

Advance Construction Material Red Mud: A Review

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Abstract

Red mud is a waste material produced at the aluminum refinery in whole world. It is generated in production of alumina from bauxite in the Bayer process. The production of red mud depends on the raw material processed, generally 1-2.5 tons of red mud is generated from 3-5 tons of bauxite to produce 1 ton of alumina. Most alumina refineries have the problem of disposal of red mud as it has high P^H and alkaline in nature. Red mud is disposed as dry or semi dry material in red mud pond or bauxite mines. Untreated red mud has such high P^H (Typically 11-13) that plant growth is impossible and this poses a very serious and alarming environmental problems. After many studies of research paper it has found that the red mud has cementitious properties which may use as cementitious material.

Keywords: Red Mud, Compressive Strength, Split Tensile Strength

1. Introduction

Red mud is a waste material generated by the Bayer Process which is widely used in the production of alumina from bauxite in the whole world. Disposal of red mud is not easy as it produced in large quantity and alkaline in nature. Red mud is directly disposed off on land or in pond which negatively affect environment. The aim of the present research work was to investigate the possibility utilization of red mud in construction industry. The use of industrial waste in place of conventional raw material will help to decrease the environmental pollution also conserve our natural resource. Red mud may also used for brick manufacturing, water treatment, concrete production, dam construction and road construction as an embankments landfill. Cement was partially replaced by red mud in concrete and workability and strength properties of concrete is determined.

Around 3 tons of bauxite produced 1 ton of alumina and around 2 tons of alumina produced 1 ton Aluminum. Production of 1 ton of alumina generated 1-2.5 tons of red mud which depend on the raw material used.

2. Production of Red Mud

Aluminium is the third most abundant element in the earth's crust which constitutes about 7.3% by mass. After steel aluminium is world's second most used metal. Now-a day the demand of aluminium products is gradually increased year by year because it has various benefits which make it unique from all. It can provide strength of steel when forming alloys, durability, flexibility, impermeability, lightweight, corrosion-resistant, recyclable and many other benefits. Metallic aluminium is not found in

nature, it produced from bauxite which occurs in the form of hydrated oxides or silicates (clays) with various mixture of silica, iron oxide titania, aluminium silicates and other impurities in minor or trace amounts. The primary aluminium is produced from bauxite through two steps. In the first step alumina is produced by wet chemical, caustic leach method (Bayer process). In the second step aluminium is produced from alumina by Hall-Heroult process. Red bauxite sludge or residue is produced in the Bayer process as a by-product called red mud. Bauxite residue contains iron oxide upto 60% which make it red. Approximately 90 million tons of red mud being produced globally every year. It has been estimated that the world production of bauxite was at 248 million tonnes in 2012 and in India the production of bauxite was at 12,877 thousand tonnes in 2012-13 increased marginally as compared to the previous year.

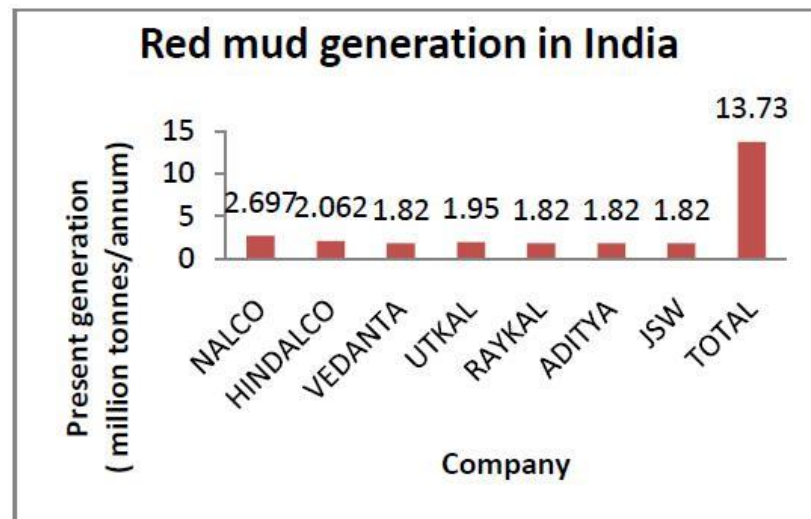


Fig: 1 Generation of red mud in India, Source [1]

