CENTRAL BUILDING RESEARCH INSTITUTE, ROORKEE-247667 (INDIA)

# BUILDING RESEARCH NOTE

B.R.N. 34

## LOW COST SANITATION FOR RURAL & URBAN HOUSES

### Introduction

Poor health in developing countries is largely due to diseases like cholera, dysentery, gastroenteritis and worm infections carried by contaminated food, water and ground. Effective sanitation is an important way of reducing the incidence of such diseases but modern water-borne sanitation system is not possible in many parts of the world due to its high cost and shortage of water. High cost of providing sewers for rural as well as urban areas having low density makes them non-acceptable due to financial constraints. Therefore, it is important to search for appropriate alternatives.

In India a large number of people have no latrines or have bucket or dry latrines, specially in rural areas condition is worse in comparison to these national average and majority of people resort to open air defecation. Statistics reveal that 120 million people in the world are without adequate water supply and 1350 million without sanitary facilities. World average for people having access to sanitary facilities in rural areas is 15 per cent.

Bore-hole latrines with precast slabs had been tried in India but these suffered from the nuisance of odour and fly breeding. The pits get filled up soon necessitating a change of site. The design was improved with the addition of a concrete pan and water seal trap to cut out odour and flies.

A number of efforts have been made since 1930, to further improve the design, as a result of which more than a dozen designs of sanitary latrines have been developed varying from the simplest design of bore-hole type to the complex design of Electrolux Vacuum System. Their applicability and acceptance depend on the preferences based on availability of space, local soil conditions and finance. Each of them has potentiality of its adoption under different circumstances.

However, a design for wider application should be simple, inexpensive in construction and should provide freedom from odour, unsightly conditions, handling of fresh excreta and its contact with flies and animals. It should eliminate chances of contamination of surface soil, and surface and ground water that may enter the springs or wells.

In addition to these basic criteria the following requirements have to be considered while proposing any excreta disposal system for developing countries :

1. Daily operation should require minimum education and guidance to users of all ages.
2. Cost of the system should be within the reach of users.
3. Construction of the system should be based mainly on the use of local materials and its maintenance should be possible with semiskilled labour, available in the area.
4. Requirement of water for transport and treatment should be minimum.
5. The system should include the possibility of improvement in future when economic condition of the users improves.

**CBRI's Contribution**

This Institute has studied different types of designs available for construction of low cost rural and urban latrines to suggest economically viable and acceptable solutions for developing countries. Different aspects like size of the super-structure, type of latrine pans and water seal, different specifications for construction of leaching pits including their distance from one another and from existing buildings have been examined. Following recommendations are made on the basis of these studies :-

*1. Type of Latrine*

Hand-flushed water seal latrine seat proposed by Planning Research and Action Institute (PRAI), Lucknow and National Environmental Engineering Research Institute (NEERI), Nagpur and as already adopted by Indian Standards Institution (ISI), New Delhi is recommended for adoption due to its low water requirement for flushing and low cost. The design consists of cement concrete/mosaic F.R.P./Vitreous china pan, known in the market as PRAI Type Seat, or Rural Pan. P-shaped trap having 20 mm water seal, foot rests. The trap is connected to chamber with S.W.G. pipe or cement pipe which permits ease in shifting the connection to the second leaching pit when the first gets filled up after the stipulated period of 5 years. The first pit can be emptied for successive use after a further lapse of 3 to 5 years and the contents can be used as manure.

*2. Size of Latrine*

Size of 75 cm × 90 cm is the minimum but it needs strict supervision and control of dimensions while fixing the pan and foot rests to maintain proper clearances. Fat and tall people feel it a bit congested. The size of 80 cm × 100 cm is more appropriate and optimum to satisfy all the persons. Therefore, 80 cm × 103 cm size is adopted after considering the size of the brick available in the market.

*3. Materials and Construction*

Nine different specifications for the construction of latrine, sixteen for lining the leaching pits and four for pit covers were finalized alter considering the materials and skills available in different parts of the country. The materials used include brick, concrete, ferro-cement, empty bitumen drum, bamboo mats and earthen rings. Typical designs using brick (due to their availability in the most of the areas) with brief specifications are shown in Fig. 1 and Fig. 2. However, drawings proposing use of other materials can be made available on specific requirement.

