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PRODUCTION OF BRICKS USING INDUSTRIAL EFFLUENT TREATMENT PLANT SEDIMENT

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ABSTRACT

Experimental studies were conducted on the bricks manufactured using industrial effluent treatment plant sediment generated from a recycling paper mill. The sediment was the residual waste paper pulp unsuitable for further manufacturing of paper. The sediment generated from the mill was used as an additive in the manufacture of bricks. Laboratory tests were conducted on the bricks as per Indian Standard guidelines. This paper describes the results of the tests conducted on the bricks and illustrates its suitability for construction.

Keywords: Industrial waste treatment effluent, Burnt bricks, Compressive strength, Water Absorption, Efflorescence, Warpage

1. INTRODUCTION

Growth of population, increasing urbanization and rising standards of living have contributed to an increase both in the quantity and variety of wastes generated by various activities which are harmful to the environment.

As per United Nations Environment Programme, it is defined as “Wastes are substances or objects, which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law.”

There are many waste types as per modern systems of waste management, notably

monitoring, treatment, handling, reuse and residual disposition of solid wastes". There are various types of solid waste including including urban waste, industrial waste, Bio-mass waste and Bio-medical waste.

Solid waste means any garbage, refuse, sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility and other discarded materials including solid, liquid, semi-solid, or contained gaseous material, resulting from industrial, commercial, mining and agricultural operations, and from community activities, but does not include solid or dissolved materials in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges.

Solid waste management is the "generation, prevention, characterization, municipal (residential, institutional, commercial), agricultural, and special (health care, household hazardous wastes,

sewage sludge). The term usually relates to materials produced by human activity, and the process is generally undertaken to reduce their effect on health, the environment or aesthetics.
Methods used for the management of solid wastes include dumping, sanitary land fill, incineration, composting, reuse and recycling. So, recycling is done by using the industrial waste as an additive in the manufacture of bricks.

2. BRICKS

A brick is a block or a single unit of a kneaded Clay-bearing soil, sand and lime, or concrete material, fire hardened or air dried, used in masonry construction. Fired bricks are the most numerous type and are laid in courses and numerous patterns known as bonds, collectively known as brickwork, and may be laid in various kinds of mortar to hold the bricks together to make a durable structure. Bricks are produced in numerous classes, types, materials and sizes which vary with region and time period and are produced in bulk quantities. Two most basic categories of brick are burnt and unburnt brick. Clay bricks are used for building-up exterior and interior walls, partitions, piers, footings and other load bearing structures.

2.1 MANUFACTURE OF INDUSTRIAL WASTE TREATMENT EFFLUENT BRICKS

The bricks are manufactured at the site by following operations:

(a)Unsoiling: In this process, the soil for making building bricks should be processed so as to be free of gravel, coarse sand(particle size not more than 2mm),lime and kankar particles, organic matter,etc. About 20cm of the top layer of the earth, normally containing stones, pebbles, gravel, roots, etc., is removed after clearing the trees and vegetation.

(b)Digging: After removing the top layer of the earth, proportions of additives such as fly ash, sandy loam, rice husk ash, stone dust, etc. should be spread over the plane ground surface on volume basis. The soil mass is then manually excavated, puddled, watered and left over for weathering and subsequent processing. The digging operation was done before rains.

(c) Weathering: Stones, gravels, pebbles, roots, etc. are removed from the dug earth and the soil is heaped on level ground in layers of 60–120 cm. The soil is left in heaps and exposed to weather for at least one month in cases where such weathering is considered necessary for the soil.

(d) Blending: The earth is then mixed with sandy-earth and calcareous-earth in suitable proportions to modify the composition of soil. Moderate amount of water is mixed so as to obtain the right consistency for moulding. The mass is then mixed uniformly with spades. Addition of water to the soil at the dumps is necessary for the easy mixing and workability, but the addition of water should be controlled in such a way that it may not create a problem in moulding and drying. Excessive moisture content may affect the size and shape of the finished brick.

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A sample of 60 kg of clay is taken and the pulp sample of required proportion is weighed and placed. The proportions of the pulp taken are 10%, 15%, 20%, 25% and 30% of the total weight of the clay in the mould i.e.,60kg. The corresponding weights of the proportion of pulp are 6kg, 9kg, 12kg, 15kg, 18kg. The mixtures corresponding to these are named type 1,2,3,4 and 5.

(e)Moulding: It is a process of giving a required shape to the brick from the prepared brick earth. The dimensions of the mould is 20 × 10 × 10 cm.

Figure1. Weighing of samples in the field

Figure2. Calculated proportions placed to mix

Figure3. Kneading

Figure4. Drying

Class of bricks	Clay (kg)	Industrial waste treatment effluent(kg)	% of effluent
1	60	6	10
2	60	9	15
3	60	12	20
4	60	15	25
5	60	18	30

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2.2 BURNING OF BRICKS IN LABORATORY

Figure5. Bricks in the furnace after heating

Hence, the clay and industrial waste treatment effluent are hand mixed according to the proportions. A total of 13 bricks of type1 were made. The number of bricks increased with increase in proportion of pulp and a total of 75 bricks were made. They were dried for 20days and then transported to the laboratory for testing.

