Teaching Ecological Sanitation in Schools

A compilation of manuals and fact sheets
(March 2010 edition)

Peter Morgan and Annie Shangwa

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Teaching Ecological Sanitation in Schools

Building a round brick VIP toilet with a steel door and frame

Peter Morgan and Annie Shangwa

Building a round brick VIP toilet with steel door and frame

This unit was built as an upgrade on the brick lined pit with seepage holes in the walls. The original superstructure was made of poles and grass, with the intention of upgrading later. The grass structure was taken down and a more permanent facility erected in its place over the same lined pit. The method of lining the pit is described in another manual. With a pit of this volume it makes sense to construct a stronger and longer lasting structure from bricks. Trees were also planted around this brick lined pit with seepage holes in the walls.

The original pit and slab

The original pole and grass structure and the upgraded brick structure

Building the brick toilet

1. Making the dished cement floor

All toilet floors should be dished or sloped so that wash water can drain into the pit. This is particularly important for Blair VIP toilets which are also used as washrooms. The cement used for plastering should be strong and finished off with a steel float. A 3:1 mix of pit sand and Portland cement is used. In this case a circle of bricks has been laid around the rim of the slab first and the floor being dished down inside these bricks.

The slab has been washed down and a layer of strong cement plaster (3:1 with pit sand and PC15 Portland cement) applied around the rim of the slab. Bricks are then laid in this mortar around the slab.

Once the brick work is finished additional cement mortar is added all round and dished towards the squat hole. This is smoothed down flat. A 75mm length of 110mm PVC pipe is fitted to the ventilation hole whilst the floor mortar is being added. This PVC pipe is withdrawn after an hour and the floor left to set and harden.

2. Add the steel door frame and brick up the walls

In this case the steel door frame and door has been made commercially. It is fitted with steel "sprags" or thin fingers welded to the door frame. These are held by the mortar in the brickwork and hold the door and door frame tight.

The door frame is fitted first. This stands directly on top of the brick rim around the slab and is held in the vertical position by two poles as shown.

The bricks are then laid with weaker mortar (about 12 parts pit sand to one part cement) in a circle above the existing brick circle. The steel sprags are inserted in between bricks in the mortar (see later photo). The walls are built up as vertical as possible. The round shape makes the structure easy to build and strong even if the walls are not perfectly vertical.

 

The brick work rising up. Right photo shows steel sprags welded to the frame. These are embedded in the cement mortar used to bon the bricks together.

 

The walls of the round structure have now been built up. After a few days The two poles can now be removed as the frame is now held up by the brickwork.

 

The floor is now cleaned down

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The door is now fitted inside the frame. Rubber hinges are used to make the door self closing. A roof and vent pipe must now be fitted.

3. The roof

The roof of this structure can be made with asbestos or corrugated iron sheet. It can also be made using cement impregnated hessian mounted on a timber frame. In this case the roof is made of a timber frame made from "brandering" and two sheets of cement filled hessian.

Making the timber frame.

In this case the timber frame has a length of 1.4m and a width of 1.3m. Two lengths of 1.4m are required and 5 lengths of 1.2m. The size is made to suit the individual toilet. The individual pieces of timber are first treated with a mix of creosote and old engine oil to prevent termite attack. After a day or two of soaking the roof frame timbers are nailed together.

 

The roof timbers are cut first to suit the individual toilet. The roof should have an overlap around the structure. Roof timbers being treated with a mix of old engine oil and creosote. Then they can be nailed together.

Making the cement impregnated hessian roof sheet

The hessian is purchased in a standard width of 1.4m. Two hessian sheets are cut 1.5m long. The hessian sheets overlap the frame slightly on the sides and at the front and back. So the wooden frame is made slightly smaller than the hessian sheet.

Making up the cement paint

The cement paint is made by mixing 10 litres of PC 15 cement into 6 litres of water to which two heaped tablespoons of table salt has been dissolved. The mix is thoroughly stirred with rubber gloves and applied liberally to the first hessian sheet which is placed over a plastic sheet. The paint should soak in. In fact this mix should be able to fill 3 sheets of hessian this size.


Hessian sheet laid over plastic sheet. Stirring the cement paint mix.


The cement paint is thoroughly applied to the first sheet using rubber gloves.


The second sheet is laid over the first and rubbed into the cement. Then further cement paint is applied. For additional strength and durability a third sheet can be applied and filled with cement paint. If the cement paint is not enough a little more can be made to fill a third sheet.


It is important that the sheet is allowed to cure under a plastic sheet for several days. The hessian panel is slightly larger than the roof frame. After a few days it can be slid onto the timber frame and carried to the toilet and mounted.


The roof is carried to the toilet and small nails are used to attach the roof sheet to the roof frame.

The roof is then mounted on the toilet and wired in place.

4. Fitting a ventilation pipe

A ventilation pipe is an important part of any VIP toilet. Commercial pipes are available in PVC and resin impregnated hessian. In this case a 2.3m long 110mm resin impregnated hessian pipe fitted with an aluminium fly screen is being used.

This pipe is a new unit on the market and is being field tested. It is about half the cost of a PVC pipe. A length of PVC pipe is fitted at both ends.


A hole is cut in the roof material and the pipe passed through from underneath. Then weak cement mortar is prepared and laid around the pipe with a trowel. This stops rainwater penetrating through the roof at this point.


Some cement mortar is also laid around the base of the pipe. This toilet is surrounded by a circle of gum trees which are watered regularly.

The completed toilet.

Teaching Ecological Sanitation in School

Making a ring beam to support light-weight toilet superstructures in stable soils.

Peter Morgan and Annie Shangwa

Introduction

The ring beam is a valuable method of protecting a pit without a brick lining and works well in soils which are a moderately stable. The method is suitable for light weight superstructures. The pit is dug inside the ring beam once it has become hard and cured for a few days. Ring beams can be made with bricks, but are more durable if made from concrete.

A ring beam made from bricks. The bricks are best mounted in cement mortar. However traditional anthill mortar can also be used in mortar traditional structures. The brick ring beam supports a fibreglass slab in this photo. Most toilets slabs are made of concrete.

In this case the ring beam is cast within two steel shutters. The inner shutter is 0.9m across and the outer shutter 1.3m across.


A mix of 10 litres of Portland cement and 60 litres of river sand is prepared. The soil on the ground within the ring beams is wetted down.


Half the concrete mix is added between the shutters and levelled off. Then two rings of 3mm wire, 3.7m long are added half way between the shutters or bricks as reinforcing.


The remaining concrete is added and levelled off


The shuttering is then removed with a turning motion. First the outer shutter is removed, then the inner shutter.


The ring beam is then neatened up and left to harden overnight. It is kept wet for several days to cure. Then the pit is dug down within the ring beam to a depth of 1m or 1.5m in firmer soils.


It is best to dig the hole so the diameter of the base is slightly less than the diameter of the top. A matching slab will have been made measuring between 1.0m and 1.2m in diameter.

Before the slab is fitted a layer of weak cement mortar is added on the top surface of the ring beam. Then the slab is added. This has two useful effects. It provides an even surface on which to mount the slab which prevents slab cracking and also makes an airtight seal between the ring beam and slab. An airtight seal is essential if a vent pipe is fitted later and is expected to draw air efficiently from the pit.

The sealed pit is then ready for the construction of the superstructure.

Teaching Ecological Sanitation in Schools

How to make standard corbelled pit linings

Peter Morgan and Annie Shangwa

Introduction

This method of lining toilet pits has been described in several toilet construction manuals in this series. The method makes it possible to line a large capacity pit with bricks and fit a smaller low cost concrete slab on top to cap the pit. Using this method a pit with a life of at least 10 years can be lined and capped with a strong concrete slab using a single bag of PC15 cement. This includes making the slab. The best size of the slab is 1.1m in diameter (see another manual). Most of the pits dug at the school using this technique have been dug to 1m depth to make it easier for the children. Normally however the pits would be 2m deep or even 2.5m deep. The pit can be dug about half a metre deeper below the brickwork and it is normal for the upper courses of brickwork to rise above ground level. The deepest corbelled pit lined at the school was dug in a pit 1.6m deep and the final depth of the pit was 1.8m, since the lining rose 0.2m above ground level.

The internal diameter of the pit can vary between 1.3m to 1.5m and the depth should be 2m or more. When estimating the width of the pit to be dug, add an extra 30 cm to the required internal diameter. Thus a 1.3m internal diameter pit (inside brickwork) should be dug at least 1.5m in diameter. A 1.4m internal diameter pit should be dug 1.6m in diameter and so on. The pit walls should be dug straight down and the pit base should be level.


Dig hole and assemble bricks


The mix of cement and pit sand is 1 part cement and 16 parts pit sand. A ring of bricks is dug at the base of the pit. Everybody can lay some bricks as the number of courses in increased from the base of the pit. The cement mortar is laid on plastic sheet on the pit floor.


About half a metre from the ground level the courses of brickwork are stepped in. About 2cm every course. Thus the diameter of the pit starts to decrease as the pit walls get higher.


The bricks are stepped in until the external diameter is the same as the concrete slab which has already been case. The bricks should rise above ground level by at least two courses.