4. *Infilterative Capacity of Soils*

It has been observed that the infilterative capacity i.e. rate of percolation of water decreases after first use of the leaching pit due to deposition of organic matter in between the soil particles. This can be improved by keeping the pit open to sky for one month after removing the decomposed excreta during dry weather and digging the bottom of pit to remove part of the soil.

Studies have also been carried out on water-percolation in leaching pits with honey comb brick wall and with solid brick wall without plaster or pointing; with impervious floor and without floor. Effect of walls with or without honey comb brick work was found to be insignificant but that of floors was very high. It is, therefore recommended that the walls of leaching pit should be made solid but without plastering or pointing to make them structurally strong and to avoid caving of soil. The floor should, however, be without any lining except in high subsoil water table areas where it has to be impervious to reduce chances of pollution.

5. *Distance Between Leaching Pits*

A minimum distance of one metre is recommended between two leaching pits to avoid seepage of water from one to the other. However, where space available for the purpose is very limited, and the two leaching pits can be built together it is proposed to divide them with a common impervious wall between them (Fig. 2) thus permitting percolation of water in three directions only. This is better achieved by making two square pits together as one rectangular pit and extending the dividing wall about 30 cm below floor level and plastering the same with cement sand morter (1 : 4) on poth the sides. It has been observed that making two leaching pits together with a common wall is easier to construct.

6. *Distance of Leaching Pits from Existing Buildings*

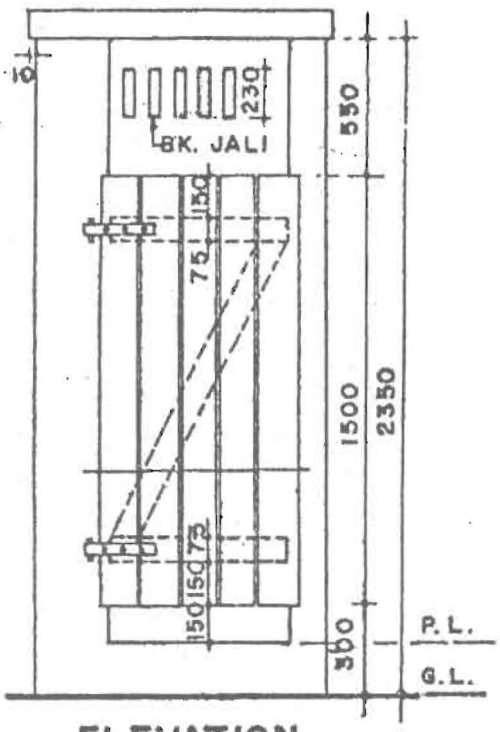
When the depth of leaching pit goes 100 cm below the foundation of the buildings, the minimum distance of a leaching pit from existing structure can be 85 cm for clayey sand and 125 cm for sandy clays. This distance can be adjusted proportionately when the depth of leaching pit below the foundation varies.

7. *Volume of Leaching Pits*

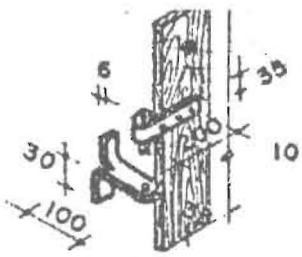
Studies have been conducted in clayey soil having low rate of water percolation and in sandy soil having very high rate of percolation. It has been found that in the first case the decomposition of excreta takes place in wet condition and volume of sludge reduces to 27 to 30 lit. per person per year. In sandy soil, water gets absorbed much faster and the decomposition of excreta takes place in semi dry condition, thus producing a spongy mass, the volume of which varies from 45 to 58 lit. per person per year. The volume of leaching pit has been based on the average values of 44 lit. per person per year and a pit of 1.1 cubic metre capacity will therefore, serve five users for about 4 years in sandy soil and 6 years in clayey soils.

