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"Feasibility Study on Suitability of Building Bricks by using Waste Materials"

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Abstract – *The current framework shows, every day in municipal corporation of sewage treatment plant Davanagere district generates 3-4 tons of sludge and there is no much place for dumping these waste because it contains much of toxic substance such as (cadmium, chromium, copper, sodium etc) which causes impact on the environment and causes the water pollution if these sludge waste is disposed to the landfills. So that the attempt is made to reduce the impact on environment by using STP sludge and copper tailings as partial replacement in manufacturing of burnt bricks. Sludge is brought and dried it for 10 to 14 days and then experiment is made with varying proportion of dry sludge (0%, 5%, 10%, 15% and 20%) and add 10% of copper tailings for each mix of (5%, 10%, 15%, 20%) of sludge with clay. And then add required amount of water, then prepared 11 bricks for each mix of mould size 230mmx110mmx70mm and then dry for 8 to 10 days in open atmosphere and then placed in kiln for burning. After two days of cooling, then it is taken for testing of strength, water absorption, efflorescence, soundness and hardness. Then it should be satisfied according to IS standard 1077-1992.*

***Key Words*: STP sludge, copper tailings, burnt bricks, etc**

1. INTRODUCTION

Waste which can be defined as unwanted materials generated during the manufacturing processes of industrial, agricultural or household activity. These wastes are unwanted material which requires proper disposal site. These waste causes inconvenience in the environment. It created many forms of bacterial infection for all living creatures. Plotting Space for different kinds of waste has become a major problem in all the countries of world. Attention should be paid to the increase amount of residual sludge that obtained as impurities precipitated during processes of water treatment at different stages and the treatment at different stages and the methods of disposal. The way this sludge is disposed of is becoming a big concern in water treatment plants. Lai and Liu, found that mineralogical compositions of water treatment sludge are similar to those of clay, which helps them to make sludge bricks. Feenstra et al, from Netherland, combined different proportions of clay and sludge; they demonstrated the feasibility of the study and its importance. Linetal, managed to produce bricks with different clay proportions, incinerated ash together with two different sludge types (sewage and water treatment sludge, and incinerated-ash.

The use of industrial waste therefore helps to reduce waste created by rapid industrialization, and also helps to reduce construction costs. If the use of copper tailing in clay bricks typically has positive effects on properties such as lightweight bricks with increased shrinkage, heat and strength. To protect the environment and clay resources, some countries had started to use the waste with clay in making of bricks. Several researchers had been made attempts to make use of waste in the manufacturing of bricks. the waste used are limestone dust, polystyrene foam, cotton waste, wood sawdust, Kraft pulp production residue, textile effluent treatment plant, fly ash, paper processing residues, welding flux slag, waste paper pulp. The current study was concerned about environment sustainability. The non-degradable waste is used for the manufacturing of bricks.

1.1 PROBLEM IDENTIFICATION

Waste water treatment sludge storage and disposal is one of the most important issues facing all countries.

- Final disposal of sludge include land application, disposal in a sanitary sewers, disposal in surface water and deep well injection of brine. Because sludge waste interacts with natural resources, it contributes to natural resource degradation.
- Landfill disposal of the sludge and copper tailing is impractical due to the high transport costs and the capacity of the landfill is degraded.
- Landfill disposal of the copper tailing, resulting in increased load on the landfill site and wide area needed

1.2 OBJECTIVES OF THE STUDY

- To study the suitability of utilizing the STP Sludge and copper tailing waste for the manufacturing of bricks.
- To study the various proportion (0%, 5%, 10%, 15%, and 20%) of sewage sludge and add constant 10% of copper tailings for each mix of (5%, 10%, 15%, and 20%) STP sludge with clay for making of bricks.

- To study the behavior of strength, water absorption, efflorescence, soundness and weight loss on ignition of the produced bricks.
- To compare the obtained bricks results with each other and with actual results of the normal brick.
- Cost estimation of produced bricks and compare with normal bricks.

