Effect of High Silica Powder And Paper Mill Waste In Bricks

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***Abstract*—In Civil engineering field it is a great challenge that replacing the industrial waste material as the construction materials. Paper industry is one of the oldest and largest sectors in India, it has several environmental impacts causing land pollution with toxicity. Waste management becomes a big problem nowadays. In the present study, an attempt has been made to utilize the paper waste with high silicate powder in making of fired clay bricks. Paper mill waste was incorporated in clay bricks manufacturing of size 230×100×70mm, and it was observed that with increase in paper content, there is a decrease in compressive strength and weight of bricks. The purpose of this study was to determine the compressive strength and water absorption test. It was observed that 6% of paper waste and 30% of high silicate powder in normal clay bricks gives the higher compressive strength of 6 N/mm² and 8.7 N/mm² respectively and also the water absorption result is better in 30% usage of high silicate powder and 6% of paper mill waste.**

I. INTRODUCTION

Burnt clay bricks are most utilizing bricks in construction world. Since the large demand has been placed building materials industry especially in the decade owing to increasing the population which cause a chronic shortage of building material. But the unlimited use of clay is harmful to society as all the brick kilns in India, depend on good quality clay available from agricultural field and weight of 3 kg per brick. So the last 40% per weight. Brick use of industrial waste products such as paper waste and high silicate powder for making fired clay bricks is ecologically and economically.In our project , we are going to use high silicate powder and paper mill waste in clay brick. Due to its silica content, amorphous glassy structure and availability, silicate powder is determined to be a feasible option for addition. The specimen with glass additions exhibited an increase in compressive and flexural strength, a decrease in the initial rate of absorption and an increase in firing shrinkage.

II. MATERIALS

A. Clay

Clay is a hydrous aluminium silicate. Minor impurities present in clay are potassium, sodium, calcium, Magnesium (or) iron oxide. The chemical formula of clay is $Al_2O_32Sio_22H_2o$.

B. High silicate powder:

The glasses are rich and high in silicate content. It is non crystalline (amorphous) nature. The particle size of high silicate powder is important and had a significant effect on the properties of fired clay bricks.

• . This waste having low thermal conductivity (good insulate PAPER WASTE:

The waste comes from the paper mill is the paper waste).

CRITICAL COMMENTS

- Paper mill waste and orange peel does not make a good bond with each other and it crumbles only when it is totally dried.
- (40% waste glass addition) in brick results decrease in apparent porosity.
- The water absorption capacity of papercrete brick was found to be more than 20%, which makes it not suitable for water logging and external walls.
- To overcome the above failures,we selected paper waste and high silicate powder to be used in fired clay brick.

C . Paper mill waste

The waste comes from the paper mill is the paper waste. This waste having low thermal conductivity (good insulator).This is collected from " NISA Paper Industries" in Thiruchirapalli.

D . Water.

Water is an important ingredient for the production of brick as it actually participates in the chemical reaction. Since it helps to form the strength. The quality and quantity of water is required to be looked carefully Normal portable water is used in this study.

E. Brick specimen.

- Brick of size 23×10×7cm is used for making fired clay brick.
- It is casted by this dimension.

III. METHODS

The methodology to be adopted and the modeling to be carried out are described in this chapter. The methodology which explains the procedure follows the entire project. The methodology is explained in the form of flow chart as follows.

A. Grinding of paper waste.

The waste paper is used for the replacement of clay because it has the binding property. By the addition of

paper waste the brick can be classified as the light weight brick. The paper waste is highly grinded by electric mixer in order to increase the workability.

B. Weighing of materials.

The materials which are used for making of bricks are weighed under weigh batching. The weighing process is more important as the strength depends on the proportion of each materials in this project. This process requires high accuracy so weigh batching is preferred.

C. Mixing.

All the materials required for the manufacturing of bricks are mixed correctly by using hand mixing or by machine mixing. Hand mixing is preferred to mix the each ingredients in this work. The materials used in this projects are listed as follows:

- clay soil
- high silicate powder
- paper mill waste
- water

D. Formation of bricks.

The paper obtained from the industries was utilized for commercial Fired clay brick manufacturing. The binding materials like clay and high silicate powder were mixed with the various proportions of paper by a measured weight by adding a small amount of water. Now the mixture is completely mixed and then later on after few minutes clay soil is mixed in the mixer. If the paper is not mixed properly the water absorption will be high, which will lead to breakage of the block. The hand mould is used for casting of bricks are shown in fig. 3.5.

E. Drying

After casting process, the bricks were dried for 4 days to attain the high strength. Drying Process was done by normal method by sunlight. The brick is casted in the required dimensioned mould to get the proper shape for each brick in order to dry it uniformly without any irregular surface and heating process.