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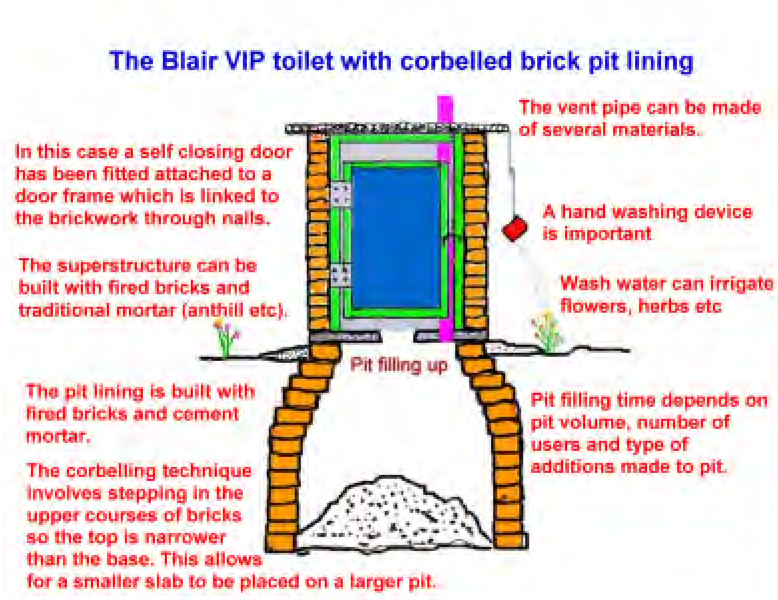
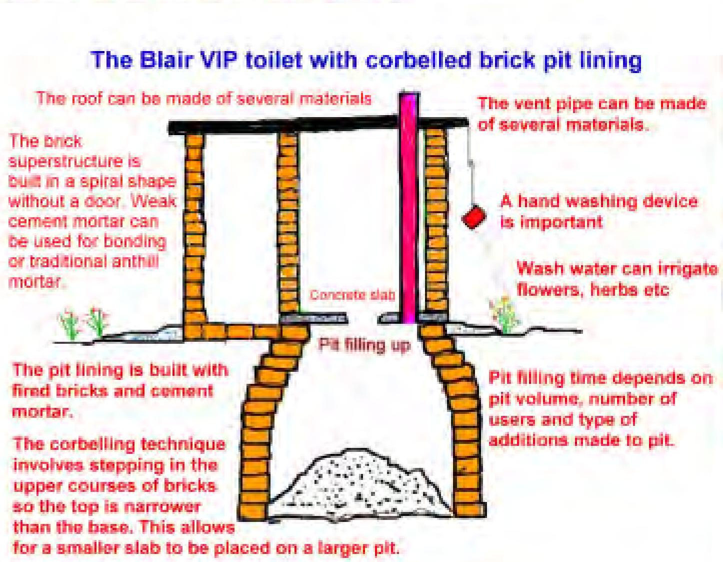
The external diameter of the lined pit is measured to match the concrete slab. The slab should sit on top of the bricks with just a little brickwork showing out side the slab for mortaring and making seal.

The slab is then lowered in position with the squat hole facing the correct direction. This will depend on the type of structure built. The slab is laid down in a bed of weak cement mortar to make a good seal and also to ensure that the slab is supported evenly all round. Otherwise the slab may crack.

The slab must also be level. If the slab is not level it should be propped up with stones until is becomes level and the cement mortar applied underneath the slab. The slab must be supported by cement mortar all around. Once the slab is set in position and the mortar has been allowed to harden, the construction of the superstructure can begin.

Cross sectional diagrams of a pit lined with bricks using the mortaring technique.





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Teaching Ecological Sanitation in Schools

A method of lining a pit with bricks using the corbelling technique and also making provision for seepage from the walls into the surrounding soil.

Peter Morgan

Introduction

The corbelling method used to line pits with bricks has the advantage that a small economical slab can be placed over a large capacity pit. Those pits built in trials are generally constructed so they have internal diameter (between bricks) ranging from 1.3m to 1.5m at the pit base. The internal diameter at the top is around 0.8m to 0,9m. The depth is normally 2m but can be increased to 2.5m by digging down further within the brickwork. This capacity should last for 10 or more years for an average family.

This new technique, where lateral pit seepage is encouraged by the provision of a series of holes in the side wall of the pit, is best used where the pit contents build up as liquor, and not as a solid. Ecological pit toilets are shallow and the addition of soil and ash is encouraged in larger quantities to promote composting and reduce smells and flies.

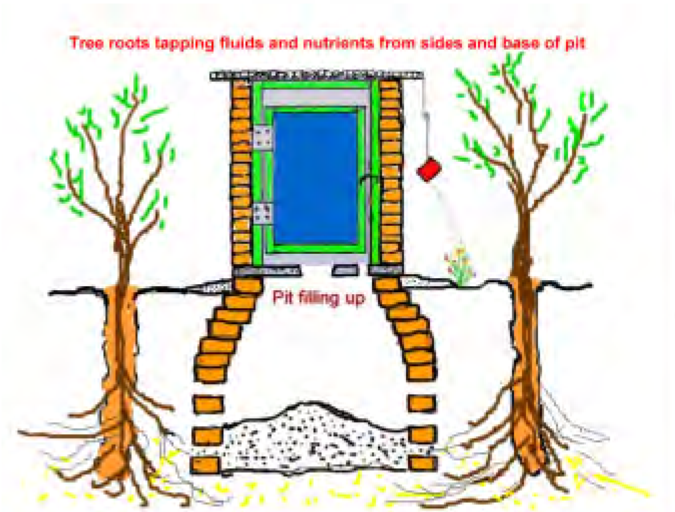
This design works on different principles. The addition of wash water is encouraged (as in a normal Blair VIP toilet), so that the pit fills with a liquor rather than a solid. Thus the use of the toilet as a bathroom is thus encouraged. Ash can be added to help reduce flies and odours. An important part of this design is the biological component – a series of trees planted around the pit. The trees are planted in a circle in a series of drilled tubes about 1m deep. The tubes are filled with a mix of compost and soil to encourage fast growth and deeper root penetration. Diluted urine can also be added to the trees to accelerate growth (see separate manual). As the trees grow they are able to tap the nutrients supplied from the pit which will accelerate their growth. Suitable trees like gum (*Eucalyptus grandis*) will also extract moisture from the surrounding soil, thus reducing liquor penetration to deeper layers.

The value of the brick lined pit is that it can be built with a large capacity and makes the pit stable. Unlike the *Arborloo*, there is no need for annual movement of the toilet. However trees planted around the pit can take advantage of pit nutrients if the pit walls are permeable to liquors.

Fully lined corbelled pits 2m deep with an internal diameter of 1.3m can be lined with bricks using mortar from a single 50kg bag of Portland cement (30 litres) with enough cement left over to make a 1m or 1.1m diameter concrete slab (which uses 10litres). A full bag of cement holds 40 litres. This is a very economical way of using a single bag of cement.

This refinement (adding seepage holes in the side walls of the pit lining) also reduces the number of bricks required in the pit lining. This is because 8 courses of the brickwork are made with holes, which reduces the number of bricks used for every course built.

This manual describes the construction of a corbelled and permeable pit lining. This is achieved by building up the brickwork in the normal fashion and leaving spaces in the brickwork. In this case discarded alloy cans have been used to make the holes in the pit wall.



Diagrammatic view of root growth formation around porous pit lining

The constructional technique

1. Dig the pit

The pit is dug in a suitable site 1.6m deep and 1.6m wide. The depth can be increased to 2m or more if sufficient bricks are available. The side walls are dug vertical and the pit base level.

2. Make the cement mortar for the pit brickwork.

Prepare mortar by mixing 16 parts of pit sand with 1 part of Portland cement. This can be prepared in smaller lots using 5 litres of cement mixed with 80 litres (8 X 10 litre buckets) of pit sand.

3. Make the first course of brickwork at the pit base.

A ring of bricks is laid in mortar around the base of the pit. In this case 21 bricks were used in the lowest course of bricks.

4. Start the special porous lining technique.

This is done by placing used alloy cans in spaces made between bricks in each course. Mortar is laid around the cans as well as around the bricks.

The cans are laid between the bricks and cement mortar laid around them.


About two courses are laid with the alloy can inserts. Then the cans are removed with a twisting motion and used to make holes in higher courses. The cans must be removed when the cement mortar it fresh.


The number of bricks used per course is reduced from 21 and 16.


8 courses of the special pit lining with seepage are built followed by normal brick lining. In this pit the internal diameter of the brickwork was 1.4m.

5. Carry on lining the pit using the corbelling technique

The lowest brick course and the special lining technique will raise the pit lining by about 0.9m. That is about 10cm per course. The courses above this are stepped in a small amount at every course so the diameter of the pit lining is reduced. The mix of 0.5 litres of cement with 80 litres of pit sand to make brick mortar will bond about 4 courses of bricks.


Each brick course is stepped in about 2cm so the overall diameter of the pit lining is reduced as the pit lining goes higher




The corbelling continues above ground until the external diameter of the brickwork is just slightly more than the diameter of the concrete slab. In this case it 1.03m. The base of the pit is cleaned out of all mortar which could clog the base of the pit.


The space between the pit and the brick lining is then filled with soil to ground level. The slab is then placed on the pit lining i n a bed of weak cement mortar (16:1)


It is important that the concrete slab is level. Stones may be used to prop up the slab to make it level, then cement mortar is placed below and on the sides of the slab all round to support it. Once the slab is fitted construction of the superstructure can begin. In this case the brickwork rose 20cm above ground level making the total depth of the pit 1.8m. 360 bricks were used and less than 30 litres of Portland cement leaving able to make the concrete slab.

Teaching Ecological Sanitation in Schools

How to make a 1.1m diameter concrete slab for use on the Arborloo, Fossa alterna and Blair VIP toilets

Peter Morgan

Introduction

A strong concrete slabs lies at the heart of a sound toilet structure. Slabs can be made round, square and rectangular to suit different situations. Also slabs can me made in a variety of sizes from 0.9m to 1.2m if a vent hole is to be fitted in addition to the squat hole. The ideal size is 1.1m as this is not too heavy to move and also when fitted to a brick lined pit a round brick superstructure can be built on top of the slab around the rim. The circular slab is convenient because it can be added to a ring beam on lower cost Arborloo toilets or can be added to round pits which are lined with bricks using the corbelling technique. This manual describes how to make a 1.1m diameter slab.

