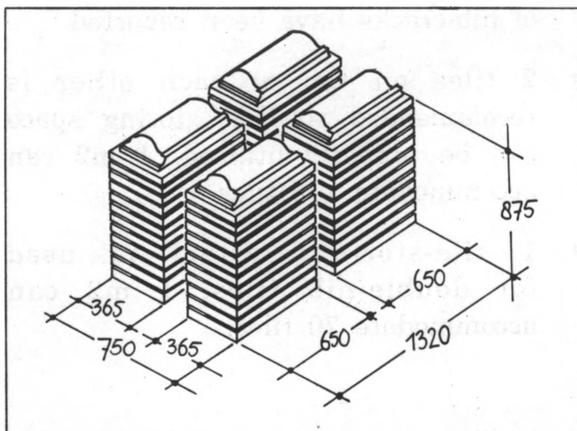
Space must be available for stacking the empty moulds on one side and the moulds with the green tiles on the other side.

Vibrating and moulding area
approx. 4 x 3m

2.2.4 Mould curing

The area needed to store the moulds with the green tiles during the first 24 hours has to be large enough for the:

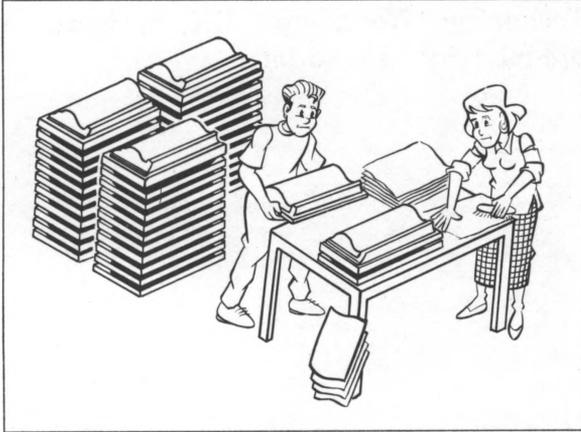
Production of one day
(200 moulds approx. 3 m²)



The green tiles on the self-stacking moulds are stored and protected from air circulation. Not more than 1 to 1.2m height of self-stacking moulds should be on one pile. The floor needs to be levelled precisely to avoid deformation of the green tile.

The tiles produced in the morning should be demoulded the next morning, those produced later in the day should be demoulded at the same time the following day.

2.2.5 Demoulding



Demoulding is done on a small table. If an alignment tool was used for the tile moulding, the demoulding jig is no longer required for the control of the tile shape. The trimming of the MCR tile edge needs to be made during the demoulding process.

After demoulding, the moulds and the interface sheets have to be cleaned immediately. This work requires a wash basin (water supply) and an area for drying the sheets in the open air.

2.2.6 Water and vapour curing

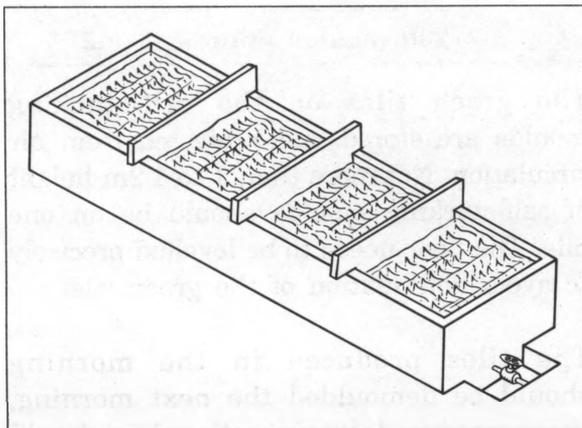
The capacity of the water tank is based on the weekly production capacity of the workshop. It should be large enough to hold the:

Production of one week

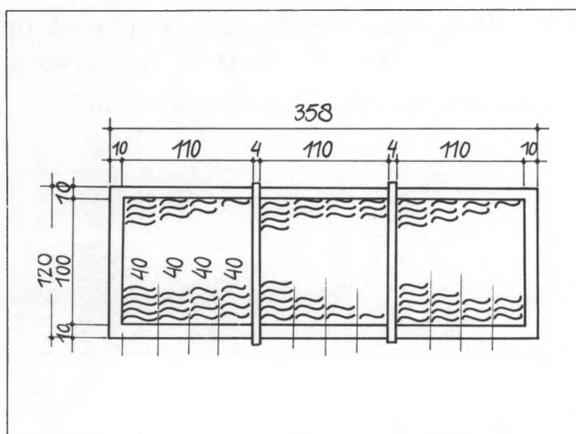
Water curing system

Care should be taken when stacking tiles on top of each other as the nib of the fresh tiles may be damaged.

There are different stacking methods possible, each with different space requirements.



- 3 tiles on top of each other is not recommended; too many incidences of nib-cracks have been reported.
- 2 tiles on top of each other is recommended so that storing space can be properly utilised. 1 m² can accommodate 135 tiles.
- 1 tile-storing system is used for double-nib tiles. 1 m² can accommodate 70 tiles.



The depth of the water should be 70cm for the one-tile storing system, 130cm for the 2-tile storing system.

- The tanks should be divided into compartments to accommodate each day's production separately.
- The tanks should be easily accessible from all sides.
- Water supply and drainage is required.
- The tanks may be located in the open air; a roof is not required.

Every day, 4 to 5 percent of the total tile production should be ridge or cap tiles. This figure is based on an average MCR tile workshop producing 200 MCR tiles a day. In order to cure these tiles, space should be provided inside the water tank.

Alternative curing facility

An alternative way of ensuring good tile curing for special tiles (ridge or cap tiles) or even if the MCR production unit is a mobile one is to cut old oil drums into two parts. One part should be two-thirds of the total height, the other one-third. The bottom two-third can be used to store a total of 32 MCR 10 mm tiles, the top one-third can be used to store special tiles such as ridge or cap tiles.

Vapour curing system



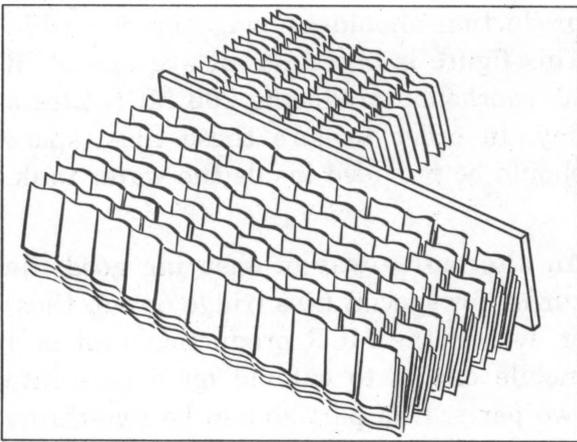
Another MCR tile-curing system is the vapour system. This system gives the best results when using pigments to produce coloured tiles. The curing time can be reduced to 4 days in a tropical climate.

