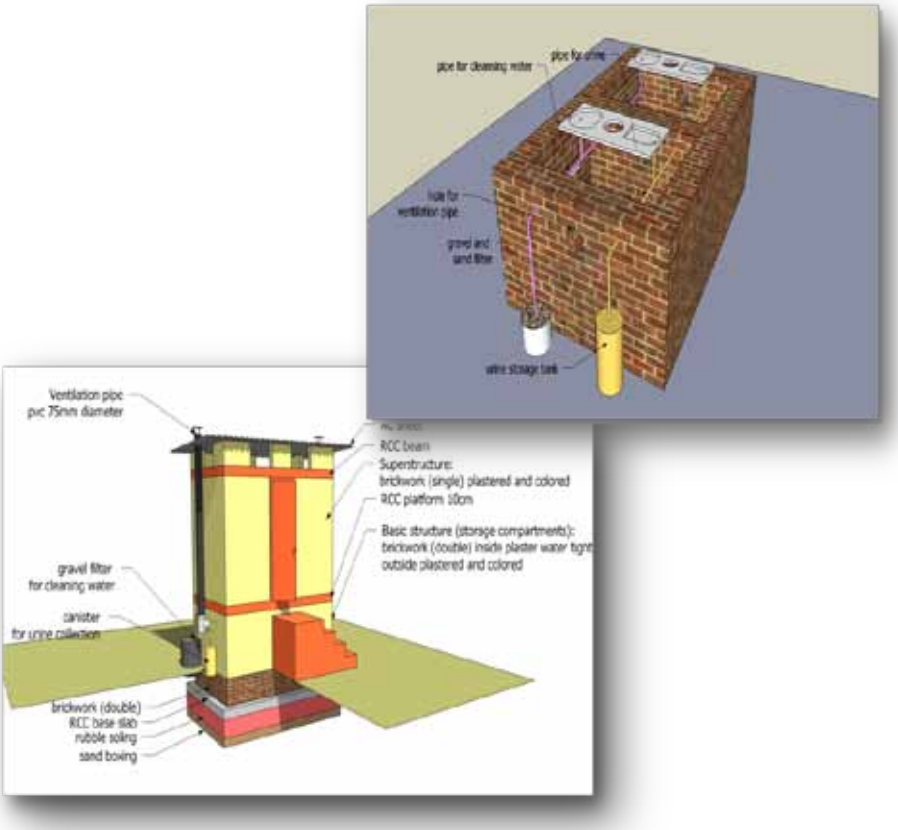

Urine Diversion Dehydration Toilet (UDDT)

Construction Manual

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ecosan SERVICES FOUNDATION

seecon international gmbh

Imprint

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Table of contents

Index of figures

Index of Tables

Index of Figures (Annexure)

I. Water and Sanitation India

Water supply and sanitation in India continue to be inadequate, despite longstanding efforts by the various levels of government and communities at improving coverage. The situation is particularly inadequate for sanitation, since only one of three Indians has access to improved sanitation facilities (including improved latrines). While the share of those with access to an improved water source is much higher than for sanitation (86%), the quality of service is poor and most users that are counted as having access receive water of dubious quality and only on an intermittent basis. In absolute numbers, some 700 million Indians do not have access to a proper toilet and thus open defecation is widespread, even in urban areas of India.

The level of investment in water and sanitation is relatively high, but the local government institutions in charge of operating and maintaining the infrastructure are weak and lack the financial resources to carry out their functions, partly due to very low tariff levels. In particular in sanitation, innovative approaches

have been initiated to increase especially rural sanitation through community-led total sanitation that emphasizes demand for services and community action instead of supply-driven programs of latrine construction by the government. In rural water supply, the focus has also shifted away from supply-driven to demand-driven approaches.

Recently, access to on-site sanitation has increased in both rural and urban areas. In rural areas, Government of India's Total Sanitation Campaign has been moving successfully. In urban areas, the National Urban Sanitation Manual is launched by Ministry of Urban Development, aiming at open-defecation free cities by 2012. A good practice in this direction is demonstrated by the Slum Sanitation Program in Mumbai that has provided access to sanitation for a quarter million slum dwellers.

II. Need for Ecological Sanitation

India faces serious problems in providing adequate sanitation, sewers and wastewater management systems for the whole community. Where conventional, waterborne sewerage systems exist; human wastes are flushed away with huge amounts of scarce freshwater, polluting rivers and the drinking water sources of people living further downstream. In addition, more than 700 million Indians do not have access to adequate sanitation at all – there is a huge demand, which cannot possibly be met by conventional sanitation systems due to the enormous costs for the pipe network, lack of water and serious environmental drawbacks. For this reason, many countries have made a paradigm shift to provide sustainable sanitation & waste management.

Ecological sanitation, or "ecosan" for short, is this new paradigm in sanitation that recognizes human excreta and water from households not as a waste but as resources that can be recovered, treated where necessary and safely used again. The philosophy of ecosan is to not only to manage the excreta for pathogens and thus minimize / negate spread of diseases but

also encourage reuse of resources - nutrients and water - contained in “waste water” for agriculture, horticulture or wasteland greening, instead of disposing them into rivers, lakes or groundwater aquifers where they cause many environmental problems and contaminate precious fresh water resources. Ecosan is a philosophy which houses a multitude of different technologies applied in ecological sanitation projects, ranging from simple, low-cost Urine Diversion Dehydration Toilets to high-tech vacuum systems with membrane filter technology.

Details of Urine Diversion Dehydration Toilets along with construction procedure has been has been explained in this manual.

III. Urine Diversion Dehydration Toilet (UDDT)

The basic concept of Urine Diversion Dehydration Toilets (UDDT) is to keep the faeces as dry as possible. This is achieved by diverting all liquids i.e. urine and anal cleansing water (if applicable) from the faeces and thus keeping the processing chambers dry. They make use of desiccation (dehydration) processes for the hygienically safe on-site treatment of human excreta. Adding wood ash, saw-dust, etc. after each defecation, helps in lowering moisture content and raises the pH. The system thus creates conditions of dryness and pathogen die-off due to raised pH and time.

There are two distinct types of UDDTs i.e. double-vault UDDTs and single vault UDDTs. In order to facilitate collection of finished 'compost' (desiccated faeces and cover material), the former ones are designed to operate in batches while the latter ones provide only one collection cum storage compartment for containment of faeces.

