Sustainable Disposal of Water Treatment Plant Sludge by Reuse in Bricks Manufacturing

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ABSRTACT

Surface water treatment for consumable supplies normally includes coagulation, flocculation, sedimentation, and filtration processes for removing colloidal and suspended solids from raw water. All water treatment plant (WTP) produce waste/ residue known as water treatment sludge during the purification of raw water. The water treatment plant create substantial measure of municipal sludge that must be disposed of. Releasing this water treatment sludge into waterways, rivers, streams, ponds, lakes, drains and so on or landfilling the dewatered water treatment sludge is not environment friendly disposal option. An essential issue is to discover the ecological destination for its final disposal. It is important to realize that generation of alum sludge may stay unavoidable in the current processing of drinking water treatment techniques. This work studies the possibility of assimilating water treatment waste into red burnt bricks for general civil construction work. Reuse of water treatment sludge as a construction and building material converts the waste into useful products that can mitigate the disposal and environmental issues.

Keywords — Water treatment plant, WTP sludge, cyclone fly ash, soil, bricks, compressive strength

1. INTRODUCTION

Water treatment residue is created as a result at coagulation procedure of water treatment. Coagulation evacuate dirt and other particles suspended in water. Commonly used coagulants are aluminium sulphate (Alum), poly-aluminium chloride (PAC) and ferric chloride. Coagulants are added into water to form sticky particles called flocs. Flocs are a piece of suspended particles and alum blend. Flocs are sufficiently heavy to sink to the bottom during sedimentation. These flocs when washed from sedimentation tank forms water treatment residue (WTR) or water treatment sludge. Generally, this sludge is discharged straightforwardly into adjacent hydric bodies or dumped in landfills after dewatering. The basic strategy for final disposal, although less expensive, is not a proper solution due to the possibility of contamination of water bodies and soil from the chemical products used in the treatment. Water treatment sludge contains aluminium salts that dirty the waterway water source and cause potential health hazard to consumers. A few investigations have demonstrated that the collective admission of aluminium salt can prompt to Alzheimer's disease. Aluminium has likewise been recognized to be causative specialist in neurological disease. Water treatment residue can possibly be recuperated into some useful materials. WTR reusing is both environment friendly and economically advantageous. In this manner advancement of appropriate sludge administration procedures under stringent ecological standards is a challenging task for environmental scientists and engineers. This has started more enthusiasm for investigating the reuse alternatives for these disposed of water treatment sludge. Water treatment sludge has different physical and chemical qualities which are like common to ordinary soil. The reuse of sludge for various construction materials is a powerful way of reducing the measure of sludge. And furthermore diminish the unsafe consequences for human life and environment. In numerous countries the reuse of water treatment sludge has been done in many construction materials like aggregates, cement, tiles, bricks, road foundation etc.

The fly ash disposal is additionally a major concern as it is produced in extensive quantities and are dangerous to wellbeing and environment. Fly ash is carried off in the flue gas and usually collected from the flue gas by means of electrostatic precipitators or mechanical collection devices such as cyclones. Utilization of such fly ash in construction road sub- base, light weight aggregate, low cost adsorbent for removal of organic compounds has been generally analyzed. As bricks are one of the most important material for development work, the reuse of water treatment sludge in brick manufacturing can be a successful method for reuse of water treatment sludge and cyclone fly ash.

2. MATERIALS AND METHODS

2.1Materials-

The properties and the details of all kind of materials to be used in the brick manufacturing are as below:

a. Water Treatment Plant Sludge :-

Sludge has been collected from PCMC's water treatment plant, sector 23, Nigdi, Pradhikaran where Poly Aluminum Chloride (PAC) is used as coagulant. Sludge was collected from clariflocculation unit provided for backwash water of filter beds constructed on plant site. Sludge has been kept on open land for dewatering by natural sunlight. This was kept for about 2-3 weeks. The chemical analysis of this sludge was done by using ICP- OES 6000 series (Inductivity Couple Plasma – Optical Emission Spectrometer).

