Construction of toilet system which can be used in schools and homesteads.

Peter Morgan

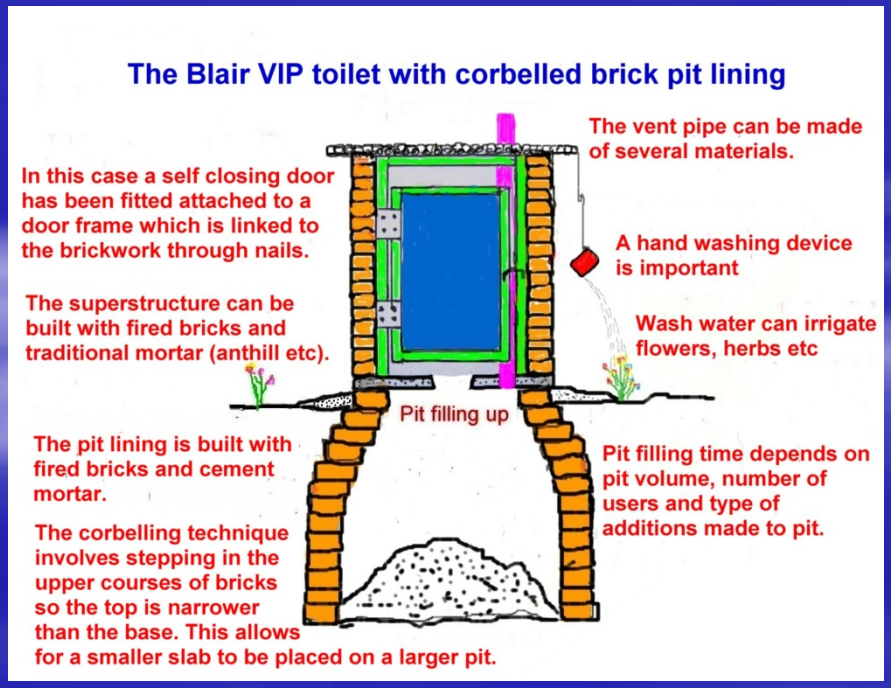
Most toilet systems made for schools are based on multi-compartment systems

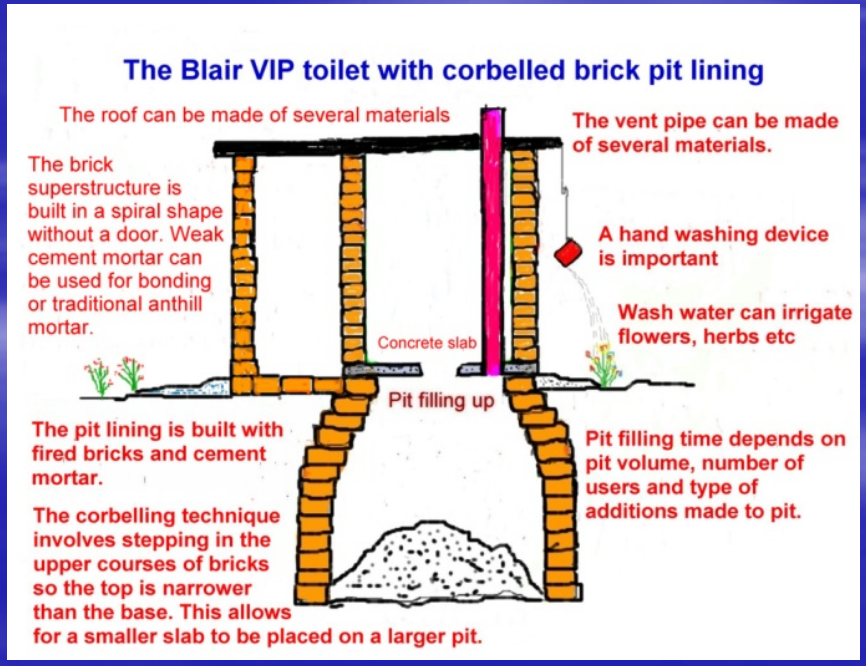
In most schools in Malawi and Zimbabwe these are based on pit toilet systems and often VIP toilets.
A Blair VIP multi-compartment toilet like the one shown below can last for over 20 years. Once full the pits are difficult to empty and a new construction is generally required.

In a new experimental approach being undertaken in Zimbabwe the concept of building single units is being tried at schools.

