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SUSTAINABLE DEVELOPMENT OF WATER RESOURCES, WATER SUPPLY AND ENVIRONMENTAL SANITATION

A Comparison of Guidelines on Septic Tanks and Soakage Systems in Sri Lanka

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Excreta related waste is a major cause of surface and groundwater pollution in Sri Lanka. The fact that decentralized onsite disposal is the dominant form of disposal for human excreta related waste makes it an even difficult problem to handle. Therefore well laid out national standards and guidelines on the construction and design of onsite disposal systems are essentially required to ensure safety of water resources in Sri Lanka with the growing population and urbanization. Many attempts have been made by different government authorities to fulfill this requirement at different times. The objective of this paper is to critically and comparatively analyze the contents and level of information given in different key guidelines, codes of practice and regulations related to onsite disposal of human excreta related wastes and suggest methods to integrate and effectively disseminate this information.

Introduction

THE civilization of the Indian subcontinent at large is characterized by its particular focus on Sanitation and Hygiene. In Sri Lanka archaeological evidence on well designed latrine systems are found in historic sites which date back to at least the 5th Century A.D. However these early systems were either obliterated through the passage of time or replaced widely by the western perspectives of sanitation during 19th and 20th centuries.

Without doubt onsite-disposal is the dominant method in disposal of excreta related wastes in Sri Lanka today, including all the urban and suburban areas except the Colombo city limit (Werellagama and Hettiarachchi, 2003). The appropriateness of the ultimate disposal method has more importance than the front-end sophistication of a latrine. The authors have come across many instances in Sri Lanka where toilets with expensive fittings and floor tiling discharge raw sewage into adjoining natural streams and rivers.

The objective of this paper is to critically and comparatively analyze the contents and level of information given in different key guidelines, codes of practice and regulations related to onsite disposal of human excreta related wastes in Sri Lanka. The authors also suggest methods for integrating and re-standardizing to effectively disseminate this scattered information.

Methodology

Since this is purely a review paper the research was entirely based on literature survey. The survey was done mainly using the publications on the relevant subject published by the government of Sri Lanka. Few scientific research works and foreign standards are quoted in the analysis to support the contentions of the authors. Two foreign standards are quoted mainly to maintain consistency,

1. Indian Code of Practice for Installation of Septic Tanks (IS 2470: 1985)
2. Standard for Design and Construction of Onsite Wastewater Systems in State of Kansas USA.

The Indian standard was selected because India is a developing country which has many socio-environmental similarities to Sri Lanka. Main reason to select the Kansas standard was to compare the local guidelines with a typical standard of a country like USA which observes comparatively more stringent environmental guidelines.

The local documents studied for this review were as follows

1. **SLS 745 of 1986:** *Code of Practice for Construction of Septic Tanks, Standards* Institute of Sri Lanka
2. **SLS 745 of 2003**
3. **PHI Manual:** Manual for Sri Lanka Public Health Inspector (1989) published by the Ministry of Health of Sri Lanka
4. **NWS&DB Design Manual D7:** For wastewater treatment-March 1989, National Water Supply and Drainage Board of Sri Lanka
5. **CFRR manual:** Implementation guideline issued by the government of Sri Lanka (2005) for Rehabilitation Work after the Tsunami disaster in 2004.

Discussion

Design considerations of Septic tank according to different standards in Sri Lanka

A septic tank can be defined as a primary sedimentation tank. This has the capability of removing 60-70 % of the dissolved matter which enters it. The effluent from such a tank should be disposed to a secondary treatment system or a soakage system.

Design considerations were compared with regard to Average flow of sewage, Tank capacity, Ventilation, Length-Width ratio and Freeboard space allowed in the septic tank (summery given in Table 1). Authors assume that a good design for septic tank should provide adequate capacity to reduce the desludging frequency, prevent direct currents between the tank inlet and outlet to enhance sedimentation, prevent disturbance of scum, allow for proper removal of gas and have good structural strength with minimal possibilities of leakage.

Average flow of sewage

The average flow of sewage (daily per capita) depend on the user group, such as houses (luxury or low income), shops, schools and commercial buildings etc. SLS 745 of 2002 categorizes the average daily per capita flow of sewage according to the user group whereas SLS 745 of 1986 and NWS&DB design manual specifies a single value (150 l/p/d). No mention is made about the average per capita flow of sewage in the PHI manual and the CFRR. Determining the daily per capita wastewater flow according to the user type is a standard approach (Emmanuel 2003), but this approach may only be essential when designing large systems. For small onsite systems giving a single average value is reasonable.

Capacity of septic tank

The total capacity of the tank consists of the capacity needed for sludge and scum storage and capacity for liquid retention. The design equations given in SLS 745 of 1986 (appendix C) for calculation of working capacity of a septic tank, only allow for settling and sludge storage, where as the 2002 version gives an additional equation to allow for sludge digestion also. The design values given in the 2002 version are moderate and economic. Values given for minimum capacity a septic tank in the SLS 745 (1986 & 2002) and the NWS&DB design manual are 2m^3 and 1.575m^3 respectively. The minimum capacity given in the standard of the US state of Kansas is 4.5 m^3. Larger capacities will always ensure lesser risks of overflowing but could be strictly constrained by the cost factor. Therefore 2m^3 is a reasonable value for a developing country like Sri Lanka.