- The tiles are placed in a cement tank with only 5 cm water at the bottom. This tank is then covered with a plastic sheet, ensuring the proper functioning of the vapour curing system.



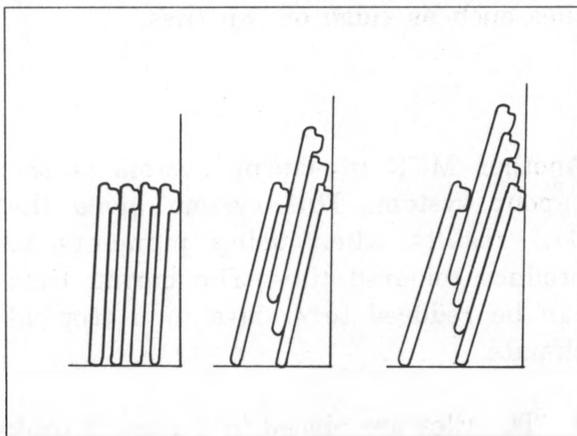
The MCR tiles should not be placed in water at the bottom as this will show a white line and some discolouration.

2.2.7 Air curing and tile storing

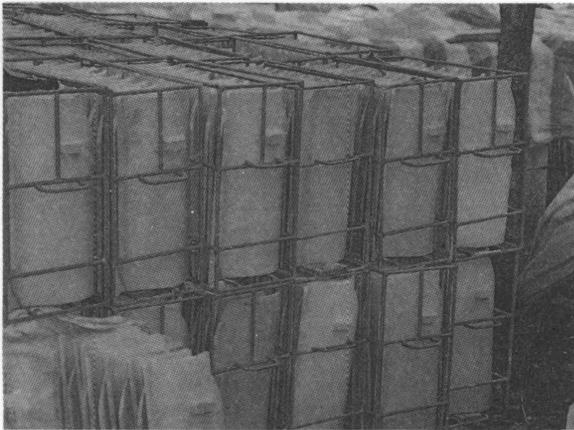
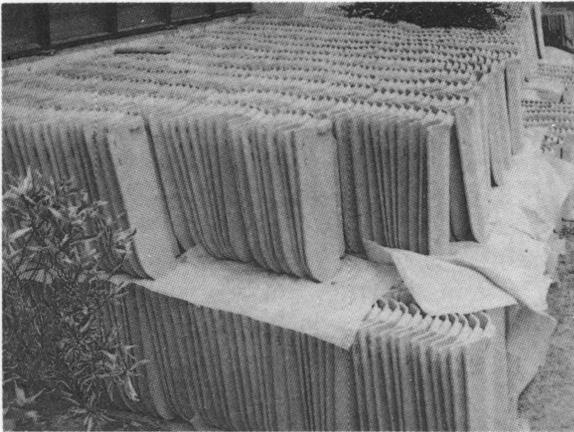


After the water or vapour curing period, the tiles are moved to the storing area. This area must be safe for tiles from mechanical damage (from playing children, falling branches, etc.).

During the air curing period, the tiles should be shaded and protected from air circulation. If the area is not roofed, the tiles should be covered by jute bags or plastic sheets. In dry weather conditions, frequent sprinkling is required (water supply required). The tiles are best placed on a sand bed if a concrete floor is not available.



The capacity of the storing area depends on the expected turnover. It is possible that the demand for tiles fluctuates with the seasons. The capacity of the storing area should allow a buffer for such irregularities and, therefore, must be estimated individually, depending on the specific situation of each workshop, its production capacity, and the anticipated selling fluctuations.



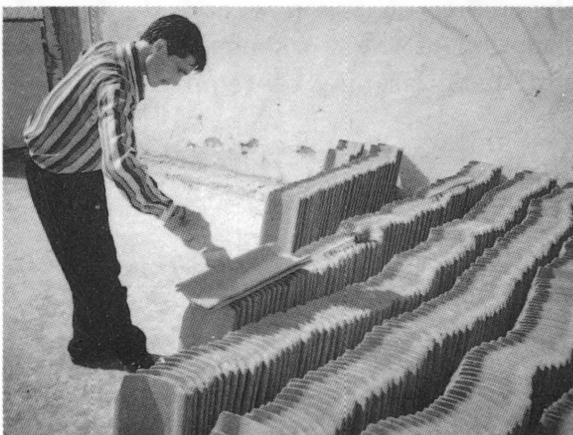
There are several tile-stocking systems possible.

Tiles can also be stored in crates. This is costly but has the advantage of using less storing space as the crates can be placed on top of each other. Crates can also be handy as containers for long-distance shipping.

- After three weeks of air curing, the tiles are ready for selling.
- The area should be arranged so that storing in batches is possible. Each weekly production should be marked with the date of production and stored in a separate batch that is easily accessible. This is because the oldest tiles should be sold first. (fifo)

2.2.8 Other working space requirements

Painting



Additional space should be allocated for the painting of tiles.

- If painting is done manually, about 20 m² space is needed to paint 100 tiles at a time.
- These facilities should be located next to the tile storage and despatch area.

Display area



The entrepreneur should actively promote his products to visitors, even in the workshop area.

- Painted tiles, tiles of different shapes, pictures of finished roofs or demonstration roofs, recommended designs of houses, etc., could be displayed in this area.
- This area should be located next to the office or near the despatch area.

Tile testing and despatch

- Before selling and despatching, the tiles must be tested. These facilities should be located next to the tile storage and despatch area.
- This area should be accessible to trucks because each tile, before loading, should be tested for possible damage incurred during air curing and storing.

Approx. space 2m x 3m = 6 m²

Staff facilities

Depending on the size and the specific situation of the workshop, the following staff facilities may be required:

- Sanitary rooms: toilets, washroom, wardrobe
- Canteen and kitchen
- First-aid facilities

2.3 Layout Examples

The layout of a workshop should be designed to allow the best organisation of the production flow, without unnecessary long links and obstacles between the different nodes of production.

Safety measures

Safety measures must be taken in any production process, not only while doing the actual job.

It is also very important to consider safety factors when planning and organising the work process, the infrastructure, and the equipment.

