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Strength Characteristics Study on Red Mud Concrete

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***Abstract*—In India and worldwide, varieties of wastes are generated in different forms, shape and texture. These industrial wastes mostly possess threat to the environment and the society living nearby. During the Bayer process for the production of aluminum oxide from bauxite ore large amount bauxite residues are produced which is known as red mud. It is generated by an average of 10 million tons per year. Disposal is a major problem for these industries as this is highly caustic and causes ground water contamination, leading to health hazards. By taking cementatious behavior of the red mud into account, an experiment was carried out to partially replace the cement by red mud in concrete for different percentages. The percentage replacements adopted in this study are 5%, 10%, 15%, 20% &25%. The untreated (without any neutralization) red mud is used. The compressive, tensile and flexural strength of red mud concrete have been compared with control specimens.**

***Index Terms*—Compressive Strength, Flexural Strength, Red Mud, Slump, Tensile strength**

I. Introduction

Red mud is a by-product of the Bayer process, which is used for the production of alumina from bauxite. Washed and crushed bauxite is treated with a solution of hydroxide at an elevated temperature and pressure. This process brings all the recoverable alumina from bauxite into solution and the residue known as red mud. For each part of alumina produced by this process, about one part of red mud is generally discarded as a waste. In Western countries, about 35 million tons of red mud are produced yearly. Due to its caustic nature, it poses a major environmental problem. Disposal of this waste was the first major problem encountered by the alumina industry after the adoption of the Bayer process. The conventional method of disposal of red mud in ponds has often adverse environmental impacts as during monsoons, the waste may be carried by run-off to the surface water courses and as a result of leaching may cause contamination of ground water: Further disposal of large quantities of Red mud dumped, poses increasing problems of storage occupying a lot of space.

In this paper the attempt is made to check the effectiveness of red mud at 5%,10%,15%,20%,25% over Portland cement by partial replacement of cement in concrete.

II. Objectives of the Study

The experiment was carried out to overcome the problems created due to huge requirement of the raw material for manufacturing of conventional building material and also to minimize hazards caused by Industrial waste on the environment.

Some other objectives are:

- The development of alternate low-cost and environment suitable building materials from industrial wastes is an economic way.
- Importance must be given to cheap and locally available building materials and hence it is necessary to check & utilize the suitable waste products to replace some of the conventional materials.
- Current demand of cement is far in excess of production and is rapidly increasing.

III. Materials Used

A. Cement

Cement is the most important constituent in a concrete mixture. The function of cement is first, to bind the sand and the coarse aggregate together and second, to fill the voids in between sand coarse aggregate particles to form a compact mass. For the present work, Ordinary Portland Cement (OPC) of 53 grade was used. The brand of cement used is Ramco cement.

B. Aggregates

The maximum size of coarse aggregate from stone crusher used for this investigation is 20 mm and specific gravity is 2.74. M Sand is used as fine aggregate in mix of having a nominal maximum size of 4.75 mm. The specific gravity of fine aggregate is 2.73.

C. Water

Fresh and clean water is used for casting and curing of specimen. The water is relatively free from organic matters, silt, oil, sugar, chloride and acidic material as per requirements of Indian standard. Combining water with a cementitious material forms a cement paste by the process of hydration. A cement paste glues the aggregate together fills voids within it, and

makes floor freely.

D. Red Mud

Red mud or red sludge is a waste product generated in the industrial production of aluminium. With about 10 million tons of this hazardous material produced annually, red mud is one of the most important disposal problems in the mining industry. Red mud is the iron rich residue from the digestion of bauxite. It is one of major solid waste coming from Bayer process of alumina production.

Chemical properties of red mud are shown in Table I it indicates that percentage of CaO is very less as compared to that of cement hence it has no cementitious properties but when it react with water and cements it starts gaining cementitious properties. Also Percentage of silica available, contributes to strength.

TABLE I
CHEMICAL COMPOSITION OF RED MUD

Ingredients	Red Mud (%)	Cement (%)
Fe_2O_3	38.3	3
Al_2O_3	21.6	6
SiO_2	11.4	22
CaO	1.47	63
Na_2O	6.87	0.5

TABLE II
PHYSICAL PROPERTIES OF MATERIALS

Material	Test results	Recommended value
Cement	Specific gravity=3.15	3.15 -3.1 [IS 4031- 1988]
	Standard consistency=34	30 – 36 % [269-1958]
	Initial setting time=40 minutes	>30 minutes [4031 - 1968.]
Fine aggregate	Specific gravity=2.6	2.6 – 2.8
	Uniformity coefficient=3.68	Cu <5 for well graded soil
Coarse aggregate	Specific gravity=2.74	2.6 – 2.8
	Uniformity coefficient=1.45	Cu <3 for uniform grade
Red mud	Specific gravity=3.15	
	Standard consistency=32	
	Initial setting time= 74 minutes	