These units have been designed so they are relatively low cost and where the structures can either be built fully or partly by the children themselves.

The unit is based on the VIP concept . The pit has been reshaped to be wider (1.4m ID) but shallower (2m), which makes it easier to construct. The pit is lined with bricks using a corbelling technique where the base is wider than the top. Superstructures can be made with doors or with door-less spirals, which have no moving parts. Roofs can be made of several materials. The unit can be upgraded overtime.





The advantage of the spiral (door-less) structure is that it has no moving parts. Doors and their hinges must be robust enough to withstand rigorous use. Also if fly control (in the VIP) is to effective, the interior should remain semi-dark (but not very dark). However structures with doors use about half the number of bricks used in the spiral structures and the roof area is smaller.

A special toilet structure using a door has been designed specifically for school children to build (and those less skilled at building). It has been named the horseshoe toilet, as the structure is made in the shape of a horseshoe with both ends of the brick wall being located against two stout treated gum poles (a door being hinged to one of them). This arrangement of bricks makes the toilet above ground much easier to build.

The toilet is built in a series of stages:

1 Make the **slab** (curing time one week)
2. Dig the **pit** (2m deep and 1.7m wide)
3. **Line the pit with bricks**(using corbelling technique)
4. Place slab on pit lining and prepare for superstructure construction by extending slab area
5. Prepare **door unit (**with poles) – if a doored unit is used
6. Build **superstructure**
7. Make and fit **roof**
8. Add **vent pipe** if required
9. make **sloped floor** and add coating if neccesary

Stages of construction - make the concrete slab

The concrete slab is flat and 1.2m in diameter and is made using a mix of 12 litres of Portland cement and 60 litres of clean sharp river sand (5:1). It is cast either in steel shuttering or a mould made of bricks. 3mm wire is used as reinforcing. A mould for the squat hole (30cm X 15cm) is placed 30cm from the rear of the slab. A vent pipe hole (diameter 110mm) is placed 110mm from the edge of the slab to one side and in line with the rear of the squat hole.

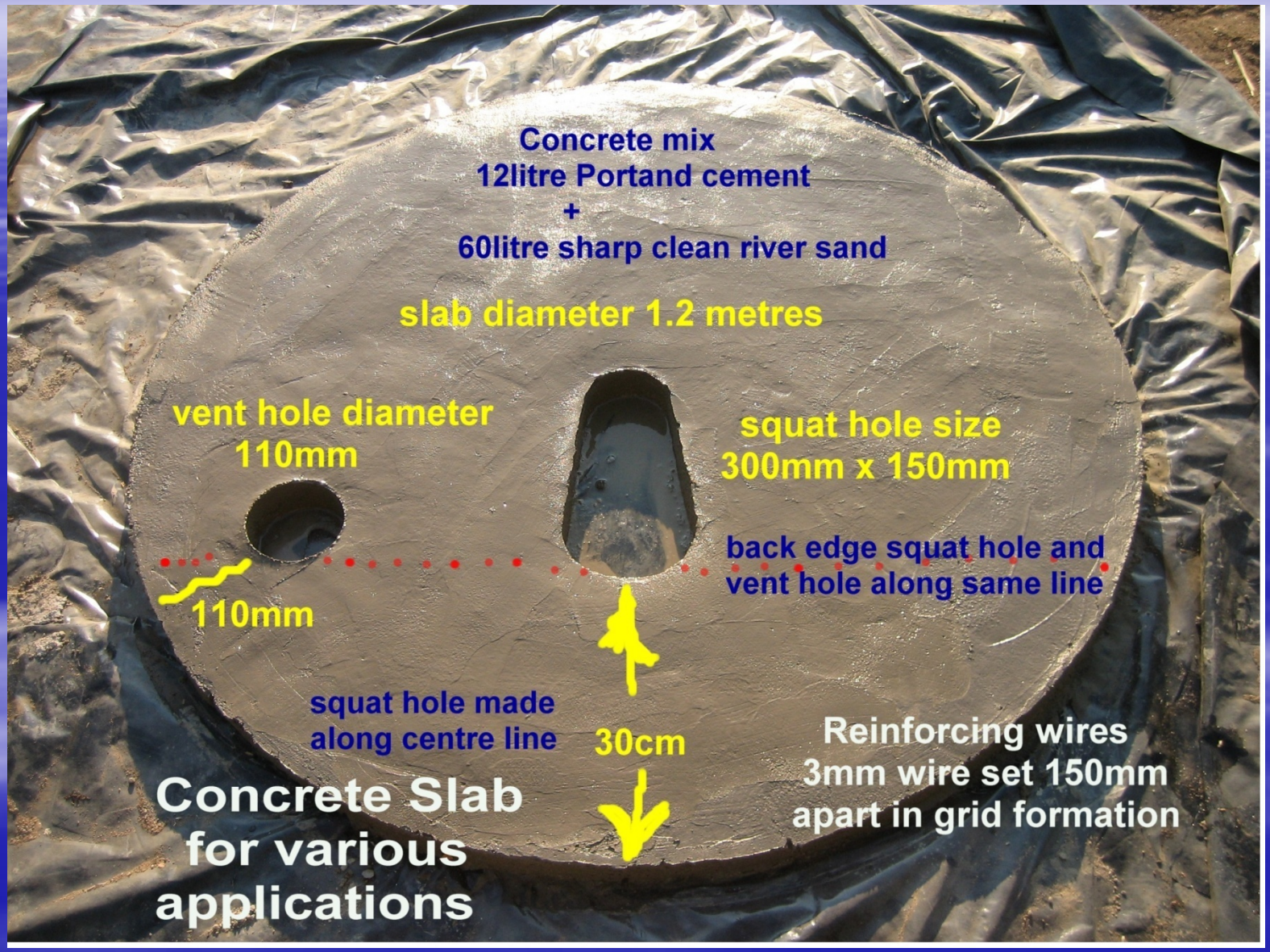
Stages of construction - make the concrete slab