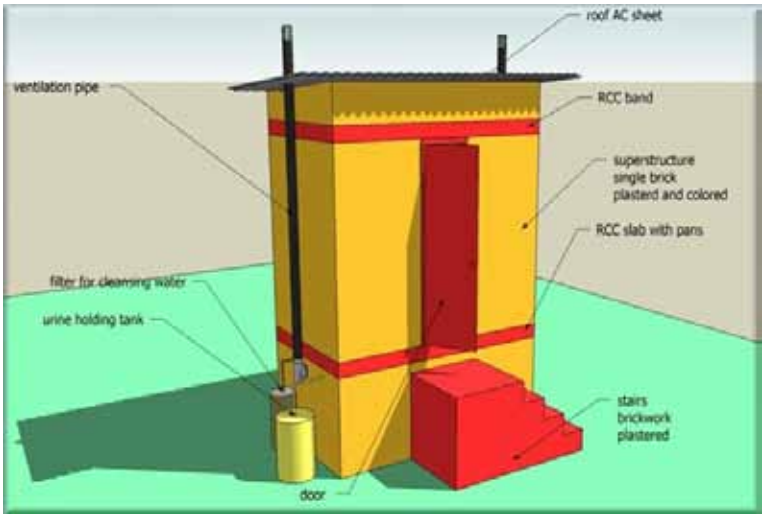


Figure 1: Urine Diversion Dehydration Toilet

IV. Nutrient values of human urine and fecal matter

The very basic objective of fecal matter and urine management is to provide sustainable, socially acceptable and hygienically safe sanitation concepts that allow for the reuse and application of recyclates (sanitized human excreta) in agricultural production.

Human urine contributes the largest share of nutrients to household wastewater. At least 60% of the phosphorus and 80% of the nitrogen in household wastewater comes from urine. The total quantities of nutrients in human urine are significant when compared with the quantities of nutrients in the mineral fertilizers used in agriculture. By source-separating human urine, the amounts of nutrients recoverable could be significantly increased while at the same time the nutrient load of wastewater can be significantly reduced.

The fertilizer value of urine produced by a human per year is as follows:-

Urea (Nitrogen) - 2.5 - 4.3 kg

Phosphorus - 0.7 - 1.0 kg

Potassium - 0.9 - 1.0 kg

Although faeces contain fewer nutrients than urine, they are a valuable soil conditioner, if treated and applied properly.

V. General hygiene aspects

Some of the general hygiene aspects of faeces and urine are discussed, in the context of UDDT toilets. The important operational recommendations are provided below:

- Urine diversion is always recommended. This reduces the amount of faecal material to be sanitized and lowers the risk for disease transmission. This also reduces odour and flies;
- Faecal collection should occur above ground in closed compartments that will not leak into the groundwater or the surrounding environment;
- Handling and transport systems should involve minimal contact with the faeces;
- Material such as sanitary pads/napkins should be treated as solid waste; and
- Anal cleansing water should not be mixed with urine, but infiltrated into soil or added to the greywater and subsequently treated. Contents of potties should be put into the faecal compartment. Further addition of absorbent material, such as ash, or a bulking agent, such

as sawdust, may be needed when diarrhoea is prevalent.

Key points

Compared to regular mixed systems, source-separation of faeces and urine in toilets will result in:

- Less volume of material requiring sanitization;
- Reduced odor and fewer flies;
- Lower risk of pathogens leaking from the system;
- Resource recovery opportunities; and
- Safer handling.

In some cases the pathogens can survive for long periods outside the human body and in other cases they are readily destroyed. Factors such as heat, pH, moisture, solar radiation/UV-light, nutrient availability and presence of other microorganisms affect survival.

i. Urine

Contamination of urine with faeces considerably increases the need for urine sanitization. The recommended treatment of urine for large scale systems is storage. Storing at ambient

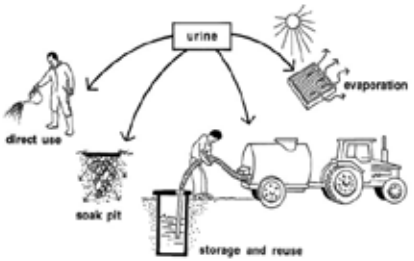
temperature significantly decreases the number of pathogens in the urine. Recommended storage time at 4-20°C is between one and six months, depending on the type of crop to be fertilized. For urine that is significantly contaminated a longer storage time and/or a higher temperature is recommended. The urine should preferably be stored undiluted to provide a harsh environment for pathogens, and in a sealed container to prevent loss of nitrogen.

ii. Faeces

Faeces and the lack of adequate personal and domestic hygiene have been implicated in the transmission of many infectious diseases including cholera, typhoid, hepatitis, polio, cryptosporidiosis, ascariasis, and schistosomiasis. Faeces contain disease-causing organisms or pathogens to a much higher degree.

- **Primary treatment of Faeces**

The need of primary processing is to reduce the volume and weight of faecal material to facilitate storage, transport and secondary treatment, and to make further handling safer. This process takes place where the faeces are being deposited, either in or under the toilet. Usually the containment period is 6-12 months, depending on the size of the collection chamber. During this phase, pathogen levels will be reduced as a result of storage time, decomposition, dehydration, increased pH, and the presence of other organisms and competition for nutrients.



- **Secondary treatment of Feaces**

The purpose of secondary treatment is to make human faeces safe enough to return to the soil. Secondary processing includes high temperature composting, chemical addition of urea and

longer storage times. Incineration is used if a completely sterile end product is needed.

Thermal composting, Alkaline treatment, ***Storage***, ***Incineration*** are some processes for treatment on faeces.

VI. Reuse of Sanitized Urine and Faeces

A period of at least one month between application and harvest is recommended both for urine and for treated faeces. This will further reduce the risk of any pathogens due to microbial activity in the soil, UV-radiation from the sun and desiccation. This period is also required for the crops to utilize the nutrients. Furthermore, the use of recovered toilet products as fertilizers encourages organic farming, and will reduce the use of chemical fertilizers, as well as reduce the resources (mining, logistics, etc.) needed to produce and distribute them. A further advantage of using human urine instead of sewage sludge is the no / very low concentrations of heavy metals found in urine. After pathogen destruction through dehydration and/or decomposition in the fecal matter, the resulting inoffensive material can be applied to the soil to increase the organic matter content, improve water-holding capacity and increase the availability of nutrients.

i. Reuse of Urine

After storing urine as per the pervious chapter -

- Urine should be applied close to the ground to avoid aerosol formation;

- The urine should thereafter be incorporated INTO the soil, either mechanically, manually or by subsequent addition of water; and

- Separate equipment should be used for transportation of unsanitized faeces and for the treated product.