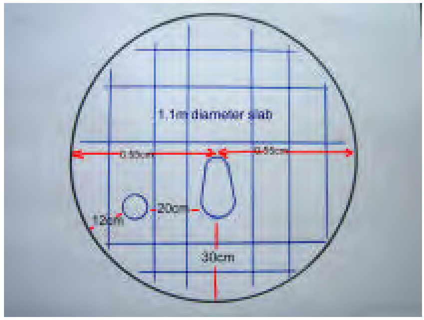
Making the slab

Prepare the shuttering and moulds for vent pipe and squat hole

The shuttering for the concrete slab can be made from a ring of bricks laid on levelled ground. The bricks are laid around a circle 1.1m in diameter (radius 5.5cm). The bricks can be laid on a plastic sheet placed on the ground. Alternatively the ground can be levelled off and river sand laid down and levelled off and the circle of bricks laid on the sand. The sand should be moistened with water. Using a centre mark, bricks are laid around in a circle. A string or wire radiating from a nail placed in the ground is ideal. Or a length of 3mm wire bent at both ends at a right angle to form a 1.1m circle. A mould which has been made for the squat hole is then laid 30cm from the rear end of the slab. This can be made from a 15 litre plastic bucket, with a wire to make the shape), or a commercially made squat hole mould. A durable steel squat hole mould is made by V & W Engineering (who also manufacture shuttering to make both the slab and the ring beam). The vent pipe hole is 110mm in diameter. The vent hole is made using a 75mm length of 110mm PVC pipe. This is laid to one side of the squat hole, so the lower edge of the pipe hole and the squat hole are in line (see diagram). The vent hole is caste 12cm in from the edge of the slab. The distance between the vent hole and squat hole should be about 20cm.

The wire reinforcing

3mm steel wire or barbed wire can be used for reinforcing. For the 1.1m slab 3 pieces 1.1m and 4 pieces 0.9m and 4 pieces of 0.6m are used. The wires are laid on the concrete when half has been added. The remaining half of the concrete mix covers the wire.



Figures 10 & 11: Brick mould for slab showing the dimensions for locating squat and vent pipe holes and also position of the 3mm wire reinforcing. Diagram showing layout of wire reinforcing.

1.1m diameter concrete slab being made by school children. Steel shuttering is used and a steel mould for the squat hole.

The concrete mix

The slab is made with a mix of 10 litres of Portland cement (PC 15) and 50 litres of clean river sand. The dry ingredients are thoroughly mixed and then water is added to make thick concrete. Mix thoroughly. A 50kg bag of cement contains about 40 litres of cement. The remaining 30 litres of cement is used to make mortar to line the pit with bricks.

5 X 10li buckets of clean river sand and 1 X 10li bucket of Portland cement are used to make the concrete. These are thoroughly mixed, water added and thoroughly mixed again.

Adding the concrete to the shuttering

Add half the concrete mix within the shuttering and around the squat hole and vent hole moulds and level off with a trowel. The reinforcing wires are then added in a grid formation as shown in the diagram and photos. The remaining concrete is then added and levelled off with a wooden float and then a steel trowel. After two hours the squat hole and vent hole moulds are carefully remove and the edges of the squat hole smoothed off. Lay some thin poles over the slab and cover with plastic sheet and leave overnight. Once the concrete is hard the following morning add water and cover again with plastic sheet (or sand). If a ventilation pipe is not going to be used immediately the vent hole can be filled with a small weak mix of sand and cement (15:1). Place a ring of plastic sheet in the hole first and then fill with concrete. This forms a plug which can be knocked out later when the pipe is fitted.

Start by adding the concrete mix around the vent and squat hole moulds. Then build up the concrete using half the mix. Add the wires on top of the concrete and press in.

Using the rest of the concrete mix add to the mould and level off. After about 2 hours carefully remove the squat and vent hole moulds and the outer shuttering. Neaten up any edges with a trowel. Cover with plastic sheet and leave for a week to cure. After the first night water down thoroughly and keep wet for the whole week.

Curing

The slab is left to cure for at least 7 days. It is kept wet under plastic sheet or paper all the time. It can also be covered with sand which is kept wet. The curing process (where the slab is kept wet all the time and not allowed to dry out) is very important. Slabs only develop strength when cured properly. If they are allowed to dry out once made, they never develop strength. Curing is essential for a long life concrete slab. The longer the slab cures the stronger it will become.

Adding the slab to the ring beam or pit lining

Move the slab carefully and place on the ring beam or pit lining. It is best to add a layer of thin mortar around the ring beam or on the upper course of bricks in which to bed down the slab. It is important that the slab is bedded down evenly all round to avoid cracking.

Bedding down the slab in a ring of weak cement mortar is important.

Teaching Ecological Sanitation in School

Making a 1.2m concrete slab suitable for both brick and tubular vent pipes

Peter Morgan

Introduction

This series of manuals has described making concrete slabs which are suitable for tubular vent pipes placed within the toilet structure. This design and configuration allows for a small economic 1.1m diameter slab to be made which can be adapted to suit a wide range of substructures and superstructures. In 2010 the Government of Zimbabwe relaxed its policy of standardising on the brick Blair VIP (BVIP) toilet alone to include an additional design called an Upgradeable BVIP (uBVIP). In this version the basic requirement is for a brick lined pit and a covering concrete slab, which allows the owner to upgrade in a sequence of steps to attain the final brick built Blair VIP. The starting point is a brick lined pit of suitable capacity capped by a slab which has both squat and vent holes. The government specifies that the range of vent pipe options should include those made from bricks as well as tubes (eg PVC or asbestos etc). In fact the specified pipe in the existing technical option for Zimbabwe is made from bricks, although tubular pipes are also fitted.

This new revision of policy which is regarded as a relaxation of the earlier policy necessitates a change in the configuration of the vent and squat holes in the concrete slab and also a slight enlargement of the slab from 1.1m to 1.2m. The existing policy recommends a 1.3m diameter slab built over a pit 1.1m in diameter and 3m deep.

In order to satisfy the new revision of government policy the Chisungu schools program started to build revised slabs with the intention of building a range of substructures and superstructures which could be adapted to use both brick and tubular pipes and also superstructures fitted with doors and without doors (spiral shape).

Brick built pipes can be constructed at relatively low cost with traditional materials (locally made fired bricks) and cement mortar. That is why they have been specified in the existing policy for decades. However brick pipes are bulky and heavy and are not suitable for light weight structures built on ring beams (such as the *Arborloo*). Neither can they be built inside superstructures since they take up too much space. Brick pipes must be constructed outside the superstructure and in fact form part of the brick superstructure of current brick built BVIP designs. This necessitates that the diameter of the slab must be greater than 1.1m. In current designs a heavy 1.3m diameter slab is specified and even this is smaller than the original 1.5m diameter slabs specified in the early 1980's. However in modern Zimbabwe an era of constraint dictates that cement should be used sparingly and carefully so that the investment made is good value for money and time. Also donors are no longer willing to provide the large material subsidies offered in former times.

Consequently a smaller, lighter and more economical 1.2m diameter slab which permits the construction of both brick and tubular pipes has been designed for the schools program. This uses 12 litres of Portland cement and 50 litres of clean river sand (5:1) and 3mm wire for reinforcing. A total of 10m of 3mm wire is used per slab (4 X1.1m + 4 X 1m + 3 X 0.5m). Slabs are caste within steel shuttering as the photos show, but can also be cast within brick moulds.

Earlier 1.1m design (left) for tubular pipes placed inside structure. Later (right) 1.2m design used for wider range of pipes. The 1.1m slab uses 10 litres of cement per slab and the 1.2m slab 12 litres of cement per slab.

Sequence of slab construction

In this case steel shuttering has been used as a mould 1.2m in diameter. The hole for the brick vent has been made 140mm in diameter using a short length of PVC pipe as mould. The squat hole in this case is made using a specially designed steel mould. The brick pipe has a square cross section but a round hole has been chosen to provide extra strength at this point. The 140mm hole is placed 110mm from the edge of the slab and the vent and squat holes are 300mm apart. The squat hole is 300mm long and 150mm wide. The holes are placed down the centre line of the slab.


The slab is being cast over sand on the ground which has been wetted and smoothed down. The moulds for vent and squat holes have been laid in position down the centre line of the slab. The role of 3mm wire is cut into lengths (see above) to reinforce the slab.


A mix of 12litres of cement (one level 10litre plastic bucket) and 60 litres of clean river sand (five level 10 litre plastic buckets) is thoroughly mixed and water added to make a slurry like concrete. This is added into the shuttering around the moulds which are held in position whilst the concrete is added.

Half the concrete mix is added first and levelled off. Then the lengths of 3mm reinforcing wire are added as shown.

The remaining concrete mix is added and then levelled and compacted with a wooden float or bricks. Then it is smoothed down with steel floats.

After about 2 hours the squat hole and vent hole moulds are removed. The outer shuttering is also removed. The slab is covered with plastic sheet and left overnight to harden. The following morning it is carefully watered and covered again. To gain the proper strength before moving the slab should be kept wet and covered for at least 7 days.

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Options for the substructure (lined pit)

Once the slab is cured it can be mounted over a suitable brick lined pit. The pits can be of various depths and diameters. The pits can be 2m deep and corbelled or 3m deep and straight walled. The internal diameter of the 2m deep corbelled pit can be 1.3m in diameter or the straight walled 3m deep pit can be 1.1m in diameter. If sufficient cement and bricks are available, pit size can be increased in size. In all cases the uppermost external diameter of the brick lining should be 1.2m one or two courses of bricks above ground level.

Simple early “start up” superstructures

The superstructures built on and around this slab can be spiral shaped without doors or “horseshoe” shaped with doors. Treated poles and grass can be used at first but brick built structures are much preferred, as they are much more durable.

The very simplest first step is to surround the slab with a simple grass and pole structure and cover the ventilation pipe hole with a small concrete cover. Alternatively the vent hole can be filled with a weak mix of cement and pit sand (20:1) which can later be knocked out when the pipe is built or fitted. At first odours and flies can be controlled by regularly adding wood ash to the pit to cover fresh faeces. Also a cover can be placed over the squat hole to reduce flies.

