Sambizanga Workshop

A Production Centre For Building Materials

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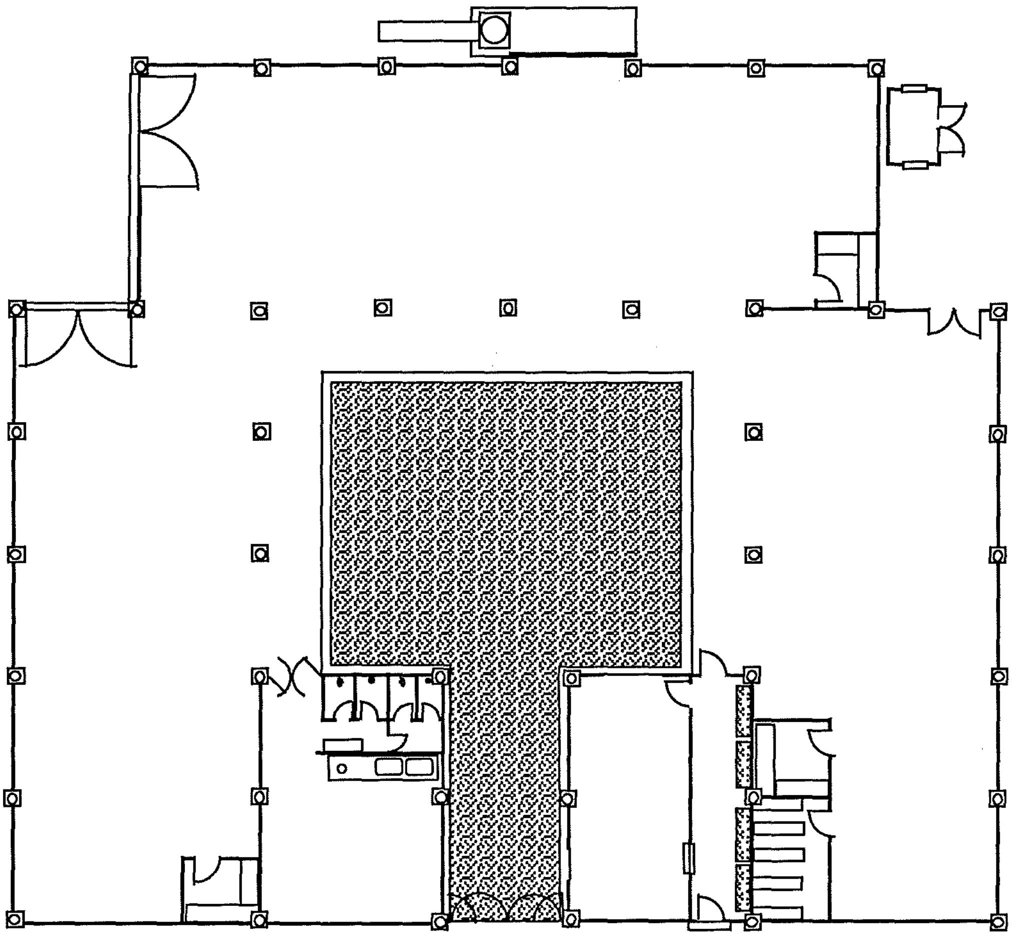

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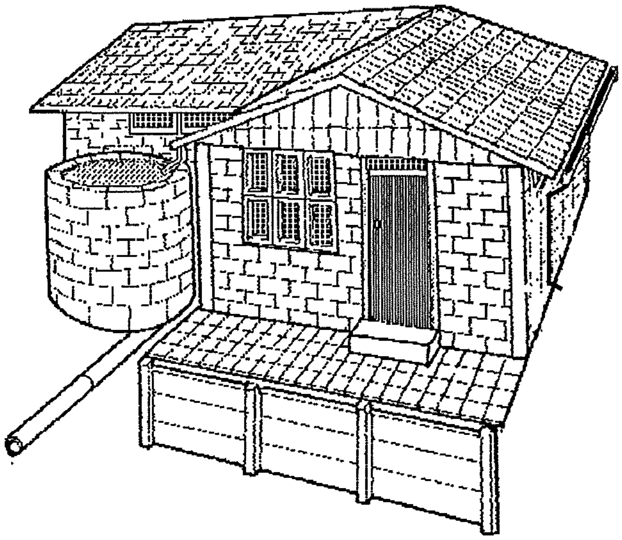


Background

The Sambizanga Project is an attempt to develop an approach to settlement upgrading, which, with appropriate modifications to suit local conditions, can be used to provide an affordable level of urban infrastructure and community services to the musseques throughout Angola. The general idea is that musseque residents should be encouraged to undertake improvements to their dwelling units on their own and to determine their priorities in terms of social services and infrastructure for the area. The government's role is to assist in the provision of urban infrastructure (such as potable water supply, latrines, surface drainage, electricity, roads), community facilities and services (such as refuse collection, schools, health clinics), and assistance in finance (e.g., access to credit, building materials) and management (e.g., organization of cooperatives, local level institutions).

The Sambizanga Bairro upgrading Pilot Project is divided into various sectors each having a specific task. Development Workshop has been involved in this project through institutional development (of GARM), Community Development, and developing community facilities and services.

The Sambizanga community workshop, which is part of the pilot project, is intended to be the focal point of training activities in the project. A second objective is to increase the availability of lower cost construction materials and building elements that residents can use to improve their dwellings.

Specifically, the workshop is designed to serve the following functions:

- to serve as a training facility for the community's construction brigades;
- to provide construction materials and building elements (e.g., doors, fittings, latrine covers) for the residents of the project area;
- to provide assistance (both material and technical) to small-scale manufacturing and/or construction enterprises within the project area.

The report

This report will deal solely with the aspects of developing the Sambizanga Workshop into a workshop that can support community construction needs, services, employment, etc. It is written from the premise that:

- It will be built;
- The site location for the workshop as shown in January 1989 will remain the same;
- The drawings for the workshop will be used to construct the structure and the basic layout and size of the structure and location on the property will not be altered;
- The author has been given the right to propose altering the internal layout of the workshop based on his experience with operating such workshops;
- The workshop will be used as a production centre for providing building and construction materials to allow the residents of Sambizanga to build or upgrade their homes, provide community drainage systems, walkways, etc.;
- Given the changing economy, that resources and raw materials are difficult to come by and will hamper growth of any suggested production ideas;
- The parallel or black market exists and dominates local economies and initiatives and this fact will be used as a basis for formulating management and price controls of the workshop;
- The original concept of the workshop was that it will be divided into 3 distinct areas of activities that consist of: cement based production area, woodworking area and metalworking/maintenance area, and that these areas are still felt to be important and will remain the same.

The report will focus on the following six general areas:

1. Suggested uses for the building;
2. Equipment and tools list needed for the workshop to carry out the suggestions;
3. Materials and space required to produce the items;
4. Personnel list with job descriptions of the staff who would run the workshop;
5. Revised drawings of the workshop showing alterations to accommodate the suggested ideas;
6. Management and financial control policies for operating the workshop as a cost effective centre.

The proposed workshop can be used for a wide variety of uses, limited only by the imagination of those who will run the program. It has been expressed that the main objective of the workshop would be to produce building materials that would aid in the development of Sambizanga. Cement based building materials have been identified as an important production area to begin with.

Taking into account the size of the proposed workshop, its location in the project area, the availability of raw materials, the following items can be recommended to be produced within the workshop:

Products That Could Be Produced

Cement-based production

- concrete blocks for latrine pits, retaining walls, quality construction jobs, etc.
- concrete "U" blocks for making cast lintels
- concrete floor tiles for latrines and houses
- fibre-concrete drainage pipes
- cement jars for storing drinking water
- pit latrine slabs
- door and window lintels
- precast fibre-concrete drainage troughs
- precast fibre-concrete VIP latrine vent pipes
- precast window frames
- breezeway blocks
- fibre-concrete roofing tiles
- soil stabilized blocks
- soil stabilized pathways (compacted locally)

Metalwork production

- door and window frames
- roof purlins and trusses
- burglar bars
- bed, chairs, tables made from tube steel
- simple medical equipment (for local health posts)
- sheetmetal rain gutters
- equipment repair-welding
- moulds for cement-based products
- hand blockmaking machines

Woodworking production

- wooden moulds and forms
- prototype equipment
- window and door frames
- window shutters and doors
- timber preparation for local carpenters (for a fee)

The production of the items listed above will take a good deal of raw materials that may be difficult to come by. It will also require machines and equipment that are expensive to purchase and may be expensive to run and maintain.

The whole approach to this workshop should be production and to produce any item requires the raw materials, tools and equipment to do it.

Production Proposals

The following are descriptions for a number of different types of products that could be produced within the workshop. The majority of the examples are cement based products as these types of products, although easy to produce, take a good amount of time, energy and raw materials to produce in quantity. The proposals therefore will help to give a realistic idea of what it would take in terms of raw materials, equipment, space and number of workers to produce them.

Sand/Cement Blocks, Tile and Brick production

Background:

Block, tile and brick production

Sand/cement blocks are currently being produced locally by the community for use in building their homes. However examining the blocks and seeing the method used to make them it is quite clear that the quality (and here it is meant structurally/durability) is very low and not suitable for structural high load bearing construction work. The problem stems from the fact that the blocks are being made in some cases with too little cement, they are poorly hand compacted and therefore not dense, and undergo very poor curing conditions (the blocks themselves are mainly stabilized sand and subject to cracking and have poor weathering qualities). As there appears to be no local building standards enforced and no local standards for building materials, people within the community are beginning to accept that the blocks that they produce are "normal", that is a concrete block is a concrete block no matter who makes it, and suitable for use in all types of building constructions.

Proposal:

The Sambizanga workshop could assign 200 square metres of floor space to producing high quality sand/cement blocks, bricks and tiles. These items could be made using a "block laying " machine which would produce high density blocks, "U" blocks, bricks and tiles suitable for use in high load structures, below ground work, etc. These machines are simple to operate and provide a means for vibrating and compressing the sand/cement mixture into a variety of block shapes that no hand method could match in strength and durability. The final use of the materials could be to make community structures (health posts, schools, workshops, etc.), latrines, paving bricks or tiles for floors and pathways.

Work Description:

The principal phases of operating the most common type of block laying machine are as follows: filling the mould with a sand/cement or sand/cement/aggregate mixture; vibrating the mixture in the mould which causes trapped air bubbles to leave and the mixture to consolidate; stamping or moulding the shape using pressure and vibration causing a dense block to be formed; demoulding the block by mechanical means right onto the floor (no carrying pallets are necessary); and repositioning the machine for the next operation (the machine is on wheels and moves about the block laying floor depositing its blocks and the mixture is brought to the machine by wheelbarrows to keep it operating). From filling the mould to repositioning the machine for the next drop takes about one minute to produce four 40 x 20 x 20 cm blocks at one time.