Crop	Human urine lit /ha	Urine required /plant (lit)
Maize	**50,000**	**0.9**
Finger millet	**33,333**	**0.6**
Jowar	**33,333**	**0.13**
Pearl millet	**33,333**	**0.15**
Wheat	**33,333**	**0.06**
Paddy	**33,333**	**0.29**
Chilli	**50,000**	**1.69**
Tomato	**38,333**	**3.38**
Brinjal	**41,667**	**1.13**
Radish	**25,000**	**0.11**
Banana	**135,000**	**53.33**
Sugarcane	**83,333**	**2.25**

Table 1: Criteria for urine application for different crops

ii. Reuse of Faeces

After storing faeces as per the pervious chapter -

- Treated faeces should be mixed well into the soil, and not left on the surface; andTreated faeces should not be used for root crops that will be consumed raw. Precautions in terms of personal hygiene should be followed while handling this compost.

Considering these advantages, the UDDTs are proposed as a viable option to harvest nutrients and thus, this manual is developed to help design a UDDT. The following design is for a double vault type UDDT. Unless specified all the details given are with reference to double vault UDDT

VII. Construction Details for a UDDT

i. Assumptions:

One Family: 5 persons

Retention time: 9 – 12 months

ii. Basic structure:

Size of the compartments:

- Dimensions of each compartment (length, breadth, height): 1.2 x 1.0 x 0.6 to 0.9 (m) (recommended height is 0.65 m)
- Compartment volume: 700 to 1100 litre(Recommended volume is 800 l)

Precaution during the compartment construction

- Thickness of wall one brick (9 inches) and preferably plaster on both sides, inner wall is mandatory
- Floor of the compartment should be water tight, with no sharp edges

- Opening of compartments from back side of toilet is preferable
- Compartments should be water tight
- Fixing of Ventilation Pipe
    - Ventilation pipes (PVC with diameter of 110 mm) have to be placed one for each compartment, when you build up the walls of the compartment
    - It is not advisable to drill later a 100mm hole into the brick/cement block walls

Figure 2, 3: Laying of the bricks, two pipes for ventilation to be integrated in the walls

Figure 4, 5: Inside plastering of the compartment

iii. Compartment Opening

- The opening for each compartment is 0.5 m x 0.5 m
- Close the opening of compartments with a cover stone (e.g. Kadappa stone)
- Use steel frame to place the cover stone
- Seal the edges with light mortar for easy removal when the faeces is composted and has to be removed

Figure 6, 7: Steel frame for the compartment opening and cover stone

i. Plinth slab

- Make RCC plinth slab of thickness of 3 inches

- A pipe has to get integrated into the shuttering of the plinth slab for draining out floor cleaning water (Refer Figure 18)

Box out for the pans

- A proper box out in the shuttering is necessary for placement of the pans
- The pans should get placed 2 cm above the slab to prevent water entering the compartment during floor cleaning

Figure 8: Box out for the pans

Figure 9: Supporting of a shuttering

Figure 10, 11: Arrangement/Placing of Reinforcement

Figure 12, 13: Arrangement/Placing of Shuttering for Plinth

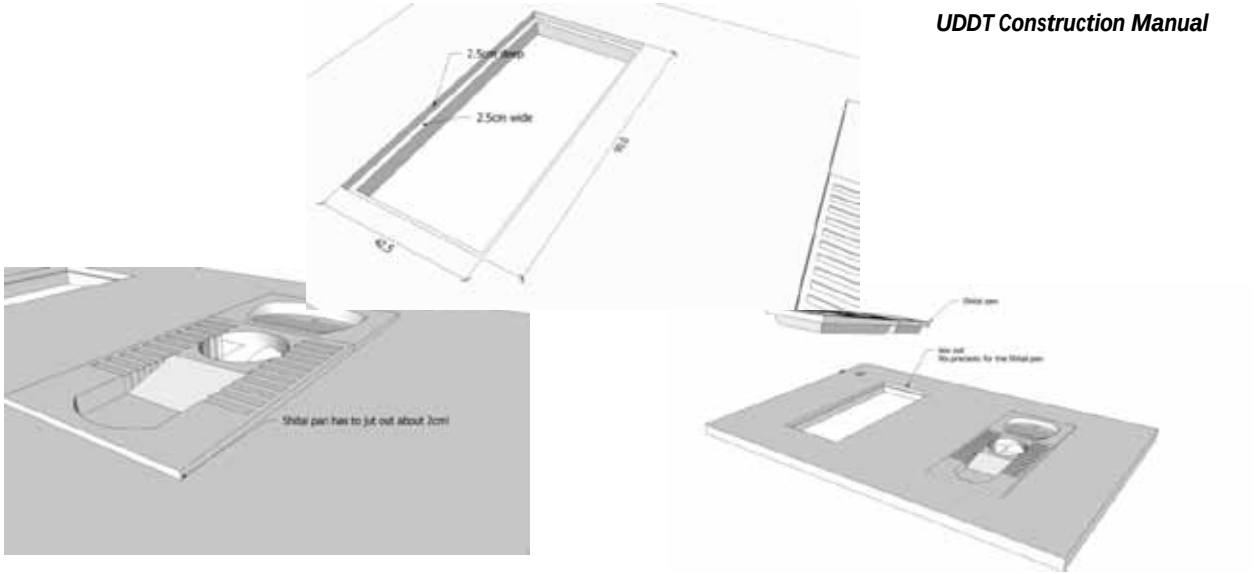


Figure 14, 15, 16: Arrangement/Placing of Pan in the Compartment

v. Piping for urine and wash water

- Separate pipes for urine and cleansing water should be placed;
- The pipes should extend from one end to other end of the compartment for easy removal of dirt to avoid pipes get choked; and
- Use rigid pipes (PVC 1 Inch diameter) inside the compartment and flexible pipes outside the compartment for easier handling.

Figure 17: Schematic Arrangement of Urine and Anal Cleansing water Pipe and Collection Tanks

Precautions

- The urine pipe flows into a urine collection tank (20 to 35 Litre);
- The urine collection tank should be closed;
- The cleansing water flows into a filter tank (gravel and sand) or a small garden;

- Filter tank with different size of gravel and top layer should be sand, if possible do the flower plantation;
- The cleansing water pipe should go into the filter, so no direct contact with the cleansing water is possible;
- The filter tank has to be open at the bottom for water to percolate into the soil after filtering; and
- Water used for floor (slab) cleaning shall also be drained to the gravel filter.