Table 1 Bauxite Production in different countries, Source [1]

Country	Mine production (X10 ⁶ tons)		Reserves(X10 ⁶ tons)
	2013	2014	
Australia	81.1	81.0	6.50
Brazil	32.5	32.5	2.60
China	46.0	47.0	0.83
Greece	2.1	2.1	0.60
Guinea	18.8	19.3	7.40
Guyana	1.71	1.8	0.85
India	15.4	19.0	0.54
Indonesia	55.7	0.5	1.00
Jamaica	9.44	9.8	2.00
Kazakhstan	5.44	5.5	0.16
Russia	5.32	5.3	0.20

Suriname	2.7	2.7	0.58
Venezuela	2.16	2.20	0.32
Vietnam	0.25	1.00	2.10
Other	4.57	4.76	2.40
World total	283.00	234.0	28.00

Properties of Red Mud

The physical properties of red mud shown in table

Table 2 Physical properties of red mud, Source [2]

Property	Value
Fineness	1000-3000 cm ² /gm
P _H	10.5 to 12.5 (Alkaline)
Specific gravity	2.51

Chemical properties of red mud

Chemical properties of red mud are shown in Table -1. Red mud has no cementitious properties but when mixed with cement and water it shows cementitious properties. Presence of silica improve strength properties of red mud .

Table 3 Red mud chemical composition, Source [3]

Composition	Percentage
Fe ₂ O ₃	30% - 60%
Al ₂ O ₃	10% - 20%
SiO ₂	10% - 20%
Na ₂ O	2% - 10%
CaO	2% - 8%
TiO ₂	Trace - 25%

Table 4 Chemical composition of Indian red muds, Source [3]

Company	Al ₂ O ₃ %	Fe ₂ O ₃ %	SiO ₂ %	TiO ₂ %	Na ₂ O %	CaO %	LOI %
BALCO, Korba	18-21	35-37	6-7	17-19	5-6	2-3	11-14
HINDALCO, Renukoot	17-19	35-36	7-9	14-16	5-6	3-5	10-12
HINDALCO, Muri	19-21	44-46	5-7	17-19	3-4	1-2	12-14
HINDALCO, Belgum	17-20	44-47	7-9	8-11	3-5	1-3	10-14
NALCO, Metturdam	18-22	40-46	12-16	3-4	4-5	1-3	11-15
NALCO, Damonjodi	17-20	48-54	4-6	3-4	3-5	1-2	10-14

LITERATURE SURVEY

Mahin Sha O B and his companions studied on RED MUD CONCRETE. In this research work partial replacement of Portland cement by red mud is carried out 5% to 25% of Portland cement at an interval of 5% in concrete. The workability of concrete increases with increasing the percent of red mud and 20% partial replacement of cement by red mud is optimum dose, Source [4].

Mr. Ramesh R.Rathod and his companions studied on Evaluation of the properties of Red Mud Concrete. Partial replacement of Portland cement was carried out up to 40 % Red Mud by weight of cement at an interval of 5%. Strength properties are evaluated by performing compressive strength and splitting tensile strength test on concrete casted for each replacement after curing of 28 days. Compressive and tensile strength of concrete decreases as increase in red mud content. 25% replacement of cement by red mud is optimum percentage at this replacement results are nearly equal to the results of controlled concrete, Source [5].

D Linora metilda and his companions studied on finding Optimum Possibility of partial replacement of cement by red mud in concrete. The objective of the research is to find out the possibility of partial replacement of Portland cement by red mud in concrete and evaluating its compressive and splitting tensile strength. This study examine the effect of red mud on the properties of hardened concrete and compare with conventional concrete. The test result show that 15% of cement can be optimally replaced by red mud beyond which compressive strength, split tensile and flexural strength start decreasing.

