

Suitability of Red Mud as an Admixture in Concrete

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Abstract-Red mud is a waste material generated by the Bayer Process widely used to produce alumina from bauxite throughout the world. The aim of the present project work was to investigate the possibility of the use of red mud. Because of storing issues, the waste negatively affects the environment. To solve this problem, Portland cement was replaced by 10%, 15% and 20 % RM by wt of cement by balancing its chemical composition. To balance the chemical composition of red mud hydrated lime and silica fume were added after optimization and Evaluating its compressive strength, splitting tensile strength and flexural strength of red mud concrete. It was concluded that optimum percentage of the replacement of cement by weight was found to be 10%.

Keywords- Red mud, Compressive strength, splitting tensile strength, flexural strength.

I. INTRODUCTION

The commercially mined aluminum 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 aluminum production process consists of three stages: Mining of bauxite, followed by refining of bauxite to alumina by the Bayer process and finally melting of alumina to aluminum. 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 color and name from its iron oxide content. 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 posing a very serious and alarming environmental problem. If we see the output of red mud then, About 1 tons of alumina is produced from 3 tons of bauxite and about 1 tone Aluminium is produced from 2 tons of alumina. Depending on the raw material processed, 1-2.5 tons of red mud is generated per ton of alumina produced.

I. PROPERTIES OF RED MUD

A. Physical properties of red mud

The following are the physical properties of red mud powder.

1. Generally Fineness of red mud is varies in between 1000-3000 cm²/gm. We collected red mud from Hindalco Industries Limited, Belgaum, Karnataka (INDIA).In our study we have taken red mud passing through 300 micron I.S. Sieve.
2. Its PH is varies in between 10.5 to 12.5 hence alkaline in nature.
3. Specific gravity of red mud is found to be 2.51.

B. Chemical properties of red mud

Chemical properties of red mud are shown in Table -1 it indicates that percentage of Cao is very less hence it has no cementitious properties but when it react with water and cements it starts gaining cementitious properties. And also to improve this property we adding the optimized percentage of lime (5%).

Table 1 Chemical composition of red mud.

Ingredients	Red Mud In%
Fe ₂ O ₃	38.3
Al ₂ O ₃	21.6
SiO ₂	11.4
CaO	1.47
Na ₂ O	6.87

II. EFFECTS OF RED MUD ON ENIRONMENT

1. Ground water pollution.
2. Alkali seepage in to underground water-Underground water resources such as wells, aquifer may get polluted.
3. Impact on plant life-Alkaline air born dust fly with air and affects on transpiration process of plant Result in reduction of plant life.
4. Land disposal changes the property of soil and result in lesser fertility.
5. Vast areas of land consumed for their storage purpose.

III. EXPERIMENTAL WORKS

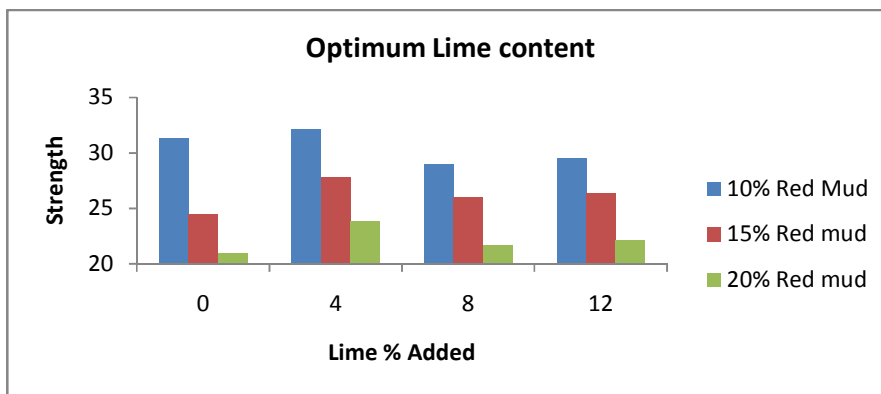
For the experimental purpose M₃₀ grade concrete was prepared as per Indian Standard Method (IS: 10262-1982). Opc cement of 53 grades, natural sand, 10mm&20mm coarse aggregate, lime and red mud was used for experiments. The used proportion is (0.553:1:2.325:2.87).As per the mix design, control mix was prepared. Cubes, cylinders and beam were casted. After 28 days the compressive, split tensile and flexural strength was found out. Compressive and splitting tensile strength of Control mix was found to be 39.25 and 4.1 respectively. Project includes replacement of cement by (10%, 15%, and 20%) With the optimized percentage of 5% lime. Figure 1 shows red mud powder. These composite concrete specimens were tested after 28 days water curing. The compressive, split tensile and flexural strength of resultant concrete was found out and compared with controlled concrete results.

