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Study on Effect of Partial Replacement of Sludge in Bricks

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Abstract: ***The present scenario shows, every day in Tamil Nadu 2.5 to 3 tonnes of waste sludge generated and there is no place to dump this solid waste because it contains many toxic constituents (copper, manganese, cadmium, chromium, potassium, sodium, etc.,) which may cause pollution of water sources and other problem, hence an attempt is made to reduce the pollution by manufacture eco-friendly bricks. Brick is the constituent material in construction industry. The main component of the brick includes clay, sand and water. Sludge is the waste product which is collected from the industries. The collected sludge is dried at open atmosphere for 40 days and powdered. The powdered sludge is replaced by clay (10%, 20%, 30%, and 40%) and sand (10% and 20%). The performance was found good when the various tests such as water absorption (30% replacement by clay and 10% by sand), compressive strength (by 10% in both clay and sand) and basic characteristics test for bricks are examined and determined.***

Key words: Sludge, Water absorption, Compressive strength, Eco-friendly bricks.

I. INTRODUCTION

Growing awareness among the public and enforcement of strict rules by statutory bodies, waste management is gaining momentum in recent years. However, many industries facing difficulty in disposing the waste generated in the premises of their industry. The common effluent treatment plant 4 is having such problem of waste disposal. Here every day 2.5 to 3 tonnes of waste sludge will be generated and there is no place to dump this solid waste because it contains many toxic constituents (copper, manganese, cadmium, chromium, potassium, sodium, etc.,) which may cause pollution of water sources and other problems. Recycling of waste material in brick could reduce the problems of waste disposal and usage of construction materials. Sludge will be obtained in three forms Liquid sludge, Semi solid sludge (wet sludge), and dry sludge.

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A. Liquid sludge

The effluent coming from the industries are treated by flocculation process, during this treatment the sludge obtained is called as liquid sludge

B. Semi solid sludge

This is the second form of sludge, obtained by dewatering of liquid sludge by passing through centrifuges at 1500 rpm, because of this high revolution the sludge gets dewatered and comes out as wet cake. This wet cake is called wet sludge.

C. Dry sludge

The sludge from the centrifuges is dried by spreading it over a large area, i.e., on the sludge drying beds in the presence of sunlight. Thus wet sludge is converted into dry sludge in a period of 40 days. All the three forms of sludge which have been discussed above are being used as composite material and influence of each on compressive strength and other parameters have been discussed in subsequent articles.

II. MATERIALS AND METHODS

A. Brick Production

The top layer of loose soil about 20 cm depth contains lot of impurities and hence it should be taken out and thrown away. The earth is dugged out from the ground. This earth is spread into heaps about 60 cm to 120 cm height. All the undesirable matters like stones, vegetable matter etc., are removed. Lumps of clay should be converted into powder form. The earth exposed for softening. The period of exposure various from weeks to full season. It is then mixed with suitable ingredients. It is carried out by taking a small portion of clay every time and turning it up and down in vertical direction. This is done to make the whole mass of clay homogenous and plastic.

B. Sludge

The sludge we got from waste treatment plant is dried in open natural atmosphere for a period of 40 days then sludge is powdered in hand process. The size of sludge powdered is between 60 to 30 micron**.**

C. Mixing and Casting:

Hand mixing was used for convenient handling. Sand and clay were mixed dry and kept separately.

Then sludge and dry mix of clay and sand were kept in three layers and approximate amount of water was sprinkled on each layer and mixed thoroughly in case of dry sludge, it is powdered manually. The mix is filled in mould and mix is compacted with hand. The excess mix in mould is cut and levelled using plate and the mould is inverted on the ground, which was levelled and sprayed with dry sand. After drying of the brick in natural sunlight for a period of 5 to 12 days the bricks are placed in a kiln for one week at 1400° c. The type of kiln used is rotatory kiln. After completion of all the above process the bricks are taken for testing and observations. We have replaced in brick by Sludge which is done as follow

Table. 1 Percentage replacement in brick

Replaced for	% Replaced
CLAY	10
CLAY	20
CLAY	30
CLAY	40
SAND	10
SAND	20

D. PROPERTIES OF SLUDGE:

Table. 2 Norms of Tamil Nadu pollution control board

Elements	Parameters (mg/kg)
Boron	0.020
Copper	51.20
Zinc	94.04
Lead	57.68
Chromium	4.68

Quantity of sludge generated per year = 750 ton/annum.

Mode of storage/disposal Packed in HDPE & stored on impervious floor in closed sheds.

Table. 3 Result of Collected Sludge

Parameters	Results in %
Loss of ignition (L.O.I)	49.35%
Sand and Silica	39.68%
Calcium oxide (CaO)	2.11%
Magnesium oxide (MgO)	1.68%
Iron Oxide (Fe_2O_3)	1.04%

Table. 4 Comparison of Minerals in normal brick with sludge

Parameters	Normal brick	Sludge
Sand and silica	50% to 60%	39.68%
Magnesium oxide (MgO)	Less than 1%	1.68%
Iron oxide (Fe_2O_3)	5 to 6%	1.04%
Aluminium Oxide (Al_2O_3)	20% to 30%	3.60%

III. EXPERIMENTAL INVESTIGATION

A. Specific gravity tests for sludge

The pycanometer is cleaned and weighed with its cap. Then one-third of pycanometer is filled with sludge and weighed after screwing the cap. Distilled water is added and weighed. The specific gravity is calculated and resulted in 4.1.1.

