Current scenario and challenges of septage treatment - A societal perspective

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Abstract. This paper analyzes the problem of septage management related to opportunities and solution. in accordance with present treatment technologies. The scenario in India is about 41 % of septage sludge is disposed in local area without treatment Still some of the individual housing is not connected to suitable public sewage system. The current scenario of FSM in Warangal city is 77 % of the households have proper access to toilet and 23% insanitary toilet and open defecation were found. The samples were collected from the Warangal city and were tested for the characteristics. BOD and COD were very high above 9800 mg/l. As per CPHEEO norms TSS should be less than 15000 mg/l, but it is observed in all the samples it is in the range of 24,800 mg/l to 82,460 mg/l. Currently the treatment such as sludge drying beds, lime treatment, anaerobic baffled reactor, stabilization pond, constructed wetland, composting with solid waste, Mechanical dewatering,. Neglected septage waste ash was tried for several trial run in the mix design and found 20 % to be optimum replacement of septage ash. Strength enhancement is achieved by adding glass chopped strands and workability is improved by Super plasticizer Polycarboxlate ether. Utilization of residue in septage treatment plant in cost effective and ecofriendly way by replacing cement in concrete was tried in the pilot scale study near Warangal and proven to be effective.

Keywords: septage management, septic tank, Feacal Sludge Treatment Plant.

1. Introduction

Urbanisation of countries not only leads to the development of nation, it also generates huge quantum of waste both in the form of liquid and solid[1]. Still in developing countries like India the treatment of municipal solid waste is given importance, the treatment of septage was not thought of[2]. Until past decade septage management strategies are left out in darkness in the perspective of government and authorities[3][4]. The adverse impact on health and environment, due to improper management of septage have spotlighted the imperative call for septage management[5].Septage is blend of both solid and liquid, which is found at the bottom of septic tank with organic content and pathogens.In the rural and urban areas it is considered as onsite treatment process but the functioning of the treatment system is not managed effectively[6]. To maintain the treatment efficiency of septic tank

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periodic desludging is to be ensured. Emptying frequency of septic tank contributes towards the BOD loading and Total Solid Content[7].
As per the observation emptying frequency is low in individual housing when compared to flat. Organic content of septage would be several times greater than municipal solid waste[8].There are various reasons for the failure and performance of septic tanks, it includes inadequate area for treatment and disposal facilities, variation in filling the tank based on occupancy, poor drainage facility, subjected to high water table or flooding, improper desludging facility[9]. Irrigation of untreated effluent from septic tank causes disease like dysentery, gastroenteritis , typhoid, polio, hepatitis and skin infection[10] .Estimates on faecal sludge quality and quantity vary based on individual living style. Septic tank filling rates call for desludging rather than estimated time. Faecal sludge characteristic analysis using statistical tool prove to reduce sampling process.[11] Investigations reveal the impact of septic tank on groundwater quality is significant. Nitrogen rate is high in the unsaturated zone to the water table, even the indicator bacteria were found in the soil water and groundwater. The contaminants flow also occurred along the aquifer based on the lithology of the site[12].

Major component to be taken in to consideration in the septage treatment nutrient reduction, energy consumption, air cycling and performance. Christine et.al., compared the performance of bio dome , bio card and zebra mussels treatment system and concluded septage temperature has influence on performance of the treatment system[13]. In the constructed wetland for septage treatment the final results were not encouraging and the effluent does not meet standard. But the planted wetland have less BOD content compared to unplanted wetland. Nutrient removal and reduction of Total Solids were appreciable in planted wetland. Still redesigning of wetland is required to improve the efficiency[14]. To plan FSSM, assessment of basic details through field study in each area is essential. To determine the gaps and plan technical and economical feasibility ground truth data proves to be a efficient tool. In countries like France septage treatment were adopted using reed beds which proves higher rate of COD removal in the order of 98% and 95% kjeldal nitrogen were removed[15].

At present wetlands are constructed as the septage treatment options, but the greywater contains stronger organic loading than waste water, it influence the efficiency of treatment process[8]. In the vertical flow constructed wetlands, hydraulic loading rate had the impact on removal of nitrogen and organic matter, but total solids doesn't had any correlation with that.Further in the current practice the septage treatment either in the form of landfill or FSTP doesn't use the nutrients and the residue in an efficient manner[16]. Compared to sewage, septage contains higher nutrient value, the treatment facilities should make use of this opportunities to put forth the better treatment option. It was observed that phosphorous, ammonia and heavy metals are found rich in septage[17]. It was concluded in the studies on the impact of septage on the mixed reactor, the stabilization of sludge was appreciable, owing to moisture content and bacterial population present in the septage. The gas production increased gradually after 200 days observed with increase in acidity with decrease in pH value, further methanogenic bacteria present in septage accustomed with reactors environmental condition in a rapid manner[12].