The concrete mix is made up (a 10 litre bucket full to the brim is 12litres). Half of the mix is added within the mould or shuttering (taking care that the vent and squat hole moulds do not move. Then the 3mm wire is added in a grid formation. The second half of the concrete mix is added and levelled off and smoothed with s steel float or trowel. After an hour or two the moulds for the squat hole, and vent hole are removed. Steel shuttering can also be removed at this time

Stages of construction - make the concrete slab

The slab can be made over wet levelled ground covered with sand or on plastic sheet. Plastic sheet is preferred. Once the slab has hardened slightly it is covered with plastic sheet and left to harden overnight. The following morning it is soaked with water and recovered. It is kept wet at all times for at least a week (under plastic) before it is moved. During this time the pit can be dug and lined with bricks.

Slab details



Stages of construction – dig the pit

The pit is dug 2m deep and 1.7m wide. Walls must be vertical and the bottom level. After the pit has been lined with bricks the internal diameter of the pit is 1.4m for most of its depth but the diameter is reduced higher up the lining to match the 1.2m slab. A corbelling technique is used for bricking up the pit.

Stages of construction – line the pit with bricks

About 500 standard fired bricks are required to line the pit. These are bonded together using a cement mortar mix (Portland cement) of 20 parts pit sand and 1 part cement. This is a weak mix but years of experimenting have shown that it is very effective. 5 litres of cement are thoroughly mixed with 100 litres of pit sand. The use of this mix and the economy slab means that the pit can be lined and the slab made using a single 50kg bag of Portland cement with about 10 litres of cement left over.

Stages of construction - lining the pit with bricks

The size of bricks varies considerably, but about 500 farm bricks are normally enough to line a pit of this size. The pit is lined so the internal diameter within the brickwork is 1.4m. This diameter is maintained for 1.6m above the base of the pit. Then the corbelling begins, with each course being stepped in by about 25mm. The brickwork should rise above ground level by about 2 courses.

Stages of construction - lining the pit with bricks

At 2m depth a man can lined the pit by taking bricks laid around the rim of the pit. The cement mortar is passed down into the pit in a bucket. If pupils line the pit, the bricks are thrown down to them. A simple ladder is used to enter and leave the pit. As the corbelling proceeds the gap between the brickwork and dug pit increases.

Stages of construction - lining the pit with bricks

The corbelling (stepping in) technique allows for a large diameter pit to be dug and lined (about 3 cu.m. in volume), whilst using a smaller, lighter and cheaper concrete slab.

Stages of construction - lining the pit with bricks

The space between the earth pit wall and brick work is backfilled with soil to ground level and rammed in. The next stage involves fitting the concrete slab on top of the brickwork. The external diameter of the upper most course of brickwork should be slightly more than 1.2m

Stages of construction – fitting the concrete slab

The cured concrete slab can then be moved and placed over the pit. It is very important that the slab is made level and is placed in a bed of weak cement mortar which is laid on the bricks. This will support the slab all round and prevent the slab from cracking.

