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EXPERIMENTAL INVESTIGATION ON UTILIZATION OF WASTE FOUNDRY SAND AND FLYASH IN BRICKS

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Abstract: In rural and urban parts of India, burnt clay bricks are extensively used for housing purpose. Clay is obtained from agricultural land and bricks are manufactured from this clay. Overuse of clay cause loss of fertile soil and divert agricultural land for the purpose of brick manufacturing. It may be possible to produce clay bricks by replacing some percentage of conventional soil by Waste Foundry Sand and some percentage by Flyash.

Index Terms **– Waste Foundry Sand, Flyash, Burnt clay bricks.**

I. INTRODUCTION

Foundry sand is silica sand which is a by-product from the production of both non-ferrous and ferrous metal casting industries. Iron- steel industry and aluminium and copper based alloys are molded by foundry sand. Industries use huge quantities of sand as a part of the metallic casting process, that's recycled and reused normally in a foundry however while it may not be reused, it's eliminated from the foundry and it is termed as "waste foundry sand".

Flyash(FA) is a by-product of coal-fired electric power stations. "In India, generation of fly ash from coal based thermal power plants is 131 Mt/year. Flyash is the finely divided mineral residue resulting from the combustion of powdered coal in thermal power generating plants. during the combustion of coal some products are formed such as bottom ash, fly ash and vapor. Fly ash which tries to escape with the combustion gas from the boiler is collected by either mechanical or electro static precipitator. Fly Ash is a great resource material in construction industry"[2].

It Increases the compressive strength of concrete when 10-20% Fine aggregate replaced by foundry sand. The chemical as well as physical properties of foundry sand mostly depend on the type of casting procedure and also the industries from which it is originated. 4-5 tons of sand is required for 1 ton of foundry. This ratio might be changed, depends on the metal type which needs to be casted, parts size, and moulding technique. In India near about 6 to 10 million tons of foundry sand is produced annually. Basically, foundry sand is available in two types, one is chemically bonded sand and another is Green sand. Green sand also known as moulding sand , in which clay is used as the binding material. And in chemically bonded sand the sand grains together binded by using polymers. In foundries mostly Green sand is used. Green sand consists of silica (85-95%), bentonite clay (4-10%), carbonaceous additives (2-10%), and (2-5%) water. It is basically black in color, due to carbon content. While the coating of clay bricks together, high content of silica sand resists high temperatures. Chemically bonded sands are used for core making where high strengths are necessary to withstand the heat of molten metal as well as for mould making. Most chemical binder systems consist of an organic binder is activated due to catalyst, also some systems uses inorganic binders.

II. MOTIVATION

India is facing the global challenges like energy conservations, rapid automation, advanced technology, high productivity, low prices and efficiency-oriented privatization for economic survival and growth. The conventional construction materials like concrete, bricks, hollow blocks, solid blocks, pavement blocks and tiles are manufactured from the existing natural resources. In the present scenario in the construction industry, use of economic and environment friendly material is of a great concern. In india we use standard burnt clay bricks. These bricks have several drawbacks such as environmental pollution i.e. air pollution and land pollution. coal and wood are necessary for burning as a fuel which leads to air pollution. coal used for burning give rise to greenhouse gases which leads to environmental pollution. large amount of clay is required for manufacturing these bricks. This clay is obtained from agricultural land. Thus, it gives rise to pollution of land that is loss of good fertile soil. disposal becoming a big problem against environment. Foundry sand is composed of silica sand, coating of thin film of burnt carbon, residual binder (sea coal, resins) and dust.

Simultaneously, India has to face serious challenge is the use of agricultural clay for bricks manufacturing , which is important for farmers. Foundry industries are the largest source of generating solid waste like WFS. The waste sand is directly disposed into the environment, by landfill method contaminate the soil due to metals which may also contaminate the groundwater resources and surrounding superficial environment. Therefore, managing industrial waste by-products and materials by reusing them has become an attractive alternative form of disposal.

III. PROBLEM STATEMENT

An ancient building material such as burnt clay bricks are used for housing in many rural and urban parts of India. These bricks are manufactured from clay, which are obtained from agricultural land. Excess use of clay result in loss of fertility in soil also alteration of agricultural land for manufacturing bricks. It may be possible to produce clay bricks by replacing some percentage of conventional soil by WFS.