Although working in an MCR workshop poses few hazardous activities, the following should be kept in mind:

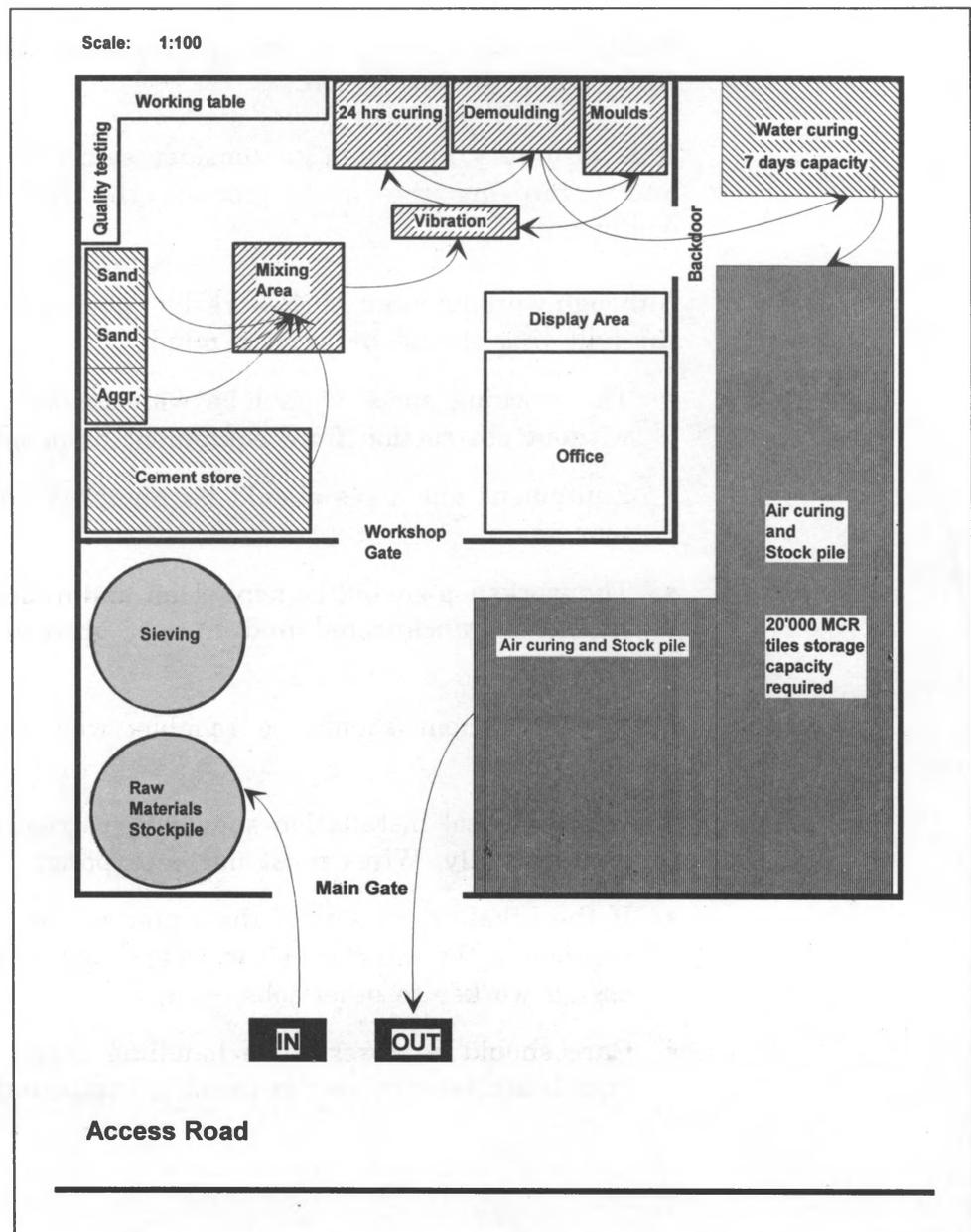
- The working space should be wide enough to allow movement without obstruction from equipment or people.
- Equipment and tools should be regularly checked for wear and tear.
- The workshop should be kept clean and in order, the traffic areas should be uncluttered and free of obstacles; floors should be dry.
- The equipment should be reliable, well-installed and properly maintained.
- The electrical installation should be carried out and maintained professionally. Wires must not be exposed.
- If the alkaline content of the water in the curing tank and the residue on the interface sheet causes skin allergies, use gloves or assign worker to other jobs.
- Care should be observed in handling chemicals such as battery liquid, accelerators, water-proofing compounds and pigments.

