11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

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Development of the Buguruni-type VIP

INTRODUCTION

In May 1982 H.P. Gauff GmbH, Consulting Engineers, were commissioned by the Ministry of Lands, Housing and Urban Development of Tanzania (ARDHI) to design and construct prototypes of a permanent emptyable pit latrine (VIP) suitable for use in the Buguruni squatter area of Dar es Salaam and other urban areas of Tanzania. Funds for the Project were provided by the West German aid bank Kreditanstalt fuer Wiederaufbau (KFW). For research and development work the Consultant used the facilities of the Building Research Unit in Dar es Salaam (BRU).

DESIGN CRITERIA

The principal design criteria established for the VIP were that it had to be cheap, be suitable for self help construction and make maximum use of local materials. The VIP also had to have a minimum life of 20 years and be suitable for emptying at least 4 or 5 times during this period. A target cost of 2000 Tanzanian Shillings (Tsh), about pds.118, was set for the basic latrine elements of substructure, squatting plate and vent pipe.

SUBSTRUCTURE

A fully lined pit type of substructure was adopted to meet the requirements of a 20 year lifespan and the need for emptying. This also eliminated any doubts concerning the long term stability of the pit in the variable local soil conditions.

Concrete and concrete products are technicaly suitable for use as pit lining materials. In Dar es Salaam concreting aggregates are expensive, 4 to 5 times that of sand and as a consequence concrete items are more expensive than their sand cement equivalents. Also at this level of construction the crushing strength of concrete is more than required for a stable structure and so its use represents an extra cost with no technical advantage. Large concrete items such as one piece pit liners were considered but they pose problems in the field due to their weight, taking them out of the self help catagory and their cost, more than twice that of the target cost set for the basic latrine elements.

A number of building materials were identified as being potential pit lining materials and test samples were made up and immersed in the first chamber of a septic tank for an initial period of 30 days. The contents of this tank were taken as representative of those in a pit latrine.

In Table 1 below details of the results of this test are given. For comparison a thin section (50 mm wide) concrete block was also included in the test.

TABLE 1 Pit Lining Material Test

No.	Description	Condition
1.	Sand/cement block	No deterioration
2.	Crusher dust/cement block (30% clay)	Minor deterioration
3.	Sisal cement panels and blocks	Cracked/softened
4.	Soil cement block (50% clay)	Major deterioration
5.	Sun dried mud block	Complete collapse
6.	Concrete block	No deterioration

On cost and durability grounds sand/cement blocks gave the best result. In a subsequent test when the clay content of the crusher dust block was reduced to 15 to 20% then the durability of the block increased. Two latrines were constructed from blocks of this material and after two years use no deterioration of the pit lining has been observed. Although technically suitable crusher dust was not widely used in the Project because it is slightly more expensive than sand.

It had been hoped to use sisal fibre reinforced cement panels for pit lining. There is a lot of research being carried out on this material in Tanzania. Unfortunately, when exposed to the pit contents the fibres swell and rot causing the panels to crack with a consequent loss in strength. It may be possible to use this material in the future, if the absorption and deterioration of the sisal fibres can be inhibited by a chemical treatment.

After a number of trials at the BRU an optimum sand/cement ratio of 6 to 1 was determined for 50 mm by 200 mm wide blocks.

The blocks were made by hand in simple timber moulds. Various lengths of block were tried 225mm, 300mm, 330mm. An optimum length of 300 mm was determined as the standard size. This length allowed the construction of either a 1.03 m square or a 1.17m diameter circular substructures using the same square squatting plate and superstructure.
For leaching purposes standard size blocks with two 50mm by 100mm tapering to 40 mm by 80mm holes in them were developed. These blocks were produced in standared size block moulds. Use of such blocks allowed better control of the available leaching area and the structural integrity of the pit lining compared to the alternatives of open joints or half blocks. Details of the leaching block are given in Figure 1.

