Utilization of Redmud and Pond Ash as Alternative Raw Materials to Produce Eco-Friendly Bricks

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Abstract— Red mud is the waste product generated by bayer process in the aluminium industry. Enoromous quantity of redmud is generated worldwide every year facing a serious environmental problems of storage occupying a lot of space. Pondash is produced in large quantities during the combustion of coal for energy production and recoganised as an environmental pollution. The study focused on evaluation of mechanical properties of bricks by replacement of normal soil with varying % of red mud and pondash. The test results are compared with normal bricks, optimum compressive strength values was achieved for 5% redmud replacement to normal soil, normal soil + 5%redmud +15%pondash, normal soil+10%redmud+5%pondash and also water absorption and efflorescence test results were also found satisfactory.

Keywords: Pond Ash, Red Mud, Compressive Strength

I. INTRODUCTION

The construction industries preferably use locally available and sustainable materials for structural building applications. The building materials should be chosen and used without any adverse effect on environment. The utilization of industrial waste in manufacturing of bricks is dependent on the technical suitability, economic viability and acceptability in the market and society. In this study bauxite residue commonly known as red mud, industrial waste pond ash is also used as major component for making bricks with normal clay.

In the production of alumina by Bayer process redmud is separated from sodium aluminate liquor before precipitation of alumina hydrate for each tonne of alumina thus produced an average 1.10-1.50 tonne of red mud is generated. The red mud generation in India is approximated as 4.5MT/annum and that is expected to reach 13.7 MT/annum unfortunately recycling options identified so far are not satisfactory in terms of bulk utilization and product generation. High volume and affordable cost of utilization of red mud with minimum or no waste generation may be the right choice in order to achieve economic viability of processing options. Red mud has to be used in manufacturing of bricks without generating further waste.

Pond ash is the residue obtained after combustion of the coal in thermal power plant. Pond ash utilization in building material have many advantages like cost effectiveness, increase in strength and also conservation of natural resources and material. The pond ash is the part of residue collected at the bottom of the furnace. Land disposal of pond ash would requiring about 100 sq km. To overcome this problem and encourage the utilization of pond ash it is used as admixture in construction. In this present study pond ash is effectively utilized in manufacturing of bricks. Pond ash increases the aesthetic quality and superior structure of brick it is depending upon the quality of coal or ash. Pond ash in building industry as it possess suitable pozzolanic properties. They are produced in large quantity during combustion of coal for energy production

II. OBJECTIVES

1) To make proper utilization of industrial waste from thermal power stations and Aluminum refineries.
2) To check compatibility of combination of red mud and pond ash in the production of masonry bricks.
3) To find optimum % of combination of ingredients to obtain quality masonry bricks on the basis of their mechanical properties such as compressive strength, water absorption and efflorescence

III. METHODOLOGY

Manufacturing of bricks consisting of following steps by using varying proportions of Red mud and pond ash

1) Preparation of bricks clay
2) Moulding of bricks
3) Air drying of bricks
4) Burning of bricks

A. *Preparation of Bricks Clay:*

The raw materials are initially sieved using 2.36mm IS sieve and then laid on leveled ground .after soil is cleaned of impurities such as vegetation matter, stones or pebbles etc. after removing impurities it is mixed with water to make the slurry of raw materials by adding the materials in different proportion.

Fig. 1: Preparation of Clay

B. *Moulding of Bricks:*

Giving the required shape to the prepared slurry is known as moulding of bricks. Initially the area of land on which is molding is to be done is leveled, plastered smooth and sprinkled over with sand.

Fig. 2: Moulding of bricks

C. Air Drying of Bricks:

After the completion of the molding process, the bricks contain some amount of moisture in it. So, drying is to be done otherwise they may get cracked while burning. The period of drying may be 3 to 10 days

Fig. 3: Air drying of bricks

D. Burning of Bricks:

Bricks are burned at high temperature to gain the strength, durability, density and red color appearance. All the water is removed at the temperature of 650^{0}C but they are burnt at a temperature of 1100^{0}C because the fusing of sand and lime takes place at the temperature and chemical bonding is takes place between these materials after the temperature is cooled down resulting in the hard and denser mass.

IV. TESTS ON MANUFACTURED BRICKS

According to IS 3495:1992 tests conducted on burnt clay bricks are

1) Compressive Strength Test(Part-1)
2) Water Absorption Test (Part-2)
3) Efflorescence Test(Part-3)

A. Compressive Strength Test

SL NO	MIX PROPORTION	LOAD IN KN	AREA IN MM^2	COMPRESSIVE STRENGTH N/mm^2	AVERAGE COMPRESSIVE STRENGTH N/mm^2
1	Normal soil	80	20000	4.0	3.8
		72		3.6	
2	Normal soil +5 % red mud	111	20000	5.55	5.5
		109		5.45	
3	Normal soil +10 % red mud	94	20000	4.7	4.82
		91		4.55	
4	Normal soil +15 % red mud	98	20000	4.9	4.62
		96		4.8	
5	Normal soil +20 % red mud	96	20000	4.8	4.05
		66		3.3	
6	Normal soil +5 % red mud +5% pond ash	75	20000	3`75	3.05
		47		2.35	
7	Normal soil +5 % red mud + 10% pond ash	94	20000	4.7	4.65
		92		4.6	
8	Normal soil +5 % red mud + 15% pond ash	104	20000	5.2	5.3
		107		5.35	
9	Normal soil +5 % red mud + 20 % pond ash	104	20000	5.2	4.1
		99		4.95	
		110		5.5	5.3