By considering the impact of fecal sludge on the environment, government of Telangana has taken effort to promote urban areas as open defecation free(ODF).Even though the residents are provided with individual toilet it is not a solution, septage should be managed from generation to disposal. As an initiative to achieve ODF, Fecal sludge treatment plant is established in the jurisdiction of Great Warangal Municipal corporation in the year 2016.

Septage treatment is need of the hour; grey water gets mixed up with the groundwater bodies if the septage is disposed in an unscientific manner. Suchitwa mission of central government is organized to spend towards local bodies on technology , design, operation and maintenance of septage treatment [14].Performance of fecal sludge management strategies lead to public health and environmental consequences. Before it is too late local authorities should focus on FSM to develop sustainable development.

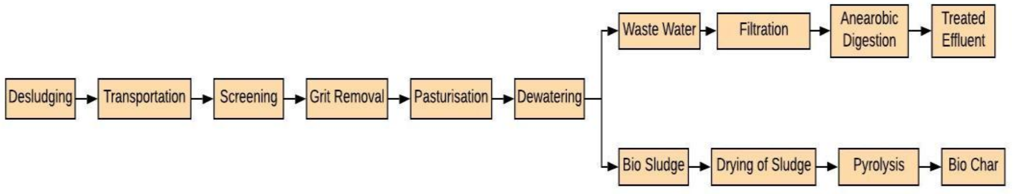


Fig. 1. Feacal sludge treatment process

2. Septage generation pattern -Current scenario

In India most of the houses are fixed with flush along with toilet, it increases the volume of faecal content to enormous extent, hence the corporation or municipality have to spent huge cost for the separation of faecal content from effluent[1]. Directly taking this faecal content to the treatment system is costlier or it will not suits all the terrain condition. Hence onsite treatment system, septic tank should be constructed as per the code IS2470 and managed properly.

AS per the 2011 census 1.75 million tonnes of excreta is generated in India by the population of 1.2 billion people. Out of which 38 % of people use septic tank, the quality is often poor. In India 65% of the cities do not have proper safety kits and arrangements for the safe collection and transportation of septage. As the collection and transportation is in preliminary stage, still the treatment and disposal is in crucial stage. Before 2013 there was no awareness about septage treatment and disposal, In 2013 ministry of urban development released note on septage management in India[18]. As per code septic tank should be constructed with two chambers each of minimum 1000 litre capacity and should be water tight. Based on the constrain most of the septic tanks are constructed as single chamber even for 6000 litres. In some of the area effluent from septic tank without any treatment, directly let out in to the open ground and open drains. Desludging of septic tank should be done at least once in three years, but in most of the cases desludging is done once the septic tank gets filled up. While desludging it should be ensured, small portion of sludge should be left over for anaerobic digestion of sludge, but this is violated while desludging in most of the cases.

2.1 Septage treatment Need

As a swachh bharath mission open free defecation (ODF) is targeted on October 2019 as dead line, according to census as on April 2018 house hold left without toilet is 27.8 Million. The rate of toilet construction increased from 28 lakh to 3 crore from 2014-2018, in total 8 crore toilets were constructed. But still desludging, treatment and disposal is in the preliminary stage.

The scenario in India is about 41 % of septage sludge is disposed in local area without treatment, 19% is open or pit defecation, 17 % is left over in leakages, 14% is not treated to standard and only 9 % of the septage are treated effectively. Diarrheal is one of the large killer disease and 80% of the diarrheal disease is due to insanitary condition and poor hygiene.