Length to width Ratio

Both versions of SLS 745 recommend that the length should be about 4 times the width and the minimum width 750mm. The NWS&DB design manual has specified length as 2 times the width. Rectangular shapes are generally recommended by many authors (Emmanuel, 2003; Vazirani & Chandola, 1980) to ensure better sedimentation, reduce turbulence and induce laminar flow. But some guidelines in the US recommend even square shapes due to the large volumes and retention time followed in the US (Standard of State of Kansas, 1997). Because of the cost factor involved with larger volumes, rectangular shapes will be more suited for Sri Lanka.

Ventilating pipe

Ventilating pipe is for the removal of gas produced in the septic tank. No particular specifications are given in the NWS&DB design manual and CFRR manual about the ventilation pipe. SLS 745 of 1986 specifies that a 50mm diameter pipe to the height of 2 m should be fixed if the nearest building is 15m away, otherwise 600mm above the highest vent opening of the building. But in the 2002 revision the diameter has been reduced to 25mm and gives no information about the height of the pipe. Both documents say that the ventilation pipe top should be covered to prevent mosquito problems.

Free board

Free board is the height between the top water level and the soffit of the cover slab of the septic tank. NWS&DB design manual, SLS 745 of 1986 and CFRR manual give three different values 400mm, 300mm and 250mm respectively for

Table 1. Some important design parameters for septic systems given in the documents reviewed

Parameter	Value			
	NWS&DB	SLS 745:1986	CFRR	SLS 745:2002
Average flow	150l/p/d	120 l/p/d (with cistern) 40 l/p/d (without cistern)	-	depend on the user category
Hydraulic retention time	1 day	1.5-2 days	-	equation given
Desludging	3 years	when $^1/_3$ filled	-	when $^1/_3$ to $^1/_2$ full
Minimum capacity	1.575m^3	1m^3	-	1m^3 to 12m^3
Ventilation pipe	-	50 mm dia. and height of 2 m if the nearest building 15 m away otherwise 600mm	-	25mm to sufficient height to avoid odor nuisance
Free board	400 mm	300mm	200mm	200
Liquid depth	1.5m		1.5m	1
Length: Width	2:1	4:1	2:1	2-4:1
Percolation rate	Max 50l/d/m^2	Design table given	-	Design table given
Distance to a water well		18m	18m	18

freeboard. It has been reduced to 200 mm in the 2002 version of SLS 745, which is closer to the minimum open-space (freeboard) value observed in the state of Kansas USA (180mm). Larger freeboard reduces the risk of septic tank overflowing during shock loads, but increases the cost of construction, especially in brick tanks. Since some severe shock loading conditions might occur in public buildings and commercial buildings on special occasions (Emmanuel, 2003), it's recommendable that a higher free board value such as 400mm be observed in the septic tanks for such buildings.

Construction materials and methods

A main drawback in all Sri Lankan documents reviewed by the authors is the lack of information on construction materials and methods, only SLS 745 of 2002 gives substantial details on this aspect. Some of the international guidelines referred by the authors gave detailed information about construction materials (State of Kansas, IS 2470 (Part 1 & 2)). In a country like Sri Lanka where skilled labour is at an alarming low, it's appropriate for a guideline to include the essential details of construction materials and methods.

Disposal of the effluent from septic tanks

The effluent coming out from the septic tank may contain substantially high organic loading and pathogenic microorganisms, which makes it impossible to be directly discharged in to a surface water body according to the wastewater discharge regulations in Sri Lanka. The most widely practiced method for ultimate disposal in Sri Lanka is soil soaking, where the secondary effluent from the septic tank will be soaked in to soil through a soakage pit or leaching trench. Secondary treatment through anaerobic filters is gradually becoming popular in some areas (Corea et al, 1998) where soil soaking is very ineffective or inapplicable.

Design considerations for soil soaking systems according to different standards in Sri Lanka

The key parameters used in the design of soakage systems are percolation capacity, depth above the highest ground water level and distance between the soaking system and other features. Out of all the Sri Lankan documents reviewed only SLS 745 gives substantial information about the soakage systems. SLS 745 of 2002 contains much more descriptive details on soakage systems than the former version. Although SLS 745 of 2002 contains substantial information on Secondary Treatment systems such as anaerobic filters, only soakage systems will be discussed in this paper due the length constraints.

Estimation of Percolation Capacity

Both versions of SLS 745 give standard percolation test as the method for estimation of the percolation rate. This method is widely accepted and recommended by many authors and overseas standards (Emmanuel, 2003; IS 2470:1985; Standard of State of Kansas). The standard used in the US state of Kansas recommends getting information from the available soil survey reports and examining a soil profile to the depth concerned prior to onsite testing, in addition to the percolation test. Difficulty in obtaining soil survey reports and the cost of digging observation pits will render the above recommendations inapplicable in most cases in Sri Lanka.

