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FEASIBILITY STUDY OF THE USAGE OF FLOODED SOIL AND SEWAGE WASTE ON BRICK

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Abstract - *Bricks are the major construction and building material used around the world. Conventionally bricks are produced from kilns with huge amount of energy in terms of coal and diesel and it also reduces the availability of natural materials used for brick making. To overcome these issues waste materials can be incorporated in making of bricks with less energy. The project aims to develop bricks with waste materials such as soil after flood event and sewage waste from industries. Bricks are produced in various percentages such as 0%, 10%, 20%, 30%, 40%, and 50% of sludge waste which are incorporated with flooded soil and its physical and chemical properties are tested out. Among these the brick with 20% of sludge with soil shows maximum compressive strength and water absorption.*

Key Words: **bricks, sewage waste, soil after flood (flooded soil), compressive strength, water absorption**

1. INTRODUCTION

Flash flood is one of the most common natural disaster that occurring in most parts of the world. On august 2019, Malappuram and Calicut district was hit by flash flood and it's considered the worst in decades. After the flood event, a lot of debris and mud were found along the affected area. The research was used flood deposit as raw materials in the local manufacture of burnt bricks. Industrialization and urbanization generate huge amounts of waste materials. The accumulation of these materials is not only a burden to the industry but also affects the environment adversely. Therefore, development of new technologies to recycle and convert waste materials into reusable materials is critically important for protection of our environment and sustainable development of our society[9].

For environmental protection and sustainable development, many researchers have been studied the utilization of waste materials to produce the bricks. Waste causes many nuisances in the environment. It produces many types of infection, for human and animal. It is the discarded material which essential requirement of disposal. Therefore this sludge waste bricks can be used efficiently as a replacement for clay brick. The natural resource is practically utilized for manufacture of sludge bricks, and as an alternative to normal cement bricks, which helps in conservation of naturally available resource and improves the environment quality [8].

1.1 Objective of the study

- To check the feasibility of sewage sludge and flooded soil as ingredient in brick making
- To determine the water absorption and compressive strength of brick from flooded soil and sludge waste
- To reduce the construction cost.
- To reduce environmental pollution

2. METHODOLOGY

2.1 Sample Collection

In this project the clay or flooded soil was taken from Kizhuparamba Panjayath, Malappuram district. And sludge collected from Shanthi Hospital in Omassery, Calicut district.

2.2 Materials

2.2.1 Dry sludge

It is found that, each person will produce 35 to 85 grams of solid sludge per day. In recent years, waste production has dramatically increased in developing nations such as India and other countries. The collected waste from Shanthi hospital are sun dried and then oven dried.

Fig-1 Waste Sludge

2.2.2 Flooded soil

Flooded soils are the soil that arises due to a condition in which the area of soil is oversaturated with water, often due to natural occurrence of events or with intended purpose for

agricultural reasons. One of the most important effects of flooded soil is that, the presence of oxygen is limited in such an environment, and any of the remaining oxygen is quickly used up by aerobic respiration. The flooded soil obtained after the flood event that occurs in Kerala. The soil is sun dried and oven dried to remove the water content from it.

Fig-2 soil deposit after the flood event

2.3 Sample Preparation

There are four different series of mixing ratios were tried. However, the batching proportions of raw materials required to produce brick with nominal dimensions of 19×9×9 centimeters are shown in below table.

Table-1: Different Proportion of Raw Materials

Trail	Sludge (%)	Flooded soil (%)
A	10	90
B	20	80
C	30	70
D	40	60
E	50	50

2.4 Making of Brick

In this experiment, two raw materials namely Sludge and flooded soil are as the major ingredients. The sludge and soil are mixed together and added water with sprinkle. After mixing the lump of mix is taken and slapped into the wooden mould. This mould is placed in an area where bricks are arranged for dry in sunlight. The mould is wiped by oil and then some amount of river sand is poured along the sides so that the moulded specimens can be easily removed from it. The mixture is filled in the mould with proper compaction. After filling its surface is leveled by using trowel. After the mould is removed and these specimens dried under sunlight for 7 to 8 days and then it is oven dried for 105°C for 24 hours. And further tests on bricks are carried out.

2.5 Tests on soil

In order to know whether the soil is similar to usual clayey soil used for brick making several soil tests should be essential.

2.5.1 Moisture content

It is an indicator of the amount of water present in soil. Known amount of soil are taken, after weighing it is placed on oven and then weighed again after drying. Then the moisture content is found by below equation [4].

$$W = \frac{W_2 - W_3}{W_3 - W_1} \times 100$$

Where W_1, W_2 and W_3 are the weight of container, wet weight of soil and dry weight of soil respectively.

2.5.2 Liquid limit (Atterberg Limits)

It is the boundary between liquid and plastic states of consistency. About 120g of soil is taken and mixed with known amount of soil and placed on Casagrante apparatus and made a groove in it with grooving tool. And note the number of blows required to cause the groove come closer. And the water content corresponding to 25 no of blows are noted [5].