Production Output/ Week:

To give some idea of what a machine could do in the Sambizanga Workshop, let us take a look at a commercially available block laying machine called the Toutagglo P.60. This machine will produce the following items:

Block, tile and brick production

- 40 x 20 x 5cm at 11 tiles/blocks per drop (solid)
- 40 x 8 x 20cm at 7 blocks per drop
- 40 x 10 x 20cm at 6 blocks per drop
- 40 x 15 x 20cm at 4 blocks per drop
- 40 x 20 x 20cm at 3 blocks per drop

The word drop refers to how many blocks are made (mould capacity) in each cycle that the machine moulds are filled and emptied. Each drop takes up 60cm x 40cm of floor space. Assuming some space around each drop to allow the machine to manoeuvre this would mean that each drop would consume 70cm x 50cm of floor space.

The Sambizanga workshop has a usable open area of about 25m x 8m (please refer to alterations made to original floor layout) leaving space to move about on the floor. This area could contain approximately 570 drops. The manufacture states that from 266 to 333 drops can be done each day if one uses the 40 x 20 x 20cm block mould. Taking a reasonable conservative assumption and considering the skills and motivation of the local workforce about 190 drops could be done per day. At this rate it would take three working days to fill the floor area. Blocks should remain on the floor for 3 working days (constantly kept moist) before moving them outside to be stacked under shade for a further 2 week cure. The process of making and removing blocks to the curing area would be an on going daily activity in the cycle of production.

Equipment Needs:

1 blockmaking machine, electric 3 phase, 2.5 kva

1 block mould for making 40 x 20 x 20cm block

1 block mould for making 40 x 15 x 20cm block

1 block mould for making 40 x 10 x 10cm block

1 tile mould for making 40 x 20 x 5cm tile

1 block mould for making 20 x 20 x 20cm "U" block

1 brick (or paver) mould for making bricks (size to be given)

1 pan type cement mixer, electric 3 phase, 3kva

3 special type wheel barrows to carry mix to machine

3 wheelbarrows for bringing sand to mixer

2 two hundred litre drums to store water by mixer.

Electric Blockmaking Machine

Electric pan type cement mixer

Block, tile and brick production

Raw Materials Needed:

Assuming work production of Monday to Friday (Saturday for maintenance of machines and watering blocks) it would be possible to produce weekly the following:

2,850 blocks 40 x 20 x 20cm (needs 100 bags cement and 29m3 sand)

or

3,800 blocks 40 x 15 x 20cm (needs 114 bags cement and 35m3 sand)

or

5,700 blocks 40 x 10 x 10cm (needs 143 bags cement and 43m3 sand)

or

10,450 blocks/tiles 40 x 20 x 5cm

For any of the above productions one would need 3,500 litres of water per week simply to make the concrete mixture to make the blocks or tiles. In addition one would need another 5,000 litres of water per week for curing the blocks and washing up the equipment daily.

Space Required:

200 square metres of floor space within the workshop and 100 square metres of outdoor shaded space where the blocks or bricks will be stacked chest high and kept moist each day (the outdoor area would be a open lean-to shed).

Block, tile and brick production

Transport Required:

Transport needed weekly to maintain constant output:

150 sacks cement = 2 deliveries of a 5 ton truck

3 to 4 trips of a 5,000 litre water tanker to fetch water

15 lorry loads of sand using a 5 ton truck

Number of Workers:

Number of people to make blocks: 2 for block machine; 3 for bringing concrete mix to machine; 3 for moving sand, water, cement to mixer; and 1 to operate mixer. All workers can be unskilled labourers who can easily be trained in the method of producing the blocks. In addition there would have to be workers for loading sand at the sand pit.

Advantages:

The advantages of purchasing a block laying machine are that it will produce high quality blocks or tiles in a short amount of time using a minimum of workers. Some units only produce blocks but there are on the market various machines that will produce hollow blocks of various sizes and shapes, floor tiles, "U" blocks (which can be used to make door and window lintels), solid bricks, paving bricks. The blocks could be used to make community structures, latrines, pit latrine liners, paving bricks or tiles for floors pathways. The machine could produce enough blocks to build one small structure each week.

Disadvantages:

The disadvantage for the Sambizanga workshop would be dealing with the weekly needs of maintaining supplies of sand, cement and water. Without reliable transport this would be impossible. Electricity would be required to operate the machines and therefore a generator would be required.

Fibre Concrete Pipes

Fibre Concrete Pipes

Proposal:

The Sambizanga Workshop could produce on a daily basis six fibre concrete pipes 100cm long by 10cm diameter. These pipes could be used for land drainage, water supply pipe, downpipes from roof guttering, ventilation pipes for pit latrines and delivery pipes for an offset latrine system.

Description of Process:

A fibre/cement/sand mixture along with special moulds are used to form the pipe. An external mould is used to form the outside of the pipe and an internal removable mould to form the inside and establish the thickness of the pipe. The moulds are set up so that they stand vertically. The fibre/sand/cement mixture is then poured down between the two pipes. A special vibrating device attached to the outside of the mould is switched on (the vibrator is powered by a 12 volt car battery) and causes the mixture to settle evenly and compactly without air bubbles between the two moulds. This process continues until the space between the moulds is filled.

Fibre Concrete Pipes

After a few minutes the inner mould is pulled out and removed. The mixture then remains in the remaining mould for twenty-four hours. After this period the outer mould is removed and the newly formed piped is cured under water in special curing tanks for the next ten days. The pipe is then removed from the curing tanks and allowed to air cure in a shaded area for a further week before it can be used.

Production Output/Week:

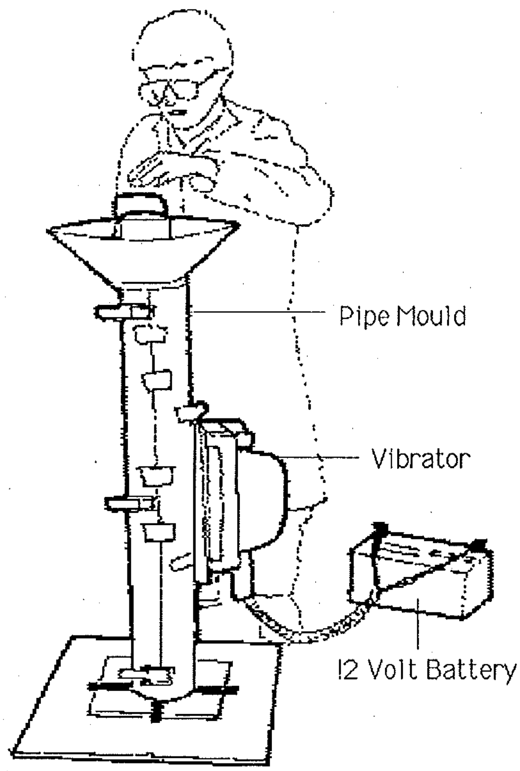
The number of pipes that can be produced in one day is directionally proportional to the number of moulds one has. The manufacturer states that fifteen pipes 1 metre by 10 cm can be produced a day with a team of 6 workers. This in theory would produce 75 pipes a week or 75 running metres of pipe. The standard kit that normally is purchased comes with only six moulds and requires two workers to produce six pipes a day. Until a production unit is well established and all the problems that will develop are resolved, it would be reasonable to use the number of six pipes per day or 30 per week as the production output figure.

Equipment Needs:

The standard fibre concrete water pipe kit is sold through Intermediate Technology Workshops in the United Kingdom for £1,600. The kit comes with 1 vibrating device, six outer moulds mounted on a base, and one inner mould. In addition there is a need to purchase one 12 volt car battery; some means to daily charge that battery (i.e. battery charger connected to the city mains [or a generator] or a solar powered battery charger); assorted but common masonry tools and wheel barrows; a small cutting machine to cut the fibres into 1cm lengths; and curing tanks large enough to hold 60 cast pipes at a time - completely submerged in water with the pipes standing up vertically.

Raw Materials:

The main ingredients for the mixture are fibre, sand, cement and water. Fibres such as sisal, jute, manila, coconut coir and some grasses used in making string and ropes are normally suitable (the authors of this report have cut up sisal rope and string and have used these fibres successfully to produce fibre concrete materials). In addition certain grades of waste industrial fibres such as the polypropylene used in flour sacks can be used. The cement is ordinary portland cement but it must be fresh. The sand should be fine sharp river sand normally selected for plastering walls. Coarse sand may cause porosity problems and sand with high clay contamination will produce lower strength products. The water should be potable. Rain water collected from a roof is ideal.



Fibre Concrete Pipes

To produce six pipes a day one would use 1.2 kilos of fibre, 24 kilos of cement and 123 kilos of sand. For one weeks production 6.0 kilos of fibres, 120 kilos (2.5 sacks) of cement, and 615 kilos (0.5 m3) of sand would be needed. (please note these figures are an estimate and have been over estimated to insure adequate supplies).

Space Required:

Twenty square metres of floor space would be required for cutting the fibres to length, preparing the fibre/sand/cement mixture and forming the pipes. An outdoor water curing tank would be needed that would have a curing capacity for 100 pipes each standing up vertically (i.e. not piled one on top of the other). The internal size of the tank would be 1.1 metres deep by 1.1 metres wide by 1.1 metres in length. An air drying shaded area for the final cure and storage of the pipes; about 2 metres by 5 metres in area will also be needed.

Transport Required:

Transport needed to maintain a constant output of 30 pipes weekly would be:

- one 5 ton truck delivery of sand would last seven weeks.
- one Toyota landcrusier carrying ten sacks of cement would allow 4 weeks production of pipes.
- one water tanker carrying 2,000 litres of water would last one month
- one truck carrying one ton of fibres would last for two years of production.

Number of Workers:

The manufacturer states that two workers can easily produce six pipes a day. These workers can be easily trained and do not need to have any previous masonry experience. It would be recommended to employ four for the process to compensate for work absenteeism and to insure that there will be constant output. (note: It would be ideal to produce other fibre concrete products at the same time to allow overlapping of similar jobs such as cutting the fibres and putting newly formed products under water. This would be the most efficient use of the workers.)