2. MATERIALS USED

2.1 CLAY

Clay is a finely-grained natural rock or soil material that combines one or more clay minerals with traces of metals of metals oxides and organic matter. They have ability to be crushed and mixed with water to form a plastic material which can be moulded into various shapes, this can be fired to a high temperature during which process it attains a hard, weather resistant characteristic. The clay used for this study is collected from P.K.S local brick factory in Chitradurga district.

Plate 1: Clay Available at Local Brick Factory Chitradurga

2.1.1 CHEMICAL CHARACTERISTICS OF CLAY

Particulars	% of Content
SiO_2	65.34
Fe_2O_3	7.52
Al_2O_3	13.88
CaO	1.2
MgO	0.96
SO_3	0.07
Na_2O	2.62
K_2O	0.76
TiO_2	1.47
P_2o_5	0.29
L.O.I	5.88

Table 1: Chemical Properties of Clay

2.1.2 PHYSICAL CHARACTERISTICS OF CLAY

Sl.No	Properties	Results
1	Specific gravity	2.27
2	Fineness modulus	5.24
3	Plastic limit, %	21.17
4	Liquid limit, %	33.15

Table 2: physical Properties of Clay

2.2 DRY SLUDGE

Sludge is the solid, liquid, or semisolids residuals generated as a byproduct of waste water treatment. Usually sludge contains 0.25-12 percent solids by weight, depending upon the operations and the processes used The construction of treatment plants has caused problems with huge content of sludge. It has been found that each person produce 35 to 85 grams of solid sludge per day. Sewage is collected from sewage treatment plant (STP) in Davanagere district. The proposed scheme includes construction of 20 MLD capacities sewage treatment plant. Every day 3 tons per day of sludge is produced.

Plate 2: STP Davangere

Plate 3: Crushed Dry Sludge

2.2.1 CHEMICAL CHARACTERISTICS OF DRY SLUDGE

Particulars	% of Content
SiO_2	43.13
Fe_2O_3	5.27
Al_2O_3	15.98
CaO	5.57
MgO	5.58
Na_2O	0.53
L.I.O	26.80

Table 3: Chemical Properties of Dry Sludge

2.2.2 PHYSICAL CHARACTERISTICS OF DRY SLUDGE

Sl. No	PROPERTIES	RESULTS
1	Specific gravity	1.35
2	Bulk density, kg/m3	688
3	Water absorption, %	0.7
4	Clay and sulphate content, %	0.2
5	Softening coefficient	0.97
6	Grain type coefficient	1.1

7	Moisture content	0.1-11.5

Table 4: Physical Properties of Dry Sludge

2.3 COPPER TAILING

Copper tailings are finely ground waste after copper minerals which have been removed from the ores during beneficiation. The chitradurga copper co- Ltd was formed in 1966 to explore and exploit the copper at Ingaidhal. 200 tones were mill every day and gives 10 tons of copper concentrate and these copper concentrate are send to the another industry for the extraction of copper.

Plate 4: Copper Slag Waste after Pulverization

CHEMICAL CHARACTERISTICS OF COPPER TRAILINGS

Chemical Compounds	Weight (%)
SiO_2	64.7
$F_{e2}O_3$	4.32
Al_2O_3	7.09
MgO	4.07
CaO	7.53
Na_2O	0.91
SO_3	1.67
K_2O	3.27

Table 5: Chemical Properties of copper tailings

2.3.1 PHYSICAL CHARACTERISTICS OF COPPER TAILINGS

Sl. No	Properties	Results
1	Specific gravity	2.76
2	Water content, (%)	67
3	Liquid limit, (%)	28
4	Plastic limit, (%)	13
5	Plasticity index, (%)	15
6	Coefficient of uniformity	14.7
7	Coefficient of curvature	2.13

Table 6: Physical Properties of Copper tailings

3. METHODOLOGY

In this study following methodology is adopted for the manufacturing of burnt bricks with various proportions of (sludge, copper tailings and clay).