b. Soil :-

Locally available soil sample were taken which was used at kiln site for manufacturing of bricks. Kiln is located at Jambhe. . The chemical analysis of this sludge was done by using ICP- OES 6000 series (Inductivity Couple Plasma – Optical Emission Spectrometer).

c. Fly ash :-

Fly ash has been collected from Shri Sant Tukaram Sahakari Sakhar Karkhana located at Kasarsai. For each brick sample 10% fly ash has been used. The chemical analysis of this sludge was done by using ICP- OES 6000 series (Inductivity Couple Plasma – Optical Emission Spectrometer).

d. Water :-

Locally available water sample was used for the mixing process and manufacturing of bricks. Source of water at kiln site is of Pawana River. Analysis of this water sample was done in laboratory of water treatment plant located at Nigdi, Pradhikaran.

Table 1: Chemical analysis of sludge collected from water treatment plant

Ingredient	Weight (%)
P_2O_5	0.28
Cl^-	35.70
K_2O	0.82
Fe_2O_3	26.60
Na_2O	3.68
CaO	1.90
MgO	0.29
SiO_2	42.48
Al_2O_3	36.02

Table 2: Chemical analysis of soil available at brick kiln

Ingredient	Weight (%)
P_2O_5	1.31
Cl^-	11.33
K_2O	0.88
Fe_2O_3	30.61
Na_2O	4.81
CaO	1.10
MgO	0.13

SiO_2	45.60
Al_2O_3	30.82

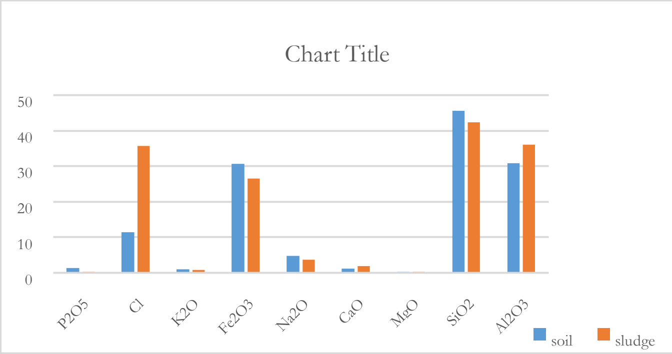

Fig no.1- Bar chart of comparison of chemical characteristics of soil and sludge samples

From above chart it is clear that sludge sample collected from water treatment plant has somewhat similar chemical characteristics as that of soil sample of bricks collected from brick kiln located at Kasarsai.

Table 3: Chemical analysis of cyclone fly ash collected from sugar factory

Ingredient	Weight (%)
P_2O_5	1.26
SO_4	0.44
K_2O	1.85
Fe_2O_3	1.52
Na_2O	0.10
CaO	1.79
MgO	0.86
SiO_2	0.12
Al_2O_3	0.48

Table 4: Analysis of water sample collected from brick kiln site

Parameter	Result	Unit
Hardness	60	mg/l
Calcium	19.23	mg/l
Chloride	20	mg/l
Turbidity	2.48	NTU
Ph	7.44	-
DO	6.57	mg/l
TDS	80.7	Ppm
Conductivity	161.5	µs
Chlorine	0.001	mg/l

3. METHODOLOGY

Flow chart of methodology for bricks manufacturing-

Collecting water treatment plant sludge from Nigdi, Pradhikaran

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Dewatering of sludge by natural sunlight

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Collecting cyclone fly ash from Sant Tukaram Sugar Factory

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Chemical analysis of water treatment plant

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Chemical analysis of clay from brick kiln

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Chemical analysis of cyclone fly ash

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Manufacturing of bricks using WTP sludge

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Testing strength of bricks manufactured using

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Comparing all the results with standards given by IS 3495 (Part 1-4):1992

The sludge collected from water treatment plant which was kept for dewatering by natural sunlight was as shown in fig no. 2