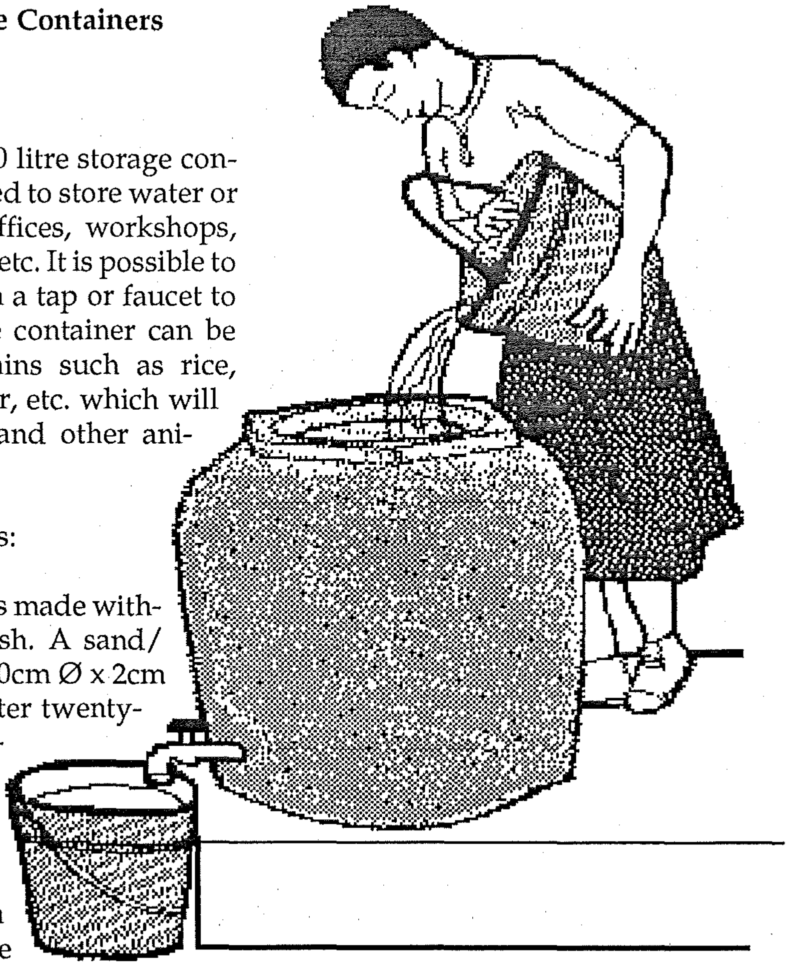
Advantages:

The advantage of the process is that it creates employment locally using unskilled labour and produces an item that can be used for a number of different applications. It is easily produced, installed, maintained and repaired by local workers. It uses the minimum of materials and when made correctly, meets building standards.

Disadvantages:

An important ingredient to the mixture is the fibre. Obtaining constant supplies of fibre could be difficult. A thousand litre capacity water curing tank needs to be kept filled with water. This water needs to be changed every two to three weeks, and may put strain on delivering the water regularly to the workshop. The vibrator is powered by a car battery which must be charged up daily. A solar panel would be required to maintain the charge if city electric mains were not available.

Cement Storage Containers



Proposal:

To produce 200 litre storage containers that can be used to store water or food in the home, offices, workshops, health posts, schools, etc. It is possible to make a lid and attach a tap or faucet to these containers. The container can be used for storing grains such as rice, maize, sorghum, flour, etc. which will protect it from rats and other animals.

Cement Storage Containers:

Description of Process:

The container is made without steel or wire mesh. A sand/cement round base (60cm Ø x 2cm thick) is cast first. After twenty-four hours a sack-mould is placed on top of this sack and filled with sand. This sack-mould is beaten into the shape of a container. Once shaped, the sack-mould, is plastered with a cement mortar mix (1:2 cement to sand). A specially shaped wooden ring is used to form the opening of the container. The plaster is applied until it is 10mm thick. The jar is covered and left for 24 hours.

After 24 hours the ring mould is removed and the sand inside the sack is removed and the sack-mould pulled out. Any small cracks are repaired at this time. The jar under goes a 7 day curing process in which the container is kept moist with wet sacks in a shaded area. On the seventh day the jar is filled one quarter with water. On the eighth day the jar is filled to half with water. This continues until the jar has been completely filled with water at which point the jar can be said to be cured and fit for sale. The containers can be lifted by two people and transported over many kilometers without fear of breaking it, provided they are careful.

Production Output:

The whole process of preparing the sack-mould, mixing and applying the cement mortar to the mould, casting a new bottom base, attending to the previous days production, and clean-up takes about three hours per container. It is possible to easily produce two containers per day. In some cases it may be advantageous to produce only one container per day and the workers produce other cement based products the remainder of the day.

Cement Storage Containers:

Equipment:

The equipment needed to make the containers are: 2 grain sacks sewn together to make the mould; 1 grain sack to place on the ground to prevent the container from sticking;1 strip of metal, 193 cm in length and 2 cm wide to make the base of the container; 1 wooden ring with a diameter of 40cm to make the opening of the container; 1 hexagonal wooden ring to make the opening of the container; 1 wooden paddle to beat the sand-mould into the correct shape; 1 bucket; and 2 trowels.

Raw materials:

The raw materials needed to make one container are: 50 kilos of clean fine sand; 25 kilos of cement; 12. 5 litres of clean water for mixing; and sand or sawdust to fill the mould with (note: the sand or sawdust is reusable for filling other moulds). To produce 5 containers per week one would need 250 kilos of sand (0.2m3) and 125 kilos of cement (2.5 bags of cement). Eventually there would be a need to have 1,000 litres of water to test fill all five containers at one time but this water can be reused a number of times.

Space Required:

The jars should be made in the shade on a smooth level floor and in a place protected from the wind (the ideal location is inside the workshop). Each jar requires about 4 square metres of floor space. If five containers were made each week 60 square metres of floor space would be needed to maintain the on going process (the jars can't be moved from where they were made for at least 12 to 14 days). If ten containers were made each week for a month one would need at least about 120 square metres of floor space.

Transport:

One 5 ton truck delivery of sand plus one truck lorry of 1000 kilos of cement (20 bags of cement) each month could kept a two container per day operation going.

Number of Workers:

Four workers are required to produce the container. One of the workers must be a qualified mason with good skills in plastering. The other three workers can be unskilled labourers responsible for shaping the sand-mould sack, mixing the mortar, and curing the containers.

Advantages:

It uses ordinary materials of sand/cement/water. It is easy to make, a mason will be able to make one immediately and a person without plastering experience can learn the technique in a short amount of time. It uses simple tools and equipment; the mould is made from ordinary materials, grain sacks and small amount of wood. Leaks resulting from poor workmanship or damage can be easily repaired. It needs little or no maintenance and with care a container can last more than 15 years. It also protects the contents from rats and animals.

Disadvantages:

It uses cement which can sometime be difficult to obtain in some areas. Like any pot or container, it can crack or break if treated too violently.

Fibre-Concrete Tiles

Fibre-Concrete Tiles

Proposal:

To manufacture fibre-concrete tiles in the workshop for use in covering small roofs such as pit latrines, outdoor kitchens, verandas, etc.

Description of Process:

There are 6 main steps to producing fibre-concrete tiles:

1. measuring and mixing of the raw materials of sisal, sand and cement and water in correct quantities;

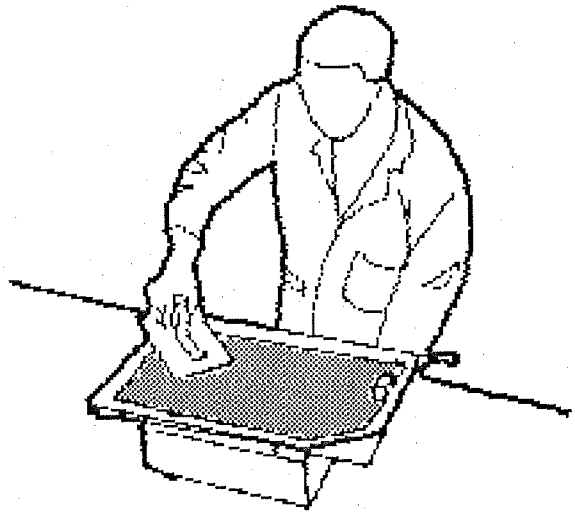
2. vibration of the mixture on the vibrating frame (powered by a 12 volt battery) to remove air bubbles, compact the mixture, and establish the thickness of the final tile;

3. moulding - the vibrated mixture is then transferred by plastic sheet and placed on a special plastic mould that gives it a tile shape;

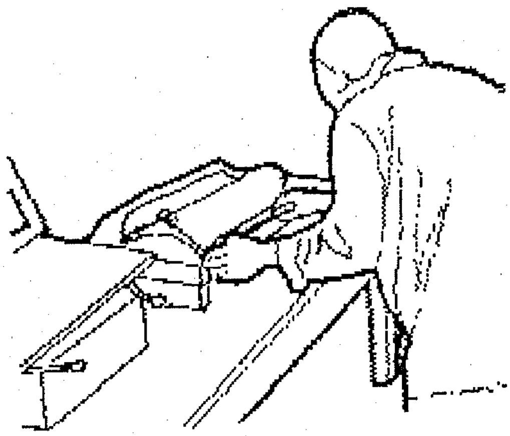
4. drying- the tile is left on the mould for 24 hours to harden;

5. demoulding and trimming - the tile is removed from the mould the next day and the edges are trimmed of excess cement;

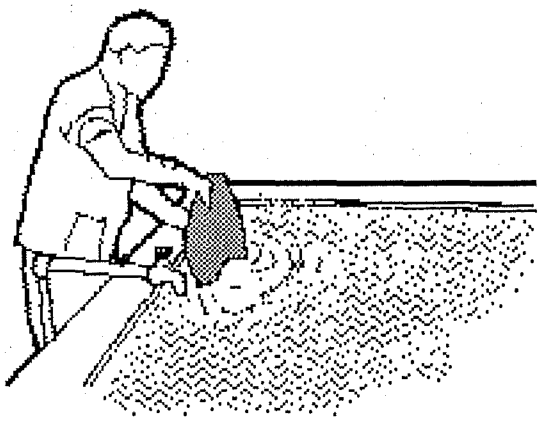
6. curing - the tiles are placed in water tanks for 10 to 14 days to gain strength. The tiles are then ready for storage or use in construction.



Vibrating frame



Moulding tile on plastic mould



Curing tiles under water

Fibre-Concrete Tiles

Production Output:

After one month of on the job training, a team can produce 100 tiles a day or 500 a week if Saturday is a workday. 100 tiles will cover 7.7 square metres of roof.

