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Community Waste Treatment and Disposal Options

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ABSTRACT
The paper presents cost effective and appropriate technologies at rural level for proper collection and disposal of the waste generated in the houses. To separate the toilet and non toilet wastes and to improve the functioning of septic tank, an improved system; ash & silt trap chamber & ferrocement septic tank has been proposed. The technology discussed in this paper consists of a simple hand trowelling of cement rich mortar into a wire reinforced (wire mesh or check mesh) with the help of form work in layers to cast different units of superstructure, pan and pit of sanitary latrines, thus making it low cost, easy to work with avoiding heavy equipment and expansive scarce materials, minimum skill requirement (self help), labour intensive and appropriate to the rural social and economic conditions. In order to have the safe and effective disposal of the solid waste in the form of garbage and rubbish, compositing methods viz windrow, static pile & vermin composting have been highlighted.

Keywords: *Solid & Liquid waste, Waste treatment, Septic Tank, Ferrocement Technology, Composting, Windrow, Static Pile, Vermin composting Garbage, Rubbish*

INTRODUCTION
A large section of Ethiopia population lives in villages and is mainly engaged in agriculture. They belong to the weaker section of the society. There is s definite trend of rural population migrating to urban areas due to lack of employment opportunities, low earnings, and insufficient means of transportation and in sanitary living conditions. The latter is mainly responsible for repelling youth from rural to urban areas. The residential areas of Jimma are almost non sewered. The liquid waste from non toilet sources like floor washings, lawn care chemicals, paints solvents, automotive products, etc is being disposed of in the drains outside the residences in open earthen drains or in the septic tanks. These earthen drains do not have proper designs to carry the wastes and have lot of weed growth. Water remains infiltrating in the ground slowly and remains stagnant in the drains, becomes breeding place for mosquitoes, the carrier of various diseases. The disposal of waste from non toilet sources directly into the septic tanks is a serious threat to the working conditions of the septic tank. The addition of soaps detergents, phenols from washing s hot water from the kitchen etc, impairs the normal functioning of the septic tank. The waste from toilet sources has the outlet to the septic tanks, they being underground; the reliability for the proper functioning is a serious threat to the underground water. The solid waste, like food wastes, plastic bottles, polythene bags, pieces of cloths, garbage, batteries tubes etc generated in the house of Jimma generally thrown outside, near the houses in open of small drains carrying low discharges in the locality. Accumulation of wastes

along the sides of the roads and heaped in many places in Jimma town looks unsightly, bad smelling and results into serious health hazard through (a) Soil pollution (b) Water pollution (c) Contamination of foods and (d) Propagation of flies, mosquitoes, worms and other vehicles of transmission of diseases.

The waste thrown in the running waters is also not a wise act because Eutrophication is one of the major causes of waste substances. Last but not least the absence of public conveniences like toilets, lavatories in Jimma causes unsightly scene when residents belonging to underprivileged sections are seen answering the nature's call (urinating etc) in open. This is not only a question of the environment pollution but also of civilization. Similar problems mentioned above have been tackled in India effectively in the past. In 1989, central building research institute (CBRI), Roorke pioneered Ash& silt chamber technology at the rural level to collect & treat the non toilet liquid waste separately for each and every dwelling unit. The technology has been tested successful and because of its easy affordability, is still prevalent in rural India. Secondly, Ferro cement technology is an improvement over the conventional designs (masonry /RCC designs) for septic tanks. This technology has also been advocated and proved successful by CBRI. Ferro cement is a composite material consisting of cement (OPC or PPC), coarse sand and wire mesh. The wire mesh consists of 0.5 to 2mm diameter wire at 5 to 50mm C/C spacing. The cement mortar consists of 1:2 or 1:3 ratio. The basic advantage of using this material is that concrete can undergo large strains without cracking. As on date fibrocement technology is a big construction industry in India. 3rdly the handling of solid waste in the form of rubbish, garbage by means of composting is widely accepted the world over. All developed countries especially America is handling the solid waste in effective and efficient manner. The states like Texas, Michigan, and Virginia have been successful in converting the community waste into wealth. These days the city of Austin has its own website and provides free consultancy to the residents regarding composting and online trouble shooting steps also.