I. RESEARCH METHODOLOGY

3.1Introduction

Clay bricks are one of the most important building materials. It plays an important role in construction of any type of building. Bricks are used in residential, commercial, institutional and almost every type of building. Majorly they are used for making partitions or partition walls, compound walls, parapet walls. Brickwork is non-structural part of the building, so they are not necessarily should be of very high strength. But they must have some minimum Compressive strength to carry self-weight of the wall.

Another important parameter is Thermal conductivity of bricks. Thermal conductivity of bricks should be as minimum as possible to maintain the optimum room temperature irrespective of outside temperature. Water absorption of bricks are recommended to be nearly 20%. It facilitates the binding.

To check the performance of Bricks manufactured by using Waste Foundry Sand and Flyash we have to test Crushing strength, water absorption and Thermal conductivity of these bricks. We here are performing three tests as following :

I. Crushing Strength Test
II. Water Absorption Test
III. Thermal Conductivity Test
IV. Efflorescence Test

3.2 Raw Material Collection and Moulding

Raw materials such as Foundry sand and Fly ash were collected. We collected foundry sand from Moraya Auto-cast Alloy Industry whereas fly ash is collected from ISM Ready-mix Plant. Conventional sand was available at brick manufacturing plant. The raw materials then were mixed with the decided proportions and kept soaked for 24 hours. Now this soaked material is ready to get moulded.

Sample bricks are now moulded and kept for sun drying for a period of 10-12 days. Later on, they were sent to kiln. Prepared bricks are marked uniquely for identification purpose. The material i.e., conventional sand, foundry sand and flyash was taken by sieving and drying to standard values as described in C15.1, IS 11650:1991. The manufacturing of the burnt clay bricks is done by referring to the procedure given as per Indian Standard Code (IS 11650:1991). The formation of the clay for making the brick was prepared as per the procedures in Cl8.1, IS11650:1991.

For making bricks, following compositions were used.

Table 3.1 Compositions used for samples

Sample	Foundry sand	Flyash	Conventional sand	No. of samples
F	0%	0%	100%	10
A	20%	0%	80%	10
B	20%	5%	75%	10
C	20%	10%	70%	10
D	20%	15%	65%	10
E	20%	20%	60%	10

3.3 Crushing Strength Test

The brick samples are kept sin water for 24 hours. The frog of the brick is filled flush with 1:3 cement mortar and the specimen are stored in damp jute bag for 24 hours and then immersed in clean water for 3 days. The specimen is placed in Universal Testing Machine (UTM) with 6 mm plywood on top and bottom of it to get uniform load on the specimen. “Then load is applied axially at a uniform rate of 14 N/mm2. The crushing load is noted. Then the crushing strength is the ratio of crushing load to the area of brick loaded. Average of three specimen is taken as the crushing strength.”[12]

Formula Used: Compressive Strength = $\frac{Max.load\ at\ failure}{Area\ of\ specimen}$

IS Code used: IS 3495: Part 1

3.4Water Absorption Test

Brick Specimens are kept in oven for 24 hours to make them dry. Now their dry weight is taken down which is denoted as W1. After weighing, brick specimens are kept in water bath for next 24 hours. Then this samples are taken out of water and wiped out with cloth. Now weight of each specimen in wet condition is determined. This is wet weight of the bricks denoted as W2. The percentage water absorption is the ratio of weight of water absorbed to the dry weight of the brick multiplied by 100.

Formula used: Water Absorption (%) = $\frac{W2-W1}{W1} x\ 100$

IS Code used: IS 3495: Part 2

3.5Thermal Conductivity Test

The ability of a material to conduct heat is called as Thermal conductivity. Good bricks should have low thermal conductivity so as to keep the rooms cool during summer and warm during winters. Thermal conductivity of bricks is calculated using Parallel and counter Heat Flow Exchanger apparatus. We used composite wall apparatus for this purpose. Temperature below and above the brick is measured and then thermal conductivity is found out by using formula.

Formulae used: P = $\frac{Q}{\Delta t}$; P = $\frac{k.A.\Delta T}{L}$; k = $\frac{P.L}{A.\Delta T}$

3.6 Effloresecence Test

The presence of alkalies in brick is not desirable because they form patches of gray powder by absorbing moisture. Hence to determine the presence of alkalies, efflorescence test is conducted. The brick specimens are placed in a tray containing water up to a depth of 25 mm in a well-ventilated room. After all the water absorbed or evaporated, again new water is added up to a depth of 25 mm.The alkalies present in bricks is unpleasant because it absorbs and form patches of gray powder. IS Code used:IS 3495:Part 3.