B. Sieve analysis test for sludge

Dried sludge was taken and weighed 2kg.weighed sludge was carried in sieve set and placed in sieve shaker for 3mon.the residues retained in each sieve was weighed. The values of finesse modulus of sludge were tabulated in table 5.

C. Field tests for bricks

1. The brick should be truly rectangular in shape with sharp edges and plane faces and of the same size.
2. They should be hard and well burnt and should give a metallic ringing sound when struck with a steel rod.
3. They should be of uniform red colour and of fine texture.
4. When the bricks are dropped on the ground from one metre height, they should no crack or break.
5. They should be free from cracks. Fissures, pebbles or modules of free lime.

D. Test of water absorptions for bricks

Three samples of clean well dried bricks are taken and their dry weight is found out individually.

Then bricks are immersed in water for 24 hours. After 24 hours, the bricks are taken out, surface dried and weighed in a balance and wet weight found out. If the weight of each brick is w_2,

The percentage water absorption of each bricks = $((w_2-w_1)/w_1)* 100$

The average percentage of water absorption of three samples is the water absorption of the bricks are resulted in table required standard. The average absorption should not be greater than 20%. Too much of water absorption indicates under burnt condition and poor strength. The result was tabulated in table 11 and comparison of clay with sludge and sand with sludge is compared in fig.c

E. Test for efflorescence for bricks

Salts like calcium, magnesium, sodium and potassium present in brick will cause efflorescence on the brick surface, when they get dissolved in water. Bricks containing too much of salt are less resistant to weathering and will have poor strength.

Three sample of bricks are immersed in water for 24 hours. After 24 hours bricks are taken out and examined for white patches of salt on the surfaces.

- If the white patches of salt present are heavy, the bricks are poor and area to be rejected.
- If the patches present are small to medium, the bricks can be accepted. Efflorescence result is tabulated in table 11.

F. Test for compressive strength

The load carrying capacity of bricks is increased, as the compressive strength increase. Three sample of brick is taken and immersed in good water for 24 hours. After 24 hours of immersion, the bricks are taken out and surface dried. Each bricks are placed on compression testing machine and the load on the brick is gradually increased until the brick fails. The failure load of each brick is founded out. Average failure load of the 3 bricks is the compressive strength of the bricks. The result is tabulated below.

IV. RESULT AND DISCUSSION

A. Test result for sludge

Test for determining the specific gravity of sludge by using pycanometer apparatus is done and the sieve analysis test is also done to find the soil particle distribution. From the above table it is concluded that the more soil particle is between .60mm to .30mm. So sludge can easily mix with the brick materials because size materials are also range between the above mentioned values.

Specific gravity of sludge= 2.428

B. Test on brick

The brick have been tested for determining the strength using universal testing machine because it is important property required for this project.

1. Country bricks = 3.5 to 5.0 N/mm^2
2. II class bricks = 5.0 to 7.5 N/mm^2
3. I class bricks = 7.5 to 12.5 N/mm^2

Minimum crushing strength = 3.5 N/mm^2

Table. 5 Sieve analysis

IS-SIEVE SIZE	Weight retained in each sieve	Cumulative Weight Retained (kg)	Cumulative Weight Retained (%)
4.75	0.05	0.05	5
2.36	0.075	0.125	12.5
1.18	0.150	0.275	27.5
0.60	0.257	0.532	53.2
0.30	0.358	0.890	89
0.15	0.045	0.935	93.5
Pan	0.065	1.00	100.00

C. Result of replacement of clay in brick by sludge

Table. 6 Replaced by 10%

Specimen	Load	Area (mm^2)	Crushing strength(N/mm^2)
1	75	225*100	3.33
2	86.25	225*100	3.83
3	85	225*100	3.77
		Average=	3.64

Table. 7 Replaced by 20%

Specimen	Load	Area (mm^2)	Crushing strength(N/mm^2)
1	46.05	225*100	2.2

2	66.20	225*100	2.9
3	61	225*100	2.7
		Average=	2.6

Table. 8 Replaced by 30%

Specimen	Load	Area (mm^2)	Crushing strength(N/mm^2)
1	50	225*100	2.2
2	43.5	225*100	1.9
3	45	225*100	2
		Average=	2.03

	Replaced %	Original weight (Kg)	After water absorption (Kg)	Absorption %	Efflorescence
CLAY	10	2.840	3.305	16.3	NO
	20	2.725	3.210	17.7	NO
	30	2.680	3.205	19.6	NO
	40	2.730	3.200	17.2	NO
SAND	10	2.740	3.240	18.2	NO
	20	2.520	3.235	28.37	NO

Table. 9 Replaced by 40%

Specimen	Load	Area (mm^2)	Crushing strength(N/mm^2)
1	40	225*100	1.7
2	43.5	225*100	1.9
3	38	225*100	1.69
		Average=	1.76

