EWCE 333
Wastewater Engineering and Sanitation

Lecture 5

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Lecture Outlines

Topics	Reference
• Pour-Flush Latrine Latrine - design considerations and design	Water Supply and Sanitation - Feroz Ahmed and Mujibur Rahman ITN -BUET

Water Seal (Pour-Flush) Technologies

- A further improvement to the pit latrine can be obtained with a water-seal.
- The pour-flush latrine has three major components parts: (a) the superstructure, (b) The latrine pan with its integral water seal and (c) a single or altering twin leach pits.
- Water-seal is a U-pipe filled with water, attached below the squatting pan that completely prevents passage of flies and odor.

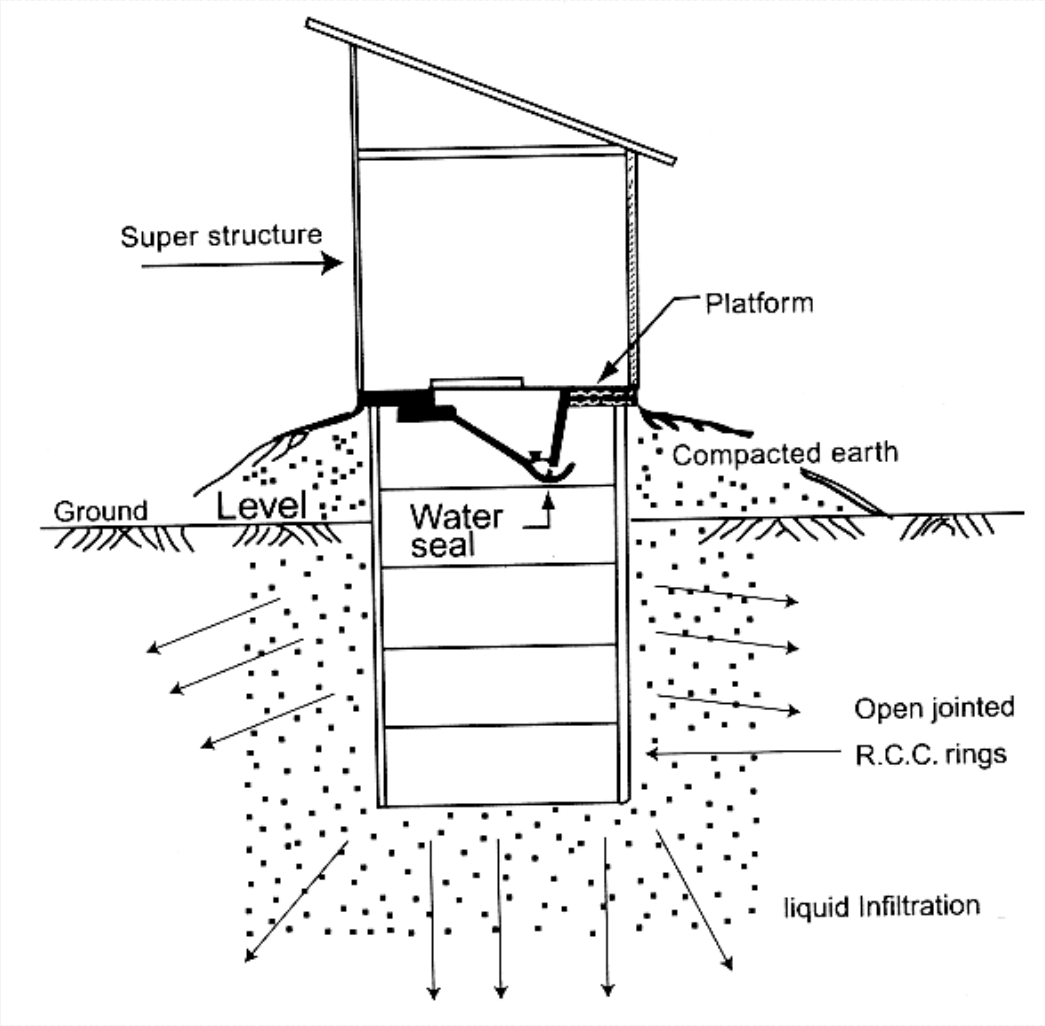
Pour-Flush Technologies

