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Manufacturing Of Bricks from Water Treatment Plant Sludge

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Abstract
For thousands of years, bricks have been made from clay. The water treatment plant sludge is extremely close to bricks clay in chemicals composition. So the sludge could be potential substitute for brick clay. The water treatment process generates a sludge that must be disposed of in an environmentally sound manner. The sludge generated in the most of the treatment system around the world is discharged into the nearest watercourse, which uses to accumulative rise of aluminum concentration in water and human bodies.
Keywords: *Water treatment plant sludge, Flyash¸Cement, Soil, Water.*

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I. INTRODUCTION

1.1.1 What is waste ?

Waste may be defined as an unwanted material generated after the manufacturing process of industrial, or from agricultural, or from house hold activity. It is the discarded material which essential requirement of disposal.Waste causes many nuisances in the environment. It produces many types of viral or bacterial infection for the human and animal which create bed effect on health

1.1.2TYPES OF WASTE

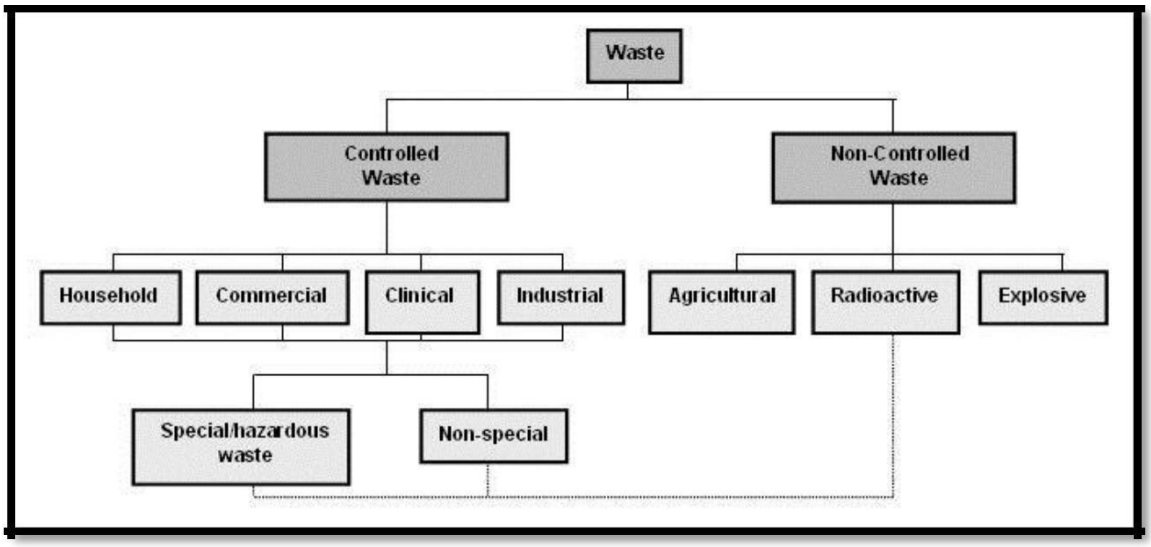

Figure1: Linear alkylbenzene flow diagram (UOP 2009[2])

1.2 NEEDS FOR STUDY

1. To check the feasibility of water treatment plant sludge as ingredient in brick making.
2. Conservation of natural resource like clay.
3. To solve the problem of disposal of water treatment plant sludge in urban region.
4. To make eco-friendly low cost and durable construction material.

1.3 OBJECTIVES OF STUDIES

1. Conservation of Natural Resources.
2. To give better environment to the town.

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4. To give better environment to the town.
5. Economical design and light weight product.
6. Reduce in construction cost.
7. To achieve strength in brick and investigation for check feasibility.
8. To examine the effect of dry sludge in brick properties.
9. Reduce pollution.

1.4 METHODOLOGY

- **DATA COLLECTION**

Data will be collected pertaining to available methodologies and applications of dry sludge used in the brick.

- **DATA ANALYSIS**

Based on the collected data analysis will be made to find out the most suitable methodology that can be applied for replacement of dry sludge in brick as soil. It is required to study the compressive strength, water absorption, weight and other aspects as well as economical as parts in detail inform the stakeholders for maximizing its use.