2.3.1

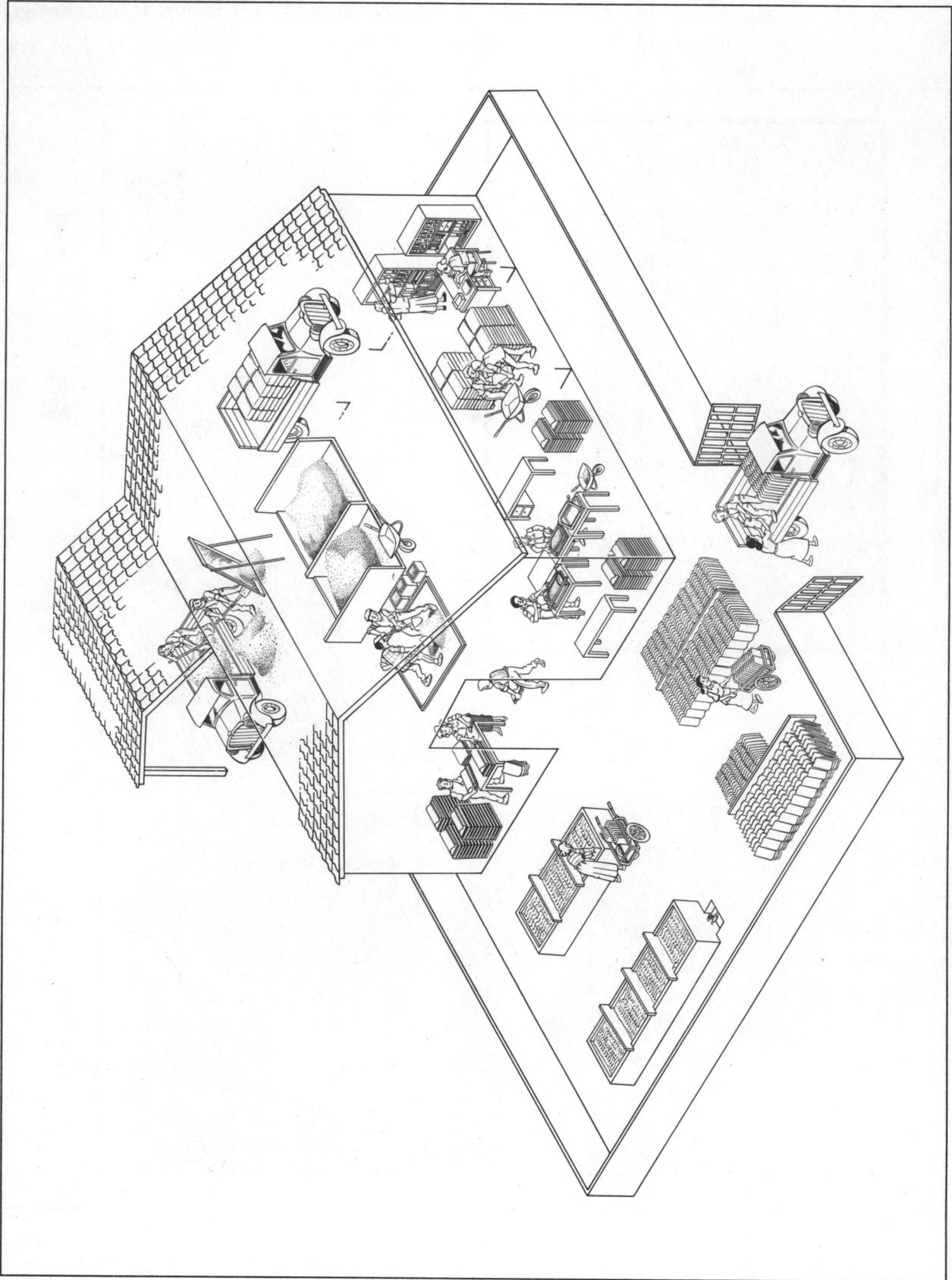
Workshop for 1000 tiles per week

The following examples show two possible workshop layout designs for an MCR tile production of 1000 tiles per week.

Example I

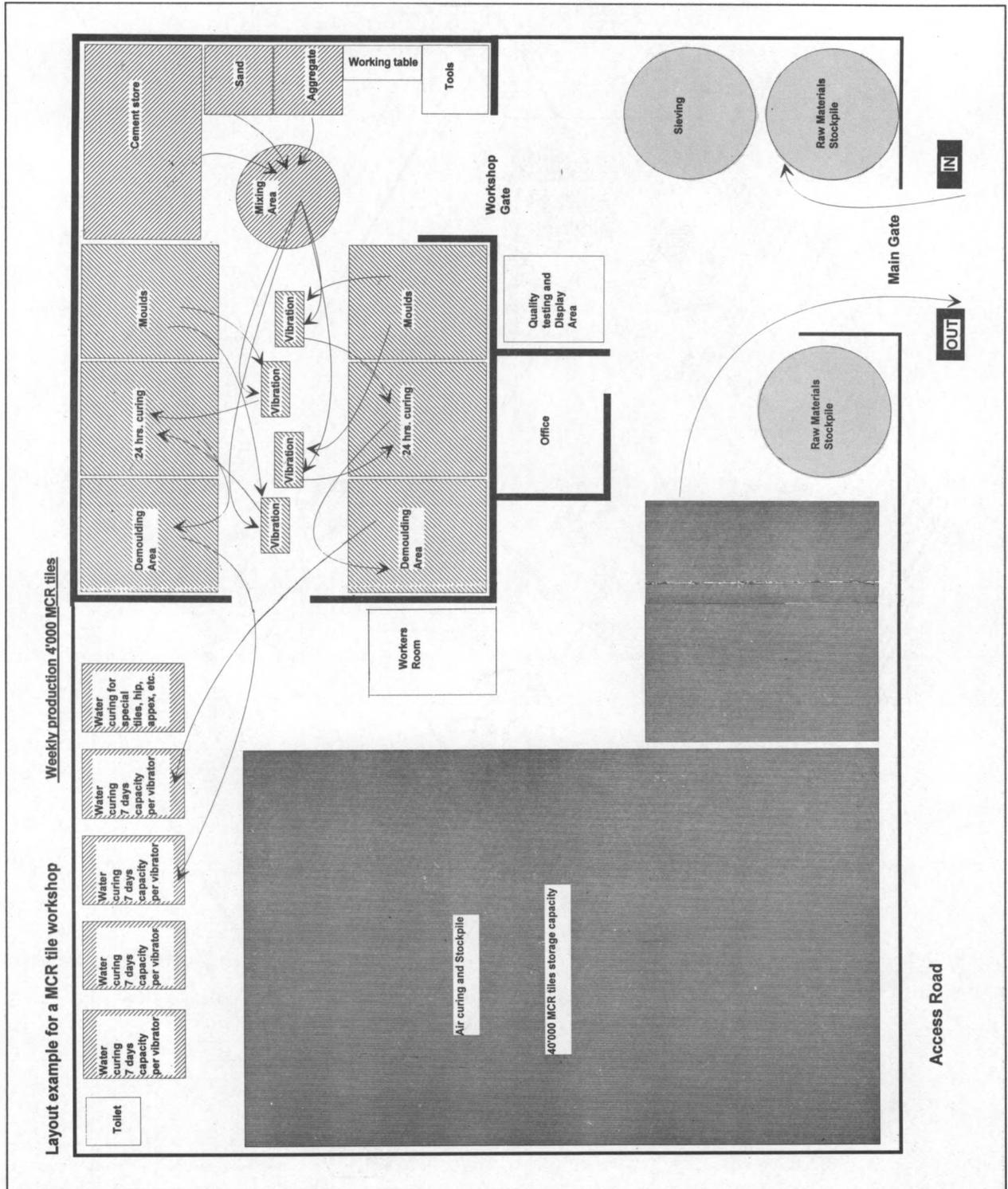


Example II



2.3.2 Workshop for 4000 tiles per week

The following example shows one possible workshop layout design for an MCR tile production of 4000 tiles per week.



3. Services

3.1 Water

Fresh water

Water is an essential component for the production of MCR tiles. It is required for:

- Mixing of mortar
- Curing
- Cleaning and refilling of curing tanks
- Cleaning of interface sheets and moulds
- Maintenance and cleaning of workshop and equipment
- Laboratory use
- Canteen, kitchen, toilet, shower

Sewage

Wherever a water supply is installed, a connection to a sewage system is required. This may be a pipe to a septic tank or to a community sewage system. Due to lime sedimentation in the MCR tile curing water tanks, contacts with city authorities should be established to find a solution on how to dispose of the lime. Sometimes, a special sedimentation tank needs to be constructed before the workshop sewage water can be connected to the community sewage system.

Safe water

Although water forms an essential part in the production of MCR tiles, it should be used as economically as possible.

3.2 Electricity

It is possible to operate a workshop without electricity by using hand- or pedal-driven vibrating tables.

Solar power

Where electrical supply is not available, batteries may be charged by solar panels. This is an ecologically sound solution, though rather expensive.

When opting for a solar-powered system, the vibrator motor should be 12 V.

Power supply and light

Where electricity is available, it can be used for power supply and for light. Electricity is a valuable and expensive form of energy. It should be used sparingly.