A. Optimization of hydrated lime.

For the optimization of lime we were casted 7.05 cm x 7.05 cm x 7.05cm cube. And testing was done after 7 days curing. The result gives that the strength increases slightly for 4% Lime addition and there after strength decreases with increase in lime content. Hence after plotting graphs corresponding to all red mud percentage and lime percentage we chose the 5 % lime for the experimentation. Following table 2 shows the result of optimization.

Table2 optimization of hydrated lime content.

Lime percentage	7 days compressive strength in N/mm ²		
	10% red mud replacement.	15% red mud replacement	20% red mud replacement
0	31.27	24.44	20.98
4	32.10	27.79	23.85
8	28.97	26.00	21.66
12	29.55	26.37	22.08



B. DETERMINATION OF STRUCTURAL PROPERTIES OF RED MUD CONCRETE

1. Compressive strength

For the determination of compressive strength we casted the 15 cm x 15cm x15cm cube with different percentage of red mud(10%, 15%,20%) with addition of 5% optimized percentage of lime.5% lime was adding by the weight of red mud And it was tested after 28 days curing. Table 3 shows the results of compressive strength and it was obtained near same to control mix result.

2. Splitting tensile strength:

For the determination of splitting tensile strength we casted the cylinder having 15 cm in diameter And 30 cm in length. With different percentage of red mud (10%, 15%, and 20%) with addition of 5% optimized percentage of lime. And (According to IS 516:1959) it was tested after 28 days curing. Table 4 shows the results of splitting tensile strength

3. Flexural strength.

(According to IS 516:1959)

For the determination of flexural strength we casted the 15 cm x 15cm x 70 cm beam with different percentage of red mud with addition of 5% optimized percentage of lime. And it was tested after 28 days curing. Table 5 shows the results of flexural strength and its deflection in mm. for the determination of flexural strength we measured the crack from nearest support and selecting corresponding equation from is 516:1959. And which is $F_b = \frac{P_l}{b d^2}$.

Table 3 Compressive strength results

Red mud in varying percentage by the weight of cement. And 5% hydrated lime.	28 days compressive Strength (N/mm ²) (Avg. of three specimen)
0	39.00
10	37.50
15	35.50
20	22.60

Table4 splitting tensile strength results

Red mud in varying percentage by the weight of cement. And 5% hydrated lime.	28 days Splitting Tensile Strength (N/mm ²) (Avg. of three specimen)
0	3.70
10	3.30
15	3.10
20	2.84

Table5 flexural strength result.

Red mud in varying percentage by the weight of cement. And 5% hydrated lime.	28 days flexural Strength (N/mm ²) (Avg. of three specimen)	Deflection. (mm)
0	7.12	1.30
10	4.61	1.97
15	3.91	2.56
20	3.26	2.92



Fig.1 Red mud powder



Fig.2 set up of splitting tensile strength



Fig.3 set up of flexural strength

IV. CONCLUSION

1. From the experimental work it was found that if we use red mud without any balancing its chemical properties then there is decrease in all structural properties of concrete.

2. After addition of optimized 5% hydrated lime we got the improved compressive, splitting tensile and flexural strength.
3. Optimum percentage of the replacement of cement by weight was found to be 10 %.By this replacement results got are nearly equal to the results of controlled concrete.
4. Concrete prepared by using red mud is suitable in ornamental works because of improved tensile & flexural strength of red mud concrete. And also it gives aesthetically pleasant appearance.
5. It was observed that the workability of concrete get affected with addition of red mud content but it can improved by adding corrective chemical agents.
6. Also we can use red mud for non structural application i.e. for the preparation of brick, paving block.

V. ACKNOWLEDGEMENTS

Very thanks to Hindalco Industries Limited Belgaum works & Dr. Sureshan k. Moothedath (ass. Vice-president of Hindalco Industries Limited Belgaum works). I would like to thanks Prof. S. S. Deshmuk Head of civil department trinity academy of engineering and Prof. S. V. Wagh Head of civil department KJ College of engineering for their help and supports.

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