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Original Research Article

STUDY ON BEHAVIOUR OF RED MUD WITH CEMENT IN CONCRETE

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Abstract—
This study aims at utilization of industrial by product for value added application. Red mud is a main waste generated in aluminum production by the Bayer process. Concrete cubes and mortars cubes were made by replacing cement with red mud in concrete 5%, 10% &15% respectively. The compressive strength, consistency and setting time tests were conducted for the above replacements. The study indicates that red mud can be used in mortars and concretes for nonstructural application.

Index Terms—Red mud, Industrial waste

Introduction

Red Mud is a waste product of the aluminum industry formed by washing and purifying bauxite (aluminum ore). It is pumped in slurry form into a disposal pond. Over a period of time, as the water partly seeps into the ground and partly evaporates forming red mud. The global production of bauxite in 2009 was 205 million tons, and the main producing countries were Australia, China, Brazil, Guinea, India, and Jamaica. Roughly 0.3–1.0 tons of red muds are generated for each ton of aluminum produced [1]. These works is aimed at utilizing this large amount of byproducts which is occupying large land and making them usable & also help solve the environmental problem. It was found that the amount of SiO_2 and Al_2O_3 in red mud to increase its cementitious activity. Also the hydration reaction of portland cement is catalyzed by highly alkaline environment, as in red mud [2].

Calcium aluminates are formed when calcium oxide react with the alumina in red mud. The strong calcium-silicate hydrates (C-S-H) are formed due to the hydration of calcium oxide which are well known to be responsible for the strength of cement mortars with high alumina content [3].

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Materials

Aggregate

River sand form the river cavery near tirchy confirming to zone III as per IS: 383-1970 was used as fine aggregate (F.A). Specific gravity of

TABLE 1
CHEMICAL ANALYSIS OF CEMENT IN %

Silicon di oxide SiO_2	21.56
Aluminium oxide Al_2O_3	5.39
Ferric oxide Fe_2O_3	3.39
Magnisium oxide Mgo	1.19
Calcium oxide CaO	65.5
Sulphur tri oxide SO_3	2.76
Loss of Ignition	1

fine aggregate was 2.65. Broken stones form the local quarry at Reddiarchattiram, near dindigul
confirming to table 2 of IS 383-1970 was used as coarse aggregate (C.A). Specific gravity of coarse aggregate was 2.69.

Cement

Cement used was Ordinary Portland Cement (OPC) supplied by Dalmia Cements. Specific gravity of cement was 3.13. Analysis of the cement is given in the Table 1.

Water

Water used in the concrete was ordinary portable water.

Red mud

Red mud is composed of elements like Fe_2O_3, Al_20_3, TiO_2, SiO_2, and Na_2O. However the composition percent varies accordingly depending upon the site location. The red mud got its colour due to its rich iron content. The red mud used was collected from MALCO Industries Salem. The chemical composition of the red mud in MALCO is listed in the table 2. The material was sun dried for 8 hours before use to remove moisture.

Concrete Mix proportion

Four different mix proportions were chosen for this study. A plane concrete with water cement ratio of 0.45 was used a control mix. In other three mixes 5%, 10%, 15% of cement is replaced by red mud in weight. The mix proportions are given in Table 3

Cement Mortar Mix proportion

Four different mix proportions were used for this study with the mix ratio of 1:4. A plane cement mortar mix with water cement ratio calculated form the relation, Water = (p/4+3.0) % of combined weight of cement and glass powder, where p is the water required for standard consistency

TABLE 2
CHEMICAL ANALYSIS OF RED MUD IN %

Ferric oxide Fe_2O_3	45.17
Aluminium oxide Al_2O_3	27
Titanium oxide TiO_2	5.12
Silicon di oxide SiO_2	6.74
Sodium Oxide Na_2O	8.09

Cement Mortar Mix proportion

The tests applied in this study to investigate the effect of utilizing red mud as cement
replacement on the properties of concrete are shown in Table 4.

Test Results and Discussion

Consistency Test

There is a small increase in the water demand when the replacement percentage was increased up to 10 % of replacement as shown in the Figure 1.

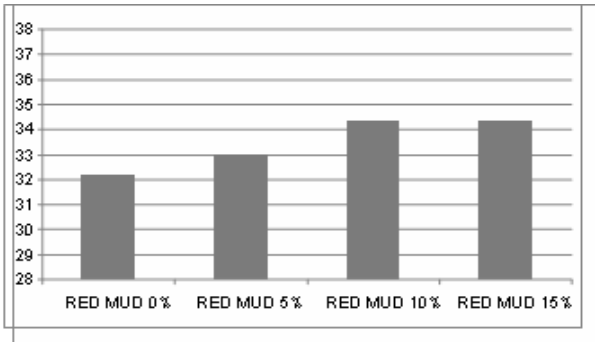

Fig 1.