8. *Optimization of Leaching Pit*

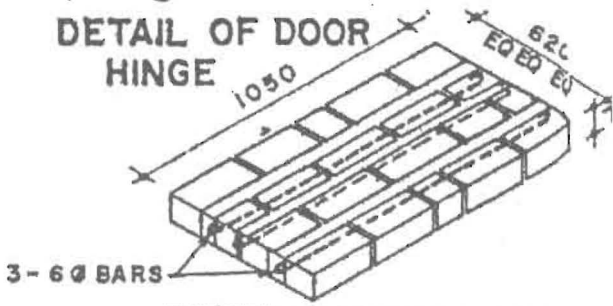
Two basic shapes i.e., square and circular were studied for structural stability and ease in construction. It has been found that the size of leaching pit being small, there is no significant difference in the structural properties of the two. However, construction of a circular pit needs skilled labour and proper care while the square



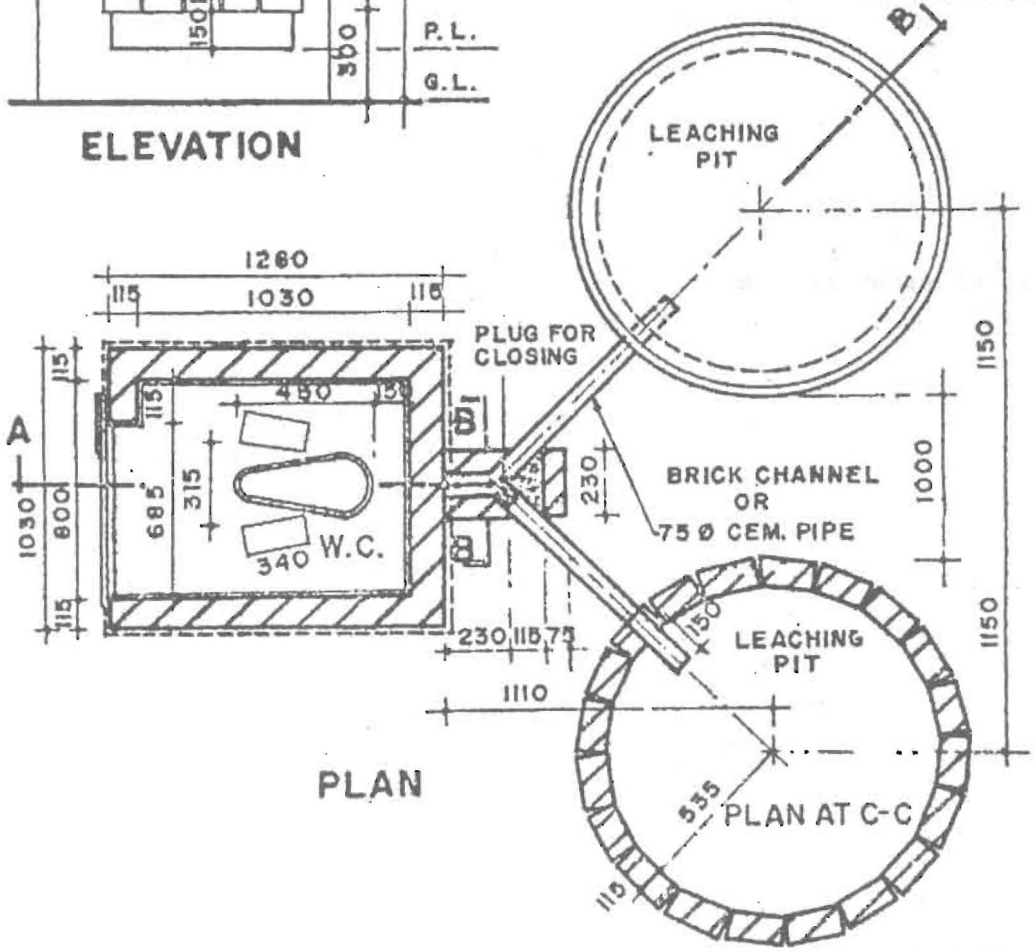

ELEVATION




DETAIL OF DOOR HINGE

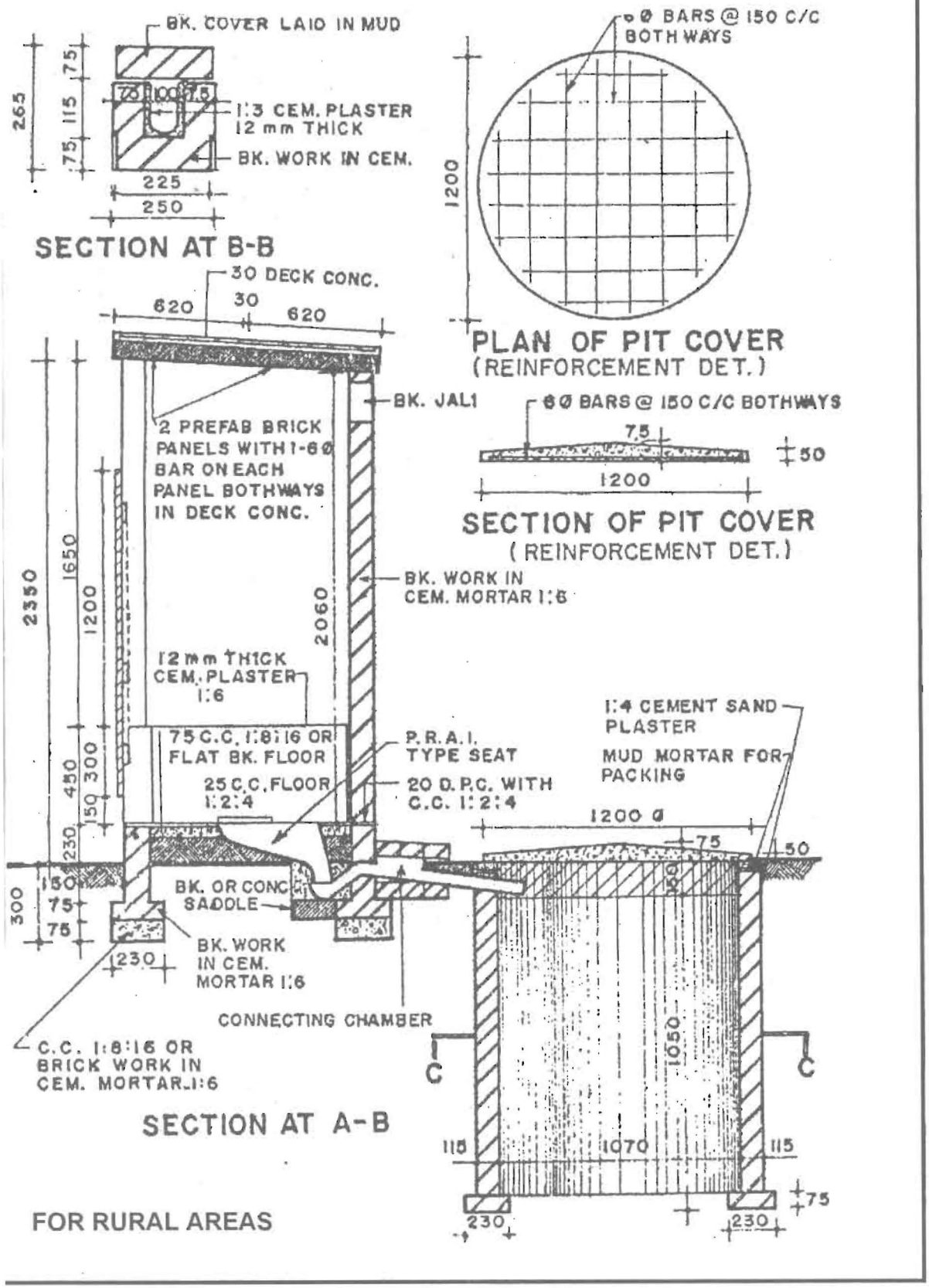



PREFAB BRICK PANEL




PLAN

Fig. 1 : LOW COST LATRINE


BK. COVER LAID IN MUD
265
75
115
75
1:3 CEM. PLASTER 12 mm THICK
BK. WORK IN CEM.
225
250
SECTION AT B-B