A total of 30 un-burnt bricks (6 from each type) were burnt in furnace at 100˚C for 2 days and at 300˚C for one day. There is a slight change in colour of the bricks. The 2 burnt bricks from each type (a total of 10 bricks) were kept in water for curing for 3days. After 3 days, the bricks were swollen and most of the bricks were broken into pieces due to more water absorption exceeding 20%. Hence they failed and were not suitable for water absorption and compressive strength tests.

So, a total of 30 bricks were again burnt in furnace at 800˚C for one day and the colour of the bricks was turned to dark red in colour. When two bricks were rubbed against each other, they gave a metallic sound. Hence, the bricks passed the soundness test. A total of 5 bricks of each type were dropped form a height of 2.5metres to the ground but they were not broken. Thus, they passed Height test.

When the bricks were burnt to 100˚C for 3 days and kept in curing for 3 days after heating, they were swollen after curing period due to insufficient heating of bricks. They had no change in colour. The bricks could not meet the requirement of colour at 100˚C.

They were heated at 800˚C for 2days.The bricks did develop sufficient rigidity and their colour turned to bright red.

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3. LABORATORY TESTS ON BRICKS

3.1 DETERMINATION OF COMPRESSIVE STRENGTH

The determination of Compressive Strength of the brick according to IS 3495 (Part 1):1992.

The report is given as

(a) The un-burnt bricks failed to show any resistance to compression. The un-burnt bricks of type 3,4,5 did not fail and bulged along their length and width on further increase in load. Hence, they are not suitable for construction.

(b) The bricks were cooled by exposing them to the air after switching off furnace. The bricks were tested for compression after removing from the furnace but the burnt clay bricks made of industrial waste treatment effluent of all proportions, failed under compression.

Figure 6. Compression test on burnt brick

3.2 DETERMINATION OF WATER ABSORPTION

Water Absorption of burnt bricks is determined by conducting the test as per IS 3495 (Part 2): 1992.

$$\text{WaterAbsorption}(\%)=(W2-W1)/W_1 \times 100$$

The report is given as

The burnt bricks of type 3,4,5 absorbed more than 20% of water by weight and were swollen.

3.3 DETERMINATION OF EFFLORESCENCE

The Efflorescence of burnt bricks is determined by conducted as per to code IS 3495 (Part 3):1992 as mentioned below.

The dimensions are measured to the nearest 1mm.

The report is given as

The burnt bricks have slight efflorescence as white spots were observed on faces of the bricks at some places not more than 10% of the exposed surface area

Figure7. Bricks in efflorescence test

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3.4 DETERMINATION OF WARPAGE

The Determination of warpage of burnt clay building bricks is conducted as per IS 3495(Part 4):1992 as below.

The dimensions are measured to the nearest 1mm.

The report is given as

(a) The convex and concave warpage of un-burnt bricks are more. So, they cannot form good bonding with the other bricks in the constructions.

(b) The burnt bricks have very less concave and convex warpage and can form good bonding with the other bricks in constructions.

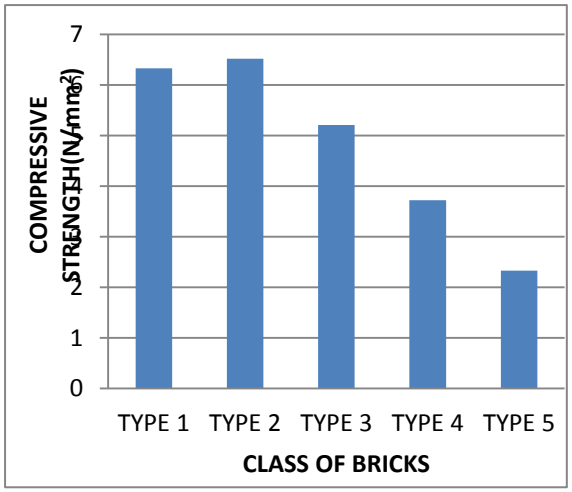

Figure8. COMPRESSIVE LOAD VS AREA OF BURNT BRICKS

From the graph, it is observed that the compressive strength of the bricks increased with increase in proportion of the industrial waste treatment effluent upto 15% and further decreased from 15% to 30%.

Due to non-uniform mixing of the clay and pulp during manufacturing of bricks, the inner part of the brick i.e., pulp could not burn completely in the furnace. The bricks were cooled by exposing them to the air after switching off furnace. The bricks were tested for compression immediately after removing from the furnace but the burnt clay bricks made of pulp of all proportions, failed under compression.

4. CONCLUSION

The burnt clay bricks mixed with pulp as explained in chapter 3 cannot meet the requirements of good Indian standard brick.

1.According to Indian standards, the minimum compressive strength of a good burnt clay brick is 7 N/mm^2 but the compressive strengths of clay bricks mixed with pulp of all proportions are less than 7N/mm^2. Hence, the bricks failed in compression.

2.The water absorption of a good burnt clay brick should not exceed 20% by weight but the pulp bricks of type 1 and 2 passed the water absorption test.

3.The efflorescence of the bricks of all proportions are slight.

4.The un-burnt bricks made of pulp of all proportions failed in compression and the type 3,4,5 bulged on increasing the load.

5.The un-burnt bricks are not kept for water absorption and efflorescence as the clay melts in water.

6. The convex and concave warpages of un-burnt bricks are mare as compared to that of burnt bricks.

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