Experimental work

The aim of present study is to determine the possibility of utilization of red mud in construction. Several experimental works are carried out to investigate workability and strength parameters of red mud concrete produced by replacing cement with red mud. The work study conducted is laboratory oriented. The materials such as red mud, lime, cement, fine aggregate, coarse aggregate and super plasticizers are used in experimental work. The materials are collected and the properties of material are studied as per standards mentioned in IS codes. Mix design is done for several grade of concrete as per IS 10262:2009. Cubes and cylinders were casted and various tests such as slump cone test and compaction factor test are used to find out workability and Compression Test, Split Tensile Test and Flexural Test are used to find out strength properties. Production of concrete cubes of size 150mm x 150 mm, beams and cylinders of 150mm diameter and 300 mm length to determine the respective specimens. The samples will be tested at 7 and 28 days age of different proportions of red mud with or without hydrated lime.

Result and Discussion

Following are the results of various experimental works carried out on red mud concrete. The chemical composition and characteristics of red mud is vary according to place. So that there is variation in test results.

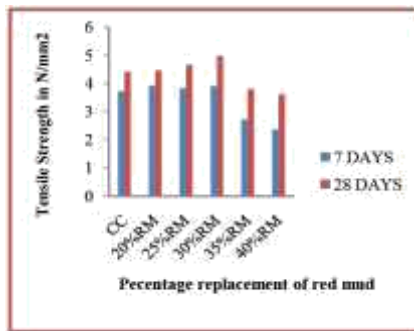


Fig: 2 Results of tensile strength test, Source [4]

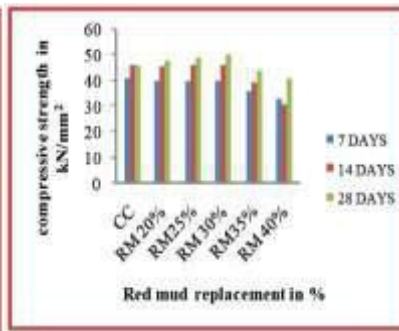


Fig: 3 Results of Compressive strength test, Source [4]