Stages of construction – fitting the concrete slab

The slab is laid flat over the pit and mortar fill can be placed between the slab and the bricks to ensure it is level and properly embedded. Once the slab is caste in position and the pit “capped” the toilet floor is extended. The method depends on the type of superstructure used – doored or spiral.

Stages of construction – the doored superstructure

In this method two pressure treated gum poles (2.4 to 2.6m long) are prepared and fitted with a door – attached to one pole by two strong rubber (self closing)hinges. The door panel can be made from light timber like plywood fitted over a frame of "building timber called brandering. All timbers are painted with a mix of old engine oil and carbolinium. The door size is 0.5m X 1.5m for schools and 0.5m X 1.6m for homesteads.

Painting the wooden parts

The door frame

Stages of construction – the doored superstructure

Once the wooden parts are coated with wood preservative, the parts are nailed together.

Nailing the wooden parts together

Small nails are used

Stages of construction – the doored superstructure

Two pressure treated straight gum poles are then taken (1.6m long) and the door attached to one of them using rubber hinges. 40cm of each pole rises above the door frame. The lower section of each pole its buried in a hole drilled in the ground in front of the slab.

Placing the poles and door together

Cutting the rubber hinge

Stages of construction – the doored superstructure

Two rubber hinges are used each measuring 150mm X 100mm. These are nailed onto the door first at top and bottom and then each is nailed to the pole. The poles should be as straight as possible.

Nailing the rubber hinge to door

Nailing the upper hinge

Stages of construction – the doored superstructure

Once the treated door and gum pole unit have been put together they can be mounted in front of the concrete slab. Two holes are drilled with a earth auger in front of the slab so that the distance between the front of the squat hole and the door is 85cm.

Completing the door and pole unit

Drilling the post holes in front of the slab

Stages of construction – the doored superstructure

Mounting the gum poles

The gum poles are mounted in the holes drilled in the ground. The bottom of the door should be about 75mm above the slab level.

The poles are mounted si the tops are level and the door fits neatly between them.

Mounting the gum poles

Stages of construction – the doored superstructure

Once the poles are mounted correctly earth is rammed hard around the holes in the holes to about half the depth of the holes.

Inspecting pole positions

Soil is rammed in the two holes to stabilise the poles

Stages of construction – the doored superstructure

Once the poles are in the correct position a wooden cross member is nailed to the top of the poles to stabilise them. A brick mould is then laid around the poles in front of the slab. This will be filled with a mix of bricks and concrete. This part embeds the poles in concrete and thus stabilises them. It also extends the floor area of the toilet.

Stages of construction – the doored superstructure

The area within the brick mould is then filled with half and cut bricks and concrete. The concrete is made using 6 parts river sand and one part Portand cement. The concrete is also rammed down in the holes around the poles. The concrete mix fills the mould un to slab level. This is left to cure overnight.

Stages of construction – building the doored structure

Once the pit has been lined with bricks, the slab fitted, the two door posts and door mounted and the toilet floor area extended, the construction of the brick superstructure can begin.

Stages of construction – building the doored structure

Because of its shape, this type of structure is called the "horseshoe" toilet in Zimbabwe. This method of construction has been designed specifically for school children and those less experienced in building. Its shape gives it great strength, even if not built perfectly. The two posts (king posts) provide a starting and ending point for each course of bricks. The mortar used for the brickwork can either be traditional mortar (1 part anthill soil and 2 parts sandy soil) or cement mortar (20 parts pit sand to 1 part Portland cement). .

Stages of construction – building the doored structure

In this sequence of photos pupils from the Chisungu Primary school will build the superstructure. In this case an experienced builder shows the children how to lay the bricks and he builds two starter courses of bricks. Then he observes when the pupils themselves take over. After the fourth course he leaves the construction to the pupils themselves. They learn by doing the job.

Stages of construction – building the doored structure

The cement mortar for bonding the bricks is made up first. This uses a mix of 20 parts pit sand and 1 part Portland cement. A 5 litre plastic container is used as a measure. Once the mortar is made up, the brick laying can begin.
The first two courses are built by the builder with the teacher (in red hat) watching. He explains the technique to them.