1.2m slab with vent hole filled with weak cement mortar. This can be used as a start up slab. When the upgrade takes place and a pipe is built or fitted, the weaker mortar is knocked out exposing the vent hole in the slab. The alternative (right) is to make a small concrete cover and mortar in place over the vent hole.

Demonstration of brick "horseshoe" shaped structure

In this case the area within the toilet is extended forward in front of the slab. The shape of the structure becomes horseshoe shaped. As described in earlier manuals, two treated poles are placed in holes dug in the ground in front of the slab. The distance between the squat hole and each pole is about 65cm. The photos below show a demonstration unit being built at the school.


In this demonstration the slab remains on the ground where it has been cast. The bricks are laid on the slab and in front of the slab so they join the two door posts which are 50cm apart. In this demonstration the poles are 65cm from the front of the squat hole. The arrangement of bricks which form the vent pipe is also shown. There are four bricks per course in this vent pipe which is built around the 140mm hole.


A series of bricks is then laid in front of the slab and around the door posts. This forms a temporary mould in which concrete will be laid to form the front part of the toilet floor. The concrete mix (about 8:1 with river sand) is laid down level with the slab. The toilet wall will be built on this foundation.


The finished toilet floor before mortaring the bricks in place. The arrangement of the brick pipe around the 140mm diameter hole.


Using a weak economical cement mortar mix (20 parts pit sand to 1 part PC15 cement) the bricks of the vent and walls are bonded together. If traditional anthill mortar is used for the walls, the pipe should still be mortared with cement mortar.


The bricks are laid in the mortar so they join up with the door posts in a gentle curve (horseshoe shape). A second course of bricks is laid for the vent pipe. The brick walls and pipe are then extended upwards so the final height of the wall is about 1.8m and the vent 2.3m.

Bonding the brick vent

The courses of the brick pipe are linked to the brickwork of the wall. This continues as the courses of the wall and vent are built up.

The brick vent pipe can be built at low cost and is very durable. It is later capped by a corrosion resistant fly screen.

After the demonstration has been built the floor was cleaned down to allow the cement floor to cure smoothly. Building brickwork always leaves pieces of mortar on the toilet floor. Later the floor will be dished to allow for cleaning.

Demonstration of brick spiral shaped structure

The more durable and popular Blair VIP is the brick spiral version. This has the advantage that it has more space inside and no moving parts (eg door). If made correctly it can have a long life span. The life is normally linked to the capacity of the pit. Larger pits have longer lives. This version of the BVIP uses more bricks (about double) compared to the version fitted with a door. The roof area is also much larger. It is also more difficult to take apart and rebuild. The following photos show a demonstration of this unit being built by children at the Chisungu Primary School.


The bricks are laid down in a spiral (square or round spiral or combination of both as in these photos). The bricks for the wall foundation are also laid. The distance between walls at the entrance varies from 50cm to 60cm. The entrance to the toilet cubicle is the same. In this case the toilet entrance is 50cm wide.


Particular attention is paid to the four bricks making up the brick pipe. The brick pipe forms part of the brick superstructure.


A foundation of bricks is also laid at the entrance. The first course of bricks is laid over the slab and foundation to demonstrate the shape of the structure.

Using tubular pipes with the same slab.

The brick pipe has been the most popular type used in the rural program because it can be constructed from locally available fired bricks. However tubular pipes can also be fitted to the slab and are more efficient than brick pipes, although they are expensive to buy. A special concrete adaptor is made to fit over the 140mm vent hole for the 110m pipe. This can be cast in strong concrete (3:1) about 16cm X 18cm within bricks using a short (75mm) length of 110mm PVC casing as an internal mould. Four 3mm wires can be set in the concrete as reinforcing. The adaptor is bonded to the slab above the 140mm vent hole in cement mortar.


The concrete adaptor is made in strong concrete. This is bonded to the slab over the 140mm hole. The same series of superstructures can be built using the tubular pipe. These include simple grass and pole structures to brick structures built with doors or without doors.

A versatile slab

The 1.2m concrete slab is a versatile unit which can be used with a wide range of substructures (brick lined pits) and superstructures. In the upgradeable BVIP series, a vent pipe may not be fitted at first. In this case the vent hole is filled in with a weak cement mortar or capped with a concrete cover. A simple superstructure is then built around the slab for privacy. This unit can be upgraded over time by the family according to its wishes and to the funds available for construction. There is a wide choice of routes to follow up the sanitation ladder. Both tubular and bricks pipes can be fitted to toilets which have superstructures made of several materials. Fired brick structures are more durable and the door-less spiral version is the most durable.

The basic 1.2m slab

1.2m slab with vent hole filled in (temporarily) or with concrete cover.

1.2m slabs fitted with brick pipe or adapted for 110mm tubular pipes.

Teaching Ecological Sanitation in Schools

How to make a variety of toilet houses with poles and grass

Peter Morgan

Introduction

The use of treated gum poles and thatching grass can make very effective and durable superstructures for lower cost toilets. This manual illustrates three methods of using treated gum poles and thatch to make suitable structures:

Model 1. Poles placed in ground and straight walls with larger flat roof of poles and cement impregnated hessian
Model 2. Poles in ground and conical walls with domed roof of cement impregnated hessian
Model 3. Poles formed into panels which are each thatched with grass and mounted on the slab with a domed roof of cement impregnated hessian

MODEL ONE

Poles placed in ground and straight walls with larger flat roof of poles and cement impregnated hessian

In this demonstration a fibreglass slab has been used and placed over a concrete ring beam placed over a shallow pit. 6 holes are drilled with an auger around the edge of the ring beam

A door frame is prepared to attach between the two poles at the front of the toilet

The door frame is fitted to the main "king post" with rubber hinges. Meanwhile a timber roof frame is made up to fit over the 6 upright poles.

The roof frame is fitted and nailed to each of the upright poles

3 wires are attached tightly around the poles on to which the grass will be attached. Using thatching rope the grass is added to the structure.

3


Once fully thatched a cement impregnated roof sheet is made on flat ground and left to cure for 3 days under plastic sheet.


After curing the cement impregnated hessian sheet is lifted and carried to the toilet


The door is added to the main "king post" with rubber tyre hinges and a door covering made (hessian).

Model two

Poles in ground and conical walls with domed roof of cement impregnated hessian.


This grass structure is placed over a lined pit fitted with a 1.1m concrete slab. 8 poles are used in this case and holes are drilled in the ground around the slab to take the poles.


Each hole is drilled about 60cm down into the earth. The poles are treated with a mix of engine oil and creosote.


A 100mm nail is driven into the end of each poles. The domed roof (see instructions in another manual) has been predrilled with holes which the nails pass through. Each nail is bent over to secure


The poles should ideally be 50mm to 75mm in diameter to accept the nails and make the structure rigid. The soil around the poles is rammed hard in place.


A door is made to match the shape and distance between the two front poles. This is fitted with car tyre hinges and attached to the left hand post.


The structure is then thatched completely on 4 wires fitted to the posts. Thatching string is used. The door is fitted with a hessian covering

Model three

Poles formed into panels which are each thatched with grass and mounted on the slab with a domed roof of cement impregnated hessian

This model uses 12 upright poles to make 6 separate panels joined together top and bottom with shorter poles. The upright poles are 1.9m long, the lower spacer poles are 55cm long and the upper spacer poles 35cm long. The wooden panels are nailed together.

The panels are mounted over the slab (on a ring beam in this case) and held together with rubber initially, then wire.

Using wires attached to the side poles and thatching twine, the grass is attached to each panel. 5 panels are made up with one panel being used to support the door.

A domed cement impregnated hessian roof is added on top and can be wired in position for security.

A suitably sized door panel is made and fitted the main post with rubber hinges. A hessian door covering is attached to provide privacy.

Teaching Ecological Sanitation in Schools

(Outreach program)

How to make a toilet with gum poles and fabric or hessian as walling

Peter Morgan and Annie Shangwa

Introduction

It is possible to erect simple toilets very rapidly if treated gum poles and tough materials are available for making the walls of the toilet house. In these examples cotton fabric and hessian sheet were used to make the toilet house walls and doors. In both cases described the roof was fabricated from cement impregnated hessian sheet to form a dome.

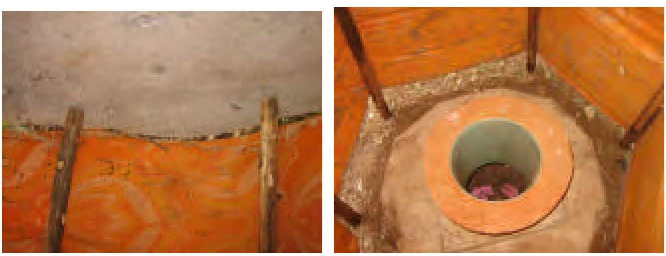
Where gum poles are placed in the ground it is essential to treat the poles against termite attach. This can be done by buying pressure treated poles or by soaking untreated poles in a mixture of creosote and old engine oil. Some measure of protection can be gained my mixing wood ash with the soil used to ram the poles in place within the holes made for them. But termites are very determined and proper treatment is recommended.

In this case the toilet was made for a girl child and was fitted with a pedestal made from a bucket and concrete. The toilet was an *Arborloo* type made with a brick ring beam and small concrete slab.

The gum poles in this case were only 1.8m long (fence posts) but were ideal for use in the children's toilet. The lower 0.5m was treated with a mix of creosote and old engine oil. 6 holes were drilled with an auger around the ring beam. The tops of each poles were drilled with a hole and a 100mm nail was driven into the end for attachment to the domed hessian cement roof.

View of the nails hammered into the poles before and after the hessian cement roof was fitted.

A fabric sheet is wrapped around the toilet to provide privacy. It is held in place with wire. A simple door (without hinges) has been added. In this case using poles and an opened plastic sack held at the top and weighted at the bottom.