- **SCOPE OF STUDIES**

The scope of the current work can be summarized as follow:

1. The dry sludge samples used in this work was brought from Bhandup Water Treatment Plant.
2. The dry sludge was dried at natural sun light.
3. The dry sludge used to produce different compositions of brick.
4. The use of dry sludge in several types of concrete mixes was investigated.

II. EXPERIMENTAL MATERIALS

2.1 INTRODUCTION

The properties and the detail of the all kind of material to be used in the concrete mix design are as given bellow.

1. Dry Sludge
2. Soil
3. Fly Ash

2.2 DRY SLUDGE

Now a day, disposal of sewage has become a necessity for societies. The construction of treatment plants has caused problems with huge content of dry sludge. It has been found that each person produce 35 to 85 grams of solid sludge per day. In recent years, waste production has increased dramatically in developing nations such as India.There are two methods to solve the problem such as disposal of solid waste (dry sludge) including land filling and using dry sludge as fertilizers. But by both these methods some harmful material remains in sludge which causes harm to environment including land, air and water as a whole.In the sense grit sludge may be generated in a grit channel or chamber. Grit particles are removed because they may damage pumps and other equipment.Here, we try dry sludge too replace as a soil.

Sample Image of dry Sludge Source: Water Treatment Plant Bhandup

PROPERTIES OF DRY SLUDGE

SR.NO	PROPERITES	RESULTS
1	Specific Gravity	1.34-1.45
2	Bulk Density, kg/m3	687
3	Water Absorption,%	0.6
4	Clay And Sulphate Content,%	0.1-0.5
5	Softening Coefficient	0.96
6	Grain Type Coefficient	1.1
7	Moisture Content, %	0.1-11.5

Table 2.1: Typical Physical Properties of Sludge

2.3 SIEVE ANALYSIS OF DRY SLUDGE

Determination of quantitative size distribution of particles of dry sludge to fine grained fraction:

Procedure

1. Take a suitable quantity of oven dried dry sludge. The mass of dry sludge sample required for each test depends on the maximum size of material.
2. Clean the sieve to be used and record the weight of each sieve and the pan.
3. Arrange the sieves to have the largest mesh size at the top of the stack. Pour carefully the soil sample into the top sieve and place lid over it.
4. Place the sieve stack on the mechanical shaker, screw down the lid, and vibrate the dry sludge sample for 10 minutes.
5. Remove the stack and re-weight each sieve and the bottom pan with the soil sample fraction retained on it.
6. Initial mass of soil sample taken for analysis (kg) = 0.500 kg.

Figure 2.1-Sieve shaker

SIEVE SIZE (MM)	SOIL RETAINED (G)	PERCENT RETAINED (%)	CUMULATIVE PERCENT RETAINED (%)	PERCENT FINER (%)
4.75 mm	223.4	44.7	44.7	55.3
2.0 mm	97.1	19.4	64.1	35.9
1.0 mm	90.2	18	82.1	17.9
600 µm	23.4	4.7	86.8	13.2
425 µm	17.2	3.4	90.2	9.8
300 µm	10.8	2.2	92.4	7.6
212 µm	9.1	1.8	94.2	5.8
150 µm	8.5	1.7	95.9	4.1

75 µm	10.2	2.0	97.9	2.1
Pan	10.1	2.1	100	0

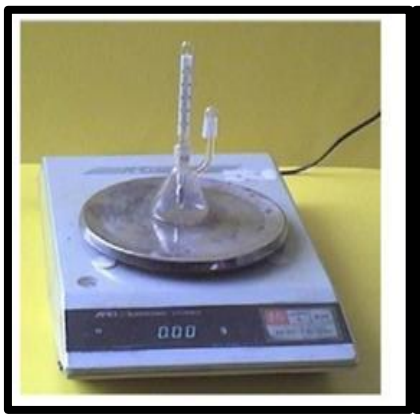
Table 2.2 Observation Table

2.4 DRY SLUDGE SPECIFIC GRAVITY

Determination of the specific gravity of dry sludge particles :