Stages of construction – building the doored structure

Particular attention is given to the method of laying the bricks embedded in mortar beneath and between bricks. Also the method of using half bricks so that the joints between the bricks are stepped as shown in the photo. This technique known as xxx. Ensures that the structure will be strong.

Stages of construction – building the doored structure

The third course is then built by the pupils, with the most experienced pupil leading. In this case one pupil had shown particular skill at bricklaying during the training at the school. He takes the lead at first, being closely watched by his friends. The builder stands back and guides the operation. One by one each pupil takes a turn to lay bricks.

Stages of construction – building the doored structure

The method of using a spirit level is also taught to try to get the structure as upright as possible. Each pupil takes on a course or half a course, has a break, watching the others and then resumes with more building. 22 courses of bricks will be used each requiring 16 bricks.

Stages of construction – the doored superstructure

Construction continues – the whole superstrcture can be built in an afternoon!

Stages of construction – the doored superstructure

As the structure gets taller chairs are required to stand on.

Stages of construction – the doored superstructure

The final 22nd course is built and the proud builders and their teacher pose for a photo. The builder himself has long gone, and returns the following day to marvel at the work of his students.

Stages of construction – the spiral superstructure

The spiral superstructure is a preferred option as it has no moving parts to wear out or fall off. It can also be built on the same pit/slab basic unit. It is more difficult to build than the doored horseshoe unit and also requires more bricks and a larger roof. But it has no moving parts which is an advantage as maintenance costs are reduced. The brickwork of the wall is first laid around the rim of the slab and then off the slab, laid over a brick foundation. The toilet entrance, and entrance to the cubicle are 50 cm 60 60cm wide. This method is currently being refined to make it easier to build in Zimbabwe.

Stages of construction – the spiral superstructure

The mortar used for the wall (in this case) is cement mortar (20:1) for the brickwork up to the first course on the slab, and from then on with traditional mortar (one part anthill soil to two parts pit sand). The whole wall could be built with cement mortar, but traditional mortar is very durable. The area within the walls (off the slab) is filled with stones and half bricks. A layer of river sand and cement (6:1) is then laid as a floor. Remarkably, and with a skilled builder, the entire structure, up to this stage was built with a single bag of Portland cement.

Stages of construction – the spiral superstructure

The wall are then built up to 22 courses.

Stages of construction – the spiral superstructure

The wall are then built up to 22 courses.

Stages of construction – the roof

There are several methods of constructing the roof. These can be made from:

1. Thin concrete panels

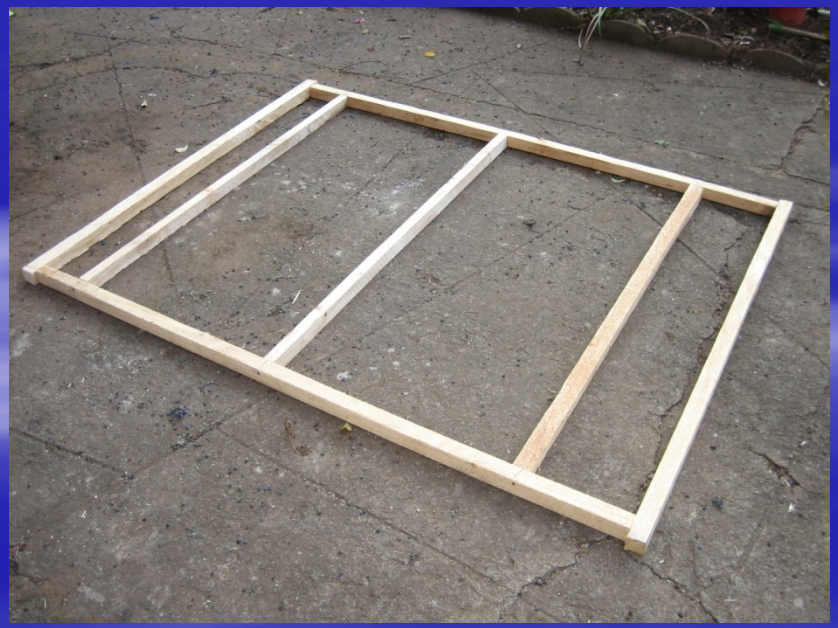
2. Corrugated asbestos or corrugated iron sheets laid over a wooden frame.