Power can be used to drive the vibrators and in the future, other machinery such as the mixer. Vibrators can be driven by the direct mains or by batteries. Batteries should be charged daily. Electrical light allows production to be extended at dawn and into the night. It should not be used to replace good daylight, which is always preferable.

Good lighting is required for the following areas:

- Vibrating
- Office
- Laboratory
- Testing
- Staff rooms

Nominal lighting is sufficient for the following areas:

- Store rooms
- Curing areas
- Compound

Professional installation

Electricity, carelessly used, can be a threat to life. Therefore, installation and maintenance should be done by professionals only. Do-it-yourself applications should be avoided.

4. Mobile Equipment

4.1 Tile-making Equipment

General

The production of MCR tiles requires some very specific equipment and tools. The most important of these are shown in this chapter.

There are nowadays many different types of equipment available internationally for the production of MCR tiles. RAS's advice is to buy good quality and field-tested equipment from producers who offer after-sales services.

The basis for a good tile is good equipment

Together with well-trained and skilled workers, the quality of the equipment plays a determining factor. It is impossible to produce good tiles with equipment of poor quality.

For purchasers of equipment (entrepreneurs), it is often difficult to determine the quality of the equipment and, due to great differences in cost, many tile producers make the wrong decisions. The "Equipment Quality Guidelines," Technical Report Nr. 28, ILO/SKAT, provides useful basic information about the required quality of MCR tile production equipment.

Equipment copy

The easy MCR production process, especially the tile vibration part, encouraged many entrepreneurs to make their own vibrators. RAS does not recommend this practice as too many have failed to produce a good quality vibrator or mould.

If you copy the vibrator or the mould, be smart enough to make the copy better than the original; otherwise, let the professionals do it !

4.1.1 Vibrating table

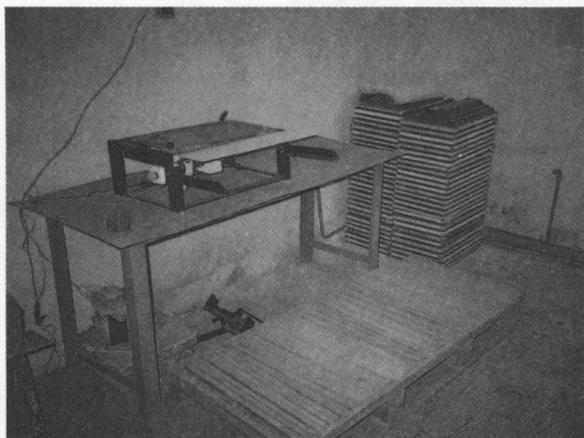
General

Vibration provides compaction in the mortar. Every tile has to receive the appropriate vibration in order to achieve maximum strength and durability. Good vibrators allow the producer to optimise the cement dosage and the vibration time of the tile. This saves time and raw materials and above all produces a very good quality MCR tile.

Single tables

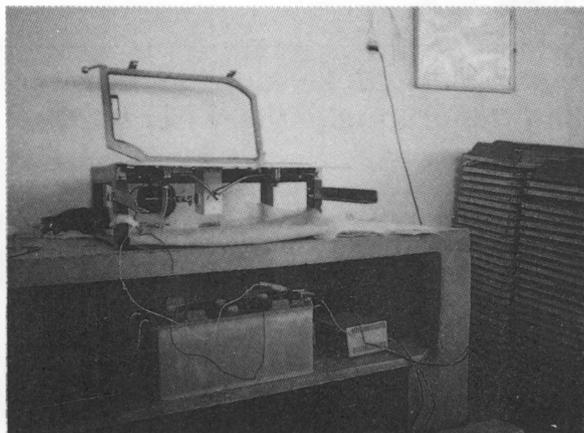
The basic types of single vibrator tables available are:

Mains-powered



The smooth functioning of the mains-powered vibrator depends on a regular supply of electricity. The installation wiring must be done properly and by a professional.

Battery-powered



Battery-powered vibrators are used where the regular supply of electricity is a problem. The batteries need to be recharged daily and exchanged after some years.

Foot-powered / hand-powered



The foot-or hand-powered vibration table has been developed for MCR tile production centres in rural areas where no electric supply is available. The quality of the vibration depends on the experience of the operator, which varies from person to person.

Production street

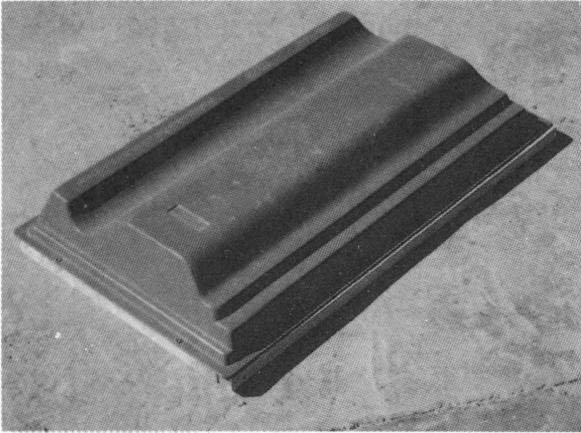


The single vibrator production system is not designed for a large-scale MCR tile production. A first step towards increased MCR tile productivity has been made by John Parry, Intermediate Technology Workshops, UK, and some innovative private entrepreneurs in the Philippines who developed an MCR tile "Production Street."

Further R&D work is required to make large-scale MCR tile vibration units available to MCR entrepreneurs who want to enter the growing mass housing market.

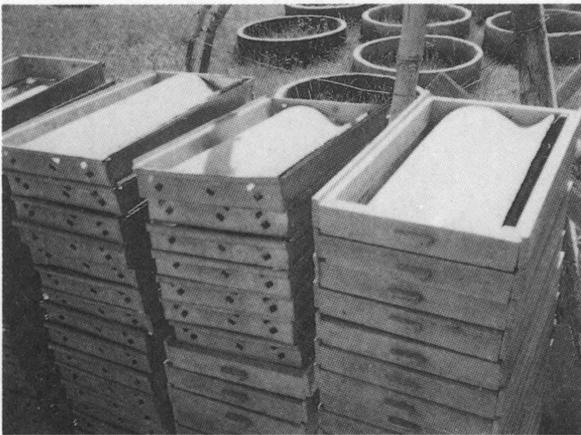
4.1.2 Moulds

General



The role of the mould in the MCR tile production process is very often underestimated. It is only with perfectly shaped tiles that a roof keeps out heavy rains and withstands strong winds. Any difference in shape from one tile to another will result in an inferior roof quality. As the tiles are shaped on the moulds, utmost attention has to be paid to this part of the equipment.