2.6 Tests on brick

All the moulded specimen after oven drying are taken out for conducting several tests which is useful for further evaluation

2.6.1 Water Absorption Test

The casted brick specimens after oven drying are cooled to room temperature. Note the dry weight and these bricks are immersed in water at room temperature for 24 hours. After these casted specimens are removed from the water and after cleaning the water from surface its wet weight also noted down. And the water absorption is calculated by formula below [6].

$$W = \frac{M_2 - M_1}{M_1} \times 100$$

Where M_1 and M_2 are the wet weight and dry weight of the brick respectively.
As per IS specification no cases the water absorption should be greater than 20% by weight.

2.6.2 Compressive Strength Test

The bricks are placed with flat faces horizontal. Compression testing machines are used for the test. The brick was carefully centered between plates of testing machine. Load applied axially at a uniform rate of 14 N/mm^2 per minute till

failure occurs and note down the maximum load at failure. The procedure is done for three of the samples [6]. And the compressive strength is found out by equation below.

$$\text{comp: strength} = \frac{\text{load at failure in Newton}}{\text{Avg.area in mm}^2}$$

The bricks are classified based on the IS specification given below,

Table-2: Classes of common burnt clay bricks (*Clause* 4.1)

Class Designation	Average compressive strength not less than	
	N/mm²	(Kgf/cm²) (Approx)
35	35.0	(350)
30	30.0	(300)
25	25.0	(250)
20	20.0	(200)
17.5	17.5	(175)
15	15.0	(150)
12.5	12.5	(125)
10	10.0	(100)
7.5	7.5	(75)
5	5.0	(50)
3.5	3.5	(35)

3. RESULTS AND DISCUSSION

This section deals with the various test results and its discussion. Bricks with 19×9×9 size are casted. Each percentage has four numbers of bricks and these are used for testing. After all the test these test results are compared by the brick from market, which are usually used for construction purposes.

Fig-3: moulded specimen

Fig-4: casted specimen

3.1 Results of soil tests

3.1.1 Soil Moisture Content

Table-3: Observation for moisture content

SL NO	1	2	3
Weight of container(g)	14	13.5	13.5
Weight of container + wet soil (g)	24	23.5	23.5
Weight of container + dry soil (g)	22	20.5	20.5
Wet weight of soil (g)	10	10	10
Dry weight of soil (g)	8	7	7
Water content (%)	25	42.8	42.8

From the above table the average water content is 36.9%.

3.1.2 Liquid limit of soil

Table-4: Liquid limit observation

Sl. NO	1	2	3	4
no of blows	45	31	12	8
Weight of container	13	16	15	17
Weight of container +wet soil	20	22	25	25.5
Weight of container+ dry soil	18	20	21.5	22
Weight of water(g)	2	2	3.5	3.5
Weight of wet soil (g)	7	6	10	8.5
Weight of dry				

soil (g)	5	4	6.5	5
Water content (%)	40	50	53.8	70

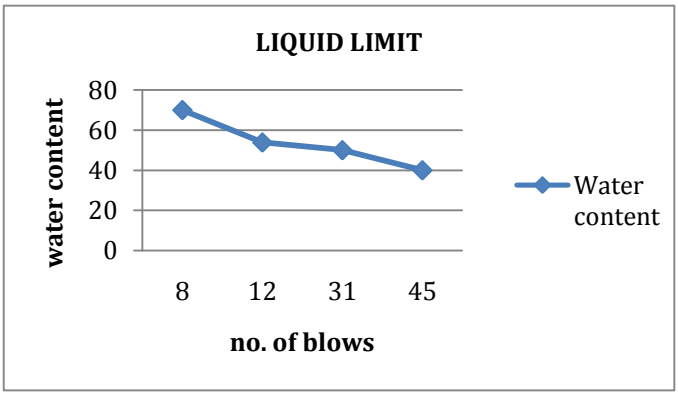

Fig-5: graph showing liquid limit of soil

From graph the water content corresponding to 25 no of blows is = 50%. As per IS specifications the water content corresponding to 25 number of blows can be considered as the soil's liquid limit.

Among the above results it can be clear that the soil obtained after flood event have the properties similar to the soil which is used for the brick making and all other construction purposes. Hence the soil obtained after the flood event can be used for brick making.

3.2 Results of tests on brick

The observations of test results on casted brick specimens are as follows.

3.2.1 Effect of water absorption

Table-5: Observation for water absorption test

SL NO:	BRICK DESIGNATION	WATER ABSORPTION (% BY WEIGHT)
1	Ordinary brick from market	14.2
2	Casted brick specimen with 0% sludge	22.8
3	Casted brick specimen with 10% sludge	17.6
4	Casted brick specimen with 20% sludge	10
5	Casted brick specimen with 30% sludge	18.7
6	Casted brick specimen with 40% sludge	21.3
7	Casted brick specimen with 50% sludge	24.4

