USE OF SLUDGE WASTE AS AN INGREDIENT IN MAKING OF BRICKS

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Abstract: Brick is one of the most important and widely used construction material due to its properties. Now-adays many attempts have been made to incorporate different wastes into the production of bricks. In many countries, Sludge waste is a serious problem due to its high treatment costs and the risks to environment and human health. The sludge generated in various treatment systems around the world is discharged into the nearest watercourse. Thus, rather than disposing, the use of sludge in producing constructional elements is considered to be the most economic and environmentally sound option. The properties of STP Sludge and Fly Ash is extremely close to brick clay so, it could be a potential substitute for clay bricks. In this study the bricks were produced with sewage sludge additions ranging from 10, 20, 30, 40 and 50 % by dry weight and compared the produced brick with conventional brick. The manufacturing of bricks is done by moulding clay in rectangular blocks of uniform size and then by drying and burning these blocks. Burnt clay bricks have good resistance to moisture, insects and erosion and create a good environment. Their cost is comparatively low and have medium to high compressive strength. Results of the tests performed indicated that the sludge proportion and the firing temperature were the two key factors determining the brick quality. Results showed that the loss of brick weight after ignition was mainly attributed to the organic matter content in the sludge being burnt off during the firing process. Hence sludge can be used as a replacement for clay, soil in manufacturing of bricks. Also from this investigation we can solve disposal problems completely and also construct an economical structure with easy designing.

Keywords— Brick, Sludge, Compressive Strength.

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).

In the earlier days, 6000 B.C. bricks were prepared by an ancient method, in which the moist clay was pressed into the rectangular moulds by hand and then let it dry in sun light. To prevent the moist clay from the sticking to the moulds, the moulds were dipped into the water before being filled. After this method, the civilians found that the fired bricks are more favourable as compare to the sun-dried bricks. The fired clay bricks are more durable and weathering resistant. These fired clay bricks were made under the wooden fire which maintained for some days. In nowadays, the bricks are made with the partial or fully replacement of clay soil with the various waste materials like rice husks, sludge, marble dust, tea wastes etc. This paper presents use of dry sludge in the manufacturing of bricks as a raw material or as the partial replacement of the clay soil in the bricks. There are number of experiments have been carried away in many countries for the use of sludge in the brick.

2. PROBLEM STATEMENT

Keeping in view the huge amount of these waste materials, their disposal problems their use in the production of brick appears a good alternative. Use of these waste materials as replacement of clay for brick production, the present work was undertaken with following objectives:

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

3. MIX DESIGN

There are four different series of mixing ratios that were tried. However, the batching of raw materials required to produce brick with nominal dimensions are shown in the table below.

Mix design for Sludge Bricks

Different % Of Sludge	Soil	Fly Ash	Rice Husk	Water
10%	75%	10%	5%	As per Requirement
20%	65%	10%	5%	As per Requirement
30%	55%	10%	5%	As per Requirement
40%	45%	10%	5%	As per Requirement

4. MAKING OF BRICKS

In this work, raw materials namely sludge, Fly Ash, and clay are as the major ingredients. They are mix with each other in proportion as mention in table above to produce brick. The following steps are taken for making brick.

- First of all raw material with required proportion i.e. sludge and clay are mix together and added water to a sprinkle. And the mixing of material properly it is kept in the same manner for 12 to 16 hours.
- After 12 to 16 hours the mixture is again mixed properly by adding some water. The all the mixing is done manually with hand and feet.
- After mixing the lump of the mix is taken, rolled in sand and slapped into mould. The mould used for this study is metal mould and this mould is empty at drying area where brick is arranged for dry in sunlight.
- When brick is kept in sunlight after every two days they are turned over to facilitate uniform drying and prevent from warping.
- After 8 to 10 days they are ready to be burnt in kiln. The green bricks arranged in kiln and insulation is provided with a mud pack. Fire holes are left to ignite the kiln are later sealed to keep the heat inside.
- This is maintained for a week. After a week kiln is disassembled and brick are sorted according to colour.

Colour is an indication of the level of burning.

5. TEST CONDUCTED ON BRICKS

5.1 COMPRESSIBILITY TEST (AS PER IS-3495(PART-1):1992

To determine the compressive strength of bricks the compressive strength of bricks are obtained by placing the brick on the flat horizontal surface between the plates of the testing machine. The axial load is applied at a uniform rate until the brick gets a failure.

The compressive strength of the brick is obtained by using the formula,

Compressive strength=Maximum load at failure/ average area of the surface.

5.2 WATER ABSORPTION TEST (AS PER IS-3495(PART-2):1992

Dry the brick in an oven at a temperature of 105-115°C, cool the brick to the room temperature and it is weighed (M1). Then immersed the dry brick in water completely at room temperature for 24hrs and remove the brick from the water and wipe out the traces of water with a cloth and the brick is weighed (M2).