Mould types



There are many different types of moulds produced. The most common are:

- Injection-moulded plastic moulds
- Vacuum-formed plastic moulds
- Fibreglass moulds
- Concrete moulds
- Iron sheet moulds

RAS recommendation

Global experience has shown that fibreglass, concrete and iron sheet moulds are not up to standard for producing a good roof. Therefore, RAS recommends the use of only injection-moulded plastic moulds for the production of MCR tiles.

Advantages / disadvantages

The use of any type of mould has advantages as well as disadvantages. The following table should give a general overview of the pros and cons of the different types of moulds.

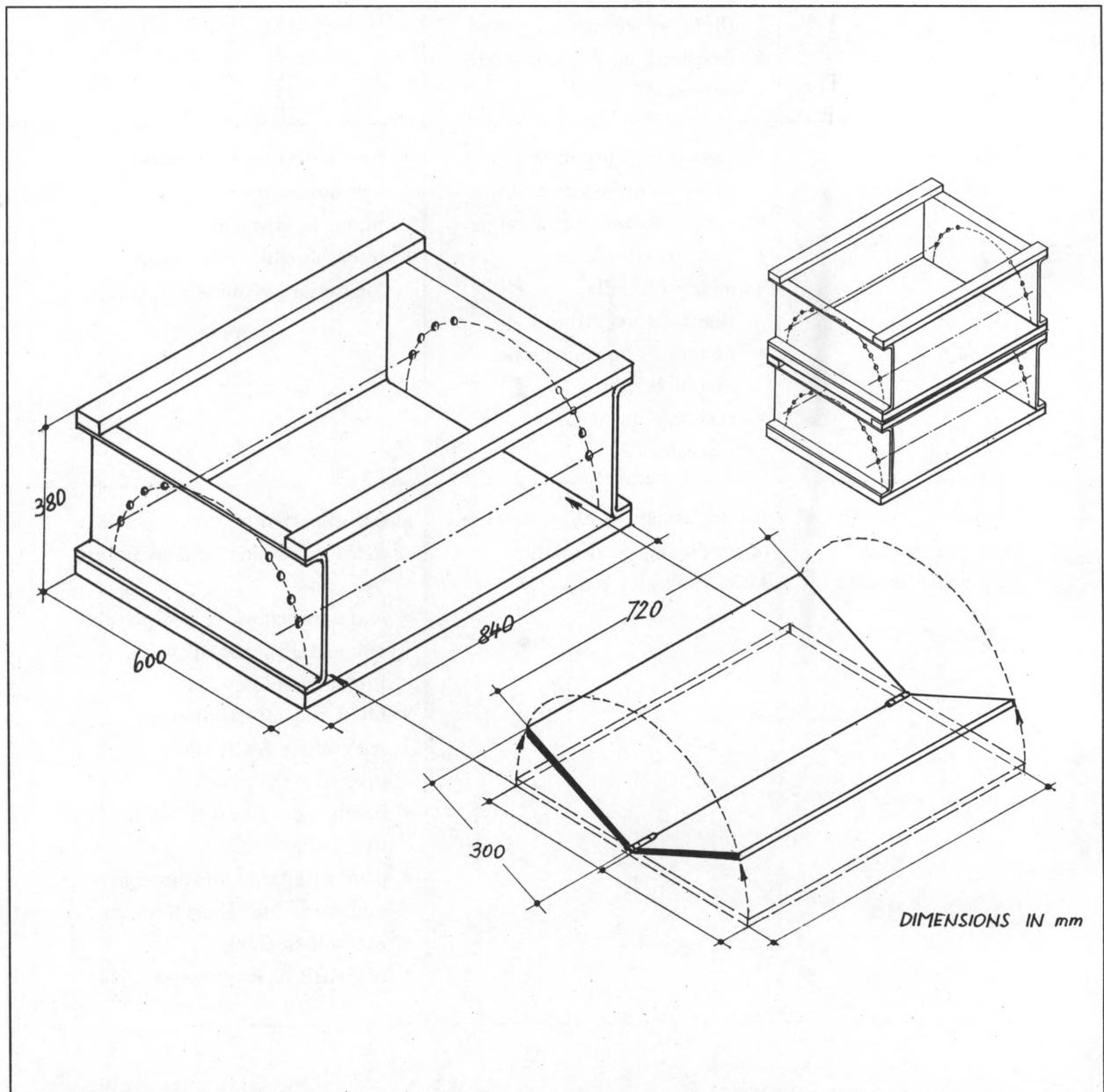
Nr.	Type of mould	Advantages	Disadvantages
1.	Injection-moulded plastic mould	<ul style="list-style-type: none"> • perfect in uniformity • self-stacking possible • perfectly airtight, allowing proper mould curing • MCR tile interchanging with other MCR tile producer possible • easy to clean • high durability in use • easy to handle (light in weight) • resistant to abrasion and corrosion 	<ul style="list-style-type: none"> • high initial investment required • large lot size for production • production technology not available in some countries
2.	Vacuum-formed plastic moulds	<ul style="list-style-type: none"> • Low initial production investment required • easy self-stacking possible • easy to clean • easy to handle (light in weight) • airtight, allowing proper mould curing • resistant to abrasion and corrosion 	<ul style="list-style-type: none"> • not perfect in uniformity • low durability • prone to cracking • interchanging with other MCR tile producer difficult
3.	Fibreglass moulds Concrete moulds Iron sheet moulds	No advantage, with a view of producing good quality MCR tiles and roofs	<p>global experience has shown that these moulds lead to failure</p> <ul style="list-style-type: none"> • standardisation is not possible • not airtight, not allowing proper mould-curing • MCR tile interchanging with other MCR tile producer not possible • partly heavy and difficult to handle • poor resistance to abrasion and corrosion, short life-time • not self-stacking • not easy to keep clean

Hip and apex mould

The proper construction of the apex of a hip roof is a demanding job; therefore, special attention should be given to the production of the hip roof apex tile. The skill and experience of the MCR entrepreneur is a very important factor for the proper making of special hip moulds in general.

A good MCR tile production workshop has a kind of R&D corner, where such special tile moulds can be developed. There are no such special moulds available on the international equipment market.

A possible design of an adjustable ridge tile mould is shown below.