3.1 MIX DESIGN OF BURNT BRICKS

Mix	Percentage of Sludge, (%)	Percentage of Copper Slag, (%)	Percentage of Clay, (%)	Water
M-1	0	0	100	As per requirement
M-2	5	10	85	As per requirement
M-3	10	10	80	As per requirement
M-4	15	10	75	As per requirement
M-5	20	10	70	As per requirement

Table 7: Mix Proportion of Burnt Bricks

In this study, three raw materials namely sludge; copper tailings and clay are as the major ingredients. They are mix with each other in proportion as mention in table to produce brick. The following steps are taken for making brick.

The making process of bricks can be done by the two methods:

- Volume batching
- Weighing batching

In this study, I used the weighing batching for the manufacturing of bricks. Weight batching is always preferable as it is the most accurate method to mix the materials in the desired proportion. This is the best method to measure the quantity of the material.

1)First of all raw materials are collected, required proportion of sludge 0%, 5%, 10%, 15%, 20%, and use copper tailings of constant 10% for each mix with the clay and named as mix (M-1, M-2, M-3, M-4, M-5). Sludge, copper tailings, clay are mixed together properly and add water with sprinkle, and mixing of the materials properly it is kept in same manner for 12 to 16 hours.

2) After 12 to 16 hours the mixture is again mixed properly by adding some water. Then all mixing is done manually with hand and feet.

3) After the mixing, the lump of mix is taken, rolled in clay and slapped into mould. The mould used for this study is metal mould, mould of size 230mm x110mm x70mm, and

then the brick are demoulded.
4) For each mix, I have casted of 11 bricks, totally 55 bricks are casted.
5) When bricks are kept in the sunlight after every two day they are turned over for uniform drying and stop from warping.
6) After 8 to 10 days they are ready to be burnt in kiln. Totally 55 bricks are arranged in kiln and insulation is contribute with mud pack. Fire holes are made to ignite the kiln are later sealed to keep the heat inside.
7) This is continuing for week. After a week kiln is dismantled and brick are classify according to colour

Plate 5: mixing various proportion of dry sludge and copper tailings with clay

Plate 6: Various Proportion of Sludge and Copper Slag Bricks

3.2 TESTING OF BRICKS.

Following tests have been conducted on the brick sample
1) Compressibility test (as per IS-3495 (part1):1992
2) Water absorption test (as per IS-3495(part2):1992
3) Efflorescence test (as per IS-3495(part3):1992
4) Soundness test

3.2.1 TEST ON COMPRESSIVE STRENGTH OF NORMAL AND PRODUCED BRICKS.

The determination of compressive strength of normal and produced burnt bricks as per ((IS 3495 (part-1) -1992)) and the compressive strength values of the produced and normal burnt bricks are given in table 4.1 below.

As the load carrying capacity of bricks increases, the compressive strength also increases. In each mix, three samples of bricks are taken for the trail and then immersed in water for 24 hours. After immersion in water for 24 hours, then bricks are removed out and left the surface to dry. Each bricks are put on compression testing machine and then apply the load axially at a uniform rate of 14 N/mm2 per minute till the failure occurs and note down the maximum load of each brick at failure. The failure load of the three bricks gives the compressive strength of three bricks. Finally mean of three bricks gives the average compressive strength of the brick.

Compressive strength (N/mm2) = Maximum load at failure of brick (KN) / Area of brick (mm2)