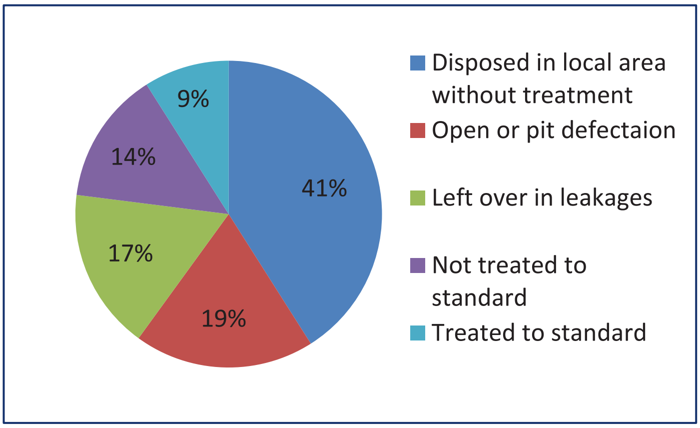
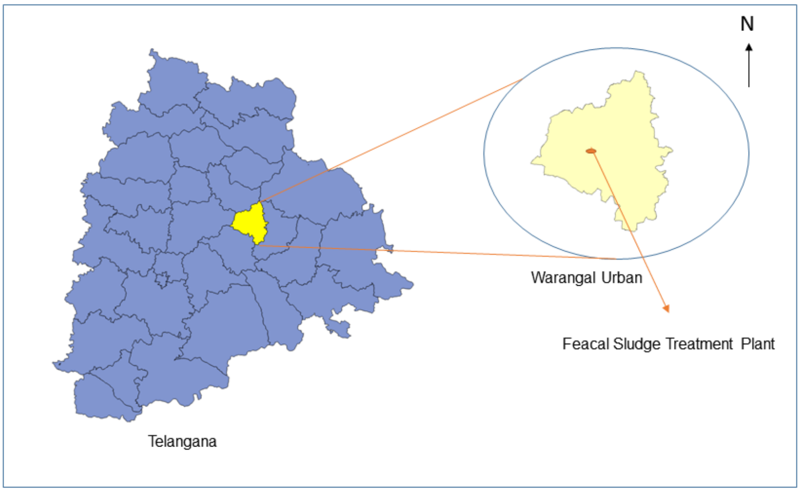


Fig. 2. Fate of excreta in India

2.2 Demography and technical data of the area:

Warangal is the second largest city in Telangana and is one of the smart cities in India. It has an area of 472 Sq.Kms located at 18.00°N 79.58°E. Great Warangal Municipal Corporation is the apex body which manages faecal waste, with 42 villages including 30 % of slum population. Even though it ranks 35 in swachh sarvekshan proper sewerage system is absent in the city[18].



The current scenario of FSM is as per the census of 2011 Warangal city is with the population of 0.61 million, 77 % of the households have proper access to toilet. Pit latrines were used by 18% of the population and septic tank directly discharges grey water to open drains. In most of the septic tank soak pit or trench is not provided. Septic tank directly drains the effluent in open drain.

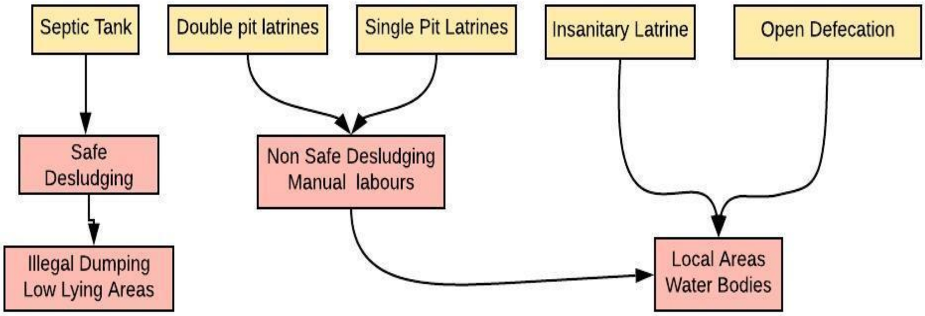


Fig 3. Present scenario of septage disposal

The procedure to get building approval along with septic tank design is not followed and the constructed toilets were not according to the swachh bharath mission. Awareness on desludging was not found among publics and it was not periodic. Desludging is done once it gets filled up or back flow is notices. Desludging was done by the private agencies and absence of safety kit among desludging operators and workers were found. Present mode of disposing the collected sludge is on the agricultural field, water bodies and low lying areas[9]. There is no monitoring regarding feacal sludge management were observed in Warangal city. Per capita water supply requirement is 100 lpcd, but only 50 % of the need is satisfied in the city with effective drains of 42 %. Sanitary system of Warangal city is shown in the table1.

