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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

TECHNICAL BRIEF

SANITATION

Light-weight, moveable superstructures for VIP toilets

As ventilated improved pit (VIP) toilets become full they have to be emptied or new pits dug. In the case of the latter, what becomes of the superstructure? A WRC-funded project applied some innovation to solve this problem.

The importance of the toilet superstructure in sanitation delivery

In South Africa there are still many households without access to basic infrastructure such as water and sanitation. In order to address backlogs, many toilets will still have to be constructed. In rural areas especially, onsite dry sanitation systems in the form of Ventilated Improved Pit latrines (VIPs) or Urine Diversion toilets will continue to be an appropriate technology choice. However, any chosen sanitation system will only work if a durable superstructure is provided for each toilet.

The current shortage of standard building materials of good quality, as well as critical skills shortages in remote rural areas hampers efforts to provide and maintain basic sanitation infrastructure. Whilst many South African households are yet to be provided with a VIP or a VIP derivative, both new and existing systems ultimately also require rehabilitation or replacement when the pit reaches its capacity or the end of its design life.

Rehabilitation could entail moving the superstructure to allow access for de-sludging or for the relocation of the toilet. Moving is difficult when current standard construction techniques and materials are used. These make the superstructure either very heavy or difficult to dismantle, should reuse of the material be necessary for the building of a new structure. In many cases it is just not possible for the average household to relocate the superstructure, resulting in overflow of raw sewage.

Deficiencies to be addressed in superstructure construction

Ideally, modern technology and materials should be used to develop a building system that can be used by communities to build and move their own infrastructure, as needed.

Consequently, an investigation was conducted by the University of Pretoria into the development of an affordable, lightweight, moveable superstructure for a VIP toilet for use in rural communities. As a point of departure, a literature review was undertaken to establish the current state of knowledge.

Thereafter, local and international experience, including input obtained from suppliers of VIP superstructures, served as a point of departure in seeking to develop suitable lightweight superstructures for VIP toilets that are more easily moveable than the superstructures currently in use. Whereas the reviewed literature contains many research reports on sanitation systems for rural communities, much less published information is to be found on toilet superstructures and community needs in this regard.

From information gathered, a list has been compiled of the types of superstructures currently available for use in South Africa, together with the current cost attached to each system. Various construction systems are being employed for these toilet superstructures, which fall into two main groups, namely, the lightweight systems that can be moved (as such or in dismantled form) when the pit of a VIP is full, and the systems that cannot be moved, but are built from

materials that may be reused in the construction of new superstructures.

The perceived advantages and disadvantages of currently available superstructures were taken into account in setting up a set of requirements for a new VIP superstructure design.

Apart from having to meet structural strength requirements, a newly developed superstructure would need to meet the following criteria:

- The superstructure should be useable for different types of sanitation systems.
- The slab should be manufactured to allow access to the pit other than through the pedestal.
- The superstructure has to be moveable.
- The superstructure must be adjustable to allow changes in layout.
- The local community must be able to benefit financially from the construction process.
- The superstructure has to be durable and aesthetically acceptable.
- The risk of failure of critical components has to be limited.

It also appears that the only way to improve superstructure systems currently in use would be to enable communities to take ownership by manufacturing and building as much of the system as possible. Community involvement in manufacturing and building VIP superstructures can only be successful if a proper quality control system is in place. It is suggested that a franchising system is used, where the materials needed is pre-blended and sold to the communities in bags that eliminate the need of precision batching to ensure quality.

Construction and evaluation of an easily moveable, durable superstructure

It was decided to investigate the construction of two types of lightweight, moveable, toilet superstructure, the first being one that uses pre-cast components that can be easily assembled and dismantled, while the second uses blocks that can be re-used if the structure needs to be moved.

The first superstructure is made from high strength fibre reinforced concrete, and consists of a base slab, wall panels, a roof and a door. This system can be provided to communities in package form or can be manufactured by the communities themselves in controlled environments. The re-usable lightweight blocks employed by the second superstructure system under consideration are manufactured from foamed concrete.

The two alternatives were tested and priced to determine the most suitable moveable, lightweight VIP superstructure.

In testing the superstructures, it was decided that the Agrément (fit-for-purpose) minimum criteria would be suitable criteria against which to evaluate the superstructure strength. Agrément tests were consequently conducted on a full scale structure to ensure that the structure can withstand the forces that it will be subjected to during a typical lifespan without undue distortion or distress.

These forces include wind loads, impact loads from people or sharpedged objects colliding with walls, door slamming or localized loads caused by various fittings. Although the superstructure with precast walls, in particular, tested successfully, testing was done on a limited number of samples only. Further tests are therefore required to ensure that results are representative.

The financial viability of the University of Pretoria systems and alternative manufacturing approaches were investigated by costing systems based on the assumption of a ten-year lifetime as well as current material and construction costs. Of the options considered, the one which resulted in the lowest cost per superstructure unit was the setting up of a factory to manufacture 20 precast units daily.

An alternative option, where a person in the community works with three friends to manufacture precast components for one superstructure per day, resulted in a higher but still acceptable unit cost. The system based on the manufacture and use of lightweight blocks could not compete with the pre-cast system as far as cost, or even quality, was concerned.

Guidelines for construction and installation

Transfer of the University of Pretoria toilet superstructure technology to the potential user community has taken place through demonstrations and workshops. In addition, detailed guides have been produced for parties interested in manufacturing and installing these toilet superstructures.

Conclusions

Choice of appropriate superstructure

The University of Pretoria superstructure and various

commercially available, high-quality, moveable, precast superstructures on the market do not differ much in cost. Therefore, other factors, not least of which are community involvement and acceptability, will determine which of the systems would be most suitable for a given community.

The superstructure selection process might thus involve economic and social research, the building of demonstration units, the desired level of community involvement in construction, installation and maintenance, and the monitoring and evaluation of the reactions of the potential user community.

Facilitation of community involvement in construction

Enabling communities to take ownership by manufacturing and building as much of the superstructure as possible appears to be a key factor in the improvement of a superstructure system. Community involvement in manufacturing and building VIP superstructures can, however, only be successful if quality is carefully controlled. Adequate control could be achieved through a franchising system, where the materials needed are pre-blended and sold to the communities in bags, thus eliminating the need for precision batching to ensure quality.

Need for national standard

A problem which all suppliers of well-priced, high quality superstructures face is that they are disadvantaged by other suppliers who deliver inferior products at lower prices. In South Africa, structures should normally comply with the requirements set in the National Building Regulations.

If an alternative building material or system is used that does not fall within the areas covered by the National Building Standards, the material or system can be tested and certified as fit-for-purpose by the Agrément Board of South Africa. However, the fact that there is no standard with which VIP superstructures provided to clients must comply, presents a major problem.

This allows each supplier to determine what quality of product they wish to deliver. It is therefore strongly recommended that a national standard be developed with minimum requirements to be adhered to by all VIP superstructures. The requirements can include aspects such as minimum dimensions, load capacities, requirements for doors and fittings, etc.

Having minimum functional requirements for suppliers will prevent user communities from opting for inferior products that, at the time, may appear to be more economical.

Further reading:
To obtain the reports, *Lightweight Moveable Superstructures for VIP Toilets* (**Report No:1781/1/10**); *Lightweight Toilet Superstructures – Installation & Assembly Guide* (**Report No: TT 484/10**) or *Lightweight Toilet Superstructure: Manufacturing Guide* (**Report No: TT 483/10**) contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; E-mail: orders@wrc.org.za; or Visit: www.wrc.org.za