MATERIALS & METHODS

There is a difference between the living habits of the people in the rural & the urban areas. The urban type of underground drainage system is not suitable because of the settlement of silt and ash in drains insufficient quantity of water for self cleaning of drains, high maintenance & running cost. The lack of interest in the maintenance of community services leads one to conclude that the proposed system should be such that it should make the individuals responsible to run their own water disposal system. At the same time the system should be within the economic reach of a villager who can maintain it without help. The disposal of the waste from toilet & non toilet sources should be separate, following system is proposed for the disposal of waste from the non toilet sources.

Improved System

The proposed the proposed system consist of ash silt trap chamber and a borehole (6). The ash trap chamber (fig 1&2) is rectangular in shape having 7.5 cm thick wall of burnt brick laid in 1:8 cement sand mortar and is constructed near waste water outlet. It is divided into two compartment by 7.5 cm thick wall and is covered with R.C.C reinforce brick lid. The size of first and second compartment is made as 45*45*75cm 30*45*70cm respectively. Triangular ducts 8*8 cm in size and 46cm deep are made in the corner adjacent to each other in both compartment, diagonally opposite to inlet. A hole is left in the partition wall 19.0cm below the top of the duct portion to provide connection between the two ducts. The second compartment is filled with 4cm gauge brick ballast. In the first compartment, heavier particles of silt and ash, flowing with waste water, settle down and floating and greasy materials get trapped. The water having colloidal particles get struck to the brick ballast and only clear water is allowed to flow into the bore hole for final disposal underground. When the first compartment gets filled with ash and silt, the lower mouth of the duct will be closed and water will stop flowing to the second compartment. This will cause flooding of the first compartment and back flow of water indicating that the compartment requires cleaning. This system is reactivated by removing ash, silt from the first compartment.

Unlike the existing soakage systems where the ash and silt directly flow into the soakage pit and cause chocking, the proposed system provides for their retention in ash-silt trap chamber and its subsequent cleaning when the water starts overflowing.

The materials required for the construction of one unit include cement(1/2bag),bricks(160 no.), mild steel bars 6mm dia (3kg),brick ballast (0.35Cum),sand(0.15 cum), stone ballast (0.02cum),skilled labor(one man days) the cost of this materials and labor (2 man days) The cost of these materials and labor has been estimated as 250 Birr.

The retention of water in the first compartment and its passage through the brick aggregates (filled in the second compartment and bore hole) is also expected to reduce the BOD before the water reaches the subsoil water level. The proposed soakage system is a small compact unit designed for individual dwelling. This simple technique involves the use of locally available materials and labour, hence economical. The chances of mosquito breeding are completely eliminated.

Septic Tanks

Septic tanks constructed in masonry are seldom 100% water tight due to large no of joints in masonry. Leakage from these tanks can contaminate the ground strata. These occupy and need larger area for construction due to extra thickness of the masonry. The technology discussed in this paper consists of a simple hand trowelling of cement rich mortar into a wire reinforced (wire mesh or check mesh) with the help of form work in layers to cast different units of superstructure, pan

and pit of sanitary latrines, thus making it low cost, easy to work with, avoiding heavy equipment and expansive scarce materials, minimum skill requirement (self help), labour intensive and appropriate to the rural social and economic conditions. This wire mesh technology is known as Ferrocement Technology.

Ferrocement Technology

Ferrocement is a composite material consisting of cement (OPC/PPC), coarse sand and wire mesh (2&4). The closely spaced wire mesh is impregnated with rich mortar mix. The wire mesh consists of 0.5 to 2mm diameter wires at 5to 50mm spacing. The cement mortar consists of 1:2 to 1:3 cement sand with water cement ratio varying from about 0.4 to 0.5. The natural aggregate size varies from 2 to 10 mm depending upon the wire mesh size. The ferrocement elements are usually of the order 10-50mm in thickness with 2-5mm clear cover mesh. Once the mortar is set, moist curing is done for about 10-14 days. The common types of steel wire mesh used in ferrocement are square, rectangular and hexagonal and expanded metal mesh. These meshes may be woven, twisted, or welded. This composite material exhibits two important properties: higher elasticity and higher resistance to cracking The basic advantage of using this material is that is that concrete can undergo large strains in the vicinity of the reinforcement without cracking and magnitude of strains will depend upon the distribution and sub division of the reinforcement throughout the mass of the concrete (Ref3). This flexibility cannot be achieved in conventional steel bar reinforce cement concrete because of greater thickness involved as compared to the thin ferrocement structure. Ferrocement structure is able to resist shrinkage cracking during curing and severe cracking under tensile loads. This occurs because the wire mesh, distributed relatively densely through the mortar will allow the load to be taken throughout the complete layer and will prevent the concentration of critical stresses in planes of weakness (Ref1). Any cracks that do appear under moderate loading will not be wide enough to allow water to reach the reinforcing bars.