TABLE III
MIX PROPORTION OF M30 CONCRETE

Grade of concrete	Mix proportion for 1 m^3			
	Cement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Water (kg)
M_{30}	479	751	1008	192

IV. RESULTS AND DISCUSSION

A. Workability Test

1) Slump test

The concrete slump test is an empirical test that measures the workability of fresh concrete. More specifically, it measures the consistency of the concrete in that specific batch. It is also used to determine consistency between individual batches. The test is popular due to the simplicity of apparatus used and simple procedure. Unfortunately, the simplicity of the test often allows a wide variability in the manner that the test is performed. The slump test is used to ensure the uniformity for different batches of similar concrete under field conditions, and to ascertain the effects of plasticizers on their introduction.

Fig. 1. Slump test

2) Compaction factor test

Compaction factor is the ratio of the weight of partially compacted concrete to the weight of the concrete when fully compacted in the same mould. The weight of partially compacted concrete in relation to its fully compacted state is a reasonably good indication of the workability of concrete.

Fig. 2. Compaction factor test

B. Compressive Strength Test

Mechanical test measuring the maximum amount of compressive load a material can bear before fracturing.

The compressive strength increases up to 20% replacement

with red mud. Beyond that compressive strength decreases.

Fig. 3. Compression testing machine

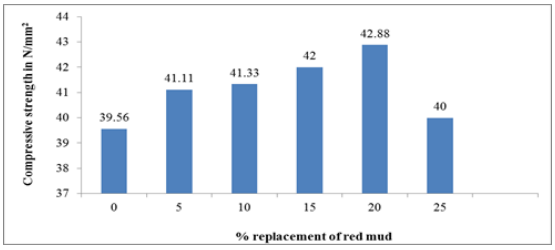

Fig. 4. Compressive strength at varying % replacement of red mud after 28 days curing

Maximum value is obtained as 42.88 N/mm^2 at 20 % replacement of red mud.

C. Splitting Tensile Test

Fig. 5. Splitting tensile test

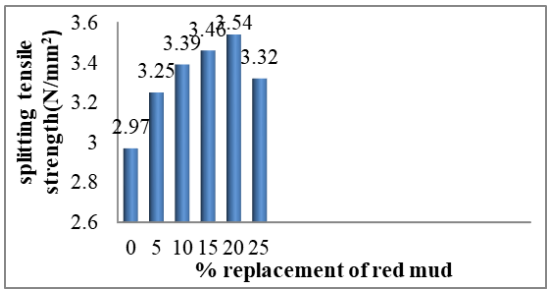

Fig. 6. Splitting tensile strength at varying % replacement of red mud after 28 days curing

The splitting tensile strength increases up to 20% replacement with red mud. Beyond that splitting tensile strength decreases. Maximum value is obtained as 3.54 N/mm^2 at 20 % replacement of red mud.

D. Flexural Strength Test

Fig. 7. Flexural testing machine

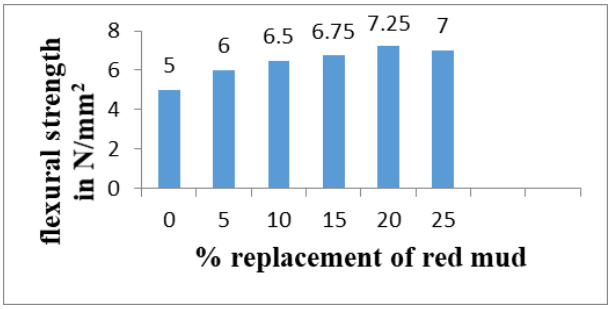

Fig. 8. Flexural strength at varying % replacement of red mud after 28 days curing

The flexural strength increases up to 20% replacement with red mud. Beyond that flexural strength decreases. Maximum value is obtained as 7.25 N/mm^2 at 20 % replacement of red mud

V. Conclusion

From this experimental study following points are concluded

- Physical properties of cement, sand, aggregate and red mud were checked by conducting various tests.
- The physical properties of materials conformed to IS specification.
- The properties of red mud seem to be similar to that of cement. So, cement can be replace by red mud in concrete
- The properties of red mud concrete in fresh and hardened state were tested.
- The compressive strength, split tensile strength and flexural strength of red mud concrete were tested by replacing cement by red mud in different proportions
- Maximum value of strength (compressive, splitting tensile & flexural) were obtained at 20% replacement of cement by red mud.
- At 25% replacement, the strength reduces.
- Used for road construction as an embankment landfill is an

attractive option with a high potential for large volume reuse.

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