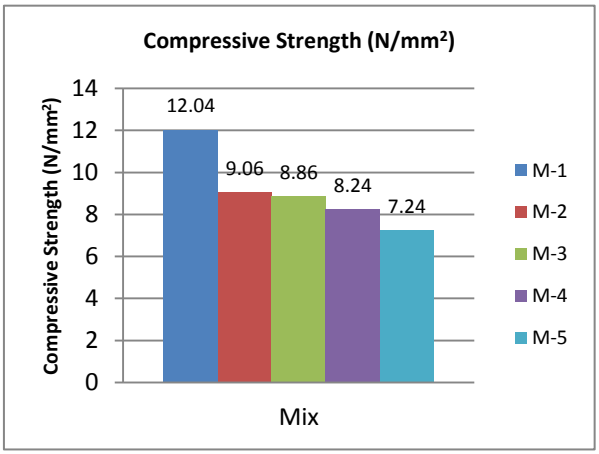

Chart 1: Graph on Compressive Strength of Produced Brick

It is observed from the above results that, the difference in compressive strength of produced brick with 5%, 10%, 15%, and 20% of dry sludge and copper tailings of constant 10% for each mix of dry sludge with the normal brick gives 24.75%, 26.41%, 31.56%, and 41.52%. There is no much difference or variation in the compressive strength of produced brick of (5%, 10%, 15%) of sludge and copper tailings of 10% constant added to the each mix of sludge with the normal brick. however, the difference between compressive strength of normal brick and produced brick of 20% of sludge is slightly high as 41.52%. as dry sludge and copper tailings proportion increases, strength goes on decreases.

As per IS 1077-1992, the minimum strength of brick should be 3.5 N/mm2 and grade- AA should be more than 14 N/mm2 and grade-A brick should be 7-14 N/mm2. From this study, brick made of (5%, 10%, 15% and 20%) with constant 10% of copper tailings for each mix of dry sludge with clay can be classified as grade-A. these bricks can used in the construction.

3.2.2 TEST ON WATER ABSORPTION OF NORMAL AND PRODUCED BRICKS

The determination of water absorption of normal and produced burnt bricks as per (IS 3495 (part-2) -1992) and the water absorption values of the produced and normal burnt bricks are given in table 4.2 below.

In this test, for each mix, three samples of bricks are taken for trail. Three samples of bricks are well dried are taken and then dry weight of bricks found out individually (W1). Then for 24 hours bricks are immersed in water. After 24 hours, the bricks are taken out and then bricks are surface

dried and then find out the wet weight of each brick (W2). The percentage water absorption of each bricks = ((W_2- W_1) / W_1)) x 100. Where, W_1= dry weight of brick.

W_2 = weight of brick after 24 hrs of water immersion.

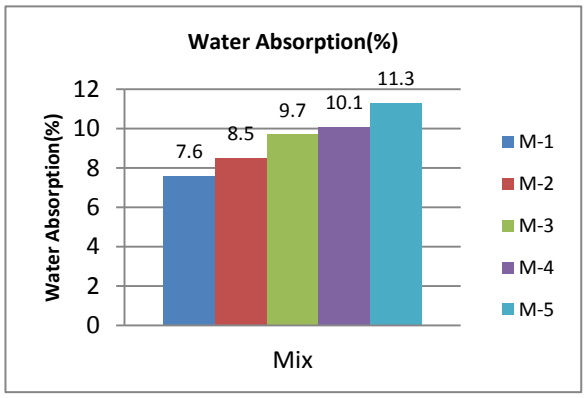

Chart 2: Graph on Water Absorption Test of normal and Produced Bricks.

As far as water absorption is concerned, the water absorption of brick with proportion (0%, 5%, 10%, 15%, and 20%) of dry sludge with 10% of copper tailings for each mix of dry sludge is 7.6%, 8.5%, 9.7%, 10.1% and 11.3%. The difference between absorption of brick with proportion (5%, 10%, 15% and 20%) of dry sludge and constant 10% of copper slag for each mix of sludge with normal brick is 11.84%, 27.63%, 32.84 % and 48.68%. we can absorb that as the sludge proportion increases, the absorption goes on increases. durability of brick depends on the water absorption, as water absorption increases durability decreases. as per the IS 1077-1992, the maximum water absorption of brick should be 20%. in this study, each mix added to brick are within in this limit. these bricks can be recommended for construction.