Procedure

1. Wash, dry and weight the pycnometer.
2. Place about 10 g of dry sludge sample in the pycnometer. Weight the bottle with the dry sludge.
3. Add sufficient desired water to cover the dry sludge, and connect the bottle to a vacuum pump to remove all entrapped air.
4. Disconnect the pump and fill the bottle with water up to the calibration mark.
5. Clean the exterior surfaces of the bottle pycnometer with dry clothe, and weight the bottle with the contents.
6. Empty the bottle and clean it. Fill it with distilled water up to the mark and record its weight.
7. Conducts the test for 3 times.



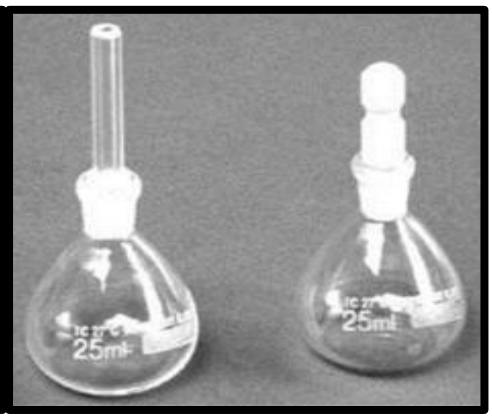


Figure 2.2- Take empty pycnometer bottle wt. Figure 2.3- Pycnometer bottle

TEST NO	1	2	3
Mass Of Pycnometer, W_1(G)	34.3	34.3	34.3
Mass Of Pycnometer + Dry Sludge, W_2 (G)	44.3	44.3	44.3
Mass Of Pycnometer + Dry Sludge +Water, W_3 (G)	88.5	87.5	88
Mass Of Pycnometer + Water, W_4 (G)	85.6	85.5	85.4
Specific Gravity	1.40	1.25	1.35

Table 2.3 Observation table

2.5 Dry sludge Liquid limit

Procedure

1. Take about 150gm of dry soil passing 425 µm sieves, and mix it with distilled water in a porcelain dish to form a uniform paste.
2. Place a portion of the paste in the cup of liquid limit device with a spatula , press the soil down to remove air pockets, spread it to maximum depth of 10 mm, and form an approximately horizontal surface.
3. By holding a grooving tool perpendicular to the cup, carefully cut through the sample from back to front, and form a clean straight groove in the centre by dividing into two halves.
4. Turn the crank handle of the device at a steady rate of two revolutions per second. Continue turning until the two halves of the groove is closed along a distance of 13 mm. Record the number of blow to reach this condition.
5. Take about 15 gm of the soil from the joined portion of the groove to a moisture can for determining water content.

6. Transfer the remaining soil from the cup into the porcelain dish. Clean and dry the cup and the grooving tool.

Figure 2.4 :Casagrande apparatus

Figure 2.5 : Casagrande apparatus test **Figure 2.6- 15 gm sludge**

TEST NO	1	2	3
No. of blows	24	28	23
Mass of can (g)	42	42	42
Mass of can + wet. Sludge	57.5	57.2	57.11
Mass Of can +dry Sludge,(g)	51.2	51	51.51
Mass of water (g)	6.3	6.2	5.6
Mass of Dry soil (g)	9.2	9	9.51
Water content (%)	68.48	68.88	58.89

Table 2.4 – Observation Table

2.6 PROCTOR COMPACTION TEST

Procedure:

1. Obtain a sufficient quantity of air dried soil and pulverize it. Take about 3 kg of soil passing through 4.75 mm sieve in a mixing tray.
2. Weigh the mould with base plate and apply grease lightly on the interior surfaces. Fit the collar and place the mould on a solid base.
3. Add water to the soil to bring its moisture content to about 8% and then mix it thoroughly using the trowel until the soil gets a uniform color.
4. For light compaction, compact the moist soil in three equal layers using a rammer of mass 2.6 kg and having free fall of 31 cm. Distribute the blows evenly and apply 25 blows in each layer. Ensure that the last compacted layer extends above the collar joint. Alternatively for heavy compaction, compact
5. the soil with 25 blows per layer, in five equal layers with a rammer of mass 4.9kg and 45 cm free fall.
6. Rotate the collar so as to remove it, trim off the compacted soil flush with the top of the mould, and weigh the mould with soil and base plate.
7. Extrude the soil from the mould and collect soil samples from the top, middle and bottom parts for water content determination. Place the soil back in the try, add 2% more water based on the original soil mass, and re mix as in step 3. Repeat steps 4 and 5 until a peak value of compacted soil mass is reached followed by a few samples of lesser compacted soil masses.

Figure 2.7: Proctor (Mould and hammer)

Test No.	1	2	3	4
Mass of mould +	4930	4960	5006	5040
compacted sludge (g)				
Mass of compacted sludge, W_t (g)	1010	1040	1086	1120
Bulk density $\gamma_t = W_t / v$	1.01	1.04	1.08	1.12
Average water content w(%)	0.08	0.12	0.14	0.16
Dry density, (g/cc) $\gamma_d = \gamma_t / 1 + w$	0.94	0.93	0.95	0.96
Dry density at 100% saturation (g/cc)	0.51	0.52	0.54	0.56

Table no. 2.5 – Observation Table

EXPERIMENTAL DESIGN ANALYSIS

4.1 MIX DESIGN

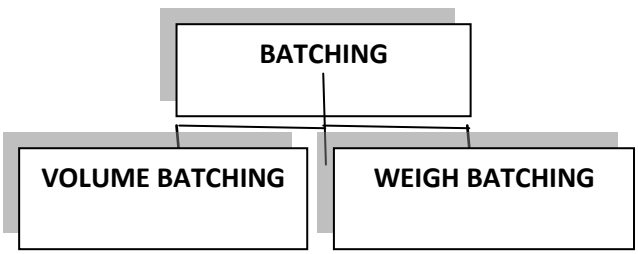
Different Percentage of Sludge	Soil	Fly ash	Water
15%	70%	15%	40 lit
25%	60%	15%	42 lit
35%	50%	15%	44 lit

2.7 MANUFACTURING PROCESS

4.2.1 WEIGHT BATCHING

The measurement of materials for making is known as batching. There are two method of batching.

1) Volume batching
2) Weight batching



4.3 MIXING

Figure: 2.8: Material mix at site

(Work at site with use of mix design of brick making materials (Soil, Dry Sludge, Fly Ash and Water).

2.8 MAKING AND PLACING:

Sample Image of Making and placing of bricks

Place the mould on a firm, level surface. Form the test sample by placing material mix in the mould (Size 190 x 90 x 90 mm) in three layers of approximately equal volume. Move the scoop around the top edge of the mould to ensure a symmetrical distribution of the material mix within the mould.

Drying of Bricks

After drying it's in sunlight for 4 days, Bricks required to putting in the kiln for the fester.

Placing Of Bricks in Kiln

III. TESTING & RESULTS

3.1 TESTING:

Figure 3.1: Bricks for Testing

Source: Shivajirao S Jondhle Polytechnic, Asangaon

3.1.1 WEIGHT OF DIFFERENT PERCENTAGE OF SLUDGE BRICKS

No. Of Bricks	Conventional Bricks	15% Sludge Bricks	25% Sludge Bricks	35% Sludge Bricks
1	2330gm	2080gm	1800gm	1500gm
2	2340gm	2115gm	1725gm	1540gm
3	2350gm	2085gm	1750gm	1540gm
4	2340gm	2110gm	1710gm	1545gm
5	2330gm	2198gm	1690gm	1535gm

Table 3.1: Weight of Bricks

3.1.2 WATER ABSORPTION:

Figure 3.2: Water Absorption of Bricks
Source: Shivajirao S Jondhle Polytechnic, Asangaon

Table 3.2: Weight of Bricks After Water Absorption

No. Of Bricks	Conventional Bricks	15% Sludge Bricks	25% Sludge Bricks	35% Sludge Bricks
1	2650gm	2250gm	2100gm	1900gm
2	2680gm	2210gm	2110gm	1960gm
3	2715gm	2280gm	2165gm	1915gm
4	2695gm	2200gm	2145gm	1945gm
5	2740gm	2274gm	2125gm	1880gm