Ferrocement septic tanks have the following advantages:-

a) Absolutely water tight chamber.
b) Can resist the shock during earthquakes.
c) Will get affected due to minor earth settlement. Also will not crack or get damaged
d) Free from risk of ground contamination
e) Long, trouble free service life.
f) Occupies less space less space due to thin walls
g) Very fast installation due to precast ready to transport and install septic tanks.
h) Economical in cost and no maintenance required.

Disposal of solid waste & refuse of a society: All solid and semi solid waste of a community, except human excreta and sullage is classified under general term refuse, refuse thus represents the dry wastes or solid wastes of the society and includes (a) garbage viz food wastes from kitchens, hotels restaurants, dry leaves vegetable wood chips etc (b) ashes i.e. incombustible waste products from hearth and furnaces and house and industries (c) Rubbish, like rags, paper pieces, broken pieces of glass and furniture card board, broken crochery etc

Composting: Composting of refuse is a biological method of decomposing solid wastes. This decomposing can be effected either under aerobic conditions, or under anaerobic condition or both. The final end product is compost or humus which is in great demand in European countries as fertilizer for farms.

What can be composted: Grass, Clipping, Yard, Trimming, leaves, vegetable, wood chip, shredded paper, and night solid

What to avoid: Meat, Fish and poultry (including bones), food sauces, fats, greases, oils treated woods, non organics like plastics, metals, glass etc.
Compost contains a full spectrum of nutrient, including micro-nutrients, such as iron and manganese. The compost breaks up the tightly bound soil particles & allows roots to spread, water to drain and air to penetrate. Compost introduces bacteria & worms. Compost increases the soil's ability to retain water and decrease runoff.
The composting is practiced in rural area on the mixture of night soil and refuse. Three methods are generally adopted

1. Window method
2. Static pile method
3. Vermin composting

Window method uses manual turning of piled up mass (refuse +night soil), for its decomposition under aerobic condition. In this method, layers of vegetable waste and night soil are alternatively piled in depth of about 7.5 to 10cms each, to a total depth of about 1.5m in a trench, or above the ground to form a mound called window. The mixture is kept aerobic by turning regularly for 2 to 3 months, this compost mass is then left for another about 1 to 1.5 month without turning: after which the compost becomes ready for use. The entire process thus takes about 4 months. This method is primarily aerobic in nature.

Static pile method: is primarily anaerobic in nature and does not involve any turning or handling of the mass, hence, more clean than windrow type. This method is widely used by municipal authorities, the refuse and night soil, in this method are piled up in layers in an underground earthen trench (about 10m*1.5m*1.5m). The mass is covered at its top by layer of earth of about 15 cm dept, and is finally left over for decomposition. Within 2 to 3 days of burial,

intensive biological action starts taking place and organic matter begins to be destroyed. Considerable heat gets evolved in the process which raises the temperature of the decomposing mass to about 75 c. this heat prevents breeding of flies by destroying the larvae. After about 4 to 5 months (depending upon the season), the refuse gets fully stabilized and change into a brown colored odorless innocuous powdery mass, called Humus. This humus is removed from the trenches, sieved on 12.5 mm sieves to removed stones, broken glass, brickbats etc, and then sold out in the market as manure. The empty trenches can again be used for receiving further batches of refuse. The initial C-N ratio (carbon-Nitrogen) and moisture content of the compost heap are important factors controlling the success of anaerobic digestion, which finally produces compost free from pathogens and contains 1% N, 1.1% P, and 1.5% k on dry basis, thus providing valuable nutrient for the soil, along with producing biogas as a byproduct.