The interior of the simple toilet

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The door made of hessian sheet and poles


A length of hessian sheet was cut and folded and stapled (or sewn) so that a thin gum poles could be attached to the upper and lower ends. The gum pole at the upper end was supported by two nails driven into the front house poles. This was held firm with wire.


Another pole was placed through the pocket made at the lower end of the hessian sheet. The door this hangs under its own weight.

A similar structure made of hessian sheet

A similar arrangement of treated poles can be covered with hessian sheet as the following series shows


The ring beam is placed in a suitable position. The slab, door and roof are prepared.


6 holes have been drilled around the ring beam and treated gum poles placed in each. In this method a short length of gum pole connects each upright pole near the top. A domed roof is fitted and nails are driven through the roof into the poles.


The hessian sheet is then attacked to the poles using cut pieces of wire used as nails.

5


The hessian sheet is fitted all round. The hole inside the ring beam can be dug before the toilet is built or during construction.


The door has been fitted with rubber hinges. The interior of the toilet, in this case fitted with a high quality fibreglass slab.


Teachers and staff talk to the homestead family and pupils on how to manage the *Arborloo*. The completed unit in Epworth.

Treating the hessian with cement paint.

The hessian may last longer and be less prone to damage if it is treated with cement paint. The paint is made by mixing Portland cement with water to make a liquid which is then applied to the hessian cloth with a large brush. To aid hardening a small tin of salt can be mixed in the water before it is added to the cement.

The cement mix is made in a large bucket and thoroughly mixed using long rubber gloves.

All the panels are treated with the liquid cement which is applied with a large brush.

The door panel is also treated. A hand washing facility has been fitted.

Teaching Ecological Sanitation in Schools

Making self closing doors for toilets

Peter Morgan

Introduction

For many years toilets built in the rural areas of Zimbabwe have been built with door-less spiral shaped structures. These units have no moving parts and have proved to be durable. However the roof area and walling of spiral structures uses a lot more material than smaller structures fitted with a door.

If a vent pipe is fitted and the properties of a VIP are required it is important that the interior of the toilet is semi dark. This means that if a door is fitted it must have hinges which are self closing. Self closing hinges can be made of suitably cut pieces of car tyre and nailed or screwed to the door and to the post on which it is hung.

There are several ways of making a light weight door. The method used in the Epworth Schools program uses wooden timbers called “brandering.” With some local skill gum poles could also be used. Plywood panels are used to link the various lengths of “brandering” together. Nails are used. The pieces of car tyre can be cut with a sharp knife. The door panel itself should be light and can be made of hessian sheet or cement treated hessian. Heavy duty shade cloth can also be used. It is best that the wood is treated in some way to avoid attack by termites. If the door is attached to posts which are made of treated gum poles, the termites may not pass up the pole to the wood of the door. Doors and roofs are made by the pupils as part of the schools program in Epworth.


Door frame made of “brandering” can be made with vertical sides or slanting sides to fit the type of doorway required. Also the middle reinforcing timber can be a diagonal or straight across as shown above. In each case the timbers are held together with plywood triangles nailed to the brandering as shown. This seems to be fast and effective for light doors.

The rubber hinges are made from car tyre, cut with a knife. They can also be made from sheets of polyurethane.

Method of fitting the door frame to the supporting pole

Two strong pressure treated gum poles form the "king posts" of several structural designs for new toilet houses. The poles are placed in holes drilled in the ground at the front of the toilet slab.

The upper and lower hinges nailed into position

Pupils making doors


Pupils putting together the door frame with triangular pieces of plywood and nails.


Pupils cutting the rubber hinges from car tyre.


Pupils attaching the rubber hinges to the door frame and supporting pole.

The material used to cover the door should be durable and light weight. Thin sheets of galvanised tin work well. A low cost method uses cement impregnated hessian sheet (2 layers) which is nailed to the door frame and painted. Doors do need care and maintenance to last.

Making and fitting a door panel

Once the door frame and hinges are made a door panel must be fitted to provide privacy. The panel can be made from a variety of materials including plywood, thin galvanised tin sheet, cement impregnated hessian, heavy duty shade cloth etc.

Making a door panel from cement impregnated hessian


Two sheets of hessian are cut to the required size to fit the door frame (0.5m X 1.5m in this case). A cement paint mix is made by adding 2litres of Portland cement to 1 litre of salty water (about 2 tablespoons salt added).


Using rubber gloves the cement paint is poured onto the hessian and rubbed in with the hands wearing rubber gloves (the cement is caustic). Once the first sheet is soaked the second sheet is applied over the first and rubbed in. More cement paint is applied all over. The hessian is covered with plastic sheet for several days before it is moved and mounted on the door frame with small nails. It is also best to paint the door panel with enamel paint to make it more attractive and long lasting.

Fitting the door panel and painting


Using small nails to attach the hessian cement panel to the door frame


The cement impregnated hessian door panel has been mounted on the door frame with small nails. It is allowed to dry and then painted with enamel paint if decoration is required. The door and its frame may require ongoing maintenance. The door panel and hinges must be kept in good condition and replaced in they are worn or damaged.

Teaching Ecological Sanitation in Schools

Construction of flat cement impregnated hessian roof sheet supported on wooden frame.

Peter Morgan

Introduction

Cement impregnated hessian is a useful material for making roofing sheets which are durable. Unlike the domed roof which is self supporting, the flat hessian sheeting is flexible and requires support from a wooden frame made from gum poles or wooden "brandering" used in the building trade. This manual describes the construction of roof panels of two sizes, 1.4m X 1.5m supported on a frame made of brandering and 1.8m X 1.8m supported on a frame made of gum poles.

1. Making the wooden roof frame from brandering

Roof frame from "Brandering"

The roof frame can also be made of brandering. In this case 7 pieces are cut to make a frame 1.4m wide and 1.5m long to suit the structure on which it will be placed. 5 pieces are cut 1.2m long and 2 pieces 1.4m long. The roof sheet overlaps a little all round.

The pieces of wood are cut and can be nailed together. They can also be wired together as shown in these photos.

A roof frame wired together and wired to superstructure poles

Preparing the cement impregnated hessian sheet

In this case the cement impregnated roof sheet was made 1.4m wide and 1.5m long. 2 layers of hessian were used. 8 litres of Portland cement mixed with 5 litres of water to which 300mls salt had been dissolved. The salt was first dissolved in the water in a bucket and then the cement was added to the salty water and thoroughly mixed using rubber gloves. The first hessian sheet was laid on a large piece of plastic sheet and the cement paint rubbed into the hessian all over. The second sheet of hessian was then added and more cement paint rubbed in all over. For extra strength and durability a third sheet could be added. In this case 10 litres of cement and the 6li water (and salt) is sufficient mix for the three layers of hessian. Finally the roof sheet was covered with another sheet of plastic and left to cure for several days before being lifted in position. This hessian cement method is useful for a variety off sizes of roof panel. The salt helps to harden the panel. The three layered version is stiffer and stronger and is preferred.


The cement paint is prepared and the hessian sheet laid on plastic sheet,


The cement paint is thoroughly rubbed into the first hessian sheet. Extra cement is added and the second hessian sheet is placed over the first. More cement paint is rubbed in all over. Then the sheet of covered with plastic sheet to cure.

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Placing the wooden frame and roof sheet on the structure

There are two methods of adding the roof frame to the structure. The frame can be added first and the roof panel placed on this later or the roof panel can be added to the frame and the combination placed on the structure. In this case the frame was added to the structure first and the panel added later.


Attaching the frame to the simple treated gum poles structure. And adding the cement filled hessian sheet to the frame.


The roof sheet is attached to the roof sheet using small nails. The roof frame can either be nailed or wired to the supporting poles.

Roof frame from gum poles.

The roof frame is made from 9 small gum poles 1.8m long. These are bound together with thatching twine as shown in the photos. The roof timbers are cut to match the superstructure. In this case about 1.8m square.


Binding the roof timbers with thatching twine

2. Preparing the hessian sheet

The hessian sheet is cut and prepared to match the structure and roof frame. Standard hessian cloth has a width of 1.4m and is sold by the metre in Zimbabwe. In this case (to make a sheet 1.9m X 1.9m) 2 pieces are cut 1.9m X 1.4m and 2 pieces 1.9m X 0.7m. A plastic sheet is laid on the flat ground and the first later of hessian sheet is prepared so it measures 1.9m X 1.9m.

Laying the plastic sheet on the ground and laying the hessian sheet over this. Later the plastic sheet will be folded over to cover the hessian during the curing stage,

3. Preparing the cement paint

A cement paint mix is prepared by adding 10litres of PC15 (Portland) cement to a large bucket and adding 6 litres of water to which 400mls of table salt has been dissolved. The salt accelerates and helps to harden the cement mix once it has soaked into the hessian. This paint is applied to the hessian sheet using a cup and is rubbed into the hessian using long rubber gloves. The cement is corrosive to the skin.


The cement and salty water are mixed in a large bucket and thoroughly stirred using rubber gloves.

4. Applying the cement paint to the hessian sheet

Using rubber gloves the cement paint is rubbed into the hessian all over. At the overlap between the two pieces the paint is applied all over one sheet before the second sheet is soaked in paint. This makes a good bond between the two sheets. Once the first layer has been soaked in cement paint the second sheets of hessian are laid on top of the first sheets and more cement paint is added. A little extra paint may be required to soak all the material.


Adding cement paint to the first layer of hessian. Adding the second layer of hessian, once the first layer has been filled with cement.


Adding the cement mix to the second layer of hessian so that the upper and lower layers of hessian bond together. Once the two hessian sheets are filled with cement the roof is covered over with plastic sheet and left to cure for several days.

5. Lifting the sheet after curing and placing on roof timbers


The flexible cement impregnated hessian roof sheet is carefully moved on to the roofing timbers

6. Adding roof to toilet structure


The roof is then carried to the toilet and fitted on top

7

The roof timbers are bound to the structure with strong twine or wire. The roof sheet is also bound on to the roof frame with strong twine (thatching twine).