- The water-seal is only 15-25 mm deep and the latrine can be flushed by hand using 1.5 to 2.0 litres of water.
- The latrine can also be located, if desired inside the house with off-set pit.
- Small quantity of water used in a pour flush toilet is sufficient to carry the excreta to a soakage pit up to 80m away.

Types of Pour-Flush Technologies

(1) **Direct Pit Pour-flush Latrine**

- Modification of simple pit latrine where the squatting plate is provided with a 25 mm water seal and is placed directly over the pit.



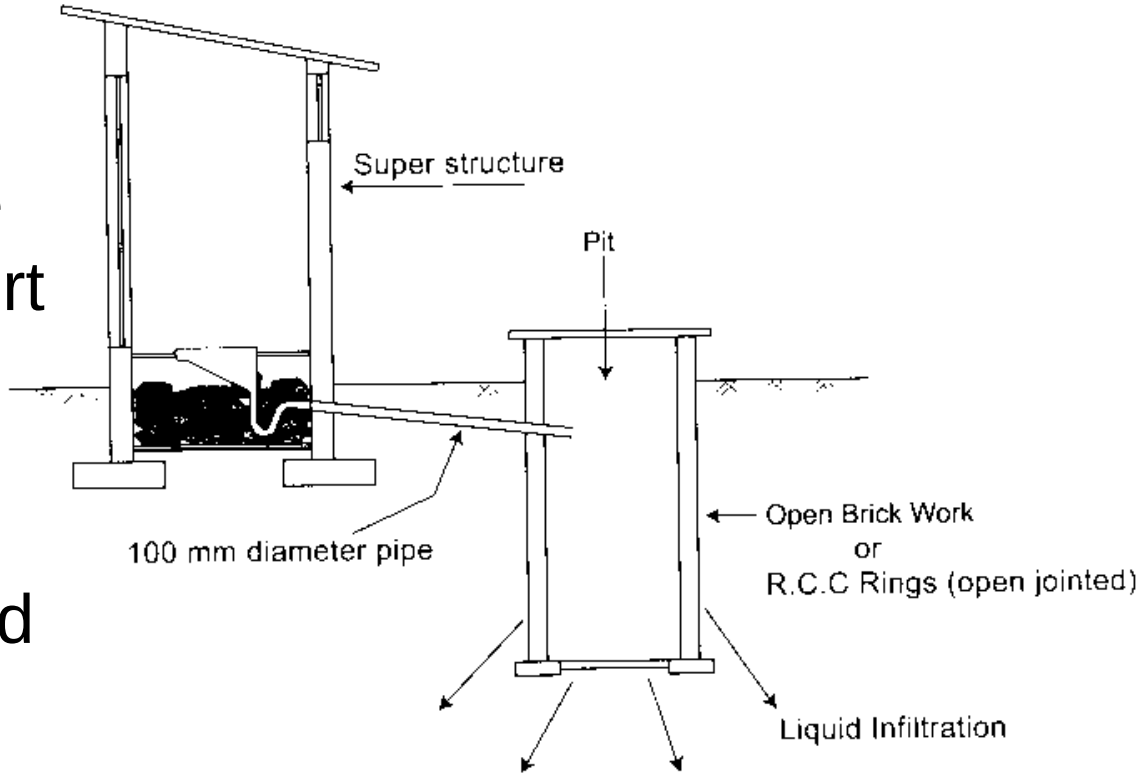
Types of Pour-Flush Technologies

(2) Off-set Pit Pour-flush Latrine

- Completely off-set pit

- Pit is connected to the pour-flush pan by a short length of 100 mm diameter pipe.