IV. RESULTS AND DISCUSSION

4.1 Crushing Strength Test

Table 4.1: Crushing Strength Test Results

Sample	Foundry sand	Flyash	Conventional sand	Crushing Load (kN)	Crushing Strength (MPa)
F	0%	0%	100%	90.9	12.12
A	20%	0%	80%	68.03	9.07
B	20%	5%	75%	85.65	11.42
C	20%	10%	70%	66.68	8.89
D	20%	15%	65%	49.80	6.64
E	20%	20%	60%	44.18	5.89

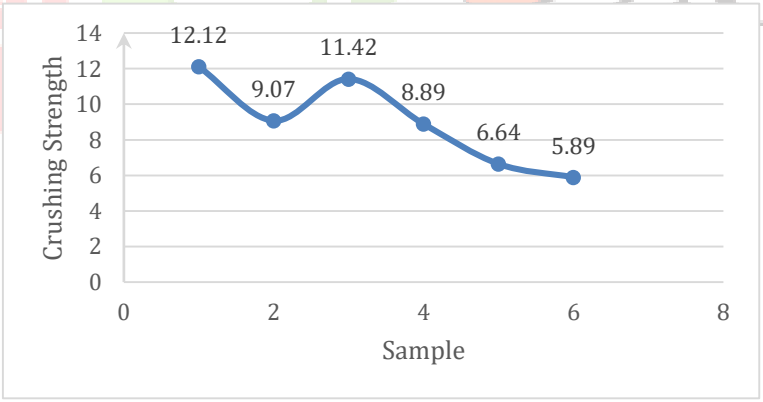

Fig. 4.1: Crushing Strength Variation

Table 4.1 displayed Crushing Strength Test Results. Maximum crushing strength is achieved when conventional sand is replaced with 20% Waste foundry sand and 5% Flyash. We got 94.22% strength to that of original sample casted purely with conventional sand. Also, we can observe that, as the percentage of flyash is increasing, crushing strength is decreasing.

4.2 Thermal Conductivity Test

Table 4.2: Thermal Conductivity Test Results

Sample	Foundry sand	Flyash	Conventional sand	Thermal Conductivity
F	0%	0%	100%	0.56
A	20%	0%	80%	0.49
B	20%	5%	75%	0.27
C	20%	10%	70%	0.41
D	20%	15%	65%	0.36
E	20%	20%	60%	0.40

Minimum thermal conductivity was observed when conventional sand is replaced with 20% foundry sand and 5% flyash.

4.3 Water Absorption Test

Table 4.3: Water Absorption Test Results

Sample	Foundry sand	Flyash	Conventional sand	% Water Absorption
F	0%	0%	100%	17.28
A	20%	0%	80%	23.59
B	20%	5%	75%	24.17
C	20%	10%	70%	25.57
D	20%	15%	65%	25.65
E	20%	20%	60%	26.51

Water absorption is found to be increased. Its effect can be reduced if the bricks are cured before using.

4.4 Efflorescence Test

From the observation, patches formed on the bricks have covered less than 5% area. Therefore, observation is reported as 'Nil'.

V. CONCLUSION

[1] Maximum crushing strength and Minimum Thermal conductivity was observed when conventional sand is replaced by 20% Foundry sand and 5% Flyash. Hence, this composition can be treated as the best possible combination of Conventional sand, Waste foundry sand & Flyash.
[2] Due to low thermal conductivity, these bricks can be effectively used in the thermal insulator chambers, heat sink chambers and cavity walls.
[3] Using fly ash and foundry sand in bricks makes them environment friendly and also reduces manufacturing cost.
[4] With minimal raw material processing and adopting local conditions, it was possible to introduce WFS and fly ash as raw materials in production of bricks.
[5] Effective use of waste materials can be done in making of bricks with the advantage of less use of natural soil resource in manufacturing process.
[6] Also it was observed that there was no any significant difference observed in the physical appearance of these bricks than conventional bricks.
[7] Increasing the percentage of fly ash reduced the weight of soil in given volume i.e. Bulk density. That can be attributed to poor packing ability of bricks causing reduction in compressive strength.
[8] The decreased thermal conductivity was observed due to the introduction of waste foundry soil as a raw material in manufacturing of bricks.

VI. ACKNOWLEDGMENT

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