Teaching Ecological Sanitation in Schools

How to make vent pipes from reeds and cement filled fabric

Peter Morgan and Annie Shangwa

Making low cost vent pipes for low cost VIP toilets

In ecological pit toilets soil and ash are added regularly to the pit for help form pit compost. These additions also reduce fly and odour nuisance. However a vent pipe does help to withdraw air and water vapour from the pit (or vault) and makes the interior of the toilet less smelly.

There are several methods for making low cost vent pipes for ecological VIP toilets. Most use the method of making paint by mixing cement and water and applying this to Hessian cloth or other material which is laid over a mould. The mould is covered with plastic sheet and can be made with PVC pipe. The cement filled fabric is allowed to cure slowly and the material can set very hard. Portland cement (PC15) must be used for this type of work.

Method of laying cement filled cloth over reed pipes.

If PVC pipe is not available it is possible to make a pipe in the form of a frame from reeds or slit bamboos. Cement impregnated material can then be wrapped around the pipe frame and left to cure and get hard. The reeds or slit bamboos should be around 2.2metres long. They can be wrapped around old tins with the bottoms cut out for support being held by strips of old car or bicycle tube. Alternatively the reeds can be bound together around a series of wire loops of a suitable diameter to form a tube. If well bound these tubes can be quite rigid and form an ideal frame around which the cement impregnated cloth can be wrapped. It is best to soak the material (old cloths, sacking, hessian, thin cloth etc) in the cement paint to which some sand has been added to give it extra strength. The material can be held in place over the pipe frame with string.

Making tubes out of reeds fitted over old tins or wire loops. The reeds should be around 2.1metres long. The reeds (or bamboo) can be drilled out at certain points along the length and the wire loops threaded through them. Or cut lengths of reed or bamboo can be bound to the loops with string.

Old cloth is cut up into suitable sized pieces and then soaked in a mix of cement (1 part) and fine sand (2 parts) which has been made into a thin porridge like mix. This cement soaked material is then wrapped around the pipe. The material can be held with string. Small lengths of pipe frame are demonstrated at first and wrapped with smaller pieces of material

Demonstrating the method of making vent pipes at Chisungu school. At first short lengths of tube are shown and covered with cement and sand soaked material. This is left to harden. It is best to cover the slurry filled material with plastic sheet to stop it drying out. The slurry gets hard because it cures and not because it dries out. This process takes time and once hardened it is best to keep the cement wet to gain maximum strength.


Stout tubes can be made with reeds. A fly screen is bound to the end of the tube either before or after applying the material.


Full length pipes being covered with cement and sand impregnated cloth at Chisungu school. The technique takes a bit of practice to get it right.


A section of the cloth is coated in a strong cement and sand slurry to demonstrate the method. The full length pipe completed.

4

Teaching Ecological Sanitation in Schools

How to make a hessian cement vent pipe

Peter Morgan and Annie Shangwa

Introduction

Very durable and effective vent pipes can be made using hessian sheets filled with cement paint. The paint hardens more quickly if salt is added. Earlier pipes were made 90mm in diameter, but the larger 110mm version is more effective. The following steps are used to make the pipe

1. Preparing the hessian sheets

Two pieces of hessian sheet are cut 2.3m long and 40cm wide.

2. Preparation of plastic sheets

Three pieces of plastic sheet are cut. 2 are 2.4m long and 40cm wide. The third is 2.5m long and 50cm wide. Two will be attached to the pipe mould (a length of PVC pipe), the third will act as a ground sheet

3. Preparation of pipe mould

The pipe mould is made from a 2.5m length of 110mm PVC pipe. The 40cm x 2.4m plastic sheet is folded twice along the length and attached along the length of the pipe with tape. Next the second 40cm x 2.4m plastic sheet is wrapped around the pipe and secured with tape. The third sheet of plastic forms a clean sheet on which the pipe is made on the ground. The first sheet of hessian is laid down over the ground plastic sheet.

The folded sheet of plastic is laid along the length of the PVC pipe and taped in place. Later this will be withdrawn from the mould first. The PVC pipe is then covered with another sheet of plastic and taped in place. The hessian sheet is then laid on a further piece of plastic placed on the ground. The application of cement paint now begins. NOTE: The folded piece of plastic is withdrawn first after the cement has cured and hardened. Without this folded plastic the hessian pipe would be difficult to withdraw from the mould.

4. Preparation of cement paint

The cement mix is prepared by placing 6 litres of Portland cement into a bucket. 3 litres of water are added to another bucket and a small tin (150 ml) of salt is added and dissolved in the water. This salty water mix is added to the cement and thoroughly mixed using rubber gloves.

Stages in the preparation of the cement paint. 6 litres of PC15 cement is mixed with 3 litres of water to which 150mls of salt has been added. Here salt is being added to the water.

The salty solution is being added to the cement. The PVC pipe mould is ready and the first sheet of hessian laid down on a plastic sheet on the ground.

5. Application of cement paint.

Using an old cup the cement paint is poured on to the hessian sheet and thoroughly spread around and rubbed into the sheet by hand using the rubber gloves. The paint should be thoroughly absorbed into the hessian. The PVC pipe is then laid down the centre of the hessian filled sheet which is then wrapped tightly around the pipe. Extra cement paint is applied along the joint to seal it well. The cement paint should be applied liberally.

Stages of apply the cement paint

The second sheet of hessian is then laid on the plastic sheet and the cement paint is applied all over. The pipe is then placed down the middle of the sheet and once again the cement filled hessian is wrapped around the pipe. Extra cement paint is added to thoroughly fill the hessian. The pipe is then mounted on bricks. Finally an extra strip of hessian is cut and placed around each end of the pipe to give extra thickness. This is also filled with the cement mix.

Further stages of pipe construction

5. Sealing off pipe for curing

After the hessian is thoroughly soaked with the remaining paint, the plastic sheet is wrapped around the pipe. This will ensure that the cement will cure properly without drying out and will develop full strength. It should be left in place for at least 7 days before removal.

 

The cement impregnated hessian is allowed to cure a little and is then covered with the plastic sheet

6. Removing pipe from mould.

The folded plastic sheet is first removed from the mould. This loosens the pipe from the mould a little. The hessian pipe can then be removed from the mould with the plastic inside. The plastic sheet is then withdrawn from the inside the pipe.

 

Remove folded plastic sheet first. This loosens the pipe a little so it can be withdrawn from the mould. Then pull out the PVC pipe from the outer hessian cement pipe. Care is required

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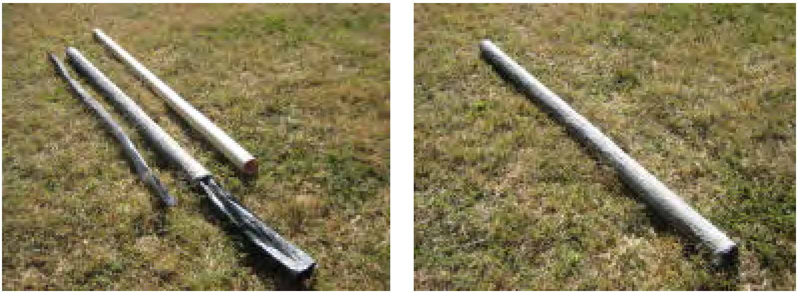


The plastic sheet is now removed from the inside of the pipe with a twisting motion. This leaves a free standing hessian cement pipe.

7. Adding the aluminium fly screen

To be effective as a fly trap fly screen should be added to the pipe. This is best made of aluminium or stainless steel as these are corrosion resistant. Aluminium screen is cheaper. A piece 15cm square is cut and attached to the end of the pipe with wire. Then a sheet of hessian filed with cement is wrapped around the pipe and covered with a plastic bag to help it cure. Leave for a few days before using.

Attaching the fly screen to the vent pipe

Making the vent pipe at the school

A length of folded plastic is laid down the PVC pipe mould and attached with tape. This is covered with another sheet of plastic which is also taped in position.

The cement paint is made as described earlier with 6 litres of Portland cement, and 3 litres of water in which salt has been added.

8

The cement mix is stirred thoroughly using rubber gloves.

The hessian sheet is then cut 2 pieces measuring 2.3m long and 40 wide. The first sheet is laid on plastic. The application of the cement paint begins.

The first hessian sheet is thoroughly soaked with the cement paint. This sheet is then wrapped around the plastic covered pipe.

The second sheet of hessian is then laid on the plastic next to the pipe and this is also filled with the cement paint. The second sheet is then wrapped around the pipe over the first sheet.

Further stages in pipe making

The hessian sheet is rubbed down thoroughly and any left over cement paint applied.

An additional piece of hessian is applied at each end of the pipe to strengthen it. The pipe is mounted on bricks and covered with plastic and allowed to cure for at least a week.

Withdrawing the pipe after curing


The pipe after curing. Removing the folded plastic sheet


Removing folded plastic sheet and withdrawing PVC pipe


A tug of war takes place and finally the pipe is removed. The plastic sheet is removed from inside the pipe with a twisting motion. The pipe is now ready for attachment of the fly screen

Teaching Ecological Sanitation in Schools

How to make pedestals

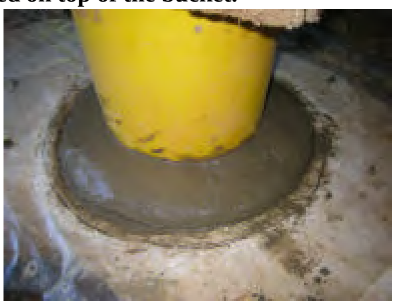
Peter Morgan and Annie Shangwa

MAKING LOW COST PEDESTALS

Very effective pedestals for sitting on toilets can be made with standard plastic buckets and concrete. If Portland cement is available the mix is one part cement to 3 parts sand. If masonry cement is available it may be best to make a 1:1mix. It is possible to make both a standard pedestal and a urine diverting pedestal using a 10litres bucket and concrete. The bucket provides the inside of the pedestal with a smooth wall which can be cleaned down. The outer shell of concrete (with some wire reinforcing) offers strength and durability. The unit can be painted in bright enamel paint colours once the concrete has been allowed to thoroughly cure and dry off.