Figure 18: Arrangement for Fixing of Pipe (Urine or Anal Cleansing)

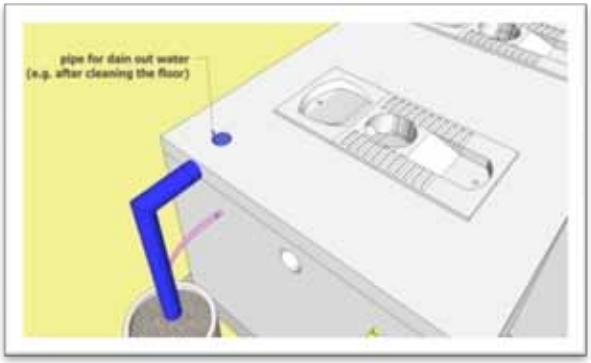


Figure 19: Arrangement for Fixing of Drain Pipe for Floor

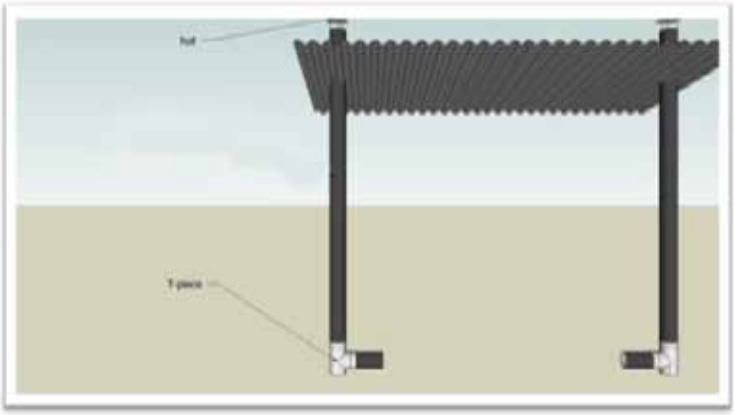
vi. Superstructure

- Make single brick wall;
- Ventilator for proper air circulation; and
- Position of ventilator (side wall or Back Wall) depends upon the position of toilet.

Figure 20, 21: Arrangement of Ventilator on Backside of Toilet

vii. Ventilation Pipe

- PVC pipes with a diameter of 110 mm; and
- Place a mesh at the top and the bottom of the pipe to prevent entering of flies into the compartment.



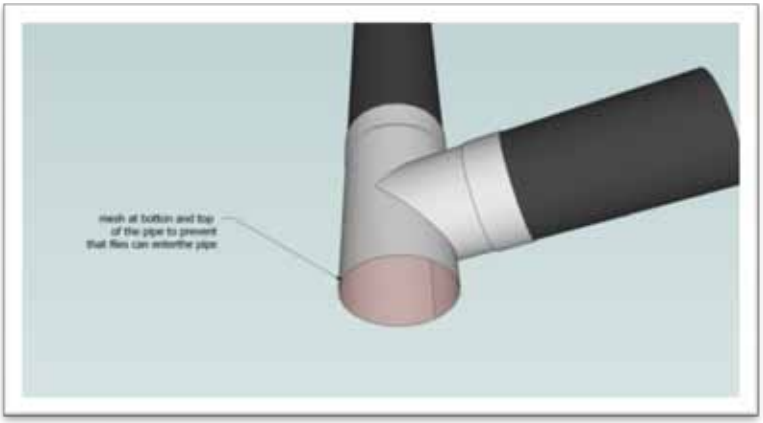


Figure 22, 23: Arrangement of Ventilator on Backside of Toilet

viii Roofing

- Take an Asbestos Cement /Fibreglass Reinforced Plastic sheet for the roof; and

ix Colouring

Recommended colouring: Preferably light colours inside the toilet.

VIII. Cost estimation for single UDDT

The cost is estimated for different areas and at different points in time, to provide an idea to the user that the costs vary from place to place and from time to time. The table is also divided into 4 broad categories, so that the expenses are clear and cost savings for different contexts can further be elaborated.

Construction component	Total cost
Foundation	**Rs. 2540**
Chambers	**Rs. 2110**
Superstructure	**Rs. 3055**
Fittings (doors, light, etc.)	**Rs. 3220**
Total	**Rs. 10925**

Table 2: Cost break-up for one double-vault UDDT

Note: Estimated costs in a village of Gujarat, as on 11th Nov 2009

The different contexts for cost savings or cost increase is discussed below:

i. Based on type of soil conditions:

Type of soil	Areas in India	UDDT recommendations
Alluvial Soil	This type of soil covers Punjab, Haryana, Uttar Pradesh, Bihar, West Bengal, Assam and some other areas in India.	Normal construction, with adequate protection by plastering against water seepage.
Black Soil	This soil covers the greater part of Maharashtra, Gujarat, the whole of Andhra Pradesh and the Western part of Madhya Pradesh	Black soil is an alluvial soil and foundation will have to be adequately strengthened to prevent the building from sinking.
Red Soil	This soil covers the whole of Tamil Nadu, Karnataka and South-East Bombay and extends through	Normal construction, with potential savings on plastering on outside due to dryness.

	the east of Andhra Pradesh and Madhya Pradesh to Orissa and Chhotta Nagpur. In the north, it extends into some districts of West Bengal and Uttar Pradesh and it also covers the eastern half of Rajasthan.	

Laterite Soil	This type of soil is found in Madhya Pradesh, Assam and along the Western and Eastern ghats	Normal construction, with savings on foundation due to strong rocky sub-strata.

Table 3: UDDT recommendations based on type of soil conditions

ii. Based on the construction material

1. Mud block superstructure with plastering
Cost: Rs. 7,939
(as in November 2009)

2. Brick super-structure
Cost: Rs. 7370
(as in Nov 2009)

3. Cement block super-structure
Cost: Rs. 7025 (as in Nov 2009)

4. Tin Sheet super structure
Cost: Rs. 5823 (as in Nov 2009)

5. Hollow block superstructure
Cost: Rs. 6279
(as in Nov 2009)

6. Waste wood superstructure
Cost: Rs. 6066
(as in Nov 2009)

7. Bamboo super structure
Cost: Rs. 5823 (as in Nov 2009)

8. Palm leaf superstructure
Cost: Rs. 5423 (as in Nov 2009)

9. Coconut thatch superstructure Cost: Rs. 5323 (as in Nov 2009)

The above options are courtesy UNICEF, India.