Fig no.2- Collected water treatment plant sludge

Fig no.3- soil sample from brick kiln site

Fig no.4- cyclone fly ash

After complete dewatering that is drying of water treatment plant sludge under sunlight, the sludge was crushed into powdered form. The sieving of sludge sample has been done to remove large size particles. Varying proportions of sludge sample were taken for the manufacturing of bricks. Sludge sample were taken as 10%, 20%, 30%, 40%, and 50%. Two different sets of brick samples were manufactured such as-

i. Bricks manufactured using water treatment plant sludge and soil available at brick kiln.
ii. Bricks manufactured using water treatment plant sludge, soil from brick kiln and cyclone fly ash from Sant Tukaram Sugar factory, Kasarsai.

For casting of bricks aluminium moulds were used. The size of mould is 9”×6”×4”

Fig no. 5- Aluminium brick mould

4. DETAILS OF PROPORTIONS OF MATERIALS OF BRICK FOR SET I

Table no.5- Proportions of materials

Different percentage of sludge	Soil	Water
0%	100%	30 lit
10%	90%	30 lit
20%	80%	30 lit
30%	70%	30 lit
40%	60%	30 lit
50%	50%	30 lit

5. DETAILS OF PROPORTIONS OF MATERIALS OF BRICK FOR SET II

Table no. 6- Proportion of materials

Different percentage of sludge	Soil	Fly ash	Water
0%	90%	10%	30 lit
10%	80%	10%	30 lit
20%	70%	10%	30 lit
30%	60%	10%	30 lit
40%	50%	10%	30 lit
50%	40%	10%	30 it

4. RESULTS AND DISCUSSIONS

The tests are performed for the manufactured bricks. For testing of bricks IS 3495 (Part 1 to 4):1992 was referred.

A. *WATER ABSORPTION TEST :-*

Table no. 7- Results of water absorption test for set I

Sludge percentage	Wt. of dried sample (M_1) gm	Wt. of wet sample (M_2) gm	Water absorption (%)
0 %	3722	4368	17.36
0 %	3622	4223	16.59
0 %	3677	4366	18.74
0 %	3856	4547	17.92
Average water			17.65

absorption			
10 %	3244	3886	19.79
10 %	3588	4266	18.90
10 %	3616	4301	18.94
10 %	3248	3851	18.56
Average water absorption			19.05
20 %	3784	4574	20.88
20 %	3079	3648	18.48
20 %	3218	3820	18.71
20 %	3589	4267	18.90
Average water absorption			19.36
30 %	3654	4388	20.09
30 %	3238	3855	19.05
30 %	3679	4410	19.87
30 %	3676	4401	19.72
Average water absorption			19.68
40 %	3373	4178	23.87
40 %	3689	4566	23.77
40 %	3463	4266	23.19
40 %	3224	3986	23.64
Average water absorption			23.62
50 %	3363	4232	25.84
50 %	3677	4632	25.97
50 %	3453	4312	24.88
50 %	3212	4043	25.87
Average water absorption			25.84

Table no. 8- Results of water absorption test for set II

Sludge percentage	Wt. of dried sample (M_1) gm	Wt. of wet sample (M_2) gm	Water absorption (%)
0 %	4124	4804	16.49
0 %	4155	4846	16.63
0 %	4027	4703	16.79
0 %	4030	4700	16.23
Average water absorption			16.61
10 %	4266	5033	17.98
10 %	4144	4863	17.35
10 %	4015	4737	17.98
10 %	4260	5012	17.65
Average water absorption			17.74
20 %	3978	4697	18.07
20 %	4009	4738	18.18
20 %	3942	4678	18.67
20 %	4132	4912	18.88
Average water absorption			18.45
30 %	4003	4765	19.04
30 %	4121	4926	19.53
30 %	3242	3896	20.17
30 %	3883	4984	20.63
Average water absorption			19.84
40 %	3372	4158	23.30