Vermicomposting: Vermicomposting or worm composting (5) is the decomposition of organic waste with red worm. It is a convenient way of composting for apartment dwellers, school staff and students persons with disabilities, office workers, elderly persons and anyone else who would have difficulty in maintaining an outdoor compost pile. Vermicomposting creates fine black granular compost called "casting". Worm's castings are excellent sources of slow release soil nutrient for plants or lawns. They also act as an excellent soil additive that prevent the caking of soil in potted plants

Creating a Home for Worms

Bedding: Red worms can live in bins made from plastic or wood. These containers are partially filled with bedding materials, most commonly peat moss, shredded newspaper, shredded cardboard, straw or a combination of these materials.

Moisture: The worm bedding should be kept as moist as a well wrung sponge occasionally; the bedding can become too wet and needs to be gently loosened with a hand cultivator or garden fork.

Acidity: Red worms prefer bedding that is slightly acidic. However, if the bedding is all peat moss, or the materials added are very acidic, add crushed and cried egg shells to reduce the acidity

Light: - Red worm are sensitive to light and read an opaque bin that has a lid or a car plastic bad placed over the bedding to keep out the light

Ventilation: Most bin also have some means of ventilation either through holes drilled in the bin itself or a system of air tubing that runs through the bin from one side to another. Additional dry bedding material can also be added to help air in bedding.

Drainage: Worm bin with holes in the bottom for drainage should be placed on one by two inch blocks on a plastic tray. The tray will collect any liquid may drain from the bin. A piece of sheer fabric should be laid over the drainage holes to prevent the worms from falling through.

Choosing the size of your bin: The following guide will help you decide what size of bin one may require. We should keep in mind that red worms eat their own weight in food every day. In other words, if you produce two pounds of food waste every day, then you should have two pound of worms in your bin. If you find that your worms are overfed, simply get another bin and more worms.

Number of people	Quantity of worm	Bin Size
1 to 2	0.45 kg	60*60*30
2 to 3	0.90kg	75 * 60 * 30 cm
4 to 6	1.4 to 1.8 kg	90 * 60 * 30 cm

Finding the worm: Red worms are available for purchase from commercial growers, but can also be found for free in the backyard. They are small, less than four inches in length, and red, with alternating dark and light brown strips. Red worm live in organic matter which is in contact with the ground. We can find them in decomposing leaves and decaying plants, manure, and cooler decomposed parts of compost piles. They generally live within the top four inches of soil thus they are called the "surface feeders" of the earthworm family. We should keep in mind that red worms are not the worms that appear on the road and sidewalks after the rainfall.

Feeding the Worms: worms eat almost everything that humans eat. Worms should be fed at least few days. Simple bury the food scrapes a minimum of one inch below the surface of the bedding and leave for the worms to eat. Fresh food wastes decompose in about a week or two.

Harvesting the Bin: Worm will cover every three to six month the food waste and their bedding into a mass of rich dark castings when the volume of the bedding has decreased, becomes noticeably darker, and you begin to see individual castings, it is then time to change or harvest the bedding. Worms do not survive in their own waste and must be removed

Method of harvesting:
Layering: Expose the content of the bin to light. This will cause the worm to work their way down towards the bottom of the bin, as they will try to avoid the light. As they move downwards, remove one layer of the compost at a time. The last layer will be mostly worms. Add new bedding and the vermin composting process will start again.

CONCLUSION & RECOMMENDATION

The proposed soakage system is a small compact unit designed for individual dwellings. This simple technique involves the use of locally available materials and labour. This technique is compatible to average villager's level. This whole system is covered and below the ground level enabling free traffic movement above it. Chances of mosquito breeding are completely eliminated. Pollution of rivers and ponds are avoided in this system. Because of the simplicity of construction and low cost of the treatment processes discussed in the paper viz ash and silt trap, ferrocement septic tanks, composting method, it is hoped that it will encourage the villagers to adopt the systems, thereby improving the environmental condition of the villages as a whole. It is recommended that the appropriate authorities should take immediate and appropriate steps like provision of public convenience at suitable places to make our town more comfortable to live. It has also been seen that in spite of having the provision of waste drum (provided by municipal authorities), resident are throwing the waste around the drum rather in the drum. It is also recommended that people should be made aware of the issues like consequences of waste disposal in open, composting method etc so that conversion of waste into wealth becomes slogan of every individual