IX. Annexure

i. *Sketches & technical drawings*

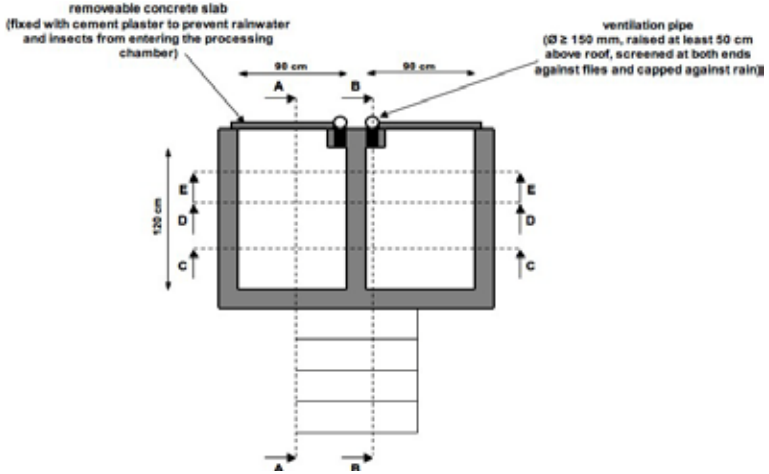


Figure 1 Conceptual sketch of individual UDD-Toilet (horizontal cross section)

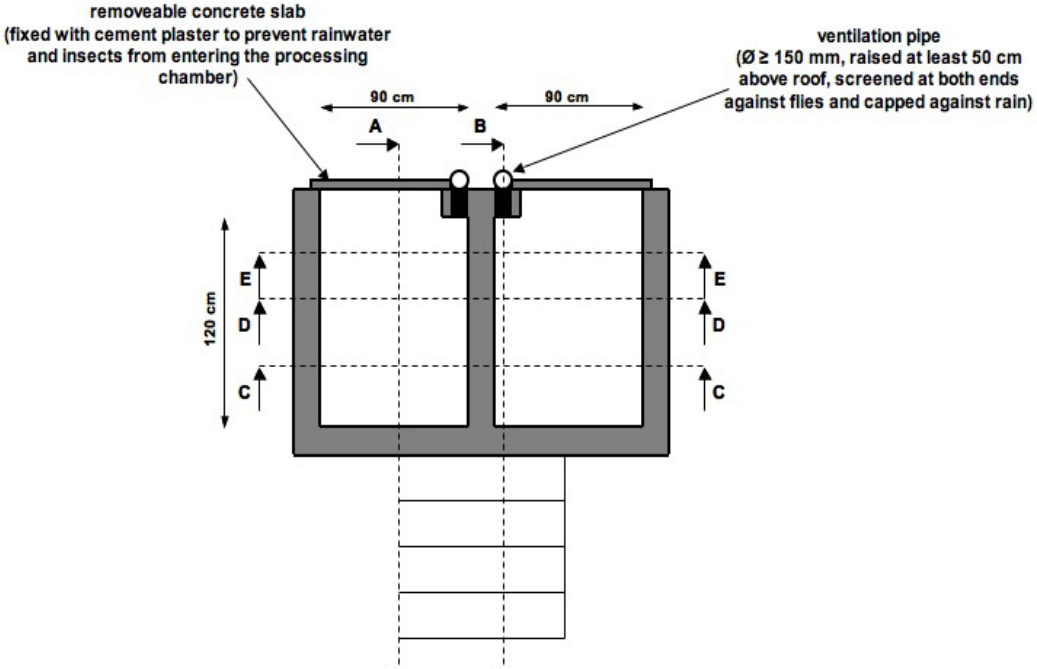


Figure 2 Conceptual sketch of individual UDD-Toilet (horizontal cross section)

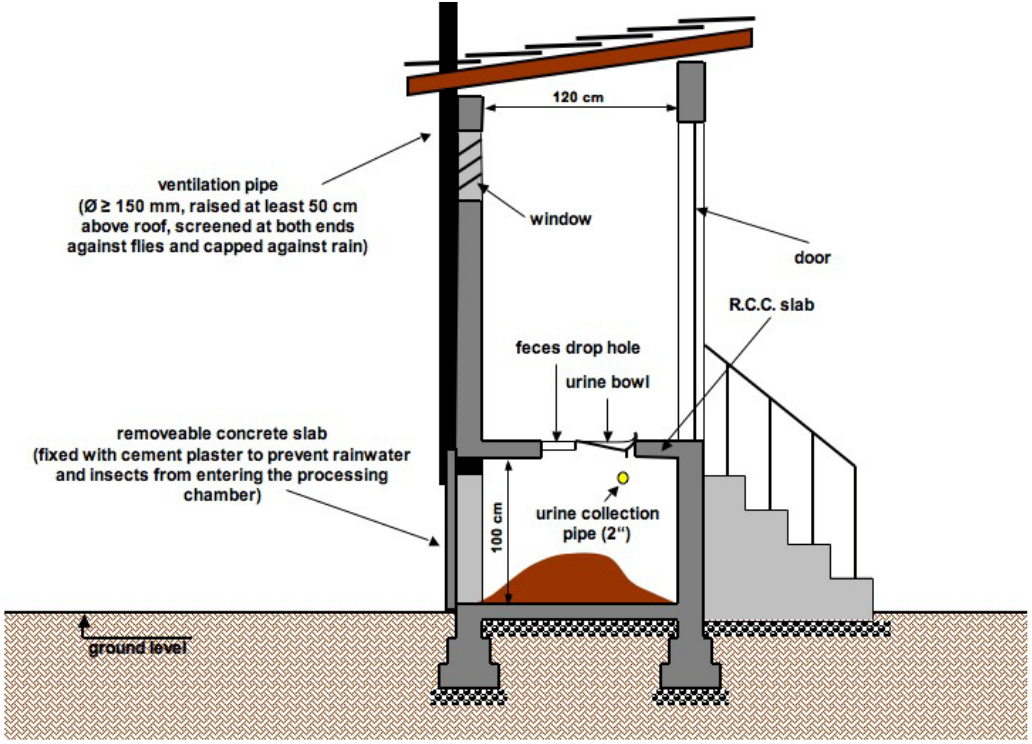


Figure 3 Conceptual sketch of individual UDD-Toilet (cross section A - A)