Equipment:

The following is a list of equipment and prices that comes with the fibre-concrete roofing tile kit from the manufacturer with the capacity to produce 100 tiles per day:

1 vibro-screeding machine 2 amp 12 Volt

1 set if ancillary components:

2 batching boxes

1 500 g scale

2 screeding trowels

1 sieve

1 quality control jig

1 manual

100 stackable shaped moulds for pantiles with plastic interface sheets

1 special screeding frame for ridge tiles
10 stackable moulds for ridges

Other Necessary Equipment

Some of the equipment that must be supplied locally in addition to the equipment in the kit is the following:

2 hand trowels/spades (for mixing)

1 work table for vibrator

1 sisal cutter/guillotine

1 battery 35 amp hr or larger to power the vibrator

1 battery charger 4 amp hr to charge the battery
or
1 solar panel

1 work table for sisal cutter and quality control gauge

1 one litre measuring cup (plastic or metal)

2 spatulas or knives (for trimming excess flange)

1 large cleaning surface (eg. metal sink)

- replacement plastic interface sheets (0.3 - 0.5 mm)

Raw materials:

The main ingredients for the mixture are fibre, sand, cement and water. Fibres such as sisal, jute, manila, coconut coir and some grasses used in making string and ropes are normally suitable (the author of this report has cut up sisal rope and string and has used these fibres successfully to produce fibre concrete materials). In addition certain grades of waste industrial fibres such as the polypropylene used in flour sacks can be used. The cement is ordinary portland cement but it must be fresh. The sand should be fine sharp river sand normally selected for plastering walls. Coarse sand may cause porosity problems and sand with high clay contamination will produce lower strength products. The water should be potable. Rain water collected from a roof is ideal.

The quantity of raw material needed will depend on:

1. the proportion of cement, sand, fibre used, and

2. the number of tiles produced.

Using a proportion of 1:3 by weight, 100 tiles can be produced that will cover 7.7m2 of roof with the following materials:

1 bag of cement (50 kg)
150 kg sand
2.5 kg fibre (sisal)
25 litres water (approx.)

Fibre-Concrete Tiles

At this proportion of 1:3, it would take 13 bags of cement to cover a building 8 metres by 9 metres with 100 square metres of roof covering.

Annually if the production was 100 tiles per day and 24,000 tiles per year, the unit would use 240 bags of cement, 36 tons (24 m3) of sand, 600 kg of sisal and 6,000 litres of water. This quantity of materials would be sufficient to cover 18 buildings with dimensions of 8 metres by 9 metres.

Space Required:

Forty square metres of workshop floor space would be needed for preparing, mixing, moulding, and stacking the tiles if producing 100 tiles per day. Outside the workshop five water curing tanks with a capacity to store 250 tiles each will be necessary. Each tank is 3.5m x 1.2m x 0.6m high. Special tanks for curing ridge tiles and gutters will also be needed. Their size will depend on the size and shape of the ridge tiles and gutters. Once the tiles are removed from the curing tanks, they need to air cure for another 7 to 10 days in a shaded area protected from drying winds. Approximately 22 m2 of area will store 1, 400 tiles.

Transport Needed:

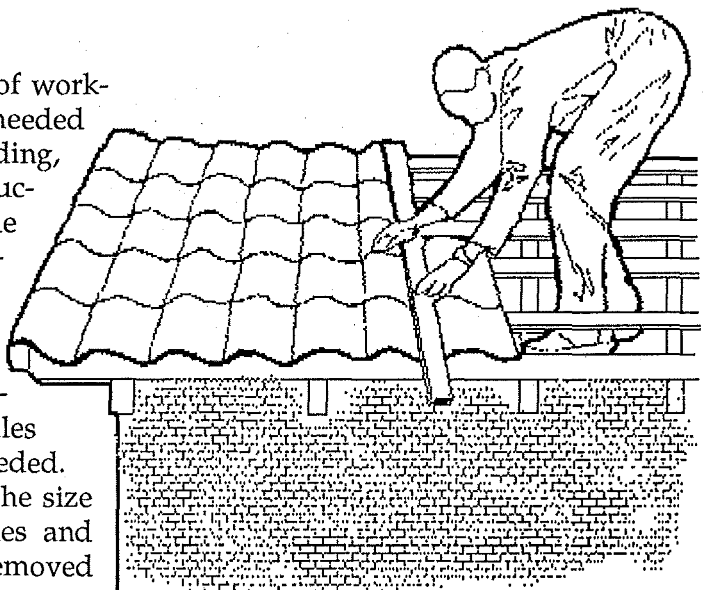
5 bags of cement would be used each week

750 kilos of sand is needed each week but one five ton lorry could supply enough sand for six and a half weeks of work.

700 litres of fresh water would be needed each week for the mixture and cleaning of tools and equipment and 1,300 litres every other week for filling up the curing tanks.

Number of Workers:

Five unskilled workers would be specially trained to produce the tiles. It is not necessary to hire masons as masons sometimes see themselves with narrowly defined duties and responsibili-



Fibre-Concrete Tiles

ties. For masons, mixing the cement, sand and sisal would be acceptable as would vibrating and moulding the tile but most of the other tasks necessary for producing tiles (cleaning moulds and plastic sheets, moving tiles, sieving sand, cutting sisal, etc. etc.) would not because these tasks are often seen as "servant's work" and demeaning for a skilled mason. This attitude can create hierarchical problems with the other members of the team and would limit its flexibility. Ideally all workers should share and rotate tasks, and all learn how to make the tiles on the machine.

Advantages:

The process produces a high quality roofing material that is easy to produce by unskilled workers after a short training program. The tiles can be more flexible than large roofing sheets when placed on roofs made with unseasoned timber and poor workmanship, resulting in less breakage. The roofs can be a variety of sizes and shapes. Should the tile become broken, they are easy to replace.

Disadvantages:

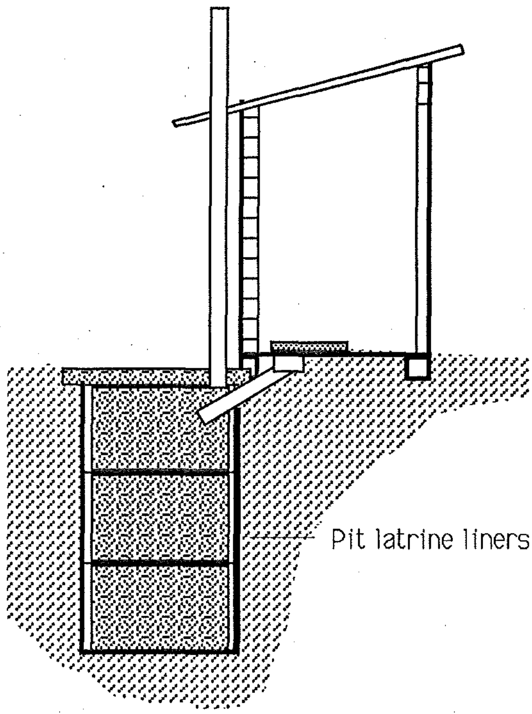
The fibre may be difficult to obtain. The support structure for tiles uses more timber than that for a standard roofing sheet. and can make roof structures more expensive. The thousand litre capacity water curing tanks need to be maintained with water. This water needs to be changed every two to three weeks, and may put strain on delivering the water regularly to the workshop. The vibrator is powered by a car battery which must be charged up daily. A solar panel would be required to be installed to maintain the charge if no city electric mains were available.

Prefabricated Pit Latrine Liners

Proposal:

Pit Latrine Liners

To make concrete rings 100 diameter by 60 cm high. These rings can be used as pit latrine liners or placed on a suitable concrete platform and sealed at the bottom and used as water tanks (425 litre capacity per ring). For pit latrines 3 rings could be sold as one kit to provide a 1.8 metre deep lining. With this system there is no need for a block lining or plastering latrine pits with cement. The manufacture of the concrete rings, the digging of the pits, and inserting of the rings can be done with unskilled workers. The metal moulds and other auxiliary parts are manufactured locally by blacksmiths and semi-skilled metal workers. [Note: this same process was



used by the Municipio of Olinda in Brazil to produce liners for pit latrines; for information read "Alternativas Techológicas Para Habitação e Saneamento" published by UNDP.]

Description of Process:

The inside form is assembled and placed on a level floor with the outside form positioned symmetrically around it. The concrete mixture is prepared using a ratio of 1:2:3 (cement : sand : stone). The mixture is placed between the inner and outer forms and the forms tapped with a steel bar to remove all air voids. When the inner form has been filled to the level of the outside form, the top is smoothed with a trowel and left for 24 hours to set.

Pit Latrine Liners

After 24 hours the mould forms can be removed by lifting them off the ring by loosening the special bolts holding them together. The ring should be left where it has been cast without disturbing it for seven days during which time it must be kept wet for the concrete to cure well. After a week the ring may be lifted on to its side and rolled and stored until needed.

Production Output:

The number of rings that can be made daily is directly proportional to the number of moulds, workers and space available. Three rings could easy be produced in a day by a team of two if three moulds were available. If 15 rings a week were produced and if one assumes each pit latrine is 1.8 metres deep, 5 latrines could be lined a week at this production level.

Equipment:

All mould forms would be made in the Sambizanga metal workshop. To make each mould the following materials are needed: one sheet of 2mm thick black iron steel 60 cm x 293 cm for inner mould; one sheet of 2mm thick black iron steel 60 cm x 314 cm for outer mould; angle iron 30 x 30mm x 3mm thick 1.5 metres in length; assorted nuts and bolts and iron rivets.

Raw Materials:

To make each ring 1.0 metres in diameter by 60 cm in height by 5 cm thick would take: 14 kilos of cement , 0.023m3 sand, 0.035m3 of crushed stone, 10 litres of water. To produce 15 rings a week would take 4.5 sacks of cement, 0.345m3 of sand, 0.525m3 of crushed stone and 150 litres of water.

Space Required:

30 square metres of floor space would be needed to maintain a production rate of 3 rings per day, 5 days per week.

Transport Required:

A five ton truck could deliver enough cement for 5 months production; a five ton truck delivering sand would be sufficient for nine weeks of production; a five ton truck delivering stone would be sufficient for five weeks. In addition transport would be need to deliver the rings to the work site. Each ring would weigh about 120 kilos.

Number of Workers:

To maintain a production rate of 3 rings per day would take 2 unskilled workers who would be trained on the job.

Pit Latrine Liners

Advantages:

Provides a latrine lining that, if made correctly, is superior to a latrine lined with bricks or concrete blocks.