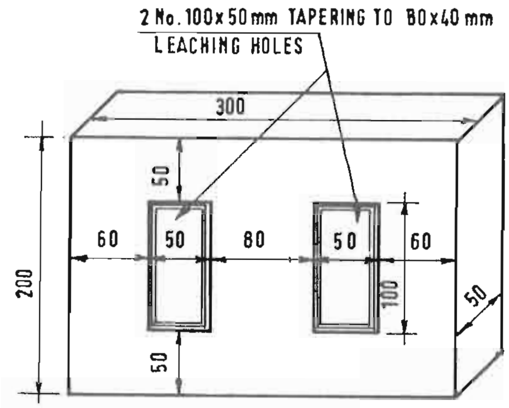


FIG. No. 1 — LEACHING BLOCK

SQUATTING PLATE

The opening in the squatting plate on top of the pit had to be large enough to permit emptying by vacuum tanker and yet small enough to prevent children from falling into the pit. To meet these twin demands the concept of the removable squatting plate was developed. The key dimensions for the hole and foot-rests in the squatting plate are in accordance with World Bank recommendations.

A number of materials were proposed for the squatting plate including reinforced or mass concrete and fibreglass. Concrete is an expensive material and steel reinforcement is almost impossible to obtain locally. Fibre glass would have to be imported and the use of this material is uncommon in Tanzania.

Experiments with ferrocement squatting plates made in timber moulds using a sand/cement mixture with galvanised chicken wire reinforcement proved successful. In normal use the squatting plate is bedded in sand on a ferrocement supporting slab. The squatting plate is removed during emptying. The opening in the supporting slab is large enough to accommodate a variety of suction hose types and permits agitation of the pit contents to facilitate emptying.

The squatting plate, although thin in section, 35mm tapering to 22mm at the hole is quite strong. It was tested in a concrete crushing machine and failed, i.e the plate cracked but the chicken wire matrix held it together with a load of 2500 kg across the plate. Field tests on completed latrines have been made with 5 or 6 adults inside the latrine causing no damage to the plate/slab combination.
Details of the squatting plate and supporting slab are given in Figure 2 and Figure 3.

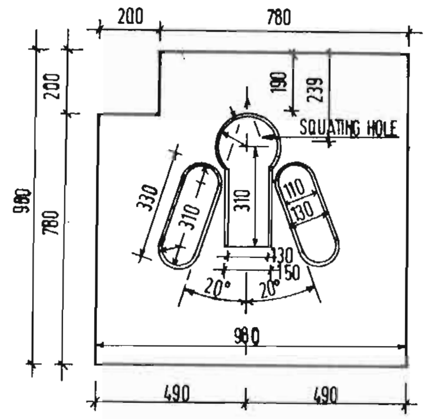


FIG. No. 2— SQUATTING PLATE

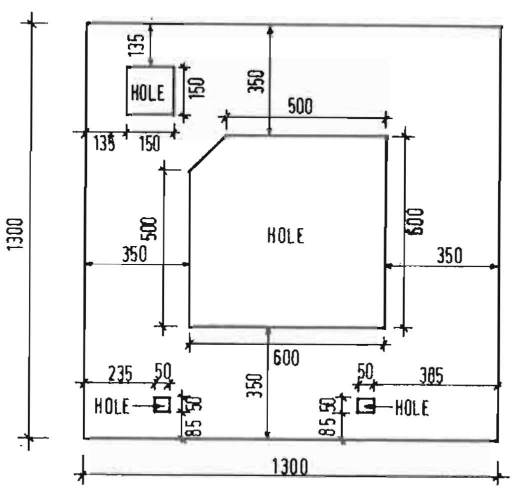


FIG. No. 3—SUPPORTING SLAB

VENT PIPE

For consistency with the rest of the latrine the vent pipe was constructed from sand/cement blocks made in timber moulds with a central 150mm diameter hole. The diameter of this hole its position in the latrine, in the right or left rear and its final height above the roof line were determined after tests were made using air velocity meters and similar equipment by staff of the ARDHI Training Institute. The vent pipe block is shown in Figure 4. The vent pipe is capped with a nylon flyscreen in a timber frame. Later research by the World Bank has shown stainless steel or fibreglass to be better fly screen materials.