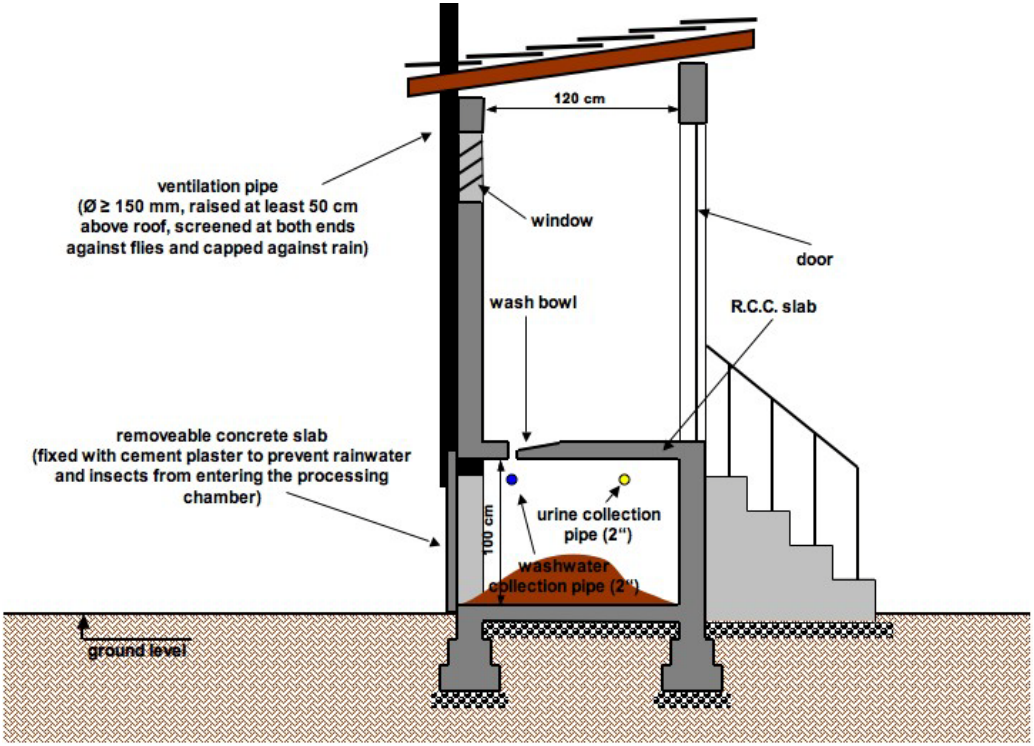


Figure 4 Conceptual sketch of individual UDD-Toilet (cross section B - B)

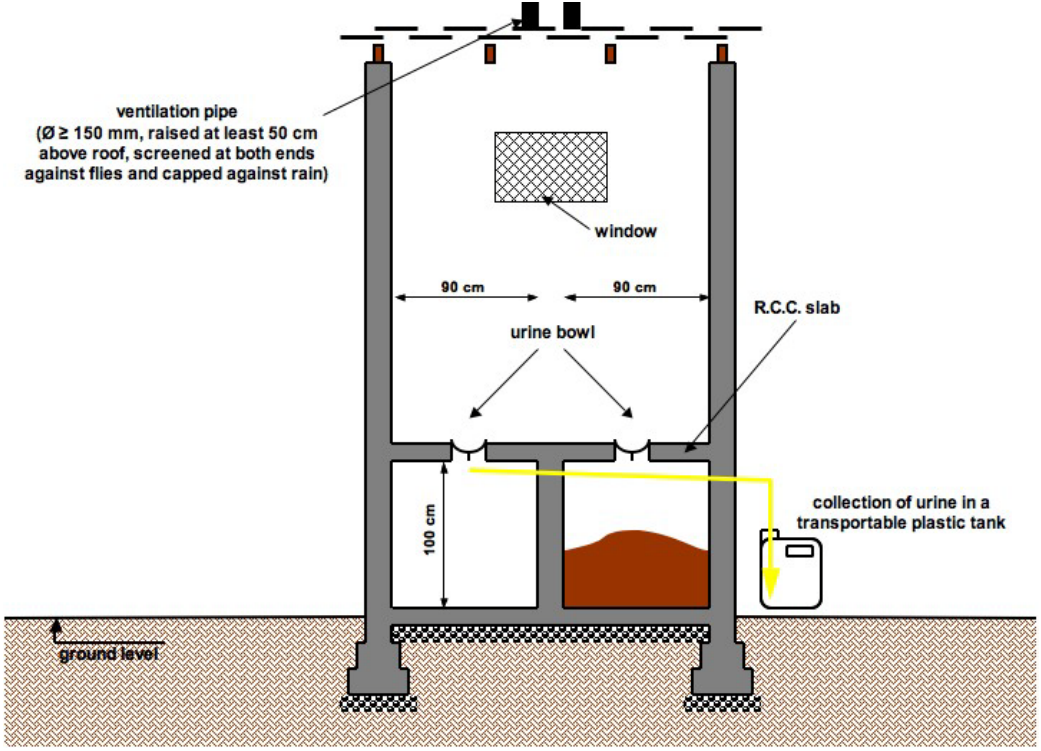


Figure 5 Conceptual sketch of individual UDD-Toilet (cross section C - C)