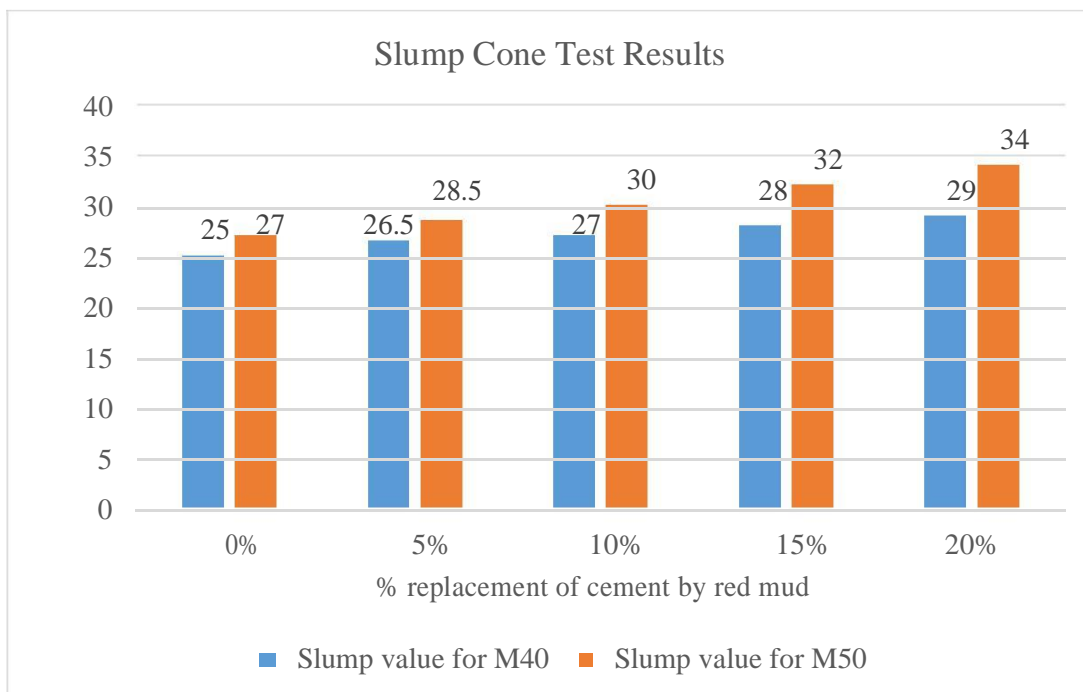


Fig: 4 Results of Slump cone test, Source [2]

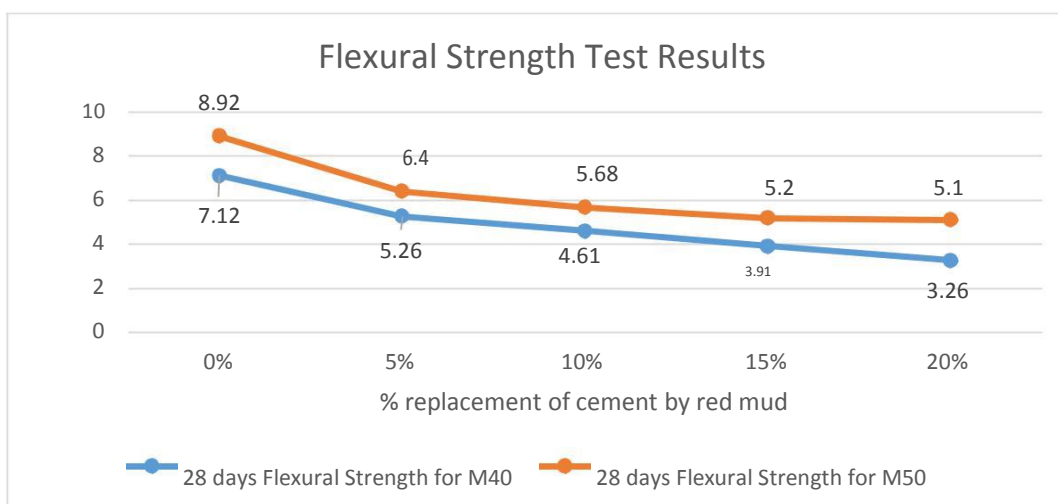


Fig: 5 Results of Flexural strength test result, Source [2]