- Latrine can be installed inside the house



- Free from fecal odor and insect problems

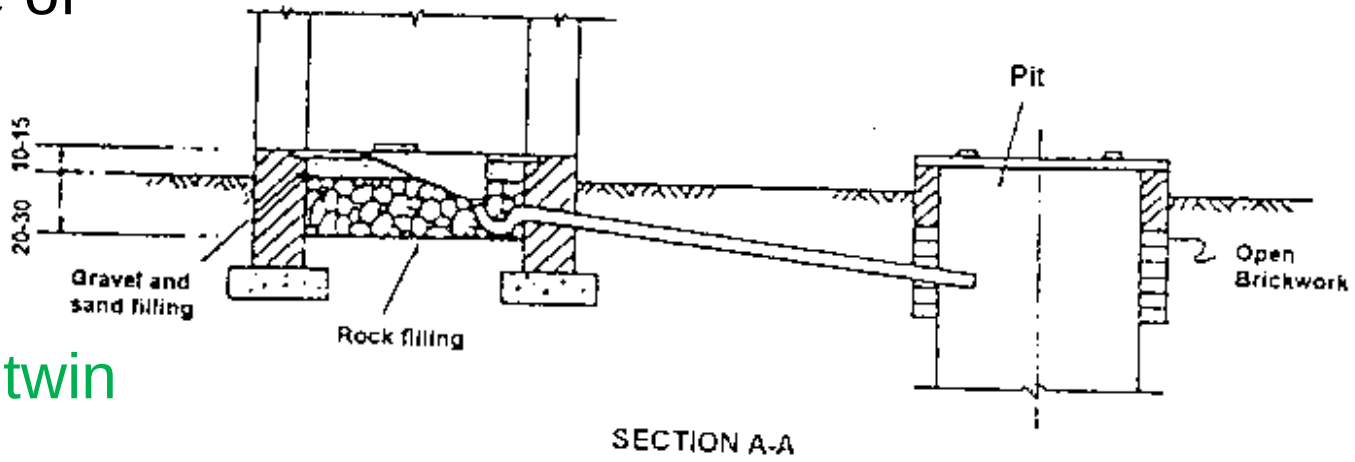
- No need for a separate superstructure.

Types of Pour-Flush Technologies

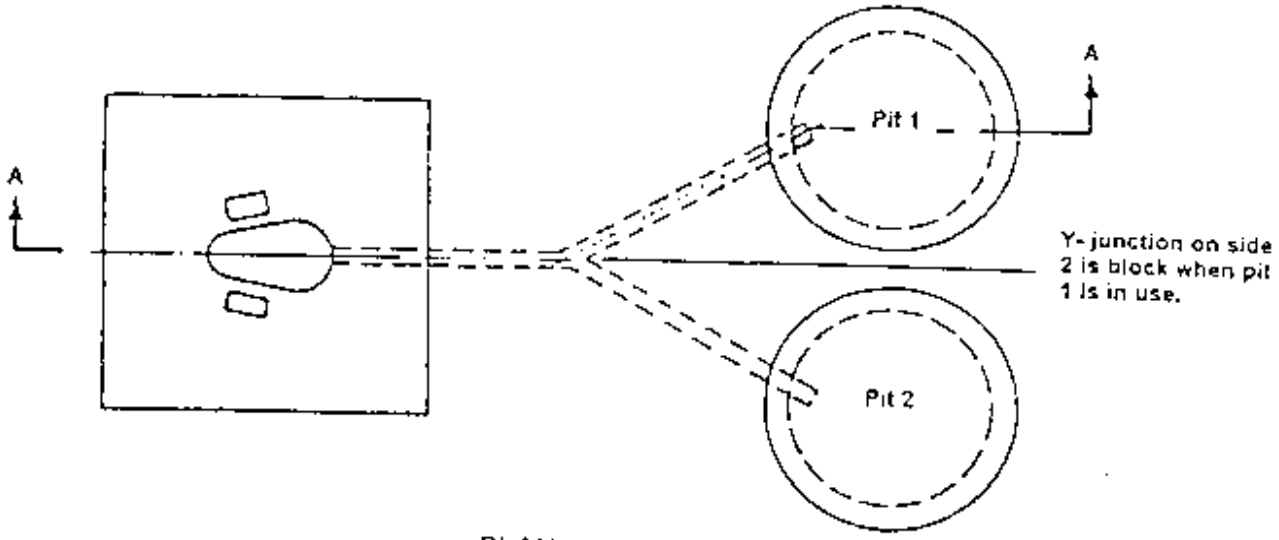
Off-set pit pour-flush latrines can be of two types –