4.1.3

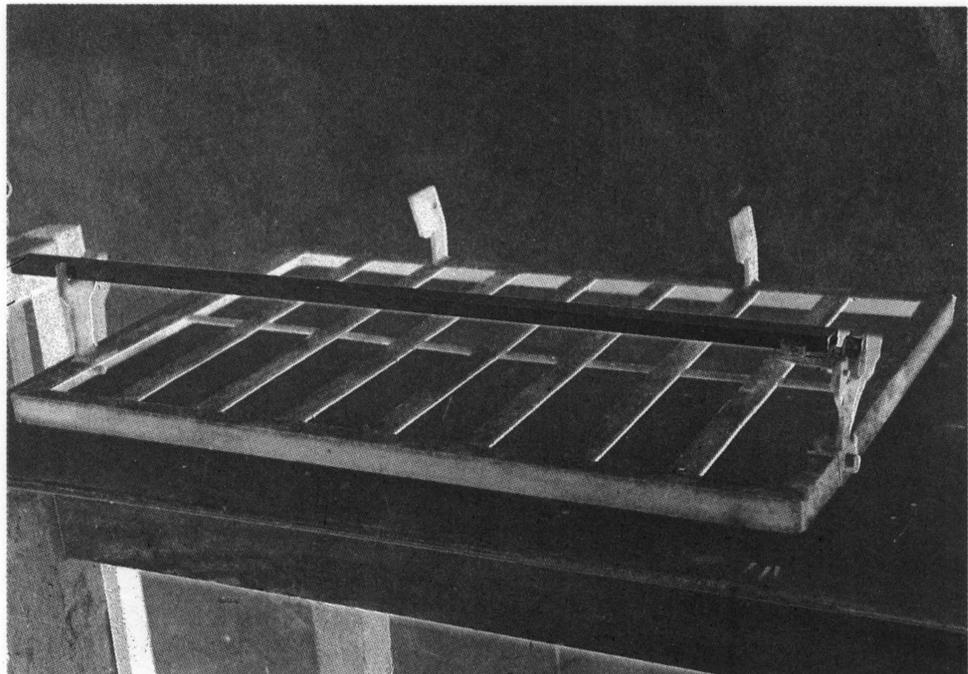
Alignment tool

General

The edge of the MCR tile facing the worker should be aligned with a raised line on the mould. But because this line is covered with the interface sheet, this is often done improperly. Even an experienced worker will sometimes miss the mark. Although it might be argued that an experienced operator may achieve a good alignment percentage, it is still guesswork.

Alignment tool

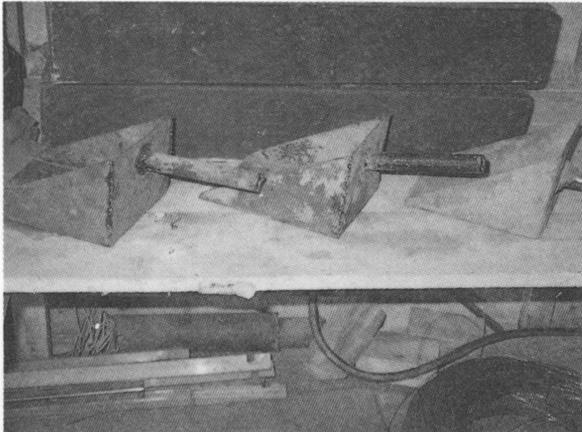
An alignment tool which removes the guesswork was developed to ensure that the screed edge and the mould line coincide while attaining tile squareness. This simple tool, integrated into the MCR tile production line, makes the job of placing the screes error-free. The alignment tool can be integrated into existing MCR tile production lines as well.



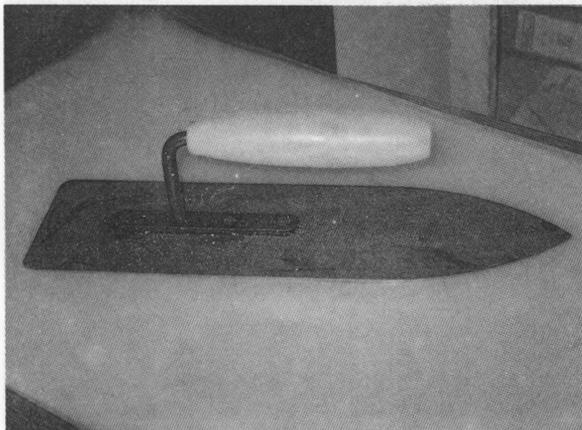
4.1.4 Auxiliary equipment



Plastic interface sheets



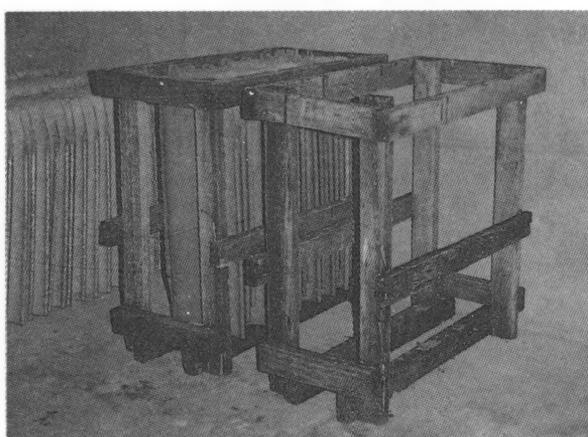
Measuring scoop for the exact quantity of mortar to produce one tile of different thicknesses



Trowel



Table or water point for cleaning interface sheets, etc.