Disadvantages:

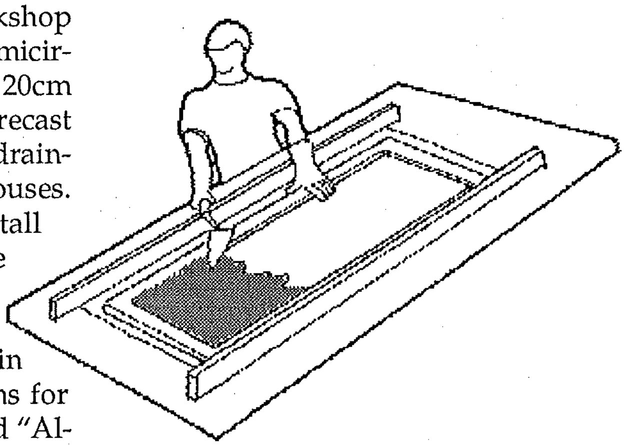
The raw materials and transport to deliver them may be too difficult to obtain. Special lifting rigs (three pole jerry rig) may be necessary for lowering rings into the ground.

Precast Drainage Troughs

Precast Drainage Troughs

Proposal:

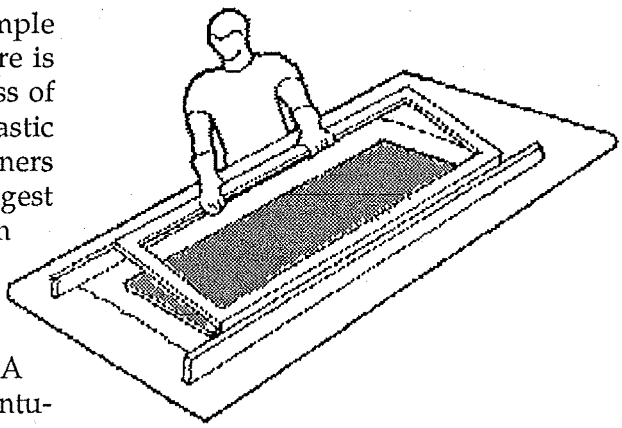
To produce within the workshop fibre concrete drainage troughs, semicircular in shape with a diameter of 20cm and a length of 1 metre. These precast troughs would then be used for drainage along roads, pathways, or houses. They are easy to make, easy to install in the ground and, should they be broken, are easily replaced. [Note: this same process was used by the Municipio of Olinda in Brazil to produce drainage troughs for use in Olinda; for information read "Alternativas Techológicas Para Habitação e Saneamento" published by UNDP.]



Placing mixture in wooden frame

Description of Process:

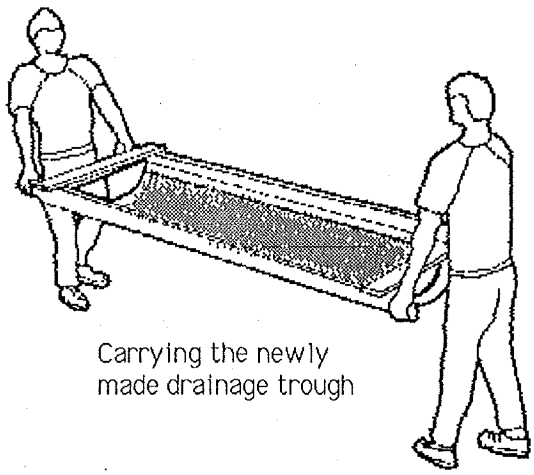
A fibre/cement/sand mixture placed in special moulds form the drainage trough. The mould is a simple wooden frame in which the mixture is placed and leveled off to a thickness of 20mm. This frame sits on top of a plastic sheet which has two wooden runners attached to it running along its longest sides. Once the mixture has been placed inside the wooden frame and leveled, the frame is lifted off and removed. The newly formed mixture now rests on the plastic. A special spacing bar which will eventually rest on the wooden runners, is put between the runners at each end of the

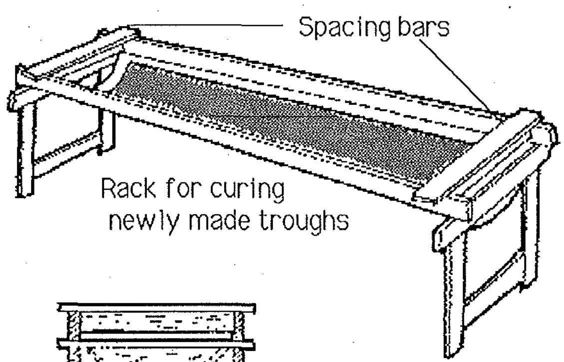


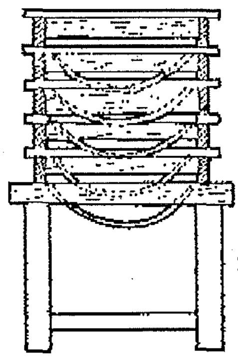
Removing frame

plastic sheet. The wooden runners are carefully lifted and the spacing bars hooked on to them. The result is that the plastic sheet with the mixture will bend downward due to its own weight and form a semicircular shape (the drainage trough) with the width predetermined by the spacing bars. All of this is carefully carried to a simple rack were the mixture will be allowed to hang and take its final shape. It is possible to stack 5 of these newly-made troughs on top of each other. The troughs are then left in this position for 24 hours to harden after which they are removed from the plastic sheet, and the edges trimmed of excess cement if necessary. The troughs are then placed in water tanks for 10 to 14 days to gain strength. After this period they are ready for storage or use in construction.

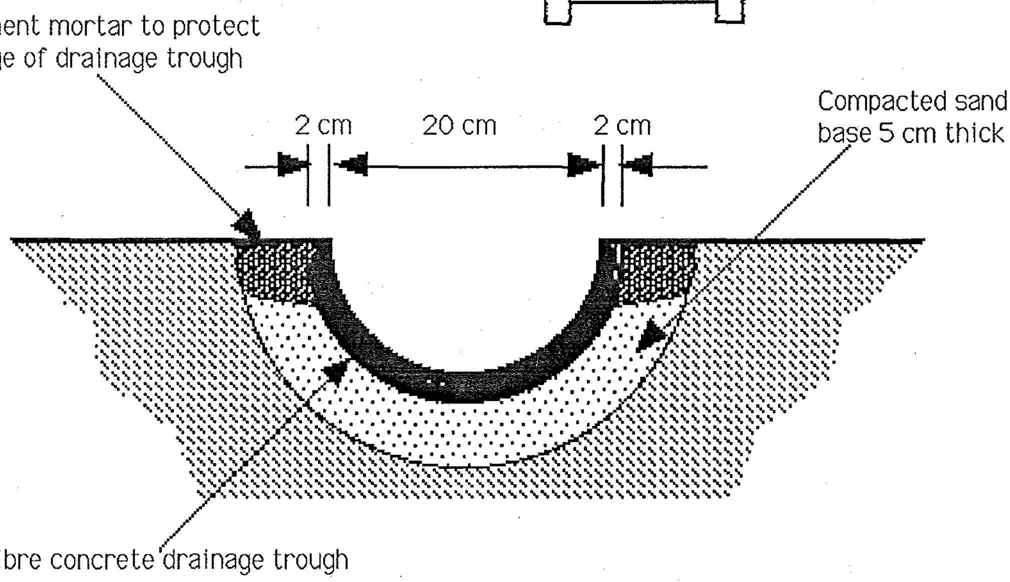
Precast Drainage Troughs







The following drawing shows the recommended method of supporting the troughs in the ground.



Precast Drainage Troughs

Production Output:

The number of drainage troughs that can be made daily is directly proportional to the number of moulds, workers and space available. It would be reasonable to suggest that 20 fibre concrete troughs could be produced each day.

Equipment:

Wooden forms would have to be made and forming racks built. The shape of the trough is determined by the plastic sheet. Rolls of plastic 0.3mm thick 1.0 to 1.3 metres wide would have to be bought and sheets cut from the rolls. Each sheet is reusable about 50 times before it will have to be replaced. Batching boxes for gauging the materials would be built from wood. A scale would be necessary to weigh out the fibre material. Other than that, normal masonry tools would be used.

Raw Material:

The main ingredients for the mixture are fibre, sand, cement and water the same as for the fibre concrete tiles and tubing. It is estimated that using a proportion of 1:3 by weight, the following quantities of materials will produce approximately 25 drainage troughs:

one bag of cement (50kg),
150 kg of sand,
2.5 kg of fibre and
25 litres of water.

To produce 100 drainage troughs per week would take 4 bags of cement, 0.4m3 of sand, 10 kilos of fibre and 100 litres of water for mixing.

Space Required:

Thirty square metres of workshop floor space would be needed for preparing, mixing, moulding and stacking of the drainage troughs if producing 20 per day. Outside the workshop one large curing tank with a capacity to store 200 troughs (standing vertically under water) is needed.

Transport Needed:

One five ton delivery of sand would be enough for six weeks of work. 700 litres of fresh water will be needed each week for the mixture and cleaning of tools and equipment and 1,500 litres every other week for filling up the curing tanks.

Number of Workers:

4 unskilled workers are needed for this process.

Advantages:

The process produces a very cheap drainage trough which is easy to produce and install. Unskilled labour can be trained in very little time to produce the product.

Disadvantages:

The fibre may be difficult to obtain. A special team would have to be trained to install the troughs correctly to prevent them from breaking.

Pedestrian Pathways

Pedestrian Pathways

Proposal:

To provide 2 metre wide pedestrian pathways throughout the project area using compacted soil stabilized with cement.

Description of Process:

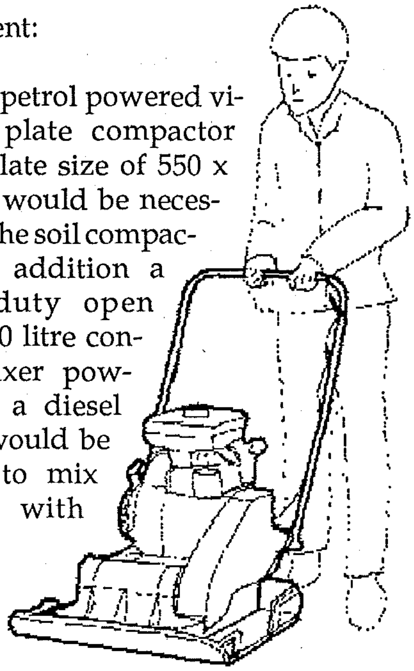
The pathways are laid out two metres wide and are composed of three layers of compacted soil. The bottom layer is a 10 centimeter layer of soil mechanically compacted using a petrol driven vibrator plate compactor. The middle layer is composed of soil-cement with a ratio of 1:15 and is compacted 5 centimeters deep on top of the bottom layer. A final layer of soil-cement with a ratio of 1:12 is compacted 5 centimeters deep. The sides of the pathway would be lined with paving blocks to prevent the erosion of the path.

