Experimental Study on Utilization of Industrial Waste Red Mud

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Abstract— Red mud is an industrial waste material generated during production of alumina from bauxite by Bayer process. These industrial wastes hold some heavy aim of the paper is to investigate the possibility off partially replacing Portland cement in concrete by Red mud and evaluating its compressive and splitting tensile strength. In this test we are going to find out the values of compressive strength and flexural strength. When there is a replacement of cement with Red mud which varies from 0% to 25% with the increment of 5% respectively for M35 grade of concrete. The optimum gained after 7 and 28 days curing periods gives good compressive and flexural strength with the replacement of Red mud.

Key words: Red Mud, Compressive Strength, Flexural Strength

I. INTRODUCTION

Aluminium is a light weight, high strength and recyclable structural metal. It plays an important role in social progress and has a pivotal contribution in transportation, food and beverage packaging, infrastructure, building and construction, electronics and electrification, aerospace and defense. It is the third abundant element in the earth‘s crust and is not found in the free state but in combined form with other compounds. The commercially mined aluminium ore is bauxite, as it has the highest content of alumina with minerals like silica, iron oxide, and other impurities in minor or trace amount. The primary aluminium production process consists of three stages: Mining of bauxite, followed by refining of bauxite to alumina by the Bayer process (invented by Karl Bayer in 1887) and finally smelting of alumina to aluminium (Hall –Heroult process). Production of alumina is basically a chemical enrichment process. It is a process of separating alumina from undesired components like oxides of iron, titanium, silicium, calcium, vanadium, manganese etc. in bauxite. The Bayer process of extraction of alumina from bauxite remains the most economical process till date. In the Bayer process, the insoluble product generated after bauxite digestion with sodium hydroxide at elevated temperature and pressure to produce alumina is known as red mud‘ or _bauxite residue‘. The waste product derives its colour and name from its iron oxide content. Red mud is a mixture of compounds originally present in the parent mineral, bauxite and of compounds formed during the Bayer process. As the bauxite has been subjected to sodium hydroxide treatment, the red mud is highly caustic with a pH in the range of 10.5-12.5. Bauxite ore mined globally amounts to be around 205 million tones per year for 2008 and 201 million tones per year for 2009, posing a very serious and alarming environmental problem. Considerable research and development work for the storage, disposal and utilization of red mud is being carried out all over the world.

II. OBJECTIVES

1) To find the optimum replacement of cement by different percentage of red mud
2) To find the compression strength and flexural strength of different percentage of red mud used concrete with the conventional concrete.
3) To compare the compression strength, and flexural strength of different percentage of red mud concrete with the conventional concrete.
4) To find and compare the slump value of different percentage of red mud with conventional concrete.
5) To use of industrial wastes in place of conventional raw materials will help to decrease the environmental pollution and also conserve our natural resources.

III. SCOPE

1) It can be used construction building material in bricks, blocks, light weight aggregate, in cement Industry as cement and special cement and in concrete industry.
2) It can also be used as an additive to cement, mortars and concrete construction of dykes and as ceramics refractory product.

IV. MATERIALS & METHODS

A. Material used:

1) Cement:

In this experiment, 43 Grade Ordinary Portlandcement (OPC) with brand name Ultratech Cement was used for all concrete mixes. The cement used was fresh and free from lumps and impurities. The testing of cement was done as per IS 8112:1989. The specific gravity of cement was found to be 3.13.

Sr. No	Particulars	Experimental Results	Standard Results
1.	Fineness	7.60	100
2.	By Le Chatlier mould	3.13	3.15
3.	Initial Setting time	80min	30min
4	Final Setting time	210min	600min

Table 1: Physical of OPC 43 Grades

2) Fine Aggregate:

The sand used for the experimentation was locally procured and was confined to zone-II. The specific gravity of fine aggregate was found to be 2.45. The fine aggregate used for all the specimens was complying with IS 383-1970.