3.2.3 TEST ON EFFLORESCENCE OF NORMAL AND PRODUCED BRICKS.

Bricks containing the salts like calcium, magnesium, sodium and potassium present in brick will cause efflorescence on the surface of brick, when got dissolved in water. if brick contains too much of salt lead to poor strength and less resistance to weathering. in this test, for each mix 3 sample of bricks is taken for trail, three sample of bricks ends placed in the dish, they are immersed in the water to a depth of 25mm. place the whole arrangement in the well ventilated room until all the water in the dish is absorbed by the bricks and the surface water evaporate. When bricks are completely absorbed by the water and get evaporated, place the same quantity of the water in dish and allow the bricks to be absorbed and evaporate as before. Then examine the bricks after all above process finishes and determine the percentage of the white spots on the surface area of the brick. If any difference is observed in the bricks report the results as:

Nil- when there is no perceptible deposit of efflorescence.
Slight - thin deposit of salt is covered not more than 10%.
Moderate - covering up to 50% of the brick area.
Heavy - covering more than 50% brick area.
In this all mix M-1 to M-2 of bricks all are free from salt deposit.

SOUNDNESS TEST

The soundness test has a peculiar behavior, for each mix two bricks are taken for trail. Dry sludge with proportion (0%, 5%, 10%, 15% and 20% and constant 10% of copper tailings gives the clear ringing sound without broken of bricks, when the two bricks are strikes each other. then it means that the produced bricks are sufficiently sounds.

BRICK WEIGHT LOSS ON IGNITION

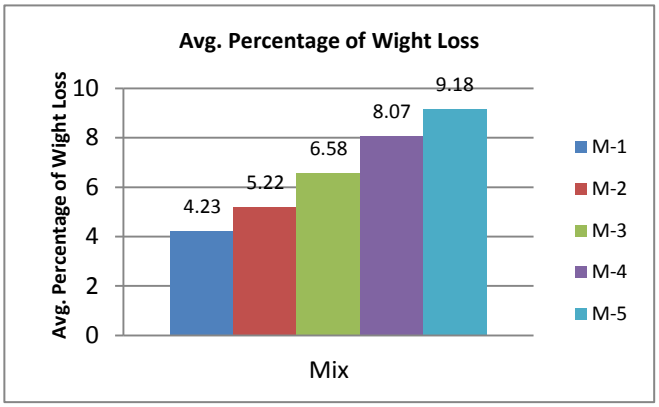

Chart 3: Graph on Average Percentage Weight Loss of Bricks after Ignition.

Dry sludge with proportion (0%, 5%, 10%, 15% and 20%) and copper tailings of constant 10% for each mix have a percentage weight loss on ignition gives 4.23%, 5.22, 6.58, 8.07 and 9.18. it is observed that, the loss in weight after burning is considerably large as the proportion of dry sludge increases. however, the maximum limit for the weight loss on ignition as per IS 1077- 1992 is 15%.so that the obtained bricks are within this limit, these produced bricks can be used for construction.

COST ESTIMATION

Sl. No	Normal brick (Rs)	M-2 brick (Rs)	M-3 brick (Rs)	M-4 brick (Rs)	M-5 brick (Rs)
1	6	5.1	4.8	4.5	4.2

Table 8: Cost Estimation of the Normal and Produced Bricks

CONCLUSIONS

- The bricks can be very effectively used with 5 to 20% of STP dry sludge and constant copper slag of 10% for each mix of dry sludge with clay for non – load bearing structures, because the framed structures requires filling the panels.

- As the water absorption is slightly higher in case of STP bricks, it is recommended plastering to avoid water absorption.
- As the efflorescence effect is absolutely nil, so the STP bricks do not have any effect on the any type of brand of cement used in construction
- As in the STP- bricks, losses the self – weight after burning substantially the dead load on the frame work can be considerably reduces.
- This study concludes that some proportion of STP sludge and copper tailings can be used for making bricks to required size and shape, because dumping and disposal of sludge requires more space and creates an impact on the environment.

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