Production Output:

The figures are difficult estimate. The best estimated would be that 20 metres of pathway two metres wide could be prepared in a working day.

Equipment:

A petrol powered vibratory plate compactor with a plate size of 550 x 650 mm would be necessary for the soil compaction. In addition a heavy duty open drum 280 litre concrete mixer powered by a diesel engine would be needed to mix the soil with cement.

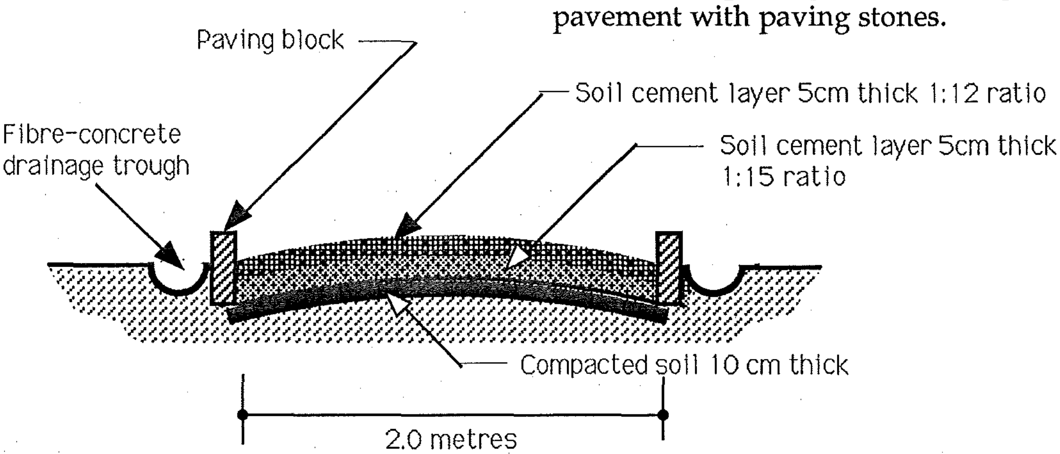


Raw Materials:

Soil would be used to mix with the cement and a small amount of water. This soil could be found locally. To pave 20 metres of pavement a day would require 15 sacks of cement. Paving stones or blocks made in the workshop would be needed.

Number of Workers:

A team of ten to fifteen would be required to maintain the whole process of digging soil, sieving it, mixing with cement, compacting it and lining the pavement with paving stones.

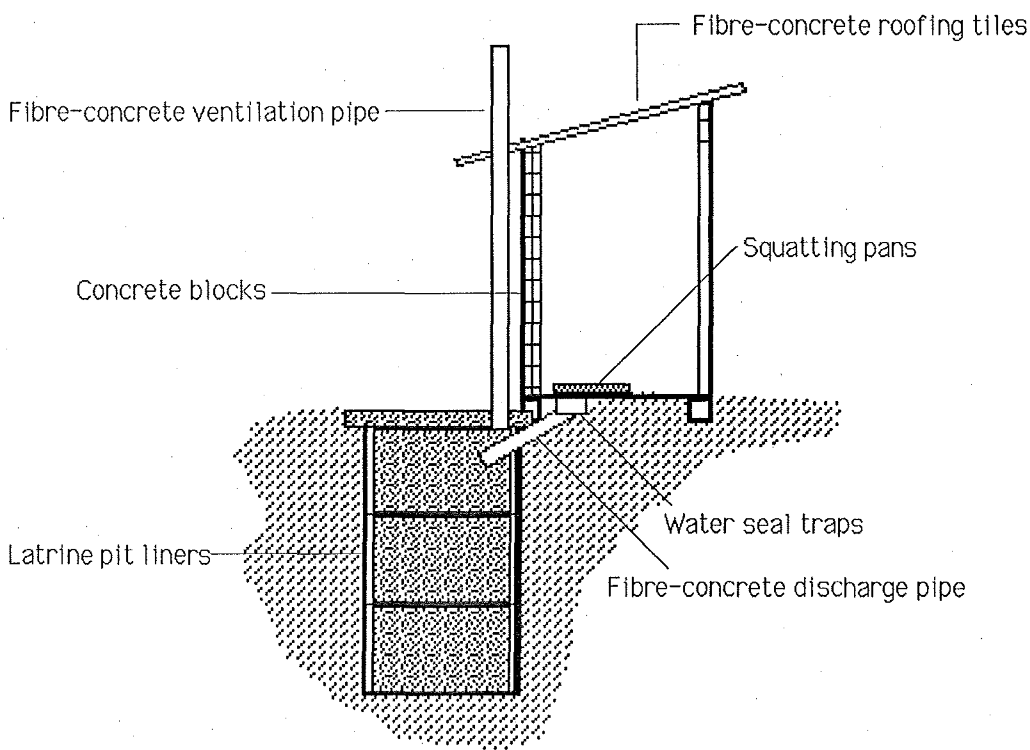


Pit Latrine Components

Pit Latrine Components

Proposal:

To produce special latrine components within the workshop. These components could be any or all of the following: special squatting platforms; fibre-concrete discharge pipes connecting the squatting slabs to offset pits; squatting pans for pour-flush units made from cement mortar mix; water-seal traps for pour-flush units made from cement mortar mix; ventilation pipes made from fibre-concrete; precast latrine pit liners; special concrete blocks for lining the pits and or building the walls; fibre-concrete tiles for covering the latrine room. The components could be sold as a package (that is everything for the latrine is produced in the workshop and sold as one complete unit) A team of installers could be setup to insure that the latrines were then built to specifications. Many of the components that would be used in the pit latrine have been described elsewhere in this report.



Metalwork Products

Metalwork Products

There are too many products that can be manufactured within the metal workshop to mention here. Rather it is better to list the types of equipment that could be bought and how that equipment would be used to produce useful items.

Welder: both electric and diesel-powered welders are necessary to allow electric arc welding to be done. The repair and manufacture of equipment is dependent upon this equipment.

Gas welding equipment: there are some types of welding that can only be done by gas welding. Usually this includes very thin sheet metal or thin walled tubes. One advantage of gas is that special cutting nozzles can be used to cut steel that is too thick to cut with saws.

Metalwork Products

Power Hacksawing machine: this machine is used to cut steel bars, angle iron, tubes, round stock to length and is a necessity in any steel production shop as it frees the worker to concentrate on assembling the work. It is very useful for mass producing door and window frames, roof trusses and burglar bars.

For sheet metal work the following machines are standard in any well equipped workshop.

- Box and pan folding machine for bending sheet metal to various angles such as when making rain gutters.
- Slip roll forming machines are used to form sheet metal into cylinders, curves, buckets, hoops, down spouts, etc.
- A combination rotary machine is used for preparing sheet-metal for a wired edge, turning a narrow flange (used to make buckets), beading and crimping. This machine is used to prepare the ends of down spouts so that they fit into one another, and the bottoms of buckets.
- Foot powered squaring shears are used to cut and square up large sheets of sheet metal. It is far quicker and more accurate than cutting the sheets by hand. When producing large amounts of sheet metal products this machine is a necessity.

Other simple equipment that is useful are:

- Angle bending machine for bending flatbar, squarebar, round bar and angle iron to various angles.
- Tube and pipe bender for bending pipe.
- Bench shear for cutting sheet stock and metal bars.

Woodworking Production

Woodworking Production

In the first phase of the workshop program, the woodworking section would act more as a support section for the other areas by making moulds, gauge boxes, and other wooden forms needed. Wooden window frames and doors could be produced along with window shutters and solid doors but this would depend on the availability of timber supplies.

The equipment recommended for this area is based on the hope that the economy of Angola will improve in the near future. If this should happen, then more timber may be available on the market. Angola has hardwood varieties which can be difficult to transform in to usable timber. As a result, the equipment that is recommended is heavy duty and specialized. There are a number of universal type machines on the market that can saw, plane, and drill timber. These machines are an excellent

Woodworking Production

choice for low-production workshops. They are not suitable for high production workshops as the machines are not designed for this type of work. As a result, individual machines are recommended for Sambizanga workshop to handle the future production needs. The machines recommended are: heavy-duty circular saw bench, bandsaw, surface planer/thicknesser, surface planer/jointer, and wood turning lathe.

Workshop - Alterations to be Made to Original Design

Alterations to original design

To accommodate some of the suggested ideas for production, the original workshop would need to be slightly changed. Basically the original shape remains the same but the carpentry and blockmaking areas are switched; the indoor showers are moved to another area; the large tool rooms are broken down into smaller areas; the kitchen/dining area is reduced in size; and the whole workshop is rotated 90 degrees to accommodate it better on the site.

Details of the change:

1.) The carpentry and blockmaking areas are switched to allow a better flow of materials in and out of the workshop area. The blockmaking area will have the most movement of raw materials and finished products. In fact an additional door has been suggested in the bloqueira to help move the goods about.

2.) The indoor showers that were located near the carpentry shop in the original drawings have been moved to the refeitorio. This was done to allow more space in the workshop areas. It is recommended that the four showers be divided into two shower stalls and two toilet areas. One shower and toilet stall for women and the other shower and toilet stall for men. The toilet stall would be a squat type, water seal unit which is flushed with a litre of water. A pipe leads to a simple septic-like tank. In the men's toilet it is advisable to install a urinal of some type. It is proposed to have the toilets indoors as this cuts down on workers wandering out the back door for long periods of time in the excuse of using the latrines.

3.) The area designated as the refeitorio can be smaller. The room could also be used as a meeting room for the staff.

4.) The tool rooms and battery charging room have been broken down into smaller rooms. Individual tool rooms (3.0 x 2.5 m) are placed in each workshop. It is recommended that each area be responsible for its own tools. In this manner there will be much less tool theft and with good supervisory management it will be easier to keep track of all the tools. A small storeroom (3.0 x 5.0 m) is recommended to store bulk materials such as spare parts, nuts and bolts, etc.

5.) The whole workshop is recommended to be rotated 90 degrees to allow it to sit better on the site. This will allow easier access to the large fenced in area in the back of the workshop. It is here where sand will be stock piled and all the various cement products cured or stored.