3) Coarse Aggregate:

The coarse aggregate used in this experimentation were 20mm and 10mm size and was confirming to IS 383-1970. The specific gravity was found to be 2.70.

4) Red Mud:

Red mud is an a Industrial waste product which is Red in color. It's character is depends on the nature of Bauxite ore used in the extraction of Aluminum which slightly differ from place to place, out of which4.5 tones of Bauxite 1.0 tons of Aluminum is extracted and 2/3 will be the waste produce.

5) Water:

Clean and potable water must be used. Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully. In present work tap water is used for both mixing and curing.

B. Mix Design:

Red mud 0%, 5%, 10%, 15%, 20% and 25% is replaced by weight of cement.

Material	Volume (Kg/m^3)
Cement	438
F.A	719.03
C.A	1008.5
Water	197
Proportion Ratio	1:1.62:2.29

Table 2: Mix Design of M35

C. Experimental Process:

1) Compressive Strength Test:

For the compressive strength test, the specimen of size 150 X 150 X 150 mm were casted for 7 and 28days and tested on compressive testing machine of capacity 2000KN as per IS 516:1959.

2) Flexural Strength Test:

For the flexural strength, the beam specimen of size 150 X 150 X 170 mm were casted for 7 and 28 days. Two point loading was adopted on an effective span of 400mm while testing the beam specimen as per IS 516:1959

V. RESULTS

Sl. No	% Of red mud added	Compressive strength					
		7 Days			28 Days		
		A_1 N/ mm^2	A_2 N/ mm^2	Avg N/ mm^2	A_1 N/ mm^2	A_2 N/ mm^2	Avg N/ mm^2
1	0	28.93	29.11	29.02	36.97	36.84	36.90
2	5	26.71	26.44	26.57	27.37	27.15	27.26
3	10	21.77	21.37	21.57	24.04	26.44	25.24
4	15	20.08	17.51	18.795	27.02	25.91	26.46
5	20	18.17	16.4	17.29	23.11	24.266	23.68
6	25	18.4	22.04	19.215	18.00	18.88	18.59

Table 3: Compressive Strength at 7 and 28 Days

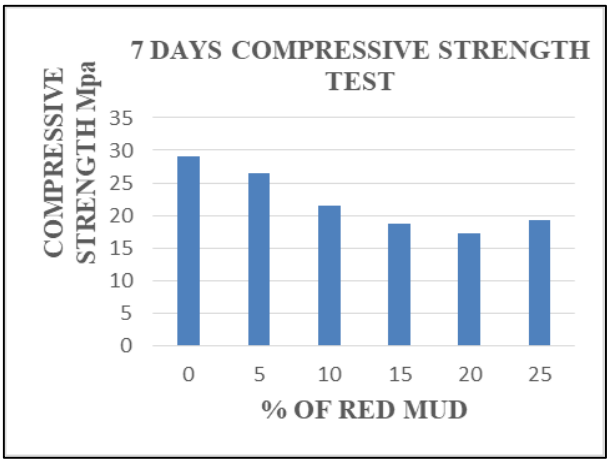

Fig. 1: Variation of Compression Test Strength with Different Percentages of Red Mud.

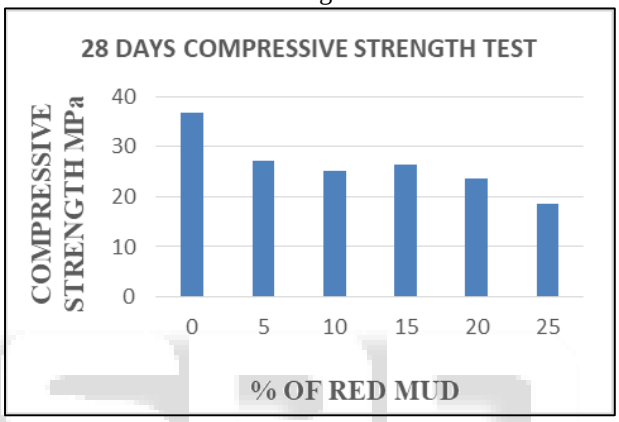

Fig. 2: Variation of Compression Strength with Different Percentages of Red Mud.