Table 1. Sanitary system of Warangal city

Usage of Water	Quantity
Per capita water supply	<100 lpcd
Drains	<42%
Water supply	<50%
House hold with toilets	77%
With septic tank	59%
With pit latrine	18%
Insanitary toilet and open defecation	23%
Open defecation in slums	>50%
Insanitary toilet in slum	>30%

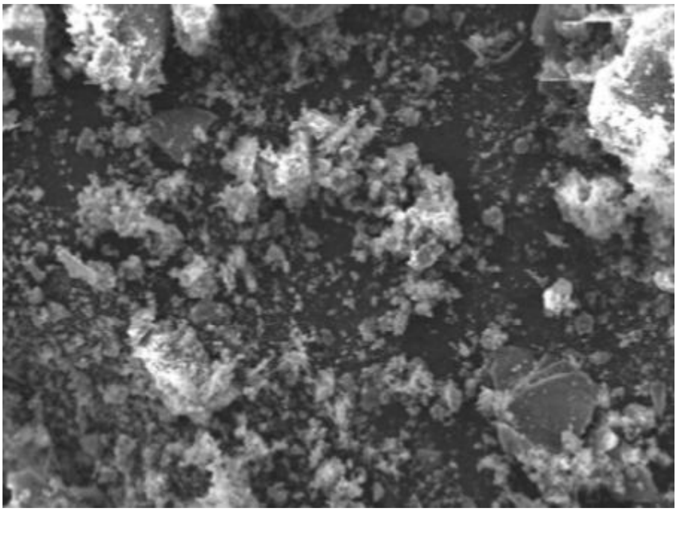
2.3 Septage characters and components

It's important to study the characteristic of sewage before going for treatment options. Septage quality and quantity depends on several factors like design of the tank, desludging period, water usage, chemical agent's usage for cleaning. In general septage characteristic is highly inconsistent both in chemical and biological nature. The constituent of septage results in health hazard, unpleasant odour and pose risk to environment[17]. Disposal of untreated sewage both on land and water pose threat to living organisms. The samples were collected from the Warangal city and were tested for the characteristics. pH was in the range of 6.9 to 7.24. Color was in the range of 400 to 600 Hazen. BOD and COD were very high above 9800 mg/l. As per CPHEEO norms TSS should be less than 15000 mg/l, but it is observed in all the samples it is in the range of 24,800 mg/l to 82,460 mg/l. N- total was within the permissible limit of 1000mg/l. Total volatile solids should be less than 7000 mg/l as per CPHEEO norms but it is above 19390 mg/l. Physical, chemical and biological characteristics of septage is presented in the table 1.

Table 2. Characteristics of septage Sem image

Parameter	CPHEEO NORMS	**Minimum**	**Maximum**
pH	**NA**	6.9	7.24
Color (1:100 ratio) Hazen	NA	400	600
BOD, mg/l	NA	9800	42000
COD, mg/l	NA	28000	140000
TSS, mg/l	<15,000	24800	82460
TS mg/l	<30,000	21600	80720
TVS, mg/l	<7,000	19390	78390
Alkalinity, mg/l	NA	70	2300
Turbidity, mg/l	NA	210	456
NH3-N, mg/l	NA	11.7	620
N-Total, mg/l	<1,000	45.3	940
Nitrate as NO3, mg/l	NA	25.2	226.3
Total Phosphorous, mg/l	NA	8.68	130
Sulphates, mg/l	NA	186.4	274.5
Viscosity, cps	NA	-	-
Density, g/cm3	NA	1.003	1.18
Faecal Coliform, MPN/100ml	NA	>18000	>18000
E Coli, MPN/100ml	NA	>18000	>18000

Scanning Electron Microscope image was taken to the study the characteristic of septage ash. Low sphericity formed by the irregular and angular particles were absorbed. Conglomeration of septage ash particles were found as it proves to be the filler material improving cement matrix. There is much lackness in the uniformity of the particles with the minimum particle size of 2μm. It compose of TSS, Nitrates, Phosphate, Sulphate, smaller portion of magnesium oxide and calcium oxide.



2.4 Current treatment Practice-Merits and Demerits

Currently the treatment such as sludge drying beds, lime treatment, anaerobic baffled reactor, stabilization pond, constructed wetland, composting with solid waste, Mechanical dewatering, Advanced nutrient recovery, Bio Methanation, Pyrolysis etc were practiced for sludge management[19]. Selection of Feacal sludge treatment process depends on initial and operating cost, pre and post treatment requirement, Efficiency of the output, Utilization or disposal of the end product generated.