Depth above the highest ground water level

SLS 745 of 1986 recommends a minimum depth of 1.2m between the bottom of the soakage pit or dispersion trench and the highest ground water level in the site, whereas SLS 745 of 2002 gives a set of different depths to be observed under different percolation rates. Both IS 2470:1985 and the standard of the US State of Kansas gives a single minimum value of 1.2m (4ft.) for this parameter. Considering the high ground water levels frequently experienced in Sri Lanka, especially in the coastal sand domain aquifers and some inland lateritic perched aquifers (Arumugam, 2002), the detailed method followed in SLS 745 of 2002 ensures the safety of ground water resources.

Dimensions

Sizing of soakage pits and seepage trenches are based on the specific effective area calculated by the percolation rates. Both versions of SLS 745 give tables to obtain the specific area values according to the percolation rates.

Soakage Pits: Both versions of SLS 745 give 900mm as the minimum diameter for a soakage pit, but only the 2002 version stipulates a maximum diameter of 3m. IS 2470:1985 also specifies 900mm as the minimum diameter, but does not give a maximum value. Since diameters larger than 3m might pose problems with constructing large unsupported cover slabs and with the lateral strength of the walls, giving a maximum diameter is recommended. SLS 745 of 1986 and IS 2470:1985 gives a maximum limit for inflow (30m^3/d) to a single soakage pit, which acts as an indirect restriction on the diameter also.

Seepage Trenches: For seepage trenches, SLS 745 of 1986 specifies a width of 0.3 – 1m and a total depth of 0.3 – 1m, distance between two adjacent trenches is specified as 1.8m. The 2002 version stipulates a width of 300-600mm, a minimum total depth of 400m (including a minimum of 100mm topsoil layer) and a minimum distance of 1m between two adjacent trenches. The dimensions given in SLS 745 of 1986 are comparatively higher to the values stipulated in IS 2470 and the Standard of the US State of Kansas, which ensure high safety margins. Since the seepage trenches are essentially located in the unsaturated zone, which facilitates vertically downward percolation and also because the water enters the ground with very low horizontal velocities such as 0.2 m/d at maximum, soaked water will not travel a considerable lateral distance unless the unsaturated zone is temporarily saturated due to heavy precipitation (Todd, 1980). Therefore the 1m distance between two adjacent seepage trenches as recommended in SLS 745 of 2002 is a reasonable value, but may cause problems under very wet conditions.

Distance between the soaking system and other features

Main concern here is the distance between a drinking water source and a soakage system. Both versions of SLS 745 recommend a minimum distance of 18m (54 ft.) and the PHI manual recommends 50 ft. for this value. Although IS 2470:1985 also recommends 18m, the Kansas standard stipulates a lager offset distance of 100ft (30.3m). Considering the space constraints encountered in most parts of the wet zone urban and suburban areas in Sri Lanka 18m is a reasonable value. Hettiarachchi and Warellagama (2004) who did an extensive study on the recommended distance between a drinking water source and a fecal pollution source, contended that 18m is a good value for most parts of Sri Lanka but may be inadequate in highly percolative coastal sand domain aquifers or discrete limestone domain aquifers (north and eastern parts of Sri Lanka). Therefore the value remains a fresh frontier for environmental engineering research in Sri Lanka. The standard of the US State of Kansas gives an array of different recommended distances to different features from a soakage system, such as property line, dwelling foundation, different types of water sources, stream etc. Although suggesting values for such an array of off-set distances for Sri Lanka is beyond the scope of this paper, considering the complicated nature of urban dwellings and settlements, the approach followed in the Standard of the US state of Kansas is strongly recommended for Sri Lanka too.

Conclusions

Based on the above comparisons it's quite evident that there are some notable differences among the reviewed documents regarding the design of septic tanks and soakage systems (Table 1). SLS 745 of 2002 is undoubtedly the most comprehensive document in Sri Lanka regarding the onsite disposal of excreta related wastes.

In all the documents reviewed above the information provided on operation and maintenance of Septic Tanks and Onsite-disposal systems was very low.

Since the Local Government Authorities (LGA) bare the primary responsibility of approving minor building works and maintaining public health, the "PHI Manual" should be the focal point of knowledge dissemination with regard to proper construction and operation of septic tanks and onsite disposal systems. Therefore this document should be developed into a more comprehensive source of information with well defined guidelines for construction, following the SLS 745 of 2002. It's strongly recommended that the manual should have a separate chapter on Operation and Maintenance of Septic tanks.

In addition to the PHI manual, a booklet on operation and maintenance of septic systems for public can be distributed through LGAs as a user guideline.

For major building works it can be recommended that a specification and a design guideline for septic and soakage systems (based on SLS 745 of 2002) should be released by a competent construction industry regulatory or training authority such as Institute of Construction Training and Development (ICTAD).

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