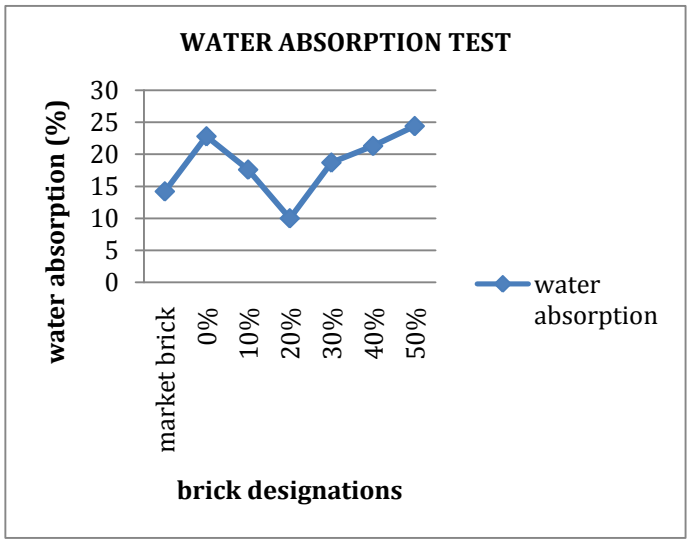

Fig-6: variation in water absorption

Effects of water absorption on different classes of bricks are shown above. Maximum water absorption is present in brick with 50% of sludge and less water absorption found in brick having 20% of sludge. Graph shows a pattern of decrease from 0% to 20% of sludge bricks. And then a sudden increase up to 50% sludge bricks. The bricks from market show water absorption less than 15% and hence it is in first class bricks. Likewise casted specimens with 20% sludge are also included in first class. The bricks with 10% and 30% sludge show second class designation. And remaining 0%, 40% and 50% are includes in third class bricks.

3.2.2 Effect of Compressive Strength

Table-6: Observation for compressive strength test

SL NO:	BRICK DESIGNATION	CRUSHING STRENGTH TEST N/mm²
1	Ordinary brick from market	13.5
2	Casted brick specimen with 0% sludge	8.6
3	Casted brick specimen with 10% sludge	10.4
4	Casted brick specimen with 20% sludge	12.82
5	Casted brick specimen with 30% sludge	7.8
	Casted brick specimen with	

6	40% sludge	6.5
7	Casted brick specimen with 50% sludge	5

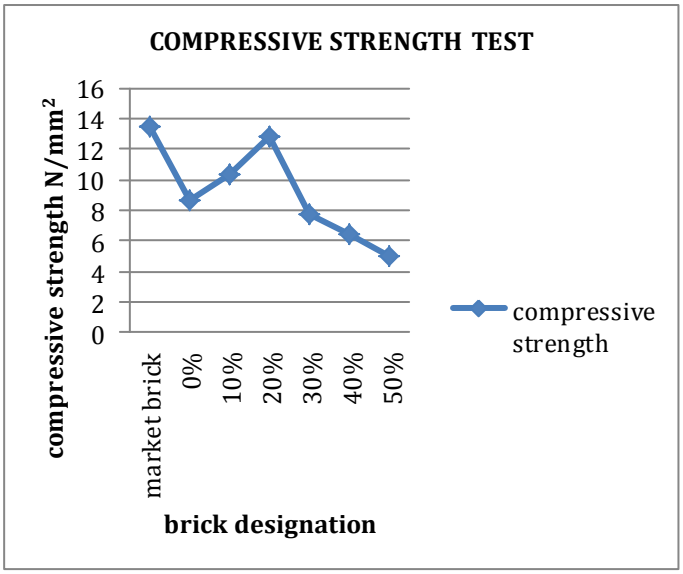

Fig-7: variation in compressive strength

Effects of compressive strength on different classes of bricks are shown above. Among the specimens bricks with 20% sludge show maximum compressive strength. Here the compressive strength increases to 20% sludge bricks and then decreases to bricks with 50% sludge. As per IS specification the brick brought from market and the casted brick with 20% sludge are as similar to class 12.5. Bricks with 0% and 30% sludge includes in class 7.5. Bricks with 10% sludge are in class 10. And bricks with 40% and 50% sludge show a class of 5.

From the all above results it can be seen that the brick with 20% sludge are in first class brick as per IS specification, and this can be used for construction purposes. All the casted bricks can be used for small construction purposes and for major construction purposes first class brick must be used.

4. CONCLUSIONS

According to the results obtained, the soil obtained after flood event can be used for the production of brick material. For more improvement the sludge waste can be included in it. As the sludge waste increases in the soil its strength are improved. But after certain percentage of sludge with soil its characteristics shows poor values. Hence the bricks can be produced with the soil and waste sludge up to those certain limits. Based on the study the brick shows better results with 20% sludge by weight. It shows better results as per IS specifications of bricks usually used for construction purposes, which is available on market. It have a compressive strength of 12.8 N/mm^2 which includes in a class of 12.5 as per IS specification and also in first class bricks. The water absorption is less than 15% which corresponds to the first class brick.

This study gives an effective way to reduce the waste after the flood event and also the disposal of sludge become easy with less harmful effects to the environment. In case the usage of these waste sludge and waste soil for the production of an industrially beneficial product like bricks leads to reduce the waste from the environment. Hence this study gives a better future to the environment with less waste.

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