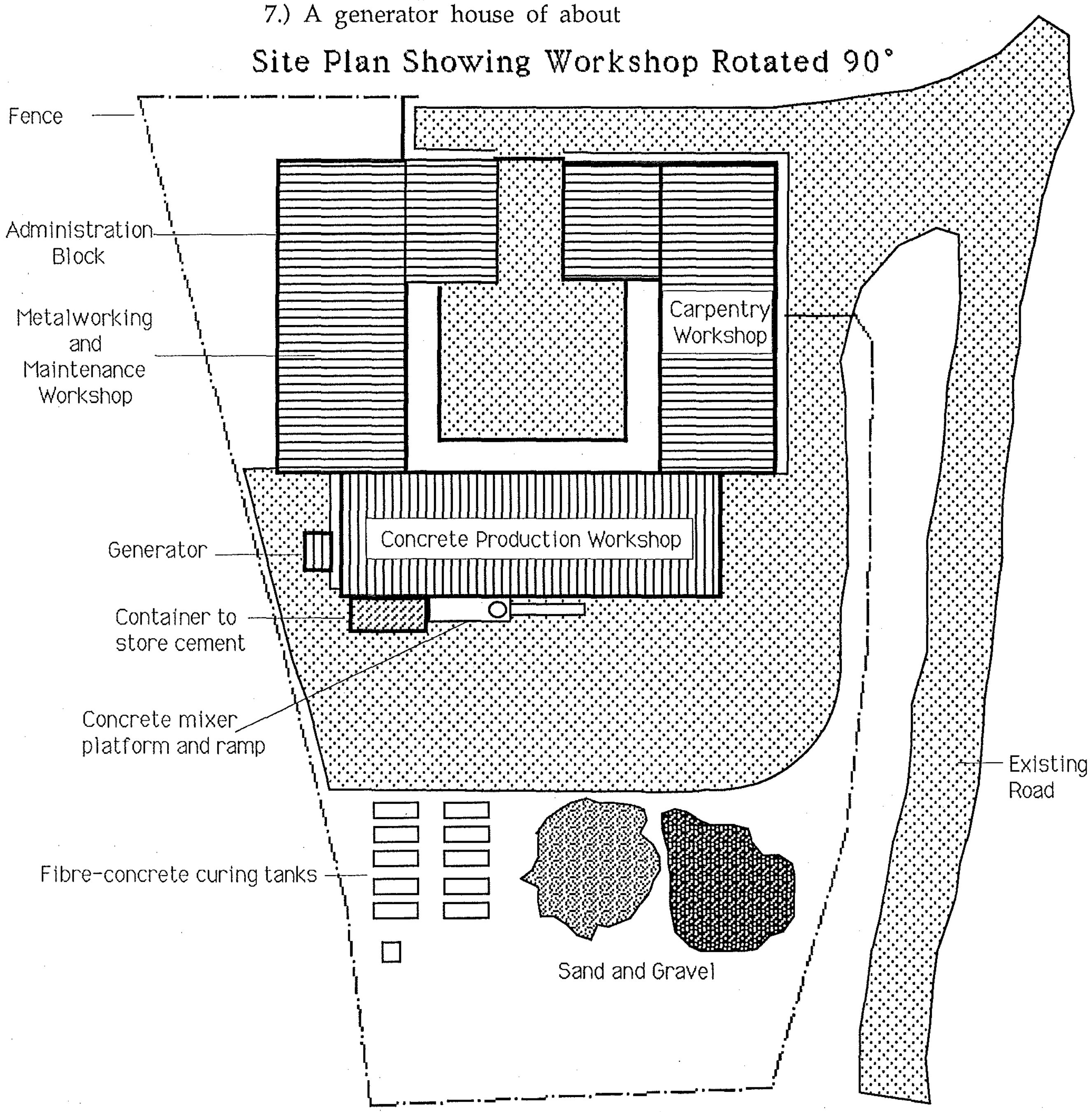
Alterations to original design

6.) A sliding door has been added into one wall of the bloqueira. This will lead to a concrete mixer platform on which an electric tilting pan mixer will sit. The platform is 6.7m x 2.0m and is level with the floor level of the workshop to allow easy movement of wheel barrows. The mixer sits on this platform and a slopping ramp allows wheelbarrows of sand to roll up it to fill the mixer.

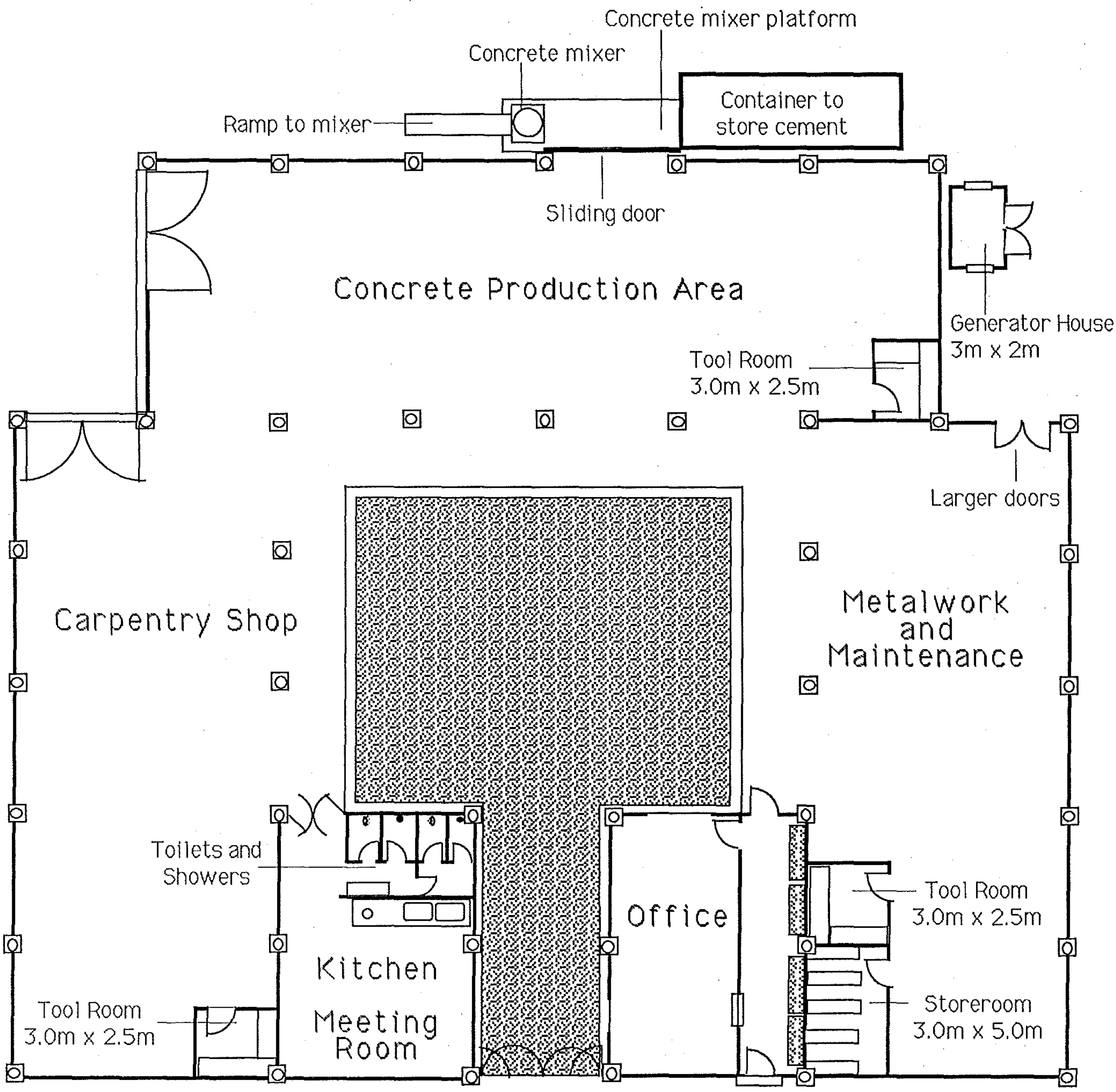
7.) A generator house of about 3.0m x 2.0m will need to be built to house a 25 kVa generator.

8.) The rear door of the serralharia has been enlarged to 2.0 metres to allow for easy movement of raw materials.

Site Plan Showing Workshop Rotated 90°



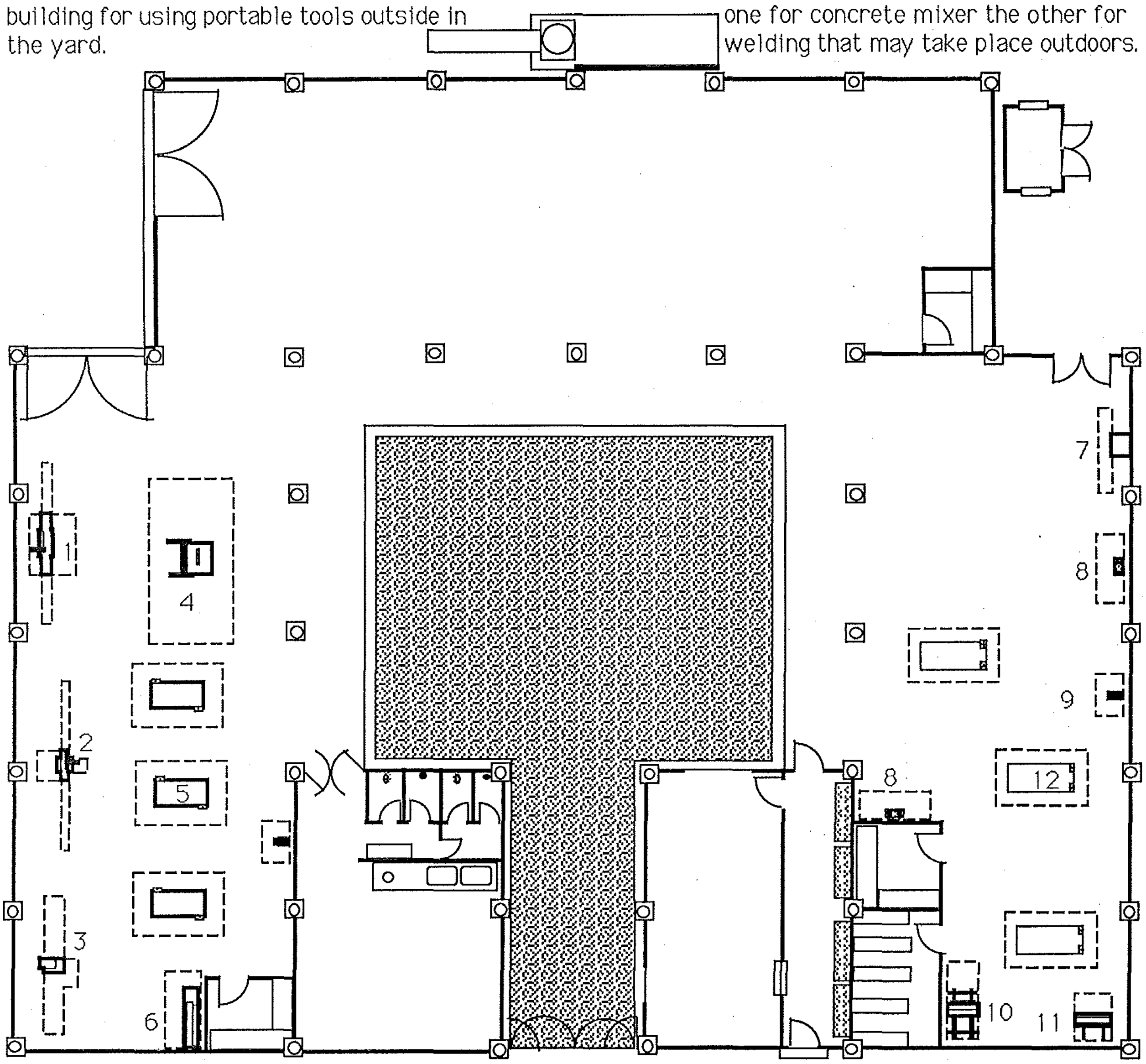
Floor Plan Showing Workshop Alterations



Floor Plan Showing Location Of Major Equipment

Single phase double outlets located at a minimum of every five metres along every wall; a number of outdoor water-proof outlets located on the exterior of the building for using portable tools outside in the yard.