8 Ø BARS @ 150 C/C BOTH WAYS
1200
PLAN OF PIT COVER
(REINFORCEMENT DET.)
30 DECK CONC.
620
30
620
BK. JALI
2 PREFAB BRICK PANELS WITH 1-6Ø BAR ON EACH PANEL BOTHWAYS IN DECK CONC.
6Ø BARS @ 150 C/C BOTHWAYS
7.5
50
1200
SECTION OF PIT COVER
( REINFORCEMENT DET.)
2350
1650
1200
2060
BK. WORK IN CEM. MORTAR 1:6
12 mm THICK CEM. PLASTER 1:6
1:4 CEMENT SAND PLASTER
MUD MORTAR FOR PACKING
75 C.C. 1:8:16 OR FLAT BK. FLOOR
P.R.A.I. TYPE SEAT
25 C.C. FLOOR 1:2:4
20 D.P.C. WITH C.C. 1:2:4
1200 Ø
75
50
450
300
150
230
300
150
75
75
BK. OR CONC SADDLE
BK. WORK IN CEM. MORTAR 1:6
230
CONNECTING CHAMBER
C.C. 1:8:16 OR BRICK WORK IN CEM. MORTAR 1:6
C
C
1050
SECTION AT A-B
115
1070
115
75
230
230
FOR RURAL AREAS