The standard pedestal


A 10 litre plastic bucket is used and the base sawn off. The bucket is placed base down on a piece of clear plastic and a mark drawn 75cm around the bucket. To keep it secure a weight is placed on top of the bucket.

A mix of cement and river sand is now made up. If Portland cement is used the mix is 1 part cement and 3 parts river sand. If masonry cement is used a 1:1 mix is used. The concrete can be mixed in small lots with a litre of cement being mixed with the sand at any one time. The concrete is made into a neat round shape with a trowel. A ring of 3mm wire is placed inside the concrete.

This ring of concrete will become the seat of the pedestal. Additional concrete is then added half way up the side wall of the bucket. This is covered with a plastic sheet and allowed to cure for 1-2 days. The following morning the concrete is wetted down and a ring of 3mm wire prepared and wound around the middle of the bucket. The bucket is then carefully turned over.

The base of the pedestal is then built up in the same way using the same mark on the plastic sheet. A 3mm wire ring is placed in the concrete. The concrete is shaped neatly so that upper and lower layers meet to form a strong shell around the bucket. The pedestal is then covered with plastic sheet. The next day it is watered and kept wet for at least 7 days to cure.

After this period it is allowed to dry out in the sun. The seat section is then filed and sanded down to make it smooth. It can then be coated with enamel paint. Bright colours are best!

Children making the pedestals at Chisungu School


The procedure follows the one described above. A strong mix of cement and river sand is made.


The mix is applied with a trowel to the bucket mould


Wire loops are added around the bucket inside the cement to strengthen and prevent cracking.

The deluxe model!

The same technique can be used to make a very smart pedestal. In this case the pedestal is not painted by coated with an extra layer of cement mortar mixed with red oxide.

The 10 litre bucket (with base removed) is placed over a plastic sheet and a strong cement mortar (5 litres PC15 cement and 10 litres river sand) is added around the wider part of the bucket. A length of 3mm wire is placed within the cement. Next day the bucket s carefully turned over and the base made.

Once complete red oxide is added to a further mix of strong mortar and skilfully applied over the surface to make a fine looking pedestal.

Making to low cost urine diverting pedestal

This is made in a similar way to the simple pedestal, but additional parts are added to provide the urine diverting properties. A 20mm plastic polythene pipe is required and also a piece of specially shaped tin sheet (from a pea tin).


The base is cut off a 10 litre bucket. Carefully using a sharp knife a hole is made in the side wall of the bucket to take a 20mm polypipe fitting.


The hole must be cut precisely so the plastic pipe fits tight.


A tin sheet is cut from a tin, flattened and then cut into shape. This fits inside the bucket to form the urine diverter. It is held in place by wire.

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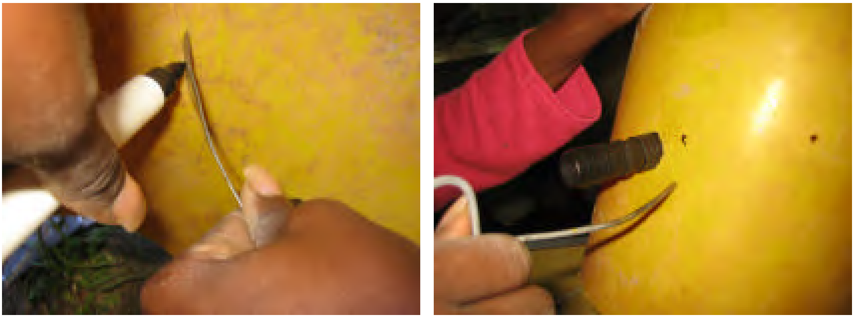

The position of the tin sheet is marked and a series of holes are made in the bucket with a hot wire.

Wires are then used to secure the tin in position. The wires are bent over the tin sheet.

One wire passes along the top of the tin sheet and through the bucket and is bent over at each end. This secures the tin well. Chewing gum is used to make a seal between the bucket and the tin sheet. The sheet can be replaced later if required. The wire is best galvanised so it lasts longer.


A mark is made around the bucket about 75mm away in a circle. Using a concrete mix and careful shaping the seat of the pedestal is built up. If Portland cement is available a 1:3 mix can be used (3 parts river sand and 1 part cement). If masonry cement is available the mix is 1:1. Make the concrete up in small quantities using a litre of cement at a time. A 3mm wire ring is inserted in the concrete. In this case the wider part of the bucket will be uppermost and have the seat formed around it. This is left to cure for a day.


After a full day of curing the bucket is turned over and placed back on the plastic sheet. More concrete is missed and built up around the base and also around the side walls of the bucket and around the plastic pipe. The concrete is then allowed to set overnight and then is cured over the course of a week or more. It is kept wet at all times to allow the concrete to develop full strength.


It is important that the concrete work be allowed to cure fully to gain maximum strength. After this period the pedestal is placed in the sun and allowed to dry out completely.


Rough edges are filed down with a steel file or smoothened with course sand paper.

After this the concrete can be painted with brightly coloured enamel paint. The unit will still work if not painted, but is more attractive if brightly coloured. The urine pipe placed above slab level makes it possible to divert the urine to a tree or plastic container even when the toilet is placed over a pit.

Teaching Ecological Sanitation in Schools

How to make urine diverting slabs

Peter Morgan and Annie Shangwa

Making a urine diverting slab in concrete.

Urine diversion is a relatively new technique which makes it possible to collect urine when using a toilet. Urine is directed into a urine catching area in front of the "drop hole" and is piped out of the toilet into a container or into a seepage area. The faeces drop directly into a shallow pit or vault built above ground level. Most urine diverting toilets are built above ground level. Some have a single vault, most have two vaults, the use of which is alternated. Sometimes a bucket or other container may accept the faeces. Ash and soil are also thrown down on to the faeces to help dry them out and promote composting. There are many ways of making urine diverting pedestals and squat plates. This method is quite simple and requires mainly cement, sand and wire. Some form of plastic container like a bucket is required to make the "urine catcher" and a pipe to lead the urine down from the urine catcher to a plastic container.

1. Making the urine diverting slab

(With urine outlet below slab)

First a plastic "urine catcher" must be made to fit into the concrete slab. In this case a 10 litre plastic bucket has been chosen. This is cut with a saw to the shape shown in the photos. It is best to use a pre-made template (a shaped piece already made) to fit over the new bucket and mark the outline. Then the bucket can be cut around the mark. Two "urine catchers" can be made from one 10li bucket.


The 10 litre bucket is cut with a saw. The width of the narrow end depends on the size of the squat hole. In this case a 160mm squat hole is used and the width of the narrow end is 170mm. The width of the wider end is 185mm.

A hole is drilled in the "urine catcher" as shown in the photo. Urine will drain through the hole into a pipe fitting and then through a plastic pipe to the outside of the toilet. The "urine catcher" is laid down over a sheet of plastic and placed close to a suitable mould for the squat hole (diameter about 160mm). This can be a round pipe. The end nearest the squat hole is held down with a wire or nail so it lays flat next to the squat hole. A mould of bricks is laid around these parts which offers a large enough in area to accommodate two foot rests on either side of the squat hole. The slab area can be the same as the final slab required, or smaller so that it can be adapted to fit into larger slabs of various shapes and sizes later. The smaller slab can be fitted within a larger mould and the extra concrete added.

Cut "urine catcher" placed within a brick mould together with a squat hole mould. Design by Annie Shangwa.

A hole in the "urine catcher" will become the lowest point when the slab is turned over. This is the drain hole for the urine. A 20mm plastic pipe fitting is placed over the hole and held in place by a length of wire (or screwdriver as shown). In this case a 20mm plastic hose connector has been used. But PVC fittings can also be used. This pipe can be attached before hand with hard setting putty. Or as shown in this case, can be held in place by the concrete which will be added. Urine passing into the urine catcher passes down the pipe into a plastic container or into a seepage area outside the toilet.

A strong mix of concrete is then prepared (3 parts river sand and 1 part cement). This is then added around and over the plastic parts. 3mm reinforcing wire is also added within the concrete.

The pipe connector held in place. Concrete mix being added to mould.

The concrete is added to a depth of 30 – 40mm. The concrete is laid carefully around the urine pipe. The concrete is allowed to cure for at least 3 days before the slab is turned over and laid on bricks, so the footrests can be added and the final surface of the slab made.

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The slab is then turned over and laid on bricks around the rim.

The wire used to hold the plastic is removed and the exit hole for urine smoothened down. The foot rests can now be added. These can be hand shaped or freshly made concrete can be placed in wooden moulds as shown.

Each foot rest mould is filled up and made smooth and neat. When the concrete has started to harden, the moulds are carefully removed and extra cement plaster is used to smooth down the entire surface of the slab.

The unit shown can be made as part of a complete slab (either round or rectangular), or (as shown above) it can be made as a special smaller unit which can then be placed within a larger slab caste around it. Where a smaller unit is made first, this can form the central part of a larger slab. The technique is shown below.

A hole is dug in the ground and a sheet of plastic is laid over it with a hole in the middle.

The slab can then be placed over the plastic sheet so the urine pipe enters the hole.

A circle of bricks is laid down around the slab to the required size. This is then filled with concrete with some reinforcing wire inserted. It is left to cure. This urine diverting slab offers a clean non absorbent surface for urine collection, which can be made at low cost.