Three phase outlets for each machine that requires it plus two outlets in cement production area to plug in block making machine; two outlets outside of workshop one for concrete mixer the other for welding that may take place outdoors.



1- Jointer
2- Thicknesser/Planer
3- Band Saw
4- Table Saw
5- Woodwork Bench
6- Wood Lathe
Note: Dotted lines show work area needed for each type of equipment.

7- Power Hacksaw
8- Grinder
9- Drill Press
10- Squaring Machine
11- Box Pan
12- Metalwork Bench

Staffing of Workshop

Staffing of Workshop

There are five different types of workers that would be involved in the operation of a workshop of this size. They are as follows:

1.) Administration staff — four people

2.) Skilled craftsmen for overseeing the workshop — four people

3.) Unskilled labour or casual labour — six to twenty people

4.) Equipment operators - two people

5.) Production brigades that work out of the workshop but within the community — team of six.

Administration Staff

The administration staff would have the responsibility for:

- purchasing and insuring delivery of all raw materials used within the workshop;
- that technical equipment is installed correctly and regularly maintained;
- maintaining safety for all workers;
- the quality of the product and that it is checked regularly and all goods are inspected before delivery to the customer;
- establishing prices for all production items;
- managing the accounts through maintaining accurate billing and bookkeeping system;
- selling the finished products to the community;
- ensuring there is a smooth flow of production which includes regular sales and delivery of the product in order to keep the area clear of finished stock and to have a regular income for the workshop;
- ensuring adequate financial arrangements are made for wages and purchases;
- recruiting and training suitable skilled personnel;
- overseeing the development of new production items;
- ensuring the staff have specific tasks or roles and have the necessary tools and information to do the job;
- checking that the product is being installed correctly and for purposes appropriate to those for which they were designed;
- ensuring that there is a cash flow to guarantee regular payment of the workers and to make necessary purchases for the workshop.

Staffing of Workshop

Staff Breakdown:

Director/Administrator oversees all staff and is responsible for the smooth operation of the workshop; office is located within workshop; liaisons with local municipalities, government structures, and the local population; has complete responsibility for hiring and firing personnel; an equal voting member on any management board that may be established and reports directly to them. The director should be technically oriented and have skills in managing a production centre of this type.

Technical/Management Advisors: Due to the newness of the workshop it would be recommended that special positions be created for one to two technical advisors that would last for at least five years. They would act as technical and management advisors whose role would be to develop the products that would be produced, train the personnel to carry out the production, establish "norms" for production in terms of quality and production rates; would represent the donors and ensure that the workshop proceeds in becoming a production centre that would help the community of Sambizanga; reports to the director with responsibilities for supervising all workshop activities.

Accountant/bookkeeper keeps all financial records; does all banking; pays salaries and bills; keeps sales records on all products sold.

Purchaser/Stock Controller responsible for purchasing all raw materials; maintains inventories of all raw materials, products produced and materials used; responsible for quality control on all items produced; and maintains a list of who works daily.

Skilled Craftsmen (permanent staff)

The workshop will require a number of skilled craftsmen to oversee activities in the four major production areas of cement based products, woodworking, metalworking and maintenance.

Carpenter (foreman) skilled in machine and hand tool production for wood based items; responsible for building equipment, furniture, doors, moulds, etc., and maintaining equipment; will oversee any assistants that may work within the carpentry shop and provide training.

Metalworker (foreman) responsible for all metal fabrication including welding, forging and sheet metal; will oversee any assistants that may work within the metalwork shop and provide training.

Mechanic responsible for maintaining all vehicles, generators, concrete mixers, and other mechanical and electrical equipment.

Chief mason (foreman) responsible for overseeing the production of cement based products and training of workers to produce them.

Unskilled Labour
(semi-permanent and casual labour)

There will be a need to hire additional workers from time to time, depending on the production schedules and availability of materials. It is therefore difficult to give exact numbers. It is advisable to employ personnel only when there is specific work to be done. Keeping a large work force on hand and paying them without establishing and maintaining production will lead quickly to financial ruin of a workshop production centre. Potential areas that will need workers are:

Staffing of Workshop

- Within the carpentry shop one person could be hired (semi permanently) to assist the chief carpenter as an assistant. This person should have some basic carpentry skills.

- Within the metalwork shop one person could be hired to assist the metalworker from time to time depending on the workload.

- Within the cement based production area, from four to ten people would be required depending on the type of product being produced. A full scale mechanized block production unit would require eight people to operate. Some of the fibre concrete based products require from two to five people.

- The fetching of raw materials if done regularly will require a permanent workforce. The loading of sand or gravel into a truck may require from six to ten people. If the need for sand was small then the people working within the cement based production area could be expected to do it reducing labour costs.

Equipment Operators

If trucks and motorized tippers and backhoes are bought for the project then there will be a need to hire qualified drivers. It may be possible to have one equipment operator to operate all equipment, but this would depend upon the timing of the work. The problem with keeping a number of drivers on the staff is that sometimes they see themselves only as drivers and refuse to participate in other types of work outside the realms of operating a vehicle. This can be very inefficient and at times very costly. For contractor type equipment such as tippers or backhoes, it is recommended that a number of workers be trained in the operation of this equipment. As example, the foreman and chief mason of the construction brigades should be taught to operate and maintain the equipment. When there is no need for using the equipment they return to their normal duties.

Production Brigades

The number of workers for a production brigade should be no more than six per brigade. Their chief duties may be building latrines, laying drainage pipe, lining latrine pits, putting in pavements, installing tiles, etc. As such there will be a need for a foreman who is qualified in all the construction areas to handle the installation of the concrete products the workshop may produce. The remainder of the workers do not necessarily need be masons as training could be done on the job for those lacking skills.

Selection of Staff

Staffing of Workshop

In general the following rules for selection of staff should be followed:

- all staff should come from the local Sambizanga community and live near the project area; this includes the director, administration staff and skilled craftsmen;

- there is no job within the workshop setting that should exclude women. It is therefore recommended that at least half the workers be women;

- many of the production jobs require no previous skills or for that manner any sort of work experience. Within the cement production area it would be wise not to hire masons because of their sometimes inflexible attitude to work. Many masons see themselves with narrowly defined duties and responsibilities. Mixing cement, sand, crushed stone or fibres would be acceptable as would operating some of the moulding equipment but most of the other tasks necessary for producing materials such as cleaning moulds and plastic sheets, fetching sand, moving blocks tiles etc. to curing areas, sieving sand, cutting fibres, etc. etc. would not because these tasks are seen as "servants work" and demeaning for a skilled mason. This type of attitude can create hierarchical problems with the other members of the team and would limit its flexibility. For this area it is better to train people with no previous experience (or prejudice) and to train all the members of the team to be able to do all the tasks involved in producing the concrete products. Therefore all workers share and rotate tasks and all learn how to make all the concrete products and all receive the same salary.

- the skilled craftsmen ideally should be mature and have a broad experience within their trade with many years of work experience. They will act as foremen overseeing all production and the staff involved in that production. Motivation of the workers will come through them and as such these people must have good work ethics.

- all effort must be given to employing disabled people and ensuring that the workshop is designed in such a way that these people can move about within it (this means that ramps should be installed, doors are made wide enough for them to get through, etc.). All the administration jobs, equipment operators, and some work within the production areas should be open to the disabled.

- due to the nature of some of the production there may be times when there will be no work, therefore in selecting the staff it is wise to choose people who are flexible and can do multiple tasks.

Overall Management Of Workshop

Management Of Workshop

In order for a production type workshop to succeed there must be good management principles used in operating the workshop. In fact management is probably the most difficult problem that must be overcome within the Sambizanga workshop and in comparison, technical problems are much more easily resolved. There tends to be a view within government structures, whether consciously or not, that the normal rules and constraints of business and manufacturing do not apply to their own production enterprises. These views are often expressed by people who have no business experience. It is common to find government run enterprises similar to the Sambizanga Workshop that have turned management over to people who have no experience in organization of a work place, or running a small business, and regularly expect them to produce results without even the minimum of financial backing, resources, training or support.

The Sambizanga workshop is doomed to failure unless good management is put in place. This management includes planning, organizing, staffing, and controlling in order that items can be produced within a budget and sold at a reasonable price.

The following are recommendations for the management of this workshop:

1.) The workshop must be independent. It must be allowed to operate independently from other government departments; establishing its own operating procedures, hiring and firing its own staff, controlling its own operational costs (salaries, purchasing raw materials, etc.) by having its own separate accounts, and establishing its own working hours and environment. The workshop should be an entity of its own and not under a department that has no knowledge of manufacturing or its problems.

2.) If an advisory board is established to help oversee the operation of the workshop it should be made up of members selected from GARM, Development Workshop (representing the donors) and the local commisario. The role of the advisory board is to help to resolve problems, give direction, and basically advise on matters that will effect the long term smooth operation of the workshop. The day to day management of the workshop must however remain in the hands of the workshop management for them to control.

3.) Development Workshop should provide technical and managerial assustance and training over a ten year period. In addition Development Workshop should be allowed to use the workshop for training and experimental work for development projects.

4.) In the beginning years, start-up funds will have to be provided until the workshop operates well and is self sustaining. These funds must cover all operating costs.

5.) The selling price for all goods and services provided by the workshop should be determined by monitoring the parallel market and establishing prices accordingly. Fixed government prices for items to be sold should be avoided and real market value given to each item made. If this is not done, the workshop will quickly fall into financial problems.