F. Burning of bricks.

After drying process, the bricks were burned for 2 days at the temperature 900-1100°C. Burning is the important process in order to reduce the formation of voids in the bricks. Burning should be uniformly done in order to get the regular shape and color.

G. Testing of bricks.

Normally the bricks are burned for 2-3 days, so that it attains full strength. Then there are some field tests that we can conduct in the field in order to check the quality of bricks. Bricks are tested for the following tests:

- Compressive strength test
- Water absorption test
- Shape and size test
- Hardness test

IV. EXPERIMENT

Laboratory tests are the one of the method of finding physical and chemical properties of the materials. In this project we have more than two materials to find the properties of that material and find out whether the materials are suitable for use. There are separate tests for clay soil, high silicate powder.

A. Specific gravity

The Specific gravity of the fine aggregates that are used is tested by following the Indian Standards specification by following IS 2386 (Part III) –1963. The design parameters of bricks also depend on the specific gravity of materials used. As the particle size is less, pycnometer is used for clay soil. The empty weight of the pycnometeris measured and then it is filled with sand up to a mark and the weight is measured. Then water is filled with water and the weight is measured. Then weight of the pycnometeronly with water is measured and the specific gravity of the fine aggregates used is calculated. The same method is used for determining the specific gravity of the high silicate powder.

B. Sieve analysis

Sieve analysis is done as per IS 2386 (Part I)-1963. The first step involves arranging the IS sieves in the order of 4.75mm - 2.36mm -1.18mm-600µ-300µ-150µ. 2kg of fine aggregate is taken and placed on the top most sieves. Sieving is done for 15minutes and weight retained on each IS sieve is found. Using the above value fineness modulus is calculated.

C. Liquid limit.

By using casagrande apparatus we did this liquid limit test. Initially clay soil is taken and it is mixed with water. we have to take a empty weight of vessel (W_1) .Then we have to take a empty weight and wet weight of the clay soil (W_2) . By using oven we dry the wet soil at normal temperature. Finally we have to take a empty weight and dry weight of the soil (W_3) . Further calculation has done by using above values.

D. Plastic limit

By using casagrande apparatus we did this plastic limit test. Initially clay soil is taken and it is mixed with water. And it is rolled on the glass plate with 3mm diameter. Empty weight of the vessel is taken as (W_1) .Then, empty weight and wet weight of rolled clay soil is taken as (W_2) . By using oven we dry the rolled soil at normal temperature. Finally we have to take dry weight of the rolled soil (W_3) . Calculation of plastic limit is done by using above values.

E. Compressive strength test.

T he compressive strength of this bricks is greater than the conventional clay bricks. The minimum strength of clay bricks is 3.5 N/mm². The minimum strength of this bricks we obtained is 5 N/mm².After the curing periods the bricks are kept for testing. To test the specimens the bricks are placed in the Compression testing machine. The load at failure is the maximum load which the bricks can withstand. In that three

numbers of bricks were tested for each mix proportion. Each brick may give different strength. Hence, average of three bricks was taken.

C. Water absorption Test

The bricks should not absorb more than 12% of water. The bricks to be tested are weighed in the dry condition and then immersed in the portable water for 24 hours. After immersion of 24 hours those are taken out and wiped with cloths. And then weighed in wet condition. The difference between the weights is the water absorbed by the bricks. Water Absorption test as per
IS -3495 (Part - 2):1992.
Water absorption in % by weight = $[(W_2 - W_1)/W_1] \times 100$
W_1 = Dry weight of brick
W_2 = Saturated weight of brick

G. Shape and size

In this test, a brick is closely inspected .It should be of standard size and its shape should be truly rectangular with sharp edges. For this purpose the bricks are selected at random and they are stacked lengthwise along the width and along the height. A good quality brick should have bright and uniform color throughout.

H. Soundness test

In this test, the two bricks are taken and they are struck with each other. During the stroking process the brick should not break, if it breaks then it indicates that the bricks are weak. For the high strength, the bricks should not break and clear ringing sound should be produced. For predicting the ringing sound the brick is stroked by hands.

I. Hardness test

In this test, the hardness is tested by the help of nails. A scratch is made on brick surface with the help of finger nail in order to test the hardness of bricks. If no impression is left on the surface ,the brick is sufficiently hard. It also indicates that the brick is highly strong. The presence of impression during the scratching process indicates that the brick is weak and it lacks on clear ringing.

V. RESULT AND DISCUSSION

The investigations are carried out to determine the strength of clay bricks replaced with some proportion of high silicate powder and paper mill waste. And also to determine the water absorption, compressive strength.

A. Compressive strength Test

Compressive strength test is calculated for brick specimen in compressive testing machine.