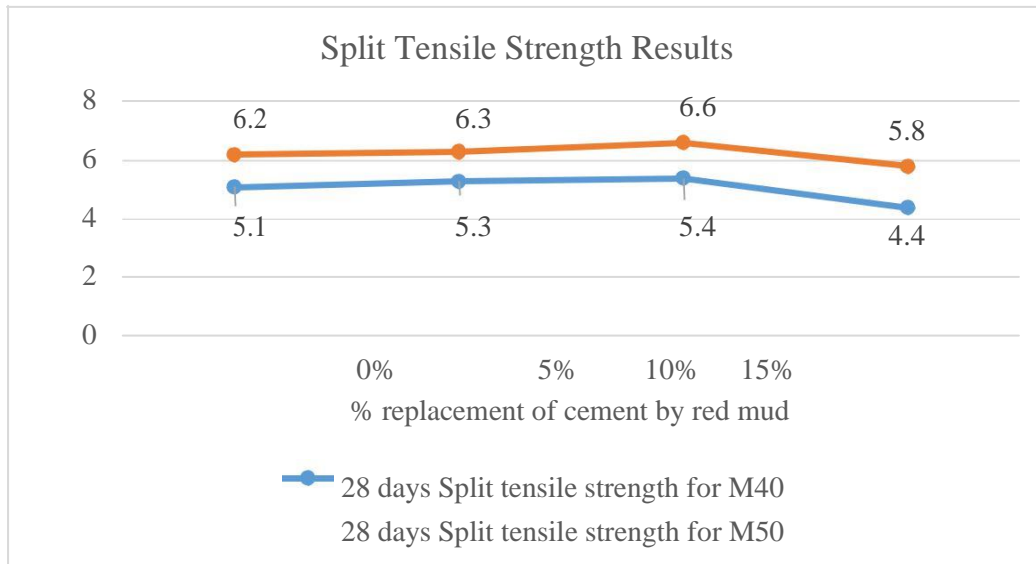


Fig: 6 Results of split tensile strength, Source [2]

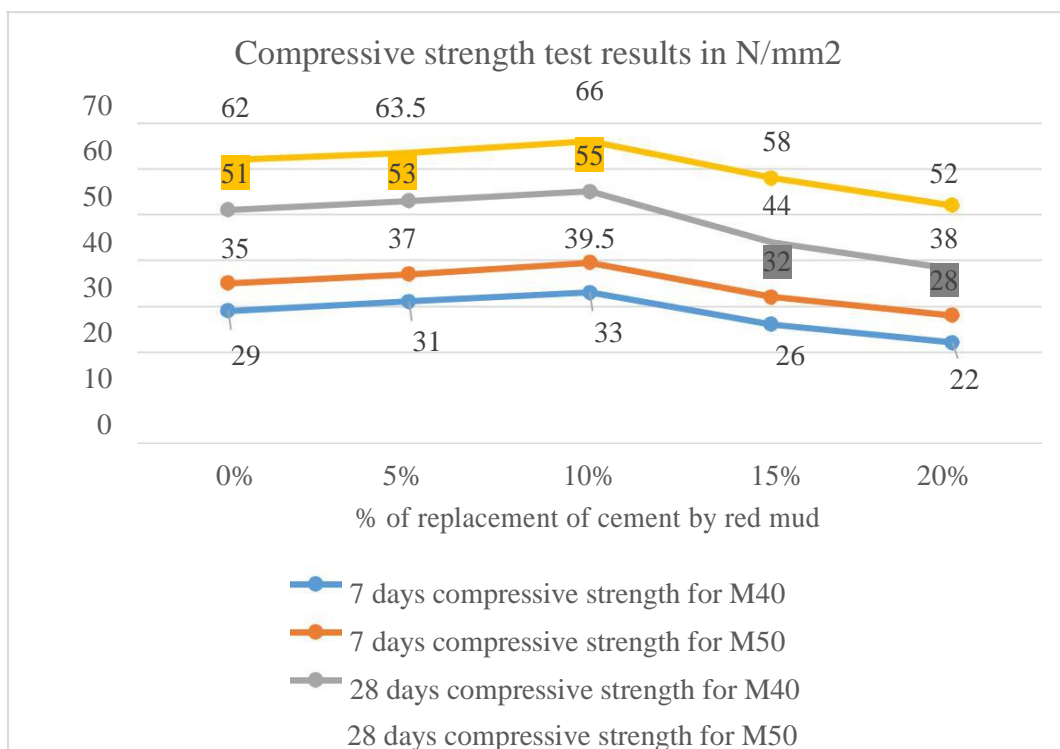


Fig: 7 Results of compressive strength, Source [2]

Conclusion

From this review the following conclusions are:

The slump value is increasing with increase in the percentage of red mud in concrete. Due to increase in the red mud leads to decrease in the quantity of cement results in increase in the workability of concrete.

For a good grade of bauxite the strength properties of concrete increased as increase in red mud percentage. But for a lower grade of bauxite strength properties are increased upto 10 % replacement.

Future Scope

The review will help to find out the effect of addition and replacement of cement by industrial waste which provide reuse of industrial waste in concrete mix and help in reducing amount of industrial waste for disposal. It also help in producing cheap concrete.

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