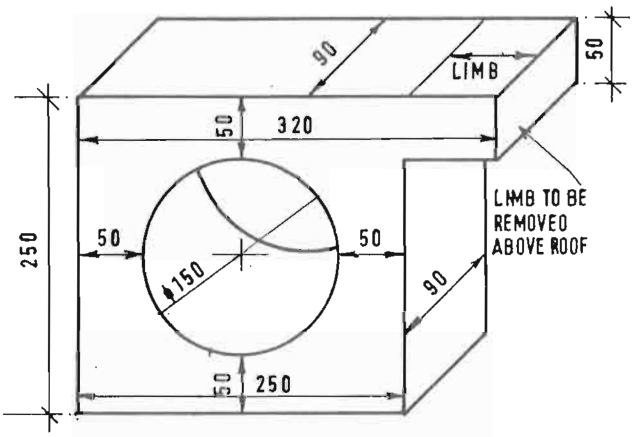


FIG. 4- VENT PIPE BLOCK

SUPERSTRUCTURE

Standard section blocks as used for the pit were used for the superstructure. A timber door and frame and roof purlins were used.

From research work carried out at the BRU, sisal cement sheets were developed for the latrine roof. These sheets are made on site by un-skilled labour from locally available materials, unlike the more expensive alternatives of corrugated iron or asbestos cement sheets.

PROTOTYPE CONSTRUCTION

Twelve prototype latrines were constructed in the Buguruni area of Dar es Salaam by local masons. This was to prove the concept of the latrine and to try out a number of varients including square and circular substructures, a pour flush type of squatting plate and a latrine with an extended superstructure with provision for bathing. Two latrines with local mud and wattle superstructures were tried but these were expensive, required constant maintenance and were not popular with local people.

The conclusions drawn from the prototype construction were the standard latrine with a square pit, was suitable for immediate mass production. The circular pit type latrine needs corble blocks to step from the circular pit to the square supporting slab and this requires a more highly skilled mason than for the square pit. More research needs to be done to develop a pour flush plate suitable for local conditions. The bathing type latrine is available, if there is a demand. All of these latter types are more expensive than the standard latrine and are moving away from the low cost, low technology, design objectives of the Project.

CONCLUSION

In conclusion, the key elements of the latrine, i.e. substructure, squatting plate and vent pipe were produced for Tsh.1660 (pds98) in 1982 prices, well below the design target of Tsh.2000. The complete standard latrine was produced and built for Tsh. 3000 (pds. 176). The only imported items used were the nylon flyscreen and the metal door furniture, both of which were available in the local market. The latrine was fabricated and constructed by local labour using simple tools and equipment, thus meeting the low-technology design objectives.