Water absorption= (M2-M1)/ (M1) X100
Where M1 = Dry weight of Sample

M2 = Weight after 24 hrs in water

5.3 EFFLORESCENCE TEST

The efflorescence test of the brick is conducted by placing the end of the brick in the dish and the distilled water is filled up to the depth of 25mm.The whole arrangement is made at the room temperature with the well-ventilated room until all water in the dish is absorbed by the brick and the surface water evaporate. The dish is covered in order to reduce excess evaporation. When the water is absorbed the bricks appeared to be dry, place a similar quantity in the dish allows it to evaporate as made before.

The efflorescence is obtained after second evaporation is made.

Nil- No observable deposit of efflorescence

Slight-Less than 10 % area of bricks covered a thin deposit of salt.

Moderate-Covering up to 50% area of the brick

Heavy-Covering 50% or more area of the brick

5.4 SOUNDNESS TEST

The two bricks are taken and made struck with each other. Brick of good quality should not break and produce a ringing sound.

5.5 HARDNESS TEST

Scratch is made on the brick surface with the help of finger nail. If no impression on the surface, the brick is sufficiently hard.

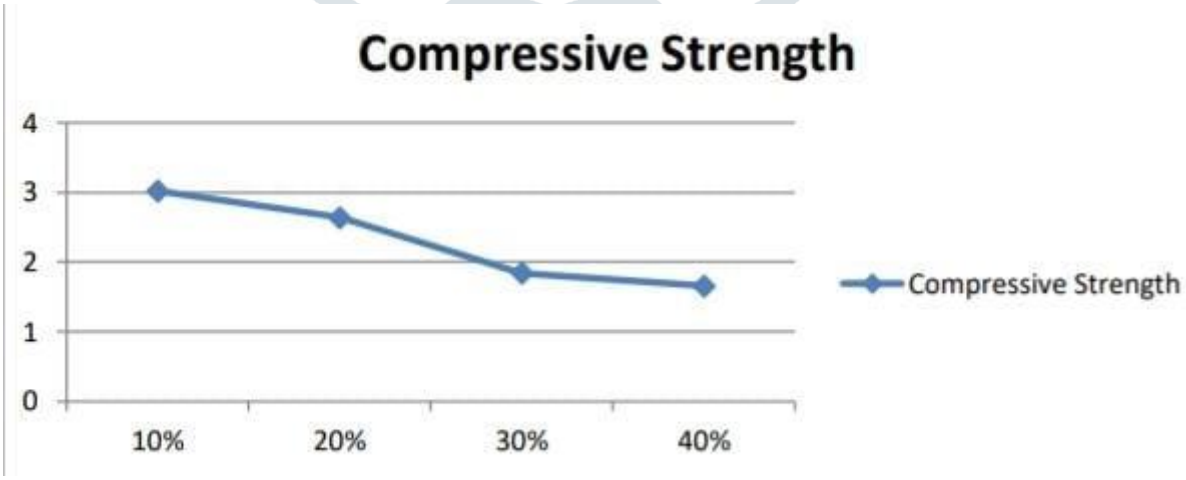
6. RESULTS AND DISCUSSION

6.1 COMPRESSIBILITY TEST RESULT

The results of the compressive strength test on the brick made from both fly ash and sludge mixtures with three trials are shown

% of Sludge	Avg. compressive strength N/mm^2
10%	3.02
20%	2.64
30%	1.84
40%	1.66

Fig. Variation of compressive strength with % of Sludge



Above fig. illustrates the compressive strength of the bricks tested. The addition of sludge is in less amount to the other constituents increased the compressive strength of bricks. Even so, the addition of sludge is more in percentage resulted in a reduction of compressive strength. However, sludge being finer than soils itself, it also may fill the voids within the soil causing a reduction in void space thereby making bricks denser. Hence, the filler action of sludge should increase the compressive strength of bricks. The observed changes in strength should obviously be the sum total of these two effects.

Filler action is dominant when percentage sludge added is less than 10%. Further addition of sludge occupies the space only by pushing the coarse sand particles in the soil apart. This will result in a reduction in the friction between sand particles which contribute significantly to the compressive strength of bricks. Therefore, reduction in compressive strength is expected at higher percentages of sludge

6.2 WATER ABSORPTION TEST OF BRICK

The amount of water absorption is calculated from the following equation.