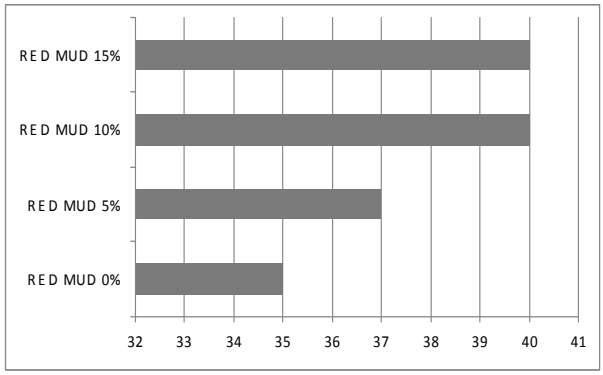

Fig:2

Setting time

When the relative amount of water was augmented to ensure equal consistency of composite containing higher mud contents the setting process was obviously decelerated because mortars with a larger amount of red mud were prepared with more water as seen in figure 2. The setting time was delayed in

TABLE 4

PLASTIC AND MECHANICAL PROPERTIES TESTS	
Plastic Properties	Standard consistency test
	Initial setting time
Mechanical Properties	Compressive strength of cement mortar
	Compressive strength of concrete cube

mortars containing 10% mud [4]. This behavior can be explained by the larger amount of water added.

This increased amount of water ensures that there is enough water to wet the compounds with large aluminum present in the mud, making the presence of the higher amount sodium, calcium effective. These elements, which are highly unsolvable, form a layer around the hydration particles of cement. This dense and insoluble wrapper noticeably reduces hydration by resisting the ionization rate, thus causing the occurrence of slow hardening of the paste [5].

Mortar Cubes

The cement replacement of 5% and 10% showed an increase in the relative amount of water was augmented to ensure equal consistency of composite containing higher mud contents the setting process was delayed. This affects the mechanical strength, the mechanical strength diminished with increasing levels of cement replacement after 10% replacement as seen in the figure 3, since red mud has limited hydraulic characteristics.

Concrete Cubes

In case of concrete cube there was a drastic reduction in the strength as seen the figure 4. These studies fail to identify the reasons leading to this behavior.

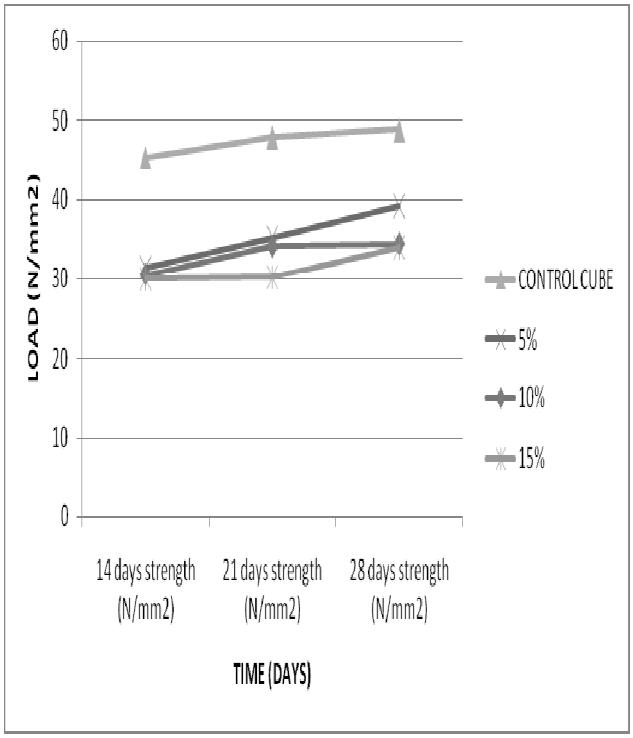

Fig: 3

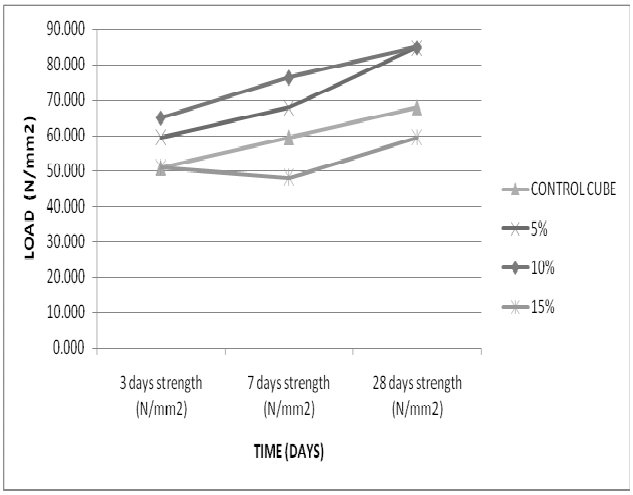

Fig: 4

Conclusion

Based on experimental observations, the following conclusions are drawn.

1. The results in this study recommend that red mud is an appealing material for use in mortars and concretes for nonstructural application.
2. The mechanical strength diminishes with increasing proportions of red mud in place of cement, up to 10%, substitution still show suitable strength for non-structural applications.
3. The concrete cubes made with cement replacements showed decrease in strength.
4. The colour of the concrete changes to red with increase in replacement.
5. Further investigation can be done by calcinating the red mud as the properties of the material change at high temperature.

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