3 Cement impregnated hessian sheets laid over a wooden frame.

Stages of construction – the roof

1. Corrugated iron sheets over a wooden frame (doored)

The frame is made from “brandering” and is cut to suit the shape and size of the structure. In this case corrugated iron sheets have been used a roofing material. The depth of the roof is both doored and spiral configurations is 1.8m. The corrugated iron panels cover a width of about 65cm. For the doored structure a 3.6m length of sheet is cut in half to make 2 sheets of 0.7m X 1.8m. The wooden frame is made to support this.



Stages of construction – the roof

1. Corrugated iron sheets over a wooden frame

The wooden frame is nailed together and painted with a mix of old engine oil and carbolinium or other wood preservative. For the doored structure two roofing sheets of length 1.8m are required. A single 3.6m length can be cut in half. The iron sheets are nailed to the wooden frame and mounted over the superstructure. The roof measures 1.8m deep and 1.4m wide.

Stages of construction – the roof

1. Corrugated iron sheets over a wooden frame

The wooden frame is mounted on the superstructure and is attached with wire which passes through the wooden frame and post support in the front and through the bonding of the bricks and the wooden frame at the rear.

Stages of construction – the roof

1. Corrugated iron sheets over a wooden frame

The binding wires secure the roof to the superstructure, but the roof can easily be removed for maintenance and repair if necessary.

Stages of construction – the roof

1. Corrugated iron sheets over a wooden frame (spiral)

The roof for the spiral structure has the same length but is wider (2.1m) than for the doored structure. The same technique is used for construction, but three iron sheet are required not two. This is mounted on the structure and secured by wires.

Stages of construction – the roof

1. Corrugated iron sheets over a wooden frame (spiral)

Once the roof is secured the floor can be sloped with strong cement mortar and an internal plaster laid on the interior wall.

Stages of construction – the roof

2. Cement filled hessian sheers over a wooden frame

The frame is made from “brandering” and is cut to suit the shape and size of the structure. In this case corrugated the roofing material is made by cutting hessian (sacking) sheet. The width of the sheet is 1.35m and 3 lengths of 1.9m are cut. A plastic sheet is laid on the ground and the first hessian sheet laid on it. The cement “paint “mix is made up using a mix of 12 litres of Portland cement, 7.5 litres water in which 500gms of salt have been dissolved.

Stages of construction – the roof

2. Cement filled hessian sheers over a wooden frame

The cement paint is then poured onto the hessian sheet and rubbed in with the rubber glove covered hands. It is spread all over the hessian sheet. Then another layer of hessian sheet is laid over the first and pressed in to the first sheet. Another layer of cement paint is added. A third layer of hessian sheet is added and pressed on to the second sheet and the final application of cement paint added

Stages of construction – the roof

2. Cement filled hessian sheers over a wooden frame

The cement impregnated hessian sheet is then covered with plastic sheet and allowed to cure for a few days. Meanwhile a wooden frame made from brandering is made up, nailed together and treated with a mix of carbolinium and old engine oil. The cement filled hessian sheet, which is slightly flexible is then rolled over on to the wooden frame.

Stages of construction – the roof

2. Cement filled hessian sheers over a wooden frame

The hessian sheet is then nailed to the wooden frame and lifted on to the toilet structure. It is held in place with steel wires bound around the wooden frame and the wooden support between the two posts and through brickwork at the rear.