2. Making a urine diverting slab

(Outlet pipe above main slab)

This is similar to the urine diverting slab described earlier, but the slab is designed so the pipe comes out above the main slab and not beneath it. Urine is directed into a urine catching area in front of the "drop hole" and is piped out of the toilet into a container or into a seepage area. The faeces drop directly into a shallow pit or vault built above ground level. This method allows the urine diverting device to be placed on top of an existing slab which can be mounted over a pit as well as an above the ground vault. The plastic components are made first.

Making the urine diverting slab

First a plastic "urine catcher" is made from a 10 litre bucket. This is cut with a saw to the shape shown in the photos. It is best to use a pre-made template (a shaped piece already made) to fit over the new bucket and mark the outline. Then the bucket can be cut around the mark. Two "urine catchers" can be made from one 10li bucket. In this case a plastic pipe is attached to the lower end of the plastic urine catcher and this directs urine to the slide of the slab in which the device is caste.

The 10 litre bucket is cut with a saw. The width of the narrow end depends on the size of the squat hole. In this case a 160mm squat hole is used and the width of the narrow end is 170mm. The width of the wider end is 185mm. A hole is cut in a 0.5m length of 25mm plastic pipe as shown.

A hole is drilled in the “urine catcher” as shown in the photo. Urine will drain through the hole into the pipe and then drain away to the side. The following photos show the sequence.

A long hole is cut in the 25mm polyethylene pipe

A hole is also cut with a sharp knife in the cut section of bucket at the lowest part where the urine will collect

Small holes are then drilled into the bucket, through which wires are massed to secure the polyethylene pipe. Urine will fall into the urine collector and then through the pipe and out of the slab.

This plastic "assembly" is then placed in a concrete slab as shown in the following photos. The assembly is placed in the middle of a mould made of bricks. It is then filled with strong concrete (4:1 river sand and cement). Note the plastic pipe passes through the concrete and then out of the slab. It will later carry urine to a container.

First additions of concrete. Note the polyethylene pipe passes through the concrete and then out of the slab area.

Later additions of concrete up to the level of the urine catcher

The two foot rest moulds are then added filled with concrete. These are allowed to set and the wooden moulds removed. The slab is smoothed down with a strong coast of cement mortar. The slab is cured for several days.

When cured the slab (which is quite heavy) can be mounted over the main toilet slab of a pit toilet or above the ground vault. The urine pipe is fitted with a connector to a pipe extension which is then led to a plastic container or a tree nearby. Ideally the concrete surface should be smooth and painted with an epoxy paint or a gloss enamel paint to reduce urine being absorbed into the concrete which will make it smell.

Teaching Ecological Sanitation in Schools

How to make hand washing devices

Peter Morgan and Annie Shangwa

How to make hand washing devices

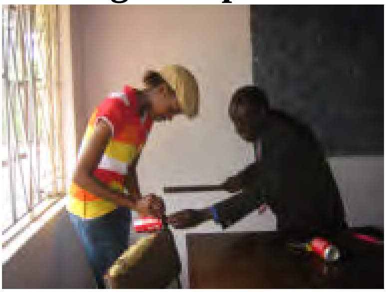
If health benefits are to be gained from a sanitation programme the inclusion of a hygiene and hand washing component is essential. Hand washers of many types are easy to make and cost almost nothing. They should be fitted to every toilet made. Hand washers can be made from tin cans and plastic bottles and cups as the following pictures show.

Making a simple hand washer from plastic bottle


There are several types of simple hand washer. This one uses a plastic bottle. Cut the bottom off about one third up. Make a hole in one corner of the base near the edge with a sharp nail or sharpened piece of wire.


Wrap some thin wire around the bottle and hook up to part of the toilet. To use the washer it can be dipped into a container of water on the ground or some water from another bottle can be added to the washer. The water comes out slowly, but it is sufficient to wash the hands. It uses water economically. Tin cans can also be used. This is described next.

Making a simple hand washer from an alloy can



Take an alloy can (coke etc) and take the top off with a can opener. Make two holes with a nail at the top of the can with a nail and another hole half way between these holes at the base of the can.

The can is placed over a log or pole which makes the hole easy to make with a nail. Two holes are made on either side of the can at the top. Then a single hole is punched into the base of the can in a position between the two holes at the top of the can. A good nail diameter is 3mm.

A length of wire about 30cm long is then taken and passed through the two holes at the top of the can. The wires are twisted together behind the can as shown. A loop is made at the end of the wire. The hand washer is hung from another wire attached to the toilet roof.


A container of water is required as a source of water. The hand washer is dipped into the water and then hung up on the wire hook. Then hands can be washed. A bowl of flowers or herbs can catch the washing water.

The water container for hand washer

The hand washing device requires a container of water beneath it from which to charge the washer. This can be made from a traditional pot or a bucket. To make a more permanent fixture the bucket can be mounted in a concrete base. The hand washing device can be hung on a wire hanging from the roof of the toilet or can be mounted on a wire attached to a pole mounted in the ground.


Hand washing device suspended on a wire fitted to the gum pole of an *Arborloo*. The water container can be a traditional clay pot or a bucket. Alternatively the hand washer can be suspended from a wire frame attached to a pole placed in the ground.

Mounting the bucket

The plastic bucket is placed in a suitable position just outside the toilet next to the place where the hand washer hangs. The bucket is then concreted in position as shown. Bricks are laid around the bucket and the space between the bucket and the bricks is filled with concrete. This is finished off neatly.

Fitting the hand washing device over flower or tree

The waste water which pours from the hand washing device washes the hands and then falls to the ground. It is a very good idea to use this water to irrigate a tree, flowers or herbs which are also valuable. A small garden or flowers or a pot of flowers or herbs can be placed under the hand washer so they are regularly watered.

Soap or wood ash?

Soap can be drilled with a hole and hung on a wire from the toilet roof. Also a wider tin container can be attached to the side wall of the toilet and filled with wood ash. The fingers are wetted first, dipped into the ash and then washed again. It is a very effective and simple method of washing hands.

Watering a flower garden or tree with the hand washer.

A tree can also be watered with used water from the hand washer. In this case the tree is best planted to the side of the toilet.


Small gardens of flowers or herbs beneath the hand washer


Hand washer over flower garden and also a tree

The importance of hand washing

There are few things related to health more important than hand washing. Hands can carry bacteria that carry many serious diseases. Hand washers like the simple ones described here cost almost nothing to make and can be placed in several places in the garden or near the kitchen. They do not use much water. This simple device can make a huge difference to the health and wellbeing of a family.

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Teaching Ecological Sanitation in Schools

Building a urine collection tank attached to the boys urinal

Peter Morgan

Building a urine collecting tank attached to the boys urinal.

A huge amount of urine is deposited in every school boys urinal and this material can be put to good use if it collected and applied to the school garden correctly. This chapter describes how to make a tank which will store urine from the urinal and a method of pumping it out of the tank into buckets which can then be conveyed to the school garden. The urinal is inspected and a suitable urinal wall chosen so that a PVC pipe cut in half along the length can be attached to the wall. The pipe is sloped so that urine collected in the pipe will flow downwards outside the toilet into a brick lined tank outside.

Preparing the tank slabs

Two concrete tank slabs were prepared off site.

Concrete base slab for tank. This is one metre in diameter and made using a mix of 10 litres cement and 35 litres river sand and 4 pieces of 3mm wire.

The tank lid is made slightly smaller (diameter 0.9m) with two holes, one for the urine inlet and one for the pump.


Central hole of upper tank slab with stainless steel screen and also the concrete plate made to hold the 50mm steel pipe socket in which the hand pump (Blair Pump) is screwed.

Preparing the PVC urine collecting pipe

A length of 75mm PVC pipe is prepared and cut to suit the urinal. The pipe is mounted along one of the urinal walls so that it will collect urine which will drain into a tank outside the urinal. The pipe is sloped a little to allow the urine to flow into the tank. The pipe is fitted loosely at first to get the correct position.


The PVC pipe is used as a urine collector and attached to the existing wall of the urinal. The pipe was 2.5m long made from 75mm PVC pipe. A section of 1.7m was cut out to form a channel in which the urine will flow. A hole is made in the external wall of the urinal and the pipe is placed along the existing urinal wall leading out through the wall to fit over the tank outside.

The position of the pipe outside the urinal is calculated and the hole for the tank dug around this point.

Once the position of the end of the pipe is established the hole can be dug down below ground level. The tank will be constructed inside the hole.

The concrete base slab is placed level on loosened soil laid down inside the hole. The brick wall is now built up to ground level.

Bricks are laid in strong cement mortar within the hole and on top of the base slab. The inside of the tank is low coated with a strong cement mortar to make it water tight.

The tank is plastered from within using a strong cement and pit sand mixture.

The base of the tank is also plastered with the mortar. The lid is then fitted with mortar being laid on the upper brickwork in which the lid is embedded. The pipe is laid in position to check that the end lies over the tank opening

The PVC pipe is then mounted within the urinal and is supported by short brick columns. The pipes slopes downwards slightly allowing urine to flow towards the tank. The pipe should fit neatly against the urinal wall.


Once the pipe is in its final position cement mortar is placed around the pipe as it passes through the brick wall. In this case only one section of the urinal is used to direct urine to the external tank.


Securing the pipe in the urinal brick wall. Fitting the pump support ring. This is made with a 50mm steel pipe socket which is embedded in a ring of concrete. The unit is embedded in strong cement mortar t the tank lid. This is allowed to cure before the pump is fitted.


Photo showing the arrangement of the pipe and tank. The plastic Blair Pump is fitted and a platform of bricks on which the bucket will be placed.

Photo of the urine held in the tank. If the urine fills the tank, an overflow pipe is required. This can be fitted within the tank itself through the upper part of the wall. Or another PVC channel can be fitted beneath the urine outlet pipe. Urine is pumped out of the tank with a modified Blair Pump into a bucket. This model of the Blair Pump is made entirely of plastic and rubber. It is threaded into the socket held in the lid only when urine is required.

Pumping urine holds a certain fascination! It is now standard practice at the Chisungu School. Rubber gloves are usually worn and frequent hand washing when handling urine.