MASS PRODUCTION

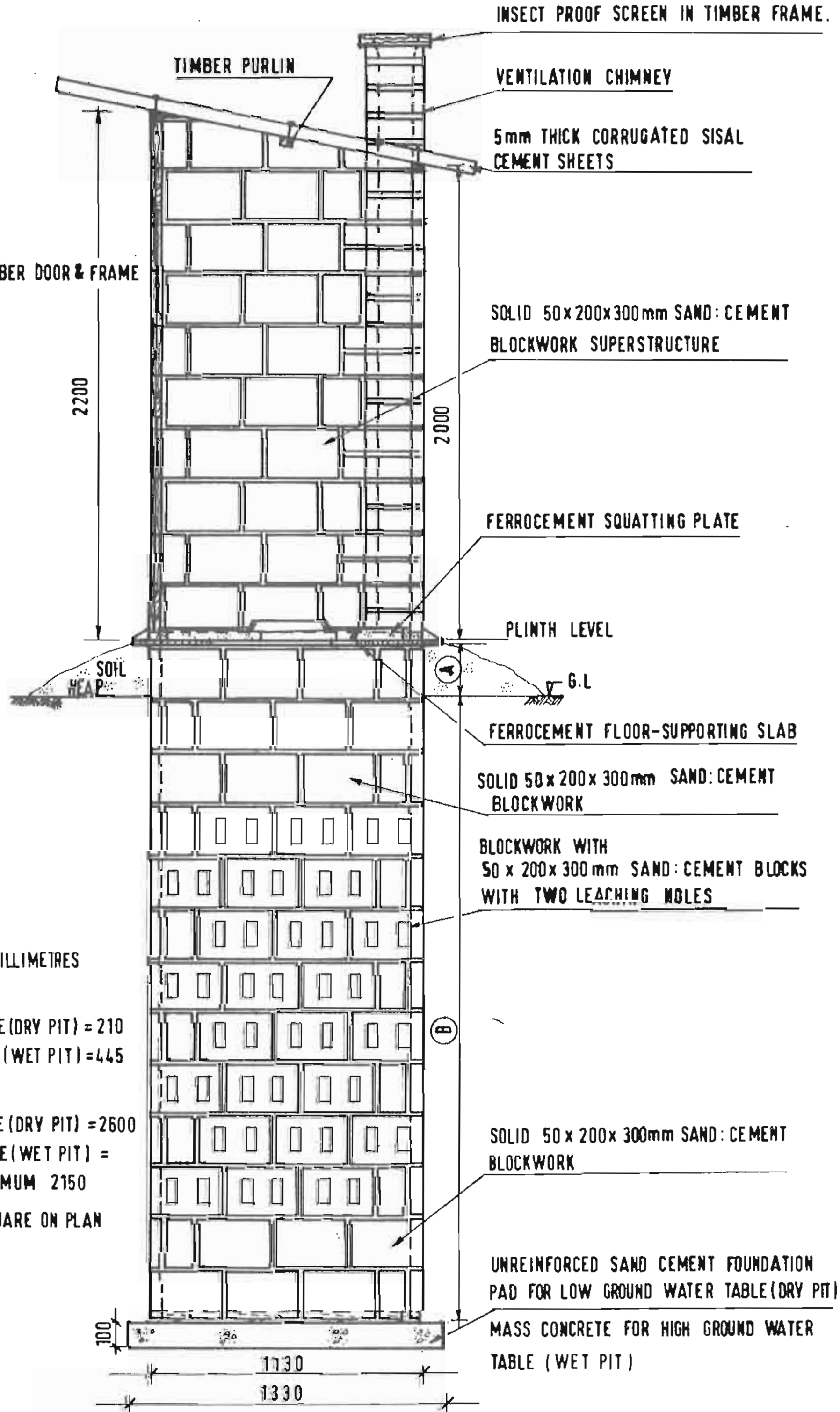
To meet an estimated demand for 2000 latrines in Buguruni the Project has been extended to include the construction of an appropriate technology plant to manufacture components for between 3 to 5 latrines per day. This phase of the Project is funded by KFW, ARDHI and the Dar es Salaam City Council World Bank financed Department of Sewage and Sanitation (DSSD).

The plant is being constructed directly by the Project Consultant using local labour and hand tools. Earthworks were done free of cost to the Project by the City Engineers Department of Dar es Salaam. Production is scheduled to start in April 1985. After full commissioning operation of the plant will be handed over to the DSSD.

In the design, construction and operation of the plant the low cost, low technology aspects of the Project have been maintained. All sand/cement items will be made in locally produced moulds and equipment. The only imported equipment apart from hand tools will be woodworking equipment. This could be dispensed with if a reliable source of planed and cut timber were available.

The latrine design has been adopted by the DSSD for use in Dar es Salaam. Initialy they plan to construct some 3600 units in the Temeke area of the City.

In Figure 5 an elevation of the standard latrine is given.



NOTES.

1. ALL DIMENSIONS ARE IN MILLIMETRES
2. DIMENSION 'A':
   LOW GROUND WATER TABLE (DRY PIT) = 210
   HIGH GROUND WATER TABLE (WET PIT) = 445
3. DIMENSION 'B':
   LOW GROUND WATER TABLE (DRY PIT) = 2600
   HIGH GROUND WATER TABLE (WET PIT) = MINIMUM 1720 TO MAXIMUM 2150
4. SUB/SUPERSTRUCTURE SQUARE ON PLAN

FIG. 5 - STANDARD LATRINE ELEVATION