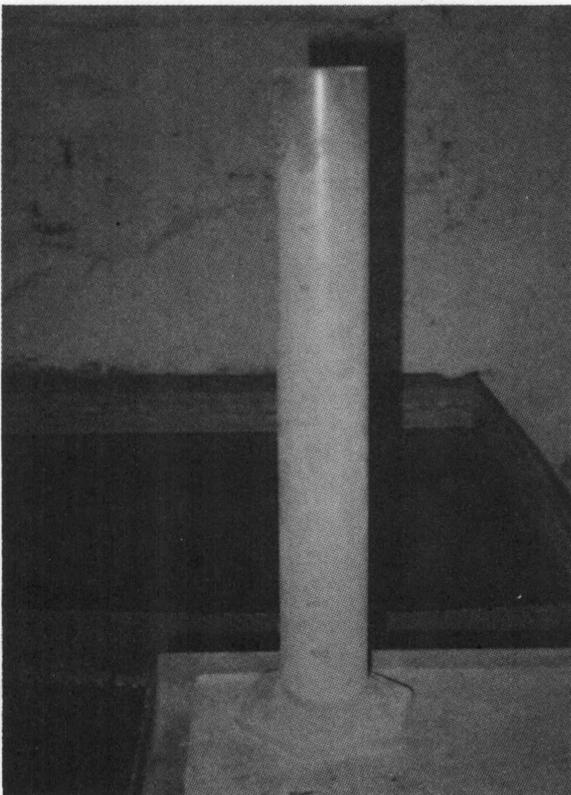


Wooden crate for moving tiles in the workshop and eventually for transport

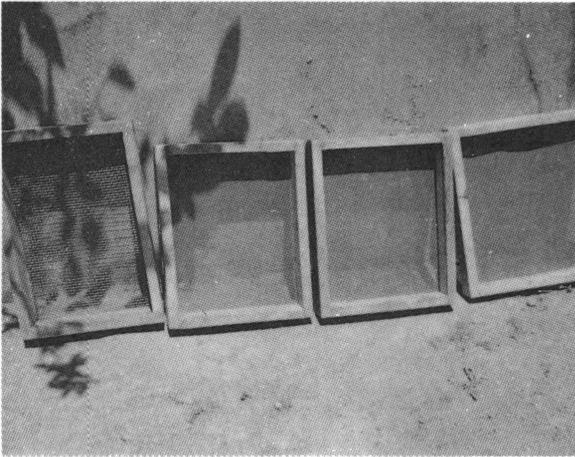
4.2 Testing Equipment



Balance
capacity 1 - 2 kg
accuracy 1 gr for
sand and aggregate
grading test



Jar for clay and silt
content test

**Set of sieves**

1 pc 0.5 mm

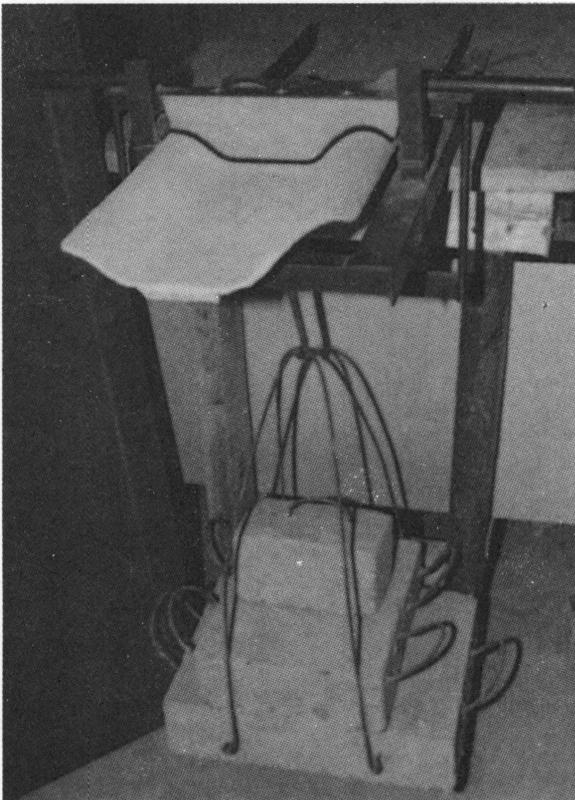
1 pc 1 mm

1 pc 2 mm

1 pc 6 mm for

Sand & aggregate grading test

(see Techn. Bulletin Nr. 4)

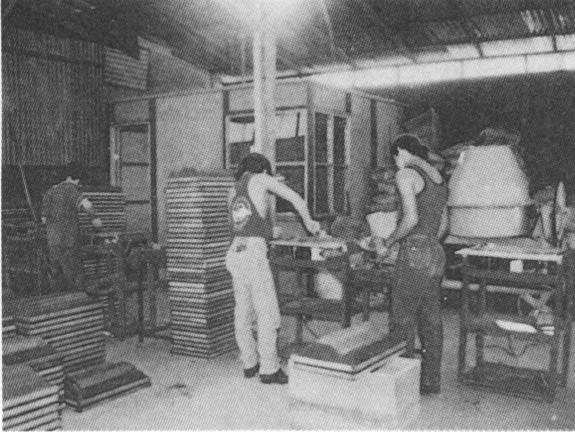


Frame for bending strength
test

(There are many more testing tools such as; workability pipe, gauge etc. See FCR/MCR Toolkit Element 23: Quality Control Guide)

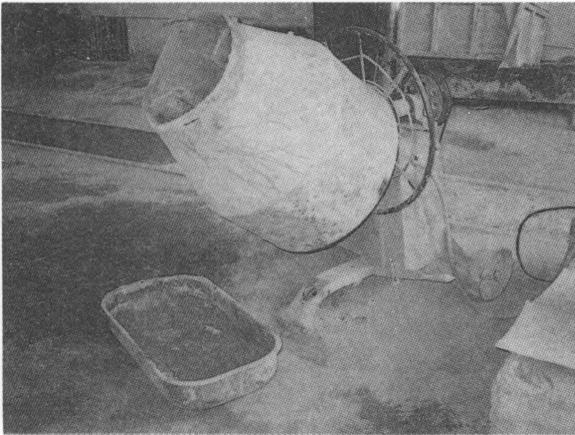
4.3 General Equipment

General

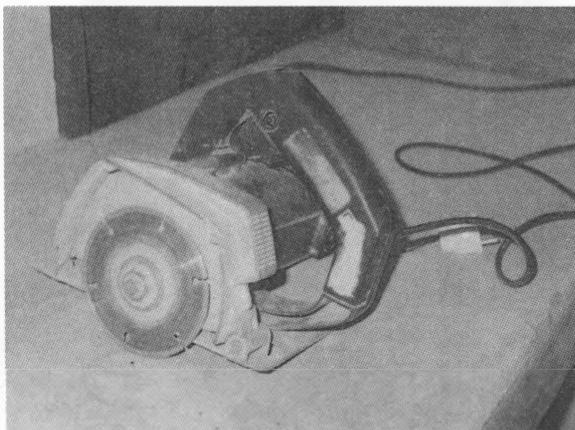


The tools required to produce MCR tiles depend largely on the scale of production. The working habits and tradition of workers is an important factor to be considered when equipping the workshop with tools. It is not necessary here to list all the tools required for the smooth operation of a MCR tile workshop. Tools such as a bucket, watering can, broom, shovels, etc., are assumed and need not be especially mentioned.

Special tools



Concrete mixer for production of large numbers of MCR tiles



Concrete-cutting machine for certain R&D works

4.4

Spare Parts

General

The MCR tile entrepreneur needs to be aware that the profit of a MCR tile business largely depends on the highest possible tile production output. Therefore, it is essential that all necessary spare parts for the vibrator and other equipment, e.g., mixer, are always available in adequate numbers and quality. This will avoid long periods of production interruption. It is therefore important that a MCR tile entrepreneur has close contact with his equipment supplier or agent.

The official agent will advise you on the kind of spare parts you need to have in stock.

4.5 Office Equipment

The production of MCR tiles requires proper administration. This can be made at the MCR tile workshop or at the MCR tile entrepreneur's private office. If the administration is attached to the MCR tile workshop, proper office equipment will help to cut down the administration cost.



Annexures

Further Reading

(E) = English; (F) = French; (S) = Spanish; (G) = German

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