(a) single

(b) alternating twin off-set pit.



SECTION A-A



PLAN

Alternating Twin Off-set Pit Pour-Flush Latrine

- The alternating twin-pit system comprises –
  (i) a squatting pan and
  (ii) a Y-junction for directing excreta from squatting pan to either of the two leach pits.

- The pits are used alternately and at a given time only one pit is in use.

- When the first pit is full, the flow of excreta is directed to the second pit through a Y-junction and contents of the first pit are left to decompose.

Alternating Twin Off-set Pit Pour-Flush Latrine

- The contents of the first pit decompose to safe, pathogen-free humus within 18 to 24 months.

- The contents of the first pit may then be dug out and the pit is kept ready for reuse.

Functions of Pour-Flush Latrine

- After each use, the latrine is manually pour-flushed with about 2-3 liters of water (compared to 10-20 liters used in conventional toilets)

- The water seal provides a barrier against odour and insect.

- From excreta, flush water and wash water around 10-20 liters/capita/day (lpcd) of wastewater enter into the pit.

Functions of Pour-Flush Latrine

- The pit has to provide sufficient volume for solids storage, as well as sufficient area for the wastewater to infiltrate into the soil.

- It requires that the soil has sufficient long term infiltrative capacity.

- If the soil is unsuitable for infiltration, the liquid effluent can be removed by other means e.g., by connection to the sewerage system if available.

Suitability of Pour-Flush Latrine

- Pour-flush latrines may be used in both rural and urban areas provided they are appropriately designed and that they can rely on water availability for flushing, and for maintaining the water seal.

- Single pits may be appropriate in urban areas only if they can be desludged mechanically by a vacuum tanker, since their contents are not pathogen free.

- Twin-pits are recommended if the pits are to be desludged manually, as the resting period ensures that the contents to be removed are substantially free of pathogens.

Design of Pour-Flush Latrine

Table 1: Design Values for Long-term Infiltration Rates for Wastewater into Various Soils

Soil Type	Long term infiltration rate, I (L/m^2-day)
Sand	50
Sandy loam	30
Porous loam, porous silty clay loam	20
Compact silty loam, clay	10

Design of Pour-Flush Latrine

The side wall area required for infiltration, (A_i, m^2) is given by:

$$A_i = Q / I \quad \ldots\ldots\ldots (1)$$

where, **Q** = waste water flow rate (L/day)

I = long-term infiltration rate (L/m^2 - day)

- The wastewater flow (Q) depends on the number of users, frequency of flushing, flush volume, urine volumes and amount of water used for anal cleansing.

- Generally Q varies between 5-20 Lcd.