Fig. 1. Value of compressive strength test

Table 1. Compressive Strength Result (High Silicate Powder)

Proportions of HSP (%)	Trial 1 (kN)	Trial 2 (kN)	Compressive Strength (N/mm^2)
1	128	130	5.6
10	143	140	6.2
20	156	154	6.8
30	200	200	8.7
40	154	150	6.7
50	125	121	5.4

Table 2. Compressive Strength Result (Paper Mill Waste)

Proportions of PW (%)	Trial 1 (kN)	Trial 2 (kN)	Compressive Strength (N/mm^2)
0	128	130	5.6
3	130	132	5.8
6	135	138	6.0
9	120	125	5.4
12	108	110	4.8
15	95	97	4.1

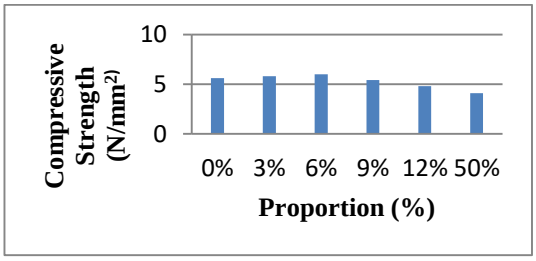

Fig. 2. Compressive Strength for Paper Mill Waste

Calculations

Area of brick = 230×100mm
Crushing load = 205 kN
Compressive strength = (crushing load)/(area)
= $(205\times10^3)/(230\times100)$
= 5.125N/mm²

B. Water Absorption Test

The bricks should not absorb more than 12% of water. The bricks to be tested are weighed in the dry condition and then immersed in the portable water for 24 hours. After immersion

of 24 hours those are taken out and wiped with cloths. And then weighed in wet condition. The difference between the weights is the water absorbed by the bricks.

Table 3 Water Absorption Result
(High Silicate Powder)

Proportions (%)	W_1(dry weight) (kg)	W_2(wet weight) (kg)	(W_2-W_1) (Kg)	Water absorption (%)
0	3.100	3.27	0.17	5.80
10	3.066	3.268	0.202	6.6
20	3.030	3.246	0.216	7.15
30	2.760	2.972	0.212	7.7
40	2.640	2.828	0.188	7.14
50	2.516	2.730	0.214	8.51

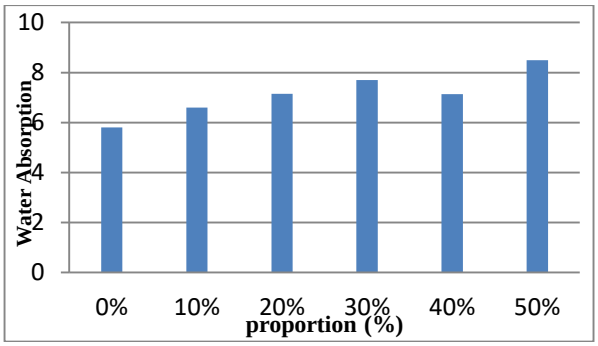

Fig. 3. Water Absorption Result
(High Silicate Powder)

Table 4. Water Absorption Result
(Paper Mill Waste)

Proportions (%)	W_1(dry weight) (kg)	W_2(wet weight) (kg)	(W_2-W_1) (Kg)	Water absorption (%)
0	3.100	3.270	0.170	5.80
10	2.408	2.571	0.163	6.80
20	1.990	2.135	0.145	7.30
30	1.854	2.004	0.150	8.10
40	1.275	1.387	0.112	8.80
50	1.396	1.525	0.129	9.30

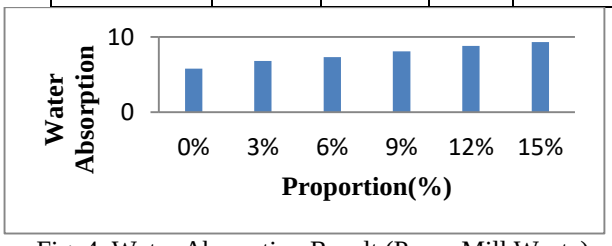

Fig. 4. Water Absorption Result (Paper Mill Waste)

Calculations
W_1 = weight oh dry brick
W_2 = weight of wet brick
Water absorption = [(W2-W1)/W1] x 100
=[(9.842-10.546)/9.842]x100 = 7.15%

VI. CONCLUSION

This experimental study came to the conclusion that the brick specimen of size 230×100×70mm were casted for different mix percentage of clay, high silicate powder, paper mill waste instead of clay. However the specimens have been tested for 6 mix proportions. The test such as compressive strength and water absorption were tested and the result was drawn. From the result it was observed that among 6 mix proportions, the maximum compressive strength for 30% of High Silicate Powder (8.7N/mm²),maximum compressive strength for 6% of Paper Mill Waste (6N/mm²)was obtained. And also the water absorption is good in that percentage.

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