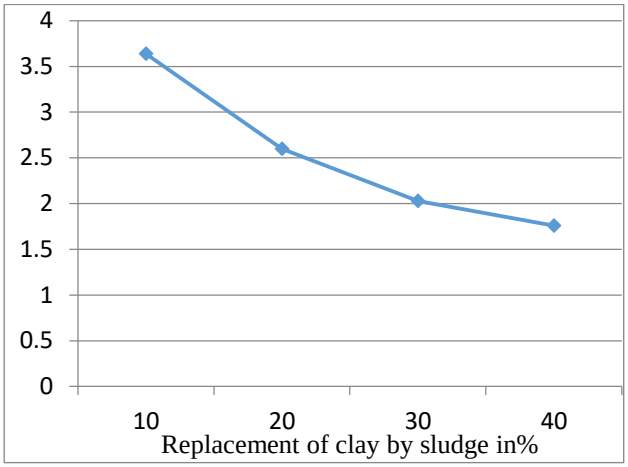

Fig. a. Strength of brick when clay is replaced with sludge.

D. Result of replacement of sand in brick by sludge

Table. 10 Replaced by 10%

Specimen	Load	Area (mm^2)	Crushing strength(N/mm^2)
1	57.5	225*100	2.5
2	55	225*100	2.44
3	61	225*100	2.7
		Average=	2.55

Table. 11 Replaced by 20%

Specimen	Load	Area (mm^2)	Crushing strength(N/mm^2)
1	23.40	225*100	1.04
2	25	225*100	1.11
3	22.5	225*100	1
		Average=	1.05

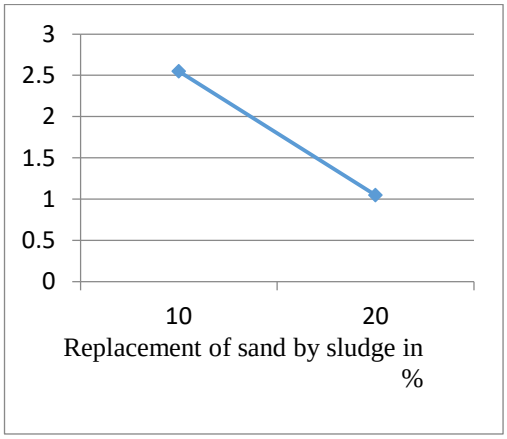

Fig. b. Strength of brick when sand is replaced with sludge

E. Water absorption test

Table. 12 Water Absorption Test (Permissible = 20% TO 22%)

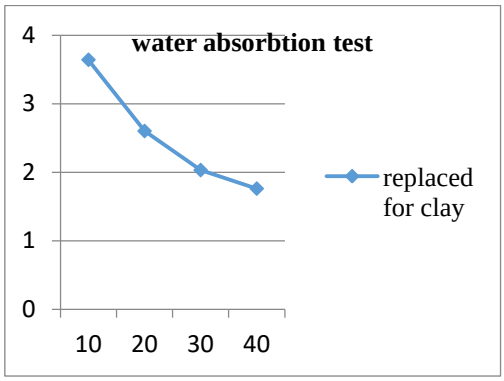

Fig .c. Water absorption of brick when clay is replaced with sludge

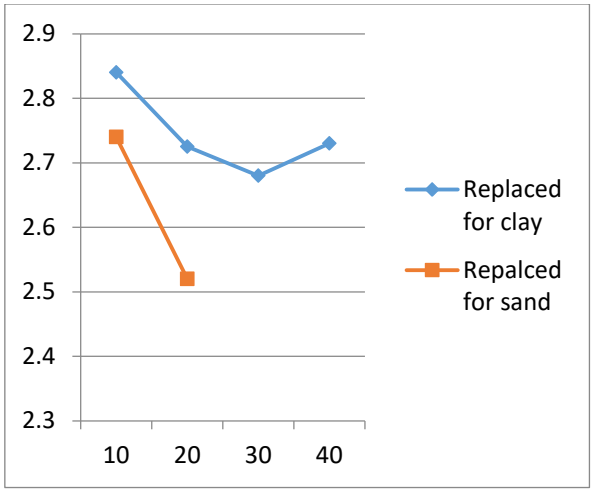

Fig. d. Weight change with addition of sludge in brick

F. General tests

Table. 13General tests

TEST	REPLACED					
	CLAY				SAND	
	10%	20%	30%	40%	10%	20%
Drop from 1m height	Not broken	Not broken	Not broken	Not broken	Not broken	Not broken
Nail impression	Nil	Nil	Light	Light	Nil	Light
Sounding	Sound Well	Sound Well	Sound Well	Sound Well	Sound Well	Sound Well

V. CONCLUSION

From the results it clearly shows that, the sludge is replaced by clay (10%, 20%, 30%, and 40%) and sand (10% and 20%). The performance was found good when the various tests such as water absorption (30% replacement by clay and 10% by sand), compressive strength (by 10% in both clay and sand) and basic characteristics test for bricks are examined and determined. In case of other tests of brick, which were conducted for test of brick shows that there is no significant change in strength & other properties.

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