10	Normal soil +10 % red mud + 5 % pond ash	101	20000	5.05	
11	Normal soil +10 % red mud + 10 % pond ash	96	20000	4.8	4.1
		68		3.4	
12	Normal soil +10 % red mud +15 % pond ash	73	20000	3.7	3.6
		64		3.2	
13	Normal soil +10 % red mud +20 % pond ash	70	20000	3.5	3.5
		69		3.45	
14	Normal soil +15 % red mud +5 % pond ash	101	20000	5.05	4.97
		98		4.9	
15	Normal soil +15 % red mud +10 % pond ash	93	20000	4.65	4.02
		68		3.4	
16	Normal soil +15 % red mud +15 % pond ash	73	20000	3.65	3.97
		86		4.3	
17	Normal soil +15 % red mud +20 % pond ash	72	20000	3.6	3.90
		84		4.2	
18	Normal soil +20 % red mud +5 % pond ash	92	20000	4.6	4.35
		82		4.1	
19	Normal soil +20 % red mud +10 % pond ash	80	20000	4.0	4.05
		82		4.1	
20	Normal soil +20 % red mud +15 % pond ash	72	20000	3.6	3.9
		84		4.2	
21	Normal soil +20 % red mud +20 % pond ash	58	20000	2.9	2.67
		49		2.45	

Table 1: Compressive Strength Results for Varying Percentage of Raw materials

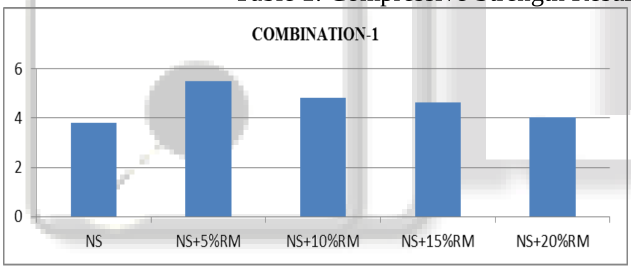

Plate No. 1: Combination of Normal soil and varying % of Redmud bricks

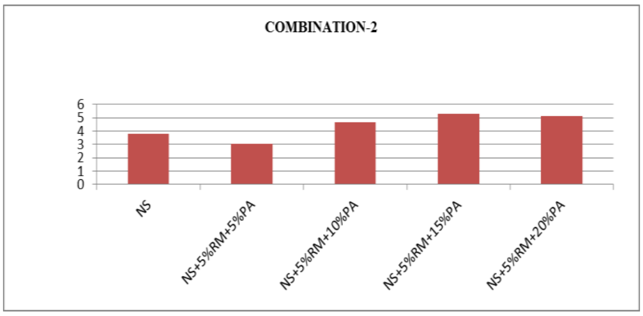

Plate No. 2: Combination of Normal soil and 5 % of Redmud with varying % of pond ash bricks

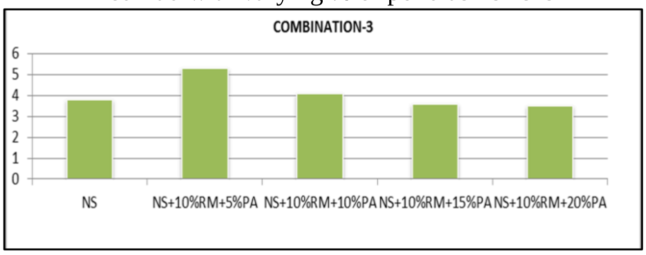

Plate No. 3: Combination of Normal soil and 10 % of Redmud with varying % of pond ash bricks

1) Discussion

- Compressive strength is the main criteria to know the mechanical properties of bricks.
- The compressive strength test is conducted for the bricks prepared with various percentages of redmud and pond ash added to normal soil.
- Plate No.2: When normal soil is replaced with 5% redmud by varying % of pond ash from 5 to 20% we observed the optimum compressive strength was 15% replacement of pond ash.
- Plate No.3: When normal soil is replaced with 10% redmud with varying % of pond ash from 5 to 20%, we observed that optimum compressive strength was obtained for 5% replacement of pond ash

2) Water Absorption Test

- The water absorption test result for normal soil+5%redmud was 15.78%
- The water absorption test result for normal soil+5%redmud+15%pondash was 20%
- The water absorption test result for normal soil+10%redmud+5%pondash was 17.32%

3) Efflorescence Test

The liability to efflorescence shall be reported as 'nil', 'slight', 'moderate', 'heavy' or 'serious' Efflorescence test showed that bricks are within the limits and falls under the category "Slight".

V. CONCLUSION

This study was conducted to evaluate the effect of using red mud and pondash as the ingredients of brick composites.

Following conclusions can be drawn from the experimental work,

- When normal soil is replaced with varying % of redmud from 0 to 20%, it was observed that the optimum compressive strength was obtained for 5% replacement of redmud.
- When normal soil is replaced with 5% red mud by varying % of pondash the optimum compressive strength was achieved for 15% replacement.
- When normal soil is replaced with 10% red mud with varying % of pondash the optimum compressive strength was obtained for 5% replacement of pondash.
- It is found from the experimental results that compressive strength was 5.5 N/mm2, so it can be concluded that bricks falls under Class II.
- Water absorption for various combination of manufactured bricks are within 20%
- Efflorescence test showed that bricks are in within the limit and falls under the category “slight”.
- From obtained results it can be concluded that industrial waste materials can be properly utilized for the production of Eco-friendly bricks.

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IS Codes

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[9] IS 2720 PART 7 – 1980 Methods of test for soil, “Determination of water content – dry density relation using heavy compactiont” BIS New Delhi, India
[10] IS 3495:1992 PART-1 Compressive strength test on burnt clay bricks
[11] IS 3495:1992 PART-2 Water absorption test on burnt clay bricks