REFERENCES

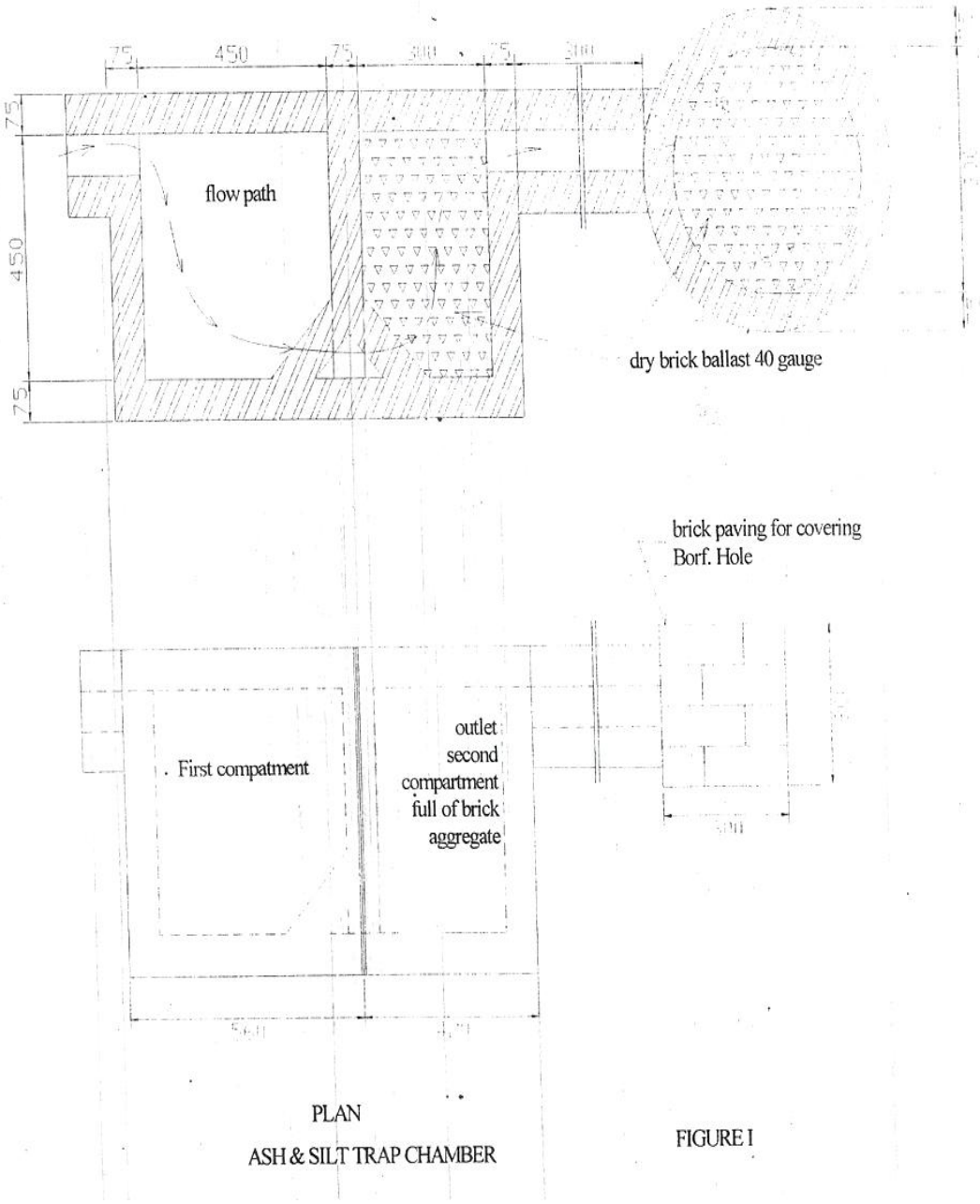
ACI committee 211.4R(1993) Guide for selecting proportion for high strength concrete with Portland Cement and fly ash, ACI manual of concrete practice part 2000, Detroit

ACI committee 544(1993) Guide for specifying, proportioning mixing placing and finishing Steel fiber reinforced concrete ACI materials Journal, Jan, Feb, pp 94-101

Naville, A.m (1994) Properties of Concrete, 4th Edition. Longman Scientific & Technical Essex, U.K

A.K Jain (200). Reinforced concrete, limit state design, 6th Edition, Nem Chad & Bros, RoorkeeWater Quality program committee, Virginia Tech,448-404 (July 1996) Small community waste water treatment and disposal option Virginia state University, U.S.A.