First FSTP was installed in Devanahalli, Karnataka in the year 2015 with the capacity of 6 m^3/day with the construction cost of 70 Lakhs. The operational and maintenance cost of the plant is about 3 to 4 lakhs per annum. In the plant the anaerobic digestion was done with biogas production, as secondary and tertiary treatment sludge was stabilized, dried and finally co composted using municipal solid waste. Effluent was treated using polishing pond and used for growing plants. In India totally out of 826 FSTP 522 are under operating condition.

Some of the private sectors also construct their own FSTP, because of their water demand and huge generation of septage. Arvind eye care hospital at puducherry adopted FSTP in 2003 with anaerobic baffled reactor, planted gravel filter bed and polishing pond. Daily about 270 Kilo Litres of waste water is treated in the plant and effluent used for irrigation.

In Jhenaidah Bangladesh FSTP was constructed with the capacity of 45 m^3/ day in the year 2016 with the area of 500 Sq mt. Septage is emptied from the tankers in sand drying beds to separate solid and liquid. Sludge from the bed is taken for composting and liquid is taken to the constructed wetlands or taken to the planted drying beds. Sludge is directly used as fertilizers. The separated liquid is given as input in constructed wetlands. The clean water is discharged from wetland.

Feacal sludge treatment plant at Binoli, Jhansi was installed in the year of 2018 with the investment of 2.1 Crore to treat 6 KLD of septage. Septage was taken to plant drying beds for stabilization. Percolated water is taken to aerobic filter for primary treatment followed by horizontal planted gravel filter treated water is stored in polishing pond and is used for irrigation. The sludge from the plant is planned to use as manure.

3. Challenges in septage management:

Access to toilet: In any country toilet is the preliminary step of sanitation. In India still now open defecation cannot be eradicated as it needs facility along with human behavioural change[20]. However in India Swacch Bharath mission started in 2014 targeted with achieving zero open defecation is marching on its way. Data from swacch Bharath mission portal reveals that 27 states out of 36 state are ODF(open defecation free).

Awareness among public: It is concluded by researchers varun gauri etal., that mere constructing of toilets doesn't stop open defecation. Policy makers have to take efforts to change in behavioural nature related to toilet use[21]. Lack of knowledge on proper emptying of septic tank at regular interval decreases the efficiency of the septic tank

Septage collection and conveyance: Rate of septage generation varies based on several factors. Septage should be removed from onsite sanitation system in a safe manner and cleaning of tank is not ensured, at regular interval of 3 years septic tank should be emptied[22]. Generally desludging or vacuum truck is used for the removal of septage, size and design is varied according to the requirement.

Mannual scavengers: In early days manual scavengers were used for desludging the septic tank[23]. The Prohibition of employment as manual Scavengers and their Rehabilitation Act, 2013, Prohibit engagement or employment of person for hazardous cleaning of sewers and septic tank.

Construction of septic tank: Common material used for the construction of septic tank is brick masonry[24]. Civil or sanitary engineers are responsible for the construction of septic tank, but in rural areas without proper knowledge this kind of structures are constructed by masons. Disciplinary actions are not taken to the substandard service providers.

Maintenance of septic tank: Excess quantity of water entering the septic tank increases the load of the system, ultimately it may lead to the failure. While flushing non degradable waste such as shampoo packets, cotton buds, menstrual hygiene products, cigarette butts may cause clogging of the septic tank. Using chemicals for flushing may kill the bacteria which is essential for anaerobic decomposition of sludge and interfere in operating of septic tank.

Lack of manpower for transportation and cleaning: High health cost to be paid for weak sanitation. Presently sanitation with community involvement faces threat due to lack of manpower for transportation and cleaning.

Monitoring private players: In many of the cities legal or illegal private service providers operate trucks to transport the septage from septic tank. In most of the cases treatment is not done and is being disposed illegally in water bodies.

Utilization of septage ash for eco-friendly construction:

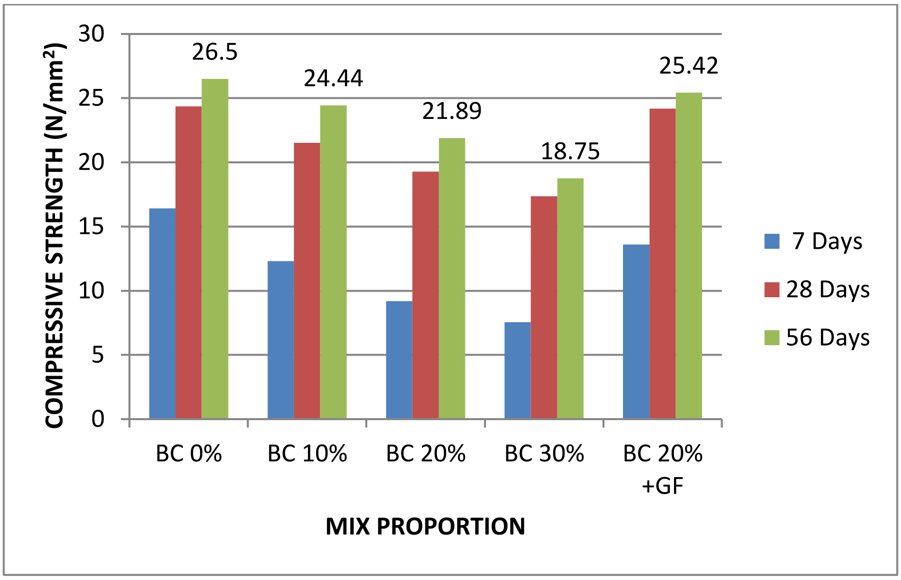
Until past decade septage management strategies are left out in darkness.
Adverse impacts on health and environment, due to improper management of septage have spotlighted the imperative call for septage management, eco-friendly and optimal disposal solution is need of an hour. Septage Ash, Final product from FSTP (Faecal Sludge Treatment Plant, Warangal) which is a waste material was utilized for casting eco-friendly construction material. The samples were collected from the FSTP Warangal. In the present research, the dry sludge of Warangal Feacal Sludge Treatment Plant (FSTP) was used as secondary binding material in interlocking concrete pavement block. Pilot scale study was implemented in constructing compound wall of a small park near Warangal.


4. Materials and methods

Pozzalanic Portland cement of grade 53 (Similar to ASTM Type 1), with Specific Gravity of 3.15 has been used Fine aggregate (River sand) of 2.36 mm sieved was used for study. Coarse aggregate retained in 8 mm sieve and passing through 12 mm sieve is used for the study. Aggregated was tested as per IS 2386-1963 Part 3. Potable water confirming to IS3025-1986 Part 22 & 23 and IS 456-2000 was used in the study. Glass chopped strands (fibre-6mm length) were added to about 0.06% volume of concrete to increase the compressive the strength of concrete. The bulk density of chopped strands 635 kg/m^3. Super plasticiser: Super plasticizer Polycarboxlate ether is used for increasing the workability of concrete. It is added in the ratio of 0.3% in the volume of concrete. Water Cement Ratio of 0.50 is used.

5. Results and discussion

The influence of septage ash on concrete properties was studied by preparing several concrete mixes connecting different amount of septage ash. The mix with septage ash content 10,20 and 30% has shown decrement in compressive strength at 28 days curing than conventional concrete. Leaching of material from the concrete was observed at over dosage of Septage ash. Increase in septage ash content in the concrete decreased the compression strength by 25%, 44% and 54% respectively in 7 days curing. Gradually strength increased at 28 days. There is no appreciable increase in strength after 28 days. The septage ash 20% mix with 0.06%(by volume of concrete) glass chopped strand has shown a development in compressive strength and merely meeting the actual strength of conventional concrete at 28 days curing.



6. Conclusion

In the current scenario septage is one of the neglected wastes, if this continues it may cost high health risk to the public. In most of the cases overflowing septic tank is cleaned rather than once in three years as regular maintenance. As septage is infectious material safety kit should be used while operating septic tank. Increasing the mechanism for collecting the septage and enforcing desludging of septic tank, once in 3 years should be done. Regulation and penalties should be put in effect to ensure periodic cleaning. Either through government or private sectors sufficient number of trucks to be put in operation. Awareness generation activities should be created among publics through panchayats, related to regular cleaning and personnel hygiene. The value of resource recovery from excreta should not be over-looked to increase the sustainability of excreta management in any country. Either septage can be converted to compost or energy. Early Amazon technology terra preta sanitation using worms to compost could be best option for sludge disposal. To convert to energy, anaerobic biogas reactor, gasification, incineration, pyrolosis etc., is used. Presently research is adopted to convert biochar in to useful construction materials. The employment of septage ash with fibre improved the performance in terms and durability of concrete. It reveals that the structural performance of the building component improved by addition of fibre. It is concluded that the use of 20% of septage ash and Glass fiber 0.06% addition in M20 grade mix is optimum dosage level in pozzolanic Portland cement concrete. Septage if stabilized and treated duly will become the potential source for alternative cementious material also in the preliminary studies, promising results were obtained which motivates further research.

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