40 %	3453	4256	23.26
40 %	3244	4012	23.67
40 %	3214	3982	23.90
Average water absorption			23.53
50 %	3368	4238	25.83
50 %	3449	4346	26.01
50 %	3239	4077	25.87
50 %	3209	3992	24.40
Average water absorption			25.53

B. COMPRESSIVE STRENGTH TEST :-

Table no. 9- Results of compressive strength for set I

Sludge percentage	Bed area (mm²)	Maximum loading (KN)	Compressive strength (N/mm²)
0 %	29892	104.45	3.49
0 %	29680	110.76	3.73
0 %	30240	120.21	3.98
0 %	30033	115.76	3.85
Average water absorption			3.76
10 %	30240	99.00	3.27
10 %	30315	98.97	3.26
10 %	30246	96.87	3.20
10 %	29892	97.68	3.26
Average water absorption			3.25
20 %	30033	92.30	3.07
20 %	29960	101.20	3.35
20 %	29610	98.45	3.30
20 %	29540	93.46	3.16
Average water absorption			3.22
30 %	30104	95.21	3.17
30 %	30174	94.98	3.17
30 %	29820	97.70	3.30
30 %	29400	93.89	3.19
Average water absorption			3.21
40 %	29820	63.24	2.12
40 %	29960	70.88	2.37
40 %	30315	60.82	2.01
40 %	29540	62.12	2.10
Average water absorption			2.15
50 %	29820	58.67	1.97
50 %	29610	52.65	1.78
50 %	29960	48.77	1.63
50 %	29751	45.16	1.52
Average water absorption			1.73

Table no. 10- Results of compressive strength for set II

Sludge percentage	Bed area (mm²)	Maximum loading (KN)	Compressive strength (N/mm²)
0 %	30456	121.26	3.98
0 %	29680	112.45	3.79
0 %	29400	110.87	3.77
0 %	29751	114.21	3.84

Average water absorption			3.85
10 %	30100	101.01	3.36
10 %	29610	97.86	3.30
10 %	30033	100.24	3.34
10 %	29400	96.12	3.27
Average water absorption			3.32
20 %	29820	99.23	3.33
20 %	29610	97.92	3.31
20 %	29751	96.45	3.24
20 %	29400	95.78	3.26
Average water absorption			3.29
30 %	29960	96.47	3.22
30 %	29820	99.12	3.32
30 %	29960	95.56	3.19
30 %	29751	97.46	3.28
Average water absorption			3.25
40 %	29820	65.24	2.19
40 %	29960	63.76	2.13
40 %	29540	72.23	2.45
40 %	29610	61.84	2.09
Average water absorption			2.22
50 %	29610	51.88	1.75
50 %	29751	56.76	2.00
50 %	29820	52.04	1.75
50 %	29400	50.42	1.71
Average water absorption			1.80

C. EFFLORESCENCE TEST :-

Table no. 11- Results of efflorescence test for set I

Sludge percentage	Result of efflorescence test
0%	No deposits of salts
10%	No deposits of salts
20%	No deposits of salts
30%	No deposits of salts
40%	No deposits of salts
50%	No deposits of salts

Table no. 12- Results of efflorescence test for set II

Sludge percentage	Result of efflorescence test
0%	No deposits of salts
10%	No deposits of salts
20%	No deposits of salts
30%	No deposits of salts
40%	No deposits of salts
50%	No deposits of salts

5. CONCLUSION

In this paper, reuse of water treatment plant sludge in bricks manufacturing was studied so we can find out one of the suitable method of disposal and reduce the waste produced at water treatment plant. From the water absorption test taken for manufactured bricks using water treatment plant sludge it was observed that we can replace the conventional soil by water treatment plant sludge up to 30%. Also from compressive strength test it was observed that we can successfully replace 30% of conventional clay by Water treatment plant sludge. And for all the bricks manufactured no deposits of salts observed. So we can successfully manufactured bricks by reusing water treatment plant sludge.

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