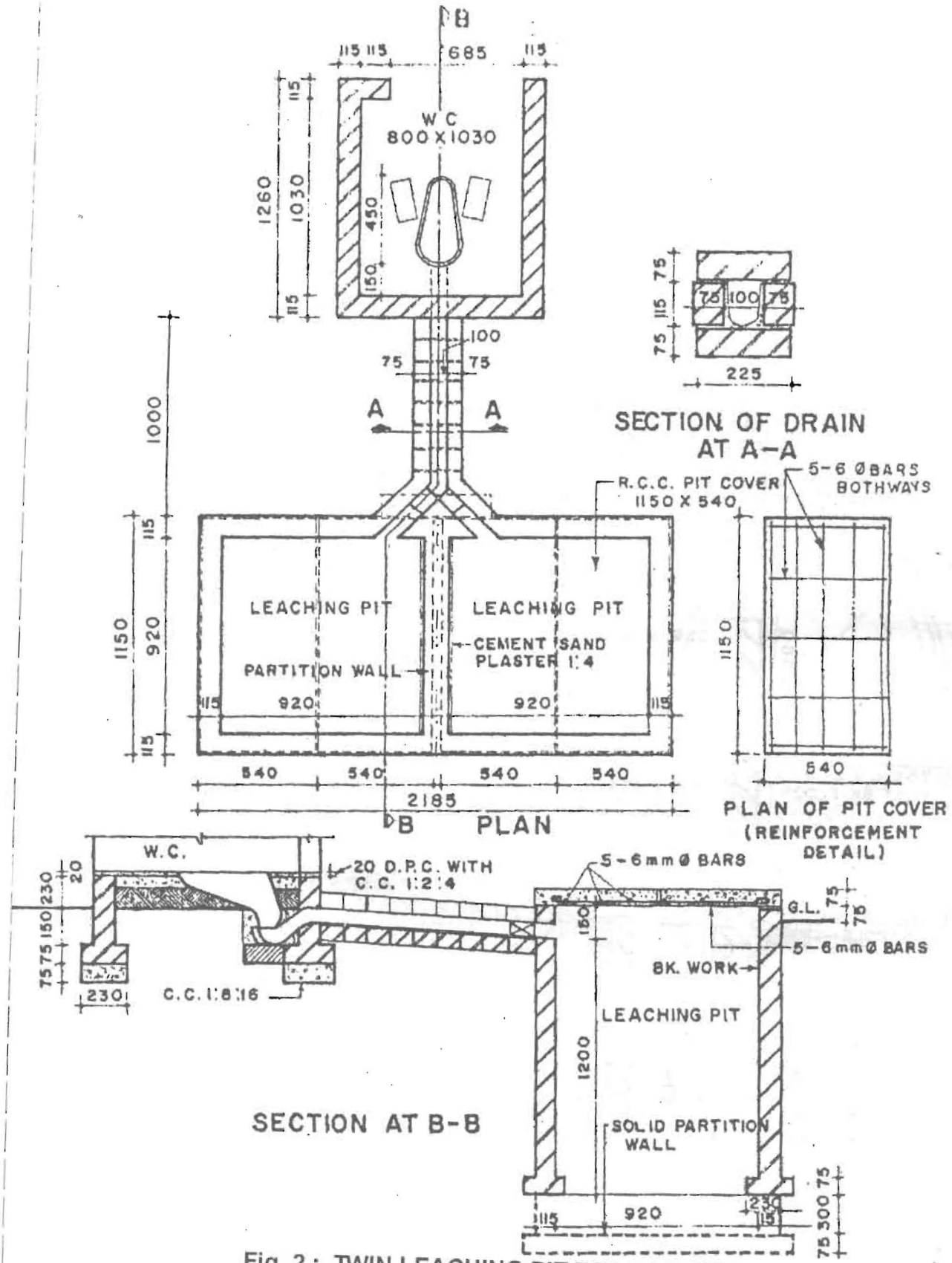



Fig. 2 : TWIN LEACHING PIT FOR LATRINE

one is easy to construct for most of the masons. Other parameters like structural safety of the pit and its cover, handling of the covers by the labour, absorption characteristics of the soil, working space required by labour during construction and removal of decomposed excreta and minimum cost of the leaching pit, when considered together, lead to the conclusion that optimum diameter and depth for circular pit should be 1.07 m and 1.22 m respectively for five users for five years. Similarly width and depth for square pits should be 0.92 m and 1.2 m respectively.