SL. NO	% Of red mud added	Flexural strength					
		7 Days			28 Days		
		A_1 N/ mm^2	A_2 N/ mm^2	Avg N/ mm^2	A_1 N/ mm^2	A_2 N/ mm^2	Avg N/ mm2
1	0	3.37	3.20	3.28	4.08	3.91	3.99
2	5	2.66	3.02	2.84	3.37	3.55	3.46
3	10	2.80	3.02	2.91	3.37	3.20	3.28
4	15	2.84	2.84	2.84	2.84	3.02	2.93
5	20	2.66	3.02	2.84	2.66	2.84	2.75
6	25	2.66	2.84	2.75	2.48	2.66	2.57

Table 4: Flexural Strength at 7 and 28 Days

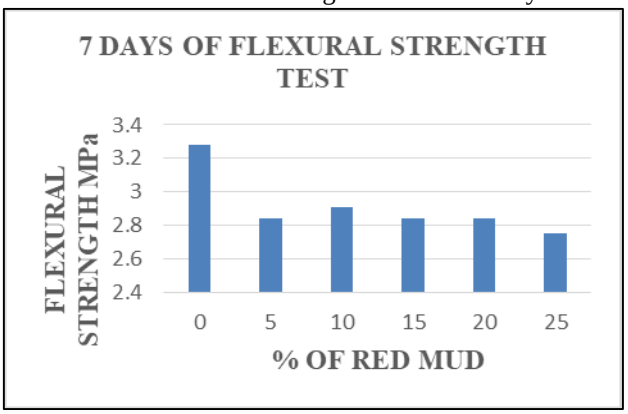

Fig. 3: Variation of Flexural Strength with Different Percentages of Red Mud.

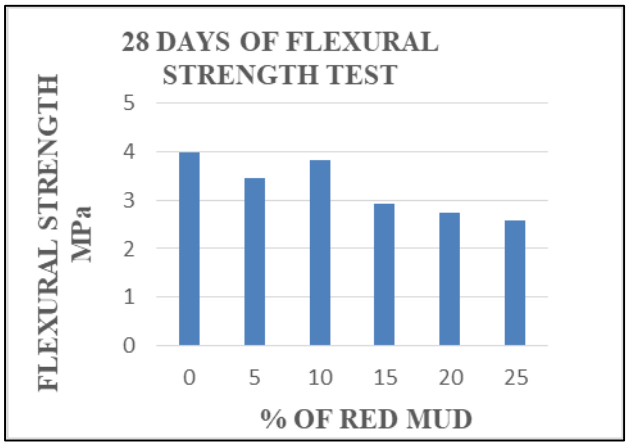

Fig. 4: Variation of Flexural Strength with Different Percentages of Red Mud.

VI. CONCLUSIONS

- The maximum compressive strength is obtained when the cement is replaced by 5% of red mud the maximum compressive strength being 27.26 N/mm^2.
- The maximum flexural strength is obtained when the cement is replaced by 5% of red mud the maximum flexural strength being 3.46N/mm^2.
- The compressive strength and flexural strength of concrete reduces. When the cement is replaced by red mud more than 5%.
- It was observed that workability of concrete get affected with addition of red mud content but it can improved by adding corrective chemical agents.
- Also we can used red mud for non structural application that is for the preparation of bricks paving blocks.
- In the present study the effort has been taken to suggest the possible percentage of replacement of red mud with cement in concrete which will help to reduce the cement consumption and also reduce the disposal problem of red mud which is a waste product from Bayer's process in aluminum industries.
- Availability of raw material required for manufacturing of cement and production of concrete are limited in nature but required for the cement for construction is high by using this type of method effectively we can in a construction field.

REFERENCES

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