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Evaluation of the properties of Red Mud 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 research work was to investigate the possibility of replacing the Portland cement by red mud. Because of storing issues, the waste negatively affects the environment. To solve this problem, Portland cement was replaced up to 40 % RM by wt of cement. And evaluating its compressive and splitting tensile strength of red mud concrete. This study examines the effects of red mud on the properties of hardened concrete. The test results show that how its compressive strength & splitting tensile strength decreases with increase red mud content, it is concluded that Optimum percentage of the replacement of cement by weight is found to be 25%.By this percentage replacement we can have strength is equal to the strength of controlled concrete.*

Key words: Bayer process, C*ompressive strength, Red mud, transpiration, splitting tensile strength.*

I. INTRODUCTION

Aluminum 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 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 smelting 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.

1. OUTPUT OF BAUXITE RESIDUES

About 1 ton of alumina is produced from 3 tons of bauxite and about 1 ton Aluminum 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.

II. PROPERTIES OF RED MUD

2.1 PHYSICAL PROPERTIES OF RED MUD:

The following tests were conducted to evaluate physical properties.

2.1.1 Generally Fineness of red mud is varies in between 1000-3000 cm^2/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.

2.1.2 Its PH is varies in between 10.5 to 12.5 hence alkaline in nature.

2.1.3 Specific gravity of red mud is found to be 2.51.

2.2 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 cementitius properties but when it react with water and cements it starts gaining cementitious properties. Also Percentage of silica available, contributes to strength.

III. EFFECTS OF RED MUD ON ENIRONMENT

3.1 Ground water pollution-when the red mud gets mix with water.

3.2 Alkali seepage in to underground water-Underground water resources such as wells, aquifer may get polluted.

3.3 Impact on plant life-Alkaline air born dust fly with air and affects on transpiration process of plant Result in reduction of plant life.

3.4 Land disposal changes the property of soil and result in lesser fertility.
3.5 Vast areas of land consumed.

IV. EXPERIMENTAL WORKS

4.1 Concrete mix design was carried out by using Indian Standard Method (IS: 10262-1982). Mix design of grade M_{30} is used.

Materal Used:

Cement: OPC 53 Grade (Sp. Gravity=3.15)
Red mud: (Sp. Gravity=2.51)
Coarse Aggregates:
10MM (Sp. Gravity=2.87)
20MM (Sp. Gravity=2.88)
Fine Aggregates (Natural sand) (Sp. Gravity=2.76)

As per the mix design control mix was prepared. Cubes and cylinders were casted. After 28 days the compressive and split tensile strength was found out.
Compressive and splitting tensile strength of Control mix was found to be 38.25 and 3.70 respectively.
Study includes replacement of cement by red mud hence we have replaced cement in varying percentages 5%,10%,15%,20%,25%,30%,40%.Figure 1 and Figure 2 shows red mud powder and red mud cement concrete cubes. These composite concrete specimens were tested after 28 days water curing. The compressive and split tensile strength of resultant concrete was found out and compared with controlled concrete results.

V. DETERMINATION OF MECHANICAL PROPERTIES OF CONCRETE

5.1. Compressive strength:

Concrete cubes of 15cmx 15cm were casted by replacing cement using red mud in varying percentages 5%, 10%, 15%, 20%, 25%, 30%, 40% by its weight cubes were water cured for 28 days and taken for testing under compression testing machine. The results are tabulated in Table 2 and represented graphically by Fig.3

5.2 Splitting tensile strength:

Concrete Cylinders of diam. 100mm and 200mm in length were casted by replacing cement using red mud in varying percentages 5%, 10%, 15%, 20%, 25%, 30%, 40%.these cylinders were water cured for 28days and tested . Test set up is as shown in Fig.4 it also shows failure of cylinder after loading. The results are tabulated in Table 3 and represented graphically by Fig.5

VI. CONCLUSION

1. From experimental work it was found that increase in red mud content decreases the compressive as well as tensile strength of concrete.
2. Optimum percentage of the replacement of cement by weight is found to be 25%.By this replacement results got are nearly equal to the results of controlled concrete.
3. Concrete prepared by using red mud is suitable in ornamental works and gives aesthetically pleasant appearance.
4. Workability of concrete may get affected with increase of red mud but it can be improved by adding superplastcizers.
5. We use mixture of red mud & cement for non structural work. There is future scope for the use of red mud concrete in structural point of view.

VII. Acknowledgements

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Table 1 Chemical composition of red mud.