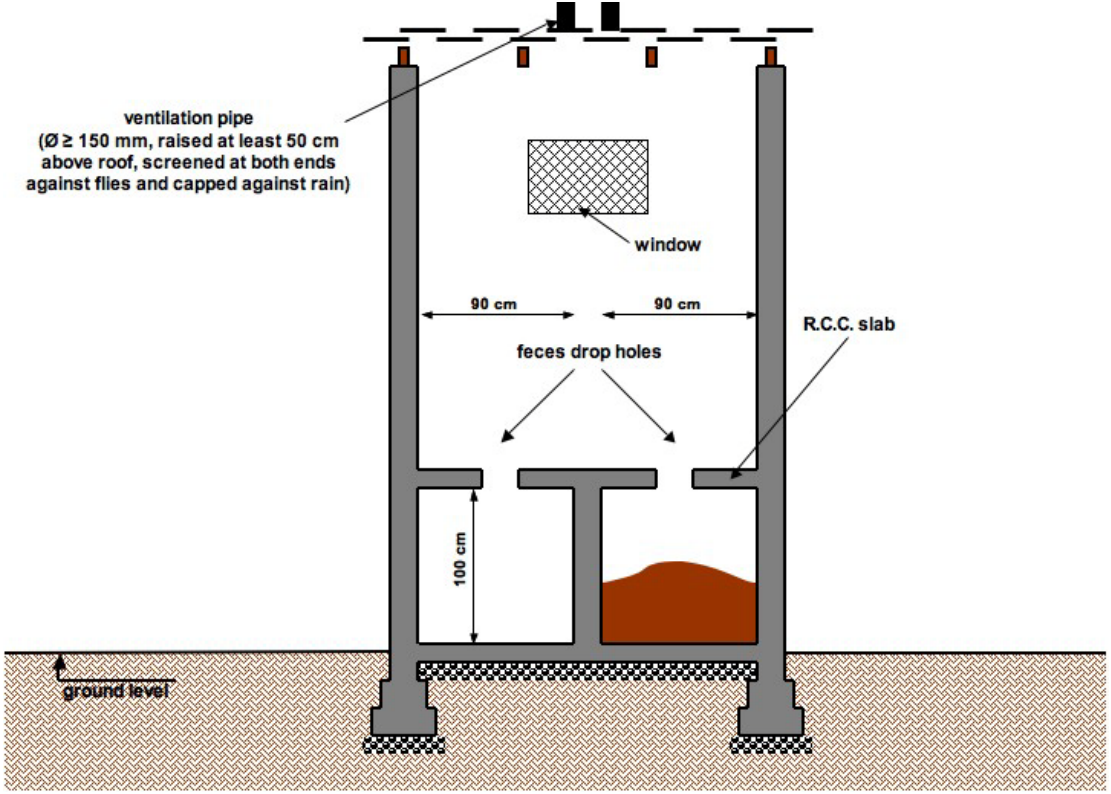


Figure 6 Conceptual sketch of individual UDD-Toilet (cross section D - D)

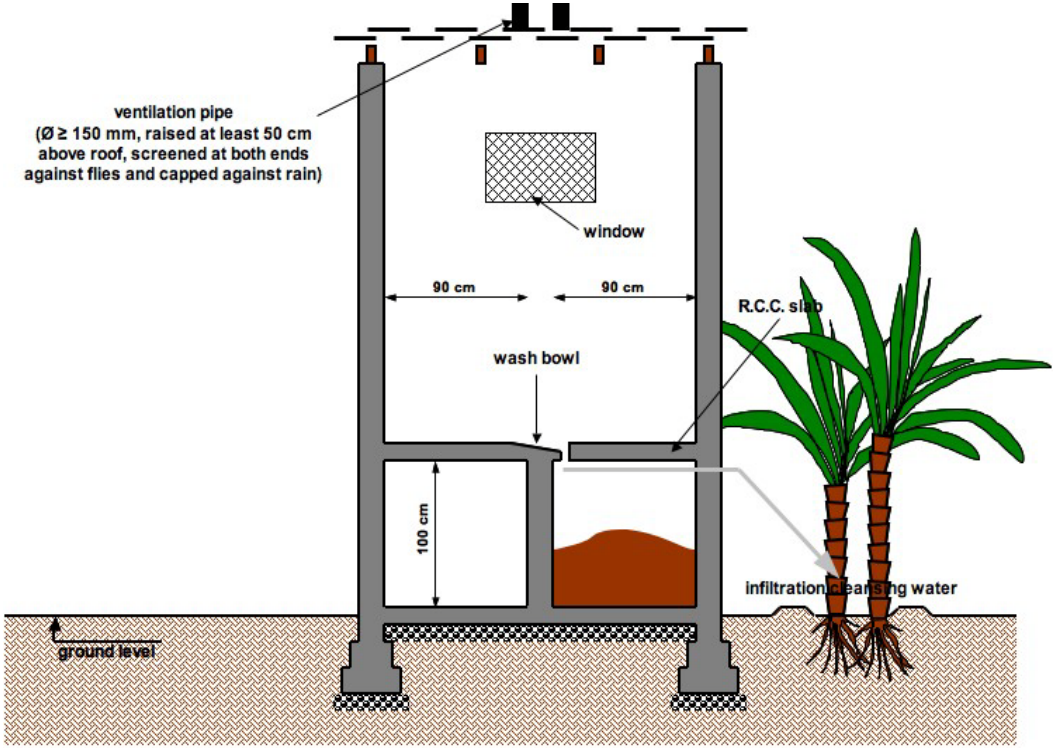


Figure 7 Conceptual sketch of individual UDD-Toilet (cross section E - E)

ii. Different types of UDDT Pans

Fibro Reinforced Plastic Pvt.Ltd.
48/B, IV 'N' Block, III Stage, Rajajinagar, Bangalore - 560 010, Karnataka
Price: Rs. 1300 as on 23rd October 2009

SHITAL CERAMICS WORKS
B-1, 1st Floor, Vasupujya Chambers,B/h. Navdeep Building,Near Income Tax Road, Ashram Road
Ahmedabad - 380014
phone: +91-(0)79-26402123
mobile: +91-(0)98-25408254
fax: +91-(0)79-26402123
email:shitalcera@rediffmail.com
Price: Rs. 910.00 (as on Nov 2009)

Prakash Ceramic
Vagadia Road,
Thangadh 363530
Phone: +91(02751)220856
Mobile: 9825231856
Fax No.:+91(02751)220859
Price: Rs. 356.50 (as on May 2009)

Sustainable Technologies in the Community
Pulari. 49 Assan Nagar, Vallakadavu, Trivandrum – 695008, Kerala, India
web: http://www.eco-solutions.org

ARIES
169, New H Sector, Govindpura Industrial Estate, Bhopla, Madhya Pradesh, India
phone: +91-(0)755-2587777
mobile: +91-(0)98-26065345
fax: +91-(0)755-5221719
email: ariesngo@rediffmail.com

Mythri Sarva Seva Samithi
1300 D, 1st Cross, 1st Main, HAL 3rd stage, New Thippasandra, Bangalore - 560 075, India
phone: +91-(0)80-25255543
fax: +91-(0)80-25273941
email: msss@vsnl.com
Price: Approximately Rs. 690 (as on December 2009)

iii. Sample budget of one double vault UDDT

Measurements							
Sr no	**Description**	**No**	**Length**	**Width**	**Depth**	**Quantity**	**Unit**
1	Excavation for foundation including throwing out the excavated stuff up to lead of 50 mt. up to depth of 1.5 mt.	2	2	0.45	0.45	0.81	
		2	0.6	0.45	0.45	0.24	
						1.05	Cu.M
2	Providing & laying cement concrete for foundation including throwing excavated stuff ramming, curing etc. comp. with using black stone aggregate 20mm size(1:3:6) with finishing etc. complete.	2	2	0.45	0.1	0.18	

		2	0.6	0.45	0.1	0.05	Cu.M
		1	1.35	0.85	0.075	0.09	
						0.32	
3	Providing burnt brick masonry for foundation and plinth in CM 1:5 with bricks of approved quality and including racking out joints, curing etc. complete.						
	Long wall	2	1.8	0.23	1	0.83	
	Short wall	2	0.85	0.23	1	0.39	
	Partition	1	0.85	0.1	0.6	0.05	
	Step	1	0.75	0.5	0.2	0.08	
		1	0.75	0.25	0.2	0.04	
	Deduction	-2	0.45	0.23	0.6	-0.12	
						1.26	Cu.M
4	Providing Partition burnt brick masonry for super structure in C.M. 1:4 with bricks of approved quality and including racking out joints, curing etc. complete.						