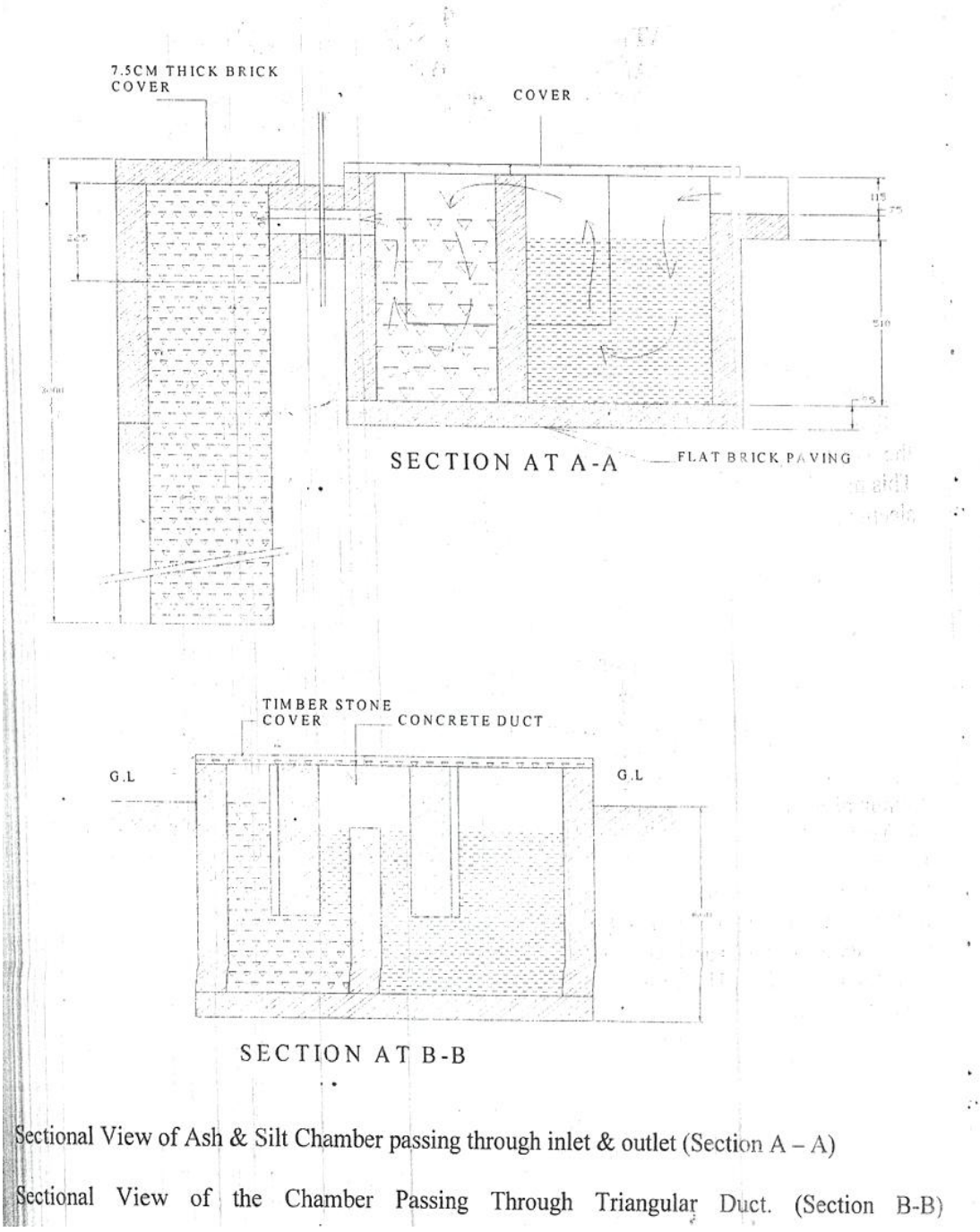
Sanjay Sharma (March 1999), A course material on Rural drainage and sanitation, technical teacher's training institute, sector 26 Chandigarh, India



PLAN

ASH & SILT TRAP CHAMBER

FIGURE I



Sectional View of Ash & Silt Chamber passing through inlet & outlet (Section A – A)

Sectional View of the Chamber Passing Through Triangular Duct. (Section B-B)