Ingredients	**Red Mud In%**
Fe_2O_3	38.3
Al_2O_3	21.6
SiO_2	11.4
CaO	1.47
Na_2O	6.87

Table2 Compressive strength results

Red mud in varying percentage by the weight of cement	**28 days compressive strength (N/mm^2)**
Red Mud (5%)	50.91
Red Mud (10%)	47.65
Red Mud (15%)	43.65
Red Mud (20%)	40.74
Red Mud (25%)	**37.11**
Red Mud (30%)	35.00
Red Mud (35%)	32.00
Red Mud (40%)	27.74

Red mud in varying percentage by the weight of cement	**28 days Splitting Tensile Strength (N/mm^2)**
Red Mud (5%)	4.51
Red Mud (10%)	3.95
Red Mud (15%)	3.79
Red Mud (20%)	3.70
Red Mud (25%)	**3.67**
Red Mud (30%)	3.68
Red Mud (40%)	2.70

Table 3 splitting tensile strength results

Fig.1 Red mud powder.

Fig.2 Red mud concrete cubes.

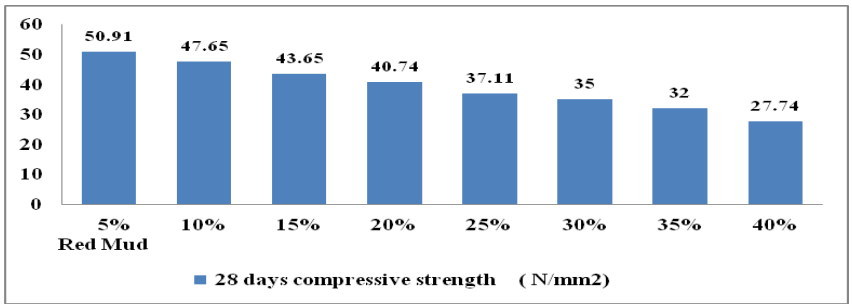

Fig.3 Percentage replacement of cement by red mud v/s 28days Compressive Strength

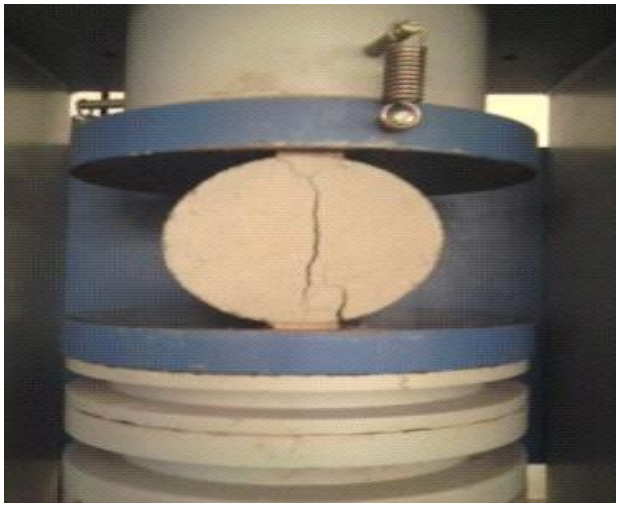

Fig.4 Set up and Failure of cylinder after loading

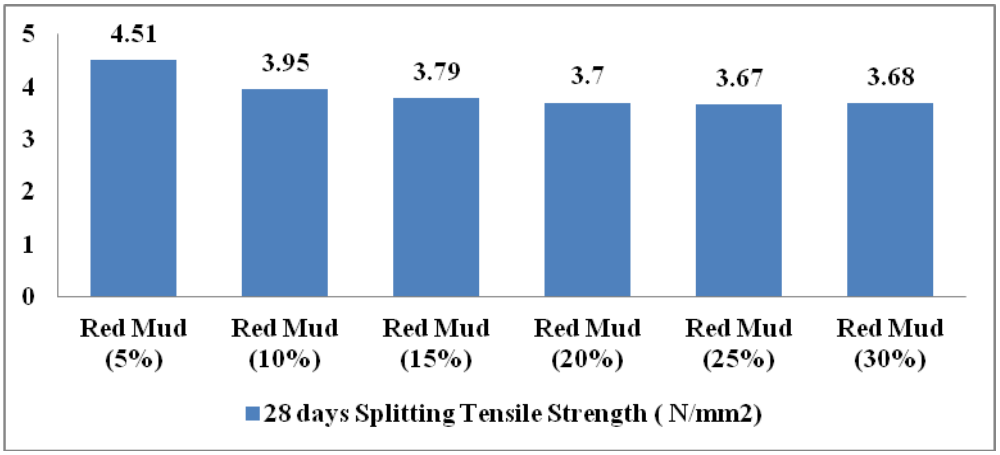

Fig.5 Percentage replacement of cement by red mud v/s 28days splitting Tensile Strength