	Long wall	2	1.8		2.1	7.56	
	Short wall	2	1.1		2.1	4.62	
	Deduction door	-1	0.75		1.8	-1.35	
	Ventilation	-2	0.45		0.6	-0.54	
						10.29	Sq.M
5	Providing and laying R.C.C. slab including transportation, unloading taxes with finishing & joints filling in C.M. 1:2:4 of 10 cm thick slab	1	1.8	1.3	0.08	0.19	
	Deduction	-2	0.5	0.3	0.08	-0.02	
						0.16	Cu.M
6	Providing Reinforcement steel for slab & beam with cutting, bending, pacing & fixing at site including transportation etc. complete.	1				**10.00**	Kg
7	Cement plaster including racking the joints and finishing curing etc complete in C.M. 1:3						
	Out side	2	1.8		2.7	9.72	

			2	1.3		2.7	7.02	
	In side		2	1.6		2.1	6.72	
			2	1.1		2.1	4.62	
		Deduction	-2	0.75		1.8	-2.70	
			-2	0.6		0.45	-0.54	
							24.84	Sq.M
8	White washing the exterior & interior sides (as per above item)						**24.84**	Sq.M
9	Providing Supplying & fixing at site of work including freight , loading, unloading, insurance & all taxes etc. complete.							
	A) Providing &fixing a pan in R.C.C		2				**2**	No
	B) Ventilator		1				**1**	No
	C) Door		1				**1**	No
	D) Precast R.C.C Cover		2				**2**	No
	E) Ventilation pipe		1	3			**3**	RMt
	F) Roofing material AC Sheet		1	1.8	1.67		**3.0**	Sq.M
	G) Urine and wash pipe		1	3			**3**	Rmt

H) Precast Lintel (23x60cm)	2		**2**	No
I) Urine cane (10 lit)	1		1	No

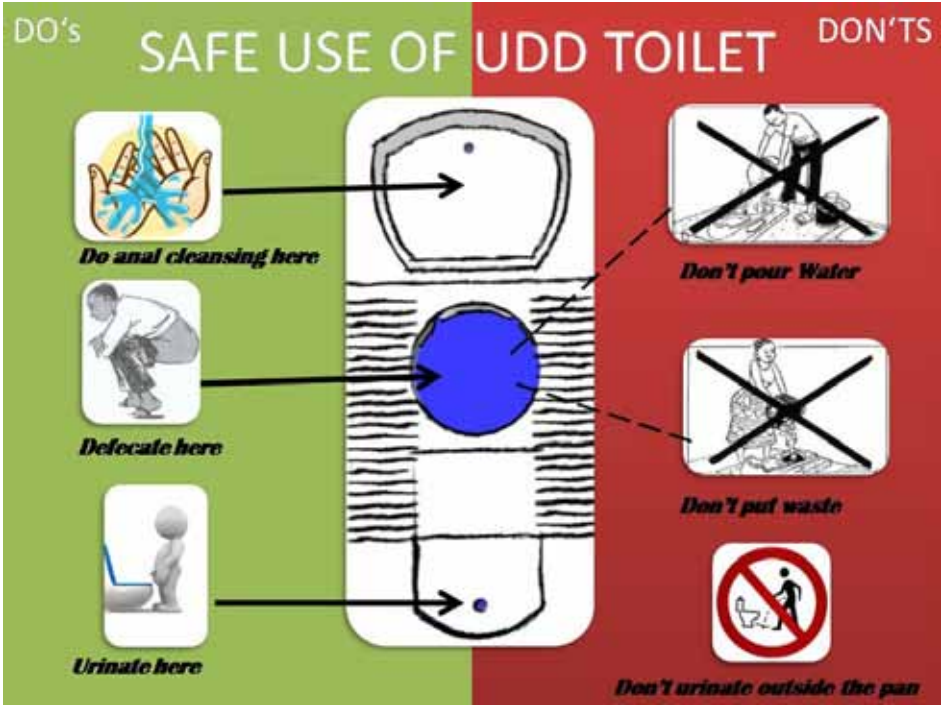
Abstract						
S.No	**Description**	**No.**	**Quantity**	**Rate**	**Unit**	**Amount**
1	Excavation for foundation including throwing out the excavated stuff up to lead of 50 mt. up to depth of 1.5 mt.	1	1.05	50	cum	52.65
2	Providing & laying cement concrete for foundation including throwing excavated stuff ramming, curing etc. comp. with using black stone aggregate 20mm size(1:3:6) with finishing etc. comp.	1	0.32	1599	cum	511.78
3	Providing burnt brick masonry for foundation and plinth in CM 1:5 with bricks of approved quality and including racking out joints, curing etc. comp.	1	1.2583	1568	cum	1973.01

4	Providing Partition burnt brick masonry for super structure in C.M. 1:4 with bricks of approved quality and including racking out joints, curing etc. comp.	1	10.29	218	sqm	2243.22
5	Providing and laying R.C.C. slab including transportation, unloading taxes with finishing & joints filling in C.M. 1:2:4 of 10 cm thick slab	1	0.1632	2294	cum	374.38
6	Providing Reinforcement steel for slab & beam with cutting, bending, pacing & fixing at site including transportation etc.complete.	1	10	36	kg	360
7	Cement plaster including racking the joints and finishing curing etc complete in C.M. 1:3	1	24.84	85	sqm	2111.4

8	White washing the exterior & interior sides (as per above item)	1	24.84	3.1	sqm	77.00
9	Providing Supplying & fixing at site of work including freight, loading, unloading, insurance & fixing etc complete.					0
	A) Providing &fixing a pan in R.C.C	1	2	357	no	714
	B) Ventilator	1	1	75	no	75
	C) Door with Frame	1	1	1100	no	1100
	D) Precast R.C.C Cover	1	2	90	no	180
	E) Ventilation pipe	1	3	50	Rmt	150
	F) Roofing material AC Sheet	1	3.0	150	Rmt	450.9
	G) Urine and wash pipe	1	3	50	Rmt	150
	H) Precast Lintel (23x60cm)	2	2	75	no	150
	I) Urine cane (10 lit)	1	1	50	no	50
	J) Fitting Charges					200
					Total	**10923.35**

Table 4 Sample budget in detail for a single UDD toilet

iv Do's and Don'ts of UDD toilet



X. References

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