Stages of construction

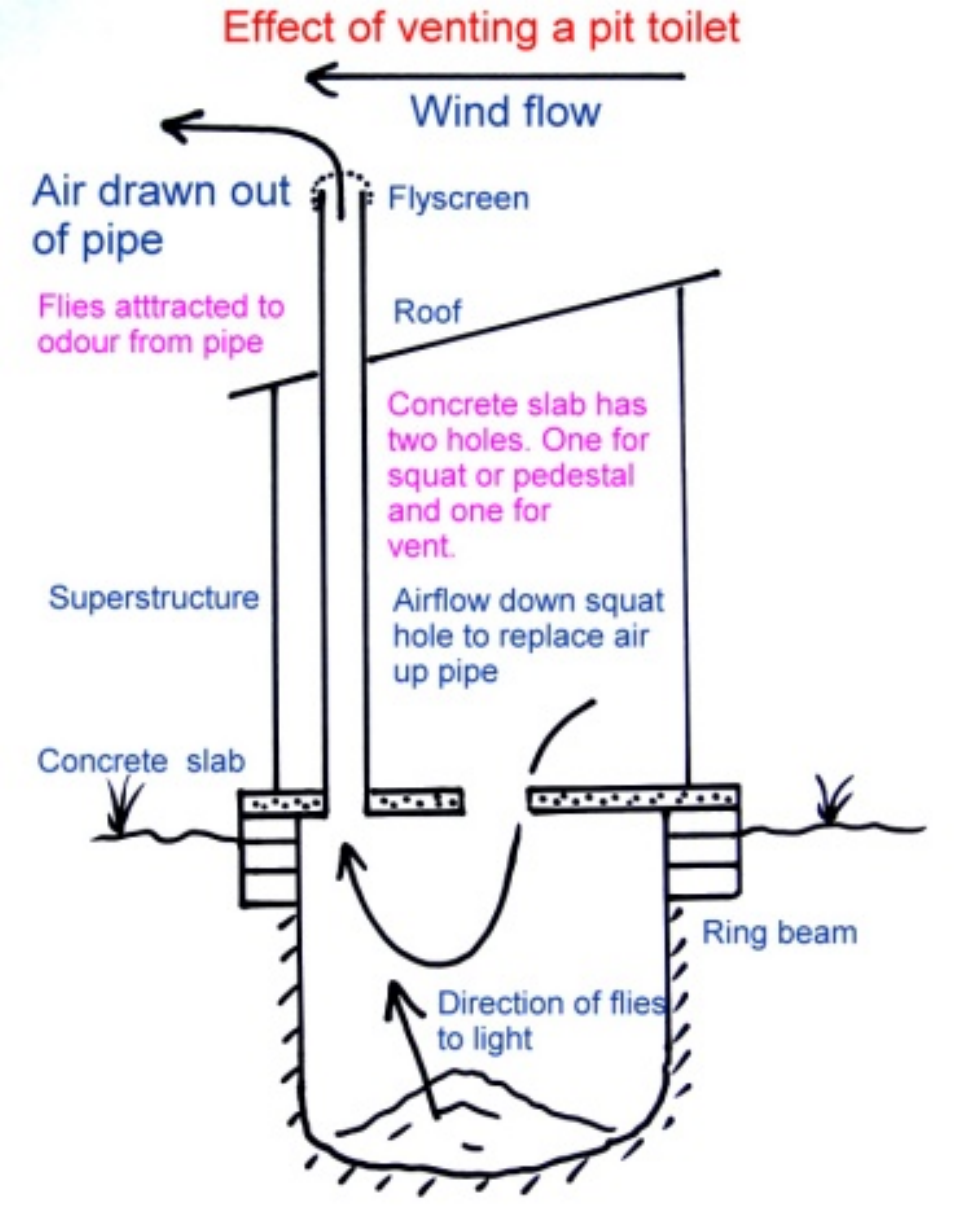
Add sloping floor

A sloping floor is essential if the toilet floor is to be cleaned down properly. It is inevitable that urine will spill on to the concrete slab and be absorbed and this will smell. Regular washing down with water helps. A small sloping surface will assist the cleaning down process. Also painting on a epoxy back paint over the floor area will reduce the amount of urine held in or on the slab.

Stages of construction
Adding a vent pipe

A vent pipe draws air out of the pit and thus reduces odours coming out of the squat hole inside the toilet. If the pipe is fitted with a fly screen and the toilet interior is semi dark, the pipe will also trap flies.

Vent pipes can be made of bricks, PVC, resin filled hessian, cement filled hessian and other materials



Stages of construction

Fitting a vent pipe

In the design described in this power point a tubular pipe will be required and this will be fitted inside the structure. The minimum diameter of tubular pipes is 110mm. Vent pipes work well if they are fitted inside the structure, as in this design. Screen material should be corrosion resistant and aluminium or stainless steel are the best materials. Where pipes are fitted within the toilet structure a hole must be made in the roof material to allow the pipe to pass through.

Stages of construction

Fitting a vent pipe

Since a hole is made in the roof through which the pipe passes a waterproofing material must be placed around the pipe. This can be made of cement mortar.

Stages of construction

Finishing off

Once the construction is complete, the area around the toilet is cleaned up and levelled off and a hand washing device can be fitted. Trees can also be planted around the toilets. Trees like banana can also be planted at the end of a run-off from the school hand pump and fed with urine to increase the rate of growth.