3.1.3 COMPRESSIVE STRENGTH TEST

Figure 3.3: Compressive Strength Test Machine
Source: Shivajirao S Jondhle Polytechnic, Asangaon

No. Of Bricks	Conventional Bricks (N/mm^2)	15% Sludge Bricks (N/mm^2)	25% Sludge Bricks (N/mm^2)	35% Sludge Bricks (N/mm^2)
1	3.2	2.2	2.9	2.0
2	3.3	2.4	3.0	1.8
3	3.6	2.6	2.5	1.5
4	3.5	2.2	2.6	1.9
5	3.9	2.1	2.7	2.0

Table 3.3: Compressive Strength of Bricks

3.2 COST ESTIMATION OF SLUDGE BRICK:

Total weight of 1 brick = 1.8 KG
Proportion of Sludge: Soil: Flyash = 25:60:15
Weight of sludge = 0.45 KG
Weight of Soil = 1.08 KG
Weight of Flyash = 0.30KG

- Cost of Flyash (Including transportation) = Rs 2100/Ton= Rs 2.1/KG= 0.30*2.1 =Rs. 0.63/brick
- Cost of sludge (Including Transportation) = Rs 0/brick(According to Indian Government provisions it is mandatory for authorities of WTP to dispose off sludge free of cost at required places.)
- Cost of Labour = Rs 700/1000 brick = Rs 0.7/brick
- Cost of Coal = Rs 0.3/ brick

Total Cost = (0.63+0+0.70+0.30) = Rs. 1.63
= Almost under Rs. 2.0

No. Of Bricks	Conventional Bricks (Rs.)	15% Sludge Bricks (Rs.)	25% Sludge Bricks (Rs.)	35% Sludge Bricks (Rs.)
1	RS 3.00	Rs. 2.25	Rs. 2.00	Rs. 1.80

Table 3.4: Cost comparison between conventional and WTP sludge bricks

	Water Absorption	Compressive Strength	Cost of Brick	Suitability
Conventional Brick	15.50%	3.5 N/mm^2	Rs. 3.00	For all works
25% Sludge Brick	20.25	2.85 N/mm^2	Rs. 2.00	For medium construction

Table 3.5: Overall Comparison between conventional and WTP sludge bricks

3.2.1 CONCLUSION:

1. Dry sludge is available free of cost so, we will reduce cost of brick. After doing the practical we judge some properties are match with soil.
2. In this project we have incorporated the use of Dry Sludge in brick up to 50% by replacing soil. **(Dry Sludge 15%, 25%, 35%, 45% and 55%)**
3. Based on limited experimental investigation concerning the water absorption and compressive strength of brick, the following observations are made regarding the resistance of partially replaced Dry Sludge. The water absorption decreased up to 20% replacement of soil by Dry Sludge. Compressive strength increase when replacement of Dry Sludge percentage increases when compare to traditional Brick. From this project, replacement of soil with this Dry Sludge material provides good compressive strength at **Dry Sludge 25% replacement**.
4. Thus, this project shows that replacement of soil with this Dry Sludge material reduce the weight of brick. And it's become light weight product.
5. Use of Dry Sludge in brick can save the ferrous and non-ferrous metal industries disposal, land pollution, cost and produce a "greener" brick for construction.

RESEARCH PAPER'S :

1. "Incorporation of water sludge, silica fume, and rice husk ash in brick making"

By- Badr El-Din Ezzat Hegazy, Hanan Ahmed Fouad and Ahmed Mohammed Hassanain*

2. "BRICKS MANUFACTURED FROM SLUDGE"

By- Joo-Hwa Tay1
3. "Durability of Bricks Cast With Industrial Sludge"

By - G. Reddy Babu1, N. Venkata Ramana2
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By - Shrikant S Jahagirdar1, S. Shrihari2, B Manu3 1 NITK, Surathkal, India
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