Amount of water absorbed (%) = (W2-W1)/W1

Where W2 = weight of wet brick in gm,

The W1= weight of dry brick in gm,

Results of Water Absorption Test of Bricks

% Sludge	Avg. weight of dry bricks (W1) (gm)	Avg. weight of wet bricks (W2) (gm)	Amount of Water Absorbed (%)
0%	2766.33	3246.00	17.95 %
10%	2509.67	2865.00	18.72 %
20%	2130.33	2549.33	19.79 %
30%	1854.67	2236.67	19.85 %
40%	1575.00	1921.00	19.98 %

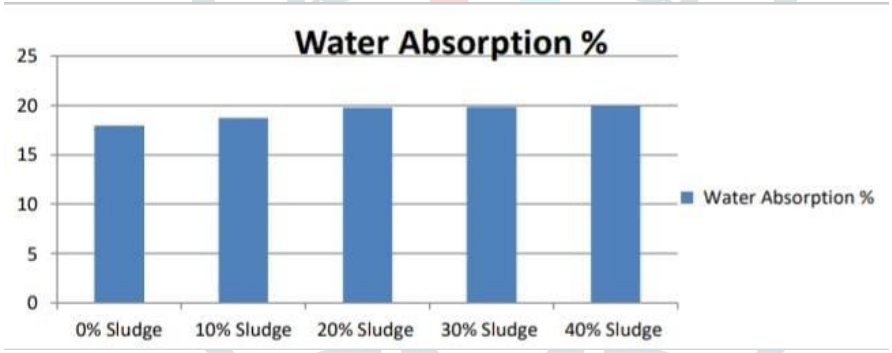


Fig. Water Absorption

6.3 EFFLORESCENCE TEST

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Results of efflorescence test

% of Sludge	Status
10%	Slight
20%	Moderate
30%	Moderate
40%	Heavy

6.4 SOUNDNESS TEST

In this test, we have checked the bricks to check its hardness in case of the sudden impact. The two bricks are taken and made struck with each other. Brick of good quality should not break and produce a ringing sound. The ringing sound of brick goes on decreasing with increase in the amount of sludge content. Ringing sound is excellent for original bricks with 0% sludge. Ringing sound is least for 20% of sludge addition bricks. This may be because of increased porosity of the bricks. For bricks, up to 20% sludge addition has good ringing sound is heard.

6.5 HARDNESS TEST

Scratch is made on the brick surface with the help of finger nail. If no impression on the surface, the brick is sufficiently hard. First three samples show good results and last three samples do not show good results**.**

6.6 COST ESTIMATION

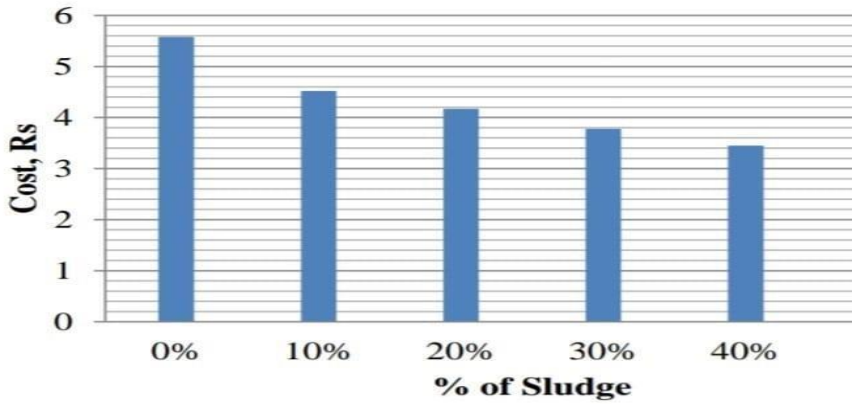
After all the tests over the dry sludge bricks, we did an analysis to the cost of the bricks. The analysis of the cost of the brick is done on the basis of the four factors

- Price of soil
- Price of sludge
- Price of fly ash
- Labour cost

According to the mix design calculation, we achieved the weight of water, sludge and fly ash for bricks. As the water is largely available in India, its costs can, therefore, be neglected. The current study shows that replacement of soil using sludge can be made as much as 20% (by weight). After the Analysis, we come to know that as the percentage of the sludge in the brick is increasing, the cost of the brick is decreasing in the same way.

Cost Comparison between Conventional and Sludge Bricks

% of Sludge	Weight of bricks (gm)	Cost per Brick, Rs
0 %	2466	6.50
10 %	2200	4.44
20 %	2130	4.29
30 %	1850	3.87
40 %	1570	3.53



On the basis of the analysis done, it comes to know that the cost of the brick is reducing the use of dry sludge in it. According to the Government norms, the sludge can be avail at free of cost including transport charges. Hence the cost of the brick is decreasing with the increase in the quantity of dry sludge in the brick.

7. CONCLUSION

1. The expected outcome of the said project is to incorporate upto 40% of dry sludge in bricks by replacing the soil and to produce a light weight product.
2. In this project we have incorporated the use of Dry Sludge in brick up to 40% by replacing soil. (Dry Sludge 10%, 20%, 30% and 40%)
3. As dry sludge is available free of cost, so the cost of bricks will automatically be reduced.
4. This will lead to the conservation of natural resources such as soil/clay.
5. 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.
6. Thus, this project shows that replacement of soil with this Dry Sludge material reduces the weight of brick and it becomes a light weight product.
7. It is expected that the 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.
8. Environmental effects from wastes and disposal problems of waste can be reduced or controlled through this research.
9. A better measure by an innovative Construction Material is formed through this project.

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