9. *Pollution Aspect in High Subsoil Water Level Areas*

Water discharged along with the excreta gets absorbed underground and has potential danger of mixing up with subsoil water and this carrying contamination for long distances. Safe distance to avoid these chances has been recommended as 2 m between the bottom of the pit and sub soil water table but it is not always possible to maintain this. In many places the subsoil water table is so high as to cause direct mixing of the water discharged with excreta, with it. There is a need to avoid such mixing and therefore the design is not suitable for such locations. It is proposed to make the bottom of the pit impervious by using polythene sheet and filling 45 cm thick layer of fine sand around the pit act as filter to reduce the chances of pollution. This Institute has also develop a low cost alternative to solve the problem of excreta disposal for areas with very high subsoil water level. It consists of a decomposition tank and two leaching pits. The night soil is allowed to pass to the leaching pits after it has completely decomposed. The details of the system can be supplied on demand.

**Field Experiments**

The latrines described above have been constructed in Roorkee town and Mewad Kalan, Khanjarpur and other villages for individual owners and by Sulabh International, Patna for making feed back studies. Following observations have been made :-

1. Owners, masons and labourers preferred two square pits built together, with solid partition wall against two circular pits due to ease in construction, in digging of pits and less space required to accommodate them.

2. 11.5 cm (4 ½ ") thick wall for lining the leaching pit behaves better than 7.5 cm (3") thick wall due to ease in laying and better stability against concentrated lateral loads.

3. Solid R.C.C. pit cover, 7.5 cm thick with sufficient reinforcement should be provided to avoid any accident due to unexpectedly high loads or point load caused by cattle.

4. All the latrines are working satisfactorily and their demand has increased manifold.

**Cost**

The cost of latrine upto plinth level and with superstructure have been estimated as Rs. 4550 and Rs. 7600 respectively at Roorkee market rates in Jan 2004. Details of material and labour requirements are given in Appndices A and B.

**Conclusion**

Satisfactory performance of the low-cost sanitary latrines built at various places has

paved the way towards a solution of the problem Low initial expenditure and maintenance cost makes them more acceptable even to the weaker section of society.

## APPENDIX A
### Material and Labour requirement for construction of low cost latrine up to PLINTH LEVEL only

**Materials**

| | | |
|---|---|---|
| 1. | Cement | 4.5 bags |
| 2. | Sand | 0.6 $m^3$ |
| 3. | Ist class brick | 750 nos |
| 4. | Stone Aggregate 12 mm & Down gauge | 0.2 $m^3$ |
| 5. | Brick Aggregate 40 mm size | 0.12 $m^3$ |
| 6. | M.S. Bar 6 mm dia | 10.5 Kg |
| 7. | W.C. Seat with trap | one set |
| 8. | Foot rests | one pair |
| 9. | Binding Wire | 200 gms |

**Labour**

| | |
|---|---|
| Skilled | 4 man days |
| Unskilled | 8 man dyas |

## APPENDIX B
### Materials and labour requirement for construction of low cost latrine (complete).

**Materials**

| | | |
|---|---|---|
| 1. | Cement | 6.5 bags |
| 2. | Sand | 1.0 $m^3$ |
| 3. | Ist class brick | 1180 nos |
| 4. | Stone Aggregate 12 mm & Down gauge | 0.3 $m^3$ |
| 5. | Brick Aggregate 40 mm size | 0.12 $m^3$ |
| 6. | M.S. Bar 6 mm dia | 13.0 Kg |
| 7. | Door shutter complete including painting | 1 no. |
| 8. | W.C. Seat with trap | one set |
| 9. | Foot rest | one pair |
| 10. | Binding Wire | 200 gms |

**Labour**

| | |
|---|---|
| Skilled | 8 man days |
| Unskilled | 14 man dyas |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