Design of Pour-Flush Latrine

The pit volume, V_i (m^3) corresponding to the sidewall area can now be calculated. For a circular pit of diameter, D,

$$\mathbf{V_i = \pi D^2 h/4 \ldots\ldots\ldots\ (2)}$$

Now, side wall area for a cylinder, $A_i = \pi Dh$

where h= the height of the sidewall area

$= A_i / \pi D$ …… (3)

Replacing the value of h (from eqn 3) in equation 2

$$V_i = (\pi D^2/4) *(A_i /\pi D)$$
$$= A_i D/4$$
$$= (Q/I) * (D/4) \text{ (from eqn 1)}$$

i.e., $\mathbf{V_i = QD / 4I \ldots\ldots\ldots\ (4)}$

Design of Pour-Flush Latrine

For alternating twin-pits, the effective volume of each pit is calculated –

- ✓ either using **equation 4** (**$V_i = QD / 4l$**)
- ✓ or **$V_s = C \times P \times N$**, whichever is greater.

For single pit pour-flush latrines, the effective volume is given by:

$$V = V_s + V_i \quad \text{..... (5)}$$

Advantages of Pour-Flush Latrine

- Less expensive compared to conventional latrines.
- Offers appropriate and hygienic solution for excreta disposal.
- Requires less volume of water for flushing (1-3 lit/flush only).
- Can be upgraded to connect to a sewerage system or septic tank system.
- Eliminates odor release, insect and fly breeding.

Advantages of Pour-Flush Latrine

- Safe for children.
- Can be located inside the house.
- Potential for resource recovery using the sludge as soil conditioner.
- Easy construction and maintenance.
- Twin pit latrine can serve as a permanent structure because of its pits is used alternatively.

Disadvantages of Pour-Flush Latrine

- Requires separate sullage disposal facilities.
- Water (at least 4 liters / person / day) must be available throughout the year.
- Water seal may be clogged easily if garbage is thrown into it.
- Construction is difficult and expensive in areas with high ground water and shallow soil overlying hard rock.

Disadvantages of Pour-Flush Latrine

- Risk of polluting ground water and/or nearly water sources.
- Construction and maintenance of twin pit pour-flush latrine is difficult.

Design of Pour-Flush Latrine

Problem:

Design leach pits for both – (a) single pit and (b) twin offset pit pour – flush latrine for a family of 7 members for a design period of 2.5 years.

The X-section of the pits has to be square.

The average waste water flow rate is 12 liters per person per day.

The soil is porous silty loam with long – term infiltration rate of 20 L/m^2-day.

In sketch, show the designed latrine and pit arrangement.

Design of Pour-Flush Latrine

Solution:

Given,

Family Members = 7

Design Period, N = 2.5 years

Pit X-section Shape = square

Avg. Wastewater flow rate, q= 12 lpcd

Soil type = Porous silty loam

Long term infiltration rate, I = 20 L/m^2-day

Design of Pour-Flush Latrine

Now,
Total waste water flow, Q = 12×7 = 84 l/d

Area required for infiltration, A_i = Q/I m^2
= 84/20
= 4.2 m^2

Assuming, pit width = 1.2 m

Therefore, Pit Volume, V_i = QD/4I
= (84×1.2)/(4×20)
= 1.26 m^3

Design of Pour-Flush Latrine

Pit volume with respect to solid storage

Let, solid accumulation rate, C = 0.04 m^3/person-yr

N = 2.5 years

Therefore, pit volume, V_s = CPN

=0.04×7×2.5

= 0.7 m^3

Design of Pour-Flush Latrine

Case – 1 : single pit pour – flush system :

The effective volume, $V = V_i + V_s$

$=1.26+0.7$

$=1.96m^3 \approx 2m^3$

Considering, pit width = 1.2m

For square pit, effective depth, $h=V/1.2^2$

$=2/1.2^2=1.39m$

$\approx 1.5m$

Assuming 0.5m clear space, total depth=1.5+0.5

=2m

Design of Pour-Flush Latrine

Case II: alternating twin pit pour flush system

Governing volume of pit $=1.26m^3$

Pit width= 1.2m

Depth of pit= $v/1.2^2$

$=1.26/1.2^2$

$= 0.875m^2$

Let, Clear depth = 0.5m

Therefore, total depth $=0.875+0.5$

$=1.375m \approx 1.5m$