

Research background

Sand mining is a direct cause of erosion and impacts the local ecosystem and habitat. Therefore, in 2013, the Government of India banned illegal sand mining from river beds. As a result, use of Manufactured (M) sand has increased in construction and other sectors. However, its applicability is yet to be explored in wastewater & sludge treatment. M sand has many advantages over river sand, viz. lesser cost, easier availability & less harmful impacts on the environment. These advantages, coupled with its characteristics and performance in treatment, are the key factors for considering its applicability in wastewater & sludge treatment.

This study is aimed at understanding the use of M sand as filter media in (two types of) Sludge Drying Beds, specifically Un-Planted & Planted Drying Beds (UDB & PDB) where fine sand is used as a top layer of filter media.

Objectives of the study

- To study the characteristics of M sand with respect to its usage as filter media in drying beds.
- To develop lab scale models of two UDBs and two PDBs using appropriate river and M sand respectively.
- To carry out performance evaluation and comparative study of lab scale models

Manufactured sand OR Crushed Stone sand (IS 383-1970)

- Production of M sand generally involves crushing, screening and washing the source material (Granite/Basalt) in controlled environments. Therefore, its quality & physical properties can be controlled as per requirement.
- M sand is free from organic & soluble contents.
- Particle size: 0.075-4.75 mm | Shape: Angular & rough



Technology overview

Sludge Drying Bed (SDB) is a shallow basin filled with filter media, usually sand & gravel. It is used for sludge treatment in wastewater treatment plants and also in Faecal Sludge (FS)/ septage treatment. It dewaters sludge by draining through filter media & by evapo-transpiration to give percolate (liquid) and dried sludge as by products.

Typical sand layers in SDBs (from top to bottom)

Un-planted Drying Bed (UDB)	Planted Drying Bed (PDB)
- 0.3 -1.2 mm fine sand for	- 0.3-1.2 mm fine sand for
150 mm	200-300 mm
- 5-8 mm fine gravel for	- 5-8 mm fine gravel for
75-100 mm	100 mm
- 12-20 mm medium gravel	- 12-20 mm medium gravel
for 75-100 mm	for 200-250 mm
- 30-50 mm coarse gravel for	- 30-60 mm coarse gravel for
100-150 mm	100-150 mm

Experimental Setup





Experimental Setup

- Four lab scale models have been developed:
 - 1. UDB with river sand 3. PDB with river sand
 - 2. UDB with M sand 4. PDB with M sand
- Sand media layer in UDB & PDB (at top): 150 & 200 mm respectively
- Diameter of models: 0.6 m
- FS feeding depth in UDB & PDB: 150 & 100 mm respectively
- FS feeding frequency UDB & PDB: 12-15 days

Comparison: Characteristics of M sand vs. river sand





Parameter	Unit	Criteria	River sand	M sand	
Shape	-	Sub angular to round Sub angular		Sub angular to Angular	
Colour	-	-	Brown	Whitish grey	
Effective grain size	mm	0.3 to 1.2	89.2 %	88.5	
Specific Gravity	-	-	2.58	2.61	
Bulk density	g/cc	-	1.55	1.47	
Porosity	%	-	66.45	43.68	
Coefficient of Uniformity	-	3-5	2.79	3.13	
Silt Content	%	< 6	0.56	1.12	
Hydraulic Conductivity	m/s	10 ^{-³} to 10 ⁻⁴	3.2 × 10 ⁻⁴	4.3× 10 ⁻⁴	

Performance evaluation and comparative study of lab scale models of UDB & PDB

	Unit	Inlet	Percolate (monitored up to 72 hrs.)			
Parameter			UDB		PDB	
			River	м	River	м
Total Suspended Solids (TSS)	mg/L	13,800-46,500	3-188	7-103	10-84	4-43
Fixed Solids (FS)	mg/L	9,447-30,843	1,093-2133	723-1,733	1,007-2,757	1,040-2,443
Total Solids (TS)	mg/L	28,690-81,760	1,307-4,453	843-2,640	1,407-4,803	1,497-5,477
Biochemical Oxygen Demand	mg/L	5,000-10,000	30-40	25-30	20-25	15-20
Chemical Oxygen Demand	mg/L	14,800-54,800	166-410	110-383	84-312	121-221
E-Coli	MPN/ 100 ml	54,000	9,300-21,000	1,500-7,500	2,300-3,600	1,500-2,900
Turbidity	NTU	-	4-69	6-60	8-62	4-26
Quantity of percolate	%	100	25-52	35-50	45-50	40-55
Dried sludge	Moisture content (%)		64-68	62-70	Yet to be emptied	
	Weight (Kg)		3-4	3.3-4		

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3

UDB

Findings

- The quality of percolate is better in drying beds with M sand than those with river sand and Moisture content in drying beds with M and river sand is quite similar.
- Vegetation growth in PDB with M sand is lesser than that of PDB with river sand.
- It is safe to say that M sand can be used instead of river sand; and will reduce the cost of filter media in drying beds by 30 40%.

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1 – Sample Inlet (FS);

- 2 Sample percolate from bed with river sand;
- 3 Sample percolate from bed with M sand

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